2021 New Jersey Air Quality Report

New Jersey Department of Environmental Protection

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https://nj.gov/dep/airmon/

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Photo: Secaucus, NJ, sunrise; 1/8/2021. Taken by Luana Diaz

Executive Summary

This report presents the New Jersey Department of Environmental Protection (NJDEP) air quality data for 2021, collected from NJDEP's extensive air monitoring network. The state of New Jersey has been monitoring air quality since 1965. During that time, as a result of state, regional and national air pollution reduction efforts, pollution levels have improved significantly.

In 2021, New Jersey had exceedances of the ozone and fine particulate matter ($PM_{2.5}$) National Ambient Air Quality Standards (NAAQS). Ozone pollution in New Jersey tends to be a seasonal problem, since it is formed in the presence of sunlight from other pollutants such as volatile organic compounds and nitrogen oxides. Particulate matter levels in New Jersey are usually good to moderate, but in July 2021 wildfires in the western United States and Canada contributed to high levels across the northeastern U.S.

What's in the Annual Air Quality Report

This report includes detailed chapters for ozone, particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide and lead. These are the criteria pollutants, that is, those for which National Ambient Air Quality Standards (NAAQS), or criteria, have been set. Other measurements made at our air monitoring stations and discussed in this report include air toxics, ozone precursors, and chemical components of airborne fine particles.

The chapter on the Air Quality Index (AQI) describes a national air quality rating system based on the NAAQS, and discusses the overall quality of New Jersey's air in 2021. Included is a detailed list of the fifteen days on which the AQI was over 100. This means that the NAAQS were exceeded, and the days were classified as "Unhealthy for Sensitive Groups" or, in one instance, "Unhealthy."

Figures 1-1 through 1-6 below illustrate the downward trends in concentrations of criteria pollutants in New Jersey over the past few decades by graphing the statewide design values for each pollutant. A design value is the actual statistic that is compared to a NAAQS. If this value exceeds the NAAQS at any site in the state, the state is determined to be in nonattainment. Design values for each of the criteria pollutants are described in detail in each pollutant-specific chapter of this report.

New Jersey is getting close to meeting the ozone NAAQS (Figure 1-1), and will continue to implement control strategies to reduce ambient concentrations. Because ozone is formed in the presence of sunlight and high temperatures, the highest levels occur in the summer months. Ozone has been found to have serious health effects at lower levels than previously thought. In response, the United States Environmental Protection Agency (USEPA) periodically revises and lowers the NAAQS. USEPA lowered the ozone standard to 0.070 ppm in 2015 (effective in 2016).

Particulate air pollution less than 2.5 micrometers in diameter is referred to as fine particulate or $PM_{2.5}$. These small particles can be inhaled deep into the lungs, and are known to have a greater impact on public health than larger particles, which were the focus of the earliest ambient air quality standards. Even though in 2021 there were two days on which the 24-hour $PM_{2.5}$ NAAQS was exceeded, monitoring data in New Jersey shows a steady decline in overall $PM_{2.5}$ levels, which are now in compliance with the NAAQS (Figure 1-2).

Nitrogen dioxide (NO_2) is a reactive gas emitted primarily from motor vehicles. It is known to cause serious health problems, especially for sensitive individuals such as children, the elderly, and people with asthma. New Jersey has long been in compliance with the NAAQS for NO_2 (Figure 1-3).

The sharp increase and subsequent decrease in sulfur dioxide (SO_2) concentrations in New Jersey shown in Figure 1-4 are attributable to a coal-burning facility across the Delaware River in Pennsylvania. NJDEP established the Columbia monitoring station in 2010 to determine the facility's impact on New Jersey's air quality. Exceedances of the SO_2 NAAQS were recorded that same year. Since the plant ceased operations under a court agreement, SO_2 levels in New Jersey have again dropped below the standard.

Outdoor concentrations of carbon monoxide can affect people with cardiovascular problems. Levels in New Jersey have been below the NAAQS for over twenty-five years (Figure 1-5).

Air concentrations of lead have dropped dramatically since a standard was established in 1978. The phase-out of leaded gasoline and removal of lead from paint and other products have had a measurable impact. The last exceedances of the NAAQS were in the early 1980s (Figure 1-6).

The Bureau of Air Monitoring website can be found at https://nj.gov/dep/airmon. Available information includes a table and map of current air quality readings, the daily air quality forecast, annual reports, trend graphs, and other data.

Figure 1-1
Statewide New Jersey Ozone Trend, 1997-2021
3-Year Average of 4th-Highest Daily Maximum 8-Hour Average Concentrations
Parts per Million (ppm)

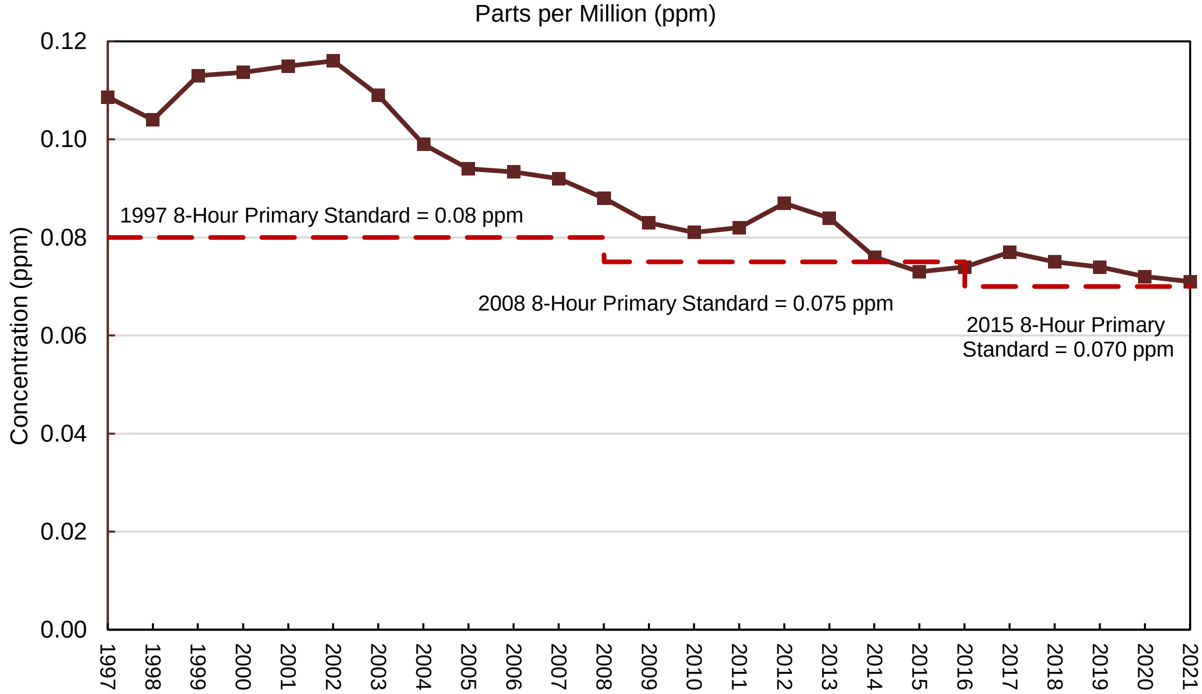


Figure 1-2
Statewide New Jersey Fine Particulate ($PM_{2.5}$) Trend, 2001-2021
3-Year Average of the Highest Annual Average Concentrations
Micrograms per Cubic Meter (µg/m³)

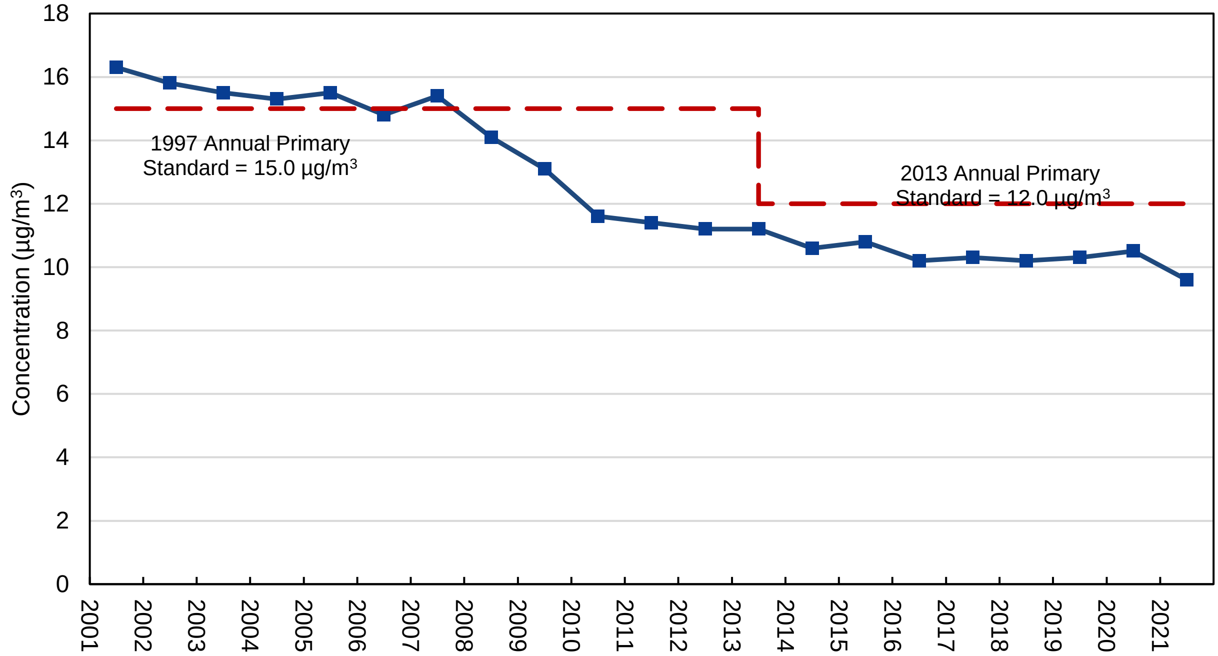


Figure 1-3
Statewide New Jersey Nitrogen Dioxide (NO_2) Trend, 2000-2021
3-Year Average of the 98th Percentile Daily Maximum 1-Hour Average Concentrations
Parts per Billion (ppb)

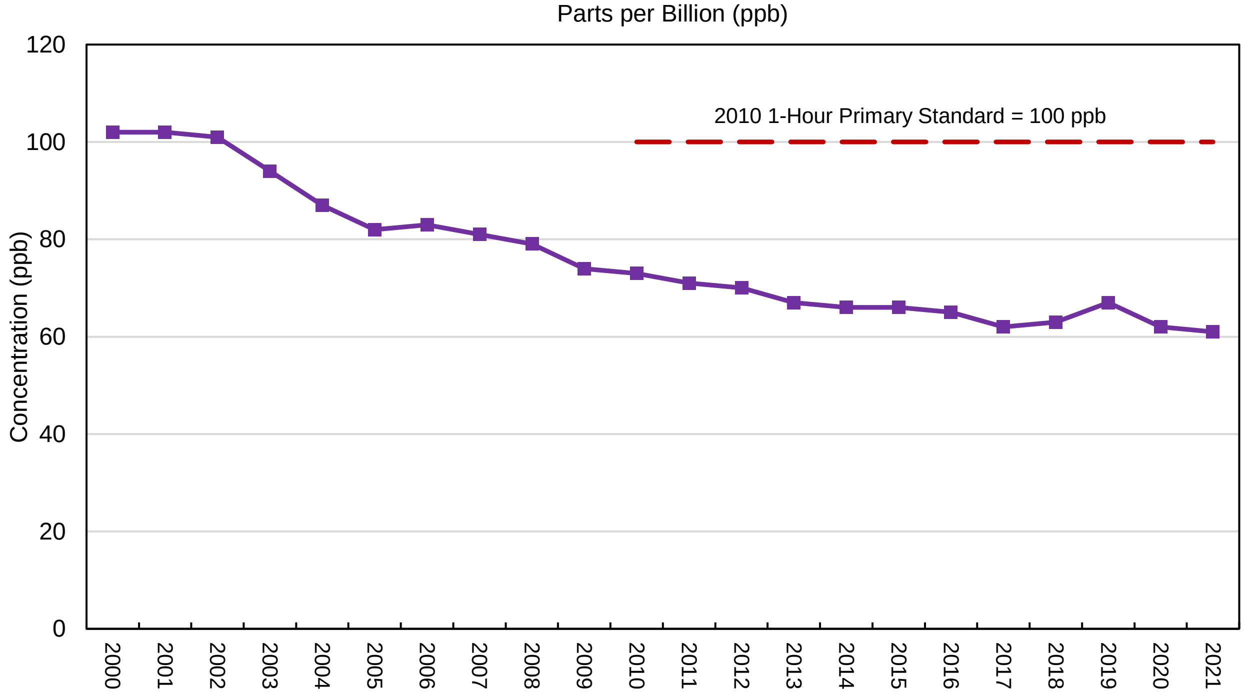


Figure 1-4
Statewide New Jersey Sulfur Dioxide (SO_2) Trend, 2000-2021
3-Year Average of the 99th-Percentile of Daily Maximum 1-Hour Average Concentrations
Parts per Billion (ppb)

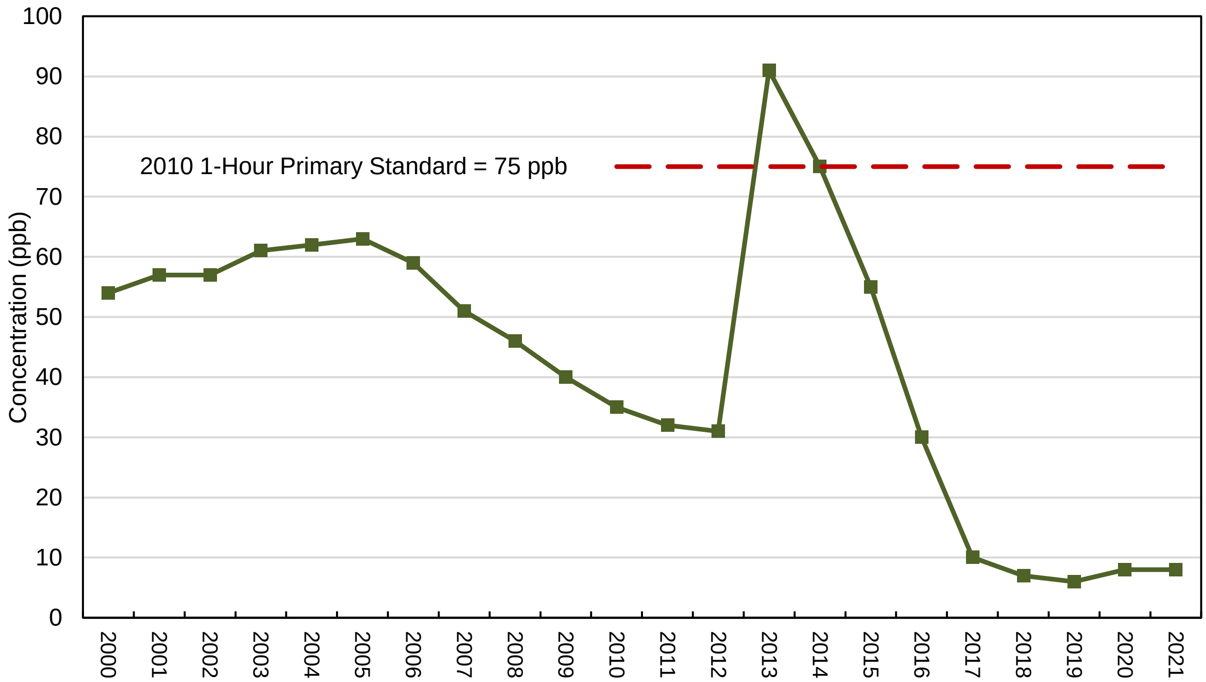


Figure 1-5
Statewide New Jersey Carbon Monoxide (CO) Trend, 1990-2021
2nd-Highest 8-Hour Average Concentrations
Parts per Million (ppm)

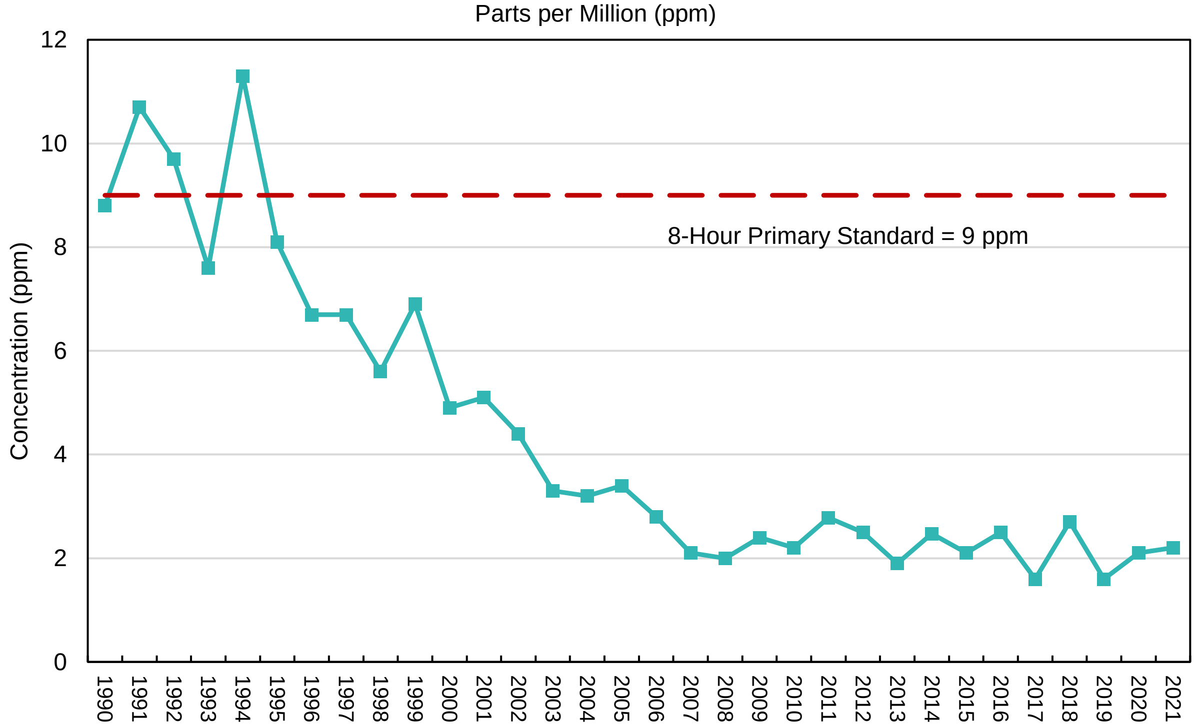
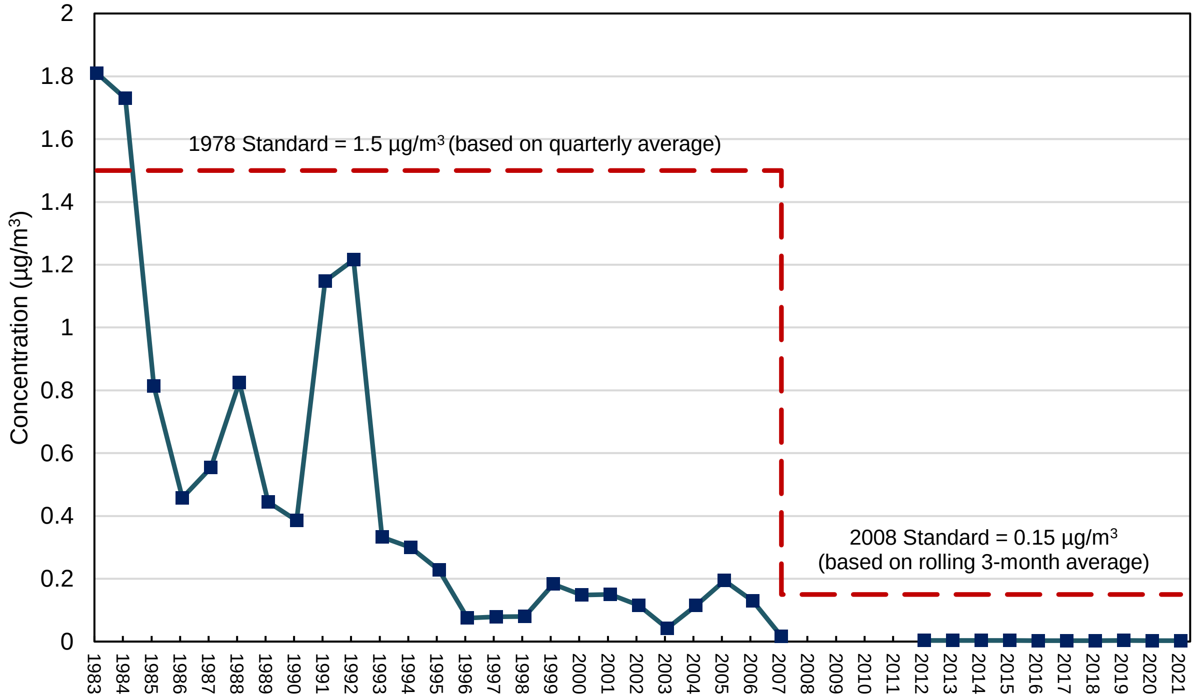


Figure 1-6
Statewide New Jersey Lead Trend, 1983-2021
Highest 3-Month Averages
Micrograms per Cubic Meter (µg/m³)



2021 Air Monitoring Network

New Jersey Department of Environmental Protection

Network Description

In 2021 the New Jersey Department of Environmental Protection (NJDEP) Bureau of Air Monitoring (BAM) operated 30 ambient air monitoring stations around the state. The monitoring stations vary in the number and type of monitors at each site. New Jersey's air monitoring program is primarily focused on the measurement of pollutants for which National Ambient Air Quality Standards (NAAQS) have been established, also known as criteria pollutants. Criteria pollutant monitoring is regulated by the United States Environmental Protection Agency (USEPA), which prescribes the design and siting of the monitoring networks, the acceptable monitoring methods, and the minimum quality assurance activities. Only data which meet USEPA requirements can be used to determine compliance with the NAAQS. There are six criteria air pollutants: ozone (O_3), particulate matter (PM), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), and lead (Pb). Because particulate matter includes a wide range of contaminants, there are separate NAAQS for two different size fractions of particles. There are NAAQS for fine particles, less than 2.5 microns in size, also referred to as $PM_{2.5}$ (1 micron = one millionth of a meter), and another NAAQS for inhalable particles, less than 10 microns in size, referred to as PM_{10}.

Criteria Pollutants

In New Jersey, O_3, NO_2, SO_2 and CO are measured using USEPA-approved real-time monitoring methods, and data for these pollutants are continuously transmitted to a central data acquisition system. Once an hour, the Bureau of Air Monitoring posts this air quality data to its website (https://nj.gov/dep/airmon) and to the USEPA's Air Now website (www.airnow.gov). Data is subsequently reviewed and certified, and is available from USEPA's Air Quality Database at https://www.epa.gov/outdoor-air-quality-data.

$PM_{2.5}$ is measured with both 24-hour filter-based samplers and real-time continuous monitors. Filters must be installed and removed manually, and brought to the BAM lab to be weighed and analyzed. A filter-based sampler is also used to determine lead and PM_{10} concentrations. NJDEP is gradually replacing many of its filter-based $PM_{2.5}$ samplers with real-time samplers, so that the current air quality from those sites can be reported on the BAM website, and to reduce the manpower and time needed to obtain the data.

In New Jersey, USEPA's National Core Multipollutant Monitoring Network (NCore) is represented by the Newark Firehouse monitoring station. NCore is a program that integrates several advanced measurement systems for gaseous pollutants, particles, and meteorology. This includes total reactive oxides of nitrogen, NO_y.

Establishment of "near road" stations were required as part of the 2010 revisions to the NO_2 NAAQS. The Fort Lee Near Road monitoring station was established to comply with these requirements, for NO_2 and other monitors in large urban areas with high vehicular traffic. These stations, located within 50 meters of a major roadway where peak hourly NO_2 concentrations are expected to occur, measure the relative worst-case population exposures that could occur in the near-road environment.

Other Pollutants

Along with criteria pollutants, the NJDEP also measures "non-criteria pollutants," or pollutants that do not have health-based National Ambient Air Quality Standards. Certain non-criteria pollutants are grouped together by their purpose or collection method.

The Rutgers University monitoring site is part of USEPA's Photochemical Assessment Monitoring Station (PAMS) Program. PAMS measures non-criteria pollutants that are important in the formation of ozone. Since most ozone is not directly emitted from sources but forms in the atmosphere when volatile organic compounds and oxides of nitrogen react in the presence of sunlight, it is important to know the levels of these "precursor" pollutants. In addition, PAMS requires monitoring of NO_y, as well as various meteorological parameters.

Other non-criteria pollutants monitored by BAM include some commonly emitted by motor vehicles and other combustion sources: benzene, toluene, ethylbenzene, xylenes (measured with a "BTEX" analyzer), and black carbon (measured with an aethalometer).

Five air monitoring stations collect samples of $PM_{2.5}$ that are analyzed to determine the chemical makeup of the particles. These are part of USEPA's Chemical Speciation Network (CSN). This data is used in helping to identify the primary sources of particles, and in assessing potential health effects.

Volatile organic compounds (VOCs) are collected and analyzed at four monitoring sites. These non-criteria pollutants are classified as "air toxics," pollutants that have potential health effects but for which NAAQS have not been established. They can be carcinogenic or have other serious health effects, and are very diverse in their chemical composition.

Two sites, Cattus Island and Washington Crossing, are part of the National Atmospheric Deposition Network. BAM staff collect precipitation samples and ship them to a national laboratory for analysis of acids, nutrients, and base cations.

A number of sites within the air monitoring network also take measurements of meteorological parameters, such as temperature, relative humidity, barometric pressure, wind speed, wind direction, rain, and solar radiation.

Figure 2-1 shows the Clarksboro monitoring station in Gloucester County. It measures ozone and $PM_{2.5}$.

Figure 2-1
Clarksboro Air Monitoring Station

CHANGES TO THE NETWORK IN 2021

The only change made to New Jersey's air monitoring network in 2021 involved replacing the $PM_{2.5}$ filter-based monitor at the Trenton monitoring station with a continuous $PM_{2.5}$ monitor. BAM plans to replace more of the filter-based $PM_{2.5}$ monitors. This will allow the collection of 1-hour data in real time, which can be displayed on BAM's air quality website.

A few $PM_{2.5}$ filter-based monitors remained inaccessible in 2021 for reasons related to Covid-19 shutdowns. This is discussed in the Particulate Matter section.

The locations of all the monitoring stations that operated in 2021 are displayed on the map in Figure 2-2. Table 2-1 lists the parameters that were measured at each site. More information about the monitoring stations can be found in Appendix A.

Figure 2-2
New Jersey Air Monitoring Sites in 2021

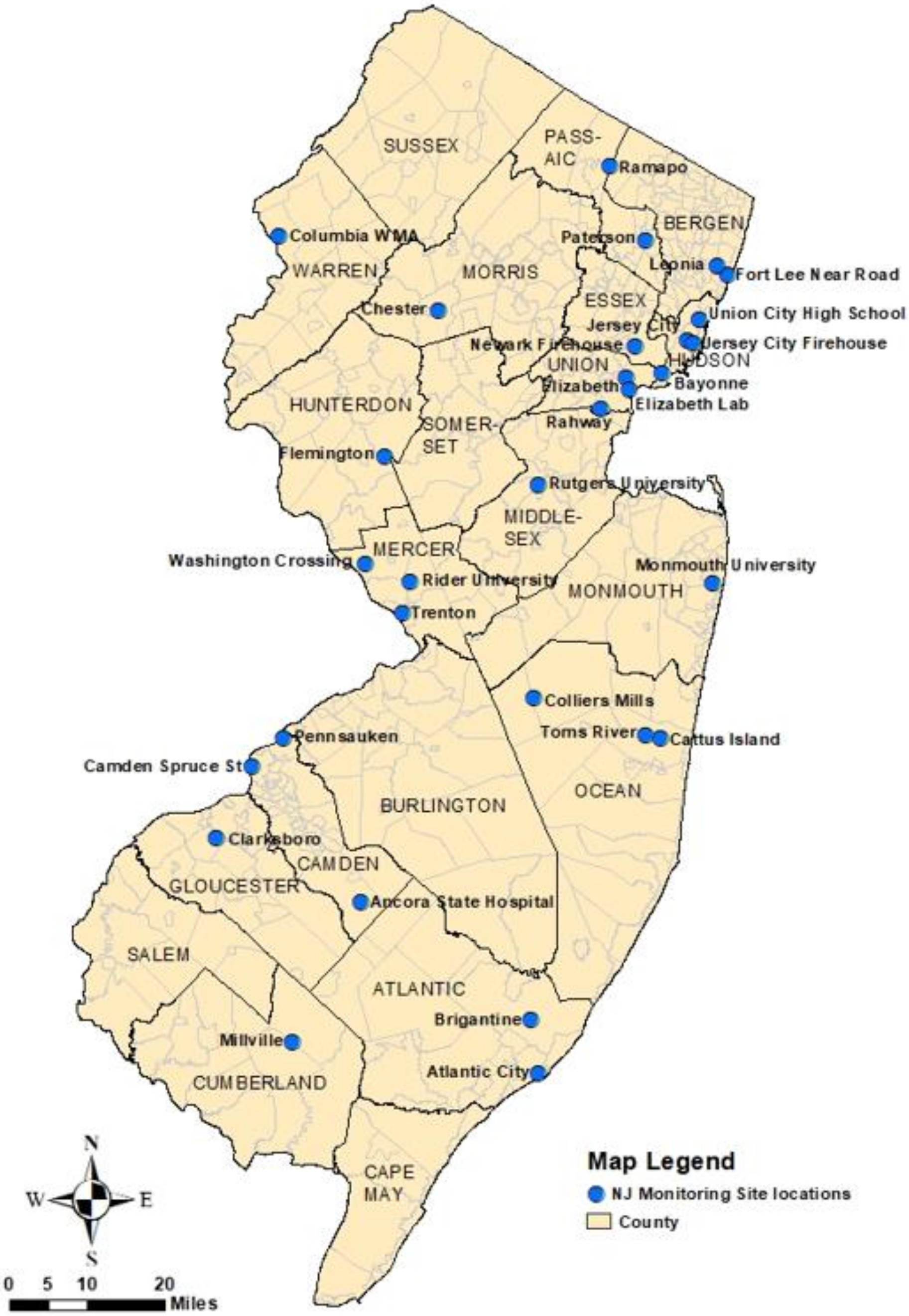


Table 2-1
2021 New Jersey Air Monitoring Network Parameters

	Monitoring Station \ Monitoring Parameter	O_3	$PM_{2.5}$ (Filter-based)	Real-Time $PM_{2.5}$	PM_{10}	NO_2	NOy	SO_2	CO	Lead	Toxics	$PM_{2.5}$-Speciation	O_3 Precursors (PAMS)	BTEX & Black Carbon	Visibility	Acid Deposition	Mercury	Meteorological[a]	Solar Radiation
1	Ancora State Hospital	X																	
2	Atlantic City		X																
3	Bayonne	X				X		X						X				X	
4	Brigantine	X	X	X				X							X	X			
5	Camden Spruce Street	X	X	X	X	X		X	X		X	X		X				X	
6	Cattus Island															X			
7	Chester	X	X			X		X			X	X							
8	Clarksboro	X	X																
9	Colliers Mills	X																	
10	Columbia	X		X		X		X										X	
11	Elizabeth							X	X										
12	Elizabeth Lab		X	X		X		X	X		X	X		X			X	X	
13	Flemington	X		X														X	
14	Fort Lee Near Road			X		X			X					X				X	
15	Jersey City					X		X	X										
16	Jersey City Firehouse		X	X	X														
17	Leonia	X																	
18	Millville	X		X		X													
19	Monmouth University	X																	
20	Newark Firehouse	X	X	X	X	X	X	X	X	X		X		X				X	X
21	Paterson		X*																
22	Pennsauken		X																
23	Rahway			X															
24	Ramapo	X																	
25	Rider University	X		X														X	
26	Rutgers University	X	X	X		X	X				X	X	X				X	X	X
27	Toms River		X	X															
28	Trenton		X*	X															
29	Union City High School		X*																
30	Washington Crossing															X			
	TOTAL	16	14	14	3	10	2	9	6	1	4	5	1	5	1	3	2	9	2

X - Parameter measured in 2021.
*Did not operate in 2021.
NO_2 usually includes NO and NO_x.
a - Meteorological parameters include temperature, relative humidity, barometric pressure, wind direction & wind speed.

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2021 Air Quality Index

New Jersey Department of Environmental Protection

What is the Air Quality Index (AQI)?

The Air Quality Index (AQI) is a national air quality rating system based on the National Ambient Air Quality Standards (NAAQS). An index value of 100 is equal to the primary, or health-based, NAAQS for each pollutant. This allows for a comparison of each of the pollutants used in the AQI. These pollutants are ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide. Although air concentrations of pollutants have been dropping over the past few years, the U.S. Environmental Protection Agency (USEPA) periodically reviews the NAAQS to make sure that they are protective of public health, and adjusts them accordingly in response to new research. The latest NAAQS revision, for ozone, occurred in October 2015.

Every morning an air pollution forecast for the current and following day is prepared by the New Jersey Department of Environmental Protection (NJDEP) using the AQI format. The forecast is provided to USEPA and is disseminated through the Enviroflash system to subscribers who sign up to receive air quality forecast and alert emails or texts (www.enviroflash.info). Anyone can view the forecast and current air quality conditions at USEPA's AirNow website (www.airnow.gov) or at NJDEP's air monitoring webpage (https://nj.gov/dep/airmon).

In an effort to make the AQI easier to understand, a color code and descriptive interpretation are assigned to the numerical ratings (see Table 3-1). Table 3-2 contains suggested actions to take to protect public health for different AQI levels. For more information on the AQI, visit EPA's web site at www.airnow.gov.

Table 3-1
Air Quality Index Levels and Associated Health Impacts

AQI Level of Health Concern	*Numerical Value*	*Meaning*	*Color Code*
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk.	**Green**
Moderate	51 to 100	Air quality is acceptable; 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.	**Yellow**
Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.	**Orange**
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.	**Red**
Very Unhealthy	201 to 300	Health warnings of emergency conditions. The entire population is more likely to be affected.	**Purple**
Hazardous	301 to 500	Health alert: everyone may experience more serious health effects.	**Maroon**

Table 3-2
AQI Suggested Actions to Protect Health

Air Quality Index Level	AQI Value Actions to Protect Your Health
Good (1-50)	None
Moderate (51-100)	Unusually sensitive individuals should consider limiting prolonged outdoor exertion.
Unhealthy for Sensitive Groups (101-150)	Children, active adults, and people with respiratory disease such as asthma should limit prolonged outdoor exertion.
Unhealthy (151-200)	Children, active adults, and people with respiratory disease such as asthma should avoid prolonged outdoor exertion: Everyone else should limit prolonged outdoor exertion.
Very Unhealthy (201-300)	Children, active adults, and people with respiratory disease such as asthma should avoid outdoor exertion. Everyone else should limit outdoor exertion.
Hazardous (301-500)	Everyone should avoid all physical activity outdoors.

Table 3-3 shows the pollutant-specific ranges for the AQI categories. These are set according to the corresponding NAAQS.

Table 3-3
AQI Pollutant-Specific Ranges

Category	AQI Level	O_3	$PM_{2.5}$	NO_2	SO_2	CO
		(ppm) 8-hour	(µg/m³) 24-hour	(ppb) 1-hour	(ppb) 1-hour	(ppm) 8-hour
Good	0-50	0.000-0.054	0.0-12.0	0-53	0-35	0.0-4.4
Moderate	51-100	0.055-0.070	12.1-35.4	54-100	36-75	4.5-9.4
Unhealthy for Sensitive Groups	101-150	0.071-0.085	35.5-55.4	101-.360	76-185	9.5-12.4
Unhealthy	151- 200	0.086-0.105	55.5-150.4	361-649	186-304	12.5-15.4
Very Unhealthy	201-300	0.106-0.200	150.5-250.4	605-1249	305-604	15.5-30.4
Hazardous	301-500	>0.200	250.5-500.4	1250-2049	605-1004	30.5-1004

Pollutants:
O_3 – Ozone
$PM_{2.5}$ – Fine particulate matter
NO_2 – Nitrogen dioxide
SO_2 – Sulfur dioxide
CO – Carbon monoxide

Units:
ppm – parts per million
µg/m³ – micrograms per cubic meter
ppb – parts per billion

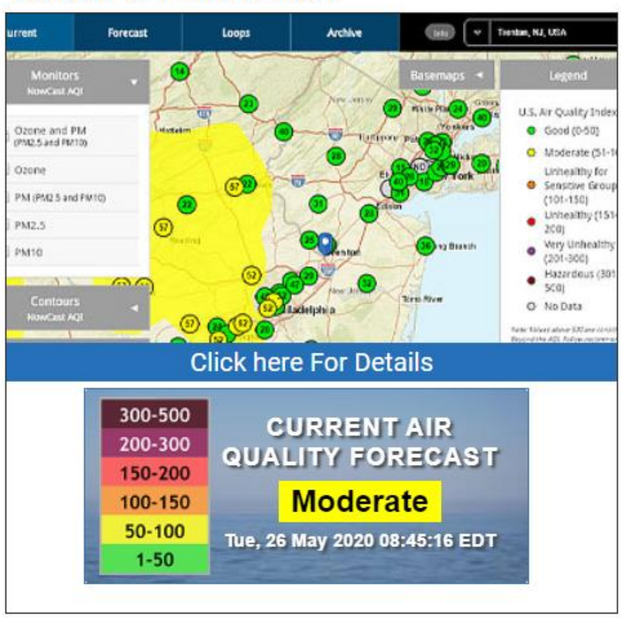
On days when the air quality is expected to reach the “Unhealthy for Sensitive Groups” range or above, cautionary statements similar to those in Tables 3-1 and 3-2 are provided as part of the forecast. These air quality alerts are issued through Enviroflash emails, are displayed on the AirNow and NJDEP air monitoring websites, and can also be viewed on the National Weather Service page for the Philadelphia/Mount Holly area (http://airquality.weather.gov/). Maps, tables, annual trends and other air quality information are also available on the NJDEP air monitoring web site, as shown in Figure 3-1 below.

Figure 3-1
Examples of Information Available on NJDEP’s Air Monitoring Website
https://nj.gov/dep/airmon

Current Air Quality

MAP OF THE LATEST DATA

TODAY'S FORECAST



2021 New Jersey AQI Summary

Not all of New Jersey's monitoring sites have 365 (or 366) days of reported air quality index values. Certain ozone monitors only operate during "ozone season," from March through October. Also, not all monitoring sites measure all pollutants. Table 3-4 shows which pollutants are used to determine the daily AQI at different monitoring stations.

There is also an ozone monitor at Washington Crossing State Park that is managed by USEPA. Although it is not officially part of the NJDEP network and does not report to the BAM website, its data is included in determining exceedances in New Jersey.

Table 3-4
Pollutants Monitored at Each Air Quality Index Monitoring Site in New Jersey in 2021

	Monitoring Site	Ozone	Particulate Matter	Carbon Monoxide	Sulfur Dioxide	Nitrogen Dioxide
1	Ancora State Hospital	√ (s)				
2	Bayonne	√			√	√
3	Brigantine	√	√		√	
4	Camden Spruce St.	√	√	√	√	√
5	Chester	√			√	√
6	Clarksboro	√ (s)				
7	Colliers Mills	√ (s)				
8	Columbia	√	√		√	√
9	Elizabeth			√	√	
10	Elizabeth Lab		√	√	√	√
11	Flemington	√	√			
12	Fort Lee Near Road		√	√		√
13	Jersey City			√	√	√
14	Jersey City Firehouse		√			
15	Leonia	√ (s)				
16	Millville	√	√			√
17	Monmouth University	√ (s)				
18	Newark Firehouse	√	√	√	√	√
19	Rahway		√			
20	Ramapo	√ (s)				
21	Rider University	√	√			
22	Rutgers University	√	√			√
23	Toms River		√			
24	Trenton		√			

(s) – Seasonal operation only (March 1 through October 31).

A summary of the 2021 AQI ratings for New Jersey is displayed in the pie chart in Figure 3-2 below. In 2021, there were 199 “Good” days (55%), 151 were “Moderate” (41%), 14 (4%) were “Unhealthy for Sensitive Groups,” and one (0.3%) was “Unhealthy.” Air pollution was still bad enough on 4.3% of days to potentially affect sensitive people.

Figure 3-2
2021 Air Quality Summary by Days

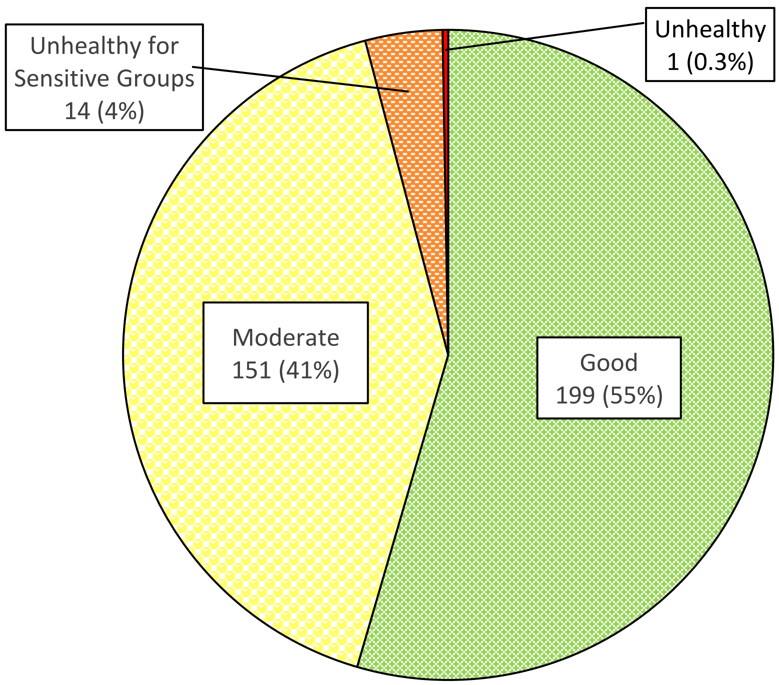


Figure 3-3 shows the distribution of AQI days since 2000. It should be noted that AQI ranges change whenever a NAAQS for a specific pollutant is revised. So even though improvement in AQI days appears to be somewhat erratic, to see how things really have improved, refer to the concentration trend graphs in the individual criteria pollutant reports or in the executive summary.

Figure 3-3
Number of Days in Each AQI Category Since 2000

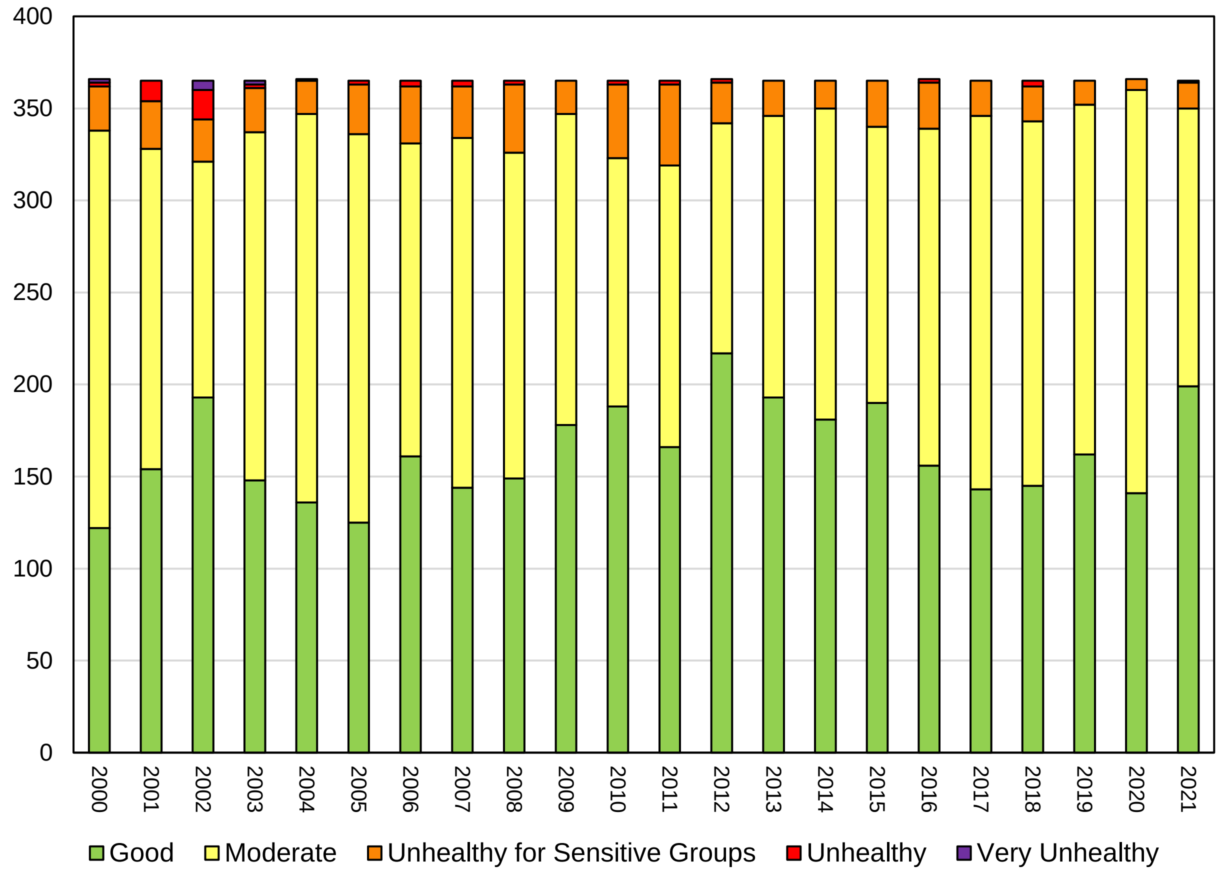


Table 3-5 presents the number of days when the AQI reached or exceeded the "Unhealthy for Sensitive Groups" (USG) or "Unhealthy" threshold at any monitoring location in New Jersey in 2021. Table 3-6 lists the individual exceedance dates and shows the specific pollutants and their locations and concentrations.

Of all the criteria pollutants, ozone is predominantly responsible for AQI days above the moderate range in New Jersey. Exceedances are the result of weather conditions that favor the formation and transport of ozone. Ozone forms when emissions of nitrogen oxides and volatile organic compounds undergo chemical reactions in the presence of sunlight.

The $PM_{2.5}$ exceedances on July 20 and 21 are attributed to wildfire smoke that originated in the western United States and Canada. Although emissions from cars, trucks, and industry contribute to $PM_{2.5}$ air quality, limited mixing heights allowed the combination of the pollution from the wildfire and these local sources to accumulate close to the surface, leading to a regional NAAQS $PM_{2.5}$ exceedance event throughout the Northeast.

Table 3-5
2021 Total Number of NAAQS Exceedance Days in New Jersey

Pollutant	Exceedances
Ozone	13
$PM_{2.5}$	2

Table 3-6
AQI Days Over 100 in New Jersey in 2021

Day No.	Date	Monitor Location	Pollutant	Concen-tration	Units	AQI Rating	AQI Value
1	5/19/21	Ancora	O_3	0.072	ppm	USG	105
		Clarksboro	O_3	0.071	ppm	USG	101
		Colliers Mills	O_3	0.075	ppm	USG	115
		Millville	O_3	0.074	ppm	USG	112
		Monmouth University	O_3	0.079	ppm	USG	129
2	5/21/21	Rider University	O_3	0.077	ppm	USG	122
		Rutgers University	O_3	0.079	ppm	USG	129
3	6/5/21	Colliers Mills	O_3	0.078	ppm	USG	126
		Leonia	O_3	0.076	ppm	USG	119
		Millville	O_3	0.071	ppm	USG	101
		Monmouth University	O_3	0.071	ppm	USG	101
4	6/6/21	Leonia	O_3	0.072	ppm	USG	105
5	6/18/21	Leonia	O_3	0.081	ppm	USG	136
		Rider University	O_3	0.071	ppm	USG	101
6	7/15/21	Rider University	O_3	0.071	ppm	USG	101
7	7/20/21	Camden Spruce Street	$PM_{2.5}$	43.3	µg/m3	USG	120
		Columbia	$PM_{2.5}$	41.1	µg/m3	USG	115
		Elizabeth Lab	$PM_{2.5}$	50.9	µg/m3	USG	139
		Fort Lee Near Road	$PM_{2.5}$	49.9	µg/m3	USG	136
		Newark Firehouse	$PM_{2.5}$	45.1	µg/m3	USG	125
		Rahway	$PM_{2.5}$	46.1	µg/m3	USG	127
		Rider University	$PM_{2.5}$	47.3	µg/m3	USG	130
		Rutgers University	$PM_{2.5}$	45.7	µg/m3	USG	126
		Toms River	$PM_{2.5}$	40	µg/m3	USG	112
		Trenton	$PM_{2.5}$	46	µg/m3	USG	127
8	7/21/21	Camden Spruce Street	$PM_{2.5}$	38	µg/m3	USG	107
		Rider University	$PM_{2.5}$	35.7	µg/m3	USG	101
		Rutgers University	$PM_{2.5}$	40.2	µg/m3	USG	102
		Toms River	$PM_{2.5}$	35.9	µg/m3	USG	113
9	7/26/21	Monmouth University	O_3	0.087	ppm	U	154
10	7/27/21	Clarksboro	O_3	0.071	ppm	USG	101
		Leonia	O_3	0.071	ppm	USG	101
		Newark Firehouse	O_3	0.071	ppm	USG	101
11	8/6/21	Leonia	O_3	0.078	ppm	USG	126
		Rider University	O_3	0.079	ppm	USG	129
		Rutgers University	O_3	0.079	ppm	USG	129
12	8/13/21	Bayonne	O_3	0.078	ppm	USG	126
		Camden Spruce St	O_3	0.071	ppm	USG	101
		Leonia	O_3	0.075	ppm	USG	115

Continued

Table 3-6 (continued)
AQI Days Over 100 in New Jersey in 2021

Day No.	Date	Monitor Location	Pollutant	Concen-tration	Units	AQI Rating	AQI Value
13	8/25/21	Bayonne	O_3	0.074	ppm	USG	112
		Leonia	O_3	0.074	ppm	USG	112
14	8/26/21	Bayonne	O_3	0.072	ppm	USG	105
		Leonia	O_3	0.084	ppm	USG	147
		Newark Firehouse	O_3	0.072	ppm	USG	105
		Rider University	O_3	0.072	ppm	USG	105
		Rutgers University	O_3	0.072	ppm	USG	105
		Washington Crossing	O_3	0.082	ppm	USG	140
15	8/27/21	Monmouth University	O_3	0.073	ppm	USG	108

Rating
USG = Unhealthy for sensitive groups

Pollutants
O_3 – Ozone
$PM_{2.5}$ – Fine particles

Units
ppm – parts per million
µg/m^3 - micrograms per cubic meter

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"Appendix G to Part 58 - Uniform Air Quality Index (AQI) and Daily Reporting." Title 40 *Code of Federal Regulations*. https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=3b421c7ca640647158c90279e577c578&mc=true&n=pt40.6.58&r=PART&ty=HTML#ap40.6.58_161.g. Accessed 7/1/2022.

