2001 Particulate Summary

New Jersey Department of Environmental Protection

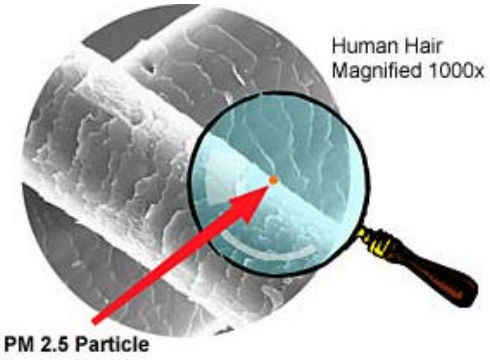
Nature and Sources

Particulate air pollution consists of both solid particles and liquid droplets suspended in the atmosphere. Suspended particles can range in size from 70 microns in diameter, approximately the size of a pinhead, to less than 1 micron in diameter. Particulates can be directly emitted, or they can form in the atmosphere from gaseous emissions, such as sulfur dioxide (SO_2) and oxides of nitrogen (NOx).

Particulate matter is generally categorized according to the size of the particles. Total Suspended Particulates (TSP) include all but the largest particles and were the basis for the first health standards for particulate matter. The human respiratory tract will usually trap particles above about 10 microns in diameter before they reach the lungs. Particles smaller than 10 microns (PM10) are considered to be inhalable and are generally considered to be more harmful to human health than larger particles.

Particles less than 2.5 microns in diameter are referred to as fine particulate matter or PM2.5 (See Figure 1). Coarse particles (defined here are particles larger than 2.5 microns) and fine particles have distinctly different sources and health and environmental effects. Coarse particle sources include windblown dust and industrial sources such as grinding operations, while fine particles come from sources such as fuel combustion, power plants, and diesel engines.

Figure 1



Graphics Courtesy of the US Department of Energy

Health Effects

Inhalable particles (PM10) and especially fine particles (PM2.5) are a health concern because they easily reach the deepest recesses of the lungs. When breathed, these particles can accumulate in the respiratory system and are associated with increased hospital admissions and emergency room visits for heart and lung disease, increased respiratory disease such as asthma, decreased lung function, and even premature death. Groups that appear to be at the greatest risk from particulates include children, the elderly, and individuals with cardiopulmonary disease such as asthma.

Environmental Effects

In addition to health effects, particulate matter is the major cause of reduced visibility in many parts of the United States. Figure 2 provides an example of reduced visibility recorded by our WebCam site in Newark (accessible via the internet at www.state.nj.us/dep/airmon). Airborne particles can also impact vegetation and aquatic ecosystems, and can cause damage to paints and building materials.

Figure 2

Visibility WebCam

STANDARDS

In 1971, EPA set primary (health based) and secondary (welfare based) standards for total suspended particulate matter (TSP). These standards established 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. EPA felt this was necessary because monitoring for TSP was intermitent – generally occuring only once every six days. Although New Jersey still maintains a state standard for TSP, the national standards have been replaced with standards for smaller particles as described below. As a result, monitoring for TSP has largely been discontinued, with the exception of two stations where TSP samples are taken in order to be analyzed for lead (Pb). See the Lead Summary section for more details.

In 1987, EPA replaced the TSP standards with standards that focused only on inhalable particles. Inhalable particles are defined as particles less than 10 microns in diameter (PM10). Particles larger than 10 microns are normally filtered out by the upper respiratory tract (nose and throat) and do not reach the lungs. The 24-hour PM10 standard was set at 150 $\mu g/m^3$ and the annual standard at 50 $\mu g/m^3$ was. The annual standard for PM10 is based on the arithmethic as opposed to the geometric mean that was used for TSP.

In 1997, EPA promulgated new standards for "fine" particulates, which it defined as particles less than 2.5 microns in diameter (PM2.5). They kept the existing standards for PM10 as well. Particles smaller than 2.5 microns come from combustion sources or are formed in the atmosphere from gasses. The PM2.5 annual standard concentration was set at 15 $\mu g/m^3$ and the 24-hour standard was set at 65 $\mu g/m^3$. Table 1 provides a summary of the Particulate Matter standards.

