2004 Ozone Summary

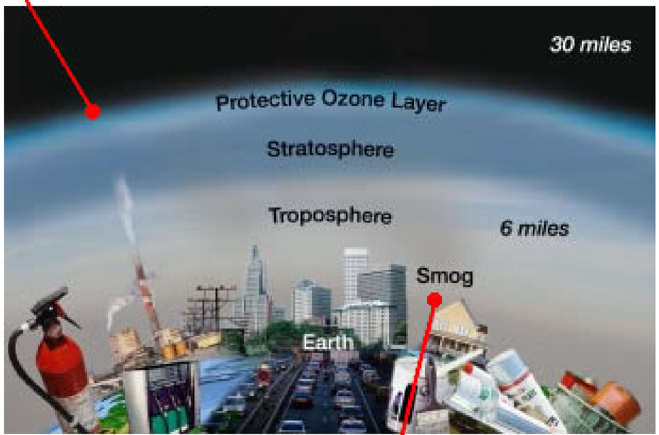
New Jersey Department of Environmental Protection

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.

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

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 season runs from April 1st to October 31st, although unhealthy conditions are rare before mid-May or after the first few weeks of September. 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".

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 are damage caused by exposure to ground-level ozone. (Figure 2 and 3 Photos by: Teague Prichard, Wisconsin Department of Natural Resources)

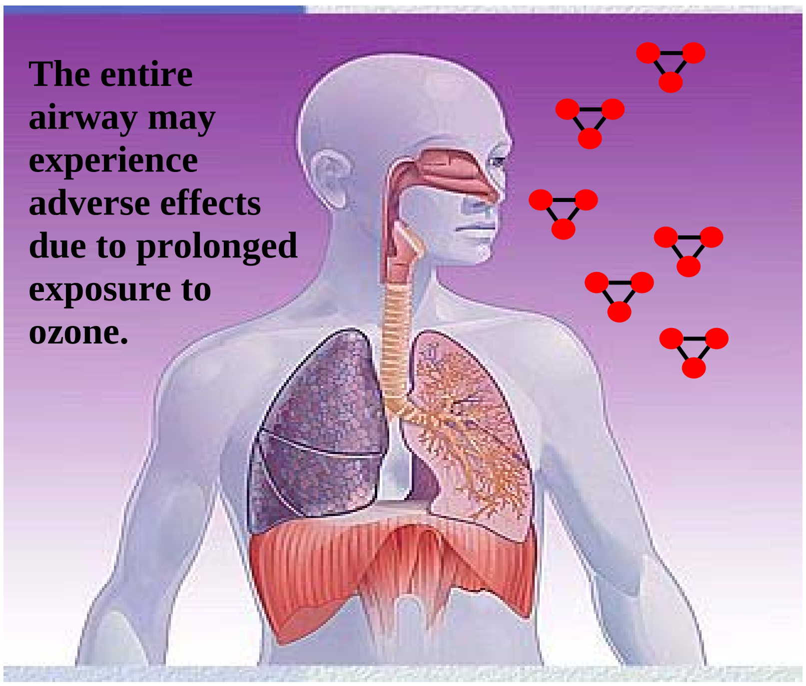
Figure 2: Ozone Damage to Blackberry Bush

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



Area of the Respiratory Tract that may be Affected by Ozone

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 1997 because EPA had determined that the old standard of 0.12 parts per million (ppm) maximum daily one-hour average was not sufficiently protective of public health. They set a revised standard of 0.08 ppm maximum daily 8-hour average. The standard changes were challenged in court but eventually upheld. 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.

OZONE NETWORK

Ozone was monitored at 14 locations in New Jersey during 2004. Of those 14 sites, 11 operated year round and 3 operated only during the ozone season (April 1st through October 31st). Site locations are shown in Figure 5.

