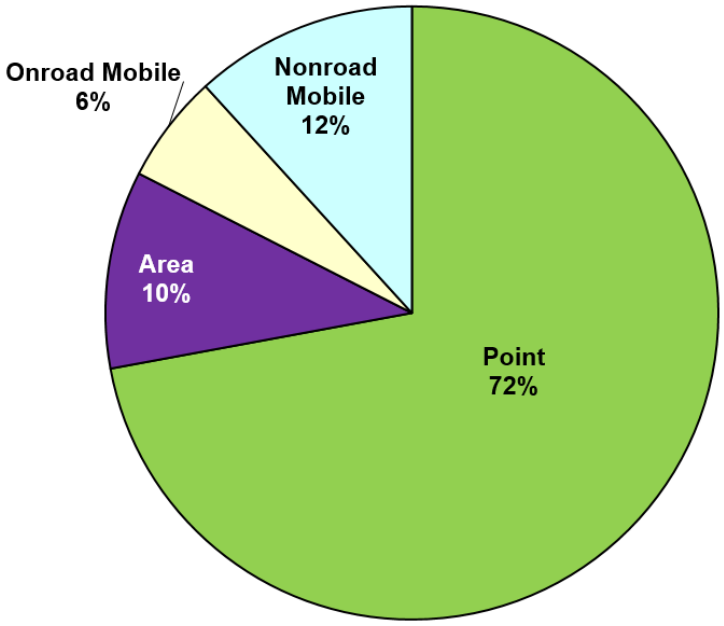
2018 Sulfur Dioxide Summary

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 ($\mu g/m^3$)

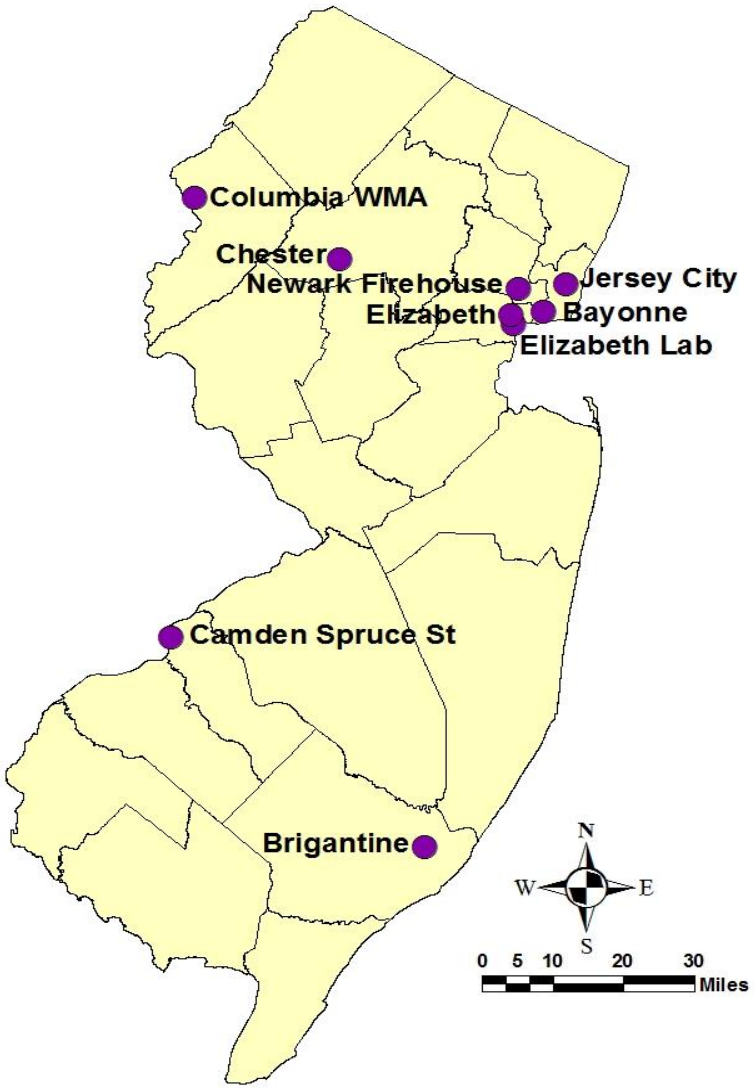
Averaging Period	Type	National	New Jersey[a]
1–hour[b]	Primary	75 ppb	---
3–hours	Secondary	0.5 ppm[c]	1300 $\mu g/m^3$ (0.5 ppm)
24–hours[d]	Primary	---	365 $\mu g/m^3$ (0.14 ppm)
24–hours[d]	Secondary	---	260 $\mu g/m^3$ (0.10 ppm)
12–months	Primary	---	80 $\mu g/m^3$ (0.03 ppm)
12–months	Secondary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

