NETWORK ASSESSMENT

New York State Ambient Air Monitoring Program

June 19, 2015

BUREAU OF AIR QUALITY SURVEILLANCE

DIVISION OF AIR RESOURCES

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

www.dec.ny.gov

Executive Summary

This document is prepared as part of the requirements specified in the Monitoring Regulations 40 CFR Parts 53 and 58. All monitoring networks operated by the Bureau of Air Surveillance, Division of Air Resources were evaluated to determine if they meet the monitoring objectives as defined by the regulations. Considerations were given to: population and geographical coverage; air quality trends; attainment classification; emissions inventory; parameters monitored; special purpose monitors; health related and scientific research; external data users; new and proposed regulations; quality assurance; technology; personnel and training.

As a whole New York has one of the most comprehensive and robust ambient air monitoring programs in the nation. New York meets or exceeds current monitoring requirements in nearly all instances. There are adequate monitoring stations in populated areas, including where sensitive subgroups reside. Networks for criteria and non-criteria pollutants meet specified monitoring objectives. The toxics analytical laboratory has proven to be one of the best in the country, as demonstrated by data produced for the School Air Toxics Project and the Tonawanda Community Air Quality Study. New York is amongst the first to deploy new monitoring technology in the network. Staff routinely communicate findings via publication in peer reviewed scientific journals as well as presenting these data at technical conferences.

The monitoring network has been consolidated over the past five years to better utilize resources and eliminate redundancy in parameters in terms of sites and sampling frequency. One emerging issue that requires serious consideration is the aging of current monitoring staff. To address this matter, program management needs to recruit young professionals into the organization to replace retiring staff.

Introduction

The U.S. Environmental Protection Agency (EPA) finalized Revisions to Ambient Air Monitoring Regulations 40 CFR Parts 53 and Part 58 on October 17, 2006. As required by §58.10(d), "the State, or where applicable local, agency shall perform and submit to the EPA Regional Administrator an assessment of the air quality surveillance system every 5 years to determine, at a minimum, if the network meets the monitoring objectives defined in appendix D to this part whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation into the ambient air monitoring network." The first such assessment was submitted to the EPA on July 1, 2010. This document is prepared and submitted along with the 2015 Annual Monitoring Network Plan (AMNP) to fulfill these requirements.

New York State Ambient Air Monitoring Networks

The Division of Air Resources, New York State Department of Environmental Conservation (NYSDEC) operates 55 monitoring sites statewide for the measurement of criteria and non-criteria contaminants. A site map depicting monitor locations is shown in Figures 1 and 2. The continuous monitoring network is comprised of 28 ozone (O_3), 18 sulfur dioxide (SO_2), nine oxides of nitrogen (NO_x//NO_y), 9 carbon monoxide (CO), 29 continuous $PM_{2.5}$ (TEOM) including five 1405-DF($PM_{2.5}$, PM_{10}, PMcoarse), two speciated carbon, two black carbon (aethalometer), two speciated mercury, four particulate sulfate, one size distribution ultrafine particle counter, and 12 meteorological data stations. In addition, there are manual sampling networks in place for the measurement of $PM_{2.5}$ (21 FRM, 8 Speciation), PM_{10} (5), toxics (11 VOCs, 10 carbonyls, 2 PAHs), lead (3), PM_{10} metals (2), and acid deposition (7). New York's ambient air monitoring program is one of the most robust and comprehensive operations in the country. Detailed information about the monitoring networks is provided in the 2015 AMNP.

The objectives of New York's ambient air monitoring networks are to:

(a) Provide air pollution data to the general public in a timely manner;
(b) Provide data to determine compliance with ambient air quality standards and to develop emission control strategies; and
(c) Support air pollution research studies.

Using our monitoring data, the NYSDEC meteorologists provide daily Air Quality Index (AQI) forecasts and health advisories when warranted to the public through the news media as well as the Department's website, on which up to the hour air quality measurements from all monitoring sites are posted. Ozone and $PM_{2.5}$ data are electronically transmitted hourly to the EPA's AIRNow. Annual or more frequent reports for all other monitored parameters are available on our website. (http://www.dec.ny.gov/chemical/8406.html)

Data from our monitors for the criteria pollutants are used for comparing an area's air pollution levels against the National Ambient Air Quality Standards (NAAQS) to determine attainment status classification. In addition, the data are utilized for the development of attainment and maintenance plans, evaluation of the regional air quality models used in developing emission

strategies, and the tracking of trends in air pollution abatement control measures aimed at improving air quality. In monitoring locations near major air pollution sources, source-oriented monitoring data provide insight into how well industrial sources are controlling their pollutant emissions.

Our monitoring data have been used to supplement data collected by researchers working on health effects assessments and atmospheric processes, and for monitoring methods development work. Collaborations with external researchers have culminated in the publication of significant findings in peer-reviewed scientific journal articles in many instances. A listing of publications and presentations can be found in the AMNP.

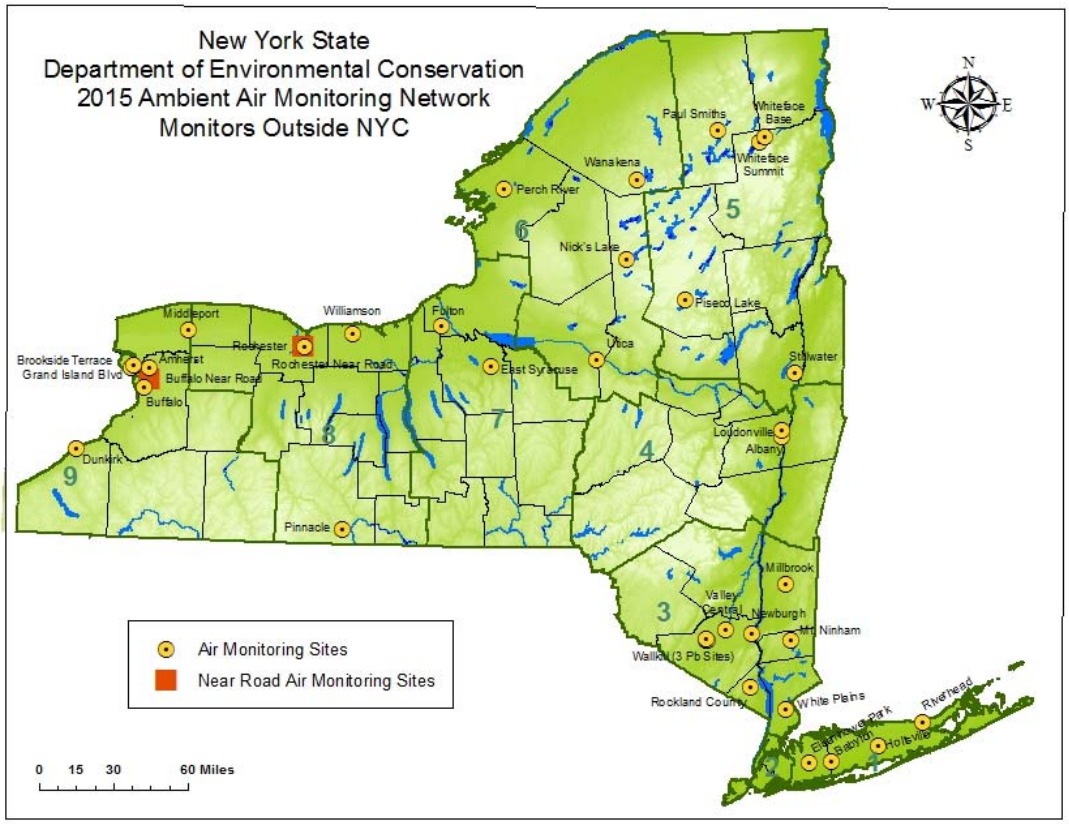


Figure 1. Location Map of Monitoring Sites in New York State Outside of New York City

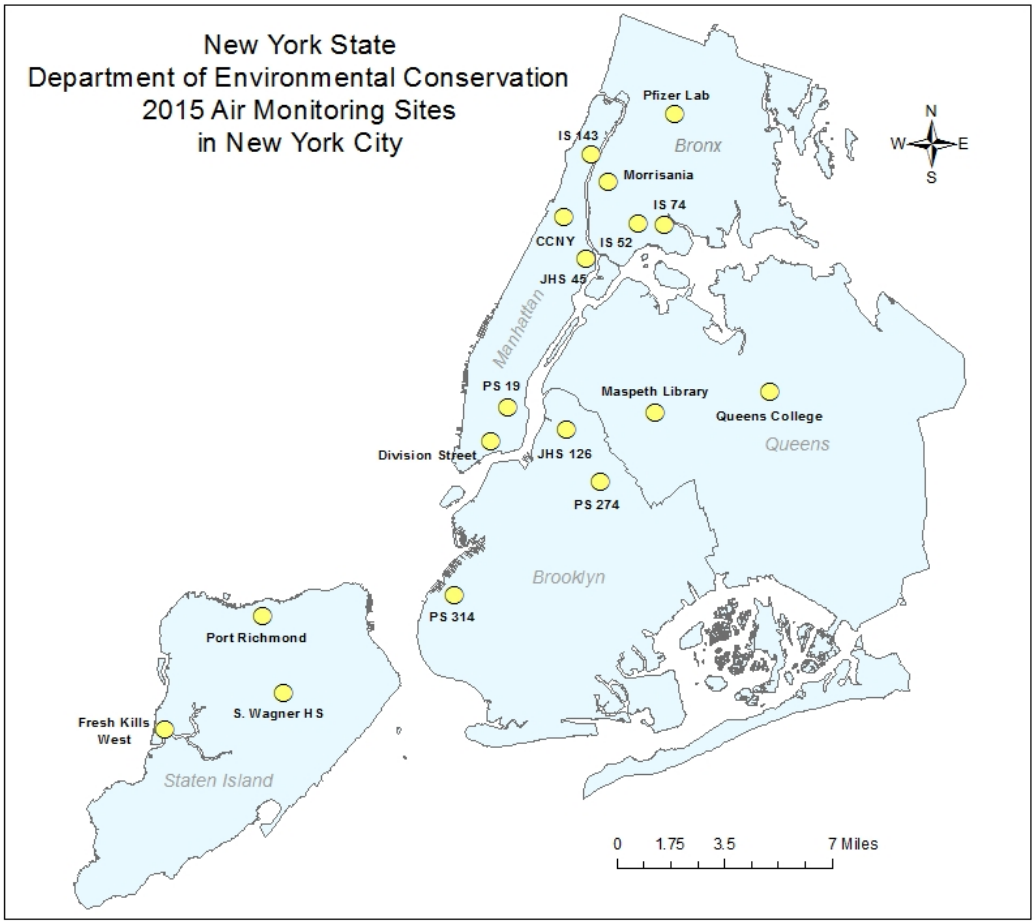


Figure 2. Location Map of Monitoring Sites in New York City

In accordance to requirements specified in the Monitoring Regulations 40 CFR Parts 53 and 58, annually the monitoring agency is required to evaluate "if the network meets the monitoring objectives defined in appendix D to this part, whether new sites are needed, whether existing sites are no longer needed and can be terminated, and whether new technologies are appropriate for incorporation into the ambient air monitoring network." With EPA's approval, the number of monitoring sites has been reduced from 68 in 2010 to 55 currently.

Population

The 2010 Census lists the state population for New York as 19,378,102. According to Census Bureau estimates the NY state population in 2014 totaled 19,746,227, the fourth most populous state in the nation. The population change in the previous four-year period indicates a net increase of 368,125 for the entire state. A Census Bureau estimated population breakdown of major Metropolitan Statistical Areas (MSAs) is provided in Table 1 below. The state saw a modest growth overall in the four-year period, mostly in the downstate areas at the expense of the western MSAs, and some small declines in some upstate MSAs.

Table 1. Population of Major Metropolitan Statistical Areas in New York

MSA	2010	2014*	Difference	%
Albany-Schenectady-Troy	870,716	880,167	9,451	1.1
Binghamton	251,725	247,219	-4,506	-1.8
Buffalo-Niagara Falls	1,135,509	1,134,115	-1,394	-0.1
Elmira	88,830	87,770	-1,060	-1.2
Glens Falls	128,923	127,345	-1,578	-1.2
Ithaca	101,564	104,691	3,127	3.1
Kingston	182,493	180,445	-2,048	-1.1
Poughkeepsie-Newburgh-Middletown	670,301	672,678	2,377	0.4
Nassau-Suffolk	2,832,882	2,861,595	28,713	1.0
New York-White Plains	9,908,456	10,163,678	255,222	2.6
Rochester	1,079,671	1,083,393	3,722	0.3
Syracuse	662,577	661,478	-1,099	-0.2
Utica-Rome	299,397	296,615	-2,782	-0.9
State Total	19,378,102	19,746,227	368,125	1.9

*Census Bureau estimation

A population density map by county based on the 2010 census data is depicted in Figure 3.

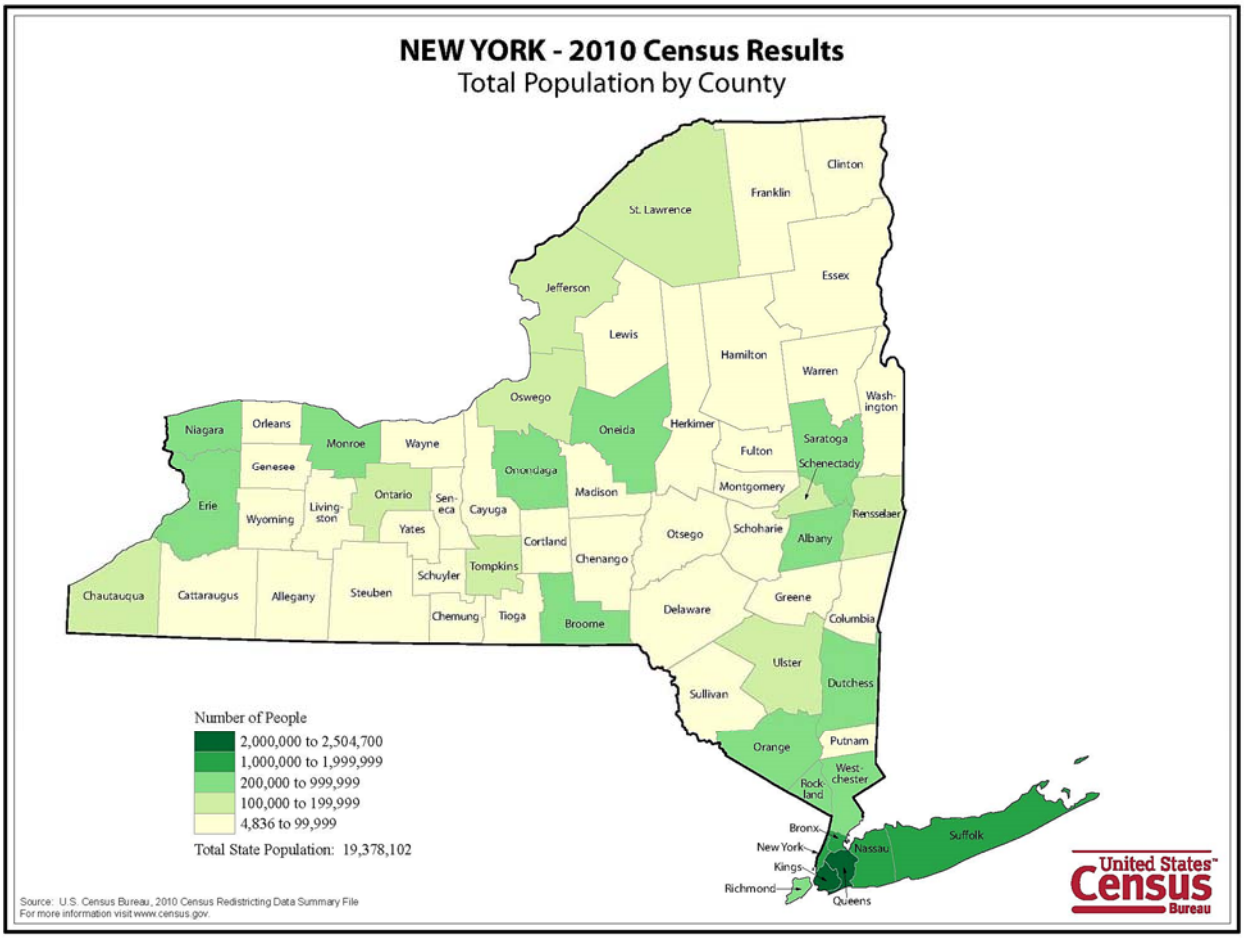


Figure 3. Population Density in New York State by County

<u>Environmental Justice Areas</u>

Environmental justice (EJ) is defined as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Environmental justice efforts focus on improving the environment in communities, specifically minority and low-income communities, and addressing disproportionate adverse environmental impacts that may exist in those communities.

A map of potential EJ areas in the State is shown in Figure 4. Approximately 37% of New York's population resides in potential EJ areas. In our network, there are 19 air monitors, 14 of which are downstate, sited within areas designated as such. The number of air monitoring sites located in potential EJ areas is commensurate with the population percentage residing therein. In the populous downstate area, 58% of the network monitors are located in potential EJ areas, where 52% of the population lives. Table 2 lists potential EJ monitors in the network.

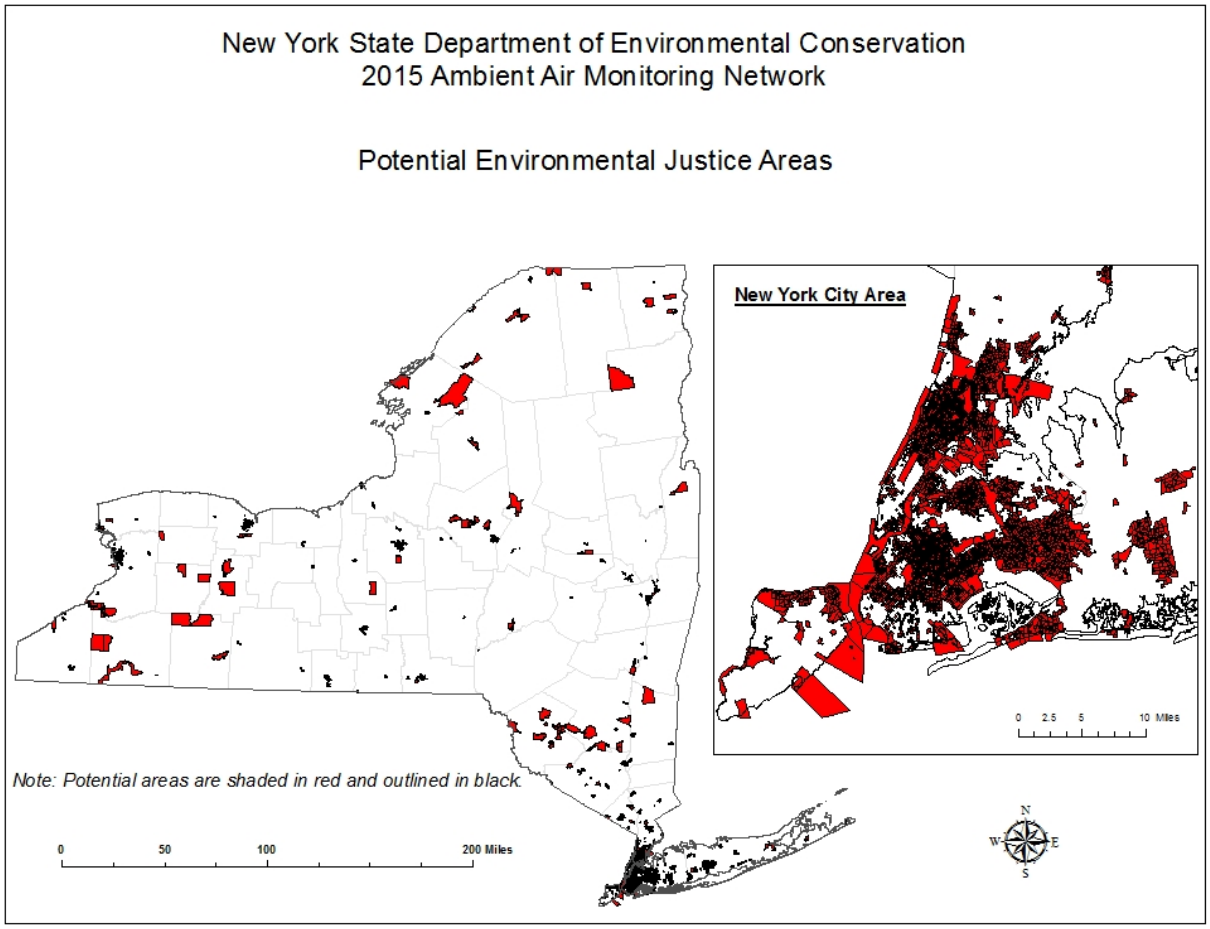


Figure 4. Potential Environmental Justice Areas in New York State

Table 2. Monitoring Sites Located in Potential EJ Areas

DEC Region	AIRS #	DEC #	Site Name	County	Location
2	36-005-0080	7094-05	Morrisania II	Bronx	Family Care Ctr, 1225-57 Gerard Ave
2	36-005-0083	7094-06	NYBG Pfizer Lab	Bronx	200th St. & Southern Blvd.
2	36-005-0110	7094-07	IS 52	Bronx	681 Kelly St., E 156th St.
2	36-005-0112	7094-08	IS 74	Bronx	730 Bryant Avenue
2	36-047-0052	7095-07	PS 314	Kings	330 59th St.
2	36-047-0118	7095-98	PS 274	Kings	800 Bushwick Ave
2	36-061-0079	7093-08	JHS 45	New York	2351 1st Avenue
2	36-061-0115	7093-15	IS 143	New York	511 W 182nd St.
2	36-061-0128	7093-21	PS 19	New York	185 1st Avenue
2	36-061-0134	7093-24	Division Street	New York	Division Street

DEC Region	AIRS #	DEC #	Site Name	County	Location
2	36-061-0135	7093-25	CCNY	New York	160 Convent Avenue
2	36-081-0120	7096-13	Maspeth Library	Queens	69-70 Grand Avenue
2	36-081-0124	7096-15	Queens College II	Queens	NYSDEC Monitoring Building
2	36-085-0067	7097-01	Susan Wagner	Richmond	1200 Manor Road (near Brielle Ave)
2	36-085-0055	7097-03	Port Richmond	Richmond	364 Port Richmond Avenue
3	36-071-0002	3502-04	Newburgh	Orange	Public Safety Building
4	36-001-0005	0101-13	Albany	Albany	Albany County Health Department
4	36-001-0012	0101-33	Loudonville	Albany	Reservoir
6	36-065-2001	3202-01	Utica	Oneida	Utica Health Dept
9	36-029-0005	1401-18	Buffalo	Erie	Off Dingens St., near Weiss

Sensitive Sub-Populations

Children, the elderly, and people with underlying health issues may be more susceptible to the deleterious effects associated with air pollution, and are considered to be under the sensitive sub-populations category. Sixteen monitoring sites in the network are located on public school grounds, where attending students are of grade school to high school age.

Citizens groups often approach the Department to request studies in areas where they believe there are high incidences of health related problems due to air pollution, such as asthma, respiratory diseases, and cancer clusters. Where possible we try to accommodate concerned citizens by providing air quality data from nearby monitoring sites. For example, data from IS 143 has been provided to the Lower Washington Heights Neighborhood Association. We have established special purpose monitors in the Peace Bridge area, as well as in Albany in response to community concerns.

Air Quality in New York State

Statewide concentration trends for all criteria contaminants are provided in the pollutant specific discussion below. Other than ozone, there has been no contravention of the NAAQS for all other criteria pollutants in the entire state since the last network assessment. Therefore, considerations are given here for ozone only.

The Air Quality Index (AQI) is an index for reporting daily air quality. It was created as an easy way to correlate levels of different pollutants to one scale to show the public how clean or polluted the air is, and what associated health effects might be of concern. When levels of ozone and/or fine particles are expected to exceed an AQI value of 100, an Air Quality Health Advisory is issued alerting sensitive groups to take necessary precautions.

As an alternative to using the actual pollutant concentrations, one can assess air quality by using the number of AQI days that are unhealthy for sensitive groups (AQI>100) as a metric. The following table shows the number of unhealthy AQI days for ozone during the last three years based on the current NAAQS. Also listed is the three-year average, which serves to lessen the influence of year-to-year variations in meteorology.

Table 3. Days AQI>100 for Ozone Based on 24-hr Monitoring Data

MSA/Micropolitan Site	Days O_3 AQI>100 (24-hr)			3-year average
	2012	2013	2014	
New York-White Plains				
CCNY	2	0	1	1
Pfizer Lab	4	1	2	2.3
IS 52	--	0	1	0.7
Queens College	8	2	1	3.7
Susan Wagner	6	1	3	3.3
White Plains	4	2	3	3
Mt. Ninham	1	0	0	0.3
Rockland	4	1	0	1.7
Buffalo-Niagara Falls				
Amherst	7	1	0	2.7
Middleport	6	0	0	2
Nassau-Suffolk				
Babylon	9	1	0	3.3
Holtsville	5	3	1	3
Riverhead	6	6	0	4
Albany-Schenectady-Troy				
Loudonville	2	0	0	0.7
Stillwater	0	0	0	0
Utica-Rome				
Nicks Lake	0	0	0	0
Syracuse				
East Syracuse	1	0	0	0.3
Fulton	1	0	0	0.3
Poughkeepsie-Newburgh-Middletown				
Millbrook	2	0	0	0.7
Valley Central	0	0	0	0
Rochester				
Rochester	2	0	0	0.7

Williamson	2	0	1	1
Watertown-Fort Drum				
Perch River	5	0	1	2
Jamestown-Dunkirk-Fredonia				
Dunkirk	8	1	0	3
Corning				
Pinnacle State Park	0	0	0	0
Essex County				
Whiteface Summit	4	0	0	1.3
Whiteface Base	0	0	0	0
Hamilton County				
Piseco Lake	2	0	0	0.7

The three-year average number in Table 3 is a good indicator of the severity of ozone pollution in the monitored area. It appears that ground level ozone pollution in the Northeast has improved over the past three years as demonstrated by the number of violation days shown in Table 4 below.

