



2011 Air Quality Report

New Jersey Department of Environmental Protection

SUMMARY

This report summarizes the New Jersey air quality monitoring data for 2011. It contains information on the Air Quality Index (AQI), concentrations of individual pollutants – carbon monoxide, nitrogen oxides, ozone, particulate matter, and sulfur dioxide. Data on acid precipitation, speciation of fine particulates, ozone precursors, toxic air contaminants, including mercury, and meteorological data are also provided.



INTRODUCTION

The State of New Jersey has been monitoring air quality since 1965. During that time, pollution levels have improved significantly as a result of state regulations, which are among the most stringent in the country, as well as regional and national air pollution reduction efforts.

Air quality problems still exist across the state. Ozone continues to be a significant problem in the summer months, and has been found to have serious health effects at lower levels than previously thought. The United States Environmental Protection Agency (USEPA) revised the National Ambient Air Quality Standards (NAAQS) for ozone in 2008 to account for this public health information and emission reduction strategies continue to be implemented to meet these standards.

In addition to ozone, sulfur dioxide (SO₂) and nitrogen dioxides (NO₂) have also been proven to have serious respiratory health problems with sensitive individuals, especially children, the elderly and people with asthma. In 2010, the USEPA revised the NAAQS for both SO₂ and NO₂ to account for this new public health concern. New Jersey continues to closely monitor these pollutants to keep them within the NAAQS.

Fine particles are also a problem that faces the state of New Jersey. Fine particles are defined as particles less than 2.5 micrometers in diameter and are referred to as PM_{2.5}. These small particles have been found to have a greater impact on public health than larger particles, which were the focus of the previous standards. Monitoring data indicate PM_{2.5} levels could be a problem in some areas of New Jersey.

Additionally, there is an increasing concern about a class of air pollutants termed "air toxics". These pollutants include substances known to cause cancer or other serious health problems. The list of potential air toxics is very large and includes many different types of compounds including heavy metals and toxic volatile organic compounds. New Jersey continues to use the results of an EPA air toxics study and other information to address this complex problem. More comprehensive monitoring of ozone, fine particles, and air toxics in New Jersey is being implemented and data from these programs are presented in this report.

Questions or comments concerning this report can be made by e-mailing us at bamweb@dep.state.nj.us, by phone at (609) 292-0138 or by writing to us at:

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2011 Network Summary

New Jersey Department of Environmental Protection

NETWORK DESIGN

In 2011, the Bureau of Air Monitoring maintained 40 Ambient Air Monitoring Sites in New Jersey. These monitoring sites fulfill one or more of the following objectives: measure maximum pollutant concentration, assess population exposure, determine the impact of major pollution sources, measure background levels, determine the extent of regional pollutant transport, or measure secondary impacts in rural areas.

Data from the network are provided to various public and media outlets and are used to provide hourly updates on air quality to the Bureau's web page at <http://www.njaqinow.net>.

MONITORING NETWORK

NJ's Air Monitoring Network measures for a wide variety of pertinent ambient air pollutant data and most of the data is sent to the Bureau's data acquisition system. Ambient air data sent to the acquisition system are either transmitted in real-time or subsequently added to the system. A map showing the locations of NJ's Air Monitoring sites are shown in Figure 3 (page 3).

Ambient air quality data measured in real-time, at NJ's monitoring sites, are transmitted via wireless communication directly to the Bureau's data acquisition system. Most of the data is transmitted once every minute, thus providing real-time data retrieval capability. This technology provides New Jersey resident's with the ability to view ambient air data, within their respected communities, on the Bureau of Air Monitoring's web site (<http://www.njaqinow.net>) and on the Environmental Protection Agency's AirNow website (<http://airnow.gov>). Real-time parameters measured throughout New Jersey's Air Monitoring sites are: carbon monoxide (CO), oxides of nitrogen (NO_x) measuring both nitrogen dioxide and nitric oxide, ozone (O₃), sulfur dioxide (SO₂), smoke shade (SS), total reactive oxides of nitrogen (NO_y), real-time fine particulates (PM_{2.5}), visibility, and meteorological data which include wind speed (WS), wind direction (WD), barometric pressure, solar radiation, temperature, and relative humidity.

Figure 1

Photo of Brigantine Air Monitoring Station located on the grounds of the Edwin B. Forsythe National Wildlife Refuge in Atlantic County.



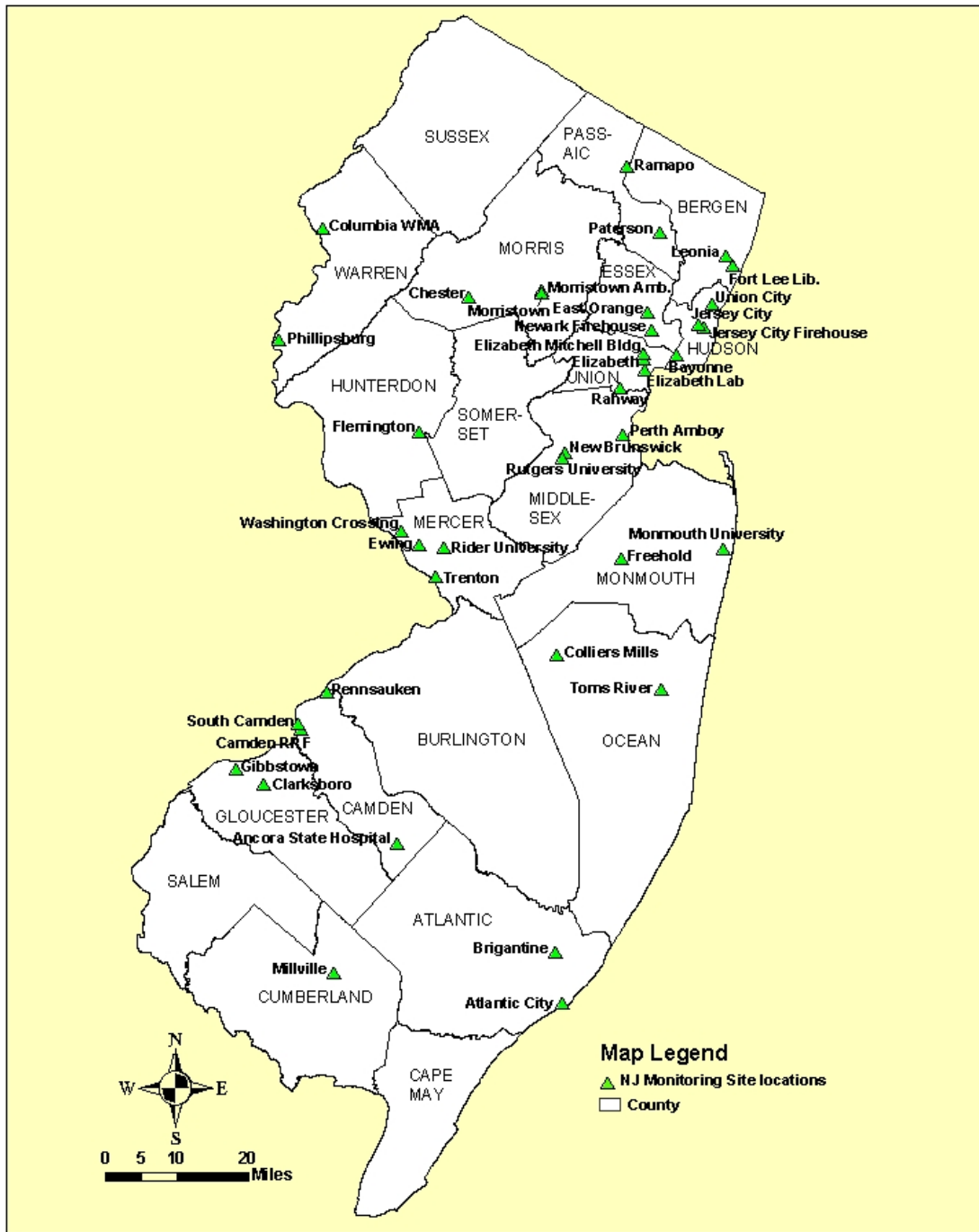
Data subsequently sent to the Bureau's data acquisition system, consists mainly of instruments that collect samples for analysis in a laboratory. The data collected throughout New Jersey's Air Monitoring sites are: fine particulates (particles smaller than 2.5 micrometers in diameter or $PM_{2.5}$) see figure 2 which is a photo of a $PM_{2.5}$ sampler, inhalable particulates (particles smaller than 10 micrometers in diameter or PM_{10}), mercury (Hg), several parameters associated with acid deposition, pollutants important in the formation of ground level ozone (ozone precursors), and a group of organic and inorganic compounds that are considered toxic pollutants. Sites that measure ozone precursors are part of the national Photochemical Assessment Monitoring Station (PAMS) program. PAMS data are collected on a seasonal basis (June 1st – August 31st). While these ozone precursors are automatically measured every hour, the data are retrieved once a day and require extensive review before they are validated.

Parameters recorded at each site are displayed in Table 1 (page 4). Changes to the Network are summarized in Table 2 (page 5).

Figure 2
Photo of USEPA-approved $PM_{2.5}$ sampler on the roof of the Union City Health Department building in Hudson County



**Figure 3
New Jersey Air Monitoring Sites 2011
Network Summary**




**Table 1
Monitoring Network Chart**


	CO	NO _x	NO _y	O ₃	SO ₂	Smoke Shade	PM _{2.5}	PM _{2.5} -Speciation	Real-Time PM _{2.5}	Visibility	PM ₁₀	O ₃ Precursors - PAMS	VOCs	Carbonyls	Acid Deposition	Mercury	Barometric Pressure	Relative Humidity	Solar Radiation	Temperature	Wind Direction	Wind Speed
Ancora State Hospital	Y			Y											Y							
Atlantic City							Y															
Bayonne		Y		Y	Y																	
Brigantine				Y	Y		Y		Y	Y					Y ¹	Y						
Camden RRF											Y											
Chester		Y		Y	Y		Y	Y					Y	Y		Y			Y			
Clarksboro				Y																		
Colliers Mills				Y																		
Columbia WMA		Y		Y	Y		Y		Y								Y	Y		Y	Y	Y
East Orange	Y	Y																Y		Y		
Elizabeth	Y				Y	Y																
Elizabeth Lab	Y	Y			Y	Y	Y	Y	Y				Y	Y		Y					Y	Y
Elizabeth Mitchell Bldg							Y															
Ewing									Y													
Flemington				Y					Y								Y	Y	Y	Y	Y	Y
Fort Lee Library							Y															
Freehold	Y																					
Gibbstown							Y															
Jersey City	Y				Y	Y																
Jersey City Firehouse							Y		Y		Y											
Leonia				Y																		
Millville		Y		Y					Y													
Monmouth University				Y																		
Morristown	Y																					
Morristown Amb Squad							Y															
New Brunswick							Y	Y	Y				Y	Y		Y						
Newark Firehouse	Y	Y	Y	Y	Y		Y	Y	Y								Y	Y	Y	Y	Y	Y
Paterson							Y															
Pennsauken							Y															
Perth Amboy	Y																					
Phillipsburg							Y															
Rahway							Y		Y													
Ramapo				Y																		
Rider University				Y													Y	Y	Y	Y	Y	Y
Rutgers University		Y		Y								Y					Y ²	Y ²	Y ²	Y ²	Y ²	Y ²
South Camden									Y													
Toms River							Y															
Trenton							Y				Y											
Union City							Y															
Washington Crossing							Y								Y							
TOTAL	9	8	1	15	8	3	20	4	11	1	3	1	3	3	3	4	5	6	5	6	6	6

Y - Measuring Parameter Data in 2011

¹ The United States Fish and Wildlife Service is responsible for sample collection

² Meteorological measurements at the Site are collected by Rutgers University

 Began measuring data in 2011. See Table 2 (page 5)

 Shutdown from measuring data in 2011. See Table 2 (page 5)

**Table 2
2010-2011 Network Changes**

Monitoring Site	Parameter(s)	Action	Date
Ancora State Hospital	SO ₂	Shut down	12/31/10
	CO	Shut down	06/30/11
Atlantic City	PM ₁₀	Shut down	03/09/10
Clarksboro	SO ₂	Shut down	12/31/10
Columbia WMA	SO ₂ , PM _{2.5}	Start-up	09/23/10
	Real-Time PM _{2.5}	Start-up	10/22/10
	NO _x , O ₃	Start-up	01/20/11
	WS, WD, Relative Humidity, Temperature, Barometric Pressure	Start-up	03/11/11
Freehold	SS	Shut down	12/31/10
	CO	Shut down	06/30/11
Hackensack	CO, SO ₂ , SS	Shut down	12/31/10
Leonia	NO _x	Shut down	12/31/10
Millville	SO ₂	Shut down	12/31/10
Morristown	SS	Shut down	12/31/10
	CO	Shut down	06/30/11
Newark-Firehouse	NO _y , WS, WD, Barometric Pressure, Solar Radiation	Start-up	11/09/10
	Temperature	Start-up	11/10/10
	Relative Humidity	Start-up	12/17/10
	NO _x	Start-up	01/12/11
Perth Amboy	CO	Shut down	06/30/11
	SO ₂ , SS	Shut down	12/31/10
Rider University	O ₃ Precursors - PAMS	Shut down	08/31/10
	NO _x	Shut down	12/31/10
Trenton	PM ₁₀	Shut down	03/31/11

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2011 Air Quality Index Summary

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). Generally, an index value of 100 is equal to the primary, or health based, NAAQS for each pollutant. This allows for a direct comparison of each of the pollutants used in the AQI (carbon monoxide, nitrogen dioxide, particulate matter, ozone, and sulfur dioxide). The Nitrogen Dioxide and Sulfur Dioxide NAAQS were revised in 2010 because the U.S. Environmental Protection Agency (EPA) had determined that the old standards were not sufficiently protective of public health. On January 22, 2010, they set a revised standard of 100 ppb maximum daily 1-hour average for NO₂ and on June 2, 2010, they set a revised standard of 75 ppb maximum daily 1-hour standard for SO₂, making 2011 the first full year with these new standards. The AQI rating for a reporting region is equal to the highest rating recorded for any pollutant within that region. In an effort to make the AQI easier to understand, a descriptive rating and a color code, based on the numerical rating are used (see Table 1). For more information on the AQI, visit EPA's web site at <http://www.airnow.gov>.

Every morning a forecast for the current and following day is prepared by NJDEP using the AQI format. The forecast is provided to EPA and is disseminated through the Enviroflash system (<http://www.enviroflash.info>) to those who subscribe to receive air quality forecast and alert emails. Those who are not subscribed to Enviroflash can view the forecast and current air quality conditions at EPA's AirNow website or on NJDEP's air monitoring webpage.

For purposes of reporting the AQI, the state is divided into 9 regions (see Figure 1). Table 2 shows the monitoring sites and parameters used in each reporting region to calculate the AQI values.

Table 1
Air Quality Index

Numerical AQI Rating	Descriptive Rating	AQI Color Code
0-50	Good	Green
51-100	Moderate	Yellow
101-150	Unhealthy for Sensitive Groups	Orange
151-200	Unhealthy	Red
201-300	Very Unhealthy	Purple

Figure 1
Air Quality Index Regions

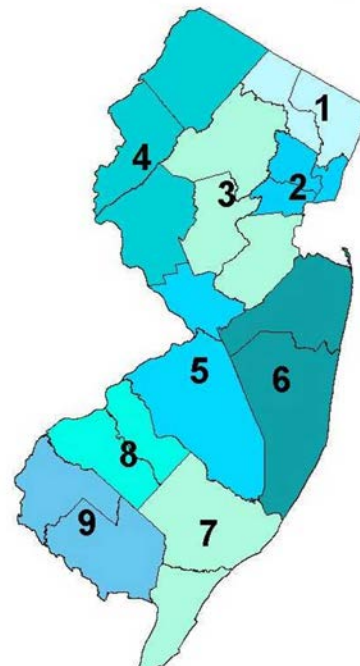


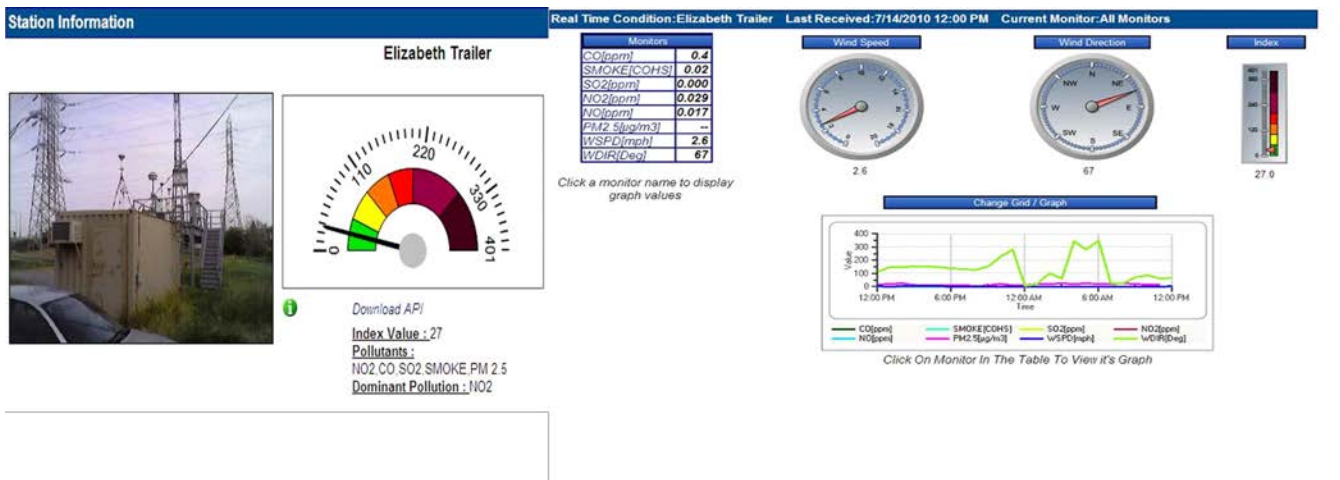
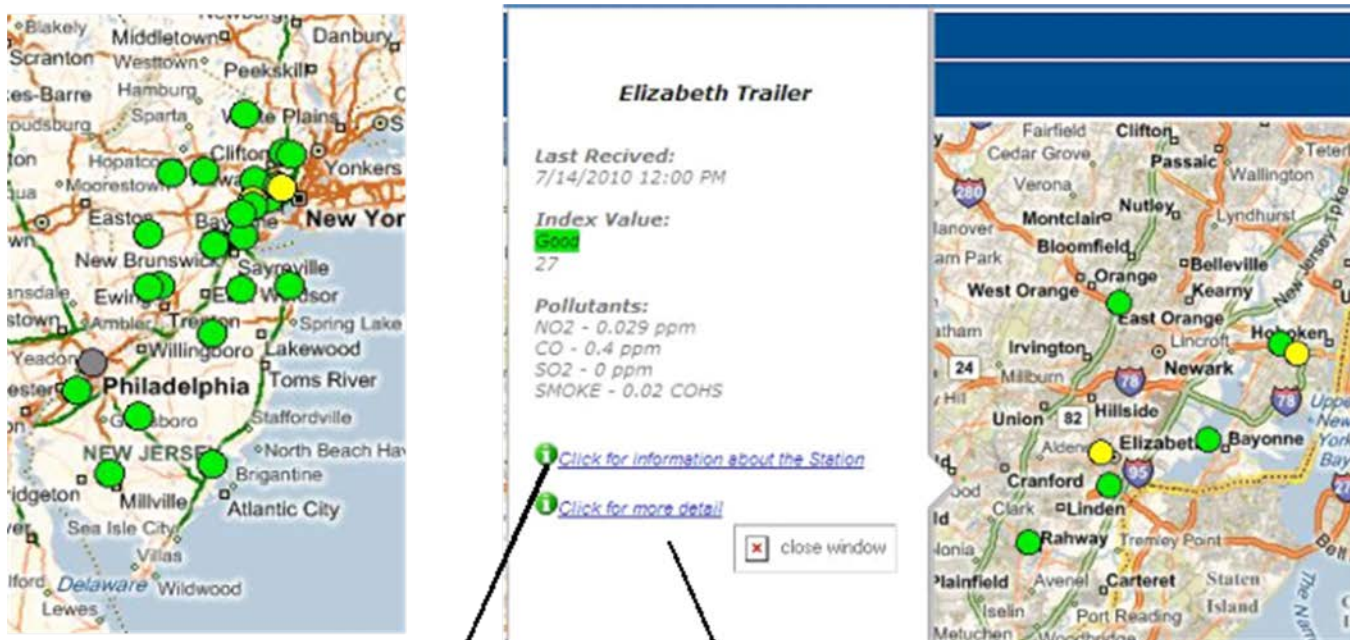
Table 2
Pollutants Monitored According to Air Quality Index Reporting Region – 2011

CO - Carbon Monoxide O₃ - Ozone
 SO₂ - Sulfur Dioxide NO₂ - Nitrogen Dioxide
 PM - Particulate Matter

Reporting Region	Monitoring Site	CO	SO ₂	PM	O ₃	NO ₂
1. Northern Metropolitan	Leonia	---	---	---	X	---
	Ramapo	---	---	---	X	---
2. Southern Metropolitan	Bayonne	---	X	---	X	X
	East Orange	X	---	---	---	X
	Elizabeth	X	X	X	---	---
	Elizabeth Lab	X	X	X	---	X
	Jersey City	X	X	X	---	---
	Jersey City Firehouse	---	---	X	---	---
	Newark Firehouse	X	X	X	X	X
	Rahway	---	---	X	---	---
3. Suburban	Chester	---	X	---	X	X
	Morristown	X	---	---	---	---
	New Brunswick	---	---	X	---	---
	Perth Amboy	X	---	---	---	---
	Rutgers University	---	---	---	X	X
4. Northern Delaware Valley	Columbia WMA	---	X	X	X	X
	Flemington	---	---	X	X	---
5. Central Delaware Valley	Ewing	---	---	X	---	---
	Rider University	---	---	---	X	---
6. Northern Coastal	Colliers Mills	---	---	---	X	---
	Freehold	X	---	---	---	---
	Monmouth University	---	---	---	X	---
7. Southern Coastal	Brigantine	---	X	X	X	---
8. Southern Delaware Valley	Ancora State Hospital	X	---	---	X	---
	Clarksboro	---	---	---	X	---
	South Camden	---	---	X	---	---
9. Delaware Bay	Millville	---	---	X	X	X

Along with the forecast, cautionary statements are provided for days when the air quality is expected to reach the unhealthy for sensitive groups range and above. These air quality alerts are issued through Enviroflash emails, 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://www.erh.noaa.gov/er/phi/>). Maps, charts and photos of the air quality information and sites from which data is collected are available on the NJDEP air monitoring web site as shown in Figure 2 below:

Figure 2
Examples of NJDEP's Air Monitoring Website



2011 AQI SUMMARY

A summary of the AQI ratings for New Jersey in 2011 is presented in the pie chart in Figure 3 below. In 2010, there were 166 "Good" days, 153 were "Moderate", 44 were rated "Unhealthy for Sensitive Groups", 2 were considered "Unhealthy", and zero were rated "Very Unhealthy". This indicates that air quality in New Jersey is considered good or moderate most of the time, but that pollution is still bad enough to adversely affect some people on about one day in eight. This is very similar to last year and an increase from 2009, however 2009 was an unusually cool and wet summer accounting for much lower concentrations of pollutants. Table 3 lists the dates when the AQI reached the "Unhealthy for Sensitive Groups" threshold at any monitoring location and shows which pollutant(s) were in that range or higher. Figure 4 shows the AQI ratings for the year broken down by AQI region.

Figure 3
2011 Air Quality Summary by Days

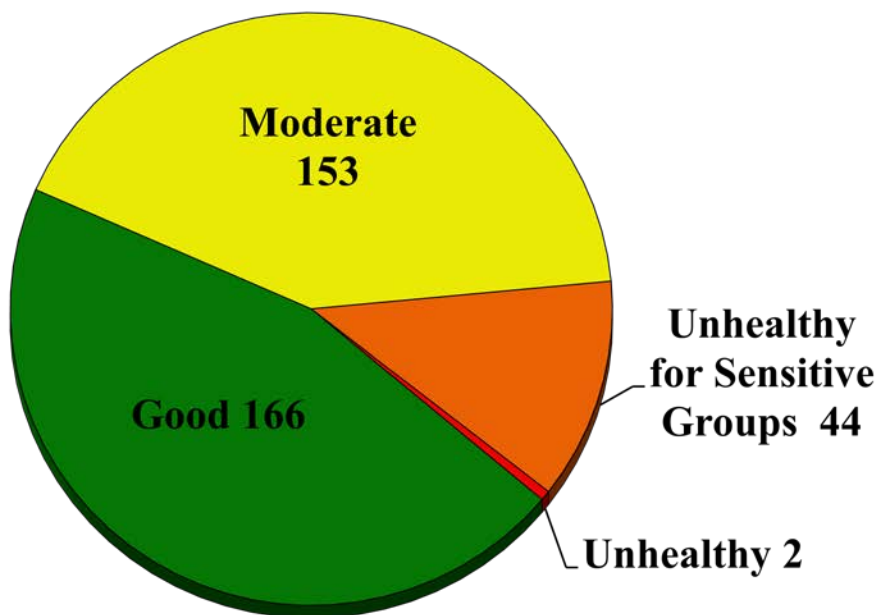


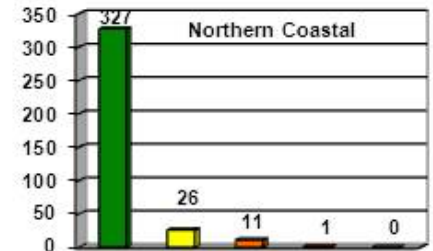
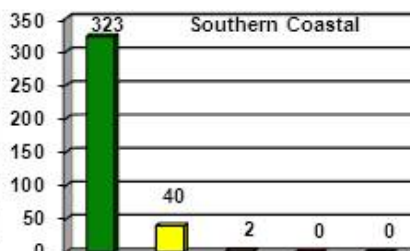
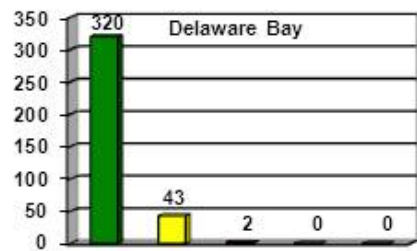
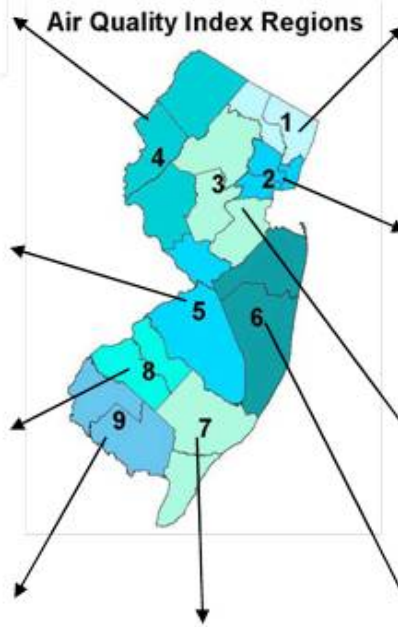
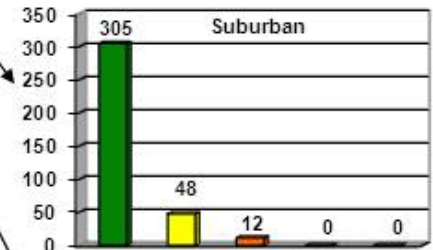
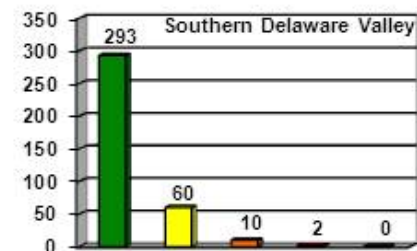
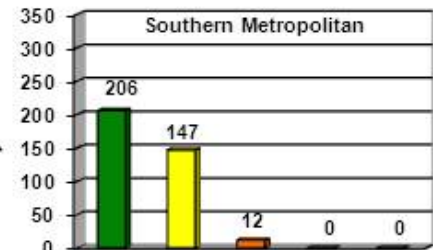
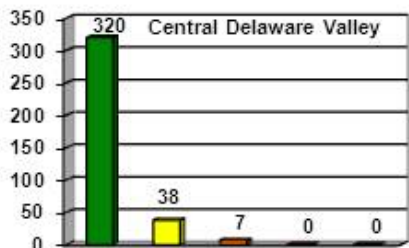
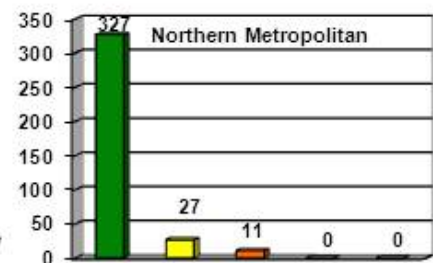
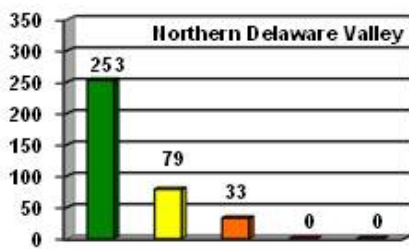
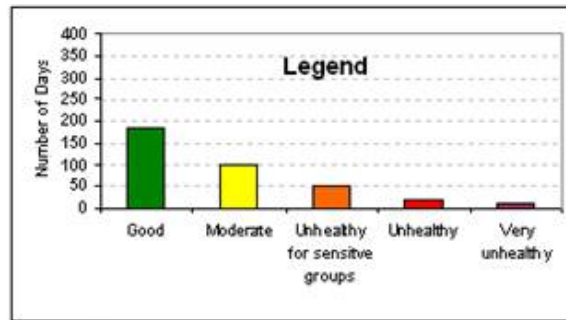
Table 3
Air Quality Index (AQI) Exceedances of 100 During 2011

	<u>Ratings</u>		<u>Pollutants</u>
USG	- Unhealthy for Sensitive Groups	PM	- Fine Particle Matter (11 Sites)
UH	- Unhealthy	O3	- Ozone (15 Sites)
VUH	- Very Unhealthy	SO2	- Sulfur Dioxide (8 Sites)
		NO2	- Nitrogen Dioxide (8 Sites)

* Number in parentheses () indicates the total number of sites exceeding 100 by pollutant on the given day

Date	Highest Location	Highest AQI Value	Highest Pollutant	Highest Rating	Pollutant(s) with AQI above 100 *
Jan 01	Newark	103	PM	USG	PM (3)
Jan 22	Columbia WMA	127	SO2	USG	SO2 (1)
Jan 24	Columbia WMA	140	SO2	USG	SO2 (1)
Feb 13	Columbia WMA	117	SO2	USG	SO2 (1)
Feb 14	Columbia WMA	103	SO2	USG	SO2 (1)
Feb 16	Columbia WMA	115	SO2	USG	SO2 (1)
Feb 23	Columbia WMA	106	SO2	USG	SO2 (1)
March 30	Columbia WMA	102	SO2	USG	SO2 (1)
April 09	Columbia WMA	107	SO2	USG	SO2 (1)
April 11	Columbia WMA	124	SO2	USG	SO2 (1)
April 20	Columbia WMA	102	SO2	USG	SO2 (1)
May 12	Columbia WMA	115	SO2	USG	SO2 (1)
May 20	Columbia WMA	138	SO2	USG	SO2 (1)
May 29	Columbia WMA	106	SO2	USG	SO2 (1)
May 31	Rutgers	106	O3	USG	O3 (2)
June 01	Rutgers	143	O3	USG	O3 (6), SO2 (1)
June 05	Columbia WMA	109	SO2	USG	SO2 (1)
June 07	Clarksboro	150	O3	UH	O3 (11)
June 08	Ancora	158	O3	UH	O3 (12)
June 09	Clarksboro	170	O3	USG	O3 (14), PM (4)
June 10	Clarksboro	134	O3	USG	O3 (3)
June 12	Columbia WMA	106	SO2	USG	SO2 (1)
June 18	Colliers Mills	110	O3	USG	O3 (1), SO2 (1)
June 21	Columbia WMA	120	SO2	USG	SO2 (1)
June 23	Elizabeth Lab	103	PM	USG	PM (1)
June 27	Columbia WMA	115	SO2	USG	SO2 (1)
July 2	Columbia WMA	115	SO2	USG	SO2 (1)
July 5	Clarksboro	108	O3	USG	O3 (1)
July 6	Newark Firehouse	115	O3	USG	O3 (3)
July 7	Clarksboro	136	O3	USG	O3 (5)
July 10	Columbia WMA	105	SO2	USG	SO2(1)
July 11	Leonias	117	O3	USG	O3 (3), SO2 (1)
July 15	Columbia WMA	104	SO2	USG	SO2 (1)
July 17	Columbia WMA	116	SO2	USG	SO2 (1)
July 18	Monmouth University	117	O3	USG	O3 (3)
July 19	Clarksboro	143	O3	USG	O3 (5)
July 20	Chester/Ramapo	117	O3	USG	O3 (4), PM (1)
July 21	Rutgers	143	O3	USG	O3 (8), PM (2)
July 22	Clarksboro	138	O3	USG	O3 (8), PM (1)
July 23	Colliers Mills	122	O3	USG	O3 (3)
July 24	Monmouth University	115	O3	USG	O3 (1)
July 26	Columbia WMA	110	SO2	USG	SO2 (1)
July 29	Clarksboro	115	O3	USG	O3 (4)
Aug 01	Clarksboro	113	O3	USG	O3 (3)
Aug 17	Columbia WMA	106	SO2	USG	SO2 (1)
Aug 20	Columbia WMA	109	SO2	USG	O3 (1), SO2 (1)

Figure 4
2011 Air Quality Index Summary
Number of Days by Reporting Region



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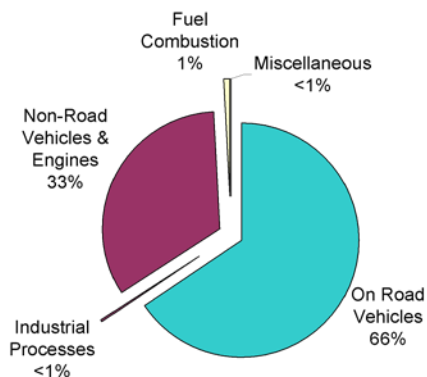
2011 Carbon Monoxide Summary

New Jersey Department of Environmental Protection

NATURE AND SOURCES

Carbon monoxide (CO) is a colorless, odorless, poisonous gas formed when carbon in fuels is not burned completely. It is a by-product of motor vehicle exhaust, which contributes over 66 percent of all CO emissions nationwide. Non-road engines and vehicles, such as construction equipment and boats, are also significant sources of CO. Overall, the transportation sector (Non-Road and On Road Vehicles combined) is responsible for about 99% of all CO emissions nationally. Other sources of CO include industrial processes, fuel combustion in sources such as boilers and incinerators, and natural sources such as forest fires. Figure 1 shows the national average contributions of these sources.

Figure 1
National Summary of CO Emissions by Source Category 2008



Source: United States Environmental Protection Agency www.epa.gov/cgi-bin/broker?_service=data&_debug=0&_program=dataprog.national_1.sas&polchoice=CO

Atmospheric inversions, which usually occur overnight when cooler air is trapped beneath a layer of warmer air, allow CO levels to accumulate near the ground. The inversion acts like a lid, preventing pollution from mixing in the atmosphere and effectively trapping it close to ground level (see Figure 2). Figure 3 shows that CO levels 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, and this diurnal variation is displayed in Figure 4.

Figure 2
Effect of Atmospheric Inversion of Pollution
www.sciencelearn.org.nz

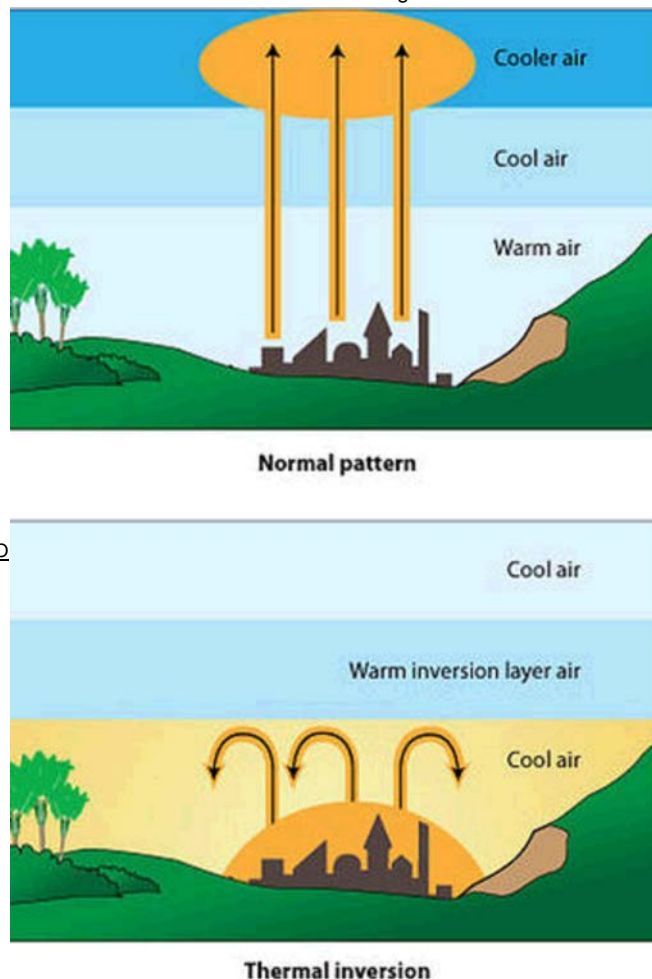


Figure 3
 2011 Carbon Monoxide Average Concentrations - New Jersey
 Monthly Variation
 Parts Per Million (PPM)

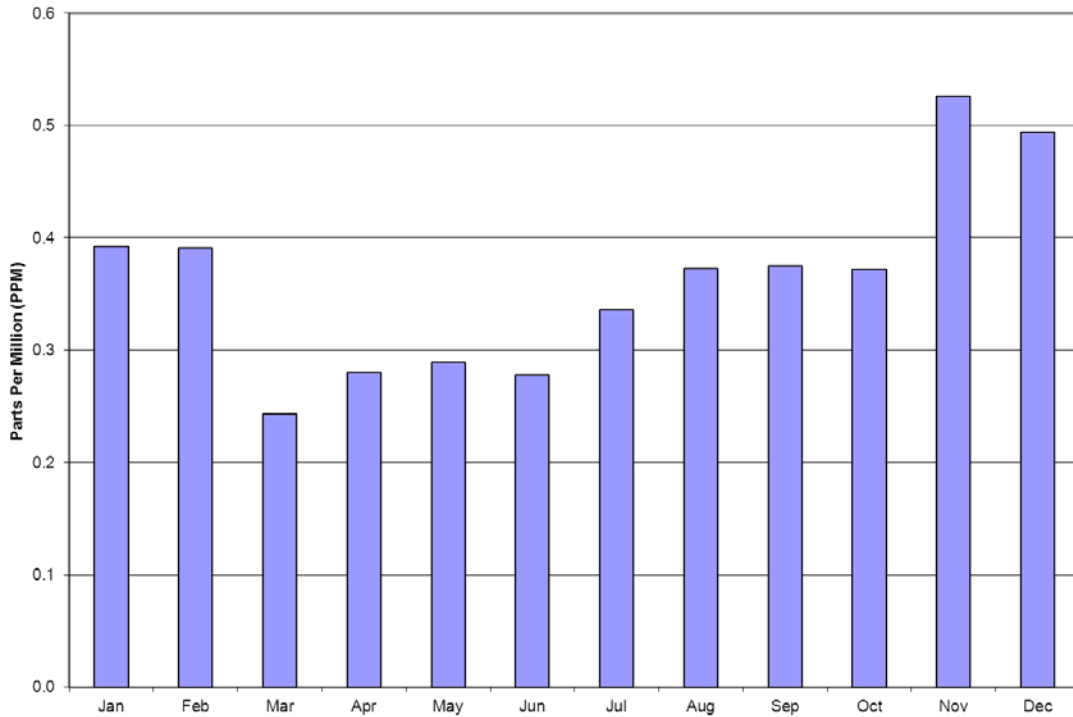
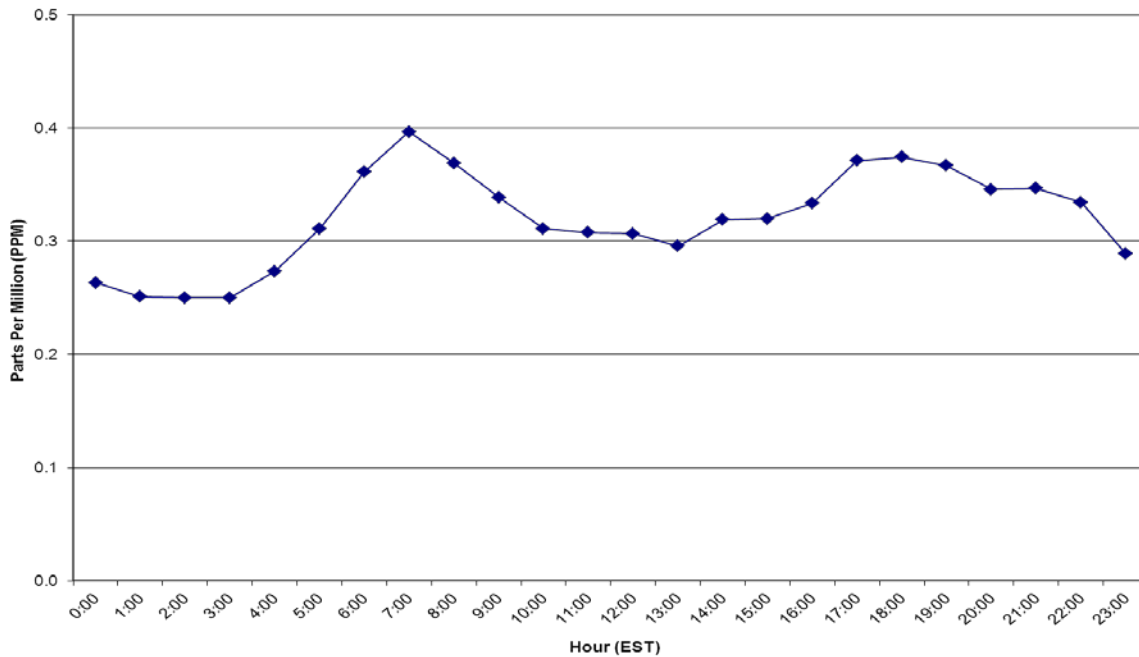


Figure 4
 Carbon Monoxide Average Concentrations - New Jersey
 Hourly Variation
 Parts Per Million (PPM)



HEALTH AND ENVIRONMENTAL EFFECTS

Carbon monoxide enters the bloodstream and reduces the body's ability to distribute oxygen to organs and tissues. The most common symptoms associated with exposure to carbon monoxide are headaches and nausea. The health threat from exposure to 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 cause chest pain and reduce that individual's ability to exercise. Healthy people are also affected, but only at higher levels of exposure. Elevated CO levels are also associated with visual impairment, reduced work capacity, reduced manual dexterity, decreased learning ability, and difficulty in performing complex tasks.

STANDARDS

There are currently two national primary, or health based, standards for carbon monoxide. They are set at a one-hour concentration of 35 parts per million (ppm), and an 8-hour average concentration of 9 ppm. These levels are not to be exceeded more than once in any calendar year. There are no national secondary (welfare based) standards for CO at this time. New Jersey state standards for CO are based on different units (milligrams per cubic meter as opposed to parts per million), and our standards are not to be exceeded more than once in any 12-month period. The state has set secondary (welfare based) standards for CO at the same level as the primary standards. The standards are summarized in Table 1.

Table 1
National and New Jersey Ambient Air Quality Standards for Carbon Monoxide

mg/m³ = Milligrams Per Cubic Meter
ppm = Parts per Million

Averaging Period	Type	New Jersey	National
1-Hour	Primary	40 mg/m ³ (35 ppm)	35 ppm
1-Hour	Secondary	40 mg/m ³ (35 ppm)	----
8-Hour	Primary	10 mg/m ³ (9 ppm)	9 ppm
8-Hour	Secondary	10 mg/m ³ (9 ppm)	----

MONITORING LOCATIONS

The state monitored CO levels at 9 locations in 2011. These sites are shown in the map in Figure 5. The Newark-Firehouse station measures CO concentrations at trace levels as part of the U.S. Environmental Protection Agency's (EPA) NCore (National Core) monitoring network. The New Jersey Department of Environmental Protection (NJDEP) is actively pursuing the establishment of new CO monitoring locations in Camden and Fort Lee. Ancora State Hospital, Freehold, Morristown and Perth Amboy CO monitoring sites were shut down on June 30, 2011.

CO LEVELS IN 2011

None of the monitoring sites recorded exceedances of any CO standards during 2011. The maximum one-hour average concentration recorded was 5.7 ppm at the Jersey City station. The highest 8-hour average concentration recorded was 3.1 ppm at the East Orange station. Summaries of the 2011 data are provided in Figure 6, Figure 7 and Table 2.

Figure 5
2011 Carbon Monoxide
Monitoring Network



Figure 6
 Highest and 2nd Highest 1-Hour Averages
 Of Carbon Monoxide in New Jersey-2011
 Parts Per Million (PPM)

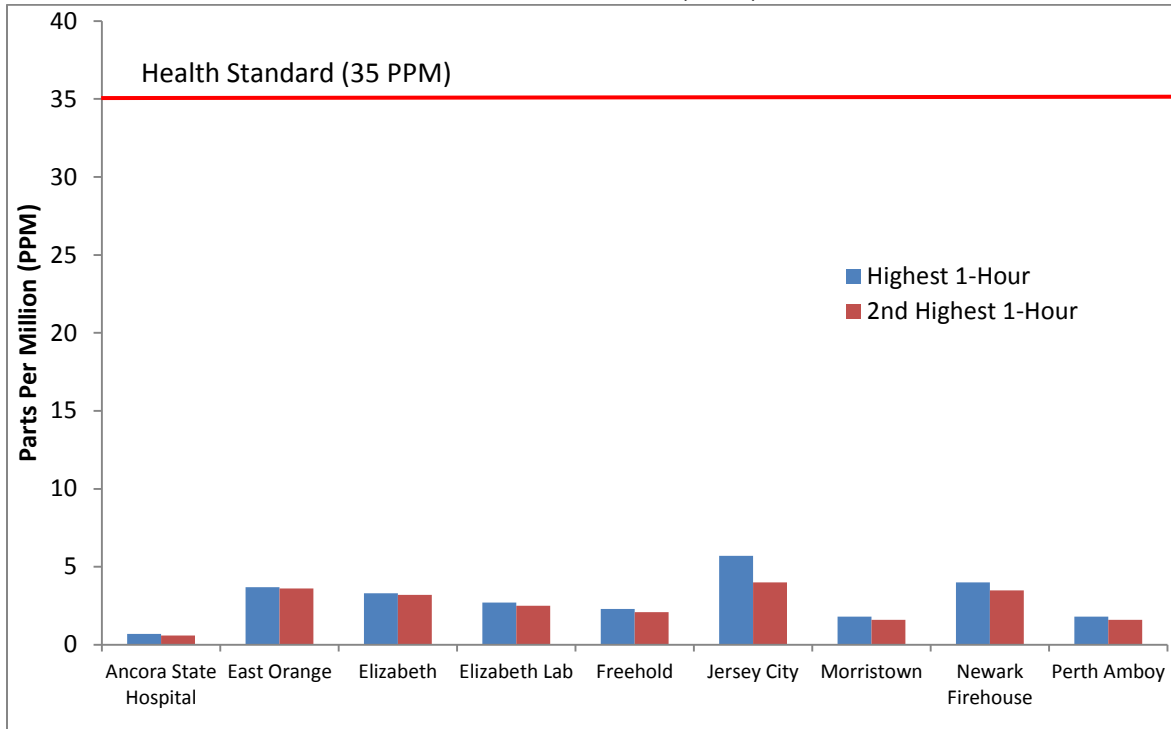
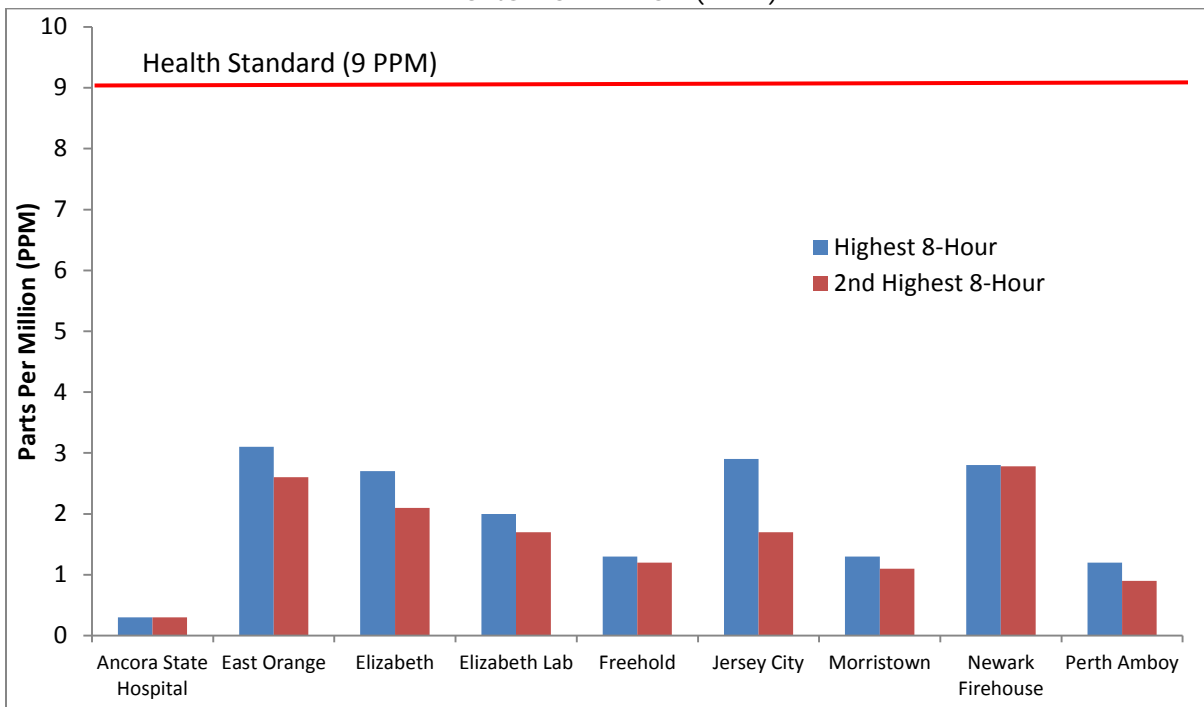


Figure 7
 Highest and 2nd Highest 8-Hour Averages
 Of Carbon Monoxide in New Jersey-2011
 Parts Per Million (PPM)



**Table 2
Carbon Monoxide Data- 2011
1-Hour and 8-Hour Averages**

Parts Per Million (PPM)
1-hour standard= 35 PPM
8-hour standard= 9 PPM

Monitoring Sites	Maximum 1-Hour Average	2nd Highest 1-Hour Average	Maximum 8-Hour Average	2nd Highest 8-Hour Average
*Ancora State Hospital	0.7	0.6	0.3	0.3
East Orange	3.7	3.6	3.1	2.6
Elizabeth	3.3	3.2	2.7	2.1
Elizabeth Lab	2.7	2.5	2.0	1.7
*Freehold	2.3	2.1	1.3	1.2
Jersey City	5.7	4.0	2.9	1.7
*Morristown	1.8	1.6	1.3	1.1
Newark Firehouse	4.02	3.49	2.80	2.78
*Perth Amboy	1.8	1.6	1.2	0.9

*Ancora State Hospital, Freehold, Morristown and Perth Amboy monitoring sites were shut down on June 30, 2011.

TRENDS

Carbon monoxide levels have improved dramatically over the past 20 years. A trend graph of CO levels showing the highest, average and lowest site concentrations recorded since 1975 is provided in Figure 8. The graph depicts the second highest 8-hour value recorded; as this is the value that determines if the health standard is being met (one exceedance per site is allowed each year). The last time the CO standard was exceeded in New Jersey was in January of 1995 (Figure 9), and the entire state was officially declared as having attained the CO standard on August 23, 2002. At one time, unhealthy levels of CO were recorded on a regular basis. The reduction in CO levels is due primarily to cleaner running cars, which are by far the largest source of this pollutant.

