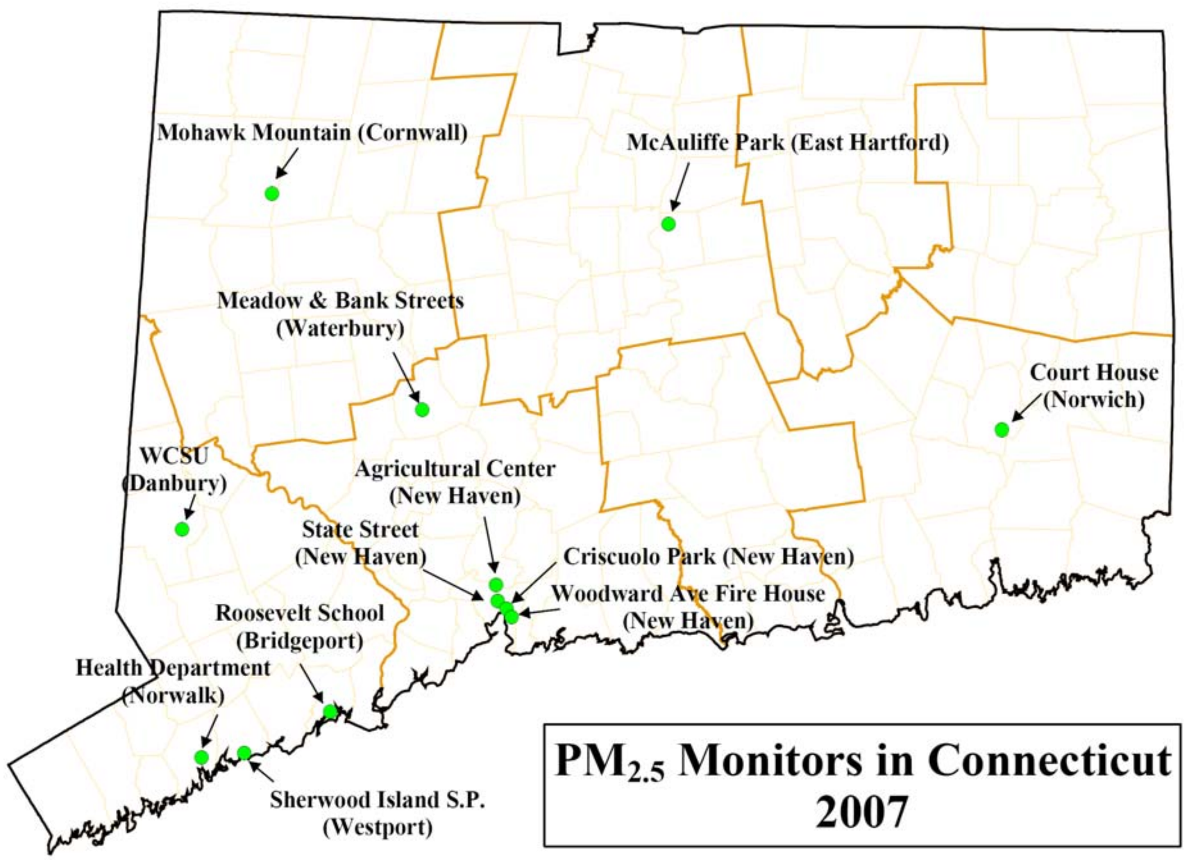
3.0 Observed $PM_{2.5}$ Air Quality Trends and Levels

This section shows the locations as well as the historical and current $PM_{2.5}$ monitoring data at Connecticut monitoring sites. Annual $PM_{2.5}$ concentrations since 1999 have been below the NAAQS of 15.0 $\mu g/m^3$ at all monitors; and trends at most sites have been downward. Annual design values (three year running averages) for the sites have all been below the standard in Connecticut; however monitors in New York and New Jersey continue to measure annual design values above the annual NAAQS of 15.0 $\mu g/m^3$. It is because of these sites in New York and New Jersey that the multi-state area was designated as nonattainment for the 1997 annual $PM_{2.5}$ NAAQS. All sites in Connecticut, as well as the entire nonattainment area are in attainment for the 1997 24-hour $PM_{2.5}$ NAAQS.

3.1 $PM_{2.5}$ Monitoring Sites in Connecticut

The CTDEP's $PM_{2.5}$ federal reference method (FRM) monitoring network for year 2007 included 12 monitor sites. Four of the sites, Criscuolo Park in New Haven, East Hartford, Westport and Norwich operated on an everyday sample schedule while all other sites operated on a 1-in-3 day sample schedule. Two sites, Waterbury and Criscuolo Park in New Haven, operated collocated $PM_{2.5}$ FRM samplers on a 1-in-6 day sample schedule. A thirteenth $PM_{2.5}$ FRM monitor is scheduled to be installed in 2008 at the Fort Griswold site in Groton. These monitor locations are plotted in Figure 3-1.

Figure 3-1. $PM_{2.5}$ Monitoring Sites in Connecticut in 2007



3.2 Annual Average $PM_{2.5}$ Data[1]

The annual average concentration is calculated from the four calendar quarterly averages at each monitoring site. The annual average is the basic statistic used in determining trends and compliance with the annual average NAAQS. Completeness criteria of 75 percent valid daily values of the expected number of samples in each quarter must be satisfied for a valid annual average. Exceptional/natural event data are excluded when calculating the averages. For sites with collocated monitors, collocated values are substituted for any missing primary values.

