2009 Air Quality Report

New Jersey Department of Environmental Protection

SUMMARY

This report summarizes the New Jersey air quality monitoring data for 2009. 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, sulfates, nitrates and other constituents of particulate matter, ozone precursors and toxic air contaminants are also provided.

2009 Air Quality Report

New Jersey Department of Environmental Protection

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2009 Introduction

New Jersey Department of Environmental Protection

INTRODUCTION

The State of New Jersey has been monitoring air quality for over 40 years. During that time, pollution levels have improved significantly. This is 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 be to 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 NAAQS for ozone in 2008 to account for this new health information. If these standards for ozone are to be met, additional emission reduction strategies will need to be implemented.

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 PM2.5. 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 PM2.5 levels in New Jersey will be a problem in some areas of the state.

In addition to ozone and PM2.5, there is 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 from heavy metals to toxic volatile organic compounds such as benzene. New Jersey is using the results of an EPA air toxics study and other information to address this complex problem. More comprehensive monitoring of air toxics in New Jersey is being implemented and data from that program is 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:

New Jersey Department of Environmental Protection
Bureau of Air Monitoring
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2009 Network Summary

New Jersey Department of Environmental Protection

NETWORK DESIGN

In 2009, the Bureau of Air Monitoring maintained 41 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 is provided to various public and media outlets and is used to provide hourly updates on air quality to the Bureau's web page at http://www.njaqinow.net/Default.htm. The Air Monitoring Sites can be divided into two primary networks: the Continuous Monitoring Network and the Manual Sampling Network.

SPATIAL SCALES

There are many factors which affect the design of a monitoring network. Among these are pollutant characteristics, topographical features, population distribution, location of pollution sources, meteorology, and logistics.

One of the most important factors to consider when selecting a site is the spatial area it actually represents. To assist with this, the United States Environmental Protection Agency (USEPA) developed specific scales of representativeness for air monitoring sites. The spatial scales specify the area surrounding a monitor where the pollutant concentrations should be relatively similar. For each monitoring objective, appropriate spatial scales can be used to identify the general physical location of a suitable monitoring site. The various spatial scales are defined below:

Figure 1: Photo of Brigantine Air Monitoring Station located on the grounds of the Edwin Forsythe National Wildlife Refuge in Atlantic County.

Micro-scale (10 – 100m): Monitors in locations that show significant concentration differences within 100 meters of the monitor are classified being Micro-scale monitors. This often occurs when monitors are located right next to low-level emission sources, such as busy roadways, construction sites, and facilities with short stacks. These locations should be in areas where the general public is exposed to the concentrations measured.

Middle Scale (100 – 5000m): These monitors are in areas where pollutant levels are reasonably consistent over an area of up to 0.5 kilometer. Such sites may be near large industrial areas with many different operations or near large construction sites. Middle scale monitoring sites are often source oriented. Monitoring measurements of this type might be appropriate for the evaluation of short-term exposure to an emission source.

Neighborhood scale (0.5 – 4km): Neighborhood scale monitors are in locations that have fairly consistent pollutant concentrations over areas up to a few kilometers. A particular location can represent not only the immediate neighborhood but also neighborhoods of the same type in other parts of the city. Neighborhood scale monitors provide good data for trend analysis studies and compliance with National Ambient Air Quality Standards (NAAQS) because their zones of representation often encompass areas where people commonly reside.

Urban Scale (4 – 50km): Urban scale monitors show consistency among pollutant measurements with monitor separations up to 50 kilometers. Urban scale sites are usually located at higher elevations and away from highly traveled roads and industries. These locations are ideal for evaluating concentrations over an entire metropolitan and/or rural area.

Regional scale (100 – 1000km): Regional scale (background monitors) monitors can represent pollutant levels over an area of a few hundred kilometers. These monitors are best located in rural areas away from local sources, and at higher elevations. National parks, national wilderness areas, and many state and county parks and reserves are appropriate areas for regional scale sites. Data gathered at this scale location is most useful in assessing pollutant concentrations over a large area and evaluating transported emissions.

THE CONTINUOUS MONITORING NETWORK

The Continuous Monitoring Network consists of sites which measure carbon monoxide (CO), oxides of nitrogen (NO_x), ozone (O_3), sulfur dioxide (SO_2), particulate matter, and meteorological data by automated instruments (not all pollutants are measured at all sites). The Bureau of Air Monitoring has a data acquisition system primarily for its continuous monitoring network. The system uses wireless communication technology to transmit data to a centralized computer station located in Trenton, NJ. The information is transmitted once every minute, thus providing real-time data retrieval capability. A map showing the location of the continuous monitoring sites is shown in Figure 2 and the parameters recorded at each site are displayed in Table 2 (page 3). Changes to the Continuous Network are summarized in Table 1. Many of the continuous site locations are also part of the Manual Monitoring Network, which is described in the next section.

Figure 2
2009 – Continuous Monitoring Network

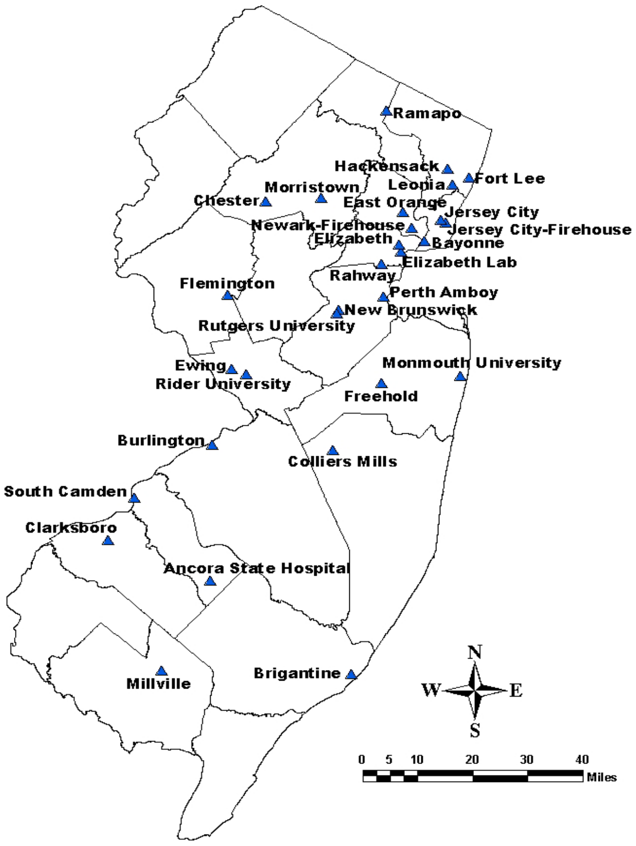

Table 1

2008-2009 Continuous Network Changes			
Monitoring Site	**Parameter(s)**	**Action**	**Date**
Burlington	CO, SO_2, SS	Shutdown	12/29/09
Camden Lab	CO, NO_x, O_3, SO_2, SS, TEOM, MET	Shut Down	09/29/08
Elizabeth	CO, SS	Restart	07/01/08
	SO_2	Restart	07/16/08
Ewing	TEOM	Start-up	01/01/09
Fort Lee	CO	Temporary Shutdown	11/04/09
	TEOM	Temporary Shutdown	10/16/09
Newark - Firehouse	CO, O_3, SO_2	Start-up	06/01/09
	TEOM	Start-up	09/01/09

Table 2
2009 – Continuous Air Monitoring Network

Continuous Parameter Codes

CO - Carbon Monoxide
NO_x - Nitrogen Dioxide and Nitric Oxide
O_3 - Ozone
SO_2 - Sulfur Dioxide

SS - Smoke Shade
TEOM - Continuous $PM_{2.5}$ Analyzer
MET - Meteorological Parameters

SITE	CO	NO_x	O_3	SO_2	SS	TEOM	MET
Ancora State Hospital	U		U	U			
Bayonne		U	N	N			
Brigantine			U	U		U	
Burlington	N			N	N		
Chester		U	U	U			N
Clarksboro			U	U			
Colliers Mills			U				
East Orange	N	N					N
Elizabeth	Mi			M	N		
Elizabeth Lab	N	N		N	N	N	N
Ewing						N	
Flemington			U			N	N
Fort Lee	M					M	
Freehold	Mi				N		
Hackensack	N			N	N		
Jersey City-Firehouse						N	
Jersey City	Mi			N	N		
Leonia		N	N				
Millville		N	N	N		N	
Monmouth University			N				
Morristown	Mi				N		
New Brunswick						N	
Newark - Firehouse	N		N	N		N	
Perth Amboy	N			N	N		
Rahway						N	
Ramapo			U				
Rider University		N	N				N
Rutgers University		N	N				U*
South Camden						N	
TOTAL	**12**	**8**	**14**	**13**	**8**	**11**	**6**

Spatial Scale codes: Mi - **Micro**, M - **Middle**, N - **Neighborhood**, U - **Urban**, R - **Regional**

* Meteorological measurements at this site are collected by Rutgers University

MANUAL MONITORING NETWORK

The Manual Monitoring Network does not transmit data in near real-time as does the Continuous Monitoring Network. The manual network consists primarily of various instruments that collect samples for subsequent analysis in a laboratory. The network provides data on fine particulates (particles smaller than 2.5 micrometers in diameter or $PM_{2.5}$), inhalable particulates (particles smaller than 10 micrometers in diameter or PM_{10}), lead (Pb), Total Suspended Particulates (TSP), several parameters associated with atmospheric 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. While these ozone precursors are automatically measured every hour, the data are retrieved once a day and require extensive review before they are validated. Changes to the Manual Network are summarized in Table 3. A map of the manual sampling sites is shown in Figure 3 and a list of the pollutants measured at each location is shown in Table 4 (page 5).

Figure 3
2009 – Manual Monitoring Network

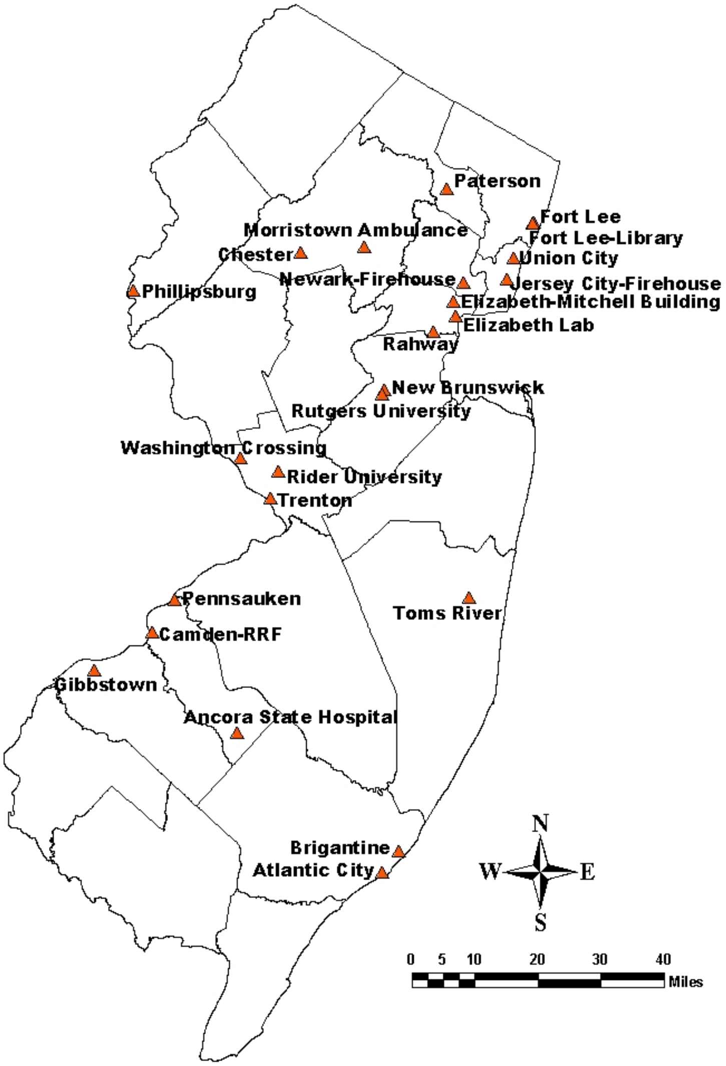

Table 3

2008-2009 Manual Network Changes			
Monitoring Site	**Parameter(s)**	**Action**	**Date**
Camden Lab	$PM_{2.5}$, PM_{10}, PAMS, $PM_{2.5}$ Spec, CARB, VOCs	Shutdown	09/28/08
New Brunswick – Delco Remy	Pb	Shutdown	05/30/08
Newark - Firehouse	$PM_{2.5}$	Start-up	07/03/09
Newark - Firehouse	$PM_{2.5}$ Spec	Start-up	12/28/09
Newark - Wills Center	$PM_{2.5}$	Shutdown	07/23/08

Table 4
2009 - Manual Air Monitoring Network

Manual Parameter Codes

$PM_{2.5}$ - FRM (Federal Reference Method) Manual $PM_{2.5}$ Sampler

PM_{10} - FRM Manual PM_{10} Sampler

TSP - Total Suspended Particulates

$PM_{2.5}$ Spec - $PM_{2.5}$ Speciation Trends Network Sampler

PAMS - Photochemical Assessment Monitoring Station (Ozone Precursors)

CARB - Carbonyls

VOCs - Volatile Organic Compounds

Acid Deposition - Acidity (pH scale) in precipitation

SITE	$PM_{2.5}$	PM_{10}	$PM_{2.5}$ Spec	PAMS	CARB	VOCs	Acid Deposition
Ancora State Hospital							U
Atlantic City	N	N					
Brigantine	U						
Camden-RRF		M					
Chester	U		U		U	U	
Elizabeth Lab	N		N		N	N	
Elizabeth-Mitchell Building	N						
Fort Lee		M					
Fort Lee-Library	N						
Gibbstown	N						
Jersey City-Firehouse	N	N					
Morristown-Ambulance Squad	N						
New Brunswick	N		N		N	N	
Newark - Firehouse	N		N				
Paterson	N						
Pennsauken	N						
Phillipsburg	N						
Rahway	N						
Rider University				N			
Rutgers University				N			
Toms River	N						
Trenton	N	N					
Union City	N						
Washington Crossing	N						U
TOTAL	**19**	**5**	**4**	**2**	**3**	**3**	**2**

Spatial Scale codes: Mi - **Micro**, M - **Middle**, N - **Neighborhood**, U - **Urban**, R - **Regional**

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2009 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 ozone NAAQS were revised in 2008 because EPA had determined that the old standard of 0.08 parts per million (ppm) maximum daily eight-hour average was not sufficiently protective of public health. On March 12, 2008 they set a revised standard of 0.075 ppm maximum daily 8-hour average, so this is the first complete year AQI values for ozone are based on this new standard. 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://airnow.gov/.

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

Each weekday morning a forecast is prepared using the AQI format. The forecast is provided to participating radio and television stations. Each afternoon, an air quality update, which includes the current air quality information and a forecast for the following day, is issued to various newspapers.

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.

Figure 1

Air Quality Index Regions

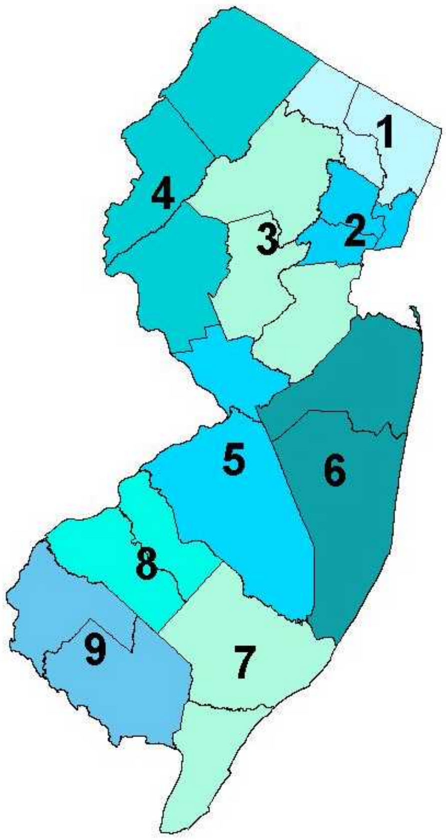


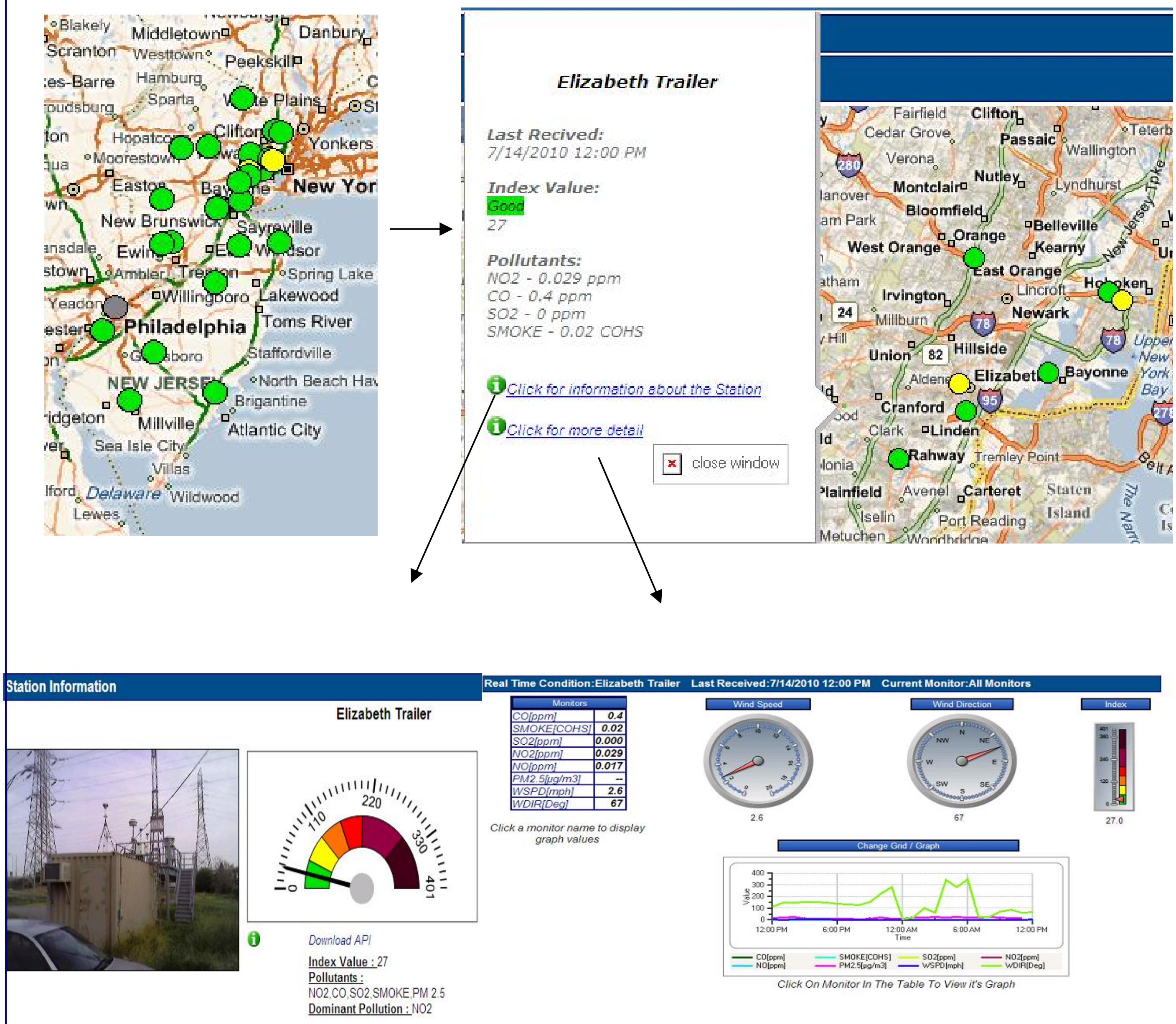
Table 2
Pollutants Monitored According to Air Quality Index Reporting Region - 2009

CO - Carbon Monoxide
SO_2 - Sulfur Dioxide
PM - Particulate Matter
O_3 - Ozone
NO_2 - Nitrogen Dioxide

Reporting Region	Monitoring Site	CO	SO_2	PM	O_3	NO_2
1. Northern Metropolitan	Fort Lee	X	---	X	---	---
	Hackensack	X	X	X	---	---
	Leonia	---	---	---	X	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	---
	Rahway	---	---	X	---	---
3. Suburban	Chester	---	X	---	X	X
	Morristown	X	---	X	---	---
	New Brunswick	---	---	X	---	---
	Perth Amboy	X	X	X	---	---
	Rutgers University	---	---	---	X	X
4. Northern Delaware Valley	Flemington	---	---	X	X	---
5. Central Delaware Valley	Burlington	X	X	X	---	---
	Ewing	---	---	X	---	---
	Rider University	---	---	---	X	X
6. Northern Coastal	Colliers Mills	---	---	---	X	---
	Freehold	X	---	X	---	---
	Monmouth University	---	---	---	X	---
7. Southern Coastal	Brigantine	---	X	X	X	---
8. Southern Delaware Valley	Ancora State Hospital	X	X	---	X	---
	Clarksboro	---	X	---	X	---
	South Camden	---	---	X	---	---
9. Delaware Bay	Millville	---	X	X	X	X

Along with the forecast, cautionary statements are provided for days when the air quality is expected to be unhealthy. A weekday air quality forecast map, introduced during the 1996 ozone season, is televised on New Jersey Network's (NJN) TV News Broadcast. An initial web page was also created in 1996 to show current air quality levels, and was updated in 2009 to a newer format. This page can be accessed at the following internet address: http://www.njaqinow.net/ . Some examples of the air quality information available on our web site are shown in Figure 2 below:

Figure 2
Examples of NJDEP's Air Monitoring Website



Elizabeth Trailer

Last Recived:
7/14/2010 12:00 PM

Index Value:
Good
27

Pollutants:
NO2 - 0.029 ppm
CO - 0.4 ppm
SO2 - 0 ppm
SMOKE - 0.02 COHS

Click for information about the Station

Click for more detail

close window

Station Information

Elizabeth Trailer

Download API

Index Value : 27
Pollutants :
NO2,CO,SO2,SMOKE,PM 2.5
Dominant Pollution : NO2

Real Time Condition:Elizabeth Trailer Last Received:7/14/2010 12:00 PM Current Monitor:All Monitors

Monitors	
CO[ppm]	0.4
SMOKE[COHS]	0.02
SO2[ppm]	0.000
NO2[ppm]	0.029
NO[ppm]	0.017
PM2.5[µg/m3]	--
WSPD[mph]	2.6
WDIR[Deg]	67

Click a monitor name to display graph values

Click On Monitor In The Table To View it's Graph

2009 AQI SUMMARY

A summary of the AQI ratings for New Jersey in 2009 is presented in the pie chart to the right. In 2009 there were 178 “Good” days, 169 were “Moderate”, 18 were rated “Unhealthy for Sensitive Groups”, zero 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 twenty. 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 (AQI data was not available for every day therefore some of the regions total day count does not add up to 365).

Figure 3
Air Quality Summary by Days

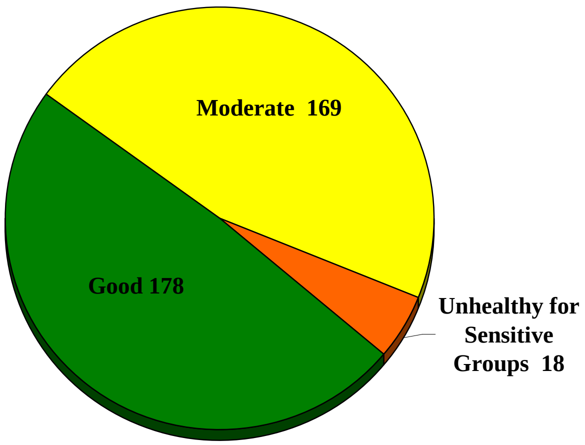


Table 3
Air Quality Index (AQI) Exceedances of 100 During 2009

Ratings

USG - Unhealthy for Sensitive Groups
UH - Unhealthy
VUH - Very Unhealthy

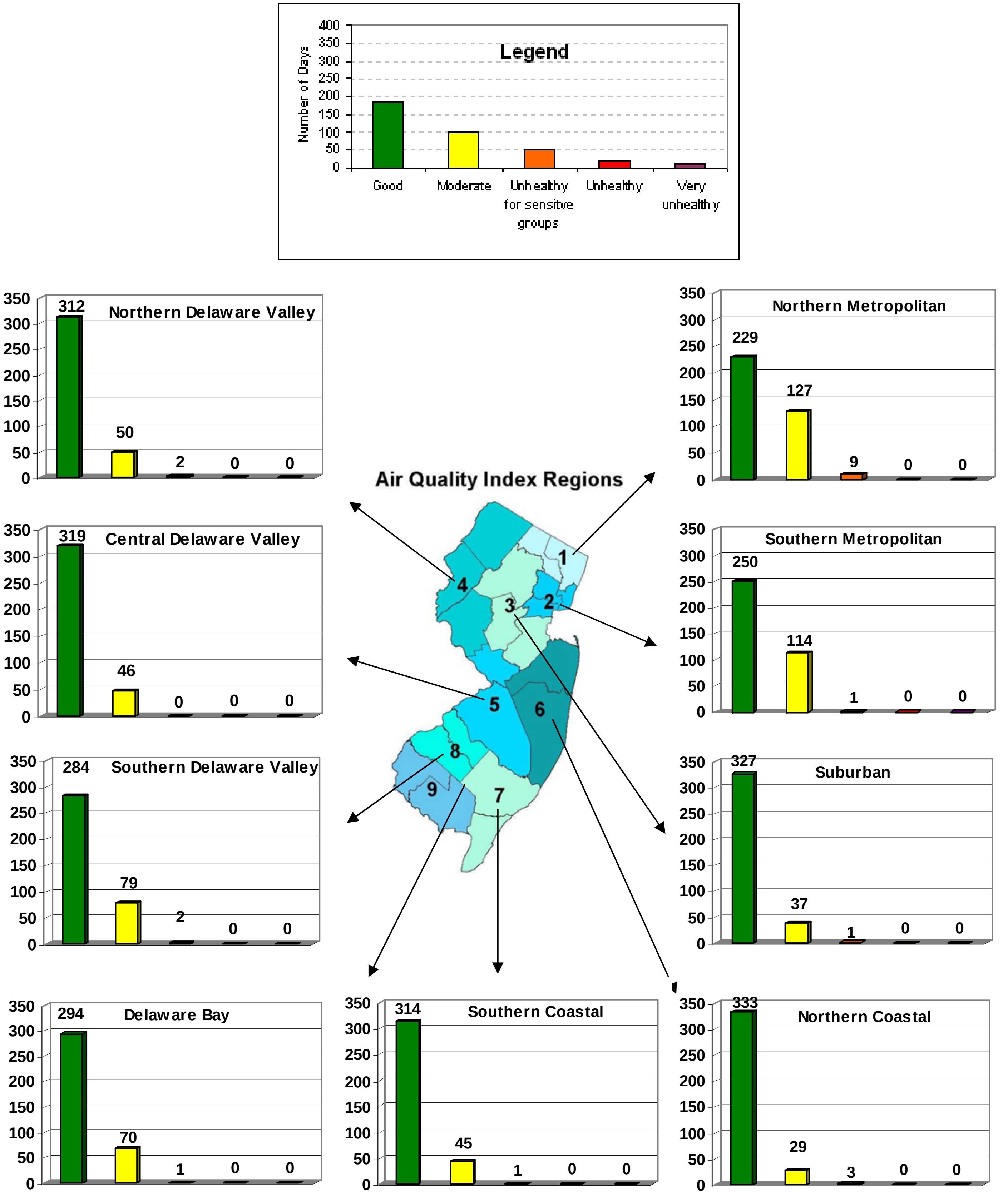
Pollutants

PM - Fine Particle Matter (11 Sites Monitored)
O3 - Ozone (14 Sites Monitored)

* Number in parentheses () indicates the total number of ozone and $PM_{2.5}$ sites exceeding 100 on a given day

Date	Highest Location	Highest AQI Value	Highest Pollutant	Highest Rating	Pollutant(s) with AQI above 100 *	
January 23	Fort Lee	104	PM	USG		PM(1)
January 30	Jersey City Firehouse	101	PM	USG		PM(1)
April 10	Fort Lee	104	PM	USG		PM(1)
April 26	Monmouth University	106	O3	USG	O3(1)	
April 27	Chester	119	O3	USG	O3(2)	
May 15	Fort Lee	103	PM	USG		PM(1)
June 26	Clarksboro	101	O3	USG	O3(1)	
July 16	Colliers Mills	111	O3	USG	O3(1)	
July 17	Fort Lee	111	PM	USG		PM(1)
July 27	Fort Lee	101	PM	USG		PM(1)
July 28	Fort Lee	127	PM	USG		PM(1)
July 29	Fort Lee	126	PM	USG		PM(1)
August 04	Flemington	101	O3	USG	O3(1)	
August 10	Millville	109	O3	USG	O3(1)	
August 15	Leonia	106	O3	USG	O3(1)	
August 17	Colliers Mills	124	O3	USG	O3(3)	PM(1)
September 05	Brigantine	111	O3	USG	O3(1)	
November 09	South Camden	103	PM	USG		PM(1)

Figure 4
2009 Air Quality Index Summary
Number of Days by Reporting Region



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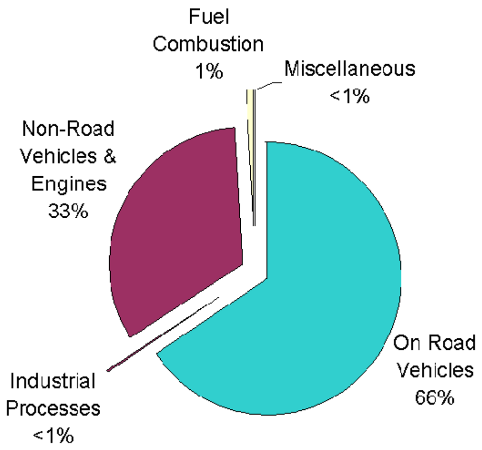
2009 Carbon Monoxide Summary

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 56 percent of all CO emissions nationwide. In cities, automobile exhaust can cause as much as 95 percent of all CO emissions. 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.

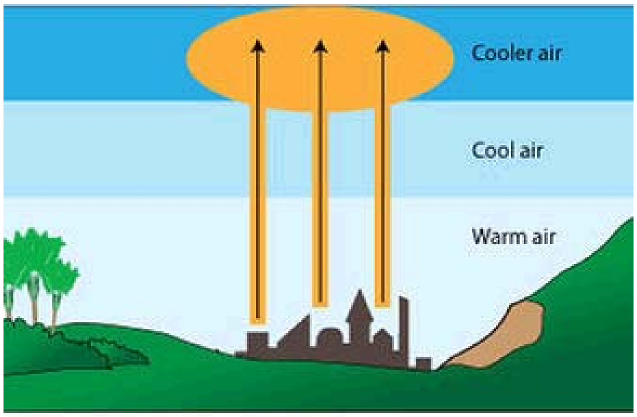
Figure 1
National Summary of
CO Emissions by Source Category



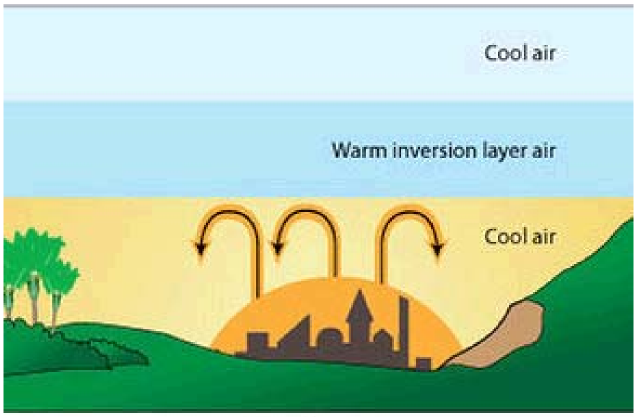
Source: United States Environmental Protection Agency
www.epa.gov/air/emissions/co.htm

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 on Air Pollution



Normal pattern



Thermal inversion

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/m^3 = 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)	----

Figure 3
2009 Carbon Monoxide Concentrations – New Jersey
Monthly Variation
Parts Per Million (PPM)

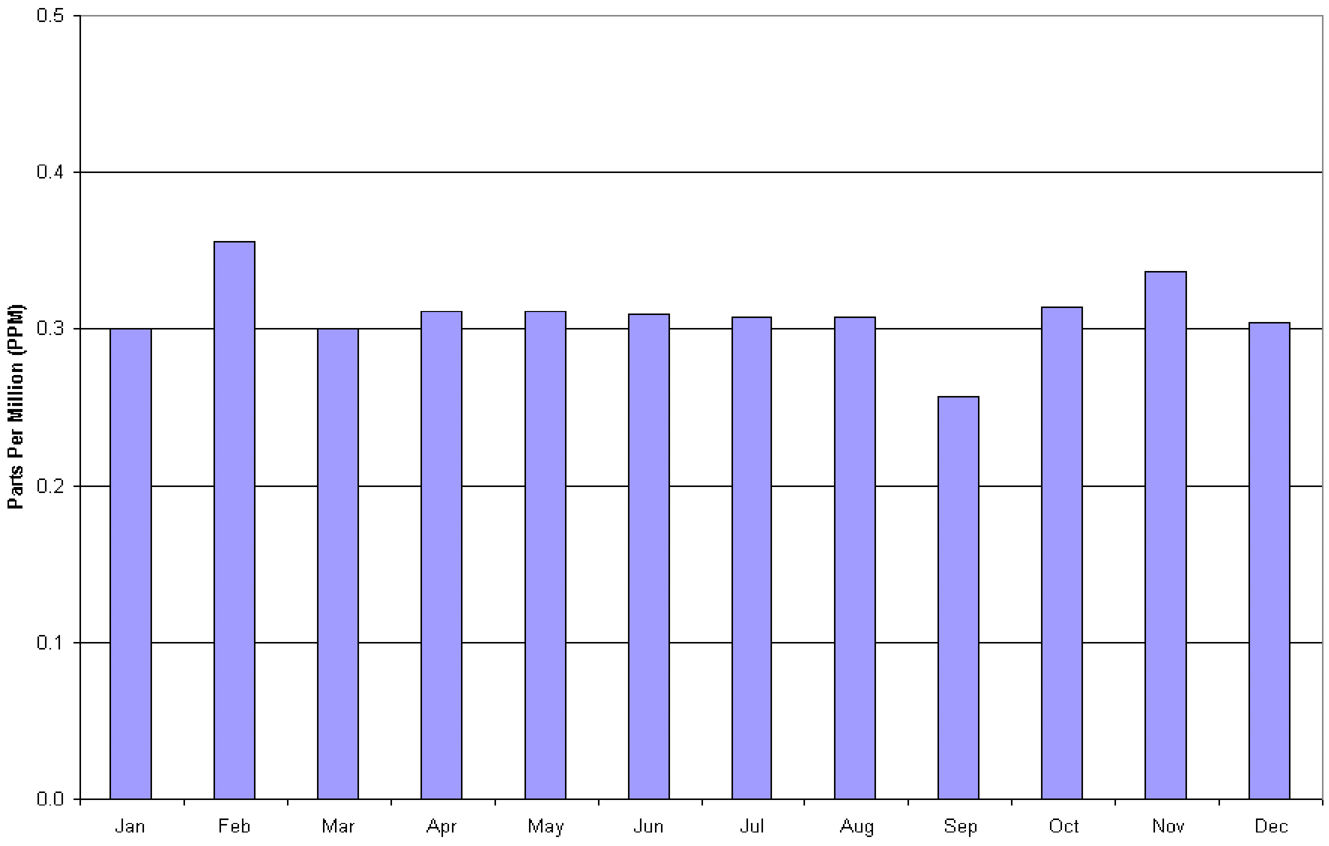
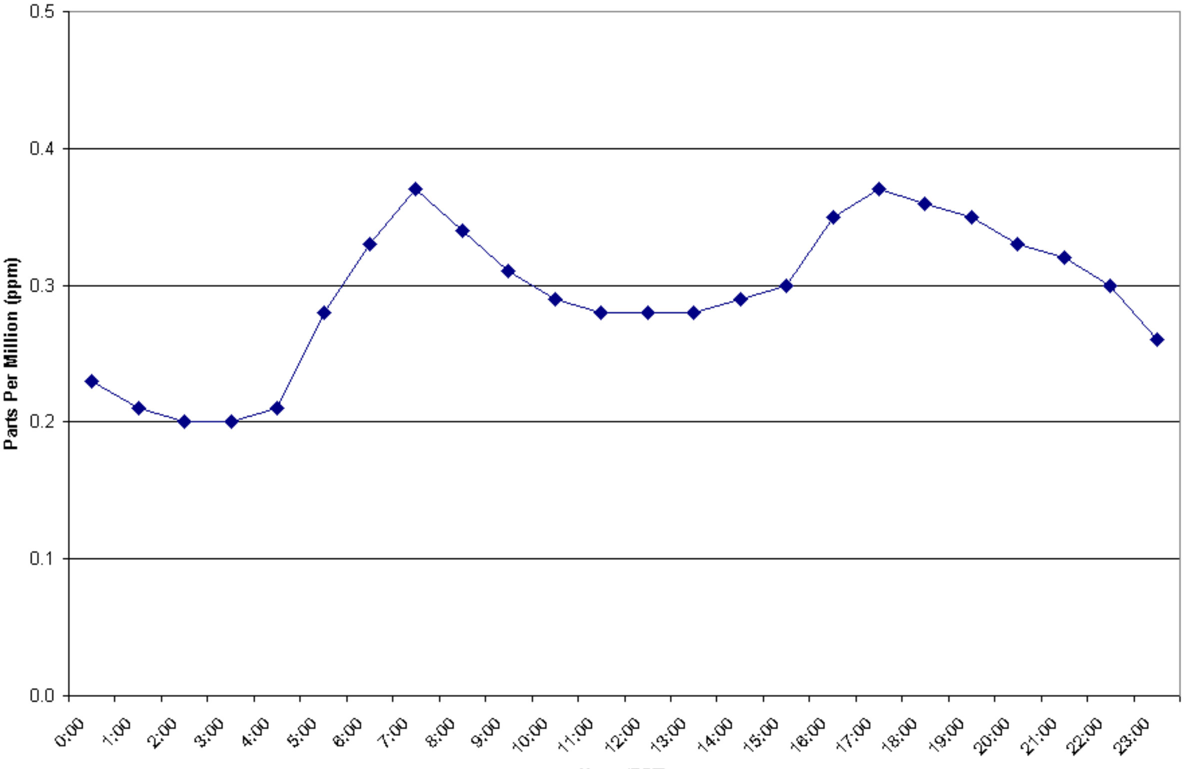


Figure 4
2009 Carbon Monoxide Concentrations – New Jersey
Diurnal Variation
Parts Per Million (PPM)



MONITORING LOCATIONS

The state monitored CO levels at 12 locations in 2009. These sites are shown in the map in Figure 5. The Fort Lee station was temporarily shutdown on November 4, 2009 due to utility problems. The Burlington station was shutdown at the end of December 2009 because the NJDEP permanently lost access to the location. A CO analyzer was installed on June 1, 2009 at the newly established Newark Firehouse station. The NJDEP is actively pursuing the establishment of a new monitoring station in Camden.

CO LEVELS IN 2009

None of the monitoring sites recorded exceedances of any CO standard during 2009. The maximum one-hour average concentration recorded was 4.4 ppm at the Freehold station. The highest 8-hour average concentration recorded was 2.6 ppm at the East Orange station. Summaries of the 2009 data are provided in Figure 6 and Table 2 (page 4).

Figure 5
2009 Carbon Monoxide Monitoring Network

Figure 6
Highest and 2nd Highest 8-Hour Averages Of Carbon Monoxide in New Jersey – 2009
Parts Per Million (PPM)

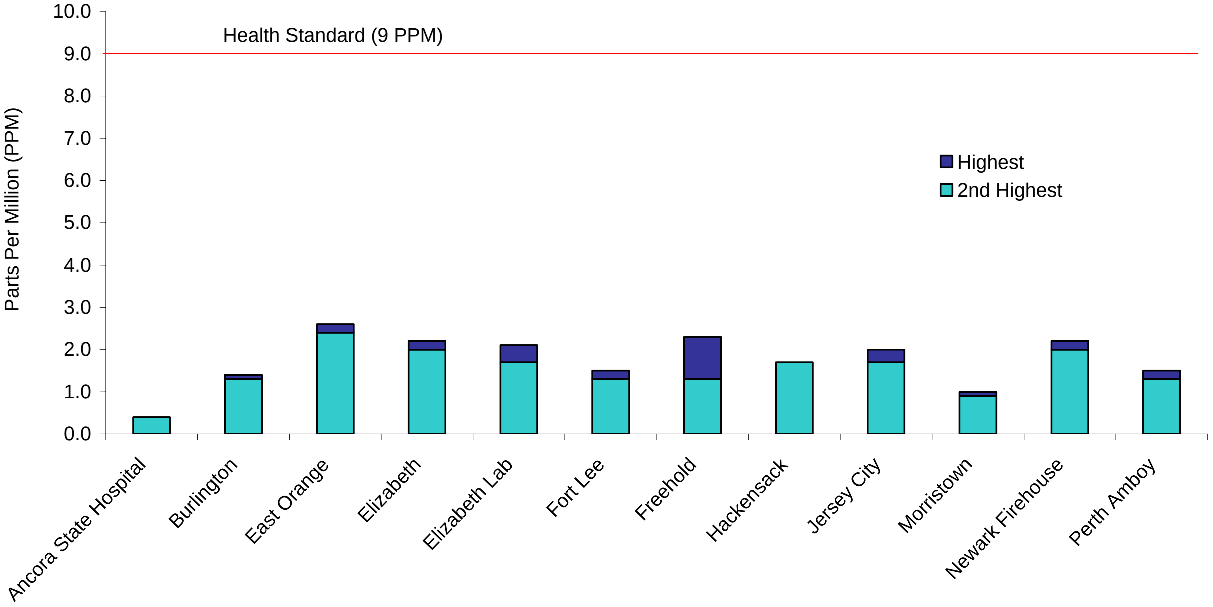


Table 2
Carbon Monoxide Data – 2009
1-Hour and 8-Hour Averages

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

Monitoring Sites	Maximum 1-Hour Average	2^{nd} Highest 1-Hour Average	Maximum 8-Hour Average	2^{nd} Highest 8-Hour Average
Ancora State Hospital	0.9	0.8	0.4	0.4
Burlington	2.5	2.2	1.4	1.3
East Orange	4.0	3.9	2.6	2.4
Elizabeth	3.5	2.9	2.2	2.0
Elizabeth Lab	2.5	2.4	2.1	1.7
Fort Lee (a)	3.0	2.1	1.5	1.3
Freehold	4.4	4.2	2.3	1.3
Hackensack	2.1	2.1	1.7	1.7
Jersey City	3.3	2.8	2.0	1.7
Morristown	2.1	2.0	1.0	0.9
Newark Firehouse (b)	2.7	2.6	2.2	2.0
Perth Amboy	2.3	2.3	1.5	1.3

(a) Data not available after November 4, 2009
(b) Data not available prior to June 1, 2009

Trends

Carbon monoxide levels have improved dramatically over the past 20 years. The last time the CO standard was exceeded in New Jersey was in January of 1995 (Figure 7), 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. A trend graph of CO levels showing the maximum, minimum, and average 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).

