Appendix B

1.0 AIR QUALITY TRENDS SUMMARY

The New Jersey Department of Environmental Protection (NJDEP) analyzed various data for trends to determine New Jersey's progress in attaining the 8-hour ozone National Ambient Air Quality Standard (NAAQS). The trends analyzed include 8-hour ozone design values, monitor exceedances, meteorology, and ozone precursor concentrations. Eight-hour average ozone concentrations have been calculated since 1986, prior to the 8-hour ozone standard implementation in 1997 in New Jersey and before designations were made in 2004. Data for 8-hour ozone before 1997 are used for analysis purposes only and do not represent official reporting for the 8-hour ozone NAAQS.

In addition to trends in 8-hour ozone data, 1-hour ozone data were also analyzed. Trends for 1-hour ozone data include design values and monitor exceedances for New Jersey and both the New York and Philadelphia nonattainment areas.

1.1 An Overview of New Jersey's Monitoring Network

There are two primary networks of air monitoring sites in New Jersey: the Continuous Monitoring Network and the Manual Sampling Network.[1] Samples collected through the Manual Sampling Network are analyzed in a laboratory. Monitoring data from automated instrumentation in the Continuous Monitoring Network is reported in real time. A site location may have both types of instrumentation so that it is a part of both networks. Figures B1 and Figure B2 show the Continuous Monitoring Network and Manual Sampling Network, respectively. The Continuous Monitoring Network currently includes 14 sites at which ozone is measured year-round. The Manual Sampling Network includes six sites at which ozone precursors are measured seasonally and is discussed in further detail in Section 1.6. Figure B3 is a map of ozone monitoring site locations in New Jersey.

[1] NJDEP. 2004 Network Summary, 2004 Air Quality Report. New Jersey Department of Environmental Protection, Bureau of Air Monitoring, 2005.

Figure B1: 2005 New Jersey Continuous Monitoring Network

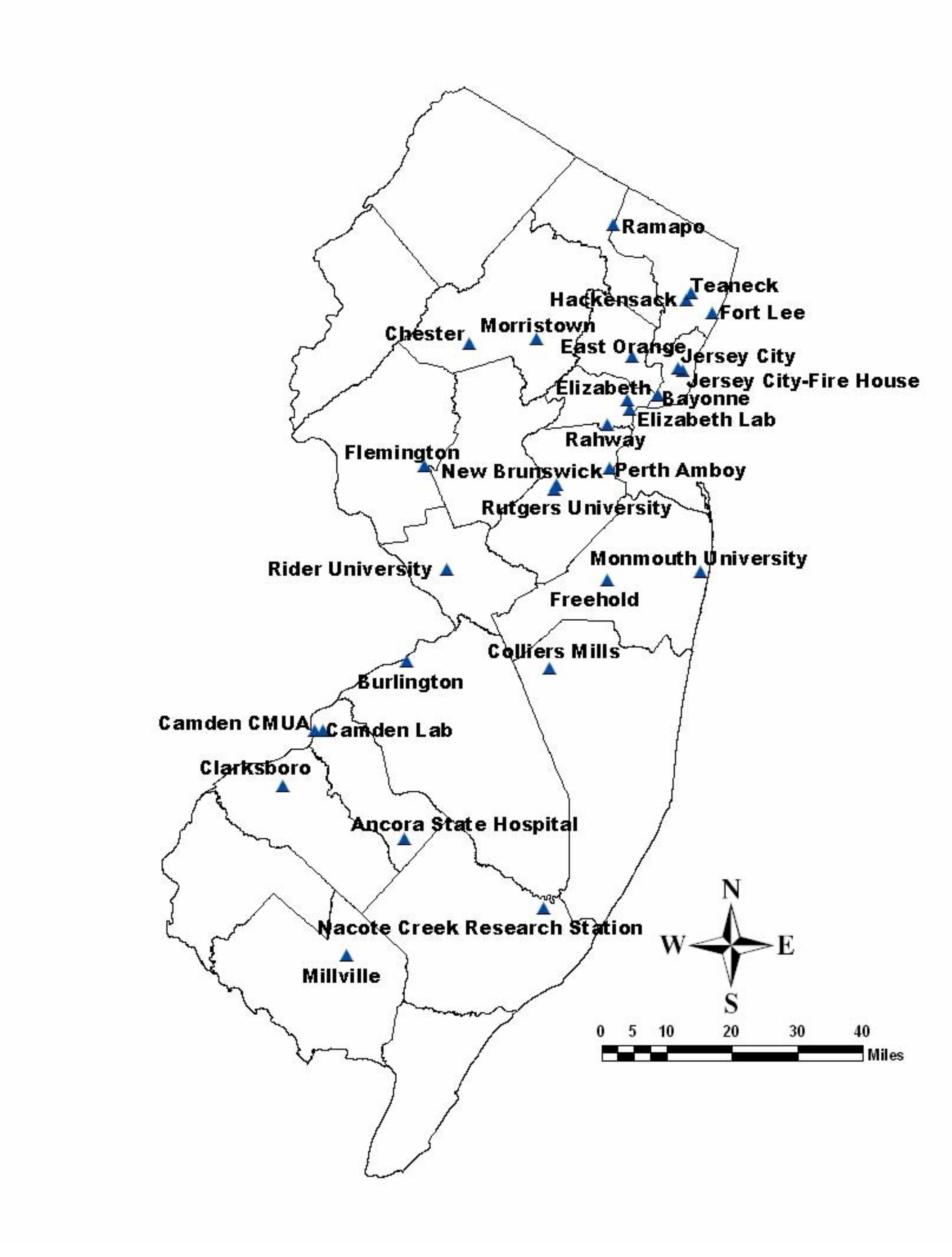
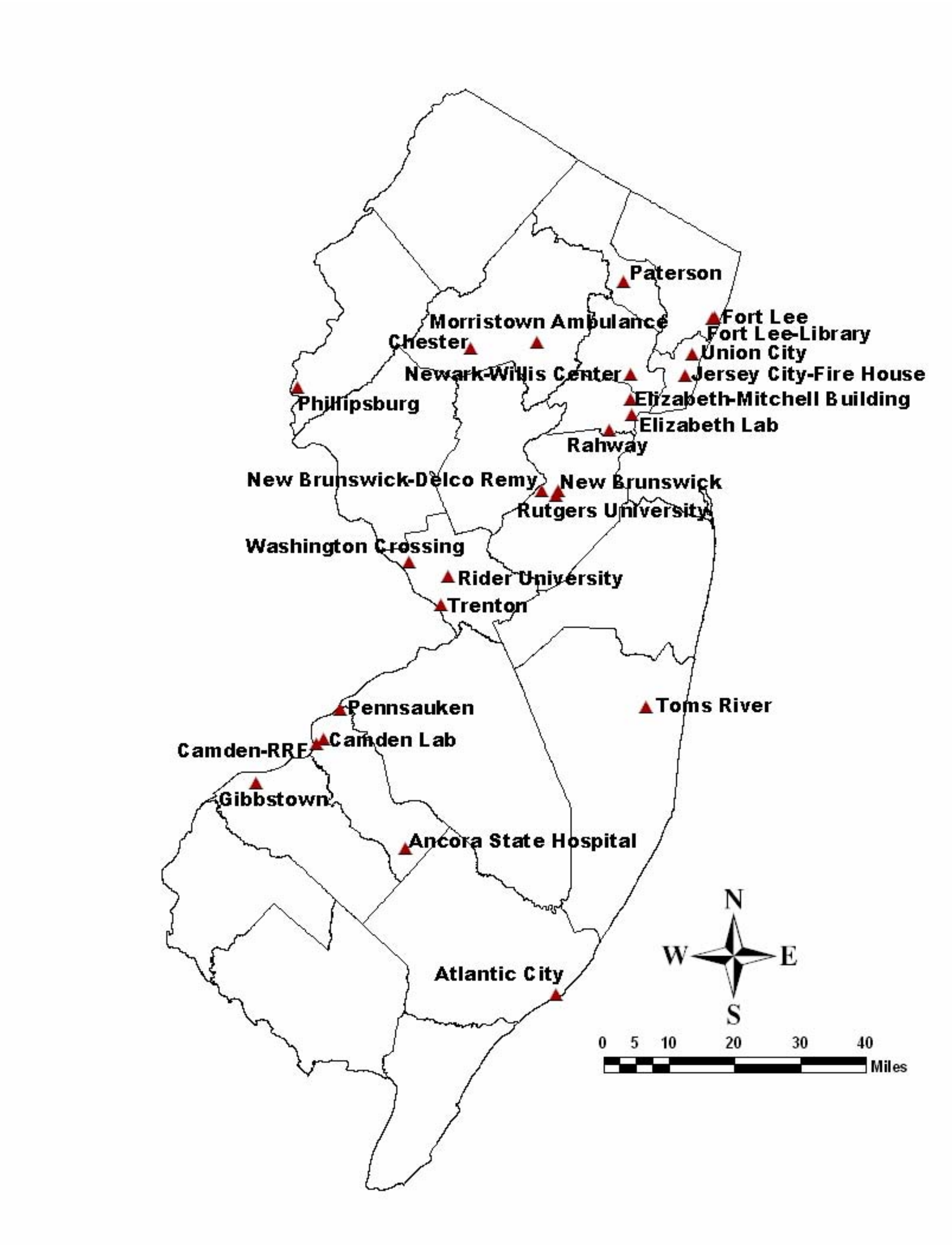
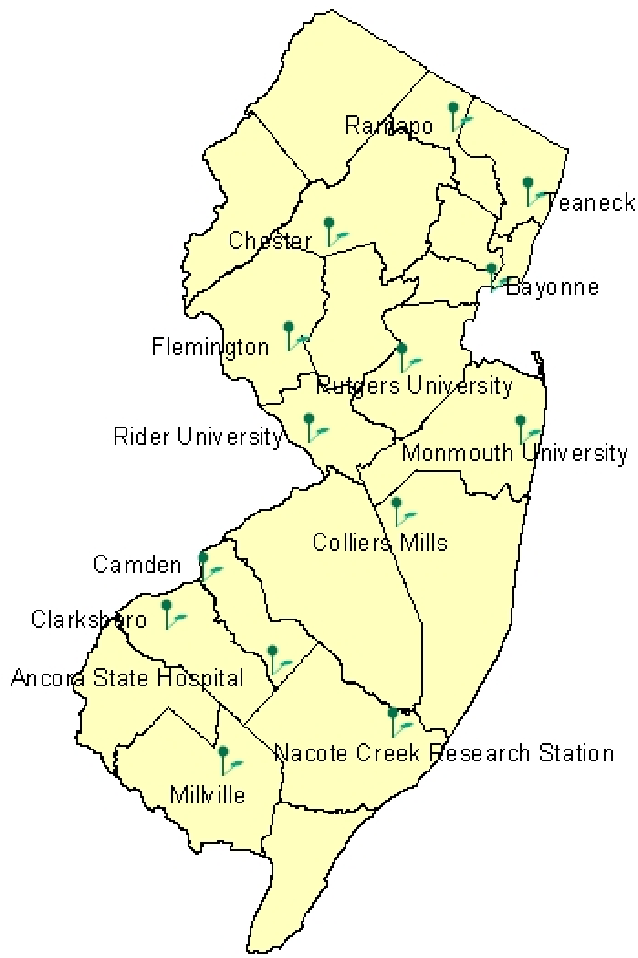


Figure B2: 2005 New Jersey Manual Monitoring Network



<u>Figure B3</u>: 2006 New Jersey Ozone Monitoring Network



1.2 1-Hour Ozone

1.2.1 1-Hour Ozone Design Values and Exceedances

In order to determine compliance for an area under the NAAQS for ozone, a design value is calculated based upon ambient air monitoring data and compared to the federal standard. An area is considered to be attaining the 1-hour average ozone standard if the average number of times the standard is exceeded at any one monitoring station over a three-year period was 1 or less (after correcting for missing data) (40 <u>C.F.R</u>. 50, Appendix H). Thus, it is the fourth highest daily maximum 1-hour concentration that occurs over a three-year period that determines if an area is in attainment. If the fourth highest value is above 0.12 parts per million (ppm) then the average number of exceedances is greater than 1. The fourth highest value is also known as the design value. One-hour ozone design values in nonattainment areas associated with New Jersey have declined substantially over time. The maximum 1-hour ozone average concentration (not shown) recorded in New Jersey in 1988 was 0.218 ppm, compared to a maximum of 0.119 ppm in 2004.[2] In fact, of the 14 ozone monitoring sites that were operating during the 2004 ozone season in New Jersey, none recorded levels above the 1-hour standard of 0.12 ppm during the year. Most recently, all but one New Jersey monitor (at 0.125 ppm) met the 1-hour ozone standard in 2006. Figure B4 displays the statewide maximum, median, and minimum site 1-hour ozone design values for New Jersey from 1986 to 2006. Figure B5 displays the 1-hour ozone design values for the 24 county 1-hour ozone New York nonattainment area from 1982 to 2006. Average 1-hour ozone design values in the 1-hour ozone New York nonattainment area from 1991-2006 have declined approximately 29 percent from average design values compared to 1982-1990 (pre-1990 Clean Air Act Amendments).[3,4] The design value for a nonattainment area is the maximum monitor design value for all monitors for each 3-year period.

One-hour ozone design values in the 1-hour ozone Philadelphia nonattainment area from 1991-2006 have declined approximately 20 percent from average design values compared to 1982-1990 (pre-1990 Clean Air Act Amendments).[5,6] Figure B6 displays the 1-hour ozone design values for the 14 county 1-hour ozone Philadelphia nonattainment area from 1982 to 2006.

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[2] NJDEP. 2004 Ozone Summary, 2004 Air Quality Report. New Jersey Department of Environmental Protection, Bureau of Air Monitoring, 2005.
[3] NJDEP. Mid-Course Review for the New Jersey Portion of the Philadelphia-Southern New Jersey and New York-Northern New Jersey 1-Hour Ozone Nonattainment Areas. New Jersey Department of Environmental Protection, Bureau of Air Quality Planning, January 2005.
[4] USEPA. AirData: Access to Air Pollution Data, 2006. United States Environmental Protection Agency, http://www.epa.gov/air/data/, accessed December 7, 2006.
[5] op. cit., note 3
[6] op. cit., note 4

<u>Figure B4</u>: New Jersey 1-Hour Ozone Design Values, 1988-2006
(Based on 4th Highest 1-Hour Average Concentration)

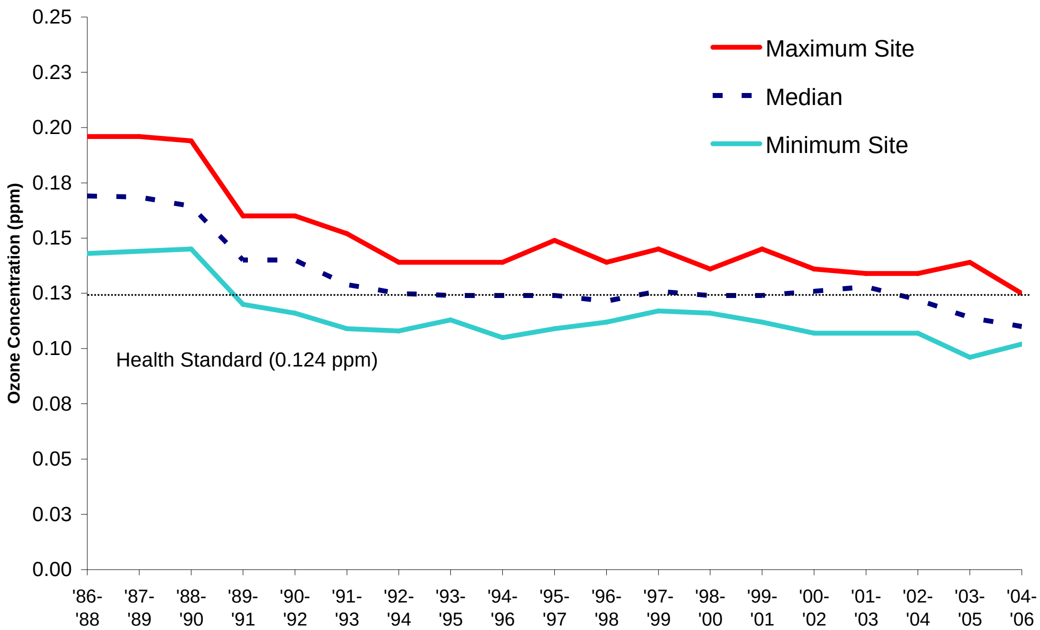
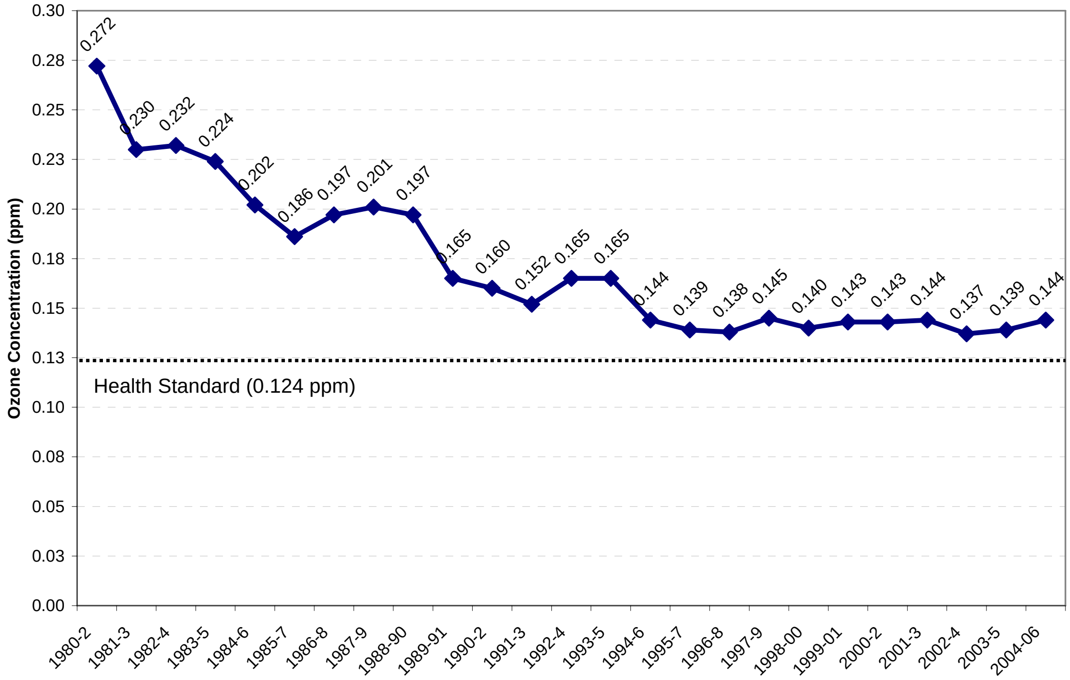
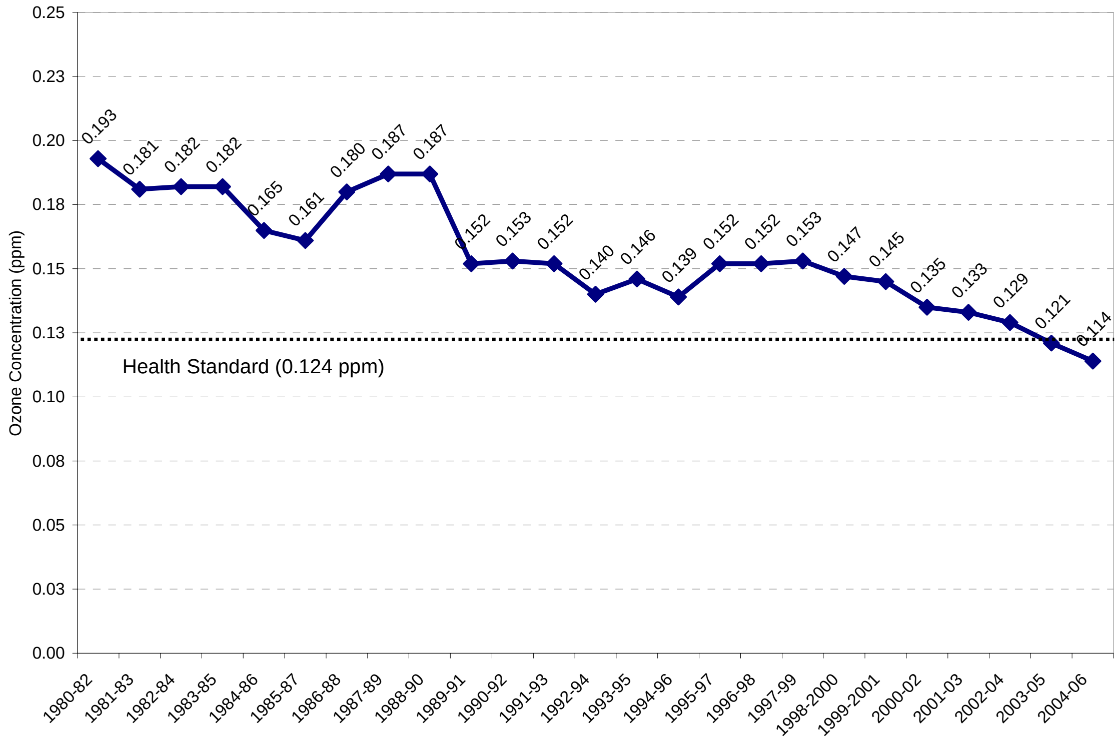


Figure B5: Design Values for the 1-Hour Ozone New York Nonattainment Area,[7] 1982-2006



[7] Only monitors with 3-years of valid 1-hour ozone concentrations were used. These design values do not include 1-hour ozone concentrations for some days in July 2002 for monitors in the New Jersey and Connecticut portions of the New York nonattainment area. Many states in the northeast have flagged this data as an exceptional event due to the influence of the northern Quebec forest fires.

