2010 Sulfur Dioxide Summary

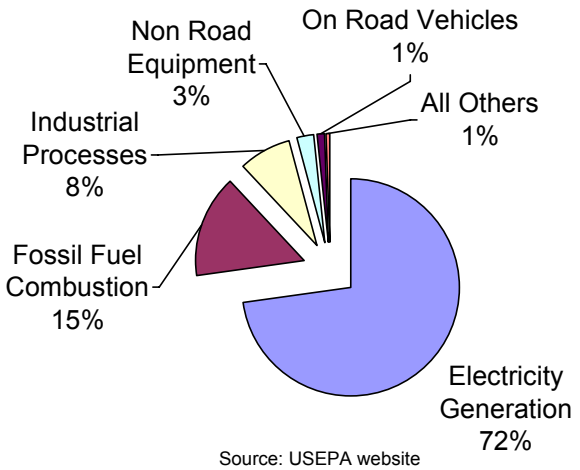
New Jersey Department of Environmental Protection

Nature and 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 electric utilities, especially those that burn coal with high sulfur content. Sulfur is found in raw materials such as crude oil, coal, and ores that contain metals such as 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 major sources of SO_2 is shown in Figure 1.

Figure 4 (page 6) shows that SO_2 concentrations in New Jersey are generally higher in the winter than in the summer due to higher emissions from space heating and other sources. As shown in Figure 5 (page 6), SO_2 levels tend to peak in mid to late morning as emissions accumulate prior to being more effectively dispersed when wind speeds increase and atmospheric mixing increases later in the day.

Figure 1
National Summary
SO_2 Emissions by Source Sector



Source: USEPA website
HTTP://WWW.EPA.GOV/AIR/EMISSIONS/SO2.HTM
2005 data.

Health and Environmental Effects

Sulfur dioxide causes irritation of the mucous membranes. This is probably the result of the action of sulfurous acid that is formed when the highly soluble SO_2 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 belonging to these sensitive groups and those who are active outdoors may have trouble breathing. The International Agency for Research on Cancer (IARC) evaluated SO_2 and based on available information, determined that no conclusion can be made as to the carcinogenicity of SO_2 to human beings (IARC, 1992).

Sulfur dioxide reacts with other gases and particles in the air to form sulfates that can be harmful to people and the environment. Sulfate particles are the major cause of reduced visibility in the eastern United States. SO_2 can also react with other substances in the air to form 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 eventually speeds up the decay of building materials and paints.

Standards

From 1971 through June 2010, there were three National Ambient Air Quality Standards (NAAQS) for SO_2. In June 2010, based on its review of the air quality standard for oxides of sulfur as measured by SO_2, the United States Environmental Protection Agency (USEPA) revised the primary SO_2 NAAQS. USEPA has established a new 1-hour SO_2 standard at a level of 75 parts per billion (ppb). This new standard is based on the 3-year average of the annual 99th percentile of 1-hour daily maximum concentrations (Federal Register, 2010). The 1971 SO_2 standards remain in effect until one year after an area is

designated for the 2010 standard. In areas designated nonattainment for the 1971 standards, the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standards are approved (USEPA, 2010). The 1971 standards include an annual average health standard of 0.03 parts per million (ppm). This is based on a calendar year average of continuously monitored levels. There is also a 24-hour average health based standard of 0.14 ppm which is not to be exceeded more than once a year, and a secondary (welfare based) 3-hour average concentration standard of 0.5 ppm that is also not to be exceeded more than once per year.

New Jersey has also set state air quality standards for SO_2. They are similar to the federal standards but are expressed in micrograms per cubic meter ($\mu g/m^3$) instead of ppm. They are also based on rolling averages rather than block averages. So, for example, the state's primary 12-month standard is based on any twelve-month average recorded during the year, while the federal standard is based solely on the calendar year average. The state also has secondary 12-month, 24-hour, and 3-hour average standards. Table 1 summarizes the NAAQS and the New Jersey Ambient Air Quality Standards (NJAAQS) for SO_2.

