2018 New Jersey Air Quality Report

New Jersey Department of Environmental Protection

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Cover photo: Brigantine HazeCam, https://hazecam.net/archive.aspx?site=brigantine&h=8, 4/11/19.

EXECUTIVE SUMMARY

This report presents the New Jersey Department of Environmental Protection (NJDEP) air quality monitoring data for 2018, 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.

The chapter on the Air Quality Index (AQI), a national air quality rating system based on the National Ambient Air Quality Standards (NAAQS), describes the overall quality of New Jersey's air in 2018, and lists the days on which the AQI was over 100 (meaning the NAAQS were exceeded). Nineteen days were classified as "Unhealthy for Sensitive Groups" in 2018, because their numerical AQI ratings were greater than 100. Three days were classified as "Unhealthy," with AQI ratings greater than 150.

This report also includes detailed chapters for ozone, sulfur dioxide, nitrogen dioxide, particulate matter, and carbon monoxide. These are the criteria pollutants, that is, those for which NAAQS (or criteria) have been set. Other measurements made at our air monitoring stations include levels of air toxics and particulate species, and meteorology.

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 previous ambient air quality standards. Monitoring data in New Jersey shows a steady decline in $PM_{2.5}$ levels that 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), although there was one exceedance of the 1-hour standard in 2018, most likely caused by a truck idling near the monitor.

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 been meeting 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 years (Figure 1-5).

Air concentrations of lead have dropped dramatically since a standard was established in 1978. The last exceedances of the NAAQS were in the early 1980s (Figure 1-6).

Figure 1-1
Ozone Design Value Trend in New Jersey, 1997-2018
3-Year Average of 4th-Highest Daily Maximum 8-Hour Average Concentrations
Parts per Million (ppm)

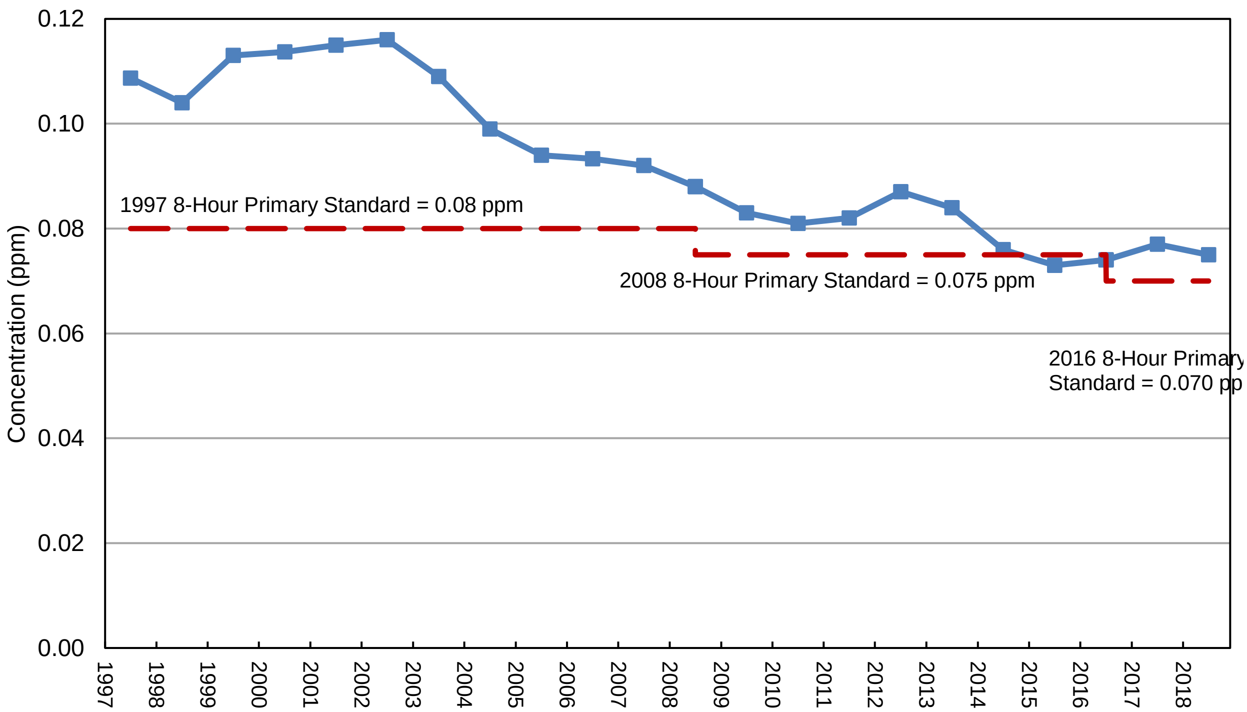


Figure 1-2
Fine Particulate ($PM_{2.5}$) 24-Hour Design Value Trend in New Jersey, 2001-2018
3-Year Average of the 98th-Percentile 24-Hour Average Concentrations
Micrograms per Cubic Meter (µg/m³)

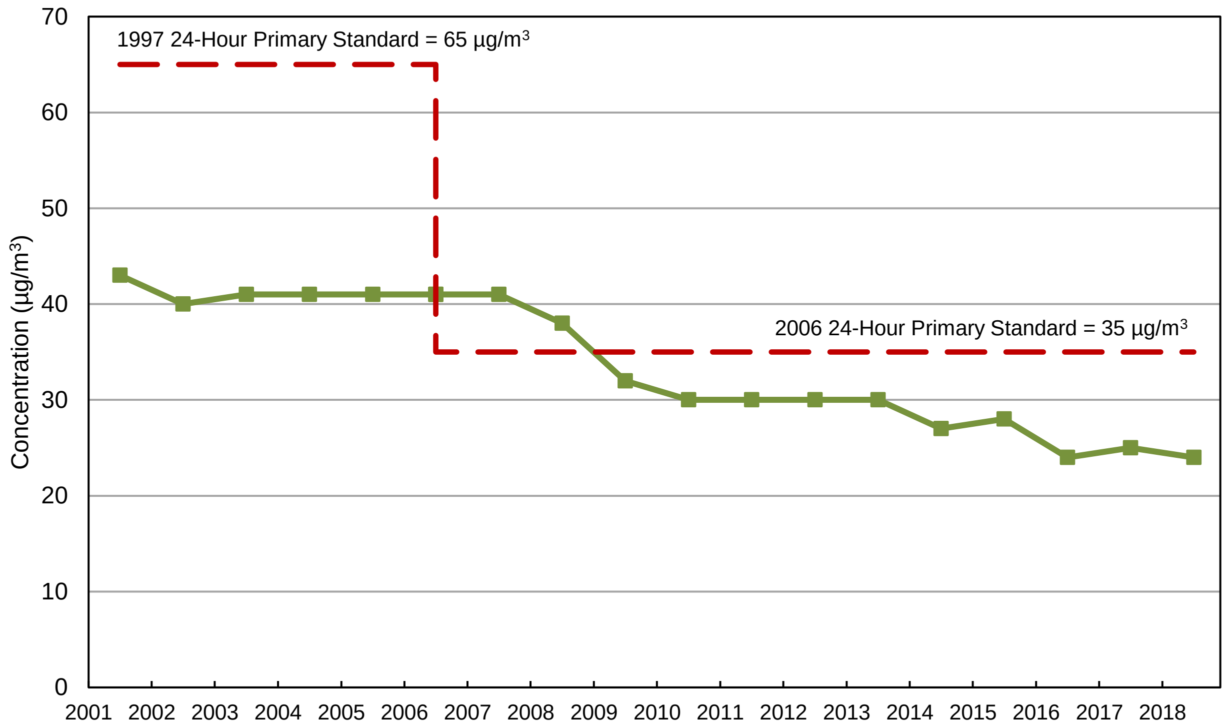


Figure 1-3
Nitrogen Dioxide (NO_2) Design Value Trend in New Jersey, 2000-2018
3-Year Average of the 98th Percentile Daily Maximum 1-Hour Average Concentration
Parts per Million (ppm)

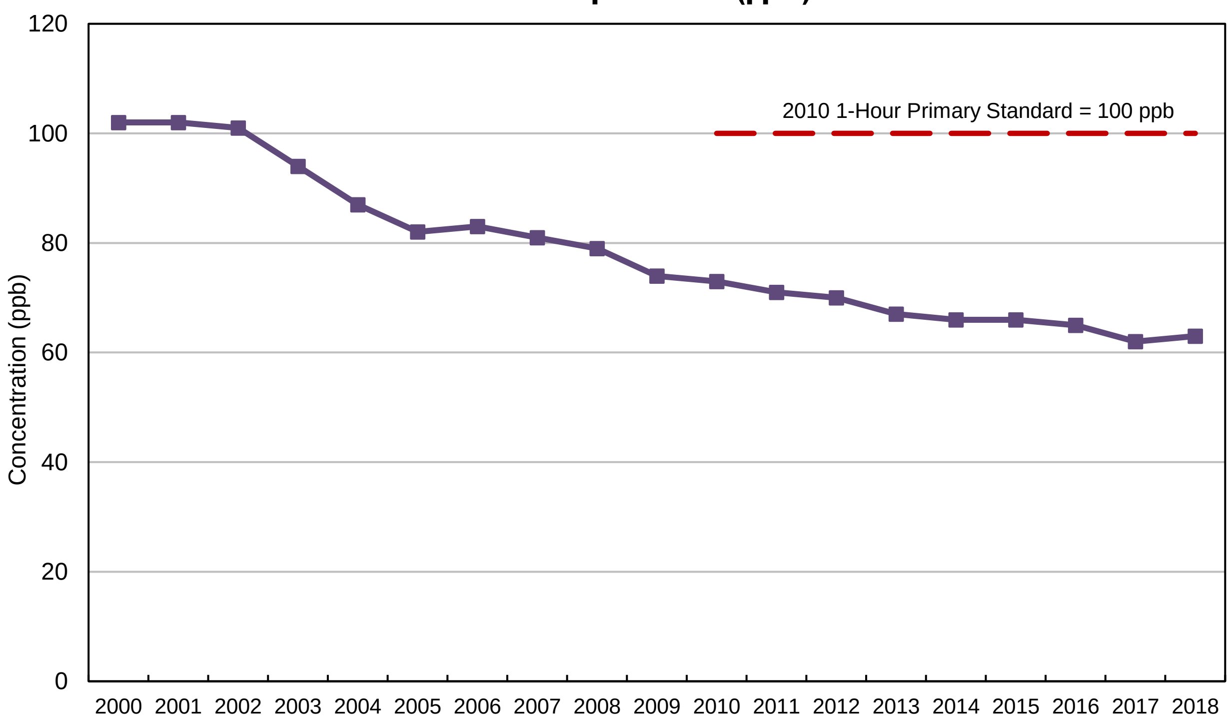


Figure 1-4
Sulfur Dioxide (SO_2) Design Value* Trend in New Jersey, 2000-2018
***3-Year Average of the 99th-Percentile of Daily Maximum 1-Hour Average Concentrations in Parts per Million (ppm)**

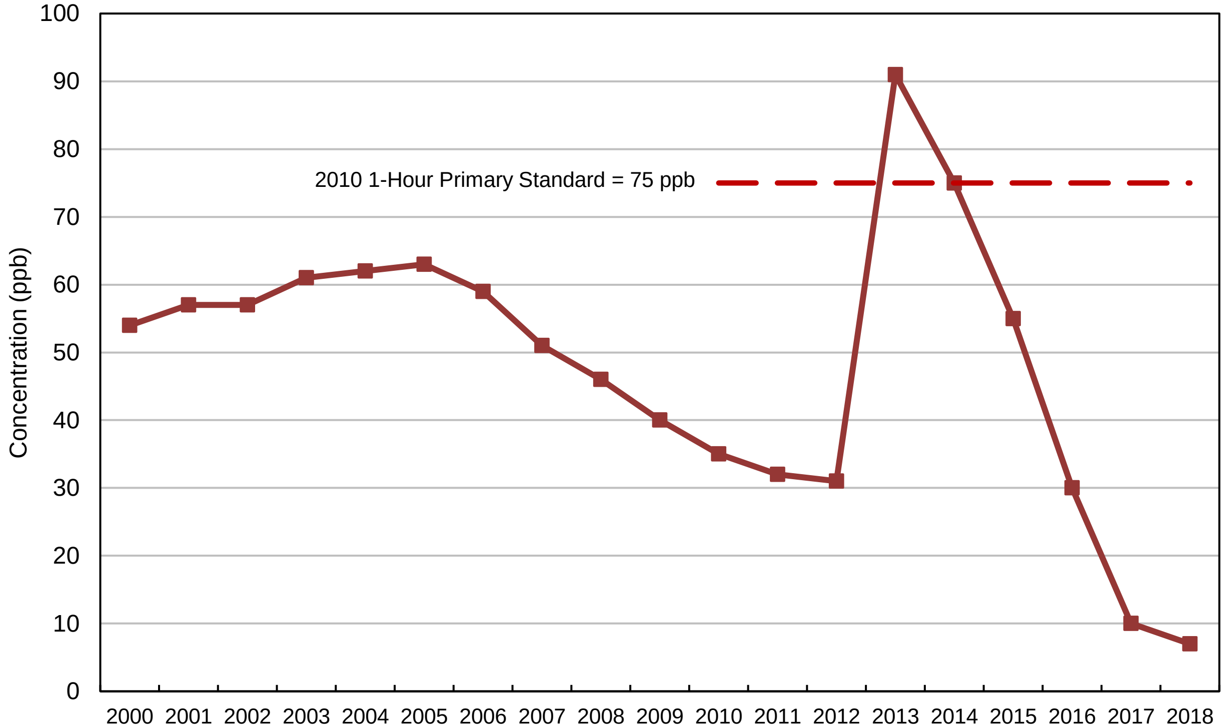


Figure 1-5
Carbon Monoxide (CO) Design Value Trend in New Jersey, 1990-2018
2nd-Highest 8-Hour Average Concentration
Parts per Million (ppm)

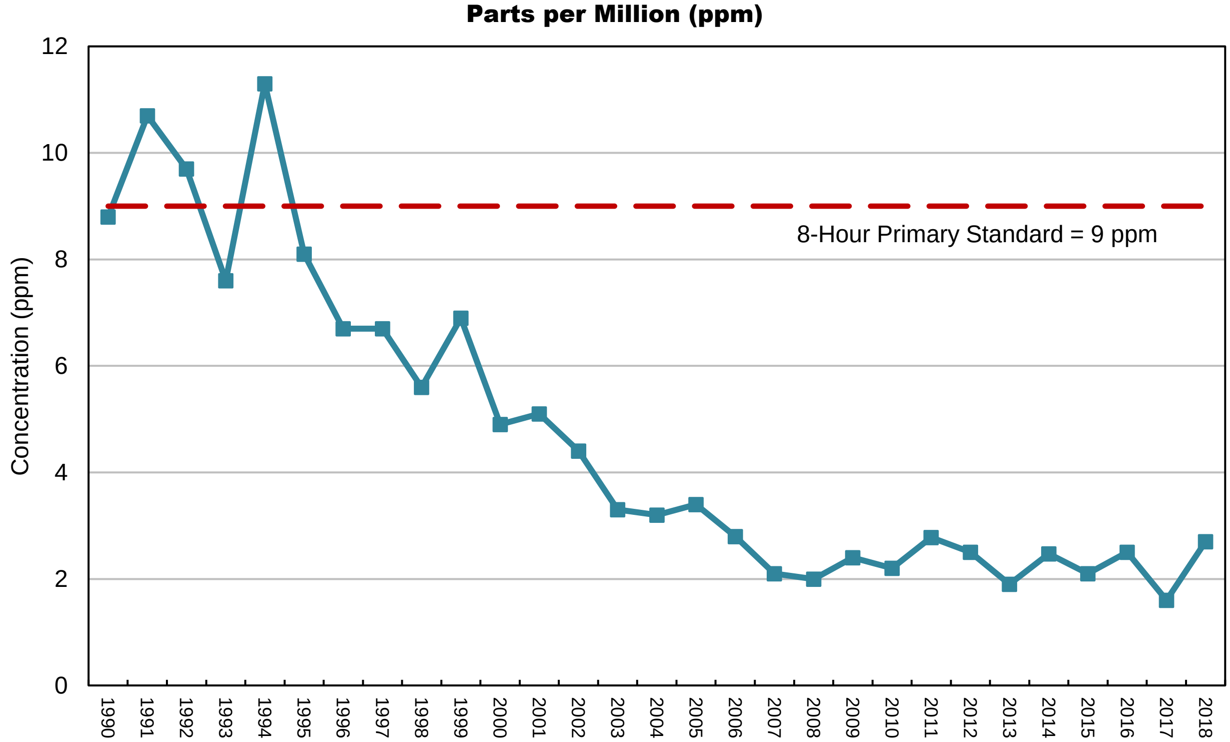
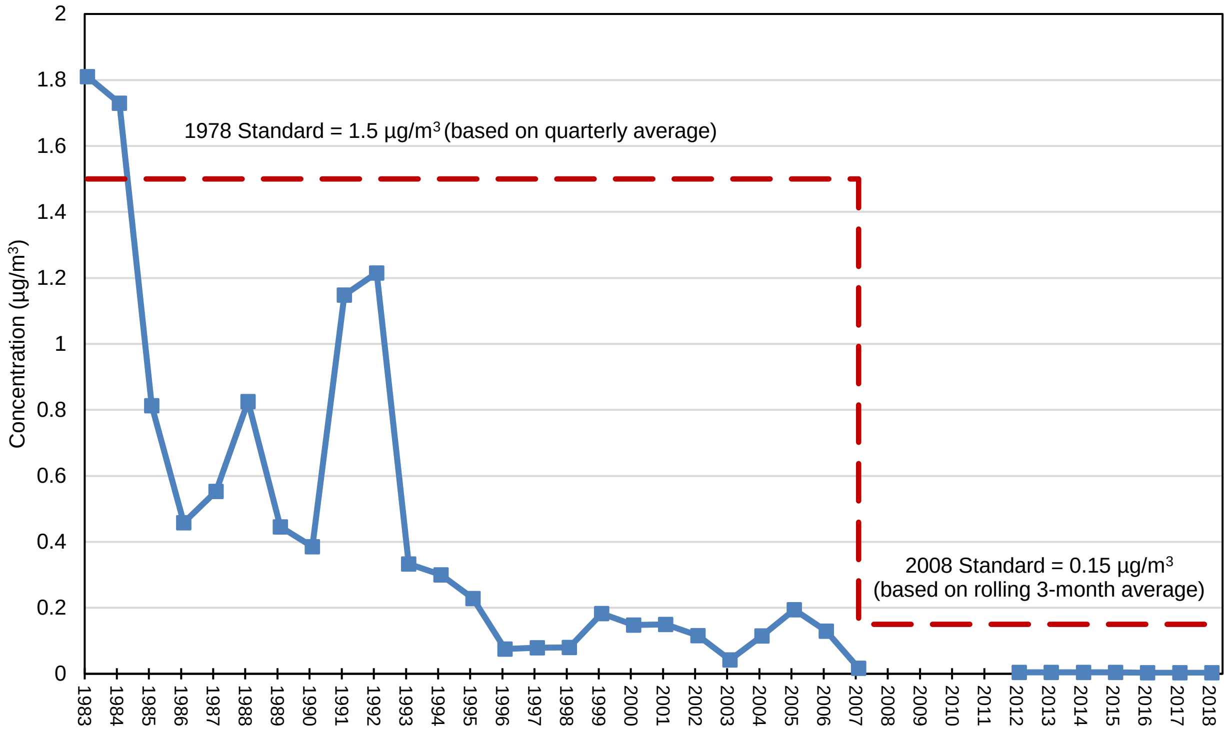


Figure 1-6
Lead Design Value Trend in New Jersey, 1983-2018
Highest 3-Month Average
Micrograms per Cubic Meter (µg/m³)



2018 Air Monitoring Network

New Jersey Department of Environmental Protection

NETWORK DESCRIPTION

In 2018, the New Jersey Department of Environmental Protection (NJDEP) Bureau of Air Monitoring (BAM) operated 32 ambient air monitoring stations. The monitoring stations vary in the number and type of monitors operating 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 encompasses such 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}.

Figure 2-1
Millville Air Monitoring Station

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 (www.njaqinow.net) 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.

In addition to monitoring 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. USEPA’s Photochemical Assessment Monitoring Station (PAMS) program, for example, 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.

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 sites in the monitoring network 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, precipitation, and solar radiation.

Figure 2-1 shows the monitoring station at Millville in Cumberland County. Figure 2-2 shows a filter-based manual $PM_{2.5}$ sampler located at Union City High School in Hudson County.

The locations of all the monitoring stations that operated in 2018 are shown on the map in Figure 2-3. Table 2-1 lists the parameters that were measured at each site. More details about the monitoring stations can be found in Appendix A.

The only changes to New Jersey’s monitoring network in 2018 involved replacing monitoring equipment.

Figure 2-2
Filter-Based $PM_{2.5}$ Sampler in Union City

Figure 2-3
New Jersey Air Monitoring Sites in 2018

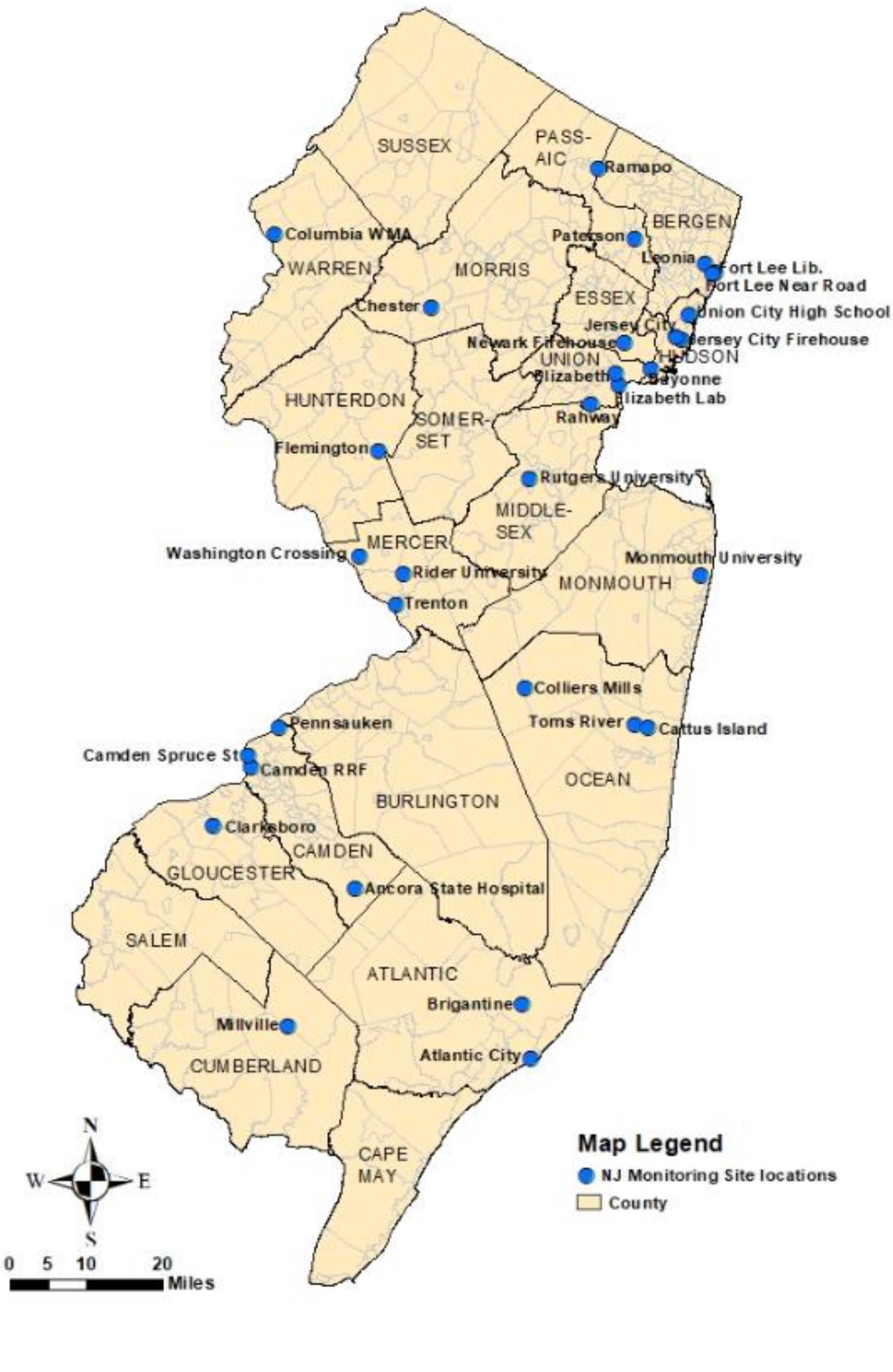


Table 2-1
2018 New Jersey Air Monitoring Network Summary

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

* Meteorological parameters include temperature, relative humidity, barometric pressure, wind direction & wind speed.
X - Parameter measured in 2018

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2018 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 (www.njaqinow.net/).

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

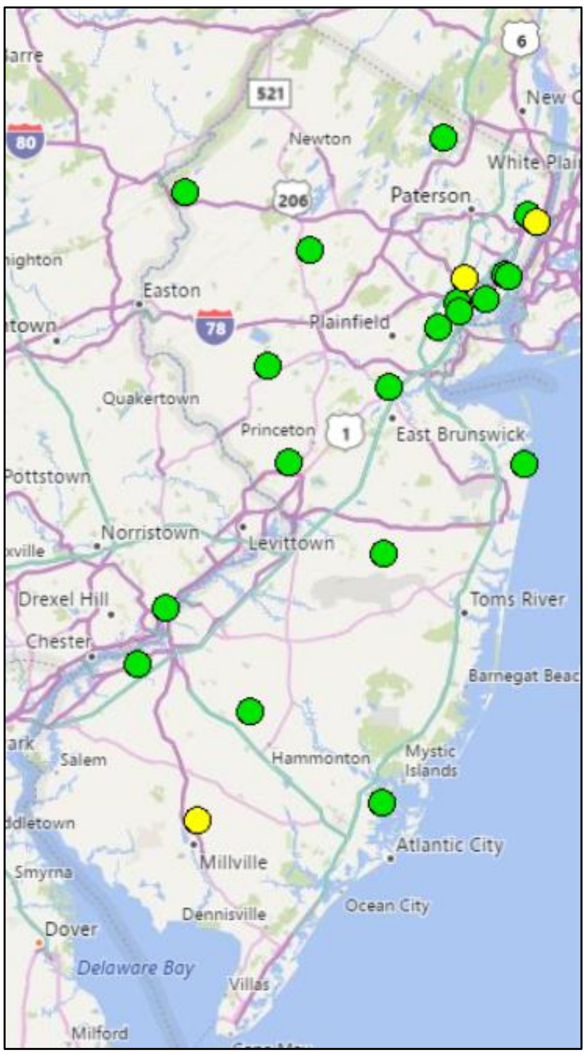
Category	AQI Level	O_3 (ppm) 8-hour	$PM_{2.5}$ (µg/m^3) 24-hour	CO (ppm) 8-hour	SO_2 (ppm) 1-hour	NO_2 (ppm) 1-hour
Good	0-50	0.000-0.054	0.0-12.0	0.0-4.4	0-0.035	0-0.053
Moderate	51-100	0.055-0.070	12.1-35.4	4.5-9.4	0.036-0.075	0.054-0.100
Unhealthy for Sensitive Groups	101-150	0.071-0.085	35.5-55.4	9.5-12.4	0.076-0.185	0.101- 0.360
Unhealthy	151- 200	0.086-0.105	55.5-150.4	12.5-15.4	0.186-0.304	0.361-0.649
Very Unhealthy	201-300	0.106-0.200	150.5-250.4	15.5-30.4	0.305-0.604	0.605-1.249
Hazardous	301-500	>0.200	250.5-500.4	30.5-1004	0.605-1.004	1.250-2.049

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

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, charts, site photos, 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
www.njaqinow.net

Current Air Quality



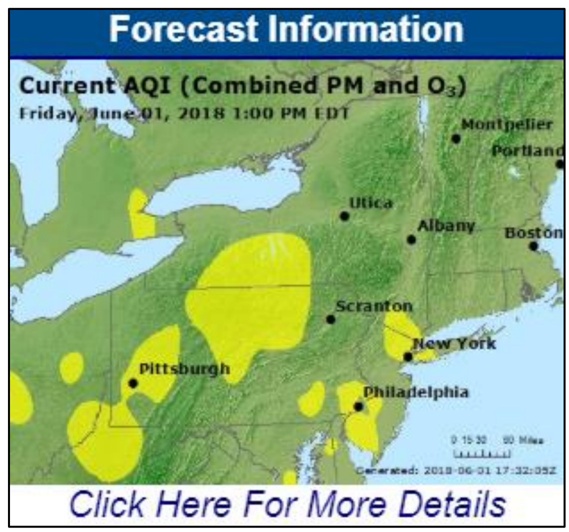
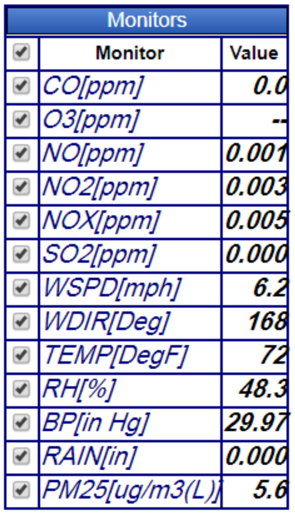
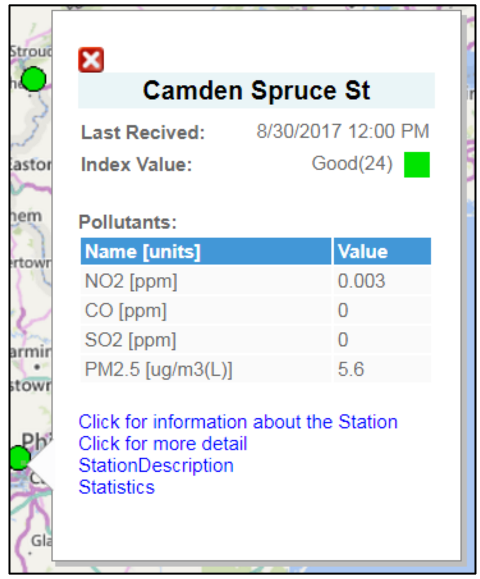


Figure 3-1 (continued)
Examples of Information Available on NJDEP's Air Monitoring Website



Monitors	
Monitor	Value
CO[ppm]	0.0
O3[ppm]	--
NO[ppm]	0.001
NO2[ppm]	0.003
NOX[ppm]	0.005
SO2[ppm]	0.000
WSPD[mph]	6.2
WDIR[Deg]	168
TEMP[DegF]	72
RH[%]	48.3
BP[in Hg]	29.97
RAIN[in]	0.000
PM25[ug/m3(L)]	5.6



Camden Spruce St

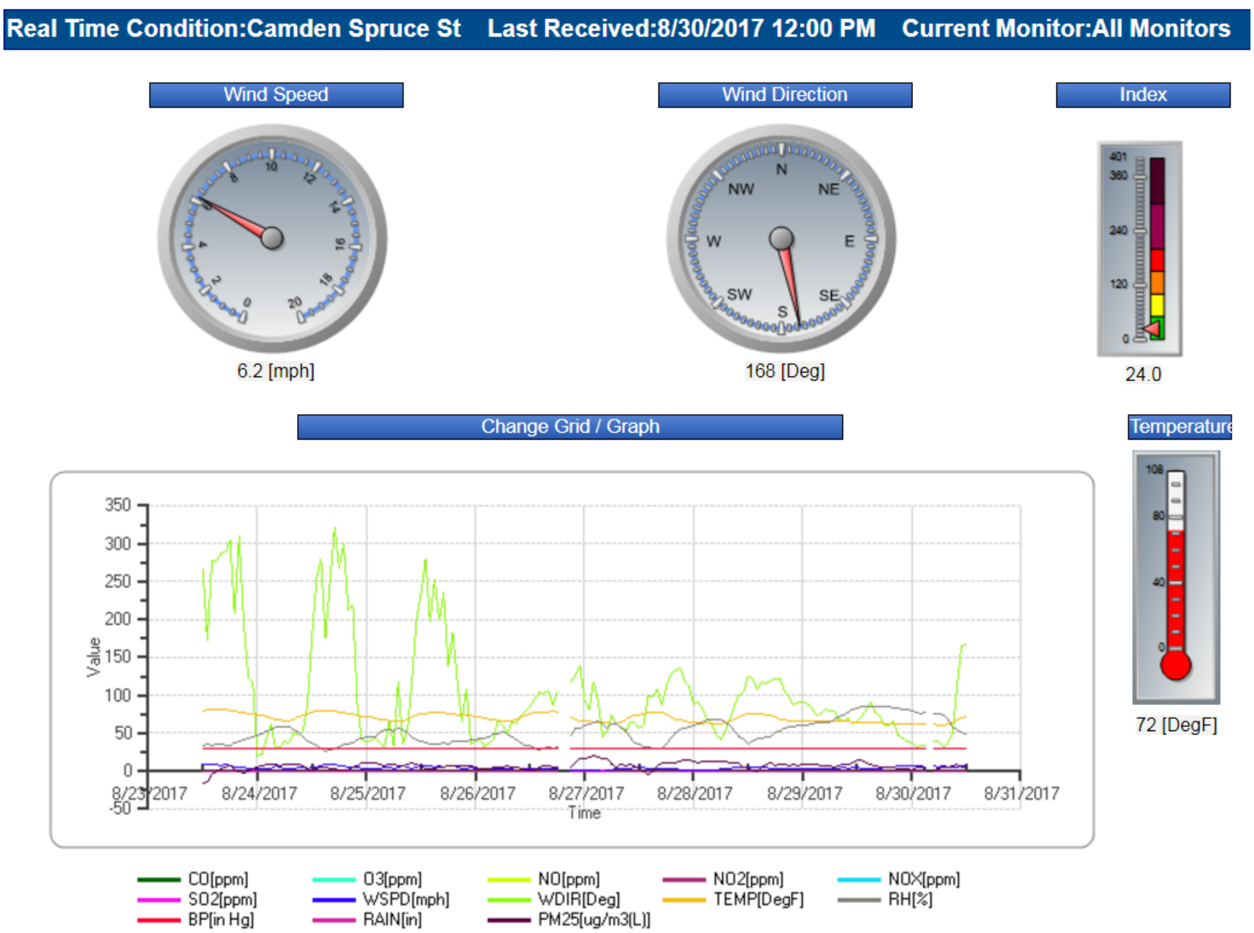
Last Recived: 8/30/2017 12:00 PM

Index Value: Good(24)

Pollutants:

Name [units]	Value
NO2 [ppm]	0.003
CO [ppm]	0
SO2 [ppm]	0
PM2.5 [ug/m3(L)]	5.6

Click for information about the Station
Click for more detail
StationDescription
Statistics



2018 AQI SUMMARY

Not all of New Jersey's monitoring sites have 365 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, 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 2018

	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 WMA	√	√		√	√
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	√	√			√

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

A summary of the AQI ratings for New Jersey in 2018 is displayed in the pie chart in Figure 3-2 below. In 2018, there were 145 “Good” days, 198 were “Moderate,” 19 were “Unhealthy for Sensitive Groups,” and 3 were “Unhealthy.” This indicates that air quality in New Jersey is mostly good or moderate (40% and 54% of days, respectively), However, air pollution was still bad enough in 2018 to adversely affect sensitive people about 5% of the time, and potentially affect everyone on less than 1% of days.

Figure 3-2
2018 Air Quality Summary by Days

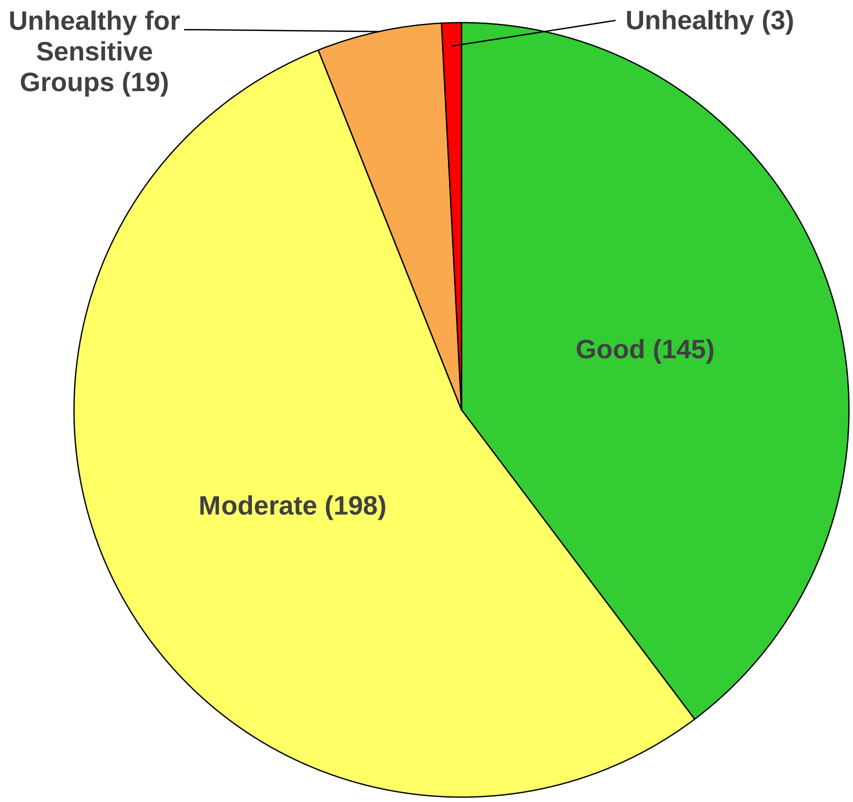


Figure 3-3 shows the distribution of AQI days since 2000. It should be noted that AQI ranges change whenever a NAAQS for a specific pollutant is revised. So even though improvement in AQI days appears to be somewhat erratic, to see how things really have improved, refer to the concentration trend graphs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

Of all the criteria pollutants, ozone is predominantly responsible for AQI days above the moderate range in New Jersey.

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

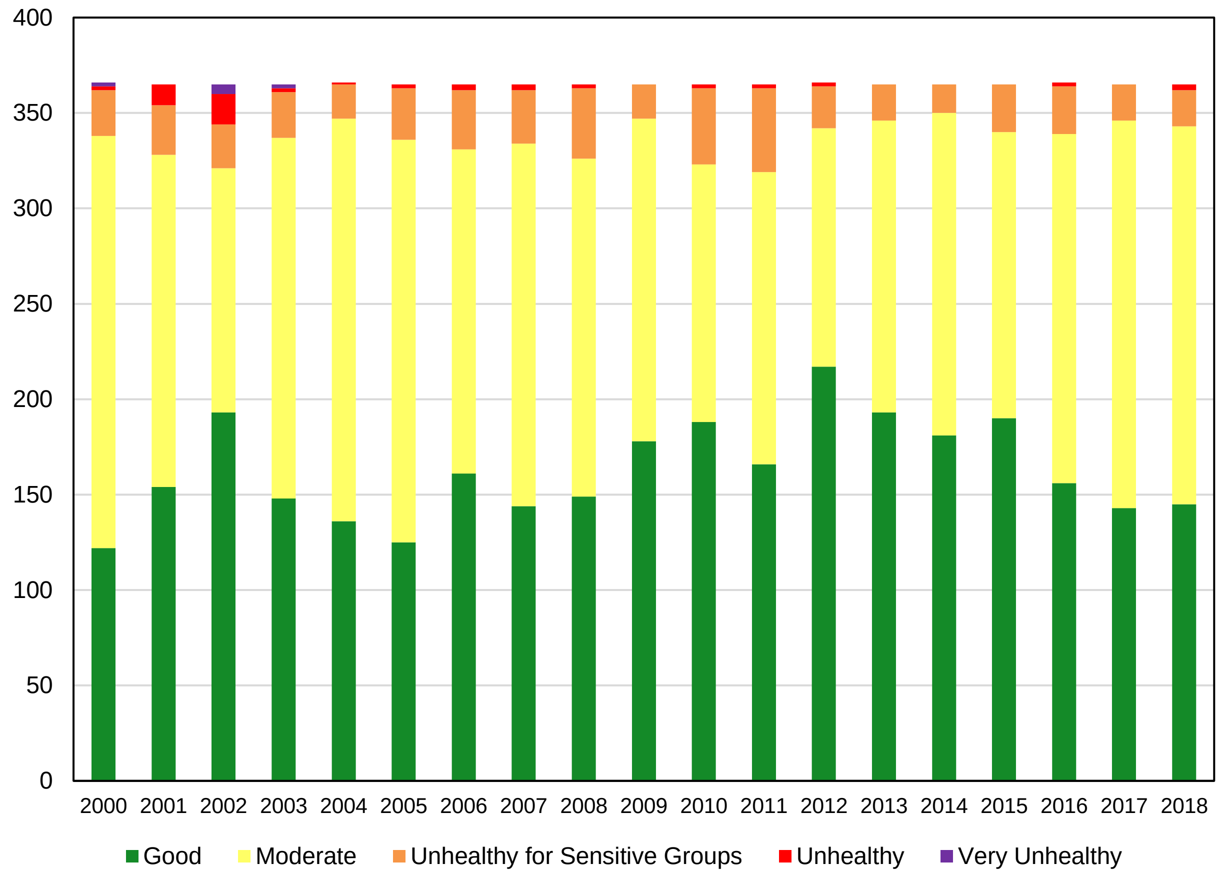


Table 3-5 is a summary of the days when the AQI reached the "Unhealthy" or "Unhealthy for Sensitive Groups" ("USG") threshold at any monitoring location in New Jersey. Table 3-6 lists the individual exceedance dates and shows the responsible pollutants and their concentrations. The nitrogen dioxide exceedance is attributed to vehicles idling near the Fort Lee Near Road monitoring station.

Table 3-5
2018 Total Number of NAAQS Exceedance Days in New Jersey

Pollutant	Exceedances
Nitrogen Dioxide	1
Ozone	21

Table 3-6
AQI "Unhealthy" or "USG" Days in New Jersey During 2018

Day	Date	Monitor Location	Pollutant	Concen-tration	Units	AQI Rating	AQI Value
1	1/3/18	Fort Lee Near Road	NO_2	0.131	ppm	USG	107
2	5/1/18	Brigantine	O_3	0.074	ppm	USG	112
		Chester	O_3	0.071	ppm	USG	101
		Clarksboro	O_3	0.072	ppm	USG	105
		Colliers Mills	O_3	0.074	ppm	USG	112
		Flemington	O_3	0.072	ppm	USG	105
		Washington Crossing*	O_3	0.072	ppm	USG	105
3	5/2/18	Chester	O_3	0.073	ppm	USG	108
		Clarksboro	O_3	0.074	ppm	USG	112
		Colliers Mills	O_3	0.076	ppm	USG	119
		Columbia	O_3	0.074	ppm	USG	112
		Flemington	O_3	0.072	ppm	USG	105
		Leonia	O_3	0.071	ppm	USG	101
		Ramapo	O_3	0.072	ppm	USG	105
4	5/25/18	Rider University	O_3	0.072	ppm	USG	105
		Rutgers University	O_3	0.071	ppm	USG	101
5	5/29/18	Bayonne	O_3	0.072	ppm	USG	105
		Leonia	O_3	0.074	ppm	USG	112
		Newark Firehouse	O_3	0.074	ppm	USG	112
		Ramapo	O_3	0.075	ppm	USG	115
6	6/9/18	Rutgers University	O_3	0.076	ppm	USG	119
7	6/17/18	Bayonne	O_3	0.075	ppm	USG	115
		Leonia	O_3	0.074	ppm	USG	112
8	6/18/18	Bayonne	O_3	0.079	ppm	USG	129
		Camden Spruce St.	O_3	0.073	ppm	USG	108
		Flemington	O_3	0.072	ppm	USG	105
		Leonia	O_3	0.075	ppm	USG	115
		Rider University	O_3	0.076	ppm	USG	119
		Rutgers University	O_3	0.078	ppm	USG	126
9	6/21/18	Colliers Mills	O_3	0.071	ppm	USG	101
10	6/30/18	Bayonne	O_3	0.071	ppm	USG	101
		Camden Spruce St.	O_3	0.075	ppm	USG	115
		Clarksboro	O_3	0.079	ppm	USG	129
		Colliers Mills	O_3	0.078	ppm	USG	126
		Leonia	O_3	0.077	ppm	USG	122
		Newark Firehouse	O_3	0.071	ppm	USG	101
11	7/1/18	Bayonne	O_3	0.095	ppm	U	174
		Camden Spruce St.	O_3	0.075	ppm	USG	115
		Clarksboro	O_3	0.071	ppm	USG	101
		Leonia	O_3	0.090	ppm	U	161

Continued on next page.

Table 3-6 (continued)
AQI "Unhealthy" or "USG" Days in New Jersey During 2018

Day	Date	Monitor Location	Pollutant	Concen-tration	Units	Rating	AQI Value
12	7/2/18	Bayonne	O_3	0.092	ppm	U	166
		Chester	O_3	0.081	ppm	USG	136
		Flemington	O_3	0.097	ppm	U	179
		Leonia	O_3	0.091	ppm	U	164
		Newark Firehouse	O_3	0.096	ppm	U	177
		Ramapo	O_3	0.085	ppm	USG	150
		Rider University	O_3	0.091	ppm	U	164
		Rutgers University	O_3	0.075	ppm	USG	115
		Washington Crossing*	O_3	0.100	ppm	U	187
13	7/3/18	Washington Crossing*	O_3	0.081	ppm	USG	136
14	7/9/18	Bayonne	O_3	0.072	ppm	USG	105
		Camden Spruce St.	O_3	0.076	ppm	USG	119
		Chester	O_3	0.075	ppm	USG	115
		Clarksboro	O_3	0.078	ppm	USG	126
		Colliers Mills	O_3	0.072	ppm	USG	105
		Leonia	O_3	0.079	ppm	USG	129
15	7/10/18	Ancora	O_3	0.082	ppm	USG	140
		Bayonne	O_3	0.078	ppm	USG	126
		Camden Spruce St	O_3	0.080	ppm	USG	133
		Chester	O_3	0.077	ppm	USG	122
		Clarksboro	O_3	0.084	ppm	USG	147
		Colliers Mills	O_3	0.083	ppm	USG	143
		Flemington	O_3	0.086	ppm	U	151
		Leonia	O_3	0.081	ppm	USG	136
		Newark Firehouse	O_3	0.080	ppm	USG	133
		Rider University	O_3	0.080	ppm	USG	133
		Rutgers University	O_3	0.078	ppm	USG	126
		Washington Crossing*	O_3	0.083	ppm	USG	143
16	7/16/18	Leonia	O_3	0.078	ppm	USG	126
		Rider University	O_3	0.077	ppm	USG	122
		Rutgers University	O_3	0.080	ppm	USG	133
17	7/19/18	Clarksboro	O_3	0.076	ppm	USG	119
18	7/28/18	Bayonne	O_3	0.073	ppm	USG	108
		Leonia	O_3	0.077	ppm	USG	122
19	8/6/18	Leonia	O_3	0.076	ppm	USG	119
20	8/8/18	Leonia	O_3	0.074	ppm	USG	112
21	8/28/18	Colliers Mills	O_3	0.071	ppm	USG	101
22	8/29/18	Colliers Mills	O_3	0.071	ppm	USG	101

Rating
USG = Unhealthy for sensitive groups
U = Unhealthy

Pollutants
NO_2 –Nitrogen dioxide
O_3 – Ozone

Units
ppm – parts per million
ppm – parts per million

*The Washington Crossing air monitoring station is operated by USEPA. Although it is not part of NJDEP's network, the site's data is included in determining exceedances in New Jersey.

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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 4/15/19.