Figure B6: Design Values for the 1-Hour Ozone Philadelphia Nonattainment Area,[8] 1982-2006



Monitored exceedances of the 1-hour ozone standard occur whenever a monitor's 1-hour ozone concentration is greater than or equal to 0.125 ppm. The declining total number days on which monitors exceeded the 1-hour ozone standard for New Jersey's monitors between 1985 and 2006 is shown in Figure B7. In addition, there has been a dramatic decrease in the number of monitored exceedances since 1985 in each nonattainment area.[9] In the New Jersey portion of 1-hour ozone New York nonattainment area, the number of monitored exceedances from 1991-2006 declined approximately 70 percent compared to the number of exceedances between 1980-90. This decrease cannot be attributed to a change in the number of monitors in the New Jersey portion of the 1-hour ozone New York nonattainment area since the number of ozone monitors has remained steady, with nine monitors operating in 1985 and eight in 2006.

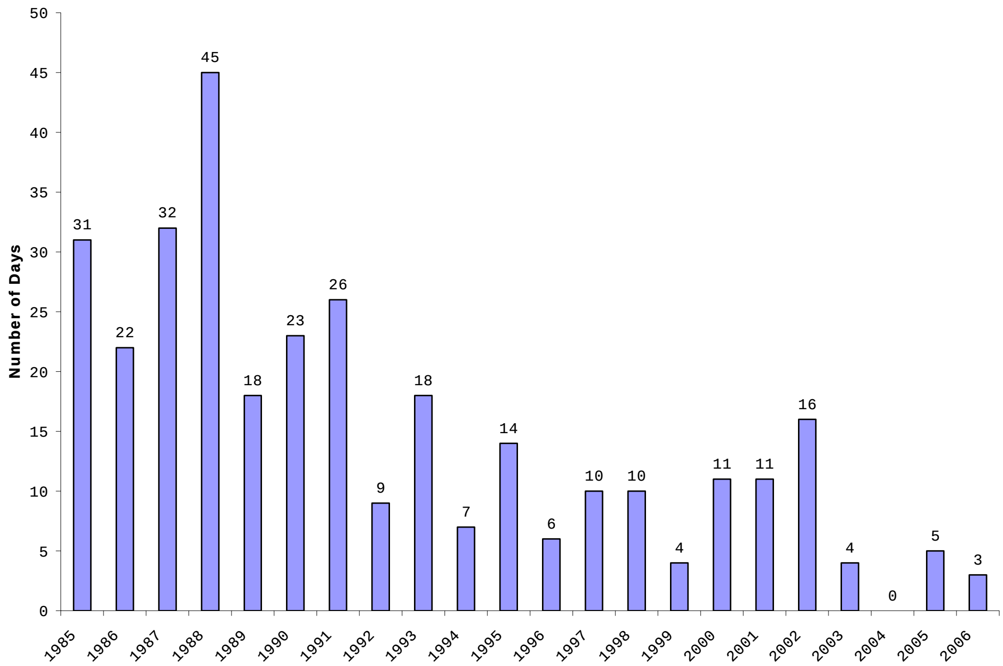
In the New Jersey portion of the 1-hour ozone Philadelphia nonattainment area, the number of monitored exceedances from 1991-2006 declined approximately 62 percent

[8] Only monitors with 3-years of valid 1-hour ozone concentrations were used. These design values do not include 1-hour ozone concentrations for July 8th and 9th, 2002. Many states in the northeast have flagged this data as an exceptional event due to the influence of the northern Quebec forest fires. For consistency, all data for these sites were removed from this analysis.

[9] op. cit., note 3

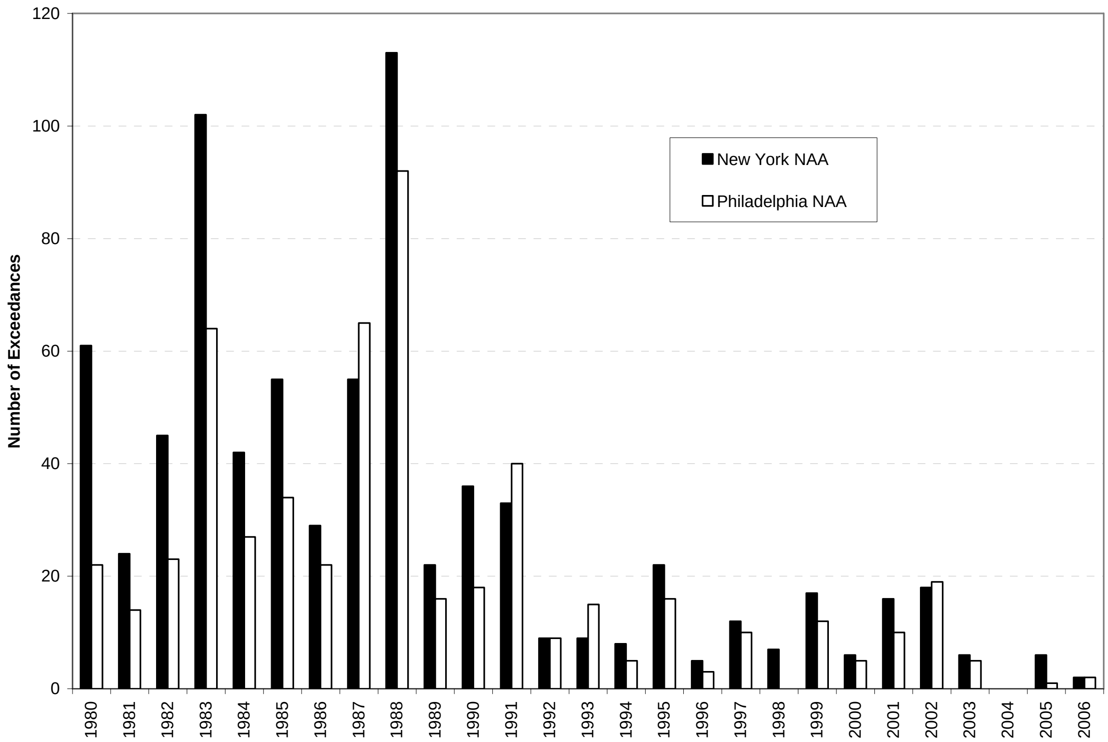
compared to the number of exceedances between 1980-90. Again, this decrease cannot be attributed to a change in the number of monitors in the New Jersey portion of the 1-hour ozone Philadelphia nonattainment area since the number of ozone monitors has remained relatively steady, with five monitors operating in 1985 and 2006. Figure B8 shows the monitored exceedances in the New Jersey portion of the 1-hour ozone Philadelphia and New York nonattainment areas.

<u>Figure B7</u>: Number of Days on which the 1-Hour Ozone Standard was Exceeded in New Jersey, 1985-2006[10]



[10] As used here, monitor exceedances refer to the total number of days the ozone health standard was exceeded.

<u>Figure B8</u>: Monitored Exceedances in the New Jersey Portion of 1-Hour Ozone New York and Philadelphia Nonattainment Areas,[11] 1980-2006



The data presented for the 1-hour ozone Philadelphia and New York nonattainment areas demonstrate that the states within those nonattainment areas have made great progress in reducing ozone precursor levels through the implementation of control strategies, thereby reducing ozone concentrations and exceedances in the region. However, further reductions in ozone precursors, not only from local sources but also from sources upwind of New Jersey, are needed in order to attain the 8-hour ozone NAAQS.

1.2.2 Other New Jersey-Associated 1-Hour Ozone Nonattainment Areas

As discussed in Chapter 11, in addition to the Philadelphia and New York nonattainment areas, the Atlantic City and Allentown-Bethlehem-Easton, PA-NJ nonattainment areas were originally designated as moderate. Both of these areas have ambient air quality levels that meet the 1-hour ozone NAAQS. For additional details on these nonattainment areas, refer to Chapter 11.

[11] As used here, monitor exceedances refer to the sum across the network of each monitor's individual number of exceedance days in a given year.

1.3 8-Hour Ozone

Seven of these monitors operate in the 12 county New Jersey portion of Northern New Jersey/New York/Connecticut nonattainment area. In the entire 8-hour ozone Southern New Jersey/Philadelphia nonattainment area, there are currently 22 ozone monitors. Seven of these monitors operate in the nine county New Jersey portion of the 8-hour ozone Southern New Jersey/Philadelphia nonattainment area.

1.3.1 8-Hour Ozone Design Values

A design value under the 8-hour ozone NAAQS is defined as the average of the fourth highest daily maximum 8-hour ozone concentration that is recorded each year for three years for a given monitoring site (40 C.F.R. 50, Appendix I). For this analysis, only monitors with 3-years of valid 8-hour ozone concentrations were used.[12] The statewide maximum, median, and minimum site 8-hour ozone design values for New Jersey are displayed in Figure B9. The overall trend for the 8-hour ozone design values in New Jersey is declining. Median design values from 1988-2006 have declined approximately 28 percent.

Figure B10 shows that the trends are similar for the average 8-hour ozone design values for the Northern New Jersey and Southern New Jersey portions of each nonattainment area. Average 8-hour ozone design values in the 8-hour ozone Northern New Jersey/New York/Connecticut nonattainment area from 1999-2006 have declined approximately 14 percent.[13] Figure B11 displays the 8-hour ozone design value for the 24 county Northern New Jersey/New York/Connecticut nonattainment area from 1999 to 2006.[14] The design value for an entire nonattainment area is the monitor in the nonattainment area with the highest design value. The 8-hour ozone Northern New Jersey/New York/Connecticut nonattainment area's current monitor with the highest design value is Danbury, Fairfield County, Connecticut.

Average 8-hour ozone design values in the 8-hour ozone Southern New Jersey/Philadelphia nonattainment area from 1999-2006 have declined approximately 16 percent.[15] Figure B12 displays the 8-hour ozone design values for the 18 county Southern New Jersey/Philadelphia nonattainment area from 1999-2006.[16] In the entire 8-hour ozone Southern New Jersey/Philadelphia nonattainment area, there are currently 22

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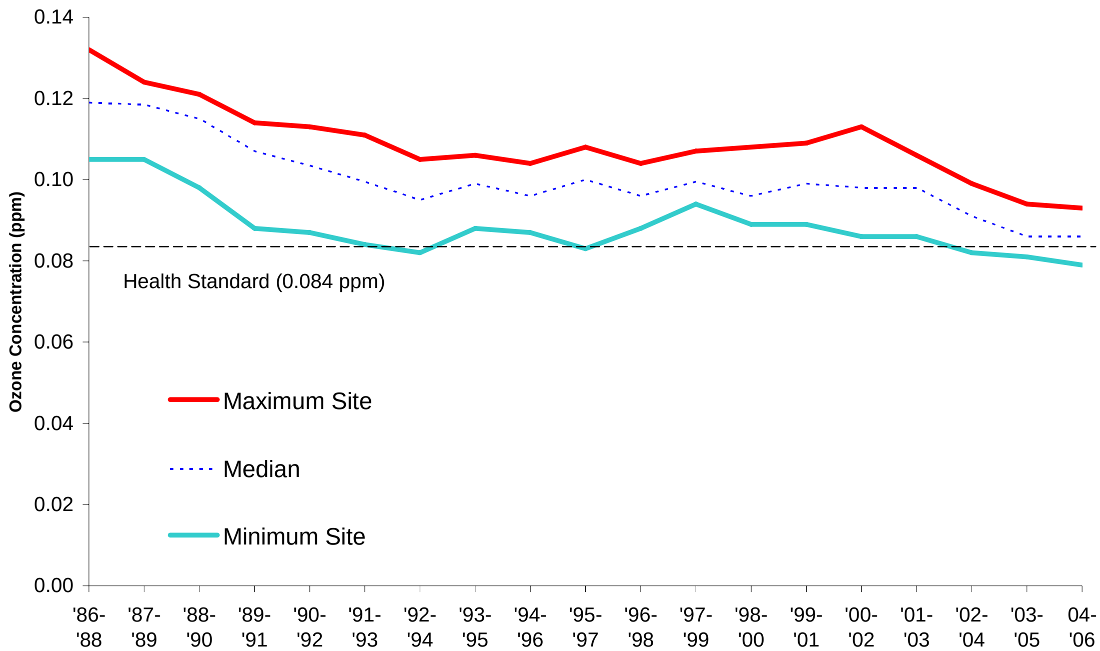
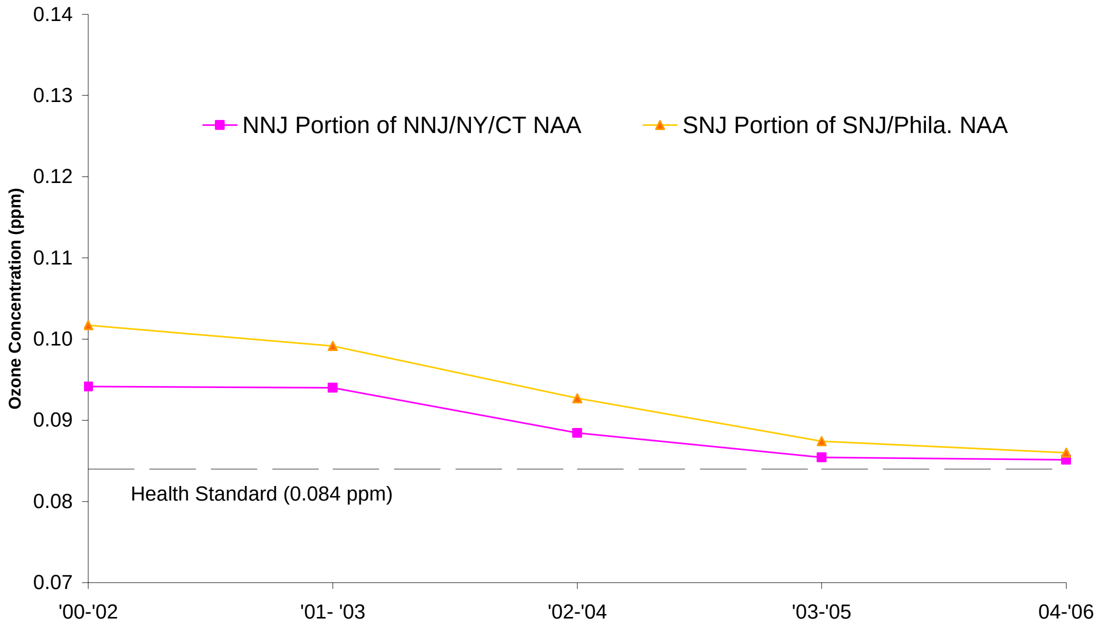
[12] These design values do not include 8-hour ozone concentrations for some days in July 2002. Many states in the northeast have flagged this data as an exceptional event due to the influence of the northern Quebec forest fires. For consistency, all data for these dates were removed from this analysis.
[13] Data for other states in the nonattainment areas were obtained from USEPA's Air Quality System (AQS) and might not reflect states' corrected data, T. Downs, personal communication, November 3, 2006.
[14] USEPA. 8-Hour Ozone Nonattainment Area/State/County Report. United States Environmental Protection Agency, 2006, http://www.epa.gov/air/oaqps/greenbk/gnca.html, accessed November 8, 2006.
[15] ibid.
[16] op. cit., note 13

ozone monitors. Seven of these monitors operate in the nine county New Jersey portion of the 8-hour ozone Southern New Jersey/Philadelphia nonattainment area. The 8-hour ozone Southern New Jersey/Philadelphia nonattainment area's current monitor with the highest design value is Colliers Mills, Ocean County, New Jersey.

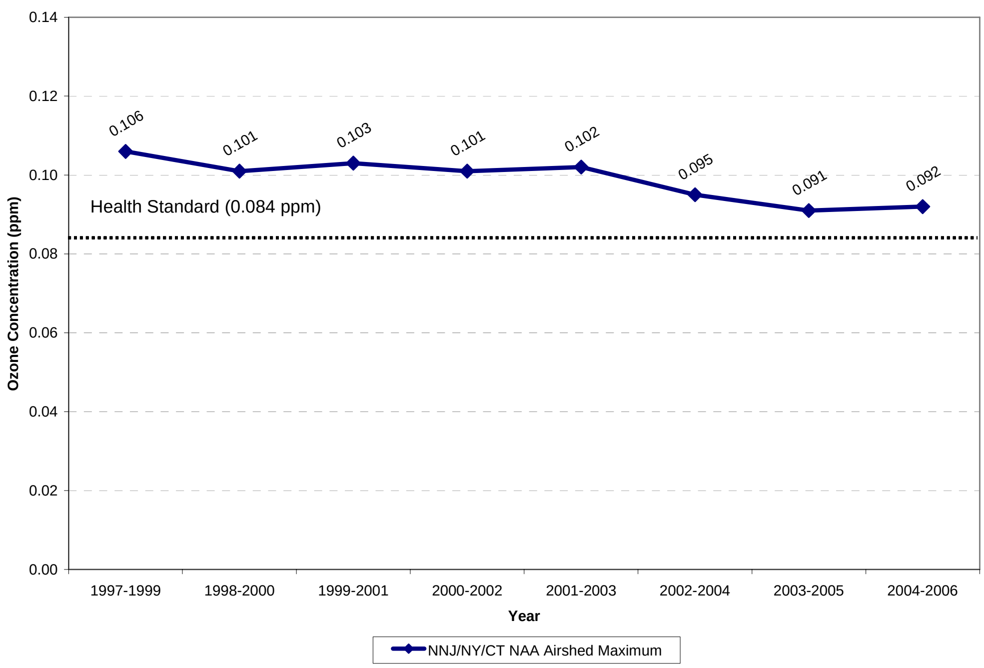
<u>Figure B9</u>: New Jersey 8-Hour Ozone Design Values, 1988-2006
(Based on 3-Year Average of 4th Highest Daily 8-Hour Concentration)



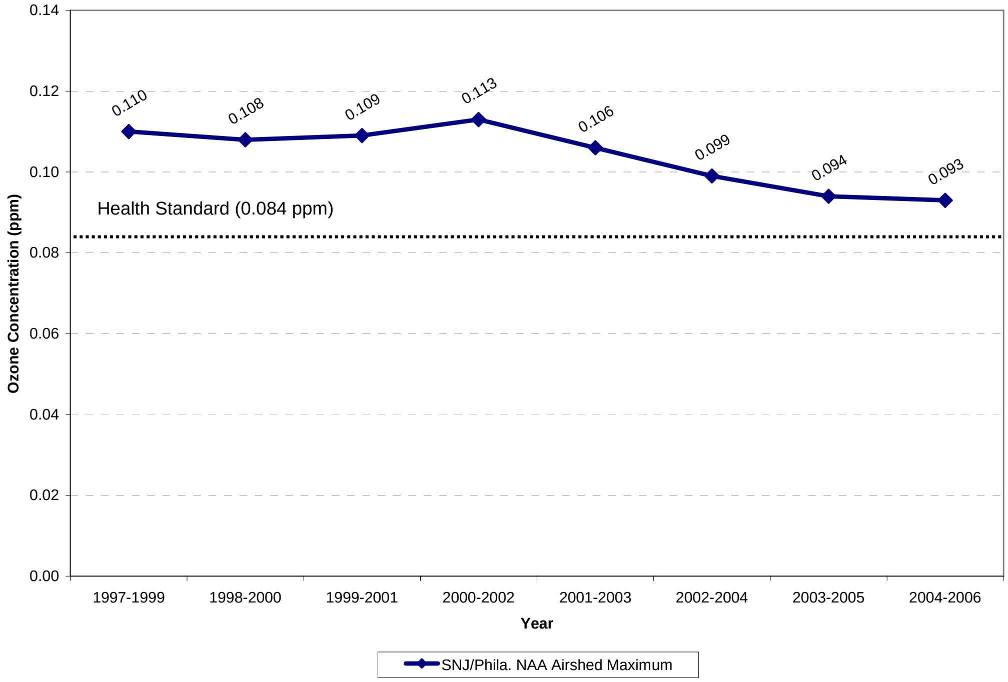
<u>Figure B10</u>: 8-Hour Ozone Design Values for the New Jersey Portions of Each Nonattainment Area