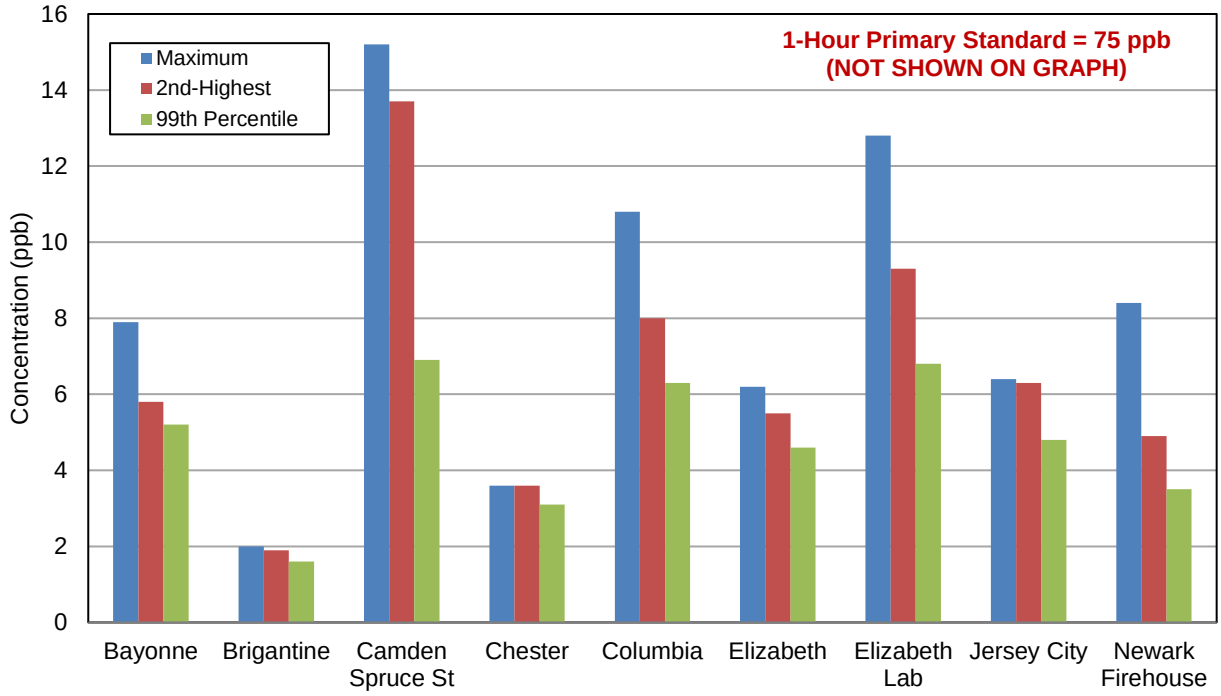


Figure 7-4
New Jersey Sulfur Dioxide Design Values for 2016-2018
3-Year Average of the 99th Percentile of the 1-Hour Daily Maximum Concentrations
Parts per Billion (ppb)