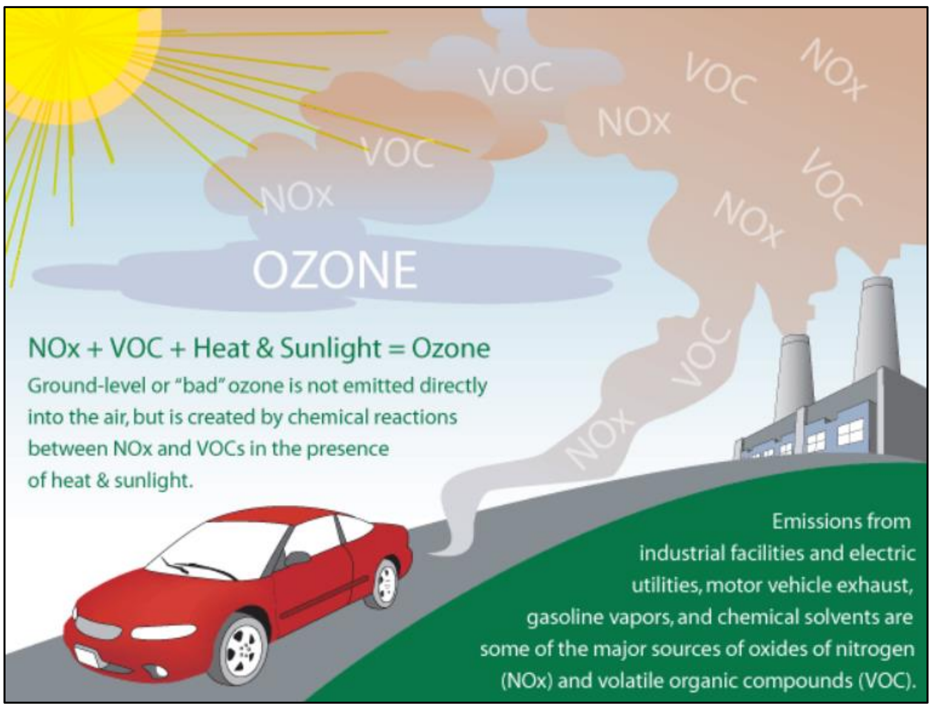
2018 Ozone Summary

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

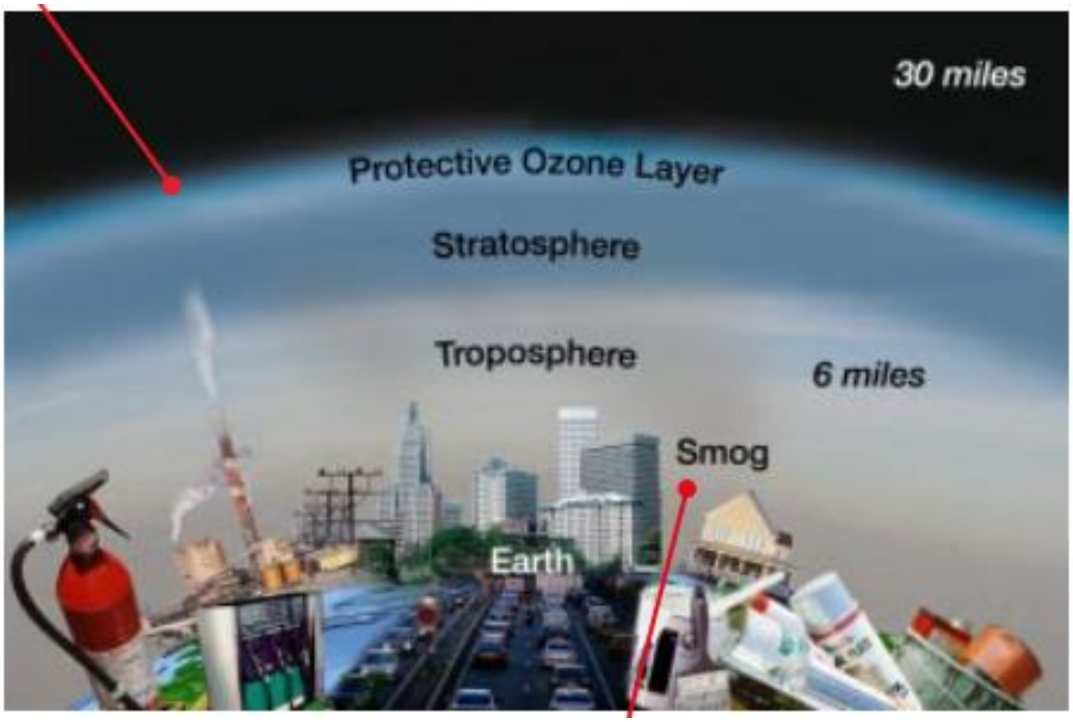


https://airnow.gov/index.cfm?action=aqibasics.ozone

Since ground-level ozone needs sunlight to form, it is mainly a problem in the daytime during the summer months. The U.S. Environmental Protection Agency (USEPA) requires New Jersey to monitor ozone from March 1st to October 31st, the so-called "ozone season." Weather patterns have a significant effect on ozone formation, and hot dry summers will result in more ozone than cool wet ones. For a more complete explanation of the difference between ozone in the upper and lower atmosphere, see Figure 4-2, and the USEPA publication, "Good Up High, Bad Nearby – What is Ozone?"

Figure 4-2. 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://www3.epa.gov/airnow/gooduphigh/ozone.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 is responsible for 500 million dollars in reduced crop production in the United States 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 brown areas on the leaf shown in Figure 4-3 are damage caused by exposure to ground-level ozone.

Figure 4-3
Leaf Damage Caused by Ozone

https://www.ars.usda.gov/

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 still uses 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)

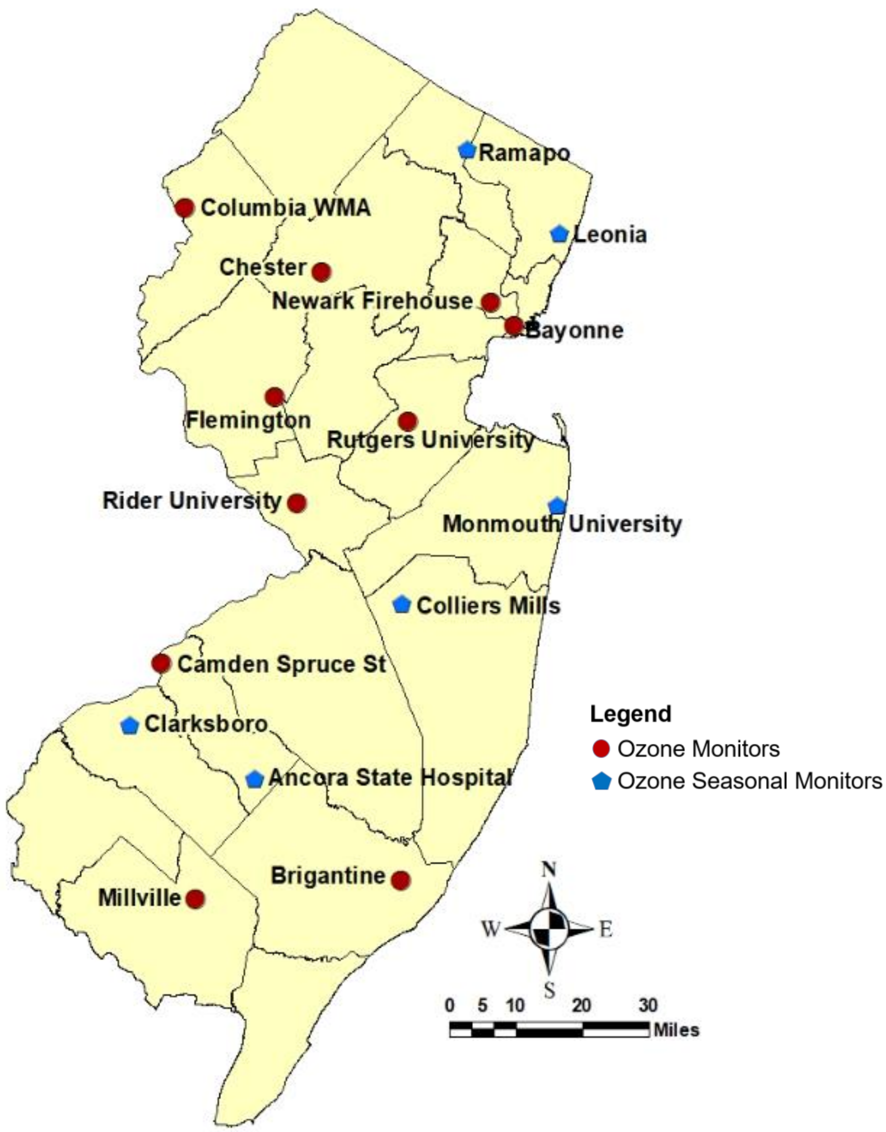
Averaging Period	Type	National	New Jersey
1-Hour	Primary	---	0.12 ppm
8-Hours	Primary & secondary	0.070 ppm	---

OZONE MONITORING NETWORK

Ozone was measured at 16 monitoring stations in New Jersey during 2018 (see Figure 4-4). 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. 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. Data from the site is also used in determining New Jersey's NAAQS compliance status, although it is not presented here. It can be obtained from USEPA.

Figure 4-4
2018 Ozone Monitoring Network



OZONE LEVELS IN 2018

During the 2018 ozone season, 14 of the 16 New Jersey monitoring sites recorded levels above the 8-hour standard of 0.070 ppm at least once. There were twenty-one (21) days, between May 1 and August 29, on which the standard was exceeded somewhere in the state (including USEPA's Washington Crossing site). On three of those days (July 1, 2 and 10), the Air Quality Index reached the "Unhealthy" category (see the Air Quality Index section for details).

Table 4-2 presents the USEPA-verified 2018 New Jersey ozone data. Of the 16 monitoring sites that operated during the 2018 ozone season, two recorded levels above the New Jersey 1-hour standard of 0.12 ppm. The highest daily 1-hour concentration was 0.135 ppm, recorded at Flemington on July 2nd. The Leonia site also exceeded the 1-hour standard that day, with a value of 0.131 ppm. The last time the 1-hour standard was exceeded in New Jersey was in 2010. Figure 4-5 shows the one-hour data for each site.

The highest daily maximum 8-hour average concentration was 0.097 at Flemington on July 9th. All sites except Millville and Monmouth University exceeded the 8-hour standard (0.070 ppm) at least once (see Figure 4-6). Leonia had the most exceedances with 13. Ten sites (Bayonne, Camden Spruce Street, Chester, Clarksboro, Colliers Mills, Flemington, Leonia, Newark Firehouse, Rider University, and Rutgers University) were above the design value (4th-highest 8-hour daily maximum>0.070 ppm). Figure 4-7 presents each site's 8-hour daily maximum average values, and Figure 4-8 shows the 3-year average 8-hour design value for the 2016-2018 period.

Table 4-2
2018 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	2016-2018 Average of 4th-Highest Daily Max.
Ancora	0.091	0.082	0.068	0.066
Bayonne	0.110	0.095	0.078	0.071
Brigantine	0.080	0.074	0.063	0.063
Camden Spruce St.	0.091	0.076	0.075	0.075
Chester	0.110	0.081	0.073	0.070
Clarksboro	0.096	0.084	0.077	0.074
Colliers Mills	0.098	0.083	0.074	0.073
Columbia	0.078	0.074	0.067	0.065
Flemington	0.135	0.097	0.072	0.072
Leonia	0.131	0.091	0.079	0.075
Millville	0.078	0.065	0.063	0.064
Monmouth University	0.085	0.071	0.068	0.065
Newark Firehouse	0.120	0.096	0.071	0.067
Ramapo	0.108	0.085	0.069	0.067
Rider University	0.113	0.091	0.076	0.072
Rutgers University	0.098	0.080	0.076	0.075

Figure 4-5
2018 Ozone Concentrations in New Jersey
1-Hour Daily Maximum Concentrations
Parts per Million (ppm)

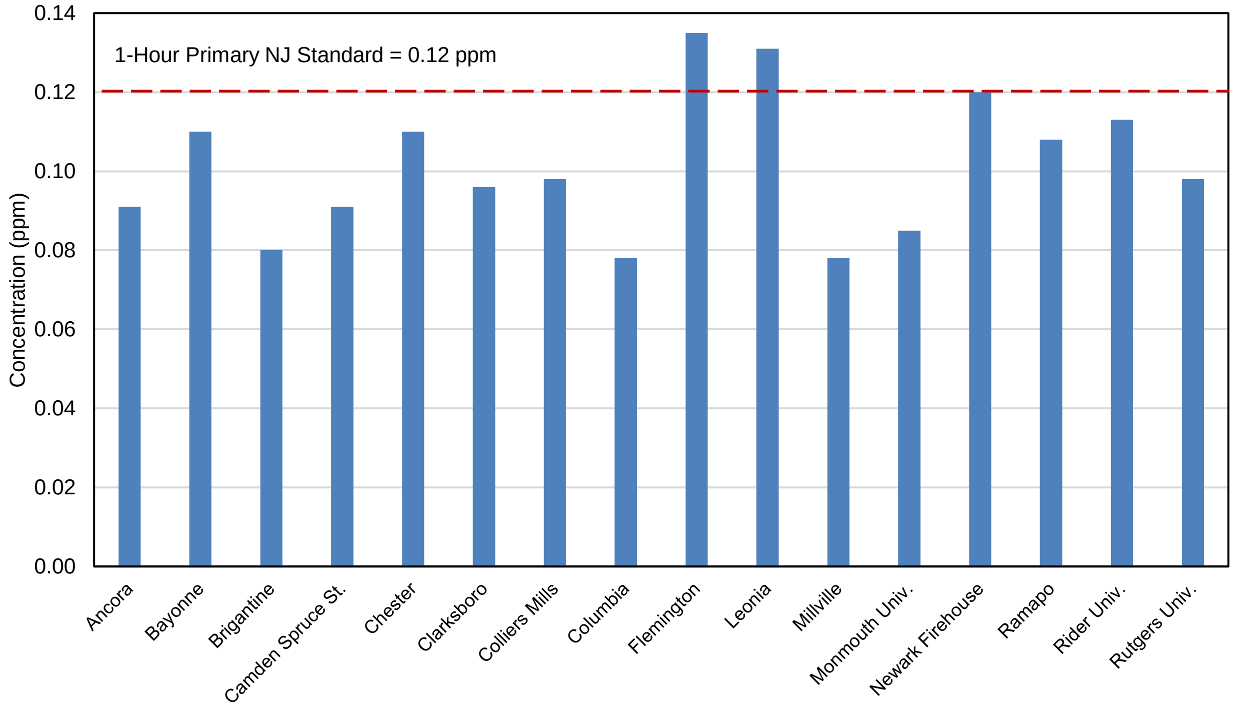


Figure 4-6
Number of Exceedance Days of the 8-Hour O_3 NAAQS in 2018 at New Jersey's Monitors

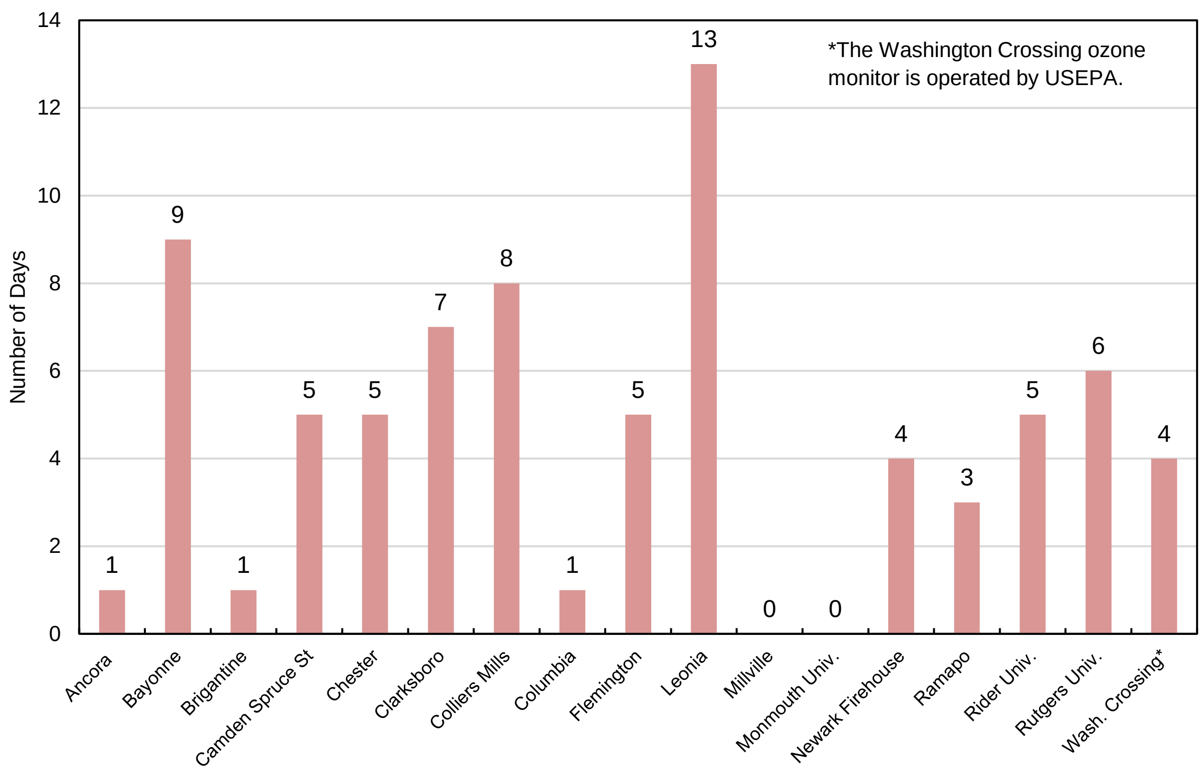


Figure 4-7
2018 Ozone Concentrations in New Jersey
8-Hour Daily Maximum Concentrations
Parts per Million (ppm)

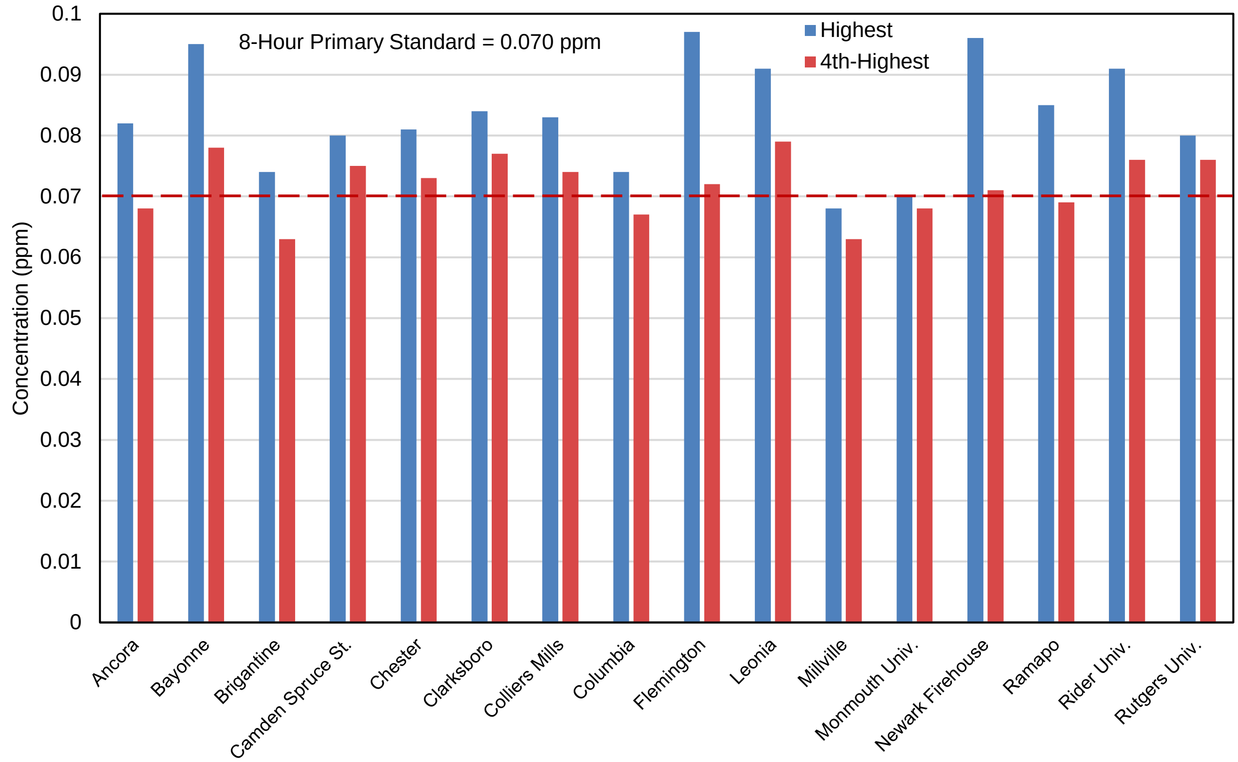
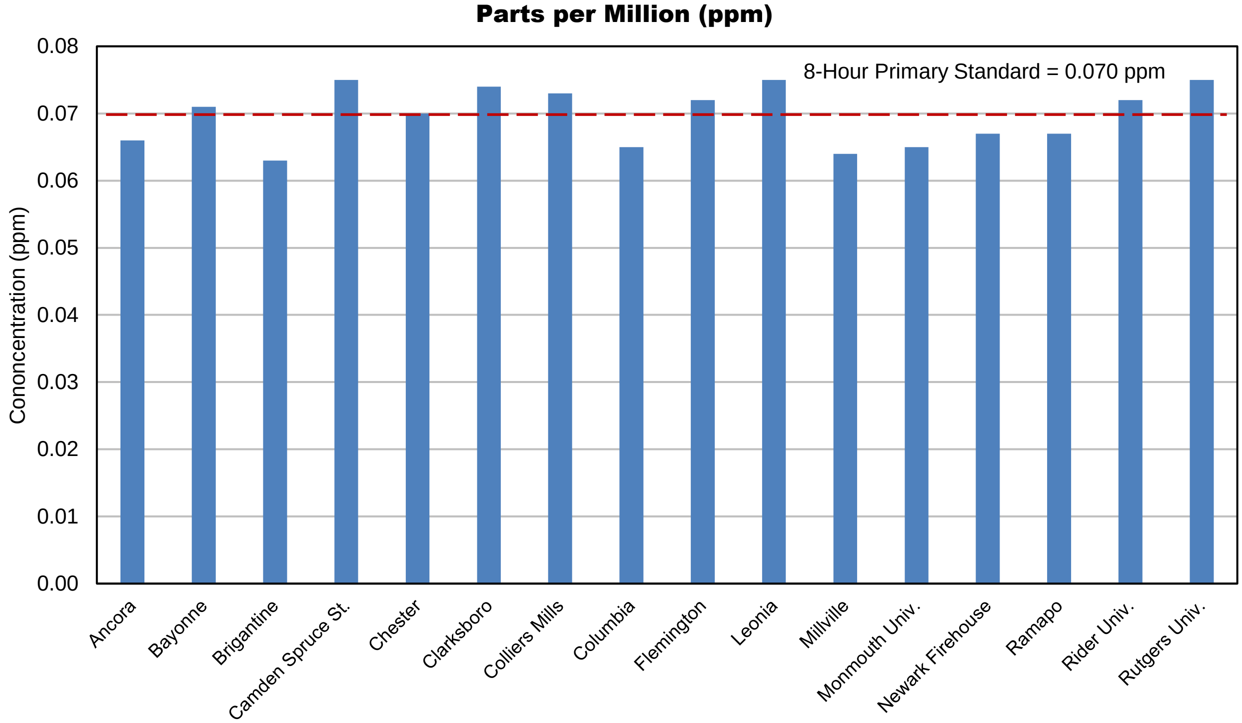


Figure 4-8
New Jersey Ozone Design Values for 2015-2018
3-Year Average of the 4th-Highest Daily Maximum 8-Hour Average
Parts per Million (ppm)



Ozone Trends

Studies have shown that in order to lower 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 decrease in ozone levels in New Jersey. However, it will take some new initiatives for the state to further decrease ozone concentrations in order to meet the lower 2016 standard. The chart in Figure 4-9 shows the fourth-highest statewide 8-hour maximum average concentration recorded each year since 1997. In 2018, this value was 0.079 ppm (measured at Leonia). The 2018 design value, which is the three-year average of the 4th-highest maximum daily 8-hour concentration at any site statewide, was 0.075 ppm, as shown in Figure 4-10. This exceeds the 0.070 ppm NAAQS.

Figure 4-9
Ozone Trend in New Jersey, 1997-2018
4th-Highest Daily Maximum 8-Hour Averages
Parts per Million (ppm)

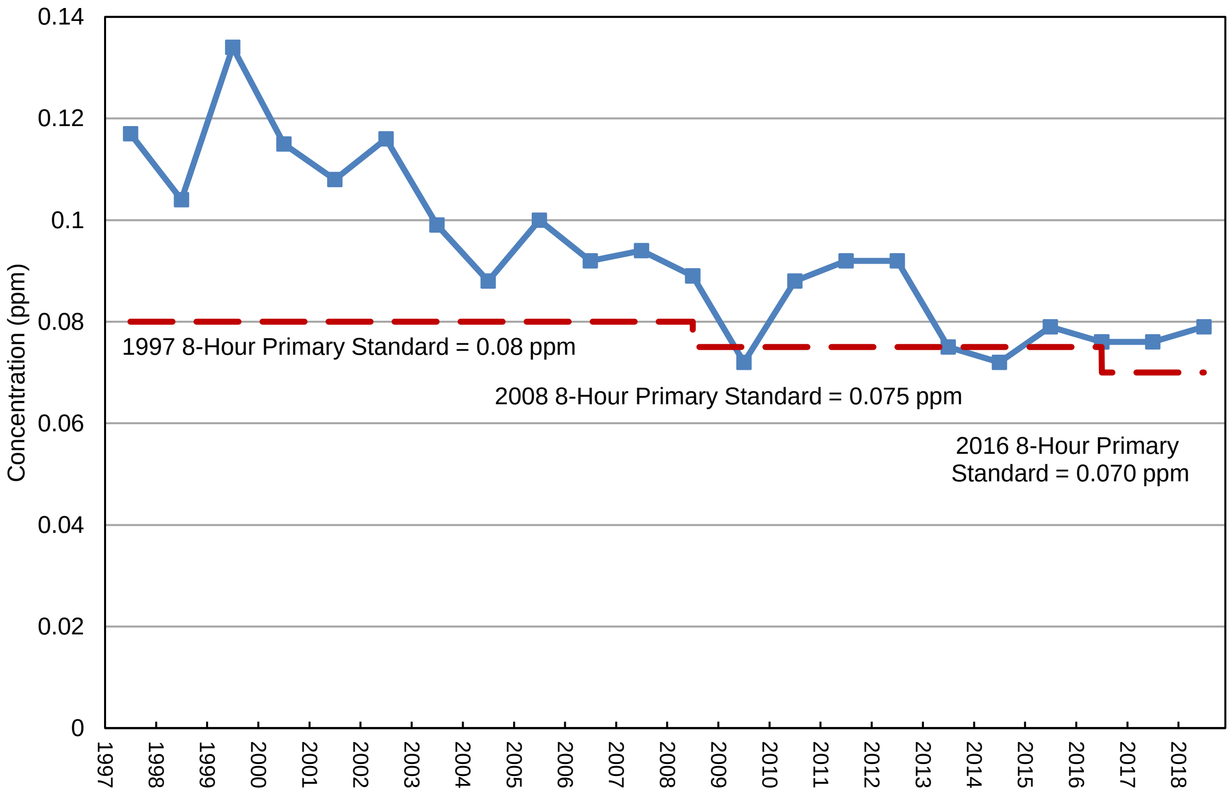
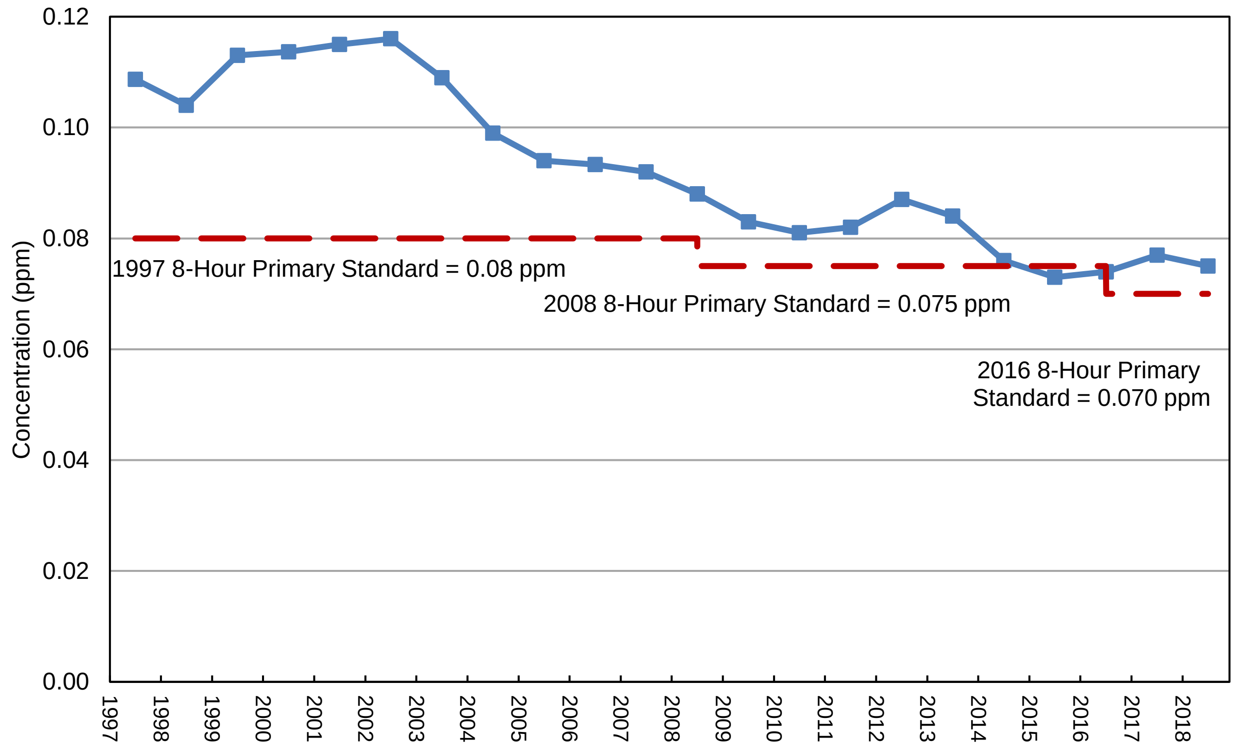


Figure 4-10
Ozone Design Value Trend in New Jersey, 1997-2018
3-Year Average of 4th-Highest Daily Maximum
8-Hour Average Concentration
Parts per Million (ppm)

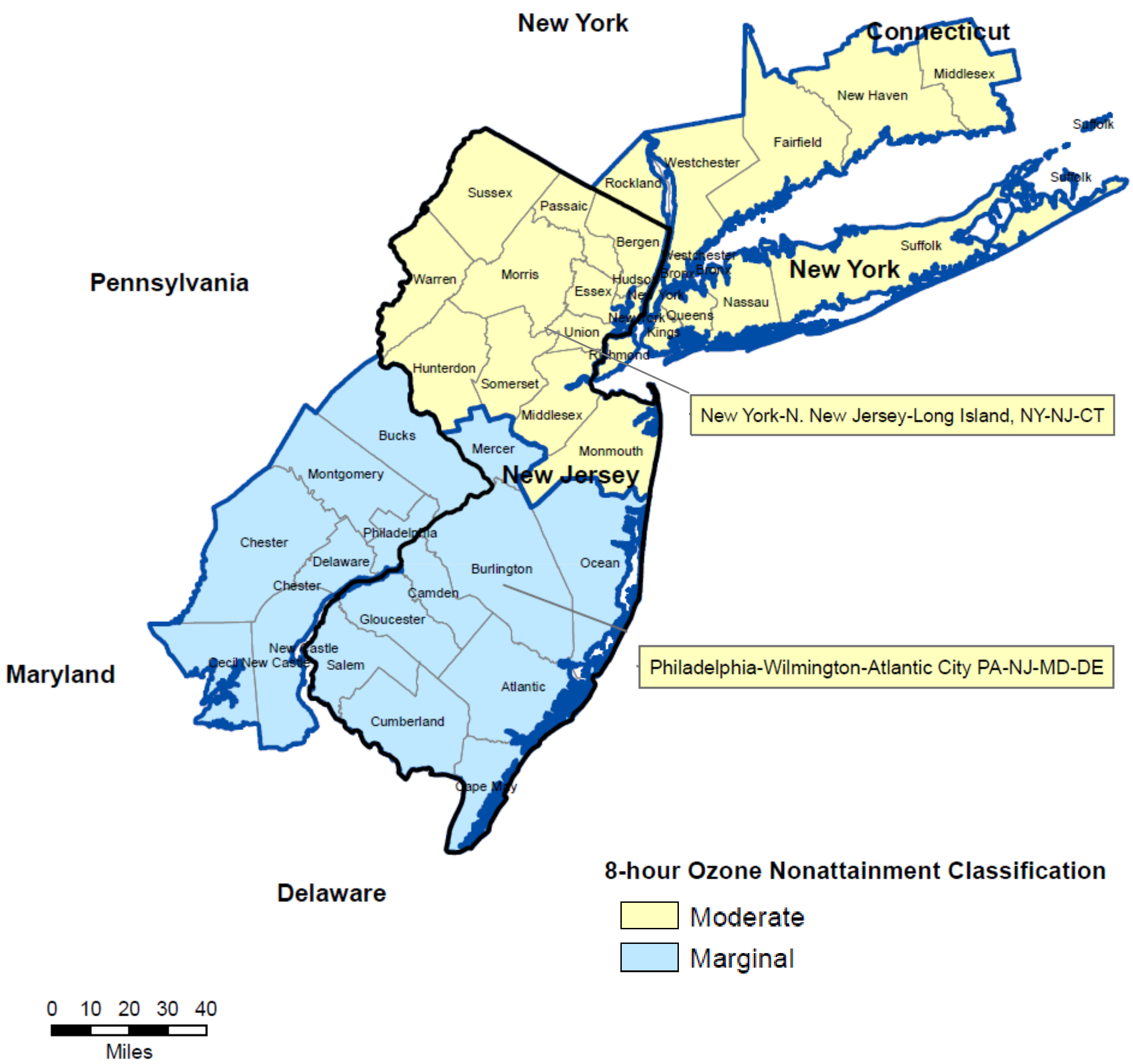


OZONE NONATTAINMENT AREAS IN NEW JERSEY

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 state of New Jersey has been in nonattainment for the ozone NAAQS with the northern part of the state classified as being "moderate" and the southern part of the state classified as being "marginal." New Jersey's current classification with respect to the 2016 8-hour standard is shown in Figure 4-11.

Figure 4-11
New Jersey 8-Hour Ozone Nonattainment Areas



Source: https://www3.epa.gov/airquality/greenbook/map/nj8_2015.pdf

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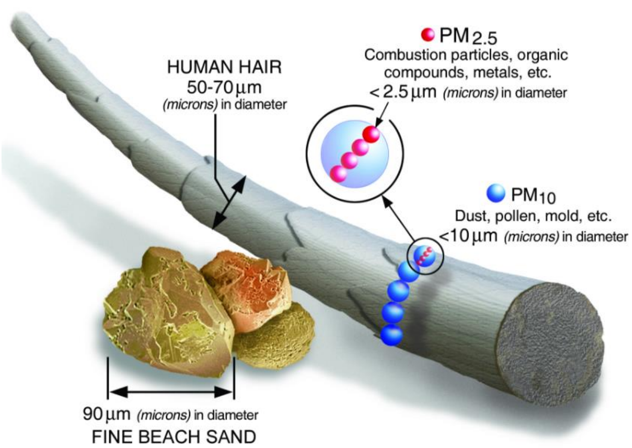
2018 Particulate Matter Summary

New Jersey Department of Environmental Protection

Figure 5-1
Size Comparisons for PM Particles



USEPA. www.epa.gov/pm-pollution

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.

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. Figure 5-2a provides an example of reduced visibility due to particulate pollution, recorded by the Camnet visibility camera in Newark (www.hazecam.net), which focuses on the New York skyline. Figure 5-2b is an example of a day with low particulate pollution and good visibility. Airborne particles can also impact vegetation and aquatic ecosystems, and can cause damage to paints and building materials.

Figure 5-2a

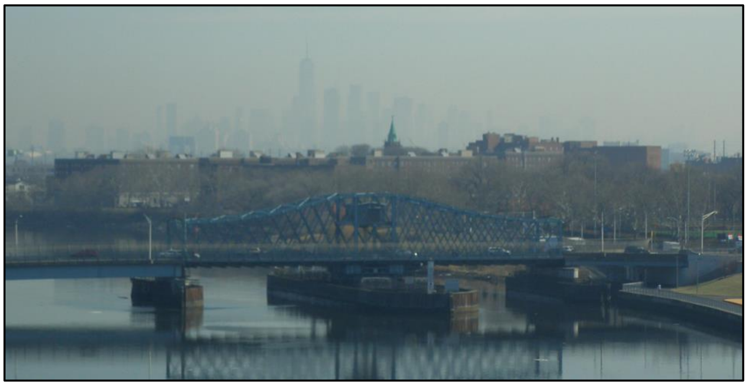


Figure 5-2b

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. Ten years later, 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 in a given year.

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

Pollutant	Averaging Period	Type	Level
Fine Particulate ($PM_{2.5}$)	Annual	Primary	12.0 $\mu g/m^3$
	Annual	Secondary	15.0 $\mu g/m^3$
	24-Hours	Primary & Secondary	35 $\mu g/m^3$
Inhalable Particulate (PM_{10})	24-Hours	Primary & Secondary	150 $\mu g/m^3$

PARTICULATE MONITORING NETWORK

The New Jersey Department of Environmental Protection (NJDEP) particulate monitoring network in 2018 consisted of twenty-one $PM_{2.5}$ monitoring sites and three PM_{10} monitoring sites. Criteria pollutant monitors must meet strict USEPA requirements in order to determine compliance with the NAAQS. NJDEP uses three different methods to measure particulate.

Sixteen $PM_{2.5}$ sites and the three PM_{10} sites use filter-based samplers, which 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.

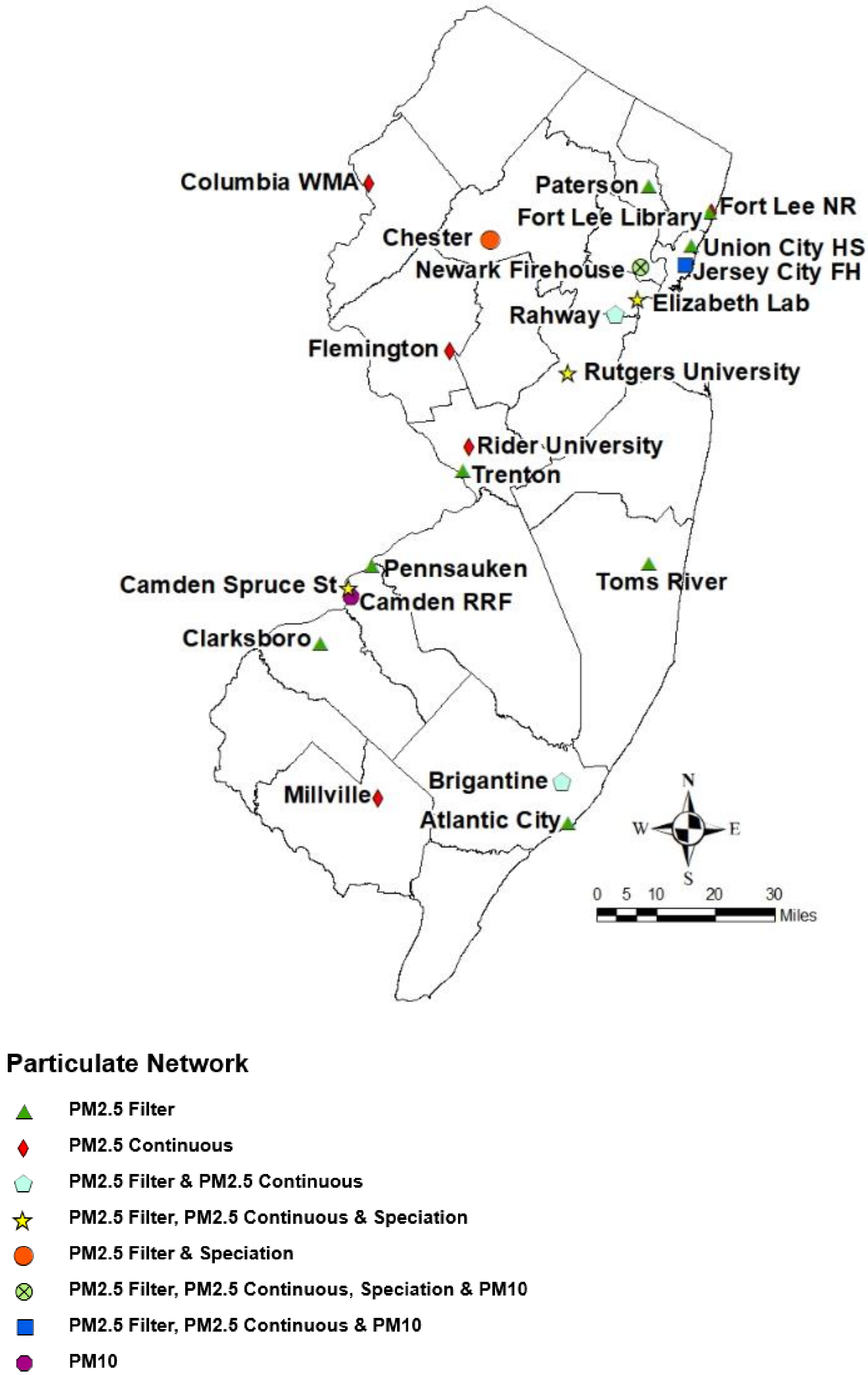
In order to provide real-time hourly data to the public (through the Air Quality Index at www.njaqinow.net), NJDEP has also been using particulate monitors that operate continuously. Twelve sites in New Jersey use Beta Attenuation Monitors (BAM), which measure the loss of intensity (attenuation) of beta 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 be used to determine compliance with the NAAQS.

At one time, the NJDEP PM_{10} monitoring network consisted of more than twenty sampling sites. Due to many years of low concentrations and the shift in emphasis to $PM_{2.5}$ monitoring, the network has been reduced to only three sites: the Camden Resource Recovery Facility (RRF), Jersey City Firehouse, and Newark Firehouse. PM_{10} samples are taken once every six days at Camden and Jersey City, and every three days at Newark.

Five monitoring stations are part of the national Chemical Speciation Network (CSN). They use a separate 24-hour filter-based $PM_{2.5}$ sampler to determine the concentrations of the chemical analytes that make up the particle sample. The sample is collected on three types of filter media which are subsequently analyzed using ion chromatography (IC), X-ray fluorescence (XRF), and Thermal Optical Transmittance (TOT). CSN monitoring takes place at the Camden Spruce Street, Chester, Elizabeth Lab, Newark Firehouse and Rutgers University monitoring stations. 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
2018 Particulate Monitoring Network



Fine Particle ($PM_{2.5}$) Levels in 2018

$PM_{2.5}$ Levels for Filter-Based FRM Monitors

In 2018, none of the filter-based FRM $PM_{2.5}$ monitoring sites were in violation of either the annual NAAQS of 12.0 μg/m^3 or the 24-hour NAAQS of 35 μg/m^3. The annual mean concentrations of $PM_{2.5}$ measured at the sixteen FRM samplers ranged from 5.33 μg/m^3 at the Brigantine monitoring site to 9.13 μg/m^3 at the Camden Spruce Street station. The highest 24-hour concentrations ranged from 15.9 μg/m^3 at Brigantine to 33.2 μg/m^3 at the Elizabeth Lab. Table 5-2 shows the annual mean, highest and 98^{th}-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. Four sites (Elizabeth Lab, Jersey City Firehouse, Toms River and Trenton) operate every day. The other twelve sites (Atlantic City, Brigantine, Camden Spruce Street, Chester, Clarksboro, Fort Lee Library, Newark Firehouse, Paterson, Pennsauken, Rahway, Rutgers University, and Union City High School) take a sample every third day. At the Columbia monitoring station, the continuous $PM_{2.5}$ sampler was redesignated as the primary monitor for the site, and the filter-based $PM_{2.5}$ sampler became a secondary (co-located) monitor. USEPA uses data from co-located monitors only for quality assurance, not for determining compliance with the NAAQS, so that data is not included in this report.

Table 5-2
2018 $PM_{2.5}$ Concentrations in New Jersey
Annual and 24-Hour Averages (FRM)
Micrograms Per Cubic Meter (μg/m^3)

Monitoring Site	Number of Samples	Annual Average	24-Hour Average	
			Highest	98^{th}%-ile
Atlantic City	117	6.28	17.1	15.0
Brigantine	107	5.33	15.9	13.1
Camden Spruce Street	119	9.13	29.9	20.6
Chester	108	5.88	18.4	15.1
Clarksboro	108	7.01	17.1	15.9
Elizabeth Lab	347	8.82	33.2	21.8
Fort Lee Library	114	7.41	19.6	18.0
Jersey City Firehouse	357	8.15	30.3	20.0
Newark Firehouse	119	7.75	26.1	18.3
Paterson	118	7.62	30.0	18.9
Pennsauken	105	6.64	19.0	16.4
Rahway	118	7.69	22.5	19.3
Rutgers University	116	6.79	18.1	16.5
Toms River	344	6.33	19.9	17.1
Trenton Library	324	7.06	20.0	17.0
Union City High School	115	7.59	20.8	19.2

Figure 5-4
2018 $PM_{2.5}$ Concentrations in New Jersey
Annual Averages (Filter-Based Monitors)
Micrograms Per Cubic Meter (µg/m³)

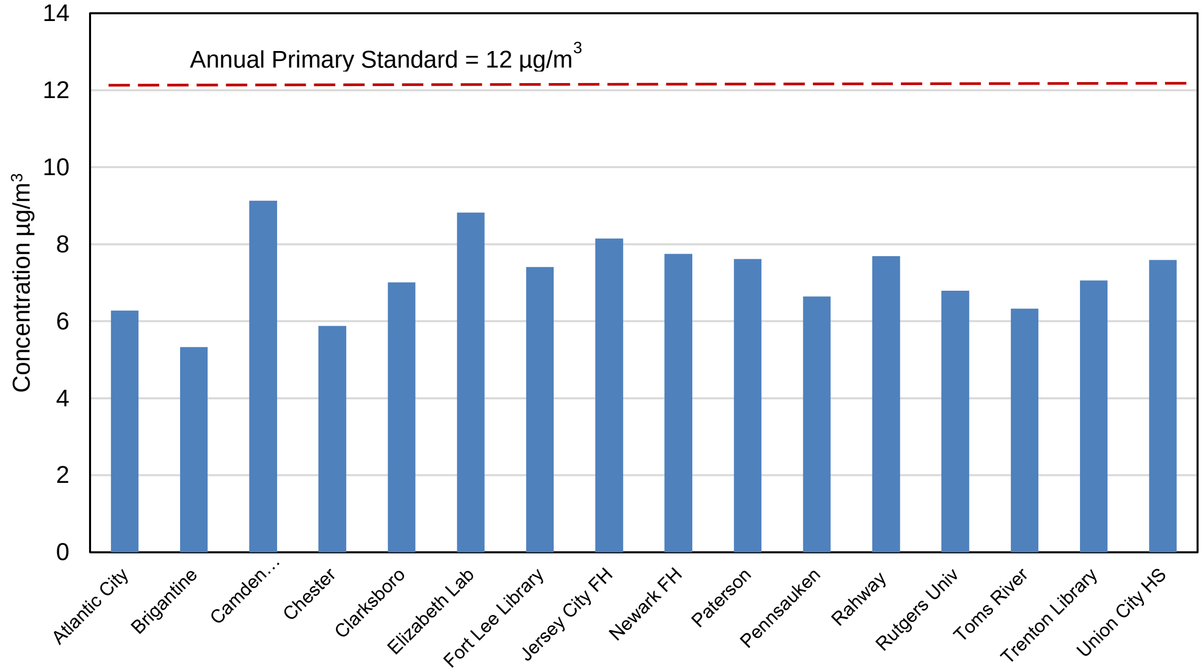
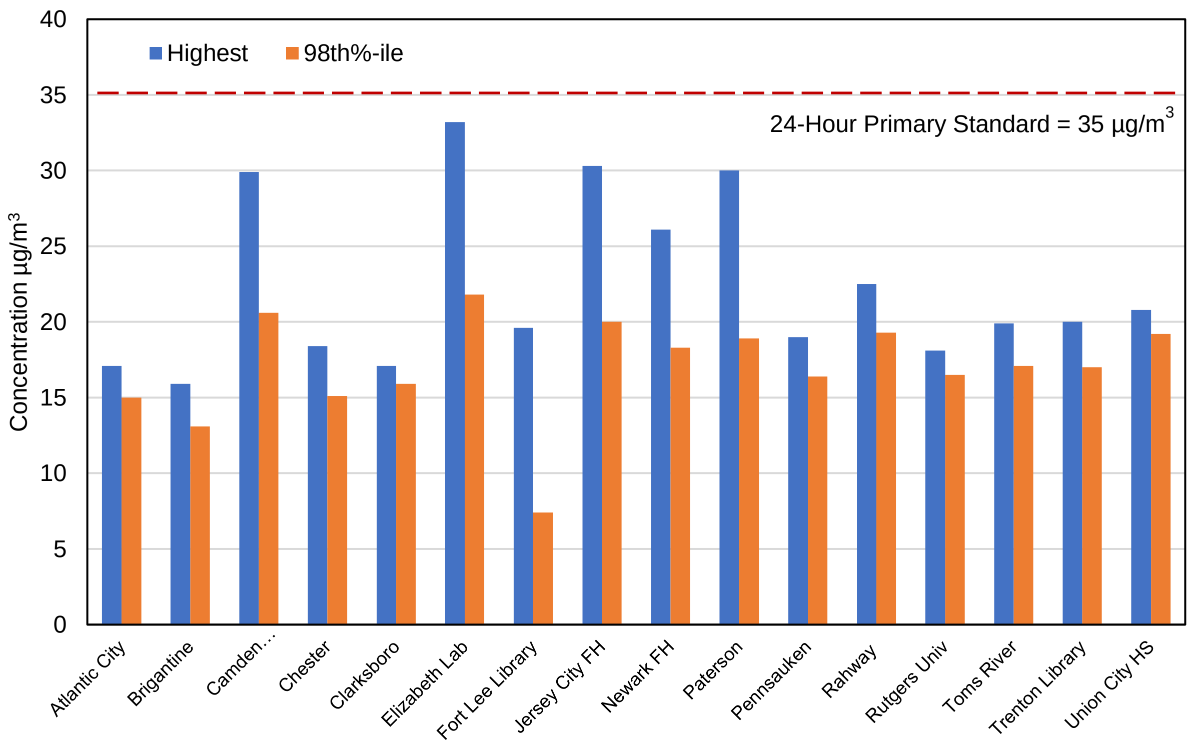


Figure 5-5
2018 $PM_{2.5}$ Concentrations in New Jersey
24-Hour Averages (Filter-Based Monitors)
Micrograms Per Cubic Meter (µg/m³)



$PM_{2.5}$ LEVELS FOR CONTINUOUS FEM MONITORS

New Jersey's continuous $PM_{2.5}$ monitoring network consists of twelve sites: Brigantine, Camden Spruce Street, Columbia, Elizabeth Lab, Flemington, Fort Lee Near Road, Jersey City Firehouse, Millville, Newark Firehouse, Rahway, Rider University, and Rutgers University. One-minute readings are transmitted to a central computer in Trenton, where they are averaged every hour and automatically updated on the NJDEP website at www.njaqinow.net. Table 5-3 presents the annual mean, highest 24-hour, and 98th-percentile 24-hour values from these sites for 2018. Figures 5-6 and 5-7 show the same data in graphs. In 2018 there were no exceedances of either the 12.0 $\mu g/m^3$ annual standard or the 35 $\mu g/m^3$ 24-hour standard.

