TSD-5

Baseline and Future $PM_{2.5}$ Design Values in the New York City Metropolitan Non-Attainment Area

Bureau of Air Quality Analysis and Research

Division of Air Resources

New York State Department of Environmental Conservation

Albany, NY 12233

December 14, 2007

Introduction

Baseline $PM_{2.5}$ design values for a given area are based solely on measured Federal Reference Method (FRM) data, whereas air quality model-based results utilizing emissions from a target future year are needed to project $PM_{2.5}$ design values to determine future attainment status of that area. The modeling guidance (USEPA, 2007a) states that the results from the regulatory applications of air quality models are not to be used in an absolute sense; rather, they are to be used to estimate the effects of changes in emissions on pollutant levels in a relative sense. For a single pollutant like ozone, the future design value at a given location is the product of the current observed value and the ratio of the future-to-current model predictions. The ratio of the future-to-current model prediction is also known as the relative response factor (RRF). Unlike ozone, $PM_{2.5}$ is comprised of a variety of ions, trace elements, and carbon species. To demonstrate future attainment of air quality standards for $PM_{2.5}$, one needs to project how each of the major species changes between the baseline and future model yeasr; that is, it is necessary to estimate speciated RRF values. In this report we present an overview of the calculation of the baseline $PM_{2.5}$ design values and speciated RRFs for monitors in the 22-county New York City non-attainment area (NYC NAA), which when combined yield future year $PM_{2.5}$ design values across the NYC NAA.

Baseline $PM_{2.5}$ design values

The first step in the modeled attainment test for the annual National Ambient Air Quality Standard (NAAQS) is to compute the baseline design values at each FRM site in the NYC NAA. The baseline design value is based on a five-year weighted average of observations from 2000-2004 to straddle the baseline emissions/modeling year of 2002 (EPA, 2007a). This calculation is to be performed utilizing data on a quarterly basis. In other words, for each quarter the baseline concentration is the average of the concentrations from the corresponding quarters of the three year periods of 2000-2002, 2001-2003, and 2002-2004. Table 1 lists the baseline design values, based on the EPA's official quarterly averages (EPA, 2007b), at each FRM site across the NYC NAA having at least two years of sampling data during this five-year period. We note that one monitor – P.S. 59 (360610056) in New York County – had recorded one anomalously high average concentration of 25.2 $\mu g\ m^{-3}$ during the third quarter of 2003. Examination of the data shows that for this quarter there were only five valid data points at the beginning of the quarter, and the monitor was subsequently shut down because of construction activity at the site. Because this short time period is not representative of air quality over the entire quarter, in this analysis this quarter was treated as missing, and this is reflected in Table 1. Attachment 1 provides a more detailed analysis of this particular issue.

Current species concentrations

The next step in the modeled attainment test is to determine the current species composition at each FRM monitor, based on measured species data. The $PM_{2.5}$ species composition is highly complex, but if the goal of air quality management decisions is to reduce $PM_{2.5}$, it is necessary to know the dominant chemical species. Some of FRM monitors in the NYC NAA are collocated with Speciation Trends Network (STN) monitors that collect major ions, including sulfate (SO_4), nitrate (NO_3), and ammonium (NH_4); carbon species, including elemental carbon (EC) and organic carbon (OC); and about 50 trace elements. At sites where both STN and FRM data are available, it is possible to relate the total FRM mass with the mass of individual species; however, during the 2000-2004 period, in the NYC NAA there were only two sites in CT, three in NJ, and four in NY that had collocated STN and FRM monitors. At those FRM sites that do not have collocated STN monitor, we assumed that the speciation data from the nearest STN monitor is sufficient to characterize the FRM site. Table 1 also lists the nearest STN site that is to be associated with the FTM site in the NYC NAA for computing the current species concentrations.

It is known that FRM monitor filters do not retain semi-volatile species such as ammonium nitrate and some organics with high efficiency, particularly during the warmer months. Hence, one cannot simply add up the major species from the STN monitor and expect to relate this identically to the total mass from the FRM monitor. It is necessary to adjust some of the STN data to estimate the species composition of mass measured by the FRM monitor. According to the modeling guidance (USEPA, 2007a) the mass from the FRM monitor can be expressed as:

$PM_{2.5}$ = "retained nitrate mass" + "ammoniated sulfate mass" + "ammonium associated with sulfate and retained nitrate" + "particle-bound water" + "other primary $PM_{2.5}$" + "blank mass" + "carbonaceous mass" [Eq. 1]

where $PM_{2.5}$ refers to the total mass measured at each FRM site; "retained nitrate mass" and "ammonium associated with sulfate and retained nitrate" refer only to the fractions of NO_3 and NH_4, respectively, that are not volatilized; "ammoniated sulfate mass" refers to the SO_4 that is measured by the STN; "particle-bound water" refers to water that is associated with the hygroscopic ammonium sulfate and nitrate, and can be estimated as a polynomial function of retained ammonium, sulfate, and nitrate; "other primary $PM_{2.5}$" refers to unspeciated, inert $PM_{2.5}$ such as soil/crustal elements (here assumed to be the sum of major crustal oxides – Si, Ca, Fe, and Ti); "blank mass" refers to passively collected contamination, assumed to be 0.5 $\mu g\ m^{-3}$; and "carbonaceous mass" refers to EC and an estimate of retained OC. Because of uncertainties in the measured OC, the modeling guidance suggests that organic mass be computed as the difference between the measured FRM mass and the sum of the other species listed above.

To compute the current species concentrations at each FRM site in the NYC NAA, we used the EPA's official database of STN data (EPA, 2007b) covering the period 2002-2004. This database also includes the adjusted speciation data needed to compute the various retained species. For each quarter, the average species composition was computed; this was a simple arithmetic average, not a weighted average like the FRM mass. Table 2 lists the current species composition, as defined in Equation 1 above. Note that in the case of retained NH_4, the actual measured data were not used here, due to uncertainties in its measurement. The modeling guidance suggests that NH_4 can be estimated according to degree of neutralization (DON) of sulfate:

$$NH_4 = DON \times SO_4 + 0.29 \times NO_3r \quad \text{[Eq. 2]}$$

Where NO_3r refers to retained nitrate. As will be shown in a later section, using the DON – which also is included in the official EPA database – will allow the future NH_4 value to depend only on SO_4 and NO_3, since reductions in emissions generally are targeting precursors of SO_4 and NO_3. The formulas for particle-bound water (PBW) and other primary $PM_{2.5}$ (OPP) are listed in the modeling guidance (USEPA, 2007a).

Relative Response Factors

As stated in the Introduction, the air quality modeling results are to be used in a relative sense to compute future $PM_{2.5}$ design values. For each species *i*, the future concentration of each species (CF_i) is the product of the baseline concentration (CB_i) and the corresponding RRF_i:

$$CF_i = CB_i \times RRF_i \quad \text{[Eq. 3]}$$

As with the measured data to obtain current FRM mass and species composition, the model results are used on a quarterly basis. For each quarter and species, we computed the quarterly average concentration for the base and future year simulations. The RRF is the ratio of the quarterly average future-to-base year values. For this analysis, at each FRM site we considered the average of the surrounding nine grid cells and not just the grid cell that corresponds to that FRM site.

The RRF values for SO_4, NO_3r, OC, EC, and OPP were based on application of CMAQ model (TSD-2c, 2007) for 2002 and 2009. Table 3 lists the appropriate CMAQ variables that were used to estimate the speciated RRF values. For NH_4, we used the future values of SO_4 and NO_3r to obtain the future year value, as per Equation 2. For PBW, we used the future year SO_4, NO_3r, and NH_4 values and the polynomial formulation listed in the modeling guidance (USEPA, 2007a). Finally, the blank concentration of 0.5 $\mu g\ m^{-3}$ is assumed to remain constant in the future year.