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	0.12 ppm
1-Hour	Secondary	0.08 ppm	0.12 ppm
8-Hour	Primary	-----	0.08 ppm
8-Hour	Secondary	-----	0.08 ppm

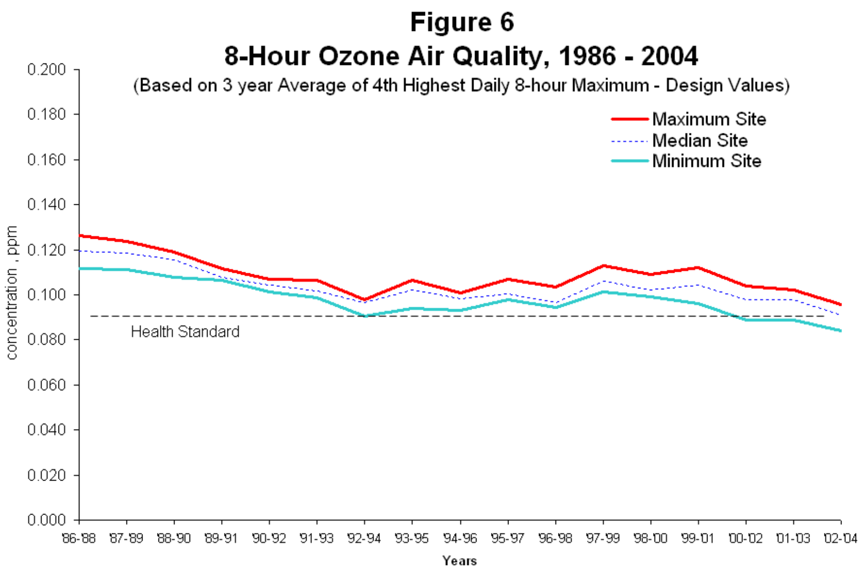
Figure 5
2004 Ozone Monitoring Network

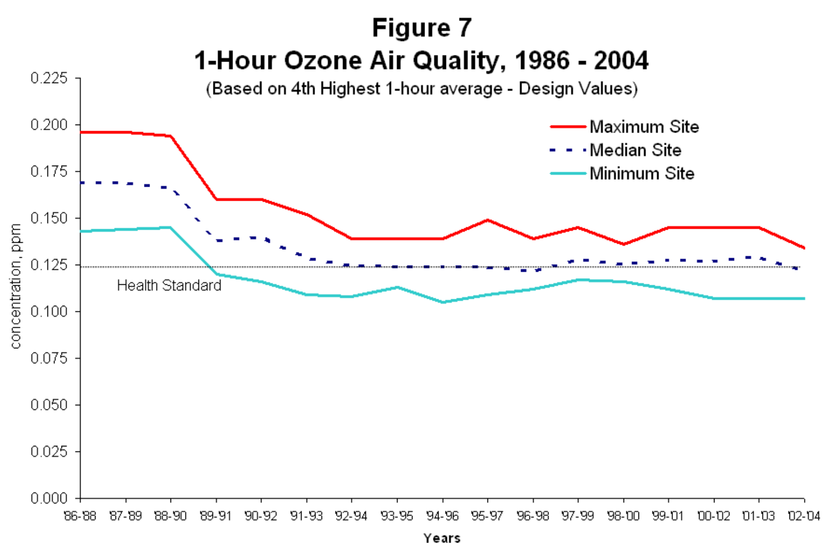
DESIGN VALUES

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 having to develop plans based on extremely rare events.

Figures 6 and 7 show the design value for the 1 and 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.





How the Changes to the Ozone Standards Affect Air Quality Ratings

In 2004 there were no days on which the old standard was exceeded in New Jersey and 14 days on which the new standard was exceeded. Significant progress was being made towards meeting the old standards (see Figure 8 below). There are fewer days on which that standard is exceeded, and when it is, 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 1988 was 0.218 ppm, compared to a maximum of 0.119 ppm in 2004.

It is apparent, however, that the current standard is significantly more stringent than the old one (compare Figure 8 to Figure 9 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 8

