Connecticut's Response to the EPA 9-Factor Analysis for PM2.5 Designations

Connecticut Department of Environmental Protection

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1. INTRODUCTION

The U.S. Environmental Protection Agency (EPA) promulgated new National Ambient Air Quality Standards (NAAQS) for particulate matter of less than 2.5 microns in diameter ($PM_{2.5}$) in 1997. Following years of litigation EPA is now implementing the standard and is planning to designate areas as attainment and nonattainment by December 31, 2004. In February 2004, Connecticut provided EPA with a recommendation to designate the entire State as attainment.

In the technical support document (February 2004 TSD) provided to the EPA on February 10, 2004, the Connecticut Department of Environmental Protection (CTDEP) presented analyses clearly demonstrating that the Stiles Street $PM_{2.5}$ monitor was measuring "microscale" events and thus should not be considered in the determination of compliance with the annual $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS). CTDEP also demonstrated that emissions from Connecticut are not contributing to $PM_{2.5}$ NAAQS nonattainment monitored in New York City and New Jersey. Despite the overwhelming evidence provided in the February 10, 2004 submission, on June 29, 2004, the CTDEP received a letter and supporting documents from EPA Region 1 stating that, based on an EPA analysis of nine factors, EPA is considering designating both New Haven and Fairfield counties as a part of a $PM_{2.5}$ nonattainment area that encompasses the New York City (NYC) metropolitan area.

CTDEP has reviewed EPA's 9-Factor Analysis and believes that some of the conclusions made by the EPA are not scientifically justified. Additional data have become available to further support CTDEP's conclusion. This document will review the nine factors presented by the EPA and show that the conclusion reached is untenable.

The nine factors presented in the Holmstead memo (EPA, April 1, 2003) that are used to determine the boundaries between areas included and excluded in a nonattainment area are as follows:

- **Emissions**
- **Air quality**
- **Population density** and degree of urbanization including commercial development
- **Traffic and commuting patterns**
- **Expected growth** (including extent, pattern and rate of growth)
- **Meteorology** (weather/transport patterns)
- **Geography/ topography** (mountain ranges or other air basin boundaries)
- **Jurisdictional boundaries** (e.g., counties, air districts, Reservations, etc.)
- **Level of control of emission sources**

The Holmstead memo further states that "A demonstration supporting the designation of boundaries that are less than the full metropolitan area must show both that violations are not occurring in the excluded portions of the metropolitan area and that the excluded portions are not source areas that contribute to the observed violations."

This document presents evidence demonstrating that $PM_{2.5}$ NAAQS violations are not occurring in Connecticut's ambient air and that Connecticut counties are not a significant contributor of $PM_{2.5}$ to the violating sites in the NYC consolidated statistical area (CSA). The only logical conclusion possible from the evidence presented is a designation of attainment for all of Connecticut for the $PM_{2.5}$ NAAQS.

2. FACTOR 1: EMISSIONS

EPA presented documentation based on an "urban excess" analysis that ranked the CSA and surrounding counties based on a calculated "emissions score." Although the basic concept of an urban excess has validity, CTDEP disagrees with EPA's overly simplistic approach of identifying the urban excess strictly by ranking the highest emitting counties, with no consideration to emissions density, distance, meteorology, chemical conversion rates or other important factors. EPA's methodology makes no distinction between counties in the CSA with equal emissions, ignoring any differences in county size, the varying distance of counties from violating monitors and the frequency over a year that each county is located upwind of violating monitors. Furthermore, EPA has not properly considered more rigorous modeling conducted by both EPA and CTDEP that leads to different conclusions, as described below.

EPA's IAQR Modeling

The most compelling evidence of Connecticut's insignificant impact on nonattainment in NYC and New Jersey is provided by EPA's modeling conducted in support of the proposed Interstate Air Quality Rule (IAQR)[1], now known as the proposed Clean Air Interstate Rule[2]. EPA's analysis used the REMSAD model, which incorporates sophisticated techniques to simulate the effect of emissions, transport, diffusion, chemical reactions and removal processes on resultant concentrations of various $PM_{2.5}$ species (see Section 3.C. in CTDEP's February 2004 TSD). EPA's REMSAD modeling included state-by-state "zero out" runs (in which emissions for each State are set to zero) to determine the impact of each state on annual $PM_{2.5}$ concentrations in other States. Modeling results indicated Connecticut's maximum annual $PM_{2.5}$ contribution to any other state was 0.07 ug/m^3 in New York County, well below EPA's significant impact threshold of 0.15 ug/m^3. EPA's IAQR proposal concluded:

> *"… that EPA proposes today that Connecticut contributes significantly to downwind ozone nonattainment, but not to fine particle nonattainment. Thus, Connecticut would not be subject to an annual NOx control requirement, and is not included in the 28-State and DC region we are proposing for annual controls."* [3]

[1] 68FR20, January 30, 2004, pp.4566-4650
[2] 69FR112, June 10, 2004, pp.32684-32722
[3] 69FR112, pp.4618-4619

It is unclear to CTDEP why EPA has decided to ignore these more scientifically rigorous IAQR results, relying instead on the crude and inadequate "emissions score" procedure described above to determine whether Connecticut contributes significantly to measured violations in NYC and New Jersey.

CTDEP's ISCST3 Modeling

In CTDEP's analysis, as described in the February 2004 TSD (Section 3.A.), CTDEP used the ISCST3 model to estimate the effect of Connecticut's primary fine-particulate matter emissions on $PM_{2.5}$ concentrations in NYC and northern New Jersey. CTDEP's analysis did not attempt to account for secondary particle formation, however, results were consistent with EPA's IAQR analysis, showing Connecticut's annual contribution to primary $PM_{2.5}$ concentrations in NYC to be small (*i.e.*, on the order of 2% of the modeled primary particulate matter).

The ISCST3 modeling results also indicated that primary $PM_{2.5}$ concentrations dropped off significantly after a distance of 40 km from NYC. Investigation confirmed that this was largely due to higher emission densities within NYC and adjacent counties than in counties further afield. Figure 1 shows county level emission densities (i.e., the sum of SOx, NOx, carbon, and crustal emissions divided by county area) based on emissions reported in EPA's 9-Factor Analysis. The greatest emission densities exist in the immediate vicinity of NYC, with much lower emission densities in outlying counties.

EPA's simplistic "emissions score" methodology does not include important factors such as emissions density or distance. For example, EPA's method results in the impacts of Fairfield County ranking equally to those from Kings County in NYC, due largely to similar emission levels of carbon (~ 1800 tons/year), identified by EPA as the dominant urban excess component. However, EPA's method fails to account for the almost 10-fold higher emissions density in Kings County, or that Kings County is within only a few miles of three violating monitors in New York County.

The introduction of just a few of the factors described above into EPA's emissions scoring approach would greatly change the conclusions regarding counties contributing to nonattainment. Both the ISCST3 primary $PM_{2.5}$ modeling previously described by CTDEP (*see* Figure 37 of the February 2004 TSD) and EPA's IAQR modeling more properly account for key parameters such as emissions density, source-receptor distance and meteorological effects. Thus, results from those modeling efforts should be given much more weight when EPA makes final decisions regarding Connecticut's impacts on nearby nonattainment areas.

3. <u>FACTOR 2: AIR QUALITY</u>

Inexplicably, EPA's 9-Factor Analysis limits discussion of New Haven's air quality data to a single statement indicating that "In New England, only one county, New Haven, shows a violation of the annual $PM_{2.5}$ standard." EPA's analysis does not even acknowledge, let alone rebut, the extensive documentation submitted by CTDEP regarding the microscale nature of the Stiles Street monitoring site (see Section 2 of the February 2004 TSD). In addition, EPA's analysis does not address CTDEP's conclusion that EPA regulations and guidance preclude the use of the Stiles Street data for determining compliance with the annual $PM_{2.5}$ standard (see Section 5 of the February 2004 TSD). CTDEP encourages EPA to examine the evidence presented on this issue thoroughly, both in the February 2004 TSD and in this document, before making a final determination regarding New Haven's attainment designation.

As described in Section 2 of the February 2004 TSD, CTDEP recently expanded its $PM_{2.5}$ monitoring network in the New Haven area from three to six locations (*see* Figure 2). This was done to examine spatial concentration patterns, to determine the factors contributing to elevated $PM_{2.5}$ levels at the Stiles Street location and to determine if the Stiles Street site is representative of community exposure. Primary findings related to the Stiles Street site from the February 2004 TSD are summarized below:

- Although most of the Connecticut $PM_{2.5}$ monitors are sited in industrial/urban areas in proximity to major interstate highways, only the Stiles Street site exceeds the annual $PM_{2.5}$ NAAQS.
- The Stiles Street site is unique. It is located within a Connecticut Department of Transportation right-of-way, between an elevated section of Interstate 95 (I-95),which is 70 feet away and above the sampling probe, and the I-95 on-ramp, which is 30 feet away (*See* Figure 5). The on-ramp is the primary highway access point for large numbers of heavy duty diesel trucks servicing the nearby New Haven Terminal area. The I-95 on-ramp is steeply graded in its approach to the I-95 Q-Bridge harbor crossing, requiring maximum acceleration of trucks on the steep ramp as they attempt to reach highway speeds. The area is industrial.
- The Stiles Street monitor location measures the highest $PM_{2.5}$ concentrations, with a strong gradient of decreasing concentrations extending out to the surrounding New Haven area monitors, indicating the existence of a strong local source at Stiles Street.
- Comparison of daily $PM_{2.5}$ data for the six New Haven area monitors suggests that the central business district (State Street) and areas immediately adjacent to the interstate highways (Toll Booth) are experiencing urban excess $PM_{2.5}$ levels of approximately 2 $\mu g/m^3$ above urban neighborhood background levels. Meanwhile the Stiles Street monitor is experiencing a micro-scale excess of approximately 2 $\mu g/m^3$ above the urban excess levels (Agricultural Station and Woodward Fire House).
- Higher ratios of black carbon to $PM_{2.5}$ at Stiles Street compared to State Street suggest that the Stiles Street monitor is more highly impacted by local diesel tailpipe emissions than State Street.
- Hourly black carbon and wind data indicate that wind direction and time of day have more significant impacts on black carbon at Stiles Street than at State Street.
- Traffic counts and diurnal black carbon data suggest a relationship between high-density heavy duty diesel truck traffic and morning black carbon maxima at Stiles Street.
- $PM_{2.5}$ levels measured at the West Haven Toll Booth site, which is 100 feet from I-95, are approximately 2 $\mu g/m^3$ less than at Stiles Street. This information should convince EPA that high $PM_{2.5}$ levels measured at the Stiles Street Site are not representative of any other high traffic areas near I-95 and I-91.

