2010 Particulate Summary

New Jersey Department of Environmental Protection

Nature and Sources

Particulate air pollution is a complex mixture of organic and inorganic substances present in the atmosphere as either liquids or solids. Particulates may be as large as 70 microns in diameter or smaller than 1 micron in diameter. Most particulates are small enough that individual particles are undetectable by the human eye. Also, particulates may travel hundreds of miles suspended in the atmosphere from their sources before reaching ground level.

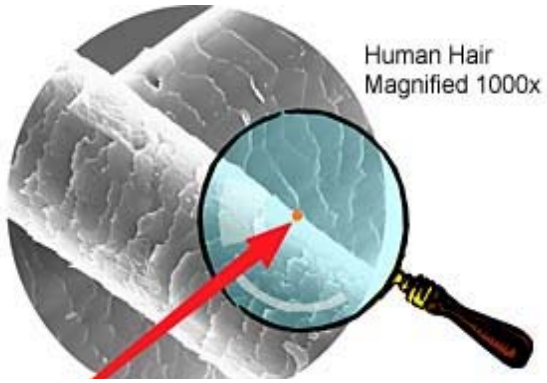
Generally particulate pollution is categorized by size. Particulates with diameters of 2.5 microns or less are considered Fine Particulates, often referred to as $PM_{2.5}$ (Figure 1). Particulates with diameters of 10 microns or less are considered to be Inhalable Particulates. Total Suspended Particulates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

Particulates can occur naturally or be man made. Examples of naturally occurring particulates are windblown dust and sea salt. Man made particulates 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 arithmethic 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 $\mu g/m^3$

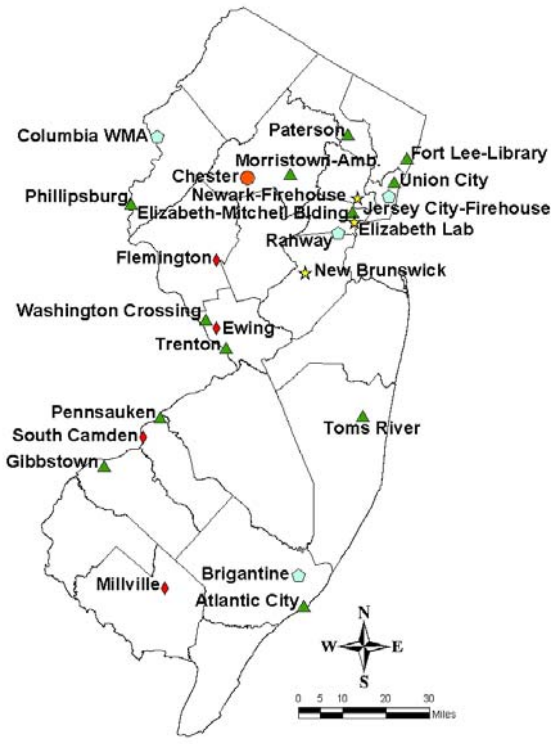
‡ Annual Geometric Mean
† Annual Arithmetic Mean

PARTICULATE MONITORING NETWORK

New Jersey's Particulate Monitoring Network consists of 24 $PM_{2.5}$ monitoring sites, 4 PM_{10} monitoring sites, and 7 sites where smoke shade is monitored.

20 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 four 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 Transmittance (TOT) to determine the concentrations of the chemical analytes that constitute the sample.

Figure 3
2010 $PM_{2.5}$
Monitoring Network



Fine Particulate Network

- Filter (FRM) and Speciation Sampler
- Filter (FRM), Continuous and Speciatio
- Filter (FRM) and Continuous
- Filter (FRM) Sampler

FINE PARTICLE SUMMARY

FINE PARTICLE MONITORING SITES

There are 20 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 September 2010, an FRM sampler and TEOM analyzer were established at the Columbia WMA monitoring station.

FINE PARTICLE CONCENTRATION SUMMARY

The annual mean concentration of $PM_{2.5}$ ranged from 7.4 $\mu g/m^3$ at New Brunswick to 10.6 $\mu g/m^3$ at Union City. The highest daily concentration ranged from 24.9 $\mu g/m^3$ at Gibbstown to 42.2 $\mu g/m^3$ at Union City. Figure 4 and Table 2 depict the mean and maximum concentrations at each site. Table 2 also shows the 2010 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 2008-2010. Design values are used to determine attainment status.

No sites were in violation of the annual standard of 15.0 $\mu g/m^3$. Ten monitoring sites measured exceedences of the 24-hour standard of 35 micrograms.