Table 4. Days with Ozone Violation in Northeastern States

	Number of Violation Days		
State	**2012**	**2013**	**2014**
Connecticut	27	18	8
Delaware	21	2	3
District of Columbia	11	0	1
Maryland	30	9	5
Massachusetts	17	6	0
New Jersey	23	10	3
New York	20	10	5
Pennsylvania	32	11	7
Rhode Island	11	7	0

National Ambient Air Quality Standards

EPA is required to set National Ambient Air Quality Standards (NAAQS) for wide-spread pollutants from numerous and diverse sources considered harmful to public health and the environment. The Clean Air Act established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against visibility impairment, damage to animals, crops, vegetation, and

buildings. The Clean Air Act requires periodic review of the science upon which the standards are based and the standards themselves. Listed in Table 5 below are the NAAQS for six principal pollutants, which are called "criteria" pollutants. Monitoring data from our networks are used for comparison against these standards to determine attainment classifications.

Table 5. National Ambient Air Quality Standards

Pollutant		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide		primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead		primary and secondary	Rolling 3-month average	0.15 µg/m^3 (1)	Not to be exceeded
Nitrogen Dioxide		primary	1-hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	Annual	53 ppb (2)	Annual Mean
Ozone		primary and secondary	8-hour	0.075 ppm (3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution	$PM_{2.5}$	primary	Annual	12 µg/m^3	annual mean, averaged over 3 years
		secondary	Annual	15 µg/m^3	annual mean, averaged over 3 years
		primary and secondary	24-hour	35 µg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide		primary	1-hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

(1) Final rule signed October 15, 2008. The 1978 lead standard (1.5 µg/m3 as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

(2) The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

(3) Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.

(4) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO_2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

Except for ozone, all other criteria contaminants meet the NAAQS in New York State. Although not yet finalized, the EPA intends to designate the New York-Northern New Jersey-Long Island, NY-NJ-PA Metropolitan Statistical Area, and the Jamestown-Dunkirk-Fredonia, NY Micropolitan Area as non-attainment for the 2008 ozone standard based on monitoring data from 2008 to 2010.

Table 6. Intended Nonattainment Area Designations for 8-hr Ozone (2008 -2010 Data)

Nonattainment Area	Counties
New York-Northern New Jersey-Long Island	Bronx, Kings, Nassau, New York, Queens, Richmond, Rockland, Suffolk, Westchester
Jamestown-Dunkirk-Fredonia	Chautauqua

Ozone Attainment Classification Updated with Most Current Data

Based on 3 years of monitoring data ending December 2014, against the current 8-hr standard of 0.75 ppm, the design values for ozone sites are provided Table 7 below.

Table 7. 2014 Design Values for New York Ozone Sites

MSA/Micropolitan Site	Annual 8-hr 4th Maximum, ppm			Design Value 3-year average
	2012	2013	2014	
New York-White Plains				
CCNY	0.074	0.064	0.065	0.065
Pfizer Lab	0.076	0.068	0.070	0.071
IS 52	--	0.071	0.071	--
Queens College	0.082	0.071	0.063	0.072
Susan Wagner	0.078	0.071	0.072	0.073
White Plains	0.079	0.072	0.074	0.075
Mt. Ninham	0.069	0.067	0.066	0.067
Rockland	0.079	0.069	0.068	0.072
Buffalo-Niagara Falls				
Amherst	0.079	0.071	0.063	0.071
Middleport	0.082	0.065	0.061	0.069
Nassau-Suffolk				
Babylon	0.083	0.072	0.066	0.073

MSA/Micropolitan Site	Annual 8-hr 4th Maximum, ppm			Design Value 3-year average
	2012	2013	2014	
Nassau-Suffolk (cont.)				
Holtsville	0.083	0.078	0.064	0.075
Riverhead	0.079	0.074	0.062	0.071
Albany-Schenectady-Troy				
Loudonville	0.073	0.064	0.061	0.066
Stillwater	0.068	0.062	0.061	0.063
Utica-Rome				
Nicks Lake	0.065	0.061	0.057	0.061
Syracuse				
East Syracuse	0.074	0.065	0.063	0.067
Fulton	0.073	0.063	0.058	0.064
Poughkeepsie-Newburgh-Middletown				
Millbrook	0.075	0.065	0.068	0.069
Valley Central	0.065	0.057	0.062	0.061
Rochester				
Rochester	0.075	0.064	0.058	0.065
Williamson	0.072	0.066	0.064	0.067
Watertown-Fort Drum				
Perch River	0.077	0.066	0.059	0.067
Jamestown-Dunkirk-Fredonia				
Dunkirk	0.081	0.066	0.066	0.071
Corning				
Pinnacle State Park	0.066	0.061	0.058	0.061
Essex County				
Whiteface Summit	0.082	0.065	0.062	0.069
Whiteface Base	0.071	0.063	0.065	0.066
Hamilton County				
Piseco Lake	0.070	0.063	0.058	0.063

Consideration of Meteorological Conditions

Wind data in the form of wind roses for multiple years of hourly data from the NYSDEC air monitoring sites were examined and compared to similar plots for nearby National Weather Service (NWS) weather observation sites. Many of our air monitoring sites are not in ideal locations for measuring wind, since they are sometimes subject to effects from obstructions. However, examination of these plots indicates that for most monitors there is general agreement between the NYSDEC sites and the NWS sites.

In the New York City/Long Island/Lower Hudson Valley metropolitan area, northwesterly and southerly winds are the most common. The frequency of northeast and southeast winds varies with location relative to the Atlantic Ocean and Long Island Sound, due to the localized sea breezes.

In the Poughkeepsie/Newburgh area, data from two NWS sites and our Millbrook monitor are in agreement that most of the stronger winds are either from the SW to W or NNW to NNE. Light winds are especially common in this area, and the directions of the light winds vary extensively with location. The Millbrook monitor site frequently records light SE winds, while the directions of the light winds at Poughkeepsie are more variable.

In the Albany area, agreement is good between the NWS site at Albany International Airport and the NYSDEC monitor sites. In the Hudson Valley, winds from the S to SSE and from the NW quadrant predominate, with very little in the way of SW or E winds

In the Buffalo area, good agreement is seen between the wind roses from the NWS sites and the NYSDEC monitoring sites. Southwesterly winds prevail throughout the area, with secondary maximum directions showing variation depending on the site's location relative to the lakeshores.

Wind data from the NYSDEC's monitor site in Chautauqua County at Dunkirk match up well with those from the NWS site at Dunkirk.

NYSDEC meteorologists regularly use a wide variety of sources for important upper air information and other real-time meteorological data, including stagnation data, for use in forecasting and SIP decision making. They include the following, among many others:

- NOAA/NWS/NCEP Model Analyses and Forecasts website
- NOAA Air Resources Lab READY website
- NOAA Air Quality Forecast Guidance
- Proprietary air quality modeling done by a contractor for a consortium of states
- Environment Canada cloud forecasts
- University at Albany Meteorology website

During the three-year period, there appeared to be a steady decrease in the frequency of high-ozone days. This is due in part to year-to-year variability of weather conditions. However, the

NYSDEC air quality forecasters have noted the effects of reduced emissions as well. There were many days when, based on past experience over the years, ozone levels would have been expected to be significantly higher than they turned out. This trend toward fewer exceedances of the ozone standard had already been noted by 2012, and studies have shown that it is a significant trend when looking at long enough time periods to filter out meteorological variability.

Wind rose analysis was performed comparing average winds throughout the ozone season with winds on high-ozone days. In the New York Metropolitan Area, winds from the southwest predominate on days when the level of the ozone standard is exceeded.

Ozone Nonattainment Areas

1. NYC Metro Area

Weather data were examined for the dates of all ozone NAAQS exceedances in the NYC area for 2012-2014. The data showed the patterns that have come to be recognized over the years as being conducive to high ozone. Local wind circulation patterns, particularly those related to sea breezes, show influences on the timing and location of high ozone within the metro area. Seasonal and day-to-day differences in these circulations cause the highest ozone levels to occur in different places within the area on different days. When synoptic-scale winds are weak, and thus sea-breeze circulations are the strongest, they sometimes push the polluted air completely out of NYC Metro area by late afternoon, and the highest ozone levels may occur at White Plains. The highest 8-hour ozone in New York City during the three-year period occurred on Staten Island on August 27, 2014, a day when the synoptic-scale wind was light westerly. The sea breeze effect competed with the westerly breeze, causing converging winds over Staten Island. This caused polluted air to be transported into that area from both the west and the east, resulting in an 8-hour average ozone level of 100 ppb at the Susan Wagner monitor site. Meanwhile, the other monitors within New York City remained below 75 ppb for a maximum 8-hour average that day. The White Plains monitor had a maximum 8-hour average of 78 ppb. It appears that most of the variability in ozone levels within the metro area is explained by mesoscale, rather than microscale, wind patterns. The monitoring network currently in place is deemed sufficient to give the air quality forecasters a reasonably good idea of what is happening on a mesoscale level.

2. Chautauqua County

All but one of the ozone exceedances at the Dunkirk monitor site during the three-year period were in 2012. The wind roses from the NWS site at Dunkirk were compared for ozone exceedance days in 2012 and all ozone-season days for 2012-2014. In both cases, winds from the SSW dominate. The main difference seen between the exceedance days and all season days is that winds on the high ozone days tend to be lighter. To investigate further, NOAA's HYSPLIT model was used to plot 48-hour back trajectories ending in the late afternoon of the 2012 ozone exceedance days. Inspection of those trajectories shows that they vary, but have certain things in common – the air masses mostly traveled over high emission areas of Ohio, Michigan, and in some cases southern Ontario or Erie, Pennsylvania area before arriving in New York. Also, they have a strong tendency to have traveled over the waters of Lake Erie just before arriving at Dunkirk. The boundary layer over the cool lake waters is much shallower, and thus concentrates ozone and precursors near the surface as they approach Chautauqua County. The back trajectory

plots provide a clear illustration that ozone exceedances in Chautauqua County are largely, if not entirely, caused by the transport of ozone and precursors from outside of New York.

Emissions Inventories

Emissions inventories are the basis for numerous efforts including trends analysis, regional and local scale air quality modeling, regulatory impact assessments, and human exposure modeling. In general emissions arise from the following source categories:

- Point sources – Point sources are large, stationary (non-mobile), identifiable sources of emissions that release pollutants into the atmosphere.
- Area sources - Area sources collectively represent individual sources that have not been inventoried as specific point, mobile, or biogenic sources. These individual sources are typically too small, numerous, or difficult to inventory using the methods for the other classes of sources.
- Mobile source (on-road and off-road) – A motor vehicle, non-road engine or non-road vehicle.
- Biogenic sources (natural) – Biogenic emissions are all pollutants emitted from non-anthropogenic sources.

Accurate accounting of emissions inventory is vital in the development of pollution reduction strategies. It also supports the selection of proper site locations for the intended monitoring objectives.

Tables 8 through 10 below are compiled from EPA's National Emission Inventory database showing emissions for various pollutants in New York and upwind states. The inventory is updated every three years. The 2014 database is still under preparation. Here PMcon and VOC denote condensable particulate matter and volatile organic compounds, respectively.

Table 8. 2008 Summary of Emissions (tons/yr) for Selected States

State	CO	NH_3	NO_x	PM_{10}	$PM_{2.5}$	PM_{10} CON	$PM_{2.5}$ CON	SO_2	VOC
Delaware	157497	13975	43619	16468	2445	5149	4456	44286	55797
Maryland	960441	38867	208423	70748	12949	24859	22923	264698	299896
Michigan	2538959	71418	642618	375045	66629	57144	55825	415688	993769
New Jersey	1191061	19993	246724	48399	7450	23927	21132	44512	352824
New York	2679183	50749	449822	270008	45517	55659	48041	193758	854786
Ohio	2787466	96689	757134	472546	84570	96785	92979	877161	732168
Pennsylvania	2265472	79778	625002	281136	61605	73428	85253	987855	857620
Virginia	1841868	51149	384342	150894	31009	46485	41147	202080	1072087
West Virginia	629914	16002	217997	99453	18292	46073	42853	350251	430847

Table 9. 2011 Summary of Emissions (tons/yr) for Selected States

State	CO	NH_3	NO_x	PM_{10}	$PM_{2.5}$	PM_{10} CON	$PM_{2.5}$ CON	SO_2	VOC
Delaware	127571	5784	30378	11685	2534	3509	3121	13891	45797
Maryland	772295	26894	168928	58970	16016	18625	15087	71945	263570
Michigan	2182070	65902	461298	354032	60293	67994	62523	273632	939089
New Jersey	950805	8331	169922	30436	11019	20977	16181	18008	288138
New York	1995767	51521	397316	229079	42271	62271	52004	115001	801213
Ohio	2735840	105763	603111	376293	77413	91764	81458	680421	754168
Pennsylvania	1969471	81078	573331	215407	55920	59863	54694	398659	822530
Virginia	1361785	52584	324501	152329	32148	44660	38708	107821	1075075
West Virginia	521868	12084	177603	101275	20366	23230	20841	122785	516981

The difference between 2008 and 2011 is tabulated in Table 10.

Table 10. Difference (2008-2011) of Emissions (tons/yr) for Selected States

State	CO	NH_3	NO_x	PM_{10}	$PM_{2.5}$	PM_{10} CON	$PM_{2.5}$ CON	SO_2	VOC
Delaware	29926	8191	13241	4783	-89	1639	1335	30395	10000
Maryland	188147	11973	39494	11779	-3067	6235	7836	192753	36326
Michigan	356890	5516	181320	21012	6336	-10851	-6698	142056	54679
New Jersey	240257	11662	76802	17963	-3569	2951	4951	26503	64687
New York	683416	-772	52506	40929	3246	-6612	-3964	78757	53572
Ohio	51627	-9074	154023	96253	7157	5022	11521	196740	-22000
Pennsylvania	296001	-1300	51672	65729	5685	13565	30558	589196	35090
Virginia	480083	-1436	59840	-1435	-1139	1824	2440	94259	-2988
West Virginia	108047	3918	40395	-1823	-2074	22843	22012	227466	-86134

The change of emissions for all listed pollutants is charted in Figure 5, from which it is evident that New York State achieved the most reduction in CO as compared to other states. Federal and New York State cap and trade regulations have proved effective in significantly controlling NO_x and SO_2 emissions. Further reduction in SO_2 is expected through the July 1, 2012 amendments to the New York State Environmental Conservation Law (ECL), which require that all number two heating oil sold for use in residential, commercial or industrial heating within New York State must have a sulfur content of 15 ppm or less.

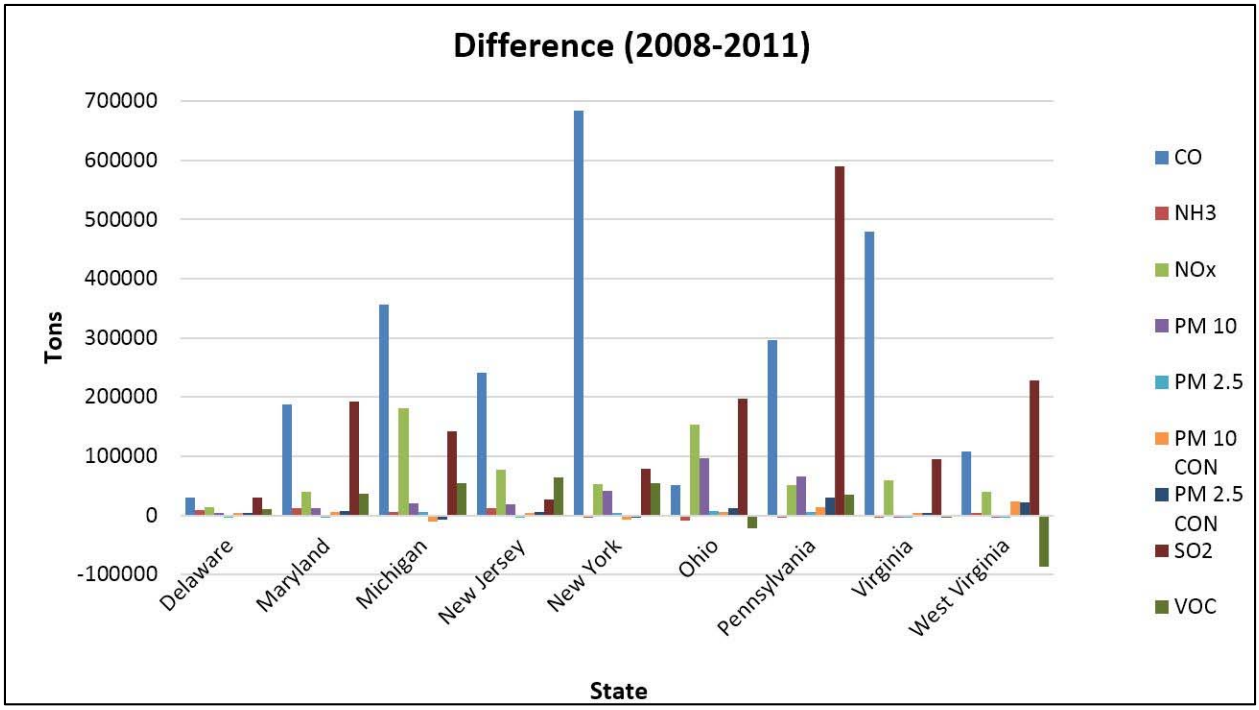


Figure 5. Difference (2008-2011) of Emissions (tons/yr) for Selected States

Pollutant Specific Discussion

Ozone

Currently, the minimum number of ozone monitors required in an MSA ranges from zero (for an area with a population of at least 50,000 and under 350,000 and no recent history of an ozone design value greater than 85 percent of the level of the NAAQS) to four (for an area with a population greater than 10 million and an ozone design value greater than 85 percent of the level of the NAAQS). A design value is a statistic that describes the air quality status of a given area relative to the level of the NAAQS. Design values are especially helpful when the standard is exceedance-based (e.g. 24-hour $PM_{2.5}$) because they are expressed as a concentration instead of an exceedance count, thereby allowing a direct comparison to the level of the standard. Because these requirements apply at the MSA level, large urban areas consisting of multiple MSAs can be required to have more than four monitors.

MSA population[1,2]	Most recent 3-year design value concentrations ≥85% of any O_3 NAAQS[3]	Most recent 3-year design value concentrations <85% of any O_3 NAAQS[3,4]
>10 million	4	2
4 - 10 million	3	1
350,000 - <4 million	2	1
50,000 - <350,000[5]	1	0

[1] Minimum monitoring requirements apply to the Metropolitan Statistical Area (MSA).
[2] Population based on latest available census figures.
[3] The ozone (O_3) National Ambient Air Quality Standards (NAAQS) levels and forms are defined in 40 CFR part 50.
[4] These minimum monitoring requirements apply in the absence of a design value.
[5] Metropolitan Statistical Areas (MSA) must contain an urbanized area of 50,000 or more population.

Figure 6 shows the trend line for the current 8-hr standard.

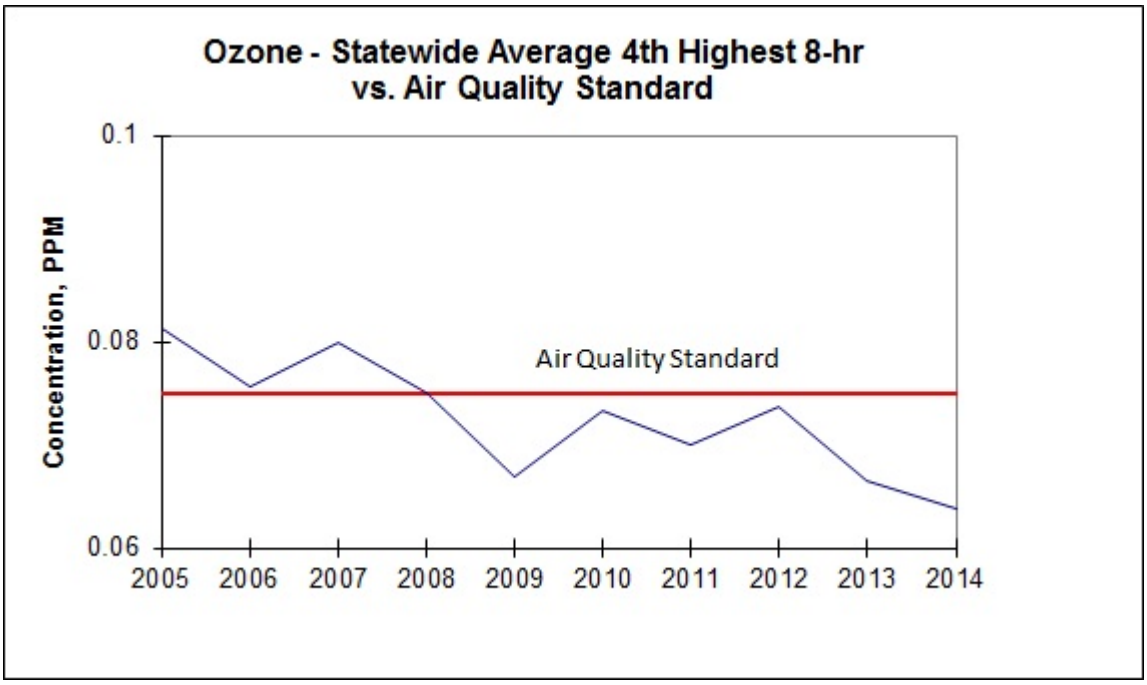


Figure 6. Statewide Trend for Annual 8-hr Ozone Levels

Since the 2010 assessment, the ozone network has contracted by five monitors. Table 11 below lists each monitoring site, county, and the intended attainment status designated by the EPA based on three years' data from 2008-20010, against the 8-hr standard of 0.075 ppm, as well as the 2012-2014 design value. A location map of ozone sites is shown in Figure 7.

Table 11. Listing of Site Locations and Attainment Status for the Ozone Network

Site	**County**	**Attainment** (2008-2010) 0.075 ppm 8-hr std.	**Design Value** (2012-2014) ppm
Babylon	Suffolk	no	0.073
Holtsville	Suffolk	no	0.071
Riverhead	Suffolk	no	0.075
City College of NY (CCNY)	New York	no	0.074
Pfizer Lab	Bronx	no	0.071
IS 52	Bronx	no	0.070
Queens College	Queens	no	0.072
Susan Wagner	Richmond	no	0.073
White Plains	Westchester	no	0.075
Valley Central	Orange	no	0.061
Rockland	Rockland	no	0.072
Millbrook	Dutchess	yes	0.069
Mt. Ninham	Putnam	yes	0.067
Loudonville	Albany	yes	0.066
Stillwater	Saratoga	yes	0.063
Whiteface Summit	Essex	yes	0.069
Whiteface Base Lodge	Essex	yes	0.066
Piseco Lake	Hamilton	yes	0.063
Perch River	Jefferson	yes	0.067
Nicks Lake	Herkimer	yes	0.061
East Syracuse	Onondaga	yes	0.067
Fulton	Oswego	yes	0.064
Rochester	Monroe	yes	0.065
Williamson	Wayne	yes	0.067
Pinnacle State Park	Steuben	yes	0.061
Dunkirk	Chautauqua	no	0.071
Amherst	Erie	yes	0.071
Middleport	Niagara	yes	0.069

It is expected that ozone standards will be lowered to between 0.065 to 0.070 ppm later this year. If 0.065 ppm is adopted, it is likely that most MSAs in New York State will be in non-attainment status.

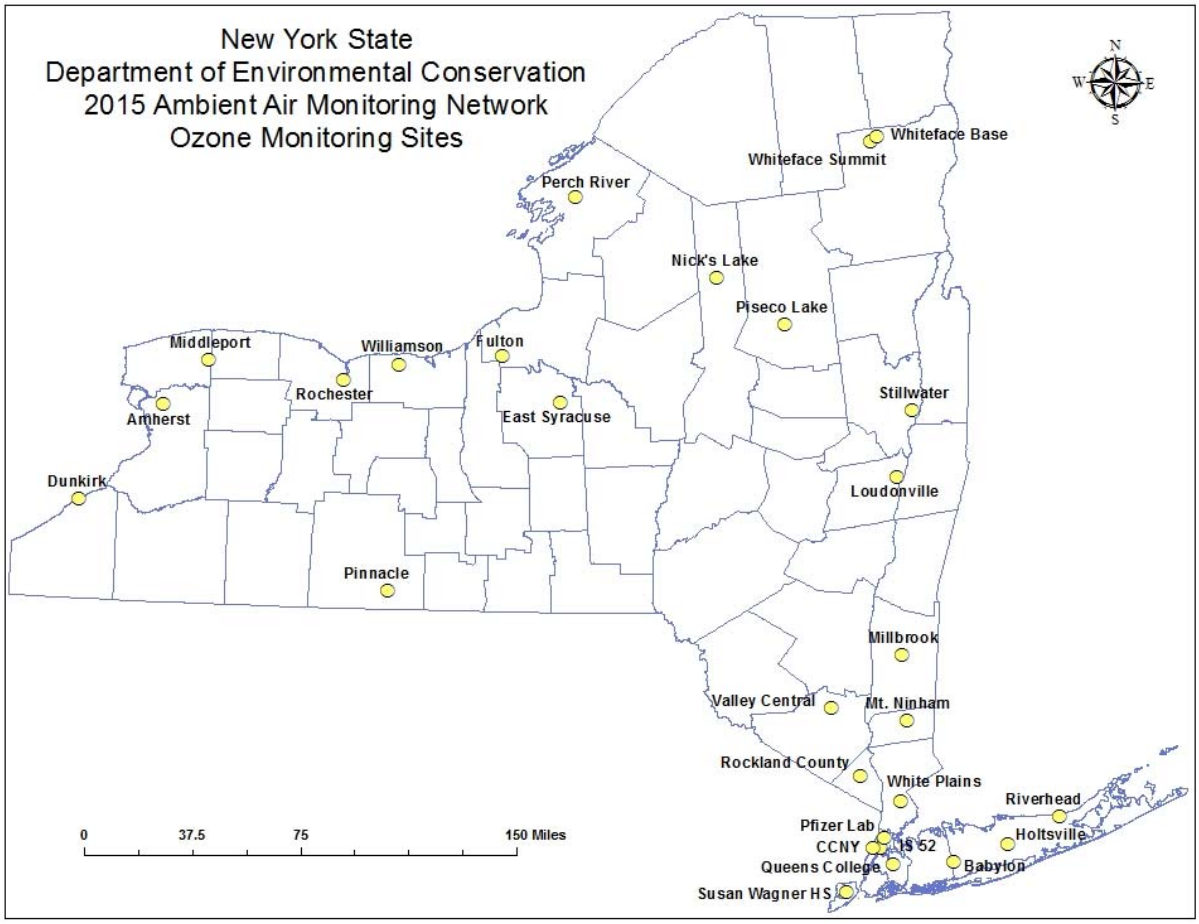


Figure 7. Location Map of Ozone Monitoring Sites in New York State

The current network has 28 monitors sited at various locations statewide in order to meet the monitoring objectives specified in Appendix D to Part 58.