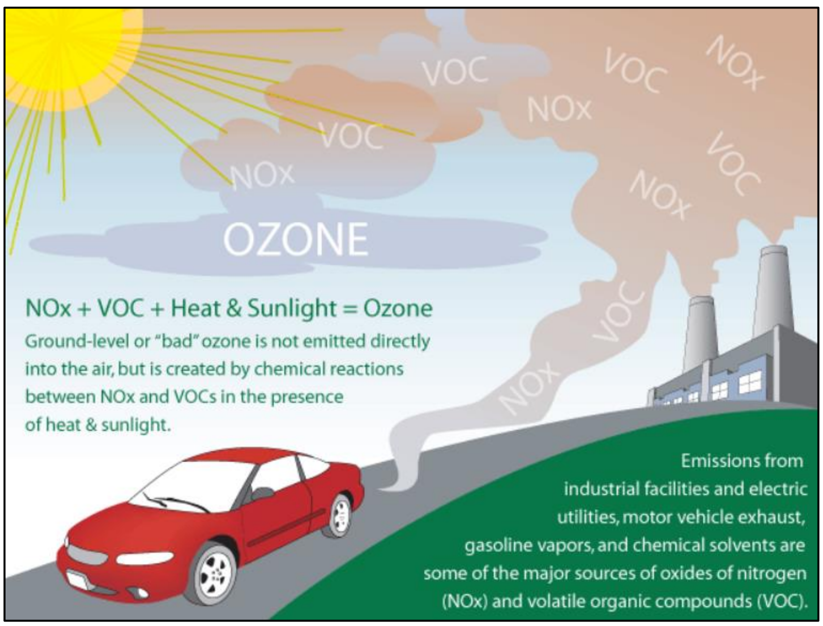
2021 Ozone Summary

New Jersey Department of Environmental Protection

SOURCES

Ozone (O_3) is a gas consisting of three oxygen atoms. It occurs naturally in the upper atmosphere (stratospheric ozone) where it protects us from harmful ultraviolet rays. However, at ground-level (tropospheric ozone), it is considered an air pollutant and can have serious adverse health effects. Ground-level ozone is created when nitrogen oxides (NO_x) and volatile organic compounds (VOCs) react in the presence of sunlight (see Figure 4-1). NO_x is primarily emitted by motor vehicles, power plants, and other sources of combustion. VOCs are emitted from sources such as motor vehicles, chemical plants, factories, consumer and commercial products, and even natural sources such as trees. The pollutants that form ozone, referred to as "precursor" pollutants, and ozone itself can also be transported into an area from sources hundreds of miles upwind.

Figure 4-1
Ozone Formation



https://www.epa.gov/ground-level-ozone-pollution/ground-level-ozone-basics#wwh

Since ground-level ozone needs sunlight to form, it is mainly a problem in the daytime during the summer months. Figures 4-2 and 4-3 show the effect of sunlight on ambient ozone concentrations. The U.S. Environmental Protection Agency (USEPA) requires New Jersey to monitor ozone from March 1st to October 31st, the so-called "ozone season." However, weather patterns have a significant effect on ozone formation, and hot dry summers will result in higher levels than cool wet ones.

Figure 4-2
2021 Ozone Concentrations in New Jersey
Monthly Variation
Parts per Million (ppm)

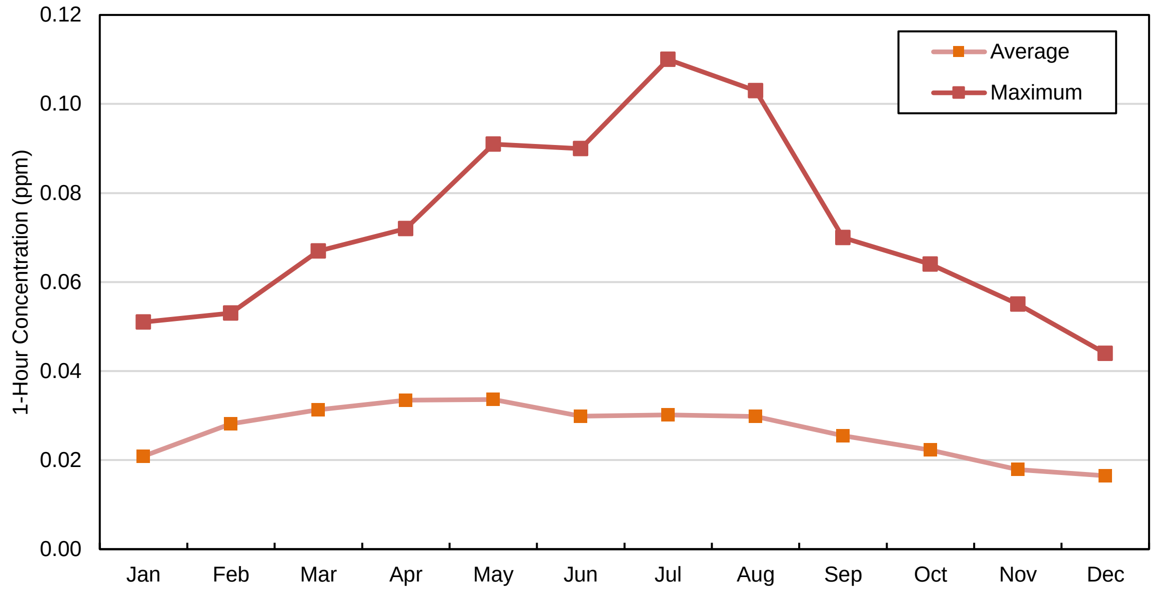


Figure 4-3
2021 Ozone Concentrations in New Jersey
Daily Variation
Parts per Million (ppm)

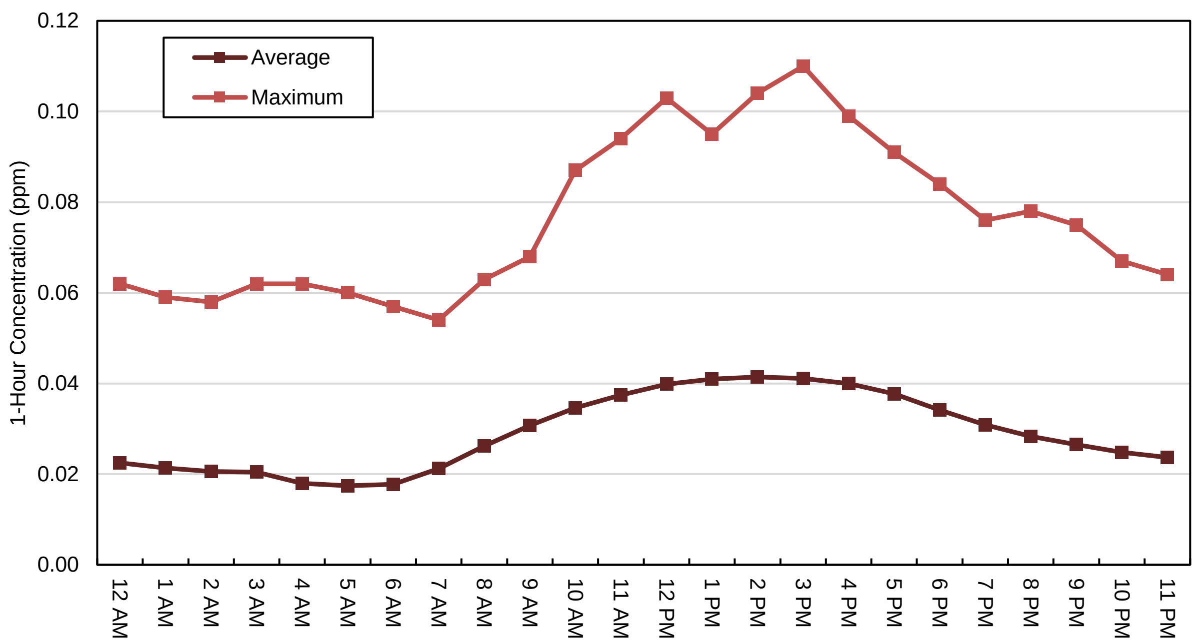
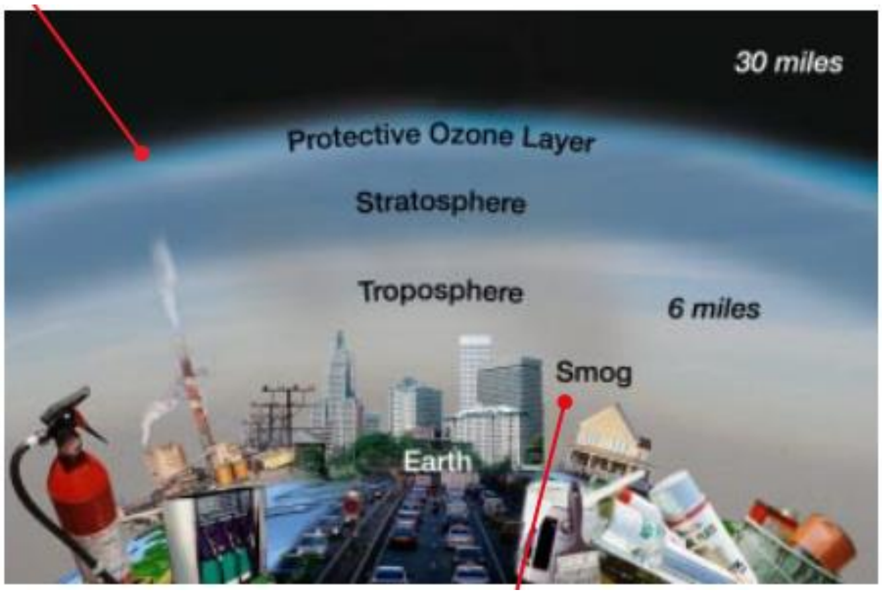


Figure 4-4 explains the difference between ozone in the upper and lower atmosphere. For more information, refer to the USEPA publication, “Good Up High, Bad Nearby – What is Ozone?”

Figure 4-4. Good and Bad Ozone

Ozone is good up here…Many popular consumer products like air conditioners and refrigerators involve CFCs or halons during either manufacturing or use. Over time, these chemicals damage the earth's protective ozone layer.



Ozone is bad down here…Cars, trucks, power plants and factories all emit air pollution that forms ground-level ozone.

https://www.epa.gov/sites/production/files/documents/gooduphigh.pdf

HEALTH AND ENVIRONMENTAL EFFECTS

Ozone can irritate the entire respiratory tract. Repeated exposure to ozone pollution may cause permanent damage to the lungs. Even when ozone is present at low levels, inhaling it can trigger a variety of health problems including chest pains, coughing, nausea, throat irritation, and congestion. Ozone also can aggravate other medical conditions such as bronchitis, heart disease, emphysema, and asthma, and can reduce lung capacity. People with pre-existing respiratory ailments are especially prone to the effects of ozone. For example, asthmatics affected by ozone may have more frequent or severe attacks during periods when ozone levels are high. Children are at special risk for ozone-related problems. They breathe more air per pound of body weight than adults, and ozone can impact the development of their immature respiratory systems. They tend to be active outdoors during the summer when ozone levels are at their highest. Anyone who spends time outdoors in the summer can be affected, and studies have shown that even healthy adults can experience difficulty in breathing when exposed to ozone. Anyone engaged in strenuous outdoor activities, such as jogging, should limit activity to the early morning or late evening hours on days when ozone levels are expected to be high.

Ground-level ozone damages plant life, and a recent study (see below) estimated that it is responsible for about $1 billion in reduced crop yield in the U.S. each year. It interferes with the ability of plants to produce and store food, making them more susceptible to harsh weather, disease, insects, and other pollutants. It damages the foliage of trees and other plants, sometimes marring the landscape of cities, national parks and forests, and recreation areas. The yellowed areas on the leaf shown in Figure 4-5 are damage caused by exposure to ground-level ozone.

For more information see: https://coe.northeastern.edu/news/research-reveals-air-pollution-costs-us-estimated-1b-a-year-in-perennial-crop-yield/.

Figure 4-5
Leaf Damage Caused by Ozone

www.epa.gov/ground-level-ozone-pollution/ecosystem-effects-ozone-pollution

AMBIENT AIR QUALITY STANDARDS

National and state air quality standards for ground-level ozone were first promulgated in 1971. There are both primary standards, which are set to provide public health protection (including protecting the health of sensitive populations such as asthmatics, children, and the elderly), and secondary standards, which are based on welfare effects (such as damage to trees, crops and materials). For ground-level ozone, the primary and secondary National Ambient Air Quality Standards (NAAQS) are the same (see Table 4-1). The USEPA must periodically review the NAAQS to determine if they are sufficiently protective of public health based on the latest studies. Initially, the ozone NAAQS was an hourly average of 0.12 ppm, established in 1979. It has since been revoked by USEPA, although New Jersey retains it as a primary state standard. In 1997, the 0.08 parts per million (ppm) ozone NAAQS was promulgated, based on the maximum 8-hour average daily concentration. It was changed to 0.075 ppm in 2008. In October 2015 the 8-hour ozone NAAQS was lowered once again, to 0.070 ppm, effective in 2016.

Compliance with a NAAQS is based on meeting the design value, the actual statistic that determines whether the standard is being met. For ozone, calculating the design value is a two-step process using data from the most recent three years. The first step involves determining the fourth-highest daily maximum 8-hour average concentration for each monitoring site in the state for each of the three years. The values for each site are then used to calculate a three-year average. If this value exceeds the NAAQS at any site in the state, the state is determined to be in nonattainment.

Table 4-1
National and New Jersey Ambient Air Quality Standards for Ozone
Parts per Million (ppm)

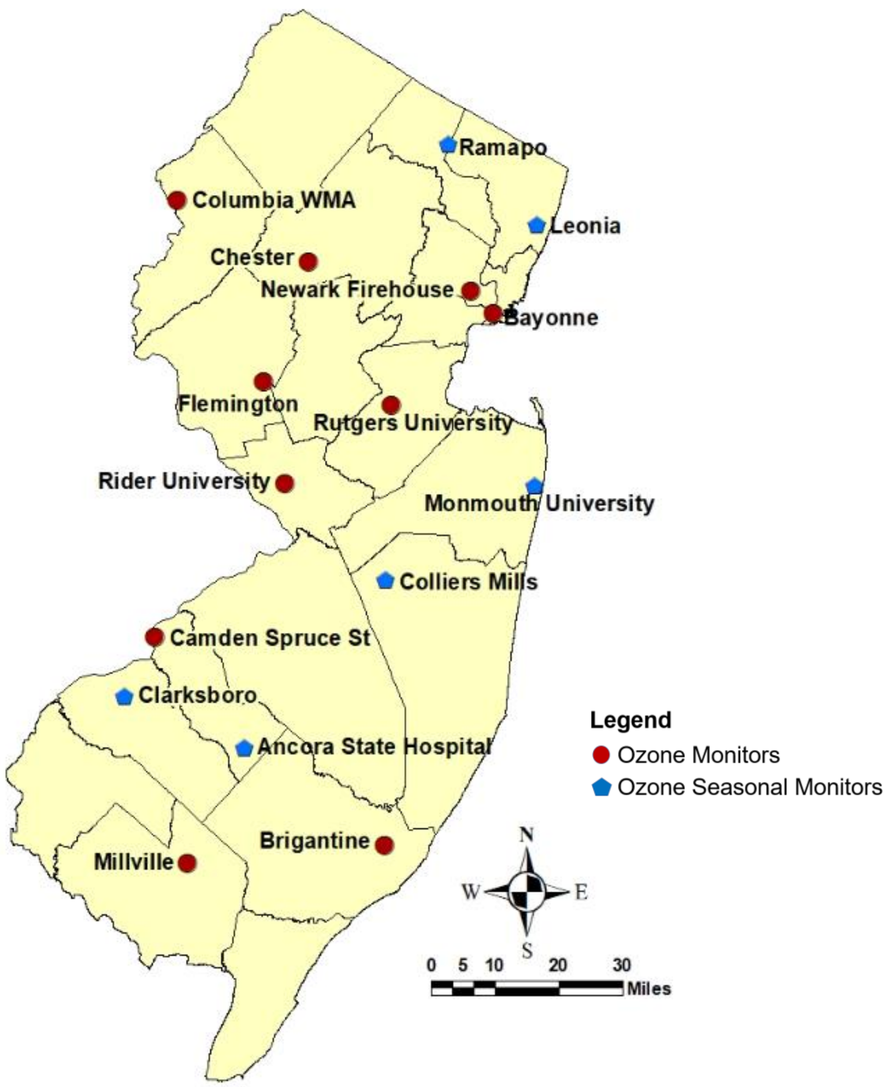
Averaging Period	Type	National Level	New Jersey Level	Design Value
1-Hour	Primary	---	0.12 ppm	Annual 2nd-highest daily maximum
8-Hours	Primary & secondary	0.070 ppm	---	3-year average of the annual 4th-highest daily maximums

OZONE MONITORING NETWORK

The New Jersey Department of Environmental Protection operated 16 monitoring stations in New Jersey during 2021 (see Figure 4-6). Of those 16 sites, ten operate year-round and six operate only during the ozone season, which is March 1st through October 31st. Bayonne, Brigantine, Camden Spruce Street, Chester, Columbia, Flemington, Millville, Newark Firehouse, Rider University and Rutgers University operate year-round. The Ancora, Clarksboro, Colliers Mills, Leonia, Monmouth University, and Ramapo sites operate only during the ozone season.

There is an ozone monitor at Washington Crossing State Park in Mercer County which is maintained and operated by USEPA. The site is included when determining New Jersey's NAAQS compliance status, although the data is not presented here. It can be obtained from USEPA at https://www.epa.gov/outdoor-air-quality-data.

Figure 4-6
2021 Ozone Monitoring Network



OZONE LEVELS IN 2021

The 2021 ozone season had thirteen days on which the NAAQS (8-hour daily maximum average concentration of 0.070 ppm) was exceeded, as shown in Table 4-2. 12 monitoring sites (including Washington Crossing) recorded levels above the standard at least once. Leonia had the most exceedances (eight), followed by Rider (five), and Monmouth University (four, including one at the "Unhealthy" level). Bayonne and Rutgers had three exceedances each; Clarksboro, Collliers Mills, Millville and Newark Firehouse each had two; and Ancora, Camden Spruce Street and Washington Crossing all had one. Brigantine, Chester, Columbia, Flemington, and Ramapo had no exceedances in 2021. For details, see the Air Quality Index section of this air quality report.

Table 4-2
2021 Exceedances of the O_3 NAAQS

Day	Date	Site	8-Hour Maximum Average Concentration (ppm)	AQI Rating
1	5/19/21	Ancora	0.072	USG
		Clarksboro	0.071	USG
		Colliers Mills	0.075	USG
		Millville	0.074	USG
		Monmouth University	0.079	USG
2	5/21/21	Rider University	0.077	USG
		Rutgers University	0.079	USG
3	6/5/21	Colliers Mills	0.078	USG
		Leonia	0.076	USG
		Millville	0.071	USG
		Monmouth University	0.071	USG
4	6/6/21	Leonia	0.072	USG
5	6/18/21	Leonia	0.081	USG
		Rider University	0.071	USG
6	7/15/21	Rider University	0.071	USG
7	7/26/21	Monmouth University	0.087	U
8	7/27/21	Clarksboro	0.071	USG
		Leonia	0.071	USG
		Newark Firehouse	0.071	USG
9	8/6/21	Leonia	0.078	USG
		Rider University	0.079	USG
		Rutgers University	0.079	USG
10	8/13/21	Bayonne	0.078	USG
		Camden Spruce St	0.071	USG
		Leonia	0.075	USG
11	8/25/21	Bayonne	0.074	USG
		Leonia	0.074	USG
12	8/26/21	Bayonne	0.072	USG
		Leonia	0.084	USG
		Newark Firehouse	0.072	USG
		Rider University	0.072	USG
		Rutgers University	0.072	USG
		Washington Crossing	0.082	USG
13	8/27/21	Monmouth University	0.073	USG

AQI = Air Quality Index
USG = Unhealthy for Sensitive Groups
U = Unhealthy

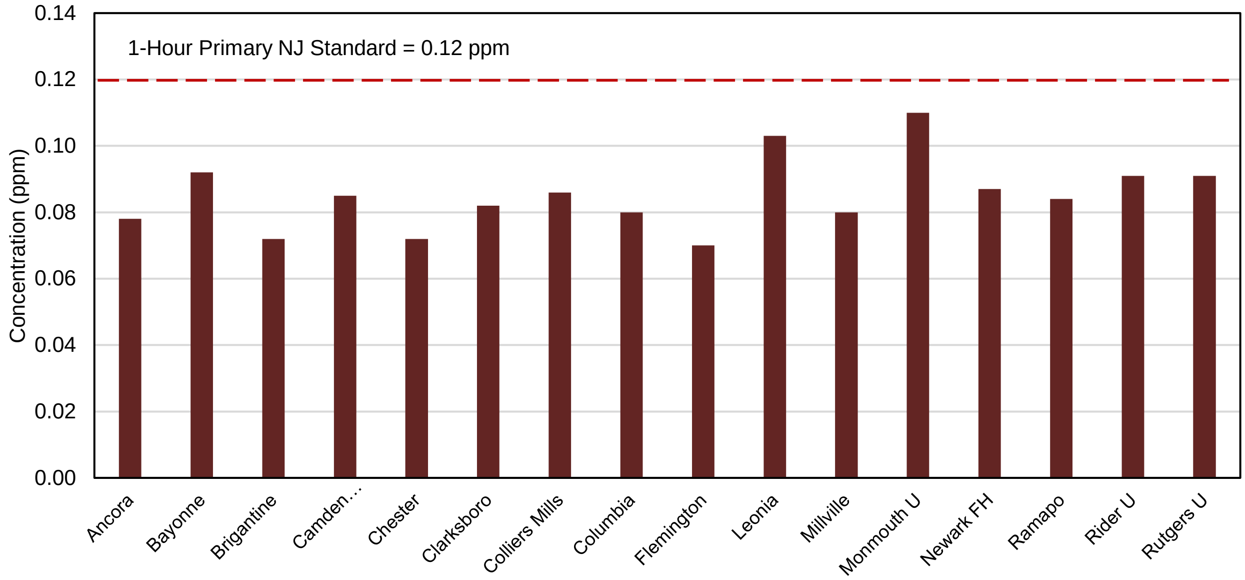
Table 4-3 presents the 2021 ozone data for the sixteen monitoring sites operated by NJDEP.

Table 4-3
2021 Ozone Concentrations in New Jersey
Parts per Million (ppm)

Monitoring Site	1-Hour Daily Maximum	8-Hour Averages		
		Highest Daily Maximum	4th-Highest Daily Maximum	2018-2021 Average of 4th-Highest Daily Max.
Ancora	0.078	0.072	0.062	0.062
Bayonne	0.092	0.078	0.070	0.066
Brigantine	0.072	0.068	0.059	0.059
Camden Spruce St.	0.085	0.071	0.068	0.066
Chester	0.072	0.069	0.064	0.062
Clarksboro	0.082	0.071	0.067	0.066
Colliers Mills	0.086	0.078	0.068	0.066
Columbia	0.080	0.069	0.062	0.058
Flemington	0.075	0.069	0.066	0.063
Leonia	0.103	0.084	0.076	0.071
Millville	0.080	0.074	0.068	0.065
Monmouth University	0.110	0.087	0.071	0.066
Newark Firehouse	0.087	0.072	0.066	0.065
Ramapo	0.084	0.064	0.062	0.062
Rider University	0.091	0.079	0.071	0.069
Rutgers University	0.091	0.079	0.070	0.068

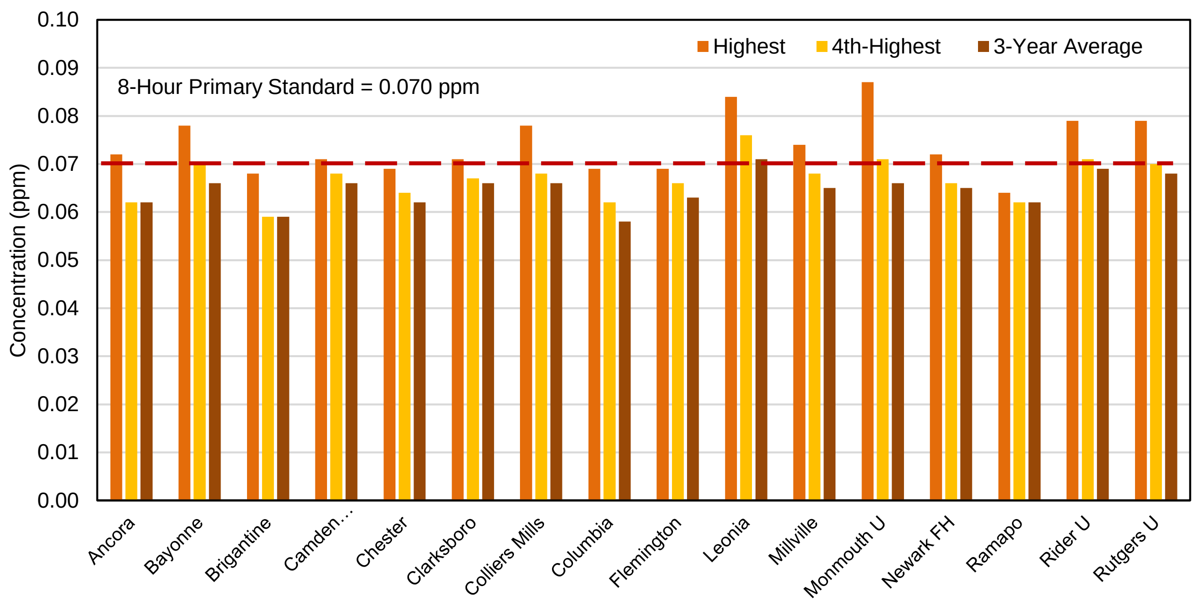
No site recorded levels above the New Jersey 1-hour standard of 0.12 ppm. The highest daily 1-hour concentration was 0.110 ppm, recorded at Monmouth University on July 26. The 1-hour standard was most recently exceeded in 2018. Figure 4-7 shows the maximum one-hour data for each site.

Figure 4-7
2021 Ozone Concentrations in New Jersey
1-Hour Daily Maximums
Parts per Million (ppm)



The highest daily maximum 8-hour average concentration was 0.087 ppm, recorded at Monmouth University on July 26. The 4th-highest 8-hour daily maximum value (0.076 ppm) was measured at Leonia. Leonia also exceeded the design value during the 2021 ozone season (3-year average of the 4th-highest 8-hour daily maximum) at 0.071 ppm. Figure 4-8 shows the 8-hour values for each site.

Figure 4-8
2021 Ozone Concentrations in New Jersey
8-Hour Daily Maximums (Highest, 4th-Highest, and 3-Year Average of 4th Highest)
Parts per Million (ppm)



OZONE TRENDS

Studies have shown that to decrease ground-level ozone concentrations, emissions of VOCs and NOx must be reduced. Over the past couple of decades, emissions reductions have resulted in a relatively steady lowering of ozone levels in New Jersey. The chart in Figure 4-9 shows both the fourth-highest statewide 8-hour maximum daily average concentrations and the ozone design value (which is a 3-year average of these values) recorded each year since 1997. In 2021, Leonia had the maximum fourth-highest 8-hour maximum daily average of 0.076 ppm. The highest statewide 2021 design value was 0.071 ppm, recorded at Leonia. This exceeds the 0.070 ppm NAAQS. Design values can also be found in Table 4-4.

Figure 4-10 shows the total number of exceedance days in New Jersey since 2000.

Figure 4-9
Statewide New Jersey Ozone Trends, 1997-2021
4th-Highest & 3-Year Average of the 4th-Highest Daily Maximum 8-Hour Averages
Parts per Million (ppm)

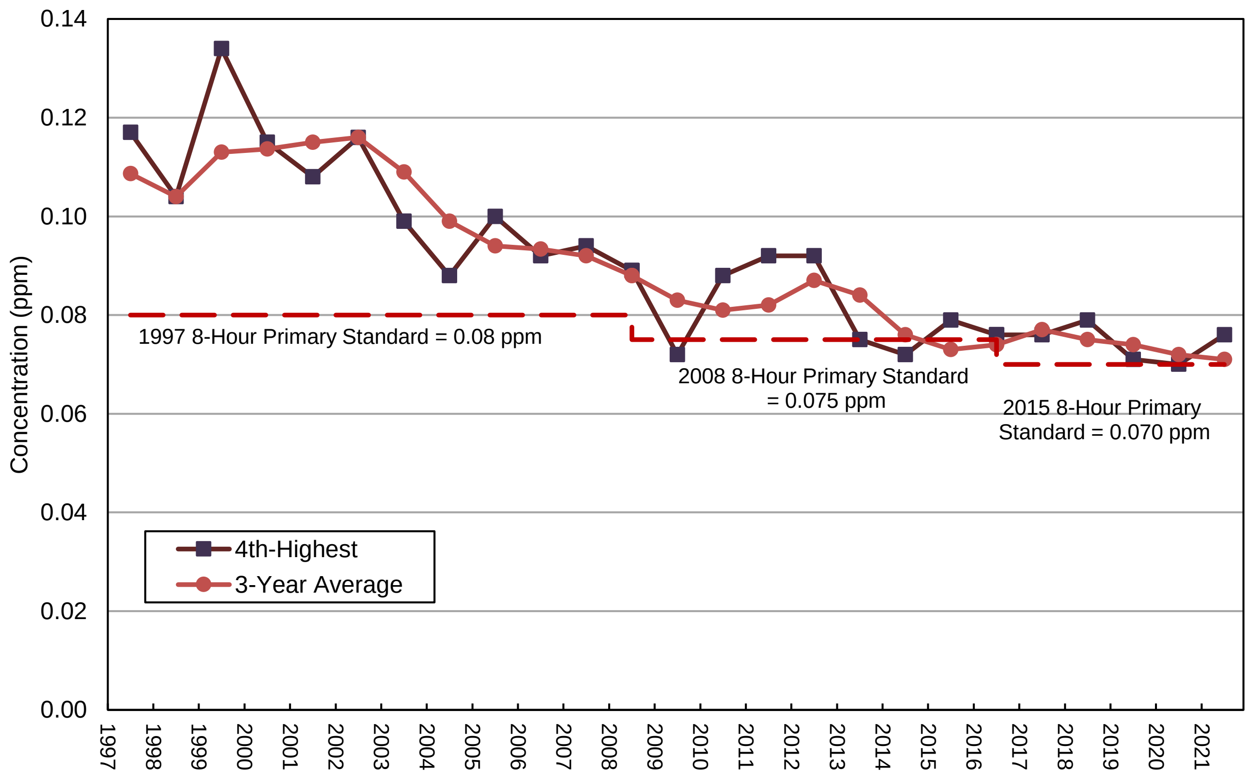
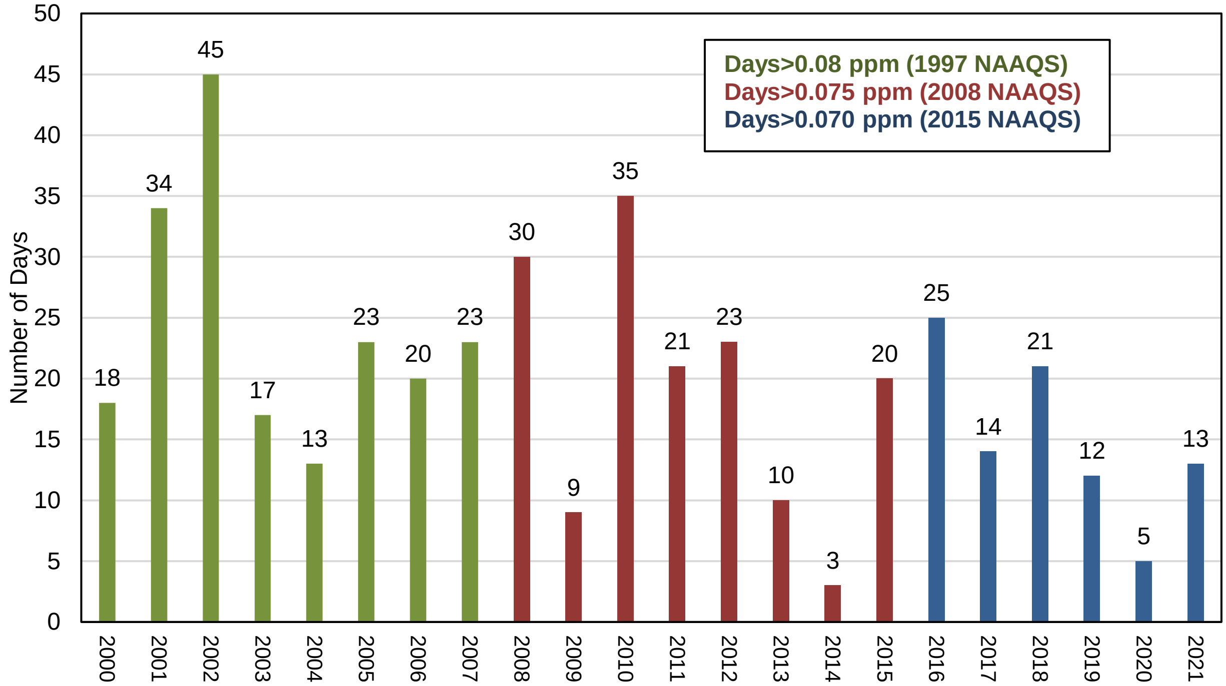


Table 4-4
Statewide New Jersey Ozone Trends, 1997-2021
Daily Maximum 8-Hour Average Concentrations
Parts per Million (ppm)

Year	4th-Highest	3-Year Average of 4th-Highest*
1997	0.117	0.109
1998	0.104	0.104
1999	0.134	0.113
2000	0.115	0.114
2001	0.108	0.115
2002	0.116	0.116
2003	0.099	0.109
2004	0.088	0.099
2005	0.100	0.094
2006	0.092	0.093
2007	0.094	0.092
2008	0.089	0.088
2009	0.072	0.083
2010	0.088	0.081
2011	0.092	0.082
2012	0.092	0.087
2013	0.075	0.084
2014	0.072	0.076
2015	0.079	0.073
2016	0.076	0.074
2017	0.076	0.077
2018	0.079	0.075
2019	0.071	0.074
2020	0.070	0.072
2021	0.076	0.071

*Design value

Figure 4-10
Number of Days on Which the Ozone NAAQS was Exceeded in New Jersey, 2000-2021

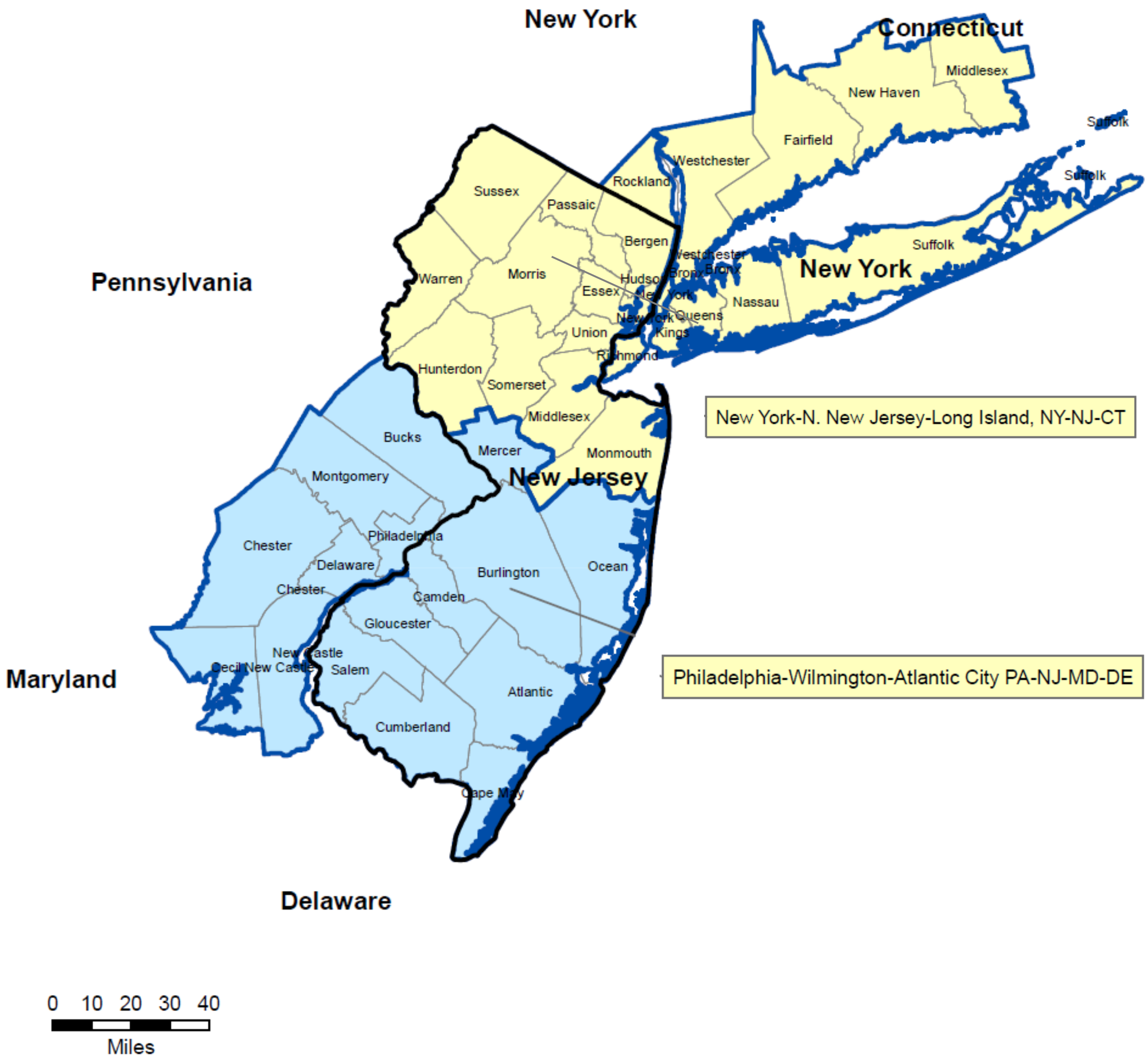


Ozone Nonattainment Areas in New Jersey

The Clean Air Act requires that all areas of the country be evaluated for attainment or nonattainment for each of the NAAQS. The 1990 amendments to the Clean Air Act required that areas be further classified based on the severity of nonattainment. The classifications range from "marginal" to "extreme" and are based on the design values that determine whether an area meets the standard.

The entire state of New Jersey is designated as nonattainment for the ozone NAAQS. New Jersey's nonattainment areas for the 2008 0.075 ppm and 2015 0.070 ppm 8-hour standards are shown in Figure 4-11. New Jersey's northern nonattainment area is classified as "moderate" for the 0.08 ppm and 0.07 ppm 8-hour ozone standards and "serious" for the 0.075 ppm 8-hour ozone standard. New Jersey's southern nonattainment area is classified as "moderate" for the 0.08 ppm 8-hour ozone standard, and "marginal" for the 0.075 ppm and 0.070 ppm 8-hour ozone standards.

Figure 4-11
New Jersey 8-Hour Ozone Nonattainment Areas
0.075 & 0.070 ppm NAAQS



Source: https://www3.epa.gov/airquality/greenbook/nj8_2015.html

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2021 Particulate Matter Summary

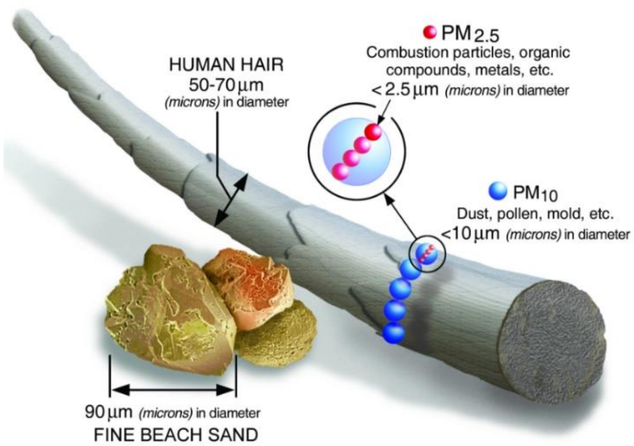
New Jersey Department of Environmental Protection

SOURCES

Particulate air pollution is a complex mixture of organic and inorganic substances in the atmosphere, occurring as either liquids or solids. Particulates may be as large as 70 microns in diameter or smaller than 1 micron in diameter. Most particulates are small enough that individual particles are undetected by the human eye. Particulates may travel hundreds of miles from their original sources, suspended in the atmosphere, before falling to the ground.

Particulate pollution is categorized by size, measured in microns (one millionth of a meter, also known as a micrometer). Particulates with diameters of 2.5 microns or less are considered “fine particulate matter,” referred to as $PM_{2.5}$ (Figure 5-1). Particulates with diameters of 10 microns or less are “inhalable particulate matter,” and are referred to as PM_{10}. “Total suspended particulate” (TSP) refers to all suspended particulates, including the largest ones.

Figure 5-1
Size Comparisons for PM



USEPA. www.epa.gov/pm-pollution/particulate-matter-pm-basics#PM

Particulates can occur naturally or can be man-made. Examples of naturally-occurring particles are windblown dust and sea salt. Man-made particulates, which come from sources such as fossil fuel combustion and industrial processes, can be categorized as either primary particulates or secondary particulates. Primary particulates are directly emitted from their sources, while secondary particulates form in the atmosphere through reactions of gaseous emissions.

HEALTH AND ENVIRONMENTAL EFFECTS

The size of particles is directly linked to their potential for causing health problems. Fine particles ($PM_{2.5}$) pose the greatest health risk. They can get deep into the lungs and some may even get into the bloodstream. Exposure to these particles can affect a person's lungs and heart. They can lead to premature death in people with heart or lung disease, can cause heart attacks, decrease lung function, and aggravate asthma. PM_{10} is of less concern, although it is inhalable and can irritate a person's eyes, nose, and throat.

Particulates of all sizes have an impact on the environment. PM is the major cause of reduced visibility in many parts of the United States. New Jersey has one Class I area listed under the Regional Haze Program. The program seeks to improve and protect visibility and air quality in specially designated areas such as national parks and wilderness areas. New Jersey’s Class I site is the Brigantine wilderness area, located within the Edwin B. Forsythe National Wildlife Refuge. A visibility camera (www.hazecam.net) is located there. Airborne particles can also impact vegetation and aquatic ecosystems, and can cause damage to paints and building materials.

AMBIENT AIR QUALITY STANDARDS

The U.S. Environmental Protection Agency (USEPA) first established National Ambient Air Quality Standards (NAAQS) for particulate matter in 1971. It set primary (health-based) and secondary (welfare-based) standards for total suspended particulate (TSP), which included PM up to about 25 to 45 micrometers. Over the years, new health data shifted the focus toward smaller and smaller particles. In 1987, USEPA replaced the TSP standards with standards for PM_{10}. The 24-hour PM_{10} primary and secondary standards were set at 150 µg/m^3, and an annual standard was set at 50 µg/m^3 (it was revoked in 2010). In 1997, USEPA began regulating $PM_{2.5}$. The annual $PM_{2.5}$ primary and secondary standards were set at 15.0 µg/m^3 until 2013, when the primary annual standard was lowered to 12.0 µg/m^3. A 24-hour $PM_{2.5}$ standard of 65 µg/m^3.was promulgated in 1997, then lowered in 2006 to 35 µg/m^3. Table 5-1 provides a summary of the current particulate matter standards.

Compliance with the standards is determined by calculating a statistic called the design value. For the annual $PM_{2.5}$ NAAQS, the design value is the highest statewide 3-year average of each site's annual average concentrations. For the 24-hour NAAQS, the 98th percentile of the 24-hour concentrations for each monitoring site must be averaged for the three most recent years. The highest site's value is the state's design value. For PM_{10}, the design value is the second-highest 24-hour average concentration for a given year.

Table 5-1
National Ambient Air Quality Standards for Particulate Matter
Micrograms Per Cubic Meter (µg/m^3)

Pollutant	Averaging Period	Type	Level	Design Value
Fine Particulate ($PM_{2.5}$)	Annual	Primary	12.0 µg/m^3	3-year average of the annual means
	Annual	Secondary	15.0 µg/m^3	3-year average of the annual means
	24-Hours	Primary & Secondary	35 µg/m^3	3-year average of the annual 98th percentile values
Inhalable Particulate (PM_{10})	24-Hours	Primary & Secondary	150 µg/m^3	2nd-highest annual average over 3 years

PARTICULATE MONITORING NETWORK

Criteria pollutant monitors must meet strict USEPA requirements to determine compliance with the NAAQS. To measure ambient particulate matter, the New Jersey Department of Environmental Protection (NJDEP) uses two different approaches: a filter-based method, and continuous beta attenuation.

Filter-based samplers pull a predetermined amount of air through $PM_{2.5}$ or PM_{10} size-selective inlets for a 24-hour period. The filters are weighed before and after sampling under controlled environmental conditions to determine the concentration of the captured particles. This filter-based method has for years been designated as the Federal Reference Method (FRM) for particulate matter compliance determination. It requires daily to weekly visits to pick up and replace filters.

New Jersey also uses Beta Attenuation Monitors (BAM), which measure the loss of intensity (attenuation) of beta particles due to absorption by $PM_{2.5}$ particles collected on a filter tape. These monitors are classified by USEPA as Federal Equivalent Methods (FEM) for $PM_{2.5}$, and can also be used to determine compliance with the NAAQS. These monitors provide real-time hourly PM data, which is available to the public on the NJDEP air monitoring website (https://nj.gov/dep/airmon/).

In 2021, two monitoring sites, Paterson and Union City High School, remained off-limits because of ongoing COVID-19 concerns. They both have filter-based samplers, which require frequent visits by site operators. Although these two sites had no data for 2021, they are not shut down. Their filter-based monitors are in the process of being replaced by continuous samplers, and will be providing data in the coming years.

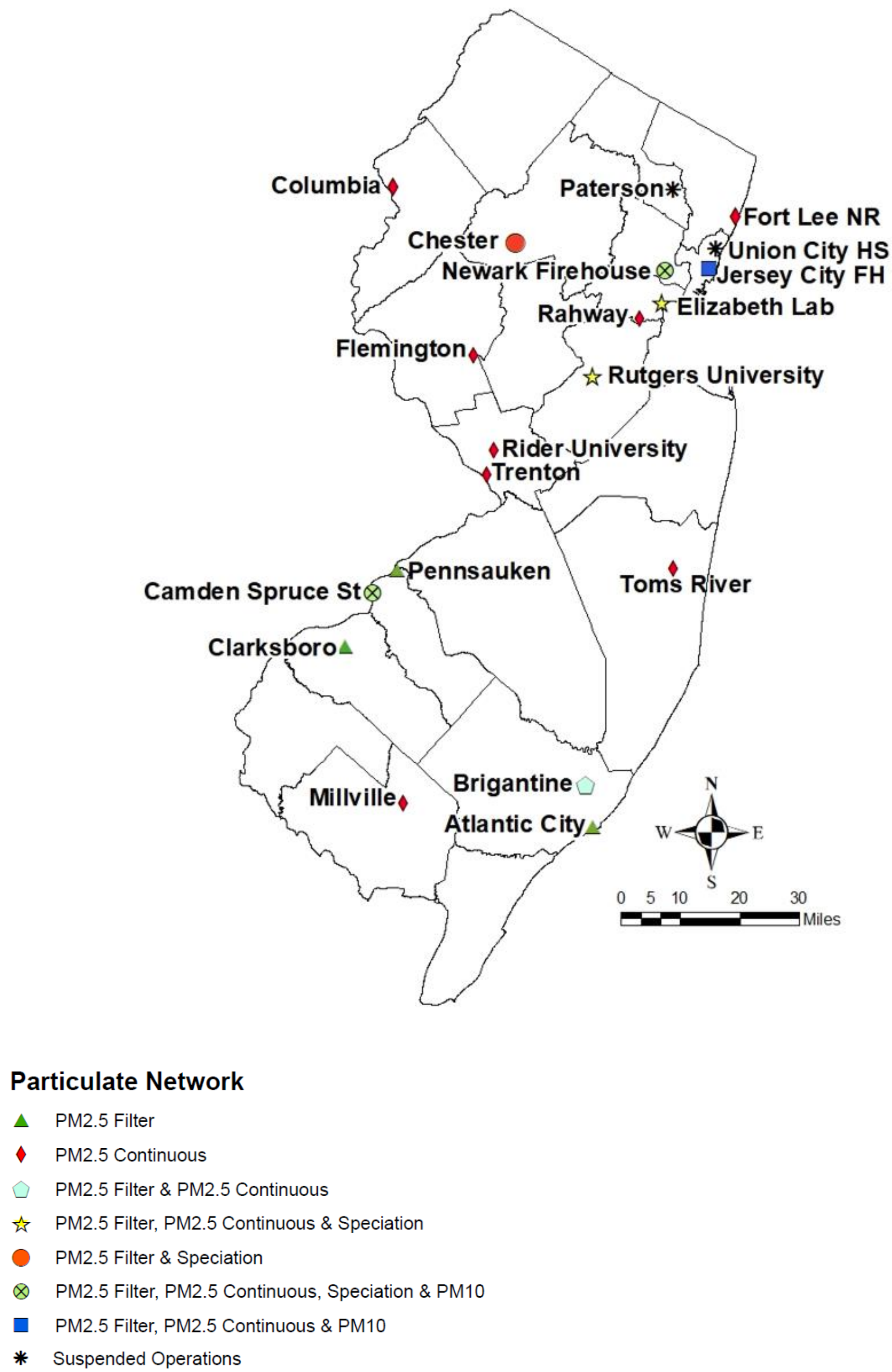
For 2021, NJDEP had eighteen $PM_{2.5}$ monitoring sites around the state. There are ten filter-based monitors and 14 continuous monitors. Six sites have both..