Figure 4
2010 Fine Particulate ($PM_{2.5}$) Concentration

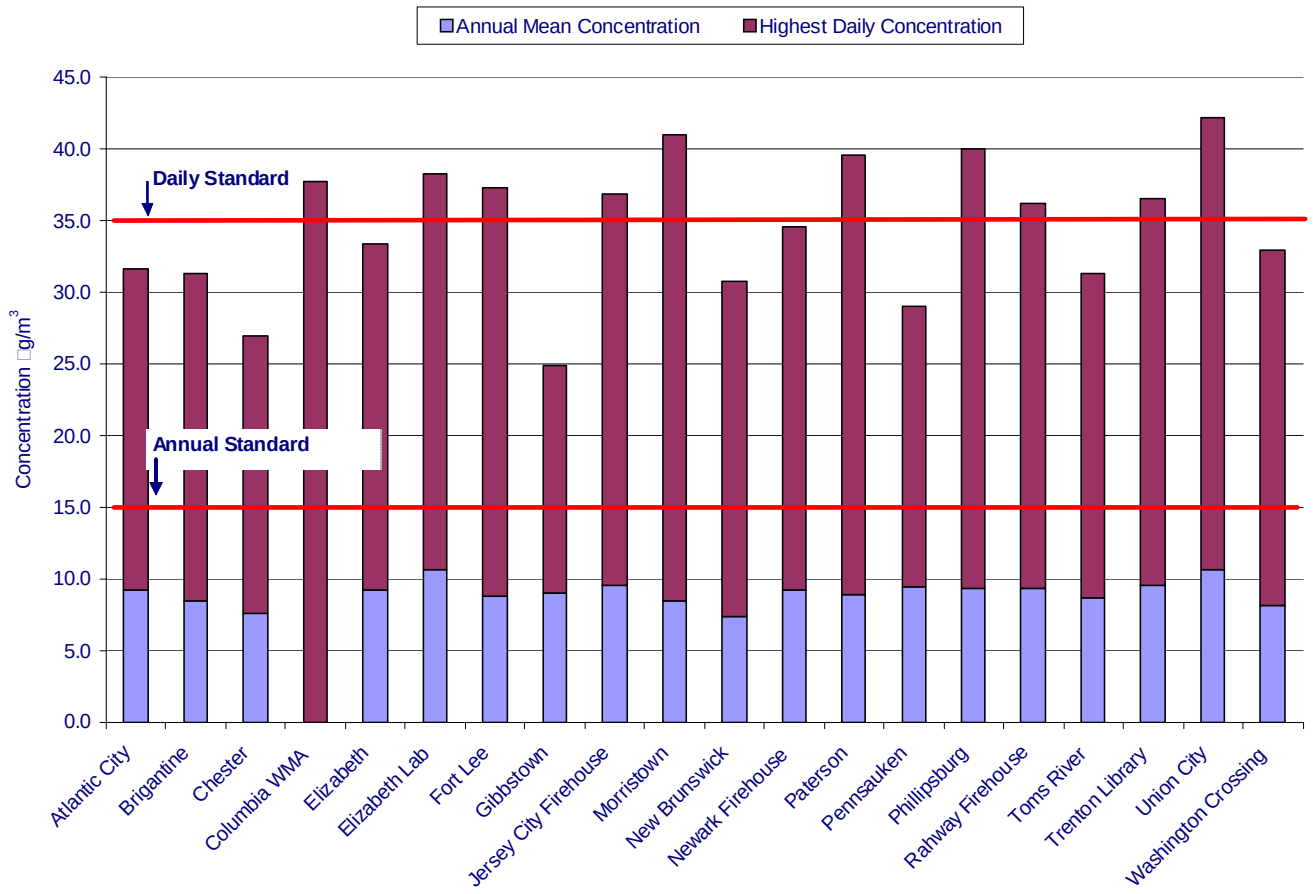


Table 2

2010 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	2010 Annual Average Design Values
Atlantic City	115	9.2	31.6	22.7	9.6
Brigantine	119	8.4	31.3	24.4	8.9
Chester	116	7.5	26.9	24.7	7.8
Columbia WMA *	78	----	37.7	29.7	----
Elizabeth	109	9.2	33.4	26.1	10.3
Elizabeth Lab	343	10.5	38.2	35.4	11.6
Fort Lee	120	8.8	37.3	25.1	9.8
Gibbstown	113	9.0	24.9	22.9	9.9
Jersey City Firehouse	347	9.5	36.8	33.2	10.6
Morristown	118	8.5	41.0	33.1	8.7
New Brunswick	118	7.4	30.7	23.2	8.8
Newark Firehouse*	118	9.1	34.5	27.6	----
Paterson	109	8.9	39.6	32.1	9.7
Pennsauken	117	9.4	29.0	25.2	10.2
Phillipsburg	114	9.3	40.0	26.1	9.7
Rahway Firehouse	117	9.3	36.2	27.0	10.2
Toms River	329	8.6	31.3	29.8	9.0
Trenton Library	360	9.5	36.5	35.3	10.0
Union City	112	10.6	42.2	27.4	11.5
Washington Crossing	108	8.1	32.9	19.5	8.7

