



2015 Sulfur Dioxide Summary

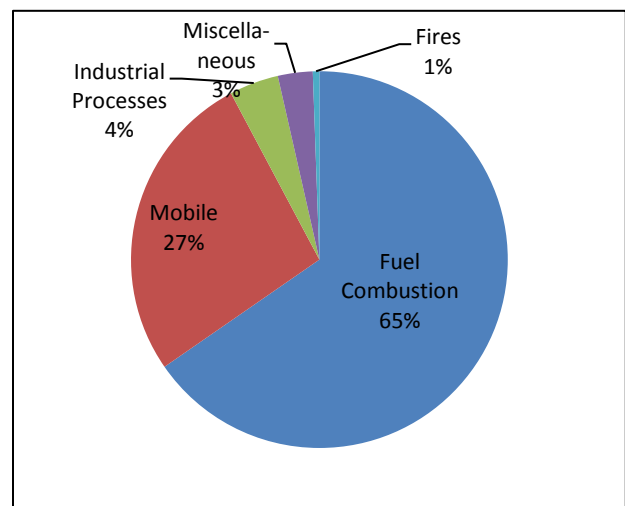
New Jersey Department of Environmental Protection

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 can be formed when fuels containing sulfur 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, including aluminum, copper, zinc, lead and iron. Industrial facilities that derive their products from these materials may also release SO_2 . A pie chart summarizing the primary sources of SO_2 in New Jersey is shown in Figure 1 for 2011 (the most recent year available).

Figure 2 shows that SO_2 concentrations in New Jersey are generally higher in the winter than in the summer because of higher emissions from heating buildings and other sources. As shown in Figure 3, daily SO_2 levels tend to peak in the morning as emissions accumulate during rush hour, prior to being dispersed later in the day when wind speeds and atmospheric mixing increase.

Figure 1
2011 New Jersey SO_2 Emissions
by Source Category



www3.epa.gov/air/emissions/index.htm

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.

Figure 2
 2015 Sulfur Dioxide Concentrations in New Jersey
 Monthly Variation
 Parts per Million (ppm)