<u>Figure B11</u>: NNJ/NY/CT Nonattainment Area 8-Hour Ozone Design Values, 1999-2006



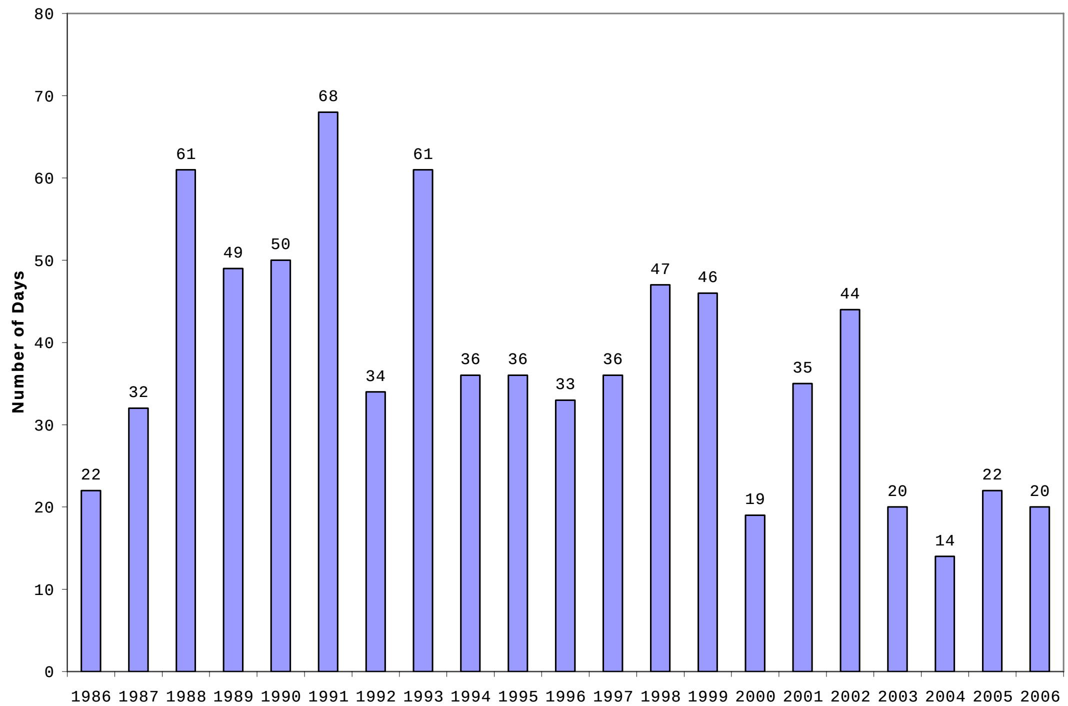
<u>Figure B12</u>: SNJ/Phila. Nonattainment Area 8-Hour Ozone Design Values, 1999-2006



1.3.2 8-Hour Ozone Monitor Exceedances

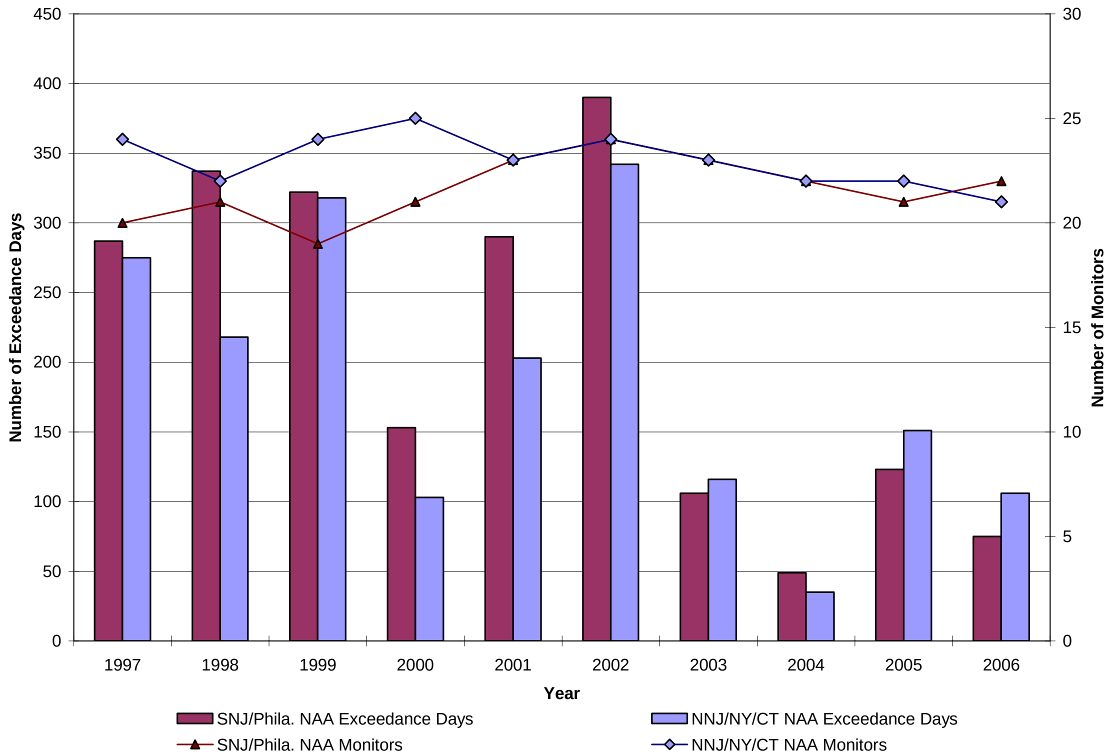
Monitored exceedances (i.e., number of days that exceeded the health standard) occur whenever a monitor's 8-hour ozone concentration is greater than or equal to 0.085 ppm. The total number of monitored exceedances of the 8-hour ozone standard for New Jersey between 1986 and 2006 are shown in Figure B13. There is a slight decreasing trend in the number of monitored exceedances in New Jersey. Figure B14 shows the monitored exceedances along with the number of monitors in a given year within each nonattainment area. In the 8-hour ozone Northern New Jersey/New York/Connecticut nonattainment area, the total number of monitored exceedances declined approximately 61 percent from 1997-2006. In the 8-hour ozone Southern New Jersey/Philadelphia nonattainment area, the total number of monitored exceedances from 1997-2006 declined approximately 74 percent. This decrease cannot be attributed to a change in the number of monitors in either nonattainment area since the number of ozone monitors measuring 8-hour ozone has remained relatively consistent over the time period considered (24 in 1997 versus 21 in 2006 in the 8-hour ozone Northern New Jersey/New York/Connecticut nonattainment area, and 20 in 1997 versus 22 in 2006 in the 8-hour ozone Southern New Jersey/Philadelphia nonattainment area).

<u>Figure B13</u>: Number of Days on which the 8-Hour Ozone Standard was Exceeded in New Jersey,[17] 1985-2006



[17] As used here, monitor exceedances refer to the total number of days the ozone health standard was exceeded.

<u>Figure B14</u>: Monitored Exceedances in the 8-Hour Ozone NNJ/NY/CT Nonattainment Area and SNJ/Phila. Nonattainment Area, 1997-2006[18,19]



1.3.3 New Jersey Monitor Trends

Eight-hour ozone monitor trends were analyzed for the New Jersey portions of Northern New Jersey/New York/Connecticut nonattainment area and Southern New Jersey/Philadelphia nonattainment area.[20] As mentioned previously, continuous monitoring for 8-hour ozone began in 1986 in New Jersey, well before the 8-hour standard was in place and before designations were made in 2004. Thus, there are monitors that were associated with different nonattainment areas under the 1-hour ozone standard compared to the current 8-hour standard. Due to monitor relocations and new monitoring sites, data from closely related monitors are listed to account for the entire 1986-2006 timeframe and are noted appropriately as the data are presented.

Table B1 lists current 8-hour ozone design values, average design values for 1988-2006, and the percent change from 1986-88 design values for the seven monitors presently in the 12 county New Jersey portion of the 8-hour ozone Northern New Jersey/New

[18] As used here, monitor exceedances refer to the sum across the network of each monitor's individual number of exceedance days in a given year.
[19] op. cit., note 13
[20] ibid.

York/Connecticut nonattainment area. Figure B15 displays the initial and current design values for these monitors. Design values have fallen 7-32 percent.

<u>Table B1</u>: 8-Hour Ozone Design Values in the Twelve County New Jersey Portion of the NNJ/NY/CT Nonattainment Area

County[a]	Monitor	1988 Design Value[b] (ppm)	2006 Design Value (ppm)	Average 1988-2006 Design Value[c] (ppm)	Percent Change
Bergen	**Teaneck[d]**	0.092 (‘00-’02)	0.086	0.089	-7
Hudson	**Bayonne**	0.117	0.086	0.098	-26
Hunterdon	**Flemington**	0.111	0.089	0.100	-20
Middlesex	**New Brunswick & Rutgers University[e]**	0.122	0.088	0.102	-28
Monmouth	**Monmouth University[f]**	0.108 (‘89-‘91)	0.085	0.096	-21
Morris	**Chester**	0.121	0.082	0.100	-32
Passaic	**Ramapo[g]**	0.089 (‘96-’98)	0.080	0.087	-8

a) Counties that do not presently have monitors for ozone include Essex, Somerset, Sussex, Union, and Warren.
b) If 1988 data were not available, then the earliest dataset available was used and is indicated per monitor.
c) The average design value is an average of all of the design values over 1986-2006.
d) The Teaneck monitor began measuring ozone in 2000. The first available design value was 2000-2002.
e) The Rutgers University monitor replaced the New Brunswick monitor. These 2 monitors were approximately 1 mile apart. For this analysis, the 1988-95 values at New Brunswick were used and the 1997-2006 values at Rutgers University were used. The design value for 1996 was calculated using fourth highest values from both sites.
f) The Monmouth University monitor began measuring ozone in 1989. The first available design value was 1989-1991.
g) Available 8-hour ozone data for the Ramapo monitor only included 1998-2006.

<u>Figure B15</u>: 8-Hour Ozone Design Values in the Twelve County New Jersey Portion of the NNJ/NY/CT Nonattainment Area

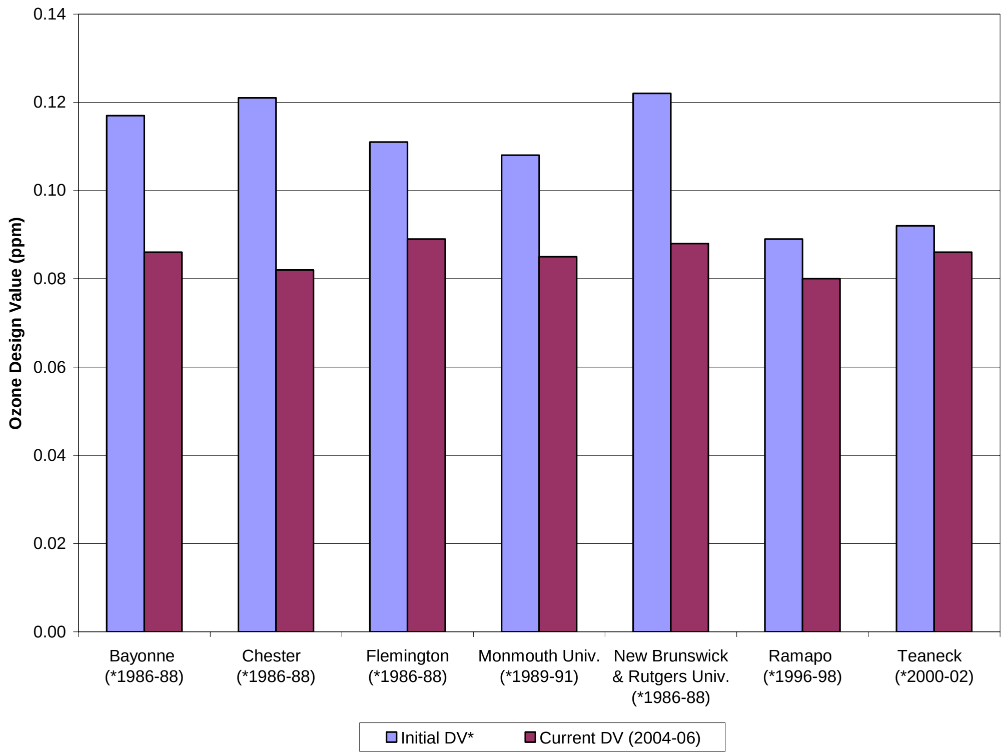


Table B2 lists the average number of days on which the 8-hour ozone standard was exceeded (i.e., an exceedance day) by a monitor in the 12 county New Jersey portion of the 8-hour ozone Northern New Jersey/New York/Connecticut nonattainment area for 1986-2006, if the 8-hour ozone standard had been in place prior to 1997. Figure B16 displays the initial and current exceedances for these monitors. Two more exceedances were observed at the Teaneck monitor in 2006 compared to 2000. There have been significant reductions in the number of 8-hour ozone exceedance days for the other New Jersey monitors in this nonattainment area. Overall, 8-hour ozone exceedance days at individual monitors decreased up to 88 percent.

<u>Table B2</u>: 8-Hour Ozone Exceedances in the Twelve County New Jersey Portion of the NNJ/NY/CT Nonattainment Area, 1986-2006

County[a]	Monitor	1986 Exceedance Days[b] (per year)	2006 Exceedance Days (per year)	Average 1986-2006 Exceedance Days[c] (per year)	Percent Change
Bergen	**Teaneck[d]**	2 ('00)	4	7	100
Hudson	**Bayonne**	11	6	12	-45
Hunterdon	**Flemington**	15	5	16	-67
Middlesex	**New Brunswick & Rutgers University[e]**	22	6	15	-73
Monmouth	**Monmouth University[f]**	15 ('89)	5	11	-67
Morris	**Chester**	29	9	17	-69
Passaic	**Ramapo[g]**	8 ('98)	1	7	-88

a) Counties that do not presently have monitors for ozone include Essex, Somerset, Sussex, Union, and Warren.
b) If 1986 data were not available, then the earliest dataset available was used and is indicated per monitor.
c) The average number of exceedance days is an average of all of the exceedance days per year over 1986-2006.
d) The Teaneck monitor began measuring ozone in 2000.
e) The Rutgers University monitor replaced the New Brunswick monitor. These 2 monitors were approximately 1 mile apart. For this analysis, the 1986-94 values at New Brunswick were used and the 1996-2006 values at Rutgers University were used. The average value of each monitor's exceedances for 1995 was used.
f) The Monmouth University monitor began measuring ozone in 1989.
g) Available 8-hour ozone data for the Ramapo monitor only included 1998-2006.

<u>Figure B16</u>: 8-Hour Ozone Exceedances in the Twelve County New Jersey Portion of the NNJ/NY/CT Nonattainment Area, 1986-2006

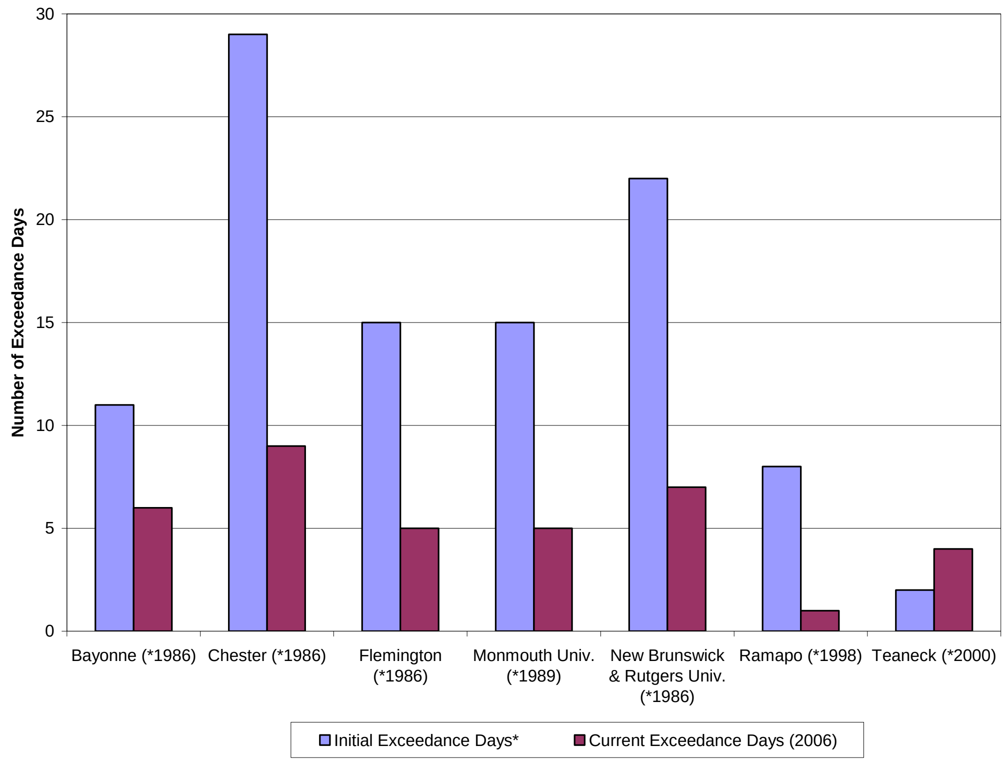


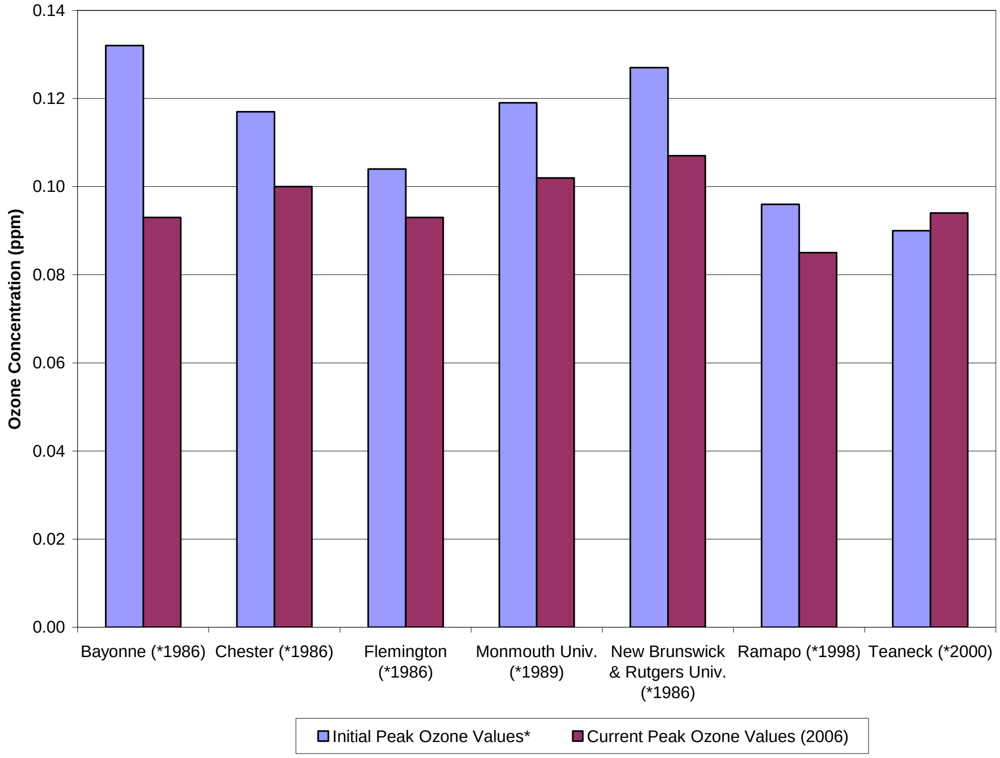
Table B3 lists the changes in peak 8-hour ozone concentrations, had the 8-hour standard been implemented prior to 1997, for the seven monitors in the 12 county New Jersey portion of the Northern New Jersey/New York/Connecticut nonattainment area that had continuous 8-hour measurements between 1986 and 2006. Figure B17 displays the initial and current peak ozone values for these monitors. Peak 8-hour ozone concentrations have generally decreased by 11-30 percent, however, peak 8-hour ozone concentrations within the 1986-2006 timeframe have increased by 4 percent for the Teaneck monitor.

