State Implementation Plan

PLAN TO IMPROVE AIR QUALITY IN THE WASHINGTON, DC-MD-VA REGION

March 7, 2008

Photo courtesy of the EPA

State Implementation Plan (SIP) for Fine Particle (PM2.5) Standards
And 2002 Base Year Inventory for the
Washington DC-MD-VA Nonattainment Area

METROPOLITAN WASHINGTON COUNCIL OF GOVERNMENTS

PLAN TO IMPROVE AIR QUALITY IN THE WASHINGTON, DC-MD-VA REGION

State Implementation Plan (SIP) for Fine Particle ($PM_{2.5}$) Standard and 2002 Base Year Inventory for the

WASHINGTON DC-MD-VA NONATTAINMENT AREA

Prepared by:

Metropolitan Washington Council of Governments

for the
District of Columbia Department of Environment

Maryland Department of the Environment
and the
Virginia Department of Environmental Quality

on behalf of the Metropolitan Washington Air Quality Committee

March 7, 2008

Alternative formats of this publication can be made available for persons with disabilities.
Phone: 202.962.3300 or 202-962.3213 (TDD)
Email: accommodations@mwcog.org.
For details: www.mwcog.org.
For Virginia: Phone: (804) 698-4070
Email: abbanks@deq.virginia.gov

TABLE OF CONTENTS

List of Tables

List of Figures

List of Appendices

1.0 EXECUTIVE SUMMARY

1.1 Introduction and Background

The Washington metropolitan area is planning to continue to meet federal requirements for reducing fine particles ($PM_{2.5}$) in 2009. The Metropolitan Washington region's Federal Reference Monitors (FRMs) demonstrated compliance with the $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS) in 2005 and 2006. Although recent data for 2005 and 2006 show the region's $PM_{2.5}$ levels are meeting the national standards, this regional plan will guarantee continued compliance with the standards in 2009. When implemented, the measures in this plan will result in levels of particle pollution below the annual standard and close to the new daily standard for fine particles. According to the CASAC, reductions in fine particles should improve the health of all residents in the region and reduce mortality for people at risk for cardiovascular disease.

$PM_{2.5}$ matter consists of tiny airborne particles that result from particulate emissions; condensation of sulfates, nitrates, and organics from the gas phase; and coagulation of smaller particles. Unlike $PM_{2.5}$, coarse-mode particles such as dust, pollen, sea salt, and ash are usually produced by mechanical processes including wind and erosion. $PM_{2.5}$ are less than or equal to 2.5 microns across, about 1/30th the average width of a human hair, whereas coarse-mode particles are more than 2.5 microns and may be as large as 10 microns across.

The size of particles is directly linked to their potential for causing health problems. Fine particles less than 2.5 microns in diameter pose the greatest problems because they can lodge deep into the lungs, and some may get into the bloodstream. Therefore, exposure to such particles can affect both lungs and heart. $PM_{2.5}$ pollution affects both human health and the environment such as crops and vegetation. Particle pollution exposure is linked to a variety of health problems, including increased respiratory symptoms, such as irritation of the airways, coughing, or difficulty breathing; decreased lung function; aggravated asthma; development of chronic bronchitis; irregular heartbeat; nonfatal heart attacks; and premature death in people with heart or lung disease.

The Clean Air Act was passed in 1970 to protect the public's health and welfare. Congress amended the Act in 1990 to establish requirements for areas not meeting the National Ambient Air Quality Standards (NAAQS). The Clean Air Act Amendments (CAAA) established a process for evaluating air quality in each region and identifying and classifying nonattainment areas according to the severity of its air pollution problem. The Clean Air Act sets health standards for six ambient pollutants: carbon monoxide, sulfur dioxide, nitrogen oxides, ozone, lead, and particulate matter. The Environmental Protection Agency (EPA) establishes rules and regulations to implement the Clean Air Act.

In 1997 EPA reviewed air quality criteria and standards and established two new $PM_{2.5}$ standards: an annual standard of 15.0 $\mu g/m^3$. and a 24-hour standard of 65 $\mu g/m^3$. EPA revised the secondary standards, making them identical to the primary standards. There were a series of legal challenges to the particulate matter (PM) standards that were not resolved until March

2002, at which time the standards and the EPA's decision process were upheld.[1] The $PM_{2.5}$ standards designations became effective on April 5, 2005, with state implementation plans due three years later on April 5, 2008.

In January 2005 EPA designated the Washington area as a nonattainment area for the 1997 $PM_{2.5}$ NAAQSs. EPA did not use a classification system for $PM_{2.5}$ nonattainment areas. The boundary of the Washington nonattainment area is defined in the *Federal Register,* Vol.; 70, No. 3, 1/5/05. The Washington $PM_{2.5}$ nonattainment area includes the District of Columbia; Arlington, Fairfax, Loudoun, Prince William counties and the cities of Alexandria, Falls Church, Fairfax, Manassas, and Manassas Park in Virginia; as well as Charles, Frederick, Montgomery, and Prince George's counties and the cities of Bowie, College Park, Gaithersburg, Greenbelt, Frederick, Rockville, and Takoma Park in Maryland. A map outlining the nonattainment area is shown in Figure 1-1.

States with nonattainment areas must submit to EPA by April 5, 2008, an attainment demonstration and associated air quality modeling, adopted state regulations to reduce emissions of $PM_{2.5}$ and its precursors, and other supporting information demonstrating that the area will attain the standards as expeditiously as practicable.[2] EPA will determine the region's attainment on the basis of air quality data for 2007-2009. The Metropolitan Washington nonattainment area is required to attain the standards no later than April 2010.

This document, the State Implementation Plan (SIP) for Fine Particle ($PM_{2.5}$) Standards and 2002 Base Year Inventory for the Metropolitan Washington, DC-MD-VA Nonattainment Area, is a plan to demonstrate continued improvement and compliance with the 1997 NAAQSs for $PM_{2.5}$ in the Washington region in 2009. The Plan consists of Base Year inventories for 2002, projection inventories for 2009, an attainment plan, a demonstration of reasonably available control measures, motor vehicle emission budgets for 2009 and 2010, attainment demonstration, and contingency plans for attainment.

The Plan has been prepared by the Metropolitan Washington Air Quality Committee (MWAQC) to comply with the CAAA of 1990 and with EPA requirements for the Washington region as stated in EPA's 2005 designation of the Washington region and EPA's Clean Air Fine Particle Implementation Rule.[3]

[1] *Federal Register*, 40 CFR Part 50, Vol.62, no.138, July 18. 1997, 38652-38701.
[2] CAAA Section 172 (a)(2) requires states to attain the standards as expeditiously as possible but within five years of designation.
[3] *Federal Register*, 40 CFR 51, Part II, Clean Air Fine Particle Implementation Rule, Vol.72, No. 79, 4/25/07, pp.20586-20667.

Figure 1-1


Washington, DC Metropolitan Region
PM2.5 Non-Attainment Area
2000 - 2004 FRM and STN Monitoring Network
N
W
E
S
Frederick Co.
Montgomery Co.
Loudoun Co.
Washington, DC
Arlington Co.
Fairfax Co.
Alexandria
Prince George's Co.
Prince William Co.
Charles Co.
Monitors
1. 11-001-0041 (River Terrace)
2. 11-001-0042 (Park Services)
3. 11-001-0043 (McMillan)
4. 24-031-3001 (Rockville)
5. 24-033-0001 (Bladensburg)
6. 24-033-0002 (Greenbelt)
7. 24-033-0030 (Beltsville)
8. 24-033-8001 (Suitland)
9. 24-033-8003 (Equestrian Center)
10. 51-013-0020 (Aurora Hills)
11. 51-059-0030 (Franconia)
12. 51-059-1005 (Annandale)
13. 51-059-5001 (Lewinsvile)
14. 51-107-1005 (Ashburn)
FRM Monitors
STN Monitors

1.2 SIP Requirements for Nonattainment Areas

The Clean Air Act Section 172 of subpart 1 states the general requirements for state implementation plans (SIPs) and Section 110 (a)(2) establishes further requirements.

- Attainment demonstration due 3 years after designation (4/5/08)
- Reasonably Available Control Techniques/Reasonably Available Control Measures (RACT/ RACM) for major sources
- Enhanced Inspection and Maintenance (I/M) for vehicles
- Contingency measures for failure to attain the health standard

EPA issued implementation guidance for the $PM_{2.5}$ standards published in the *Federal Register* on April 25, 2007 (40 CFR 51, Part II, Clean Air Fine Particle Implementation Rule, Vol. 72, No. 79, 4/25/07, pp. 20586-20667). The policy on $PM_{2.5}$ and precursors identified that $PM_{2.5}$, sulfur dioxide, and nitrogen oxides must be addressed in all areas. Volatile organic compounds (VOCs) and ammonia are not required to be addressed in all areas, but may be addressed if the state or EPA demonstrates that either compound is a significant contributor.

The Fine Particle Attainment Plan for the Washington nonattainment areas has been developed by the MWAQC in cooperation with Maryland, Virginia, and the District of Columbia. Table A identifies the Washington region's control measures that maintain compliance with the $PM_{2.5}$ standards in 2009 (see Page 1-10).

1.3 SIP Process

The Act requires states to develop and implement $PM_{2.5}$ reduction strategies in the form of a SIP. The SIP is the state's "master plan" for attaining and maintaining the NAAQS.

Once the administrator of the EPA approves a state plan, the plan is enforceable as a state law and as federal law under Section 113 of the Act. If EPA finds the SIP inadequate to attain the NAAQS in all or any regions of the state and if the state fails to make the requisite amendments, the EPA administrator may issue binding amendments under Section 110(c)(1).

EPA is required to impose severe sanctions on the states under three circumstances: the state's failure to submit a SIP revision; on the finding of the inadequacy of the SIP to meet prescribed air quality requirements; and the state's failure to enforce the control strategies that are contained in the SIP.

Sanctions include the withholding of federal funds for highway projects -- other than those for safety, mass transit, or transportation improvement projects related to air quality improvement or maintenance -- beginning 24 months after the EPA announcement. No federal agency or department will be able to award a transportation grant or fund, license, or permit any other transportation project that does not conform to the most recently approved SIP.

1.4 The Metropolitan Washington Air Quality Committee (MWAQC)

Under Section 174 of the CAAA, the governors of Maryland and Virginia and the mayor of the District of Columbia certified the MWAQC to develop specific recommendations for a regional air quality plan in the Washington, DC-MD-VA nonattainment area. The agreement was renewed in 2004.

Members of MWAQC include elected officials from the cities of Bowie, College Park, Frederick, Gaithersburg, Greenbelt, Rockville, and Takoma Park in Maryland; the cities of Alexandria, Fairfax, Falls Church, Manassas, and Manassas Park in Virginia; the Montgomery and Prince George's county councils; the Montgomery and Prince George's county executives; the mayor of the District of Columbia and representatives of the Council of the District of Columbia; and representatives of Calvert, Charles, and Frederick counties in Maryland and of Arlington, Fairfax, Loudoun, and Prince William counties in Virginia.

Representatives of the general assemblies of Maryland and Virginia, the state air management directors, the state transportation directors, and the chairman of the National Capital Region Transportation Planning Board also are members of MWAQC. The membership roster is contained in Appendix A.

The Metropolitan Washington Council of Governments, in close cooperation with state air quality and transportation agencies, provides technical support to the MWAQC. Additional technical staff support is provided by county and city technical staffs.

MWAQC also has established a public advisory committee to provide recommendations regarding public participation in the development of the air quality plans. The Air Quality Public Advisory Committee (AQPAC) works closely with staff and submits formal recommendations to MWAQC. AQPAC members represent academic, business, civic, and environmental groups. AQPAC members are listed in Appendix A.

Representatives of the following state air management agencies are members of MWAQC: District of Columbia Department of the Environment (DDOE), Air Quality Division; Air and Radiation Management Administration of the State of Maryland's Department of the Environment (MDE); and the Commonwealth of Virginia's Department of Environmental Quality (VADEQ). Representatives of the following state transportation agencies are members of MWAQC: District Department of Transportation (DDOT), Maryland Department of Transportation (MDOT), and the Virginia Department of Transportation (VDOT).

Since the Washington metropolitan nonattainment area crosses state boundaries, the states and the District of Columbia established MWAQC to prepare a regional control plan. MWAQC's recommendations are forwarded to the Interstate Air Quality Council (IAQC) and to the three state air agencies. In turn, each state will submit a SIP revision to EPA. In Maryland, the submittal is made by the governor or a designee; in the District of Columbia, by the mayor or a designee; and in Virginia by the Director of the Virginia Department of Environmental Quality on behalf of the governor.

1.5 Interstate Air Quality Council

The Interstate Air Quality Council (IAQC) is a cabinet-level collaboration among the District of Columbia, the State of Maryland, and the Commonwealth of Virginia, comprising the secretaries of the environment and transportation. The purpose of IAQC is to address issues of interstate transport of air pollutants and to provide a sound process for improving regional air quality. IAQC transmits air quality planning proposals and materials to MWAQC for review and consideration. MWAQC transmits proposed plans and reports to the IAQC for submittal by the governors and the mayor to EPA.

1.6 State Commitment/Implementation Assurances

The measures in the SIP must be supported by any necessary legislative authority adopted by the states and the District of Columbia and adopted by the applicable governmental body responsible for their implementation.

Section 110 of the 1990 CAAA specifies the conditions under which EPA approves SIP submissions. These requirements are being followed by MWAQC and the states in developing this air quality plan or SIP. To develop effective control strategies, EPA has identified four fundamental principles that SIP control strategies must adhere to in order to achieve the desired emissions reductions. These four fundamental principles are outlined in the General Preamble to Title I of the Clean Air Act Amendments of 1990 at *Federal Register* 13567 (EPA, 1992a). The four fundamental principles are

a) Emissions reductions ascribed to the control measure must be quantifiable and measurable;
b) The control measures must be enforceable, in that the state must show that they have adopted legal means for ensuring that sources are in compliance with the control measure;
c) Measures are replicable;
d) The control strategy must be accountable in that the SIP must contain provisions to track emissions changes and to provide for corrective actions if the emissions reductions are not achieved according to the plan.

1.7 Submittal of the Plans

The governors and the mayor (or their designees) are required to submit to the EPA air quality SIPs to meet the requirements of the CAAA. After MWAQC and the IAQC approve the SIP, each of the states and the District of Columbia will submit the document, along with specific commitments, schedules for adoption as appropriate, to EPA's Region III Office in Philadelphia.

1.8 Sanctions

EPA must impose various sanctions if the states or the District of Columbia does not submit a plan, submits a plan that the EPA does not approve, or fails to implement the plan. These include withholding federal highway funding, withholding air quality planning grants, and imposing a federal plan ("federal implementation plan"). Failure to submit or implement a plan will have significant consequences for compliance with conformity requirements.

1.9 Base Year 2002 Emission Inventories and Future Year 2009 Emissions Inventories

EPA issued implementation guidance for the fine particle standards published in the *Federal Register* on April 25, 2007. The policy on $PM_{2.5}$ and precursors identified that $PM_{2.5}$, sulfur dioxide, and nitrogen oxides must be addressed in all areas. VOCs and ammonia are not required to be addressed in all areas, but may be addressed if the state or EPA demonstrates that either compound is a significant contributor.

The average annual composition of $PM_{2.5}$ in the Washington region is 58% sulfate, 28% carbon/$PM_{2.5}$ Direct, 7% nitrates (see Chapter 2, Figure 2-10). The rest are crustal matter and trace elements. Emissions inventories for the three major precursors, $PM_{2.5}$ ("Direct"), nitrogen oxides (NOx), and sulfur dioxide (SO_2) are compared in Figures 1-2 to 1-4. $PM_{2.5}$ increases slightly by 5.3% from 2002 to 2009, shown in Figure 1-2. Nitrogen oxides emissions are shown in Figure 1-3; they decline by 41% between 2002 and 2009. The largest reductions in NOx come from reductions in point sources and mobile sources. Sulfur dioxide emissions increase during this period by 3.8% due to increases from the utility sector (Figure 1-4).

Figure 1-2

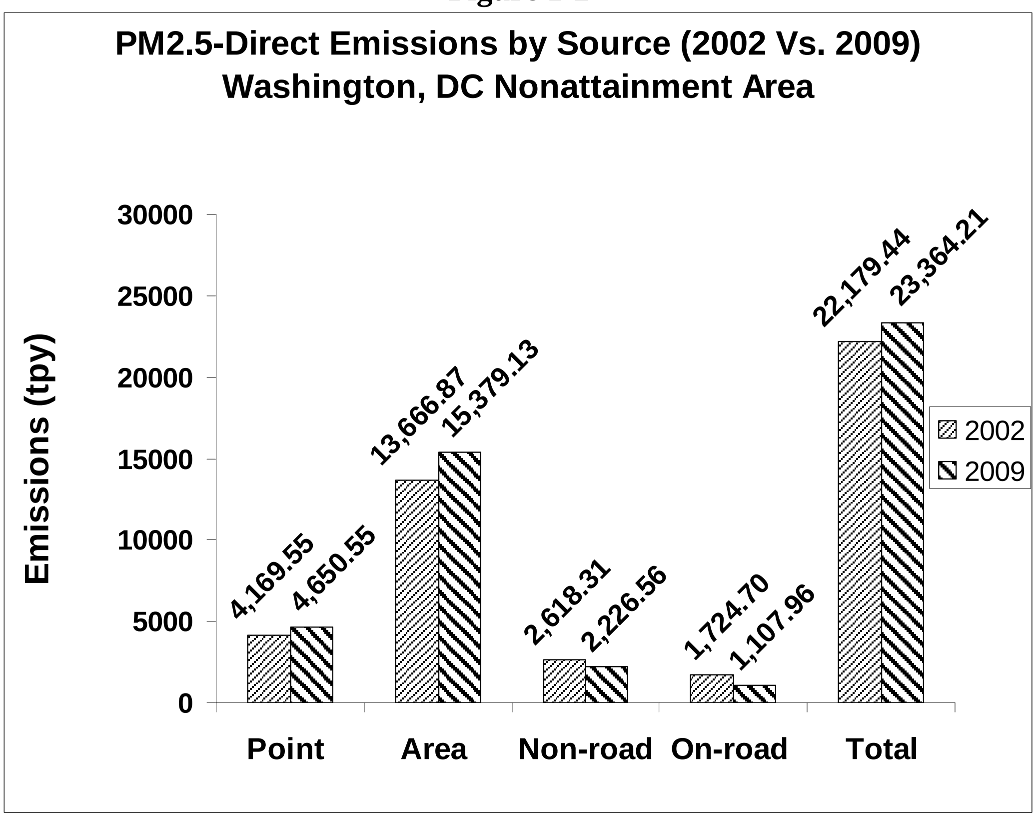


Figure 1-3

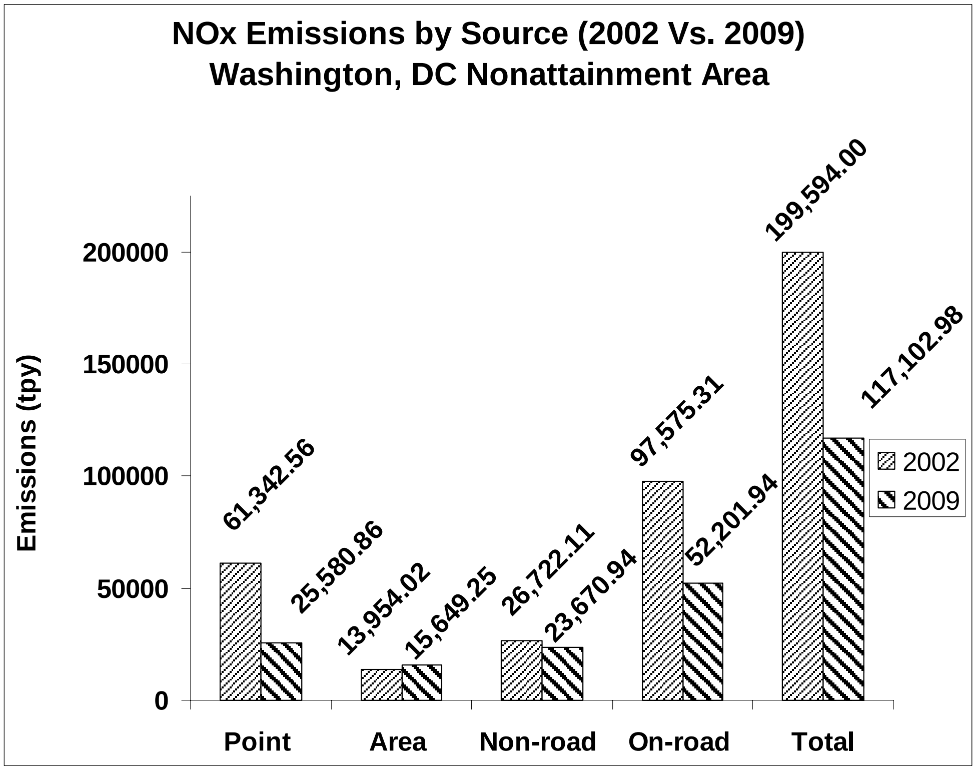
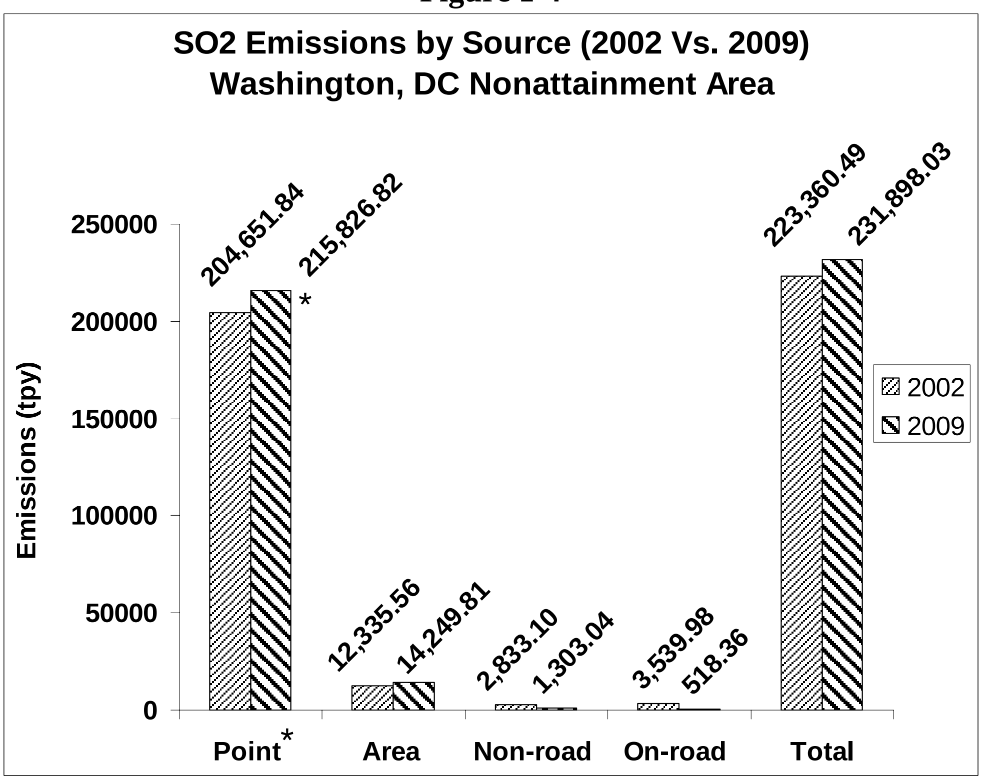


Figure 1-4



* There will be a total of 169,154.11 tons (MD - 158,353.6 tons; VA - 10,800.5 tons) of SO_2 reduction between the years 2009 and 2011due to the Clean Air Interstate Rule and the Maryland Healthy Air Act.

1.10 Reductions in $PM_{2.5}$ Precursors from Measures, 2002-2009

Overall, the 2009 plan for the Metropolitan Washington region includes total reductions by 2009 of 599 tons/year of $PM_{2.5}$-Direct, 77,330 tons/ year of nitrogen oxides (NO_x), and 23,615 tons/ year of sulfur dioxide. The reductions are calculated as the difference between controlled 2009 inventory and uncontrolled and are shown in Table A. The plan may be summarized as follows:

- NO_x reductions are from the NO_x SIP call, the Clean Air Interstate Rules and the Healthy Air Act, state NO_x Reasonably Available Control Technologies (RACT), EPA Nonroad Gasoline and Diesel Engines Rules, and a suite of on-road measures including High-Tech Vehicle Inspection and Maintenance programs, the National Low Emission Vehicle Program, and Tier 2 Motor Vehicle Emissions Standards.
- Sulfur dioxide reductions are from the Clean Air Interstate Rules and the Healthy Air Act, EPA Nonroad Gasoline and Diesel Engine Rules, low-sulfur fuel requirements, and a suite of on-road measures including High-Tech Vehicle Inspection and Maintenance Programs, the National Low Emission Vehicle Program, Tier 2 Motor Vehicle Emissions Standards.
- $PM_{2.5}$ Direct reductions are from federal Nonroad Gasoline Engines Rules, the Nonroad Diesel Engines Rule, Emissions Standards for Spark Ignition Marine Engines, Emissions Standards for Large Spark Ignition Engines and Standards for Locomotives, and the Heavy-Duty Diesel Rules for On-Road Measures.

TABLE A
SUMMARY OF CONTROL STRATEGIES
PM2.5, NOx, and SO_2 Benefits of Control Measures
(2009 uncontrolled-2009 controlled)

Ref No.	*Control Measure*	Reductions $PM_{2.5}$ Direct tons/year	 NOx tons/year	 SO_2 tons/year
MEASURES INCLUDED IN THE BASELINE CONTROLS SCENARIO				
POINT SOURCE MEASURES				
5.1.1	State Regional Transport Requirement	0	0	0
5.1.2	Visibility Standards	0	0	0
AREA SOURCE MEASURES				
5.2.1	Seasonal Open Burning Restrictions	0	0	0
ON-ROAD MEASURES				
5.4.1	High-Tech Inspection/Maintenance (original cutpoints)	0	0	0
5.4.2	Evaporative Standards	0	0	0
5.4.3	National Low Emission Vehicle Program	0	0	0
5.4.6	Transportation Control Measures and Vehicle Technology, Fuel, or Maintenance Measures	0	0	0
NON-ROAD MEASURES				
5.3.1	EPA Non-Road Gasoline Engines Rule	0	0	0
5.3.2	EPA Non-Road Diesel Engines Rule	0	0	0
5.3.3	Emissions Standards for Spark Ignition Marine Engines	0	0	0
5.3.4	Emissions Standards for Large Spark Ignition Engines	0	0	0
MEASURES INCLUDED IN THE FUTURE CONTROLLED SCENARIO				
POINT SOURCE MEASURES				
5.1.1	State and Regional Transport Requirement (RACT, NOx SIP Call, CAIR, HAA)	-	43,091	17,967
SUBTOTAL			**43,091**	**17,967**
AREA SOURCE MEASURES				
SUBTOTAL		**-**	**-**	**-**
NON-ROAD MEASURES				
5.3.1	EPA Non-Road Gasoline Engines Rule			
5.3.2	EPA Non-Road Diesel Engines Rule			
5.3.3	Emissions Standards for Spark Ignition Marine Engines	393	5,320	2,152
5.3.4	Emissions Standards for Large Spark Ignition Engines			
5.3.5	Standards for Locomotive			
SUBTOTAL		**393**	**5,320**	**2,152**
ON-ROAD MEASURES				
5.4.1	High-Tech Inspection/Maintenance (updated cutpoints)			
5.4.3	National Low Emission Vehicle Program	204	28,770	3,496
5.4.4	Tier 2 Motor Vehicle Emission Standards			
5.4.5	Heavy-Duty Diesel Engine Rule			
5.4.6	Transportation Control Measures and Vehicle Technology, Fuel, or Maintenance Measures	2.6	149.1	0
SUBTOTAL		**207**	**28,919**	**3,496**
TOTAL REDUCTIONS		**599**	**77,330**	**23,615**

Notes: No additional emission reductions are expected for measures fully implemented before 2002.

1.11 Establishment of a Budget for Transportation On_Road Motor Vehicle Emissions

As part of the development of the plan, MWAQC in consultation with the Transportation Planning Board (TPB) will establish motor vehicle emissions budgets (MVEBs) or maximum allowable levels of $PM_{2.5}$ Direct and NO_x. These budgets will be the benchmark used to determine if the region's long-range transportation plan, known as the Constrained Long-Range Plan (CLRP), and the six-year transportation improvements program (TIP) conform with the CAAA of 1990. Under EPA regulations the projected on-road motor vehicle source emissions for 2009 -- minus the Transportation Control Measures (TCM) and vehicle technology, fuel, or maintenance-based measures -- become the motor vehicle emissions budgets for the region unless MWAQC takes actions to set another budget level. The motor vehicle emissions budgets were developed using computer models MOBILE6.2.03 and Travel Demand Model version 2.1d#50.

Attainment Year Motor Vehicle Emission Budgets (MVEBs)

The Motor Vehicle Emission Budgets (MVEBs) for the 2009 attainment year are based on the projected 2009 on-road motor vehicle source emissions, accounting for the emission reductions from on-road motor vehicle source control measures identified in Chapter 5, including TCMs and vehicle technology, fuel, or maintenance-based measures.

The Motor Vehicle Emissions Budget for 2009:

$PM_{2.5}$ Direct = 1,105.4 tons/year NO_x = 52,052.9 tons/year

Contingency Budget

The Motor Vehicle Emission Budgets MVEBs for the 2010 year are based on the projected 2009 on-road motor vehicle source emissions accounting for the emission reductions from on-road motor vehicle source control measures identified in Chapter 5, including TCMs and vehicle technology, fuel, or maintenance-based measures, minus the reductions required for the contingency plan discussed in Chapter 10. The reduction amount provided to satisfy the contingency plan is 657 tons/year NO_x.

The Motor Vehicle Emissions Budget for 2010:

NO_x = 51,395.9 tons/year

1.12 Attainment Modeling Demonstration

The Fine Particle Attainment Plan includes a modeling demonstration that the Washington metropolitan area will maintain compliance with the annual and 24-hour (as specified in 1997) $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS). The demonstration is based on results from the Community Multiscale Air Quality Model (CMAQ).

In the base year 2002, three monitors in the region were above the annual standard of 15.0 $\mu g/m^3$. Modeling the projected controlled emissions for 2009 with reductions from the measures listed in Table A, the 2009 modeling results show no monitors in the Washington, DC-MD-VA region above the annual $PM_{2.5}$ health standard of 15.0 $\mu g/m^3$ or above the 24-hour fine PM2.5 standard of 65 $\mu g/m^3$. Additionally, modeling done by the Association for Southeastern Integrated Planning (ASIP) group provides further evidence that all the monitors in the Washington region will be below the $PM_{2.5}$ health standards in 2009.

In addition to attainment modeling, the monitor data (Figure 1-5) shows a downward trend in $PM_{2.5}$ design values, starting in 2002. In 2005 and 2006 the monitors in the region were in compliance with the annual $PM_{2.5}$ standard (Figure 1-5). During the period 2001-2006, all monitors in the region were in compliance with the 1997 24-hour $PM_{2.5}$ standard (Figure 1-6).

Figure 1-5: Annual $PM_{2.5}$ Design Value, 2001-2006

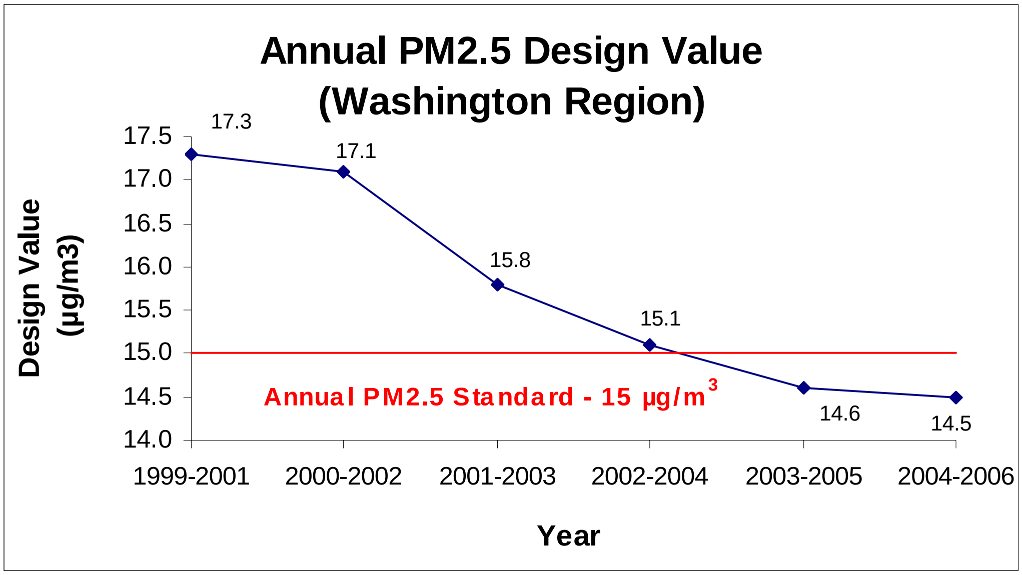
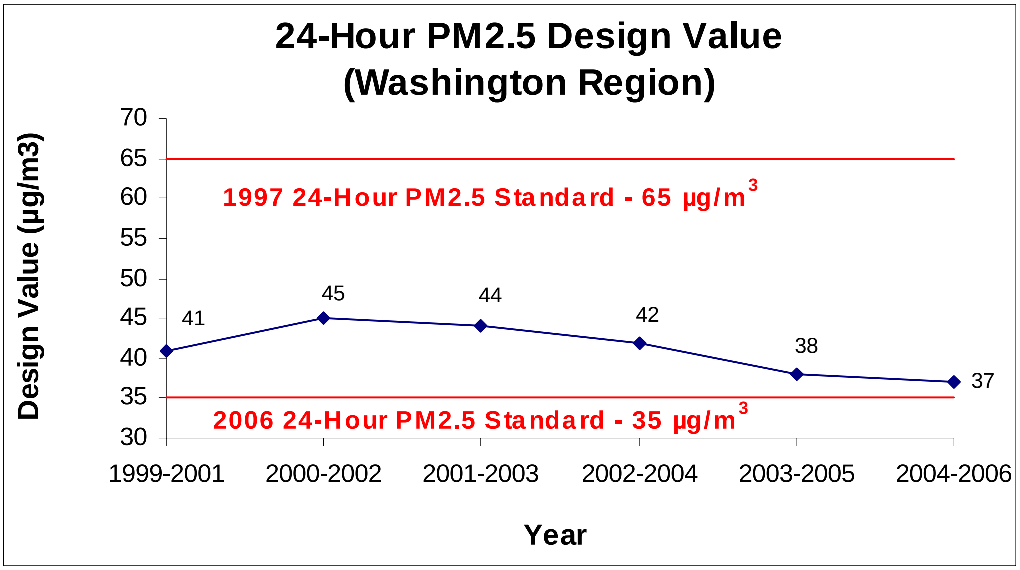


Figure 1-6: 24-Hour $PM_{2.5}$ Design Value, 2001-2006



1.13 Determination of Reasonably Available Control Measures (RACM)

The cumulative impact of previously adopted and on-going, measures described in Chapter 5 has been sufficient to comply with the $PM_{2.5}$ NAAQS (1997) based on 2003-2005 ambient monitoring data. The states of Maryland and Virginia and the District of Columbia will continue to implement the RACM measures already adopted and described in Chapter 5. The analysis in Chapter 6 establishes that these measures contributed to the region being able to comply with the $PM_{2.5}$ NAAQS (1997) based on 2003-2005 design values. Therefore, this analysis demonstrates that there are no additional measures that are necessary to demonstrate attainment as expeditiously as practicable and to meet any RFP requirements and that there are no potential measures that if considered collectively would advance the attainment year by one year or more. The above analysis meets the applicable statutory requirements set forth at Section 172(c)(1) of the Clean Air Act and the applicable regulatory requirements set forth at 40 C.F.R. Section 51.1010.

1.14 Contingency Measures

Two measures, the Tier 2 Motor Vehicle Emissions Standards and the Regional Transport NOx reductions from the Clean Air Interstate Rule and the Healthy Air Act, provide a total benefit of more than 169,000 tons/year SO_2 and 657 tons/year NO_x. The combined reduction is greater than the required reductions, therefore meeting the contingency measure requirement. The SO_2 reductions are more than 15 times the required NO_x reduction, and this ratio is significantly higher than all of the equivalency assessments described in Chapter 10.

1.15 Document Contents

Chapter 2	Presents a detailed overview of fine particle pollution, including a precursor significance determination.
Chapter 3	Presents revisions to the 2002 base year inventory using MOBILE 6.2.03, Travel Demand Model version 2.1d#50 including corrections to nonroad, area, and stationary source emissions.
Chapter 4	Presents the 2009 projected inventories using MOBILE 6.2.03 and Travel Demand Model Version 2.1d#50 and a discussion of the growth projection methodology.
Chapter 5	Outlines the control strategies that the states will implement to achieve the reductions in $PM_{2.5}$, NO_x, and SO_2, including Supplemental Measures.
Chapter 6	Discusses the demonstration of Reasonably Available Control Measures (RACM).
Chapter 7	Discusses mobile source conformity issues and establishes 2009 and 2010 mobile emissions budgets for the Metropolitan Washington region.
Chapter 8	Presents the states' schedules and adoption of regulations to meet requirements for severe nonattainment areas and presents the states' commitments to EPA.
Chapter 9	Presents the Metropolitan Washington region's demonstration of attainment based on CMAQ modeling.
Chapter 10	Presents contingency measures for the 2009 attainment demonstration.

2.0 FINE PARTICLE POLLUTION

2.1 Definition of Fine Particle Matter

Fine particle ($PM_{2.5}$) matter consists of tiny airborne particles that result from particulate emissions; condensation of sulfates, nitrates, and organics from the gas phase; and coagulation of smaller particles. Unlike $PM_{2.5}$, coarse particles such as dust, pollen, sea salt, and ash are usually produced by mechanical processes including wind and erosion. $PM_{2.5}$ are less than or equal to 2.5 microns across, about 1/30th the average width of a human hair, whereas coarse particles are more than 2.5 microns and may be as large as 10 microns across.

Gas-phase precursors SO_2, NO_x, VOCs, and ammonia undergo chemical reactions in the atmosphere to form secondary PM (see Figure 2-1). Formation of secondary PM depends on numerous factors including the concentrations of precursors; the concentrations of other gaseous reactive species; atmospheric conditions including solar radiation, temperature, and relative humidity (RH); and the interactions of precursors with preexisting particles and with cloud or fog droplets. Several atmospheric aerosol species, such as ammonium nitrate and certain organic compounds, are semi-volatile and are found in both gas and particle phases. Given the complexity of $PM_{2.5}$ formation processes, new information from the scientific community continues to emerge to improve our understanding of the relationship between sources of PM precursors and secondary PM formation.

There are 14 monitors, Federal Reference Monitors or FRMs that sample $PM_{2.5}$ in the Washington region (see Figure 1-1). The purpose of the filter-based FRMs is to determine compliance with the $PM_{2.5}$ NAAQS. FRMs are filter based that measure $PM_{2.5}$ mass by passing a measured volume of air through a preweighed filter. The coarse PM is separated out before air is passed through the filter.

2.2 Health and Environmental Effects

The size of particles is directly linked to their potential for causing health problems. Fine particles less than 2.5 microns in diameter pose the greatest problems because they can lodge deep into the lungs and some may get into the bloodstream. Therefore, exposure to such particles can affect both lungs and heart. Particle pollution may occur all year as opposed to ozone, which occurs during the summer months. Particle pollution exposure is linked to a variety of health problems, including increased respiratory symptoms, such as irritation of the airways, coughing, or difficulty breathing; decreased lung function; aggravated asthma; development of chronic bronchitis; irregular heartbeat; nonfatal heart attacks; and premature death in people with heart or lung disease.

Studies have demonstrated a relationship between increased levels of $PM_{2.5}$ and higher rates of death and complications from cardiovascular disease. Evidence shows that inhalation of particles leads to direct vascular injury and atherosclerosis, or hardening of the arteries. According to the American Lung Association, an estimated 1.0 million people, 25% of the population in the metropolitan Washington area, are at risk for cardiovascular disease.[1] Additional populations at increased risk in the Metropolitan Washington region include 404,135 asthmatics, including 104,161 children and 299,974 adults, and 196,356 residents with other chronic or persistent respiratory diseases, such as chronic bronchitis and emphysema.