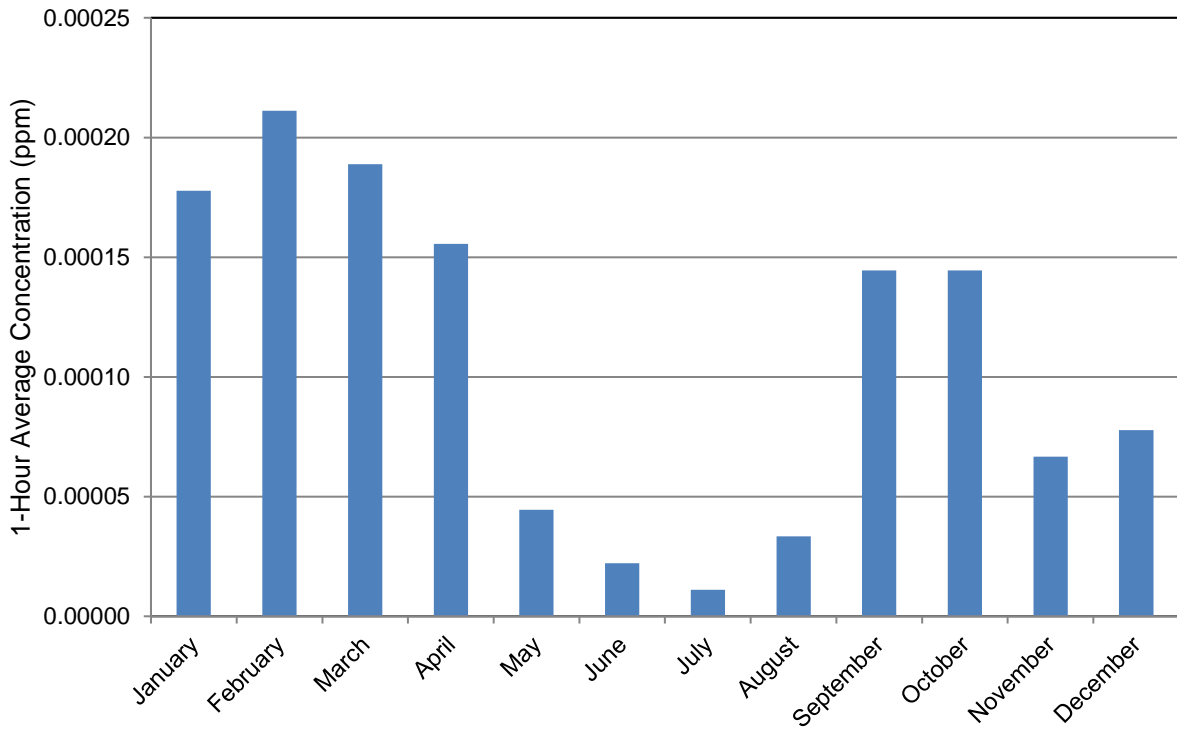
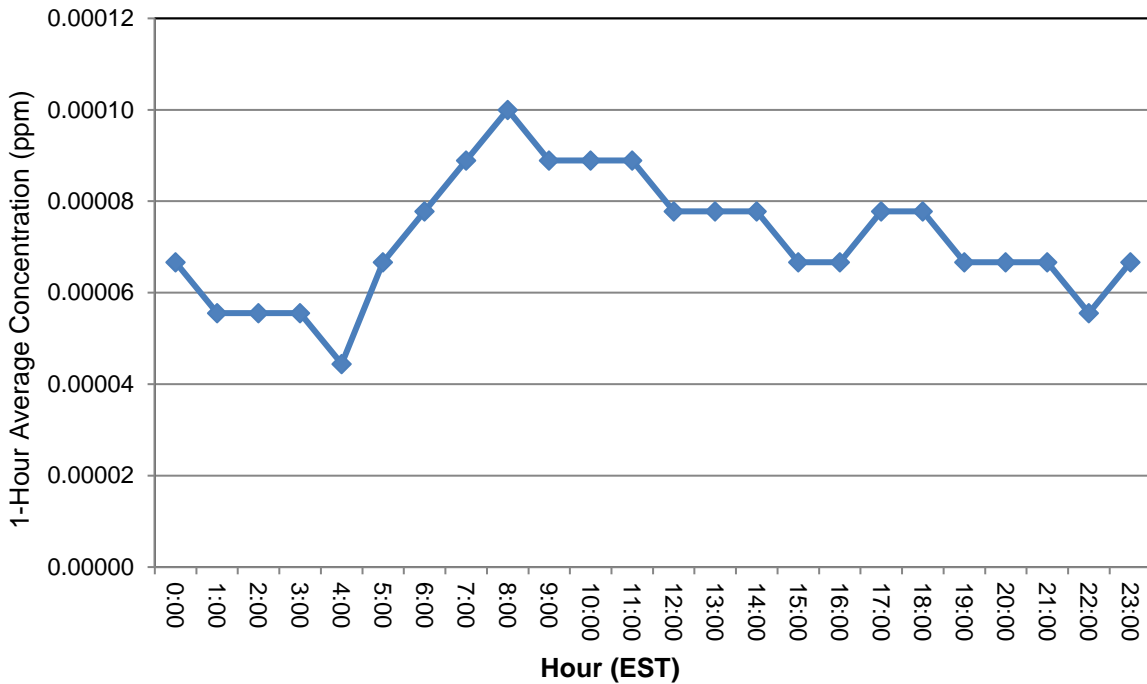


Figure 3
 2015 Sulfur Dioxide Concentrations in New Jersey
 Hourly Variation
 Parts per Million (ppm)



AMBIENT AIR QUALITY STANDARDS

The National Ambient Air Quality Standards (NAAQS) for SO₂ are shown in Table 1. In June 2010 the United States Environmental Protection Agency (USEPA) established a new 1-hour NAAQS for SO₂ 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. The New Jersey Ambient Air Quality Standards (NJAAQS) for SO₂ are expressed in micrograms per cubic meter (µg/m³) instead of ppm. The 12-month and 24-hour NJAAQS are based on rolling averages. For the annual average, that is any 12-month average recorded during two consecutive years. As shown in Table 1, New Jersey also has secondary 12-month and 24-hour standards. The secondary 3-hour standard is the same as the NAAQS.