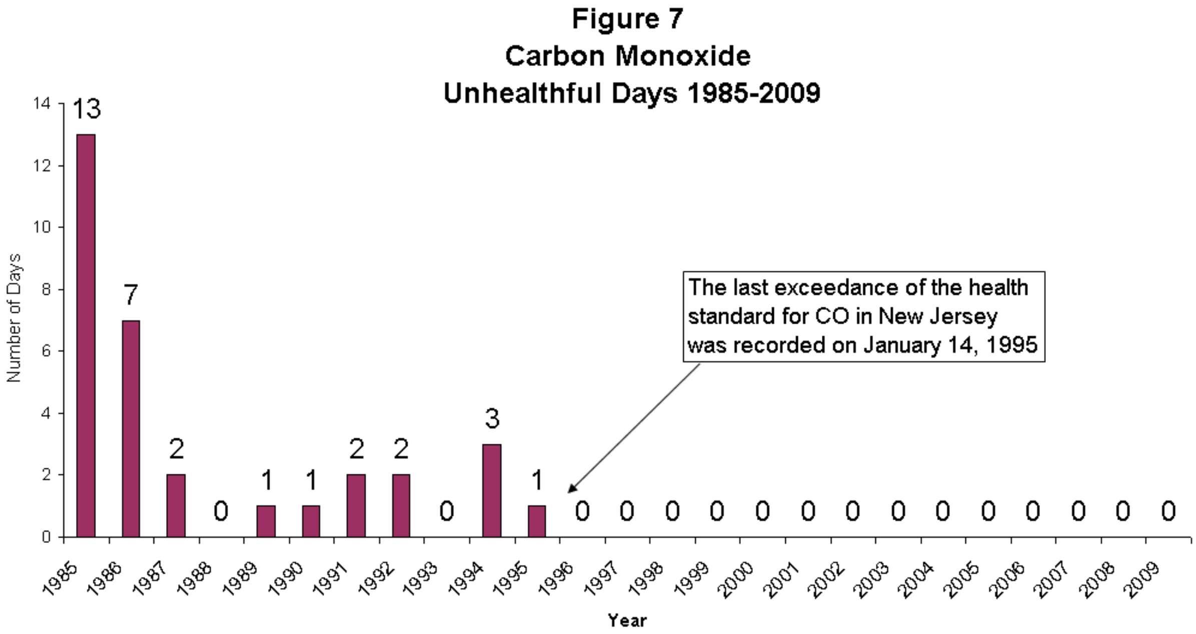


Figure 7
Carbon Monoxide
Unhealthful Days 1985-2009

The last exceedance of the health standard for CO in New Jersey was recorded on January 14, 1995

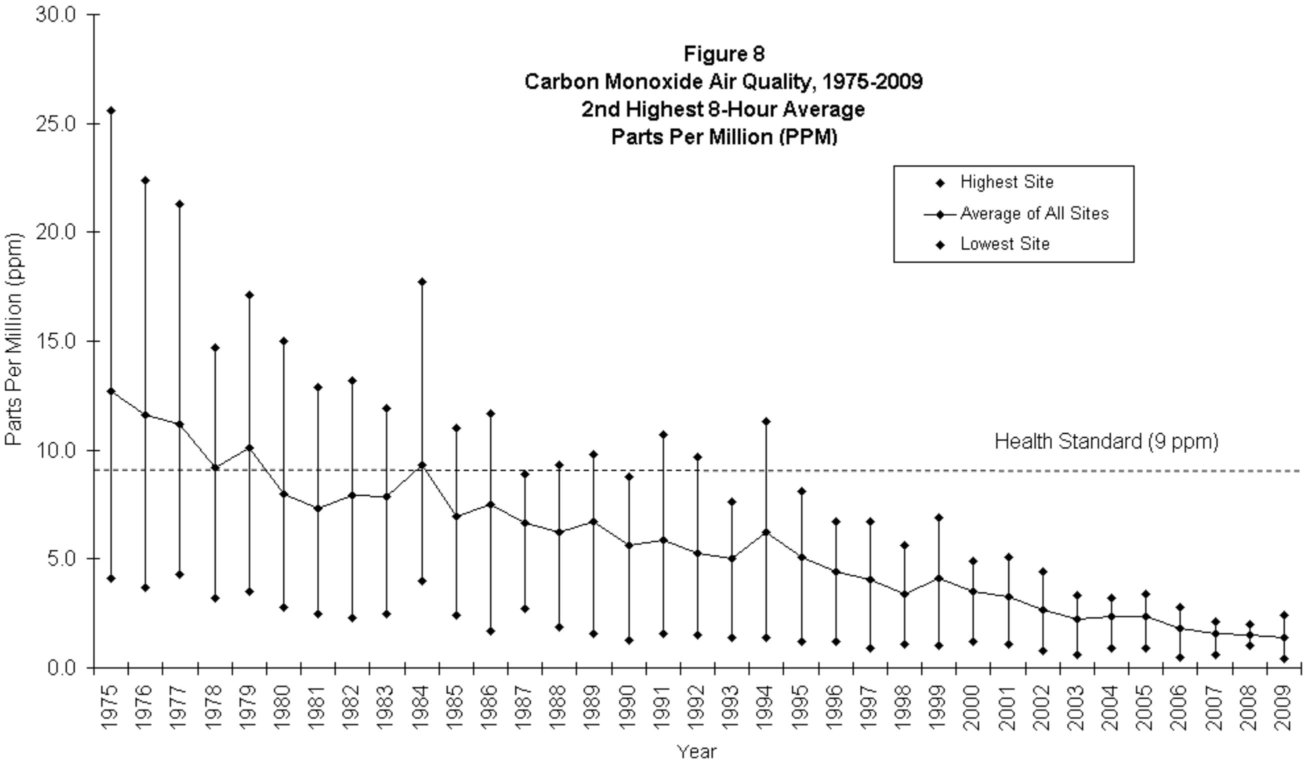


Figure 8
Carbon Monoxide Air Quality, 1975-2009
2nd Highest 8-Hour Average
Parts Per Million (PPM)

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www.sciencelearn.org.nz Effect of Atmospheric Inversion on Air Pollution

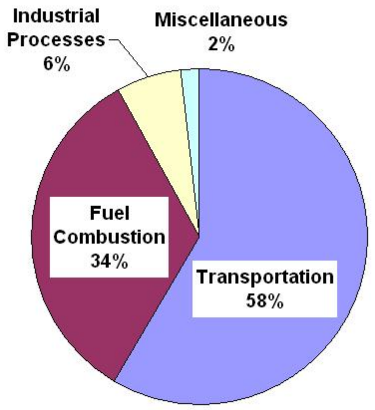
2009 Nitrogen Dioxide Summary

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 below (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). Figures 6-8 (pages 5-6) 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.

Figure 1
National Summary of 2005 Oxides of Nitrogen (NO_x) Emissions by Source Category



Source: USEPA National Summary of Nitrogen Oxides Emissions, 2005

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.

STANDARDS

The primary (health based) and secondary (welfare based) National Ambient Air Quality Standards (NAAQS) for NO_2 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 ($\mu g/m^3$) are the standard units and the state standard applies to any 12-month period, not just the calendar year. In 2007, the State of California changed their one-hour average standard of 470 $\mu g/m^3$ to 339 $\mu g/m^3$. New Jersey uses the State of California's standard as a guideline in assessing short-term impacts from specific sources. Table 1 provides a summary of the NO_2 standards.

Table 1
National and New Jersey Ambient Air Quality Standards for Nitrogen Dioxide (NO_2)
Parts Per Million (ppm) and Micrograms Per Cubic Meter (µg/m^3)

Averaging Period	Type	New Jersey	National	California
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			339 µg/m^3 (0.18 ppm)

Figure 2
Nitric Oxide – New Jersey
2009 Hourly Variation
Parts Per Million (ppm)

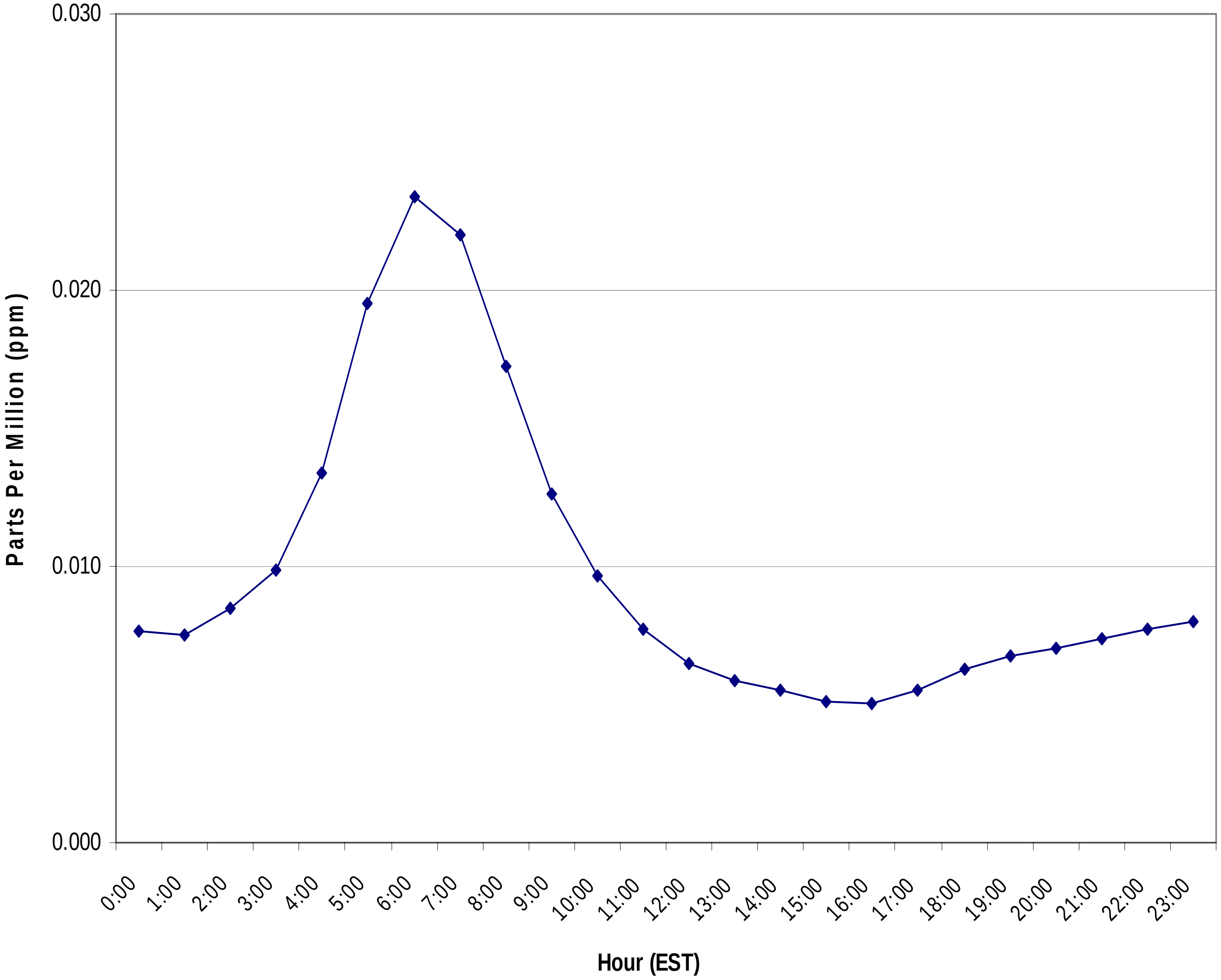


Figure 3
Nitrogen Dioxide – New Jersey
2009 Hourly Variation
Parts Per Million (ppm)

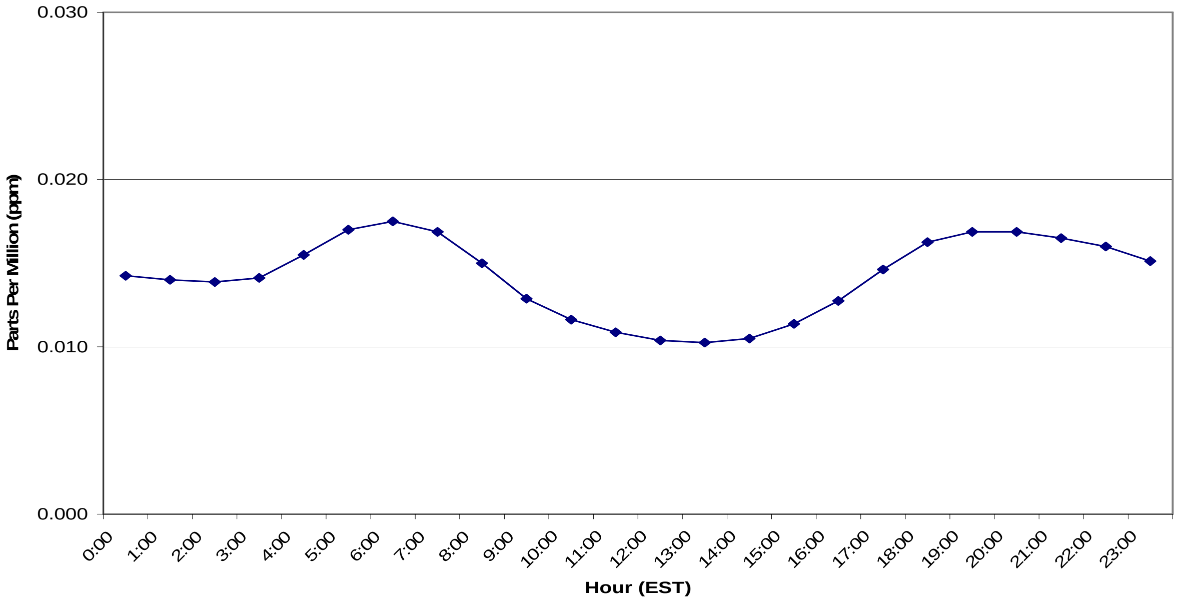
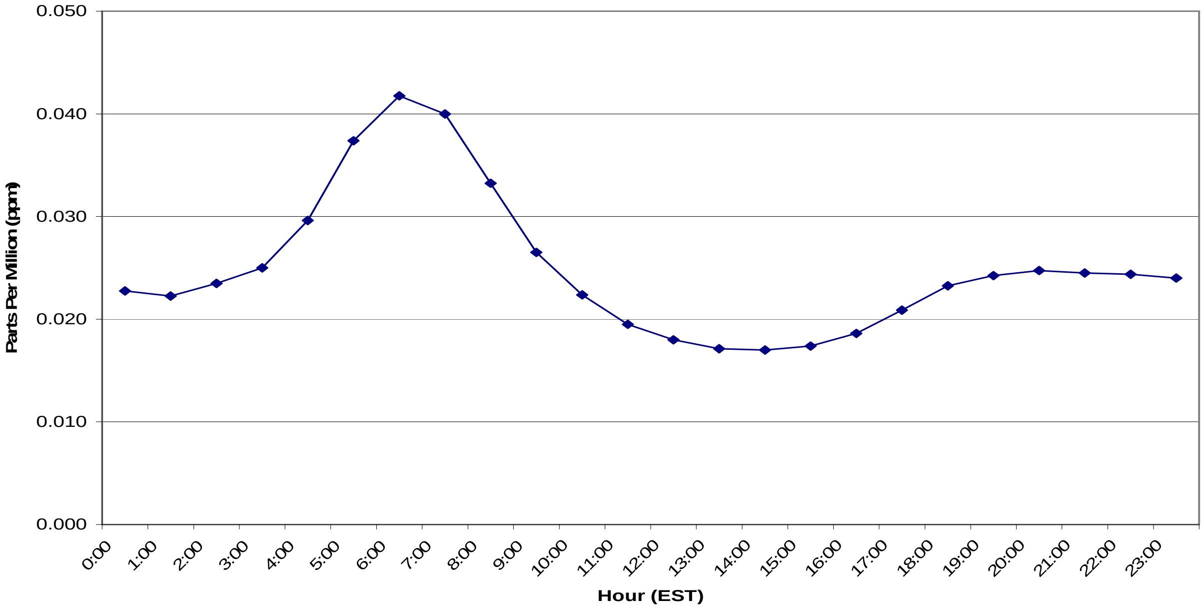


Figure 4
Total Oxides of Nitrogen – New Jersey
2009 Hourly Variation
Parts Per Million (ppm)



MONITORING LOCATIONS

The state monitored NO_2 levels at 8 locations in 2009. These sites are shown in the map to the right.

NO_2 LEVELS IN 2009

None of the monitoring sites recorded exceedances of either the National or New Jersey Air Quality Standards for NO_2 during 2009. The highest 12-month (calendar year) average concentration of NO_2 recorded was 0.026 ppm at the Elizabeth Lab site located at Exit 13 of the New Jersey Turnpike (Table 2, page 5 and Figure 9, page 7). 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. The maximum annual average concentration of NO recorded in 2009 was 0.027 ppm, also at the Elizabeth Lab site (Table 2, page 5 and Figure 10, page 7).

TRENDS

Routine monitoring for NO_2 began in 1966 and 1974 was the last year that concentrations exceeded the NAAQS in New Jersey. A graph of NO_2 levels provided in Figure 11 (page 8) shows the statewide average annual mean concentrations recorded from 1975 to 2009 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 NO_2 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 5
2009 Nitrogen Dioxide Monitoring Network

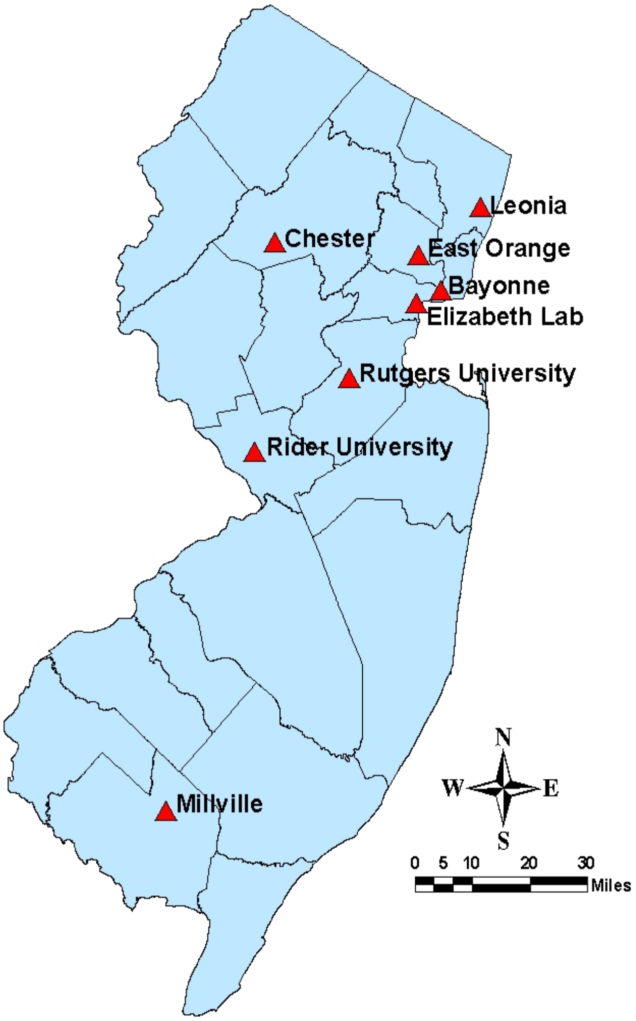


Table 2
Nitrogen Dioxide (NO_2) and Nitric Oxide (NO) Data - 2009
1-Hour and 12-Month Averages

Parts Per Million (ppm)
California 1-Hour Standard = 0.18 ppm
National 12-Month Standard = 0.053 ppm

	Nitrogen Dioxide 1-Hour Average (ppm)		Nitrogen Dioxide 12-Month Average (ppm)		Nitric Oxides Annual Average(ppm)
Monitoring Sites	**Maximum**	**2nd Highest**	**Maximum**	**Calendar year**	
Bayonne	0.091	0.086	0.019	0.019	0.009
Chester	0.067	0.047	0.006	0.005	0.000
East Orange	0.094	0.088	0.021	0.020	0.015
Elizabeth Lab	0.094	0.091	0.026	0.026	0.027
Leonia	0.077	0.074	0.019	0.017	0.014
Millville	0.048	0.044	0.009	0.009	0.005
Rider University	0.045	0.044	0.009	0.008	0.005
Rutgers University	0.074	0.063	0.011	0.011	0.004

Figure 6
Nitric Oxide – New Jersey
2009 Monthly Variation
Parts Per Million (ppm)

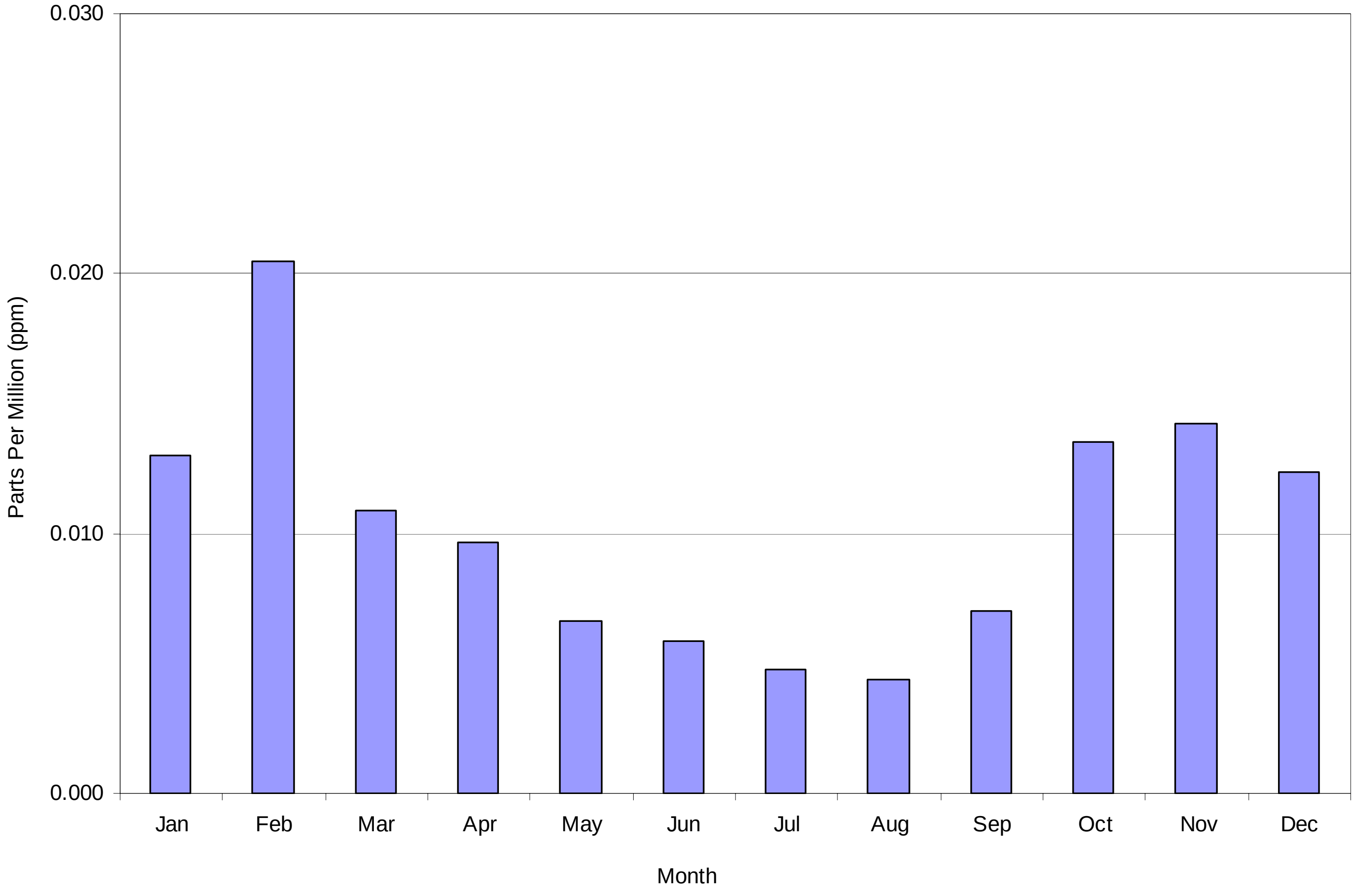


Figure 7
Nitrogen Dioxide – New Jersey
2009 Monthly Variation
Parts Per Million (ppm)

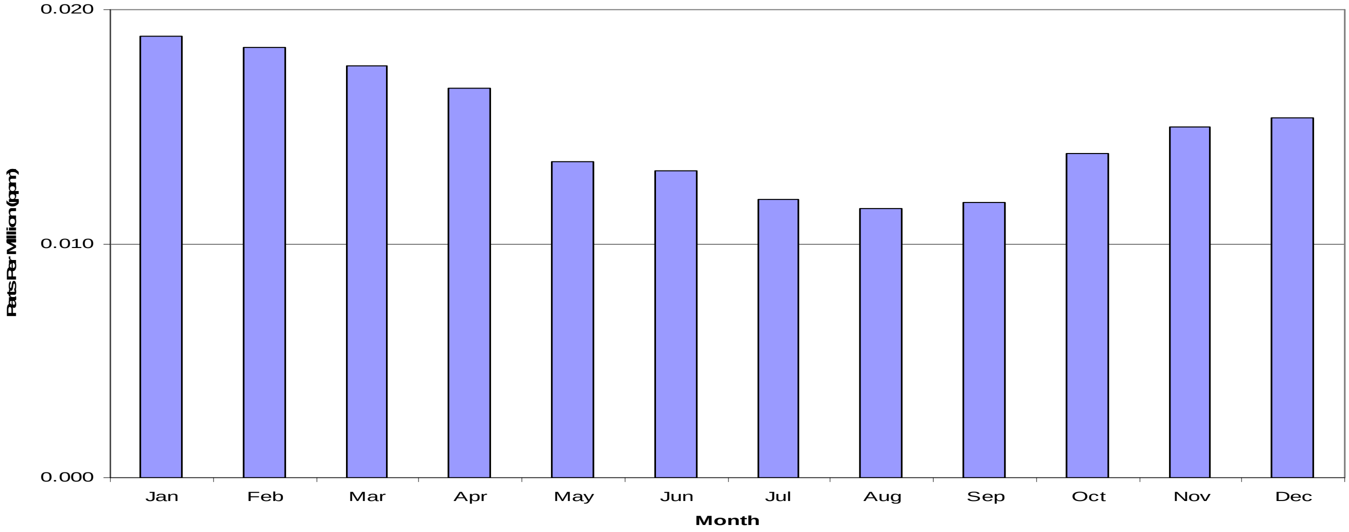


Figure 8
Total Oxides of Nitrogen – New Jersey
2009 Monthly Variation
Parts Per Million (ppm)

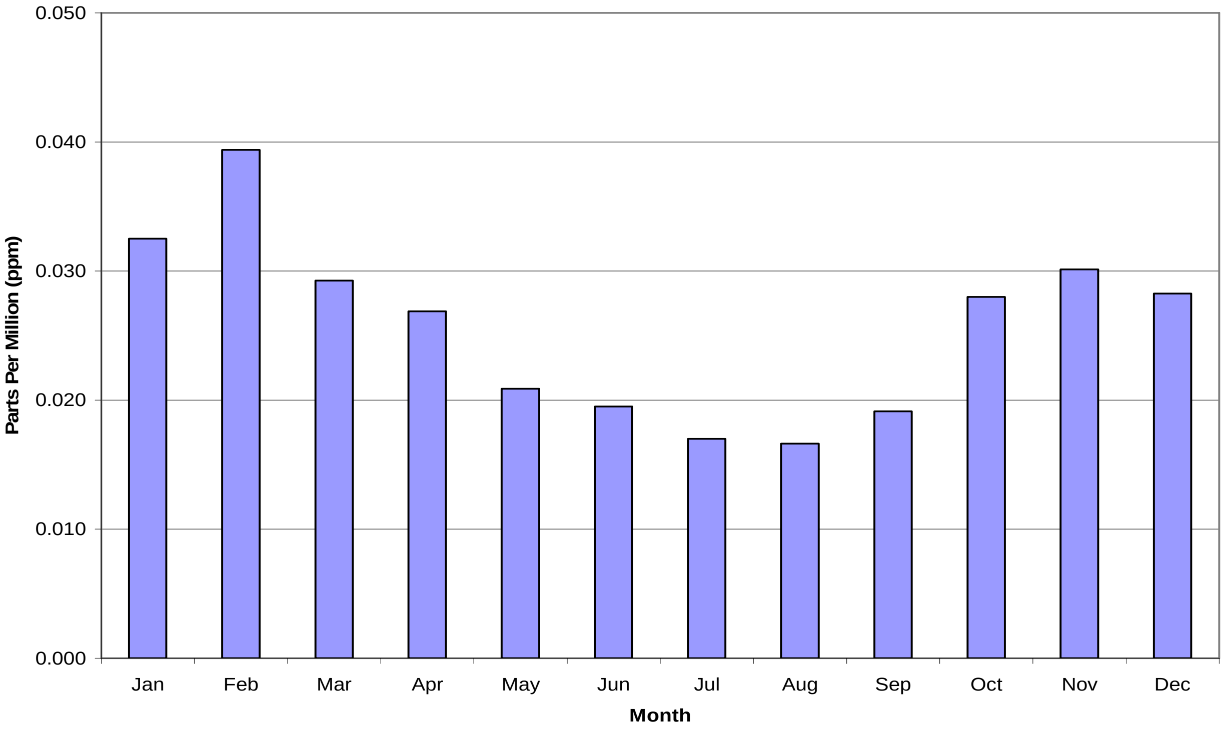


Figure 9
Annual Average Nitrogen Dioxide Concentrations In New Jersey – 2009 Parts Per Million (ppm)

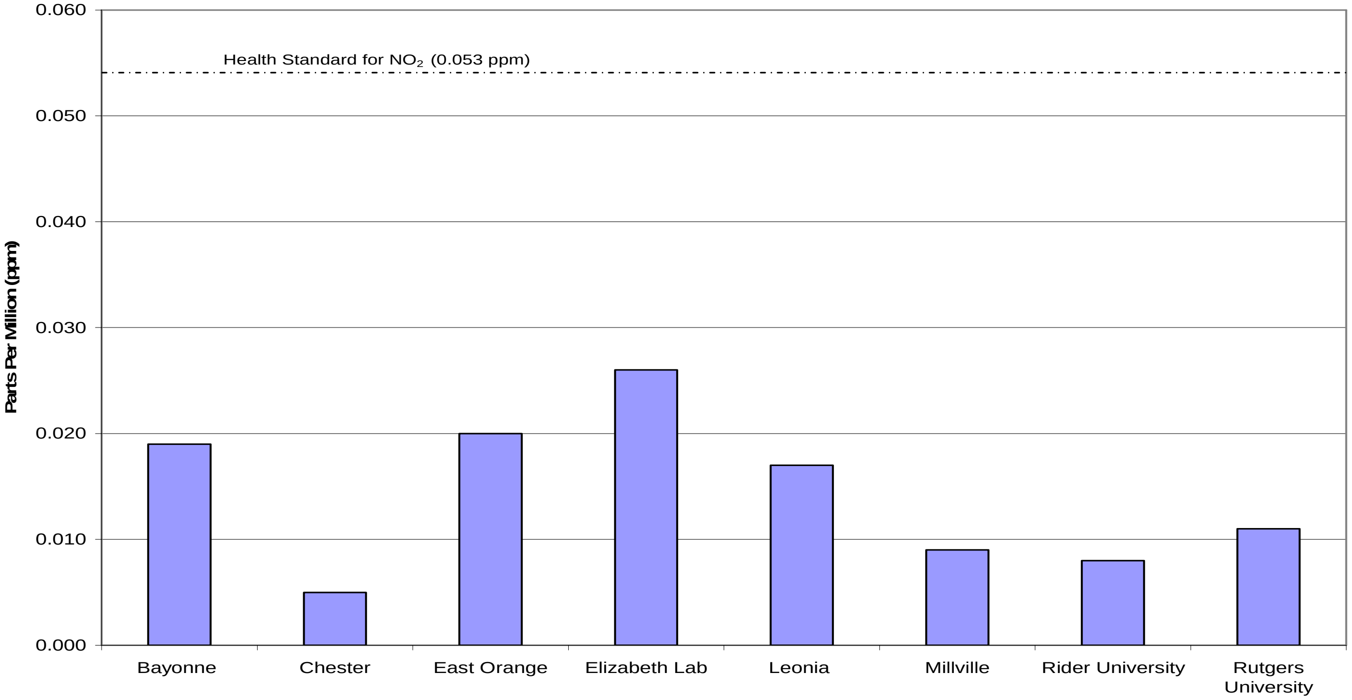


Figure 10
Annual Average Nitric Oxide Concentrations In New Jersey – 2009 Parts Per Million (ppm)

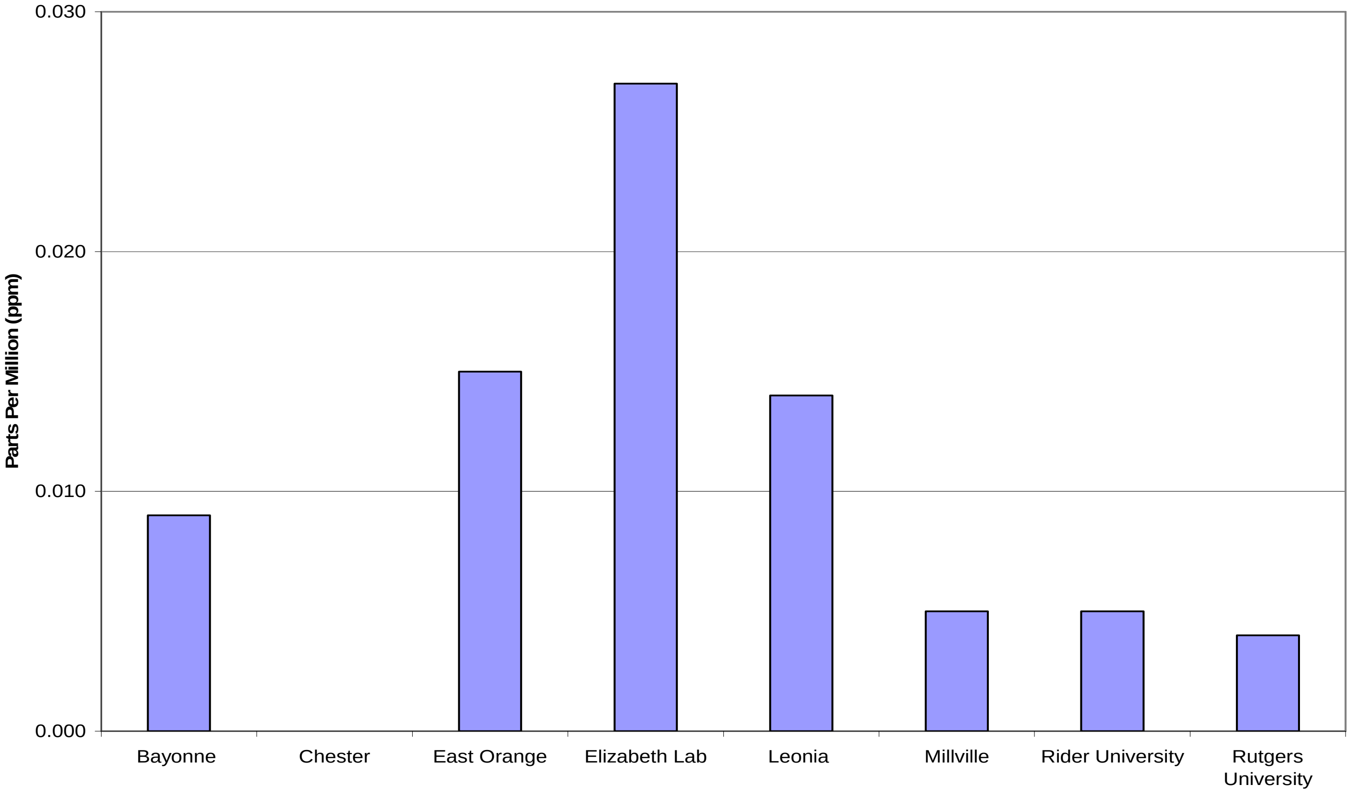
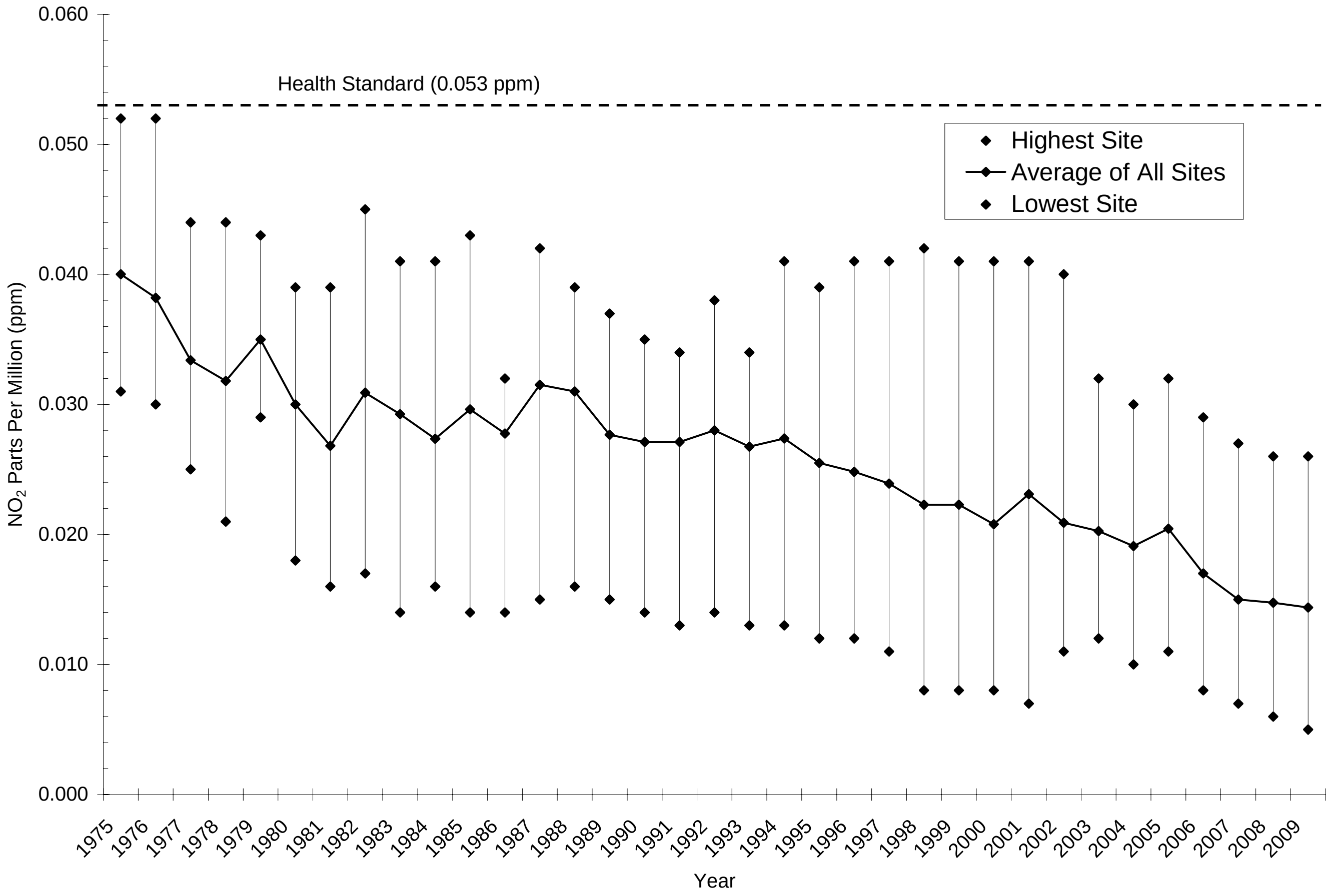


Figure 11
Nitrogen Dioxide Concentrations in New Jersey 1975-2009
12-Month (Calendar Year) Average
Parts Per Million (ppm)



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2009 Ozone Summary

New Jersey Department of Environmental Protection

NATURE AND SOURCES

Ozone (O_3) is a gas consisting of three oxygen atoms. It occurs naturally in the upper atmosphere (stratospheric ozone) where it protects us from harmful ultraviolet rays (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 (NOx) and volatile organic compounds (VOC's) react in the presence of sunlight and heat. NOx 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

Ozone is good up here…Many popular consumer products like air conditioners and refrigerators involve CFCs or halons during either manufacturing or use. Over time, these chemicals damage the earth's protective ozone layer.

Ozone is bad down here… Cars, trucks, power plants and factories all emit air pollution that forms ground-level ozone, a primary component of smog.

Source: EPA

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 blackberry bush and sassafras tree shown in Figure 2 and Figure 3 is damage caused by exposure to ground-level ozone. (Figure 2 and 3 Photos by: Teague Prichard, Wisconsin Department of Natural Resources)

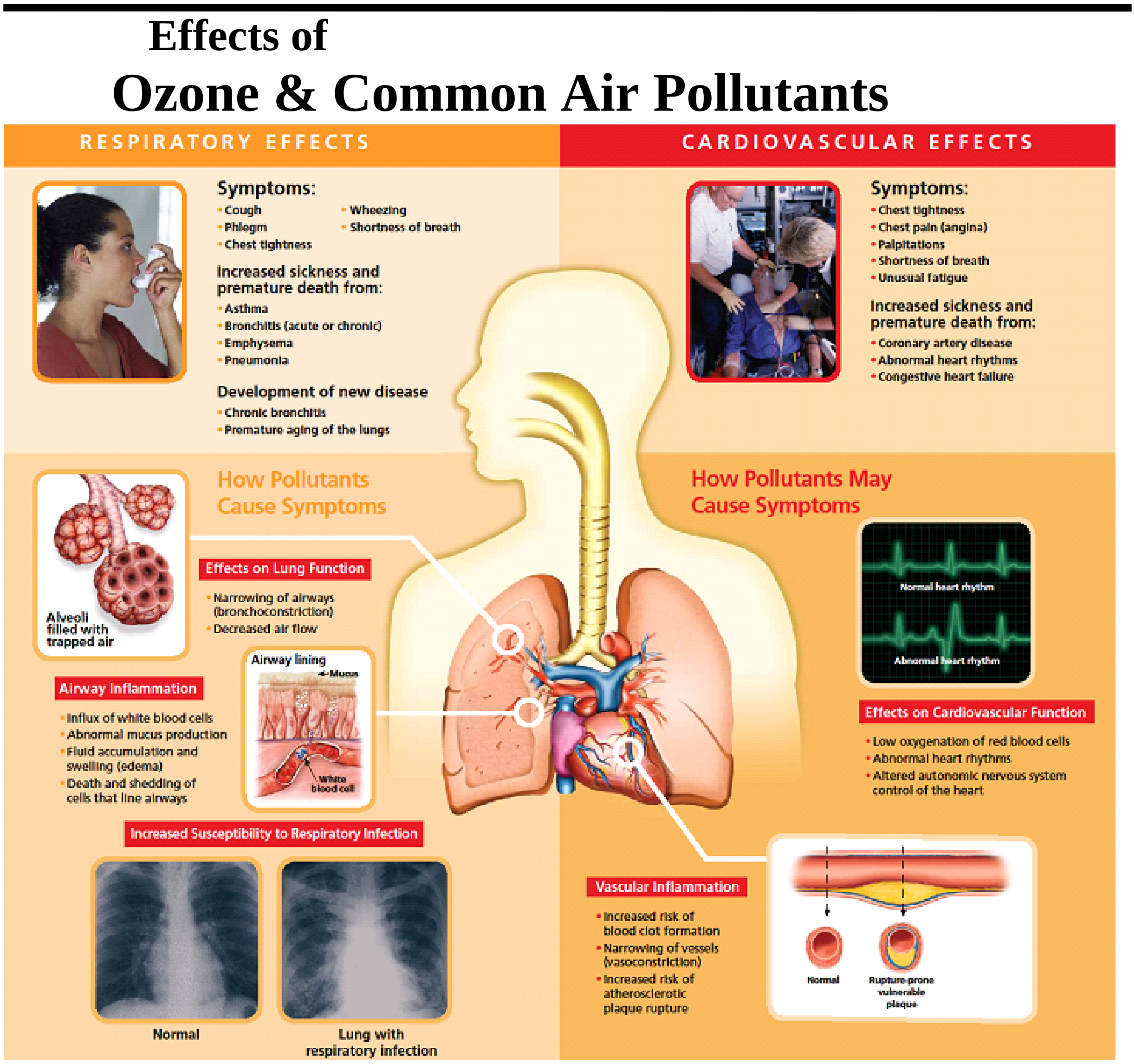

Figure 2: Ozone Damage to Blackberry Bush


Figure 3: Ozone Damage to Sassafras Tree

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 4 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 4



Effects of
Ozone & Common Air Pollutants

RESPIRATORY EFFECTS

Symptoms:
- Cough
- Phlegm
- Chest tightness
- Wheezing
- Shortness of breath

Increased sickness and premature death from:
- Asthma
- Bronchitis (acute or chronic)
- Emphysema
- Pneumonia

Development of new disease
- Chronic bronchitis
- Premature aging of the lungs

How Pollutants Cause Symptoms

Alveoli filled with trapped air

Effects on Lung Function
- Narrowing of airways (bronchoconstriction)
- Decreased air flow

Airway Inflammation
- Influx of white blood cells
- Abnormal mucus production
- Fluid accumulation and swelling (edema)
- Death and shedding of cells that line airways

Airway lining
Mucus
White blood cell

Increased Susceptibility to Respiratory Infection

Normal
Lung with respiratory infection

CARDIOVASCULAR EFFECTS

Symptoms:
- Chest tightness
- Chest pain (angina)
- Palpitations
- Shortness of breath
- Unusual fatigue

Increased sickness and premature death from:
- Coronary artery disease
- Abnormal heart rhythms
- Congestive heart failure

How Pollutants May Cause Symptoms

Normal heart rhythm
Abnormal heart rhythm

Effects on Cardiovascular Function
- Low oxygenation of red blood cells
- Abnormal heart rhythms
- Altered autonomic nervous system control of the heart

Vascular Inflammation
- Increased risk of blood clot formation
- Narrowing of vessels (vasoconstriction)
- Increased risk of atherosclerotic plaque rupture

Normal
Rupture-prone vulnerable plaque

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

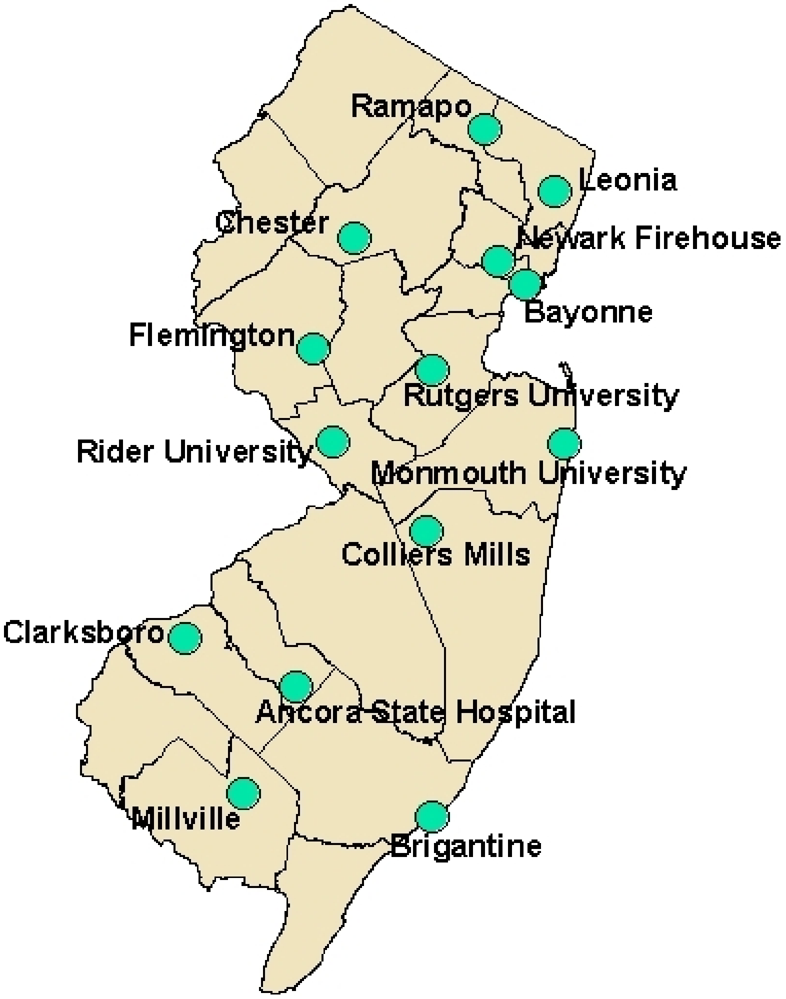
OZONE NETWORK

Ozone was monitored at 14 locations in New Jersey during 2009. Of those 14 sites, 11 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 5.