Subsequent to our submittal of the February 2004 TSD, CTDEP has continued to collect and analyze data from the six New Haven area $PM_{2.5}$ monitors. Significant results from those analyses pertinent to EPA's "Air Quality" factors are summarized below.

Recent New Haven Monitored Data

Average $PM_{2.5}$ concentrations for the first quarter of 2004, coincident with data collected since the installation of the Criscuolo Park site, are displayed in Figure 2 for the six New Haven area monitors. Figure 3 is an aerial map showing the relative location of the Criscuolo Park site to Stiles Street and the Woodward Avenue Fire House site to the highway. Figures 4 shows an aerial photograph of the Stiles Street site area and Figure 5 shows a close-up photograph of the Stiles Street Site and on-ramp.

Not surprisingly, Stiles Street experienced the highest $PM_{2.5}$ concentrations, averaging 15.9 µg/m^3 over the first quarter of 2004. The Toll Booth site, also immediately adjacent to I-95, experienced an average concentration of 13.8 µg/m^3.

The concentrations along with distances from interstate highway are provided in Table 1:

Table 1. 1st quarter 2004 $PM_{2.5}$ Concentrations From New Haven Area Monitors

Monitoring Site	Distance to Highway	Concentration µg/m^3
Stiles Street	70 feet (<30 feet to on-ramp)	15.9
Toll Booth	100 feet	13.8
State Street	600 feet	13.1
Woodward Fire House	575 feet	11.7
Criscuolo Park	775 feet	12.4
Agricultural Station	>6000 feet	11.7

EPA's June 29, 2004 letter to the Commissioner stated that EPA is not convinced that the Stiles Street monitor "…is not representative of the area and that there are not other high-traffic areas near Interstates 95 or 91 with elevated $PM_{2.5}$ levels." CTDEP installed the special purpose monitor at the West Haven Toll Booth site (Figure 6) specifically to address this concern. Note in Figure 6, an aerial photograph of the Toll Booth site, that residences are situated near the highway, but greater than 100 feet from the driving lanes. There is no doubt that a "highway excess" of $PM_{2.5}$ exists within 100 feet of the highway, but a cursory survey of aerial photographs indicates that it is probable that no residence is situated within 100 feet of the highway; therefore exposures to annual average concentrations greater than what is being measured at the Toll Booth site are not likely. The Stiles Street monitor, which is closer to the highway than the Toll Booth site (70 feet versus 100 feet) and 30 feet away from a high truck volume on-ramp, measures, on average, about a 2µg/m^3 greater concentration. This adds further evidence that a microscale factor is increasing the concentrations at Stiles Street.

Special Purpose Monitors. New $PM_{2.5}$ data have been analyzed since the submittal of the February 2004 TSD. Figure 7 shows that the linear regression line for Stiles street is nearly parallel to and above that for the Woodward Fire House site. The figure indicates that Stiles Street $PM_{2.5}$ is typically about 3.4 µg/m^3 higher than at the Woodward Fire House. These results strongly support the conclusion that there is a high $PM_{2.5}$ concentration gradient in the vicinity of

Stiles Street, which is most likely due to a strong local source. The only known source in the Stiles Street vicinity is vehicular traffic on I-95 and the I-95 access ramp, which is a microscale source (at distances of less than 100 meters). The two sites with the most similar concentrations, State Street and West Haven, are also within relatively close proximity to a high volume interstate highway and/or access ramp. This further supports the concept of a "microscale" increment at the Stiles Street site.

Figure 8 shows the 24-hour average $PM_{2.5}$ concentrations for all sites in Connecticut for 2003. Highest levels occur simultaneously State-wide, which is a regional signature, representative of transport. In other word, on high $PM_{2.5}$ days, Connecticut residents are exposed primarily to transported $PM_{2.5}$, but at levels much less than the 65 µg/m^3 24-hour NAAQS.

The 2001-2003 annual and 24-hour design values for all Connecticut $PM_{2.5}$ monitoring sites are presented in Table 2. This table is an update of what CTDEP provided in the February 2004 TSD, which contained design values for 2000-2002.

Table 2. 2001-2003 PM2.5 Design Values in CT (µg/m^3)

Monitor Location	Annual	24hr*	Monitor Location	Annual	24hr*
Bridgeport Roosevelt School	13.5	37	New Haven Stiles St.**	16.7	42
Bridgeport Congress St.	12.9	37	Norwalk	13.3	35
Danbury	13.2	34	Norwich	11.7	38
East Hartford	11.9	35	Stamford	13.3	39
Hamden	11.9	36	Waterbury	13.4	35
Hartford	13.1	33	Westport	11.9	39
New Haven State St.	13.9	40	**NAAQS**	**15.0**	**65.0**

* Design values for 24-hr levels are the three year average of the 98th percentile values.
** Microscale effects at the Stiles Street monitor preclude its use in annual attainment designations.

The first full year (April 2003-March 2004) of annual and 24-hour $PM_{2.5}$ data for comparison with the new monitoring sites in New Haven, is presented in Table 3. The annual $PM_{2.5}$ level at the Toll Booth was 13.1 µg/m^3 while that at Stiles Street was 15.5 µg/m^3 which, is 2.4 µg/m^3 greater. As mentioned previously, the Toll Booth site is about 100 feet from the high-speed traffic lane of I- 95.

Table 3. April 2003 – March 2004 New Haven Area PM2.5 Annual Averages and 24 Hour 98th Percentile Values* (μg/m^3)

Monitor Location	Annual	24hr
New Haven Stiles St.	15.5	41
New Haven State St.	13.4	41
New Haven Woodward Avenue Fire House	11.8	42
New Haven Huntington St. CT Agricultural Station.	11.7	42
West Haven Former Toll Booth	13.1	45

* Averages and percentiles include only 1-in-3 day scheduled samples for each site for the 1-year period 4/1/2003 – 3/31/2004.

The Woodward Fire House monitor was also deployed to assess $PM_{2.5}$ levels that the public living near I-95 could be exposed to. The first year of data indicates that the average $PM_{2.5}$ levels are 3.7 μg/m^3 below the levels at Stiles Street (11.8 μg/m^3 vs. 15.5μg/m^3).

The Agricultural Station monitor was designed to provide an estimate of urban neighborhood background levels for the city of New Haven. The average $PM_{2.5}$ level measured here was 11.7μg/m^3 which, is much lower than Stiles Street and similar to that of the Woodward Fire House.

The above information leads CTDEP to conclude that the public in New Haven is not being exposed to $PM_{2.5}$ levels exceeding the NAAQS.

Aethalometer Study. CTDEP has conducted a spatial analysis using 1-minute black carbon (BC) measurements from an aethalometer installed at Stiles Street and 5-minute BC measurements from a similar instrument installed at Criscuolo Park, from April 1, 2004 through June 30, 2004. The analysis was performed to determine contributions from micro-scale, middle-scale, and neighborhood- to urban- scale sources. In this study, the average BC (which is comparable to elemental carbon, EC) concentrations at Criscuolo Park and Stiles Street were 0.90 μg/m^3 and 2.00 μg/m^3, respectively. The aethalometer used for the study only measures the BC component of diesel emissions. Organic carbon (OC), although not measured, is also a particulate matter component of diesel exhaust and is emitted at ratios that range from 1 to 10 times EC under typical engine loading conditions and operating temperatures[4] consistent with traffic patterns around the Stiles Street monitoring site.

The micro-scale contribution at Stiles Street of the EC was determined to be 0.73 μg/m^3, thus the estimated total contribution of the OC ranged from 0.73 μg/m^3 to 7.30 μg/m^3. The total $PM_{2.5}$ (OC and EC) micro-scale contribution from diesel sources could be estimated to range from 1.46 μg/m^3 to 8.03 μg/m^3. Using a more appropriate and narrow range of OC to EC ratios from 2 to 5, it could be reasonably concluded that *the micro-scale $PM_{2.5}$ contribution from diesel vehicles at Stiles Street is approximately 2 to 4 μg/m^3*.

[4] See Appendix A for a detailed description on the analysis performed along with the corresponding results.

4. FACTORS 3 AND 4: POPULATION DENSITY, TRAFFIC AND COMMUTING PATTERNS

EPA has concluded that Fairfield, New Haven and Hartford counties in Connecticut have moderate sized populations and population densities relative to the other counties in the CSA. They have also concluded that these three counties score relatively high for vehicle miles traveled (VMT) when compared to the rest of the CSA and adjacent counties. EPA states (EPA's 9-Factor Analysis) that the number of commuters from Fairfield and New Haven counties to other CSA counties is moderately high even though there is "a much smaller number of commuters in the three Connecticut counties than in some NY counties in the NY-NJ-CT-PA CSA" and that heavy-duty truck traffic from Connecticut to both New York and New Jersey may not have been adequately taken into account.

EPA's general conclusions add little to the non-attainment/attainment discussion, and, could be misleading in this context. While EPA states that the number of commuters in Fairfield and New Haven counties is "moderately high," EPA's ranking of the Fairfield and New Haven counties among the 30 NY-NJ-CT-PA CSA counties is low, 18th and 20th, respectively. When compared on a cumulative percentile basis, the number of commuters to other counties from Fairfield and New Haven are at the 87th and 91st percentile, respectively, well below the 80% threshold EPA used in its emission scoring procedure. In addition, when the percentage commuting to other CSA counties is considered, Fairfield (19%) and New Haven (19%) both are tied for 28th out of 30 counties.

It is important to remember that the statistics presented by EPA and discussed above represent people from Fairfield and New Haven that commute to **any other** county in the NYC CSA (including to other Connecticut counties), **not** just to counties in the NYC and New Jersey portions of the CSA where violating $PM_{2.5}$ monitors are located. As described in the February 2004 TSD (see Section 3.D), Connecticut accounts for only 0.7% of all work-trip commutes into the New York and New Jersey portion of the CSA, with only 0.9% of work-trip commutes into the five New York City boroughs and only 0.1% into the New Jersey portion of the CSA. CTDEP asserts these statistics provide a much better picture of commuter impacts on violating monitors than the more general statistics in EPA's analysis. In summary, commuters from Connecticut have a small influence on air quality in NYC and New Jersey.