Figure 8
Carbon Monoxide Air Quality, 1975-2011
2nd Highest 8-hour Average
Parts Per Million (PPM)

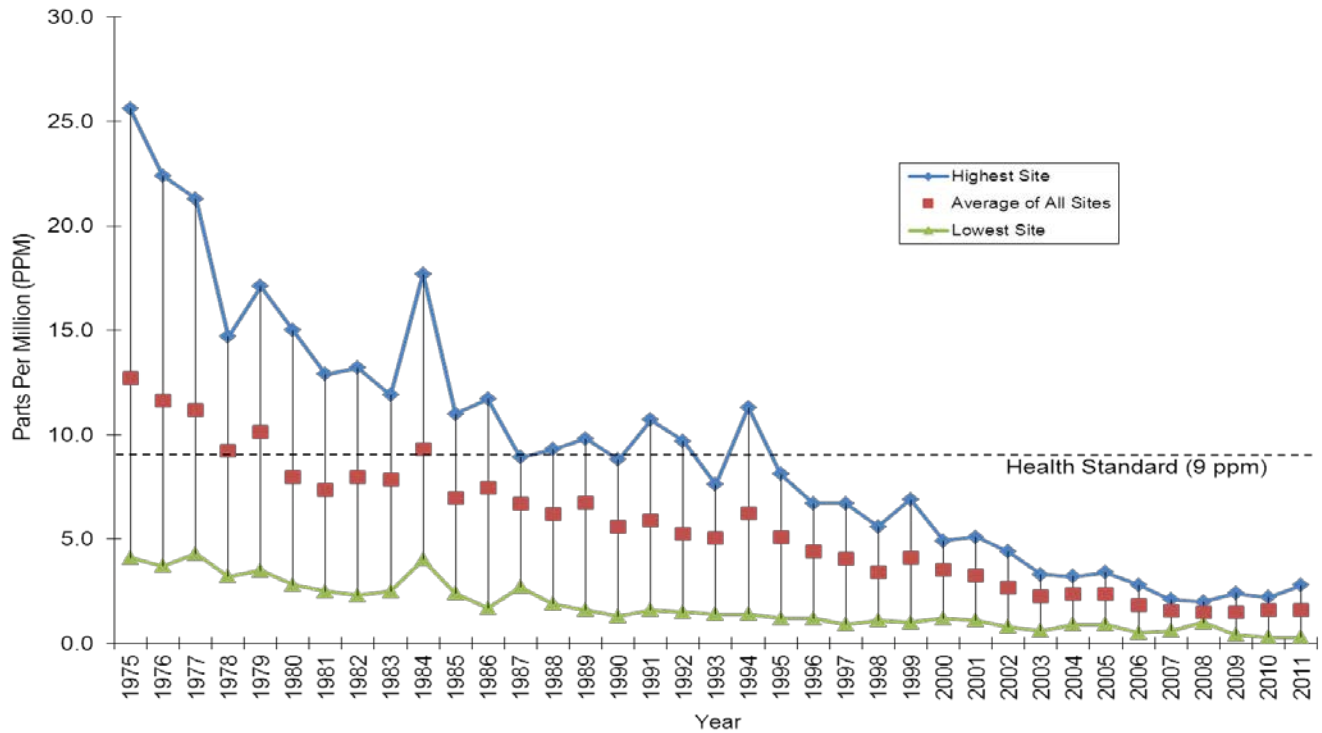
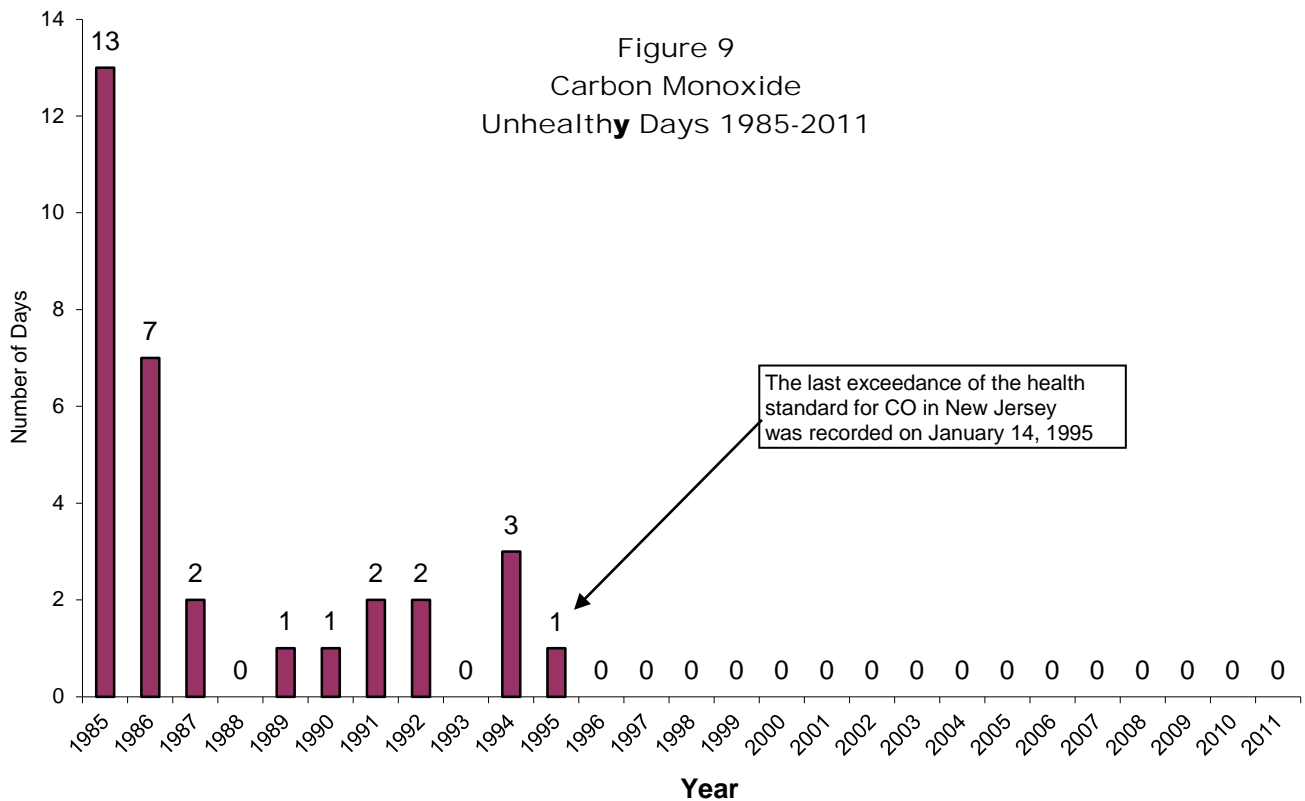


Figure 9
Carbon Monoxide
Unhealthy Days 1985-2011



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2011 Nitrogen Dioxide Summary

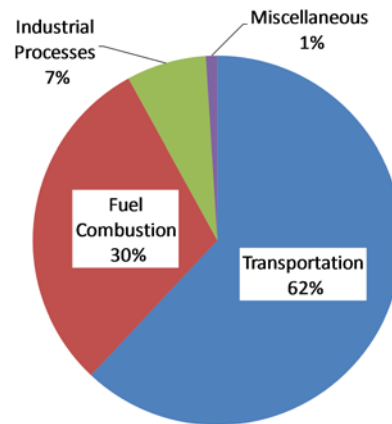
New Jersey Department of Environmental Protection

NATURE AND 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). When NO_2 reacts with other chemicals, it can form ozone, particulate matter, and other compounds which can contribute to regional haze and acid rain. Oxides of Nitrogen (NO_x) is a mixture of gases which is mostly comprised of NO and NO_2 . These gases are emitted from the exhaust of motor vehicles, the burning of coal, oil or natural gas, and during 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. A pie chart summarizing the major sources of NO_x is shown in Figure 1. As 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 the graph in Figures 2-4 (pages 2-3).

Figure 1
National Summary of 2008 Oxides of Nitrogen (NO_x) Emissions by Source Category



Source: USEPA National Summary of Nitrogen Oxides Emissions, 2008

HEALTH AND ENVIRONMENTAL EFFECTS

Short-term exposures (less than 3 hours) to low levels of nitrogen dioxide may aggravate pre-existing respiratory illnesses, and can cause respiratory illnesses, particularly in children ages 5-12. 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. NO and NO_2 are found in tobacco smoke, so people who smoke or breathe in second-hand smoke may be exposed to NO_x .

The U.S. Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the U.S. Environmental Protection Agency (EPA) have determined that, with the available information, no conclusion can be made as to the carcinogenicity of NO or NO_2 to human beings. Nitrogen Oxides contribute to a wide range of environmental problems. These include potential changes in the composition of some plants in wetland and terrestrial ecosystems, acidification of freshwater bodies, eutrophication of estuarine and coastal waters, increases in levels of toxins harmful to fish and other aquatic life, and visibility impairment.

Figure 2
Nitric Oxide - New Jersey
2011 Hourly Variation
Parts Per Million (ppm)

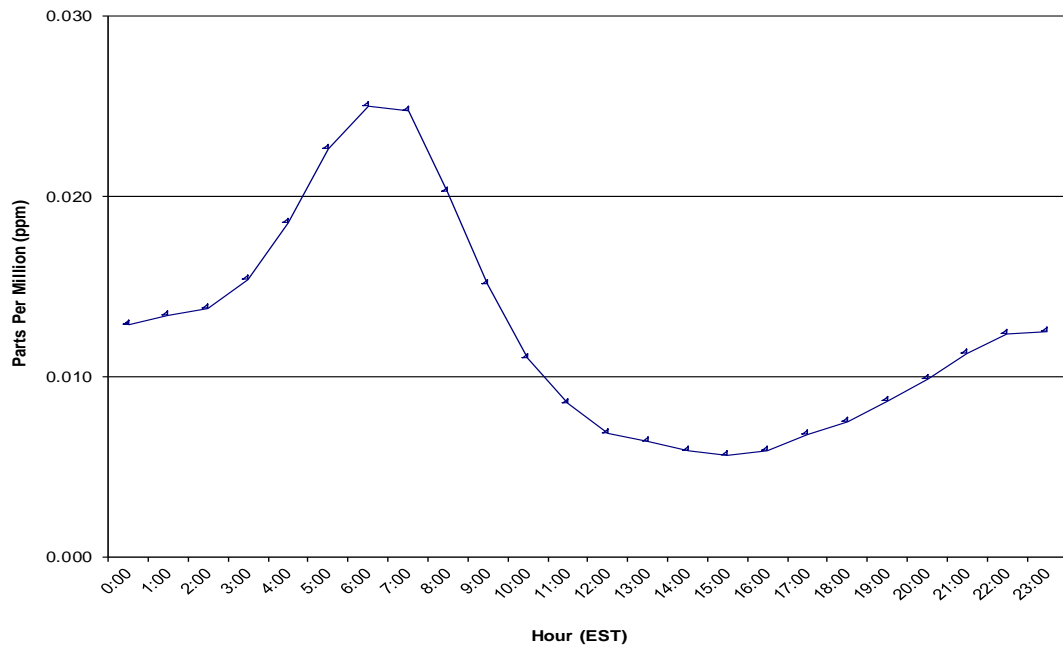


Figure 3
Nitrogen Dioxide - New Jersey
2011 Hourly Variation
Parts Per Million (ppm)

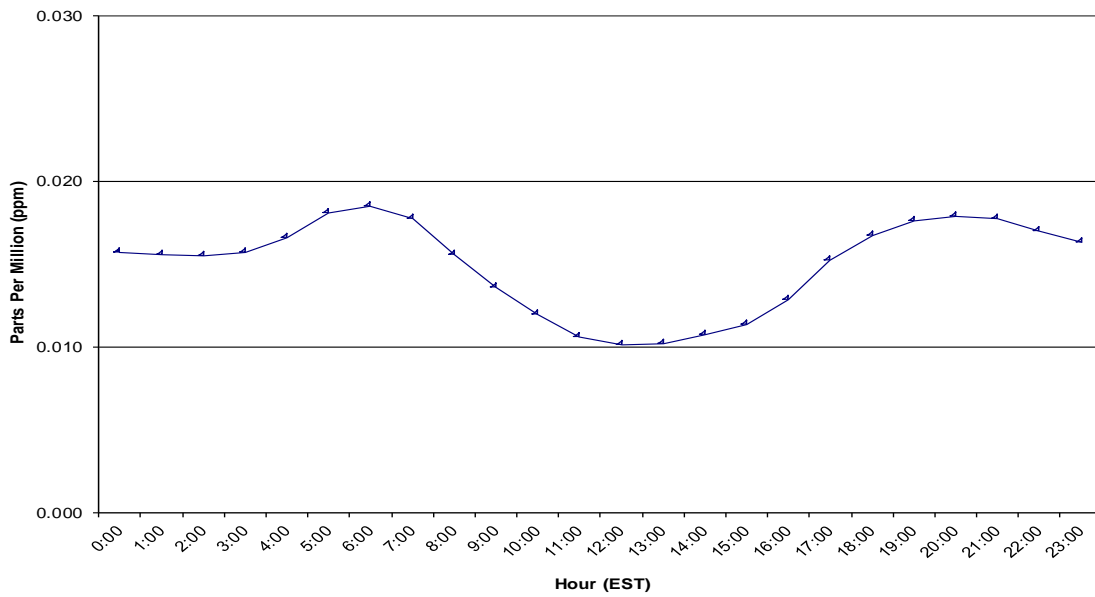
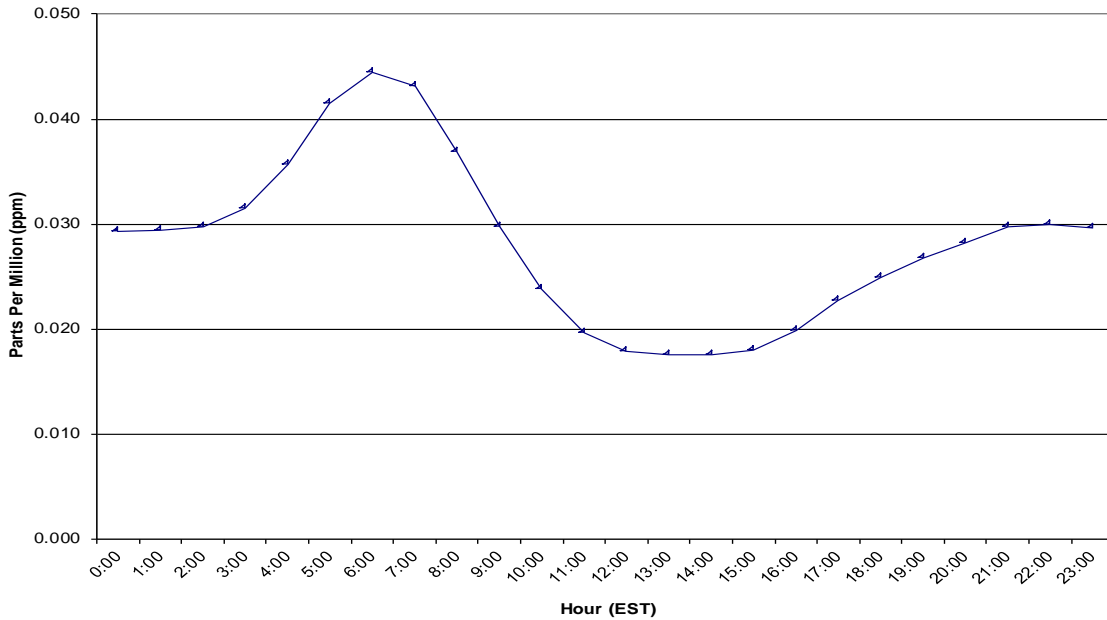


Figure 4
Total Oxides of Nitrogen – New Jersey
2011 Hourly Variation
Parts Per Million (ppm)



STANDARDS

The primary (health based) and secondary (welfare based) National Ambient Air Quality Standards (NAAQS) annual average for NO₂ are the same. They are set at a calendar year average concentration of 0.053 parts per million (ppm). The New Jersey Ambient Air Quality Standards (NJAAQS) are identical to the NAAQS except micrograms per cubic meter (µg/m³) are the standard units and the state standard applies to any 12-month period, not just the calendar year. In 2010, the EPA strengthened the primary NAAQS by adding a 1-hour NO₂ standard of 0.100 ppm along with the current annual average NO₂ standard of 0.053 ppm. Table 1 provides a summary of the NO₂ standards.

Table 1
National and New Jersey Ambient Air Quality Standards for Nitrogen Dioxide (NO₂)
Parts Per Million (ppm) and Micrograms Per Cubic Meter (µg/m³)

Averaging Period	Type	New Jersey	National
12-month average	Primary	100 µg/m ³ (0.053 ppm)	
Annual average	Primary		0.053 ppm (100 µg/m ³)
12-month average	Secondary	100 µg/m ³ (0.053 ppm)	
Annual average	Secondary		0.053 ppm (100 µg/m ³)
1-hour average	Primary		0.100 ppm (190 µg/m ³)

An area meets the new 1-hour NO₂ standard when the 3-year average of the 98th percentile of the daily maximum 1-hour NO₂ concentrations measured in this area is less than 0.100 ppm. This statistic, also known as the design value, is determined by first obtaining the maximum 1-hour average NO₂ concentrations for each day. Then,

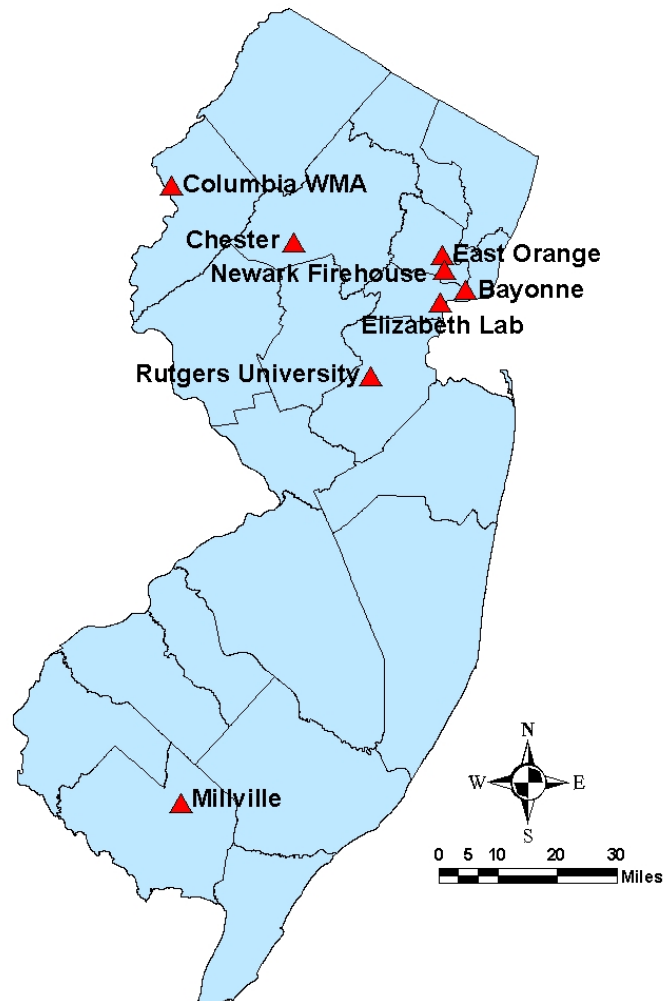
determine the 98th percentile of the daily maximum NO₂ concentrations for the current year, and for each of the previous two years. Finally, the average of these three 98th percentile values is the design value.

In addition to adding a 1-hour NO₂ standard of 0.100 ppm in 2010, the EPA requires a NO₂ near-roadway monitoring station to be operational by January 1, 2013. A near-roadway station must be located no more than 50 meters (164 feet) from the nearest traffic lane of a major roadway. NJDEP plans to establish one near-roadway NO₂ station in the New York-Northern New Jersey-Long Island Metropolitan area that meets the EPA criteria.

MONITORING LOCATIONS

The state monitored NO₂ levels at 8 locations in 2011. NO₂ monitors were established in the Columbia WMA and Newark Firehouse stations in January 2011. These sites are shown in Figure 5.

Figure 5
2011 Nitrogen Dioxide Monitoring Network



NO₂ LEVELS IN 2011

None of the monitoring sites recorded exceedances of either the National or New Jersey Air Quality Standards for NO₂ during 2011. The highest 12-month (calendar year) average concentration of NO₂ recorded was 0.024 ppm at the Elizabeth Lab site located at Exit 13 of the New Jersey Turnpike (Table 2, below and Figure 6, page 6). The maximum annual average concentration of NO recorded in 2011 was 0.027 ppm, at the Columbia WMA site (Table 2, below and Figure 7, page 6).

There were no exceedances of the 1-hour average NO₂ NAAQS of 0.100 ppm, although the Elizabeth Lab and Newark Firehouse sites each measured a 1-hour average NO₂ concentration that equaled 0.100 ppm as a maximum for 2011. The site that measured the highest 98th percentile of the daily maximum 1-hour NO₂ concentrations in 2011 was Elizabeth Lab with 0.071 ppm (Table 2, below and Figure 8, page 7). The site that measured the highest 1-hour NO₂ design value for the 3-year period from 2009 to 2011 was also Elizabeth Lab with 0.071 ppm (Table 2, below and Figure 9, page 7). All sites in New Jersey met the new 1-hour NO₂ standard. While national health and welfare standards have not been established for Nitric Oxide (NO), it is considered to be an important pollutant that contributes to the formation of ozone, fine particles and acid rain.

Table 2
Nitrogen Dioxide (NO₂) and Nitric Oxide (NO) Data - 2011
1-Hour and 12-Month Averages

Parts Per Million (ppm)
National 1-Hour Standard = 0.100 ppm
National 12-Month Standard = 0.053 ppm

Monitoring Sites	Nitrogen Dioxide 1-Hour Average (ppm)				Nitrogen Dioxide 12-Month Average (ppm)		Nitric Oxide 12-Month Average (ppm) Calendar Year
	Maximum	2nd Highest	2011 98th%-ile	2009-2011 98 th %-ile (3-year)	Maximum (Running 12- month)	Calendar year	
Bayonne	0.076	0.074	0.064	0.065	0.019	0.018	0.010
Chester	0.059	0.053	0.041	0.037	0.005	0.005	0.000
Columbia WMA	0.065	0.057	0.050	---*	0.022	0.014	0.027
East Orange	0.085	0.075	0.062	0.064	0.021	0.021	0.015
Elizabeth Lab	0.100	0.097	0.071	0.071	0.024	0.024	0.026
Millville	0.039	0.038	0.036	0.039	0.008	0.007	0.006
Newark Firehouse	0.100	0.088	0.068	---*	0.027	0.021	0.013
Rutgers University	0.060	0.050	0.047	0.048	0.010	0.010	0.003

* Columbia WMA and Newark Firehouse do not have enough data to calculate a 3-year average.

Figure 6
 Annual Average Nitrogen Dioxide Concentrations
 In New Jersey - 2011
 Parts Per Million (ppm)

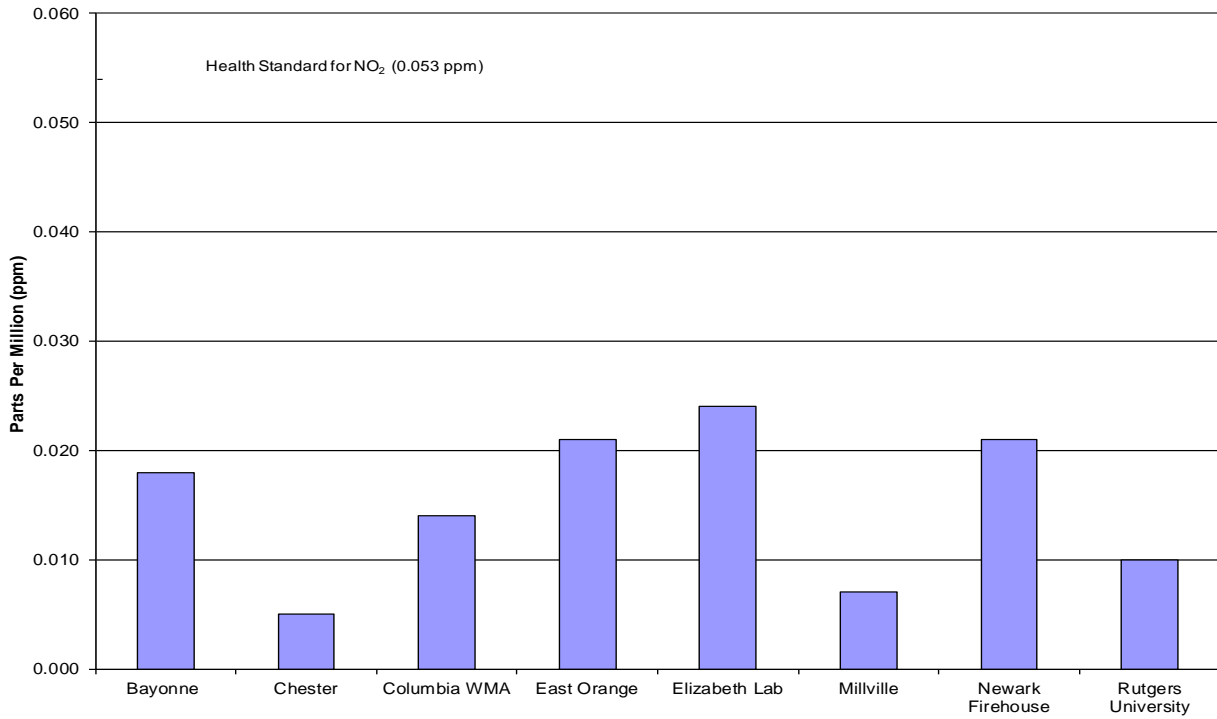


Figure 7
 Annual Average Nitric Oxide Concentrations
 In New Jersey - 2011
 Parts Per Million (ppm)

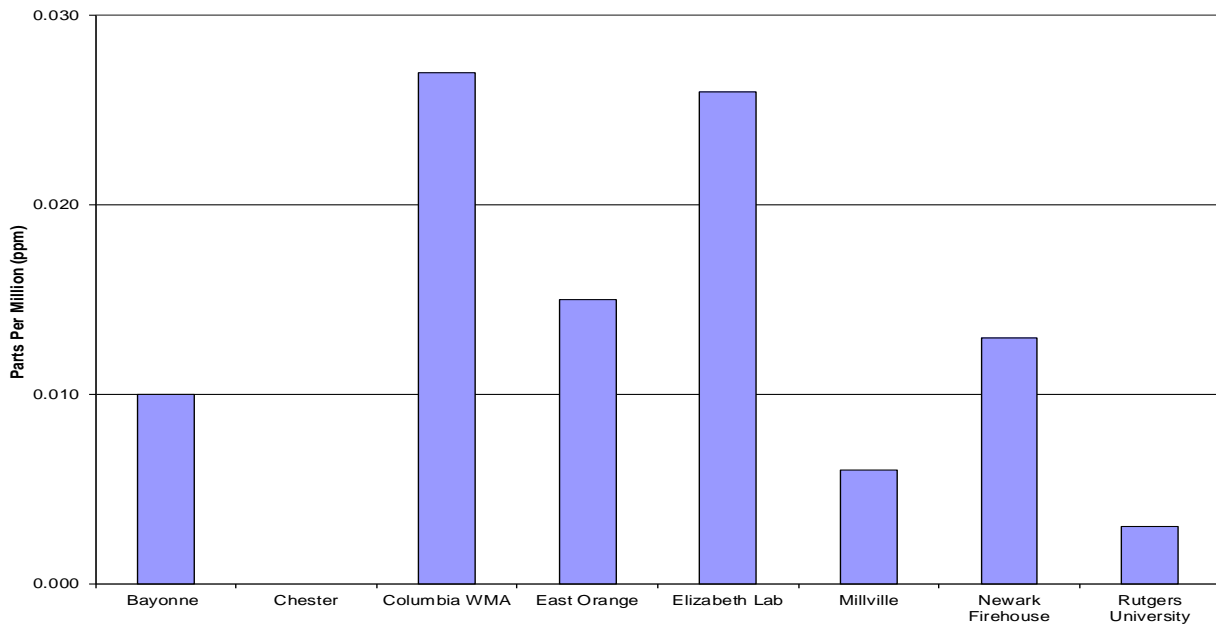


Figure 8
 2011 98th Percentile Daily Maximum 1-Hour
 Nitrogen Dioxide Concentration in New Jersey
 Parts Per Million (ppm)

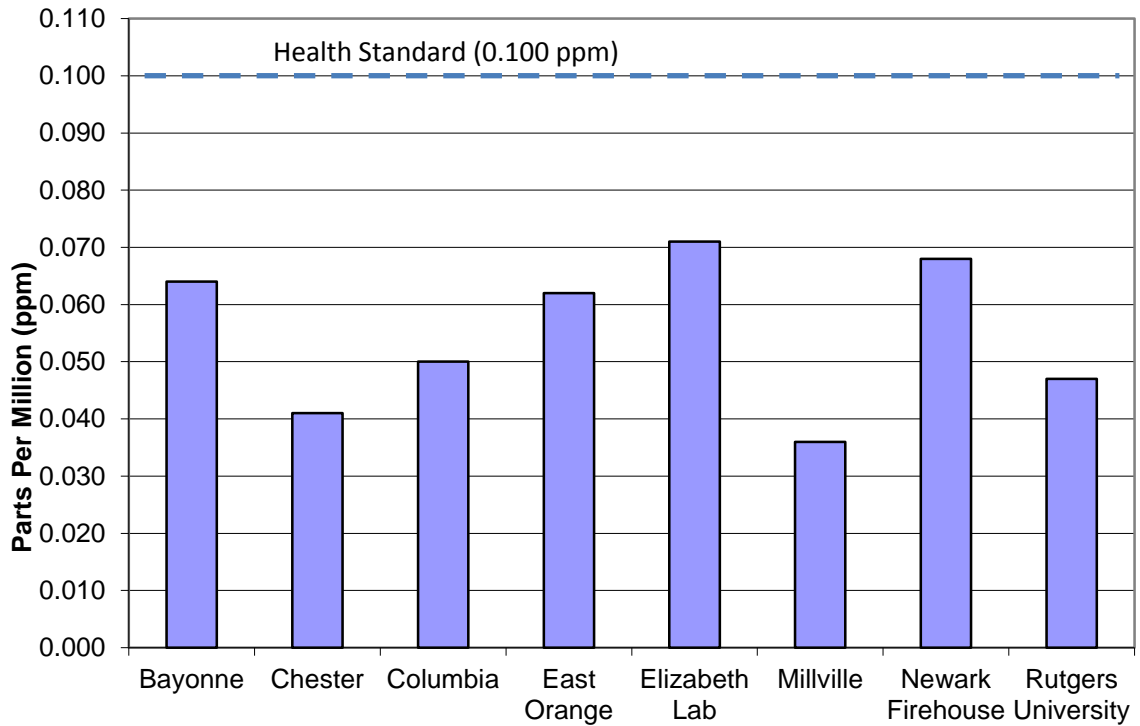
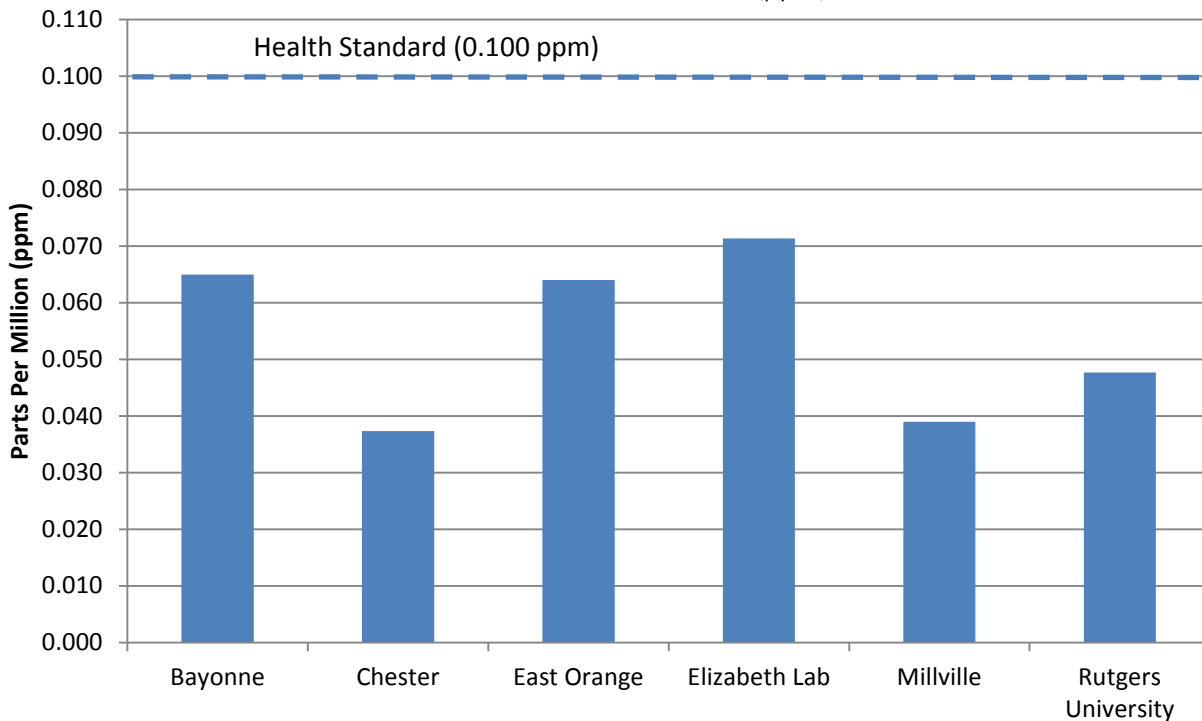


Figure 9
 3-Year Average of the 98th Percentile Daily Maximum 1-Hour Average
 Nitrogen Dioxide Concentration in New Jersey (2009-2011)
 Parts Per Million (ppm)



TRENDS

Figures 10-12 (pages 8-9) indicate that concentrations tend to be higher in the winter than the summer. This is due in part to space heating and poorer local dispersion conditions caused by light winds and other weather conditions that are more prevalent in the colder months of the year.

Routine monitoring for NO₂ began in 1966, and 1974 was the last year that concentrations exceeded the annual average NAAQS for NO₂ in New Jersey. A graph of NO₂ levels provided in Figure 13 (page 10) shows the statewide average annual mean concentrations recorded from 1975 to 2011 in the form of a trendline. The graph also includes the levels of the sites that measured the highest annual mean and lowest annual mean in each year as points above and below this trendline. Although NO₂ concentrations are well within the NAAQS, there is still a great deal of interest in oxides of nitrogen because of their role in the formation of other pollutants – most notably ozone and fine particles. Both these pollutants are of concern over much of the northeastern United States and efforts to reduce levels of ozone and fine particles are likely to require reductions in NO emissions.

Figure 10
Nitric Oxide – New Jersey
2011 Monthly Variation
Parts Per Million (ppm)

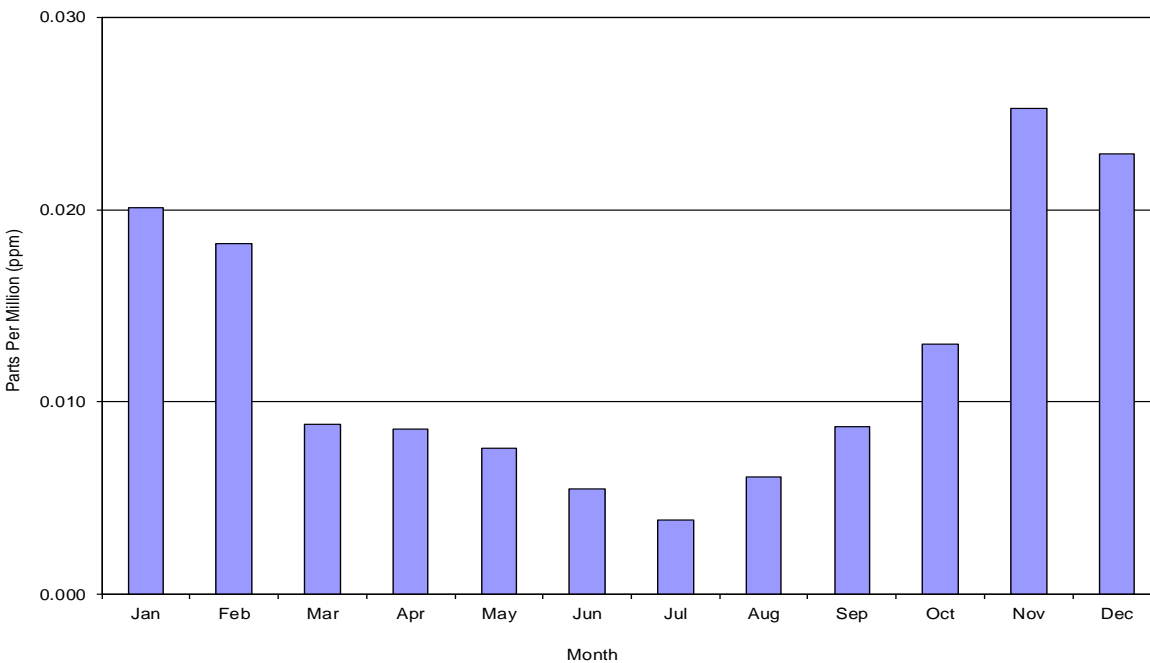


Figure 11
Nitrogen Dioxide - New Jersey
2011 Monthly Variation
Parts Per Million (ppm)

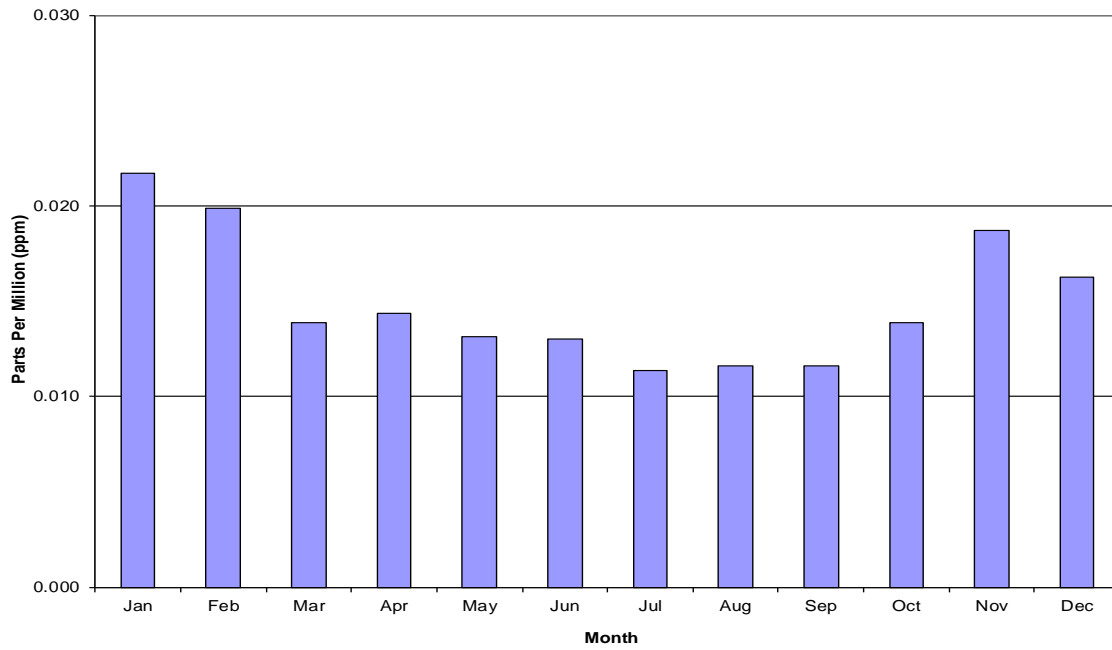


Figure 12
Total Oxides of Nitrogen - New Jersey
2011 Monthly Variation
Parts Per Million (ppm)

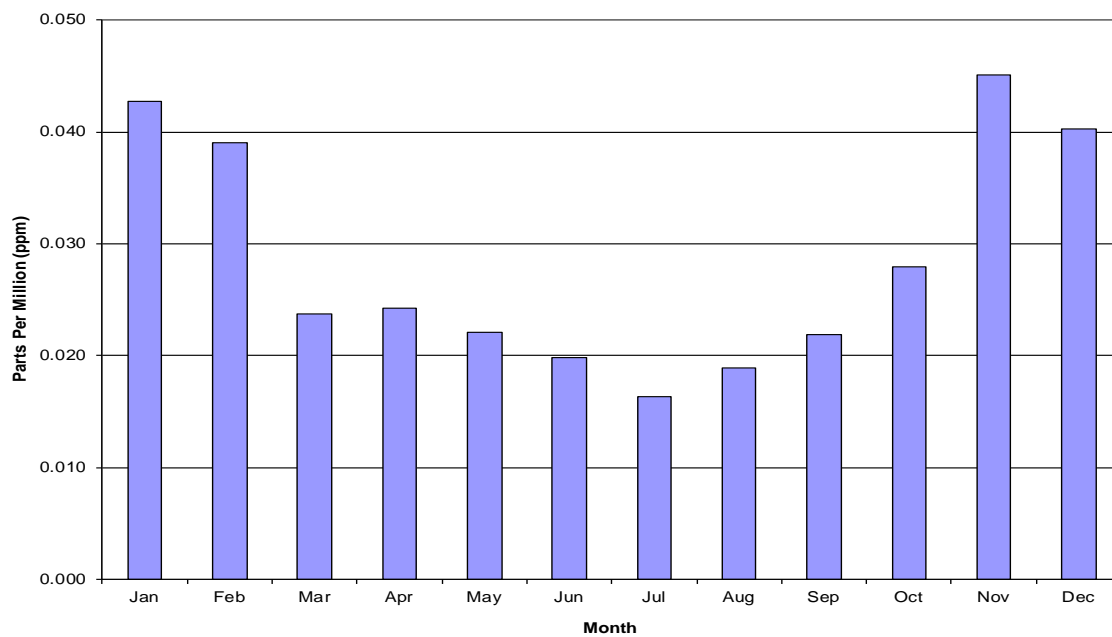
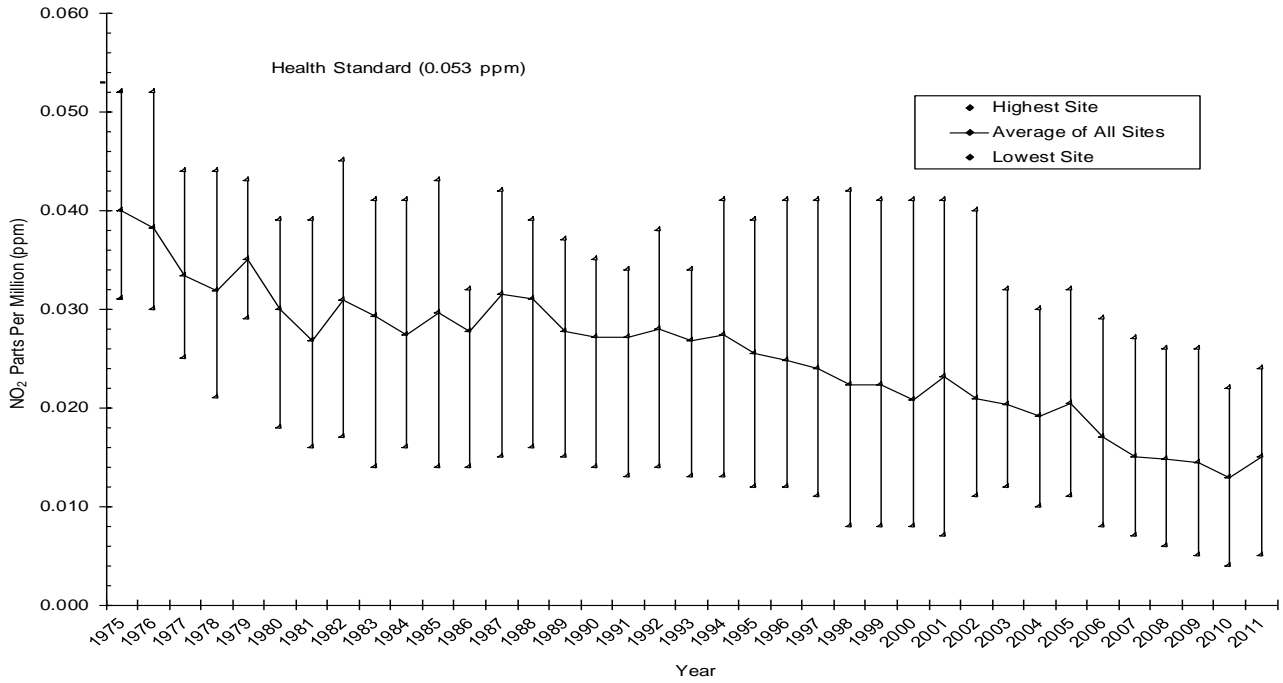


Figure 13
 Nitrogen Dioxide Concentrations in New Jersey 1975-2011
 12-Month (Calendar Year) Average
 Parts Per Million (ppm)



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2011 Ozone Summary

New Jersey Department of Environmental Protection

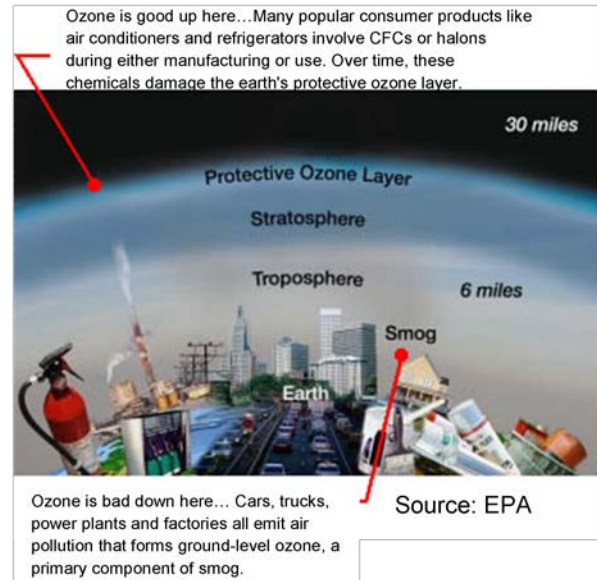
NATURE AND SOURCES

Ozone (O₃) 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 (see Figure 1). 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 (VOC's) react in the presence of sunlight and heat. NO_x is primarily emitted by motor vehicles, power plants, and other sources of combustion. VOC's are emitted from sources such as motor vehicles, chemical plants, factories, consumer and commercial products, and even natural sources such as trees. Ozone and the pollutants that form ozone (precursor pollutants) can also be transported into an area from sources hundreds of miles upwind.

Since ground-level ozone needs sunlight to form, it is mainly a daytime problem during the summer months.

Weather patterns have a significant effect on ozone formation and hot, dry summers will result in more ozone than cool, wet ones. In New Jersey, the ozone monitoring season runs from April 1st to October 31st. For a more complete explanation of the difference between ozone in the upper and lower atmosphere, see the U.S. Environmental Protection Agency (EPA) publication "Ozone: Good Up High, Bad Nearby."

Figure 1
Good and Bad Ozone



ENVIRONMENTAL EFFECTS

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 disease, insects, other pollutants, and harsh weather. "Bad" ozone damages the foliage of trees and other plants, sometimes marring the landscape of cities, national parks and forests, and recreation areas. The black areas on the leaves of the watermelon plant, shown in Figure 2, are damage caused by exposure to ground-level ozone.

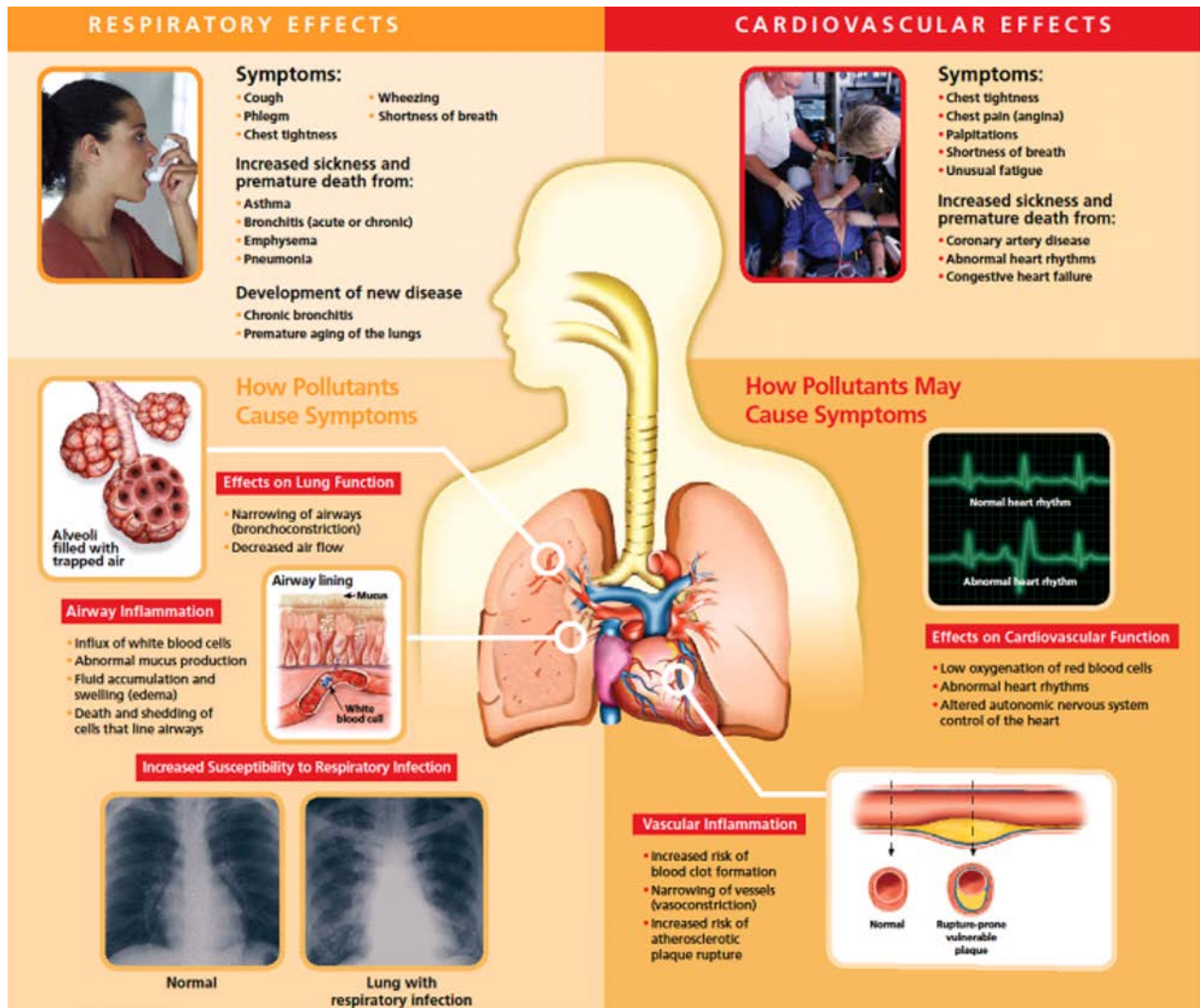


(Figure 2 Photos by: Gerald Holmes, NCSU Dept. of Horticulture)

HEALTH EFFECTS

Repeated exposure to ozone pollution may cause permanent damage to the lungs. Even when ozone is present in 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 health problems 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. As shown in Figure 3 ozone can irritate the entire respiratory tract. Children are also at risk for ozone related problems. Their respiratory systems are still developing and they breathe more air per pound of body weight than adults. They are also generally 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.

Figure 3
Effects of Ozone & Common Air Pollutants



Source: www.airnow.gov

AMBIENT AIR QUALITY STANDARDS FOR OZONE

National and state air quality standards have been established for ground-level ozone. There are both primary standards, which are based on health effects, and secondary standards, which are based on welfare effects (e.g. 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 1). The ozone NAAQS were revised in 2008 because EPA determined that the old standard of 0.08 parts per million (ppm) maximum daily eight-hour average was not sufficiently protective of public health. The revised standard of 0.075 ppm maximum daily 8-hour average went into effect on May 27, 2008. As many people are accustomed to the old standards, summary information relative to that standard will be provided in this report along with summaries based on the new standard.