Figure 5

2009 Ozone Monitoring Network

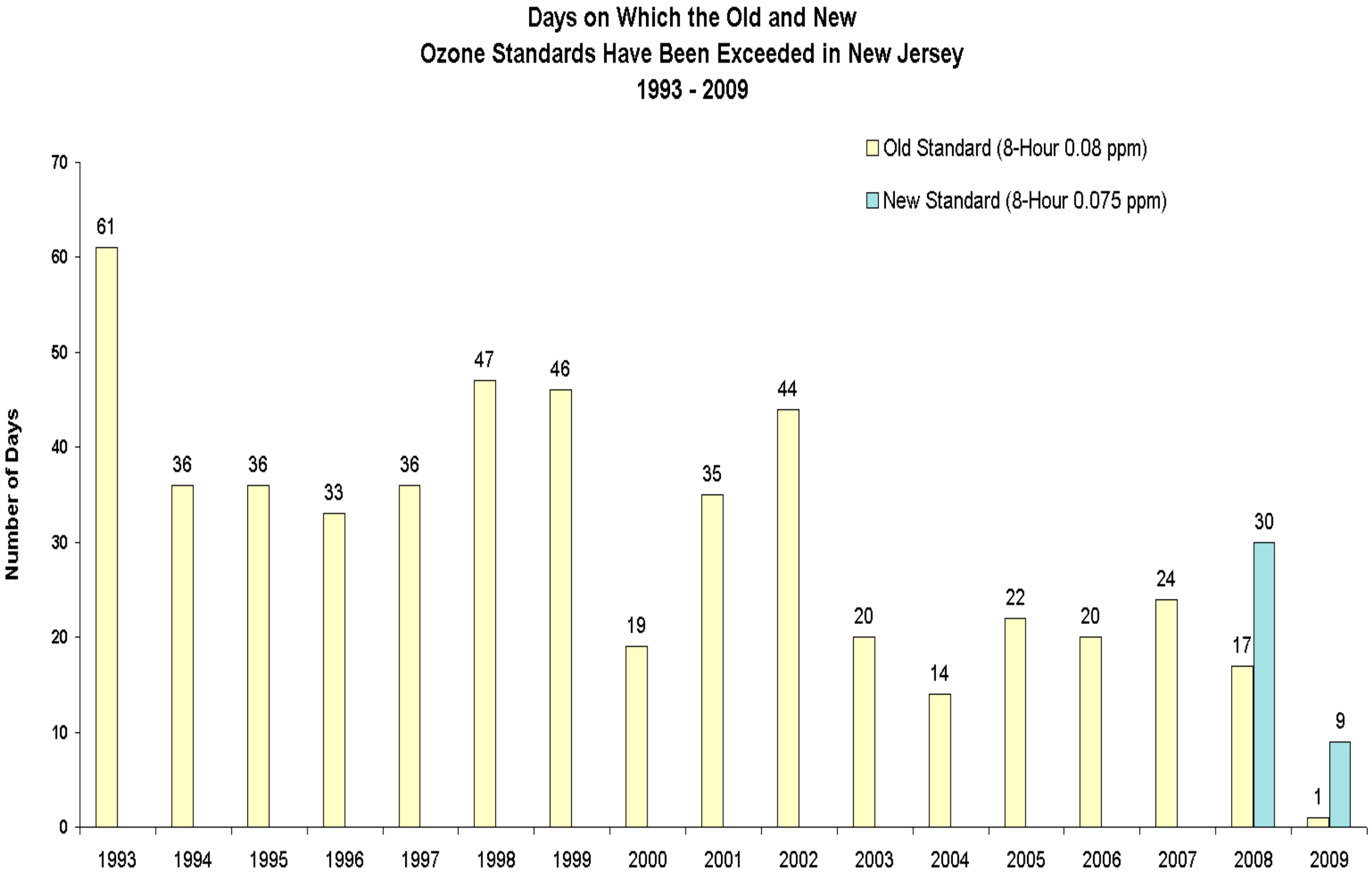


HOW THE CHANGES TO THE OZONE STANDARDS AFFECT AIR QUALITY RATINGS

In regards to ground level ozone pollution, 2009 was the cleanest year on record. Just nine days exceeded the 0.075 ppm 8-hour standard and just one day exceeded the old 0.08 ppm 8-hour standard. There are 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 0.109 ppm in 2009.

It is apparent, however, that the current standard is significantly more stringent than the old (see Figure 6 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.

Figure 6



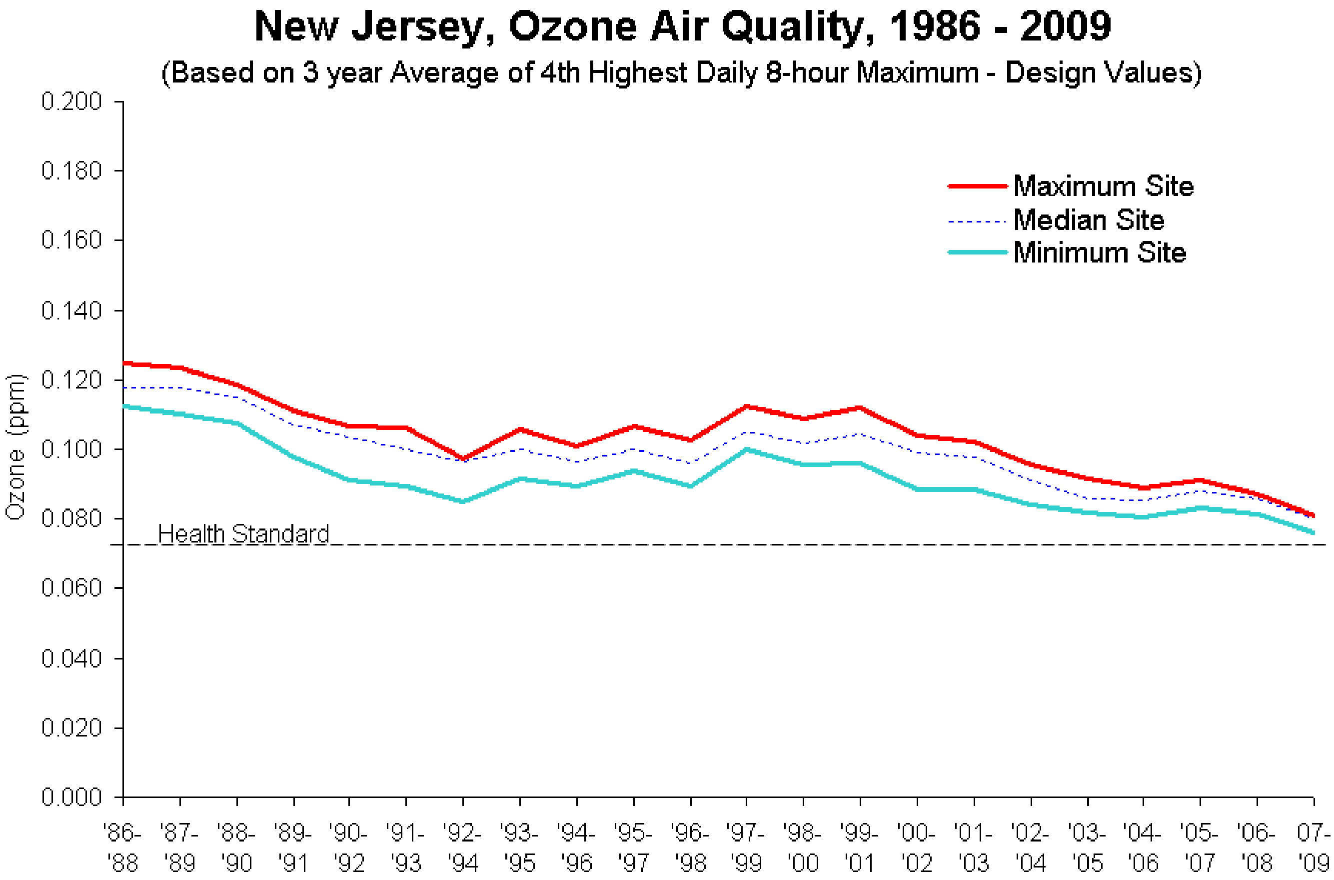
DESIGN VALUES

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.

Figure 7 shows the design value for the 8-hour standards starting with the 1986-1988 period. Design values are calculated for all ozone sites in the network and the median, maximum, and minimum for each year were used in the graphics.

Figure 7



SUMMARY OF 2009 Ozone Data Relative to the OLD 1-HOUR STANDARD

Of the 14 monitoring sites that were operated during the 2009 ozone season, none recorded levels above the old 1-hour standard of 0.12 ppm during the year. The highest 1-hour concentration was 0.109 ppm recorded at Colliers Mills on August 17th. This is the second consecutive year that 1-hour ozone values remained below the old standard. As recent as 2002, New Jersey recorded 16 days above this old 1-hour standard.

Figure 8

Highest and Second Highest Daily Ozone 1-Hour Averages

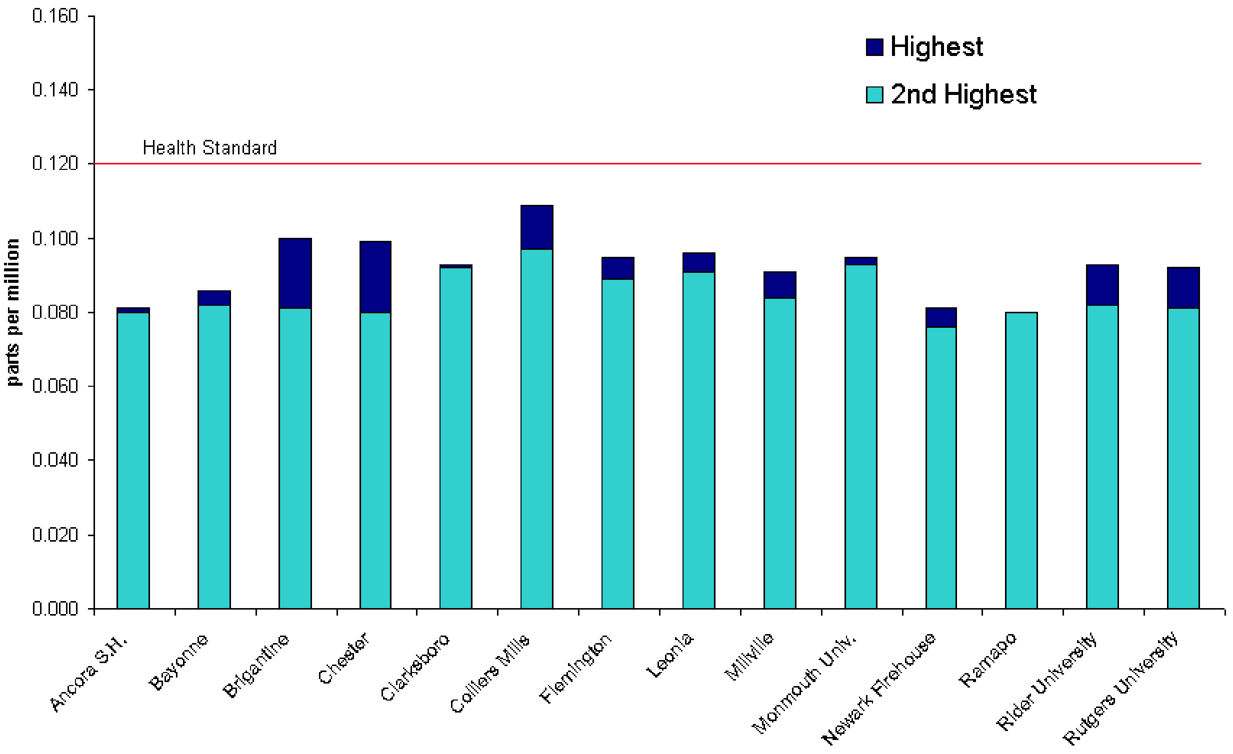


Table 3
Ozone Data – 2009
1-Hour Averages

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 2007-2009	# of days with 1-hour Averages above 0.12ppm
Ancora S.H.	.081	.080	.101	0
Bayonne	.086	.082	.108	0
Brigantine	.100	.081	.089	0
Chester	.099	.080	.101	0
Clarksboro	.093	.092	.107	0
Colliers Mills	.109	.097	.105	0
Flemington	.095	.089	.106	0
Leonia	.096	.091	.102 (3rd Highest)	0
Millville	.091	.084	.091	0
Monmouth Univ.	.095	.093	.105	0
Newark Firehouse	.081	.076	.076 (2nd Highest)	0
Ramapo	.080	.080	.097	0
Rider University	.093	.082	.111	0
Rutgers University	.082	.081	.108	0
Statewide	.109	.100		0

SUMMARY OF 2009 OZONE DATA RELATIVE TO THE 8-HOUR STANDARD

Only 8 of the 14 monitoring sites that were operated during the 2009 ozone season recorded levels above the 8-hour standard of 0.075 ppm. The highest 8-hour concentration recorded was 0.085 at Colliers Mils on August 17th. Design values for the 8-hour standard were above the standard at 13 of 14 sites, indicating that the ozone standard is being violated throughout almost all of New Jersey.

Figure 9

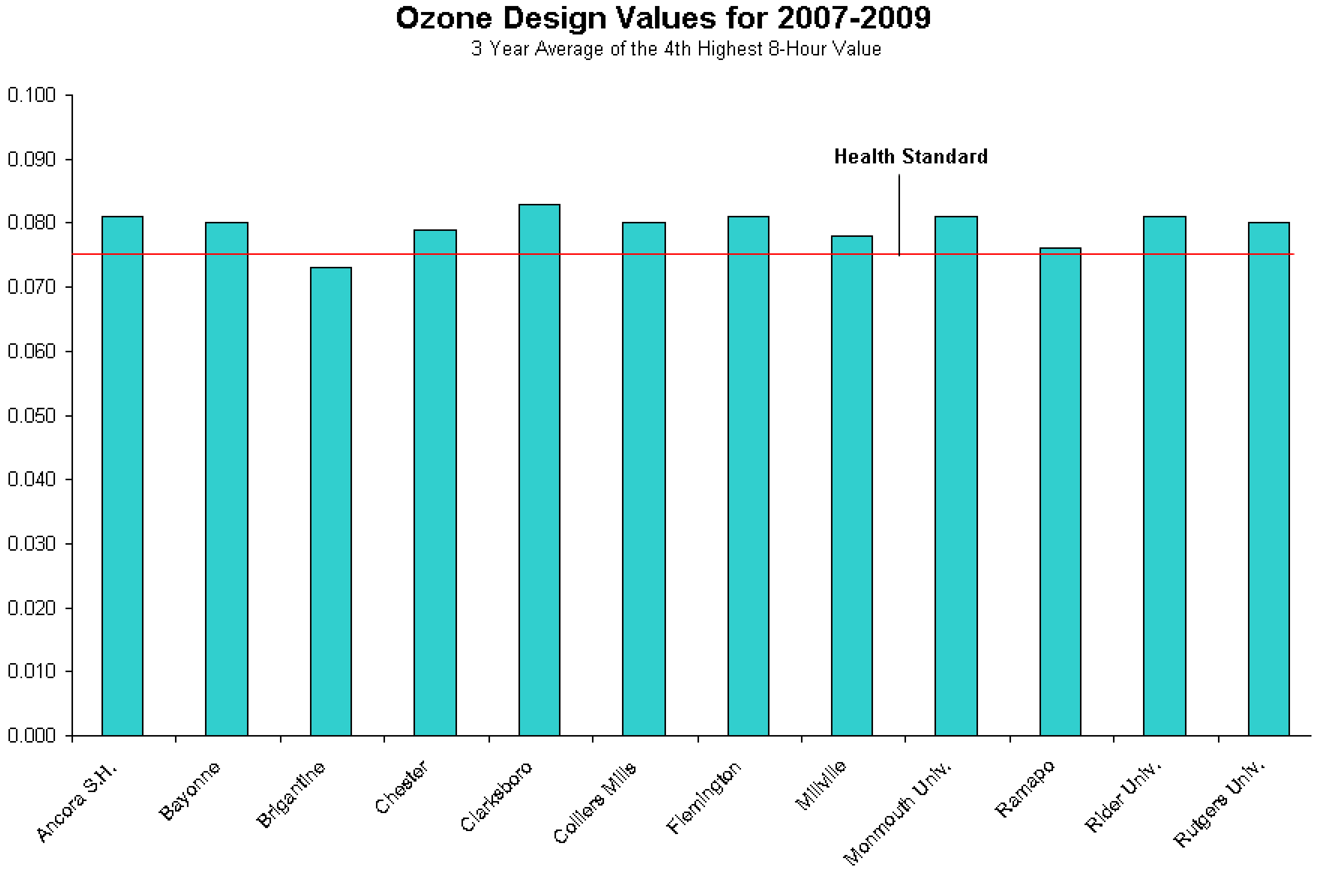

Ozone Design Values for 2007-2009
3 Year Average of the 4th Highest 8-Hour Value

Table 4
Ozone Data – 2009
8-Hour Averages

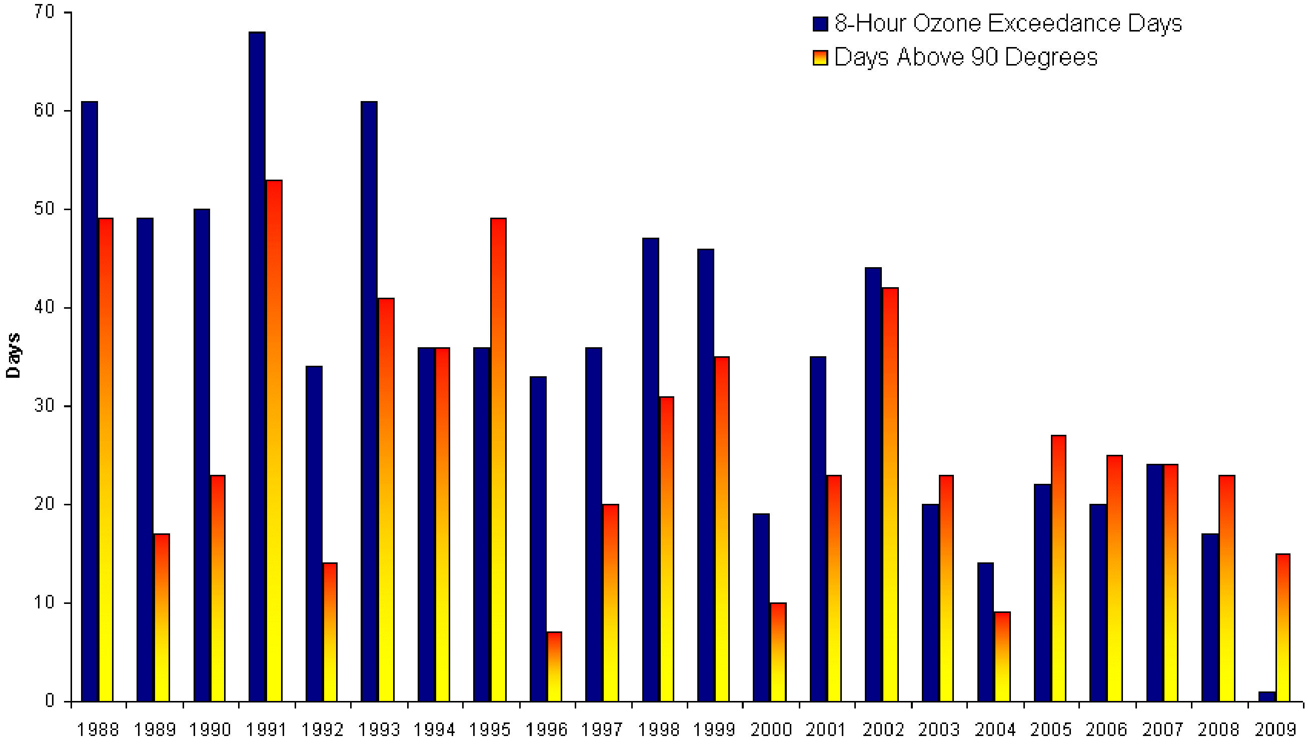
Parts Per Million (ppm) **8-hour standard is 0.075 ppm**

Monitoring Site	1st Highest	2nd Highest	3rd Highest	4th Highest	Avg. of 4th Highest 8-hour Averages 2007-2009	# of days with 8-hour above 0.075ppm
Ancora S.H.	.075	.074	.073	.071	.081	0
Bayonne	.074	.072	.072	.069	.080	0
Brigantine	.080	.072	.071	.071	.073	1
Chester	.083	.070	.069	.068	.079	1
Clarksboro	.076	.074	.072	.071	.083	1
Colliers Mills	.085	.080	.072	.071	.080	2
Flemington	.081	.076	.072	.070	.081	2
Leonia	.078	.078	.073	.072	Insufficient data	2
Millville	.079	.075	.073	.072	.078	1
Monmouth Univ.	.078	.078	.073	.072	.081	2
Newark Firehouse	.072	.068	.064	.064	Insufficient data	0
Ramapo	.075	.072	.069	.069	.078	0
Rider University	.073	.073	.072	.071	.081	0
Rutgers University	.072	.068	.067	.067	.080	0
Statewide	.085	.083	.080	.080	.092	9

Figure 10

Number of Days 8-Hour Ozone Standard was Exceeded and Number of Days Above 90 Degrees in New Jersey 1988 - 2009

{Using 8-Hour 0.08 ppm standard (old) across entire time period.}



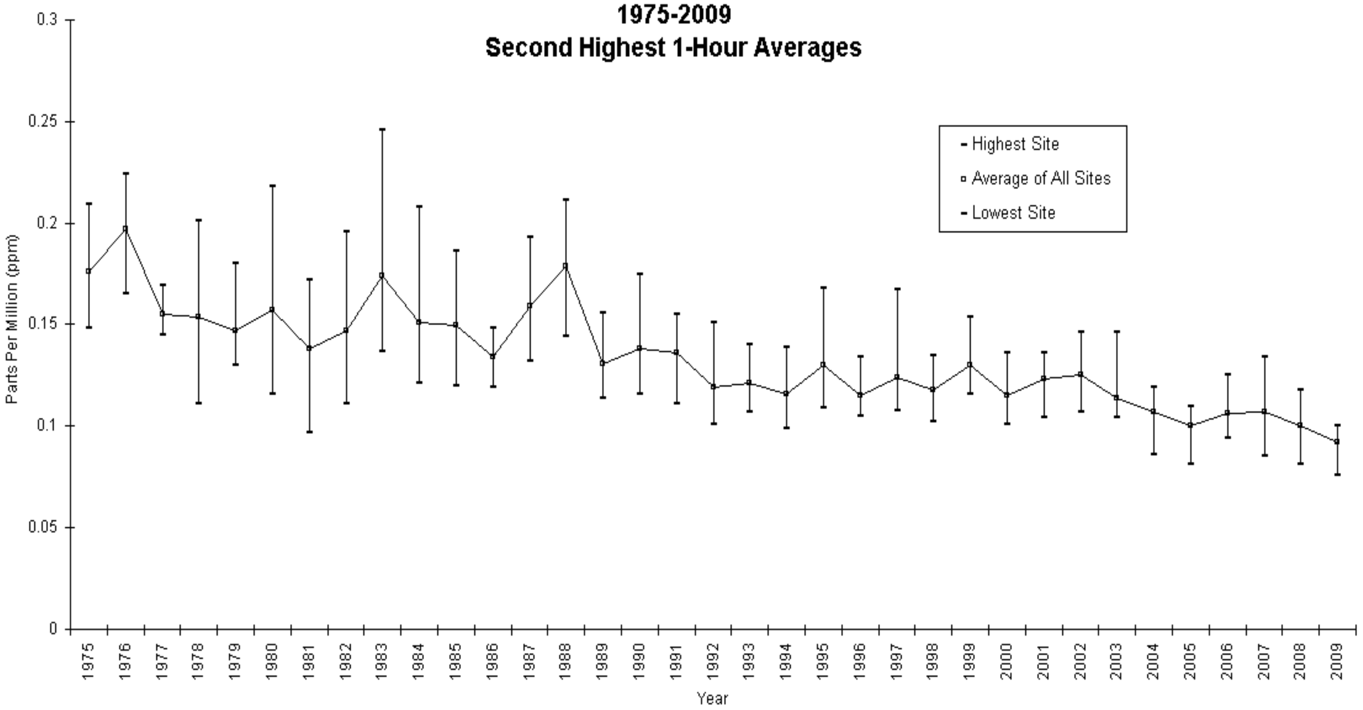
ACCOUNTING FOR THE INFLUENCE OF WEATHER

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 10. 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 11). 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 11
Ozone Concentrations in New Jersey
1975-2009
Second Highest 1-Hour Averages

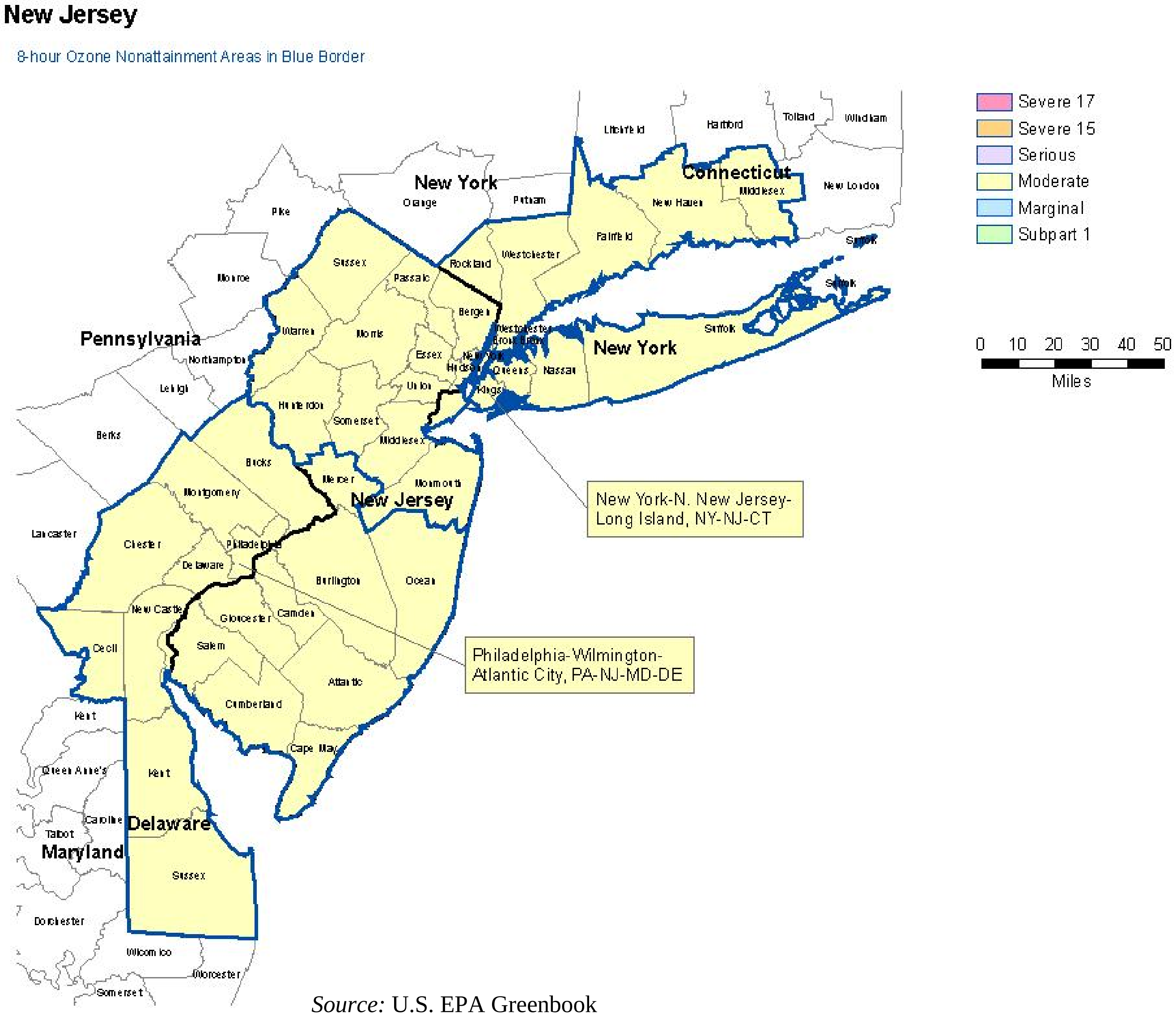


OZONE NON-ATTAINMENT AREAS IN NEW JERSEY

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 12 below. The entire state of New Jersey is in non-attainment and is classified as being “Moderate.” A “Moderate” classification is applied when an area has a design value from 0.092 ppm to 0.106 ppm.

Figure 12



Source: U.S. EPA Greenbook

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2009 Sulfur Dioxide Summary

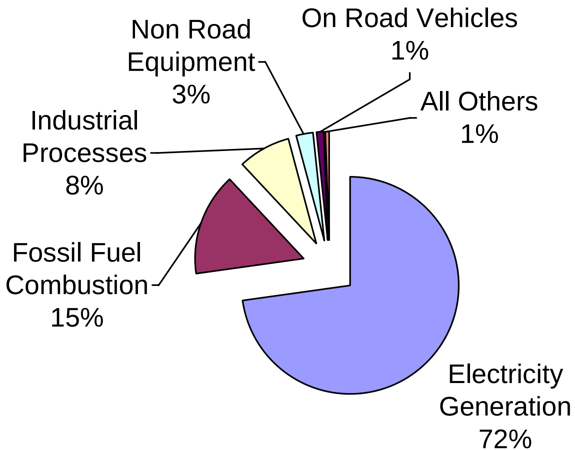
New Jersey Department of Environmental Protection

Nature and Sources

Sulfur dioxide (SO_2) is a heavy, colorless gas with a suffocating odor that easily dissolves in water to form sulfuric acid. SO_2 gases can be formed when fuels containing sulfur are burned, or when gasoline is extracted from oil. Most of the sulfur dioxide released into the air comes from electric utilities, especially those that burn coal with high sulfur content. Sulfur is found in raw materials such as crude oil, coal, and ores that contain metals such as aluminum, copper, zinc, lead and iron. Industrial facilities that derive their products from these materials may also release SO_2. A pie chart summarizing the major sources of SO_2 is shown in Figure 1.

Figure 2 (page 2) shows that SO_2 concentrations in New Jersey are generally higher in the winter than in the summer due to higher emissions from space heating and other sources. As shown in Figure 3 (page 2), SO_2 levels tend to peak in mid to late morning as emissions accumulate prior to being more effectively dispersed when wind speeds increase and atmospheric mixing increases later in the day.

Figure 1
National Summary
SO_2 Emissions by Source Sector



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

Health and Environmental Effects

Sulfur dioxide causes irritation of the mucous membranes. This is probably the result of the action of sulfurous acid that is formed when the highly soluble SO_2 dissolves at the surface of the membranes. Groups that are especially susceptible to the harmful health effects of SO_2 include children, the elderly, and people with heart or lung disorders such as asthma. When SO_2 concentrations in the air become elevated, people belonging to these sensitive groups and those who are active outdoors may have trouble breathing. The International Agency for Research on Cancer (IARC) evaluated SO_2 and based on available information, determined that no conclusion can be made as to the carcinogenicity of SO_2 to human beings.

Sulfur dioxide reacts with other gases and particles in the air to form sulfates that can be harmful to people and the environment. Sulfate particles are the major cause of reduced visibility in the eastern United States. SO_2 can also react with other substances in the air to form acids that fall to the earth in rain and snow. Better known as acid rain, this acidic precipitation can damage forests and crops, can make lakes and streams too acidic for fish, and eventually speeds up the decay of building materials and paints.

Standards

There are three National Ambient Air Quality Standards (NAAQS) for SO_2. There is 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) standard of 0.5 ppm, 3-hour average concentration that is also not to exceeded more than once per year.

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

Figure 2
Sulfur Dioxide – New Jersey
2009 Monthly Variation
Parts Per Million (ppm)

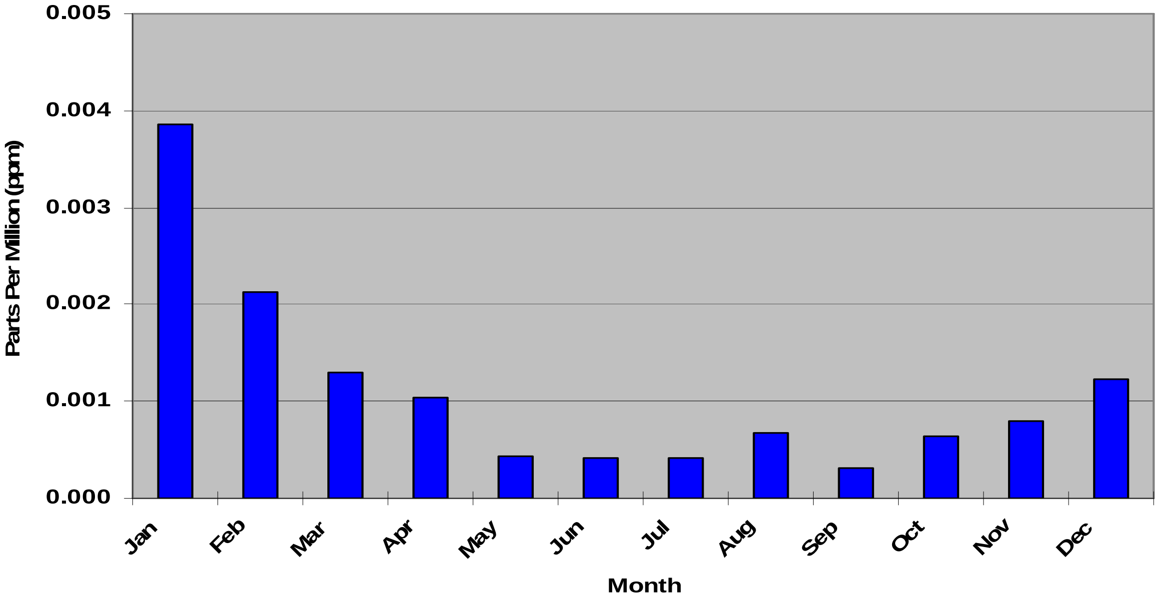


Figure 3
Sulfur Dioxide – New Jersey
2009 Hourly Variation
Parts Per Million (ppm)

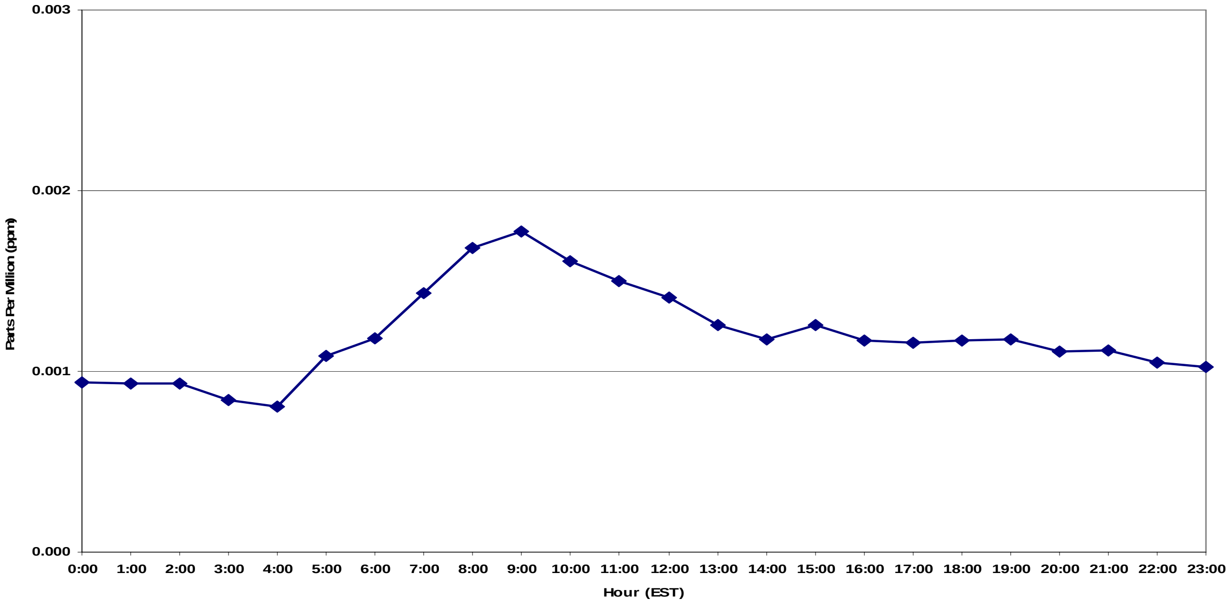


Table 1
National and New Jersey Ambient Air Quality Standards for Sulfur Dioxide
Parts Per Million (ppm)
Micrograms Per Cubic Meter (µg/m^3)

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

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

MONITORING LOCATIONS

The state monitored SO$_2$ levels at 13 locations in 2009. These sites are shown in Figure 4. Monitoring location changes included the start up of the Newark Firehouse site on June 1, 2009, and the shutdown of the Burlington site on December 29, 2009 because the NJDEP permanently lost access to the location.

SO$_2$ LEVELS IN 2009

None of the monitoring sites recorded exceedances of the primary or secondary SO$_2$ standards during 2009. The maximum 12-month average concentration recorded was 0.003 ppm at the Bayonne, Elizabeth Lab, and Jersey City sites. The maximum 24-hour average level recorded was 0.018 ppm at the Ancora State Hospital site. The highest 3-hour average recorded was 0.036 ppm at the Burlington site. Summaries of the 2009 data are provided in Tables 2 and 3 (page 4), and Figures 5 and 6 (page 5).

Figure 4
2009 Sulfur Dioxide Monitoring Network

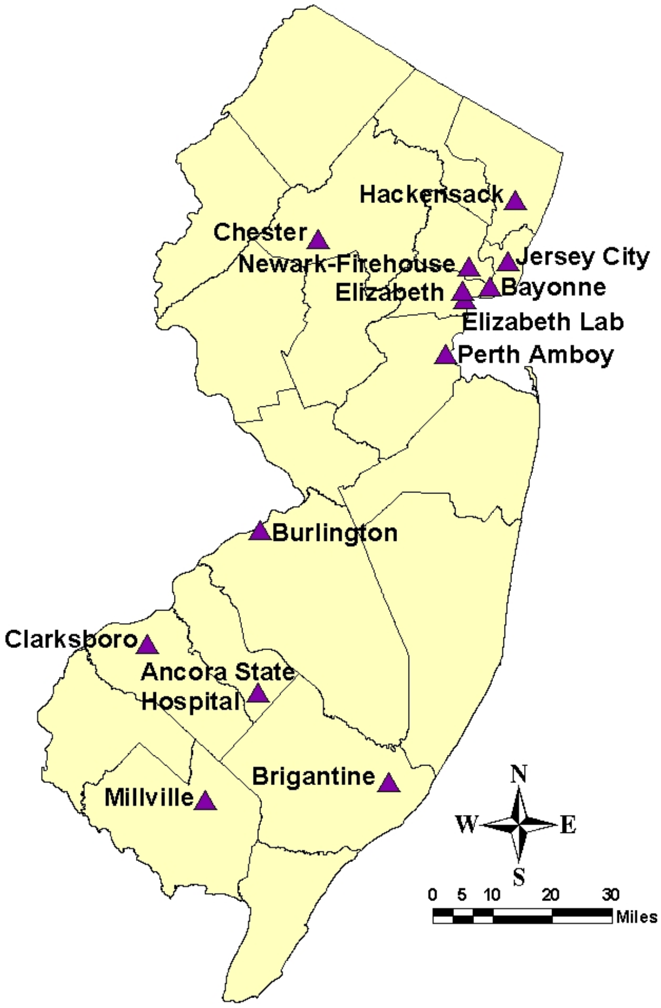


Table 2
2009 Sulfur Dioxide Data
3-Hour and Annual Averages
Parts Per Million (ppm)

Monitoring Sites	3-Hour Average Maximum	3-Hour Average 2nd Highest [b]	12-Month Average Maximum	Calendar Year Average
Ancora State Hospital	0.026	0.024	0.001	0.000
Bayonne	0.028	0.027	0.003	0.002
Brigantine	0.021	0.018	0.001	0.000
Burlington	0.036	0.030	0.002	0.001
Chester	0.031	0.031	0.001	0.001
Clarksboro	0.025	0.024	0.002	0.002
Elizabeth	0.023	0.021	0.002	0.001
Elizabeth Lab	0.031	0.028	0.003	0.002
Hackensack	0.023	0.021	0.001	0.001
Jersey City	0.027	0.026	0.003	0.002
Millville	0.021	0.019	0.001	0.001
Newark Firehouse (c)	0.017	0.016	-----	-----
Perth Amboy	0.017	0.016	0.002	0.001

[b] – Based on non-overlapping 3 – hour moving averages.

[c] – Station started collecting data June 2009 and does not have sufficient amount of data to calculate 12-Month and Calendar Year averages.

Table 3
2009 Sulfur Dioxide Data
24-Hour and Daily Averages
Parts Per Million (ppm)

Monitoring Sites	24-Hour Average Maximum	24-Hour Average 2nd Highest [b]	Daily Average Maximum	Daily Average 2nd Highest
Ancora State Hospital	0.018	0.010	0.015	0.007
Bayonne	0.016	0.015	0.014	0.012
Brigantine	0.012	0.009	0.010	0.008
Burlington	0.015	0.012	0.013	0.012
Chester	0.013	0.012	0.012	0.012
Clarksboro	0.017	0.013	0.014	0.012
Elizabeth	0.011	0.011	0.010	0.010
Elizabeth Lab	0.012	0.011	0.010	0.010
Hackensack	0.009	0.009	0.009	0.008
Jersey City	0.017	0.015	0.017	0.014
Millville	0.013	0.008	0.012	0.008
Newark Firehouse (c)	0.007	0.007	0.007	0.007
Perth Amboy	0.011	0.010	0.011	0.010

[b] – Based on non-overlapping 24 – hour moving averages.

[c] – Station started collecting data June 2009.