Table 5-3
2018 $PM_{2.5}$ Concentrations in New Jersey
Annual and 24-Hour Averages (Continuous Monitors)
Micrograms Per Cubic Meter ($\mu g/m^3$)

Monitoring Site	Annual Average	24-Hour Average	
		Highest	98th-%ile
Brigantine	6.74	19.5	14.0
Camden Spruce Street	10.41	25.7	22.1
Columbia	7.89	27.5	19.4
Elizabeth Lab	10.56	27.8	23.1
Flemington	7.93	22.4	19.1
Fort Lee Near Road	11.11	33.7	27.1
Jersey City Firehouse	9.45	33.5	21.1
Millville	8.72	23.5	18.2
Newark Firehouse	8.61	31.7	21.7
Rahway	7.25	20.9	20.0
Rider University	7.83	20.8	17.8
Rutgers University	8.02	22.5	18.6

Figure 5-6
2018 $PM_{2.5}$ Concentrations in New Jersey
Annual Averages from Continuous Monitors
Micrograms Per Cubic Meter (µg/m³)

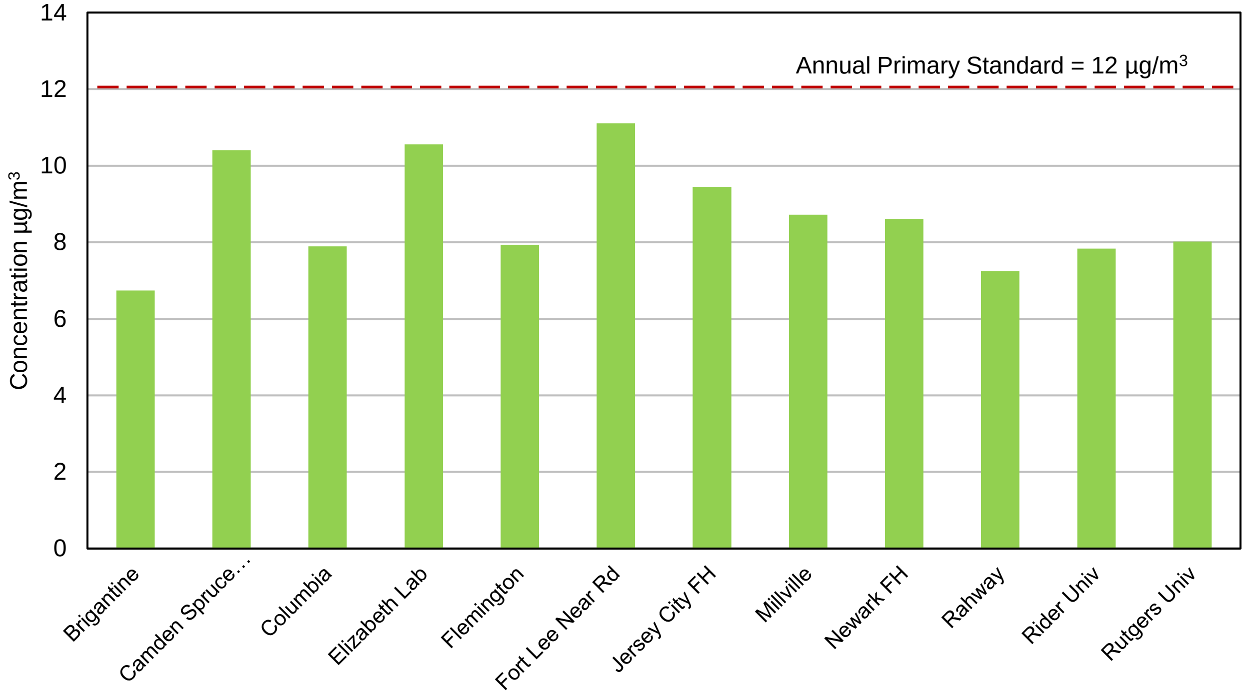
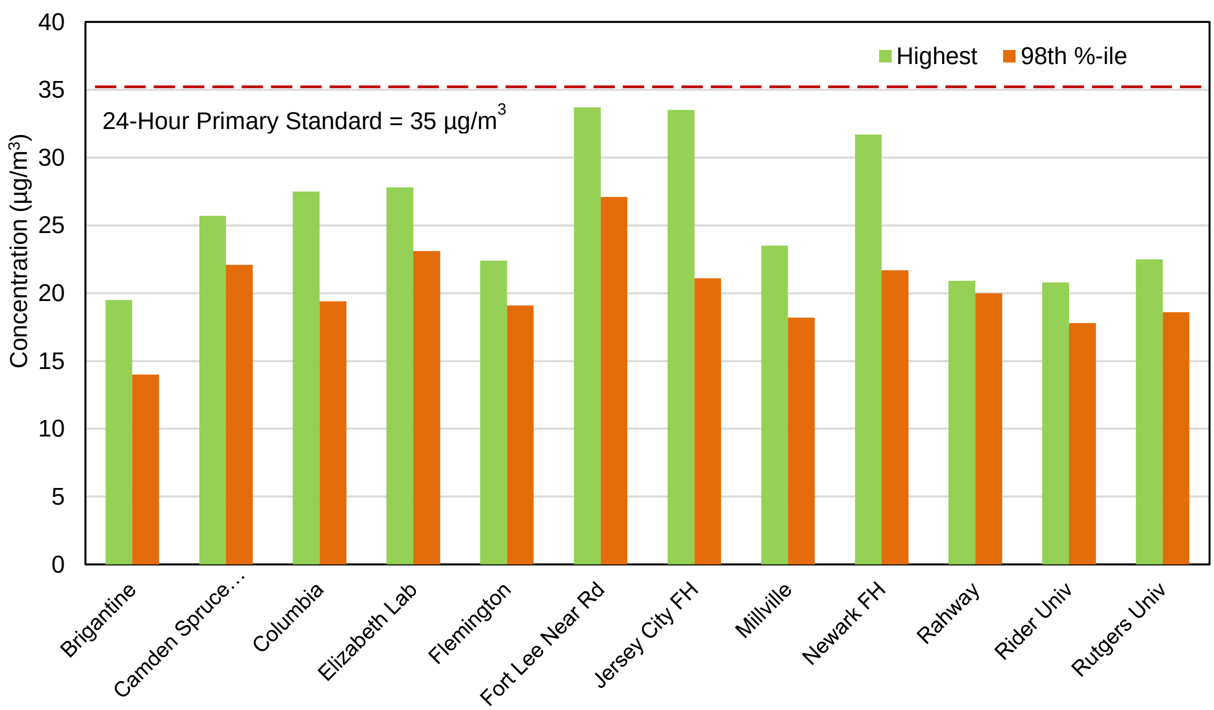


Figure 5-7
2018 $PM_{2.5}$ Concentrations in New Jersey
24-Hour Averages from Continuous Monitors
Micrograms Per Cubic Meter (µg/m³)



$PM_{2.5}$ DESIGN VALUES

Table 5-4 and Figures 5-8 and 5-9 show the $PM_{2.5}$ design values for each of the New Jersey monitors, as calculated by USEPA. Some sites have both a filter-based FRM monitor and a continuous FEM monitor. At sites with both, the data from the FRM monitor takes precedence, and FEM data is added in for periods when there is no FRM data.

Clarksboro, Flemington, Fort Lee Near Road, Millville, and Pennsauken do not have complete data sets for 2016-2018, but their USEPA design value estimates are included here anyway (marked with an asterisk).

Table 5-4
New Jersey $PM_{2.5}$ Design Values for 2016-2018
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 (2016-2018) Average	
	Annual	98th %-ile 24-Hour
Atlantic City	6.8	16
Brigantine	6.6	14
Camden Spruce Street	10.2	24
Chester	5.9	14
Clarksboro*	7.5	19
Columbia	8.1	20
Elizabeth Lab	9.2	21
Flemington*	8.2	18
Fort Lee Library	7.6	18
Fort Lee Near Road*	10.0	22
Jersey City Firehouse	8.2	19
Millville*	8.1	17
Newark Firehouse	8.4	19
Paterson	7.6	18
Pennsauken*	7.6	17
Rahway	7.7	18
Rider University	8.2	17
Rutgers University	8.2	19
Toms River	6.6	16
Trenton Library	7.3	17
Union City High School	8.0	19

*3-year data set is incomplete per USEPA requirements.

Figure 5-8
New Jersey $PM_{2.5}$ Design Values for 2016-2018
3-Year Average of the Annual Average Concentrations
Micrograms Per Cubic Meter (µg/m³)

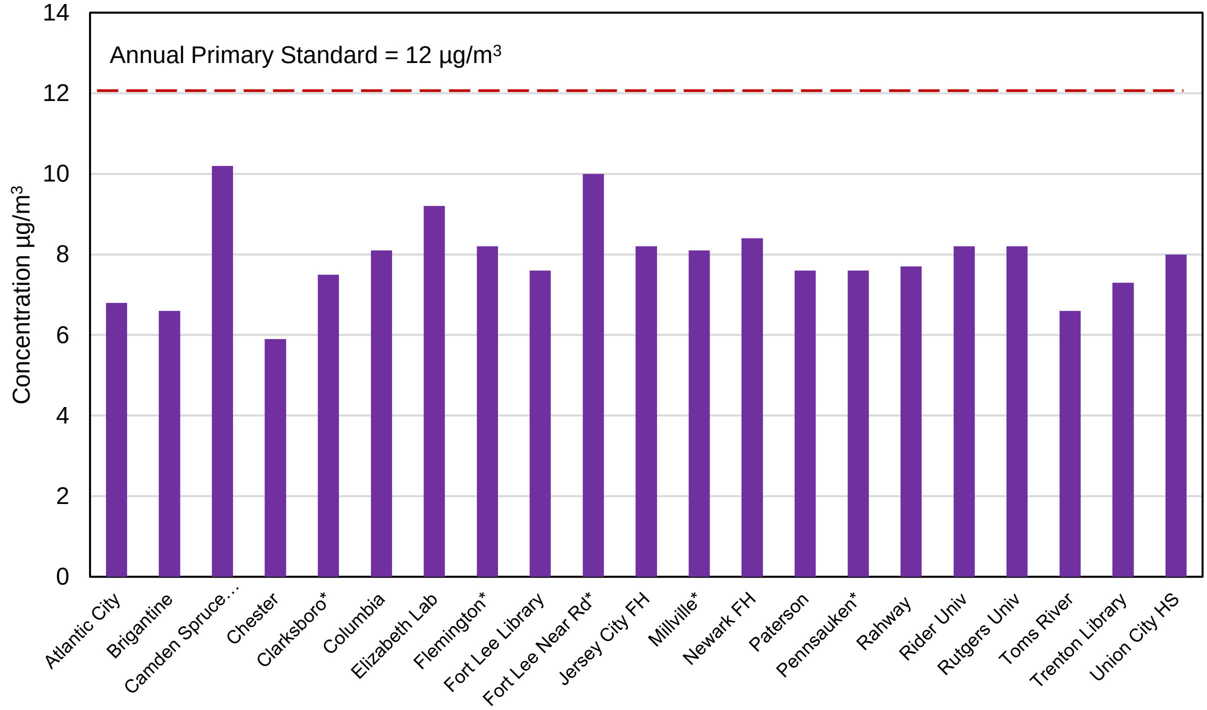
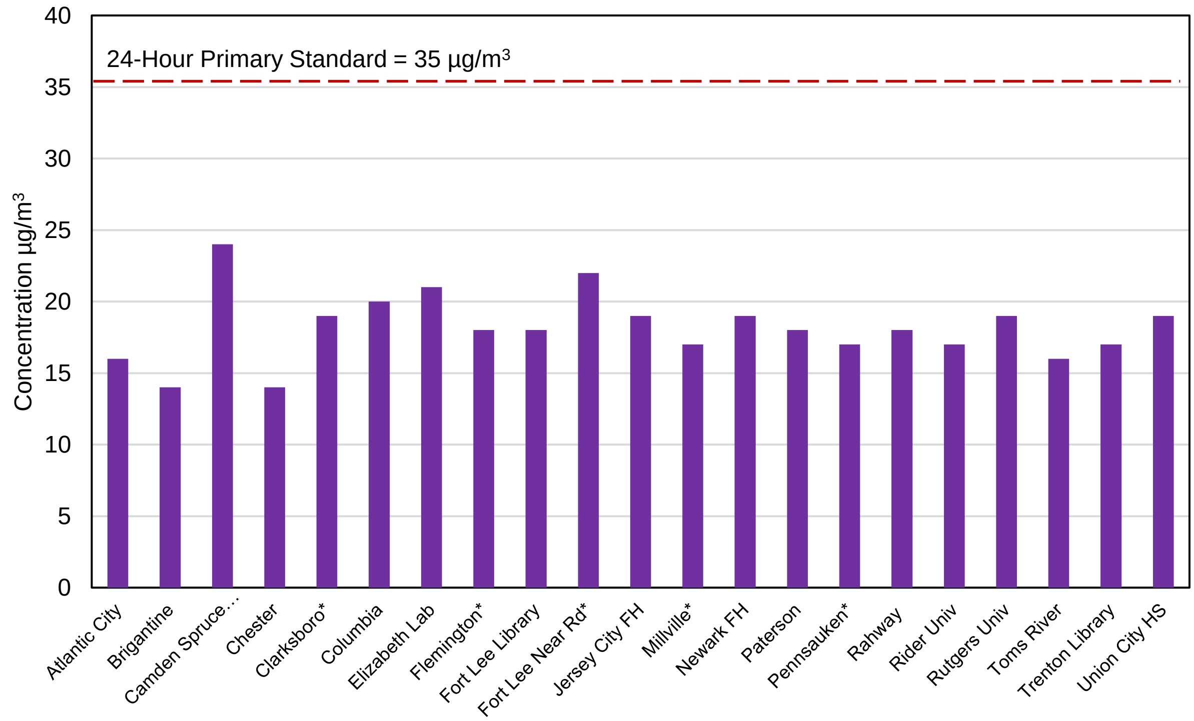


Figure 5-9
New Jersey $PM_{2.5}$ Design Values for 2016-2018
3-Year Average of the 98th Percentile of the 24-Hour Average Concentrations
Micrograms Per Cubic Meter (µg/m³)



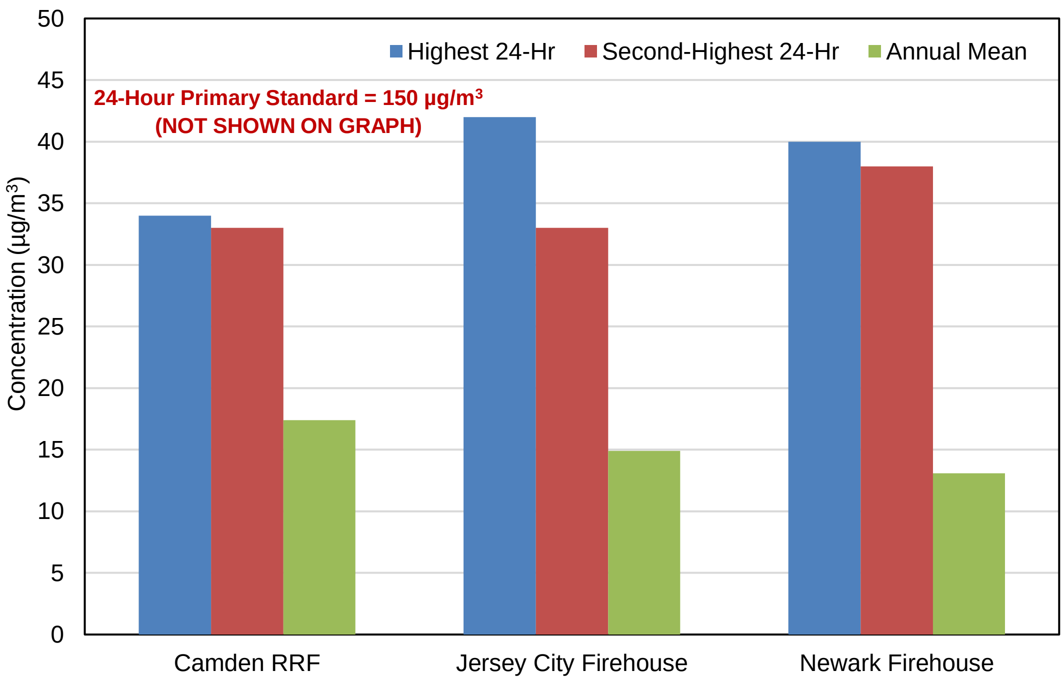
INHALABLE PARTICULATE (PM_{10}) LEVELS IN 2018

Table 5-5 shows 2018 values for each of the New Jersey PM_{10} monitors. The highest and second-highest 24-hour concentrations, as well as the annual average, are presented. All areas of the state are in attainment for the 24-hour standard of 150 µg/m³, as can be seen in Figure 5-10. The standard is based on the second-highest 24-hour value.

Table 5-5
2018 PM_{10} Concentrations in New Jersey
24-Hour and Annual Averages
Micrograms Per Cubic Meter (µg/m³)

Monitoring Site	Number of Samples	Annual Average	24-Hour Average	
			Highest	Second-Highest
Camden RRF	45	17.4	34	33
Jersey City Firehouse	58	14.9	42	33
Newark Firehouse	114	13.1	40	38

Figure 5-10
2018 PM_{10} Concentrations in New Jersey
Maximum 24-Hour Averages & Annual Mean
Micrograms per Cubic Meter (µg/m³)



PARTICULATE TRENDS

The $PM_{2.5}$ monitoring network in New Jersey has been in place since 1999. Figures 5-11 and 5-12 show the 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
$PM_{2.5}$ Design Value Trend in New Jersey, 2001-2018
3-Year Average of the Annual Average Concentrations
Micrograms per Cubic Meter (µg/m³)

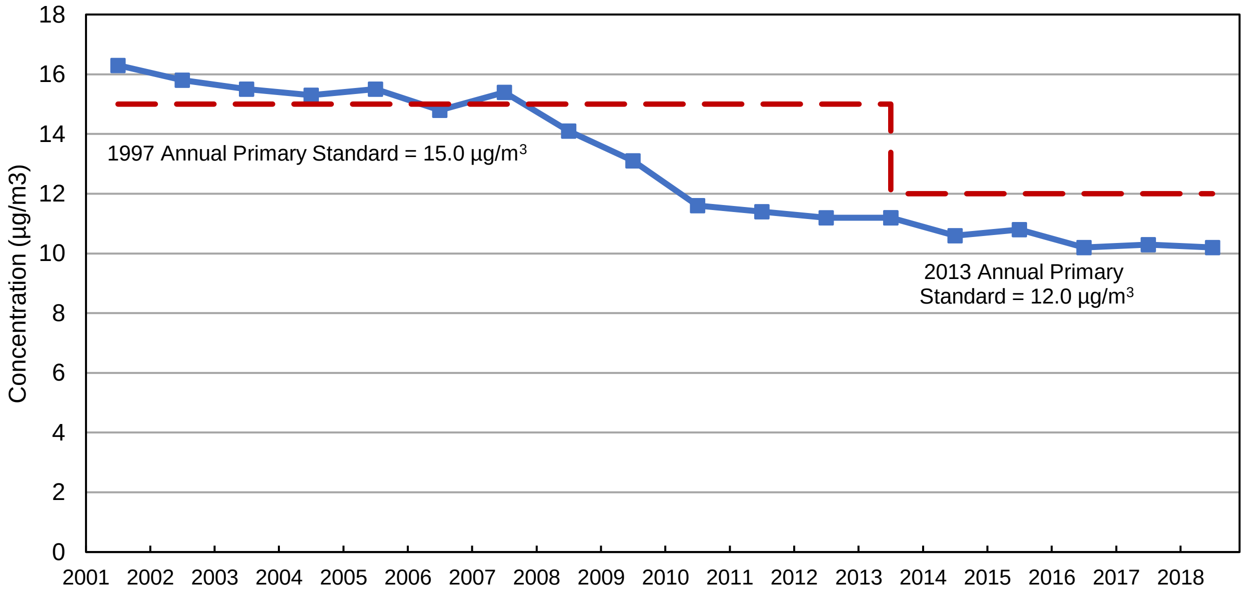
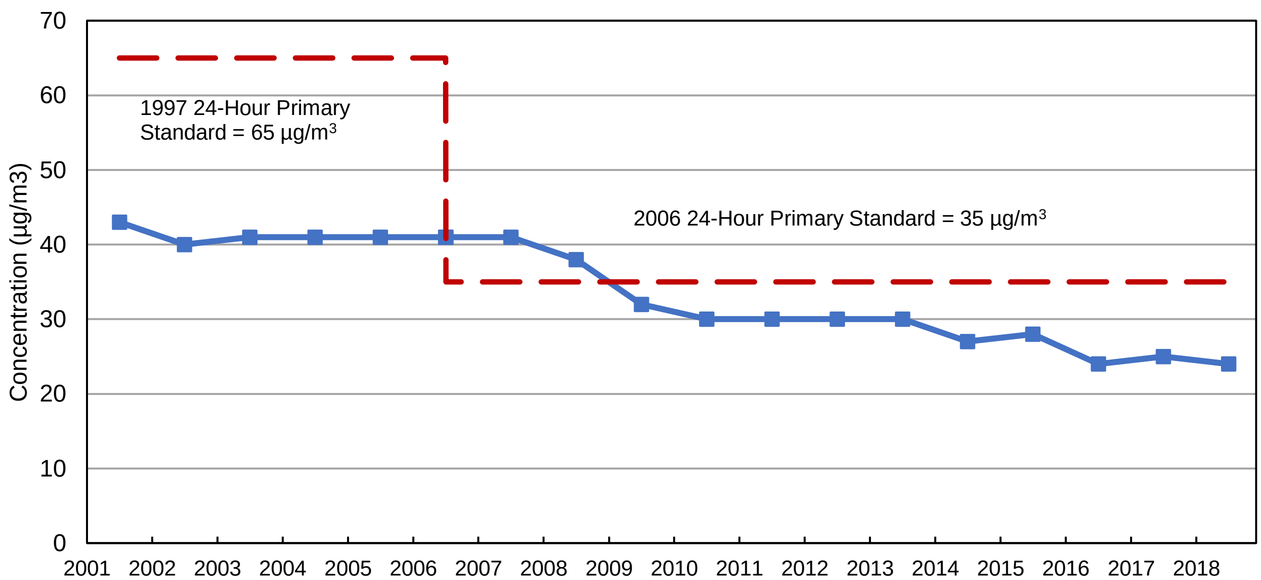
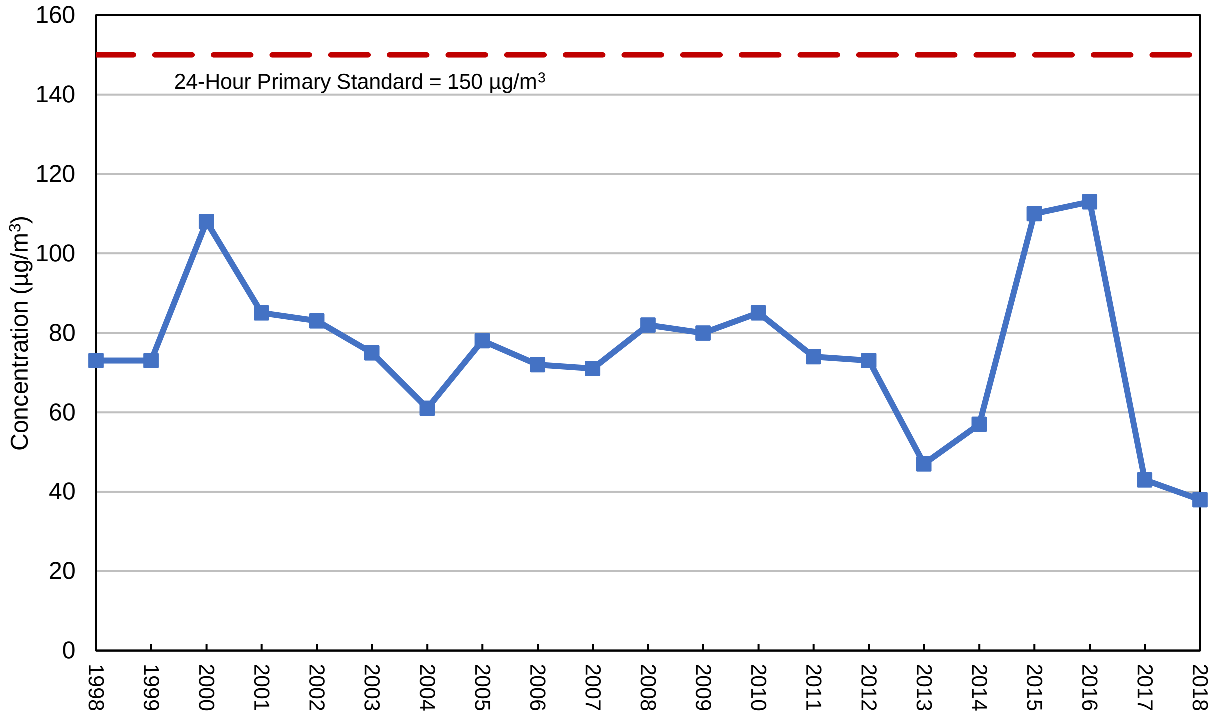


Figure 5-12
$PM_{2.5}$ Design Value Trend in New Jersey, 2001-2018
3-Year Average of the 98th Percentile 24-Hour Average Concentrations
Micrograms per Cubic Meter (µg/m³)



The PM_{10} design value trend is shown in Figure 5-13. The increase in concentration in 2015 and 2016 occurred at the Camden Spruce Street monitor, during a period of major road construction.

Figure 5-13
PM_{10} Design Value Trend in New Jersey, 1998-2018
2nd-Highest 24-Hour Average Concentrations
Micrograms per Cubic Meter (µg/m³)



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2018 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 6-1
2017 New Jersey NO_x Estimated Annual Emissions

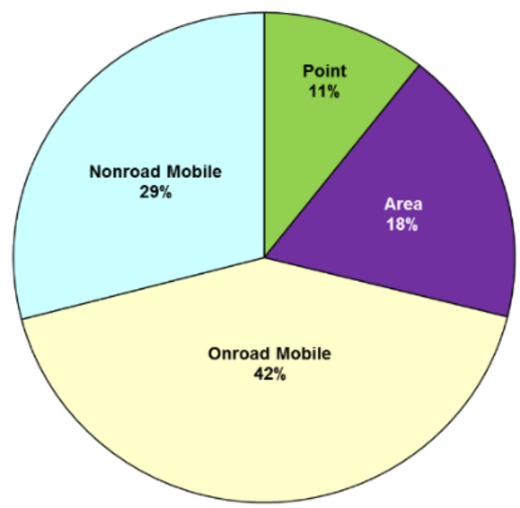
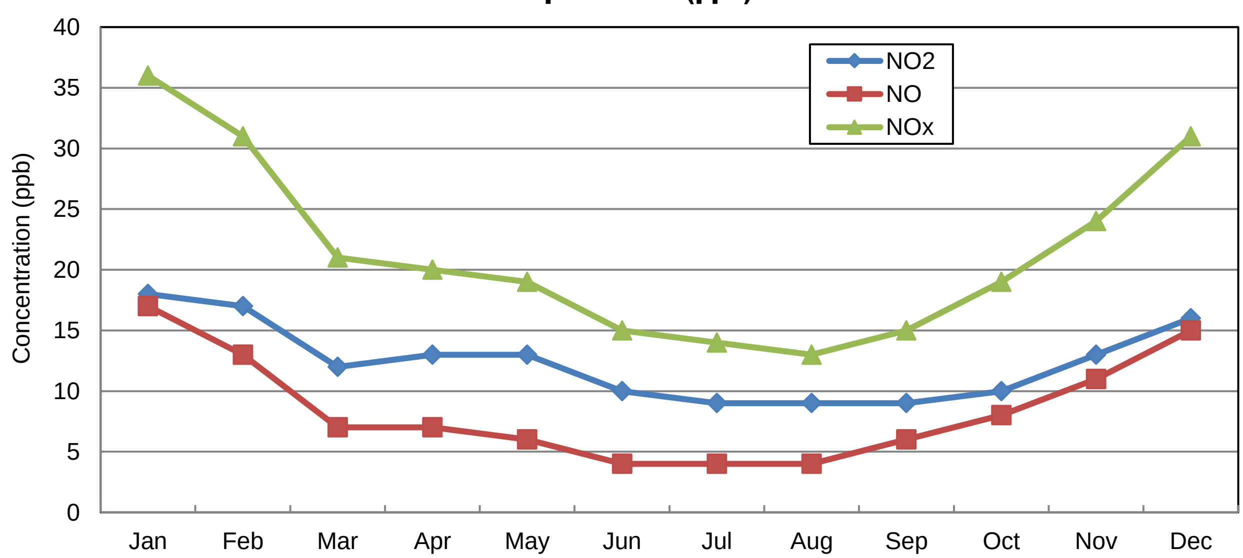


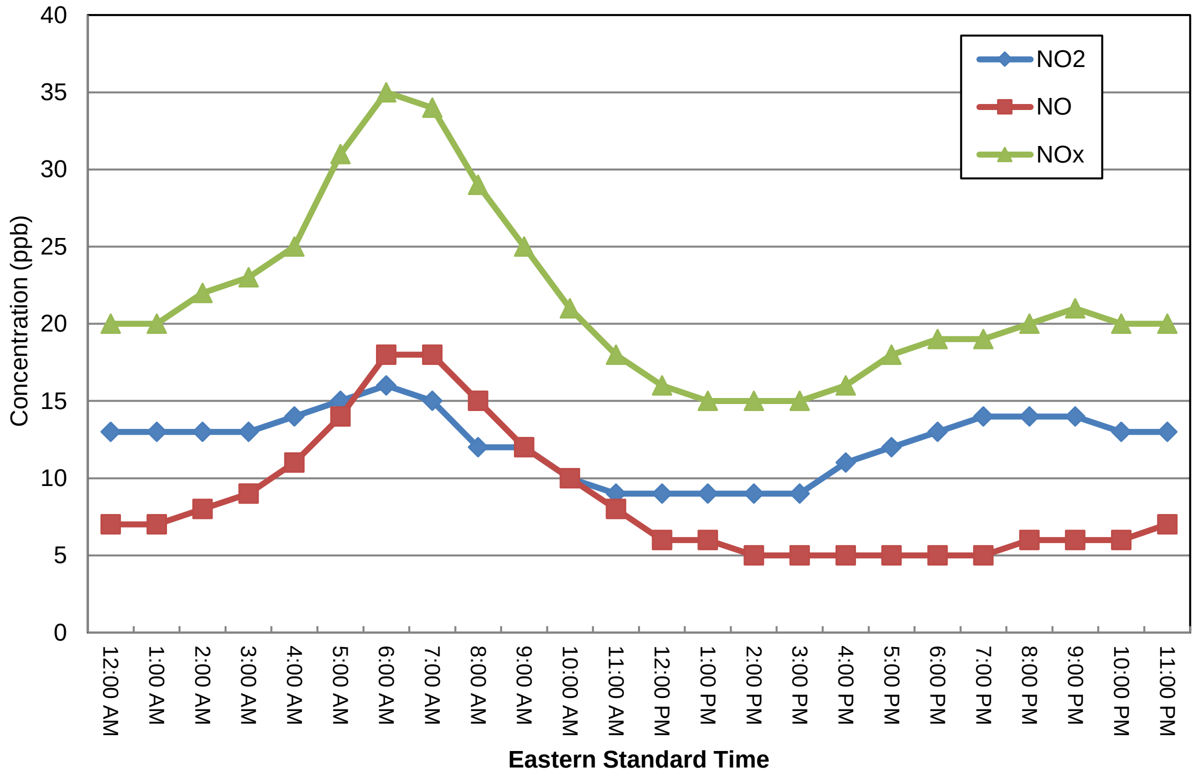
Figure 6-2 shows that NO_x concentrations tend to be higher in the winter than in the summer. This is due in part to heating of buildings, and to weather conditions that are more prevalent in the colder months of the year, such as lighter winds that result in poorer local dispersion conditions.

Figure 6-2
2018 Nitrogen Oxides Concentrations in New Jersey
Average 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
2018 Nitrogen Oxides Concentrations in New Jersey
1-Hour Average Hourly 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 are 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 ($\mu g/m^3$) 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 (NO_2)
Parts per Billion (ppb)
Parts per Million (ppm)
Micrograms per Cubic Meter ($\mu g/m^3$)

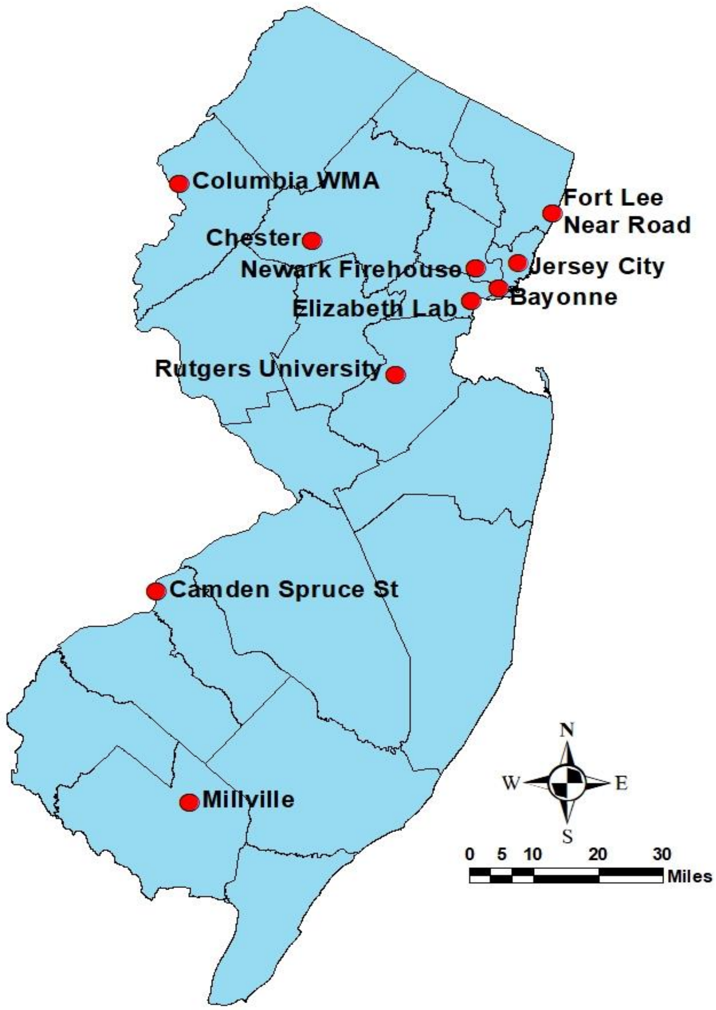
Averaging Period	Type	National	New Jersey
1-Hour	Primary	100 ppb (0.100 ppm)	---
Annual	Primary & secondary	53 ppb (0.053 ppm)	---
12-Month	Primary & secondary	---	100 $\mu g/m^3$ (0.053 ppm)

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 2018. 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.

Figure 6-4
2018 Nitrogen Dioxide Monitoring Network



NO_2 LEVELS IN 2018

There was one exceedance of a NO_2 NAAQS in 2018. The Fort Lee Near Road monitoring station had a daily maximum 1-hour concentration of 131 ppb on January 3 (see Table 6-2 and Figure 6-5). This is much higher than the next-highest 1-hour value (85 ppb at Jersey City), and is attributed to vehicles idling near the site.

The 98^{th}-percentile values for each monitoring station are also shown in Table 6-2 and Figure 6-5. The design value for NO_2, which determines whether or not there is a violation of the NAAQS, is actually the 3-year average of the 98^{th}-percentile of the 1-hour daily maximum concentrations. The 2016-2018 design value for each site is given in Table 6-2 and Figure 6-6. The site with the highest design value for 2016-2018 was Fort Lee Near Road, with 63 ppb. The design value for Millville station had incomplete data for the three-year period (see Table 6-2 footnote).

Table 6-2
2018 Nitrogen Dioxide Concentrations in New Jersey
1-Hour Averages
Parts per Billion (ppb)

Monitoring Site	1-Hour Average (ppb) Daily Maximum	98th-Percentile	2016-2018 98th-%ile 3-Yr Avg
Bayonne	84	56	57
Camden Spruce St.	54	45	48
Chester	47	31	32
Columbia	45	41	44
Elizabeth Trailer	84	61	60
Fort Lee Near Road	131	68	63
Jersey City	85	58	54
Millville*	38	32	33*
Newark Firehouse	77	52	55
Rutgers University	50	42	41

*Millville was temporarily shut down February through June in 2016. Since it does not have three complete years of data for 2016 to 2018, it does not meet the design value criteria for NO_2.

Figure 6-5
2018 Nitrogen Dioxide Concentrations in New Jersey
Daily Maximum 1-Hour Values
Parts per Billion (ppb)

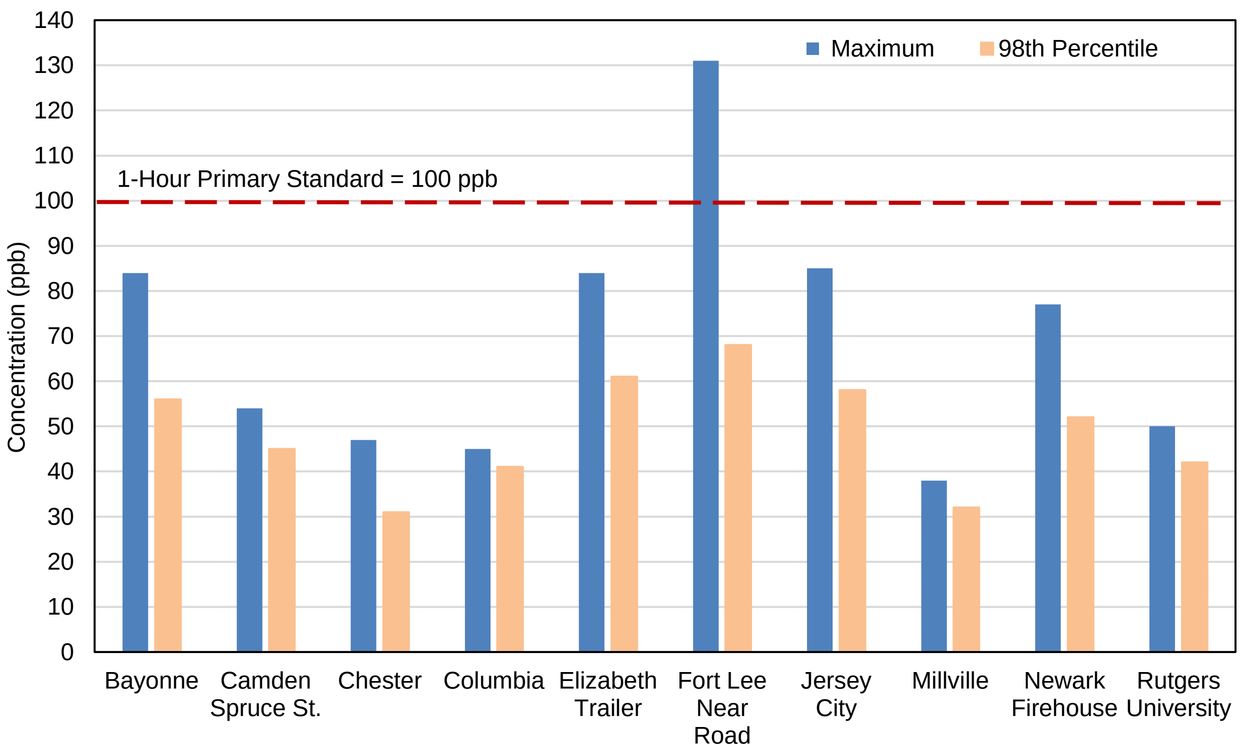
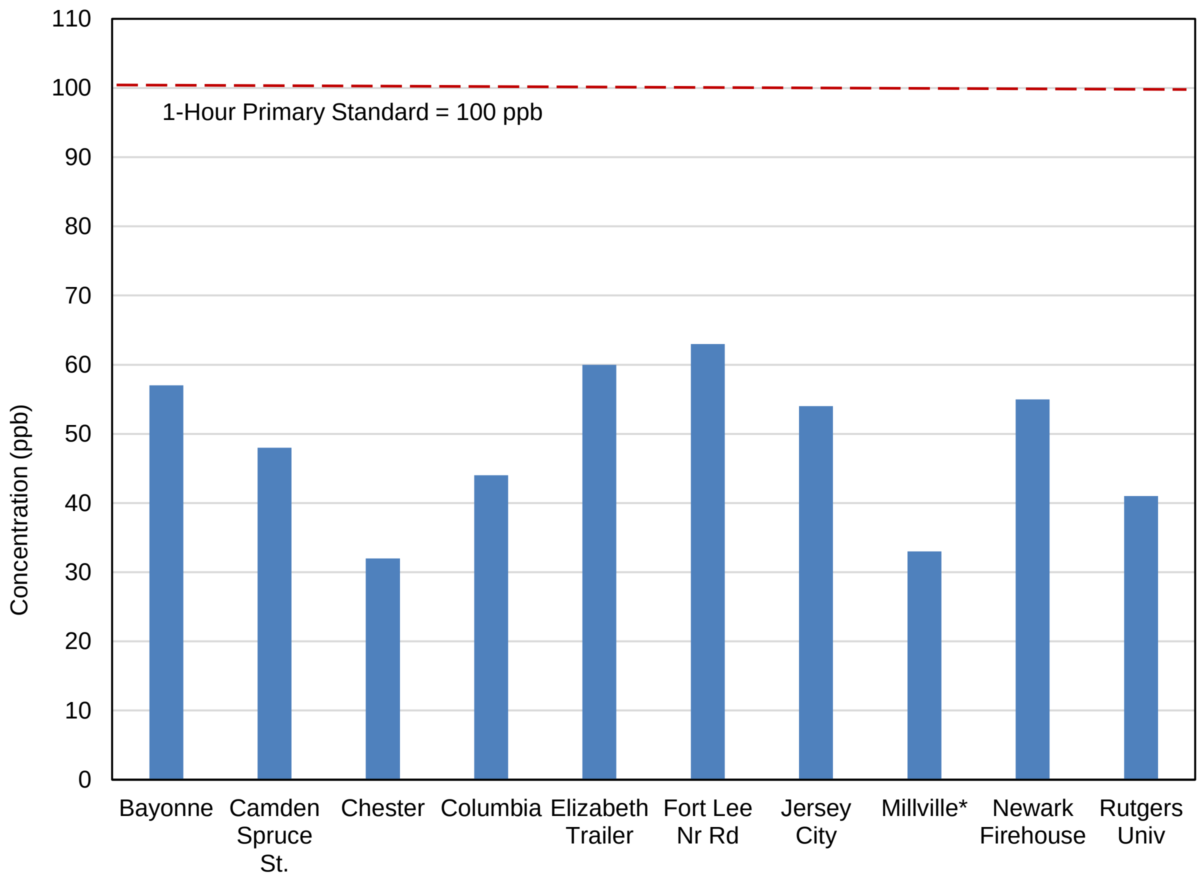


Figure 6-6
2018 Nitrogen Dioxide Design Values in New Jersey
3-Year Average of the 98th-Percentile Daily Maximum 1-Hour Concentrations (2016-2018)
Parts per Billion (ppb)



***Note:** 2016-2018 data for Millville is incomplete and does not meet design value requirements. See Table 6-2 for details.

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 6-7, the highest calendar-year average of 19 ppb occurred at two sites, the Jersey City monitoring station on J.F.Kennedy Boulevard near Journal Square, and the Elizabeth Lab monitoring station at Exit 13 of the New Jersey Turnpike. The highest running 12-month average NO_2 concentration of 22 ppb was measured at the Jersey City site. These values are well below the standards.

Table 6-3
2018 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	16	16
Camden Spruce Street	11	12
Chester	3	3
Columbia	9	10
Elizabeth Lab	19	20
Fort Lee Near Road	17	18
Jersey City	19	22
Millville	5	6
Newark Firehouse	14	15
Rutgers University	8	8

Figure 6-7
2018 Nitrogen Dioxide Design Values in New Jersey
Annual (12-Month) Average Concentrations
Parts per Billion (ppb)

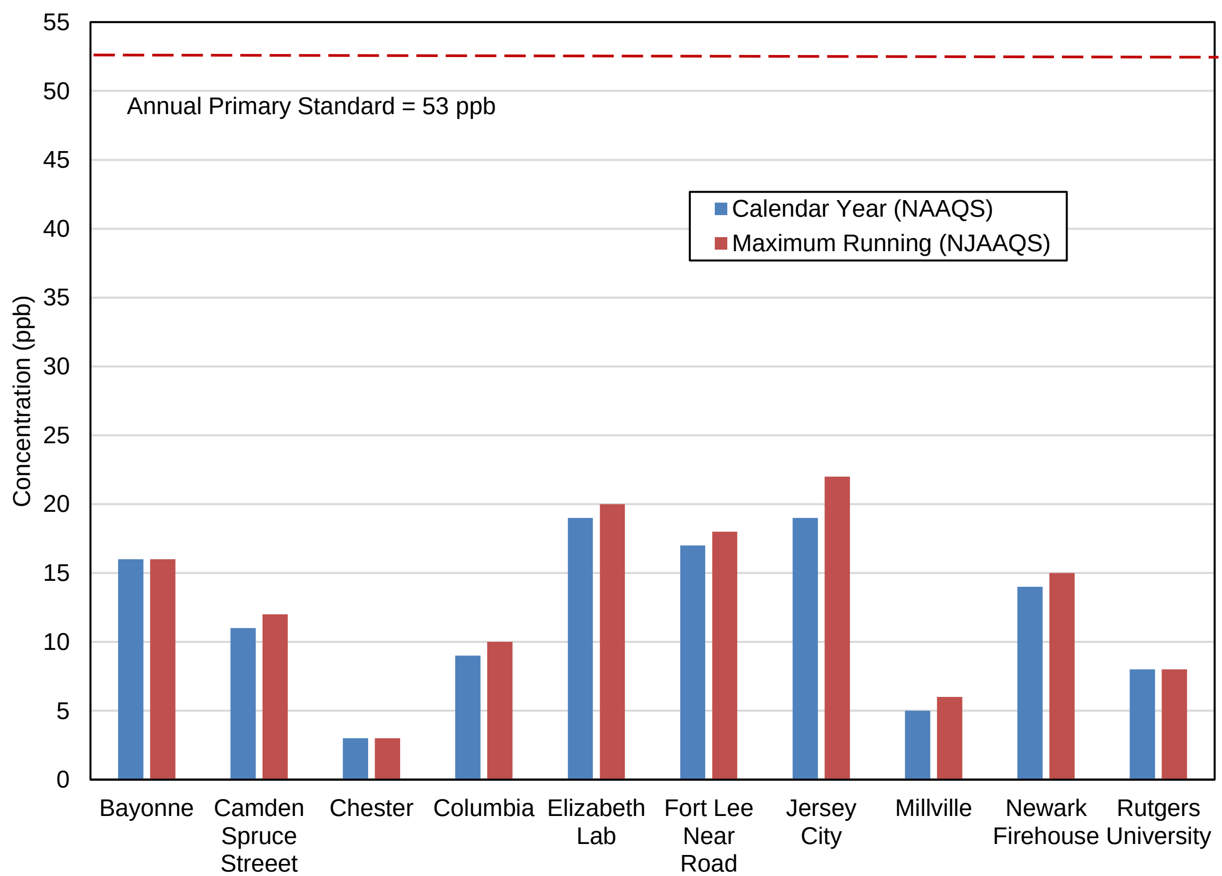
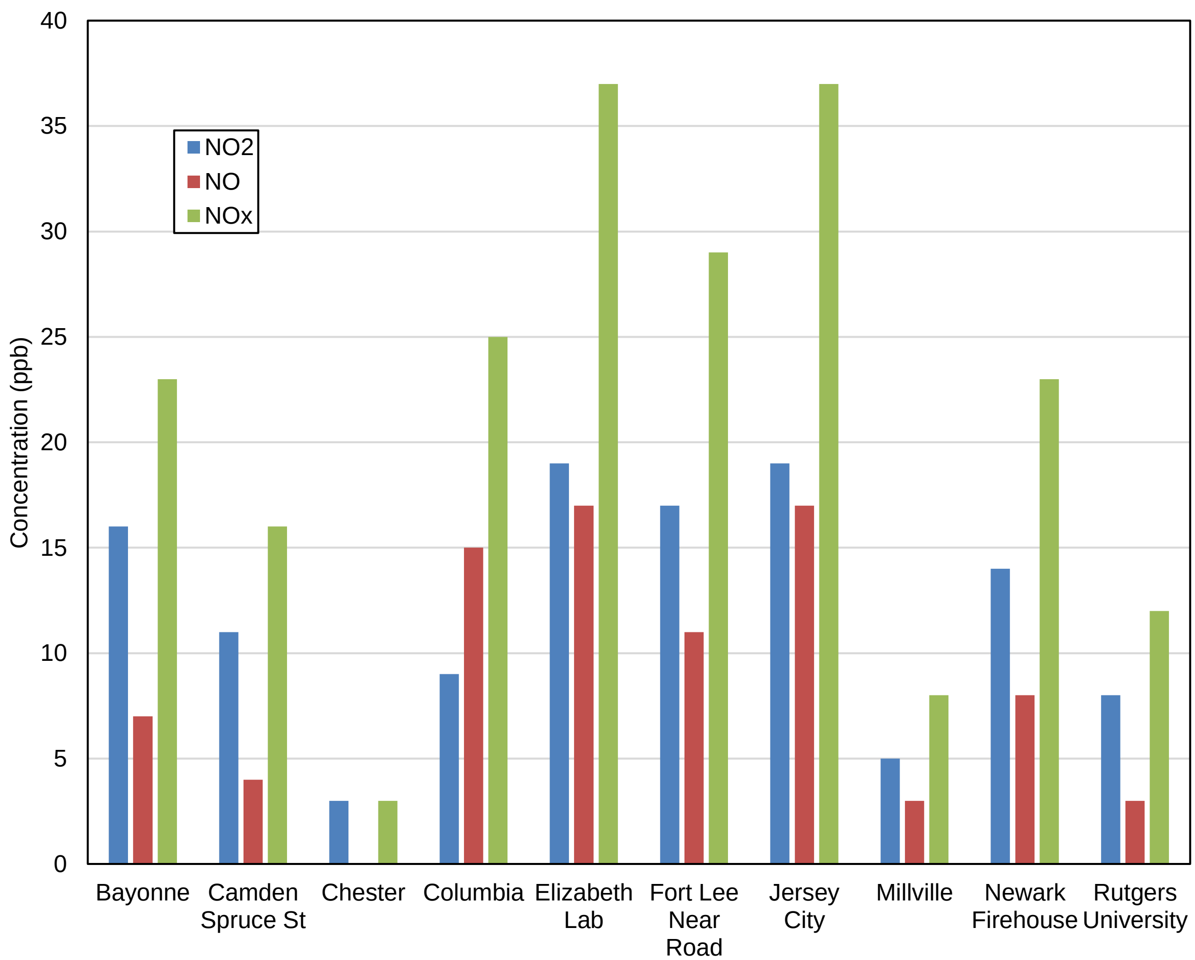


Figure 6-8 shows the calendar-year annual average concentrations of NO_2, NO and NO_x at each New Jersey monitoring site. The stations that measure NO_2 concentrations also measure NO and NO_x, even though there are no ambient air standards for them. NO_x levels are approximately (not exactly) the sum 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 6-8
2018 Nitrogen Oxides Concentrations in New Jersey
Calendar-Year Annual Averages
Parts per Billion (ppb)



Note: The annual average concentration of NO at Chester was 0 ppb.