At one time, NJDEP had more than twenty PM_{10} sampling sites. After many years of low concentrations and the shift in emphasis to $PM_{2.5}$ monitoring, three sites remain. Currently, PM_{10} samples are taken once every six days at Camden and Jersey City, and every three days at Newark.

There are five monitoring stations that are part of the national Chemical Speciation Network (CSN). They use separate 24-hour filter-based $PM_{2.5}$ samplers to determine the concentrations of the chemical analytes that make up the particles. Teflon filters are analyzed for 33 elements, nylon filters are analyzed for ions, and quartz filters are analyzed for carbon. CSN monitoring takes place at the Camden Spruce Street, Chester, Elizabeth Lab, Newark Firehouse and Rutgers University monitoring stations. New Jersey's 2021 CSN data can be found in Appendix B of the Air Quality Summaries.

Figure 5-3 shows the locations of all the particulate monitors in New Jersey.

Figure 5-3
2021 Particulate Monitoring Network



FINE PARTICLE ($PM_{2.5}$) LEVELS IN 2021

$PM_{2.5}$ LEVELS FOR FILTER-BASED MONITORS

In 2021, none of the filter-based FRM $PM_{2.5}$ monitoring sites were in violation of annual NAAQS of 12.0 $\mu g/m^3$. There were two exceedances of the 24-hour NAAQS (35 $\mu g/m^3$) at two sites, Elizabeth Lab on July 20, and Camden Spruce Street on July 21. Over those days, a wildfire in the western U.S. and Canada caused an exceedance event across the Northeast states.

The annual mean concentrations of $PM_{2.5}$ measured at the ten filter-based samplers ranged from 6.28 $\mu g/m^3$ at the Chester monitoring site, to 10.31 $\mu g/m^3$ at the Camden Spruce Street monitoring station. The highest 24-hour concentrations ranged from 21.0 $\mu g/m^3$ at Chester to 50.9 $\mu g/m^3$ at Elizabeth Lab. Table 5-2 shows the annual mean, highest and 98th-percentile 24-hour concentrations, as well as the number of valid samples collected. The data is also shown graphically in Figures 5-4 and 5-5. Two sites (Elizabeth Lab, Jersey City Firehouse) sample $PM_{2.5}$ every day. The other eight sites (Atlantic City, Brigantine, Camden Spruce Street, Chester, Clarksboro, Newark Firehouse, Pennsauken and Rutgers University) take a sample every third day, resulting in about 122 samples per year.

Table 5-2
2021 $PM_{2.5}$ Concentrations in New Jersey
Annual and 24-Hour Averages for Filter-Based Monitors
Micrograms Per Cubic Meter ($\mu g/m^3$)

Monitoring Site	Number of Samples	Annual Average	24-Hour Average	
			Highest	98th%-ile
Atlantic City	89	8.53	28.8	24.0
Brigantine	63	6.98	33.0	18.2
Camden Spruce St.	116	10.31	38.0	26.6
Chester	111	6.28	21.0	20.2
Clarksboro	118	7.78	28.1	19.8
Elizabeth Lab	327	9.70	50.9	22.3
Jersey City Firehouse	303	8.97	34.9	23.6
Newark Firehouse	116	8.66	27.1	24.1
Pennsauken	113	8.55	33.3	23.2
Rutgers University	114	7.90	33.7	20.8

Figure 5-4
2021 $PM_{2.5}$ Concentrations in New Jersey
Annual Averages for Filter-Based Monitors
Micrograms Per Cubic Meter (µg/m³)

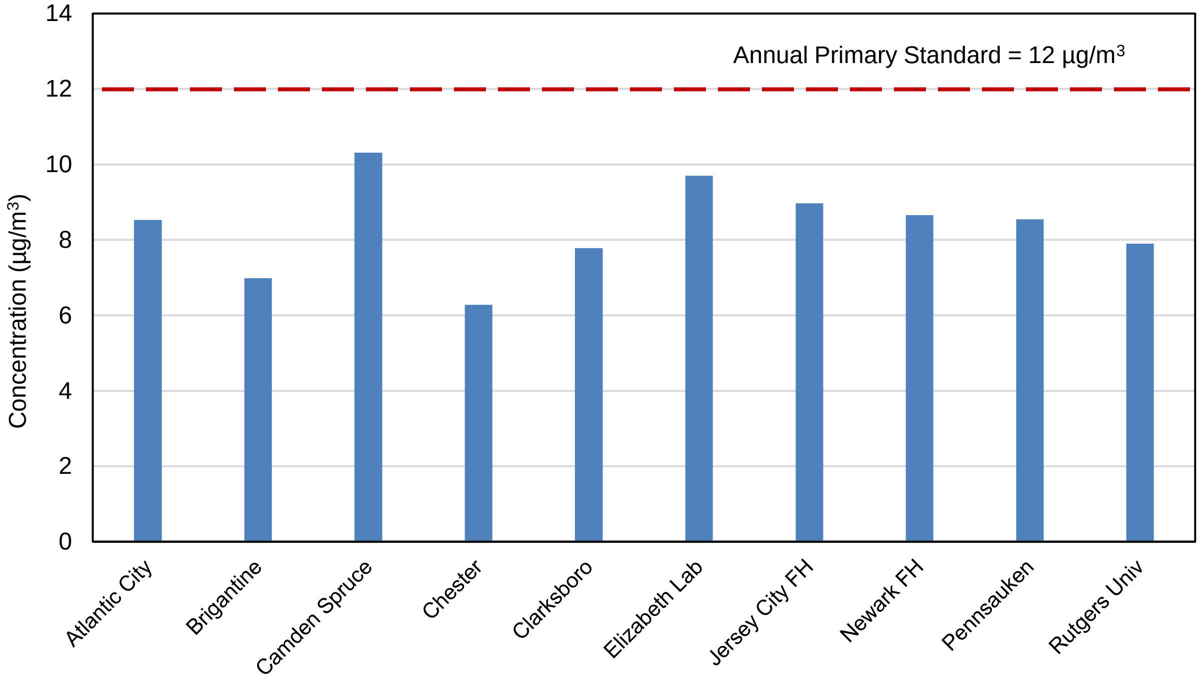
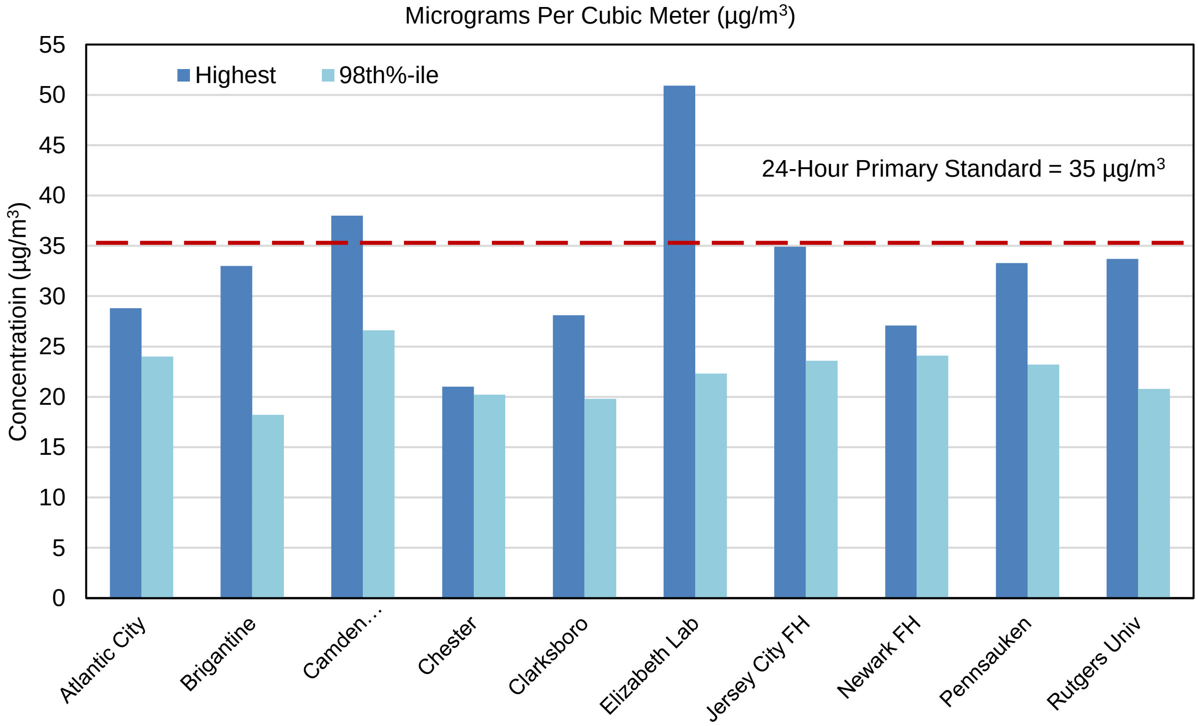


Figure 5-5
2021 $PM_{2.5}$ Concentrations in New Jersey
24-Hour Averages for Filter-Based Monitors
Micrograms Per Cubic Meter (µg/m³)



$PM_{2.5}$ LEVELS FOR CONTINUOUS MONITORS

In 2021, New Jersey had continuous $PM_{2.5}$ monitors at fourteen sites: Brigantine, Camden Spruce Street, Columbia, Elizabeth Lab, Flemington, Fort Lee Near Road, Jersey City Firehouse, Millville, Newark Firehouse, Rahway, Rider University, Rutgers University, Toms River and Trenton. One-minute $PM_{2.5}$ readings are transmitted to a central computer in Trenton, where they are averaged every hour and reported on the NJDEP website at https://nj.gov/dep/airmon.

Table 5-3 presents the annual mean, highest 24-hour, and 98^{th} percentile 24-hour values from these sites for 2021. Figures 5-6 and 5-7 show the same data in graphs. In 2021 there were no exceedances of the 12.0 $\mu g/m^3$ annual standard. However, there were thirteen exceedances of the 24-hour standard, attributable to wildfire smoke that originated in the western U.S and Canada. On July 20, there were exceedances at nine sites: Camden Spruce Street, Columbia, Fort Lee Near Road, Newark Firehouse, Rahway, Rider University, Rutgers University, Toms River and Trenton. On the following day (July 21) there were exceedances at Camden, Rider, Rutgers and Toms River. See Table 3-6 in the Air Quality Index section of the 2021 New Jersey Air Quality Report for details.

Table 5-3
2021 $PM_{2.5}$ Concentrations in New Jersey
Annual and 24-Hour Averages for Continuous Monitors
Micrograms Per Cubic Meter ($\mu g/m^3$)

Monitoring Site	Annual Average	24-Hour Average	
		Highest	98^{th}-%ile
Brigantine	6.20	28.1	15.4
Camden Spruce Street	9.55	43.3	21.9
Columbia	8.25	49.9	20.9
Elizabeth Lab	9.56	28.4	21.0
Flemington	7.77	33.6	20.2
Fort Lee Near Road	8.33	49.9	23.4
Jersey City Firehouse	7.12	30.1	20.0
Millville	7.03	29.1	19.3
Newark Firehouse	8.79	45.1	23.3
Rahway	7.53	46.1	18.8
Rider University	8.71	47.3	20.6
Rutgers University	8.34	45.7	20.1
Toms River	7.68	40.0	19.1
Trenton	8.96	46.0	19.8

Figure 5-6
2021 $PM_{2.5}$ Concentrations in New Jersey
Annual Averages for Continuous Monitors
Micrograms Per Cubic Meter (µg/m^3)

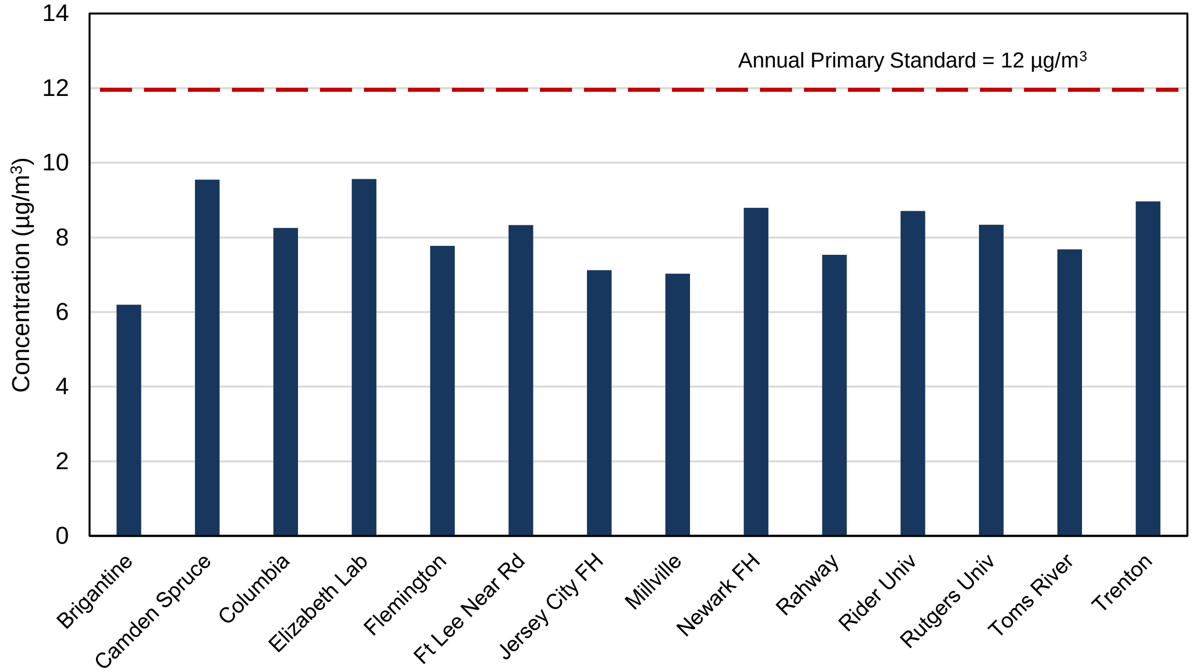
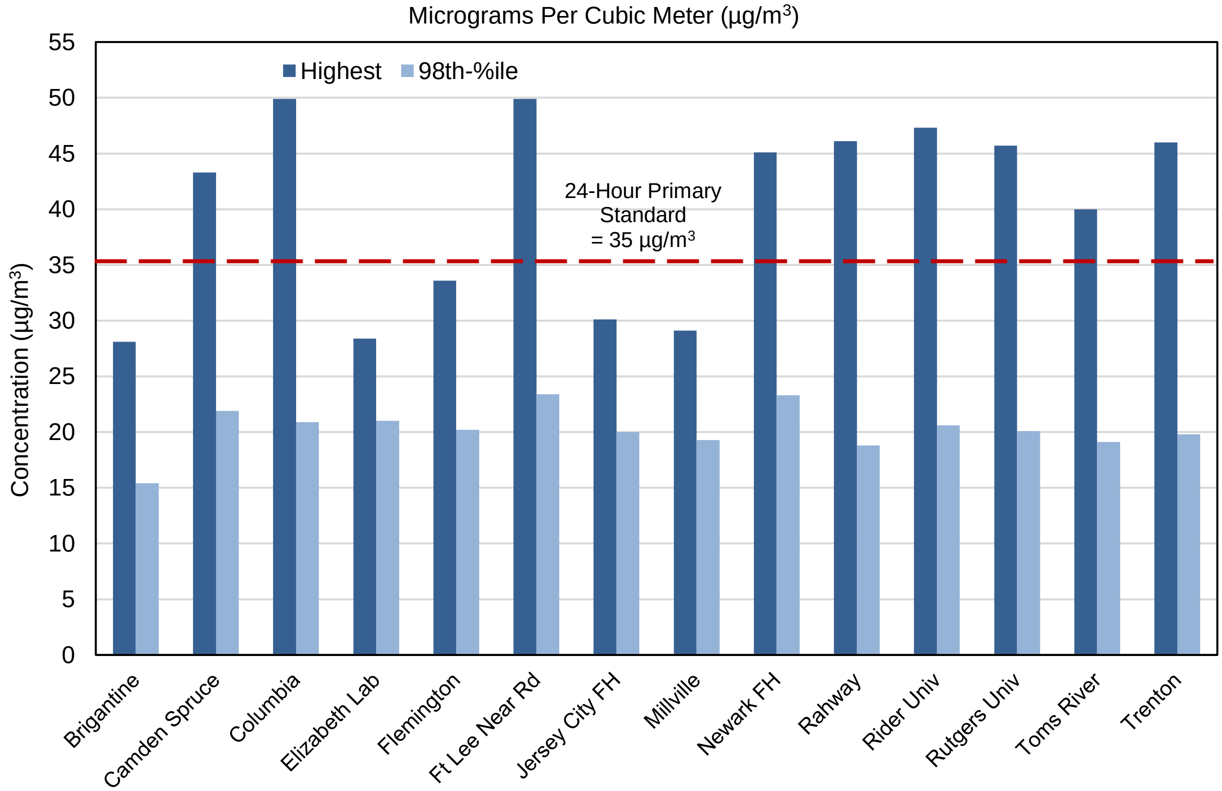


Figure 5-7
2021PM$_{2.5}$ Concentrations in New Jersey
24-Hour Averages for Continuous Monitors
Micrograms Per Cubic Meter (µg/m^3)



2021 $PM_{2.5}$ DESIGN VALUES

For $PM_{2.5}$ monitoring sites that have both a filter-based monitor and a continuous monitor, the data from the filter-based monitor usually takes precedence, and continuous monitor data is added in for periods when there is no filter data.

$PM_{2.5}$ design values are calculated using three years of complete data. Due to limited access to many monitoring stations in 2020 because of the COVID-19 pandemic and some equipment issues in 2021, only eight out of eighteen $PM_{2.5}$ monitoring stations had the three years of complete data necessary to calculate a 2021 design value. USEPA determines the validity and completeness of a data set, and calculates design values. Sites with incomplete data are determined to have invalid design values, and these are marked with an asterisk in the table and figures below.

Table 5-4 and Figures 5-8 and 5-9 show USEPA's calculated $PM_{2.5}$ 2021 design values for each of the New Jersey monitors. All of New Jersey's $PM_{2.5}$ monitoring sites were below the annual and 24-hour design values in 2021.

Table 5-4
New Jersey $PM_{2.5}$ Design Values for 2019-2021
3-Year Average of the Annual Average Concentrations
& 98th Percentile 24-Hour Average Concentrations
Micrograms Per Cubic Meter (µg/m^3)

Monitoring Site	3-Year (2019-2021) Average	
	Annual	98th Percentile 24-Hour
Atlantic City*	6.6	17
Brigantine	6.5	16
Camden Spruce Street	9.4	23
Chester*	5.8	17
Clarksboro*	7.2	18
Columbia	7.5	19
Elizabeth Lab	9	22
Flemington	7.6	19
Fort Lee Near Road*	9.6	24
Jersey City Firehouse*	7.5	22
Millville*	7.7	18
Newark Firehouse	8.6	21
Pennsauken*	7.5	21
Rahway*	7.2	20
Rider University*	7.8	18
Rutgers University	7.9	19
Toms River	6.7	16
Trenton Library*	8	19

*Design value deemed invalid by USEPA because of incomplete data set.

Figure 5-8
New Jersey $PM_{2.5}$ Design Values for 2019-2021
3-Year Average of the Annual Average Concentrations
Micrograms Per Cubic Meter (µg/m³)

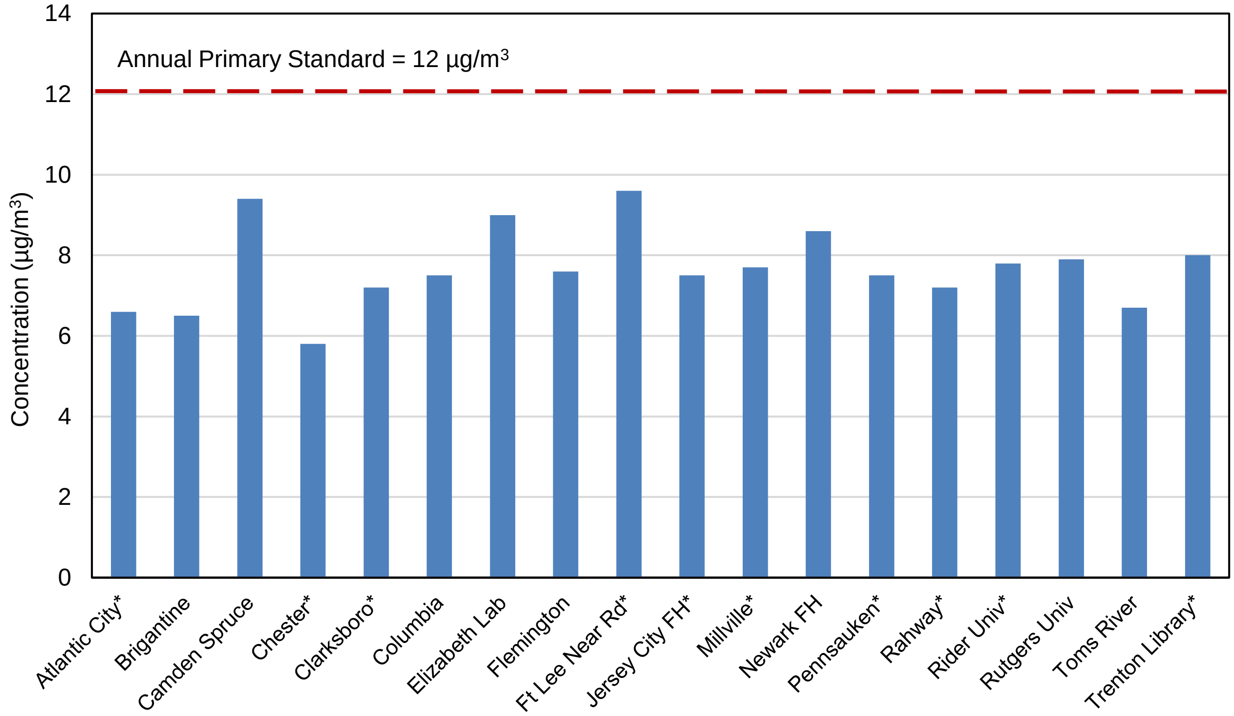
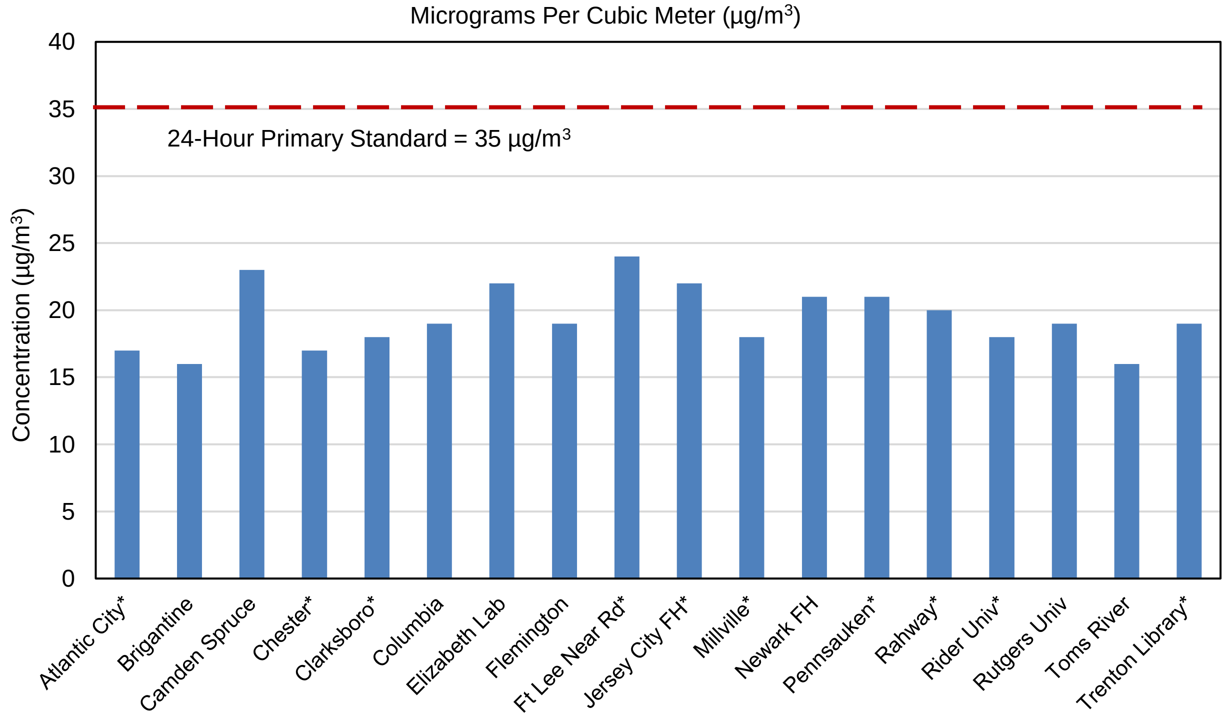


Figure 5-9
New Jersey $PM_{2.5}$ Design Values for 2019-2021
3-Year Average of the 98th Percentile 24-Hour Average Concentrations
Micrograms Per Cubic Meter (µg/m³)



*Design value deemed invalid by USEPA because of incomplete data set.

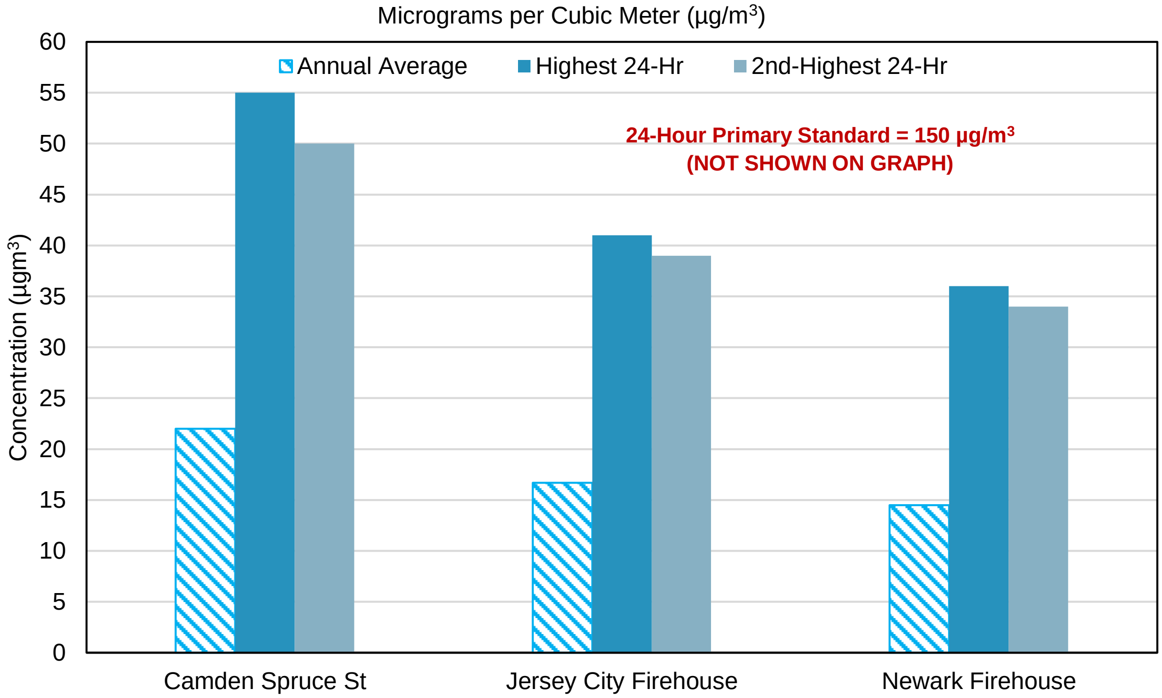
Inhalable Particulate (PM_{10}) Levels in 2021

Table 5-5 presents 2021 data for each of the New Jersey PM_{10} monitors. The highest and second-highest 24-hour concentrations are shown, as well as the annual averages. All areas of the state are in attainment for the 24-hour standard of 150 µg/m^3, as can be seen in Figure 5-10. The standard is based on the second-highest 24-hour value.

Table 5-5
2021 PM_{10} Concentrations in New Jersey
Annual and 24-Hour Averages
Micrograms Per Cubic Meter (µg/m^3)

Monitoring Site	Number of Samples	Annual Average*	24-Hour Average	
			Highest	Second-Highest
Camden Spruce Street	57	22.0	55	50
Jersey City Firehouse	59	16.7	41	39
Newark Firehouse	115	14.5	36	34

Figure 5-10
2021 PM_{10} Concentrations in New Jersey
Annual and 24-Hour Averages
Micrograms per Cubic Meter (µg/m^3)



Particulate Trends

A $PM_{2.5}$ monitoring network was established in New Jersey in 1999. Figures 5-11 and 5-12 show the statewide trend in the design values (3-year averages) since 2001, as well as changes to the NAAQS. Years of data show a noticeable decline in fine particulate concentrations.

Figure 5-11
Statewide New Jersey $PM_{2.5}$ Trends, 2001-2021
Annual Mean & 3-Year Average of the Annual Mean Concentrations
Micrograms per Cubic Meter (µg/m³)

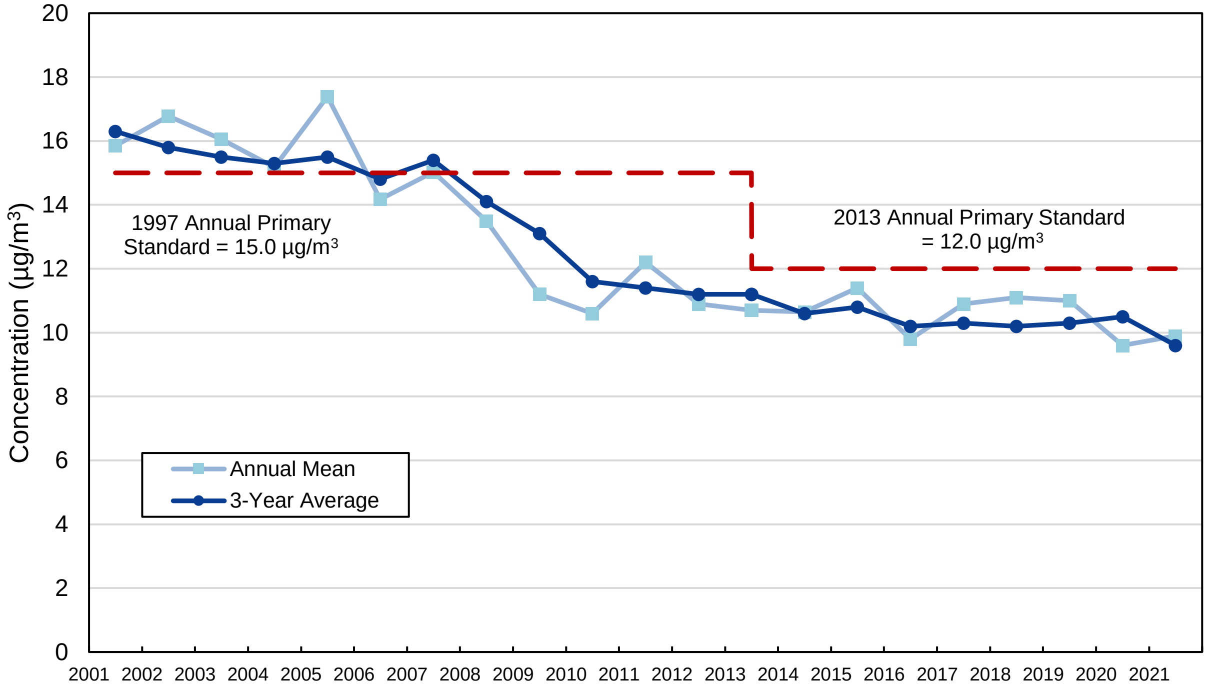
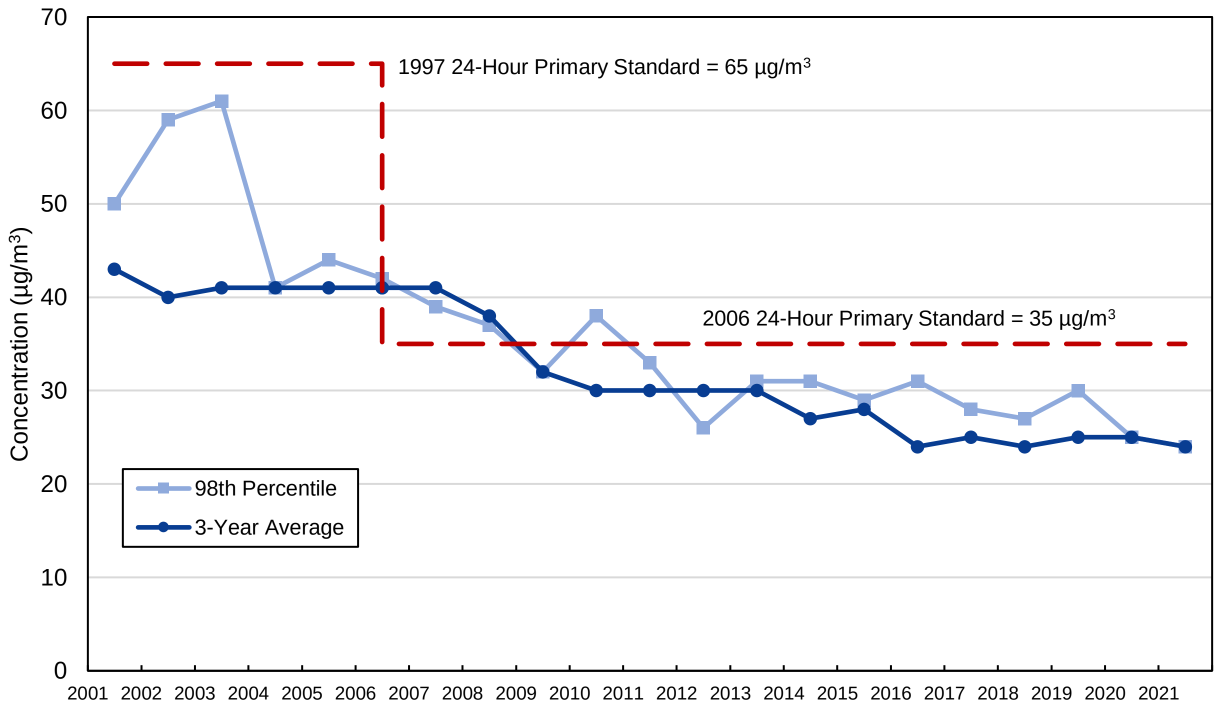


Figure 5-12
Statewide New Jersey $PM_{2.5}$ Trends, 2001-2021
98th Percentile & 3-Year Average of the 98th Percentile 24-Hour Average Concentrations
Micrograms per Cubic Meter (µg/m³)



The PM_{10} statewide design value trend is shown in Figure 5-13. The increase in concentration in 2015 and 2016 occurred at the Camden RRF monitor at 600 Morgan Street, during a period of major road reconstruction nearby. The Camden RRF site was shut down in early 2020, when a PM_{10} monitor was placed at the Camden Spruce Street station.

Figure 5-13
Statewide New Jersey PM_{10} Trend, 2001-2021
2nd-Highest 24-Hour Average Concentrations
Micrograms per Cubic Meter (µg/m³)

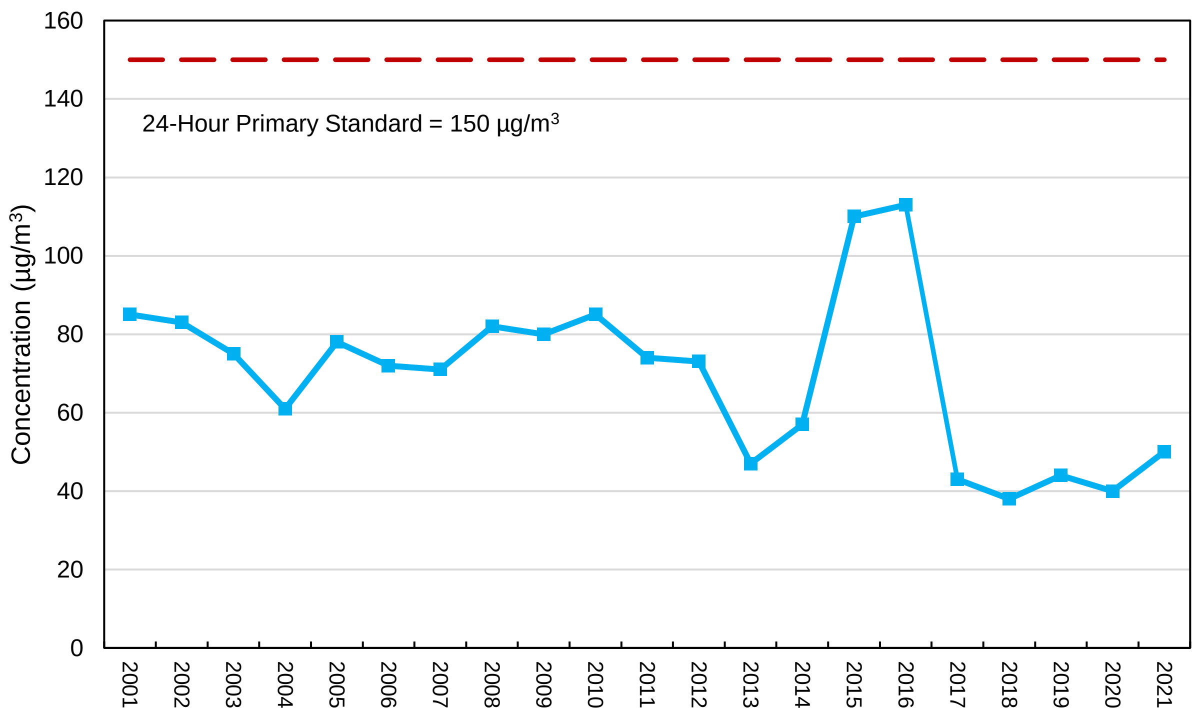


Table 5-6 below presents the trend data displayed in Figures 5-11, 5-12 and 5-13.

Table 5-6
Statewide New Jersey Particulate Matter Trends, 2001-2021
$PM_{2.5}$ & PM_{10} Concentrations
Micrograms per Cubic Meter ($\mu g/m^3$)

Year	$PM_{2.5}$				PM_{10}
	Annual		24-Hour		24-Hour
	Mean	3-Year Average*	98th Percentile	3-Year Average*	2nd-Highest*
2001	15.8	16.3	50	43	85
2002	16.8	15.8	59	40	83
2003	16.1	15.5	61	41	75
2004	15.2	15.3	41	41	61
2005	17.4	15.5	44	41	78
2006	14.2	14.8	42	41	72
2007	15.0	15.4	39	41	71
2008	13.5	14.1	37	38	82
2009	11.2	13.1	32	32	80
2010	10.6	11.6	38	30	85
2011	12.2	11.4	33	30	74
2012	10.9	11.2	26	30	73
2013	10.7	11.2	31	30	47
2014	10.6	10.6	31	27	57
2015	11.4	10.8	29	28	110
2016	9.8	10.2	31	24	113
2017	10.9	10.3	28	25	43
2018	11.1	10.2	27	24	38
2019	11.0	10.3	30	25	44
2020	9.6	10.5	25	25	40
2021	9.9	9.6	24	24	50

*Design value

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2021 Nitrogen Dioxide Summary

New Jersey Department of Environmental Protection

SOURCES

Nitrogen dioxide (NO_2) is a reddish-brown highly reactive gas that is formed in the air through the oxidation of nitric oxide (NO). NO_2 is used by regulatory agencies as the indicator for the group of gases known as nitrogen oxides (NO_x). These gases are emitted from motor vehicle exhaust, combustion of coal, oil or natural gas, and industrial processes such as welding, electroplating, and dynamite blasting. Although most NO_x is emitted as NO, it is readily converted to NO_2 in the atmosphere. In the home, gas stoves and heaters produce substantial amounts of nitrogen dioxide. When NO_2 reacts with other chemicals it can form ozone, particulate matter, and other pollutant compounds. A pie chart summarizing the major sources of NO_x in New Jersey in 2017 is shown in Figure 6-1.

Figure 6-2 shows that NO_x concentrations tend to be higher in the winter than in the summer. This is due in part to heating of buildings, and to weather conditions that are more prevalent in the colder months of the year, such as lighter winds that result in poorer local dispersion conditions.

Figure 6-1
2017 New Jersey
NO_x Annual Emissions

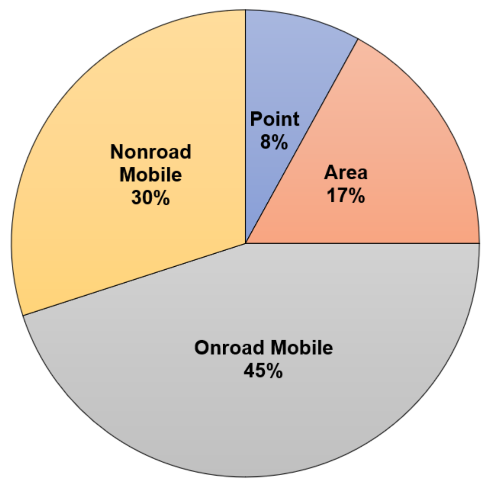
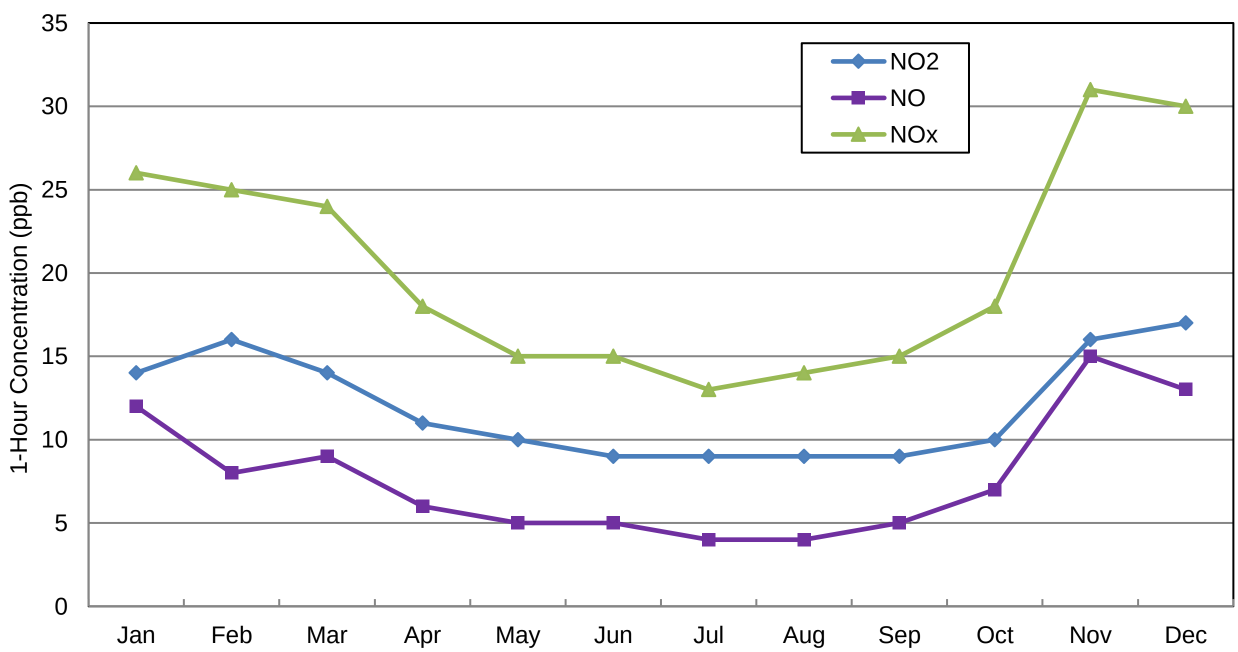
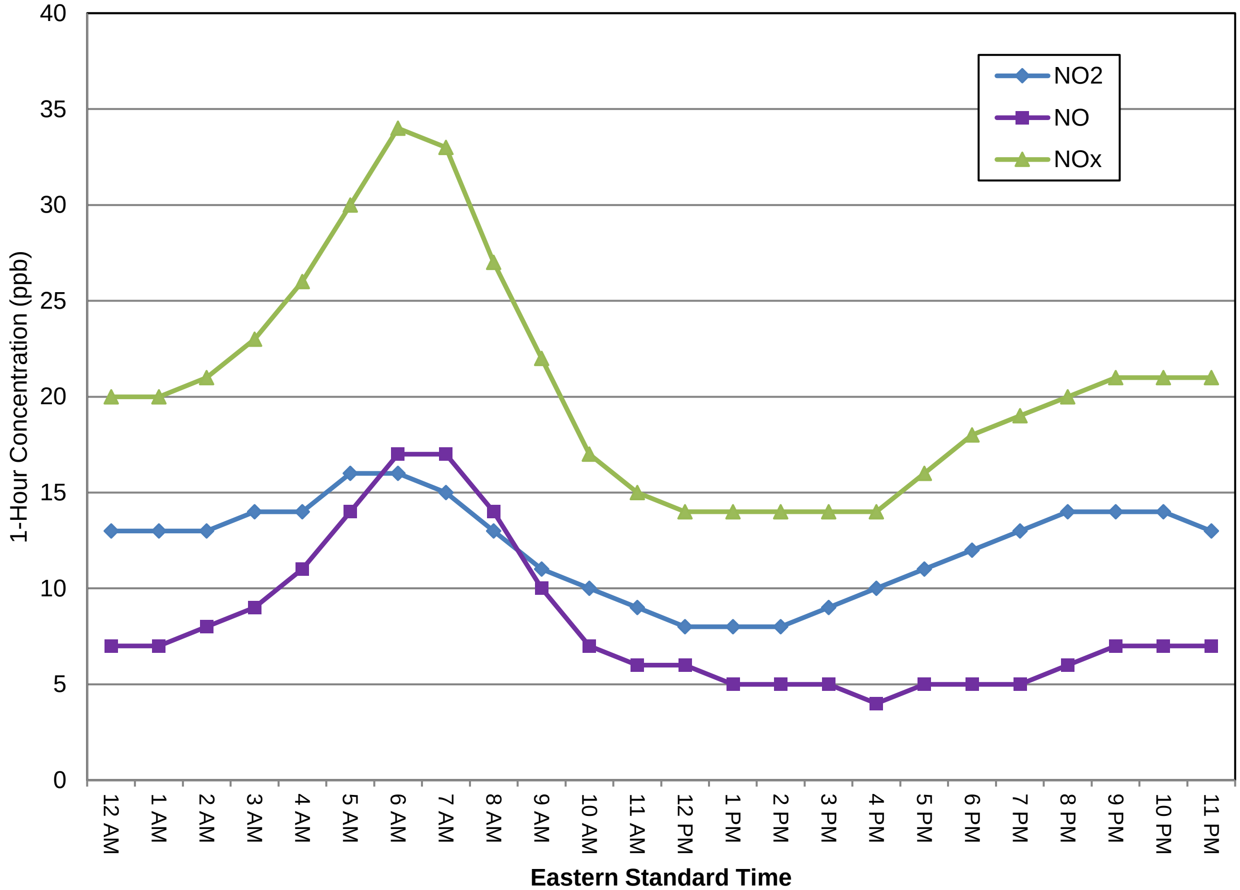


Figure 6-2
2021 Nitrogen Oxides Concentrations in New Jersey
Monthly Variation
Parts per Billion (ppb)



Because much of the NO_x in the air is emitted by motor vehicles, concentrations tend to peak during the morning and afternoon rush hours. This is shown in Figure 6-3.

Figure 6-3
2021 Nitrogen Oxides Concentrations in New Jersey
Daily Variation
Parts per Billion (ppb)



HEALTH AND ENVIRONMENTAL EFFECTS

Short-term exposures to low levels of nitrogen dioxide may aggravate pre-existing respiratory illnesses and cause respiratory illnesses in children, people with asthma, and the elderly. Symptoms of low-level exposure to NO and NO_2 include irritation to eyes, nose, throat and lungs, coughing, shortness of breath, tiredness and nausea. Long-term exposures to NO_2 may increase susceptibility to respiratory infection and may cause permanent damage to the lung. Studies show a connection between breathing elevated short-term NO_2 concentrations and increases in hospital emergency room visits and hospital admissions for respiratory issues, especially asthma. Individuals who spend time on or near major roadways can experience elevated short-term NO_2 exposures.

Nitrogen oxides contribute to a wide range of environmental problems. Chemical reactions in the air form both ozone and particulate matter. Nitrate particles make the air hazy and impair visibility, and contribute to nutrient pollution in coastal waters, resulting in eutrophication. NO_2 also reacts with water and oxygen to form nitric acid, a component of acid rain, which causes acidification of freshwater bodies and harms sensitive ecosystems such as lakes and forests.