Figure 5
2009 Sulfur Dioxide Concentrations
Highest and 2nd Highest 24-Hour Averages
Parts Per Million (ppm)

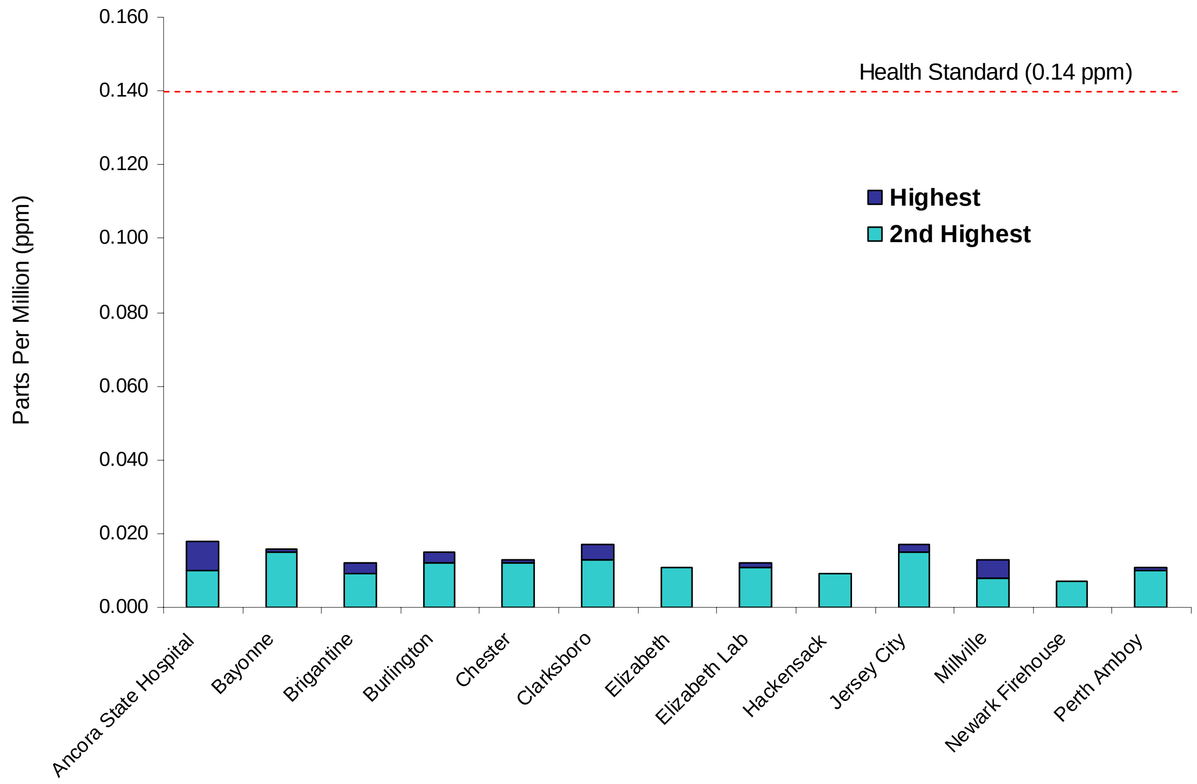
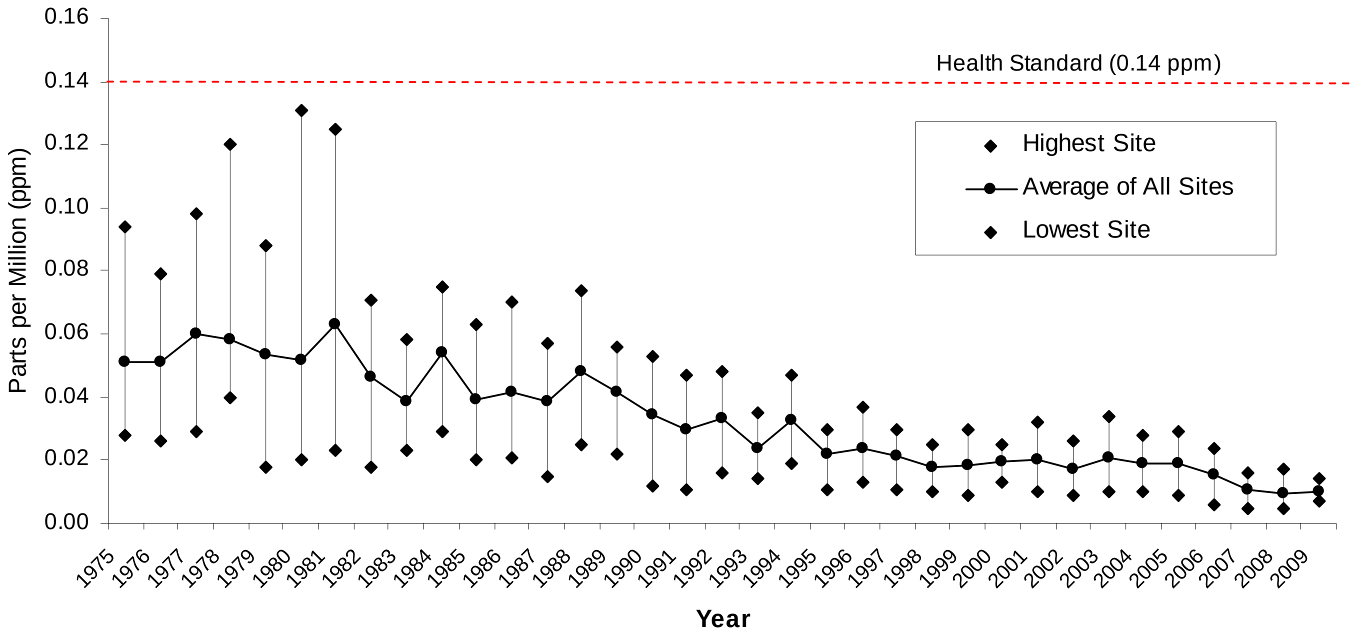


Figure 6
1975 - 2009 Sulfur Dioxide Concentrations
Second Highest Daily Average
Parts Per Million (ppm)

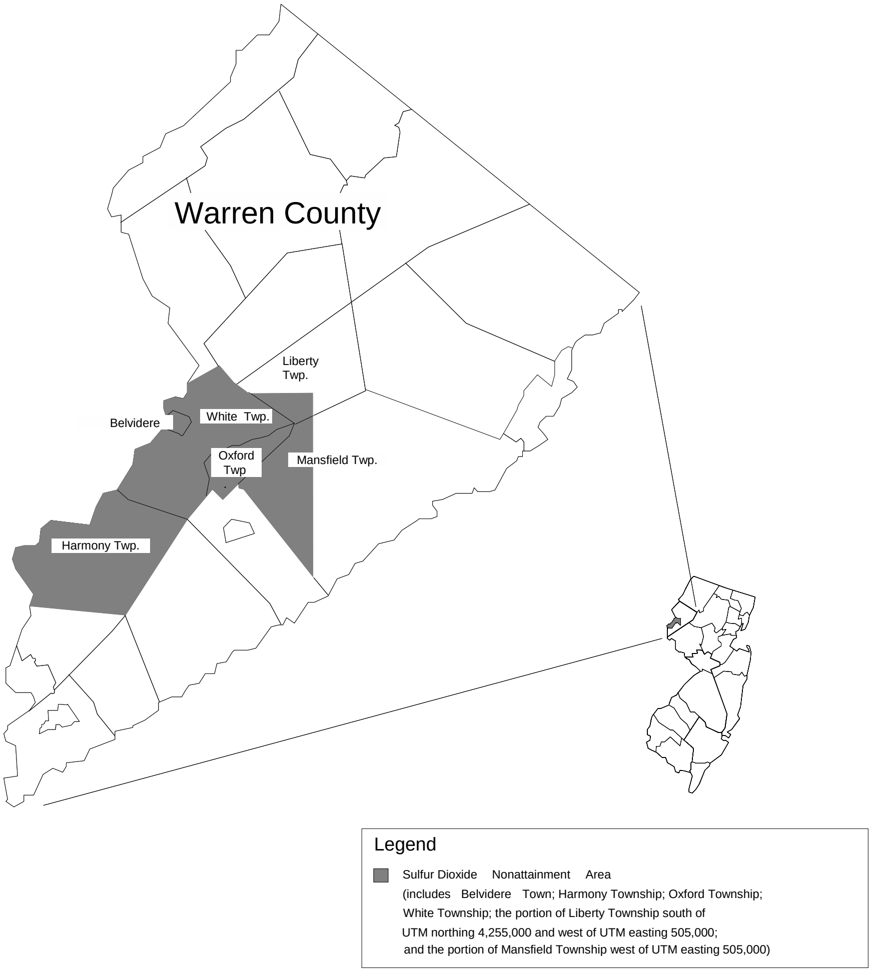


TRENDS

Since the implementation of regulations requiring the use of low sulfur fuels in New Jersey, SO_2 concentrations have improved significantly. The last time an exceedance of any of the National SO_2 standards was recorded in the state was in 1980. A trend graph of SO_2 levels showing the daily average concentrations recorded since 1975 from the highest, average, and lowest of all sites is shown in Figure 6 (page 5). The graph uses the second highest daily average, as this is the value that determines if the national health standard is being met (one exceedance per site is allowed each year).

Although there has not been a measured exceedance of the NAAQS in over two decades, there is still a small area of New Jersey that is classified as a non-attainment area for SO_2. This is the result of air quality modeling studies that predicted non-attainment of the standard within a small area of Warren County. The area is shown below in the map in Figure 7.

Figure 7
Sulfur Dioxide Non-attainment Areas in New Jersey



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

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2009 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 less than 2.5 microns are considered Fine Particulates, often referred to as $PM_{2.5}$ (Figure 1). Particulates with diameters greater than 2.5 microns are considered to be Coarse Particulates. Coarse Particulates are further divided into Total Suspended Particulates (TSP) and Inhalable Particulates (PM_{10}). TSP consists of all suspended Particulates including the largest ones. PM_{10} consists of particulates that are 10 microns in diameter or less. 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.

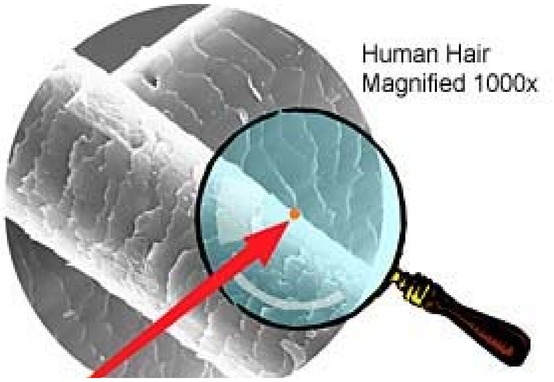
Particulates can occur naturally or be man made. Examples of naturally occurring particulates are windblown dust and sea salt. Man made particulates come from sources such as fossil fuel combustion and industrial processes. Man made sources can be divided into two categories: Primary Particulates and 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 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 section of this report.

Figure 1

Size of $PM_{2.5}$ Particulate Compared to a Human Hair



$PM_{2.5}$ Particulate

Graphics Courtesy of the US Department of Energy

Figure 2a

Figure 2b

HEALTH EFFECTS

Inhalable particulates (PM_{10}) and especially Fine Particulates ($PM_{2.5}$) are a health concern 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 (*US EPA, 2001).*

STANDARDS

In 1971, 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 ($\mu g/m^3$) and the annual geometric mean health standard was set at 75 $\mu g/m^3$. The 24-hour secondary standard was set at 150 $\mu g/m^3$. While EPA did not establish a secondary annual standard for TSP they did set a guideline of 60 $\mu g/m^3$ 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. Inhalable particles are defined as particles less than 10 microns in diameter (PM_{10}). The 24-hour PM_{10} primary and secondary standards were set at 150 $\mu g/m^3$, and the annual primary and secondary standards were set at 50 $\mu g/m^3$. 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, while maintaining the existing standards for PM_{10} as well. The $PM_{2.5}$ annual primary and secondary standards were set at 15.0 $\mu g/m^3$ and the 24-hour standard was set at 65 $\mu g/m^3$. In October 2006 the EPA revised the 24-hour Standard. It currently is set at 35 $\mu g/m^3$. 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 ($\mu g/m^3$)

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

[‡] Annual Geometric Mean

[†] Annual Arithmetic Mean

PARTICULATE MONITORING NETWORK

New Jersey's Particulate Monitoring Network consists of 24 PM$_{2.5}$ monitoring sites, 5 PM$_{10}$ monitoring sites, and 8 sites where smoke shade is monitored.

19 samplers that comply with strict EPA requirements are used for collecting data that is submitted to a national database maintained by the EPA. Samplers that meet these requirements are called Federal Reference Method (FRM) samplers. These samplers pull a predetermined amount of air through a filter for a 24-hour period capturing particles on the filter. Different sample inlets determine what size particles will be captured. 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 federal health and welfare standards for particulate matter. Because these samplers are required to run for 24-hour period and can 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 particle reporting. The TEOM analyzers collect a sample of fine particles 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 particles 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 three of these locations, a separate 24-hour filter based sampler collects fine particles on three types of filter media which are subsequently analyzed using ion chromatography (IC), X-ray fluorescence (XRF), and Thermal Optical Analysis (TOA) to determine the concentrations of the chemical analytes that constitute the sample.

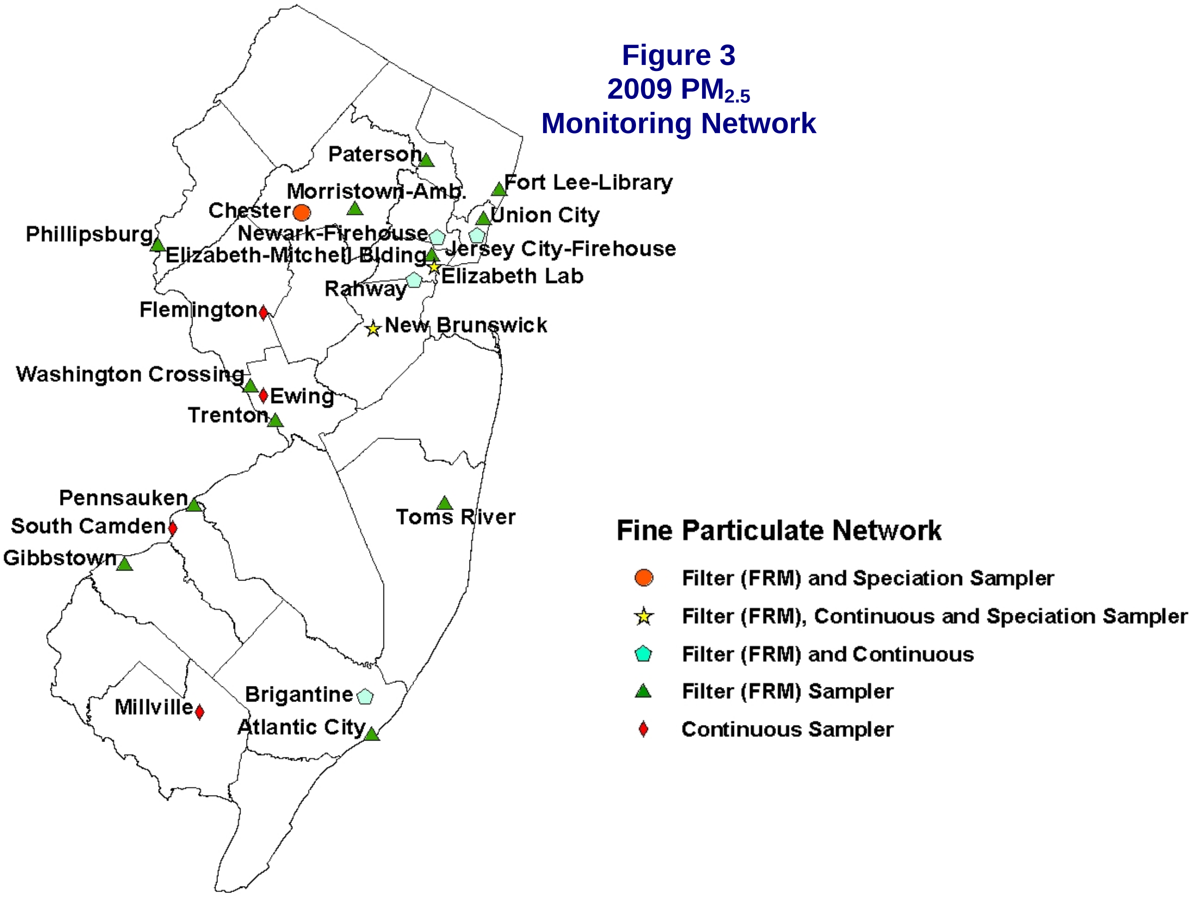


Figure 3
2009 PM$_{2.5}$
Monitoring Network

FINE PARTICLE SUMMARY

FINE PARTICLE MONITORING SITES

There are 19 monitoring sites in New Jersey where FRM samplers routinely collect 24-hour PM$_{2.5}$ samples (see Figure 3). At 11 sites, continuous particulate monitors (TEOMs) measure the concentration 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). In 2009, an FRM sampler was established in June and a TEOM analyzer was established in September at the Newark Firehouse station. The TEOM analyzer at the Fort Lee station was temporarily shutdown in October 2009 due to utility problems.

FINE PARTICLE CONCENTRATION SUMMARY

The annual mean concentration of PM$_{2.5}$ ranged from 7.1 μg/m^3 at Chester to 11.2 μg/m^3 at the Elizabeth Lab. The highest daily concentration ranged from 22.2 μg/m^3 at Brigantine to 41.5 μg/m^3 at Fort Lee. Figure 4 and Table 2 depict the mean and maximum concentrations at each site. Table 2 also shows the 2009 annual design value for each site. An annual design value is calculated by averaging the average concentration from 12 consecutive quarters (3 years), in this case 2007-2009. Design values are used to determine attainment status.

No sites were in violation of the annual standard of 15.0 μg/m^3. Four monitoring sites measured exceedences of the 24-hour standard of 35 micrograms.

Figure 4
2009 Fine Particulate (PM$_{2.5}$) Concentration

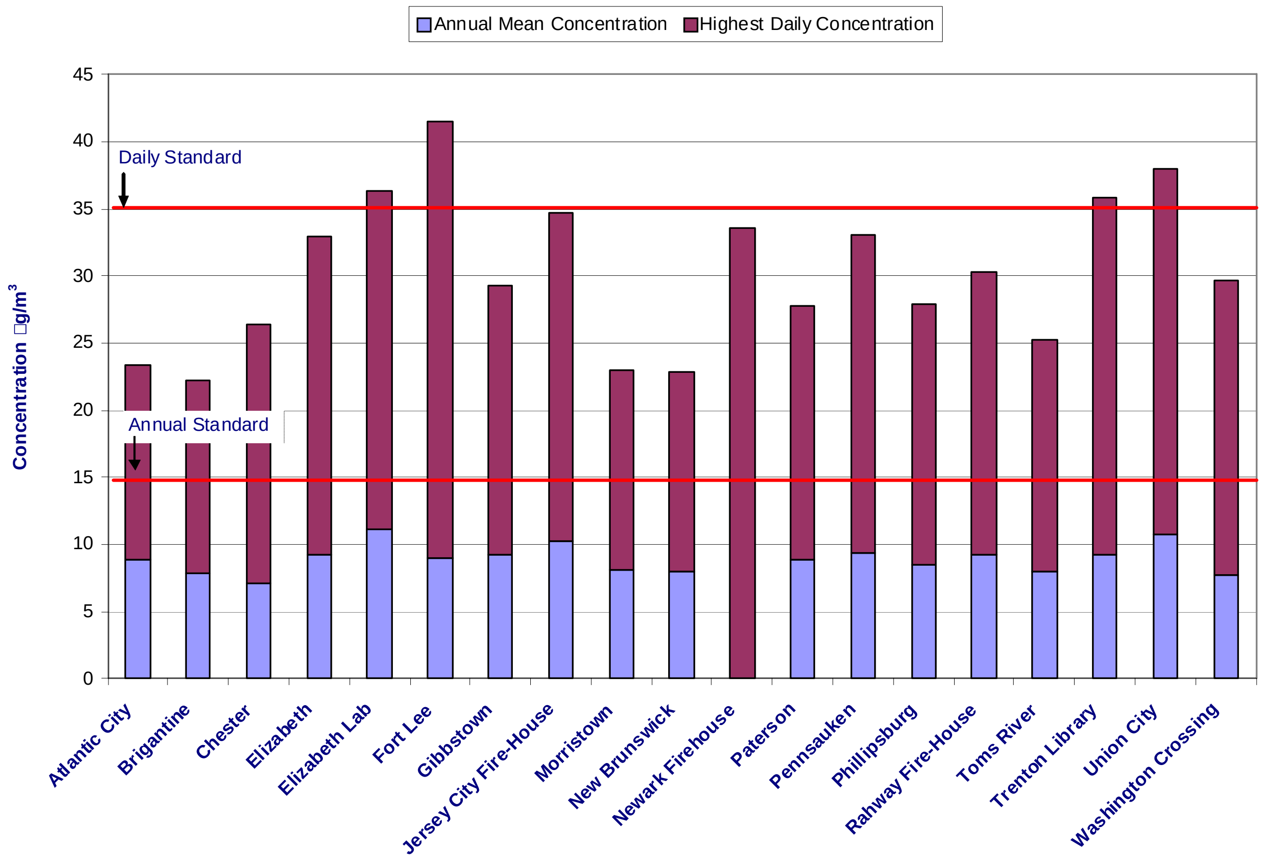


Table 2

2009 Summary of $PM_{2.5}$ Sampler Data

Concentration in Micrograms Per Cubic Meter ($\mu g/m^3$)

Monitoring Site	Number of Samples	Annual Mean Concentration	Highest Daily Concentration	Second Highest Daily Concentration	2009 Annual Average Design Values
Atlantic City	104	8.9	23.3	21.4	9.9
Brigantine	124	7.9	22.2	20.7	9.6
Chester	116	7.1	26.4	23.1	8.7
Elizabeth	115	9.3	32.9	29.3	11.6
Elizabeth Lab	343	11.2	36.3	32.6	12.6
Fort Lee	115	9.0	41.5	35.3	11.3
Gibbstown	116	9.2	29.3	24.7	11.3
Jersey City Fire-House	332	10.3	34.7	31.8	11.8
Morristown	115	8.1	23.0	22.0	9.6
New Brunswick	123	8.0	22.9	22.2	10.4
Newark Firehouse *	59	---	33.5	25.0	---
Paterson	116	8.9	27.7	26.7	11.2
Pennsauken	115	9.4	33.1	29.6	11.7
Phillipsburg	117	8.5	27.9	25.4	10.8
Rahway Fire-House	119	9.3	30.3	27.5	11.5
Toms River	349	8.0	25.2	24.7	9.5
Trenton Library	350	9.2	35.8	31.0	10.8
Union City	117	10.7	38.0	28.6	13.0
Washington Crossing	113	7.8	29.7	23.5	9.3

* There was not enough data to calculate an annual mean concentration or an average design value.

Table 3

2009 Summary of Continuous $PM_{2.5}$ Data

Concentration in Micrograms Per Cubic Meter ($\mu g/m^3$)

Monitoring Site	Annual Mean Concentration	Highest Daily Concentration	Second Highest Daily Concentration
Brigantine	8.4	29.8	29.2
Elizabeth Lab	10.4	32.7	31.7
Ewing	6.7	25.5	23.6
Flemington	8.7	24.6	24.2
Fort Lee *	16.8	51.1	50.8
Jersey City Firehouse	11.8	35.8	33.5
Millville	10.9	30.6	27.2
New Brunswick	6.6	23.9	22.9
Newark Firehouse**	---	32.6	27.0
Rahway	10.1	28.1	27.2
South Camden**	---	36.6	33.6

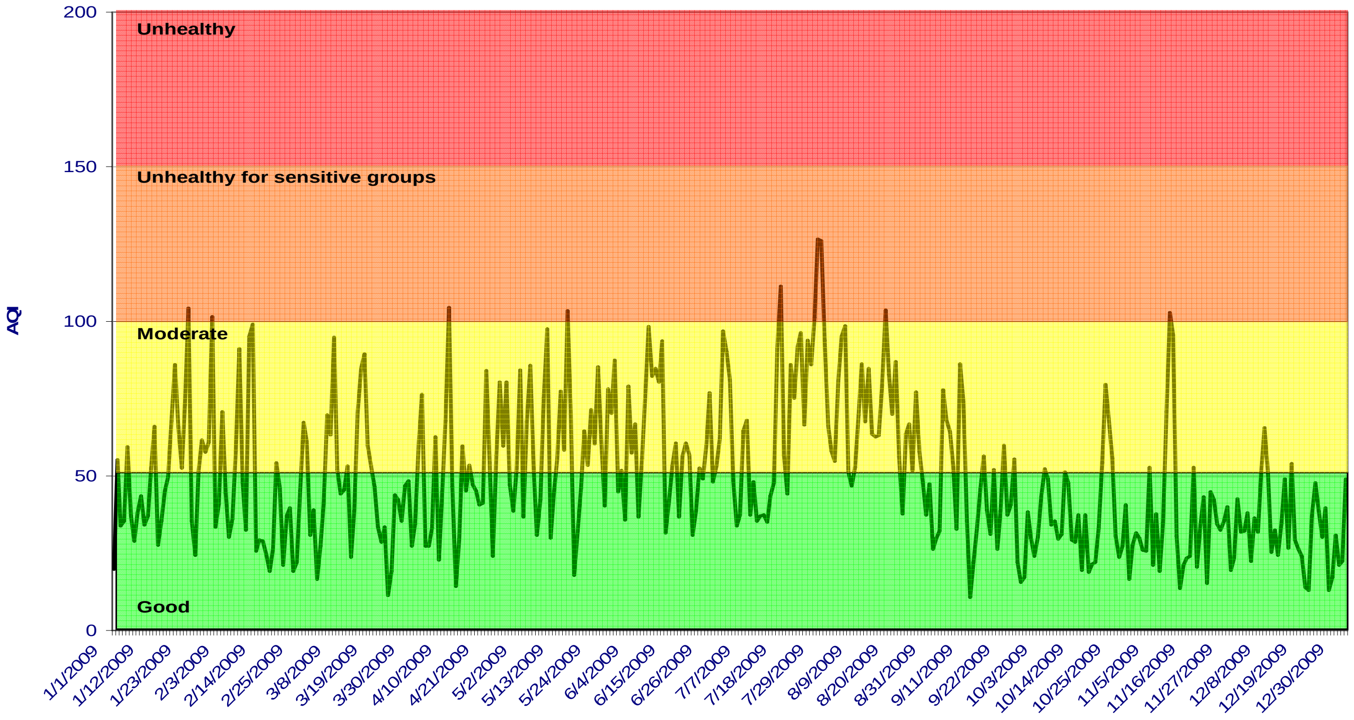
*Fort Lee was temporarily shut down in October, 2009.

**There was not enough data to calculate an annual mean concentration.

PM$_{2.5}$ REAL-TIME MONITORING

New Jersey's continuous PM$_{2.5}$ monitoring network consists of 11 sites: Brigantine, Elizabeth Lab, Ewing, Flemington, Fort Lee, 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 maximum daily fine particulate concentration recorded in the state each day for the entire year.

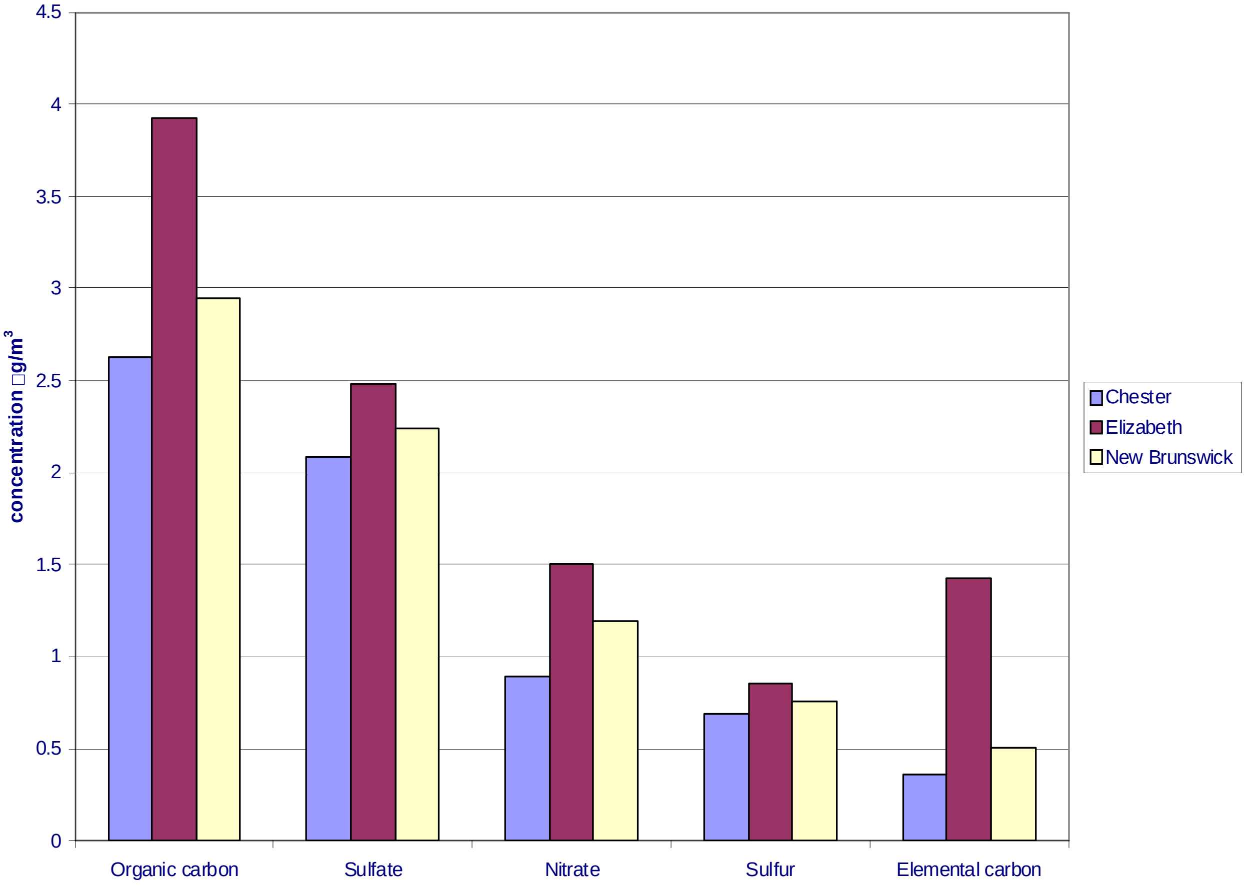
Figure 5
2009 Maximum Daily Fine Particulate Concentration
(Highest site)
Air Quality Index (AQI)



FINE PARTICLE SPECIATION SUMMARY

New Jersey’s Fine Particulate Speciation Network consists of 3 monitoring sites: Elizabeth Lab, New Brunswick, and Chester. Samplers run every third day on a schedule concurrent with the Federal Reference Method sampling network. Of the 55 measured analytes, organic carbon, sulfate, nitrate, sulfur and elemental carbon are the most prevalent species, Combined, they create the majority of the particulates total mass. Figure 6 depicts the average concentration of the 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 the primary source for those species. Appendix B shows the average, maximum, and 2nd highest daily average concentrations for each species for 2009.

Figure 6
2009 Fine Particulate Analyte Composition
Annual Average
(Highest 5 Analytes Depicted)



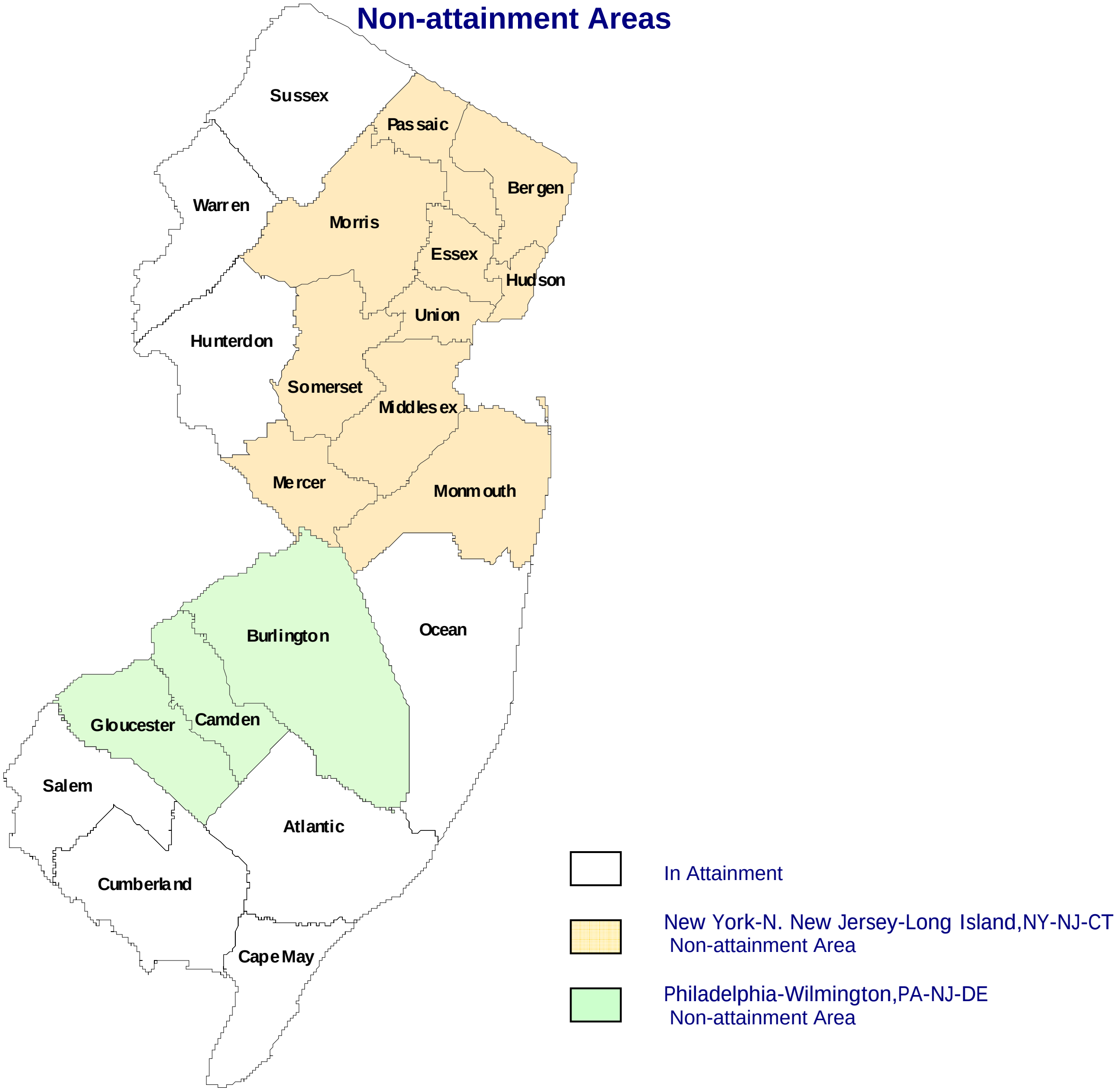
FINE PARTICULATE NON-ATTAINMENT AREAS

On April 5, 2005, thirteen New Jersey counties were classified as non-attainment areas. Non-attainment classification is given to an area that exceeds the air quality standard or contributes to the exceedance of that standard. In order to determine if the $PM_{2.5}$ annual standard is met, the average of 12 consecutive quarters of valid data within 3 calendar years is compared to 15 $\mu g/m^3$.

While the 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 additional sites in New York City that recorded violations of the $PM_{2.5}$ Standards.

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

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

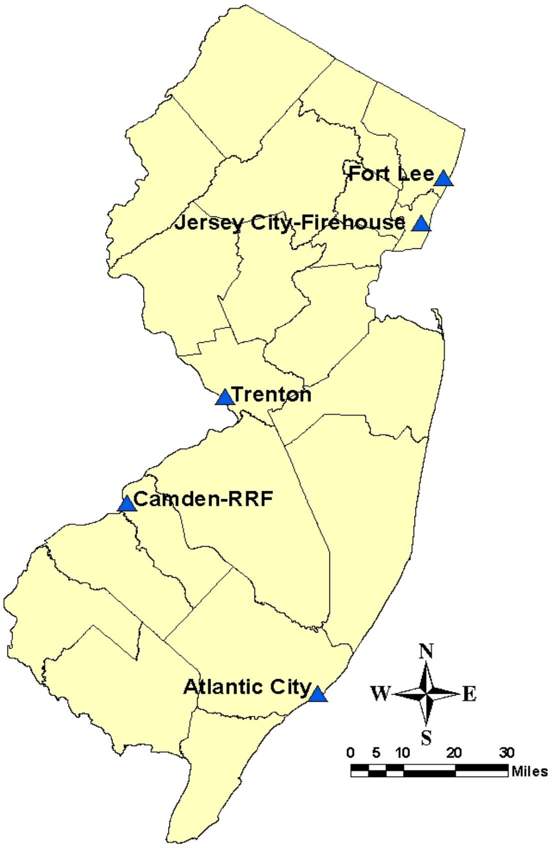


2009 COARSE PARTICLE SUMMARY

COARSE PARTICLE MONITORING SITES

The coarse particulate monitoring network is composed of 5 PM_{10} sampling sites. PM_{10} samples, taken once every six days are collected on a filter that is weighed before and after sampling to determine the concentration. Fort Lee was temporarily shut down in November 2009. Figure 8 depicts the PM_{10} particulate monitoring network in New Jersey.

Figure 8
2009 PM_{10}
Monitoring Network



PM_{10} CONCENTRATION SUMMARY

In 2009, the annual mean concentration of PM_{10} ranged from 17.0 $\mu g/m^3$ at Trenton to 37.0 $\mu g/m^3$ at Camden RRF. Table 4 and Figure 9 show the annual mean and 24-hour maximum PM_{10} concentrations throughout the state. All areas of the state are in attainment for the both the annual PM_{10} standards of 50 $\mu g/m^3$ and the 24-hour standard of 150 $\mu g/m^3$.

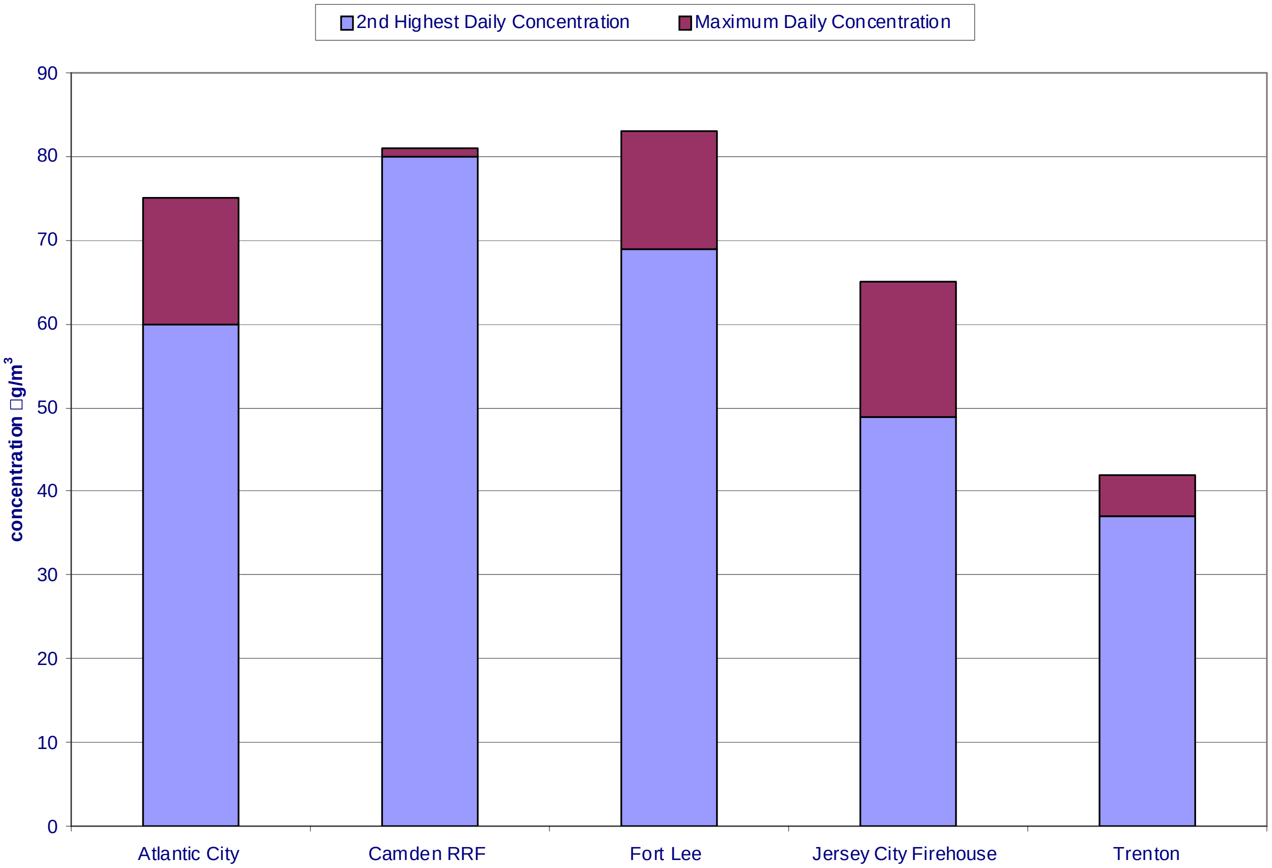
Table 4
PM_{10} Data - 2009
Daily and Annual Averages

Micrograms Per Cubic Meter (µg/m^3)
Daily Standard = 150 (µg/m^3)
Annual Standard = 50 µg/m^3

Monitoring Site	Number of Samples	Highest Daily Concentration	Second Highest Daily Concentration	Annual Mean
Atlantic City	41	75	60	**
Camden RRF	60	81	80	37
Fort Lee*	53	83	69	**
Jersey City-Firehouse	42	65	49	**
Trenton	60	42	37	17

* Fort Lee was temporarily shut down in November 2009.
** There was not enough data to calculate an annual mean concentration.

Figure 9
Summary of PM_{10} Concentrations, New Jersey 2009



SMOKE SHADE SUMMARY

SMOKE SHADE MONITORING SITES

In addition to fine and coarse particulate monitoring, smoke shade is also monitored at 8 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 2009, the annual mean concentration of smoke shade ranged from 0.14 Coefficient of Haze units (COH) at Hackensack to 0.36 COH at 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 maximum and second highest daily average and annual mean smoke shade levels recorded at the monitoring sites in 2009.

Figure 10
2009 Smoke Shade Monitoring Network

Table 5
Smoke Shade - 2009

Coefficient of Haze (COHs)
No Standard

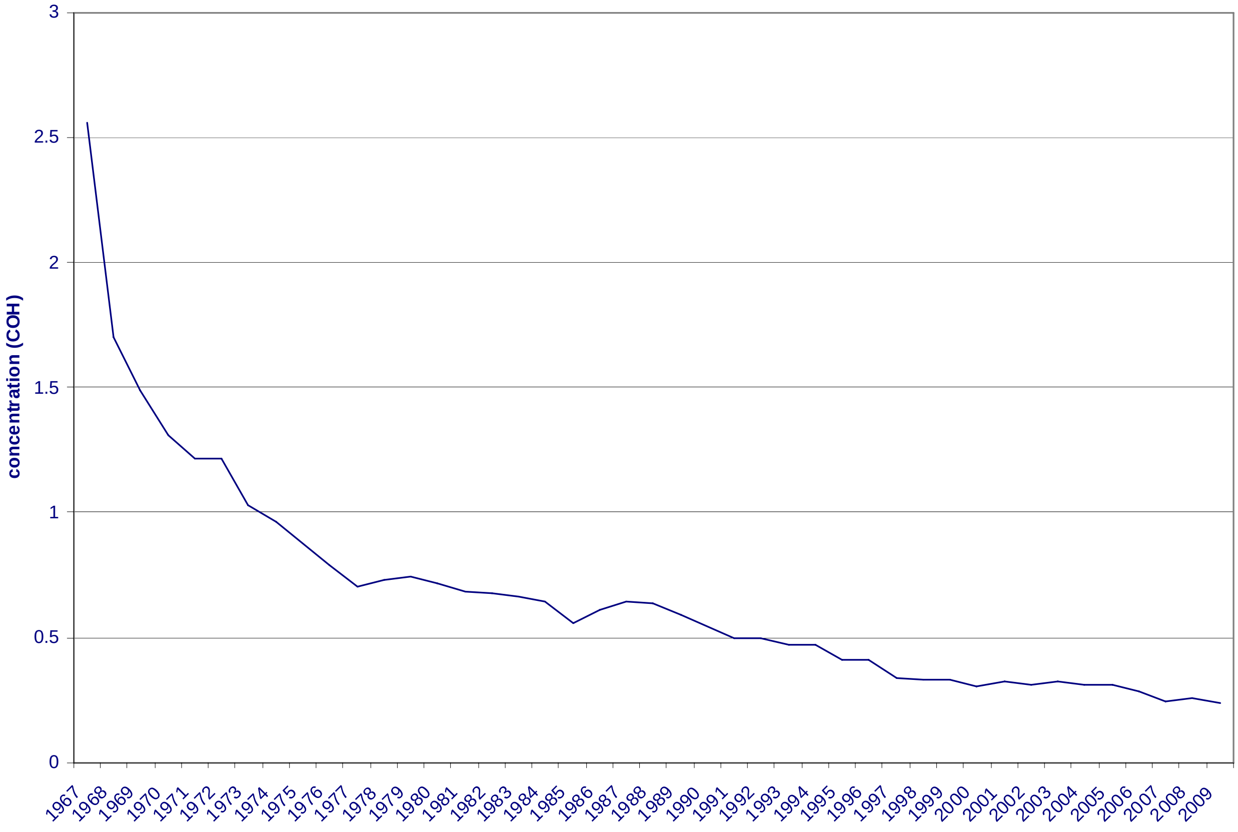
Site	Maximum Daily Average	2nd Highest Daily Average	Annual Mean
Burlington	0.57	0.55	0.19
Elizabeth	0.67	0.61	0.21
Elizabeth Lab	1.33	1.21	0.36
Freehold	0.51	0.49	0.17
Hackensack	0.81	0.63	0.14
Jersey City*	1.31	1.12	---
Morristown	0.77	0.71	0.19
Perth Amboy	0.86	0.78	0.19

*There was not enough data to calculate an annual mean concentration.

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 in effect for over 40 years and still has 8 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, PM_{10} and $PM_{2.5}$ health standards.