NO_2 TRENDS

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 2018. 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 of these 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.

Figure 6-10 shows the statewide highest 98th-percentile values of the daily maximum one-hour concentrations of NO_2 for the years 2000 to 2018 in New Jersey. Even though in 2018 the highest 1-hour New Jersey value exceeded the NAAQS of 100 ppb (at Fort Lee Near Road), the 98th-percentile value was below that at 68 ppb.

Figure 6-11 shows the New Jersey design values for the 1-hour NAAQS for the years 2000-2018. 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 each New Jersey monitoring site. New Jersey has not violated the 1-hour NAAQS since it was implemented in 2010.

Figure 6-9
Nitrogen Dioxide Concentrations in New Jersey, 1990-2018
Highest Annual (Calendar Year) Averages
Parts per billion (ppb)

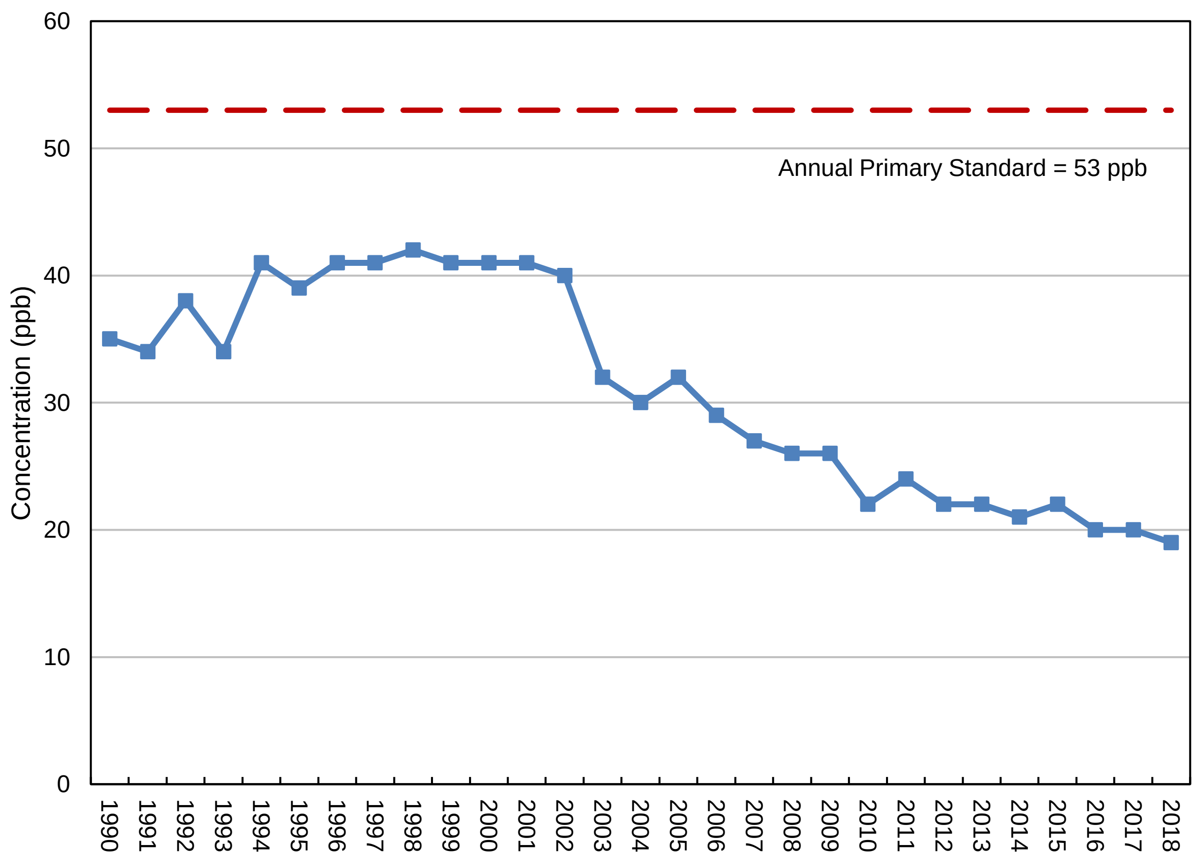


Figure 6-10
Nitrogen Dioxide Concentrations in New Jersey, 2000-2018
98th-Percentile of the Daily Maximum 1-Hour Concentrations
Parts per Billion (ppb)

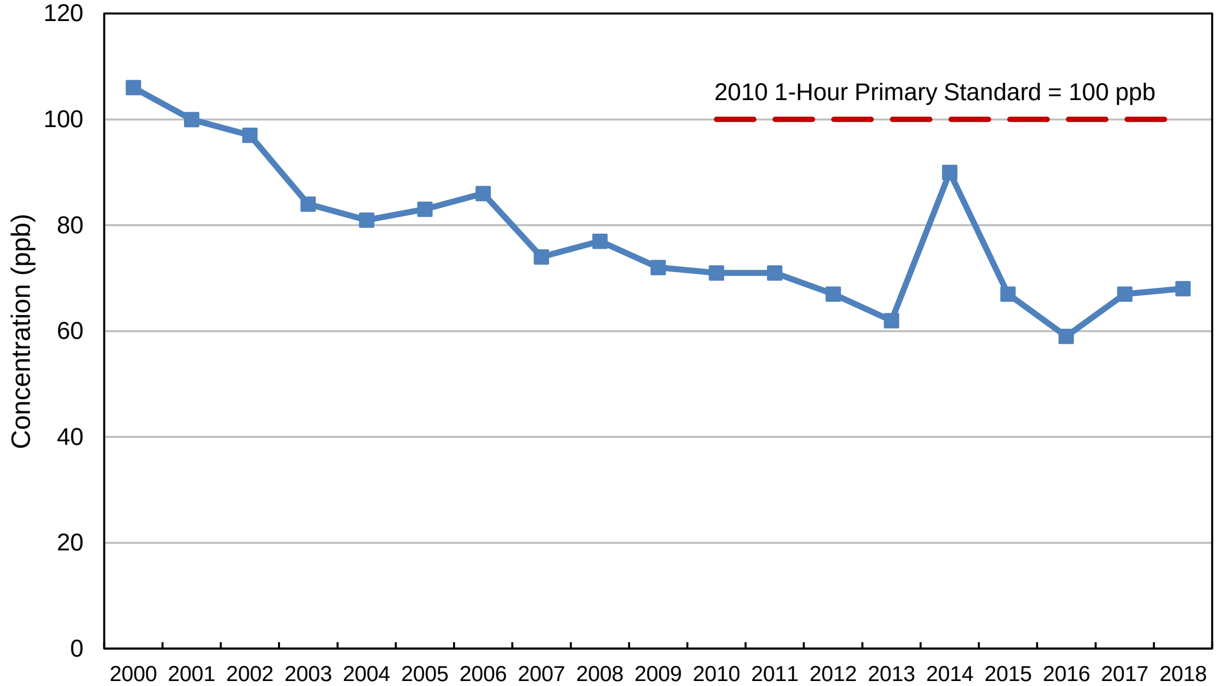
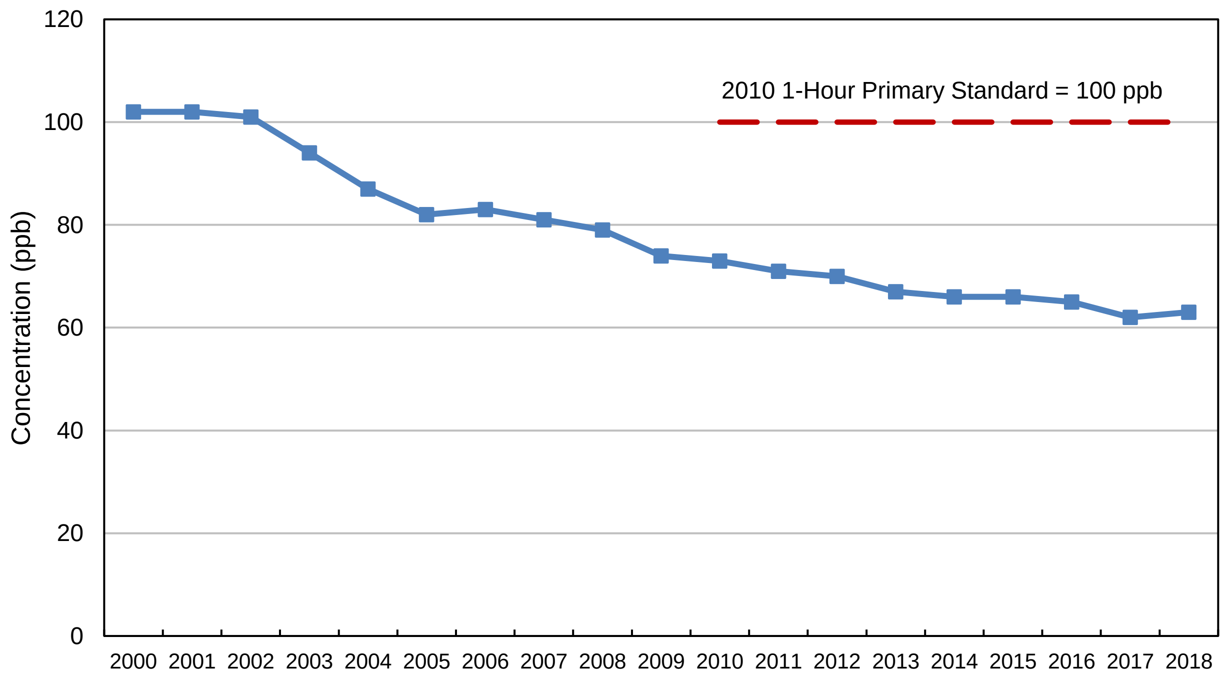


Figure 6-11
Nitrogen Dioxide Design Value Trend in New Jersey, 2000-2018
3-Year Average of the 98th-Percentile Daily Maximum 1-Hour Concentrations
Parts per Billion (ppb)



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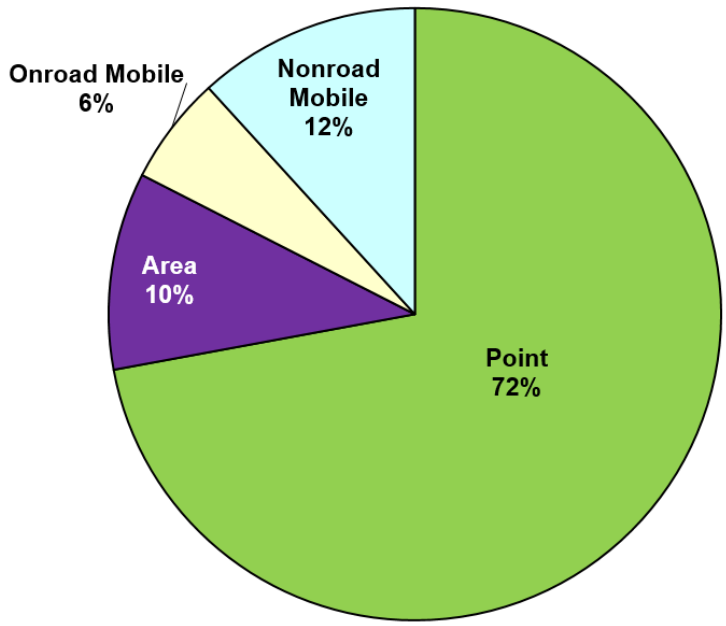
2018 Sulfur Dioxide Summary

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 Estimated 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.

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 expressed in micrograms per cubic meter ($\mu g/m^3$) as well as ppm, and 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.

Table 7-1
National and New Jersey Ambient Air Quality Standards for Sulfur Dioxide (SO_2)
Parts per Billion (ppb)
Parts per Million (ppm)
Micrograms per Cubic Meter ($\mu g/m^3$)

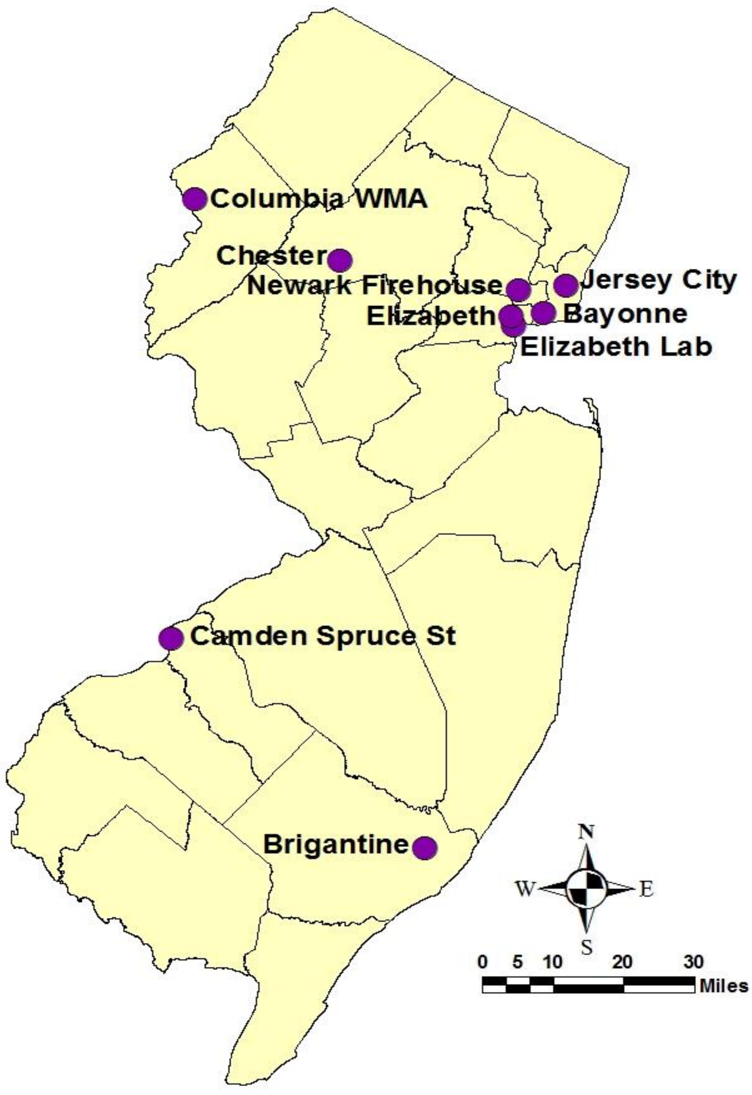
Averaging Period	Type	National	New Jersey[a]
1–hour[b]	Primary	75 ppb	---
3–hours	Secondary	0.5 ppm[c]	1300 $\mu g/m^3$ (0.5 ppm)
24–hours[d]	Primary	---	365 $\mu g/m^3$ (0.14 ppm)
24–hours[d]	Secondary	---	260 $\mu g/m^3$ (0.10 ppm)
12–months	Primary	---	80 $\mu g/m^3$ (0.03 ppm)
12–months	Secondary	---	60 $\mu g/m^3$ (0.02 ppm)

[a] Based on running averages, over any 12 consecutive months in a year.
[b] To meet this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour averages at each monitor within the state must not exceed 75 ppb.
[c] Based on successive non-overlapping blocks, beginning at midnight each day.
[d] Not to be exceeded more than once in a year.

SO_2 MONITORING NETWORK

The New Jersey Department of Environmental Protection (NJDEP) monitored SO_2 levels at nine sites in 2018. 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.

Figure 7-2
2018 Sulfur Dioxide
Monitoring Network



SO_2 LEVELS IN 2018

In 2018, there were no exceedances of the 1-hour NAAQS of 75 ppb. See Table 7-2 and Figures 7-3 and 7-4. Camden Spruce Street had the highest 1-hour value of 15.2 ppb and the highest 99th percentile value of 6.9 ppb. The highest design value, the 3-year average of the 99th-percentile of the daily maximum 1-hour SO_2 concentrations, was 7 ppb at Camden Spruce Street. This is the result of some very high values recorded at the Camden site in 2016, including two exceedances of the NAAQS, possibly due to port activity on the Delaware River.

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 3-hour block and running averages were measured at Columbia, at 0.0092 ppm and 0.0099 ppm, respectively. However, the second-highest 3-hour averages were recorded at Camden Spruce Street. The block average was 0.0055 ppm, and the running average was 0.0070 ppm. Results are shown in Table 7-3 and Figure 7-5.

No monitoring sites had exceedances of the New Jersey 24-hour (0.14 ppm) or 12-month (0.03 ppm) SO_2 standards during 2018. The highest and second-highest 24-hour average concentrations were 0.0046 and 0.0036 ppm, measured at the Columbia station. Jersey City was close behind with values of 0.0042 and 0.0035 ppm. The highest 12-month running average concentration of 0.0006 ppm was recorded at Jersey City. See Tables 7-4 and 7-5, and Figures 7-6 and 7-7 for data for the other monitoring sites.

Table 7-2
2018 Sulfur Dioxide Concentrations in New Jersey
Daily Maximum and 99th Percentile 1-Hour Averages
Parts per Billion (ppb)

Monitoring Site	1-Hour Average (ppb)			2016-2018 Design Value[a]
	Highest Daily Maximum	2nd-Highest Daily Maximum	99th Percentile Daily Maximum	
Bayonne	7.9	5.8	5.2	4
Brigantine	2.0	1.9	1.6	3
Camden Spruce St.	15.2	13.7	6.9	7
Chester	3.6	3.6	3.1	4
Columbia	10.8	8.0	6.3	6
Elizabeth	6.2	5.5	4.6	4
Elizabeth Lab	12.8	9.3	6.8	6
Jersey City	6.4	6.3	4.8	5
Newark Firehouse	8.4	4.9	3.5	3

[a] 3-Year (2016-2018) average of the 99th percentile 1-hour daily maximum concentrations.

Figure 7-3
2018 Sulfur Dioxide Concentrations in New Jersey
1-Hour Averages
Parts per Billion (ppb)

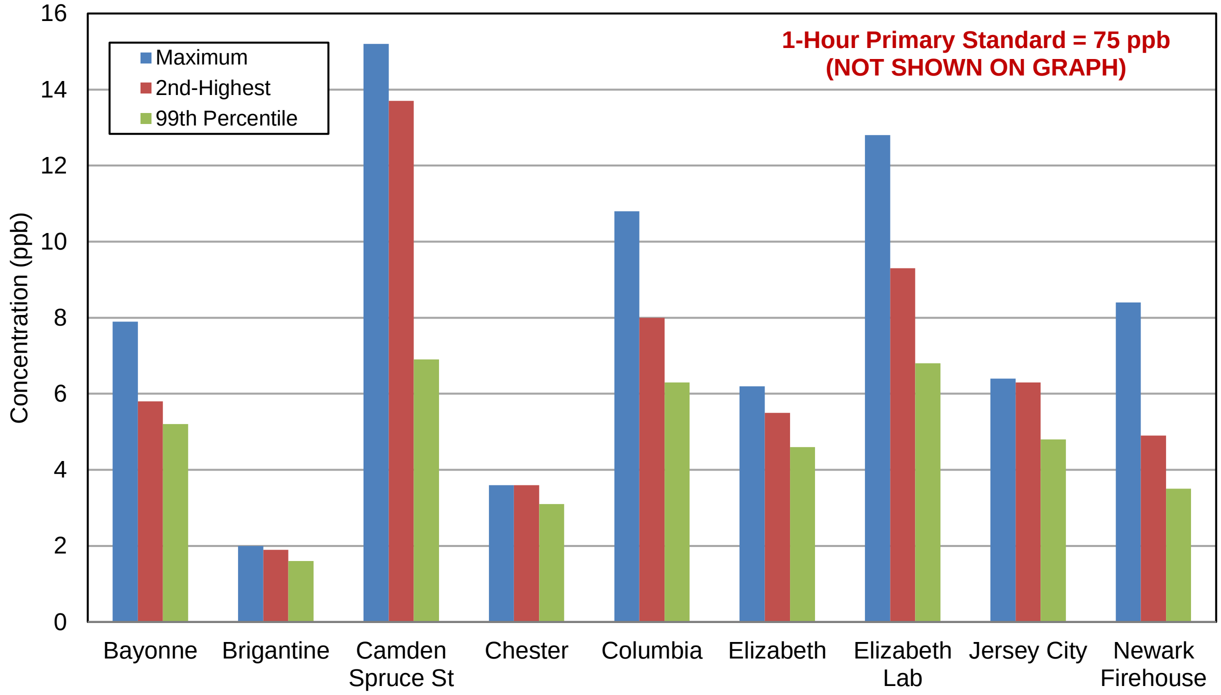


Figure 7-4
New Jersey Sulfur Dioxide Design Values for 2016-2018
3-Year Average of the 99th Percentile of the 1-Hour Daily Maximum Concentrations
Parts per Billion (ppb)

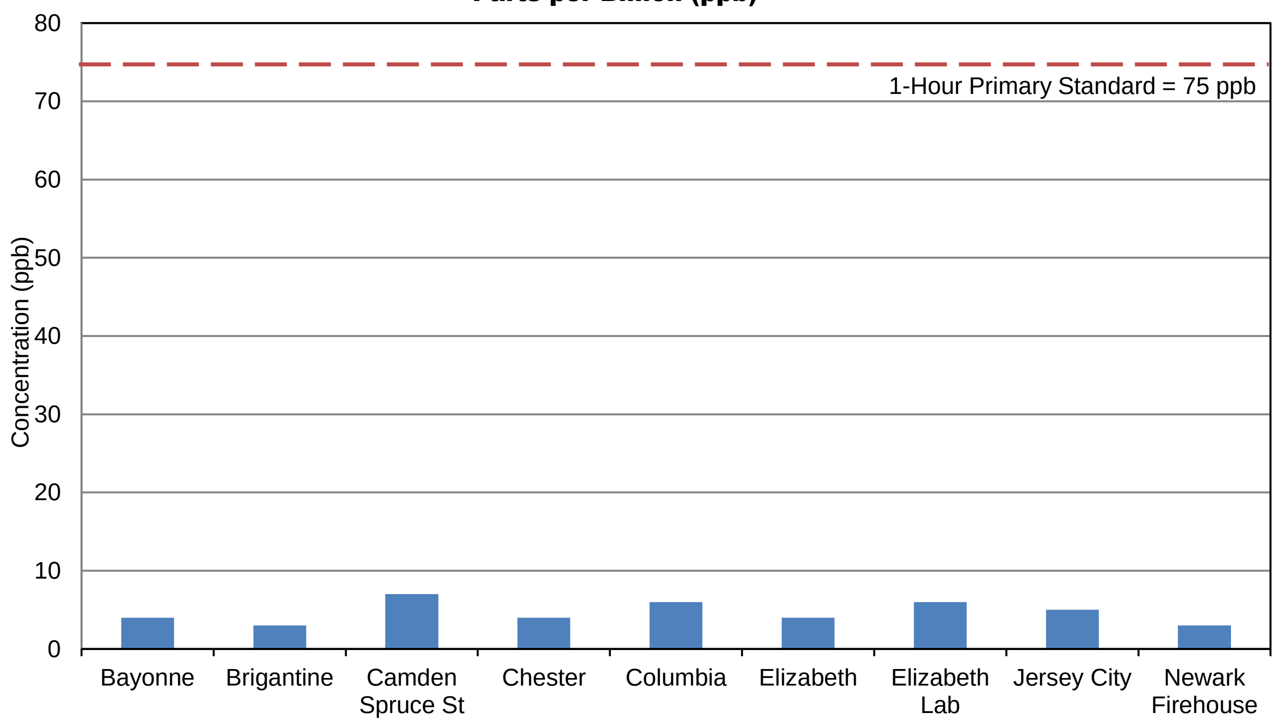


Table 7-3
2018 Sulfur Dioxide Concentrations in New Jersey
3-Hour Averages
Parts per Million (ppm)

Monitoring Site	3-Hour Average Concentrations			
	Block[a]		Running[b]	
	Maximum	2nd-Highest	Maximum	2nd-Highest*
Bayonne	0.0042	0.0041	0.0042	0.0041
Brigantine	0.0015	0.0014	0.0015	0.0015
Camden Spruce	0.0082	0.0055	0.0082	0.0070
Chester	0.0030	0.0026	0.0034	0.0029
Columbia	0.0092	0.0049	0.0099	0.0056
Elizabeth	0.0057	0.0051	0.0058	0.0046
Elizabeth Trailer	0.0057	0.0053	0.0057	0.0057
Jersey City	0.0058	0.0047	0.0060	0.0058
Newark Firehouse	0.0056	0.0030	0.0056	0.0033

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

Figure 7-5
2018 Sulfur Dioxide Concentrations in New Jersey
2nd Highest 3-Hour Averages
Parts per Million (ppm)

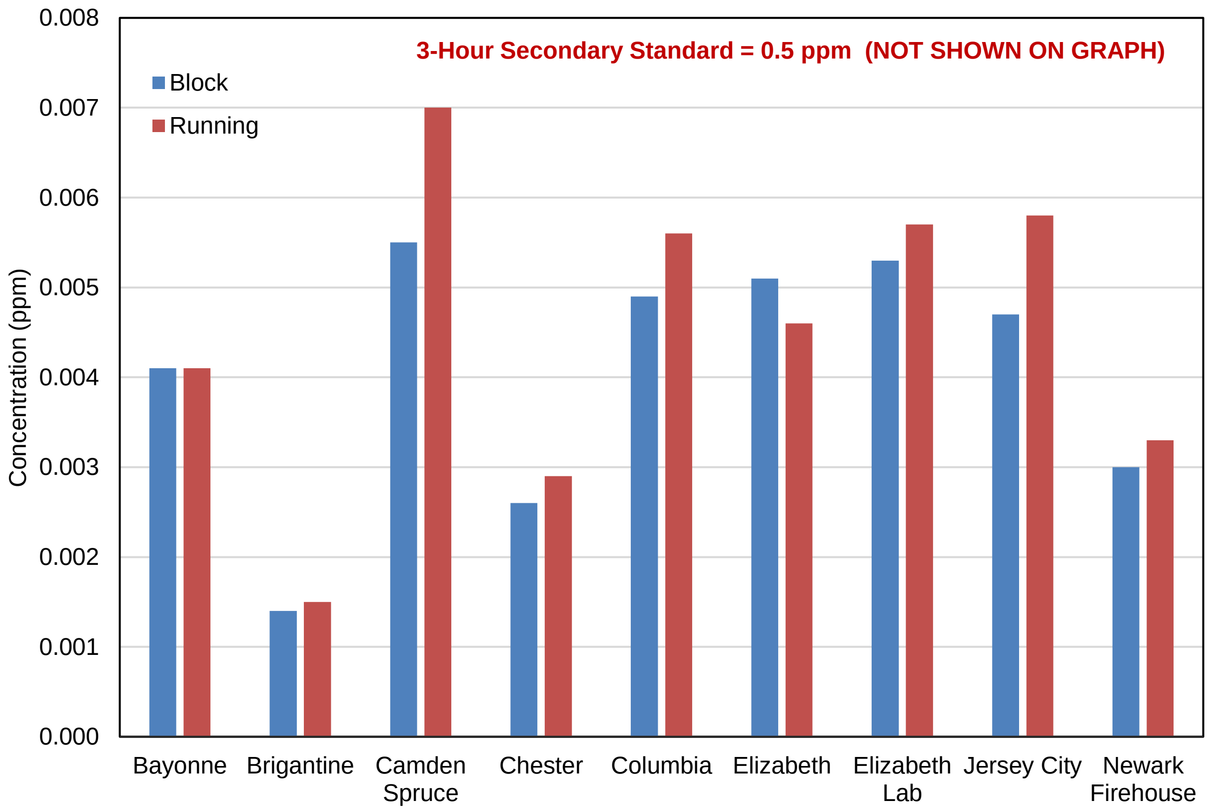


Table 7-4
2018 Sulfur Dioxide Concentrations in New Jersey
24-Hour Averages
Parts per Million (ppm)

Monitoring Site	24-Hour Running Average	
	Maximum	2nd Highest (Non-overlapping)
Bayonne	0.0020	0.0019
Brigantine	0.0009	0.0008
Camden Spruce St.	0.0021	0.0020
Chester	0.0019	0.0016
Columbia	0.0046	0.0036
Elizabeth	0.0039	0.0026
Elizabeth Lab	0.0030	0.0021
Jersey City	0.0042	0.0035
Newark Firehouse	0.0023	0.0016

Figure 7-6
2018 Sulfur Dioxide Concentrations in New Jersey
2nd-Highest 24-Hour Averages
Parts per Million (ppm)

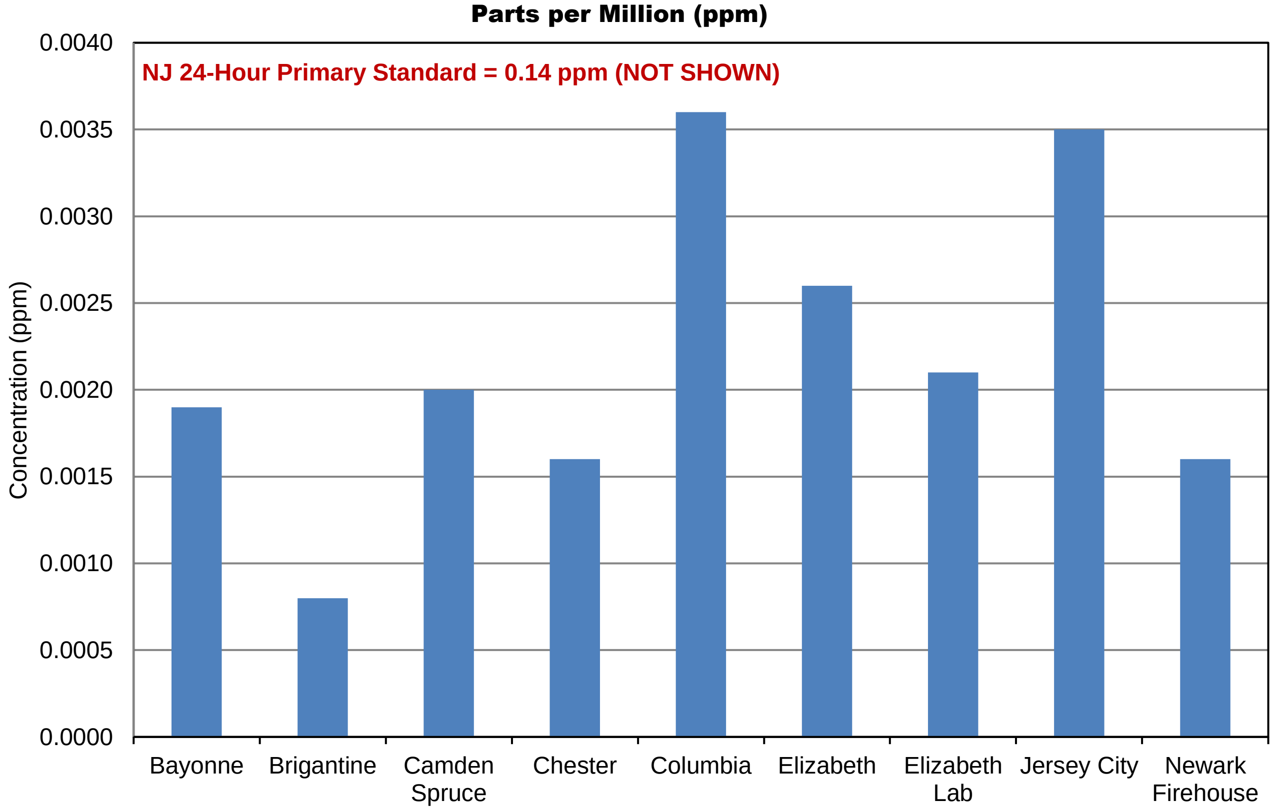
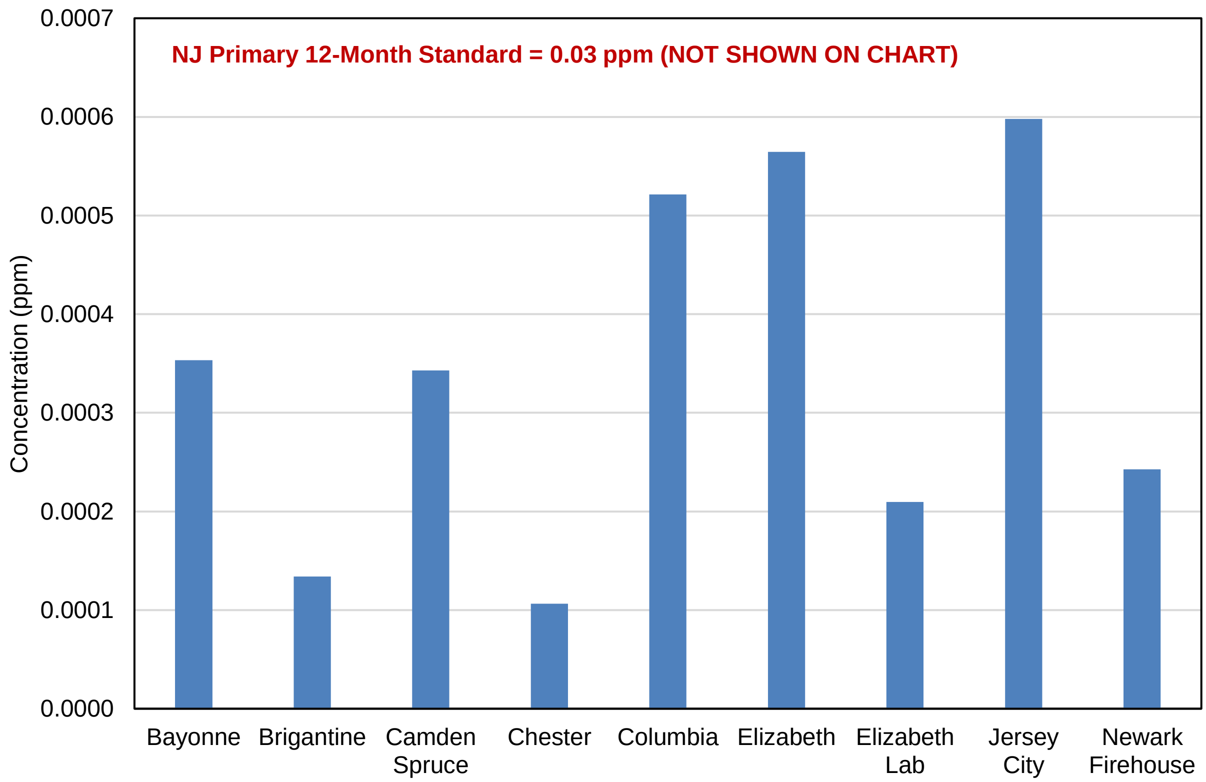


Table 7-5
2018 Sulfur Dioxide Concentrations in New Jersey
Maximum 12-Month Running Averages
Parts per Million (ppm)

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

Figure 7-7
2018 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 7-8 shows the second-highest daily average concentrations of SO_2 recorded in New Jersey each year since 1975. 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 7-9) 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 7-10 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 7-8
Sulfur Dioxide Trend in New Jersey, 1975-2018
2nd-Highest 24-Hour Average Concentrations
Parts per Million (ppb)

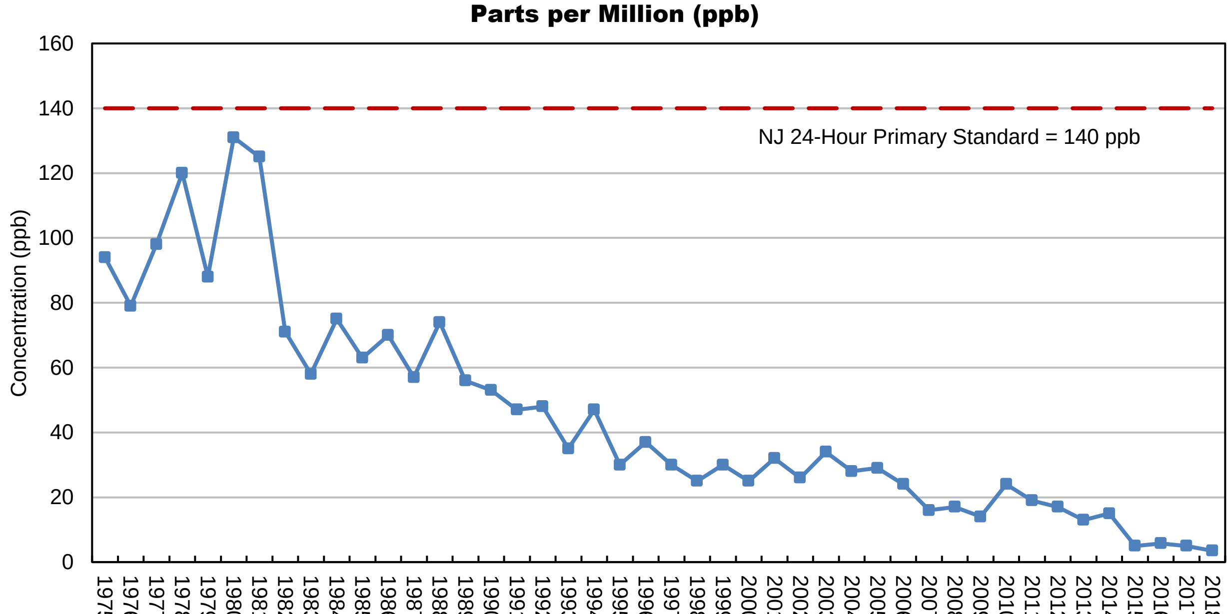


Figure 7-9
Sulfur Dioxide Trend in New Jersey, 2000-2018
99th Percentile of the Daily Maximum 1-Hour Concentrations
Parts per Million (ppb)

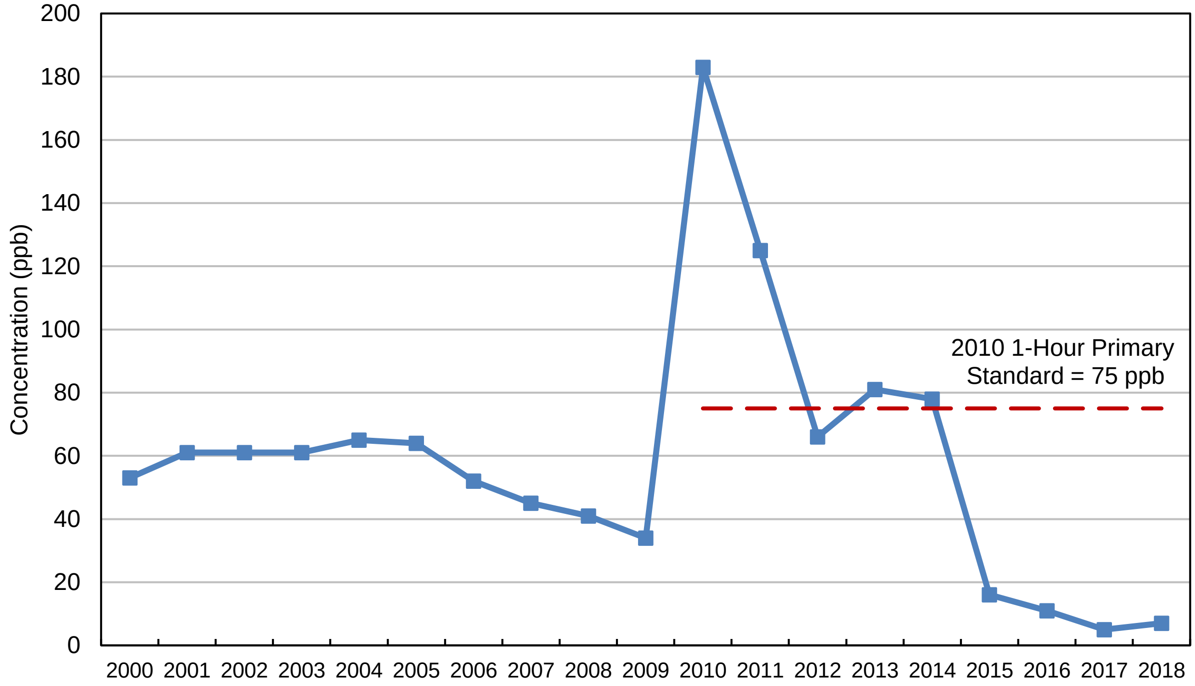
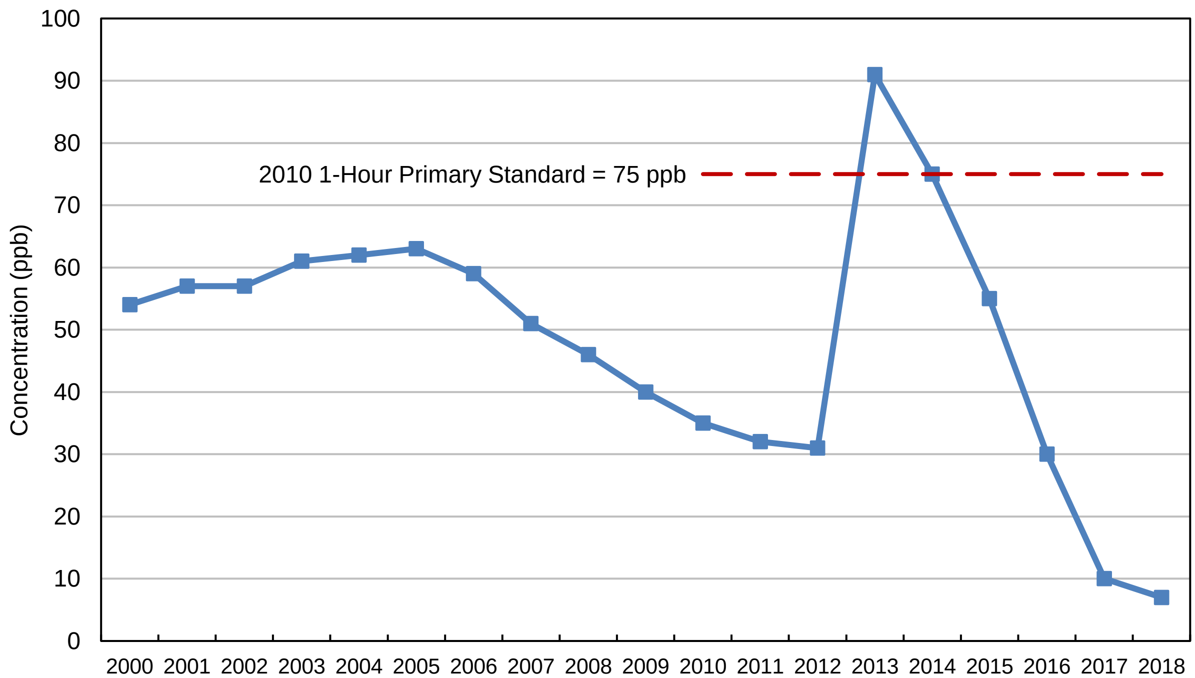


Figure 7-10
Sulfur Dioxide Design Value Trend in New Jersey, 2000-2018
3-Year Average of the 99th Percentile Daily Maximum 1-Hour Concentrations
Parts per Million (ppb)



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USEPA. What is Acid Rain? www.epa.gov/acidrain/what-acid-rain. Accessed 7/1/19.

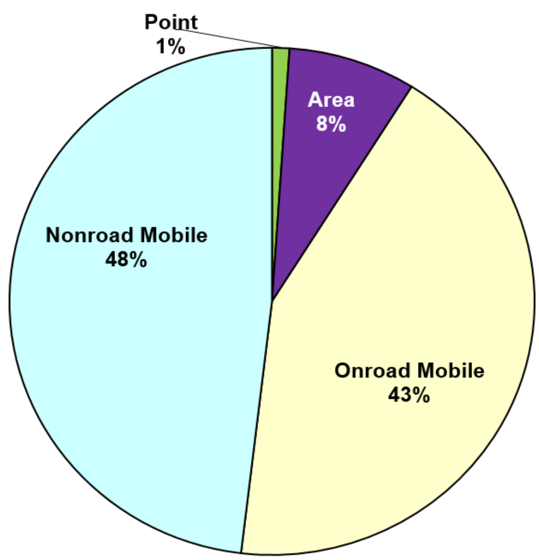
2018 Carbon Monoxide Summary

New Jersey Department of Environmental Protection

Sources

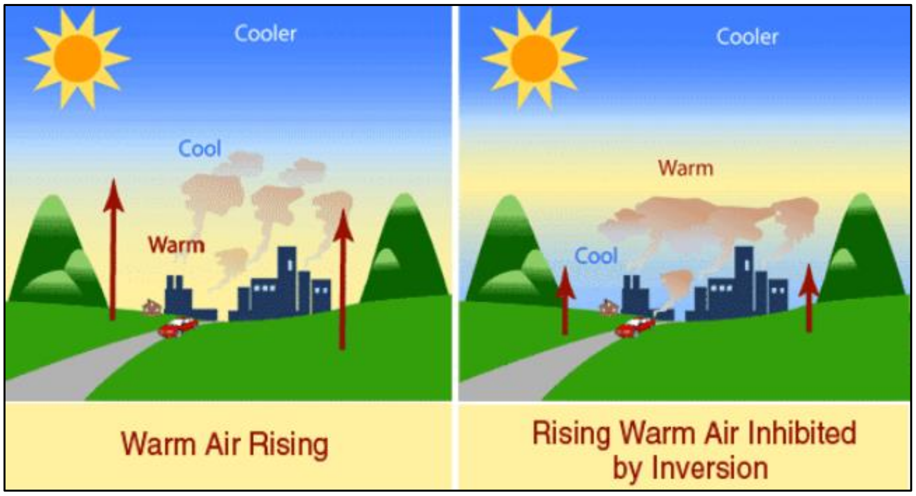
Carbon monoxide (CO) is a colorless, odorless gas formed when carbon in fuels is not burned completely. The main source of outdoor CO is exhaust from internal combustion engines, primarily on-road vehicles, as well as non-road vehicles, generators, construction equipment, boats and other types of mobile 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 is shown in Figure 8-1.

Figure 8-1
2017 New Jersey Estimated CO Annual Emissions



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 8-2
Effect of Atmospheric Inversion on Pollution Levels



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

Figure 8-3 shows that CO concentrations are slightly higher in the winter, probably because inversions are more frequent during the winter months. Also, high CO levels often coincide with morning and afternoon rush hours. This diurnal variation is displayed in Figure 8-4.