TABLE 1

NATIONAL AND NEW JERSEY

AMBIENT AIR QUALITY STANDARDS FOR PARTICULATE MATTER

STANDARD	AVERAGING PERIOD	TYPE	NEW JERSEY	NATIONAL
TOTAL	12-MONTH‡	PRIMARY	75 $\mu g/m^3$	- - -
SUSPENDED	24-HOUR	PRIMARY	260 $\mu g/m^3$	- - -
PARTICULATES	12-MONTH‡	SECONDARY	60 $\mu g/m^3$	- - -
	24-HOUR	SECONDARY	150 $\mu g/m^3$	- - -
INHALABLE	ANNUAL†	Primary	- - -	50 $\mu g/m^3$
PARTICULATES	24-HOUR AVERAGE	Primary	- - -	150 $\mu g/m^3$
FINE	ANNUAL†	Primary	- - -	15 $\mu g/m^3$
PARTICULATES	24-HOUR AVERAGE	Primary	- - -	65 $\mu g/m^3$

‡ ANNUAL GEOMETRIC MEAN

† ANNUAL ARITHMETIC MEAN

PARTICULATE MONITORING NETWORK

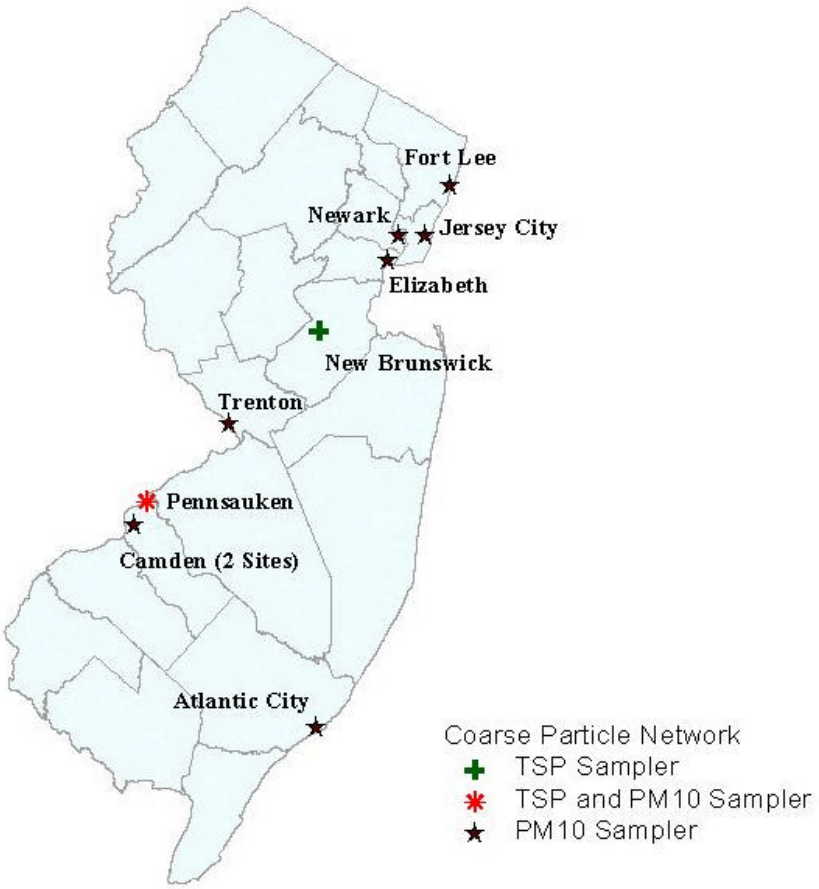
New Jersey's Particulate Monitoring Network consists of 20 fine particulate monitoring sites, 9 PM10 monitoring sites, 2 TSP monitoring sites, and 12 locations where smoke shade is monitored. Smoke shade is a measure of light transmittance that is used as a surrogate for particle concentrations. As most monitoring methods for particulates require that samples be collected and weighed, data are not available in real time. Smoke shade is a semi-continuous method that is near real-time and is used primarily for estimating particle levels for use in daily air quality index reporting.

COARSE PARTICLE MONITORING SITES

The coarse particulate monitoring network is composed of PM10 and TSP samplers located at 10 sites. Samples are collected on a filter, which is weighed before and after sampling. The amounts of Sulfate and Nitrate are measured on some PM10 samples and Lead is measured on the TSP samples. Figure 3 depicts the coarse particulate monitoring network in New Jersey.