Finally, EPA commented that heavy-duty truck traffic from Connecticut to New York and New Jersey was not taken into account. CTDEP has investigated this further and found that according to data compiled by the United States Department of Transportation Bureau of Transportation Statistics, 1997 truck shipments from Connecticut accounted for less than 0.5% (by weight) of total domestic truck shipments into New York State [5]. By comparison, New Jersey accounted for 6% (by weight) of 1997 truck shipments into New York State, while 76% of shipments originated within New York. Similarly, Connecticut accounted for less than 1% of shipments into New Jersey [6], while New York and New Jersey accounted for 4% and 72%, respectively. Although these statistics are compiled on a statewide basis, CTDEP expects that CSA-level data

[5] http://www.bts.gov/publications/state_transportation_profiles/new_york/html/table_03_05.html
[6] http://www.bts.gov/publications/state_transportation_profiles/new_jersey/html/table_03_05.html

would not appreciably alter our conclusion that emissions from Connecticut truck traffic do not significantly impact violating $PM_{2.5}$ monitors in either New York City or New Jersey.

5. FACTOR 5: EXPECTED GROWTH

EPA has concluded that Fairfield and New Haven counties had low population growth between 1990 and 2000 (7% and 2%, respectively), compared to other NYC CSA counties. Although not mentioned in their 9-factor analysis, EPA's data also indicate that population growth in New Haven County is expected to be flat between 2002 and 2010, with a slight increase of 0.3%. Population in Fairfield County is actually projected to decrease by 4% over the same period. This compares to a higher 3% overall population increase projected by EPA for the CSA as a whole.

EPA's review of VMT data asserts that both Fairfield and New Haven counties had a sizeable increase in VMT from 1996 to 2002 compared to other CSA counties. EPA's conclusion regarding VMT is based on the absolute increase in VMT over the period in each county, with no consideration given to the area over which that VMT is spread. When county area is incorporated, resulting "VMT densities" reveal that VMT increases in New Haven and Fairfield Counties from 1996 to 2002 rank in the bottom half of all NYC CSA counties at 18th and 21st, respectively, out of 30 counties.

Growth in Connecticut's VMT is constrained by Connecticut's one-hour ozone attainment demonstration, which established transportation emission budgets for ozone precursors for the required attainment year of 2007. The budgets for ozone precursors indirectly set an effective cap on VMT as well. For the Fairfield County area, VMT growth is projected to average 0.9% per year between 2005 and 2015. Growth in New Haven County is projected be slightly higher, at 1.1% per year. These projected growth figures are lower than the growth rates quoted by EPA for the period of 1996 to 2002 (i.e., 1.5 % per year for Fairfield and 1.8% per year for New Haven).

EPA's analysis examines only growth in population and VMT. Growth statistics that affect other source categories of emissions (e.g., point and area sources) are not mentioned. Although CTDEP does not have data for other states in the CSA, it is worth noting that the Connecticut Department of Labor (see Appendix D of Connecticut's October 15, 2001, Post-1999 Rate-of-Progress Plan) projects that manufacturing employment in Connecticut will decrease by more than 2% between 1998 and 2008, indicating likely decreases in emissions from that sector in the foreseeable future.

Based on the projected growth data described above, CTDEP concludes that emissions from Connecticut will continue be an insignificant contributor to $PM_{2.5}$ levels at violating monitors in the remainder of the NYC CSA.

6. FACTOR 6: METEOROLOGY

Connecticut's Impact on New York City

EPA's 9-Point Analysis relies on a "bubble-rose" displaying $PM_{2.5}$ concentrations vs. wind speed and wind direction for the Bronx monitor to assert that "some component of elevated $PM_{2.5}$ measured at the monitor in the Bronx does originate from the northeastern direction (i.e., direction of CT)." EPA also indicates that Connecticut's ISCST3 and HYSPLIT4 modeling "make a strong case that Connecticut is not frequently a significant contributor to elevated $PM_{2.5}$ in the New York City urban area." However, EPA apparently concludes that the Bronx bubble-rose and their previously discussed emissions scoring procedure provide enough information to determine that Fairfield and New Haven Counties contribute significantly to nonattainment monitors in New York City.

EPA's analysis fails to consider the results of the more scientifically rigorous modeling they conducted for the IAQR, which shows that Connecticut's contribution to annual $PM_{2.5}$ in New York City is insignificant. It is perplexing that EPA's 9-Point Analysis cites the IAQR modeling to demonstrate "that both New York and New Jersey" contribute significantly to New Haven County", but fails to mention that the same modeling shows that Connecticut's contribution to New York and New Jersey is insignificant.

Local Meteorological Effects at Stiles Street

EPA's 9-Point Analysis presents a bubble-rose (Figure 9) for New Haven-Stiles Street $PM_{2.5}$ data paired with wind data from Sikorsky Airport in Stratford, located 14 miles away. Although that pairing provides a reasonable depiction of regional scale winds (and regional emission contributions) associated with high concentrations at Stiles Street, it does not provide an accurate picture of the microscale meteorology affecting local contributions to the Stiles Street monitor.

Figure 10 is similar to EPA's bubble-rose, but it is prepared using on-site meteorological data from Stiles Street. Daily averaged wind vectors from Stiles Street for 2003 are plotted with 24-hour $PM_{2.5}$ concentrations and they show an equally distributed wind direction, with the highest $PM_{2.5}$ concentrations occurring with easterly and southerly wind components. Conversely, the EPA bubble-rose chart for the Stiles Street/Sikorsky pairing shows the highest $PM_{2.5}$ concentrations occurring during west to southwest wind directions. The differences are likely due to both natural (i.e., the alignment of New Haven Harbor, along with sea breeze effects) and man-made (i.e., the elevated and filled portion of I-95 immediately adjacent to the monitor) features that create local micrometeorological wind flows.

Microscale effects of local wind patterns are also evident in hourly black carbon data from Stiles Street. Figure 11 shows a bubble-rose of 2003 hourly black carbon concentrations distributed by wind speed and direction, superimposed over an aerial view of the Stiles Street area. Peak black carbon concentrations most often occur with local winds from the northeast and southeast, consistent with the direction of travel of heavy-duty diesel trucks entering the on-ramp from Stiles Street and passing directly by the sampling probe. The general local wind distribution pattern depicted in the bubble-rose is reflected by the Stiles Street wind rose, shown in Figure 12.

7. FACTOR 7: GEOGRAPHY/ TOPOGRAPHY

EPA concluded that geography and topography did not play significant roles in the attainment designation process. CTDEP agrees that this factor should not affect attainment designations.

8. FACTOR 8: JURISDICTIONAL BOUNDARIES

In EPA's June 29, 2004 letter, EPA states that Connecticut counties are contributing to the nonattainment monitors around NYC. However, EPA's and CTDEP's modeling studies have shown that Connecticut is not significantly contributing to these monitors. As a consequence, Connecticut does not believe any weight should be given to this assertion, especially in light of the compelling evidence provided previously that shows Connecticut does not contribute significantly to nonattainment in NYC.

9. FACTOR 9: LEVEL OF CONTROL OF EMISSION SOURCES

EPA notes that their emissions scoring procedure used emission estimates for 2001. Control strategies implemented after that date were not included in the calculations, resulting significantly, in the exclusion of the emission reductions from Connecticut's recently adopted NOx Budget Program and SO_2 control program.

Beginning in January 2003, large point sources in Connecticut are required to meet a very stringent 0.3lb SO_2/ mmBTU emission limit, and a year-round limit of .15lb NO_x/ mmBTU beginning October 1, 2003. Connecticut is also continuing to expand its ultra-low sulfur diesel program, as well as retrofit programs for school buses and nonroad equipment used on highway construction projects. Additional regional level emission reductions are expected from the IAQR (or substitute approach), requirements for new onroad and nonroad engine standards and related clean fuel standards. The combination of these strategies is expected to continue the observed downward trend in particulate matter concentrations.

10. CONCLUSION

EPA's conclusion that Fairfield and New Haven Counties should be included as part of a $PM_{2.5}$ nonattainment area with the remainder of the New York City CSA is based on the assertion that:

- The Stiles Street monitor measures concentrations exceeding the annual $PM_{2.5}$ NAAQS; and
- Fairfield and New Haven Counties significantly contribute to violating monitors in the NYC area.

The information contained in CTDEP's February 2004 TSD, along with the supplemental data described in this document, contradicts EPA's conclusions:

- The recently acquired monitoring data demonstrate unequivocally that the community in New Haven is not being exposed to $PM_{2.5}$ concentrations above the level of the National Ambient Air Quality Standards. The Stiles Street monitor is sited inappropriately for determining annual nonattainment designations because it is measuring diesel exhaust emissions on a micro-scale. Thus, the City of New Haven should be designated attainment for $PM_{2.5}$.
- Atmospheric transport and dispersion modeling conducted by EPA and CTDEP confirm that emissions from Connecticut are not contributing significantly to measured $PM_{2.5}$ nonattainment in New York City and northern New Jersey. In fact, EPA's proposed Clean Air Interstate Rule (CAIR) specifically and uniquely excludes Connecticut from the emission reduction program designed to reduce $PM_{2.5}$ because EPA concluded that Connecticut's emissions do not significantly contribute to the $PM_{2.5}$ nonattainment measured in New York and New Jersey. Therefore, there is no technical justification for including the Connecticut portion of the New York Combined Statistical Area (CSA) as part of a multi-state $PM_{2.5}$ nonattainment area having the same CSA boundaries.

Based on the information contained in the February 2004 TSD and in this supplemental document, CTDEP requests that EPA designate the entire State of Connecticut as "attainment" for the $PM_{2.5}$ NAAQS.