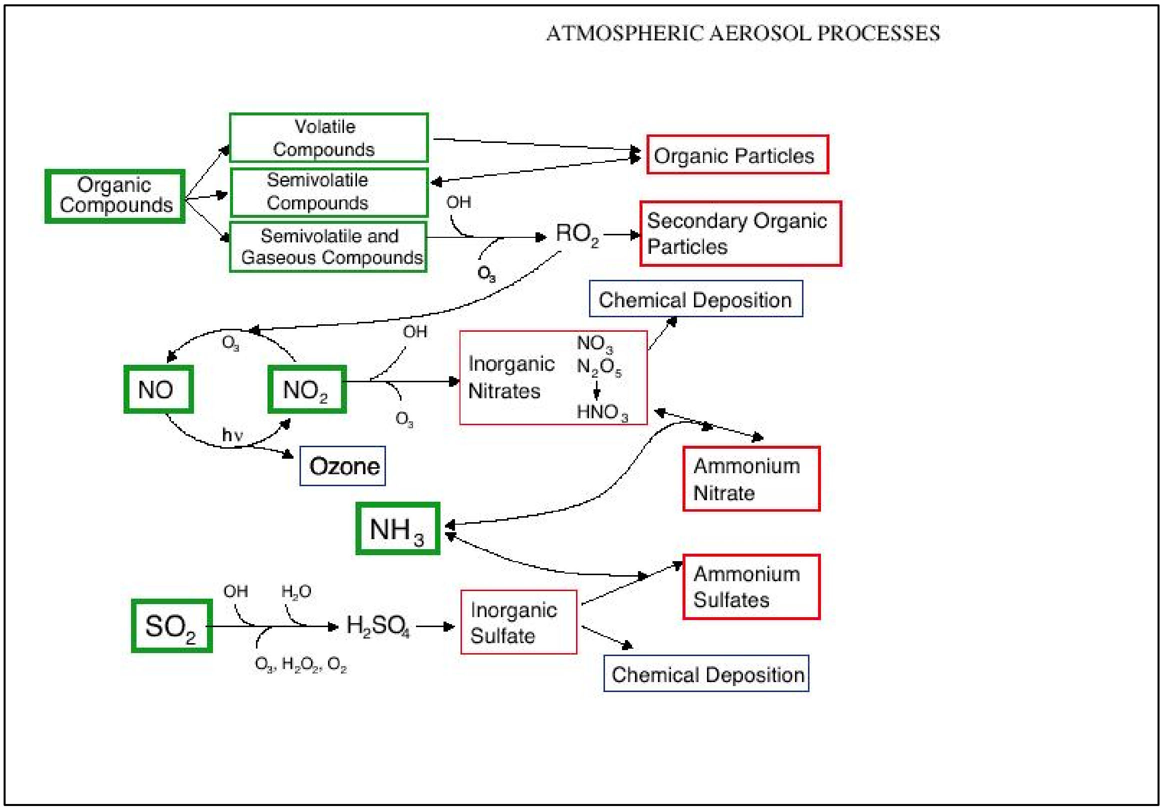


Figure 2-1. Atmospheric chemical reactions that contribute to $PM_{2.5}$, from the North American Strategy for Tropospheric Ozone (NARSTO) Assessment 2004.[1]

Environmental effects of particle pollution include reduced visibility, environmental damage, and aesthetic damage. $PM_{2.5}$ are the major cause of reduced visibility (haze) in parts of the United States, including many of our treasured national parks and wilderness areas. Particles can be carried over long distances by wind and then settle on ground or water. The effects of this settling include making lakes and streams more acidic, changing the nutrient balance in coastal waters and large river basins, depleting the nutrients in soil, damaging sensitive forests and farm crops, and affecting the diversity of ecosystems. Particle pollution can stain and damage stone and other materials, including culturally important objects such as statues and monuments.

When implemented, the measures in this plan will result in levels of particle pollution below the annual standard and close to the new daily standard for fine particles. According to the CASAC, reductions in fine particles should improve the health of all residents in the region and reduce mortality for people at risk for cardiovascular disease.[2]

2.3 Seasonal Variation of $PM_{2.5}$ Concentrations and Constituents

Seasonal variation of $PM_{2.5}$ concentrations (Figure 2-2) depends on the composition and speciation of the particles and the precursors from which the particles form via preferred chemical reactions. Figure 2-1 shows how precursors such as SO_2, NO_x, and organic compounds help produce important components of $PM_{2.5}$, such as ammonium sulfate, ammonium nitrate, and organic particles. These $PM_{2.5}$ components may coagulate to produce $PM_{2.5}$, or these reactions may take place on the surfaces of $PM_{2.5}$ and thus produce secondary particles. Chemical reactions that produce nitrates are favored in the winter, when nitrate concentrations are enhanced and ozone concentrations are lowered. However, organic carbon and sulfates are produced more readily during the summer because warmer temperatures favor chemical reactions involving SO_2 and VOCs.

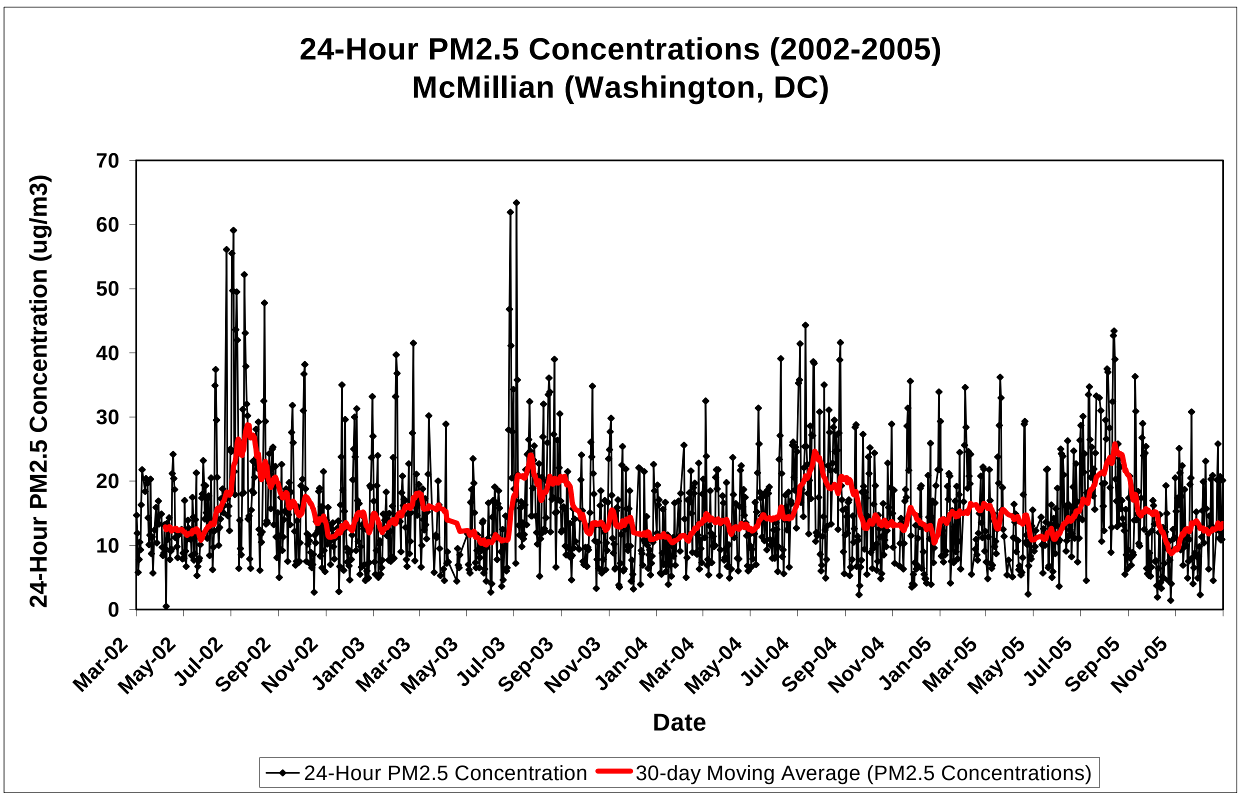


Figure 2-2. Seasonal variation of $PM_{2.5}$ Concentrations during 2002-2005 at the River Terrace monitor (110010041), Washington, DC. Source: 24-Hour PM2.5 Concentrations, AQS.

1) Sulfates

Sulfates, one of the most significant components of $PM_{2.5}$ in the Washington, DC region, generally has higher average concentrations during the spring and summer than during the autumn and winter in the Washington, DC area (Figure 2-3). Sulfates are produced when sulfur dioxide (SO_2) is oxidized; these oxidation reactions occur more frequently during the summer, hence the higher sulfate concentrations occur during the summertime.

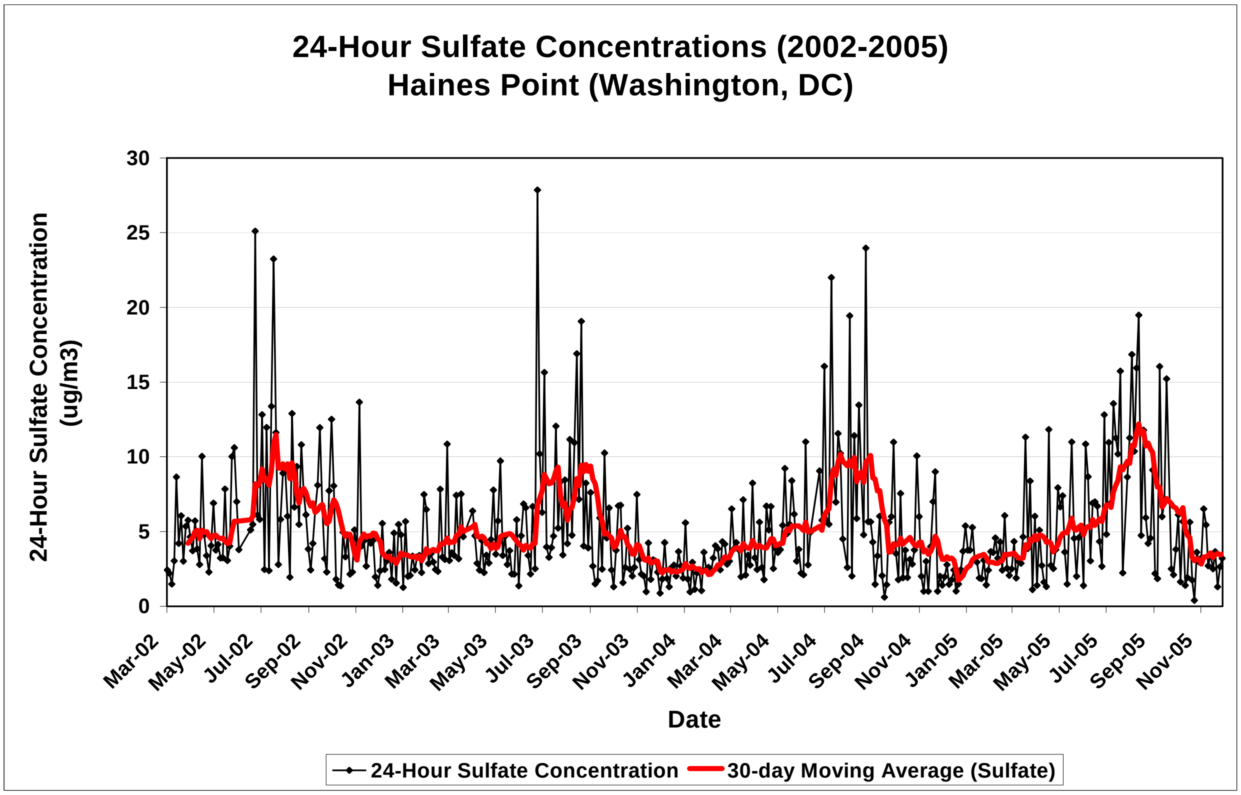


Figure 2-3. Seasonal variation of sulfates during 2002-2005 at the Haines Point monitor (110010042), Washington, DC. Source: 24-Hour Sulfate Concentrations, AQS.

2) Nitrates

Nitrate concentrations increase markedly as seasonal temperatures decrease. Nitrate concentrations are thus heightened during winter and spring (Figure 2-4); thus NO_x typically does not react as readily with VOCs during winter and spring, hence the higher wintertime and spring-time nitrate concentrations. During summer, however, higher air temperatures enable NO_x to react more readily with VOCs and produce ozone. As a result, nitrate concentrations are minimized during the warm season. During winter, heightened nitrate concentrations contribute to slightly elevated $PM_{2.5}$ levels, despite relatively low sulfate concentrations.

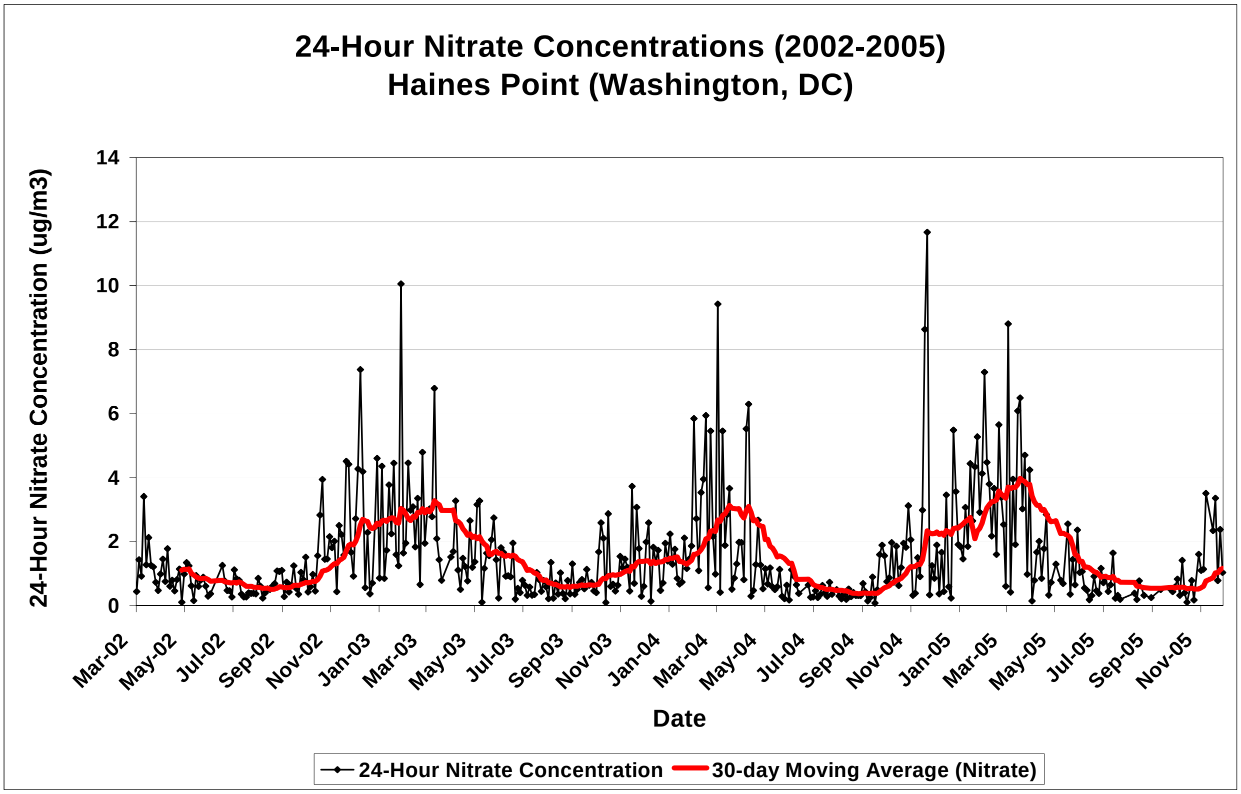


Figure 2-4. Seasonal variation of nitrates during 2002-2005 at the Haines Point monitor (110010042), Washington, DC. Source: 24-Hour Nitrate Concentrations, AQS.

3) Organic and Elemental Carbon

Concentrations of another precursor, organic carbon (Figure 2-5), is quite variable at almost any time of the year, and the highest daily values may originate from forest fires upwind of the region. Another precursor that has high variability throughout the year is elemental carbon. Elemental carbon concentrations are highest during the fall and winter seasons and lowest during the spring and summer seasons.[2]

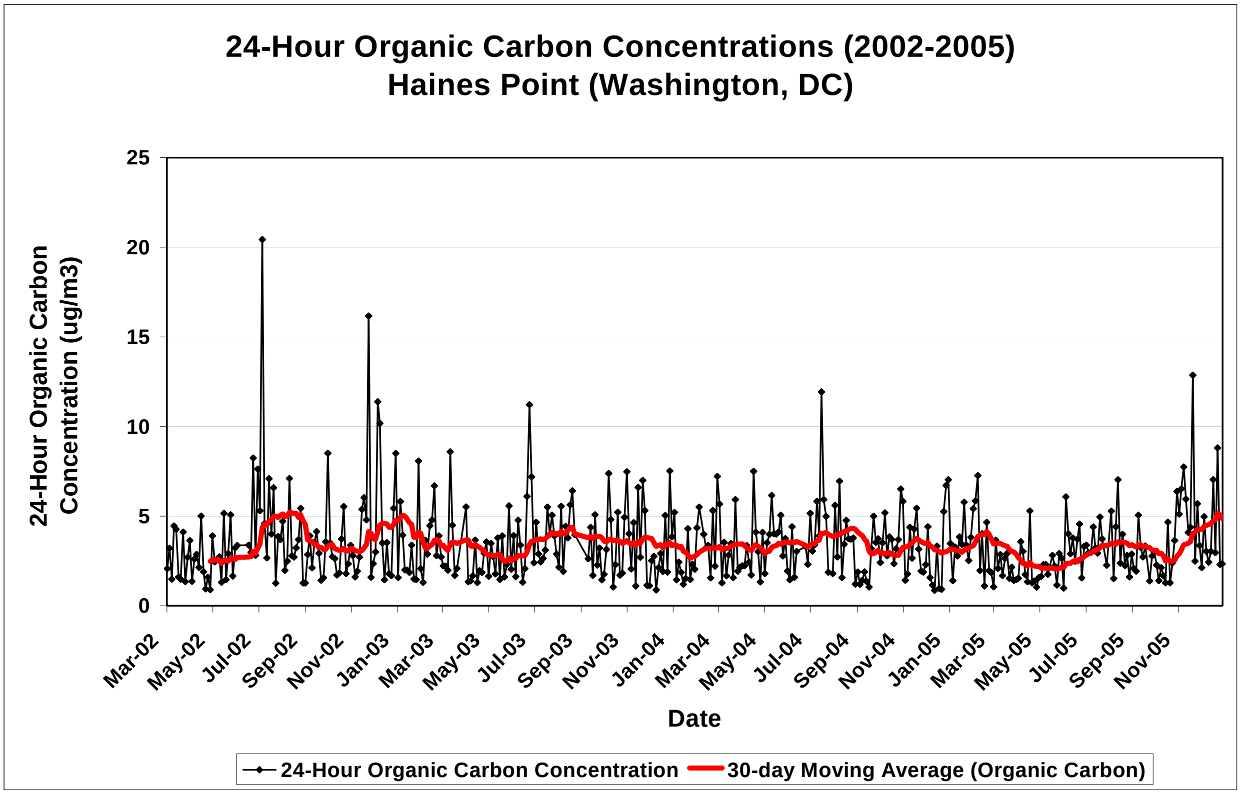


Figure 2-5. Seasonal variation of organic carbon during 2002-2005 at the Haines Point monitor (110010042), Washington, DC. Source: 24-Hour Organic Carbon Concentrations, AQS.

4) Ammonium

Ammonium ions do not exist independently in the atmosphere. They either exist as ammonium sulfate or ammonium nitrate as ammonia reacts with sulfates and nitrates to form these two compounds. Therefore, ammonium concentrations depend on ammonium sulfate or ammonium nitrate concentrations. Concentrations of ammonium sulfate and ammonium nitrate vary seasonally depending on whether sulfates or nitrates have higher concentrations. The chemicals that have higher concentrations are more available for chemical reactions than those with lower concentrations. Since sulfates have much higher concentrations during the summer than other precursors, ammonia will typically react with the sulfates to produce ammonium sulfate, as in Figure 2-1. Hence, ammonium sulfates have higher concentrations in the summer (Figure 2-6), whereas ammonium nitrates have elevated concentrations in the winter due to heightened concentrations of nitrates available for chemical reactions with ammonia.

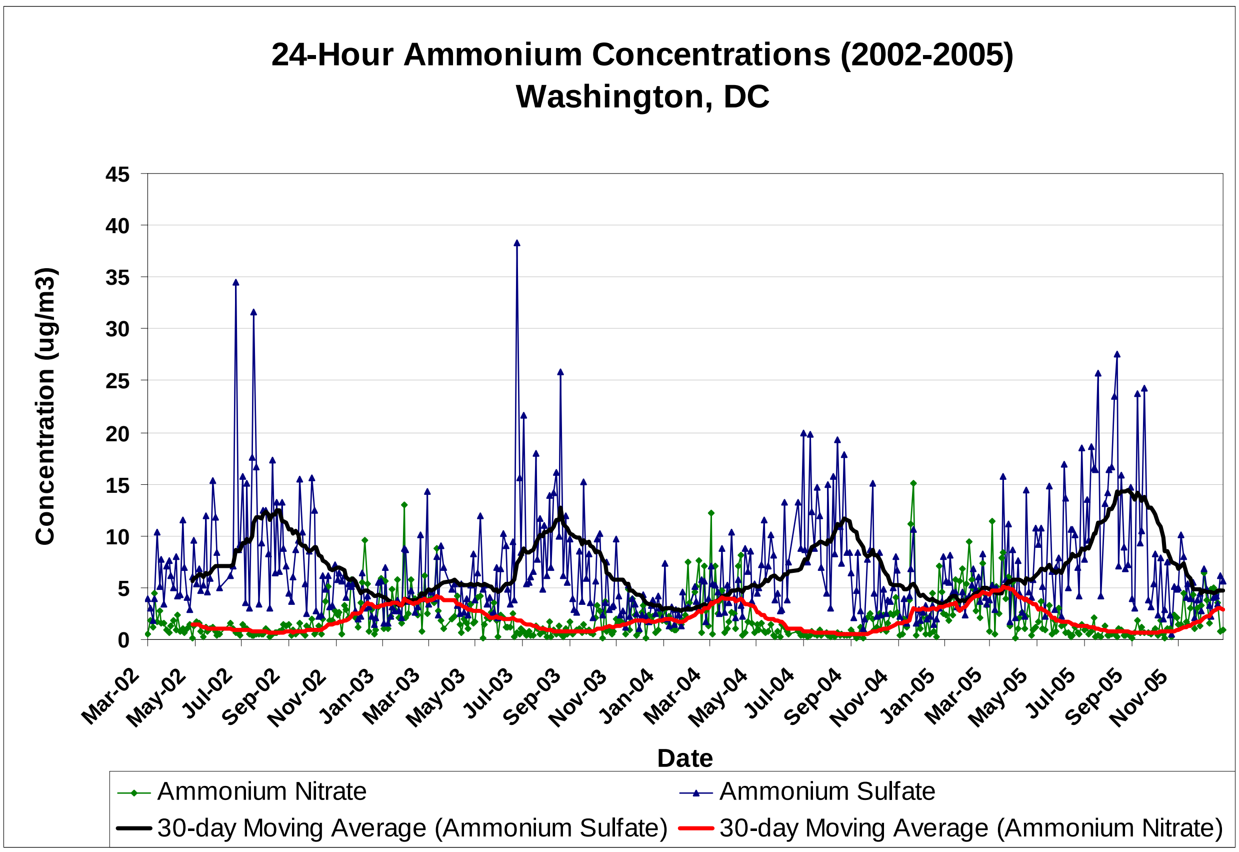


Figure 2-6. Seasonal variation of ammonium during 2002-2005 at the McMillan monitor (110010043), Washington, DC. Source: 24-Hour Ammonium Nitrate & Ammonium Sulfate Concentrations, AQS.

2.4 Diurnal Variation of Fine Particles

$PM_{2.5}$ concentrations not only vary seasonally but also diurnally, as shown in Figure 2-7 using hourly $PM_{2.5}$ data between March 2003 and March 2007. $PM_{2.5}$ concentrations appear to be heightened during the morning and early evening hours, coinciding with peak traffic times for the Washington, DC metropolitan area. A notable minimum in $PM_{2.5}$ concentrations occurs during the late morning to early afternoon hours, presumably due to a diurnal increase in surface winds that help diffuse the particles about and away from the region. A lesser minimum also occurs during the overnight hours due to a strong reduction in mobile and industrial activity during sleeping hours.

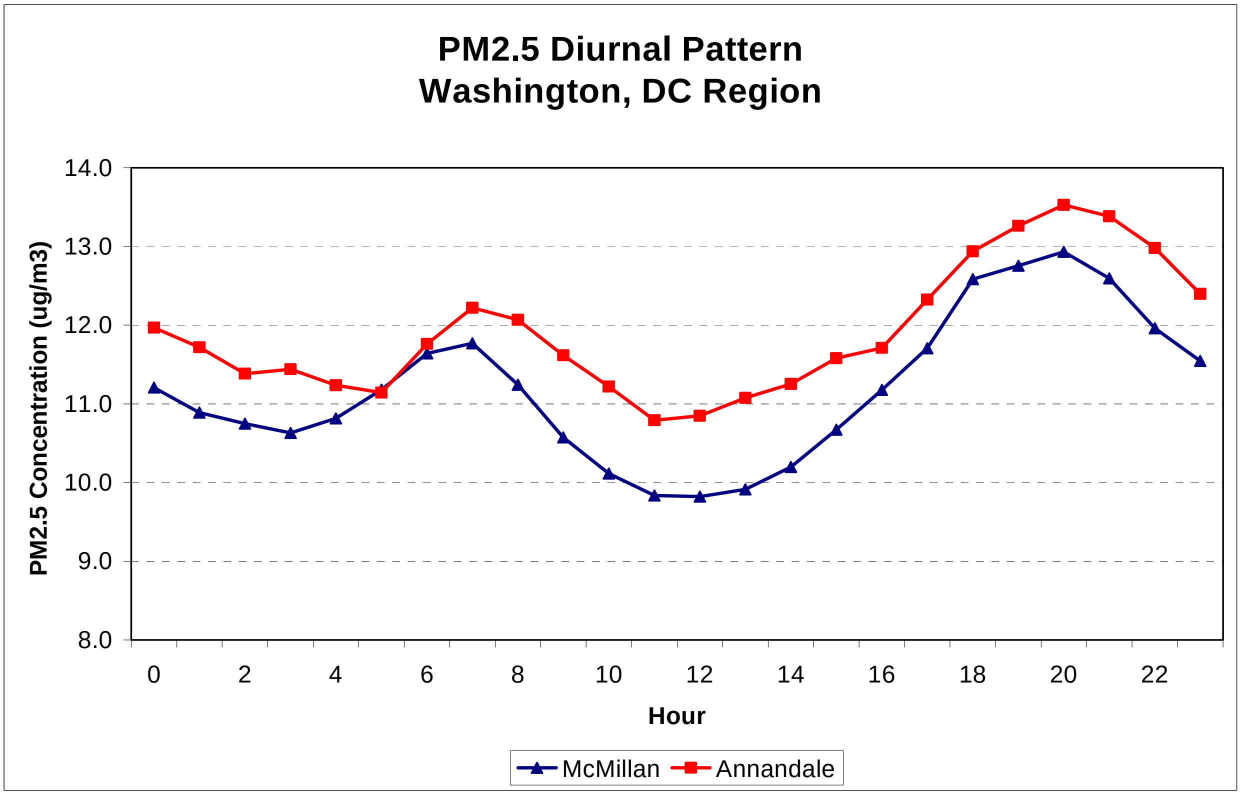


Figure 2-7. Washington $PM_{2.5}$ diurnal pattern based on daily $PM_{2.5}$ data from March 2003 to March 2007. MWCOG, October 2007.

2.5 Trajectories of Fine Particles

$PM_{2.5}$ may originate both locally and remotely. A back trajectory analysis show particles from remote areas are carried by the wind into the region.[1] When high particle concentrations occur upwind, concentrations in the area of interest may also increase as a result. Back trajectories for days with high $PM_{2.5}$ concentrations usually show particle tracks originating over the continental United States (Figure 2-8). Many of these trajectories circulate and track through pollution source regions in the Midwest and Ohio Valley. When winds flow through pollution-heavy

[1] Back Trajectory is a trace backward in time showing where an air mass has been.

regions, particles are carried downstream by the wind, causing $PM_{2.5}$ concentrations to jump in affected areas. Forest fires, however, are a special case where trajectories need not circulate through the continental United States but may originate from the burning areas that are typically clean and unpolluted, such as eastern Canada on July 7, 2002. Clean days with low particle concentrations typically have trajectories running from distant points in western Canada or looping clockwise from eastern Canada through the Atlantic Ocean into the Washington area.

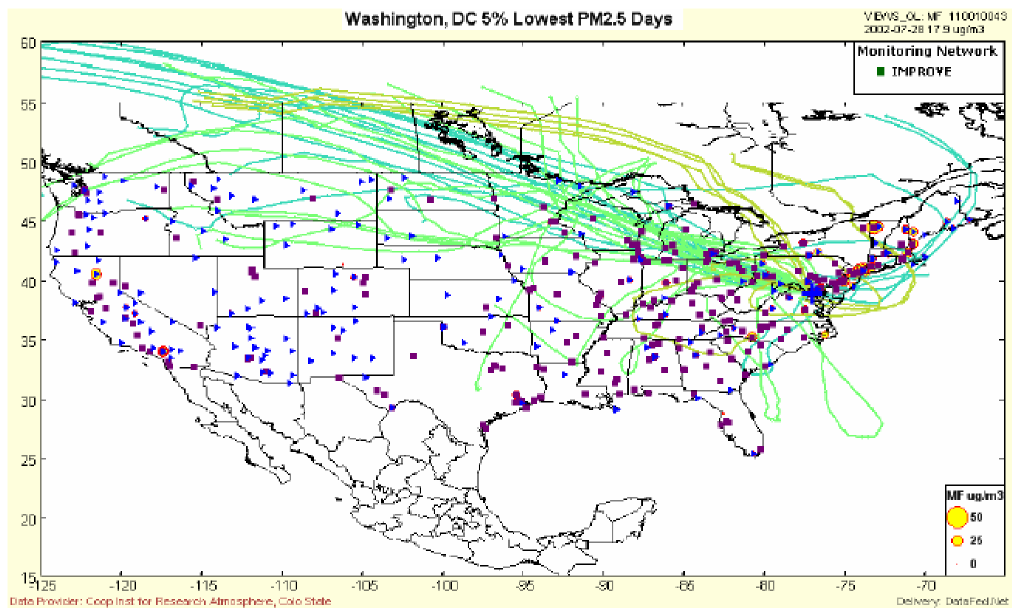


Figure 5-136 Washington, DC, Back Trajectories for the Five Percent Cleanest Days

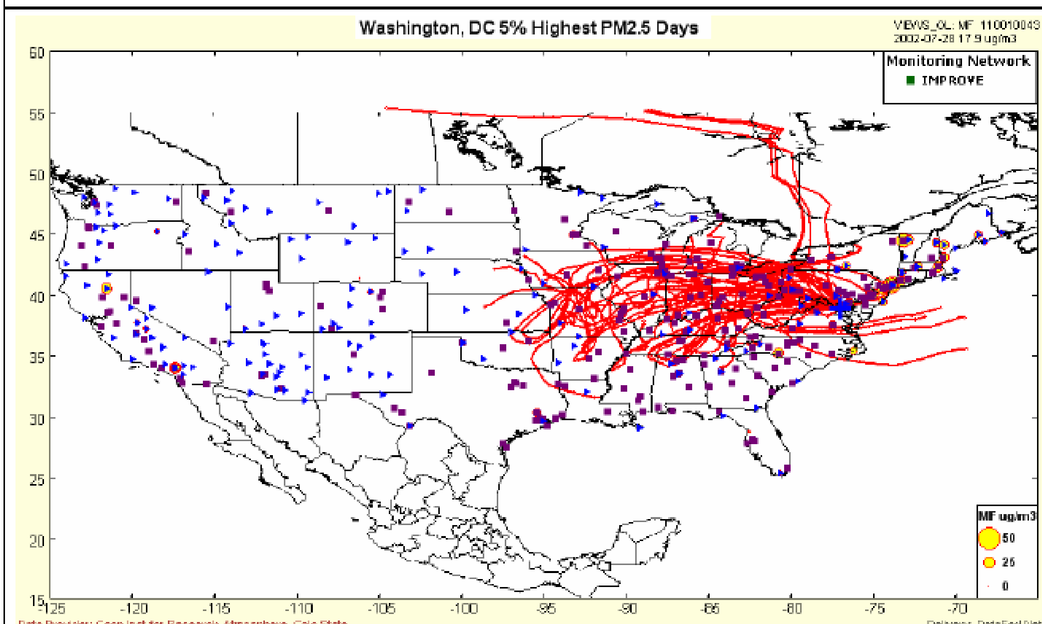


Figure 5-137 Washington, DC, Back Trajectories for the Five Percent Dirtiest Days

Figure 2-8. Fine PM trajectories for Washington, DC based on data from April 2001 to December 2003.[2]

2.6 Major Constituents of $PM_{2.5}$ in the Washington Region

Most observed ambient $PM_{2.5}$ matter originates from precursor gases, SO_2, NO_x, ammonia (NH_3), VOCs, and primary $PM_{2.5}$ emissions and is transferred to the condensed phase through a variety of physiochemical processes, forming major constituents of $PM_{2.5}$. Data from speciation monitors provide information about the relative contribution of the chemical components and the sources of these pollutants.

$PM_{2.5}$ speciation monitors are used to support SIP development by providing information on $PM_{2.5}$ chemical composition. There are two speciation monitors in the Washington nonattainment area, one located at McMillan Station in the District and the other at Annandale, Virginia. The relative concentrations of each $PM_{2.5}$ constituent, annually averaged over 2001-2003, are shown in Figure 2-9, with sulfates being one of the most significant contributors to $PM_{2.5}$ mass concentrations. However, primary aerosol particles have both direct and indirect roles in the formation of secondary particle matter. For example, primary particles can serve as reaction sites for the formation of new PM.

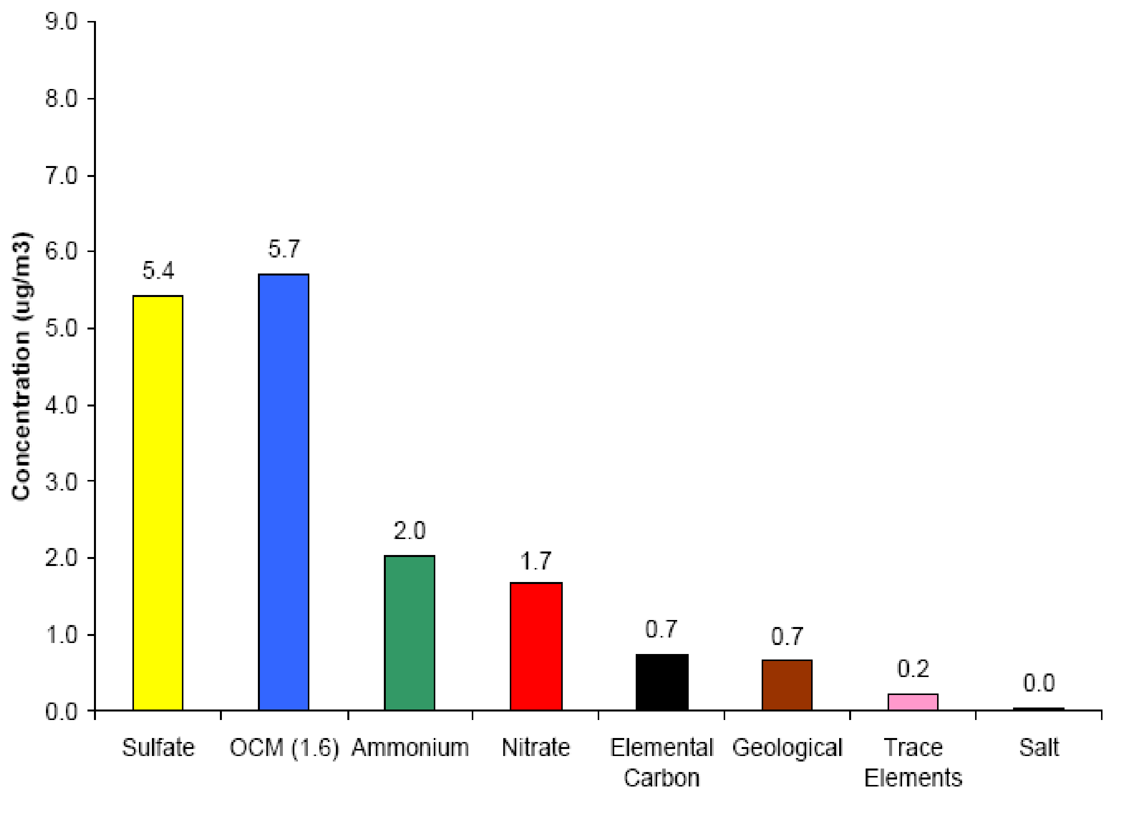


Figure 5-128 Major Constituents of $PM_{2.5}$ Mass, Washington, DC

Figure 2-9. Annually averaged 2001-2003 concentrations of $PM_{2.5}$ constituents for Washington, DC.[3] Source: "$PM_{2.5}$ Area Profiles Mid-Atlantic Region Observations," August 2006. EPA Staff working draft. OCM is Organic Carbon Mass. Organic Mass / Organic Carbon ratio of 1.6.

2.7 Sources of $PM_{2.5}$ and Constituents

Sources of $PM_{2.5}$ include all types of combustion activities including motor vehicle emissions, coal power plants, wood and vegetative burning, and certain industrial processes involving nitrates and sulfates. EPA uses the SANDWICH (Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbon Hybrid material balance) method to chemically characterize ambient $PM_{2.5}$ speciation data. Figure 2-10 shows that a large portion, about 65%, of annual averaged $PM_{2.5}$ composition consists of ammonium sulfate and ammonium nitrate, which are products of reactions of ammonia, sulfates, and nitrates in the atmosphere in summer and winter, respectively.

Ammonia from sources such as fertilizer and animal feed operations contribute to the formation of ammonium sulfates and ammonium nitrates suspended in the atmosphere. The rest originates from sulfates, carbon and organic compounds from vegetative burning, coal power plants, geological dust, oil combustion, motor vehicle emissions, and diesel vehicle emissions. Nitrates usually originate from vehicle emissions and power generation.

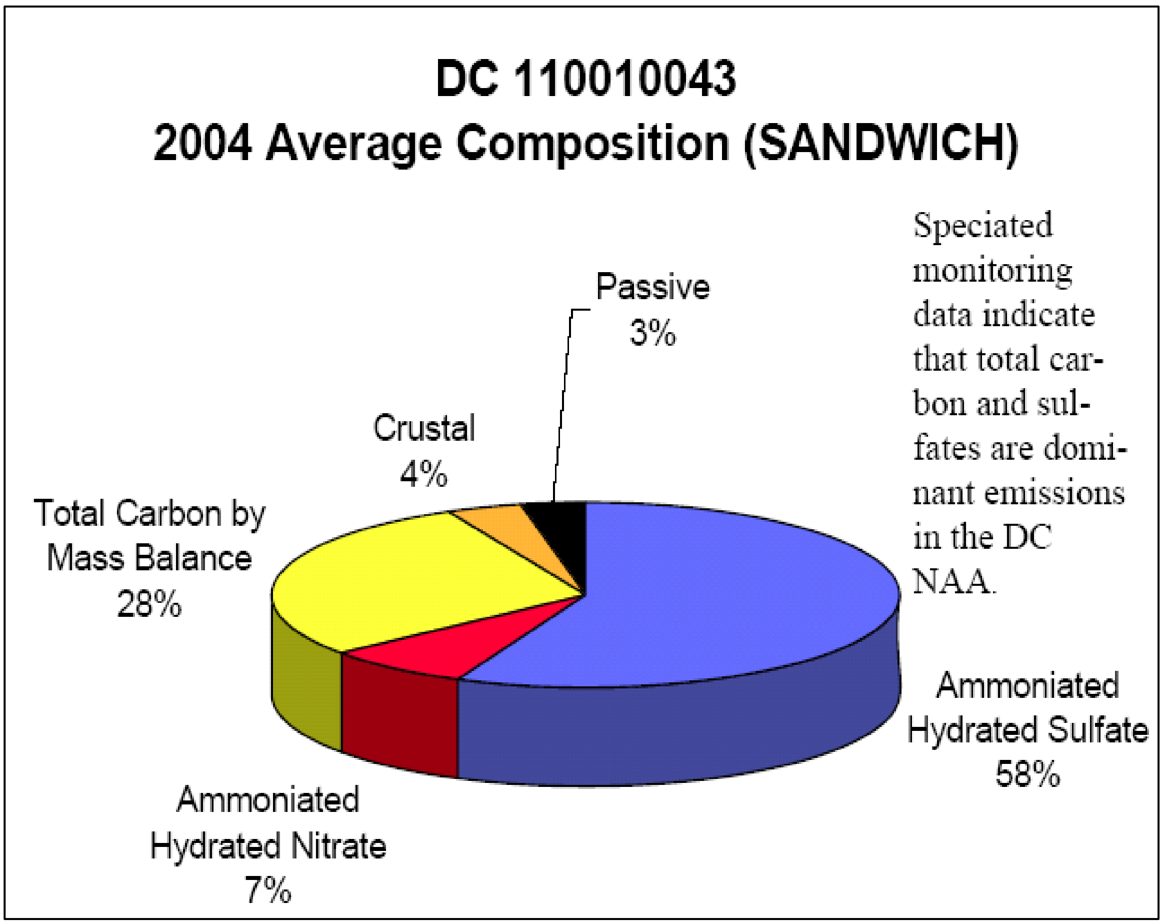


Figure 2-10. $PM_{2.5}$ Composition (% by mass) data from the McMillan Station in Washington, DC in 2004. "$PM_{2.5}$ Area Profiles Mid-Atlantic Region Observations," August 2006. EPA Staff working draft. NAA is nonattainment area. "Passive" represents other components not shown in the graph.