AMBIENT AIR QUALITY STANDARDS

There are two types of National Ambient Air Quality Standards (NAAQS) established by the U.S. Environmental Protection Agency (USEPA), primary and secondary. Primary standards protect public health, including sensitive populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. A 1-hour primary standard for NO_2 of 100 parts per billion (ppb) was promulgated in 2010. The primary and secondary annual NAAQS for NO_2 is the same, a calendar year average concentration of 53 ppb. The annual New Jersey Ambient Air Quality Standards (NJAAQS) are identical to the NAAQS, except that micrograms per cubic meter (µg/m^3) are the standard units and the averaging time is any 12-month period (a running average) instead of a calendar year. Table 6-1 presents a summary of the NO_2 standards.

Table 6-1
National and New Jersey Ambient Air Quality Standards for Nitrogen Dioxide (NO2)
Parts per Billion (ppb)
Parts per Million (ppm)

Averaging Period	Type	National Level	New Jersey Level	Design Value
1-Hour	Primary	100 ppb	---	3-year average of the annual 98th percentile daily maximums
Annual	Primary & secondary	53 ppb	---	Annual mean
12-Month	Primary & secondary	---	0.05 ppm	Highest 12-month running average

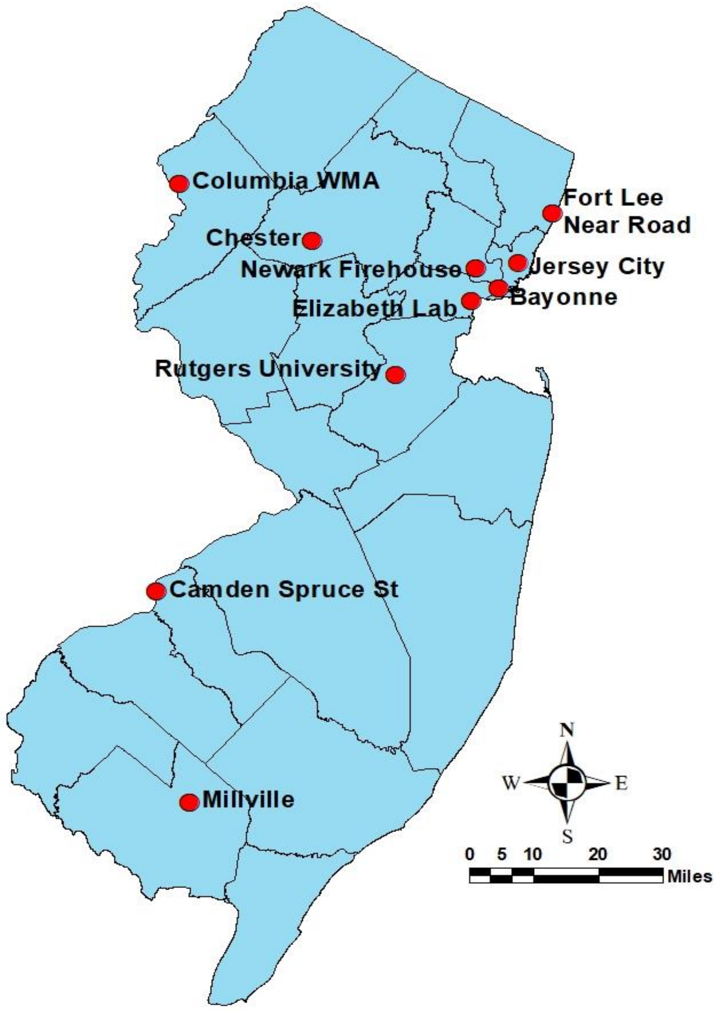
A state or other designated area is in compliance with a NAAQS when it meets the design value. For the annual standard, the annual average is the design value. However, for the 1-hour NO_2 standard, the NAAQS is met when the 3-year average of the 98^{th}-percentile of the daily maximum 1-hour NO_2 concentrations is less than 100 ppb. This statistic is calculated by first obtaining the maximum 1-hour average NO_2 concentrations for each day at each monitor. Then the 98^{th}-percentile value of the daily maximum NO_2 concentrations must be determined for the current year, and for each of the previous two years. Finally, the average of these three annual 98^{th}-percentile values is the design value.

NO_2 MONITORING NETWORK

NJDEP measured NO_2 levels at ten locations in 2021. The monitoring stations are Bayonne, Camden Spruce Street, Chester, Columbia, Elizabeth Lab, Fort Lee Near Road, Jersey City, Millville, Newark Firehouse, and Rutgers University. These sites are shown in Figure 6-4. These sites also measure NO and NOx, except for Rutgers, which measures NO and total reactive nitrogen (NO_y) as required for the Photochemical Assessment Monitoring Station (PAMS) Program. NO_y is also measured at Newark Firehouse, as required for an NCore Mulitpollutant Monitoring Network site.

The Jersey City monitoring station was shut down until May 6^{th} because of water damage at the site.

Figure 6-4
2021 Nitrogen Dioxide Monitoring Network



NO_2 LEVELS IN 2021

There were no exceedances of any NO_2 NAAQS in 2021.

See Table 6-2 and Figure 6-5 for 1-hour values for all the monitoring sites. The maximum daily 1-hour average concentration was 84 ppb, recorded at Elizabeth Lab. Elizabeth Lab also had the highest 1-hour 98th percentile value of 65 ppb, and the highest design value for 2019-2021, with 61 ppb.

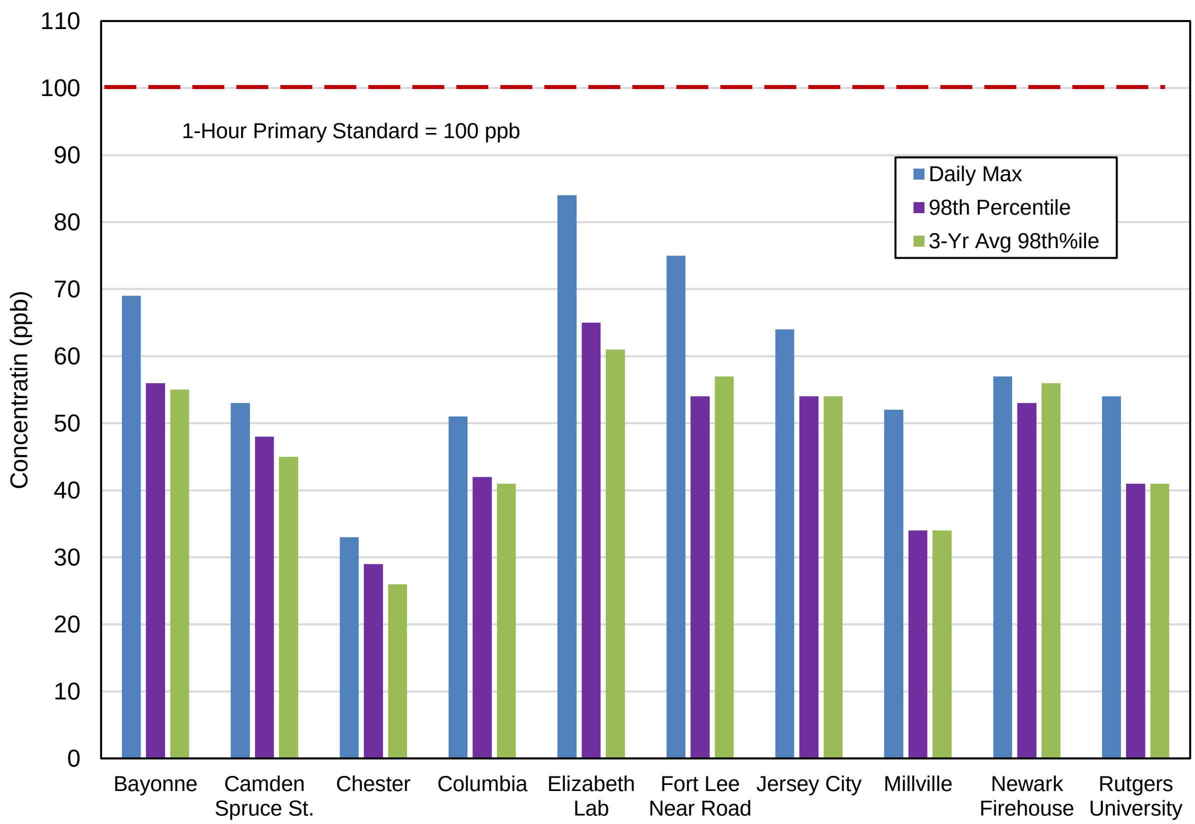
As noted, the Jersey City site had no data until May 6 because of a temporary shutdown.

Table 6-2
2021 Nitrogen Dioxide Concentrations in New Jersey
Maximum, 98th-Percentile, & 3-Year Average of 98th-Percentile Daily 1-Hour Averages
Parts per Billion (ppb)

Monitoring Site	1-Hour Average (ppb)		
	Daily Maximum	98th-Percentile	2019-2021 98th-%ile 3-Yr Avg
Bayonne	69	56	55
Camden Spruce St.	53	48	45
Chester	33	29	26
Columbia	51	42	41
Elizabeth Trailer	84	65	61
Fort Lee Near Road	75	54	57
Jersey City*	64	54	54
Millville	52	34	34
Newark Firehouse	57	53	56
Rutgers University	54	41	41

* Jersey City had no data from January 2021 until May 2021 because of a temporary shutdown.

Figure 6-5
2021 Nitrogen Dioxide Concentrations in New Jersey
Maximum, 98th-Percentile, & 3-Year Average of 98th-Percentile Daily 1-Hour Averages
Parts per Billion (ppb)



In order to meet the annual NAAQS for NO_2, the calendar-year average (January 1 to December 31) must be less than or equal to 53 ppb, rounded to no more than one decimal place. The NJAAQS is also 53 ppb, but it is compared to the maximum running 12-month average (of any twelve consecutive months in the year). As shown in Table 6-3 and Figure 6-6, both the highest calendar-year average of 19 ppb and the highest 12-month running average of 20 ppb occurred at the Elizabeth Lab monitoring station off Exit 13 of the New Jersey Turnpike. Both these values are well below the standards.

Table 6-3
2021 Nitrogen Dioxide Concentrations in New Jersey
Annual (12-Month) Averages
Parts per Billion (ppb)

Monitoring Site	12-Month Average (ppb)	
	Calendar Year	Maximum Running
Bayonne	15	15
Camden Spruce Street	11	11
Chester	3	3
Columbia	10	10
Elizabeth Lab	19	20
Fort Lee Near Road	15	16
Jersey City*	17	17
Millville	6	7
Newark Firehouse	14	15
Rutgers University	8	8

* Jersey City had no data from 1/1/21 to 5/6/21

Figure 6-6
2021 Nitrogen Dioxide Concentrations in New Jersey
Annual (12-Month) Averages
Parts per Billion (ppb)

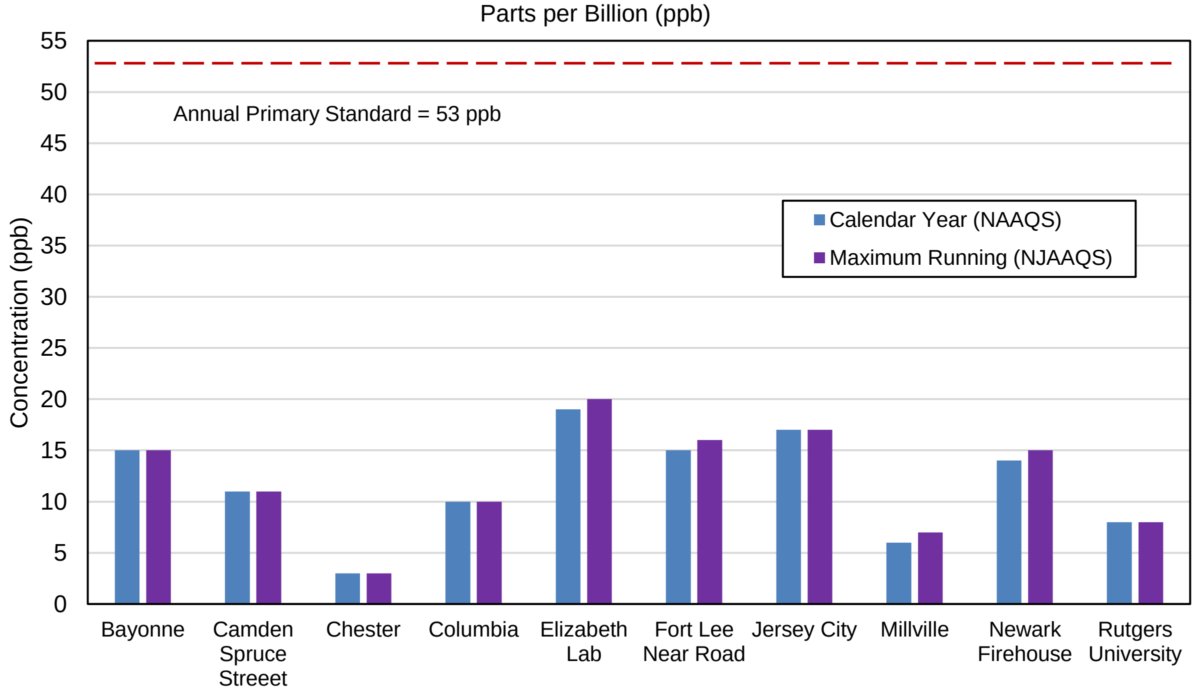


Figure 6-7 and Table 6-4 show the calendar-year annual average concentrations of NO_2, NO and NO_x at each New Jersey monitoring site. Even though there are no ambient air standards for NO and NO_x, the stations that measure NO_2 concentrations also measure them (except for Rutgers, which measures NO_y instead of NO_x). NO_x levels are approximately (not exactly) the sum of the NO_2 and NO concentrations. The concentration of NO tends to be lower than NO_2, because it quickly reacts with other air pollutants (particularly ozone) after it is emitted from a source and converts to NO_2. The Columbia monitoring site is an exception to this, with annual average levels of NO higher than NO_2. The monitor is about 100 feet from Interstate Highway 80. The road is a significant source of NO emissions from vehicles, but the expected conversion of NO to NO_2 is probably hindered by the area's relatively low levels of other pollutants.

Figure 6-7
2021 Nitrogen Oxides Concentrations in New Jersey
Annual Averages
Parts per Billion (ppb)

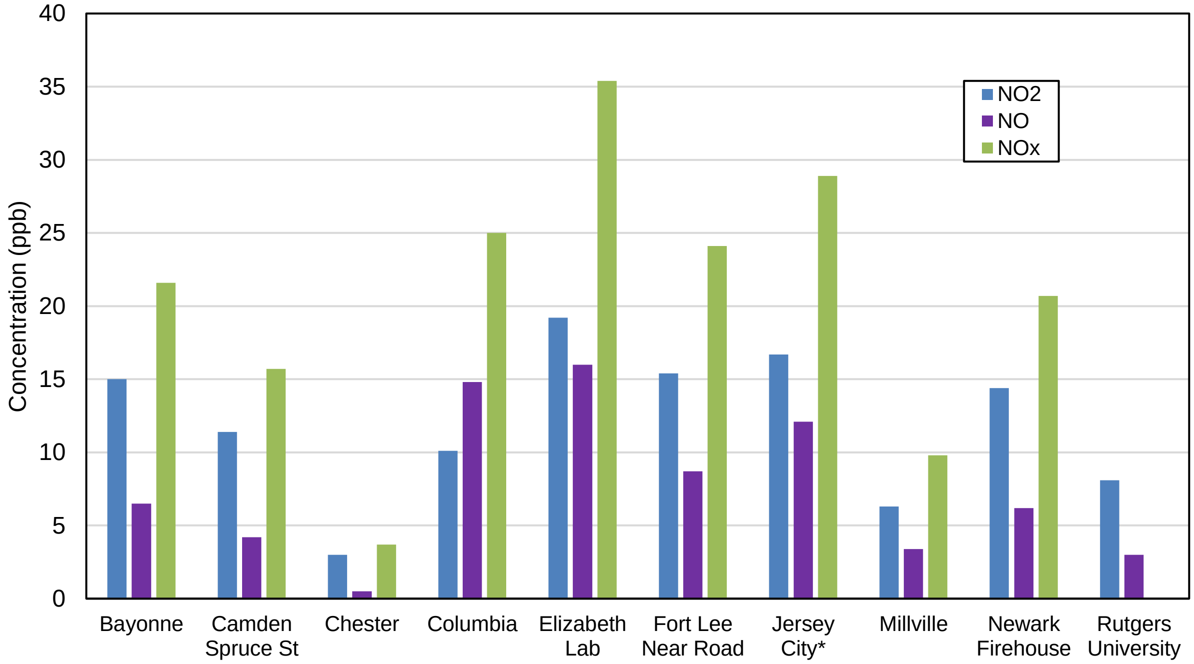


Table 6-4
2021 Nitrogen Oxides Concentrations in New Jersey
Annual Averages
Parts per Billion (ppb)

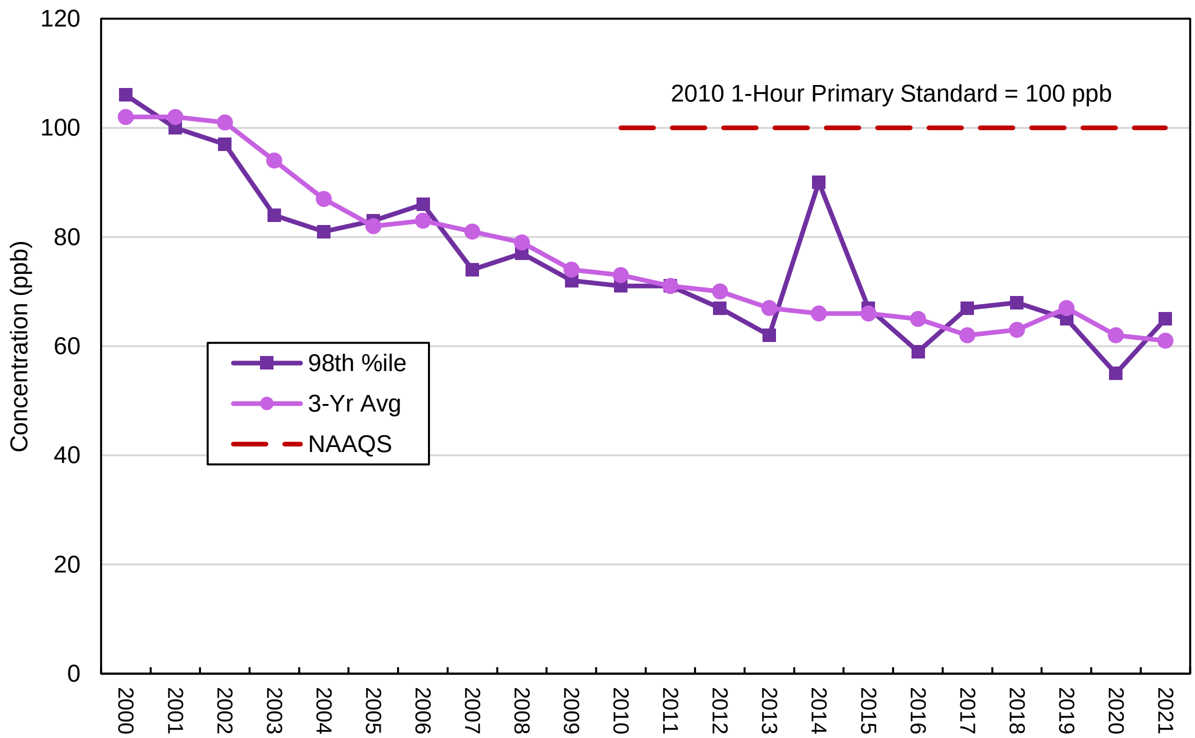
Site	NO_2	NO	NO_x
Bayonne	15	7	22
Camden Spruce Street	11	4	16
Chester	3	1	4
Columbia	10	15	25
Elizabeth Lab	19	16	35
Fort Lee Near Road	15	9	24
Jersey City*	17	12	29
Millville	6	4	10
Newark Firehouse	14	6	21
Rutgers University	8	3	

*The Jersey City site had no data 1/1-5/6/2021.

NO_2 TRENDS

New Jersey has not violated the 1-hour NAAQS since it was implemented in 2010. Figure 6-8 shows the highest statewide 98th percentile and design values for the 1-hour NAAQS for the years 2000-2021. The design value, which officially determines compliance with the 1-hour NO_2 NAAQS, is the highest 3-year average of the 98th percentile values of the daily maximum one-hour concentrations at any New Jersey monitoring site.

Figure 6-8
Statewide New Jersey Nitrogen Dioxide Trends, 1990-2021
98th Percentile & 3-Year Average 98th Percentile Daily Maximum 1-Hour Concentrations
Parts per Billion (ppb)



Routine monitoring for NO_2 in New Jersey began in 1966. The last year in which the annual average NO_2 concentration exceeded the NAAQS was 1974. The graph of NO_2 levels in Figure 6-9 shows the highest statewide annual average concentrations recorded from 1990 to 2021. Although NO_2 concentrations are well within the NAAQS, there is still a great deal of concern about the role of nitrogen oxides in the formation of other pollutants, most notably ozone and fine particles. Both pollutants still occasionally reach problematic levels in the northeastern United States. Efforts to reduce levels of ozone and fine particles are likely to require continued reductions in NO_x emissions.

The statewide trend data is also presented in Table 6-5.

Figure 6-9
Statewide New Jersey Nitrogen Dioxide Trend, 1990-2021
Highest Annual (Calendar Year) Average Concentrations
Parts per Billion (ppb)

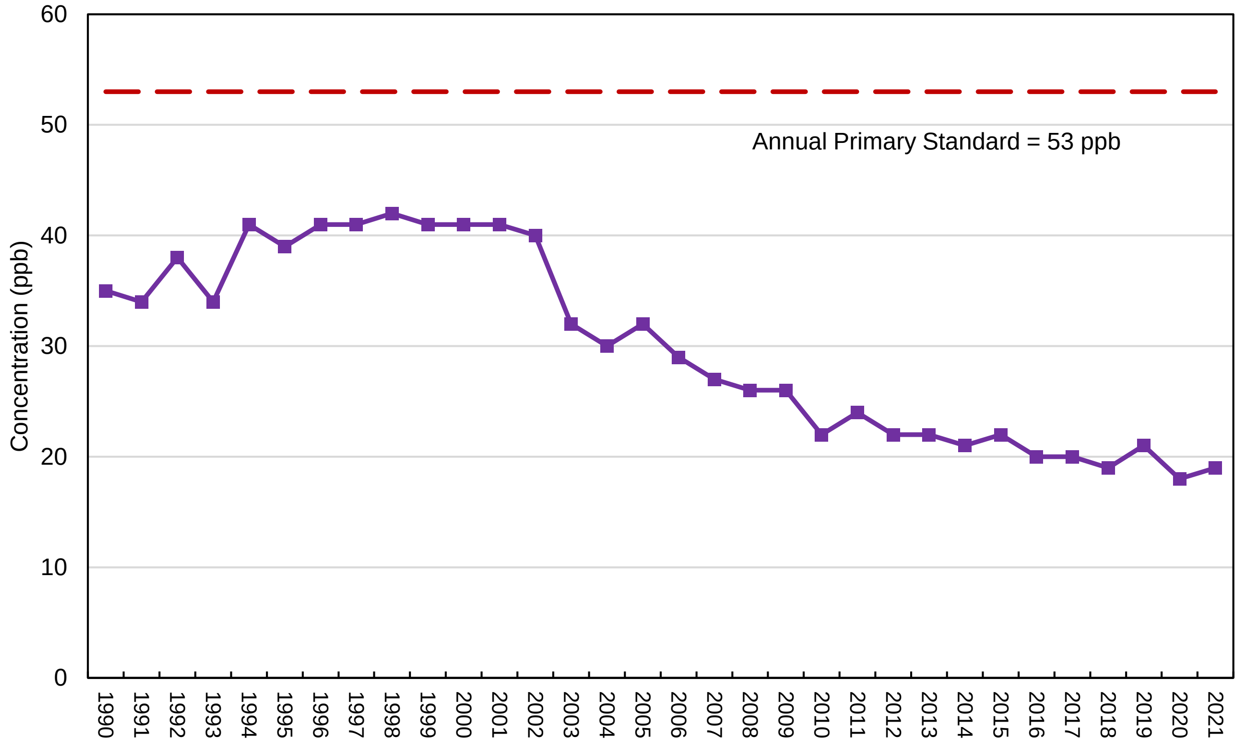


Table 6-5
Statewide New Jersey Nitrogen Dioxide Trends, 1990-2021
1-Hour Daily & 3-Year Average of 98th Percentile Concentrations
Annual Maximum Average Concentrations
Parts per Billion (ppb)

Year	1-Hour Daily		Annual Average*
	98th Percentile	3-Year Average of 98th Percentile*	
1990	112	---	35
1991	103	---	34
1992	120	112	38
1993	96	106	34
1994	116	111	41
1995	92	101	39
1996	104	104	41
1997	106	101	41
1998	101	104	42
1999	100	102	41
2000	106	102	41
2001	100	102	41
2002	97	101	40
2003	84	94	32
2004	81	87	30
2005	83	82	32
2006	86	83	29
2007	74	81	27
2008	77	79	26
2009	72	74	26
2010	71	73	22
2011	71	71	24
2012	67	70	22
2013	62	67	22
2014	90	66	21
2015	67	66	22
2016	59	65	20
2017	67	62	20
2018	68	63	19
2019	65	67	21
2020	55	62	18
2021	65	61	19

*Design value

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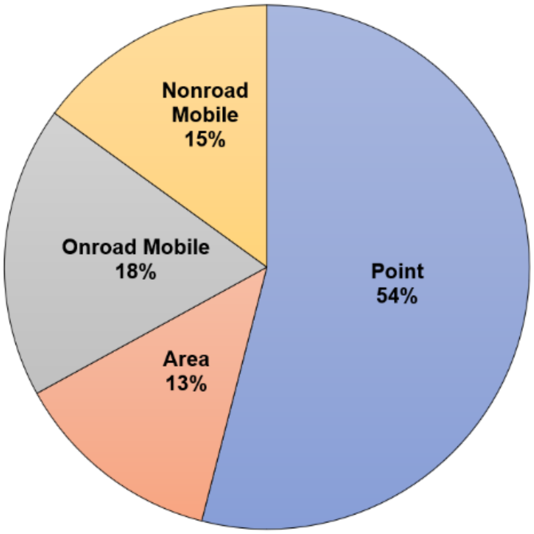
2021 Sulfur Dioxide Summary

New Jersey Department of Environmental Protection

Sources

Sulfur dioxide (SO_2) is a heavy, colorless gas with a suffocating odor, that easily dissolves in water to form sulfuric acid. SO_2 gases are formed when fuels containing sulfur (coal, oil, and gasoline) are burned, or when gasoline is extracted from oil. Most of the sulfur dioxide released into the air comes from fuel combustion in electric utilities, especially those that burn coal with a high sulfur content. Sulfur is found in raw materials such as crude oil, coal, and ores that contain metals. Industrial facilities that derive their products from these materials may also release SO_2. The pie chart in Figure 7-1 summarizes the primary sources of SO_2 in New Jersey in 2017.

Figure 7-1
2017 New Jersey
SO_2 Annual Emissions



Health and Environmental Effects

Sulfur dioxide causes irritation of the mucous membranes. This is probably the result of sulfurous acid forming when the highly soluble SO_2 gas dissolves at the surface of the membranes. Groups that are especially susceptible to the harmful health effects of SO_2 include children, the elderly, and people with heart or lung disorders such as asthma. When SO_2 concentrations in the air become elevated, people in these sensitive groups and those who are active outdoors may have trouble breathing.

Sulfur dioxide reacts with other gases and particles in the air to form sulfates, which also can be harmful to people and the environment. Sulfate particles are the major cause of reduced visibility in the eastern United States. SO_2 forms acids that fall to the earth in rain and snow. Better known as acid rain, this acidic precipitation can damage forests and crops, can make lakes and streams too acidic for fish, and can speed up the decay of building materials and paints.

AMBIENT AIR QUALITY STANDARDS

The current National Ambient Air Quality Standards (NAAQS) for SO_2 are shown in Table 7-1. Primary standards are set to provide public health protection, including protecting the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. In June 2010 the United States Environmental Protection Agency (USEPA) established a new primary 1-hour NAAQS for SO_2 at a level of 75 parts per billion (ppb). At the same time, the old 24-hour and annual average NAAQS were revoked, and the 3-hour secondary NAAQS was retained. Compliance with the 1-hour standard is determined by calculating the 99th percentile of 1-hour daily maximum concentrations for each monitoring site in the state each year, and then averaging each site's values for the three most recent years. This statistic is called the design value. Compliance with the secondary standard is based on the second-highest 3-hour average concentration for a given year.

Table 7-1 also shows New Jersey's ambient air quality standards (NJAAQS) for SO_2, which are based on the older NAAQS. NJAAQS for SO_2 are calculated using running averages (consecutive 3-hour, 24-hour and 12 month averages) rather than calendar year or non-overlapping block averages. The secondary 3-hour New Jersey standard is the same as the NAAQS, except that New Jersey uses a running average. Also, the NJAAQS use ppm units instead of ppb.

Table 7-1
National and New Jersey Ambient Air Quality Standards for Sulfur Dioxide (SO_2)
Parts per Billion (ppb)
Parts per Million (ppm)

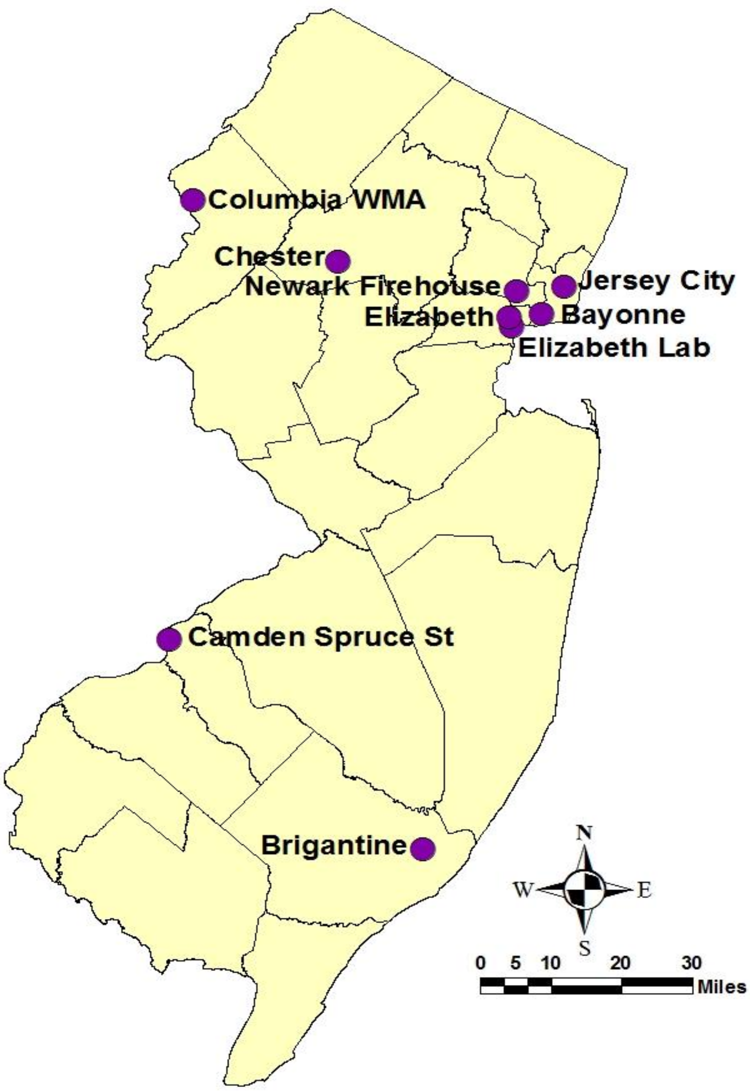
Averaging Period	Type	National Level	New Jersey Level[a]	Design Value
1–hour	Primary	75 ppb	---	3-year average of the annual 99th percentile daily maximums
3–hours	Secondary	0.5 ppm[b]	0.5 ppm	Annual 2nd-highest
24–hours	Primary	---	0.14 ppm	Annual 2nd-highest
24–hours	Secondary	---	0.1 ppm	Annual 2nd-highest
12–months	Primary	---	0.03 ppm	Not to be exceeded
12–months	Secondary	---	0.02 ppm	Not to be exceeded

[a] Based on running averages, over any 12 consecutive months.
[b] Based on successive non-overlapping blocks, beginning at midnight each day.

SO_2 MONITORING NETWORK

The New Jersey Department of Environmental Protection (NJDEP) monitored SO_2 levels at nine sites in 2021. The monitoring stations are Bayonne, Brigantine, Camden Spruce Street, Chester, Columbia, Elizabeth, Elizabeth Lab, Jersey City, and Newark Firehouse. Their locations are shown in Figure 7-2. However, the Jersey City monitoring station was closed until mid-May 2021 because of storm damage suffered in 2020.

Figure 7-2
2021 Sulfur Dioxide Monitoring Network



SO_2 LEVELS IN 2021

For 2021, there were no exceedances of any NAAQS. 1-hour data is presented in Table 7-2 and Figure 7-3. Chester had the highest 1-hour value at 19.9 ppb and Columbia had the second-highest 1-hour value at 9.5 ppb. Camden Spruce Street had the highest 99th percentile value at 5.5 ppb. The highest design value, the 3-year average of the 99th percentile of the daily maximum 1-hour SO_2 concentrations, was at Jersey City with a value of 8 ppb.

Three-hour averages for all sites were well below the national and New Jersey 3-hour secondary standards of 0.5 ppm. The NAAQS is based on successive non-overlapping 3-hour blocks, while the NJAAQS uses running 3-hour averages (although the second-highest value can't overlap the highest value). The highest values were measured at Columbia. The block averages were 0.0080 and 0.0078 ppm, and the running averages were 0.0082 and 0.0080 ppm. Results are shown in Table 7-3 and Figure 7-4.

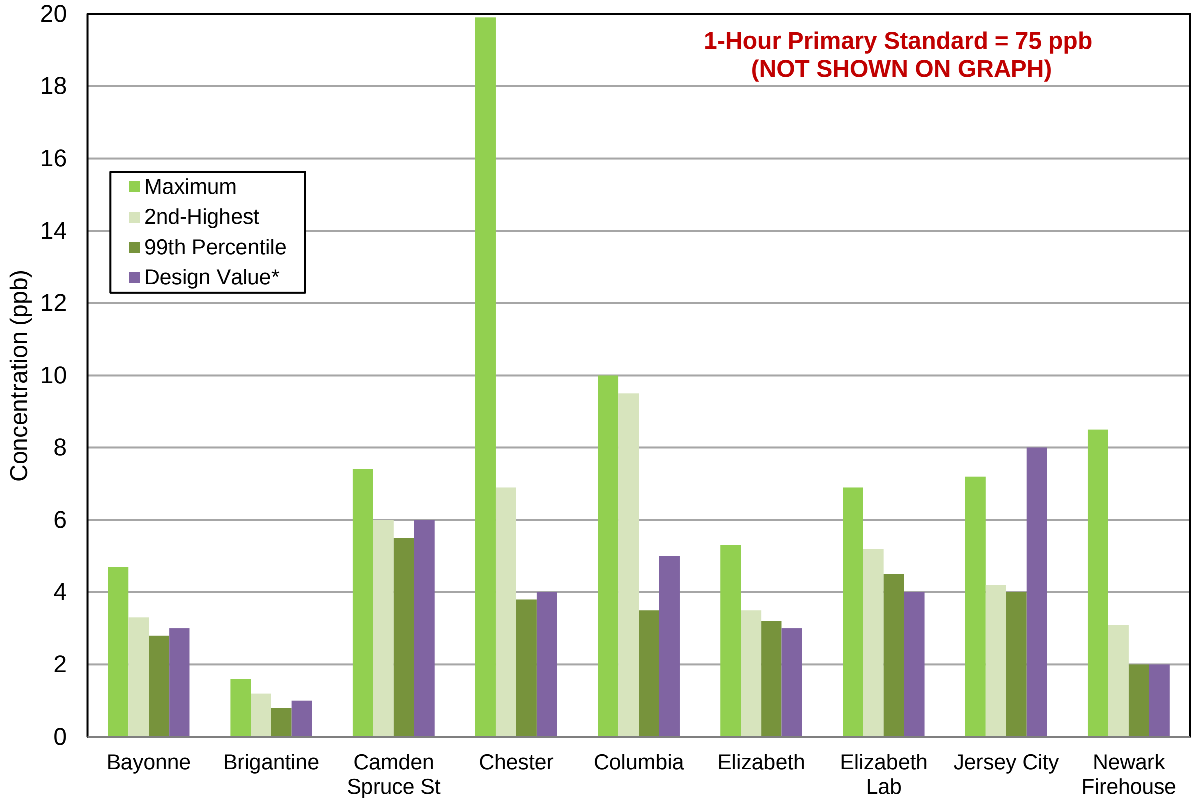
The New Jersey 24-hour ambient air quality standard is 0.14 ppm, and the 12-month standard is 0.03 ppm. In 2021, the highest values were all at the Jersey City site. The highest and second-highest 24-hour average concentrations were 0.0032 ppm and 0.0031 ppm. The highest 12-month running average concentration of was 0.0035 ppm. See Tables 7-4 and 7-5, and Figures 7-5 and 7-6, for data for the other monitoring sites.

Table 7-2
2021 Sulfur Dioxide Concentrations in New Jersey
1-Hour Averages & Design Values
Parts per Billion (ppb)

Monitoring Site	1-Hour Average (ppb)			2019-2021 Design Value[a]
	Highest Daily Maximum	2nd-Highest Daily Maximum	99th Percentile Daily Maximum	
Bayonne	4.7	3.3	2.8	3
Brigantine	1.6	1.2	0.8	1
Camden Spruce Street	7.4	6.0	5.5	6
Chester	19.9	6.9	3.8	4
Columbia	10.0	9.5	3.5	5
Elizabeth	5.3	3.5	3.2	3
Elizabeth Lab	6.9	5.2	4.5	4
Jersey City*	7.2	4.2	4.0	8
Newark Firehouse	8.5	3.1	2.0	2

[a] 3-Year (2019-2021) average of the 99th percentile 1-hour daily maximum concentrations.
*The Jersey City monitoring station did not meet completeness criteria for 2021 because of a temporary shutdown at the site.

Figure 7-3
2021 Sulfur Dioxide Concentrations in New Jersey
1-Hour Averages & Design Values
Parts per Billion (ppb)



*Design value = 3-year average of the 99th percentile 1-hour daily maximum concentrations.

Table 7-3
2021 Sulfur Dioxide Concentrations in New Jersey
3-Hour Averages
Parts per Million (ppm)

Monitoring Site	3-Hour Average Concentrations			
	Block[a]		Running[b]	
	Maximum	2nd-Highest	Maximum	2nd-Highest*
Bayonne	0.0030	0.0025	0.0030	0.0028
Brigantine	0.0013	0.0009	0.0014	0.0009
Camden Spruce Street	0.0050	0.0036	0.0050	0.0045
Chester	0.0072	0.0038	0.0072	0.0038
Columbia	0.0080	0.0078	0.0082	0.0080
Elizabeth	0.0037	0.0031	0.0046	0.0031
Elizabeth Lab	0.0041	0.0040	0.0050	0.0041
Jersey City	0.0039	0.0038	0.0041	0.0036
Newark Firehouse	0.0029	0.0016	0.0028	0.0020

[a] NAAQS
[b] NJAAQS
*Non-overlapping

Figure 7-4
2021 Sulfur Dioxide Concentrations in New Jersey
2nd Highest 3-Hour Averages
Parts per Million (ppm)

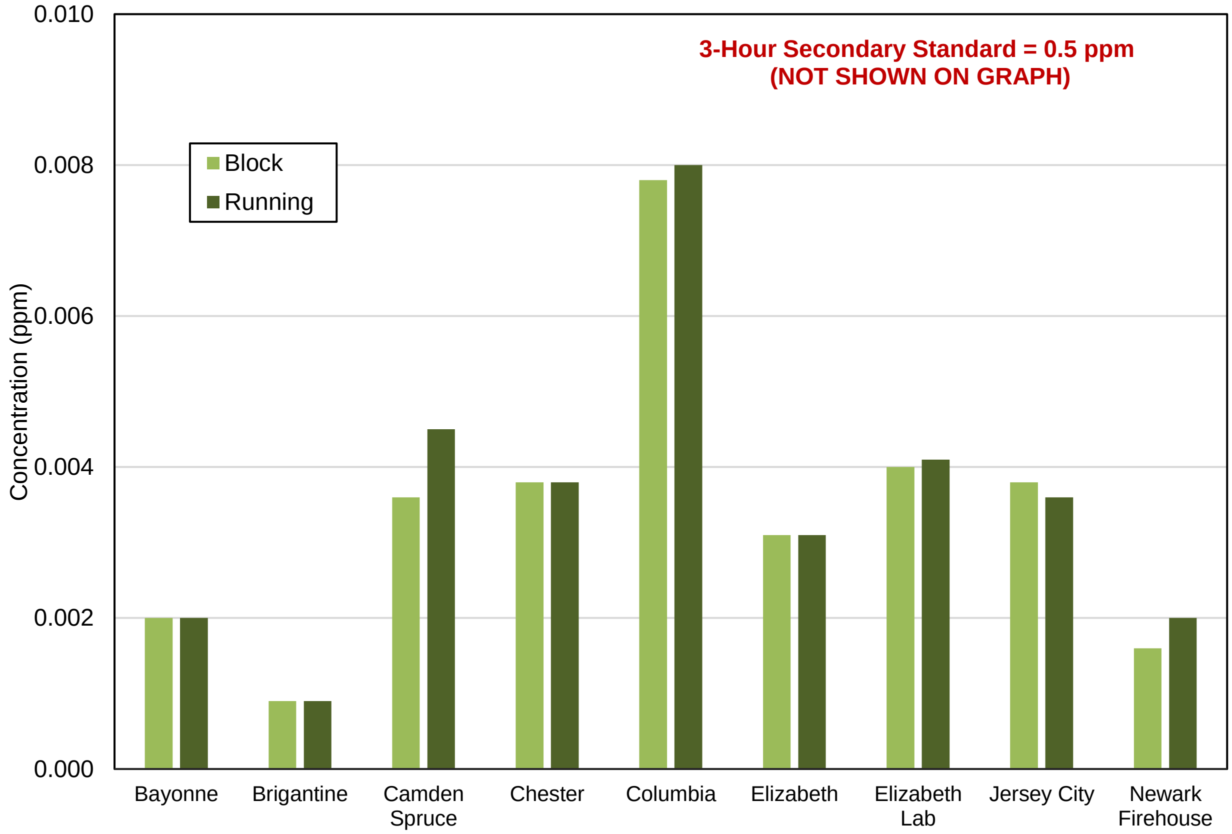


Table 7-4
2021 Sulfur Dioxide Concentrations in New Jersey
24-Hour Running Averages
Parts per Million (ppm)

Monitoring Site	24-Hour Running Average	
	Maximum	2nd Highest (Non-overlapping)
Bayonne	0.0013	0.0012
Brigantine	0.0004	0.0001
Camden Spruce Street	0.0028	0.0028
Chester	0.0013	0.0017
Columbia	0.0026	0.0025
Elizabeth	0.0021	0.0019
Elizabeth Lab	0.0021	0.0021
Jersey City	0.0032	0.0031
Newark Firehouse	0.0009	0.0008

Figure 7-5
2021 Sulfur Dioxide Concentrations in New Jersey
24-Hour Running Averages
Parts per Million (ppm)

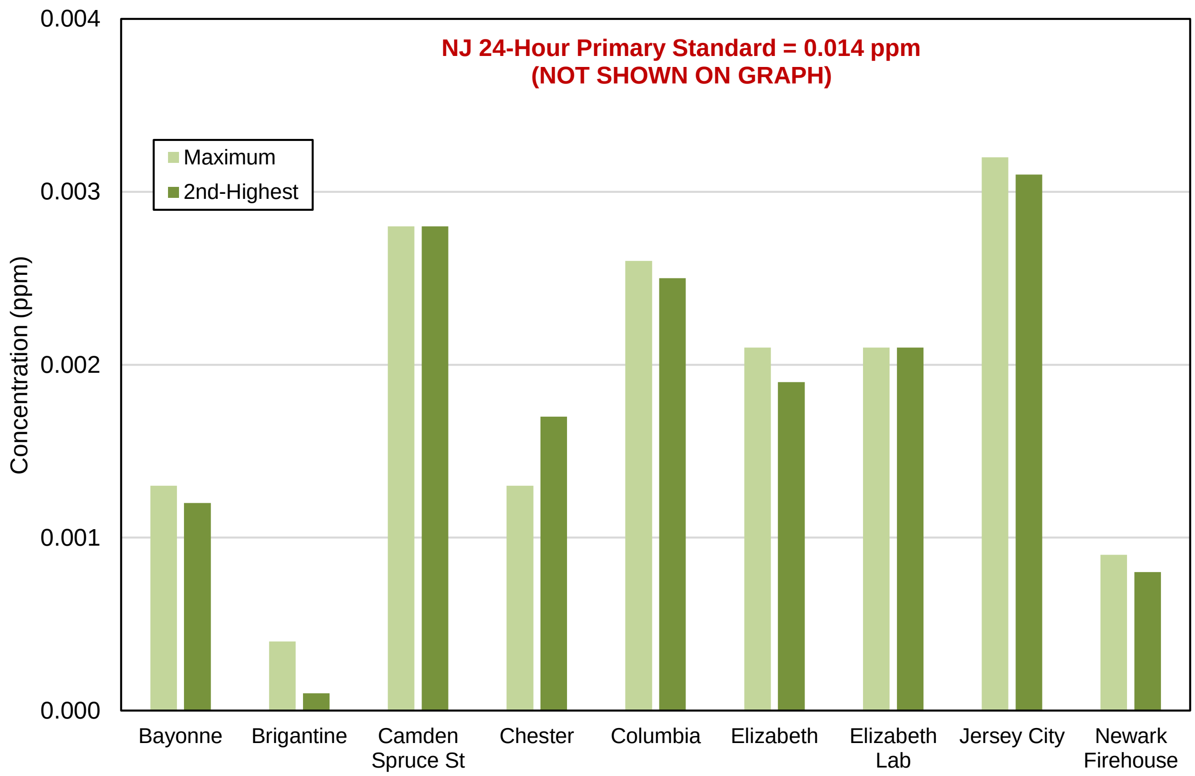
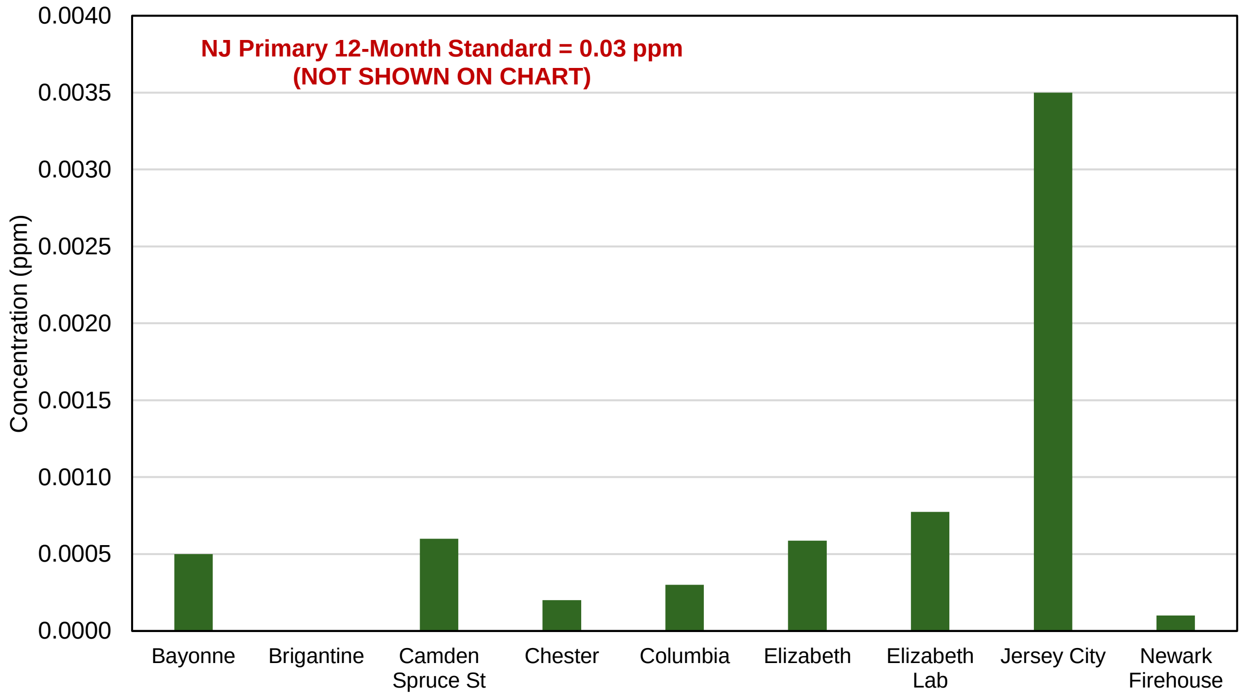


Table 7-5
2021 Sulfur Dioxide Concentrations in New Jersey
Maximum 12-Month Running Averages
Parts per Million (ppm)

Monitoring Site	Maximum 12-Month Running Average
Bayonne	0.0005
Brigantine	0.0000
Camden Spruce Street	0.0006
Chester	0.0002
Columbia	0.0003
Elizabeth	0.0006
Elizabeth Lab	0.0008
Jersey City	0.0035
Newark Firehouse	0.0001

Figure 7-6
2021 Sulfur Dioxide Concentrations in New Jersey
Maximum 12-Month Running Averages
Parts per Million (ppm)



SO_2 TRENDS

Sulfur dioxide concentrations across the country have decreased significantly since the first NAAQS were set in 1971. Figure 7-7 shows the second-highest daily average concentrations of SO_2 recorded in New Jersey each year since 1980 (also see Table 7-6). Nationwide efforts to reduce ambient sulfur levels have focused on sulfur in fuels. Regulations passed in 2000 reduced the sulfur content of gasoline by up to 90 percent, and enabled the use of new emission control technologies in cars, sport utility vehicles (SUVs), minivans, vans and pick-up trucks (beginning with model year 2004). Even more stringent gasoline and emissions controls for sulfur went into effect in 2017. And in New Jersey, limits on sulfur in commercial fuel oil were implemented beginning in 2014.