Table 1
National and New Jersey Ambient Air Quality Standards for Ozone
 ppm = Parts per Million

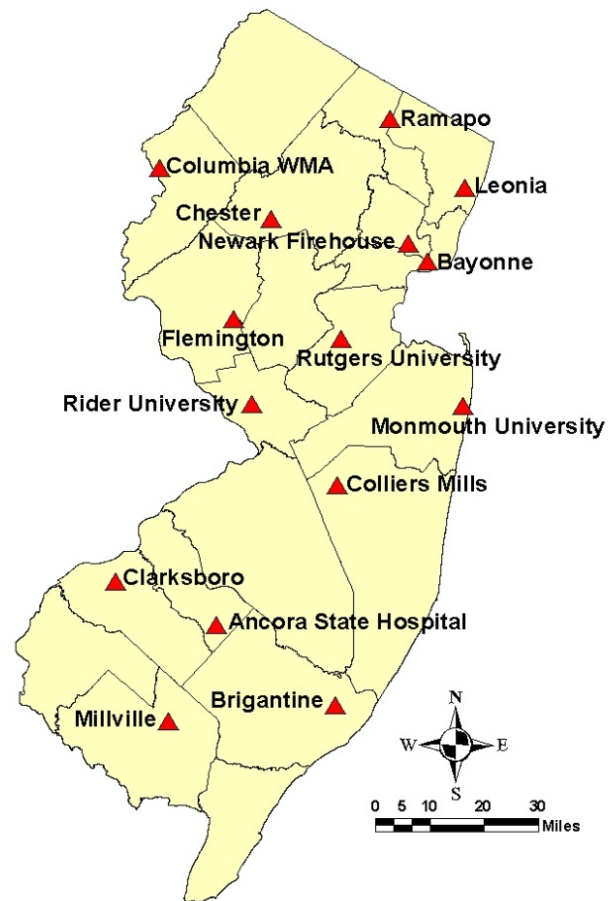
Averaging Period	Type	New Jersey	National
1-Hour	Primary	0.12 ppm	-----
1-Hour	Secondary	0.08 ppm	-----
8-Hour	Primary	-----	0.075 ppm
8-Hour	Secondary	-----	0.075 ppm

OZONE NETWORK

Ozone was monitored at 15 locations in New Jersey during 2011. Of those 15 sites, 12 operated year round and 3 operated only during the ozone season (April 1st through October 31st). Colliers Mills, Monmouth University, and Ramapo were only operated during the ozone season.

Site locations are shown in Figure 4.

FIGURE 4
 2011 Ozone Monitoring Network

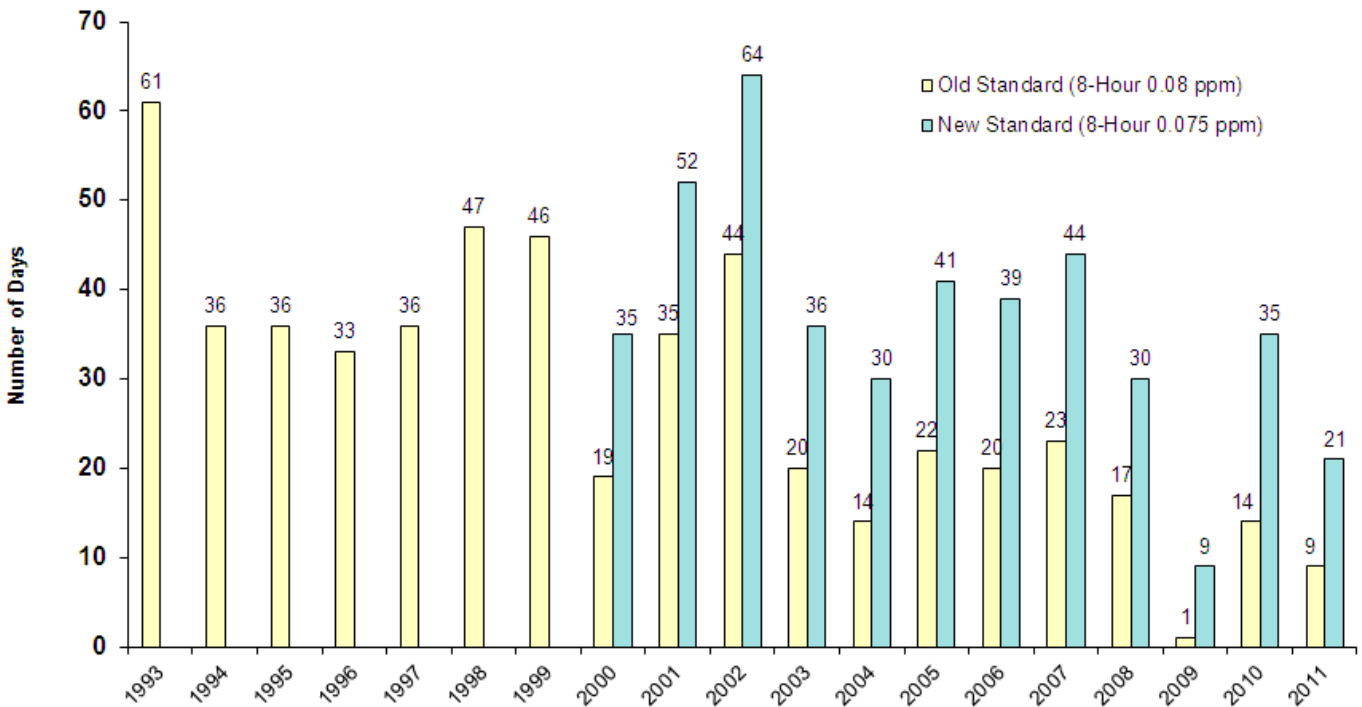


HOW THE CHANGES TO THE OZONE STANDARDS AFFECT AIR QUALITY RATINGS

Unlike 2010, 2011 was a much more typical summer in New Jersey for air pollution. 21 days exceeded the 0.075 ppm 8-hour standard and 9 days exceeded the old 0.08 ppm 8-hour standard. There are, however, fewer days on which those old standards are exceeded, and when they are, fewer sites tend to be involved. Also, the maximum levels reached are not as high as they were in the past. The maximum 1-hour average concentration recorded in 1993 was 0.162 ppm, compared to a maximum of 0.118 ppm in 2011.

It is apparent, however, that the current standard is significantly more stringent than the old (see Figure 5 below). As a result, additional control measures to reduce ozone levels will be needed. These measures will have to be implemented over a wide area and will require the cooperative effort of many states and the federal government if they are to be successful. In Figure 5 the new standard has been projected back through 2000 for comparison purposes. As mentioned previously, the current 8-hour standard of 0.075 ppm, was promulgated in May 2008.

FIGURE 5
**Days on Which the Old and New
 Ozone Standards have been exceeded in New Jersey
 1993-2011**



DESIGN VALUE

The NAAQS for ozone are set in such a way that determining whether they are being attained is not based on a single year. For example, an area was considered to be attaining the old 1-hour average standard if the average number of times the standard was exceeded over a three-year period was 1 or less (after correcting for missing data). Thus it was the fourth highest daily maximum 1-hour concentration that occurred over a three-year period that determined if an area would be in attainment. If the fourth highest value was above 0.12 ppm then the average number of exceedances would be greater than 1. The fourth highest value is also known as the design value.

Under the new standard, attainment is determined by taking the average of the fourth highest daily maximum 8-hour average concentration that is recorded each year for three years. This becomes the design value for an area under the new standard. When plans are developed for reducing ozone concentrations, an area must demonstrate that the ozone reduction achieved will be sufficient to ensure the design value will be below the NAAQS, as opposed to ensuring that the standards are never exceeded. This avoids developing plans based on extremely rare events.

Table 2 and Table 3 on the following pages display the current design values for both the 1-hour standard and the 8-hour standard respectively.

SUMMARY OF 2011 OZONE DATA RELATIVE TO THE OLD 1-HOUR STANDARD

Of the 15 monitoring sites that were operated during the 2011 ozone season, none recorded levels above the old 1-hour standard of 0.12 ppm (Figure 7). The highest 1-hour concentration was 0.118 ppm recorded at Leonia on June 9th. As recently as 2002, New Jersey recorded 16 days above this old 1-hour standard.

Figure 7

Highest and Second Highest Daily 1-Hour Averages

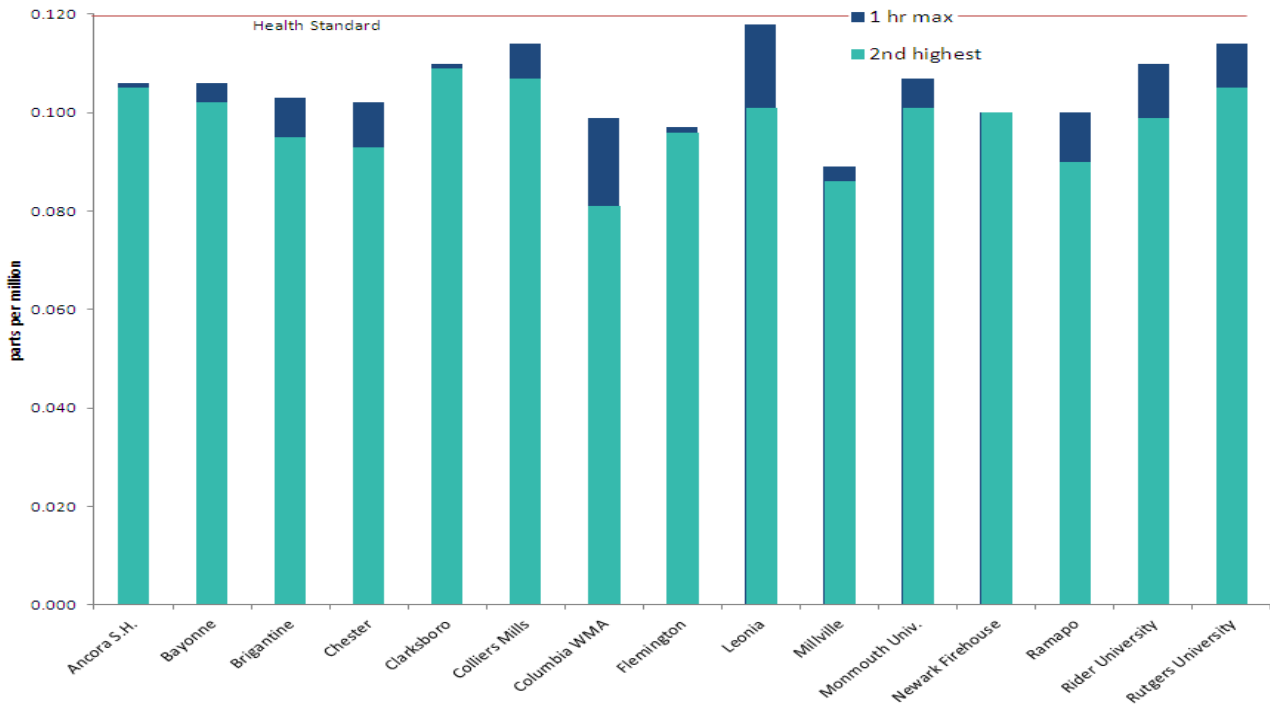


Table 2
Ozone Data – 2011
1-Hour Averages
Parts Per Million (ppm)

Old 1-hour standard is 0.12 ppm

Monitoring Site	1-hr Max	2nd Highest 1-hr Max	4th Highest 1-hour Average 2009-2011	# of days with 1-hour Averages above 0.12ppm
Ancora S.H.	.106	.105	.106	0
Bayonne	.106	.102	.103	0
Brigantine	.103	.095	.095	0
Chester	.102	.093	.094	0
Clarksboro	.110	.109	.107	0
Colliers Mills	.114	.107	.109	0
Columbia WMA*	.099*	.081*	.081*	0
Flemington	.097	.096	.096	0
Leonia	.118	.101	.105	0
Millville	.089	.086	.089	0
Monmouth Univ.	.107	.101	.106	0
Newark Firehouse	.100	.100	.100	0
Ramapo	.100	.090	.092	0
Rider University	.110	.099	.099	0
Rutgers University	.114	.105	.105	0

*Columbia WMA data based on 2011 data only. Uses 2nd highest daily maximum 1-hour average.

SUMMARY OF 2011 OZONE DATA RELATIVE TO THE 8-HOUR STANDARD

All 15 monitoring sites that were operated during the 2011 ozone season recorded levels above the 8-hour standard of 0.075 ppm. The highest 8-hour concentration recorded was 0.102 ppm at Clarksboro on June 9th. Design values for the 8-hour standard (Figure 8) were above the standard at 10 of 14 sites, indicating that the ozone standard is being violated throughout almost all of New Jersey. Columbia began sampling in 2011 and therefore does not have a valid design value for this period.

Figure 8

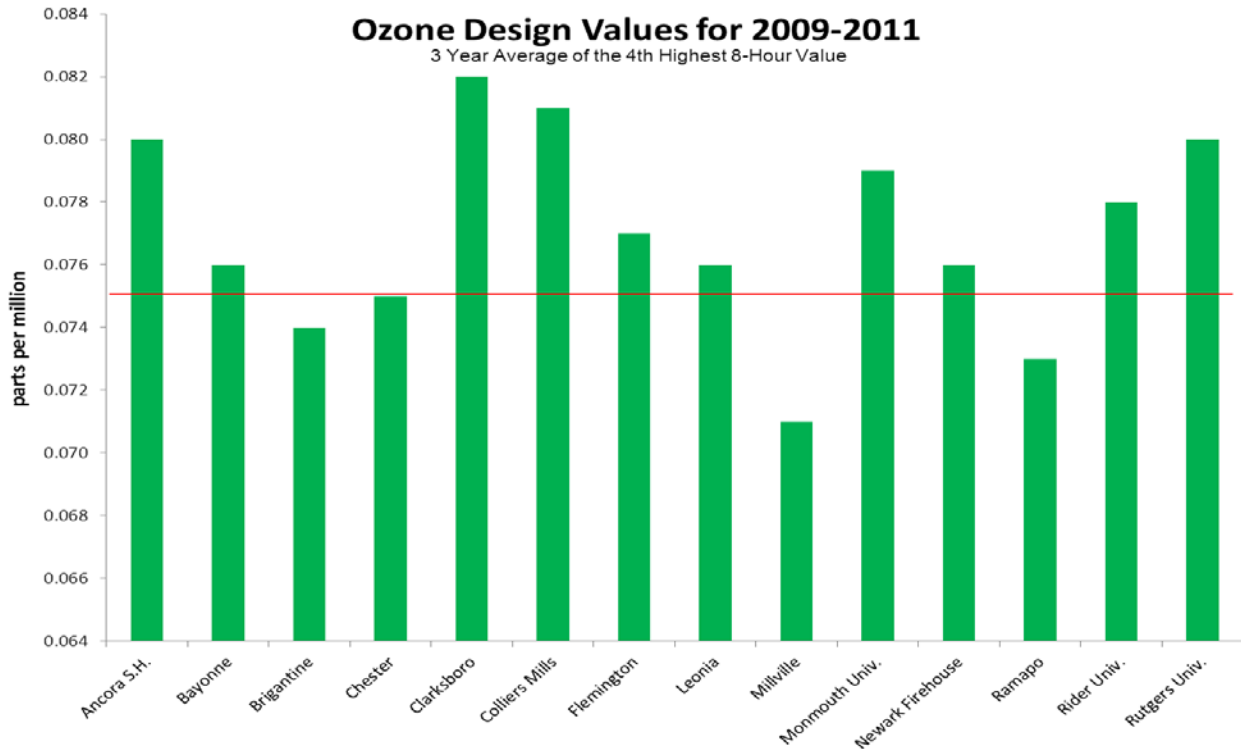
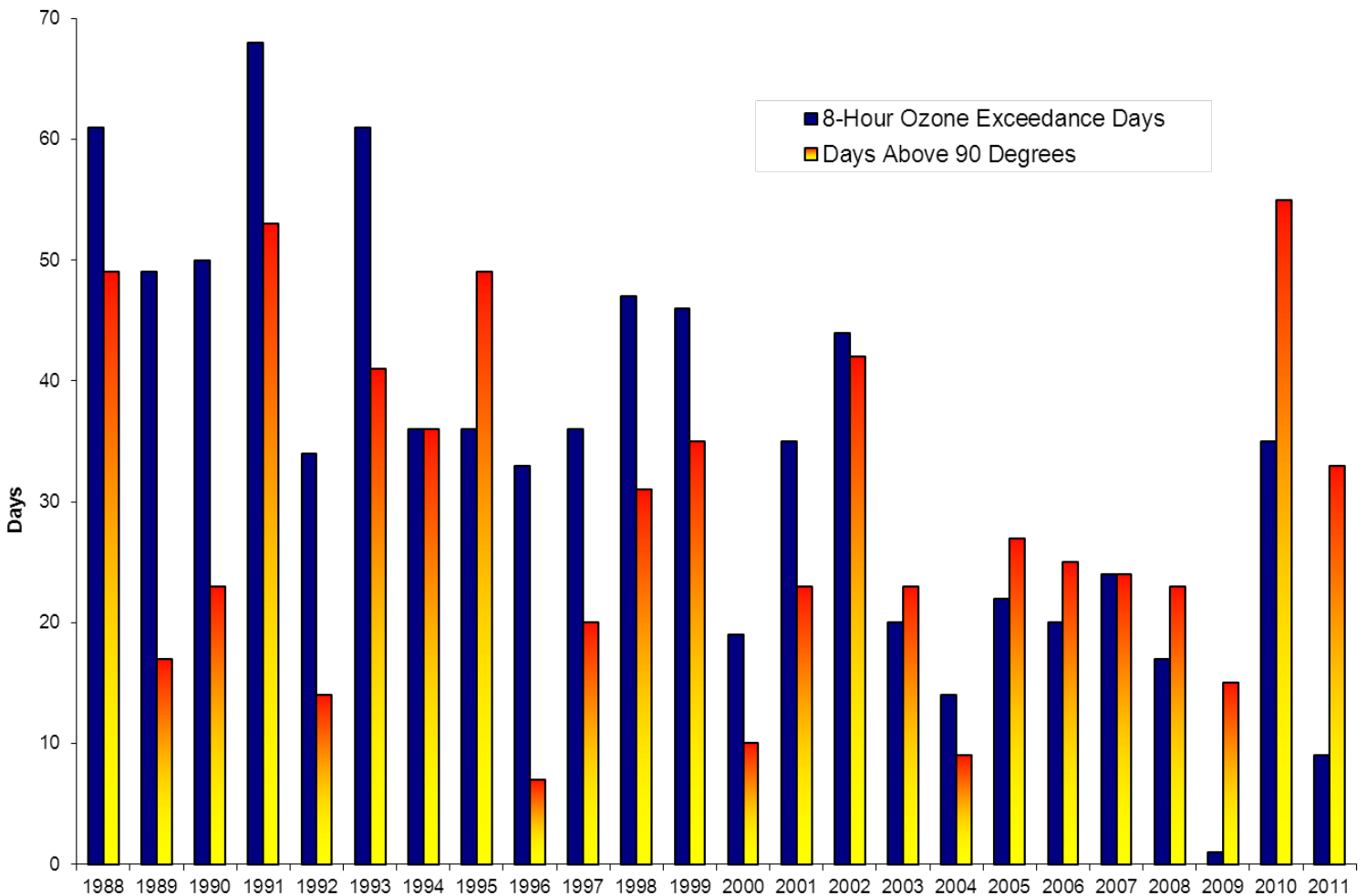


Table 3
Ozone Data – 2011
8-Hour Averages
Parts Per Million (ppm)

Monitoring Site	1 st Highest	2 nd Highest	3 rd Highest	4 th Highest	Avg. of 4 th Highest 8-hour Averages 2009-2011	# of days with 8-hour Avg. above 0.075 ppm
Ancora S.H.	0.097	0.096	0.084	0.083	0.080	8
Bayonne	0.088	0.082	0.081	0.078	0.076	5
Brigantine	0.081	0.078	0.074	0.073	0.074	2
Chester	0.084	0.084	0.082	0.081	0.075	6
Clarksboro	0.102	0.095	0.093	0.092	0.082	11
Colliers Mills	0.101	0.094	0.089	0.085	0.081	11
Columbia WMA*	0.087	0.073	0.071	0.070	*	1
Flemington	0.088	0.086	0.085	0.081	0.077	7
Leonia	0.095	0.087	0.087	0.082	0.076	10
Millville	0.077	0.077	0.068	0.066	0.071	2
Monmouth Univ.	0.097	0.094	0.083	0.081	0.079	8
Newark Firehouse	0.091	0.091	0.084	0.081	0.076	8
Ramapo	0.081	0.079	0.076	0.075	0.073	3
Rider University	0.089	0.088	0.086	0.079	0.078	7
Rutgers University	0.092	0.092	0.090	0.087	0.080	11

*Columbia WMA data based on 2011 data only.

Figure 9
 Number of Days 8-Hour Ozone Standard was Exceeded and
 Number of Days Above 90 Degrees in New Jersey 1988-2011
 (Using 8-Hour 0.08 ppm standard (old) across entire time period)



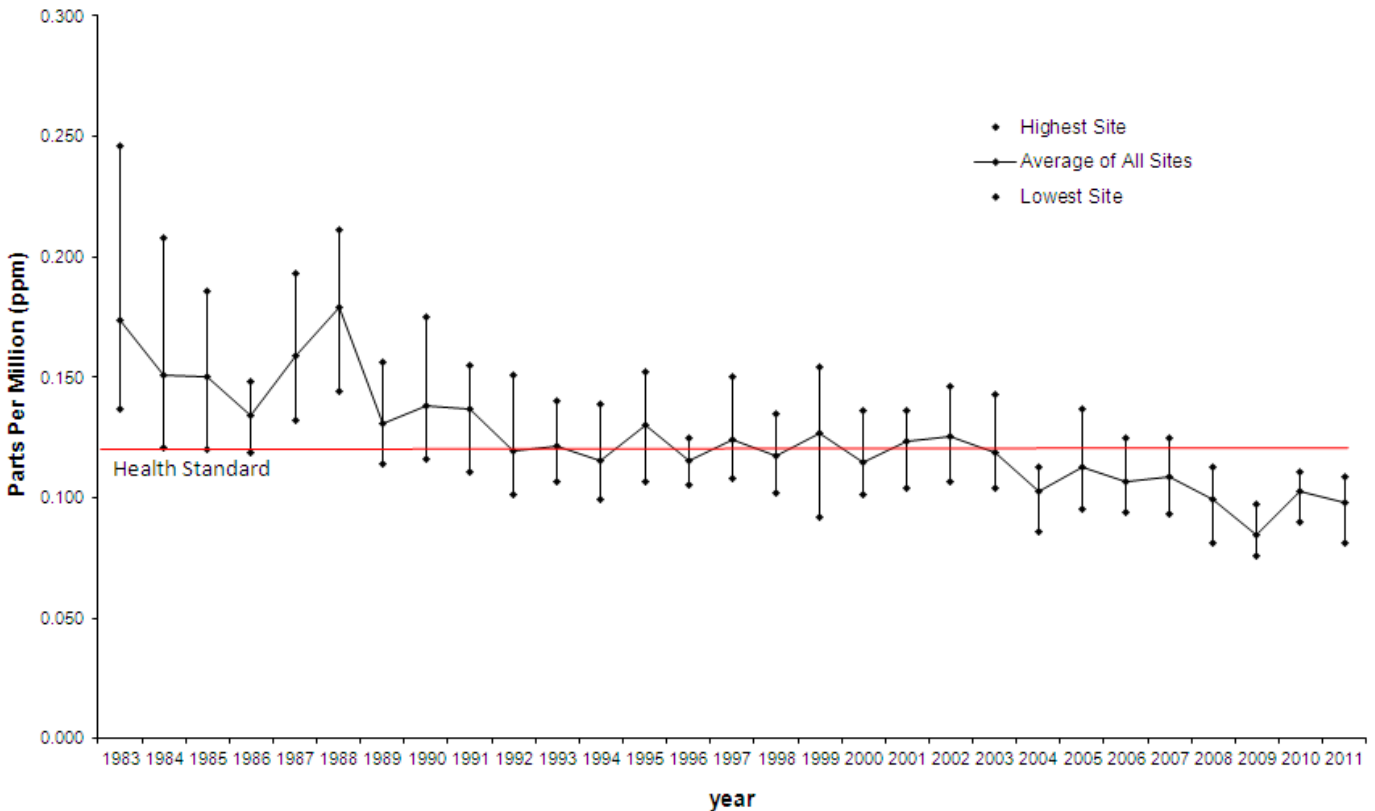
ACCOUNTING FOR THE INFLUENCE OF WEATHER

Trends in ground level ozone are influenced by many factors including weather conditions, transport, growth, and the state of the economy, in addition to changes brought about by regulatory control measures. Of these factors, weather probably has the most profound effect on year to year variations in ozone levels. Several methods have been developed to try to account for the effect of weather on ozone levels so that the change due to emissions could be isolated. While none of these methods are completely successful they do show that over the long term, real reductions in ozone levels have been achieved. A simple way of showing the changing effect of weather on ozone is shown above in Figure 9. The number of days each year on which the ambient temperature was 90 degrees or greater is shown next to the number of days the ozone standard was exceeded. In the earliest years shown (1988-1993) there are significantly more days with high ozone than days above 90 degrees. But this pattern gradually changes and for the most recent years there are more “hot” days than “ozone” days. This is an indication that on the days when conditions are suitable for ozone formation, unhealthy levels are being reached less frequently.

OZONE TRENDS

The primary focus of efforts to reduce concentrations of ground-level ozone in New Jersey has been on reducing emissions of volatile organic compounds (VOCs). Studies have shown that such an approach should lower peak ozone concentrations, and it does appear to have been effective in achieving that goal. Maximum 1-hour concentrations have not exceeded 0.200 ppm since 1988 and the last time levels above 0.180 ppm were recorded was in 1990 (Figure 10). Improvements have leveled off in recent years, especially with respect to maximum 8-hour average concentrations. Significant further improvements will require reductions in both VOCs and NOx. The NOx reductions will have to be achieved over a very large region of the country because levels in New Jersey are dependent on emissions from upwind sources.

Figure 10
Ozone Concentrations in New Jersey
1983-2011
Second Highest 1-Hour Averages



OZONE NON-ATTAINMENT AREAS IN NEW JERSEY

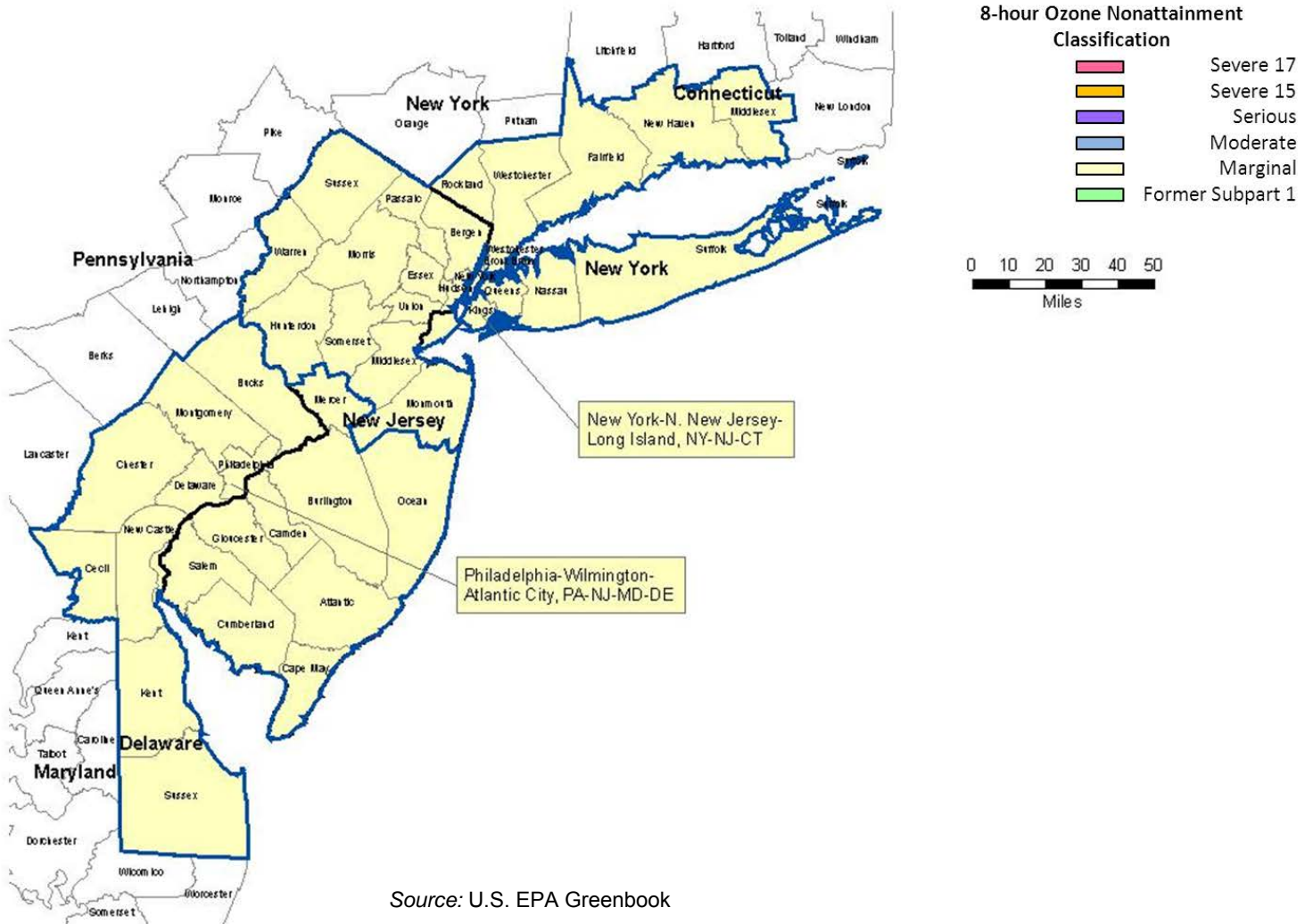
The Clean Air Act requires that all areas of the country be evaluated and then classified as attainment or non-attainment areas for each of the National Ambient Air Quality Standards. Areas can also be found to be “unclassifiable” under certain circumstances. The 1990 amendments to the act required that areas be further classified based on the severity of non-attainment. The classifications range from “Marginal” to “Extreme” and are based on “design values”. The design value is the value that actually determines whether an area meets the standard. For the 8-hour ozone standard for example, the design value is the average of the fourth highest daily maximum 8-hour average concentration recorded each year for three years.

Their classification with respect to the 8-hour standard is shown in Figure 11 below. The entire state of New Jersey is in non-attainment and is classified as being “Marginal.” A “Marginal” classification is applied when an area has a design value of 0.085 ppm up to but not including 0.092 ppm.

Figure 11

New Jersey

8-hour Ozone Nonattainment Areas in Blue Border



Source: U.S. EPA Greenbook

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2011 Particulate Summary

New Jersey Department of Environmental Protection

NATURE AND SOURCES

Particulate air pollution is a complex mixture of organic and inorganic substances present in the atmosphere 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 undetectable by the human eye. Also, particulates may travel hundreds of miles suspended in the atmosphere from their sources before reaching ground level.

Generally, particulate pollution is categorized by size. Particulates with diameters of 2.5 microns or less are considered Fine Particulates, often referred to as $PM_{2.5}$ (Figure 1). Particulates with diameters of 10 microns or less are considered to be Inhalable Particulates and are referred to as PM_{10} . Total Suspended Particulates (TSP) consists of all suspended Particulates including the largest ones. Particulates smaller than 10 microns are considered to be inhalable and are a greater health risk, but particulates of all sizes have an impact on the environment.

Particulates can occur naturally or be man-made. Examples of naturally occurring particulates are windblown dust and sea salt. Man-made particulates, which come from sources such as fossil fuel combustion and industrial processes, can be divided into two categories: Primary Particulates and Secondary Particulates. Primary Particulates are directly emitted from their sources while Secondary Particulates are created in the atmosphere through reactions of gaseous emissions.

ENVIRONMENTAL EFFECTS

Particulate matter is the major cause of reduced visibility in many parts of the United States. Figure 2a provides an example of reduced visibility due to particulate pollution recorded by the New Jersey

Figure 1
Size of $PM_{2.5}$ Particle Compared to a Human Hair

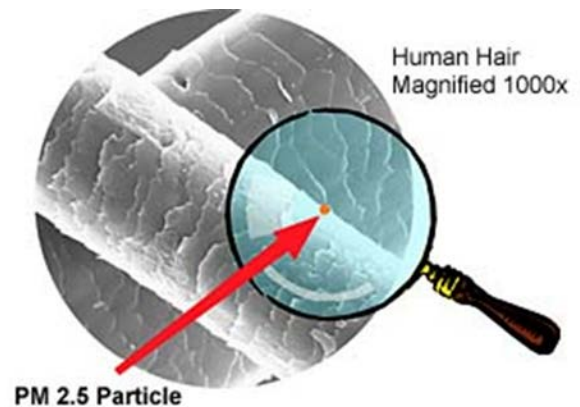


Figure 2a



Figure 2b



Department of Environmental Protection's (NJDEP) visibility camera in Newark that shows the New York City skyline. Figure 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. More information regarding NJDEP's visibility efforts is provided in the Regional Haze and Visibility section of the 2011 Air Quality Report.

HEALTH EFFECTS

Inhalable Particulates (PM_{10}) and especially Fine Particulates ($PM_{2.5}$) are health concerns because they are easily breathed into the lungs. Various health problems are associated with both long and short-term exposures. When inhaled, these particles can accumulate in the respiratory system and are responsible for heart and lung conditions, such as asthma, bronchitis, cardiac arrhythmias, heart attacks, and can even be attributed to premature death. Groups that appear to be at the greatest risk from particulates include children, the elderly, and individuals with heart and lung diseases, such as asthma.

STANDARDS

In 1971, U.S. Environmental Protection Agency (EPA) set primary (health based) and secondary (welfare based) standards for Total Suspended Particulate matter (TSP). These standards, known as the National Ambient Air Quality Standards (NAAQS), were based on maximum 24-hour and annual concentrations. The annual standards were based on the geometric mean concentrations over a calendar year, and the 24-hour standards were based on the arithmetic average concentration from midnight to midnight. The primary 24-hour average standard for TSP was set at 260 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) and the annual geometric mean health standard was set at $75 \mu\text{g}/\text{m}^3$. The 24-hour secondary standard was set at $150 \mu\text{g}/\text{m}^3$. While EPA did not establish a secondary annual standard for TSP, they did set a guideline of $60 \mu\text{g}/\text{m}^3$ to be used to ensure that the secondary 24-hour standard was being met throughout the year. Although New Jersey still maintains state standards for TSP, the national standards have been replaced with standards for smaller particles as described below. As a result, the monitoring effort for TSP has steadily diminished. NJDEP's sole TSP sampler was discontinued in early 2008.

In 1987, EPA replaced the TSP standards with standards that focused only on Inhalable Particulates (PM_{10}). The 24-hour PM_{10} primary and secondary standards were set at $150 \mu\text{g}/\text{m}^3$, and the annual primary and secondary standards were set at $50 \mu\text{g}/\text{m}^3$. The annual standard for PM_{10} is based on the arithmetic mean, as opposed to the geometric mean that was used for TSP.

In 1997, EPA promulgated new standards for Fine Particulates ($PM_{2.5}$), while maintaining the existing standards for PM_{10} as well. The $PM_{2.5}$ annual primary and secondary standards were set at $15.0 \mu\text{g}/\text{m}^3$ and the 24-hour standard was set at $65 \mu\text{g}/\text{m}^3$. In October 2006 the EPA revised the 24-hour Standard to the current value at $35 \mu\text{g}/\text{m}^3$. Table 1 provides a summary of the Particulate Matter standards.

Table 1
National and New Jersey
Ambient Air Quality Standards for Particulate Matter

Micrograms Per Cubic Meter ($\mu\text{g}/\text{m}^3$)

Standard	Averaging Period	Type	New Jersey	National
Total Suspended Particulates (TSP)	12-Month [‡]	Primary	75 $\mu\text{g}/\text{m}^3$	---
	24-Hour	Primary	260 $\mu\text{g}/\text{m}^3$	---
	12-Month [‡]	Secondary	60 $\mu\text{g}/\text{m}^3$	---
	24-Hour	Secondary	150 $\mu\text{g}/\text{m}^3$	---
Inhalable Particulates (PM ₁₀)	Annual [†]	Primary & Secondary	---	50 $\mu\text{g}/\text{m}^3$
	24-Hour Average	Primary & Secondary	---	150 $\mu\text{g}/\text{m}^3$
Fine Particulates (PM _{2.5})	Annual [†]	Primary & Secondary	----	15.0 $\mu\text{g}/\text{m}^3$
	24-Hour Average	Primary & Secondary	----	35 $\mu\text{g}/\text{m}^3$

[‡] Annual Geometric Mean

[†] Annual Arithmetic Mean

PARTICULATE MONITORING NETWORK

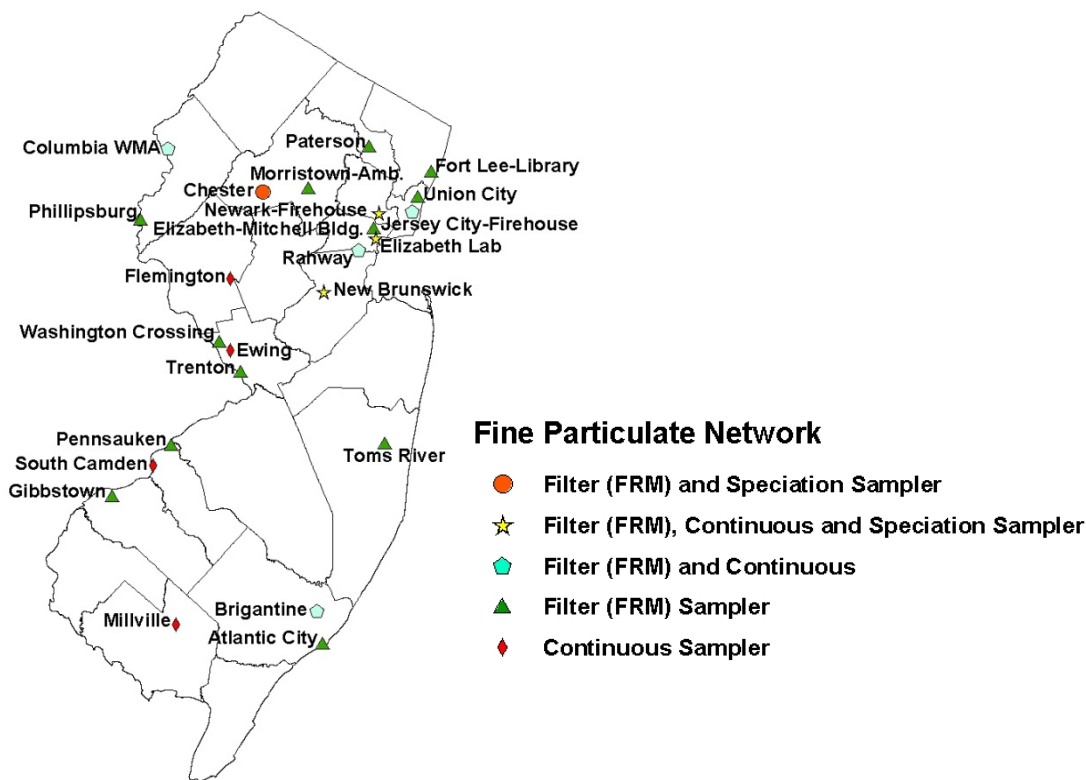
New Jersey's Particulate Monitoring Network consists of 24 PM_{2.5} monitoring sites, 2 PM₁₀ monitoring sites, and 3 sites where smoke shade is monitored. A third PM₁₀ monitoring site at Trenton was discontinued in March 2011 due to many years of low concentrations.

The NJDEP operates PM_{2.5} and PM₁₀ samplers that comply with strict EPA requirements, and are designated as Federal Reference Method (FRM) samplers. These samplers pull a predetermined amount of air through PM_{2.5} or PM₁₀ size-selective inlets onto a filter for a 24-hour period, thereby capturing particles on the filter. The filters are weighed before and after sampling under controlled environmental conditions to determine the concentration. The data is then used by the NJDEP and EPA to determine whether the state, or portions of the state, meets the NAAQS for particulate matter.

Because these samplers are required to run for 24-hour period and do not provide data in real time, the NJDEP employs additional monitors that continuously measure particulate concentrations. These monitors are used by the NJDEP to report current air quality to the public through the Air Quality Index (www.njaqinow.net). The NJDEP uses Tapered Element Oscillating Microbalance (TEOM) analyzers and smoke shade instruments for real-time particulate reporting. The TEOM analyzers collect a sample of PM_{2.5} on an oscillating filter and determine the concentration based on the change in the frequency at which the filter oscillates. Smoke shade instruments collect a sample of TSP on a paper tape for one hour. At the end of each hour the amount of light that will pass through the spot that has formed on the tape is measured, the tape advanced, and the cycle started over. The amount of light transmittance measured is used as an estimate of actual particulate concentrations.

Additionally, at four locations, a separate 24-hour filter based sampler collects PM_{2.5} on three types of filter media which are subsequently analyzed using ion chromatography (IC), X-ray fluorescence (XRF), and Thermal Optical Transmittance (TOT) to determine the concentrations of the chemical analytes that constitute the sample.

Figure 3
2011 PM_{2.5}
Monitoring Network



FINE PARTICLE (PM_{2.5}) SUMMARY

PM_{2.5} MONITORING SITES

The 20 monitoring sites in New Jersey where FRM samplers routinely collect 24-hour PM_{2.5} samples are shown on Figure 3. At 11 sites, continuous particulate monitors (TEOMs) measure the concentrations of fine particles every minute and transmit the data to the Bureau of Air Monitoring's central computer, where it is made available on the Bureau's public website (www.njaqinow.net).

PM_{2.5} CONCENTRATION SUMMARY

The annual mean concentrations of PM_{2.5} ranged from 7.9 $\mu\text{g}/\text{m}^3$ at Chester to 12.2 $\mu\text{g}/\text{m}^3$ at the Elizabeth Lab. The highest 24-hour concentrations ranged from 24.8 $\mu\text{g}/\text{m}^3$ at Morristown to 42.4 $\mu\text{g}/\text{m}^3$ at the Elizabeth Lab. Figure 4a and 4b depict the annual mean concentrations and the 98th percentile 24-hour concentrations in 2011 for all the sites. Table 2 shows the 2011 annual mean, highest 24-hour and 98th percentile 24-hour concentrations as well as the 2009-2011 annual and 24-hour design values. An annual design value for a given site is calculated by averaging the annual mean concentrations for the 3 most recent consecutive calendar years, in this case 2009-2011. Similarly, the 24-hour design value for a given site is calculated by averaging the 98th percentile 24-hour concentrations for each year for the same 3-year period. Design values are used to determine attainment status. No sites were in violation of either the annual standard of 15.0 $\mu\text{g}/\text{m}^3$ or the 24-hour standard of 35 $\mu\text{g}/\text{m}^3$.

Figure 4a
 2011 Fine Particulate (PM_{2.5}) Concentrations
 Annual Mean Concentration

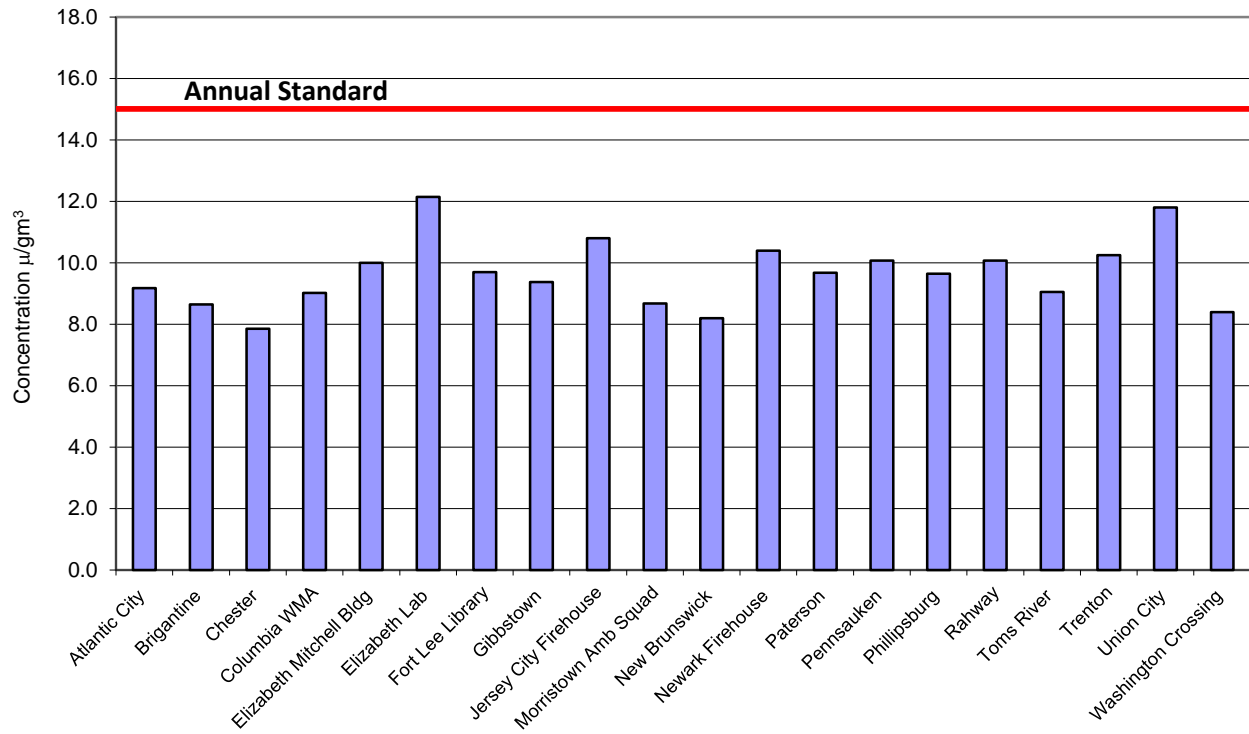


Figure 4b
 2011 Fine Particulate (PM_{2.5}) Concentrations
 98th Percentile 24-Hour Concentration

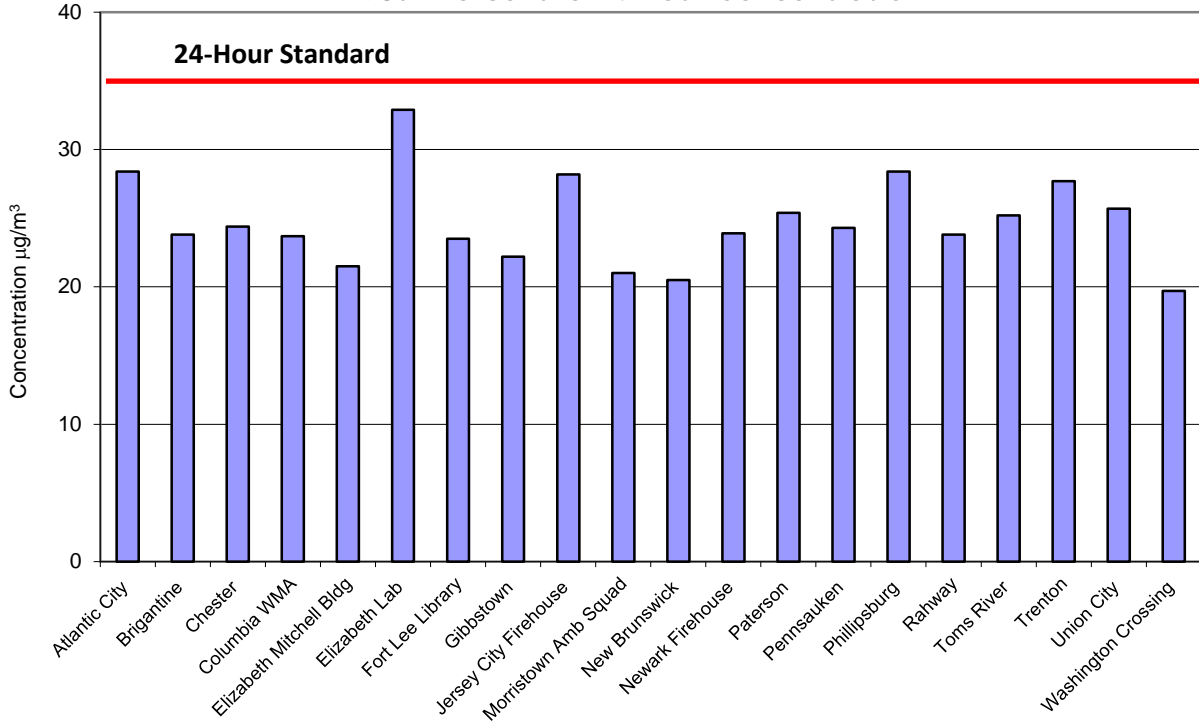


Table 2
2011 Summary of PM_{2.5} Sampler Data

Concentration in Micrograms Per Cubic Meter (µg/m³)

Monitoring Site	Number of Samples	Annual Mean Concentration	Highest 24-Hour Concentration	98 th %-ile 24-Hour Concentration	2009-2011 24-Hour Design Value (98 th %-ile)	2009-2011 Annual Design Value
Atlantic City	111	9.3	32.1	28.4	23	9.1
Brigantine	114	8.7	25.4	23.8	21	8.3
Chester	108	7.9	25.4	24.4	23	7.5
Columbia WMA*	319	9.0	39.1	27.8	-	-
Elizabeth Mitchell Bldg	109	10.0	29.5	21.5	24	9.5
Elizabeth Lab	330	12.2	42.4	32.9	30	11.3
Fort Lee Library	112	9.8	26.4	23.5	25	9.2
Gibbstown	117	9.4	30.7	22.2	22	9.2
Jersey City Firehouse	336	10.8	40.8	28.2	28	10.2
Morristown Amb Squad	112	8.7	24.8	21.0	22	8.4
New Brunswick	115	8.3	25.8	20.5	20	7.9
Newark Firehouse*	116	10.5	27.7	23.9	-	-
Paterson	107	10.1	34.0	25.4	25	9.2
Pennsauken	120	10.1	27.0	24.3	24	9.6
Phillipsburg	111	9.7	28.8	28.4	26	9.2
Rahway	116	10.1	27.0	23.8	24	9.6
Toms River	333	9.1	32.6	25.2	23	8.6
Trenton	349	10.3	33.8	27.7	26	9.7
Union City	115	11.9	26.8	25.7	26	11.0
Washington Crossing	108	8.4	25.4	19.7	20	8.1

* Site does not have enough data to calculate 2009-2011 design values.

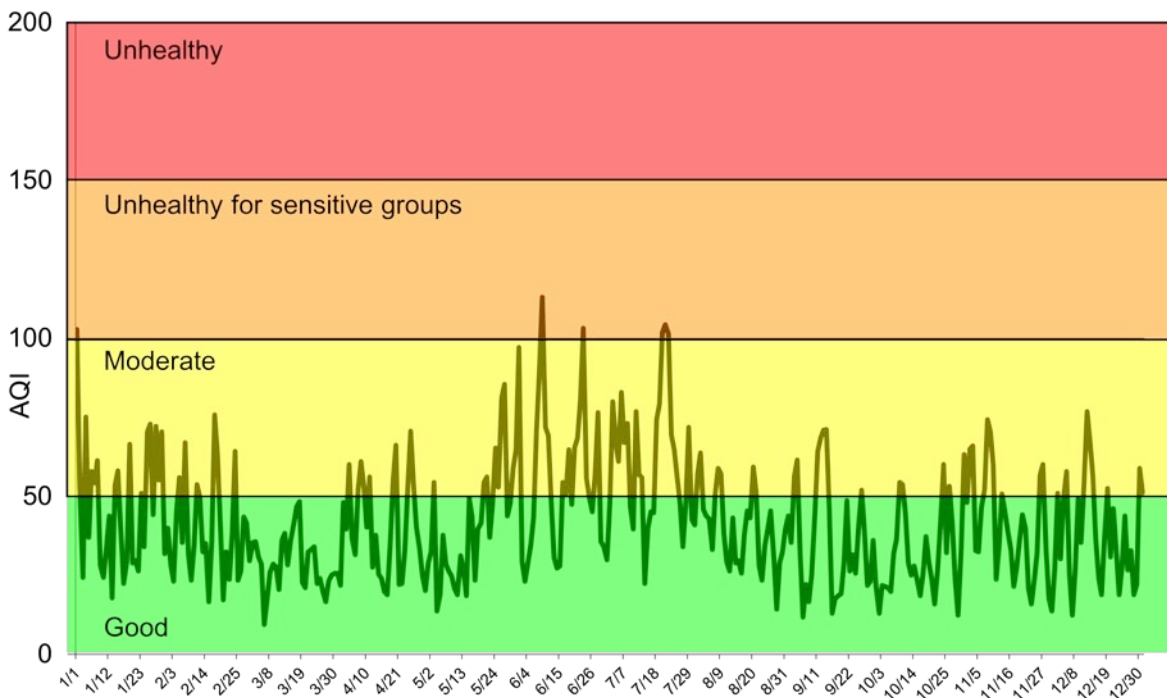
PM_{2.5} REAL-TIME MONITORING

New Jersey's continuous PM_{2.5} monitoring network consists of 11 sites: Brigantine, Columbia WMA, Elizabeth Lab, Ewing, Flemington, Jersey City Firehouse, Millville, New Brunswick, Newark Firehouse, Rahway and South Camden. The data is transmitted once a minute to a central computer in Trenton, where it is averaged and automatically updated on the Bureau's website every hour. Table 3 provides a summary of the data from these sites, and Figure 5 depicts the health level associated with the highest 24-hour fine particulate concentration recorded in the state each day for the entire year.