2.8 Determination of Significance for Precursors

The significance of each precursor for $PM_{2.5}$ has been analyzed and determined by EPA. Based on EPA's advice, $PM_{2.5}$ Direct, SO_2, and NO_x were deemed significant for the Washington, DC nonattainment area, while NH_3 and other precursors were deemed insignificant at this time. According to EPA's $PM_{2.5}$ implementation guidance, sources of direct $PM_{2.5}$ and SO_2 must be evaluated for control measures in all nonattainment areas.[2] Direct $PM_{2.5}$ emissions include organic carbon, elemental carbon, and crustal material. If emissions of a precursor contribute significantly to $PM_{2.5}$ concentrations in the area, then the sources of that precursor will need to be evaluated for reasonable control measures. EPA found sulfates and carbon to be the most significant fractions of $PM_{2.5}$ mass in all nonattainment areas and therefore concluded that the reductions in SO_2 will lead to a significant net reduction in $PM_{2.5}$ concentrations despite a potential slight increase in nitrates.

The contribution of VOC to $PM_{2.5}$ formation is the least understood of all precursors, and the reactions involving VOC are highly complex. In light of these factors, states are not required by EPA to address VOC as a $PM_{2.5}$ attainment plan precursor and evaluate them for control measures, unless the state or EPA makes a finding that VOCs significantly contributes to $PM_{2.5}$ concentrations in the non-attainment area or to other downwind air quality concerns. Due to lack of conclusive information at this time, given the state of science and research on $PM_{2.5}$ precursors, the Washington, DC region decided to follow EPA's advice on VOC for the current Annual $PM_{2.5}$ NAAQS SIP and reevaluate VOCs and their significance in future $PM_{2.5}$ SIPs and revisions.

The role of ammonia in $PM_{2.5}$ is also not as well understood as those of SO_2 and carbon. Although ammonia is a constituent of $PM_{2.5}$ as ammonium sulfate and ammonium nitrate as shown in Figure 2-10, the mass of ammonia takes up only a small fraction of the total mass of $PM_{2.5}$ constituents. Reducing ammonia emissions may marginally reduce $PM_{2.5}$ concentrations, but particle and precipitation acidity may increase as a result. Increased acidity in particles and precipitation is a more adverse side effect of reducing ammonia concentrations, so ammonia is not required by EPA to be evaluated in this implementation plan unless deemed significant by the state or EPA. Due to lack of conclusive information at this time, the states decided to follow EPA's advice on ammonia in the current SIP for Annual $PM_{2.5}$ NAAQS and reevaluate ammonia's significance in future $PM_{2.5}$ SIPs and revisions.

The role of NO_x in the formation of $PM_{2.5}$ is very important. It forms nitrate in significant amounts during winter, favored by the availability of ammonia, low temperatures, and high relative humidity. $PM_{2.5}$ concentrations respond most effectively to NO_x reductions in the winter by reducing the oxidation process and SO_2 formation. Therefore, states are required to address NO_x as a $PM_{2.5}$ attainment plain precursor and evaluate reasonable controls for nitrates in implementation plans, unless the EPA finds that NO_x emissions from sources in the state do not significantly contribute to the $PM_{2.5}$ concentrations in the nonattainment area. The states have determined that NO_x is a significant precursor in the plan for the Metropolitan Washington region.

[2] EPA, $PM_{2.5}$ Implementation Guidance, *Federal Register*, vol. 72, No. 79m 4/25/07, pp. 20586-20666.

EPA's $PM_{2.5}$ implementation rule requires that state air agencies make a determination of the significance of $PM_{2.5}$ pollutants/precursors for SIP planning purposes, including requirements for motor vehicle emission budgets for use in conformity. The known PM pollutants include $PM_{2.5}$ Direct as well as the precursors NO_x, SO_2, VOCs, and NH_3 (see Table 2-1). $PM_{2.5}$ Direct and the precursors NO_x and SO_2 are deemed significant under the EPA guidance. PM_{10} is required for the base year emission inventory but does not need to be included in the SIP control strategy. For the current annual $PM_{2.5}$ SIP, several precursors are presumed to be insignificant and are not required be included in the SIP control strategy unless the state or EPA makes a finding of significance. Table 2-1 summarizes the federal requirements for each precursor.

Table 2-1. EPA SIP Requirements for PM Pollutants

	$PM_{2.5}$ Direct	NO_x	SO_2	VOC	NH_3	PM_{10}
Base Year Emission Inventory	√	√	√	√	√	√
SIP Controls	√	√	√	-	-	Not required

- = Not required unless precursor deemed significant by states or EPA.

Summary of Significance Determinations for PM Pollutants

Through interagency consultation and consideration of available information, the state air agencies have completed significance determinations for each of the PM precursors. The determination was conducted using a two-step process. Step 1 involved determining whether PM pollutants/precursors are considered significant for SIP planning purposes. Step 2 involved determining whether PM pollutants/precursors identified as significant in Step 1 require Motor Vehicle Emission Budgets (MVEBs) for conformity. Table 2-2 summarizes the determination.

Table 2-2. Summary of Significance Determinations for SIP Controls and Motor Vehicle Emission Budgets

	PM Direct	NO_x	SO_2	VOC	NH_3
Step 1: Determine Significance for SIP Controls	√	√	√	No*	No*
Step 2: Determine Significance for Establishing Motor Vehicle Emission Budgets for Conformity	√	√	No	No*	No*

* = Due to lack of conclusive information at this time, given the state of science and research on $PM_{2.5}$ precursors, the Washington, DC region decided to follow EPA's advice on VOC and NH_3 for the current Annual $PM_{2.5}$ NAAQS SIP and reevaluate their significance in future $PM_{2.5}$ SIPs and revisions.

EPA notes that any significance or insignificance finding made prior to EPA's adequacy finding for budgets in a SIP, or EPA's approval of the SIP, should not be viewed as the ultimate determination of the significance of precursor emissions in a given area. State and local agencies may reconsider significance findings based on information and analyses conducted as part of the SIP development process.

Determine Significance for SIP Controls

The only precursors for which significance determinations are needed for SIP control purposes are VOCs and ammonia. EPA requires that $PM_{2.5}$ Direct, NO_x, and SO_2 controls be evaluated and included in the SIP. A primary factor considered for VOCs and ammonia is that the region's monitors already show compliance with the $PM_{2.5}$ annual NAAQS so no additional controls are needed for attainment purposes. A second factor considered is that EPA guidance allows states to presume that these precursors are insignificant unless modeling or other analysis indicates that the precursor should be considered significant. A summary of the rationale for the significance determinations for VOCs and ammonia is listed in Table 2-3.

Table 2-3. Summary of Rationale for Insignificance Determinations for VOCs and NH_3 for SIP Controls

Criteria	Pollutant	
	VOC	**NH_3**
Are emission controls needed for attainment or maintenance?	No	No
Is there evidence to counter EPA's presumption that the precursor be considered insignificant?	No	No
Will reducing emissions of the precursor have a significant impact on $PM_{2.5}$ concentrations?	No, based on VISTAS modeling	No, based on VISTAS modeling
Are technology options available to control emissions?	Yes	Varies by source
Is the precursor considered significant for Annual $PM_{2.5}$ NAAQS SIP planning purposes?	No	No

*VISTAS is Visibility Improvement State and Tribal Association of the Southeast.

National research is underway to assess the contribution of VOCs to secondary organic aerosol formation. States are following the research and will reconsider the significance determination for both VOC and ammonia when further technical information becomes available for future $PM_{2.5}$ SIPs and revisions.

2.9 Compliance with the $PM_{2.5}$ NAAQS

The Metropolitan Washington region's Federal Reference Monitors (FRMs) (see Figure 1-1) demonstrate compliance with the annual $PM_{2.5}$ National Ambient Air Quality Standard in 2005 and 2006 and with the 24-hour standard throughout the period 2001-2006. The purpose of the filter-based FRMs is to determine compliance with the $PM_{2.5}$ NAAQS. Filter-based FRMs measure $PM_{2.5}$ mass by passing a measured volume of air through a preweighed filter.

Design value trends for the annual and 24-hour $PM_{2.5}$ standards are shown in Figure 2-11 and 2-12 respectively. The data are from EPA's air trends data (www.epa.gov/air/airtrends). In 2005 the design value was 14.6 µg/m^3; in 2006 the design value was 14.5 µg/m^3, again below the annual $PM_{2.5}$ standard of 15.0 µg/m^3.

Figure 2-11. Annual $PM_{2.5}$ Design Values, Washington Region, 2001-2006

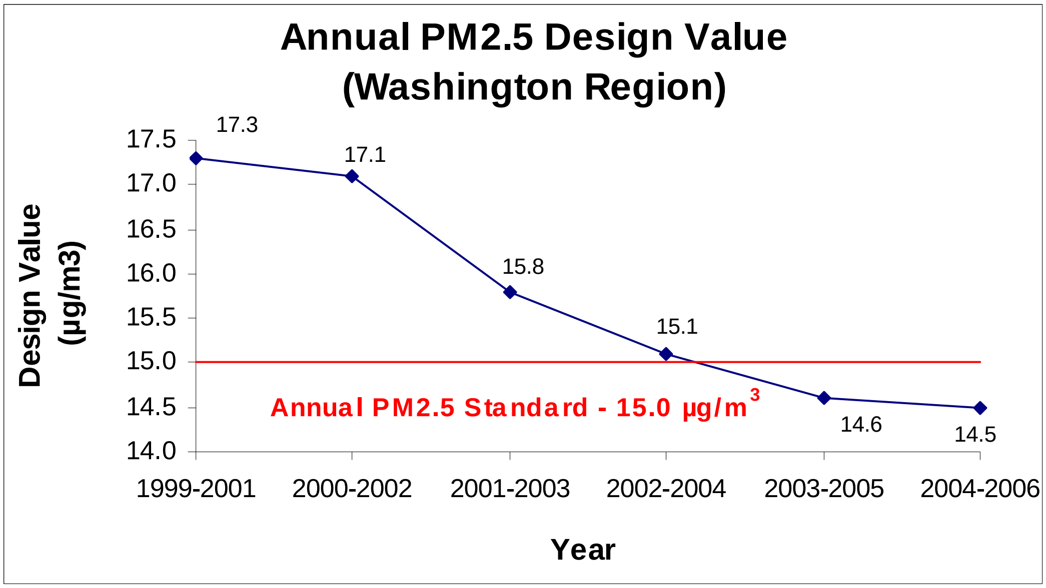
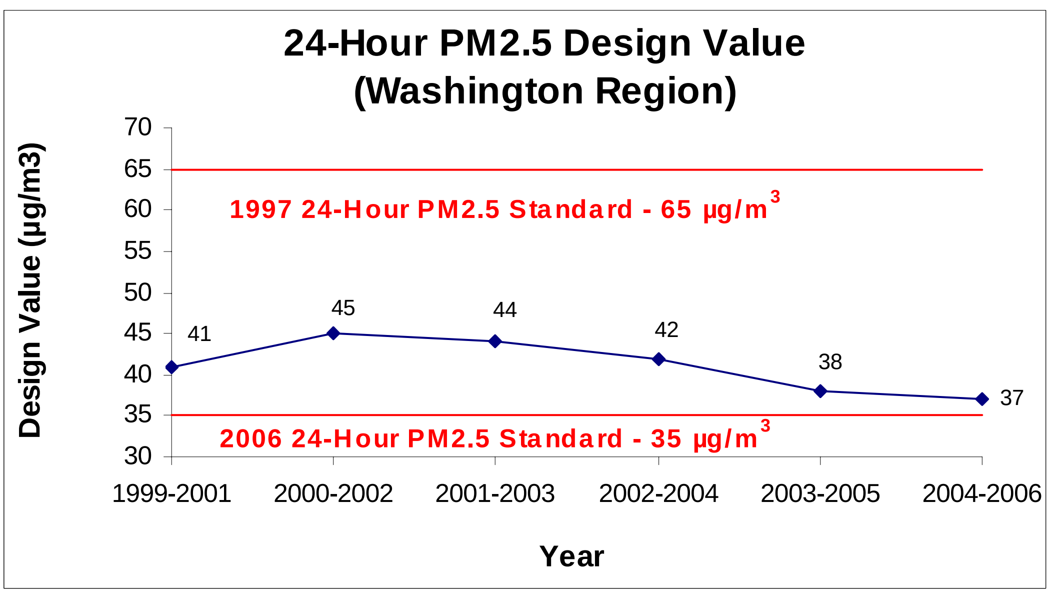


Figure 2-12. 24-Hour $PM_{2.5}$ Design Values, Washington Region, 2001-2006



References

1. American Lung Association, State of the Air Report 2007, www.lungusa.org

2. EPA, Air Quality Criteria Document for PM (October 2004), EPA/600/P-99/002aF

3. NARSTO 2004 PM Assessment for Policy Makers: A NARSTO Assessment. P. McMurry, M. Shepherd and J. Vickery, Cambridge University Press, Cambridge, England ISBN 0-52-1842875.

4. An Analysis of Speciated $PM_{2.5}$ Data in the MARAMA Region," Mid-Atlantic Regional Air Management Association. May 31, 2006, pp. 171-181.

5. "PM2.5 Area Profiles Mid-Atlantic Region Observations," August 2006. EPA Region 3 Staff working draft, pp.103-118.

3.0 2002 Base Year Inventory

3.1 Background and Requirements

The 2002 Base Year Inventory is documented in detail in Appendix B (2002 Base Year Emissions Inventory Document for Washington, DC-MD-VA $PM_{2.5}$ Nonattainment Area) of the $PM_{2.5}$ SIP document. This inventory document was prepared for the District of Columbia, Maryland, and Virginia by the Metropolitan Washington Council of Governments (MWCOG) under the auspices of MWAQC. It is available for inspection along with rest of the $PM_{2.5}$ SIP documents at the offices of the MWCOG and the District of Columbia, Maryland, and Virginia air management agencies in addition to the MWCOG Web site (http://sharepoint.mwcog.org/airquality).

The emissions inventory covers the Washington, DC-MD-VA $PM_{2.5}$ nonattainment area, Figure 1-1, which is classified as a nonattainment area for the annual $PM_{2.5}$ standard by the Environmental Protection Agency (EPA). The 2002 emissions inventory is the baseline for tracking the progress for emissions in future years, such as the attainment year 2009. It also serves as the starting point for calculating the emissions reduction requirement (for man-made sources of emissions) needed to meet the contingency requirements in case the $PM_{2.5}$ standards are not met in the attainment year 2009. Emissions reductions for attainment contingency are required for nonattainment areas by the Clean Air Act Amendments (CAAA) and EPA.

Appendix B (2002 Base Year Emissions Inventory Document for Washington, DC-MD-VA $PM_{2.5}$ Nonattainment Area) of the $PM_{2.5}$ SIP document addresses emissions of $PM_{2.5}$-Direct, oxides of nitrogen (NO_x), sulfur dioxide (SO_2), volatile organic compounds (VOCs), ammonia (NH_3), and PM_{10}-Direct on an annual basis. Included in the inventory are anthropogenic (man-made) sources, such as point, area, nonroad, and on-road mobile sources and biogenic (naturally occurring) sources of $PM_{2.5}$ precursors.

The 2002 base year annual inventories for $PM_{2.5}$ Direct, NO_x, SO_2, VOCs, NH_3, and PM_{10} Direct can be seen in Tables 3-1 through 3-6.

Table 3-1
2002 Base Year Annual $PM_{2.5}$-Direct Inventory
(tons/year)

	District of Columbia	Maryland	Virginia	Total[a]
Point	126.53	3,497.31	545.71	4,169.55
Area	495.07	7,479.48	5,692.32	13,666.87
Nonroad	298.71	1,007.45	1,312.15	2,618.31
On-Road	156.27	841.18	727.25	1,724.70
Biogenics	0.00	0.00	0.00	0.00
Total[a]	1,076.58	12,825.42	8,277.43	22,179.44

[a] Small discrepancies may result due to rounding.

Table 3-2
2002 Base Year Annual NO_x Inventory
(tons/year)

	District of Columbia	Maryland	Virginia	Total[a]
Point	1,317.46	45,829.43	14,195.67	61,342.56
Area	1,694.70	5,167.94	7,091.38	13,954.02
Nonroad	3,535.64	9,972.89	13,213.58	26,722.11
On-Road	8,827.37	47,640.16	41,107.78	97,575.31
Biogenics	25.91	430.75	301.22	757.88
Total[a]	15,401.08	109,041.17	75,909.63	200,351.88

[a] Small discrepancies may result due to rounding.

Table 3-3
2002 Base Year Annual SO_2 Inventory
(tons/year)

	District of Columbia	Maryland	Virginia	Total[a]
Point	2,467.55	164,784.06	37,400.23	204,651.84
Area	463.44	2,375.52	9,496.59	12,335.56
Nonroad	376.46	894.19	1,562.46	2,833.10
On-Road	289.88	1,734.88	1,515.22	3,539.98
Biogenics	0.00	0.00	0.00	0.00
Total[a]	3,597.33	169,788.65	49,974.50	223,360.49

[a] Small discrepancies may result due to rounding.

Table 3-4
2002 Base Year Annual VOCs Inventory
(tons/year)

	District of Columbia	Maryland	Virginia	Total[a]
Point	87.76	1,112.16	701.94	1,901.86
Area	6,313.88	31,667.71	34,395.80	72,377.39
Nonroad	2,042.83	14,224.36	14,225.08	30,492.27
On-Road	4,913.24	20,495.11	18,495.56	43,903.91
Biogenics	2,519.63	31,126.70	24,906.38	58,552.71
Total[a]	15,877.34	98,626.04	92,724.76	207,228.14

[a] Small discrepancies may result due to rounding.

Table 3-5
2002 Base Year Annual NH_3 Inventory
(tons/year)

	District of Columbia	Maryland	Virginia	Total[a]
Point	11.13	25.33	0.00	36.46
Area	12.59	3,113.84	543.72	3,670.14
Nonroad	0.00	0.00	0.00	0.00
On-Road	383.37	2,035.19	1,827.06	4,245.62
Biogenics	0.00	0.00	0.00	0.00
Total[a]	407.08	5,174.36	2,370.78	7,952.22

[a]Small discrepancies may result due to rounding.

Table 3-6
2002 Base Year Annual PM_{10}-Direct Inventory
(tons/year)

	District of Columbia	Maryland	Virginia	Total[a]
Point	181.56	5,208.23	997.63	6,387.42
Area	2,680.45	23,359.83	26,571.31	52,611.59
Nonroad	310.18	1,057.65	1,380.70	2,748.53
On-Road	223.62	1,200.36	1,048.21	2,472.19
Biogenics	0.00	0.00	0.00	0.00
Total[a]	3,395.81	30,826.06	29,997.85	64,219.72

[a] Small discrepancies may result due to rounding.

3.2 Total Emissions by Source

3.2.1 Point Sources

For emissions inventory purposes, point sources are defined as stationary, commercial, or industrial operations that emit more than 10 tons/year. The point source inventory consists of actual emissions for the base year 2002 and includes sources within the geographical area of the Washington, DC-MD-VA $PM_{2.5}$ nonattainment area. The states of Maryland and Virginia and the District of Columbia are responsible for compiling and submitting point source emission estimates.

In 2002, the State of Maryland also included all types of Andrews Air Force Base (AFB) emissions in their point source emissions. These sources are called quasi-point source emissions.

3.2.2 Area Sources

Area sources are sources of emissions that are too small to be inventoried individually and that collectively contribute significant emissions. Area sources include smaller stationary point sources not included in the states' point source inventories such as printing establishments, dry cleaners, and auto-refinishing companies as well as nonstationary sources such as evaporative emissions during transport of petroleum tank trucks and portable fuel containers.

Area source emissions typically are estimated by multiplying an emission factor by some known indicator of collective activity for each source category at the county level. An activity level is any parameter associated with the activity of a source, such as production rate or fuel consumption that may be correlated with the air pollutant emissions from that source. For example, the total amount of VOC emissions emitted by commercial aircraft can be calculated by multiplying the number of landing and takeoff cycles (LTOs) by an EPA-approved emission factor per LTO cycle for each specific aircraft type.

Several approaches are available for estimating area source activity levels and emissions. These include apportioning statewide activity totals to the local inventory area and using emissions per employee (or other unit) factors. For example, solvent evaporation from consumer and commercial products such as waxes, aerosol products, and window cleaners cannot be routinely determined for many local sources. The per capita emission factor assumes that emissions in a given area can be reasonably associated with population. This assumption is valid over broad areas for certain activities such as dry cleaning and small degreasing operations. For some other sources an employment-based factor is more appropriate as an activity surrogate.

3.2.3 Onroad Mobile Sources

Motor vehicles constitute onroad mobile sources. Emissions from mobile sources were derived from the use of the National Capital Region Transportation Planning Board (TPB) travel demand forecasting procedure, which simulates vehicle travel across the region's transportation system. Travel was simulated on all highways in the region, including both volume and speed of travel for each hour of the day. An EPA emissions model, MOBILE 6.2.03, was used to determine the emissions characteristics of the vehicle fleet in place in the year 2002. Input for this emissions model includes locally specific information such as age distribution of registered vehicles, evaporation characteristics of motor fuel, and temperature data. The general equation for the estimation of mobile sources is

Emissions = (Travel Component) x (Emission Factor).

Emissions accounted for in the mobile source inventory include

Origin:	Emissions include "cold start" and "hot start" emissions occurring during the first few minutes of vehicle operation.
Running:	Emissions occurring on local streets and on the region's network of arterial streets, freeways, and nonramp freeways.
Running Loss:	Emissions due to the heating of fuel and fuel lines.
Crankcase:	Emissions due to blow-by.
Destination:	Evaporative or "hot soak" emissions occurring at the conclusion of a vehicle trip after the engine is turned off.
Diurnal:	Evaporative emissions occurring when the vehicle is at rest due to temperature fluctuations.
Resting Loss:	Emissions due to the permeation of fuel through hoses and fittings.
Auto Access:	Emissions attributable to auto trips to Metrorail stations or to park-and-ride lots.
Bus:	Bus emissions, i.e., Metrobus, Ride-on, etc.

3.2.4 Nonroad Mobile Sources

Emissions for all nonroad vehicles and engines except airport [aircraft, ground support equipment (GSE), and auxiliary power units (APUs)], locomotives, and diesel marine vessels were calculated using EPA’s NONROAD2005 model version 2005a (February 8, 2006). This model was run with its associated graphic user interface NONROAD2005.1.0 (June 12, 2006), reporting utility version 2005c (March 21, 2006), and all geographical allocation data files updated until February 1, 2006.

Emissions from the “nonroad vehicles and engines” category result from the use of fuel in a diverse collection of vehicles and equipment, including vehicles and equipment in the following categories:

• Recreational vehicles, such as all-terrain vehicles and off-road motorcycles;
• Logging equipment, such as chain saws;
• Agricultural equipment, such as tractors;
• Construction equipment, such as graders and back hoes;
• Industrial equipment, such as fork lifts and sweepers;
• Residential and commercial lawn and garden equipment, such as leaf and snow blowers; and
• Aircraft ground support equipment.

The nonroad model estimates emissions for each specific type of nonroad equipment by multiplying the following input data estimates:

• Equipment population for base year (or base year population grown to a future year), distributed by age, power, fuel type, and application;

- Average load factor expressed as average fraction of available power;
- Available power in horsepower;
- Activity in hours of use per year; and
- Emission factor with deterioration and/or new standards.

The emissions are then temporally and geographically allocated using appropriate allocation factors.

Aircraft (military, commercial, general aviation, and air taxi) and auxiliary power units (APU) operated at airports along with locomotives and diesel marine vessels are also considered nonroad sources and are included in the nonroad category.

Metropolitan Washington Airports Authority (MWAA) provided all types of airport emissions for Dulles (Fairfax and Loudoun) and Reagan National (Arlington) airports, which are documented in *Air Pollution Emission Inventories for Washington Dulles International Airport and Ronald Reagan Washington National Airport for Calendar Years 2002, 2008, 2009*[1] (see Attachment B4 of the 2002 Base Year Inventory document). Nonroad model-generated ground support equipment emissions for Loudoun and Arlington counties were replaced by emissions provided by MWAA. While MWAA GSE emissions for Dulles airport were equally divided between Fairfax and Loudoun counties, Reagan National emissions were put into Arlington County. Aircraft and APU emissions for other counties were provided by the respective states. Emissions from locomotives and commercial diesel marine vessels were also provided by the states.

3.2.5 Biogenic Sources

An important component of the inventory is biogenic emissions. Biogenic emissions are those resulting from natural sources. Biogenic emissions are primarily VOCs that are released from vegetation throughout the day. Biogenic emissions of NO_x include lightning and forest fires. EPA used a biogenic computer model (BEIS3.12) to estimate biogenic emissions for each county in the country for all 12 months of the year 2002. Emissions data for Washington, DC $PM_{2.5}$ nonattainment-area counties were acquired from the EPA Web site (ftp://ftp.epa.gov/EmisInventory/2002finalnei/biogenic_sector_data/). EPA has recommended that states use these emissions in case they do not have their own estimated biogenic emissions. The Washington, DC-MD-VA $PM_{2.5}$ nonattainment area decided to use the inventories provided by the EPA.

3.3 Annual Inventories

The 2002 base year inventories for $PM_{2.5}$-Direct, NO_x, SO_2, VOCs, NH_3, and PM_{10}-Direct in Tables 3-1 through 3-6 are for the annual emissions. A summary of the annual inventories for $PM_{2.5}$ Direct, NO_x, SO_2, VOCs, NH_3, and PM_{10} Direct is also found in Table 1-1 of Appendix B.

[1] Metropolitan Washington Airports Authority, *Air Pollution Emission Inventories for Washington Dulles International Airport and Ronald Reagan Washington National Airport for Calendar Years 2002, 2008, 2009,* prepared by URS Corporation, Washington, DC., March 2006.

4.0 2009 Projected Uncontrolled and Controlled Inventories

Projected uncontrolled and controlled inventories for the attainment year 2009 are required for the region to calculate benefits from various control measures. Comparison of the base year 2002 and the attainment year 2009 controlled inventories provides a trend in emissions between these two milestone years. Also, the base year 2002 and the attainment year 2009 controlled inventories are required for emissions reduction calculation to meet attainment contingency requirements. The 2002 Base Year Inventory is described in Chapter 3. This chapter presents the 2009 projected uncontrolled and controlled inventories and the estimation of the levels of emissions in 2009 before and after the consideration of emissions controls.

4.1 2009 Projected Uncontrolled Inventories

The 2009 projected uncontrolled inventory was derived by applying the appropriate growth factors to the 2002 base year emissions inventory. EPA guidance describes four typical indicators of growth. In order of priority, these are product output, value added, earnings, and employment. Surrogate indicators of activity, for example, population growth, household growth, are also acceptable methods.

Round 7.0a Cooperative Forecasts (population, household, and employment projections) and Vehicle Miles Traveled (VMT) projections for 2009 were used to project area sources emissions. Round 7.0a Cooperative Forecasts were prepared by the Metropolitan Washington Council of Governments (MWCOG) staff and officially adopted by its Board of Directors on October 11, 2006.

VMT projections were developed by the MWCOG Department of Transportation Planning staff as part of the report on 2005 Constrained Long-Range Plan (CLRP) and 2006-2011 Transportation Improvement Program (TIP) for the National Capital Region Transportation Planning Board. Projections for onroad emissions were developed using MOBILE6.2 (January 2003) model and the Travel Demand Model version 2.1d #50 developed by the National Capitol Region Transportation Planning Board. The travel demand modeling process also used Round 7.0a Cooperative Forecasts.

EPA's nonroad model, NONROAD2005, was used for developing uncontrolled 2009 nonroad inventory. The Economic Growth Analysis System (EGAS) model was used by all three jurisdictions to project growth in point source emissions.

4.1.1 Growth Projection Methodology

The following sections describe the methods followed to develop the projected uncontrolled inventories for 2009 for point, area, nonroad, and onroad sources.

4.1.1.1 Growth Projection Methodology for Point Sources: EGAS

The growth in point source emissions is projected using EGAS version 5.0. Point source emissions for 2002 are provided from the state data sources, and the model is run with the following options selected: Source Classification Code, the Bureau of Labor Statistics national economic forecast, and the baseline regional economic forecast. Point source emission projections using EGAS for 2009 are contained in Appendix C.

4.1.1.2 Growth Projection Methodology: Area Sources

Base year 2002 area source emissions were calculated using the year 2002 population, household, and employment data. Growth factors for the periods 2002 through 2009 were derived by dividing Cooperative Round 7.0a population, household, and employment forecasts and VMT data provided by the MWCOG Department of Transportation Planning for 2009 by the year 2002 population, household, employment, and VMT data for the region, respectively. Cooperative Round 7.0a Forecasts and VMT data are provided in Appendix D1 and E1, respectively. Projected uncontrolled area source inventories for 2009 are contained in Appendix D1. Growth factors used for the 2009 projection years are presented in Table 4-1.

Table 4-1
2002-2009 Growth Factors

Jurisdiction	Employment[a]	Population[a]	Household[a]	VMT[b]
District of Columbia	1.043	1.049	1.051	1.038
Charles County	1.291	1.141	1.160	1.159
Frederick County	1.297	1.162	1.165	1.175
Montgomery County	1.106	1.097	1.095	1.057
Prince George's County	1.108	1.052	1.076	1.062
City of Alexandria	1.166	1.083	1.101	1.083
Arlington County	1.137	1.082	1.102	1.023
Fairfax County	1.138	1.117	1.120	1.074
Fairfax City	1.066	1.071	1.070	1.074
Falls Church City	1.194	1.141	1.172	1.074
Loudoun County	1.427	1.515	1.517	1.331
Prince William County	1.235	1.304	1.312	1.189
Manassas City	1.067	1.064	1.089	1.189
Manassas Park City	1.489	1.286	1.322	1.189

[a] Growth factors based on MWCOG Final Round 7.0a Cooperative Forecasts.
[b] Growth factors based on VMT estimates from 2005 CLRP & 2006-2011 TIP provided by the MWCOG Department of Transportation Planning.

Uncontrolled 2009 emissions for area sources were calculated by multiplying the 2002 base year area emissions by the above growth factors for 2009 for each jurisdiction. Each area source category was matched to an appropriate growth surrogate based on the activity used to generate the base year emission estimates. Surrogates were chosen as follows:

Residential Fuel Combustion - Household was chosen as the growth surrogate, except for residential coal combustion, where no growth was assumed.

Industrial/Commercial/Institutional Fuel Combustion - Population was chosen as the growth surrogate except for the commercial/institutional coal combustion category, where no growth was assumed.

Open Burning - Population was chosen as the growth surrogate as yard wastes, land debris, etc., increase with population.

Structural Fires, Motor Vehicle Fires – Population was chosen as the growth surrogate.

Forest Fires, Prescribed Burning - No growth was assumed.

Municipal Landfills – Base year emissions are estimated using data on total refuse deposited. Population was chosen as a surrogate, since deposited waste is from the general population rather than industrial facilities.

Commercial Cooking - Population growth was used as the surrogate.

Forest Fires, Slash Burning, Prescribed Burning – Zero growth was applied to this category.

Incineration– Zero growth was applied to this category.

Agricultural production (Crop Tilling, Dust Kicked-up by Animal Hooves) – Zero growth was applied to this category.

Fugitive Dust – VMT growth was applied to this category.

Construction – Household growth was applied to residential category. Industrial/commercial/institutional construction was grown based on the employment growth. Road construction was grown using VMT projections. Mining emissions were not grown.

4.1.1.3 Growth Projection Methodology: Nonroad Sources

Uncontrolled nonroad source inventory for the year 2009 was developed using the NONROAD model, except for locomotives, aircrafts, and aircraft auxiliary power units (APUs), which were either grown from the base year 2002 using appropriate surrogates or projected using the Emissions and Dispersion Modeling System (EDMS) model by the Metropolitan Washington Airports Authority (MWAA).

NONROAD Model Sources

The 2009 projected uncontrolled nonroad source inventory was created through the use of EPA's NONROAD2005 model version 2005a (February 8, 2006), except for locomotives, aircrafts, and aircraft APUs. This model was run with its associated graphic user interface NONROAD2005.1.0 (June 12, 2006), reporting utility version 2005c (March 21, 2006), and all geographical allocation data files updated until February 1, 2006. The base year 2002 nonroad source inventory was also created using the same model, reporting utility, geographical allocation data files, and graphic user interface versions.

A four-season approach was adapted for developing annual emissions. The NONROAD2005 model was run for the Metropolitan Washington region for the four seasons (winter, spring, summer, and autumn), and then seasonal emissions were summed up to get the annual emissions. Four seasons considered were winter (December, January, and February), spring, (March, April, and May), summer (June, July, and August), and autumn (September, October, and November).

Model inputs (temperature, fuel, and other parameters) were prepared for the four seasons used for annual model runs and are provided in the Appendix B along with the details of methodology used to develop those inputs. For projected 2009 uncontrolled inventory, all nonroad model inputs valid for the base year 2002 were used, the technology limiter was set at the 2002, and the growth assumptions valid for the year 2009 were used.

<u>Ground Support Equipment Emissions</u>
MWAA only provided projected controlled 2009 ground support equipment (GSE) emissions for Dulles (Fairfax and Loudoun) and Reagan National (Arlington) airports in their report (see Appendix B4). NONROAD2005 model generated GSE emissions for Arlington and Loudoun counties were replaced by MWAA emissions. Since Dulles airport is spread across Fairfax and Loudoun counties, MWAA emissions from Dulles airport were divided equally between Fairfax and Loudoun counties.

Non-NONROAD Model Sources

<u>Aircraft and Auxiliary Power Units</u>
MWAA only provided projected controlled 2009 commercial aircraft and auxiliary power unit emissions for Dulles (Fairfax and Loudoun) and Reagan National (Arlington) airports in their report (see Appendix B4). Base year 2002 military aircraft emissions were provided by Virginia Department of Environmental Quality, which were not grown to 2009. General aviation and air taxi emissions were grown using population as the surrogate.

Railroad

Railroad or locomotive emissions were provided by all three states and were grown using employment as the surrogate.

Projected uncontrolled nonroad source inventory for 2009 are contained in Appendix D1. Detailed NONROAD2005 model output files are being provided separately in electronic format as Appendix D2 of this document.

4.1.1.4 Growth Projection Methodology: Onroad Sources

The projected uncontrolled 2009 mobile source inventory was created through the use of transportation and emissions modeling techniques. This involved use of the MOBILE6.2.03 emissions factor model and version 2.1d #50 Travel Demand Model with 2009 planned highway network. For projected 2009 uncontrolled inventory, all mobile model fuel inputs, Inspection and Maintenance (I/M) Programs, and technology controls valid for the base year 2002 were used. Registration Distribution, Diesel Sales Fraction, and VMT valid for the year 2009 were used. Full documentation of the development of the uncontrolled 2009 mobile inventory is included in Appendix E1. Detailed MOBILE 6.2.03 model input, output, and external output files are being provided separately in electronic format as Appendix E2 of this document. Appropriate population, household, and employment growth are input through the Round 7.0a Cooperative Forecasting techniques. Cooperative Forecast Round 7.0a was adopted in October 2006 and does not reflect the U.S. Department of Defense Base Realignment and Closure (BRAC) plans for the metropolitan Washington region.

4.1.1.5 Biogenic Emission Projections

2002 base year emissions were estimated by EPA using the BEIS3.12 model. Biogenic emission inventories for 2009 are the same as those used for the 2002 base year for Washington, DC-VA-MD $PM_{2.5}$ nonattainment region. Year-specific biogenic inventory for 2009 was not estimated.

4.1.2 2009 Projected Uncontrolled Inventory – Summary of Emissions

The 2009 $PM_{2.5}$-Direct, NO_x, and SO_2 projection year emission inventory results with no control measures applied are summarized by component of the inventory in Tables 4-2 though 4-4 below.

Table 4-2
2009 Projected Uncontrolled $PM_{2.5}$-Direct Emissions (tons/year)
Washington, DC-MD-VA $PM_{2.5}$ Nonattainment Area

Emission Source	District of Columbia	Maryland[a]	Virginia	Total[b]
Point	159.35	3,992.83	498.38	4,650.55
Area	519.19	8,203.50	6,656.44	15,379.13
Nonroad	278.87	1,004.19	1,336.39	2,619.46
Mobile	113.19	634.31	564.48	1311.98
Total[b]	1,070.60	13,834.82	9,055.70	23,961.12

[a] Maryland point source emissions include 16.66 tons/year of quasi-point source emissions from Andrews AFB.
[b] Small discrepancies may result due to rounding.

Table 4-3
2009 Projected Uncontrolled NO_x Emissions (tons/year)
Washington, DC-MD-VA $PM_{2.5}$ Nonattainment Area

Emission Source	District of Columbia	Maryland[a]	Virginia	Total[b]
Point	1,895.35	52,747.80	14,028.67	68,671.82
Area	1,778.14	5,569.68	8,301.43	15,649.25
Nonroad	3,630.08	10,651.04	14,710.05	28,991.17
Mobile	7,336.95	38,798.34	34,836.73	80,972.02
Total[b]	14,640.51	107,766.86	71,876.88	194,284.25

[a] Maryland point source emissions include 822.84 tons/year of quasi-point source emissions from Andrews AFB.
[b] Small discrepancies may result due to rounding.

Table 4-4
2009 Projected Uncontrolled SO_2 Emissions (tons/year)
Washington, DC-MD-VA $PM_{2.5}$ Nonattainment Area

Emission Source	District of Columbia	Maryland[a]	Virginia	Total[b]
Point	3,724.49	193,276.64	36,792.91	233,794.03
Area	480.63	2,601.76	11,167.43	14,249.82
Nonroad	443.81	1,071.27	1,939.89	3,454.97
Mobile	308.60	1,952.39	1,753.04	4,014.03
Total[b]	4,957.52	198,902.06	51,653.27	255,512.84

[a] Maryland point source emissions include 55.43 tons/year of quasi-point source emissions from Andrews AFB.
[b] Small discrepancies may result due to rounding.

4.2 Emission Reductions from Control Measures

Chapter 6 of this SIP describes the control measures that have already been implemented or will be implemented by 2009 that will reduce emissions in that year. Most control measures are required by federal or state regulations. Local governments and state agencies have voluntarily committed to other measures, as described in Chapter 5. Projected controlled inventory for 2009 assume a number of control measures to be in place by that year.

Section 4.3.5 presents the projected controlled emissions for the 2009 attainment year resulting from implementation of the control measures. Below is a list of the measures implemented by the year 2002 in the Washington region. Chapter 5 presents detailed information on the measures and the projected reductions from each.

Point

- NO_x Reasonably Available Control Technology (RACT) for Major Sources
- NO_x Ozone Transport Commission (OTC) Phase II Budget Rules
- NO_x SIP Call
- Visible Emissions and Fugitive Dust/Emissions Standards for Existing Sources
- Standards of Performance for Visible Emissions and Fugitive Dust/Emissions for New and Modified Stationary Sources

Area

- Seasonal Open Burning Restrictions

Nonroad

- 1994 EPA Nonroad Diesel Engines Rule
- 1995 EPA Nonroad Small Gasoline Engines Rule, Phase 1 and Phase 2 (handheld and nonhandheld)
- 1996 EPA Emissions Standards for Spark Ignition Marine Engines
- 2002 EPA Emissions Standards for Large Spark Ignition Engines
- Reformulated gasoline (off-road)

On-Road

- High-Tech Inspection/Maintenance (I/M)
- Reformulated gasoline (on-road)
- Federal Tier I Vehicle Standards and New Car Evaporative Standards
- National Low Emission Vehicle Program

Below is a list of the measures with phased-in implementations between 2002 and 2009 in the Washington region.

Point

- NO_x SIP Call
- Clean Air Interstate Rule (CAIR) (VA and DC)
- Maryland Healthy Air Act (MD)
- Utility Reductions (Possum Point Fuel Conversion) (VA)

Area

- Additional phase-in of reductions from National Locomotives Rule

Nonroad

- 2004 Nonroad Heavy Duty Diesel Rule (negligible benefits by 2009)
- Additional phase-in of technology rules implemented by 2002

On-Road

- Heavy-Duty Diesel Engine Rule (2004)
- Heavy-Duty Diesel Engine Rule (2007)
- Tier 2 Motor Vehicle Emission Standards
- I&M Program with Final Cutpoints
- Transportation Control Measures (TCMs)
- Vehicle Technology, Maintenance, or Fuel-Based Measures

4.3 2009 Projected Controlled Inventories

The projection of 2009 controlled emissions is simply the 2009 uncontrolled emissions minus the emission reductions achieved from the federal control measures and attainment strategies implemented by states for the $PM_{2.5}$ plan. This information is presented in Sections 4.3.1 through 4.3.5.

4.3.1 2009 Projected Controlled Inventory: Point Sources

2009 projected controlled inventories for point sources were developed by subtracting the emission reductions due to federal and state control measures (see Section 4.2) in 2009 from the projected uncontrolled 2009 inventories.

4.3.2 2009 Projected Controlled Inventory: Area Sources

2009 projected uncontrolled and controlled inventories for area sources were the same, as there was no control measure available.

4.3.3 2009 Projected Controlled Inventory: Nonroad Sources

2009 projected controlled inventory for nonroad sources was developed using the NONROAD model, except for locomotives, aircrafts, and APUs, which were either developed by subtracting emissions benefits in 2009 due to federal rules (see Section 4.2) or were developed using the EDMS model by the MWAA. The nonroad model also used all control measures described in Section 4.2.

NONROAD Model Sources

The 2009 projected controlled nonroad source inventory was created through the use of EPA's NONROAD2005 model, which is described in detail in Section 3.2.4. The same methodology, which was used to develop the base year 2002 and uncontrolled 2009 inventories, was also used to develop the controlled 2009 inventory. This methodology is described in detail in Appendix B.