A coal-burning power plant across the Delaware River in Pennsylvania had for many years been suspected of causing high SO_2 levels in New Jersey. Air dispersion modeling carried out by NJDEP showed that the facility was causing likely violations of the SO_2 NAAQS. New Jersey petitioned the USEPA under Section 126 of the Clean Air Act to take action against the Portland Power Plant. In support of the petition, NJDEP established an SO_2 monitoring station at the Columbia Wildlife Management Area in Knowlton Township, Warren County, in September 2010. The dramatic increase in the monitored 99th percentile 1-hour SO_2 concentration in 2010 (shown in Figure 7-8) is attributable to measurements taken at the Columbia site. In October 2011, USEPA finalized a rule to grant New Jersey's petition. This final rule required the Portland Power Plant to reduce its SO_2 emissions such that the plant's contribution to predicted air quality standard violations would be lowered within one year, and completely eliminated within three years. The power plant stopped operating in mid-2014. Recent monitoring data has shown that Warren County and its vicinity are now able to meet the 1-hour SO_2 NAAQS.

Figure 7-8 also shows the trend in the design value, the value that determines compliance with the NAAQS. The design value for the 1-hour NAAQS is the 3-year average of the 99th percentile of the daily maximum 1-hour concentrations of SO_2 at each site. The values presented are the highest statewide for a given year.

Figure 7-7
Statewide New Jersey Sulfur Dioxide Trend, 1980-2021
2nd-Highest 24-Hour Average Concentrations
Parts per Billion (ppb)

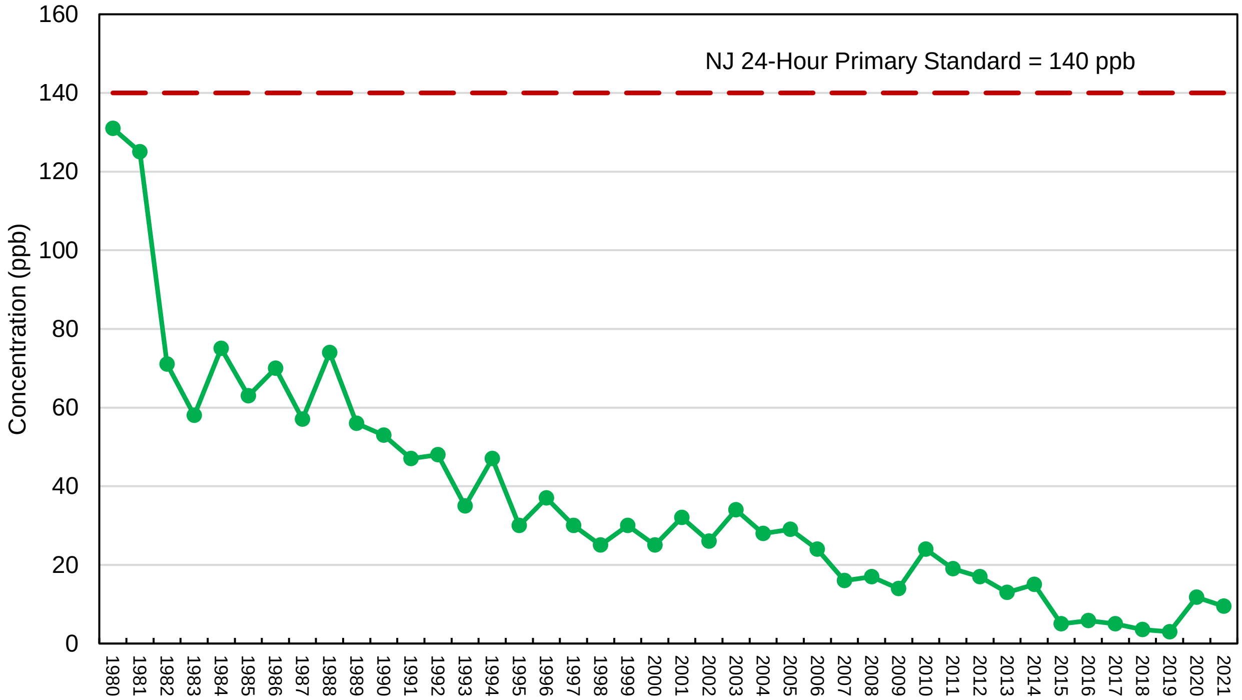


Figure 7-8
Statewide New Jersey Sulfur Dioxide Trends, 1980-2021
99th Percentile & 3-Year Average of the 99th Percentile Daily Maximum 1-Hour Concentrations
Parts per Billion (ppb)

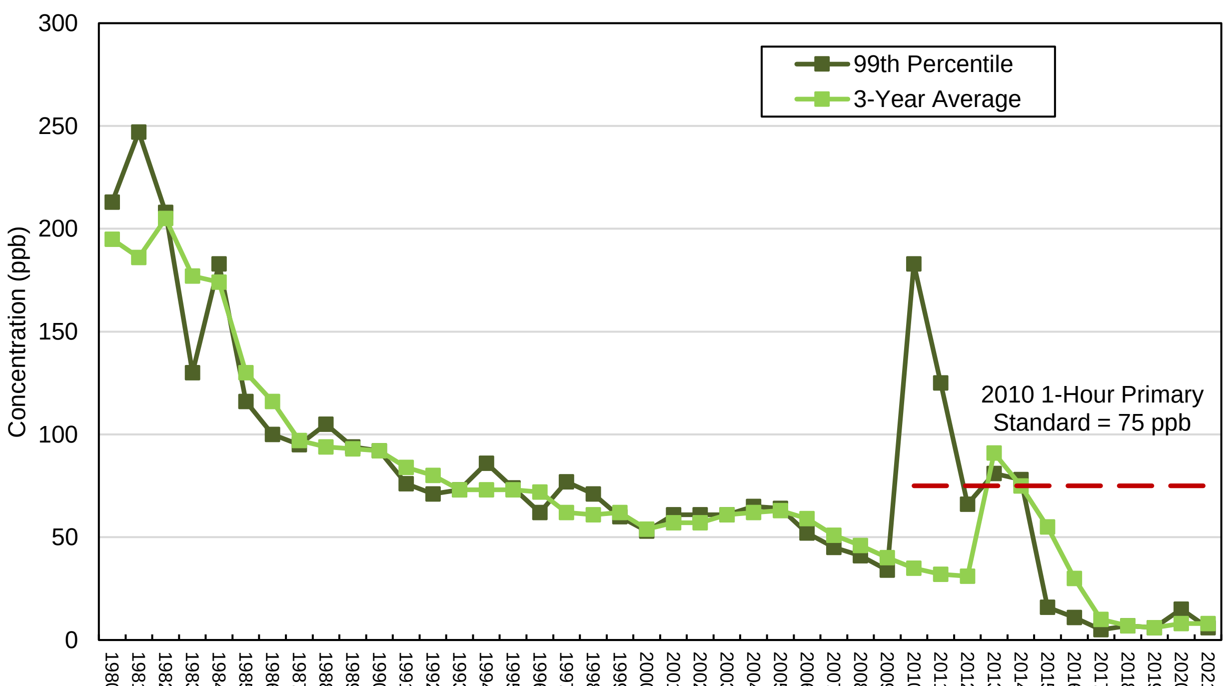


Table 7-6
Statewide New Jersey Sulfur Dioxide Trends
Parts per Billion (ppb)

Year	24-Hour Average	1-Hour Daily Maximum	
	2nd-Highest	99th Percentile	3-Year Average*
1980	131	213	195
1981	125	247	186
1982	71	208	205
1983	58	130	177
1984	75	183	174
1985	63	116	130
1986	70	100	116
1987	57	95	97
1988	74	105	94
1989	56	94	93
1990	53	92	92
1991	47	76	84
1992	48	71	80
1993	35	73	73
1994	47	86	73
1995	30	74	73
1996	37	62	72
1997	30	77	62
1998	25	71	61
1999	30	60	62
2000	25	53	54
2001	32	61	57
2002	26	61	57
2003	34	61	61
2004	28	65	62
2005	29	64	63
2006	24	52	59
2007	16	45	51
2008	17	41	46
2009	14	34	40
2010	24	183	35
2011	19	125	32
2012	17	66	31
2013	13	81	91
2014	15	78	75
2015	5	16	55
2016	5.8	11	30
2017	5	5	10
2018	3.5	7	7
2019	3	6	6
2020	11.8	15	8
2021	9.5	6	8

*Design value

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2021 Carbon Monoxide Summary

New Jersey Department of Environmental Protection

Sources

Carbon monoxide (CO) is a colorless, odorless gas formed when carbon in fuels is not burned completely. The main source of outdoor CO is exhaust from internal combustion engines, primarily on-road vehicles, as well as non-road vehicles, generators, construction equipment, boats and other types of mobile sources. Fifty percent of all CO emissions nationwide are attributable to mobile sources, and over 90% in New Jersey. Significant amounts of CO are also emitted from fuel combustion in boilers and incinerators, natural sources such as forest fires, and various industrial processes. A pie chart estimating the contribution of different source categories of CO in New Jersey in 2017 (latest estimate available) is shown in Figure 8-1.

Outdoor concentrations of CO can rise during atmospheric inversions. This phenomenon occurs when cooler air is trapped beneath a layer of warmer air, which often occurs overnight. The inversion acts like a lid, preventing pollution from mixing in the atmosphere and effectively trapping it close to the ground (see Figure 8-2). This can allow CO to accumulate at ground-level.

Figure 8-1
2017 New Jersey
CO Annual Emissions

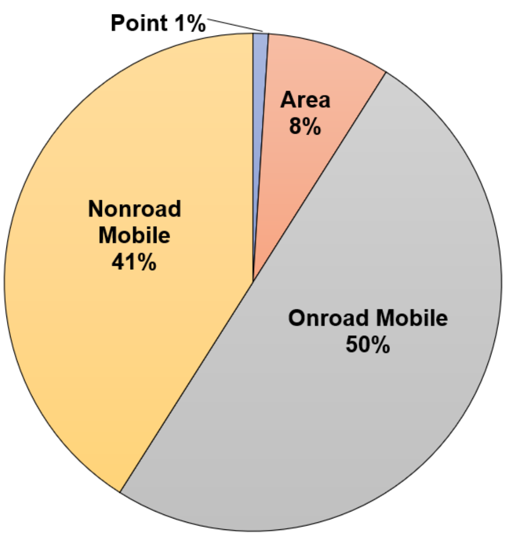
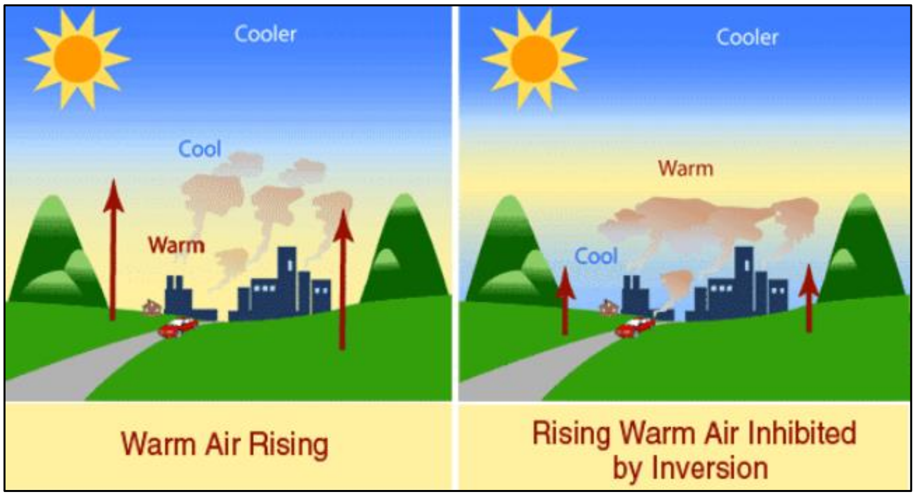


Figure 8-2
Effect of Atmospheric Inversion on Pollution Levels



https://www.epa.gov/pmcourse/what-particle-pollution

HEALTH EFFECTS

Carbon monoxide reduces the oxygen-carrying capacity of blood, therefore reducing the distribution of oxygen to organs like the heart and brain. The most common symptoms of exposure to high concentrations of carbon monoxide are headaches and nausea. Exposure to extremely high concentrations, usually resulting from combustion exhaust accumulating in enclosed indoor spaces, can be life-threatening. Such high levels of CO are not likely to occur outdoors. The health threat from exposure to outdoor CO is most serious for those who suffer from cardiovascular disease. For a person with heart disease, a single exposure to CO at low levels may reduce that individual's ability to exercise and may cause chest pain (also known as angina).

AMBIENT AIR QUALITY STANDARDS

National Ambient Air Quality Standards (NAAQS) for CO are summarized in Table 8-1. Primary standards are set to protect the health of the public, including sensitive populations such as asthmatics, children, and the elderly. For carbon monoxide, there are currently two primary health-based, NAAQS: a 1-hour standard of 35 parts per million (ppm), and an 8-hour standard of 9 ppm. These levels are not to be exceeded more than once in any calendar year, so the design values, or the actual statistical values that determine compliance with the NAAQS, are the second-highest 1-hour and 8-hour values in a given year. Even though New Jersey's primary standards are the same as the NAAQS, the 8-hour state standard is based on a running average, not to be exceeded more than once in a 12-month period, rather than a calendar year.

Secondary standards provide public welfare protection from decreased visibility and damage to animals, crops, vegetation, and buildings. Although there are no national secondary standards for CO at this time, New Jersey has set secondary standards for CO equal to the primary standards.

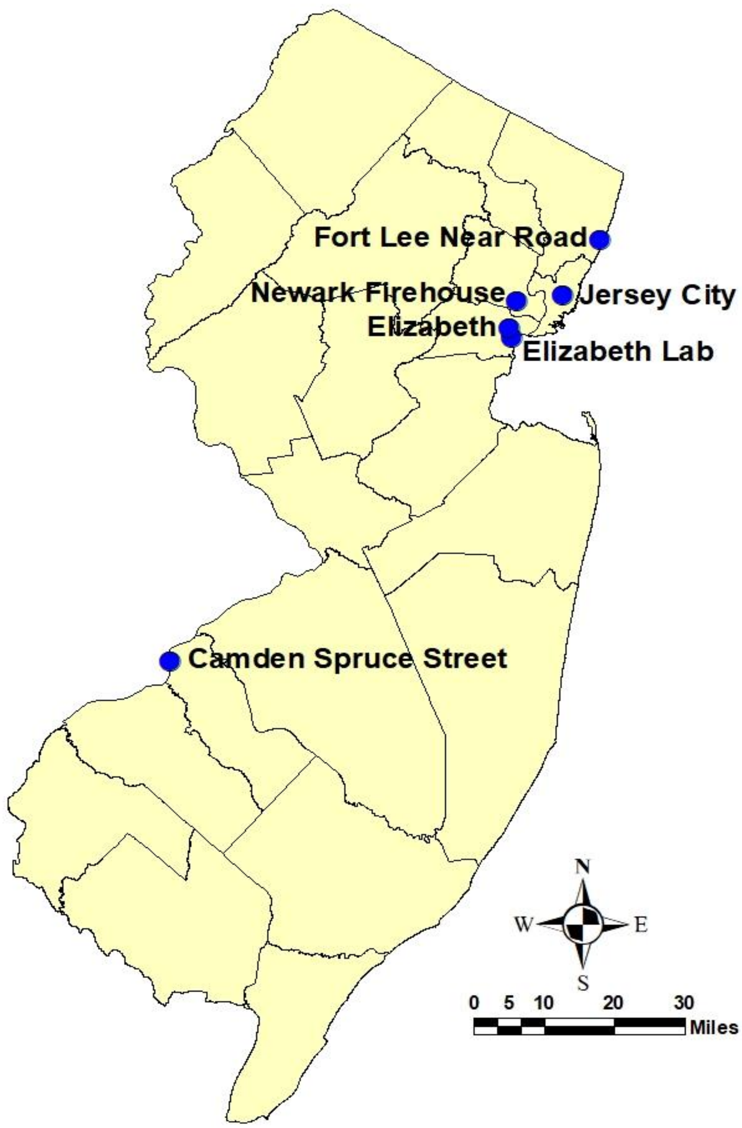
Table 8-1
National and New Jersey Ambient Air Quality Standards
for Carbon Monoxide
Parts per Million (ppm)

Averaging Period	Type	National Level	New Jersey Level	Design Value
1-Hour	Primary	35 ppm	35 ppm	Annual 2nd-highest
1-Hour	Secondary	----	35 ppm	2nd-highest 12-month value
8-Hours	Primary	9 ppm	9 ppm	Annual 2nd-highest
8-Hours	Secondary	----	9 ppm	2nd-highest 12-month value

CO Monitoring Network

The New Jersey Department of Environmental Protection (NJDEP) has six CO monitors around the state, as shown on the map in Figure 8-3. The Newark Firehouse station is part of the U.S. Environmental Protection Agency's (USEPA) National Core Multipollutant Monitoring Network (NCore). It measures and reports CO concentrations at trace levels, down to a thousandth of a ppm (0.000 ppm). The other stations are Camden Spruce Street, Elizabeth, Elizabeth Lab, Fort Lee Near Road, and Jersey City. The Jersey City site was temporarily shut down on October 31, 2020, because of storm damage. It was finally reopened in early May of 2021.

Figure 8-3
2021 Carbon Monoxide Monitoring Network



CO LEVELS IN 2021

There were no exceedances of any CO standards at any of the New Jersey monitoring sites during 2021. The maximum and 2nd-highest 1-hour average CO concentrations, both recorded at the Newark Firehouse site, were 3.072 ppm and 2.987 ppm. The highest 8-hour average CO concentration was 2.3 ppm at both the Elizabeth and Newark Firehouse. Elizabeth also had the greatest second-highest 8-hour average concentration of 2.2 ppm. The 2021 data is summarized in Table 8-2, and Figures 8-4 and 8-5.

Table 8-2
2021 Carbon Monoxide Concentrations in New Jersey
Parts per Million (ppm)

Monitoring Site	1-Hour Average Concentrations		8-Hour Average Concentrations	
	Highest	2nd-Highest	Highest	2nd-Highest*
Camden Spruce Street	2.2	2.0	1.7	1.2
Elizabeth	2.6	2.5	**2.3**	**2.2**
Elizabeth Lab	1.8	1.8	1.3	1.3
Fort Lee Near Road	1.3	1.2	0.9	0.9
Jersey City	1.9	1.9	1.6	1.4
Newark Firehouse	**3.072**	**2.987**	**2.3**	1.9

*Non-overlapping 8-hour periods

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Figure 8-4
2021 Carbon Monoxide Concentrations in New Jersey
1-Hour Averages
Parts per Million (ppm)

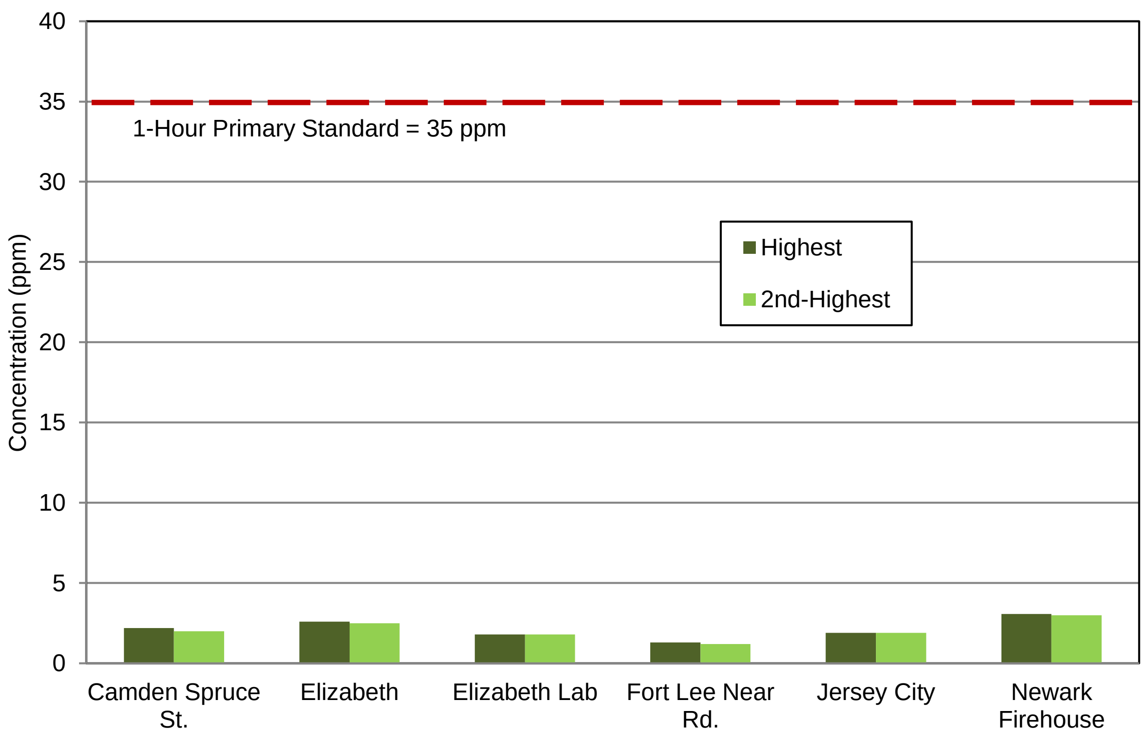
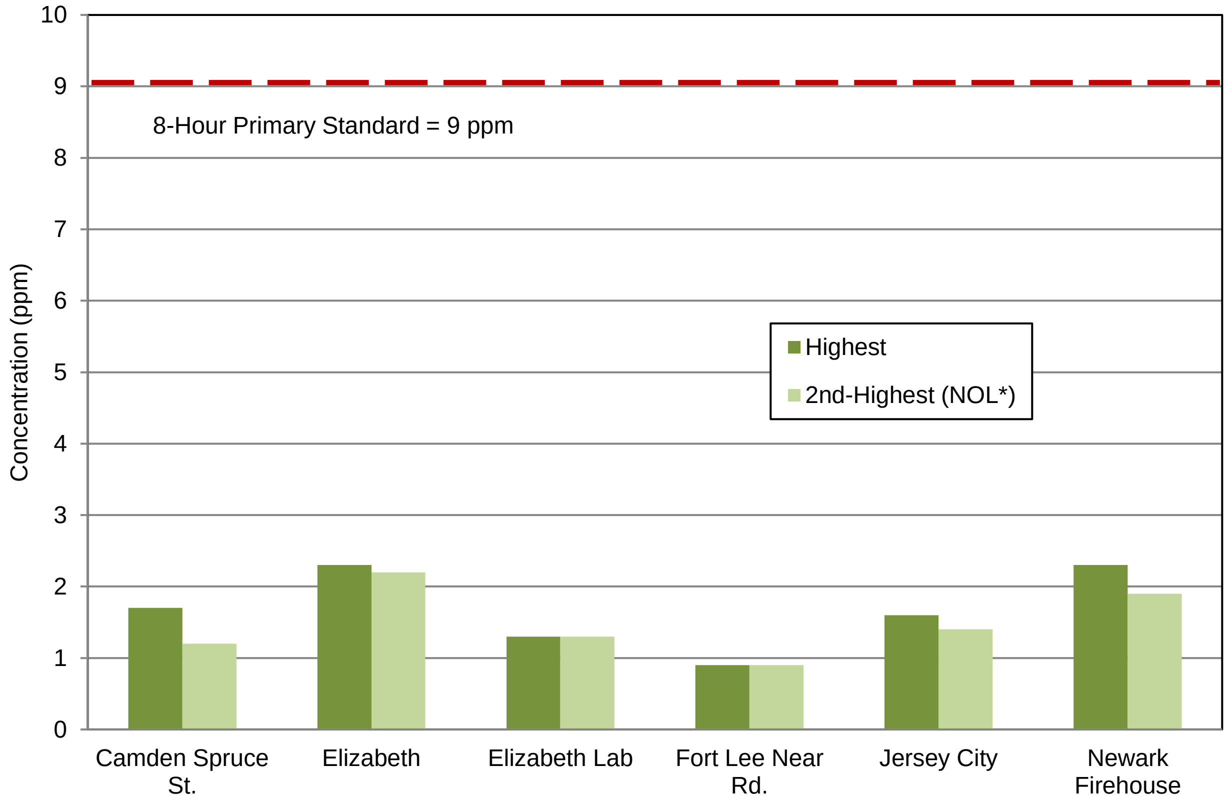


Figure 8-5
2021 Carbon Monoxide Concentrations in New Jersey
8-Hour Averages
Parts per Million (ppm)



*Non-overlapping 8-hour periods

CO TRENDS

Carbon monoxide levels in outdoor air have improved dramatically over the past two-and-a-half decades. Figures 8-6 and 8-7 and Table 8-3 present the trends in CO levels since 1990. The graphs and table actually show the second-highest 1-hour and 8-hour values recorded, because those are the design values that determine if the NAAQS are being met (one exceedance per site is allowed each year). The entire state was officially declared to have attained the CO standards as of August 23, 2002. Years ago, unhealthy levels of CO were recorded on a regular basis. The reduction in CO levels is due primarily to cleaner-running cars and other vehicles, which are by far the largest source of this pollutant outdoors. The last violation of the 8-hour NAAQS was in 1994.

Figure 8-6
Carbon Monoxide Design Value Trend in New Jersey, 1990-2021
2nd-Highest 1-Hour Average Concentration
Parts per Million (ppm)

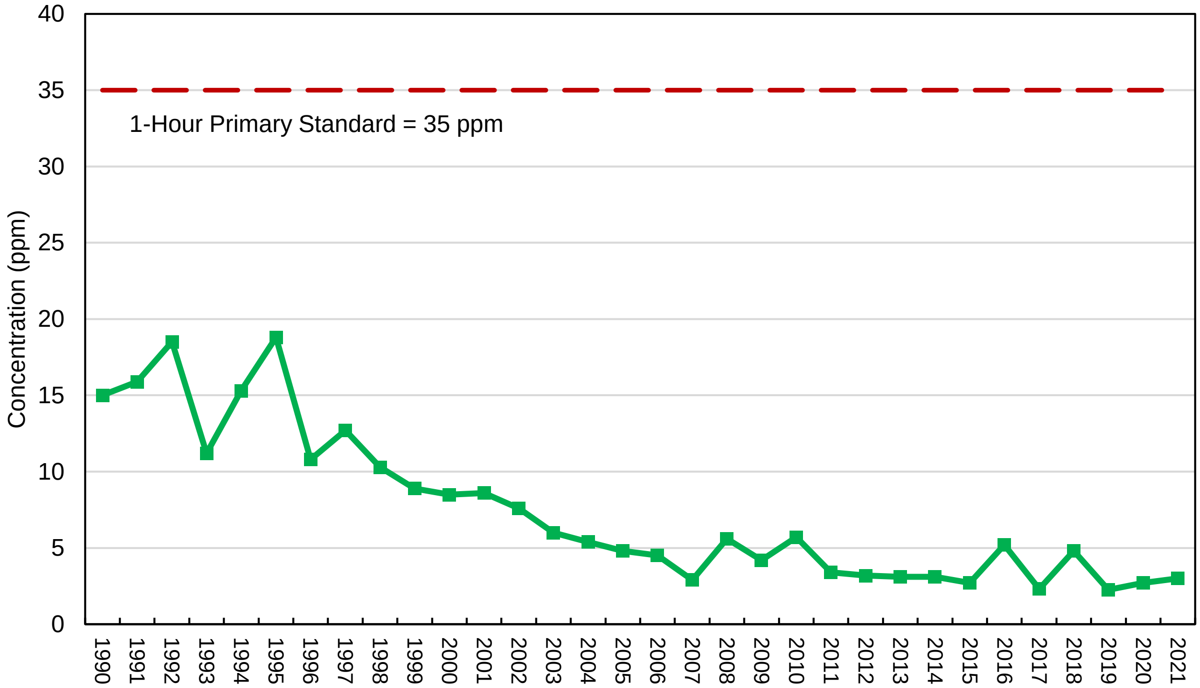


Figure 8-7
Carbon Monoxide Design Value Trend in New Jersey, 1990-2021
2nd-Highest 8-Hour Average Concentration
Parts per Million (ppm)

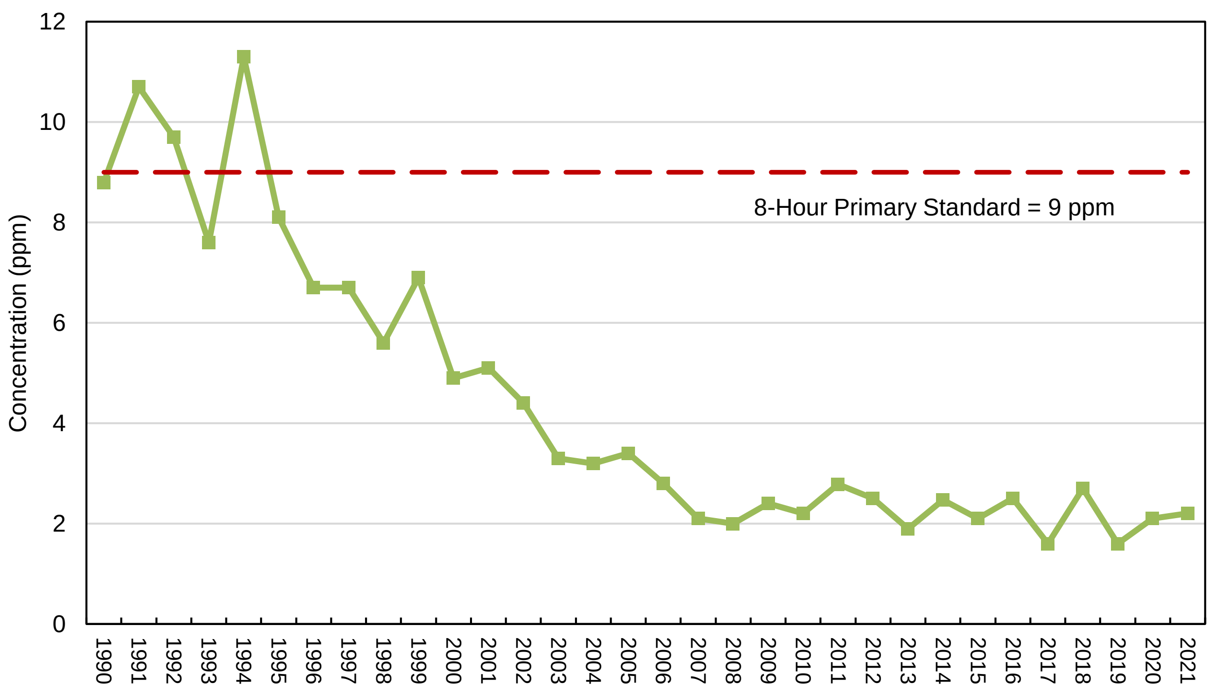


Table 8-3
Statewide New Jersey Carbon Monoxide Trends, 1990-2021
1-Hour and 8-Hour Average Concentrations
Parts per Million (ppm)

Year	2nd-Highest Average Concentrations*	
	1-Hour	8-Hour
1990	15	8.8
1991	15.9	10.7
1992	18.5	9.7
1993	11.2	7.6
1994	15.3	11.3
1995	18.8	8.1
1996	10.8	6.7
1997	12.7	6.7
1998	10.3	5.6
1999	8.9	6.9
2000	8.5	4.9
2001	8.6	5.1
2002	7.6	4.4
2003	6	3.3
2004	5.4	3.2
2005	4.8	3.4
2006	4.5	2.8
2007	2.9	2.1
2008	5.6	2
2009	4.2	2.4
2010	5.7	2.2
2011	3.4	2.8
2012	3.2	2.5
2013	3.1	1.9
2014	3.1	2.5
2015	2.7	2.1
2016	5.2	2.5
2017	2.3	1.6
2018	4.8	2.7
2019	2.3	1.6
2020	2.7	2.1
2021	3.0	2.2

*Design values

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2021 Lead Summary

New Jersey Department of Environmental Protection

Sources

Lead is a criteria pollutant as well as a Hazardous Air Pollutant listed under the 1990 Clean Air Act. It is one of the first known and most widely studied environmental and occupational toxins.

Lead was once commonly used in paint and gasoline, and is still used in batteries, solder, pipes, pottery, roofing materials and some cosmetics. Since 1980, there has been a 99% decrease in the average lead air concentration nationwide. A phase-out of lead additive in gasoline began in the mid-1970s, although it is still used in aviation fuel in some smaller aircraft. The USEPA National Emissions Inventory estimates that 4.36 tons of lead were emitted in New Jersey in 2017, mostly from aircraft. New Jersey no longer has any significant industrial sources of lead.

Health Effects

Lead that is emitted into the air can be inhaled, or ingested after it settles (ingestion is actually the main route of human exposure to airborne lead). There is no level of lead exposure that is considered safe. The main target for lead toxicity is the nervous system, both in adults and children. However, children's developing brains are the most vulnerable to the effects of lead, leading to lifelong effects, even after exposure ceases. The brain damage caused by lead exposure can result in learning disabilities and delinquent behavior, impacting IQ and academic achievement. Lead can also damage red blood cells and weaken the immune system. Other effects in adults include increased blood pressure, cardiovascular disease, and decreased kidney function. In addition, lead is classified as a "probable human carcinogen."

Ambient Air quality Standards

A NAAQS for lead was first promulgated in 1978. A value of 1.5 $\mu g/m^3$ was established as both the primary and secondary standard. It was based on an average for each calendar quarter, and was not to be exceeded. The New Jersey AAQS was based on a rolling three-month average. Thirty years later, in 2008, the NAAQS was lowered tenfold to 0.15 $\mu g/m^3$, also averaged over a rolling three-month period, and not to be exceeded.

A rolling three-month average considers each of the 12 three-month periods associated with a given year, not just the four calendar quarters within that year. The old NAAQS required lead to be sampled as total suspended particulate (TSP). In New Jersey, lead is now measured as PM_{10}.

Table 9-1
National Ambient Air Quality Standards for Lead
Micrograms Per Cubic Meter ($\mu g/m^3$)

Averaging Period	Type	Level	Design Value
3 Months (Rolling)	Primary & Secondary	0.15 $\mu g/m^3$	Not to be exceeded

LEAD AIR LEVELS IN 2021

In the 1980s NJDEP had more than 20 lead monitors around the state, including a few specifically located near lead-emitting facilities, such as a battery manufacturer in New Brunswick and a paint factory in Newark. By 2008, after years of decreasing concentrations, all of New Jersey's lead monitors were shut down. In March 2012, a lead monitor was installed at the Newark Firehouse monitoring station in accordance with new NAAQS requirements. Figure 9-1 presents all of the data from the Newark site since it started operating. Table 9-1 shows the rolling three-month averages for 2021.

Figure 9-1
Lead Concentrations at Newark Firehouse in New Jersey, 2012-2021
24-Hour Averages
Micrograms per Cubic Meter (µg/m^3)

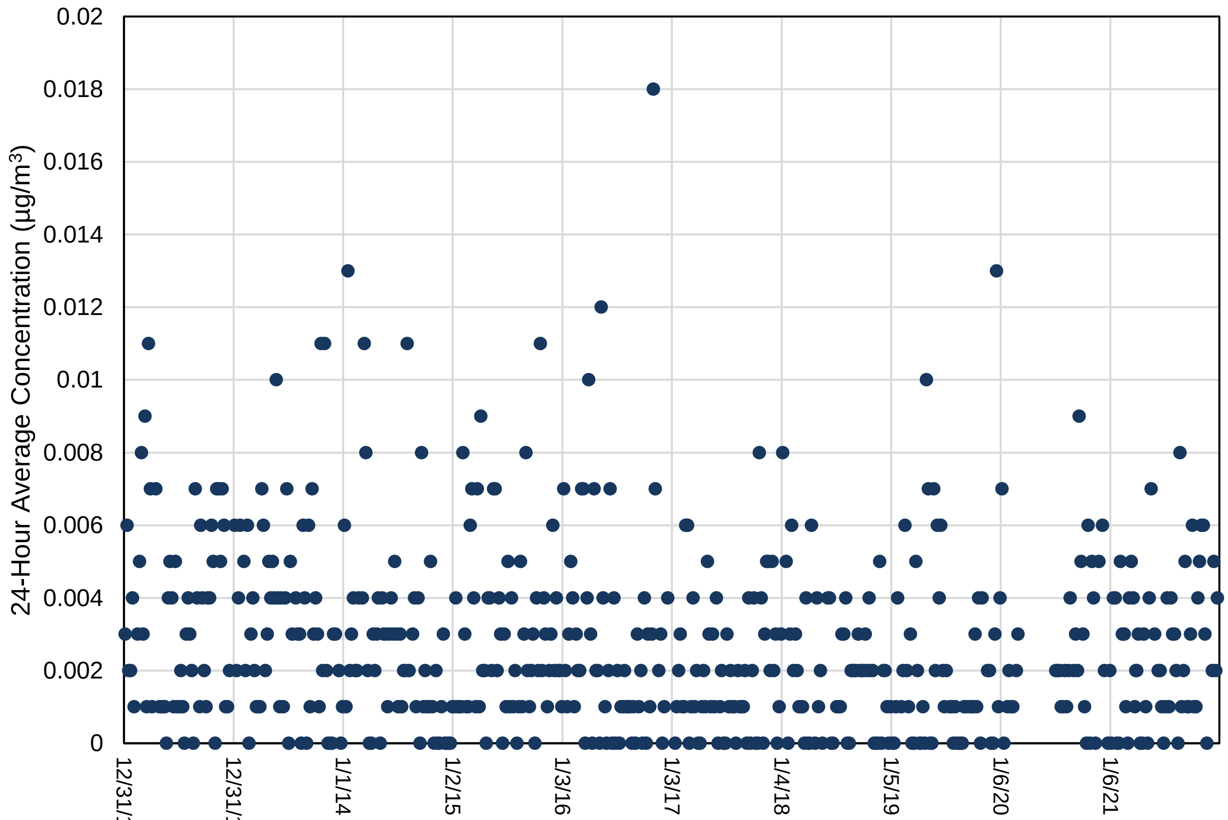


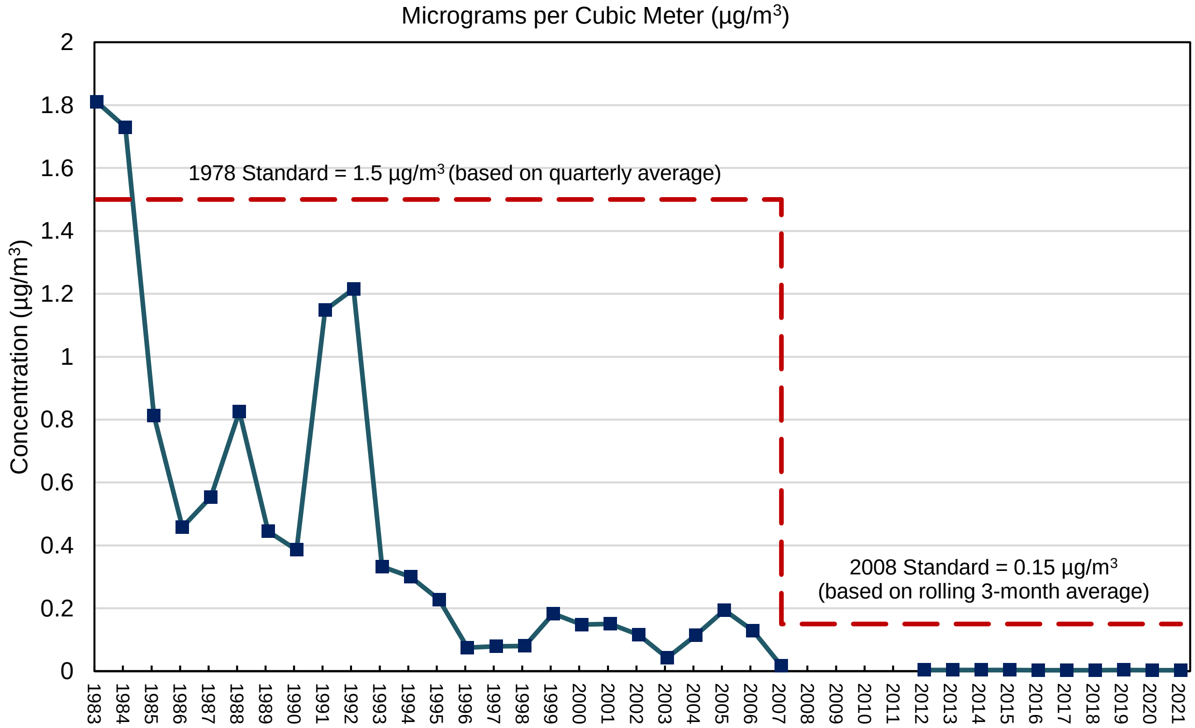
Table 9-1
2021 Lead Concentrations in New Jersey
3-Month Rolling Averages
Micrograms per Cubic Meter (µg/m³)

3-Month Period	3-Month Average
November-January	0.003
December-February	0.002
January-March	0.002
February-April	0.002
March-May	0.002
April-June	0.002
May-July	0.002
June-August	0.002
July-September	0.002
August-October	0.003
September-November	0.003
October-December	0.003

Lead Air Trend

The last exceedances of the NAAQS were in 1983 and 1984 (as shown in Figure 9-2), and the last exceedance of the NJAAQS was in 1992 (based on a rolling 3-month average; not shown in the graph). Since then, air concentrations of lead in New Jersey have dropped considerably. The highest annual 3-month rolling average concentrations at Newark Firehouse since 2012 have ranged from 0.003 to 0.004 µg/m³.

Figure 9-2
Statewide New Jersey Lead Trend, 1983-2021
Highest 3-Month Averages
Micrograms per Cubic Meter (µg/m³)



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2021 Air Toxics Summary

New Jersey Department of Environmental Protection

Introduction

Air pollutants can be generally divided into two categories: criteria pollutants (ozone, sulfur dioxide, carbon monoxide, nitrogen dioxide, particulate matter, and lead); and air toxics. The criteria pollutants have been addressed at the national level since the 1970s. The United States Environmental Protection Agency (USEPA) has set National Ambient Air Quality Standards (NAAQS) for them, and states and local or tribal jurisdictions are required to plan and implement a process to bring and keep levels below the NAAQS, using monitoring, reporting, and control measures. Each of these pollutants is discussed in its own section (Sections 4 through 9) of this New Jersey Department of Environmental Protection (NJDEP) 2019 Air Quality Report.

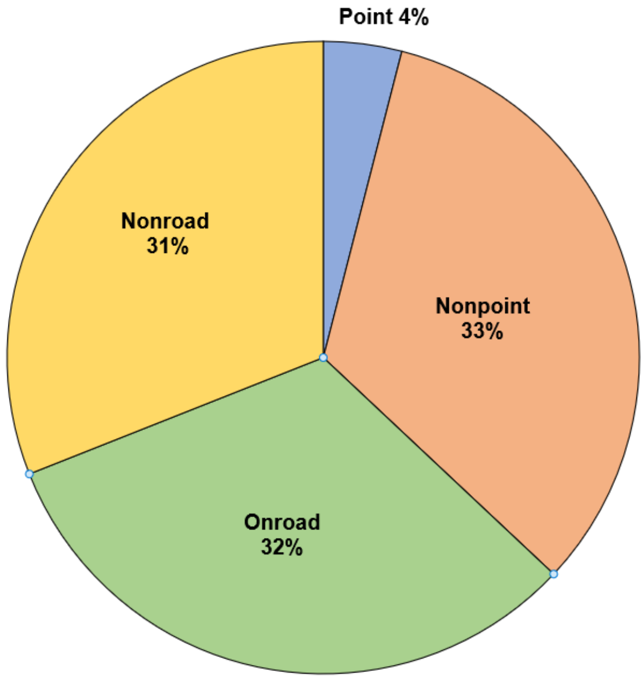
Air toxics are all the other chemicals released into the air that have the potential to cause adverse health effects in humans. These effects cover a wide range of conditions, from lung irritation to birth defects to cancer. There are no NAAQS for these pollutants, but in 1990 the U.S. Congress directed the USEPA to begin addressing a list of 187 air toxics by developing control technology standards for specific types of sources that emit them. These air toxics are known as the Clean Air Act Hazardous Air Pollutants (HAPs). You can get more information about HAPs at the USEPA Air Toxics web site at www.epa.gov/ttn/atw. NJDEP also has several web pages dedicated to air toxics. They can be accessed at www.nj.gov/dep/airtoxics.

Sources of Air Toxics

USEPA compiles a National Emissions Inventory (NEI) every three years. In addition to criteria pollutants and criteria precursors, it also collects information on emissions of hazardous air pollutants. The pie chart in Figure 10-1, taken from the most recent available NEI (for 2017), shows that mobile sources are the largest contributors of air toxics emissions in New Jersey.

In New Jersey, on-road mobile sources (cars and trucks) account for 32% of the air toxics emissions, and non-road mobile sources (airplanes, trains, construction equipment, lawnmowers, boats, dirt bikes, etc.) contribute an additional 31%. Nonpoint sources (residential, commercial, and small industrial sources) represent 33% of the inventory and point sources (such as factories and power plants) account for the remaining 4%.

Figure 10-1
2017 Air Toxics Emissions Source Estimates for New Jersey

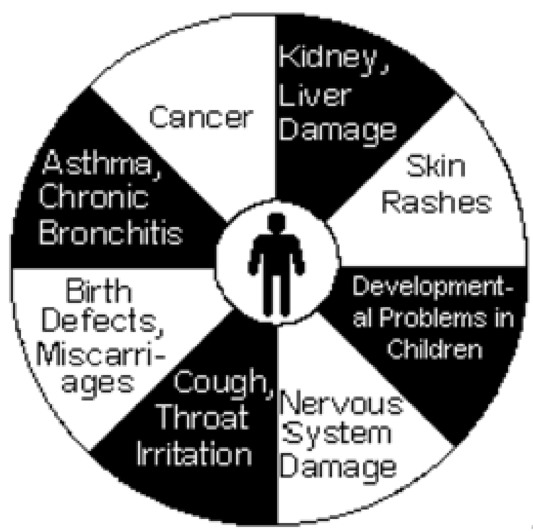


https://dep.nj.gov/airplanning/airtoxics/emissions2017/

HEALTH EFFECTS

People exposed to air toxics in significant amounts or for significant periods may have an increased chance of developing cancer or experiencing other serious health effects. The noncancer health effects can range from respiratory, neurological, reproductive, developmental, or immune system damage, to irritation and effects on specific organs (see Figure 10-2). In addition to inhalation exposure, there can be risks from the deposition of toxic pollutants onto soil or surface water. There, they can be taken up by humans directly, or by consuming exposed plants and animals.

Figure 10-2
Potential Effects of Air Toxics

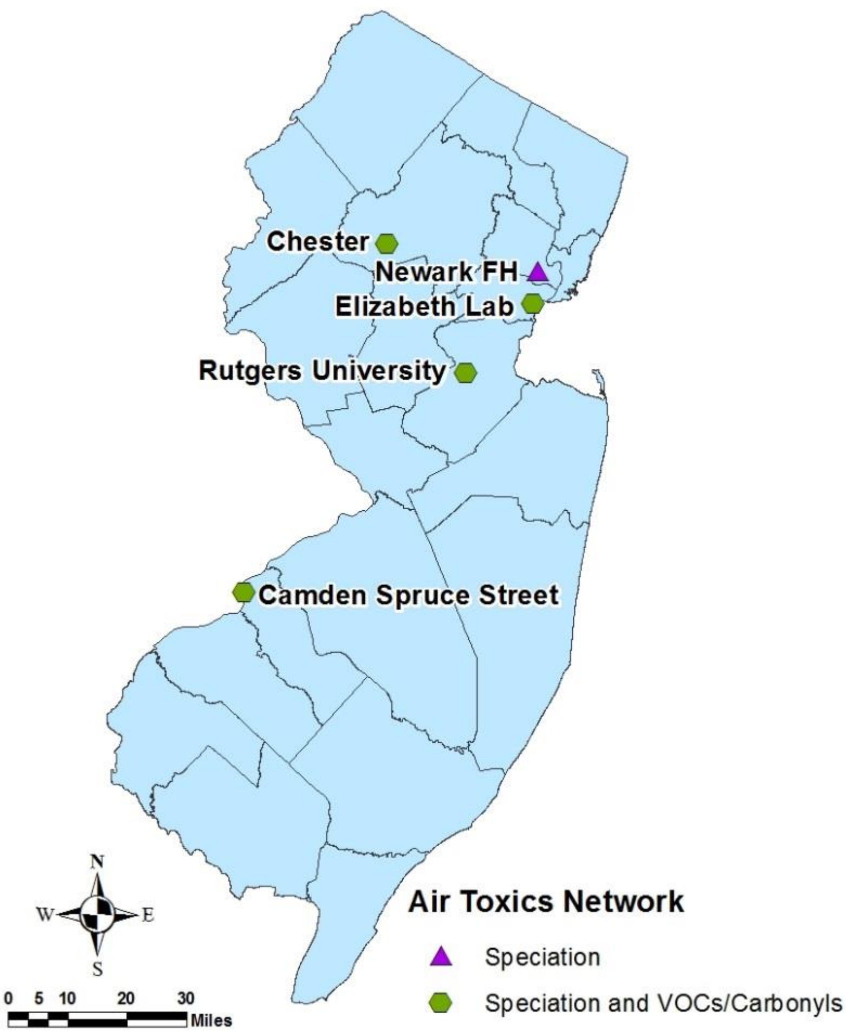


www3.epa.gov/ttn/atw/3_90_024.html

MONITORING LOCATIONS

NJDEP has four air toxics monitoring sites that measure volatile organic compounds (VOCs) and carbonyls (a subset of VOCs that includes formaldehyde, acetaldehyde and other related compounds). As shown in Figure 10-3, the monitors are located at Camden Spruce Street, Chester, Elizabeth Lab, and Rutgers University in East Brunswick. Toxic metals data are collected at the same four monitoring stations, plus Newark Firehouse.

