2003 Ozone Summary

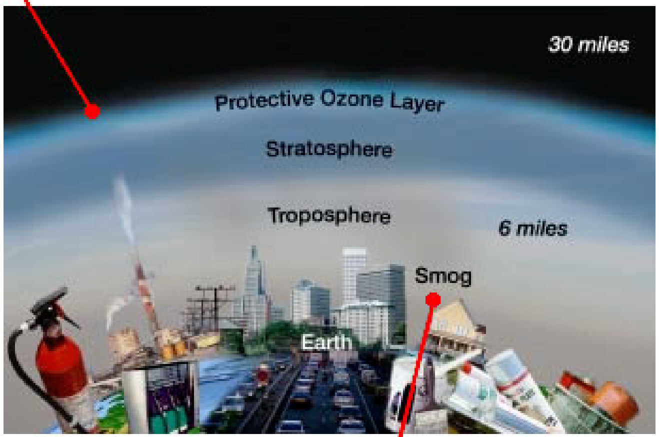
New Jersey Department of Environmental Protection

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 monitoring season runs from April 1st to October 31st, although unhealthy conditions are not common 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[2]. 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)

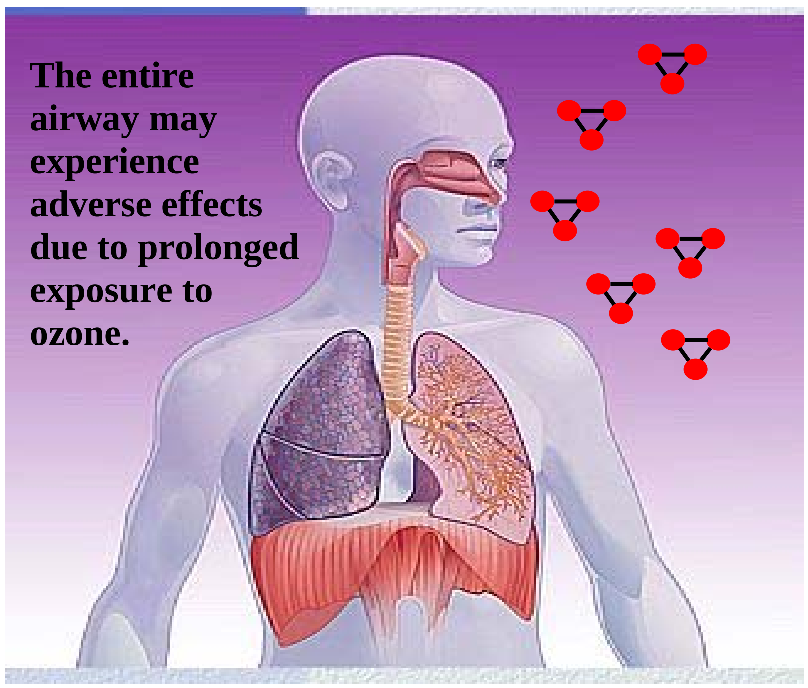
Figure 2: Ozone Damage to Blackberry Bush

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 these activities to days when ozone levels are not 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 eight-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

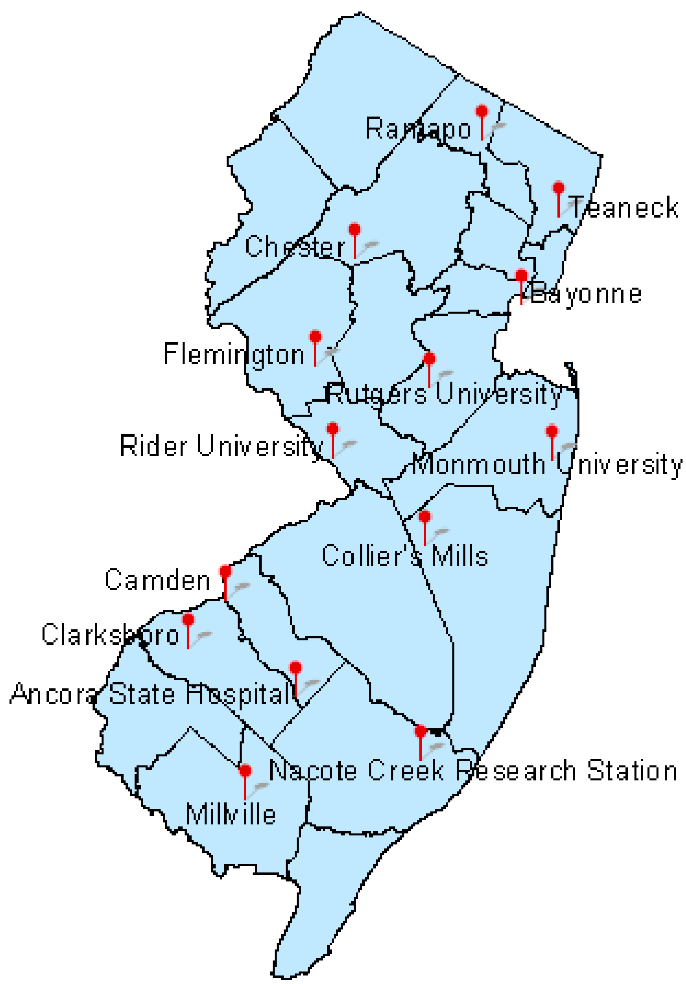
Ozone was monitored at 14 locations in New Jersey during 2003. Of those 14 sites, 11 operated year round and 3 operated only during the ozone monitoring season (April 1st through October 31st). Site locations are shown in Figure 5.