Figure 8-3
2018 Carbon Monoxide Concentrations in New Jersey
Monthly Variation
Parts per Million (ppm)

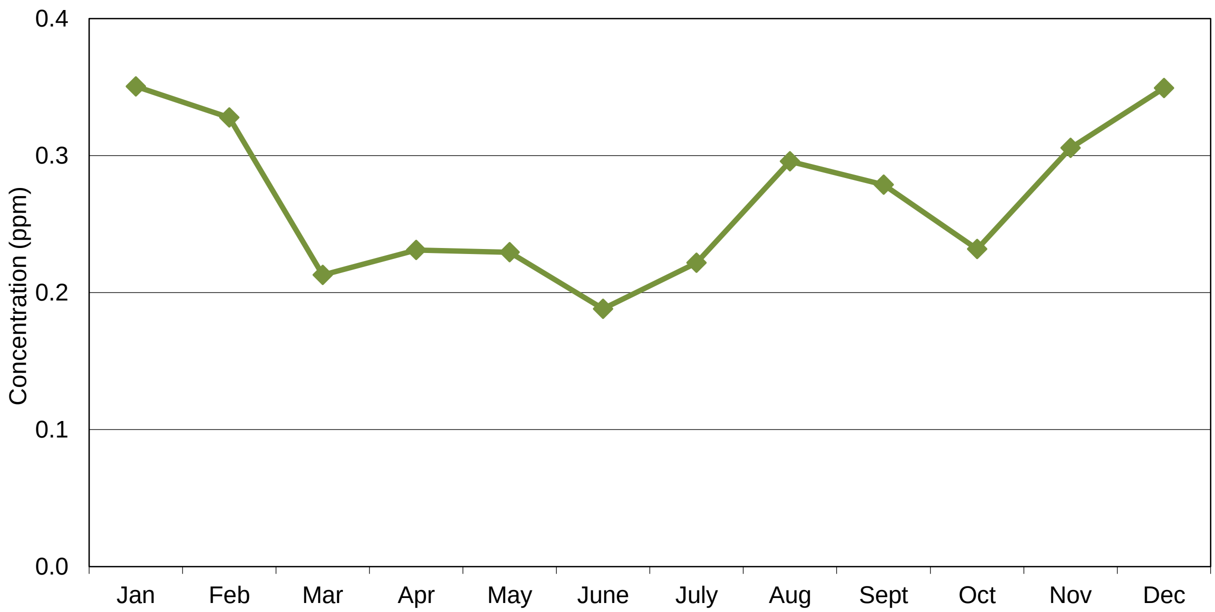
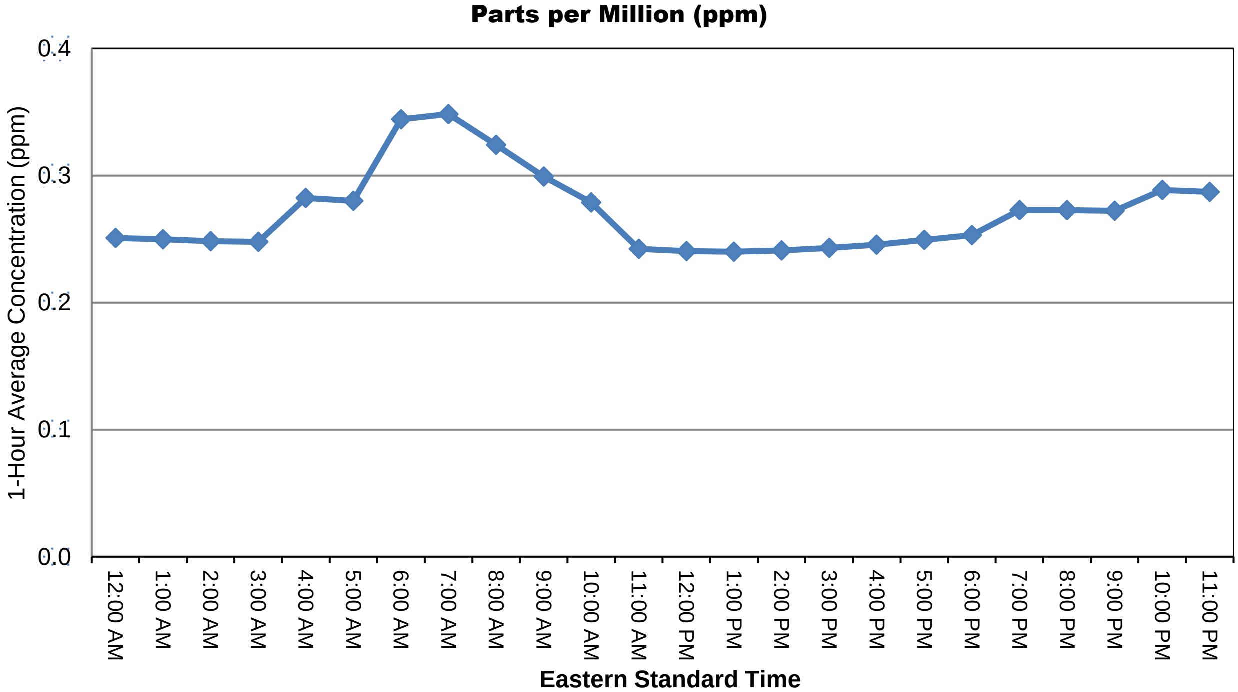


Figure 8-4
2018 Carbon Monoxide Concentrations in New Jersey
Hourly Variation
Parts per Million (ppm)



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) are established for the entire U.S. 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. For carbon monoxide, there are currently two primary, or 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. Therefore, 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. There are no national secondary, or welfare-based, standards for CO at this time. New Jersey also has standards for CO, and they are equivalent to the NAAQS even though they have different units (milligrams per cubic meter as opposed to parts per million). Also, the 8-hour state standard is based on a running average, not to be exceeded more than once in a 12-month period. The state has set secondary standards for CO at the same level as the primary standards. The standards are all summarized in Table 8-1.

Table 8-1
National and New Jersey Ambient Air Quality Standards for Carbon Monoxide
Parts per Million (ppm)
Milligrams per Cubic Meter (mg/m3)

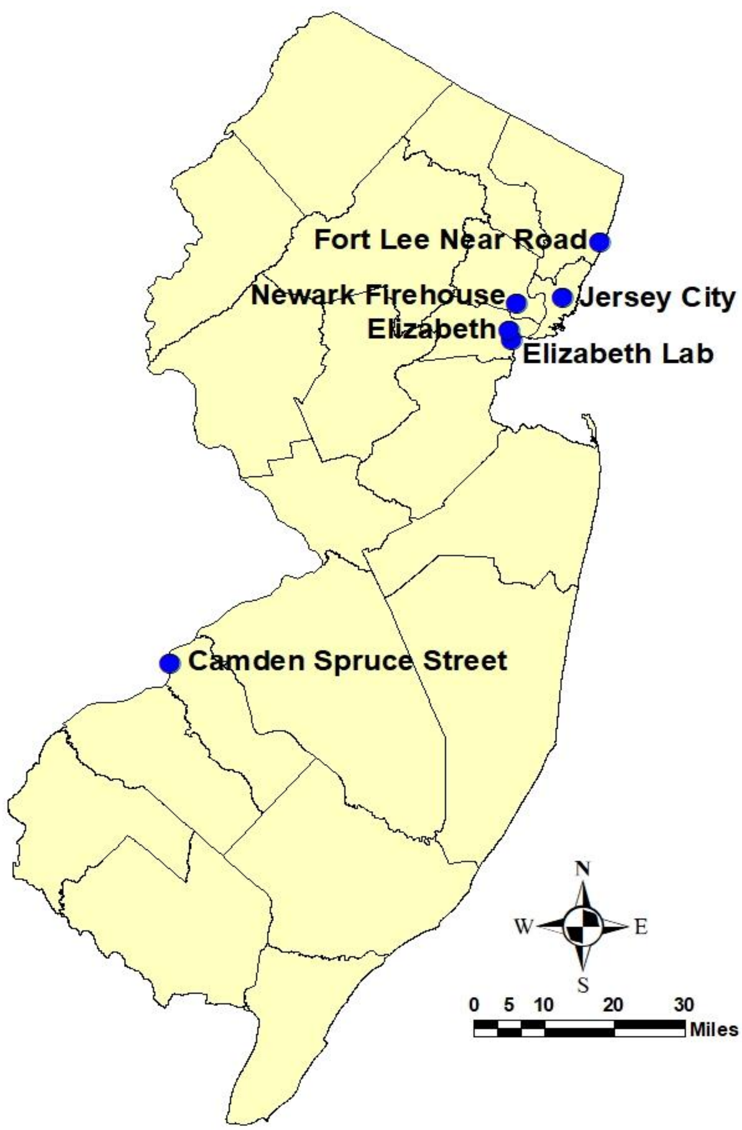
Averaging Period	Type	National [a]	New Jersey [b]
1-Hour	Primary	35 ppm	40 mg/m^3 (35 ppm)
1-Hour	Secondary	----	40 mg/m^3 (35 ppm)
8-Hours	Primary	9 ppm	10 mg/m^3 (9 ppm)
8-Hours	Secondary	----	10 mg/m^3 (9 ppm)

[a] Not to be exceeded more than once in a calendar year.
[b] Not to be exceeded more than once in any consecutive 12-month period.

CO Monitoring Network

The New Jersey Department of Environmental Protection (NJDEP) had six CO monitors operating in 2018. The locations are shown in the map in Figure 8-5. 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.

Figure 8-5
2018 Carbon Monoxide Monitoring Network



CO LEVELS IN 2018

There were no exceedances of any CO standards at any of the New Jersey monitoring sites during 2018. The maximum 1-hour average CO concentration recorded in 2018 was 5.1 ppm, at the Jersey City station. The highest 8-hour average CO concentration recorded was 3.2 ppm, at the Jersey City station. Summaries of the 2018 data are provided in Table 8-2, and Figures 8-6 and 8-7.

Table 8-2
2018 Carbon Monoxide Concentrations in New Jersey
1-Hour and 8-Hour Averages
Parts per Million (ppm)

Monitoring Site	1-Hour Average Concentrations		8-Hour Average Concentrations	
	Highest	2nd-Highest	Highest	2nd-Highest*
Camden Spruce St.	1.4	1.4	1.2	1.0
Elizabeth	2.9	2.8	2.8	2.7
Elizabeth Lab	2.3	2.1	1.3	1.2
Fort Lee Near Rd.	4.9	3.1	1.8	1.5
Jersey City	5.1	4.8	3.2	1.6
Newark Firehouse	2.626	2.569	1.8	1.7

*Non-overlapping 8-hour periods

Figure 8-6
2018 Carbon Monoxide Concentrations in New Jersey
1-Hour Averages
Parts per Million (ppm)

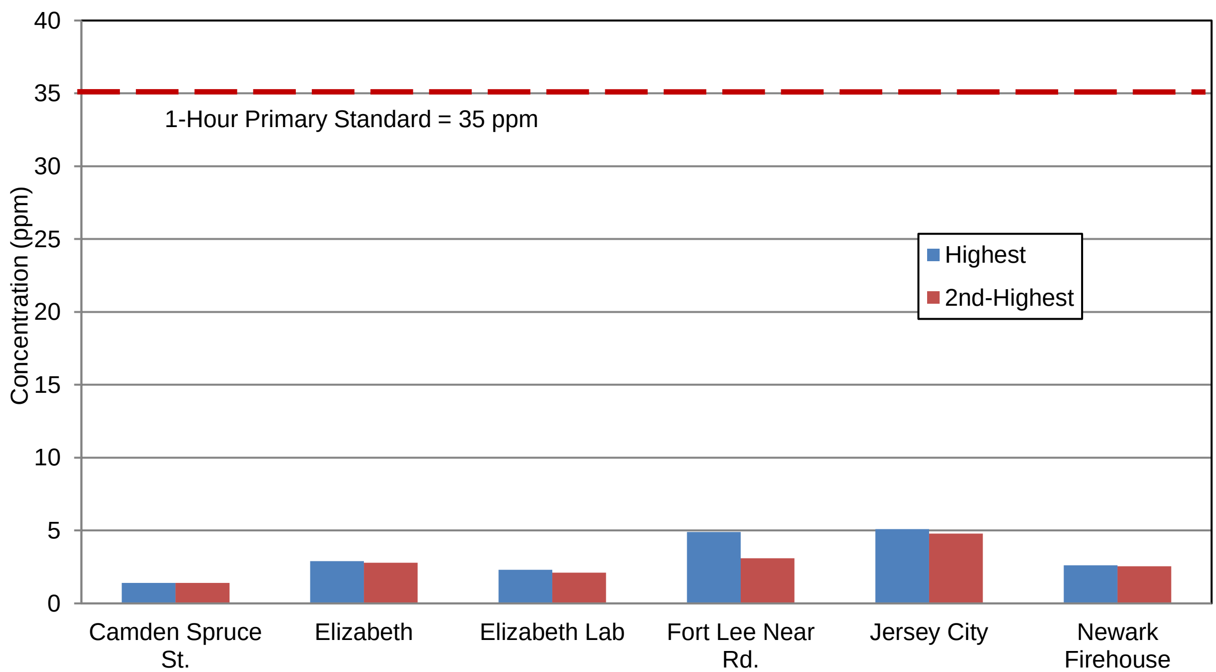
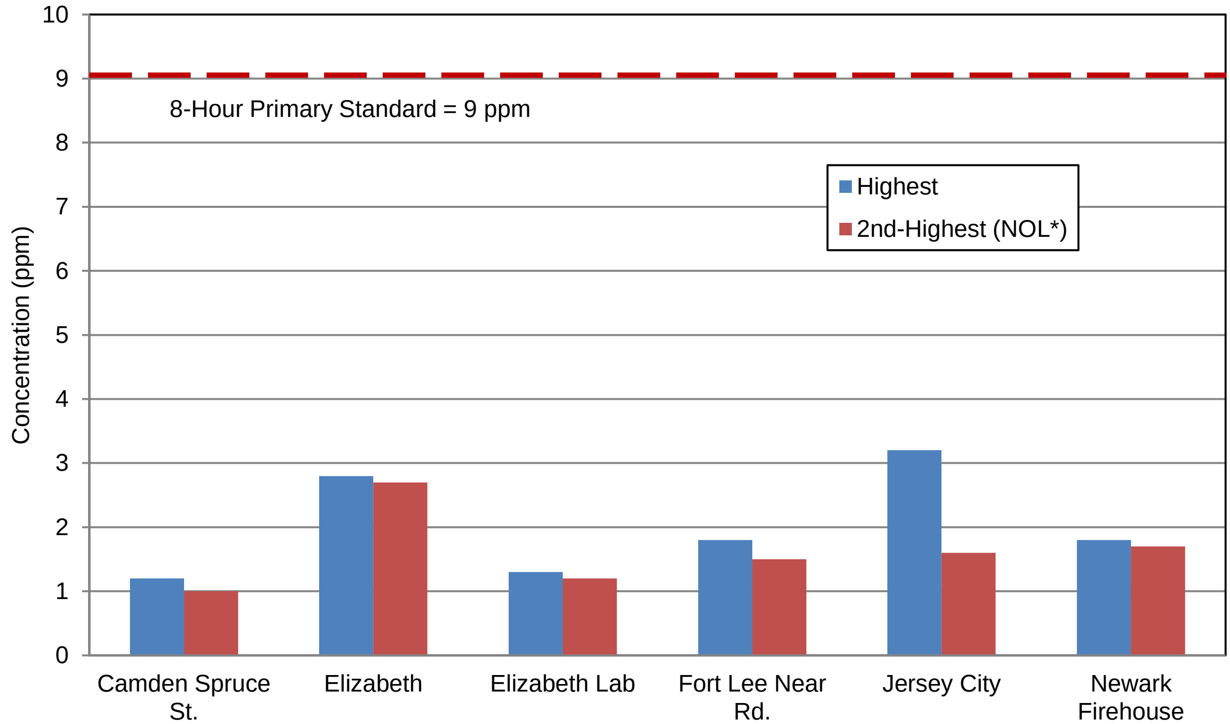


Figure 8-7
2018 Carbon Monoxide Concentrations in New Jersey
8-Hour Averages
Parts per Million (ppm)



*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 8-8 and 8-9 present the trends in CO levels since 1990. The graphs 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 8-8
Carbon Monoxide Design Value Trend in New Jersey, 1990-2018
2nd Highest 1-Hour Average Concentrations
Parts per Million (ppm)

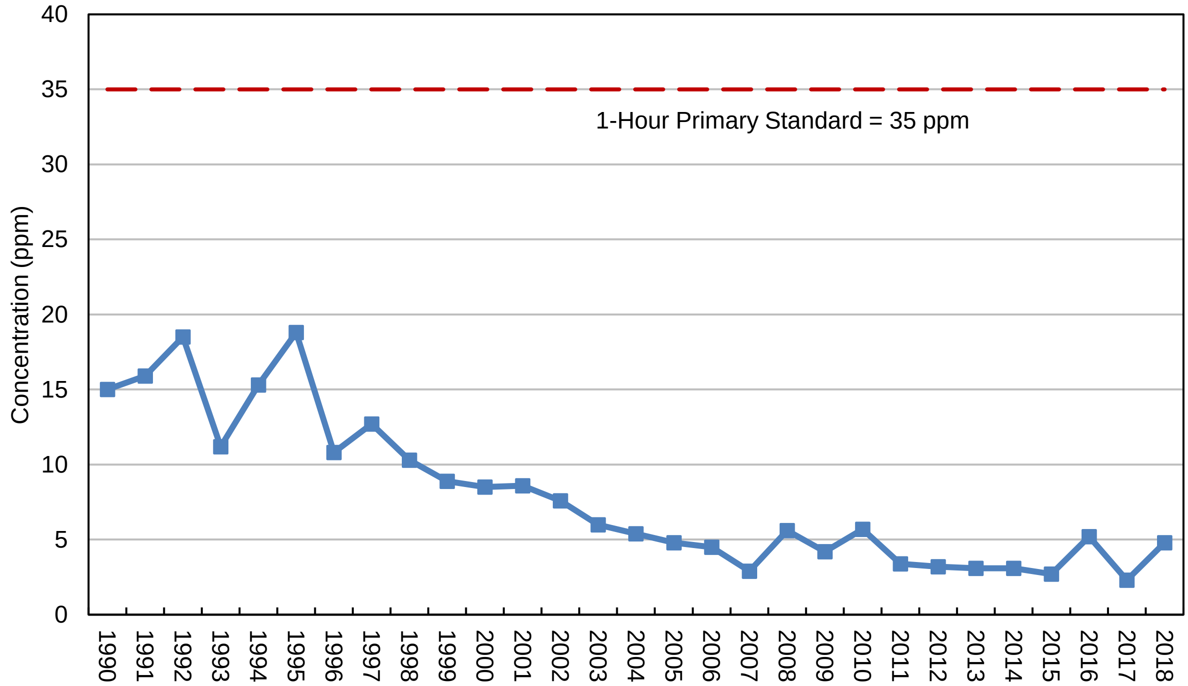
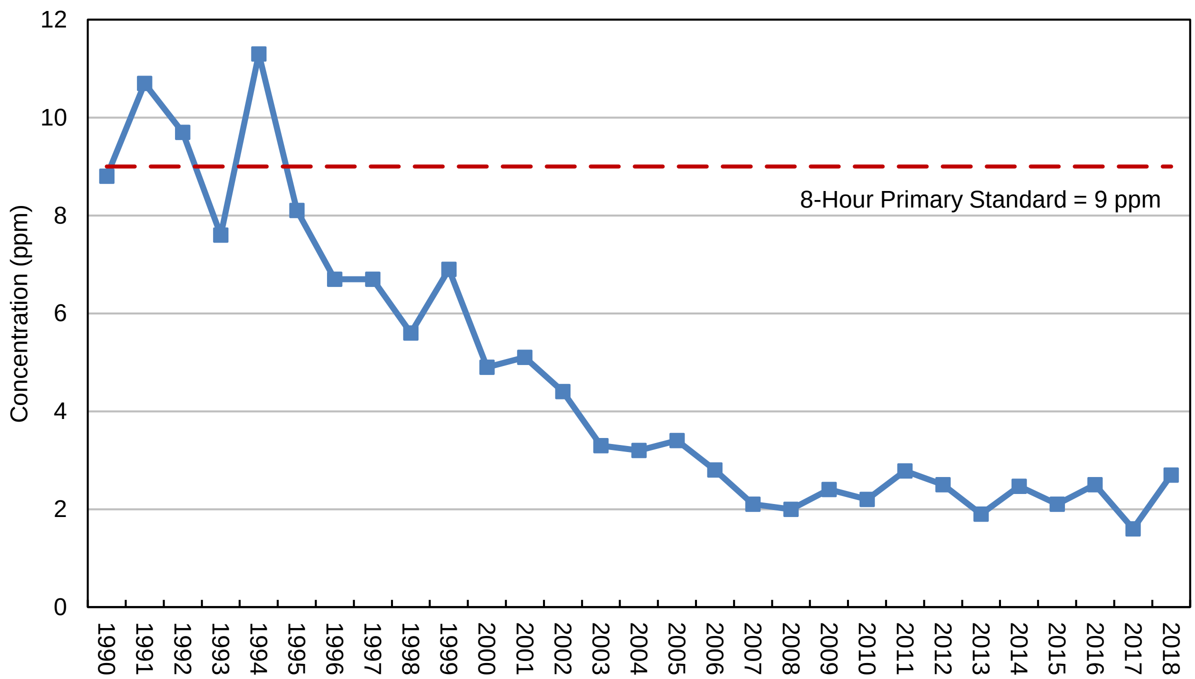


Figure 8-8
Carbon Monoxide Design Value Trend in New Jersey, 1990-2018
2nd Highest 8-Hour Average Concentrations
Parts per Million (ppm)



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2018 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. It is still used in aviation fuel in some smaller aircraft, accounting for about 74% of the estimated 9 tons emitted in New Jersey in 2014. 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 (this 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
3 Months (Rolling)	Primary & Secondary	0.15 $\mu g/m^3$

Lead Air Levels in 2018

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 measurements, all of New Jersey's lead monitors were shut down. In 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 2018.

Figure 9-1
Lead Concentrations at Newark Firehouse in New Jersey, 2012-2018
24-Hour Averages
Micrograms per Cubic Meter (µg/m³)

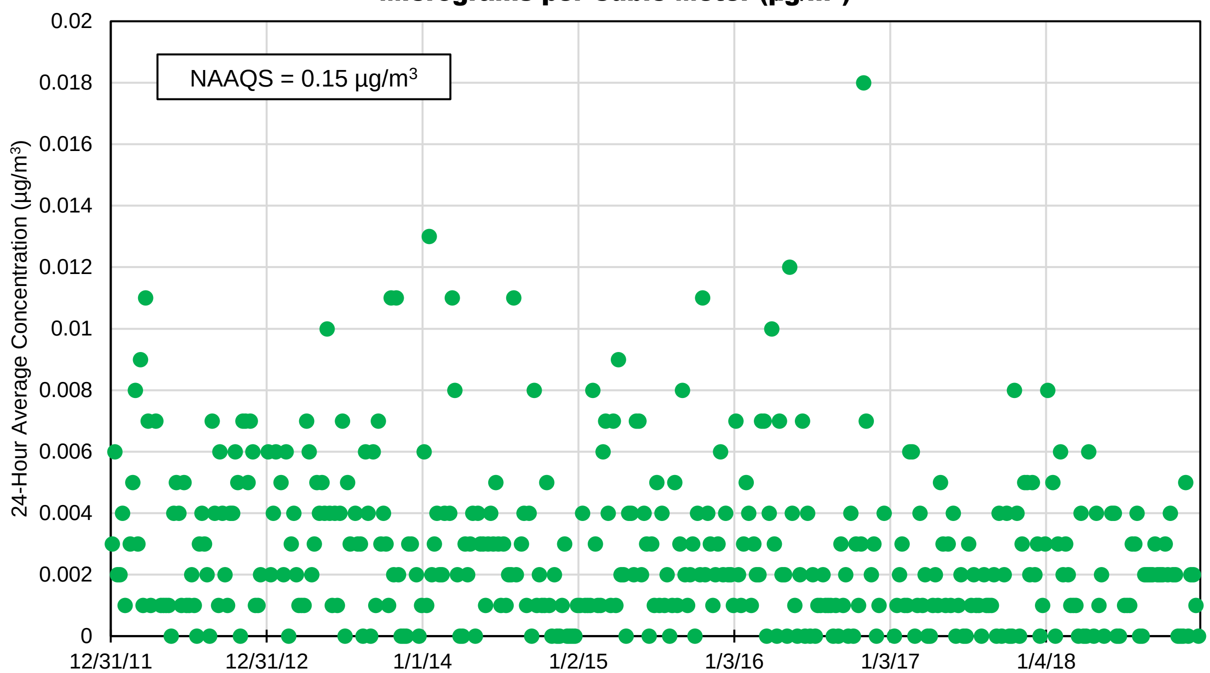


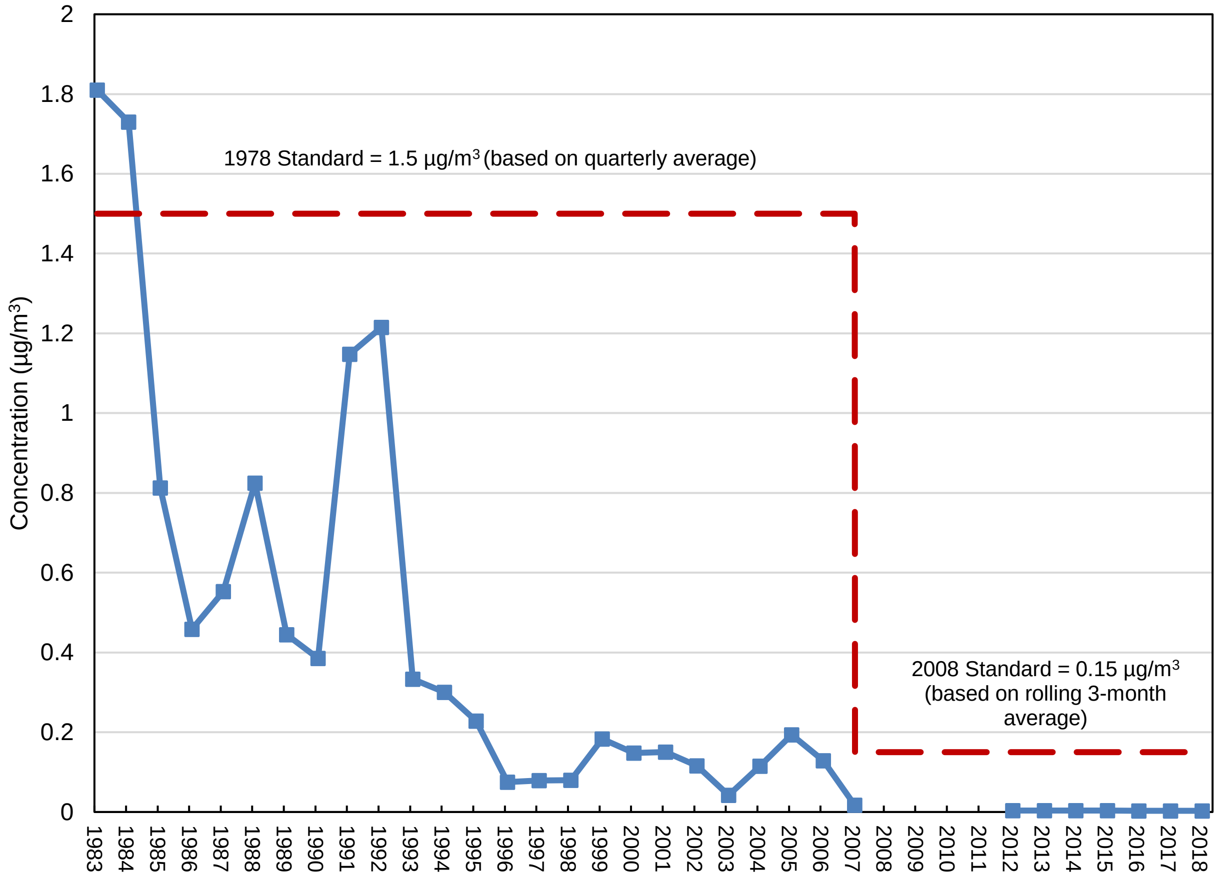
Table 9-1
2018 Lead Concentrations in New Jersey
3-Month Rolling Averages
Micrograms per Cubic Meter (µg/m³)

3-Month Period	3-Month Average
November-January	0.003
December-February	0.003
January-March	0.002
February-April	0.002
March-May	0.001
April-June	0.001
May-July	0.001
June-August	0.001
July-September	0.001
August-October	0.002
September-November	0.002
October-December	0.001

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
Lead Design Value Trend in New Jersey, 1983-2018
Highest 3-Month Average
Micrograms per Cubic Meter (µg/m³)



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2018 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 they are subject to a standard planning process that includes monitoring, reporting, and control requirements. Each of these pollutants is discussed in its own section (Sections 4 through 9) of this New Jersey Department of Environmental Protection (NJDEP) 2018 Air Quality Report.

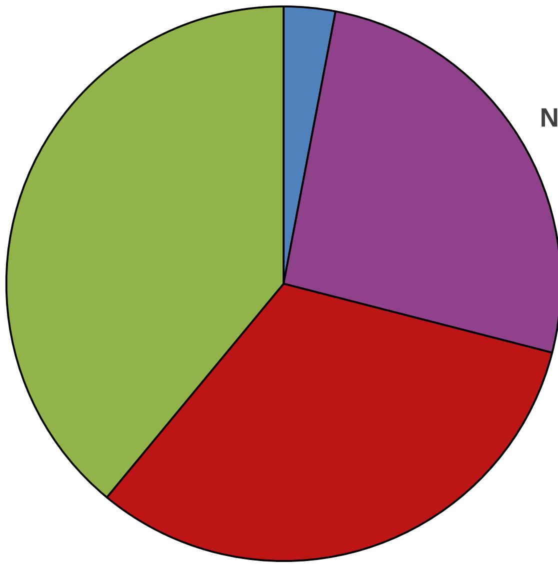
Air toxics are all the other chemicals released into the air that have the potential to cause adverse health effects in humans. These effects cover a wide range of conditions, from lung irritation to birth defects to cancer. There are no NAAQS for these pollutants, but in 1990 the U.S. Congress directed 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. This data is then used for the National-Scale Air Toxics Assessment (NATA), which combines emissions data and complex dispersion and exposure models to estimate the public's exposure to air toxics around the country. The pie chart in Figure 10-1, taken from the 2014 NEI, shows that mobile sources are the largest contributors of air toxics emissions in New Jersey. More information can be found at www.epa.gov/national-air-toxics-assessment.

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 39%. Nonpoint sources (residential, commercial, and small industrial sources) represent 26% of the inventory and point sources (such as factories and power plants) account for the remaining 3%.

Figure 10-1
2014 Air Toxics Emissions Source Estimates for New Jersey

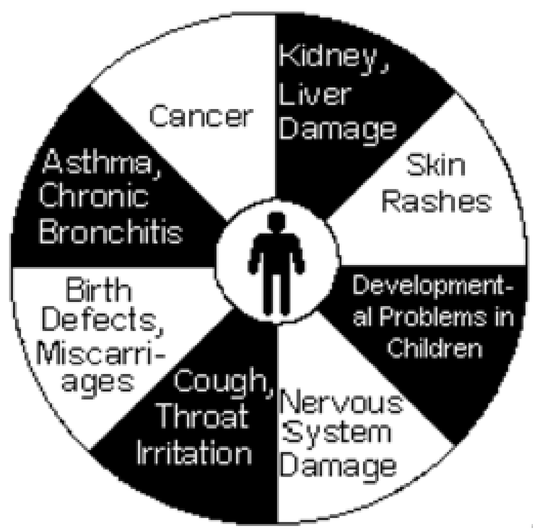


Source: 2014 NATA (USEPA)

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

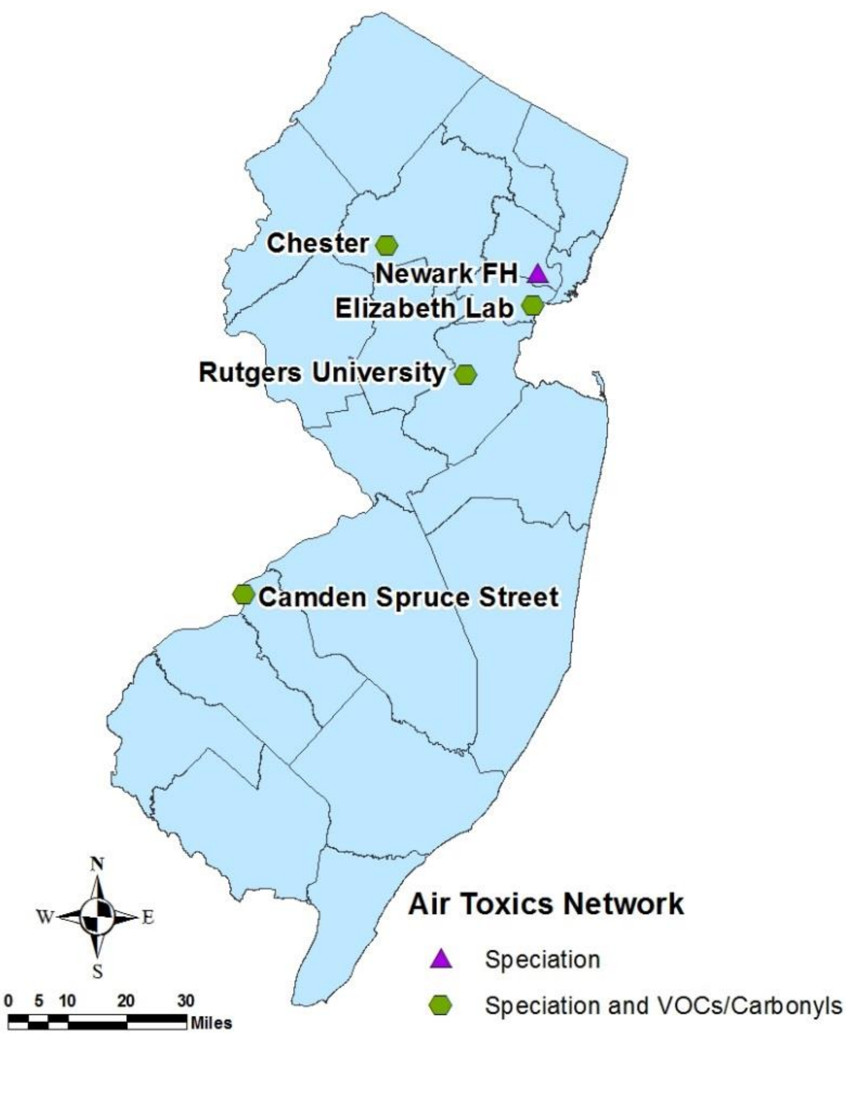


Source: www3.epa.gov/ttn/atw/3_90_024.html

Monitoring Locations

In 2018 NJDEP had 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 at Rutgers University in East Brunswick. Toxic metals data are collected at the same four monitoring stations, plus Newark Firehouse.

Figure 10-3
2018 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 in a suburban setting on Rutgers 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 the 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. It 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 the New Brunswick and Chester sites started in July 2001. In 2016 the New Brunswick VOC monitor was replaced by one at a new station at Rutgers University, less than a mile away.

Analysis of some 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 2018

2018 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 ($\mu g/m^3$). More detail can be found in Tables 10-5 through 10-8, including additional statistics, detection limit information, health benchmarks used by NJDEP, risk ratios, and concentrations in parts per billion by volume (ppbv). 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.

A number of compounds were mostly below the detection limit of the lab analysis method used (see Table 10-9). 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 10-5 through 10-8 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 average 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.

For the past few years, acrolein measurements were considered to be highly unreliable according to the USEPA. However since the lab that analyzes New Jersey's samples, has modified their procedures according to USEPA' latest recommendation, the acrolein measurements are now considered "verified."

Table 10-1
2018 Summary of Toxic Volatile Organic Compounds Monitored in New Jersey

Annual Average Concentrations
Micrograms per Cubic Meter (μg/m³)

	Pollutant	Synonym	HAP	CAS No.	Camden	Chester	Elizabeth	Rutgers
1	Acetaldehyde		*	75-07-0	1.916	0.979	2.268	1.340
2	Acetone			67-64-1	2.496	1.870	2.834	2.152
3	Acetonitrile		*	75-05-8	1.325	0.833	0.824	1.147
4	Acetylene			74-86-2	0.714	0.474	0.871	0.591
5	Acrolein		*	107-02-8	0.943	0.804	0.908	0.777
6	Acrylonitrile		*	107-13-1	*0.001*	*0.001*	*0.001*	*ND*
7	tert-Amyl Methyl Ether			994-05-8	*0.002*	*0.003*	*0.002*	*0.002*
8	Benzaldehyde			100-52-7	0.208	0.079	0.119	0.108
9	Benzene		*	71-43-2	0.635	0.338	0.709	0.437
10	Bromochloromethane			74-97-5	*0.001*	*0.001*	*0.002*	*0.001*
11	Bromodichloromethane			75-27-4	*0.010*	*0.005*	*0.005*	*0.008*
12	Bromoform		*	75-25-2	*0.006*	*0.008*	*0.008*	*0.008*
13	Bromomethane	Methyl bromide	*	74-83-9	0.100	0.038	0.044	0.041
14	1,3-Butadiene		*	106-99-0	0.062	0.022	0.092	0.041
15	Butyraldehyde			123-72-8	0.297	0.157	0.304	0.237
16	Carbon Disulfide		*	75-15-0	0.057	0.056	0.060	0.062
17	Carbon Tetrachloride		*	56-23-5	0.538	0.541	0.557	0.549
18	Chlorobenzene		*	108-90-7	*0.006*	*0.006*	*0.006*	*0.007*
19	Chloroethane	Ethyl chloride	*	75-00-3	0.038	*0.024*	0.032	0.072
20	Chloroform		*	67-66-3	0.135	0.113	0.154	0.149
21	Chloromethane	Methyl chloride	*	74-87-3	1.212	1.176	1.167	1.184
22	Chloroprene	2-Chloro-1,3-butadiene	*	126-99-8	*0.002*	*0.003*	*0.001*	*0.001*
23	Crotonaldehyde			123-73-9	0.211	0.211	0.311	0.207
24	Dibromochloromethane	Chlorodibromomethane		124-48-1	*0.015*	*0.013*	*0.014*	*0.011*
25	1,2-Dibromoethane	Ethylene dibromide	*	106-93-4	*0.005*	*0.005*	*0.003*	*0.003*
26	m-Dichlorobenzene	1,3-Dichlorobenzene		541-73-1	*0.004*	*0.007*	*0.005*	*0.003*
27	o-Dichlorobenzene	1,2-Dichlorobenzene		95-50-1	*0.007*	*0.007*	*0.005*	*0.006*
28	p-Dichlorobenzene	1,4-Dichlorobenzene	*	106-46-7	0.058	*0.014*	0.053	0.034
29	Dichlorodifluoromethane			75-71-8	2.657	2.509	2.480	2.504
30	1,1-Dichloroethane	Ethylidene dichloride	*	75-34-3	*0.004*	*0.005*	*0.004*	*0.004*
31	1,2-Dichloroethane	Ethylene dichloride	*	107-06-2	0.104	0.079	0.088	0.083
32	1,1-Dichloroethylene	Vinylidene chloride	*	75-35-4	*0.004*	*0.004*	*0.004*	*0.004*
33	cis-1,2-Dichloroethylene	cis-1,2-Dichloroethene		156-59-2	*ND*	*0.001*	*ND*	*ND*
34	trans-1,2-Dichloroethylene	trans-1,2-Dichloroethene		156-60-5	*0.017*	*0.003*	*0.007*	*0.005*
35	Dichloromethane	Methylene chloride	*	75-09-2	0.495	0.392	0.537	0.482
36	1,2-Dichloropropane	Propylene dichloride	*	78-87-5	*0.002*	*0.008*	*0.002*	*0.004*

- *Values in **italics** indicate averages based on less than 50% of samples above the detection limit.*
- **ND** indicates that all samples were below the detection limit.
- HAP = Hazardous air pollutant as listed in the Clean Air Act.

Table 10-1 (continued)
2018 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-Dichloropropene	cis-1,3-Dichloropropylene	*	10061-01-5	*0.003*	*0.003*	*0.003*	*0.002*
38	trans-1,3-Dichloropropene	trans-1,3-Dichloropropylene	*	10061-02-6	*0.001*	*ND*	*0.001*	*0.002*
39	Dichlorotetrafluoroethane	Freon 114		76-14-2	0.130	0.129	0.127	0.128
40	2,5-Dimethylbenzaldehyde			5799-94-2	*ND*	*ND*	*ND*	*ND*
41	Ethyl Acrylate		*	140-88-5	*ND*	*0.002*	*ND*	*ND*
42	Ethylbenzene		*	100-41-4	0.660	0.099	0.301	0.220
43	Ethyl tert-Butyl Ether	tert-Butyl ethyl ether		637-92-3	*0.004*	*0.004*	*0.006*	0.031
44	Formaldehyde		*	50-00-0	2.833	1.998	3.971	2.427
45	Hexachlorobutadiene	Hexachloro-1,3-butadiene	*	87-68-3	0.061	0.054	0.054	0.047
46	Hexaldehyde	Hexanaldehyde		66-25-1	0.165	0.081	0.155	0.226
47	Isovaleraldehyde			590-86-3	*ND*	*ND*	*ND*	*ND*
48	Methyl Ethyl Ketone	MEK, 2-Butanone		78-93-3	0.394	0.308	0.486	0.533
49	Methyl Isobutyl Ketone	MIBK	*	108-10-1	0.166	0.102	0.183	0.122
50	Methyl Methacrylate		*	80-62-6	0.054	*0.005*	*0.024*	*0.015*
51	Methyl tert-Butyl Ether	MTBE	*	1634-04-4	*0.004*	*0.003*	*0.004*	*0.008*
52	n-Octane			111-65-9	0.261	0.093	0.331	0.123
53	Propionaldehyde		*	123-38-6	0.377	0.213	0.474	0.277
54	Propylene			115-07-1	0.812	0.346	3.007	0.511
55	Styrene		*	100-42-5	0.485	0.026	0.077	0.067
56	1,1,2,2-Tetrachloroethane		*	79-34-5	*0.003*	*0.006*	*0.004*	*0.004*
57	Tetrachloroethylene	Perchloroethylene	*	127-18-4	0.146	0.073	0.145	0.097
58	Tolualdehydes				0.246	0.138	0.212	0.163
59	Toluene		*	108-88-3	2.115	0.509	1.716	0.842
60	1,2,4-Trichlorobenzene		*	120-82-1	*0.027*	*0.028*	*0.025*	*0.021*
61	1,1,1-Trichloroethane	Methyl chloroform	*	71-55-6	0.021	*0.013*	0.020	0.017
62	1,1,2-Trichloroethane		*	79-00-5	*0.004*	*0.003*	*0.002*	*0.001*
63	Trichloroethylene		*	79-01-6	0.052	*0.008*	0.031	*0.014*
64	Trichlorofluoromethane			75-69-4	2.201	1.241	1.265	1.250
65	Trichlorotrifluoroethane	1,1,2-Trichloro-1,2,2-trifluoroethane		76-13-1	0.608	0.605	0.598	0.604
66	1,2,4-Trimethylbenzene			95-63-6	0.424	0.071	0.301	0.134
67	1,3,5-Trimethylbenzene			108-67-8	0.136	0.033	0.099	0.052
68	Valeraldehyde			110-62-3	0.078	0.033	0.091	0.077
69	Vinyl chloride		*	75-01-4	*0.010*	*0.004*	*0.005*	*0.005*
70	m,p-Xylene		*	108-38-3,106-42-3	2.338	0.196	0.816	0.499
71	o-Xylene		*	95-47-6	0.919	0.106	0.361	0.232

- *Values in **italics** are averages based on less than 50% of samples detected.*
- **ND** indicates that all samples were below the detection limit.
- HAP = Hazardous air pollutant as listed in the Clean Air Act.

Table 10-2 presents the annual average concentrations of toxic metals and elements, along with their health benchmarks (see the "Estimating Health Risk" section below for an explanation). No risk ratios were calculated, because most of the chemicals were below the detection limit and 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 10-2
2018 Summary of Toxic Metals and Elements Monitored in New Jersey

Annual Average Concentrations[a]
Micrograms per Cubic Meter (μg/m³)

Pollutant	HAP[b]	Camden	Chester	Elizabeth	Newark	Rutgers	Health Benchmark (μg/m³)[c]
Antimony	*	0.006	0.002	*0.002*	0.005	0.005	*0.2*
Arsenic	*	*0.001*	*0.0001*	0.0001	*0.0002*	*0.0003*	0.00023
Cadmium	*	*0.0004*	0.002	*0.0001*	0.001	*0.001*	0.00024
Chlorine	*	0.167	*0.001*	0.017	0.016	0.009	*0.2*
Chromium[d]	*	0.002	0.003	0.004	0.002	0.004	0.000083
Cobalt	*	*0.0001*	*0*	*0*	*0*	*0*	0.00011
Lead	*	0.005	0.002	0.003	0.002	0.002	0.083
Manganese	*	0.003	0.0004	0.002	0.001	0.001	*0.05*
Nickel[e]	*	0.001	0.001	0.002	0.001	0.001	0.0021
Phosphorus	*	0.001	0.0002	0.001	0.001	0.0003	*0.07*
Selenium	*	*0.0002*	0.0003	0.0004	0.0003	*0.0002*	*20*
Silicon		0.056	0.033	0.08	0.065	0.041	*3*
Vanadium		*0.0003*	*0.0002*	*0.0002*	*0.0003*	*0.0003*	*0.1*

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

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 chemical-specific 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). Not all air toxics have health benchmarks, because of a lack of toxicity studies. Available health benchmarks for the VOCs and carbonyls monitored in New Jersey are listed in Tables 10-5 through 10-8.

If ambient air concentrations exceed health benchmarks, regulatory agencies can focus their efforts on reducing emissions or exposure to those chemicals. Dividing the air concentration of a chemical by its health benchmark gives us a number referred to as a **risk ratio**. 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.

The pollutants with risk ratios greater than one for at least one monitoring site are summarized in Table 10-3. Table 10-4 shows the different types of sources that contribute to the levels of those pollutants in the air in New Jersey, according to USEPA's 2014 National Emissions Inventory.

Acrolein and formaldehyde showed the highest risk at all four monitoring sites. Other pollutants above health benchmarks at all four sites were acetaldehyde, benzene, carbon tetrachloride, chloroform, chloromethane (methyl chloride), and 1,2-dichloroethane (ethylene dichloride). 1,2-Dibromoethane had a risk ratio above one at all sites as well, but most of the samples were below the detection limit. Ethylbenzene was above the health benchmark at Camden only, while 1,3-butadiene was over the health benchmark at Camden and Elizabeth. Chloroprene concentrations were mostly below the detection limit. However, hexachlorobutadiene analysis improved in 2018, so that slightly more than 50% of samples were above detection levels.

Table 10-3
Monitored Toxic Air Pollutants with Risk Ratios Greater Than One in 2018

Pollutant		CAS No.	Risk Ratio			
			Camden	Chester	Elizabeth	Rutgers
1	Acetaldehyde	75-07-0	4	2	5	3
2	Acrolein	107-02-8	47	40	45	39
3	Benzene	71-43-2	5	3	5	3
4	1,3-Butadiene	106-99-0	1.9	0.7	3	1.3
5	Carbon Tetrachloride	56-23-5	3	3	3	3
6	Chloroform	67-66-3	3	3	4	3
7	Chloromethane	74-87-3	2	2	2	2
8	*Chloroprene*	126-99-8	*1.2*	*1.7*	*0.6*	*0.4*
9	*1,2-Dibromoethane*	106-93-4	*3*	*3*	*2*	*2*
10	1,2-Dichloroethane	107-06-2	3	2	2	2
11	Ethylbenzene	100-41-4	1.7	0.2	0.8	0.6
12	Formaldehyde	50-00-0	37	26	52	32
13	Hexachlorobutadiene	127-18-4	1.4	1.2	1.2	1.0

NOTE: Values in italics are based on less than 50% of samples detected.

Table 10-4
Sources of Air Toxics with Risk Ratios >1 in 2018

Pollutant	Contribution from						
	Point Sources	Nonpoint Sources	On-Road Mobile Sources	Nonroad Mobile Sources	Back-ground[a]	Secondary Formation[b]	Bio-genics[c]
Acetaldehyde	0.1%	5%	7%	2%	0%	74%	11%
Acrolein	2%	27%	29%	21%	0%	21%	0%
Benzene	1.5%	29%	50%	20%	0%	0%	0%
1,3-Butadiene	0.1%	21%	59%	19%	0%	0%	0%
Carbon Tetrachloride	0.002%	0.01%	0%	0%	100%	0%	0%
Chloroform	69%	31%	0%	0%	0%	0%	0%
Chloromethane	27%	73%	0%	0%	0%	0%	0%
Chloroprene	0%	100%	0%	0%	0%	0%	0%
1,2-Dibromoethane	100%	0.02%	0%	0%	0%	0%	0%
1,2-Dichloroethane	7%	93%	0%	0%	0%	0%	0%
Ethylbenzene	1.6%	8%	66%	24%	0%	0%	0%
Formaldehyde	0.8%	7%	6%	4%	0%	73%	9%
Hexachlorobutadiene	97%%	3%	0%	0%	0%	0%	0%

[a] Background concentrations are levels of pollutants that would be found in in the air in a given year even if there had been no recent human-caused emissions, because of persistence in the environment of past years' emissions and long-range transport from distant sources.
[b] Secondary formation occurs when some volatile organic compounds (VOCs) react chemically in the air with other emitted compounds (usually oxides of nitrogen).
[c] Biogenic emissions are those directly emitted from trees, plants and soil microbes (excludes secondary formation).

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 10-16 present data for some of the VOCs that have been sampled over the past decade. 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 10-16 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.

Acrolein and chloroprene are not graphed below, because of a lack of data for previous years. As described above, acrolein has been difficult to measure accurately. Improvements in laboratory methods have recently been implemented. Acrolein is formed by combustion of organic matter and fuels, and the breakdown of other air pollutants.

Until recently chloroprene has been below detectable levels in New Jersey's air samples. It is used primarily in the manufacture of polychloroprene (a synthetic rubber known commercially as Neoprene), which is used to make numerous products (such as automotive parts, caulks, and wire and cable covers) resistant to other chemicals, oil and weather.

According to USEPA's 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 could have 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.

Figures 10-5 and 10-6 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.

Carbon tetrachloride (Figure 10-7) 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 its ability to deplete 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.

Some of the increase in **chloroform** concentrations shown in Figure 10-8 is believed to be from improvements in the lab 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.

As seen in Figure 10-9, **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.

1,2-Dibromoethane (or ethylene dibromide) (Figure 10-10) is currently used as a pesticide in the treatment of felled logs for bark beetles and termites, and control of wax moths in beehives. It was once used as an additive to leaded gasoline and as a soil and grain fumigant, but those uses have been banned by USEPA. Most of the monitoring results fall below the detection limit, so the data in the graph is fairly uncertain.