Figure 10-3
2021 Air Toxics Monitoring Network



The Chester monitoring site is in rural Morris County, away from known sources, and serves as kind of a "background" monitor. The Rutgers University monitoring station is situated on Rutgers University agricultural lands in East Brunswick. The Elizabeth Lab monitoring station sits next to the Exit 13 tollbooths on the New Jersey Turnpike. The Camden Spruce Street monitoring station is located in an industrial urban setting. The Newark Firehouse monitoring station is in an urban residential area. More information about the air monitoring sites can be found in the Air Monitoring Network section and Appendix A of this annual Air Quality Report.

New Jersey's VOC monitors are part of the Urban Air Toxics Monitoring Program (UATMP), sponsored by the USEPA. A 24-hour integrated air sample is collected in a canister every six days, and then sent to the USEPA contract laboratory (ERG, located in North Carolina) to be analyzed for VOCs and carbonyls. A previous monitoring site in Camden (officially called the Camden Lab site) had been measuring toxic VOCs for the UATMP since 1989, but was shut down in 2008 when NJDEP lost access to the location. A new monitoring station, the Camden Spruce Street monitoring site, became operational in 2013. The Elizabeth Lab site began measuring VOCs in 2000, and in July 2001 toxics monitoring began at the Chester and New Brunswick monitoring stations. In 2016 the New Brunswick VOC monitor was moved to the Rutgers University monitoring site, less than a mile away.

Analysis of fine particulate matter for toxic metals and other elements also began in 2001, at Camden, Chester, Elizabeth Lab and New Brunswick, as part of USEPA's Chemical Speciation Network (CSN). The Newark Firehouse site was added in 2010, and the New Brunswick CSN monitor was moved to Rutgers University in 2016. The CSN was established to characterize the metals, ions and carbon constituents of $PM_{2.5}$. Filters are collected every three or six days and sent to a national lab for analysis.

NEW JERSEY AIR TOXICS MONITORING RESULTS FOR 2021

Annual average concentrations of VOCs and carbonyls for the four New Jersey monitoring sites are shown in Table 10-1. All values are in micrograms per cubic meter ($\mu g/m^3$). Values in parts per billion by volume (ppbv), as well as other statistics and risk estimates, can be found in Tables 10-4 through 10-7. The ppbv units are more common in air monitoring, while $\mu g/m^3$ units are generally used in air dispersion modeling and health studies.

Detection limit information and health benchmarks used in the analysis can be found in Table 10-9. A number of compounds were not detected in the samples analyzed by the lab; however, this does not mean they are not present in the air below the detection limit level. For chemicals detected in less than 50% of the samples, there is significant uncertainty in the calculated averages. Median values (the value of the middle sample when the results are ranked) are reported in Tables 10-4 through 10-7 along with the mean (average) concentrations, because for some compounds only a single value or a few very high values were recorded. These high values could skew the mean concentrations, but would have less effect on the median value. In such cases, the median value may be a better indicator of long-term exposure concentrations.

Table 10-1
2021 Summary of Toxic Volatile Organic Compounds Monitored in New Jersey
Annual Average Concentrations
Micrograms per Cubic Meter (μg/m^3)

	Pollutant	Synonym	HAP	CAS No.	Camden	Chester	Elizabeth	Rutgers
1	Acetaldehyde		*	75-07-0	3.202	1.540	2.074	1.292
2	Acetone			67-64-1	2.801	1.698	2.318	2.384
3	Acetonitrile		*	75-05-8	0.334	0.502	1.285	0.600
4	Acetylene			74-86-2	0.777	0.432	1.020	0.758
5	Acrolein		*	107-02-8	0.846	0.714	0.900	0.837
6	Acrylonitrile		*	107-13-1	*0.002*	*0.0004*	*0.005*	*0.002*
7	tert-Amyl Methyl Ether			994-05-8	*0*	*0*	*0*	*0*
8	Benzaldehyde			100-52-7	0.337	0.101	0.122	0.087
9	Benzene		*	71-43-2	0.802	0.344	0.733	0.475
10	Bromochloromethane			74-97-5	*0.0003*	*0*	*0.0006*	*0.0002*
11	Bromodichloromethane			75-27-4	*0.001*	*0.001*	*0.001*	*0.003*
12	Bromoform		*	75-25-2	0.014	0.011	0.018	0.015
13	Bromomethane	Methyl bromide	*	74-83-9	0.197	0.034	0.043	0.037
14	1,3-Butadiene		*	106-99-0	0.059	0.011	0.072	0.034
15	Butyraldehyde			123-72-8	0.331	0.130	0.219	0.136
16	Carbon Disulfide		*	75-15-0	0.055	0.040	0.142	0.044
17	Carbon Tetrachloride		*	56-23-5	0.464	0.454	0.467	0.448
18	Chlorobenzene		*	108-90-7	*0.004*	*0.001*	*0.001*	*0.001*
19	Chloroethane	Ethyl chloride	*	75-00-3	0.019	*0.009*	0.016	0.045
20	Chloroform		*	67-66-3	0.129	0.098	0.145	0.133
21	Chloromethane	Methyl chloride	*	74-87-3	1.021	0.983	1.028	1.019
22	Chloroprene	2-Chloro-1,3-butadiene	*	126-99-8	*0.0001*	*0*	*0.001*	*0.0004*
23	Crotonaldehyde			123-73-9	0.044	0.017	0.052	0.034
24	Dibromochloromethane	Chlorodibromomethane		124-48-1	*0.002*	*0.001*	*0.003*	*0.003*
25	1,2-Dibromoethane	Ethylene dibromide	*	106-93-4	*0*	*0.001*	*0*	*0.0004*
26	m-Dichlorobenzene	1,3-Dichlorobenzene		541-73-1	*0.0002*	*0.001*	*0.0001*	*0.001*
27	o-Dichlorobenzene	1,2-Dichlorobenzene		95-50-1	*0.001*	*0.001*	*0.002*	*0.001*
28	p-Dichlorobenzene	1,4-Dichlorobenzene	*	106-46-7	0.063	0.010	0.053	0.029
29	Dichlorodifluoromethane			75-71-8	2.564	2.497	2.522	2.494
30	1,1-Dichloroethane	Ethylidene dichloride	*	75-34-3	*0*	*0.0003*	*0*	*0.0005*
31	1,2-Dichloroethane	Ethylene dichloride	*	107-06-2	0.069	0.054	0.051	0.055
32	1,1-Dichloroethylene	Vinylidene chloride	*	75-35-4	*0.002*	0.004	*0.002*	*0.003*
33	cis-1,2-Dichloroethylene	cis-1,2-Dichloroethene		156-59-2	*0.0001*	*0*	*0.002*	*0.0001*
34	trans-1,2-Dichloroethylene	trans-1,2-Dichloroethene		156-60-5	0.009	*0.003*	0.022	0.063
35	Dichloromethane	Methylene chloride	*	75-09-2	0.575	0.467	0.647	0.674
36	1,2-Dichloropropane	Propylene dichloride	*	78-87-5	*0.001*	*0.0005*	*0.002*	*0.001*

Continued

- Values in ppbv can be found in Tables 10-4 through 10-7.
- *Values in **italics** indicate that fewer than 50% of samples had detectable levels.*
- **Zero** indicates that there were no samples with reportable levels.
- HAP = Hazardous air pollutant as listed in the Clean Air Act.

Table 10-1 (continued)
2021 Summary of Toxic Volatile Organic Compounds Monitored in New Jersey
Annual Average Concentrations

Micrograms per Cubic Meter ($\mu g/m^3$)

	Pollutant	Synonym	HAP	CAS No.	Camden	Chester	Elizabeth	Rutgers
37	cis-1,3-Dichloropropylene	cis-1,3-Dichloropropene	*	10061-01-5	*0*	*0*	*0*	*0*
38	trans-1,3-Dichloropropylene	trans-1,3-Dichloropropene	*	10061-02-6	*0*	*0*	*0*	*0*
39	Dichlorotetrafluoroethane	Freon 114		76-14-2	0.118	0.119	0.096	0.121
40	Ethyl Acrylate		*	140-88-5	*0*	*0*	*0*	*0*
41	Ethylbenzene		*	100-41-4	0.454	0.056	0.287	0.133
42	Ethyl tert-Butyl Ether	tert-Butyl ethyl ether		637-92-3	*0.0001*	0.022	*0.001*	0.027
43	Formaldehyde		*	50-00-0	4.394	2.288	3.641	2.215
44	Hexachlorobutadiene	Hexachloro-1,3-butadiene	*	87-68-3	*0.001*	*0.001*	*0.001*	*0.002*
45	Hexaldehyde	Hexanaldehyde		66-25-1	0.214	0.120	0.231	0.154
46	Methyl Ethyl Ketone	MEK, 2-Butanone		78-93-3	0.361	0.202	0.328	0.450
47	Methyl Isobutyl Ketone	MIBK	*	108-10-1	0.162	0.069	0.176	0.130
48	Methyl Methacrylate		*	80-62-6	*0.002*	*0.005*	*0.003*	*0.006*
49	Methyl tert-Butyl Ether	MTBE	*	1634-04-4	*0.001*	*0.002*	*0.005*	*0.003*
50	n-Octane			111-65-9	0.314	0.039	0.280	0.115
51	Propionaldehyde		*	123-38-6	0.491	0.242	0.411	0.284
52	Propylene			115-07-1	2.281	0.712	3.331	1.059
53	Styrene		*	100-42-5	0.268	0.009	0.123	0.043
54	1,1,2,2-Tetrachloroethane		*	79-34-5	*0.0001*	*0.001*	*0*	*0*
55	Tetrachloroethylene	Perchloroethylene	*	127-18-4	0.165	0.048	0.115	0.082
56	Toluene		*	108-88-3	2.478	0.360	1.697	0.830
57	1,2,4-Trichlorobenzene		*	120-82-1	*0.004*	*0.004*	*0.005*	*0.003*
58	1,1,1-Trichloroethane	Methyl chloroform	*	71-55-6	0.012	0.010	0.014	0.012
59	1,1,2-Trichloroethane		*	79-00-5	*0.004*	*0.000*	*0.001*	*0.000*
60	Trichloroethylene		*	79-01-6	*0.016*	0.023	0.034	0.032
61	Trichlorofluoromethane			75-69-4	2.034	1.326	1.360	1.345
62	Trichlorotrifluoroethane	1,1,2-Trichloro-1,2,2-trifluoroethane		76-13-1	0.407	0.410	0.413	0.410
63	1,2,4-Trimethylbenzene			95-63-6	0.518	0.045	0.331	0.157
64	1,3,5-Trimethylbenzene			108-67-8	0.142	0.012	0.081	0.036
65	Valeraldehyde			110-62-3	0.224	0.096	0.173	0.117
66	Vinyl chloride		*	75-01-4	*0.010*	*0.001*	*0.001*	*0.001*
67	m,p-Xylene		*	108-38-3 106-42-3	1.213	0.125	0.855	0.345
68	o-Xylene		*	95-47-6	0.486	0.055	0.331	0.140

- Values in ppbv can be found in Tables 10-4 through 10-7.
- *Values in **italics** indicate that fewer than 50% of samples had detectable levels.*
- **Zero** indicates that there were no samples with reportable levels.
- HAP = Hazardous air pollutant as listed in the Clean Air Act.

ESTIMATING HEALTH RISK

The effects on human health resulting from exposure to specific air toxics can be estimated by using chemical-specific **health benchmarks**. These are based on toxicity values developed by the USEPA and other agencies, using animal or human health studies. For carcinogens, which are chemicals suspected of causing cancer, the health benchmark is the concentration of the pollutant that corresponds to a one-in-a-million increase in the risk of getting cancer if a person was to breathe that concentration over his or her entire lifetime. The health benchmark for a noncarcinogen is the air concentration at which no adverse health effect is expected to occur, even if a person is exposed to that concentration on a daily basis for a lifetime (this is also known as a reference concentration). Because of a lack of toxicity studies, not all air toxics have health benchmarks. Health benchmarks used to evaluate the VOCs and carbonyls monitored in New Jersey are listed in Table 10-9. Health benchmarks for specific toxic metals and elements are shown in Table 10-3. These are all based on long-term exposure.

A **risk ratio** can be used to quantify risk from exposure to a specific chemical. This is calculated by dividing the annual average air concentration of a chemical by its long-term health benchmark. If the risk ratio is less than one, the air concentration should not pose a health risk. If it is greater than one, it may be of concern. The risk ratio also indicates how much higher or lower the estimated air concentration is compared to the health benchmark. Identifying problematic chemicals helps regulatory agencies focus their efforts to reduce emissions and exposure.

Air toxics with risk ratios greater than one for at least one monitoring site are summarized in Table 10-2. Acrolein and formaldehyde showed the highest risk statewide. Other pollutants above health benchmarks at all four sites were acetaldehyde, benzene, carbon tetrachloride, chloroform, chloromethane (methyl chloride), and 1,2-dichloroethane (ethylene dichloride). 1,3-Butadiene had a risk ratio slightly greater than one at all sites except Chester. Ethylbenzene and tetrachloroethylene had a risk ratio slightly greater than one at Camden.

Table 10-2
Monitored Air Toxics with Risk Ratios Greater Than One in 2021

Pollutant		CAS No.	Annual Average Risk Ratio			
			Camden	Chester	Elizabeth	Rutgers
1	Acetaldehyde	75-07-0	7	3	5	3
2	Acrolein	107-02-8	*42*	*36*	*45*	*42*
3	Benzene	71-43-2	6	3	6	4
4	1,3-Butadiene	106-99-0	1.8	0.3	2	1.02
5	Carbon Tetrachloride	56-23-5	3	3	3	3
6	Chloroform	67-66-3	3	2	3	3
7	Chloromethane	74-87-3	1.8	2	1.8	1.8
8	1,2-Dichloroethane	107-06-2	1.8	1.4	1.3	1.4
9	Ethylbenzene	100-41-4	1.1	0.1	0.7	0.3
10	Formaldehyde	50-00-0	57	30	47	29
11	Tetrachloroethylene	127-18-4	1.03	0.3	0.7	0.5

- Risk ratio = annual average air concentration/health benchmark
- Health benchmarks in italics have a noncancer endpoint. See section on “Estimating Health Risk” for more information.

Table 10-3 presents annual average concentrations and health benchmarks for certain toxic metals and elements that can be found in fine particles. This fine particulate matter is analyzed through USEPA’s Chemical Speciation Network (CSN). No risk ratios were calculated, because most of the chemicals were below the detection limit and so the resulting average concentrations are highly uncertain. Additional data from the CSN monitors can be found in Appendix B (Fine Particulate Speciation Summary) of the annual Air Quality Report.

Table 10-3
2021 Summary of Toxic Metals and Elements Monitored in New Jersey
Annual Average Concentrations & Health Benchmarks
Micrograms per Cubic Meter ($\mu g/m^3$)

Pollutant	HAP	Camden	Chester	Elizabeth	Newark	Rutgers	Health Benchmark
Antimony	*	*0*	0.002	0.001	0.001	0.001	*0.2*
Arsenic	*	*0*	*0*	*0*	*0*	*0*	0.00023
Cadmium	*	*0.001*	0.001	0.0008	0	0.001	0.00024
Chlorine	*	0.104	0.002	0.020	0.020	0.021	*0.2*
Chromium[a]	*	0.002	0.001	0.002	0.001	0.001	0.000083
Cobalt	*	*0*	*0*	*0*	*0*	*0*	0.00011
Lead	*	0.003	0.002	0.002	0.002	0.002	0.083
Manganese	*	0.004	0.00003	0.002	0.001	0.001	*0.05*
Nickel[b]	*	0.001	0.0004	0.001	0.001	0.0004	0.0021
Phosphorus	*	0.0005	0.0003	0.001	0.001	0.0003	*0.07*
Selenium	*	0.001	*0*	*0.00003*	0.0003	*0.00002*	*20*
Silicon		0.088	0.055	0.083	0.086	0.062	*3*
Vanadium		0.0003	*0.0001*	*0.0003*	*0.0002*	*0.0001*	*0.1*

- Annual average values in ***italics*** had fewer than 50% of samples detectable, so the means are highly uncertain.
- HAP = Hazardous air pollutant listed in the Clean Air Act.
- Health benchmarks in italics have a noncancer endpoint. See section on "Estimating Health Risk" for more information.

a) Chromium's health benchmark is based on carcinogenicity of hexavalent chromium (Cr+6). It is not known how much of the chromium measured by the monitor is hexavalent.

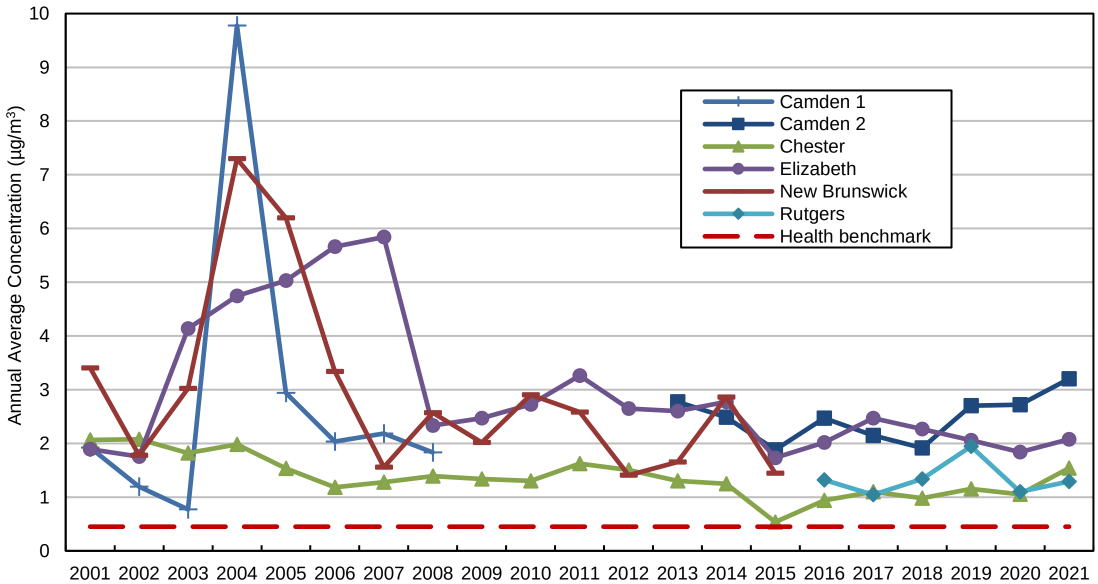
b) Nickel's health benchmark is based on specific nickel compounds. It is not known how much of the nickel measured by the monitor is in that form.

TRENDS AND COMPARISONS

Monitoring of air toxics in New Jersey has been going on since a UATMP site was established in Camden in 1989. Sampling and analysis methods continue to evolve, most notably with improvements in the ability to detect chemicals at lower concentrations. Figures 10-4 through 10-11 present data for some of the VOCs that have been measured for a number of years at levels of concern (above their health benchmarks). As mentioned previously, the first toxics monitoring site in Camden (Camden Lab) was shut down in 2008. It is identified in Figures 10-4 through 10-11 as "Camden 1." The new Camden site (Camden Spruce Street), located about two miles from the old site, is designated "Camden 2" in the trend graphs. The New Brunswick monitoring station was shut down in 2016, and the monitors were moved less than a mile to the Rutgers University site.

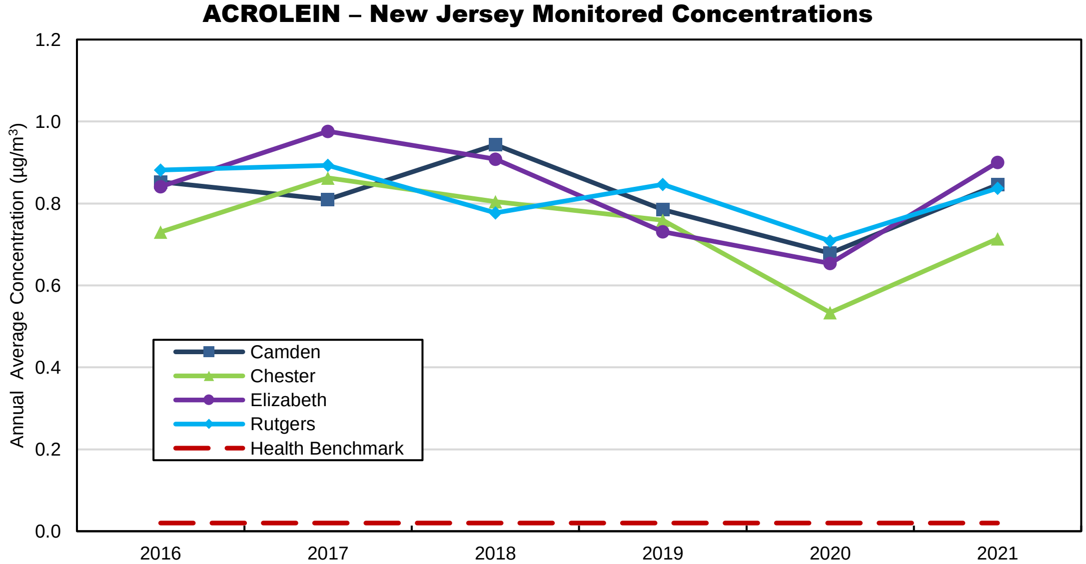
According to USEPA's 2014 National Air Toxics Assessment (NATA), **acetaldehyde** concentrations in New Jersey (Figure 10-4) are primarily influenced by secondary formation, a process in which chemicals in the air react with each other and are transformed into other chemicals. Mobile sources also contribute to ambient levels. In 2003, no data was collected in Camden after September, which probably had an influence on the low annual average for that year. In 2004, high levels of acetaldehyde were measured over a number of weeks at both Camden and New Brunswick.

Figure 10-4
ACETALDEHYDE – New Jersey Monitored Concentrations



Acrolein is sometimes used as a pesticide and to make other chemicals, but by far most of it is formed in the air from burning fossil fuels (gasoline, oil) and organic matter (including cigarettes). It is not known if it causes cancer, but it can have detrimental effects on the respiratory system. Prior to 2016, there were concerns that the laboratory methods used to measure acrolein were inadequate. The analysis methods have since been improved, and the recent data is presented in Figure 10-5.

Figure 10-5
ACROLEIN – New Jersey Monitored Concentrations



Figures 10-6 and 10-7 show a general decrease in **benzene** and **1,3-butadiene** concentrations over the past decade. Over 50% of New Jersey's ambient benzene and 1,3-butadiene comes from on-road mobile sources, and about 20% comes from non-road mobile sources.

Figure 10-6
BENZENE – New Jersey Monitored Concentrations

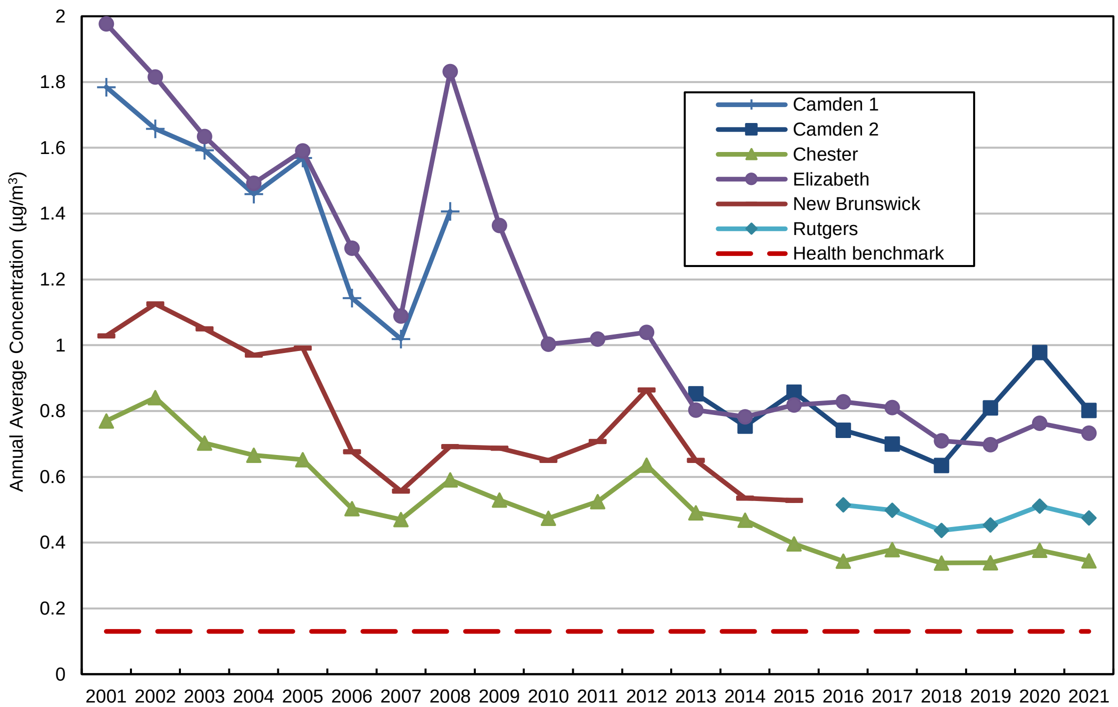
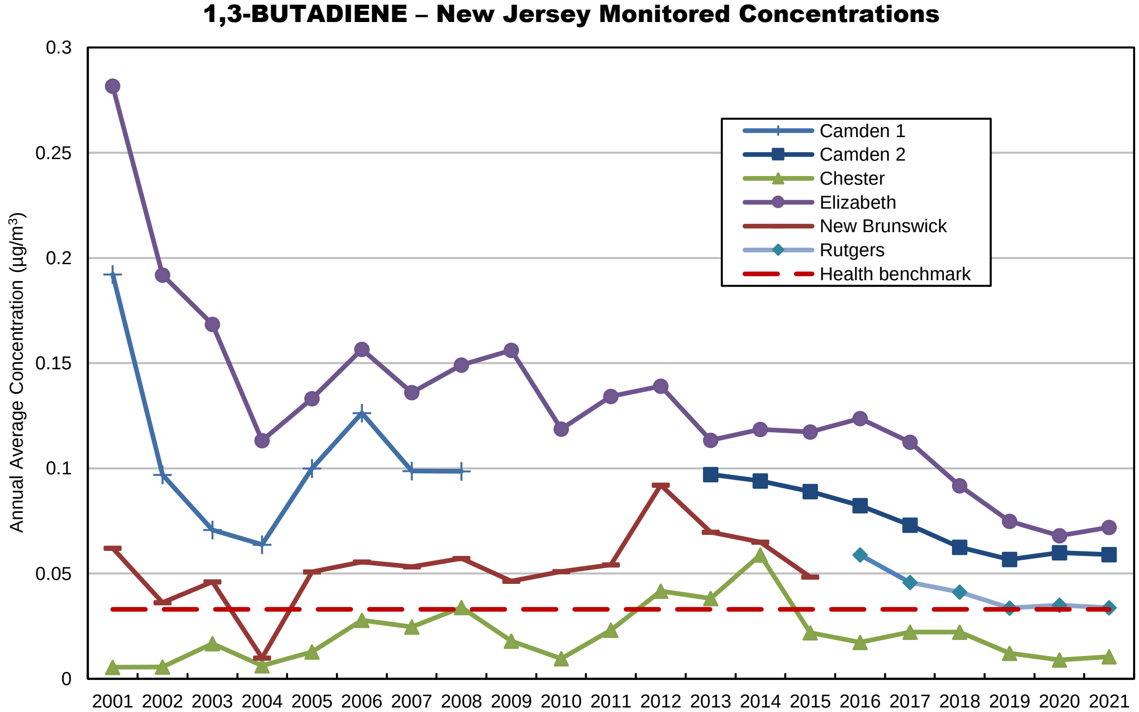
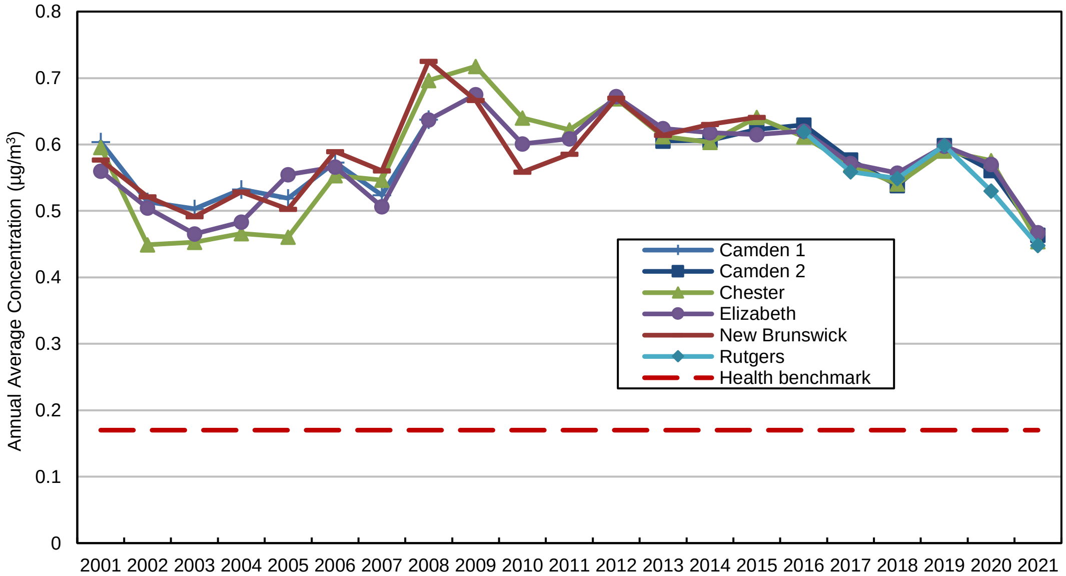


Figure 10-7
1,3-BUTADIENE – New Jersey Monitored Concentrations



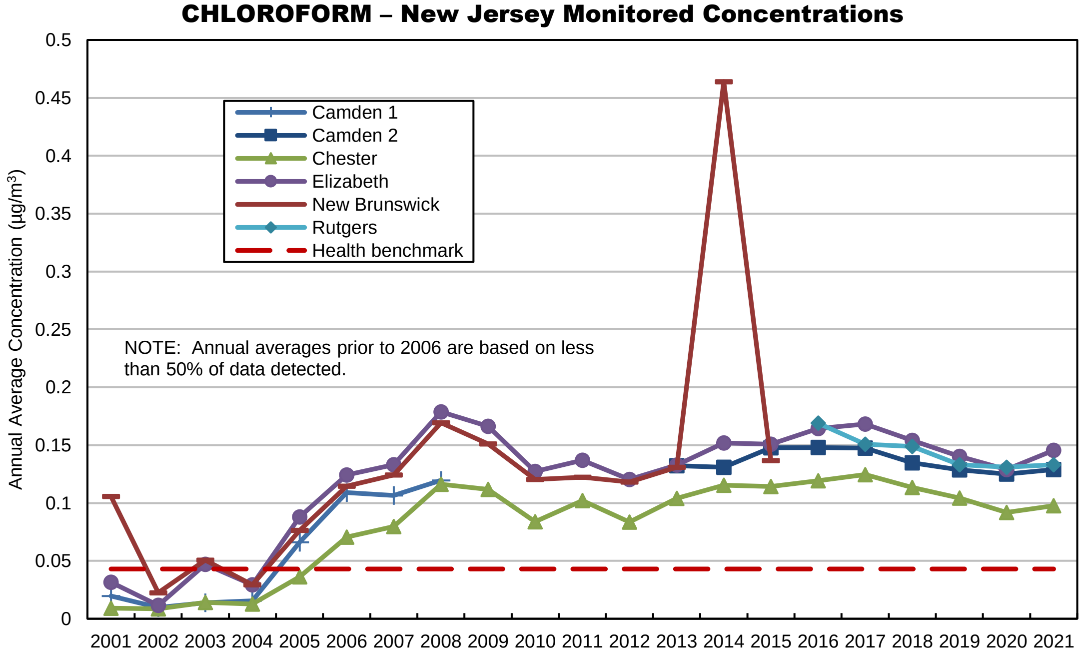
Carbon tetrachloride (Figure 10-8) was once used widely as a degreaser, household cleaner, propellant, refrigerant, and fumigant. It has been phased out of most production and use because of its toxicity and because it depletes stratospheric ozone. However, about 100 tons are still emitted annually by industry in the U.S., although no emissions have been reported in New Jersey for years. It degrades slowly in the environment, so it can be transported from other areas, and levels in the air can remain relatively steady for a long time.

Figure 10-8
CARBON TETRACHLORIDE – New Jersey Monitored Concentrations



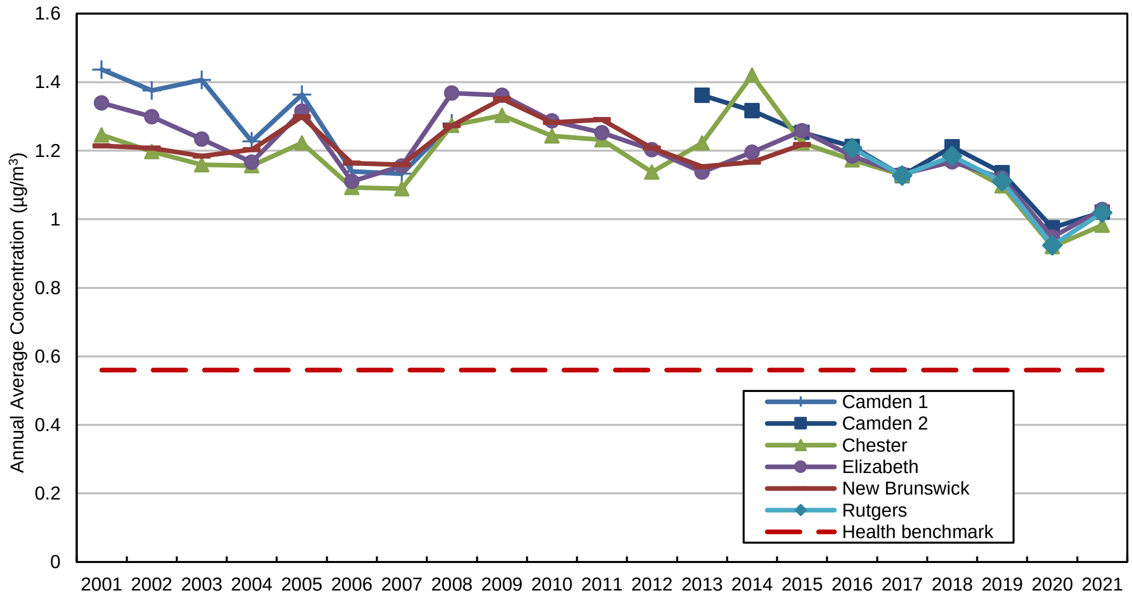
Some of the increase in the **chloroform** concentration shown in Figure 10-9 is believed to be from improvements in the laboratory detection limit. The high annual average concentration for New Brunswick in 2014 is attributable to a period of high values in May and June. Point and nonpoint sources (related to waste disposal) are the major contributors to ambient chloroform levels in New Jersey. Chloroform can be formed in small amounts by chlorination of water. It breaks down slowly in ambient air.

Figure 10-9
CHLOROFORM – New Jersey Monitored Concentrations



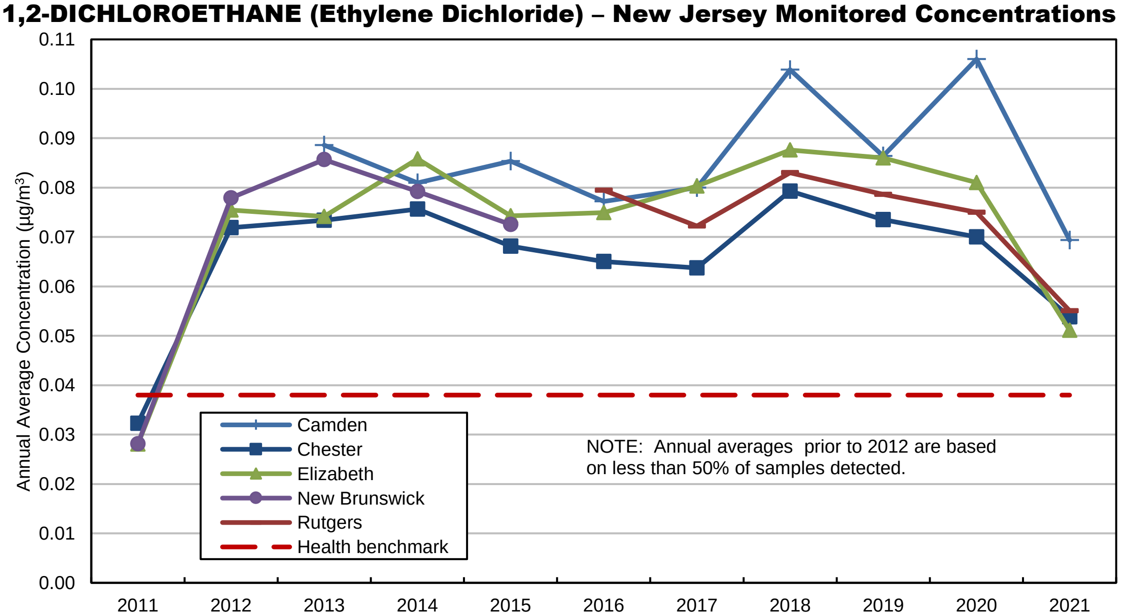
As seen in Figure 10-10, **chloromethane** (also known as methyl chloride) levels have remained relatively stable from year to year, and all the sites show similar levels. It was once commonly used as a refrigerant and in the chemical industry, but was phased out because of its toxicity. According to the USEPA's 2014 National Emissions Inventory, about 73% of the chloromethane in New Jersey's air is from nonpoint sources, primarily waste disposal, while 27% is from point sources.

Figure 10-10
CHLOROMETHANE (Methyl Chloride) – New Jersey Monitored Concentrations



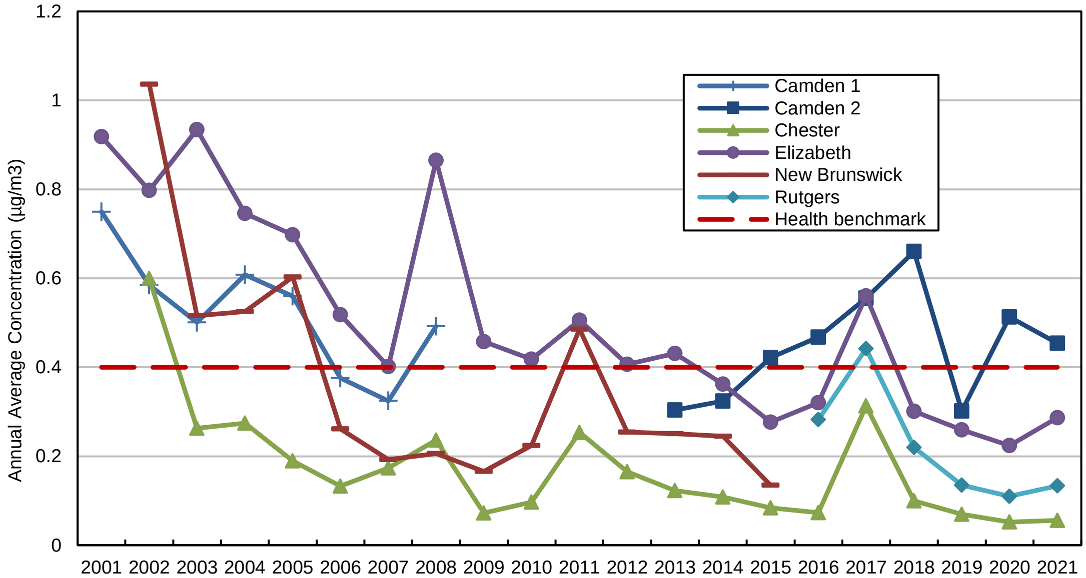
1,2-Dichloroethane (also known as ethylene dichloride) (Figure 10-11) is primarily used in the production of chemicals, as a solvent, dispersant and wetting and penetrating agent. The increase in concentrations after 2011 is related to an improvement in the laboratory detection limit, resulting in over 90% of samples having detectable levels. The 2014 National Emissions Inventory estimates that 93% of 1,2-dichloroethane in New Jersey's air is from point sources, and 7% from nonpoint sources.

Figure 10-11
1,2-DICHLOROETHANE (Ethylene Dichloride) – New Jersey Monitored Concentrations



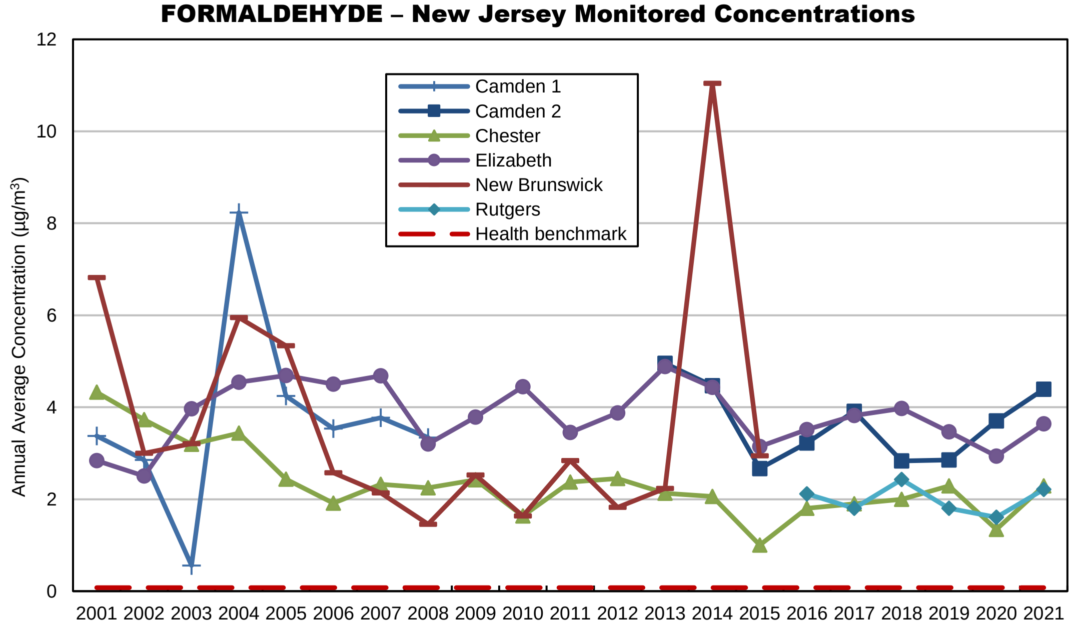
About 90% of **ethylbenzene** is emitted from mobile sources. Improvements in mobile source emissions controls have contributed to the downward trend in air concentrations. 2001 data for Chester and New Brunswick have been omitted from the graph because of technical problems encountered when sampling began that year (Figure 10-12).

Figure 10-12
ETHYLBENZENE – New Jersey Monitored Concentrations



Formaldehyde (Figure 10-13) is a ubiquitous pollutant that is often found at higher concentrations indoors rather than outdoors because of its use in many consumer goods. It is used in the production of fertilizer, paper, plywood, urea-formaldehyde resins, and many other products. In New Jersey the primary emitters of formaldehyde are mobile sources, although high outdoor levels are mostly the result of secondary formation. In 2014, concentrations at the New Brunswick site were consistently higher than at the other monitors, although levels subsequently dropped to the range of the other monitoring sites.

Figure 10-13
FORMALDEHYDE – New Jersey Monitored Concentrations



Tetrachloroethylene (commonly known as perchloroethylene) (Figure 10-14) is widely used as an industrial solvent and in dry cleaning. It is a common contaminant of hazardous waste sites because of a tendency to dispose of it improperly. In recent years, production and demand for it by industry and dry cleaners has been declining.

Figure 10-14
TETRACHLORETHYLENE – New Jersey Monitored Concentrations

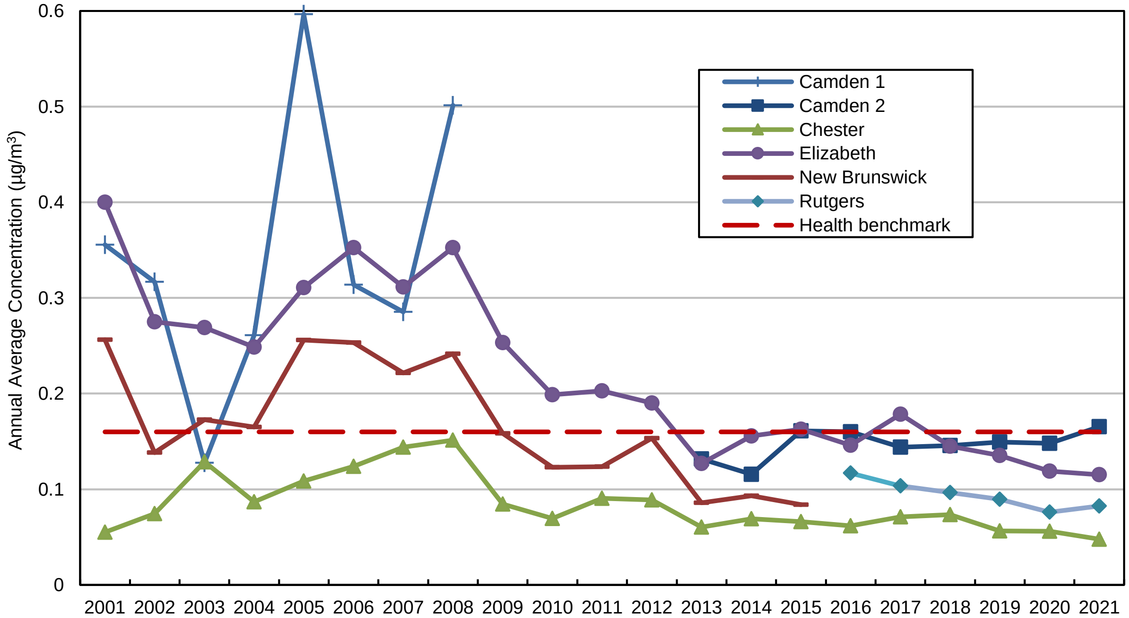


Table 10-4
CAMDEN SPRUCE STREET – 2021 NJ Air Toxics Monitoring Data

	Pollutant	Annual Mean	Annual Median	24-Hour Max.	Annual Mean	Annual Median	24-Hour Max.	% Detected	Annual Mean Risk Ratio
		ppbv			µg/m^3				
1	Acetaldehyde	1.777	1.550	4.910	3.202	2.793	8.847	100	**7**
2	Acetone	1.179	1.020	4.780	2.801	2.423	11.355	100	*0.0001*
3	Acetonitrile	0.199	0.166	0.702	0.334	0.279	1.179	92	*0.006*
4	Acetylene	0.730	0.628	2.030	0.777	0.668	2.160	100	
5	Acrolein	0.369	0.339	0.914	0.846	0.777	2.096	100	**42**
6	Acrylonitrile	*0.001*	0	0.038	*0.002*	0	0.083	7	0.1
7	tert-Amyl Methyl Ether	*0*	0	0	*0*	0	0	0	
8	Benzaldehyde	0.078	0.038	0.302	0.337	0.163	1.311	100	
9	Benzene	0.251	0.233	1.010	0.802	0.744	3.227	100	**6**
10	Bromochloromethane	*0.00005*	0	0.002	*0.0003*	0	0.010	5	0.00001
11	Bromodichloromethane	*0.0001*	0	0.003	*0.001*	0	0.021	7	0.03
12	Bromoform	0.001	0.001	0.008	0.014	0.014	0.082	70	0.02
13	Bromomethane	0.051	0.011	1.010	0.197	0.041	3.922	100	*0.04*
14	1,3-Butadiene	0.027	0.023	0.077	0.059	0.050	0.171	93	**1.8**
15	Butyraldehyde	0.112	0.103	0.279	0.331	0.304	0.823	100	
16	Carbon Disulfide	0.018	0.016	0.048	0.055	0.050	0.149	100	*0.0001*
17	Carbon Tetrachloride	0.074	0.078	0.099	0.464	0.488	0.622	100	**3**
18	Chlorobenzene	*0.001*	0	0.023	*0.004*	0	0.108	7	*0.000004*
19	Chloroethane	0.007	0.005	0.051	0.019	0.013	0.135	51	*0.000002*
20	Chloroform	0.026	0.024	0.067	0.129	0.117	0.327	100	**3**
21	Chloromethane	0.494	0.496	0.622	1.021	1.024	1.284	100	**1.8**
22	Chloroprene	*0.00003*	0	0.002	*0.0001*	0	0.007	2	0.1
23	Crotonaldehyde	0.015	0.009	0.100	0.044	0.026	0.287	78	
24	Dibromochloromethane	*0.0002*	0	0.002	*0.002*	0	0.019	23	0.1
25	1,2-Dibromoethane	*0*	0	0	*0*	0	0	0	
26	m-Dichlorobenzene	*0.00004*	0	0.001	*0.0002*	0	0.005	5	
27	o-Dichlorobenzene	*0.0002*	0	0.003	*0.001*	0	0.018	16	*0.000005*
28	p-Dichlorobenzene	0.011	0.008	0.044	0.063	0.048	0.262	91	0.7
29	Dichlorodifluoromethane	0.518	0.523	0.589	2.564	2.587	2.913	100	0.03
30	1,1-Dichloroethane	*0*	0	0	*0*	0	0	0	
31	1,2-Dichloroethane	0.017	0.017	0.052	0.069	0.068	0.212	88	**1.8**
32	1,1-Dichloroethylene	*0.001*	0	0.008	*0.002*	0	0.030	28	*0.00001*
33	cis-1,2-Dichloroethylene	*0.00002*	0.000	0.001	*0.0001*	0	0.005	2	
34	trans-1,2-Dichloroethylene	0.002	0.002	0.012	0.009	0.007	0.047	56	
35	Dichloromethane	0.166	0.127	0.906	0.575	0.441	3.147	100	0.01
36	1,2-Dichloropropane	*0.0002*	0	0.008	*0.001*	0	0.035	4	0.01
37	cis-1,3-Dichloropropylene	*0*	0	0	*0*	0	0	0	
38	trans-1,3-Dichloropropylene	*0*	0	0	*0*	0	0	0	
39	Dichlorotetrafluoroethane	0.017	0.017	0.019	0.118	0.120	0.134	100	
40	Ethyl Acrylate	*0*	0	0	*0*	0	0	0	
41	Ethylbenzene	0.105	0.078	0.672	0.454	0.338	2.918	100	**1.1**
42	Ethyl tert-Butyl Ether	*0.00002*	0	0.001	*0.0001*	0	0.005	2	
43	Formaldehyde	3.578	2.810	9.140	4.394	3.451	11.225	100	**57**
44	Hexachlorobutadiene	*0.0001*	0	0.002	*0.001*	0	0.020	21	0.03
45	Hexaldehyde	0.052	0.042	0.228	0.214	0.171	0.934	100	

Continued

Table 10-4 (continued)
CAMDEN SPRUCE STREET – 2021 NJ Air Toxics Monitoring Data

	Pollutant	Annual Mean	Annual Median	24-Hour Max.	Annual Mean	Annual Median	24-Hour Max.	% Detected	Annual Mean Risk Ratio
		ppbv			µg/m³				
46	Methyl Ethyl Ketone	0.123	0.110	0.496	0.361	0.324	1.461	100	*0.0001*
47	Methyl Isobutyl Ketone	0.039	0.034	0.123	0.162	0.141	0.504	100	*0.0001*
48	Methyl Methacrylate	*0.001*	0	0.032	*0.002*	0	0.113	4	*0.000003*
49	Methyl tert-Butyl Ether	*0.0002*	0	0.006	*0.001*	0	0.022	4	0.0002
50	n-Octane	0.067	0.050	0.218	0.314	0.234	1.018	88	
51	Propionaldehyde	0.207	0.190	0.450	0.491	0.451	1.069	100	*0.1*
52	Propylene	1.325	1.090	4.980	2.281	1.876	8.571	100	*0.001*
53	Styrene	0.063	0.037	0.402	0.268	0.158	1.712	96	0.1
54	1,1,2,2-Tetrachloroethane	*0.00001*	0	0.001	*0.0001*	0	0.003	2	0.004
55	Tetrachloroethylene	0.024	0.019	0.083	0.165	0.132	0.565	98	**1.03**
56	Toluene	0.658	0.421	3.570	2.478	1.586	13.452	100	*0.001*
57	1,2,4-Trichlorobenzene	*0.001*	0	0.005	*0.004*	0	0.036	33	*0.002*
58	1,1,1-Trichloroethane	0.002	0.002	0.006	0.012	0.012	0.035	82	*0.00001*
59	1,1,2-Trichloroethane	*0.001*	0	0.024	*0.004*	0	0.133	4	0.1
60	Trichloroethylene	*0.003*	0	0.015	*0.016*	0	0.080	30	0.1
61	Trichlorofluoromethane	0.362	0.290	1.160	2.034	1.629	6.518	100	*0.003*
62	Trichlorotrifluoroethane	0.075	0.074	0.095	0.407	0.404	0.521	100	*0.00001*
63	1,2,4-Trimethylbenzene	0.105	0.072	0.331	0.518	0.354	1.627	100	*0.01*
64	1,3,5-Trimethylbenzene	0.029	0.021	0.113	0.142	0.102	0.555	98	*0.002*
65	Valeraldehyde	0.063	0.054	0.159	0.224	0.190	0.560	100	
66	Vinyl Chloride	*0.004*	0	0.042	*0.010*	0	0.106	37	0.1
67	m,p-Xylene	0.279	0.186	1.120	1.213	0.808	4.863	100	0.01
68	o-Xylene	0.112	0.080	0.410	0.486	0.348	1.780	100	*0.005*

- Arithmetic means in *italics* had fewer than 50% of samples with detectable concentrations.
- For a valid 24-hour sampling event, when the analyzing laboratory reports the term “Not Detected” for a particular pollutant, the concentration of 0.0 ppbv is assigned to that pollutant. These zero concentrations were included in the calculation of annual averages and medians for each pollutant regardless of percent detection.
- Annual mean **risk ratios** in *italics* are based on noncancer effects.
- A risk ratio for a pollutant is calculated by dividing the annual mean air concentration by the long-term health benchmark. If the annual mean is 0, then the risk ratio is not calculated. See Table 10-9 for chemical-specific health benchmarks.