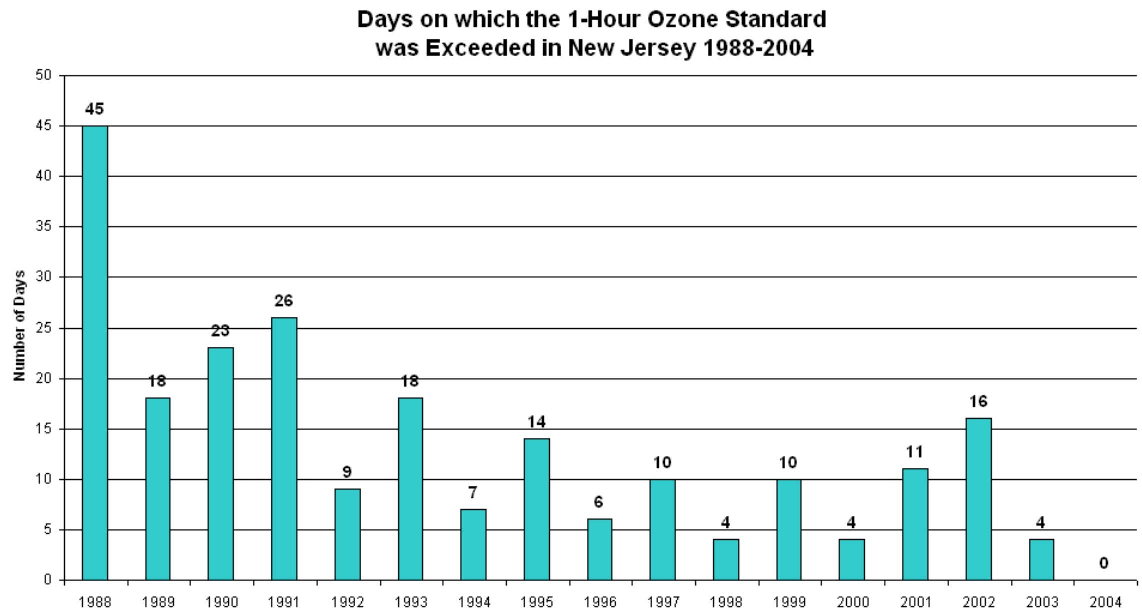
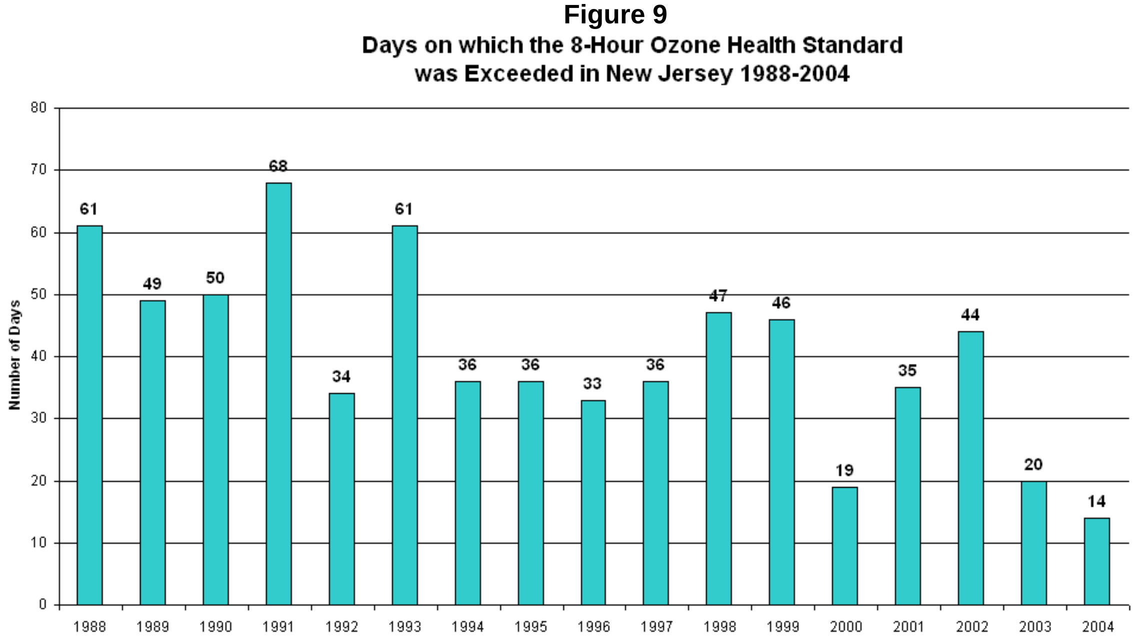