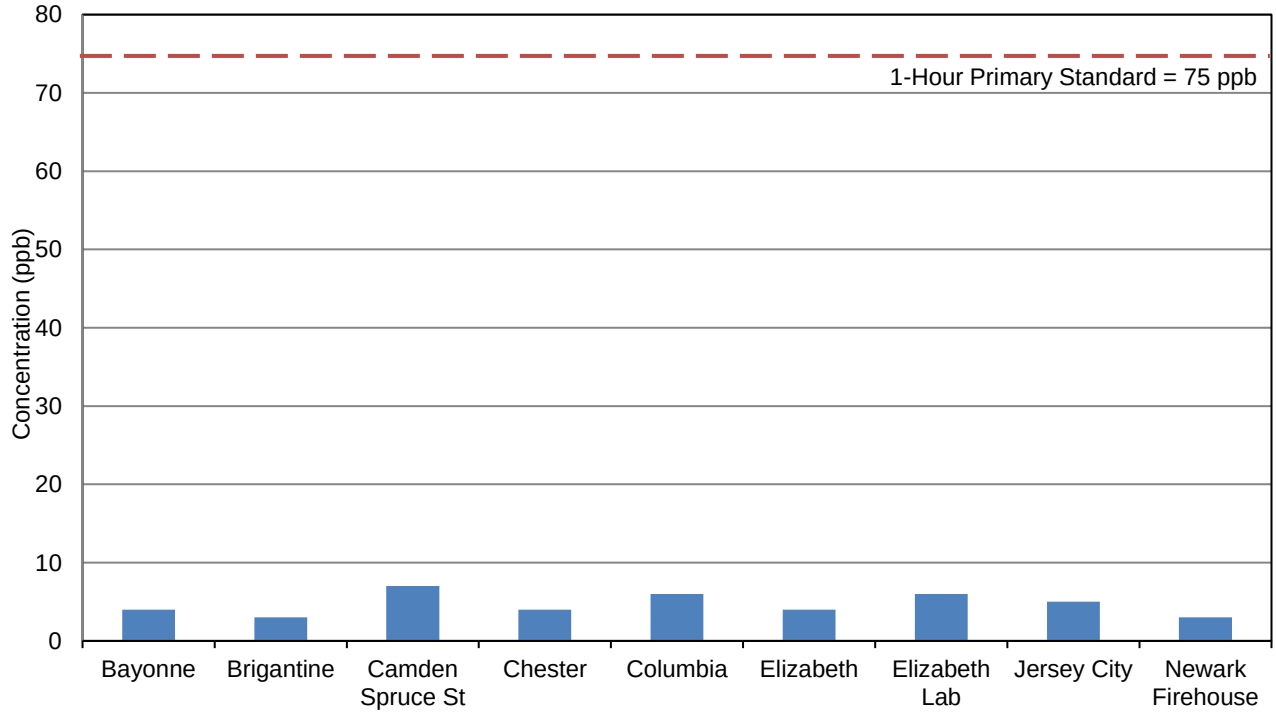


Table 7-3
2018 Sulfur Dioxide Concentrations in New Jersey
3-Hour Averages
Parts per Million (ppm)

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)