Future $PM_{2.5}$ design values

Table 4 lists the baseline and future design values for the annual NAAQS at each FRM location in the NYC NAA. In 2009 all sites except for one – P.S. 59 (360610056) in New York County, NY – are projected to be in attainment of the NAAQS, since the future design values are below 14.5 $\mu g\ m^{-3}$. The P.S. 59 site has a projected future concentration of 15.3 $\mu g\ m^{-3}$, meaning that corroboratory analyses are needed for a weight of evidence (WOE) determination to demonstrate attainment at this monitor. It should be noted that on the average the design values across the NYC NAA were reduced by about 1.6 $\mu g\ m^{-3}$, ranging from 1.2-2.2 $\mu g\ m^{-3}$, in 2009 compared to baseline design values. Attachment 2 details the WOE analyses that support the assertion that the entire NYC NAA is projected to be in attainment of the $PM_{2.5}$ NAAQS by 2009.

References

United States Environmental Protection Agency (USEPA), 2007a. Guidance on the use of models and other analyses for demonstrating attainment of air quality goals for ozone, $PM_{2.5}$, and regional haze. EPA-454/B-07-002, Research Triangle Park, NC.

United States Environmental Protection Agency (USEPA), 2007b. Electronic mail correspondence from Kenneth Fradkin, EPA Region 2, on 17 August, 2007 contains two data files used here to demonstrate attainment of the annual $PM_{2.5}$ NAAQS: Annual-official-FRM-99-06-v1.zip (official quarterly average FRM mass) and STN-only-02-04-R2.zip (daily speciation data).

TSD-2c, 2007. $PM_{2.5}$ modeling using the SMOKE/CMAQ system over the Ozone Transport Region (OTR)

Table 1. Base year $PM_{2.5}$ design values across the NYC NAA based on weighted averages over 2000-2004, and the nearest STN monitor to each FRM monitor. Base year design values listed in bold are above the annual NAAQS.

FRM site	Base year Design Value, $\mu g\ m^{-3}$	Nearest STN monitor
090010010	13.1	090019003
090010113	12.6	090019003
090011123	12.8	090019003
090012124	12.9	090019003
090013005	12.9	090019003
090019003	11.8	090019003
090091123	13.7	090091123
090092123	13.1	090091123
090099005	11.6	090091123
340030003	13.7	360050110
340171003	14.9	360610062
340172002	**16.0**	360610062
340210008	13.9	340230006
340218001	11.9	340230006
340230006	12.5	340230006
340270004	12.4	340273001
340273001	11.1	340273001
340310005	13.2	360050083
340390004	**15.7**	340390004
340390006	13.5	340390004
340392003	13.1	340390004
360050080	**15.8**	360050110
360050083	13.8	360050083
360050110	14.7	360050110
360470052	**15.1**	360610062
360470076	14.2	360610062
360470122	14.8	360610062
360590008	12.2	360810124
360610056	**16.9**	360610062
360610062	**16.3**	360610062
360610079	14.7	360050110
360610128	**15.9**	360610062
360710002	11.5	090019003
360810124	13.3	360810124
360850055	14.0	340390004
360850067	12.1	340390004
361030001	12.1	360810124
361191002	12.3	360050083

Table 2. Current species composition in μg m^{-3} across the NYC NAA, based on speciation data from the nearest STN monitor. "SO_4" is sulfate; "NO_3r" is retained nitrate; "OM" is organic mass; "PBW" is particle-bound water; "NH_4" is ammonium associated with SO_4 and NO_3r; and "OPP" is other primary $PM_{2.5}$, assumed to equal the sum of major crustal oxides (Si, Ca, Fe, and Ti).

FRM site	SO_4	NO_3r	OM	EC	PBW	NH_4	OPP
090010010	3.98	0.61	4.09	0.86	1.18	1.34	0.56
090010113	3.81	0.61	3.93	0.83	1.14	1.29	0.53
090011123	3.85	0.60	3.97	0.84	1.15	1.30	0.54
090012124	3.90	0.59	4.02	0.85	1.16	1.31	0.55
090013005	3.89	0.61	4.00	0.85	1.16	1.31	0.55
090019003	3.56	0.52	3.73	0.76	1.06	1.18	0.50
090091123	4.26	0.69	3.67	1.00	1.46	1.63	0.51
090092123	4.05	0.68	3.52	0.96	1.38	1.55	0.49
090099005	3.62	0.57	3.06	0.84	1.24	1.38	0.43
340030003	4.10	0.95	3.32	1.04	1.37	1.70	0.66
340171003	4.40	1.28	3.38	1.33	1.46	1.92	0.68
340172002	4.71	1.41	3.59	1.43	1.56	2.07	0.73
340210008	4.68	0.85	3.32	0.75	1.52	1.77	0.52
340218001	4.01	0.68	2.86	0.63	1.30	1.50	0.44
340230006	4.19	0.73	2.98	0.66	1.36	1.57	0.46
340270004	4.52	0.62	2.91	0.45	1.44	1.59	0.36
340273001	4.04	0.53	2.61	0.39	1.29	1.41	0.32
340310005	3.80	0.82	3.49	1.26	1.26	1.50	0.61
340390004	4.40	1.02	4.03	1.74	1.47	1.83	0.67
340390006	3.76	0.91	3.46	1.50	1.25	1.58	0.57
340392003	3.67	0.84	3.38	1.46	1.22	1.52	0.56
360050080	4.73	1.17	3.84	1.23	1.57	1.99	0.77
360050083	3.95	0.92	3.61	1.34	1.31	1.57	0.64
360050110	4.39	1.08	3.56	1.14	1.46	1.84	0.71
360470052	4.45	1.28	3.42	1.34	1.47	1.94	0.68
360470076	4.20	1.22	3.20	1.26	1.39	1.83	0.64
360470122	4.36	1.26	3.32	1.31	1.44	1.90	0.67
360590008	3.85	0.82	2.97	0.69	1.29	1.55	0.55
360610056	4.98	1.50	3.81	1.51	1.65	2.19	0.77
360610062	4.81	1.40	3.66	1.45	1.59	2.10	0.74
360610079	4.41	1.05	3.58	1.13	1.47	1.84	0.71
360610128	4.68	1.39	3.59	1.42	1.55	2.05	0.72
360710002	3.46	0.49	3.65	0.74	1.03	1.14	0.49
360810124	4.22	0.92	3.24	0.75	1.41	1.70	0.60
360850055	3.93	0.87	3.62	1.56	1.31	1.63	0.60
360850067	3.39	0.75	3.10	1.34	1.13	1.40	0.51
361030001	3.82	0.81	2.95	0.68	1.28	1.53	0.55
361191002	3.52	0.78	3.23	1.18	1.17	1.39	0.57

Table 3. Model variables from CMAQ used to compute speciated RRF values.

$PM_{2.5}$ species, μg m^{-3}	**CMAQ variables, μg m^{-3}**
SO_4	ASO4I + ASO4J
NO_3r	ANO3I + ANO3J
OC	AORGPAI + AORGPAJ + AORGAI + AORGAJ + AORGBI + AORGBJ
EC	AECI + AECJ
OPP	A25I + A25J

Table 4. Base year and future (2009) $PM_{2.5}$ design values across the NYC NAA. Concentrations listed in bold are above the annual NAAQS.