Monitoring Locations

The state monitored SO_2 levels at 13 locations in 2010. These sites are shown in Figure 2. Monitoring location changes included the start up of the Columbia WMA site in September 2010, and the permanent shutdown of the SO_2 analyzers at the Ancora State Hospital, Clarksboro, Hackensack, Millville and Perth Amboy sites on December 31, 2010.

SO_2 Levels in 2010

None of the monitoring sites recorded exceedances of the primary or secondary SO_2 standards during 2010. The maximum 12-month average concentration recorded was 0.002 ppm at the Bayonne, Elizabeth Lab, and Jersey City sites. The maximum 24-hour average level recorded was 0.031 ppm at the Columbia WMA site. The highest 3-hour average recorded was 0.133 ppm at the Columbia WMA site. The highest 99th percentile of the 1-hour daily maximum concentration for 2010 was recorded at Columbia WMA (183 ppb). While this value is high, it does not amount to an exceedance because the comparison to the standard requires 3 years of data.

Three sites (Newark, Columbia WMA, and Camden) do not have sufficient data to compare with the 1-hour standard. The 10 remaining sites all have adequate amounts of data to compare to the new standard. Of those, the Elizabeth Lab location had the highest 1-hour average at 35 ppb. Summaries of the 2010 data are provided in Tables 2, 3, 4 and Figure 3 (pages 4 and 5), and Figures 6 and 7 (page 7).

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

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

[a] – National standards are block averages rather than moving averages.

[b] – Final rule signed June 2, 2010 and effective on August 23, 2010. To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hr average at each monitor within an area must not exceed 75 ppb.