Table B3: Peak 8-Hour Ozone Concentrations in the Twelve County New Jersey Portion of the NNJ/NY/CT Nonattainment Area, 1986-2006

County[a]	Monitor	8-Hour Ozone Peak Values (ppm)			
		1986[b]	2006	Average 1986-2006[c]	Percent Change
Bergen	**Teaneck**[d]	0.090 ('00)	0.094	0.099	4
Hudson	**Bayonne**	0.132	0.093	0.115	-30
Hunterdon	**Flemington**	0.104	0.093	0.110	-11
Middlesex	**New Brunswick & Rutgers University**[e]	0.127	0.106	0.117	-17
Monmouth	**Monmouth University**[f]	0.119 ('89)	0.102	0.117	-14
Morris	**Chester**	0.117	0.100	0.112	-15
Passaic	**Ramapo**[g]	0.096 ('95)	0.085	0.096	-11

a) Counties that do not presently have monitors for ozone include Essex, Somerset, Sussex, Union, and Warren.
b) If 1986 data were not available, then the earliest dataset available was used and is indicated per monitor.
c) The average 8-hour ozone peak value is the average of the 8-hour ozone peak value for each year within the 1986-2006 timeframe.
d) The Teaneck monitor began measuring ozone in 2000.
e) The Rutgers University monitor replaced the New Brunswick monitor. These 2 monitors were approximately 1 mile apart. For this analysis, the 1986-94 values at New Brunswick were used and the 1996-2006 values at Rutgers University were used. The average value of each monitor's peak ozone value for 1995 was used.
f) The Monmouth University monitor began measuring ozone in 1989.
g) Available data for the Ramapo monitor only included 1995 and 1998-2006.

<u>Figure B17</u>: Peak 8-Hour Ozone Concentrations in the Twelve County New Jersey Portion of the NNJ/NY/CT Nonattainment Area, 1986-2006



Eight-hour ozone monitor trends were also analyzed for the nine county New Jersey portion of the 8-hour ozone Southern New Jersey/Philadelphia nonattainment area. It should be noted that the Colliers Mills monitor replaced the monitor that was in place at the time the 1-hour ozone nonattainment classifications were made in 1990.[21] The original monitor site was located at McGuire Air Force Base in Burlington County. Subsequent to the 1-hour ozone nonattainment designations, the monitor at McGuire Air Force Base was relocated 6 miles away in Colliers Mills, Ocean County, which was part of the New York nonattainment area under the 1-hour ozone standard but is now part of Southern New Jersey/Philadelphia nonattainment area for the 8-hour ozone standard. This relocation took place because the monitor could no longer be accommodated at McGuire Air Force Base. Colliers Mills is downwind of most of the major emission sources in the Southern New Jersey/Philadelphia nonattainment area. As such, the USEPA agreed to include this monitor in the Southern New Jersey/Philadelphia nonattainment area because this monitor is heavily influenced by emissions from this area.

Table B4 lists current 8-hour ozone design values, average design values for 1988-2006, and the percent change from 1986-88 for all monitors in the nine county New Jersey

[21] op. cit., note 3

portion of Southern New Jersey/Philadelphia nonattainment area. Figure B18 displays the initial and current design values for these monitors. Design values have fallen 19-36 percent.

Table B4: 8-Hour Ozone Design Values in the Nine County New Jersey Portion of the SNJ/Phila. Nonattainment Area

County[a]	Monitor	1988 Design Value[b] (ppm)	2006 Design Value (ppm)	Average 1988-2006 Design Value[c] (ppm)	Percent Change
Atlantic	**Nacote Creek Research Station**	0.105	0.079	0.095	-25
Camden	**Camden Lab**	0.132	0.084	0.101	-36
	Ancora State Hospital	0.119	0.089	0.104	-25
Cumberland	**Millville**	0.112	0.084	0.098	-25
Gloucester	**Clarksboro**	0.122	0.086	0.103	-30
Mercer	**Rider University**	0.124	0.087	0.104	-30
Ocean	**McGuire AFB & Colliers Mills[d]**	0.115	0.093	0.106	-19

a) Counties that do not presently have monitors for ozone include Burlington, Cape May, and Salem.
b) If 1988 data were not available, then the earliest dataset available was used and is indicated per monitor.
c) The average design value is an average of all of the design values over 1986-2006.
d) The Colliers Mills monitor replaced the McGuire Air Force Base (AFB) monitor. These 2 monitors were approximately 6 miles apart. For this analysis, the 1988-91 values at McGuire AFB were used and the 1994-2006 values at Rutgers University were used. The 1992 and 1993 design values were calculated using fourth highest values from each monitor.

<u>Figure B18</u>: 8-Hour Ozone Design Values in the Nine County New Jersey Portion of the SNJ/Phila. Nonattainment Area

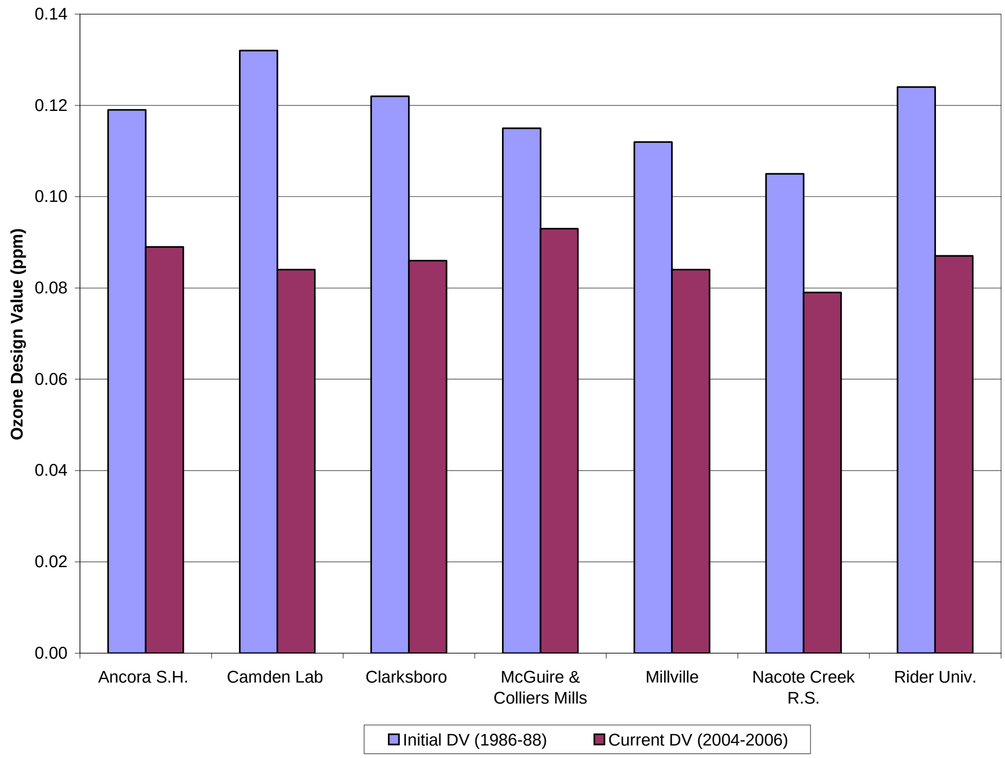


Table B5 lists the average number of days on which the 8-hour ozone standard was exceeded (i.e., an exceedance day) by a monitor in the nine county New Jersey portion of the 8-hour ozone Southern New Jersey/Philadelphia nonattainment area for 1986-2006, if the 8-hour ozone standard had been in place prior to 1997. Figure B19 displays the initial and current exceedances for these monitors. There have been significant reductions in the number of 8-hour ozone exceedance days for the other New Jersey monitors for this nonattainment area. Overall, 8-hour ozone exceedance days at individual monitors decreased 40-89 percent.

Table B5: 8-Hour Ozone Exceedances in the Nine County New Jersey Portion of the SNJ/Phila. Nonattainment Area, 1986-2006

County[a]	Monitor	1986 Exceedance Days[b] (per year)	2006 Exceedance Days (per year)	Average 1986-2006 Exceedance Days[c] (per year)	Percent Change
Atlantic	**Nacote Creek Research Station**	8	1	12	-88
Camden	**Camden Lab**	28	4	15	-86
	Ancora State Hospital	24	6	21	-75
Cumberland	**Millville**	19	2	15	-89
Gloucester	**Clarksboro**	26	3	18	-88
Mercer	**Rider University**	27	8	19	-70
Ocean	**McGuire AFB & Colliers Mills[d]**	15	9	18	-40

a) Counties that do not presently have monitors for ozone include Burlington, Cape May, and Salem.
b) If 1986 data were not available, then the earliest dataset available was used and is indicated per monitor.
c) The average number of exceedance days is an average of all of the exceedance days per year over 1986-2006.
d) The Colliers Mills monitor replaced the McGuire AFB monitor. These 2 monitors were approximately 6 miles apart. For this analysis, the 1986-91 values at McGuire AFB were used and the 1992-2006 values at Rutgers University were used.

<u>Table B19</u>: 8-Hour Ozone Exceedances in the Nine County New Jersey Portion of the SNJ/Phila. Nonattainment Area, 1986-2006

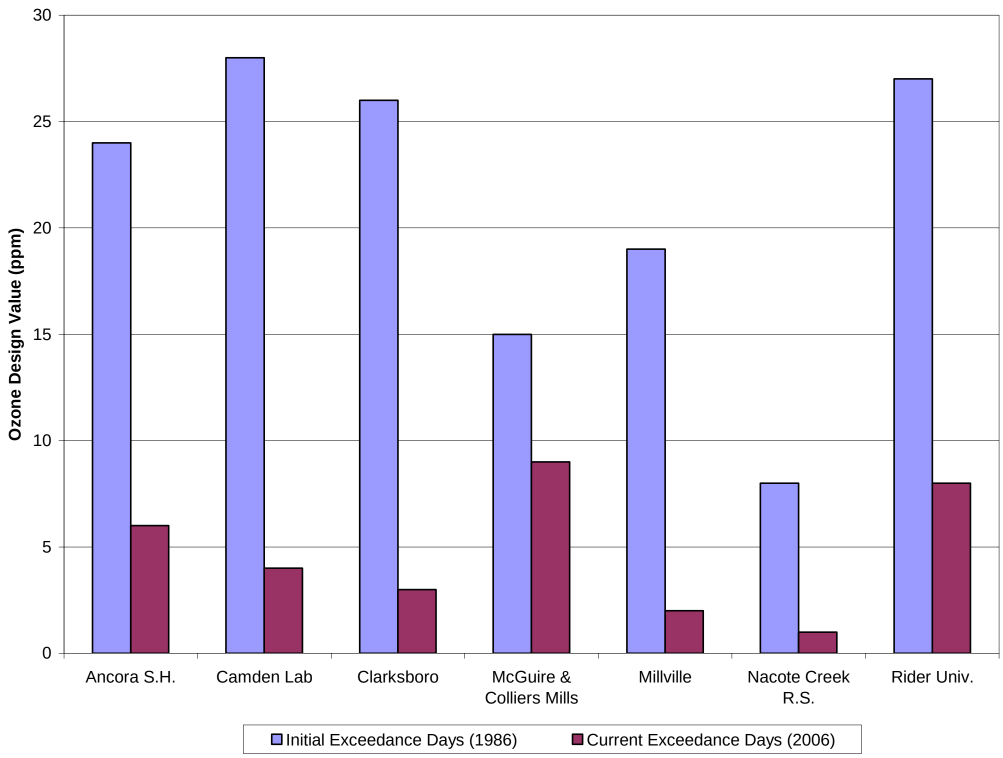


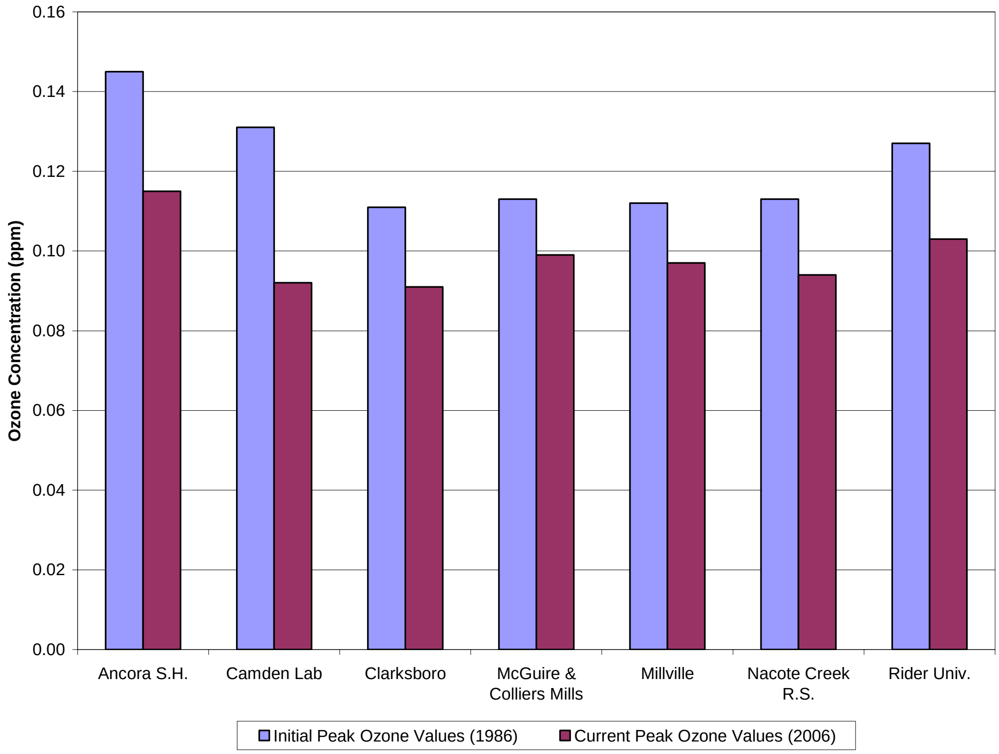
Table B6 lists the changes in peak 8-hour ozone concentrations for the seven monitors in the nine county New Jersey portion of the Southern New Jersey/Philadelphia nonattainment area that had continuous 8-hour measurements between 1986 and 2006. Figure B20 displays the initial and current peak ozone concentrations for these monitors. Overall, peak 8-hour ozone values have decreased by 12-30 percent.

Table B6: Peak 8-Hour Ozone Concentrations in the Nine County New Jersey Portion of the SNJ/Phila. Nonattainment Area, 1986-2006

County[a]	Monitor	8-Hour Ozone Peak Values (ppm)			
		1986[b]	2006	Average 1986-2006[c]	Percent Change
Atlantic	Nacote Creek Research Station	0.113	0.094	0.108	-17
Camden	Camden Lab	0.131	0.092	0.115	-30
	Ancora State Hospital	0.145	0.115	0.121	-21
Cumberland	Millville	0.112	0.096	0.111	-14
Gloucester	Clarksboro	0.111	0.091	0.115	-18
Mercer	Rider University	0.127	0.103	0.121	-19
Ocean	McGuire AFB & Colliers Mills[d]	0.113	0.099	0.122	-12

a) Counties that do not presently have monitors for ozone include Burlington, Cape May, and Salem.
b) If 1986 data was not available, then the earliest dataset available was used and is indicated per monitor.
c) The average 8-hour ozone peak value is the average of the 8-hour ozone peak value for each year within the 1986-2006 timeframe.
d) The Colliers Mills monitor replaced the McGuire AFB monitor. These 2 monitors were approximately 6 miles apart. For this analysis, the 1986-91 values at McGuire AFB were used and the 1992-2006 values at Rutgers University were used.

<u>Figure B20</u>: Peak 8-Hour Ozone Concentrations in the Nine County New Jersey Portion of the SNJ/Phila. Nonattainment Area, 1986-2006



Based upon the data available for New Jersey, and its associated nonattainment areas, the general trend for 8-hour ozone is improving. However, attainment of the 8-hour ozone NAAQS has not yet been reached.

1.4 Ozone Precursor Concentrations

This section outlines the monitoring trends for specific ozone precursors, lending additional support to the State's claim that ozone levels have been, and continue to be, reduced throughout New Jersey.

1.4.1 Volatile Organic Compounds (VOCs)

Ozone is formed when oxides of nitrogen (NO_x) and VOCs react in the presence of sunlight. VOCs are chemicals that evaporate easily at room temperature. The term *organic* in VOCs indicates that the compounds contain carbon and *volatile* indicates that these compounds react more readily in the atmosphere compared to other compounds.[22] They include compounds known as hydrocarbons, which only contain carbon and hydrogen, and carbonyls, which contain a carbon atom double-bonded to an oxygen

[22] USEPA's regulatory definition of *volatile organic compounds* is defined at 40 <u>C.F.R.</u> 51.100(s).

atom. In addition, some VOCs are more harmful than others and can be found in both indoor and outdoor environments. VOCs are emitted from a wide variety of manufacturing processes and product use including cosmetics and hair products, solvents, industrial adhesives, and cooking. Sources of VOCs also include gasoline and motor vehicles, in addition to biogenic emissions.

In 1993, federal revisions to air monitoring regulations required states to enhance monitoring for ozone and its precursors.[23] Because of those new regulations, New Jersey now gathers data for ambient concentrations of VOCs, including several carbonyls, through the Photochemical Assessment Monitoring Station (PAMS) program as part of New Jersey's Manual Monitoring Network.[24,25] The VOC and carbonyl measurements are only taken during the peak part of the ozone season, from June 1st to August 31st each year. Other measurements recorded by PAMS include ozone, NO_x, nitric oxide (NO), nitrogen dioxide (NO_2), and some meteorological parameters. Figure B21 displays the three PAMS locations within the Manual Monitoring Network in New Jersey: Rider University, Rutgers University, and Camden Lab, which began in 1995, 1996, and 1997, respectively.[26] New Jersey's three PAMS monitors are part of both the Philadelphia and New York Metropolitan areas,[27] which are different from the nonattainment areas. A PAMS network required for 1-hour nonattainment areas is designed around a metropolitan area, an area with a population greater than 50,000,[28] where the ozone problem exists.

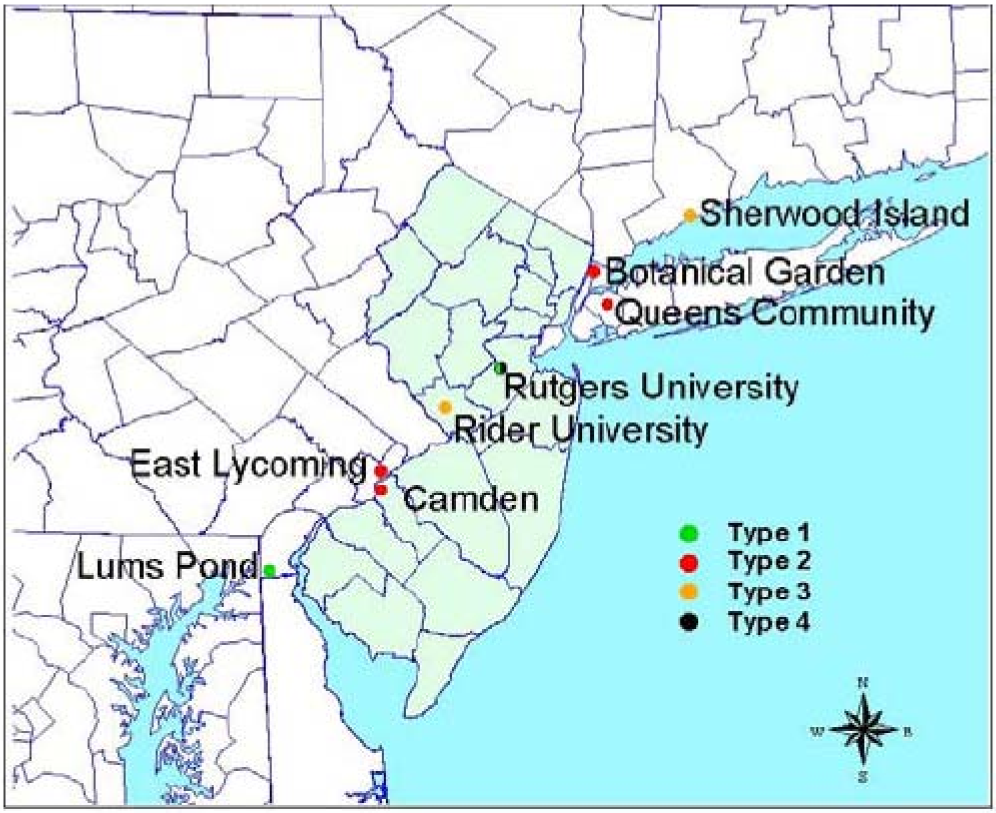
The objectives of the PAMS program include providing a speciated ambient air database which is both representative of and useful for ascertaining ambient profiles and distinguishing among various individual VOCs and which is characteristic of source emission impacts. In addition, PAMS sites contribute to a better understanding of the ozone problem in metropolitan areas while taking into account meteorological and transport factors so that effective and efficient control strategies may be considered and implemented.