Table 3
2011 Summary of Continuous PM_{2.5} Data

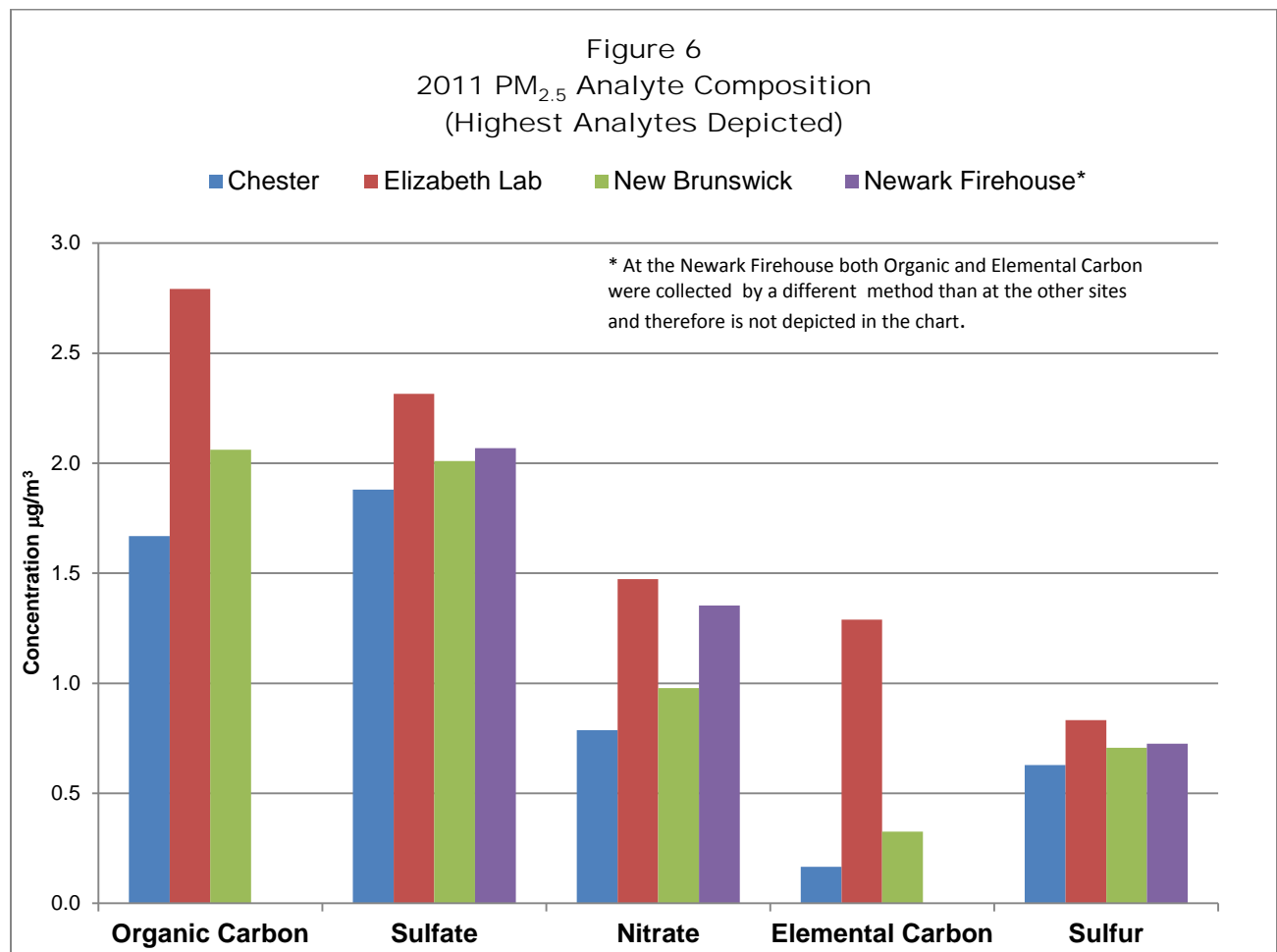
Concentration in Micrograms Per Cubic Meter ($\mu\text{g}/\text{m}^3$)			
Monitoring Site	Annual Mean Concentration	Highest 24-Hour Concentration	Number of Unhealthy Air Quality Days
Brigantine	7.7	32.5	0
Columbia WMA	8.8	33.6	0
Elizabeth Lab	11.1	39.0	5
Ewing	6.9	27.3	0
Flemington	9.3	34.7	0
Jersey City Firehouse	10.1	38.7	3
Millville	8.8	37.9	1
New Brunswick	8.2	34.7	0
Newark Firehouse	8.4	36.6	1
Rahway	10.4	33.2	0
South Camden	9.7	42.8	2

Figure 5
 2011 Highest 24-Hour Continuous PM_{2.5} Concentrations
 (Highest of all Sites)
 Air Quality Index (AQI)



PM_{2.5} SPECIATION SUMMARY

New Jersey's PM_{2.5} Speciation Network consists of 4 monitoring sites: Elizabeth Lab, Newark Firehouse, New Brunswick, and Chester. Samplers run every third day on a schedule concurrent with the Federal Reference Method sampling network. Of the 39 measured analytes, organic carbon, sulfate, nitrate, sulfur and elemental carbon are the most prevalent species; and combined, they create the majority of the PM_{2.5} total mass concentration. Figure 6 depicts the average concentration of these five most prevalent species. High organic and elemental carbon concentrations at Elizabeth Lab are due to the sites' proximity to high traffic volume, and motor vehicles are a primary source for those species. Appendix B of the 2011 Air Quality Report provides the average, highest, and 2nd highest 24-hour average concentrations for each species for 2011.



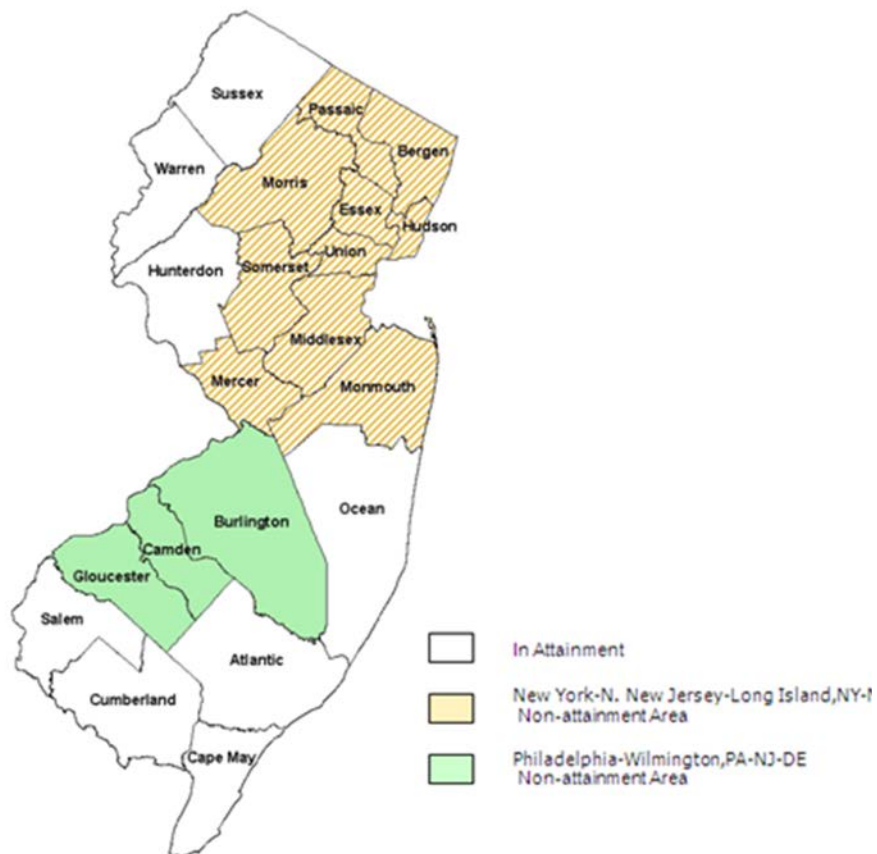
PM_{2.5} NON-ATTAINMENT AREAS

In order to determine if the PM_{2.5} annual or 24-hour NAAQS are met in New Jersey, 12 consecutive quarters of valid data within 3 calendar years are required. The classification of attainment or non-attainment areas for the PM_{2.5} NAAQS is proposed by New Jersey, and final attainment or non-attainment designations are made by the EPA. Non-attainment classification is given to an area that violates the air quality standard or contributes to the violation of that standard.

On April 5, 2005, thirteen New Jersey counties were designated by the EPA as non-attainment areas for PM_{2.5}. While Elizabeth Lab was the only site to record a violation of the annual standard, 10 counties in the northeast and central region of the state were designated as non-attainment due to their potential PM_{2.5} contribution to the Elizabeth Lab monitor and to additional sites in New York City that recorded violations of the PM_{2.5} annual standard.

Similarly, 3 counties in the southwestern part of the state have been classified as non-attainment due to their PM_{2.5} contribution to monitors in the city of Philadelphia that violated the PM_{2.5} NAAQS. DEP is currently devising a strategy to lower PM_{2.5} levels in these affected areas.

Figure 7
New Jersey Fine Particulate Matter (PM_{2.5})
Non-attainment Areas



2011 INHALABLE PARTICULATE (PM₁₀) SUMMARY

PM₁₀ MONITORING SITES

At one time, NJDEP's PM₁₀ monitoring network consisted of more than 20 sampling sites. Due to many years of low concentrations and the greater focus on fine particulate monitoring (PM_{2.5}), the network has been reduced to its current level of only 2 sites, Camden RRF and the Jersey City Firehouse. A third site, Trenton was discontinued in March 2011 due to many years of low concentrations. PM₁₀ samples, taken once every six days are collected on a filter that is weighed before and after sampling to determine the concentration. Figure 8 depicts the PM₁₀ particulate monitoring network in New Jersey.

PM₁₀ Concentration Summary

In 2011, the annual mean concentration measured at the Camden RRF and at the Jersey City Firehouse was 33 µg/m³ and 30 µg/m³ respectively. Table 4 and Figures 9a and 9b show the annual mean and highest 24-hour PM₁₀ concentrations. All areas of the state are in attainment for the both the annual PM₁₀ standards of 50 µg/m³ and the 24-hour standard of 150 µg/m³.

Figure 8
2011 PM₁₀
Monitoring Network

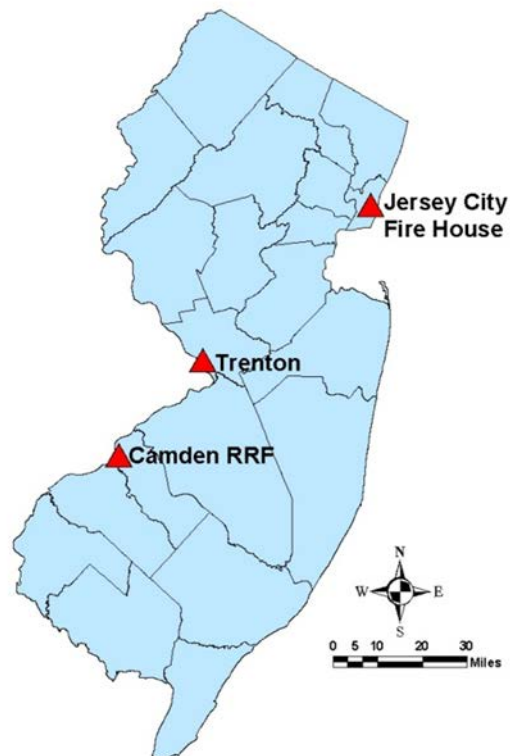


Table 4
PM₁₀ Data - 2011
24-Hour and Annual Averages

Micrograms Per Cubic Meter (µg/m³)
24-hour Standard = 150 (µg/m³)
Annual Standard = 50 µg/m³

Monitoring Site	Number of Samples	Highest 24-Hour Concentration	Second Highest 24-Hour Concentration	Annual Mean
Camden RRF	60	77	74	33
Jersey City Firehouse	57	63	61	30
Trenton*	14	29	26	-

*The Trenton sampler was discontinued on March 31, 2011 and therefore does not have enough data to calculate the annual mean

Figure 9a
Summary of PM₁₀ Concentrations, New Jersey 2011

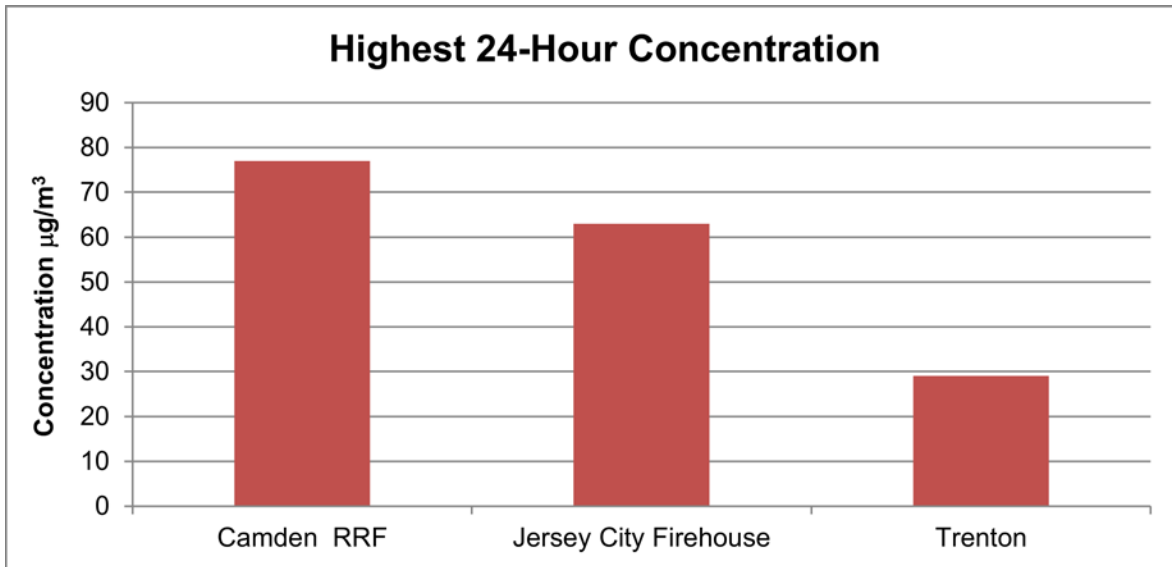
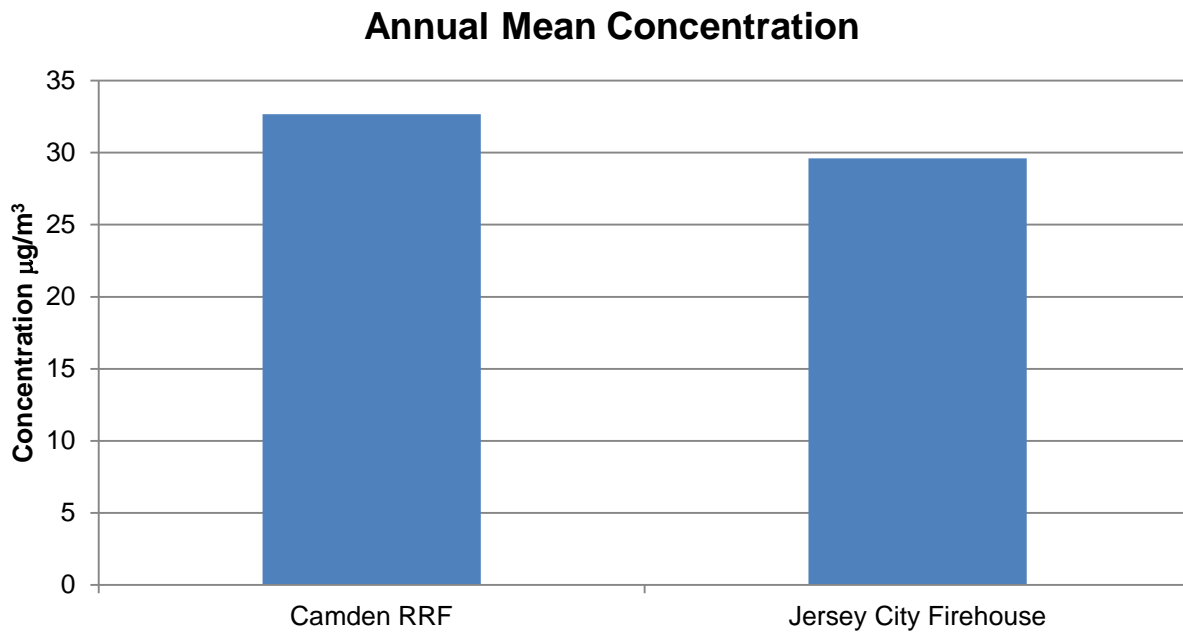


FIGURE 9B
Summary of PM₁₀ Concentrations, New Jersey 2011



SMOKE SHADE SUMMARY

SMOKE SHADE MONITORING SITES

In addition to PM_{2.5} and PM₁₀ monitoring, smoke shade is also monitored at 3 stations around the state. Smoke shade, which is an indirect measurement of particles in the atmosphere, has been monitored in New Jersey for over 40 years. Smoke shade is primarily used for the daily reporting of particulate levels in the Air Quality Index. The sites monitoring smoke shade are shown in Figure 10.

SMOKE SHADE CONCENTRATION SUMMARY

In 2011, the annual mean concentration of smoke shade ranged from 0.21 Coefficient of Haze units (COH) at the Elizabeth site to 0.39 COH at the Elizabeth Lab. COH are units of light transmittance, and smoke shade is not a direct measure of particle mass. A 24-hour average level of 2.0 COH is used as a benchmark. Readings above the 2.0 COH benchmark are reported as Unhealthy for Sensitive Groups on the daily Air Quality Index. For more details see the Air Quality Index section of this report. Table 5 lists the highest and second highest 24-hour average, and annual mean smoke shade levels recorded at the monitoring sites in 2011.

Figure 10
2011 Smoke Shade Network



Table 5
Smoke Shade - 2011

Coefficient of Haze (COHs)
No Standard

Site	Highest 24-Hour Average	2nd Highest 24-Hour Average	Annual Mean
Elizabeth	0.65	0.59	0.20
Elizabeth Lab	0.99	0.95	0.39
Jersey City	0.90	0.88	0.29

TRENDS IN PARTICULATE CONCENTRATIONS

The longest continuously operating particulate monitoring network in the state that is suitable for looking at trends is the smoke shade network. As noted earlier, this monitoring program has been running for over 40 years and still has 3 active sites. The trend graph for smoke shade, shown in Figure 11 indicates that particulate levels have steadily declined over the past 40 years. Smoke shade is not a direct measurement of particle mass, but can be related to TSP, PM₁₀ and PM_{2.5} health standards.

The PM_{2.5} monitoring network has been in place since 1999. Twelve years of sampling has shown a noticeable decline in fine particulate concentrations. Figure 12 shows the trend of the annual mean PM_{2.5} concentrations for all sites since the network began.

Figure 11
 Long Term Trends in Particulate Levels as Smoke Shade
 State Average
 1967-2011

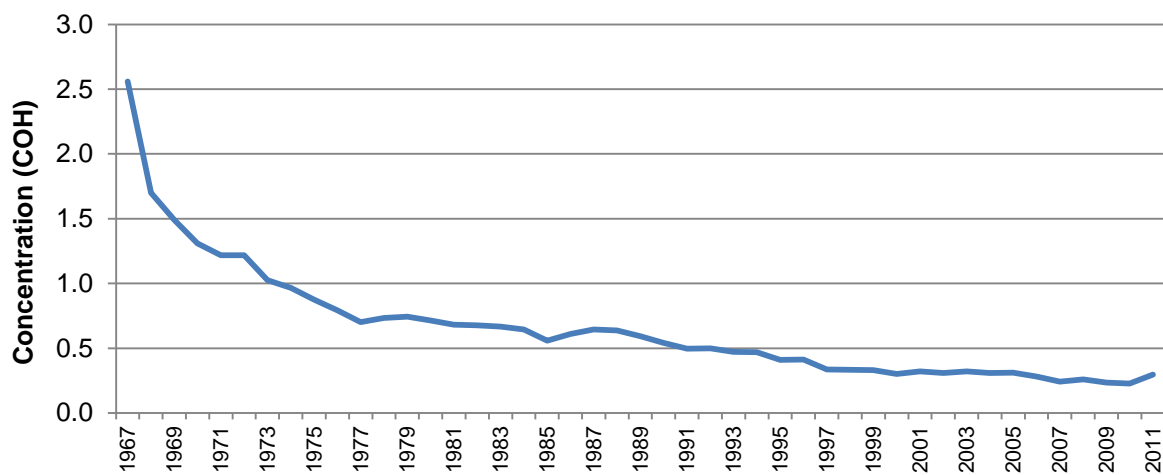
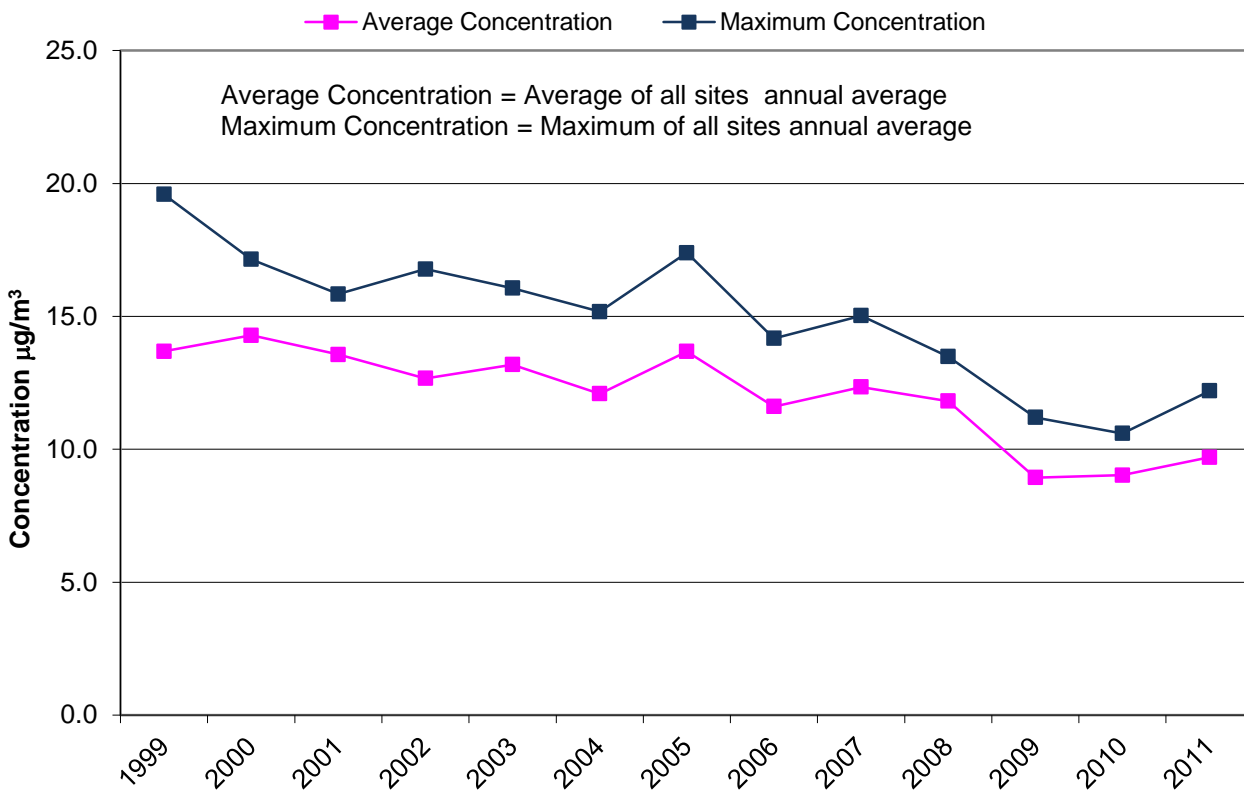


Figure 12
 New Jersey
 Trend of PM_{2.5} Annual Averages of All Sites
 1999-2011



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2011 Sulfur Dioxide Summary

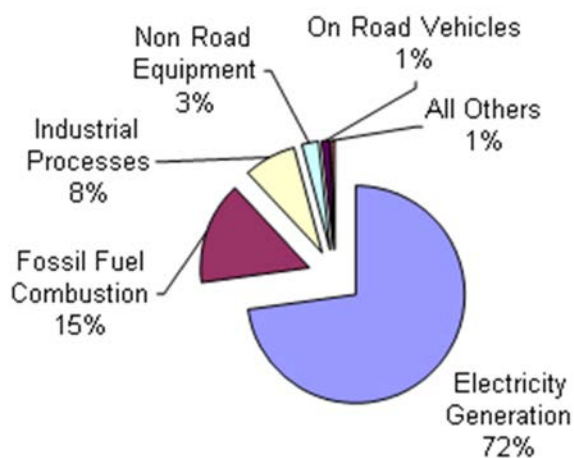
New Jersey Department of Environmental Protection

NATURE AND SOURCES

Sulfur dioxide (SO₂) is a heavy, colorless gas with a suffocating odor that easily dissolves in water to form sulfuric acid. SO₂ 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 SO₂. A pie chart summarizing the major sources of SO₂ is shown in Figure 1.

Figure 4 (page 6) shows that SO₂ concentrations in New Jersey are generally higher in the winter than in the summer due to higher emissions from space heating and other sources, but peak SO₂ daily levels can occur any time during the year. As shown in Figure 5 (page 6), SO₂ 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
SO₂ Emissions by Source Category



SOURCE: USEPA WEBSITE
[HTTP://WWW.EPA.GOV/AIR/EMISSIONS/SO2.HTM](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 SO₂ dissolves at the surface of the membranes. Groups that are especially susceptible to the harmful health effects of SO₂ include children, the elderly, and people with heart or lung disorders such as asthma. When SO₂ 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 SO₂ and based on available information, determined that no conclusion can be made as to the carcinogenicity of SO₂ 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. SO₂ 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 can speed up the decay of building materials and paints.

STANDARDS

From 1971 through June 2010, the National Ambient Air Quality Standards (NAAQS) for SO₂ were revised three times. In June 2010, based on its review of the air quality standard for oxides of sulfur (as measured by SO₂), the United States Environmental Protection Agency (USEPA) established a new 1-hour NAAQS for SO₂ 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 SO₂ 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 also has state air quality standards for SO₂. They are similar to the Federal standards but are expressed in micrograms per cubic meter (µg/m³) instead of ppm, and are based on rolling averages rather than block averages. This means the State's primary 12-month standard is based on any twelve-month average recorded during two consecutive years, while the Federal standard is based solely on the calendar year (block) 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 SO₂.

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 (µg/m³)

Averaging Period	Type	New Jersey	National^a
12 – month average	Primary	80 µg/m ³ (0.03 ppm)	0.03 ppm
12 – month average	Secondary	60 µg/m ³ (0.02 ppm)	---
24 – hour average	Primary	365 µg/m ³ (0.14 ppm)	0.14 ppm
24 – hour average	Secondary	260 µg/m ³ (0.10 ppm)	---
3 – hour average	Secondary	1300 µg/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.

MONITORING LOCATIONS

The state monitored SO₂ levels at 8 locations in 2011. These sites are shown in Figure 2. In 2010, the NJDEP submitted a section 126 petition showing emissions from the Portland Generating Station, located in Pennsylvania, significantly contribute to nonattainment or interfere with maintenance of the 1-hour SO₂ NAAQS. In support of this petition, NJDEP has been monitoring SO₂ concentrations in Columbia, Warren County (Figure 8, page 8) since September 23, 2010.

SO₂ LEVELS IN 2011

In 2011, 27 exceedences of the 1-hour standard were recorded at the Columbia WMA site. The highest 99th percentile of the 1-hour daily maximum concentration for 2011 was recorded at Columbia WMA (125 ppb). While this value is high, it does not violate the Federal standard because 3 years of data are necessary to determine violations. Attainment or non-attainment with the new 1-hour standard will be determined beginning in October 2013, when enough data has been collected to determine if the standard has been violated. Two sites (Newark and Columbia WMA) do not have sufficient data to compare with the 1-hour standard. Of the remaining 6 sites with adequate data capture, the Elizabeth Lab location had the highest 1-hour average at 32 ppb.

None of the other monitoring sites recorded violations of the primary or secondary SO₂ standards during 2011. The maximum 12-month average concentration recorded was 0.0022 ppm at the Newark site. The maximum 24-hour average level recorded was 0.027 ppm at the Columbia WMA site. The highest 3-hour average recorded was 0.107 ppm at the Columbia WMA site. Summaries of the 2011 data are provided in Tables 2, 3, 4 (pages 4 and 5),

Figure 2
2011 Sulfur Dioxide
Monitoring Network

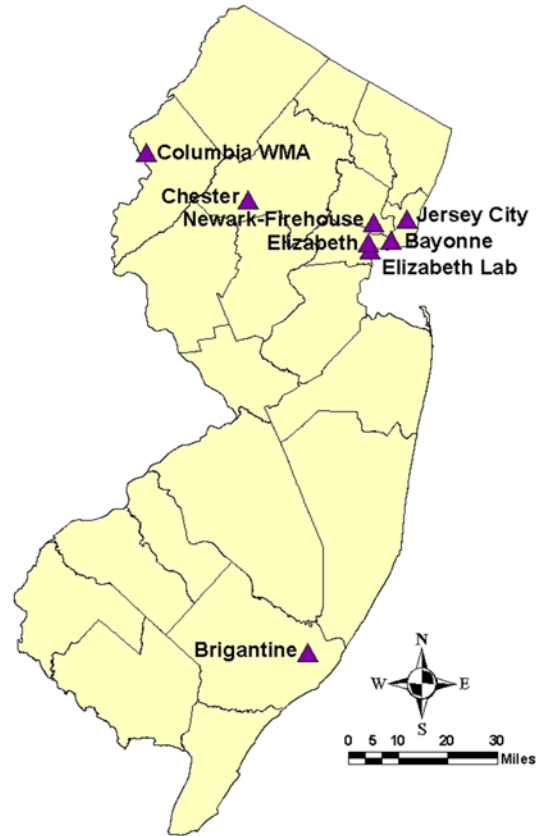


Table 2
2011 Sulfur Dioxide Data
3-Year Average of 99th Percentile
of Daily Maximum 1-Hour Average
Parts Per Billion (ppb)

Location	99th Percentile of Daily Maximum			3 – Year Average
	2009	2010	2011	2009 - 2011
Bayonne	33	26	27	29
Brigantine	14.0	9.8	7.2	10.3
Chester	29	26	25	27
Columbia WMA ^a	---	183	125	---
Elizabeth	22	11	15	16
Elizabeth Lab	34	30	32	32
Jersey City	22	19	22	21
Newark Firehouse ^b	---	18.0	18.9	---

^a – Columbia WMA site started in September 2010.

^b – Newark Firehouse site started in July 2009.

Table 3
2011 Sulfur Dioxide Data
3-Hour and Annual Averages
Parts Per Million (ppm)

Monitoring Sites	3-Hour Average Maximum	3-Hour Average 2 nd Highest ^a	12-Month Average Maximum	Calendar Year Average
Bayonne	0.027	0.021	0.002	0.002
Brigantine	0.0093	0.0076	0.0009	0.0006
Chester	0.052	0.036	0.001	0.000
Columbia WMA	0.107	0.096	0.002	0.002
Elizabeth	0.014	0.012	0.001	0.001
Elizabeth Lab	0.040	0.029	0.001	0.001
Jersey City	0.022	0.020	0.002	0.002
Newark Firehouse	0.0212	0.0193	0.0022	0.0020

^a – Based on non-overlapping 3 – hour moving averages.

**Table 4
2011 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
Bayonne	0.012	0.009	0.009	0.009
Brigantine	0.0042	0.0041	0.0041	0.0038
Chester	0.013	0.010	0.010	0.010
Columbia WMA	0.027	0.020	0.023	0.019
Elizabeth	0.007	0.005	0.005	0.005
Elizabeth Lab	0.013	0.010	0.011	0.009
Jersey City	0.013	0.012	0.011	0.011
Newark Firehouse	0.0097	0.0091	0.0090	0.0080

^a – Based on non-overlapping 24 – hour moving averages.

**Figure 3
Sulfur Dioxide – New Jersey
2011 – 3 Year Design Value
Parts Per Billion (ppb)**

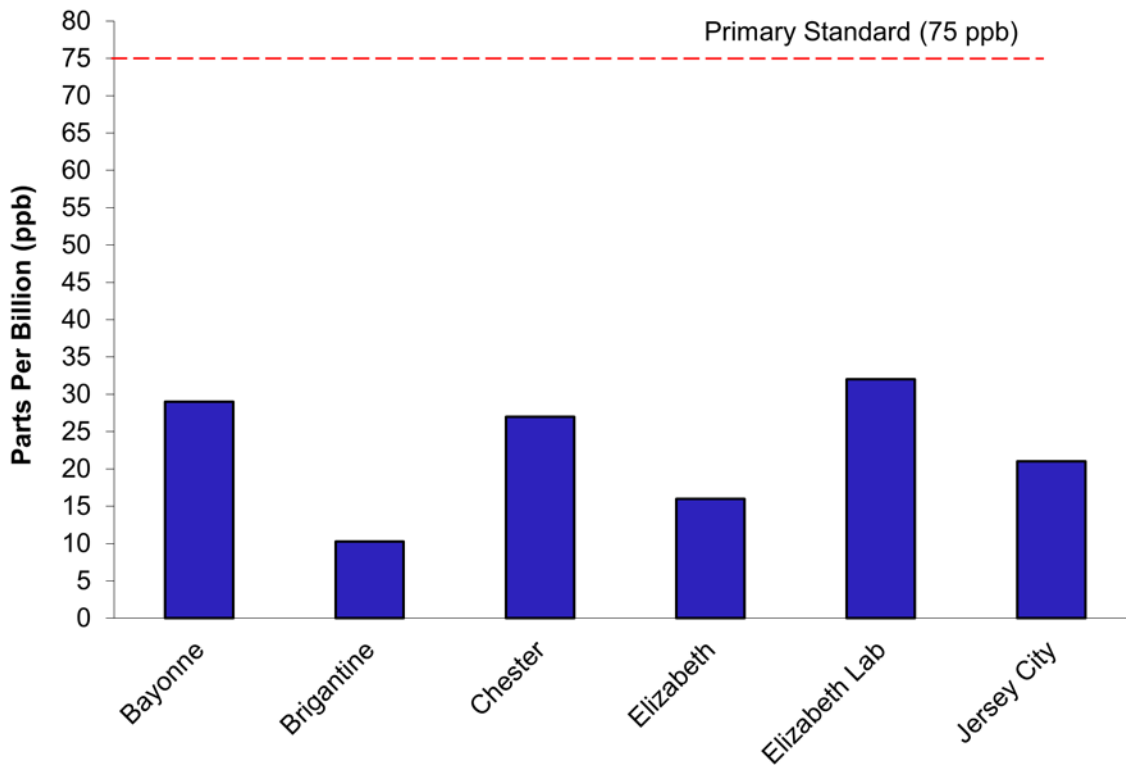


Figure 4
Sulfur Dioxide – New Jersey
2011 Monthly Variation
Parts Per Million (ppm)

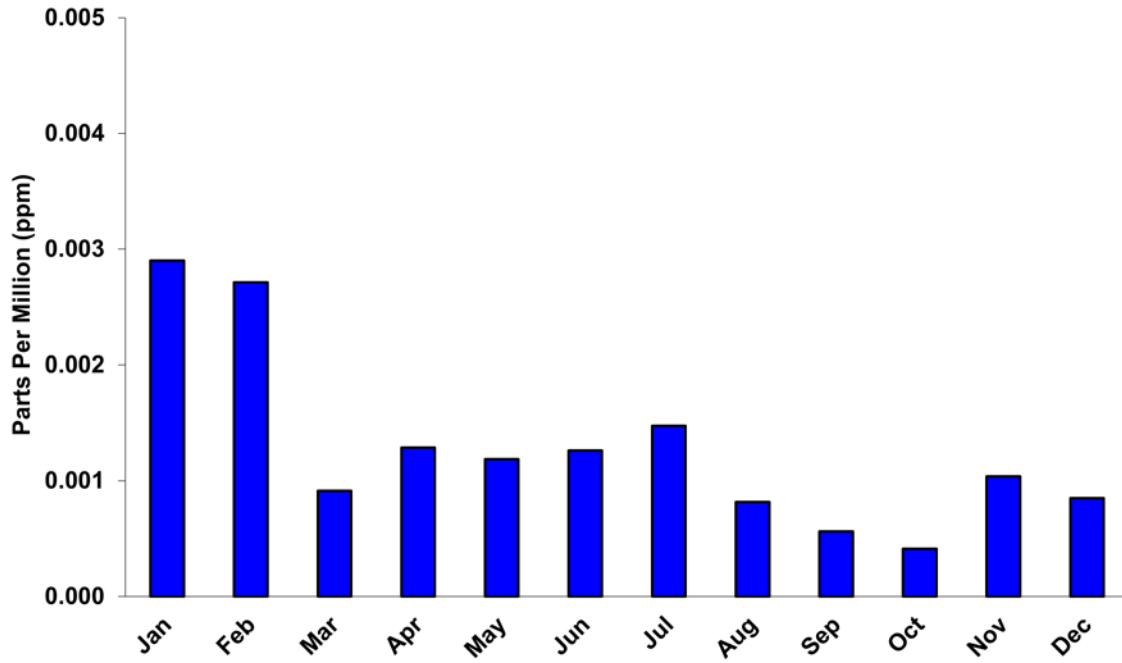


Figure 5
Sulfur Dioxide – New Jersey
2011 Hourly Variation
Parts Per Million (ppm)

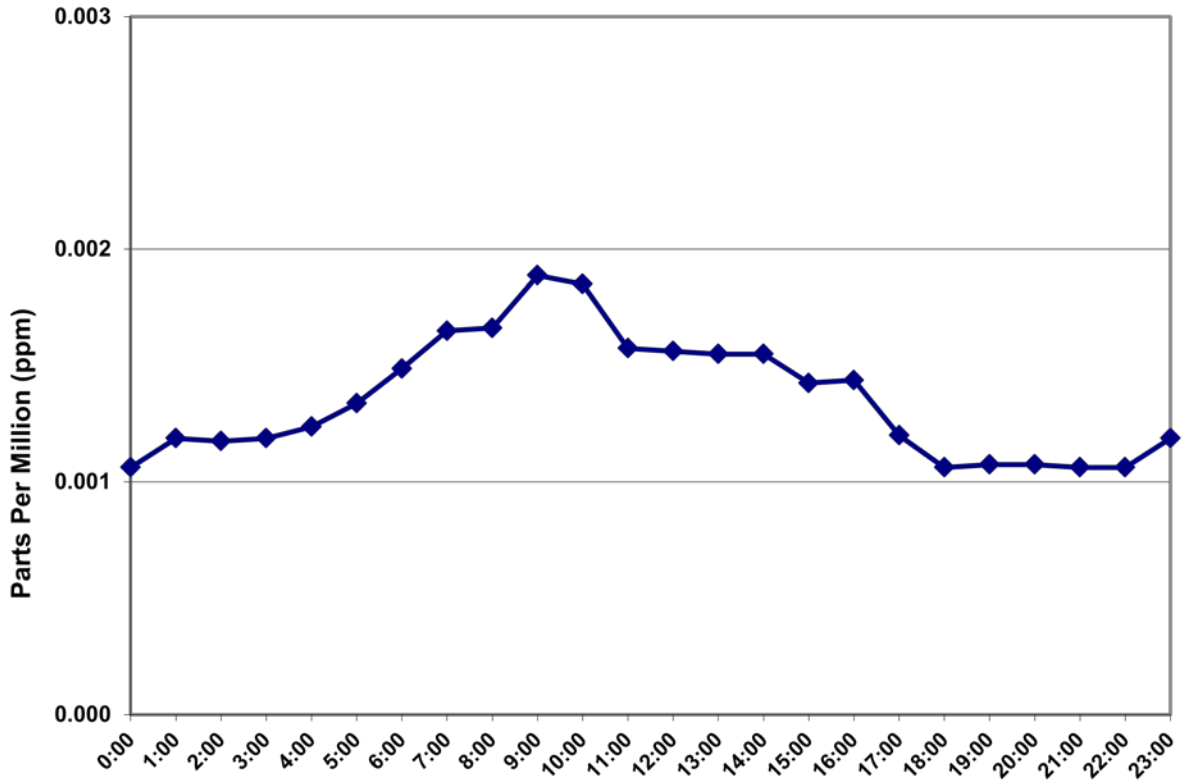


Figure 6
2011 Sulfur Dioxide Concentrations
Highest and 2nd Highest 24-Hour Averages
Parts Per Million (ppm)

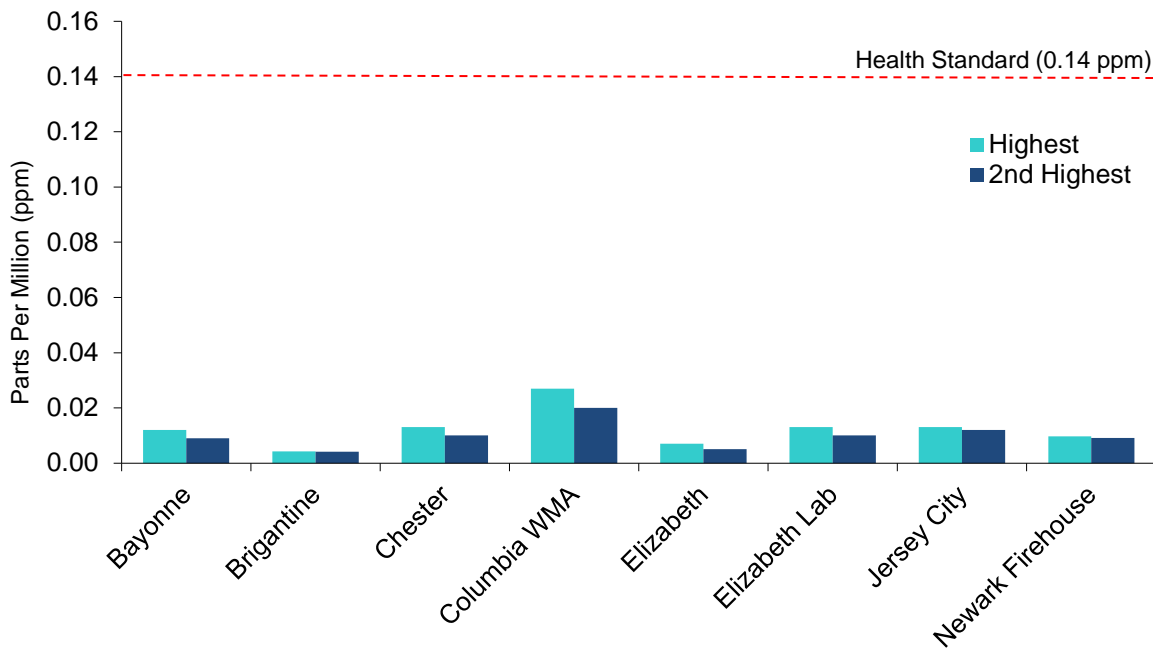
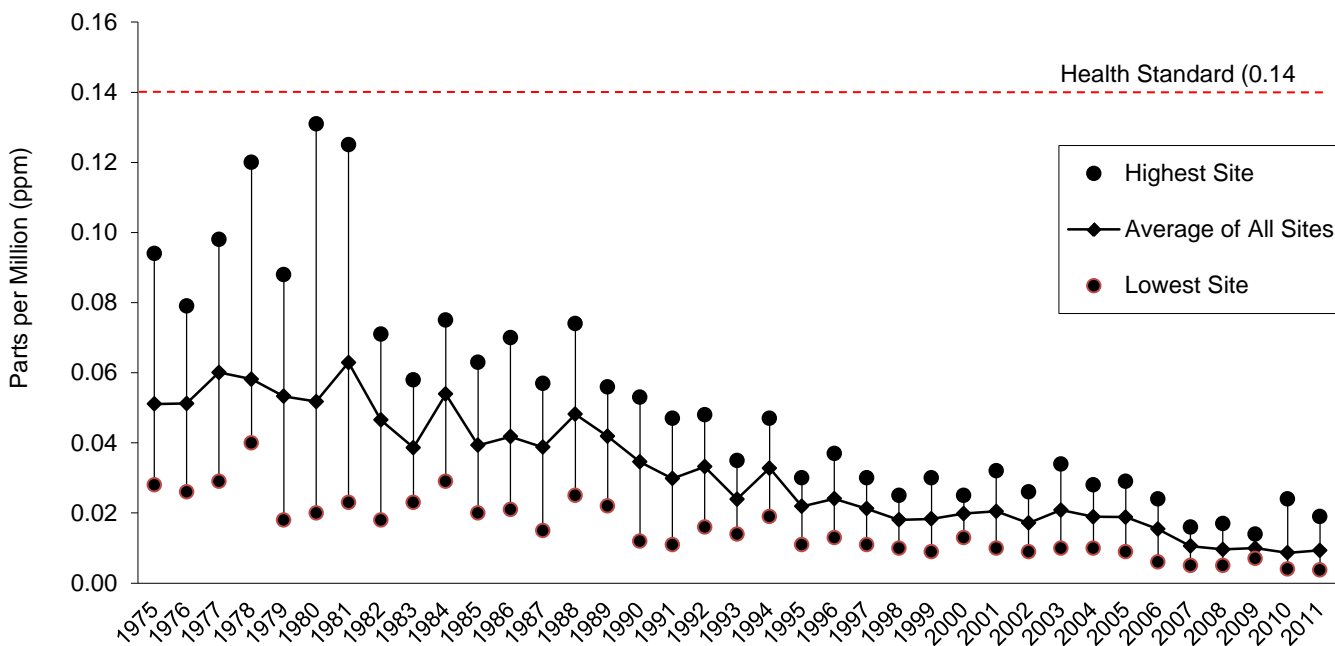


Figure 7
1975 - 2011 Sulfur Dioxide Concentrations
Second Highest Daily Average
Parts Per Million (ppm)

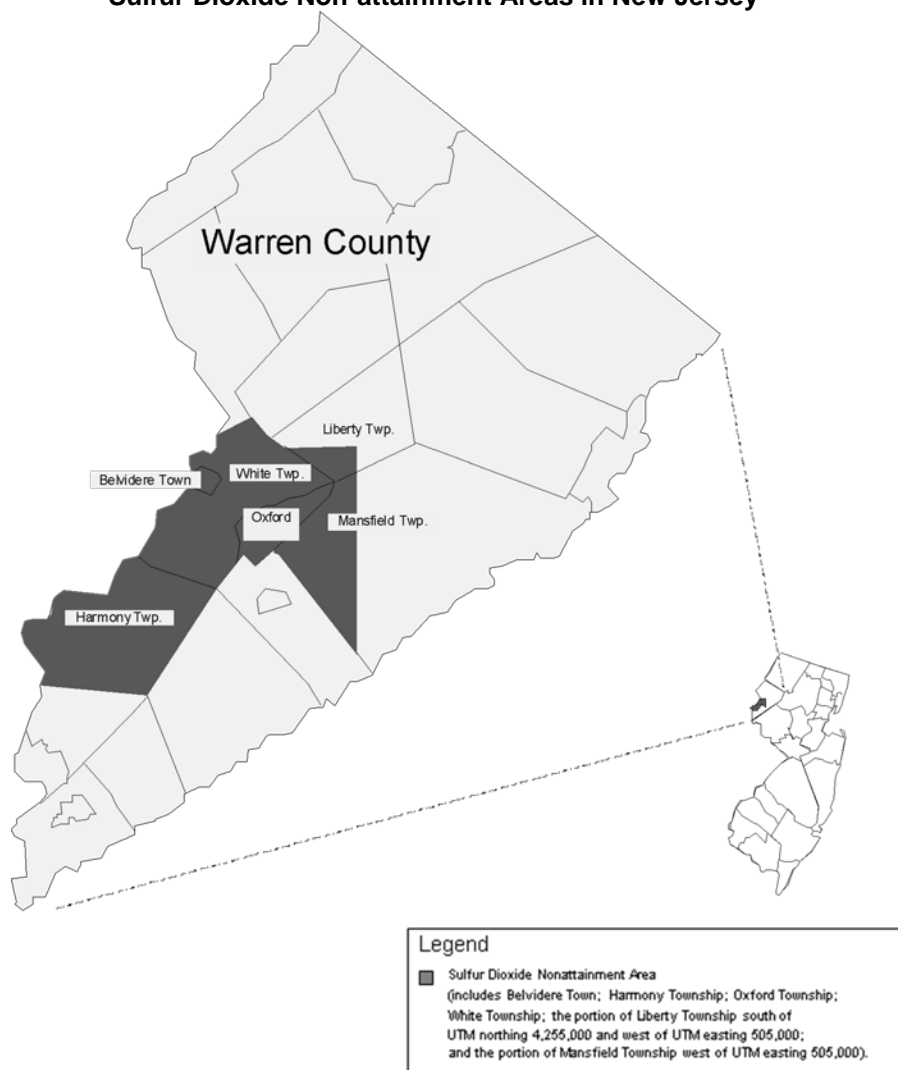


TRENDS

Since the implementation of Federal regulations requiring the use of lower sulfur fuels nationwide, SO₂ concentrations have improved significantly. The last time an exceedence of the 3-hour, 24-hour, or 12-month NAAQS for SO₂ was recorded in the state was in 1980. Although exceedences of the 1-hour standard were measured at Columbia WMA, it does not violate the Federal standard because 3 years of data are necessary to determine violations. A trend graph of SO₂ 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 exceedence per site is allowed each year).

There is still a small area of New Jersey that is classified as a non-attainment area for SO₂. 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 in Figure 8. In June 2011, New Jersey petitioned the USEPA to take action against the Portland Power Plant in Pennsylvania as a larger area of New Jersey is being influenced by SO₂ emissions from the plant. This area includes all of Warren County and portions of Sussex, Somerset, and Hunterdon counties. A detailed map of the affected areas can be found at <http://www.state.nj.us/dep/baqp/docs/SO2%20package.pdf>.

Figure 8
Sulfur Dioxide Non-attainment Areas in New Jersey



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

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2011 Air Toxics Summary

New Jersey Department of Environmental Protection

INTRODUCTION

Air pollutants can be divided into two categories: the 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 of this New Jersey Department of Environmental Protection (NJDEP) 2011 Air Quality Report.

Air toxics are basically 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 almost 200 air toxics by developing control technology standards for specific categories 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.state.nj.us/dep/airtoxics.

HEALTH EFFECTS

People exposed to significant amounts of air toxics may have an increased chance of getting 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. 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 plants and animals which are later consumed by humans.

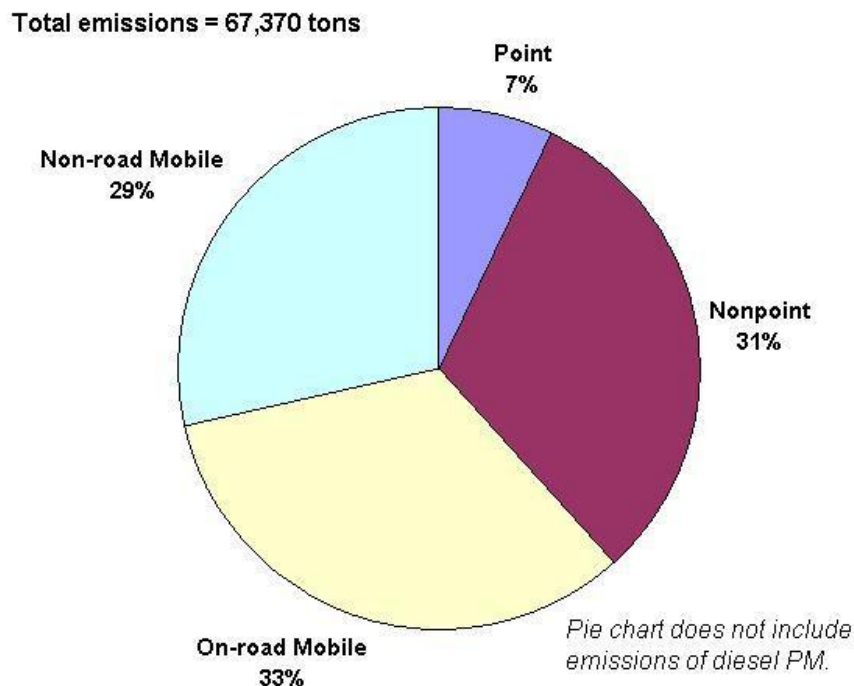
The effects on human health resulting from exposure to specific air toxics can be estimated by using chemical-specific health benchmarks. These are based on toxicity values developed by the USEPA and other agencies, using chemical-specific health studies. For carcinogens (chemicals suspected of causing 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 air toxics monitored in New Jersey are listed in Tables 6 through 8. If ambient air concentrations exceed the health benchmarks then some action, such as a reduction in emissions, should be considered.

SOURCES OF AIR TOXICS

A number of years ago, USEPA began the National-Scale Air Toxics Assessment (NATA). Starting with the year 1996, they set out on a three-year cycle to determine people's exposure to air toxics around the country. To do this, USEPA first prepares a comprehensive inventory of air toxics emissions from all man-made sources. The emissions inventory is reviewed and updated by each state. Although there are likely to be some errors in the details of such a massive undertaking, the emissions inventory still can give us a reasonable indication of the most important sources of air toxic emissions in our state. The pie chart in Figure 1, based on the most recent NATA (for 2005) emissions estimates, shows that mobile sources are the largest contributors of air toxics emissions in New Jersey.