FRM site	Base Year Design Value μg m^{-3}	Future $PM_{2.5}$ Design Value μg m^{-3}
090010010	13.1	11.5
090010113	12.6	11.2
090011123	12.8	11.2
090012124	12.9	11.4
090013005	12.9	11.3
090019003	11.8	10.4
090091123	13.7	11.7
090092123	13.1	11.2
090099005	11.6	9.9
340030003	13.7	12.1
340171003	14.9	13.3
340172002	**16.0**	14.3
340210008	13.9	11.8
340218001	11.9	10.1
340230006	12.5	10.4
340270004	12.4	10.4
340273001	11.1	9.3
340310005	13.2	11.4
340390004	**15.7**	13.5
340390006	13.5	11.8
340392003	13.1	11.4
360050080	**15.8**	14.2
360050083	13.8	12.4
360050110	14.7	13.3
360470052	**15.1**	13.6
360470076	14.2	12.8
360470122	14.8	13.3
360590008	12.2	11.0
360610056	**16.9**	**15.3**
360610062	**16.3**	14.4
360610079	14.7	13.3
360610128	**15.9**	14.3
360710002	11.5	10.3
360810124	13.3	12.1
360850055	14.0	12.3
360850067	12.1	10.6
361030001	12.1	10.7
361191002	12.3	10.9

Attachment 1

Analysis of the FRM data at PS 59 in New York (Manhattan) County, NY

New York State DEC
Division of Air Resources

Background

The New York State DEC analyzed the measurements of $PM_{2.5}$ mass data across the New York City metropolitan non-attainment area for use in estimating the future design values, which are based on air quality modeling of the 2002 base and 2009 future years. The EPA Guidance (US EPA, 2007) requires the use of the measured data from the five-year period around the base year (2000-2004) to estimate the current design value (DVc). Although the Modeled Attainment Test Software (MATS) has not yet been released, the New York State DEC has been able to compute preliminary baseline and future $PM_{2.5}$ levels, based on discussions with EPA/OAQPS. These preliminary calculations suggest that, except for one monitor – PS 59 [AQS ID 36-061-0056] in New York (Manhattan) County, NY – the region will be at or below the annual $PM_{2.5}$ NAAQS. If the official FRM data received from OAQPS are used 'as-is,' PS 59 will be *slightly* above the prescribed level of the annual $PM_{2.5}$ NAAQS. This is despite the fact that on average, $PM_{2.5}$ levels have been decreasing at this site by nearly ~0.4-0.5 $\mu g\ m^{-3}\ yr^{-1}$ since 1999. In the following we investigate the cause for this dichotomy, and note that the measurements taken during the third quarter of 2003 play an important role in the estimated $PM_{2.5}$ DVc and the potential future status of nonattainment at this location.

PS 59 monitoring location

The FRM unit is located on the roof of PS 59 in New York County and has been operational since 1999. Appendix A provides the location and description of the monitoring site. The FRM sampler was collocated with a duplicate sampler, as part of the network design requirements. Both monitors were shut down for most of the third quarter of 2003 due to roof repairs. Appendix B provides the correspondence from New York City School Construction Authority indicating the working hours of construction activities at the location with the requirement that the *roof-main work to be completed by August 25, 2003*. Ambient monitoring was resumed at this site in October 2003. So for the third quarter in 2003 there were only the first five samples out of a possible 31 were available.

Duplicate Monitors and Analysis

Appendix C describes the analysis associated with the primary and duplicate measurements, which shows that there is very good agreement between the two monitors, except for one outlier, which is found to be not associated with the period in question – 3rd quarter of 2003. The estimated correlation coefficient (r^2=0.9867) and the almost zero intercept (0.0081) suggest either of the monitors could be used in the analysis. It should also be noted that from a monitoring perspective the site meets the criteria for data completeness in 2003 based on the remainder of the measurements. Yet, examination of the data on a quarterly average basis indicates that an average based on these five data points is not necessarily representative of air quality over the entire quarter at this location in addressing model-based attainment. The reason for examining the data by quarter arises from the modeling guidance (US EPA, 2007) that calls for a weighted five-year running quarterly average to compute baseline concentration levels.

In the following two sections we will present a case that a more appropriate quarterly concentration value be used for this quarter at this site, rather than one based on only the five values, in estimating the DVc.

Observed $PM_{2.5}$ mass in New York County, 2003

Figure 1 displays the time series of $PM_{2.5}$ mass at the four New York County FRM monitors in 2003 – PS 59 (360610056), Canal Street (360610062), JHS 45 (360610079), and PS 19 (360610128). Each site tends to track the others rather well over the entire year. Considering only those days for which valid measurements are available for all four sites, there were a total of 64 days out of a possible 121 days which were used to estimate the annual arithmetic average at each site: PS 59, 17.11 $\mu g\ m^{-3}$; Canal Street, 15.69 $\mu g\ m^{-3}$ JHS 45, 14.75 $\mu g\ m^{-3}$ and PS 19, 16.18 $\mu g\ m^{-3}$. These averages, not to be confused with the regulatory definition, indicate that in 2003 the PS 59 monitor is on avergae about 1 to 2 $\mu g\ m^{-3}$ higher than the other sites.

Figures 2a-d display the quarterly average concentrations covering the five year span of 2000 to 2004 for these four monitors. With the exception of the third quarter of 2003 (Figure 2c) the quarterly average concentrations are quite comparable at these four monitors. As evident from Figure 2c however, the estimated quarterly average for PS 59 is more than 8 $\mu g\ m^{-3}$ higher than the other three sites, whose third quarter averages based on 20 to 29 samples were in the 16-17 $\mu g\ m^{-3}$ range.

Current and baseline $PM_{2.5}$ levels at PS 59

To compute baseline $PM_{2.5}$ levels at this site, we started with the data file that was provided to the New York State DEC by Region 2 on August 17, 2007. The file labeled "Annual-official-FRM-99-06-v1.csv" lists the EPA's official quarterly averages at each FRM site across the country for the period 1999-2006, as well as the corresponding attainment status and completion codes.

Base year $PM_{2.5}$ levels were computed three ways. The first method (method A) includes the FRM data from the anomalous third quarter of 2003. The other two methods involve data substitution; method B substitutes the third quarter average (16.70 $\mu g\ m^{-3}$) from a nearby site (PS 19, ~3.5 km south of PS 59), while method C substitutes the average of the third quarter values from the other years (16.51 $\mu g\ m^{-3}$; 2000-2002 and 2004). The third quarter of 2003 at PS 19 and the average of the third quarters from the other years at PS 59 are considered complete for attainment/non-attainment purposes and are more likely to reflect the average air quality at or near this site.

If method A is used the base DVc is 17.37 μg m^{-3}, while the methods B and C result in a DVc of 16.90 μg m^{-3} and 16.89 μg m^{-3}, respectively. Hence, if the ‘anomalous quarter’ from 2003 is used in this calculation (method A), the base year DVc is about 0.5 μg m^{-3} higher than the other methods that used substitution. Preliminary calculations of the future 2009 design value are estimated to be about 15.7 μg m^{-3} using method A, and about 15.3 μg m^{-3} based on either method B or C.

Summary

The above analysis has demonstrated that the use of quarterly average based on the measured data ‘as-is’ has significant consequences for $PM_{2.5}$ non-attainment status at the PS 59 monitor. A quarterly average that covers only five days for the third quarter of 2003 is not consistent with the measurements available at other monitor locations in New York County. It is recommended that this quarterly average be re-calculated using either the substitution of a third quarter concentration from a nearby monitor such as PS 19, or the substitution of the composite average of the third quarters from the other years at that monitor.