1,2-Dichloroethane (also called 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 detection limit, resulting in over 90% of samples having detectable levels. The most recent National Emissions Inventory estimates that 93% of 1,2-dichloroethane in New Jersey's air is from point sources, and 7% from nonpoint sources.

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).

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 secondary formation contributes the most to high outdoor levels. In 2014, concentrations at the New Brunswick site were consistently higher than at the other monitors, although they dropped in 2015.

Hexachlorobutadiene is used to make rubber compounds and lubricants, and is also used as a hydraulic fluid and as a solvent. It has only recently become measurable above detection limits in New Jersey's air samples (Figure 10-14), and has been found to be above its health benchmark.

The annual average **styrene** concentration at the Camden Spruce Street monitor dropped below its health benchmark in 2017, although levels are still higher than at the other New Jersey monitors (see Figure 10-15). NJDEP has not been able to find the source of the styrene in Camden. Styrene used in the production of polystyrene plastics and resins, but a significant amount also comes from vehicles.

Tetrachloroethylene (commonly known as perchloroethylene) (Figure 10-16) 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 10-4
ACETALDEHYDE – New Jersey Monitored Concentrations

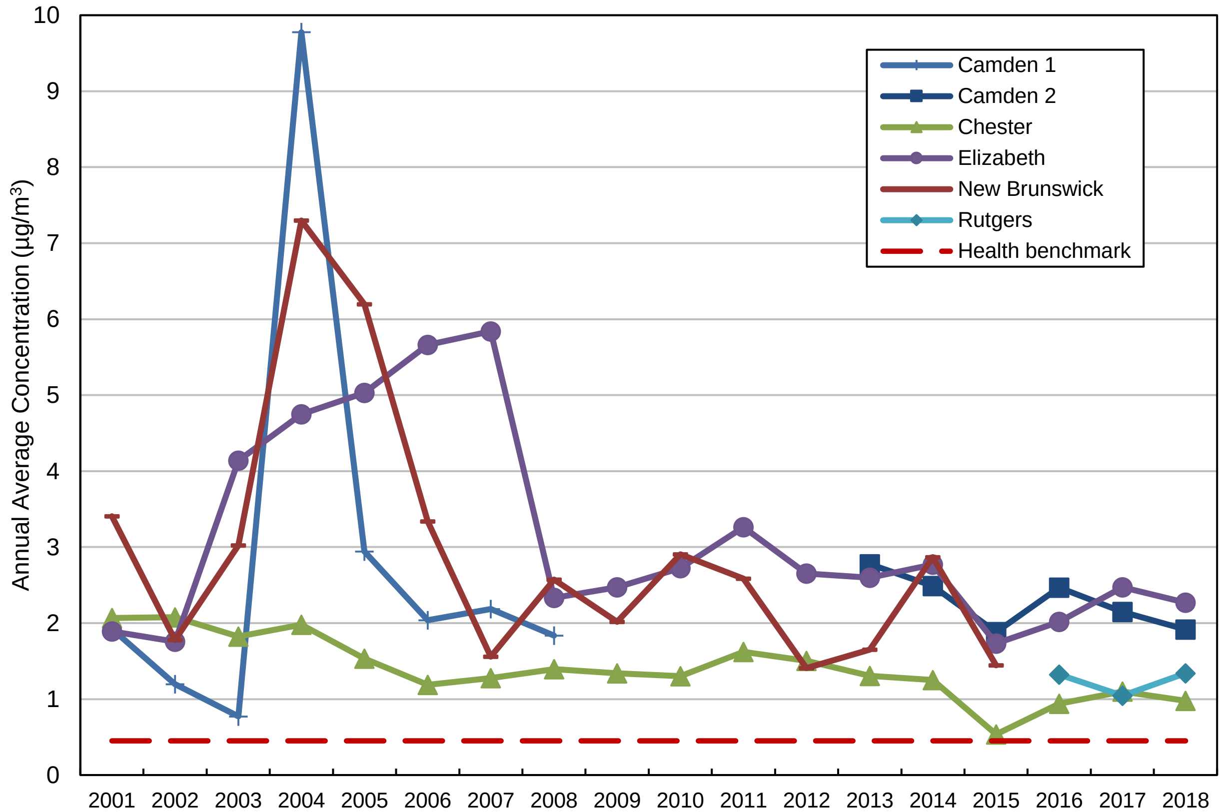


Figure 10-5
BENZENE – New Jersey Monitored Concentrations

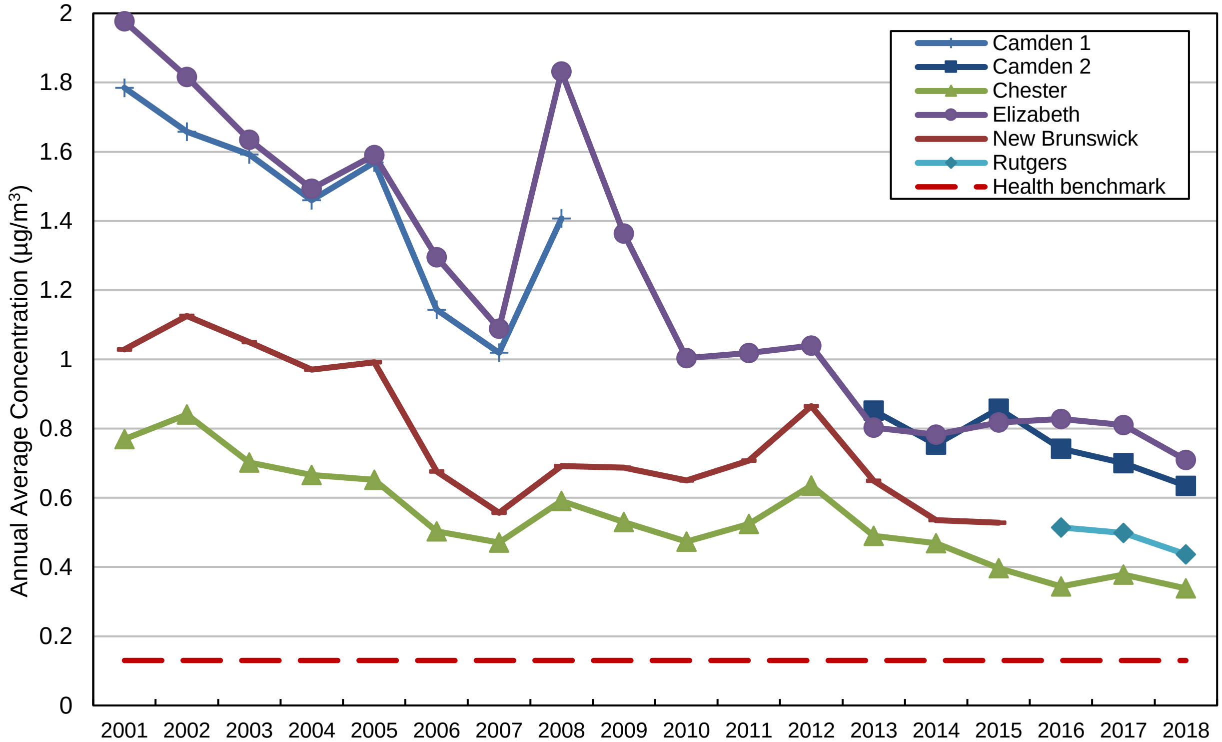


Figure 10-6
1,3-BUTADIENE – New Jersey Monitored Concentrations

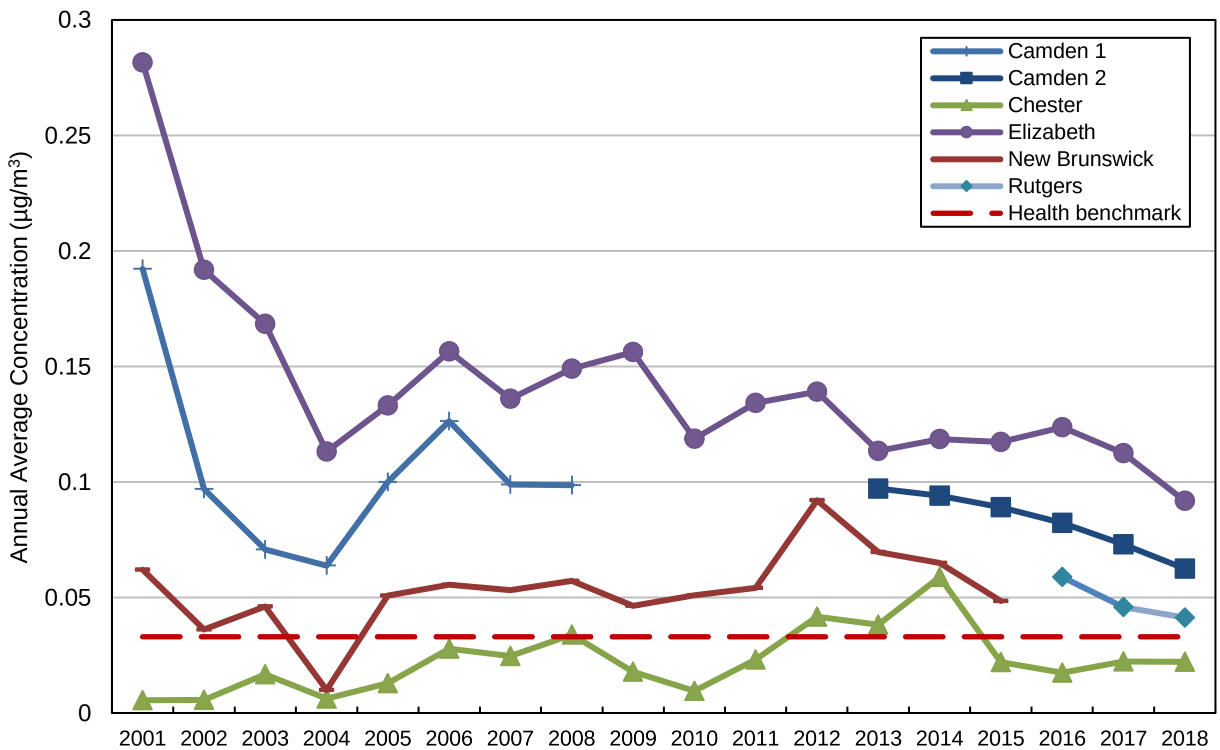


Figure 10-7
CARBON TETRACHLORIDE – New Jersey Monitored Concentrations

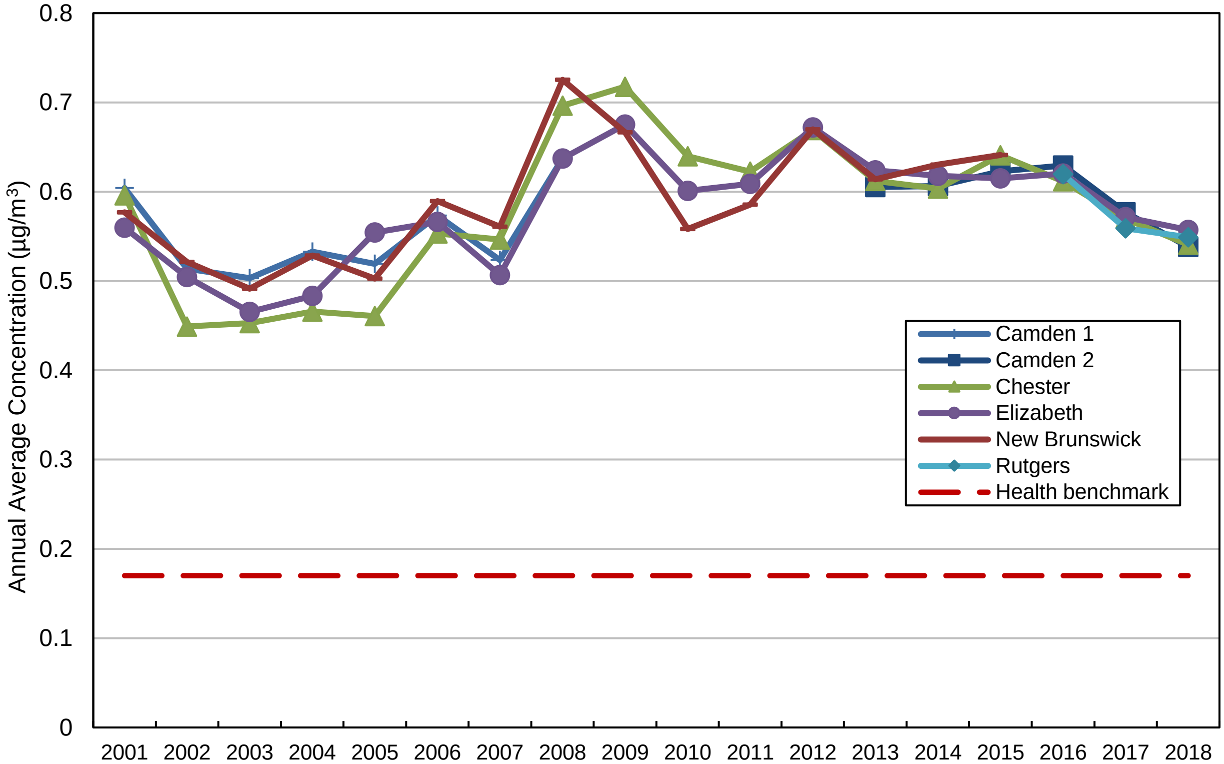


Figure 10-8
CHLOROFORM – New Jersey Monitored Concentrations

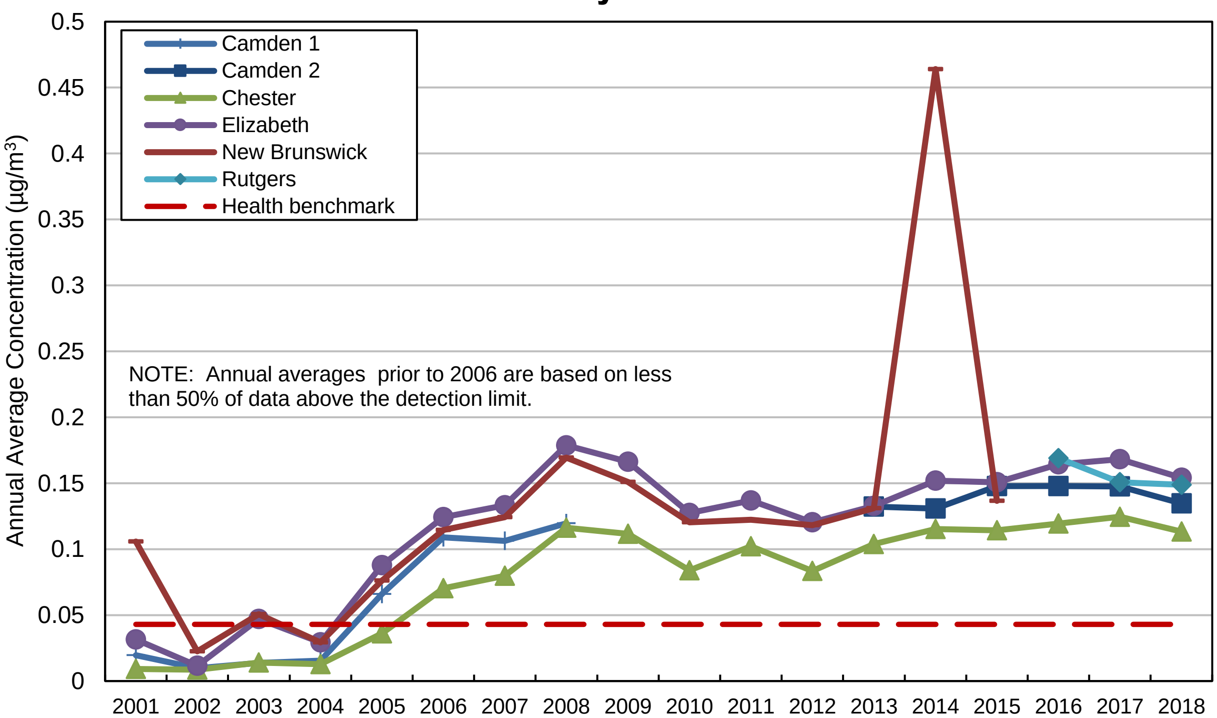


Figure 10-9
CHLOROMETHANE (Methyl Chloride) – New Jersey Monitored Concentrations

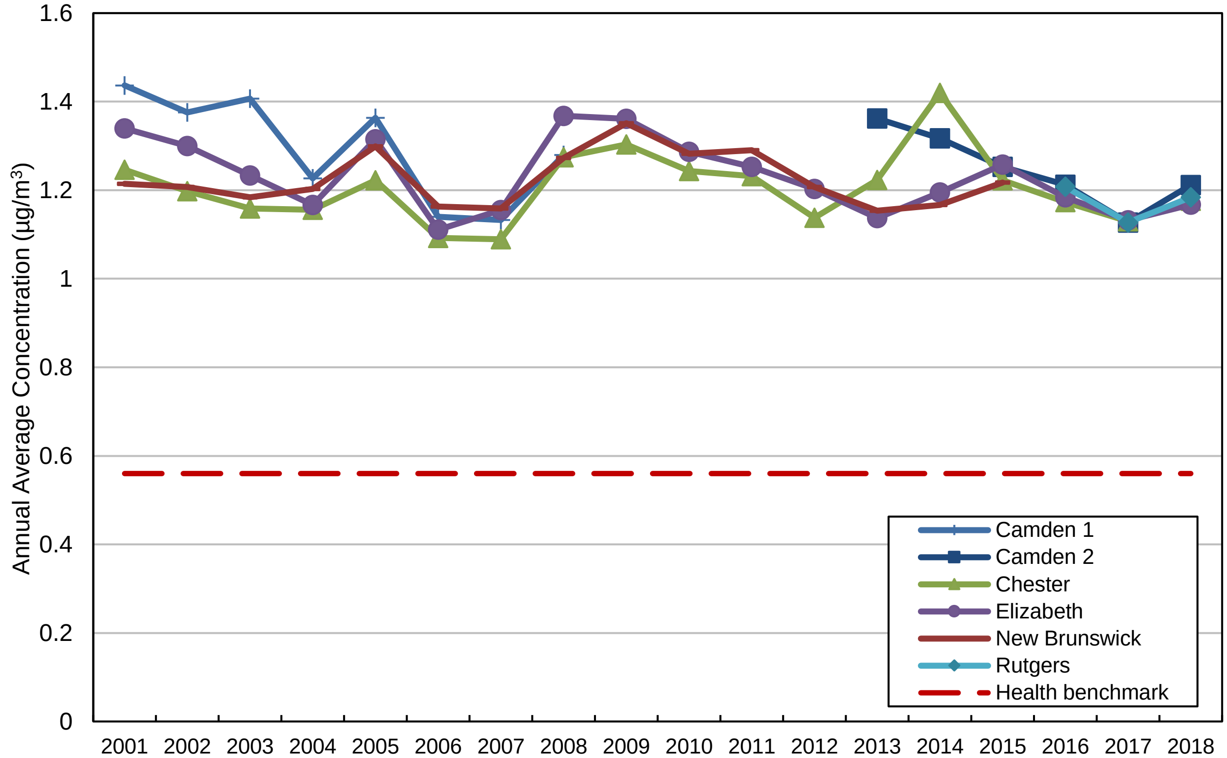


Figure 10-10
1,2-DIBROMOETHANE (Ethylene Dibromide) – New Jersey Monitored Concentrations

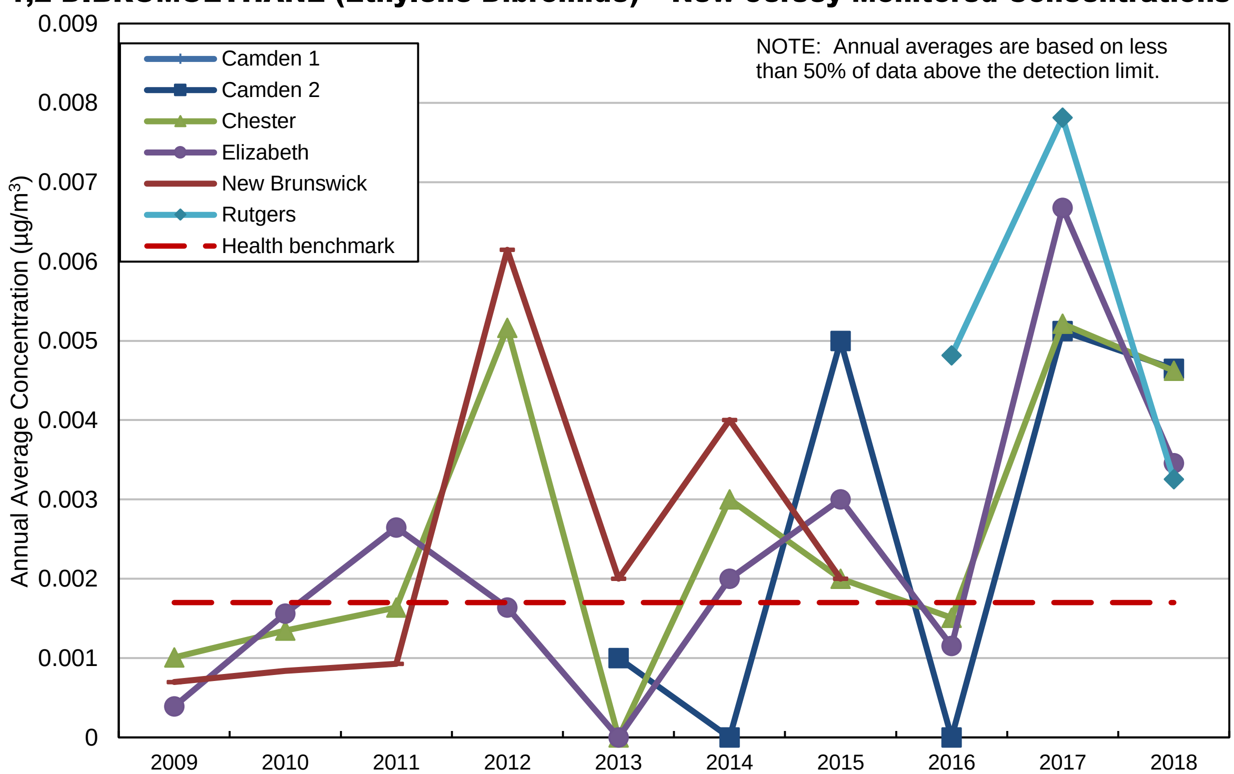


Figure 10-11
1,2-DICHLOROETHANE (Ethylene Dichloride) – New Jersey Monitored Concentrations

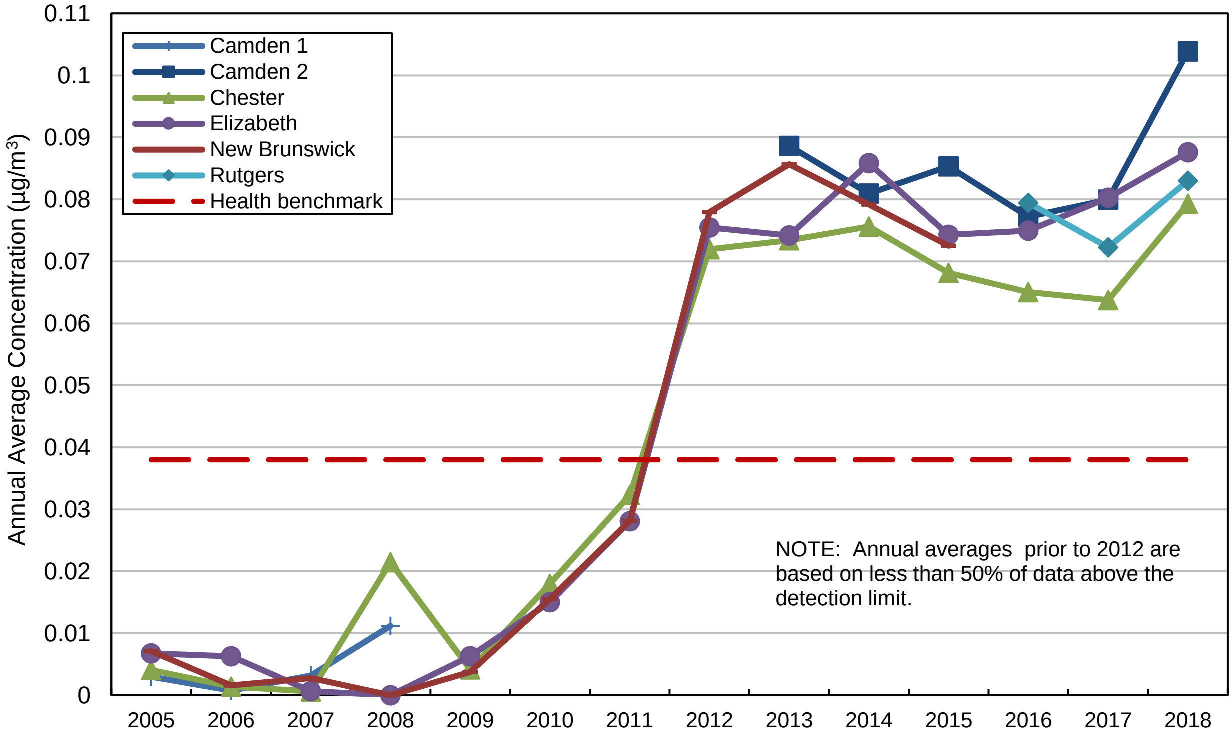


Figure 10-12
ETHYLBENZENE – New Jersey Monitored Concentrations

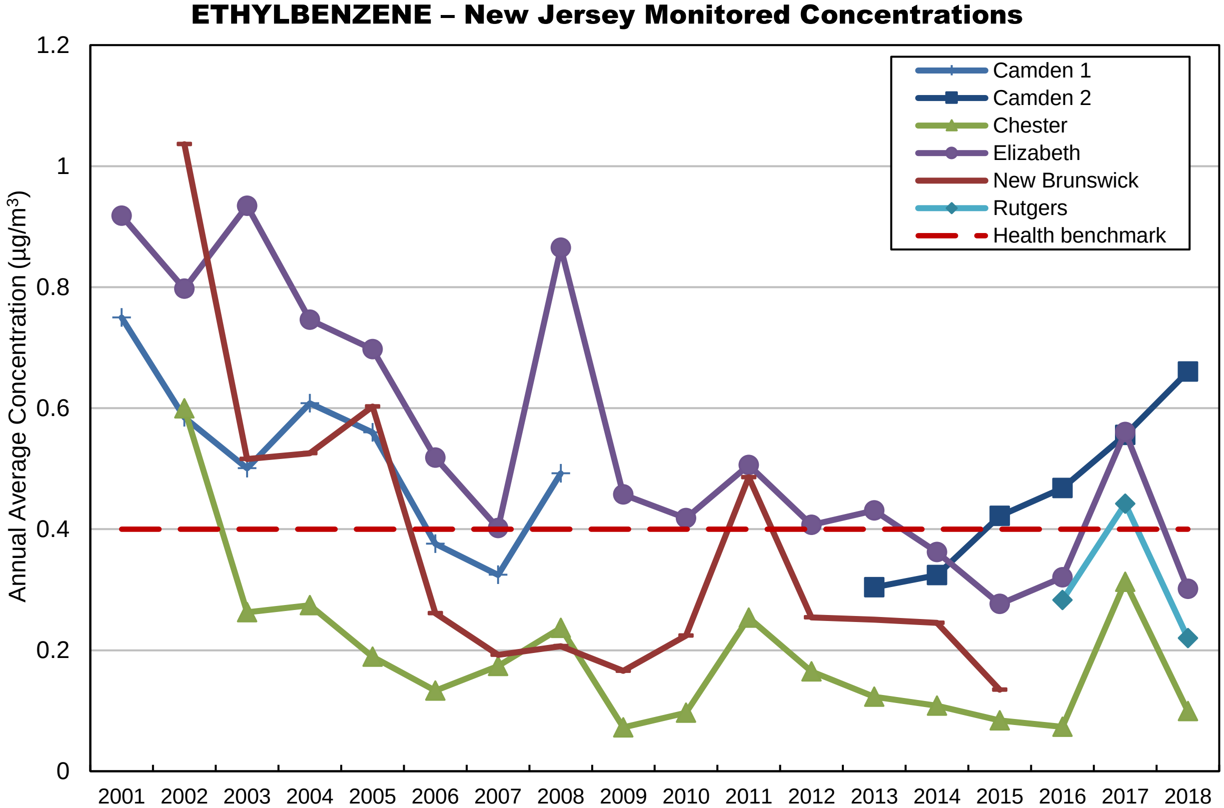


Figure 10-13
FORMALDEHYDE – New Jersey Monitored Concentrations

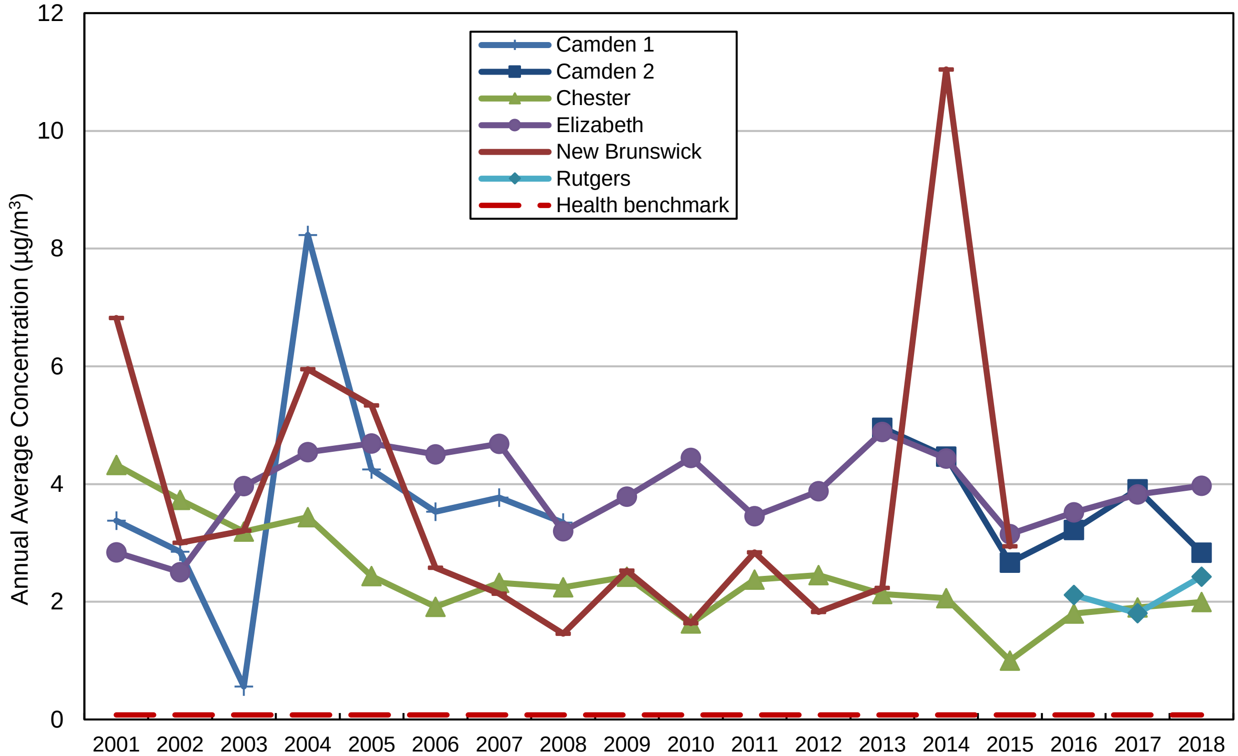


Figure 10-14
HEXACHLOROBUTADIENE – New Jersey Monitored Concentrations

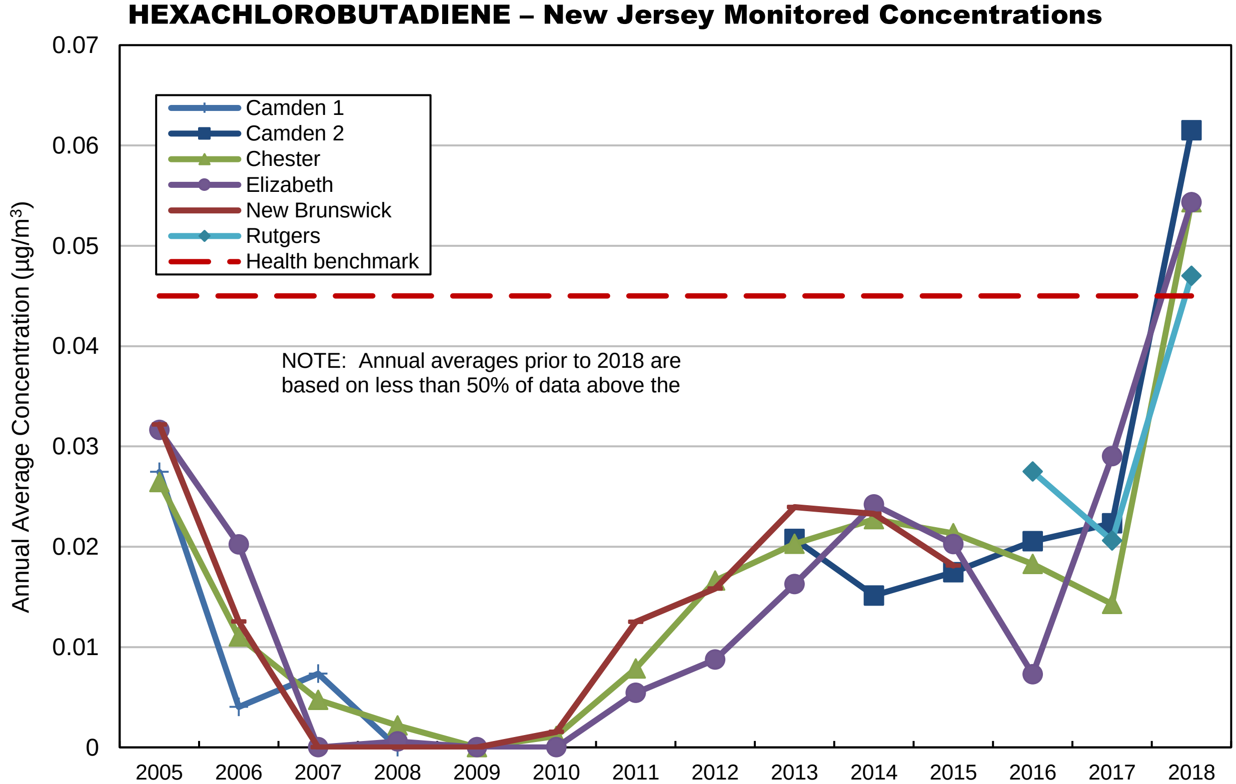


Figure 10-15
STYRENE – New Jersey Monitored Concentrations

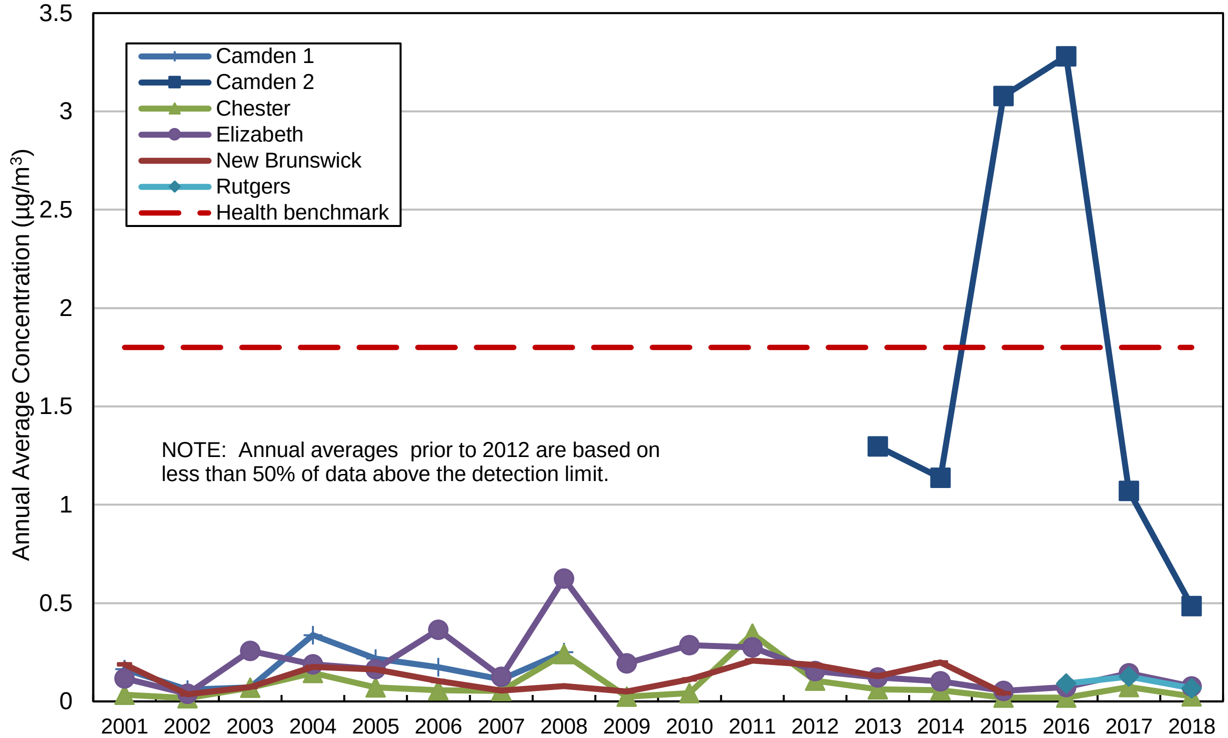


Figure 10-16
TETRACHLOROETHYLENE – New Jersey Monitored Concentrations

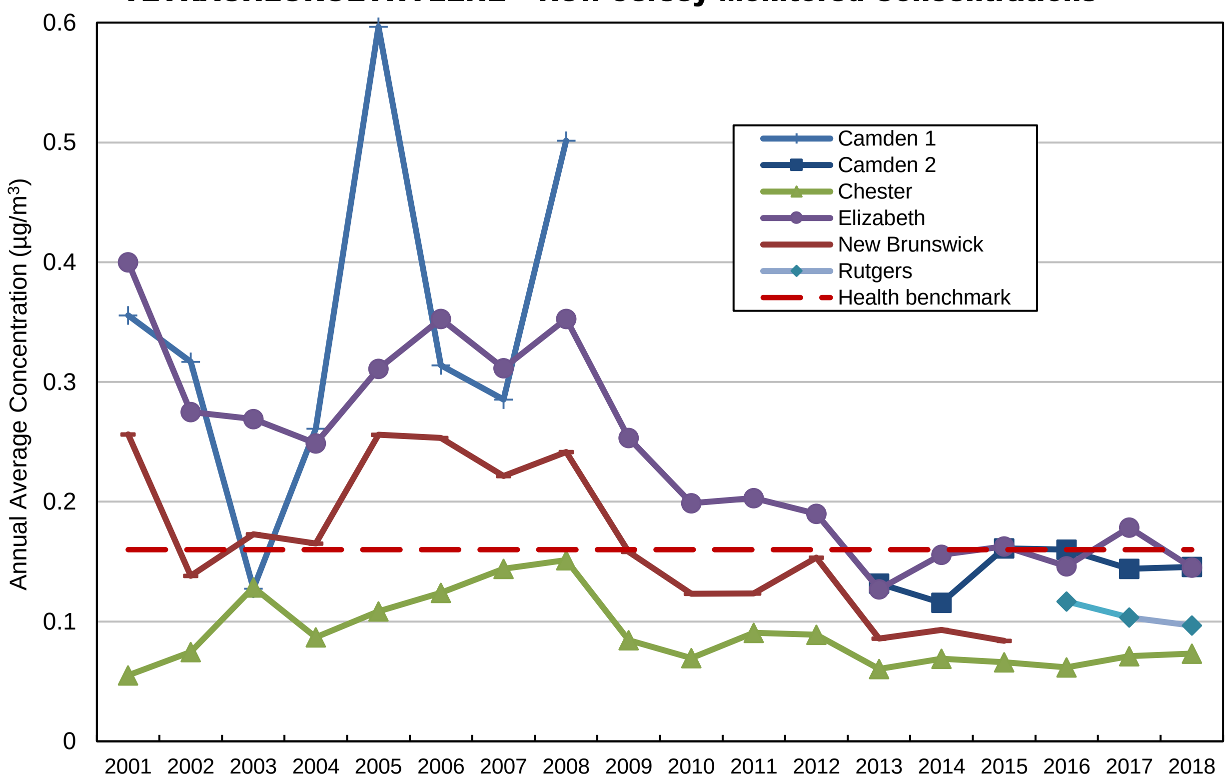


Table 10-5
CAMDEN SPRUCE STREET - 2018 NJ Toxic VOCs Monitoring Data[a]

Analyte	CAS No.	Annual Mean (ppbv)[b,c]	Annual Median (ppbv)[c]	24-Hour Maximum (ppbv)	Annual Mean ($\mu g/m^3$)[b,c]	Annual Median ($\mu g/m^3$)[c]	24-Hour Maximum ($\mu g/m^3$)	Health Bench-mark ($\mu g/m^3$)[d]	Annual Mean Risk Ratio[e]	Detection Limit ($\mu g/m^3$)	% Above Minimum Detection Limit
Acetaldehyde	75-07-0	1.064	0.953	2.640	1.916	1.716	4.757	0.45	**4**	0.031	100
Acetone	67-64-1	1.051	0.982	2.810	2.496	2.333	6.675	*31000*	0.0001	0.328	100
Acetonitrile	75-05-8	0.789	0.177	34.400	1.325	0.297	57.755	*60*	0.02	0.027	100
Acetylene	74-86-2	0.671	0.550	3.010	0.714	0.585	3.203			0.042	100
Acrolein[g]	107-02-8	0.411	0.380	0.981	0.943	0.871	2.249	*0.02*	**47**	0.516	100
Acrylonitrile	107-13-1	*0.0005*	0	0.029	*0.001*	0	0.062	0.015	0.1	0.023	2
tert-Amyl Methyl Ether	994-05-8	*0.001*	0	0.010	*0.002*	0	0.043			0.052	8
Benzaldehyde	100-52-7	0.048	0.031	0.176	0.208	0.134	0.764			0.008	100
Benzene	71-43-2	0.199	0.175	0.525	0.635	0.559	1.677	0.13	**5**	0.046	100
Bromochloromethane	74-97-5	*0.0002*	0	0.010	*0.001*	0	0.053	*40*	0.00002	0.070	2
Bromodichloromethane	75-27-4	*0.001*	0	0.015	*0.010*	0	0.099	0.027	0.4	0.111	18
Bromoform	75-25-2	*0.001*	0	0.020	*0.006*	0	0.208	0.91	0.01	0.183	5
Bromomethane	74-83-9	0.026	0.014	0.224	0.100	0.054	0.870	*5*	0.02	0.045	93
1,3-Butadiene	106-99-0	0.028	0.026	0.078	0.062	0.058	0.173	0.033	**1.9**	0.043	100
Butyraldehyde	123-72-8	0.101	0.095	0.245	0.297	0.280	0.723			0.047	100
Carbon Disulfide	75-15-0	0.018	0.015	0.090	0.057	0.045	0.280	*700*	0.00008	0.239	98
Carbon Tetrachloride	56-23-5	0.086	0.089	0.122	0.538	0.559	0.768	0.17	**3**	0.084	100
Chlorobenzene	108-90-7	*0.001*	0	0.013	*0.006*	0	0.058	*1000*	0.00001	0.088	18
Chloroethane	75-00-3	0.014	0.014	0.048	0.038	0.036	0.125	*10000*	0.000004	0.066	66
Chloroform	67-66-3	0.028	0.026	0.055	0.135	0.126	0.270	0.043	**3**	0.063	100
Chloromethane	74-87-3	0.587	0.582	0.725	1.212	1.202	1.497	0.56	**2**	0.096	100
Chloroprene	126-99-8	*0.001*	0	0.011	*0.002*	0	0.039	0.002	***1.2***	0.047	8
Crotonaldehyde	123-73-9	0.074	0.032	0.352	0.211	0.093	1.009			0.007	100
Dibromochloromethane	124-48-1	*0.001*	0	0.014	*0.015*	0	0.136	0.037	0.4	0.153	30
1,2-Dibromoethane	106-93-4	*0.001*	0	0.011	*0.005*	0	0.081	0.0017	***3***	0.145	7
m-Dichlorobenzene	541-73-1	*0.001*	0	0.010	*0.004*	0	0.061			0.109	10
o-Dichlorobenzene	95-50-1	*0.001*	0	0.012	*0.007*	0	0.072	200	0.00003	0.124	13
p-Dichlorobenzene	106-46-7	0.010	0.011	0.026	0.058	0.063	0.156	*0.091*	0.6	0.120	77
Dichlorodifluoromethane	75-71-8	0.537	0.518	0.761	2.657	2.562	3.764	*100*	0.03	0.135	100
1,1-Dichloroethane	75-34-3	*0.001*	0	0.013	*0.004*	0	0.053	0.63	0.01	0.058	10
1,2-Dichloroethane	107-06-2	0.026	0.023	0.158	0.104	0.093	0.639	0.038	**3**	0.056	100
1,1-Dichloroethene	75-35-4	*0.001*	0	0.011	*0.004*	0	0.042	*200*	0.00002	0.047	16
cis-1,2-Dichloroethylene	156-59-2	*0*	0	0	*0*	0	0			0.074	0
trans-1,2-Dichloroethylene	156-60-5	*0.004*	0	0.044	*0.017*	0	0.176			0.053	31
Dichloromethane	75-09-2	0.143	0.12	0.742	0.495	0.417	2.578	77	0.01	0.050	100

[a] See page 10-26 for footnotes.

Table 10-5 (continued)

CAMDEN SPRUCE STREET - 2018 NJ Toxic VOCs Monitoring Data[a]

Analyte	CAS No.	Annual Mean (ppbv)[b,c]	Annual Median (ppbv)[c]	24-Hour Maximum (ppbv)	Annual Mean (µg/m³)[b,c]	Annual Median (µg/m³)[c]	24-Hour Maximum (µg/m³)	Health Bench-mark (µg/m³)[d]	Annual Mean Risk Ratio[e]	Detection Limit (µg/m³)	% Above Minimum Detection Limit
1,2-Dichloropropane	78-87-5	*0.0004*	0	0.014	*0.002*	0	0.064	0.1	0.02	0.094	3
cis-1,3-Dichloropropene	10061-01-5	*0.001*	0	0.015	*0.003*	0	0.066	0.25	0.01	0.089	5
trans-1,3-Dichloropropene	10061-02-6	*0.0002*	0	0.014	*0.001*	0	0.064	0.25	0.004	0.089	2
Dichlorotetrafluoroethane	76-14-2	0.019	0.018	0.026	0.130	0.127	0.184			0.094	100
2,5-Dimethylbenzaldehyde	5779-94-2	*0*	0	0	*0*	0	0			0.013	0
Ethyl Acrylate	140-88-5	*0*	0	0	*0*	0	0	*8*		0.096	0
Ethyl tert-Butyl Ether	100-41-4	0.152	0.065	3.290	0.660	0.283	14.285	0.40	**1.7**	0.112	100
Ethylbenzene	637-92-3	*0.001*	0	0.009	*0.004*	0	0.039			0.046	16
Formaldehyde	50-00-0	2.307	1.940	9.670	2.833	2.382	11.875	0.077	**37**	0.060	100
Hexachlorobutadiene	87-68-3	0.006	0.007	0.018	0.061	0.070	0.192	0.045	**1.4**	0.292	66
Hexaldehyde	66-25-1	0.040	0.036	0.110	0.165	0.146	0.451			0.006	95
Isovaleraldehyde	590-86-3	*0*	0	0	*0*	0	0			0.009	0
Methyl Ethyl Ketone	78-93-3	0.134	0.127	0.410	0.394	0.374	1.207	*5000*	0.00008	0.110	100
Methyl Isobutyl Ketone	108-10-1	0.041	0.037	0.114	0.166	0.152	0.467	*3000*	0.00006	0.097	100
Methyl Methacrylate	80-62-6	0.015	0.008	0.215	0.054	0.029	0.757	*700*	0.0001	0.352	62
Methyl tert-Butyl Ether	1634-04-4	*0.001*	0	0.016	*0.004*	0	0.058	3.8	0.001	0.037	11
n-Octane	111-65-9	0.056	0.042	0.186	0.261	0.194	0.869			0.151	100
Propionaldehyde	123-38-6	0.159	0.148	0.377	0.377	0.352	0.896	*8*	0.05	0.004	100
Propylene	115-07-1	0.472	0.439	1.140	0.812	0.756	1.962	*3000*	0.0003	0.110	100
Styrene	100-42-5	0.114	0.053	1.300	0.485	0.224	5.537	1.8	0.3	0.155	97
1,1,2,2-Tetrachloroethane	79-34-5	*0.000*	0	0.011	*0.003*	0	0.073	0.017	0.2	0.143	7
Tetrachloroethylene	127-18-4	0.021	0.019	0.095	0.146	0.127	0.647	0.16	0.9	0.099	98
Tolualdehydes		0.050	0.040	0.098	0.246	0.199	0.484			0.014	100
Toluene	108-88-3	0.561	0.423	1.680	2.115	1.594	6.330	*3760*	0.0006	0.490	100
1,2,4-Trichlorobenzene	120-82-1	*0.004*	0	0.038	*0.027*	0	0.281	*2*	0.01	1.848	21
1,1,1-Trichloroethane	71-55-6	0.004	0.004	0.015	0.021	0.021	0.080	*1000*	0.00002	0.075	67
1,1,2-Trichloroethane	79-00-5	*0.001*	0	0.016	*0.004*	0	0.087	0.063	0.06	0.104	7
Trichloroethylene	79-01-6	0.010	0.007	0.092	0.052	0.036	0.492	0.2	0.3	0.081	59
Trichlorofluoromethane	75-69-4	0.392	0.262	1.570	2.201	1.472	8.822	*700*	0.003	0.065	100
Trichlorotrifluoroethane	76-13-1	0.079	0.080	0.091	0.608	0.609	0.698	*30000*	0.00002	0.075	100
1,2,4-Trimethylbenzene	95-63-6	0.086	0.060	0.402	0.424	0.294	1.976	*60*	0.007	0.132	98
1,3,5-Trimethylbenzene	108-67-8	0.028	0.021	0.104	0.136	0.102	0.511	*60*	0.002	0.167	98
Valeraldehyde	110-62-3	0.022	0.020	0.065	0.078	0.070	0.230			0.006	95
Vinyl chloride	75-01-4	*0.004*	0	0.036	*0.010*	0	0.093	0.11	0.09	0.033	36
m,p-Xylene	108-38-3, 106-42-3	0.539	0.176	13.600	2.338	0.764	59.050	*100*	0.02	0.156	100
o-Xylene	95-47-6	0.212	0.082	4.460	0.919	0.356	19.365	*100*	0.009	0.116	100

[a] See page 10-26 for footnotes.

