MARYLAND DEPARTMENT OF THE ENVIRONMENT
1800 Washington Boulevard • Baltimore MD 21230
410-537-3000 • 1-800-633-6101

Washington County, MD
$PM_{2.5}$
State Implementation Plan and Base Year Inventory

SIP Number: 08-05

February 29, 2008

Prepared for:

U.S. Environmental Protection Agency

Prepared by:

Maryland Department of the Environment

This Page Left Intentionally Blank

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY 1

1.1 Introduction and Background 1
1.2 SIP Requirements for Nonattainment Areas 4
1.3 SIP Process 5
1.4 State Commitment/Implementation Assurances 5
1.5 Submittal of the Plans 6
1.6 Sanctions 6
1.7 Base Year 2002 Emission Inventory and Future Year 2009 Emission Inventory 6
1.8 Reductions in $PM_{2.5}$ Precursors from Measures, 2002-2009 8
1.9 Establishment of a Budget for Transportation Mobile Emissions 8
1.10 Attainment Demonstration 9
1.11 Determination of Reasonably Available Control Measures (RACM) 10
1.12 Contingency Measures 10
1.13 Document Contents 11

2.0 FINE PARTICLE POLLUTION 13

2.1 Definition of Fine Particle Matter 13
2.2 Health and Environmental Effects 13
2.3 Seasonal Variation of PM2.5 Constituents 15
2.4 Diurnal Variation of Fine Particles 19
2.5 Trajectories of Fine Particles 20
2.6 Major Constituents of PM2.5 and Sources in the Martinsburg, WV - Hagerstown, MD Region 22
2.7 Sources of Fine Particles and Constituents 23
2.8 Determination of Significance for Precursors 24
2.9 Compliance with the $PM_{2.5}$ NAAQS 26

3.0 THE 2002 BASE-YEAR INVENTORY 29

3.1 Background and requirements 29
3.2 Total Emissions by Source 30
3.2.1 Point Sources 30
3.2.2 Quasi-Point Sources 30
3.2.3 Area Sources 30
3.2.4 Mobile Sources 31
3.2.5 Nonroad Sources 32
3.2.6 Biogenic Emissions 33

4.0 THE 2009 PROJECTED UNCONTROLLED AND CONTROLLED INVENTORIES 35

4.1 Growth Projection Methodology 35
4.1.1 Growth Projection Methodology for Point Sources: EGAS 35
4.1.2 Growth Projection Methodology for Quasi-Point Sources 36
4.1.3 Growth Projection Methodology: Area Sources 36
4.1.4 Growth Projection Methodology: Nonroad Model Sources 38
4.1.5 Growth Projection Methodology: Nonroad Sources 39
4.1.6 Growth Projection Methodology: Onroad Sources 40
4.1.7 Biogenic Emission Projections 40
4.2 Offset Provisions, Emission Reduction Credits and Point Source Growth 41

4.3 ACTUAL VS. ALLOWABLE EMISSIONS IN DEVELOPMENT OF THE 2009 PROJECTED EMISSIONS INVENTORIES 43
4.4 2009 CONTROLLED EMISSIONS FOR ATTAINMENT 44
4.4.1 2009 Projected Controlled Inventory: Point Sources 44
4.4.2 2009 Projected Controlled Inventory: Quasi-Point Sources 44
4.4.3 2009 Projected Controlled Inventory: Area Sources 44
4.4.4 2009 Projected Controlled Inventory: Nonroad Sources 44
4.4.5 2009 Projected Controlled Inventory: Onroad Sources 46
4.5 2009 PROJECTED CONTROLLED INVENTORY – SUMMARY OF EMISSIONS 46

5.0 CONTROL MEASURES 47

5.1 CONTROL MEASURES INCLUDED IN 2002 BASELINE SCENARIO 47
5.1.1 Point Source Measures 47
5.1.2 Area Source Measures 49
5.1.3 On-Road Mobile Measures 52
5.1.4 Non-Road Measures 53
5.2 CONTROL MEASURES FOR $PM_{2.5}$ ATTAINMENT 54
5.2.1 Point Sources 54
5.2.2 On-Road Mobile 56
5.2.3 New Non-Road Measures 61
5.3 VOLUNTARY AND INNOVATIVE CONTROL MEASURES 66
5.3.1 High Electricity Demand Day (HEDD) Initiative 66
5.3.2 Emission Reductions from Transportation Measures 67

6.0 REASONABLY AVAILABLE CONTROL MEASURE (RACM) ANALYSIS 71

6.1 ANALYSIS OVERVIEW AND CRITERIA 71
6.1.1 Implementation Date 72
6.1.2 Enforceability 72
6.1.3 Technological Feasibility 73
6.1.4 Economic Feasibility and Cost Effectiveness 73
6.1.5 Substantial and Widespread Adverse Impacts 73
6.1.6 De Minimis Threshold 73
6.1.7 Advancing Achievement of Annual 15.0 mg/ m3 Standard 73
6.1.8 Intensive and Costly Effort 74
6.2 RACM MEASURE ANALYSIS 74
6.2.1 Analysis Methodology 74
6.2.2 Analysis Results 74
6.3 RACM DETERMINATION 74
6.4 RACT APPLICABILITY 74

7.0 MOBILE SOURCE CONFORMITY 77

7.1 SIGNIFICANCE OF PM2.5 POLLUTANTS AND PRECURSORS FOR WASHINGTON COUNTY, MD NONATTAINMENT AREA 77
7.2 TRANSPORTATION CONFORMITY 77
7.2.1 Responsibility for Making a Conformity Determination 78
7.2.2 Mobile Emissions Budget and the Baltimore Region Transportation Conformity Process 79
7.3 BUDGET LEVEL FOR ON-ROAD MOBILE SOURCE EMISSIONS 79
7.3.1 Modeling and Data 79

7.3.2 Attainment Year Mobile Budgets *79*

8.0 1997 $PM_{2.5}$ NONATTAINMENT AREA PLAN COMMITMENTS 81

8.1 SCHEDULE OF ADOPTED CONTROL MEASURES 81
8.2 RACT APPLICABILITY 82
8.3 REVISION OF NEW SOURCE REVIEW (NSR) REGULATIONS 82

9.0 ATTAINMENT PLAN DEMONSTRATION AND WEIGHT OF EVIDENCE 83

9.1 MODELING STUDY OVERVIEW 83
9.1.1 Background and Objectives *83*
9.1.2 Relationship to Regional Modeling Protocols *84*
9.1.3 Conceptual Model *85*
9.2 DOMAIN AND DATABASE ISSUES 85
9.2.1 Episode Selection *85*
9.2.2 Size of the Modeling Domain *86*
9.2.3 Horizontal Grid Size *86*
9.2.4 Vertical Resolution *86*
9.2.5 Initial and Boundary Conditions *86*
9.2.6 Meteorological Model Selection and Configuration *87*
9.2.7 Emissions Model Selection and Configuration *87*
9.2.8 Air Quality Model Selection and Configuration *87*
9.2.9 Quality Assurance *88*
9.3 MODEL PERFORMANCE EVALUATION 88
9.3.1 Overview *88*
9.3.2 Diagnostic and Operational Evaluation *89*
9.3.3 Summary of Model Performance *97*
9.4 ATTAINMENT DEMONSTRATION 97
9.4.1 Overview *97*
9.4.2 Modeled Attainment Test *98*
9.4.3 Unmonitored Area Analysis *102*
9.4.4 Local Area Analysis *103*
9.4.5 Emissions Inventories *103*
9.5 WEIGHT OF EVIDENCE DEMONSTRATION 103
9.5.1 Trend in $PM_{2.5}$ Design Values *104*
9.5.2 The Composition of $PM_{2.5}$ *107*
9.5.3 Review of Literature on $PM_{2.5}$ *107*
9.5.4 $PM_{2.5}$ Trends Over the Mid-Atlantic Region *108*
9.5.5 $PM_{2.5}$ Composition As it Relates to Effectiveness of Controls *108*
9.5.6 Monitoring Data From Surface-Based Speciation Sites *109*
9.5.7 CMAQ $PM_{2.5}$ Modeling *109*
9.6 SUMMARY AND CONCLUSIONS OF ATTAINMENT DEMONSTRATION 110
9.7 PROCEDURAL REQUIREMENTS 110
9.7.1 Reporting *110*
9.7.2 Data Archival and Transfer of Modeling Files *110*

10.0 CONTINGENCY PLAN 111

10.1 CONTINGENCY MEASURES FOR THE ATTAINMENT DEMONSTRATION 111
10.1.1 Background *111*
10.1.2 Required Reductions *111*

10.1.3 Identified Contingency Measures 112

APPENDICES

Appendix A – Base Year Emission Inventory
- Appendix A-1: Base Year Emission Inventory Methodologies
- Appendix A-2: Point Source Base Year Inventory
- Appendix A-3: Quasi-Point Source Base Year Inventory
- Appendix A-4: Area Source Base Year Inventory
- Appendix A-5: Mobile Source Base Year Inventory
- Appendix A-6: Nonroad Source Base Year Inventory

Appendix B – Projection Year Methodologies

Appendix C – RACM Appendices

Appendix D – Mobile Budget Documentation

Appendix E – OTC MOU

Appendix F – Contingency Synopsis of the ASIP Sensitivity Study

Appendix G – Attainment Modeling and Weight of Evidence
- Appendix G-1: Conceptual Model
- Appendix G-2: Modeling Domain Boundary
- Appendix G-3: Horizontal Grid Definitions for MM5 and CMAQ Modeling Domain
- Appendix G-4: Vertical Layer Definitions for MM5 and CMAQ Modeling Domain
- Appendix G-5: MM5 Model Configuration
- Appendix G-6: MM5 Model Performance Evaluation
- Appendix G-7: SMOKE Processing Description and Configuration
- Appendix G-8: CMAQ Configuration
- Appendix G-9: CMAQ Model Performance
- Appendix G-10: Additional Information on Design Value Calculations
- Appendix G-11: Weight of Evidence Report

INDEX OF TABLES

TABLE 2-1: EPA SIP REQUIREMENTS FOR PM POLLUTANTS 25

TABLE 2-2: SUMMARY OF SIGNIFICANCE DETERMINATIONS FOR SIP CONTROLS AND MOTOR VEHICLE EMISSION BUDGETS 25

TABLE 2-3: SUMMARY OF RATIONALE FOR VOC AND NH3 INSIGNIFICANCE DETERMINATIONS FOR SIP CONTROLS 26

TABLE 3-1: 2002 BASE-YEAR ANNUAL INVENTORY 29

TABLE 4-1: 2002-2009 AREA SOURCE GROWTH FACTORS 36

TABLE 4-2: 2009 NONROAD MODEL INPUTS 39

TABLE 4.3: EMISSION REDUCTION CREDITS 41

TABLE 4-4: 2009 PROJECTED CONTROLLED ANNUAL INVENTORY (TPY) 46

TABLE 5-1: MARYLAND HEALTHY AIR ACT ANNUAL NOX EMISSIONS REDUCTIONS (TPY): 55

TABLE 5-2: ON-ROAD MOBILE EMISSIONS REDUCTIONS (TPY): 56

TABLE 5-3: OFF-ROAD MOBILE EMISSIONS REDUCTIONS (TPY): 61

TABLE 7-1: 2009 ATTAINMENT MOBILE BUDGETS FOR THE WASHINGTON, COUNTY, MD 80

TABLE 8-1: MARYLAND SCHEDULE OF ADOPTED CONTROL MEASURES 81

TABLE 9-2. EPA $PM_{2.5}$ MODELING PERFORMANCE GOALS 89

TABLE 9-3. VISTAS RPO $PM_{2.5}$ MODELING PERFORMANCE GOALS 89

TABLE 9-3. ANNUAL SMAT RESULTS FOR HAGERSTOWN-MARTINSBURG, MD-WV NAA 101

2009 BEYOND-ON-THE-WAY CONTROL MEASURES 101

TABLE 9-4. 24-HOUR MODELING ATTAINMENT TEST USING EPA SMAT METHODOLOGY 2009 BEYOND-ON-THE-WAY CONTROL MEASURES 101

TABLE 10-1: CONTINGENCY REQUIREMENT FOR PM AND PM PRECURSORS 111

TABLE 10-2: CONTINGENCY MEASURES FOR 2008 $PM_{2.5}$ ATTAINMENT 112

INDEX OF FIGURES

FIGURE 1-1: MARTINSBURG, WV – HAGERSTOWN, MD PM2.5 NON-ATTAINMENT AREA 3

FIGURE 1-2: WASHINGTON COUNTY, MD $PM_{2.5}$ MONITOR 4

FIGURE 1-3: $PM_{2.5}$ EMISSIONS BY SOURCE CATEGORY (2002 & 2009) 7

FIGURE 1-4: NO_X EMISSIONS BY SOURCE CATEGORY (2002 & 2009) 7

FIGURE 1-5: SO_2 EMISSIONS BY SOURCE CATEGORY (2002 & 2009) 8

FIGURE 1-6: ANNUAL $PM_{2.5}$ DESIGN VALUE, 2002-2006 10

FIGURE 2-1: ATMOSPHERIC CHEMICAL REACTIONS THAT CONTRIBUTE TO PM2.5 14

FIGURE 2-2: SEASONAL VARIATION OF $PM_{2.5}$ DURING 2000-2006 IN THE WASHINGTON COUNTY, MD NON-ATTAINMENT AREA 15

FIGURE 2-3: SEASONAL VARIATION OF SULFATE $PM_{2.5}$ (ESSEX MONITOR, 2001-2005) 16

FIGURE 2-4: SEASONAL VARIATION OF NITRATE $PM_{2.5}$ (ESSEX MONITOR, 2001-2005) 17

FIGURE 2-5: SEASONAL VARIATION OF ORGANIC CARBON (ESSEX MONITOR, 2001-2005) 18

FIGURE 2-6: SEASONAL VARIATION OF AMMONIUM (ESSEX MONITOR, 2001-2005) 19

FIGURE 2-7: DIURNAL $PM_{2.5}$ PATTERN – HAGERSTOWN, MD 20

FIGURE 2-8A: PM_{FINE} BACK TRAJECTORIES 21

FIGURE 2-8B: PM_{FINE} BACK TRAJECTORIES 21

FIGURE 2-13: ANNUALLY AVERAGED 2001-2003 CONCENTRATIONS OF PM2.5 CONSTITUENTS 22

FIGURE 2-10: PM2.5 COMPOSITION DATA FROM THE ESSEX, MD MONITOR 23

FIGURE 2-11: ANNUAL $PM_{2.5}$ DESIGN VALUE, 2002-2006 27

FIGURE 2-12: 24-HOUR $PM_{2.5}$ DESIGN VALUE, 2001-2006 27

FIGURE 9-1: HAGERSTOWN-MARTINSBURG, MD-WV NAA 84

FIGURE 9-2: LOCATIONS USED FOR THE MODEL EVALUATION ACROSS THE OTR+ REGION: FRM (●, 264), STN (■, 50), AND IMPROVE (▲, 21) 91

FIGURE 9-3: COMPOSITE FRM TIME SERIES ACROSS THE OTR+ REGION (264 MONITORS) 92

FIGURE 9-4: MFE AND MFB TIME SERIES FOR FRM $PM_{2.5}$ ACROSS THE OTR+ REGION 92

FIGURE 9-5: MFE BUGLE PLOT FOR FRM $PM_{2.5}$ ACROSS OTR+ REGION 93

FIGURE 9-6: MFE BUGLE PLOT FOR SO_4 ACROSS OTR+ REGION 93

FIGURE 9-7: MFE BUGLE PLOT FOR NO_3 ACROSS OTR+ REGION 94

FIGURE 9-8: MFE BUGLE PLOT FOR NH_4 ACROSS OTR+ REGION 94

FIGURE 9-9: MFE BUGLE PLOT FOR EC ACROSS OTR+ REGION 95

FIGURE 9-10: MFE BUGLE PLOT FOR OM ACROSS OTR+ REGION 95

FIGURE 9-11: MFE BUGLE PLOT FOR SOIL/CRUSTAL ACROSS OTR+ REGION 96

FIGURE 9-12: HAGERSTOWN-MARTINSBURG, MD-WV NONATTAINMENT AREA MARYLAND $PM_{2.5}$ MONITORS USED IN THE MODELING DEMONSTRATION 102

FIGURE 9-13: ANNUAL $PM_{2.5}$ DESIGN VALUES FOR HAGERSTOWN, MD FROM 2002-2006. 105
FIGURE 9-14: 24-HOUR $PM_{2.5}$ DESIGN VALUE FOR HAGERSTOWN, MD FROM 2002-2006. 105
FIGURE 9-15: ANNUAL $PM_{2.5}$ DESIGN VALUE FOR MARTINSBURG-BALLFIELD, WV MONITOR FROM 2002-2006. 106
FIGURE 9-16: 24-HOUR $PM_{2.5}$ DESIGN VALUE FOR MARTINSBURG-BALLFIELD, WV MONITOR FROM 2002-2006. 106

This Page Left Intentionally Blank

1.0 EXECUTIVE SUMMARY

1.1 Introduction and Background

Fine particle 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 fine particles, mechanical processes including wind and erosion usually produce coarse-mode particles such as dust, pollen, sea salt, and ash. Fine particles ($PM_{2.5}$) are less than or equal to 2.5 microns across, about $1/30^{th}$ the average width of a human hair, while coarse-mode particles are more than 2.5 to around 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 your lungs and some may get into your bloodstream. Therefore, exposure to such particles can affect both lungs and heart. Fine particle 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 public health and welfare. Congress amended the Act in 1990 to establish requirements for areas not meeting the National Ambient Air Quality Standards (NAAQS). The CAAA established a process for evaluating air quality in each region and identifying 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 establishes rules and regulations to implement the Clean Air Act.

In 1997 EPA reviewed PM 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 of 65 $\mu g/m^3$. This document addresses these 1997-based standards. EPA revised the secondary standards, making them identical to the primary standards. There were a series of legal challenges to the PM standards that were not resolved until March 2002, at which time the standards and EPA's decision process were upheld.

In January 2005 EPA designated portions of the Martinsburg, WV – Hagerstown, MD Metropolitan Statistical area as a nonattainment area for the annual $PM_{2.5}$ standard. EPA did not use a classification system for $PM_{2.5}$ nonattainment areas. The boundary of the Martinsburg, WV - Hagerstown, MD is defined in the *Federal Register, Vol.; 70, No. 3, 1/5/05.* The Maryland portion of the Martinsburg, WV – Hagerstown, MD $PM_{2.5}$ nonattainment area includes Washington County. A map of the nonattainment area is shown in Figures 1-1 and 1-2.

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.[1] EPA will determine the region's attainment based on air quality data

[1] CAAA Section 172 (a)(2) requires states to attain the standard as expeditiously as possible but within five years of designation.

for 2007-2009. The Martinsburg, WV - Hagerstown, MD is required to attain the standard no later than April 5, 2010.

This document, the Washington County, MD PM2.5 State Implementation Plan and Base Year Inventory, is a plan to demonstrate continued improvement and compliance with the annual National Ambient Air Quality Standard (NAAQS) for fine particles in the Washington County, Maryland region in 2009. The Plan consists of a Base Year inventory for 2002, a projection inventory for 2009; an attainment plan; a demonstration of reasonably available control measures; mobile budgets, an attainment demonstration, a weight of evidence section, and a contingency plan for attainment.

The plan has been prepared by the Maryland Department of the Environment (MDE) to comply with the Clean Air Act Amendments of 1990 and with EPA requirements for the Martinsburg, WV - Hagerstown, MD Nonattainment Area as stated in EPA's Clean Air Fine Particle Implementation Rule.[2]

[2] 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: MARTINSBURG, WV – HAGERSTOWN, MD PM2.5 NON-ATTAINMENT AREA

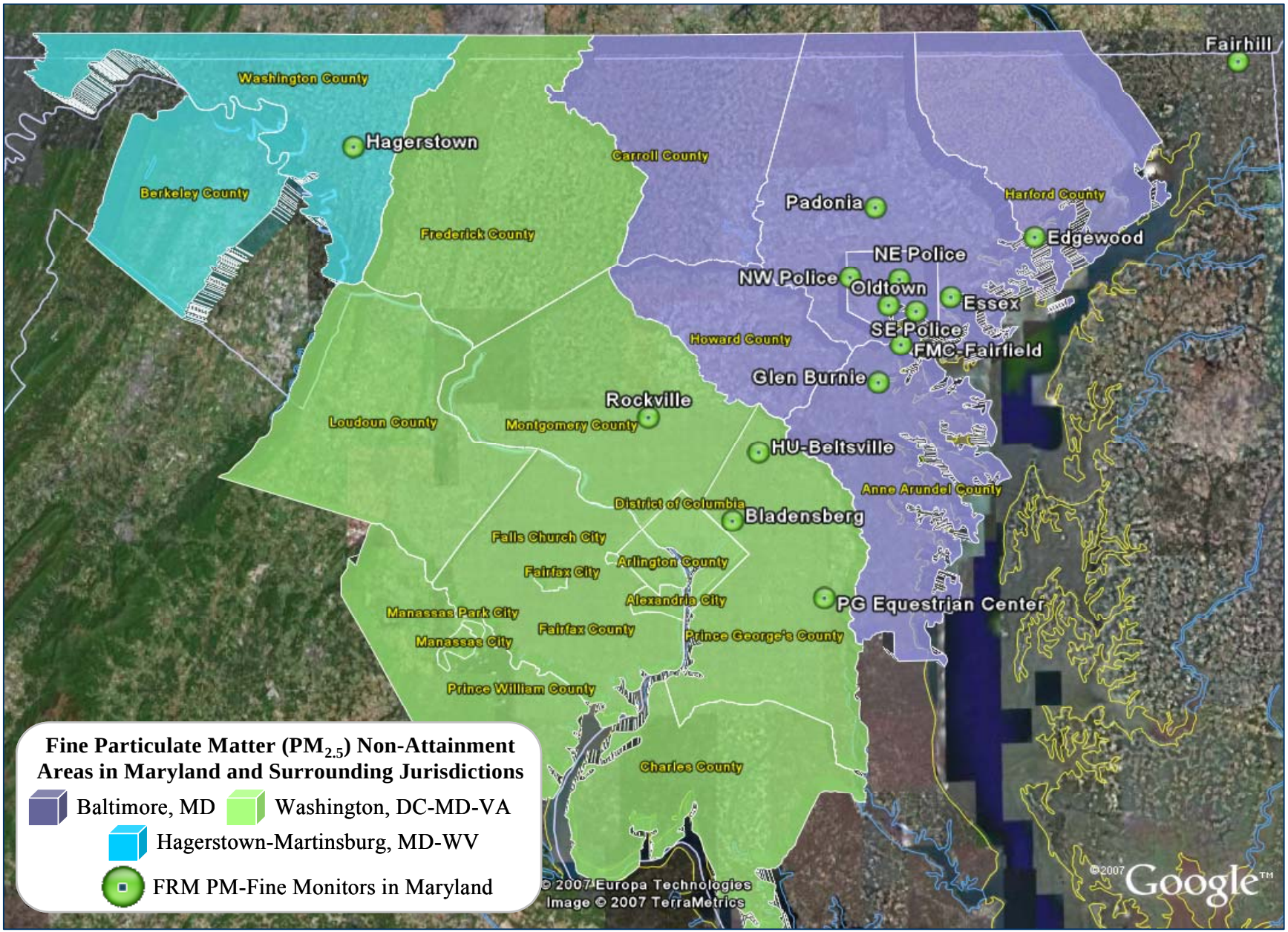
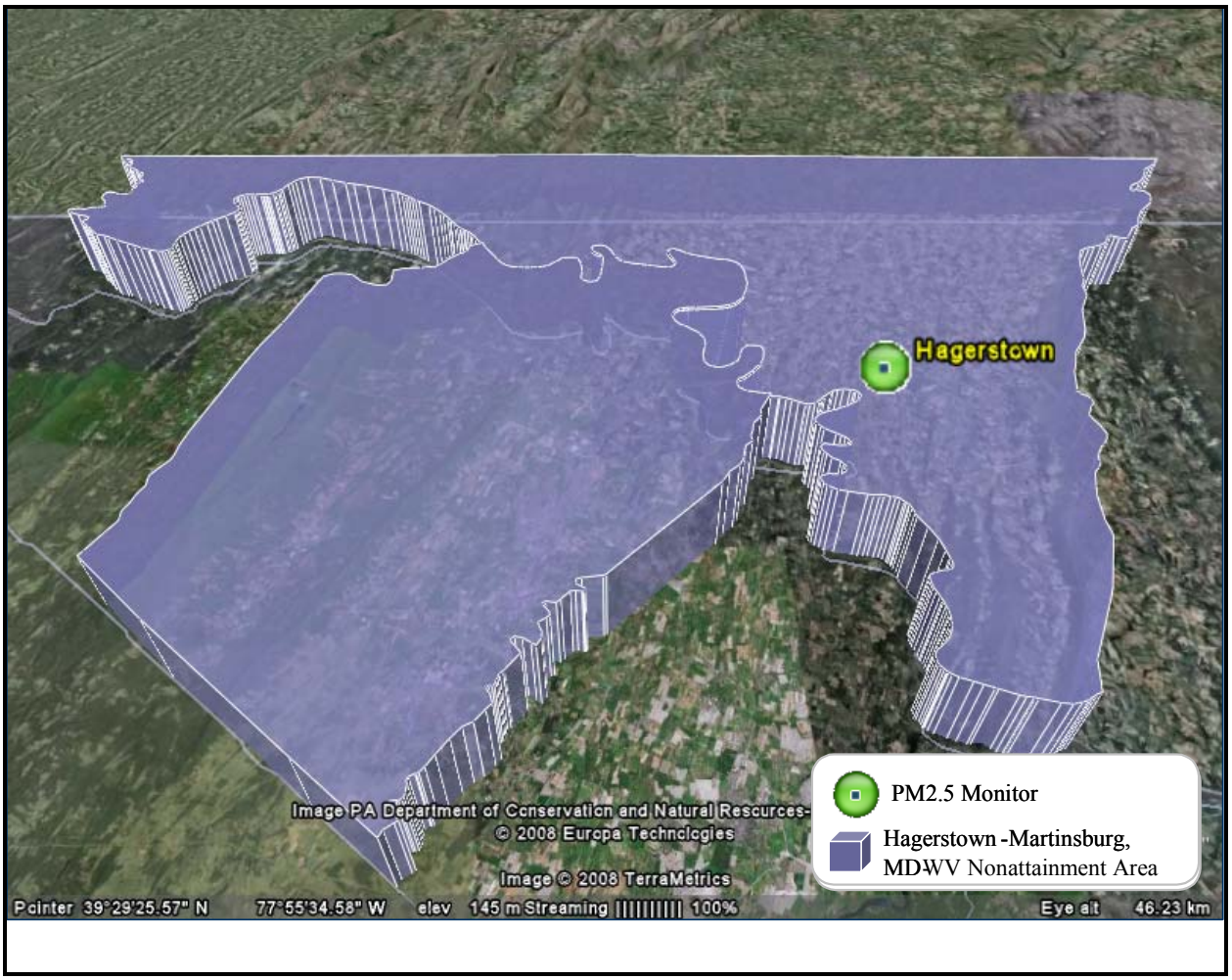


FIGURE 1-2: WASHINGTON COUNTY, MD $PM_{2.5}$ MONITOR



1.2 SIP Requirements for Nonattainment Areas

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

- Attainment demonstration due 3 years after designation (4/5/08)
- RACT/RACM required for major sources
- Basic Inspection and Maintenance (I/M) for vehicles
- Contingency measures required for failure to attain

EPA issued implementation guidance for the fine particle standard 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 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 Washington County, MD PM2.5 State Implementation Plan and Base Year Inventory for the Maryland portion of the Martinsburg, WV - Hagerstown, MDs has been developed by the Maryland Department of the Environment (MDE). Chapter 5 identifies the Washington County, MD region's control measures needed to maintain compliance with the annual and daily $PM_{2.5}$ standard in 2009.