PAMS networks are designed with four types of monitors, as presented in Figure B22. The Rutgers University monitor is both a Type 1 and Type 4 PAMS monitor for New York City and Philadelphia, respectively. The Rider University monitor is a Type 3

[23] 58 Fed. Reg. 8452 (February 12, 1993).
[24] NJDEP. State Implementation Plan (SIP) Revision for the Attainment and Maintenance of the Ozone National Ambient Air Quality Standards, Meeting the Federal Clean Air Act Requirements for November 15, 1993. New Jersey Department of Environmental Protection, September 14, 1993, p. 83.
[25] NJDEP. 2003 Photochemical Assessment Monitoring Stations (PAMS), 2003 Air Quality Report. New Jersey Department of Environmental Protection, Bureau of Air Monitoring, 2004.
[26] NJDEP. 1999 Air Quality Report. New Jersey Department of Environmental Protection, Bureau of Air Monitoring, 2000.
[27] op cit., note 25
[28] 40 C.F.R. 58.1

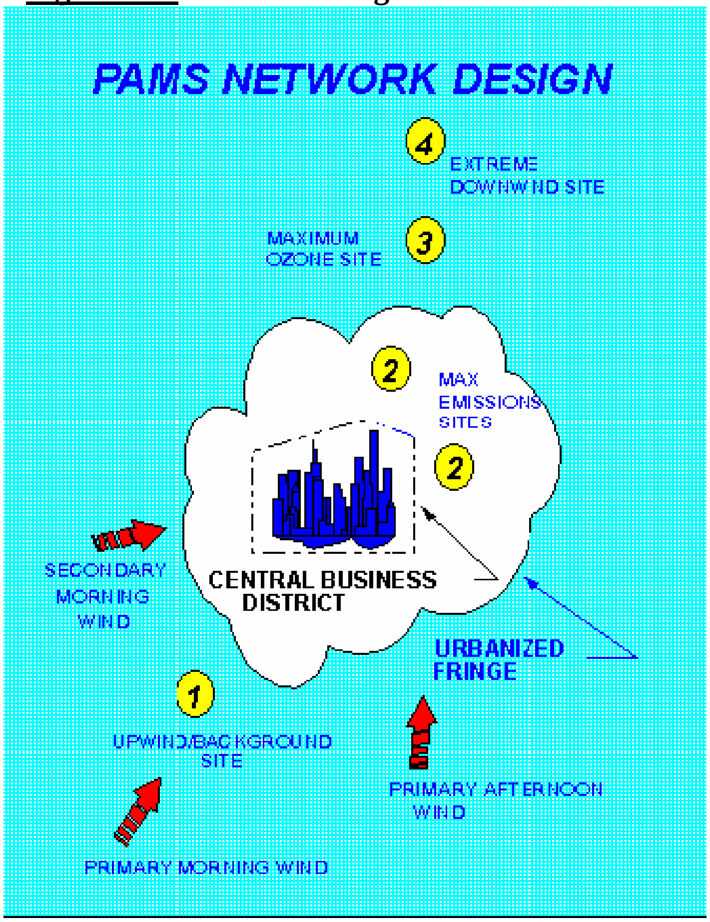
maximum ozone site for Philadelphia and the Camden Lab monitor is a Type 2A maximum emissions site located downwind of Philadelphia.

<u>Figure B21</u>: Regional PAMS Sites



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

Figure B22: General Design of a PAMS Network



Source: USEPA. Enhanced Ozone Monitoring – PAMS. United States Environmental Protection Agency, 2006, http://www.epa.gov/air/oaqps/pams/general.html, Accessed October 30, 2006.

A list of the hydrocarbons monitored at PAMS sites in New Jersey are presented in Table B7.[29] Of the total hydrocarbon species measured at these sites, the top species, by mean concentration, for each year at a PAMS monitor are presented in Figures B23 through B25.[30] Within the time period of data available, the top PAMS species are not always the same for each year. For example, at the Camden Lab monitor shown in Figure B23, propane, n-butane, and isopentane were in the top PAMS species for the entire 8-year period. Propylene was only in the top five for 2004 while n-pentane was only in the top five for 1997 and 2004 but the data for all the years for all seven pollutants were included to further elucidate the developing trends at this site. At the Rider University monitor in

[29] See also the USEPA's list of hydrocarbon PAMS species in elution sequence at http://www.epa.gov/ttn/amtic/pams.html

[30] Main, H. H. and Roberts, P. T. PAMS Data Analysis Workbook: Illustrating the Use of PAMS Data to Support Ozone Control Programs. Prepared for the United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, by Sonoma Technology, Inc., Petaluma, CA, September 2000.

Figure B24, propane, isopentane, toluene, and ethane were consistently in the top five within the seven-year period while ethylene was only in the top five for 2001 and isoprene was in the top five for 1998 and 2005. Similarly, at the Rutgers University monitor shown in Figure B25, propane, isopentane, toluene, ethane, and isoprene were consistently in the top five within the seven-year period with ethylene in the top five compounds for 1998 and 2001. It should be noted that ethane is considered to have negligible photochemical activity, as defined by the USEPA in 40 C.F.R. 51.100(s).

All sites are also impacted by naturally occurring isoprene, which is emitted by trees.[31] All VOCs are not equal in their contribution to ozone formation (i.e., some are more readily reactive) and while isoprene levels are generally lower than many other VOCs, isoprene can account for a significant amount of the ozone forming potential, especially at the non-urban sites. Isoprene levels are thought to be influenced by factors that affect tree health and growth, such as rainfall, severe temperatures, and solar intensity. Isoprene levels in New Jersey seem to peak later in the day. This may be due, in part, to either a heat-stress response by the leaf stomata in plants closing during the day and reopening later or the combination of sunlight availability and the occurrence of photochemical reactions that convert isoprene to ozone, which accounts for lower levels during the day and higher levels at night.

Overall, while it appears that some compounds have stayed relatively constant over the timeframe analyzed, most others have shown significant reductions, up to 70 percent lower concentrations observed in 2005 compared to either 1997 or 1998, depending upon the monitor.

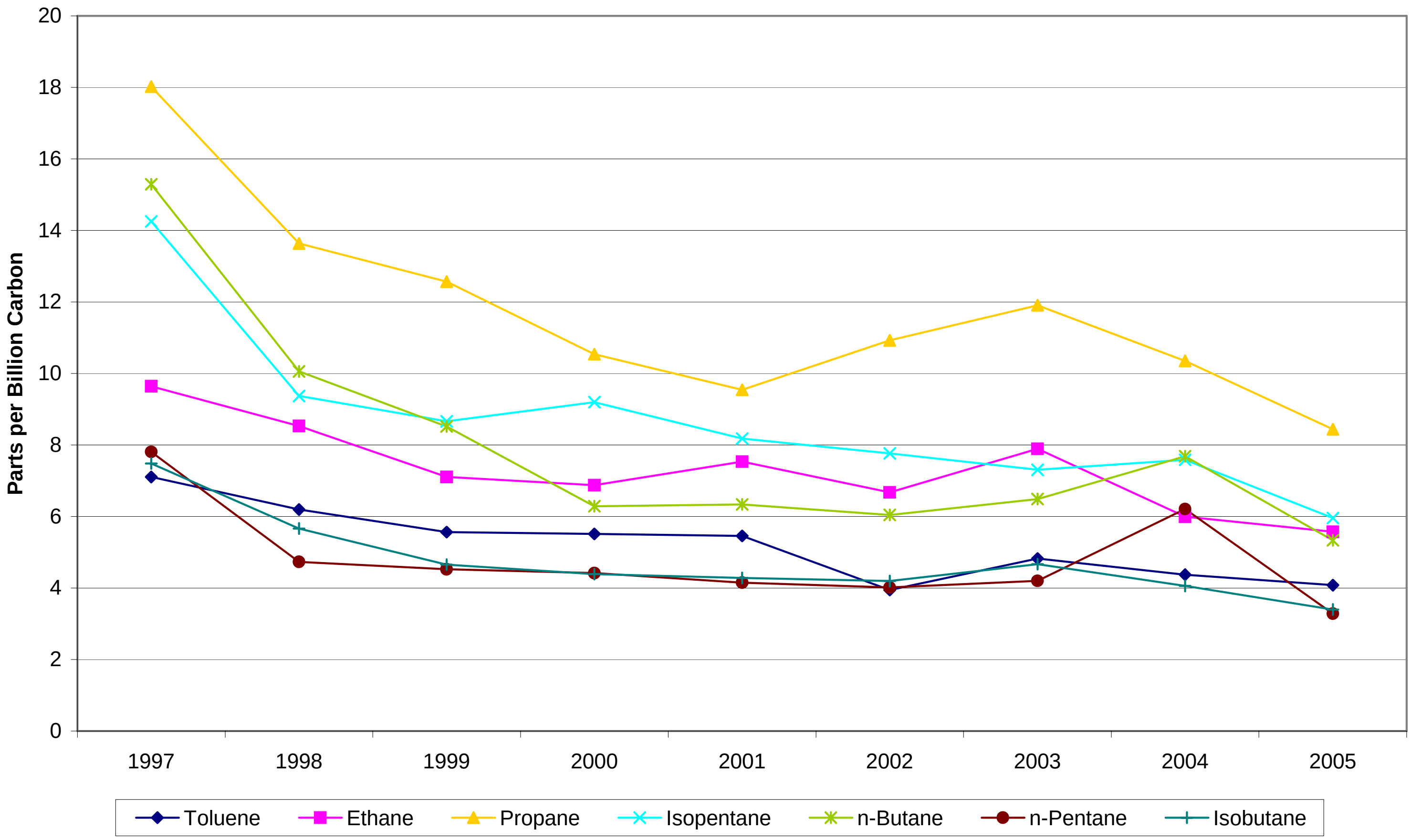
[31] op. cit., note 25

Table B7: Hydrocarbons Measured at PAMS Sites in New Jersey

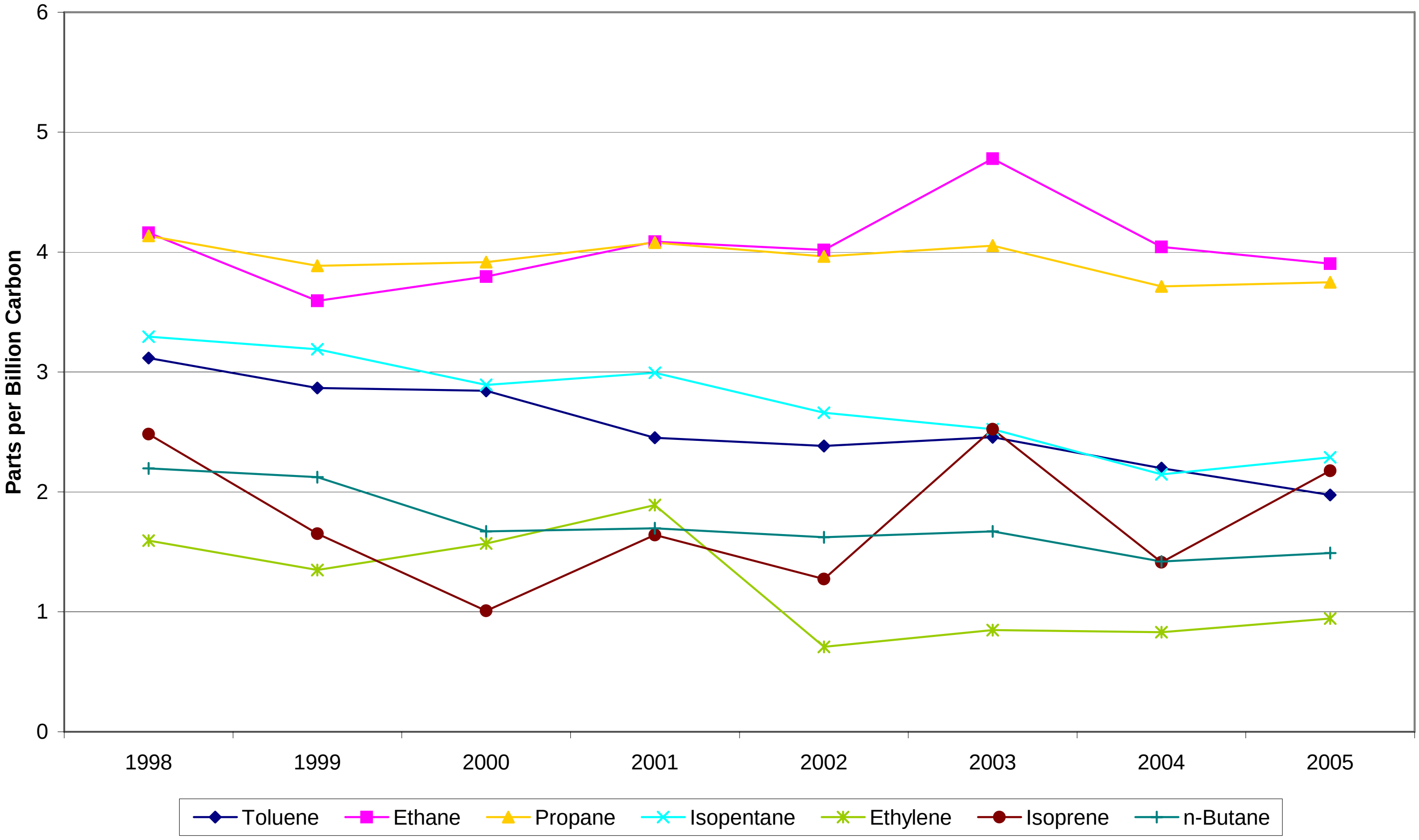
Acetylene	Isomers of Ethyltoluene	n-Pentane
Benzene	n-Heptane	1-Pentene
n-Butane	Hexane	cis-2-Pentene
1-Butene	1-Hexene	trans-2-Pentene
cis-2-Butene	Isobutane	Propane
trans-2-Butene	Isopentane	n-Propylbenzene
Cyclohexane	Isoprene	Propylene (Propene)
Cyclopentane	Isopropylbenzene	Styrene
n-Decane	Methylcyclohexane	Toluene
m-Diethylbenzene	Methylcyclopentane	1,2,3-Trimethylbenzene
p-Diethylbenzene	2-Methylheptane	1,2,4-Trimethylbenzene
2,2-Dimethylbutane	3-Methylheptane	1,3,5-Trimethylbenzene
2,3-Dimethylbutane	2-Methylhexane	2,2,4-Trimethylpentane
2,3-Dimethylpentane	3-Methylhexane	2,3,4-Trimethylpentane
2,4-Dimethylpentane	2-Methylpentane	n-Undecane
Ethane*	3-Methylpentane	m/p-Xylene
Ethylbenzene	n-Nonane	o-Xylene
Ethylene (Ethene)	n-Octane	

*Not a VOC as defined in 40 C.F.R. 51.100(s)

<u>Figure B23</u>: Top PAMS Species by Seasonal Mean Concentration at Camden Lab, New Jersey (Type 2A), 1997-2005



<u>Figure B24</u>: Top PAMS Species by Seasonal Mean Concentration at Rider University, New Jersey (Type 3), 1998-2005



<u>Figure B25</u>: Top PAMS Species by Seasonal Mean Concentration at Rutgers University, New Jersey (Type 4, Philadelphia Area/Type 1, New York Area), 1998-2005

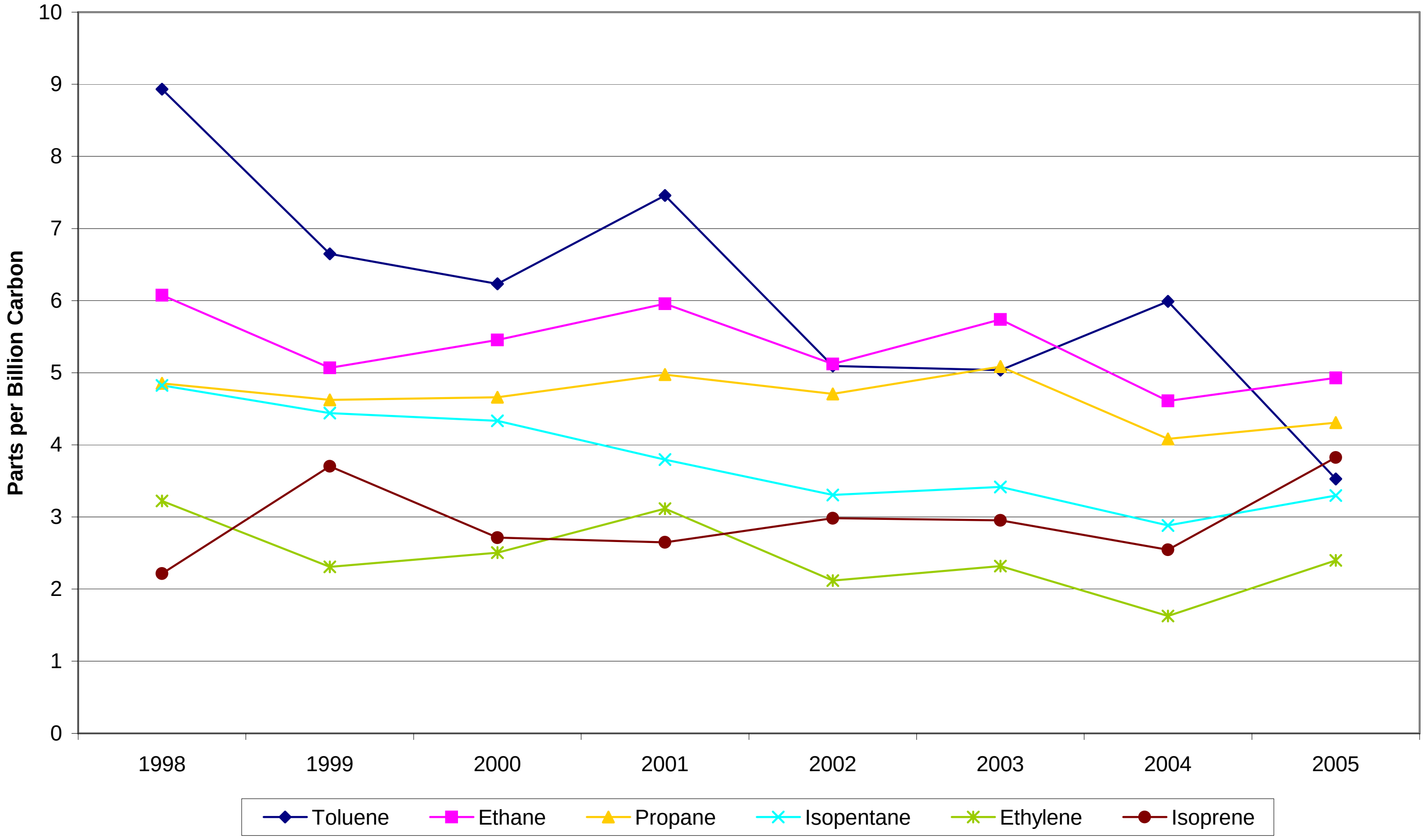


Figure B26 shows VOC trends for the PAMS sites in the New York City metropolitan area.[32] In general, observations here are similar to those for the Philadelphia area in Figure B27. The Type 2 site in the New York area at the Bronx Botanical Gardens shows even more year to year variability than does the Philadelphia Type 2 site at East Lycoming. Overall, the level of total non-methane organic carbon (TNMOC) at Rutgers University has decreased by almost half and the total level at Sherwood Island has decreased by more than half. Operation of the Queens Community College site (ID 36-081-0097) was discontinued by the New York State Department of Environmental Conservation (NYSDEC) after the 2001 season.[33,34]

<u>Figure B26</u>: Total Non-methane Organic Carbon (TNMOC), Seasonal Average 1995-2005, New York Metropolitan Area