On-road mobile sources (cars and trucks) account for 33% of the air toxics emissions, and non-road mobile sources (airplanes, trains, construction equipment, lawnmowers, boats, dirt bikes, etc.) contribute an additional 20%. Nonpoint sources (residential, commercial, and small industrial sources) represent 31% of the inventory, and point sources (such as factories and power plants) account for the remaining 7%.

Figure 1
2005 Air Toxics Emissions Source
Estimates for New Jersey

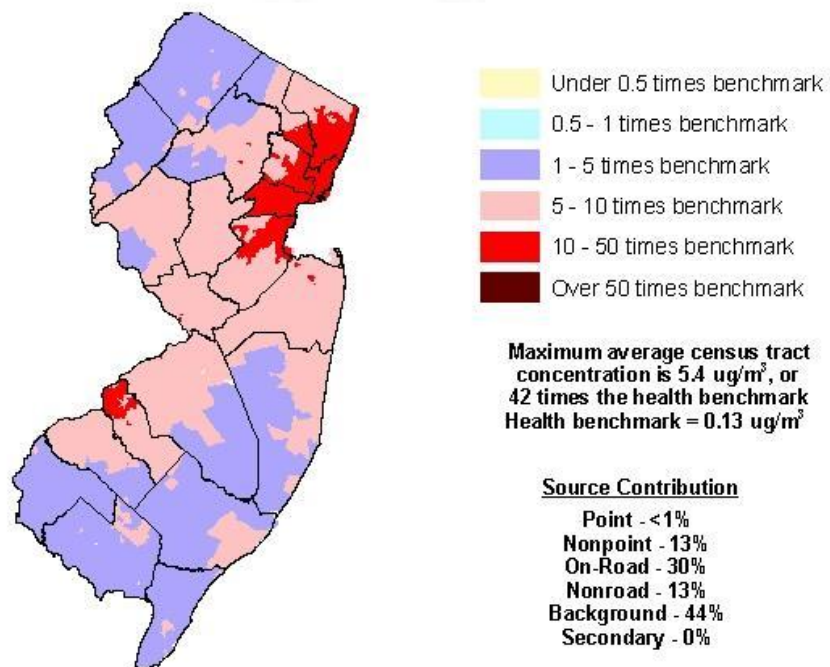


ESTIMATING AIR TOXICS EXPOSURE

There are a limited number of air toxics monitors located throughout the country, because of costs and logistics. In order to estimate air toxics concentrations in areas across the U.S., especially those areas with no monitors, USEPA's NATA project uses its emissions inventory in an air dispersion model that predicts ambient annual average concentrations. (A comparison of some the NATA results with monitoring results is presented in Figure 19).

The map in Figure 2 shows the predicted concentrations of benzene throughout New Jersey. The high concentration areas tend to overlap the more densely populated areas of the state, following the pattern of emissions. Not all air toxics follow this pattern, as some are more closely associated with individual point sources or transport, but in general, higher population densities result in greater emissions of, and exposure to, air toxics. Maps for other air toxics can be found at www.nj.gov/dep/airtoxics/nataest05.htm.

Figure 2
BENZENE - 2005 NATA Predicted
Concentrations for New Jersey



Analysis of the NATA state and county average air toxics concentrations indicates that twenty-three chemicals were predicted to exceed their health benchmarks, or level of concern, in one or more counties in 2005. Twenty-two of these are considered to be cancer-causing (carcinogenic) chemicals, and one (acrolein) is not. Estimated air concentrations of these 23 pollutants vary around the state, depending on the types of sources that emit them. This is summarized in Table 1.

Table 1
Air Toxics of Greatest Concern in New Jersey
Based on 2005 National-Scale Air Toxics Assessment

Pollutant of Concern	Number of Counties Above Health Benchmark	Primary Source of Emissions
Acetaldehyde	Statewide	Background, secondary
Acrolein	Statewide	Background, nonpoint
Acrylonitrile	2 (Bergen & Essex)	Point, nonpoint
Arsenic Compounds	19	Background, secondary
Benzene	Statewide	Background, mobile
1,3-Butadiene	Statewide	Background, mobile
Cadmium Compounds	1 (Warren)	Nonpoint, background
Carbon Tetrachloride	Statewide	Background
Chloroform	Statewide	Nonpoint, background
Chromium (hexavalent)	20	Background, point
Cobalt Compounds	7	Point
1,4-Dichlorobenzene	8	Nonpoint, background
1,3-Dichloropropene	1 (Hudson)	Nonpoint
Diesel Particulate Matter	Statewide	Mobile
Ethylbenzene	6	Mobile, nonpoint
Ethylene Oxide	6	Background, nonpoint
Formaldehyde	Statewide	Background, secondary
Methyl Chloride	Statewide	Background
Naphthalene	20	Nonpoint, mobile
Nickel compounds	1 (Hudson)	Nonpoint, point
PAH/POM	18	Nonpoint
Perchloroethylene	8	Nonpoint, background
1,1,2-Trichloroethane	1 (Salem)	Nonpoint

NEW JERSEY AIR TOXICS MONITORING PROGRAM RESULTS FOR 2011

NJDEP has three established air toxics monitoring sites for **volatile organic compounds (VOCs)** around the state, located in Elizabeth, New Brunswick and Chester (see Figure 3). The Camden Lab site, which had been measuring several toxics since 1989, was shut down on September 29, 2008, because NJDEP lost access to the station. (A new site in Camden is expected to become operational in 2013.) The Elizabeth Lab site began measuring VOCs in 2000, and the New Brunswick and Chester sites started in July 2001. Analysis of toxic metals at these sites also began in 2001, with Newark added in 2010. Data for some of the toxic metals will be discussed below. All samples are analyzed by a laboratory contracted through USEPA.

VOCs and carbonyls (a subset of VOCs that includes formaldehyde and acetaldehyde) are sampled every six days. 2011 air toxic monitoring results for VOCs are shown in Table 2. This table contains the annual average concentration for each air toxic measured at the three New Jersey monitoring sites. All values are in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$). More detail can be found in Tables 6 through 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 for monitoring results, while $\mu\text{g}/\text{m}^3$ units are generally used in modeling and health studies. Many of the compounds that were analyzed were below the detection limit of the method used. These are listed separately in Table 9.

Chemicals with reported averages based on data with less than 50% of the samples above the detection limit should be viewed with extreme caution. Median values (the value of the middle sample value when the results are ranked) are reported in Tables 6 through 8 along with the mean (average) concentrations because for some compounds only a single or very few high values were recorded. These high values will tend to increase the average concentration significantly, but would have less effect on the median value. In such cases, the median value may be a better indicator of long-term exposures (the basis for the air toxics health benchmarks).

The Chester site had the lowest concentrations for the bulk of the prevalent air toxics. The highest concentrations for most compounds were split between Elizabeth and New Brunswick, with the majority occurring at Elizabeth.

USEPA has recently determined that the methods used to collect and analyze acrolein in ambient air are not producing reliable results. More information is available at www.epa.gov/schoolair/acrolein.html. Although we are including the 2011 New Jersey acrolein data in this report, the concentrations are highly uncertain and should be viewed with caution.

Included in this report for the first time are results for toxic metals from the particulate speciation monitors in Chester, Elizabeth, New Brunswick, and Newark. The data is collected every three days. Monitoring data for other speciated particulate can be found in Appendix B (Fine Particulate Speciation Summary) of this report. Table 3 presents the annual average concentrations for pollutants which have a health benchmark, along with estimated risk ratios. (For more information see the section on "Estimating Health Risk" below.) Chromium and nickel have cancer-based health benchmarks that are based on carcinogenicity of specific compounds. Since the monitoring data cannot distinguish between the types of chromium or nickel compounds, cancer risk ratios are not calculated with those benchmarks. However, risk ratios are calculated for nickel based on noncancer effects.

Table 2
2011 Summary of Toxic Volatile Organic Compounds Monitored in New Jersey

Annual Average Concentration
micrograms per cubic meter ($\mu\text{g}/\text{m}^3$)

Pollutant	Synonym	HAP	CAS No.	Chester	Elizabeth	New Brunswick
Acetaldehyde		*	75-07-0	1.61	3.24	2.49
Acetone			67-64-1	1.85	2.41	2.16
Acetonitrile		*	75-05-8	3.11	0.63	0.78
Acetylene			74-86-2	0.54	1.20	0.79
Acrolein ^a		*	107-02-8	1.19	0.96	0.76
Acrylonitrile		*	107-13-1	0.10	0.03	0.09
tert-Amyl methyl ether			994-05-8	ND	0.0003	0.001
Benzaldehyde			100-52-7	0.10	0.13	0.07
Benzene		*	71-43-2	0.52	1.02	0.71
Benzyl chloride	Chloromethylbenzene	*	100-44-7	ND	ND	ND
Bromochloromethane			74-97-5	0.001	ND	ND
Bromodichloromethane			75-27-4	0.003	0.002	ND
Bromoform		*	75-25-2	0.002	0.01	0.005
Bromomethane	Methyl bromide	*	74-83-9	0.04	0.05	0.07
1,3-Butadiene		*	106-99-0	0.02	0.13	0.05
tert-Butyl ethyl ether	Ethyl tert-Butyl Ether		637-92-3	0.001	ND	ND
Butyraldehyde & isobutyraldehyde	Butyraldehyde			0.27	0.39	0.26
Carbon disulfide		*	75-15-0	5.90	1.56	0.77
Carbon tetrachloride		*	56-23-5	0.62	0.61	0.59
Chlorobenzene		*	108-90-7	0.01	0.003	ND
Chloroethane	Ethyl chloride	*	75-00-3	0.37	0.01	0.04
Chloroform		*	67-66-3	0.10	0.14	0.12
Chloromethane	Methyl chloride	*	74-87-3	1.23	1.25	1.29
Chloroprene	2-Chloro-1,3-butadiene	*	126-99-8	ND	ND	ND
Crotonaldehyde			123-73-9	0.31	0.31	0.28
Dibromochloromethane			594-18-3	0.01	0.01	0.01
1,2-Dichlorobenzene	o-Dichlorobenzene		95-50-1	0.003	0.001	0.01
1,3-Dichlorobenzene	m-Dichlorobenzene		541-73-1	0.004	0.002	0.004
1,4-Dichlorobenzene	p-Dichlorobenzene	*	106-46-7	0.03	0.10	0.06
Dichlorodifluoromethane			75-71-8	2.73	2.72	2.73
1,1-Dichloroethane	Ethylidene dichloride	*	75-34-3	ND	ND	ND
1,1-Dichloroethylene	Vinylidene chloride	*	75-35-4	0.001	0.0004	0.0004
cis-1,2-Dichloroethylene	cis-1,2-Dichloroethene		156-59-2	ND	ND	ND
trans-1,2-Dichloroethylene	trans-1,2-Dichloroethene		156-60-5	0.001	0.0005	0.001
Dichloromethane	Methylene chloride	*	75-09-2	0.54	0.71	1.37
1,2-Dichloropropane	Propylene dichloride	*	78-87-5	ND	ND	ND

- 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.

^a Acrolein concentrations are highly uncertain because of problems with collection and analysis methods.

Table 2 (continued)
2011 Summary of Toxic Volatile Organic Compounds Monitored in New Jersey

**Annual Average Concentration
micrograms per cubic meter ($\mu\text{g}/\text{m}^3$)**

Pollutant	Synonym	HAP	CAS No.	Chester	Elizabeth	New Brunswick
cis-1,3-Dichloropropylene		*	542-75-6	<i>0.001</i>	ND	<i>0.002</i>
trans-1,3-Dichloropropylene		*	542-75-6	0.001	ND	ND
2,5-Dimethylbenzaldehyde			5799-94-2	ND	ND	ND
Ethyl acrylate		*	140-88-5	ND	<i>0.003</i>	ND
Ethylbenzene		*	100-41-4	0.25	0.51	0.49
Ethylene dibromide	1,2-Dibromoethane	*	106-93-4	<i>0.002</i>	<i>0.003</i>	<i>0.001</i>
Ethylene dichloride	1,2,-Dichloroethane	*	107-06-2	<i>0.03</i>	<i>0.03</i>	<i>0.03</i>
Formaldehyde		*	50-00-0	2.37	3.44	2.70
Freon 114	Dichlorotetrafluoroethane		76-14-2	0.13	0.12	0.13
Hexachlorobutadiene	Hexachloro-1,3-butadiene	*	87-68-3	<i>0.01</i>	<i>0.01</i>	<i>0.01</i>
Hexanaldehyde	Hexaldehyde		66-25-1	0.11	0.10	0.09
Isovaleraldehyde			590-86-3	ND	ND	ND
Methyl chloroform	1,1,1-Trichloroethane	*	71-55-6	0.06	0.06	0.07
Methyl ethyl ketone	MEK		78-93-3	1.32	1.38	1.32
Methyl isobutyl ketone	MIBK	*	108-10-1	0.12	0.17	0.15
Methyl methacrylate		*	80-62-6	<i>0.02</i>	<i>0.04</i>	<i>0.01</i>
Methyl tert-butyl ether	MTBE	*	1634-04-4	<i>0.02</i>	<i>0.01</i>	<i>0.02</i>
n-Octane			111-65-9	0.16	0.37	0.18
Propionaldehyde		*	123-38-6	0.26	0.45	0.29
Propylene			115-07-1	0.48	2.24	0.86
Styrene		*	100-42-5	0.34	0.27	0.21
1,1,2,2-Tetrachloroethane		*	79-34-5	<i>0.004</i>	<i>0.001</i>	<i>0.003</i>
Tetrachloroethylene	Perchloroethylene	*	127-18-4	0.09	0.20	0.12
Tolualdehydes				0.16	0.17	0.14
Toluene		*	108-88-3	1.42	2.85	2.06
1,2,4-Trichlorobenzene		*	102-82-1	<i>0.001</i>	<i>0.001</i>	<i>0.004</i>
1,1,2-Trichloroethane		*	79-00-5	<i>0.002</i>	ND	ND
Trichloroethylene		*	79-01-6	<i>0.05</i>	<i>0.09</i>	<i>0.02</i>
1,1,2-Trichloro-1,2,2-trifluoroethane	Trichlorotrifluoroethane		76-13-1	0.77	0.75	0.77
Trichlorofluoromethane			75-69-4	1.54	1.61	1.56
1,2,4-Trimethylbenzene			95-63-6	0.26	0.56	0.28
1,3,5-Trimethylbenzene			108-67-8	0.11	0.20	0.11
Valeraldehyde			110-62-3	0.09	0.11	0.07
Vinyl chloride		*	75-01-4	<i>0.001</i>	<i>0.001</i>	<i>0.003</i>
m,p-Xylene		*	1330-20-7	0.64	1.54	1.11
o-Xylene		*	95-47-6	0.26	0.60	0.37

- 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 3
2011 New Jersey Toxic Metals Summary & Risk Ratios

Pollutant	HAP ^a	Annual average concentration (µg/m ³)				Health Benchmark (µg/m ³) ^b	Risk Ratio ^c			
		Chester	Elizabeth	New Brunswick	Newark		Chester	Elizabeth	New Brunswick	Newark
Antimony	*	0.007	0.008	0.007	0.007	0.2	0.04	0.04	0.03	0.04
Arsenic	*	0.0003	0.0004	0.0004	0.0004	<i>2.3E-04</i>	1.3	1.7	1.5	1.7
Cadmium	*	0.002	0.003	0.003	0.003	<i>2.4E-04</i>	10	13	13	10
Chlorine	*	0.004	0.04	0.04	0.03	0.2	0.02	0.20	0.20	0.14
Chromium^d	*	0.004	0.002	0.005	0.006	<i>8.3E-05</i>	48	28	64	70
Cobalt	*	0.0004	0.0007	0.0007	0.0006	<i>1.1E-04</i>	4	6	6	5
Lead	*	0.001	0.002	0.002	0.002	0.15	0.01	0.01	0.01	0.01
Manganese	*	0.0007	0.002	0.003	0.001	0.05	0.01	0.04	0.05	0.02
Nickel	*	0.001	0.003	0.002	0.003	0.05	0.03	0.06	0.04	0.06
Nickel^e	*	0.001	0.003	0.002	0.003	<i>2.1E-03</i>	0.7	1.3	1.0	1.5
Phosphorus	*	0	0.0001	0.00003	0.0002	0.07	0	0.001	0.0005	0.003
Selenium	*	0.0004	0.0004	0.0003	0.0003	20	0.00002	0.00002	0.00001	0.00002
Silicon		0.03	0.06	0.09	0.04	3	0.01	0.02	0.03	0.01
Vanadium		0.0006	0.006	0.0015	0.0031	0.1	0.01	0.06	0.02	0.03

^a HAP = Hazardous air pollutant as listed in the Clean Air Act.

^b The health benchmark is defined as the chemical-specific air concentration above which there may be human health concerns. Toxicity values are not available for all chemicals. For more information, go to www.nj.gov/dep/aqpp/risk.html.

Health benchmarks in italics have a cancer endpoint.

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.

^c The risk ratio for a chemical is a comparison of the annual mean air concentration to the health benchmark. A risk ratio greater than one may be of concern. If the annual mean is 0, then the risk ratio cannot be calculated.

^d Chromium - The 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 - The cancer-based health benchmark for nickel is based on specific nickel compounds. It is not known how much of the nickel measured by the monitor is in that form.

- More information on speciated fine particulate measured in New Jersey can be found in NJ's 2011 Air Quality Report, Appendix B - Fine Particulate Speciation Summary at www.njaqinow.net/Default.ltr.aspx.

ESTIMATING HEALTH RISK

A simplified way to determine whether the ambient concentration of an air toxic could pose a potential human health risk is to compare the air concentration to a health benchmark. The number that we get when we divide the concentration by the benchmark is called 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 4. In addition to the toxic VOCs and carbonyls, speciated metals were also evaluated for risk. Elizabeth had sixteen pollutants with annual average concentrations that exceeded their health benchmarks, New Brunswick had twelve and Chester had ten. The toxic VOCs with risk ratios greater than one at all sites are acetaldehyde, acrylonitrile, benzene, carbon tetrachloride, chloroform, chloromethane (methyl chloride), and formaldehyde. Toxic metals that had risk ratios greater than one at the four monitoring sites (including Newark) were arsenic, cadmium, and cobalt. The noncancer risk ratio for nickel was slightly over one at Elizabeth and Newark.

Formaldehyde contributed the highest risks, but note that the risks varied substantially from site to site. The carbon tetrachloride risk ratio is lower in 2011 than in previous years because of a change in its cancer toxicity value. Some pollutants were over the level of concern at some sites but not others. Although acrolein risk ratios at all sites were greater than one, they are not included here because of problems with the sampling method. More detail for each site, including health benchmarks used to calculate risk ratios, can be found in Tables 6-8.

Table 4 can be compared with the risk results predicted by NATA in Table 5. Chromium and nickel cancer risk cannot be estimated from monitoring data because the sampling method measures total chromium and total nickel concentrations; the amounts that are in the carcinogenic form cannot be determined. 1,3-Dichloropropene and 1,1,2-trichloroethane samples were mostly below the detection limits, so no annual average concentration could be calculated. Ethylene oxide and naphthalene are not sampled at the New Jersey sites. PAH/POM are polycyclic aromatic hydrocarbons/polycyclic organic matter, a broad class of compounds that are not measured in New Jersey because of a lack of a reliable sampling method. On the other hand, acrylonitrile is measured in New Jersey at levels higher than estimated by NATA.

NATA estimates that concentrations of diesel particulate matter (DPM) in New Jersey are at levels that potentially pose a higher cancer risk than the other air toxics combined. However, actually measuring diesel in the ambient air is problematic. It is difficult to distinguish particulate matter from diesel engines from other types of particulate matter. Diesel emissions consist of agglomerated and condensed fine particles and gases, onto which are adsorbed potentially hundreds of compounds formed by incomplete combustion, such as polycyclic aromatic hydrocarbons (PAHs) and nitrated PAHs. Some of these very specific compounds have been suggested as indicators for DPM, but sampling technologies and costs continue to be obstacles. Elemental carbon is sometimes assumed to be an indicator for diesel emissions. See Figure 3 for a comparison of DPM concentrations from NATA with monitored concentrations of elemental carbon. For more information about diesel, see www.nj.gov/dep/airtoxics/diesemis.htm.

Table 4
 Monitored Toxic Air Pollutants with Risk Ratios Greater Than One in NJ

POLLUTANT	RISK RATIO			
	Chester	Elizabeth	New Brunswick	Newark
Acetaldehyde	4	7	6	
Acrylonitrile	7	1.7 ^a	6 ^a	
Arsenic	1.3	1.7	1.5	1.7
Benzene	4	8	5	
1,3-Butadiene	0.7	4	1.6	
Cadmium	10	13	13	10
Carbon tetrachloride	4	4	3	
Chloroform	2.4	3	2.8	
Chloromethane	2.2	2.2	2.3	
Cobalt	4	6	6	5
1,4-Dichlorobenzene	0.3 ^a	1.1	0.7	
Ethylbenzene	0.6	1.3	1.2	
Ethylene dibromide	0.96 ^a	1.6 ^a	0.5 ^a	
Formaldehyde	31	45	35	
Nickel ^b	0.7	1.3	1.0	1.5
Tetrachloroethylene	0.5	1.2	0.7	

^a Based on less than 50% of samples above the detection limit.

^b The cancer-based health benchmark for nickel is based on specific nickel compounds.

Figure 3. Comparison of Elemental Carbon Monitoring Data with NATA 2005 Predicted Concentrations for Diesel PM

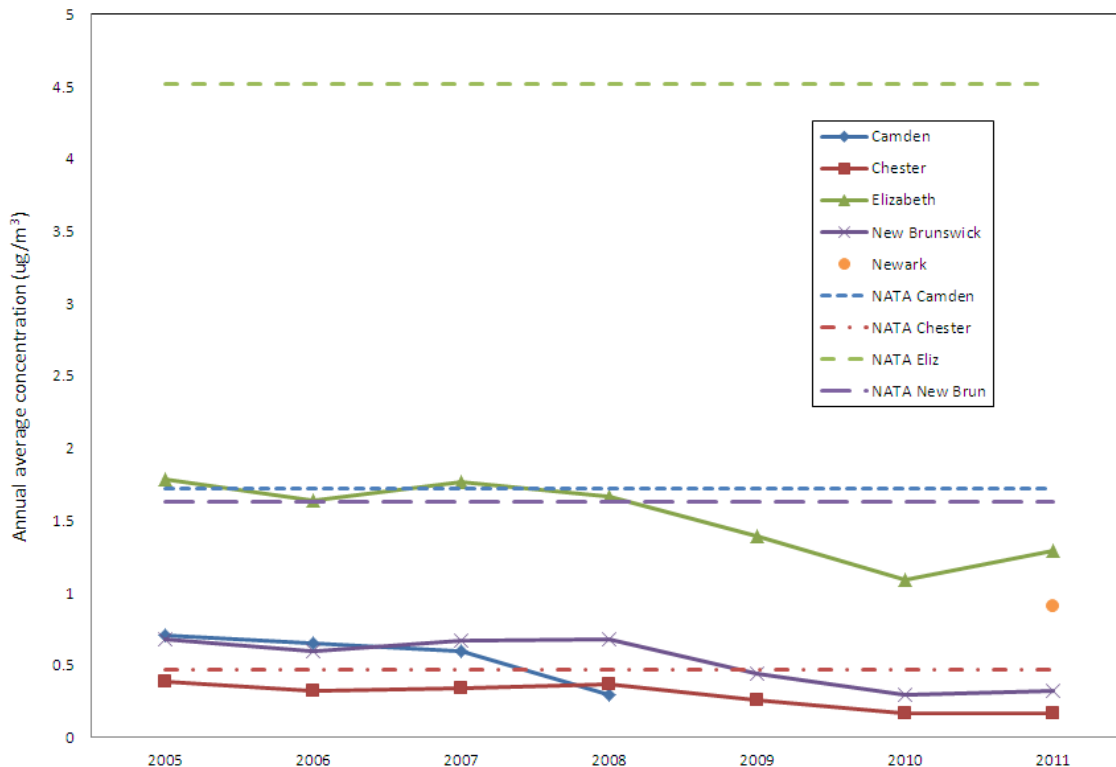


Table 5
2005 NATA Modeled Air Concentrations Compared to Health Benchmarks
New Jersey Statewide Averages

Pollutant	Modeled Air Concentration ($\mu\text{g}/\text{m}^3$)	Health Benchmark ($\mu\text{g}/\text{m}^3$)	Risk Ratio	% Contribution from				
				Major Sources	Area Sources	On-Road Mobile Sources	Nonroad Mobile Sources	Background & Secondary Formation
Acetaldehyde	1.9	0.45	4.3	<1%	4%	6%	3%	87%*
Acrolein	0.062	0.020	3.1	<1%	22%	14%	9%	55%*
Arsenic compounds	0.00053	0.00023	2.3	3%	13%	5%	5%	74%
Benzene	1.3	0.13	10	<1%	13%	30%	13%	44%
1,3-Butadiene	0.095	0.033	2.9	<1%	<1%	40%	17%	43%
Cadmium compounds	0.00011	0.00024	0.5	12%	44%	0%	1%	43%
Carbon tetrachloride	0.61	0.17	3.6	0%	<1%	0%	0%	100%
Chloroform	0.13	0.043	3.1	<1%	54%	0%	0%	46%
Chromium (hexavalent form)	0.00024	0.000083	2.9	29%	10%	4%	1%	56%
Cobalt Compounds	0.000093	0.00011	0.8	93%	7%	0%	0%	0%
1,4-Dichlorobenzene	0.12	0.091	1.3	<1%	58%	0%	0%	42%
1,3-Dichloropropene	0.14	0.25	0.5	0%	100%	0%	0%	0%
Diesel particulate matter	1.1	0.0033	327	0%	0%	47%	53%	0%
Ethylbenzene	0.34	0.40	0.9	1%	30%	45%	24%	0%
Ethylene oxide	0.011	0.011	1.0	12%	18%	0%	0%	70%
Formaldehyde	2.2	0.077	28	<1%	3%	9%	6%	82%*
Methyl chloride	1.2	0.56	2.2	<1%	1%	0%	0%	99%
Naphthalene	0.13	0.029	4.6	1%	48%	26%	4%	21%
Nickel Compounds	0.0012	0.0021	0.6	36%	37%	2%	10%	15%
PAH/POM**	0.012	0.0072*	1.6	1%	79%	8%	12%	0%
Perchloroethylene	0.25	0.17	1.4	<1%	61%	0%	0%	39%
1,1,2-Trichloroethane	0.0066	0.063	0.1	<1%	100%	0%	0%	0%

- For information on risk ratios see section on “Estimating Health Risk” above.
- Chemicals with risk ratios greater than or equal to 1 are in bold.
- Risk ratios based on noncarcinogenic effects are in *italics*.
- For diesel particulate matter, onroad and nonroad concentrations include a model-estimated background concentration.
- *Acetaldehyde, acrolein and formaldehyde concentration estimates include secondary formation, which is the process by which chemicals in the air are transformed into other chemicals.
- **PAH/POM is "polycyclic aromatic hydrocarbons/polycyclic organic matter." These define a broad class of compounds. The chemicals making up this class were broken up into 8 groups based on toxicity, and each group was assigned a cancer-weighted toxicity estimate. 0.0072 $\mu\text{g}/\text{m}^3$ is the health benchmark average across the 8 groups.

TRENDS AND COMPARISONS

Monitoring of air toxics in New Jersey has been going on for over a decade, although it continues to evolve, with improvements in the ability to detect chemicals and lowering the concentrations that can be measured for a given pollutant. Figures 4 through 13 show data for some of the VOCs that have been sampled over the past decade. For many of the chemicals of concern in New Jersey, we have been able to see a downward trend, although not in all cases.

According to USEPA's National Air Toxics Assessment (NATA), acetaldehyde concentrations in New Jersey (Figure 4) are primarily influenced by secondary formation, a process in which chemicals in the air are transformed by chemical reactions 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 in both Camden and New Brunswick, high levels of acetaldehyde were measured over a number of weeks. Note the similarity with the formaldehyde graph (Figure 12).

Acrylonitrile concentrations (Figure 5) are impacted by nonpoint sources and background. The high concentration in 2008 in Elizabeth is the result of a number of high sample values that year. Although there has been improvement in analysis, most of the samples are still below the minimum detection limit (MDL).

Benzene concentrations have been decreasing over the past two decades, as can be seen with the Camden site data in Figure 6. Most benzene now comes from mobile and area sources, and is also transported from other regions (background). Sources of 1,3-butadiene (Figure 7) are similar to those of benzene.

Some of the increase in chloroform concentrations shown in Figure 8 is because of improvements in the detection limit. Nonpoint sources and background are the major contributors to ambient chloroform levels.

Chloromethane (also known as methyl chloride) levels are influenced primarily by background. Figure 9 shows that concentrations have remained relatively stable from year to year, and that all sites show similar levels.

1,4-Dichlorobenzene (Figure 10) is emitted primarily from nonpoint sources. It is used in products such as pesticides, disinfectant, mothballs and toilet deodorizer blocks. There is also a significant background level. The high annual average for New Brunswick in 2005 is attributable to an exceptionally high reading on July 27th that may be an error.

Ethylbenzene is associated with mobile sources, which is probably why it is higher at the Elizabeth monitoring site and lower at Chester (Figure 11). 2001 data for Chester and New Brunswick have been omitted from the graph because of problems encountered when sampling was begun that May.

Formaldehyde (Figure 12) 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 on-road mobile sources, although secondary formation and transport contribute

significantly to high outdoor concentrations. As with acetaldehyde, a number of very high samples were measured at Camden, and New Brunswick, in 2004.

Tetrachloroethylene (also known as perchloroethylene) (Figure 13) is used as an industrial solvent and in dry cleaning. It is a common contaminant of hazardous waste sites because of a tendency in the 20th century to dispose of it improperly. Production and demand for it by industry has been declining.