Table 10-5
CHESTER – 2021 NJ Air Toxics Monitoring Data

	Pollutant	Annual Mean	Annual Median	24-Hour Max.	Annual Mean	Annual Median	24-Hour Max.	% Detected	Annual Mean Risk Ratio
		ppbv			µg/m^3				
1	Acetaldehyde	0.855	0.658	3.670	1.540	1.186	6.612	100	**3**
2	Acetone	0.715	0.651	2.130	1.698	1.546	5.060	100	*0.0001*
3	Acetonitrile	0.299	0.172	6.000	0.502	0.289	10.074	98	*0.01*
4	Acetylene	0.406	0.332	1.310	0.432	0.353	1.394	100	
5	Acrolein	0.311	0.258	0.904	0.714	0.592	2.073	100	**36**
6	Acrylonitrile	*0.0002*	0	0.006	*0.0004*	0	0.013	4	0.03
7	tert-Amyl Methyl Ether	*0*	0	0	*0*	0	0	0	
8	Benzaldehyde	0.023	0.015	0.242	0.101	0.067	1.050	98	
9	Benzene	0.108	0.098	0.248	0.344	0.313	0.792	100	**3**
10	Bromochloromethane	*0.000004*	0	0.0002	*0.00002*	0	0.001	2	0.000001
11	Bromodichloromethane	*0.0001*	0	0.006	*0.001*	0	0.037	2	0.03
12	Bromoform	0.001	0.001	0.009	0.011	0.009	0.092	56	0.01
13	Bromomethane	0.009	0.009	0.019	0.034	0.033	0.073	98	*0.01*
14	1,3-Butadiene	0.005	0.004	0.030	0.011	0.008	0.065	58	0.3
15	Butyraldehyde	0.044	0.033	0.148	0.130	0.097	0.436	100	
16	Carbon Disulfide	0.013	0.011	0.135	0.040	0.033	0.420	92	*0.0001*
17	Carbon Tetrachloride	0.072	0.078	0.097	0.454	0.490	0.612	96	**3**
18	Chlorobenzene	*0.0001*	0	0.007	*0.001*	0	0.031	2	*0.000001*
19	Chloroethane	*0.003*	0	0.020	*0.009*	0	0.052	37	*0.000001*
20	Chloroform	0.020	0.020	0.034	0.098	0.096	0.167	100	**2**
21	Chloromethane	0.476	0.483	0.576	0.983	0.997	1.189	100	**1.8**
22	Chloroprene	*0*	0	0	*0*	0	0	0	
23	Crotonaldehyde	0.006	0.001	0.043	0.017	0.004	0.122	53	
24	Dibromochloromethane	*0.0001*	0	0.004	*0.001*	0	0.043	12	0.03
25	1,2-Dibromoethane	*0.0001*	0	0.005	*0.001*	0	0.041	2	0.46
26	m-Dichlorobenzene	*0.0001*	0	0.004	*0.001*	0	0.023	6	
27	o-Dichlorobenzene	*0.0001*	0	0.004	*0.001*	0	0.026	13	*0.000004*
28	p-Dichlorobenzene	0.002	0.001	0.007	0.010	0.007	0.043	63	0.11
29	Dichlorodifluoromethane	0.505	0.511	0.581	2.497	2.525	2.873	100	0.02
30	1,1-Dichloroethane	*0.0001*	0	0.004	*0.0003*	0	0.018	2	0.001
31	1,2-Dichloroethane	0.013	0.015	0.023	0.054	0.060	0.094	87	**1.4**
32	1,1-Dichloroethylene	0.001	0.001	0.003	0.004	0.002	0.012	50	*0.00002*
33	cis-1,2-Dichloroethylene	*0*	0	0	*0*	0	0	0	
34	trans-1,2-Dichloroethylene	*0.001*	0	0.007	*0.003*	0	0.029	25	
35	Dichloromethane	0.134	0.112	0.584	0.467	0.389	2.029	100	0.01
36	1,2-Dichloropropane	*0.0001*	0	0.005	*0.0005*	0	0.024	2	0.005
37	cis-1,3-Dichloropropylene	*0*	0	0	*0*	0	0	0	
38	trans-1,3-Dichloropropylene	*0*	0	0	*0*	0	0	0	
39	Dichlorotetrafluoroethane	0.017	0.017	0.021	0.119	0.121	0.144	100	
40	Ethyl Acrylate	*0*	0	0	*0*	0	0	0	
41	Ethylbenzene	0.013	0.012	0.031	0.056	0.050	0.133	98	0.14
42	Ethyl tert-Butyl Ether	0.005	0.005	0.012	0.022	0.021	0.051	90	
43	Formaldehyde	1.863	1.310	6.560	2.288	1.609	8.056	100	**30**
44	Hexachlorobutadiene	*0.0001*	0	0.004	*0.001*	0	0.042	15	0.03
45	Hexaldehyde	0.029	0.021	0.148	0.120	0.084	0.606	100	

Continued

Table 10-5 (continued)
CHESTER – 2021 NJ Air Toxics Monitoring Data

	Pollutant	Annual Mean	Annual Median	24-Hour Max.	Annual Mean	Annual Median	24-Hour Max.	% Detected	Annual Mean Risk Ratio
		ppbv			µg/m^3				
46	Methyl Ethyl Ketone	0.069	0.057	0.176	0.202	0.167	0.518	100	*0.00004*
47	Methyl Isobutyl Ketone	0.017	0.015	0.043	0.069	0.061	0.177	96	*0.00002*
48	Methyl Methacrylate	*0.001*	0	0.075	*0.005*	0	0.265	2	*0.00001*
49	Methyl tert-Butyl Ether	*0.001*	0	0.005	*0.002*	0	0.017	19	0.001
50	n-Octane	0.008	0.008	0.028	0.039	0.038	0.132	51	
51	Propionaldehyde	0.102	0.095	0.260	0.242	0.225	0.618	100	*0.03*
52	Propylene	0.414	0.371	1.210	0.712	0.639	2.082	100	*0.0002*
53	Styrene	0.002	0.001	0.007	0.009	0.004	0.031	50	0.01
54	1,1,2,2-Tetrachloroethane	*0.0001*	0	0.003	*0.001*	0	0.021	6	0.04
55	Tetrachloroethylene	0.007	0.006	0.025	0.048	0.042	0.168	94	0.3
56	Toluene	0.096	0.087	0.241	0.360	0.327	0.908	100	*0.0001*
57	1,2,4-Trichlorobenzene	*0.001*	0	0.008	*0.004*	0	0.056	19	*0.002*
58	1,1,1-Trichloroethane	0.002	0.002	0.006	0.010	0.010	0.031	83	*0.00001*
59	1,1,2-Trichloroethane	*0.00004*	0	0.001	*0.0002*	0	0.006	4	0.004
60	Trichloroethylene	0.004	0.004	0.008	0.023	0.022	0.045	79	0.1
61	Trichlorofluoromethane	0.236	0.235	0.271	1.326	1.320	1.523	100	*0.002*
62	Trichlorotrifluoroethane	0.075	0.074	0.096	0.410	0.403	0.523	100	*0.00001*
63	1,2,4-Trimethylbenzene	0.009	0.008	0.025	0.045	0.041	0.121	72	*0.001*
64	1,3,5-Trimethylbenzene	0.002	0.002	0.011	0.012	0.011	0.053	83	*0.0002*
65	Valeraldehyde	0.027	0.026	0.097	0.096	0.091	0.340	98	
66	Vinyl Chloride	*0.0002*	0	0.003	*0.001*	0	0.008	12	0.01
67	m,p-Xylene	0.029	0.026	0.076	0.125	0.114	0.332	100	*0.001*
68	o-Xylene	0.013	0.011	0.033	0.055	0.046	0.141	100	*0.001*

- Arithmetic means in *italics* had fewer than 50% of samples with detectable concentrations.
- For a valid 24-hour sampling event, when the analyzing laboratory reports the term “Not Detected” for a particular pollutant, the concentration of 0.0 ppbv is assigned to that pollutant. These zero concentrations were included in the calculation of annual averages and medians for each pollutant regardless of percent detection.
- Annual mean **risk ratios** in *italics* are based on noncancer effects.
- A risk ratio for a pollutant is calculated by dividing the annual mean air concentration by the long-term health benchmark. If the annual mean is 0, then the risk ratio is not calculated. See Table 10-9 for chemical-specific health benchmarks.

Table 10-6
ELIZABETH – 2021 NJ Air Toxics Monitoring Data

	Pollutant	Annual Mean	Annual Median	24-Hour Max.	Annual Mean	Annual Median	24-Hour Max.	% Detected	Annual Mean Risk Ratio
		ppbv			μg/m³				
1	Acetaldehyde	1.151	1.105	2.720	2.074	1.99	4.901	100	**5**
2	Acetone	0.976	0.892	3.510	2.318	2.12	8.338	100	*0.0001*
3	Acetonitrile	0.765	0.360	13.100	1.285	0.60	21.994	94	*0.02*
4	Acetylene	0.958	0.708	3.750	1.020	0.75	3.991	100	
5	Acrolein	0.393	0.371	0.927	0.900	0.85	2.126	100	***45***
6	Acrylonitrile	*0.002*	0	0.041	*0.005*	0	0.089	9	0.3
7	tert-Amyl Methyl Ether	*0*	0	0	*0*	0	0	0	
8	Benzaldehyde	0.028	0.023	0.092	0.122	0.101	0.398	100	
9	Benzene	0.229	0.213	0.512	0.733	0.680	1.636	100	**6**
10	Bromochloromethane	*0.0001*	0	0.004	*0.001*	0	0.019	11	0.00002
11	Bromodichloromethane	*0.0001*	0	0.002	*0.001*	0	0.013	9	0.03
12	Bromoform	0.002	0.002	0.010	0.018	0.019	0.101	75	0.02
13	Bromomethane	0.011	0.010	0.054	0.043	0.037	0.210	98	*0.01*
14	1,3-Butadiene	0.033	0.029	0.100	0.072	0.065	0.221	93	**2**
15	Butyraldehyde	0.074	0.062	0.220	0.219	0.183	0.649	100	
16	Carbon Disulfide	0.046	0.034	0.146	0.142	0.105	0.455	100	*0.0002*
17	Carbon Tetrachloride	0.074	0.078	0.104	0.467	0.492	0.654	98	**3**
18	Chlorobenzene	*0.0003*	0	0.007	*0.001*	0	0.034	7	*0.000001*
19	Chloroethane	0.006	0.005	0.030	0.016	0.012	0.079	51	*0.000002*
20	Chloroform	0.030	0.028	0.053	0.145	0.139	0.260	100	**3**
21	Chloromethane	0.498	0.502	0.654	1.028	1.037	1.351	100	**1.8**
22	Chloroprene	*0.0003*	0	0.017	*0.001*	0	0.063	2	0.5
23	Crotonaldehyde	0.018	0.011	0.075	0.052	0.032	0.215	92	
24	Dibromochloromethane	*0.0003*	0	0.002	*0.003*	0	0.024	37	0.1
25	1,2-Dibromoethane	*0*	0	0	*0*	0	0	0	
26	m-Dichlorobenzene	*0.00002*	0	0.001	*0.0001*	0	0.008	2	
27	o-Dichlorobenzene	*0.0003*	0	0.003	*0.002*	0	0.016	23	*0.00001*
28	p-Dichlorobenzene	0.009	0.007	0.035	0.053	0.044	0.207	91	0.6
29	Dichlorodifluoromethane	0.510	0.515	0.586	2.522	2.547	2.898	100	*0.03*
30	1,1-Dichloroethane	*0*	0	0	*0*	0	0	0	
31	1,2-Dichloroethane	0.013	0.015	0.022	0.051	0.062	0.088	77	**1.3**
32	1,1-Dichloroethylene	*0.001*	0	0.004	*0.002*	0	0.016	32	*0.00001*
33	cis-1,2-Dichloroethylene	*0.001*	0	0.006	*0.002*	0	0.023	18	
34	trans-1,2-Dichloroethylene	0.006	0.002	0.072	0.022	0.009	0.285	60	
35	Dichloromethane	0.186	0.151	0.549	0.647	0.525	1.907	100	0.01
36	1,2-Dichloropropane	*0.0003*	0	0.008	*0.002*	0	0.036	5	0.02
37	cis-1,3-Dichloropropylene	*0*	0	0	*0*	0	0	0	
38	trans-1,3-Dichloropropylene	*0*	0	0	*0*	0	0	0	
39	Dichlorotetrafluoroethane	0.014	0.015	0.023	0.096	0.104	0.161	91	
40	Ethyl Acrylate	*0*	0	0	*0*	0	0	0	
41	Ethylbenzene	0.066	0.057	0.203	0.287	0.245	0.881	100	0.7
42	Ethyl tert-Butyl Ether	*0.0001*	0	0.004	*0.001*	0	0.015	5	
43	Formaldehyde	2.965	2.630	7.150	3.641	3.230	8.781	100	**47**
44	Hexachlorobutadiene	*0.0001*	0	0.002	*0.001*	0	0.017	18	0.02
45	Hexaldehyde	0.056	0.043	0.290	0.231	0.174	1.188	100	

Continued

Table 10-6 (continued)
ELIZABETH – 2021 NJ Air Toxics Monitoring Data

	Pollutant	Annual Mean	Annual Median	24-Hour Max.	Annual Mean	Annual Median	24-Hour Max.	% Detected	Annual Mean Risk Ratio
		ppbv			µg/m³				
46	Methyl Ethyl Ketone	0.112	0.096	0.386	0.328	0.283	1.137	100	*0.0001*
47	Methyl Isobutyl Ketone	0.043	0.038	0.241	0.176	0.155	0.987	98	*0.0001*
48	Methyl Methacrylate	*0.001*	0	0.023	*0.003*	0	0.080	5	*0.000004*
49	Methyl tert-Butyl Ether	*0.001*	0	0.062	*0.005*	0	0.224	5	0.001
50	n-Octane	0.060	0.057	0.132	0.280	0.268	0.617	89	
51	Propionaldehyde	0.173	0.155	0.678	0.411	0.367	1.611	100	*0.1*
52	Propylene	1.935	1.290	20.900	3.331	2.220	35.970	100	*0.001*
53	Styrene	0.029	0.015	0.286	0.123	0.064	1.218	71	0.1
54	1,1,2,2-Tetrachloroethane	*0*	0	0	*0*	0	0	0	
55	Tetrachloroethylene	0.017	0.014	0.058	0.115	0.094	0.396	98	0.7
56	Toluene	0.450	0.398	0.920	1.697	1.500	3.467	100	*0.0005*
57	1,2,4-Trichlorobenzene	*0.001*	0	0.006	*0.005*	0	0.047	33	*0.002*
58	1,1,1-Trichloroethane	0.003	0.002	0.013	0.014	0.013	0.073	86	*0.00001*
59	1,1,2-Trichloroethane	*0.0001*	0	0.008	*0.001*	0	0.041	2	0.01
60	Trichloroethylene	0.006	0.007	0.014	0.034	0.038	0.076	86	0.2
61	Trichlorofluoromethane	0.242	0.240	0.308	1.360	1.349	1.731	100	*0.002*
62	Trichlorotrifluoroethane	0.076	0.075	0.114	0.413	0.410	0.622	100	*0.00001*
63	1,2,4-Trimethylbenzene	0.067	0.065	0.145	0.331	0.319	0.713	100	*0.01*
64	1,3,5-Trimethylbenzene	0.017	0.016	0.040	0.081	0.076	0.198	100	*0.001*
65	Valeraldehyde	0.049	0.044	0.204	0.173	0.154	0.719	100	
66	Vinyl Chloride	*0.0003*	0	0.005	*0.001*	0	0.014	14	0.01
67	m,p-Xylene	0.197	0.165	0.695	0.855	0.716	3.018	100	*0.01*
68	o-Xylene	0.076	0.068	0.206	0.331	0.294	0.894	100	*0.003*

- Arithmetic means in *italics* had fewer than 50% of samples with detectable concentrations.
- For a valid 24-hour sampling event, when the analyzing laboratory reports the term “Not Detected” for a particular pollutant, the concentration of 0.0 ppbv is assigned to that pollutant. These zero concentrations were included in the calculation of annual averages and medians for each pollutant regardless of percent detection.
- Annual mean **risk ratios** in *italics* are based on noncancer effects.
- A risk ratio for a pollutant is calculated by dividing the annual mean air concentration by the long-term health benchmark. If the annual mean is 0, then the risk ratio is not calculated. See Table 10-9 for chemical-specific health benchmarks.

Table 10-7
RUTGERS – 2021 NJ Air Toxics Monitoring Data

	Pollutant	Annual Mean	Annual Median	24-Hour Max.	Annual Mean	Annual Median	24-Hour Max.	% Detected	Annual Mean Risk Ratio
		ppbv			µg/m^3				
1	Acetaldehyde	0.717	0.767	1.650	1.292	1.382	2.973	100	**3**
2	Acetone	1.004	0.802	3.970	2.384	1.905	9.431	100	*0.0001*
3	Acetonitrile	0.357	0.225	1.960	0.600	0.378	3.291	94	*0.01*
4	Acetylene	0.712	0.485	3.320	0.758	0.516	3.533	100	
5	Acrolein	0.365	0.328	0.952	0.837	0.752	2.183	100	***42***
6	Acrylonitrile	*0.001*	0	0.019	*0.002*	0	0.040	7	0.1
7	tert-Amyl Methyl Ether	*0*	0	0	*0*	0	0	0	
8	Benzaldehyde	0.020	0.016	0.117	0.087	0.071	0.508	100	
9	Benzene	0.149	0.122	0.443	0.475	0.390	1.415	100	**4**
10	Bromochloromethane	*0.00004*	0	0.002	*0.0002*	0	0.008	5	0.00001
11	Bromodichloromethane	*0.0005*	0	0.009	*0.003*	0	0.062	15	0.1
12	Bromoform	0.001	0.001	0.011	0.015	0.013	0.110	63	0.02
13	Bromomethane	0.010	0.009	0.036	0.037	0.034	0.141	98	*0.01*
14	1,3-Butadiene	0.015	0.011	0.071	0.034	0.023	0.158	90	**1.02**
15	Butyraldehyde	0.046	0.040	0.126	0.136	0.119	0.372	100	
16	Carbon Disulfide	0.014	0.012	0.048	0.044	0.037	0.149	100	*0.0001*
17	Carbon Tetrachloride	0.071	0.077	0.100	0.448	0.483	0.629	100	**3**
18	Chlorobenzene	*0.0003*	0	0.007	*0.001*	0	0.033	7	*0.000001*
19	Chloroethane	0.017	0.009	0.208	0.045	0.023	0.549	67	*0.000005*
20	Chloroform	0.027	0.025	0.058	0.133	0.120	0.283	100	**3**
21	Chloromethane	0.494	0.491	0.784	1.019	1.014	1.619	100	**1.8**
22	Chloroprene	*0.0001*	0	0.006	*0.0004*	0	0.022	3	0.2
23	Crotonaldehyde	0.012	0.005	0.085	0.034	0.015	0.243	82	
24	Dibromochloromethane	*0.0003*	0	0.008	*0.003*	0	0.076	23	0.1
25	1,2-Dibromoethane	*0.00005*	0	0.002	*0.0004*	0	0.012	3	0.2
26	m-Dichlorobenzene	*0.0001*	0	0.006	*0.001*	0	0.037	3	
27	o-Dichlorobenzene	*0.0001*	0	0.006	*0.001*	0	0.035	10	*0.000004*
28	p-Dichlorobenzene	0.005	0.004	0.023	0.029	0.027	0.138	85	0.3
29	Dichlorodifluoromethane	0.504	0.510	0.569	2.494	2.520	2.814	100	*0.02*
30	1,1-Dichloroethane	*0.0001*	0	0.006	*0.0005*	0	0.026	3	0.001
31	1,2-Dichloroethane	0.014	0.016	0.024	0.055	0.064	0.095	87	**1.4**
32	1,1-Dichloroethylene	*0.001*	0	0.008	*0.003*	0	0.032	32	*0.00001*
33	cis-1,2-Dichloroethylene	*0.00003*	0	0.001	*0.0001*	0	0.005	3	
34	trans-1,2-Dichloroethylene	0.016	0.001	0.838	0.063	0.002	3.323	50	
35	Dichloromethane	0.194	0.153	0.688	0.674	0.530	2.390	100	0.01
36	1,2-Dichloropropane	*0.0003*	0	0.008	*0.001*	0	0.037	5	0.01
37	cis-1,3-Dichloropropylene	*0*	0	0	*0*	0	0	0	
38	trans-1,3-Dichloropropylene	*0*	0	0	*0*	0	0	0	
39	Dichlorotetrafluoroethane	0.017	0.017	0.022	0.121	0.121	0.154	100	
40	Ethyl Acrylate	*0*	0	0	*0*	0	0	0	
41	Ethylbenzene	0.031	0.026	0.111	0.133	0.115	0.482	100	0.3
42	Ethyl tert-Butyl Ether	0.006	0.007	0.014	0.027	0.029	0.058	82	
43	Formaldehyde	1.804	1.700	4.380	2.215	2.088	5.379	100	**29**
44	Hexachlorobutadiene	*0.0002*	0	0.006	*0.002*	0	0.061	20	0.05
45	Hexaldehyde	0.038	0.025	0.256	0.154	0.100	1.049	100	

Continued

Table 10-7 (continued)
RUTGERS – 2021 NJ Air Toxics Monitoring Data

	Pollutant	Annual Mean	Annual Median	24-Hour Max.	Annual Mean	Annual Median	24-Hour Max.	% Detected	Annual Mean Risk Ratio
		ppbv			µg/m³				
46	Methyl Ethyl Ketone	0.153	0.098	1.970	0.450	0.289	5.801	100	*0.0001*
47	Methyl Isobutyl Ketone	0.032	0.026	0.251	0.130	0.107	1.028	97	*0.00004*
48	Methyl Methacrylate	*0.002*	0	0.079	*0.006*	0	0.279	3	*0.00001*
49	Methyl tert-Butyl Ether	*0.001*	0	0.008	*0.003*	0	0.027	18	0.001
50	n-Octane	0.025	0.022	0.126	0.115	0.103	0.589	71	
51	Propionaldehyde	0.120	0.116	0.337	0.284	0.276	0.801	100	*0.04*
52	Propylene	0.616	0.534	1.900	1.059	0.918	3.270	100	*0.0004*
53	Styrene	0.010	0.007	0.048	0.043	0.031	0.206	67	0.02
54	1,1,2,2-Tetrachloroethane	*0*	0	0	*0*	0	0	0	
55	Tetrachloroethylene	0.012	0.009	0.060	0.082	0.063	0.404	98	0.5
56	Toluene	0.220	0.170	1.010	0.830	0.639	3.806	100	*0.0002*
57	1,2,4-Trichlorobenzene	*0*	0	0.005	*0.003*	0	0.036	25	*0.001*
58	1,1,1-Trichloroethane	0.002	0.002	0.009	0.012	0.012	0.049	82	*0.00001*
59	1,1,2-Trichloroethane	*0.0001*	0	0.003	*0.0004*	0	0.014	3	0.01
60	Trichloroethylene	0.006	0.007	0.018	0.032	0.035	0.095	82	0.2
61	Trichlorofluoromethane	0.239	0.238	0.273	1.345	1.337	1.534	100	*0.002*
62	Trichlorotrifluoroethane	0.075	0.075	0.095	0.410	0.409	0.517	100	*0.00001*
63	1,2,4-Trimethylbenzene	0.032	0.030	0.098	0.157	0.146	0.480	93	*0.003*
64	1,3,5-Trimethylbenzene	0.007	0.006	0.026	0.036	0.028	0.125	98	*0.001*
65	Valeraldehyde	0.033	0.035	0.093	0.117	0.124	0.326	100	
66	Vinyl Chloride	*0.0003*	0	0.005	*0.001*	0	0.012	12	0.01
67	m,p-Xylene	0.080	0.070	0.340	0.345	0.302	1.476	100	*0.003*
68	o-Xylene	0.032	0.028	0.126	0.140	0.120	0.547	100	*0.001*

- Arithmetic means in *italics* had fewer than 50% of samples with detectable concentrations.
- For a valid 24-hour sampling event, when the analyzing laboratory reports the term “Not Detected” for a particular pollutant, the concentration of 0.0 ppbv is assigned to that pollutant. These zero concentrations were included in the calculation of annual averages and medians for each pollutant regardless of percent detection.
- Annual mean **risk ratios** in *italics* are based on noncancer effects.
- A risk ratio for a pollutant is calculated by dividing the annual mean air concentration by the long-term health benchmark. If the annual mean is 0, then the risk ratio is not calculated. See Table 10-9 for chemical-specific health benchmarks.

In 2021, samples of the chemicals in Table 10-8 were never detected at the monitoring location specified. However, these pollutants may be present in the air at levels the lab cannot measure. Chemical-specific average detection limits can be found in Table 10-9.

Table 10-8
Air Toxics with 100% Non-Detects in 2021

	Pollutant	CAS No.	Camden	Chester	Elizabeth	Rutgers
1	Tert-Amyl Ethyl Ether	994-05-8	X	X	X	X
2	Chloroprene	126-99-8		X		
3	1,2-Dibromoethane	106-93-4	X		X	
4	1,1-Dichloroethane	75-34-3	X		X	
5	cis-1,2-Dichloroethylene	156-59-2		X		
6	cis-1,3-Dichloropropylene	10061-01-5	X	X	X	X
7	trans-1,3-Dichloropropylene	10061-02-6	X	X	X	X
8	Ethyl Acrylate	140-88-5	X	X	X	X
9	1,1,2,2-Tetrachloroethane	79-34-5			X	X

Table 10-9
2021 Air Toxics Detection Limits and Health Benchmarks

	Pollutant	CAS No.	Detection Limit (ppbv)	Detection Limit (μg/m^3)	Health Bench-mark (μg/m^3)
1	Acetaldehyde	75-07-0	0.017	0.031	0.45
2	Acetone	67-64-1	0.095	0.227	*31000*
3	Acetonitrile	75-05-8	0.053	0.088	*60*
4	Acetylene	74-86-2	0.110	0.117	
5	Acrolein	107-02-8	0.102	0.234	*0.02*
6	Acrylonitrile	107-13-1	0.017	0.037	0.015
7	tert-Amyl Methyl Ether	994-05-8	0.014	0.060	
8	Benzaldehyde	100-52-7	0.008	0.035	
9	Benzene	71-43-2	0.012	0.037	0.13
10	Bromochloromethane	74-97-5	0.011	0.060	*40*
11	Bromodichloromethane	75-27-4	0.009	0.063	0.027
12	Bromoform	75-25-2	0.014	0.141	0.91
13	Bromomethane	74-83-9	0.010	0.039	*5*
14	1,3-Butadiene	106-99-0	0.017	0.037	0.033
15	Butyraldehyde	123-72-8	0.004	0.011	
16	Carbon Disulfide	75-15-0	0.019	0.059	*700*
17	Carbon Tetrachloride	56-23-5	0.011	0.070	0.17
18	Chlorobenzene	108-90-7	0.013	0.061	*1000*
19	Chloroethane	75-00-3	0.011	0.028	*10000*
20	Chloroform	67-66-3	0.007	0.036	0.043
21	Chloromethane	74-87-3	0.051	0.105	0.56
22	Chloroprene	126-99-8	0.017	0.062	0.002
23	Crotonaldehyde	123-73-9	0.001	0.003	
24	Dibromochloromethane	124-48-1	0.014	0.142	0.037
25	1,2-Dibromoethane	106-93-4	0.015	0.118	0.0017
26	m-Dichlorobenzene	541-73-1	0.016	0.095	
27	o-Dichlorobenzene	95-50-1	0.017	0.099	*200*
28	p-Dichlorobenzene	106-46-7	0.015	0.090	0.091
29	Dichlorodifluoromethane	75-71-8	0.024	0.121	*100*
30	1,1-Dichloroethane	75-34-3	0.007	0.029	0.63
31	1,2-Dichloroethane	107-06-2	0.007	0.029	0.038
32	1,1-Dichloroethylene	75-35-4	0.009	0.035	*200*
33	cis-1,2-Dichloroethylene	156-59-2	0.017	0.068	
34	trans-1,2-Dichloroethylene	156-60-5	0.007	0.028	
35	Dichloromethane	75-09-2	0.103	0.358	77
36	1,2-Dichloropropane	78-87-5	0.008	0.039	0.1
37	cis-1,3-Dichloropropylene	10061-01-5	0.008	0.035	0.25
38	trans-1,3-Dichloropropylene	10061-02-6	0.016	0.072	0.25
39	Dichlorotetrafluoroethane	76-14-2	0.007	0.049	
40	Ethyl Acrylate	140-88-5	0.013	0.053	*8*
41	Ethylbenzene	100-41-4	0.009	0.041	0.4
42	Ethyl tert-Butyl Ether	637-92-3	0.010	0.042	
43	Formaldehyde	50-00-0	0.053	0.065	0.077
44	Hexachlorobutadiene	87-68-3	0.019	0.201	0.045
45	Hexaldehyde	66-25-1	0.022	0.091	

Continued

Table 10-9 (continued)
Air Toxics Detection Limits and Health Benchmarks

	Pollutant	CAS No.	Detection Limit (ppbv)	Detection Limit (μg/m³)	Health Bench-mark (μg/m³)
46	Methyl Ethyl Ketone	78-93-3	0.006	0.018	*5000*
47	Methyl Isobutyl Ketone	108-10-1	0.008	0.031	*3000*
48	Methyl Methacrylate	80-62-6	0.035	0.122	*700*
49	Methyl tert-Butyl Ether	1634-04-4	0.009	0.033	3.8
50	n-Octane	111-65-9	0.008	0.038	
51	Propionaldehyde	123-38-6	0.005	0.011	*8*
52	Propylene	115-07-1	0.130	0.224	*3000*
53	Styrene	100-42-5	0.016	0.070	1.8
54	1,1,2,2-Tetrachloroethane	79-34-5	0.016	0.108	0.017
55	Tetrachloroethylene	127-18-4	0.018	0.125	0.16
56	Toluene	108-88-3	0.059	0.223	*3760*
57	1,2,4-Trichlorobenzene	120-82-1	0.069	0.509	*2*
58	1,1,1-Trichloroethane	71-55-6	0.007	0.039	*1000*
59	1,1,2-Trichloroethane	79-00-5	0.011	0.059	0.063
60	Trichloroethylene	79-01-6	0.015	0.078	0.2
61	Trichlorofluoromethane	75-69-4	0.014	0.078	*700*
62	Trichlorotrifluoroethane	76-13-1	0.012	0.065	*30000*
63	1,2,4-Trimethylbenzene	95-63-6	0.013	0.063	*60*
64	1,3,5-Trimethylbenzene	108-67-8	0.015	0.074	*60*
65	Valeraldehyde	110-62-3	0.006	0.020	
66	Vinyl chloride	75-01-4	0.009	0.022	0.11
67	m,p-Xylene	108-38-3 106-42-3	0.019	0.083	*100*
68	o-Xylene	95-47-6	0.013	0.056	*100*

- **Detection limits** are from ERG analytic lab, Morrisville, NC.
- **Health benchmark** - the chemical-specific air concentration above which there may be human health concerns. Not available for all chemicals. Those presented here are for long-term exposure.
- For a carcinogen (cancer-causing chemical), the health benchmark is set at the air concentration that would cause no more than a one-in-a-million increase in the likelihood of getting cancer, even after a lifetime of exposure.
- For a noncarcinogen, the health benchmark is the maximum air concentration to which exposure is likely to cause no harm, even if that exposure occurs on a daily basis for a lifetime.
- Health benchmarks in *italics* are based on noncancer effects.
- Health benchmarks are from *Toxicity Values for Inhalation Exposure*, NJDEP Bureau of Evaluation & Planning, June 2020. https://www.state.nj.us/dep/aqpp/downloads/risk/ToxAll2020.pdf

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2021 PAMS Summary

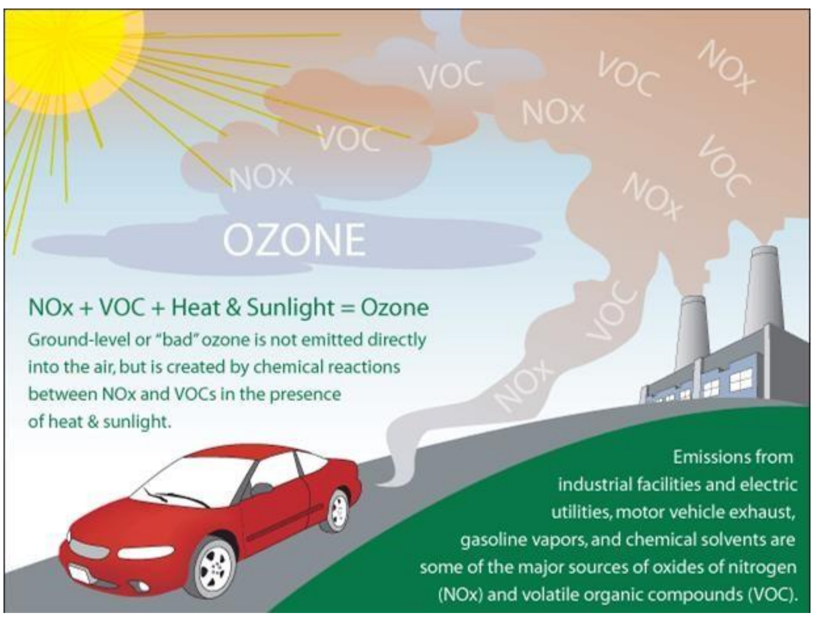
New Jersey Department of Environmental Protection

Photochemical Assessment Monitoring

Most ground-level ozone (O_3) is formed when volatile organic compounds (VOCs) and oxides of nitrogen (NO_x) react in the presence of sunlight, as shown in Figure 11-1. Therefore, to effectively evaluate strategies for reducing ozone levels, it is necessary to measure these ozone-forming pollutants, also known as precursor pollutants. The Photochemical Assessment Monitoring Stations (PAMS) network was established by the U.S. Environmental Protection Agency (USEPA) for this purpose. Data from the PAMS network is used to better characterize the nature and extent of the ozone problem, track VOC and NO_x emissions, assess air quality trends, and make planning decisions.

PAMS monitor both criteria and non-criteria pollutants. These include ozone, nitric oxide (NO), nitrogen dioxide (NO_2), total reactive oxides of nitrogen (NO_y), and specific VOCs, including several that are carbonyls and are important in ozone formation. In addition, the measurement of specific weather parameters is required at all PAMS: wind speed and direction; temperature; barometric pressure; relative humidity; precipitation; solar radiation; UV radiation; and mixing layer height. The VOC and carbonyl measurements are taken only during peak ozone season, from June 1st to August 31st each year. The VOC and carbonyl data is the focus of this section of the annual Air Quality Report.

Figure 11-1
Ozone Formation



https://www.epa.gov/ground-level-ozone-pollution/ground-level-ozone-basics#wwh

In 2015, USEPA revised the National Ambient Air Quality Standard (NAAQS) for ozone, including the requirements for monitoring. This led to an overhaul of the PAMS program, with changes to the methodology for measuring the PAMS target pollutants and also to the locations of PAMS sites in the U.S. To support the implementation, USEPA designated specific instruments for the continuous hourly measurement of ozone precursor VOCs, provided funding to the states for purchasing the equipment, and set a date of June 1, 2021, to begin monitoring using the approved instruments. NJDEP purchased the new instruments in 2018, evaluated and tested them through 2020, and met the deadline of June 1, 2021, for measuring the target VOCs.

New Jersey once had a number of PAMS sites around the state. Currently, its sole PAMS station is on Rutgers University agricultural land in East Brunswick.

Figure 11-2
2021 Photochemical Assessment Monitoring Station

New Jersey collects samples using the Markes-Agilent system, which electrically cools and freezes humidified air, allowing the detection of more polar compounds, and the reporting of concentrations of both alpha and beta pinenes. The concentrations of the 2021 PAMS target compounds are presented in Table 11-1 below.

Table 11-1
2021 PAMS Target Compounds in New Jersey
Annual Average and Hourly Maximum Concentrations
Parts per Billion Carbon (ppbC)
Parts per Billion by Volume (ppbv)
Micrograms per Cubic Meter (µg/m³)

Compound	Annual Average			Hourly Maximum		
	ppbC	ppbv	µg/m³	ppbC	ppbv	µg/m³
Acetylene	0.24	0.12	0.13	0.93	0.47	0.50
Benzene	0.54	0.09	0.29	3.64	0.61	1.94
1,3-Butadiene	0.42	0.11	0.23	1.43	0.36	0.79
n-Butane	1.9	0.48	1.13	29.72	7.43	17.66
1-Butene	0.18	0.05	0.10	0.58	0.15	0.33
c-2 Butene	0	0.00	0.00	0.44	0.11	0.25
t-2 Butene	0	0.00	0.00	0.41	0.10	0.24
Cyclohexane	0.16	0.03	0.09	3.64	0.61	2.09
Cyclopentane	0.26	0.05	0.15	2.34	0.47	1.34
n-Decane	0.09	0.01	0.05	0.89	0.09	0.52
m-Diethylbenzene	0.04	0.00	0.02	0.96	0.10	0.53
p-Diethylbenzene	0.01	0.00	0.01	0.4	0.04	0.22
2 2-Dimethylbutane	0.12	0.02	0.07	1.28	0.21	0.75
2 3-Dimethylbutane	0.24	0.04	0.14	1.67	0.28	0.98
2 3-Dimethylpentane	0.12	0.02	0.07	0.92	0.13	0.54
2 4-Dimethylpentane	0.05	0.01	0.03	0.72	0.10	0.42
n-Dodecane	0	0.00	0.00	0.46	0.04	0.27
Ethane	4.29	2.15	2.64	18.07	9.04	11.11
Ethylbenzene	0.21	0.03	0.11	1.07	0.13	0.58
Ethylene	0.82	0.41	0.47	3.81	1.91	2.19
m-Ethyltoluene	0.12	0.01	0.07	1.76	0.20	0.96
o-Ethyltoluene	0.03	0.00	0.02	0.66	0.07	0.36
p-Ethyltoluene	0.18	0.02	0.10	2.15	0.24	1.17
Hexane	0.51	0.09	0.30	4.33	0.72	2.54
1-Hexene	0.01	0.00	0.01	0.34	0.06	0.20
n-Heptane	0.24	0.03	0.14	1.35	0.19	0.79
Isobutane	0.77	0.19	0.46	6.3	1.58	3.74
Isopentane	1.82	0.36	1.07	31.6	6.32	18.65
Isoprene	3.84	0.77	2.14	34.21	6.84	19.06
Isopropylbenzene	0.02	0.00	0.01	0.61	0.07	0.33
Methylcyclohexane	0.14	0.02	0.08	1.46	0.21	0.84
Methylcyclopentane	0.21	0.04	0.12	1.68	0.28	0.96
2-Methylheptane	0.06	0.01	0.04	0.47	0.06	0.27
3-Methylheptane	0.07	0.01	0.04	0.51	0.06	0.30

Continued

Table 11-1 (continued)
2021 PAMS Target Compounds in New Jersey
Annual Average and Hourly Maximum Concentrations
Parts per Billion Carbon (ppbC)
Parts per Billion by Volume (ppbv)
Micrograms per Cubic Meter ($\mu g/m^3$)

Compound	Annual Average			Hourly Maximum		
	ppbC	ppbv	$\mu g/m^3$	ppbC	ppbv	$\mu g/m^3$
2-Methylhexane	0.3	0.04	0.18	2.4	0.34	1.41
3-Methylhexane	0.33	0.05	0.19	2.71	0.39	1.59
2-Methylpentane	0.65	0.11	0.38	5.04	0.84	2.96
3-Methylpentane	0.36	0.06	0.21	3	0.50	1.76
n-Nonane	0.08	0.01	0.05	0.95	0.11	0.55
n-Octane	0.09	0.01	0.05	0.71	0.09	0.41
n-P entane	1.17	0.23	0.69	20.38	4.08	12.03
1-Pentene	0.19	0.04	0.11	16.9	3.38	9.69
c2-Pentene	0	0.00	0.00	0.44	0.09	0.25
t2-Pentene	0.03	0.01	0.02	0.76	0.15	0.44
a-Pinene	0.26	0.03	0.14	3.24	0.32	1.81
b-Pinene	0.08	0.01	0.04	0.92	0.09	0.51
Propane	3.15	1.05	1.89	14.17	4.72	8.52
n-Propylbenzene	0.05	0.01	0.03	0.57	0.06	0.31
Propylene	0.48	0.16	0.28	2.25	0.75	1.29
Styrene	0.09	0.01	0.05	0.68	0.09	0.36
Toluene	1.27	0.18	0.68	10.71	1.53	5.77
1 2 3-Trimethylbenzene	0.2	0.02	0.11	3.56	0.40	1.94
1 2 4-Trimethylbenzene	0.15	0.02	0.08	2.11	0.23	1.15
1 3 5-Trimethylbenzene	0.06	0.01	0.03	1.3	0.14	0.71
2 2 4-Trimethylpentane	0.54	0.07	0.32	6.45	0.81	3.77
2 3 4-Trimehtylpentane	0.18	0.02	0.11	1.19	0.15	0.69
n-Undecane	0.05	0.00	0.03	0.63	0.06	0.37
m,p-Xylene	0.57	0.07	0.31	3.76	0.47	2.04
o-Xylene	0.23	0.03	0.12	1.25	0.16	0.68
PAMHC	28.53	x	x	127.19	x	x
T-NMOC	30.42	x	x	130.67	x	x
Unknowns	1.89	x	x	16.09	x	x

The three main contributors to total PAMS hydrocarbons at the Rutgers site were ethane, isoprene, and propane, as shown in the pie graph in figure 11-3. These compounds made up more than one-third of the total measured hydrocarbons for the summer ozone season. Ethane and propane are major components of natural gas and processing of crude oil, whereas isoprene is a biogenic compound released from plants, particularly trees.

Figure 11-3
Percentage of Components of Total Non-Methane Organic Carbon (TNMOC) for the 2021 PAMS Season in New Jersey

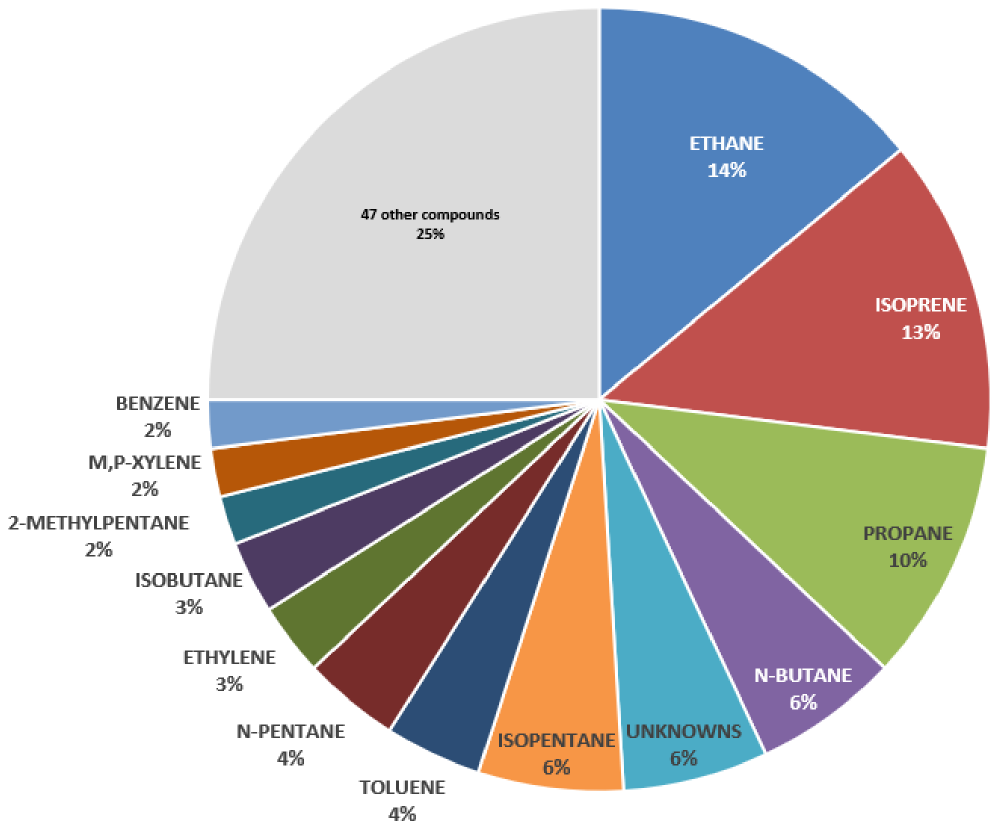


Figure 11-4 below is a comparison of the daily average concentrations of ethane, isoprene, propane, benzene and toluene. Figure 11-5 shows the diurnal trend for isoprene, toluene and the average of all of the other PAMS hydrocarbons (PAMHC). Most of the anthropogenic compounds show peaks in the early morning and late evening due to the mixing layer height being lower at those times. In contrast, the biogenic compounds like isoprene tend to peak during the day, when sunlight drives plant photosynthesis.