1.3 SIP Process

The Act requires states to develop and implement particulate matter 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 more stringent New Source Review offset requirements (2:1) and 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 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 State Commitment/Implementation Assurances

The measures in the SIP must be supported by any necessary legislative authority 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 Maryland in developing this air quality plan or SIP. In order 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; and
d) Enforceable.

1.5 Submittal of the Plans

These plans are developed through a public process, formally adopted by the State, and submitted by the Governor's designee to EPA. The Clean Air Act requires EPA to review each plan and any plan revisions and to approve the plan or plan revisions if consistent with the Clean Air Act (the Act).

1.6 Sanctions

EPA must impose various sanctions if the states do not submit a plan; or submit a plan that the EPA does not approve; or fail to implement the plan. These include: more stringent New Source Review offset requirements (2:1); 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.

1.7 Base Year 2002 Emission Inventory and Future Year 2009 Emission Inventory

EPA issued implementation guidance for the fine particle standard 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. Volatile organic compounds 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. More information on emission contribution can be found in Section 2.8.

The average annual composition of fine particles in the Maryland region is 53% sulfate, 33% carbon/PM direct, 6% nitrates (see Chapter 2, Figures 2-10). The rest are crustal matter and trace elements. The rest are crustal matter and trace elements. Emissions inventories for the three major precursors, $PM_{2.5}$ ("direct"), nitrogen oxides (NO_X) and sulfur dioxide (SO2) are compared in the following three figures, Figure 1-3 to Figure 1-5. $PM_{2.5}$ increases slightly by 6% from 2002 to 2009, shown in Figure 1-3. Nitrogen oxides emissions are shown in Figure 1-3; they decline by 17% between 2002-2009. The largest reductions in NO_X come from reductions in point sources and mobile sources. Sulfur dioxide emissions increase during this period by 12% due to increases from the utility sector (Figure 1-5).

FIGURE 1-3:
$PM_{2.5}$ EMISSIONS BY SOURCE CATEGORY (2002 & 2009)

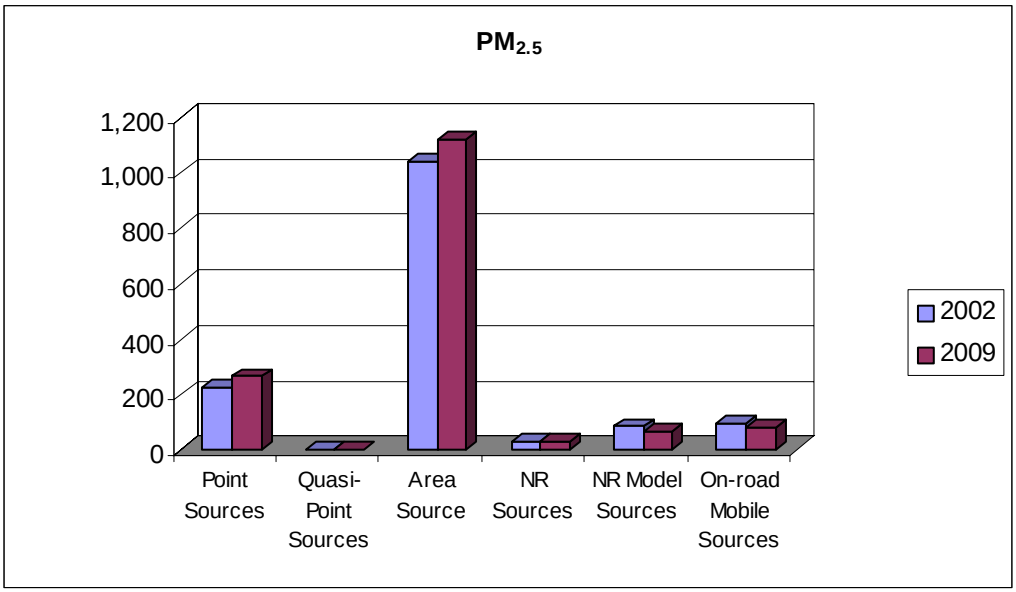


FIGURE 1-4:
NO_X EMISSIONS BY SOURCE CATEGORY (2002 & 2009)

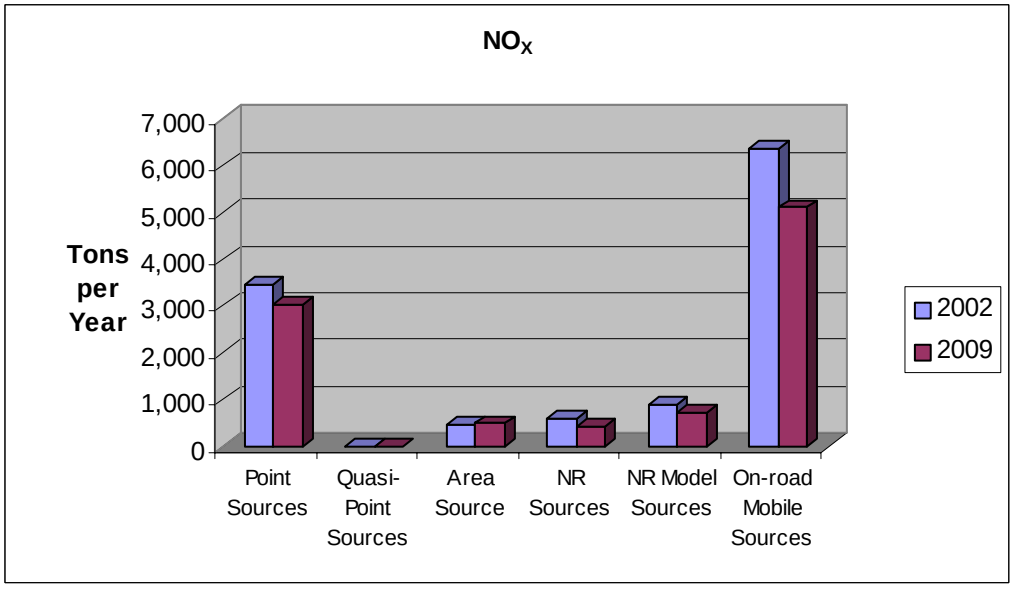
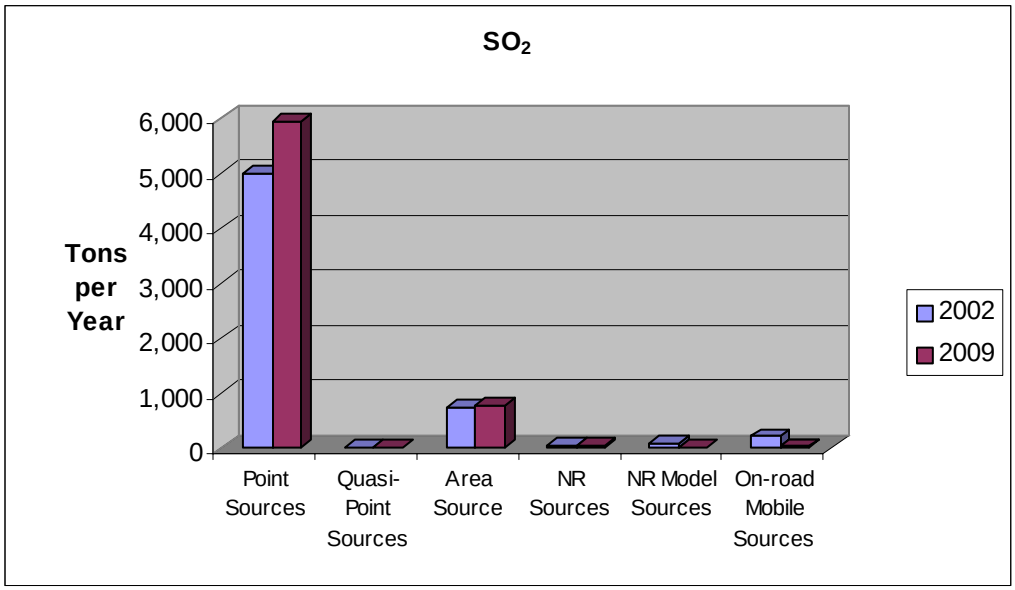


FIGURE 1-5:
SO_2 EMISSIONS BY SOURCE CATEGORY (2002 & 2009)



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

Overall, the 2009 plan for the Martinsburg, WV - Hagerstown, MD includes total reductions by 2009 of 2,054 tons per year of nitrogen oxides (NO_X). The significant emission reducing programs identified in this plan may be summarized as follows:

- NO_X reductions are from State NO_X Reasonably Available Control Technologies (RACT) and the Maryland Healthy Air Act, EPA Non-road gasoline engines rule, and a suite of on-road measures including High-tech Vehicle Inspection and Maintenance programs, National Low Emission Vehicle Program, Tier 2 Motor Vehicle Emissions Standards.

1.9 Establishment of a Budget for Transportation Mobile Emissions

As part of the development of the plan, MDE in consultation with the Hagerstown/Eastern Panhandle metropolitan planning organization (HEPMPO) established mobile source emissions budgets 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, and the shorter term Transportation Improvement Program (TIP) conform with the CAAA. Under EPA regulations, the projected mobile source emissions for 2009 -- minus the vehicle technology, fuel, or maintenance-based measures -- become the mobile emissions budgets for the region unless MDE takes actions to set another budget level. The mobile emissions budgets were developed using computer models MOBILE 6.2.03 and HPMS.

Attainment Year Mobile Budgets

The mobile emissions budgets for the 2009 attainment year are based on the projected 2009 mobile source emissions accounting for all the mobile control measures, and vehicle technology, fuel, or maintenance-based measures. Unlike the Ozone SIP mobile budgets that are based on daily emissions, the $PM_{2.5}$ mobile budgets are based on annual emissions. The mobile emissions budgets for the 2009 Attainment Year are 80.69 tons/year $PM_{2.5}$ direct and 5,106.94 tons/year NO_X.

The annual Mobile Emissions Budget for 2009 attainment year, based upon the projected 2009 mobile source emissions accounting for all the mobile control measures, and vehicle technology, fuel, or maintenance-based measures: $PM_{2.5}$ Direct = 80.69 tons/year NOx = 5,106.94 tons/year

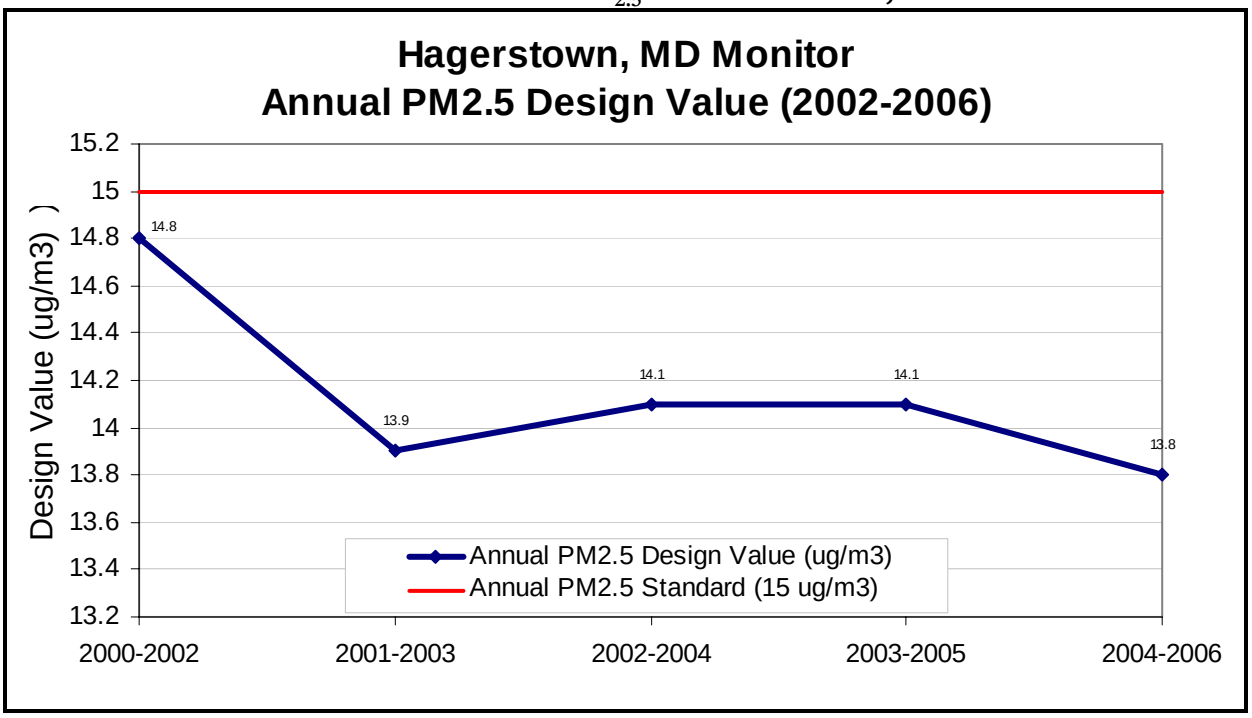
1.10 Attainment Demonstration

The Annual Fine Particle Attainment Plan includes a modeling demonstration that the Martinsburg, WV - Hagerstown, MD region will maintain compliance with the annual and 24-hour $PM_{2.5}$ standard in 2009. The demonstration is based on results from the Community Multiscale Air Quality Model (CMAQ).

Washington County, Maryland was designated nonattainment primarily because of violations in Berkeley Count, West Virginia. Based on the modeling performed for the region, the 2009 design value for Berkeley County, West Virginia is predicted to range between 12.8 and 13.1 $\mu g/m^3$ which clearly demonstrates that Washington County does not contribute to violations in Berkeley County.

In the base year 2002, the monitor in the region was below the annual standard of 15.0 $\mu g/m^3$. Modeling the projected controlled emissions with reductions from the measures listed in Chapter 5, the results show no monitors in the Maryland portion of the Martinsburg, WV - Hagerstown, MD, MD region above the annual $PM_{2.5}$ health standard of 15.0 $\mu g/m^3$.

FIGURE 1-6: ANNUAL $PM_{2.5}$ DESIGN VALUE, 2002-2006 [3]



1.11 Determination of Reasonably Available Control Measures (RACM)

The cumulative impact of previously adopted and on-going, measures described in Chapter 5 will be sufficient to comply with the $PM_{2.5}$ NAAQS (1997) based on the attainment modeling exercises completed for this SIP.

Based on the RACM analysis completed by MDE there were no RACM measures identified specifically or in mass that would advance the attainment date by one calendar year. 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.

1.12 Contingency Measures

The Maryland Healthy Air Act provides a total benefit of more than 451.9 tons per year (tpy) of SO_2 in 2010. These SO_2 reductions are more than 12 times the required NO_X reductions under contingency, and this 12:1 ratio is significantly higher than any of the equivalency assessments described in Section 10. Therefore the Healthy Air Act fulfills the contingency measure requirement.

3 Data from EPA Air Trends: Design Values website at http://www.epa.gov/airtrends/values.html

1.13 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 and HPMS including corrections to nonroad, area and stationary source emissions

Chapter 4 presents the 2009 projected inventories using MOBILE 6.2.03 and HPMS 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 mobile emissions budgets for the Maryland portion of the Martinsburg, WV - Hagerstown, MD Particulate Matter Nonattainment Area

Chapter 8 presents the schedules and adoption of regulations to meet requirements for nonattainment areas and presents commitments to EPA

Chapter 9 presents the Washington County, MD's demonstration of attainment based on CMAQ modeling

Chapter 10 presents contingency measures for the 2009 attainment demonstration.

This Page Left Intentionally Blank

2.0 FINE PARTICLE POLLUTION

2.1 Definition of Fine Particle Matter

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

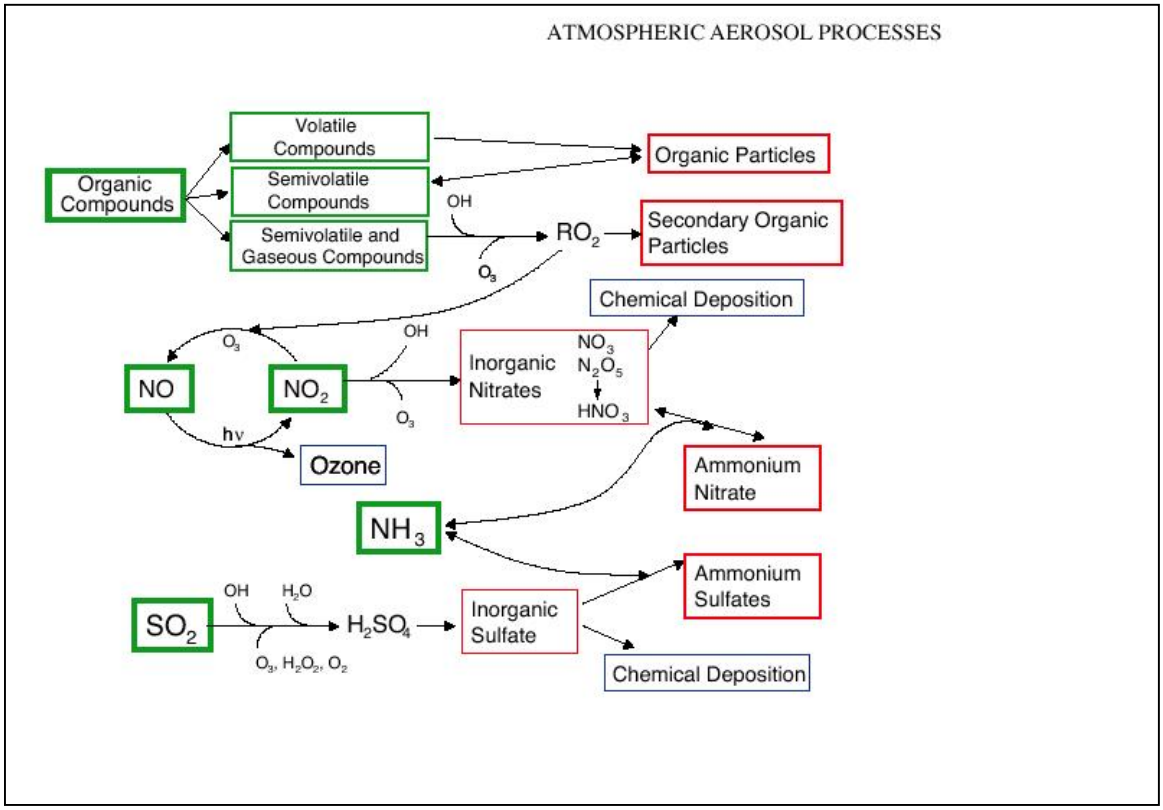
Gas-phase precursors SO_2, NO_X, VOC, and ammonia undergo chemical reactions in the atmosphere to form secondary particulate matter. Formation of secondary PM depends on numerous factors including the concentrations of precursors, the concentrations of other gaseous reactive species, atmospheric conditions such as 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.

Federal Reference Monitors (FRM) sample fine particles in the Baltimore and Washington regions and Washington County Maryland (see Figure 1-1). The purpose of the filter-based FRM monitors is to determine compliance with the $PM_{2.5}$ NAAQS. FRM monitors are filter-based that measure $PM_{2.5}$ mass by passing a measured volume of air through a pre-weighed 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 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. Another concern with fine particles is that there can be adverse impacts from PM2.5 pollution all year versus the seasonal nature of ozone impacts.

FIGURE 2-1: ATMOSPHERIC CHEMICAL REACTIONS THAT CONTRIBUTE TO PM2.5 [4]



Studies have demonstrated a relationship between increased levels of fine particles 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.[5]

Environmental effects of particle pollution include reduced visibility, environmental damage, and aesthetic damage. Fine particles ($PM_{2.5}$) 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: more acidic lakes and streams, changed nutrient balance in coastal waters and large river basins, depletion of nutrients in soil, damage to sensitive forests and farm crops, and affects on the diversity of ecosystems. Particle pollution can stain and damage stone and other materials, including culturally important objects such as statues and monuments.

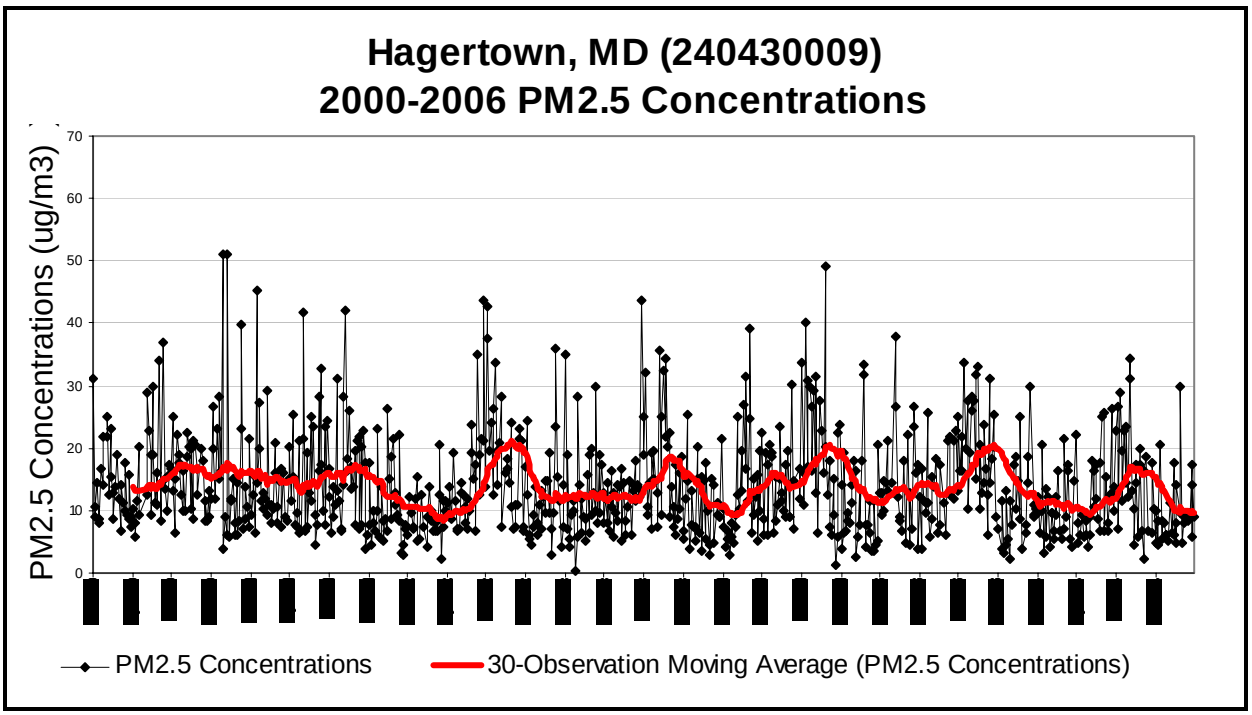
[4] Atmospheric chemical reactions that contribute to $PM_{2.5}$ from the North American Strategy for Tropospheric Ozone (NARSTO) Assessment, 2004

[5] Cardiovascular Risks from Fine Particulate Air Pollution. *Douglas W. Dockery, Sc.D., and Peter H. Stone, M.D.,* New England Journal of Medicine, February 1, 2007, Volume 356:511-513, Number 5

2.3 Seasonal Variation of PM2.5 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 1 shows how precursors such as SO_2, NO_X, and organic compounds help produce components of $PM_{2.5}$, including inorganic sulfates and nitrates, ammonium sulfate, ammonium nitrate, and organic particles. These $PM_{2.5}$ components may coagulate to produce fine particles, or these reactions may take place on the surfaces of fine particles 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 VOC.