Table 10-6
CHESTER - 2018 NJ Toxic VOCs Monitoring Data[a]

Analyte	CAS No.	Annual Mean (ppbv)[b,c]	Annual Median (ppbv)[c]	24-Hour Maximum (ppbv)	Annual Mean ($\mu g/m^3$)[b,c]	Annual Median ($\mu g/m^3$)[c]	24-Hour Maximum ($\mu g/m^3$)	Health Bench-mark ($\mu g/m^3$)[d]	Annual Mean Risk Ratio[e]	Detection Limit ($\mu g/m^3$)	% Above Minimum Detection Limit
Acetaldehyde	75-07-0	0.543	0.437	1.650	0.979	0.786	2.973	0.45	**2**	0.031	100
Acetone	67-64-1	0.787	0.846	2.240	1.870	2.008	5.321	*31000*	0.0001	0.328	100
Acetonitrile	75-05-8	0.496	0.234	9.940	0.833	0.393	16.689	*60*	0.01	0.027	100
Acetylene	74-86-2	0.445	0.324	3.330	0.474	0.345	3.544			0.042	100
Acrolein[g]	107-02-8	0.351	0.322	0.973	0.804	0.738	2.231	*0.02*	**40**	0.516	100
Acrylonitrile	107-13-1	*0.0004*	0	0.024	*0.001*	0	0.052	0.015	0.1	0.023	2
tert-Amyl Methyl Ether	994-05-8	*0.001*	0	0.010	*0.003*	0	0.041			0.052	9
Benzaldehyde	100-52-7	0.018	0.016	0.081	0.079	0.068	0.352			0.008	98
Benzene	71-43-2	0.106	0.096	0.207	0.338	0.305	0.661	0.13	**3**	0.046	100
Bromochloromethane	74-97-5	*0.0003*	0	0.015	*0.001*	0	0.079	*40*	0.00004	0.070	2
Bromodichloromethane	75-27-4	*0.001*	0	0.012	*0.005*	0	0.081	0.027	0.2	0.111	11
Bromoform	75-25-2	*0.001*	0	0.016	*0.008*	0	0.164	0.91	0.01	0.183	7
Bromomethane	74-83-9	0.010	0.010	0.022	0.038	0.038	0.087	*5*	0.01	0.045	91
1,3-Butadiene	106-99-0	0.010	0.010	0.033	0.022	0.021	0.074	0.033	0.7	0.043	70
Butyraldehyde	123-72-8	0.053	0.050	0.126	0.157	0.149	0.372			0.047	100
Carbon Disulfide	75-15-0	0.018	0.017	0.039	0.056	0.054	0.123	*700*	0.0001	0.239	100
Carbon Tetrachloride	56-23-5	0.086	0.089	0.122	0.541	0.557	0.768	0.17	**3**	0.084	100
Chlorobenzene	108-90-7	*0.001*	0	0.016	*0.006*	0	0.072	*1000*	0.00001	0.088	16
Chloroethane	75-00-3	*0.009*	0	0.048	*0.024*	0	0.127	*10000*	0.000002	0.066	41
Chloroform	67-66-3	0.023	0.022	0.048	0.113	0.109	0.235	0.043	**3**	0.063	100
Chloromethane	74-87-3	0.570	0.576	0.671	1.176	1.189	1.386	0.56	**2**	0.096	100
Chloroprene	126-99-8	*0.001*	0	0.014	*0.003*	0	0.050	0.002	***1.7***	0.047	9
Crotonaldehyde	123-73-9	0.073	0.021	0.433	0.211	0.061	1.241			0.007	100
Dibromochloromethane	124-48-1	*0.001*	0	0.014	*0.013*	0	0.134	0.037	0.3	0.153	21
1,2-Dibromoethane	106-93-4	*0.001*	0	0.016	*0.005*	0	0.124	0.0017	***3***	0.145	5
m-Dichlorobenzene	541-73-1	*0.001*	0	0.014	*0.007*	0	0.083			0.109	13
o-Dichlorobenzene	95-50-1	*0.001*	0	0.014	*0.007*	0	0.082	200	0.00004	0.124	13
p-Dichlorobenzene	106-46-7	*0.002*	0	0.024	*0.014*	0	0.146	*0.091*	0.2	0.120	21
Dichlorodifluoromethane	75-71-8	0.507	0.508	0.594	2.509	2.512	2.938	*100*	0.03	0.135	100
1,1-Dichloroethane	75-34-3	*0.001*	0	0.013	*0.005*	0	0.053	0.63	0.01	0.058	14
1,2-Dichloroethane	107-06-2	0.020	0.019	0.034	0.079	0.078	0.138	0.038	**2**	0.056	100
1,1-Dichloroethene	75-35-4	*0.001*	0	0.010	*0.004*	0	0.041	*200*	0.00002	0.047	16
cis-1,2-Dichloroethylene	156-59-2	*0.0002*	0	0.010	*0.001*	0	0.038			0.074	0
trans-1,2-Dichloroethylene	156-60-5	*0.001*	0	0.011	*0.003*	0	0.045			0.053	9
Dichloromethane	75-09-2	0.113	0.104	0.348	0.392	0.361	1.209	77	0.01	0.050	100

[a] See page 10-26 for footnotes.

Table 10-6 (continued)

CHESTER - 2018 NJ Toxic VOCs Monitoring Data[a]

Analyte	CAS No.	Annual Mean (ppbv)[b,c]	Annual Median (ppbv)[c]	24-Hour Maximum (ppbv)	Annual Mean (µg/m³)[b,c]	Annual Median (µg/m³)[c]	24-Hour Maximum (µg/m³)	Health Bench-mark (µg/m³)[d]	Annual Mean Risk Ratio[e]	Detection Limit (µg/m³)	% Above Minimum Detection Limit
1,2-Dichloropropane	78-87-5	*0.002*	0	0.017	*0.008*	0	0.078	0.1	0.08	0.094	14
cis-1,3-Dichloropropene	10061-01-5	*0.001*	0	0.017	*0.003*	0	0.075	0.25	0.01	0.089	5
trans-1,3-Dichloropropene	10061-02-6	*0*	0	0	*0*	0	0	0.25		0.089	0
Dichlorotetrafluoroethane	76-14-2	0.019	0.018	0.028	0.129	0.125	0.195			0.094	100
2,5-Dimethylbenzaldehyde	5779-94-2	*0*	0	0	*0*	0	0			0.013	0
Ethyl Acrylate	140-88-5	*0.001*	0	0.013	*0.002*	0	0.051999877	*8*		0.096	5
Ethylbenzene	100-41-4	0.023	0.020	0.094	0.099	0.089	0.407	0.40	0.2	0.112	100
Ethyl tert-Butyl Ether	637-92-3	*0.001*	0	0.009	*0.004*	0	0.038			0.046	16
Formaldehyde	50-00-0	1.627	1.160	6.140	1.998	1.425	7.540	0.077	**26**	0.060	100
Hexachlorobutadiene	87-68-3	0.005	0.006	0.026	0.054	0.059	0.274	0.045	**1.2**	0.292	55
Hexaldehyde	66-25-1	0.020	0.015	0.078	0.081	0.060	0.321			0.006	96
Isovaleraldehyde	590-86-3	*0*	0	0	*0*	0	0			0.009	0
Methyl Ethyl Ketone	78-93-3	0.104	0.099	0.368	0.308	0.291	1.084	*5000*	0.0001	0.110	98
Methyl Isobutyl Ketone	108-10-1	0.025	0.023	0.065	0.102	0.095	0.267	*3000*	0.00003	0.097	96
Methyl Methacrylate	80-62-6	*0.001*	0	0.017	*0.005*	0	0.058	*700*	0.00001	0.352	18
Methyl tert-Butyl Ether	1634-04-4	*0.001*	0	0.010	*0.003*	0	0.037	3.8	0.001	0.037	11
n-Octane	111-65-9	0.020	0.019	0.045	0.093	0.090	0.209			0.151	100
Propionaldehyde	123-38-6	0.090	0.077	0.191	0.213	0.184	0.454	*8*	0.03	0.004	100
Propylene	115-07-1	0.201	0.182	0.650	0.346	0.312	1.119	*3000*	0.0001	0.110	100
Styrene	100-42-5	0.006	0.005	0.029	0.026	0.020	0.123	1.8	0.01	0.155	52
1,1,2,2-Tetrachloroethane	79-34-5	*0.001*	0	0.010	*0.006*	0	0.070	0.017	0.3	0.143	13
Tetrachloroethylene	127-18-4	0.011	0.010	0.027	0.073	0.070	0.186	0.16	0.5	0.099	91
Tolualdehydes		0.028	0.023	0.075	0.138	0.115	0.370			0.014	93
Toluene	108-88-3	0.135	0.131	0.324	0.509	0.494	1.221	*3760*	0.0001	0.490	100
1,2,4-Trichlorobenzene	120-82-1	*0.004*	0	0.024	*0.028*	0	0.180	*2*	0.01	1.848	23
1,1,1-Trichloroethane	71-55-6	*0.002*	0	0.013	*0.013*	0	0.070	*1000*	0.00001	0.075	39
1,1,2-Trichloroethane	79-00-5	*0.0005*	0	0.016	*0.003*	0	0.086	0.063	0.04	0.104	4
Trichloroethylene	79-01-6	*0.002*	0	0.013	*0.008*	0	0.068	0.2	0.04	0.081	18
Trichlorofluoromethane	75-69-4	0.221	0.219	0.270	1.241	1.231	1.517	*700*	0.002	0.065	100
Trichlorotrifluoroethane	76-13-1	0.079	0.079	0.094	0.605	0.602	0.723	*30000*	0.00002	0.075	100
1,2,4-Trimethylbenzene	95-63-6	0.014	0.013	0.039	0.071	0.066	0.189	*60*	0.001	0.132	98
1,3,5-Trimethylbenzene	108-67-8	0.007	0.005	0.023	0.033	0.026	0.113	*60*	0.001	0.167	86
Valeraldehyde	110-62-3	0.009	0.009	0.034	0.033	0.031	0.120			0.006	80
Vinyl chloride	75-01-4	*0.002*	0	0.014	*0.004*	0	0.036	0.11	0.04	0.033	20
m,p-Xylene	108-38-3, 106-42-3	0.045	0.039	0.273	0.196	0.168	1.185	*100*	0.002	0.156	100
o-Xylene	95-47-6	0.024	0.022	0.083	0.106	0.096	0.361	*100*	0.001	0.116	100

[a] See page 10-26 for footnotes.

Table 10-7
ELIZABETH LAB - 2018 NJ Toxic VOCs Monitoring Data[a]

Analyte	CAS No.	Annual Mean (ppbv)[b,c]	Annual Median (ppbv)[c]	24-Hour Maximum (ppbv)	Annual Mean (µg/m³)[b,c]	Annual Median (µg/m³)[c]	24-Hour Maximum (µg/m³)	Health Bench-mark (µg/m³)[d]	Annual Mean Risk Ratio[e]	Detection Limit (µg/m³)	% Above Minimum Detection Limit
Acetaldehyde	75-07-0	1.259	1.120	3.520	2.268	2.018	6.342	0.45	**5**	0.031	100
Acetone	67-64-1	1.193	1.010	5.180	2.834	2.399	12.305	*31000*	0.0001	0.328	100
Acetonitrile	75-05-8	0.491	0.206	9.250	0.824	0.345	15.530	*60*	0.01	0.027	100
Acetylene	74-86-2	0.818	0.673	2.310	0.871	0.716	2.458			0.042	100
Acrolein[g]	107-02-8	0.396	0.364	0.946	0.908	0.835	2.169	*0.02*	**45**	0.516	100
Acrylonitrile	107-13-1	*0.0004*	0	0.023	*0.001*	0	0.049	0.015	0.1	0.023	3
tert-Amyl Methyl Ether	994-05-8	*0.0004*	0	0.010	*0.002*	0	0.040			0.052	7
Benzaldehyde	100-52-7	0.027	0.025	0.106	0.119	0.109	0.460			0.008	98
Benzene	71-43-2	0.222	0.197	0.501	0.709	0.628	1.601	0.13	**5**	0.046	100
Bromochloromethane	74-97-5	*0.0004*	0	0.015	*0.002*	0	0.077	*40*	0.0001	0.070	5
Bromodichloromethane	75-27-4	*0.001*	0	0.019	*0.005*	0	0.129	0.027	0.2	0.111	8
Bromoform	75-25-2	*0.001*	0	0.019	*0.008*	0	0.200	0.91	0.01	0.183	10
Bromomethane	74-83-9	0.011	0.011	0.044	0.044	0.041	0.170	*5*	0.01	0.045	90
1,3-Butadiene	106-99-0	0.041	0.037	0.103	0.092	0.082	0.228	0.033	**3**	0.043	100
Butyraldehyde	123-72-8	0.103	0.093	0.279	0.304	0.273	0.823			0.047	100
Carbon Disulfide	75-15-0	0.019	0.016	0.052	0.060	0.049	0.162	*700*	0.00009	0.239	98
Carbon Tetrachloride	56-23-5	0.089	0.090	0.127	0.557	0.566	0.799	0.17	**3**	0.084	100
Chlorobenzene	108-90-7	*0.001*	0	0.011	*0.006*	0	0.052	*1000*	0.00001	0.088	20
Chloroethane	75-00-3	0.012	0.013	0.043	0.032	0.035	0.113	*10000*	0.000003	0.066	61
Chloroform	67-66-3	0.032	0.027	0.079	0.154	0.133	0.385	0.043	**4**	0.063	100
Chloromethane	74-87-3	0.565	0.571	0.692	1.167	1.178	1.429	0.56	**2**	0.096	100
Chloroprene	126-99-8	*0.0003*	0	0.013	*0.001*	0	0.046	0.002	0.6	0.047	5
Crotonaldehyde	123-73-9	0.109	0.045	0.783	0.311	0.128	2.245			0.007	100
Dibromochloromethane	124-48-1	*0.001*	0	0.014	*0.014*	0	0.143	0.037	0.4	0.153	30
1,2-Dibromoethane	106-93-4	*0.0005*	0	0.012	*0.003*	0	0.089	0.0017	**2**	0.145	7
m-Dichlorobenzene	541-73-1	*0.001*	0	0.014	*0.005*	0	0.083			0.109	11
o-Dichlorobenzene	95-50-1	*0.001*	0	0.013	*0.005*	0	0.080	200	0.00003	0.124	11
p-Dichlorobenzene	106-46-7	0.009	0.009	0.038	0.053	0.057	0.227	*0.091*	0.6	0.120	61
Dichlorodifluoromethane	75-71-8	0.501	0.504	0.559	2.480	2.490	2.765	*100*	0.02	0.135	100
1,1-Dichloroethane	75-34-3	*0.001*	0	0.013	*0.004*	0	0.054	0.63	0.01	0.058	13
1,2-Dichloroethane	107-06-2	0.022	0.021	0.033	0.088	0.086	0.132	0.038	**2**	0.056	100
1,1-Dichloroethene	75-35-4	*0.001*	0	0.011	*0.004*	0	0.044	*200*	0.00002	0.047	15
cis-1,2-Dichloroethylene	156-59-2	*0*	0	0	*0*	0	0			0.074	0
trans-1,2-Dichloroethylene	156-60-5	*0.002*	0	0.018	*0.007*	0	0.073			0.053	20
Dichloromethane	75-09-2	0.155	0.134	0.682	0.537	0.466	2.369	77	0.01	0.050	100

[a] See page 10-26 for footnotes.

Table 10-7 (continued)
ELIZABETH LAB - 2018 NJ Toxic VOCs Monitoring Data[a]

Analyte	CAS No.	Annual Mean (ppbv)[b,c]	Annual Median (ppbv)[c]	24-Hour Maximum (ppbv)	Annual Mean (µg/m³)[b,c]	Annual Median (µg/m³)[c]	24-Hour Maximum (µg/m³)	Health Bench-mark (µg/m³)[d]	Annual Mean Risk Ratio[e]	Detection Limit (µg/m³)	% Above Minimum Detection Limit
1,2-Dichloropropane	78-87-5	*0.0004*	0	0.016	*0.002*	0	0.072	0.1	0.02	0.094	5
cis-1,3-Dichloropropene	10061-01-5	*0.001*	0	0.014	*0.003*	0	0.061	0.25	0.01	0.089	7
trans-1,3-Dichloropropene	10061-02-6	*0.0002*	0	0.012	*0.001*	0	0.055	0.25	0.004	0.089	3
Dichlorotetrafluoroethane	76-14-2	0.018	0.018	0.025	0.127	0.122	0.178			0.094	100
2,5-Dimethylbenzaldehyde	5779-94-2	*0*	0	0	*0*	0	0			0.013	2
Ethyl Acrylate	140-88-5	*0*	0	0	*0*	0	0	*8*		0.096	2
Ethyl tert-Butyl Ether	100-41-4	0.069	0.060	0.204	0.301	0.262	0.886	0.40	0.8	0.112	100
Ethylbenzene	637-92-3	*0.001*	0	0.013	*0.006*	0	0.055			0.046	21
Formaldehyde	50-00-0	3.234	2.575	13.300	3.971	3.162	16.333	0.077	**52**	0.060	100
Hexachlorobutadiene	87-68-3	0.005	0.006	0.020	0.054	0.061	0.210	0.045	**1.2**	0.292	57
Hexaldehyde	66-25-1	0.038	0.035	0.099	0.155	0.143	0.407			0.006	98
Isovaleraldehyde	590-86-3	*0*	0	0	*0*	0	0			0.009	2
Methyl Ethyl Ketone	78-93-3	0.165	0.132	0.577	0.486	0.389	1.699	*5000*	0.0001	0.110	100
Methyl Isobutyl Ketone	108-10-1	0.045	0.039	0.145	0.183	0.161	0.594	*3000*	0.00006	0.097	95
Methyl Methacrylate	80-62-6	*0.007*	0	0.072	*0.024*	0	0.253	*700*	0.00003	0.352	38
Methyl tert-Butyl Ether	1634-04-4	*0.001*	0	0.023	*0.004*	0	0.084	3.8	0.001	0.037	13
n-Octane	111-65-9	0.071	0.055	0.211	0.331	0.259	0.986			0.151	100
Propionaldehyde	123-38-6	0.200	0.170	0.662	0.474	0.404	1.573	*8*	0.06	0.004	100
Propylene	115-07-1	1.747	0.742	11.800	3.007	1.276	20.309	*3000*	0.001	0.110	100
Styrene	100-42-5	0.018	0.016	0.054	0.077	0.067	0.229	1.8	0.04	0.155	95
1,1,2,2-Tetrachloroethane	79-34-5	*0.001*	0	0.012	*0.004*	0	0.082	0.017	0.2	0.143	8
Tetrachloroethylene	127-18-4	0.021	0.018	0.098	0.145	0.121	0.663	0.16	0.9	0.099	100
Tolualdehydes		0.043	0.036	0.083	0.212	0.178	0.410			0.014	100
Toluene	108-88-3	0.455	0.385	1.500	1.716	1.449	5.652	*3760*	0.0005	0.490	100
1,2,4-Trichlorobenzene	120-82-1	*0.003*	0	0.023	*0.025*	0	0.174	*2*	0.01	1.848	20
1,1,1-Trichloroethane	71-55-6	0.004	0.004	0.024	0.020	0.021	0.133	*1000*	0.00002	0.075	59
1,1,2-Trichloroethane	79-00-5	*0.0003*	0	0.012	*0.002*	0	0.063	0.063	0.03	0.104	5
Trichloroethylene	79-01-6	0.006	0.003	0.059	0.031	0.014	0.315	0.2	0.2	0.081	51
Trichlorofluoromethane	75-69-4	0.225	0.222	0.293	1.265	1.247	1.646	*700*	0.002	0.065	100
Trichlorotrifluoroethane	76-13-1	0.078	0.079	0.093	0.598	0.602	0.710	*30000*	0.00002	0.075	100
1,2,4-Trimethylbenzene	95-63-6	0.061	0.054	0.181	0.301	0.267	0.890	*60*	0.005	0.132	100
1,3,5-Trimethylbenzene	108-67-8	0.020	0.019	0.051	0.099	0.093	0.251	*60*	0.002	0.167	98
Valeraldehyde	110-62-3	0.026	0.020	0.075	0.091	0.070	0.265			0.006	97
Vinyl chloride	75-01-4	*0.002*	0	0.016	*0.005*	0	0.040	0.11	0.05	0.033	26
m,p-Xylene	108-38-3, 106-42-3	0.188	0.154	0.562	0.816	0.666	2.440	*100*	0.01	0.156	100
o-Xylene	95-47-6	0.083	0.068	0.228	0.361	0.297	0.990	*100*	0.004	0.116	100

[a] See page 10-26 for footnotes.

Table 10-8

RUTGERS UNIVERSITY - 2018 NJ Toxic VOCs Monitoring Data[a]

Analyte	CAS No.	Annual Mean (ppbv)[b,c]	Annual Median (ppbv)[c]	24-Hour Maximum (ppbv)	Annual Mean (µg/m^3)[b,c]	Annual Median (µg/m^3)[c]	24-Hour Maximum (µg/m^3)	Health Bench-mark (µg/m^3)[d]	Annual Mean Risk Ratio[e]	Detection Limit (µg/m^3)	% Above Minimum Detection Limit
Acetaldehyde	75-07-0	0.744	0.692	2.320	1.340	1.247	4.180	0.45	**3**	0.031	100
Acetone	67-64-1	0.906	0.932	3.250	2.152	2.214	7.720	*31000*	0.0001	0.328	100
Acetonitrile	75-05-8	0.683	0.194	14.900	1.147	0.326	25.016	*60*	0.02	0.027	100
Acetylene	74-86-2	0.555	0.443	1.620	0.591	0.471	1.724			0.042	100
Acrolein[g]	107-02-8	0.339	0.334	0.691	0.777	0.766	1.584	*0.02*	**39**	0.516	100
Acrylonitrile	107-13-1	*0*	0	0	*0*	0	0	0.015		0.023	0
tert-Amyl Methyl Ether	994-05-8	*0.0004*	0	0.011	*0.002*	0	0.044			0.052	7
Benzaldehyde	100-52-7	0.025	0.018	0.129	0.108	0.079	0.560			0.008	96
Benzene	71-43-2	0.137	0.126	0.295	0.437	0.403	0.942	0.13	**3**	0.046	100
Bromochloromethane	74-97-5	*0.0003*	0	0.015	*0.001*	0	0.077	*40*	0.00003	0.070	2
Bromodichloromethane	75-27-4	*0.001*	0	0.016	*0.008*	0	0.105	0.027	0.3	0.111	18
Bromoform	75-25-2	*0.001*	0	0.019	*0.008*	0	0.197	0.91	0.01	0.183	7
Bromomethane	74-83-9	0.011	0.010	0.053	0.041	0.039	0.207	*5*	0.01	0.045	85
1,3-Butadiene	106-99-0	0.019	0.017	0.054	0.041	0.037	0.119	0.033	**1.3**	0.043	91
Butyraldehyde	123-72-8	0.080	0.071	0.488	0.237	0.211	1.439			0.047	100
Carbon Disulfide	75-15-0	0.020	0.018	0.067	0.062	0.055	0.210	*700*	0.0001	0.239	100
Carbon Tetrachloride	56-23-5	0.087	0.092	0.124	0.549	0.580	0.780	0.17	**3**	0.084	100
Chlorobenzene	108-90-7	*0.002*	0	0.015	*0.007*	0	0.067	*1000*	0.00001	0.088	22
Chloroethane	75-00-3	0.027	0.014	0.288	0.072	0.038	0.760	*10000*	0.00001	0.066	62
Chloroform	67-66-3	0.030	0.026	0.063	0.149	0.129	0.308	0.043	**3**	0.063	100
Chloromethane	74-87-3	0.573	0.577	0.686	1.184	1.192	1.417	0.56	**2**	0.096	100
Chloroprene	126-99-8	*0.0002*	0	0.007	*0.001*	0	0.026	0.002	0.4	0.047	4
Crotonaldehyde	123-73-9	0.072	0.029	0.408	0.207	0.083	1.170			0.007	100
Dibromochloromethane	124-48-1	*0.001*	0	0.015	*0.011*	0	0.146	0.037	0.3	0.153	20
1,2-Dibromoethane	106-93-4	*0.0004*	0	0.016	*0.003*	0	0.124	0.0017	***2***	0.145	4
m-Dichlorobenzene	541-73-1	*0.001*	0	0.011	*0.003*	0	0.063			0.109	7
o-Dichlorobenzene	95-50-1	*0.001*	0	0.014	*0.006*	0	0.085	200	0.00003	0.124	11
p-Dichlorobenzene	106-46-7	0.006	0.006	0.028	0.034	0.033	0.166	*0.091*	0.4	0.120	51
Dichlorodifluoromethane	75-71-8	0.506	0.511	0.576	2.504	2.527	2.849	*100*	0.03	0.135	100
1,1-Dichloroethane	75-34-3	*0.001*	0	0.011	*0.004*	0	0.043	0.63	0.01	0.058	11
1,2-Dichloroethane	107-06-2	0.021	0.020	0.028	0.083	0.080	0.114	0.038	**2**	0.056	100
1,1-Dichloroethene	75-35-4	*0.001*	0	0.011	*0.004*	0	0.044	*200*	0.00002	0.047	15
cis-1,2-Dichloroethylene	156-59-2	*0*	0	0	*0*	0	0			0.074	0
trans-1,2-Dichloroethylene	156-60-5	*0.001*	0	0.014	*0.005*	0	0.054			0.053	13
Dichloromethane	75-09-2	0.139	0.121	0.689	0.482	0.420	2.394	77	0.01	0.050	100

[a] See page 10-26 for footnotes.

Table 10-8 (continued)
RUTGERS UNIVERSITY - 2018 NJ Toxic VOCs Monitoring Data[a]

Analyte	CAS No.	Annual Mean (ppbv)[b,c]	Annual Median (ppbv)[c]	24-Hour Maximum (ppbv)	Annual Mean (μg/m³)[b,c]	Annual Median (μg/m³)[c]	24-Hour Maximum (μg/m³)	Health Benchmark (μg/m³)[d]	Annual Mean Risk Ratio[e]	Detection Limit (μg/m³)	% Above Minimum Detection Limit
1,2-Dichloropropane	78-87-5	*0.001*	0	0.014	*0.004*	0	0.063	0.1	0.04	0.094	7
cis-1,3-Dichloropropene	10061-01-5	*0.0004*	0	0.015	*0.002*	0	0.066	0.25	0.01	0.089	4
trans-1,3-Dichloropropene	10061-02-6	*0.0004*	0	0.019	*0.002*	0	0.088	0.25	0.006	0.089	2
Dichlorotetrafluoroethane	76-14-2	0.018	0.018	0.026	0.128	0.127	0.184			0.094	100
2,5-Dimethylbenzaldehyde	5779-94-2	*0*	0	0	*0*	0	0			0.013	0
Ethyl Acrylate	140-88-5	*0*	0	0	*0*	0	0	*8*		0.096	0
Ethyl tert-Butyl Ether	100-41-4	0.051	0.037	0.344	0.220	0.159	1.494	0.40	0.6	0.112	100
Ethylbenzene	637-92-3	0.007	0.009	0.020	0.031	0.039	0.084			0.046	71
Formaldehyde	50-00-0	1.977	1.330	8.360	2.427	1.633	10.267	0.077	**32**	0.060	100
Hexachlorobutadiene	87-68-3	0.004	0.005	0.025	0.047	0.051	0.270	0.045	**1.0**	0.292	51
Hexaldehyde	66-25-1	0.055	0.027	0.980	0.226	0.110	4.015			0.006	96
Isovaleraldehyde	590-86-3	*0*	0	0	*0*	0	0			0.009	0
Methyl Ethyl Ketone	78-93-3	0.181	0.130	2.150	0.533	0.383	6.331	*5000*	0.0001	0.110	98
Methyl Isobutyl Ketone	108-10-1	0.030	0.029	0.095	0.122	0.119	0.390	*3000*	0.00004	0.097	93
Methyl Methacrylate	80-62-6	*0.004*	0	0.036	*0.015*	0	0.125	*700*	0.0000	0.352	38
Methyl tert-Butyl Ether	1634-04-4	*0.002*	0	0.017	*0.008*	0	0.061	3.8	0.002	0.037	27
n-Octane	111-65-9	0.026	0.024	0.100	0.123	0.113	0.467			0.151	100
Propionaldehyde	123-38-6	0.117	0.114	0.369	0.277	0.271	0.877	*8*	0.03	0.004	98
Propylene	115-07-1	0.297	0.282	0.790	0.511	0.485	1.360	*3000*	0.0002	0.110	100
Styrene	100-42-5	0.016	0.014	0.118	0.067	0.059	0.503	1.8	0.04	0.155	85
1,1,2,2-Tetrachloroethane	79-34-5	*0.001*	0	0.013	*0.004*	0	0.087	0.017	0.2	0.143	7
Tetrachloroethylene	127-18-4	0.014	0.013	0.063	0.097	0.090	0.428	0.16	0.6	0.099	96
Tolualdehydes		0.033	0.028	0.094	0.163	0.138	0.463			0.014	97
Toluene	108-88-3	0.223	0.212	0.856	0.842	0.799	3.225	*3760*	0.0002	0.490	100
1,2,4-Trichlorobenzene	120-82-1	*0.003*	0	0.022	*0.021*	0	0.160	*2*	0.01	1.848	18
1,1,1-Trichloroethane	71-55-6	0.003	0.004	0.015	0.017	0.020	0.079	*1000*	0.00002	0.075	55
1,1,2-Trichloroethane	79-00-5	*0.0003*	0	0.015	*0.001*	0	0.080	0.063	0.02	0.104	2
Trichloroethylene	79-01-6	*0.003*	0	0.014	*0.014*	0	0.077	0.2	0.1	0.081	31
Trichlorofluoromethane	75-69-4	0.222	0.220	0.296	1.250	1.236	1.663	*700*	0.002	0.065	100
Trichlorotrifluoroethane	76-13-1	0.079	0.080	0.090	0.604	0.611	0.693	*30000*	0.00002	0.075	100
1,2,4-Trimethylbenzene	95-63-6	0.027	0.022	0.113	0.134	0.106	0.555	*60*	0.002	0.132	98
1,3,5-Trimethylbenzene	108-67-8	0.011	0.009	0.044	0.052	0.045	0.217	*60*	0.001	0.167	91
Valeraldehyde	110-62-3	0.022	0.014	0.238	0.077	0.048	0.838			0.006	93
Vinyl chloride	75-01-4	*0.002*	0	0.015	*0.005*	0	0.038	0.11	0.04	0.033	18
m,p-Xylene	108-38-3, 106-42-3	0.115	0.072	1.150	0.499	0.314	4.993	*100*	0.005	0.156	100
o-Xylene	95-47-6	0.054	0.037	0.514	0.232	0.161	2.232	*100*	0.002	0.116	100

[a] See page 10-26 for footnotes.

Footnotes for Tables 10-5 through 10-8

[b] Concentrations in italics are arithmetic means (or averages) based on less than 50% of the samples above the detection limit.

[c] 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.

[d] A health benchmark is defined as the chemical-specific air concentration above which there may be human health concerns. 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 non-carcinogen, 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. These toxicity values are not available for all chemicals. For more information, go to www.nj.gov/dep/aqpp/risk.html.

NOTE: Health benchmarks in italics are based on noncancer effects.

[e] A risk ratio for a chemical is a comparison of the annual mean air concentration to the long-term health benchmark. If the annual mean is 0, then the annual mean risk ratio is not calculated.

Table 10-9
Analytes with 100% Non-Detects in 2018

Pollutant		CAS No.	Camden	Chester	Elizabeth	Rutgers
1	Acrylonitrile	107-13-1				X
2	cis-1,2-Dichloroethylene	156-59-2	X	X	X	X
3	trans-1,3-Dichloropropene	542-75-6		X		
4	2,5-Dimethylbenzaldehyde	5799-94-2	X	X		X
5	Ethyl Acrylate	140-88-5	X			X
6	Isovaleraldehyde	590-86-3	X	X		X

In 2018, samples of the chemicals in Table 10-9 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 Tables 10-5 through 10-8.

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2018 Meteorology Summary

New Jersey Department of Environmental Protection

Air Pollution and Meteorology

Meteorology plays an important role in the distribution of pollution throughout the troposphere, the layer of the atmosphere closest to the earth's surface. Atmospheric processes such as wind speed and wind direction affect the transport and dispersion of air pollution. Precipitation, solar radiation, and other weather phenomena influence chemical reactions and atmospheric transformations. By studying meteorological and air pollution data together, scientists and mathematicians have developed reasonably accurate models for predicting the fate of pollutants as they go through the stages of transport, dispersion, transformation, and removal. Air pollution models can assist in predicting pollutant concentrations for comparison to National Ambient Air Quality Standards (NAAQS), in determining the impacts of new and existing air pollution sources, and in designing ambient air monitoring networks.

The New Jersey Department of Environmental Protection (NJDEP) Bureau of Air Monitoring collects meteorological data at eight of its air monitoring stations. This data can be used by planners in preparing State Implementation Plans (SIPs) to reduce pollutant emissions; by engineers to design or evaluate air pollution permit applications; and by scientists to site air monitoring stations.

Climatology in New Jersey

Although New Jersey is one of the smallest states in the country, with a land area of 7,836 square miles, it has five distinct climate zones, which are classified as the Northern, Central, Pine Barrens, Southwest, and Coastal Zones. The topography of the different zones, their distance from the Atlantic Ocean, and the prevailing atmospheric flow patterns affecting them produce distinct variations in the daily weather. This accounts for different results at our air monitoring stations. The climate zones are shown in Figure 11-1.

According to the New Jersey Weather & Climate Network, 2018 was the 11th warmest year on record (since 1895), with an average temperature of 54.2˚F.

2018 was also the wettest calendar year on record in New Jersey. Statewide annual precipitation averaged 64.79 inches, 18.43 inches above average. There were 11 days which had four or more inches of rain recorded somewhere in the state.

Figure 11-1

New Jersey Climate Zones

Source: Office of the New Jersey State Climatologist

2018 MONITORING LOCATIONS & RESULTS

NJDEP collected meteorological data at eight stations in its air monitoring network in 2018. Not all meteorological parameters were measured at each site. Problems with the rain instrument resulted in only partial data from Camden Spruce Street and Rider University. In July, the meteorological monitor at Newark Firehouse stopped functioning and needed to be repaired. Table 11-1 lists the parameters monitored at each station, and Figure 11-2 is a map of the 2018 meteorological monitoring network. In Tables 11-2 through 11-6, the 2018 meteorological data is summarized for temperature, rain, relative humidity, solar radiation, and barometric pressure. Figure 11-3 presents the average temperature for each monitoring site along with the statewide 30-year and 2018 averages. Figure 11-4 shows the monthly rainfall at each site, compared to the statewide 30-year and 2018 average total precipitation. The difference between our results and data from the Office of the New Jersey State Climatologist is most likely related to the method used at our monitoring stations to measure rainfall. Our instruments use sound, rather than a collection bucket, which could result in an underestimate, especially for light showers or snow.

Figures 11-5 through 11-11 presents annual wind roses for Bayonne, Camden Spruce Street, Columbia, Elizabeth Lab, Flemington, Fort Lee Near Road, and Rider University, respectively. (There is no wind data from Newark Firehouse after June 30.) A wind rose shows, in a circular format, the frequency of winds blowing *from* a specific direction for a specified period. The length of each "spoke" around the circle is related to the frequency that the wind blows from a particular direction per unit time. Each concentric circle represents a different frequency, starting with zero at the center and increasing frequencies at the outer circles. Each spoke is broken down into color-coded bands that show wind speed ranges.

Table 11-1
2018 New Jersey Meteorological Monitoring Network
Parameter Summary

Site Name	Temperature	Relative Humidity	Wind Speed	Wind Direction	Barometric Pressure	Rain	Solar Radiation
Bayonne	X	X	X	X	X	X	
Camden Spruce Street	X	X	X	X	X	X*	
Columbia	X	X	X	X	X	X	
Elizabeth Lab	X	X	X	X	X	X	
Flemington	X	X	X	X	X	X	
Fort Lee Near Road	X	X	X	X	X	X	
Newark Firehouse	X*	X*	X*	X*	X*	X*	X
Rider University	X	X	X	X	X	X*	

*Data available for part of year only:

- Newark Firehouse - no temperature, relative humidity, wind speed, wind direction, barometric pressure or rain data after 6/30/18.
- Camden Spruce Street - no rain data until 4/1/18.
- Rider University - no rain data until 6/16/18.

Figure 11-2
2018 Meteorological Monitoring Network

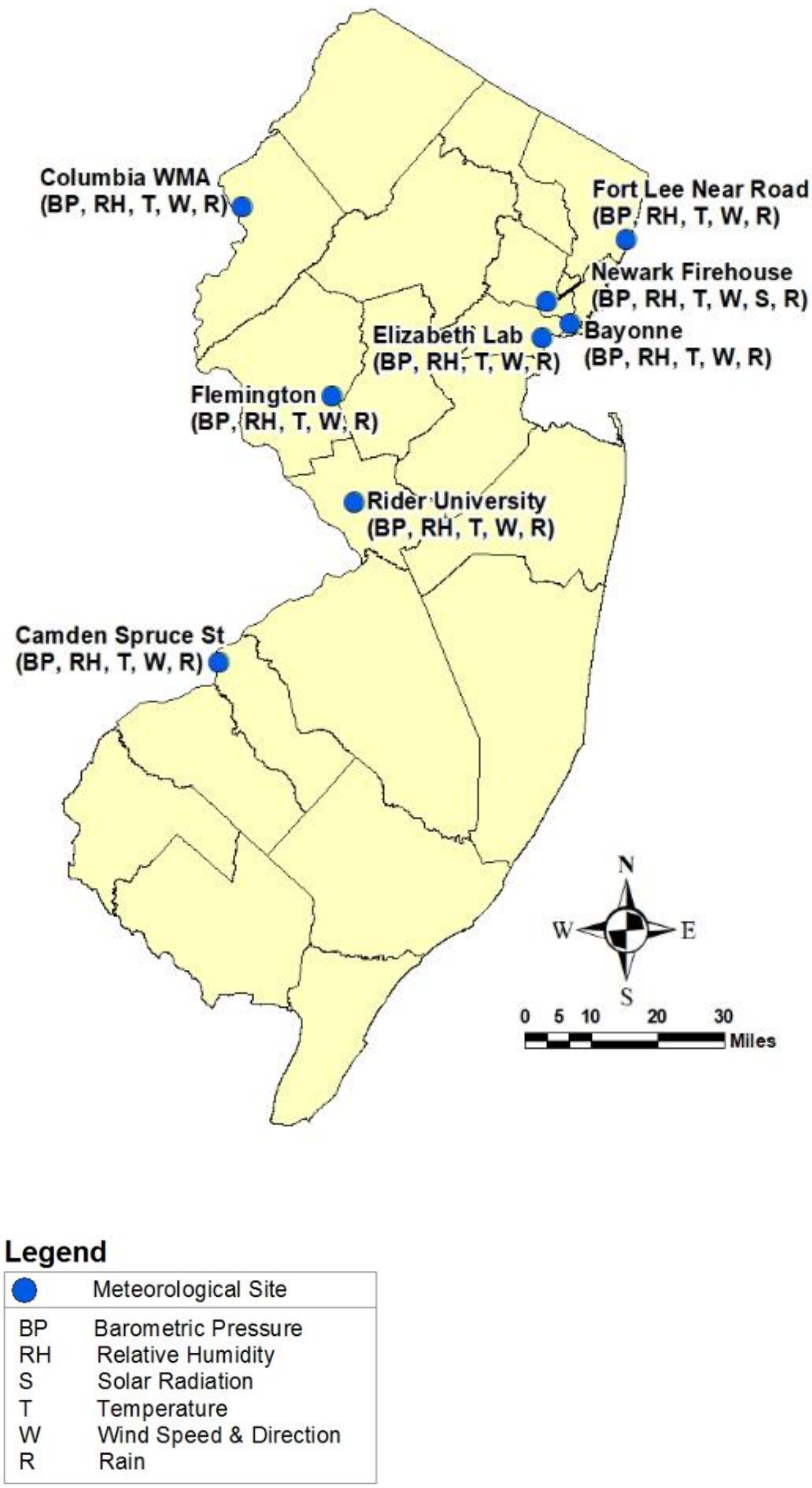


Table 11-2
2018 Temperature Data (in Degrees Fahrenheit)
from NJ's Air Monitoring Sites

SITE		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Bayonne	Mean	30	39	38	47	64	70	77	77	70	57	43	39	54
	Minimum	5	17	28	32	46	51	61	64	55	37	16	25	5
	Maximum	63	72	58	78	87	93	97	94	93	81	72	60	97
Camden Spruce St	Mean	33	42	39	50	67	73	78	78	71	59	44	41	56
	Minimum	7	18	30	32	47	52	61	64	55	40	17	24	7
	Maximum	64	76	74	83	90	97	98	95	96	84	72	64	98
Columbia	Mean	25	35	35	44	63	67	72	72	65	52	39	35	50
	Minimum	-4	10	22	24	35	45	50	54	46	31	9	17	-4
	Maximum	62	76	58	83	89	90	94	91	90	80	70	60	94
Elizabeth Trailer	Mean	29	40	38	47	65	71	77	78	70	57	43	39	55
	Minimum	4	16	27	31	47	51	60	61	54	34	14	23	4
	Maximum	62	78	59	83	91	94	96	95	95	83	73	61	96
Flemington	Mean	28	37	36	46	64	68	74	74	67	54	40	36	52
	Minimum	-1	13	21	22	40	44	51	54	46	29	9	15	-1
	Maximum	61	78	59	82	89	93	94	93	93	81	72	62	94
Fort Lee Near Road	Mean	29	39	37	46	64	70	76	77	69	55	42	37	53
	Minimum	3	14	25	30	45	56	61	63	53	36	13	22	3
	Maximum	60	76	56	79	90	93	95	94	92	79	70	59	95
Newark Firehouse	Mean	30	40	38	47	65	70	ND	ND	ND	ND	ND	ND	*
	Minimum	5	15	27	31	45	51	ND	ND	ND	ND	ND	ND	5
	Maximum	63	77	59	81	90	92	ND	ND	ND	ND	ND	ND	95
Rider University	Mean	29	39	37	46	64	69	74	75	68	55	41	37	53
	Minimum	-3	13	24	25	38	46	52	55	50	31	10	17	-3
	Maximum	64	76	66	76	90	93	97	94	94	82	72	62	97

ND = no data
*Not able to determine an annual statistic because of missing data.

Figure 11-3
2018 Average Temperatures at NJDEP Air Monitoring Sites
Compared to the Statewide 30-Year Average

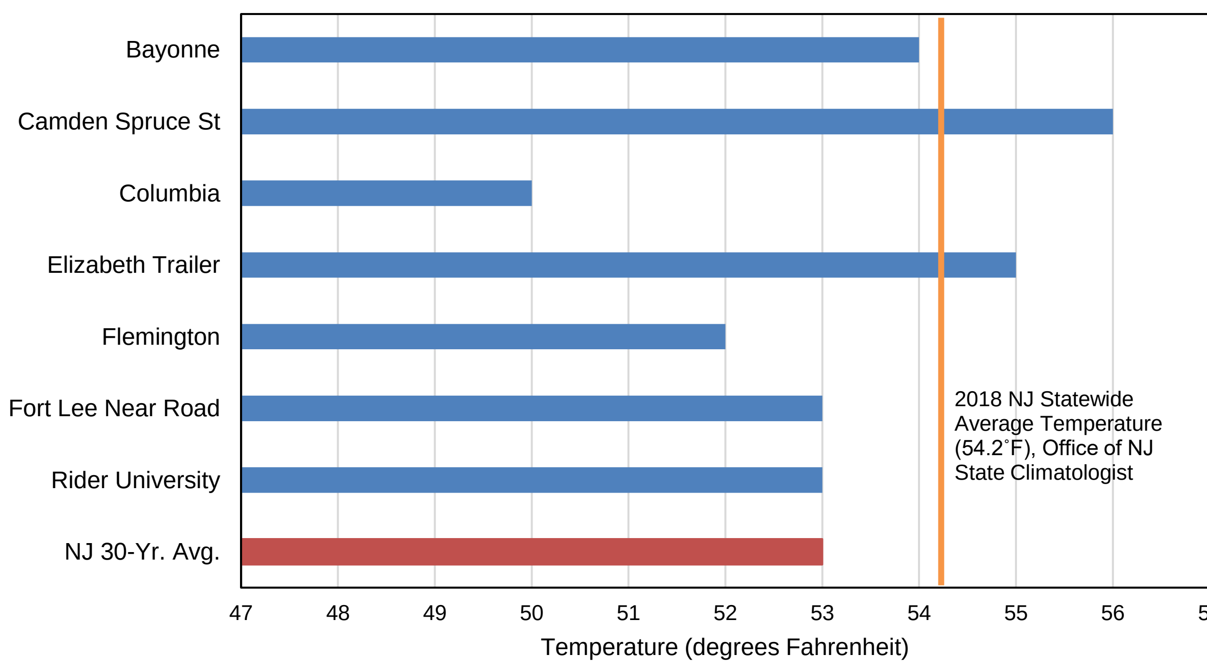
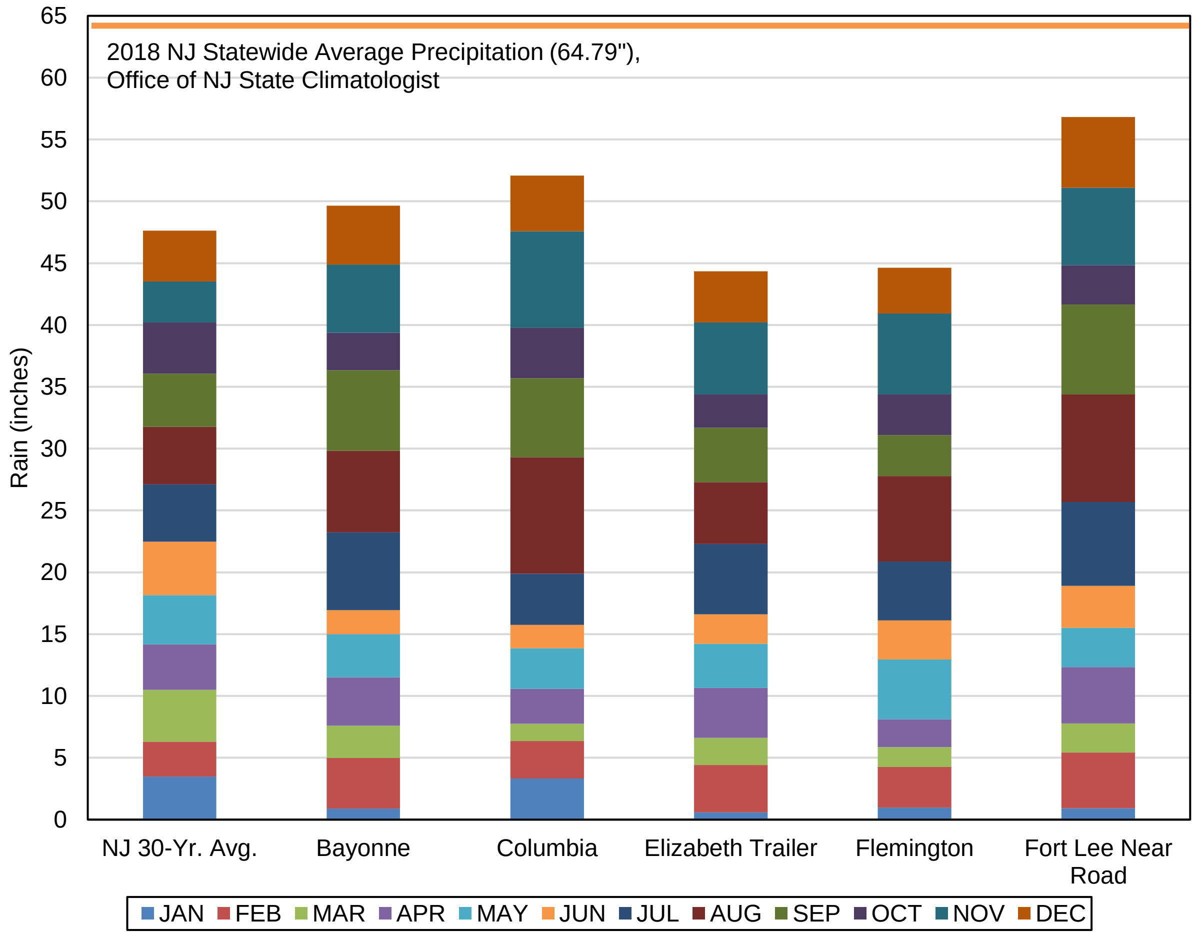


Table 11-3
2018 Rain Data (Inches) from NJ's Air Monitoring Sites

SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL TOTAL
Bayonne	0.90	4.08	2.63	3.92	3.47	1.95	6.29	6.59	6.53	3.01	5.53	4.76	49.66
Camden Spruce St	ND	ND	ND	3.32	3.92	6.31	4.68	5.71	8.37	4.06	7.73	4.75	*
Columbia	3.33	3.03	1.40	2.81	3.28	1.90	4.15	9.41	6.39	4.10	7.79	4.50	52.08
Elizabeth Trailer	0.58	3.82	2.20	4.05	3.57	2.37	5.70	4.99	4.39	2.71	5.80	4.15	44.34
Flemington	0.97	3.30	1.60	2.24	4.84	3.16	4.76	6.92	3.30	3.29	6.55	3.71	44.64
Fort Lee Near Road	0.93	4.49	2.36	4.56	3.18	3.40	6.77	8.70	7.27	3.17	6.26	5.73	56.83
Newark Firehouse	1.17	5.28	3.15	5.48	4.08	2.38	ND	ND	ND	ND	ND	ND	*
Rider University	ND	ND	ND	ND	ND	1.33	6.29	3.31	7.46	3.55	8.37	3.53	*

ND = no data
*Not able to determine an annual statistic because of missing data.