Figure 3

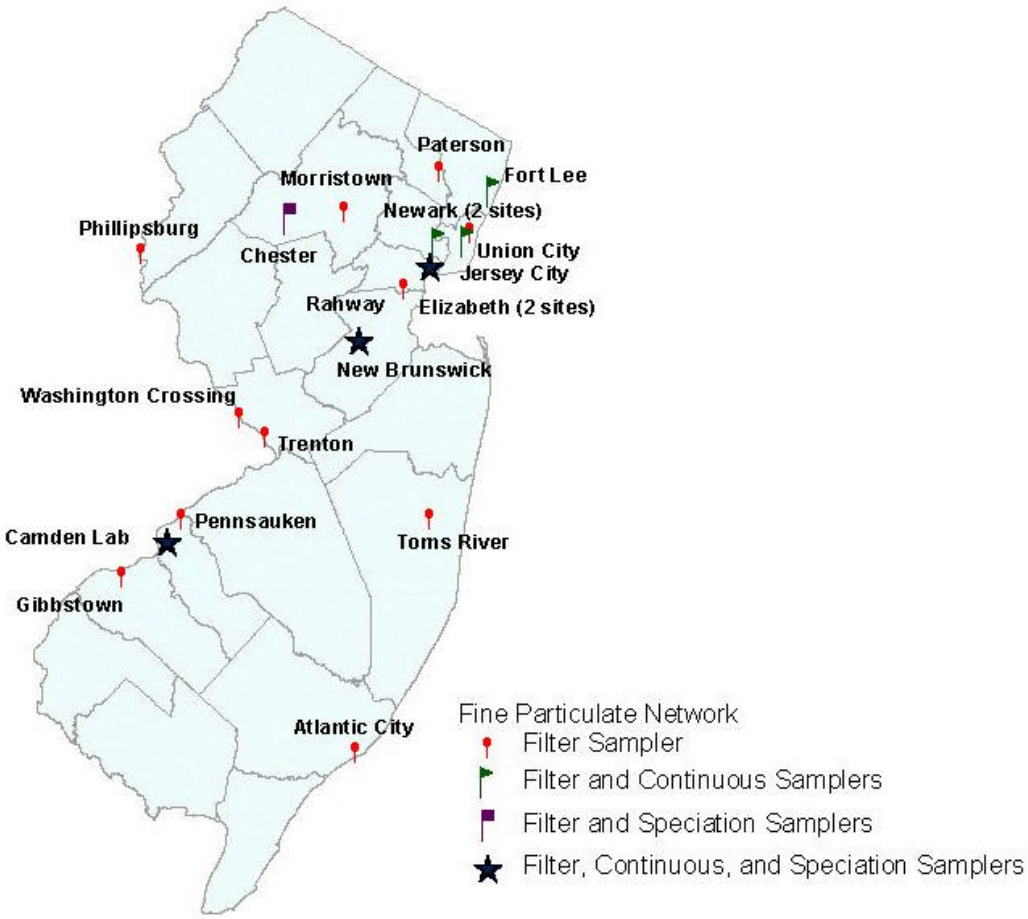
2001 Coarse Particulate Monitoring Network



FINE PARTICLE MONITORING SITES

Each of the 20 fine particulate monitoring sites (Figure 4) has a filter-based sampler, which collects a 24-hour sample on a Teflon filter. At 5 sites, there are also continuous monitors, which record the average 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.state.nj.us/dep/airmon). Additionally, fine particulate speciation samplers are located at four sites. Analyses are performed on the samples from these sites to determine the types and amounts of chemicals that make up fine particles.

Figure 4
2001 Fine Particulate Monitoring Network



SMOKE SHADE MONITORING SITES

In addition to fine and coarse particulate monitoring, smoke shade is also monitored at 12 stations around the state. Smoke shade, which is an indirect measurement of particles in the atmosphere, has been monitored in New Jersey for over 30 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 5 below.

Figure 5
2001 Smoke Shade Monitoring Network

2001 Summary

Maximum Concentrations

In 2001, the maximum daily TSP concentration recorded was 156 $\mu g/m^3$ at the site in Pennsauken on June 6th. This is well below the state's 24-hour primary air quality standard of 260 $\mu g/m^3$. Pennsauken also recorded the highest annual geometric mean of 52 $\mu g/m^3$, which is below both the state's primary and secondary 12-month standards of 75 and 60 $\mu g/m^3$.

The maximum daily concentration of inhalable particles (PM10) was 91 $\mu g/m^3$ recorded at Fort Lee on May 1st. The 24-hour National Ambient Air Quality Standard (NAAQS) for PM10 is 150 $\mu g/m^3$. None of the monitoring locations recorded values above the annual NAAQS of 50 $\mu g/m^3$ although not all sites had a complete year of data. The highest annual average recorded in 2001 was 37.4 $\mu g/m^3$ also at the Fort Lee site.

The maximum daily concentration of fine particles in 2001 was 52.5 $\mu g/m^3$ recorded at Union City on June 30th. The 24-hour NAAQS for PM2.5 is 65 $\mu g/m^3$. The Elizabeth Lab, Newark Lab, and Union City sites recorded annual concentrations above the 15 $\mu g/m^3$ annual NAAQS but by regulation it takes three complete years of data to determine if the standards are being met. The maximum annual average PM2.5 concentration recorded was 15.8 $\mu g/m^3$, recorded at both the Elizabeth Lab and Union City sites.