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
2003 Ozone Monitoring Network

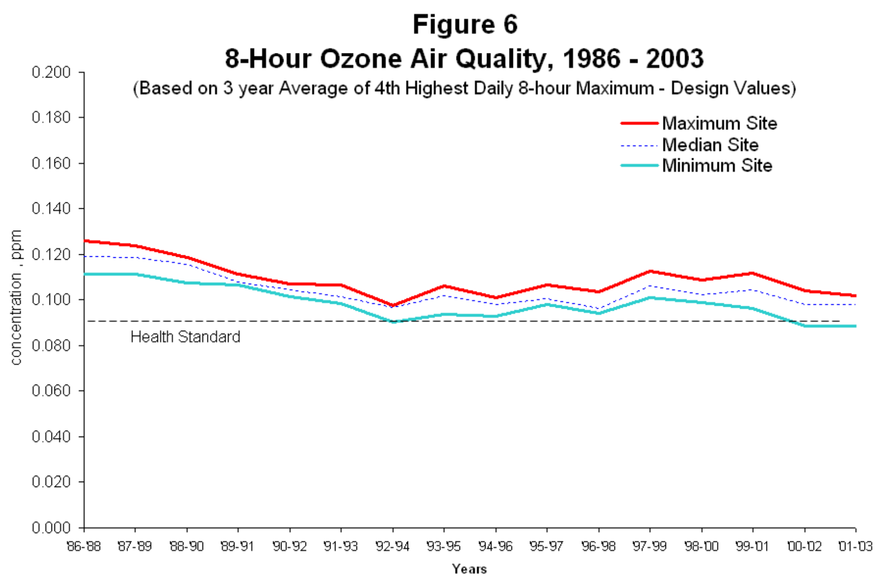


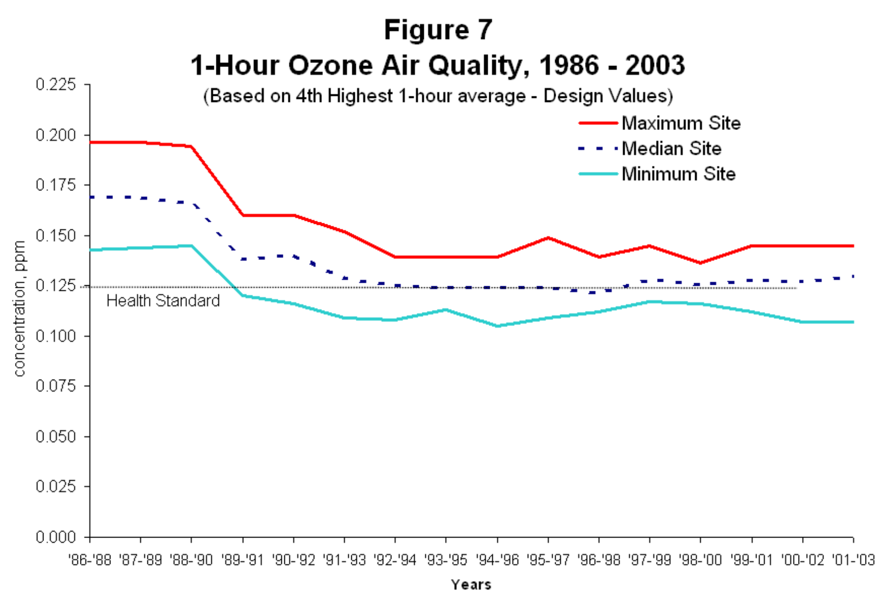
DESIGN VALUES

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 4^{th} 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 values 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 2003 there were 4 days on which the old standard was exceeded in New Jersey and 20 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 0.151 ppm in 2003.