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

Table 3

2010 Summary of Continuous $PM_{2.5}$ Data

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

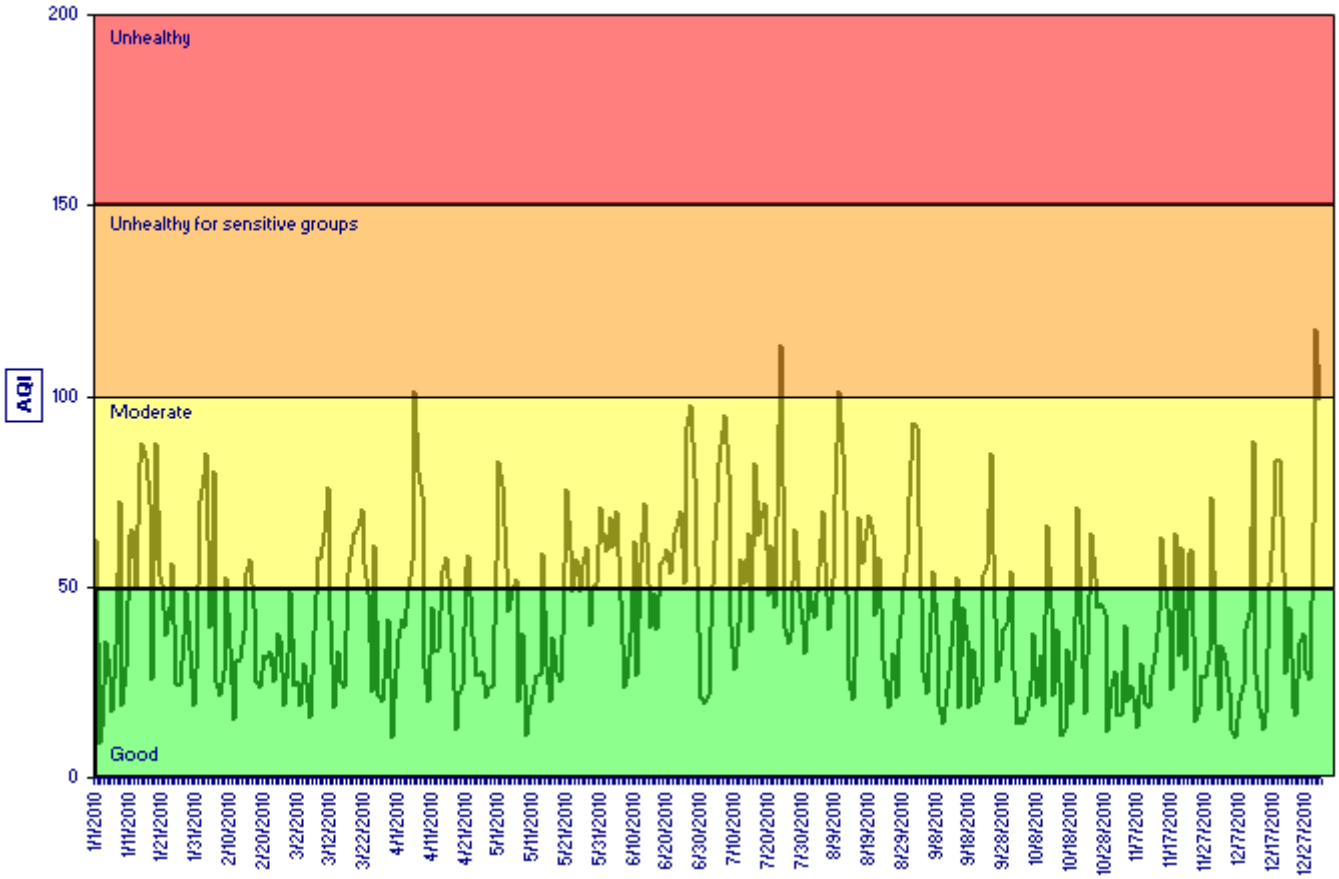
Monitoring Site	Annual Mean Concentration	Highest Daily Concentration	Second Highest Daily Concentration
Brigantine	8.0	30.1	28.9
Columbia WMA*	----	30.4	24.9
Elizabeth Lab	11.1	35.7	35.6
Ewing	8.3	30.2	27.1
Flemington	9.6	31.5	30.2
Jersey City Firehouse	10.2	35.3	35.0
Millville	8.5	32.3	31.8
New Brunswick	6.9	27.7	27.1
Newark Firehouse	8.5	27.7	25.6
Rahway	10.2	33.2	30.5
South Camden	10.4	37.7	32.2