Figure 4
ACETALDEHYDE – New Jersey Monitored Concentrations

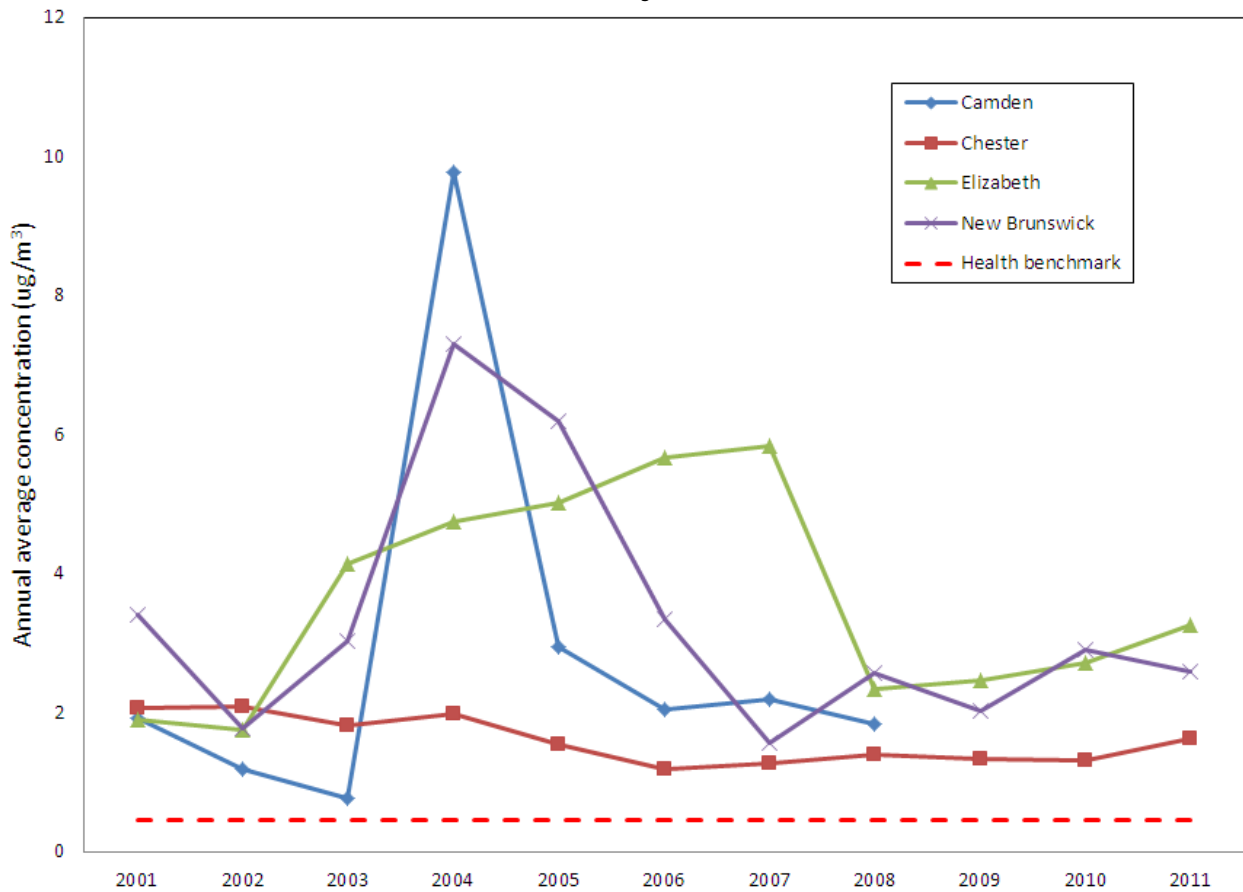


Figure 5
 ACRYLONITRILE - New Jersey Monitored Concentrations

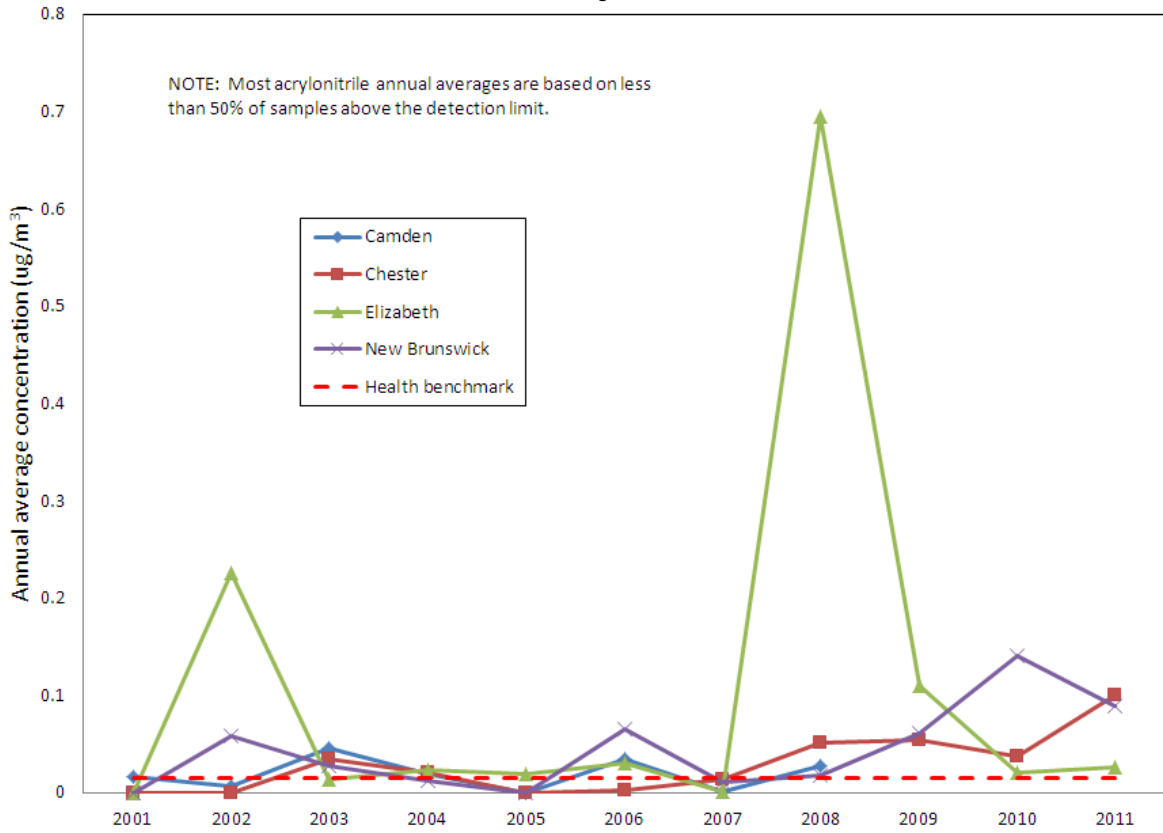


Figure 6
 BENZENE - New Jersey Monitored Concentrations

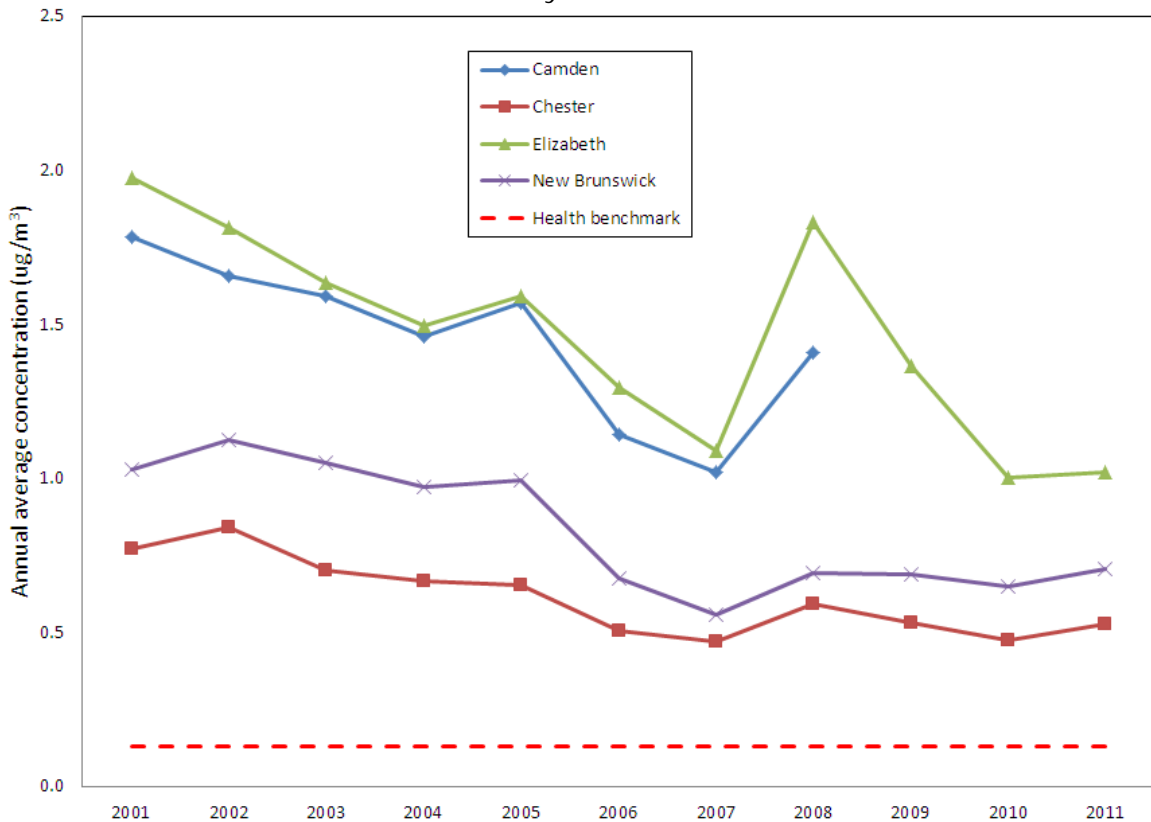


Figure 7
1,3-BUTADIENE – New Jersey Monitored Concentrations

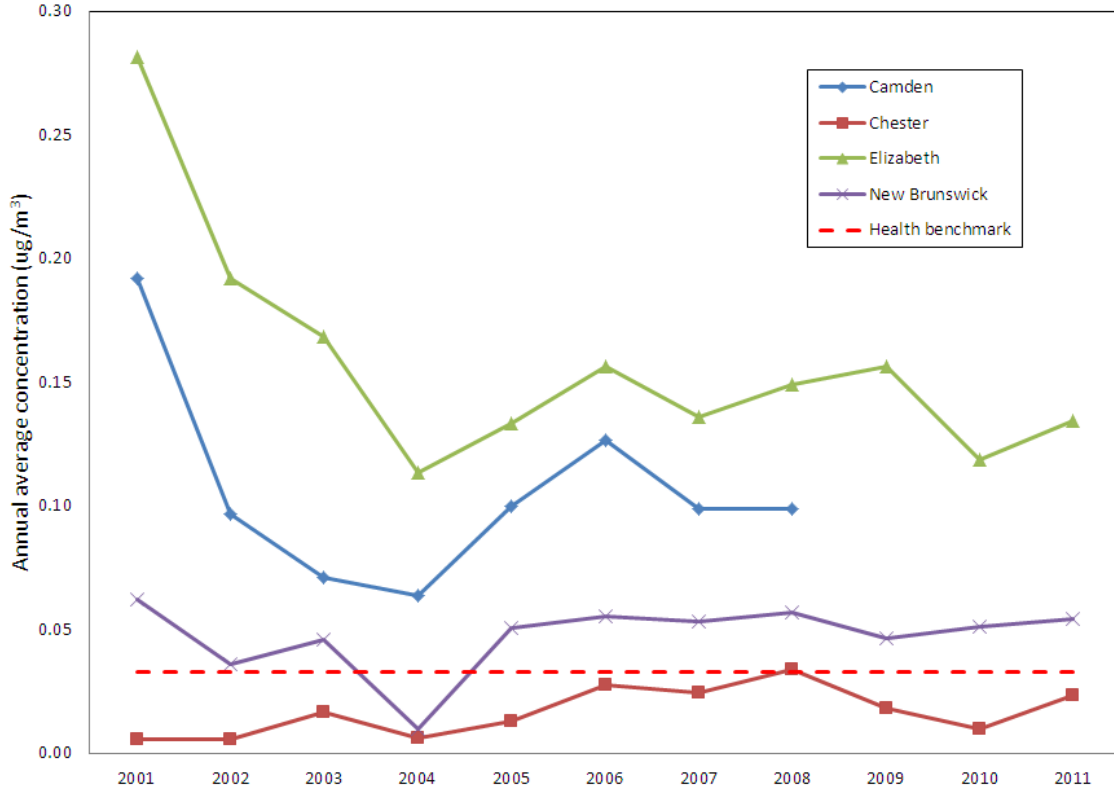


Figure 8
CHLOROFORM – New Jersey Monitored Concentrations

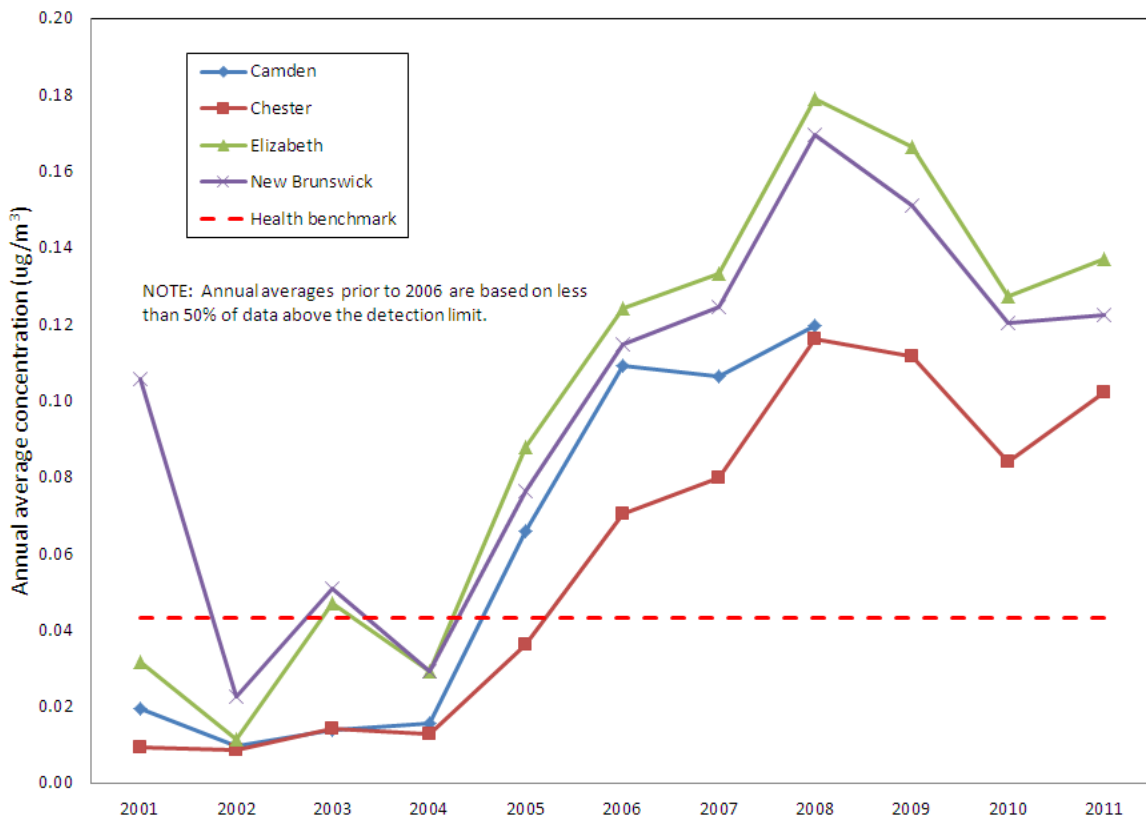


Figure 9
 CHLOROMETHANE (Methyl chloride) - New Jersey Monitored Concentrations

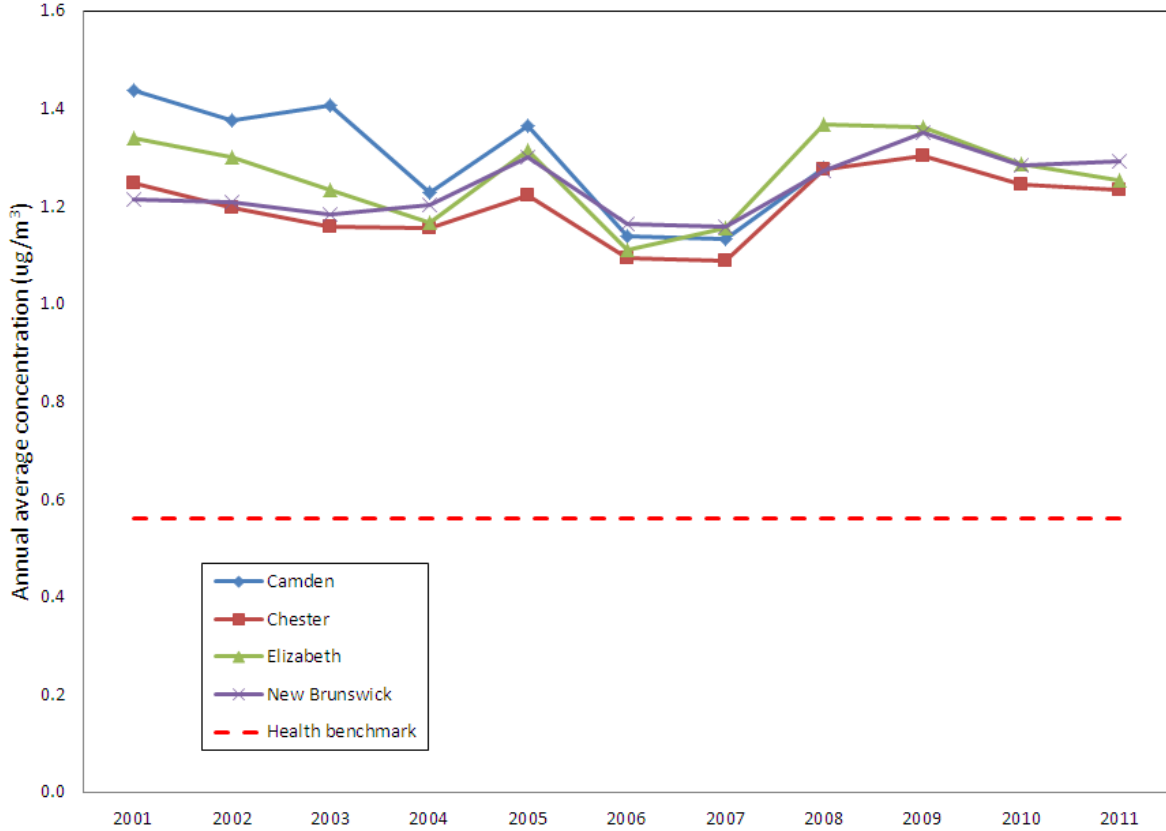


Figure 10
 1,4-DICHLOROBENZENE - New Jersey Monitored Concentrations

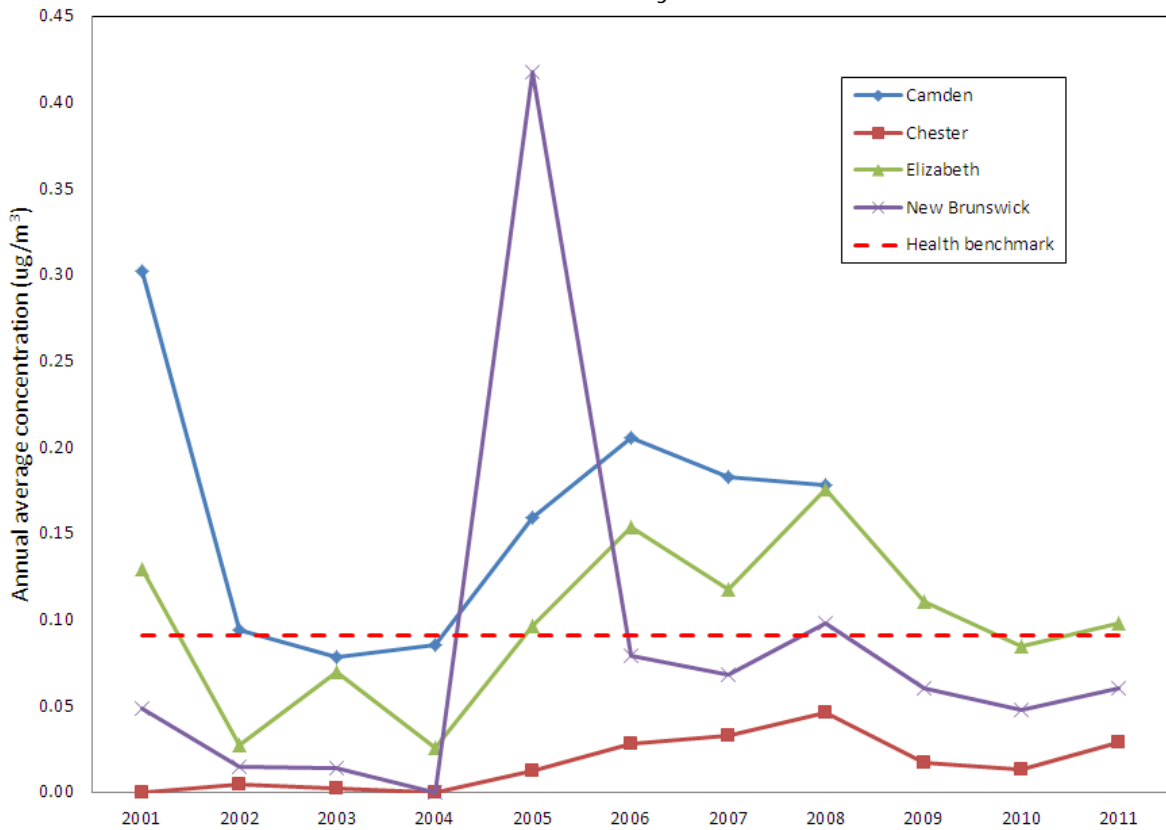


Figure 11
ETHYLBENZENE - New Jersey Monitored Concentrations

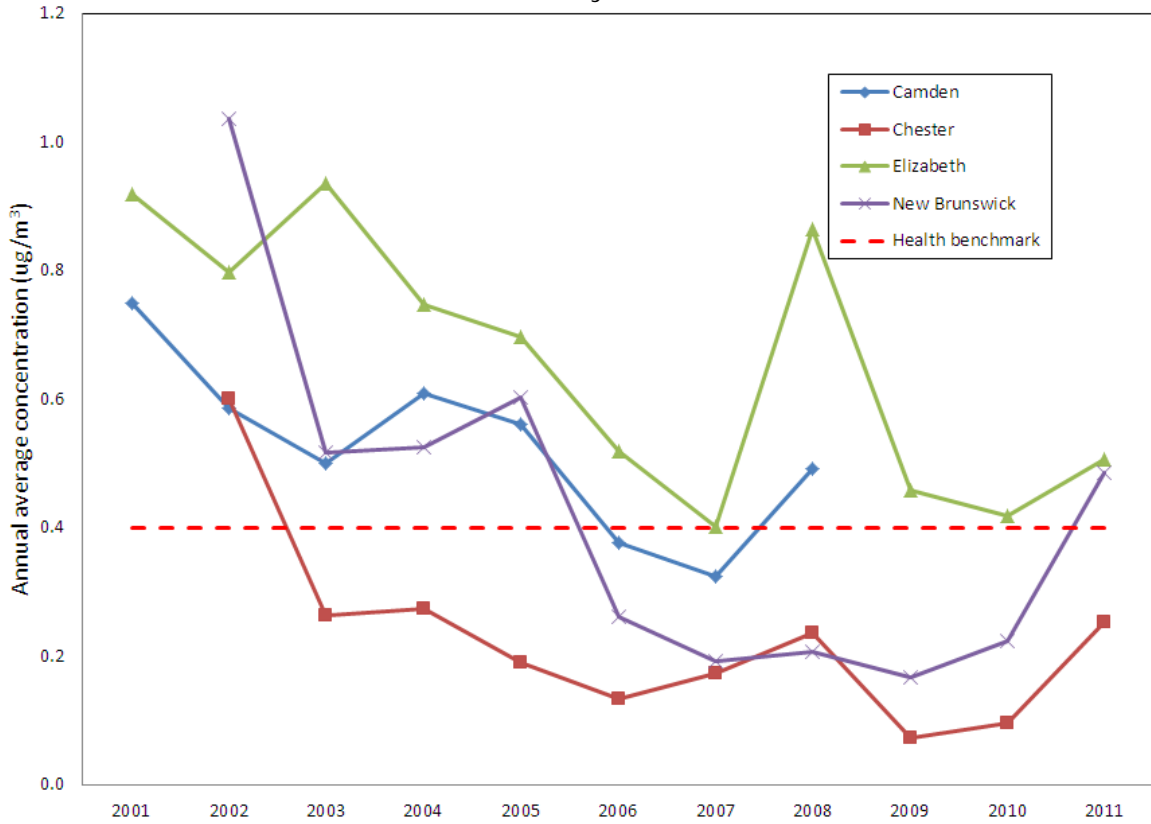


Figure 12
FORMALDEHYDE - New Jersey Monitored Concentrations

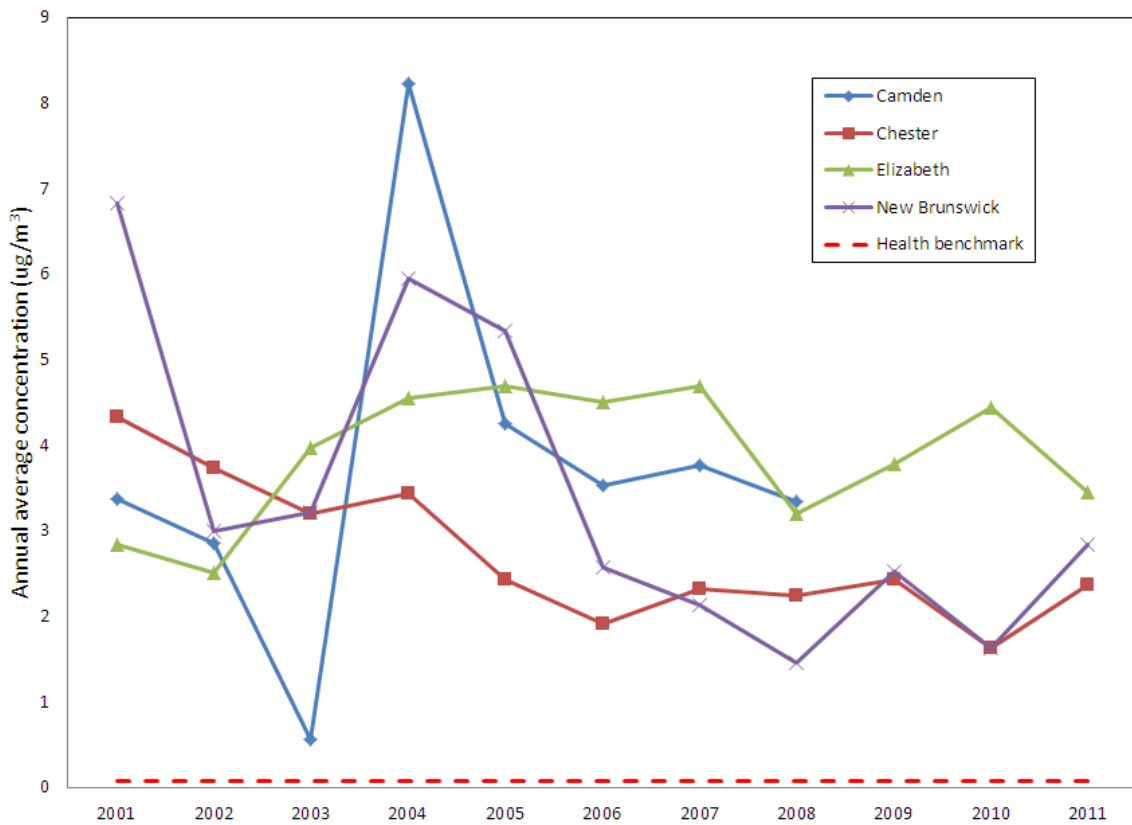
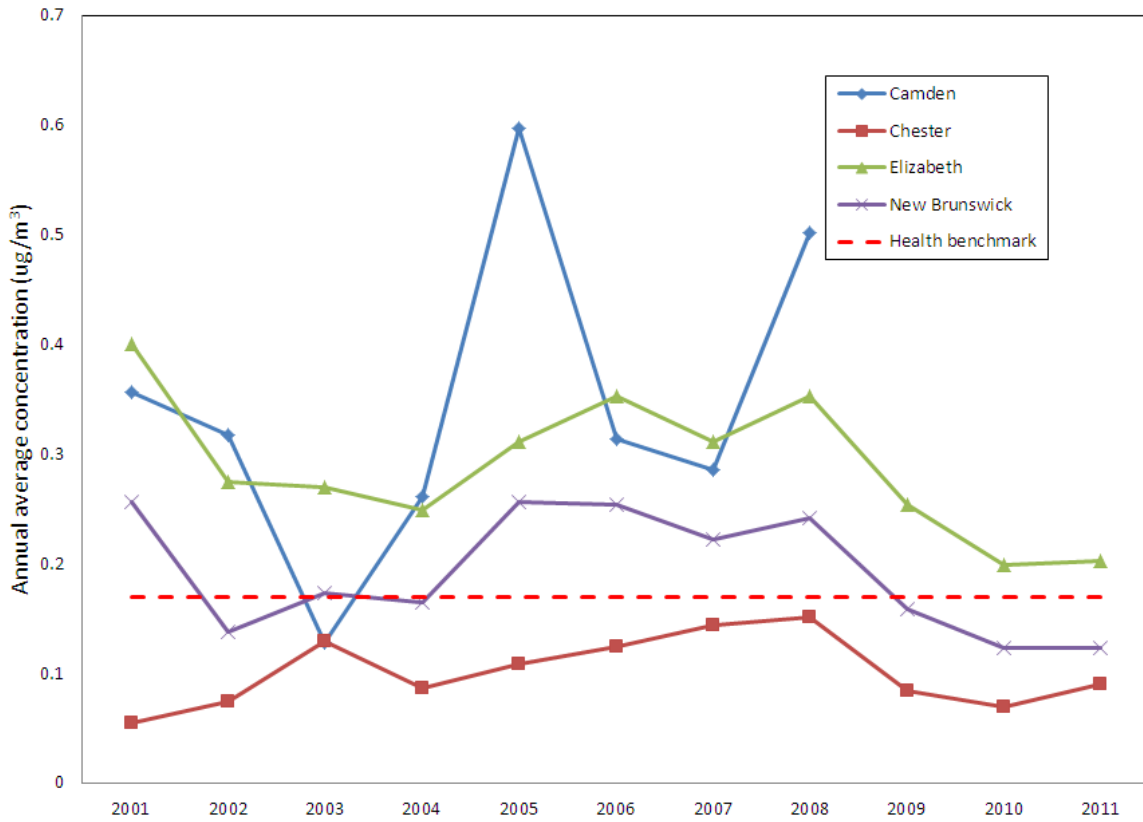


Figure 13

TETRACHLOROETHYLENE - New Jersey Monitored Concentrations



TOXIC METALS data are presented in Figures 14 through 18, taken from the PM_{2.5} speciation monitors around the state. The Newark site became operational in 2010.

Chromium and nickel are shown here because NATA 2005 indicated that there are levels of their carcinogenic forms in the air above the one-in-a-million cancer risk level. The data in Figures 16 and 18 are for total chromium and nickel. The specific carcinogenic compounds cannot be measured with available monitoring methods.

Arsenic, cadmium, and cobalt concentrations are all influenced by combustion, industrial processes, and transport. Arsenic levels in New Jersey are decreasing.

Note that in a few of the graphs some of the years are marked with an asterisk, indicating that less than 50% of the samples used to calculate the annual average were above the detection limit.

Figure 14
ARSENIC - New Jersey Monitored Concentrations

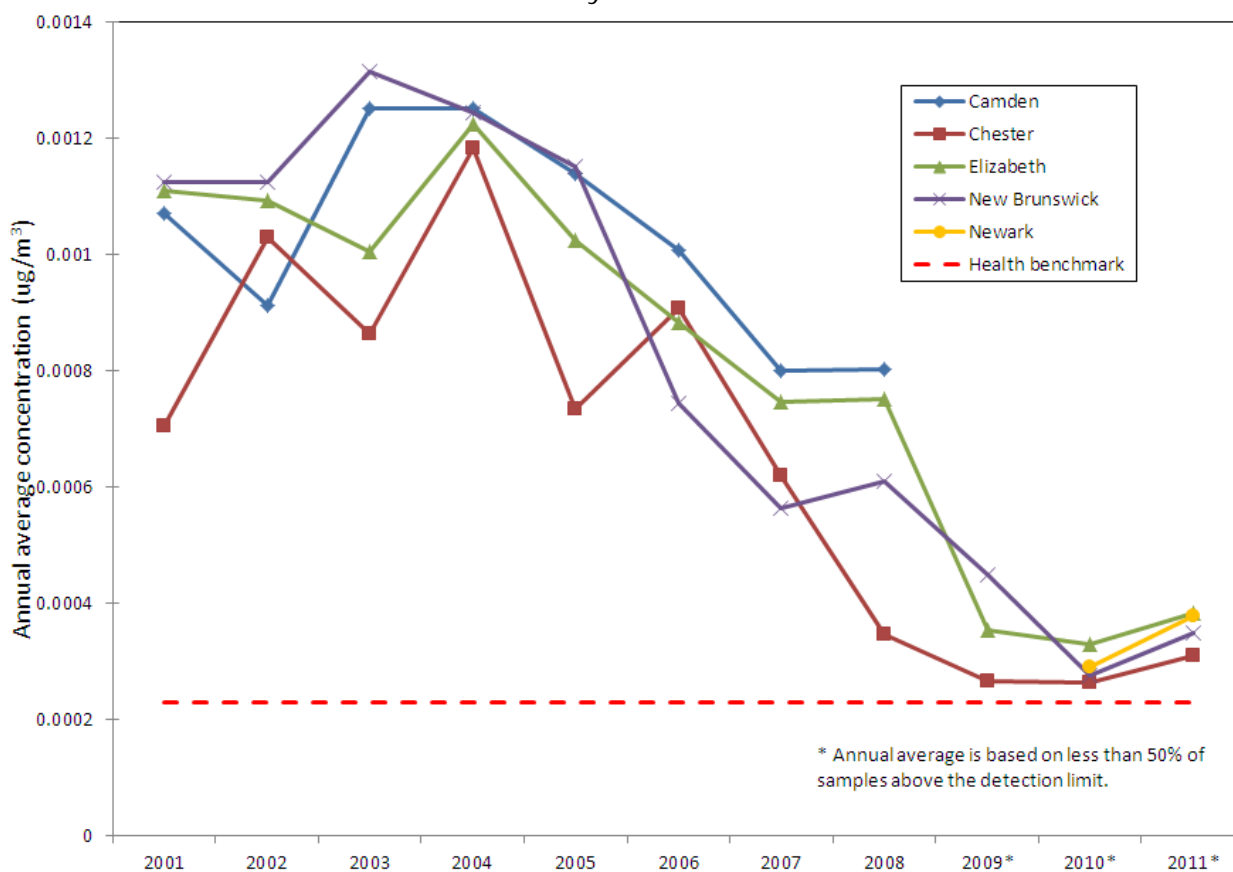


Figure 15
 CADMIUM – New Jersey Monitored Concentrations

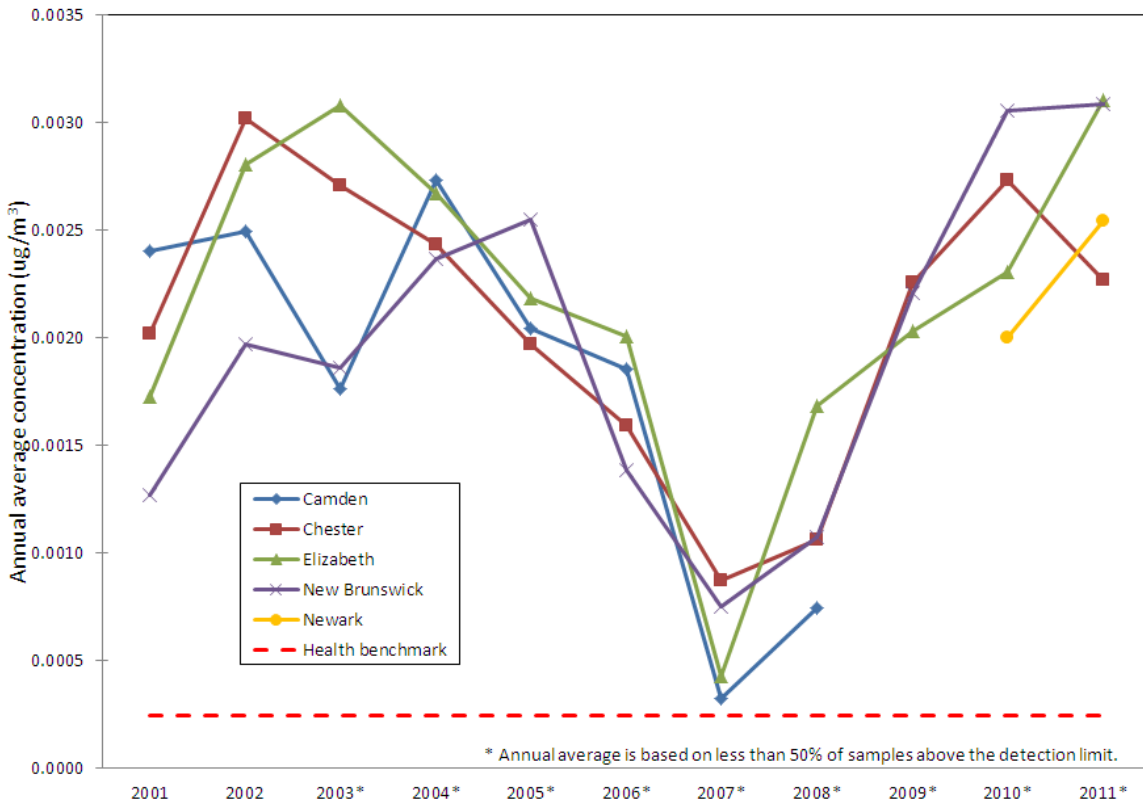


Figure 16
 CHROMIUM – New Jersey Monitored Concentrations

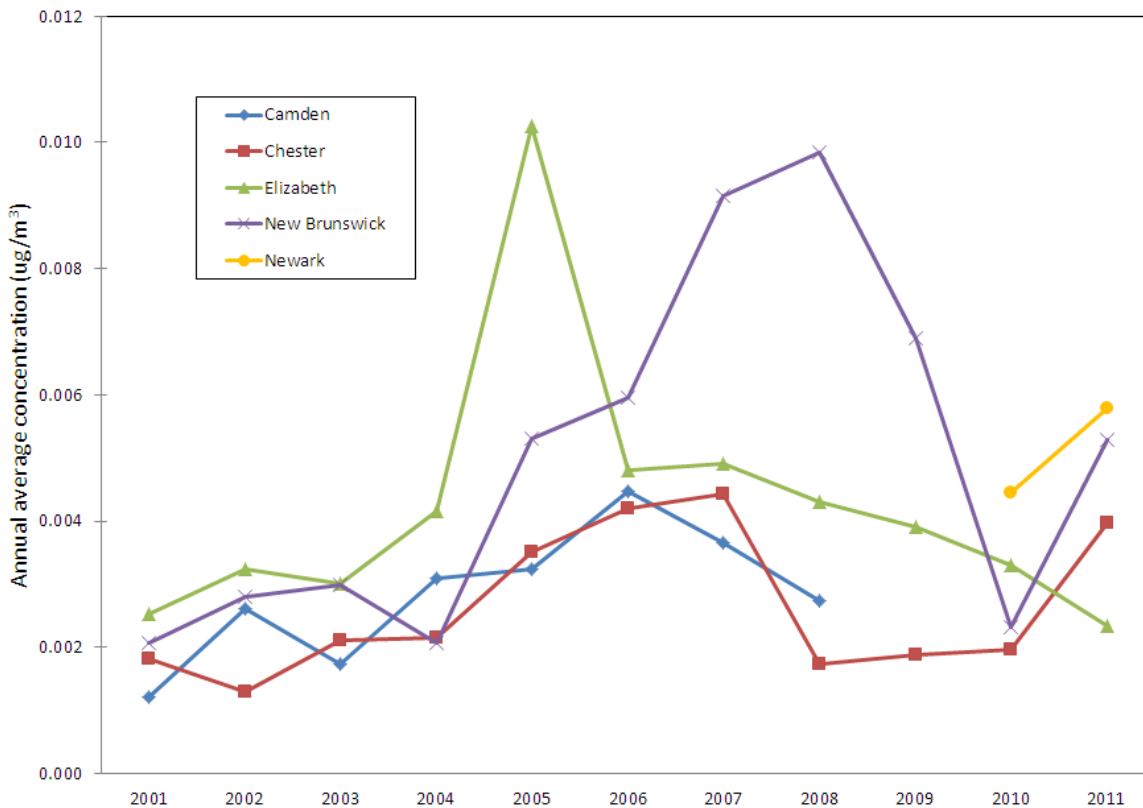


Figure 17
COBALT - New Jersey Monitored Concentrations

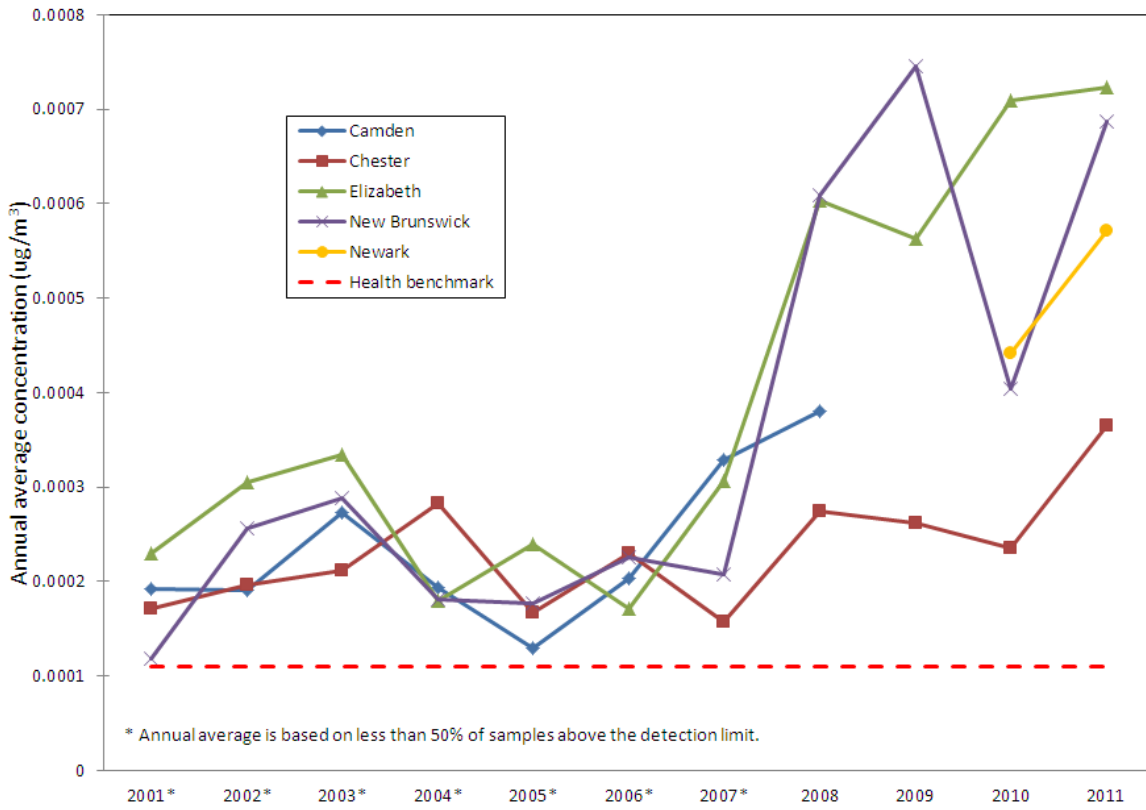


Figure 18
NICKEL - New Jersey Monitored Concentrations

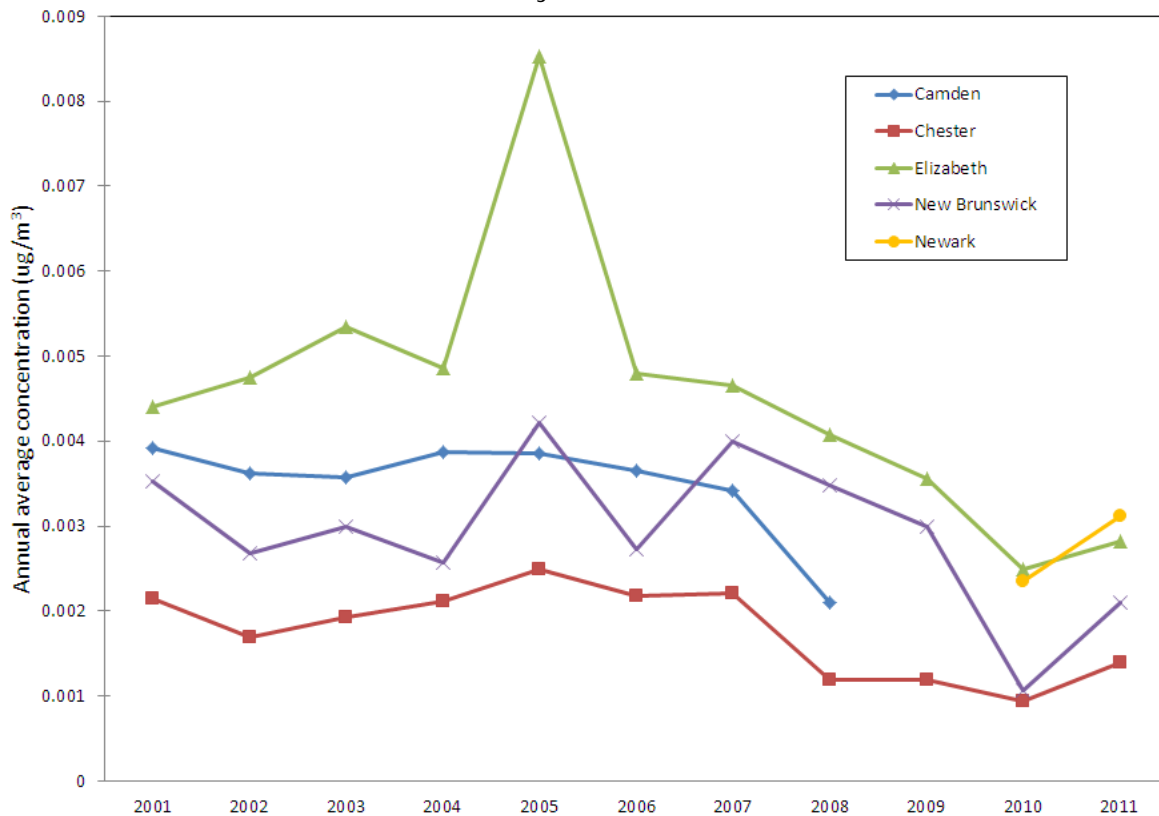
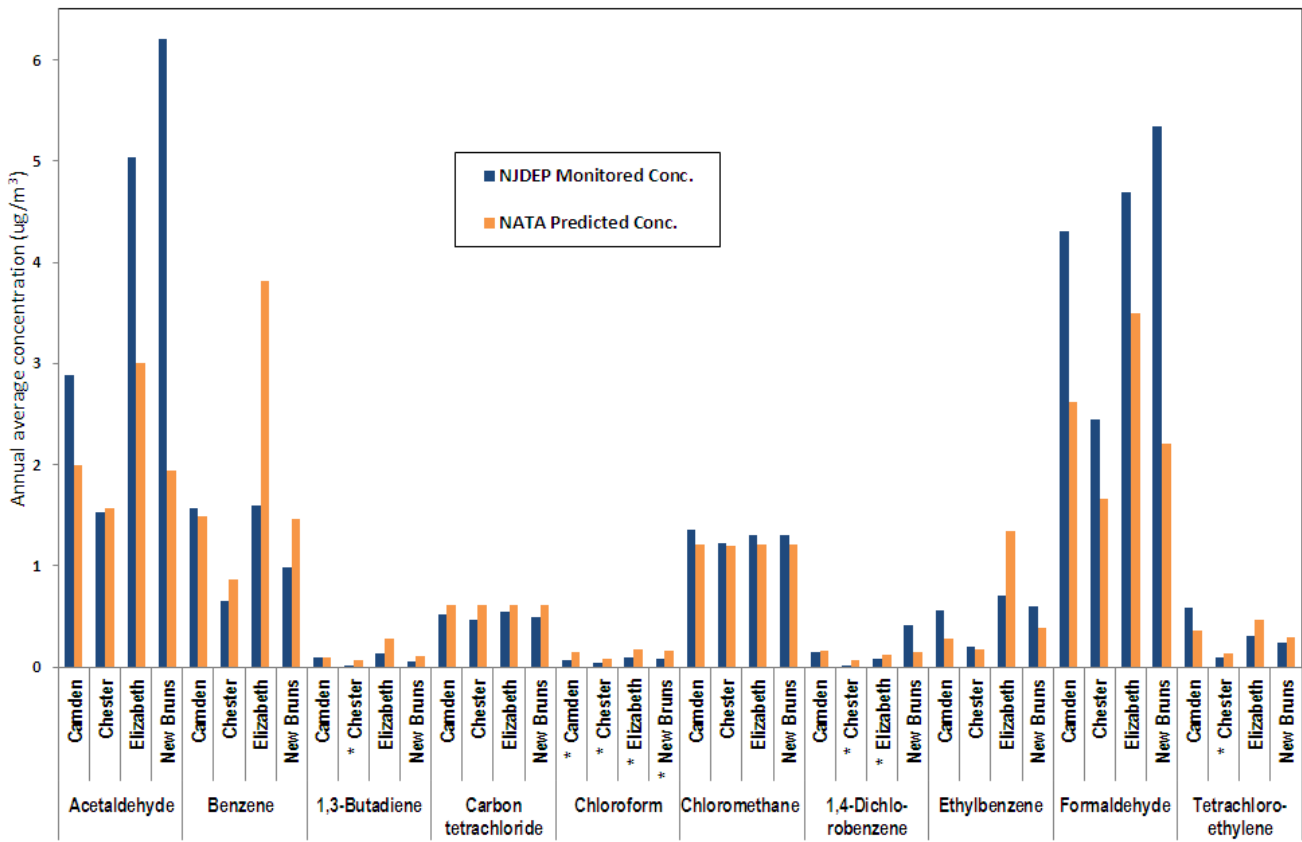


Figure 19 below shows a comparison of annual average concentrations measured at New Jersey's four air toxics monitoring sites in 2005 with annual average concentrations predicted by USEPA's 2005 NATA (at the monitoring site census tract). Most of the pollutants show agreement within a factor of 2 or less, although acetaldehyde and formaldehyde appear to be underestimated by NATA.

Figure 19
2005 New Jersey Monitored Concentrations Compared to 2005 NATA Predicted Concentrations



* Monitoring data average is based on less than 50% of samples above the detection limit.

Table 6
CHESTER NJ 2011 Toxic VOCs Monitoring Data^a

Analyte ^b	CAS No.	Annual Mean (ppbv) ^{c,d}	Annual Median (ppbv) ^{c,d}	24-Hour Min. (ppbv)	24-Hour Max. (ppbv)	Annual Mean (ug/m ³) ^{c,d}	Annual Median (ug/m ³) ^{c,d}	24-Hour Min. (ug/m ³)	24-Hour Max. (ug/m ³)	Health Benchmark (ug/m ³) ^e	Annual Mean Risk Ratio ^f	Detection Limit (ug/m ³)	% Above Minimum Detection Limit
Acetaldehyde	75-07-0	0.89	0.78	0.322	2.44	1.61	1.41	0.58	4.40	0.45	4	0.011	100
Acetone	67-64-1	0.78	0.74	0.308	1.63	1.85	1.75	0.73	3.87	31000	0.0001	0.014	100
Acetonitrile	75-05-8	1.85	0.40	0.132	42.2	3.11	0.67	0.22	70.85	60	0.05	0.040	100
Acetylene	74-86-2	0.51	0.45	0.15	1.12	0.54	0.48	0.16	1.19			0.017	100
Acrolein^g	107-02-8	0.52	0.27	0.078	2.36	1.19	0.63	0.18	5.41	0.02	59	0.115	100
Acrylonitrile	107-13-1	0.046	0.04	0	0.63	0.10	0.087	0	1.37	0.015	7	0.026	54
tert-Amyl methyl ether	994-05-8	0	0	0	0	0	0	0	0			0.067	0
Benzaldehyde	100-52-7	0.023	0.016	0	0.18	0.098	0.069	0	0.77			0.009	92
Benzene	71-43-2	0.16	0.15	0.064	0.65	0.52	0.49	0.20	2.07	0.13	4	0.093	100
Benzyl chloride	100-44-7	0	0	0	0	0	0	0	0	0.02		0.202	0
Bromochloromethane	74-97-5	0.0002	0	0	0.011	0.001	0	0	0.058			0.042	2
Bromodichloromethane	75-27-4	0.0005	0	0	0.017	0.003	0	0	0.11			0.168	3
Bromoform	75-25-2	0.0002	0	0	0.014	0.002	0	0	0.14	0.91	0.003	0.258	2
Bromomethane	74-83-9	0.009	0.01	0	0.05	0.036	0.039	0	0.19	5	0.007	0.035	64
1,3-Butadiene	106-99-0	0.010	0.008	0	0.12	0.023	0.018	0	0.26	0.033	0.7	0.015	51
tert-Butyl ethyl ether	637-92-3	0.0002	0	0	0.015	0.001	0	0	0.063			0.033	2
Butyraldehyde & isobutyraldehyde		0.092	0.07	0.038	0.50	0.27	0.21	0.11	1.47			0.009	100
Carbon disulfide	75-15-0	1.89	0.25	0.053	7.05	5.90	0.78	0.17	21.95	700	0.008	0.103	100
Carbon tetrachloride	56-23-5	0.099	0.097	0.058	0.17	0.62	0.61	0.36	1.06	0.17	4	0.151	100
Chlorobenzene	108-90-7	0.002	0	0	0.084	0.008	0	0	0.39	1000	0.00001	0.097	3
Chloroethane	75-00-3	0.14	0	0	8.18	0.37	0	0	21.59	10000	0.00004	0.024	16
Chloroform	67-66-3	0.021	0.019	0	0.19	0.10	0.093	0	0.91	0.043	2	0.044	82
Chloromethane	74-87-3	0.60	0.58	0.417	0.92	1.23	1.20	0.86	1.90	0.56	2	0.025	100
Chloroprene	126-99-8	0	0	0	0	0	0	0	0	0.0033		0.029	0
Crotonaldehyde	123-73-9	0.11	0.029	0	0.68	0.31	0.08	0	1.96			0.009	95
Dibromochloromethane	594-18-3	0.001	0	0	0.015	0.01	0	0	0.15			0.208	15
1,2-Dichlorobenzene	95-50-1	0.0006	0	0	0.011	0.003	0	0	0.066	200	0.00002	0.222	7
1,3-Dichlorobenzene	541-73-1	0.0006	0	0	0.012	0.004	0	0	0.072			0.204	7
1,4-Dichlorobenzene	106-46-7	0.005	0	0	0.026	0.03	0	0	0.16	0.091	0.3	0.210	39
Dichlorodifluoromethane	75-71-8	0.55	0.54	0.41	0.81	2.73	2.68	2.03	4.00	200	0.01	0.054	100
1,1-Dichloroethane	75-34-3	0	0	0	0	0	0	0	0	0.63		0.032	0
1,1-Dichloroethylene	75-35-4	0.0002	0	0	0.01	0.001	0	0	0.040	200	0.000003	0.036	2
cis-1,2-Dichloroethylene	156-59-2	0	0	0	0	0	0	0	0			0.036	0
trans-1,2-Dichloroethylene	156-60-5	0.0002	0	0	0.01	0.001	0	0	0.040			0.032	2
Dichloromethane	75-09-2	0.16	0.096	0.062	2.53	0.54	0.33	0.22	8.79	2.1	0.3	0.035	100
1,2-Dichloropropane	78-87-5	0	0	0	0	0	0	0	0	0.1		0.106	0
cis-1,3-Dichloropropylene	542-75-6	0.0002	0	0	0.012	0.001	0	0	0.054	0.25	0.004	0.100	2
trans-1,3-Dichloropropylene	542-75-6	0.0002	0	0	0.011	0.001	0	0	0.050	0.25	0.003	0.113	2

Table 6
CHESTER NJ 2011 Toxic VOCs Monitoring Data^a

Analyte ^b	CAS No.	Annual Mean (ppbv) ^{c,d}	Annual Median (ppbv) ^{c,d}	24-Hour Min. (ppbv)	24-Hour Max. (ppbv)	Annual Mean (ug/m ³) ^{c,d}	Annual Median (ug/m ³) ^{c,d}	24-Hour Min. (ug/m ³)	24-Hour Max. (ug/m ³)	Health Benchmark (ug/m ³) ^e	Annual Mean Risk Ratio ^f	Detection Limit (ug/m ³)	% Above Minimum Detection Limit
2,5-Dimethylbenzaldehyde	5799-94-2	0	0	0	0	0	0	0	0			0.011	0
Ethyl acrylate	140-88-5	0	0	0	0	0	0	0	0	2		0.082	0
Ethylbenzene	100-41-4	0.058	0.038	0.009	1.21	0.25	0.16	0.039	5.25	0.4	0.6	0.074	100
Ethylene dibromide	106-93-4	0.0002	0	0	0.013	0.002	0	0	0.100	0.0017	0.96	0.138	2
Ethylene dichloride	107-06-2	0.008	0	0	0.13	0.03	0	0	0.52	0.038	0.9	0.036	30
Formaldehyde	50-00-0	1.93	1.34	0.425	12.5	2.37	1.65	0.52	15.35	0.077	31	0.010	100
Freon 114	76-14-2	0.018	0.017	0	0.033	0.13	0.12	0	0.23			0.063	97
Hexachlorobutadiene	87-68-3	0.0007	0	0	0.013	0.008	0	0	0.14	0.045	0.2	0.395	7
Hexanaldehyde	66-25-1	0.026	0.019	0	0.24	0.11	0.078	0	0.97			0.008	92
Isovaleraldehyde	590-86-3	0	0	0	0	0	0	0	0			0.004	0
Methyl chloroform	71-55-6	0.011	0.01	0	0.03	0.058	0.055	0	0.16	1000	0.0001	0.120	87
Methyl ethyl ketone	78-93-3	0.45	0.28	0.115	4.73	1.32	0.81	0.34	13.93	5000	0.0003	0.462	100
Methyl isobutyl ketone	108-10-1	0.028	0.018	0	0.43	0.12	0.074	0	1.75	3000	0.00004	0.090	89
Methyl methacrylate	80-62-6	0.006	0	0	0.34	0.02	0	0	1.20	700	0.00003	0.077	3
Methyl tert-butyl ether	1634-04-4	0.005	0	0	0.274	0.02	0	0	0.99	3.8	0.004	0.029	3
n-Octane	111-65-9	0.035	0.03	0	0.35	0.16	0.14	0	1.64			0.070	95
Propionaldehyde	123-38-6	0.11	0.09	0.035	0.33	0.26	0.21	0.083	0.79	8	0.03	0.005	100
Propylene	115-07-1	0.28	0.26	0.132	0.77	0.48	0.44	0.23	1.33	3000	0.0002	0.067	100
Styrene	100-42-5	0.081	0.031	0	3.06	0.34	0.13	0	13.03	1.8	0.2	0.094	93
1,1,2,2-Tetrachloroethane	79-34-5	0.0006	0	0	0.017	0.004	0	0	0.12	0.017	0.2	0.165	5
Tetrachloroethylene	127-18-4	0.013	0.011	0	0.15	0.091	0.075	0	1.02	0.17	0.5	0.122	66
Tolualdehydes		0.033	0.029	0	0.092	0.16	0.14	0	0.45			0.015	93
Toluene	108-88-3	0.38	0.16	0.047	12.7	1.42	0.60	0.18	47.85	5000	0.0003	0.060	100
1,2,4-Trichlorobenzene	102-82-1	0.0002	0	0	0.011	0.001	0	0	0.082	4	0.0003	0.267	2
1,1,2-Trichloroethane	79-00-5	0.0003	0	0	0.017	0.002	0	0	0.093	0.063	0.02	0.136	2
Trichloroethylene	79-01-6	0.008	0	0	0.49	0.05	0	0	2.63	0.5	0.09	0.134	5
1,1,2-Trichloro-1,2,2-trifluoroethane	76-131	0.10	0.099	0.074	0.18	0.77	0.76	0.57	1.38	30000	0.00003	0.084	100
Trichlorofluoromethane	75-69-4	0.27	0.27	0.194	0.45	1.54	1.51	1.09	2.52	700	0.002	0.056	100
1,2,4-Trimethylbenzene	95-63-6	0.054	0.037	0.006	1.05	0.26	0.18	0.029	5.16			0.138	100
1,3,5-Trimethylbenzene	108-67-8	0.023	0.018	0	0.39	0.11	0.088	0	1.90			0.128	92
Valeraldehyde	110-62-3	0.024	0.016	0	0.18	0.086	0.056	0	0.62			0.007	93
Vinyl chloride	75-01-4	0.0005	0	0	0.012	0.001	0	0	0.031	0.11	0.01	0.020	5
m/p- Xylene	1330-20-7	0.15	0.067	0.012	4.74	0.64	0.29	0.052	20.58	100	0.006	0.148	100
o-Xylene	95-47-6	0.061	0.032	0	1.69	0.26	0.14	0	7.34	100	0.003	0.078	98

a See page 29 for footnotes.

Table 7

ELIZABETH NJ 2011 Toxic VOCs Monitoring Data^a

Analyte ^b	CAS No.	Annual Mean (ppbv) ^{c,d}	Annual Median (ppbv) ^{c,d}	24-Hour Min. (ppbv)	24-Hour Max. (ppbv)	Annual Mean (ug/m ³) ^{c,d}	Annual Median (ug/m ³) ^{c,d}	24-Hour Min. (ug/m ³)	24-Hour Max. (ug/m ³)	Health Benchmark (ug/m ³) ^e	Annual Mean Risk Ratio ^f	Detection Limit (ug/m ³)	% Above Minimum Detection Limit
Acetaldehyde	75-07-0	1.80	1.54	0.547	4.48	3.24	2.77	0.99	8.07	0.45	7	0.011	100
Acetone	67-64-1	1.01	0.88	0.238	2.18	2.41	2.09	0.57	5.18	31000	0.0001	0.014	100
Acetonitrile	75-05-8	0.37	0.18	0.071	5.80	0.63	0.30	0.12	9.74	60	0.01	0.040	100
Acetylene	74-86-2	1.12	0.93	0.261	2.71	1.20	0.99	0.28	2.88			0.017	100
Acrolein^g	107-02-8	0.42	0.32	0.106	2.48	0.96	0.73	0.24	5.69	0.02	48	0.115	100
Acrylonitrile	107-13-1	0.012	0	0	0.15	0.03	0	0	0.33	0.015	1.7	0.026	15
tert-Amyl methyl ether	994-05-8	0.0001	0	0	0.005	0.0003	0	0	0.021			0.067	2
Benzaldehyde	100-52-7	0.031	0.026	0.006	0.079	0.13	0.11	0.026	0.34			0.009	100
Benzene	71-43-2	0.32	0.30	0.13	1.17	1.02	0.95	0.42	3.74	0.13	8	0.093	100
Benzyl chloride	100-44-7	0	0	0	0	0	0	0	0	0.02		0.202	0
Bromochloromethane	74-97-5	0	0	0	0	0	0	0	0			0.042	0
Bromodichloromethane	75-27-4	0.0002	0	0	0.015	0.002	0	0	0.10			0.168	2
Bromoform	75-25-2	0.0005	0	0	0.013	0.005	0	0	0.13	0.91	0.006	0.258	5
Bromomethane	74-83-9	0.012	0.011	0	0.12	0.048	0.043	0	0.48	5	0.01	0.035	62
1,3-Butadiene	106-99-0	0.061	0.059	0	0.15	0.13	0.13	0	0.33	0.033	4	0.015	97
tert-Butyl ethyl ether	637-92-3	0	0	0	0	0	0	0	0			0.033	0
Butyraldehyde & isobutyraldehyde		0.13	0.13	0.051	0.37	0.39	0.37	0.15	1.08			0.009	100
Carbon disulfide	75-15-0	0.50	0.48	0.225	1.33	1.56	1.49	0.70	4.14	700	0.002	0.103	100
Carbon tetrachloride	56-23-5	0.097	0.098	0.019	0.15	0.61	0.62	0.12	0.94	0.17	4	0.151	100
Chlorobenzene	108-90-7	0.0008	0	0	0.039	0.003	0	0	0.18	1000	0.000003	0.097	3
Chloroethane	75-00-3	0.004	0	0	0.058	0.009	0	0	0.15	10000	0.000001	0.024	13
Chloroform	67-66-3	0.028	0.024	0	0.12	0.14	0.12	0	0.61	0.043	3	0.044	79
Chloromethane	74-87-3	0.61	0.59	0.35	1.09	1.25	1.23	0.72	2.25	0.56	2	0.025	100
Chloroprene	126-99-8	0	0	0	0	0	0	0	0	0.0033		0.029	0
Crotonaldehyde	123-73-9	0.11	0.042	0.012	0.58	0.31	0.12	0.034	1.65			0.009	100
Dibromochloromethane	594-18-3	0.0007	0	0	0.01	0.007	0	0	0.099			0.208	11
1,2-Dichlorobenzene	95-50-1	0.0002	0	0	0.008	0.001	0	0	0.048	200	0.00001	0.222	3
1,3-Dichlorobenzene	541-73-1	0.0003	0	0	0.007	0.002	0	0	0.042			0.204	5
1,4-Dichlorobenzene	106-46-7	0.016	0.015	0	0.083	0.098	0.09	0	0.50	0.091	1.1	0.210	79
Dichlorodifluoromethane	75-71-8	0.55	0.55	0.375	0.74	2.72	2.70	1.85	3.64	200	0.01	0.054	100
1,1-Dichloroethane	75-34-3	0	0	0	0	0	0	0	0	0.63		0.032	0
1,1-Dichloroethylene	75-35-4	0.0001	0	0	0.006	0.0004	0	0	0.024	200	0.000002	0.036	2
cis-1,2-Dichloroethylene	156-59-2	0	0	0	0	0	0	0	0			0.036	0
trans-1,2-Dichloroethylene	156-60-5	0.0001	0	0	0.007	0.0005	0	0	0.028			0.032	2
Dichloromethane	75-09-2	0.20	0.13	0.07	3.29	0.71	0.45	0.24	11.43	2.1	0.3	0.035	100
1,2-Dichloropropane	78-87-5	0	0	0	0	0	0	0	0	0.1		0.106	0
cis-1,3-Dichloropropylene	542-75-6	0	0	0	0	0	0	0	0	0.25		0.100	0
trans-1,3-Dichloropropylene	542-75-6	0	0	0	0	0	0	0	0	0.25		0.113	0

Table 7

ELIZABETH NJ 2011 Toxic VOCs Monitoring Data^a

Analyte ^b	CAS No.	Annual Mean (ppbv) ^{c,d}	Annual Median (ppbv) ^{c,d}	24-Hour Min. (ppbv)	24-Hour Max. (ppbv)	Annual Mean (ug/m ³) ^{c,d}	Annual Median (ug/m ³) ^{c,d}	24-Hour Min. (ug/m ³)	24-Hour Max. (ug/m ³)	Health Benchmark (ug/m ³) ^e	Annual Mean Risk Ratio ^f	Detection Limit (ug/m ³)	% Above Minimum Detection Limit
2,5-Dimethylbenzaldehyde	5799-94-2	0	0	0	0	0	0	0	0			0.011	0
Ethyl acrylate	140-88-5	0.0007	0	0	0.041	0.003	0	0	0.17	2	0.001	0.082	2
Ethylbenzene	100-41-4	0.12	0.09	0.028	1.15	0.51	0.40	0.12	4.99	0.4	1.3	0.074	100
Ethylene dibromide	106-93-4	0.0003	0	0	0.009	0.003	0	0	0.069	0.0017	1.6	0.138	5
Ethylene dichloride	107-06-2	0.007	0	0	0.073	0.03	0	0	0.30	0.038	0.7	0.036	26
Formaldehyde	50-00-0	2.80	2.32	0.808	7.70	3.44	2.85	0.99	9.46	0.077	45	0.010	100
Freon 114	76-14-2	0.017	0.017	0	0.026	0.12	0.12	0	0.18			0.063	97
Hexachlorobutadiene	87-68-3	0.0005	0	0	0.009	0.005	0	0	0.096	0.045	0.1	0.395	8
Hexanaldehyde	66-25-1	0.023	0.019	0	0.098	0.096	0.078	0	0.40			0.008	98
Isovaleraldehyde	590-86-3	0	0	0	0	0	0	0	0			0.004	0
Methyl chloroform	71-55-6	0.012	0.011	0	0.03	0.064	0.06	0	0.16	1000	0.0001	0.120	92
Methyl ethyl ketone	78-93-3	0.47	0.37	0.131	2.02	1.38	1.08	0.39	5.95	5000	0.0003	0.462	100
Methyl isobutyl ketone	108-10-1	0.041	0.031	0	0.28	0.17	0.13	0	1.14	3000	0.0001	0.090	98
Methyl methacrylate	80-62-6	0.012	0	0	0.16	0.04	0	0	0.55	700	0.0001	0.077	25
Methyl tert-butyl ether	1634-04-4	0.004	0	0	0.18	0.01	0	0	0.63	3.8	0.004	0.029	8
n-Octane	111-65-9	0.080	0.061	0.018	0.37	0.37	0.28	0.084	1.74			0.070	100
Propionaldehyde	123-38-6	0.19	0.17	0.051	0.50	0.45	0.40	0.12	1.18	8	0.06	0.005	100
Propylene	115-07-1	1.30	0.85	0.247	6.03	2.24	1.46	0.43	10.38	3000	0.0007	0.067	100
Styrene	100-42-5	0.065	0.041	0	1.37	0.27	0.17	0	5.84	1.8	0.2	0.094	98
1,1,2,2-Tetrachloroethane	79-34-5	0.0002	0	0	0.01	0.001	0	0	0.069	0.017	0.07	0.165	2
Tetrachloroethylene	127-18-4	0.030	0.026	0	0.18	0.20	0.18	0	1.22	0.17	1.2	0.122	92
Tolualdehydes		0.034	0.024	0.006	0.13	0.17	0.12	0.029	0.64			0.015	100
Toluene	108-88-3	0.76	0.51	0.14	11.30	2.85	1.93	0.53	42.58	5000	0.001	0.060	100
1,2,4-Trichlorobenzene	102-82-1	0.0001	0	0	0.008	0.001	0	0	0.059	4	0.0002	0.267	2
1,1,2-Trichloroethane	79-00-5	0	0	0	0	0	0	0	0	0.063	0	0.136	0
Trichloroethylene	79-01-6	0.017	0	0	0.52	0.093	0	0	2.81	0.5	0.2	0.134	38
1,1,2-Trichloro-1,2,2-trifluoroethane	76-131	0.098	0.098	0.057	0.13	0.75	0.75	0.44	0.98	30000	0.00003	0.084	100
Trichlorofluoromethane	75-69-4	0.29	0.28	0.194	0.48	1.61	1.56	1.09	2.67	700	0.002	0.056	100
1,2,4-Trimethylbenzene	95-63-6	0.11	0.09	0.022	1.01	0.56	0.44	0.11	4.96			0.138	100
1,3,5-Trimethylbenzene	108-67-8	0.042	0.035	0.008	0.38	0.20	0.17	0.039	1.89			0.128	100
Valeraldehyde	110-62-3	0.031	0.028	0.009	0.11	0.11	0.10	0.032	0.39			0.007	100
Vinyl chloride	75-01-4	0.0005	0	0	0.008	0.001	0	0	0.020	0.11	0.01	0.020	7
m/p- Xylene	1330-20-7	0.35	0.24	0.075	6.00	1.54	1.02	0.33	26.05	100	0.02	0.148	100
o-Xylene	95-47-6	0.14	0.095	0.031	1.99	0.60	0.41	0.13	8.64	100	0.006	0.078	100

a See page 29 for footnotes.