Table 1
National and New Jersey Ambient Air Quality Standards for Sulfur Dioxide (SO₂)
Micrograms per Cubic Meter (µg/m³)
Parts per Million (ppm)
Parts per Billion (ppb)

Averaging Period	Type	New Jersey	National
12-month average ^a	Primary	80 µg/m ³ (0.03 ppm)	---
12-month average ^a	Secondary	60 µg/m ³ (0.02 ppm)	---
24-hour average ^b	Primary	365 µg/m ³ (0.14 ppm)	---
24-hour average ^b	Secondary	260 µg/m ³ (0.10 ppm)	---
3-hour average ^{b,c}	Secondary	1300 µg/m ³ (0.5 ppm)	0.5 ppm
1-hour average ^d	Primary	---	75 ppb

^a Based on rolling averages.

^b Based on non-overlapping rolling averages.

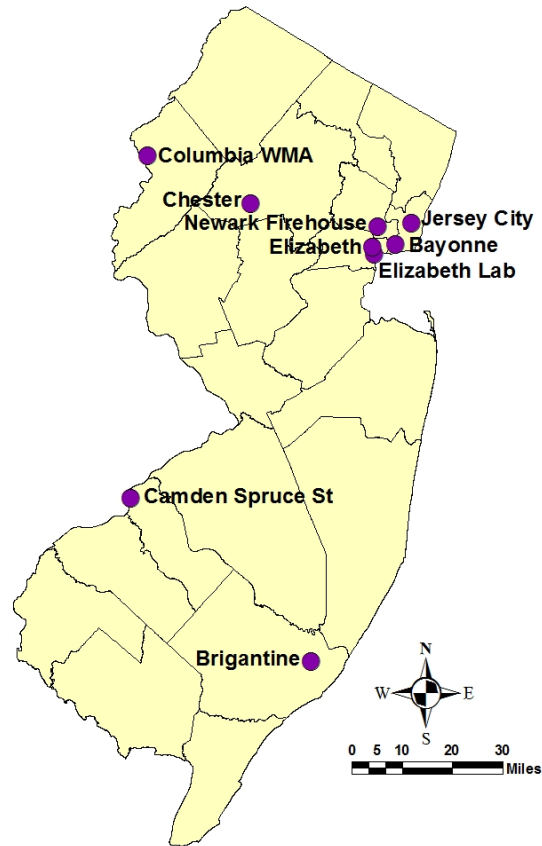
^c Not to be exceeded more than once per year.

^d To meet this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within the state must not exceed 75 ppb.

MONITORING LOCATIONS

The New Jersey Department of Environmental Protection (NJDEP) monitored SO₂ levels at nine locations in 2015. These sites are shown in Figure 4. Two sites, Brigantine and Newark Firehouse, measure SO₂ concentrations at trace levels, down to a hundredth of a part per million. The newest SO₂ monitoring site is at Camden Spruce Street, which became operational in April 2012. In September 2010, the monitoring station at the Columbia Wildlife Management Area (WMA) in Warren County was established in support of a petition submitted to USEPA by NJDEP under Section 126 of the Clean Air Act. The petition showed that emissions from the Portland Generating Station, located in Pennsylvania, significantly contributed to nonattainment or interfered with maintenance of the 1-hour SO₂ NAAQS in New Jersey. The facility stopped operating in 2014.

Figure 4
2015 Sulfur Dioxide
Monitoring Network



SO₂ LEVELS IN 2015

In 2015, there were no exceedances of the 1-hour NAAQS of 75 ppb recorded at any site. This is in contrast to 2014, when five exceedances were recorded at the Columbia station. The highest 99th-percentile of the daily maximum 1-hour concentration for 2015 was 16 ppb recorded at Camden Spruce Street. However, for 2015 Columbia still has the highest design value, the 3-year average of the 99th percentile of the daily maximum 1-hour SO₂ concentration, at 55 ppb. This is because of the high values recorded in 2013 and 2014. The Bayonne site did not have sufficient data from 2013 to determine the three-year design value for the 1-hour SO₂ standard. The Bayonne site did not operate between October 2012 and July 2013 because of damage from Superstorm Sandy.