Figure 11
Long Term Trend in Particulate Levels
State Average
1967- 2009



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2009 PHOTOCHEMICAL ASSESSMENT MONITORING STATIONS (PAMS)

New Jersey Department of Environmental Protection

PHOTOCHEMICAL ASSESSMENT MONITORING STATIONS (PAMS)

Most ground-level ozone (O_3) is formed as the result of oxides of nitrogen (NOx) 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 O_3 problem, track VOC and NOx emission inventory reductions, assess air quality trends, and make attainment/nonattainment decisions. PAMS monitor both criteria and non-criteria pollutants including ozone (O_3), oxides of nitrogen (NOx), 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 below. 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 is located at Rider University in Mercer County, a secondary Type 2 (or Type 2A) maximum emissions site is 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

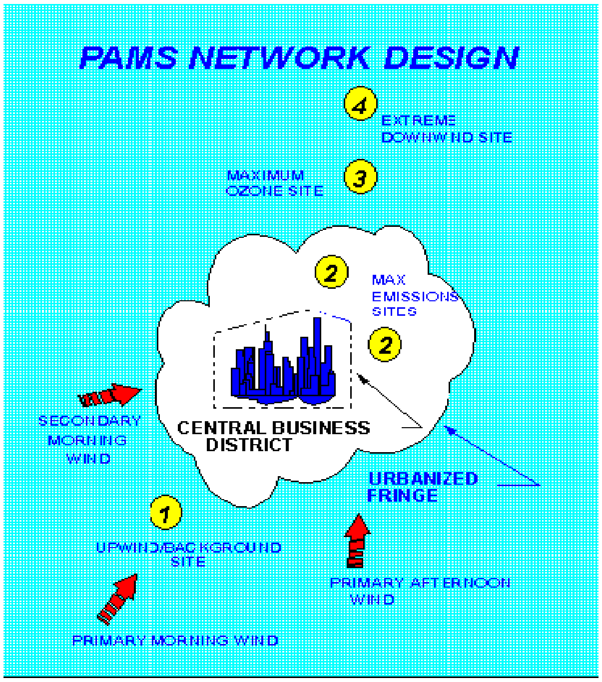
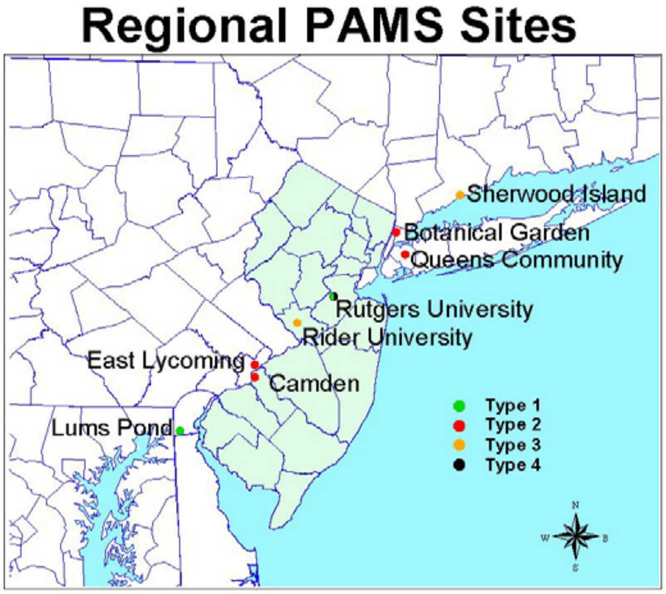


Figure 2



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

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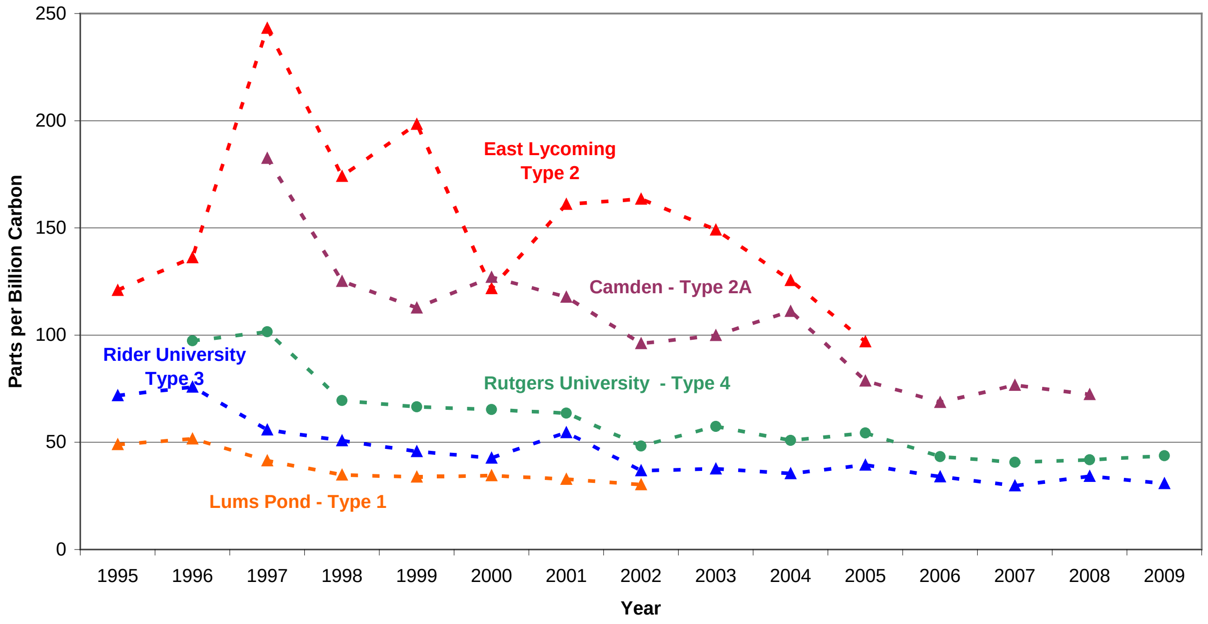
[5] USEPA , PAMS General Information

PAMS (CONT.)

The Camden site did not operate during the 2009 season due to our losing access to the site. The sampling trailer is currently being relocated. 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. 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). Delaware's Department of Natural Resources and Environmental Control (DNREC) discontinued operation of the Lums Pond site after the 2002 season.

Figure 3
Philadelphia Region
Total Non-methane Organic Carbon (TNMOC)
Seasonal Average 1995-2009



PAMS (cont.)

Figure 4 shows VOC trends for the PAMS sites in the New York City metropolitan area. In general, observations here 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. Operation of the Queens Community College site was discontinued after the 2001 season.

In conclusion, trends for VOC values measured at all PAMS sites in the Philadelphia and New York City areas show a decline over the time period during which these measurements were made. Changes in gasoline formulation over the period as well as the effect of newer, cleaner vehicles replacing older vehicles in the automotive fleet might account for the 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.

Figure 4
New York City Region
Total Non-methane Organic Carbon (TNMOC)
Seasonal Average 1995-2009

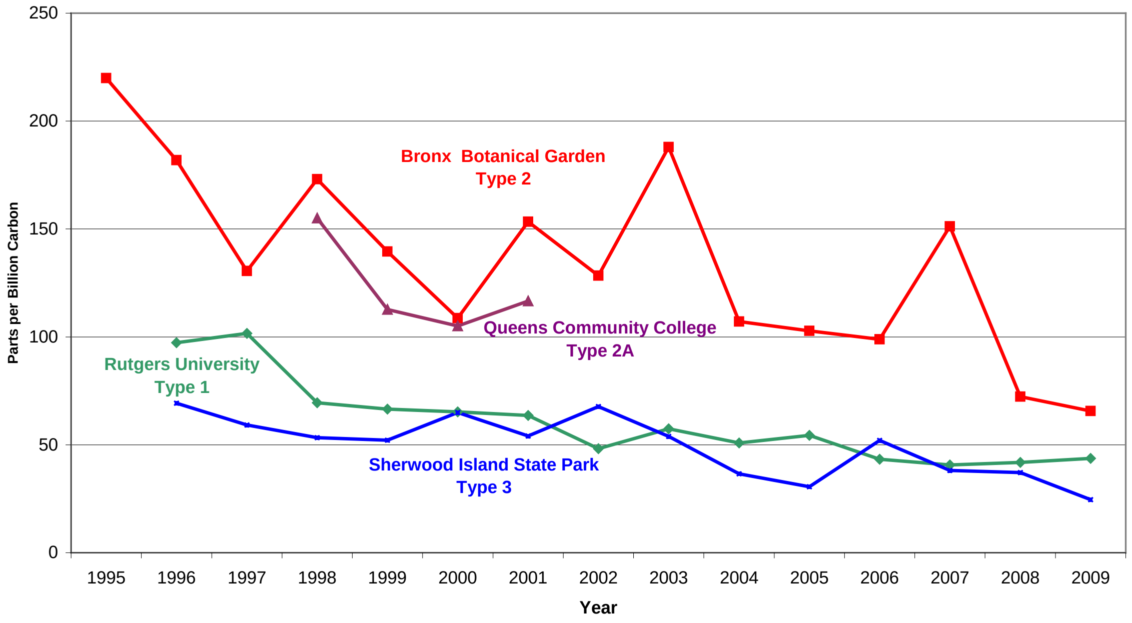


Table 1
Summary of Photochemical Assessment Monitoring (PAMS) Data
June, July, and August, 2009

Parts Per Billion (Volume) – ppbv

Parts Per Billion (Carbon) – ppbC

Max – Maximum   Avg - Average

	Rider University				**Rutgers University**			
	ppbv		**ppbC**		**ppbv**		**ppbC**	
	Max	**Avg**	**Max**	**Avg**	**Max**	**Avg**	**Max**	**Avg**
Acetylene	1.86	0.20	3.71	0.40	0.67	0.11	1.33	0.22
Benzene	0.82	0.10	4.91	0.58	0.46	0.08	2.76	0.47
n-Butane	3.89	0.35	15.56	1.39	8.71	0.62	34.83	2.47
1-Butene	0.43	0.03	1.71	0.14	0.30	0.05	1.20	0.21
cis-2-Butene	0.16	0.02	0.65	0.09	0.30	0.04	1.20	0.16
trans-2-Butene	0.27	0.03	1.07	0.10	0.23	0.04	0.92	0.15
Cyclohexane	0.17	0.03	1.00	0.18	0.35	0.04	2.07	0.22
Cyclopentane	0.21	0.04	1.06	0.20	0.29	0.03	1.43	0.15
n-Decane	0.31	0.02	3.14	0.23	0.21	0.03	2.06	0.25
m-Diethylbenzene	0.09	0.01	0.87	0.14	0.31	0.02	3.08	0.16
p-Diethylbenzene	0.06	0.01	0.58	0.12	1.98	0.01	19.83	0.11
2,2-Dimethylbutane	0.11	0.02	0.56	0.12	0.27	0.03	1.36	0.14
2,3-Dimethylbutane	0.27	0.07	1.34	0.34	0.41	0.05	2.04	0.24
2,3-Dimethylpentane	0.19	0.04	1.32	0.25	0.23	0.03	1.61	0.23
2,4-Dimethylpentane	0.12	0.03	0.82	0.22	0.52	0.03	3.66	0.20
Ethane	6.37	1.90	12.74	3.79	11.13	2.47	22.25	4.94
Ethylbenzene	0.19	0.03	1.48	0.25	0.31	0.04	2.45	0.29
Ethylene (Ethene)	2.92	0.44	5.84	0.87	3.84	0.56	7.68	1.12
m-Ethyltoluene	0.27	0.05	2.43	0.41	0.57	0.04	5.10	0.37
o-Ethyltoluene	0.11	0.02	1.00	0.15	0.36	0.01	3.26	0.11
p-Ethyltoluene	0.30	0.06	2.71	0.54	0.31	0.02	2.81	0.18
n-Heptane	0.30	0.04	2.10	0.28	0.41	0.07	2.85	0.47
Hexane	0.69	0.09	4.14	0.54	1.24	0.12	7.42	0.73
1-Hexene	0.07	0.01	0.42	0.08	0.18	0.01	1.06	0.08
Isobutane	2.29	0.20	9.16	0.81	3.89	0.29	15.55	1.15
Isopentane	3.36	0.37	16.78	1.87	6.44	0.54	32.19	2.72
Isoprene	4.35	0.30	21.75	1.50	4.60	0.48	22.99	2.38
Isopropylbenzene	0.98	0.02	8.82	0.18	0.15	0.01	1.34	0.13
Methylcyclohexane	0.23	0.03	1.61	0.22	0.32	0.05	2.26	0.37
Methylcyclopentane	0.35	0.05	2.07	0.33	0.67	0.06	3.99	0.35
2-Methylheptane	0.28	0.04	1.65	0.27	0.18	0.02	1.06	0.13
3-Methylheptane	0.10	0.02	0.61	0.13	0.16	0.02	0.94	0.13

Table 1 (Continued)
Summary of Photochemical Assessment Monitoring (PAMS) Data
June, July, and August, 2009

	Rider University				**Rutgers University**			
	ppbv		**ppbC**		**ppbv**		**ppbC**	
	Max	**Avg**	**Max**	**Avg**	**Max**	**Avg**	**Max**	**Avg**
2-Methylhexane	0.40	0.01	3.22	0.12	0.26	0.04	2.11	0.29
3-Methylhexane	0.25	0.04	1.96	0.32	0.32	0.05	2.59	0.37
2-Methylpentane	0.56	0.09	3.94	0.60	1.07	0.10	7.50	0.71
3-Methylpentane	0.37	0.06	2.61	0.39	0.67	0.07	4.70	0.47
n-Nonane	0.17	0.02	1.57	0.18	0.46	0.03	4.10	0.24
n-Octane	0.13	0.02	1.05	0.17	0.23	0.03	1.80	0.22
n-Pentane	1.92	0.21	9.62	1.04	3.49	0.25	17.46	1.23
1-Pentene	0.08	0.02	0.42	0.10	0.13	0.02	0.67	0.09
cis-2-Pentene	0.08	0.02	0.42	0.09	0.19	0.01	0.93	0.07
trans-2-Pentene	0.13	0.02	0.66	0.11	0.41	0.02	2.06	0.11
Propane	5.85	1.06	17.55	3.17	7.53	1.34	22.58	4.03
n-Propylbenzene	0.07	0.01	0.67	0.13	0.16	0.01	1.45	0.11
Propylene (Propene)	2.34	0.18	7.03	0.53	2.20	0.34	6.60	1.02
Styrene	0.52	0.03	4.18	0.22	0.14	0.02	1.15	0.14
Toluene	1.61	0.23	11.27	1.63	1.97	0.59	13.76	4.15
1,2,3-Trimethylbenzene	0.46	0.06	4.17	0.55	1.62	0.06	14.55	0.54
1,2,4-Trimethylbenzene	0.71	0.05	6.40	0.43	3.30	0.07	29.69	0.60
1,3,5-Trimethylbenzene	0.22	0.02	2.00	0.19	0.53	0.02	4.77	0.18
2,2,4-Trimethylpentane	0.48	0.12	3.86	0.99	0.68	0.12	5.40	0.97
2,3,4-Trimethylpentane	0.13	0.03	1.07	0.22	0.20	0.03	1.58	0.24
n-Undecane	0.41	0.02	4.56	0.20	0.17	0.01	1.91	0.15
m/p-Xylene	0.63	0.08	5.02	0.63	0.86	0.10	6.89	0.83
o-Xylene	0.24	0.03	1.94	0.28	0.24	0.04	1.90	0.30

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2009 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) 2009 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 to address 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 non-cancer 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 toxicity values are developed by the USEPA and other agencies, using health studies on a chemical. For carcinogens, 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 non-carcinogens is a concentration at which no adverse health effect is expected to occur (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 4 through 6. If ambient air concentrations exceed the health benchmarks then some action, such as a reduction in emissions, should be considered.

SOURCES OF AIR TOXICS

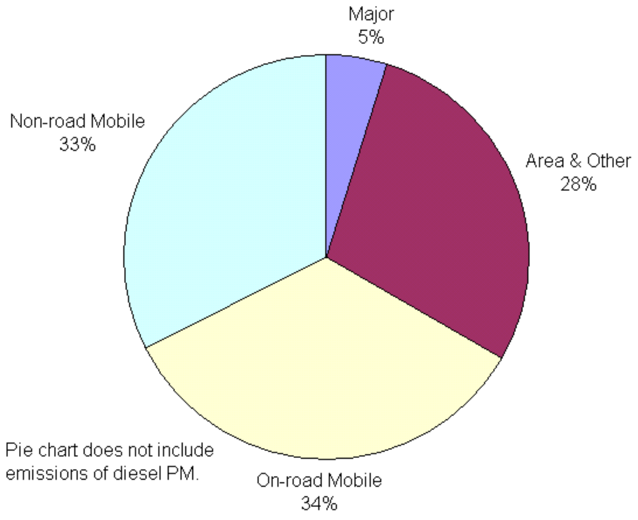
A number of years ago, USEPA began the National-Scale Air Toxics Assessment (NATA). Starting with the year 1996, they set out on a three-year cycle to determine people's exposure to air toxics around the country. To do this, USEPA first prepares a comprehensive inventory of air toxics emissions from 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 2002 NATA 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 and additional 34%. Area sources (residential, commercial, and small industrial sources) represent 28% of the inventory, and major point sources (such as factories and power plants) account for the remaining 5%.

ESTIMATING AIR TOXICS EXPOSURE

The second step in USEPA's NATA project is to use the emissions information in an air dispersion model to estimate air toxic concentrations across the country. 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, but in general, larger populations result in greater emissions of, and exposure to, air toxics.

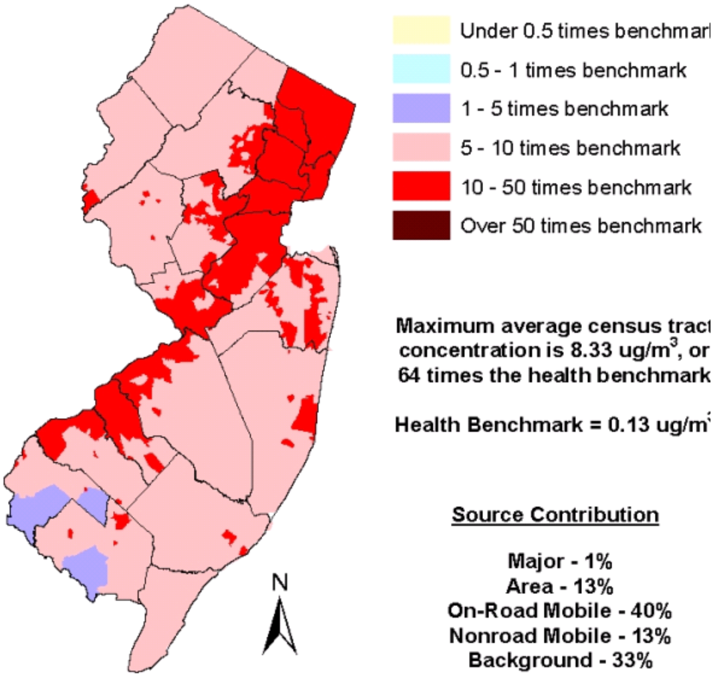
Analysis of the NATA state and county average air toxics concentrations indicates that twenty-one chemicals were predicted to exceed their health benchmarks, or level of concern, in one or more counties in 2002. Twenty of these are considered to be cancer-causing (carcinogenic) chemicals, and one (acrolein) is not. Estimated air concentrations of these 21 pollutants vary around the state, depending on the types of sources that emit them. This is summarized in Table 1.

Figure 1.
2002 Air Toxics Emissions Source Estimates for New Jersey



Pie chart does not include emissions of diesel PM.

Figure 2. BENZENE
2002 NATA Predicted Concentrations for NJ



Maximum average census trac concentration is 8.33 ug/m^3, or 64 times the health benchmark

Health Benchmark = 0.13 ug/m

Source Contribution

Major - 1%
Area - 13%
On-Road Mobile - 40%
Nonroad Mobile - 13%
Background - 33%

Table 1.
Air Toxics of Greatest Concern in New Jersey
Based on 2002 National-Scale Air Toxics Assessment

Pollutant of Concern	Number of Counties Above Health Benchmark	Primary Source of Emissions
Acetaldehyde	Statewide	Mobile & background
Acrolein	Statewide	Mobile
Arsenic Compounds	19	Background & area
Benzene	Statewide	Mobile & background
1,3-Butadiene	Statewide	Mobile & background
Cadmium Compounds	1 (Warren)	Major
Carbon Tetrachloride	Statewide	Background
Chloroform	Statewide	Area & background
Chromium (hexavalent)	19	Major & background
1,4-Dichlorobenzene	8	Area & background
1,3-Dichloropropene	1 (Hudson)	Area
Diesel Particulate Matter	Statewide	Mobile
Ethylbenzene	7	Mobile
Ethylene Oxide	7	Area & background
Formaldehyde	Statewide	Mobile & background
Methyl Chloride	Statewide	Background
Methyl tert-Butyl Ether	Statewide	Background
Naphthalene	19	Area
PAH/POM	18	Area
Perchloroethylene	7	Area & background
1,1,2-Trichloroethane	1 (Salem)	Area

NJ Air Toxics Monitoring Program Results For 2009

NJDEP has established three air toxics monitoring sites around the state. They are located in Elizabeth, New Brunswick and Chester (see Figure 3). The Camden Lab site, which had been measuring several toxic volatile organic compounds (VOCs) since 1989, was shut down on September 29, 2008, because the NJDEP lost access to the station. The Elizabeth Lab site began measuring VOCs in 2000, and the New Brunswick and Chester sites became operational in July 2001. Analysis of toxic metals at each site also began in 2001. Metals data can be found in Appendix B (Fine Particulate Speciation Summary 2009) of the Air Quality Report.

2009 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 four New Jersey monitoring sites. All values are in micrograms per cubic meter (µg/m^3). More detail can be found in Tables 5 through 7, 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 µg/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 8.

Reported averages for which significant portions of the data (more than 50%) were below 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 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 most of the air toxics health benchmarks).

The Chester and New Brunswick sites had the lowest concentrations for the majority of the prevalent air toxics, while Elizabeth had the highest concentration for most compounds. This is comparable to previous years, along with Elizabeth detecting the most individual compounds.

**Figure 3.
2009 Air Toxics
Monitoring Network**

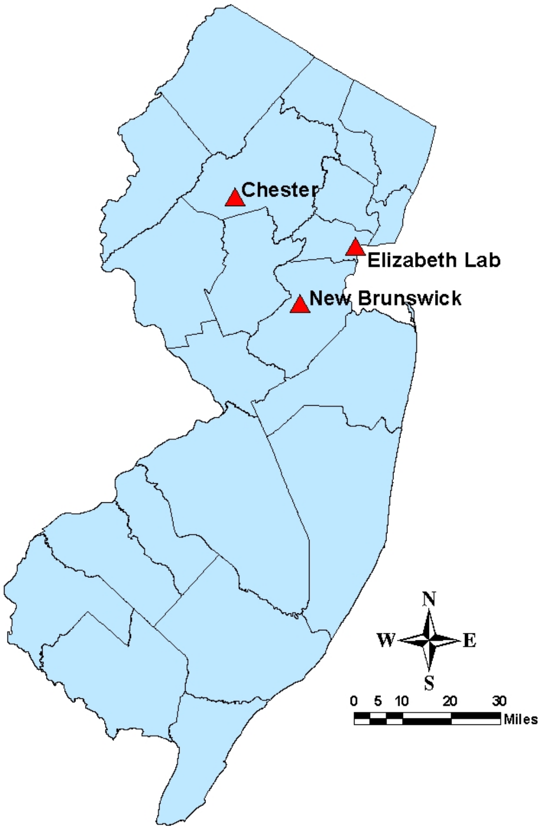


Table 2
New Jersey Air Toxics Summary – 2009

Annual Average Concentration
micrograms per cubic meter (μg/m^3) [a]

Pollutant	Chester	Elizabeth	New Brunswick
Acetaldehyde	1.34	2.47	2.02
Acetone	2.18	3.39	3.05
Acetonitrile	2.95	0.85	1.25
Acetylene	0.51	1.39	0.83
Acrolein	0.53	1.20	0.85
Acrylonitrile	(0.06)	(0.11)	(0.06)
tert-Amyl Methyl Ether	-	(0.0005)	-
Benzaldehyde	0.10	0.15	0.08
Benzene	0.53	1.36	0.70
Bromochloromethane	(0.001)	(0.0004)	-
Bromodichloromethane	(0.001)	(0.004)	(0.001)
Bromoform	(0.001)	(0.002)	(0.002)
Bromomethane	0.05	0.06	0.05
1,3-Butadiene	0.02	0.16	0.05
Butyraldehyde	0.25	0.39	0.26
Carbon Disulfide	11.18	4.53	0.60
Carbon Tetrachloride	0.76	0.73	0.73
Chlorobenzene	(0.003)	(0.002)	-
Chloroethane	0.03	0.05	0.06
Chloroform	0.11	0.17	0.15
Chloromethane	1.38	1.44	1.45
Chloromethylbenzene	-	(0.01)	-
Chloroprene	(0.0005)	(0.004)	-
Crotonaldehyde	0.26	0.33	0.24
Dibromochloromethane	(0.003)	(0.003)	(0.002)
1,2-Dibromoethane	(0.001)	(0.0004)	(0.001)
m-Dichlorobenzene	-	(0.0004)	(0.0004)
o-Dichlorobenzene	-	(0.001)	-
p-Dichlorobenzene	(0.02)	0.11	0.06
Dichlorodifluoromethane	3.12	3.15	3.20
1,1-Dichloroethane	(0.0002)	(0.001)	(0.0003)
1,2-Dichloroethane	(0.004)	(0.01)	(0.004)
1,1-Dichloroethene	-	(0.0003)	(0.0004)
cis-1,2-Dichloroethylene	(0.01)	(0.01)	-
trans-1,2-Dichloroethylene	-	(0.0005)	(0.002)
Dichloromethane	0.40	0.78	0.62
1,2-Dichloropropane	(0.001)	(0.001)	-
cis-1,3-Dichloropropene	-	(0.0002)	-
trans-1,3-Dichloropropene	-	(0.0002)	-
Dichlorotetrafluoroethane	0.13	0.13	0.13

[a] Numbers in parenthesis indicate averages based on less than 50% detection and dashes represent 100% non-detects

Table 2 (Continued)
New Jersey Air Toxics Summary – 2009

Annual Average Concentration
micrograms per cubic meter (µg/m^3) [a]

Pollutant	Chester	Elizabeth	New Brunswick
Ethyl Acrylate	-	(0.0001)	-
Ethyl tert-Butyl Ether	-	(0.0001)	-
Ethylbenzene	0.07	0.46	0.17
Formaldehyde	2.42	3.79	2.53
Hexaldehyde	0.15	0.23	0.11
Isovaleraldehyde	(0.01)	(0.01)	(0.01)
Methyl Ethyl Ketone	0.73	1.33	0.92
Methyl Isobutyl Ketone	0.05	0.15	0.09
Methyl Methacrylate	(0.001)	(0.02)	(0.001)
Methyl tert-Butyl Ether	(0.002)	(0.02)	(0.01)
n-Octane	0.04	0.23	0.07
Propionaldehyde	0.25	0.45	0.28
Propylene	0.36	4.26	0.72
Styrene	0.02	0.19	0.05
1,1,2,2-Tetrachloroethane	(0.0003)	(0.001)	-
Tetrachloroethylene	0.08	0.26	0.16
Tolualdehydes	0.13	0.17	0.12
Toluene	0.45	3.34	1.90
1,2,4-Trichlorobenzene	-	(0.001)	-
1,1,1-Trichloroethane	0.09	0.09	0.09
1,1,2-Trichloroethane	-	(0.001)	-
Trichloroethylene	(0.01)	0.08 (0.03	)
Trichlorofluoromethane	1.67	1.72	1.73
Trichlorotrifluoroethane	0.82	0.82	0.84
1,2,4-Trimethylbenzene	0.05	0.99	0.14
1,3,5-Trimethylbenzene	0.02	0.33	0.05
Valeraldehyde	0.10	0.18	0.09
Vinyl chloride	(0.004)	(0.01)	(0.004)
m,p-Xylene	0.14	1.28	0.40
o-Xylene	0.06	0.57	0.16

[a] Numbers in parenthesis indicate averages based on less than 50% detection and dashes represent 100% non-detects

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 air 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.

Elizabeth had twelve compounds with annual average concentrations that exceeded their health benchmarks, New Brunswick had nine and Chester had eight. The toxic air pollutants that exceeded their health benchmarks at all sites are acetaldehyde, acrolein, acrylonitrile, benzene, carbon tetrachloride, chloroform, chloromethane, and formaldehyde.

The top five toxic compounds of concern based on annual risk ratios are listed in Table 3. Acrolein or formaldehyde contributed the highest risks at every site, but note that the magnitude of the risks was highest at Elizabeth. Carbon tetrachloride and benzene and were common to all four sites as well.

TRENDS AND COMPARISONS

The closed site in Camden was the New Jersey monitoring location that had the longest history of measuring air toxics. The graph in Figure 4 shows the change in concentrations for three of the most prevalent air toxics, benzene, toluene, and xylene, from 1990 to 2008. The graph shows that while average concentrations can vary significantly from year to year, the overall trend is downward. High individual samples may also result in high annual averages in some years. Concentrations of most air toxics have declined significantly over the last ten years. Because air toxics comprise such a large and diverse group of compounds, however, these general trends may not hold for other compounds.

Table 3
Analytes with the Five Highest Risk Ratios [a,b]
at NJ's Air Toxics Monitoring Sites in 2009

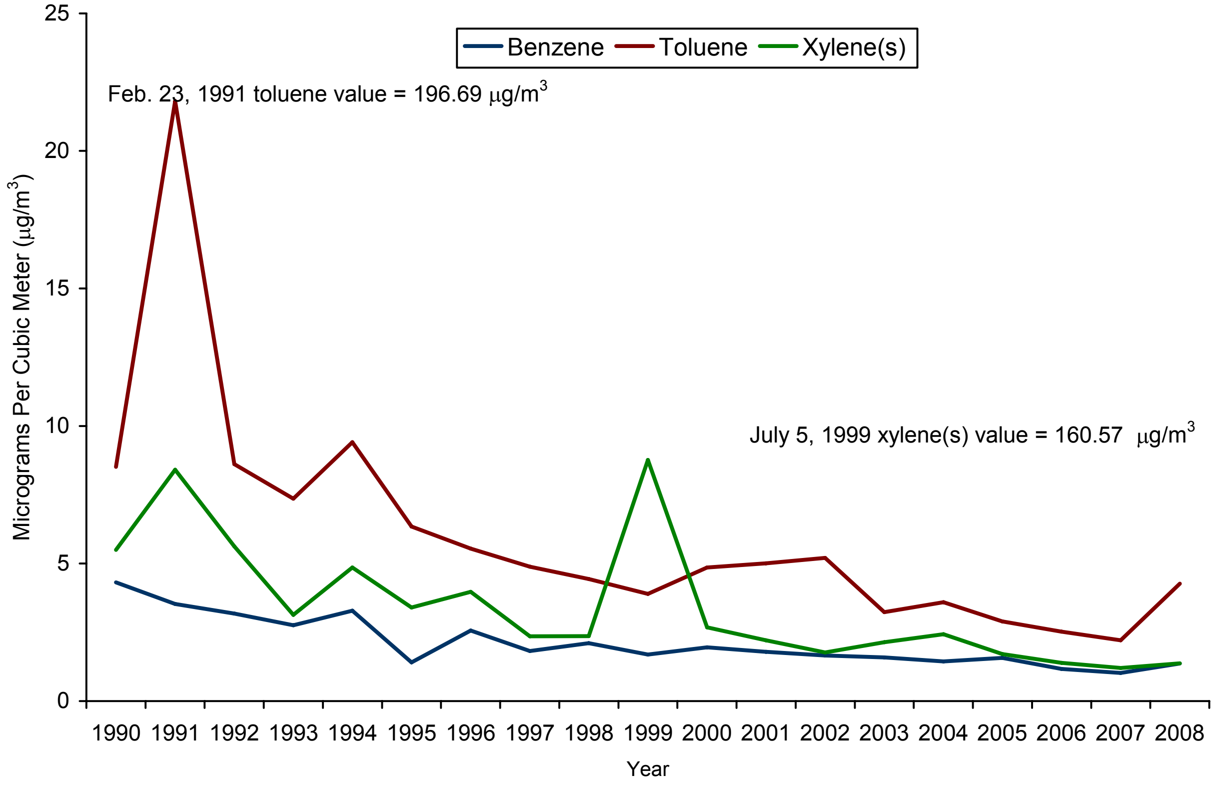
	Chester		**Elizabeth**		**New Brunswick**	
Rank	**Analyte**	**Risk Ratio**	**Analyte**	**Risk Ratio**	**Analyte**	**Risk Ratio**
1	Formaldehyde	31.5	Acrolein	60.1	Acrolein	42.5
2	Acrolein	26.3	Formaldehyde	49.2	Formaldehyde	32.8
3	Carbon Tetrachloride	11.4	Carbon Tetrachloride	10.9	Carbon Tetrachloride	11.0
4	Benzene	4.1	Benzene	10.5	Benzene	5.4
5	Acrylonitrile	3.7	Acrylonitrile	7.3	Acetaldehyde	4.5

[a] The risk ratio for a chemical is a comparison of the annual mean air concentration to a long-term health benchmark.

[b] The long-term 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.

Figure 4.

Annual Averages for Selected Hazardous Air Pollutants (HAPs) at Camden from 1990-2008[a]



[a] Annual concentrations for Camden in 2008 calculated from data spanning January 1st to October 21st.

The graphs in Figures 5 through 8 below show concentrations of some of the air toxics in New Jersey with the highest risk ratios (see Table 3): benzene, acetaldehyde, carbon tetrachloride, and formaldehyde. These graphs compare data from our three different monitoring sites (and Camden through 2008) over the past seven or more years. (Acrolein data began to be reported in 2005.) As seen in Figures 4 and 5, benzene concentrations have been gradually decreasing over the past decade. Most benzene now comes from mobile and area sources, and is transported in from other regions. Acetaldehyde, shown in Figure 6, is also emitted primarily by on-road mobile sources such as cars.

Figure 5. Benzene Monitored Concentrations 1990-2009

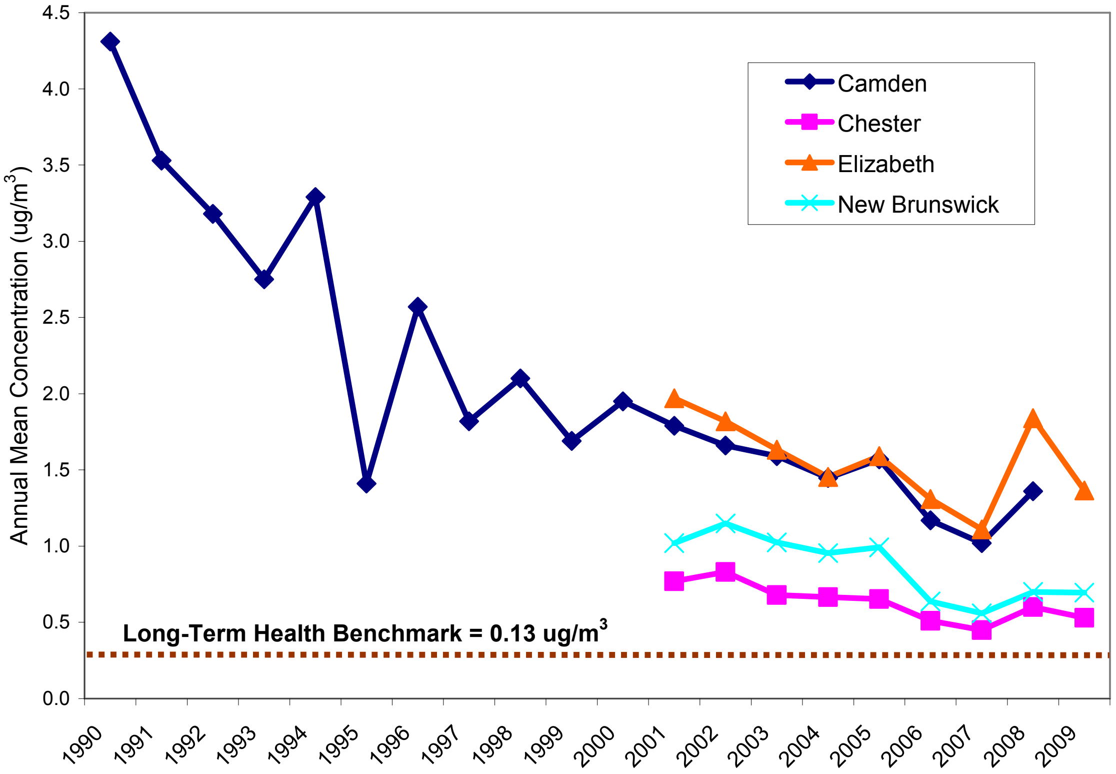
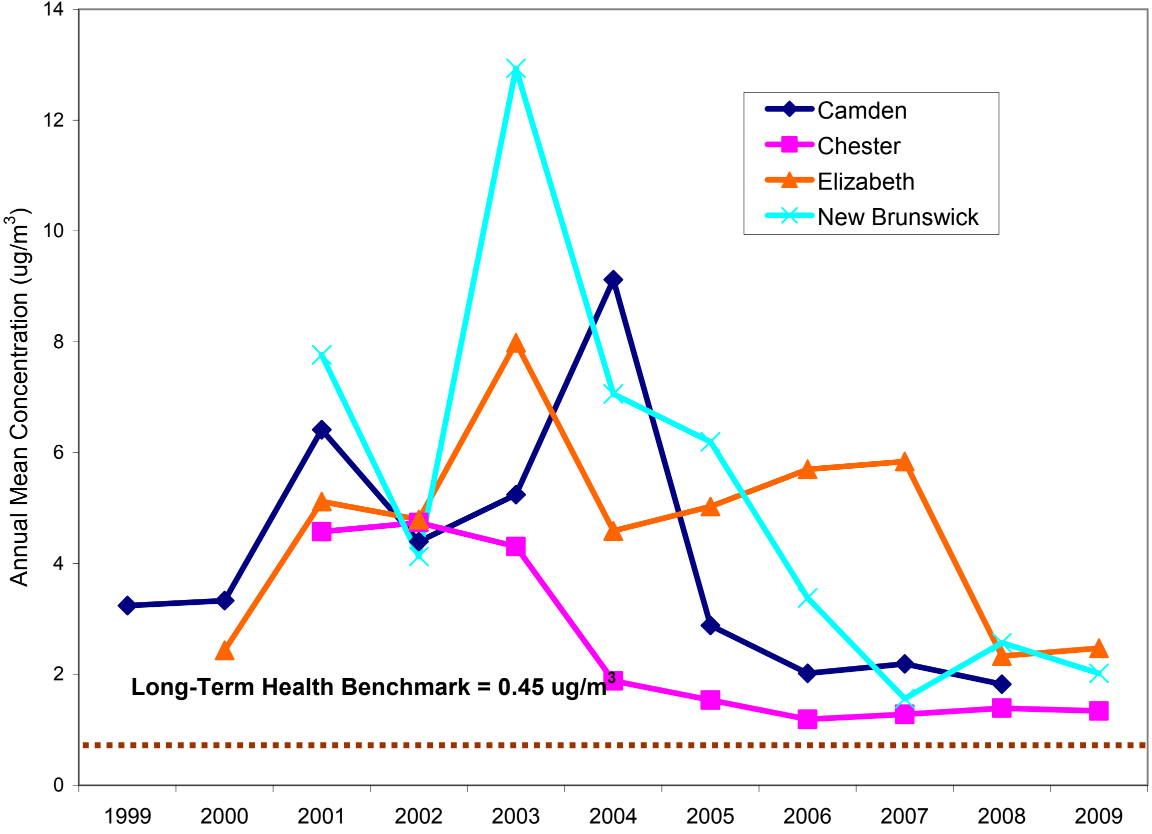
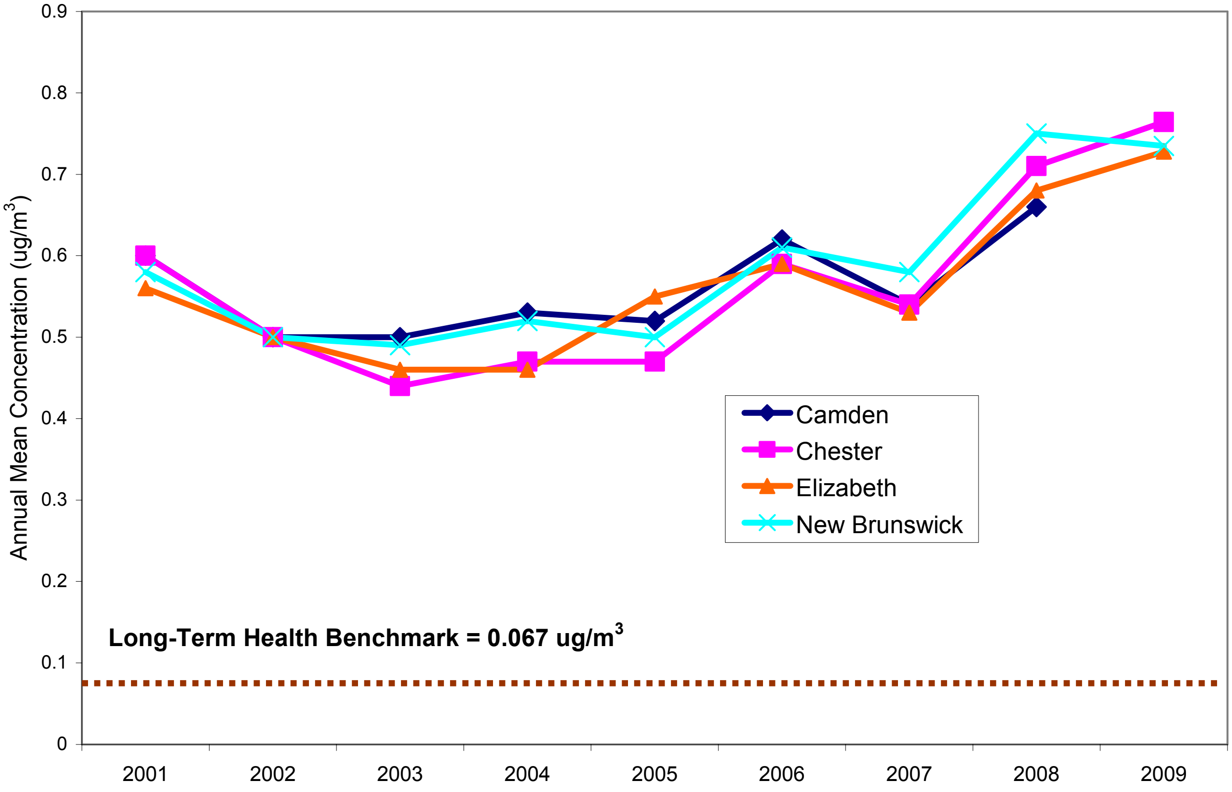


Figure 6. Acetaldehyde Monitored Concentrations 1999-2009



Carbon tetrachloride (Figure 7) was once used extensively as a degreaser, household cleaner, propellant, refrigerant, and fumigant. It has been phased out of most production and use because of its toxicity and its ability to deplete stratospheric ozone. However, about 100 tons are still emitted annually by industry in the U.S, although no emissions have been reported in New Jersey for a number of years. It degrades slowly in the environment, so levels in the air remain relatively steady.

Figure 7. Carbon Tetrachloride Monitored Concentrations 2001-2009



Formaldehyde (Figure 8) 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, and urea-formaldehyde resins. In New Jersey the primary emitters of formaldehyde are on-road mobile sources, although secondary formation and transport can contribute significantly to high outdoor concentrations. Monitored concentrations in New Jersey average around 30 times over the health benchmark (thirty in a million risk level).

Figure 8. Formaldehyde Monitored Concentrations 1996-2009

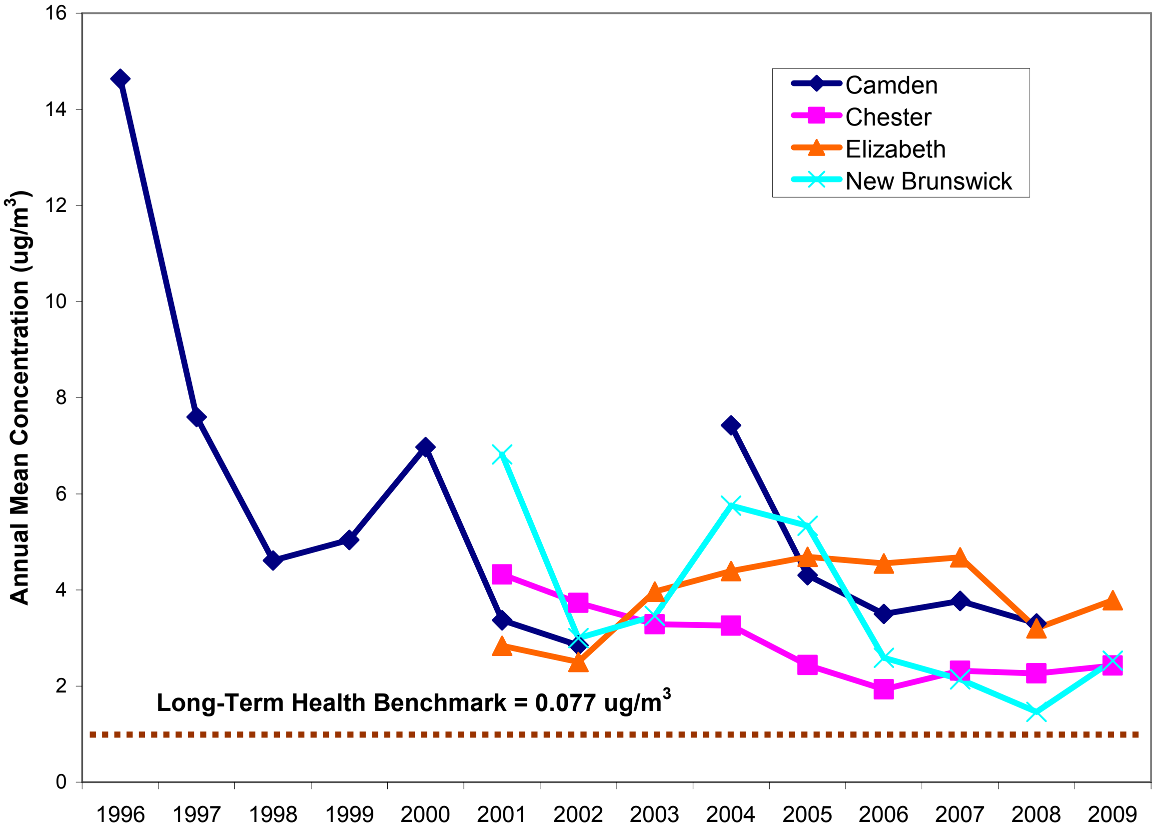


Figure 9 below shows a comparison of annual average concentrations measured at New Jersey's four air toxics monitoring sites in 2002 with annual average concentrations predicted by USEPA's 2002 NATA (at the monitoring site census tract). The comparison for five chemicals (acetaldehyde, benzene, chloromethane, ethylbenzene and formaldehyde) at all four monitoring sites shows agreement within a factor of 2 or less.