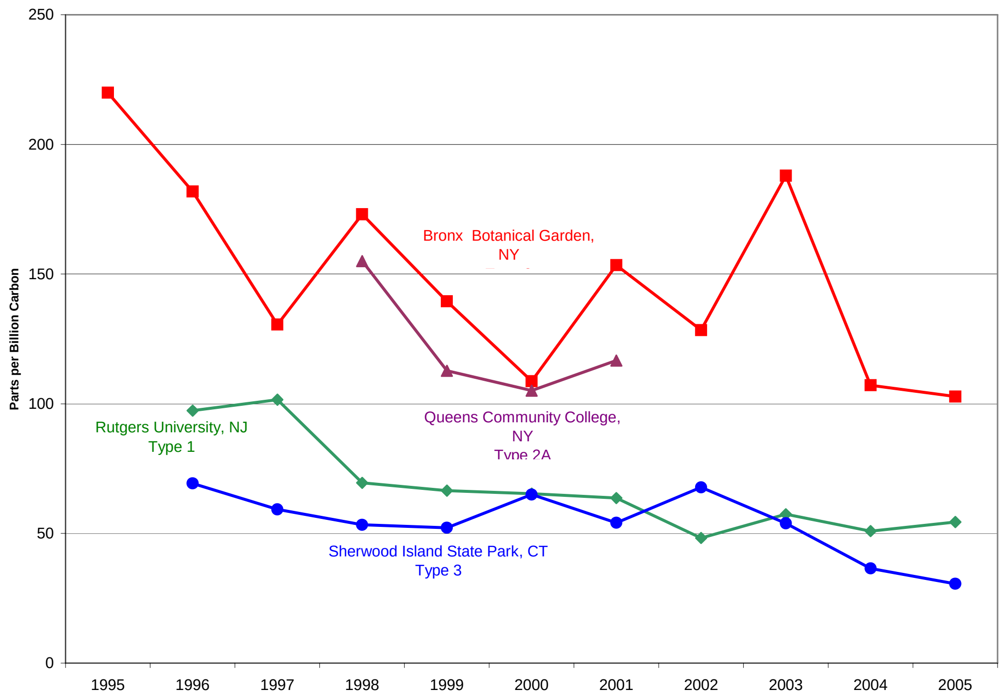


Figure B27 shows VOC trends for the PAMS sites in the Philadelphia metropolitan area. In general, for Lums Pond (upwind - Type 1), Rider University (maximum ozone concentration - Type 3) and Rutgers University (downwind - Type 4), VOCs have

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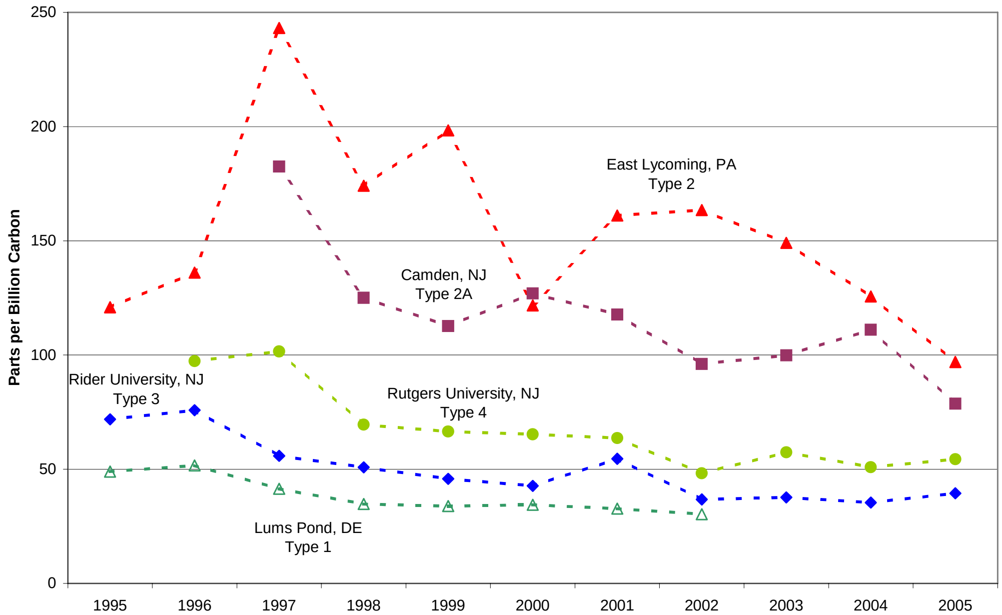
[32] op cit., note 25

[33] A potential continuation of data for this location is the PS219 site (ID 36-081-0124) for 2002 to present, R. Twaddell, NYSDEC, personal communication, November 29, 2006. However, different sampling methodology may lead to an ambiguous trend.

[34] NYSDEC. Volatile Organic Compounds (VOC) Data for the Years 1990-2003. New York State Department of Environmental Conservation, Division of Air Resources, Bureau of Air Quality Surveillance, http://www.dec.state.ny.us/website/dar/baqs/voc/index.html, accessed November 29, 2006.

declined over the measurement period. The maximum emissions, Type 2 and 2A sites[35] (East Lycoming and Camden, respectively), for this area show more variation from year to year, though the trend at both sites is downward since 1997. Operation of the Lums Pond site was discontinued after the 2002 season by Delaware's Department of Natural Resources and Environmental Control (DNREC) due primarily to lack of funding.[36]

<u>Figure B27</u>: Total Non-methane Organic Carbon (TNMOC), Seasonal Average 1995-2005, Philadelphia Metropolitan Area



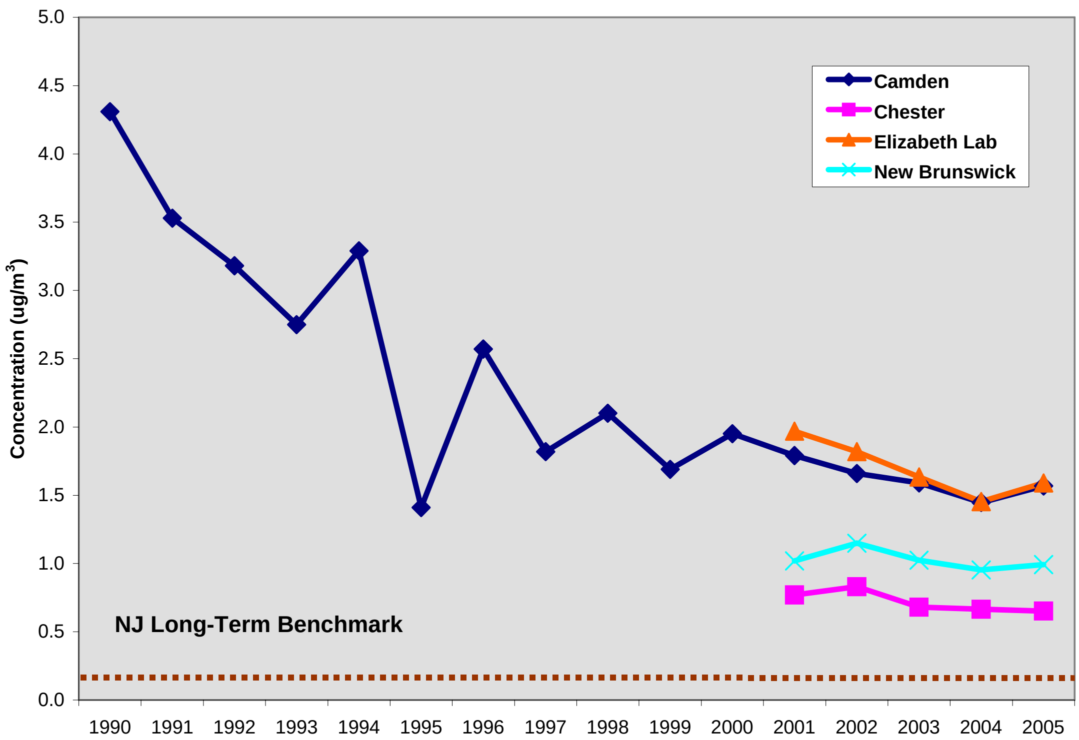
In summary, trends for VOC values measured at all PAMS sites in the New York City and Philadelphia metropolitan areas show a decline over the time period these measurements were made. However, for most locations considered, there is less than 10 years of data and there are several meteorological variables that impact the concentrations of PAMS compounds since measurements are made throughout the course of the day.

Changes in gasoline formulation over the period as well as the effect of newer, cleaner vehicles replacing older vehicles in the automotive fleet likely account for a good portion of the decreasing trends. Figures B28 through B30 show improving trends for the toxic VOC species identified from mobile sources that are "pollutants of concern" statewide in

[35] For clarification, a Type 2 site is located in the area of maximum precursor impact when the wind is blowing in the most common morning direction and a Type 2A site is located in the area of maximum precursor impact when the wind is blowing in the second most common morning direction.
[36] M. Martini, DNREC, personal communication, November 29, 2006.

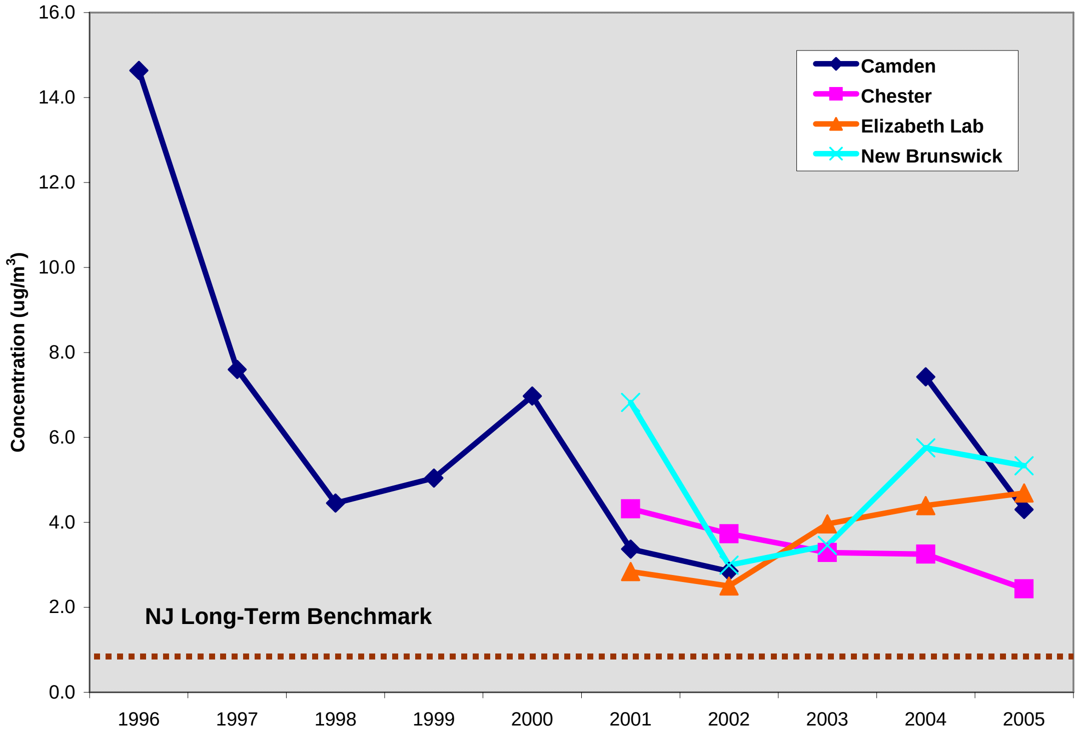
New Jersey: benzene, 1,3-butadiene, and formaldehyde.[37] A "pollutant of concern" for air toxics indicates that the pollutant exceeds its health benchmark.

Figure B28: Air Quality Trend for Benzene Concentrations, 1990-2005

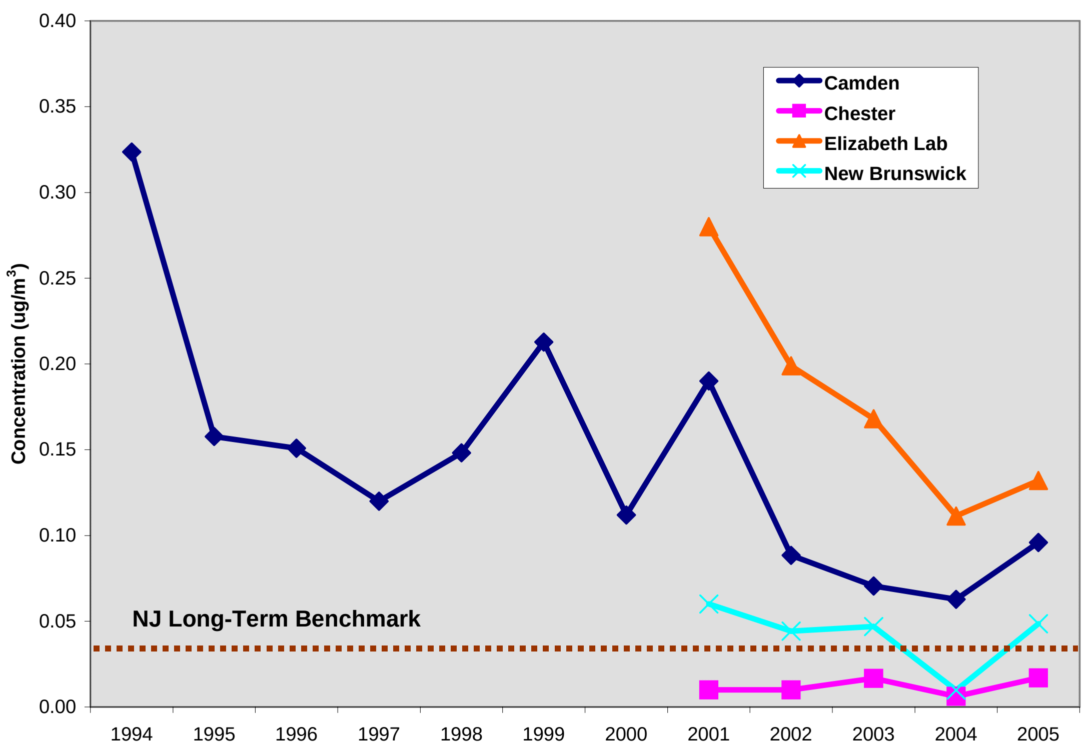


[37] NJDEP. What NATA Means to NJ. New Jersey Department of Environmental Protection, 2006, http://www.nj.gov/dep/airtoxics/nataest.htm, accessed October 30, 2006.

<u>Figure B29</u>: Air Quality Trend for Formaldehyde Concentrations, 1996-2005



<u>Figure B30</u>: Air Quality Trend for 1,3-Butadiene Concentrations, 1994-2005



1.4.2 Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a reddish-brown, highly reactive gas that is formed in the air through the oxidation of nitric oxide (NO).[38] NO_x is a mixture of gases comprised mostly 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 troposphere, near the Earth's surface, NO_2, not molecular oxygen, provides the primary source of the oxygen atoms required for ozone formation. Currently, New Jersey monitors NO_2 and NO levels at nine locations in the Continuous Air Monitoring Network, separate from the PAMS measurements of NO_x, NO_2, and NO.[39,40] As Figure B30 shows, NO_2 levels have decreased in New Jersey from 1975-2005.[41] The NO_2 NAAQS is 0.053 ppm and the last exceedance occurred in 1974. The annual means measured at the highest and lowest sites are plotted above and below the trendline along with the 12-month average for all of the sites. Figure B31 shows the hourly variability of NO_x. NO_x concentrations are higher in the winter compared to the summer partially because poorer local dispersion conditions caused by light winds and other weather conditions that are more prevalent in the colder months of the year. On average, peak concentrations of NO_x (NO_2 and NO) have been observed in the morning and afternoon hours. This trend coincides with motor vehicle rush hours.

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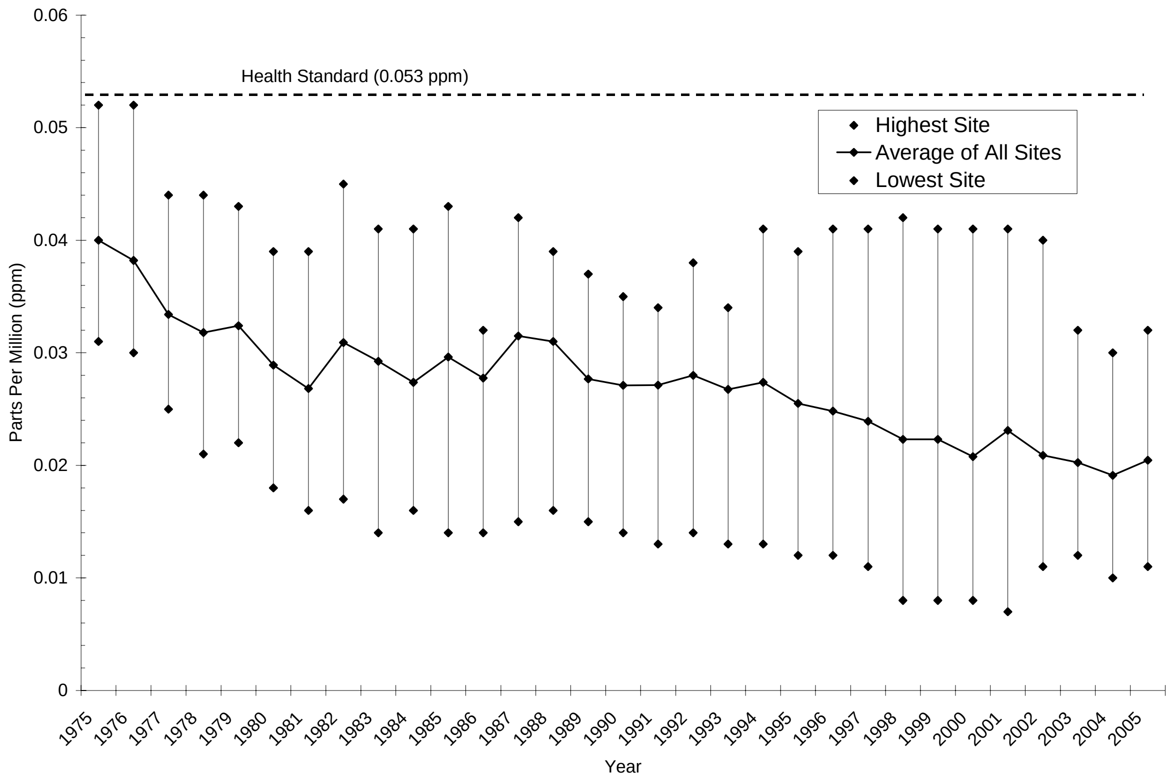
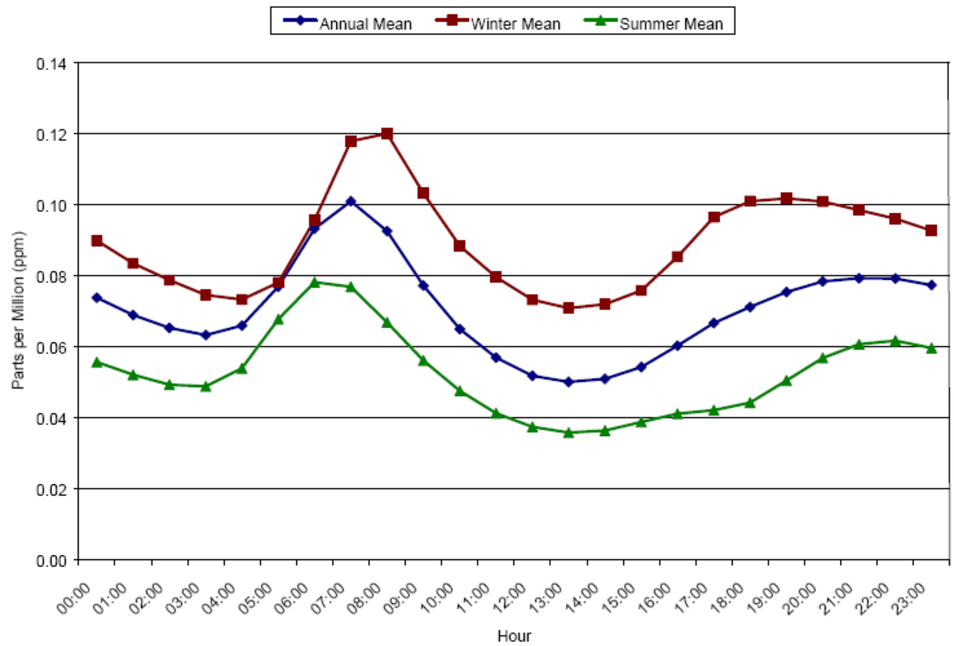
[38] NJDEP. 2005 Nitrogen Dioxide Summary, 2005 Air Quality Monitoring Report. New Jersey Department of Environmental Protection, Bureau of Air Monitoring, 2006.
[39] op. cit., 1
[40] op. cit., 25
[41] op. cit., 38

<u>Figure B31</u>: New Jersey Nitrogen Dioxide Air Quality, 1975-2005, 12-Month (Calendar Year) Average



<u>Figure B32</u>: New Jersey Nitrogen Dioxide and Nitric Oxide Concentrations, Seasonal and Hourly Variation, 1967-1999



1.4.3 Carbon Monoxide

Carbon monoxide (CO) is a by-product of mobile vehicle/equipment exhaust, industrial processes, fuel combustion in sources such as boilers and incinerators, and natural sources such as forest fires.[42] Carbon monoxide is an ozone precursor produced as a result of incomplete combustion.[43] The oxidation of carbon monoxide results in a net production of carbon dioxide and ozone. New Jersey monitored carbon monoxide levels at twelve locations in 2005.[44] The NAAQS for carbon monoxide is 35 ppm for the 1-hour standard and 9 ppm for the 8-hour standard. The last time the carbon monoxide NAAQS were exceeded in New Jersey was January of 1995 and by August 23, 2002 the entire state was officially declared in attainment for the carbon monoxide standard. As Figure B33 shows, carbon monoxide levels have decreased dramatically from 1982 to 2005. Even though winter carbon monoxide levels are typically higher than summer levels, average concentrations of carbon monoxide in New Jersey generally peak during the "normal" commuting times, morning and evening hours, as seen in Figure B34. Over half of the carbon monoxide emissions in New Jersey during the summer are due to