No monitoring sites showed exceedances of the primary or secondary SO₂ standards during 2015. The maximum 12-month average concentration was 0.001 ppm, recorded at Columbia WMA, Elizabeth, Elizabeth Lab, and Jersey City. The maximum 24-hour average concentration recorded was 0.011 ppm at the Elizabeth Lab site. The highest 3-hour average recorded was 0.042 ppm at the Elizabeth Lab site. Summaries of the 2015 data are provided in Tables 2, 3, 4, and 5, and Figures 5 and 6.

Table 2
 2015 Sulfur Dioxide Concentrations in New Jersey
 Daily Maximums and 99th Percentile 1-Hour Averages
 Parts per Billion (ppb)

Monitoring Site	1-Hour Average (ppb)			2013-2015 Design Value ^a
	Highest Daily Maximum	2 nd -Highest Daily Maximum	99 th %-ile Daily Maximum	
Bayonne ^b	8	7	5	--
Brigantine	6.8	6.7	5	6
Camden Spruce St.	20	17	16	12
Chester	11	7	7	8
Columbia WMA	9	6	5	55
Elizabeth	9	6	4	6
Elizabeth Lab	42	29	15	14
Jersey City	8	5	4	7
Newark Firehouse	8.8	5.3	5.1	7

^a 3-Year (2013-2015) average of the 99th %-ile 1-hour daily maximum concentrations.

^b Bayonne site temporarily shut down October 2012 to July 2013 due to Superstorm Sandy.

Figure 5
 2015 Sulfur Dioxide Concentrations in New Jersey
 3-Year Design Value (2013-2015)
 (99th Percentile of the 1-Hour Daily Maximum Concentrations)
 Parts per Billion (ppb)

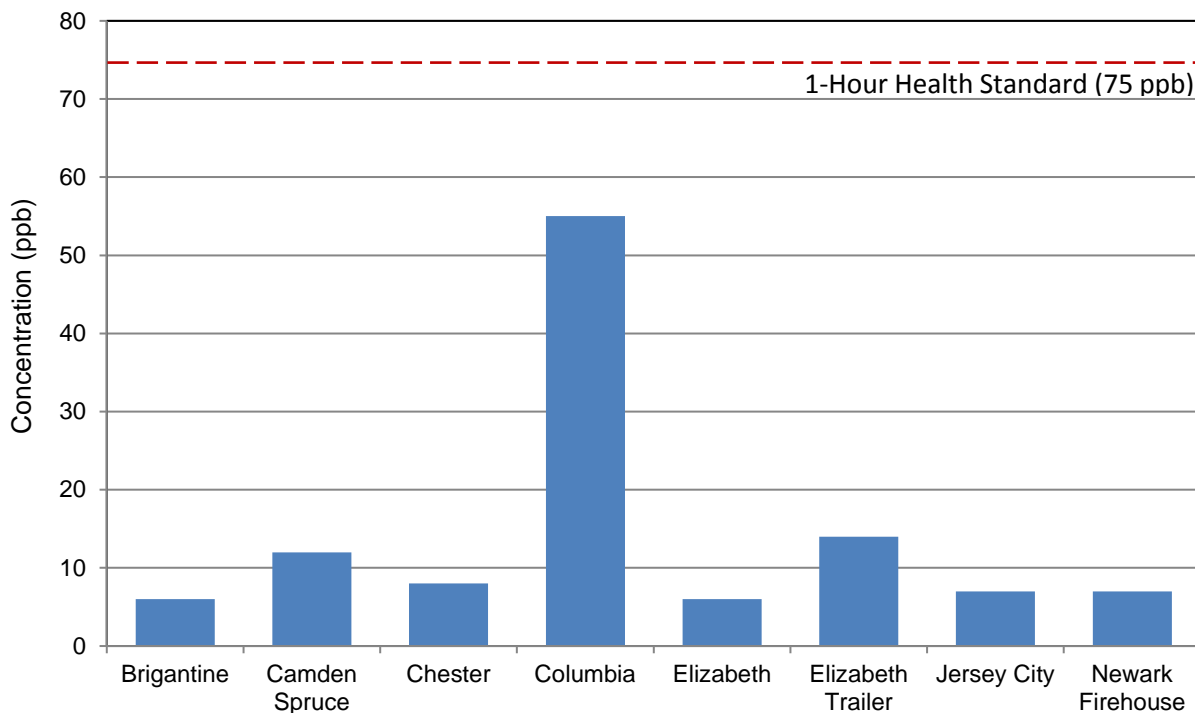


Table 3
2015 Sulfur Dioxide Concentrations in New Jersey
3-Hour Averages
Parts per Million (ppm)