Detailed model inputs are provided below in the Tables 4-5 and 4-6. Details of methodology for preparing temperature inputs are provided in Appendix B. Methodology to develop fuel Reid vapor pressure (RVP), sulfur, and oxygen content of fuel and Stage II control is being described below. While RVP varied by jurisdiction and season, other inputs were the same for all jurisdictions and seasons. For projected 2009 controlled inventory, all nonroad model inputs valid for the year 2009 were used.

<u>Development of Fuel Inputs</u>
Monthly fuel RVP data were provided by the state air agencies. These data were averaged for each of the four seasons to get season average RVP. The MOBILE6.2.03 model default for the year 2009 was used for the gasoline sulfur percent. Nonroad diesel/marine diesel/compressed natural gas (CNG)/liquidifed pretroleum gas (LPG)

sulfur percent are nonroad model defaults for the year 2009. Fuel oxygen content (3.5% by weight) is based on the Energy Policy Act, 2005. Since this Act removed the requirement of oxygenate in the fuel since the spring of 2006, ether (MTBE) is no longer used as an oxygenate. The only oxygenate remaining in the fuel is ethanol, which has an oxygen content of 35%. Based on 10% ethanol content in gasoline (by volume) used in the Washington, DC area, ethanol-blended fuel oxygen content of 3.5% was used for 2009. For the nonroad sector, stage II control data (zero %) is suggested by the EPA (Nonroad Model User Guide, pp. 3-7) and agreed to by the states.

Table 4-5
Fuel Reid Vapor Pressure

	Values			
	Winter	**Spring**	**Summer**	**Autumn**
District of Columbia	12.2	8.0	6.8	8.0
Virginia	12.9	10.9	6.8	10.9
Maryland	12.4	10.0	6.8	9.7

Table 4-6
Other NONROAD Model Inputs (District of Columbia, Virginia, Maryland)

	Values			
Parameters	**Winter**	**Spring**	**Summer**	**Autumn**
Min. Temperature	27.1	45.7	66.7	49.5
Max. Temperature	44.0	66.2	84.7	67.5
Avg. Temperature	35.6	56.0	75.7	58.5
Gasoline Sulfur (%)	0.003	0.003	0.003	0.003
Nonroad Diesel Sulfur (%)	0.0348	0.0348	0.0348	0.0348
Marine Diesel Sulfur (%)	0.0408	0.0408	0.0408	0.0408
CNG/LPG Sulfur (%)	0.003	0.003	0.003	0.003
Gasoline Oxygen Weight (%)	3.5	3.5	3.5	3.5
Stage II Control (%)	0	0	0	0

Non-NONROAD Model Sources

Aircraft and Auxiliary Power Units
MWAA provided projected controlled 2009 commercial aircraft and auxiliary power unit emissions for Dulles (Fairfax and Loudoun) and Reagan National (Arlington) airports in their report (see Appendix B4). Base year 2002 military aircraft emissions were provided by the Virginia Department of Environmental Quality (VADEQ), which were also used for 2009.

Railroad
Controlled 2009 railroad or locomotive emissions were developed by applying 2009 $PM_{2.5}$ and NO_x controls (15.15% and 32.36%, respectively) to the 2009 uncontrolled

inventory, reflecting impacts of phased-in reductions from federal regulations for locomotives.

Projected controlled nonroad source inventory for 2009 are contained in Appendix D1. Detailed NONROAD2005 model output files are being provided separately in electronic format as Appendix D2 of this document.

4.3.4 2009 Projected Controlled Inventory: Onroad Sources

The projected controlled 2009 mobile source inventory was created through the use of transportation and emissions modeling techniques. This involved use of the MOBILE6.2.03 emissions factor model and the version 2.1d #50 Travel Demand Model with the 2009 planned highway network. For projected 2009 controlled inventory, all mobile model fuel inputs, I/M Programs, and technology controls valid for the year 2009 were used. Registration Distribution, Diesel Sales Fraction, and VMT used were also valid for the year 2009. Full documentation of the development of the controlled 2009 mobile inventory is included in Appendix E1. Detailed Mob6.2.03 model input, output, and external output files are being provided separately in electronic format as Appendix E2 of this document. Appropriate population, household, and employment growth are input through the Round 7.0a Cooperative Forecasting techniques. Cooperative Forecast Round 7.0a was adopted in October 2006.

4.3.5 2009 Projected Controlled Inventory – Summary of Emissions

The 2009 $PM_{2.5}$ Direct, NO_x, and SO_2 projection year emission inventory results with control measures applied are summarized by component of the inventory in Tables 4-7 though 4-9 below. As discussed in Section 2.8, 2009 inventories for VOC, ammonia, and PM_{10} are not included in this SIP.

Table 4-7
2009 Projected Controlled $PM_{2.5}$-Direct Emissions (tons/year)
Washington, DC-MD-VA $PM_{2.5}$ Nonattainment Area

Emission Source	District of Columbia	Maryland[a]	Virginia	Total[b]
Point	159.35	3,992.83	498.38	4,650.55
Area	519.19	8,203.50	6,656.44	15,379.13
Nonroad	226.84	853.20	1,146.53	2,226.56
Mobile	97.93	534.21	475.82	1,107.96
Total[b]	1,003.30	13,583.74	8,777.17	23,364.21

[a] Maryland point source emissions include 16.66 tons/year of quasi-point source emissions from Andrews AFB.
[b] Small discrepancies may result due to rounding.

Table 4-8
2009 Projected Controlled NO_x Emissions (tons/year)
Washington, DC-MD-VA $PM_{2.5}$ Nonattainment Area

Emission Source	District of Columbia	Maryland[a]	Virginia	Total[b]
Point	1,194.55	16,300.71	8,085.59	25,580.86
Area	1,778.14	5,569.68	8,301.43	15,649.25
Nonroad	2,921.89	8,486.17	12,262.88	23,670.94
Mobile	5,059.75	24,945.31	22,196.88	52,201.94
Total[b]	10,954.33	55,301.87	50,846.78	117,102.98

[a] Maryland point source emissions include 822.84 tons/year of quasi-point source emissions from Andrews AFB.
[b] Small discrepancies may result due to rounding.

Table 4-9
2009 Projected Controlled SO_2 Emissions (tons/year)
Washington, DC-MD-VA $PM_{2.5}$ Nonattainment Area

Emission Source	District of Columbia	Maryland[a]	Virginia	Total[b]
Point	3,724.49	193,276.64	18,825.70	215,826.82
Area	480.63	2,601.76	11,167.43	14,249.82
Nonroad	93.03	257.12	952.89	1,303.04
Mobile	43.89	246.52	227.95	518.36
Total[b]	4,342.02	196,382.04	31,173.97	231,898.03

[a] Maryland point source emissions include 55.43 tons/year of quasi-point source emissions from Andrews AFB.
[b] Small discrepancies may result due to rounding.

5.0 CONTROL MEASURES

This section is divided into five sections: Point Source Measures, Area Source Measures, Nonroad Source Measures, Mobile Measures, and Supplemental Control Measures.

Reductions from the control measures presented in this Chapter are summarized in Table A.

TABLE A
SUMMARY OF CONTROL STRATEGIES
PM2.5, NOx, and SO_2 Benefits of Control Measures
(2009 uncontrolled-2009 controlled)

			Reductions	
Ref No.	***Control Measure***	**$PM_{2.5}$ Direct tons/year**	**NOx tons/year**	**SO_2 tons/year**
MEASURES INCLUDED IN THE BASELINE CONTROLS SCENARIO				
POINT SOURCE MEASURES				
5.1.1	State Regional Transport Requirement	0	0	0
5.1.2	Visibility Standards	0	0	0
AREA SOURCE MEASURES				
5.2.1	Seasonal Open Burning Restrictions	0	0	0
ON-ROAD MEASURES				
5.4.1	High-Tech Inspection/Maintenance (original cutpoints)	0	0	0
5.4.2	Evaporative Standards	0	0	0
5.4.3	National Low Emission Vehicle Program	0	0	0
5.4.6	Transportation Control Measures and Vehicle Technology, Fuel, or Maintenance Measures	0	0	0
NON-ROAD MEASURES				
5.3.1	EPA Non-Road Gasoline Engines Rule	0	0	0
5.3.2	EPA Non-Road Diesel Engines Rule	0	0	0
5.3.3	Emissions Standards for Spark Ignition Marine Engines	0	0	0
5.3.4	Emissions Standards for Large Spark Ignition Engines	0	0	0
MEASURES INCLUDED IN THE FUTURE CONTROLLED SCENARIO				
POINT SOURCE MEASURES				
5.1.1	State and Regional Transport Requirement (RACT, NOx SIP Call, CAIR, HAA)	-	43,091	17,967
SUBTOTAL			**43,091**	**17,967**
AREA SOURCE MEASURES				
SUBTOTAL		-	-	-
NON-ROAD MEASURES				
5.3.1	EPA Non-Road Gasoline Engines Rule			
5.3.2	EPA Non-Road Diesel Engines Rule			
5.3.3	Emissions Standards for Spark Ignition Marine Engines	393	5,320	2,152
5.3.4	Emissions Standards for Large Spark Ignition Engines			
5.3.5	Standards for Locomotive			
SUBTOTAL		**393**	**5,320**	**2,152**
ON-ROAD MEASURES				
5.4.1	High-Tech Inspection/Maintenance (updated cutpoints)			
5.4.3	National Low Emission Vehicle Program	204	28,770	3,496
5.4.4	Tier 2 Motor Vehicle Emission Standards			
5.4.5	Heavy-Duty Diesel Engine Rule			
5.4.6	Transportation Control Measures and Vehicle Technology, Fuel, or Maintenance Measures	2.6	149.1	0
SUBTOTAL		**207**	**28,919**	**3,496**
TOTAL REDUCTIONS		**599**	**77,330**	**23,615**

Notes: No additional emission reductions are expected for measures fully implemented before 2002.

5.1 POINT SOURCE MEASURES

5.1.1 RACT and Regional Transport Requirements (federal and state regulation)

This section documents credit for emissions reductions attributable to federal and state requirements on point sources. These credits include

- NO_x Reasonably Available Control Technology (RACT), as required for 8-hour ozone nonattainment areas;
- "NO_x Budget" rules that required a second phase of stationary source NO_x reductions as part of a coordinated regulatory initiative by the Ozone Transport Region (OTR) states to further reduce NO_x emissions in the Northeast;
- "NO_x SIP Call" to reduce ozone transport in the eastern United States;
- EPA's Clean Air Interstate Rule (CAIR); and
- Maryland's Healthy Air Act (HAA).

Control Strategy

RACT

States implemented NO_x RACT to meet the requirements for 8-hour ozone nonattainment areas. For each $PM_{2.5}$ nonattainment area, 40 CFR 51.1010 notes that a SIP revision demonstrating that all reasonably available control measures, including RACT for stationary sources, necessary to demonstrate attainment as expeditiously as practicable, have been adopted. The section of the implementation rule goes on to state that potential measures that are reasonably available, considering technical and economic feasibility, must be adopted as Reasonably Available Control Measures (RACM) if, considered collectively, they would advance the attainment date by one year or more. As discussed in Section 7.2.1, the states determined that there are no additional control measures that could be adopted by January 1, 2008. Further, existing measures, and those planned for implementation by 2009, are expected to enable the region to continue to demonstrate compliance with the $PM_{2.5}$ NAAQS (1997) through the 2009 attainment date. As such, no further actions on RACT is warranted.

NO_x OTC Phase II Budget Rules

In the late 1990's Maryland and the District adopted "NO_x Budget" rules to require a second phase of stationary source NO_x reductions as part of a coordinated regulatory initiative by the OTR states to further reduce NO_x emissions in the Northeast. The rules required large stationary sources to reduce summertime NO_x emissions by approximately 65 percent from 1990 levels. The regulation also included provisions allowing sources to comply by trading "allowances." This regulation required affected sources to reduce their emissions to meet these requirements by May 2001.

NO_x SIP Call

In late 1998, the EPA adopted a rule called the "NO_x SIP Call" to reduce ozone transport in the eastern United States. This regional NO_x reduction program required 22 states, including Maryland and Virginia, and the District of Columbia, to further reduce large point source NO_x emissions to EPA-identified state emission budget levels by 2007. State regulation adoption timelines notwithstanding, the majority of the 22 SIP call states had these regulations in place by

2003/2004.

Clean Air Interstate Rule (CAIR)
On May 12, 2005, the EPA promulgated the Clean Air Interstate Rule, which requires reductions in emissions of NO_x and SO_2 from large fossil fuel fired electric generating units. The rule is set up in several phases with the first phase of NO_x reductions to come by 2009. The first phase of SO_2 reductions are expected by 2010. The rule sets up both an annual emissions budget and an ozone season emissions budget. The rule requires that units with nameplate capacity greater than 25 megawatts (MW) emit no more NO_x or SO_2 than their allocations determined by the state either through emission controls or banking and trading.

Virginia CAIR and New Source Review Permitting
Virginia has adopted state regulations codifying the requirements of the CAIR. Virginia's rules create an emissions cap based on the allowances allocated to the facility. These nonattainment area requirements are enforceable as regulations of the State Air Pollution Control Board as provided in the Virginia Air Pollution Control Law [Chapter 13 (§ 10.1- 1300 et seq.) of Title 10.1 of the Code of Virginia] and enforceable to meet emissions reductions necessary for attainment under this plan; however, they have not been submitted to be part of the Virginia SIP in order to implement the federal CAIR program or meet the requirements of § 110(a)(2)(D)(i) of the federal Clean Air Act.

The Possum Point Power Station initiated a new source review action resulting in a netting exercise that reduced emissions. The netting exercise relied on a fuel switch from coal to natural gas for several units, thereby providing emissions reductions in SO_2.

Maryland Healthy Air Act (HAA)
In April of 2006, the Maryland General Assembly enacted the Maryland Healthy Air Act. The Maryland General Assembly record related to the HAA and the final version of the Act itself can be found at http://mlis.state.md.us/2006rs/billfile/SB0154.htm. The Maryland Department of the Environment (MDE) Regulations (Code of Maryland Regulations) can be found at http://www.mde.state.md.us/assets/document/CPR_12-26-06_Emergency_and_Permanent_HAA_Regs_for_AELR.pdf. The HAA is one of the toughest power plant emission laws on the East Coast. The HAA requires reductions in nitrogen oxide (NO_x), sulfur dioxide (SO_2), and mercury emissions from large coal burning power plants. The HAA also requires that Maryland become involved in the Regional Greenhouse Gas Initiative (RGGI), which is aimed at reducing greenhouse gas emissions. The MDE has been charged with implementing the HAA through regulations. As enacted, these regulations constitute the most sweeping air pollution emission reduction measure proposed in Maryland history. To meet the requirements of Maryland's regulations a company's "system" (covered units owned by the same company) must meet a system-wide cap by 2009. Compliance cannot be achieved through the purchase of allowances under the HAA.

District of Columbia CAIR
The District of Columbia is currently drafting its CAIR. Its CAIR regulations do not allow trading of NO_x allowances for achieving the reductions for the facilities within its jurisdiction.

Summary

The point source NO_x, SO_2, and $PM_{2.5}$ Direct controls are a phased approach to controlling emissions from power plants and other large fuel combustion sources. The following programs result in emission reductions from point sources that demonstrate progress toward attaining the PM standard:

- NO_x SIP Call Rule
- EPA's CAIR
- Maryland's HAA
- New Source Review Permitting

In Maryland, the expected emission reductions for 2009 were calculated using the emissions estimates consistent with annual allocations under the HAA implementing regulation. The program does not allow trading of emission allowances. In Virginia, the expected emission reductions for 2009 from electric generating utilities were calculated using knowledge of historical emission rates, adjusted by the expected control efficiencies achieved from various control devices that have been installed or by estimating the amount of allowances the facility would receive under the Virginia CAIR rule. In the District of Columbia, the expected emission reductions for 2009 were calculated using the listed allowances within the CAIR.

See Appendix C for further point source documentation.

Implementation

District Department of the Environment
Maryland Department of the Environment, Air and Radiation Management Administration
Virginia - Department of Environmental Quality

Projected Reductions

Emission reductions resulting from the point source controls are presented by state in the table below.

	Emission Reductions (tons/year)			
	District of Columbia	**Maryland**	**Virginia**	**Total**
2009 NO_x Reductions	700.8	36,447	5,943	43,091
2009 SO_2 Reductions	0	0	17,967	17,967
2009 $PM_{2.5}$ Direct Reductions	0	0	0	0

Emission Benefit Calculations

The emission reductions associated with the federal and state requirements on point sources were supplied by the staff of the Maryland Department of the Environment, Air and Radiation Management Administration, the District Department of the Environment, and the Virginia Department of Environmental Quality Air Division.

References

1990 Clean Air Act Amendments, 42 U.S.C. §§7513

Code of Maryland Regulations (COMAR) 26.11.27

Federal Register, Vol. 70, No. 91, May 12, 2005, p. 25162.

5.1.2 Visibility Standards (federal and state regulation)

This section documents credit for emissions reductions attributable to federal and regional requirements on point sources. These credits include visibility standards for existing and modified stationary sources.

Control Strategy

Virginia

The visibility regulations for existing facilities were adopted in Virginia under 9 VAC 5 Chapter 40 "Existing Stationary Sources" Part II "Emission Standards" Article 1 "Visible Emissions and Fugitive Dust/Emissions (Rule 4-1)." See http://www.deq.virginia.gov/air/regulations/air40.html
The paragraphs under the article are

- 9 VAC 5-40-80 "Standard for Visible Emissions"
- 9 VAC 5-40-90 "Standard for Fugitive Dust/Emissions"

The visibility regulations for new and modified units were adopted under 9 VAC 5 Chapter 50 "New and Modified Stationary Sources" Part II "Emission Standards" Article 1 "Visible Emissions and Fugitive Dust/Emissions (Rule 5-1)." See http://www.deq.virginia.gov/air/regulations/air50.html The paragraphs under the article are

- 9 VAC 5-50-80 "Standard for Visible Emissions"
- 9 VAC 5-50-90 "Standard for Fugitive Dust/Emissions"

District of Columbia

The opacity regulations in the District of Columbia were adopted in 1984 with District of Columbia Air Pollution Control Act. The official cite is 20 DCMR 606, and the effective date is March 15, 1985.

Maryland

The visibility regulations in Maryland were adopted in 1968 and have been amended several times since that time. See Chapter 9 for additional details.

Implementation
District Department of the Environment
Maryland Department of the Environment - Air and Radiation Management Administration
Virginia - Department of Environmental Quality

Projected Reductions and Emission Benefit

The benefits of this program are reflected in the 2002 baseline inventory and the 2009 projections thereof. Additional reductions from this measure are not expected.

5.2 AREA SOURCE MEASURES

5.2.1 Seasonal Open Burning Restrictions (state rule)

This measure involves amending and/or adopting state regulations to ban the open burning of such items as trees, shrubs, and brush from land clearing; trimmings from landscaping; and household or business trash during the peak ozone season. The measure is authorized by state regulations but is enforced by the local governments.

Source Type Affected

The measure affects all citizens and businesses that burn solid waste.

Control Strategy

Under the 15% VOC Reduction Plan, Maryland and Virginia adopted state regulations to prohibit open burning during peak ozone season in the Washington, D.C. ozone nonattainment area. The emissions benefits will remain constant through 2009.

Implementation

District of Columbia - Department of Environment.
Maryland Department of the Environment, Air and Radiation Management Administration; local government enforcement.
Virginia - Department of Environmental Quality; local government enforcement.

Projected Reductions and Emission Benefit

The benefits of this program are reflected in the 2002 baseline inventory and the 2009 projections thereof. Additional reductions from this measure are not expected.

References

"Open Burning in Residential Areas, Emissions Inventory Development Report," E.H. Pechan & Associates, Inc., January 31, 2003. Prepared for the Mid-Atlantic/Northeast Visibility Union.

"Northern Virginia Open Burning Rule Effectiveness Evaluation," E.H. Pechan & Associates, Inc., December 8, 2003. Prepared for the County of Fairfax.

5.3 NONROAD MEASURES

The following nonroad emission reduction measures, discussed in greater detail later in this section, are calculated using the NONROAD2005 model:

- EPA Nonroad Gasoline Engines Rule, 5.3.1
- EPA Nonroad Diesel Engines Rule, 5.3.2
- Emissions Standards for Spark-Ignition Marine Engines, 5.3.3
- Emissions Standards for Large Spark-Ignition Engines, 5.3.4
- Emission Standards for Locomotives, 5.3.5, are calculated using the Area Source spreadsheet, but emission benefits are included in the nonroad sector totals.

Projected Reductions and Emission Benefit Calculations

NONROAD2005, the current nonroad emissions model approved for use by the EPA, is not designed to calculate the benefits of each of the above control measures individually. As a result, this and future SIP revisions will not enumerate the benefits of individual nonroad control measures. The table below summarizes the combined benefits from the above control measures by jurisdiction.

	Emission Reductions (tons/year)			
	District of Columbia	Maryland	Virginia	Total
2009 NO_x Reductions	708	2,165	2,447	5,320
2009 SO_2 Reductions	351	814	987	2,152
2009 $PM_{2.5}$ Direct Reductions	52	151	190	393

5.3.1 Phase I and Phase II Emissions Standards for Gasoline-Powered Nonroad Utility Engines (federal rule)

This measure takes credit for emissions reductions attributable to emissions standards promulgated by the EPA for small nonroad, spark-ignition (SI) (i.e., gasoline-powered) utility engines, as authorized under 42 U.S.C. §7547. The measure affects gasoline-powered (or other SI) lawn and garden equipment, construction equipment, chain saws, and other such utility equipment as chippers and stump grinders, wood splitters, etc., rated at or below 19 kilowatts (kW) [an equivalent of 25 or fewer horsepower (hp)]. Phase 2 of the rule applied further controls on handheld and nonhandheld outdoor equipment.

Control Strategy

Federal emissions standards promulgated under §7547 (a) apply to SI nonroad utility engines. The EPA's Phase 1 Spark Ignition Nonroad Final Rule on such emissions standards was published in 60 *Federal Register* 34581 (July 3, 1995) and was effective beginning August 2, 1995. Compliance was required by the 1997 model year. The Phase 2 final rule for handheld nonroad equipment was published in 65 *Federal Register* 24267 (April 25, 2000). The Phase 2 final rule for nonhandheld equipment was published in 64 *Federal Register* 15207 (March 30, 1999).

Implementation

This program is implemented by the EPA, under 42 U.S.C. §7547 (a).

References

EPA Guidance Memorandum, "Future Nonroad Emission Reduction Credits for Court-Ordered Nonroad Standards," from Emission Planning and Strategies Division, Memorandum from Phil Lorang, Director, Emission Planning and Strategies Division, November 28, 1994.

U.S. Environmental Protection Agency, "Emission Standards for New Nonroad Spark-Ignition Engines at or Below 19 Kilowatts," Final Rule, 60 *Federal Register* 34581 (July 3, 1995).

U.S. Environmental Protection Agency, “Phase 2 Emission Standards for New Nonroad Spark-Ignition Nonhandheld Engines At or Below 19 Kilowatts,” Final Rule, 64 *Federal Register* 15207 (March 30, 1999); correction published 64 *Federal Register* 36423 (July 6, 1999).

U.S. Environmental Protection Agency, “Phase 2 Emission Standards for New Nonroad Spark-Ignition Handheld Engines at or Below 19 Kilowatts,” Final Rule, 65 Federal Register 24267 (April 25, 2000).

1990 Clean Air Act Amendments, 42 U.S.C. §7547 (a).

5.3.2 Emissions Standards for Diesel-Powered Nonroad Utility Engines of 50 or More Horsepower (federal rule)

This measure takes credit for emissions reductions attributable to emissions standards promulgated by the EPA for nonnroad, compression-ignition (i.e., diesel-powered) utility engines, as authorized under 42 U.S.C. § 7547. The measure affects diesel-powered (or other compression-ignition) construction equipment, industrial equipment, etc., rated at or above 37 kW (37 kW is approximately equal to 50 hp).

Control Strategy

Federal emissions standards applicable to compression-ignition nonroad utility engines are promulgated under §7547 (a).

EPA's first rule on such emissions standards was published in 59 *Federal Register* 31306 (June 17, 1994) and was effective on July 18, 1994.

Tier 2 and Tier 3 Emission Standards were promulgated in 1998. This program includes the first set of standards for nonroad diesel engines less than 37 kW (phasing in between 1999 and 2000), including marine engines in this size range. It also phases in more stringent Tier 2 emission standards from 2001 to 2006 for all engine sizes and adds yet more stringent Tier 3 standards for engines between 37 and 560 kW (50 and 750 hp) from 2006 to 2008.

EPA adopted a comprehensive national program to greatly reduce emissions from future nonroad diesel engines by integrating engine and fuel controls as a system to gain the greatest air quality benefits. This rule was published June 29, 2004. The requirement to reduce sulfur levels in nonroad diesel fuel by more than 99 percent will allow, for the first time, advanced emission control systems to be used on the engines used in construction, agricultural, industrial, and airport service equipment.

Implementation

This program is implemented by the EPA under 42 U.S.C. § 7547 (a).

References

1990 Clean Air Act Amendments, 42 U.S.C. §7547 (a).

U.S. Environmental Protection Agency, "Control of Emissions of Air Pollution from Nonroad Diesel Engines; Final Rule," 63 *Federal Register* 56967, October 23, 1998.

U.S. Environmental Protection Agency, "Control of Emissions of Air Pollution from Nonroad Diesel Engines and Fuel; Final Rule," 69 *Federal Register*, Vol. 69, No. 124, June 29, 2004.

EPA Guidance Memorandum, "Future Nonroad Emission Reduction Credits for Court-Ordered Nonroad Standard," from Emission Planning and Strategies Division, Memorandum from Phil Lorang, Director, Emission Planning and Strategies Division, November 28, 1994.

U.S. Environmental Protection Agency," Determination of Significance for Nonroad Sources and Emission Standards for New Nonroad Compression-Ignition Engines at or Above 37 Kilowatts," Final Rule, 59 *Federal Register* 31306 (June 17, 1994).

5.3.3 Emissions Standards for Spark-Ignition (SI) Marine Engines (federal rule)

This EPA measure controls exhaust NO_x emissions from new spark-ignition (SI) gasoline marine engines, including outboard engines, personal watercraft engines, and jet boat engines.

Control Strategy

EPA is imposing emission standards for two-stroke technology, outboard and personal watercraft engines. This will involve increasingly stringent control over the course of a 9-year phase-in period beginning in model year 1998. By the end of the phase-in, each manufacturer must meet a NO_x emission standard.

Implementation

This program is implemented by the EPA under 42 U.S.C. § 7547 (a).

References

1990 Clean Air Act Amendments, 42 U.S.C. §7547 (a).

U.S. Environmental Protection Agency, "Control of Air Pollution; Final Rule for New Gasoline Spark-Ignition Marine Engines; Exemptions for New Nonroad Compression-Ignition Engines at or Above 37 Kilowatts and New Nonroad Spark-Ignition Engines at or Below 19 Kilowatts," 61 *Federal Register* 52087, October 4, 1996.

Regulatory Impact Analysis "Control of Air Pollution Emission Standards for New Nonroad Spark-Ignition Marine Engines," U.S. EPA, June 1996

5.3.4 Emissions Standards for Large Spark-Ignition (SI) Engines (federal rule)

This EPA measure controls emissions from several groups of previously unregulated nonroad engines, including large industrial SI engines.

Control Strategy

The EPA requirements vary depending upon the type of engine or vehicle, taking into account environmental impacts, usage rates, the need for high performance models, costs, and other factors. The emission standards apply to all new engines sold in the United States and any imported engines manufactured after these standards began.

Controls on the category of large industrial SI engines were first required in 2004. Controls on the other engine categories began in years after 2005. Large industrial SI engines are those rated over 19 kW used in a variety of commercial applications; most use liquefied petroleum gas, with others operating on gasoline or natural gas.

EPA adopted two tiers of emission standards for large SI engines. The first tier of standards, which started in 2004, are based on a simple laboratory measurement using steady-state procedures. The Tier 1 standards are the same as those adopted earlier by the California Air Resources Board for engines used in California. Tier 2 standards became effective in 2007.

Implementation

This program is implemented by the EPA under 42 U.S.C. § 7547 (a).

References

1990 Clean Air Act Amendments, 42 U.S.C. §7547 (a).

U.S. Environmental Protection Agency, "Control of Emissions from Nonroad Large Spark-Ignition Engines, and Recreational Engines (Marine and Land-Based)," Final Rule, 67 *Federal Register* 68241 (November 8, 2002).

U.S. Environmental Protection Agency, Final Regulatory Support Document: Control of Emissions from Unregulated Nonroad Engines," EPA420-R-02-022, September 2002.

5.3.5 Standards for Locomotives (federal rule)

This measure sets NO_x standards for locomotive engines remanufactured and manufactured after 2001.

Source Type Affected

This program includes all locomotives originally manufactured from 2002 through 2004. It also applies to the remanufacture of all engines built since 1973. Regulation of the remanufacturing process is critical because locomotives are generally remanufactured five to ten times during their total service lives, which are typically 40 years or more.

Control Strategy

Three separate sets of emissions standards have been adopted, with the applicability of the standards dependent on the date a locomotive is first manufactured. The first set of standards (Tier 0) applies to locomotives and locomotive engines originally manufactured from 1973 through 2001, any time they are manufactured or remanufactured. The second set of standards (Tier 1) apply to locomotives and locomotive engines originally manufactured from 2002 through 2004. These locomotives are required to meet the Tier 1 standards at the time of manufacture and at each subsequent remanufacture. The final set of standards (Tier 2) apply to locomotives and locomotive engines originally manufactured in 2005 and later. Electric locomotives, historic steam-powered locomotives and locomotives manufactured before 1973 do not significantly contribute to the emissions problem and, therefore, are not included in the regulation.

Implementation

This program is implemented by the EPA under the *Final Emissions Standards for Locomotives* (EPA420-F-97-048) published in December 1997.

Projected Reductions

Emission reduction values are generated using the Area Source spreasheet but are presented in the overall nonroad sector totals.

Emission Benefit Calculations

Emission benefits are based on EPA guidance on emission factors for locomotives. In 2009, the reductions are 32.35 percent for NO_x and 15 percent for $PM_{2.5}$.

References

Regulatory Update, EPA's Nonroad Engine Emissions Control Programs, EPA, Air and Radiation, EPA420-F-99-001, January 1999.

Final Emissions Standards for Locomotives, EPA420-F-97-048, December 1997.

Emission Factors for Locomotives, EPA420-F-97-051, December 1997, Table 9.

5.4 ON-ROAD MEASURES

The following onroad emission reduction measures, discussed in greater detail later in this section, are calculated using the MOBILE6 model:

- Enhanced Inspection and Maintenance (I/M), 5.4.1
- Federal Tier 1 Vehicle Standards, 5.4.2
- National Low Emission Vehicle Standards, 5.4.3
- Federal Tier 2 Vehicle Standards, 5.4.4
- Heavy Duty Diesel Engine Rule, 5.4.5

Projected Reductions and Emission Benefit Calculations

MOBILE5b, the mobile emissions model used in previous SIPs, was designed to calculate the benefits of each of the above control measures individually. In the update to MOBILE6, changes were made to the model, creating synergistic effects between the five mobile control measures listed above. These effects make it difficult to calculate incremental benefits from implementation of individual control measures. As a result, this and future SIP revisions will not enumerate the benefits of individual mobile control measures, with the exception of the transportation control measures (TCMs) and vehicle technology, fuel, and maintenance-based measures, which are quantified outside of the MOBILE6 model. The table below summarizes the combined benefits from the above control measures by jurisdiction. See Appendix E1 for documentation of the MOBILE 6 modeling process.

	Emission Reductions (tons/year)			
	District of Columbia	**Maryland**	**Virginia**	**Total**
2009 NO_x Reductions	2,277	13,853	12,640	28,770
2009 SO_2 Reductions	265	1,706	1,525	3,496
2009 $PM_{2.5}$ Reductions	15	100	89	204

5.4.1 Enhanced Vehicle Emissions Inspection and Maintenance (Enhanced I/M) (federal regulation)

This measure involves requiring a regional vehicle emissions I/M program with requirements stricter than "basic" programs, as required under 42 U.S.C. §7511a(c)(3) and 7521. Before 1994, "basic" automobile emissions testing checked only tailpipe emissions while idling and sometimes at 2,500 rpm. The new procedures include a dynamometer (treadmill) test that checks the car's emissions under driving conditions. In addition, evaporative emissions and the on-board diagnostic computer are checked.

Source Type Affected

This measure affects light-duty gasoline and diesel vehicles and trucks.

Control Strategy

Maryland, the District of Columbia, and Virginia committed to EPA Performance Standard Enhanced I/M programs in the 15% VOC Emissions Reduction Plan. Each affected vehicle in the region is given a high-tech emissions test every two years, and there is extensive use of on-board diagnostics. In Maryland and the District of Columbia, emissions tests are performed at test-only stations. Virginia tests vehicles in stations that may also perform repairs using a decentralized program.

Implementation

District of Columbia - Department of Public Works, Department of Consumer and Regulatory Affairs
Maryland - Motor Vehicles Administration
Virginia - Department of Environmental Quality

Appendix E1 contains detailed information regarding implementation of I/M programs in the District, Maryland, and Virginia.

References

U.S. Environmental Protection Agency, "Inspection/ Maintenance Program Requirements," Final Rule, 57 *Federal Register* 52950 (November 5, 1992).

U.S. Environmental Protection Agency, "I/M Costs, Benefits, and Impacts Analysis," Draft, February 1992.

5.4.2 Federal Tier I New Vehicle Emission and New Federal Evaporative Emissions Standards (federal regulation)

Under 42 U.S.C. §7521, EPA issued a new and cleaner set of federal motor vehicle emission standards (Tier I standards), which were phased in beginning with model year 1994.

The benefits of this program are reflected in the 2002 baseline inventory and the 2008 and 2009 projections thereof.

Source Type Affected

These federally implemented programs affected light-duty vehicles and light-duty trucks (LDT).

Control Strategy

The Federal Motor Vehicle Control Program requires more stringent exhaust emission standards as well as a uniform level of evaporative emission controls, demonstrated through the new federal evaporative test procedures. Under 42 U.S.C. §7521(g), all post-1995 model year cars must achieve the Tier I (or Phase I) exhaust standards, which are as follows (emissions are in grams/mile and are related to durability timeframes of 5 yrs/50,000 miles and 10 yrs/100,000 miles):

Vehicle Type	*5 yrs/50,000 miles*			*10 yrs/100,000 miles*		
	VOCs	CO	NO_x	VOCs	CO	NO_x
Light-duty vehicles; light-duty trucks (loaded weight 3,750 lbs)	0.25	3.4	0.4[a]	0.31	4.2	0.6 [a]
Light-duty trucks (loaded weight of 3,751 to 5,750 lbs)	0.32	4.4	0.7[b]	0.40	5.5	0.97

[a]For diesel-fueled light-duty vehicles and for LDTs at 3,750 lbs, before model year 2004, the applicable NO_X standards shall be 1.0 at 5 yrs/50,000 miles and 1.25 at 10 yrs/100,000 miles.
[b]This NO_X standard does not apply to diesel-fueled trucks of 3,751 to 5,750 lbs.

Implementation

This program is implemented by the EPA under 42 U.S.C. §7521.

References

U.S. Environmental Protection Agency, Office of Mobile Sources, *User's Guide to MOBILE5*, Chapter 2, March 1993.

5.4.3 National Low Emission Vehicle Program (federal regulation)

Under the National Low-Emission Vehicle (LEV) program, auto manufacturers have agreed to comply with tailpipe standards that are more stringent than EPA can mandate prior to model year (MY) 2004. Once manufacturers committed to the program, the standards became enforceable in the same manner in which other federal motor vehicle emissions control requirements are enforceable. The program went into effect throughout the Ozone Transport Region (OTR), including Maryland, Virginia, and the District of Columbia, in MY 1999 and was in place nationwide in MY 2001.

The benefits of this program are reflected in the 2002 baseline inventory and the 2008 and 2009 projections thereof. Additional reductions from this measure are not expected.

Source Type Affected

These federally implemented programs affect light-duty vehicles and trucks.

Control Strategy

The National Low Emission Vehicle Program requires more stringent exhaust emission standards than the Federal Motor Vehicle Control Program Tier I (or Phase I) exhaust standards.

Implementation

This program is implemented by the EPA, under 40 CFR Part 86 Subpart R. Nine states within the OTR, including the MWAQC states, have opted-in to the program as have all the auto manufacturers. EPA found the program to be in effect on March 2, 1998.

References

U.S. Environmental Protection Agency, Office of Mobile Sources, *User's Guide to MOBILE5*, Chapter 2, March 1993.

5.4.4 Tier 2 Motor Vehicle Emission Regulations (federal regulation)

The EPA promulgated a rule on February 10, 2000, requiring more stringent tailpipe emissions standards for all passenger vehicles, including sport utility vehicles (SUVs), minivans, vans, and pick-up trucks. These regulations also require lower levels of sulfur in gasoline, which will ensure the effectiveness of low emission-control technologies in vehicles and reduce harmful air pollution.

Source Type Affected

These federally implemented programs affect light-duty vehicles and trucks.

Control Strategy

The new tailpipe and sulfur standards require passenger vehicles to be 77 to 95 percent cleaner than those built before the rule was promulgated and will reduce the sulfur content of gasoline by up to 90 percent. The new tailpipe standards are set at an average standard of 0.07 grams/mile for NO_x for all classes of passenger vehicles beginning in 2004. This includes all light-duty trucks, as well as the largest SUVs. Vehicles weighing less than 6000 pounds are being phased-in to this standard between 2004 and 2007.

Beginning in 2004, the refiners and importers of gasoline have the flexibility to manufacture gasoline with a range of sulfur levels as long as all of their production is capped at 300 parts per million (ppm) and their annual corporate average sulfur levels are 120 ppm. In 2005, the refinery average was set at 30 ppm, with a corporate average of 90 ppm and a cap of 300 ppm. Finally, in 2006, refiners met a 30 ppm average sulfur level with a maximum cap of 80 ppm.

As newer, cleaner cars enter the national fleet, the new tailpipe standards will significantly reduce emissions of nitrogen oxides from vehicles by about 74 percent by 2030.

Implementation

EPA implements this program under 40 CFR Parts 80, 85, and 86.

References

U.S. Environmental Protection Agency, "Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements," Final Rule, 65 *Federal Register 6697*, February 10, 2000.

5.4.5 Heavy-Duty Diesel Engine Rule (federal regulation)

Under the Heavy-Duty Diesel Engine Rule, truck manufacturers must comply with more stringent tailpipe standards by 2004 and 2007. The standards are enforceable in the same manner that other federal motor vehicle emissions control requirements are enforceable.

Source Type Affected

These federally implemented programs affect heavy-duty diesel engines used in trucks.

Control Strategy

The Heavy-Duty Diesel Engine Rule requires more stringent exhaust emission standards. The rule also mandates use of ultra-low sulfur diesel fuel. Sulfur in diesel fuel must be lowered to enable modern pollution-control technology to be effective on these trucks and buses. EPA requires a 97 percent reduction in the sulfur content of highway diesel fuel from its former level of 500 ppm (low sulfur diesel, or LSD) to 15 ppm (ultra-low sulfur diesel, or ULSD). Refiners began producing the cleaner-burning diesel fuel, ULSD, for use in highway vehicles beginning June 1, 2006.

Implementation

This program is implemented by the EPA, under 40 CFR Parts 9 and 86 Control of Emissions of Air Pollution From Highway Heavy-Duty Engines; Final Rule.

References

U.S. Environmental Protection Agency, Office of Mobile Sources, *User's Guide to MOBILE5*, Chapter 2, March 1993.

40 CFR Parts 9 and 86 Control of Emissions of Air Pollution from Highway Heavy-Duty Engines; Final Rule (62 FR 54694), October 21, 1997.

5.4.6 Transportation Control Measures (TCMs) and Vehicle Technology, Fuel, and Maintenance-based Measures (state and local program)

Section 108(f) of the Clean Air Act Amendments provides examples of TCMs that can be implemented to reduce emissions from mobile sources. Most TCMs are designed to improve the flow of traffic or reduce vehicle miles traveled (VMT) or vehicle trips.

In conjunction with state departments of transportation and local transit authorities, state air agencies have identified a number of projects designed to reduce vehicle travel and mitigate traffic congestion in the Metropolitan Washington nonattainment area. These measures include purchase of alternative-fueled vehicles, improvements to bicycle and pedestrian facilities, improvements to transit services, and access to transit facilities. All responsible agencies have committed to implementing these projects by January 1, 2005.

Additional information on TCMs is contained in Appendix F.

Source Type Affected
Transportation-related activities in the Metropolitan Washington nonattainment area

Implementation
District of Columbia – Department of Transportation
Maryland - Department of Transportation
Virginia - Department of Transportation
Washington Metropolitan Area Transit Authority
Northern Virginia Local Governments

Projected Reductions

Transportation Control Measures

	Emission Reductions (tons/year)			
	District of Columbia	Maryland	Virginia	Total[a]
2009 $PM_{2.5}$ Reductions	-	-	-	1.55
2009 NO_x Reductions	-	-	-	67.14

Vehicle Technology, Maintenance, or Fuel-Based Measures

	Emission Reductions (tons/year)			
	District of Columbia	Maryland	Virginia	Total[a]
2009 $PM_{2.5}$ Reductions	-	-	-	1.03
2009 NO_x Reductions	-	-	-	81.93

[a] Totals also include TCMs and Vehicle Technology, Maintenance, and Fuel-based Measures for the Washington Metropolitan Area Transit Administration (WMATA). Emission reduction estimates were supplied by the District of Columbia Department of Transportation, the Maryland Department of Transportation, the Virginia Department of Transportation. See Appendix F for details.