The daily average maximum smoke shade reading was 1.49 Coefficient of Haze units (COH) recorded at Elizabeth Lab on November 23rd. There are no national or state air quality standards for smoke shade, although a 24-hour average of 2.0 COH is used as the basis for rating air quality as unhealthy for sensitive groups in the daily Air Quality Index. See the Air Quality Index section of this report for more information.

TSP Concentration Summary

Total Suspended Particulates are no longer routinely measured in the state. However, two sites are still operating, mainly for the purpose of determining the concentration of lead in the atmosphere. For more information, see the 2001 Lead Summary section.

In 2001, the annual geometric mean concentration of TSP was 29.9 $\mu g/m^3$ at New Brunswick and 53.9 $\mu g/m^3$ at Pennsauken. The maximum 24-hour concentration recorded was 99 $\mu g/m^3$ at the New Brunswick site and 156 $\mu g/m^3$ at the Pennsauken site. All areas of the state are in attainment for the primary and secondary annual TSP standards of 75 $\mu g/m^3$ and 60 $\mu g/m^3$ respectively. Neither of the sites surpassed the 24-hour primary standard of 260 $\mu g/m^3$, although Pennsauken did exceed New Jersey's 24-hour secondary standard of 150 $\mu g/m^3$ on one occasion. Construction activities adjacent to the Pennsauken site were ongoing during the period when that value was recorded.

TABLE 2
TSP DATA – 2001
MAX - MAXIMUM

SITE	GEOM. MEAN ($\mu G/M^3$)	24-HR. MAX ($\mu G/M^3$)	24-HR. 2ND MAX ($\mu G/M^3$)
New Brunswick	29.9	99	81
Pennsauken[a]	53.9	156	112

a – No data available November 9 – December 27

PM10 Concentration Summary

In 2001, the annual mean concentration of PM10 ranged from 21.7 $\mu g/m^3$ in Atlantic City to 37.4 $\mu g/m^3$ in Fort Lee. Table 3 and Figure 6 show the annual mean and 24-hour maximum PM10 concentrations throughout the state. All areas of the state are in attainment for the annual PM10 standard of 50 $\mu g/m^3$, and no sites surpassed the 24-hour standard of 150 $\mu g/m^3$.

The concentration of Sulfates and Nitrates were also analyzed on some PM10 filters. The results showed that, on average, about 15 percent of PM10 is sulfate and about 2 percent is nitrate. The contributions of sulfate and nitrate to PM10 are significantly less than their contributions to PM2.5. This is because PM10 is predominantly made up of larger particles most of which are directly emitted into the atmosphere. PM2.5 is predominantly a secondary pollutant, forming in the atmosphere from gaseous emissions, such as SO_2 and NOx. For more details on the PM10 sulfate and nitrate results, see the section on atmospheric deposition.