Monitoring Site	3-Hour Average	
	Maximum	2 nd Highest ^a
Bayonne	0.005	0.004
Brigantine	0.0060	0.0059
Camden Spruce St.	0.012	0.012
Chester	0.006	0.005
Columbia WMA	0.007	0.004
Elizabeth	0.006	0.005
Elizabeth Lab	0.042	0.021
Jersey City	0.005	0.004
Newark Firehouse	0.0070	0.0049

^a Based on non-overlapping 3-hour rolling averages.

Table 4
2015 Sulfur Dioxide Concentrations in New Jersey
24-Hour and Daily Averages
Parts per Million (ppm)

Monitoring Site	24-Hour Average ^a		Daily Average ^b	
	Maximum	2 nd -Highest	Maximum	2 nd Highest
Bayonne	0.003	0.002	0.003	0.002
Brigantine	0.0032	0.0023	0.0031	0.0021
Camden Spruce St.	0.003	0.003	0.003	0.003
Chester	0.004	0.003	0.004	0.002
Columbia WMA	0.002	0.001	0.003	0.002
Elizabeth	0.003	0.003	0.003	0.002
Elizabeth Lab	0.011	0.005	0.007	0.005
Jersey City	0.003	0.003	0.003	0.003
Newark Firehouse	0.0044	0.0038	0.0040	0.0029

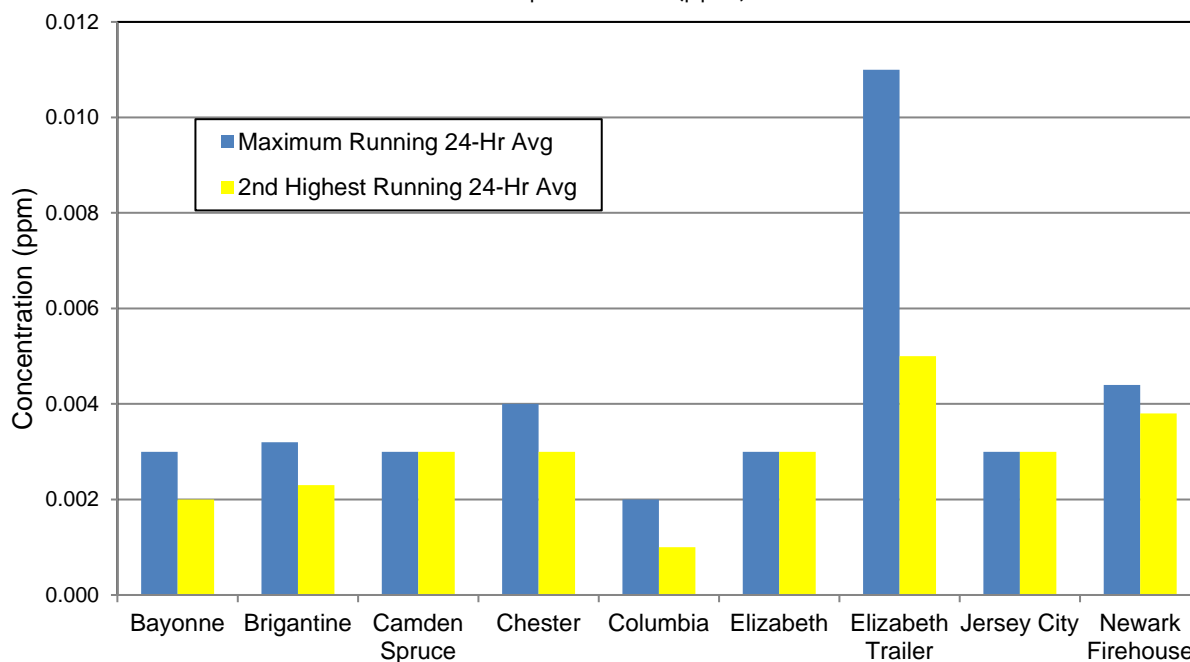
^a Based on non-overlapping 24-hour rolling averages.

^b Based on daily 24-hour block averages, midnight to midnight.