FIGURE 2-2: SEASONAL VARIATION OF $PM_{2.5}$ DURING 2000-2006 IN THE WASHINGTON COUNTY, MD NON-ATTAINMENT AREA [6]

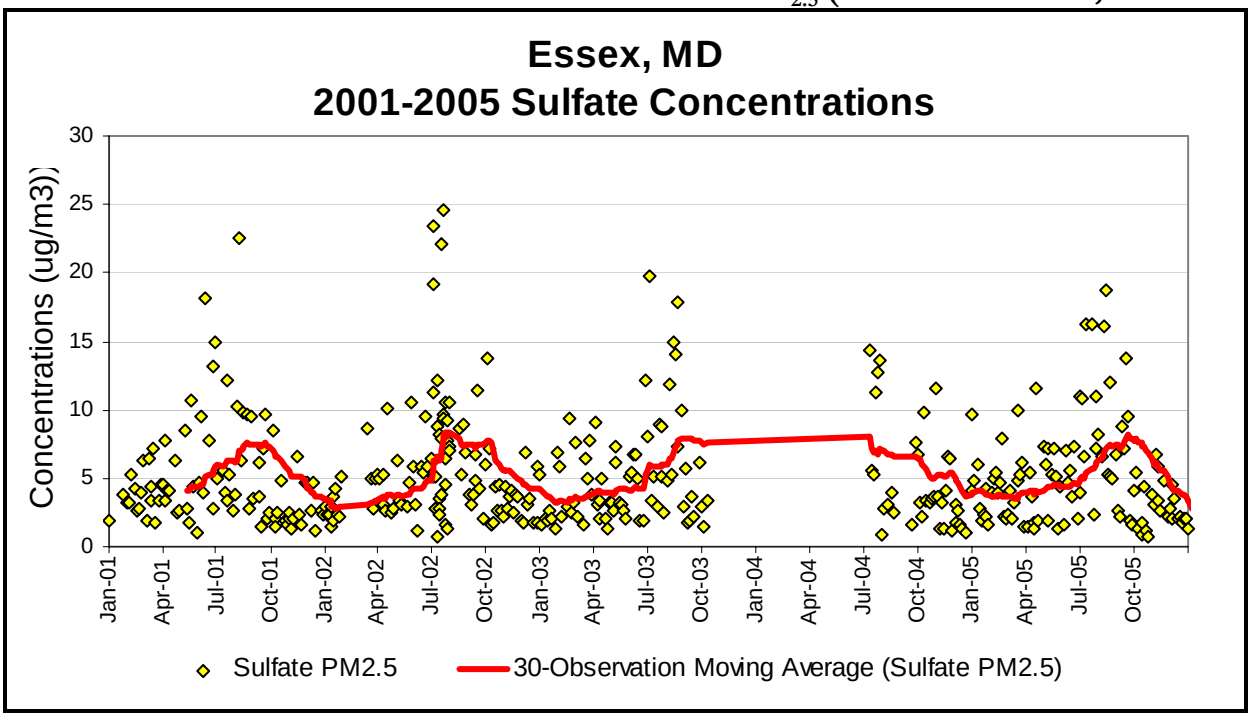


1) Sulfates

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

6 Data from the EPA Air Quality System (AQS) database

FIGURE 2-3: SEASONAL VARIATION OF SULFATE $PM_{2.5}$ (ESSEX MONITOR, 2001-2005) [7]

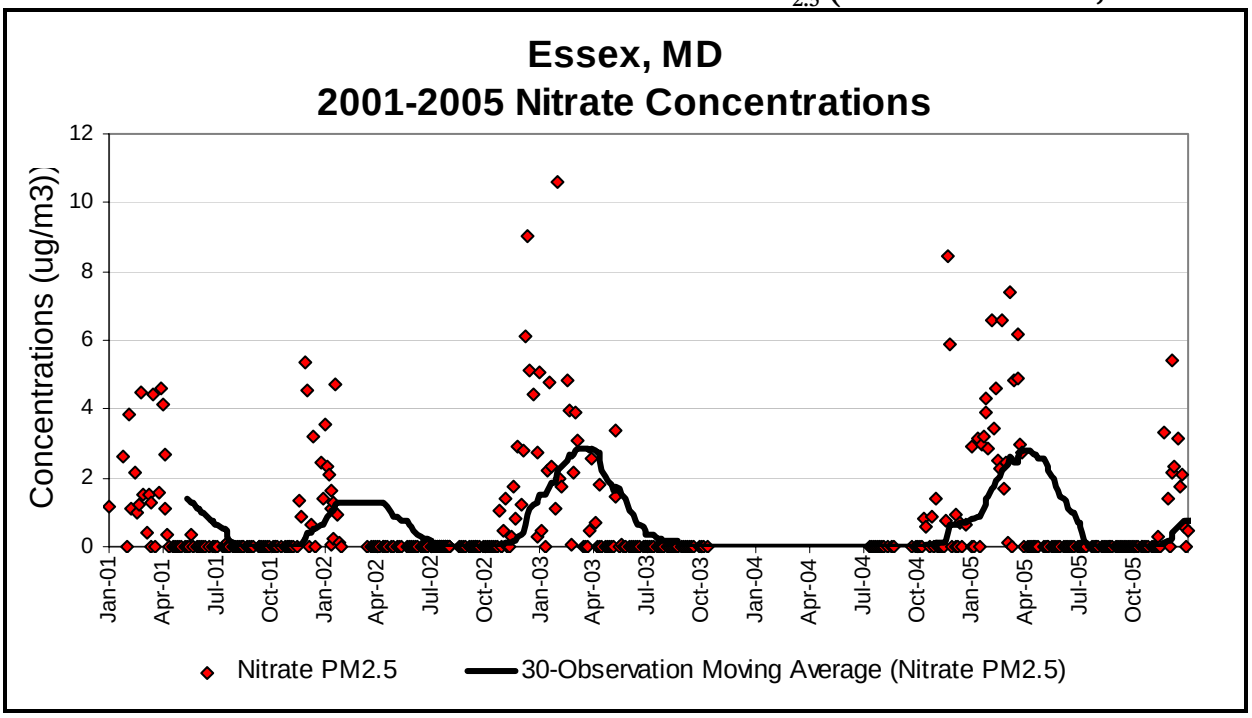


2) Nitrates

Nitrate concentrations increase markedly as seasonal temperatures decrease. Therefore nitrate concentrations are heightened during winter (Figure 2-4), so NO_X typically does not react as readily with VOC during winter, causing higher wintertime nitrate concentrations. During summer, however, higher air temperatures enable NO_X to react more readily with VOC and produce ozone. As a result, nitrate concentrations are minimized during the warm season. During winter, heightened nitrate concentrations contribute to slightly elevated PM2.5 levels, despite relatively low sulfate concentrations.

7 Data from the EPA AIR Explorer website at: http://www.epa.gov/airexplorer/ for the Essex, MD monitor. Note: No data from the last quarter of the 2003 through the second quarter of 2004.

FIGURE 2-4: SEASONAL VARIATION OF NITRATE $PM_{2.5}$ (ESSEX MONITOR, 2001-2005) [8]

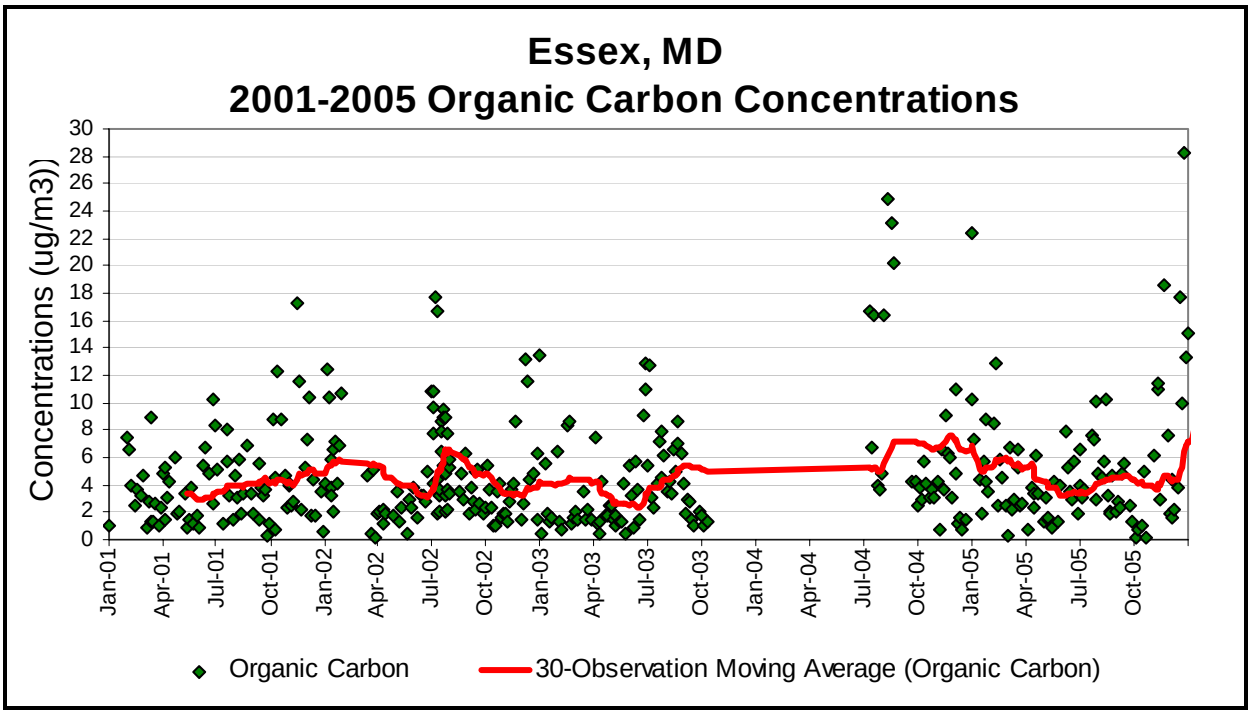


8 Data from the EPA AIR Explorer website at: http://www.epa.gov/airexplorer/ for the Essex, MD monitor. Note: No data from the last quarter of the 2003 through the second quarter of 2004.

3) Organic and Elemental Carbon

Concentrations of another precursor, organic carbon (Figure 2-5), vary 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 spring and summer seasons.

FIGURE 2-5: SEASONAL VARIATION OF ORGANIC CARBON (ESSEX MONITOR, 2001-2005) [9]

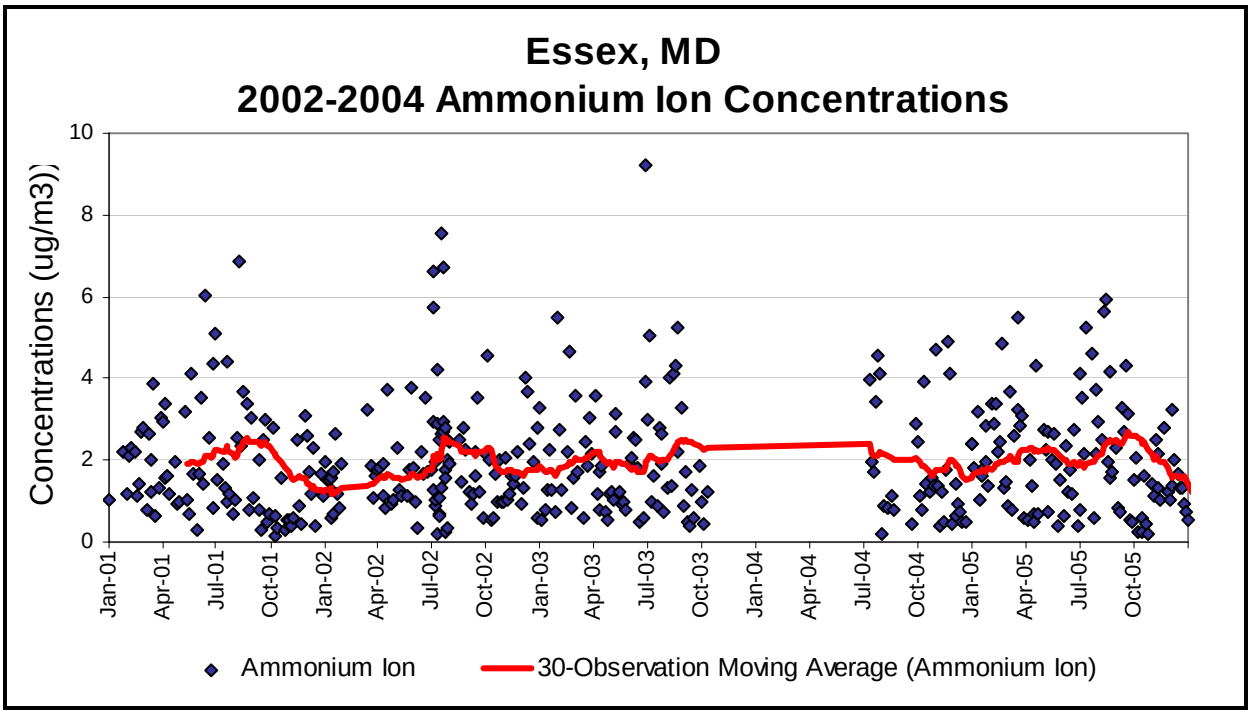


9 Data from the EPA AIR Explorer website at: http://www.epa.gov/airexplorer/ for the Essex, MD monitor. Note: No data from the last quarter of the 2003 through the second quarter of 2004.

4) Ammonium

Ammonium concentrations vary seasonally according to whichever has higher concentrations; sulfates or nitrates. The chemicals that have higher concentrations are more available for chemical reactions than those with lower concentrations. Since during the summer, sulfates have much higher concentrations than other precursors, ammonia will typically react with the sulfates to produce ammonium sulfate, as in Figure 1. Hence, ammonium sulfates have higher concentrations in the summer (Figure 2-6), while ammonium nitrates have elevated concentrations in the winter due to heightened concentrations of nitrates available for chemical reactions with ammonia.

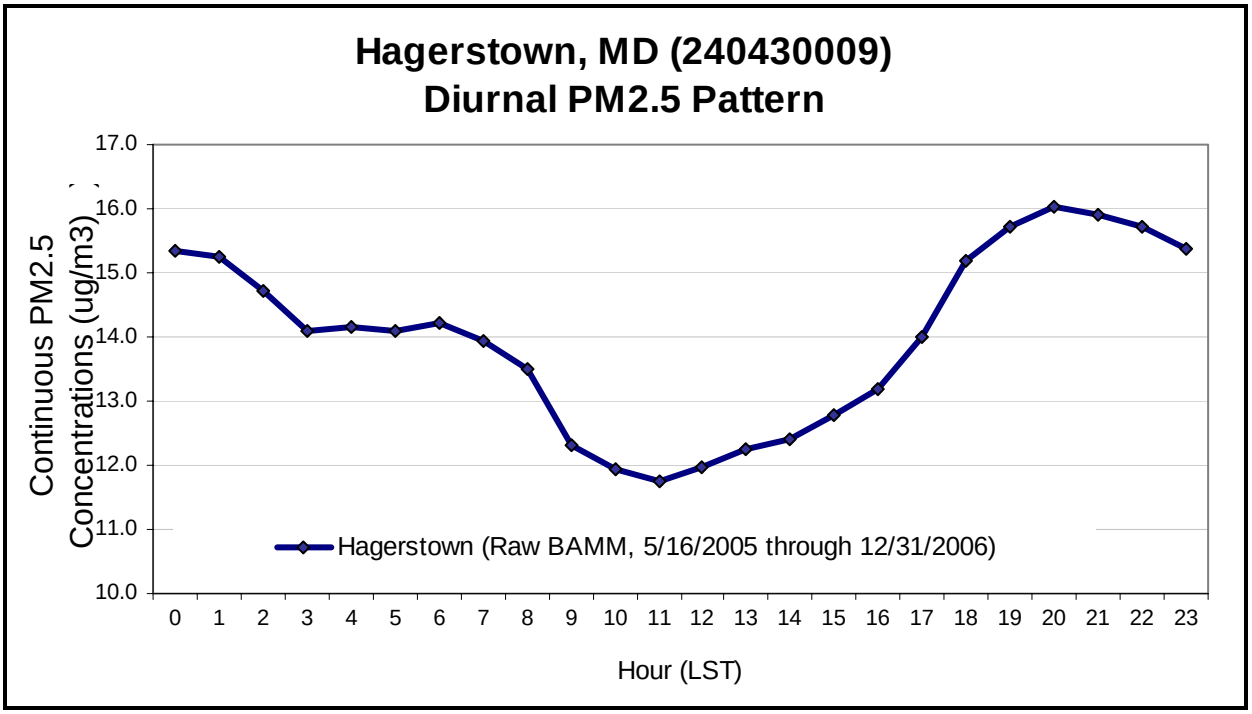
FIGURE 2-6: SEASONAL VARIATION OF AMMONIUM (ESSEX MONITOR, 2001-2005)



2.4 Diurnal Variation of Fine Particles

Fine particle 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. Fine particle concentrations appear to be heightened during the morning and early evening hours, coinciding with peak traffic times for the Martinsburg, WV - Hagerstown, MD metropolitan area. A notable minimum in fine particle 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: DIURNAL $PM_{2.5}$ PATTERN – HAGERSTOWN, MD [10]



2.5 Trajectories of Fine Particles

Fine particles may originate both locally and remotely. Particles from remote areas are carried by the wind into the region. When high particle concentrations occur upwind, concentrations in the area of interest may also increase as a result. To help in measuring upwind impacts, the paths that fine particles have taken from their sources to the Martinsburg, WV - Hagerstown, MD region are known as back trajectories. These trajectories are estimated using meteorological models that calculate wind direction and velocity. Back trajectories for days with high fine particle concentrations usually show particle tracks originating over the continental U.S (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 regions, particles are carried downstream by the wind, causing fine particle concentrations to jump in affected areas. Forest fires, however, are a special case where trajectories need not circulate through the continental U.S., 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 Martinsburg, WV - Hagerstown, MD area.

10 Data based on continuous raw BAMM data from May 16, 2005 through December, 2006.

FIGURE 2-8a: PM $_{FINE}$ BACK TRAJECTORIES [11]

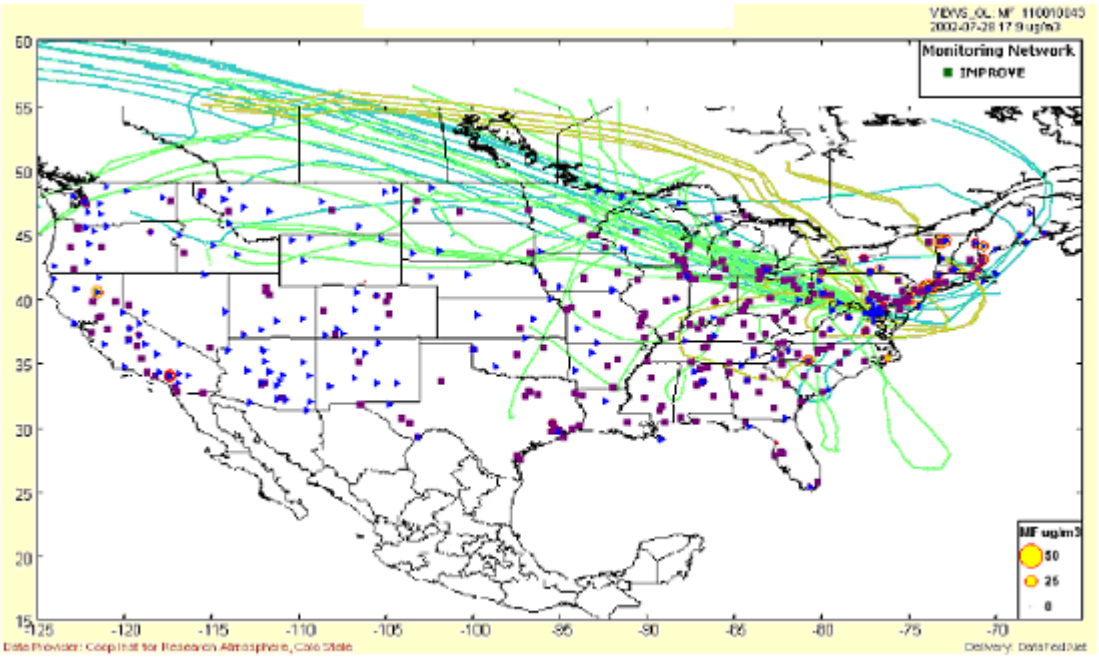
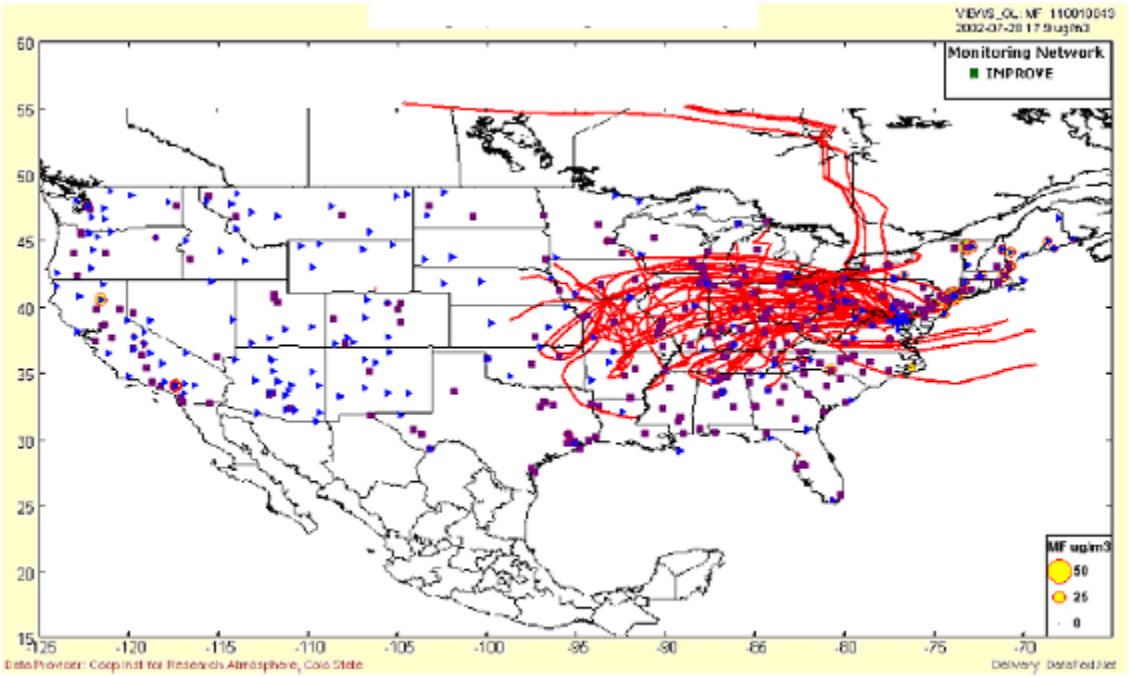


FIGURE 2-8b: PM $_{FINE}$ BACK TRAJECTORIES [12]



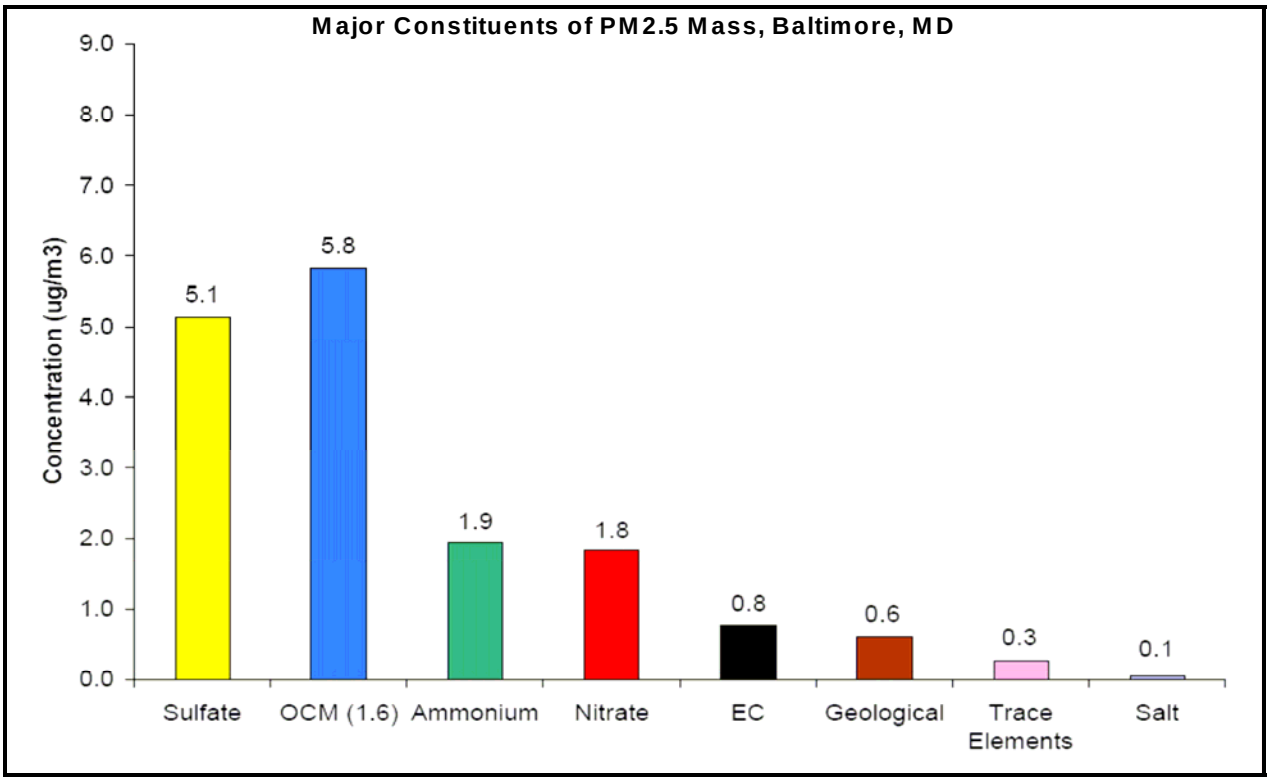
11 Based on data from April 2001 to December 2003 for Washington, D.C. – 5% Cleanest Days
12 Based on data from April 2001 to December 2003 for Washington, D.C. – 5% Dirtiest Days

2.6 Major Constituents of PM2.5 and Sources in the Martinsburg, WV - Hagerstown, MD Region

Most observed ambient $PM_{2.5}$ originates from precursor gases, sulfur dioxide (SO_2), nitrogen oxides (NO_X), ammonia (NH_3), volatile organic compounds (VOC), 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 provides information about the relative contribution of the chemical components and the sources of these pollutants.

$PM_{2.5}$ speciation monitors are used to support State Implementation Plan development by providing information on PM2.5 chemical composition. There are two speciation monitors located within the Baltimore Nonattainment Area located adjacent to Washington County to the east. There are no current speciation monitors run by MDE located in Washington County, MD. For this reason MDE chose to use speciation data from the next closest PM2.5 nonattainment area. MDE chose the more conservative speciation monitor located at the Essex station for its attainment analysis. The relative concentrations of each $PM_{2.5}$ constituent, annually averaged over 2001-2003, are shown in Figure 2-13 (as identified above, speciated data from the Baltimore PM2.5 nonattainment was used for Washington County, MD), with sulfates being one of the most significant contributors to fine particle 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 particulate material.