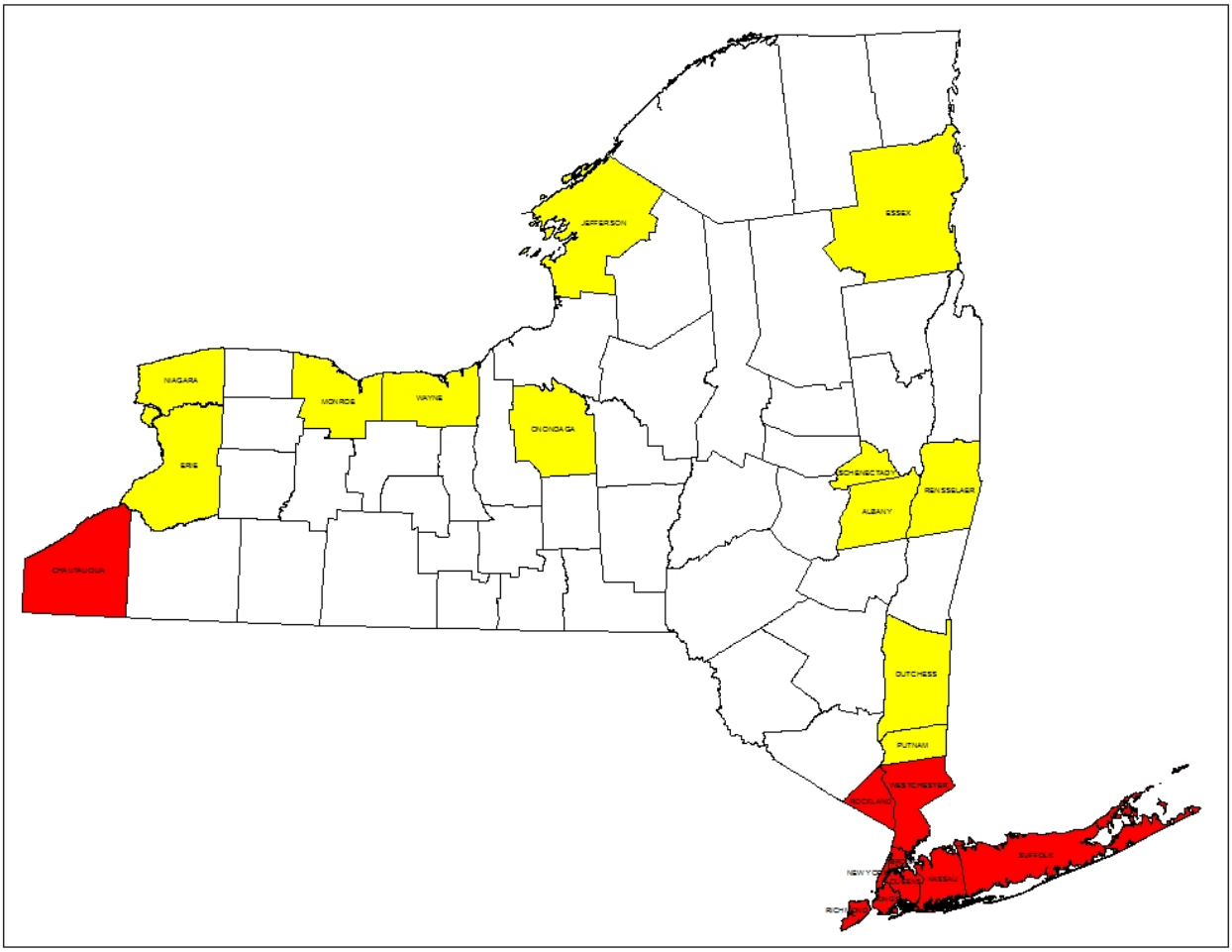


Figure 8. Counties Projected as Ozone Non-Attainment Areas

Although the latest 3 years' data show all monitors to be in attainment with the current 0.075 ppm standard, such will not be the case when the new standards are finalized later this year. In Figure 8, counties shown in red are projected to be in non-attainment if 0.070 ppm is adopted, and additionally, counties in yellow will fall under the same classification if the standard is lowered further to 0.065 ppm.

Fine Particulate Matter ($PM_{2.5}$)

A historic trend of the statewide annual $PM_{2.5}$ levels is presented in Figure 9 below. The annual NAAQS for $PM_{2.5}$ is set at 12 $\mu g/m^3$, while the 24-hr standard is 35 $\mu g/m^3$. Based on the most current three consecutive years of monitoring data 2012-2014, it appears that all areas in the State are in attainment status.

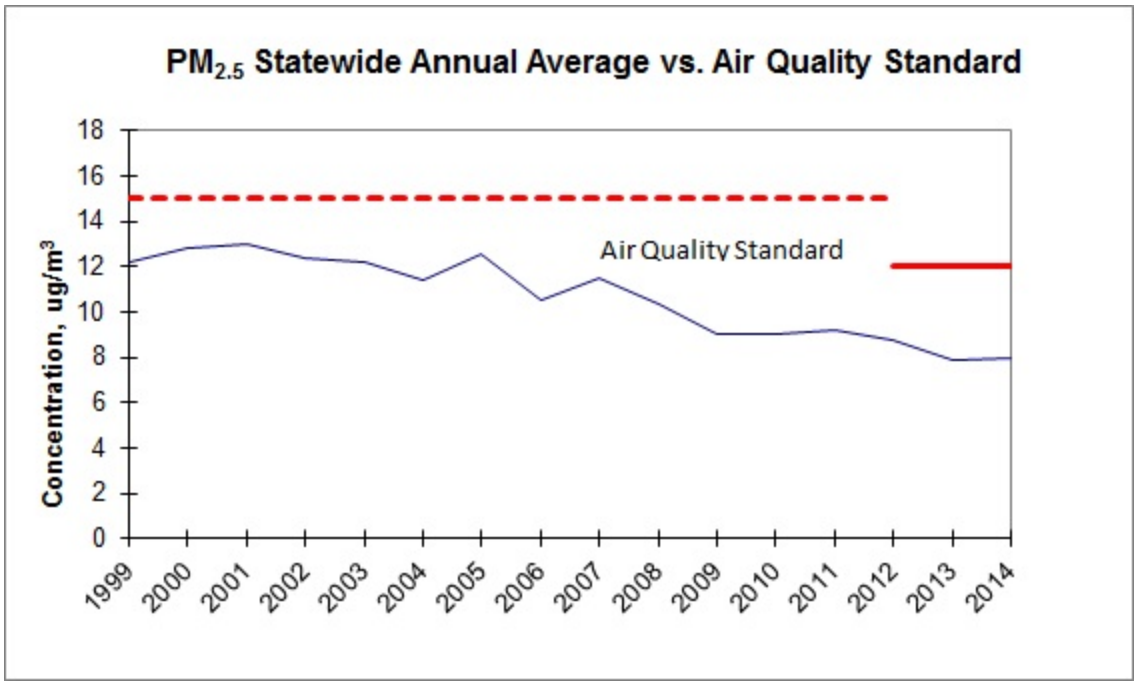


Figure 9. Statewide Trend for $PM_{2.5}$ Annual Averages

The EPA has designated the State of New York as being in attainment for the 2012 $PM_{2.5}$ standards based on 2011-2013 monitoring data. Table 12 below lists each FRM site, county, and the 2012-2014 design values for the annual and 24-hr standards. As mentioned above, only the FRM data are used for attainment determination. The continuous $PM_{2.5}$ network complements the FRM network and provides data for AIRNow and AQI forecasting. Location maps of $PM_{2.5}$ FRM and TEOM monitors are shown in Figures 10, 11 and 12, respectively.

Table12. Listing of Site Locations and Attainment Status for $PM_{2.5}$ Networks

Site	FRM	TEOM	County	Design Value ('12-'14) µg/m³	
				annual	24-hr
Eisenhower Park		✓	Nassau	n/a	n/a
Babylon	✓		Suffolk	7.7	20
Holtsville		✓	Suffolk	n/a	n/a
Morrisania II		✓	Bronx	n/a	n/a
NY Botanical Garden	✓	✓	Bronx	9.3	26
IS 52	✓	✓	Bronx	10.5	24
IS 74		✓	Bronx	n/a	n/a
JHS 126	✓		Kings	9.3	22
PS 314		✓	Kings	n/a	n/a
PS 274		✓	Kings	n/a	n/a
JHS 45	✓		New York	8.8	22
PS 19	✓	✓	New York	11.2†	26†
Division Street	✓	✓	New York	10.1	23
IS 143		✓	New York	n/a	n/a

Site	FRM	TEOM	County	Design Value ('12-'14) µg/m^3	
				annual	24-hr
City College of NY		✓	New York	n/a	n/a
Queens College	✓	✓	Queens	8.2	22
Maspeth Library		✓	Queens	n/a	n/a
Port Richmond	✓		Richmond	8.6	19
Fresh Kills West		✓	Richmond	n/a	n/a
White Plains		✓	Westchester	n/a	n/a
Newburgh	✓	✓	Orange	7.4	20
Rockland		✓	Rockland	n/a	n/a
Albany	✓	✓	Albany	7.3	19
Loudonville	✓		Albany	6.6	17
Whiteface Base	✓	✓	Essex	4.1†	13†
Utica		✓	Oneida	n/a	n/a
E. Syracuse	✓	✓	Onondaga	6.8	16
Rochester	✓	✓	Monroe	7.7	18
Rochester Near-Road	✓	✓	Monroe	--	--
Pinnacle State Park	✓	✓	Steuben	6.2	16
Dunkirk	✓		Chautauqua	7.7†	17†
Amherst	✓		Erie	7.7†	17†
Buffalo	✓		Erie	8.7	21
Buffalo Near-Road	✓	✓	Erie	--	--
Tonawanda II		✓	Erie	n/a	n/a
Grand Island Blvd		✓	Erie	n/a	n/a

† data capture <75% in one quarter or more

Since 2010, there has been a reduction of 3 FRM monitors, while the total number of continuous instruments remains the same with some site closures and additions.

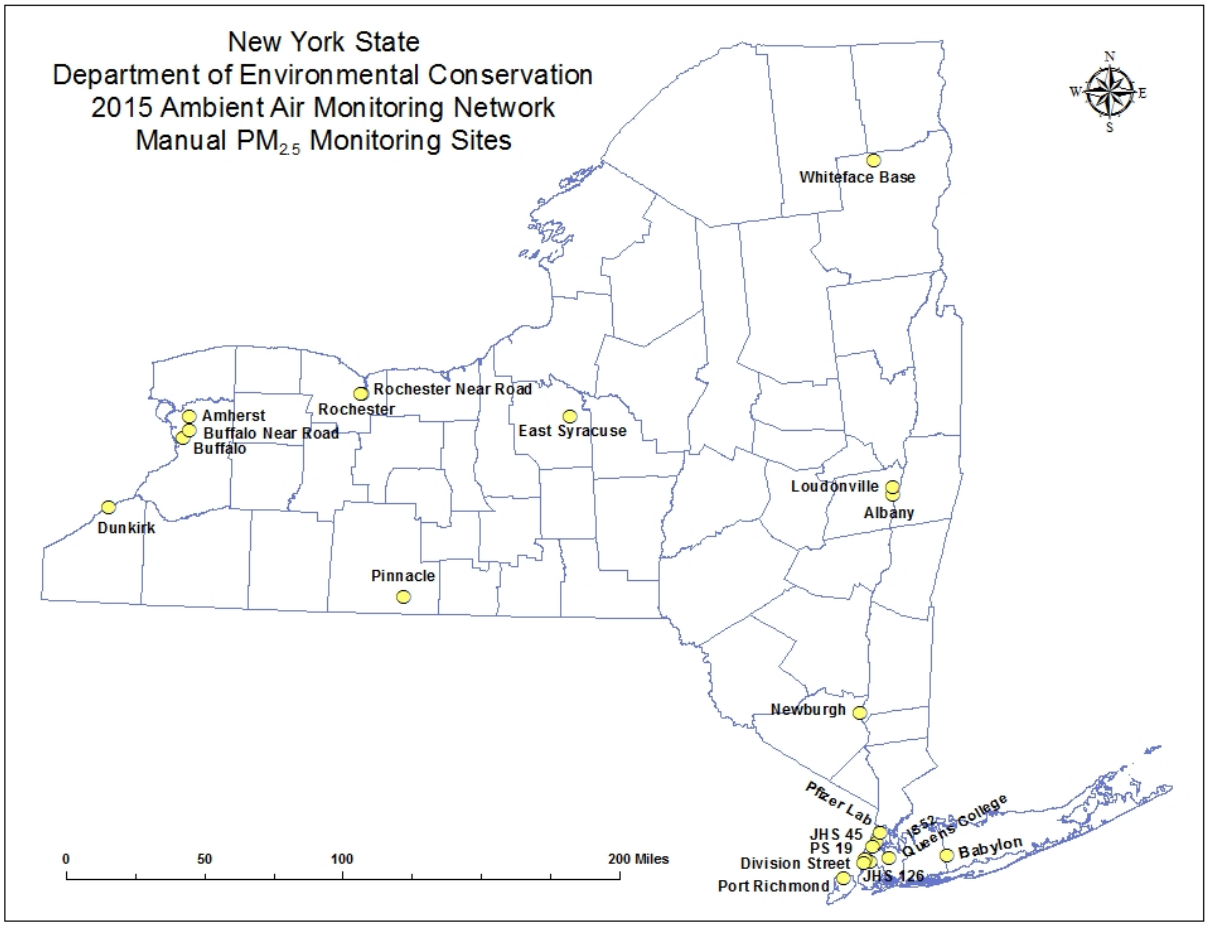


Figure 10. Location Map of Manual $PM_{2.5}$ (FRM) Monitoring Sites Outside of NYC

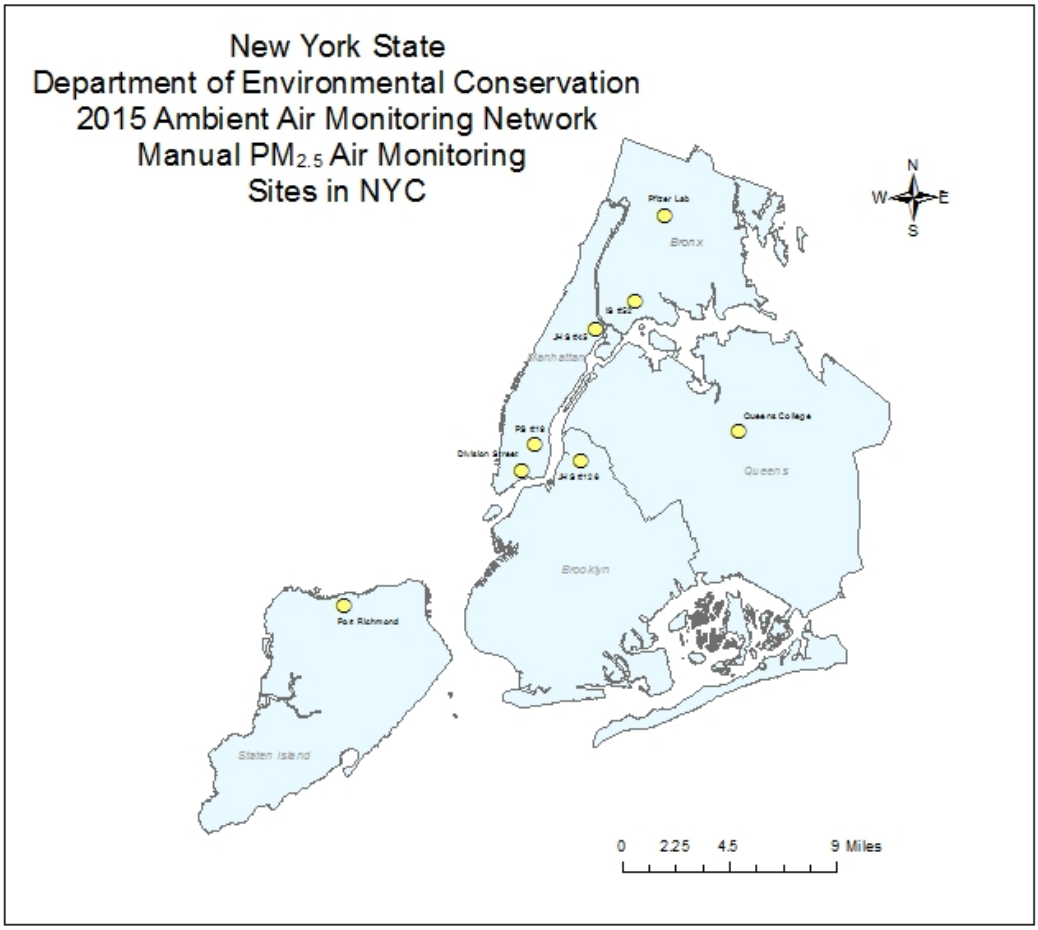


Figure 11. Location Map of Manual $PM_{2.5}$ (FRM) Monitoring Sites in New York City

For $PM_{2.5}$ currently there are 21 FRM monitors in the manual network, and 28 sites in the continuous network.

The NYSDEC utilizes standard $PM_{2.5}$ TEOMs to provide data for near real-time reporting and forecasting purposes. These instruments are less expensive and easier to operate than the newer TEOMs that are designed to capture the semi-volatile components of $PM_{2.5}$. This data is adjusted on-site via a non-linear equation in the site data logger. The equation uses the historical regional correlation between filter based measurements and the TEOM and the Julian day to adjust the data to more closely emulate filter based measurements. Five different data adjustments are used in different areas of the State. Since each adjustment is based on the variation of the comparison between filter based and continuous data over the course of a year, the day to day accuracy of the adjustment is not as good as when examined over a longer period.

Data Quality Objectives (DQOs) set forth for the comparison of the adjusted TEOM values to collocated FRM measurements are: (a) within +/- 10% total bias and (b) above 0.9 for correlation (0.81 r^2). These DQOs are met when considering data collected over the course of a year. Our approach, however, does not accurately predict the day to day variability between the filter based and continuous instruments. Our adjustment method cannot account for individual meteorological events or the

component mix found in air masses at each monitoring site thus the data adjustment is less accurate for individual sample days.

The NYSDEC also operates some of the newest continuous mass monitors which have undergone Federal Equivalent Method (FEM) designation. These instruments collect more of the volatile PM mass that the filter based FRM may or may not retain depending on the environmental conditions during and after the period in which the filter sample was collected. The Department has been evaluating the technological improvements that have led to the current $PM_{2.5}$ continuous FEMs for more than 10 years. The Thermo Scientific 1405-DF FEM performed better than the other instruments in on-site deployments at urban and rural locations in the state. Currently, there are five 1405-DF's deployed (IS 52, Queens College, East Syracuse, Rochester, and Pinnacle State Park) to simultaneously measure $PM_{2.5}$, PM Coarse (PM_{10} - $PM_{2.5}$) and PM_{10} mass concentrations. After multiple iterations of revisions and updates from the manufacturer, these DF's can finally produce data that compare well with the FRM's. Therefore, the hourly data are now submitted to AQS with the parameter code 88101, a designation that will include these measurements for attainment status determination.

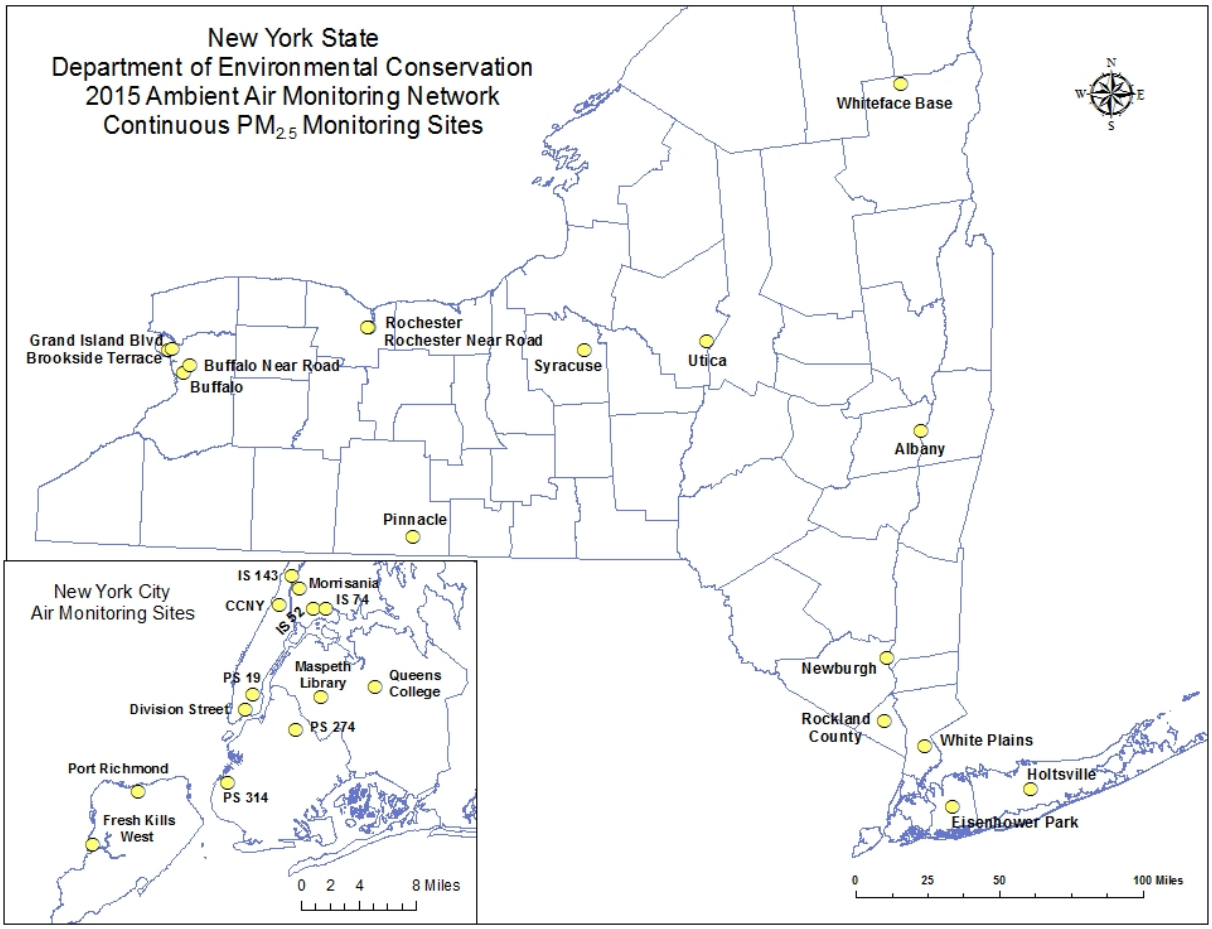


Figure 12. Site Location Map of Continuous $PM_{2.5}$ (TEOM) Monitoring Network

Inhalable Particulate (PM_{10})

A historic trend of the statewide annual PM_{10} levels is presented in Figure 13 below. The 24-hr NAAQS for PM_{10} is set at 150 µg/m^3.

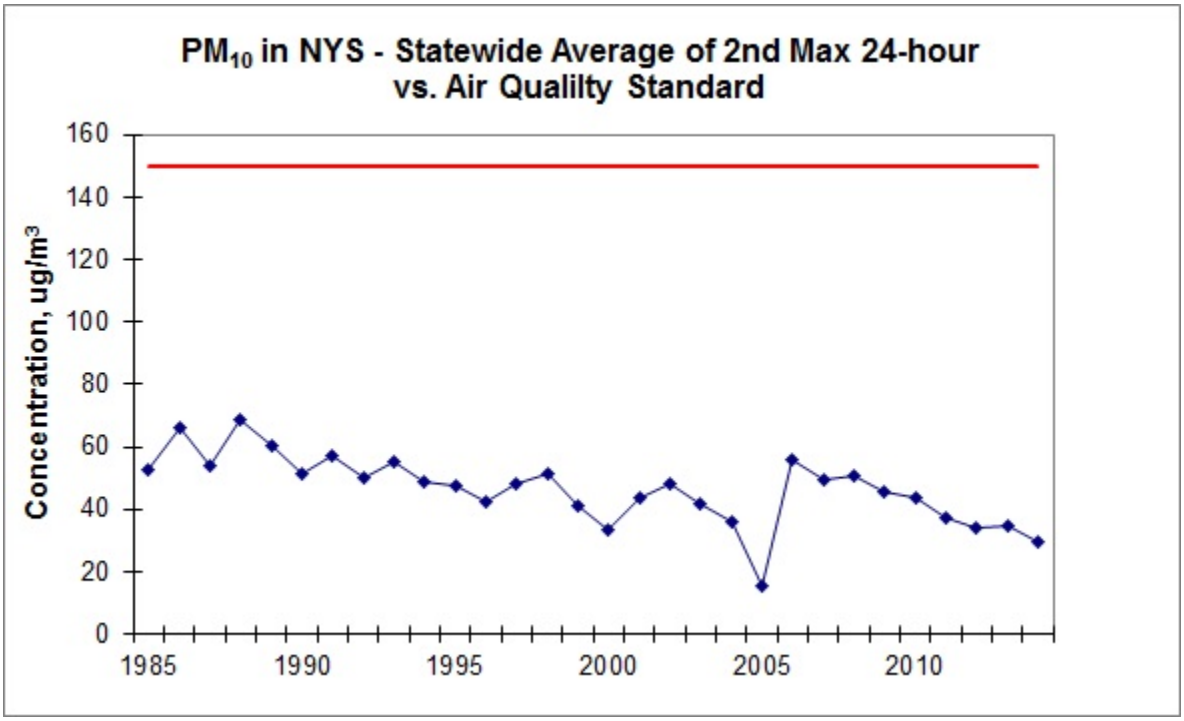


Figure 13. Statewide Annual Trend for 24-hr PM_{10} Levels

Table 13 below lists each PM_{10} site, county, and the attainment status against the 24-hr standard of 150 µg/m^3. There is a reduction of two monitors in the network compared to the last assessment five years ago.