5.5 SUPPLEMENTAL CONTROL MEASURES

EPA's voluntary measures policy, "Guidance on Incorporating Voluntary Mobile Source Emission Reduction Programs in State Implementation Plans," establishes criteria under which emission reductions from voluntary programs are creditable in a SIP. This policy permits states to develop and implement innovative programs that partner with local jurisdictions, businesses, and private citizens to implement emission-reducing behaviors at the local level.

Inclusion of the following programs in the control measures portion of this attainment plan is not intended to create an enforceable commitment by the states to implement the programs or to achieve any specific emission reductions projected as a result of implementation of the programs, and the states do not make any such commitment. In addition, the states do not rely on any emission reductions projected as a result of implementation of these programs to demonstrate attainment. While the emission reductions from these programs could be substantial and could lead to significant regional air quality benefits, actual air quality benefits are uncertain.
Consequently, projected emission reductions from these programs are not included in the emission inventory, the attainment modeling, the reasonable further progress calculation, or any other area of the SIP where specific projected emission reductions are identified.

This SIP proposes a set of supplemental controls that includes emission reductions measures included in the bundle for the 8-hour ozone SIP and several additional programs proposed herein. All of the supplemental measures have been implemented after the 2002 base year. These supplemental measures may be expanded in future SIPs as additional voluntary measures are developed and implemented. Though the benefits of these programs are not reflected in the region's 2009 controlled inventory, the programs are an important part of the region's attainment strategy. Commitment letters from participating jurisdictions are included in Appendix G.

This section contains descriptions of the supplemental control measures and other programs that are included in this SIP submission. Individual measures and programs are described on succeeding pages. Some examples of successful local programs include

- Committing to purchasing low-emission vehicles reducing emissions from on-road sources.
- Voluntary shutdowns of county waste-to-energy facilities to reduce stationary source emissions during air pollution episodes.
- Reducing emissions from peaking units that generate electricity to reduce NO_x emissions during periods of poor air quality.
- Banning operation of lawn and garden equipment to reduce nonroad emissions.
- Reducing mobile emissions through liberal leave policies and support for teleworking on Code Red Days.
- Developing tree planting programs as a long-term strategy to improve air quality.

Source Type Affected

These supplemental controls reflect commitments by owners, operators, purchasers, or users of the following types of emissions-related items/equipment in the Metropolitan Washington area: commercial power generation, municipal buildings, commuting, fleets, and urban forest trees.

Implementation

Arlington County, Virginia
City of Alexandria, Virginia
City of Falls Church, Virginia
City of Greenbelt, Maryland
Fairfax City, Virginia
Fairfax County, Virginia
Loudoun County, Virginia
Maryland Department of Transportation
Maryland National Capital Parks and Planning Commission
Montgomery County, Maryland
Prince George's County, Maryland
Prince William County, Virginia
Washington Surburban Sanitary Commission, Maryland

Supplemental Control Measures

The local governments and state agencies in the Washington region have taken a coordinated, proactive approach to reducing emissions. These actions reduce SO_2 and NO_x emissions from a variety of source sectors. Programs include

Point Source Measures

- Renewable Energy Programs
    - Regional Wind Power Purchase Program
    - Clean Energy Rewards Program
    - Renewable Portfolio Standards
- Energy Efficiency Programs
    - Light-Emitting Diode (LED) Traffic Signal Retrofit Program
    - Building Energy Efficiency Programs
- Green Building Programs
- High Electricity Demand Day Initiative (HEDD)

Mobile Source Measures

- Diesel Particulate Reductions*
- Low-Emission Vehicle Purchases*
- Telecommuting Initiative*

* Explicitly reserved for use as TERMs in transportation conformity.

Other Programs

- Clean Air Partners
- Tree Canopy Programs

Additional Programs Being Implemented or under Development**

- Early Adoption of Low-Sulfur Fuel for Off-Road Applications
- Restrictions on Installation of Wood Burning Fireplaces
- Dust Suppression for Construction
- Idling Controls
- CAIR Plus
- Distributed Generation Rule
- Industrial, Commercial, and Institutional Boiler Rule
- Energy Performance Contracting
- Airport Initiatives
- Heavy Duty I/M, Smoke Testing
- Low-Sulfur Home Heating Oil

** No further information on these initiatives is provided herein.

Point Source Strategies

5.5.1 Regional Wind Power Purchase Program

Under this measure, local and state government entities in the nonattainment area have committed to purchase a specific number of kilowatt-hours (kWh) of power during the summer ozone season from wind turbines. The government agencies will purchase the wind energy directly from an electricity supplier or purchase renewable energy certificates (RECs)[1] that ensure that such wind energy is placed on the electric grid. This zero-emission wind power will displace emissions from fossil-fueled power plants that would normally supply power to the Metropolitan Washington region. The air agencies in Maryland, the District of Columbia, and Virginia may retire NO_x allowances in an amount commensurate with the amount of emissions displaced.

Source Type Affected

The measure affects certain local and state government entities within the Metropolitan Washington nonattainment area. The region is implementing this measure to reduce electric power generation from coal, oil, and/or gas-fired sources, thereby reducing NO_x emissions from these sources.

Control Strategy

This measure is envisioned as a region-wide measure encompassing purchases of wind power or wind energy RECs by state and local government entities within the Metropolitan Washington nonattainment area.

This program was initiated on a pilot basis in the 1-hour ozone SIP and was expanded in the 8-hour ozone SIP. To meet commitments, local governments signed multi-year commitments with wind power suppliers to ensure that a fixed quantity of wind energy would be placed on the electric grid in upwind or continguous states. These purchases have displaced fossil fuel generated power, thus reducing the NO_x emitted from those plants.

Implementation

Arlington County, Virginia
Fairfax County, Virginia
Prince William County, Virginia
Montgomery County, Maryland
Members of the Montgomery County buying group (see list below)
Prince George's County
Washington Suburban Sanitary Commission (WSSC)
District of Columbia

---

[1] Renewable energy certificates represent the unique and exclusive proof that 1 megawatt-hour of energy was generated from a renewable energy source and placed on the electric grid.

In Fiscal Years (FY) 2005 and 2006, a buying group led by Montgomery County, Maryland, purchased 40,845,139 kWh of wind energy RECs per fiscal year. The purchase represented 5% of the total annual electricity consumption of each purchasing group participant. Montgomery County executed a contract amendment on September 18, 2006, to purchase additional kWhs of clean, renewable energy in compliance with SIP requirements (RECs for energy were generated at the Mountaineer Wind Energy Center in West Virginia) for FY07 and FY08 (July 1, 2006 to June 30, 2008). In the new contract, the county and many other members of the buying group opted to increase their wind energy purchase to 10% of their total annual electricity consumption, for a total of 51,809,091 kWh of clean energy purchased by the group in FY07 and 57,481,122 kWh in FY08. The purchase will cover the period from July 1, 2006 to June 30, 2008.

The following other counties, cities, and state agencies will participate in the Montgomery County buying group:

Montgomery County Public Schools (MCPS)
Montgomery County Government
Maryland National Capital Park and Planning Commissions (M-NCPPC)
Montgomery College
Housing Opportunities Commission (HOC)
City of Rockville
Gaithersburg
Takoma Park
College Park
Rockville Housing Enterprise
Town of Kensington
Chevy Chase Village
Somerset
Glenn Echo
Chevy Chase Sect. 5
Town of Laytonsville

In addition, the Virginia Energy Purchasing Governmental Association (VEPGA) issued a Reasonable Further Progress (RFP) in March 2007 to select a supplier of wind energy RECs. Current commitments amount to at least 11,470,000 kWh/year. The RFP covers the period April 2007 to March 2010. The following counties, cities, and state agencies will participate in this buying group: Fairfax County, Arlington County, City of Alexandria Schools, and Prince William County.

The District of Columbia plans to purchase 16,500 kWh/year from wind energy or wind energy RECs. There is the possibility that this purchase can be used by utilities to meet Renewable Portfolio Standard (RPS) requirements, so it is not analyzed further here.

5.5.2 Clean Energy Rewards Program

Under this measure, Montgomery County Government will provide rewards (incentives) to residents, small businesses, and community organizations purchasing clean energy products certified by the Department of Environmental Protection (DEP). The authority for this program is granted in the Montgomery County Code Section 18A-11, as amended, and Executive Regulation No. 2-06AM. Based on the program's funding of $361,000 for FY07, Montgomery County has estimated that its Clean Energy Rewards Program will provide incentives for 31,900 MWh of clean energy.

Source Type Affected

The measure affects Montgomery County residents, small businesses, congregations, and nonprofits and is supported by Montgomery County Government, within the Metropolitan Washington nonattainment area. Montgomery County is implementing this measure to reduce consumption of electric power generated from coal, oil, and/or natural gas-fired sources by consumers, thereby reducing NO_x emissions from these sources.

Control Strategy

Clean Energy Rewards is a unique program developed by Montgomery County to encourage consumers to switch to clean energy. Consumers must purchase at least 50 percent of their annual energy consumption from a clean energy product certified by DEP to be eligible for rewards.

Under the program, eligible clean energy products must be generated within the PJM Regional Transmission Organization (RTO)[2] from solar, wind, and/or Tier 1 biomass as defined by the Maryland Code, Public Utility Company Article, 7-703 (Maryland's RPS). However, current products for FY07 are limited to energy generated from wind and solar sources, and Montgomery County believes that the majority of certified clean energy products will be wind-based in 2007.

Participating suppliers must provide documentation to DEP's director verifying that all products marketed through Clean Energy Rewards meet the program's criteria. These steps ensure the clean energy is generated within the PJM region and is not used to meet the requirements of the Maryland RPS or is otherwise double counted. Only purchases of wind energy or solar will be reported for purposes of the SIP.

[2] PJM Interconnection is a regional transmission organization (RTO) that coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and the District of Columbia.

Implementation

Montgomery County Government. DEP solicited support from several energy suppliers and REC marketers for this program. Potential suppliers are required to submit product information labels or other generation data about each product to be marketed through the program and to sign a Memorandum of Understanding with the county agreeing to deliver the rewards to consumers either as a credit on their bill or as a product discount. Montgomery County residents will receive 1 cent/kWh up to 20,000 kWh/year. Nonresidential end-users (small business, congregations, and nonprofits) will receive 1.5 cents/kWh up to 100,000 kWh/year. Consumers can shop and sign up for clean energy through the DEP Web site. By choosing a program-certified product, consumers will automatically receive rewards.

DEP is the main marketing arm of the Clean Energy Rewards Program. However, program suppliers have also marketed their certified products and the program to Montgomery County consumers with DEP guidance to insure consistency. DEP developed a Web site and educational materials to inform consumers about the program and the benefits of clean energy. The county ran several advertising campaigns in print, on TV and radio, and through community organizations and other Montgomery County support structures. DEP estimates that these marketing measures reached thousands of Montgomery County electric consumers.

The Clean Energy Rewards program began enrolling consumers and delivering rewards January 1, 2007. Within the first fiscal year (ending June 2007), the program rewarded nearly 4,000 megawatt-hours (MWh) of clean energy purchased by Montgomery County residents, businesses, and nonprofit organizations. Program results for the first quarter of FY08 (July 2007 - June 2008) are over 7,500 MWh. DEP projects clean energy purchased through the program will increase and is likely to reach maximum participation of 31,900 MWh.

5.5.3 Renewable Portfolio Standards

This measure will focus on NO_x emission reductions resulting from the displacement of power generation from coal, oil, and/or gas-fired sources by zero-emission renewable energy sources.

Source Type Affected

The measure affects the District of Columbia within the Metropolitan Washington nonattainment area. According to the DC Renewable Energy Portfolio Standard (RPS) Act of 2004, a major purpose of the Act is to "ensure that the benefits of electricity from renewable energy sources, including long-term reduced emissions…accrue to the public at large."

Control Strategy

Under the DC RPS Act, retail electricity suppliers are required to meet their regulatory requirements by supplying renewable energy that is located (A) in the PJM Interconnection region or in a state that is adjacent to the PJM Interconnection region or (B) outside the area described in (A) but in a control area that is adjacent to the PJM Interconnection region, if the electricity is delivered into the PJM Interconnection region.

The increased supply of renewable energy will displace fossil fuel generated power in the PJM Interconnection area, thus reducing the NO_x emitted from these plants.

Implementation

District of Columbia. Under the DC RPS Act, retail electricity suppliers serving customers in the District of Columbia are required to provide 2.5% of their supply from Tier 1 renewable energy sources in 2009. In addition, retail electric suppliers are required to provide 0.019% from solar energy or solar REC purchases. This renewable energy percentage increases each year to a level of 11% in 2022 and later. Tier 1 renewable sources are defined to include (1) zero-emission renewable energy sources, including solar energy, wind energy, geothermal energy, and ocean energy, and (2) low-emission renewable energy, including qualifying biomass, qualified methane from anaerobic decomposition, and fuel cells.

5.5.4 Green Building Programs

Under this program, local governments in the nonattainment area have committed to reducing energy demand associated with operation of existing and new buildings by implementing Green Building Programs. Depending on the energy efficiency and renewable energy components of these programs, they will decrease demand for electricity and displace power generation from coal, oil, and/or gas-fired sources that would normally supply power to the Metropolitan Washington region, thereby reducing NO_x emissions from those sources.

Source Type Affected

The measure affects state and local governments within the Metropolitan Washington nonattainment area.

Control Strategy

This measure is envisioned as a region-wide measure encompassing Green Building Programs by state and local governments within the Metropolitan Washington nonattainment area. These programs are in the early stages of development and affect several local jurisdictions in the nonattainment area. Local governments have begun to implement a variety of Green Building Programs that may reduce demand for electricity. The reduction in energy demand will displace fossil fuel generated power, thus reducing the NO_x emitted from those plants.

Green Building Programs can include a number of initiatives such as certification under the Leadership in Environmental and Energy Design (LEED) Program, labeling under the ENERGY STAR® program, Green Globes rating, and green building codes. To provide air quality benefits, any program must include as a key component a requirement that retrofitted or new buildings achieve a reduction in energy demand compared to an established baseline.

Implementation

This section identifies the current status of Green Building Programs listed for the SIP, examines what uses or adaptations of major green building rating systems could be made to quantify emissions effects in a SIP context, and summarizes major green buildings efforts to date within the nonattainment area.

Current Status of Green Building Programs for the SIP

The following table lists the initial survey responses for Green Building Programs in the nonattainment area that the jurisdictions indicated they would like to include as voluntary measures, for SIP purposes. None of the jurisdictions intend to quantify the listed Green Buildings Program elements for 2009 emission reductions for the $PM_{2.5}$ SIP.

Summary of Initial Survey Responses of Voluntary Measures Regarding Green Building Programs (2002-2009)

Jurisdiction	Program Element
Fairfax County	LEED projects for municipal buildings
Arlington County	LEED scorecard for projects; developer incentives
Montgomery County	Green Building ordinance
District of Columbia	Planning for LEED requirements for all govt buildings
City of Alexandria	LEED silver goal for all govt buildings
City of Alexandria	Require plan for voluntary LEED for private sector
City of Greenbelt	LEED silver for public works building

Additional green building activities of the local governments in the nonattainment area are further described in the section below on "Green Building Activities in the Nonattainment Area."

Green Building Activities in the Nonattainment Area

This section identifies green buildings activities in the jurisdictions and LEED-certified buildings in the nonattainment area and discusses federal green buildings.

Jurisdiction Activities. Many of the jurisdictions are undertaking green buildings activities. These have not been included in this SIP submission. The National Renewable Energy Laboratory (NREL) compiled this information from the Internet and personal communications.

Metropolitan Washington Council of Governments (MWCOG). In June 2006, MWCOG Board Chair Jay Fisette announced a goal of promoting Green Building policies and practices in the Washington region. This effort supports the MWCOG Board's focus on growth and development and provides environmental and energy friendly methods for supporting sustainable development in the region, consistent with MWCOG's Strategic Energy Plan. On September 29, MWCOG's "Regional Leadership Conference on Green Building" was held with over 300 attendees from the public and private sectors. The conference focused on a review of local and national Green Building best management practices, policies, regulations, and legislation. In addition, several MWCOG members have adopted or will soon adopt legislation encouraging or requiring Green Building practices for government and/or private sector construction. The MWCOG Board adopted resolution R55-06 at the November 8, 2006, MWCOG Board Meeting, which supports the development of regional Green Building policies and best practice guidelines, establishes a special ad hoc elected official advisory committee, and adopts the existing Intergovernmental Green Building Group (IGBG) as an MWCOG technical committee.

The 2006 Regional Energy Strategic Plan, “Powered by Energy Efficiency – Fueled by Energy Conservation," outlines an energy vision and mission for the National Capital Region and expands existing regional energy and environmental goals. The Energy Strategic Plan also identifies potential initiatives to address the region’s diversity of energy sources, help manage energy demand, mitigate the effects of energy disruption, and enhance overall environmental quality. Development of the Plan was identified by the MWCOG Board of Directors as a 2006 priority. In addition, the Plan is consistent with and complements the proposed Green Building Program. The Plan was submitted to member governments in June 2006 for a 90-day comment period. The MWCOG Board approved the revised version of the Energy Strategic Plan by adopting resolution R56-06 at the MWCOG Board Meeting on November 8, 2006.

Washington, D.C. In December 2006, the District of Columbia Council enacted green building legislation applicable to private development. The legislation, which is expected to be approved by the U.S. Congress, would make Washington the first major city to require private developers to adhere to the standards of the U.S. Green Building Council (USGBC). Even before the legislation, that jurisdiction was already on track to open the nation's first LEED-certified stadium.

The bill requires all commercial development of 50,000 square feet or more to meet the building council's standards starting in 2012. The requirement applies to both new construction and significant renovations of old buildings.

All city-owned commercial projects funded in 2008 or later would have to attain certification, and District of Columbia-funded housing projects would be required to follow similar environmental standards. The bill also orders the mayor to adopt separate standards for schools, which the USGBC is now developing.

Montgomery County. On November 28, 2006, the Montgomery County Council unanimously enacted “Green Building” requirements for future public and private construction in Montgomery County -- the strongest “Green Building” requirements in the region.

The legislation requires that county-built or funded nonresidential buildings achieve a LEED Silver rating and requires private nonresidential or multi-family residential buildings to achieve a LEED-certified rating.

Buildings covered by the law include any newly constructed or extensively modified nonresidential or multi-family residential building with at least 10,000 square feet of gross floor area. The law would take effect for private buildings one year after the county implementing regulations are finalized, but not later than September 1, 2008. Follow-up regulations will address many of the details on the rating system [LEED New Construction (NC), Exisitng Building (EB)], and such regulations are expected to be developed by July 2007.

The current legislation does not have a defined mandatory energy-efficiency component beyond the prerequisites of the LEED rating system. The Montgomery County energy code is International Energy Conservation Code (IECC) 2003 (IECC 2006 is expected to be adopted in the spring of 2007), which is more aggressive than most of the neighboring jurisdictions.

Arlington County. Arlington County's Green Building Program is a leading municipal program in the region and has been developed in the context of the county's commitment to smart growth and community sustainability. County policy encourages all large commercial and multi-family residential projects to incorporate LEED components of 25 or more credits on a voluntary basis. Arlington's Green Building Incentive Program allows developers to apply for bonus density in exchange for official LEED certification. Projects may apply for a bonus density of 0.15 to 0.35 additional floor-to-area ratio (FAR). Developers who choose to participate in the density bonus and commit to LEED certification post a bond that is released when the building is certified. Site plan projects that do not receive official LEED certification from the USGBC are asked to contribute $0.03/square foot to the county's Green Building Fund. This money is used to fund green building education and workshops.

A few buildings have gone through the county's Green Building Incentive Program, including the new Navy League building, the National Rural Electric Cooperative Association building, and a private multi-family building currently under construction. Examples of the county's own green buildings include Langston Brown School and the Walter Reed Community Center.

Fairfax County. Fairfax County is expanding activities in support of environmentally sustainable development, which include incorporating more sustainable building practices. The county has focused its green building efforts in two areas: the greening of public buildings and policy for private development. Of 20 municipal buildings recently built in the county, 18 have LEED elements, with many moving toward certification. The county is in the process of reviewing the Comprehensive Plan, its key guidance document, and is developing broad language supporting green building.

City of Alexandria. The City of Alexandria initiated a green building policy four years ago and adopted a LEED standard for all public buildings in 2003-2004. Project staff review the LEED checklist to determine actions within their existing budgets and then make the decision whether to fully certify. They currently target a 3.5 percent premium for projects in order to meet the LEED Silver standard. One percent is reserved for green construction costs. Alexandria also enacted legislation in July 2006 to allow a design-build process for projects. Green building will be integrated into that process.

LEED Certified and Registered Buildings. At least 46 building projects in the nonattainment area jurisdictions are registered for LEED, and one LEED-certified building is currently listed on the USGBC Web site:

> Langston-Brown High School Continuation and Community Center
> LEED® Project # 0172
> LEED Version 2 Certification Level: SILVER
> September 3, 2003
> Arlington Public Schools, Arlington County
> Arlington, VA
> http://www.usgbc.org/ShowFile.aspx?DocumentID=425
> This project was awarded 1 credit for 15% reduction in the energy cost budget.

ENERGY STAR® *Buildings Label.* There are over 300 ENERGY STAR® labeled buildings in Maryland, Virginia, and Washington, D.C., but none are owned by the MWCOG government organizations. Many of the jurisdictions have signed up as ENERGY STAR® Partners committed to improving their energy efficiency. These local government partners currently include

Alexandria Public Schools
Arlington County
Commonwealth of Virginia
Fairfax County Government
Fairfax County Public Schools (Special Recognition in 2004)
Loudon County Public Schools
Prince William County
City of Washington, DC (and DC Energy Office)
Washington DC Public Schools
Charles County Public Schools
City of Takoma Park
Montgomery County

Federal Green Buildings. Legislation and federal mandates provide an example of setting guidelines for sustainable buildings generally and energy efficiency specifically. The Energy Policy Act of 2005 and Executive Order 13423 of January 2007 require all new federal buildings to achieve a 30 percent improvement in energy cost to American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 90.1-2004. This ASHRAE Standard is the same baseline applied in LEED-NC version 2.2. The Executive Order also requires federal agencies to follow the guidelines of the Memorandum of Understanding for Federal Leadership in High Performance and Sustainable Buildings. Federal agencies are also required to meet progressive energy use intensity reduction targets for their entire building stock. These goals are stated in terms of reduced energy consumption. There are a number federal buildings located in the MWCOG region with case study information available.

Effiency Programs

5.5.6 Building Energy Efficiency Programs

Under this program, the local governments in the nonattainment area have undertaken measures to improve the energy performance of government facilities.

Source Type Affected
These programs improve the energy efficiency of buildings and building equipment owned and operated by the local governments in the Metropolitan Washington area.

Control Strategy
This measure is envisioned as a region-wide measure encompassing energy performance contracts and other structured energy savings programs by state and local governments within the Metropolitan Washington nonattainment area. This program is at varying stages of development, and commitments received involve several local jurisdictions in the nonattainment area. State and local governments have signed contracts with energy service companies (ESCOs) to retrofit existing facilities to reduce the demand for electricity and have undertaken other energy efficiency measures in their facilities. The reduction in electricity demand will displace fossil fueled power generation, thus reducing the NO_x emitted from those plants.

Implementation
Arlington County, Virginia. The Arlington County government has instituted a variety of measures since 2002 to improve energy efficiency of operations. In addition, Arlington has allocated funds for additional efficiency investments that will increase the energy savings between now and 2010.

Fairfax County, Virginia. The Fairfax County government has implemented several large energy efficiency projects in 2005 and 2006. These projects involve variable speed drives; lighting and heating, ventilation, and air conditioning (HVAC) upgrades; and other efficiency investments.

Montgomery County, Maryland. Montgomery County departments undertake their own energy efficiency investments, as detailed in each of their Resource Conservation Plans. (See http://www.montgomerycountymd.gov/content/dep/Energy/2007rcp.pdf). These investments cover a wide range of measures during the period 2003 to 2008.

City of Alexandria, Virginia. The City requires purchase of Energy Star appliances in all newly constructed single famly and multi-family homes.

5.5.7 Light-Emitting Diode (LED) Traffic Signal Retrofit Program

Under this program, state and local governments in the nonattainment area have committed to replace existing traffic signals with more energy efficient light-emitting diode (LED) technology. This will decrease demand for electricity and subsequent power generation from coal, oil, and/or gas-fired sources that would normally supply power to the Metropolitan Washington region, thereby reducing NO_x emissions from those sources.

Source Type Affected

The measure affects state and local governments within the Metropolitan Washington nonattainment area.

Control Strategy

This measure is envisioned as a region-wide measure encompassing LED traffic signal retrofits by state and local governments within the Metropolitan Washington nonattainment area. This program is in the early stages of development, and commitments received at this point affect several state and local jurisdictions in the nonattainment area. Transportation agencies have begun to retrofit existing traffic signals to LED technology to reduce the demand for electricity. The reduction in energy demand will displace fossil fuel generated power, thus reducing the NO_x emitted from those plants.

Implementation

Maryland Department of Transportation (MDOT)
Virginia Department of Transportation (VDOT)
District Department of Transportation (DDOT)
Montgomery County, Maryland
Arlington County, Virginia
City of Alexandria, Virginia
City of Falls Church, Virginia

Under this program, jurisdictions are committing to replace older incandescent traffic signals with more energy-efficient LED signals. All of the identified replacements will be in place by May 1, 2009.

The following table summarizes the LED signal replacement commitments:

LED Traffic Signal Replacment	Number of LED Signal Units
Washington, DC	69,140
VDOT	6,894
MDOT	15[a]
Montgomery County, MD	250[a]
Arlington County, VA	92[a]
City of Alexandria, VA	25[a]
City of Falls Church, VA	92

[a] Data reported are number of intersections with LED signal units installed.

5.5.8 High Electrical Demand Day Emission Reduction Strategies

Heating and cooling requirements increase during the hottest and coldest days of the year, thus requiring electric generators and other industries directly using fossil fuels to increase production, which can increase emissions. High electrical demand day (HEDD) operation of these units generally have not been addressed under existing air quality control requirements, and these units are called into service on the very hot days of summer and on very cold days of winter when air pollution levels typically reach their peaks.

The Ozone Transport Commission (OTC) has been meeting with state environmental and utility regulators, EPA staff, electric generating unit (EGU) owners and operators, and the independent regional systems operators to assess emissions associated with HEDD during the ozone season and to address excess NO_x emissions on HEDDs. The OTC has found that NO_x emissions are much higher on a high electrical demand day than on a typical summer day and that there is the potential to reduce HEDD emissions by approximately 25 percent in the short term through the application of known control technologies. HEDD units consist of gasoline and diesel combustion turbines and coal and residual oil burning units.

On March 2, 2007, the OTC states and the District of Columbia agreed to a Memorandum of Understanding (MOU) committing to reductions from the HEDD source sector. The MOU includes specific targets for a group of six states to achieve reductions in NO_x emissions associated with HEDD units on high electrical demand days during the ozone season. These states agreed to achieve these reductions beginning with the 2009 ozone season or as soon as feasible thereafter, but no later than 2012. The remaining OTC states including Virginia and the District of Columbia agreed to continue to review the HEDD program and seek reductions where possible, but they do not have a formal emissions reduction target in the MOU.

Through the HEDD MOU commitments, significant NO_x reductions are anticipated in the Washington, DC-MD-VA $PM_{2.5}$ nonattainment area from the program Maryland expects to develop with EGUs. Maryland has agreed to a specific NO_x emission reduction target in the MOU of a state-wide reduction of NO_x emissions from HEDD units by 32 percent. The OTC MOU is included in Appendix G.

5.5.9 Mobile Source Strategies

The following mobile source strategies are included as supplemental controls:

- **Diesel Retrofit Program.** Under this program, local governments and transit agencies identify high-emitting, high-mileage diesel vehicles, such as older school buses and transit buses, for retrofit. These vehicles are retrofitted using any of a variety of technologies certified under EPA's Voluntary Diesel Retrofit Program. Commonly considered technologies include oxidation catalysts and particulate filters.

- **Alternative Fuel Vehicle/Low-Emission Vehicle Purchase Program.** Under this program, local governments and transit agencies purchase low-emission vehicles instead of conventional gasoline-powered vehicles.

Local governments have reserved any emission reduction credits that these programs may generate for potential future use in meeting transportation conformity or for weight of evidence.

5.5.10 Urban Heat Island Mitigation/Tree Planting/Canopy Conservation and Management

Strategic tree planting and tree canopy conservation and management are innovative voluntary measures that will achieve area-wide improvement of the tree canopy, providing air quality benefits including reductions in $PM_{2.5}$ in the Washington, DC metropolitan nonattainment area. Air quality benefits associated with trees and their shade result from lowering summertime air temperatures and from actual pollutant absorption and contact removal from the trees themselves.

One of the most dramatic improvements achievable from area-wide comprehensive tree canopy conservation and planting is reducing the negative effects of urban heat islands (the rise in temperatures due to an increased number of buildings and impermeable surface areas retaining heat). Strategic placement of trees around homes, buildings, streets, and parking lots increases shade and evapotranspiration, thereby lowering summertime air temperatures and surface temperatures of asphalt, concrete, and other impervious areas. Lowering air summertime temperatures helps reduce air pollution in several ways:

- Slows the temperature-dependent reaction that forms $PM_{2.5}$; and
- Reduces the amount of electricity generated for cooling, thereby reducing air pollutant emissions including $PM_{2.5}$ precursors, from power plants.

In addition, through up-take and contact removal, trees remove nitrogen oxides, sulfur oxides, and other $PM_{2.5}$ precursors from the air. Other air quality benefits from trees include removal of carbon monoxide and fine particulate matter less than 10 microns. Carbon dioxide is removed and stored by trees, dust is intercepted, and oxygen is released.

Source Type Affected

The measure affects state and local governments within the Washington, DC-MD-VA metropolitan nonattainment area.

Control Strategy

To achieve reductions in air pollution, government agencies, volunteer organizations, and private landowners must make long-term commitments to conserving existing canopy and planting significant numbers of trees in strategic locations. Under this measure, local governments in the metropolitan nonattainment area will commit to

1. Measure existing resources and track changes – Initiate and/or enhance efforts to measure, track, and enhance existing urban tree canopy and canopy expansion efforts.

2. Programs to enhance and increase benefits from trees – Implement urban forestry programs to enhance canopy coverage to reduce summertime air and surface temperatures. Programs include planting trees in strategic locations to cool targeted surfaces and provisions for long-term maintenance. Priority planting sites include

locations where buildings, streets, driveways, and parking lots will be shaded by the new plantings.

3. Public outreach – The region commits to undertake a public outreach program designed to promote tree and canopy conservation and planting. Local governments, counties, states, and MWCOG will work with volunteer tree planting organizations, school children, property owners, and stakeholder groups of businesses to support tree conservation and planting and to conduct educational outreach regarding the benefits of trees and canopy, species selection, tree planting and establishment, and long-term tree maintenance. Efforts will be made to document all conservation and planting efforts including voluntary programs.

4. Regional canopy management plan – Local governments will work to develop a long-range plan to enhance tree conservation and planting and to establish goals for increasing tree canopy coverage between 2010 and 2030 that could lead to lower levels of air pollution. Issues to address include coordination of efforts, tracking progress in centralized databases, continuation and increases of resources from state and federal sources, involvement of private landowners and businesses, and periodic evaluations and reports.
5. Species selection – During photosynthesis, trees release secondary metabolic products. Some of these include biogenic volatile organic compounds (VOCs), precursors to the formation of ozone. In most instances, the improvements in air quality gained from trees outweigh the concerns over additional biogenic VOC emissions. Additionally, large trees are considerably more beneficial for air quality than small trees. Therefore, when planting trees, species should be selected for their large size and long-term survival based on specific site conditions and adjusted, when possible, for low-VOC emitters.
6. Monitoring programs – Monitor these activities and report periodically.

Current Programs

Many programs that support, encourage, or require the tree and forest conservation and planting exist within the local jurisdictions, counties, and states in the Washington DC metropolitan nonattainment area. Special attention will be paid coordinating these programs to enhance tree protection, canopy conservation, and expansion to enhance regional air quality.

Implementation

Fairfax County – Tree canopy requirement for new development.
Fairfax County – Parking lot canopy ordinance.
Fairfax County – Government land planting program.
Fairfax County – County-wide nonprofit tree planting program.
Arlington County Urban Forest Master Plan.
Arlington County – 1,280 trees to be planted annually.
Arlington County Chesapeake Bay Preservation Ordinance/Landscape Conservation Plan.

City of Alexandria – Urban Forestry Plan under development.
City of Alexandria – 12,000 square feet of vegetative roof installed on city buildings.
City of Alexandria – Reflective roofs standard for government buildings.
City of Greenbelt – Tree planting program; shade tree improvement initiative.
Montgomery County – Street tree planting program; 1,200 trees per year.
Montgomery County – "Shade to Save" pilot program.
Montgomery County – A residential tree planting program is under development.
Montgomery County – Urban tree legislation is under development.
Montgomery County Stream Restoration Projects – Native trees and shrubs are planted to enhance and establish forests near stream project sites.
Montgomery County Rainscapes Program.
Montgomery County Forest Conservation Law.
Amendments to the Forest Conservation Law to adjust for changes in development patterns are being developed.
Montgomery County Forest Banking Program.
Montgomery County Legacy Open Space Program.
Montgomery County Rural Legacy Program.
Montgomery County Development Rights Program.
Prince George's County Releaf Grant Program.
Prince George's County Tree Replacement Program.
Prince George's County Gorgeous Prince George's Day.
MNCPPC Montgomery County Parks Department – Shade trees are actively maintained and planted in developed areas of parks.
MNCPPC Montgomery County Parks Department – Forested areas are established on open land within the park system.

5.5.11 Voluntary Action Campaign: Clean Air Partners

Clean Air Partners is a bi-regional public-private partnership in the Baltimore/Washington region created to develop and implement voluntary action programs to reduce emissions on the days when ozone levels are expected to be high.

The partnership was created in 1994 by the Metropolitan Washington Air Quality Committee (MWAQC), the Transportation Planning Board of the National Capitol Region (TPB), and the Baltimore Metropolitan Council (BMC). The partnership, originally known as ENDZONE Partners, has conducted an air quality public education campaign in the Washington and Baltimore metropolitan areas since 1995. The purposes of the campaign are to raise public awareness of air quality issues and to promote voluntary actions to improve air quality. The campaign is funded by public funds from Maryland, Virginia, and the District of Columbia and receives staff support from the state air management agencies. In 1997 the partnership formed a new formal public-private partnership, hired a managing director, and in 1999 changed its name to Clean Air Partners.

The partnership established the Ozone Action Days employer program in 1995 to encourage employers and their employees to take voluntary actions to reduce ozone pollution causing emissions. When the EPA designated both Baltimore and Washington, DC metropolitan regions as nonattainment for $PM_{2.5}$, Clean Air Partners' Board of Directors changed the name of the program from Ozone Action Days to Air Quality Action Days (AQAD).

The AQAD program is designed to educate employers and employees to take voluntary actions, specifically on Code Orange and Code Red Days. Clean Air Partners provides resources and information to a network of AQAD participants. Clean Air Partners assists employers in establishing on-site programs designed to reduce employee travel on bad air days and encourages voluntary actions by business, industry, government, and individuals to restrict activities that contribute to the formation and risks of bad air. Approximately 1200 individuals, businesses and organizations are registered as AQAD participants and have committed to take voluntary actions to reduce emissions on Code Orange and Code Red Days. The participants receive electronic air quality updates daily.

Clean Air Partners runs an extensive education campaign throughout the ozone season, May to September, to educate the public about the effects of ground-level ozone and $PM_{2.5}$. The messages tell people what they can do to protect their health and improve air quality. Air quality forecasts are distributed daily by fax and email to the media and AQAD participants. The air quality forecast is color coded for ease of communication, following EPA's regulation for the Air Quality Index (AQI).3

During the ozone season, in addition to communicating daily with television and radio meteorologists in the regions, Clean Air Partners places radio and television ads to advise about the health risks and to promote less polluting behaviors on unhealthy air days. The ad messages

---

3 Federal Register, Vol.64, No. 149, August 4, 1999, pp.42529-42549.

target individual emission reduction actions for behavior modification and the heath effects of poor air quality.

5.5.12 Code Red/Code Orange Telework Program

Clean Air Partners is adopting a new program to increase teleworking as an episodic strategy. Beginning in the summer of 2007, Clean Air Partners will promote teleworking throughout government and businesses when air quality is forecasted to be in the unhealthy for sensitive groups range, Code Orange or above. The decision to initiate Clean Air telework days will be guided by forecasts issued using the Air Quality Index (AQI). Three-day forecasts are issued by the Maryland Department of the Environment and the MWCOG for the Washington region.

Clean Air Partners will develop a toolkit that will assist organizations in promoting, establishing, and tracking a telework program and provide resources for keeping abreast of forecasted and current air quality levels in the region. Participants will be asked to track their participation using a Web-based system that tracks auto emission reductions resulting from teleworking (NO_x, VOC, CO, and CO_2).

The University of Maryland (UM) will evaluate the telework program through photochemical modeling by using different assumptions regarding the programs effectiveness at reducing Vehicle Miles Traveled (VMT). Preliminary UM modeling indicates that a strengthened telework program has the potential to reduce VMT and thereby leads to a measurable air pollution reduction on the worst days of summer.

6.0 REASONABLY AVAILABLE CONTROL MEASURE (RACM) ANALYSIS

Section 172(c)(1) of the Clean Air Act requires state implementation plans (SIPs) to include an analysis of reasonably available control measures (RACM). This analysis is designed to ensure that the Washington region is implementing all RACM in order to demonstrate attainment with the 1997 $PM_{2.5}$ NAAQS on the earliest date possible.

6.1 Statutory and Regulatory Requirements for RACM Analysis

The statutory RACM requirement can be found in Section 172(c)(1) of the Clean Air Act, which directs states to "provide for implementation of all reasonably available control measures as expeditiously as practicable." The regulatory RACM requirement for a $PM_{2.5}$ SIP revision can be found at 40 C.F.R. Section 51.1010; this section requires

51.1010 (a) For each $PM_{2.5}$ nonattainment area, the State shall submit with the attainment demonstration a SIP revision demonstrating that it has adopted all reasonably available control measures (including RACT for stationary sources) necessary to demonstrate attainment as expeditiously as practicable and to meet any RFP requirements. The SIP revision shall contain the list of the potential measures considered by the State, and information and analysis sufficient to support the State's judgment that it has adopted all RACM, including RACT.

(b) In determining whether a particular emission reduction measure or set of measures must be adopted as RACM under section 172(c)(1) of the Act, the State must consider the cumulative impact of implementing the available measures. Potential measures that are reasonably available considering technical and economic feasibility must be adopted as RACM if, considered collectively, they would advance the attainment date by one year or more.

6.1.1 Discussion of Reasonable Control Measures

During the period of 2002 through 2005 the State of Maryland, the Commonwealth of Virginia, and the District of Columbia implemented control measures described in Chapter 5 of this SIP. Significant additional control measures have already been adopted and are planned for implementation in 2009, including Maryland's Healthy Air Act (HAA) and the Clean Air Interstate Rule (CAIR). As a result of control measures currently in effect, the Washington region was able to reduce fine particulate emissions to demonstrate compliance with the $PM_{2.5}$ NAAQS (1997) based on the 3-year Design Value for 2003-2005 and for 2004-2006. Additionally, modeling data provided in Chapter 9 demonstrates that continued implementation of these measures along with the HAA and CAIR will allow for continued compliance with the $PM_{2.5}$ NAAQS (1997) on or before April 2010, in accordance with 40 C.F.R. Section 51.1004.

6.1.2 Evaluation of RACM for Purposes of Achieving Attainment

In accordance with 40 C.F.R. Section 51.1010, as part of the SIP revision, the state is required to submit a demonstration that it has adopted all RACM, including RACT, necessary to demonstrate attainment as expeditiously as practicable and to meet any RFP requirements. In evaluating a particular measure or set of measures, this section directs the state to consider the cumulative impact of implementing the available measures and to implement reasonably available potential measures if, considered collectively, they would advance the attainment date by one year or more.

An evaluation of the control measures described in detail in Chapter 5 of this SIP demonstrates that the cumulative impact of these, previously adopted and on-going, measures has been sufficient to comply with the $PM_{2.5}$ NAAQS (1997) based on 2003-2005 ambient monitoring data. As discussed in Chapter 1, the Washington area's $PM_{2.5}$ annual Design Value for 2003-2005 is 14.6 ug/m3.[1] The Washington region therefore can demonstrate that implementation of such measures is sufficient for purposes of attaining the standard on or before April 2010. Furthermore, as discussed in Chapter 1, the region has demonstrated continued compliance with the $PM_{2.5}$ NAAQS (1997) through 2007. Therefore, at this time, the Washington area has implemented all RACM necessary to demonstrate attainment as expeditiously as practicable and to meet any RFP requirements. No additional measures are necessary to demonstrate attainment as expeditiously as practicable and to meet any RFP requirements. For these same reasons, there are no potential measures that would advance the attainment date by one year or more.

Additionally, the time required to implement new regulatory programs in the State of Maryland, the Commonwealth of Virginia, and the District of Columbia is greater than one year. A comprehensive review of a complete list of potential control measures was completed in 2007. A summary of the results of the analysis is provided in Appendix H. The analysis found that there are no additional measures beyond those already on the books that could be adopted and implemented by January 1, 2008.