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
Days on which the 1-hour Ozone Standard was Exceeded in New Jersey 1988-2003

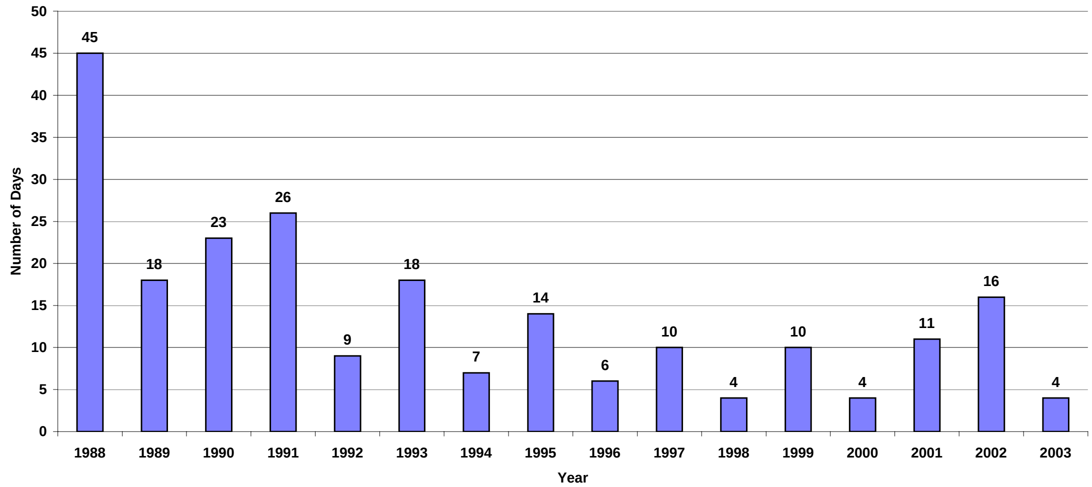
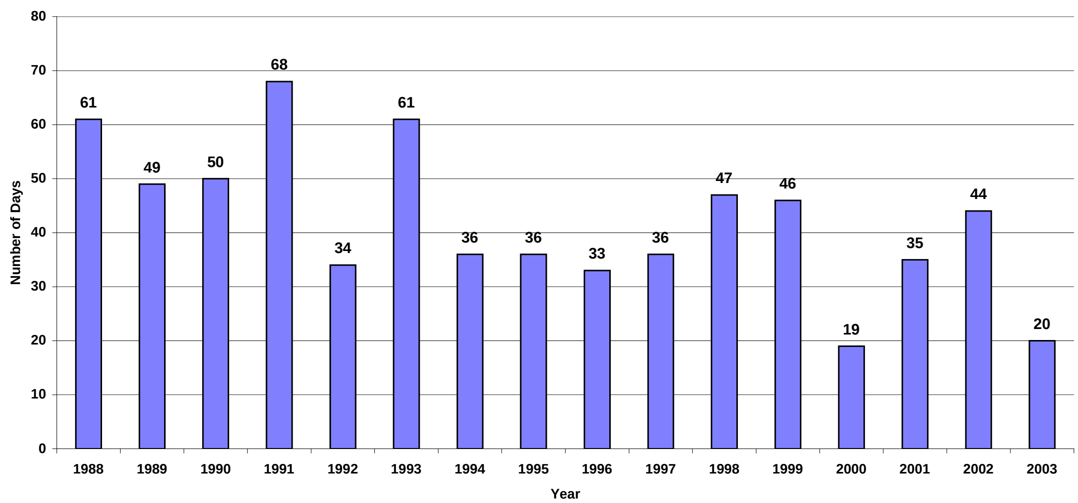


Figure 9
Days on which the 8-hour Ozone Standard was Exceeded in New Jersey 1988-2003