Table 13. Listing of Site Locations and Attainment Status for the FRM PM_{10} Network

Site	County	Attainment
Division Street	New York	yes
IS 52†	Bronx	yes
Queens College	Queens	yes
Rochester†	Monroe	yes
Buffalo	Erie	yes

†NATTS site, PM_{10} metals analysis

Figure 14 shows a location map of the low-volume PM_{10} sampling sites in the State.

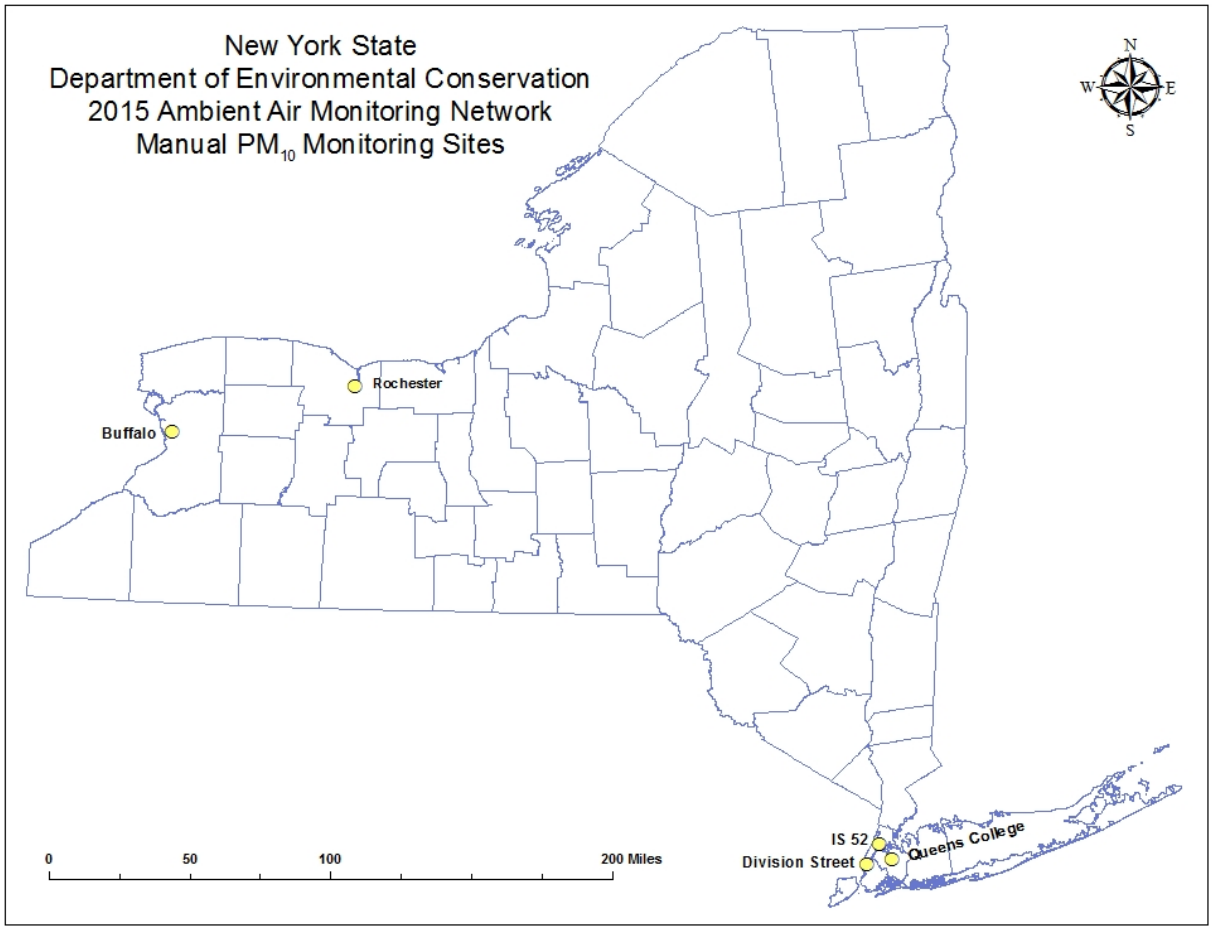


Figure 14. Site Location Map of Manual PM_{10} Monitoring Network

Chemical Speciation Network Sites

In addition to the FRM $PM_{2.5}$ mass measurement network a chemical speciation network (CSN) consisting of eight $PM_{2.5}$ sites across the State that provide a first order characterization of the metals, major ions, and carbon constituents of $PM_{2.5}$ was established as part of the monitoring requirements and principles set forth in 40 CFR Part 58, Ambient Air Quality Surveillance for Particulate Matter. Figure 15 shows a location map of the CSN sites in the State. Both the Buffalo and Whiteface Base sites have a one day in six sampling frequency, while the remainder of the sites have one in three day measurements. Albany switched to one day in six in February 2015.

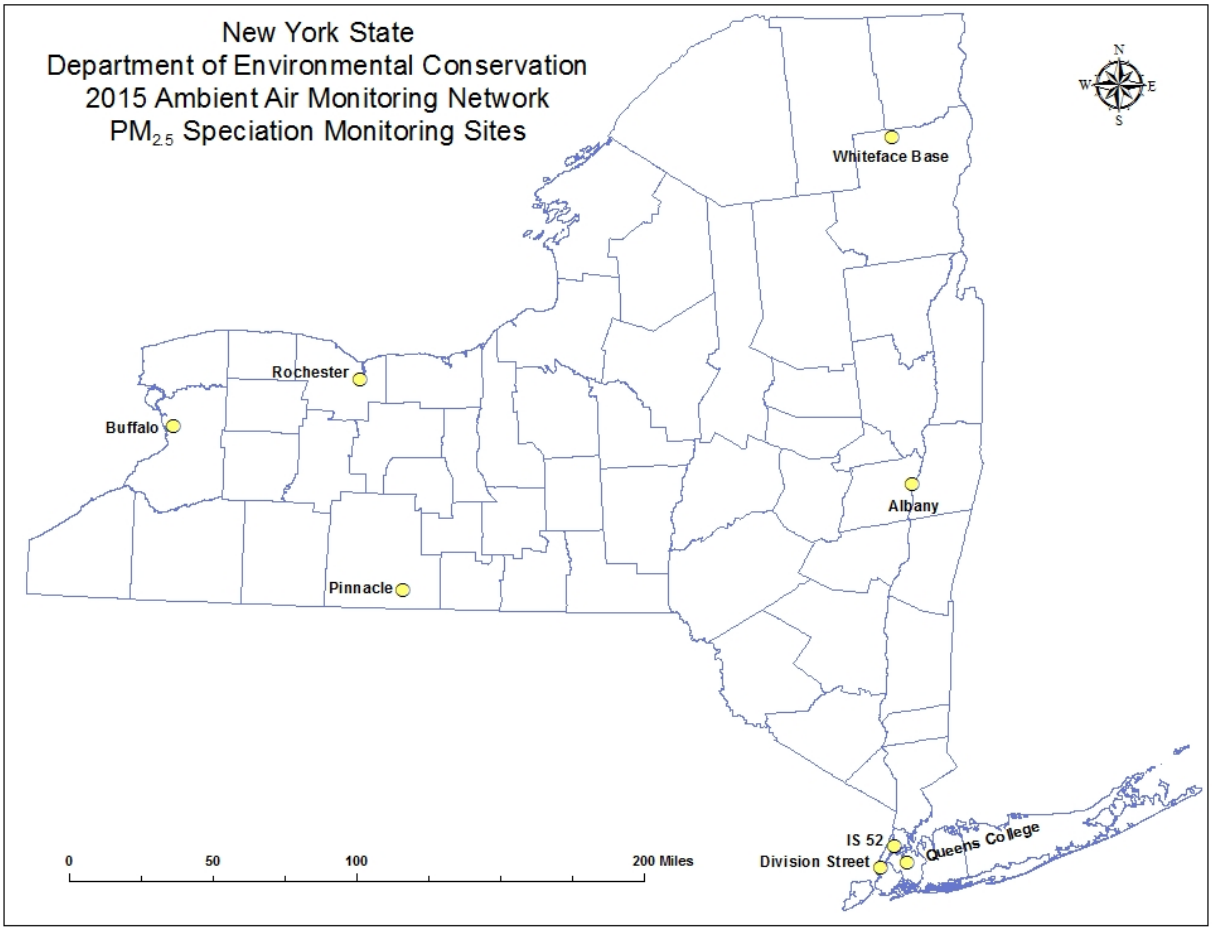


Figure 15. Site Location Map of $PM_{2.5}$ Chemical Speciation Monitoring Network

The $PM_{2.5}$ annual standard design value site in the NY Core Based Statistical Area (CBSA) was a site that was closed due to construction activity (PS 59). The building was substantially modified by the new construction and no longer met siting criteria. The site was replaced by Division St (36-061-0134) which has an FRM, a CSN and a continuous $PM_{2.5}$ instrument. The NY CBSA also has a CSN sampler in both the Bronx (IS52) and Queens (Queens College) which help determine the spatial gradient of components of $PM_{2.5}$ across the CBSA. The sites in Queens and the Bronx have suitable interior space and are hosting continuous speciation samplers as well as complementary gas species analyzers. This higher temporally resolved $PM_{2.5}$ speciation data adds tremendous value to the 24h integrated filter based CSN data. The NY CBSA 24-hr design value site is in New Jersey. This site does not have a CSN sampler and significantly complicates the interpretation of $PM_{2.5}$ speciation data.

In order to obtain higher temporal resolution data on two major components of $PM_{2.5}$, we operate two speciated carbon monitors (IS 52 and Queens College) and four continuous sulfate instruments (IS 52, Queens College, Whiteface Base and Pinnacle State Park). The following is a brief discussion of the trends and findings, demonstrating the informational value of $PM_{2.5}$ species data collection efforts.

$PM_{2.5}$ mass

A summary of annual $PM_{2.5}$ mass covering a 15 year period of measurements across New York State are shown below. Concentrations are highest in the large urban centers of NYC and Buffalo followed by Albany and Rochester and lowest at the rural sites of Pinnacle State Park and Whiteface Base. A significant downward trend is observed throughout amounting to a 30-40% decrease in annual $PM_{2.5}$ mass across the state since 2000. In NYC a substantial improvement in air quality has occurred since 2000 when $PM_{2.5}$ mass exceeded the annual standard of 15 $\mu g/m^3$ to the present which shows $PM_{2.5}$ mass below the current standard of 12 $\mu g/m^3$.

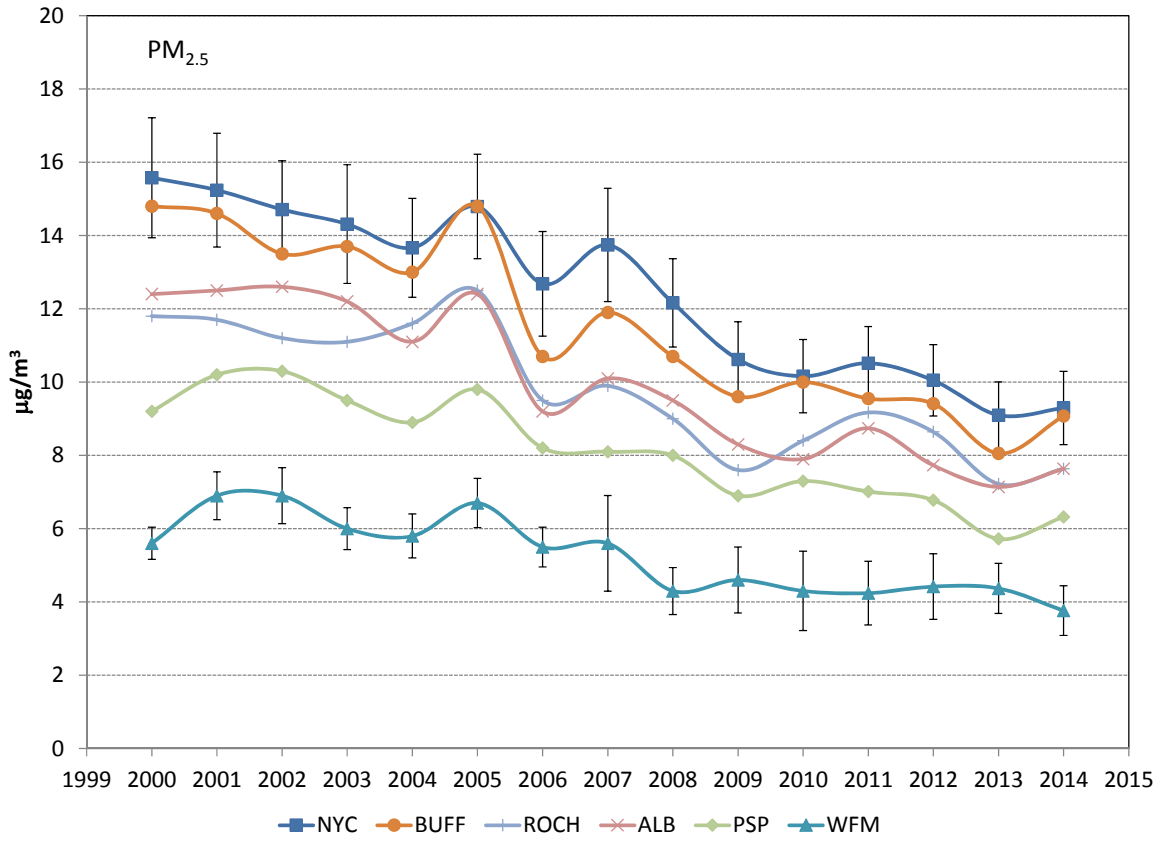


Figure 16. Annual Mean $PM_{2.5}$ Mass Across New York State*

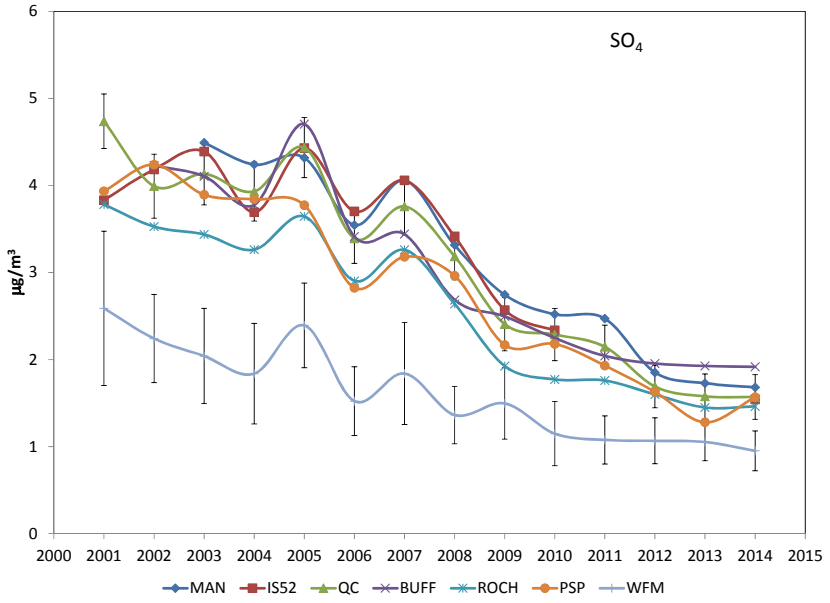
(Error bars show the 95% confidence intervals)

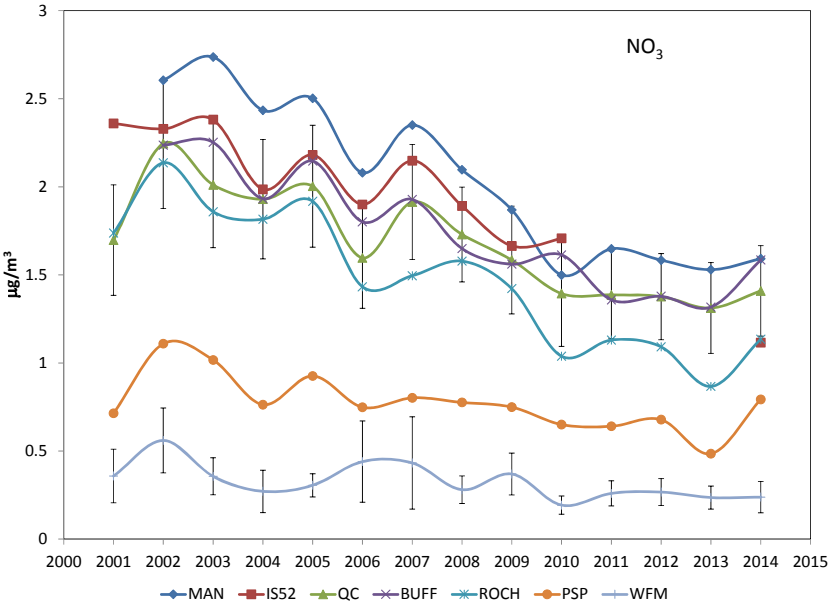
*NYC = Mean of Measurements across the 5 boroughs, Manhattan, Bronx, Queens, Brooklyn, and Staten Island. BUFF = Buffalo. Roch = Rochester. ALB = Albany. PSP = Pinnacle State Park. WFM = Whiteface Mountain Base.

Major ion species

The corresponding annual measurements of major ion species from our CSN network also shows a downward trend. Unlike $PM_{2.5}$ mass which varies across the state, particle SO_4 is relatively similar throughout with the exception of Whiteface Base which is lower in concentration by 2 $\mu g/m^3$. The similarity in SO_4 reflects its regional nature with the major source being SO_2 from coal burning Electric Power Generation Facilities which lie to the south and west of the state. As Whiteface Base lies in the northern part of the state it frequently is impacted by air from a different direction (with lower pollutant concentrations) than the other sites. Downward trends of SO_4 is observed at all sites amounting to a 50-60% reduction since 2001. Concentration appear to

have levelled off in recent years. Particle NO_3 data appear as three distinct groups with highest concentrations at urban locations and lowest at rural sites including Pinnacle State Park and Whiteface Base. Across urban sites, NO_3 is highest at Manhattan and Rochester is the lowest. Nitrate is higher in urban areas because it arises from nitrogen oxides (NO_x) whose major source is from traffic emissions. A downward trend is clearly observed at the urban sites which have higher concentrations. The decrease amounts to a 40-60% reduction since 2001. Although the decrease at rural locations appears to be lower, the percentage drop is similar. NH_4 data is also clustered with highest concentrations in urban locations and Pinnacle State Park is intermediate between the urban sites and the remote Whiteface Base site. NH_4 also shows a downward trend (50-60% reduction) most of which occurs after 2007. Particle NH_4 is usually combined with SO_4 and NO_3.





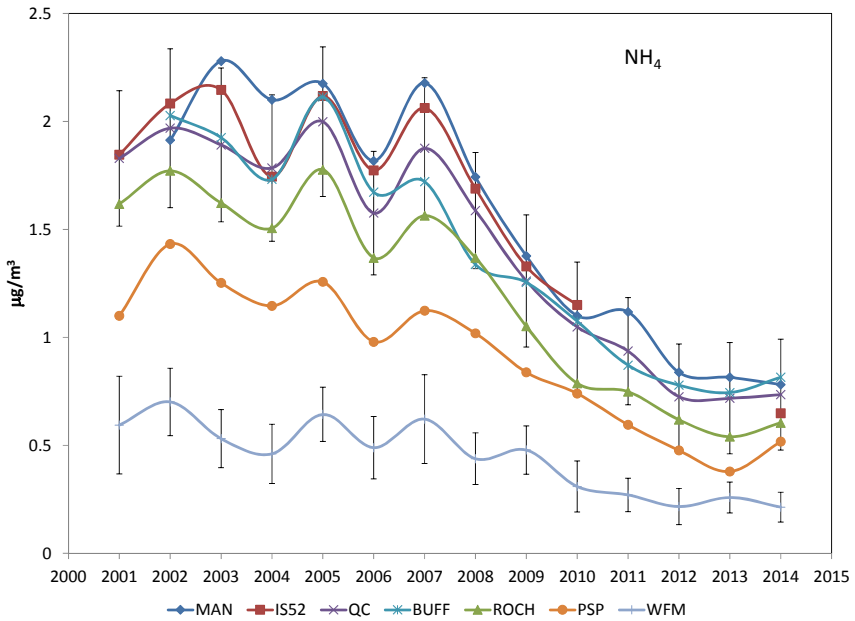


Figure 17. Annual Mean concentrations of SO_4, NO_3 and NH_4 in $PM_{2.5}$ Particles*
(Error bars show 95% confidence intervals)
*Man = Manhattan, Canal St/Division St. IS52 = Intermediate School 52, South Bronx. QC = Queens College. BUFF = Buffalo. Roch = Rochester. PSP = Pinnacle State Park. WFM = Whiteface Mountain Base.

Carbonaceous particles

The annual trends for carbon containing particles, elemental carbon (EC) and organic carbon (OC), are quite different. EC is essentially black carbon which is formed by direct emissions from fossil fuel combustion. This includes vehicles, particularly heavy duty diesels and also oil combustion boilers used for space and water heating. A large number of oil boilers in New York City use residual oils which have high emissions. Annual EC data show a large site to site variability with nearly an order of magnitude variation from the highest concentrations in NYC to the lowest at Whiteface Base. Concentrations in descending order are highest in the boroughs of Manhattan and the Bronx followed by Queens, then Buffalo and Rochester with the lowest concentrations at the rural locations. EC started to decrease around 2007-2008 with 2014 data approximately 30-35% lower than 2007-2008. The decrease coincides with the introduction of cleaner highway diesel fuel (lower S content). In addition in recent years residual oil number 6 in NYC has been replaced with distillate oil number 2 and 4 which have lower emissions. Rochester data was unusual in 2011-2012 due to an atypical coloration of the sample filters which interfered with the determination of EC for those years. There was a smaller impact on OC.

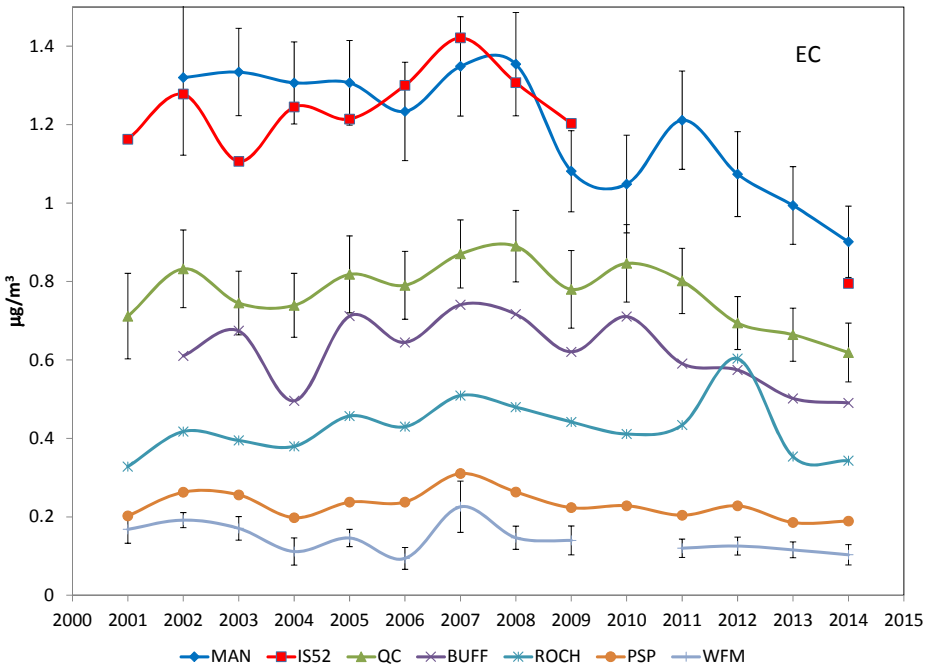


Figure 18. Annual EC Concentrations at Sites in NY*

(Error bars show 95% confidence intervals)

*Man = Manhattan, Canal St/Division St. IS52 = Intermediate School 52, South Bronx. QC = Queens College. BUFF = Buffalo. Roch = Rochester. PSP = Pinnacle State Park. WFM = Whiteface Mountain Base.

Concentrations of organic carbon (OC) are also higher at urban sites, but with less of an urban-rural contrast compared to EC. OC is highest at Manhattan and is a factor of 3-4 times higher than Whiteface Base which is the lowest. Among the urban sites, OC at Manhattan is the highest with Bronx, Queens and Buffalo 1-1.5 µg/m^3 lower and Rochester 0.5 µg/m^3 lower still. OC has a primary source from direct emissions and a secondary source from atmospheric processing of volatile organics. Therefore, concentrations can be similar in urban and rural locations (Rochester and Pinnacle State Park for example). Unlike the major ions, there is no consistent trend in OC across the sites. At NYC and Buffalo, there is no apparent trend in OC whereas at Rochester OC shows an increase up to 2008 and remains uniform afterwards. At the rural sites, concentrations show a small increasing trend, but it is not significant within the 95% confidence intervals.