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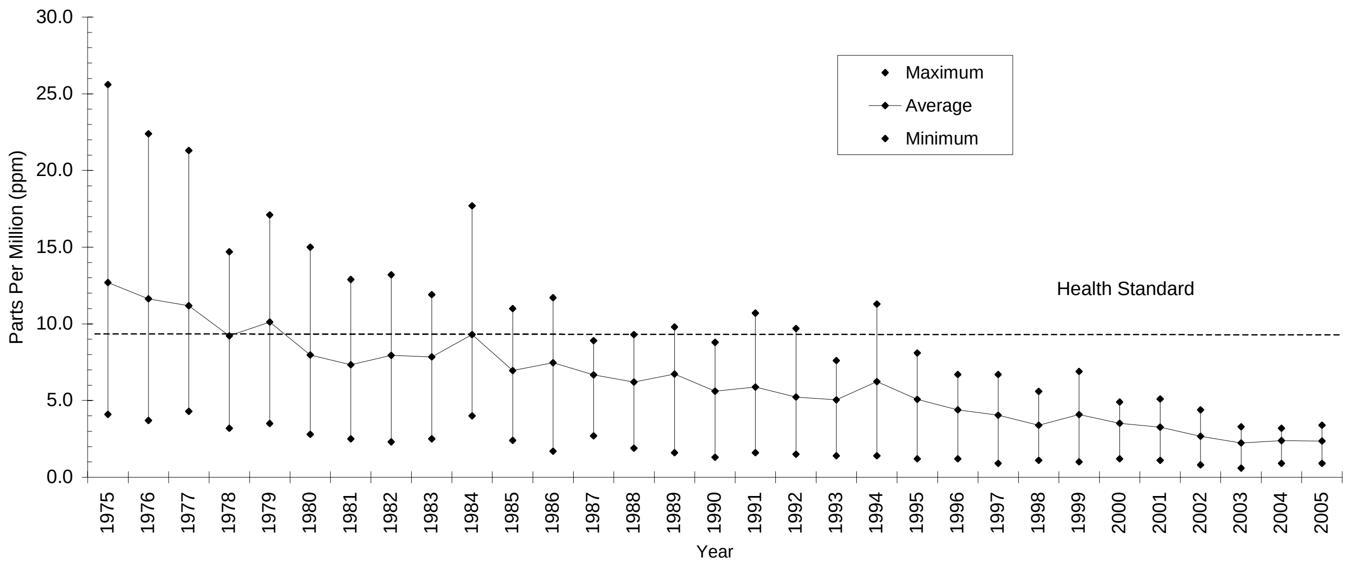
[42] NDJEP. 2004 Carbon Monoxide Summary, 2004 Air Quality Report. New Jersey Department of Environmental Protection, Bureau of Air Monitoring, 2005.
[43] USEPA. Air Quality Criteria for Ozone and Related Photochemical Oxidants (Final). United States Environmental Protection Agency, Washington, DC, EPA/600/R-05/004aF-cF, 2006.
[44] op cit., note 42

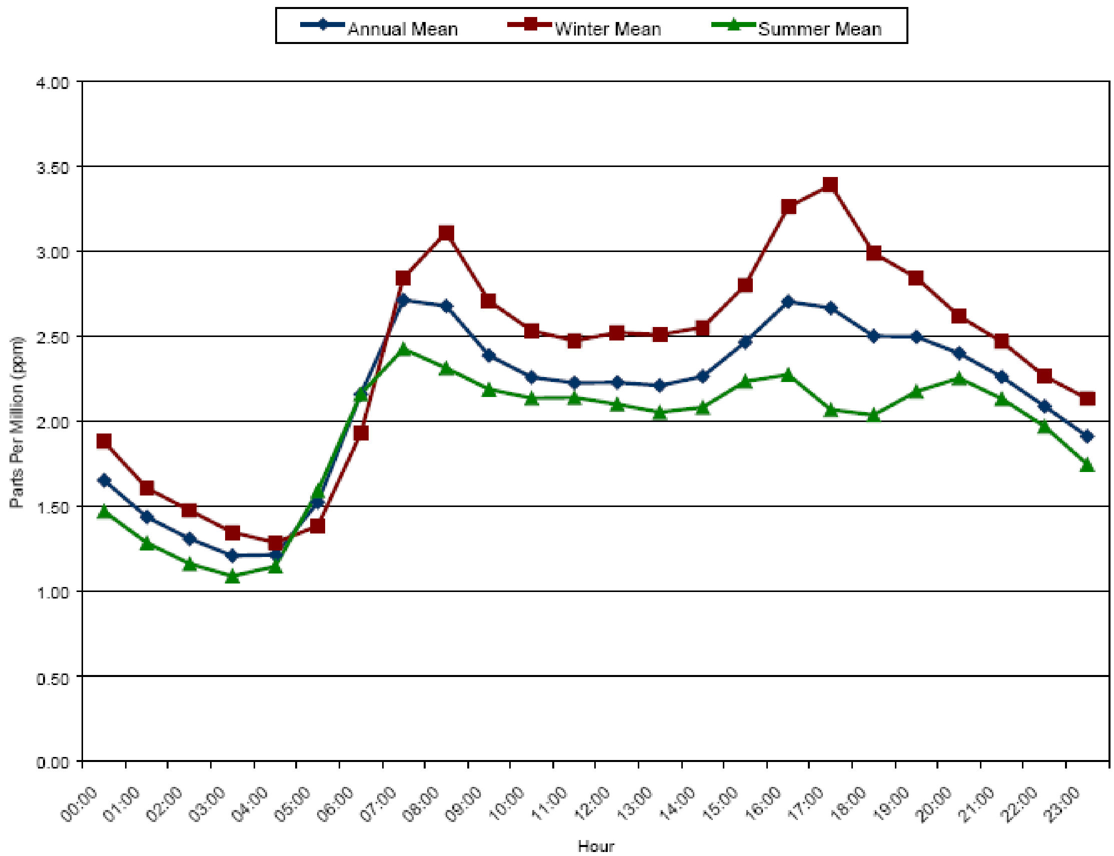
onroad sources.[45] Carbon monoxide emissions from onroad sources are higher in the winter compared to the summer because decreased air/fuel ratios are needed to maintain combustion in cold temperatures, i.e., richer air/fuel mixture, which occurs for longer periods (cold engines) coupled with less efficient emission control systems, all resulting in increased tailpipe carbon monoxide emissions.[46]

Figure B33: New Jersey Carbon Monoxide Air Quality, 1975-2005
2nd Highest 8-Hour Average



[45] NJDEP. State Implementation Plan (SIP) Revisions for the Attainment and Maintenance of the 8-Hour Carbon Monoxide National Ambient Air Quality Standard, 1-Hour Ozone National Ambient Air Quality Standard, and Fine Particulate Matter National Ambient Air Quality Standard; and the 2002 Periodic Emission Inventory. New Jersey Department of Environmental Protection, May 2006.
[46] USEPA. Automobiles and Carbon Monoxide. United States Environmental Protection Agency, Office of Mobile Sources, EPA 400-F-92-005, OMS-3, January 1993.

<u>Figure B34</u>: New Jersey Carbon Monoxide Concentrations, Seasonal and Hourly Variation, 1967-1999



1.5 Meteorological Trends

Ozone formation is influenced by many factors including weather conditions, transport, and growth in emissions, in addition to changes brought about by air quality control strategies. Of these factors, weather has a significant effect on year to year variations in ozone levels. As previously stated, ozone is not emitted directly to the atmosphere, but is formed by photochemical reactions between VOCs and NO_x in the presence of sunlight. The hot days of summer are particularly conducive to ozone formation, and as such ozone levels are of general concern during the months of May through September. Officially, the monitoring season for season in New Jersey runs from April 1st to October 31st.[47] Correlations can be made between ozone concentrations and meteorological variables such as the number of days at or above 90°F, average temperature, precipitation, and precipitation days. Hot summers usually produce long periods of elevated ozone concentrations, while ozone production is usually limited during cool and

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[47] op. cit., note 2

wet summers, which may be in part responsible for the low levels of ozone during 2004.[48,49]

New Jersey has five distinct climate zones due to its geographic location and varied topography, and the global atmospheric circulation patterns over North America.[50] The five climate zones are the North, Central, Southwest, Pine Barrens, and Coastal regions of the State. Air quality monitors are located throughout state within these regions and are inherently subject to different local climatic conditions. Climatological data collected by the National Oceanic and Atmospheric Administration (NOAA) in two locations within the State, at Newark[51] and Atlantic City,[52] were compared to data collected at the Northern and Southern New Jersey monitors.

Air quality monitors that measured ozone concentrations were compared to precipitation data during the ozone season over the past 20 years (see Figures B35 a and b). While the frequency of precipitation has remained relatively constant and the number of exceedance days per monitor has decreased in both Southern and Northern New Jersey, there does not seem to be a defining trend between the two variables. Upon a closer review of the data for both variables, the general trend is that as precipitation levels decrease, or increase, the monitored exceedances for ozone increase, or decrease. As seen in the ozone monitored exceedances versus temperature, the trend is demonstrating that the 8-hour ozone levels remain dependent upon weather-related variables, indicating that additional controls are needed to decrease ozone concentrations in both nonattainment areas.

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[48] ibid.

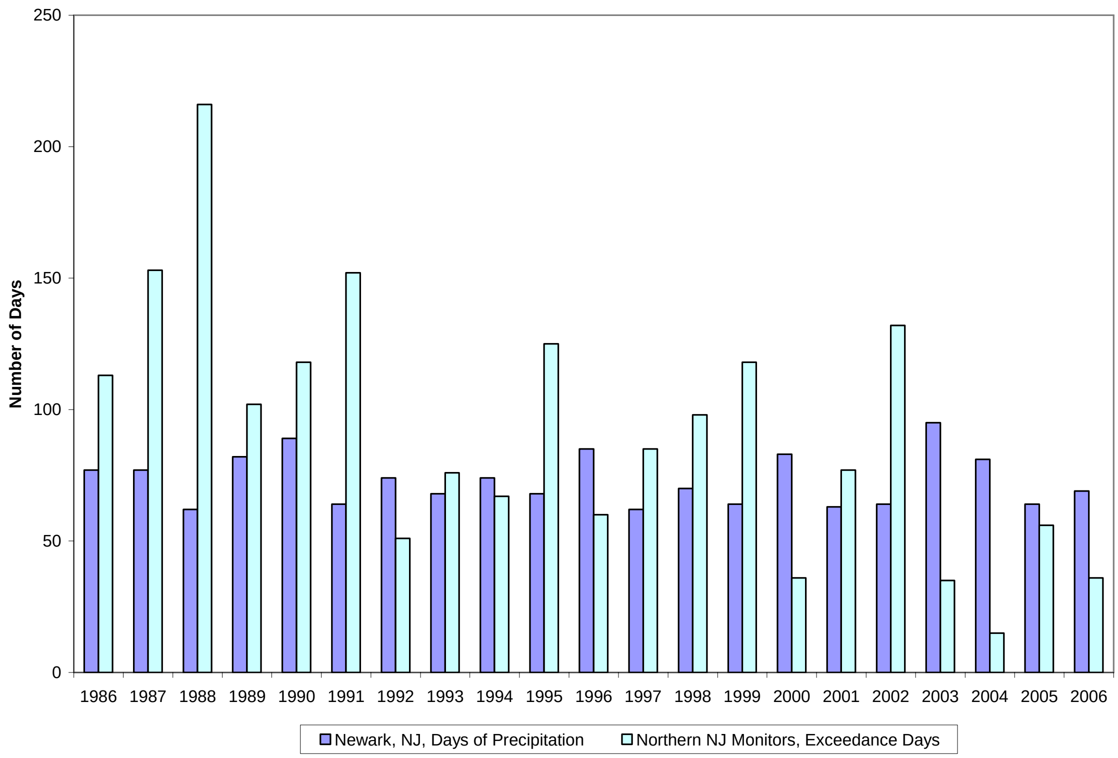
[49] USEPA. Evaluating Ozone Control Programs in the Eastern United States: Focus on the NO_x Budget Trading Program, 2004. United States Environmental Protection Agency, Office of Air and Radiation, Office of Air Quality Planning and Standards, Office of Atmospheric Programs, Washington, D.C., EPA454-K-05-001, August 2005.

[50] ONJSC. The Climate of New Jersey. Office of the New Jersey State Climatologist, Rutgers University, 2006, http://climate.rutgers.edu/stateclim/?section=njcp&target=NJCoverview, accessed November 3, 2006.

[51] NOAA. Local Climatological Data, Newark, New Jersey (EWR), Annual Summaries with Comparative Data and Monthly Summaries. National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, National Climatic Data Center, Ashville, NC, 1986-2006.

[52] NOAA. Local Climatological Data, Atlantic City, New Jersey, NAFEC (ACY), Annual Summaries with Comparative Data and Monthly Summaries. National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, National Climatic Data Center, Ashville, NC, 1986-2006.

<u>Figure B35a</u>: Comparison of Days of Precipitation and Monitor Exceedances[53] during the Ozone Season for Northern New Jersey, 1986-2006



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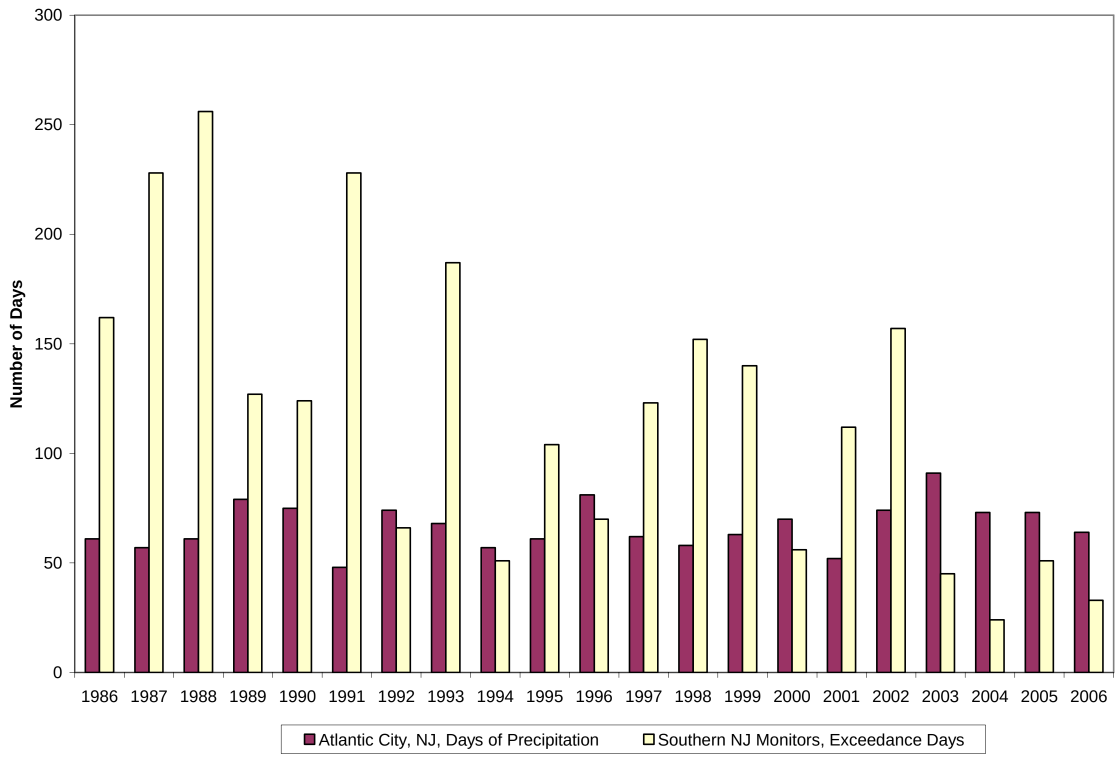
[53] As used here, monitor exceedance is the sum across the network of each monitor's individual number of exceedance days in a given year.

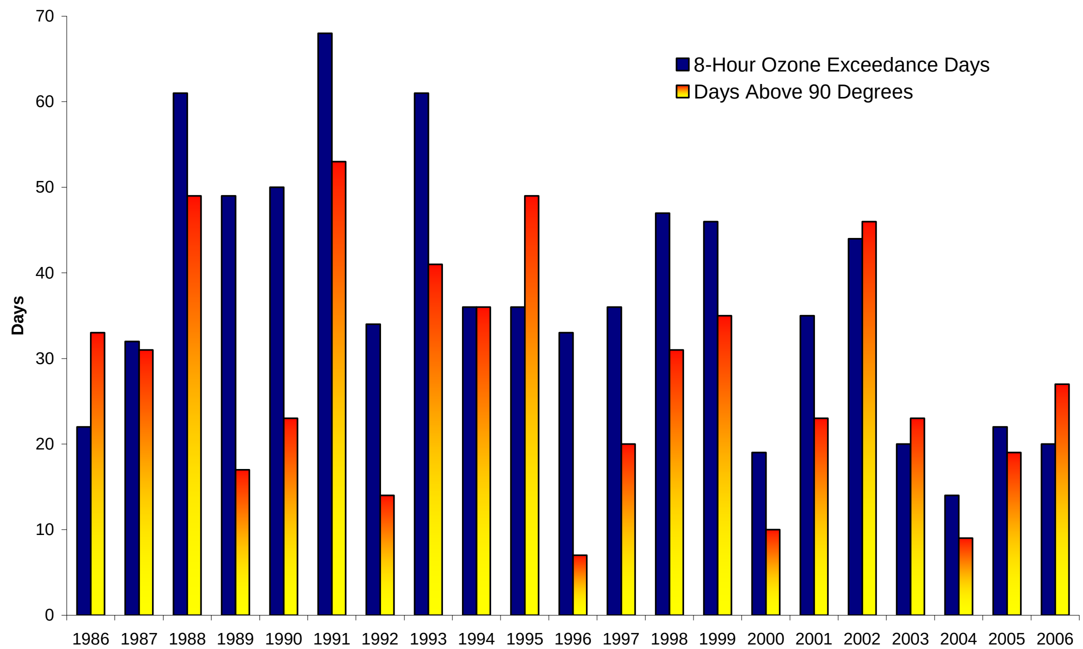
<u>Figure B35b</u>: Comparison of Days of Precipitation and Monitor Exceedances[54] during the Ozone Season for Southern New Jersey, 1986-2006



Another way to examine trends between 8-hour ozone exceedances and the effect of weather is to examine the number of summertime hot days (at or above 90°F), as shown in Figure B36. This figure compares the number of days that the ambient temperature was greater or equal to than 90°F to the number of days that the 8-hour ozone standard was exceeded. This figure shows that the trend in exceedances continues to track the 'hot' days.

[54] As used here, monitor exceedance is the sum across the network of each monitor's individual number of exceedance days in a given year.

<u>Figure B36</u>: New Jersey 8-Hour Ozone "Unhealthy" Days vs. "Hot" Days



Meteorological data from New York City-Central Park[55,56,57] and Philadelphia International Airport[58,59] weather stations were analyzed to determine trends between 8-hour ozone values and ozone season weather conditions. New York City-Central Park and Philadelphia International Airport weather stations are located in the 8-hour ozone Northern New Jersey/New York/Connecticut nonattainment area and Southern New Jersey/Philadelphia nonattainment area, respectively.

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[55] NOAA. Observed Weather Reports, April through October. National Oceanic and Atmospheric Administration National Weather Forecast Office, Upton, NY, 2006, http://www.weather.gov/climate/index.php?wfo=okx, accessed November 15, 2006.

[56] NOAA. Climatological Data. National Oceanic and Atmospheric Administration National Weather Forecast Office, New York City/Upton, NY, 2006, http://www.erh.noaa.gov/okx/climate_cms.html#Cli, accessed November 16, 2006.

[57] NOAA. Local Climatological Data, Annual Summary with Comparative Data, New York, Central Park, New York (NYC). National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, National Climatic Data Center, Ashville, NC, 1997-2005.

[58] NOAA. Local Climatological Data, Monthly Summaries for April to October, Philadelphia, Pennsylvania (PHL). National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, National Climatic Data Center, Ashville, NC, 2005-2006.

[59] NOAA. Local Climatological Data, Annual Summary with Comparative Data, Philadelphia, Pennsylvania (PHL). National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, National Climatic Data Center, Ashville, NC, 1997-2004.