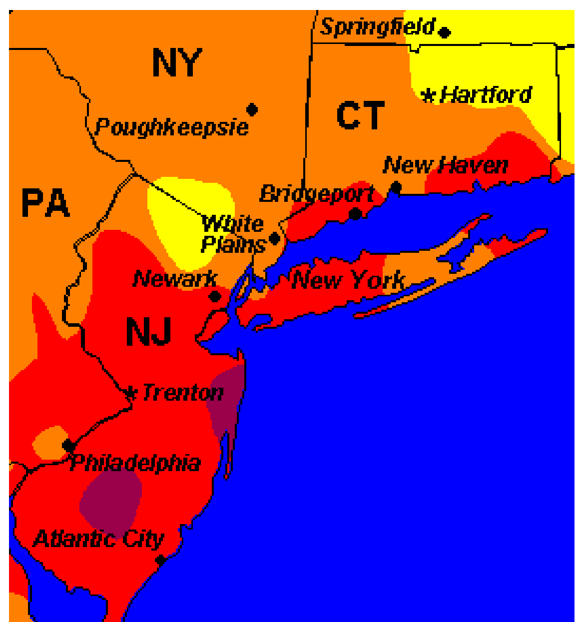


MAJOR OZONE EPISODES

Historically, several ozone episodes occur throughout the New Jersey summer. Some ozone episodes have begun as early as April while others have lasted well into the early days of autumn. The 2003 ozone season seemed as if it would be significant since the first exceedances of the 8-hour standard occurred on April 16th. Six sites throughout the state made it above the 8-hour standard of 0.08 ppm, and although the maximum values weren't much above the standard, April 16th turned out to be one of the most widespread exceedances of the summer. This early start, however, was not a great indicator of the season to come. The remainder of the summer was very clean, in regards to air quality, and only one major ozone episode occurred in the Garden State. Conditions conducive to ozone formation (sunny, warm, west-southwest winds) were almost non-existent as the majority of the summer was blanketed by cloud-cover and only 24 days between May 1st and September 31st were clear (without cloud cover). Precipitation levels were near normal in May, August and September, while June and July accumulations deviated quite significantly. June was very wet and recorded rainfall levels roughly four inches above normal, whereas July was dryer than usual, receiving nearly two and a half inches below normal rain fall. Atypical meteorological conditions played a significant role in low ground level ozone concentrations in 2003. Ground level ozone will remain a problem that requires both local and regional emission reduction strategies to effectively control its presence throughout the summer months.

June 24 – 27 On the 24th a large high pressure system centered in Ohio pushed its way through the region. New Jersey was on the eastern side of this high pressure and therefore began to receive west-northwest winds in the mid morning hours. These winds carried polluted metropolitan Philadelphia air into the southern regions of the state. Southern sites most affected by this plume, such as Ancora S.H., Millville, and Nacote Creek R.S. reported hourly ozone concentrations of 0.088, 0.082, and 0.086 ppm respectively. Temperatures settled in the mid -90°s throughout the state, pushing seven sites above the 8-hour standard. Monmouth University was the highest site that day with a maximum 8-hour value of 0.112 ppm and it also exceeded the 1-hour standard with a maximum of 0.139 ppm. The same high-pressure system stayed in place throughout the 25th, shifting to the south a bit as the day went on. Temperatures stayed in the mid-90°'s and winds remained light, allowing the long daylight hours maximum opportunity to react with ozone precursors. This southern shift brought westerly winds to the entire state for the remainder of the day causing 13 sites to exceed the 8-hour standard. June 25th was a widespread exceedance day as all but the Ramapo site exceeded the 8-hour standard, and three sites exceeded the 1-hour standard; Ancora S.H., Clarksboro, and Monmouth University. June 26th was the most prolific ozone day of the season. The highest 1-hour value of the 2003 season (0.151 ppm) was recorded at Monmouth University, while a total of six sites exceeded the 1-hour standard. Once again, every site except Ramapo exceeded the 8-hour standard as conditions conducive to ozone formation were in place throughout the region. Temperatures reached 97°, making June 26th the hottest day of the summer, and winds were now from the south-southwest. Similar conditions remained in place throughout the morning hours of the 27th, but by mid afternoon all of New Jersey was receiving brisk winds out of the west-northwest. However, nine sites still exceeded the 8-hour standard with the rural Chester location recording the highest concentration of the day with 0.099 ppm. This wind shift likely kept ozone concentrations in check and brought the only major ozone episode of the year to a close. Only the Rutgers University site exceeded the 8-hour standard on June 28th by barely making it above the standard with an 8-hour maximum concentration of 0.085 ppm.