Figure 2
2010 Sulfur Dioxide
Monitoring Network

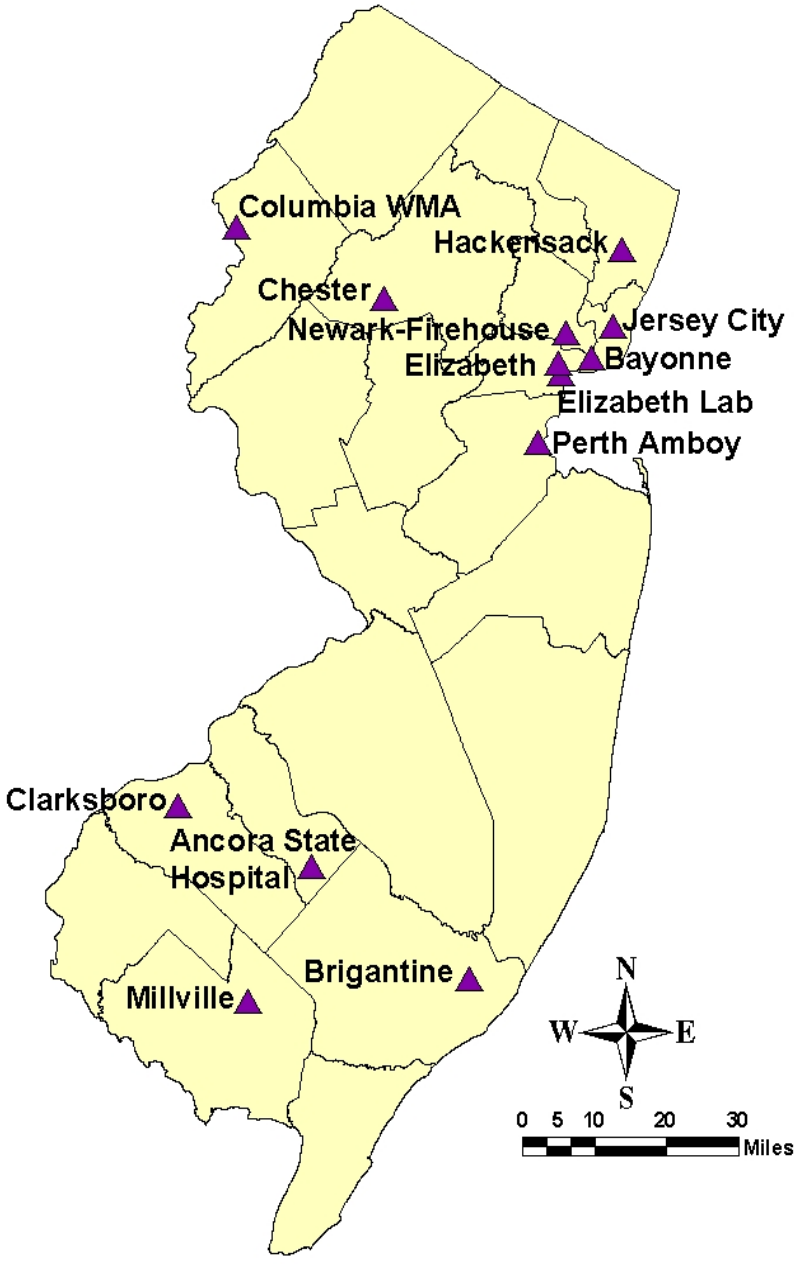


Table 2
2010 Sulfur Dioxide Data
3-Hour and Annual Averages
Parts Per Million (ppm)

Monitoring Sites	3-Hour Average Maximum	3-Hour Average 2nd Highest [a]	12-Month Average Maximum	Calendar Year Average
Ancora State Hospital	0.015	0.012	0.000	0.000
Bayonne	0.022	0.021	0.002	0.002
Brigantine	0.014	0.012	0.0009	0.0009
Chester	0.032	0.031	0.001	0.001
Clarksboro	0.024	0.017	0.001	0.001
Columbia WMA [b]	0.133	0.114	----	----
Elizabeth	0.015	0.010	0.001	0.001
Elizabeth Lab	0.032	0.029	0.002	0.001
Hackensack	0.009	0.008	0.000	0.000
Jersey City	0.021	0.019	0.002	0.001
Millville	0.013	0.011	0.001	0.001
Newark Firehouse	0.018	0.018	0.0018	0.0018
Perth Amboy	0.014	0.013	0.001	0.001

[a] – Based on non-overlapping 3 – hour moving averages.
[b] – Station started collecting data September 2010 and does not have sufficient amount of data to calculate 12-Month and Calendar Year averages.

Table 3
2010 Sulfur Dioxide Data
24-Hour and Daily Averages
Parts Per Million (ppm)

Monitoring Sites	24-Hour Average Maximum	24-Hour Average 2nd Highest [a]	Daily Average Maximum	Daily Average 2nd Highest
Ancora State Hospital	0.006	0.006	0.006	0.005
Bayonne	0.012	0.011	0.010	0.010
Brigantine	0.0065	0.0064	0.0063	0.0061
Chester	0.013	0.011	0.013	0.010
Clarksboro	0.011	0.009	0.011	0.008
Columbia WMA [b]	0.031	0.024	0.031	0.024
Elizabeth	0.007	0.006	0.006	0.006
Elizabeth Lab	0.012	0.010	0.009	0.008
Hackensack	0.005	0.004	0.004	0.004
Jersey City	0.015	0.011	0.013	0.010
Millville	0.006	0.006	0.006	0.005
Newark Firehouse	0.0108	0.0104	0.0099	0.0095
Perth Amboy	0.008	0.008	0.008	0.007

[a] – Based on non-overlapping 24 – hour moving averages.
[b] – Station started collecting data September 2010.