Annual Averages. Table 3-1 shows the annual average $PM_{2.5}$ concentration at each CTDEP monitoring site currently in operation. Figure 3-2 is a graph of these data which shows trends over the eight years of monitoring that have been conducted. The black trend line for the Bridgeport Roosevelt School site indicates a downward trend in the annual concentrations since 1999.

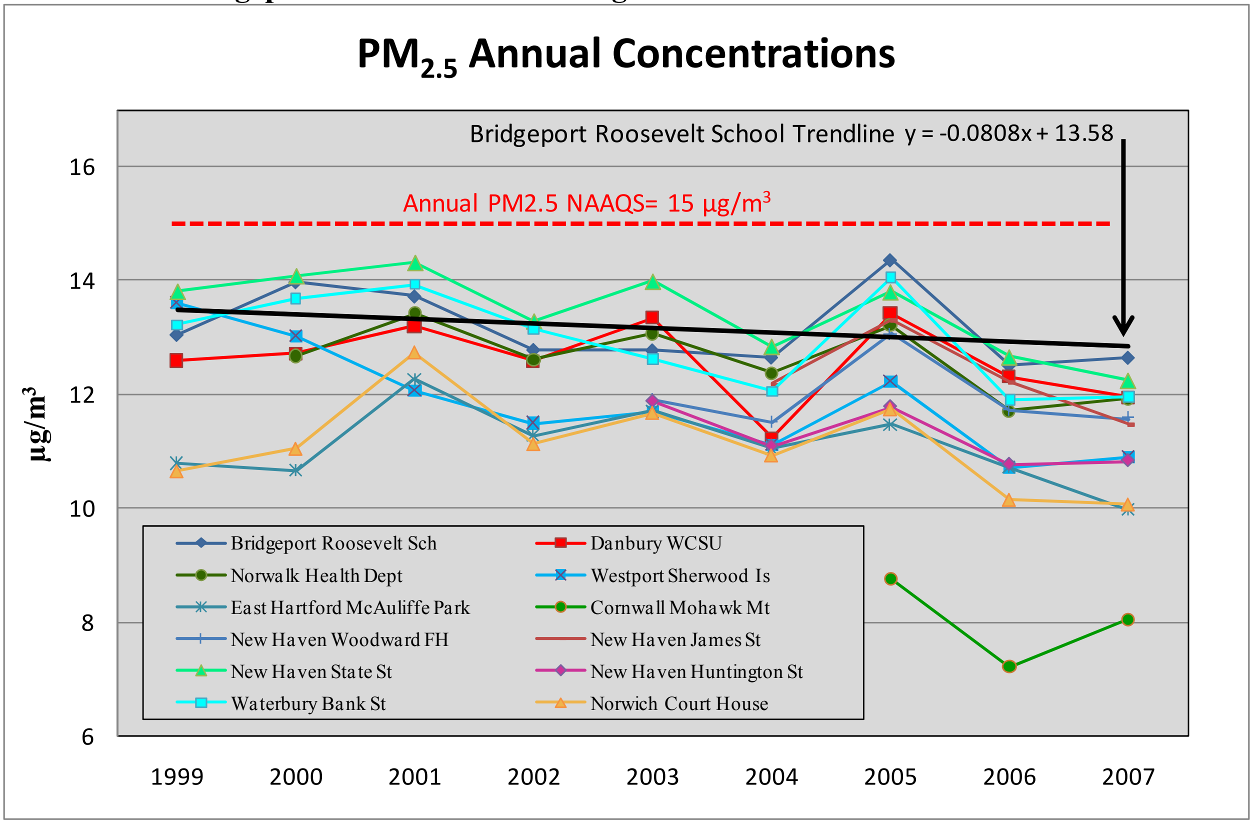
Table 3-1. Annual Average $PM_{2.5}$ Concentrations from 1999-2007

		Annual Averages µg/m³								
Town	**Site Description**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Bridgeport	Roosevelt Sch	13.1	14.0	13.7	12.8	12.8	12.7	14.4	12.5	12.7
Danbury	WCSU	12.6	12.7	13.2	12.6	13.3	11.2	13.4	12.3	12.0
Norwalk	Health Dept		12.7	13.4	12.6	13.1	12.4	13.2	11.7	11.9
Westport	Sherwood Is	13.6	13.0	12.1	11.5	11.7	11.1	12.2	10.7	10.9
East Hartford	McAuliffe Park	10.8	10.7	12.3	11.3	11.7	11.1	11.5	10.7	10.0
Thomaston	WWTP								8.7	10.2
Cornwall	Mohawk Mt							8.8	7.2	8.1
New Haven	Woodward FH					11.9	11.5	13.1	11.7	11.6
New Haven	James St						12.2	13.3	12.2	11.5
New Haven	State St	13.8	14.1	14.3	13.3	14.0	12.8	13.8	12.7	12.3
New Haven	Huntington St					11.9	11.1	11.8	10.8	10.8
Waterbury	Bank St	13.2	13.7	13.9	13.1	12.6	12.1	14.1	11.9	12.0
Norwich	Court House	10.7	11.0	12.7	11.1	11.7	10.9	11.7	10.2	10.1

(grey) Annual value does not meet completeness criteria (75% valid data in each quarter)
(yellow) Value is N/A for inclusion in DV because a quarter had less than 11 samples

[1] In addition to the $PM_{2.5}$ monitoring locations described in this section, CTDEP operated a "special purpose" monitor in New Haven at the Stiles Street I-95 on-ramp until 2006. In December 2004, upon CTDEP's request, EPA concluded that this monitor, located in an industrial section of the city near a steep on-ramp to Interstate-95, was representative of a microscale "hot spot" that did not represent population exposure in the New Haven area. The site was found to be overly influenced by microscale phenomena, including heavy duty truck exhaust from trucks leaving the New Haven Terminal area and accelerating uphill on the Interstate-95 on-ramp. The monitor was less than twenty feet from the traffic lane. Following a special, multi-site monitoring study conducted by CTDEP, the Stiles Street monitor was deemed unrepresentative of population exposure in the City of New Haven. As a result, data from this site cannot be used to make attainment or nonattainment determinations. In 2006, the Stiles Street site was shut down as part of the Interstate-95 New Haven Harbor Crossing Corridor Improvement Program.