Figure 10

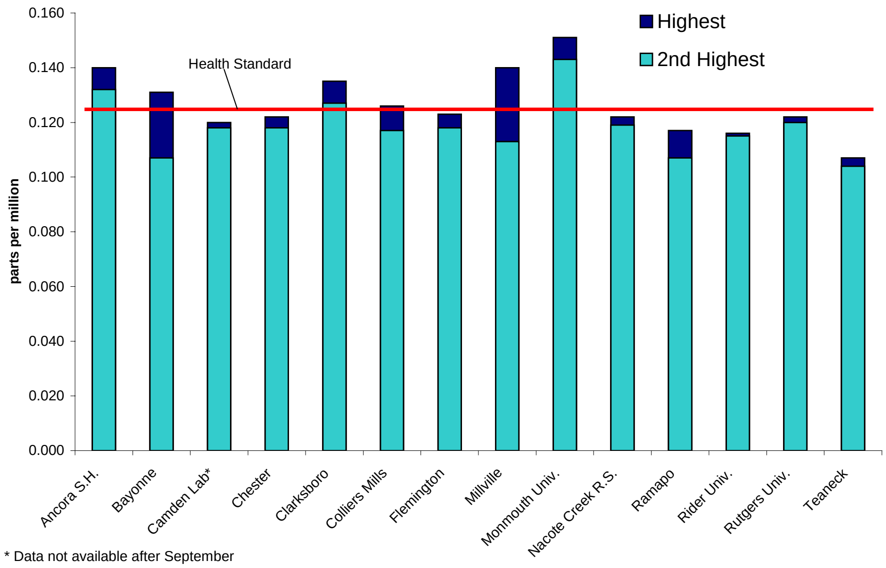


June 26, 2003

SUMMARY OF 2003 OZONE DATA RELATIVE TO THE 1-HOUR STANDARD

Of the 14 monitoring sites that were operated during the 2003 ozone season, six recorded levels above the old 1-hour standard of 0.12 ppm at least once during the year. Three sites had at least two exceedances, while Monmouth University recorded the most exceedances with four. The highest 1-hour concentration was 0.151 ppm at the Monmouth University site on June 26, 2003. By comparison, the 2002 ozone season had 13 sites that recorded levels above the standard and the maximum was 0.153 ppm, recorded at Colliers Mills.

Figure 11
Highest and Second Highest Daily 1-Hour Averages



* Data not available after September

Table 3
Ozone Data – 2003
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[a] 1-hour Average 2001-2003	# of days with 1-hour Averages above 0.12ppm
Ancora S.H.	0.140	0.132	0.122	2
Bayonne	0.131	0.107	0.130	1
Camden Lab[b]	0.120	0.118	0.128	0
Chester	0.122	0.118	0.122	0
Clarksboro	0.135	0.127	0.127	2
Colliers Mills	0.126	0.117	0.134	1
Flemington	0.123	0.118	0.128	0
Millville	0.140	0.113	0.129	1
Monmouth Univ.	0.151	0.143	0.128	4
Nacote Creek R.S.	0.122	0.119	0.107	0
Ramapo	0.117	0.107	0.116	0
Rider University	0.116	0.115	0.133	0
Rutgers University	0.122	0.120	0.132	0
Teaneck	0.107	0.104	0.127	0
Statewide	0.151	0.143	0.145	4

[a] Design value calculations exclude data affected by the July 2002 Canadian forest fire episode. See 2002 Air Quality Report for details.
[b] Data not available after September

SUMMARY OF 2003 OZONE DATA RELATIVE TO THE 8-HOUR STANDARD

All of the 14 monitoring sites that were operated during the 2003 ozone season recorded levels above the new 8-hour standard of 0.08 ppm. Monmouth University recorded the most exceedances with ten. The highest 8-hour concentration recorded was 0.131 ppm at the Monmouth University site on June 25, 2003. All sites recorded levels above the 8-hour standard in 2002 as well, with a maximum concentration of 0.138 ppm, recorded at the Colliers Mills site. Design values for the 8-hour standard were also above the standard at all sites, indicating that the ozone standard is being violated throughout New Jersey.