*There was not enough data collected 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, Columbia WMA, Elizabeth Lab, Ewing, Flemington, Jersey City Firehouse, Millville, New Brunswick, Newark Firehouse, Rahway and South Camden. The data is transmitted once a minute to a central computer in Trenton, where it is averaged and automatically updated on the bureau's website every hour. Table 3 provides a summary of the data from these sites, and Figure 5 depicts the health level associated with the maximum daily fine particulate concentration recorded in the state each day for the entire year.

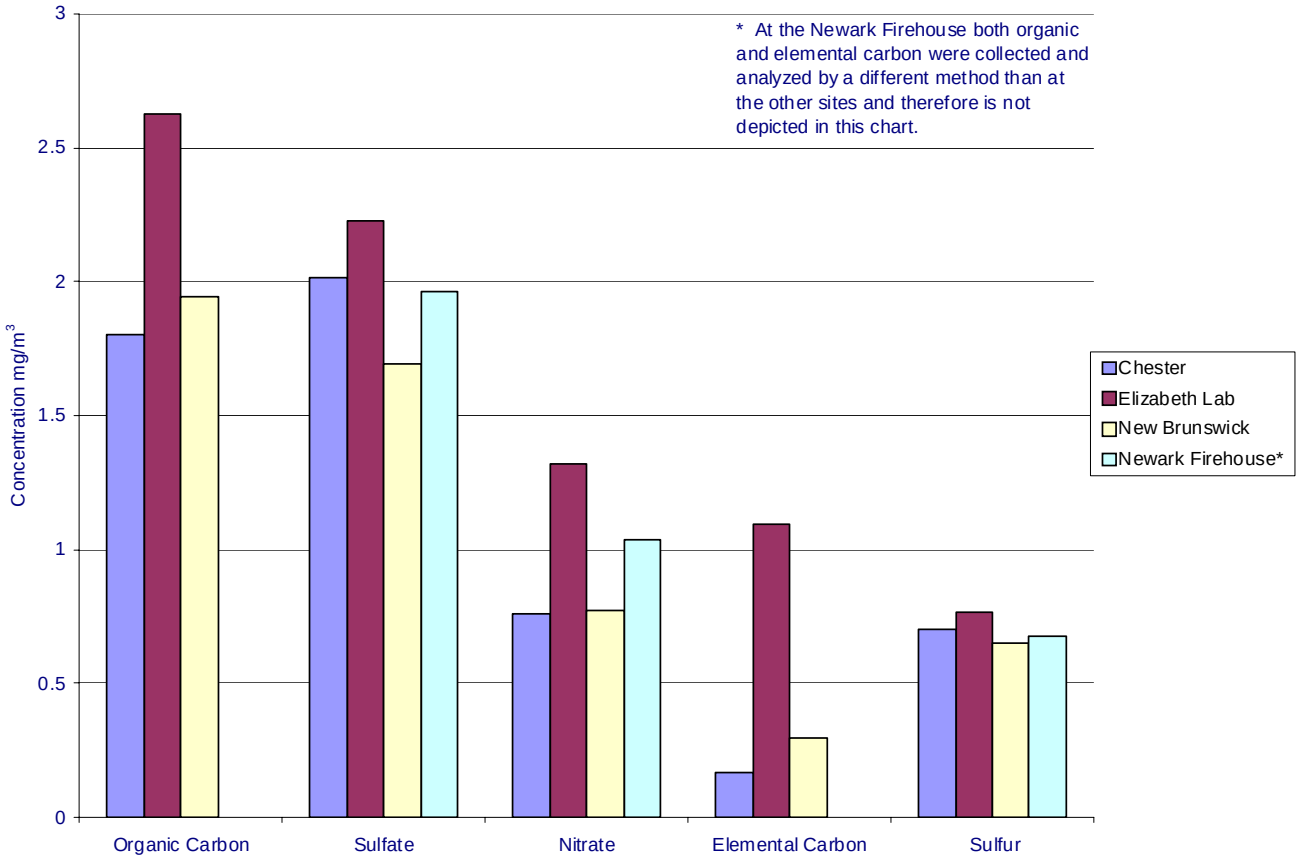
Figure 5
2010 Maximum Daily Fine Particulate Concentration
(Highest site)
Air Quality Index (AQI)



FINE PARTICLE SPECIATION SUMMARY

New Jersey's Fine Particulate Speciation Network consists of 4 monitoring sites: Elizabeth Lab, Newark Firehouse, New Brunswick, and Chester. Samplers run every third day on a schedule concurrent with the Federal Reference Method sampling network. Of the 39 measured analytes, organic carbon, sulfate, nitrate, sulfur and elemental carbon are the most prevalent species, 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 2010.