Figure 9

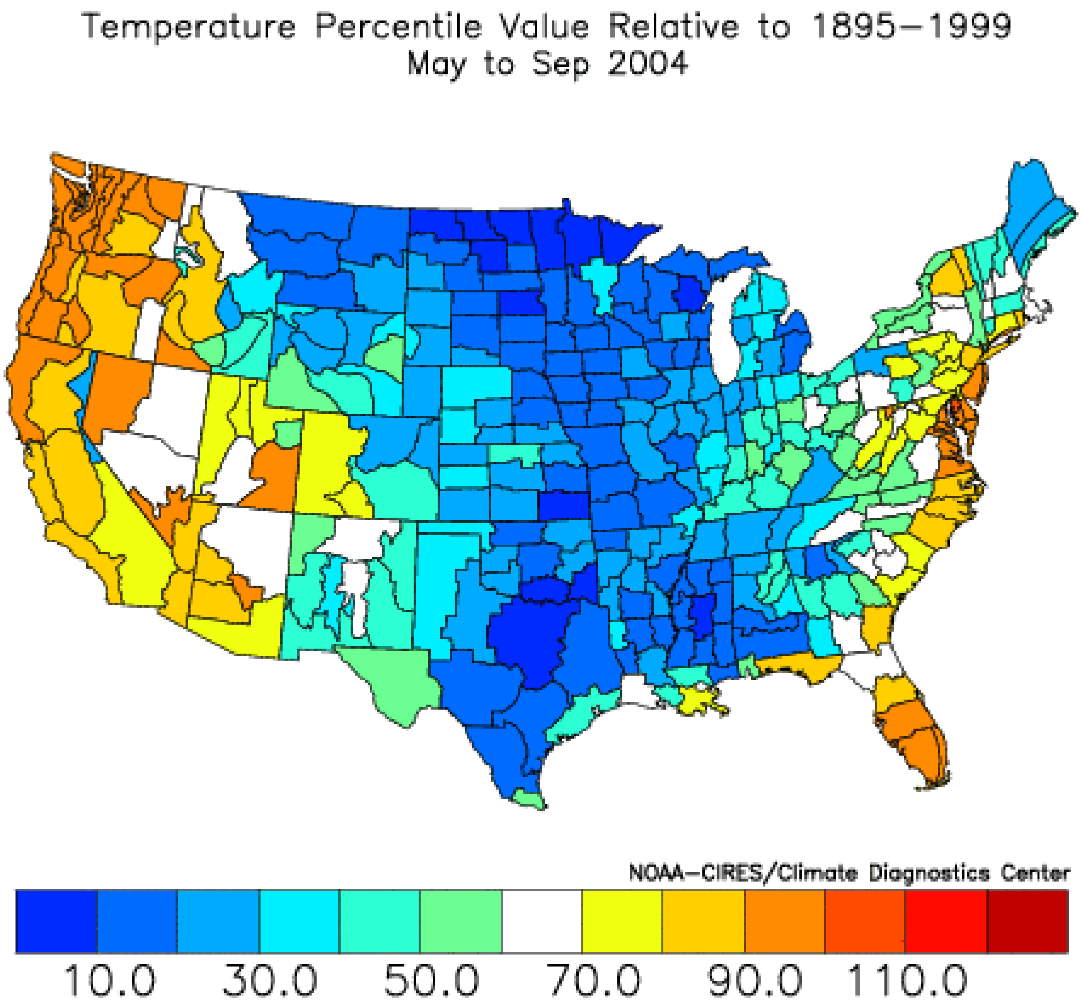


MAJOR OZONE EPISODES

Historically, several ozone episodes occur throughout the New Jersey summer. The 2004 ozone season, unlike any New Jersey ozone season to date, produced no ozone episodes. An ozone episode is loosely defined as two or more consecutive days of widespread ozone concentrations above the health standard. There were no recorded exceedances above the 0.12 ppm 1-hour health standard and no widespread exceedances of the 8-hour 0.085 ppm health standard. July 22nd produced the most single day exceedances as seven sites went above the 0.08 ppm standard with Flemington being the highest with 0.098 ppm 8-hour average. As recently as 1998, there were 47 days when ozone concentrations were above the 8-hour standard. Unlike 2004, the 1998 exceedance days were more widespread with typically more than half of the monitors exceeding the standard on each exceedance day. The summer of 2004 was noticeably cooler than most. The map below (Figure 10) illustrates the average temperature throughout the summer and how it deviated from typical averages. Aside from a few exceptions, the entire nation experienced a much cooler summer than usual. New Jersey's average summertime temperatures deviated from normal by 10 – 20%.

Atypical meteorological conditions obviously played a significant role in low ground level ozone concentrations in 2004, but those uncharacteristically low values should not be solely attributed to weather conditions. Significant reduction in the emissions of ground forming pollutants have been achieved. But there is still a long way to go and ground level ozone will remain a problem that requires both local and regional emission reduction strategies to control.