Figure 3-2. Graph of Annual Average $PM_{2.5}$ Concentrations from 2000-2007; and Trend Line for the Bridgeport Roosevelt Monitoring Site



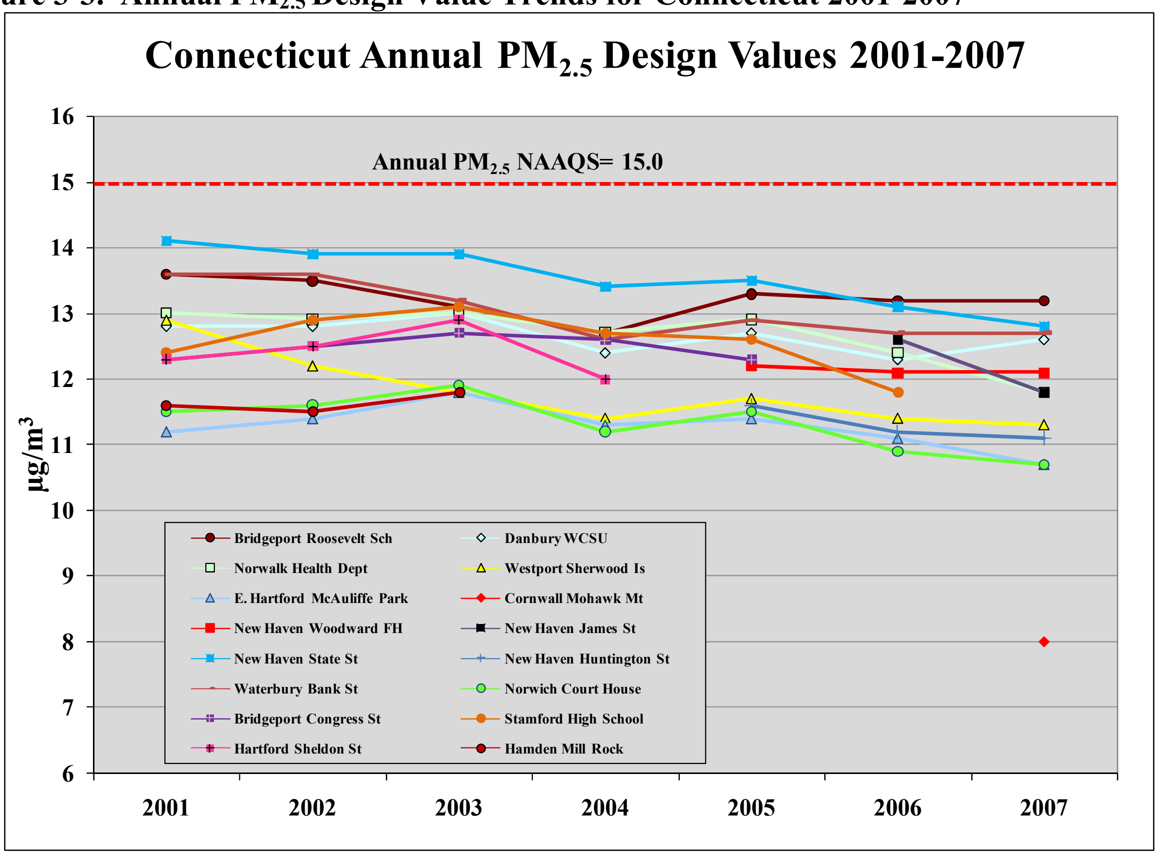
Annual $PM_{2.5}$ Design Values. The annual design value (DV) is derived by averaging three consecutive weighted annual averages, in accordance with 40 CFR Part 50 Appendix N. The annual DVs are calculated based on the 3-year arithmetic average of all valid annual values, with the exception that annual averages are included if the annual average exceeds the standard, or if inclusion of the average results in the DV exceeding the standard. Table 3-2 shows the annual $PM_{2.5}$ design values from 2001-2007 for sites currently operated by CTDEP.

Table 3-2. Annual $PM_{2.5}$ Design Values from 2001-2007

		Annual Design Values µg/m³						
Town	**Site Description**	2001	2002	2003	2004	2005	2006	2007
Bridgeport	Roosevelt School	13.6	13.5	13.1	12.7	13.3	13.2	13.2
Danbury	WCSU	12.8	12.8	13.0	12.4	12.7	12.3	12.6
Norwalk	Health Dept	13.0	12.9	13.0	12.7	12.9	12.4	11.8
Westport	Sherwood Is	12.9	12.2	11.8	11.4	11.7	11.4	11.3
East Hartford	McAuliffe Park	11.2	11.4	11.8	11.3	11.4	11.1	10.7
Thomaston	WWTP						8.7	9.5
Cornwall	Mohawk Mt					8.8	8.0	8.0
New Haven	Woodward FH			11.9	11.7	12.2	12.1	12.1
New Haven	James St				12.2	12.8	12.6	11.8
New Haven	State St	14.1	13.9	13.9	13.4	13.5	13.1	12.8
New Haven	Huntington St			11.9	11.5	11.6	11.2	11.1
Waterbury	Bank St	13.6	13.6	13.2	12.6	12.9	12.7	12.7
Norwich	Court House	11.5	11.6	11.9	11.2	11.5	10.9	10.7
(orange)	DV is N/A due to lack of 3 years of monitoring							