Table 8

NEW BRUNSWICK NJ 2011 Toxic VOCs Monitoring Data^a

Analyte ^b	CAS No.	Annual Mean (ppbv) ^{c,d}	Annual Median (ppbv) ^{c,d}	24-Hour Min. (ppbv)	24-Hour Max. (ppbv)	Annual Mean (ug/m ³) ^{c,d}	Annual Median (ug/m ³) ^{c,d}	24-Hour Min. (ug/m ³)	24-Hour Max. (ug/m ³)	Health Benchmark (ug/m ³) ^e	Annual Mean Risk Ratio ^f	Detection Limit (ug/m ³)	% Above Minimum Detection Limit
Acetaldehyde	75-07-0	1.38	1.33	0.46	3.62	2.49	2.39	0.82	6.52	0.45	6	0.011	100
Acetone	67-64-1	0.91	0.81	0.22	2.29	2.16	1.92	0.52	5.44	31000	0.0001	0.014	100
Acetonitrile	75-05-8	0.46	0.34	0.12	3.24	0.78	0.57	0.20	5.44	60	0.01	0.040	100
Acetylene	74-86-2	0.74	0.58	0.21	3.52	0.79	0.62	0.22	3.75			0.017	100
Acrolein^g	107-02-8	0.33	0.27	0.12	0.86	0.76	0.63	0.28	1.97	0.02	38	0.115	100
Acrylonitrile	107-13-1	0.041	0	0	0.62	0.089	0	0	1.34	0.015	6	0.026	41
tert-Amyl methyl ether	994-05-8	0.0001	0	0	0.008	0.0006	0	0	0.033			0.067	2
Benzaldehyde	100-52-7	0.017	0.013	0	0.081	0.073	0.056	0	0.35			0.009	90
Benzene	71-43-2	0.22	0.19	0.073	0.86	0.71	0.62	0.23	2.74	0.13	5	0.093	100
Benzyl chloride	100-44-7	0	0	0	0	0	0	0	0	0.02		0.202	0
Bromochloromethane	74-97-5	0	0	0	0	0	0	0	0			0.042	0
Bromodichloromethane	75-27-4	0	0	0	0	0	0	0	0			0.168	0
Bromoform	75-25-2	0.0004	0	0	0.011	0.005	0	0	0.11	0.91	0.005	0.258	5
Bromomethane	74-83-9	0.018	0.011	0	0.44	0.071	0.043	0	1.70	5	0.01	0.035	62
1,3-Butadiene	106-99-0	0.025	0.025	0	0.091	0.054	0.055	0	0.20	0.033	1.6	0.015	71
tert-Butyl ethyl ether	637-92-3	0	0	0	0	0	0	0	0			0.033	0
Butyraldehyde & isobutyraldehyde		0.087	0.080	0.023	0.20	0.26	0.23	0.068	0.58			0.009	100
Carbon disulfide	75-15-0	0.25	0.076	0.013	0.96	0.77	0.24	0.040	3.00	700	0.001	0.103	100
Carbon tetrachloride	56-23-5	0.093	0.098	0.021	0.14	0.59	0.62	0.13	0.87	0.17	3	0.151	100
Chlorobenzene	108-90-7	0	0	0	0	0	0	0	0	1000		0.097	0
Chloroethane	75-00-3	0.015	0	0	0.16	0.04	0	0	0.42	10000	0.000004	0.024	19
Chloroform	67-66-3	0.025	0.025	0	0.07	0.12	0.120	0	0.34	0.043	3	0.044	79
Chloromethane	74-87-3	0.63	0.59	0.4	2.53	1.29	1.22	0.83	5.22	0.56	2	0.025	100
Chloroprene	126-99-8	0	0	0	0	0	0	0	0	0.0033		0.029	0
Crotonaldehyde	123-73-9	0.097	0.028	0	0.66	0.28	0.080	0	1.88			0.009	98
Dibromochloromethane	594-18-3	0.001	0	0	0.011	0.01	0	0	0.11			0.208	19
1,2-Dichlorobenzene	95-50-1	0.0008	0	0	0.01	0.005	0	0	0.060	200	0.00003	0.222	12
1,3-Dichlorobenzene	541-73-1	0.0007	0	0	0.01	0.004	0	0	0.060			0.204	9
1,4-Dichlorobenzene	106-46-7	0.01	0.009	0	0.048	0.060	0.054	0	0.29	0.091	0.7	0.210	67
Dichlorodifluoromethane	75-71-8	0.55	0.54	0.42	0.68	2.73	2.69	2.08	3.35	200	0.014	0.054	100
1,1-Dichloroethane	75-34-3	0	0	0	0	0	0	0	0	0.63		0.032	0
1,1-Dichloroethylene	75-35-4	0.0001	0	0	0.006	0.0004	0	0	0.024	200	0.000002	0.036	2
cis-1,2-Dichloroethylene	156-59-2	0	0	0	0	0	0	0	0			0.036	0
trans-1,2-Dichloroethylene	156-60-5	0.0001	0	0	0.008	0.0005	0	0	0.032			0.032	2
Dichloromethane	75-09-2	0.39	0.14	0.071	14.2	1.37	0.48	0.25	49.33	2.1	0.7	0.035	100
1,2-Dichloropropane	78-87-5	0	0	0	0	0	0	0	0	0.1		0.106	0
cis-1,3-Dichloropropylene	542-75-6	0.0003	0	0	0.02	0.002	0	0	0.091	0.25	0.006	0.100	2
trans-1,3-Dichloropropylene	542-75-6	0	0	0	0	0	0	0	0	0.25		0.113	0

Table 8

NEW BRUNSWICK NJ 2011 Toxic VOCs Monitoring Data^a

Analyte ^b	CAS No.	Annual Mean (ppbv) ^{c,d}	Annual Median (ppbv) ^{c,d}	24-Hour Min. (ppbv)	24-Hour Max. (ppbv)	Annual Mean (ug/m ³) ^{c,d}	Annual Median (ug/m ³) ^{c,d}	24-Hour Min. (ug/m ³)	24-Hour Max. (ug/m ³)	Health Benchmark (ug/m ³) ^e	Annual Mean Risk Ratio ^f	Detection Limit (ug/m ³)	% Above Minimum Detection Limit
2,5-Dimethylbenzaldehyde	5799-94-2	0	0	0	0	0	0	0	0			0.011	0
Ethyl acrylate	140-88-5	0	0	0	0	0	0	0	0	2		0.082	0
Ethylbenzene	100-41-4	0.11	0.062	0.024	2.65	0.49	0.27	0.10	11.51	0.4	1.2	0.074	100
Ethylene dibromide	106-93-4	0.0001	0	0	0.007	0.0009	0	0	0.054	0.0017	0.5	0.138	2
Ethylene dichloride	107-06-2	0.007	0	0	0.053	0.03	0	0	0.21	0.038	0.7	0.036	31
Formaldehyde	50-00-0	2.20	1.27	0.66	22.5	2.70	1.56	0.81	27.63	0.077	35	0.010	100
Freon 114	76-14-2	0.018	0.018	0	0.025	0.13	0.13	0	0.17			0.063	98
Hexachlorobutadiene	87-68-3	0.001	0	0	0.012	0.01	0	0	0.13	0.045	0.3	0.395	14
Hexanaldehyde	66-25-1	0.023	0.014	0	0.17	0.094	0.057	0	0.70			0.008	89
Isovaleraldehyde	590-86-3	0	0	0	0	0	0	0	0			0.004	0
Methyl chloroform	71-55-6	0.013	0.012	0	0.054	0.069	0.063	0	0.29	1000	0.0001	0.120	93
Methyl ethyl ketone	78-93-3	0.45	0.36	0.13	1.4	1.32	1.06	0.38	4.12	5000	0.0003	0.462	100
Methyl isobutyl ketone	108-10-1	0.037	0.029	0	0.20	0.15	0.12	0	0.83	3000	0.00005	0.090	97
Methyl methacrylate	80-62-6	0.002	0	0	0.089	0.008	0	0	0.31	700	0.00001	0.077	7
Methyl tert-butyl ether	1634-04-4	0.006	0	0	0.26	0.02	0	0	0.94	3.8	0.005	0.029	7
n-Octane	111-65-9	0.039	0.036	0	0.14	0.18	0.17	0	0.64			0.070	98
Propionaldehyde	123-38-6	0.12	0.10	0.03	0.37	0.29	0.25	0.071	0.87	8	0.04	0.005	100
Propylene	115-07-1	0.50	0.43	0.17	1.88	0.86	0.75	0.29	3.24	3000	0.0003	0.067	100
Styrene	100-42-5	0.049	0.033	0	0.91	0.21	0.14	0	3.88	1.8	0.1	0.094	95
1,1,2,2-Tetrachloroethane	79-34-5	0.0005	0	0	0.012	0.003	0	0	0.082	0.017	0.2	0.165	5
Tetrachloroethylene	127-18-4	0.018	0.018	0	0.057	0.12	0.12	0	0.39	0.17	0.7	0.122	84
Tolualdehydes		0.028	0.021	0	0.13	0.14	0.10	0	0.64			0.015	96
Toluene	108-88-3	0.55	0.28	0.097	14.9	2.06	1.04	0.37	56.14	5000	0.0004	0.060	100
1,2,4-Trichlorobenzene	102-82-1	0.0005	0	0	0.011	0.004	0	0	0.082	4	0.001	0.267	5
1,1,2-Trichloroethane	79-00-5	0	0	0	0	0	0	0	0	0.063		0.136	0
Trichloroethylene	79-01-6	0.004	0	0	0.034	0.02	0	0	0.18	0.5	0.04	0.134	22
1,1,2-Trichloro-1,2,2-trifluoroethane	76-131	0.10	0.099	0.07	0.16	0.77	0.76	0.54	1.20	30000	0.00003	0.084	100
Trichlorofluoromethane	75-69-4	0.28	0.27	0.21	0.43	1.56	1.53	1.17	2.40	700	0.002	0.056	100
1,2,4-Trimethylbenzene	95-63-6	0.057	0.053	0.014	0.26	0.28	0.26	0.069	1.29			0.138	100
1,3,5-Trimethylbenzene	108-67-8	0.023	0.022	0	0.081	0.11	0.11	0	0.40			0.128	98
Valeraldehyde	110-62-3	0.021	0.018	0	0.086	0.073	0.062	0	0.30			0.007	90
Vinyl chloride	75-01-4	0.001	0	0	0.016	0.003	0	0	0.041	0.11	0.02	0.020	10
m/p- Xylene	1330-20-7	0.26	0.14	0.052	6.08	1.11	0.62	0.23	26.40	100	0.01	0.148	100
o-Xylene	95-47-6	0.085	0.062	0.021	1.35	0.37	0.27	0.091	5.86	100	0.004	0.078	100

a See page 29 for footnotes.

Footnotes for Tables 6 through 8

^b Analytes in bold text had annual means above the long-term health benchmark.

^c Numbers in italics are arithmetic means (or averages) based on less than 50% of the samples above the detection limit.

^d 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.

^e The 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.

^f The 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.

^g Acrolein concentrations are highly uncertain because of problems with collection and analysis methods.

Table 9
Analytes with 100% Non-Detects in 2011

Analyte	CAS No.	Chester	Elizabeth	New Brunswick
tert-Amyl methyl ether	994-05-8	X		
Benzyl Chloride	100-44-7	X	X	X
Bromochloromethane	74-97-5		X	X
Bromodichloromethane	75-27-4			X
tert-Butyl ethyl ether	637-92-3		X	X
Chlorobenzene	108-90-7			X
Chloroprene	126-99-8	X	X	X
1,1-Dichloroethane	75-34-3	X	X	X
cis-1,2-Dichloroethene	156-59-2	X	X	X
1,2-Dichloropropane	78-87-5	X	X	X
cis-1,3-Dichloropropylene	542-75-6		X	
trans-1,3-Dichloropropylene	542-75-6		X	X
2,5-Dimethylbenzaldehyde	5799-94-2	X	X	X
Ethyl Acrylate	140-88-5	X		X
Isovaleraldehyde	590-86-3	X	X	X

- In 2011, collected samples of these chemicals were never above the detection limits at the specific monitoring locations. However, they may be present in the air below the detection limit level. Chemical-specific detection limits can be found in Tables 6 through 8.

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2012 Photochemical Assessment Monitoring Stations (PAMS)

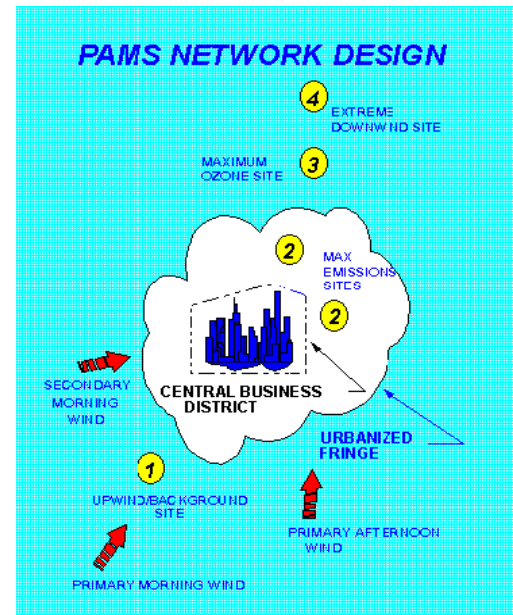
New Jersey Department of Environmental Protection

PHOTOCHEMICAL ASSESSMENT MONITORING STATIONS (PAMS)

Most ground-level ozone (O₃) is formed as the result of oxides of nitrogen (NO_x) and volatile organic compounds (VOCs) reacting in the presence of sunlight. As a result, it is necessary to measure these ozone forming pollutants, also known as precursor pollutants, to effectively evaluate strategies for reducing ozone levels. The Photochemical Assessment Monitoring Stations (PAMS) network was established for this purpose. Data from the PAMS network is used to better characterize the nature and extent of the O₃ problem, track VOC and NO_x emission inventory reductions, assess air quality trends, and make attainment/nonattainment decisions. PAMS monitor both criteria and non-criteria pollutants including ozone (O₃), oxides of nitrogen (NO_x), nitric oxide (NO), nitrogen dioxide (NO₂), and specific VOCs, including several carbonyls that are important in ozone formation. In addition, the measurement of specific weather parameters (e.g. wind speed/direction, temperature) is required at all PAMS, and upper air weather measurements are required in certain areas. The VOC and carbonyl measurements are only taken during the peak part of the ozone season, from June 1st to August 31st each year.

The PAMS network is designed around metropolitan areas where ozone is a significant problem, and each site in the network has a specific purpose as shown in Figure 1. New Jersey is part of both the Philadelphia and New York Metropolitan areas and has historically operated a total of three PAMS sites. A Type 3 maximum ozone site for the Philadelphia area was located at Rider University in Mercer County, a secondary Type 2 (or Type 2A) maximum emissions site was located downwind of the Philadelphia Metropolitan urban area in Camden, and a site at Rutgers University in New Brunswick has been designated both a PAMS Type 1 upwind site for the New York urban area, as well as a Type 4 downwind site for the Philadelphia Metropolitan urban area. An upper air weather monitoring station is also located at the Rutgers University site. All of the PAMS sites for the Philadelphia and New York City areas are shown in Figure 2.

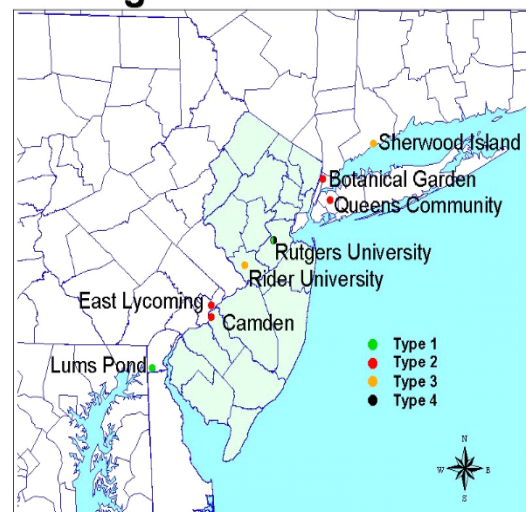
Figure 1



⁵ USEPA , PAMS General Information

Figure 2

Regional PAMS Sites

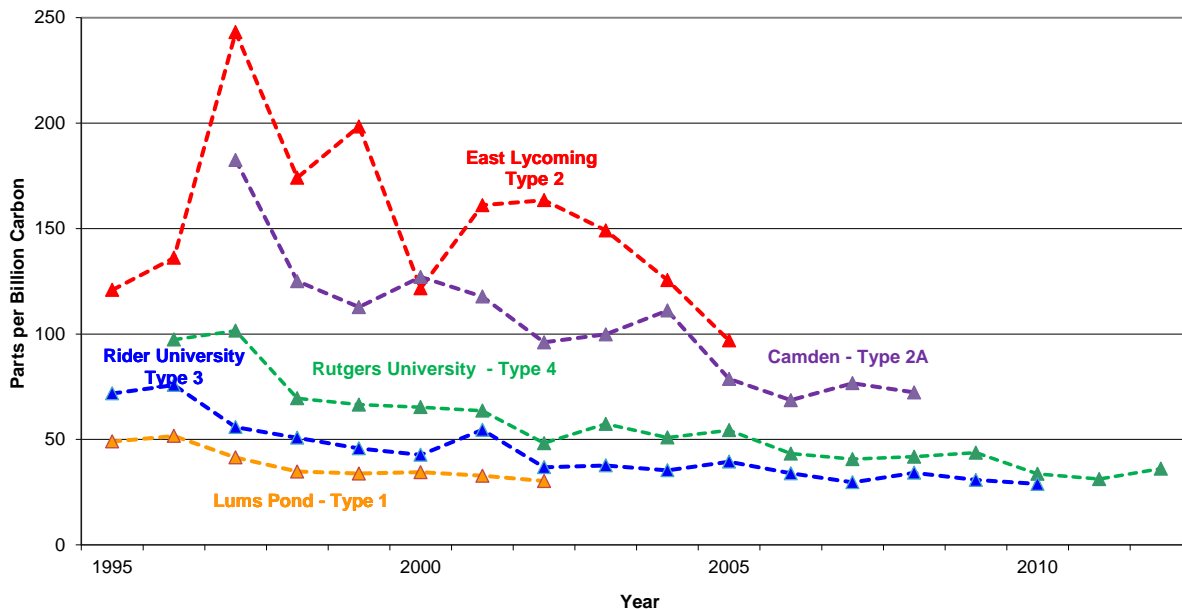


Note: Rutgers University PAMS site is both Type 4 for Philadelphia and Type 1 for New York City.

PHILADELPHIA REGION

Figure 3 shows VOC trends for the PAMS sites in the Philadelphia area. In general, at the Lums Pond (upwind - Type 1), Rider University (maximum ozone concentration - Type 3) and Rutgers University (downwind - Type 4), VOCs have declined over the measurement period. The improvements were initially more dramatic, with more level, though still discernibly declining concentrations, over the last several years. The maximum emissions -Type 2 sites (Camden and East Lycoming) for this area show more variation from year to year, though the trend at both sites is downward since 1997. This greater variability may be due to the fact that Type 2 sites are typically impacted by varied sources, whereas the other sites are mostly impacted by transportation sources.

Figure 3
Philadelphia Region
Total Non-methane Organic Carbon (TNMOC)
Seasonal Average 1995-2012



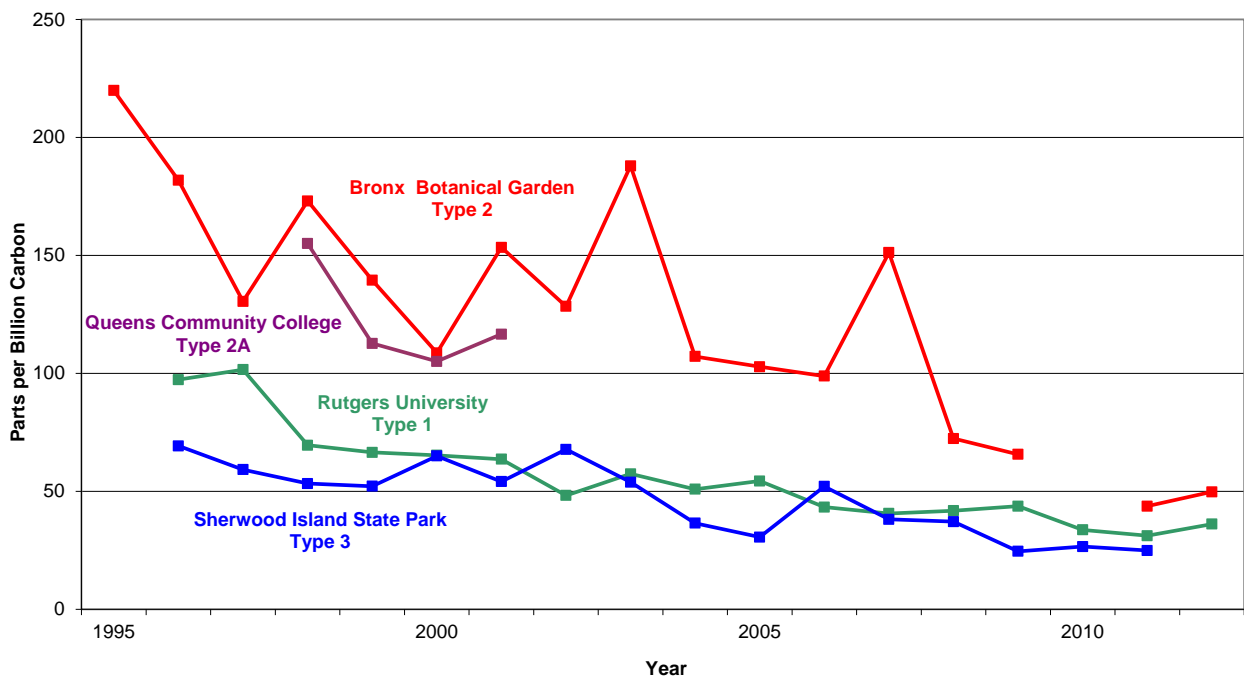
NOTE: Delaware's Department of Natural Resources and Environmental Control (DNREC) discontinued operation of the Lums Pond site after the 2002 season. Philadelphia's Air Management Services Laboratory still operates the PAMS site at their East Lycoming lab, but as of 2006 they no longer report Total Non-Methane Organic Carbon (TNMOC). Our Camden site has not operated since the 2008 season due to our losing access to the site. We have since relocated the site but have not installed a PAMS unit. The Rider University site was removed from the PAMS network following the 2010 season. An evaluation of the site showed this data was not significantly different from the Rutgers University site and it was discontinued as part on an overall restructuring the monitoring network.

NEW YORK REGION

Figure 4 shows VOC trends for the PAMS sites in the New York City metropolitan area. In general, observations in the NYC area are similar to those for the Philadelphia area. The Type 2 site in the NY area at the Bronx Botanical Gardens shows even more year to year variability than does the Philadelphia Type 2 site at East Lycoming.

NOTE: Operation of the Queens Community College site was discontinued after the 2001 season. No data was reported for the Bronx Botanical Garden site for 2010 due to equipment problems. The Sherwood Island site began using new equipment in 2012 which doesn't allow for a measure of TNMOC.

Figure 4
New York City Region
Total Non-methane Organic Carbon (TNMOC)
Seasonal Average 1995-2012



SUMMARY

In conclusion, trends for VOC values measured at all PAMS sites in the Philadelphia and New York City areas show an impressive decline over the time period during which these measurements have been made. Mandated changes in gasoline formulation over the period as well as the effect of newer, cleaner vehicles replacing older vehicles in the automotive fleet likely account for some of these reductions. Type 2 sites, though impacted by vehicle emissions, are also affected by urban stationary sources whose emission trends over the measurement period are less clear and these sites seem to show more year to year variability. All sites are also impacted by naturally occurring VOCs such as isoprene, which is emitted by trees. All VOCs are not equal in their contribution to ozone formation and while isoprene levels are generally lower than many other VOCs, isoprene can account for a significant amount of the ozone forming potential, especially in non-urban areas. Isoprene levels are also highest during the middle of the day, when photochemical conditions are most conducive to ozone formation. Isoprene emissions are thought to be influenced by factors that affect tree health and growth, such as rainfall and severe temperatures.

Summaries of results for all of the VOCs measured at the New Jersey PAMS sites are provided in Table 1.

Table 1
Summary of Photochemical Assessment Monitoring (PAMS) Data
June, July, and August, 2012

Parts Per Billion (Volume) – ppbv
Parts Per Billion (Carbon) – ppbC

	Rutgers University			
	ppbv		ppbC	
	Average	Maximum	Average	Maximum
Acetylene	0.11	0.74	0.21	1.48
Benzene	0.06	0.42	0.38	2.51
n-Butane	0.62	10.34	2.47	41.35
1-Butene	0.04	0.22	0.16	0.89
cis-2-Butene	0.03	0.47	0.11	1.89
trans-2-Butene	0.03	0.27	0.13	1.08
Cyclohexane	0.03	0.31	0.18	1.85
Cyclopentane	0.03	0.42	0.13	2.09
n-Decane	0.02	0.12	0.18	1.24
m-Diethylbenzene	0.01	0.07	0.11	0.68
p-Diethylbenzene	0.01	0.22	0.08	2.22
2,2-Dimethylbutane	0.02	0.29	0.11	1.46
2,3-Dimethylbutane	0.05	0.73	0.24	3.64
2,3-Dimethylpentane	0.02	0.62	0.15	4.36
2,4-Dimethylpentane	0.02	0.21	0.12	1.48
Ethane	3.05	14.19	6.10	28.37
Ethylbenzene	0.03	0.18	0.21	1.41
Ethylene (Ethene)	0.63	4.23	1.25	8.46
m-Ethyltoluene	0.02	0.27	0.17	2.42
o-Ethyltoluene	0.01	0.06	0.08	0.52
p-Ethyltoluene	0.03	0.18	0.25	1.62

Table 1 (Continued)
Summary of Photochemical Assessment Monitoring (PAMS) Data
June, July, and August, 2010

Parts Per Billion (Volume) – ppbv
Parts Per Billion (Carbon) – ppbC

	Rutgers University			
	ppbv		ppbC	
	Average	Maximum	Average	Maximum
n-Heptane	0.04	1.43	0.25	10.00
Hexane	0.11	1.18	0.67	7.06
1-Hexene	0.02	0.30	0.10	1.79
Isobutane	0.25	2.60	1.01	10.40
Isopentane	0.47	11.99	2.36	59.97
Isoprene	0.53	7.11	2.64	35.53
Isopropylbenzene	0.01	0.23	0.08	2.11
Methylcyclohexane	0.03	0.42	0.23	2.96
Methylcyclopentane	0.05	0.63	0.31	3.77
2-Methylheptane	0.10	1.53	0.60	9.19
3-Methylheptane	0.07	0.87	0.39	5.23
2-Methylhexane	0.01	0.15	0.10	1.16
3-Methylhexane	0.01	0.16	0.10	1.24
2-Methylpentane	0.03	1.15	0.21	8.05
3-Methylpentane	0.04	1.70	0.26	11.90
n-Nonane	0.02	0.17	0.15	1.51
n-Octane	0.02	0.21	0.16	1.68
n-Pentane	0.27	5.80	1.37	28.98
1-Pentene	0.02	0.24	0.11	1.20
cis-2-Pentene	0.02	0.29	0.08	1.43
trans-2-Pentene	0.03	0.59	0.13	2.97
Propane	1.37	9.27	4.10	27.82
n-Propylbenzene	0.01	0.06	0.08	0.53
Propylene (Propene)	0.26	2.29	0.79	6.88
Styrene	0.01	0.08	0.11	0.67
Toluene	0.21	1.44	1.47	10.07
1,2,3-Trimethylbenzene	0.06	0.34	0.50	3.02
1,2,4-Trimethylbenzene	0.04	0.45	0.40	4.08
1,3,5-Trimethylbenzene	0.01	0.10	0.11	0.92
2,2,4-Trimethylpentane	0.09	1.00	0.72	7.99
2,3,4-Trimethylpentane	0.03	0.21	0.23	1.68
n-Undecane	0.01	0.10	0.12	1.14
m/p-Xylene	0.07	0.84	0.59	6.74
o-Xylene	0.03	0.29	0.24	2.32

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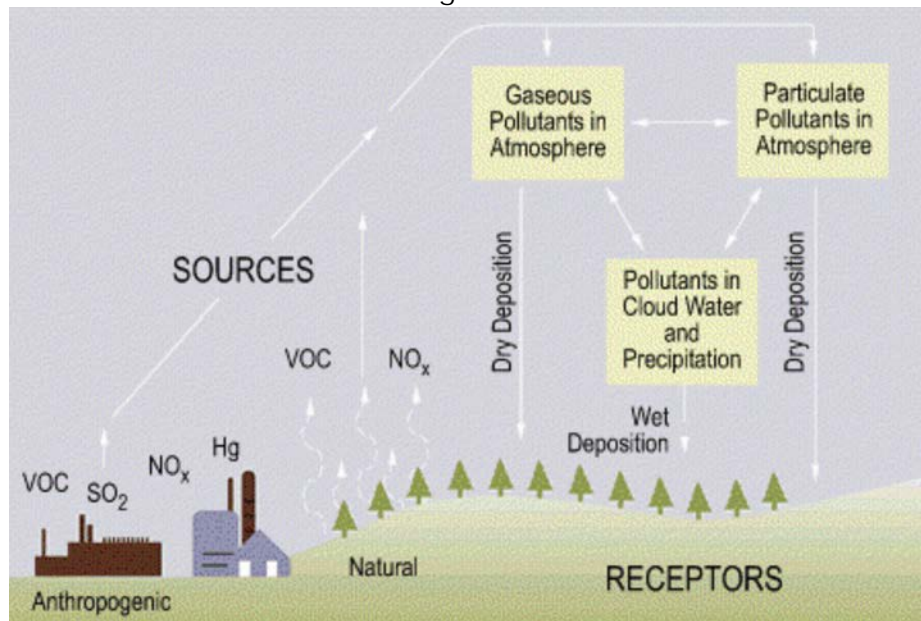
2011 Acid Deposition Summary

New Jersey Department of Environmental Protection

NATURE AND SOURCES

Atmospheric deposition is a process in which pollutants are deposited on land or water from the air. Deposition is usually the result of pollutants being removed from the atmosphere and deposited by precipitation (wet deposition) or by the settling out of particulates (dry deposition). Dry deposition also includes gaseous pollutants that are absorbed by land or water bodies. Figure 1 shows the basic mechanisms of deposition and the major pollutants of concern. These include sulfur dioxide (SO_2), nitrogen oxides (NO_x), mercury (Hg), and volatile organic compounds (VOCs). SO_2 is a major contributor to acid deposition, which can reduce the ability of water bodies to support certain types of fish and other aquatic organisms. NO_x also contributes to the acid deposition problem and can contribute to eutrophication of water bodies as well. Hg will accumulate in fish by a process known as bio-magnification. Small amounts of Hg in water are concentrated in smaller organisms. These smaller organisms are in turn consumed by larger ones. As the Hg moves up the food chain, it becomes more concentrated. Fish in Hg contaminated water can become contaminated to the point where they are no longer safe for people to eat. For more information on Hg in fish see "A Guide to Health Advisories for Eating Fish and Crabs Caught in New Jersey Waters" which is available at www.state.nj.us/dep/dsr/njmainfish.htm. VOCs are a very diverse group of compounds, some of which are toxic, including known carcinogens.

Figure 1



Source: USEPA Clean Air Markets

Web Site: <http://www.epa.gov/airmarkets/acidrain/index.html#what>

Atmospheric deposition is the result of pollution from a wide variety of sources and in some cases the pollution can travel great distances before being deposited on the land or water. Some known sources of atmospheric deposition are power plants, motor vehicles, incinerators, and certain industries.

MONITORING LOCATIONS

Figure 2 shows the three active deposition monitoring sites in New Jersey for 2011: Washington Crossing State Park, Ancora State Hospital, and the Edwin B. Forsythe National Wildlife Refuge (NWR), also known as Brigantine. Each of the sites has a sampler for collecting wet deposition (rain and snow) and a rain gauge for determining precipitation amounts.

Washington Crossing State Park and the Edwin B. Forsythe (NWR) are part of the National Atmospheric Deposition Program's (NADP) National Trends Network (NTN). A sample is collected every week from each site. The New Jersey Department of Environmental Protection (NJDEP) collects all samples from Washington Crossing. The United States Fish and Wildlife Service – Air Quality Branch (USFWS-AQB) is responsible for sample collection at the Edwin B. Forsythe NWR or Brigantine. All collected samples are shipped to the Central Analytical Laboratory (CAL) at the Illinois State Water Survey (ISWS) for analysis. The CAL analyzes each sample with the goal of providing data on amounts, trends, and geographic distributions of acids, nutrients, and base cations in precipitation. The resulting data is then used by the U.S. Environmental Protection Agency (USEPA) to assess national deposition patterns and trends. (NADP, 2011)

In addition to the NADP sites, the State also collects samples from a weekly sampler at the Ancora State Hospital site in Camden County. These samples are normally analyzed at the Department's own laboratory. Because of ongoing equipment issues, these additional samples are not being analyzed by the State.

SUMMARY OF 2011 DATA

A summary of the 2011 wet deposition data is provided in Table 1. Raw data was obtained from the NADP website (NADP, 2012). The table shows total deposition, pH, conductivity and concentrations of several important ions. When acidity is reported on the pH scale, neutral is considered a 7 with decreasing pH values corresponding to increasing acidity. Normal rainfall has a pH of approximately 5.6 due to the natural presence of carbonic acid in the air. The mean pH value recorded at the Washington

Figure 2
Acid Precipitation Monitoring Network - 2011



Crossing State Park weekly sampler was 4.94 and the Edwin B. Forsythe NWR sampler recorded a mean pH of 4.96.

Conductivity is a measure of the total density of ions in the water collected. It is used as an indicator of the total amount of pollution in the sample. Conductivity is the ability of the water to conduct electricity and generally increases as the concentration of ions in water increases.

Concentrations of specific ions considered important because they can affect the chemistry of lakes, streams and other water bodies, are also reported for each site. Summaries are provided for each season of the year along with annual averages in Table 1.

Table 1
Acid Precipitation Monitoring Network - 2011
Annual and Seasonal Averages
 Weighted by Precipitation Amount

Ca ²⁺	- Calcium	Cond.	- Specific conductance
Mg ²⁺	- Magnesium	cm	- Centimeter
K ⁺	- Potassium	uS/cm	- MicroSiemens per centimeter
Na ⁺	- Sodium	mg/L	- Milligrams per liter
NH ₄ ⁺	- Ammonium	<MDL	- Below minimum detection limit
NO ₃ ⁻	- Nitrate	Winter	- December – February
Cl ⁻	- Chloride	Spring	- March – May
SO ₄ ²⁻	- Sulfate	Summer	- June – August
-	- No Data	Fall	- September – November

Edwin B. Forsythe National Wildlife Refuge – Weekly

	Precip. cm	pH	Cond. uS/cm	Ca ²⁺ mg/L	Mg ²⁺ mg/L	K ⁺ mg/L	Na ⁺ mg/L	NH ₄ ⁺ mg/L	NO ₃ ⁻ mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L
Winter	20.30	4.84	17.07	0.155	0.136	0.070	1.066	0.152	0.933	1.922	0.921
Spring	27.20	5.12	17.09	0.137	0.193	0.093	1.561	0.241	0.582	2.512	0.986
Summer	43.76	4.96	12.15	0.143	0.054	0.082	0.314	0.437	0.945	0.586	1.071
Fall	24.89	5.39	9.78	0.152	0.073	0.070	0.450	0.407	0.841	0.801	0.889
Annual	120.02	4.96	14.18	0.138	0.102	0.071	0.746	0.321	0.911	1.278	1.004

Washington Crossing State Park – Weekly

	Precip. cm	pH	Cond. uS/cm	Ca ²⁺ mg/L	Mg ²⁺ mg/L	K ⁺ mg/L	Na ⁺ mg/L	NH ₄ ⁺ mg/L	NO ₃ ⁻ mg/L	Cl ⁻ mg/L	SO ₄ ²⁻ mg/L
Winter	21.64	4.88	10.07	0.079	0.032	0.027	0.254	0.169	0.883	0.453	0.625
Spring	40.07	5.03	10.12	0.119	0.059	0.045	0.369	0.268	0.739	0.673	0.889
Summer	59.50	4.88	9.38	0.068	0.024	0.017	0.114	0.237	0.784	0.220	0.784
Fall	38.93	5.10	7.21	0.052	0.031	0.046	0.186	0.223	0.636	0.321	0.564
Annual	165.95	4.94	9.27	0.079	0.033	0.029	0.197	0.231	0.764	0.361	0.753

WET DEPOSITION

Acid deposition is primarily the result of sulfuric and nitric acids and ammonium derived from atmospheric emissions of sulfur dioxide, nitrogen oxides, and ammonia. Excessive deposition of these materials can have significant environmental impacts on both terrestrial and freshwater ecosystems through acidification of soil and water bodies, reducing the diversity of aquatic organisms and stressing native vegetation. (Driscoll et al, 2003)

Sulfate, for example, can alter soil and water chemistry, and a deposition level of 20 kilograms per hectare per year has been generally accepted as the limit above which damage to sensitive natural resources is likely to occur (i.e. Aquatic Effect Level). Deposition in rain and snow is often expressed as mass per unit land area over time (NJCRP, 2003).

Figures 3 and 4 show the change in the amount of sulfate ion deposited over the last several years at the sites in Washington Crossing State Park and the Edwin B. Forsythe NWR, respectively. Figures 5 and 6 show the change in the amount of ammonium ion deposited at these sites, and Figures 7 and 8 shows the change in the amount of nitrate ion deposited. All figures below show “wet deposition” only. They do not include dry particulate deposited when no precipitation was occurring. Therefore, the total deposition is higher than what is shown here.

The year to year variations in the charts below are a function of both the concentrations of sulfate, nitrate, and ammonium in air and cloud droplets, and the total amount of precipitation that occurs each year. For example, in 1991 and 1992, both the sulfate concentrations and the total precipitation were below normal, while they were high in 1993 and 1994. Since the data is in the form of annual totals, it is also sensitive to loss of samples due to contamination or other factors.

According to the New Jersey Comparative Risk Project Ecological Technical Work Group, streams and lakes with significant buffering capacity are somewhat protected from the effects of acid deposition. It is for this reason that actual risk assessments are primarily based on the direct observation of pH in streams and lakes, and on actual observed effects on aquatic species, rather than on deposition measurements alone (NJCRP, 2003).

To convert the values shown in Figure 3 through Figure 8 to pounds per acre per year, multiply by 0.89 (since one kilogram equals 2.21 pounds and one hectare equals 2.47 acres).

Figure 3 through 8 Data Legend	
•	Met Criteria
▲	Did Not Meet Criteria
All Raw Data for Figure 3 through Figure 8 were obtained from the NADP website. NADP criteria requirements can also be found at http://nadp.isws.illinois.edu/ .	

Figure 3
 Sulfate (SO₄) NADP/NTN Site NJ99 (Washington Crossing State Park)
 Annual Wet Deposition (1981-2011)
 Kilograms Per Hectare (kg/ha)

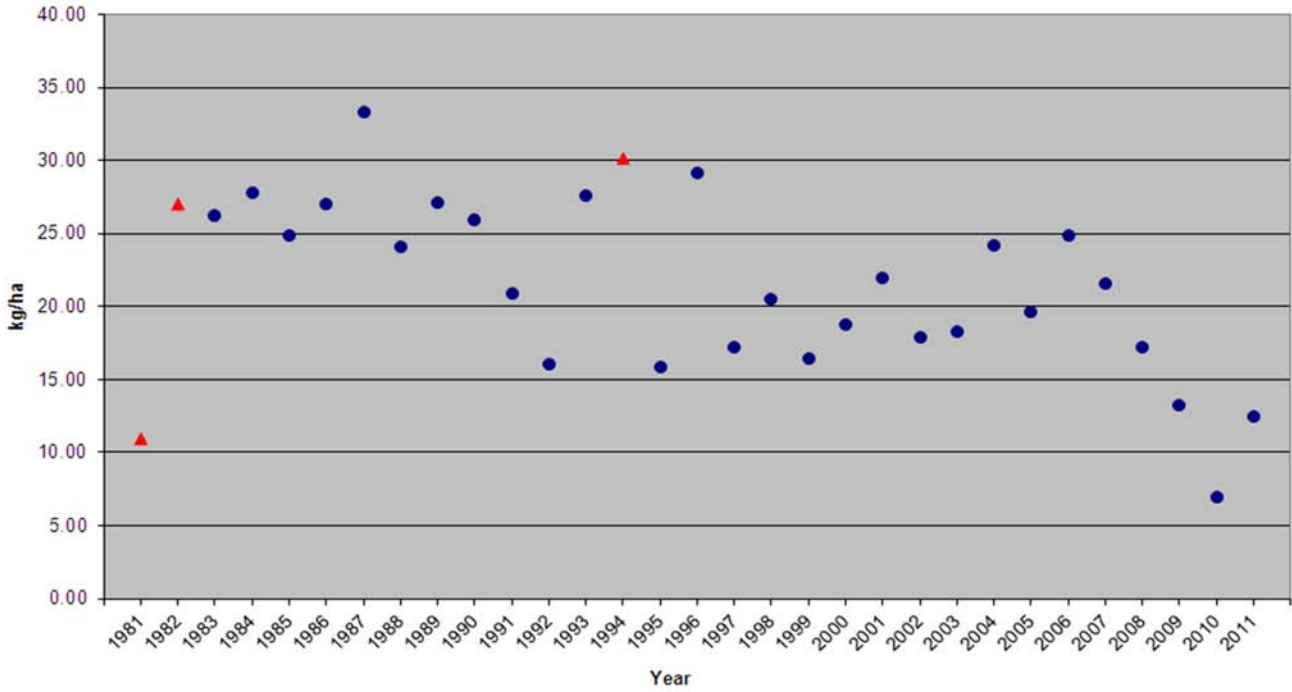


Figure 4
 Sulfate (SO₄) NADP/NTN Site NJ00 (Edwin B. Forsythe National Wildlife Refuge)
 Annual Wet Deposition (1998-2011)
 Kilograms Per Hectare (kg/ha)

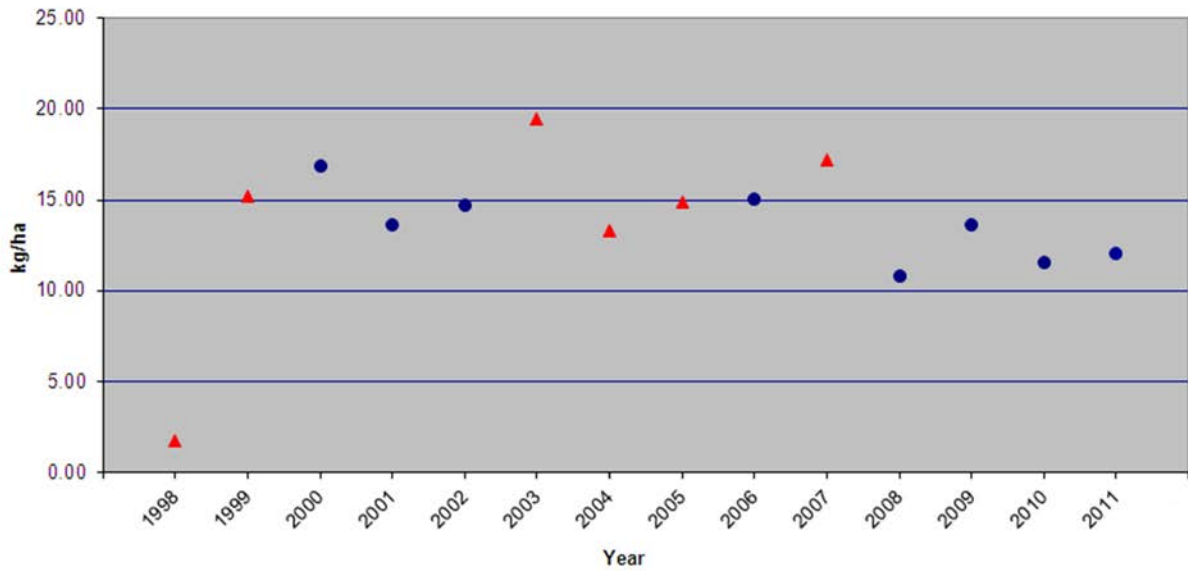


Figure 5
 Ammonium (NH₄) NADP/NTN Site NJ99 (Washington Crossing State Park)
 Annual Wet Deposition (1981-2011)
 Kilograms Per Hectare (kg/ha)

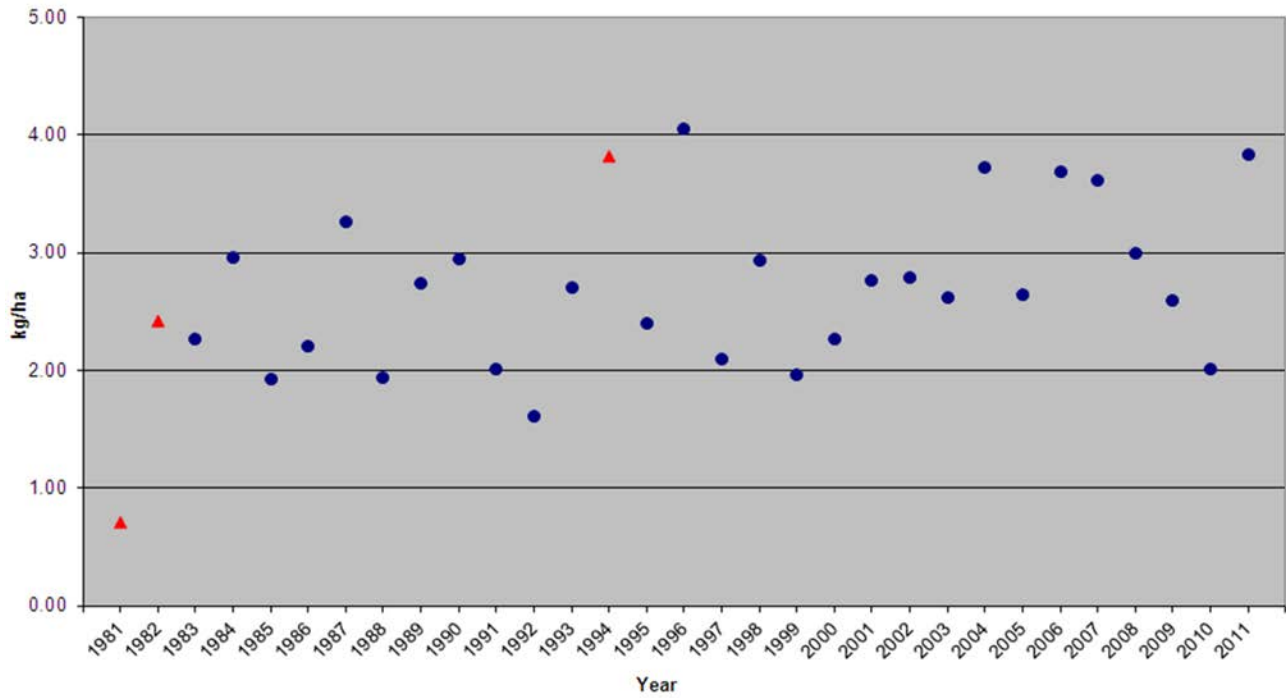


Figure 6
 Ammonium (NH₄) NADP/NTN Site NJ00 (Edwin B. Forsythe National Wildlife Refuge)
 Annual Wet Deposition (1998-2011)
 Kilograms Per Hectare (kg/ha)

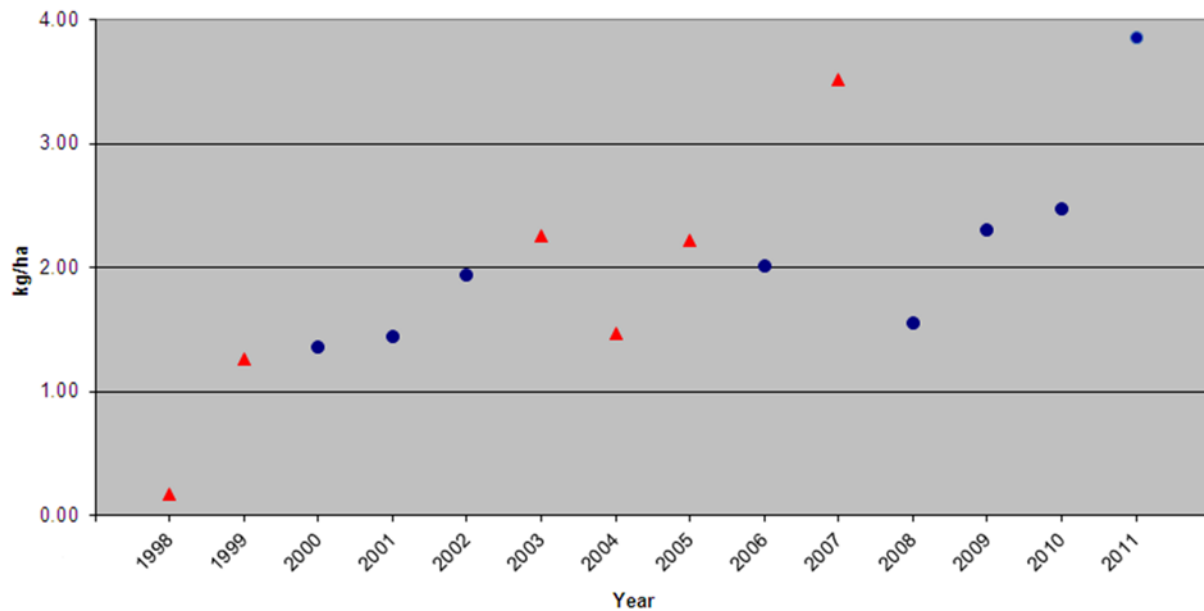


Figure 7
 Nitrate (NO₃) NADP/NTN Site NJ99 (Washington Crossing State Park)
 Annual Wet Deposition (1981-2011)
 Kilograms Per Hectare (kg/ha)

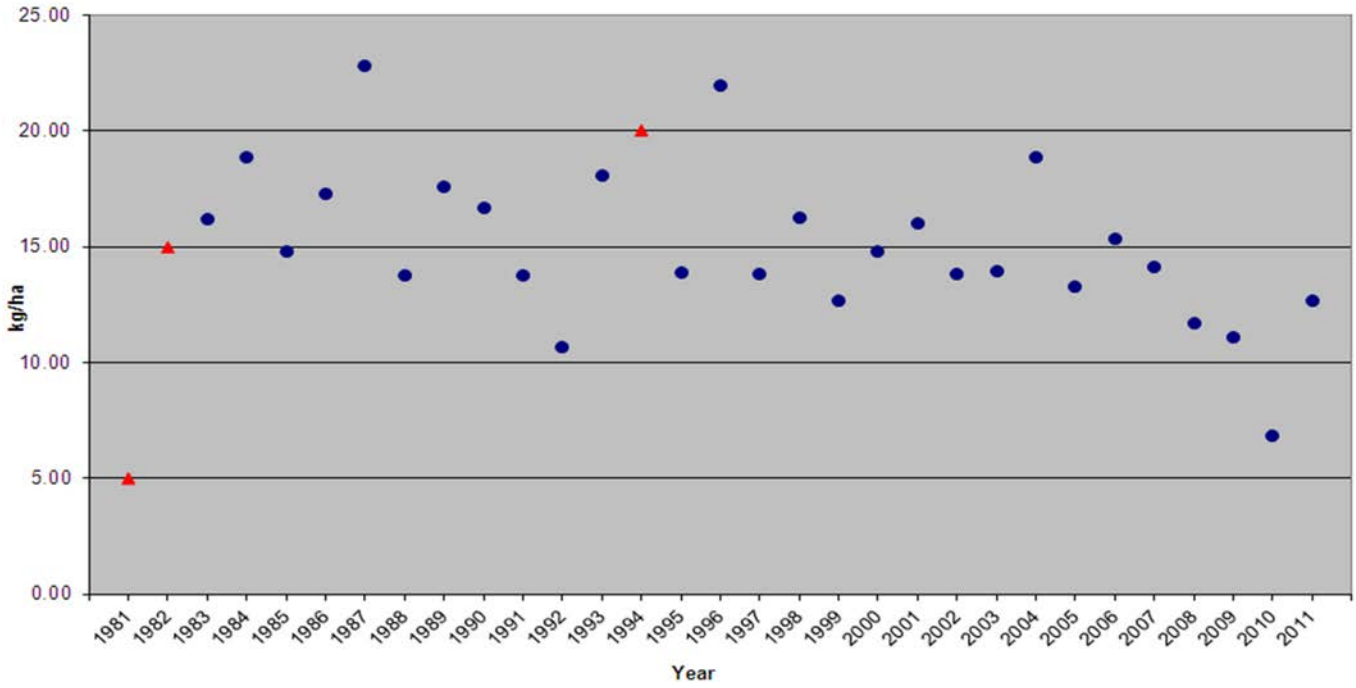
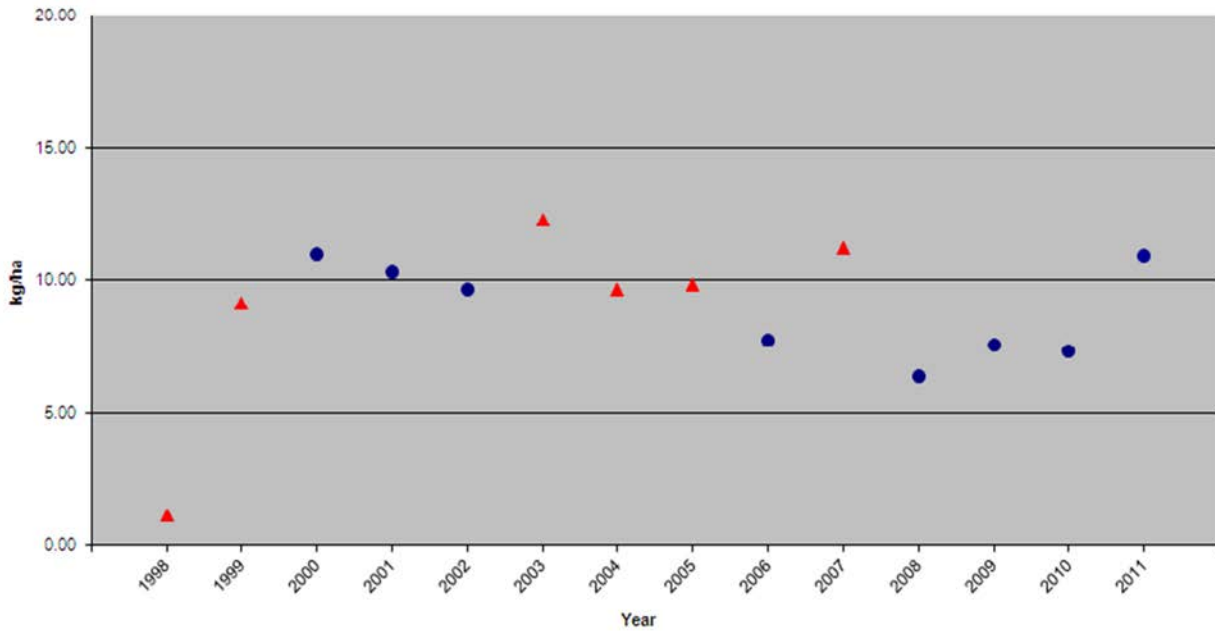


Figure 8
 Nitrate (NO₃) NADP/NTN Site NJ00 (Edwin B. Forsythe National Wildlife Refuge)
 Annual Wet Deposition (1998-2011)
 Kilograms Per Hectare (kg/ha)



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2011 Regional Haze & Visibility

New Jersey Department of Environmental Protection

THE BASICS OF HAZE

Haze is a type of visibility impairment usually associated with air pollution, and to a lesser extent, moisture in the atmosphere. Small particles and certain gaseous molecules can cause poor visibility by scattering or absorbing light before it reaches an observer (Figure 1). When high concentrations of such pollutants are well mixed in the atmosphere they form a uniform haze that can obscure distant objects.

Air pollutants come from a variety of natural and man-made sources and can occur at any time of year. Natural sources include small particles at the ocean surface and windblown dust and soot from wildfires and volcanoes. Man-made sources, which are the primary cause of visibility impairment includes motor vehicle emissions, electric utility and industrial fuel burning emissions, and manufacturing operations.