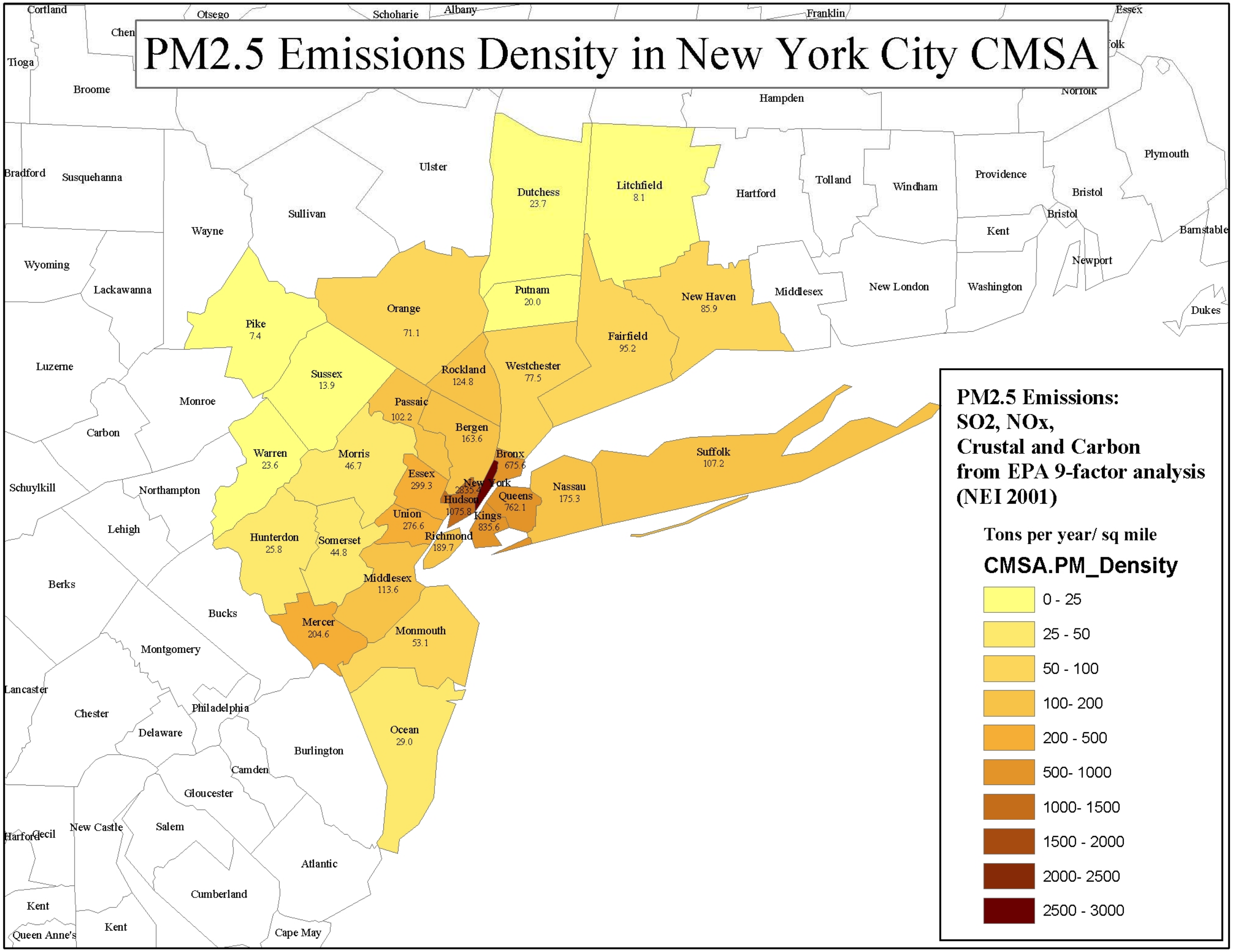


Figure 1. PM$_{2.5}$ density map.

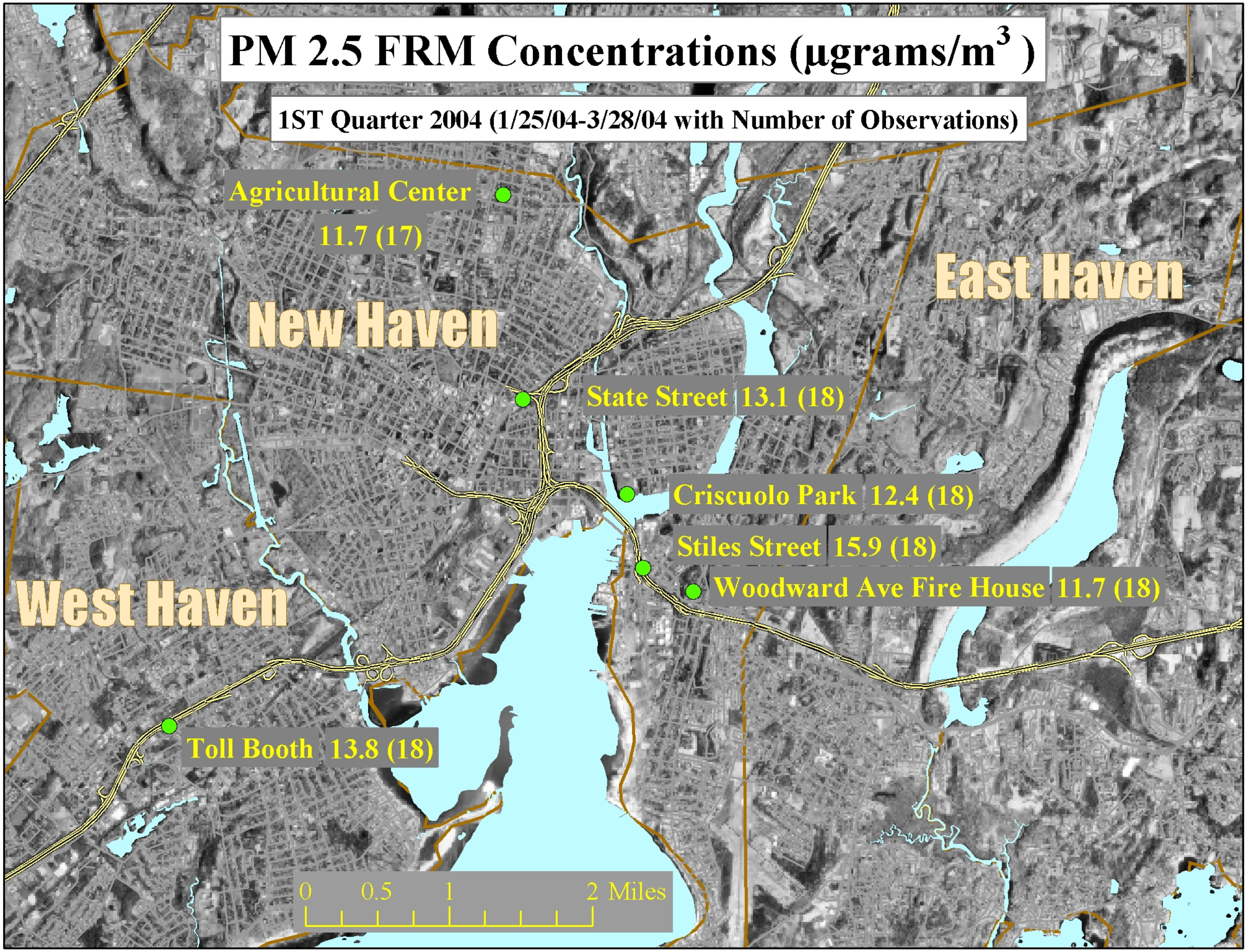


Figure 2. Comparison of New Haven area $PM_{2.5}$ monitoring site concentrations for 1st quarter 2004.

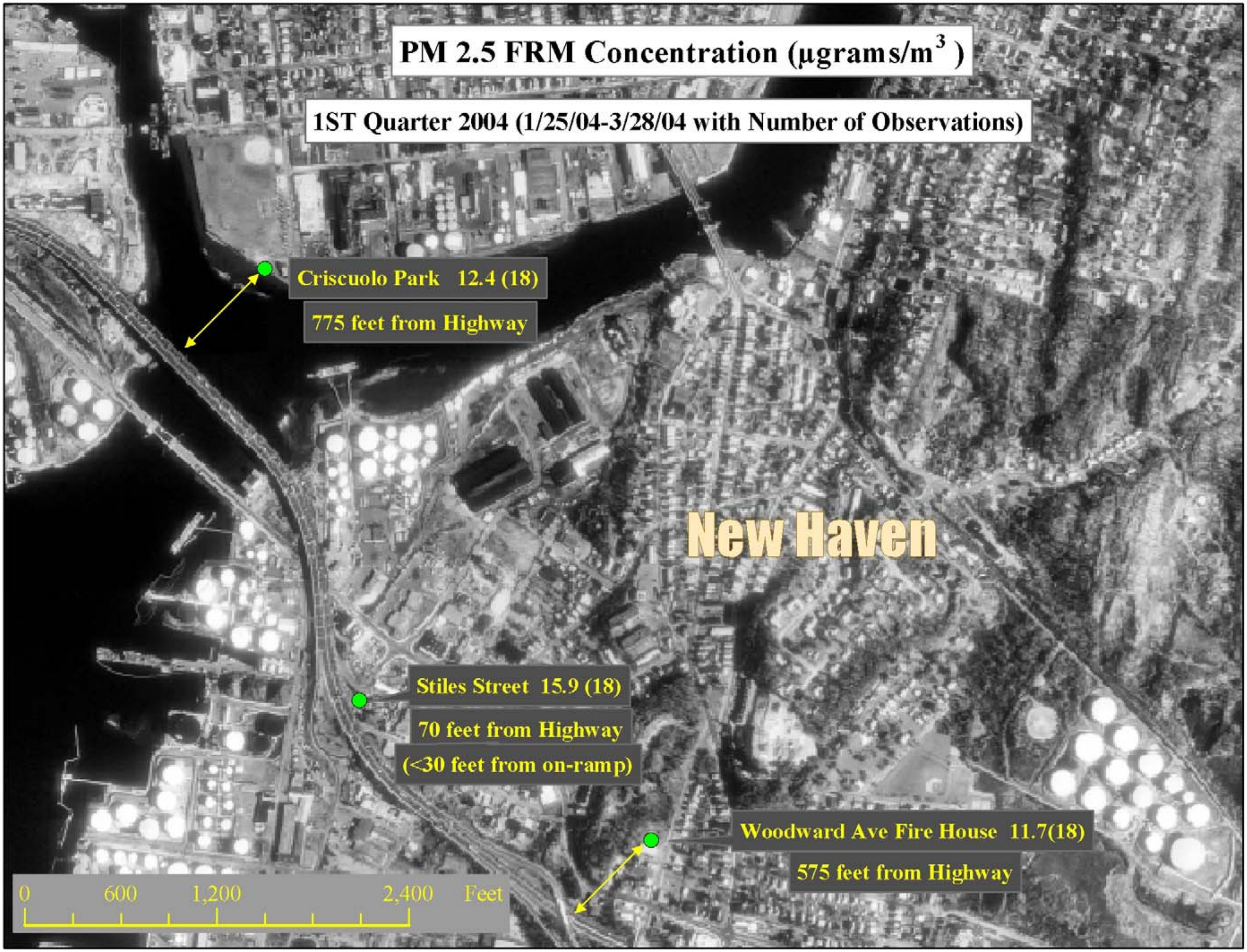


Figure 3. Comparison of Stiles Street with other nearby monitors.