Figure 9.
2002 NJ Monitored Air Toxics Concentrations Compared to NATA Predicted Concentrations

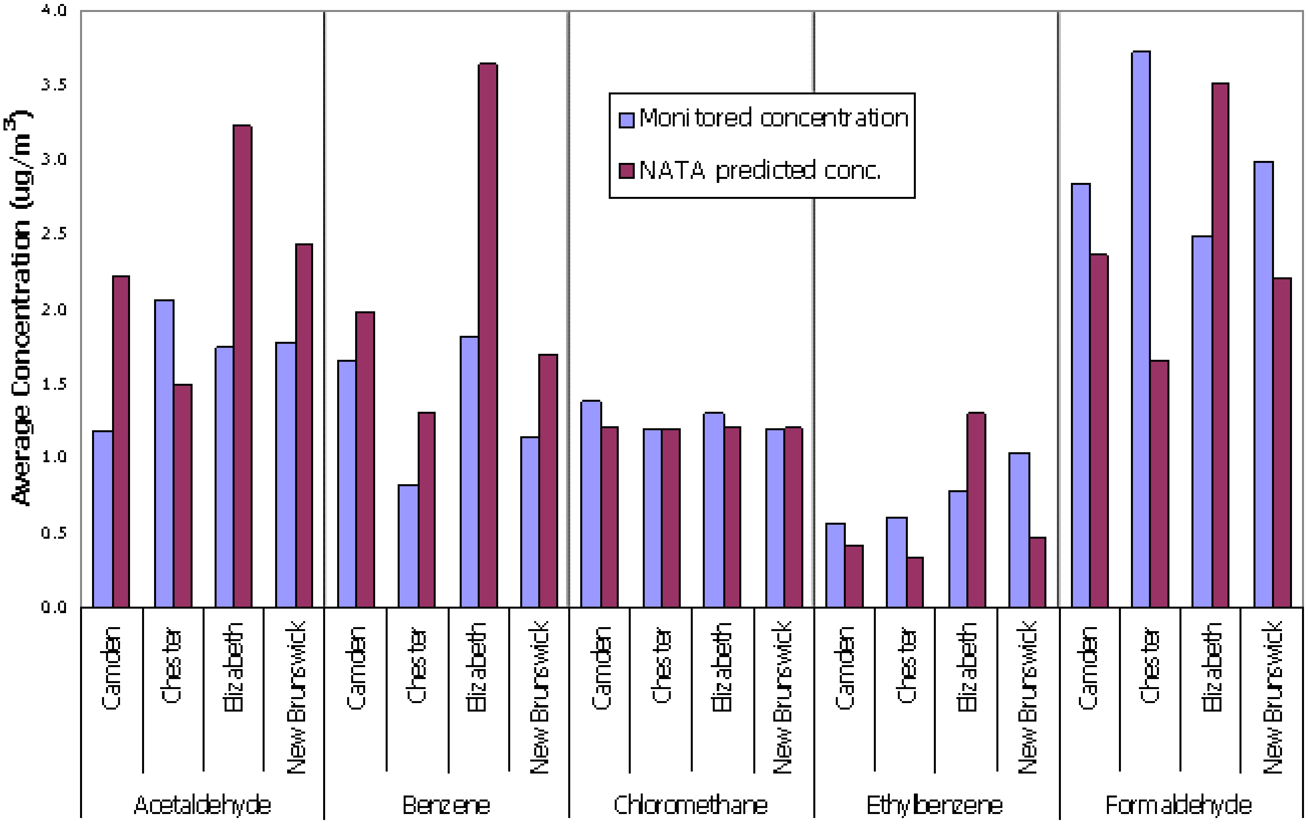


Table 4
2009 Air Toxics Data for Chester, NJ

Analyte[a]	CAS No.	Annual Mean (ppbv)[b,c]	Annual Median (ppbv)[b]	24-Hour Max. (ppbv)	Annual Mean (µg/m^3)[b,c]	Annual Median (µg/m^3)[c]	24-Hour Max. (µg/m^3)	Long-Term Health Benchmark (µg/m^3)[d]	Annual Mean Risk Ratio[e]	Detection Limit (µg/m^3)	% Above Minimum Detection Limit[f]
Acetaldehyde	75-07-0	**0.74**	0.69	1.66	**1.34**	1.25	2.99	0.45	**2.97**	0.0072	100
Acetone	67-64-1	0.92	0.84	2.43	2.18	2.01	5.77	31000	0.0001	0.0166	100
Acetonitrile	75-05-8	1.76	0.31	85.50	2.95	0.51	143.55	60	0.05	0.1662	100
Acetylene	74-86-2	0.48	0.38	1.29	0.51	0.40	1.37			0.0245	100
Acrolein	107-02-8	**0.23**	0.1580	1.28	**0.53**	0.36	2.93	0.02	**26.31**	0.2453	100
Acrylonitrile	107-13-1	**(0.03)**	0	0.13	**(0.06)**	0	0.28	0.015	**3.69**	0.1237	46
Benzaldehyde	100-52-7	0.02	0.02	0.06	0.10	0.10	0.27			0.0087	98
Benzene	71-43-2	**0.17**	0.12	0.69	**0.53**	0.40	2.21	0.13	**4.08**	0.0160	100
Bromochloromethane	74-97-5	(0.0001)	0	0.01	(0.001)	0	0.03			0.1005	2
Bromodichloromethane	75-27-4	(0.0001)	0	0.01	(0.001)	0	0.06			0.0469	2
Bromoform	75-25-2	(0.0001)	0	0.004	(0.001)	0	0.04	0.91	0.001	0.1758	2
Bromomethane	74-83-9	0.01	0.0110	0.05	0.05	0.04	0.17	5	0.01	0.0388	97
1,3-Butadiene	106-99-0	0.01	0.0060	0.05	0.02	0.01	0.11	0.033	0.55	0.0133	72
Butyraldehyde	123-72-8	0.08	0.08	0.15	0.25	0.24	0.43			0.0029	98
Carbon Disulfide	75-15-0	3.59	3.46	6.97	11.18	10.77	21.71	700	0.02	0.0280	100
Carbon Tetrachloride	56-23-5	**0.12**	0.11	0.26	**0.76**	0.68	1.60	0.067	**11.41**	0.0566	100
Chlorobenzene	108-90-7	(0.001)	0	0.03	(0.0030	0	0.13	1000	0.000003	0.0230	3
Chloroethane	75-00-3	0.01	0.0080	0.06	0.03	0.02	0.17			0.0211	74
Chloroform	67-66-3	**0.02**	0.0210	0.05	**0.11**	0.10	0.22	0.043	**2.61**	0.0195	100
Chloromethane	74-87-3	**0.67**	0.6420	1.01	**1.38**	1.33	2.09	0.56	**2.46**	0.0289	100
Chloroprene	126-99-8	(0.0001)	0	0.01	(0.0005)	0	0.03	7	0.0001	0.0797	2
Crotonaldehyde	123-73-9	0.09	0.03	0.46	0.26	0.10	1.32			0.0029	100
Dibromochloromethane	594-18-3	(0.0003)	0	0.01	(0.003)	0	0.10			0.0993	5
1,2-Dibromoethane	106-93-4	(0.0001)	0	0.01	(0.001)	0	0.05			0.1383	3
p-Dichlorobenzene	106-46-7	(0.003)	0	0.02	(0.02)	0	0.10	0.091	0.19	0.0361	49
Dichlorodifluoromethane	75-71-8	0.63	0.6020	0.98	3.12	2.98	4.86	200	0.02	0.0247	100
1,1-Dichloroethane	75-34-3	(0.00005)	0	0.003	(0.0002)	0	0.01	0.63	0.0003	0.0243	2
1,2-Dichloroethane	107-06-2	(0.001)	0	0.02	(0.0040	0	0.07	0.038	0.11	0.0607	7
cis-1,2-Dichloroethylene	156-59-2	(0.003)	0	0.11	(0.01)	0	0.45			0.0634	3
Dichloromethane	75-09-2	0.12	0.10	0.42	0.40	0.33	1.46	2.10	0.19	0.0591	100
1,2-Dichloropropane	78-87-5	(0.0002)	0	0.01	(0.001)	0	0.03			0.1525	3
Dichlorotetrafluoroethane	1320-37-2	0.02	0.0190	0.03	0.13	0.13	0.18			0.0210	100
Ethylbenzene	100-41-4	0.02	0.0140	0.04	0.07	0.06	0.19	0.4	0.18	0.0217	100
Formaldehyde	50-00-0	**1.97**	1.69	5.17	**2.42**	2.07	6.35	0.077	**31.49**	0.0061	100
Hexaldehyde	66-25-1	0.04	0.03	0.08	0.15	0.14	0.31			0.0082	100
Isovaleraldehyde	590-86-3	(0.002)	0	0.02	(0.01)	0	0.08			0.0035	13

Table 4 (Continued)
2009 Air Toxics Data for Chester, NJ

Analyte[a]	CAS No.	Annual Mean (ppbv)[b,c]	Annual Median (ppbv)[b]	24-Hour Max. (ppbv)	Annual Mean ($\mu g/m^3$)[b,c]	Annual Median ($\mu g/m^3$)[c]	24-hour Max. ($\mu g/m^3$)	Long-Term Health Benchmark ($\mu g/m^3$)[d]	Annual Mean Risk Ratio[e]	Detection Limit ($\mu g/m^3$)	% Above Minimum Detection Limit[f]
Methyl Ethyl Ketone	78-93-3	0.25	0.20	1.62	0.73	0.58	4.77	5000	0.0001	0.1296	100
Methyl Isobutyl Ketone	108-10-1	0.01	0.01	0.05	0.05	0.05	0.20			0.0287	84
Methyl Methacrylate	80-62-6	(0.0002)	0	0.01	(0.001)	0	0.04	700	0.000001	0.0211	2
Methyl tert-Butyl Ether	1634-04-4	(0.001)	0	0.02	(0.002)	0	0.05	3.8	0.001	0.0072	5
n-Octane	111-65-9	0.01	0.0080	0.03	0.04	0.04	0.14			0.0280	69
Propionaldehyde	123-38-6	0.10	0.10	0.21	0.25	0.23	0.50	8	0.03	0.0048	100
Propylene	115-07-1	0.21	0.16	1.81	0.36	0.27	3.12	3000	0.0001	0.0155	100
Styrene	100-42-5	0.01	0.01	0.04	0.02	0.02	0.17	1.8	0.01	0.0426	70
1,1,2,2-Tetrachloroethane	79-34-5	(0.00005)	0	0.003	(0.0003)	0	0.02	0.017	0.02	0.0893	2
Tetrachloroethylene	127-18-4	0.01	0.01	0.04	0.08	0.07	0.25	0.17	0.50	0.0746	82
Tolualdehydes		0.03	0.02	0.08	0.13	0.11	0.40			0.0147	98
Toluene	108-88-3	0.12	0.092	0.49	0.45	0.35	1.85	5000	0.0001	0.0188	100
1,1,1-Trichloroethane	71-55-6	0.02	0.02	0.02	0.09	0.09	0.13	1000	0.0001	0.0164	100
Trichloroethylene	79-01-6	(0.002)	0	0.02	(0.01)	0	0.09	0.5	0.02	0.0537	16
Trichlorofluoromethane	75-69-4	0.30	0.295	0.46	1.67	1.66	2.56	700	0.002	0.0393	100
Trichlorotrifluoroethane	26523-64-8	0.11	0.106	0.17	0.82	0.81	1.30			0.0920	100
1,2,4-Trimethylbenzene	95-63-6	0.01	0.0090	0.04	0.05	0.04	0.20			0.0147	89
1,3,5-Trimethylbenzene	108-67-8	0.004	0.0040	0.02	0.02	0.02	0.08			0.0197	79
Valeraldehyde	110-62-3	0.03	0.0275	0.06	0.10	0.10	0.21			0.0035	100
Vinyl chloride	75-01-4	(0.002)	0	0.04	(0.004)	0	0.09	0.11	0.04	0.0204	15
m,p-Xylene	1330-20-7	0.03	0.03	0.11	0.14	0.11	0.49	100	0.001	0.0391	98
o-Xylene	95-47-6	0.01	0.01	0.05	0.06	0.05	0.20	100	0.001	0.0174	100

[a] Analytes in bold text had annual means above the long-term health benchmark.

[b] Numbers in parentheses are arithmetic means (or averages) based on less than 50 percent detection.

[c] For a valid 24-hour sampling event when the analyzing laboratory reports the term “Not Detected” for a particular pollutant, the concentration of 0.0 ppbv is assigned to that pollutant. These zero concentrations were included in the calculation of annual averages and medians for each pollutant regardless of percent detection.

[d] The long-term 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.

[e] 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.

[f] There were 61 total VOC samples and 60 total carbonyl samples collected in 2009 in Chester.

Table 5
2009 Air Toxics Data for Elizabeth, NJ

Analyte[a]	CAS No.	Annual Mean (ppbv)[b,c]	Annual Median (ppbv)[b]	24-Hour Max. (ppbv)	Annual Mean (µg/m^3)[b,c]	Annual Median (µg/m^3)[c]	24-Hour Max. (µg/m^3)	Long-Term Health Benchmark (µg/m^3)[d]	Annual Mean Risk Ratio[e]	Detection Limit (µg/m^3)	% Above Minimum Detection Limit[f]
Acetaldehyde	75-07-0	**1.37**	1.26	4.33	**2.47**	2.27	7.80	0.45	**5.49**	0.0072	100
Acetone	67-64-1	1.43	1.18	5.39	3.39	2.80	12.80	31000	0.0001	0.0166	100
Acetonitrile	75-05-8	0.51	0.45	1.19	0.85	0.76	2.00	60	0.01	0.1662	100
Acetylene	74-86-2	1.31	0.91	8.08	1.39	0.97	8.60			0.0245	100
Acrolein	107-02-8	**0.52**	0.37	3.07	**1.20**	0.85	7.04	0.02	**60.07**	0.2453	100
Acrylonitrile	107-13-1	**(0.05)**	0	0.91	**(0.11)**	0	1.97	0.015	**7.30**	0.1237	38
tert-Amyl Methyl Ether	994-05-8	(0.0001)	0	0.01	(0.0005)	0	0.03			0.0501	2
Benzaldehyde	100-52-7	0.03	0.03	0.10	0.15	0.14	0.43			0.0087	98
Benzene	71-43-2	**0.43**	0.30	2.50	**1.36**	0.95	7.99	0.13	**10.50**	0.0160	100
Bromochloromethane	74-97-5	(0.0001)	0	0.01	(0.0004)	0	0.03			0.1005	2
Bromodichloromethane	75-27-4	(0.0006)	0	0.01	(0.004)	0	0.09			0.0469	5
Bromoform	75-25-2	(0.0002)	0	0.01	(0.002)	0	0.06	0.91	0.002	0.1758	3
Bromomethane	74-83-9	0.01	0.01	0.05	0.06	0.05	0.19	5	0.01	0.0388	100
1,3-Butadiene	106-99-0	**0.07**	0.04	1.16	**0.16**	0.09	2.57	0.033	**4.78**	0.0133	100
Butyraldehyde	123-72-8	0.13	0.13	0.34	0.39	0.37	0.99			0.0029	100
Carbon Disulfide	75-15-0	1.46	1.30	9.26	4.53	4.03	28.84	700	0.01	0.0280	100
Carbon Tetrachloride	56-23-5	**0.12**	0.11	0.20	**0.73**	0.67	1.28	0.067	**10.86**	0.0566	100
Chlorobenzene	108-90-7	(0.0005)	0	0.01	(0.002)	0	0.06	1000	0.000002	0.0230	5
Chloroethane	75-00-3	0.02	0.02	0.06	0.05	0.04	0.16			0.0211	95
Chloroform	67-66-3	**0.03**	0.03	0.11	**0.17**	0.14	0.55	0.043	**3.92**	0.0195	98
Chloromethane	74-87-3	**0.70**	0.70	0.95	**1.44**	1.45	1.97	0.56	**2.58**	0.0289	100
Chloromethylbenzene	100-44-7	(0.001)	0	0.06	(0.01)	0	0.33			0.0259	3
Chloroprene	126-99-8	(0.001)	0	0.04	(0.004)	0	0.14	7	0.001	0.0797	3
Crotonaldehyde	123-73-9	0.11	0.05	0.54	0.33	0.15	1.54			0.0029	100
Dibromochloromethane	594-18-3	(0.0003)	0	0.01	(0.003)	0	0.07			0.0993	7
1,2-Dibromoethane	106-93-4	(0.0001)	0	0.003	(0.0004)	0	0.02			0.1383	2
m-Dichlorobenzene	541-73-1	(0.0001)	0	0.004	(0.0004)	0	0.02			0.0241	2
o-Dichlorobenzene	95-50-1	(0.0001)	0	0.01	(0.001)	0	0.03			0.0301	2
p-Dichlorobenzene	106-46-7	**0.02**	0.01	0.11	**0.11**	0.08	0.67	0.091	**1.22**	0.0361	95
Dichlorodifluoromethane	75-71-8	0.64	0.63	0.93	3.15	3.11	4.61	200	0.02	0.0247	100
1,1-Dichloroethane	75-34-3	(0.0002)	0	0.01	(0.001)	0	0.03	0.63	0.001	0.0243	5
1,2-Dichloroethane	107-06-2	(0.002)	0	0.02	(0.01)	0	0.09	0.038	0.17	0.0607	8
1,1-Dichloroethene	75-35-4	(0.0001)	0	0.01	(0.0003)	0	0.02	200	0.000002	0.0555	2
cis-1,2-Dichloroethylene	156-59-2	(0.003)	0	0.11	(0.01)	0	0.42			0.0634	3
trans-1,2-Dichloroethylene	156-60-5	(0.0001)	0	0.01	(0.0005)	0	0.03			0.0714	2
Dichloromethane	75-09-2	0.22	0.19	0.86	0.78	0.65	2.97	2.1	0.37	0.0591	100
1,2-Dichloropropane	78-87-5	(0.0002)	0	0.01	(0.001)	0	0.02			0.1525	3
cis-1,3-Dichloropropene	542-75-6	(0.0001)	0	0.003	(0.0002)	0	0.01			0.0635	2
trans-1,3-Dichloropropene	542-75-6	(0.0001)	0	0.003	(0.00020	0	0.01			0.0409	2
Dichlorotetrafluoroethane	1320-37-2	0.02	0.02	0.03	0.13	0.13	0.19			0.0210	100

Table 5 (Continued)

2009 Air Toxics Data for Elizabeth, NJ

Analyte[a]	CAS No.	Annual Mean (ppbv)[b,c]	Annual Median (ppbv)[b]	24-Hour Max. (ppbv)	Annual Mean (μg/m^3)[b,c]	Annual Median (μg/m^3)[c]	24-Hour Max. (μg/m^3)	Long-Term Health Benchmark (μg/m^3)[d]	Annual Mean Risk Ratio[e]	Detection Limit (μg/m^3)	% Above Minimum Detection Limit[f]
Ethyl Acrylate	140-88-5	(0.00003)	0	0.002	(0.0001)	0	0.01	2	0.0001	0.0450	2
Ethyl tert-Butyl Ether	637-92-3	(0.00003)	0	0.002	(0.0001)	0	0.01			0.0293	2
Ethylbenzene	100-41-4	**0.10**	0.08	0.96	**0.46**	0.33	4.16	0.4	**1.14**	0.0217	100
Formaldehyde	50-00-0	**3.08**	2.73	8.83	**3.79**	3.35	10.84	0.077	**49.18**	0.0061	100
Hexaldehyde	66-25-1	0.06	0.05	0.52	0.23	0.19	2.12			0.0082	100
Isovaleraldehyde	590-86-3	(0.003)	0	0.03	(0.01)	0	0.12			0.0035	21
Methyl Ethyl Ketone	78-93-3	0.45	0.34	2.23	1.33	1.00	6.57	5000	0.0003	0.1296	98
Methyl Isobutyl Ketone	108-10-1	0.04	0.03	0.14	0.15	0.13	0.59			0.0287	98
Methyl Methacrylate	80-62-6	(0.004)	0	0.06	(0.02)	0	0.22	700	0.00002	0.0211	18
Methyl tert-Butyl Ether	1634-04-4	(0.01)	0	0.06	(0.02)	0	0.21	3.8	0.005	0.0072	30
n-Octane	111-65-9	0.05	0.03	0.25	0.23	0.15	1.16			0.0280	98
Propionaldehyde	123-38-6	0.19	0.16	0.48	0.45	0.38	1.13	8	0.06	0.0048	100
Propylene	115-07-1	2.48	1.21	15.90	4.26	2.07	27.36	3000	0.001	0.0155	100
Styrene	100-42-5	0.04	0.03	0.73	0.19	0.13	3.12	1.8	0.11	0.0426	98
1,1,2,2-Tetrachloroethane	79-34-5	(0.0001)	0	0.003	(0.001)	0	0.02	0.017	0.04	0.0893	3
Tetrachloroethylene	127-18-4	**0.04**	0.03	0.13	**0.26**	0.20	0.89	0.17	**1.50**	0.0746	98
Tolualdehydes		0.03	0.03	0.08	0.17	0.14	0.41			0.0147	98
Toluene	108-88-3	0.89	0.62	8.77	3.34	2.35	33.05	5000	0.001	0.0188	100
1,2,4-Trichlorobenzene	102-82-1	(0.0002)	0	0.01	(0.001)	0	0.07			0.1113	2
1,1,1-Trichloroethane	71-55-6	0.02	0.02	0.03	0.09	0.09	0.16	1000	0.0001	0.0164	100
1,1,2-Trichloroethane	79-00-5	(0.0002)	0	0.004	(0.001)	0	0.02	0.063	0.01	0.0327	5
Trichloroethylene	79-01-6	0.01	0.01	0.19	0.08	0.06	1.00	0.5	0.15	0.0537	73
Trichlorofluoromethane	75-69-4	0.31	0.30	0.46	1.72	1.69	2.57	700	0.002	0.0393	100
Trichlorotrifluoroethane	26523-64-8	0.11	0.11	0.15	0.82	0.80	1.16			0.0920	100
1,2,4-Trimethylbenzene	95-63-6	0.20	0.06	7.64	0.99	0.29	37.56			0.0147	100
1,3,5-Trimethylbenzene	108-67-8	0.07	0.02	2.46	0.33	0.11	12.09			0.0197	100
Valeraldehyde	110-62-3	0.05	0.05	0.32	0.18	0.16	1.14			0.0035	100
Vinyl chloride	75-01-4	(0.002)	0	0.02	(0.01)	0	0.04	0.11	0.05	0.0204	37
m,p-Xylene	1330-20-7	0.29	0.21	2.72	1.28	0.91	11.81	100	0.01	0.0391	100
o-Xylene	95-47-6	0.13	0.08	1.40	0.57	0.36	6.08	100	0.01	0.0174	100

[a] Analytes in bold text had annual means above the long-term health benchmark.

[b] Numbers in parentheses are arithmetic means (or averages) based on less than 50 percent detection.

[c] For a valid 24-hour sampling event when the analyzing laboratory reports the term "Not Detected" for a particular pollutant, the concentration of 0.0 ppbv is assigned to that pollutant. These zero concentrations were included in the calculation of annual averages and medians for each pollutant regardless of percent detection.

[d] The long-term 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.

[e] 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.

[f] There were 60 total VOC samples and 61 total carbonyl samples collected in 2009 in Elizabeth.

Table 6
2009 Air Toxics Data for New Brunswick, NJ

Analyte[a]	CAS No.	Annual Mean (ppbv)[b,c]	Annual Median (ppbv)[b]	24-Hour Max. (ppbv)	Annual Mean (μg/m^3)[b,c]	Annual Median (μg/m^3)[c]	24-Hour Max. (μg/m^3)	Long-Term Health Benchmark (μg/m^3)[d]	Annual Mean Risk Ratio[e]	Detection Limit (μg/m^3)	% Above Minimum Detection Limit[f]
Acetaldehyde	75-07-0	**1.12**	0.99	2.59	**2.02**	1.79	4.67	0.45	**4.48**	0.0072	100
Acetone	67-64-1	1.29	1.12	4.00	3.05	2.66	9.50	31000	0.00	0.0166	100
Acetonitrile	75-05-8	0.74	0.33	9.69	1.25	0.56	16.27	60	0.02	0.1662	98
Acetylene	74-86-2	0.78	0.60	2.44	0.83	0.64	2.60			0.0245	100
Acrolein	107-02-8	**0.37**	0.21	3.08	**0.85**	0.48	7.06	0.02	**42.50**	0.2453	100
Acrylonitrile	107-13-1	**(0.03)**	0	0.14	**(0.060**	0	0.30	0.015	**4.04**	0.1237	41
Benzaldehyde	100-52-7	0.02	0.02	0.06	0.08	0.08	0.24			0.0087	93
Benzene	71-43-2	**0.22**	0.17	1.08	**0.70**	0.56	3.45	0.13	**5.35**	0.0160	100
Bromodichloromethane	75-27-4	(0.0001)	0	0.01	(0.001)	0	0.05			0.0469	2
Bromoform	75-25-2	(0.0002)	0	0.01	(0.002)	0	0.05	0.91	0.00	0.1758	4
Bromomethane	74-83-9	0.01	0.01	0.02	0.05	0.05	0.09	5	0.01	0.0388	98
1,3-Butadiene	106-99-0	**0.02**	0.02	0.09	**0.05**	0.03	0.20	0.033	**1.45**	0.0133	95
Butyraldehyde	123-72-8	0.09	0.07	0.49	0.26	0.20	1.45			0.0029	100
Carbon Disulfide	75-15-0	0.19	0.10	0.64	0.60	0.31	1.98	700	0.00	0.0280	100
Carbon Tetrachloride	56-23-5	**0.12**	0.11	0.25	**0.73**	0.68	1.56	0.067	**10.97**	0.0566	100
Chloroethane	75-00-3	0.02	0.02	0.13	0.06	0.04	0.35			0.0211	95
Chloroform	67-66-3	**0.03**	0.03	0.06	**0.15**	0.16	0.27	0.043	**3.55**	0.0195	100
Chloromethane	74-87-3	**0.70**	0.70	1.28	**1.45**	1.44	2.64	0.56	**2.59**	0.0289	100
Crotonaldehyde	123-73-9	0.08	0.04	0.33	0.24	0.12	0.95			0.0029	98
Dibromochloromethane	594-18-3	(0.0002)	0	0.01	(0.002)	0	0.05			0.0993	5
1,2-Dibromoethane	106-93-4	(0.0001)	0	0.01	(0.001)	0	0.04			0.1383	2
m-Dichlorobenzene	541-73-1	(0.0001)	0	0.004	(0.0004)	0	0.02			0.0241	2
p-Dichlorobenzene	106-46-7	0.01	0.01	0.03	0.06	0.06	0.17	0.091	0.67	0.0361	88
Dichlorodifluoromethane	75-71-8	0.65	0.61	1.17	3.20	3.01	5.79	200	0.02	0.0247	100
1,1-Dichloroethane	75-34-3	(0.0001)	0	0.004	(0.0003)	0	0.02	0.63	0.00	0.0243	2
1,2-Dichloroethane	107-06-2	(0.001)	0	0.02	(0.004)	0	0.09	0.038	0.10	0.0607	5
1,1-Dichloroethene	75-35-4	(0.0001)	0	0.01	(0.0004)	0	0.02	200	0.00	0.0555	2
trans-1,2-Dichloroethylene	156-60-5	(0.001)	0	0.03	(0.002)	0	0.13			0.0714	2
Dichloromethane	75-09-2	0.18	0.14	0.62	0.62	0.50	2.15	2.1	0.30	0.0591	100
Dichlorotetrafluoroethane	1320-37-2	0.02	0.02	0.04	0.13	0.13	0.24			0.0210	100
Ethylbenzene	100-41-4	0.04	0.03	0.11	0.17	0.14	0.49	0.4	0.42	0.0217	100
Formaldehyde	50-00-0	**2.06**	1.55	15.80	**2.53**	1.90	19.40	0.077	**32.84**	0.0061	100
Hexaldehyde	66-25-1	0.03	0.02	0.14	0.11	0.08	0.59			0.0082	88
Isovaleraldehyde	590-86-3	(0.004)	0	0.08	(0.01)	0	0.27			0.0035	16
Methyl Ethyl Ketone	78-93-3	0.31	0.26	1.18	0.92	0.77	3.47	5000	0.00	0.1296	100

Table 6 (Continued)
2009 Air Toxics Data for New Brunswick, NJ

Analyte[a]	Cas #	Annual Mean (ppbv)[b,c]	Annual Median (ppbv)[b]	24-Hour Max. (ppbv)	Annual Mean (µg/m^3)[b,c]	Annual Median (µg/m^3)[c]	24-Hour Max. (µg/m^3)	Long-Term Health Benchmark (µg/m^3)[d]	Annual Mean Risk Ratio[e]	Detection Limit (µg/m^3)	% Above Minimum Detection Limit[f]
Methyl Isobutyl Ketone	108-10-1	0.02	0.02	0.08	0.09	0.08	0.33			0.0287	91
Methyl Methacrylate	80-62-6	(0.0002)	0	0.01	(0.001)	0	0.03	700	0.00	0.0211	2
Methyl tert-Butyl Ether	1634-04-4	(0.003)	0	0.04	(0.01)	0	0.14	3.8	0.00	0.0072	21
n-Octane	111-65-9	0.01	0.01	0.04	0.07	0.06	0.20			0.0280	91
Propionaldehyde	123-38-6	0.12	0.11	0.34	0.28	0.27	0.81	8	0.03	0.0048	100
Propylene	115-07-1	0.42	0.36	1.20	0.72	0.61	2.07	3000	0.00	0.0155	100
Styrene	100-42-5	0.01	0.01	0.03	0.05	0.05	0.12	1.8	0.03	0.0426	91
Tetrachloroethylene	127-18-4	0.02	0.02	0.10	0.16	0.13	0.68	0.17	0.95	0.0746	95
Tolualdehydes		0.03	0.02	0.07	0.12	0.11	0.33			0.0147	89
Toluene	108-88-3	0.50	0.19	15.20	1.90	0.70	57.28	5000	0.00	0.0188	100
1,1,1-Trichloroethane	71-55-6	0.02	0.02	0.03	0.09	0.09	0.14	1000	0.00	0.0164	100
Trichloroethylene	79-01-6	(0.01)	0	0.10	(0.03)	0	0.52	0.5	0.06	0.0537	38
Trichlorofluoromethane	75-69-4	0.31	0.30	0.52	1.73	1.67	2.93	700	0.00	0.0393	100
Trichlorotrifluoroethane	26523-64-8	0.11	0.11	0.19	0.84	0.82	1.43			0.0920	100
1,2,4-Trimethylbenzene	95-63-6	0.03	0.02	0.12	0.14	0.12	0.57			0.0147	98
1,3,5-Trimethylbenzene	108-67-8	0.01	0.01	0.04	0.05	0.04	0.20			0.0197	98
Valeraldehyde	110-62-3	0.03	0.02	0.09	0.09	0.08	0.32			0.0035	98
Vinyl chloride	75-01-4	(0.002)	0	0.02	(0.004)	0	0.04	0.11	0.04	0.0204	27
m,p-Xylene	1330-20-7	0.09	0.08	0.33	0.40	0.34	1.44	100	0.00	0.0391	100
o-Xylene	95-47-6	0.04	0.03	0.10	0.16	0.14	0.42	100	0.00	0.0174	100

[a] Analytes in bold text had annual means above the long-term health benchmark.

[b] Numbers in parentheses are arithmetic means (or averages) based on less than 50 percent detection.

[c] For a valid 24-hour sampling event when the analyzing laboratory reports the term "Not Detected" for a particular pollutant, the concentration of 0.0 ppbv is assigned to that pollutant. These zero concentrations were included in the calculation of annual averages and medians for each pollutant regardless of percent detection.

[d] The long-term 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.

[e] 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.

[f] There were 56 total VOC samples and 56 total carbonyl samples collected in 2009 in New Brunswick.

Table 7
Analytes with 100 Percent Non-Detects in 2009

Analyte	CAS #	Detection Limit ($\mu g/m^3$)	Location		
			Chester	Elizabeth	New Brunswick
1,1,2,2-Tetrachloroethane	79-34-5	0.09			X
1,1,2-Trichloroethane	79-00-5	0.03	X		X
1,1-Dichloroethene	75-35-4	0.06	X		
1,2,4-Trichlorobenzene	102-82-1	0.11	X		X
1,2-Dichloropropane	78-87-5	0.15			X
2,5-Dimethylbenzaldehyde	5799-94-2	0.00	X	X	X
Bromochloromethane	74-97-5	0.10			X
Chlorobenzene	108-90-7	0.02			X
Chloromethylbenzene	100-44-7	0.03	X		X
Chloroprene	126-99-8	0.08			X
cis-1,2-Dichloroethylene	156-59-2	0.06			X
cis-1,3-Dichloropropene	542-75-6	0.06	X		X
Ethyl Acrylate	140-88-5	0.05	X		X
Ethyl tert-Butyl Ether	637-92-3	0.03	X		X
Hexachloro-1,3-butadiene	87-68-3	0.14	X	X	X
m-Dichlorobenzene	541-73-1	0.02	X		
o-Dichlorobenzene	95-50-1	0.03	X		X
tert-Amyl Methyl Ether	994-05-8	0.05	X		X
trans-1,2-Dichloroethylene	156-60-5	0.07	X		
trans-1,3-Dichloropropene	542-75-6	0.04	X		X

In 2009, 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.

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2009 Atmospheric Deposition Summary

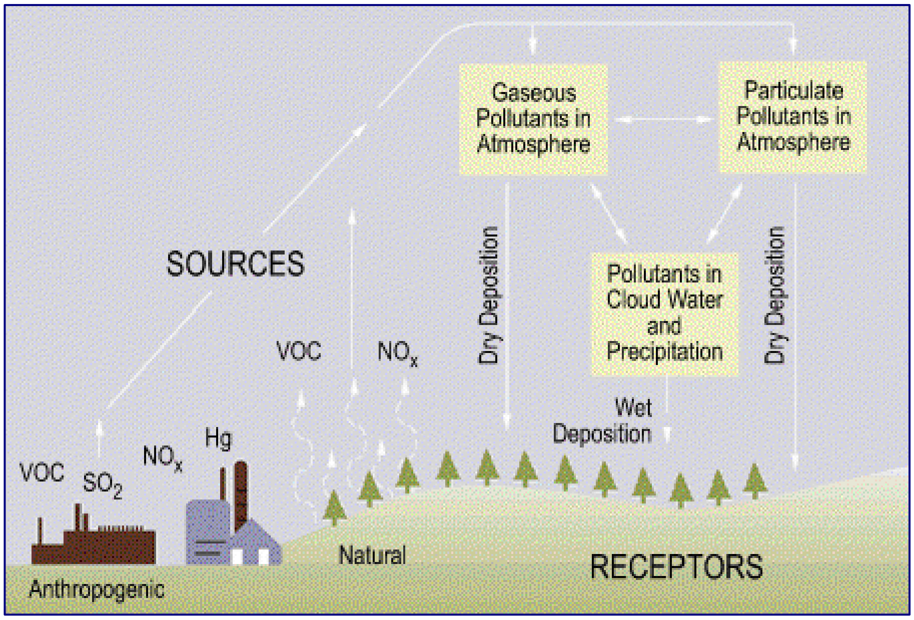
New Jersey Department of Environmental Protection

NATURE AND SOURCES

Atmospheric deposition refers to pollutants that 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.

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.

Figure 1



Source: USEPA Clean Air Markets
Web Site: http://www.epa.gov/airmarkets/acidrain/index.html#what

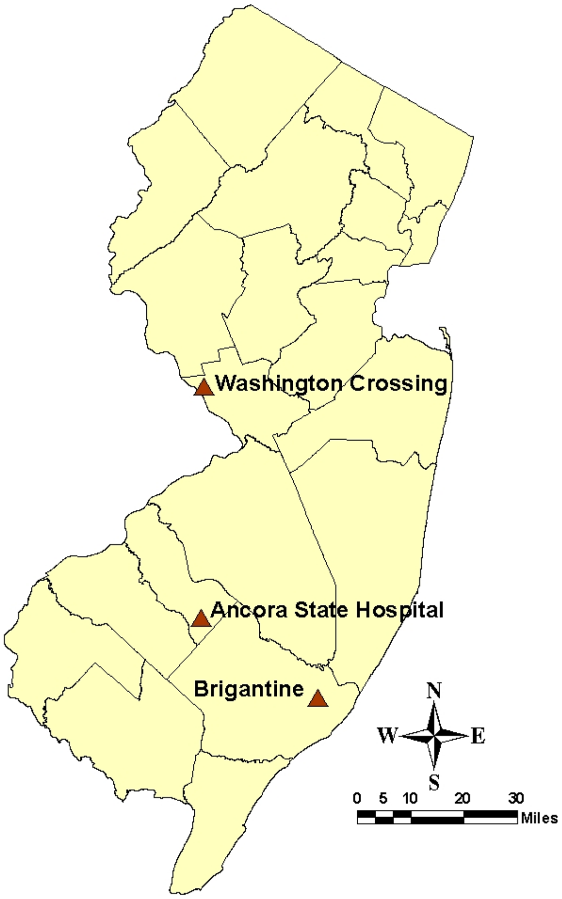
MONITORING LOCATIONS

Figure 2 shows the three active deposition monitoring sites in New Jersey for 2009: 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 samples are then 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, 2010)

In addition to the NADP sites, the State also collects samples from an event sampler at Washington Crossing next to the weekly sampler, and 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.

Figure 2
Acid Precipitation Monitoring Network - 2009



SUMMARY OF 2009 DATA

A summary of the 2009 wet deposition data is provided in Table 1. Raw data was obtained from the NADP website (NADP, 2010). 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 Crossing State Park weekly sampler was 4.73 and the Edwin B. Forsythe NWR sampler recorded a mean pH of 4.94.

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 - 2009
Annual and Seasonal Averages

Weighted by Precipitation Amount

Ca^{2+} - Calcium
Mg^{2+} - Magnesium
K^+ - Potassium
Na^+ - Sodium
NH_4^+ - Ammonium
NO_3^- - Nitrate
Cl^- - Chloride
SO_4^{2-} - Sulfate
– - No Data

Cond. - Specific conductance
cm - Centimeter
uS/cm - MicroSiemens per centimeter
mg/L - Milligrams per liter
<MDL - Below minimum detection limit
Winter - December – February
Spring - March – May
Summer - June – August
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	26.72	4.75	14.43	0.105	0.083	0.039	0.707	0.172	0.781	1.285	0.950
Spring	21.29	4.97	11.95	0.079	0.083	0.050	0.718	0.181	0.569	1.277	0.856
Summer	42.26	4.78	12.63	0.088	0.041	0.033	0.288	0.239	0.691	0.555	1.150
Fall	47.80	5.25	19.87	0.122	0.279	0.110	2.340	0.072	0.264	4.168	0.831
Annual	140.54	4.94	15.67	0.106	0.144	0.065	1.200	0.164	0.536	2.145	0.969

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	22.66	4.64	13.58	0.070	0.026	0.014	0.238	0.119	0.954	0.416	0.927
Spring	22.63	4.80	12.21	0.114	0.034	0.035	0.185	0.308	1.056	0.327	1.147
Summer	60.41	4.61	14.47	0.072	0.015	0.011	0.051	0.243	0.947	0.129	1.300
Fall	24.66	4.97	9.62	0.070	0.056	0.094	0.436	0.094	0.520	0.764	0.607
Annual	131.86	4.73	12.24	0.077	0.027	0.031	0.171	0.197	0.841	0.319	1.006

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 8 were obtained from the NADP website. NADP criteria requirements can also be found at http://nadp.sws.uiuc.edu/.	