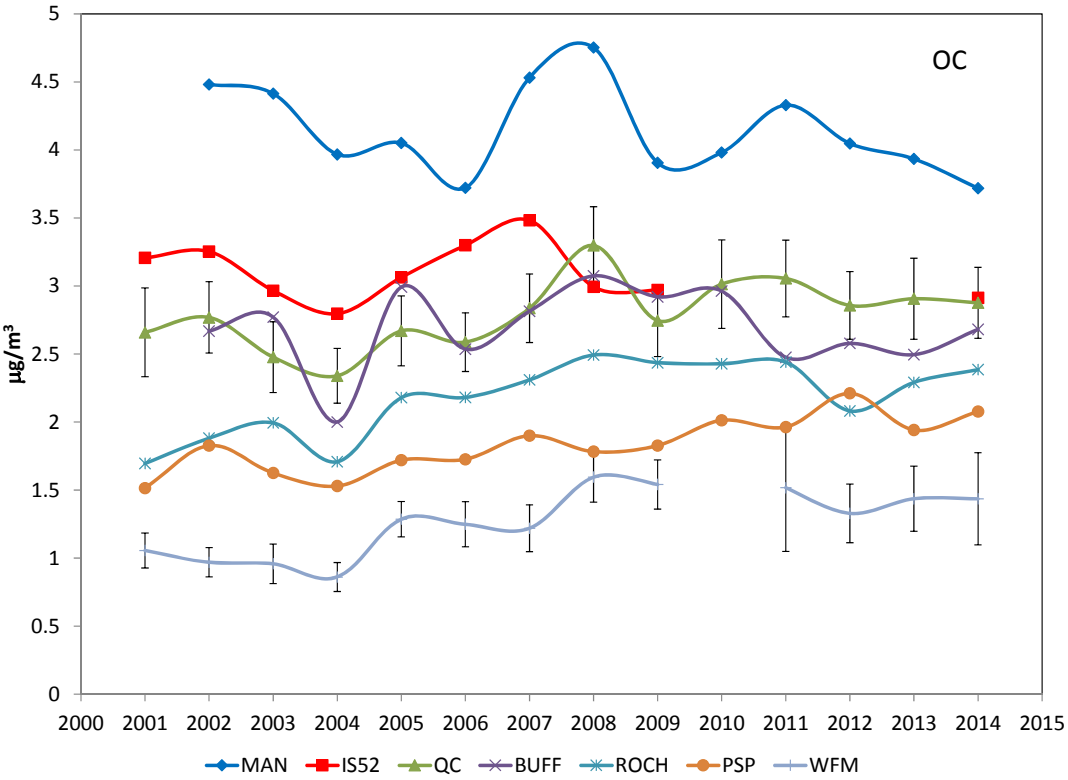


Figure 19. Annual OC Concentrations at Sites in New York State*

(Error bars are 95% confidence intervals)

*Man = Manhattan, Canal St/Division St. IS52 = Intermediate School 52, South Bronx. QC = Queens College. BUFF = Buffalo. Roch = Rochester. PSP = Pinnacle State Park. WFM = Whiteface Mountain Base.

Trace element nickel (Ni)

The annual trend for trace element Ni is shown below. Ni only shows elevated concentrations in NYC with concentrations at or below the detection limit at all other sites. The higher than average Whiteface Base 2011 Ni is due to 2 unusual days in 2011 with Ni spikes of 25 and 42 ng/m^3. Iron (Fe) and chromium (Cr) were also elevated on those dates. The filter samples may have been contaminated with stainless steel fragments from the sampling inlet. NYC annual Ni ranged from 12-20 ng/m^3 in 2001-2004 but a steady decline was observed since. By 2014 annual Ni concentrations were approximately 3 ng/m^3 amounting to a factor of 4-7 reduction. One of the major sources of Ni is residential heating oil particularly residual oil number 6, used for space and water heating in NYC[1]. A strong seasonal gradient is observed with winter Ni a factor of 2 higher than summer, reflecting the enhanced oil consumption during colder months as shown in Figure 21. NYC has required the phase out of number 6 residual oil by July 1, 2015, which has led to the large reductions in Ni.

[1]Lippmann M., 2009. Semi-continuous speciation analysis for ambient air particulate matter: An urgent need for health effects studies. *J. Expo. Sci. Environ. Epidemiol*., 19, 235-247.

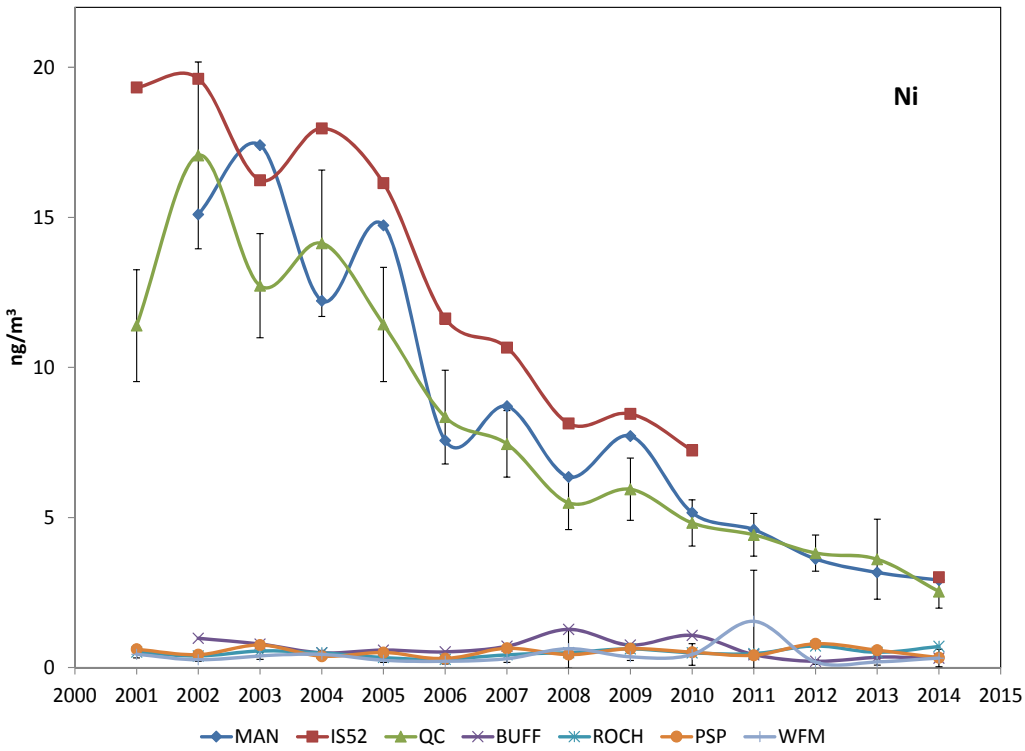


Figure 20. Annual Mean Ni Concentrations in New York State*

(Error bars show the 95% confidence intervals)

*Man = Manhattan, Canal St/Division St. IS52 = Intermediate School 52, South Bronx. QC = Queens College. BUFF = Buffalo. Roch = Rochester. PSP = Pinnacle State Park. WFM = Whiteface Mountain Base.

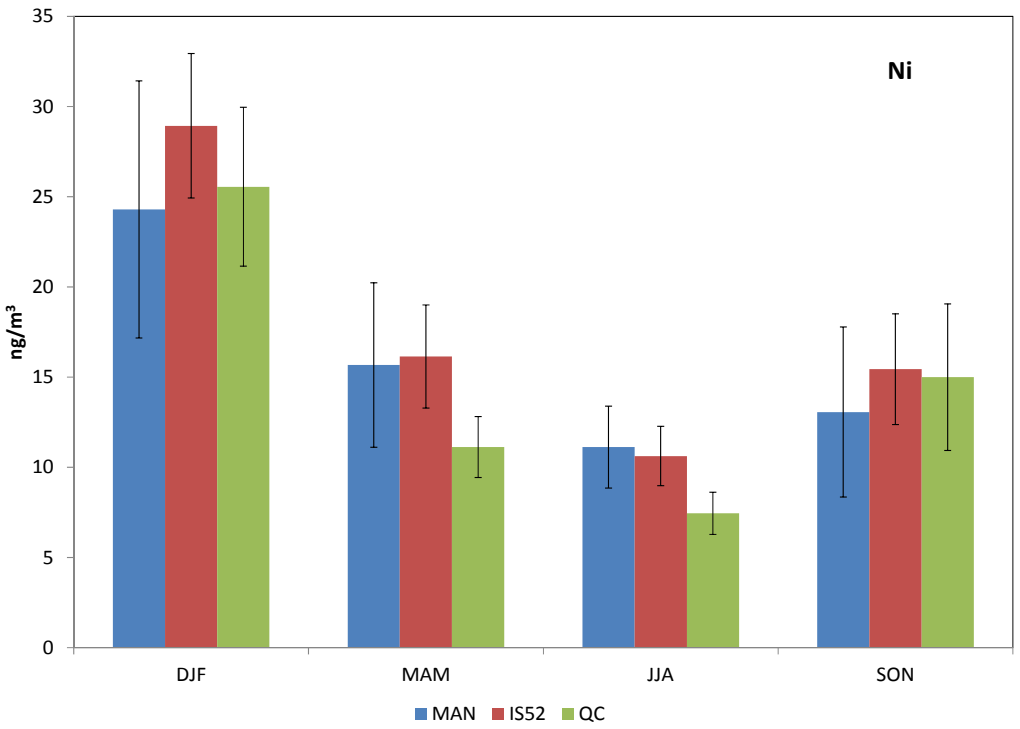


Figure 21. Mean Seasonal Ni Concentrations During 2002-2003 at NYC Sites
(Error bars show 95% confidence intervals)

Impact of PM reductions on species contribution to total $PM_{2.5}$

The impact of the pollutant reductions are shown in the species composition pie chart in Figure 22 below. This shows annual speciation data from Queens, NY for the combined years 2002-2003 versus 2012-2013. A multiplier of 1.6 was used to convert organic carbon to organic mass[2]. Metals represent the sum of soil components (coarse metal oxides) and remaining trace elements. These percentages are relative to total mass on the speciation sampler. The sum of major species is within 5% of 100%. Notice that in 2002-2003 the combined contribution of particle SO_4, NO_3 and NH_4 ions represented approximately 60% of the total mass versus 30% for organic mass. By 2012-2013 a substantial change has occurred with the major ions representing 40% compared to 45-50% for organic mass. Thus in recent years as the total $PM_{2.5}$ mass has decreased the carbonaceous fraction (OM and EC) has become the dominant component representing 50-60% of the total $PM_{2.5}$ mass.

The speciation data shows the major contributors to $PM_{2.5}$ and can help to identify likely sources. This information is very important in understanding $PM_{2.5}$ exceedances and to identify pollution control strategies that have been effective in lowering $PM_{2.5}$ levels. Further improvements in air quality may come from targeting carbonaceous emissions as this is currently the dominant PM component. A sufficiently long term data record is critical in determining if control strategies are

[2]Bae, M.S., Demerjian, K.L., Schwab, J.J., 2006. Seasonal estimation of the organic mass to organic carbon in $PM_{2.5}$ at rural and urban locations in New York State. Atmos. Environ., 40, 7467-7479.

effective in lowering PM levels because other factors such as meteorology also impact ambient pollutant concentrations.

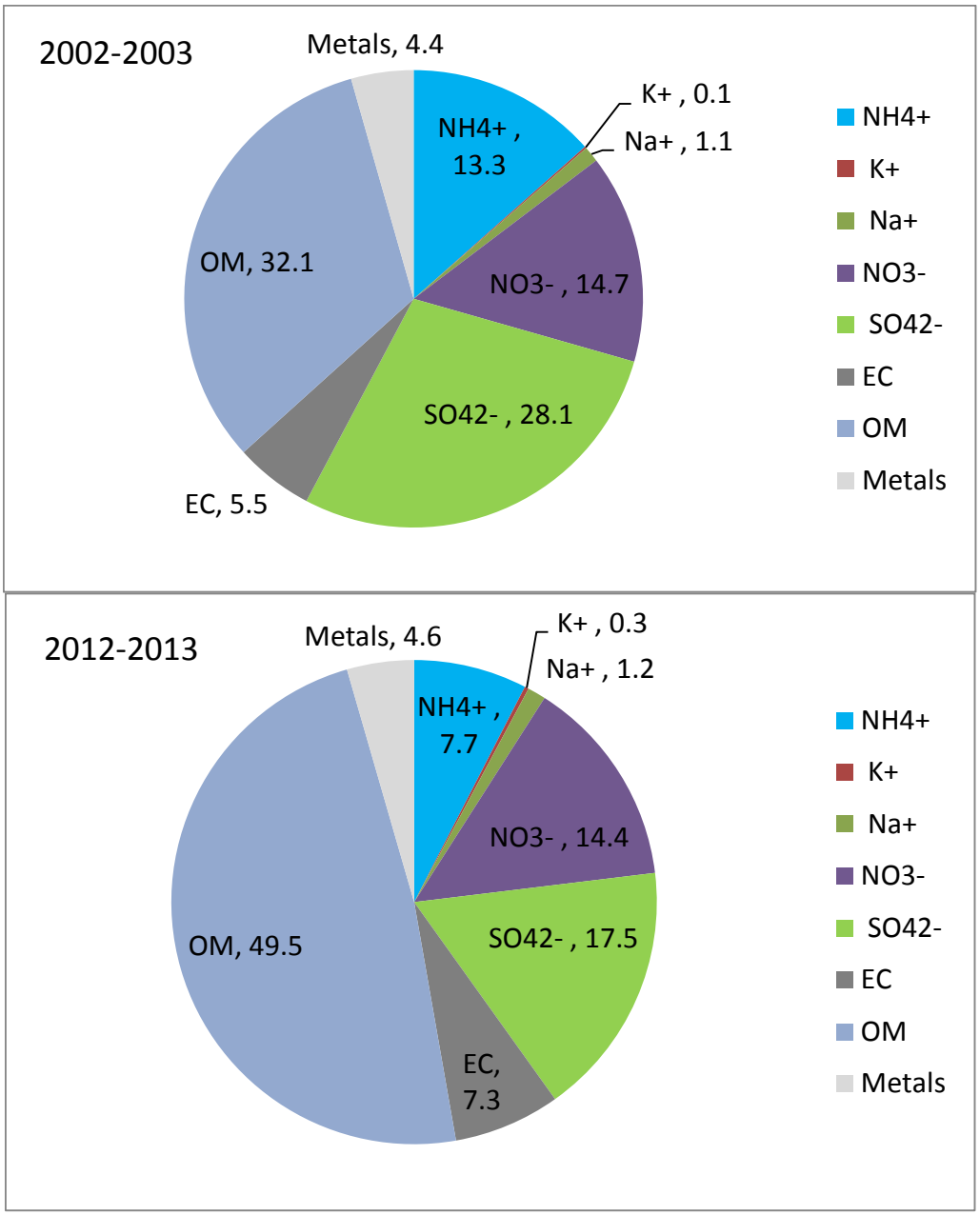


Figure 22. Species Percentage Contribution to the Total $PM_{2.5}$ Mass from the Speciation Sampler in Queens, NY in 2002-3003 vs 2012-2013

Higher time resolution data in the New York Metropolitan area such as hourly measurements of elemental carbon and organic carbon as well as aerosol sulfate and nitrate are more useful for understanding individual plume events and local source impacts. For example, the day of week pattern in elemental carbon at the South Bronx shows statistically higher concentrations during weekdays compared to weekends. This pattern is also reflected in NO_x indicating a significant mobile source contribution from nearby roadways. The weekday/weekend difference in elemental carbon and NO_x is most significant in summer months (top panel) and least noticeable in winter (bottom panel). There are additional EC emissions during cold months from space heating sources (oil boilers for example) which are not likely to exhibit a day of week pattern.

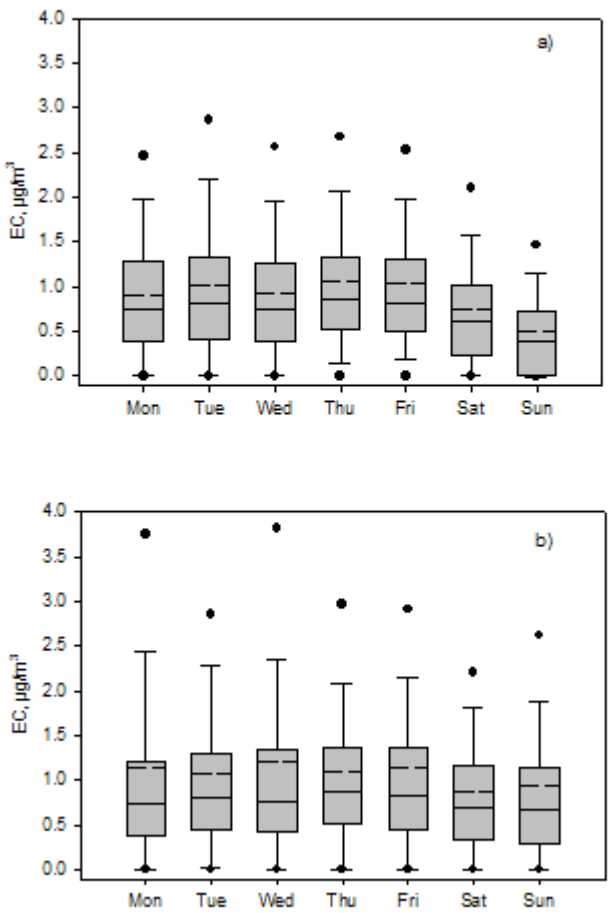


Figure 23. Day of the Week Pattern for Elemental Carbon during summer (top) and winter (bottom) in the South Bronx, NYC

The diurnal pattern for elemental carbon is similar to that of NO_x with a peak in the early morning indicative of fresh emissions into a relatively shallow boundary layer from local mobile sources during the commute period (Figure 24). Concentrations decrease in the late morning as

the boundary layer height increases and pollutants are diluted and dispersed. Concentrations rise again in the late evening because the boundary layer height decreases (concentrating pollutants) and additional emissions from space heating sources during winter months. Organic carbon sometimes shows a similar pattern in winter (top panel) because of a significant primary source contribution most likely from traffic. The organic carbon diurnal pattern is different in summer months (bottom panel) because secondary organic aerosol production is enhanced during the day as the primary component decreases resulting in a relatively flat diurnal profile. Hourly measurements indicate that secondary organic aerosol accounts for approximately 40-50% of the total organic carbon during winter and up to 63-73% of during summer months.

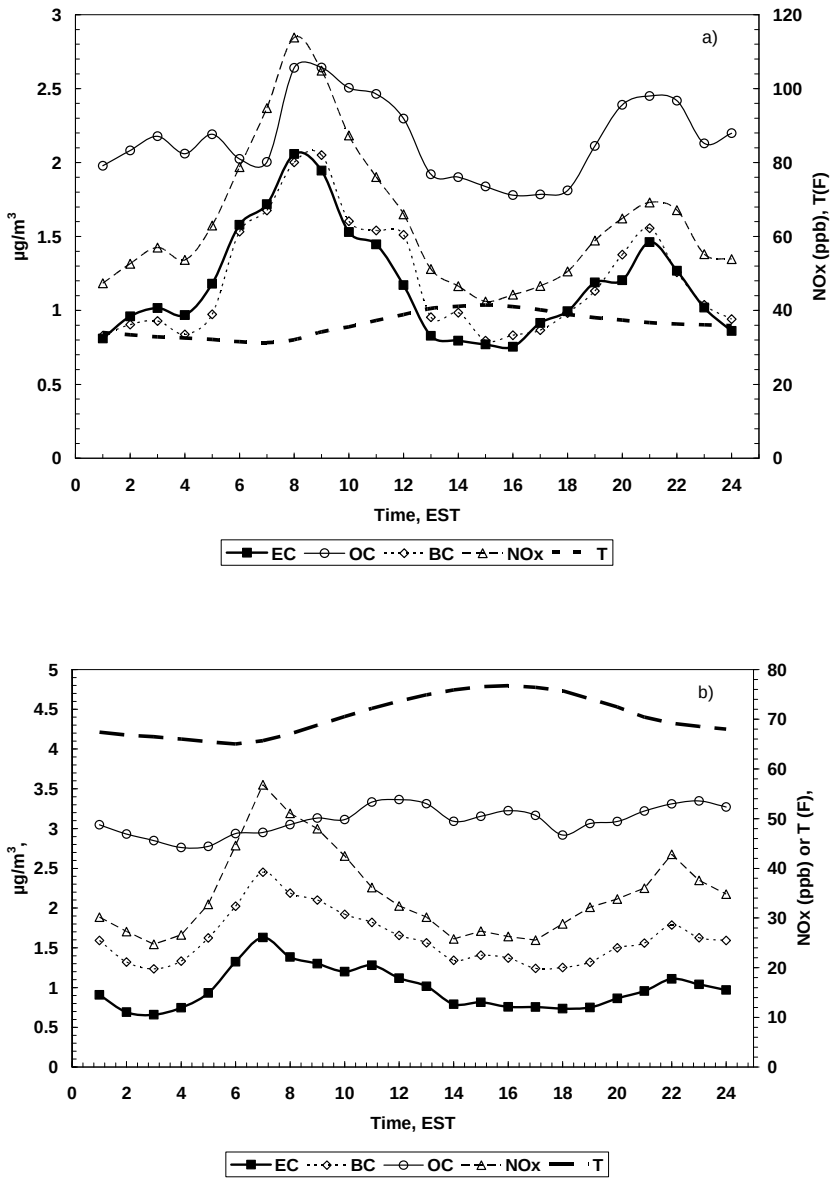


Figure 24. Diurnal Pattern for Various Parameters during winter (top) and summer (bottom) Measured in the South Bronx, NYC

Ultrafine Particulate Monitoring

The NYSDEC first began ultrafine particulate monitoring with the deployment of a TSI Model 3031 Ultrafine Particle Monitor (UPM) at Queens College in June of 2009. This instrument provides continuous measurements of size distribution and particle number concentrations of fine particles below1 micron, in the range from to 20 to 500 nanometers. The Queens College NCore site was selected for the UPM so as to complement a suite of parameters already being measured there. Concurrently a demo UPM unit on loan for one year from the manufacturer was installed at the Eisenhower Park location in Nassau County, which is expected to have a significant impact from mobile sources. Preliminary data suggest that the ultrafine particles are to a large extent regional in nature and less impacted by local mobile sources. The particle counts and size distributions for the two sites are similar, and also track the $PM_{2.5}$ profile in some cases. It is possible that the mobile signal is damped out due to the siting of the monitor, as the inlet probe height may not be optimal and there may be interference from nearby trees. In addition, a resource recovery facility located about ¼ mile west of the site, as well as other local sources (wood-fired pizza ovens, etc.) may influence the measurements. Alternate explanations may be that mobile ultrafine emissions are predominantly smaller than the 20 nanometer cut-off point or affect the measurements only on a short time scale. Data on particle size distribution and concentration will provide valuable information for the understanding of $PM_{2.5}$ formation mechanisms, as well as source apportionment determination.

There has been significant and growing interest in mobile sources and ultrafine particles. The EPA has implemented a near road monitoring program for NO_2, $PM_{2.5}$ and CO and has included additional pollutants of interest for these locations which includes ultrafines. The recent establishment of initial regulations intended to address ultrafine particle emissions from mobile sources (LEV-3 in California, Euro V-VII in the EU) is an early indicator of more extensive regulation of ultrafine particle emissions from mobile sources expected in the future, and suggests the potential emergence of regulations for ambient ultrafine particles as well.
In our Air Pollution Microscopy laboratory, three particle characterization techniques (Laser Scanning Confocal Microscopy, Scanning Electron Microscopy, and Atomic Force Microscopy) are used to investigate the morphology of real world ultrafine particles, such as those from mobile source emissions and other industrial sources. As an example, the changes in ultrafine particle morphology resulting from the use of two strategies for reducing diesel emissions, i.e., exhaust after-treatment and the use of alternative diesel fuels were studied. These activities complement the ambient monitoring data to further the understanding of the formation, distribution and transport of ultrafine particulate.

$PM_{2.5}$ Air Quality Improvements

In October, 2009, EPA issued final designations for the 2006 $PM_{2.5}$ 24-hr standards. Ten whole counties in the state: Bronx, Kings, New York, Orange, Queens, Richmond, Rockland, Westchester, Nassau, and Suffolk, were classified as non-attainment. EPA further strengthened the annual standard to 12 $\mu g/m^3$ in 2012. Based on monitoring data from 2011-2013, all of New York State is classified as being in attainment for the annual standard. The data for 2012-2014 also demonstrate attainment status for both the annual and 24-hr standards (Table 12). Implementation of policies and control strategies including new regulations contributes to the decreasing trend in the observed $PM_{2.5}$ levels. Reduction of sulfur in fuel has greatly impacted

$PM_{2.5}$ emissions in the state. In 2007, sulfur in on-road diesel fuel was lowered to 15 ppm from about 3000 ppm. Beginning in 2010, sulfur levels in most non-road diesel fuel was reduced to 15 ppm, with locomotive and marine diesel fuel to follow suit in 2012. In 2011, NYC Department of Environmental Protection amended rules for new boilers and burners to use only one of the cleanest fuels, and also to phase out the use of No. 6 oil completely by 2015. Between 2007 and 2025, emissions of sulfur dioxide (SO_2) and oxides of nitrogen (NO_x)-two of the primary precursors to particulate formation-are expected to decline by over 30 percent and 40 percent, respectively, as a result of revisions to state regulations.

Oxides of Nitrogen (NO_x)

The annual NAAQS for NO_2 is set at 53 ppb. The EPA revised the NAAQS to include an hourly standard of 100 ppb in 2010. Throughout the history of NO_2 monitoring, the annual standard has not been exceeded. The historical trend for the 1-hr standard is shown in Figure 25.