Figure 4. Closeup of Stiles Street site.

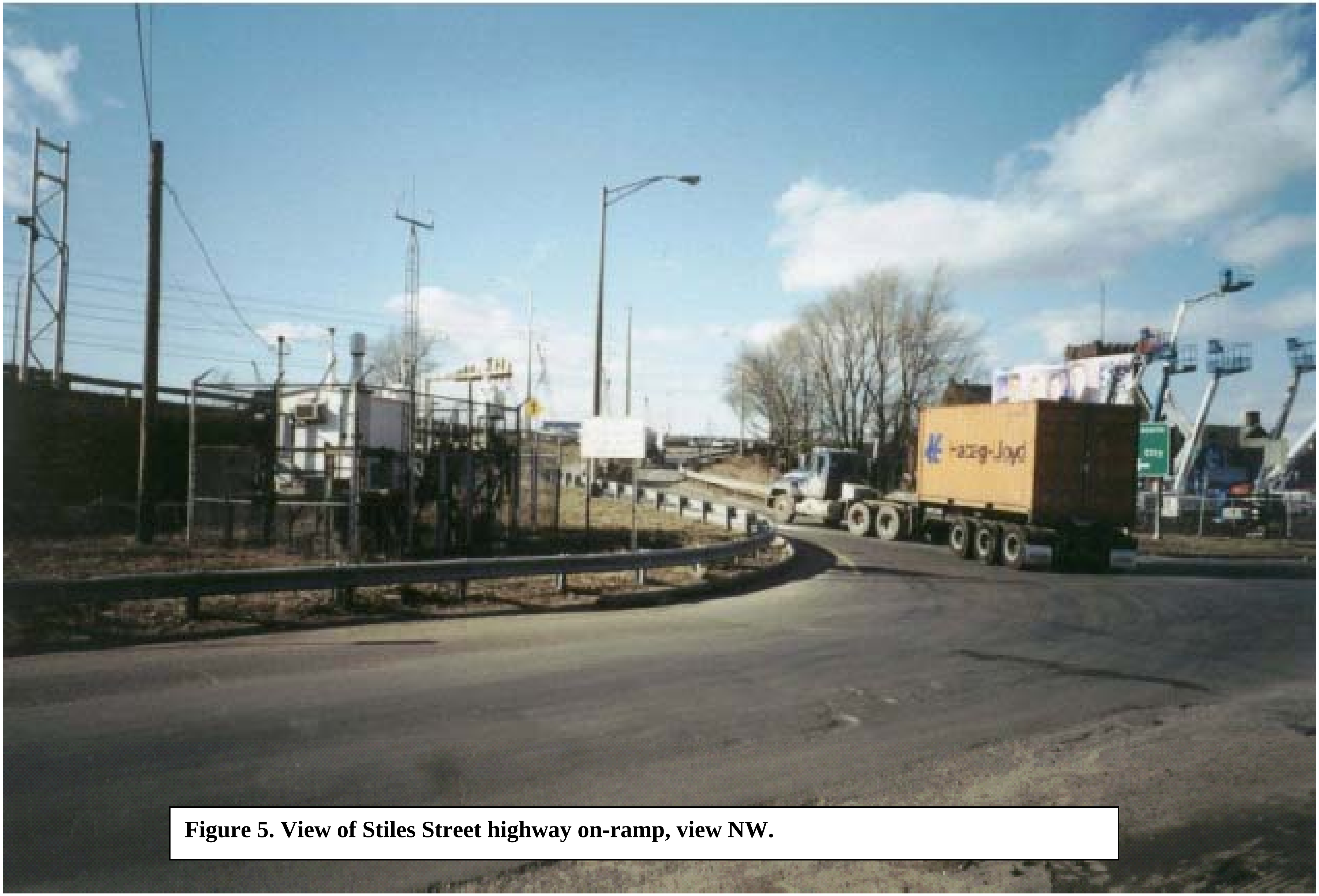


Figure 5. View of Stiles Street highway on-ramp, view NW.

Figure 6. Close-up of the Toll Booth monitoring site.

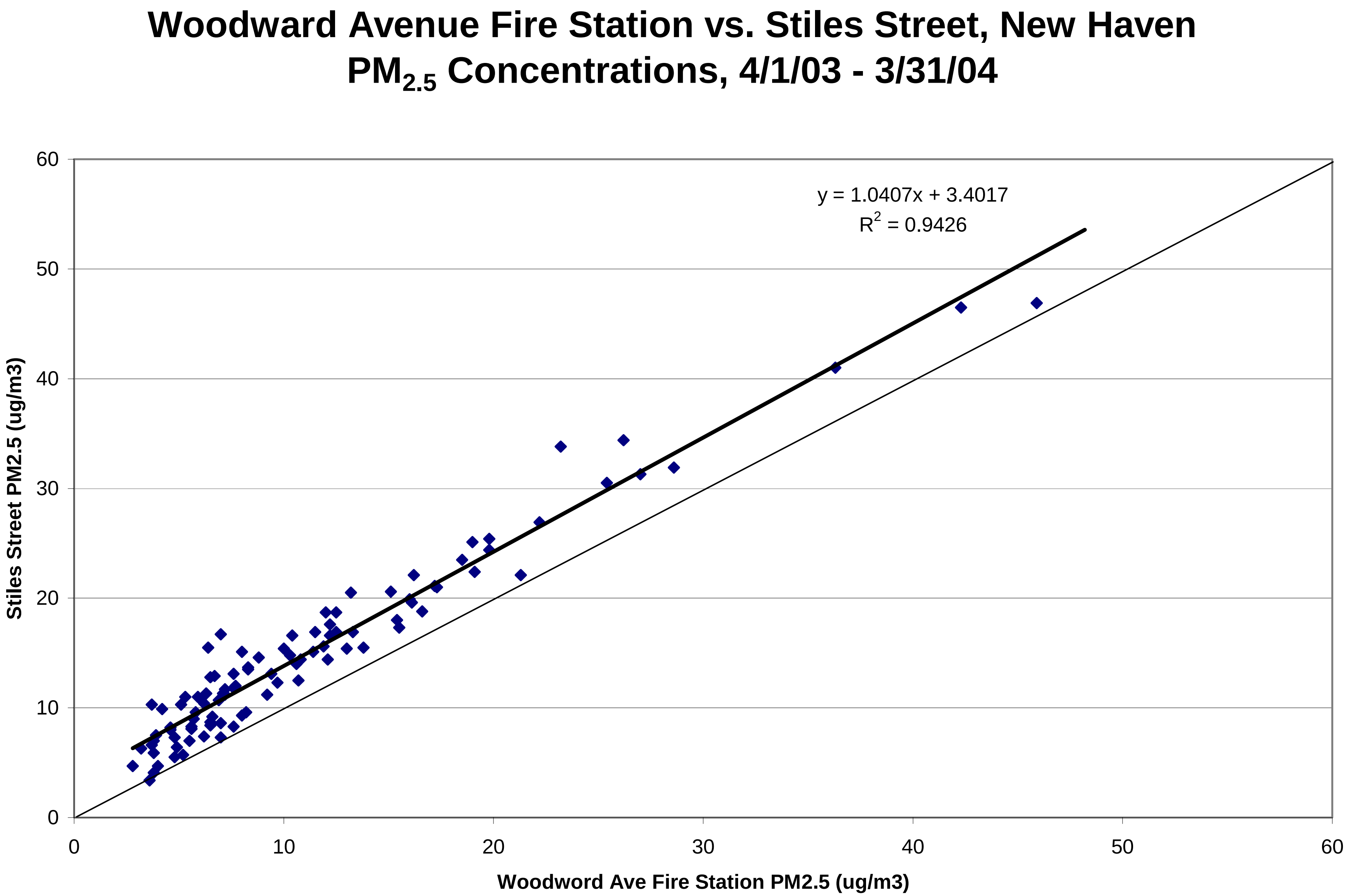
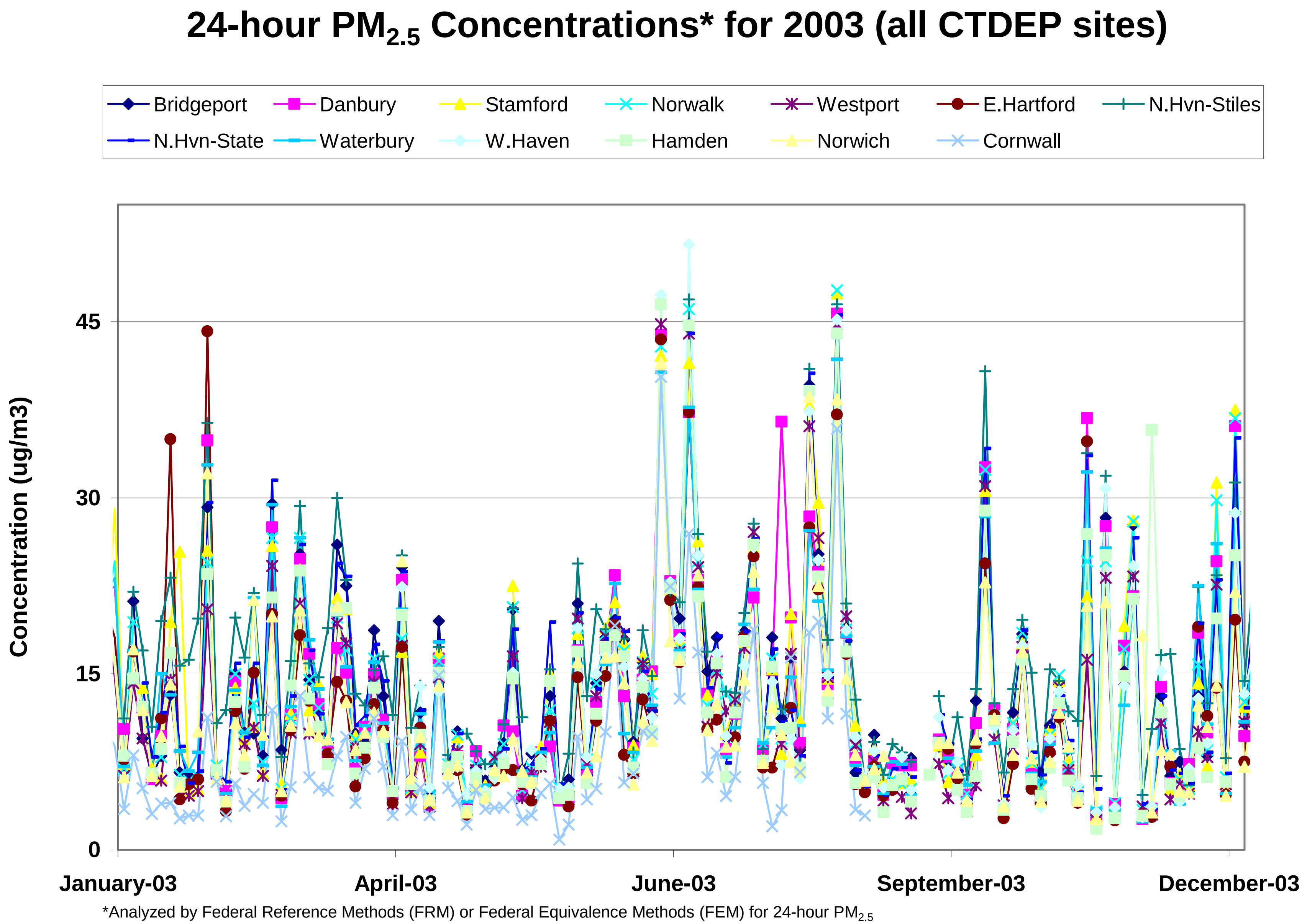