Table 4
2010 Sulfur Dioxide Data
3-Year Average of 99th Percentile
of Daily Maximum 1-Hour Average
Parts Per Billion (ppb)

Location	99th Percentile of Daily Maximum			3 – Year Average
	2008	2009	2010	2008 - 2010
Ancora State Hospital	21	20	10	17
Bayonne	29	33	26	29
Brigantine	17.0	14.0	9.8	13.6
Camden Lab[a]	31	---	---	---
Chester	26	29	26	27
Clarksboro	27	25	15	22
Columbia WMA[b]	---	---	183	---
Elizabeth	20	22	11	18
Elizabeth Lab	41	34	30	35
Hackensack	17	17	9	14
Jersey City	28	22	19	23
Millville	21	17	10	16
Newark Firehouse[c]	---	---	18.0	---
Perth Amboy	22	17	17	19

[a] – Camden Lab site shut-down indefinitely in 2008.

[b] – Columbia WMA site started in September 2010.

[c] – Newark Firehouse site started in July 2009.

Figure 3
Sulfur Dioxide – New Jersey
2010 3-Year Design Values
Parts Per Billion (ppb)

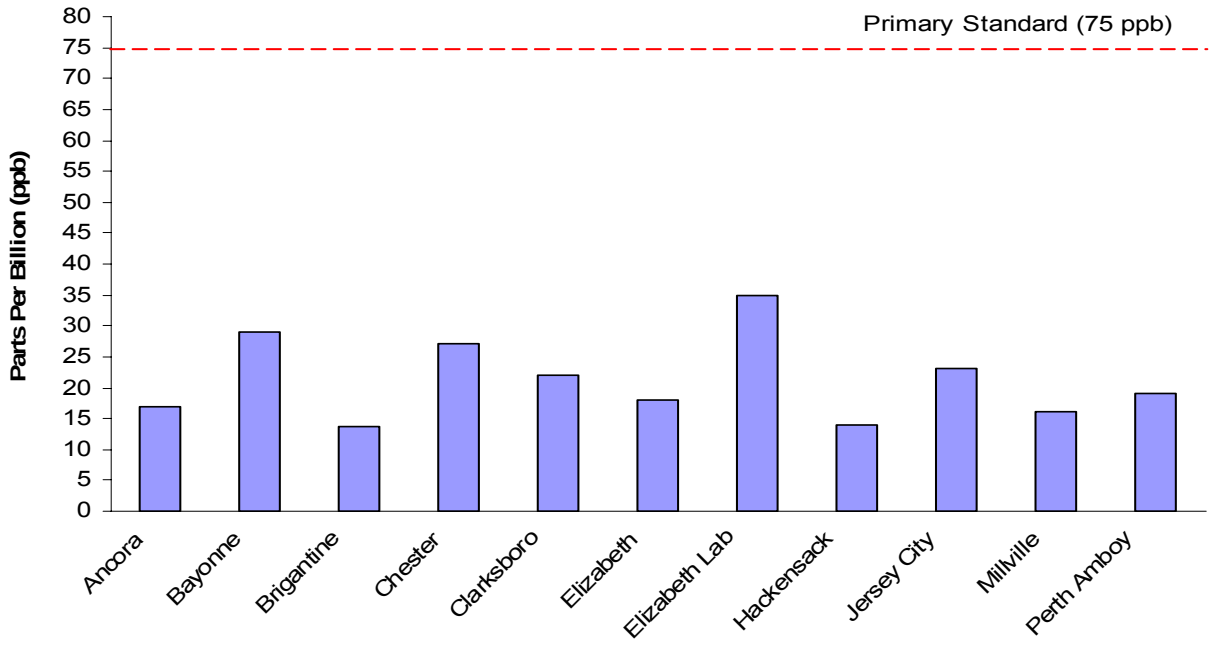


Figure 4
Sulfur Dioxide – New Jersey
2010 Monthly Variation
Parts Per Million (ppm)