Reference

US EPA, 2007. Guidance on the use of models and other analyses for demonstrating attainment of air quality goals for ozone, $PM_{2.5}$, and regional haze. Office of Air Quality Planning and Standards, 253 pp., EPA-454/B-07-002.

Figure 1. Time series of $PM_{2.5}$ mass at the four FRM sites in New York County in 2003.

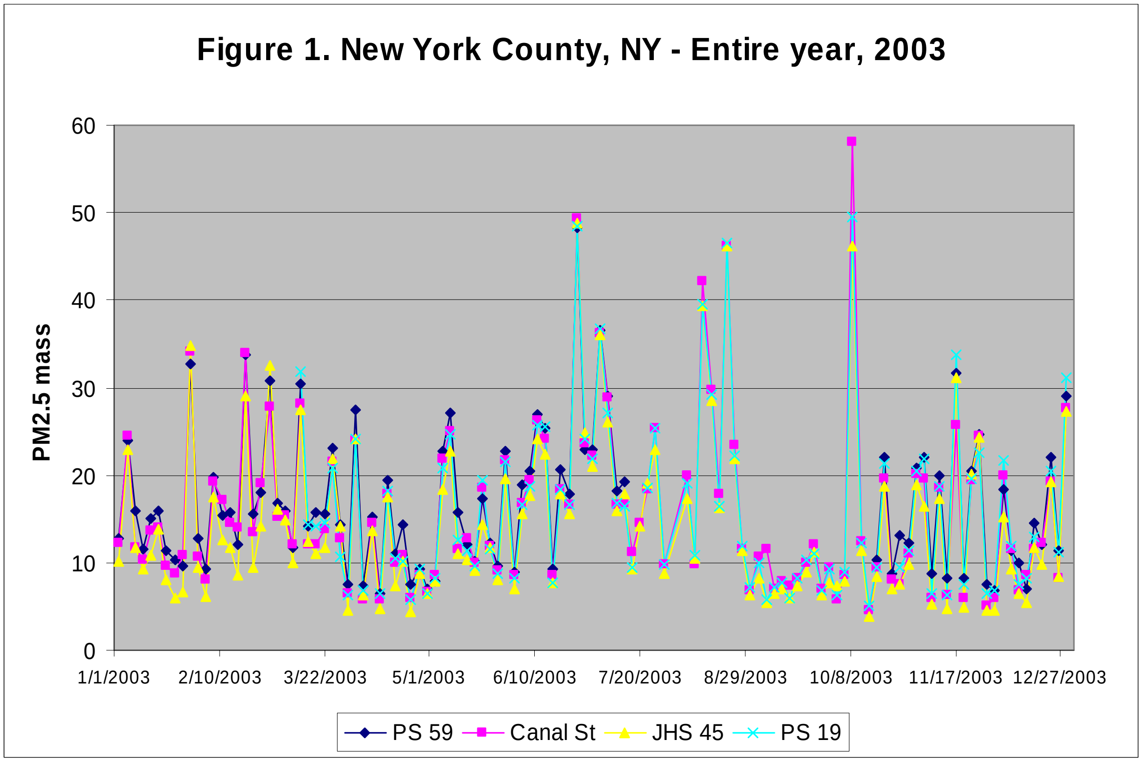
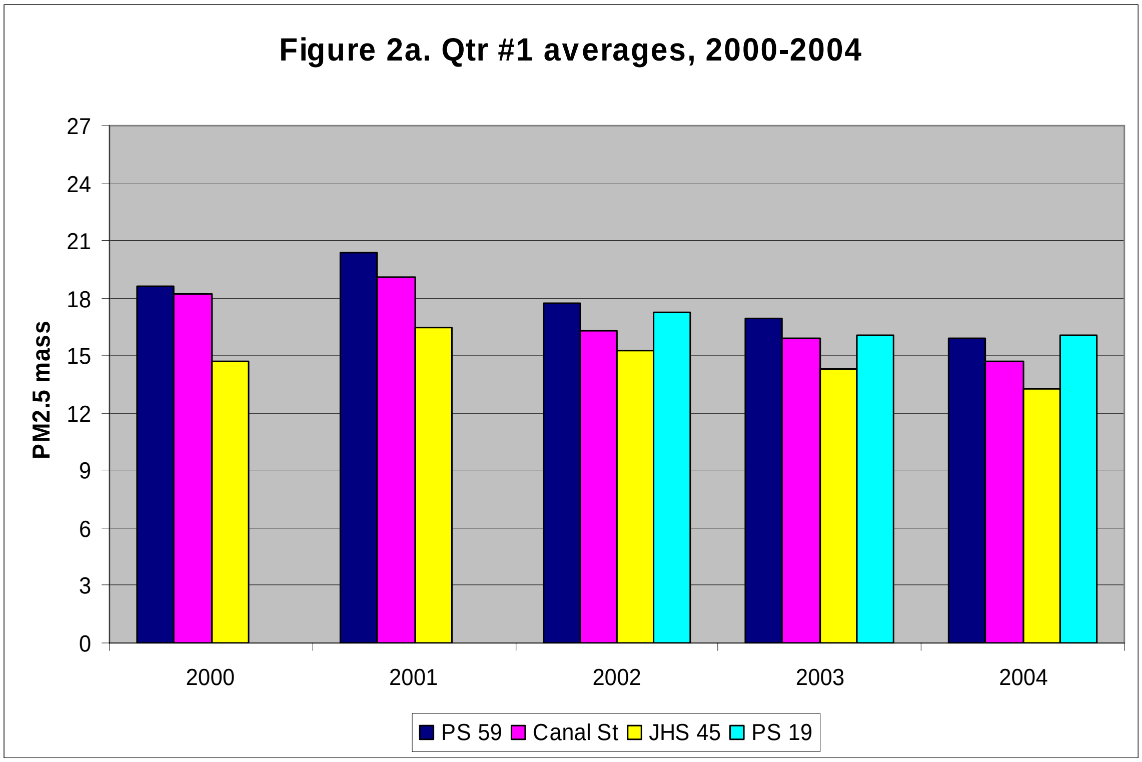


Figure 2. Comparison of quarterly averages at the four FRM monitors in New York County, 2000-2004. (a) Quarter #1, (b) Quarter #2, (c) Quarter #3, and (d) Quarter #4.