Figure 12
Ozone Design Values for 2001-2003

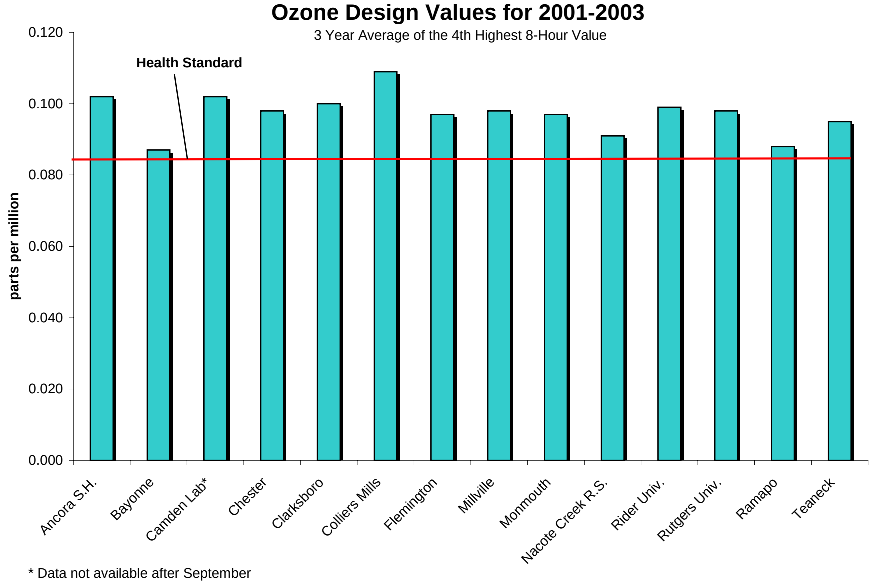


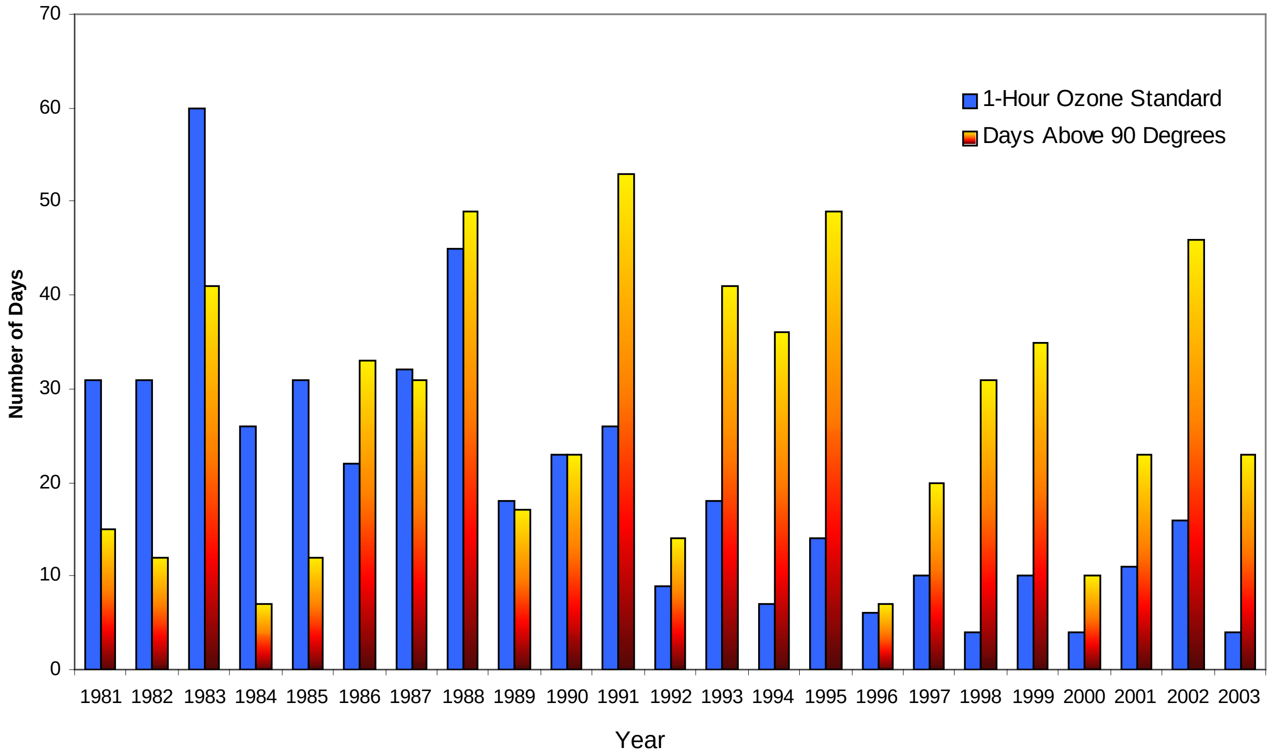
Table 4
Ozone Data – 2003
8-Hour Averages