Figure 7. Regression line for the Woodward Fire House vs. Stiles Street.



*Analyzed by Federal Reference Methods (FRM) or Federal Equivalence Methods (FEM) for 24-hour $PM_{2.5}$

Figure 8. 24 hr average $PM_{2.5}$ concentrations for all Connecticut sites in 2003

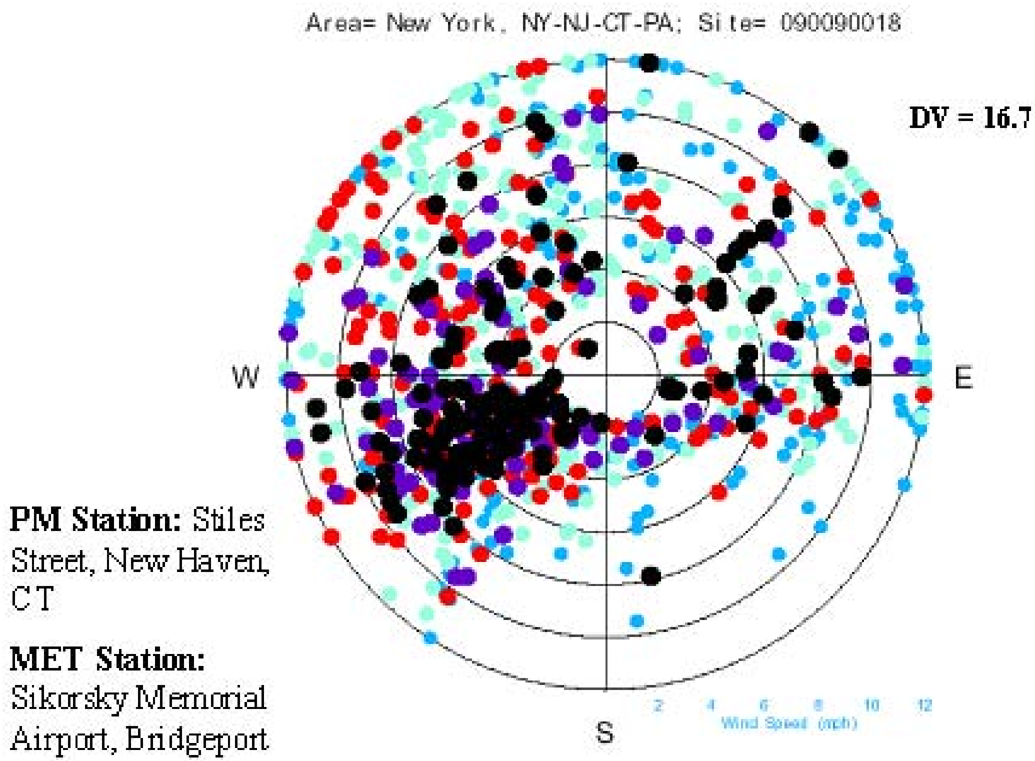


Figure 9. Bubble-rose diagram used by EPA in their 9-factor analysis.

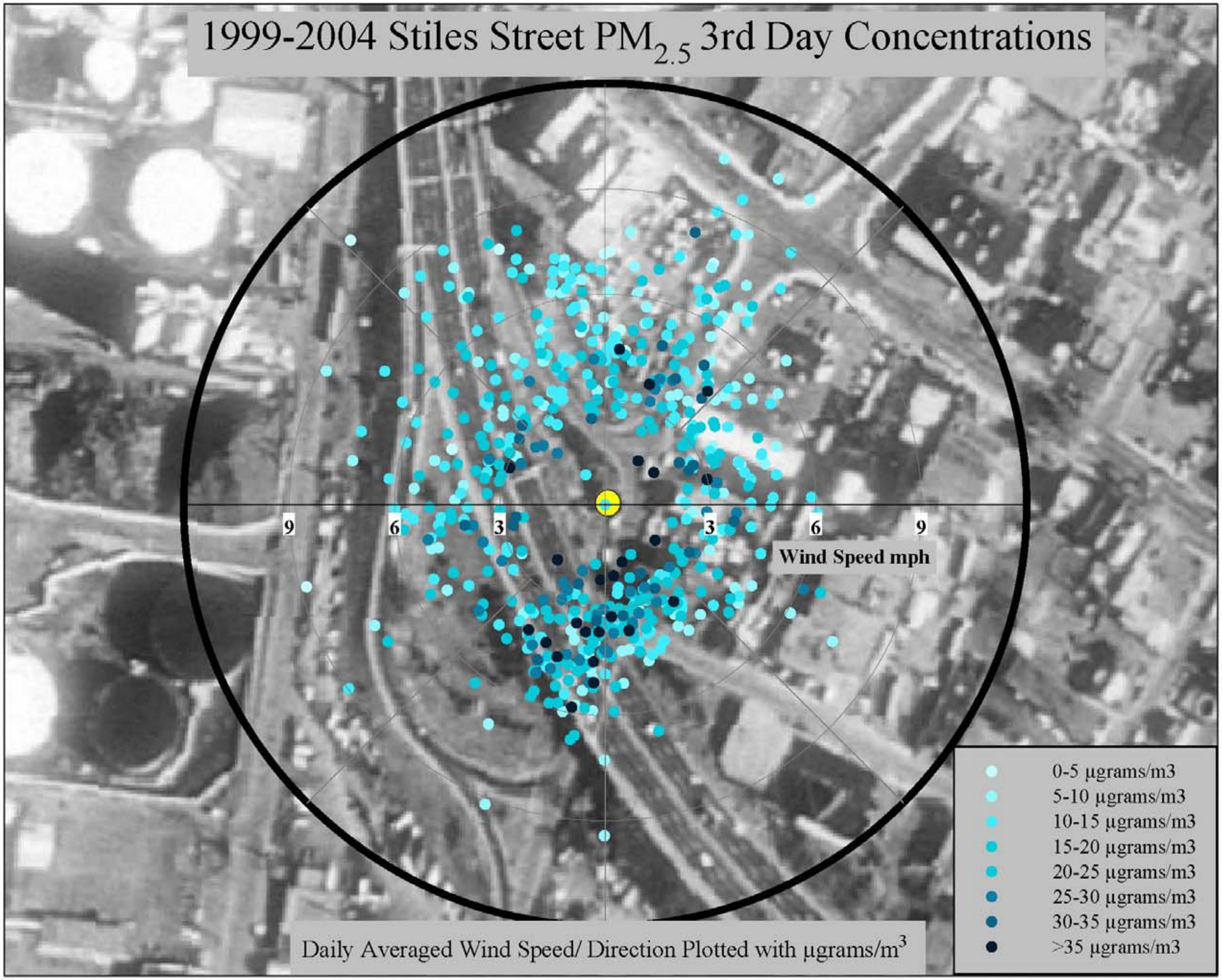


Figure 10. Bubble-rose plot of $PM_{2.5}$ concentrations vs. daily average wind speed at Stiles Street.