FIGURE 2-13: ANNUALLY AVERAGED 2001-2003 CONCENTRATIONS OF PM2.5 CONSTITUENTS[13]



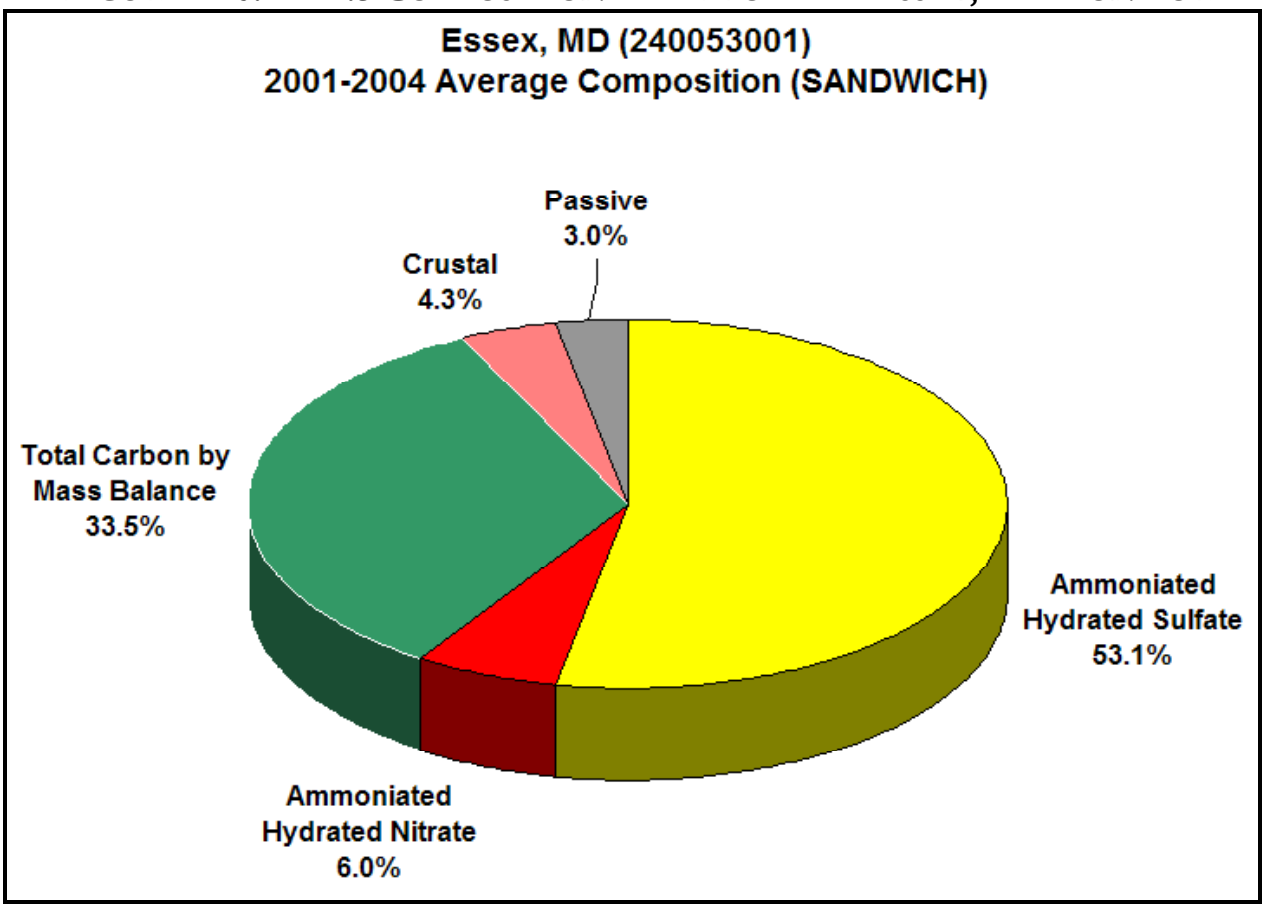
13 Figure was extracted from MARAMA report titled "An analysis of Speciated PM2.5 Data in the MARAMA Region" The report can be found at http://www.marama.org/reports/SDAReport color 0503106.pdf

2.7 Sources of Fine Particles and Constituents

Sources of fine particles 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) method to chemically characterize ambient PM2.5 speciation data. SANDWICH is a mass balance approach for estimating PM2.5 mass composition as if mass composition were measured by PM2.5 Federal Reference Monitors (FRM). This approach uses a combination of speciation measurements and modeled speciation estimates to represent FRM PM2.5 and is the default method in EPA modeling guidance to define baseline PM2.5 concentrations.

Figure 2-10 (as identified in section 2.6 above MDE used BaltimorePM2.5 nonattainment area speciation data for Washington County, MD) shows that a large portion, about 65%, of annual averaged PM2.5 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: PM2.5 COMPOSITION DATA FROM THE ESSEX, MD MONITOR [14]



14 $PM_{2.5}$ composition data from Essex, MD monitor from 2001 – 2004. Total carbon and sulfates are dominant $PM_{2.5}$ constituents in the Baltimore Nonattainment Area.

2.8 Determination of Significance for Precursors

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 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 Maryland portion of the Martinsburg, WV - Hagerstown, MD Nonattainment Area, while ammonia (NH_3) and other precursors were deemed insignificant at this time. According to EPA, sources of direct $PM_{2.5}$ and SO_2 must be evaluated for control measures in all non-attainment areas. 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 non-attainment 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. The Maryland portion of the Martinsburg, WV - Hagerstown, MD region decided to follow EPA's advice on VOC. The role of ammonia in $PM_{2.5}$ formation is also not as well understood as those of SO_2 and carbon. 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. The Maryland portion of the Martinsburg, WV - Hagerstown, MD region decided to follow EPA's advice on ammonia.

The role of NO_X in the formation of $PM_{2.5}$ is very important. In the winter more NO_x translates into increased amounts of hydrogen nitrate (HNO_3) and Ammonia Nitrate (NH_4NO_3), favored by the availability of ammonia, low temperatures, and high relative humidity. $PM_{2.5}$ concentrations will respond most effectively to NO_x reductions in the winter by reducing the amounts of hydrogen nitrate (HNO_3) and Ammonia Nitrate (NH_4NO_3) in the atmosphere that can form $PM_{2.5}$. Therefore, states are required to address NO_X as a $PM_{2.5}$ attainment plan precursor and evaluate reasonable controls for nitrates in implementation plans.

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 it is found by the EPA that NO_X emissions from sources in the state do not significantly contribute to the $PM_{2.5}$ concentrations in the non-attainment area. The Maryland portion of the Martinsburg, WV - Hagerstown, MD region decided to follow EPA's advice on NO_X.

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, VOC, and ammonia (NH_3) (see Table 4). $PM_{2.5}$ 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.

Several precursors are presumed to be insignificant and do not need to 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

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

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 VOC 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 VOC and ammonia is that the region is already showing attainment of 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 VOC and ammonia is listed in Table 2-3.

Table 2-3: Summary of Rationale for VOC and NH3 Insignificance Determinations 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 SIP Planning purposes?	No	No

* VISTAS is the 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 VOCs when further technical information becomes available.

2.9 Compliance with the $PM_{2.5}$ NAAQS

The Washington County, MD Federal Reference Monitors (see Figure 1-2) demonstrate compliance with the annual and 24-Hour PM2.5 National Ambient Air Quality Standard in 2005 and 2006. The purpose of the filter-based FRM monitors is to determine compliance with the $PM_{2.5}$ NAAQS. FRM monitors are filter-based that measure PM2.5 mass by passing a measured volume of air through a pre-weighed filter.

The design value trend for the annual PM2.5 standard is shown in the Figure 2-11 below. In 2005 the design value was 14.1 ug/m^3; in 2006 the design value was 13.8 ug/m^3, again below the annual $PM_{2.5}$ standard of 15.0 ug/m^3. Figure 2-12 shows the 24-hour standard trend, which is also decreasing.

FIGURE 2-11: ANNUAL $PM_{2.5}$ DESIGN VALUE, 2002-2006 [15]

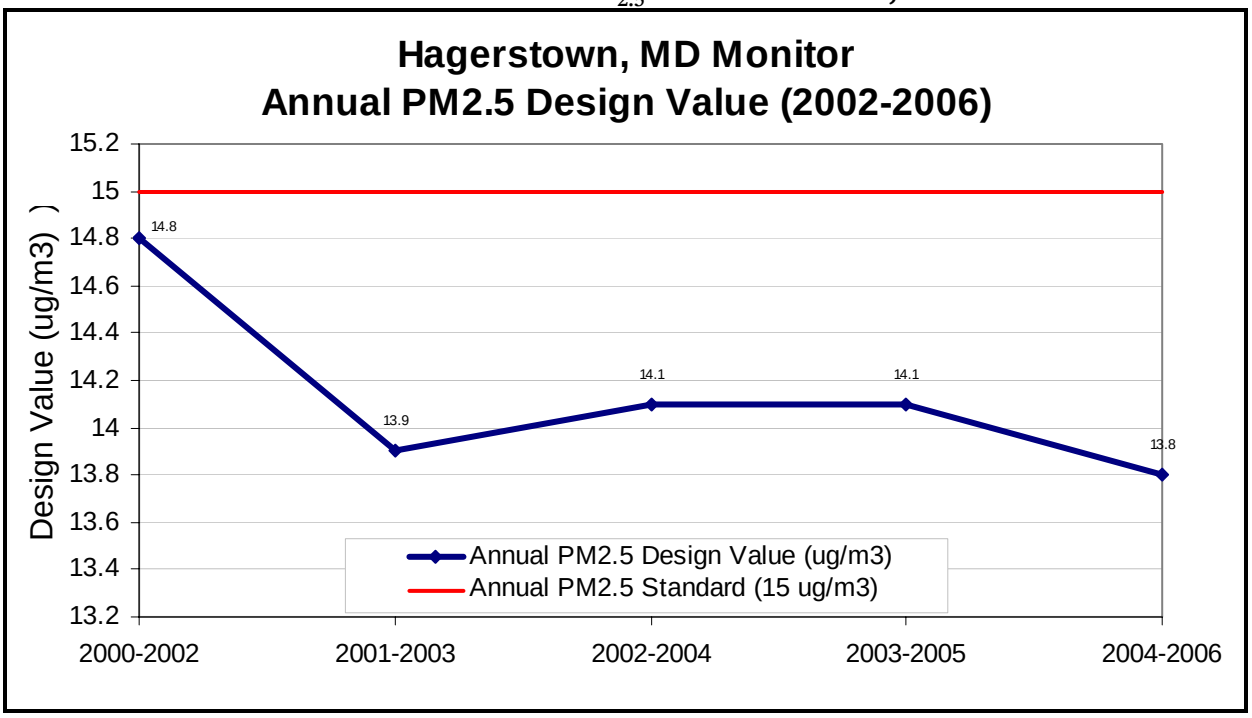
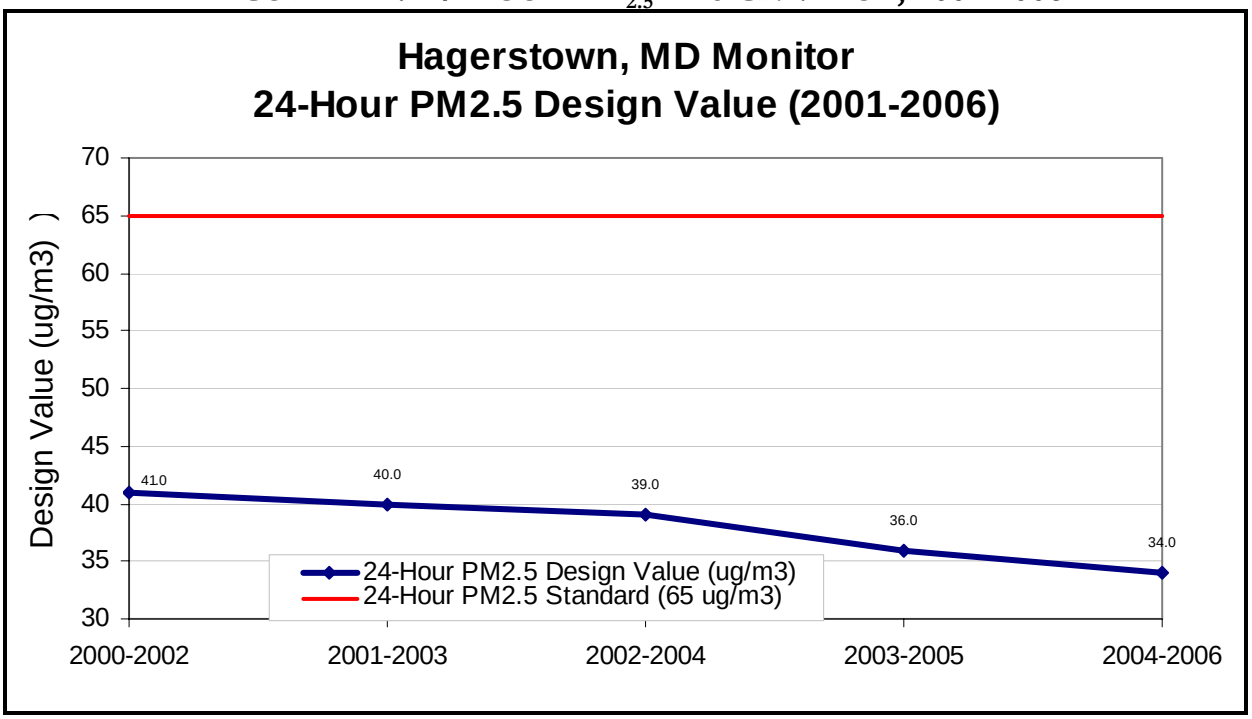


FIGURE 2-12: 24-HOUR $PM_{2.5}$ DESIGN VALUE, 2001-2006 [16]



15 Data from EPA Air Trends: Design Values website at http://www.epa.gov/airtrends/values.html
16 Data from EPA Air Trends: Design Values website at http://www.epa.gov/airtrends/values.html

This Page Left Intentionally Blank

3.0 THE 2002 BASE-YEAR INVENTORY

3.1 Background and requirements

The 2002 Base-Year Inventory is published in a separate document, "2002 Base Year Emissions Inventory & QA/QC Plan Maryland," (June 15, 2006). This document was submitted to EPA Region III. This document was prepared the Maryland Department of the Environment. It is available for inspection at the Air and Radiation Management Administration, 1800 Washington Boulevard, Suite 730, Baltimore, Maryland 21230. Relevant portions of this document including, source category listings and descriptions, methods and data sources, emission factors, controls, spatial and temporal allocations, and example calculations are included in Appendix A1. The full inventory document titled, 2002 Base-Year Emissions Inventory of PM2.5 Precursor Emissions, is attached to this SIP document in Appendix A.

The emissions inventory covers all Maryland nonattainment areas (Figure 1-1). The 2002 emissions inventory is the starting point for calculating the emissions reduction requirement needed to meet the requirements prescribed for moderate nonattainment areas by the Clean Air Act Amendments and EPA.

Appendix A (2002 Base Year State Implementation Plan Emissions Inventory and Methodologies for PM2.5 and Precursors) of the Annual PM2.5 SIP document addresses emissions of PM2.5-Primary, oxides of nitrogen (NO_X), sulfur dioxide (SO2), volatile organic compounds (VOCs), ammonia (NH3), and PM10-Primary on an annual basis. Included in the inventory are anthropogenic (man-made) sources, such as, point, area, non-road and on-road mobile sources and biogenic (naturally occurring) sources of PM2.5 precursors.

The 2002 base-year annual inventories for PM2.5-PRI, NO_X, SO2, VOC, NH3, and PM10-PRI are summarized in Table 3-1.

Table 3-1:
2002 Base-Year Annual Inventory
(Tons/Year)

	NH3	NOx	$PM_{2.5}$-PRI	PM_{10}-PRI	SOx	VOC	Total
Point	41.36	3,469.57	462.08	224.31	5,005.36	508.36	**9,711.04**
Quasi-Point	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Area	1,496.01	460.43	2,936.42	1,041.05	738.63	3,196.19	**9,868.73**
Non-Road	0.74	1,503.93	121.26	115.58	121.55	1,116.90	**2,979.96**
On-Road	190.05	6,358.56	130.78	94.75	209.16	2,936.83	**9,920.13**
Biogenics	0.00	123.01	0.00	0.00	0.00	6,203.98	**6,326.99**
Total[17]	**1,728.16**	**11,792.49**	**3,650.54**	**1,475.69**	**6,074.70**	**7,758.28**	**32,479.86**

* Small discrepancies may result due to rounding

17 Total Excludes Biogenic Emissons

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 per year (tons/year) of VOCs or 25 tons/year or more of NOx or CO. The point source inventory consists of actual emissions for the base-year 2002 and includes State of Maryland sources within the geographical area of the Martinsburg, WV - Hagerstown, MD.

For source category listings and descriptions, methods and data sources, emission factors, controls, spatial and temporal allocations, and example calculations please refer to Appendix A1.

For Base-Year Emission Inventory data please refer to Appendix A2.

3.2.2 Quasi-Point Sources

The Maryland Department of the Environment Air and Radiation Management has identified several facilities that due to size and/or function are not considered point sources. These establishments contain a wide variety of air emission sources, including traditional point sources, on-road mobile sources, off-road mobile sources and area sources. For each particular establishment, the emissions from these sources are totaled under a single point source and summary documents include these "quasi-point" sources as point sources.

Quasi-point sources will include all emissions at the facility regardless of whether they are classified as point, area, nonroad, or mobile source emissions. These emissions are actual emissions reported for the facilities. No Quasi-point sources were identified within the Maryland portion of the Martinsburg, WV - Hagerstown, MD nonattainment area.

For source category listings and descriptions, methods and data sources, emission factors, controls, spatial and temporal allocations, and example calculations please refer to Appendix A1.

For Base-Year Emission Inventory data please refer to Appendix A3.

3.2.3 Area Sources

Area sources are sources of emissions too small to be inventoried individually and which 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 non-stationary sources.

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 (or county-equivalent) 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.

For source category listings and descriptions, methods and data sources, emission factors, controls, spatial and temporal allocations, and example calculations please refer to Appendix A1.

For Base-Year Emission Inventory data please refer to Appendix A4.

3.2.4 Mobile Sources

On-road mobile sources include all vehicles registered to use the public roadways. The predominant emission source in this category is the automobiles, although trucks and buses are also significant sources of emissions.

The computation of highway vehicle emissions required two primary entities: a) vehicle emission factors and b) vehicle activity.

The Emission factors are generated by using the latest version of U.S. EPA's emission factor model MOBILE6.2. Vehicle activity (vehicle miles traveled – termed VMT for short) is usually obtained from State Highway Administration (SHA) "*Universal*" highway database. The data is used by the agency to report VMT for the Highway Performance Monitoring System (HPMS). The database contains information on all state highways and arterials, most of the major collectors, and some minor collector and local roadways. Each divided into links of varying lengths. The link segments contain descriptive data that is used in the calculation of the congested speeds input to the MOBILE6.2 emissions model.

In a simple modeling scenario, the product of emission factor and vehicle miles traveled should yield emission levels for that scenario. Proper units and conversion are used to arrive at reasonable emission estimates.

In a complex modeling scenario many types of emissions such as exhaust, evaporative, diurnal, crankcase, refueling, etc., emissions are computed separately and treated with the appropriate activity levels to yield a complex model result.

MOBILE6 expects enormous amount of local data input such as the fleet characteristics, fleet mileage accrual rates, speed, fuel parameters, inspection and maintenance (I/M) program in place, weather data, and so on.

In MOBILE6 emission factor model, the total highway vehicle population is characterized by the following 16 composite vehicle type categories:

LDV - Light-Duty Vehicles (Passenger Cars)
LDT1 - Light-Duty Trucks 1

LDT2 - Light-Duty Trucks 2
LDT3 - Light-Duty Trucks 3
LDT4 - Light-Duty Trucks 4
HDV2B- Class 2b Heavy Duty Vehicles
HDV3 - Class 3 Heavy Duty Vehicles
HDV4 - Class 4 Heavy Duty Vehicles
HDV5 - Class 5 Heavy Duty Vehicles
HDV6 - Class 6 Heavy Duty Vehicles
HDV7 - Class 7 Heavy Duty Vehicles
HDV8A- Class 8a Heavy Duty Vehicles
HDV8B- Class 8b Heavy Duty Vehicles
HDBS - School Buses
HDBT - Transit and Urban Buses
MC - Motorcycles

These composite vehicle types are further classified into 28 vehicle types - gasoline or diesel vehicles depending on the vehicle types. All motorcycles are gasoline based and transit and urban buses are diesels. School Bus can be either gasoline driven or diesel driven vehicle.

MOBILE6 also allows for the modeling of other fuel type vehicle such as hybrids and alternate fuel vehicles (AFV) as a special case in a complex modeling initiative.

MOBILE6 model produces emission factors, for each of the 28 vehicle types, and one composite factor for all vehicle types.

A post-processing system takes care of all emission computations of the modeling domain by aggregating the emissions from roads/links appropriate to the area and produces meaningful reports by area, by vehicle type and by roadway type.

For source category listings and descriptions, methods and data sources, emission factors, controls, spatial and temporal allocations, and example calculations please refer to Appendix A1.

For Base-Year Emission Inventory data please refer to Appendix A5.

3.2.5 Nonroad Sources

Emissions for all nonroad vehicles and engines except airport (aircraft, ground support equipment (GSE) and, auxiliary power units (APU)), locomotives, and diesel marine vessels were calculated using EPA's NONROAD2005.0.0 (dt. 12/02/2005) model. Since the time it was first issued on 12/02/2005, this model version underwent several corrections. The base year nonroad inventory was created using the version current as of 3/21/2006.

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.
- 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.

Baltimore Washington International Airport (BWI) and the Maryland Aviation Administration (MAA) provided all types of airport emissions for the airport. The Maryland Port Authority provided data for commercial marine vessels entering the Chesapeake Bay. Emissions from locomotives and commercial diesel marine vessels were calculated my MDE engineers.

For source category listings and descriptions, methods and data sources, emission factors, controls, spatial and temporal allocations, and example calculations please refer to Appendix A1.

For Base-Year Emission Inventory data please refer to Appendix A6.

3.2.6 Biogenic Emissions

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 NOx 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 twelve months of the year 2002.

Emissions data for Washington County, MD was acquired from the EPA website (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 Maryland portion of the Martinsburg, WV - Hagerstown, MD, MD particulate matter non-attainment area decided to use the inventories provided by the EPA.

This Page Left Intentionally Blank

4.0 THE 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, the estimation of the levels of emissions in that year before and after the consideration of emissions controls respectively

The projected inventories are 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, are also acceptable methods.

Round 6A Cooperative Forecasting results (population, household and employment projections), prepared and officially adopted by the Baltimore Metropolitan Council (BMC) were used to project emissions from area sources. Projections for onroad emissions were developed using MOBILE6.2 (January 2003) model (please see appendix F for information on mobile source emissions).

EPA's nonroad model, NONROAD2005, was used for developing both 2008 and 2009 nonroad model inventories. BMC's Round 6A Cooperative Forecasting results and the Economic Growth Analysis System (EGAS) model was used to project growth in the additional nonroad source categories such as railroad locomotives, marine vessels and airports. The Economic Growth Analysis System (EGAS) model was used to project growth in point source emissions.

4.1 Growth Projection Methodology

The following sections describe the method followed to determine the projected inventories for 2009.

4.1.1 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: projections are run by Source Classification Code; the Bureau of Labor Statistics national economic forecast; and the baseline regional economic forecast.

For source category listings and descriptions, projection methods and data sources, and surrogate growth indicators please refer to Appendix B1.

Point source emission projection data is contained in Appendix A2

4.1.2 Growth Projection Methodology for Quasi-Point Sources

Quasi-point sources will include all emissions at the facility regardless of whether they are classified as point, area, nonroad, or mobile source emissions. These emissions are actual emissions reported for the facilities. Actual emissions will be forecast to the projection years using surrogates specific to each quasi-point source. The growth factor indicators and their sources are listed below by facility:

Quasi-Point Source	Surrogate Growth Indicator
Baltimore Washington International Airport (BWI)	
Aircraft LTOs	FAA Aircraft Operations Forecasts
Mobile Source Emissions	FAA Enplanement Forecasts
Aberdeen Proving Grounds	BRAC Population Estimates

For source category listings and descriptions, projection methods and data sources, and surrogate growth indicators please refer to Appendix B1.

Quasi-point source emission projection data is contained in Appendix A3.

4.1.3 Growth Projection Methodology: Area Sources

Base-year area source surrogate growth factors for 2002 were calculated using 2002 population, household, and employment data. Linearly interpolating between 2002 and 2005 data produced the 2002 data. Dividing Round 6A population, household, and employment forecasts for the analysis year by the derived 2002 values for the region produced the growth factors for the periods of 2002 to 2008 and 2002 to 2009. Categories related to transport and storage of gasoline were grown using projected vehicle miles traveled (VMT) for analyses years. Area projection inventories are contained in Appendix B. The growth factors used for the 2008 and 2009 projection years are presented in Tables 4-1 and 4-2. The growth factors were applied to emissions categories by specific jurisdictions.

Table 4-1: 2002-2009 Area Source Growth Factors

Jurisdiction	Employment [2]	Population [2]	Household [2]
Washington County	1.0824	1.0674	1.0718

The 2009 emissions for area sources were calculated by multiplying the 2002 base-year area emissions by the growth factors for the appropriate year 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:

Surface Coating – depending on whether emission factors were based on employment or population, surrogate chosen varied with individual sub-categories. For example, automobile refinishing category was grown using employment as the emission factor was based on it, but population was chosen for growing traffic markings as its emission factor was based on population.

Commercial/Consumer Solvent Use - population was chosen as the growth surrogate since 2002 emissions are based on per capita emission factors.

Residential Fuel Combustion – households was chosen as the growth surrogate.

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

Vehicle Fueling (Stage II) and Underground Tank Breathing - all gasoline marketing categories were based on vehicle miles traveled (VMT) data since VMT is an appropriate surrogate for gasoline sales. Emission factors for these categories are based on gasoline sales.

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.

Publicly Owned Treatment Works (POTW) – households was chosen as the growth surrogate.

Dry Cleaning - population was chosen as the surrogate.

Graphic Arts - population was used to estimate growth since emissions are based on per capita emission factors.

Surface Cleaning - employment growth was used as the surrogate.

Tank Truck Unloading –growth in VMT from EGAS was applied to this category since base-year emissions are calculated using gasoline sales.

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.

Asphalt Paving - population was chosen as the surrogate since base-year emissions are calculated using per capita emission factors.

Bakeries, Breweries - population was chosen as the surrogate.

Soil/Groundwater Remediation - zero growth was applied to this category. The number of remediations during the any season, used to generate base-year emissions, does not directly correlate to population, households, or employment growth.

General Aviation and Air Taxi Emissions - Emissions from small airports were projected using the EGAS 5.0 model. The Maryland Aviation Administration (MAA) provided commercial aircraft operations at Baltimore Washington International (BWI) Airport. Emissions were calculated using FAA-approved activity data and the Emissions Dispersion Modeling system (EDMS) model. Emissions were grown by FAA Terminal Area Forecasts (TAFs).

Aircraft Refueling Emissions - emissions from refueling of aircrafts was projected based on employment.

Portable Fuel Container Emissions - emissions from portable fuel containers were grown based on households.

Railroad Locomotives - employment growth was used as the surrogate.

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

Accidental Oil Spills - zero growth was applied to this category.

Incineration– zero growth was applied to this category.

Pesticide Application - zero growth was applied to this category.

For source category listings and descriptions, projection methods and data sources, and surrogate growth indicators please refer to Appendix B1.

Area source emission projection data is contained in Appendix A4.

4.1.4 Growth Projection Methodology: 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 auxiliary power units. 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 Washington County, Maryland for the four seasons (winter, spring, summer, and autumn) and then seasonal emissions were summed up to get the annual emissions. The 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 A 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.

The methodology to prepare inputs for the summer season is provided below.

Temperature:

Temperature data was acquired from the National Climatic Data Center (NCDC). Hourly average temperature data were collected for Baltimore Washington International (BWI) station for the top ten 8-hour maximum ozone days between 2002-2004. Then minimum, maximum, and average temperatures were computed from this hourly temperature dataset.

Fuel inputs:

Month specific data for fuel RVP and oxygen weight percent were collected from BRTB18 and their staff, BMC19 and MDE Mobile Source Division. The data was averaged for the period to get seasonal average inputs. Model defaults were used for gas, diesel, marine diesel, and CNG/LPG sulfur percent. Stage II controls of zero percent was assumed for the model runs.