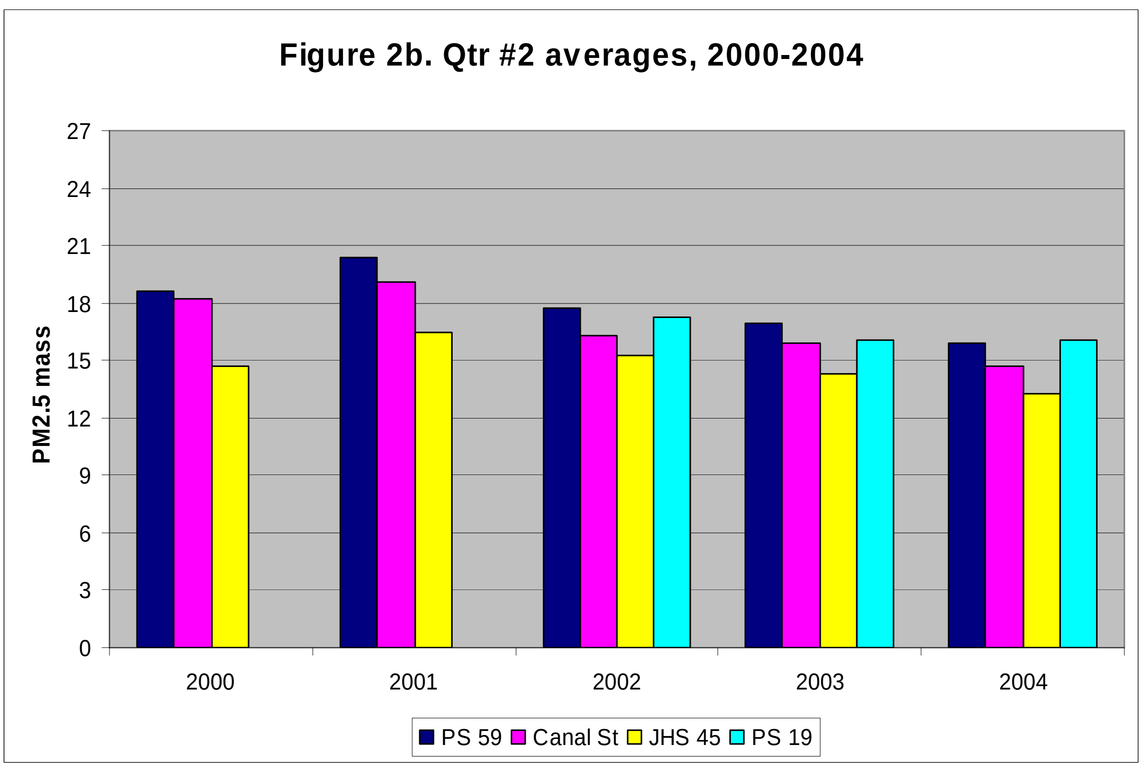
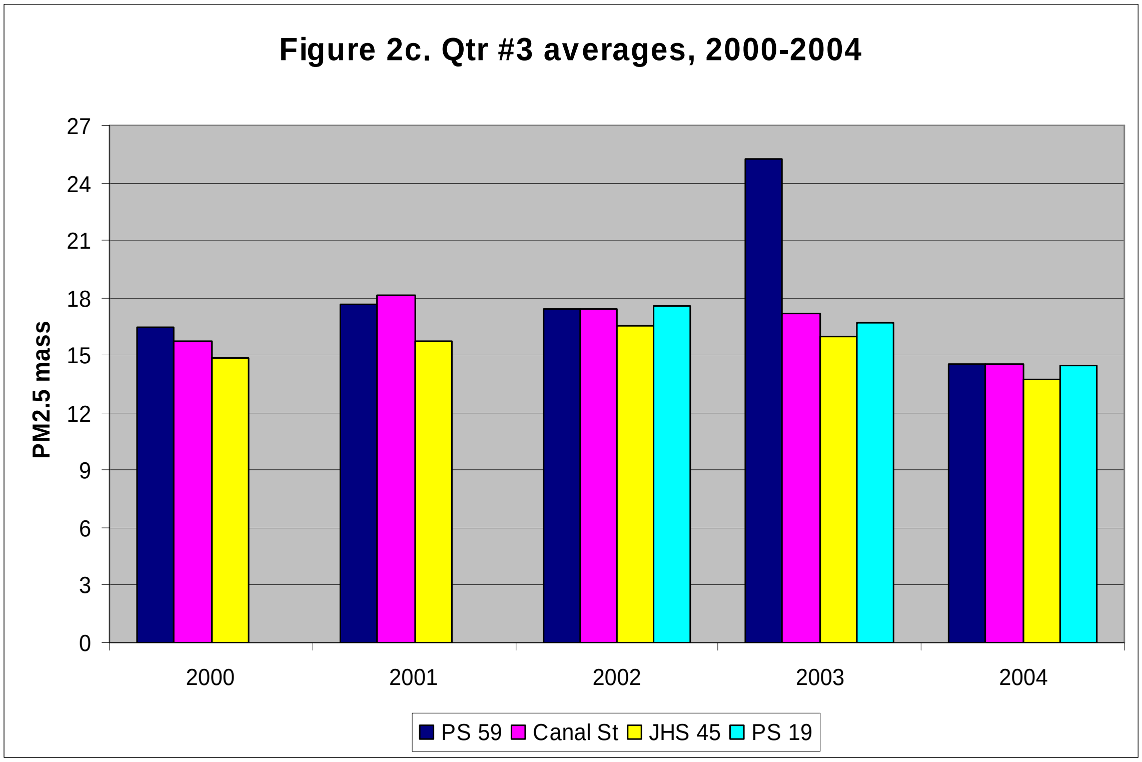
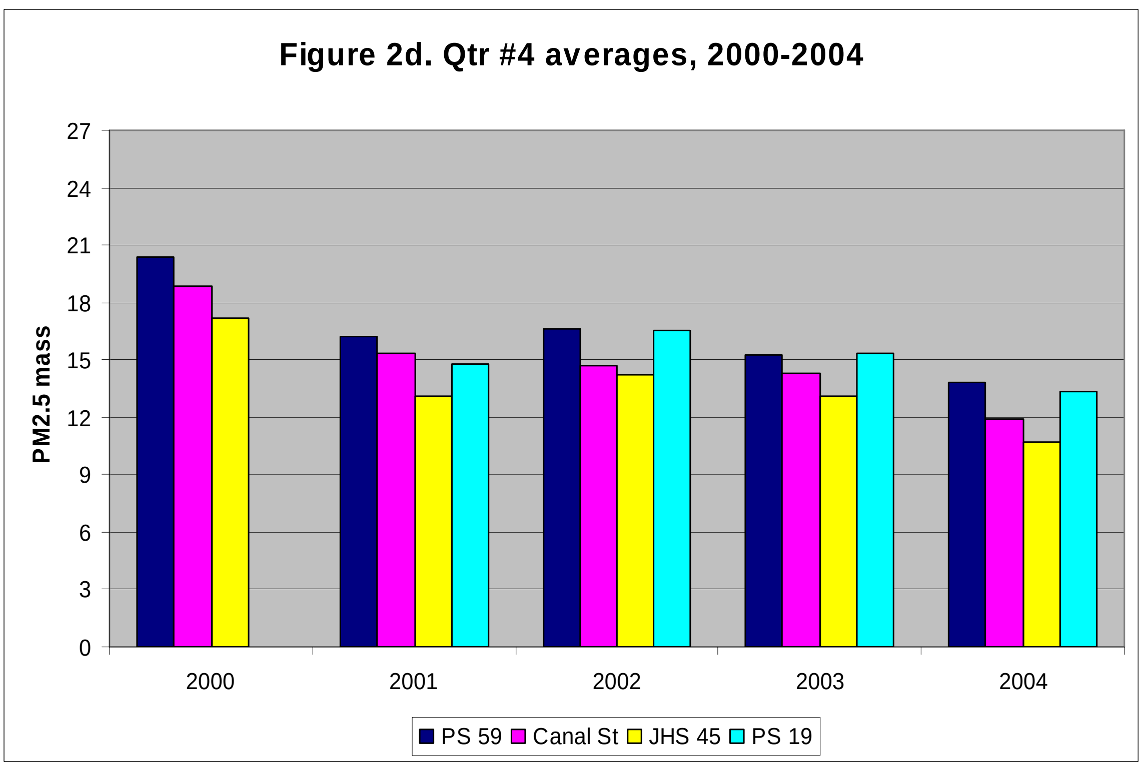


Figure 2 (continued).





Appendix A

PS 59
36-061-0056

New York City Department of Education
Public School 59
228 East 57th Street
New York, NY 10022

PS 59

Address: New York City Department of Education
Public School 59
228 East 57th Street
New York, NY 10022

AQS Number: 36-061-0056
DEC Number: 7093-10
County: New York
Statistical Area: New York City Metropolitan Area
Coordinates: 40.7591 N 73.9666 W

PS 59 was established in midtown Manhattan in July 1985. In 1999 duplicate Federal Reference Method fine particulate samplers were added. In December 2005, one of the $PM_{2.5}$ samplers was changed to a FRM PM_{10} sampler at the request of EPA to evaluate midtown Manhattan PM_{10} levels. The collocated $PM_{2.5}$ sampler was moved to JHS 45 (36-061-0079) at the same time.