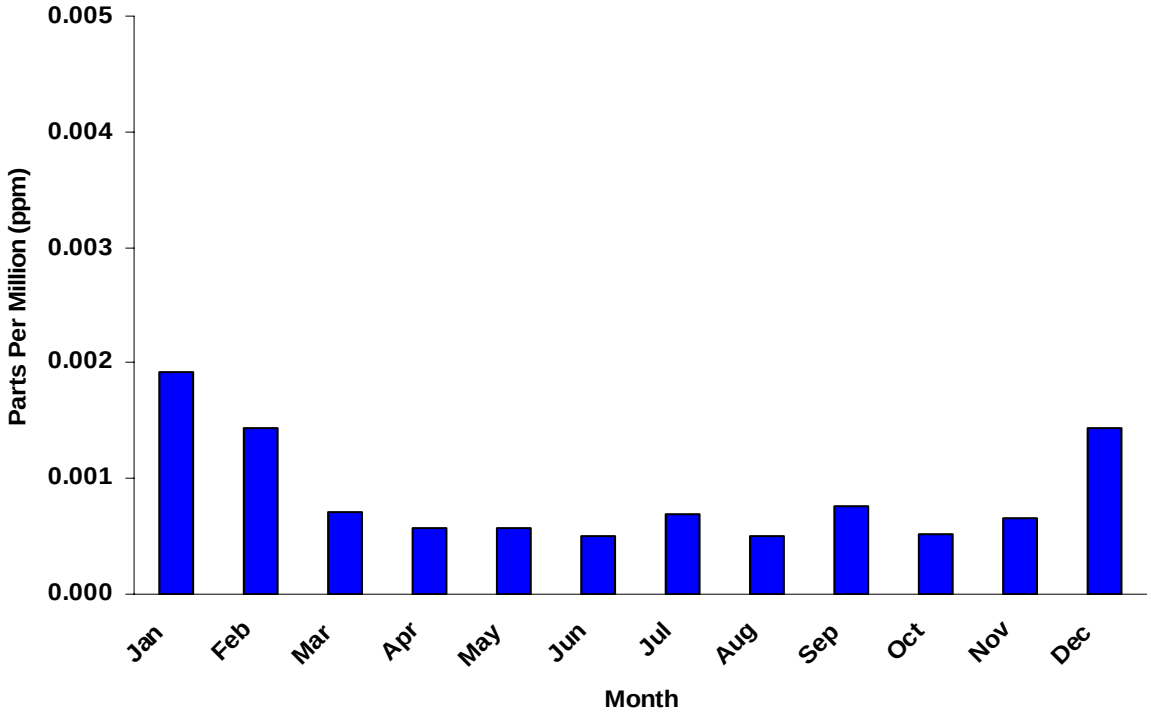


Figure 5
Sulfur Dioxide – New Jersey
2010 Hourly Variation
Parts Per Million (ppm)