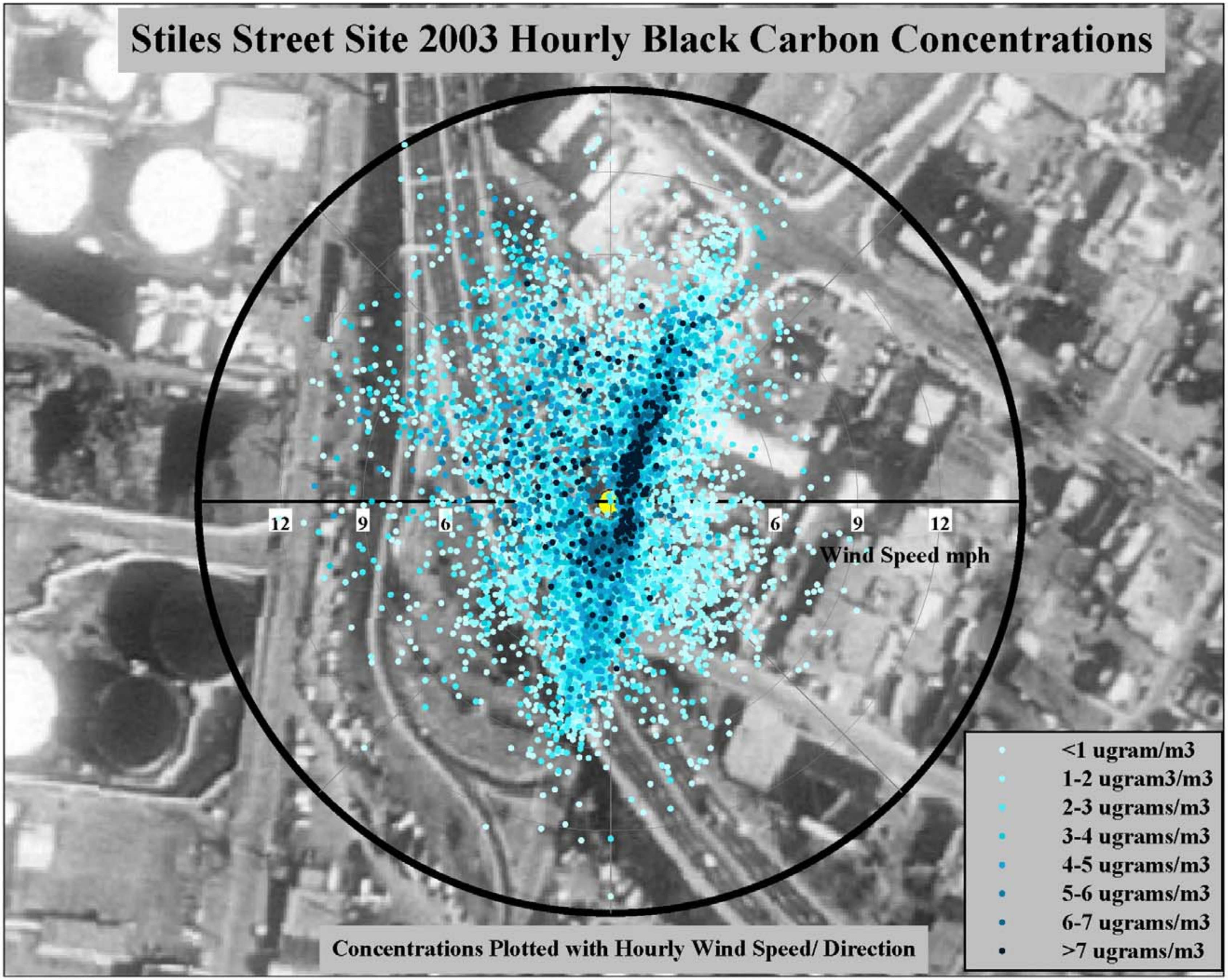


Figure 11. Bubble-rose plot of black carbon concentrations vs. hourly wind for Stiles Street.

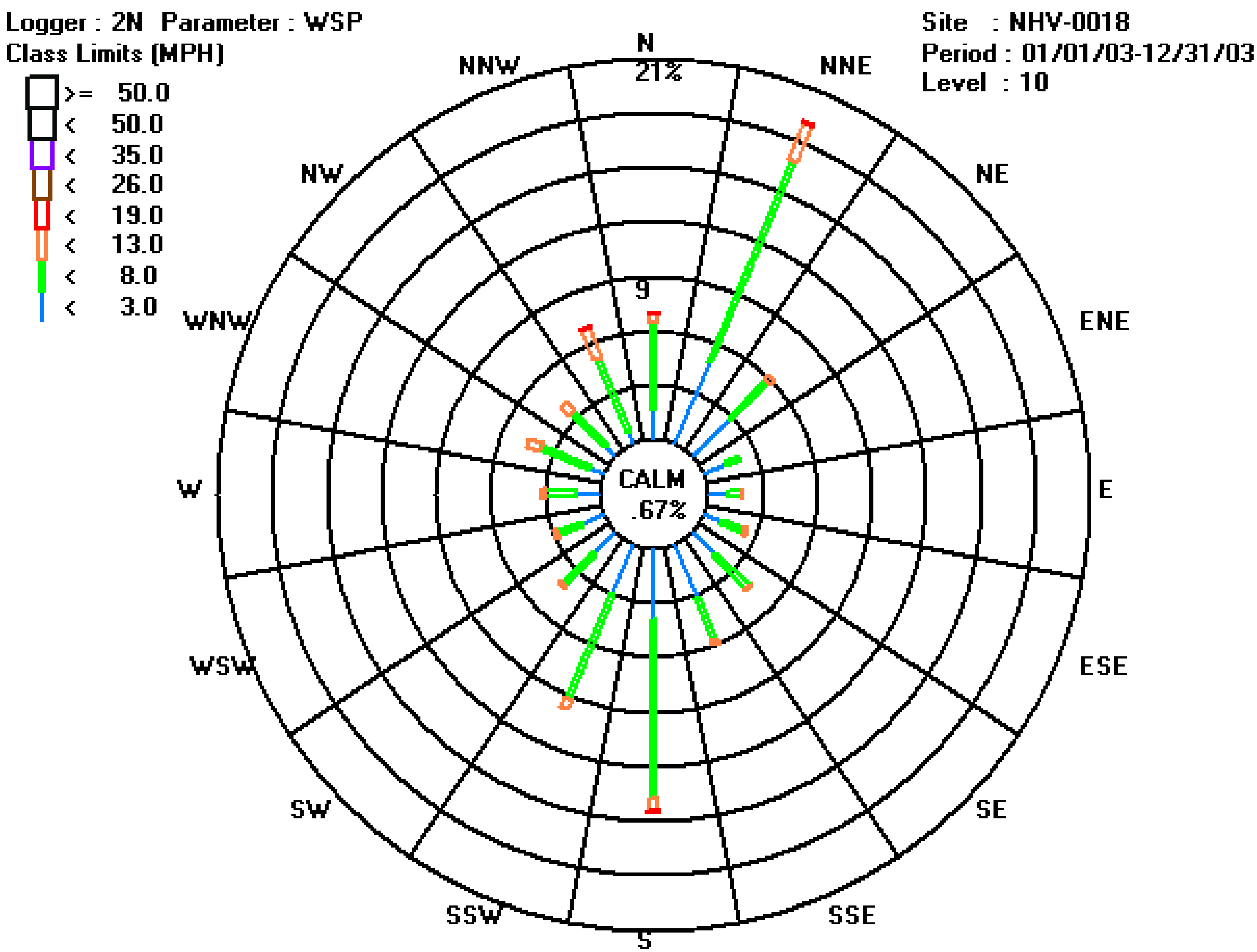


Figure 12. Wind rose generated from on-site data at Stiles Street

APPENDIX

Spatial analysis using 1-minute BC measurements at Stiles Street and 5-minute BC measurements at Criscuolo Park from April 1, 2004 through June 30, 2004.

Appendix A

SPATIAL ANALYSIS USING 1-MINUTE BC MEASUREMENTS AT STILES STREET AND 5-MINUTE BC MEASUREMENTS AT CRISCUOLO PARK FROM APRIL 1, 2004 THROUGH JUNE 30, 2004.

Conclusions: Based on spatial analysis using 1-minute and 5-minute BC measurements at Stiles Street and Criscuolo Park, respectively, and considering an average range of OC to EC ratios from diesel vehicles undergoing typical loadings characteristic of the traffic patterns at the Stiles Street site, the micro-scale (up to ~100 m) $PM_{2.5}$ contribution from local sources ranges from 2.19 $\mu g/m^3$ to 4.38 $\mu g/m^3$. This micro-scale contribution is consistent with the differences in $PM_{2.5}$ measurements observed between Stiles Street and the other New Haven monitoring sites.

Spatial analysis using high time resolution measurements was conducted using sub-hourly black carbon (BC) data obtained with aethalometers from both Stiles Street and Criscuolo Park. Previous studies have shown that black carbon (BC) measured continuously by the aethalometer has compared well with integrated elemental carbon measured of a quartz filter (Babich, et. al., 2000; Allen, et. al., 1999; Hansen & McMurry, 1990). The analysis was performed to determine contributions from micro- (up to ~100 m), middle- (~100-500 m), neighborhood- (~0.5-4 km), and urban- (~4-50 km) scale sources. The period analyzed was from April 1, 2004 through June 30, 2004. This type of analysis has been done in both Mexico City (Watson & Chow, 2001) and St. Louis (Hill & Turner, 2003) using 5-minute BC measurements. For Mexico City and St. Louis, the short duration measurements were used to quantify contributions from micro- and middle-scale emitters. A background site in Mexico City was also used to determine the middle- and urban-scale contributions. Using the 1-minute BC measurements obtained at Stiles Street, this analysis was taken one step further, and the micro-scale contributions were determined as well.

The basis of the analysis is to separate the high frequency signal that can be attributed to local sources from the low frequency signal that is attributed to urban and/or regional sources. The micro-scale contribution at Stiles Street was determined using a moving average subtraction method. The 60-minute average around each 1-minute measurement was determined and the lesser of the two values was retained. A 30-minute average around each of the values from this new dataset was determined and compared to the previous value and the lesser of the two was retained. This was repeated for 15-minute and 5-minute averages, and the resulting values are considered the “baseline” or in this case, the middle- and greater-scale contributions. The difference between the actual measurements and the baseline measurements are the micro-scale contributions at Stiles Street.

Criscuolo Park, located approximately 840 m to the north of the Stiles Street site, is considered a neighborhood-scale site. An aethalometer at Criscuolo Park was deployed to obtain 5-minute BC measurements. The moving average subtraction method as described above was used for 60-, 30-, and 15-minute averages to determine a baseline that was representative of neighborhood-scale and greater (to include urban-scale) contributions. The Criscuolo Park baseline was then subtracted from the Stiles Street baseline to quantify the middle-scale contributions at Stiles Street. Figure A-1 is a time-series plot for a one-day period, April 1, 2004, from both sites with the resulting baseline from the moving average subtraction method from both sites included as well. During this one-day period, the micro-scale contribution at Stiles Street was 0.81 $\mu g/m^3$ or 45 % of the average BC concentration. The middle- and neighborhood-/urban-scale contributions were 0.36 $\mu g/m^3$ (20 %) and 0.62 $\mu g/m^3$ (35%), respectively. This is just an example of the significant micro-scale influences at the Stiles Street site.