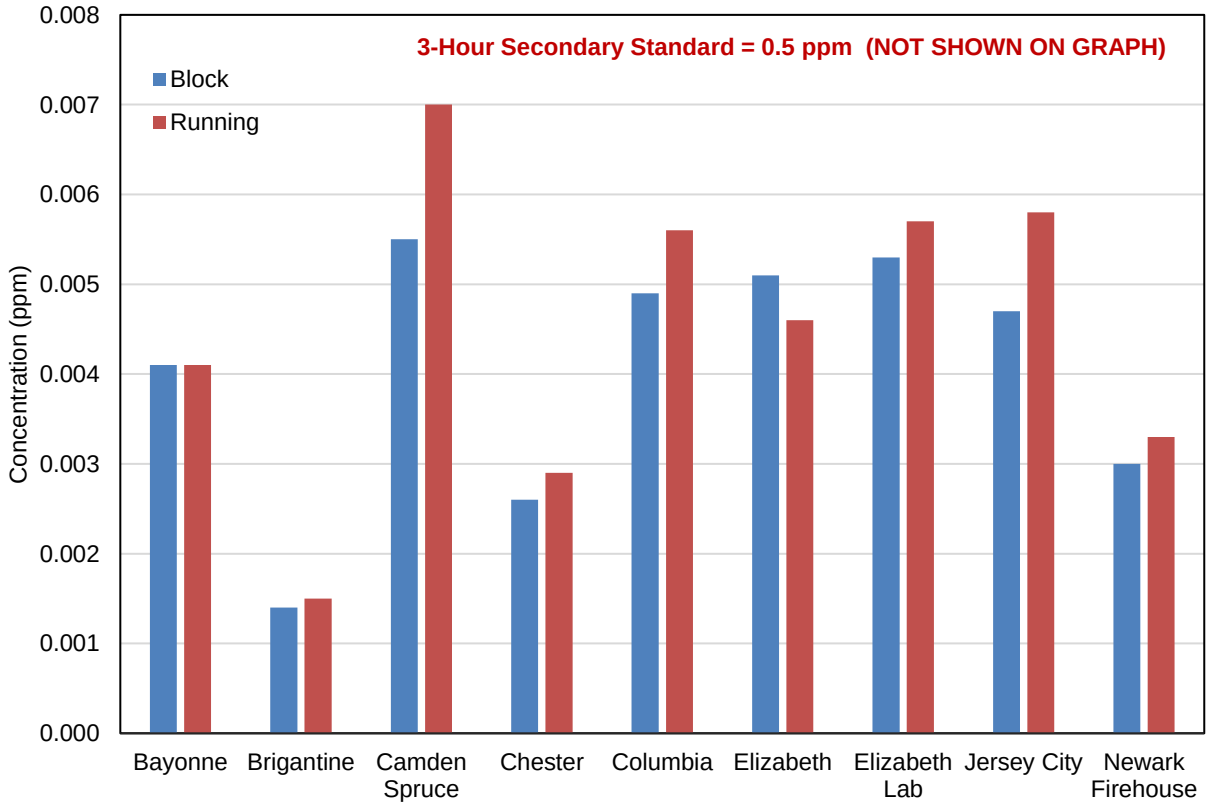


Table 7-4
2018 Sulfur Dioxide Concentrations in New Jersey
24-Hour Averages
Parts per Million (ppm)

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)