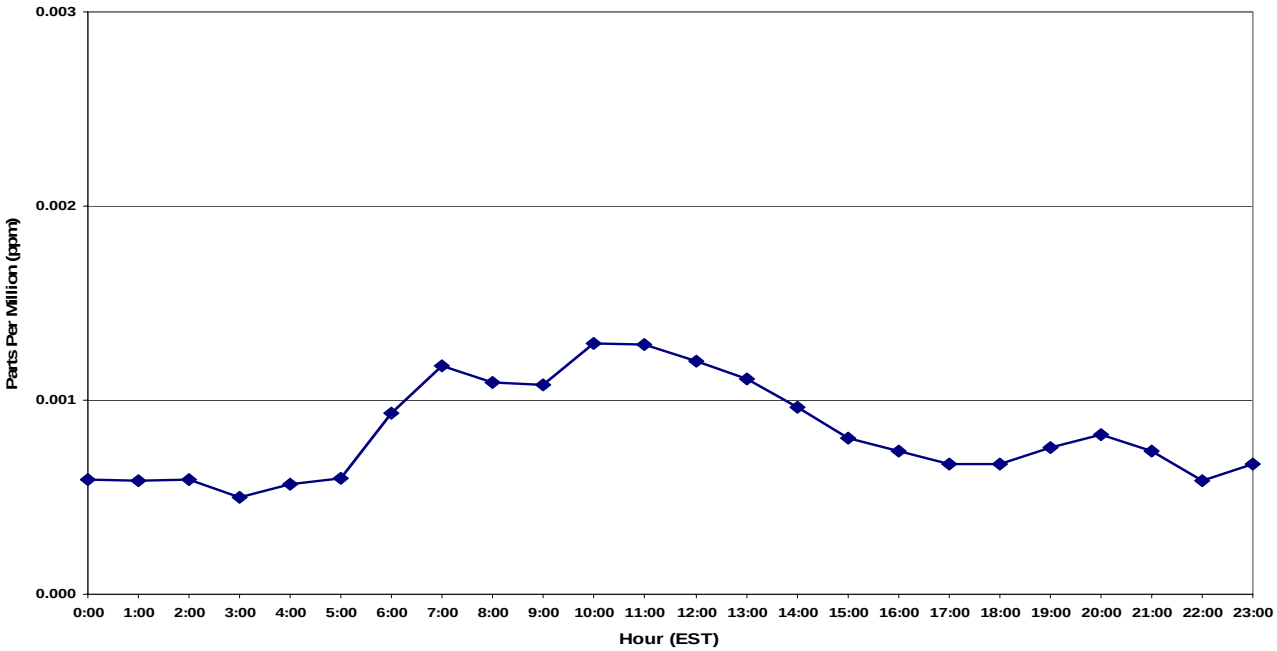


Figure 6
2010 Sulfur Dioxide Concentrations
Highest and 2nd Highest 24-Hour Averages
Parts Per Million (ppm)