6.2 Summary

6.2.1 RACM Determination

The State of Maryland, the Commonwealth of Virginia, and the District of Columbia will continue to implement the RACM measures already adopted and described in Chapter 5 of this SIP. The above analysis establishes that these measures contributed to the region being able to comply with the $PM_{2.5}$ NAAQS (1997) based on 2003-2005 Design Value. Therefore, this analysis demonstrates that there are no additional measures that are necessary to demonstrate attainment as expeditiously as practicable and to meet any RFP

[1] The Design Value for 2004-2006 is 14.5 ug/m^3.

requirements and that there are no potential measures that if considered collectively would advance the attainment year by one year or more. The above analysis meets the applicable statutory requirements set forth at Section 172(c)(1) of the Clean Air Act and the applicable regulatory requirements set forth at 40 C.F.R. Section 51.1010.

6.2.2 RACT Applicability

40 CFR 51.1010 notes that for each $PM_{2.5}$ nonattainment area, a SIP revision must be submitted that demonstrates all RACM, including RACT for stationary sources, necessary to demonstrate attainment as expeditiously as practicable have been adopted. The section of the implementation rule goes on to state that potential measures that are reasonably available considering technical and economic feasibility must be adopted as RACM if, considered collectively, they would advance the attainment date by one year or more. As discussed in Section 6.2.1, the states determined that there are no additional control measures that could be adopted by January 1, 2008. Further, existing measures, and those planned for implementation by 2009, are expected to enable the region to continue to demonstrate compliance with the $PM_{2.5}$ NAAQS (1997) through the 2009 attainment date. As such, no further actions on RACT are warranted.

7.0 ON-ROAD MOTOR VEHICLE EMISSION BUDGETS

Consistent with requirements established in the Clean Air Act as amended[1], the Transportation Conformity Rule was promulgated on November 24, 1993 in the *Federal Register*[2]. It has been amended several times since, most recently to incorporate changes resulting from federal transportation legislation passed in 2005 and from EPA guidance for implementing the 8-hour ozone and $PM_{2.5}$ national air quality standards.

A summary of currently applicable conformity requirements is provided below. With the exception of on-road motor vehicle emission budgets identified for specific years as included in this SIP revision, the summary includes references to current federal, state and local regulations and other requirements that are provided for information only and do not constitute control measure or programs established as part of this SIP revision. Additionally, the referenced regulations and other requirements are subject to change.

In general, for transportation plans and programs to be found in "conformity" with air quality plans, regional total emissions generated by on-road motor vehicle sources must meet certain tests. The relevant conformity requirements include:

- When an on-road motor vehicle emissions budget SIP has been submitted and found adequate, on-road motor vehicle emissions must not exceed the on-road motor vehicle emissions budget established in the SIP;
- In $PM_{2.5}$ nonattainment areas, prior to adequate or approved $PM_{2.5}$ SIP budgets, EPA allows two methods to demonstrate conformity. The options are build no greater than no-build or build no greater than 2002 base year on-road motor vehicle emissions inventory. In the interim period before new SIP budgets are established, only NO_x and $PM_{2.5}$ Direct are subject to the conformity requirements. Through interagency consultation, the interim test that is being used in the Metropolitan Washington region is the option of build no greater than 2002 base year.

In 2005 federal transportation legislation, the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU),[3] amended transportation conformity requirements. Under the new legislation, conformity determinations for transportation plans and Transportation Improvement Programs (TIPs) are required a minimum of every four years. Conformity for plans and TIPs must be re-determined not later than two years after new emissions budgets are found adequate. Metropolitan Planning Organizations (MPOs) are required to demonstrate conformity for the years the on-road motor vehicle emissions budgets are established, for the final year of the transportation plan, and for appropriate interim years to ensure that analysis years are no more than ten years apart. Transportation Control Measures (TCMs) can be substituted in approved SIPs with the

---

[1] CAA §176(c), 42 USC §§7401-7671(q).
[2] 40 CFR Parts 51 and 93.
[3] SAFETEA-LU, Public Law 109-56, August 10, 2005.

concurrence of the MPO, the air agencies, and EPA. A conformity lapse will not occur until 12 months after an applicable deadline has passed.

SAFETEA-LU requires MPOs to consult with agencies responsible for land use management, natural resources, environmental protection, and conservation and historic preservation in the development of transportation plans. In addition, a public participation plan is required for approval of a transportation plan. Public comment is required before the conformity determination and transportation plans can be approved.

The Clean Air Act provides penalties for MPOs in nonattainment areas that do not demonstrate conformity:

- A conformity lapse, during which limitations are imposed on which projects may be allowed to advance, occurs when the conformity determination for a transportation plan or TIP has expired,
- Highway sanctions may result if the SIP is not submitted or if EPA finds the SIP incomplete or disapproves the control strategy, and lastly,
- SIP disapproval without a protective finding for the on-road motor vehicle emissions budgets. A conformity freeze occurs immediately upon notification of the disapproval in this event. In a conformity freeze, no new projects may proceed.

A conformity freeze has some exceptions, similar to those in a conformity lapse. Those exceptions are listed in the Transportation Conformity Rule and amendments.

7.1 On-Road Motor Vehicle Emissions Budgets and the Washington Area Transportation Conformity Process

In the Metropolitan Washington region, regional growth requires that the Transportation Improvement Program (TIP) and the Constrained Long-Range Plan (CLRP) be updated, revised, and approved on an annual basis. The TIP includes transportation modifications and improvements on a 6-year program cycle. Modifications to the existing regional transportation network are advanced through the Transportation Planning Board (TPB) by state, regional, and local transportation agencies. To meet conformity requirements, forecast regional total emissions from the transportation system following the implementation of the CLRP and 6-year TIP cannot exceed the budget or budgets established in the SIP. The regional emissions analysis of the transportation plan must include all regionally significant projects included in the TIP and CLRP.

7.2 Budget Level for On-Road Motor Vehicle Source Emissions

In developing the SIP, MWAQC consults with the Transportation Planning Board (TPB), to establish on-road motor vehicle emissions budgets. For the annual $PM_{2.5}$ standard, the projected on-road motor vehicle source emissions for 2009 less reductions attributable to Transportation Control Measures and other vehicle technology, fuel, or maintenance-based measures included in the SIP become the on-road motor vehicle emissions budget for the region unless MWAQC takes actions to set other budget levels.

The 2009 on-road motor vehicle emissions inventories reflect the most recent models available, EPA's MOBILE6.2.03 and the Travel Demand Model version 2.1d#50, used by MWCOG's Transportation Planning Department, along with the most recent data available, namely, 2005 vehicle registration data. The emissions inventories also reflect MWCOG's Cooperative Forecasts Round 7.0a, which do not reflect any land use changes expected as a result of U.S. Department of Defense (DoD) Base Realignment and Closure (BRAC) plans. The methodology used to develop motor vehicle source inventories for 2009 is discussed in Sections 3.2.3 and 4.3.4. See the appendices for detailed input parameters used in modeling the inventories.

7.2.1 Attainment Year 2009 On-Road Motor Vehicle Emissions Budgets

The Motor Vehicle Emission Budgets (MVEBs) for the 2009 attainment year are based on the projected 2009 on-road motor vehicle emissions source emissions, accounting for the emission reductions from on-road motor vehicle source control measures identified in Chapter 5, including Transportation Control Measures and vehicle technology, fuel, or maintenance-based measures.

MVEBs for 2009 attainment year:

$PM_{2.5}$ Direct = 1,105.4 tons/year NO_x = 52,052.9 tons/year

7.2.2 Contingency Budget

The Motor Vehicle Emission Budget (MVEB) for the 2010 year is based on the projected 2009 on-road motor vehicle source NO_x emissions accounting for the emission reductions from on-road motor vehicle source control measures identified in Chapter 5, including Transportation Control Measures and other vehicle technology, fuel, or maintenance-based measures included in the SIP, minus the reductions required for the contingency plan discussed in Chapter 10. The reduction amount provided to satisfy the contingency plan is 657 tons/year NO_x.

MVEBs for 2010 Contingency:

NO_x = 51,395.9 tons/year

7.3 Transportation Control Measures (TCMs) and TERMs

Each time the Constrained Long-Range Plan (CLRP) or the 6-year Transportation Improvement Plan (TIP) is amended and a conformity determination is required, the TPB will estimate the emissions from the regional transportation network and compare the expected emissions against the on-road motor vehicle emissions budget set in this SIP. This determination will take into account the projects included in the region's transportation plans and the TCMs shown in Table A, which amount to 1.55 tons/year $PM_{2.5}$ Direct and 67.1 tons/year NO_x in 2009. In addition, selected vehicle technology, fuel, or maintenance-based measures are also credited in the on-road motor vehicle emissions budget. Vehicle technology, fuel, or maintenance-based measures account for 1.0 tons/year $PM_{2.5}$ Direct and 81.9 tons/year NO_x in 2009. Further information on TCMs and vehicle technology, fuel, or maintenance-based measures can be found in Section 5.4 and in Appendix F.

TERMS, or Transportation Emissions Reduction Measures, are used to mitigate on-road motor vehicle emissions if the conformity analysis demonstrates that on-road motor vehicle emissions will exceed the on-road motor vehicle emissions budget established in the SIP. In anticipation of possible on-road motor vehicle emissions mitigation needs associated with TPB plans and programs, the TPB Technical Committee Travel Management Subcommittee has analyzed a wide range of TERMs. The TERMS are used as needed in the event of a TIP and CLRP that exceed the on-road motor vehicle emissions limits set by the air quality plan. TERMs are used for conformity; TCMs are SIP measures and, as such, are permanent.

7.4 Trends in On-Road Motor Vehicle Emissions

The On-Road Motor Vehicle Emission Budgets for 2009 for $PM_{2.5}$ Direct and NO_x reflect a continuation of a downward trend in on-road motor vehicle emissions over time. The $PM_{2.5}$ Direct and NO_x emission levels for on-road motor vehicle sources provided in Section 7.2 reflect declines of 35 and 45 percent of $PM_{2.5}$ Direct and NO_x, respectively, from 2002 to 2009. The steady reductions in on-road motor vehicle emissions are attributable largely to a series of increasingly stringent federal regulations requiring cleaner vehicles and fuels, including the federal Tier 2 regulations for motor vehicles. The decline in on-road motor vehicle source emissions is also attributable in part to transportation policies that have resulted in large and continuing investments in mass transit facilities and services. Related efforts to promote transit-oriented development are helping to encourage use of transit rather than private vehicles. The Rosslyn-Ballston corridor in Arlington County, Virginia, is a nationally recognized model of long-range planning that has resulted in the location of high-density commercial and residential development within close proximity of Metrorail stations and accompanying high levels of transit use. Similar success stories can be found in the District of Columbia and suburban Maryland.

In addition to continuing investments in major transit facilities, ongoing programs to encourage alternatives to the private automobile have helped keep levels of ridesharing and transit use in the Washington region among the highest in the country. The rapidly increasing use of the Washington Metro's SmarTrip cards is permitting the direct provision of MetroChek subsidies for many transit riders at farecard machines, and the expansion of this technology to commuter rail and buses will provide for seamless transfers for transit riders within the next few years.

The region's Transportation Improvement Program (TIP) includes substantial ongoing funding commitments to promoting ridesharing, telecommuting, and transit use as well as vehicle replacement and retrofit measures and bicycle and pedestrian programs. These commitments provide additional reductions in emissions, which are being reflected in conformity determinations. While not included in the SIP, these on-going commitments are reducing emissions from on-road motor vehicle sources and are an important part of the contribution of the transportation sector to cleaner air.

Trends toward reduced on-road motor vehicle emissions are occurring despite a steady increase in population, employment, and vehicle miles traveled (VMT) within the Washington region. Between 2002 and 2009, regional household population is expected to show a 12 percent increase, while daily VMT estimates show a 10 percent increase. The emission increases from this additional travel have been further exacerbated by a shift toward the use of higher-emitting, less fuel-efficient light-duty trucks, such as SUVs, instead of passenger vehicles.

Trends toward increasing population, employment, and VMT are expected to remain strong well beyond 2009. The regional cooperative forecasting process predicts that, from 2005 to 2020, regional population will grow by 22 percent and employment will grow by 26 percent. Regional VMT is predicted to increase by 22 percent over this time. However, these trends will not reverse the expected decline in regional on-road motor vehicle emissions resulting from cleaner fuels and improved vehicle technology. The recent Tier 2 passenger vehicle standards and regulations on emissions from heavy-duty diesel vehicles and fuels are expected to produce further dramatic reductions in $PM_{2.5}$ Direct and NO_x emissions as vehicles are replaced and retrofitted over the next 20 years. Projections contained in the National Capital Region Transportation Planning Board (TPB)'s Constrained Long-Range Plan (CLRP)[4] indicate that on-road motor vehicle emission reductions in excess of 75 percent for NO_x will occur during this period.

[4] Draft Air Quality Conformity Determination of the 2006 Constrained Long-Range Plan (CLRP) and FY 2007-2012 Transportation Improvement Program (TIP) for the Metropolitan Washington Region. Metropolitan Washington Council of Governments, National Capital Region Transportation Planning Board, Washington, DC.

8.0 1997 $PM_{2.5}$ NONATTAINMENT AREA PLAN COMMITMENTS

Achieving the results shown in this Plan requires a commitment to implement the regulatory measures upon which the Plan is based. The states and the District of Columbia are taking action to implement regional measures to reduce emissions of $PM_{2.5}$ and $PM_{2.5}$ precursors. Tables 8-1 through 8-3 provide information on the implementation of each measure by Maryland, Virginia, and the District of Columbia.

Commitments for regulations required by the 40 CFR Part 51 are shown in Table 8-4.

8.1 Schedules of Adopted Control Measures

Table 8-1
District of Columbia Schedule of Adopted Control Measures
Washington Nonattainment Area

Ref. No.	Control Measure	Mandate	Regulation Number	Effective Date
	Point Source Controls			
5.1.1	RACT and Regional Transport Requirements	Federal Regulation	20 DCMR[a] Sec. 805 20 DCMR Chapter 10 20 DCMR Chapter 11	11/19/93 1/20/2000 No later than 1/1/2009
5.1.2	Opacity Regulations	Federal Regulation	20 DCMR Sec. 606	3/15/85
	Area Source Controls			
5.2.1	Seasonal Open Burning Restrictions	State Regulation	20 DCMR Sec. 604	2/1/85
	Nonroad Source Controls			
5.3.1	EPA Nonroad Gasoline Engines Rule	Federal Regulation	40 CFR Parts 90, 91	12/3/96
5.3.2	EPA Nonroad Diesel Engines Rule	Federal Regulation	40 CFR Part 9 et al.	Model Year 2000-2008 depending on engine size

Ref. No.	Control Measure	Mandate	Regulation Number	Effective Date
5.3.3	EPA Nonroad Spark-Ignition Marine Engine Rule	Federal Regulation	40 CFR Parts 89, 90, 91	Model Year 1998
5.3.4	EPA Large Spark-Ignition Engines Rule	Federal Regulation	40 CFR Parts 89, 90, 91, 94, 1048, 1051, 1065, 1068	11/8/2002
5.3.5	Emissions Controls for Locomotives	Federal Regulation	63 FR 18998	6/15/98
	On-Road Measures			
5.4.1	High-Tech Inspections and Maintenance	Federal Regulation	18 DCMR Chapters 4, 6, 7, 10, 11; 26 DCMR Chapter 26	4/30/99
5.4.2	Federal Tier I Vehicle Standards and new Car Evaporative Standards	Federal Regulation	40 CFR Part 86	Model Year 1994-1996; Evap Stds. 1996
5.4.3	National Low Emissions Vehicle Program	Federal Regulation	20 DCMR, Sec. 915	1/20/2000
5.4.4	Tier 2 Motor Vehicle Emission Standards	Federal Regulation	65 FR 6698	2/10/2000
5.4.5	Heavy-Duty Diesel Engine Rule	Federal Regulation	62 FR 54694	12/22/97

[a]District of Columbia Municipal Regulations.

Table 8-2
Maryland Schedule of Adopted Control Measures
Washington Nonattainment Area

Ref. No.	Control Measure	Mandate	Regulation Number	Effective Date
	Point Source Controls			
5.1.1	NO_x Phase II Controls	Federal Regulation	26.11.27 & .28 26.11.29 & 30	10/18/99
5.1.1	Regional Transport Requirements	Federal Regulation	26.11.29.08 26.11.27	5/10/93 No later than 1/1/2009
5.1.2	Opacity Regulations	Federal Regulation	26.11.01.10 26.11.01.11 26.11.06.02 26.11.07.05 26.11.08.04 26.11.08.08 26.11.08.08-1 26.11.09.05 26.11.10.03 26.11.10.04 26.11.12.04 26.11.18.03 26.11.18.06 26.11.20.01 26.11.25.03	7/22/91 7/22/91 7/18/80 1/2/80 5/28/68 11/9/90 4/17/2000 5/28/68 5/28/68 5/28/68 6/8/81 5/28/68 2/10/84 11/19/83 9/24/84
	Area Source Controls			
5.2.1	Seasonal Open Burning Restrictions	State Regulation	26.11.07	5/22/95
	Nonroad Source Controls			
5.3.1	EPA Nonroad Gasoline Engines Rule	Federal Regulation	40 CFR parts 90, 91	12/3/96
5.3.2	EPA Nonroad Diesel Engines Rule	Federal Regulation	40 CFR Part 9 et al.	Model Year 2000-2008 depending on engine size
5.3.3	EPA Nonroad Spark-Ignition Marine Engine Rule	Federal Regulation	40 CFR Parts 89, 90, 91	Model Year 1998

Ref. No.	Control Measure	Mandate	Regulation Number	Effective Date
5.3.4	EPA Large Spark-Ignition Engines Rule	Federal Regulation	40 CFR Parts 89, 90, 91, 94, 1048, 1051, 1065, 1068	11/8/2002
5.3.5	Emissions Controls for Locomotives	Federal Regulation	63 FR 18998	6/15/98
	On-Road Source Controls			
5.4.1	High-Tech Inspections and Maintenance	Federal Regulation	11.14.08	1/2/95, 1/1/2000
5.4.2	Federal Tier I Vehicle Standards and new Car Evaporative Standards	Federal Regulation	40 CFR part 86	Model Year 1994-1996; Evap Stds. 1996
5.4.3	National Low Emissions Vehicle Program	Federal Regulation	26.11.20.04	3/22/99
5.4.4	Tier 2 Motor Vehicle Emission Standards	Federal Regulation	65 FR 6698	2/10/2000
5.4.5	Heavy-Duty Diesel Engine Rule	Federal Regulation	63 FR 54694	12/22/97

Table 8-3
Virginia Schedule of Adopted Control Measures
Washington Nonattainment Area

Ref. No.	Control Measure	Mandate	Regulation Number	Effective Date
	Point Source Controls			
5.1.1	State NO_x RACT Requirements	Federal Regulation	9 VAC 5-40-310, 9 VAC 5-40-311	1/1/93
5.1.1	RACT and Regional Transport Requirements	Federal Regulation	By permit or compliance agreement 9 VAC 5 Chapter 130	6/25/98 No later than 1/1/ 2009
5.1.2	Existing Stationary Sources, Part II "Emission Standards" Article 1 "Visible Emissions and Fugitive Dust/Emissions (Rule 4-1)"	Federal Regulation	9 VAC 5 Chapter 40	3/17/72 Amended: 2/1/2003
5.1.2	New and Modified Stationary Sources Part II "Emission Standards" Article 1 "Visible Emissions and Fugitive Dust/Emissions (Rule 5-1)"	Federal Regulation	9 VAC 5 Chapter 50	8/9/75 Amended: 2/1/2003
	Area Source Controls			
5.2.1	Seasonal Open Burning Restrictions	State Regulation	9 VAC 5-40-5630	4/1/96
	Nonroad Source Controls			
5.3.1	EPA Nonroad Gasoline Engines Rule	Federal Regulation	40 CFR parts 90, 91	12/3/96
5.3.2	EPA Nonroad Diesel Engines Rule	Federal Regulation	40 CFR part 9 et al.	Model Year 2000-2008 depending on engine size
5.3.3	EPA Nonroad Spark-Ignition Marine Engine Rule	Federal Regulation	40 CFR Parts 89, 90, 91	Model Year 1998
5.3.4	EPA Large Spark-Ignition	Federal	40 CFR Parts 89,	11/8/2002

Ref. No.	Control Measure	Mandate	Regulation Number	Effective Date
	Engines Rule	Regulation	90, 91, 94, 1048, 1051, 1065, 1068	
5.3.5	Emissions Controls for Locomotives	Federal Regulation	63 FR 18998	6/15/98
	On-Road Measures			
5.4.1	High-Tech Inspection and Maintenance	Federal Regulation	9 VAC 5 Chapter 91	4/2/97
5.4.2	Federal Tier I Vehicle Standards and new Car Evaporative Standards	Federal Regulation	40 CFR Part 86	Model Year 1994-1996; Evap Stds. 1996
5.4.3	National Low Emissions Vehicle Program	Federal Regulation	9 VAC 5-200	4/14/99
5.4.4	Tier 2 Motor Vehicle Emission Standards	Federal Regulation	65 FR 6698	2/10/2000
5.4.5	Heavy-Duty Diesel Engine Rule	Federal Regulation	63 FR 54694	12/22/97

8.2 New Source Review Permitting

Section 173 of the Clean Air Act Amendments required the states in $PM_{2.5}$ nonattainment areas to adopt major stationary source permitting thresholds of 100 tons/year for any regulated New Source Review (NSR) pollutant, including $PM_{2.5}$. Maryland, Virginia, and the District of Columbia adopted these measures, listed in Table 8-4, on the schedule shown.

Major modification thresholds in $PM_{2.5}$ nonattainment areas are for net significant emissions increases of more than 10 tons/year $PM_{2.5}$ or 15 tons/year PM_{10} from any existing major facility.

Additional requirements for NSR permit including the generation or purchase of $PM_{2.5}$ offsets, at a ratio of 1 to 1, and the implementation of Lowest Achievable Emissions Rate (LAER) for new or modified units.

Table 8-4
Stationary Source Permitting Revisions
Washington Nonattainment Area

State	Control Measure	Regulation Number	Effective Date
Maryland	Control of NO_x Emissions for Major Stationary Sources	COMAR 09.08	Adoption: 10/03
Virginia	Permits for Major Stationary Sources and Major Modifications Locating in Nonattainment Areas or the Ozone Transport Region.	9 VAC 5-80 Part II Article 9	PM offset requirement adopted 2/27/02; effective 9/1/06. PM $PM_{2.5}$ significance level adopted 6/21/06, effective 9/1/06.
District of Columbia	Major Source Thresholds	20 DCMR Sections 715.2,715.3,715.4	8/29/03

8.3 RACT Applicability

40 CFR 51.1010 notes that for each $PM_{2.5}$ nonattainment area a SIP revision demonstrating that all reasonably available control measures (RACM), including RACT for stationary sources, necessary to demonstrate attainment as expeditiously as practicable have been adopted. The section of the implementation rule goes on to state that potential measures that are reasonably available considering technical and economic feasibility must be adopted as RACM if, considered collectively, they would advance the attainment date by one year or more. As discussed in Section 7.2.1, the states determined that there are no additional control measures that could be adopted by January 1, 2008. Further, existing measures, and those planned for implementation by 2009, are expected to enable the region to continue to demonstrate compliance with the $PM_{2.5}$ NAAQS (1997) through the 2009 attainment date. As such, no further actions on RACT is warranted.

8.4 Revision of New Source Review (NSR) Regulations

In the near future, EPA intends to promulgate further $PM_{2.5}$ nonattainment requirements, including requirements for precursor emissions, controls, and offsets. When these regulations are finalized, state agencies will adopt these changes into their respective state implementation plans.

9.0 Attainment Demonstration

9.1 Modeling Study Overview: Background and Objectives

The modeling study is designed to assess compliance with the fine particulate matter ($PM_{2.5}$) National Ambient Air Quality Standards (NAAQS). The standards include an annual standard of 15.0 micrograms per cubic meter ($\mu g/m^3$) based on the 3-year average of annual mean $PM_{2.5}$ concentrations, and a 24-hour standard of 65 $\mu g/m^3$ based on the 3-year average of the 98th percentile of 24-hour concentrations.

Section 1.1 provides a listing of the jurisdictions within the Washington, D.C. Metropolitan Statistical Area (MSA) that have been designated by EPA as nonattainment. Figure 1-1 provides a graphical representation of the Washington, D.C. MSA, including the locations of the FRM monitor locations that are being specifically evaluated in the modeling analysis.

This modeling study is designed to demonstrate attainment of the $PM_{2.5}$ standards by April 5, 2010. The procedures followed in the modeling analysis are consistent with the EPA's Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze (EPA-454/B-07-002, April 2007).

9.1.1 Relationship to Regional Modeling Protocols

The state members of the committees for this study are also members of the Ozone Transport Commission (OTC) and the Association for Southeastern Integrated Planning (ASIP) modeling committees. This membership has allowed them to coordinate the analyses performed for Washington, D.C. MSA with the regional modeling analyses conducted by OTC and ASIP. VADEQ, in consultation with the MDE, DDOE, and MWCOG, was responsible for conducting CMAQ runs for the Washington, D.C. domain. VADEQ's modeling runs were done in coordination with the OTC modeling for the 12-state Ozone Transport Region (OTR) and with the ASIP modeling, done for the southeastern states. Modeling centers for OTC included the New York State Department of Environmental Conservation (NYSDEC), the University of Maryland (UMD), Northeast States for Coordinated Air Use Management (NESCAUM) and VADEQ. Modeling inventories were developed, updated and shared among the regional modeling centers and provided by MARAMA, MANE-VU and VISTAS.

Installation of the models at VADEQ and all participating modeling centers was completed and diagnostic procedures were run successfully. The model has been benchmarked against other modeling platforms across the region to ensure accurate results.

The Policy Committee and the Technical Advisory Committee (TAC) oversaw the modeling work and made appropriate reports to the full MWAQC through regular briefings and offered other information in cases where specific technical decisions had policy implications. The Technical Committee members and members of other committees involved in the project who are also members of OTC and ASIP made sure to the extent practicable that there was consistency between the regional and urban modeling efforts.

9.1.2 Conceptual Model

EPA recommends that a conceptual description of the area's $PM_{2.5}$ problem be developed prior to the initiation of any air quality modeling study. A "conceptual description" is a qualitative way of characterizing the nature of an area's nonattainment problem. Within the conceptual description of a particular modeling exercise, it is recommended that the specific meteorological parameters that influence air quality be identified and qualitatively ranked in importance.

The conceptual model for this study consists of two documents. The first was prepared by NESCAUM for use by the OTC member States. The conceptual model document, The Nature of the Fine Particle and Regional Haze Air Quality Problems in the MANE-VU Region: A Conceptual Description (NESCAUM, November 2006), is provided in Appendix I, Attachment A. This document provides the conceptual description of the fine particle issues in the OTC states, consistent with the EPA's guidance.

The second conceptual model document that is included in Appendix I, Attachment A is The Development of $PM_{2.5}$ Forecasting Tools for Selected Cities in the MARAMA Region (ICF, September 2004). The primary objective of the Mid-Atlantic Regional Air Management Association, Inc. (MARAMA) $PM_{2.5}$ forecasting assistance project was to develop and evaluate statistical-based tools to support $PM_{2.5}$ forecasting for nine cities in the MARAMA region. The nine cities included Charlotte, North Carolina; Bristol, Roanoke, and Richmond, Virginia; Washington, D.C.; Baltimore, Maryland; Philadelphia, Pennsylvania; Wilmington, Delaware; and Newark/Elizabeth, New Jersey. The study included the analysis of $PM_{2.5}$ and meteorological data using Classification and Regression Tree (CART) analysis software and the development, testing, and evaluation of interactive forecasting tools for each area. Data and information gathered throughout the course of the project were used, together with the CART analysis results, to describe the relationships between meteorology and $PM_{2.5}$ concentration and, specifically, the conditions associated with high $PM_{2.5}$ events in each forecast area.

9.2 Domain and Database Issues

9.2.1 Episode Selection

Due to the fact that the attainment demonstration is being conducted using a resource intensive photochemical grid model, EPA accepts the use of a single, recent "representative" year to be used for an annual model simulation. Two factors were used in selecting 2002 as the "representative" year:

1. The observed annual mean concentrations of $PM_{2.5}$ are close to the 3-year observed design value at all, or most, monitoring sites.
2. The pattern of quarterly mean values is similar to the pattern of quarterly mean concentrations averaged over 3 years.

9.2.2 Size of the Modeling Domain

In defining the modeling domain, one must consider the location of the local urban area, the downwind extent of the elevated $PM_{2.5}$ levels, the location of large emission sources, and the availability of meteorological and air quality data. The domain or spatial extent to be modeled includes as its core the nonattainment area. Beyond this, the domain includes enough of the surrounding area such that major upwind sources fall within the domain and emissions produced in the nonattainment area remain within the domain throughout the day.

The boundary of the modeling domain is provided in Appendix I, Attachment B. This domain covers the Northeast region including northeastern, central and southeastern US as well as southeastern Canada. The final SIP modeling analysis utilized the modeling domain boundary established by OTC. The ASIP modeling domain boundary is provided for reference.

9.2.3 Horizontal Grid Size

The OTC platform used for the Washington, D.C. modeling analysis has a coarse grid continental United States (US) domain with a 36-kilometer (km) horizontal grid resolution. The CMAQ domain is nested in the MM5 domain. A larger MM5 domain was selected for both MM5 simulations to provide a buffer of several grid cells around each boundary of the CMAQ 36-km domain. This was designed to eliminate any errors in the meteorology from boundary effects in the MM5 simulation at the interface of the MM5 model. A 12-km inner domain was selected to better characterize air quality in OTC and surrounding Regional Planning Organization (RPO) regions. Appendix I, Attachment C contains the horizontal grid definitions for the MM5 and CMAQ modeling domains.

9.2.4 Vertical Resolution

The CMAQ vertical structure is primarily defined by the vertical grid used in the MM5 modeling. The MM5 model employed a terrain following coordinate system defined by pressure. The layer averaging scheme adopted for CMAQ is designed to reduce the computational cost of the CMAQ simulations. The effects of layer averaging have a relatively minor effect on the model performance metrics when compared to ambient monitoring data. Appendix I, Attachment D contains the vertical layer definitions for the MM5 and CMAQ modeling domains.

9.2.5 Initial and Boundary Conditions

The objective of a photochemical grid model is to estimate the air quality given a set of meteorological and emissions conditions. When initializing a modeling simulation, the exact concentration fields are unknown in every grid cell for the start time. Therefore, typically photochemical grid models are started with clean conditions within the domain and allowed to stabilize before the period of interest is simulated. In practice this is accomplished by starting the model several days prior to the period of interest.

The winds move pollutants into, out of, and within the domain. The model handles the movement of pollutants within the domain and out of the domain. An estimate of the quantity of pollutants moving into the domain is needed. These are called boundary conditions. To estimate the boundary conditions for the modeling study, three-hourly boundary conditions for the outer 36-km domain were derived from an annual model run performed by researchers at Harvard University using the GEOS-CHEM global chemistry transport model. The influence of boundary conditions was minimized by using a 15-day ramp-up period which is sufficient to establish pollutant levels that are encountered in the beginning of an air pollution episode.

9.2.6 Meteorological Model Selection and Configuration

The Pennsylvania State University/National Center for Atmospheric Research (PSU/NCAR) Mesoscale Meteorological Model (MM5) was selected for application in the Washington, D.C. MSA modeling analysis. MM5 is a non-hydrostatic, prognostic meteorological model routinely used for urban- and regional-scale photochemical regulatory modeling studies.
Based on model validation and sensitivity testing, the MM5 configurations provided in Attachment E were selected. Results of the University of Maryland's detailed performance evaluation of the MM5 modeling used in conjunction with the OTC platform are provided in Appendix I, Attachment E.

9.2.7 Emissions Model Selection and Configuration

Significant coordination efforts took place between MANE-VU and VISTAS in the development of the emissions inventories used in the modeling study. All analyses conducted in support of the Washington, D.C. modeling analysis were coordinated between the Technical and Policy Committees along with TAC.

These inventories include a base case (2002) which serves as the "parent" inventory off which all future year inventories (i.e., 2009) are based. The future year inventories include emissions growth due to any projected increase in economic activity as well as the implementation of control measures.

The Sparse Matrix Operator Kernel Emissions (SMOKE) Emissions Processing System was selected for application in the Washington, D.C. non-attainment modeling analysis.
SMOKE (Version 2.1) was used for the Washington DC attainment modeling demonstration. 2002 base case and 2009 future base case emissions data files were provided by OTC and ASIP. A detailed description of all SMOKE input files such as area, mobile, fire, point and biogenic emissions files is provided in Appendix I, Attachment F. The SMOKE model configuration is also provided.

9.2.8 Air Quality Model Selection and Configuration

EPA's Models-3/Community Multi-scale Air Quality (CMAQ) modeling system was selected for the attainment demonstration primarily because it is a "one-atmosphere" photochemical grid model capable of addressing $PM_{2.5}$ at regional scale and is considered one of the preferred models for regulatory modeling applications. The model is also recommended by the Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze (EPA-454/B-07-002, April 2007). The CMAQ configuration is provided in Appendix I, Attachment H.

9.2.9 Quality Assurance

All air quality, emissions, and meteorological data were reviewed to ensure completeness, accuracy, and consistency before proceeding with modeling. Any errors, missing data or inconsistencies, were addressed using appropriate methods that are consistent with standard practices. All modeling was benchmarked through the duplication of a set of standard modeling results.

Quality Assurance (QA) activities were carried out for the various emissions, meteorological, and photochemical modeling components of the modeling study. Emissions inventories obtained from the Regional Planning Organizations (RPO) were examined to check for errors in the emissions estimates. When such errors were discovered, the problems in the input data files were corrected.

The MM5 meteorological and CMAQ air quality model inputs and outputs were plotted and examined to ensure accurate representation of the observed data in the model-ready fields, and temporal and spatial consistency and reasonableness. Both MM5 and CMAQ underwent operational and scientific evaluations in order to facilitate the quality assurance review of the meteorological and air quality modeling procedures and are discussed in greater detail throughout this document.

9.3 Model Performance Evaluation

A critical component of every air quality modeling study is the model performance evaluation where the modeled estimates for the current year base case are compared against observed values to assess the model's accuracy and provide an indication of its reliability. This section lays out the procedures and results of the evaluation. It should be noted that the other parts of the modeling process, the emissions and meteorology, also undergo an evaluation. It is with this knowledge and the desire to keep the report concise, that the air quality model became the primary focus of this section.

The first step in the modeling process is to verify the model's performance in terms of its ability to predict the $PM_{2.5}$ and its individual components (i.e., sulfate, nitrate, ammonium, organic carbon, elemental carbon and other $PM_{2.5}$) in the right locations and at the right levels. To do this, the model predictions for the base year simulation are compared to the ambient data observed in the historical episode. This verification is a combination of statistical and graphical evaluations. If the model appears to be producing $PM_{2.5}$ in the right locations for the right reasons, then the model can be used as a predictive tool to evaluate various control strategies and their effects on $PM_{2.5}$.

The results of a model performance evaluation were reviewed prior to using modeling to support the attainment demonstration. The New York State DEC, Division of Air Resources, conducted a performance evaluation of the 2002 base case CMAQ simulation on behalf of the OTC member States. Appendix I (Attachment I) provides comprehensive operational and diagnostic evaluation results, including spreadsheets containing the assumptions made to compute statistics. Highlights of this evaluation are provided in the following sections.

9.3.1 Diagnostic and Operational Evaluation

The issue of model performance goals for $PM_{2.5}$ is an area of ongoing research and debate. To evaluate model performance, EPA recommends that several statistical metrics be developed for air quality modeling. Performance goals refer to targets that a good performing model should achieve, whereas performance benchmarks are based on historical model performance measures for the best performing simulations. Performance goals are necessary in order to provide consistency in model applications and expectations across the country and to provide standardization in how much weight may be accorded modeling study results in the decision-making process.

When EPA's guidance was first developed nearly four (4) years ago, an interim set of fine particulate modeling performance goals were suggested for aggregated mean normalized gross error and mean normalized bias as defined in Table 9-1.

Table 9-1. EPA $PM_{2.5}$ Modeling Performance Goals

Pollutant	Gross Error	Normalized Bias
$PM_{2.5}$	~30-50%	~10%
Sulfate	~30-50%	~20-30%
Nitrate	~20-70%	~15-50%
EC	~15-60%	NA
OC	~40-50%	~38%

Because regional-scale $PM_{2.5}$ modeling is an evolving science, and considerable practical application and performance testing has transpired in the intervening years since these goals were postulated, they are considered as general guidelines.

It may also be possible to adopt levels of model performance goals for bias and gross error as listed in Table 9-3 (as developed by VISTAS) to help evaluate model performance.

Table 9-2. VISTAS $PM_{2.5}$ Modeling Performance Goals

Fractional Bias	Fractional Error	Comment
≤±15%	≤35%	Ozone model performance goal for which $PM_{2.5}$ model performance would be considered good.
≤±30%	≤50%	A level of model performance that we would hope each $PM_{2.5}$ species could meet.
≤±60%	≤75%	At or above this level of performance indicates fundamental problems with the modeling system.

It does not mean that these performance goals should be generally adopted or that they are the most appropriate goals to use. Rather, the goals are being used to frame and put the $PM_{2.5}$ model performance into context and to facilitate model performance across episodes, species, models and sensitivity tests.

As noted in EPA's $PM_{2.5}$ modeling guidance, less abundant $PM_{2.5}$ species should have less stringent performance goals. Accordingly, performance goals that are a continuous function of average observed concentrations such as those proposed by Dr. James Boylan at the Georgia Department of Natural Resources have the following features:

- Asymptotically approaching proposed performance goals or criteria when the mean of the observed concentrations are greater than 2.5 $\mu g/m^3$.
- Approaching 200% error and ±200% bias when the mean of the observed concentrations are extremely small.

The above goals and criteria are not regarded as a pass/fail test, but rather as a basis of inter-comparing model performance across studies, sensitivity tests and models.

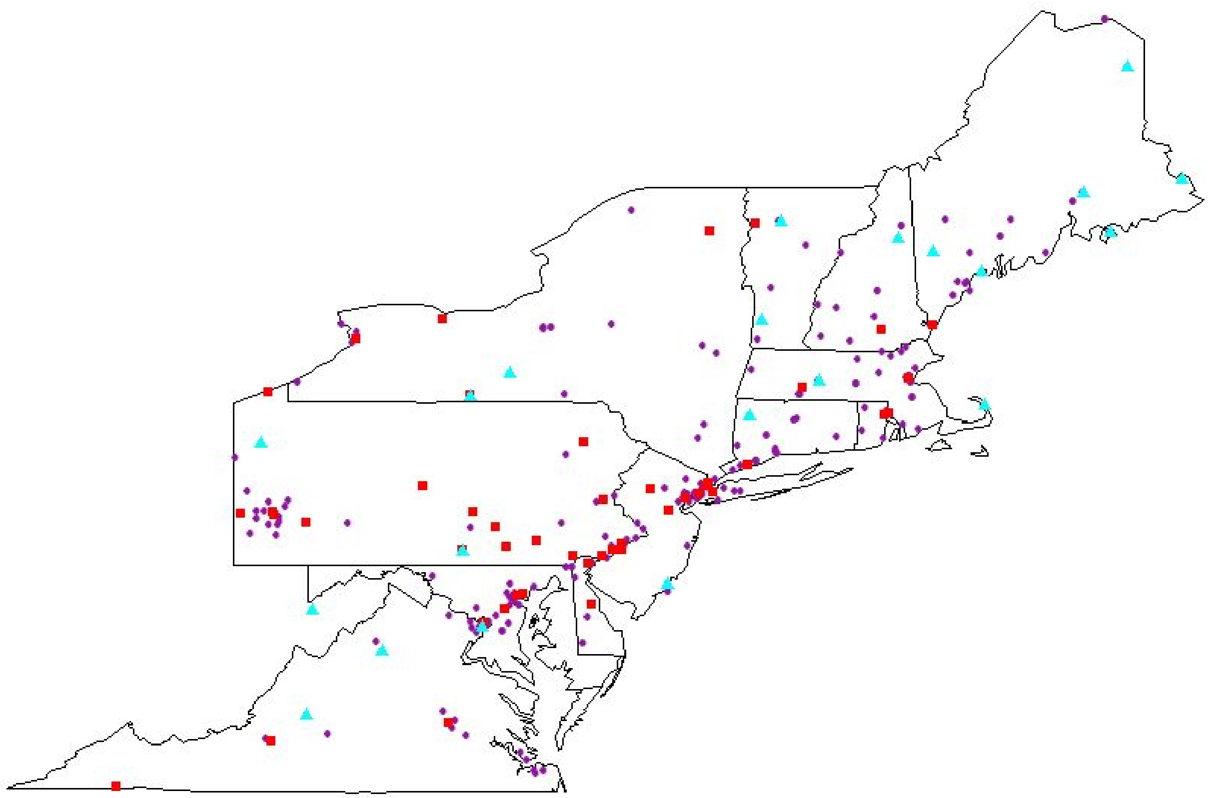
The OTC model performance evaluation was initially conducted by NYSDEC on the summer ozone season data only. VADEQ has extended the evaluation to include the entire year of 2002 observations. Four statistical parameters, two recommended by EPA (Table 9-1) and two adopted by VISTAS (Table 9-2), pertinent to model performance evaluation were computed for FRM $PM_{2.5}$ mass and for individual species of SO_4, NO3, NH_4, EC, OM (1.8* blank-corrected OC), soil or crustal material (sum of oxides of Ca, Fe, Si, and Ti). The statistics were organized into two categories: a) by date and b) by site.