Figure 11-4
2021 PAMS Daily Averages for Ethane, Isoprene, Propane, Benzene, and Toluene in New Jersey
Parts per Billion Carbon (ppbC)

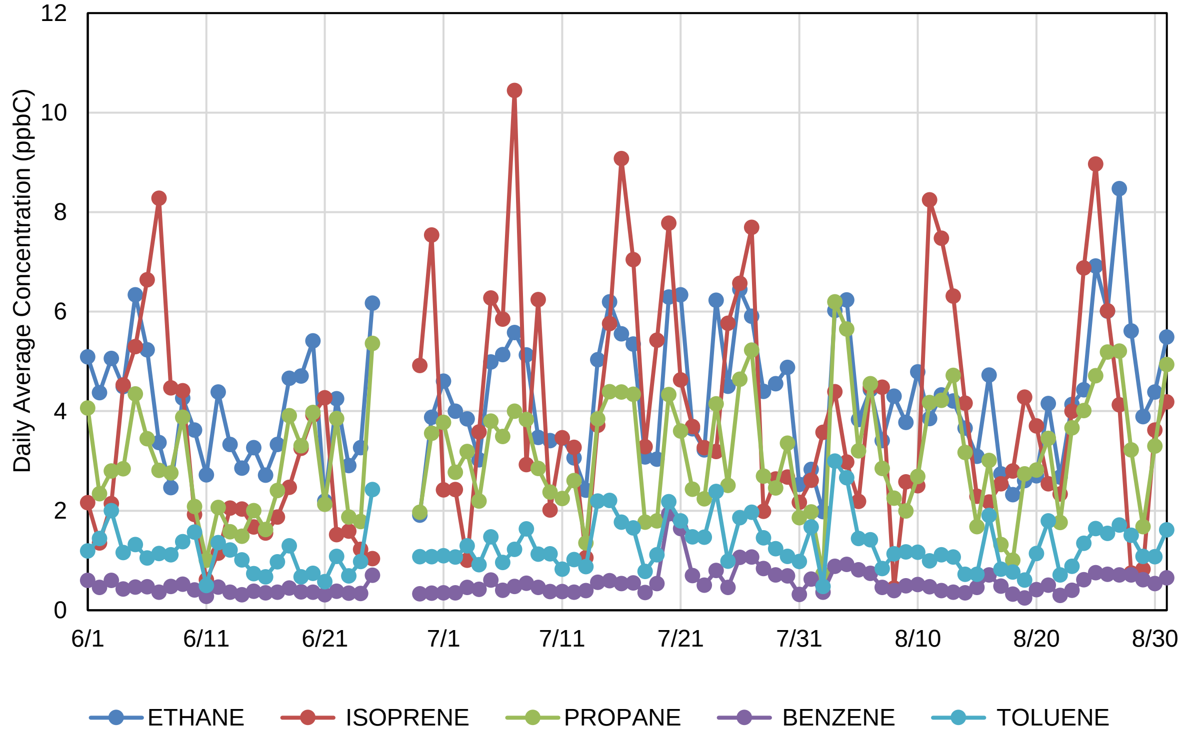
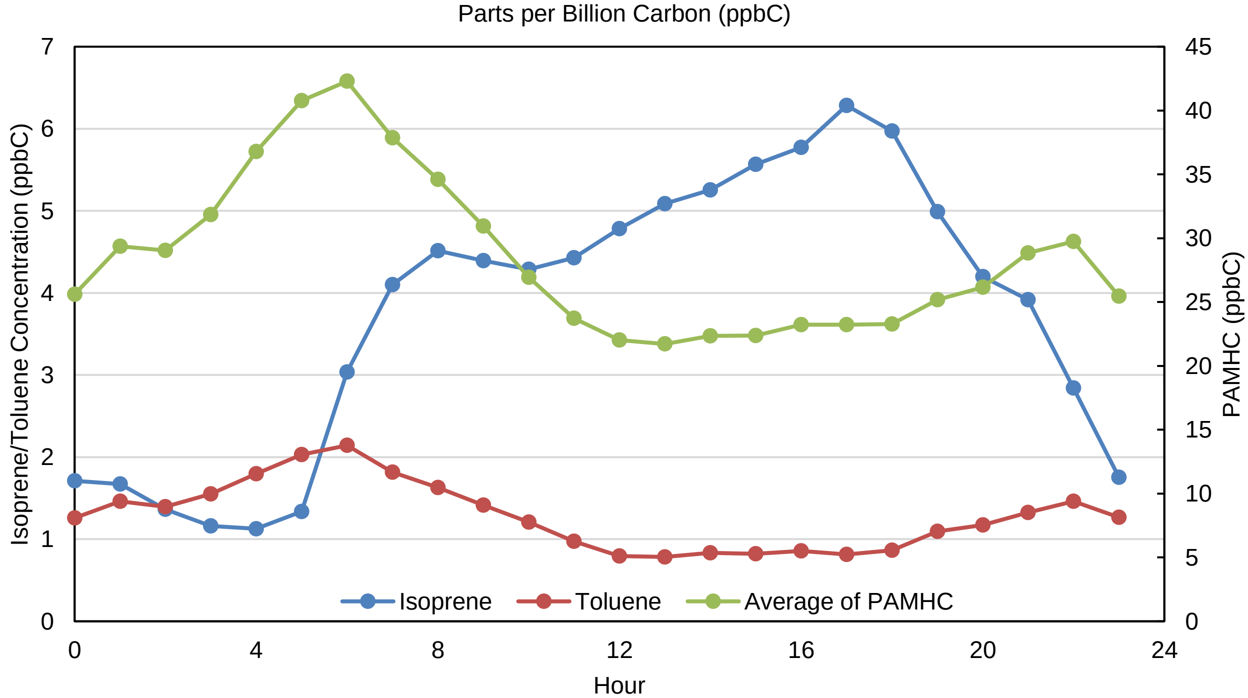
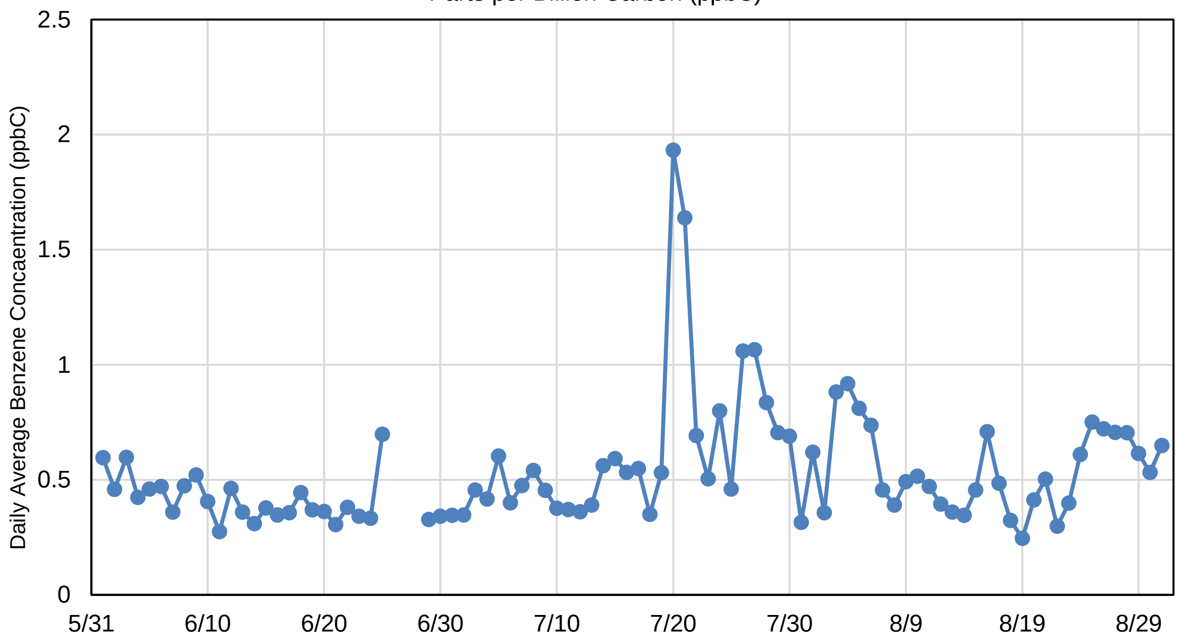


Figure 11-5
2021 PAMS Diurnal Trends in New Jersey
Hourly Average Concentrations
Parts per Billion Carbon (ppbC)



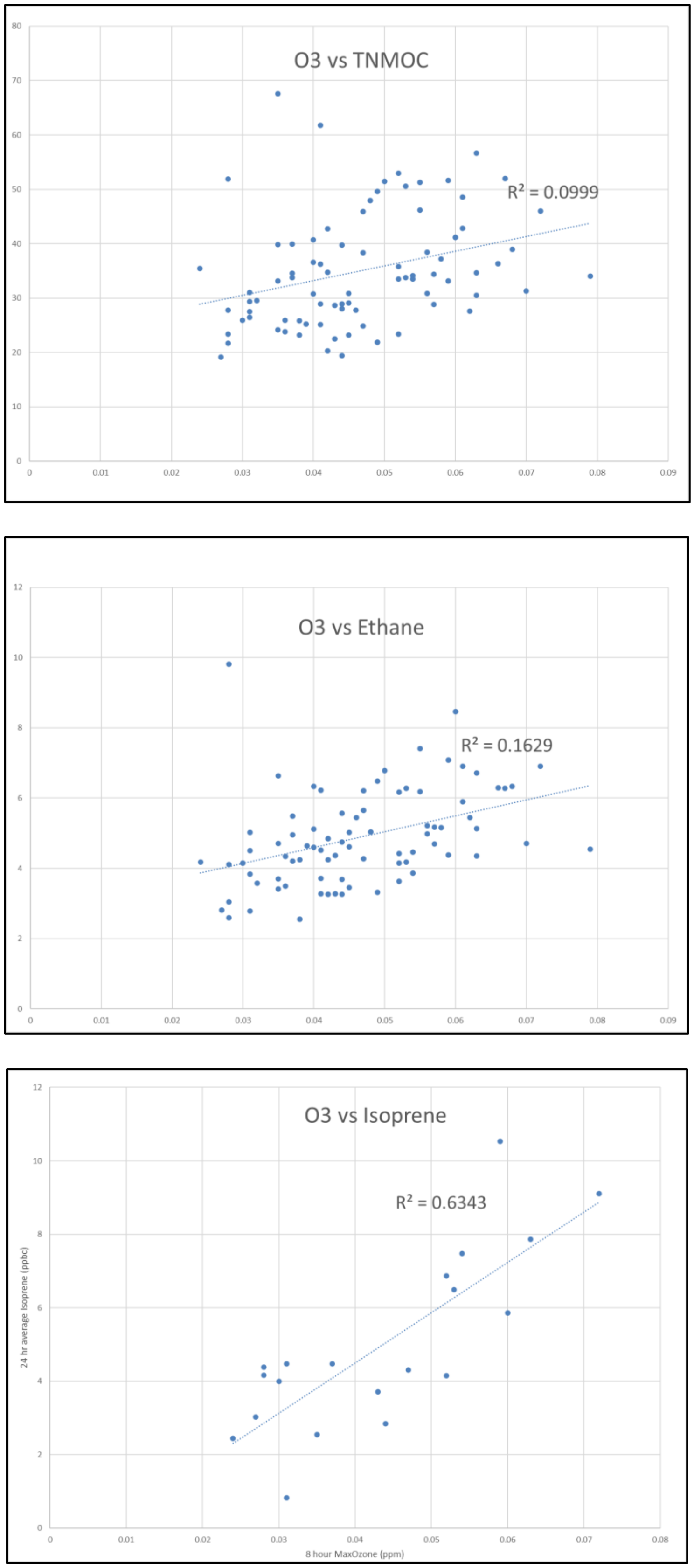
On July 20 and 21, there was a sudden sharp increase in the concentration of benzene (see Figure 11-6),. The increase correlated with milling and repaving work that was being done on those days on U.S. Highway 1, less than a mile from the PAMS site. Hot asphalt contains crude petroleum and is known to release benzene into the air. Even after paving is completed, concentrations can remain elevated as volatile compounds evaporate when sunlight heats the asphalt.

Figure 11-6
2021 PAMS Daily Benzene Concentrations in New Jersey
Parts per Billion Carbon (ppbC)



Although it takes VOCs in the atmosphere to produce ozone, some compounds are much more reactive than others. As shown in Figure 11-7, the correlation between total non-methane organic compounds (TNMOC) and ozone concentrations at Rutgers was very weak, while the correlation between isoprene and ozone was significant. Isoprene is about 2 orders of magnitude more reactive than ethane, which is the largest component of TNMOC.

Figure 11-7
2021 PAMS Maximum 8-hour Ozone Averages vs. TNMOC, Ethane, and Isoprene

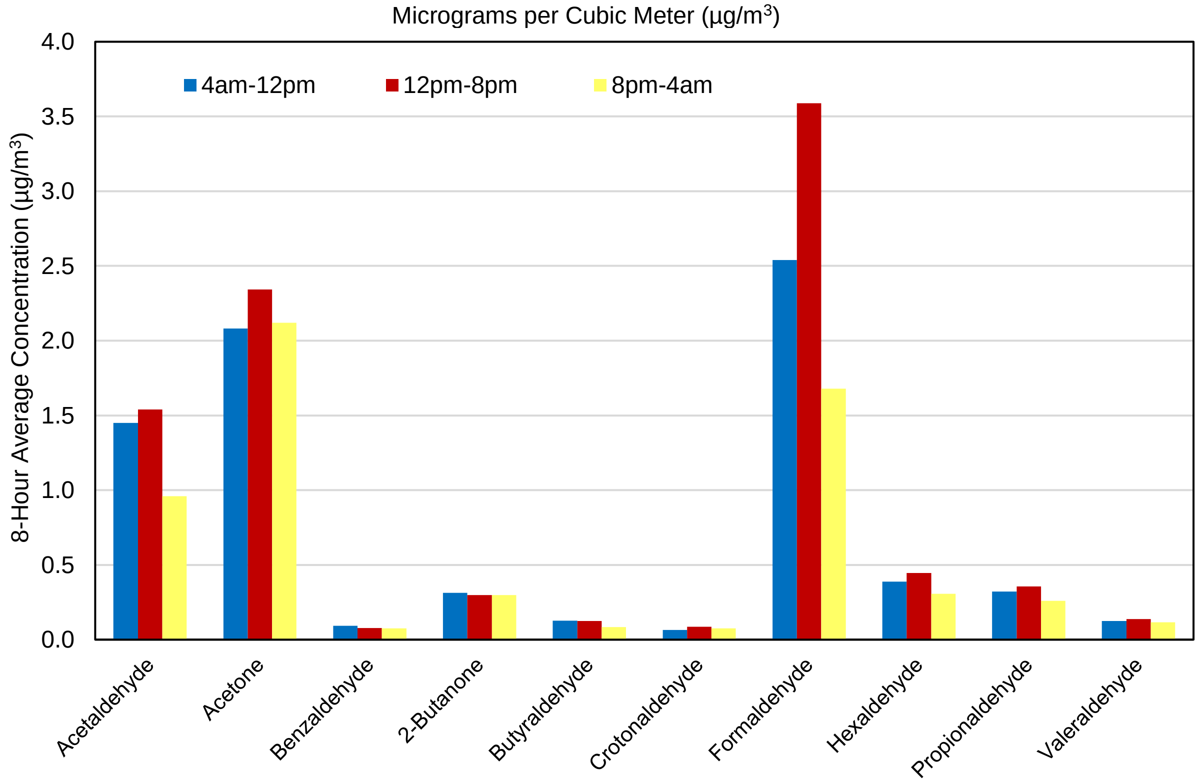


Carbonyls, a subset of VOCs, are also measured at the PAMS site during the summer. Every third day, three consecutive 8-hour samples are collected on cartridges, beginning at 4 am. These are sent to a laboratory for analysis according to USEPA's Method TO-11A protocols. Average daily concentrations for each of the ten carbonyls are shown in Table 11-2. The three carbonyls with the highest concentrations were formaldehyde, acetone, and acetaldehyde. All three of these showed higher concentrations during the afternoon. In general, the overnight hours had the lowest concentrations for most of the carbonyls (Figure 11-8).

Table 11-2
2021 PAMS 8-Hour Average Carbonyl Concentrations in New Jersey
Micrograms per Cubic Meter (µg/m³)

Carbonyl	4 am-12 pm	12 pm-8 pm	8 pm-4 am	Overall Average
Acetaldehyde	1.45	1.54	0.96	1.31
Acetone	2.08	2.34	2.12	2.18
Benzaldehyde	0.09	0.08	0.08	0.08
2-Butanone	0.31	0.30	0.30	0.30
Butyraldehyde	0.13	0.13	0.08	0.11
Crotonaldehyde	0.06	0.09	0.08	0.07
Formaldehyde	2.54	3.59	1.68	2.60
Hexaldehyde	0.39	0.45	0.31	0.37
Propionaldehyde	0.32	0.36	0.26	0.31
Valeraldehyde	0.13	0.14	0.12	0.13

Figure 11-8
2021 PAMS 8-Hour Average Carbonyl Concentrations in New Jersey
Micrograms per Cubic Meter (µg/m³)



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Weir, William. Asphalt adds to air pollution, especially on hot, sunny days. Yale News. 9/2/2020. https://news.yale.edu/2020/09/02/asphalt-adds-air-pollution-especially-hot-sunny-days

Appendix A
2021 Air Monitoring Sites

New Jersey Department of Environmental Protection

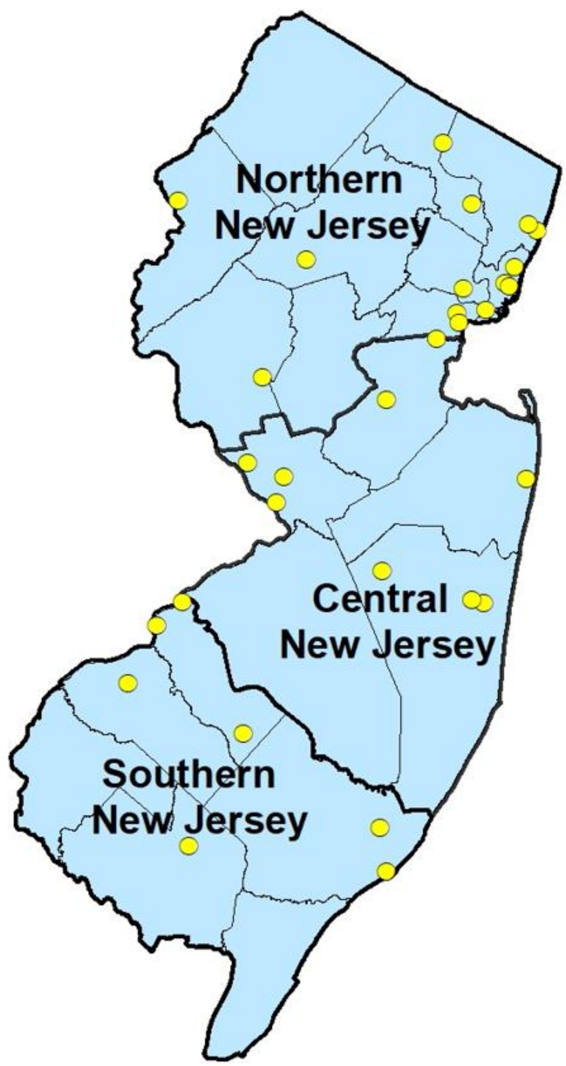

FIGURE A-1
2021 NORTHERN NEW JERSEY
AIR MONITORING SITES

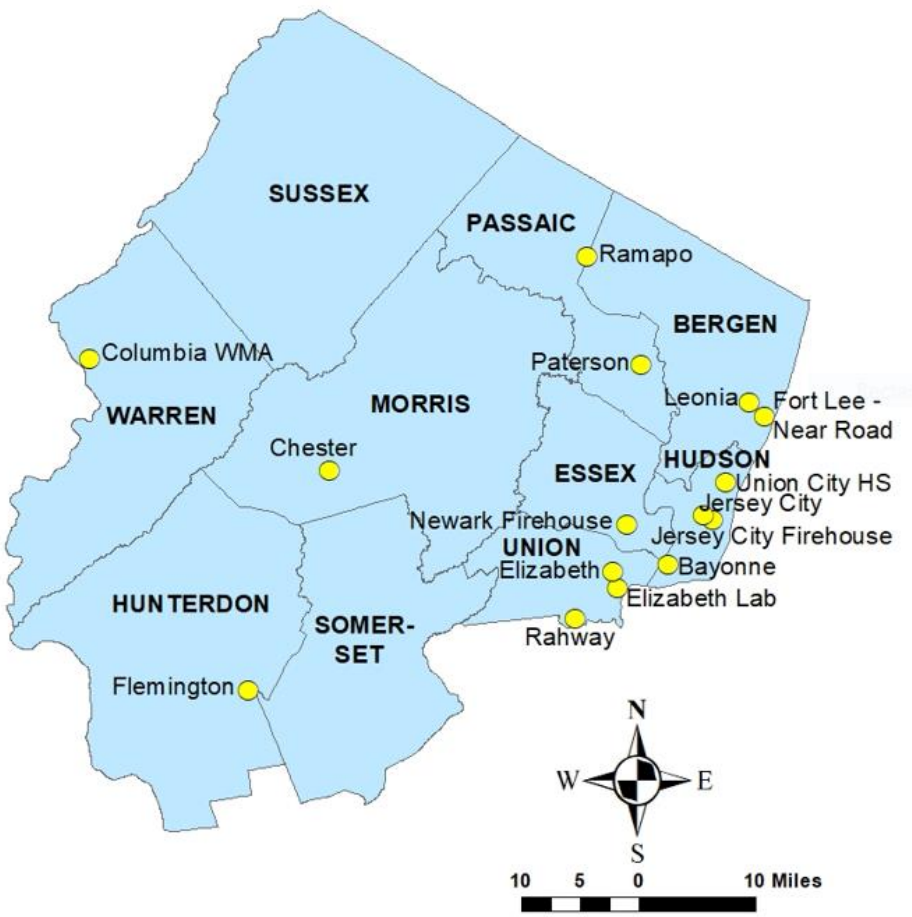

Table A-1
2021 Northern New Jersey Air Monitoring Sites

County	Monitoring Site	AQS Code	Parameter(s) Measured[1]	Coordinates (Decimal degrees)		Address
				Latitude	Longitude	
BERGEN	Fort Lee Near Road	34 003 0010	CO, NO_x, Beta, BTEX, BC, Met	40.853550	-73.966180	Hoyt Ave & Hudson St, south of toll plaza
	Leonia	34 003 0006	O_3	40.870436	-73.991994	Overpeck Park, 40 Fort Lee Road
ESSEX	Newark Firehouse	34 013 0003	CO, O_3, SO_2, $PM_{2.5}$, Spec, NOy, NO_X, BTEX, Pb, Beta, BC, Met	40.720989	-74.192892	360 Clinton Avenue
HUDSON	Bayonne	34 017 0006	NO_X, O_3, SO_2, BTEX, BC, Met	40.670250	-74.126081	Veterans Park, Park Rd at end of W. 25th St.
	Jersey City	34 017 1002	CO, NO_x, SO_2	40.731645	-74.066308	2828 John F. Kennedy Boulevard
	Jersey City Firehouse	34 017 1003	$PM_{2.5}$, PM_{10}, Beta	40.725454	-74.052290	Jersey City Fire Dept. Engine 5/Ladder 6, 355 Newark Avenue
	Union City High School	34 017 0008	$PM_{2.5}$	40.770908	-74.036218	2500 John F. Kennedy Blvd.
HUNTERDON	Flemington	34 019 0001	O_3, Met, Beta	40.515262	-74.806671	Raritan Twp. Municipal Utilities Authority, 365 Old York Road
MORRIS	Chester	34 027 3001	NO_X, O_3, SO_2, $PM_{2.5}$, Toxics, Spec	40.787628	-74.676301	Department of Public Works Bldg. #1, 50 North Road
PASSAIC	Paterson	34 031 0005	$PM_{2.5}$	40.918381	-74.168092	Paterson Board of Health, 176 Broadway
	Ramapo	34 031 5001	O_3	41.058617	-74.255544	Ramapo Station Fire Tower, Ramapo Park Drive, Wanaque
UNION	Elizabeth	34 039 0003	CO, SO_2	40.662493	-74.214800	7 Broad Street
	Elizabeth Lab	34 039 0004	CO, NO_X, SO_2, Met, $PM_{2.5}$, Toxics, Hg, Spec, BTEX, BC, Beta	40.641440	-74.208365	New Jersey Turnpike Interchange 13 Toll Plaza
	Rahway	34 039 2003	Beta	40.603943	-74.276174	Rahway Fire Department, 1300 Main Street
WARREN	Columbia	34 041 0007	NO_X, O_3, SO_2, Met, Beta	40.924580	-75.067815	Columbia Wildlife Management Area, 105 Delaware Road, Knowlton Twp.

[1] See abbreviations and acronyms in Table A-4 (page A-8).

FIGURE A-2
2021 CENTRAL NEW JERSEY
AIR MONITORING SITES

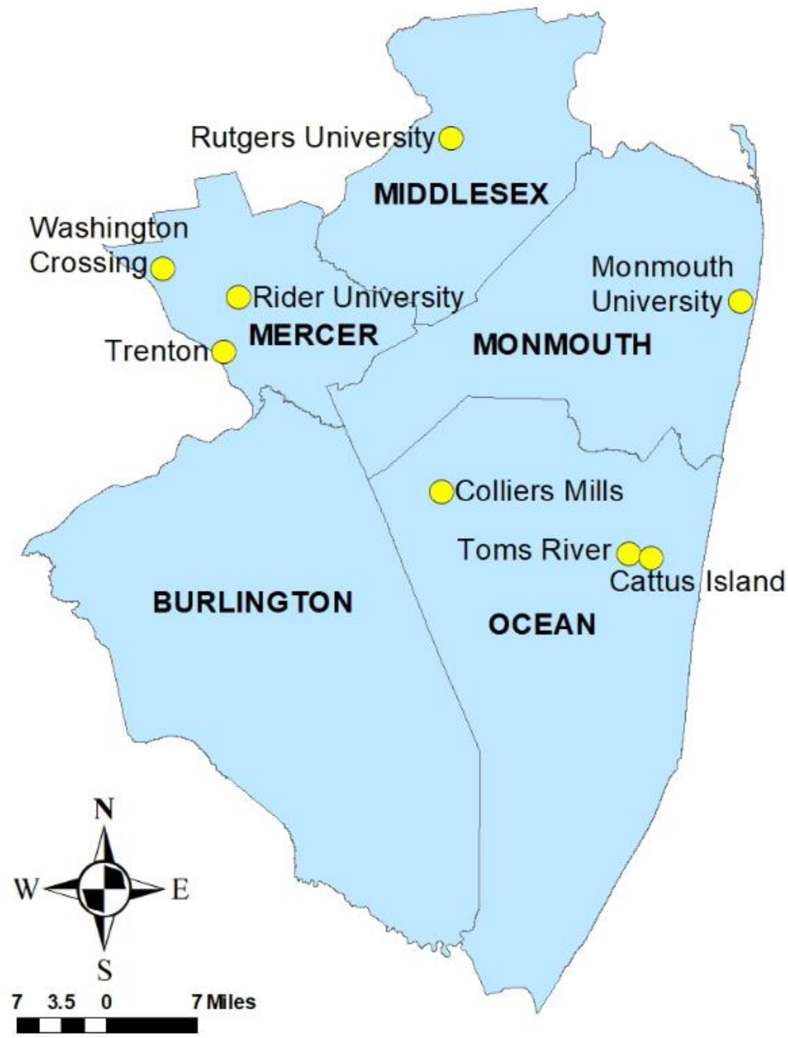

Table A-2
2021 Central New Jersey Air Monitoring Sites

County	Monitoring Site	AQS Code	Parameter(s) Measured[1]	Coordinates (Decimal degrees)		Address
				Latitude	Longitude	
MERCER	Rider University	34 021 0005	O_3, Met, Beta	40.283092	-74.742644	Athletic Fields, off of 2083 Lawrenceville Rd, Lawrence Twp.
	Trenton Library	34 021 0008	Beta	40.222411	-74.763167	120 Academy Street
	Washington Crossing	N/A	ACID	40.315359	-74.853613	Washington Crossing State Park, Philips Farm Group Area, 1239 Bear Tavern Rd.,Titusville
MIDDLESEX	Rutgers University	34 023 0011	NO_2, NO, NO_y, O_3, PAMS, Beta, $PM_{2.5}$, Toxics, Spec, Hg, Met	40.462182	-74.429439	Vegetable Farm 3, 67 Ryders Lane, East Brunswick
MONMOUTH	Monmouth University	34 025 0005	O_3	40.277647	-74.005100	Edison Science Hall, off of 400 Cedar Avenue, West Long Branch
OCEAN	Cattus Island	N/A	ACID	39.989636	-74.134132	Cattus Island County Park behind Administrative Office, end of Bandon Road, Toms River
	Colliers Mills	34 029 0006	O_3	40.064830	-74.444050	JPTD Training Center, south of Success Rd., east of Hawkin Rd., Jackson Twp.
	Toms River	34 029 2002	Beta	39.994908	-74.170447	Hooper Avenue Elementary School, 1517 Hooper Avenue

[1] See abbreviations and acronyms in Table A-4 (page A-8).

FIGURE A-3
2021 SOUTHERN NEW JERSEY
AIR MONITORING SITES

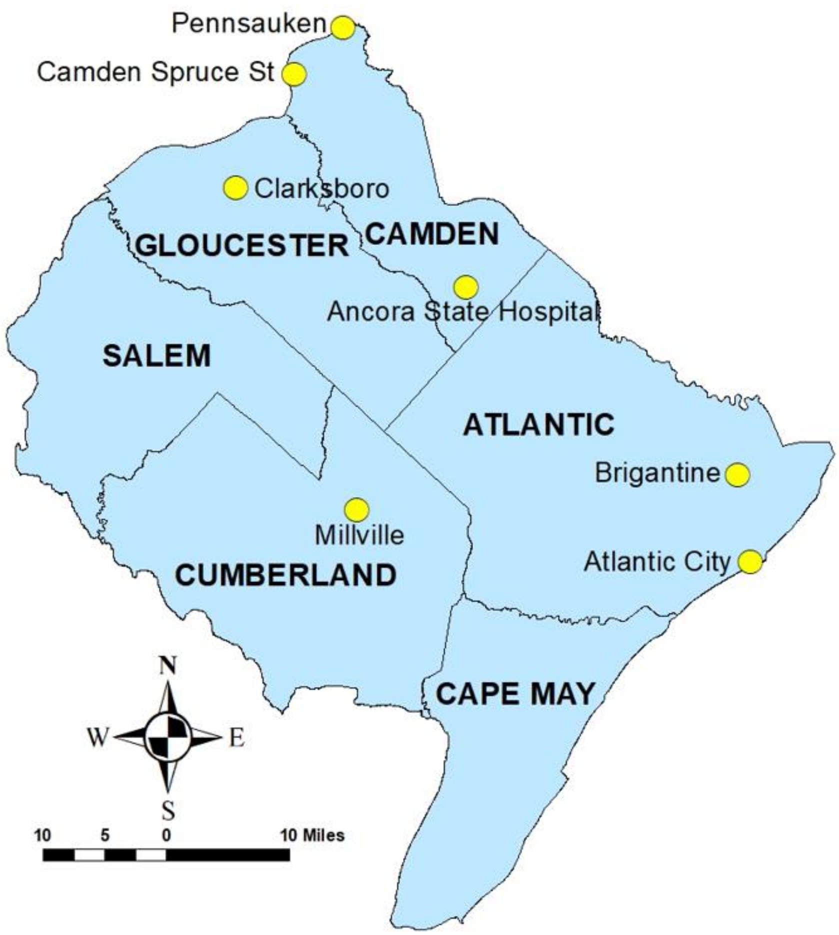

Table A-3
2021 Southern New Jersey Air Monitoring Sites

County	Monitoring Site	AQS Code	Parameter(s) Measured[1]	Coordinates (Decimal degrees)		Address
				Latitude	Longitude	
ATLANTIC	Atlantic City	34 001 1006	$PM_{2.5}$	39.363260	-74.431000	Atlantic Cape Community College, 1535 Bacharach Boulevard
	Brigantine	34 001 0006	Visibility, O_3, SO_2, Beta, $PM_{2.5}$, ACID[2]	39.464872	-74.448736	Edwin B. Forsythe National Wildlife Refuge Visitor Center, 800 Great Creek Road, Galloway
CAMDEN	Ancora State Hospital	34 007 1001	O_3	39.684250	-74.861491	301 Spring Garden Road, Hammonton
	Camden Spruce Street	34 007 0002	CO, NO_X, O_3, SO_2, $PM_{2.5}$, PM_{10}, Spec, BTEX, BC, Toxics, Met, Beta	39.934446	-75.125291	266-298 Spruce Street
	Pennsauken	34 007 1007	$PM_{2.5}$	39.989036	-75.050008	Camden Water Inc., 8999 Zimmerman Ave.
CUMBERLAND	Millville	34 011 0007	NO_X, O_3, Beta	39.422273	-75.025204	Behind 4401 S. Main Road
GLOUCESTER	Clarksboro	34 015 0002	O_3, $PM_{2.5}$	39.800339	-75.212119	Shady Lane Nursing Home, 256 County House Road

[1] See abbreviations and acronyms in Table A-4 (page A-8).
[2] United States Fish and Wildlife Service-Air Quality Branch (USFWS-AQB) is responsible for ACID sample collection.

Table A-4
Abbreviations & Acronyms

ACID	Acid deposition
BC	Black carbon measured by aethalometer
Beta	Real-time $PM_{2.5}$ analyzer
BTEX	Measurement of benzene, toluene, ethylbenzene and xylenes
CO	Carbon monoxide
Hg	Mercury
Met	Meteorological parameters
NO_X	Nitrogen dioxide and nitric oxide
NOy	Total reactive oxides of nitrogen
O_3	Ozone
PAMS	Photochemical Assessment Monitoring Station, measures ozone precursors
Pb	Lead
$PM_{2.5}$	Fine particles (2.5 microns or less) collected by a Federal Reference Method $PM_{2.5}$ sampler
PM_{10}	Coarse particles (10 microns or less) collected by a Federal Reference Method PM_{10} sampler
SO_2	Sulfur dioxide
Spec	Speciated fine particles (2.5 microns or less)
Toxics	Air toxics
Visibility	Measured by nephelometer

Appendix B: 2021 Fine Particulate Speciation Summary

New Jersey Department of Environmental Protection

Table B-1
2021 Fine Particulate Speciation Concentrations
CAMDEN SPRUCE STREET NJ
Micrograms per Cubic Meter (µg/m^3)

	Species	Annual Average*	Maximum Daily Average	% Samples Detected
1	Aluminum	0.054	0.236	89
2	Ammonium Ion	0.544	1.909	100
3	Antimony	*0*	0.033	44
4	Arsenic	*0*	0.0003	37
5	Barium	0.010	0.068	70
6	Bromine	*0.0004*	0.004	28
7	Cadmium	*0.001*	0.018	49
8	Calcium	0.061	0.220	100
9	Carbon, Elemental	0.752	3.052	100
10	Carbon, Organic	2.557	13.961	100
11	Cerium	*0*	0.071	47
12	Cesium	*0*	0.047	44
13	Chloride	0.550	3.781	100
14	Chlorine	0.104	1.981	91
15	Chromium	0.002	0.010	88
16	Cobalt	*0*	0.002	30
17	Copper	0.005	0.024	79
18	Indium	*0.0001*	0.022	42
19	Iron	0.157	1.099	100
20	Lead	0.003	0.012	75
21	Magnesium	0.021	0.171	61
22	Manganese	0.004	0.018	93
23	Nickel	0.001	0.004	79
24	Nitrate	1.215	5.486	100
25	Phosphorus	0.0005	0.006	95
26	Potassium	0.130	0.687	100
27	Potassium Ion	0.103	0.690	98
28	Rubidium	0	0.003	51
29	Selenium	0.001	0.036	53
30	Silicon	0.088	0.458	98
31	Silver	*0.001*	0.022	37
32	Sodium	0.107	0.677	91
33	Sodium Ion	0.090	0.540	100
34	Strontium	0.001	0.014	53
35	Sulfate	1.036	4.085	100
36	Sulfur	0.364	1.640	100
37	Tin	0.001	0.028	54
38	Titanium	0.006	0.056	96
39	Vanadium	*0.0003*	0.002	33
40	Zinc	0.029	0.161	100
41	Zirconium	*0*	0.016	42

Table B-2
2021 Fine Particulate Speciation Concentrations
CHESTER NJ
Micrograms per Cubic Meter (µg/m^3)

	Species	Annual Average*	Maximum Daily Average	% Samples Detected
1	Aluminum	0.034	0.462	77
2	Ammonium Ion	0.305	1.595	100
3	Antimony	0.002	0.030	63
4	Arsenic	*0*	0.000	39
5	Barium	0.003	0.026	54
6	Bromine	*0.0003*	0.004	23
7	Cadmium	0.001	0.025	50
8	Calcium	0.017	0.061	98
9	Carbon, Elemental	0.220	0.632	100
10	Carbon, Organic	1.857	8.133	100
11	Cerium	*0*	0.033	30
12	Cesium	0.002	0.047	54
13	Chloride	0.042	0.444	100
14	Chlorine	0.002	0.068	50
15	Chromium	0.001	0.006	67
16	Cobalt	*0*	0.002	44
17	Copper	0.001	0.009	55
18	Indium	0.002	0.041	54
19	Iron	0.033	0.118	98
20	Lead	0.002	0.012	68
21	Magnesium	*0.013*	0.427	46
22	Manganese	0.00003	0.005	57
23	Nickel	0.0004	0.003	58
24	Nitrate	0.834	5.772	100
25	Phosphorus	0.0003	0.004	79
26	Potassium	0.041	0.241	98
27	Potassium Ion	0.026	0.183	95
28	Rubidium	*0*	0.005	43
29	Selenium	*0*	0.003	38
30	Silicon	0.055	0.395	98
31	Silver	*0*	0.022	46
32	Sodium	0.045	0.257	82
33	Sodium Ion	0.021	0.267	96
34	Strontium	0.0004	0.005	52
35	Sulfate	0.826	2.119	98
36	Sulfur	0.277	0.801	100
37	Tin	0.005	0.034	71
38	Titanium	0.002	0.015	82
39	Vanadium	*0.0001*	0.002	27
40	Zinc	0.006	0.019	96
41	Zirconium	*0*	0.022	46

Table B-3
2021 Fine Particulate Speciation Concentrations
ELIZABETH LAB NJ
Micrograms per Cubic Meter (µg/m^3)

	Species	Annual Average*	Maximum Daily Average	% Samples Detected
1	Aluminum	0.051	0.352	92
2	Ammonium Ion	0.427	3.019	100
3	Antimony	0.001	0.030	50
4	Arsenic	*0*	0.0002	43
5	Barium	0.013	0.069	76
6	Bromine	*0.0004*	0.006	27
7	Cadmium	0.0008	0.019	52
8	Calcium	0.040	0.139	100
9	Carbon, Elemental	0.821	2.278	100
10	Carbon, Organic	2.119	10.745	100
11	Cerium	*0*	0.058	43
12	Cesium	0.0001	0.032	52
13	Chloride	0.125	0.687	100
14	Chlorine	0.020	0.467	83
15	Chromium	0.002	0.026	79
16	Cobalt	*0*	0.002	22
17	Copper	0.005	0.028	89
18	Indium	0.002	0.027	52
19	Iron	0.148	0.386	100
20	Lead	0.002	0.014	59
21	Magnesium	0.015	0.113	62
22	Manganese	0.002	0.009	74
23	Nickel	0.001	0.007	79
24	Nitrate	1.180	8.384	100
25	Phosphorus	0.001	0.006	87
26	Potassium	0.054	0.648	100
27	Potassium Ion	0.035	0.612	100
28	Rubidium	*0*	0.005	42
29	Selenium	*0.00003*	0.004	43
30	Silicon	0.083	0.569	100
31	Silver	0.0002	0.015	53
32	Sodium	0.087	0.642	92
33	Sodium Ion	0.063	0.478	100
34	Strontium	0.001	0.011	60
35	Sulfate	1.027	3.811	100
36	Sulfur	0.357	1.232	100
37	Tin	0.003	0.029	64
38	Titanium	0.007	0.022	99
39	Vanadium	*0.0003*	0.015	30
40	Zinc	0.016	0.071	100
41	Zirconium	0.001	0.022	50

Table B-4
2021 Fine Particulate Speciation Concentrations
NEWARK FIREHOUSE NJ
Micrograms per Cubic Meter (µg/m^3)

	Species	Annual Average*	Maximum Daily Average	% Samples Detected
1	Aluminum	0.040	0.303	83
2	Ammonium Ion	0.384	2.940	100
3	Antimony	0.001	0.038	57
4	Arsenic	*0*	0.0002	42
5	Barium	0.009	0.064	62
6	Bromine	*0.0003*	0.004	28
7	Cadmium	0	0.019	50
8	Calcium	0.040	0.151	100
9	Carbon, Elemental	0.523	2.432	100
10	Carbon, Organic	2.307	10.897	100
11	Cerium	*0.001*	0.095	44
12	Cesium	*0*	0.056	41
13	Chloride	0.107	0.654	100
14	Chlorine	0.020	0.565	85
15	Chromium	0.001	0.011	69
16	Cobalt	*0*	0.005	23
17	Copper	0.006	0.050	80
18	Indium	*0.0001*	0.039	47
19	Iron	0.094	0.297	100
20	Lead	0.002	0.014	61
21	Magnesium	0.014	0.109	60
22	Manganese	0.001	0.008	78
23	Nickel	0.001	0.004	64
24	Nitrate	1.187	8.382	100
25	Phosphorus	0.001	0.012	91
26	Potassium	0.058	0.363	100
27	Potassium Ion	0.037	0.373	100
28	Rubidium	*0*	0.007	42
29	Selenium	0.0003	0.004	57
30	Silicon	0.086	0.518	98
31	Silver	*0.0001*	0.021	45
32	Sodium	0.073	1.119	93
33	Sodium Ion	0.062	0.552	100
34	Strontium	0.001	0.009	56
35	Sulfate	0.876	3.623	100
36	Sulfur	0.300	1.182	100
37	Tin	*0*	0.033	48
38	Titanium	0.006	0.024	96
39	Vanadium	*0.0002*	0.005	25
40	Zinc	0.013	0.046	100
41	Zirconium	0.002	0.026	54

Table B-5
2021 Fine Particulate Speciation Concentrations
RUTGERS UNIVERSITY NJ
Micrograms per Cubic Meter (µg/m³)

Species		Annual Average*	Maximum Daily Average	% Samples Detected
1	Aluminum	0.029	0.250	78
2	Ammonium Ion	0.313	2.836	100
3	Antimony	0.001	0.028	53
4	Arsenic	*0*	0.0002	43
5	Barium	0.008	0.059	65
6	Bromine	*0.0003*	0.004	23
7	Cadmium	0.001	0.027	52
8	Calcium	0.024	0.189	100
9	Carbon, Elemental	0.350	1.085	100
10	Carbon, Organic	2.077	12.894	100
11	Cerium	*0*	0.070	42
12	Cesium	0.002	0.047	56
13	Chloride	0.082	0.572	100
14	Chlorine	0.021	0.991	70
15	Chromium	0.001	0.007	75
16	Cobalt	*0*	0.003	31
17	Copper	0.003	0.030	59
18	Indium	0.001	0.017	57
19	Iron	0.058	0.327	100
20	Lead	0.002	0.014	57
21	Magnesium	0.010	0.105	56
22	Manganese	0.001	0.017	63
23	Nickel	0.0004	0.003	61
24	Nitrate	0.932	6.558	100
25	Phosphorus	0.0003	0.003	84
26	Potassium	0.057	0.712	100
27	Potassium Ion	0.039	0.596	100
28	Rubidium	*0*	0.004	39
29	Selenium	*0.00002*	0.004	49
30	Silicon	0.062	0.568	100
31	Silver	*0*	0.017	34
32	Sodium	0.073	1.309	90
33	Sodium Ion	0.046	0.431	99
34	Strontium	0.001	0.011	61
35	Sulfate	0.884	3.833	100
36	Sulfur	0.299	1.178	100
37	Tin	0.003	0.032	61
38	Titanium	0.004	0.032	90
39	Vanadium	*0.0001*	0.002	23
40	Zinc	0.013	0.089	100
41	Zirconium	0.0003	0.025	54

*Annual averages in italics are calculated with fewer than 50% of samples detected.

USEPA's Chemical Speciation Network was established to characterize the metals, ions and carbon constituents of ambient fine particles. Information can be found at https://www.epa.gov/amtic/chemical-speciation-network-csn.

Table B-6. CSN Average Minimum Detection Limits (MDL) (μg/m^3)

	Species	MDL (μg/m^3)
1	Aluminum	0.023
2	Ammonium Ion	0.013
3	Antimony	0.016
4	Arsenic	0.0001
5	Barium	0.028
6	Bromine	0.0001
7	Cadmium	0.014
8	Calcium	0.010
9	Carbon, Elemental	0.0003
10	Carbon, Organic	0.644
11	Cerium	0.036
12	Cesium	0.027
13	Chloride	0.025
14	Chlorine	0.004
15	Chromium	0.002
16	Cobalt	0.002
17	Copper	0.004
18	Indium	0.015
19	Iron	0.009
20	Lead	0.007
21	Magnesium	0.045
22	Manganese	0.003
23	Nickel	0.001
24	Nitrate	0.039
25	Phosphorus	0.002
26	Potassium	0.005
27	Potassium Ion	0.013
28	Rubidium	0.003
29	Selenium	0.003
30	Silicon	0.014
31	Silver	0.013
32	Sodium	0.081
33	Sodium Ion	0.014
34	Strontium	0.003
35	Sulfate	0.029
36	Sulfur	0.001
37	Tin	0.016
38	Titanium	0.003
39	Vanadium	0.001
40	Zinc	0.002
41	Zirconium	0.014

Most recent detection limit information from: Chemical Speciation Network (CSN) Annual Quality Report, prepared by Air Quality Research Center, University of California, Davis, pp. 30-31, 10/25/2021.
https://www.epa.gov/system/files/documents/2021-12/csn_2020annualqualityreport_10.25.2021_final_srs.pdf

Appendix C: Glossary

New Jersey Department of Environmental Protection

GLOSSARY OF AIR MONITORING ABBREVIATIONS AND TERMS

Air Quality Index (AQI) – a national rating system for reporting daily air quality to the public

Air toxics – air pollutants that may cause adverse health effects in humans, but do not have a NAAQS

Ambient air – air in outdoor areas that are accessible to the general public

AQS – Air Quality System, USEPA's nationwide database for air quality data

BAM – NJDEP Bureau of Air Monitoring

CAMNET – a network of real-time cameras established to raise public awareness of the effects of air pollution on visibility.

Canister – a stainless steel container used for collecting an air sample to be analyzed in a lab.

Carcinogen – a chemical which may cause cancer

CO – Carbon monoxide, a criteria pollutant

Continuous monitor – an instrument that collects data around the clock, throughout the year, and transmits the data to a central data acquisition system every minute or hour.

Criteria pollutant – an air pollutant for which a National Ambient Air Quality Standard (NAAQS) has been set (ozone, particulate matter, nitrogen dioxide, sulfur dioxide, carbon monoxide & lead).

Design value (DV) – a pollutant-specific statistic applied to air monitoring data that determines whether a National Ambient Air Quality Standard is being met or exceeded

Detection limit – lowest quantity of a chemical that can be reliably measured by a laboratory method or sampling instrument

Fine particles – see $PM_{2.5}$

Hazardous Air Pollutant (HAP) – an "air toxic" pollutant that is listed in the 1990 Clean Air Act Amendments and is subject to emissions limits for specific source types.

Health benchmark – a chemical-specific air concentration above which there may be human health concerns

Inhalable particles – see PM_{10}

Lead – see Pb

Manual sampler – an instrument that collects an air sample over a specific time period on a filter, adsorbent cartridge or canister, which is then manually retrieved for analysis.

Median – the middle value in a list of numerical values, sorted in ascending or descending order

NAAQS – National Ambient Air Quality Standard; for specific air pollutants, a concentration allowable in ambient air.

NJDEP – New Jersey Department of Environmental Protection

NO – Nitric oxide

NO_2 – Nitrogen dioxide, a criteria pollutant

NO_x – Oxides of nitrogen

NO_y – Total reactive oxides of nitrogen

O_3 – Ozone, a criteria pollutant

Ozone precursors – a group of volatile organic compounds (VOCs) that affect ozone formation and destruction in the atmosphere; also called PAMS pollutants.

PAMS – Photochemical Assessment Monitoring Station; a site which measures ozone precursors.

Particulate matter (PM)– a complex mix of liquid and/or solid particles in the atmosphere

Pb – Lead, a criteria pollutant and a HAP

$PM_{2.5}$ – Fine particles, 2.5 micrometers in aerodynamic diameter or smaller; a criteria pollutant

PM_{10} – Inhalable particles, 10 micrometers in aerodynamic diameter or smaller; a criteria pollutant

$PM_{2.5}$-Speciation – a group of elements, ionic compounds and carbon compounds that are analyzed from fine particles.

ppb - parts per billion, a concentration measurement usually used for gaseous pollutants

ppm – parts per million, a concentration measurement usually used for gaseous pollutants

Real-time – a system in which data is collected and (almost) immediately presented, usually every hour.

Risk ratio – a chemical-specific air concentration divided by its health benchmark; ratios greater than one may indicate a public health concern

SO_2 – Sulfur dioxide, a criteria pollutant

USEPA - United States Environmental Protection Agency

VOC – Volatile organic compound, a carbon-based chemical compound that is normally gaseous

$\mu g/m^3$ - micrograms per cubic meter, a concentration measurement, usually used for particulate matter and air toxics