Figure 3
Sulfate (SO4) NADP/NTN Site NJ99 (Washington Crossing State Park)
Annual Wet Depositions (1981 - 2009)
Kilograms Per Hectare (kg/ha)

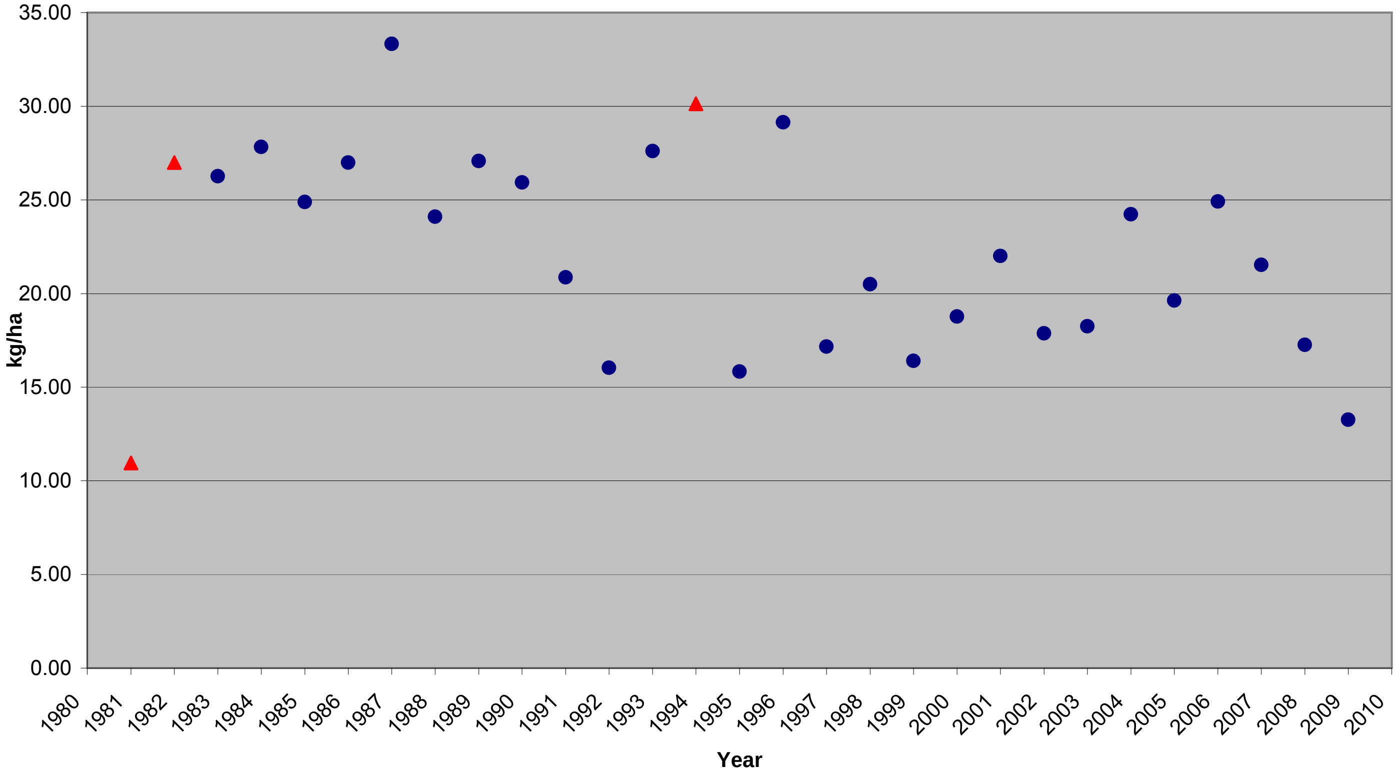


Figure 4
Sulfate (SO4) NADP/NTN Site NJ00 (Edwin B. Forsythe National Wildlife Refuge)
Annual Wet Depositions (1998 - 2009)
Kilograms Per Hectare (kg/ha)

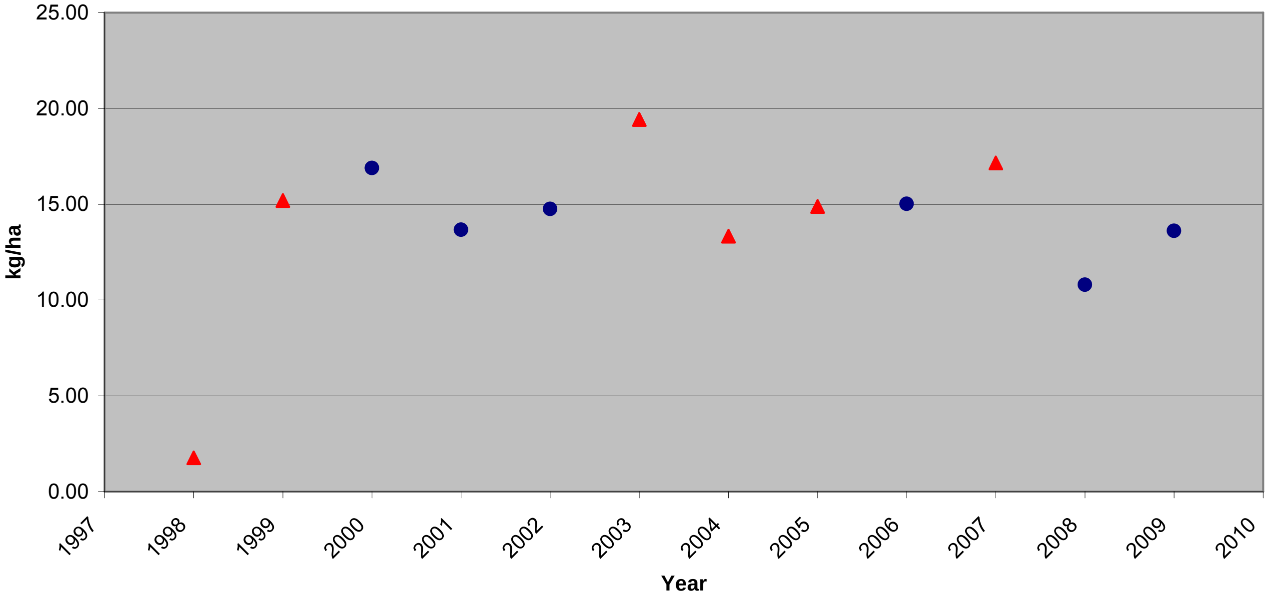


Figure 5
Ammonium (NH4) NADP/NTN Site NJ99 (Washington Crossing State Park)
Annual Wet Depositions (1981 - 2009)
Kilograms Per Hectare (kg/ha)

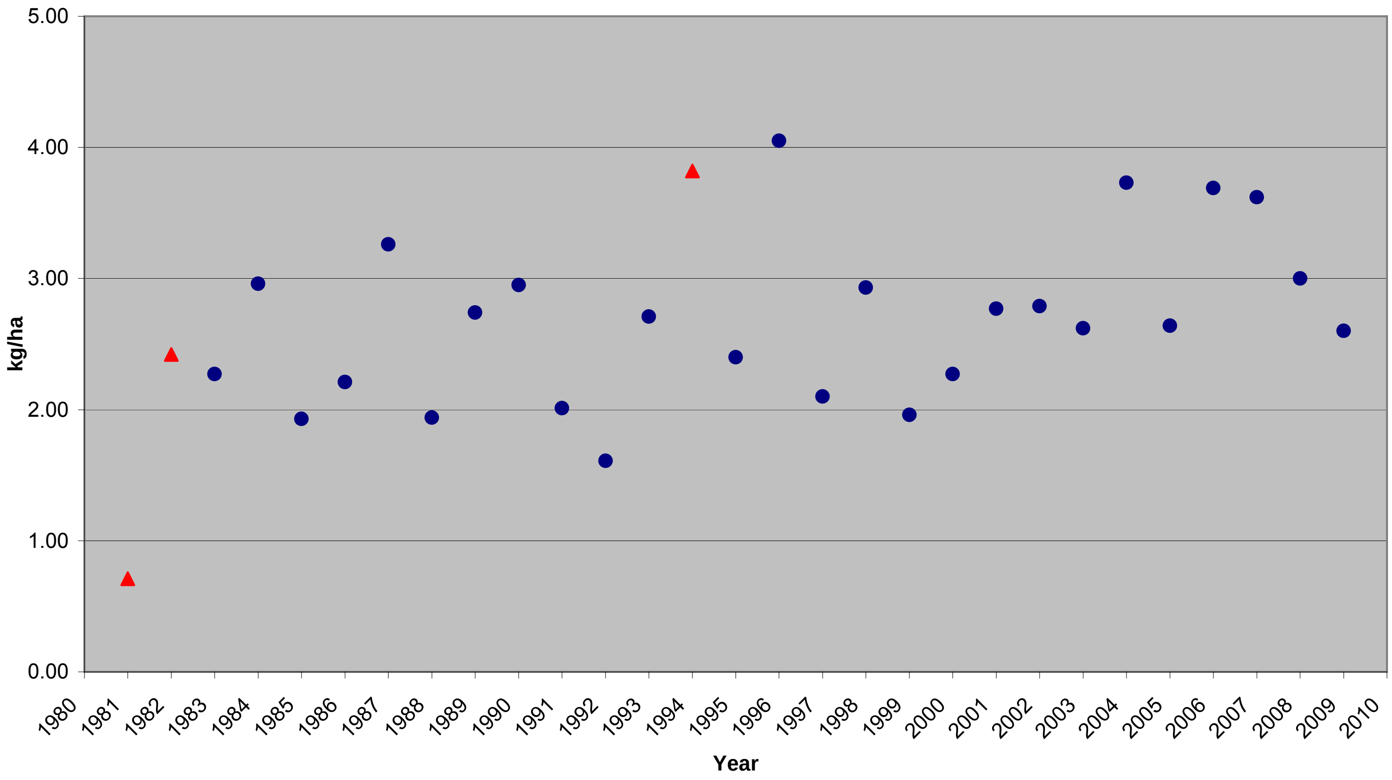


Figure 6
Ammonium (NH4) NADP/NTN Site NJ00 (Edwin B. Forsythe National Wildlife Refuge)
Annual Wet Depositions (1998 - 2009)
Kilograms Per Hectare (kg/ha)

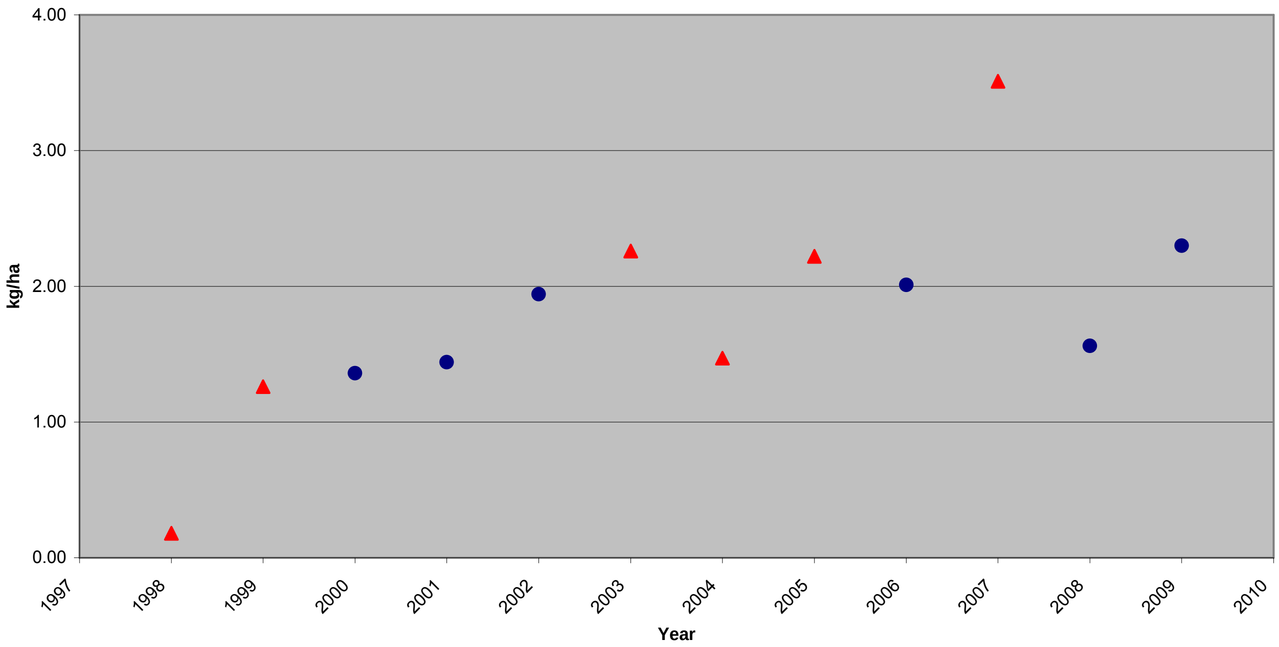


Figure 7
Nitrate (NO3) NADP/NTN Site NJ99 (Washington Crossing State Park)
Annual Wet Depositions (1981 - 2009)
Kilograms Per Hectare (kg/ha)

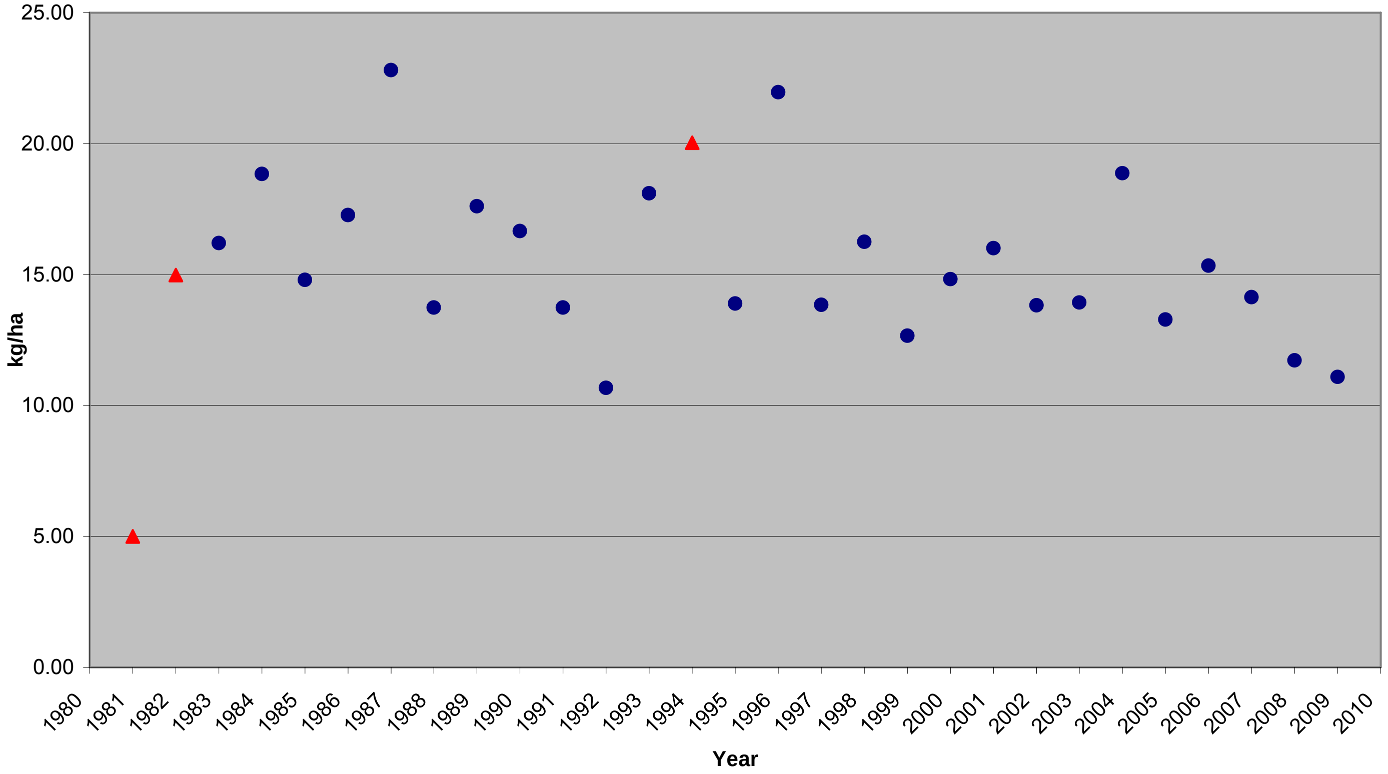
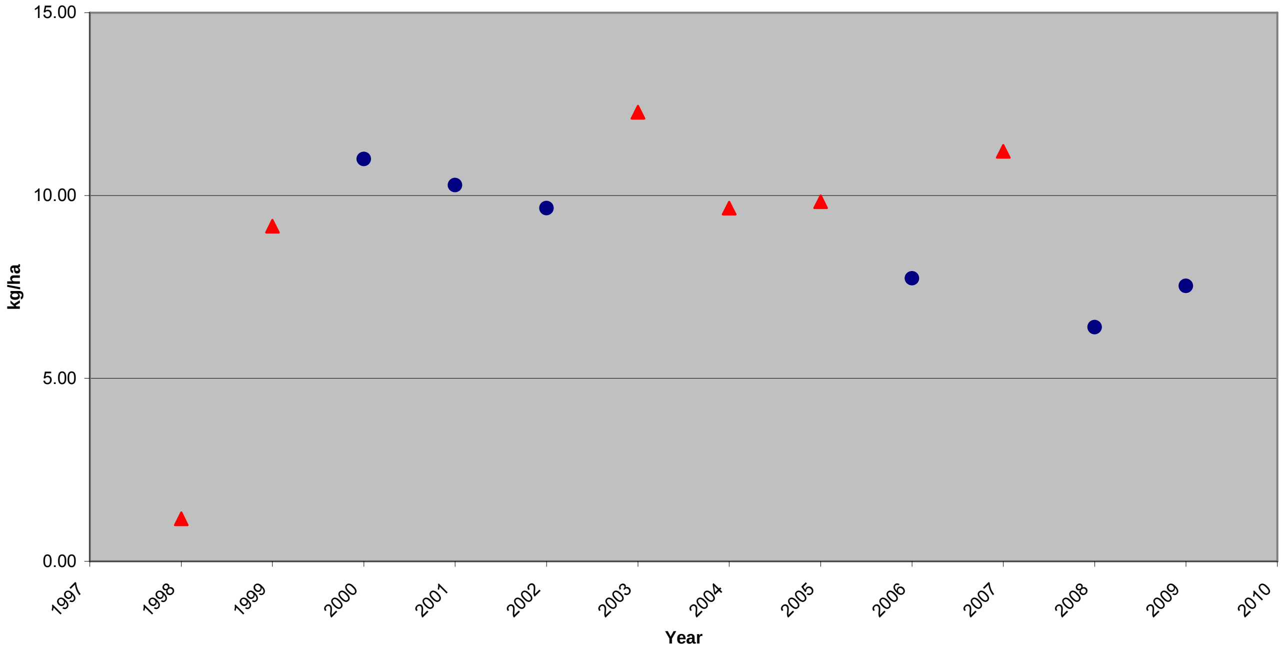


Figure 8
Nitrate (NO3) NADP/NTN Site NJ00 (Edwin B. Forsythe National Wildlife Refuge)
Annual Wet Depositions (1998 - 2009)
Kilograms Per Hectare (kg/ha)



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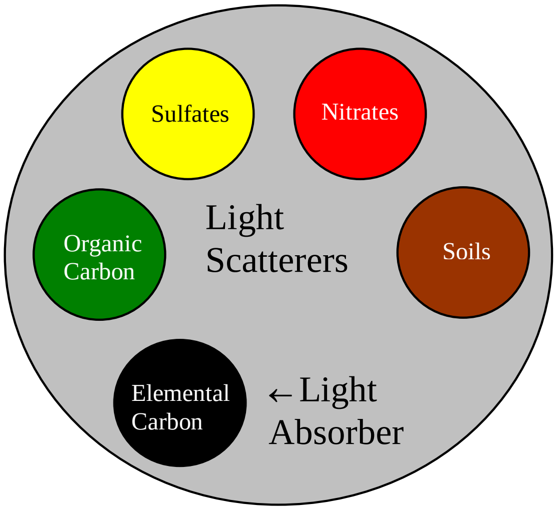
2009 Regional Haze & Visibility Summary

New Jersey Department of Environmental Protection

The Basics of Haze

Haze is caused when sunlight encounters tiny pollution particles in the air. Some light is absorbed by particles; other light is scattered away before it reaches an observer. Small particles and certain gaseous molecules in the atmosphere cause poor visibility by scattering or absorbing light (see Figure 1). More pollutants mean more absorption and scattering of light, which reduce the clarity and color of what we see. When high concentrations of such pollutants are well mixed in the atmosphere, they form a uniform haze that can obscure distant objects. Some types of particles such as sulfates scatter more light, particularly during humid conditions. Sometimes haze is the result of pollutants that have been transported considerable distances on the prevailing winds. While some visibility impairment occurs even under natural conditions, man-made aerosols are the primary cause. Air pollutants come from a variety of natural and manufactured sources. Natural sources can include windblown dust and soot from wildfires. Man-made sources can include motor vehicles, electric utility and industrial fuel burning, and manufacturing operations.

Figure 1
Contributors to Visibility Impairment



Anatomy of Regional Haze

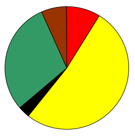
Data collected over the last decade show that fine particle concentrations, and hence visibility impairment, are highest in the industrialized and densely populated areas of the Northeast and Mid-Atlantic. Sulfate (SO4) is the primary culprit and typically constitutes 40% of the total fine mass in the region even on clear days. It can account for 60-80% of the total fine mass on very hazy days. Organic carbon usually accounts for the next largest portion of total fine particle mass. It can account for 20-30% on the haziest days. The remainder of the mass is made up primarily of nitrate (NO3), elemental carbon, and fine soil particles.

Particles and Visibility

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

Figure 2
Composition of Fine Particles on Days with Good Visibility Compared to Days with Poor Visibility
Brigantine,
New Jersey, 2009

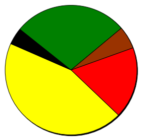
Average Fine Mass Composition on Days with Good Visibility



🟥	Ammonium Nitrate	0.20 μg/m^3	8.8%
🟨	Ammonium Sulfate	1.18 μg/m^3	51.8%
⬛	Elemental Carbon	0.07 μg/m^3	3.0%
🟩	Organic Carbon	0.68 μg/m^3	29.9%
🟫	Soils	0.15 μg/m^3	6.7%

Total 2.27 μg/m^3

Average Fine Mass Composition on Days with Poor Visibility



🟥	Ammonium Nitrate	2.63 μg/m^3	17.8%
🟨	Ammonium Sulfate	6.58 μg/m^3	44.5%
⬛	Elemental Carbon	0.59 μg/m^3	4.0%
🟩	Organic Carbon	4.14 μg/m^3	28.0%
🟫	Soils	0.83 μg/m^3	5.6%

Total 14.77 μg/m^3

Evaluations of the data for 2009 indicate that sulfates accounted for approximately half of the total fine particle mass. Most visibility impairment is due to sulfate, which can have a greater effect on light extinction (a measure of visibility impairment) than all other types of fine particles combined. Higher sulfate values in the summer can be attributed to the greater photochemical conversion of sulfur dioxide (SO_2) to SO_4 that results from the increased sunlight during the summertime. (Malm, 1999)

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. 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, to 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. Five multi-state regional planning organizations continue to work on the development of the technical basis for these plans in which regional haze will be regulated.

SOURCES OF HAZE CONTRIBUTORS

The following categories of air pollutants are the major contributors to haze.

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.

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.

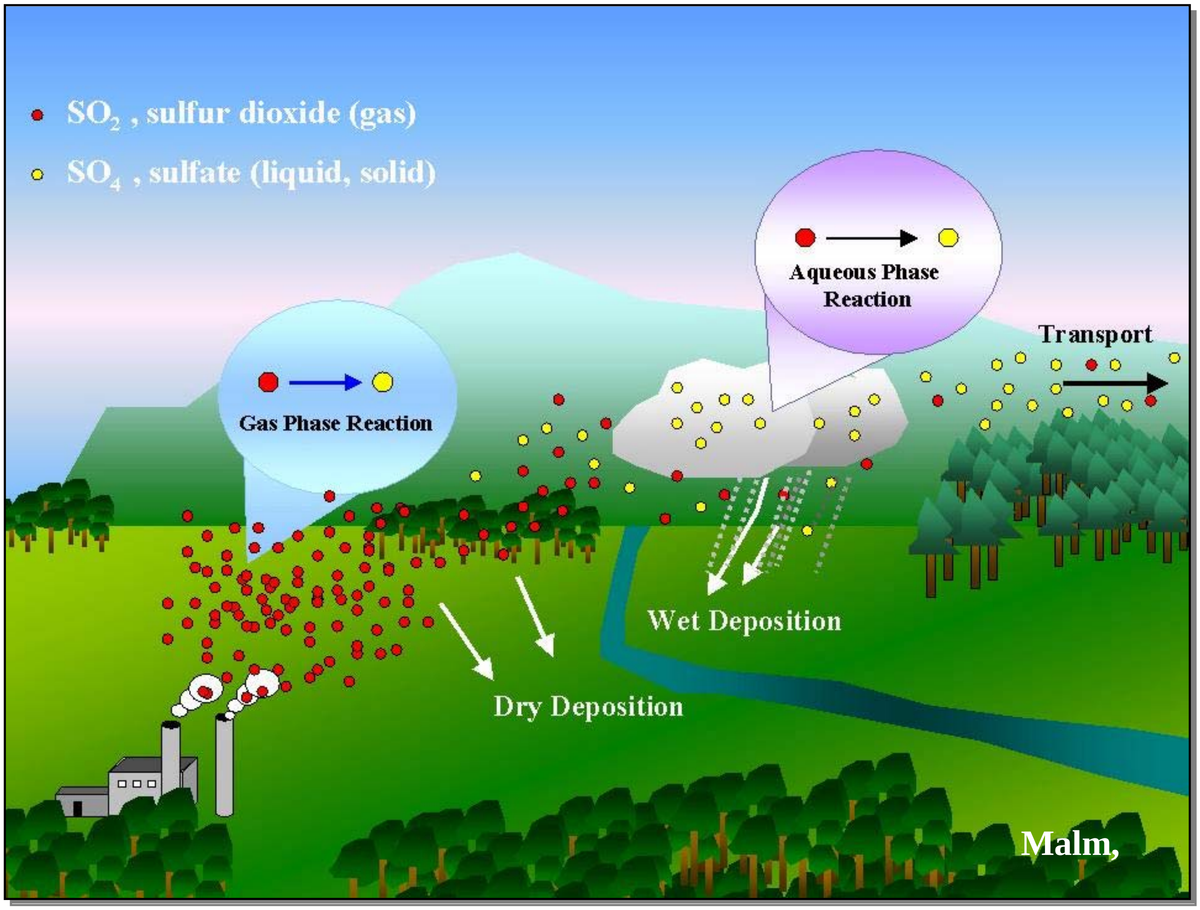
Source – www.hazecam.net

ENVIRONMENTAL EFFECTS

Regional haze is probably most closely associated with its effects on prized vistas such as the Grand Canyon or Acadia National Park. 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. But haze also affects urban area and scenes, and can obscure or eclipse the view of an urban skyline (see Figures 4 and 5) or other important urban landmarks such as the Washington Monument.

The pollution that causes regional haze has additional, multifaceted effects on the environment. The most abundant contributor to regional haze, sulfates, eventually make their way into the ecosystem through deposition - that is, they are transferred from the air into the water and soils (see Figure 3). Too much deposition can have adverse environmental effects, upsetting the delicate balance of the ecosystem. Increased sulfates in the atmosphere leads to acid rain while increased nitrates promote eutrophication of streams and lakes by depleting available oxygen (see section on Atmospheric Deposition).

Figure 3
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 the natural visual range. (www.hazecam.net)

Visiblity and haze are monitored in two locations in New Jersey; Newark and Brigantine. The monitor in Newark measures the impact of haze on visisbility 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 4). The Manhattan skyline appears non-existent when conditions conducive to haze formation are in place (Figure 5).

Visibility Camera – New Jersey Transit Building

Figure 4

Figure 5

The IMPROVE site located within the Brigantine National Wildlife Refuge monitors haze and visibility using several types of instruments. Figure 6 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 7 and not only has the skyline disappeared but the water that was visible in the foreground in the clear picture also seems to have vanished in the haze.

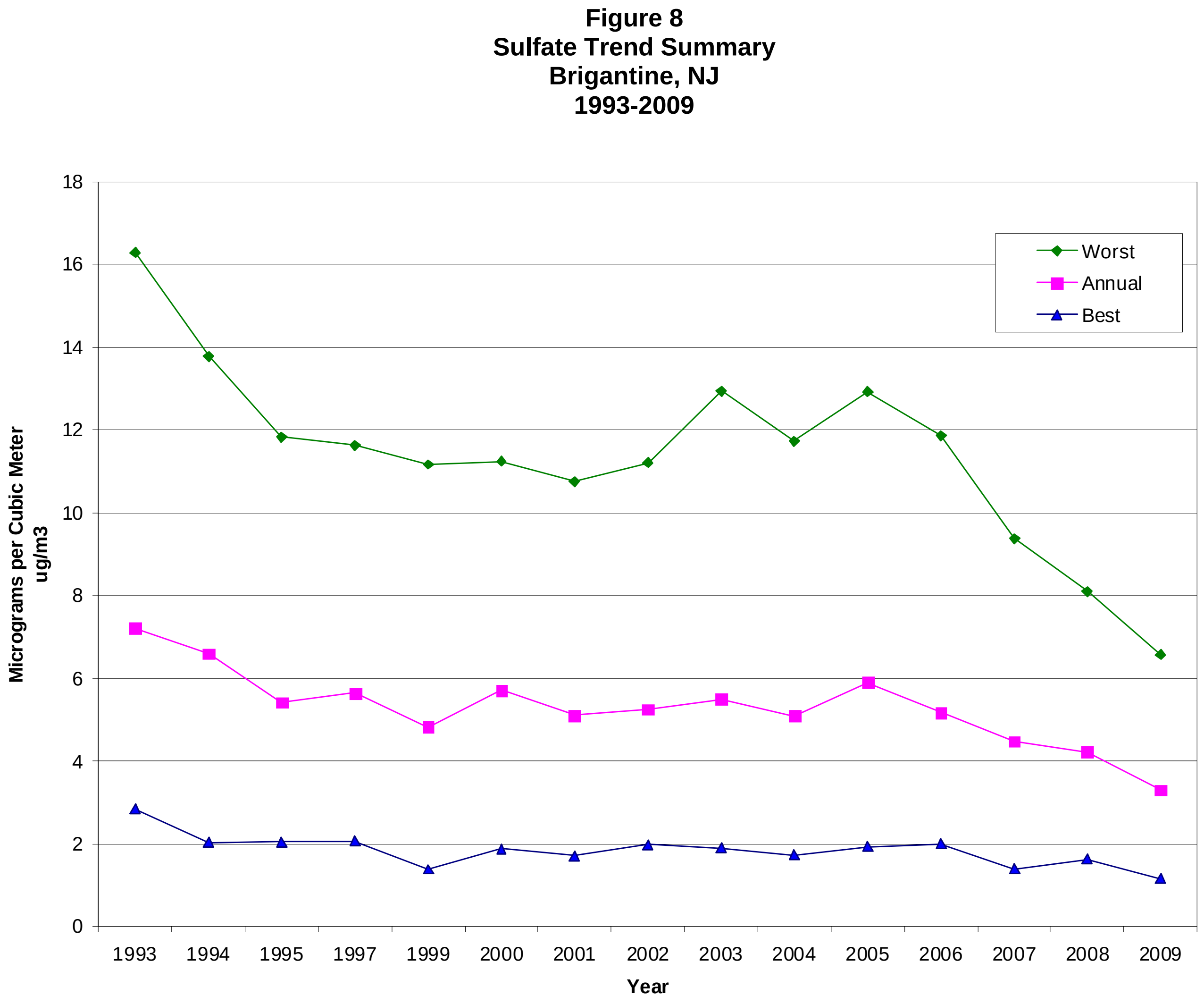
Visibility Camera – Brigantine National Wildlife Refuge

Figure 6

Figure 7

The graph below (Figure 8) 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.



*Insufficient data available for 1996 and 1998

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Regional Haze and Visibility in the Northeast and Mid-Atlantic States, Northeast States for Coordinated Air Use Management, January, 2001

vista.cira.colostate.edu/views

www.hazecam.net

2009 Meteorology Summary

New Jersey Department of Environmental Protection

AIR POLLUTION AND METEOROLOGY

Meteorology plays an important role in the distribution of pollution throughout the troposphere, the layer of the atmosphere closest to the earth's surface. Atmospheric processes such as wind speed and wind direction affect the transport and dispersion of air pollution. Weather phenomena, such as precipitation and solar radiation, influence chemical reactions and transformations in the atmosphere that affect air pollutants. By studying meteorological and air pollution data together, scientists and mathematicians have developed reasonably accurate models for predicting the fate of pollutants as they go through the stages of transport, dispersion, transformation and removal.

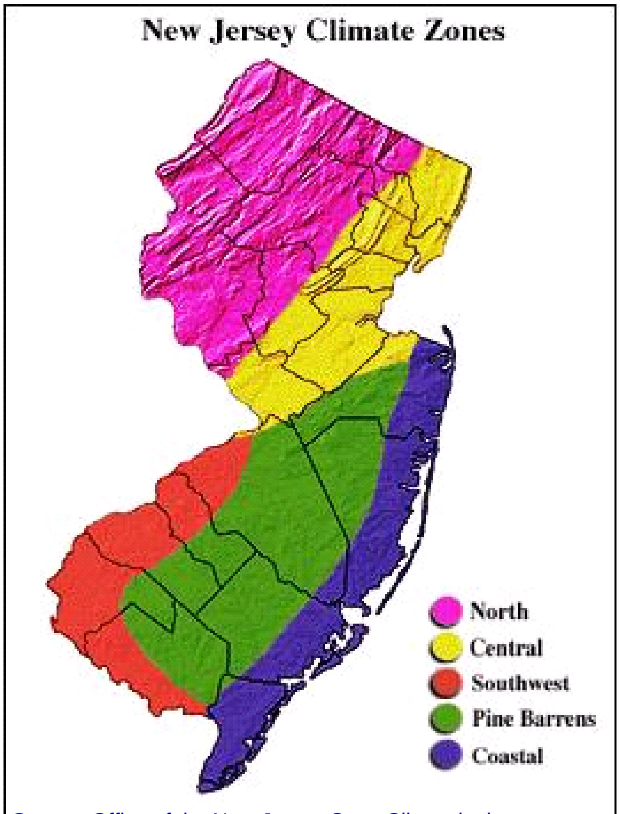
Scientists, engineers, and policy makers can use results of the air pollution models as a screening tool for comparison to the National Ambient Air Quality Standards (NAAQS), to determine the impacts of new and existing air pollution sources, and to design ambient air monitoring networks. The meteorological data collected by the New Jersey Department of Environmental Protection (NJDEP) can assist planners in preparing State Implementation Plans (SIPs), engineers in designing or evaluating air pollution permit applications and planners in locating air monitoring stations.

CLIMATOLOGY IN NEW JERSEY

New Jersey is located about halfway between the Equator and the North Pole, on the eastern coast of the United States. Its geographic location results in the State being influenced by wet, dry, hot, and cold airstreams, making for daily weather that is highly variable.

Although New Jersey is one of the smallest states in the Union, with a land area of 7,836 square miles, it has five distinct climate zones, which are classified as the Northern, Central, Pine Barrens, Southwest, and Coastal zones. The topography of the zones, their distance from the Atlantic Ocean, and the prevailing atmospheric flow patterns affecting those zones produce distinct variations in the daily weather between each of the zones. These climate zones are shown in Figure 1.

Figure 1



Source: Office of the New Jersey State Climatologist

MONITORING LOCATIONS

The NJDEP maintains a network of five meteorological monitoring locations. Not all meteorological parameters are measured at each site. These parameters are measured at Elizabeth Lab, East Orange, Chester, Flemington, and Rider University. Figure 2 provides a map of the monitoring stations. In addition, total weekly precipitation is measured in Washington Crossing and Ancora State Hospital.

NORTHERN METEOROLOGICAL STATIONS

The Elizabeth Lab meteorological station monitors wind speed and wind direction. The East Orange meteorological station monitors temperature and relative humidity. The Chester meteorological station monitors solar radiation. In Table 1, the 2009 meteorological data are combined in East Orange, Elizabeth Lab, and Chester, and are presented with the Flemington data. Figure 3 shows the monthly maximum, mean and minimum temperatures in East Orange, and Figure 4 compares the monthly mean temperature with the 30-year mean temperatures measured at Newark airport. The Flemington meteorological station monitors barometric pressure, temperature, relative humidity, wind speed, wind direction, and solar radiation. This data is summarized in Table 1. Figure 5 shows the monthly maximum, mean and minimum temperatures at Flemington, and Figure 6 compares the monthly mean temperature with the 30-year mean temperatures measured at the Lehigh Valley International Airport in Allentown, PA.

CENTRAL METEOROLOGICAL STATION

The Rider University meteorological station monitors barometric pressure, temperature, relative humidity, wind speed, wind direction, and solar radiation. This data is summarized in Table 2. Figure 7 shows the monthly maximum, mean and minimum temperatures at Rider University, and Figure 8 compares the monthly mean temperature with the 30-year mean temperatures measured at Philadelphia International airport.

Figure 2
2009 Meteorological Monitoring Network

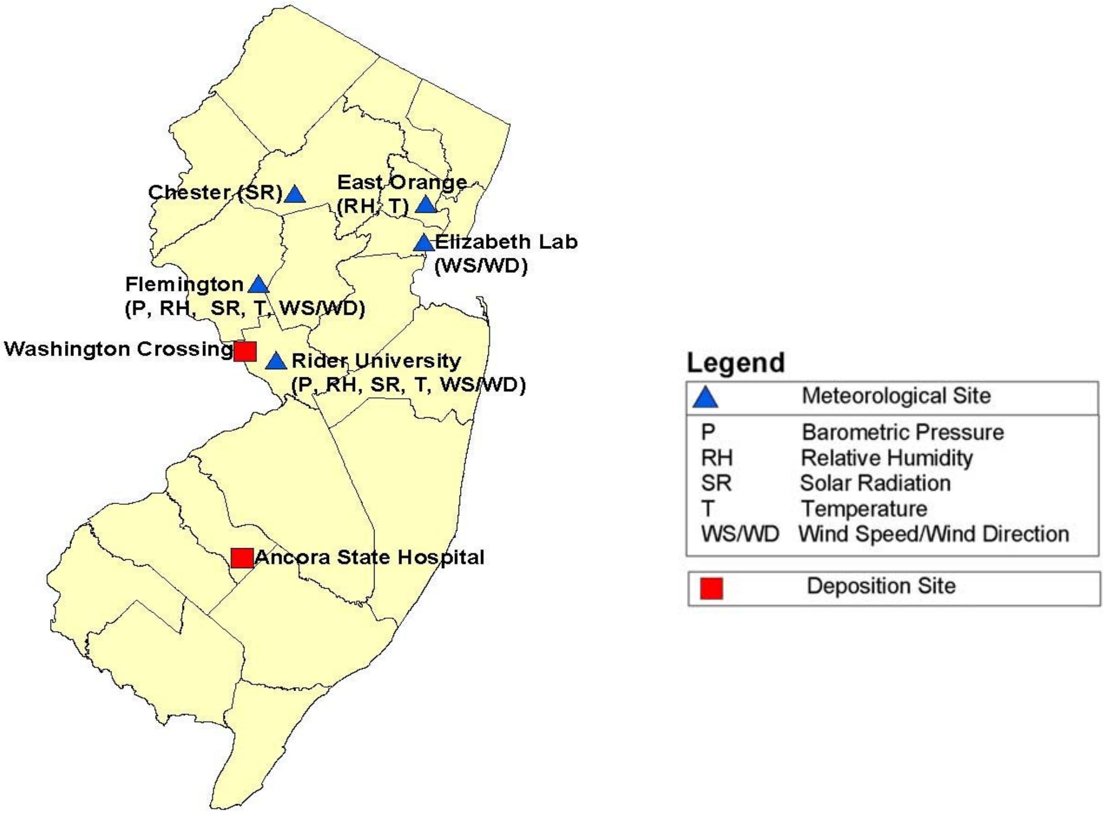


TABLE 1

SUMMARY OF METEOROLOGICAL MONITORING DATA - 2009
NORTHERN NEW JERSEY

MONITORING
SITES

East Orange and Chester		JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Temperature:	Mean[1]	26/31	35/34	40/42	53/52	63/63	68/72	73/77	76/75	65/68	54/56	50/46	35/36	53/54
(°F)	Min	4	11	11	34	41	48	59	59	47	36	32	15	4
	Max	46	64	68	91	86	86	88	92	85	75	70	75	92
Relative	Mean	63.9	60.4	64.0	63.3	74.6	86.8	78.1	81.9	80.1	79.7	76.1	68.9	73.2
Humidity:	Min	29.4	22.8	16.1	20.0	24.9	37.0	37.7	44.3	39.7	40.3	38.0	33.5	16.1
(%)	Max	97.4	97.6	97.7	98.0	98.7	98.6	98.7	98.9	98.8	98.8	98.7	98.7	98.9
Solar Radiation:	Mean	0.105	0.185	0.230	0.286	0.301	0.276	0.353	0.295	0.231	0.150	0.104	0.078	0.216
(Langleys)	Max	0.976	1.190	1.372	1.478	1.575	1.546	1.553	1.406	1.380	1.170	0.922	0.724	1.575
Precipitation	Historical[2]	3.98	2.96	4.21	3.92	4.46	3.40	4.68	4.02	4.01	3.16	3.88	3.57	46.25
(inches)	Observed[3]	2.32	0.61	0.99	2.68	5.33	6.22	5.81	13.47	3.76	3.88	2.59	6.51	54.17
Flemington														
Temperature:	Mean[4]	24/27	32/30	40/39	52/49	61/60	67/69	72/73	74/71	63/63	51/52	47/42	32/32	51/51
(°F)	Min	0	2	7	25	32	39	50	52	40	30	22	14	0
	Max	53	66	71	95	88	91	93	97	87	76	72	66	97
Relative	Mean	72.5	71.2	74.9	72.7	83.1	90.5	85.2	90.1	88.9	88.0	84.2	77.7	81.6
Humidity:	Min	37.0	30.0	24.9	31.6	37.6	47.4	22.3	57.3	50.0	46.2	39.8	38.9	22.3
(%)	Max	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.9	100.0	100.0	100.0	100.0	100.0
Solar Radiation:	Mean	0.120	0.180	0.219	0.273	0.292	0.267	0.356	0.291	0.240	0.150	0.121	0.108	0.218
(Langleys)	Max	0.869	1.033	1.256	1.354	1.418	1.402	1.388	1.300	1.245	1.097	0.793	0.781	1.418
Barometric	Mean	30.10	30.13	30.24	30.04	30.11	29.94	30.03	30.10	30.18	30.12	30.18	30.14	30.11
Pressure	Min	29.24	29.40	29.37	29.21	29.62	29.56	28.46	29.80	29.54	29.60	29.52	29.27	28.46
(in of Hg)	Max	30.67	30.58	30.67	30.58	30.55	30.37	30.43	30.37	30.48	30.48	30.54	30.62	30.67

1) Newark Airport 30-year mean shown to the right of the slash.
2) Historical monthly precipitation data for Newark Airport
3) Observed monthly precipitation collected by NJDEP at Washington's Crossing state park.
4) Lehigh Valley International Airport (Allentown, PA) 30-year mean shown to the right of the slash.