Figure 6
2010 Fine Particulate Analyte Composition
Annual Average
(Highest 5 Analytes Depicted)



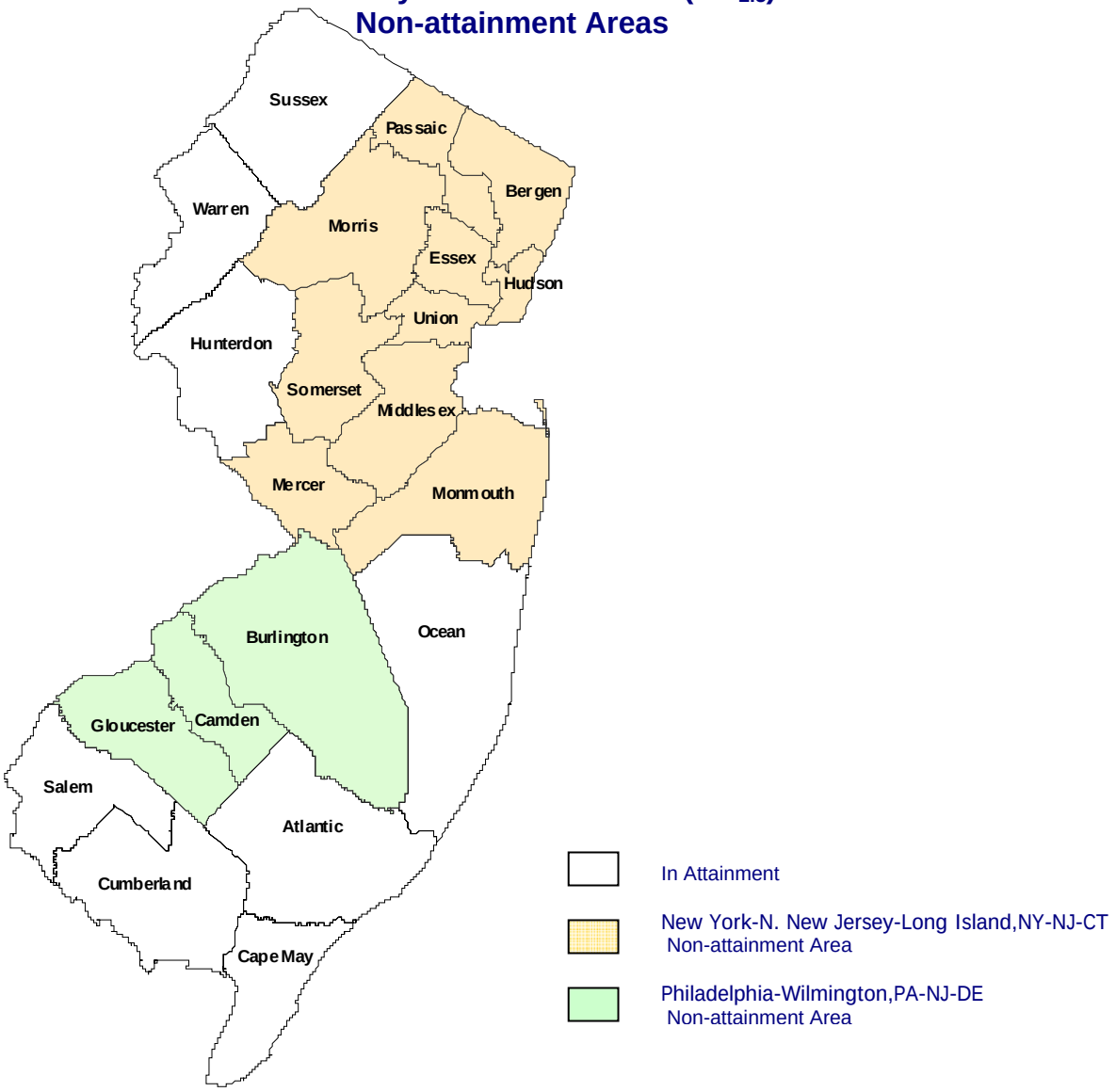
Fine Particulate Non-Attainment Areas

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 15.0 $\mu g/m^3$.