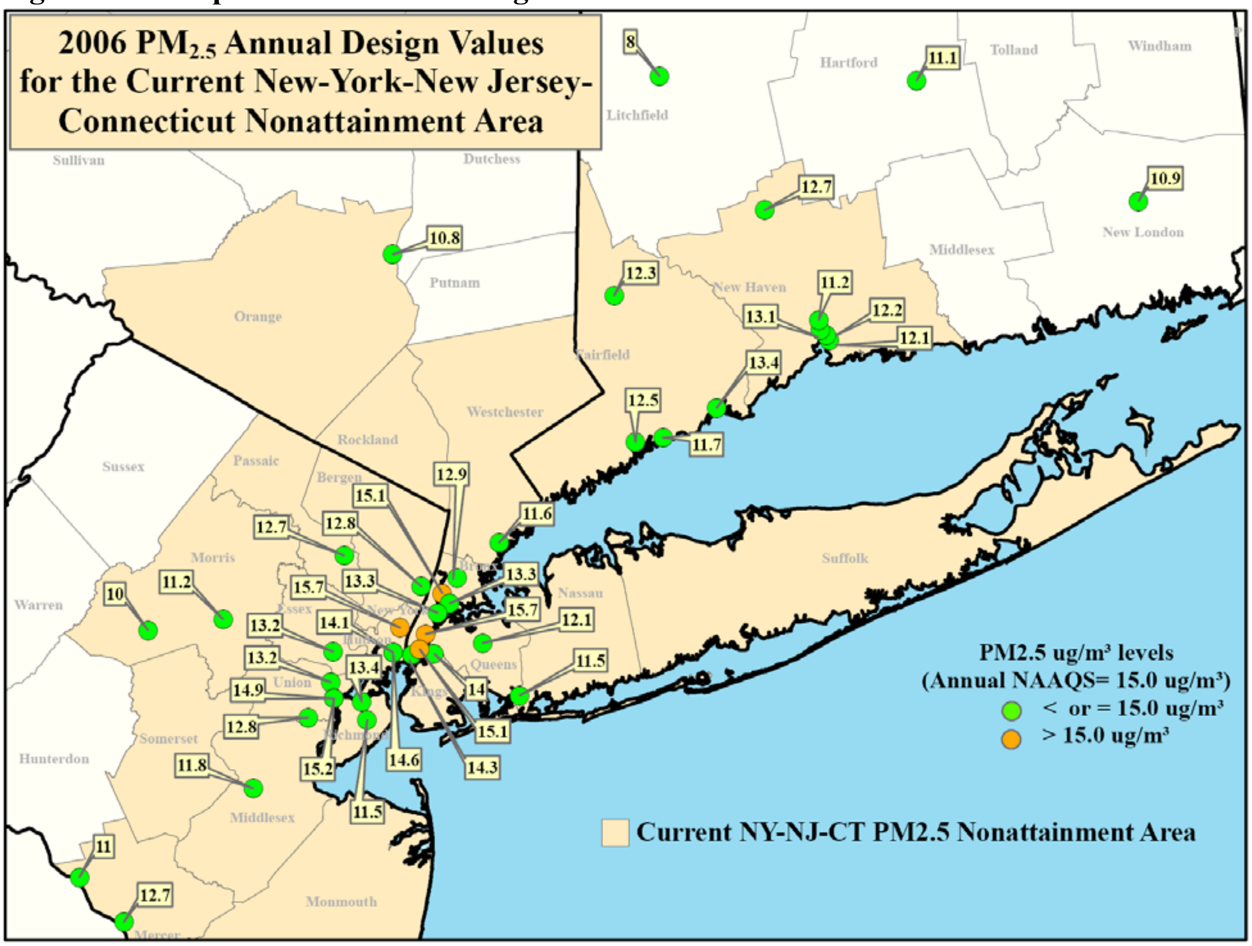
$PM_{2.5}$ Annual Design Value Trends. Annual $PM_{2.5}$ design values for Connecticut monitoring sites have remained under the annual NAAQS of 15.0 µg/m³ since 2001. Figure 3-3 graphs the design values for these sites from 2001-2007. Trends appear to be downward at most sites.

Figure 3-3. Annual $PM_{2.5}$ Design Value Trends for Connecticut 2001-2007



Nonattainment Area Design Values. Although annual $PM_{2.5}$ design values have remained below 15 µg/m^3 in Connecticut since 2001, annual design values have exceeded this value at monitors in New Jersey and New York. The current $PM_{2.5}$ nonattainment area designation was based on 2003 design values and although Connecticut had no monitors exceeding the annual standard during that year, Fairfield and New Haven Counties were included in the greater New York City nonattainment area. Figure 3-4 shows a map of the nonattainment area with the latest available (2006) annual $PM_{2.5}$ design values. Both New Jersey and New York had a monitoring site with a peak design value of 15.7 µg/m^3 for the three year period ending 2006, while the peak Connecticut monitored level was 13.4 µg/m^3.