Figure 3
2009 Maximum, Mean and Minimum Temperatures, East Orange

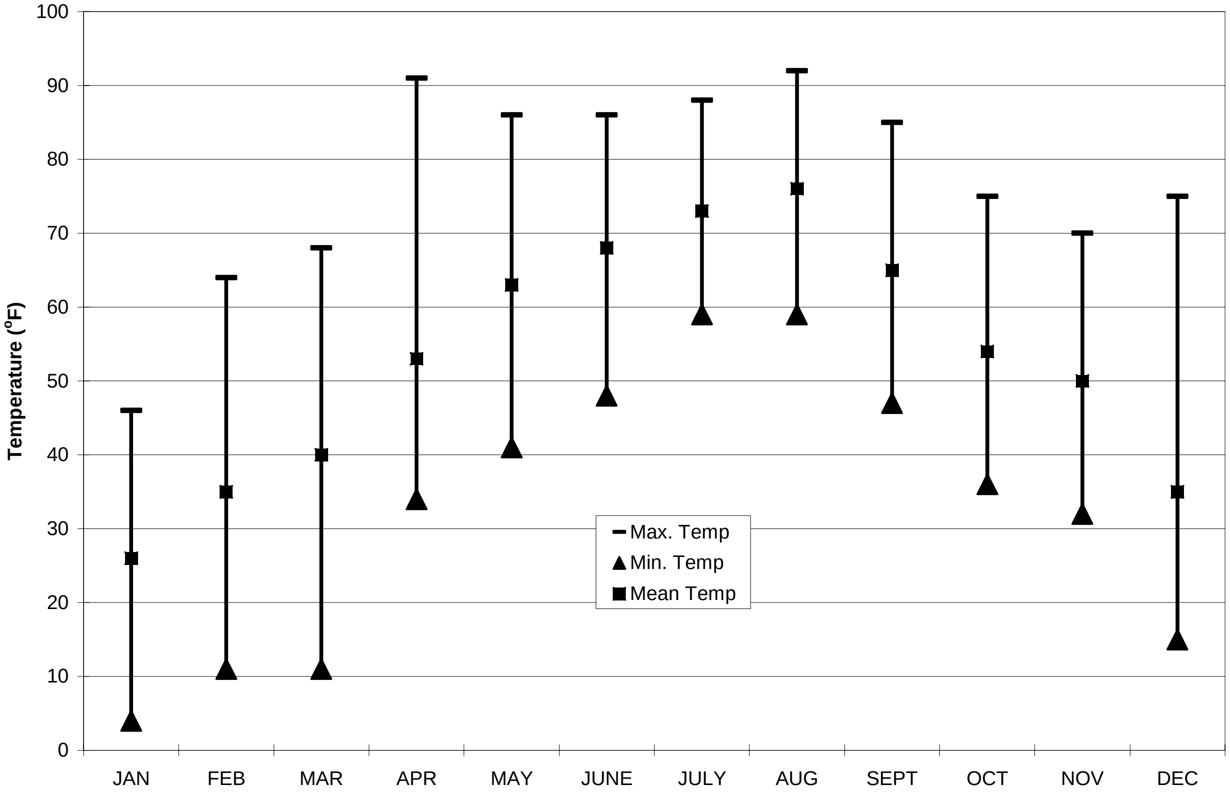


Figure 4
2009 Observed vs. 30-Year Mean Temperatures, East Orange

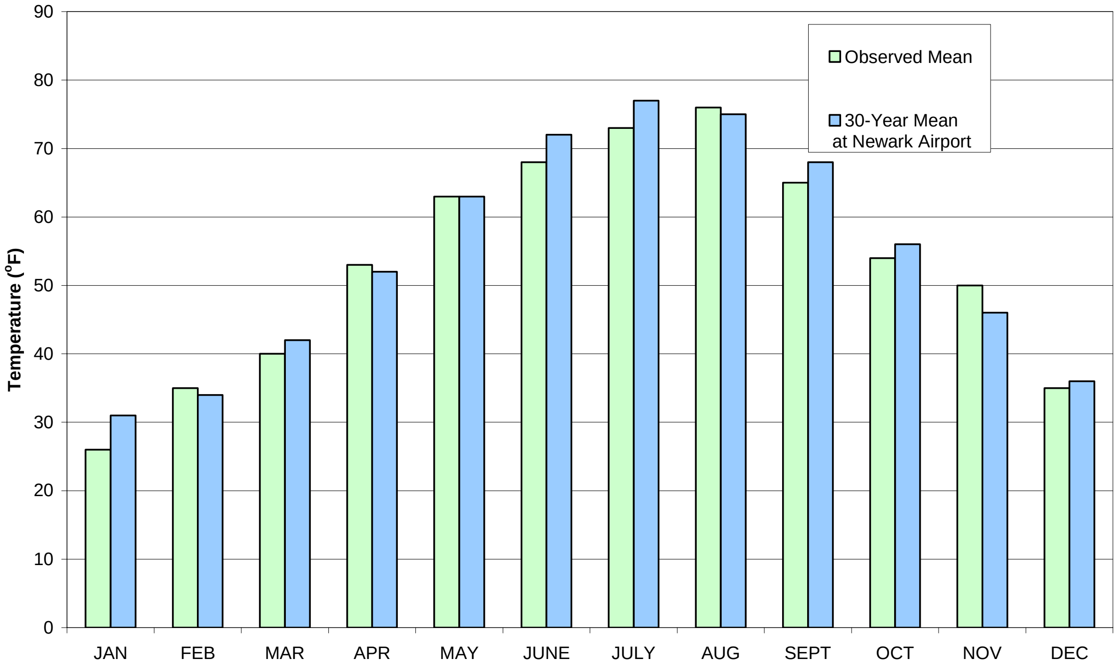


Figure 5

2009 Maximum, Mean and Minimum Temperatures, Flemington

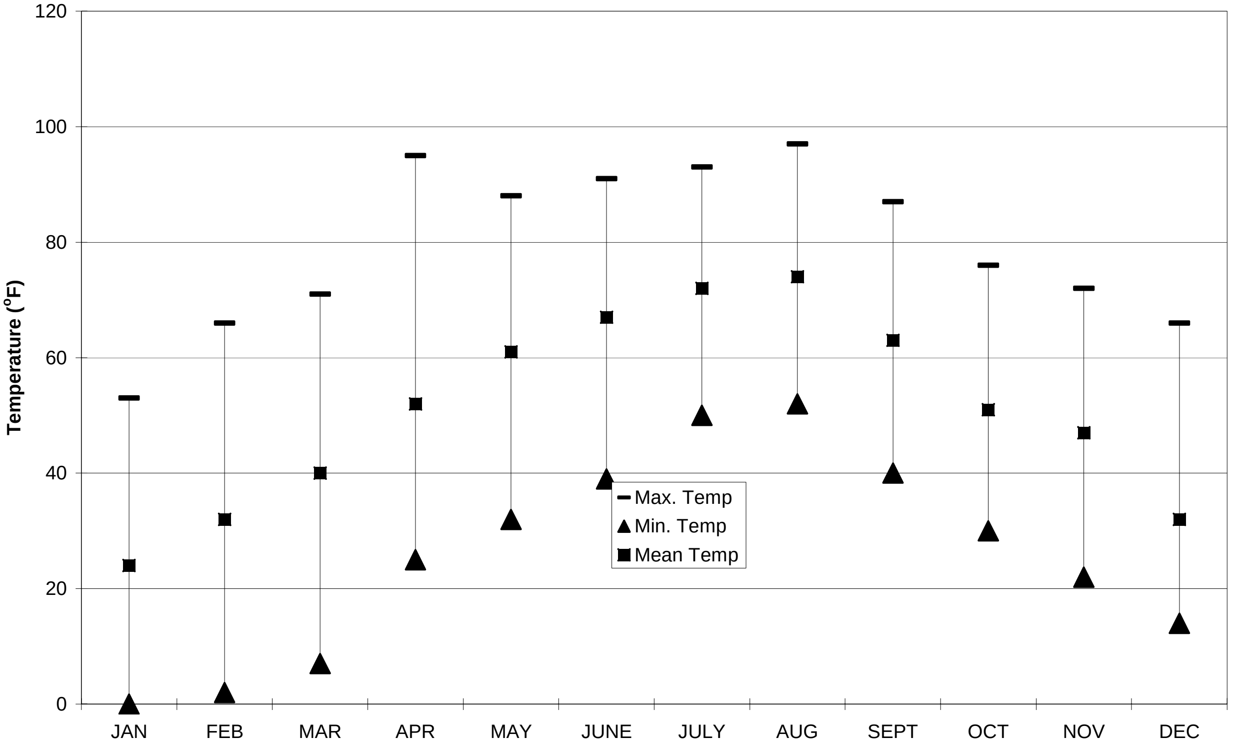


Figure 6

2009 Observed vs. 30-Year Mean Temperatures, Flemington

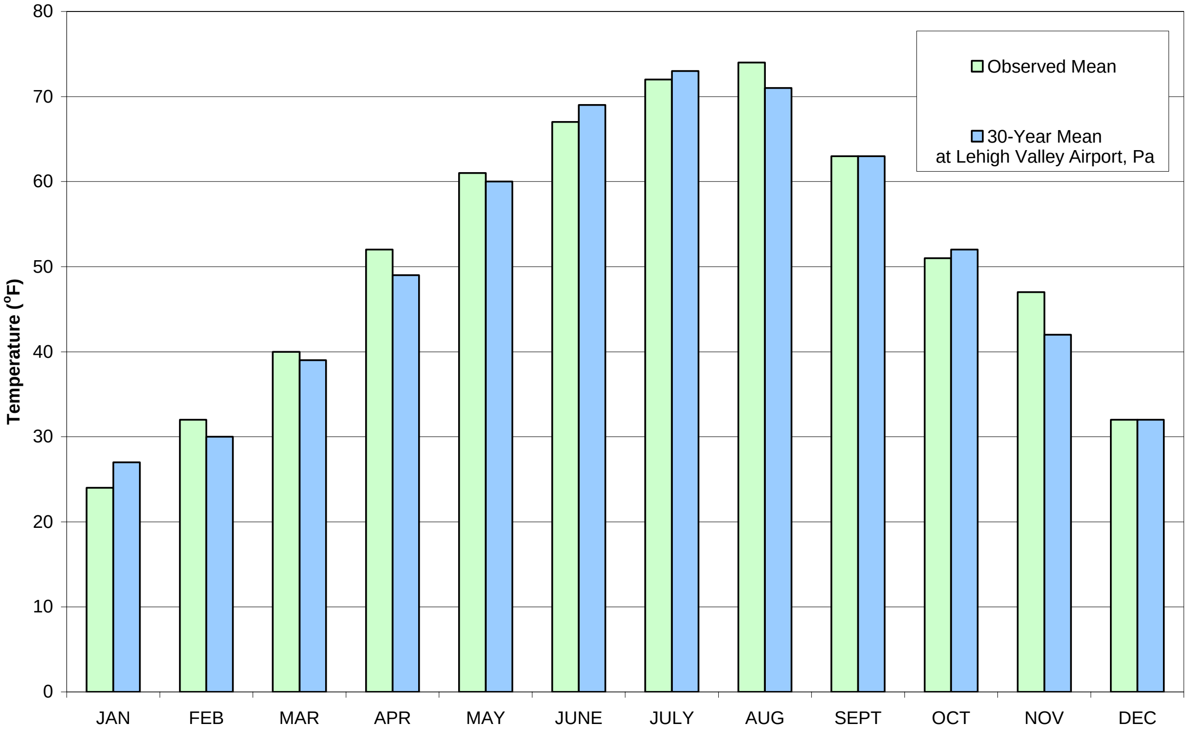


TABLE 2

SUMMARY OF METEOROLOGICAL MONITORING DATA - 2009
CENTRAL NEW JERSEY

Rider University		JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Temperature:	Mean[1]	25/32	33/35	39/43	51/53	60/64	65/72	70/78	72/76	62/69	52/57	47/47	33/37	51/55
(°F)	Min	0	7	7	26	35	42	52	56	42	32	25	12	0
	Max	52	66	70	90	82	85	87	90	80	76	68	66	90
Relative	Mean	62.8	58.6	61.2	59.7	71.7	81.6	73.1	80.2	79.0	78.6	72.7	67.1	70.6
Humidity:	Min	24.7	22.8	15.2	16.7	14.4	26.6	30.9	40.7	32.6	33.3	24.7	28.0	14.4
(%)	Max	99.6	98.4	99.2	98.5	99.3	99.3	98.8	99.2	99.4	99.8	100.0	99.4	100.0
Solar Radiation:	Mean	0.091	0.150	0.190	0.247	0.265	0.254	0.328	0.272	0.214	0.139	0.098	0.082	0.194
(Langleys)	Max	0.738	0.900	1.144	1.227	1.323	1.329	1.325	1.266	1.164	0.946	0.748	0.585	1.329
Barometric	Mean	30.21	30.24	30.35	30.15	30.22	30.03	30.11	30.18	30.27	30.21	30.28	30.25	30.21
Pressure	Min	29.28	29.50	29.41	29.26	29.71	29.63	29.82	29.86	29.60	29.68	29.61	29.34	29.26
(in of Hg)	Max	30.81	30.70	30.79	30.71	30.69	30.47	30.54	30.45	30.57	30.60	30.66	30.76	30.81
Precipitation	Historical[2]	3.52	2.74	3.81	3.49	3.89	3.29	4.39	3.82	3.88	2.75	3.16	3.31	42.05
(inches)	Observed[3]	3.93	0.89	1.63	6.26	3.72	4.25	2.68	9.31	4.83	1.65	1.97	8.63	49.75

1) Philadelphia International Airport 30 year mean shown to the right of the slash.
2) Historical monthly precipitation data for Philadelphia International Airport
3) Observed monthly precipitation collected by NJDEP at Ancora State Hospital

Figure 7
2009 Maximum, Mean and Minimum Temperatures, Rider University

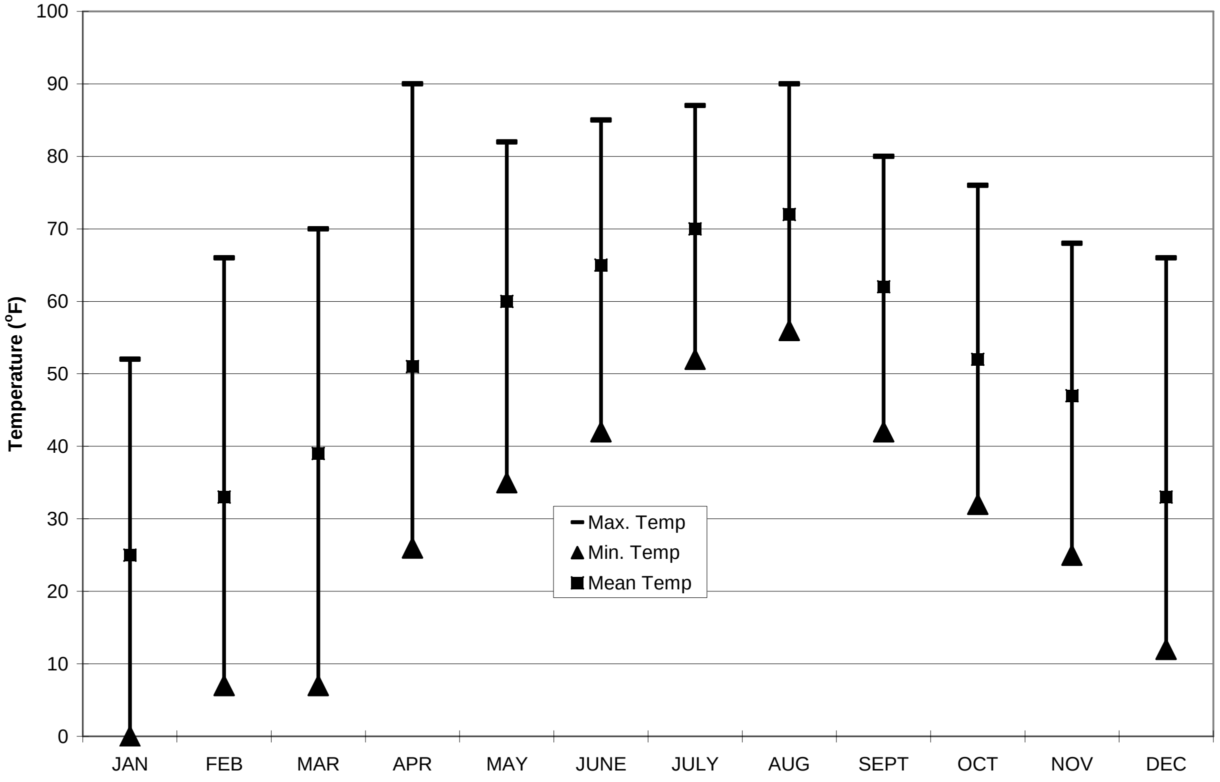
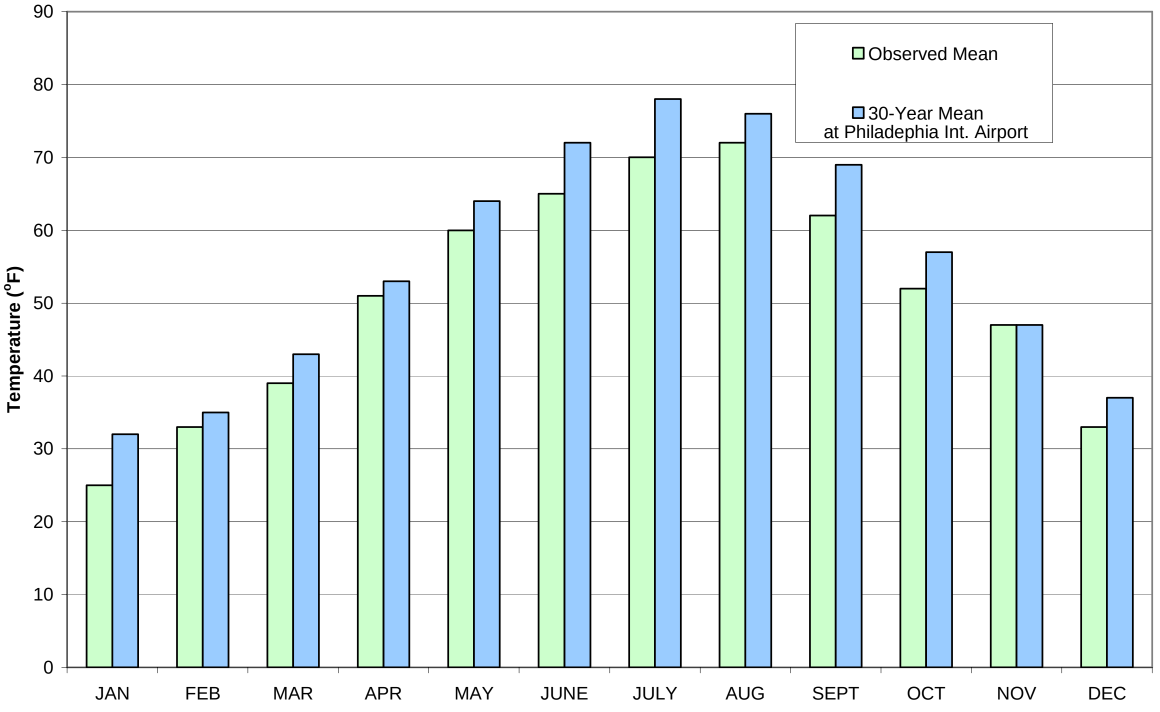


Figure 8
2009 Observed vs. 30-Year Mean Temperatures, Rider University



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Basic Air Pollution Meteorology, United States Environmental Protection Agency (USEPA), URL: http://yosemite.epa.gov/oaqps/eogtrain.nsf/DisplayView/SI_409_0-5?OpenDocument

Appendix A

2009 Air Monitoring Sites

New Jersey Department of Environmental Protection

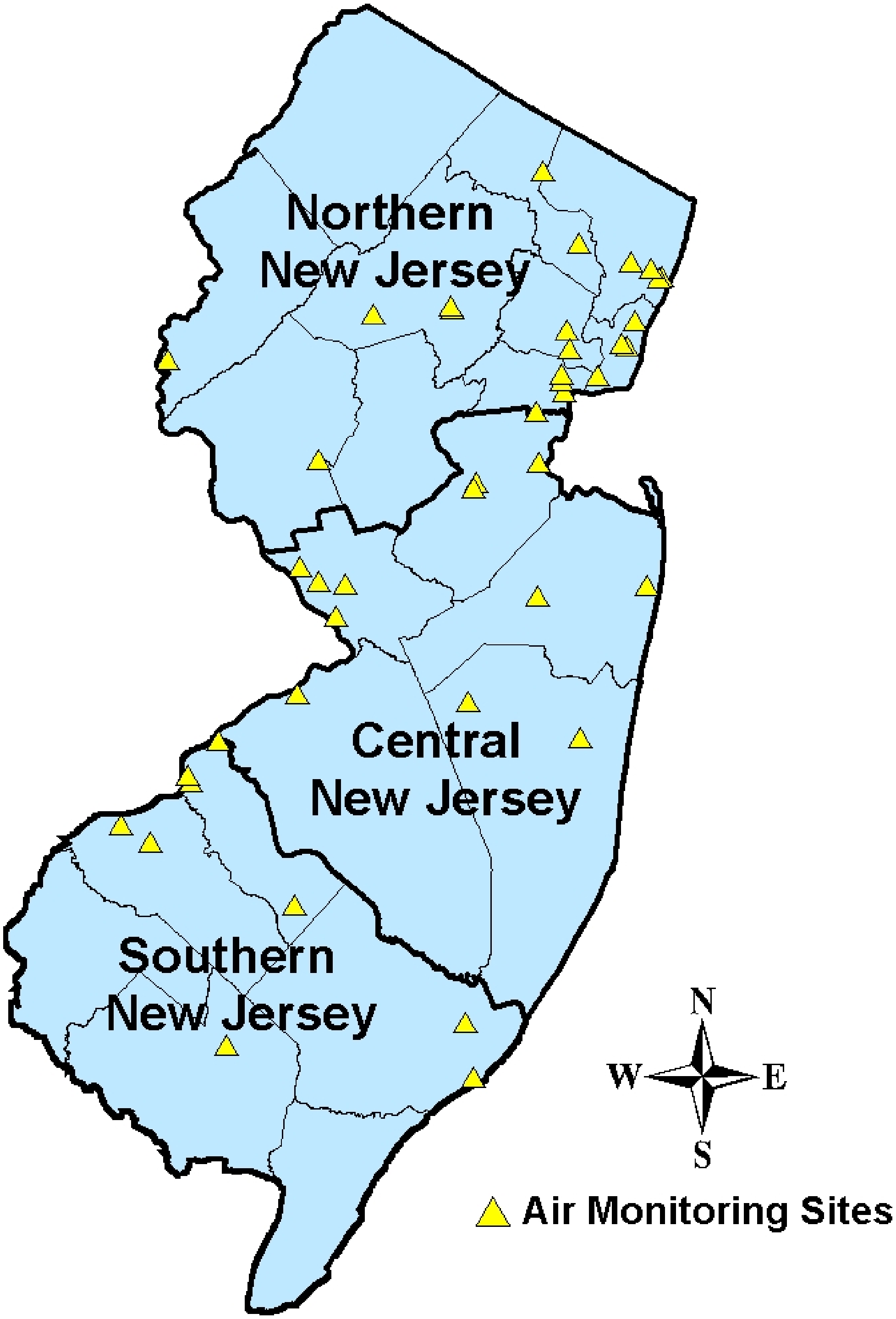

Figure 1
Northern New Jersey
Air Monitoring Sites

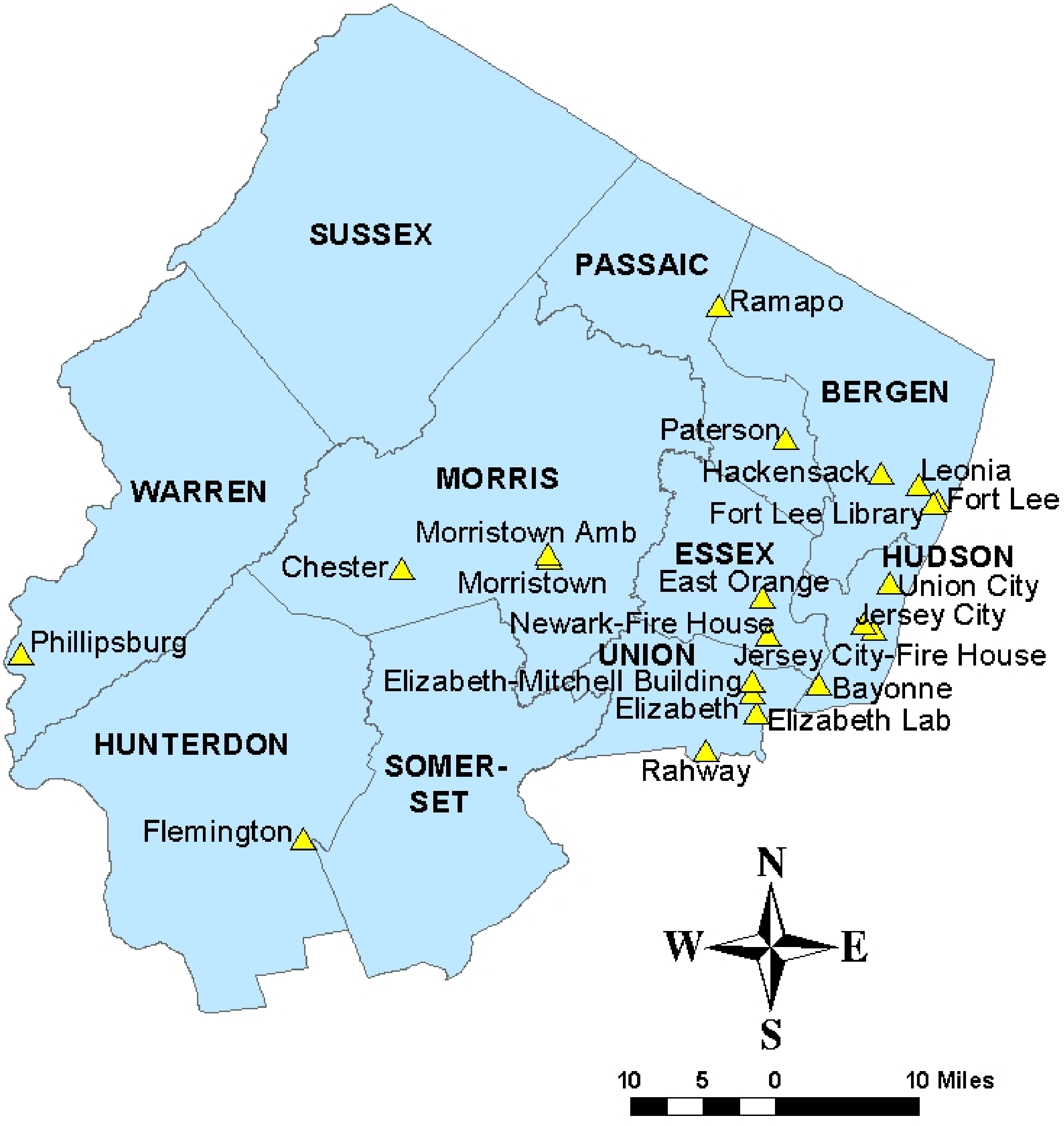

Table 1
Northern New Jersey Air Monitoring Sites

County	Monitoring Site	AIRS Code	Parameter(s) Measured[1]	Coordinates (Decimal degrees)		Address
				Latitude	Longitude	
BERGEN	Fort Lee	34 003 0004	CO, TEOM, PM_{10}	40.854583	-73.967772	Lemoine Avenue Overpass over I-95
	Fort Lee-Library	34 003 0003	$PM_{2.5}$	40.852256	- 73.973314	Fort Lee Public Library, 320 Main Street
	Hackensack	34 003 5001	CO, SO_2, SS	40.882373	- 74.042172	133 River St. near Moore & Mercer Streets
	Leonia	34 003 0006	NO_x, O_3	40.870422	-73.992053	Overpeck Park, 40 Fort Lee Road
ESSEX	East Orange	34 013 1003	CO, NO_x, MET	40.757501	- 74.200500	Engine No. 2, Dr. Martin Luther King Blvd. (Main Street) & Greenwood Ave.
	Newark-Fire House	34 013 0003	CO, O_3 , SO_2, TEOM, $PM_{2.5}$	40.721019	-74.192808	Firehouse, 360 Clinton Ave.
HUDSON	Bayonne	34 017 0006	NO_x, O_3, SO_2	40.670250	- 74.126081	Veterans Park, 25th St. near Park Road
	Jersey City	34 017 1002	CO, SO_2, SS	40.731690	- 74.066566	2828 Kennedy Blvd.
	Jersey City-Firehouse	34 017 1003	$PM_{2.5}$, PM_{10}, TEOM	40.725454	- 74.052290	Firehouse, 355 Newark Ave.
	Union City	34 017 2002	$PM_{2.5}$	40.772793	-74.031718	Health Department, 714 31st Street
HUNTERDON	Flemington	34 019 0001	O_3, MET, TEOM	40.515253	-74.806753	Raritan Twp. MUA, 365 Old York Road
MORRIS	Chester	34 027 3001	NO_x, O_3, SO_2, MET, $PM_{2.5}$, TOXICS	40.787628	- 74.676301	Bldg. #1, Lucent Tech., Route 513
	Morristown	34 027 0003	CO, SS	40.797342	-74.482494	11 Washington St.
	Morristown-Ambulance Squad	34 027 0004	$PM_{2.5}$	40.801211	- 74.483433	Ambulance Squad, 16 Early St.
PASSAIC	Paterson	34 031 0005	$PM_{2.5}$	40.918381	-74.168092	Health Department, 176 Broadway Ave.
	Ramapo	34 031 5001	O_3	41.058572	- 74.255419	Access Road, off Skyline Drive, Wanaque Borough
UNION	Elizabeth	34 039 0003	CO, SO_2, SS	40.662451	- 74.214745	7 Broad St.
	Elizabeth Lab	34 039 0004	CO, NO_x, SO_2, SS, TEOM, MET, $PM_{2.5}$, TOXICS	40.641440	- 74.208365	Interchange 13, NJTP
	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	Phillipsburg	34 041 0006	$PM_{2.5}$	40.699207	- 75.180525	Municipal Bldg., 675 Corliss Avenue

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

Figure 2
Central New Jersey
Air Monitoring Sites

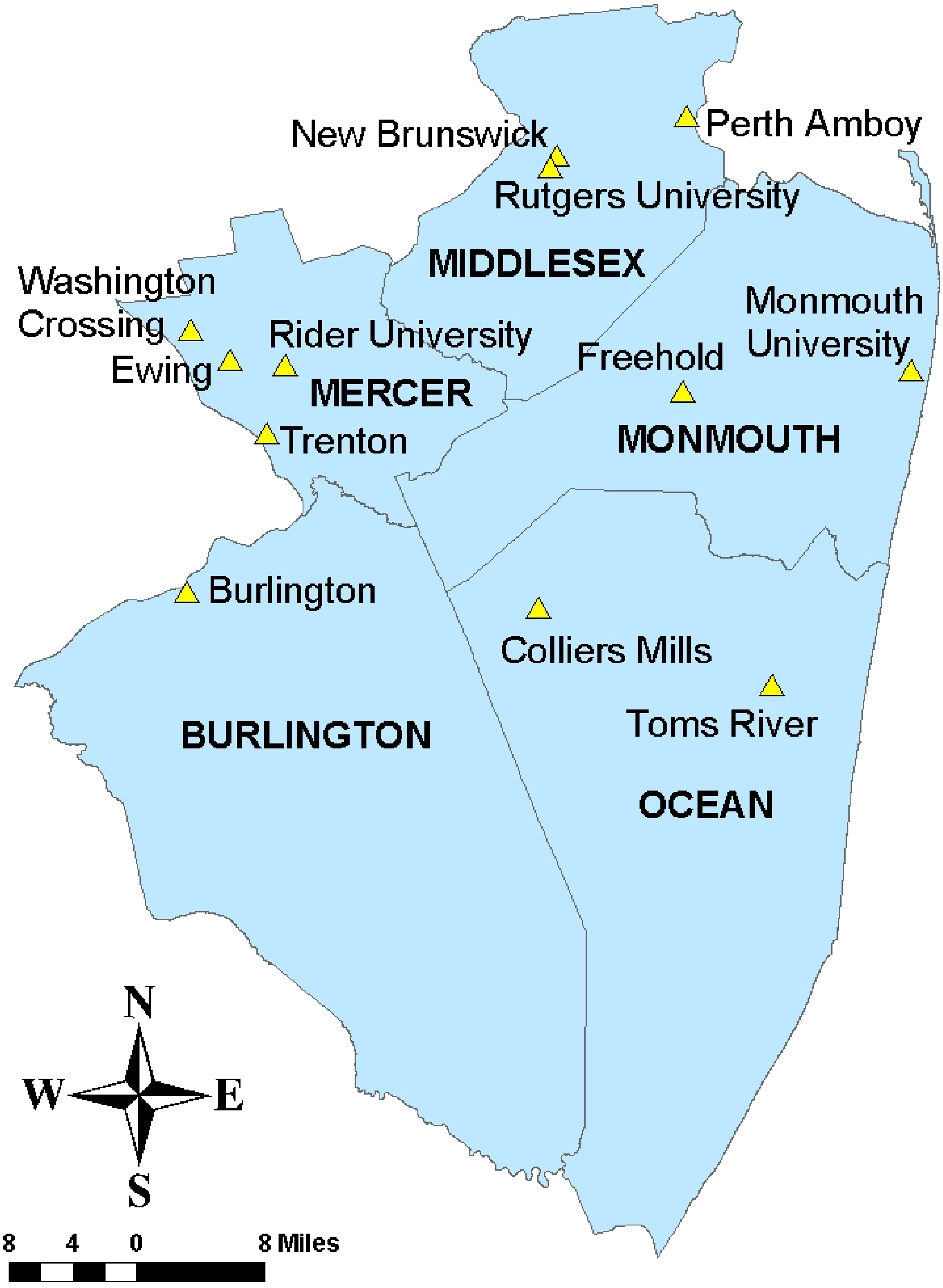

Table 2
Central New Jersey Air Monitoring Sites

County	Monitoring Site	AIRS Code	Parameter(s) Measured[1]	Coordinates (Decimal degrees)		Address
				Latitude	Longitude	
BURLINGTON	Burlington	34 005 1001	CO, SO_2, SS	40.078062	- 74.857717	1 East Broad Street
MERCER	Ewing	34 021 0010	TEOM	40.287530	-74.807770	Bureau of Air Monitoring Technical Center, 380 Scotch Road, West Trenton
	Rider University	34 021 0005	NO_x, O_3, PAMS, MET	40.283092	-74.742644	Athletic Fields, Route 206 South, Lawrenceville
	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, off Church Road, Titusville
MIDDLESEX	New Brunswick	34 023 0006	TEOM, $PM_{2.5}$, TOXICS	40.472786	- 74.422515	Cook College, Log Cabin Road
	Perth Amboy	34 023 2003	CO, SO_2, SS	40.508764	-74.268083	130 Smith Street, Perth Amboy
	Rutgers University	34 023 0011	NO_x, O_3, MET, PAMS	40.462182	- 74.429439	Horticultural Farm #3, off Ryder's Lane, New Brunswick
MONMOUTH	Freehold	34 025 2001	CO, SS	40.259895	- 74.274689	5 West Main Street
	Monmouth University	34 025 0005	O_3	40.278461	- 74.005343	Edison Science Bldg., 400 Cedar Ave., West Long Branch
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	Elementary School, 1517 Hooper Avenue

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

Figure 3
Southern New Jersey
Air Monitoring Sites

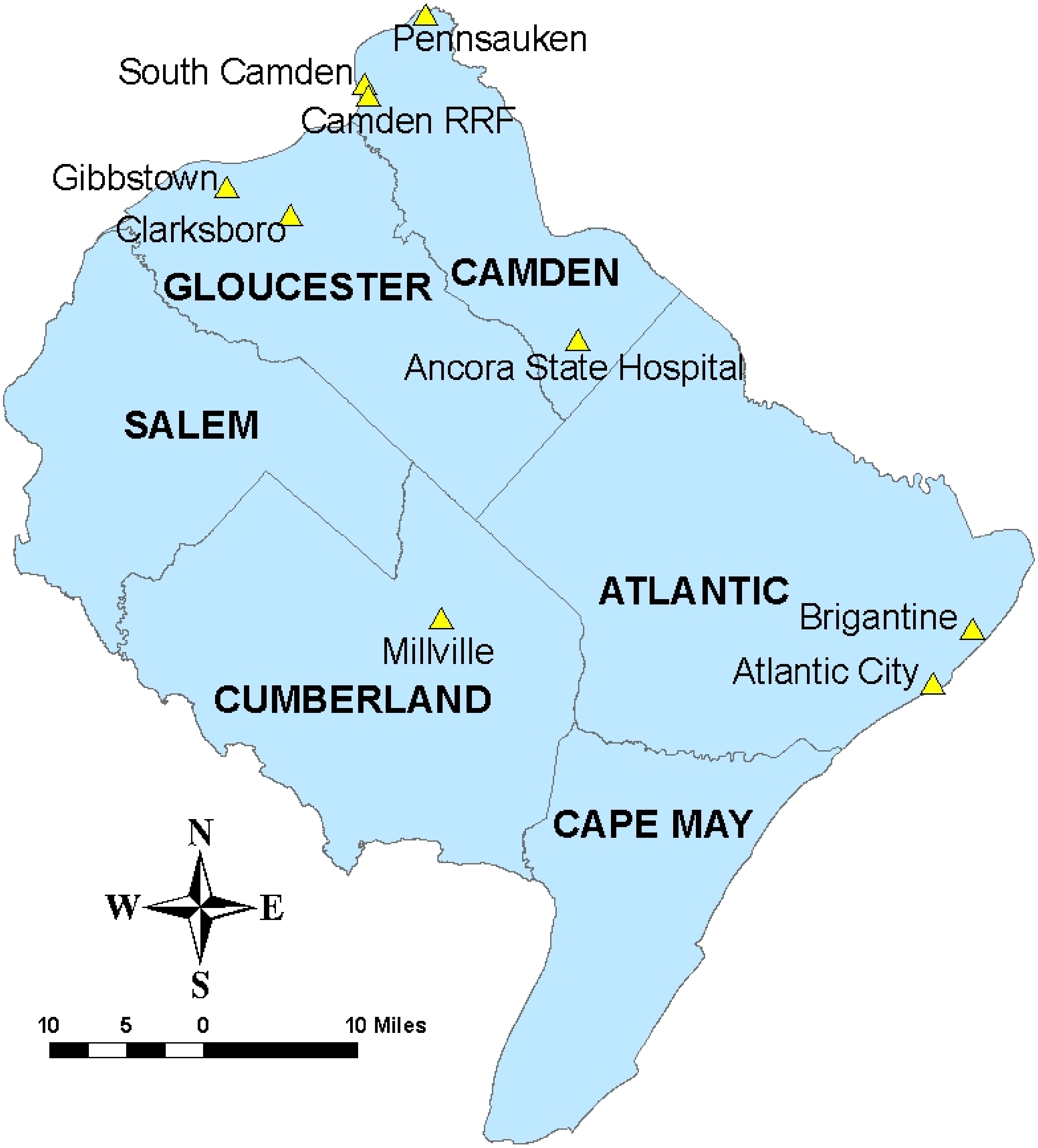

Table 3
Southern New Jersey Air Monitoring Sites

County	Monitoring Site	AIRS Code	Parameter(s) Measured[1]	Coordinates (Decimal degrees)		Address
				Latitude	Longitude	
ATLANTIC	Atlantic City	34 001 1006	$PM_{2.5}$, PM_{10}	39.363528	-74.431219	Atlantic-Cape May Community College, 1535 Bacharach Blvd., Atlantic City
	Brigantine	34 001 0006	O_3, SO_2,TEOM, $PM_{2.5}$, ACID	39.464872	-74.448736	Edwin Forsythe National Wildlife Refuge Visitor Center, Great Creek Road
CAMDEN	Ancora State Hospital	34 007 1001	CO, O_3, SO_2, ACID	39.684250	- 74.861491	Ancora State Hospital, 202 Spring Garden Road, Hammonton
	South Camden	34 007 0010	TEOM	39.923969	-75.122317	Camden County Sewage Treatment Plant, 1645 Ferry Avenue
	Camden-RRF	34 007 0009	PM_{10}	39.912431	- 75.116864	Camden RRF, Morgan Blvd. & I-676
	Pennsauken	34 007 1007	$PM_{2.5}$	39.989036	-75.050008	Morris-Delair WTP, near Griffith Morgan Lane
CUMBERLAND	Millville	34 011 0007	NO_x, O_3, SO_2 ,TEOM	39.422273	- 75.025204	Lincoln Avenue & Route 55
GLOUCESTER	Clarksboro	34 015 0002	O_3, SO_2	39.800339	-75.212119	Clarksboro Shady Lane Rest Home, County House Road
	Gibbstown	34 015 0004	$PM_{2.5}$	39.830809	-75.284720	Municipal Maintenance Yard, North School Street

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

Table 4
Parameter Codes

ACID	Acid Deposition	$PM_{2.5}$	Fine Particles (2.5 Microns or less) collected by a Federal Reference Method $PM_{2.5}$ Sampler
CO	Carbon Monoxide	TEOM	Continuous $PM_{2.5}$ Analyzer
MET	Meteorological Parameters	SO_2	Sulfur Dioxide
NO_x	Nitrogen Dioxide and Nitric Oxide	SS	Smoke Shade
O_3	Ozone	TOXICS	Air Toxics
PAMS	Photochemical Assessment Monitoring Station	TSP	Total Suspended Particulates
PM_{10}	Coarse Particles (10 Microns or less) collected by a Federal Reference Method PM_{10} Sampler		

Appendix B

Fine Particulate Speciation Summary- 2009

New Jersey Department of Environmental Protection

Table 1
Fine Particulate Speciation Data – 2009
Chester, New Jersey

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

Pollutant	Annual Average Concentration	Daily Average Maximum Concentration	Daily Average 2nd Highest Concentration
Aluminum	0.0201	0.2303	0.1915
Ammonium	0.8710	3.3744	3.0015
Antimony	0.0040	0.0921	0.0724
Arsenic	0.0003	0.0036	0.0024
Barium	0.0001	0.0043	0.0034
Bromine	0.0019	0.0099	0.0083
Cadmium	0.0023	0.0233	0.0222
Calcium	0.0111	0.1252	0.0424
Cerium	0.0001	0.0034	0.0019
Cesium	0.0009	0.0115	0.0090
Chlorine	0.0081	0.1780	0.1613
Chromium	0.0019	0.0341	0.0137
Cobalt	0.0003	0.0020	0.0014
Copper	0.0014	0.0133	0.0128
Elemental carbon **	0.2592	0.6424	0.6042
Europium *	0.0005	0.0073	0.0002
Gallium *	0.0001	0.0006	0.0002
Gold *	0.0005	0.0030	0.0022
Hafnium *	0.0010	0.0072	0.0030
Indium	0.0020	0.0292	0.0198
Iridium *	0.0001	0.0019	0.0001
Iron	0.0284	0.1403	0.0758
Lanthanum *	0.0005	0.0060	0.0016
Lead	0.0012	0.0065	0.0062
Magnesium	0.0013	0.0219	0.0129
Manganese	0.0007	0.0039	0.0033
Mercury *	0.0009	0.0067	0.0064
Molybdenum *	0.0000	0.0001	0.0000
Nickel	0.0012	0.0099	0.0069
Niobium *	0.0004	0.0038	0.0015
Nitrate	0.8957	5.9144	5.6407
Organic carbon **	2.6178	10.0994	7.3078

Table 1 (Continued)
Fine Particulate Speciation Data – 2009
Chester, New Jersey

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

Pollutant	Annual Average Concentration	Daily Average Maximum Concentration	Daily Average 2nd Highest Concentration
Phosphorus	0.0000	0.0007	0.0004
Potassium	0.0285	0.1157	0.1106
Rubidium	0.0002	0.0026	0.0017
Samarium *	0.0005	0.0043	0.0012
Scandium *	0.0001	0.0013	0.0004
Selenium	0.0003	0.0022	0.0022
Silicon	0.0277	0.0886	0.0857
Silver	0.0018	0.0152	0.0151
Sodium	0.0917	1.2216	0.5725
Strontium	0.0004	0.0088	0.0055
Sulfate	2.0824	9.9655	8.1209
Sulfur	0.6883	3.4026	3.1155
Tantalum *	0.0001	0.0014	0.0004
Terbium *	0.0001	0.0015	0.0000
Tin	0.0028	0.0455	0.0373
Titanium	0.0005	0.0039	0.0036
Total mass	7.7117	22.6804	21.8602
Vanadium	0.0004	0.0047	0.0040
Wolfram *	0.0004	0.0058	0.0000
Yttrium *	0.0002	0.0019	0.0006
Zinc	0.0036	0.0183	0.0147
Zirconium	0.0005	0.0222	0.0093

***** Analyses for these elements were discontinued in February 2009.

** Sampling method for Elemental and Organic Carbon changed in October 2009.

Table 2
Fine Particulate Speciation Data – 2009
Elizabeth Lab, New Jersey

Concentrations in Micrograms Per Cubic Meter (μg/m^3)

Pollutant	Annual Average Concentration	Daily Average Maximum Concentration	Daily Average 2nd Highest Concentration
Aluminum	0.0370	0.2789	0.1631
Ammonium	1.2702	4.1607	3.9621
Antimony	0.0049	0.0558	0.0504
Arsenic	0.0004	0.0031	0.0026
Barium	0.0020	0.0545	0.0129
Bromine	0.0029	0.0098	0.0097
Cadmium	0.0020	0.0209	0.0174
Calcium	0.0325	0.1981	0.1320
Cerium	0.0002	0.0117	0.0058
Cesium	0.0007	0.0105	0.0078
Chlorine	0.0337	0.4101	0.3692
Chromium	0.0039	0.1797	0.0245
Cobalt	0.0006	0.0030	0.0024
Copper	0.0065	0.0365	0.0339
Elemental carbon **	1.3896	7.6205	5.4183
Europium *	0.0002	0.0017	0.0009
Gallium *	0.0000	0.0005	0.0000
Gold *	0.0005	0.0030	0.0022
Hafnium *	0.0006	0.0067	0.0019
Indium	0.0021	0.0201	0.0201
Iridium *	0.0004	0.0037	0.0012
Iron	0.1372	0.8607	0.8092
Lanthanum *	0.0005	0.0039	0.0024
Lead	0.0021	0.0162	0.0154
Magnesium	0.0054	0.0568	0.0525
Manganese	0.0019	0.0150	0.0105
Mercury *	0.0004	0.0016	0.0014
Molybdenum *	0.0002	0.0013	0.0010
Nickel	0.0036	0.0584	0.0159
Niobium *	0.0001	0.0016	0.0000
Nitrate	1.4992	7.7097	6.9492
Organic carbon **	3.9683	10.9127	10.5151
Phosphorus	0.0000	0.0039	0.0000
Potassium	0.0401	0.2328	0.1973
Rubidium	0.0002	0.0024	0.0023
Samarium *	0.0002	0.0029	0.0001
Scandium *	0.0001	0.0021	0.0000
Selenium	0.0003	0.0028	0.0023

Table 2 (Continued)
Fine Particulate Speciation Data – 2009
Elizabeth Lab, New Jersey

Concentrations in Micrograms Per Cubic Meter (μg/m^3)

Pollutant	Annual Average Concentration	Daily Average Maximum Concentration	Daily Average 2nd Highest Concentration
Silicon	0.0721	0.4197	0.2901
Silver	0.0016	0.0205	0.0128
Sodium	0.1364	0.5949	0.5060
Strontium	0.0009	0.0130	0.0109
Sulfate	2.4776	9.7694	7.9175
Sulfur	0.8520	3.3016	2.9982
Tantalum *	0.0004	0.0034	0.0023
Terbium *	0.0001	0.0015	0.0000
Tin	0.0028	0.0500	0.0407
Titanium	0.0028	0.0309	0.0228
Total mass	12.3599	38.9289	28.7067
Vanadium	0.0055	0.0400	0.0310
Wolfram *	0.0004	0.0055	0.0000
Yttrium *	0.0002	0.0008	0.0006
Zinc	0.0105	0.0572	0.0470
Zirconium	0.0006	0.0105	0.0105

***** Analyses for these elements were discontinued in February 2009.

** Sampling method for Elemental and Organic Carbon changed in October 2009.

Table 3
Fine Particulate Speciation Data – 2009
New Brunswick, New Jersey

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

Pollutant	Annual Average Concentration	Daily Average Maximum Concentration	Daily Average 2nd Highest Concentration
Aluminum	0.0301	0.1611	0.1359
Ammonium	1.0029	3.6188	3.4589
Antimony	0.0074	0.0630	0.0583
Arsenic	0.0004	0.0040	0.0027
Barium	0.0007	0.0197	0.0084
Bromine	0.0023	0.0091	0.0089
Cadmium	0.0023	0.0198	0.0187
Calcium	0.0206	0.0768	0.0550
Cerium	0.0001	0.0018	0.0016
Cesium	0.0013	0.0110	0.0085
Chlorine	0.0221	0.7495	0.2863
Chromium	0.0065	0.2488	0.0469
Cobalt	0.0005	0.0054	0.0020
Copper	0.0041	0.0291	0.0211
Elemental carbon **	0.4404	1.3326	1.2101
Europium *	0.0002	0.0026	0.0000
Gallium *	0.0000	0.0000	0.0000
Gold *	0.0001	0.0016	0.0003
Hafnium *	0.0001	0.0018	0.0000
Indium	0.0031	0.0269	0.0234
Iridium *	0.0005	0.0049	0.0014
Iron	0.0767	0.8756	0.1859
Lanthanum *	0.0001	0.0013	0.0000
Lead	0.0016	0.0087	0.0071
Magnesium	0.0035	0.0642	0.0511
Manganese	0.0014	0.0148	0.0091
Mercury *	0.0004	0.0057	0.0000
Molybdenum *	0.0000	0.0004	0.0000
Nickel	0.0027	0.0831	0.0128
Niobium *	0.0000	0.0000	0.0000
Nitrate	1.1902	7.4776	6.5308
Organic carbon **	3.0094	7.9624	7.5228
Phosphorus	0.0000	0.0009	0.0000
Potassium	0.0370	0.2025	0.1704
Rubidium	0.0002	0.0031	0.0019
Samarium *	0.0001	0.0009	0.0003
Scandium *	0.0000	0.0006	0.0000
Selenium	0.0005	0.0045	0.0036

Table 3 (Continued)
Fine Particulate Speciation Data – 2009
New Brunswick, New Jersey

Concentrations in Micrograms Per Cubic Meter (μg/m^3)

Pollutant	Annual Average Concentration	Daily Average Maximum Concentration	Daily Average 2nd Highest Concentration
Silicon	0.0471	0.2714	0.1591
Silver	0.0019	0.0187	0.0177
Sodium	0.1100	0.7395	0.6257
Strontium	0.0007	0.0120	0.0065
Sulfate	2.2381	9.9168	8.0463
Sulfur	0.7251	3.2836	2.8459
Tantalum *	0.0003	0.0035	0.0005
Terbium *	0.0000	0.0000	0.0000
Tin	0.0041	0.0373	0.0361
Titanium	0.0015	0.0098	0.0084
Total mass	9.2756	26.7894	24.6773
Vanadium	0.0007	0.0071	0.0069
Wolfram *	0.0001	0.0007	0.0000
Yttrium *	0.0001	0.0007	0.0005
Zinc	0.0056	0.0216	0.0202
Zirconium	0.0004	0.0093	0.0058

***** Analyses for these elements were discontinued in February 2009.

** Sampling method for Elemental and Organic Carbon changed in October 2009.