Figure 10



SUMMARY OF 2004 Ozone Data Relative to the 1-HOUR STANDARD

Of the 14 monitoring sites that were operated during the 2004 ozone season, none recorded levels above the old 1-hour standard of 0.12 ppm during the year. The highest 1-hour concentration was 0.119 ppm at both the Rutgers University and Clarksboro sites on June 8 and July 21, respectively. In contrast, during the 2003 ozone season there were 6 sites that recorded levels above the standard and the maximum was 0.151 ppm, recorded at Monmouth University.

Figure 11
2004 Highest and Second Highest Daily 1-Hour Averages

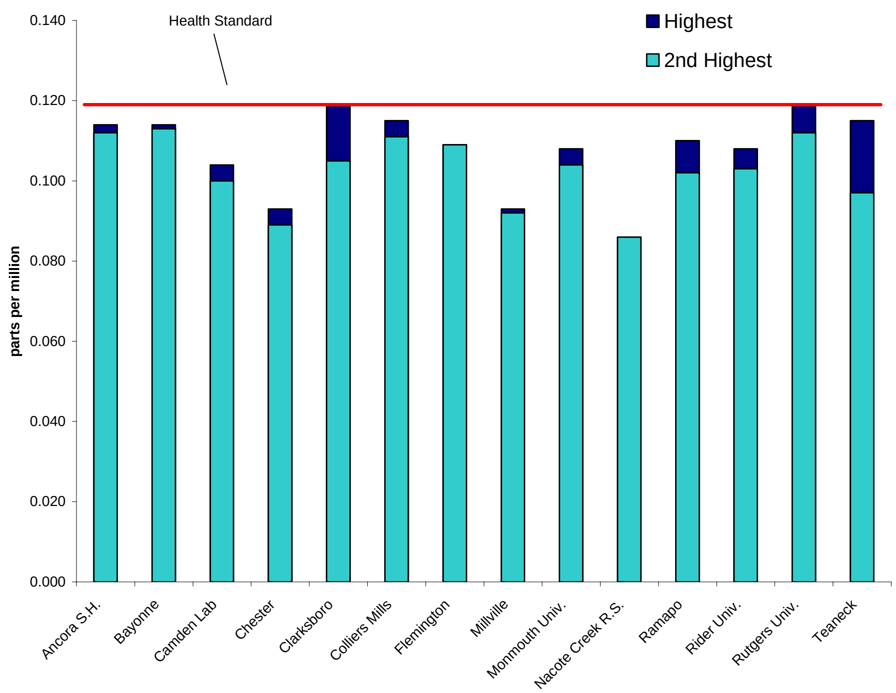


Table 3
Ozone Data – 2004
1-Hour Averages
Parts Per Million (ppm)

1-hour standard is 0.12 ppm

Monitoring Site	1-hr Max	2nd Highest 1-hr Max	4th Highest[1] 1-hour Average 2002-2004[a]	# of days with 1-hour Averages above 0.12ppm
Ancora S.H.	0.114	0.112	0.122	0
Bayonne	0.114	0.113	0.130	0
Camden Lab	0.104	0.100	0.128	0
Chester	0.093	0.089	0.122	0
Clarksboro	0.119	0.105	0.127	0
Colliers Mills	0.115	0.111	0.134	0
Flemington	0.109	0.109	0.128	0
Millville	0.093	0.092	0.129	0
Monmouth Univ.	0.108	0.104	0.128	0
Nacote Creek R.S.	0.086	0.086	0.107	0
Ramapo	0.110	0.102	0.116	0
Rider University	0.108	0.103	0.133	0
Rutgers University	0.119	0.112	0.132	0
Teaneck	0.115	0.097	0.127	0
Statewide	0.119	0.119	0.144	0

[a] Design Value calculations exclude data affected by the July 2002 Canadian forest fire episode. See 2002 Air Quality Report for details.