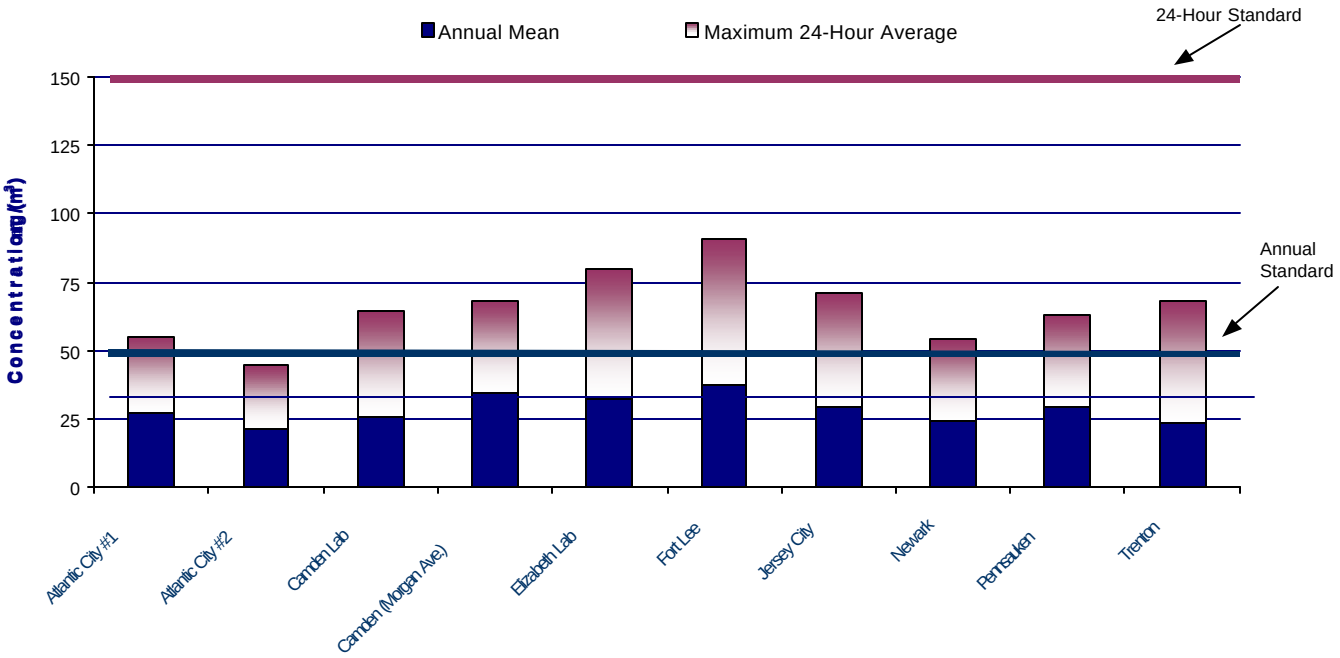
Table 3
PM10 Data – 2001

MAX – MAXIMUM 24-HOUR AVERAGES

Site	Mean ($\mu g/m^3$)	Max ($\mu g/m^3$)	2nd Max ($\mu g/m^3$)
Atlantic City (Trump)[a]	27.0	55	43
Atlantic City (Bacharach)[a]	21.7	45	41
Camden Lab	25.9	64	61
Camden (Morgan Ave.)	34.5	68	67
Elizabeth	32.2	80	61
Fort Lee[b]	37.4	91	71
Jersey City	29.3	71	85
Newark[c]	24.2	54	53
Pennsauken[d]	29.7	63	61
Trenton	23.5	68	53

a - In Atlantic City, PM10 was sampled at the Trump Plaza from January through August, and on Bacharach Boulevard thereafter.
b – No data available January 25 – April 7
c – No data available January 1 – August 17
d – No data available November 9 – December 27

Figure 6
2001 Inhalable Particulate (PM10) Concentrations



PM2.5 Concentration Summary

Table 4 and Figure 7 show the annual mean, and the 24-hour maximum fine particulate (PM2.5) concentrations recorded in New Jersey in 2001. The annual mean concentration of PM2.5 ranged from 11.8 $\mu g/m^3$ in Chester to 15.8 $\mu g/m^3$ at the Elizabeth Lab and Union City sites. The highest 24-hour level recorded was 52.5 $\mu g/m^3$ at the Union City site.

Three years of data are required to determine compliance with the National Ambient Air Quality Standards (NAAQS) for PM2.5. Based on an initial review of the data, it is apparent that the entire state will meet the 24-hour NAAQS. A number of sites will be very close to the 15 $\mu g/m^3$ annual standard. NJDEP will be evaluating all PM2.5 data collected to date in making its final determination as to whether the annual NAAQS are being met.