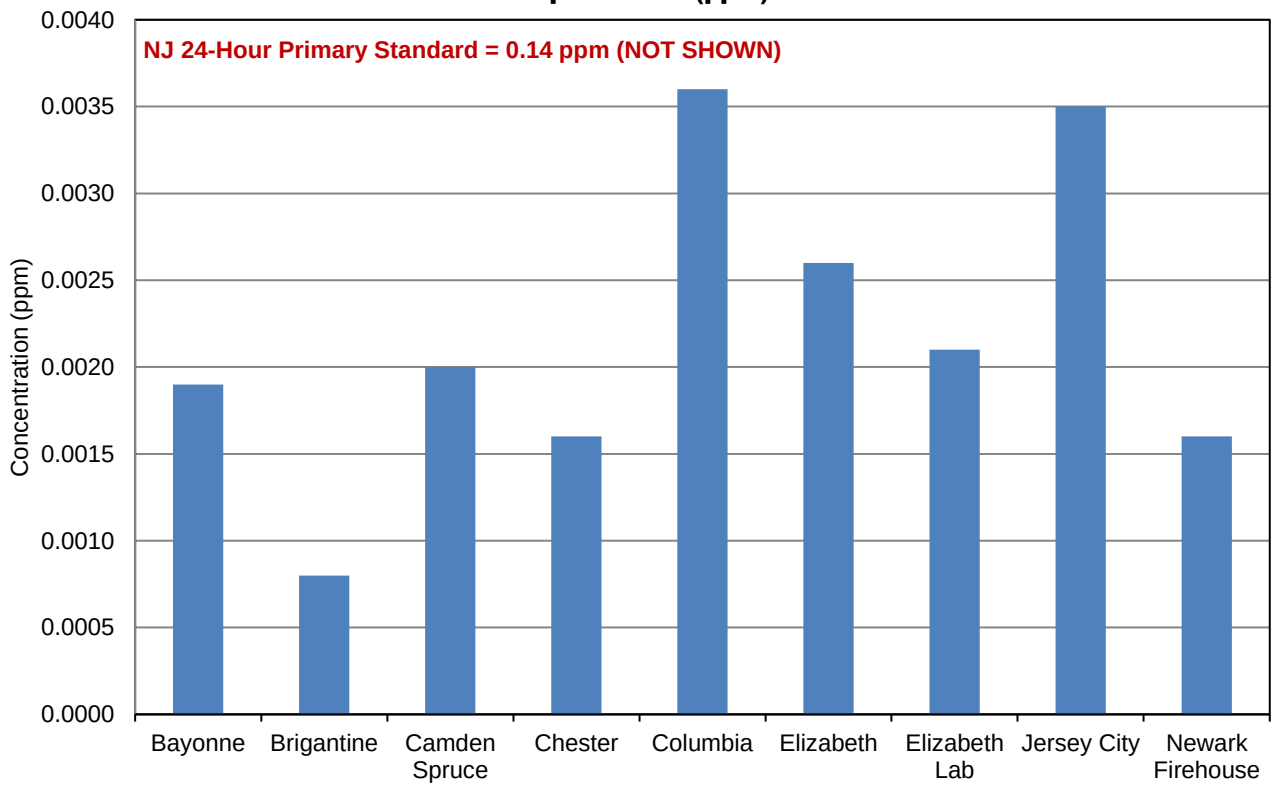
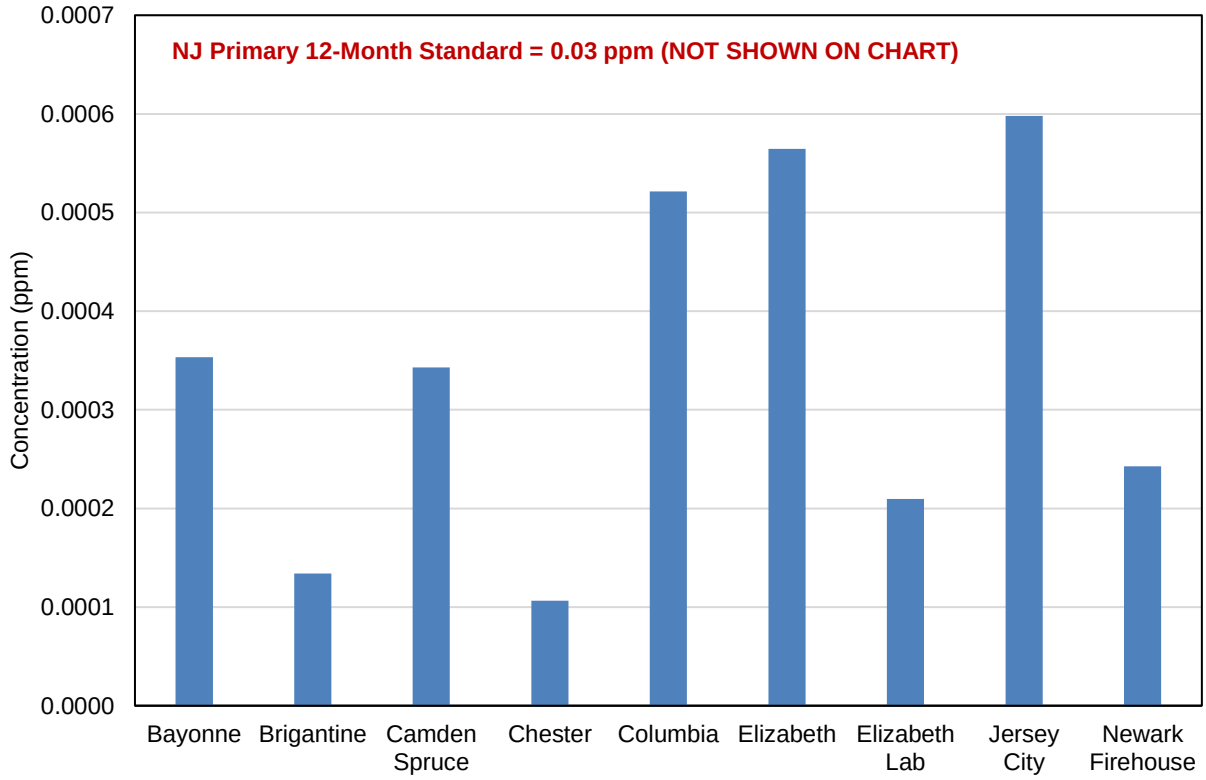


Table 7-5
2018 Sulfur Dioxide Concentrations in New Jersey
Maximum 12-Month Running Averages
Parts per Million (ppm)