SUMMARY OF 2004 OZONE DATA RELATIVE TO THE 8-HOUR STANDARD

Only 12 of the 14 monitoring sites that were operated during the 2004 ozone season recorded levels above the 8-hour standard of 0.08 ppm. Nacote Creek R.S. and Chester did not record any 8-hour exceedances. Colliers Mills recorded the most exceedances with 8. The highest 8-hour concentration recorded was 0.103 ppm at the Colliers Mills and Ancora S.H. sites on June 9 and July 21, respectively. All sites recorded levels above the 8-hour standard in 2003, with a maximum concentration of 0.131 ppm, recorded at the Monmouth University site. Design values exceeded the 8-hour standard at all sites, except Bayonne and Ramapo, indicating that the ozone standard is being violated over most of New Jersey.

Figure 12
Ozone Design Values for 2002-2004

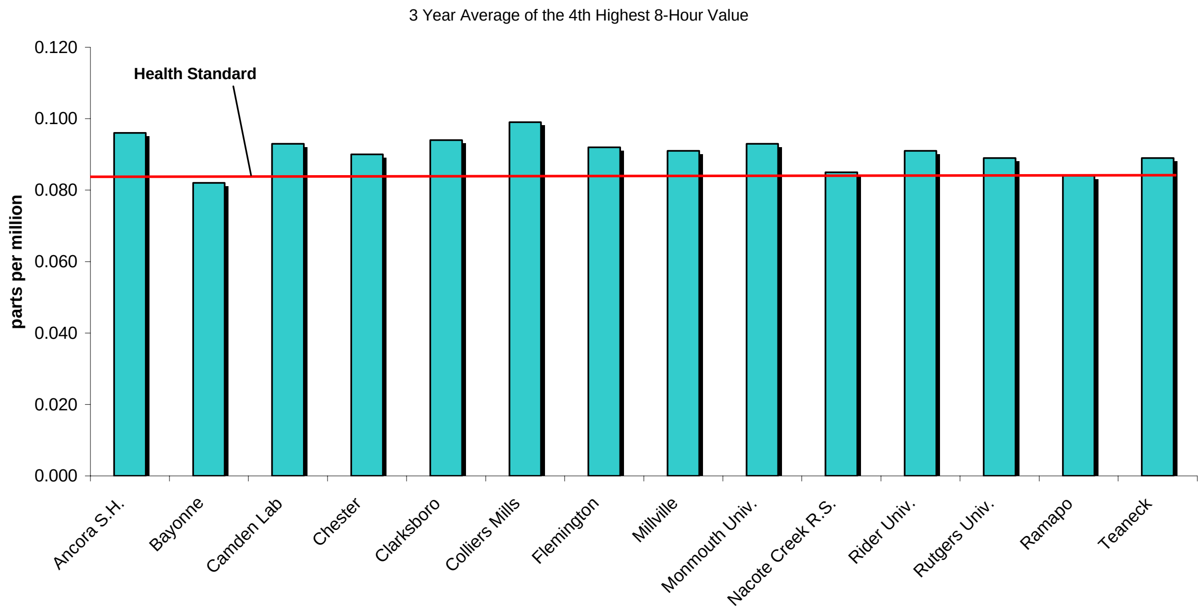


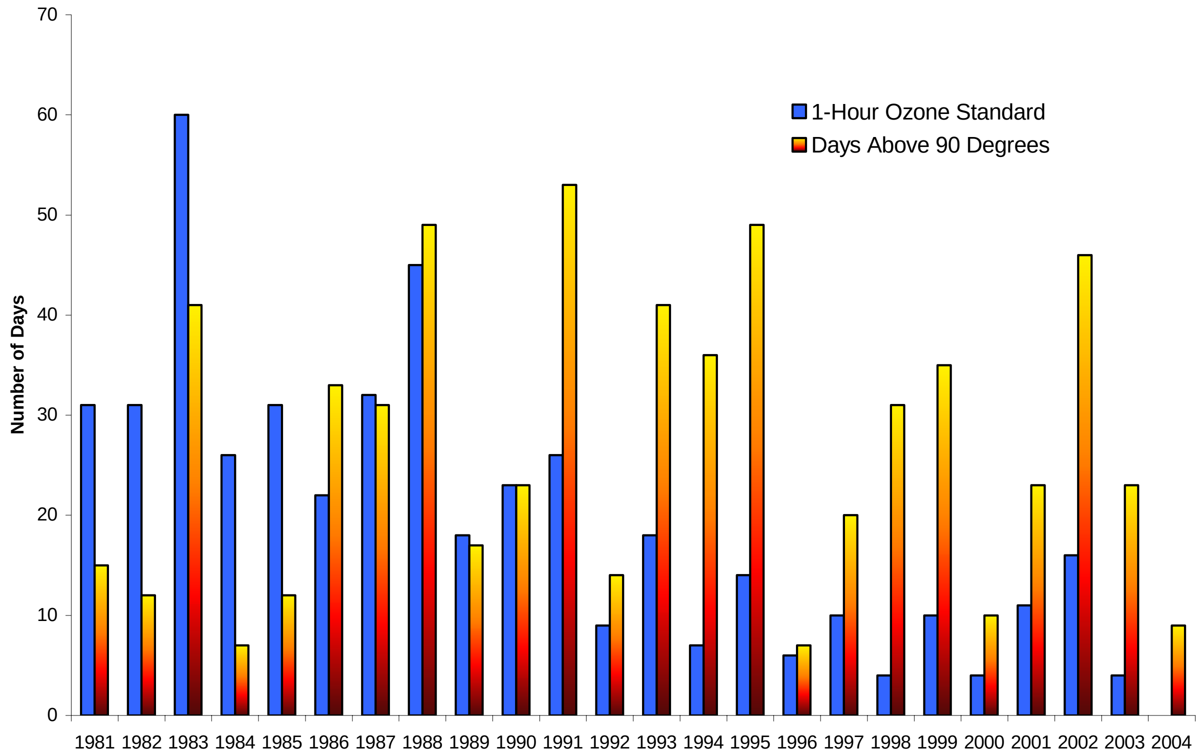
Table 4
Ozone Data – 2004
8-Hour Averages
Parts Per Million (ppm) **8-hour standard is 0.08 ppm**