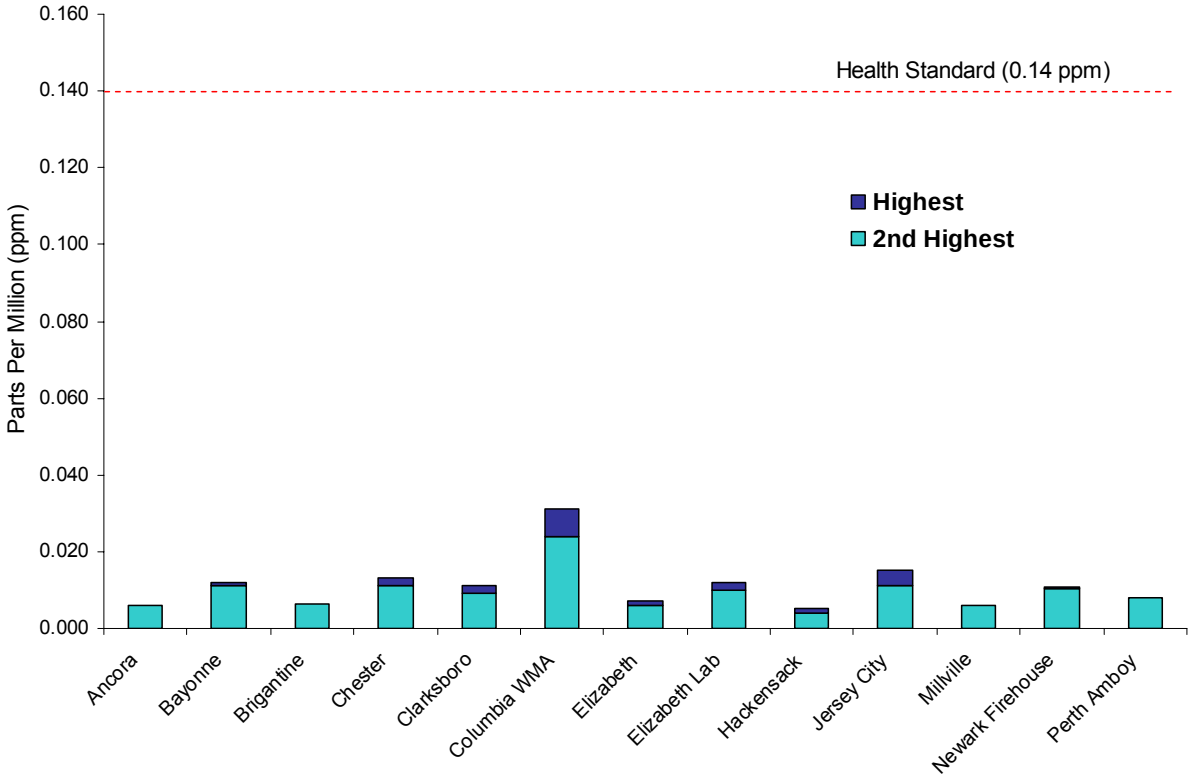
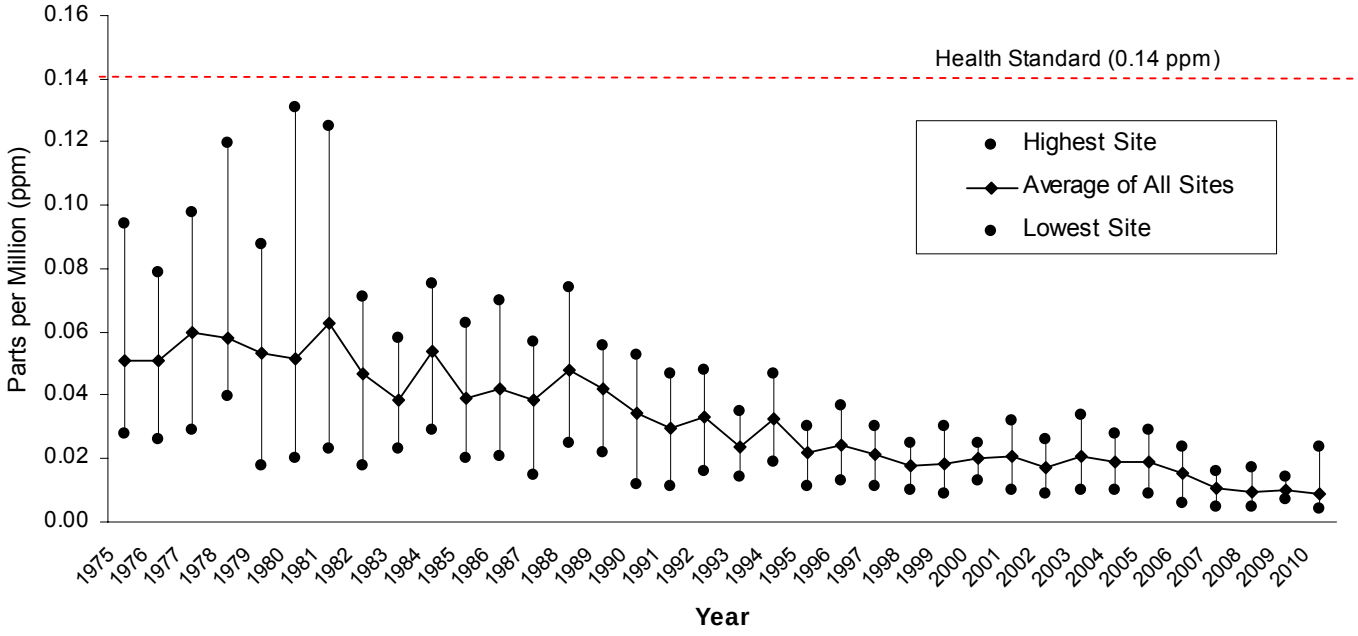


Figure 7
1975 - 2010 Sulfur Dioxide Concentrations
Second Highest Daily Average
Parts Per Million (ppm)