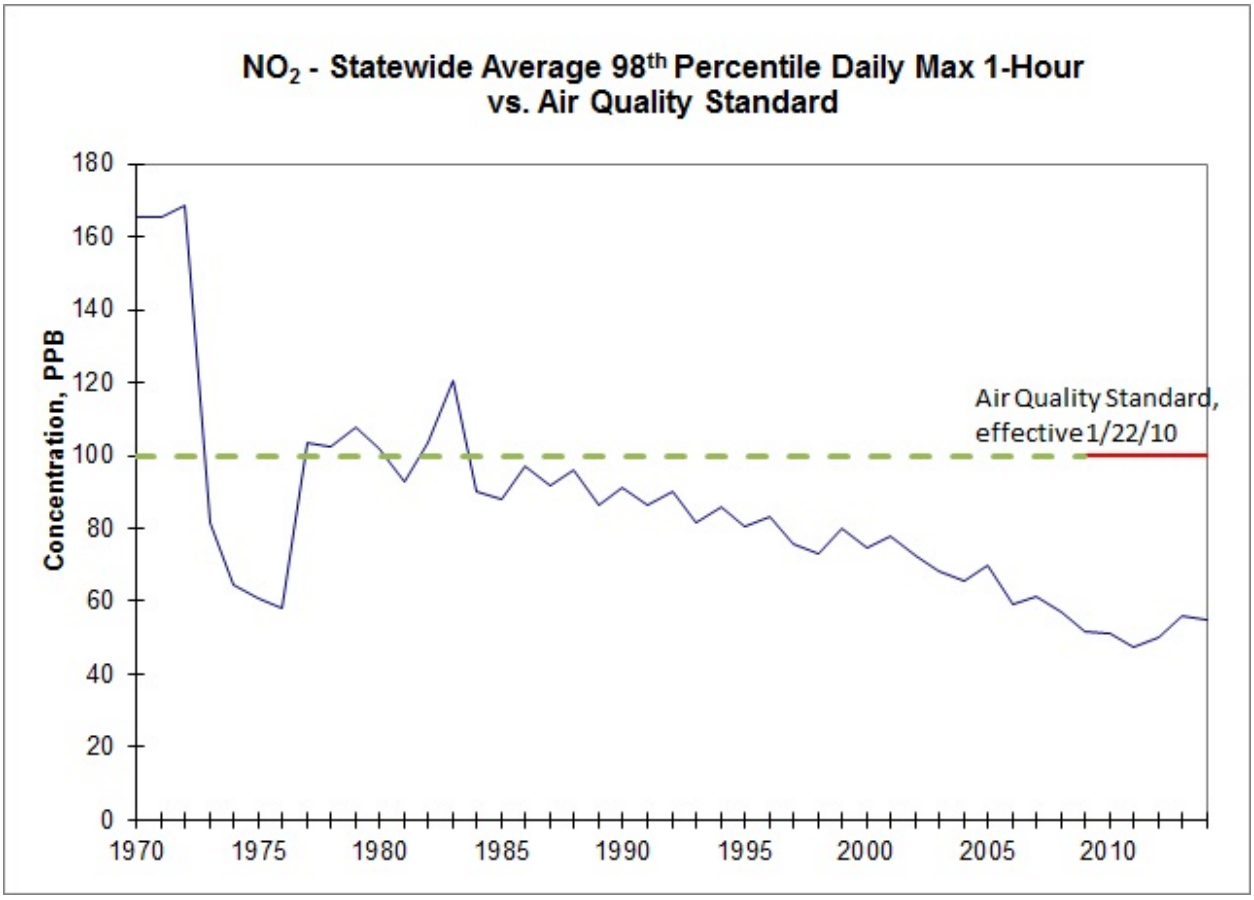


Figure 25. Statewide Trend for NO_2 98th Percentile Maximum 1-Hr Concentration

At present, there are six NO_2 monitors in the network, a location map is shown in Figure 26. Table 14 lists each site, county and MSA it serves. In addition, a NO_y monitor is being operated at each of the three NCore sites at Queens College, Rochester, and Pinnacle State Park.

Table 14. Site Location Listing of NO_2/NO_y Monitors

Site	County	MSA
NY Botanical Garden[a]	Bronx	New York-White Plains
IS 52	Bronx	New York-White Plains
Queens College[a,b]	Queens	New York-White Plains
Pinnacle State Park[b]	Steuben	Corning
Rochester[b]	Monroe	Rochester
Rochester Near-Road	Monroe	Rochester
Buffalo	Erie	Buffalo-Niagara Falls
Buffalo Near-Road	Erie	Buffalo-Niagara Falls

[a] PAMS site
[b] NCore site, NO_y

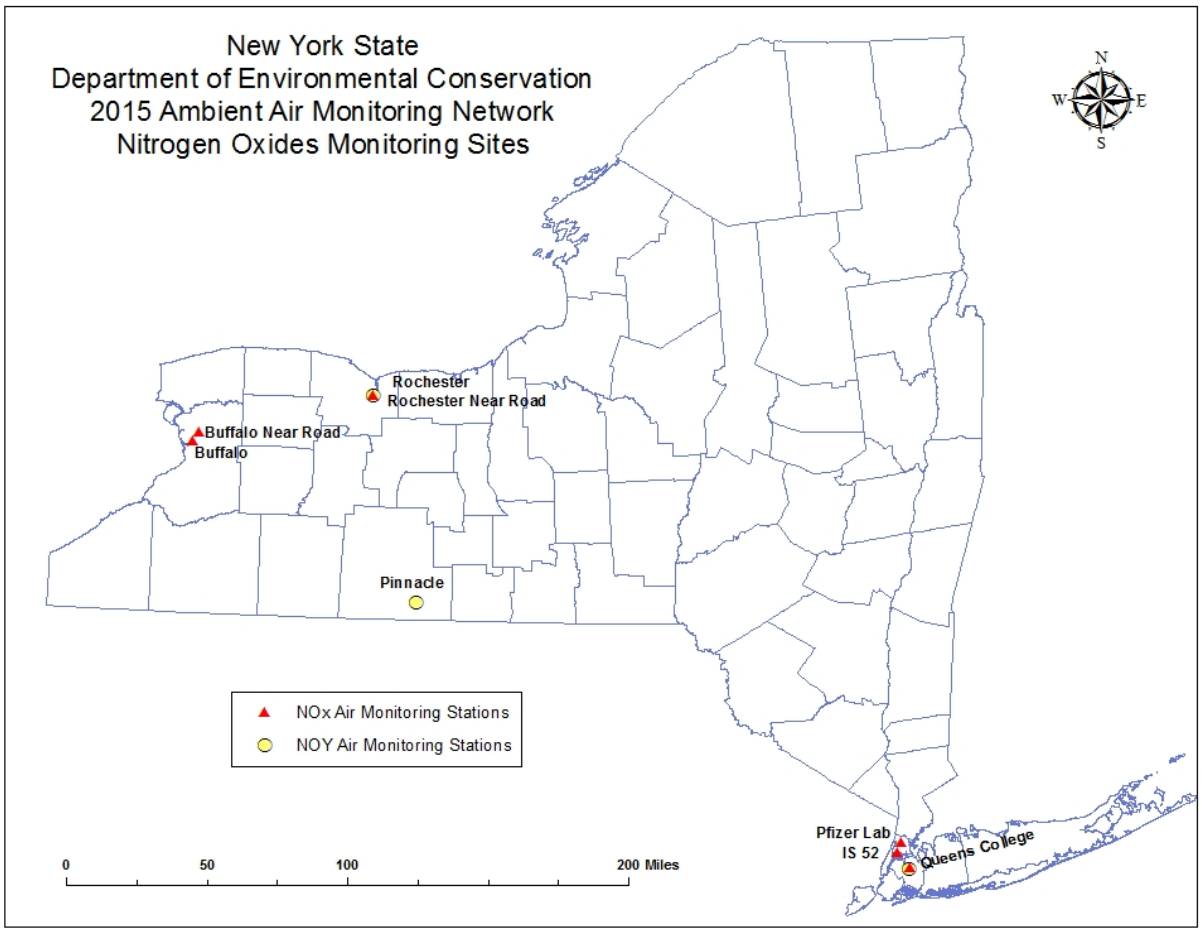


Figure 26. Site Location Map of Nitrogen Oxides Monitoring Network

Under the NO_x rule that became effective January 22, 2010 each MSA with population larger than 500,000 will be required to operate a near-road monitor beginning in 2013. New York State will need to establish such a site in each of the following areas: Albany-Schenectady-Troy, Buffalo-Niagara Falls, Poughkeepsie-Newburgh-Middletown, Nassau-Suffolk, New York-White Plains, Rochester and Syracuse. One urban community wide monitor will be located in each of

the three MSAs with population greater than 1 million: New York, Buffalo and Rochester. Furthermore, the Regional Administrators at their discretion, have the authority to require 40 additional sites nationwide in communities where susceptible and vulnerable populations are located. Data collection at the near-road sites at Buffalo and Rochester began in 2014, and the Queens site is scheduled to be fully operational by January of 2016.

Carbon Monoxide (CO)

There are no minimum requirements for the number of CO monitoring sites. Continued operation of existing SLAMS CO sites using FRM or FEM is required until discontinuation is approved by the EPA Regional Administrator. Monitoring at near-road sites is required in CBSAs over 2.5 million by January 1, 2015 and in the CBSAs over 1 million by January 1, 2017. Currently, a CO monitor is being operated at the Buffalo and Rochester near-road sites.

A historic trend of the statewide CO average 8-hr levels is presented in Figure 27 below. The 8-hr and 1-hr NAAQS for CO are 9 and 35 ppm, respectively.

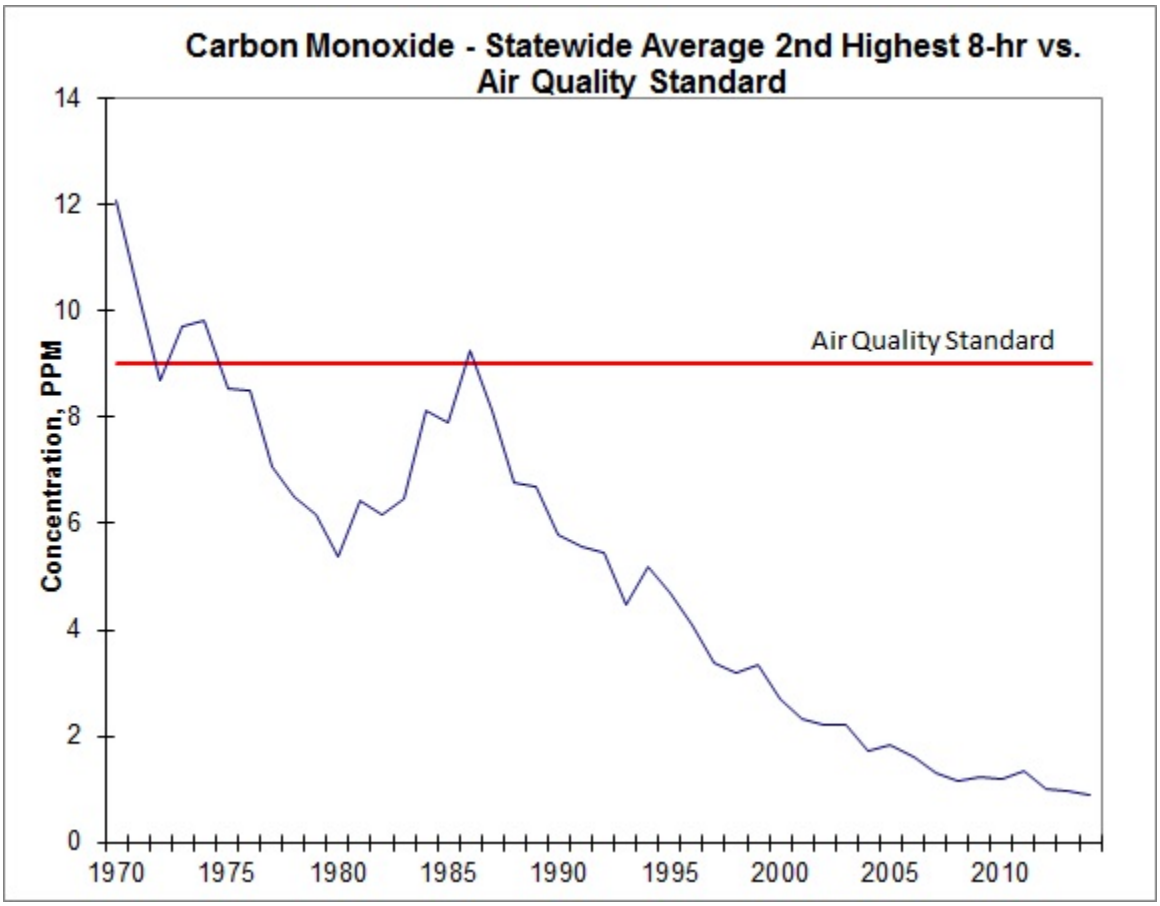


Figure 27. Statewide Average Trend for 2nd Maximum 8-hr Annual Values

CO is a product of motor vehicle exhaust, which contributes about 60 percent of all CO emissions nationwide. High concentrations of CO generally occur in areas with heavy traffic congestion. In cities, as much as 95 percent of all CO emissions may emanate from automobile exhaust. Other sources of CO emissions include industrial processes such as carbon black

manufacturing, non-transportation fuel combustion, and natural sources such as wildfires. Woodstoves, cooking, cigarette smoke, and space heating are sources of CO in indoor environments. Peak CO concentrations typically occur during the colder months of the year when CO automotive emissions are greater and nighttime inversion conditions are more frequent.

At present, there are ten CO monitors in the network, a location map is shown in Figure 28. Table 15 lists each site, county and MSA it serves. With some site closures and additions the total number of monitors has remained the same since 2010.

Table 15. Site Location Listing of CO Monitors

Site	County	MSA
NY Botanical Garden	Bronx	New York-White Plains
Queens College	Queens	New York-White Plains
City College of NY	New York	New York-White Plains
Loudonville	Albany	Albany-Schenectady-Troy
Pinnacle State Park	Steuben	Corning
Rochester	Monroe	Rochester
Rochester Near-Road	Monroe	Rochester
Buffalo	Erie	Buffalo-Niagara Falls
Buffalo Near-Road	Erie	Buffalo-Niagara Falls

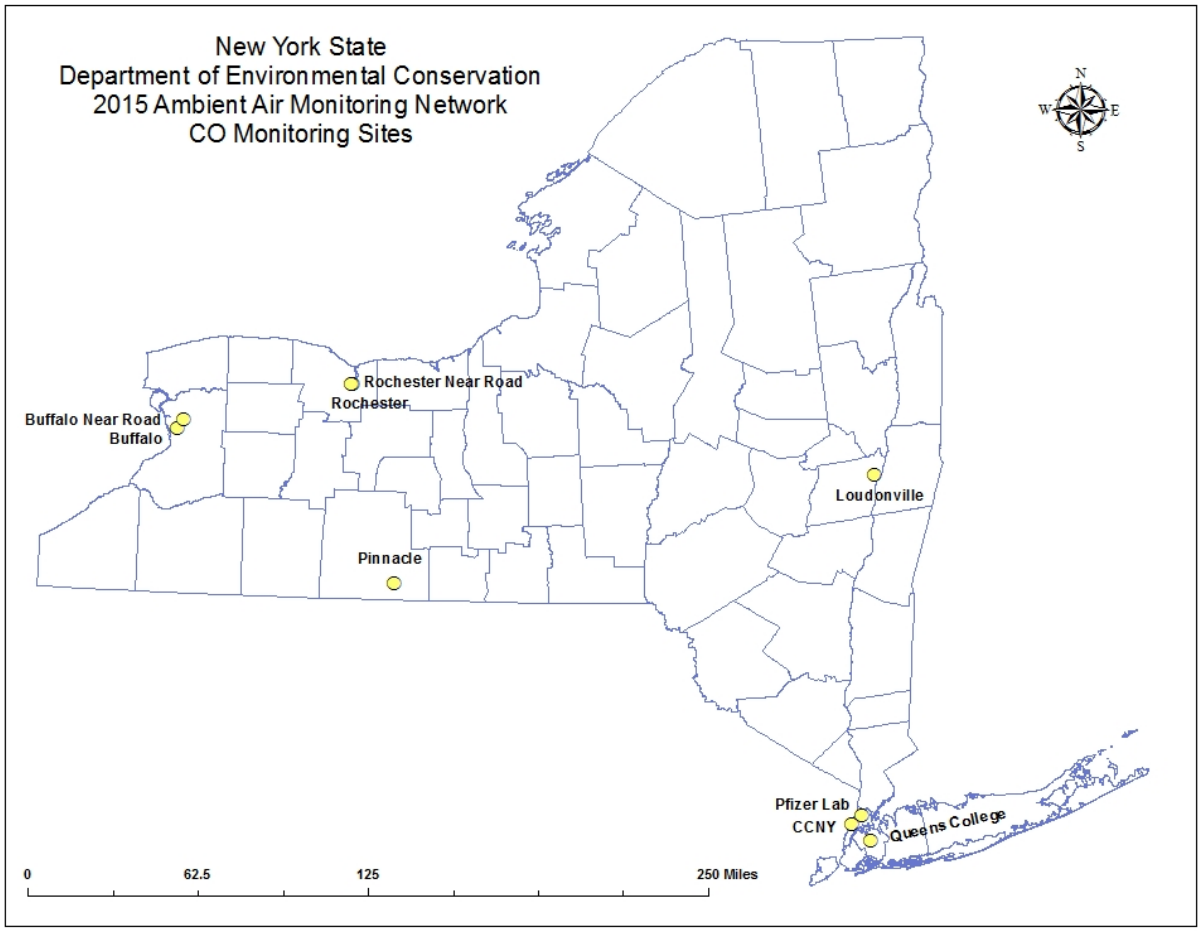


Figure 28. Site Location Map of CO Monitoring Network

Sulfur Dioxide (SO_2)

There are no minimum requirements for the number of SO_2 monitoring sites. Continued operation of existing SLAMS SO_2 sites using FRM or FEM is required until discontinuation is approved by the EPA Regional Administrator. Where SLAMS SO_2 monitoring is ongoing, at least one of the SLAMS SO_2 sites must be a maximum concentration site for that specific area.

A historic trend of the statewide SO_2 99th percentile daily 1-hr max is presented in Figure 29 below. The 1-hr, and 3-hr NAAQS for SO_2 are100, and 500 ppb, respectively.

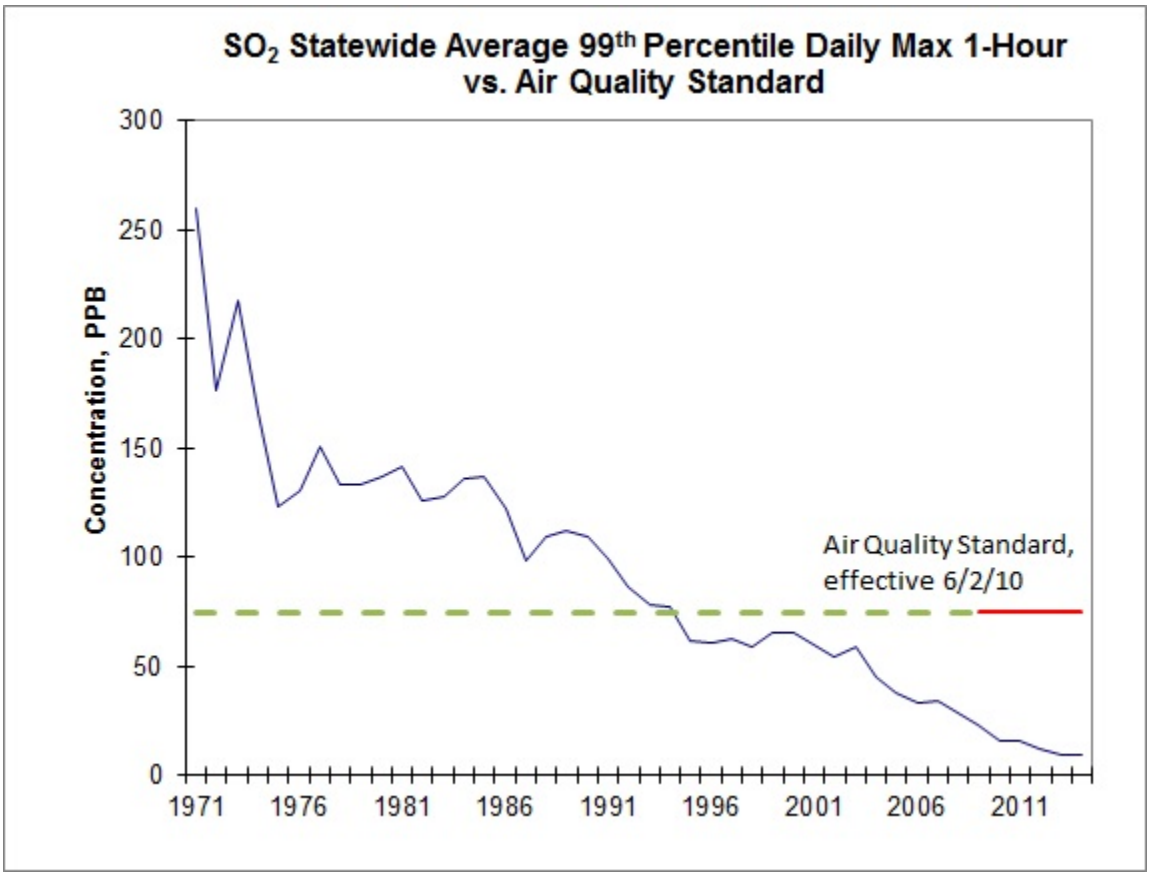


Figure 29. Statewide Trend for SO_2 99th Percentile Daily 1-Hr Max

Sulfur dioxide is produced during the burning of sulfur-containing fuels such as coal and oil, during metal smelting, and by other industrial processes. It belongs to a family of gases called sulfur oxides (SO_x). Major sources include power plants, industrial boilers, petroleum refineries, smelters, iron and steel mills. Generally, the highest concentrations of sulfur dioxide are found near large fuel combustion sources.

At present, there are 18 SO_2 monitors in the network, a reduction of five since 2010. Table 16 lists each site, county and MSA it serves. A location map of the network is shown in Figure 30.

Table 16. Site Location Listing of SO_2 Monitors

Site	County	MSA
Eisenhower Park	Nassau	Nassau-Suffolk
Holtsville	Suffolk	Nassau-Suffolk
NYBG Pfizer Lab	Bronx	New York-White Plains
IS 52	Bronx	New York-White Plains
Queens College	Queens	New York-White Plains
Millbrook	Dutchess	New York-White Plains
Mt. Ninham	Putnam	New York-White Plains
Loudonville	Albany	Albany-Schenectady-Troy
Whiteface Base	Essex	Essex County
Piseco Lake	Hamilton	Hamilton County
Paul Smiths College	Franklin	Malone
Nick's Lake	Herkimer	Utica-Rome
East Syracuse	Onondaga	Syracuse
Pinnacle State Park	Steuben	Corning
Rochester	Monroe	Rochester
Buffalo	Erie	Buffalo-Niagara Falls
Tonawanda II	Erie	Buffalo-Niagara Falls
Dunkirk	Chautauqua	Jamestown-Dunkirk-Fredonia

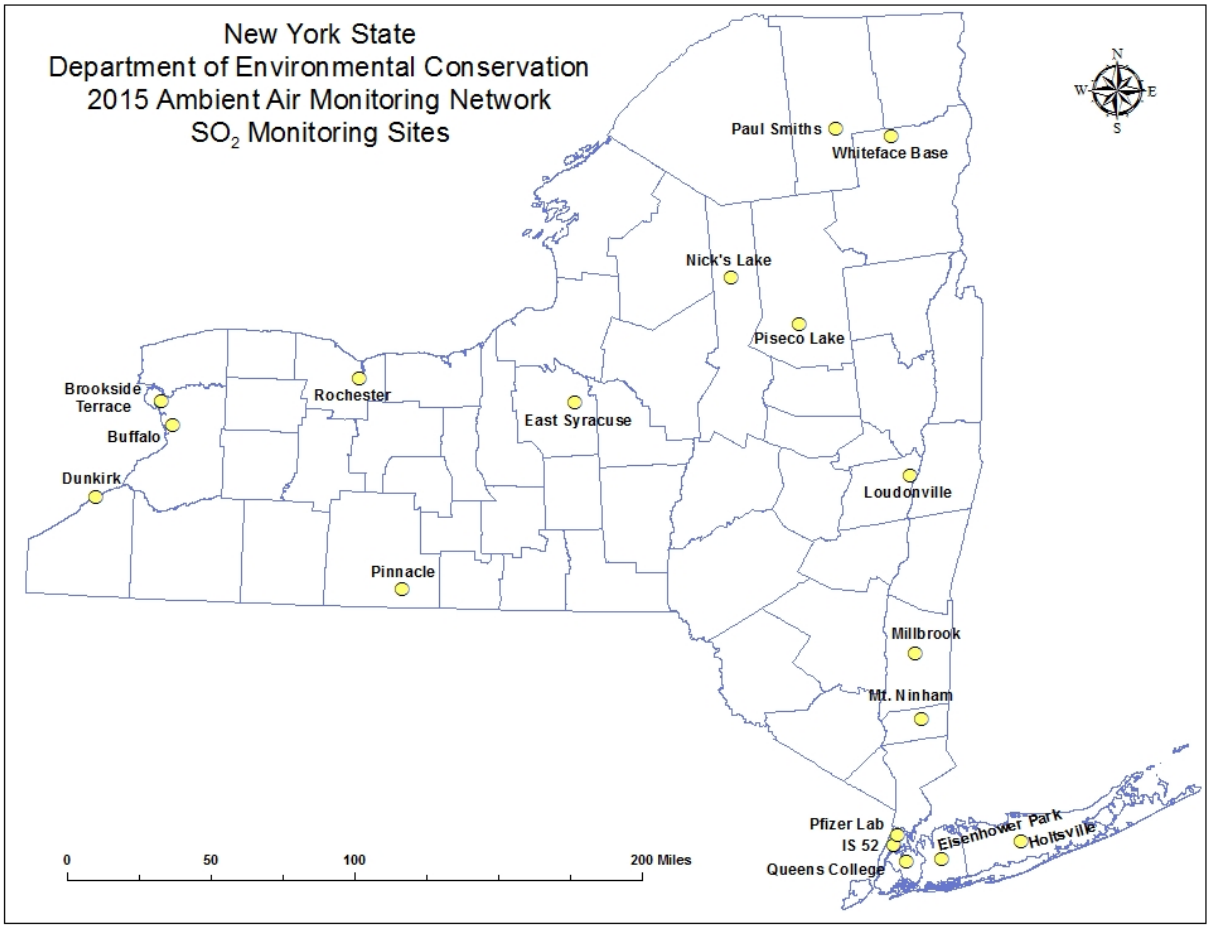


Figure 30. Site Location Map of SO_2 Monitoring Network

Lead (Pb)

The major sources of lead emissions have historically been from fuels in motor vehicles (such as cars and trucks) and industrial sources. Emissions from on-road vehicles decreased 99% between 1970 and 1995 due primarily to the use of unleaded gasoline. Use of leaded gasoline in highway vehicles was prohibited on December 31, 1995. The major sources of lead emissions to the air today are ore and metals processing and leaded aviation gasoline (lead is no longer used in motor vehicle fuel).