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 [a] 8-hour Averages 2001-2003	# of days with 8-hour above 0.08ppm
Ancora S.H.	0.131	0.115	0.097	0.096	0.102	9
Bayonne	0.102	0.097	0.082	0.081	0.087	2
Camden Lab[b]	0.108	0.106	0.092	0.090	0.102	4
Chester	0.109	0.108	0.099	0.090	0.098	5
Clarksboro	0.123	0.112	0.097	0.090	0.100	6
Colliers Mills	0.116	0.111	0.096	0.095	0.109	9
Flemington	0.115	0.110	0.093	0.092	0.097	7
Millville	0.120	0.104	0.092	0.092	0.098	6
Monmouth Univ.	0.131	0.128	0.112	0.099	0.097	10
Nacote Creek R.S.	0.110	0.108	0.089	0.085	0.091	4
Ramapo	0.088	0.085	0.082	0.081	0.088	2
Rider University	0.110	0.107	0.094	0.086	0.099	7
Rutgers University	0.117	0.113	0.091	0.086	0.098	5
Teaneck	0.099	0.098	0.090	0.085	0.095	4
Statewide	0.131	0.131	0.112	0.099	0.110	20

[a] Design Value calculations exclude data affected by the July 2002 Canadian forest fire episode. See 2002 Air Quality Report for details.
[b] Data not available after September

Figure 13
Number of Days 1-Hour Ozone Standard Was Exceeded and Number of Days Above 90 Degrees
New Jersey 1981 - 2003