The parameters monitored are indicated in the following table:

Parameter	Sampling Method	Analysis Method	Schedule
Sulfur Dioxide	Pulsed Fluorescence TEI 43C Method 060		Continuous
Oxides of Nitrogen	Gas Phase Chemiluminescence TEI 42C Method 074		Continuous
Carbon Monoxide	Gas Filter Correlation TEI 48C Method 054		Continuous
$PM_{2.5}$	R&P 2025 Method 118	Gravimetric RTI Laboratory	1 day in 3
PM_{10}	R&P 2025 Method 127	Gravimetric RTI Laboratory	1 day in 3
Toxics	Summa Canister	GC/MS	1 day in 6

Appendix B

NEW YORK CITY SCHOOL
CONSTRUCTION AUTHORITY

PS59M
3/25/03

March 25, 2003
Revised

Ms. Leslie Zackman, Principal
P.S.59M
228 East 57th Street
New York, NY

Re: Phasing Letter for the Upcoming Project:
LLW# 023607, Design# 006802 Roof Replacements

Dear Ms. Zackman:

As discussed with me, the following items pertaining to the Construction and Phasing Plan were reviewed:

1. School Hours

- Normally School hours are Monday through Friday from 8:20 AM to 3:00 PM.
- After School program from 3:00PM to 6:00PM.
- No Saturday or Sunday classes.
- School will not be in session during the Summer of 2003.

2. Standardized Testing Period

- The Contractor must allow fifteen non-sequential days during each School year for testing during normal School time during which no work will be allowed.
- The Contractor's work schedule shall account for these days and under no circumstances will the Contractor be granted an extension of time for the completion of this project.

3. Work Hours for the Project

- All physical work can be performed weekdays from 6:00 PM to 7:00 AM. Non-disturbing work will be allowed to commence at 3: 00 PM. On Saturdays and Sundays, working hours shall be 8:00 AM to 10:00 PM. The Contractor shall obtain and pay for all Custodial and Dept. of Building Permits required to perform work during non-school hours. These permit requests shall be made a minimum of 5 days in advance of the work period.

30 - 30 Thomson Avenue
Long Island City, NY 11101-3045
TEL 718 472-8000
FAX 718 472-8840
Web Site: www.nycsca.org

- Contractor must **not** perform ACM (Asbestos) removals, hot tar roofing, demolition, unloading of materials & equipment, and any operation that may impact the educational process of the School facility or any part of it, between the School hours of 8:00 AM to 6:00 PM. Work requiring shutdown of the School facility or any part of it must be preceded by two (2) week notice, and must be performed during non-school hours.

4. **Use of School Stairs/Entrances**

- The East 57th St. main entrance west door and stairway for the Contractor's use will be permitted for construction purposes. Only one entrance & stairway shall be used depending where the work is being performed, and for any changes prior approval is to be obtained from the Custodian.

5. **Employee Identification**

- All the employees working at this project must wear visible photo identification badges that identifies name of the employee, name of the company.. All workers are required to sign in and out in the School's security log book.

6. **Use of School Facilities**

- The Contractor's employees shall not use any School facilities except as follows:
- The Contractor will not be allowed to use any bathrooms, and shall furnish temporary toilet facilities for his usage. Temporary water can be obtained from existing hose bibs that may be operable. Temporary electric will be properly taken from the appropriate School power panels.
- No loitering in the School will be allowed.
- Absolutely no School equipment is to be used.
- There is no available space in the Basement for construction personnel offices and storage.
- Storage of materials and equipment will be permitted in the Children Playground only within fenced in areas within erected sidewalk sheds.

7. **Use of Dumpster**

- Custodian and Project Officer will review and approve the location of dumpsters in the adjacent street roadways. Proper DOT permits to be obtained by the Contractor.

8. **Construction Trailers**
   - The Contractor will locate at least two (2) office trailers on E.56th St. One of which will be for the Project Officer.

9. **Security Guards**

ZTV

- A minimum of 0ne(1) uniformed security guard must be present on the site at all times, seven (7) days per week. Security guards must have access to electronic communication with their headquarters and/or with the police department to address any emergencies.

10. **Site Safety Plan and Permits**

- An approved Site Safety Plan will be posted before construction will commence.
- All Construction Permits will be posted, and copies will be given to the Custodian.

11. **Phasing**

- All construction work scheduling to be coordinated in tandem with roofing work at HS of Art & Design.
- The Contractor is to phase his "Scope of Work" to insure that the * School can be used during school hours. Our intent is to first commence work at both the main roof and existing play terrace roof at the 2^{nd} floor In case of unusual conditions the Contractor will give at least two (2) weeks advanced notice, and must receive approval from the Authority and Principal for the closing of any part of the School.
- Job progress meetings will be held every two (2) weeks for coordinating purposes. Written minutes of these meetings will be distributed to the Principal and Custodian.

LZ RBS * INCLUDES 2ND FL TERRACE PLAYGROUND.

LZ RBS • ROOF-MAIN TO BE COMPLETED BY AUG. 25, 2003 WITH 2ND FL TERRACE PLAYGROUND SHORTLY THERE AFTER. ** SAFE ACCESS TO BE MAINTAINED INTO AND OUT OF THE SCHOOL AT ALL TIMES.

** INCLUDES USE ALSO.

Sincerely,

Robert B. Spear

Robert B. Spear
Project Officer

Concur: Leslie Zackman Date: 3/26/03
Leslie Zackman, Principal

Concur:________________________ Date:__________
Shelley Harwayne, District 2 Superintendent

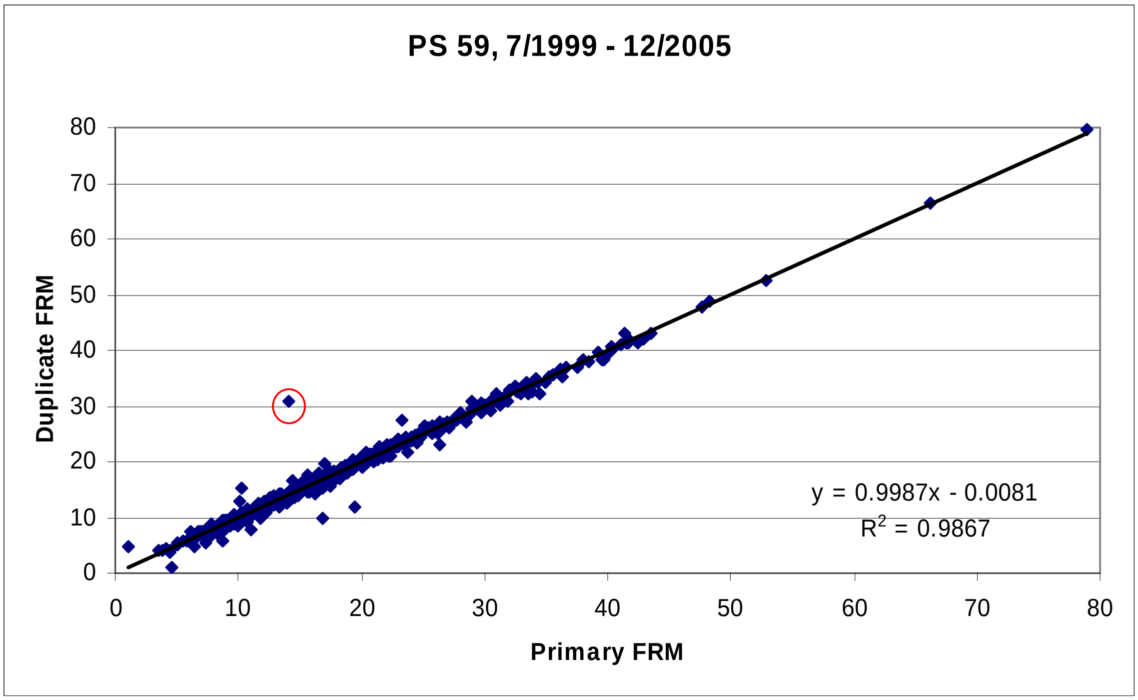
Cf: Dan Reddan, VPPM&O, Silviu Herscher, Sr. Dir., Christopher Mitchell, SPO Michael Mirisola, PSM, Kevin Zodi, Custodian/Engineer