For statistics by date, the parameters were calculated on a given day for any valid pairs of observed/predicted data across all FRM and speciation monitors that fall within the OTR modeling domain plus all of Virginia monitors (referred to as OTR+). Data collected from three different monitoring networks, FRM, STN, and IMPROVE, were used in the statistics. A subset of these "time-based composite monitor" statistics focusing only on the Washington, D.C. MSA monitors was also generated. It is important to note that predicted data used for the model performance evaluation were extracted from CMAQ outputs at the exact grid cells where monitors are located. This is in contrast to the design value calculations where predictions are based on the average of the surrounding nine grid cells (see Section 9.4).

For statistics by site, parameters were computed at a given FRM, STN, or IMPROVE monitor for any valid pairs of observed/predicted data over a period of one calendar year. Again, the full year of 2002 data was used in this “monitor-based composite period" analysis, except for the dates between July 6 and July 9 due to the exceptional event caused by the Quebec forest fires.

Figure 9-1 depicts the location of the FRM, STN and IMPROVE monitor locations used for the model evaluation across the OTR+ region.

Figure 9-1. FRM (●, 264), STN (■, 50), and IMPROVE (▲, 21) Locations Used for the Model Evaluation Across the OTR+ Region



A composite FRM time series across the OTR+ region (264 monitors) is provided in Figure 9-2. This figure indicates that there is an overall mean bias of approximately 4 ug/m^3. There is a general over-prediction during winter months and an under-prediction during summer months. There is excellent agreement during the mid-August air pollution episode.

Figure 9-2. Composite FRM Time Series across the OTR+ Region (264 monitors)

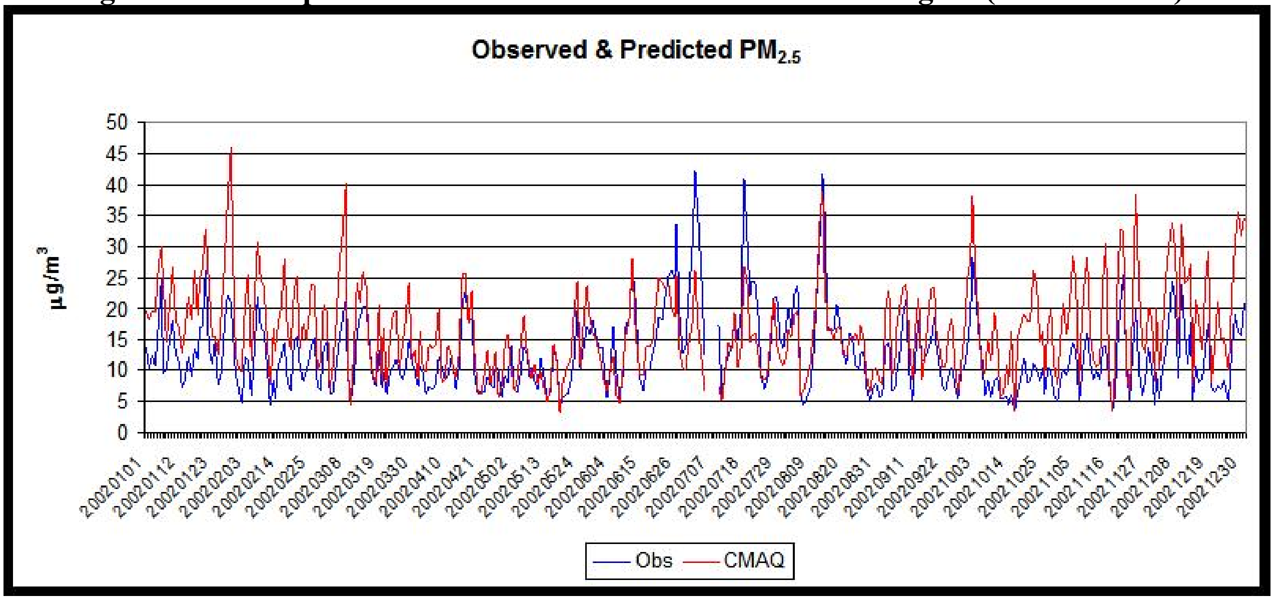
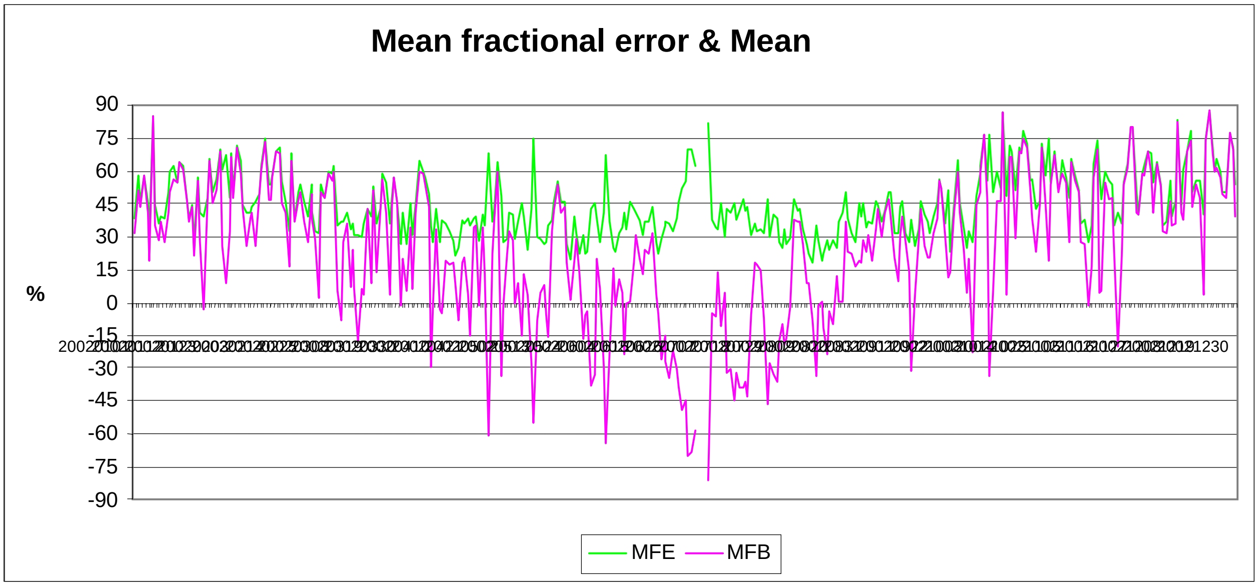


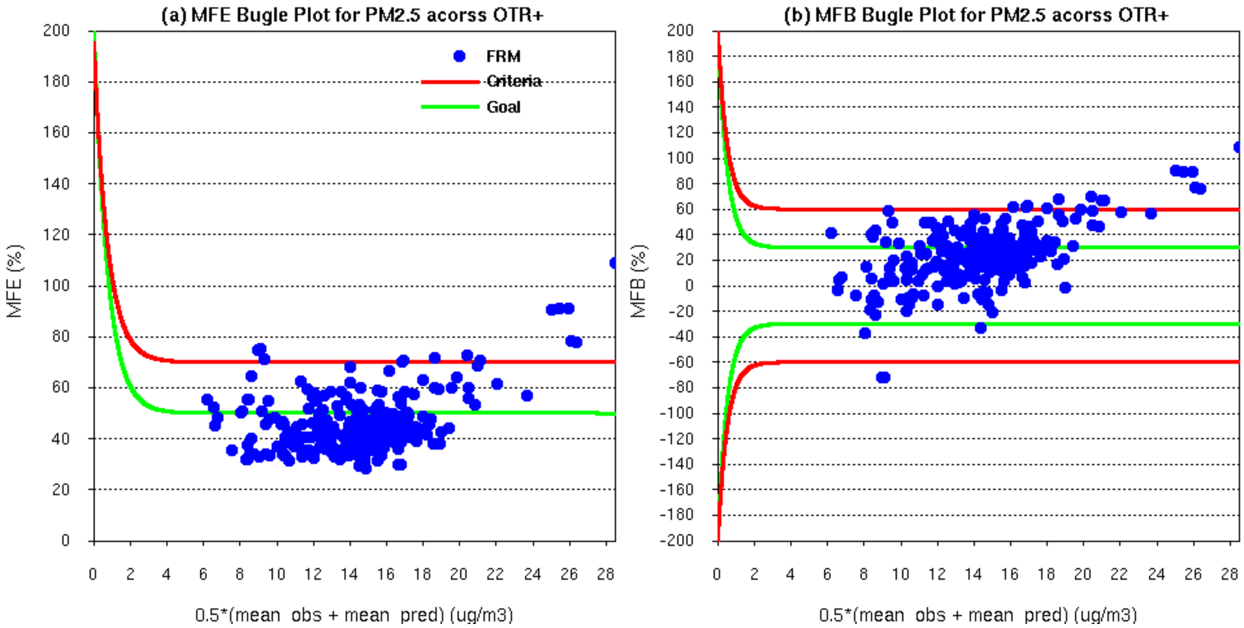
Figure 9-3 is a plot of the FRM mean fractional error (MFE) and mean fractional bias (MFB) across the OTR+ region. MFE ranges from 17% to 88% with an average of approximately 45%. MFB ranges from -82% to +88% with an average of approximately +24%. These values are generally consistent with similar studies listed in the Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze (EPA-454/B-07-002, April 2007).

Figure 9-3. MFE and MFB Time Series for FRM $PM_{2.5}$ across the OTR+ Region



A bugle plot for FRM $PM_{2.5}$ monitors across the OTR+ region is provided in Figure 9-4. “Goal” curves are the best a model can be expected to achieve while the “criteria” curves are considered acceptable for model performance. The overall model performance for $PM_{2.5}$ is fairly good, with greater than 50% of the 264 FRM sites meeting the goals and greater than 95% meeting the criteria on an annual average basis.

Figure 9-4. Bugle Plot for FRM $PM_{2.5}$ across OTR+ Region



MFE bugle plots were also generated for SO_4, NO_3, and NH_4, EC, OM, and soil/crustal across OTR+ region and are provided in Figures 9-5 through 9-10. As can be seen from the results, the performance for individual species is generally consistent with the criteria necessary for acceptable model performance.

Figure 9-5. Bugle Plot for SO_4 across OTR+ Region

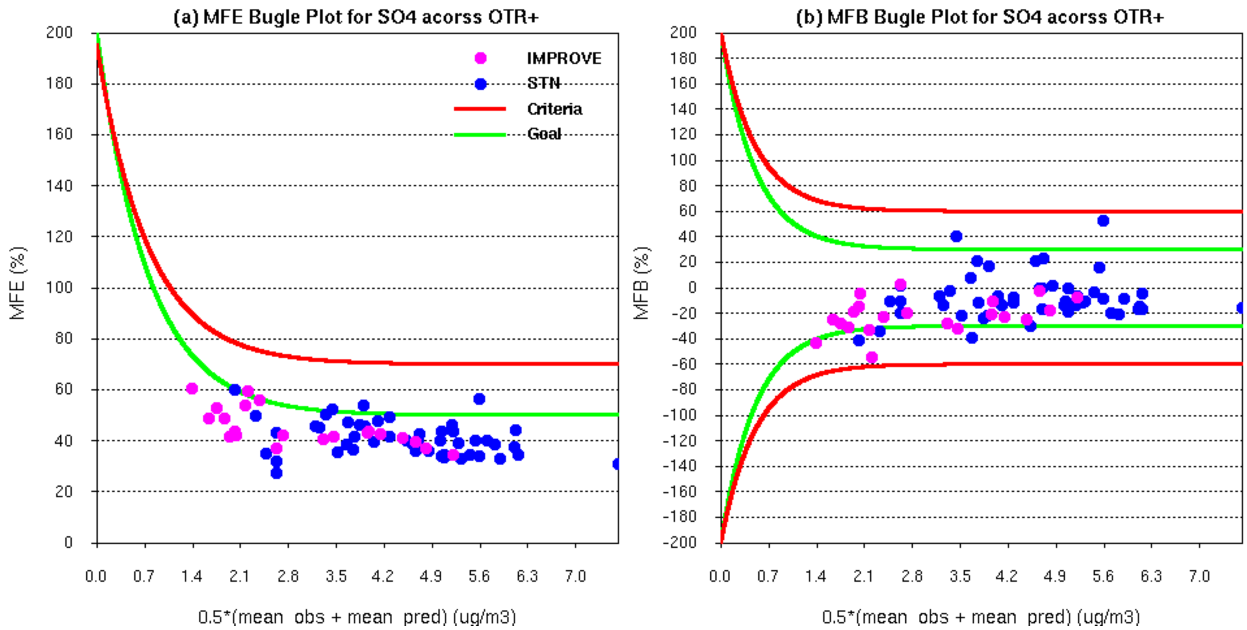


Figure 9-6. Bugle Plot for NO_3 across OTR+ Region

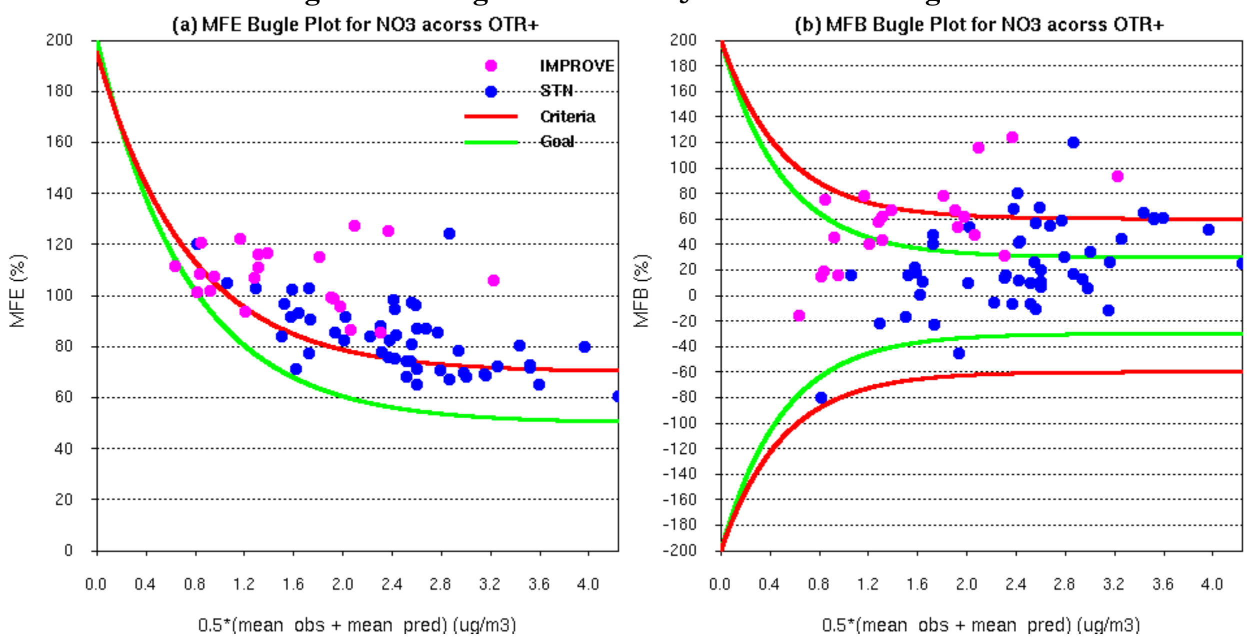


Figure 9-7. Bugle Plot for NH_4 across OTR+ Region

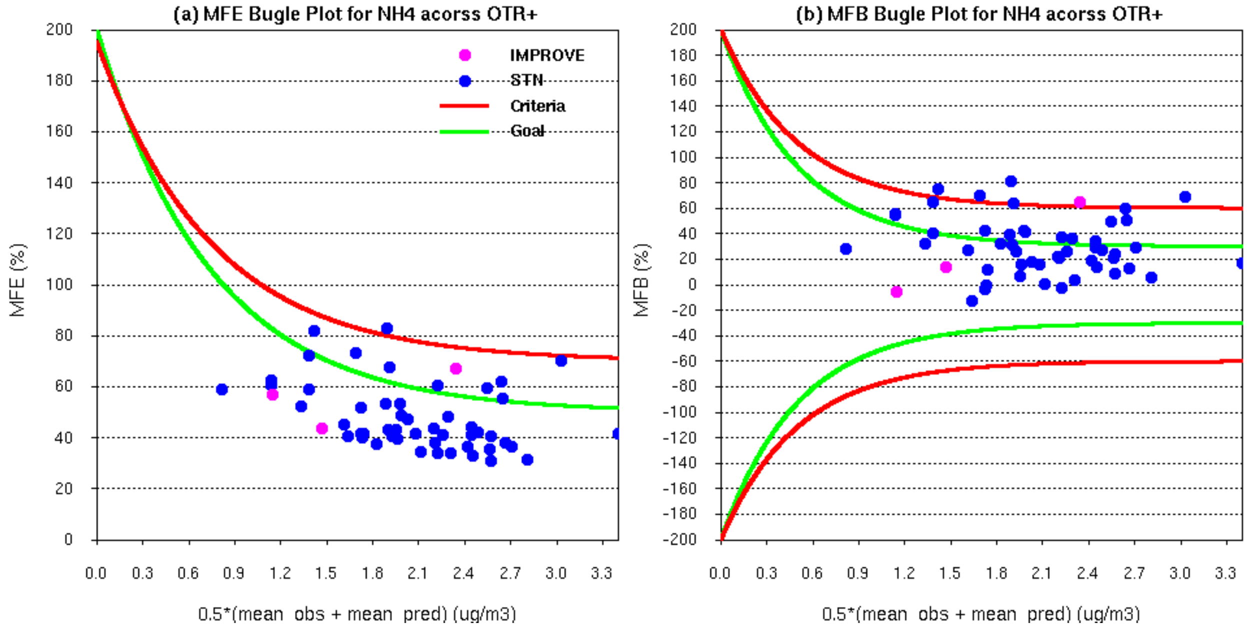


Figure 9-8. Bugle Plot for EC across OTR+ Region

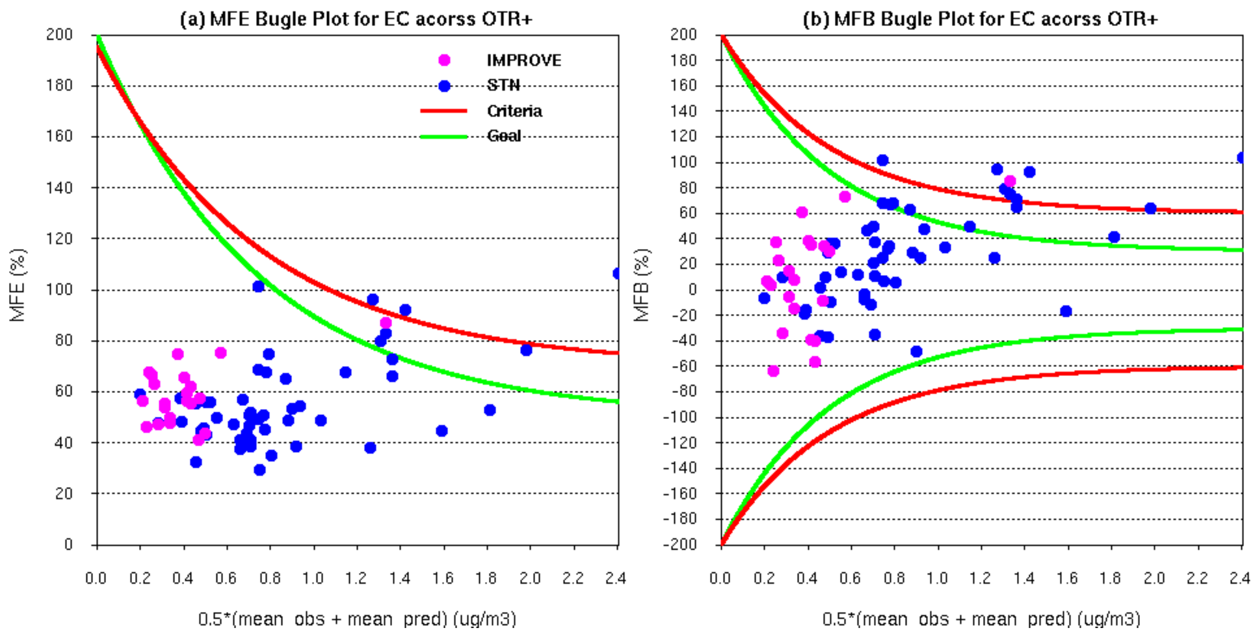


Figure 9-9. Bugle Plot for OM across OTR+ Region

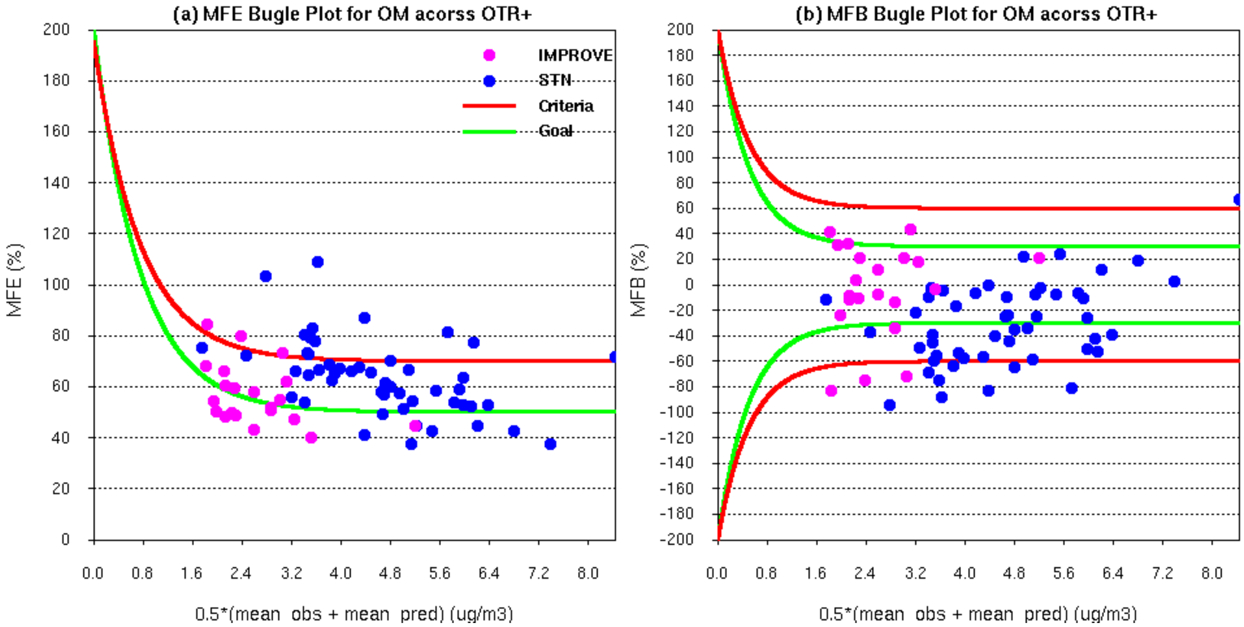
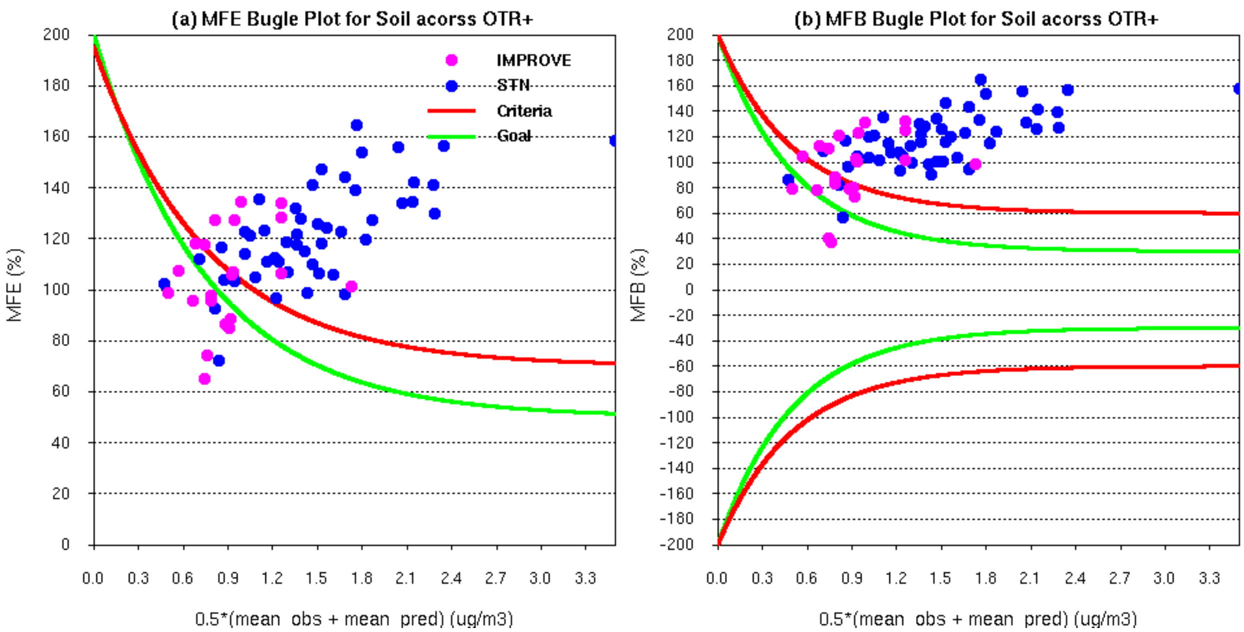


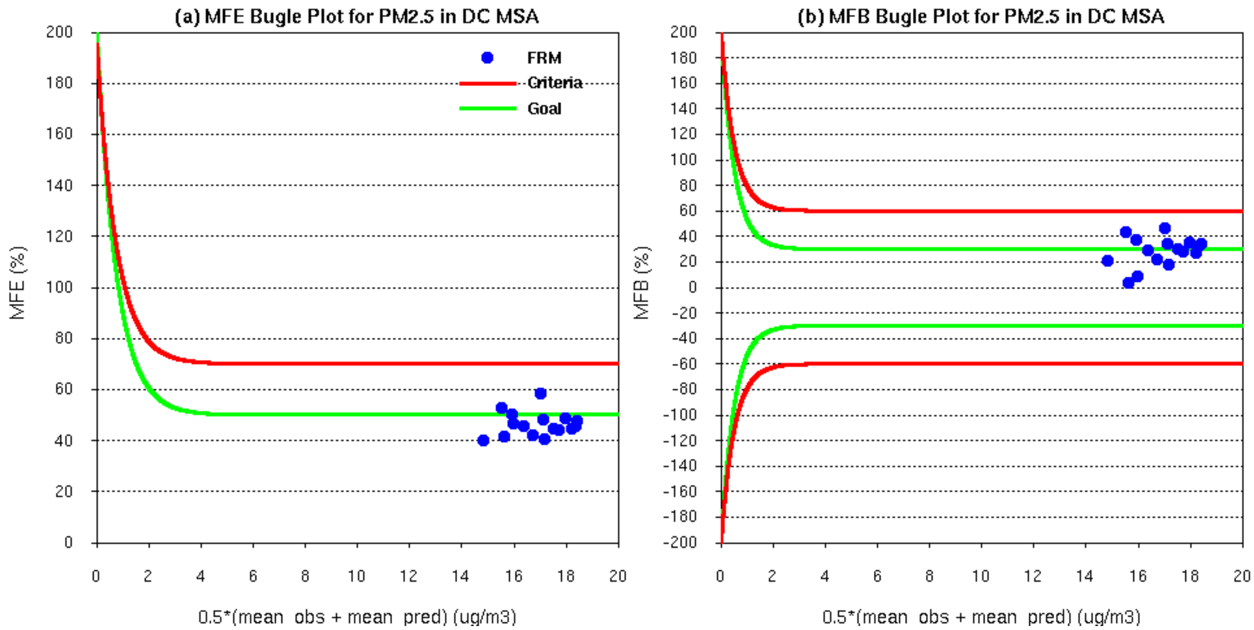
Figure 9-10. Bugle Plot for Soil/Crustal across OTR+ Region



In terms of individual $PM_{2.5}$ components, model performance for sulfate is excellent, with a great majority of the data points meeting the goals, and all of the data points meeting the criteria. The good performance is likely attributed to accurate estimates of SO_2 emissions, less complex sulfate chemistry than other component species, and high spatial homogeneity of sulfate. On the other hand, model performs poorly for nitrate, with more than half of the data points fail to meet the criteria. Nitrate, in general, exhibits an overestimated (i.e., positive bias) trend. Similar to sulfate, performance of ammonium is fairly good as well, with only a few data points falling outside of the criteria. Performance for organic compounds is considered fair, as a number of data points fail to meet the criteria. Contrary to nitrate, poorly-performed data points of organic compounds appear mostly under-predicted (i.e., negative bias). Elemental carbon, which makes up only a small portion of total $PM_{2.5}$, has a similarly good model performance as ammonium. Finally, model performance for soil compounds is quite poor, with a great majority of data points falling outside of the criteria, caused largely by over-prediction.

A separate evaluation focusing on total $PM_{2.5}$ for the FRM monitors in the Washington D.C. MSA is presented in Figure 9-11. CMAQ performs well for DC FRM monitors with all of the monitors meeting the criteria for acceptable model performance.

Figure 9-11. Bugle Plot for FRM $PM_{2.5}$ in Washington, D.C. MSA



The following is a list of several $PM_{2.5}$ statistics for the OTC domain that have also been provided in Appendix I, Attachment J.

1. Statistical evaluation of daily average $PM_{2.5}$ mass from FRM sites across the OTR+ domain. Statistics are computed by date and by site (across the OTR+).

2. Statistical evaluation of daily average $PM_{2.5}$, SO_4, NO_3, NH_4, EC, OM, and crustal/soil mass at EPA STN sites. Statistics are computed by date and by site (across the OTR+).

3. Statistical evaluation of daily average $PM_{2.5}$, SO_4, NO_3, EC, OM, and crustal/soil mass at IMPROVE sites. Statistics are computed by date and by site (across the OTR+).

4. Statistical evaluation of daily average $PM_{2.5}$ mass from FRM sites in the Washington, D.C. MSA sub-domain. Statistics are computed by date and by site.

9.3.2 Summary of Model Performance

CMAQ was employed to simulate $PM_{2.5}$ for the calendar year 2002. A review of $PM_{2.5}$ and its individual species was conducted for the study domain. Documentation for the Model Performance tests is provided in Appendix I Attachment I (CMAQ Model Performance).

The CMAQ model performance for surface $PM_{2.5}$ is good with acceptable bias and error. Several observations can be made with respect to overall model performance, including the following:

1. Approximately 80-90% of OM is in the primary fraction. Observed OM has distinct maximum during summer when secondary formation is highest; CMAQ exhibits substantial under-prediction in secondary organic aerosols (SOA). The predicted primary OM is highest during the winter.
2. CMAQ captures seasonal variation in SO_4 well.
3. CMAQ appears to overestimate primary $PM_{2.5}$ components (EC, soil, primary OM), especially during colder months.
4. CMAQ appears to underestimate secondary OM during the summer.

These issues are not of great regulatory concern since attainment tests are based on the application of relative response factors. In summary, the regional and local model performance is acceptable for $PM_{2.5}$. While there are some differences between the spatial data between sub-regions, there is nothing to suggest a tendency for the model to respond in a systematically different manner between regions. Examination of the statistical metrics by sub-region confirms the absence of significant performance problems arising in one area but not in another, building confidence that the CMAQ modeling system is operating consistently across the full OTC domain. This confidence in the modeling results allows for the modeling system to be used to support the State Implementation Plan to meet the 1997 $PM_{2.5}$ NAAQS.

9.4 Attainment Demonstration

As previously mentioned, the Washington, D.C. MSA has been classified as a nonattainment area for $PM_{2.5}$ with an attainment date of April 5, 2010. The $PM_{2.5}$ NAAQS include an annual standard of 15.0 $\mu g/m^3$ based on the 3-year average of annual mean $PM_{2.5}$ concentrations, and a 24-hour standard of 65 $\mu g/m^3$ based on the 3-year average of the 98th percentile of 24-hour concentrations.

This section summarizes the procedures that were used to demonstrate attainment of the NAAQS in the State Implementation Plan (SIP) package. As described in EPA's Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze (EPA-454/B-07-002, April 2007), an attainment demonstration consists of (a) analyses which estimate whether selected emissions reductions will result in ambient concentrations that meet the NAAQS, and (b) an identified set of control measures which will result in the required emissions reductions. The necessary emission reductions for both of these attainment demonstration components may be determined by relying on results obtained with air quality models.

EPA guidance recommends applying a modeled attainment test to the air quality modeling results to determine if the $PM_{2.5}$ NAAQS will be met. Additional technical or corroboratory analyses may also be used as part of a "supplemental analysis" or a more stringent "weight of evidence" determination to supplement the modeled attainment test and to further support a demonstration of attainment of the NAAQS.

The modeled attainment test and additional corroborative analyses are described in further detail in the remaining portions of this section.

9.4.1 Model Attainment Test

The purpose of a modeling assessment determine if control strategies currently being implemented ("on the books") and proposed control strategies will lead to attainment of the NAAQS for $PM_{2.5}$ by the attainment year of 2009. The modeling is applied in a relative sense, similar to the 8-hour ozone attainment test. However, The $PM_{2.5}$ attainment test is more complicated and reflects the fact that $PM_{2.5}$ is a mixture. In the test, ambient $PM_{2.5}$ is divided into major components, with a separate relative response factor (RRF) and future design value (DVF) calculated for each of the $PM_{2.5}$ components. Since the attainment test is calculated on a per species basis, the attainment test for $PM_{2.5}$ is referred to as the Speciated Modeled Attainment Test (SMAT). The following sections outline the process to determine 2009 projections of $PM_{2.5}$ will meet the NAAQS from regional modeling, as suggested in EPA's guidance.

9.4.1.1 Determine Baseline Design Values

The first step in any attainment test process is to determine the baseline design value (DVB). EPA guidance recommends using a DVB that is the average of the three design value periods that straddle the baseline inventory year (i.e., the average of the 2000-2002, 2001-2003, and 2002-2004 design value periods for a 2002 baseline inventory year). This works out to a 5-year weighted average, with the baseline year having the heaviest weight (i.e., {[2000] + 2*[2001] + 3*[2002] + 2*[2003] + [2004]}/9).

For the SMAT process, a mean $PM_{2.5}$ DVB is determined, as well as component specific DVB for each quarter. The following section will detail the calculation of baseline design values needed for the $PM_{2.5}$ attainment test.

9.4.1.1.1 Mean $PM_{2.5}$ Baseline Design Values

To begin the SMAT process, a mean $PM_{2.5}$ DVB is calculated on a quarterly basis for each Federal Reference Method (FRM) monitor in the $PM_{2.5}$ nonattainment areas. Concentrations are calculated based on calendar quarters (Q1: January - March; Q2: April - June; etc.) as the NAAQS is calculated for a calendar year, and the quarters need to fit evenly within a year. Also, calculating the attainment test on a quarterly basis allows states to examine the differences in $PM_{2.5}$ composition that occur during the different seasons.

9.4.1.1.2 Speciated Baseline Conditions

The monitored attainment test for $PM_{2.5}$ utilizes both $PM_{2.5}$ and individual $PM_{2.5}$ component species. A separate RRF is calculated for each $PM_{2.5}$ species. In order to perform the recommended modeled attainment test, States should divide observed mass concentrations of $PM_{2.5}$ into 7 components (plus passive mass):

1. Mass associated with sulfates (SO_4)
2. Mass associated with nitrates (NO_3)
3. Mass associated with ammonium (NH_4)
4. Mass associated with organic carbon (OC)
5. Mass associated with elemental carbon (EC)
6. Mass associated with particle bound water (PBW)
7. Mass associated with "other" primary inorganic particulate matter (Crustal)
8. And passively collected mass or the mass of the blank filter

The second part of the process is to use the quarterly mean $PM_{2.5}$ DVBs (as calculated in Section 9.4.1.1.1) with speciated data to calculate the quarterly mean concentrations of these 7 components at the FRM sites. This need to speciate the FRM data presents two issues:

1. FRM measurements and speciated $PM_{2.5}$ measurements do not always measure the same mass.
2. Not all FRM monitoring sites have co-located STN speciation monitors.

The following sections will explain how these issues were overcome to produce the speciated values needed for this attainment demonstration.

9.4.1.1.2.1 SANDWICH

As EPA guidance notes, recent data analyses have noted that the FRM monitors do not measure the same components and do not retain all of the $PM_{2.5}$ that is measured by routine speciation samplers and therefore cannot be directly compared to speciation measurements from the Speciation Trends Network (STN). By design, the FRM mass measurement does not retain all ammonium nitrate and other semi-volatile materials (negative sampling artifacts) and includes particle bound water associated with sulfates, nitrates and other hygroscopic species (positive sampling artifacts). This results in concentrations (and percent contributions to $PM_{2.5}$ mass), which may be different than the ambient levels of some $PM_{2.5}$ chemical constituents.

To resolve the differences between FRM and STN total mass, EPA recommends using the "sulfate, adjusted nitrate, derived water, inferred carbonaceous material balance approach" or SANDWICH approach. With the SANDWICH approach, nitrate mass is adjusted to account for volatilization based on hourly meteorology parameters. Subsequently, quarterly average nitrate, sulfate, elemental carbon, and crustal mass can be calculated, as well as the Degree of Neutralization (DON) of sulfates. Quarterly average NH_4 can then be calculated from adjusted the adjusted nitrate mass, sulfate mass, and DON of sulfate. Next the mass of particle bound water can be calculated from the previously obtained DON, sulfate, nitrate, and ammonium values. Finally, organic carbon is calculated by taking the difference between the total $PM_{2.5}$ mass as measured at the FRM monitor, and the calculated component mass (i.e., OC from mass balance ([OCMmb] = $PM2.5_{FRM}$:{[EC] + [SO4] + [NO3] + [NH4] + [water] + [crustal material] + [passive mass]}).

9.4.1.1.2.2 Speciated Profiles

While the SANDWICH method reconciles the differences between FRM and STN, a lingering issue is that not all FRM monitoring sites have co-located STN monitors to provide speciated data. EPA guidance suggests four measures that can be taken to resolve the lack of speciated data:

1. Use of concurrent data from a near by speciated monitor
2. Use of representative data (from a different time period)
3. Use of interpolation techniques to create a spatial field using ambient speciation data
4. Use of interpolation techniques to create spatial fields, and gridded modeling outputs to adjust the species concentrations

Of the four methodologies, the EPA recommends using one of the spatial interpolation techniques to estimate species concentrations at FRM sites that do not have speciation data (numbers 3 and 4 above). To assist in this task, the EPA is developing software tool called "Modeled Attainment Test Software" (or MATS) that will perform the spatial analysis of described options number 3 and 4. However, the MATS tool is not available at this time. In trying to pursue the EPA recommended course of action, speciated profiles from the Clean Air Interstate Rule (CAIR) SMAT tool, which is the predecessor for the MATS program, were used as an alternative.

The CAIR SMAT tool uses data from both the Interagency Monitoring of Protected Visual Environments (IMPROVE) and the US EPA's Speciation Network (ESPN) to derive mean concentrations for six $PM_{2.5}$ components. Quarterly average concentrations between Jan 2002 to December 2002 were retained for sites that had at least 11 monitored values per quarter for each of the major $PM_{2.5}$ species. Major species for ESPN include EC, OC, NH4, SO_4, NO_3, and crustal material (which include the five trace elements aluminum, calcium, iron, silicon, and titanium). The major species for IMPROVE are the same except for NH_4, which is not routinely measured in the IMPROVE protocol.

The quarterly average species concentrations at the IMPROVE and ESPN monitors were used to interpolate concentrations at the $PM_{2.5}$ FRM monitoring sites using a technique called Voronoi Neighbor Averaging (VNA). Appendix I Attachment J contains the document entitled Procedures for Estimating Future $PM_{2.5}$ Values for the CAIR Final Rule by Application of the (Revised) Speciated Modeled Attainment Test (SMAT) Updated- 11/8/04, which describes the interpolation process, and the data speciation process in detail.

As a result of the CAIR SMAT process, quarterly species fractions were generated (see Attachment J). These fractions were then applied to Observed Quarterly Mean $PM_{2.5}$ values to determine quarterly component specific concentrations. The estimated future mass of NH_4 and PBW are determined by the estimated future mass of SO_4 and NO_3, as was done in the CAIR SMAT tool using equations provided in Appendix I, Attachment J.

9.4.1.2 Relative Response Factor Calculations

The calculation of relative response factors (RRFs) for this study was performed using the EPA recommended method for "nearby" grid cells for a 12-kilometer horizontal grid resolution, with a 3x3 grid cell array for 12-km resolution modeling. The relative response factor used in the modeled attainment test is computed by taking the ratio of the mean of the predictions in the future to the mean predictions with baseline emissions, over all relevant days.

For the 24-hour and annual $PM_{2.5}$ NAAQS, the spatially averaged value of the nearby predictions (mean value of the grid cell array) was used. Each component-specific RRF was used in the modeled attainment test by taking the ratio of the mean of the spatially averaged daily predictions in the future to the mean of the spatially averaged daily predictions with current emissions.