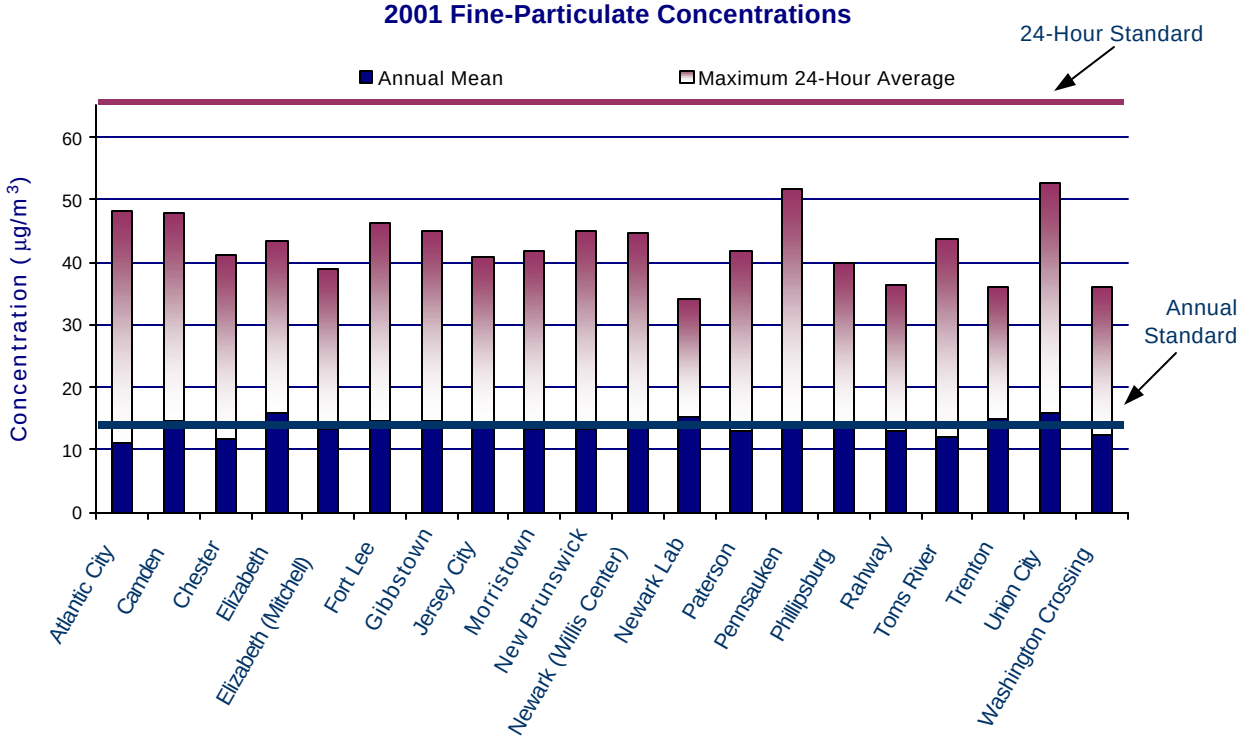
Table 4
PM2.5 Data – 2001

MAX – Maximum 24-hour

Site	Number of Samples	Mean ($\mu g/m^3$)	Max ($\mu g/m^3$)	2nd Max ($\mu g/m^3$)
Atlantic City**	45	11.2	48.1	26.3
Camden Lab	122	14.5	47.8	41.2
Chester	84	11.8	41.2	32.2
Elizabeth (Mitchell Bldg.)	92	13.4	39.0	33.8
Elizabeth Lab	286	15.8	43.4	42.4
Fort Lee	96	14.5	46.4	34.4
Gibbstown	100	14.5	45.1	40.8
Jersey City	102	14.1	40.7	37.7
Morristown	83	13.4	41.8	40.5
New Brunswick	93	13.2	45.1	34.1
Newark (Willis Center)	91	13.5	44.5	32.1
Newark Lab**	35	15.3	34.0	30.2
Paterson	84	13.1	41.9	34.2
Pennsauken	94	14.2	51.7	37.8
Phillipsburg	103	13.7	39.7	38.8
Rahway	158	12.8	36.4	35.4
Toms River	87	11.9	43.6	39.8
Trenton	98	14.9	36.0	35.4
Union City	90	15.8	52.5	39.5
Washington Crossing	83	12.2	36.0	29.4

** No data prior to August 6th

Figure 7
2001 Fine-Particulate Concentrations



PM2.5 Real-Time Monitoring

New Jersey's real-time fine PM2.5 monitoring network consists of 5 sites that transmit data once a minute to a central computer in Trenton. The data is then automatically updated on the bureau's website every hour, where it displays the health level that corresponds to the current 24-hour fine particulate concentration. Table 5 provides a summary of the data from these sites and Figure 8 depicts the health level associated with the maximum daily fine particulate concentration recorded in the state each day for the entire year.