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



2010 Inhalable Particulate Summary

Inhalable Particulate Monitoring Sites

The Inhalable Particulate monitoring network is composed of 4 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. Figure 8 depicts the PM_{10} particulate monitoring network in New Jersey. The Atlantic City PM_{10} sampler was shutdown in March 2010.

PM_{10} Concentration Summary

In 2010, the annual mean concentration of PM_{10} ranged from 21$\mu g/m^3$ at Trenton to 30$\mu g/m^3$ 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 $\mu g/m^3$.

Figure 8
2010 PM_{10}
Monitoring Network

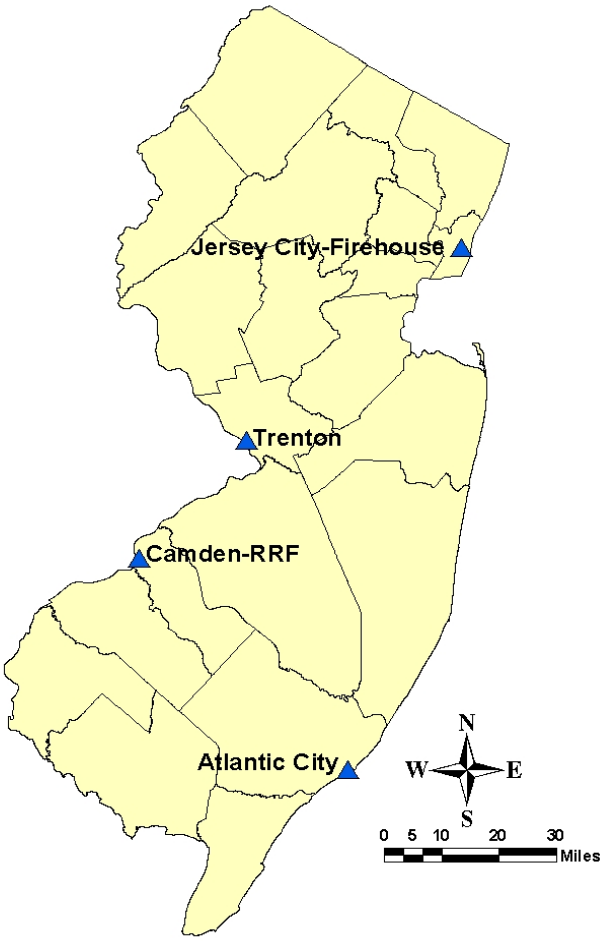


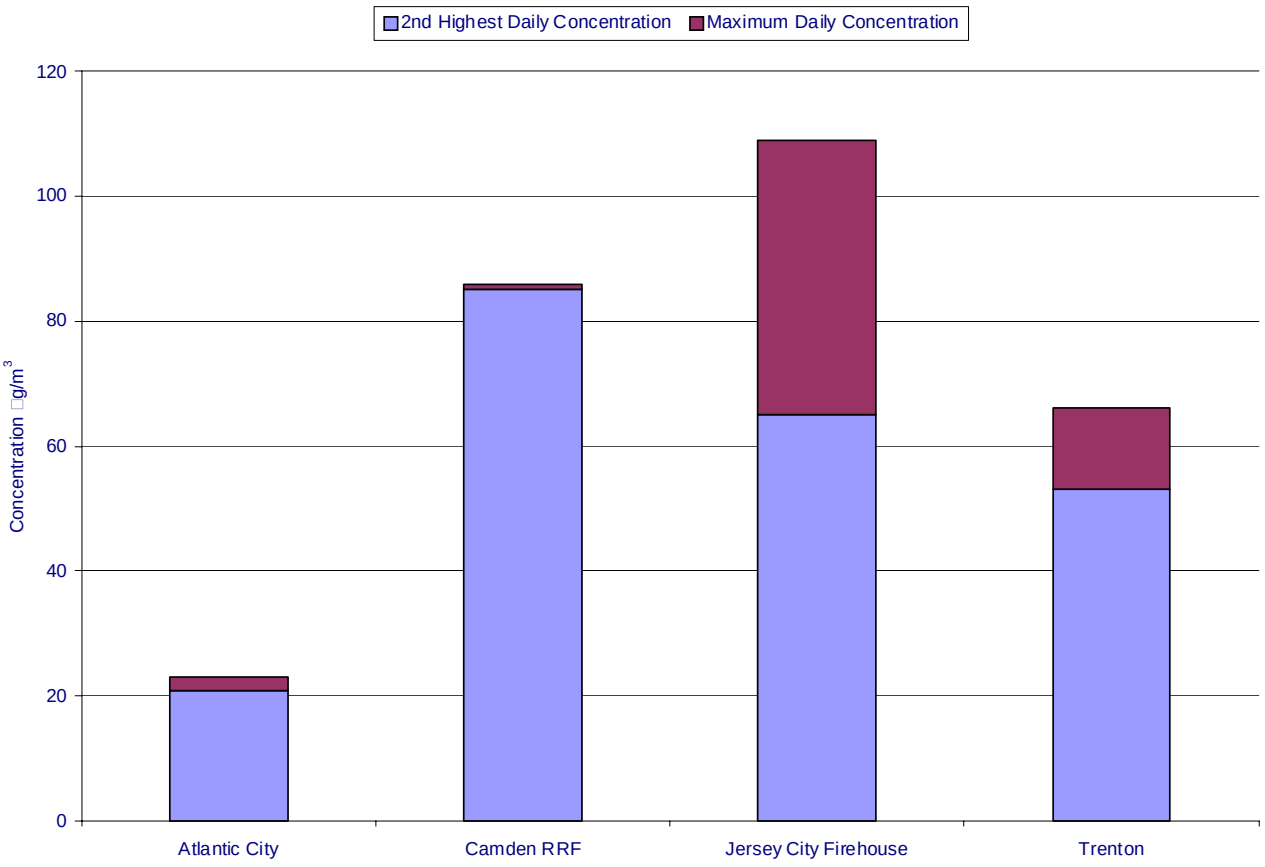
Table 4
PM_{10} Data - 2010
Daily and Annual Averages