RBS

Appendix C

Comparison of data from the primary and duplicate FRM monitors at PS 59

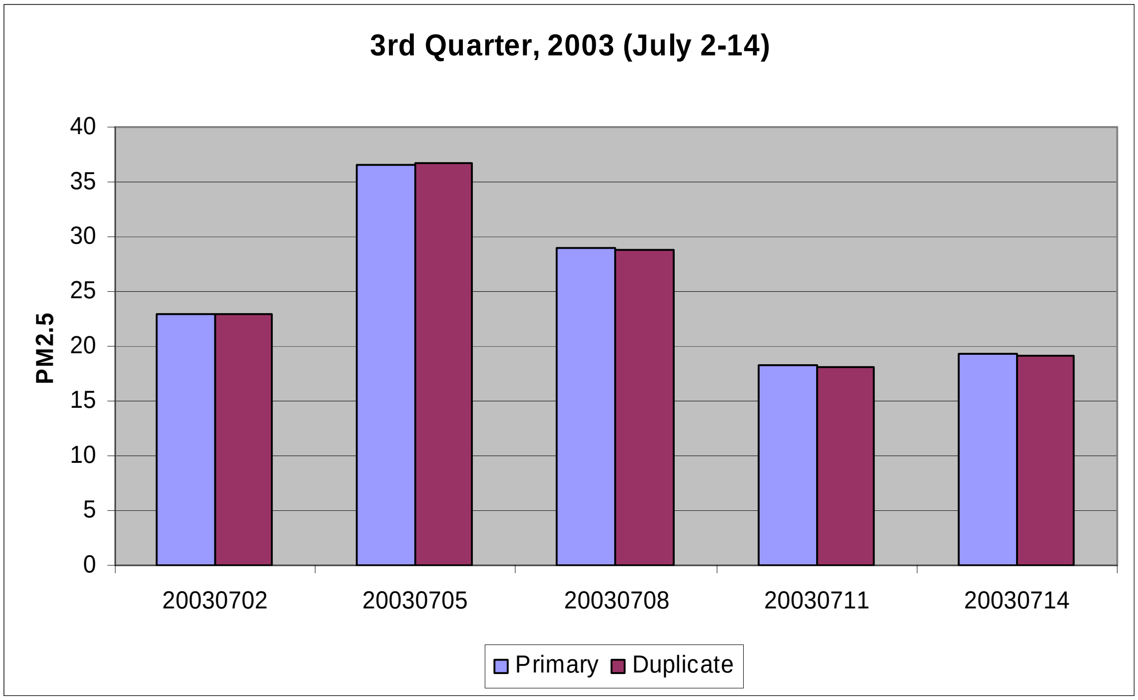
- Both sites started in July 1999; the primary monitor continues to operate but the duplicate monitor was shut down at the end of 2005
- Data were extracted from AQS on December 3, 2007
- There are 644 days during this 6.5 year period with both sets of data available



The overall arithmetic average at the primary monitor is 17.07 μg m^{-3}, while at the duplicate monitor it is 17.04 μg m^{-3}. The average difference ("primary-duplicate") is 0.03 μg m^{-3} and the standard deviation of the difference is 1.05 μg m^{-3}. The central 95% of the differences between the two monitors ranges from -1.2 μg m^{-3} to +1.5 μg m^{-3}. Of the 644 days, there appears to be only one day for which the two monitors differed substantially - January 31, 2001 with the primary and duplicate monitors reporting 14.1 μg m^{-3}, and 30.8 μg m^{-3}, respectively.

Two time periods of interest are considered to highlight the comparability between the two monitors -- July 6-9, 2002 period (very high values due to the Canadian wildfires), and the third quarter of 2003 (only the first five samples were available). On July 7, 2002 – the only FRM sampling day during the wildfire period – the primary FRM recorded 79.0 μg m^{-3}, while the duplicate FRM recorded 79.8 μg m^{-3}. Hence, even on this very high loading day the monitors were within 0.8 μg m^{-3} (1%) of each other.

As per the 3rd quarter of 2003, the following plot displays the data for both monitors that were operational only for five sampling days. Recall that the monitors were shut down for the rest of the quarter. On each of these days the two monitors agree to within 0.2 μg m^{-3}. The averages over these five days were 25.22 μg m^{-3} (primary) and 25.16 μg m^{-3} (duplicate).



Attachment 2

Weight of evidence (WOE) in support of modeled attainment of the $PM_{2.5}$ NAAQS in the New York City non-attainment area

The EPA modeling guidance (US EPA, 2007), in conjunction with ambient Federal Reference Method (FRM) $PM_{2.5}$ mass data from 2000-2004 and baseline and future air quality modeling results, has been applied to determine the attainment status of the New York City non-attainment area (NYC NAA) with respect to the annual National Ambient Air Quality Standard (NAAQS). The application of the EPA guidance for estimating the future design values based on the use of relative response factor (RRF) has resulted in one monitor – P.S. 59 (360610056), located in New York County, NY – to exceed the annual $PM_{2.5}$ NAAQS level of 15 μg m^{-3}. The estimated future $PM_{2.5}$ design value at this monitor, based on this procedure, is 15.3μg m^{-3}. This value falls within the uncertainty range of ±0.5 μg m^{-3} of the annual $PM_{2.5}$ NAAQS, and supplemental analyses are needed for this monitor be considered to be in attainment. In the following sections we provide information to suggest that there is high degree of potential that estimated future design value will be below the annual NAAQS.

Monitoring network in New York County and surroundings

For most of the 2000-2004 period New York County, NY had 4 FRM monitors, but only one Speciation Trends Network (STN) monitor collocated with the FRM at the Canal Street site (360610062) to provide information on composition of the baseline $PM_{2.5}$ species. Figure 1 displays the location of the four monitors as well as monitors in the surrounding counties. Table 1 lists the dates of operation of the FRM monitors in New York County; the base year design value for 2002, which is a weighted average of the measurements in the 2000 to 2004 period; and the nearest STN monitor. It should be noted that not all monitors in New York County were assigned the same STN monitor, because the approach selected was to use the nearest neighborhood monitor to link the FRM and STN. In the case of the J.H.S.45 (36061007) FRM monitor in New York County, the nearest STN monitor is the Bronx County I.S.52 site (360050110), and this site is also included in Table 1.