Table 5

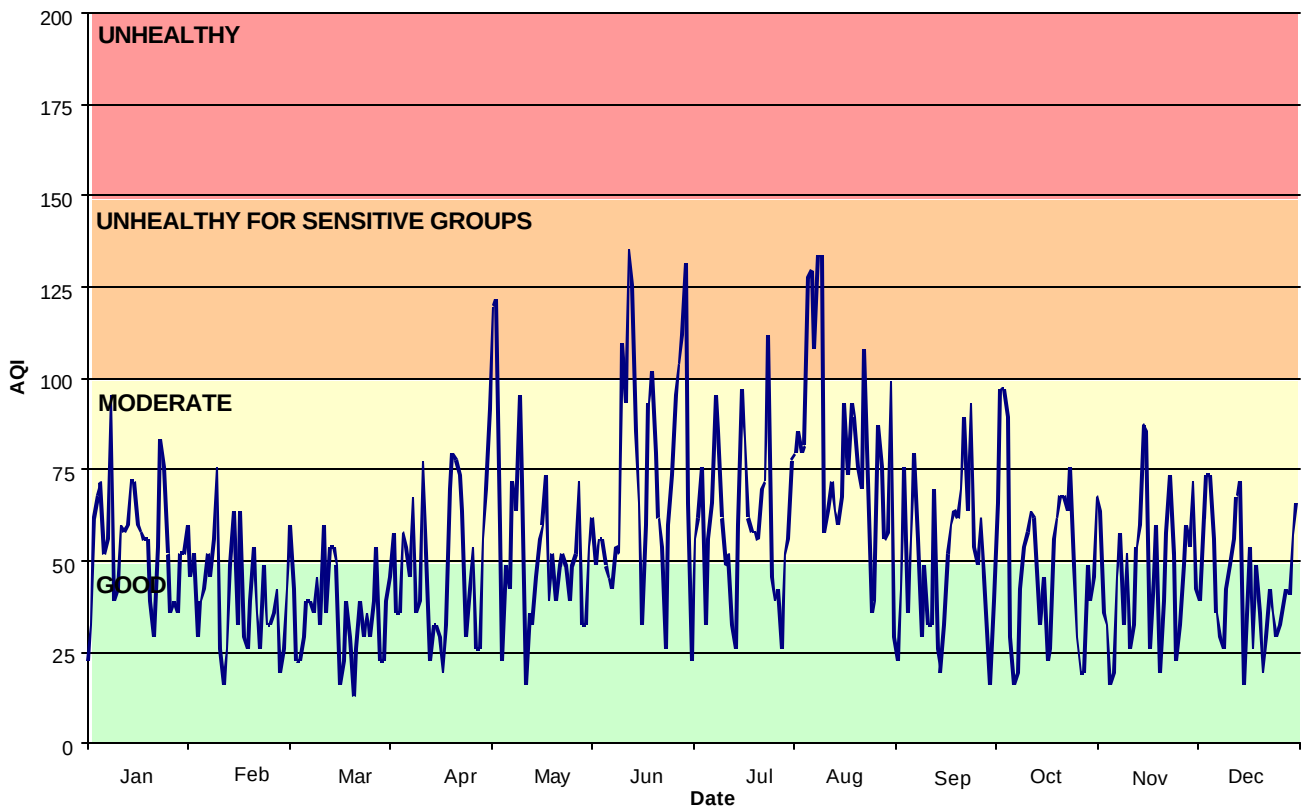
2001 Summary of Continuous PM2.5 Data

Monitoring Site	Annual Arith. Mean	24-Hour Maximum	24-Hour 2nd Highest
Camden Lab	14	57	48
Elizabeth Lab	15	58	53
Fort Lee [a]	--	58	57
Newark Lab[b]	--	34	32
New Brunswick	12	52	48

[a] Data not available from January 21st to March 11th

[b] Data not available prior to August 6th

FIGURE 8

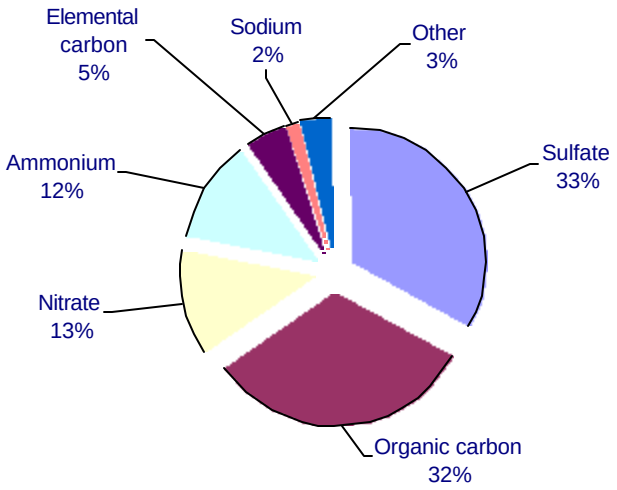


PM2.5 SPECIATION SUMMARY

A new project was started in 2001, whereby the fine particulate filters where analyzed in order to determine the chemical composition of the particles. Speciation samplers were placed in Camden, New Brunswick, Chester, and Elizabeth. All of the sites, except New Brunswick, only ran a portion of the year. The results from New Brunswick indicate that approximately 97 percent of fine particles are composed of Sulfate, Organic Carbon, Nitrate, Ammonium, Elemental Carbon, and Sodium (Figure 9).

FIGURE 9

Components of PM2.5 at New Brunswick in 2001



SMOKE SHADE SUMMARY

In 2001, the mean annual concentration of smoke shade ranged from 0.15 Coefficient of Haze units (COH) at Flemington to 0.52 COH at Elizabeth Lab. COH are units of light absorption and smoke shade in 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 6 lists the annual mean, daily maximum and second maximum smoke shade levels recorded at the monitoring sites in 2001.