Micrograms Per Cubic Meter ($\mu g/m^3$)
Daily Standard = 150 ($\mu g/m^3$)
Annual Standard = 50 $\mu g/m^3$

Monitoring Site	Number of Samples	Highest Daily Concentration	Second Highest Daily Concentration	Annual Mean
Atlantic City*	7	23	21	----
Camden RRF	59	86	85	30
Jersey City-Firehouse	51	109	65	29
Trenton	59	66	53	21

* Not enough data to calculate annual mean, sampler shutdown in March 2010

Figure 9
Summary of PM_{10} Concentrations, New Jersey 2010



SMOKE SHADE SUMMARY

SMOKE SHADE MONITORING SITES

In addition to fine and coarse particulate monitoring, smoke shade is also monitored at 7 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. As a result of the 2010 Network Assessment, the Freehold, Hackensack, Morristown, and Perth Amboy smoke shade analyzers were shut down on December 31, 2010 in order to save both time and resources.

SMOKE SHADE CONCENTRATION SUMMARY

In 2010, the annual mean concentration of smoke shade ranged from 0.15 Coefficient of Haze units (COH) at Hackensack to 0.35 COH at Jersey City. 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 2010.

Figure 10
2010 Smoke Shade Monitoring Network

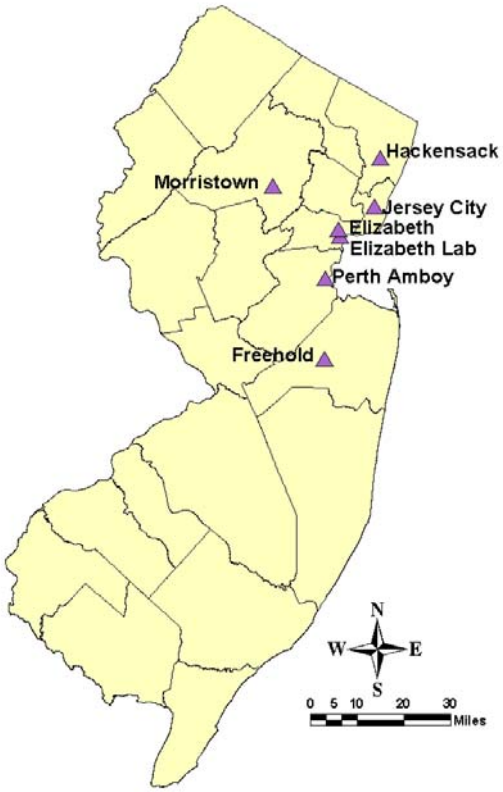


Table 5
Smoke Shade - 2010

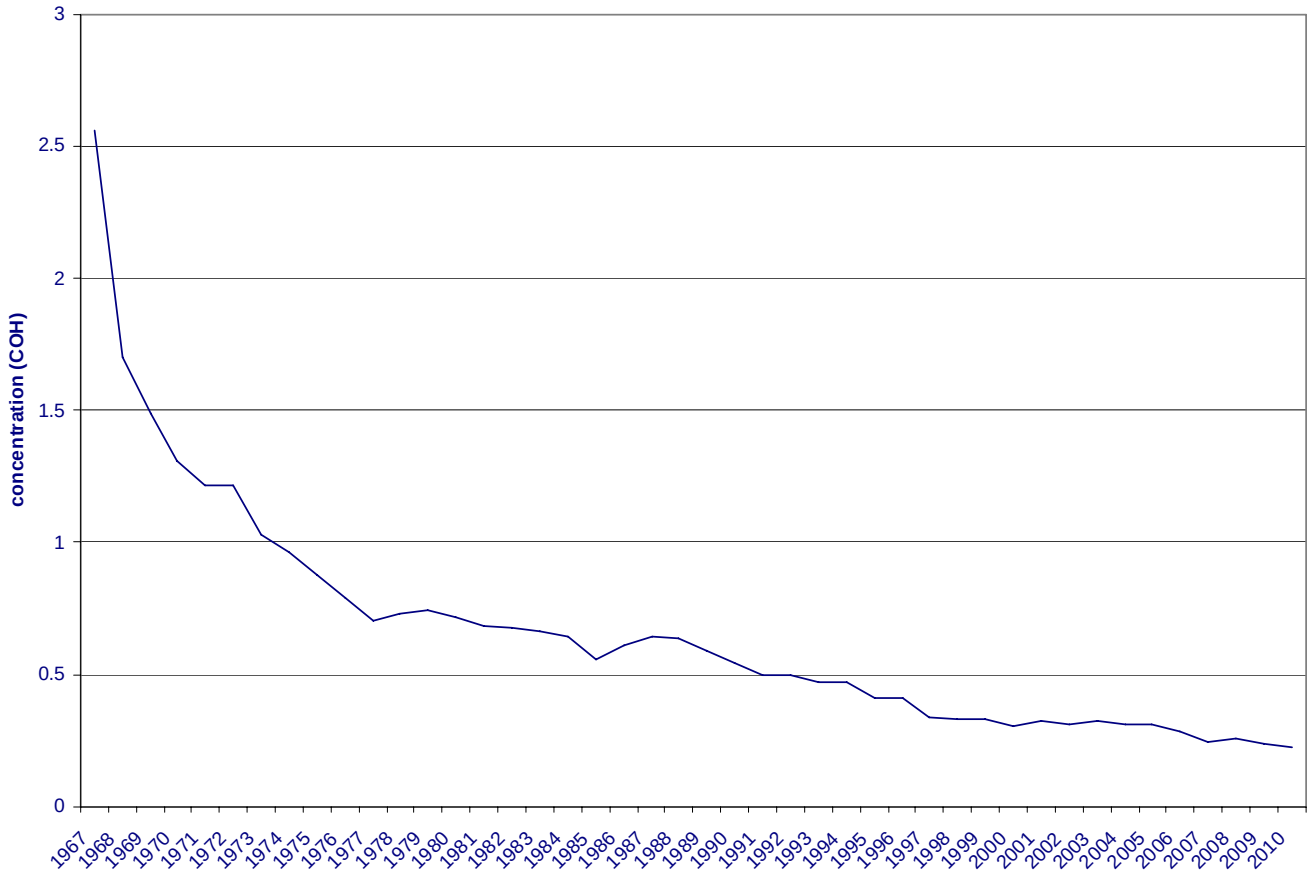
Coefficient of Haze (COHs)
No Standard