Figure 3-4. Map of 2006 Annual Design values for the NY-NJ-CT Nonattainment Area

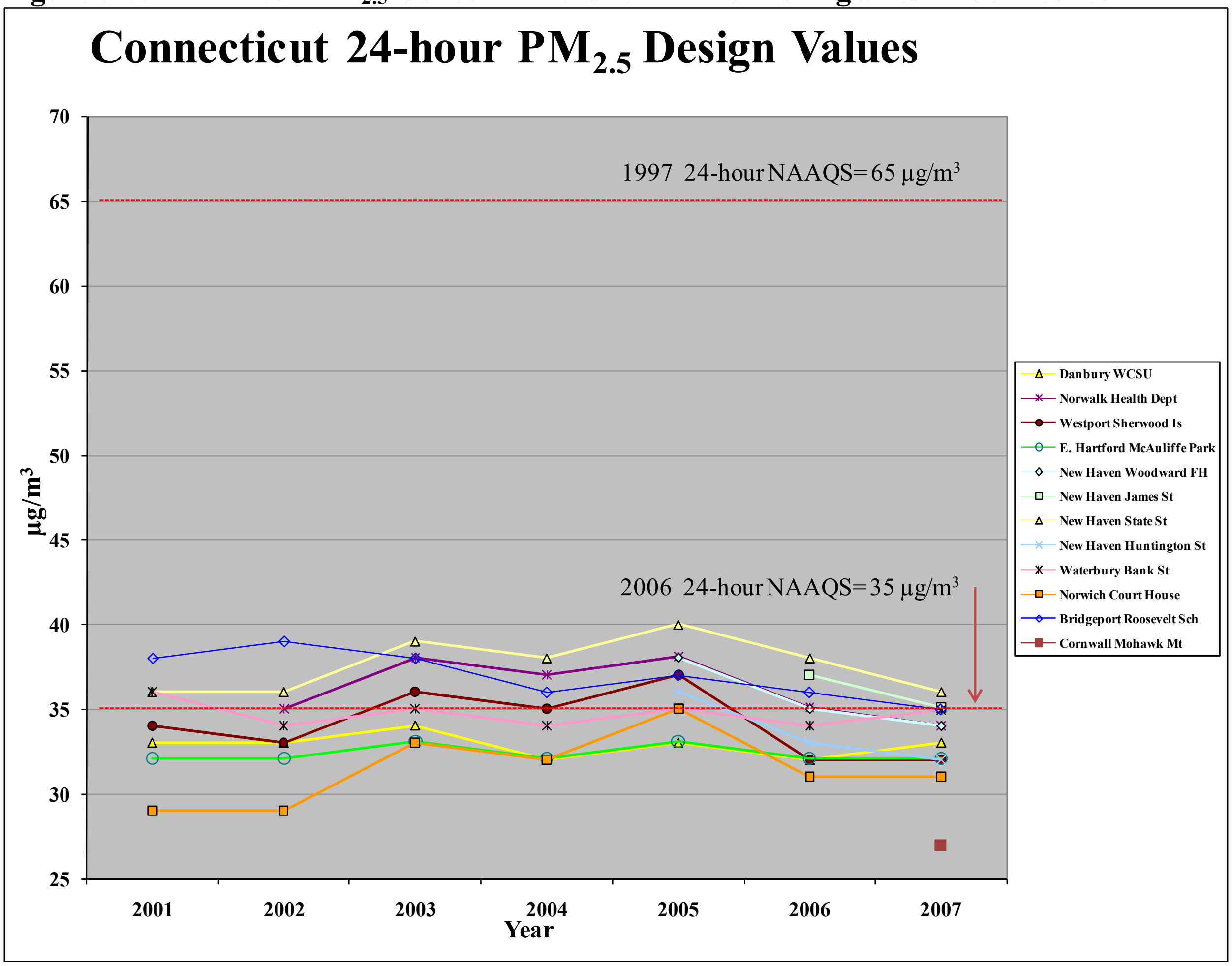


3.3 Daily (24-hour) $PM_{2.5}$ Design Values

The 24-hour design value is defined as the 3-year average of valid yearly 98th percentile $PM_{2.5}$ values, calculated in accordance with 40 CFR Part 50 Appendix N. Missing data are augmented with valid collocated values, if available, and concurred natural/exceptional events are excluded. As with the annual design values, yearly 98th percentile values not meeting completeness requirements are only included in the 3-year average if they exceed the level of the standard, or if the inclusion of the yearly 98th percentile $PM_{2.5}$ value would result in the design value exceeding the standard.

As shown in Figure 3-5, all 24-hour design values in Connecticut are well below the 1997 $PM_{2.5}$ NAAQS of 65 µg/m^3. Note, however, that the $PM_{2.5}$ NAAQS for the 24-hour standard was revised downward in December 2006 to 35 µg/m^3. Although this SIP does not apply to the 2006 NAAQS, it is worth noting that only 1 site in Connecticut registered a design value exceeding the new daily NAAQS in 2007.

Figure 3-5. 24-Hour $PM_{2.5}$ Concentrations for 12 Monitoring Sites in Connecticut



3.4 Monitor Speciation: Urban/Rural Speciation Characterization

Over the past several years the CTDEP has collected speciated $PM_{2.5}$ data from several monitor locations. Monitoring equipment was moved sequentially from site to site for three coastal sites, and from May 2002 to December 2003 was located at the Westport site. The sites were operated using the Speciation Trends Network (STN)[2] protocol. The monitoring sites were designed to characterize air quality influenced by local urban sources, primarily motor vehicles, as they are close to urban centers and interstate highways (I-95 and I-91). Additionally, their close proximity to Long Island Sound (LIS) allowed them to measure $PM_{2.5}$ transport on days with southwest winds. Transported pollution on these days is coming from out-of-state areas: not just the NYC Metropolitan Area but also from other states south and west of Connecticut.

CTDEP also operated a rural monitor located on Mohawk Mountain in Cornwall using the IMPROVE[3] (Interagency Monitoring of Protected Visual Environments) protocol for speciated $PM_{2.5}$. It is located at an elevation of 1683 feet above sea level and is designed to capture upwind transported air pollution.