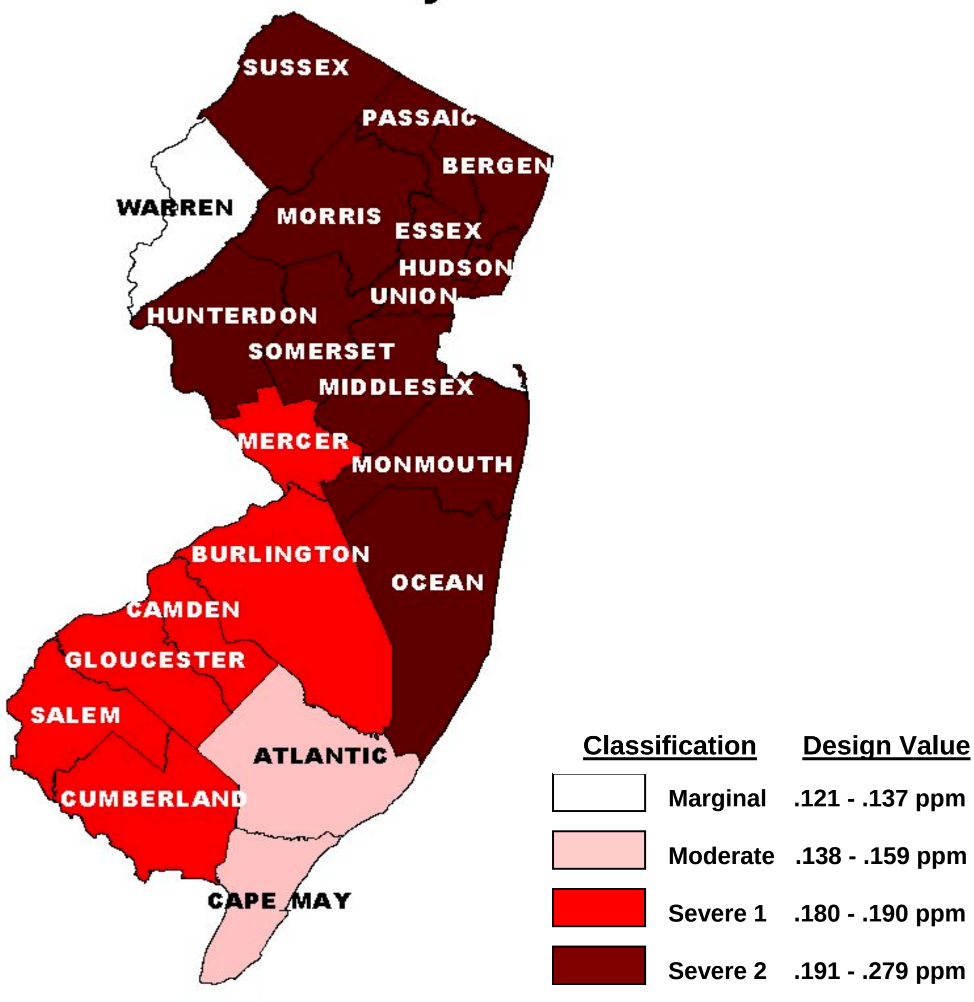
ACCOUNTING FOR THE INFLUENCE OF WEATHER

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 16. 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 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 1-hour ozone standard for example, the design value is the fourth highest daily maximum 1-hour average concentration recorded over a three year period. New Jersey is part of four planning areas, the New York, Philadelphia, Atlantic City and Allentown/Bethlehem areas. Their classification with respect to the old 1-hour standard is shown on the map below. Now that the new 8-hour average standard for ozone has been upheld by the courts, new designations will have to be made.

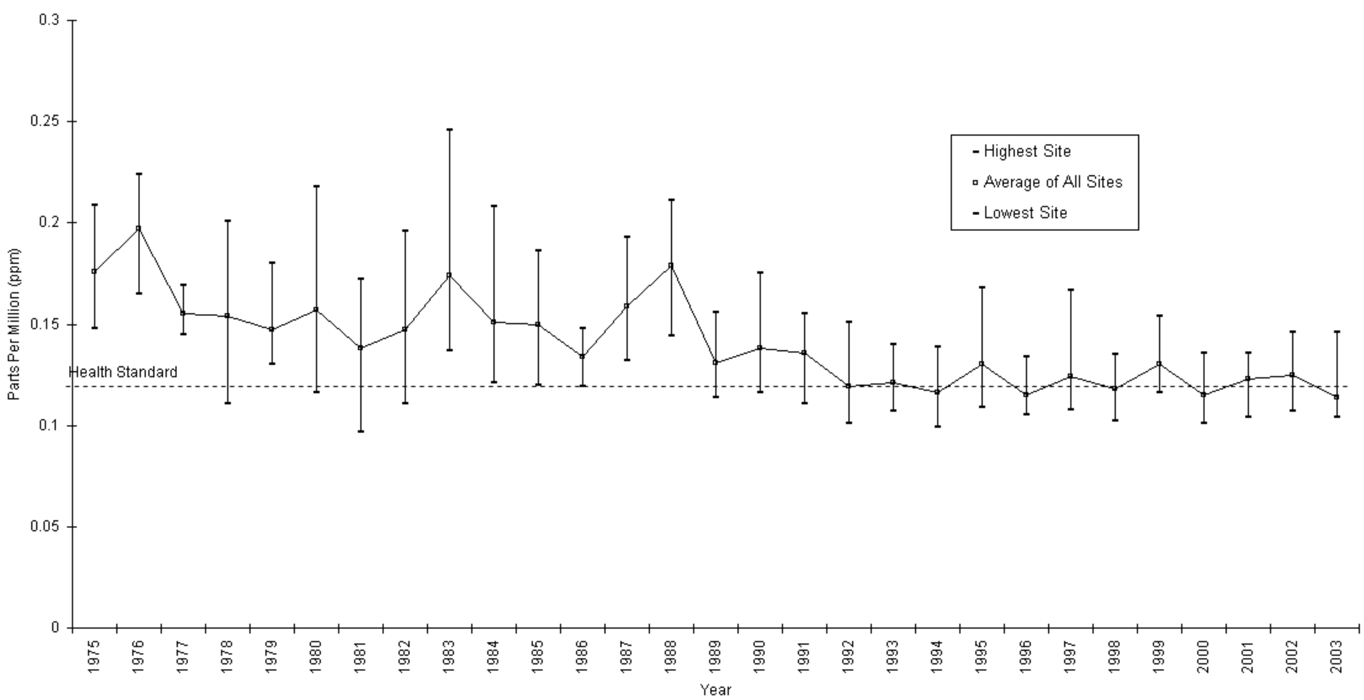
Figure 14
Ozone Non-Attainment Areas in New Jersey



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 0.20 ppm since 1988, and the last time levels above 0.18 ppm were recorded was in 1990. (Figure 15) But improvements may 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 15
Ozone Concentrations in New Jersey
1975 – 2003
Second Highest 1-Hour Averages



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