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)

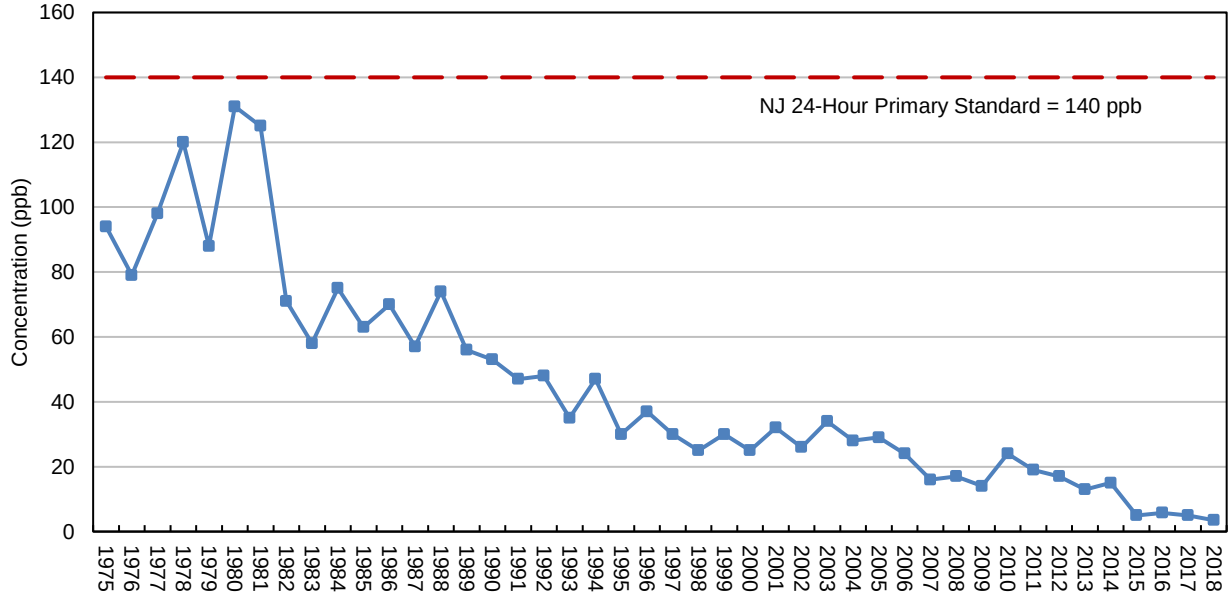


Figure 7-9
Sulfur Dioxide Trend in New Jersey, 2000-2018
99th Percentile of the Daily Maximum 1-Hour Concentrations
Parts per Million (ppb)