In November 2008, the EPA revised the NAAQS for lead from the previous quarterly average of 1.5µg/m^3 to the more protective 3-month rolling average of 0.15µg/m^3. As part of the lead monitoring requirements, monitoring agencies are required to monitor ambient air near lead sources which are expected to or have been shown to have a potential to contribute to a 3-month average lead concentration in ambient air in excess of the level of the NAAQS. At a minimum, monitoring agencies must monitor near lead sources that emit 1.0 ton per year (tpy) or more. Monitoring is also required in each CBSA with a population equal to or greater than 500,000 people as determined by the latest available census figures. Revisions to the monitoring requirements pertaining to where State and local monitoring agencies would be required to conduct lead monitoring were finalized and became effective January 26, 2011. The new

regulations replaced the population oriented monitoring requirement with a requirement to add Pb monitors to the urban NCore monitors. The EPA also lowered the emission threshold from 1.0 tpy to 0.50 tpy for industrial sources of lead (e.g., lead smelters and foundries). However, the emission threshold for airports was maintained at 1.0 tpy. Brookhaven and Republic airports in Suffolk County, New York were selected as part of a 15 airports study nationwide to assess potential lead emissions. A 12-month monitoring study at Brookhaven Airport concluded in October, 2012 while the Republic Airport monitoring began in October. Both sites exhibited lead concentrations significantly below the NAAQS, and the EPA approved the discontinuation of monitoring.

Particulate lead samples are collected on glass fiber filters using a standard TSP high volume sampler which are subsequently analyzed by a state contract laboratory using atomic absorption spectroscopy. Under the new rule, the EPA is allowing Pb-PM_{10} in lieu of Pb-TSP where the maximum 3-month arithmetic mean Pb concentration is expected to be less than 0.10µg/m^3 (i.e., two thirds of the NAAQS) and where sources are not expected to emit ultra-coarse Pb. The population oriented Pb monitors at the NCore or NATTS sites are located away from known sources of Pb and will utilize Pb-PM_{10} samplers.

An annual trend plot of the statewide lead levels is presented in Figure 31 below. The quarterly average standard of 1.5µg/m^3, which was replaced in 2008 by the more stringent 3-month rolling average of 0.15µg/m^3, is shown on the graph for historic reference.

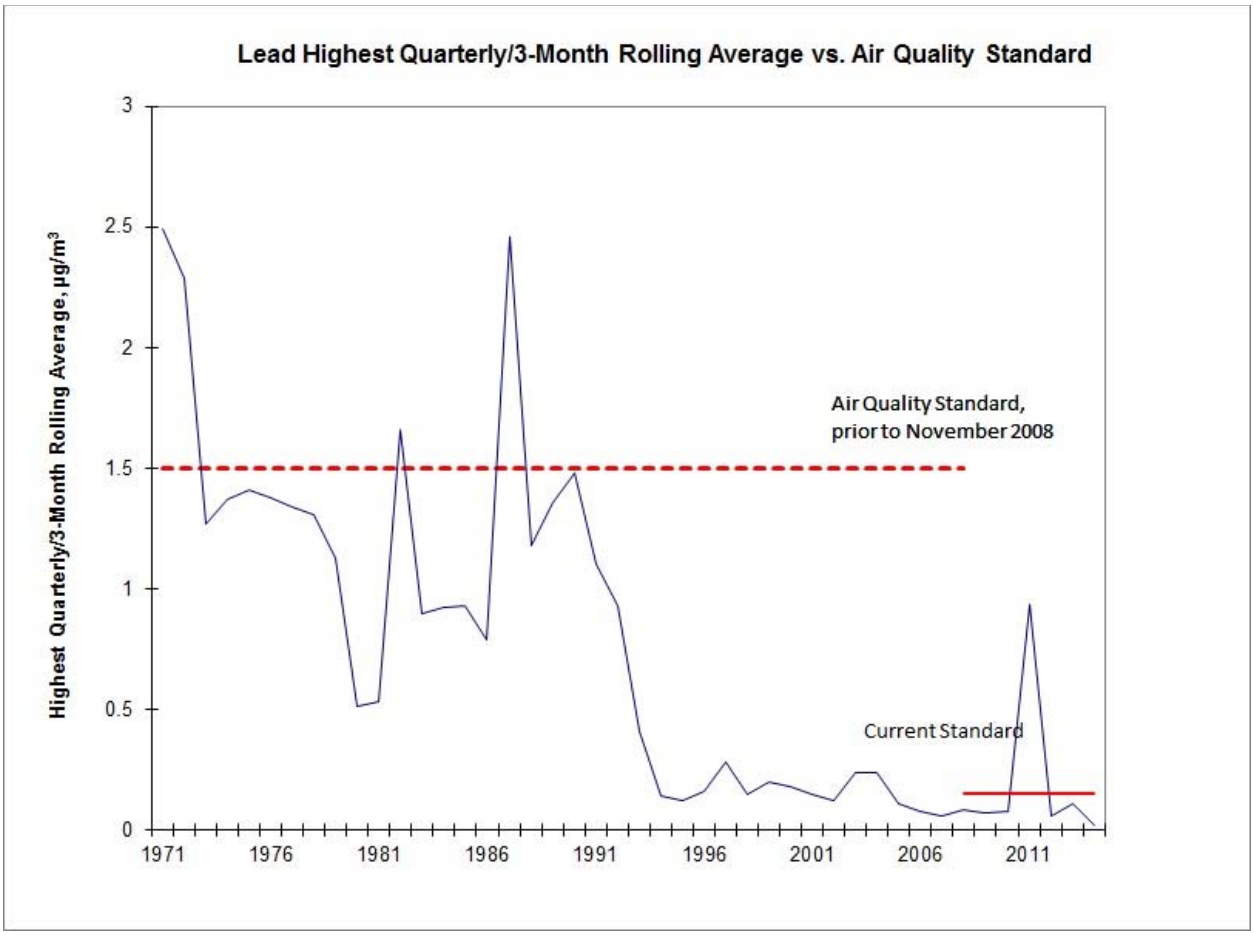


Figure 31. Statewide Annual Trend for Lead Maximum Quarterly Averages

At present, New York's lead monitoring network consists of two source oriented sites and one background site at Wallkill in Orange County (TSP). In addition there are two urban CBSA monitors (low volume PM_{10}) at the NATTS sites in the Bronx and Rochester.

Photochemical Assessment Monitoring Stations (PAMS) Network

The PAMS network is designed to enable the characterization of precursor emission sources within the area, transport of O_3 and its precursors, and the photochemical processes related to O_3 nonattainment. NYSDEC operates two Type 2 monitors in the Bronx and Queens. Type 2 sites are established to monitor the magnitude and type of precursor emissions in the area where maximum precursor emissions are expected to impact and are suited for the monitoring of urban air toxic pollutants. The relevant parameters sampled at each site are listed in Tables 17 and 18.

Table 17. PAMS Parameters Monitored at Queens College

Parameter	Sampling Method	Analysis Method	Schedule
Ozone	TEI 49C Method 047	Ultraviolet Photometric	Continuous
Oxides of Nitrogen (NO, NO_2, NO_x)	TEI 42C Method 074	Chemiluminescence	Continuous
VOCs	Canister Method 150	GC/MS	1 day in 6
Carbonyl	DNPH Cartridge Method 202	HPLC - Ultraviolet Absorption	1 day in 6
Wind Speed/direction	Method 020	---	Continuous
Temperature	Method 040	---	Continuous
Barometric Pressure	Method 011	---	Continuous
Relative Humidity	Method 011	---	Continuous

Table 18. PAMS Parameters Monitored at New York Botanical Garden/Pfizer Lab

Parameter	Sampling Method	Analysis Method	Schedule
Ozone	TEI 49C Method 047	Ultraviolet Photometric	Continuous
Oxides of Nitrogen (NO, NO_2, NO_x)	TEI 42C Method 074	Chemiluminescence	Continuous
PAMS precursor	Method 128	GC/FID	Continuous
VOCs	Canister Method 150	GC/MS	1 day in 6
Carbonyl	DNPH Cartridge Method 202	HPLC - Ultraviolet Absorption	1 day in 6
Wind Speed/direction	Method 020	---	Continuous
Relative Humidity	Method 011	---	Continuous
Temperature	Method 040	---	Continuous

The PAMS target compounds include 55 C_2-C_{12} hydrocarbons and 3 carbonyls. For the New York metro area, it appears that ozone exceedances are VOC limited. Although VOCs as a class are subject to control and reduction, particularly in nonattainment areas, specific compounds of high reactivity are not individually targeted. Controls and regulations are mainly aimed at toxic organic compounds rather than ozone precursors.

The continuous GC data verification is extremely labor intensive as peak intensities for the majority of the targeted compounds are barely above background noise levels. The analyst has to manually adjust each peak baseline for quantification. The PAMS data are used by modelers within the Division for SIP development. The EPA is currently undergoing an evaluation of the PAMS program. The program objectives, network design, and measurement technologies are being reassessed. It would be most helpful if the EPA ORD will provide guidance to reduce the number of targeted compounds, eliminating those that are at insignificant concentrations, and adjust the models accordingly.

The NYSDEC does not conduct any upper air meteorological measurements at the PAMS sites. Modelers use data available at closest installations for distinguishing stagnation events vs. transport.

NCore Monitoring Network

The NCore multipollutant sites measure multiple pollutants in order to provide support to integrated air quality management data needs. NCore sites generally include both neighborhood and urban scale measurements, in a selection of metropolitan areas and a limited number of more rural locations. These sites are required to measure O_3, CO, SO_2, and total reactive nitrogen (NO_y) (using high-sensitivity methods, where appropriate); $PM_{2.5}$ (with both a FRM and a continuous monitor); $PM_{2.5}$ chemical speciation; $PM_{10-2.5}$ (with a continuous FEM); and meteorological parameters including temperature, wind speed, wind direction, and relative humidity. The three sites in the state are at Queens College, Rochester, and Pinnacle State Park. A complete listing of parameters measured is provided in Tables 19 through 21.

Table 19. NCore Multi-parameter Site at Queens College

Parameter	Sampling Method	Analysis Method	Schedule
Ozone	TEI 49C Method 047	Ultraviolet Photometric	Continuous
Low Level SO_2	TEI 43i TLE Method 560	Pulsed Fluorescence	Continuous
Oxides of Nitrogen (NO, NO_2, NO_x)	TEI 42C Method 074	Chemiluminescence	Continuous
NO_y	API 200EU Method 082	Chemiluminescence	Continuous
Low Level CO	API 300EU Method 593	Non Dispersive Infrared	Continuous
$PM_{2.5}$	R&P Partisol 2025 Method 118	Gravimetric	Daily
$PM_{2.5}$ Speciation Ions and Elements	MetOne SASS Method 811	IC, XRF	1 day in 3
$PM_{2.5}$, PMcoarse, PM_{10}	Thermo Scientific 1405 DF FDMS Method 790	TEOM 30°C Gravimetric	Continuous
PM_{10}	R&P Partisol 2025 Method 127	Gravimetric	Daily

Parameter	Sampling Method	Analysis Method	Schedule
Carbon	URG 3000 Method 838	IMPROVE TOR	1 day in 3
	Sunset Laboratory Method 5040	Thermal Optical	Semi-continuous
Sulfate	TEI 5020i	Pulsed Fluorescence	Semi-continuous
Toxics	Canister Method 150	GC/MS	1 day in 6
Carbonyl	DNPH Cartridge Method 202	HPLC - Ultraviolet Absorption	1 day in 6
Wind Speed/direction	Method 020	---	Continuous
Temperature	Method 040	---	Continuous
Barometric Pressure	Method 011	---	Continuous
Relative Humidity	Method 011	---	Continuous

Table 20. NCore Multi-parameter Site at Pinnacle State Park

Parameter	Sampling Method	Analysis Method	Schedule
Ozone	TEI 49C Method 047	Ultraviolet Photometric	Continuous
Low Level SO_2	TEI 43i TLE Method 560	Pulsed Fluorescence	Continuous
Low Level CO	API 300EU Method 593	Non Dispersive Infrared	Continuous
NO_y	API 200EU Method 699	Chemiluminescence	Continuous
$PM_{2.5}$	Low volume FRM R&P 2025 Method 118	Gravimetric	1 day in 3
$PM_{2.5}$, PMcoarse, PM_{10}	TEI 1405 DF Method 790	TEOM 30ºC Gravimetric	Continuous
$PM_{2.5}$ Speciation Ions and Elements	Met One SASS Method 811	IC, XRF RTI Laboratory	1 day in 3
$PM_{2.5}$ Speciation Carbon	URG 3000 Method 838	IMPROVE TOR	1 day in 3
Sulfate	TEI 5020i	Pulsed Fluorescence	Semi-continuous
Toxics	Canister Method 150	GC/MS	1 in 6
Wind Speed/direction	Method 020	---	Continuous

Parameter	Sampling Method	Analysis Method	Schedule
Temperature	Method 040	---	Continuous
Barometric Pressure	Method 011	---	Continuous
Relative Humidity	Method 011	---	Continuous

Table 21. NCore Multi-parameter/NATTS Site at Rochester

Parameter	Sampling Method	Analysis Method	Schedule
Ozone	TEI 49C Method 047	Ultraviolet Photometric	Continuous
Sulfur Dioxide	TEI 43C Method 560	Pulsed Fluorescence	Continuous
Low Level CO	API 300EU Method 593	Non Dispersive Infrared	Continuous
NO_y	API 200EU Method 699	Chemiluminescence	Continuous
$PM_{2.5}$	Low volume FRM R&P 2025 Method 118	Gravimetric	1 in 6
$PM_{2.5}$, PMcoarse, PM_{10}	TEI 1405 DF Method 790	TEOM 30ºC Gravimetric	Continuous
PM_{10}	R&P Partisol 2025 Method 127	Gravimetric	1 in 6
PM_{10} - Metals	Method 907	ICPMS	1 in 6
$PM_{2.5}$ Speciation	Met One Super SASS Method 851	RTI Laboratory	1 in 3
$PM_{2.5}$ Speciation Carbon	URG 3000 Method 838	IMPROVE TOR	1 in 3
Black Carbon	Magee Scientific Aethalometer Method 866	Optical Absorption	Continuous
Mercury Elemental Reactive Gas Mercury Particle Bound Mercury	Tekran 2537B Tekran 1130 Tekran 1135	In situ cold vapor atomic fluorescence	5 minute average 2 hr avg every 3 hr 2 hr avg every 3 hr
Toxics	Canister Method 150	GC/MS	1 in 6
Carbonyl	DNPH Cartridge Method 202	HPLC - Ultraviolet Absorption	1 in 6

Parameter	Sampling Method	Analysis Method	Schedule
Polycyclic Aromatic Hydrocarbons (PAH)	Tisch TE 5007 Method 118	GC/MS EPA/ERG Lab	1 in 6
Mercury Wet Deposition	NCON Model 00-125-2 automatic sampler	Frontier Geosciences: cold vapor atomic fluorescence	Weekly
Wind Speed/direction	Climatronics Sonic Method 020		Continuous
Relative Humidity	Teledyne RH200 Method 011		Continuous
Temperature	Teledyne RH200 Method 040		Continuous
Barometric Pressure	Teledyne BP300 Method 011		Continuous
Precipitation	NAOH IV		Continuous
Acid Deposition	NCON Bucket Style Collector Model 00-120-2	Central Analytical Laboratory at the Illinois Water Survey: IC, ICP-OES, FIA	Weekly

National Air Toxics Trends Stations (NATTS) Network

The two New York NATTS sites, Rochester and IS 52 in the Bronx, are part of a 27-site national network of air toxics monitoring stations. The primary purpose of the NATTS network is tracking trends in ambient air toxics levels to facilitate measuring progress toward emission and risk reduction goals. The monitoring network is intended, over a six-year period, to be able to detect a 15% difference (trend) between two successive 3-year annual mean concentrations within acceptable levels of decision error. Parameters monitored for the Rochester and Bronx sites are given Tables 21 and 22, respectively.

Table 22. IS 52 NATTS Site

Parameter	Sampling Method	Analysis Method	Schedule
Ozone	TEI 49C Method 047	Ultraviolet Photometric	Continuous
Oxides of Nitrogen	TEI 42C Method 074	Chemiluminescence	Continuous
$PM_{2.5}$, PM_{10}, PMcoarse	Thermo Scientific 1405 DF FDMS	TEOM 30ºC Gravimetric	Continuous
$PM_{2.5}$	Low volume FRM R&P 2025 Method 118	Gravimetric	Daily 1 day in 3

Parameter	Sampling Method	Analysis Method	Schedule
$PM_{2.5}$ Speciation Ions and Elements	Met One SASS Method 811	IC,XRF	1 day in 3
$PM_{2.5}$ Speciation Carbon	URG 3000 Method 838	IMPROVE TOR	1 day in 3
PM_{10}	Low volume FRM R&P 2025 Method 127	Gravimetric	1 day in 6[a]
PM_{10} - Metals	Method 907	ICPMS	1 day in 6[a]
Sulfate	Thermo Scientific 5020i Sulfate Particulate	Pulsed Florescence	Continuous
Black Carbon	Magee Scientific Aethalometer Method 866	Optical Absorption	Continuous
Elemental Carbon/ Organic Carbon	Sunset Laboratory Method 5040	Thermal Optical	Semi-Continuous
Polycyclic Aromatic Hydrocarbons-PAH	Tisch TE 5007 Method 118	GC/MS EPA/ERG Lab	1 day in 6
Toxics	Canister Method 150	GC/MS	1 day in 6 [a]
Carbonyl	DNPH tube Method 202	HPLC - Ultraviolet Absorption	1 day in 6
Wind Speed/direction	Climatronics Method 020	Sonic	Continuous

[a] Collocated unit

Prior to the establishment of the NATTS network, the NYSDEC began a statewide toxics monitoring network back in 1990. Currently we monitor toxics (TO-15) at 13 sites and carbonyls at ten sites. Sample analysis is conducted by in-house laboratory staff.

Table 23. Site Location Listing of Toxics Monitors

Site	County	MSA	Toxics	Carbonyls
NYBG Pfizer Lab	Bronx	New York-White Plains	✓	✓
IS 52[a]	Bronx	New York-White Plains	✓	✓
PS 274	Kings	New York-White Plains	✓	
Queens College	Queens	New York-White Plains	✓	✓
Fresh Kills West	Richmond	New York-White Plains	✓	✓
Albany South[b]	Albany	Albany-Troy-Schenectady	✓	✓
Whiteface Base	Essex	Essex County	✓	✓
Rochester[a]	Monroe	Rochester	✓	✓
Rochester Near-Road	Monroe	Rochester		✓
Buffalo	Erie	Buffalo-Niagara Falls	✓	
Buffalo Near-Road	Erie	Buffalo-Niagara Falls		✓
Tonawanda II				✓
Grand Island Blvd[b]	Erie	Buffalo-Niagara Falls	✓	✓

[a]NATTS site; [b]Special Purpose Monitor

Figure 32 shows the site location map of the toxics monitoring network.

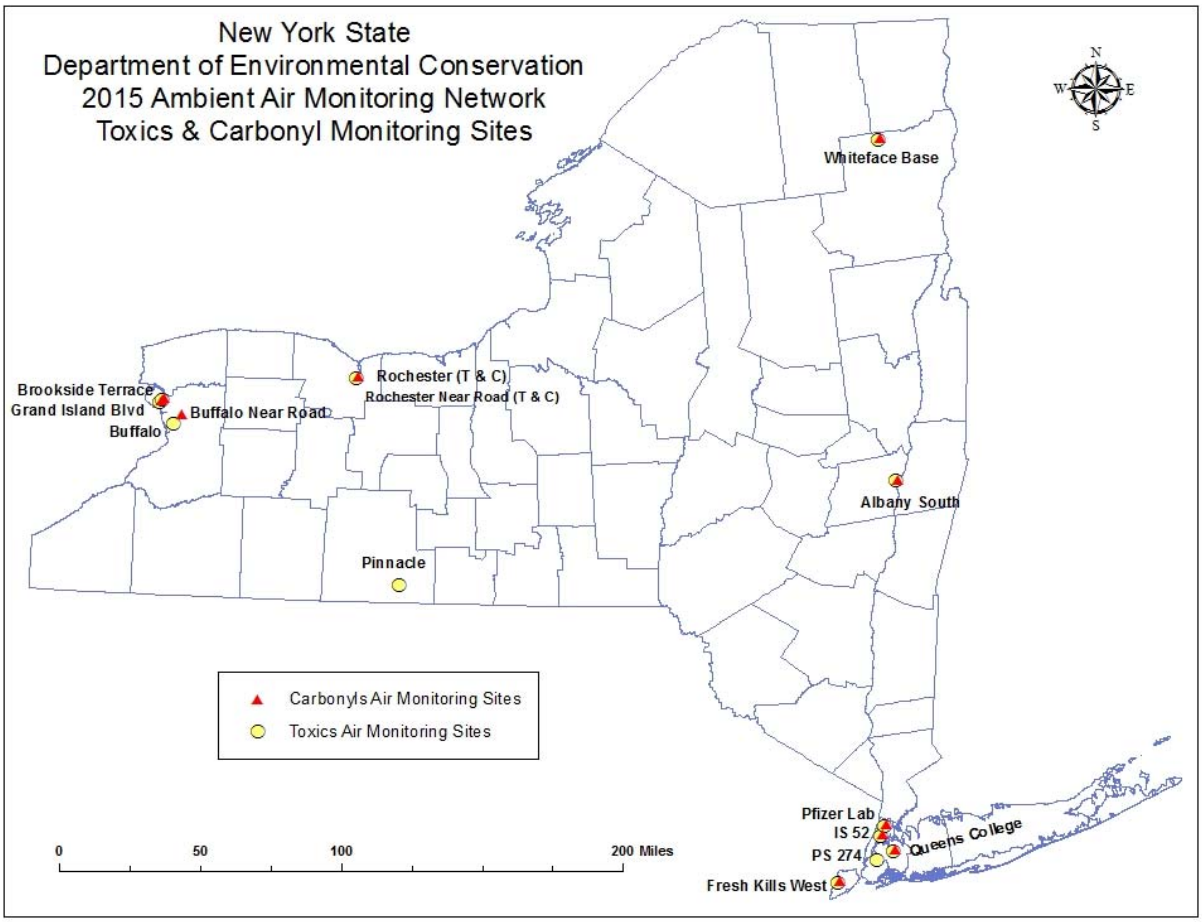


Figure 32. Site Location Map of Toxics Network

In the five years since the last network assessment, BAQS has experienced workforce reduction due to staff separations. It took until this past year to bring bureau staffing levels up to the 2010 fill level. In the intervening years, five toxics monitoring sites were closed, while four new ones were added. The Department intends to expand the toxics network to better characterize population exposure as resources become available.

The following charts (Figures 33 and 34) illustrate the statewide annual averages for benzene and 1,3-butadiene. Figures 35 and 36 show trends for the carbonyls, formaldehyde and acetaldehyde.