The current speciation levels estimated at these monitors are listed in Table 2. Only two of these sites – Canal Street and I.S.52 – have collocated STN monitors, while the species composition at the other FRM sites are only estimates based on the speciation data from a nearby monitor. Examination of the speciation data at Canal Street and I.S.52 suggests that there may be fairly substantial gradients in $PM_{2.5}$ species composition over the non-attainment area, on the order of several tenths of a μg m^{-3}. Thus the estimates listed for the other monitors should only be considered approximate, and in some cases may not necessarily be representative of species composition at these monitors. This is certainly a limitation that needs to be taken into consideration when projecting the future design values using the model results and the current speciation levels.

Although the air quality modeling results are to be used in a relative sense, it is instructive to examine the changes in $PM_{2.5}$ mass that the model predicts in an absolute sense to see the direct impacts of emissions reductions. We examined the CMAQ-predicted average $PM_{2.5}$ mass over the nine-grid cells that surround each of these FRM monitors (see Table 3) in the base (2002) and future (2009) years. Note that CMAQ predicts a consistent reduction of about 16% over each FRM monitor in New York County. Although not shown here, future $PM_{2.5}$ concentrations at each FRM location across the 22-county NYC NAA are predicted by CMAQ to decrease by 12-18%.

Estimate of future design values

Table 4 lists the base year and projected future design values based on the EPA Guidance. The only monitor that is projected to be above 15μg m^{-3} in 2009 is P.S.59 (360610056). In fact, none of the other monitors in the 22-county metropolitan non-attainment area is projected to exceed the lower end of the margin of safety range of 14.5μg m^{-3}. This suggests that on an overall basis the planned emissions reductions are projected to improve the $PM_{2.5}$ air quality over the NYC NAA.

Noting that there is only one other monitor (360610062) that is above 16μg m^{-3} besides 360610056, and that it is collocated with STN providing an estimated future design value of 14.4μg m^{-3} that is below the annual $PM_{2.5}$ NAAQS. If a simple linear extrapolation is used to compare these two monitors, then the projected future design value for P.S.59 would be 14.9μg m^{-3} and thus below the annual $PM_{2.5}$ NAAQS. Also, the change estimated based on the guidance between 2009 and 2002 at 360610062 is 1.9μg m^{-3}, whereas at 360610056 the decrease is only 1.6μg m^{-3}.

Other data analysis

A recent study by Qin et al. (2006) suggest that sum of sulfate and nitrate comprise about 40% or more of the $PM_{2.5}$ mass in the NYC metropolitan area, and that 70% or more of the $PM_{2.5}$ measured in NYC results from transport into the region. Based on results from source apportionment modeling using Positive Matrix Factorization (PMF), the authors determined that the largest single source factor affecting NYC is "secondary sulfate" associated with SO_2 emissions from upwind regions. It is clear that emission reductions in upwind states will be needed to further reduce $PM_{2.5}$ in the NYC NAA.

In an earlier chapter (TSD-3a), we showed that $PM_{2.5}$ levels appear to be decreasing across the NYC NAA. Although the data records for $PM_{2.5}$ are somewhat short, we estimated that $PM_{2.5}$ mass is decreasing by about 0.1-0.5μg m^{-3} yr^{-1}. At the P.S.59 site $PM_{2.5}$ mass measurements are decreasing by about 0.3μg m^{-3} yr^{-1} during 1999-2006. In addition to $PM_{2.5}$ mass, several criteria pollutants are also measured at the P.S.59 site. We examine the trends in SO_2 and NO_2 from 1993 to 2006 using the seasonal Kendall test, and found that ambient levels are declining at rates of 3.4% yr^{-1} and 1.7% yr^{-1}, respectively. This again points to the potential that this area would be meeting the annual NAAQS, given that there are various measures under consideration that are aimed at decreasing the emissions of $PM_{2.5}$ precursors.

Summary

In summary, the above analysis shows that, based upon the EPA guidance only one monitor in the New York $PM_{2.5}$ nonattainment area falls slightly above the level of the annual NAAQS, but still within the framework of uncertainty. The analysis suggests that lack of collocated speciation monitors and use of speciation information from the nearest neighborhood monitor may have contributed to the estimate of $PM_{2.5}$ being above the level of NAAQS at the P.S.59 monitor. Examining the trends in precursors as well as measured $PM_{2.5}$ at P.S.59 suggests a downward path and that coupled with the observation that the contribution to the secondary species is from upwind regions rather than local, favors strongly that this monitor will also be in attainment similar to the rest of them in the region. Analysis based on the only other monitor (360610062) with similar $PM_{2.5}$ concentrations is projected to be below the level of the annual NAAQS, suggests that P.S.59 (360610056) would also be similarly be below the level of the annual NAAQS.

Reference

Qin, Y., Kim., E., Hopke, P. K., 2006. The concentrations and sources of $PM_{2.5}$ in metropolitan New York City. Atmospheric Environment 40, S312-S332.

TSD-3a (2007) Analysis of Ambient $PM_{2.5}$ Mass and Speciation for the New York metropolitan area through 2006. NYSDEC, Division of Air Resources, Albany, NY 12233.

United States Environmental Protection Agency (US EPA), 2007. Guidance on the use of models and other analyses for demonstrating attainment of air quality goals for ozone, $PM_{2.5}$, and regional haze. Office of Air Quality Planning and Standards, 253 pp., EPA-454/B-07-002.

Table 1. Information for the five FRM monitors considered in this analysis: site name and ID, dates of operation during 2000-2004, base year $PM_{2.5}$ design value, and the nearest STN monitor.

Site Name	FRM site	Operational periods during 2000-2004	Base year Design Value, μg m^{-3}	Nearest STN monitor
P.S.59	360610056	1st qtr 2000 – 4th qtr 2004	16.9	360610062
Canal St	360610062	1st qtr 2000 – 4th qtr 2004	16.3	360610062
J.H.S.45	360610079	1st qtr 2000 – 4th qtr 2004	14.7	360050110
P.S.19	360610128	3rd qtr 2001 – 4th qtr 2004	15.9	360610062
I.S.52	360050110	1st qtr 2000 – 4th qtr 2004	14.7	360050110

Table 2. Current $PM_{2.5}$ species composition at each site: sulfate (SO_4), retained nitrate (NO_3r), organic carbon (OC), elemental carbon (EC), particle-bound water (PBW), retained ammonium (NH_4), and other primary $PM_{2.5}$ (OPP).

FRM site	SO_4	NO_3r	OC	EC	PBW	NH_4	OPP
360610056	4.98	1.50	3.81	1.51	1.65	2.19	0.77
360610062*	4.81	1.40	3.66	1.45	1.59	2.10	0.74
360610079	4.41	1.05	3.58	1.13	1.47	1.84	0.71
360610128	4.68	1.39	3.59	1.42	1.55	2.05	0.72
360050110*	4.39	1.08	3.56	1.14	1.46	1.84	0.71

* FRM Monitor with collocated STN

Table 3. Annual average $PM_{2.5}$ mass over the nine grid cells surrounding each monitor from the base year (2002) and future year (2009) CMAQ simulations, as well as the absolute and percent reductions.

FRM site	2002 avg., μg m^{-3}	2009 avg., μg m^{-3}	Change (μg m^{-3})	Change (%)
360610056	24.28	20.51	-3.77	-15.5
360610062	23.70	19.80	-3.90	-16.5
360610079	24.28	20.51	-3.77	-15.5
360610128	23.66	20.01	-3.65	-15.4
360050110	24.28	20.51	-3.77	-15.5

Table 4. Base and future year $PM_{2.5}$ design values.

FRM site	Base Year Design Value, $\mu g\ m^{-3}$	Future $PM_{2.5}$ Design Value, $\mu g\ m^{-3}$
360610056	16.9	15.3
360610062	16.3	14.4
360610079	14.7	13.3
360610128	15.9	14.3
360050110	14.7	13.3

Figure 1.