The average BC concentration at Stiles Street for the 2nd quarter, 2004 was 2.00 $\mu g/m^3$, while the average BC concentration at Criscuolo Park was 0.90 $\mu g/m^3$. Table A-1 summarizes the results by month and for the entire quarter, for the Stiles Street and Criscuolo Park sites. The relative contributions from micro-, middle-, and neighborhood-/urban-scales were consistent from month to month; however these contributions varied considerably on a daily and sub-daily basis. The average daily micro-scale contribution ranged from 17% to 80% of total BC measured at Stiles Street. Figure A-2 is a stacked area chart of the average daily micro-, middle-, and neighborhood-/urban-scale contributions at Stiles Street. For the quarter, the average micro-scale contribution was 0.73 $\mu g/m^3$ or 37% of the BC measured at Stiles Street. The average middle- and neighborhood-/urban-scale contributions were 0.50 $\mu g/m^3$ (25%) and 0.76 $\mu g/m^3$ (38%), respectively. Another significant difference between the two sites is that the micro-/middle-scale contributions at Criscuolo Park only accounted for 16% (0.14 $\mu g/m^3$) of the total BC measured, while the combined micro-scale and middle scale contributions at Stiles Street accounted for 62% (1.23 $\mu g/m^3$) of the total BC measured.

Table A-1: Summary of BC concentrations and contributions from micro-, middle-, and neighborhood-/urban-scale sources at Stiles Street and Criscuolo Park for 2nd quarter, 2004.

	April	May	June	2nd Quarter 2004
Stiles Street average BC concentration ($\mu g/m^3$)	1.65	1.89	2.45	2.00
Criscuolo Park average BC concentration ($\mu g/m^3$)	0.69	0.89	1.13	0.90
Stiles Street micro-scale ($\mu g/m^3$ BC; % contribution at Stiles)	0.62 (38%)	0.66 (35%)	0.91 (37%)	0.73 (37%)
Stiles Street middle-scale ($\mu g/m^3$ BC; % contribution at Stiles)	0.41 (25%)	0.49 (26%)	0.59 (24%)	0.50 (25%)
Neighborhood-/urban-scale ($\mu g/m^3$ BC; % contribution at Stiles)	0.60 (36%)	0.75 (40%)	0.94 (38%)	0.76 (38%)
Criscuolo Park micro-/middle-scale ($\mu g/m^3$ BC; % contribution at Criscuolo)	0.09 (13%)	0.14 (16%)	0.19 (17%)	0.14 (16%)

The next step is to relate micro-scale contributions of BC at Stiles Street to the total $PM_{2.5}$ micro-scale contributions. The aethalometer quantifies only the BC component (which is equivalent to elemental carbon; EC) of diesel emissions. Organic carbon (OC) is also emitted from diesel trucks as a result of unburned fuel and combustion byproducts and contributes to the fine particulate levels. The ratio of OC to EC varies depending on the type of engine and the mode of vehicle operation (Norbeck, et. al., 2004). The two modes of operation associated with the highest OC to EC ratios are the idle and creep modes. The creep mode is considered slow driving such as stop and go in heavily congested traffic. The transient and cruise modes of operation are associated with the lowest OC/EC ratios. The transient mode is considered light to medium traffic and the cruise mode is highway driving.

Diesel vehicles operating in heavily congested traffic, which best describes the traffic conditions at the Stiles Street site especially during peak hours, have the highest $PM_{2.5}$ emission rates. These traffic conditions are also associated with OC to EC ratios that range from 1 to 10. The micro-scale (up to ~100 m) contribution of BC (EC) at Stiles Street for the period of April 1, 2004 through June 30, 2004 was 0.73 $\mu g/m^3$ or 37% of the total BC measured. Therefore, it can be estimated that the micro-scale contribution of OC ranged from 0.73 $\mu g/m^3$ to 7.30 $\mu g/m^3$, which puts the total $PM_{2.5}$ (OC and EC) micro-scale contribution from diesel emissions in the range of 1.46 $\mu g/m^3$ to 8.03 $\mu g/m^3$. Selecting a tighter, and perhaps more appropriate, OC/EC ratio range from 2 to 5, it can be reasonably estimated that **the micro-scale $PM_{2.5}$ contribution is approximately 2.19 $\mu g/m^3$ to 4.38 $\mu g/m^3$ from diesel vehicles at the Stiles Street site (see Table A-2)**, indicating that it is, in fact, a micro-scale site with significant micro-scale contributions. These estimated $PM_{2.5}$ contributions from localized mobile sources is consistent with the differences in $PM_{2.5}$ measurements observed between Stiles Street and the other New Haven monitoring sites.

Table A-2: Micro-scale contributions of EC, OC and $PM_{2.5}$ at Stiles Street based on typical OC to EC ratios during predominant transient mode diesel vehicle operation for 2nd quarter, 2004.

	Micro-scale Contribution ($\mu g/m^3$)
BC (EC)	0.73
OC based on OC:EC range from 2 to 5	1.46 – 3.65
$PM_{2.5}$ based on OC:EC range from 2 to 5	**2.19 – 4.38**

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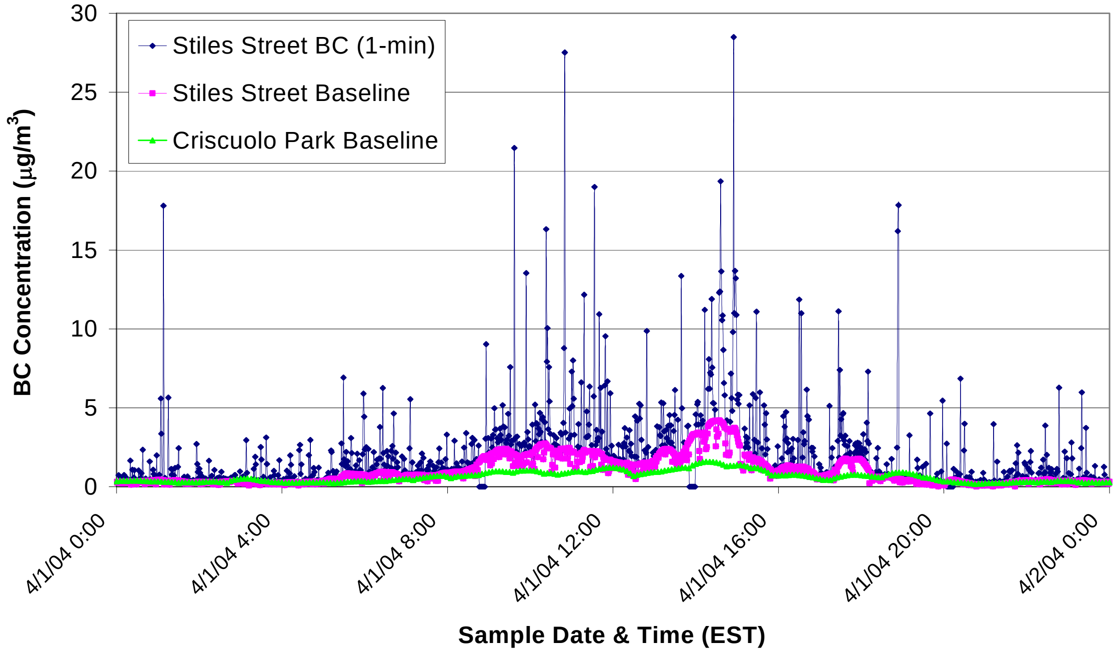

Figure A-1: Example of baselines used to determine micro-scale contributions at Stiles Street site on April 1, 2004 using 1-minute BC measurements and moving average subtraction method.

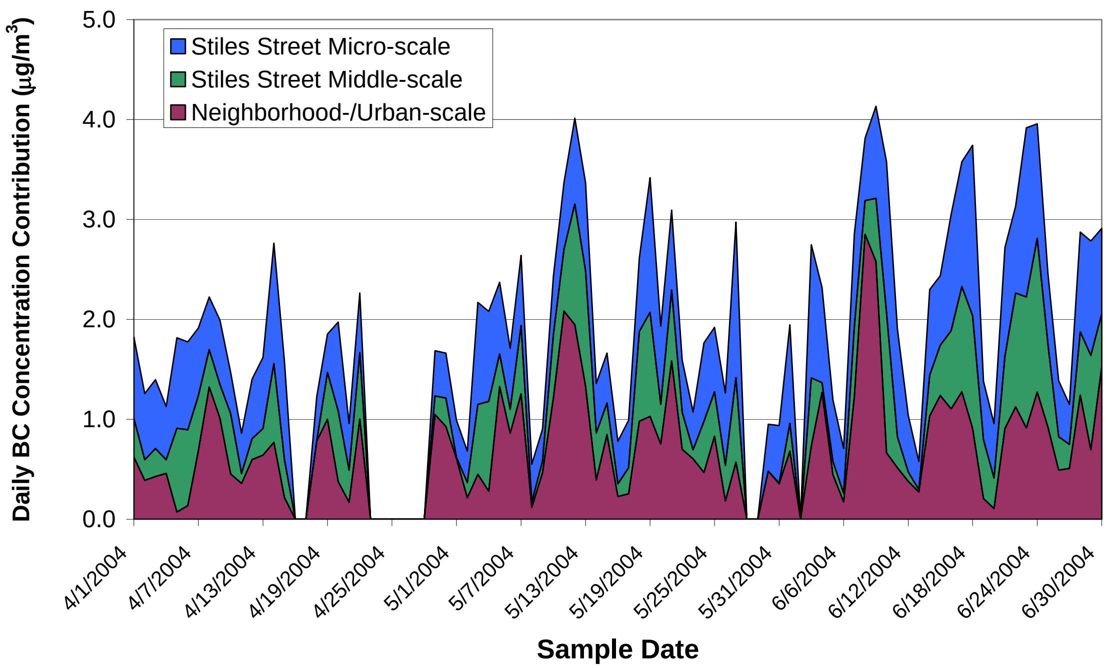

Figure A-2: Daily contributions for 2nd quarter, 2004, at Stiles Street from micro-, middle-, and neighborhood-/urban-scale black carbon sources.