TABLE 6

Smoke Shade – 2001

Max – Maximum 24-Hour Average

SITE	MEAN (COH)	MAX (COH)	2ND MAX (COH)
Ancora State Hospital	---	0.44	0.39
Burlington	0.21	0.74	0.74
Camden Lab	0.19	0.96	0.86
Elizabeth	0.37	1.37	1.29
Elizabeth Lab	0.52	1.49	1.42
Flemington	0.15	0.50	0.48
Freehold	0.26	0.75	0.65
Hackensack	0.25	0.97	0.80
Jersey City	0.49	1.29	1.24
Morristown	0.27	1.01	0.95
Newark	---	1.18	1.15
Perth Amboy	0.34	1.06	0.99

TRENDS IN PARTICULATE CONCENTRATIONS

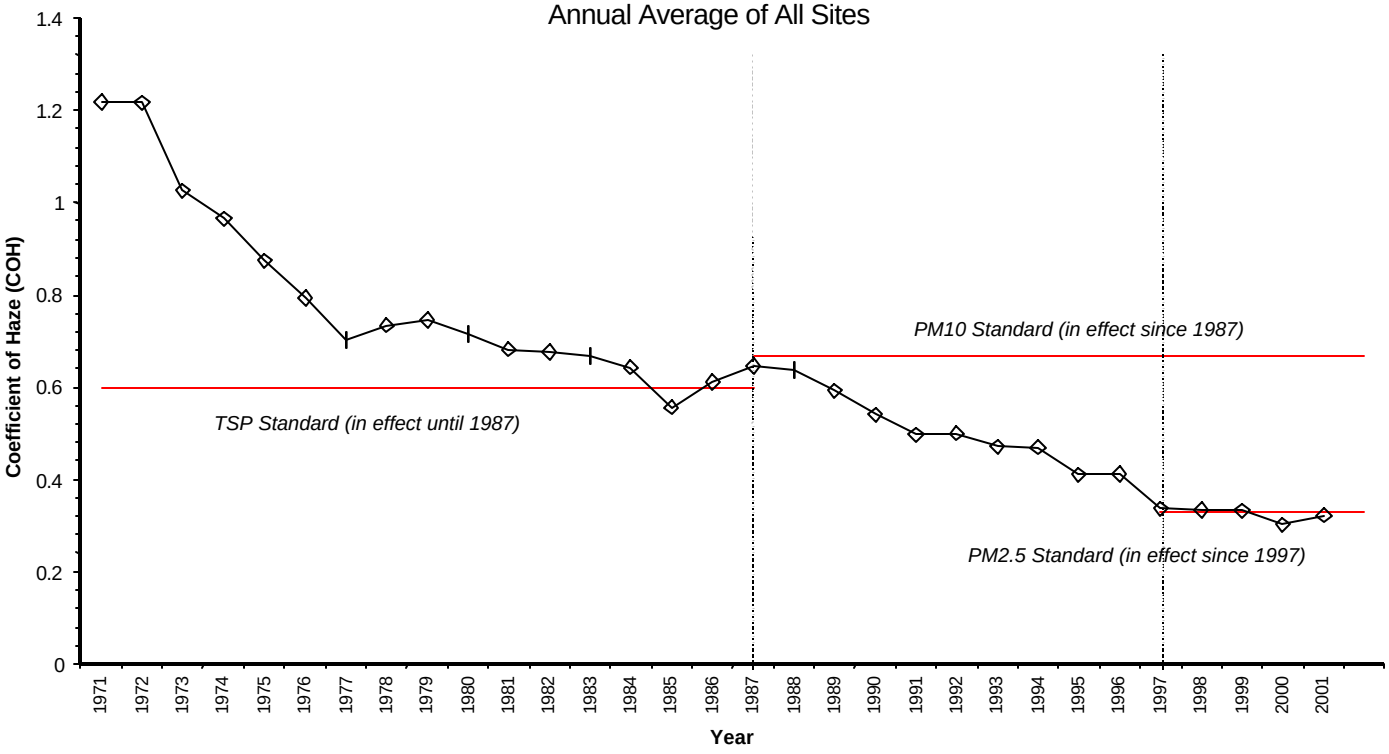
The longest continuously operating particle monitoring network in the state that is suitable for looking at trends is the smoke shade network. As noted earlier, this monitoring program has been in effect for over thirty years and still has 12 active sites. The trend graph for smoke shade, shown in Figure 10, indicates that particulate levels have steadily declined over the past thirty years. Smoke shade is not a direct measurement of particle mass, but can be related to TSP, PM10 and PM2.5 health standards. The approximate level of these standards, converted to smoke shade units, are also shown on Figure 10. It can be seen that the new PM2.5 standard is significantly lower than the TSP or PM10 standards and that current levels are very close to this standard. This is consistent with the 2001 summary of fine particle data shown earlier which was based on direct measurements of PM2.5.

Figure 10
New Jersey Trend in Particulate Levels

1971 - 2001

Smoke Shade used as a surrogate for particulate matter

Annual Average of All Sites



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