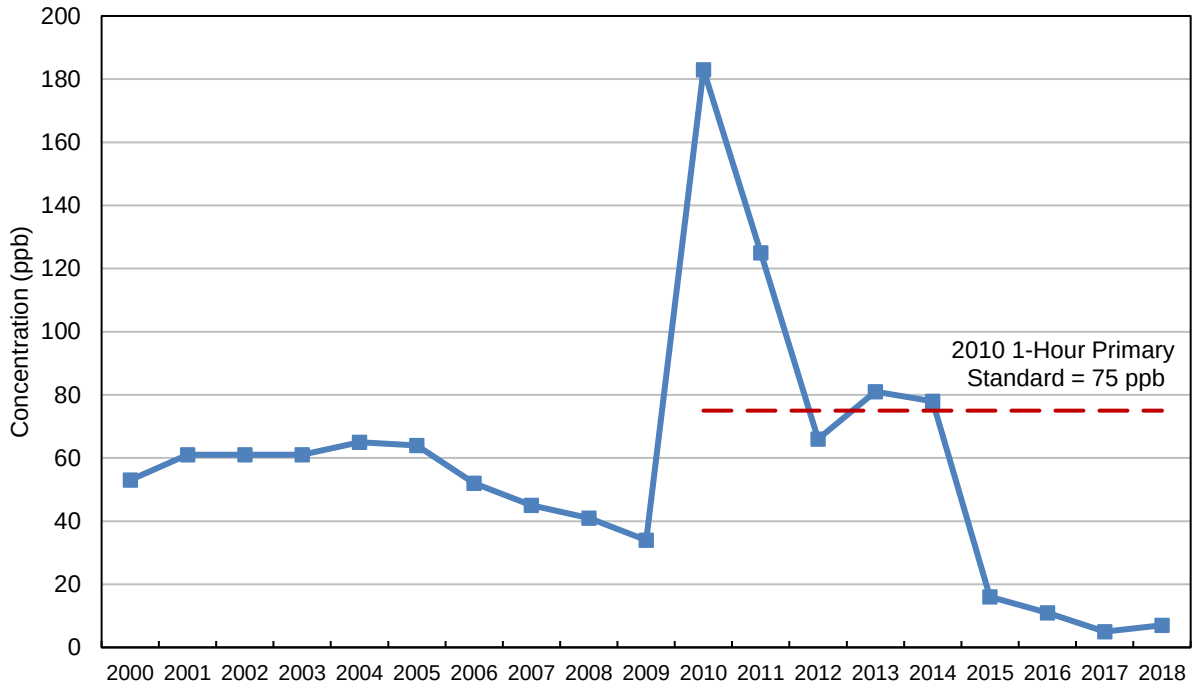
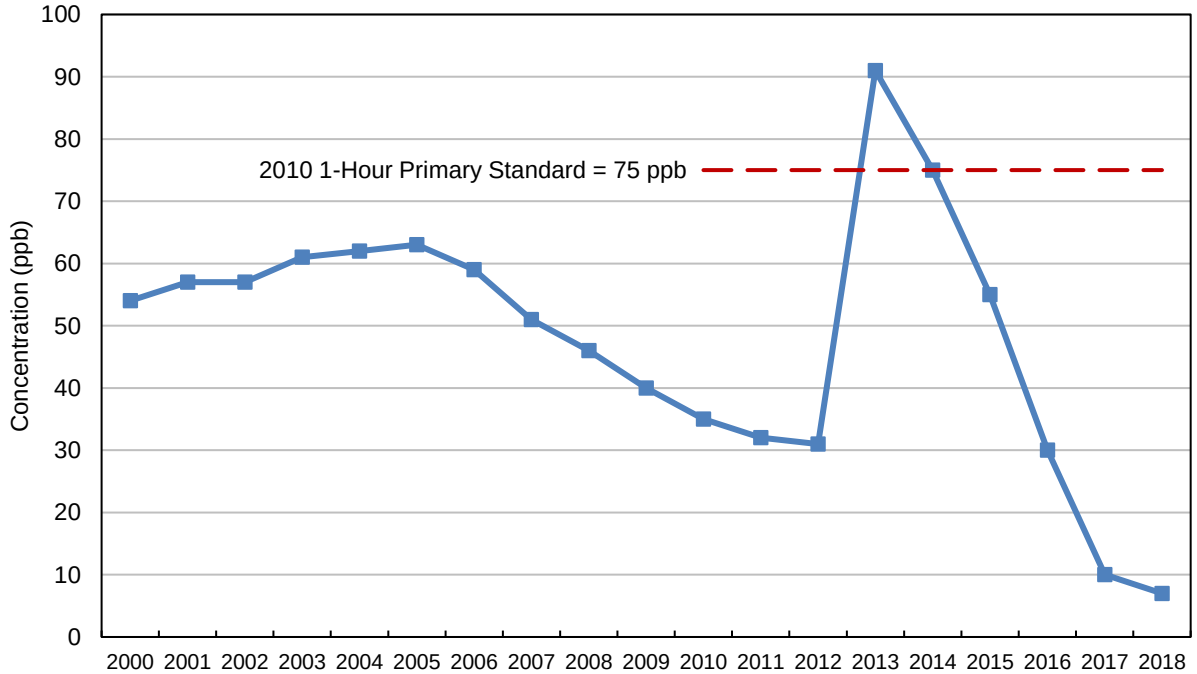


Figure 7-10
Sulfur Dioxide Design Value Trend in New Jersey, 2000-2018
3-Year Average of the 99th Percentile Daily Maximum 1-Hour Concentrations
Parts per Million (ppb)



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