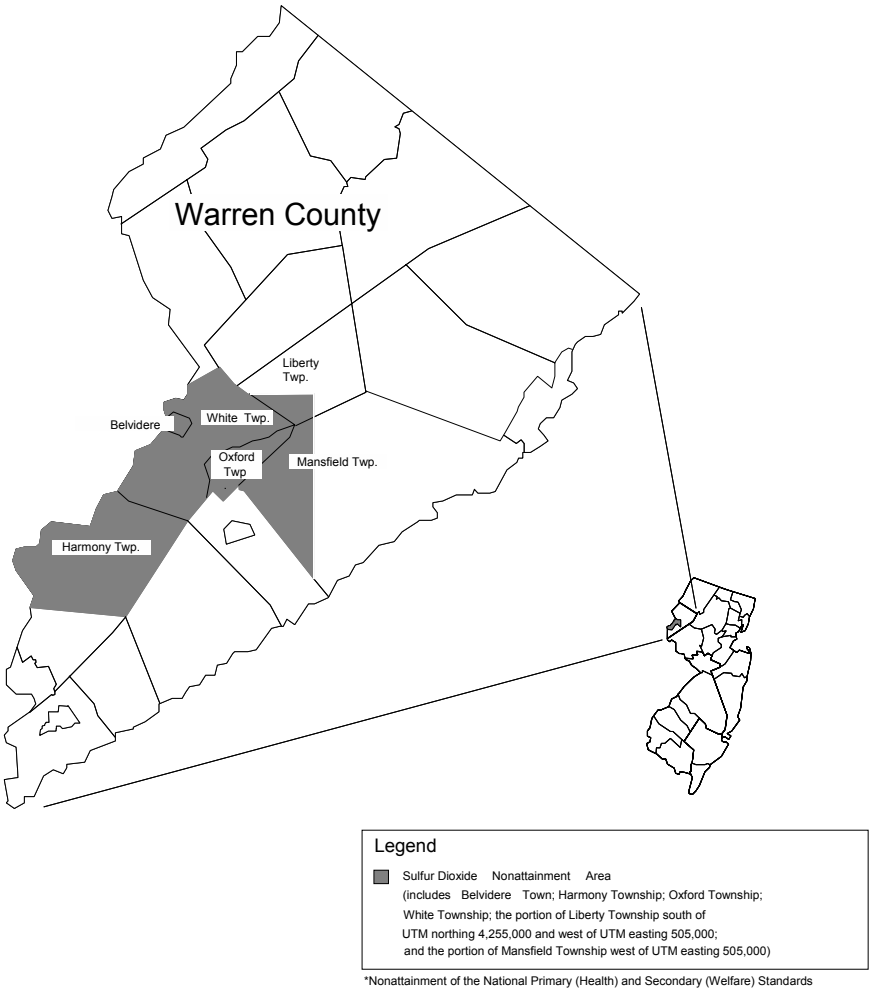


TRENDS

Since the implementation of regulations requiring the use of low sulfur fuels in New Jersey, SO_2 concentrations have improved significantly. The last time an exceedance of any of the National SO_2 standards was recorded in the state was in 1980. A trend graph of SO_2 levels showing the daily average concentrations recorded since 1975 from the highest, average, and lowest of all sites is shown in Figure 7 (page 7). The graph uses the second highest daily average, as this is the value that determines if the national health standard is being met (one exceedance per site is allowed each year).

Although there has not been a measured exceedance of the NAAQS in over two decades, there is still a small area of New Jersey that is classified as a non-attainment area for SO_2. This is the result of air quality modeling studies that predicted non-attainment of the standard within a small area of Warren County. The area is shown below in the map in Figure 8.

Figure 8
Sulfur Dioxide Non-attainment Areas in New Jersey



*Nonattainment of the National Primary (Health) and Secondary (Welfare) Standards

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