The model inputs (temperature, fuel, and other parameters) for 2009 are listed below:

Table 4-2: 2009 NONROAD Model Inputs

Parameters	2009 Values
Min. Temperature	65.55
Max. Temperature	87.6
Avg. Temperature	76.8
Reid Vapor Pressure (RVP)	6.6
Gas Sulfur (%)	0.003
Diesel Sulfur (%)	0.0348
Marine Diesel Sulfur (%)	0.0408
CNG/LPG Sulfur (%)	0.003
Oxygen Weight (%)	2.0
Stage II Control (%)	0

Since the nonroad model does not generate emissions for aircraft, APU, locomotives, and commercial diesel marine vessels, these were either projected from the base year emissions using the BMC Round 6A Cooperative Forecast or the EGAS model. Below are the details for projecting emissions for the above mentioned individual nonroad categories.

4.1.5 Growth Projection Methodology: Nonroad Sources

Aircraft emissions (military, commercial, general aviation, air taxi)

Maryland Aviation Administration (MAA) provided all types of airport activity data and emissions for Baltimore Washington International (BWI) airport. Aviation emissions from BWI were grown by FAA Terminal Area Forecasts (TAFs). Emissions were calculated using FAA-approved activity data and the Emissions Dispersion Modeling system (EDMS) model.

18 Baltimore Regional Transportation Board
19 Baltimore Metropolitan Council

General aviation and air taxi emissions from small airports were projected using the EGAS 5.0 model.

Auxiliary power units emissions

These emissions were only available for Baltimore Washington International (BWI) airport. Emissions were calculated using FAA-approved activity data and the Emissions Dispersion Modeling system (EDMS) model.

Ground support equipment emissions

The NONROAD2005.1.0 model generated these emissions for small airports. BWI GSE emissions were generated using the EDMS model, which calculated emissions based on actual aircraft operations. The Nonroad model calculates emissions based on GSE population only and therefore emissions generated this way are considered less accurate than the one generated by the EDMS model.

Commercial Diesel Marine Vessels

Base year emissions from commercial diesel marine vessels were grown to future years using employment as the surrogate.

Railroad

Railroad or locomotive emissions were grown using employment as the surrogate.

For source category listings and descriptions, projection methods and data sources, and surrogate growth indicators please refer to Appendix B1.

Nonroad mobile source emission projection data is contained in Appendix A6.

4.1.6 Growth Projection Methodology: Onroad Sources

The 2009 mobile source inventories were created through the use of several modeling including Mobile6.2 and the Highway Performance Monitoring System (HPMS). A full description of this mobile emission estimating process can be found in appendix F of this report.

4.1.7 Biogenic Emission Projections

Biogenic emission inventories for 2009 are the same as those used for the 2002 base year for Maryland portion of the Martinsburg, WV - Hagerstown, MD, MD nonattainment region. Year specific biogenic inventories for 2009 were not estimated. 2002 base year emissions were estimated by EPA using BEIS3.12 model.

4.2 Offset Provisions, Emission Reduction Credits and Point Source Growth

The Act requires that emission growth from major stationary sources in nonattainment areas be offset by reductions that would not otherwise be achieved by other mandated controls. The offset requirement applies to all new major stationary sources and existing major stationary sources that have undergone major modifications. Increases in emissions from existing sources resulting from increases in capacity utilization are not subject to the offset requirement. For the purposes of the offset requirement, major stationary sources include all stationary sources exceeding an applicable size cutoff. The NSR thresholds for the Maryland portion of the Martinsburg, WV - Hagerstown, MD nonattainment area are 10 tpy VOC and 25 tpy NOx.

EPA has issued guidance on the inclusion of emission reduction credits in the projected emissions inventory. The guidance states "The base year inventory includes actual emissions from existing sources and would not normally reflect emissions from units that were shutdown or curtailed before the base year (2002), as these emissions are not "in the air" for purposes of demonstrating attainment, they must be specifically included in the projected emissions inventory used in the attainment demonstration along with other growth in emission over the base year inventory. This step assures that emissions from shutdown and curtailed units are accounted for in attainment planning." 20 MDE has included emission reduction credits in the attainment demonstration projected inventory. A list of these emission reduction credits and associated facilities is shown in Table 4.3.

Table 4.3: Emission Reduction Credits

Facility Name	*State Facility Identifier*	*Pollutant Code*	*Emission Reduction Credits (TPY)*
Bethlehem Steel	005-0147	NOX	701
Pulaski Incinerator	510-0498	NOX	302
Quebecor Printing	003-0274	NOX	2
G. Heileman Brewing (Strohs)	005-0129	NOX	24
Grief Brothers Corp.	005-0134	NOX	1
U.S.Can - Sparrows Pt. (Amer Nat)	005-0183	NOX	7
TPS Technologies, Inc. -Todd's La.	005-2131	NOX	16
Simpkins Industries - River Rd	027-0005	NOX	87
General Electric	027-0020	NOX	82
Alltrista Metal Services	510-0508	NOX	2
Trigen (Leadenhall St)	510-2796	NOX	33
Chevron Asphalt	510-0072	NOX	49
Coca Cola	510-0242	NOX	5
Crown Cork & Seal - Duncanwood	510-0320	NOX	10
Gordon D. Garratt	510-0360	NOX	1
Proctor & Gamble	510-0185	NOX	12
Schluderberg-Kurdle	510-0283	NOX	19

20 Federal Register/Vol. 71, No. 243/ Tuesday, December 19, 2006/ Proposed Rules

Facility Name	State Facility Identifier	Pollutant Code	Emission Reduction Credits (TPY)
(Westport 510-0006 & Riverside 005-0078)	510-0006	NOX	1480
Giant - Bakery (930 King St)	031-0224	NOX	2
Armco Stainless/	510-0340	NOX	16
Bausch & Lomb	023-0019	NOX	1
Rohr Industries	043-0104	NOX	6
Showell Farms	047-0036	NOX	8
WR Grace	510-0076	NOX	17
General Motors - Truck & Bus	510-0354	NOX	119
Andrews Air Force Base	033-0655	NOX	15
Millenium Inorganic Chemicals	510-0109	NOX	30
Quebecor Printing	003-0274	VOC	322
Bethlehem Steel	005-0147	VOC	0
Pulaski Incinerator	510-0498	VOC	11
BARCO - Fairlawn	510-2854	VOC	5
Crown Cork & Seal - Duncanwood	510-0320	VOC	13
Giant - Bakery - 930 King St	031-0224	VOC	0
Cello Professional Products	025-0145	VOC	0
Grief Brothers Corporation	005-0134	VOC	0
General Motors - Truck & Bus	510-0354	VOC	0
General Motors - Electromotive	005-0692	VOC	15
Crown Central Petroleum	003-0234	VOC	21
BGE - SNG Plant	005-1054	VOC	7
Ecko-Glaco Ltd.	005-0310	VOC	27
G. Heileman Brewing Co. (Strohs)	005-0129	VOC	48
Maryland Paper Box	005-2220	VOC	15
Schlumberger Malco, Inc.	005-1614	VOC	12
U.S.Can-Sparrows Pt. (Amer Nat)	005-0183	VOC	90
TPS Technologies (Todd's La.)	005-2131	VOC	4
Simpkins Industries (River Rd)	027-0005	VOC	7
3M Commercial Graphics	013-0052	VOC	30
Blue Chip Products	015-0058	VOC	35
Baycraft Fiberglass Engineering	025-0231	VOC	10
Alltrista Metal Services	510-00508	VOC	11
Armco/Balto. Specialty Steel	510-0340	VOC	11
CE Stevens Packaging (printer)	510-2900	VOC	10
Chevron Asphalt	510-0072	VOC	2
Conoco Sun Gasoline Terminal	510-0676	VOC	27
Bata Shoe	025-0003	VOC	18
Cherokee Sanford	033-0565	VOC	0
PPG Industries	001-0005	VOC	28
Tidewater Industrial Corp.	011-0039	VOC	11
Crown Cork & Seal - Hurlock	019-0073	VOC	96

Facility Name	State Facility Identifier	Pollutant Code	Emission Reduction Credits (TPY)
Mail-Weil Graphics	019-0097	VOC	8
Metalfab - Grove Road	021-0317	VOC	11
Bausch & Lomb	023-0019	VOC	16
American Mouldings	043-0191	VOC	69
Carpenter Insulation	043-0189	VOC	146
CSX Minerals	043-0110	VOC	10
Rohr Industries	043-0104	VOC	4
Constellation - Westport 510-0006 & Riverside 005-0078	510-0006	VOC	23
Thomas Mfg.	005-0240	VOC	22
LeSaffre Yeast	510-0191	VOC	179

4.3 Actual vs. Allowable Emissions in Development of the 2009 Projected Emissions Inventories

For the purposes of calculating 2009 projection emission inventories, EPA guidance specifically outlines the circumstances under which emissions projections are to be based on actual or allowable emissions. For sources or source categories that are subject to a pre-1990 regulation and the state does not anticipate subjecting the source to additional regulation, emissions projections should be based on actual emissions levels. Actual emissions levels should also be used to project for sources or source categories that were unregulated as of 1990. For sources that are expected to be subject to post-1990 regulation, projections should be based on new allowable emissions.

To simplify comparisons between the base-year and the projected year, EPA guidance states that comparison should be made only between like emissions: actual to actual, or allowable to allowable, not actual to allowable. Therefore, all base-year and all projection-year emissions estimates are based on actual emissions.

The term "actual emissions" means the average rate, in tons per year, at which a source discharged a pollutant during a two year period, which preceded the date or other specified date, and which is representative of normal source operation. Actual emissions are calculated using the source's operating hours, production rates, and types of material processed, stored, or combusted during the selected time period.

"Allowable emissions" are defined as the maximum emissions a source or installation is capable of discharging after consideration of any physical, operations, or emissions limitations required by state regulations or by federally enforceable conditions, which restrict operations and which are included in an applicable air quality permit to construct or permit to operate, secretarial order, plan for compliance, consent agreement, court order, or applicable federal requirement.

4.4 2009 Controlled Emissions for Attainment

Chapter 6 of this SIP describes the control measures that have been or will be implemented by 2009 that will reduce emissions. Most control measures are required by federal or state regulations.

Table 4-4 presents the projected controlled emissions for the 2009 attainment year resulting from implementation of the control measures.

The projection of 2009 controlled emissions is simply the 2009 uncontrolled emissions minus the emission reductions achieved from the control measures implemented by state.

4.4.1 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 5.2.1) in 2009 from the projected uncontrolled 2009 inventories.

4.4.2 2009 Projected Controlled Inventory: Quasi-Point Sources

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

4.4.3 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.

4.4.4 2009 Projected Controlled Inventory: Nonroad Sources

2009 projected controlled inventory for nonroad sources was developed using the NONROAD model, except for locomotives, aircrafts, and aircraft auxiliary power units, which were either developed by subtracting emissions benefits in 2009 due to federal rules (see Section 5.2.3) or were developed using the EDMS model by the MWAA. The Nonroad model also used all control measures described in the Section 4.6.

<u>NONROAD Model Sources</u>

The 2009 projected controlled nonroad source inventory was created through the use of EPA's NONROAD2005 model, which is described in detail in the Section 4.2.3. The same methodology, which was used to develop the base year 2002 and uncontrolled 2009 inventories, was also used to develop controlled 2009 inventory. This methodology is described in detail in the Appendix A

Detailed model inputs are provided below in the two tables. Details of methodology for preparing temperature inputs are provided in the Appendix A Methodology to develop RVP, sulfur, and oxygen content of fuel and Stage II control is being described below. While fuel Reid Vapor Pressure (RVP) varied by jurisdiction and season, rest 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.

Development of Fuel Inputs

Monthly fuel RVP data were provided by the state air agencies. This data was averaged for each of the four seasons to get season average RVP. Mobile6.2 model default for the year 2009 was used for gasoline sulfur percent. Nonroad diesel/marine diesel/CNG/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 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 3.5%. Based on 10% Ethanol content in gasoline (by volume), Ethanol-blended fuel oxygen content of 3.5% was used for 2009. Stage II control data (zero %) is suggested by the EPA (Nonroad Model User Guide pp. 3-7) and agreed to by states.

Fuel Reid Vapor Pressure

	Values			
	Winter	**Spring**	**Summer**	**Autumn**
Washington County, MD	12.4	10.0	6.8	9.7

Other NONROAD Model Inputs (Washington County, MD)

	Values			
Parameters	**Winter**	**Spring**	**Summer**	**Autumn**
Min. Temperature	25.1	37.3	70.7	44.8
Max. Temperature	39.9	63.9	81.7	76.1
Avg. Temperature	34.8	52.7	75.8	58.6
Gas 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
Oxygen Weight (%)	3.5	3.5	3.5	3.5
Stage II Control (%)	0	0	0	0

Non-NONROAD Model Sources

Aircraft & Auxiliary Power Units

MWAA provided projected controlled 2009 commercial aircraft and auxiliary power unit emissions for Dulles (Arlington) and Reagan National (Fairfax and Loudoun) airports in their report (see Appendix A4). Base year 2002 military aircraft emissions were provided by Virginia Department of Environmental Quality, which were also used for 2009.

Railroad

Controlled 2009 railroad or locomotive emissions were developed by applying 2009 PM2.5 and NO_X controls (15.15% and 32.36% respectively) to the 2009 uncontrolled inventory:

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

4.4.5 2009 Projected Controlled Inventory: Onroad Sources

The projected controlled 2009 mobile source inventory was created through the use of transportation and emissions modeling techniques. For projected 2009 controlled inventory, all mobile model fuel inputs, Inspection & Maintenance Programs and technology controls valid for the year 2009 were used. Registration Distribution, Diesel Sales Fraction, and Vehicle Miles Traveled (VMT) used were also valid for the year 2009. Full documentation of the development of the controlled 2009 mobile inventory is included in Appendix C.

4.5 2009 Projected Controlled Inventory – Summary of Emissions

The 2009 PM2.5-Pri, NO_X, and SO2 projection year emission inventory results with control measures applied are summarized by component of the inventory in Tables 4-7 though 4-9 below.

Table 4-4: 2009 Projected Controlled Annual Inventory (TPY)

	NH3	NOx[21]	$PM_{2.5}$-PRI[22]	PM_{10}-PRI	SOx[23]	VOC	Total
Point	47.96	3,017.58	543.98	265.35	5,954.22	601.77	**10,430.86**
Quasi-Point	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Area	1,849.82	489.34	3,290.01	1,119.49	782.01	3,030.96	**10,561.63**
Non-Road	0.86	1,123.88	104.42	99.30	63.44	898.33	**2,290.23**
On-Road	213.53	5,106.94	122.78	80.69	31.11	1,472.98	**7,028.03**
Biogenics		123.01				6,203.98	**6,203.98**
Total[24]	**2,112.17**	**9,737.74**	**4,061.19**	**1,564.83**	**6,830.78**	**6,004.03**	**30,310.74**

* Small discrepancies may result due to rounding

21 The Maryland Healthy Air Act will provide additional NOx benefits in 2011.
22 The Maryland Healthy Air Act will provide PM2.5-PRI benefit
23 The Maryland Healthy Air Act will provide SO2 benefits in 2010 and additional SO2 benefits in 2012/2013.
24 Total excludes Biogenic Emissions

5.0 CONTROL MEASURES

This chapter is divided into three sections. Section 5.1 identifies the control measures that were included in the 2002 Baseline Scenario for the Washington County, MD. These regulations/ control measures continue to be in existence and continue to reduce emissions in the region. All of the emission reductions from the measures identified in Section 5.1 were part of the baseline emission inventory for the Maryland portion of the Martinsburg, WV - Hagerstown, MD nonattainment area.

Section 5.2 of this chapter identifies measures implemented after 2002 that were not part of the baseline inventory and are giving specific emission reductions to the region's $PM_{2.5}$ attainment plan demonstration.

Section 5.3 identified voluntary/ innovative measures that the Maryland is not taking formal credit for in the SIP. These measures are not commitments to programs but present information on programs that are directionally correct and could provide $PM_{2.5}$ benefits.

5.1 Control Measures Included in 2002 Baseline Scenario

The State of Maryland, Department of the Environment, Air and Radiation Management Administration has implemented the following regulations. The benefits of these programs are reflected in the 2002 baseline inventory and the 2009 projections thereof. No additional reductions are calculated.

5.1.1 Point Source Measures

Expandable Polystyrene Products

These sources use expandable polystyrene beads that contain pentane, a VOC, to manufacture foam products such as foam cups, board insulation, and custom shapes. VOC emissions typically occur during storage and pre-expansion of the beads, during manufacturing, and during "aging" when the blowing agent (pentane) slowly diffuses from the foam before shipping. This control measure requires RACT (Reasonably Available Control Technologies) to be installed at operations that manufacture foam cups, foam insulation and other foam products. The regulation became effective in July 1995.

Yeast Manufacturing

Yeast is produced using an aerated fermentation process under controlled conditions. In June 1995, MDE required RACT to be installed at two yeast-manufacturing operations. The regulation results in an overall emission reduction of approximately 60 to 70 percent from the 1990 baseline by requiring affected sources to meet specific VOC emission standards.

Commercial Bakery Ovens

This measure requires commercial bakeries using yeast to leaven bread and bread products to install RACT. Commercial bakeries generate VOC emissions from the fermentation and baking processes used to produce yeast-raised baked goods. These emissions are primarily ethanol. The regulation requires control equipment dependent upon thresholds that are based on cost effectiveness criteria.

Federal Air Toxics

This measure covers sources that are required to comply with Federal air toxics requirements. The Department has delegation to implement Federal air toxics rules that will achieve VOC emissions reductions. Federal rules that may achieve such reductions include Federal NESHAPs for vinyl chloride production plants and benzene emissions from equipment leaks, benzene storage vessels, coke by-product recovery plants, benzene transfer operations and waste operations and the EPA Maximum Achievable Control Technology (MACT) program.

Enhanced Rule Compliance

Enhanced Rule Compliance or rule effectiveness (RE) improvement refers to an improvement in the implementation of and compliance with a regulation. These RE improvements may take several forms, ranging from more frequent and in-depth training of inspectors to larger fines for sources that do not comply with a given rule.

State Air Toxics

This measure addresses stationary sources that are covered by Maryland's air toxics regulations that have achieved VOC reductions above and beyond current federally enforceable limits. In general, Maryland's air toxics regulations cover any source required to obtain a permit to construct or annually renewed state permit to operate. The Department adopted the air toxics regulations in 1988.

NOx RACT -- Reasonably Available Control Technology

This measure requires control of nitrogen oxides (NOx) emissions by installing RACT. NOx RACT will apply to utility, industrial and commercial fuel burning equipment and combustion installations. The regulation established cost-effective controls on all installations located at major NOx sources. This first phase of stationary source NOx reductions resulted in an approximate 22% reduction in NOx emissions.

NOx Phase II/Phase III Ozone Transport Commission (OTC)/NOx Budget Rule (Phase II) and NOx SIP Call (Phase III)

In 1994, the OTC member states signed a major agreement to reduce NOx emissions from power plants and other major stationary sources of pollution throughout the Northeast and Mid-Atlantic States. The agreement recognized that further reductions in NOx emissions are needed to enable the entire Ozone Transport Region (OTR) to meet the NAAQS. The Department adopted a "NOx Budget" rule to require a second phase of stationary source NOx reductions as part of this regulatory initiative. This regulation requires large stationary sources to reduce summertime NOx emissions by approximately 65% from 1990 levels. The regulation also includes provisions allowing sources to comply by trading "allowances." This regulation requires affected sources to have met these requirements by May 2000.

In late 1998, the U.S. EPA adopted its "NOx SIP Call" to reduce ozone transport in the Eastern United States. This regional NOx reduction program requires 22 states, including Maryland, to submit regulations and a revision to State Implementation Plans (SIPs) to further reduce NOx emission by 2007. Maryland's Phase III regulations achieve approximately 23% additional reductions from large stationary sources like power plants, cement kilns and large industrial boilers.

The regulations require affected sources to add specific control equipment or to reduce emissions or trade to meet the allowable amount ("cap") of seasonal NOx emissions by 2003.

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. Maryland incorporated EPA's PSD requirements by reference (COMAR 26.11.06.14). Maryland is following EPA's interim guidance calling for use of PM-10 as a surrogate for the EPA fine particle NAAQS related to the Prevention of Significant Deterioration (PSD), specifically, the April 5, 2005, Steven D. Page memorandum entitled "Implementation of New Source Review Requirements in PM-2.5 Nonattainment Areas," and the October 23, 2997 John S. Seitz memorandum entitled "Interim Implementation of New Source Review Requirements for PM2.5," referenced therein.

5.1.2 Area Source Measures

VOC Controls in Maryland

- Automotive and Light-Duty Truck Coating
- Can Coating
- Coil Coating
- Large Appliance Coating
- Paper, Fabric, Vinyl, and Other Plastic Parts Coating
- Control of VOC Emissions from Solid Resin Decorative Surface Manufacturing
- Metal Furniture Coating
- Control of VOC Emissions from Cold and Vapor Degreasing
- Flexographic and Rotogravure Printing
- Lithographic Printing
- Dry Cleaning Installations
- Miscellaneous Metal Coating
- Aerospace Coating Operations
- Brake Shoe Coating Operations
- Control of Volatile Organic Compounds from Structural Steel Coating Operations
- Manufacture of Synthesized Pharmaceutical Products
- Paint, Resin and Adhesive Manufacturing and Adhesive Application
- Control of VOC Equipment Leaks
- Control of Volatile Organic Compound (VOC) Emissions from Yeast Manufacturing
- Control of Volatile Organic Compound Emissions from Screen Printing and Digital Imaging
- Control of Volatile Organic Compounds (VOC) Emissions from Expandable Polystyrene Operations
- Control of Landfill Gas Emissions from Municipal Solid Waste Landfills
- Control of Volatile Organic Compounds (VOC) Emissions from Commercial Bakery Ovens
- Control of Volatile Organic Compounds (VOC) from Vinegar Generators
- Control of VOC Emissions from Vehicle Refinishing
- Control of VOC Emissions from Leather Coating
- Control of Volatile Organic Compounds from Explosives and Propellant Manufacturing
- Control of Volatile Organic Compound Emissions from Reinforced Plastic Manufacturing

- Control of Volatile Organic Compounds from Marine Vessel Coating Operations
- Control of Volatile Organic Compounds from Bread and Snack Food Drying Operations
- Control of Volatile Organic Compounds from Distilled Facilities
- Control of Volatile Organic Compounds from Organic Chemical Production
- Iron and Steel Production Installations
- Control of Kraft Pulp Mill Emissions

Municipal Landfills

A municipal solid waste landfill is a disposal facility where household waste is placed and periodically covered with inert material. Landfill gases are produced from the decomposition and chemical reactions of the refuse in the landfill. They consist primarily of methane and carbon dioxide, with volatile organic compounds making up less than one percent of the total emissions. The control strategy for this source category is based upon federal rules.

Burning Ban

Open burning is primarily used for the disposal of brush, trees, and yard waste and as a method of land clearing by both developers and individual citizens alike. Emissions from open burning include oxides of nitrogen, hydrocarbons, carbon dioxide, carbon monoxide and other toxic compounds. Emissions levels from open burning are high due to the inefficient and uncontrolled manner in which the material is burned. The Department adopted a regulation that prohibits open burning during the peak ozone period (June to August). There are exemptions for agricultural burning, fire training and recreational activities.

Surface Cleaning/Degreasing

Cold degreasing is an operation that uses solvents and other materials to remove oils and grease from metal parts including automotive parts, machined products and fabricated metal components. MDE adopted regulations in 1995 to require small degreasing operations such as gasoline stations, autobody paint shops and machine shops to use less polluting degreasing solvents in serious and severe ozone nonattainment areas. Also, solvent baths and rags soaked with solvents must be covered under this regulation.

Architectural and Industrial Maintenance Coatings

Architectural and industrial maintenance coatings are field-applied coatings used by industry, contractors, and homeowners to coat houses, buildings, highway surfaces, and industrial equipment for decorative or protective purposes. VOC emissions result from the evaporation of solvents from the coatings during application and drying. A federal measure requires reformulation of architectural and industrial maintenance coatings. The users of these coatings are small and widespread, making the use of add-on control devices technically and economically infeasible.

Commercial and Consumer Products

Consumer and commercial products are items sold to retail customers for household, personal or automotive use, along with the products marketed by wholesale distributors for use in institutional or commercial settings such as beauty shops, schools, and hospitals. VOC emissions result from the evaporation of solvent contents in the products or solvents used as propellants. This measure

requires the reformulation of certain consumer products to reduce their VOC content. Product reformulation can be accomplished by substituting water, other non-VOC ingredients, or low-VOC solvents for VOCs in the product.

Automobile Refinishing

Automobile refinishing is the repainting of worn or damaged automobiles, light trucks and other vehicles. Volatile organic compound emissions result from the evaporation of solvents from the coatings during application, drying and clean up techniques. This measure based on state regulation requires large and small autobody refinishing operations to use low VOC content materials in the refinishing process and cleanup, and to use efficient spray guns to control application. The Department adopted regulations in 1995 requiring the use of reformulated coatings.

Screen Printing

A screen-printing process is used to apply printing or an image to virtually any substrate. In the screen-printing operation, ink is distributed through a porous screen mesh to which a stencil may have been applied to define an image to be printed on a substrate. VOC emissions result from the evaporation of ink solvents and from the use of solvents for cleaning. The major source of VOC emissions is the printing process. This measure requires smaller printers to use water based and/or low VOC materials to reduce VOC emissions. Because the users of these coatings are relatively small, requiring the use of add-on control devices is technically and economically infeasible. Reductions in VOC emissions were obtained through the use of ink reformulation, process printing modification, and material substitution for cleaning operations. This regulation became effective on June 5, 1995.

Graphic Arts – Lithographic Printing

This source category consists of numerous small sheet-fed printers that perform non-continuous printing and web printers that print on a continuous web or roll. Heat-set web printers use drying ovens to force dry the printed matter. Web printing sources perform high volume printing on paper or paperboard. VOC emissions to the air are caused by evaporation of the ink solvents, alcohol in the fountain or dampening solution, and equipment wash solvents. These VOC discharges may also cause visible emissions and nuisance odors. MDE adopted a regulation in 1995 to require printers to use control devices and/or low VOC materials to reduce VOC emissions.

Graphic Arts – Flexographic and Rotogravure Printing

This source category consists of numerous small flexographic or rotogravure printers that perform non-continuous sheet fed printing and continuous web or roll printing. MDE adopted a printing regulation in 1987 that requires smaller printers to use control devices and/or low VOC materials to reduce VOC emissions. VOC emissions to the air are caused almost entirely by evaporation of the ink solvents. Although several control devices were evaluated over the years for rotogravure and flexographic web printers, a catalytic oxidizer has proven to be most successful. A typical oxidizer yields 96-98 percent destruction of VOC. Most sources were in compliance with all requirements by early 1992.

5.1.3 On-Road Mobile Measures

Enhanced Vehicle Inspection and Maintenance (Enhanced I/M)

The Clean Air Act requires enhanced motor vehicle inspection and maintenance (I/M) programs in serious, severe, and extreme ozone nonattainment areas and MSA/CMSA portions of the OTR with urbanized populations over 200,000. In Maryland, this required enhanced I/M program in the eight jurisdictions operating a basic I/M program as well as six new jurisdictions, for a total of 14 of the 23 jurisdictions in the state. Tailpipe emissions are measured over a transient driving cycle conducted on a dynamometer, which provides a much better indication of actual on-road vehicle performance than the existing idle test.