Table 3-3 lists the speciation monitors and protocols used for this analysis.

Table 3-3. IMPROVE and STN Monitors in Connecticut Used for Speciation Analysis

Monitor Location	Protocol Method	Period of Operation/record
Westport (Fairfield Co)	STN	May 2002-December 2003
Cornwall (Litchfield Co)	IMPROVE	September 2001- December 2004

Six major species are analyzed for the $PM_{2.5}$ data: sulfate, nitrate, elemental carbon, organic carbon, crustal material and ammonium. Figure 3-6 shows the speciation breakdown for the Westport STN site over the 17 month period of operation. Organic carbon and sulfates are the predominant species. Figure 3-7 shows the data categorized by calendar quarter for Westport. The data clearly shows that, while sulfates and organic carbon predominate in all seasons, nitrate levels are higher in the cooler seasons. Figure 3-8 shows the speciation data from the Cornwall IMPROVE site over a 40 month period. For this elevated, rural site, sulfate is the predominant species over the entire period.

Sulfate, or SO_4, is a secondary pollutant, being transformed from gaseous SO_2 to particle form in the presence of water vapor in the atmosphere. Ammonium sulfate is the most prevalent form of sulfate that is created in the atmosphere. Sulfate particles also compete with nitrate for ammonium, with the most efficient conversion to ammonium sulfate occurring in summer. The primary source of SO_2 is coal combustion. Most of the coal burned in the Northeast is by electricity generating units in the states of Pennsylvania, West Virginia and Ohio, states that are located to the south and west of Connecticut. Therefore much of the sulfate measured in Connecticut most likely originates in these states.

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[2] http://www.epa.gov/airtrends/aqtrnd03/pdfs/2_chemspecofpm25.pdf
[3] http://vista.cira.colostate.edu/improve/

Figure 3-6. Pie Chart of $PM_{2.5}$ Speciated Data for Westport Connecticut

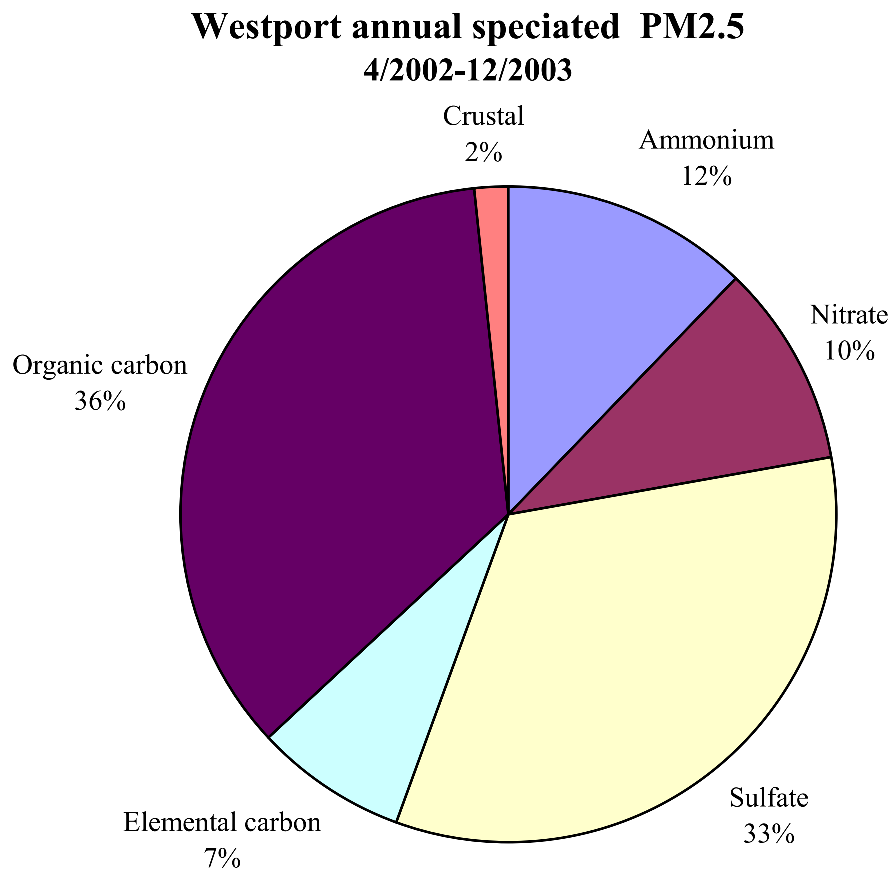


Figure 3-7. Pie Charts of Quarterly $PM_{2.5}$ Speciated Data for Westport Connecticut