Site	Maximum Daily Average	2nd Highest Daily Average	Annual Mean
Elizabeth	0.70	0.52	0.18
Elizabeth Lab	1.12	0.99	0.32
Freehold	0.76	0.54	0.22
Hackensack	0.56	0.5	0.15
Jersey City	1.15	1.1	0.35
Morristown	0.58	0.54	0.17
Perth Amboy	0.63	0.61	0.19

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 7 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- 2010



REFERENCES

PM – How Particulate Matter Affects the Way We Live and Breathe, USEPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC November 2000, URL: www.epa.gov/air/urbanair/pm/index.html

Air Quality Criteria for Particulate Matter, USEPA, Office of Research and Development, EPA-600/P-99-002A and B, March 2001

Environmental Health Threats to Children, USEPA, Office of the Administrator, EPA-176/F-96-001, September 1996.

National Ambient Air Quality Standards for Particulate Matter, Final Rule, USEPA, Part 50 of Title 40 of the Code of Federal Regulations, July 1997.

National Air Quality and Emissions Trend Report, 1999, EPA-454/R-01-004, USEPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, March 2001, URL: www.epa.gov/airtrends/reports.html

Latest Findings on National Air Quality: 2000 Status and Trends, EPA-454/K-01-002, USEPA, Office of Air Quality Planning and Standards, Research Triangle Park, September 2001, URL: www.epa.gov/airtrends/reports.html