Pollution from both natural and man-made sources can be transported over long distances and across state borders on prevailing winds causing the problem of regional haze.

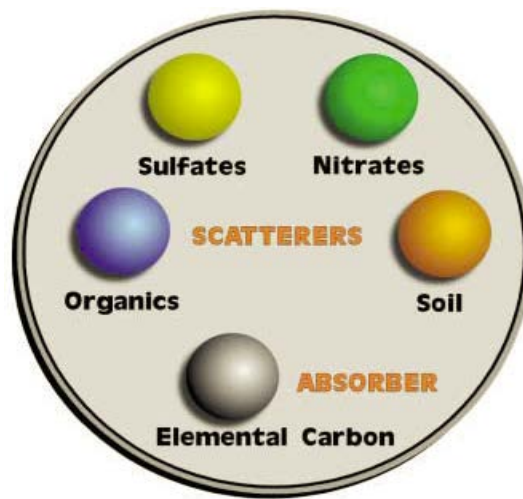
ANATOMY OF REGIONAL HAZE

Data collected over the last decade shows that fine particle concentrations are highest in the industrialized and densely populated areas of the Northeast and Mid-Atlantic. These particles are a major contributor to visibility impairment at all times of the year. The following categories of air pollutants are the major contributors to haze. (Source - www.hazecam.net)

Sulfate particles form in the air from sulfur dioxide gas. Most of this gas is released from coal-burning power plants and other industrial sources, such as smelters, industrial boilers, and oil refineries. Sulfates are the largest contributor to haze in the eastern U.S., due to the large number of coal-fired power plants that affect the region. In humid environments, sulfate particles grow rapidly to a size that is very efficient at scattering light, thereby exacerbating the problem in the East.

Organic carbon particles are emitted directly into the air and are also formed by the reaction of various gaseous hydrocarbons. Sources of direct and indirect organic carbon particles include vehicle exhaust, vehicle refueling, solvent evaporation (e.g., paints), food cooking, and various commercial and industrial sources. Gaseous hydrocarbons are also emitted naturally from trees and from fires, but these sources usually have only a small or short-term effect on overall visibility.

Figure 1
Contributors to Visibility Impairment



(Malm, 1999)

Nitrate particles form in the air from nitrogen oxide gas. This gas is released from virtually all combustion activities, especially those involving cars, trucks, off-road engines (e.g., construction equipment, lawn mowers, and boats), power plants, and other industrial sources. Like sulfates, nitrates scatter more light in humid environments.

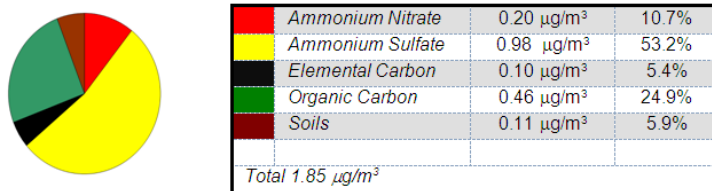
Elemental carbon particles are very similar to soot. They are smaller than most other particles and tend to absorb rather than scatter light. The "brown clouds" often seen in winter over urban areas and in mountain valleys can be largely attributed to elemental carbon. These particles are emitted directly into the air from virtually all combustion activities, but are especially prevalent in diesel exhaust and smoke from the burning of wood and wastes.

Soils are very similar to dust. It enters the air from dirt roads, fields, and other open spaces as a result of wind, traffic, and other surface activities. Whereas other types of particles form from the condensation and growth of microscopic particles and gasses, crustal material results from the crushing and grinding of larger, earth-born material. Because it is difficult to reduce this material to microscopic sizes, crustal material tends to be larger than other particles and tends to fall from the air sooner, contributing less to the overall effect of haze.

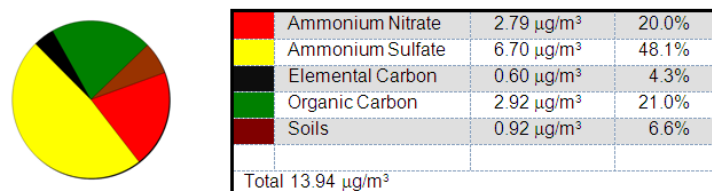
PARTICLES AND VISIBILITY

Figure 2 (below) shows the makeup of fine particles collected at the Interagency Monitoring of Protected Visual Environments (IMPROVE) site located north of Atlantic City in the Edwin B. Forsythe National Wildlife Refuge (Brigantine).

Figure 2
Composition of Fine Particles on Days with Good Visibility Compared to Days with Poor Visibility
Brigantine, NJ
July 2010 – June 2011 **
Average Fine Mass Composition on Days with Good Visibility



Average Fine Mass Composition on Days with Poor Visibility



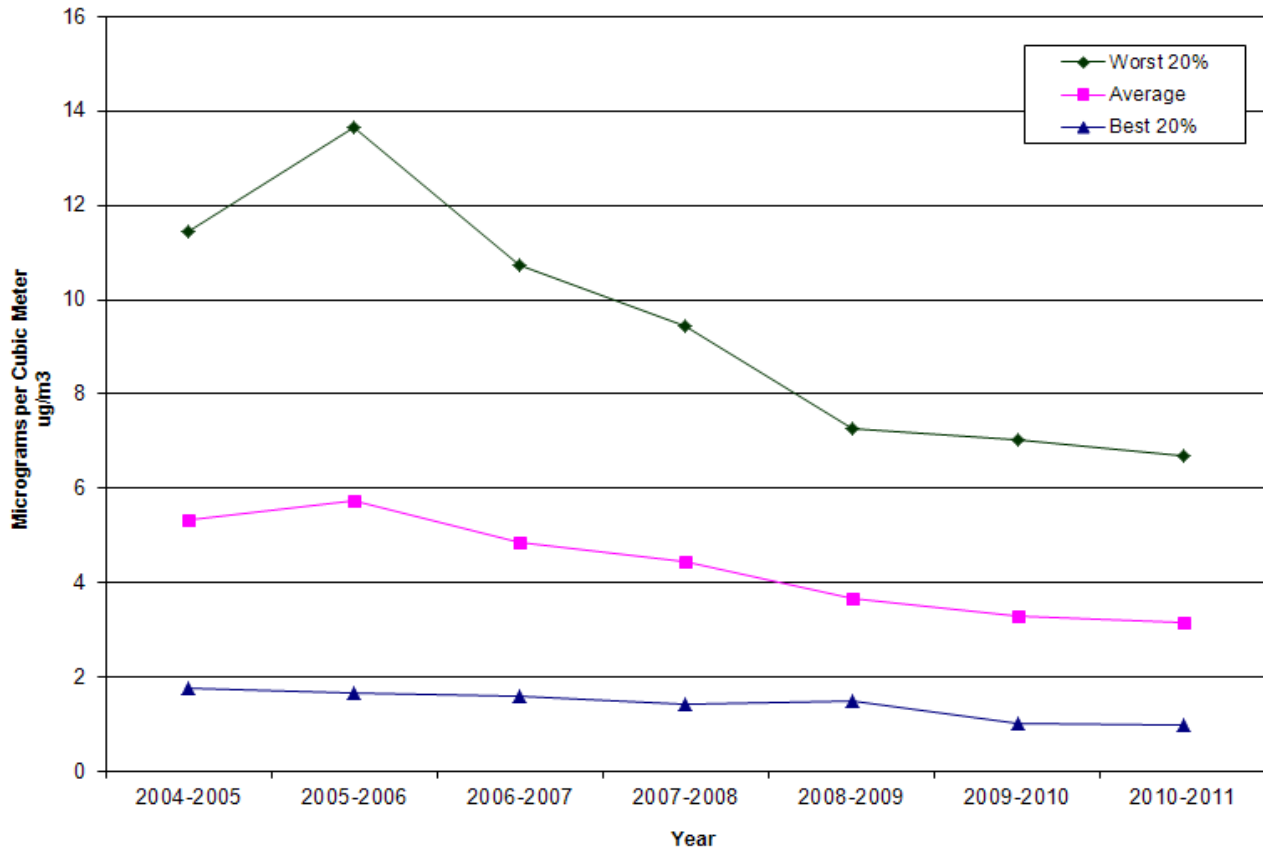
** For this report annual data for a given year is defined as data from July 1st – June 30th of the following year

Most visibility impairment is due to sulfate, which can have a greater effect on light extinction (a measure of visibility impairment), due to its ability to accumulate water and grow in size during humid conditions. Evaluations of the data for 2010-2011 indicate that sulfates accounted for approximately half of the total fine particle mass on both days with good and bad visibility. Higher sulfate values in the summer can be attributed to the greater photochemical conversion of sulfur dioxide (SO_2) to sulfate that result from the increased sunlight during the summertime. (Malm, 1999)

The graph below (Figure 3) represents the annual trend of sulfates expressed in micrograms per cubic meter measured at the Brigantine National Wildlife Refuge.

The graph shows the annual average for each year as well as the average concentration on the days with the best visibility, and the average on the days with the worst visibility, using the upper and lower 20% of the data as a cut off. Sulfate trends have improved over the last few years as a result of more stringent guidelines from both the United States Environmental Protection Agency (USEPA) and statewide planning to improve overall air quality and visibility issues.

Figure 3
Sulfate Trend Summary**
Brigantine, NJ
2004-2011



**For this report annual data for a given year is defined as data from July 1st – June 30th of the following year

HOW IS HAZE REGULATED?

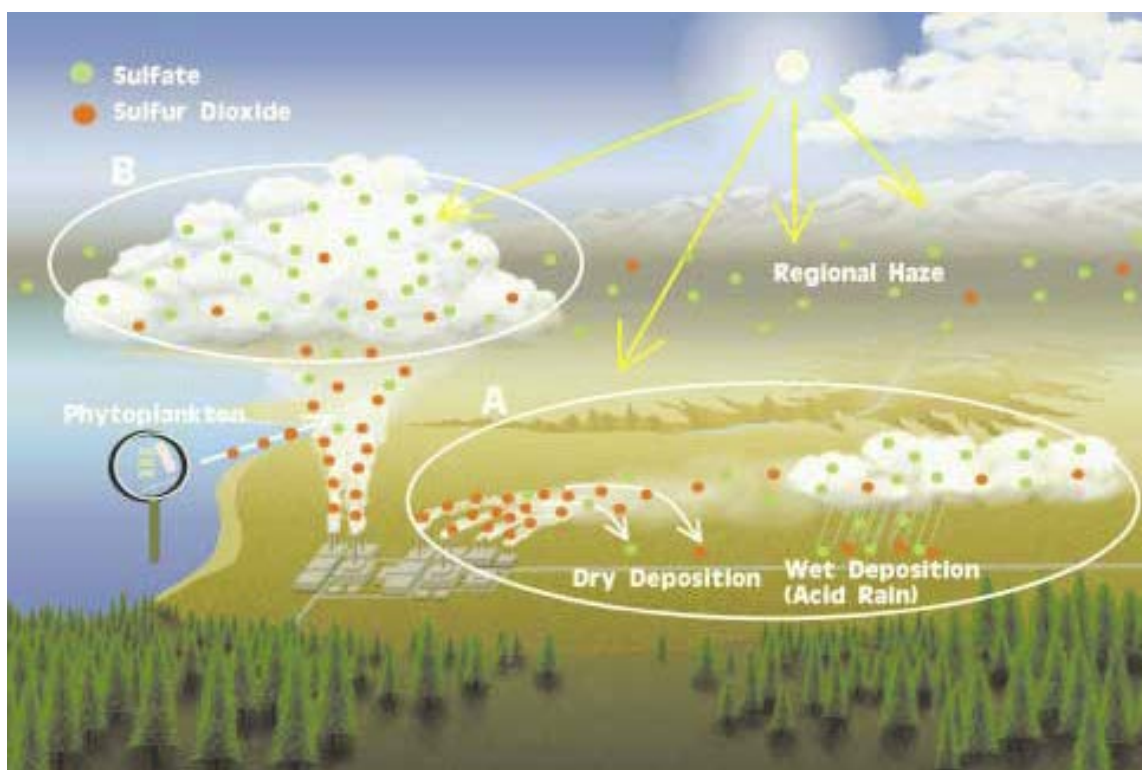
In 1999, the U.S. Environmental Protection Agency announced a major effort to improve air quality in national parks and wilderness areas aimed at achieving national visibility goals by 2064. The Regional Haze Rule calls for state and federal agencies to work together to improve visibility in 156 National Parks and wilderness areas such as the Grand Canyon, Yosemite, the Great Smokies and Shenandoah. This "regional haze rule" addresses the combined visibility effects of numerous pollution sources over a wide geographic region and how they impact Class I areas. Class I areas, as defined by the Clean Air Act, include national parks greater than 6,000 acres, wilderness areas and national memorial parks greater than 5,000 acres, and international parks that existed as of August 1977. This definition includes the Edwin B. Forsythe National Wildlife Refuge in Brigantine, New Jersey. The rule requires the states, in

coordination with the Environmental Protection Agency, the National Park Service, U.S. Fish and Wildlife Service, the U.S. Forest Service, and other interested parties, develop and implement air quality protection plans to reduce the pollution that causes visibility impairment. The first State plans for regional haze were due in the 2003-2008 timeframe. New Jersey proposed its first plan in September 2008 and was finalized in July 2009 for its Class I Area in Brigantine.

ENVIRONMENTAL EFFECTS

Regional haze is most closely associated with its effects on prized vistas such as the Grand Canyon, Acadia National Park, or Class I Areas, such as Brigantine. Its impacts may be difficult to quantify but it certainly has a negative overall effect on aesthetics and the outdoors, and how natural areas throughout the nation are enjoyed. Haze also affects urban areas and scenes, and can obscure or eclipse the view of an urban skyline or other important urban landmarks such as the Washington Monument. The pollution that causes regional haze has additional effects on the environment through the acidic makeup of fine particles, such as sulfates. Sulfates eventually make their way into the ecosystem through atmospheric deposition - that is, they are transferred from the air into the water and soils (Figure 4). Too much atmospheric deposition can have adverse environmental effects by upsetting the delicate balance of the ecosystem; thus, causing damage to waterways, plants, soils, and wildlife (see section on Atmospheric Deposition).

Figure 4
Illustration of How Sulfates Enter the
Ecosystem by way of Deposition



MONITORING OF HAZE IN NEW JERSEY

Typical visual range in the eastern U.S. is 15 to 30 miles, or about one-third of what it would be without man-made air pollution. In the West, the typical visual range is 60 to 90 miles, or about one-half of the visual range under natural conditions. Haze diminishes this natural visual range. (www.hazecam.net).

Visibility and haze are monitored in two locations in New Jersey, Newark and Brigantine. The monitor in Newark measures the impact of haze on visibility by using a digital camera. The camera is located inside the New Jersey Transit building and is pointed at the New York City skyline. On clear days the entire skyline, as well as each individual building, is easily distinguishable (Figure 5). The Manhattan skyline appears non-existent when conditions conducive to haze formation are in place (Figure 6).

Visibility Camera – New Jersey Transit Building

Figure 5



Figure 6



The IMPROVE site located within the Edwin B. Forsythe National Wildlife Refuge in Brigantine monitors haze and visibility using a digital camera. Figure 7 below is an example of a clear day in Brigantine as the Atlantic City skyline is easily distinguishable along the horizon. The example of a hazy day in Brigantine is illustrated below in Figure 8 and the skyline is barely visible.

Visibility Camera – Brigantine National Wildlife Refuge

Figure 7

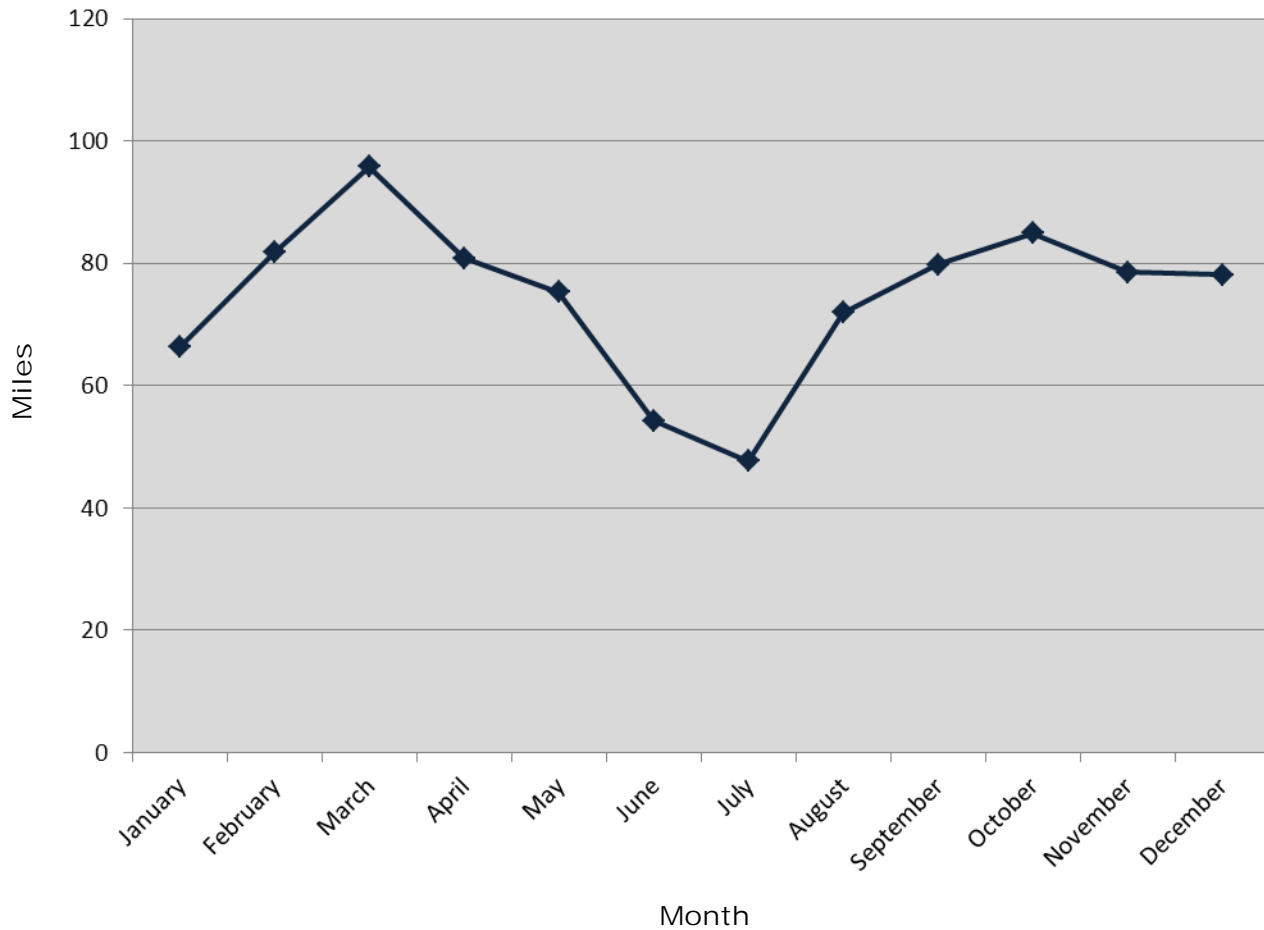


Figure 8



Brigantine also provides a real-time direct measurement of the light scattered by particles in the air that can interfere with visibility using a nephelometer. The data below (Figure 9) helps distinguish visual range in miles using a monthly average. This graph shows that monthly visual range is most impaired during the summertime months when hazy and humid conditions are most apparent.

Figure 9
Monthly Average Visual Range
Brigantine, NJ



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Appendix A

2011 Air Monitoring Sites

New Jersey Department of Environmental Protection

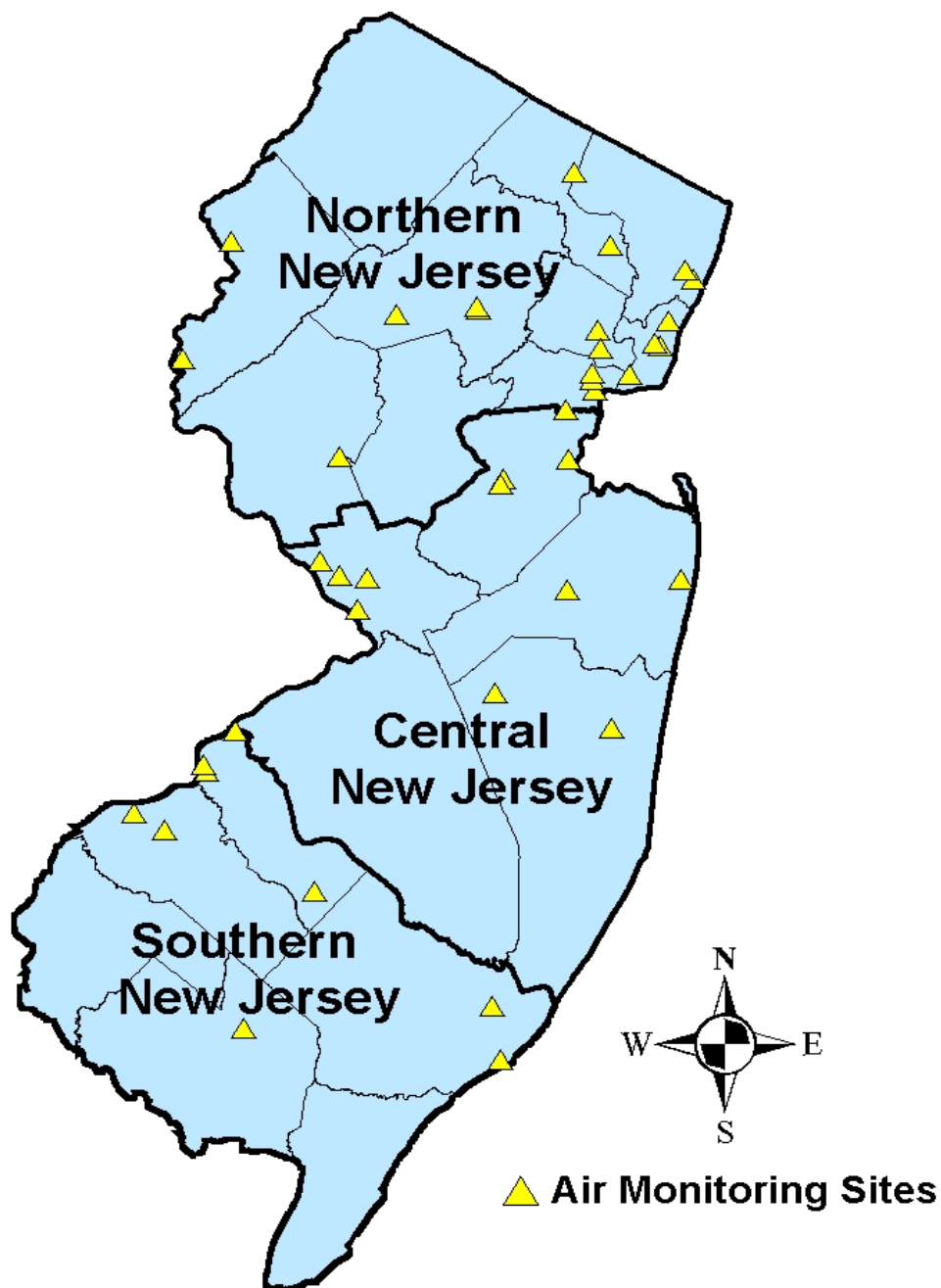


FIGURE 1
NORTHERN NEW JERSEY
AIR MONITORING SITES

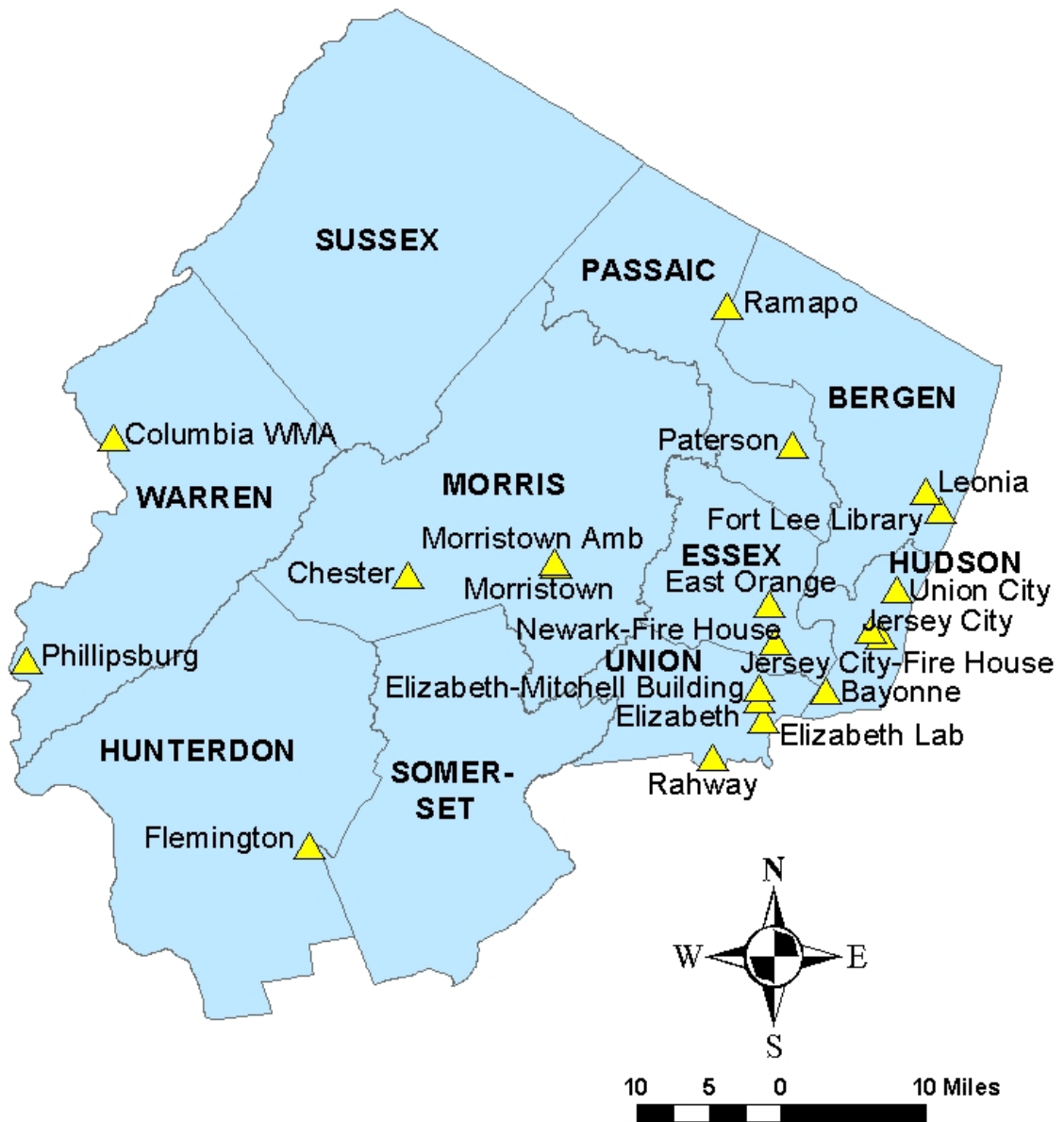


Table 1
Northern New Jersey Air Monitoring Sites

County	Monitoring Site	AIRS 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	Fort Lee Public Library, 320 Main Street
	Leonia	34 003 0006	O ₃	40.870436	-73.991994	Over peck Park, 40 Fort Lee Road
ESSEX	East Orange	34 013 1003	CO, NO _x , MET	40.757501	- 74.200500	Engine No. 2, Main Street and Greenwood Avenue
	Newark-Fire House	34 013 0003	CO, O ₃ , SO ₂ , TEOM, PM _{2.5} , PM _{2.5} Spec, MET, NO _y , NO _x	40.720989	-74.192892	360 Clinton Avenue
HUDSON	Bayonne	34 017 0006	NO _x , O ₃ , SO ₂	40.670250	- 74.126081	Veterans Park on Newark Bay, 25 th St. near Park Road
	Jersey City	34 017 1002	CO, SO ₂ , SS	40.731690	- 74.066566	2828 Kennedy Boulevard
	Jersey City-Firehouse	34 017 1003	PM _{2.5} , PM ₁₀ , TEOM	40.725454	- 74.052290	Consolidated Firehouse, 355 Newark Avenue
	Union City	34 017 2002	PM _{2.5}	40.772793	-74.031718	Health Department, 714 , 31 st Street
HUNTERDON	Flemington	34 019 0001	O ₃ , MET, TEOM	40.515253	-74.806753	Raritan Twp. Municipal Utilities Authority, 365 Old York Road
MORRIS	Chester	34 027 3001	NO _x , O ₃ , SO ₂ , PM _{2.5} , TOXICS, Hg, PM _{2.5} Spec, MET	40.787628	- 74.676301	Bldg. #1, Department of Public Works, (DPW), Route 513
	Morristown	34 027 0003	CO	40.797342	-74.482494	11 Washington Street
	Morristown-Ambulance Squad	34 027 0004	PM _{2.5}	40.801211	- 74.483433	16 Early Street
PASSAIC	Paterson	34 031 0005	PM _{2.5}	40.918381	-74.168092	Health Department, 176 Broadway Avenue
	Ramapo	34 031 5001	O ₃	41.058617	- 74.255544	Ramapo Mountain State Forest, Access Road, off Skyline Drive
UNION	Elizabeth	34 039 0003	CO, SO ₂ , SS	40.662389	- 74.214817	7 Broad Street
	Elizabeth Lab	34 039 0004	CO, NO _x , SO ₂ , SS, TEOM, MET, PM _{2.5} , TOXICS, Hg, PM _{2.5} Spec	40.641440	- 74.208365	Interchange 13, New Jersey Turnpike
	Elizabeth-Mitchell Building	34 039 0006	PM _{2.5}	40.673406	-74.213889	Mitchell Bldg., 500 North Broad Street
	Rahway	34 039 2003	PM _{2.5} , TEOM	40.603943	- 74.276174	Fire Dept. Bldg., 1300 Main Street
WARREN	Columbia WMA	34 041 0007	NO _x , O ₃ , SO ₂ , PM _{2.5} , TEOM, MET	40.924606	-75.067825	Columbia Wildlife Management Area, Delaware Road
	Phillipsburg	34 041 0006	PM _{2.5}	40.699207	- 75.180525	Municipal Bldg., 675 Corliss Avenue

¹ See Parameter Codes, Table 4 (Appendix A-8)

FIGURE 2
CENTRAL NEW JERSEY
AIR MONITORING SITES

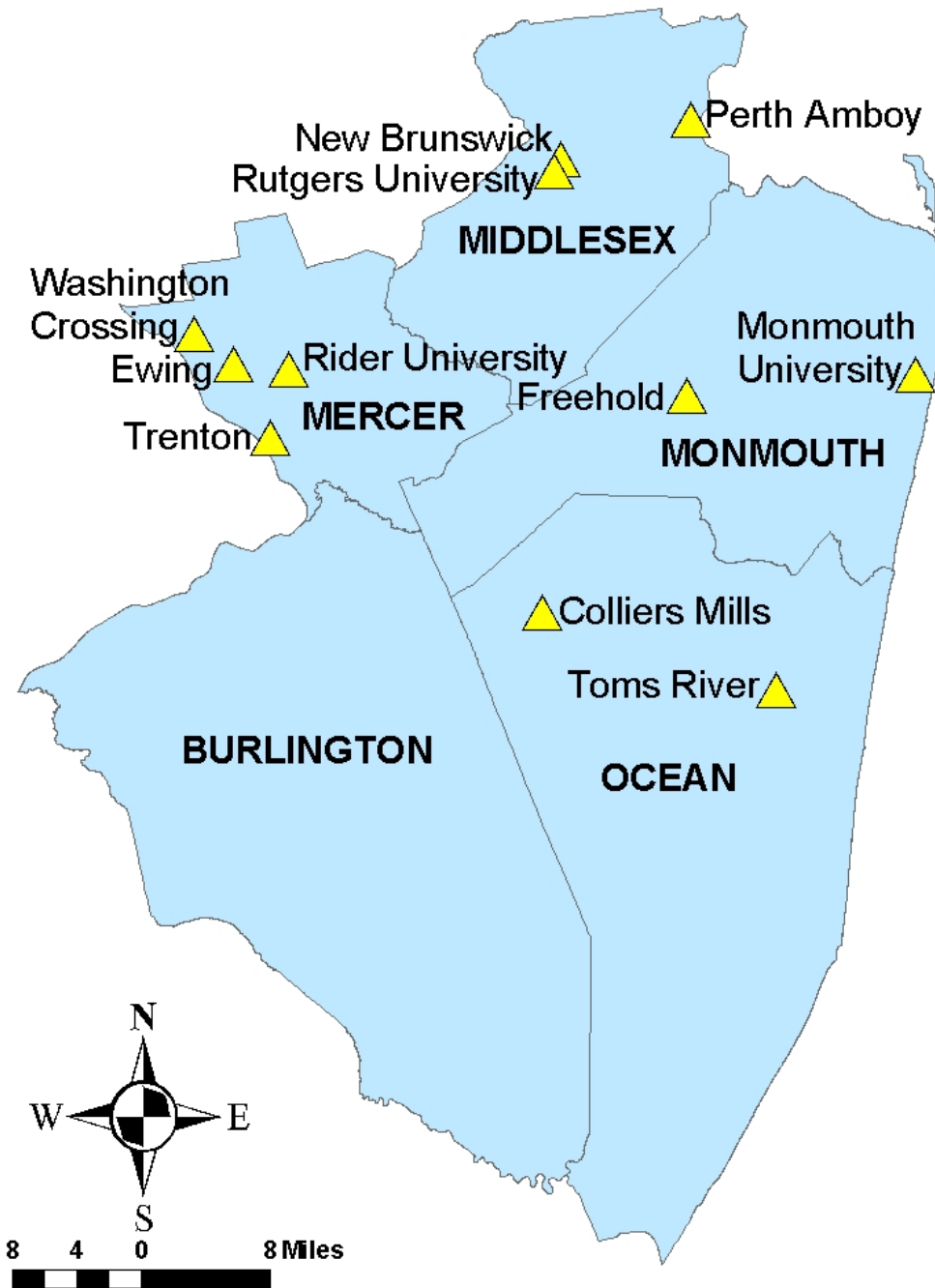


Table 2
Central New Jersey Air Monitoring Sites

County	Monitoring Site	AIRS Code	Parameter(s) Measured ¹	Coordinates (Decimal degrees)		Address
				Latitude	Longitude	
MERCER	Ewing	34 021 0010	TEOM	40.287530	-74.807770	Bureau of Air Monitoring Technical Center, 380 Scotch Road
	Rider University	34 021 0005	O ₃ , MET	40.283092	-74.742644	Athletic Fields, Route 206 South
	Trenton	34 021 0008	PM _{2.5} , PM ₁₀	40.222411	-74.763167	Trenton Library, 120 Academy Street
	Washington Crossing	34 021 8001	PM _{2.5} , ACID	40.315350	-74.853617	Washington Crossing State Park, near 66 Church Road
MIDDLESEX	New Brunswick	34 023 0006	TEOM, PM _{2.5} , Hg, PM _{2.5} Spec, TOXICS	40.472825	- 74.422403	Cook College, Log Cabin Road near Horticulture Lab
	Perth Amboy	34 023 2003	CO	40.508764	-74.268083	130 Smith Street
	Rutgers University	34 023 0011	NO _x , O ₃ , MET ² , PAMS	40.462182	- 74.429439	Horticultural Farm #3, off Ryder's Lane
MONMOUTH	Freehold	34 025 2001	CO	40.259895	- 74.274689	5 West Main Street
	Monmouth University	34 025 0005	O ₃	40.277647	- 74.005100	Edison Science Bldg., 400 Cedar Avenue
OCEAN	Colliers Mills	34 029 0006	O ₃	40.064847	-74.444058	Colliers Mills Wildlife Management Area
	Toms River	34 029 2002	PM _{2.5}	39.994908	-74.170447	Hooper Avenue Elementary School, 1517 Hooper Avenue

¹ See Parameter Codes, Table 4 (page Appendix A-8)

² Meteorological Measurements at the site are collected by Rutgers University

FIGURE 3
SOUTHERN NEW JERSEY
AIR MONITORING SITES

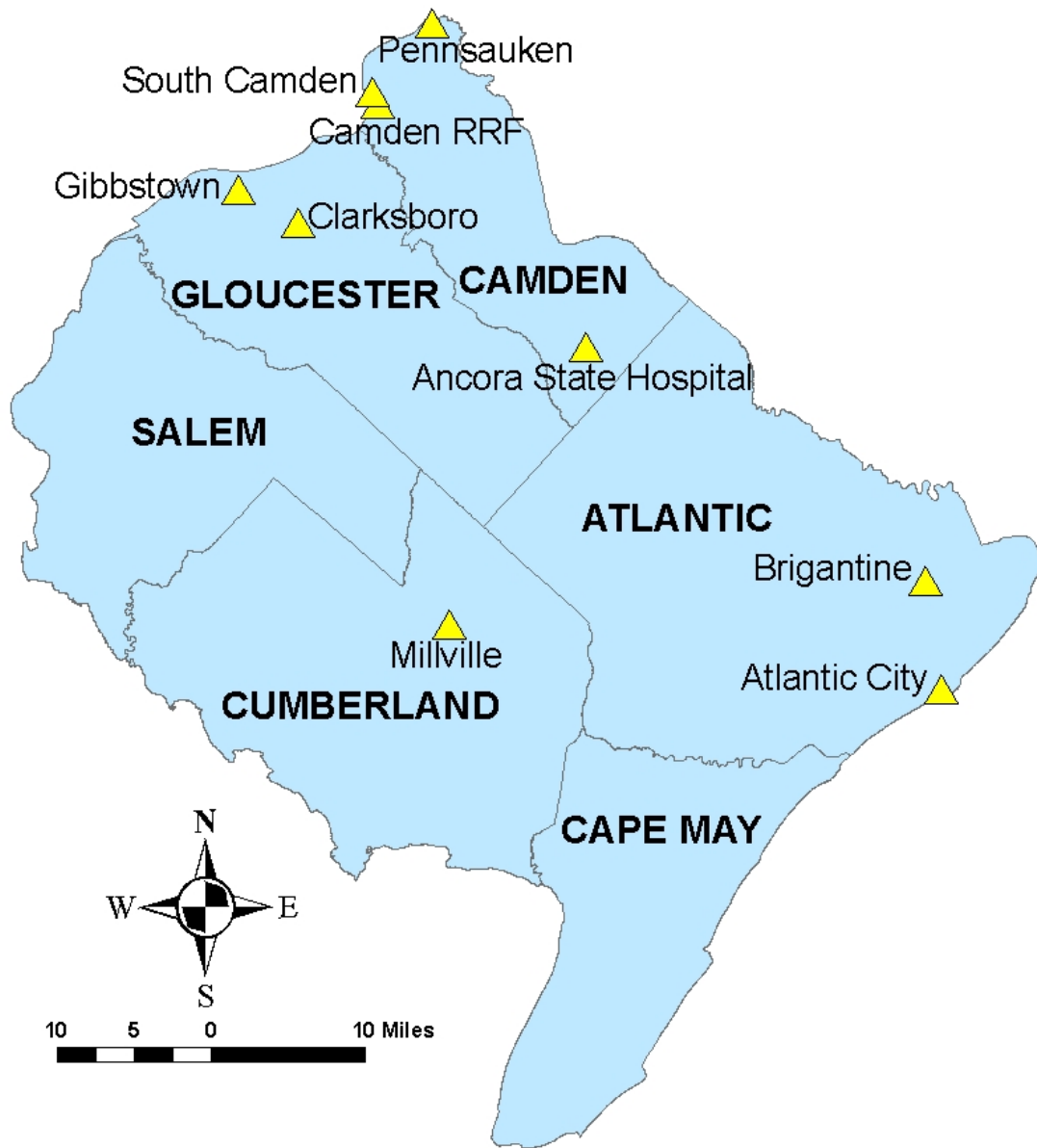


Table 3
Southern New Jersey Air Monitoring Sites

County	Monitoring Site	AIRS Code	Parameter(s) Measured ¹	Coordinates (Decimal degrees)		Address
				Latitude	Longitude	
ATLANTIC	Atlantic City	34 001 1006	PM _{2.5}	39.363528	-74.431219	1535 Bacharach Boulevard
	Brigantine	34 001 0006	Visibility, O ₃ , SO ₂ , TEOM, PM _{2.5} , Hg, ACID ³	39.464872	-74.448736	Edwin B. Forsythe National Wildlife Refuge Visitor Center, Great Creek Road
CAMDEN	Ancora State Hospital	34 007 1001	CO, O ₃ , ACID	39.684250	- 74.861491	Ancora State Hospital, 202 Spring Garden Road
	South Camden	34 007 0010	TEOM	39.923969	-75.122317	Camden County Municipal Utilities Authority, 1645 Ferry Avenue
	Camden-RRF	34 007 0009	PM ₁₀	39.912431	- 75.116864	Camden RRF, Morgan Blvd. & I-676 entrance ramp
	Pennsauken	34 007 1007	PM _{2.5}	39.989036	-75.050008	Morris-Delair Water Treatment Plant Off Griffith Morgan Lane
CUMBERLAND	Millville	34 011 0007	NO _x , O ₃ , TEOM	39.422273	- 75.025204	Lincoln Avenue & Route 55. Northeast of Millville
GLOUCESTER	Clarksboro	34 015 0002	O ₃	39.800339	-75.212119	Clarksboro Shady Rest Home, Shady Lane and County House Road
	Gibbstown	34 015 0004	PM _{2.5}	39.830806	-75.284723	Municipal Maintenance Yard, North School Street, North of Morse Avenue

¹ See Parameter Codes, Table 4 (page Appendix A-8)

³ The United States Fish and Wildlife Service-Air Quality Branch (USFWS-AQB) is responsible for sample collection

Table 4
Parameter Codes

ACID	Acid Deposition	PAMS	Photochemical Assessment Monitoring Station measure for ozone precursors
CO	Carbon Monoxide	PM₁₀	Coarse particles (10 Microns or less) collected by a Federal Reference Method PM ₁₀ Sampler
Hg	Mercury	PM_{2.5}Spec	Speciated (2.5 Microns or Less) fine particles
MET	Meteorological Parameters	PM_{2.5}	Fine Particles (2.5 Microns or less) collected by a Federal Reference Method PM _{2.5} Sampler
Visibility	Measured by Nephelometer	TEOM	Real-Time PM _{2.5} Analyzer
NO_x	Nitrogen Dioxide and Nitric Oxide	SO₂	Sulfur Dioxide
NO_y	Total Reactive Oxides of Nitrogen	SS	Smoke Shade
O₃	Ozone	TOXICS	Air Toxics



2011 Appendix B

Fine Particulate Speciation Summary- 2011

New Jersey Department of Environmental Protection

Table 1
Fine Particulate Speciation Data – 2011
Chester, New Jersey

Concentrations in Micrograms Per Cubic Meter ($\mu\text{g}/\text{m}^3$)

Pollutant	Annual Average Concentration	Daily Average Maximum Concentration	Daily Average 2nd Highest Concentration
Aluminum	0.0250	0.3027	0.1910
Ammonium	0.6328	2.5831	2.3150
Antimony	0.0073	0.0665	0.0619
Arsenic	0.0003	0.0029	0.0024
Barium	0.0005	0.0099	0.0066
Bromine	0.0024	0.0075	0.0058
Cadmium	0.0023	0.0210	0.0190
Calcium	0.0141	0.0558	0.0518
Cerium	0.0001	0.0020	0.0015
Cesium	0.0009	0.0077	0.0072
Chlorine	0.0040	0.0399	0.0200
Chromium	0.0040	0.0671	0.0569
Cobalt	0.0004	0.0022	0.0022
Copper	0.0015	0.0086	0.0085
Elemental carbon	0.1662	0.4590	0.3674
Indium	0.0037	0.0241	0.0228
Iron	0.0369	0.2344	0.2302
Lead	0.0011	0.0063	0.0062
Magnesium	0.0013	0.0344	0.0207
Manganese	0.0007	0.0069	0.0031
Nickel	0.0014	0.0178	0.0170
Nitrate	0.7873	3.9740	3.7155
Organic carbon	1.6693	4.7371	3.9869
Phosphorus	0.0000	0.0013	0.0000
Potassium	0.0334	0.1652	0.1107
Rubidium	0.0002	0.0015	0.0013
Selenium	0.0004	0.0022	0.0021
Silicon	0.0264	0.1137	0.1100
Silver	0.0013	0.0162	0.0151
Sodium	0.0442	0.3167	0.1408
Strontium	0.0005	0.0114	0.0044
Sulfate	1.8805	6.8984	6.8757

Table 1 (Continued)
Fine Particulate Speciation Data – 2011
Chester, New Jersey

Concentrations in Micrograms Per Cubic Meter ($\mu\text{g}/\text{m}^3$)

Pollutant	Annual Average Concentration	Daily Average Maximum Concentration	Daily Average 2nd Highest Concentration
Sulfur	0.6287	2.1593	2.0655
Tin	0.0043	0.0536	0.0535
Titanium	0.0009	0.0074	0.0061
Total mass	7.6126	17.9178	17.7411
Vanadium	0.0006	0.0058	0.0043
Zinc	0.0056	0.0976	0.0212
Zirconium	0.0008	0.0086	0.0084

Table 2
Fine Particulate Speciation Data – 2011
Elizabeth Lab, New Jersey

Concentrations in Micrograms Per Cubic Meter ($\mu\text{g}/\text{m}^3$)

Pollutant	Annual Average Concentration	Daily Average Maximum Concentration	Daily Average 2nd Highest Concentration
Aluminum	0.0292	0.1662	0.1507
Ammonium	1.0461	3.8907	3.6136
Antimony	0.0076	0.0511	0.0442
Arsenic	0.0004	0.0050	0.0022
Barium	0.0027	0.0297	0.0204
Bromine	0.0032	0.0130	0.0076
Cadmium	0.0031	0.0314	0.0177
Calcium	0.0355	0.0943	0.0823
Cerium	0.0001	0.0037	0.0026
Cesium	0.0006	0.0078	0.0049
Chlorine	0.0395	1.5634	0.2614
Chromium	0.0023	0.0185	0.0165
Cobalt	0.0007	0.0033	0.0028
Copper	0.0057	0.0219	0.0219
Elemental carbon	1.2887	4.3665	3.9854
Indium	0.0034	0.0337	0.0256
Iron	0.1390	0.4776	0.3793
Lead	0.0017	0.0091	0.0085
Magnesium	0.0063	0.1166	0.1072
Manganese	0.0020	0.0086	0.0073
Nickel	0.0028	0.0131	0.0116
Nitrate	1.4739	7.3653	6.0702
Organic carbon	2.7921	8.1573	7.4468
Phosphorus	0.0001	0.0019	0.0016
Potassium	0.0443	0.3251	0.1201
Rubidium	0.0001	0.0015	0.0013
Selenium	0.0004	0.0022	0.0020
Silicon	0.0592	0.1927	0.1745
Silver	0.0016	0.0154	0.0154
Sodium	0.1067	1.2436	0.6778
Strontium	0.0006	0.0066	0.0060
Sulfate	2.3149	10.1286	6.4079

Table 2 (Continued)
Fine Particulate Speciation Data – 2011
Elizabeth Lab, New Jersey

Concentrations in Micrograms Per Cubic Meter ($\mu\text{g}/\text{m}^3$)

Pollutant	Annual Average Concentration	Daily Average Maximum Concentration	Daily Average 2nd Highest Concentration
Sulfur	0.8320	3.3688	2.5617
Tin	0.0045	0.0512	0.0500
Titanium	0.0028	0.0147	0.0133
Total mass	12.9252	35.1997	32.2149
Vanadium	0.0057	0.0330	0.0312
Zinc	0.0121	0.0450	0.0384
Zirconium	0.0010	0.0151	0.0116

Table 3
Fine Particulate Speciation Data – 2011
New Brunswick, New Jersey

Concentrations in Micrograms Per Cubic Meter ($\mu\text{g}/\text{m}^3$)

Pollutant	Annual Average Concentration	Daily Average Maximum Concentration	Daily Average 2nd Highest Concentration
Aluminum	0.0447	0.3718	0.2548
Ammonium	0.7216	3.4420	2.3490
Antimony	0.0066	0.0548	0.0501
Arsenic	0.0004	0.0037	0.0028
Barium	0.0009	0.0183	0.0105
Bromine	0.0027	0.0079	0.0069
Cadmium	0.0031	0.0291	0.0268
Calcium	0.0392	0.1859	0.1356
Cerium	0.0002	0.0026	0.0020
Cesium	0.0007	0.0111	0.0064
Chlorine	0.0398	0.7060	0.6398
Chromium	0.0053	0.0927	0.0778
Cobalt	0.0007	0.0038	0.0024
Copper	0.0047	0.0233	0.0207
Elemental carbon	0.3253	1.1620	0.8460
Indium	0.0018	0.0168	0.0152
Iron	0.1039	0.6505	0.3373
Lead	0.0019	0.0097	0.0082
Magnesium	0.0061	0.0986	0.0910
Manganese	0.0026	0.0193	0.0117
Nickel	0.0021	0.0236	0.0196
Nitrate	0.9783	6.1688	4.7120
Organic carbon	2.0609	7.0724	4.9515
Phosphorus	0.0000	0.0021	0.0008
Potassium	0.0490	0.2089	0.1690
Rubidium	0.0001	0.0014	0.0012
Selenium	0.0003	0.0021	0.0017
Silicon	0.0857	0.5599	0.3856
Silver	0.0014	0.0195	0.0170
Sodium	0.0928	1.3624	0.5920
Strontium	0.0005	0.0030	0.0029
Sulfate	2.0102	8.0132	6.6831

Table 3 (Continued)
Fine Particulate Speciation Data – 2011
New Brunswick, New Jersey

Concentrations in Micrograms Per Cubic Meter ($\mu\text{g}/\text{m}^3$)

Pollutant	Annual Average Concentration	Daily Average Maximum Concentration	Daily Average 2nd Highest Concentration
Sulfur	0.7067	2.8559	2.4494
Tin	0.0024	0.0338	0.0256
Titanium	0.0035	0.0186	0.0184
Total mass	9.9860	26.1310	25.3896
Vanadium	0.0015	0.0170	0.0077
Zinc	0.0103	0.2408	0.0361
Zirconium	0.0004	0.0058	0.0054

Table 4
Fine Particulate Speciation Data – 2011
Newark, New Jersey

Concentrations in Micrograms Per Cubic Meter ($\mu\text{g}/\text{m}^3$)

Pollutant	Annual Average Concentration	Daily Average Maximum Concentration	Daily Average 2nd Highest Concentration
Aluminum	0.0263	0.2175	0.2174
Ammonium	0.9091	3.1803	3.1163
Antimony	0.0070	0.0653	0.0650
Arsenic	0.0004	0.0028	0.0027
Barium	0.0010	0.0107	0.0094
Bromine	0.0029	0.0155	0.0103
Cadmium	0.0025	0.0210	0.0187
Calcium	0.0247	0.0755	0.0712
Cerium	0.0001	0.0029	0.0026
Cesium	0.0007	0.0067	0.0065
Chlorine	0.0270	1.2599	0.1431
Chromium	0.0058	0.2431	0.0923
Cobalt	0.0006	0.0025	0.0024
Copper	0.0054	0.0405	0.0322
Elemental carbon	0.9110	3.2020	2.8402
Indium	0.0030	0.0268	0.0240
Iron	0.0926	0.7717	0.6614
Lead	0.0021	0.0211	0.0118
Magnesium	0.0043	0.1145	0.0585
Manganese	0.0012	0.0144	0.0103
Nickel	0.0031	0.0614	0.0362
Nitrate	1.3541	7.1319	5.3260
Organic carbon	3.8841	9.8609	9.0996
Phosphorus	0.0002	0.0152	0.0000
Potassium	0.0417	0.3839	0.1244
Rubidium	0.0003	0.0019	0.0018
Selenium	0.0003	0.0023	0.0016
Silicon	0.0397	0.1359	0.1278
Silver	0.0012	0.0151	0.0116
Sodium	0.0858	0.9867	0.6007
Strontium	0.0007	0.0098	0.0055
Sulfate	2.0681	6.4411	5.8970

Table 4 (Continued)
Fine Particulate Speciation Data – 2011
Newark, New Jersey

Concentrations in Micrograms Per Cubic Meter ($\mu\text{g}/\text{m}^3$)

Pollutant	Annual Average Concentration	Daily Average Maximum Concentration	Daily Average 2nd Highest Concentration
Sulfur	0.7253	2.3184	2.0187
Tin	0.0025	0.0222	0.0211
Titanium	0.0013	0.0125	0.0094
Total mass	10.1781	24.2794	22.9897
Vanadium	0.0031	0.0215	0.0191
Zinc	0.0117	0.0660	0.0623
Zirconium	0.0008	0.0084	0.0084