Table 5
 2015 Sulfur Dioxide Concentrations in New Jersey
 12-Month and Annual Averages
 Parts per Million (ppm)

Monitoring Site	12-Month Maximum Average	Annual Average
Bayonne	0.000	0.000
Brigantine	0.0004	0.0003
Camden Spruce St.	0.000	0.000
Chester	0.000	0.000
Columbia WMA	0.001	0.000
Elizabeth	0.001	0.001
Elizabeth Lab	0.001	0.000
Jersey City	0.001	0.000
Newark Firehouse	0.0007	0.0004

Figure 6
 2015 Sulfur Dioxide Concentrations in New Jersey
 Highest and 2nd-Highest 24-Hour Averages
 Parts per Million (ppm)



SO₂ TRENDS

Since the implementation of federal regulations requiring the nationwide use of lower sulfur fuels, SO₂ concentrations have improved significantly. The last time an exceedance of the 3-hour, 24-hour, or 12-month national and New Jersey AAQS for SO₂ was recorded was in 1980. A trend graph of SO₂ levels in Figure 7 shows the second-highest daily average concentrations recorded for the highest site, average of all sites, and lowest site for each year since 1975.

Figure 8 shows the trend in one-hour concentrations of SO₂ since 2000. The graph uses the 99th percentile of the daily maximum 1-hour concentrations. The increase in maximum values that begins in 2010 is attributable to the start-up of the Columbia WMA monitoring site, which was impacted by the Portland Power Plant across the Delaware River in Pennsylvania (which has since shut down).

Air dispersion modeling carried out by NJDEP in 2009-2010 showed that New Jersey was being impacted by SO₂ emissions from a coal-burning power plant across the Delaware River in Pennsylvania, causing likely violations of the 2010 1-hour NAAQS of 75 ppb. 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 SO₂ monitoring station at the Columbia Wildlife Management Area in Knowlton Township, Warren County, in September 2010. In October 2011, USEPA finalized a rule to grant New Jersey's petition. This final rule required the Portland Power Plant to reduce its SO₂ 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 have shown that Warren County and its vicinity are now able to meet the 1-hour SO₂ NAAQS.

Figure 7
Sulfur Dioxide Concentrations in New Jersey, 1975-2015
Second-Highest Daily Average
Parts per Million (ppm)