The basis for this approach is as follows:

1. Consequence of a control strategy may be "migration" of a predicted peak. If a State were to confine its attention only to the cell containing a monitor, it might underestimate the RRF (i.e., overestimate the effects of a control strategy).
2. Uncertainty in the formulation of the model and the model inputs is consistent with recognizing some leeway in the precision of the predicted location of concentrations.
3. Standard practice in defining a gridded modeling domain is to start in the southwest corner of the domain, and determine grid cell location from there. Considering several cells "near" a monitor rather than the single cell containing the monitor diminishes the likelihood of inappropriate results which may occur from the geometry of the superimposed grid system.
4. The area does not exhibit strong spatial concentration gradients of observed primary $PM_{2.5}$.

9.4.1.3 Annual SMAT Results

Table 9-3 presents the results of the annual SMAT results for the Washington, D.C. MSA. The SMAT results demonstrate that the projected average annual arithmetic mean $PM_{2.5}$ concentration calculated at each FRM monitor attains the 1997 $PM_{2.5}$ NAAQS. Specifically, all future design value (DVF) calculations are less than15.0 $\mu g/m^3$.

It is important to note that an attempt was made to calculate a DVF at each of the FRM monitors. EPA guidance is somewhat unclear as to what constitutes a valid number of quarters necessary to calculate a DVF. Special attention should be paid to this when reviewing the results in Table 9-3. Monitors with 19 or 20 valid quarters are generally considered to have a more reliable DVF than those with incomplete data. As previously mentioned, EPA is expected to release MATS in the next few months and at that time the values in this report will be verified.

Table 9-3. Annual SMAT Results for Washington, D.C. MSA 2009 Beyond-On-The-Way Control Measures and Virginia CAIR Rule (a)

AIRS ID	Site Name	Jurisdiction	State	2000-2004 DVB					2009
				Q1	Q2	Q3	Q4	#Q	DVF
11-001-0041	River Terrace	District of Columbia	---	14.85	14.91	18.76	14.16	20	12.6
11-001-0042	Park Services	District of Columbia	---	13.43	15.49	17.33	12.98	20	11.9
11-001-0043	McMillan	District of Columbia	---	13.65	15.28	18.10	13.55	20	12.1
24-031-3001	Rockville	Montgomery	MD	11.23	13.64	16.01	10.43	20	10.4
24-033-0001	Bladensburg	Prince George's	MD	14.53	16.72	22.00	14.93	11	13.9
24-033-0002	Greenbelt	Prince George's	MD	9.73	12.37	14.83	9.28	7	9.5
24-033-0030	Beltsville	Prince George's	MD	NA	NA	14.93	10.36	2	10.4
24-033-8001	Suitland	Prince George's	MD	12.04	15.61	15.66	11.62	8	11.0
24-033-8003	PG Equestrian Center	Prince George's	MD	11.61	15.72	17.26	10.87	11	11.3
51-013-0020	Aurora Hills	Arlington	VA	13.27	14.88	17.27	13.05	20	11.5
51-059-0030	Franconia	Fairfax	VA	11.59	14.01	16.95	12.02	19	10.4
51-059-1005	Annandale	Fairfax	VA	12.58	14.20	17.25	11.37	11	10.5
51-059-5001	Lewinsville	Fairfax	VA	12.63	14.05	17.80	12.37	19	10.7
51-107-1005	Ashburn	Loudoun	VA	11.38	14.14	17.32	11.71	20	10.1

(a) Includes NO_X reductions only.

Table 9-4 presents the results of the annual SMAT results for the Washington, D.C. MSA for a suite of regional modeling runs conducted by OTC and ASIP, each representing a level of emissions controls:

1. OTB/OTW – "On the Books, On the Way" control measures.
2. BOTW – "Beyond on the Way" represents control measures that Commissioners thought States might adopt. However, not all States have committed to adopt all of the BOTW measures that have been modeled.
3. BOTW + VA CAIR – The aforementioned "Beyond on the Way" control measures and the Virginia CAIR rule. This run only includes NO_X reductions and does not include SO_2 reductions for the Virginia CAIR rule.

Examination of the results confirms the absence of significant differences between the ASIP and OTC results, building confidence that the CMAQ modeling system is operating consistently across the RPO platforms. Additionally, all runs demonstrate compliance with the 1997 NAAQS.

Table 9-4. 2009 Annual SMAT Results Comparison for Regional Modeling Runs

AIRS ID	Site Name	Jurisdiction	State	2009 DVF			
				OTC OTB/OTW	OTC BOTW	OTC BOTW +VA CAIR	ASIP OTB/OTW
11-001-0041	River Terrace	District of Columbia	---	12.6	12.6	12.6	12.9
11-001-0042	Park Services	District of Columbia	---	11.9	11.9	11.9	12.2
11-001-0043	McMillan	District of Columbia	---	12.1	12.1	12.1	12.4
24-031-3001	Rockville	Montgomery	MD	10.4	10.4	10.4	10.4
24-033-0001	Bladensburg	Prince George's	MD	13.9	13.9	13.9	13.9
24-033-0002	Greenbelt	Prince George's	MD	9.5	9.5	9.5	9.4
24-033-0030	Beltsville	Prince George's	MD	10.4	10.4	10.4	10.1
24-033-8001	Suitland	Prince George's	MD	11.0	11.0	11.0	11.2
24-033-8003	PG Equestrian Center	Prince George's	MD	11.3	11.3	11.3	11.2
51-013-0020	Aurora Hills	Arlington	VA	11.5	11.5	11.5	12.0
51-059-0030	Franconia	Fairfax	VA	10.4	10.4	10.4	11.0
51-059-1005	Annandale	Fairfax	VA	10.5	10.5	10.5	11.3
51-059-5001	Lewinsville	Fairfax	VA	10.7	10.7	10.7	11.6
51-107-1005	Ashburn	Loudoun	VA	10.1	10.1	10.1	11.0

9.4.1.4 24-Hour SMAT Results

Table 9-5 presents the results of the 24-hour SMAT results for the Washington, D.C. MSA. The SMAT results demonstrate that the projected average annual arithmetic mean $PM_{2.5}$ concentration calculated at each FRM monitor attains the 24-hour $PM_{2.5}$ NAAQS. Specifically, all future design value (DVF) calculations are well below 65 $\mu g/m^3$.

Table 9-5. 24-Hour Modeling Attainment Test Using EPA SMAT Methodology
2009 Beyond-On-The-Way Control Measures and Virginia CAIR Rule (a)

AIRS ID	Site Name	Jurisdiction	State	24-Hour 98th Percentile DVB					2009
				2000	2001	2002	2003	2004	DVF
11-001-0041	River Terrace	District of Columbia	---	41.20	44.80	47.80	39.00	38.40	33.6
11-001-0042	Park Services	District of Columbia	---	37.20	35.10	35.90	38.70	36.00	29.7
11-001-0043	McMillan	District of Columbia	---	38.60	43.70	40.00	35.20	34.80	32.0
24-031-3001	Rockville	Montgomery	MD	36.20	37.50	36.30	32.10	31.70	27.3
24-033-0001	Bladensburg	Prince George's	MD	40.90	38.90	35.20	NA	NA	29.2
24-033-0002	Greenbelt	Prince George's	MD	NA	NA	27.00	32.30	16.90	23.1
24-033-0030	Beltsville	Prince George's	MD	NA	NA	NA	NA	38.10	29.0
24-033-8001	Suitland	Prince George's	MD	36.50	35.20	NA	NA	NA	27.6
24-033-8003	PG Equestrian Center	Prince George's	MD	NA	NA	47.20	31.50	37.70	32.4
51-013-0020	Aurora Hills	Arlington	VA	37.70	37.20	35.60	39.20	35.70	29.7
51-059-0030	Franconia	Fairfax	VA	35.30	34.30	36.10	32.60	35.30	27.1
51-059-1005	Annandale	Fairfax	VA	NA	NA	35.00	36.70	34.00	25.8
51-059-5001	Lewinsville	Fairfax	VA	37.20	37.80	33.70	32.90	33.70	25.4
51-107-1005	Ashburn	Loudoun	VA	36.60	35.60	32.30	35.30	34.20	24.9

(a) Includes NO_X reductions only.

Table 9-6 presents the results of the 24-hour SMAT results for the Washington, D.C. MSA for the suite of regional modeling runs conducted by OTC and ASIP. Again, the comparison confirms the absence of significant differences between the OTC and ASIP results. All runs demonstrate attainment with the 24-hour NAAQS.

Table 9-6. 2009 24-Hour SMAT Results Comparison for Regional Modeling Runs

AIRS ID	Site Name	Jurisdiction	State	2009 DVF OTC OTB/OTW	OTC BOTW	OTC BOTW +VA CAIR	ASIP OTB/OTW
11-001-0041	River Terrace	District of Columbia	---	33.6	33.6	33.6	34.7
11-001-0042	Park Services	District of Columbia	---	29.7	29.7	29.7	30.3
11-001-0043	McMillan	District of Columbia	---	31.9	31.9	32.0	32.0
24-031-3001	Rockville	Montgomery	MD	27.3	27.3	27.3	27.2
24-033-0001	Bladensburg	Prince George's	MD	29.2	29.2	29.2	29.2
24-033-0002	Greenbelt	Prince George's	MD	23.0	23.0	23.1	22.7
24-033-0030	Beltsville	Prince George's	MD	29.0	28.9	29.0	28.4
24-033-8001	Suitland	Prince George's	MD	27.6	27.6	27.6	28.7
24-033-8003	PG Equestrian Center	Prince George's	MD	32.4	32.4	32.4	32.1
51-013-0020	Aurora Hills	Arlington	VA	29.7	29.7	29.7	31.1
51-059-0030	Franconia	Fairfax	VA	27.1	27.1	27.1	28.8
51-059-1005	Annandale	Fairfax	VA	25.8	25.8	25.8	28.1
51-059-5001	Lewinsville	Fairfax	VA	25.4	25.4	25.4	27.8
51-107-1005	Ashburn	Loudoun	VA	24.9	24.9	24.9	27.5

9.4.2 Unmonitored Area Analysis

The modeled attainment test does not address future air quality at locations where there is not an $PM_{2.5}$ monitor nearby. To guard against the possibility that air quality levels could exceed the standard in areas with limited monitoring, EPA suggests that additional review is necessary, particularly in nonattainment areas where the $PM_{2.5}$ monitoring network just meets or minimally exceeds the size of the network required to report data to Air Quality System (AQS). This review is intended to ensure that a control strategy leads to reductions in $PM_{2.5}$ and its constituent pollutants at other locations that could have baseline (and future) design values exceeding the NAAQS were a monitor deployed there. The test is called an "unmonitored area analysis". The purpose of the analysis is to use a combination of model output and ambient data to identify areas that might exceed the NAAQS if monitors were located there.

It is important to note that the Washington, D.C. MSA currently operates a network of 14 $PM_{2.5}$ monitors. Several of these monitors were established as State and Local Air Monitoring Stations (SLAMS). These SLAMS monitors were selected based on specific monitoring objectives (background concentration, area of highest concentration, high population, source impact, transport, and rural impact) as required by EPA and siting scales (micro, middle, neighborhood, urban, and regional) established by EPA.

It is believed that the density of the monitoring network relieves the necessity of applying this additional analysis. Despite being confident the monitoring network is robust enough to cover the Washington, D.C. MSA, once the final version of the MATS tool has been released, and after sufficient peer review and proper guidance documentation for the analysis of the results is provided, the TAC Modeling Committee will evaluate the MATS tool output.

9.4.3 Local Area Analysis

Based on review of final EPA modeling guidance, the Local Area Analysis (LAA) is designed to identify local primary $PM_{2.5}$ sources that are thought to be contributing to a monitor and causing non-attainment of the NAAQS. At this time, no monitors within the D.C. MSA are projected to exceed the NAAQS so it is not a necessary requirement in this circumstance to conduct the LAA. Furthermore, existing monitoring data suggests a uniform regional pattern with respect to $PM_{2.5}$ concentrations rather than any “hot spot” monitor.

Some concern was expressed by stakeholders about local $PM_{2.5}$ emissions and impacts from the Mirant Potomac River Generating Station (PRGS). Virginia remains committed to evaluating $PM_{2.5}$ impacts from this facility upon promulgation of appropriate and final implementation guidance from EPA and VADEQ. Based on a schedule and protocol to be established by VDEQ after US EPA promulgates final rules for $PM_{2.5}$ analysis, or US EPA promulgates revised implementation guidance or policy for PM2.5 analysis, or VDEQ establishes a more appropriate implementation methodology for $PM_{2.5}$, Mirant Potomac River Power Station shall conduct an ambient air quality analysis for the emissions of $PM_{2.5}$ from the facility. No later than 60 days after approval of the implementation methodology by the Virginia State Air Pollution Control Board, Mirant Potomac River Power Station shall provide to VDEQ a detailed protocol outlining how the facility will implement the approved methodologies. VDEQ will make this document available to the public by publishing this protocol on the VDEQ website.

It is important to note that none of the $PM_{2.5}$ monitors currently located at the PRGS meet the EPA siting criteria; therefore, these data cannot be directly used to evaluate the attainment status of the Washington, D.C. MSA.

9.4.4 Emissions Inventories

For areas with an attainment date of no later than 2010, the emission reductions need to be implemented no later than the beginning of 2009. A determination of attainment will likely be based on air quality monitoring data collected in 2007, 2008, and 2009. Therefore, the year to project future emissions should be no later than the last year of the three year monitoring period; in this case 2009.

The 2002 base year emissions inventory were projected to 2009 using standard emissions projection techniques. 2009 inventories provided by MANE-VU and VISTAS were used in the attainment demonstration.

Emission inventory guidance documents were followed for developing projection year inventories for point, area, mobile, and biogenic emissions. These procedures addressed projections of spatial, temporal, and chemical composition change between the base year and projection year.

The alternative control strategies for evaluation in the attainment demonstration were selected by MWAQC. These were selected from groups of strategies developed by the technical subcommittees responsible for identifying and developing the regulations and/or control measures.

Consideration was given to maintaining consistency with control measures likely to be implemented by other modeling domains. Also, technology-based emission reduction requirements mandated by the Clean Air Act were included in the future year model runs.

9.4.5 Supplemental Analyses and Weight of Evidence Determination

All models, including the CMAQ, model have inherent uncertainties. Over or under prediction may result from uncertainties associated with emission inventories, meteorological data, and representation of $PM_{2.5}$ chemistry in the model. Therefore, EPA modeling guidance provides for other evidence to address these model uncertainties so that proper assessment of the probability to attain the applicable standards can be made.

EPA modeling guidance states that those modeling analyses that show that attainment with the NAAQS will be reached in the future with some margin of safety (i.e., estimated concentrations below 14.5 $\mu g/m^3$ for annual $PM_{2.5}$ and 62 $\mu g/m^3$ for 24-hour $PM_{2.5}$) need more limited supporting material.

Due to the fact that the modeling results fall well below the aforementioned “weight of evidence” thresholds established by EPA, a limited supplemental analysis was deemed necessary to support the 2009 attainment demonstration.

9.4.5.1 Trend in $PM_{2.5}$ Design Values

Figure 9-12 and 9-13 below show trends in annual and daily $PM_{2.5}$ design values, respectively. It is clear from Figure 9-12 that there is a downward trend in annual $PM_{2.5}$ design value since the period 1999-2001. During the period 2003-2005, the design value was below the annual $PM_{2.5}$ standard and this trend continued through the period 2004-2006.

Figure 9-13 shows that there is also a downward trend in 24-hour $PM_{2.5}$ design value since the period 2000-2002, which has continued through the period 2004-2006.

A downward trend in both annual and daily $PM_{2.5}$ design values indicate that the control measures implemented during this period have been providing $PM_{2.5}$ reduction benefits. With more controls anticipated in coming years, this trend is expected to continue.

Figure 9-12. Trend in Annual $PM_{2.5}$ Design Values (1999-01 through 2004-06)

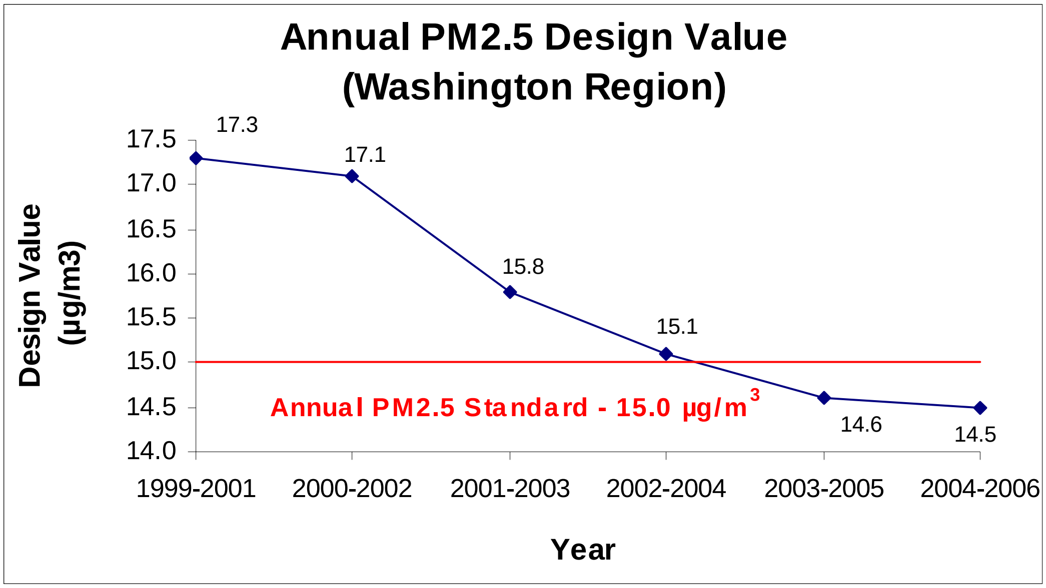
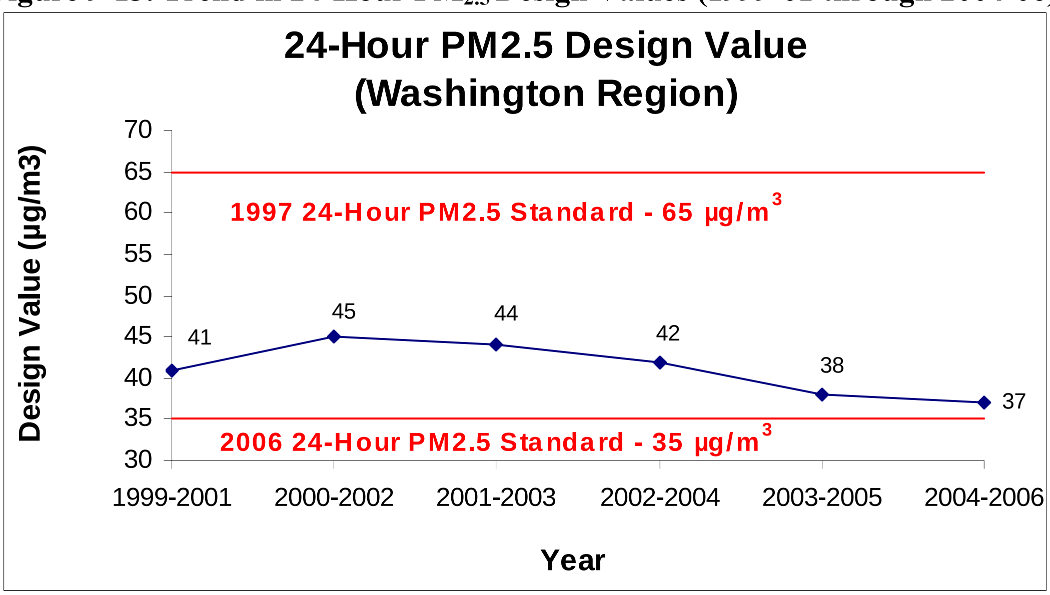


Figure 9-13. Trend in 24-Hour $PM_{2.5}$ Design Values (1999-01 through 2004-06)



9.4.6 Summary and Conclusions of Attainment Demonstration

The results from the modeling as well as the supplemental analyses present overwhelming evidence that the Washington D.C. MSA will attain the 1997 $PM_{2.5}$ NAAQS by the end of 2009. Based on air quality measurements and future predicted air quality modeling results the projected design values are below the NAAQS attainment criteria of 15.0 µg/m^3 for annual $PM_{2.5}$ and 65 µg/m^3 for 24-hour $PM_{2.5}$.

9.4.7 Procedural Requirements

9.4.7.1 Reporting

Documents, technical memorandums, and data bases developed in this study are available for distribution as appropriate. This report contains the essential methods and results of the conceptual model, episode selection, modeling protocol, base case model development and performance testing, future year and control strategy modeling, quality assurance, supplemental analyses, and calculation of $PM_{2.5}$ attainment via EPA's methodology.

9.4.7.2 Data Archival and Transfer of Modeling Files

All relevant data sets, model codes, scripts, and related software required by any project participants necessary to corroborate the study findings (e.g., performance evaluations, control strategy runs) will be provided in an electronic format approved by the Technical Committee within the framework of MWAQC. The Technical Committee has archived all modeling data relevant to this project. Transfer of data may be facilitated through the combination of a project website and the transfer of large databases via overnight mail. Database transfers will be accomplished using an ftp protocol for smaller datasets, and the use of IDE and Firewire disk drives for larger data sets.

10.0 CONTINGENCY PLAN

10.1 Background

Section 172(c)(9) of the Act, as amended, requires that nonattainment area SIPs provide for the implementation of specific measures, termed contingency measures, if an area fails to timely attain the NAAQS or make RFP. Section III(C)(3) of the General Preamble further explains that contingency measures should consist of other available control measures, beyond those necessary to meet the core moderate area control requirement to implement reasonably available control measures (RACM) [see Section 172(a)(1)(c) of the Act] and, therefore, beyond those reasonably required to expeditiously attain the standards (see 57 FR 13543).

Section 172(c)(9) of the Act specifies that contingency measures shall "take effect … without further action by the State, or the [EPA] Administrator." EPA has interpreted this latter requirement [in the General Preamble (at 57 FR 13512)] to mean that no further rulemaking activities by the state or EPA would be needed to implement the contingency measures. In general, EPA expects all actions, needed to affect full implementation of the contingency measures, to occur within 60 days after EPA notifies the state of its failure to timely attain the NAAQS or make RFP.

EPA recognizes that certain actions, such as notification of sources, modification of permits, etc., may be needed before some measures could be implemented. However, states must show that their contingency measures can be implemented with minimal further administrative action on their part and with no additional rulemaking actions such as public hearings or legislative review.

10.2 Enforceability Issues

All measures and other elements in the SIP must be enforceable by the state/local governments and/or EPA [see Sections 172(c)(6) and 110(a)(2)(A) of the Act and 57 FR 13556]. Nonattainment area plan provisions also must contain a program to provide for enforcement of control measures and other elements in the SIP [see Section 110(a)(2)(C) of the Act].

The State of Maryland, the Commonwealth of Virginia, and the District of Columbia have the authority to implement and enforce all emission limitations and control measures adopted by this SIP.

10.3 Evaluation/Required Reductions

The contingency measures for the attainment demonstration must total one year of reductions needed to attain. The inventory is calculated as described in Sections 3 and 4. Table 10-1 shows the calculation of the necessary reductions.

Table 10-1
Contingency Requirement for PM and PM Precursors

PM Precursor	PM and PM Precursor Emissions 2002-2009 (tons/year)			
	2002	**2009**	**2002-2009**	**Contingency Requirement Calculation (2002-2009) / 7**
NO_x	199,594.00	117,102.98	82,491.02	11,784.43
SO_2	223,328.56	231,861.76	(8,553.20)	None[a]
$PM_{2.5}$ Direct	25,843.77	26,590.93	(1,184.87)	None[a]

[a] No contingency measures required because emissions increase between 2002 and 2009.

10.3.1 Substitution Ratios

Contingency reductions must occur on a timetable that is directly related to the Attainment SIP schedule. States have no more than one year after notification by EPA of an attainment failure to achieve the contingency plan reductions. For a potential attainment failure, notification would be received in 2010; therefore, the contingency reductions must be achieved no later than 2011.

According to EPA guidance, emission reductions from different PM precursors can be used to meet the required contingency target. EPA recommended a method to assess equivalent reductions for different precursors. The recommended approach is to review existing data and sensitivity studies performed as part of photochemical modeling to estimate the relative impact of reductions in different precursors on PM concentrations. Basing an equivalency ratio on relative reduction factors as generated by the Community Multiscale Air Quality (CMAQ) modeling results in a ratio of 1.1 to 1.4 tons of NO_x for each ton of SO_2 (see Appendix J). Using sensitivity analyses created by Visibility Improvement of State and Tribal Association of the Southeast (VISTAS) and Georgia Tech (see Appendix J), equivalency ratios range from 3.3 to 3.6 tons of NO_x for each ton of SO_2. As discussed in Section 10.4, the contingency measures for the Metropolitan Washington, D. C. attainment plan are well in excess of these ratios and, therefore, should be an appropriate backstop for improving air quality should the monitoring network not demonstrate compliance with the 1997 $PM_{2.5}$ NAAQS in 2009.

10.4 Identified Contingency Measures

Table 10-2 lists the contingency measure identified by the District of Columbia, Maryland, and Virginia for the Attainment Demonstration. This measure delivers a total benefit of more than 169,000 tons/year SO_2 and 657 tons/year NO_x. The combined reduction is greater than the required reductions, therefore meeting the contingency measure requirement calculated in Table 10-1. The SO_2 reductions are more than 15 times the required NO_x reduction, and this ratio is significantly higher than all of the equivalency assessments described in Section 10.3.1. The contingency measures for the Metropolitan Washington, DC-MD-VA attainment plan are well in excess of the equivalency ratios described in Section 10.3.1 and therefore should be an appropriate backstop for improving air quality should the monitoring network not demonstrate compliance with the 1997 $PM_{2.5}$ NAAQS in 2009.

Table 10-2
Contingency Measures for 2009 Attainment
(tons/year)

Ref. No.	**Contingency Measure**	**SO_2 (tons/year)**	**NO_x (tons/year)**
5.4.4	Tier 2 Motor Vehicle Emission Standards	0	657
5.1.1	Regional and State Transport Requirements (Clean Air Interstate Rule, Healthy Air Act)	169,154	0
TOTAL REDUCTIONS		169,154	657

In accordance with EPA's guidance encouraging early implementation of contingency measures to guard against failure to either meet a milestone or attain, the District of Columbia, Maryland, and Virginia will implement the contingency measures identified in Table 10-2 according to the timetable indicated in Chapters 5 and 8. EPA's guidance on early implementation of control measures is as follows:

> The EPA encourages the early implementation of required control measures and of contingency measures as a means of guarding against failures to meet a milestone or to attain. Any implemented measures (that are not needed for the rate-of-progress requirements or for the attainment requirements) would need to be backfilled only to the extent they are used to meet a milestone.

The reductions from the designated contingency measures are surplus, that is, beyond those contained in the Attainment Demonstration enclosed in this SIP. They will not be used to meet that milestone requirement. As a result, the states will not be required to backfill any contingency measures that they choose to implement in advance of the requirement.

10.4.1 Tier 2 Motor Vehicle Emission Regulations

The EPA promulgated a rule on February 10, 2000, requiring more stringent tailpipe emissions standards for all passenger vehicles, including sport utility vehicles (SUVs), minivans, vans, and pick-up trucks. These regulations also require lower levels of sulfur in gasoline, which will ensure the effectiveness of low emission-control technologies in vehicles and reduce harmful air pollution.

Source Type Affected
These federally implemented programs affect light-duty vehicles and trucks.

Control Strategy
The new tailpipe and sulfur standards require passenger vehicles to be 77 to 95 percent cleaner than those built before the rule was promulgated and will reduce the sulfur content of gasoline by up to 90 percent. The new tailpipe standards are set at an average standard of 0.07 grams/mile for

NO_x for all classes of passenger vehicles beginning in 2004. This includes all light-duty trucks, as well as the largest SUVs. Vehicles weighing less than 6000 pounds will be phased-in to this standard between 2004 and 2007.

Beginning in 2004, the refiners and importers of gasoline have the flexibility to manufacture gasoline with a range of sulfur levels as long as all of their production is capped at 300 parts per million (ppm) and their annual corporate average sulfur levels are 120 ppm. In 2005, the refinery average was set at 30 ppm, with a corporate average of 90 ppm and a cap of 300 ppm. Finally, in 2006, refiners met a 30 ppm average sulfur level with a maximum cap of 80 ppm.

As newer, cleaner cars enter the national fleet, the new tailpipe standards will significantly reduce emissions of NO_x from vehicles by about 74 percent by 2030.

Implementation
EPA implements this program under 40 CFR Parts 80, 85, and 86.

Projected Reductions

This measure provides 657 tons/year NO_x reduction applied for contingency purposes. This contingency measure will be implemented via a 2010 mobile source budget as discussed in Chapter 7.

Emission Benefit Calculations

The contingency reductions are based on Tier 2 motor vehicle emission standards, for reductions occurring between 2009 and 2010.

10.4.2 Clean Air Interstate Rule/Healthy Air Act Requirements

This section documents contingency credit for SO_2 emissions reductions attributable to federal and regional SO_2 requirements on point sources. These credits include

- EPA's Clean Air Interstate Rule (CAIR); and
- Maryland's Healthy Air Act (HAA).

Control Strategy

Clean Air Interstate Rule (CAIR)
In 2005, the EPA promulgated the Clean Air Interstate Rule, which requires reductions in emissions of NO_x and SO_2 from large fossil fuel-fired electric generating units. The rule is set up in several phases with the first phase of NO_x reductions to come by 2009 and SO_2 reduction to come in 2010. The rule sets up both an annual emissions budget and an ozone season emissions budget. The rule requires that units with nameplate capacity greater than 25 megawatts emit no more NO_x or SO_2 than their allocations determined by the state either through emission controls or banking and trading.

Virginia CAIR
Virginia has adopted state regulations codifying the requirements of the Clean Air Interstate Rule. Virginia's rules create an emissions cap based on the allowances allocated to the facility. The rules do not allow trading as a method of complying with the emissions cap.

Maryland Healthy Air Act (HAA)
In April of 2006, the Maryland General Assembly enacted the Maryland Healthy Air Act (HAA). The Maryland General Assembly record related to the HAA and the final version of the Act itself can be found at http://mlis.state.md.us/2006rs/billfile/SB0154.htm. The Maryland Department of the Environment (MDE) Regulations (Code of Maryland Regulations) can be found at http://www.mde.state.md.us/assets/document/CPR_12-26-06_Emergency_and_Permanent_HAA_Regs_for_AELR.pdf. The HAA is one of the toughest power plant emission laws on the East Coast. The HAA requires reductions in NO_x, SO_2, and mercury emissions from large coal burning power plants. The HAA also requires that Maryland become involved in the Regional Greenhouse Gas Initiative (RGGI), which is aimed at reducing greenhouse gas emissions. The MDE has been charged with implementing the HAA through regulations. As enacted, these regulations constitute the most sweeping air pollution emission reduction measure proposed in Maryland history. To meet the requirements of Maryland’s regulations, a company’s “system” (covered units owned by the same company) must meet a system-wide cap by 2009. Compliance cannot be achieved through the purchase of allowances under the HAA.

District of Columbia CAIR
The District of Columbia is currently drafting its Clean Air Interstate Rule (CAIR). The District of Columbia's CAIR regulations do not allow trading of NO_x or SO_2 allowances for achieving the reductions for the facilities within its jurisdiction.

Summary

The point source NO_x and SO_2 controls are a phased approach to controlling emissions from power plants and other large fuel combustion sources. The programs resulting in emission reductions applied for contingency from point sources in the region include EPA's Clean Air Interstate Rule and Maryland's Healthy Air Act

Implementation

District Department of the Environment
Maryland - Air and Radiation Management Administration
Virginia - Department of Environmental Quality

Projected Reductions

	SO_2 Emission Reductions (tons/year)			
	District of Columbia	**Maryland**	**Virginia**	**Total**
SO_2 Reductions	-	158,354	10,800	169,154

Emission Benefit Calculations

The emission reductions associated with the state SO_2 requirements on point sources were supplied by the staffs of the Maryland Air and Radiation Management Administration, the District Department of the Environment, and the Virginia Department of Environmental Quality Air Division, for reductions occurring between 2009 and 2011.

References

1990 Clean Air Act Amendments, 42 U.S.C. §§7513

GLOSSARY OF TERMS AND ACRONYMS

AQI	Air Quality Index, daily forecast to the public about air quality on a 24-hour basis.
Air Quality Monitor	Device measuring ozone and PM levels at various locations throughout the Washington region.
APU	Auxiliary Power Units, an electrical device that provides a low-emission alternative to constant idling for large diesel engines.
ASIP	Association for Southeastern Integrated Planning.
Attainment	A designation given to an area that does meet the federal health-based air quality standard for a pollutant.
Attainment (1-hour ozone)	The expected numbers of days per calendar year with maximum hourly average concentrations above 0.12 ppm is equal to or less than 1.
Attainment (8-hour ozone)	The 3-year average of the annual fourth-highest daily maximum 8-hour average ozone concentration is less than or equal to 0.08 ppm.
Attainment (Annual $PM_{2.5}$)	The 3-year average of the annual means is less than or equal to 15.0 $\mu g/m^3$. This comparison shall be based on 3 consecutive, complete years of air quality data.
Attainment (24-hour $PM_{2.5}$)	The 3-year average of the 98th percentile values at each monitoring site is less than or equal to 65 $\mu g/m^3$. This comparison shall be based on 3 consecutive, complete years of air quality data.
AQPAC	Air Quality Public Advisory Committee.
BACT	Best available control technology.
Bump-up/Reclassification	Process by which areas failing to attain the air quality standard by the assigned date are redesignated to a more stringent nonattainment category.
CAAA	Clean Air Act Amendments of 1990.
Classification	Federal designation indicating the severity of a region's air quality problem. A region's classification determines the date on which a region must attain the CAAA requirements.
Clean Air Partners	Non-profit regionally-sponsored organization in the Baltimore-Washington metro area that educates businesses and the public to take actions to reduce ozone, especially on Air Quality Code Red Action Days.
CLRP	Constrained Long Range Plan; lists expected changes to transportation infrastructure over the next 20 years.
Control Measures	Pollution control measure implemented as part of a regional air quality plan.
Contingency Measures	Pollution control measures to be implemented after the fact if the region fails to demonstrate rate of progress toward or attainment of an air quality standard.
CTG	Control Technique Guidance, comes in the form of documents from EPA.
DCDOE	District of Columbia Department of the Environment.
Design Value	The U.S. EPA's official definition: "a design value is the mathematically determined pollutant concentration at a particular site that must be reduced to, or maintained at or below the National Ambient Air Quality Standard to assume attainment." The design value number tells us how a particular site or area compares with the National Ambient Air Quality Standards (NAAQS).
Design Value (1-hour Ozone)	The 1-hour ozone design value is the fourth highest 1-hour maximum ozone concentration at a monitoring site <u>during</u> a continuous three year period. Values of 125 ppb and above are exceeding the 1-hour ozone health standard.
Design Value (8-hour Ozone)	The 8-hour ozone design value is the fourth highest 8-hour maximum ozone concentration at a monitoring site <u>averaged over</u> a continuous three year period. Values of 85 ppb and above are exceeding the 8-hour ozone health standard.
EPA	U.S. Environmental Protection Agency.
Emission Inventory	A document that details the amounts of projected emissions from area sources

GLOSSARY OF TERMS AND ACRONYMS

	over time. Includes four types of emission sources: stationary point sources, area sources, nonroad sources, and on-road mobile sources.
Exceedance	Condition created when an air quality monitor registers ozone or PM levels exceeding the federal health standard.
FHWA	Federal Highway Administration.
General Conformity	Federally-required process during which Federal projects are evaluated to ensure that they are consistent with the region's air quality plans.
IAD	Dulles International Airport, site of a weather monitor.
IAQC	Interstate Air Quality Council; a council, consisting of the chief environmental appointees of the Chief Executives and the chief transportation appointees of the Chief Executives.
I/M	Inspection and Maintenance programs that require vehicle owners to have their vehicles' emission systems regularly tested and repaired, if necessary.
Lead Monitor	The monitor in the region with the highest Design Value.
LDT	Light-duty trucks.
LTOs	Landing and Take-Off cycles for aircraft.
MACTEC	An engineering and consulting firm under contract to OTC.
MDE	Maryland Department of the Environment.
Mid-Course Review	The Mid-Course Review is intended to show the progress being made to improve air quality in a nonattainment area and the efforts underway to assure that all necessary steps are taken to reach the federal health standard for the relevant standard by the attainment date.
MDPC	Metropolitan Development Policy Committee; a COG committee of planning directors.
MSA/CMSA	Metropolitan Statistical Area/Consolidated Metropolitan Statistical Area; serve as the presumptive boundary for nonattainment areas.
MOBILE6	EPA model used to estimate levels of mobile emissions.
Mobile Budget	Cap on mobile emissions set in the SIP and used in transportation conformity.
MWAQC	Metropolitan Washington Air Quality Committee.
MWAQC TAC	Technical Advisory Committee, advices MWAQC on technical issues.
MARAMA	Mid-Atlantic Regional Air Management Association; an RPO.
MWAA	Metropolitan Washington Airports Authority.
NAA	Nonattainment Area.
NAAQS	National Ambient Air Quality Standard. Ambient standards for six pollutants including ozone, carbon monoxide, nitrogen dioxide, lead, particulate matter, and oxides of sulfur specifically regulated under the U.S. Clean Air Act of 1990. Areas designated as nonattainment must adopt State Implementation Plans to reduce emissions in order to comply with the standard by the attainment date.
NARSTO	North American Strategy for Tropospheric Ozone. A consortium for atmospheric research in North America, including U.S., Mexico and Canada.
NEI	National Emissions Inventory. The National Emissions Inventory is the most comprehensive estimate of criteria pollutant emissions in the United States. The inventory represents a major effort by the individual states to quantify their local and regional contributions to air quality. Data from the NEI are used for air dispersion modeling, regional strategy development, regulation setting, and tracking trends in emissions over time.
NESCAUM	Northeast States for Coordinated Air Use Management.
Nonattainment	A designation given to an area that does not meet the federal health-based air quality standard for a pollutant.
NOx	Nitrogen oxide, a precursor to ozone formation.

GLOSSARY OF TERMS AND ACRONYMS

Organic Carbon (OCM)	Carbon emission, a precursor to PM formation. Organic Carbon Mass.
OTC	Ozone Transport Commission, a commission of air directors from northeastern and mid-Atlantic states affected by transported ozone pollution; an RPO.
Ozone	A pollutant (O_3) formed from chemical reactions in the atmosphere involving precursors (NOx and VOC) in the presence of sunlight and heat.
PEI	Periodic Emissions Inventory. The Clean Air Act [under Section 182(a)(3)(A)] requires that state and local agencies develop a periodic emission inventory (PEI) for ozone nonattainment areas classified as marginal and above. The PEI is a tool used to monitor a nonattainment area's progress in attaining the National Ambient Air Quality Standards (NAAQS) for ozone. A PEI for an ozone nonattainment area is required to contain emissions of ozone precursor pollutants (specifically VOC and NOx) from Point Sources, Area Sources, On-road Mobile Sources, Non-road Mobile Sources, and Biogenic Sources. A PEI is to be compiled every three years until attainment of the National Ambient Air Quality Standards (NAAQS) for ozone is reached.
PJM	Distribution grid for electricity that includes Pennsylvania, New Jersey and Maryland.
$PM_{2.5}$	Particulate matter, fine particulate. Particles of less than 2.5 microns in diameter are referred to as fine particulate.
RACM	Reasonably available control measure.
RACT	Reasonably available control technology.
REC	Renewable Energy Certificate.
Retrofit	Installation of pollution control devices on existing equipment, such as particulate filters and catalytic converters.
RFP	Reasonable Further Progress.
ROP	Rate of Progress.
RPO	Regional Planning Organization in CAAA, such as OTC, NESCAUM.
RPS	Renewable Energy Portfolio Standard Act of 2004, a District of Columbia law.
RSD	Remote sensing device, used in the field to detect motor vehicles with emissions exceeding allowable limits.
SANDWICH	Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbon Hybrid material balance approach for estimating PM2.5 mass composition produced by the PM2.5 FRM.
SI	Spark-Ignition engines, such as gasoline marine engines, including outboard, personal watercraft and jet boat.
SIP	State Implementation Plan, the air quality plan.
SMAT	Speciated Modeling Attainment Test
1-hour Standard	Ozone standard setting the maximum average ozone concentration over a one-hour period.
8-hour Standard	Ozone standard setting the maximum average ozone concentration over an eight-hour period.
24-hour Standard	PM standard setting the maximum average concentration over a 24-hour period.
Annual Standard	PM standard setting the maximum average concentration over a one-year period.
Sulfates/SO_2	Sulfur dioxide, a precursor to ozone and PM formation.
TAC	Technical Advisory Committee of the MWAQC.
TCM	Transportation Control Measure.
TDM	Transportation Demand Model; a TPB model used to estimate travel demand in the Washington region.
TERM	Transportation Emission Reduction Measure.

GLOSSARY OF TERMS AND ACRONYMS

TPB	National Capital Region Transportation Planning Board, body responsible for development of regional transportation plan.
tpd	tons per day.
tpy	tons per year.
TIP	Transportation Improvement Plan; a short term transportation plan produced by TPB, usually covering a five-year period.
Transportation Conformity	Federally-required process during which the regional transportation planning board ensures that expected transportation emissions are consistent with the region's air quality plans.
VADEQ	Virginia Department of Environmental Quality.
VISTAS	Visibility Improvement State and Tribal Association of the Southeast; an RPO.
VMT	Vehicle Miles Traveled.
VOC	Volatile organic compound, a precursor to ozone formation.
Voluntary Measure	Pollution control measures that are not regulatory in nature.
WOE	Weight of Evidence.