Tables B9 and B10 list the meteorological data for 1997-2006 for both weather stations along with average 4th highest 8-hour ozone concentrations and monitor exceedance days (i.e., total airshed values) for the Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia nonattainment areas, respectively. For both metropolitan areas, the precipitation frequency (total number of days with measurable precipitation) has remained relatively unchanged during the ozone season between 1997 and 2006. However, the precipitation totals for the New York City and Philadelphia metropolitan areas have increased. The total number of days with temperatures at or above 90°F for the ozone seasons showed high variability in both nonattainment areas with no clear pattern; however, years demonstrating the highest number of days with temperatures at or above 90°F are 2002, 1999, and 2005. Examining 8-hour ozone concentrations and monitor exceedances over 1997-2006 indicate both values are declining over time for each nonattainment area. The average 4th highest 8-hour ozone concentrations and monitor exceedance days in the 8-hour ozone Northern New Jersey/New York/Connecticut and Southern New Jersey/Philadelphia nonattainment areas have decreased over this time period. Figures B37 and B38 compare the number of days with temperatures greater than or equal to 90°F and measurable precipitation to the number of exceedances over the past several years for the Northern New Jersey/New York/Connecticut and the Southern New Jersey/Philadelphia nonattainment areas, respectively.

Table B9: Comparison of Select Meteorological and Ozone Variables during the Ozone Season, New York City-Central Park, 1997-2006

Year	90°F Days	Precipitation (inches)	Measurable Precipitation Days	Average 4th Highest 8-Hour Ozone Concentration[a] (ppm)	Monitor Exceedances[b]
1997	12	23.61	64	0.101	275
1998	8	30.00	66	0.089	218
1999	27	21.43	56	0.100	318
2000	7	30.49	81	0.084	103
2001	15	19.46	59	0.093	203
2002[c]	32	29.90	68	0.098	342
2003	8	37.40	94	0.089	116
2004	2	36.21	77	0.078	35
2005	23	34.23	65	0.089	151
2006	8	41.74	68	0.088	106
Average	**14.2**	**30.45**	**69.8**	**0.091**	**187**

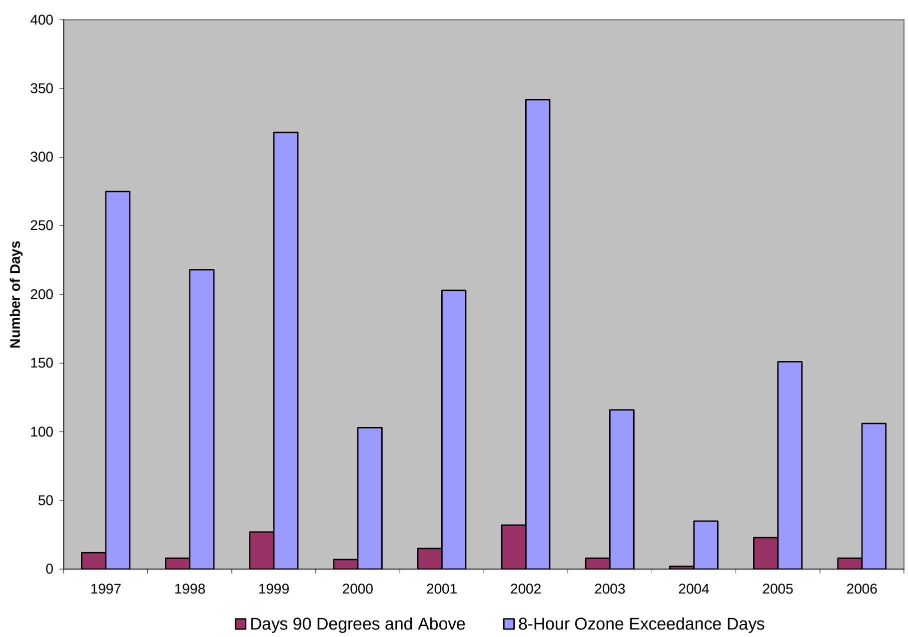
a) The average 4th highest 8-hour ozone concentration of all monitors in the Northern New Jersey/New York/Connecticut nonattainment area.
b) As used here, monitor exceedance is the sum across the network of each monitor's individual number of exceedance days in a given year.
c) 2002 was a warm summer. "Warm" is defined as summers having the greatest number of 90ºF days compared to the total years reviewed and "summer" is defined as June, July, and August.

<u>Table B10</u>: Comparison of Select Meteorological and Ozone Variables during the Ozone Season, Philadelphia International Airport, 1997-2006

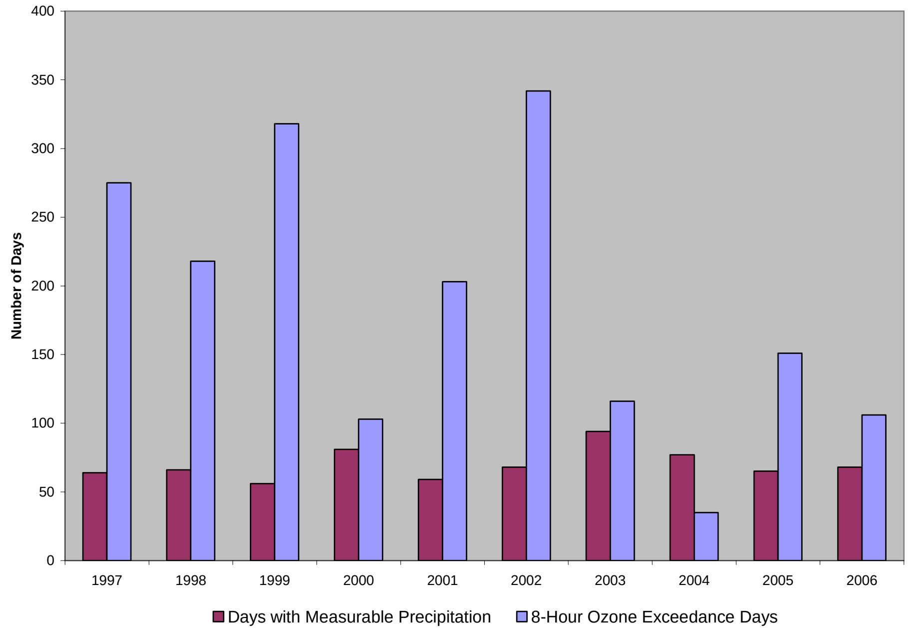
Year	90°F Days	Precipitation (inches)	Measurable Precipitation Days	Average 4th Highest 8-Hour Ozone Concentration[a] (ppm)	Monitor Exceedances[b]
1997	20	16.75	60	0.100	287
1998	31	18.23	68	0.096	337
1999	35	31.33	57	0.101	322
2000	10	28.13	82	0.093	153
2001	23	17.09	55	0.097	290
2002[c]	46	23.63	68	0.101	390
2003	23	28.83	97	0.086	106
2004	9	33.72	83	0.079	49
2005	19	25.67	65	0.086	123
2006	28	34.41	73	0.083	75
Average	**24.4**	**25.78**	**70.8**	**0.092**	**213**

a) The average 4th highest 8-hour ozone concentration of all monitors in the Southern New Jersey/Philadelphia nonattainment area.
b) As used here, monitor exceedance is the sum across the network of each monitor's individual number of exceedance days in a given year.
c) 2002 was a warm summer. "Warm" is defined as summers having the greatest number of 90ºF days compared to the total years reviewed and "summer" is defined as June, July, and August.

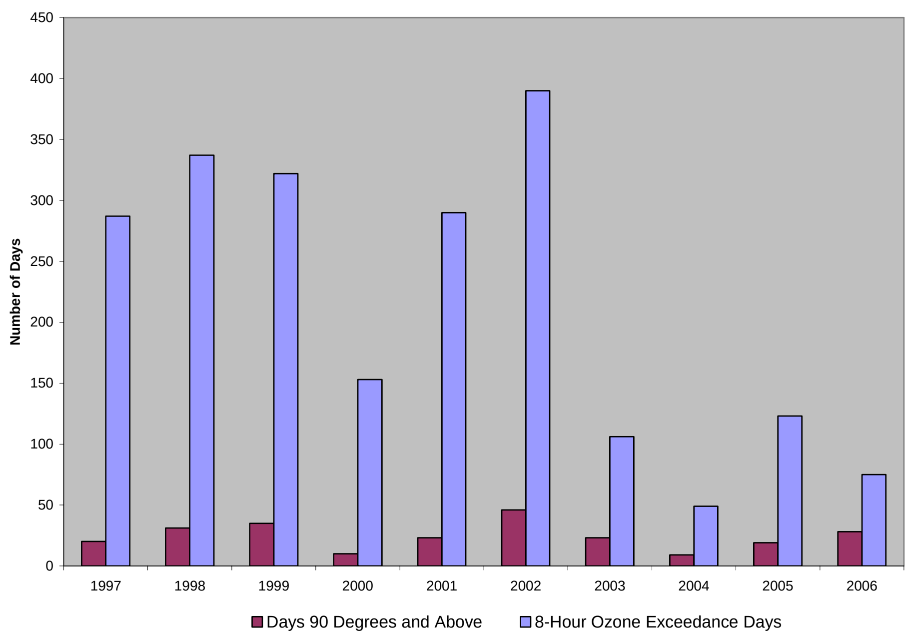
<u>Figure B37a</u>: Number of Days with Temperatures Greater or Equal to 90°F Compared to Number of 8-Hour Ozone Exceedances, NNJ/NJ/CT Nonattainment Area, 1997-2006



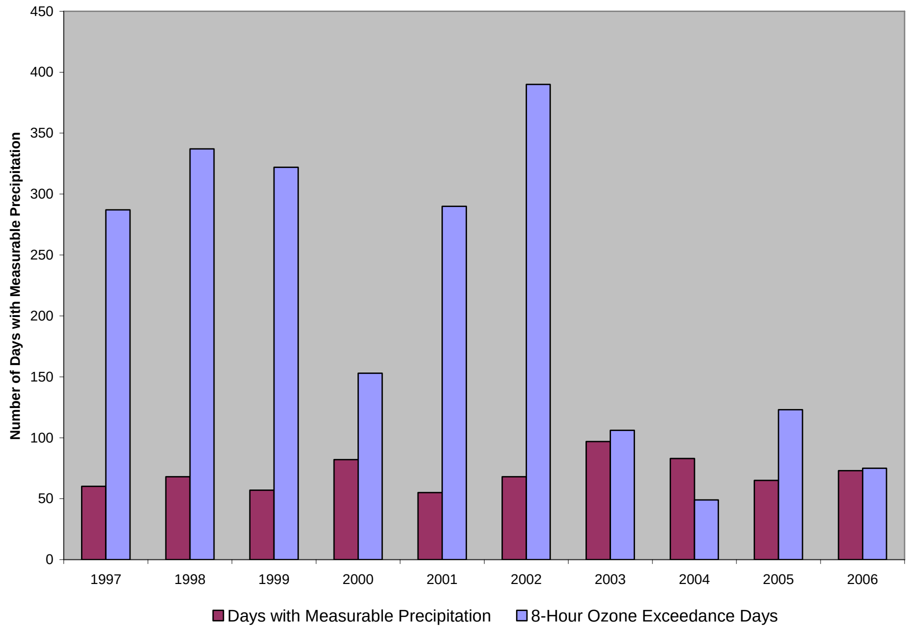
<u>Figure B37b</u>: Number of Days with Measurable Precipitation Compared to Number of 8-Hour Ozone Exceedances, NNJ/NJ/CT Nonattainment Area, 1997-2006



<u>Figure B38a</u>: Number of Days with Temperatures Greater or Equal to 90°F Compared to Number of 8-Hour Ozone Exceedances, SNJ/Phila. Nonattainment Area, 1997-2006



<u>Figure B38b</u>: Number of Days with Measurable Precipitation Compared to Number of 8-Hour Ozone Exceedances, SNJ/Phila. Nonattainment Area, 1997-2006



Further analysis of the weather conditions during ozone seasons can be compared to historical meteorological data. Comparing 1997-2006 data from New York City-Central Park to monthly 30-year averages (1971-2000), the monthly averages for days with temperatures at or above 90°F during the ozone seasons for the years reviewed were consistent except for July and September, which were slightly lower than the monthly 30-year averages. The monthly averages for days with measurable precipitation (i.e., ≥ 0.01 in.) and total precipitation were consistent. In addition, the monthly average temperature over 1997-2006 was consistent with the monthly 94-year averages (1912-2005). Comparing the 1997-2006 data from Philadelphia International Airport to monthly 30-year averages (1971-2000), the monthly averages of days with temperatures at or above 90°F during the ozone seasons for the years reviewed were consistent except for September, which was slightly lower than the 30-year average. Monthly averages for days with measurable precipitation (i.e., ≥ 0.01 in.) were consistent and total precipitation was slightly higher in June and October. In addition, the monthly average temperatures over 1997-2006 were consistent with the monthly 93-year averages (1912-2004).

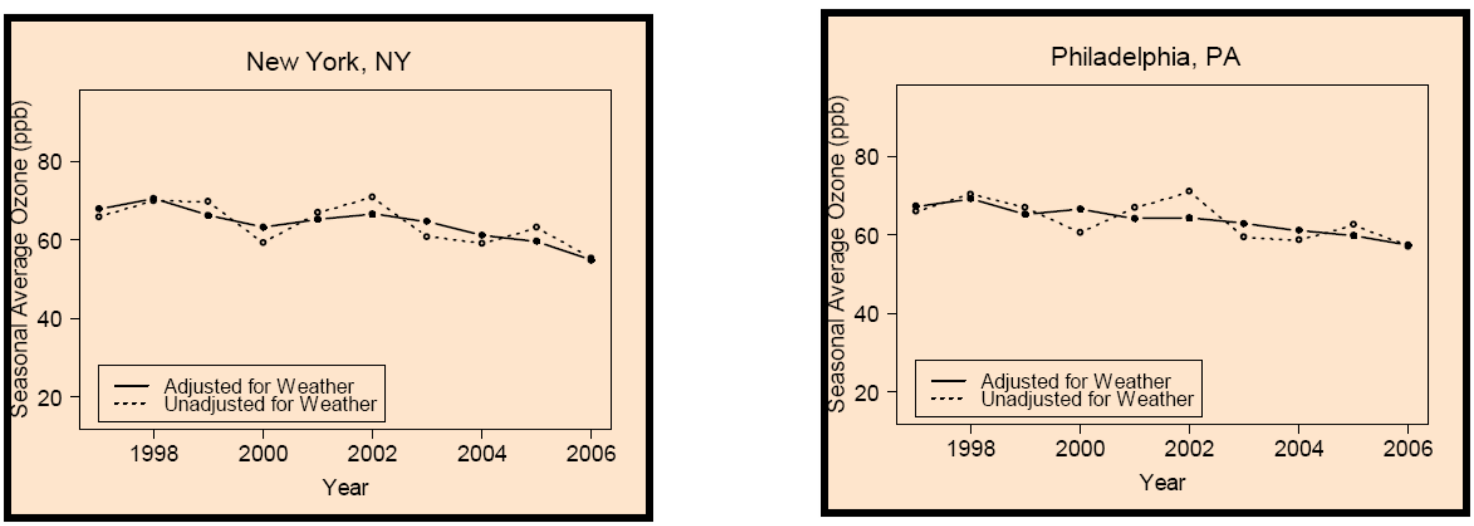
In addition to the review of meteorological data performed by the State, the USEPA conducted a statistical analysis of 8-hour ozone levels across the United States. This analysis was published in the USEPA's 2006 ozone trend report.[60] Cox and Chu developed an advanced statistical technique, which allows the effects of meteorology

[60] USEPA. Weather Makes a Difference: 8-hour Ozone Trends for 1997-2005. United States Environmental Protection Agency, August 2006, http://www.epa.gov/airtrends/2006/weather, accessed May 16, 2007.

(temperature, humidity, etc.) to be separated from the 8-hour ozone levels.[61] The USEPA applied this technique at a number of monitors across the country to develop meteorology adjusted 8-hour daily maximum ozone levels and compared them to the observed 8-hour daily maximum ozone levels.

The USEPA did not perform this analysis for any monitors located in New Jersey, however, the USEPA performed this analysis for monitors located in the Southern New Jersey/Philadelphia nonattainment area and the Northern New Jersey/New York/Connecticut nonattainment area. Figure B39 shows the results for two of these sites. It is clear from the two figures that a consistently declining trend is observed in ozone levels in response to consistently declining VOC and NO_x emissions levels once the effect of meteorology has been removed.

<u>Figure B39</u>: Meteorology Adjusted Ozone Season Average 8-Hour Daily Maximum Ozone Trend (1997-2005)

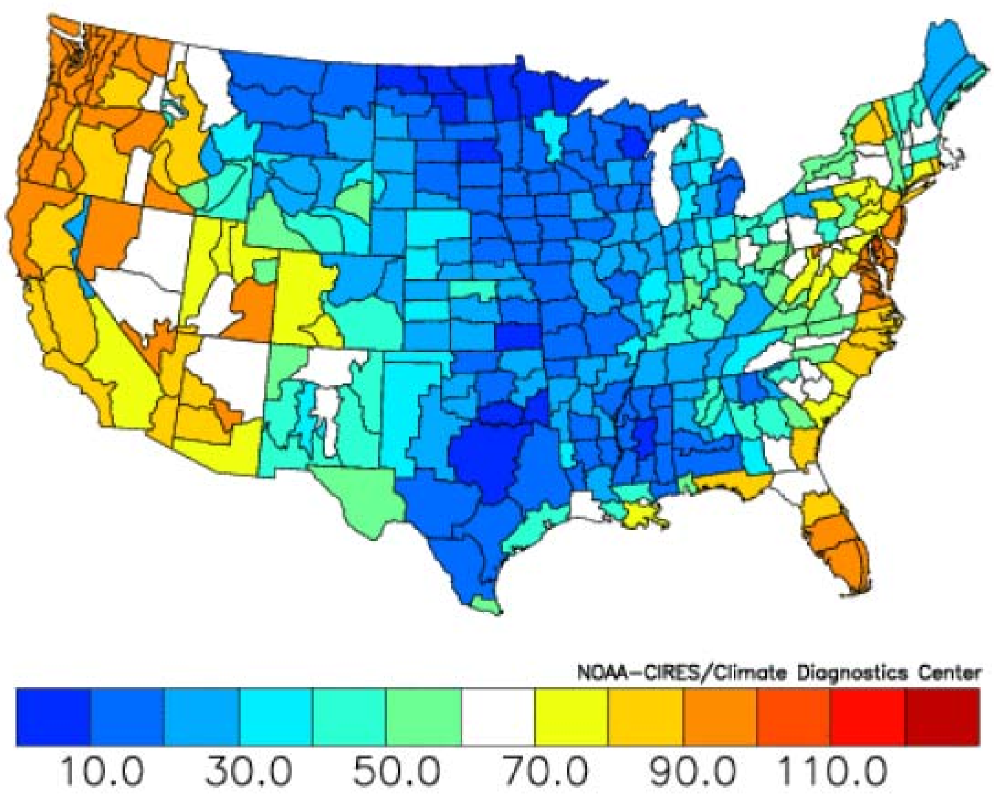


In contrast to warm summers, cool, wet summers do not produce as many high ozone days. Historically, several ozone episodes occur throughout the New Jersey summer.[62] The 2004 ozone season, unlike any New Jersey ozone season to date, produced no ozone episodes. An ozone episode is loosely defined as two or more consecutive days of widespread ozone concentrations above the health standard. There were also no widespread exceedances of the 8-hour ozone health-based standard. July 22, 2004 produced the most single day exceedances with seven sites recording unhealthy concentrations. On that day, the Flemington monitor had the highest 8-hour average at 0.098 ppm. As recently as 1998, there were 47 days when ozone concentrations were

[61] Cox, W. M. and Chu, S. H. Assessment of Interannual Ozone Variation in Urban Areas from a Climatological Perspective. *Atmospheric Environment*, 30.14, 2615-2625, 1996.
[62] op. cit., note 2

above the 8-hour ozone NAAQS. 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 in Figure B40 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 in 2004 than usual. New Jersey's average summertime temperatures deviated from normal by 10 – 20 percent. 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. Other contributing factors to ozone levels measured include additional meteorological patterns (e.g., local vs. regional circulation and mixing heights), topography, transport, biogenic emissions, and the mix of photochemical pollutants in an area.[63,64] The 2004 ozone design values, therefore, may have been influenced by the meteorological conditions.

<u>Figure B40</u>: Temperature Percentile Value Relative to 1895-1999, May to September 2004



[63] op. cit., note 30

[64] Zhang, J. S., T. Rao, and Daggupaty, S. M. Meteorological Processes and Ozone Exceedances in the Northeastern United States during the 12-16 July 1995 Episode. *Journal of Applied Meteorology*, 37, 776-789, 1997.

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