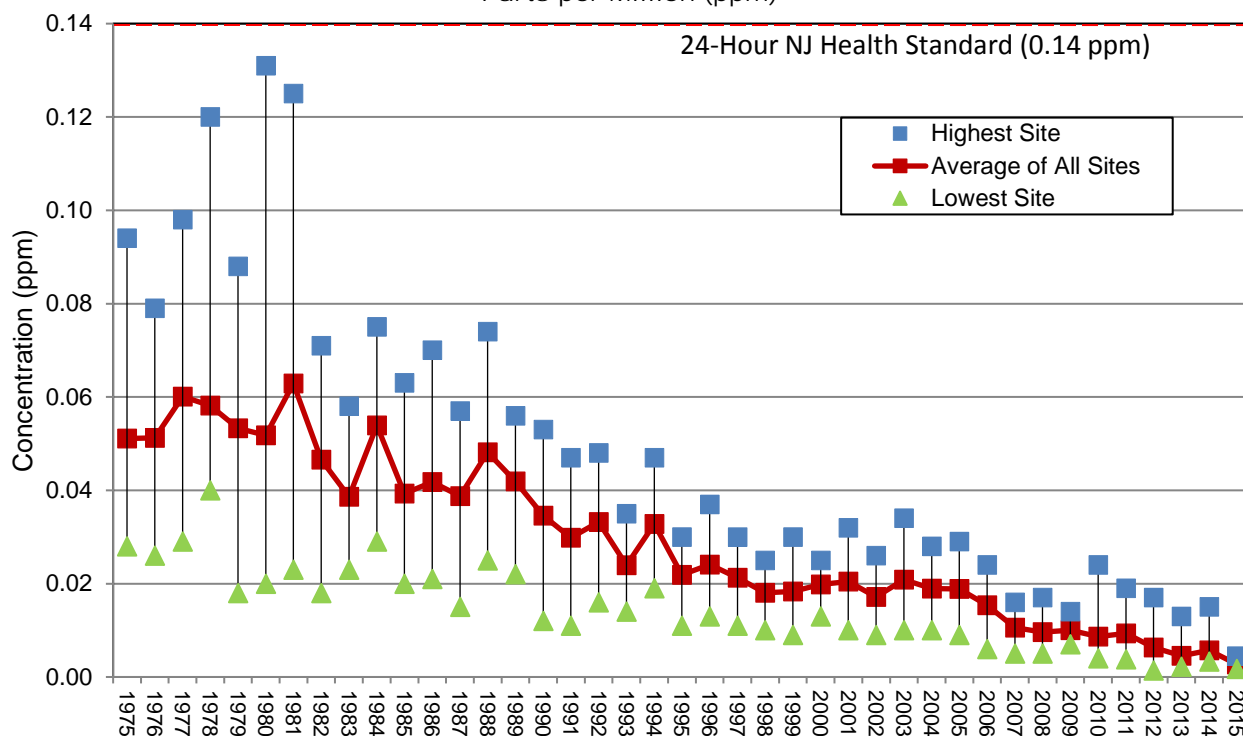
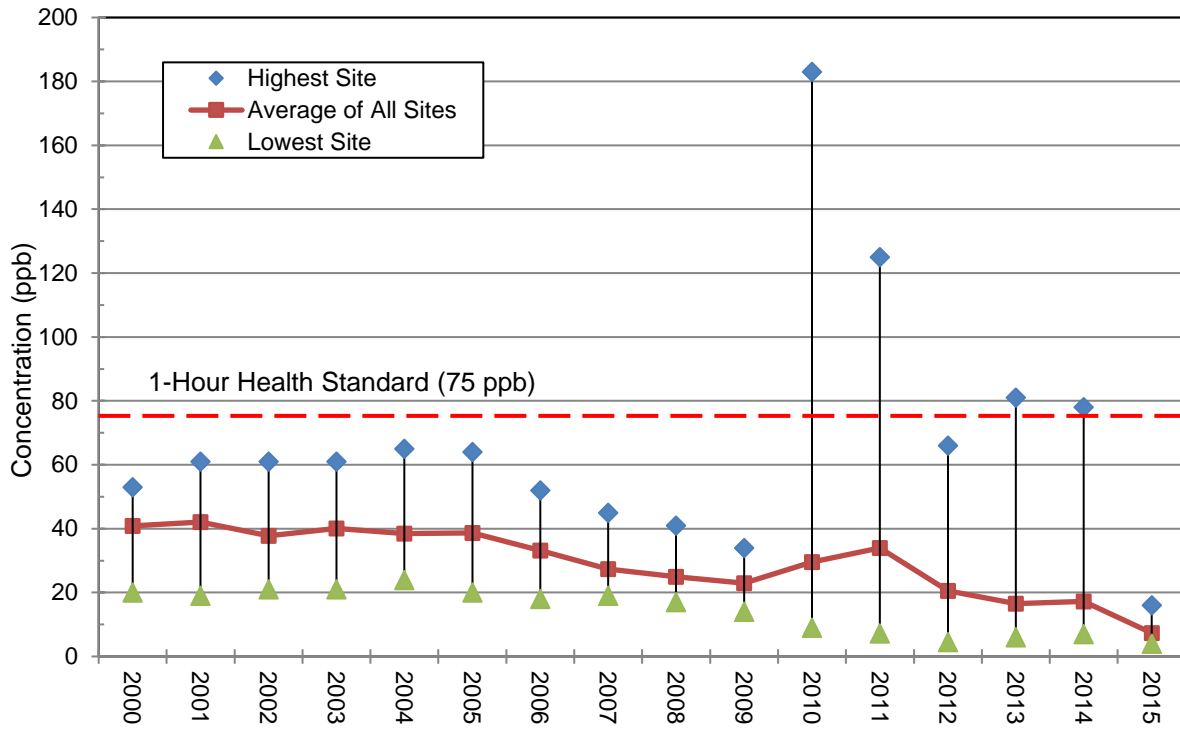


Figure 8
 Sulfur Dioxide Concentrations in New Jersey, 1975-2015
 99th Percentile of the Daily Maximum 1-Hour Concentrations
 Parts per Billion (ppb)



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