Monitoring Site	1st Highest	2nd Highest	3rd Highest	4th Highest	Avg. of 4th Highest 8-hour Averages 2002-2004[a]	# of days with 8-hour above 0.08ppm
Ancora S.H.	0.103	0.092	0.090	0.088	0.096	6
Bayonne	0.088	0.082	0.081	0.080	0.082	1
Camden Lab	0.093	0.090	0.085	0.080	0.093	3
Chester	0.082	0.078	0.075	0.075	0.090	0
Clarksboro	0.096	0.092	0.092	0.085	0.094	4
Colliers Mills	0.103	0.094	0.092	0.088	0.099	8
Flemington	0.098	0.091	0.090	0.087	0.092	6
Millville	0.090	0.085	0.084	0.083	0.091	2
Monmouth Univ.	0.099	0.094	0.081	0.080	0.093	2
Nacote Creek R.S.	0.080	0.078	0.077	0.077	0.085	0
Ramapo	0.096	0.090	0.079	0.075	0.084	2
Rider University	0.093	0.083	0.082	0.082	0.091	1
Rutgers University	0.099	0.088	0.081	0.080	0.089	2
Teaneck	0.089	0.089	0.084	0.082	0.089	2
Statewide	0.103	0.103	0.099	0.099	0.107	14

[a] Design Value calculations exclude data affected by the July 2002 Canadian forest fire episode. See 2002 Air Quality Report for details.

Figure 13

Number of Days 1-Hour Ozone Standard Was Exceeded and Number of Days Above 90 Degrees New Jersey 1981 - 2004