Tier I Vehicle Emission Standards and New Federal Evaporative Test Procedures

The Act requires a new and cleaner set of federal motor vehicle emissions standards (Tier I standards) beginning with model year 1994. The Act also requires a uniform level of evaporative emission controls, which are more stringent than most evaporative controls used in existing vehicles. These federally implemented programs affect light duty vehicles and trucks.

Reformulated Gasoline in On-road Vehicles

All gasoline-powered vehicles are affected by this control measure. Vehicle refueling emissions at service stations are also reduced. In addition, emissions from gasoline powered nonroad vehicles and equipment will be reduced by this control strategy. Since January of 1995, only gasoline that the EPA has certified as reformulated may be sold to consumers in the nine worst ozone nonattainment areas with populations exceeding 250,000.

National Low Emission Vehicle Program

The NLEV program is a vehicle technology program that provides light duty vehicles and trucks that are significantly cleaner than pre-1998 models. The National LEV program was developed through an unprecedented, cooperative effort by the northeastern states, auto manufacturers, environmentalists, fuel providers, U.S. EPA and other interested parties. National LEV vehicles are 70 percent cleaner than 1998 models. The National LEV program will result in substantial reductions in volatile organic compounds (VOCs) and oxides of nitrogen (NOx), which contribute to unhealthy levels of smog in many areas across the country.

Tier 2 Vehicle Emission Standards

In 1999, EPA proposed tighter tailpipe emissions standards for cars and light trucks weighing up to 8,500 pounds. Commonly referred to as Tier 2, these standards take effect beginning in 2004 when manufacturers start producing passenger cars that are 77 percent cleaner than those on the road today. Light-duty trucks, such as SUVs, which are subject to standards that are less protective than those for cars, would be as much as 95 percent cleaner under the new standards.

Federal Heavy-Duty Diesel Engine Rule

EPA's heavy-duty engines rule will address diesel vehicles weighing more than 8,500 pounds, These standards will take effect in 2007 and reduce emissions from new HDDEs by 95%. In order to achieve the new standards, ultra-low sulfur diesel fuel will be needed.

Stage II Recovery Systems

This measure required the installation of Stage II vapor recovery nozzles at gasoline pumps. Maryland adopted Stage II vapor recovery regulations for the Baltimore and Washington nonattainment areas and Cecil County in January of 1993. The Stage II vapor recovery regulation requires that the dispensing system be equipped with nozzles that are designed to return the vapors through a vapor line into the gasoline tank.

New Vehicle On-Board Vapor Recovery Systems

This measure required the installation of onboard refueling emissions controls for new passenger cars and light trucks beginning in the 1998 model year. The onboard refueling vapor recovery (ORVR) system was required for new passenger cars and light trucks beginning in model 1998.

5.1.4 Non-Road Measures

Nonroad Small Gasoline Engines

This measure requires small gasoline-powered engine equipment, such as lawn and garden equipment, manufactured after August 1, 1996 to meet federal emissions standards. Small gasoline-powered engine equipment includes lawn mowers, trimmers, generators, compressors, etc. These measures apply to equipment with engines of less than 25 horsepower. VOC emissions result from combustion and evaporation of gasoline used to power this equipment.

Non-Road Diesel Engines Tier I and Tier II

This measure takes credit for NOx emissions reductions from emissions standards promulgated by the EPA for non-road, compression-ignition (i.e., diesel-powered) utility engines. The measure affects diesel-powered (or other compression-ignition) heavy-duty farm, construction equipment, industrial equipment, etc., rated at or above 37 kilowatts (37 kilowatts is approximately equal to 50 horsepower). Heavy-duty farm and construction equipment includes asphalt pavers, rollers, scrapers, rubber-tired dozers, agricultural tractors, combines, balers, and harvesters. This measure applies to all compression-ignition engines except engines used in aircraft, marine vessels, locomotives and underground mining activity. NOx emissions result from combustion of diesel fuel used to power this equipment.

Marine Engine Standards

Of the nonroad sources studied by EPA, gasoline marine engines were found to be one of the largest contributors of hydrocarbon (HC) emissions (30% of the nationwide nonroad total). This measure controls exhaust emissions from new spark-ignition (SI) gasoline marine engines, including outboard engines, personal watercraft engines, and jet boat engines.

Emissions standards for large spark ignition engines

This EPA measure controls VOC and NOx emissions from several groups of previously unregulated nonroad engines, including large industrial spark-ignition engines, recreational vehicles, and diesel marine engines. The emission standards apply to all new engines sold in the United States and any

imported engines manufactured after these standards begin. Controls on the category of large industrial spark-ignition engines are first required in 2004. Controls on the other engine categories are required beginning in years after 2005. Large industrial spark-ignition 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.

Reformulated gasoline use in non-road motor vehicles and equipment
**

This federally mandated measure requires the use of lower polluting "reformulated" gasoline in the Martinsburg, WV - Hagerstown, MD. The measure involves taking credit for reductions due to the use of the reformulated gasoline in non-road mobile sources. Nonattainment areas classified as severe were required to opt in on the delivery of reformulated gasoline. This measure affects the various non-road mobile sources that burn gasoline; such as small gasoline-powered engine equipment includes lawn mowers, trimmers, generators, compressors, etc. VOC emissions result from combustion and evaporation of gasoline used to power this equipment.

Railroad Engine Standards

This measure establishes emission standards for oxides of nitrogen (NOx), hydrocarbons (HC), carbon monoxide (CO), particulate matter (PM), and smoke for newly manufactured and remanufactured diesel-powered locomotives and locomotive engines, which have previously been unregulated. This regulation took effect in 2000 and affects railroad manufacturers and locomotive re-manufacturers. It involves adoption of three separate sets of emission standards with applicability dependent on the date a locomotive is first manufactured.

5.2 Control Measures for $PM_{2.5}$ Attainment

5.2.1 Point Sources

The 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.html

The 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 (SO2) and Mercury emissions from large coal burning power plants. The Healthy Air Act also requires that Maryland become involved in the Regional Greenhouse Gas Initiative (RGGI) which is aimed at reducing greenhouse gas emissions.

The Maryland Department of the Environment (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.

Affected Sources

These Healthy Air Act NOx reduction requirements affect the following fossil fuel fired electric generating units (only the Allegheny Energy Group Systems are located in the Martinsburg, WV - Hagerstown, MD):

Constellation Energy Group System

Brandon Shores 1 & 2	Anne Arundel County
H. A. Wagner 2 & 3	Anne Arundel County
C. P. Crane 1 & 2	Baltimore County

Mirant System

Chalk Point 1 & 2	Prince George's County
Dickerson 1, 2, & 3	Montgomery County
Morgantown 1 & 2	Charles County

Allegheny Energy

R. Paul Smith, 3 & 4	Washington County

Overview of Expected Emission Reductions

Over ninety-five percent of the air pollution emitted from Maryland's power plants comes from the largest and oldest coal burning plants. The emission reductions from the Healthy Air Act come in two phases. The first phase requires reductions in the 2009/ 2010 timeframe and compared to a 2002 emissions baseline reduce NO_x emissions by almost 70%, SO2 emissions by 80% and mercury emissions by 80%.

The second phase of emission control occurs in the 2012/ 2013 timeframe. At full implementation the HAA will reduce NO_x emissions by approximately 75 percent from 2002 levels, SO_2 emissions will be reduced by approximately 85 percent from 2002 levels, and mercury emissions will be reduced by 90 percent.

Table 5-1: Maryland Healthy Air Act Annual NOx Emissions Reductions (TPY):

Unit	2002 Emissions	Uncontrolled 2009 Emissions	2009 HAA Caps	**2009 HAA Emission Reductions**	2009 HAA Emission Reduction %
R. Paul Smith 1	247.80	295.92	67	228.92	92.38%
R. Paul Smith 2	1,011.50	1,207.92	349	858.92	84.92%
TOTALS	1,259.30	1,503.84	416.00	1,087.84	86.38%

Summary - Maryland's Healthy Air Act

The point source NO_X, SO_2, and Hg direct controls are a phased approach to controlling emissions from power plants and other large fuel combustion sources. The expected emission reductions for 2009 were calculated using the emissions estimates consistent with annual allocations under the Healthy Air Act implementing regulation. The program does not allow trading of emission allowances.

5.2.2 On-Road Mobile

The following onroad emission reduction measures that are discussed in this section are calculated using the MOBILE6 emission factor model:

- Enhanced I/M
- Federal Tier 1 Vehicle Standards
- National Low Emission Vehicle Standards
- Federal Tier 2 Vehicle Standards
- Heavy Duty Diesel Engine Rule

Projected Reductions and Emission Benefit Calculations

Past SIP documents for the Baltimore region have presented the emission reductions from each of the above measures individually, and then summed the reductions to create a controlled on road inventory for each milestone year. 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 six mobile control measures listed above. These effects do not lend themselves to isolating credit from one control program, and make it very 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, 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 C for documentation of the MOBILE 6 modeling process.

Table 5-2: On-Road Mobile Emissions Reductions (TPY):

	Emission Reductions (tons per year)
	Washington County, Maryland
2009 NO_X Reductions	1,252
2009 SO_2 Reductions	178
2009 $PM_{2.5}$ Reductions	14

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

This measure involves requiring a regional vehicle emissions inspection and maintenance (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 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. The emissions tests are performed at test-only stations.

Implementation

Maryland - Motor Vehicles Administration

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.

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 per 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 mi			10 yrs / 100,000 mi		
	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 [25]	0.31	4.2	0.6 [25]
Light-duty trucks (loaded weight of 3,751 to 5,750 lbs)	0.32	4.4	0.7 [26]	0.40	5.5	0.97

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.

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 that other federal motor vehicle emissions control requirements are enforceable. The program went into effect throughout the Ozone Transport Region (OTR), including Maryland, in model year 1999 and was in place nationwide in model year 2001.

The benefits of this program are reflected in the 2002 baseline inventory and the 2008 and 2009 projections thereof. No additional reductions are calculated.

Source Type Affected

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

25 For diesel-fueled light-duty vehicles and for LDTs at 3,750 lbs, before model year 2004, the applicable NOx standards shall be 1.0 at 5 yrs/50,000 mi and 1.25 at 10 yrs/100,00 mi.
26 this NOx standard does not apply to diesel-fueled trucks of 3,751 to 5,750 lbs.

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.

Tier 2 Motor Vehicle Emission Regulations (federal regulation)

The U.S. 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 per 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.

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 parts per million (low sulfur diesel, or LSD) to 15 parts per million (ultra-low sulfurdiesel, 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.

5.2.3 New Non-Road Measures

The following non-road emission reduction measures that are discussed in this section are calculated using the NONROAD2005 emission factor model:

- EPA Non-road Gasoline Engines Rule
- EPA Non-road Diesel Engines Rule
- Emissions Standards For Spark Ignition Marine Engines
- Emissions Standards for Large Spark Ignition Engines
- Emission Standards for Locomotives are calculated using the Area Source spreadsheet but emission benefits are included in the nonroad sector totals.

Projected Reductions and Emission Benefit Calculations

Past SIP documents for the Baltimore region have presented the emission reductions from each of the above measures individually, and then summed the reductions to create a controlled on road inventory for each milestone year. NONROAD2005, the current non-road 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 non-road control measures. The table below summarizes the combined benefits from the above control measures by jurisdiction.

Table 5-3: Off-Road Mobile Emissions Reductions (TPY):

	Emission Reductions (tons per year)
	Washington County, Maryland
2009 NO_X Reductions	192
2009 SO_2 Reductions	62
2009 $PM_{2.5}$ Direct Reductions	16

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

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

Control Strategy

Federal emissions standards promulgated under §7547 (a) apply to spark-ignition non-road 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 non-handheld 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).

Emissions Standards for Diesel-Powered Non-Road 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 non-road, 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 kilowatts (37 kilowatts is approximately equal to 50 horsepower).

Control Strategy

Federal emissions standards applicable to compression-ignition non-road 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 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," 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).

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 2 – 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

Emissions Standards for Large Spark Ignition Engines (federal rule)

This EPA measure controls emissions from several groups of previously unregulated nonroad engines, including large industrial spark-ignition 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 spark-ignition engines were first required in 2004. Controls on the other engine categories began in years after 2005. Large industrial spark-ignition 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.

Standards for Locomotives (federal rule)

This 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 5 to 10 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 spreadsheet 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.

5.3 Voluntary and Innovative 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 MDE or the State to implement the programs or to achieve any specific emission reductions projected as a result of implementation of the programs, and neither MDE, nor the State makes any such commitment. In addition, MDE does 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.

5.3.1 High Electricity Demand Day (HEDD) Initiative

Emissions from Electric Generating Units (EGUs) are higher on high electric demand days, resulting in poorer air quality. High electrical demand day (HEDD) operation of EGUs 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 when air pollution levels typically reach their peaks.

The Ozone Transport Commission (OTC) has been meeting with state environmental and utility regulators, EPA staff, EGU owners and operators and the independent regional systems operators to assess emissions associated with HEDD during the ozone season and to address excess NOx

emissions on HEDDs. The OTC has found that NOx emissions are much higher on a high electrical demand day than on a typical summer day and 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 consists of gasoline and diesel combustion turbines, 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 NOx 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. The OTC MOU is included in Appendix D.

5.3.2 Emission Reductions from Transportation Measures

Substantial funding commitments have come from State and local agencies and private employers for promotion of strategies to reduce mobile emissions. Examples of these measures include idling reduction, ridesharing, telecommuting, and transit use as well as vehicle replacement and retrofit measures, and bicycle and pedestrian programs. These funding commitments produce reductions in emissions, some of which are being reflected in transportation plans.

Although these programs are working to reduce emissions from mobile sources and play an important role in the transportation sector's contribution to cleaner air, neither MDE, nor the State intends their inclusion in this SIP to constitute enforceable commitments to implement these programs or to achieve any emission reductions projected as a result of implementing these programs, and neither MDE, nor the State makes any such commitment. These directionally correct programs will continue to be used outside of the SIP for transportation planning purposes as needed.

The following are descriptions of selected emission reduction strategies occurring in and near Washington County. Information on these measures has been supplied by the Maryland Department of Transportation (MDOT) and from relevant sections of Washington County's Early Action Compact (EAC) SIP document and the June 2007 EAC Progress Report.

Traffic Flow Improvements (CHART)
The Coordinated Highways Action Response Team program, operated by MDOT and Maryland State Police, focuses its operations on non-recurring congestion such as backups caused by accidents. The Statewide Operations Center, and the three satellite Operations Centers survey the state's roadways to quickly identify incidents through the use of ITS (Intelligent Transportation System) technology. CHART also includes traffic patrols, which have been operating during peak periods on many of the state's highways since the early 1990s. On-going and planned Incident Management programs by CHART in Washington County include Highway Advisory Radio (3 locations) and CCTV (2 locations). These continued incident management and emergency information improvements to motorists will help reduce vehicular delay.

Maryland Commuter Tax Credit
As of January 2000, a tax credit went into effect statewide that allows employers to claim a 50% state tax credit for providing transit benefits (subsidy) to an employee of up to $52.50 per month, which an employer may provide to an employee without tax consequences under the Federal tax law. It is expected that the state tax credit will be even more attractive to employers as a benefit to offer employees than the Federal law (a direct tax credit as opposed to an allowable business expense). This feature of the Maryland law also has the potential to encourage increased transit use by low and moderate-income employees. Under provisions of both the 1999 and 2000 Maryland laws, private non-profit organizations will also be able to participate in the program. Employers will be able to claim a tax credit for providing transit passes and vouchers, guaranteed ride home, and parking cash-out programs. Similar to the IRS benefits, the Maryland Commuter Tax Benefit program does not provide financial assistance to carpoolers. Information is also provided online and employers are able to register to participate in the program over the Internet.

Ride Matching/Commuter Connections
MWCOG and the MTA provide incentives and support for Car & Vanpool Programs. There were approximately 143 commuters participating in these programs in Washington County as of 2007.

Transit Programs in Washington County
Washington County and the MTA provide the following transit services: County Commuter bus with 9 routes, Turning Point transit service, commuter bus from Hagerstown to Shady Grove Metro Station.

Bicycle/pedestrian Enhancements
Through MDOT, the Maryland State Highway Administration (SHA) has worked to engineer and implement new and improved bicycle and pedestrian facilities, and has implemented programs to encourage pedestrians. To promote bicycling, the SHA has designated almost 700 miles of signed bicycle lanes/routes throughout Maryland. In addition, SHA has developed the *Maryland SHA Bicycle and Pedestrian Guidelines* to provide general guidance on design. The state has a policy of considering sidewalks to reinforce pedestrian safety and promote pedestrian access adjacent to roadway projects being constructed or reconstructed. In a special effort to facilitate pedestrian and bicycle travel near schools, the SHA has instituted the Safe Routes to School Program. In addition, bicycle safety and travel are being accommodated by construction of wider shoulders, wide curb lanes and off-road pathways to separate motor vehicles from the cyclists. The Western Maryland bicycle and pedestrian Rail Trail, Phases I through IV, from Big Pool to Pearre Station was completed in 2005.

MARC Improvements
In order to insure the reliability, safety and comfort of MARC equipment the rolling stock is periodically overhauled. These include 26 MARC cars that have been or are scheduled to be refurbished between FY2005 and FY 2008. In addition, 23 locomotives are in the process of being overhauled and retrofitted to cleaner Federally required TIER standards in force at the time of the improvement. This is an ongoing effort that started in FY 2005. All the locomotives will not be improved until 2012. 100 Metro rail cars have recently been overhauled to extend their life and make them more comfortable and reliable for passengers and commuters. The MARC Brunswick Line includes service to the Brunswick station in western Frederick County (close to the Washington County line) and to points in the nearby West Virginia Eastern Panhandle. Also on the Brunswick Line, MTA plans to lengthen trains and complete the Brunswick station parking expansion by 2010.

Park and Ride Lots
The MDOT has 8 lots with 717 total parking spaces in Washington County (2007). These lots serve to accommodate carpool based work trips into the Baltimore and Washington regions. The benefits of the reduction in VMT and VT provides for a reduction in regional congestion and vehicular emissions.

Telework Center/Telecommuting
There is one telework center in Hagerstown with 32 workspaces at 78% utilization as of 2007. There is also a Telecommuting Outreach Program for home-based teleworkers.

This Page Left Intentionally Blank

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 Martinsburg, WV - Hagerstown, MD is implementing all RACM in order to demonstrate attainment with the annual PM2.5 standard on the earliest date possible.

The Maryland Department of the Environment (MDE) has prepared this RACM analysis using two independently developed lists of potential control measures. The first list consists of the RACM analysis performed for the Washington DC Region's 8-hour Ozone and PM2.5 SIPs. The MDE worked very closely with all the DC region's jurisdictions in the development of the DC Region's RACM analysis for ozone. While considering the RACM for ozone special attention was also spent on potential PM2.5 controls and after review of each potential RACM for ozone the states also considered if the item was RACM for PM2.5.

Understanding that the adjacent Washington, DC non-attainment region is both extremely similar to the metropolitan Baltimore region and was also undertaking their RACM analysis, MDE incorporated the Washington RACM criteria and analysis into this Baltimore SIP.

The Washington RACM analysis included a series of regional calls over several months to review over 200 suggested measures from numerous sources to create a master listing of measures. Each of over 200 measures was individually evaluated against established RACM criteria (the criteria is explained below).

In addition to a careful review of the Washington DC Region's RACM analysis the MDE also worked closely with the Baltimore Metropolitan Council (BMC) in developing a small list of potential transportation emission reduction measures during the fall of 2006. This analysis yielded a list of 24 specific measures that could be implemented in the Maryland portion of the Martinsburg, WV - Hagerstown, MD nonattainment area for emission reduction purposes. Based on the criteria used for RACM none of these 24 measures are to be considered RACM but these measures shall be kept on a short list of measures if the region needs additional reductions.

At the completion of the RACM analysis it was determined that no measures met the criteria.

6.1 Analysis Overview and Criteria

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 PM2.5 SIP revision can be found at 40 C.F.R. Section 51.1010; this section requires 51.1010 (a) For each PM2.5 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.

In its opinion on *Sierra Club v. EPA,* decided July 2, 2002, the U.S. Court of Appeals for the DC Circuit upheld EPA's definition of RACM, including the consideration of economic and technological feasibility, ability to cause substantial widespread and long-term adverse impacts, collective ability of the measures to advance a region's attainment date, and whether an intensive or costly effort will be required to implement the measures.

Consistent with EPA guidance and the U.S. District Court's opinion the MDE has developed specific criteria for evaluation of potential RACM measures. Individual measures must meet the following criteria:

- Will reduce emissions by the end of the 2008 calendar year as PM2.5 is an annual standard (January 1, 2008)
- Enforceable
- Technically feasible
- Economically feasible (proposed as a cost of $3,500-$5,000 per ton or less)
- Would not create substantial or widespread adverse impacts within the region
- Emissions from the source being controlled exceed a *de minimis* threshold, proposed as 0.1 tons per day

An explanation of these criteria is given in succeeding sections.

6.1.1 Implementation Date

EPA has traditionally instructed regions to evaluate RACM measures on their ability to advance the region's attainment date. This means that implementation of a measure or a group of measures must enable the region to reduce annual Pm2.5 levels to 15.0 mg/m3 as required to attain the annual PM2.5 standard at least one year earlier than expected. As the Baltimore region currently expects to reduce annual PM2.5 levels below the standard by the end of the 2009 calendar year, any RACM measures must enable the region to meet the 15.0 mg/ m3 standard by January 1, 2008.

6.1.2 Enforceability

When a control measure is added to a SIP, the measure becomes legally binding, as are any specific performance targets associated with the measure. If the state or local government does not have the authority necessary to implement or enforce a measure, the measure is not creditable in the SIP and therefore cannot be declared a RACM. A measure is considered enforceable when all state or local government agencies responsible for funding, implementation and enforcement of the measure have committed in writing to its implementation and enforcement.

In addition to theoretical enforceability, a measure must also be practically enforceable. If a measure cannot practically be enforced because the sources are unidentifiable or cannot be located, or because it is otherwise impossible to ensure that the sources will implement the control measure, the measure cannot be declared a RACM.

6.1.3 Technological Feasibility

All technology-based control measures must include technologies that have been verified by EPA. The region cannot take SIP credit for technologies that do not produce EPA-verified reductions.

6.1.4 Economic Feasibility and Cost Effectiveness

EPA guidance states that regions should consider both economic feasibility and cost of control when evaluating potential RACM measures. Therefore, the Baltimore region has specified a cost-effectiveness threshold for all possible RACM measures. Measures for which the cost of compliance exceeds this threshold will not be considered RACM.

In setting this threshold, the region took into consideration two major factors. First, EPA has issued guidance regarding the relationship between RACT and RACM. In its RACM analysis for the Dallas/Forth Worth nonattainment area, EPA states:

"RACT is defined by EPA as the lowest emission rate achievable considering economic and technical feasibility. RACT level control is generally considered RACM for major sources."

In the Baltimore region, installation of Reasonably Available Control Technology (RACT) costs are as low as approximately $3,500 per ton. The region proposes a threshold of $3,500-$5,000 for cost effectiveness.

6.1.5 Substantial and Widespread Adverse Impacts

Some candidate RACM measures have the potential to cause substantial and widespread adverse impacts to a particular social group or sector of the economy. Due to environmental justice concerns, measures that cause substantial or widespread adverse impacts will not be considered RACM.

6.1.6 *De Minimis* Threshold

In the General Preamble, EPA allows regions to exclude from the RACM analysis measures that control emissions from insignificant sources and measures that would impose an undue administrative burden. Under moderate area RACT requirements, the smallest major source subject to RACT emits 50 tpy (however, MDE considered 25 tpy sources), or approximately 0.1 tpd. Following these requirements and the precedent set by the San Francisco RACM analysis, the region will not consider control measures affecting source categories that produce less that 0.1 tpd of emissions.

6.1.7 Advancing Achievement of Annual 15.0 mg/ m3 Standard

In order for measures to be collectively declared RACM, implementation of the measures must enable the region to demonstrate attainment of the 15.0 mg/ m3 annual PM2.5 standard one full year earlier than currently expected. As discussed in this SIP document and the relevant appendices the Baltimore region currently expects to demonstrate attainment at the end of *2009.* Therefore, any RACM measures would need to enable the region to meet current standard at the end of 2008.

6.1.8 Intensive and Costly Effort

When considered together, the implementation requirements of any RACM measures cannot be so great as to preclude effective implementation and administration given the budget and staff resources available to the Baltimore region.

6.2 RACM Measure Analysis

6.2.1 Analysis Methodology

The sources of strategies analyzed for the Baltimore region include the following:

- Clean Air Act Section 108(f) measures (Transportation Control Measures)
- Transportation Emissions Reduction Measures (TERMs) listed in recent Transportation Improvement Programs (TIPs) for the Metropolitan Baltimore and Washington DC regions
- Measures identified through a review of emission reduction strategies report prepared for the Baltimore Metropolitan Council
- Measures considered in Washington, Atlanta and Houston RACM analyses

6.2.2 Analysis Results

Appendix C provides lists (in tabular form) organized by source sector, of potential measures evaluated against the RACM criteria. Each specific RACM criteria was reviewed for each individual measure identified on the lists.

Based on this analysis none of the measures reviewed were identified as RACM for the Martinsburg, WV - Hagerstown, MD.

6.3 RACM Determination

Though the measures listed in Appendix C did not meet the criteria for RACM, many of the measures are worthwhile measures that reduce emissions. These measures will be considered potential control measures for future SIPs prepared for Washington County, MD.

6.4 RACT Applicability

40 CFR 51.1010 notes that for each PM2.5 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.

Maryland has 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 demonstrate compliance with the PM2.5 NAAQS (1997) through the 2009 attainment date. As such, no further actions on RACT are warranted.

References

US EPA, "State Implementation Plans; General Preamble for the Implementation of Title I of the Clean Air Act Amendments of 1990", (57 FR 13498), April 16, 1992.

US EPA Region VI, "Reasonably Available Control Measures (RACM) Analysis for the Dallas/Fort Worth Ozone Nonattainment Area", December 2000.

Bay Area Air Quality Management District, Metropolitan Transportation Commission and Association of Bay Area Governments, "Bay Area 2001 Ozone Attainment Plan," October 24, 2001, Appendix C.

E.H. Pechan & Associates, Inc., " Review of Emission Reductions Strategies", December 8, 2006.

This Page Left Intentionally Blank

7.0 MOBILE SOURCE CONFORMITY

7.1 Significance of PM2.5 Pollutants and Precursors for Washington County, MD Nonattainment Area

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 NOx, SO_2, VOC, and ammonia (NH_3).