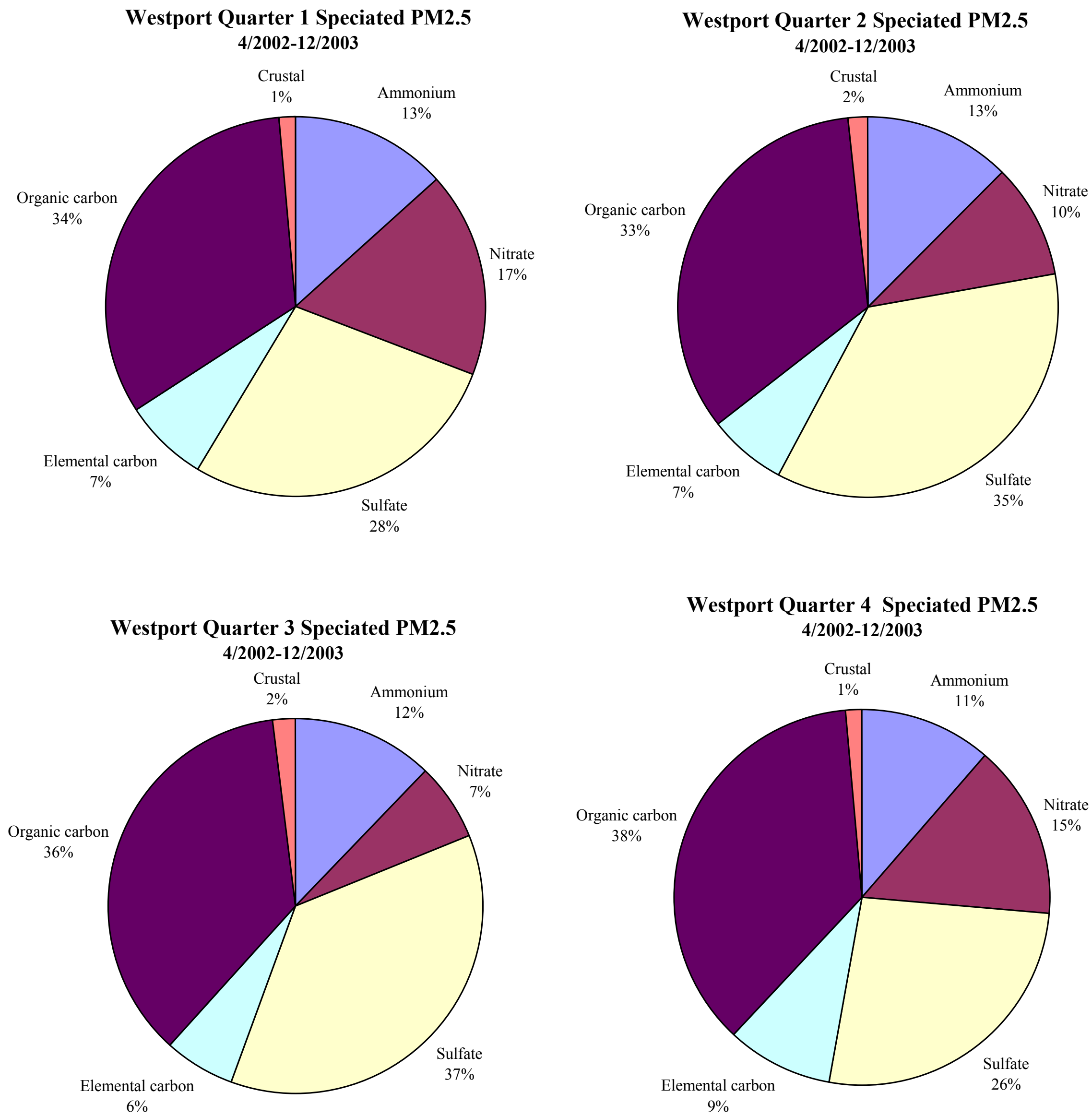
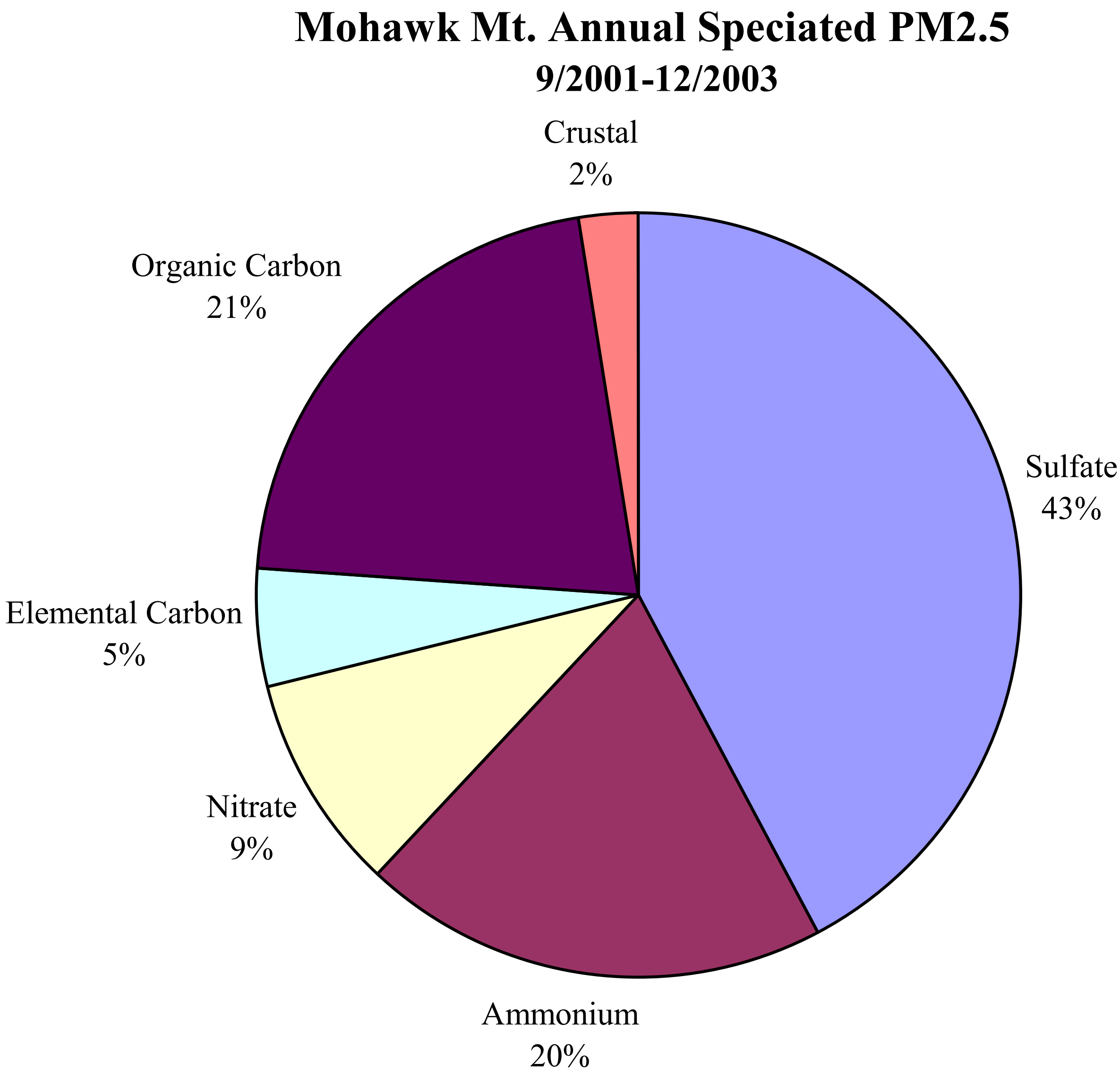