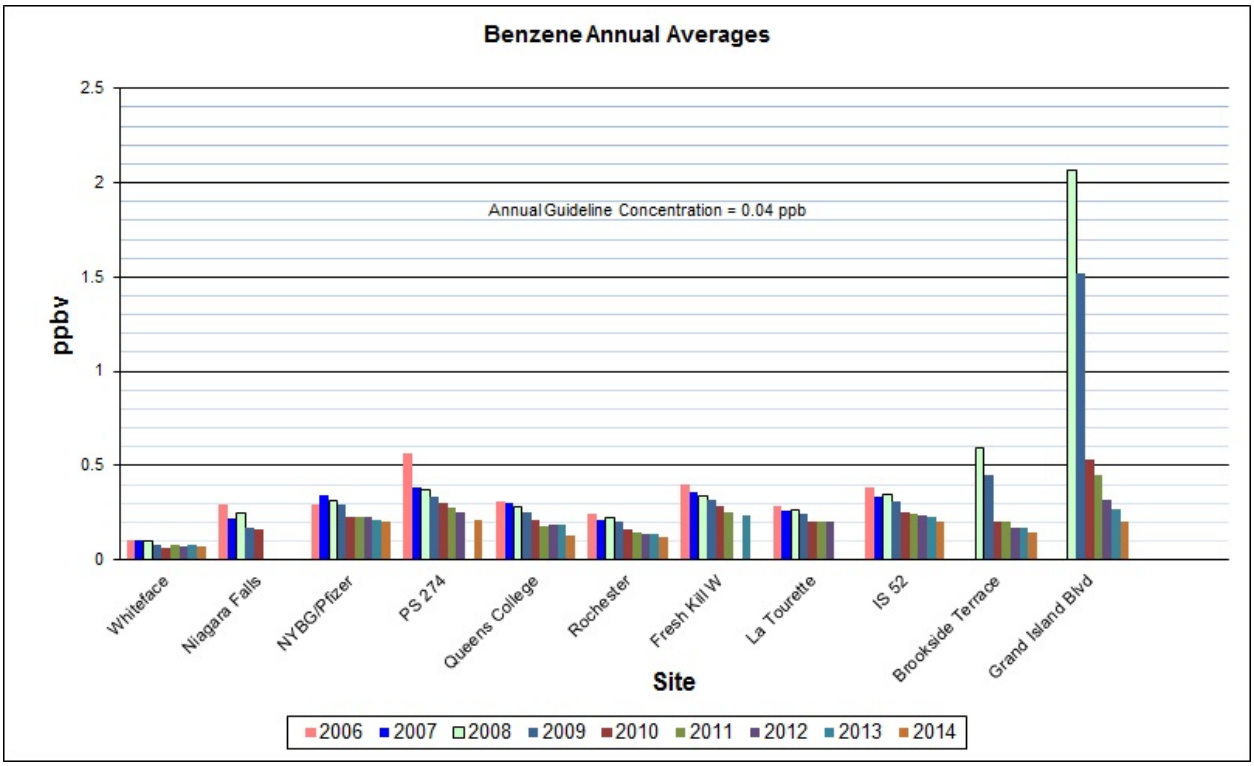


Figure 33. Benzene Annual Average Trends for Toxics Network Sites

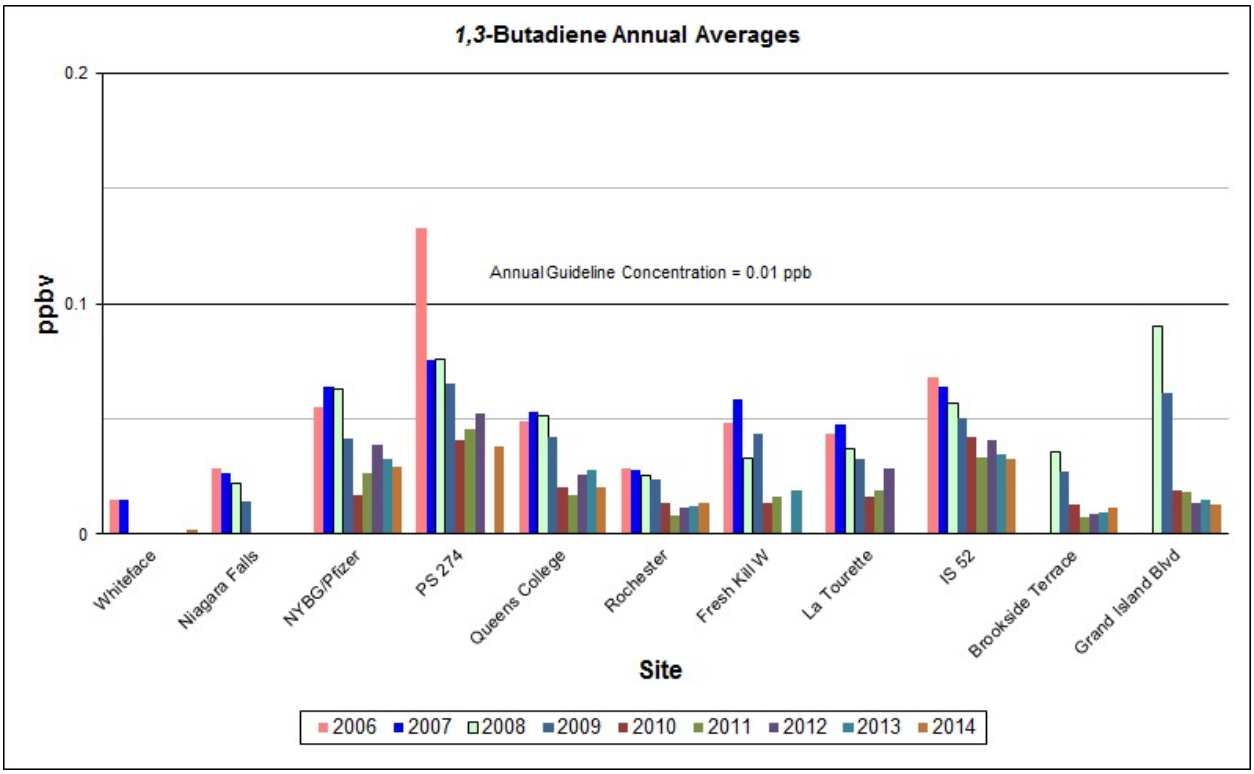


Figure 34. 1,3-Butadiene Annual Average Trends for Toxics Network Sites

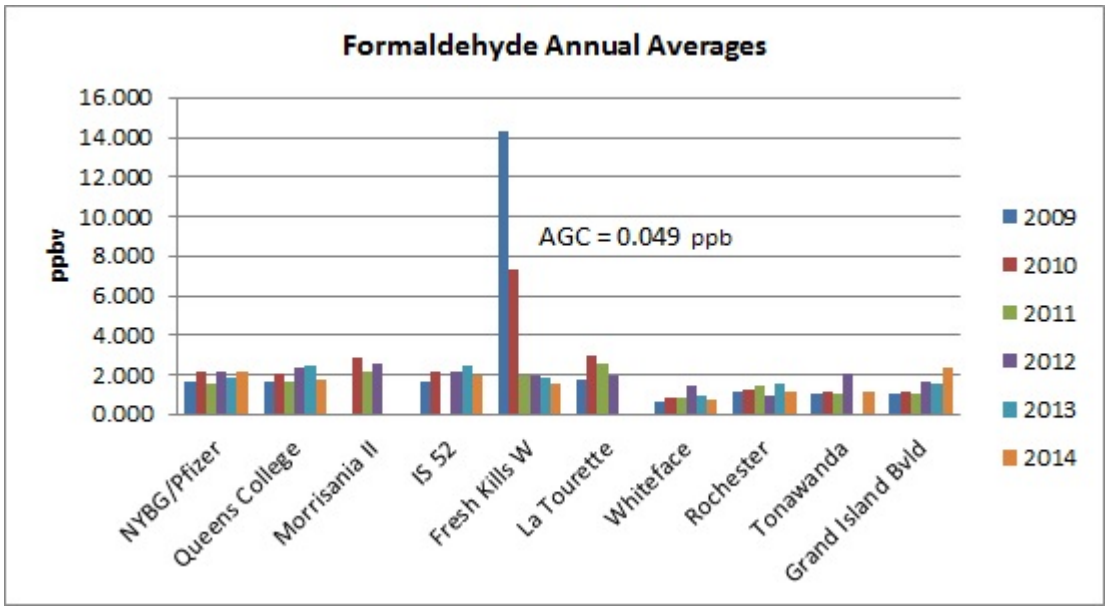


Figure 35. Formaldehyde Annual Average Trends for Toxics Network Sites

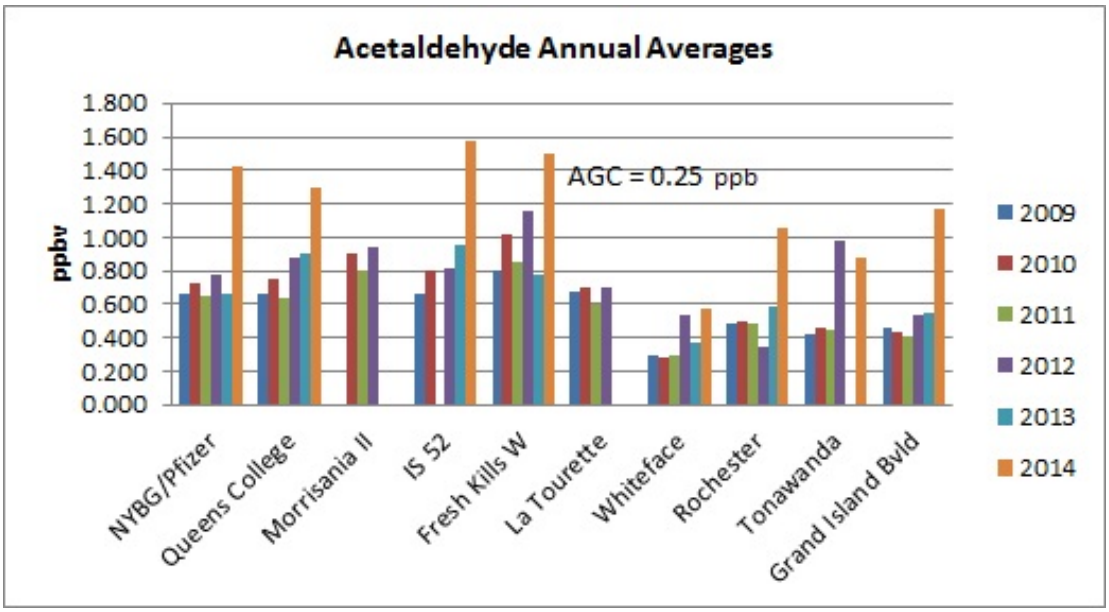


Figure 36. Acetaldehyde Annual Average Trends for Toxics Network Sites

Acid Deposition Network

New York monitors and tests for acid deposition through the New York State Acid Deposition Monitoring Network, which was designed in 1985 to carry out requirements of the State Acid Deposition Control Act (SADCA). Measurements of acid deposition and related quantities are used to assess the effectiveness of sulfur control policy and other strategies aimed at reducing the effects of acid rain. Federal and State programs were implemented in recent years to further control emissions contributing to acid deposition. These include the NO_x and SO_x Budget Trading Programs, and the Cross-State Air Pollution Rule. As a result, sulfate deposition has

decreased by more than 60% statewide since the monitoring program began and the concentrations of acidic pollutants continue to decline.

At the end of 2012, the Department discontinued the existing acid rain monitoring program and transitioned 7 monitoring locations to the National Acid Deposition Program (NADP). The transition to the NADP program will result in savings to the Department, provide better and more useful data for use in regulation development and will allow for the comparison of data from New York with other acid sensitive regions across the country. Additionally, because the NADP program provides a uniform operational framework, the data from existing NADP sites within New York and in neighboring states can be utilized in the analysis of deposition in New York.

The NADP program uses IC, ICP and FIA to determine the concentrations of free acidity (H^+ as pH), conductance, calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), potassium (K^+), sulfate (SO_4^{2-}), nitrate (NO_3^-), chloride (Cl^-), and ammonium (NH_4^+). The data and reports from this program from the 7 NYSDEC sites as well as other sites in New York and in the United States can be obtained from: http://nadp.sws.uiuc.edu/data/

The NYSDEC monitoring locations that were converted to the NADP in January 2013 are:

NY06 Bronx
NY28 Piseco Lake
NY43 Rochester (Established 2013)
NY59 Wanakena
NY92 Amherst (Established 2013)
NY93 Paul Smith's College

The other NADP sites currently operating in New York but sponsored by other organizations are:

NY01 Alfred
NY08 Aurora Research Farm
NY10 Chautauqua
NY20 Huntington Wildlife
NY22 Akwesasne Mohawk-Fort Covington
NY52 Bennett Bridge
NY67 Ithaca (NADP/AirMoN)
NY68 Biscuit Brook
NY96 Cedar Beach, Southold
NY98 Whiteface Base (Previously operated by NYSDEC)
NY99 West Point

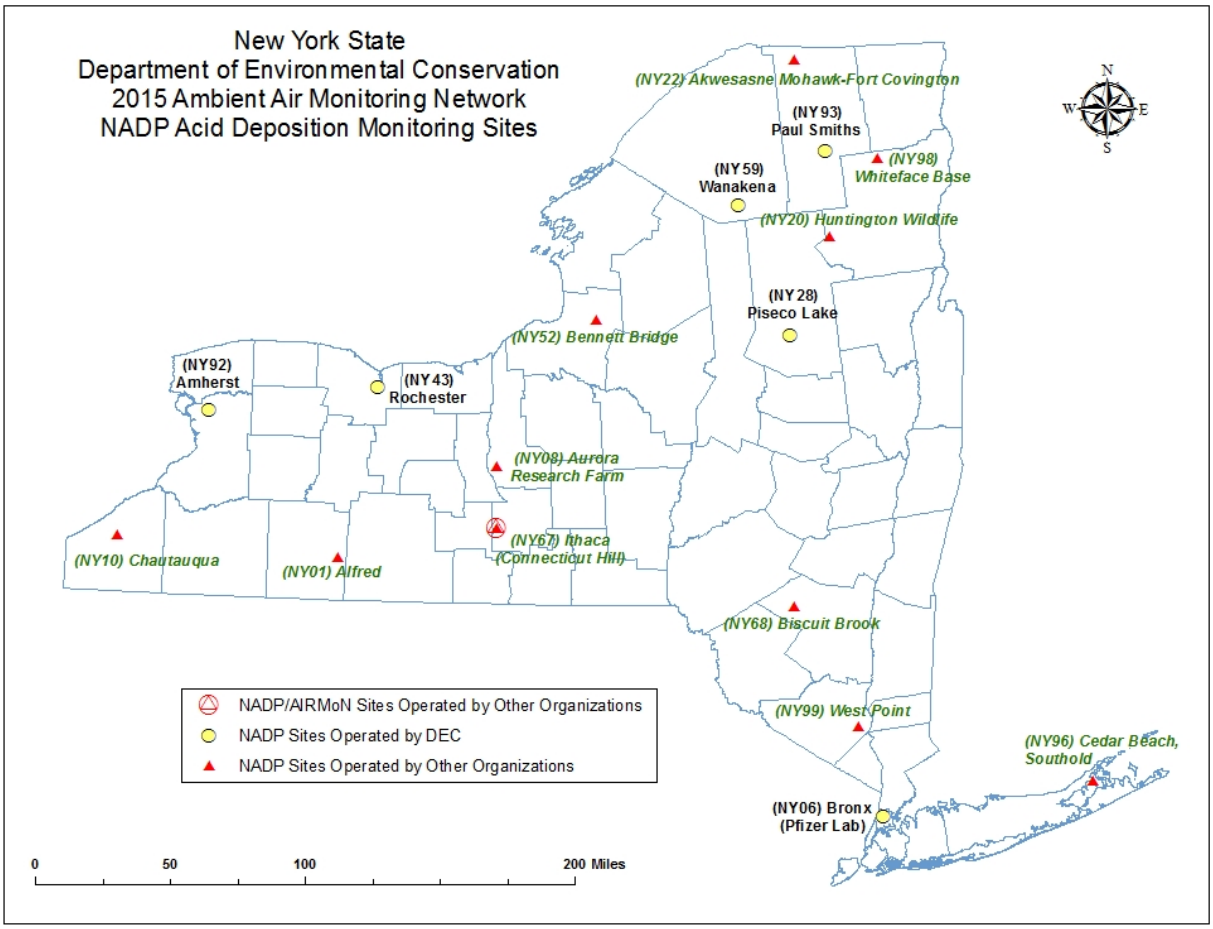


Figure 37. Site Location Map of Acid Deposition Network

Special Purpose Monitors

NYSDEC occasionally conducts short-term special ambient monitoring studies when the need arises. These include research oriented projects, sometimes grant supported, as well as studies necessitated by citizen concerns

<u>Tonawanda Community Air Quality Study</u>
Although the original study funded by EPA concluded in 2008, the NYSDEC has continued sampling at two of the four study sites with State funding. The Tonawanda II site at Brookside Terrace will remain in operation as part of the permanent network, while the Grand Island Blvd. industrial site will be maintained as a special purpose monitor, resources permitting.

As a direct outcome of this study, the source of the high benzene levels was traced to a coke oven facility using comparisons of concentration and wind direction data. Follow up actions by federal and State officials identified deficiencies in the facility's operation and remedies are

being put in place. By continuing air monitoring in the study area, NYSDEC can track the progress of the control measures, and continue to support neighborhood community groups.

Peace Bridge Air Quality Study

The DEC undertook a six month air monitoring campaign beginning in late August 2012. This data which was collected prior to the reconstruction of the Plaza indicated that the $PM_{2.5}$ collected at the two neighborhood sites in this study correlated very well with the two monitors in Buffalo and Niagara Falls. This indicates that on average, there is no significant source of $PM_{2.5}$ impacting the neighborhood around the Peace Bridge that is not also impacting the sites in Niagara Falls and Buffalo. This result is not surprising due to the heavy influence of mobile sources in the region. Historically, the DEC has used the $PM_{2.5}$ monitoring site in Buffalo on Dingens Street to assess the air quality for the region. The average $PM_{2.5}$ in Buffalo for the same period as this study was $8.3 \mu g/m^3$.

The first study focused on criteria pollutants and regional comparisons and did not provide a great deal of information regarding local sources that may be impacting area residents. DEC staff discussed the results with local community groups who were interested in more detailed monitoring for pollutants specific to mobile sources as well as for a comparison with a background monitor within their neighborhood. The DEC agreed to change the objectives of the study and began a new, year-long monitoring campaign in the fall of 2014.

The new study utilizes two monitoring locations, one adjacent to the Peace Bridge Plaza and another background urban location at a neighborhood school. The pollutants monitored at the site near the Plaza include $PM_{2.5}$, Black Carbon, Ultrafine particle number, VOCs and Carbonyls. Pollutants monitored at the urban background site include $PM_{2.5}$ and Black Carbon. In addition to pollutant data, traffic data from the Peace Bridge, I-190 and from local roadways are being collected to assist with the interpretation of the data.

The data from the year-long study are being presented to the community on a quarterly basis. Two data presentations have occurred and they can be accessed on the NYSDEC website at: http://www.dec.ny.gov/chemical/83984.html. The study will conclude in late 2015 and a final report will be posted to the same webpage.

South Albany Neighborhood Air Quality Monitoring

In response to community concerns, the Department recently added air toxics sampling near the existing long-term PM monitoring site in the south Albany neighborhood at 274 S. Pearl St., Albany, NY 12202. Samples are collected on a one in six-day schedule for the analysis of VOCs and carbonyls. The data will be useful in assessing if industrial activities in the Port area significantly impact the neighborhood air quality when compared to cities of similar size with normal urban emissions.

Miscellaneous Projects

Monitoring staff provide technical support and maintenance for several portable field instruments. The advanced leak detection and repair (LDAR) equipment purchased by the EPA

for the Department has proven to be extremely valuable during recent field deployments at petroleum storage facilities and compressor stations. In addition to the FLIR camera, staff maintain and calibrate a H_2S real-time instrument, as well as train Regional staff in their proper field use. Also, wood smoke monitoring kits that measure black carbon, $PM_{2.5}$ and wind speed/direction are available for Regional field deployment. Laboratory staff prepare and ship evacuated canisters fitted with orifice flow devices to the Regions as needed for whole air grab sampling. These samples are returned to our laboratory facility for VOC analysis. It is anticipated that staff will be involved with "citizen science" projects.

Health-Related and Scientific Research

NYSDEC air staff routinely provide support to health related and other scientific research endeavors that take place. Some examples are listed below.

Rochester PM Center
The NYSDEC collaborates with researchers from the University of Rochester Medical Center and Clarkson University who have been awarded a second PM health research grant from EPA. Their work focuses on the pathways and effects from PM pollution on the cardiovascular system. The NYSDEC provides data and support for a fine particle classifying instrument at a monitoring location near the University of Rochester. A second instrument provided by Clarkson University was also installed at IS 52.

Integrated Assessment of the Effects of NH_3, PM, SO_2, and VOC Emissions on O_3 and $PM_{2.5}$ Concentrations and Trends in New York State
This project is a collaboration with scientists from EPRI, SUNYA, ARA Inc., Envair and Syracuse University. The project includes data collection for 15 months of 5-minute intervals of nitrogen species including NO_y, NO_x, PAN, AN, HNO_3, NO_3^- and NH_4^+ at an urban monitoring site in Queens, NY and at a rural site in the Southern Tier of New York. The data will be used to investigate how specific anthropogenic sources contribute to air quality impacts. Additionally, the project data and ancillary data will be used to determine the significance of in-state vs out-of-state emissions for nitrogen and carbonaceous aerosols.

Measurement of Ambient Ammonia to Identify its Spatial and Temporal Distribution, Source Types, and its Role in Secondary Particle Formation
This project is a collaboration with scientists from Clarkson University, ARA Inc. and SUNY Albany. The project includes data collection for 15 months of ammonia by denuder difference and by passive diffusion at four locations in NY State. The locations are Queens, Rochester, the Southern Tier and Potsdam. The high frequency measurements of NH_3 from four locations will provide information necessary to determine the significance of NH_3 on particle production across the state.

External Data Users

There are a multitude of organizations and individuals that use the data that are produced by our monitoring networks. They include other regulatory government agencies, health researchers, academics, citizen groups, consulting firms and other private citizens. For example, the

American Lung Association uses our data and its own methodology to grade the air quality of states each year. Community groups also use the air quality data to alert their citizens of the potential "bad air" days. More notable uses are listed below:

- Environmental Public Health Tracking Program (EPHT) - CDC with state and local Health Depts. EPHT is the ongoing collection, integration, analysis, and interpretation of data about the following factors: 1) Environmental hazards; 2) Exposure to environmental hazards; and 3)Health effects potentially related to exposure to environmental hazards
- AIRNow
- DOH Asthma Study

New and Proposed Rules

As mandated by the Clean Air Act, the EPA must periodically review the scientific bases (or criteria) for the various NAAQS by assessing newly available scientific information on a given criteria air pollutant. In addition to revising the NAAQS when deemed appropriate, regulations are also promulgated for the implementation of these standards, which specify monitoring requirements. Often litigations lead to the reconsideration of the adopted rules. There are a number of recently adopted and proposed rules which will significantly affect the existing monitoring networks.

Ozone (O_3)

The current 8-hr ozone standard (primary and secondary) of 0.075 ppm went into effect on May 27, 2008, at which time the 1-hr standard was revoked. On November 25, 2014, the EPA proposed to strengthen the National Ambient Air Quality Standards (NAAQS) for ground-level ozone, based on extensive scientific evidence about ozone's effects. The proposed updates will improve public health protection, particularly for children, the elderly, and people of all ages who have lung diseases such as asthma. The updates also will improve protection for trees, plants and ecosystems. The EPA is proposing to update both the primary ozone standard, to protect public health, and the secondary standard, to protect the public welfare. Both standards would be 8-hour standards set within a range of 65 to 70 parts per billion (ppb). A final decision on the level and form of the standards is expected in October, 2015.

Secondary Standards for NO_x/SO_x

The EPA considered setting a secondary standard for NO_x and SO_x that would specifically target the impact of acidic deposition on wilderness areas. The EPA ultimately decided that there was not enough information at this time to tie specific water quality thresholds with ambient air concentrations. In the July 2011 final rule for NO_x and SO_x, the EPA stated that they would set up a monitoring program in sensitive areas to collect information to link water quality impacts to ambient air quality measurements. The NYSDEC is participating in this pilot monitoring program in the Adirondacks. Additional monitoring equipment has been installed at several sites to determine the concentrations of gasses and particles including ammonia. These data will be used in the future to inform the next review of the NO_x/SO_x standard. Although ambient NO_2 levels are not expected to contravene the NAAQS, monitoring is necessary due to NO_2 being an ozone precursor, and the need to track the effectiveness of emission reduction programs.

Quality Assurance

In addition to the QA/QC procedures implicit in the daily operation of each network component, independent and regularly scheduled audits are performed by personnel from the Ambient Monitoring Section of the Bureau of Quality Assurance. They also carry out the Performance Evaluation Program (PEP) for the FRM $PM_{2.5}$ network, and Through The Probe (TTP) audits for all gaseous pollutants. All QA requirements specified in the monitoring rules of 40 CFR Parts 53 and 58 are adhered to.

Technology

We continue to evaluate new equipment and instrumentation as they become available on the market. The Queens College site is often used as a platform for manufacturers to test/certify their instruments for designation. We often provide support for collocated sampling for instruments under development.

Data Acquisition

NYSDEC recently deployed ten digital data acquisition systems in field for continuous instruments. These systems have added functions and capabilities including:

- i/o for RS 232 or Ethernet connection
- minute data storage eliminating the need for strip chart/recorder (cost saving)
- remotely operate and perform diagnostics of equipment
- connect to new generation instruments that no longer provide analog output

Ultrafine Measurements

On February 11-13, 2015, the EPA held a workshop in Research Triangle Park, NC that brought together international experts on emissions, air quality, exposures, and health impacts of ultrafine particles (UFP) to present and discuss the latest research and policy issues related to UFP. The workshop consisted of platform presentations on UFP relevant science such as emissions and health control issues, health effects and evidence, and policy considerations.

The NYSDEC first began ultrafine particulate monitoring with the deployment of a TSI Model 3031 Ultrafine Particle Monitor (UPM) at Queens College in June of 2009. This instrument provides continuous measurements of size distribution and particle number concentrations of fine particles below 1 micron, in the range from 20 to 500 nanometers. The Department recently acquired three additional ultrafine instruments intended to be installed at the near-road sites.

Next-gen Laboratory and Field Equipment

The Department is in the process of updating laboratory and field instruments for toxics monitoring. In addition to replacing the legacy GCMS system, the workhorse for canister sample analysis for the last decade, the BAQS laboratory facility will be acquiring a state-of-the-art research and development instrument system that will facilitate future monitoring advancements. This system will provide the capability to analyze non-routine samples captured

in sorbent tubes or Tedlar bags. Also, an ion mobility spectrometer will be procured to complement other portable field instruments such as the FLIR camera and the H_2S monitor.

Personnel and Training

In the past ten years the monitoring program experienced a 15% staff reduction due to staff separations. Graying of the current staff could potentially lead to another 10% reduction as they become eligible for retirement and elect to do so. A considerable amount of technical expertise and skills will be lost if there is no succession plan to retain this knowledge. It is therefore our highest priority to address this issue.

New York has one of the most robust and advanced air monitoring programs in the nation. In order to maintain this high level of effort and play a major role in the implementation and development of cutting edge measurement technology, it is important for program management to recruit young professionals into the organization to replace outgoing staff. EPA Region 2 has been very supportive of New York's program by providing grant monies for equipment purchase and network upgrade necessary to implement new monitoring requirements. However, recent awards have not included funding for personal services. It will be of tremendous help if grant monies are earmarked for the hiring of new personnel in the future.