$PM_{2.5}$ direct and the precursors NOx and SO_2 are deemed significant under EPA guidance and EPA requires that $PM_{2.5}$ direct, NOx, and SO_2 controls be evaluated and included in the SIP. Through consideration of available information (with EPA and surrounding nonattainment states such as Virginia and Washington DC), the MDE has completed significance determinations for each of the PM precursors (Please refer to Section 2.8 for full details). The significance determination for Washington County was reviewed during the interagency consultation process by the Hagerstown/Eastern Panhandle metropolitan planning organization (memo from MDE to HEPMPO Air Quality Advisory Committee in Appendix D).

The precursor that EPA guidance indicates may be significant for mobile source purposes, and which the states believe is insignificant, is SO_2. SO_2 is a significant precursor for SIP planning purposes, but a motor vehicle emission budget for SO_2 is not required for the following reasons. First, based on 2002 base year and 2009 projected year inventories modeled by VISTAS/MANE-VU, SO_2 emissions from on-road sources represent less than 2 percent of the total overall SO_2 emission inventory for the region and are not a significant source of total overall SO_2 precursor emissions in the region. Second, federal requirements for sale of low-sulfur fuel are expected to substantially reduce SO_2 emissions from on-road sources by 2009.

7.2 Transportation Conformity

Transportation conformity ("conformity") is a provision of the Clean Air Act that ensures that Federal funding and approval goes to those transportation activities that are consistent with air quality goals. Conformity applies to transportation plans and projects funded or approved by the Federal Highway Administration (FHWA) or the Federal Transit Administration (FTA) in areas that do not meet or previously have not met air quality standards for ozone, carbon monoxide, particulate matter, or nitrogen dioxide.

In order to balance growing metropolitan regions and expanding transportation systems with improving air quality, EPA established regulations ensuring that enhancements to existing transportation networks will not impair progress towards air quality goals. Under the Clean Air Act Conformity Regulations, transportation modifications in an ozone or carbon monoxide nonattainment area must not impair progress made in air quality improvements. These regulations, published in EPA's Transportation Conformity rule on November 24, 1993 in the Federal Register and amended in a final rule signed on July 31, 1997, require that transportation modifications "conform" to air quality planning goals established in air quality SIP documents. The 1997 amendments were followed by further amendments in 2002 and 2004.

On May 6, 2005, EPA published a final rule that addressed the requirements for considering transportation-related $PM_{2.5}$ precursor emissions in conformity. On March 10, 2006, EPA published a final rule that established requirements for project-level ("hotspot") conformity determinations in $PM_{2.5}$ nonattainment and maintenance areas.

In essence, this SIP submission includes mobile emissions budgets for direct PM2.5 and NOx. These budgets, once EPA finds them adequate, shall be used in all conformity documents for the Washington County Nonattainment Area. In order for a transportation plan to "conform" the estimated emissions from the transportation plan can't exceed the emissions budgets set via this SIP submission. If the estimated emissions are shown to exceed the budget then mitigation measures must be taken to ensure emissions will not exceed the emission budgets.

7.2.1 Responsibility for Making a Conformity Determination

The policy board of a Metropolitan Planning Organization (MPO), in consultation with the Maryland Department of Transportation (MDOT) and MDE, is responsible to formally make a conformity determination on its transportation plans and transportation improvement programs (TIPs) prior to submittal to the FHWA and FTA for review. The USEPA also may review and comment on proposed conformity determinations.

If a particular transportation plan's projected emissions exceed the mobile emissions budget, the MPO has a variety of mitigation options to reduce emissions. These may include but are not limited to specific transportation emission reduction measures such as HOV lanes, transit enhancements, bicycle lanes, diesel retrofits, and idling reductions.

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) was enacted on August 10, 2005. Under this act, amendments were made to the transportation conformity rules (Section 6011 of the Act), which required states that have nonattainment areas like Maryland to revise their existing transportation conformity SIPs. Maryland submitted a revised transportation conformity SIP to USEPA in February of 2007. Because of changes mandated by SAFETEA-LU, conformity determinations have to be done at least every four years instead of the previous three years.

When a positive conformity determination is not made according to the required frequency, or in the event that emission mitigation can't be agreed upon, a nonattainment area is in conformity "lapse". This means that Federal transportation funds allocated to the state, which contains the lapsed nonattainment area, can only be used for the following kinds of projects:

1. TCMs in Approved SIPs;
2. Non-Regionally Significant Non-federal Projects;
3. Regionally Significant Non-federal Projects - only if the project was approved by all necessary non-federal entities before the lapse. (See Approval of a Regionally Significant Non-Federal Project by a Non-Federal Entity later in this Chapter.)
4. Project phases (i.e., design, right-of-way acquisition, or construction) that received funding commitments or an equivalent approval or authorization prior to the conformity lapse.
5. Exempt Projects - identified under 40 CFR §93.126and 40 CFR §93.127; and,
6. Traffic Synchronization Projects - however, these projects must be included in subsequent regional conformity analysis of MPO's transportation plan/TIP under 40 CFR §93.128.

The amount of federal funding a state receives is not reduced but such funds are restricted until the area can again demonstrate conformity.

7.2.2 Mobile Emissions Budget and the Baltimore Region Transportation Conformity Process

Mobile source emissions in the Hagerstown Urbanized Area FY 2008-2010 Transportation Improvement Program (TIP) cannot exceed the mobile emissions budget. The transportation plans are required to conform to the mobile budget established in the SIP for the short-term TIP years, as well as for the forecast period of the long-range plan, which must be at least twenty years. In areas of Washington County outside the Hagerstown Urbanized Area, the Maryland Department of Transportation (MDOT) acts on behalf of the county to include projects in the two counties in the State Transportation Improvement Program (STIP).

In Washington County, modifications to the existing transportation network are advanced through the state, regional and local transportation agencies through periodic updates to the long-range plan and TIP. The TIP is updated annually for Washington County and includes transportation modifications and improvements on a four-year program cycle. Pursuant to the conformity regulations, the plan and TIP must contain analyses of the motor vehicle emissions estimates for the region resulting from the transportation improvements. These analyses must show that the transportation improvements in the TIP and the plan do not result in a deterioration of (conform to) the air quality goals established in the SIP.

7.3 Budget Level for On-Road Mobile Source Emissions

As part of the development of the SIP, MDE, in consultation with MDOT and the Hagerstown Eastern Panhandle MPO (HEPMPO), establishes a mobile source emissions budget. This budget will be the benchmark used to determine if the region's long-range transportation plan and five-year transportation improvements program (TIP) conform to the SIP. Under EPA regulations the projected mobile source emissions for 2010 become the mobile emissions budgets for the region unless MDE takes actions to set other budget levels.

7.3.1 Modeling and Data

The 2009 mobile emissions inventories are calculated using the following models: EPA's MOBILE6.2 and the Highway Performance Monitoring System (HPMS) model. A detailed explanation of the model and the emission estimating methodology can be found in Appendix D. The mobile emissions budgets for the 2009 attainment year are based on the projected 2009 mobile source emissions accounting for all the mobile control measures and projected regional growth.

7.3.2 Attainment Year Mobile Budgets

The PM2.5 mobile emissions budgets for the 2009 attainment year are based on the projected 2009 mobile source emissions accounting for all mobile control measures. The mobile emissions budgets for the 2009 Attainment Year, based upon the projected 2009 mobile source emissions accounting for all the mobile control measures, are 80.69 tons per year PM2.5 direct and 5106.94 tons per year NOx.

Table 7-1: 2009 Attainment Mobile Budgets for the Washington, County, MD

Direct PM2.5 (TPY)	80.69
NOx (TPY)	5106.94

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 of Maryland is taking action to implement regional measures to reduce emissions of $PM_{2.5}$ and $PM_{2.5}$ precursors. Table 8-1 provided information on the implementation of each measure by Maryland.

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

8.1 Schedule of Adopted Control Measures

Table 8-1:
Maryland Schedule of Adopted Control Measures
Martinsburg, WV - Hagerstown, MD

No.	Control Measure	Mandate	Regulation Number	Effective Date
	Point Source Controls			
5.1.1	Maryland Healthy Air Act	Maryland Regulation		
	Non-road Source Controls			
5.3.1	EPA Non-Road Gasoline Engines Rule	Federal Regulation	40 CFR parts 90 and 91	12/3/96
5.3.2	EPA Non-Road 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	1998 Model Year
5.3.4	EPA Large Spark Ignition Engines Rule	Federal Regulation	40 CFR Parts 89, 90, 91, 94, 1048, 1051, 1065, and 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 & 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

No.	Control Measure	Mandate	Regulation Number	Effective Date
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 RACT Applicability

According to federal regulation (40 CFR 51.1010) for each $PM_{2.5}$ nonattainment area, 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 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 action on RACT is warranted.

8.3 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 PLAN DEMONSTRATION AND WEIGHT OF EVIDENCE

The annual and 24-hour $PM_{2.5}$ Standard Attainment Demonstration analyzes the potential of the Hagerstown-Martinsburg, MD-WV Nonattainment Area (NAA) to achieve attainment of the annual and 24-hour $PM_{2.5}$ standard by April 5, 2010. The attainment demonstration will only focus on the Maryland portion of the NAA and is comprised of the following sections: Modeling Study Overview, Domain and Data Base Issues, Model Performance Evaluation, Attainment Demonstration, Weight of Evidence Demonstration and Procedural Requirements.

9.1 Modeling Study Overview

9.1.1 Background and Objectives

On December 17, 2004, the Environmental Protection Agency (EPA) designated areas for 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.

A portion of the Hagerstown Metropolitan Statistical Area (MSA) was classified as a NAA for $PM_{2.5}$ with an attainment date of April 5, 2010. Once an area is designated as a NAA, the Clean Air Act requires the submittal of an implementation plan to EPA within three years. State plans are due in April 2008. States may also propose an attainment date extension for up to five years. Those areas for which EPA approves an extension must achieve clean air as soon as possible, but no later than April 5, 2015.

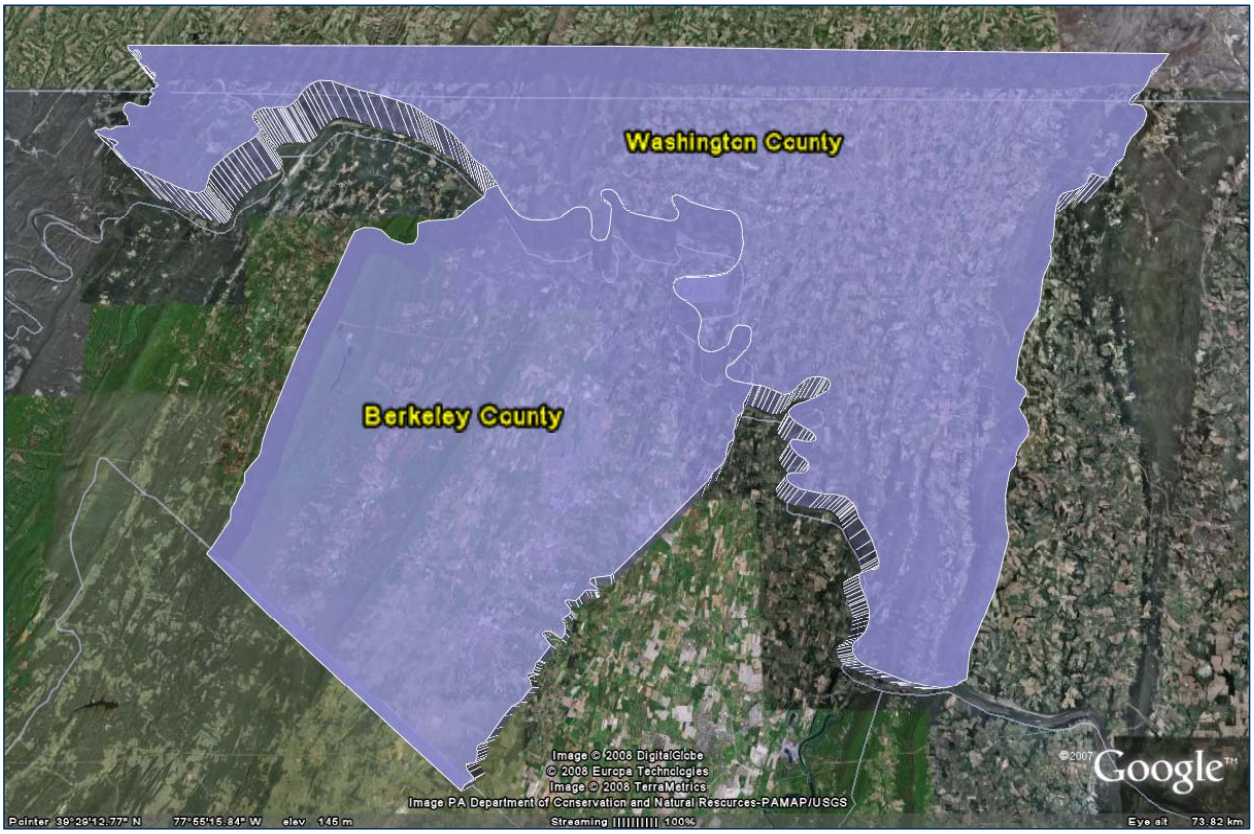
Table 9-1 identifies all jurisdictions that EPA has designated as nonattainment for $PM_{2.5}$ within the Hagerstown-Martinsburg, MD-WV NAA.

Table 9-1: Hagerstown-Martinsburg, MD-WV NAA Designations for 24-Hour and Annual $PM_{2.5}$ Standards

Jurisdiction	Counties	Classification	Maximum Attainment Date (from 2004)
Maryland	Washington	Nonattainment	April 5, 2010
West Virginia	Berkeley	Nonattainment	April 5. 2010

Figure 9-1 provides a graphical representation of the Hagerstown-Martinsburg, MD-WV.

FIGURE 9-1: HAGERSTOWN-MARTINSBURG, MD-WV NAA



The State of Maryland is located within the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Regional Planning Organization (RPO)

The MANE-VU RPO was tasked with the assignment of preparing a $PM_{2.5}$ modeling platform for the MANE-VU region that all MANE-VU states could use to demonstrate compliance with the $PM_{2.5}$ standards. It is the responsibility of the Maryland Department of the Environment (MDE) for preparing this attainment demonstration for the Maryland portion of the Hagerstown-Martinsburg, MD-WV NAA.

This modeling study is designed to demonstrate attainment of the $PM_{2.5}$ standards by April 5, 2010. The procedures followed in this 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).

The Hagerstown-Martinsburg, MD-WV NAA modeling analyses was directed by the MDE with modeling assistance from the University of Maryland at College Park (UMD).

9.1.2 Relationship to Regional Modeling Protocols

The state of Maryland is a member of MANE-VU RPO and along with other member MANE-VU states, was able to coordinate the modeling analyses performed for the Hagerstown-Martinsburg, MD-WV NAA with the regional modeling analyses conducted by MANE-VU RPO.

The lead agency for coordinating the running of the CMAQ model and performing the modeling runs for MANE-VU was the New York State Department of Environmental Conservation (NYSDEC). Modeling centers for MANE-VU included the NYSDEC, UMD, the Northeast States for Coordinated Air Use Management (NESCAUM), the New Jersey Department of Environmental Protection (NJDEP) and the Virginia Department of Environmental Quality (VADEQ). Even through the NYSDEC was the lead modeling agency for coordinating the running of the CMAQ model for MANE-VU other member states of MANE-VU, within the frame-work of MANE-VU, managed the modeling project jointly. All additional modeling for the Hagerstown-Martinsburg, MD-WV NAA was directed by MDE and performed by UMD under contract with the MDE. All modeling inventories were developed, updated and shared among the regional modeling centers and were provided by MARAMA and MANE-VU.

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

9.1.3 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 three documents. The first was prepared by NESCAUM for use by the MANE-VU 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 G-1. This document provides the conceptual description of the fine particle issues in the MANE-VU states, consistent with the EPA's guidance.

The second conceptual description document that is included in Appendix G-1 is a Conceptual Model of $PM_{2.5}$ Concentrations in Maryland (Ryan, May 2007). The purpose of this conceptual model is to place the observations of $PM_{2.5}$ in the context of climate and weather conditions in order to aid policy makers in determining the best implementation plan to reach attainment with the $PM_{2.5}$ NAAQS.

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 $PM_{2.5}$ concentrations, 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 NAA. 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 G-2. This domain covers the Northeast region including northeastern, central and southeastern US as well as southeastern Canada.

9.2.3 Horizontal Grid Size

The MANE-VU platform that provides the basic platform for the Hagerstown-Martinsburg, MD-WV NAA modeling analyses 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 the MANE-VU region and surrounding RPO regions. Appendix G-3 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 G-4 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 17-day ramp-up period, which was 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 Hagerstown-Martinsburg, MD-WV NAA 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 Appendix G-5 were selected. Results of various analyses including the UMD's detailed performance evaluation of the MM5 modeling used in conjunction with the MANE-VU platform are provided in Appendix G-6.

9.2.7 Emissions Model Selection and Configuration

Significant coordination efforts took place between MANE-VU and other RPO's in the development of the emissions inventories used in the modeling study. These inventories included 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 Hagerstown-Martinsburg, MD-WV NAA modeling analysis.

SMOKE (Version 2.1) was used for the Hagerstown-Martinsburg, MD-WV NAA attainment modeling demonstration. 2002 base case and 2009 future base case emissions data files were provided by MANE-VU.

Detailed SMOKE configurations are provided in Appendix G-7.

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 G-8.

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 RPOs 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

9.3.1 Overview

A critical component of every air quality modeling study is the model performance evaluation where the modeled estimates for the 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 this report concise, that the air quality model will be 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 $PM_{2.5}$ and its individual components (i.e., sulfate, nitrate, ammonium, organic carbon, elemental carbon and other constituents) in the right locations and concentrations. 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 NYSDEC, Division of Air Resources, conducted a performance evaluation of the 2002 base case CMAQ simulation on behalf of the MANE-VU member States. Appendix G-9 and Section 9.5.7 (Weight of Evidence, CMAQ $PM_{2.5}$ Modeling) 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.

9.3.2 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 to 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 9-2.

Table 9-2. 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 the VISTAS RPO) to help evaluate model performance.

Table 9-3. VISTAS RPO $PM_{2.5}$ 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 ug/m^3.

- Approaching 200% error and ±200% bias when the mean of the observed concentrations are extremely small.

The preceding 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 extended the evaluation to include the entire year of 2002 observations. Four statistical parameters, two recommended by EPA (Table 9-2) and two adopted by VISTAS RPO (Table 9-3), 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 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 Maryland was also generated; see Section 9.5.7 (Weight of Evidence, CMAQ $PM_{2.5}$ Modeling). 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 Attainment Demonstration).

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 9-2 depicts the location of the FRM, STN and IMPROVE monitor 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 9-3. This figure indicates that there is an overall mean bias of approximately 4 μg/m^3. There is a general over-prediction during the winter months and an under prediction during the summer months. There is excellent agreement during a mid-August poor air quality episode.

FIGURE 9-2: LOCATIONS USED FOR THE MODEL EVALUATION ACROSS THE OTR+ REGION: FRM (●, 264), STN (■, 50), AND IMPROVE (▲, 21)

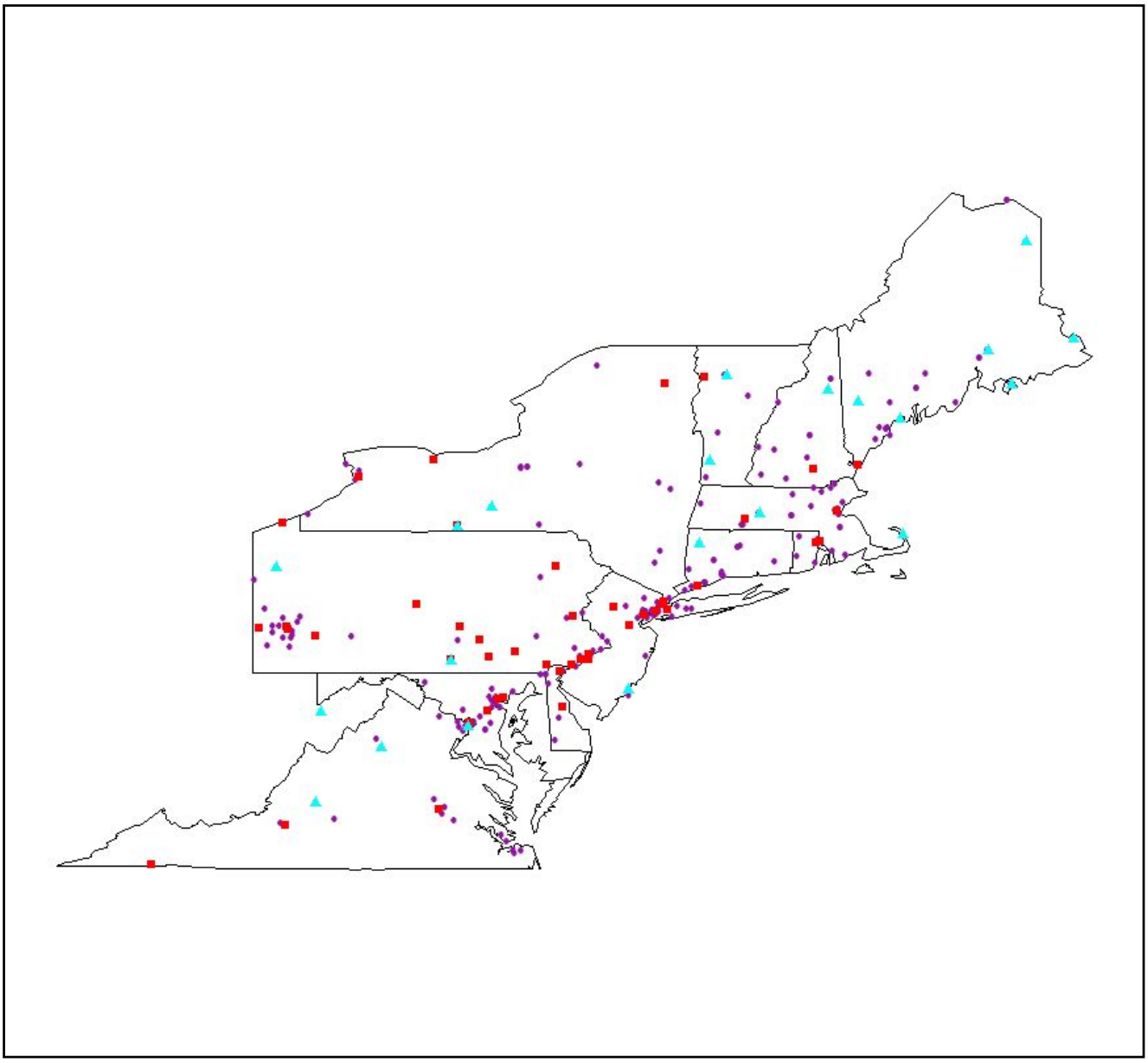


FIGURE 9-3: COMPOSITE FRM TIME SERIES ACROSS THE OTR+ REGION (264 MONITORS)

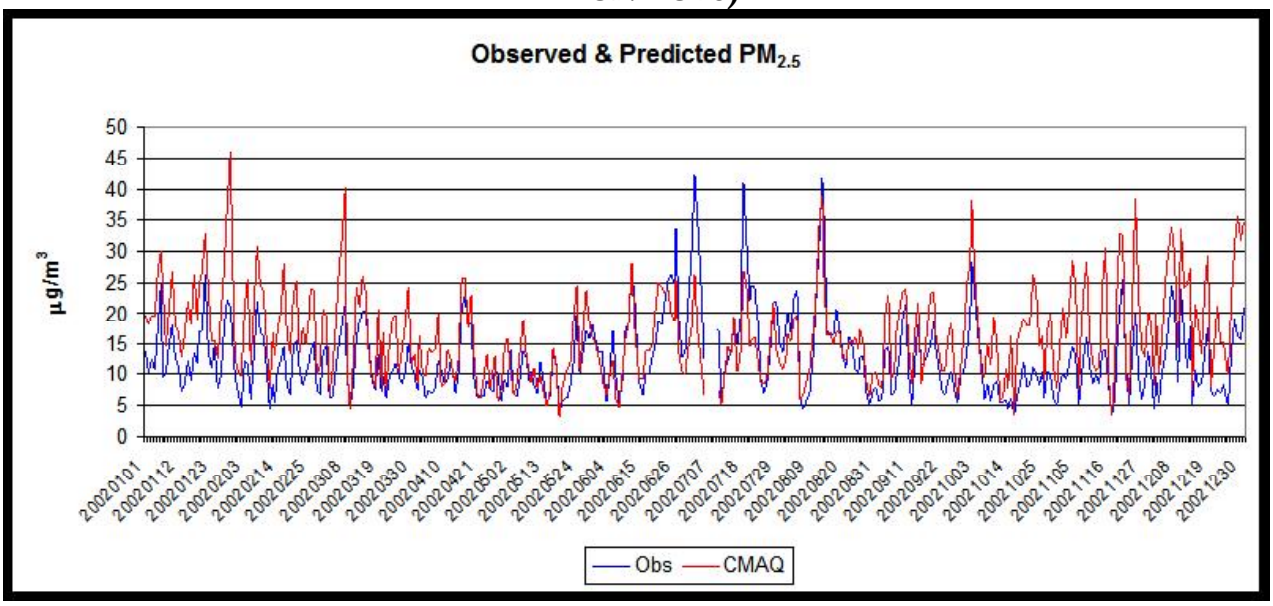
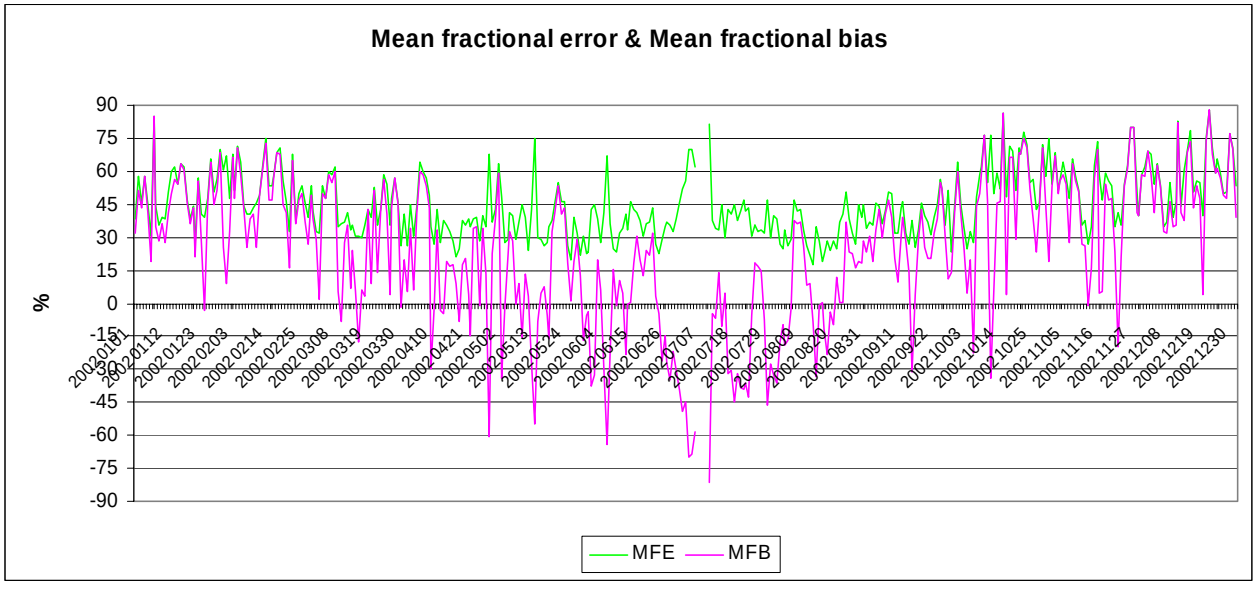


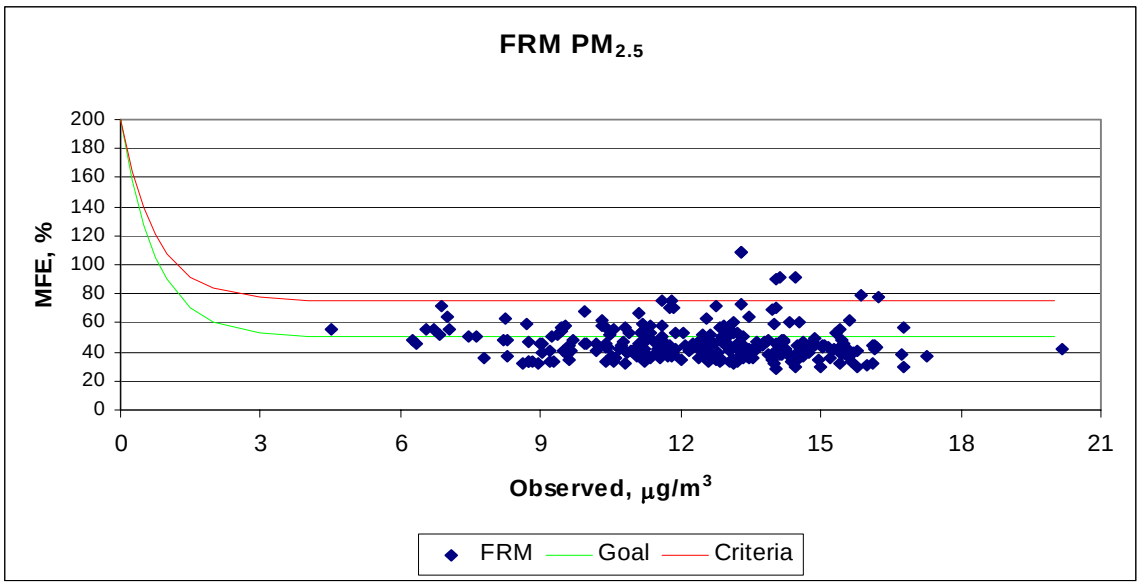
Figure 9-4 is a plot of the FRM mean fractional error (MFE) and mean fractional bias (MFB) across the OTR+ region. MFE ranges from 17% to 88% with an average of approximately 45%. MFB ranges from -82% to +88% with an average of approximately +24%. These values are generally consistent with similar studies 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 9-4: MFE AND MFB TIME SERIES FOR FRM $PM_{2.5}$ ACROSS THE OTR+ REGION



An MFE bugle plot for FRM $PM_{2.5}$ across OTR+ region is provided in Figure 9-5. "Goal" curves are the best a model can be expected to achieve while the "criteria" curves are considered acceptable for model performance. 258 of 264 sites satisfy the "criteria" restriction on an annual average basis.