Figure 3-8. Pie Chart of $PM_{2.5}$ Speciated Data for Cornwall Connecticut



The sources of nitrate are high temperature fuel combustion and agricultural operations that first create nitrogen oxides. Gaseous nitrogen oxides are eventually converted in the presence of water vapor in the atmosphere to ammonium nitrate. The largest source sectors emitting nitrogen oxides are mobile sources, coal fired power plants, industrial boilers and residential furnaces. The atmospheric and chemical conversion to ammonium nitrate can occur relatively quickly, but preferentially in the winter. Hence ammonium nitrate concentrations are highest in the winter but are present all year.

Elemental carbon, (EC is also known as black carbon or soot) is the product of incomplete fuel combustion. Sources can include diesel trucks or wood fires, residential fires or wild fires. Summertime presence of high EC can sometimes be attributed to wildfires, especially when accompanied with high concentrations of potassium. Wintertime EC can also be attributed to residential wood combustion.

Organic carbon can originate from fuel or solvent evaporation and fuel combustion. The highest density of these sources typically occurs in urban areas, i.e., motor vehicles, home heating, fuel handling, commercial businesses and industrial operations (factories, dry cleaners, bakeries, etc.). Natural sources (vegetation) emit gaseous volatile organic compounds that also contribute to secondary organic carbon particles in the atmosphere.

Crustal material is defined here as the sum of elemental Al, Ca, Fe, Si, and Ti. Crustal material can be measured in clean air masses (though concentrations are low) and also in dust kicked up by road traffic.

Although the speciation analysis does not explicitly pinpoint the source of the pollutants, it does show a pattern consistent with other monitors in the eastern United States. Overall $PM_{2.5}$ concentrations are lower at the rural Cornwall site, compared to the urban Westport site and sulfate concentrations are a greater percentage of the total at the Cornwall site. Also the elemental and volatile carbon fractions are greater in the urban areas, likely due to the diesel traffic and other combustion sources. Unlike annual $PM_{2.5}$ concentrations, for which the urban excess is more easily quantifiable, daily $PM_{2.5}$ concentrations above 35 $\mu g/m^3$ are mostly due to regional transport of $PM_{2.5}$ and its precursors, as illustrated in trajectory diagrams provided in Figures 3-9 and 3-10.

Figure 3-9. 72-hour back Trajectories from State Street, New Haven, CT 2000-2004 Days when $PM_{2.5}$ > 35µg/m^3 (1 in 3 day sampling)

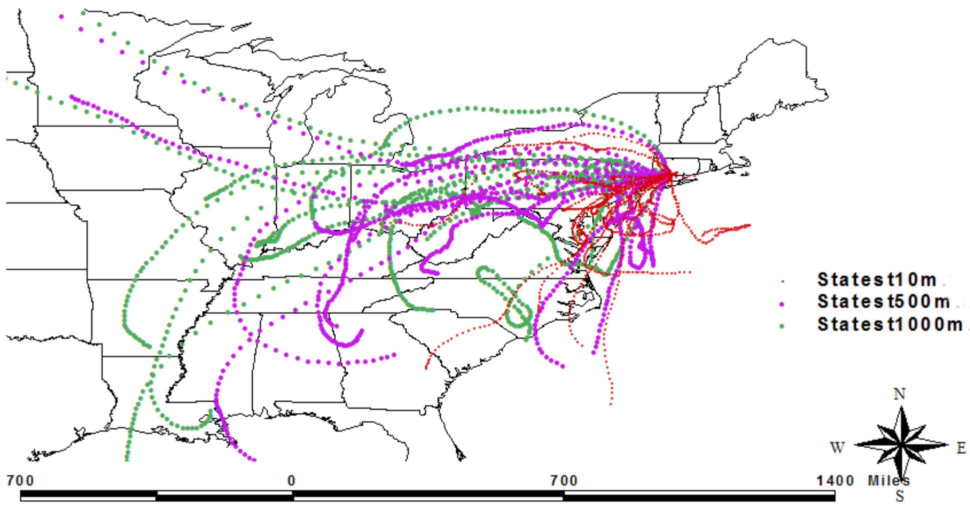


Figure 3-10. 72-hour back Trajectories from Westport, CT 2000-2004 Days when $PM_{2.5}$ > 35µg/m^3 (1 in 3 day sampling)