Figure 11-4
2018 Total Rainfall at NJDEP Air Monitoring Sites
Compared to the Statewide 30-Year Average



NOTE: Camden Spruce Street, Newark Firehouse and Rider University are not included in this graph because they have incomplete rain data for 2018.

Table 11-4
2018 Relative Humidity Data (%) from NJ's Air Monitoring Sites

SITE		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Bayonne	Mean	58	64	55	55	62	59	61	65	71	65	61	63	62
	Minimum	28	29	23	16	16	23	26	32	39	32	29	37	16
	Maximum	89	89	89	89	90	90	88	89	90	88	89	89	90
Camden Spruce St	Mean	54	63	52	49	61	58	58	64	72	63	59	61	59
	Minimum	23	24	20	13	15	23	21	29	36	27	24	31	13
	Maximum	88	90	89	90	89	90	89	90	91	89	89	89	91
Columbia	Mean	62	70	56	58	68	69	72	79	82	74	67	70	69
	Minimum	27	25	18	13	13	25	28	39	46	27	22	36	13
	Maximum	91	92	91	91	92	92	92	92	93	93	92	92	93
Elizabeth Trailer	Mean	53	63	53	54	61	58	61	65	71	65	60	61	60
	Minimum	20	26	16	13	12	23	27	32	39	25	24	29	12
	Maximum	91	91	90	91	91	91	90	90	91	90	90	90	91
Flemington	Mean	60	69	58	58	68	67	69	75	79	74	68	70	68
	Minimum	28	28	19	15	15	26	30	34	42	32	20	35	15
	Maximum	92	93	91	92	93	92	92	93	94	93	93	93	94
Fort Lee Near Road	Mean	56	63	55	53	60	56	60	64	72	65	61	63	61
	Minimum	23	27	17	14	14	23	24	29	43	27	25	33	14
	Maximum	91	91	91	91	92	92	91	91	91	91	91	91	92
Newark Firehouse	Mean	54	62	53	53	61	57	ND	ND	ND	ND	ND	ND	*
	Minimum	20	27	16	13	12	24	ND	ND	ND	ND	ND	ND	12
	Maximum	91	90	90	90	91	91	ND	ND	ND	ND	ND	ND	91
Rider University	Mean	61	70	59	59	69	67	70	75	80	74	67	69	68
	Minimum	27	29	21	18	18	27	32	36	41	33	24	35	18
	Maximum	94	94	93	94	95	94	94	94	94	94	93	93	95

ND = no data
*Not able to determine an annual statistic because of missing data.

Table 11-5
2018 Solar Radiation Data (in Langleys) from NJ's Air Monitoring Sites

SITE		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Newark Firehouse	Mean	0.11	0.12	0.21	0.26	0.29	0.36	0.37	0.30	0.18	0.15	0.10	0.08	0.21
	Maximum	0.75	0.96	1.23	1.37	1.41	1.42	1.43	1.32	1.20	1.02	0.79	0.63	1.43

Table 11-6
2018 Average Barometric Pressure Data (in inches of Hg) from NJ's Air Monitoring Sites

SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Bayonne	30.16	30.19	29.90	29.96	30.01	29.91	30.04	29.98	30.13	30.01	30.02	30.07	30.03
Camden Spruce St	30.18	30.20	29.92	29.97	30.01	29.91	30.03	29.99	30.12	30.02	30.03	30.07	30.04
Columbia	29.63	29.67	29.39	29.45	29.51	29.42	29.55	29.50	29.64	29.51	29.51	29.55	29.53
Elizabeth Trailer	30.17	30.18	29.89	29.95	30.00	29.90	30.03	29.97	30.12	30.00	30.01	30.06	30.02
Flemington	30.00	30.04	29.76	29.81	29.86	29.76	29.89	29.84	30.01	29.85	29.88	29.92	29.89
Fort Lee Near Road	29.82	29.86	29.57	29.64	29.70	29.61	29.74	29.68	29.83	29.69	29.70	29.74	29.72
Newark Firehouse	30.04	30.08	29.79	29.85	29.90	29.80	ND	ND	ND	ND	ND	ND	*
Rider University	30.06	30.09	29.81	29.87	29.91	29.81	29.92	29.89	30.02	29.91	29.94	29.97	29.93

ND = no data
*Not able to determine an annual statistic because of missing data.

Wind Roses - Distribution of Wind Speed & Wind Direction

Figure 11-5. 2018 Wind Rose for Bayonne

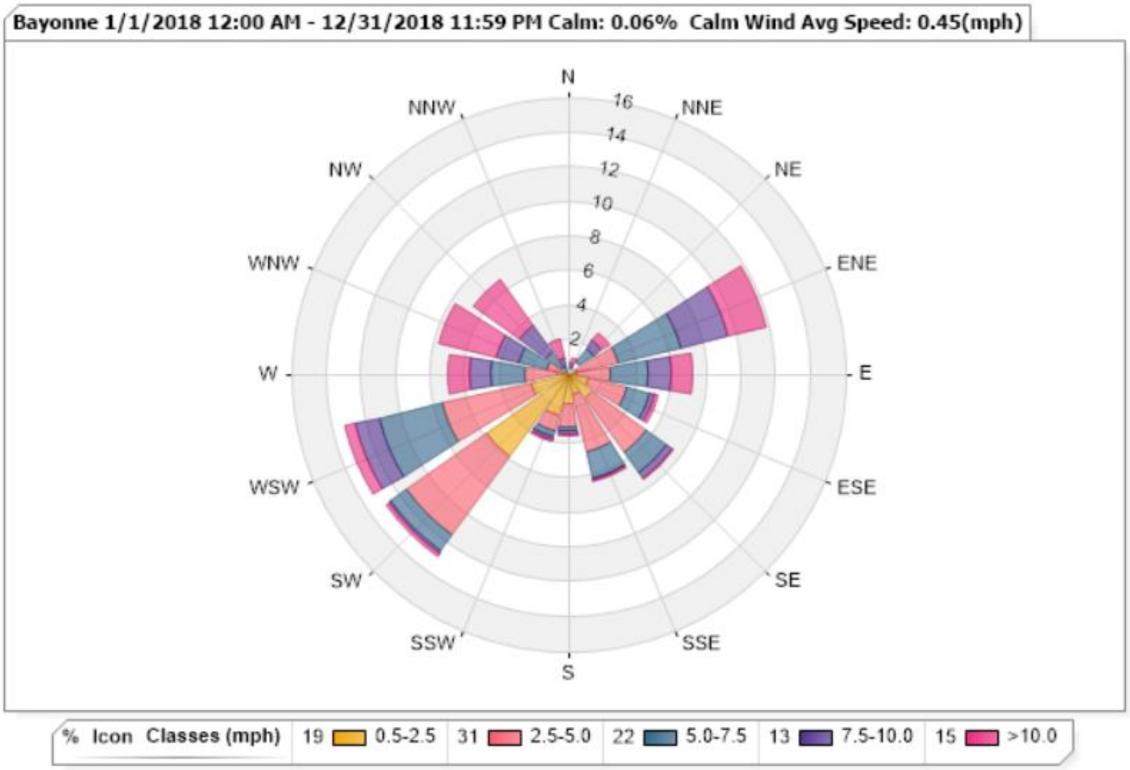


Figure 11-6. 2018 Wind Rose for Camden Spruce Street

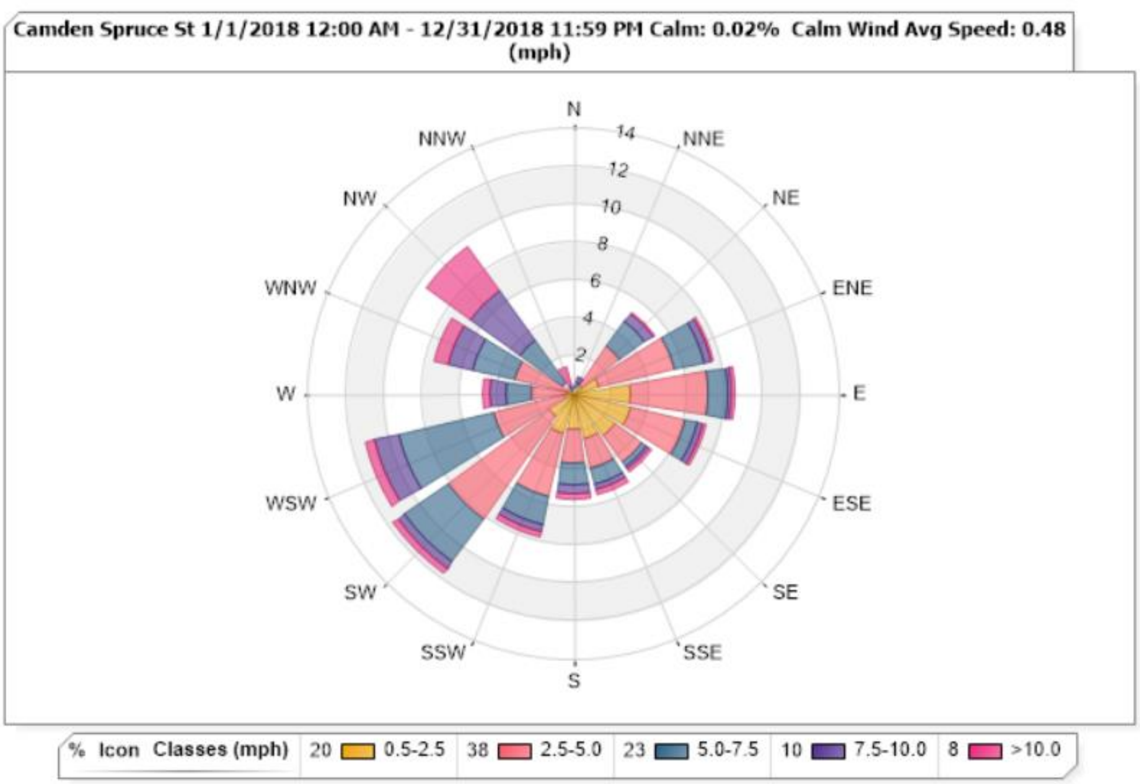


Figure 11-7. 2018 Wind Rose for Columbia

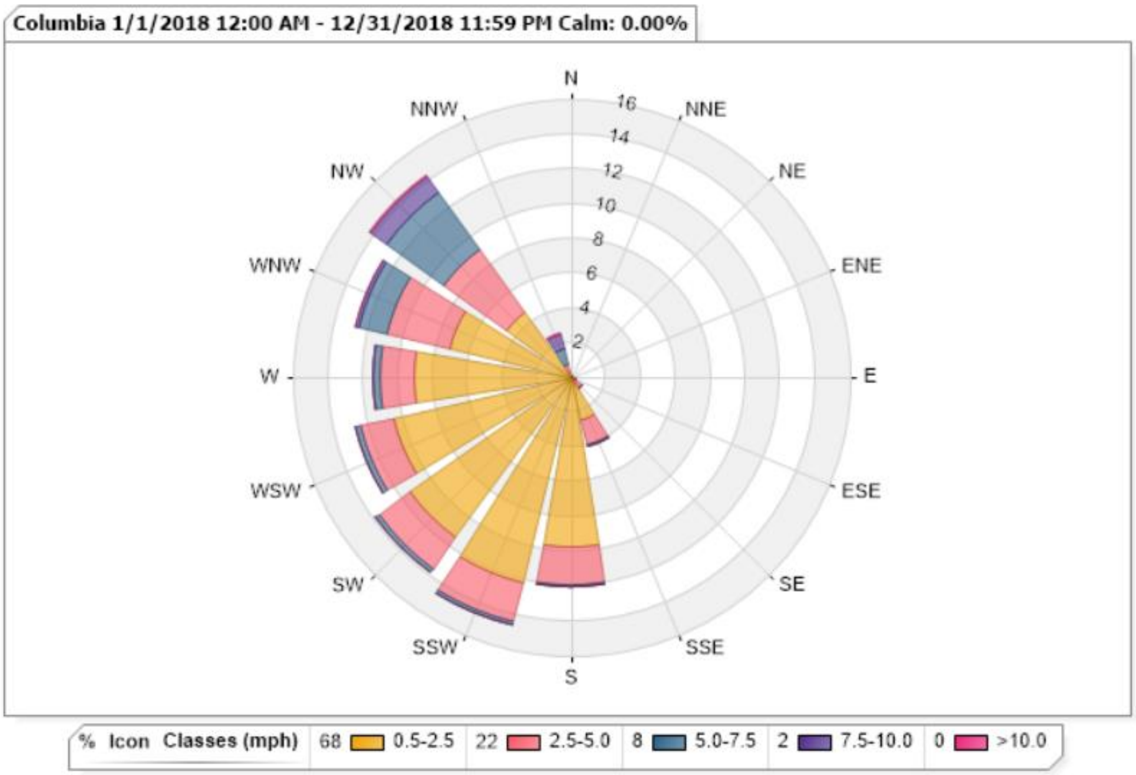


Figure 11-8. 2018 Wind Rose for Elizabeth Lab

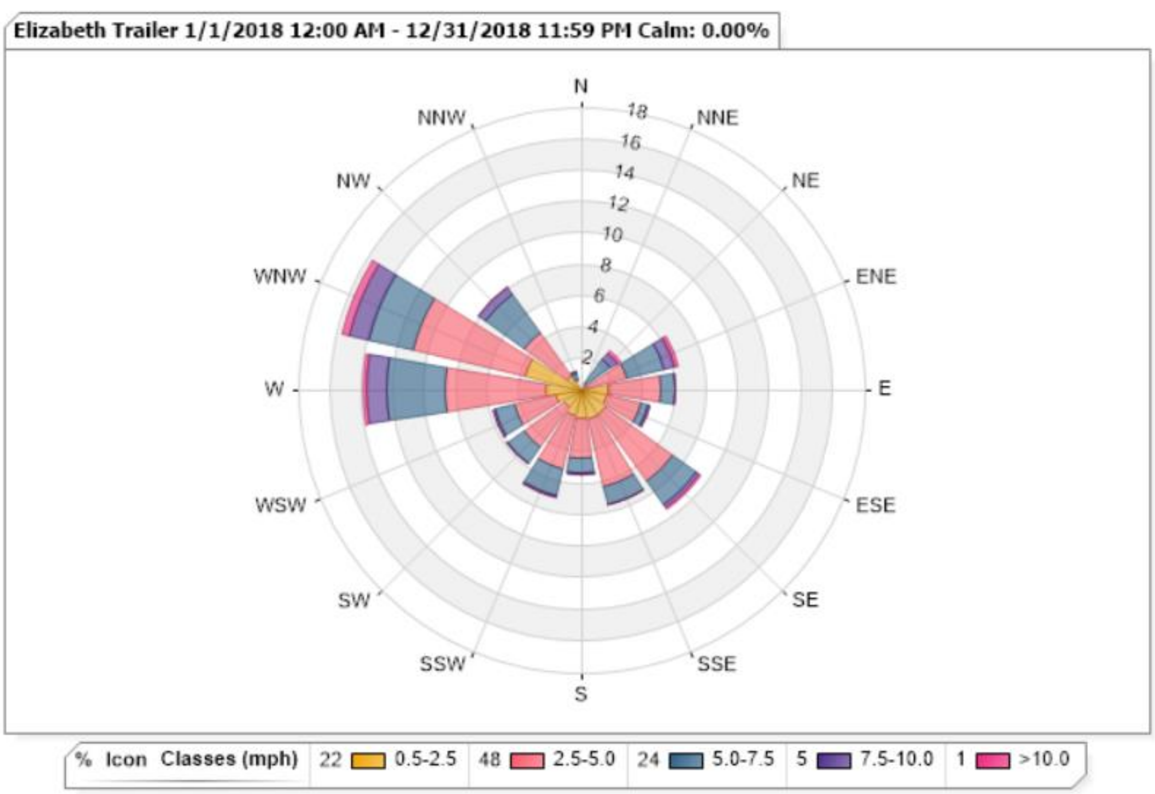


Figure 11-9. 2018 Wind Rose for Flemington

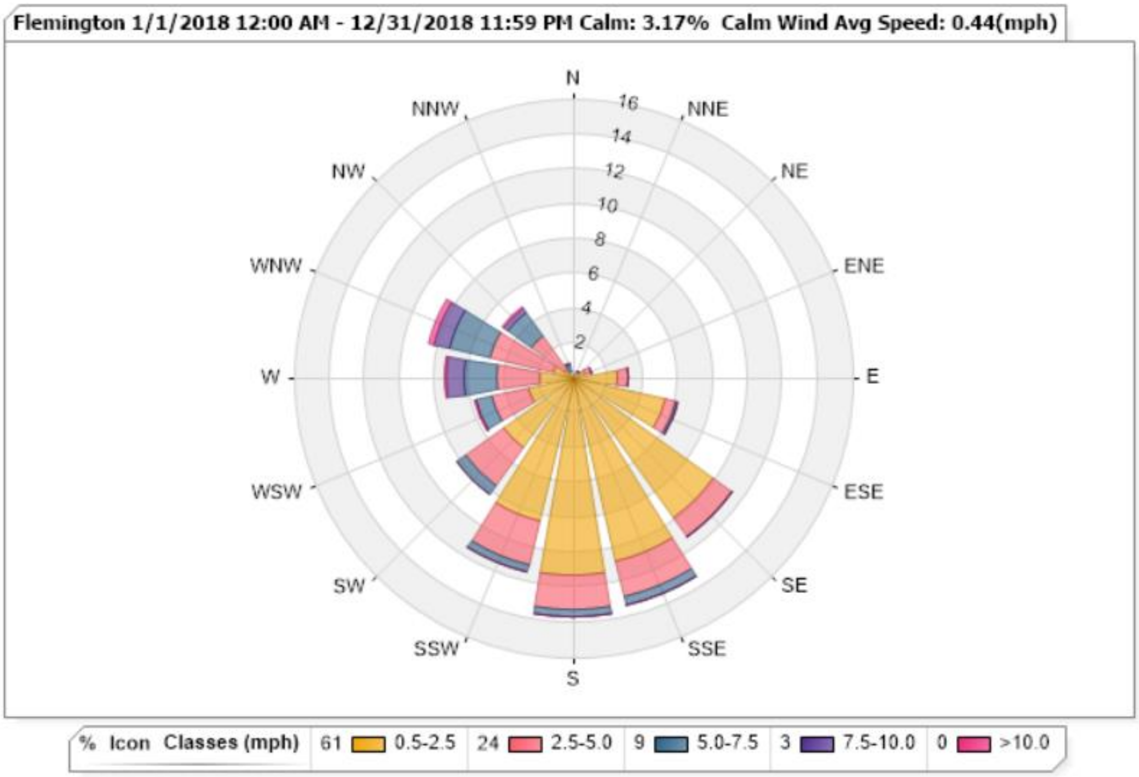


Figure 11-10. 2018 Wind Rose for Fort Lee Near Road

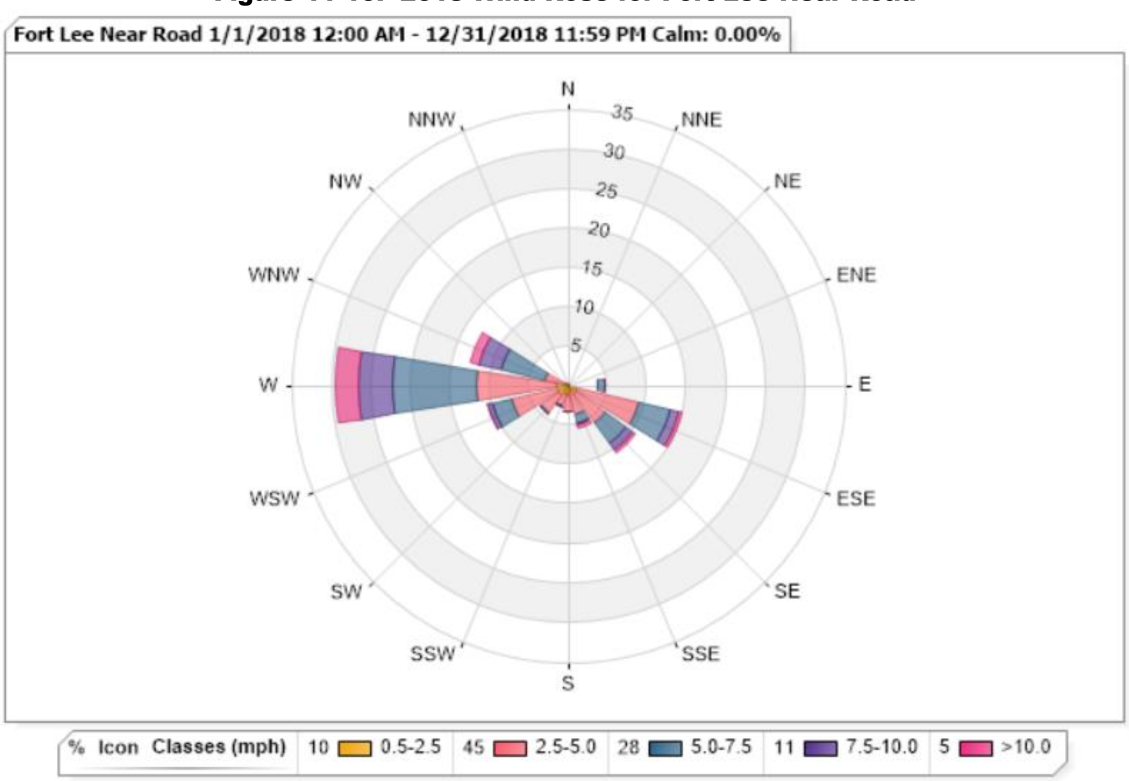
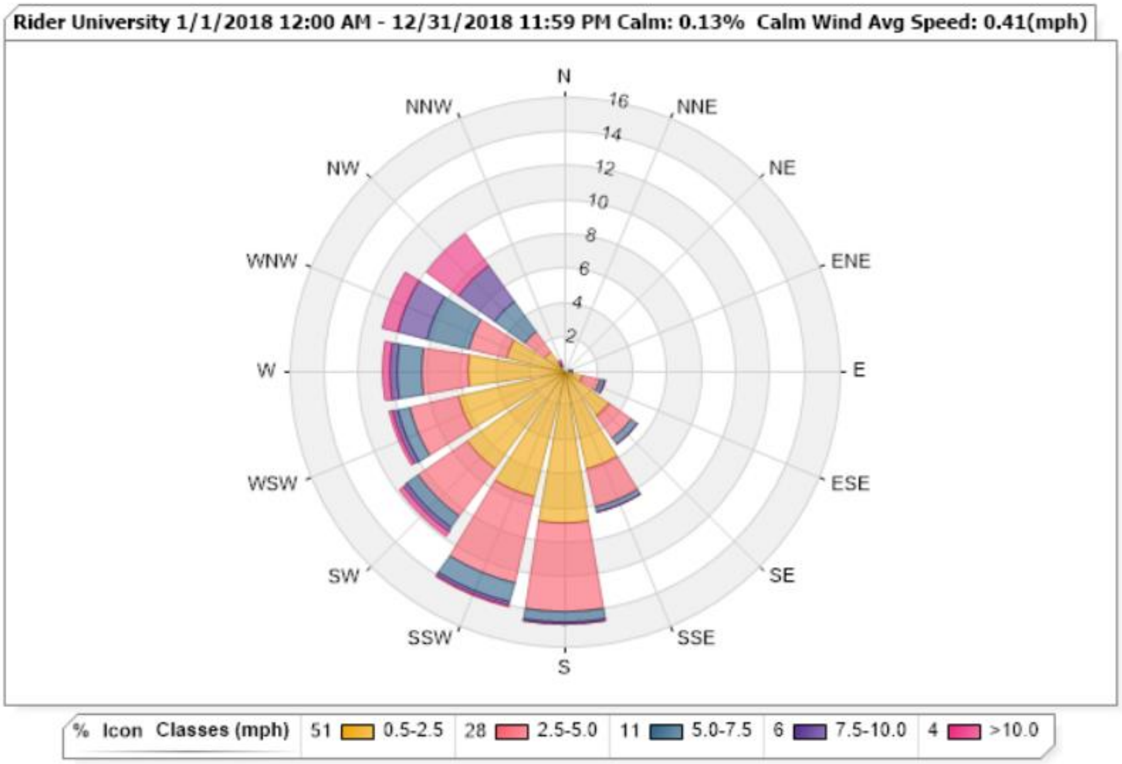


Figure 11-11. 2018 Wind Rose for Rider University



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Appendix A
2018 Air Monitoring Sites

New Jersey Department of Environmental Protection

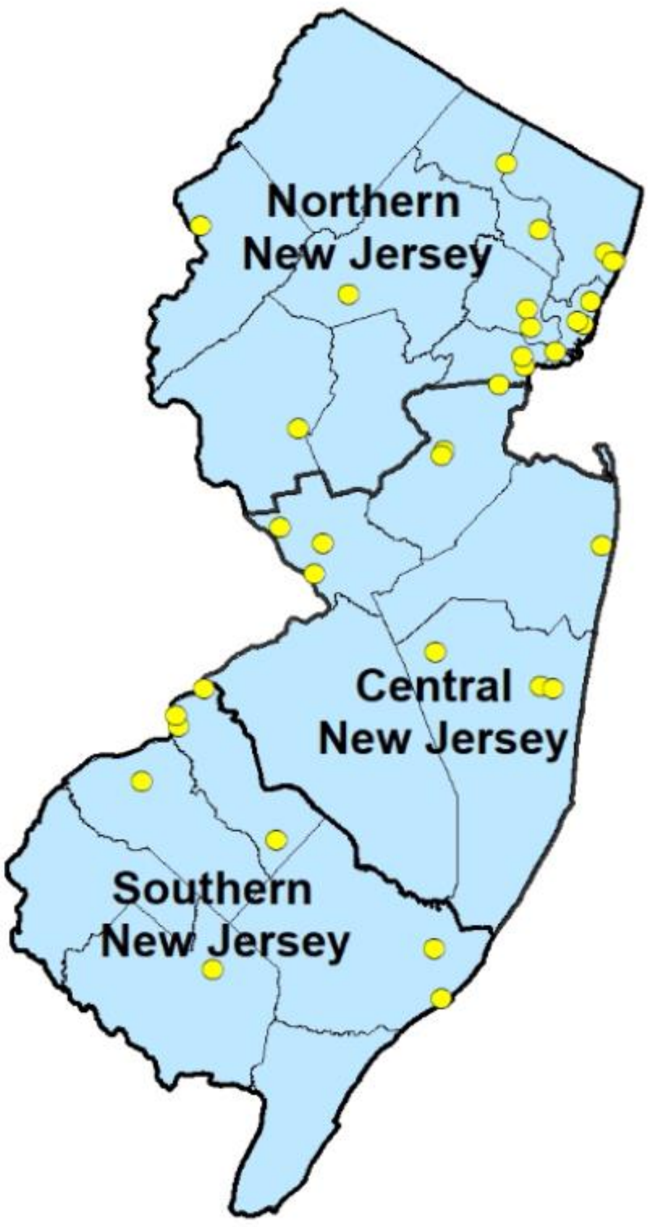

Figure A-1
2018 Northern New Jersey
Air Monitoring Sites

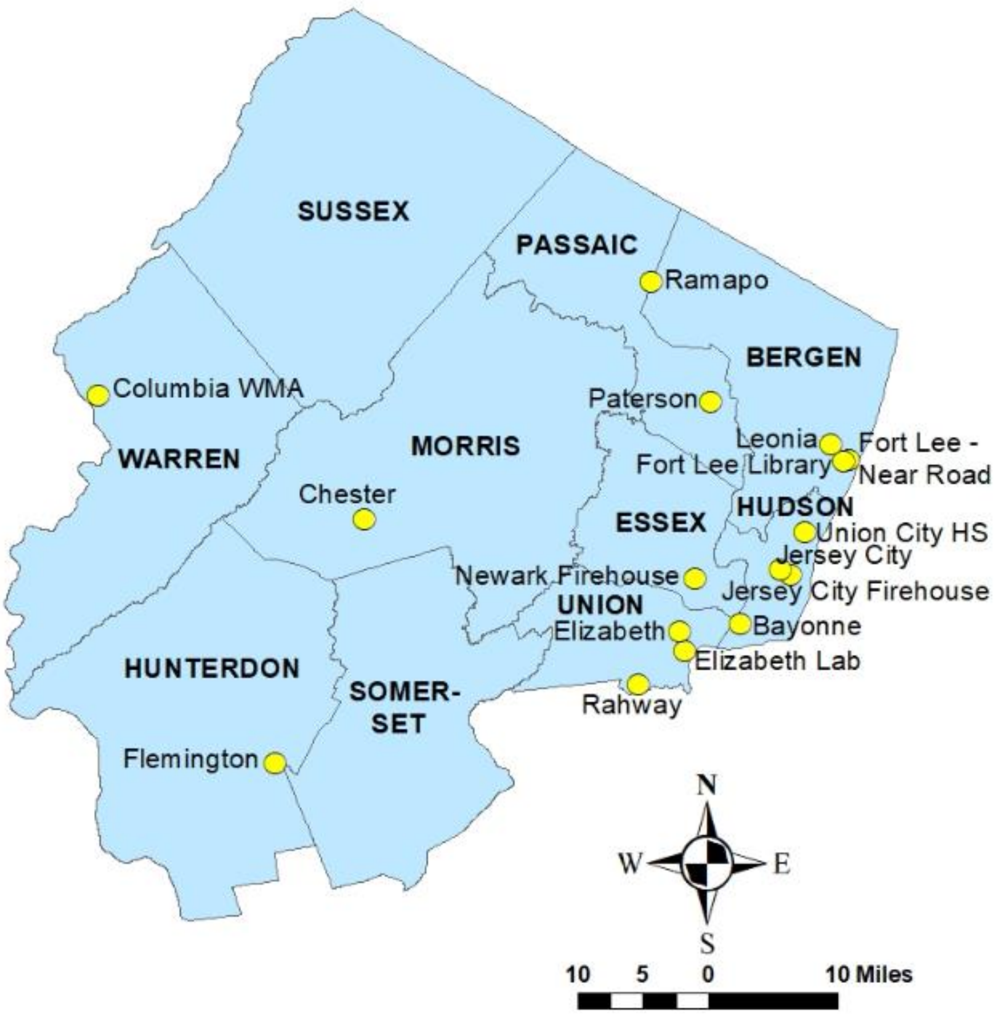

Table A-1
2018 Northern New Jersey Air Monitoring Sites

County	Monitoring Site	AQS Code	Parameter(s) Measured[1]	Coordinates (Decimal degrees)		Address
				Latitude	Longitude	
BERGEN	Fort Lee Library	34 003 0003	$PM_{2.5}$	40.852256	-73.973314	320 Main Street
	Fort Lee Near Road	34 003 0010	CO, NO_x, Beta, BTEX, BC, Met	40.853550	-73.966180	2047 N. Central Rd.
	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	$PM_{2.5}$, 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
2018 CENTRAL NEW JERSEY
AIR MONITORING SITES

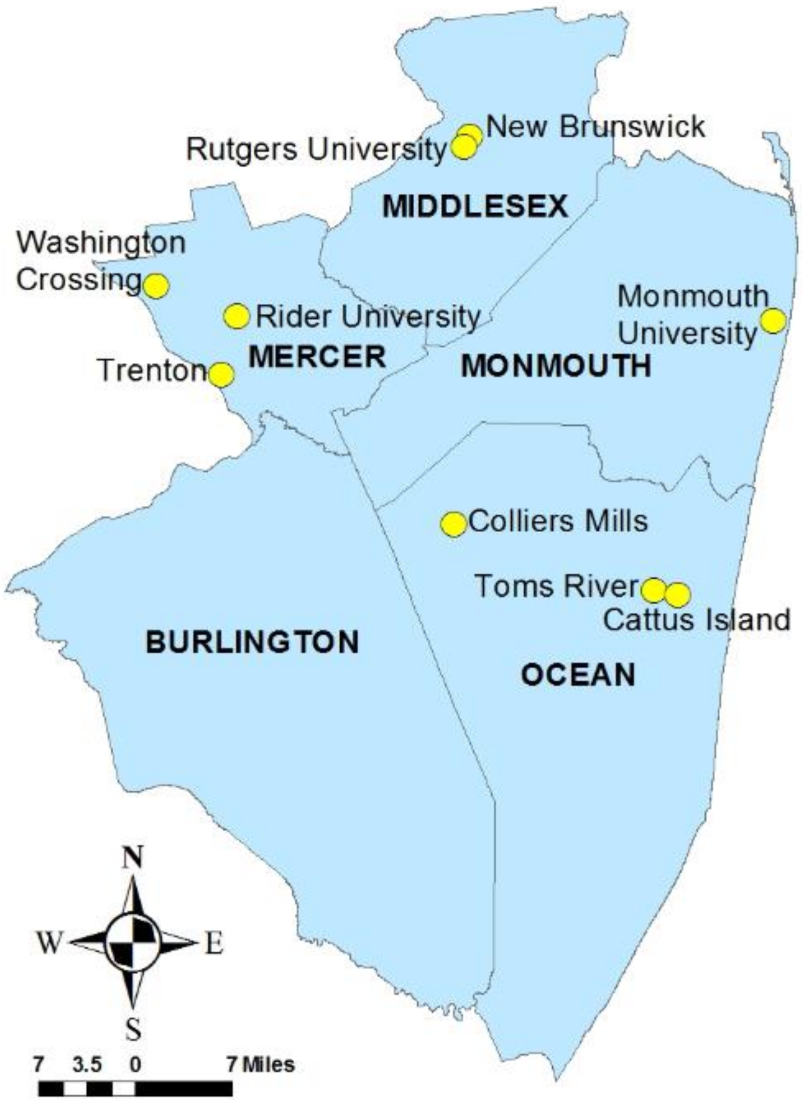

Table A-2
2018 Central New Jersey Air Monitoring Sites

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	$PM_{2.5}$	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_X, O_3, PAMS, Beta, $PM_{2.5}$, Toxics, Spec, Hg	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	$PM_{2.5}$	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
2018 Southern New Jersey
Air Monitoring Sites

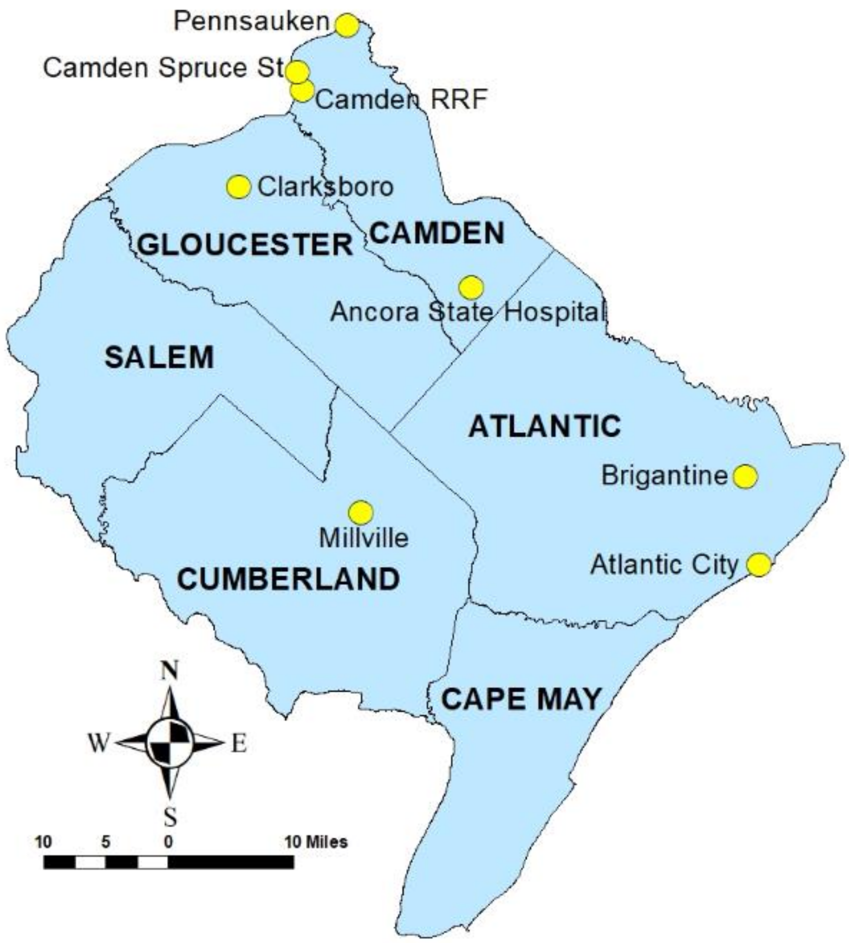

Table A-3
2018 Southern New Jersey Air Monitoring Sites

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 RRF	34 007 0009	PM_{10}	39.912431	-75.116864	600 Morgan Street
	Camden Spruce Street	34 007 0002	CO, NO_X, O_3, SO_2, $PM_{2.5}$, 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 sample collection.

Table A-4
Abbreviations & Acronyms

ACID	Acid deposition
BC	Black carbon measured by aethalometer
Beta	Real-time $PM_{2.5}$ analyzer
BTEX	Measures 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: 2018
Fine Particulate Speciation Summary

New Jersey Department of Environmental Protection

Table B-1
2018 Fine Particulate Speciation Concentrations
CAMDEN SPRUCE STREET NJ
Micrograms per Cubic Meter (µg/m³)

	Species	Annual Average*	Maximum Daily Average	% Samples Detected
1	Aluminum	0.034	0.200	75
2	Ammonium Ion	0.479	1.669	100
3	Antimony	0.006	0.059	57
4	Arsenic	*0.001*	0.006	48
5	Barium	0.004	0.072	53
6	Bromine	0.002	0.021	72
7	Cadmium	*0.0004*	0.017	48
8	Calcium	0.045	0.232	100
9	Carbon, Elemental	0.748	2.592	100
10	Carbon, Organic	2.108	5.280	100
11	Cerium	0.008	0.103	55
12	Cesium	*0.001*	0.061	48
13	Chlorine	0.167	1.905	77
14	Chromium	0.002	0.018	82
15	Cobalt	*0.0001*	0.009	47
16	Copper	0.008	0.065	90
17	Indium	0	0.021	45
18	Iron	0.216	3.354	100
19	Lead	0.005	0.092	63
20	Magnesium	0.018	0.268	65
21	Manganese	0.003	0.020	70
22	Nickel	0.001	0.021	67
23	Nitrate	0.946	4.364	100
24	Phosphorus	0.001	0.053	75
25	Potassium	0.116	1.044	100
26	Potassium Ion	0.079	0.975	98
27	Rubidium	0.0003	0.008	52
28	Selenium	*0.0002*	0.007	48
29	Silicon	0.056	0.298	97
30	Silver	*0.001*	0.026	43
31	Sodium	0.100	0.902	73
32	Sodium Ion	0.103	0.862	98
33	Strontium	0.001	0.007	75
34	Sulfate	1.018	3.246	100
35	Sulfur	0.383	1.344	100
36	Tin	0.002	0.047	55
37	Titanium	0.003	0.010	85
38	Vanadium	*0.0003*	0.002	48
39	Zinc	0.035	0.278	100
40	Zirconium	0	0.025	55

Table B-2
2018 Fine Particulate Speciation Concentrations
CHESTER NJ
Micrograms per Cubic Meter (µg/m³)

	Species	Annual Average*	Maximum Daily Average	% Samples Detected
1	Aluminum	0.019	0.163	64
2	Ammonium Ion	0.268	1.387	96
3	Antimony	0.002	0.043	66
4	Arsenic	*0.0001*	0.003	36
5	Barium	*0.001*	0.109	48
6	Bromine	0.001	0.005	67
7	Cadmium	0.002	0.017	62
8	Calcium	0.015	0.094	97
9	Carbon, Elemental	0.334	0.857	100
10	Carbon, Organic	1.587	4.270	100
11	Cerium	*0.001*	0.103	47
12	Cesium	*0*	0.061	47
13	Chlorine	*0.001*	0.019	40
14	Chromium	0.003	0.014	74
15	Cobalt	0	0.002	50
16	Copper	0.004	0.014	90
17	Indium	*0.0003*	0.020	47
18	Iron	0.034	0.140	100
19	Lead	0.002	0.016	64
20	Magnesium	0.014	0.112	66
21	Manganese	0.0004	0.005	62
22	Nickel	0.001	0.006	81
23	Nitrate	0.631	4.528	100
24	Phosphorus	0.0002	0.008	71
25	Potassium	0.032	0.115	100
26	Potassium Ion	0.016	0.057	96
27	Rubidium	0.0003	0.007	52
28	Selenium	0.0003	0.006	53
29	Silicon	0.033	0.274	95
30	Silver	0.002	0.024	57
31	Sodium	0.031	0.157	66
32	Sodium Ion	0.027	0.210	96
33	Strontium	*0.0002*	0.006	43
34	Sulfate	0.789	3.269	100
35	Sulfur	0.296	1.372	100
36	Tin	*0*	0.026	45
37	Titanium	0.001	0.009	72
38	Vanadium	*0.0002*	0.002	47
39	Zinc	0.006	0.020	100
40	Zirconium	*0*	0.026	47

Table B-3
2018 Fine Particulate Speciation Concentrations
ELIZABETH LAB NJ
Micrograms per Cubic Meter (µg/m^3)

	Species	Annual Average*	Maximum Daily Average	% Samples Detected
1	Aluminum	0.033	0.168	76
2	Ammonium Ion	0.443	1.916	99
3	Antimony	*0.002*	0.061	49
4	Arsenic	*0.0001*	0.004	27
5	Barium	0.014	0.119	58
6	Bromine	0.002	0.011	72
7	Cadmium	*0.0001*	0.020	45
8	Calcium	0.043	0.127	100
9	Carbon, Elemental	1.195	3.829	100
10	Carbon, Organic	2.452	7.068	100
11	Cerium	*0*	0.110	47
12	Cesium	*0.004*	0.089	48
13	Chlorine	0.017	0.535	76
14	Chromium	0.004	0.017	88
15	Cobalt	*0*	0.002	28
16	Copper	0.008	0.045	99
17	Indium	*0*	0.029	44
18	Iron	0.154	0.361	100
19	Lead	0.003	0.017	61
20	Magnesium	0.017	0.207	68
21	Manganese	0.002	0.009	79
22	Nickel	0.002	0.010	87
23	Nitrate	1.165	5.452	100
24	Phosphorus	0.001	0.012	74
25	Potassium	0.055	1.088	100
26	Potassium Ion	0.031	1.051	100
27	Rubidium	0.0003	0.009	54
28	Selenium	0.0004	0.005	54
29	Silicon	0.080	0.316	98
30	Silver	*0.001*	0.032	49
31	Sodium	0.062	0.719	74
32	Sodium Ion	0.068	0.629	98
33	Strontium	0.001	0.027	55
34	Sulfate	1.032	3.496	100
35	Sulfur	0.392	1.568	100
36	Tin	0.003	0.048	53
37	Titanium	0.006	0.016	98
38	Vanadium	*0.0002*	0.005	41
39	Zinc	0.016	0.097	100
40	Zirconium	0.001	0.040	51

Table B-4
2018 Fine Particulate Speciation Data
NEWARK FIREHOUSE NJ
Concentrations in Micrograms per Cubic Meter (µg/m^3)

Species		Annual Average*	Maximum Daily Average	% Samples Detected
1	Aluminum	0.028	0.433	69
2	Ammonium Ion	0.399	2.079	100
3	Antimony	0.005	0.055	61
4	Arsenic	*0.0002*	0.008	31
5	Barium	0.007	0.068	63
6	Bromine	0.002	0.014	68
7	Cadmium	0.001	0.016	54
8	Calcium	0.039	0.211	100
9	Carbon, Elemental	0.709	2.262	100
10	Carbon, Organic	2.199	6.794	100
11	Cerium	0.005	0.088	57
12	Cesium	0.002	0.051	50
13	Chlorine	0.016	0.404	70
14	Chromium	0.002	0.043	73
15	Cobalt	*0*	0.002	36
16	Copper	0.008	0.049	95
17	Indium	*0*	0.025	40
18	Iron	0.091	0.357	100
19	Lead	0.002	0.018	64
20	Magnesium	0.013	0.199	61
21	Manganese	0.001	0.010	69
22	Nickel	0.001	0.012	69
23	Nitrate	1.244	5.653	100
24	Phosphorus	0.001	0.017	78
25	Potassium	0.054	1.144	100
26	Potassium Ion	0.030	1.128	99
27	Rubidium	*0*	0.007	47
28	Selenium	0.0003	0.005	50
29	Silicon	0.065	0.550	98
30	Silver	*0.001*	0.024	47
31	Sodium	0.063	0.446	68
32	Sodium Ion	0.073	0.571	98
33	Strontium	0.001	0.027	55
34	Sulfate	0.892	3.538	100
35	Sulfur	0.334	1.505	100
36	Tin	0.005	0.054	60
37	Titanium	0.005	0.016	96
38	Vanadium	*0.0003*	0.003	43
39	Zinc	0.015	0.110	100
40	Zirconium	0.004	0.037	60

Table B-5
2018 Fine Particulate Speciation Data
RUTGERS UNIVERSITY NJ
Concentrations in Micrograms per Cubic Meter (µg/m^3)

Species		Annual Average*	Maximum Daily Average	% Samples Detected
1	Aluminum	0.017	0.194	68
2	Ammonium Ion	0.308	1.407	98
3	Antimony	0.005	0.042	60
4	Arsenic	*0.0003*	0.007	27
5	Barium	0.006	0.093	55
6	Bromine	0.001	0.008	70
7	Cadmium	*0.001*	0.030	46
8	Calcium	0.020	0.123	99
9	Carbon, Elemental	0.535	1.723	100
10	Carbon, Organic	2.055	5.951	100
11	Cerium	*0.001*	0.088	49
12	Cesium	0.004	0.074	54
13	Chlorine	0.009	0.227	58
14	Chromium	0.004	0.035	88
15	Cobalt	*0*	0.004	38
16	Copper	0.005	0.075	91
17	Indium	*0.0002*	0.029	41
18	Iron	0.053	0.179	100
19	Lead	0.002	0.014	68
20	Magnesium	0.015	0.297	64
21	Manganese	0.001	0.016	69
22	Nickel	0.001	0.011	73
23	Nitrate	0.841	4.332	100
24	Phosphorus	0.0003	0.010	72
25	Potassium	0.056	1.863	100
26	Potassium Ion	0.037	1.898	97
27	Rubidium	0.0005	0.007	51
28	Selenium	*0.0002*	0.006	46
29	Silicon	0.041	0.328	98
30	Silver	0.001	0.021	50
31	Sodium	0.054	0.339	68
32	Sodium Ion	0.045	0.383	99
33	Strontium	0.001	0.043	53
34	Sulfate	0.916	3.690	100
35	Sulfur	0.332	1.368	100
36	Tin	0.004	0.047	54
37	Titanium	0.003	0.021	84
38	Vanadium	*0.0003*	0.002	48
39	Zinc	0.010	0.052	99
40	Zirconium	0.001	0.032	55

*Annual averages in italics are arithmetic means calculated with fewer than 50% of the samples above detectable levels.

Chemical Speciation Network information can be found at https://www.epa.gov/amtic/chemical-speciation-network-csn.

Average minimum detection limits in Table B-6 are provided by the Air Quality Research Center, University of California, Davis (7/22/19).

Table B-6. Average Minimum Detection Limits (MDL) (µg/m³)

	Species	MDL (µg/m³)
1	Aluminum	0.038
2	Ammonium	0.006
3	Antimony	0.04
4	Arsenic	0.003
5	Barium	0.081
6	Bromine	0.005
7	Cadmium	0.016
8	Calcium	0.034
9	Carbon, Elemental	0.012
10	Carbon, Organic	0.081
11	Cerium	0.096
12	Cesium	0.056
13	Chlorine	0.007
14	Chromium	0.004
15	Cobalt	0.003
16	Copper	0.011
17	Indium	0.037
18	Iron	0.027
19	Lead	0.012
20	Magnesium	0.042
21	Manganese	0.006
22	Nickel	0.002
23	Nitrate	0.036
24	Phosphorus	0.002
25	Potassium	0.012
26	Potassium Ion	0.047
27	Rubidium	0.009
28	Selenium	0.005
29	Silicon	0.02
30	Silver	0.017
31	Sodium	0.088
32	Sodium Ion	0.016
33	Strontium	0.007
34	Sulfate	0.047
35	Sulfur	0.005
36	Tin	0.05
37	Titanium	0.003
38	Vanadium	0.002
39	Zinc	0.003
40	Zirconium	0.036