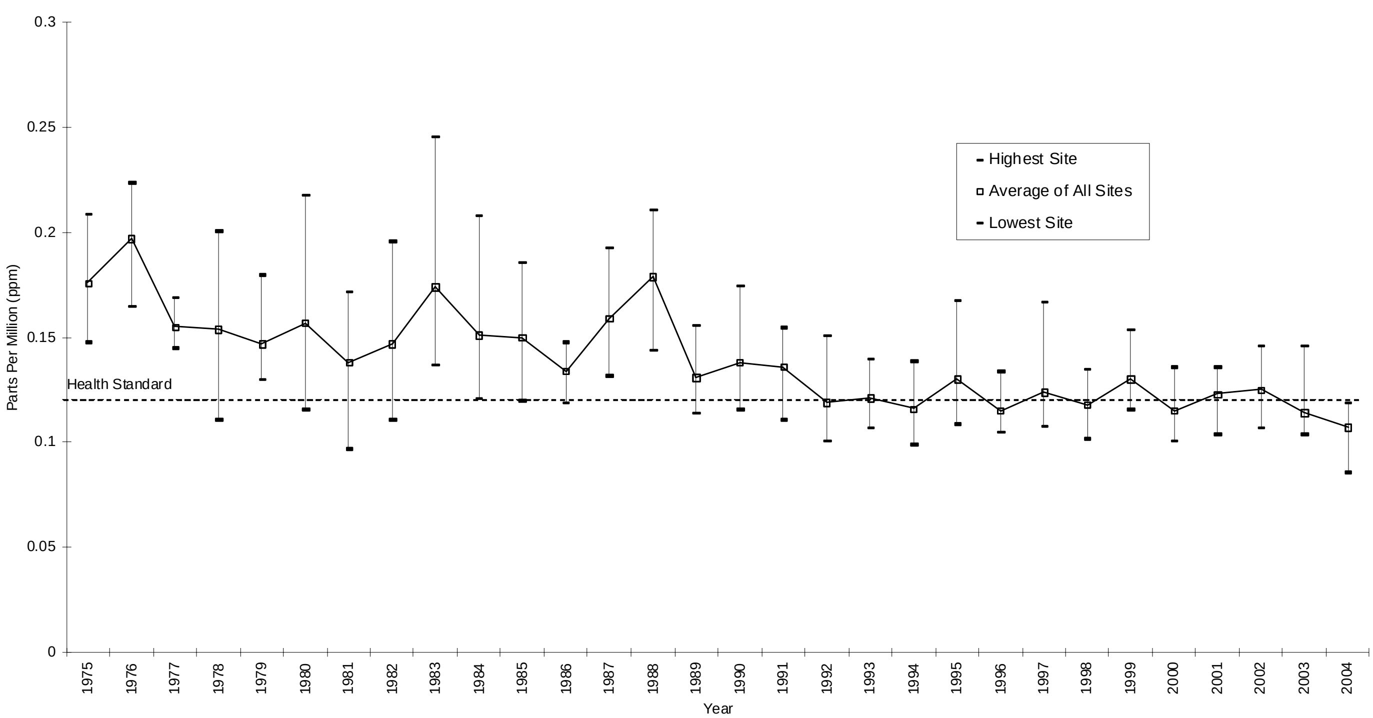
ACCOUNTING FOR THE INFLUENCE OF WEATHER

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 13. 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 (1981-1985) 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 14). 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 14
Ozone Concentrations in New Jersey
1975 – 2004
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 for each of the National Ambient Air Quality Standards. Areas can also be found to be "unclassifiable" under certain circumstances. Designations are based, in part, on "design values", which are the values that actually determines whether an area meets the standard. For the 8-hour ozone standard the design value is the 3-year average of the fourth highest daily maximum 8-hour average concentration recorded at a site each year. Based on the 3-year period from January 1, 2001 through December 31, 2003 the USEPA designated all of New Jersey as non-attainment with respect to the 8-hour ozone standard.

REFERENCES

Ozone: Good Up High, Bad Nearby, USEPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC October 1997, URL: www.epa.gov/oar/oaqps/gooduphigh/

USEPA Fact Sheet: *Health and Environmental Effects of Ground Level Ozone*, USEPA, Office of Air and Radiation, July 1997, URL: www.epa.gov/ttn/oarpg/naaqsfin/o3health.html

USEPA Ozone Map Archives, U RL: www.epa.gov/airnow/maparch.html

Enhanced Ozone Monitoring – PAMS General Information, USEPA,, 1994, URL: www.epa.gov/air/oaqps/pams/general. html

Guidelines for Developing an Air Quality (Ozone and PM2.5) Forecasting Program, EPA-456/R-03-002, June 2003

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/oar/aqtrnd99/

Latest Findings on National Air Quality: 2000 Status and Trends, EPA-454/K-01-002, USEPA , Office of Air Quality Planning and Standards, RTP, September 2001, URL: www.epa.gov/oar/aqtrnd00/

Smog – Who Does it Hurt?, EPA-452/K-99-001, USEPA, Air and Radiation, Washington, DC, July 1999, URL: www.epa.gov/airnow/health/

Ozone and Your Health, EPA-152/F-99-000, USEPA, Air and Radiation, Washington, DC, September 1999, URL: www.epa.gov/airnow/brochure.html

Air Quality Guide for Ozone, EPA-456/F-002, Air and Radiation, Washington, DC, July 1999, URL: www.epa.gov/airnow/consumer.html