FIGURE 9-5: MFE 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 9-6 through 9-11. As can be seen from the results, the performance for individual species is generally consistent with the criteria necessary for acceptable model performance.

FIGURE 9-6: MFE BUGLE PLOT FOR SO_4 ACROSS OTR+ REGION

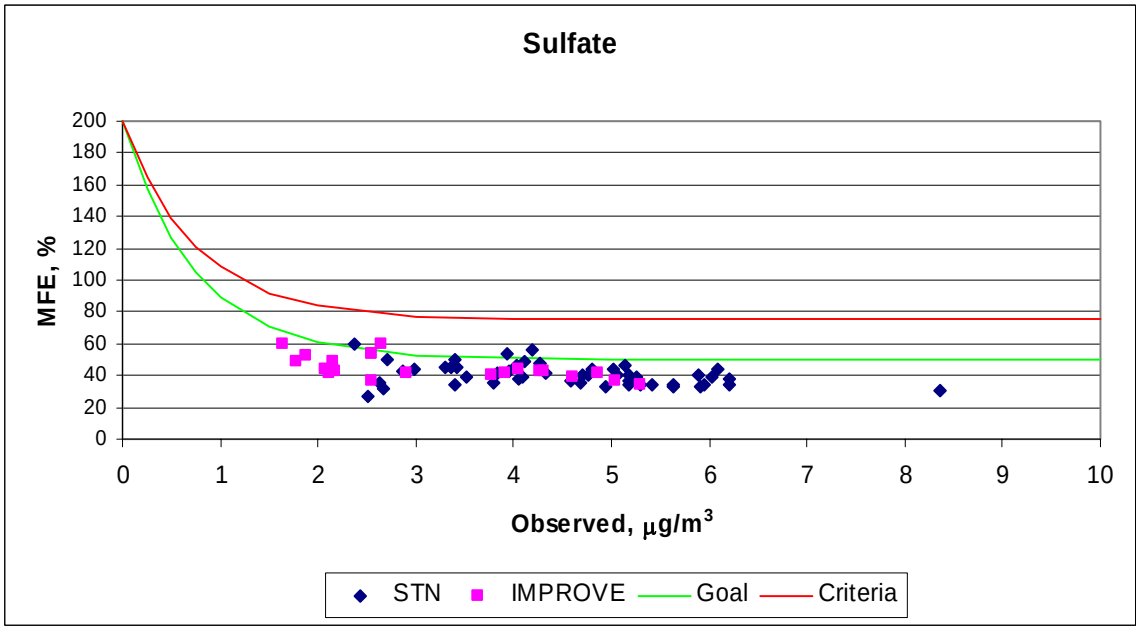


FIGURE 9-7: MFE BUGLE PLOT FOR NO_3 ACROSS OTR+ REGION

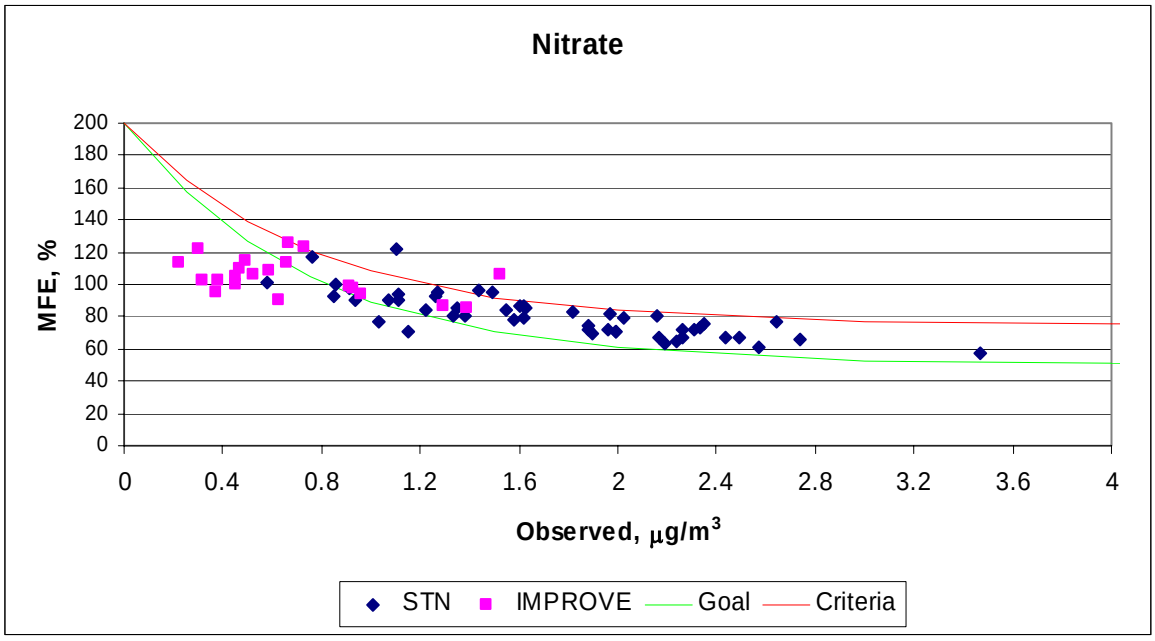


FIGURE 9-8: MFE BUGLE PLOT FOR NH_4 ACROSS OTR+ REGION

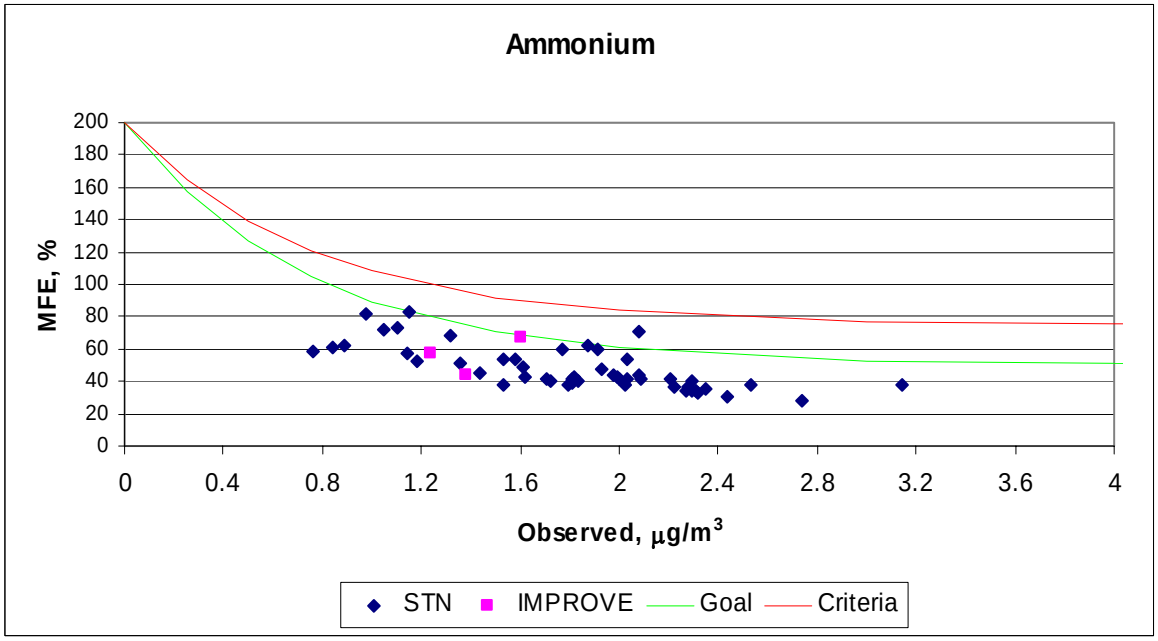


FIGURE 9-9: MFE BUGLE PLOT FOR EC ACROSS OTR+ REGION

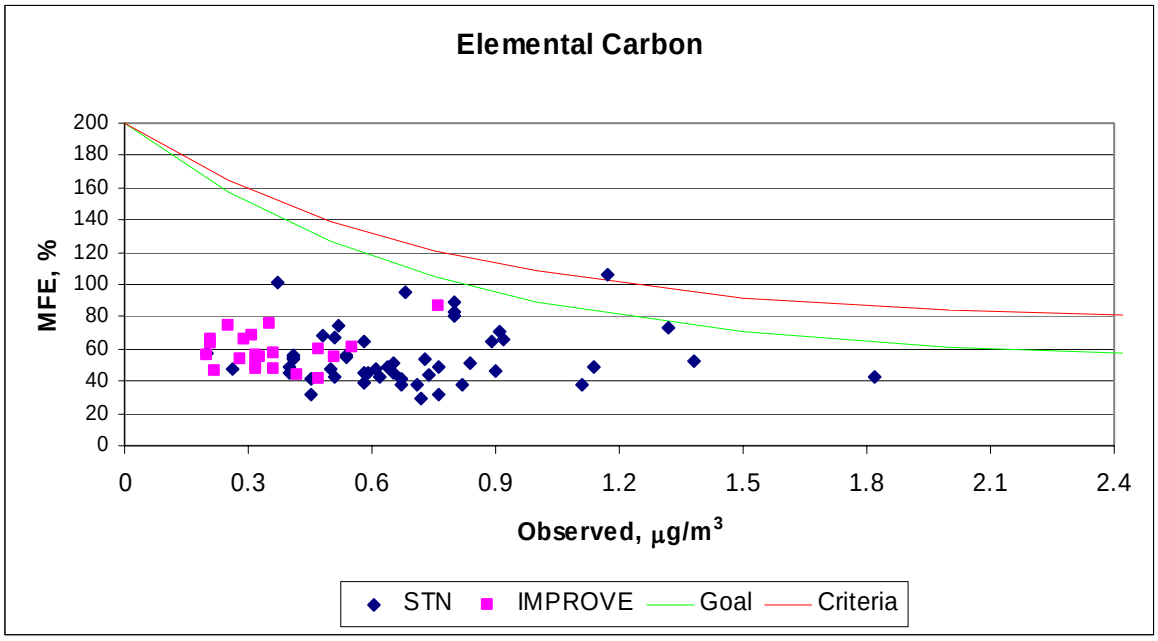


FIGURE 9-10: MFE BUGLE PLOT FOR OM ACROSS OTR+ REGION

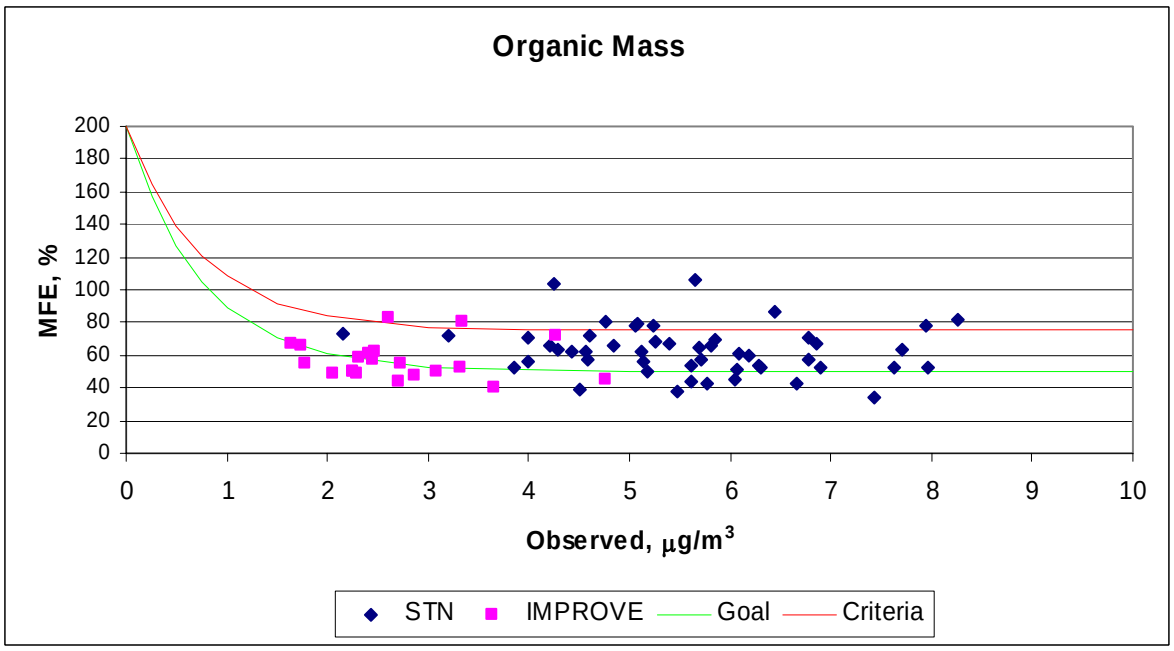
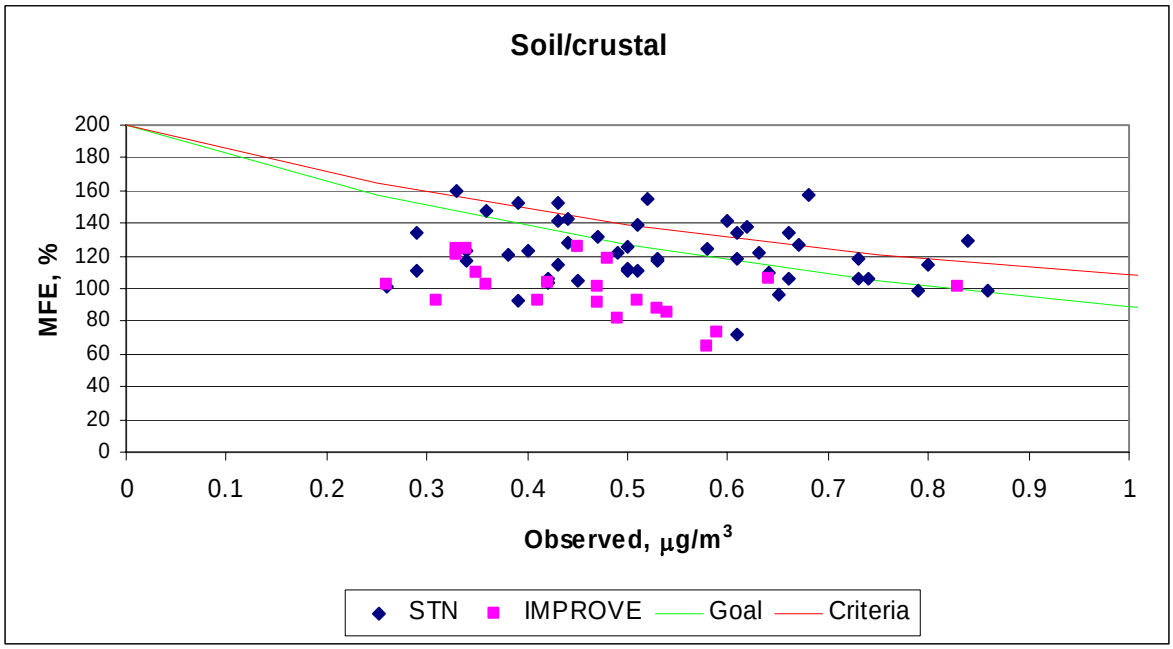


FIGURE 9-11: MFE BUGLE PLOT FOR SOIL/CRUSTAL ACROSS OTR+ REGION



Concentration-dependent performance goals for sulfate, ammonium, and elemental carbon are easily met. Concentration-dependent performance criteria for nitrate, organic mass, and soil/crustal material are met at nearly all IMPROVE sites and most STN sites.

The following is a list of several $PM_{2.5}$ statistics for the OTC domain that have also been provided in Appendix G-9.

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+). [Figure 9-3, Figure 9-4 (by date), Figure 9-5 (by site).]

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+). [Figure 9-5 to Figure 9-11 (by site).]

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+). [Figure 9-5 to Figure 9-11 (by site).]

There was insufficient data to warrant a separate statistical evaluation of individual species focusing on the Hagerstown-Martinsburg, MD-WV NAA.

9.3.3 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.

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

1. Organic matter (OM) is comprised of primary and secondary components. Approximately 80-90% of CMAQ calculated OM consists of primary OM. Observed OM has a distinct maximum during the summer when secondary formation is highest; CMAQ exhibits substantial under-prediction of secondary organic aerosol (SOA) formation.
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.

Seasonal biases in the CMAQ calculated $PM_{2.5}$ component concentrations are not of great regulatory concern since attainment tests are based on the application of relative response factors to observed concentrations. 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 (SIP) to meet the 24-hour and annual $PM_{2.5}$ NAAQS.

9.4 Attainment Demonstration

9.4.1 Overview

As previously mentioned, a portion of the Hagerstown MSA has been classified as a NAA area for $PM_{2.5}$ with an attainment date of April 5, 2010. The 1997 $PM_{2.5}$ NAAQS includes 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 is described in further detail in the following portions of this section and the additional corroborative analyses are presented in Section 9.5.

9.4.2 Modeled Attainment Test

The purpose of a modeling assessment is to 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) 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 if 2009 projections of $PM_{2.5}$ will meet the NAAQS from regional modeling, as suggested in EPA's guidance.

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.

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.

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 the Section Mean $PM_{2.5}$ Baseline Design Values) 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.

SANDWICH

As EPA guidance states, 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 (PBW) 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 meteorological 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 PBW 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]}).

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 currently developing a 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 was unavailable at the time this modeling demonstration was being prepared. When the MATS tool is available it will be used as recommended by EPA.

Due to the MATS tools being unavailable at the time of this analysis, it was decided to investigate the use of speciated data from either the Fort Meade or Essex monitoring sites located within Maryland. The Essex site was chosen due to the extensive speciated database and the representativness of the data (i.e., urban). When averaged over a season, the fractional composition of $PM_{2.5}$ at Essex should contain a larger contribution from organic carbon and elemental carbon and a smaller contribution from sulfate, nitrate, and ammonium than a more rural site. Since the largest reductions are projected to be in sulfate, this approach makes the calculation more conservative. The observed contribution of Ammonium, Elemental Carbon, Nitrate, Organic Carbon, Sulfate, Other Primary $PM_{2.5}$, and PBW by percentage of total $PM_{2.5}$ at both the Essex and Fort Meade monitoring sites are provided in Section 9.5.7 (Weight of Evidence, CMAQ $PM_{2.5}$ Modeling). Appendix G-10 contains data needed to calculate 24-hour and annual design values.

After evaluating both the Fort Meade and Essex speciated data it was decided that the Essex data would be used, as it would give the most conservative estimate of future year design values.

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 RRF 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 $PM_{2.5}$.

Annual SMAT Results

Table 9-3 presents the annual SMAT results for the Hagerstown-Martinsburg, MD-WV NAA. The SMAT results demonstrate that the Hagerstown FRM monitor attains the annual $PM_{2.5}$ NAAQS. Specifically, the future design value (DVF) is less than15.0 $\mu g/m^3$.

Table 9-3. Annual SMAT Results for Hagerstown-Martinsburg, MD-WV NAA 2009 Beyond-On-The-Way Control Measures

AIRS ID	Site Name	County	State	2000-2004 DVB					2009
				Q1	Q2	Q3	Q4	#Q	DVF
240430009	Hagerstown	Washington	MD	13.08	14.80	17.16	12.00	20	11.8

24-Hour SMAT Results

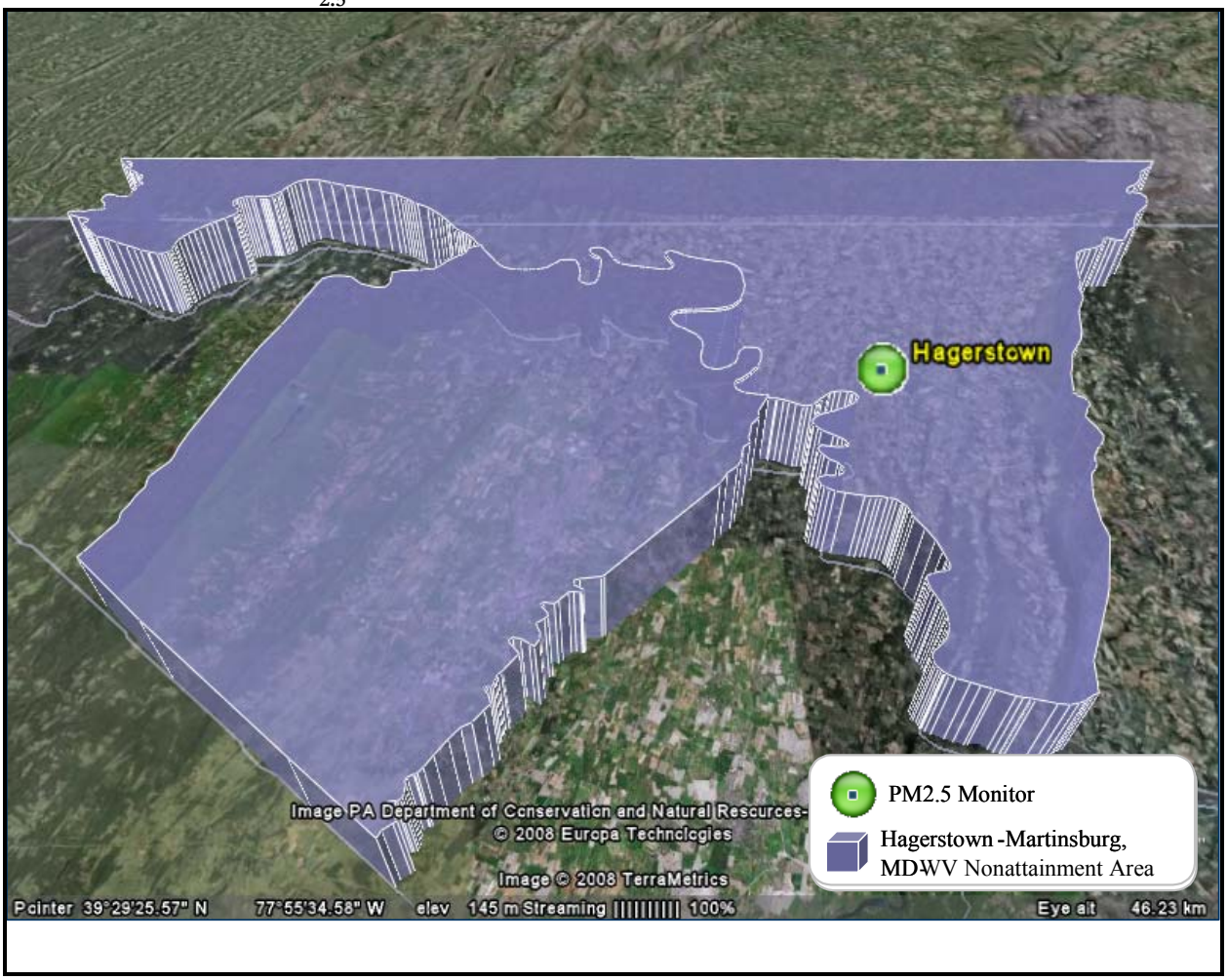
Table 9-4 presents the results of the 24-hour SMAT results for the Hagerstown-Martinsburg, MD-WV NAA. The SMAT results demonstrate that the projected average annual arithmetic mean $PM_{2.5}$ concentration calculated at the Hagerstown FRM monitor attains the 24-hour $PM_{2.5}$ NAAQS. Specifically, all future design value (DVF) calculations are well below 65 $\mu g/m^3$.

Table 9-4. 24-Hour Modeling Attainment Test Using EPA SMAT Methodology 2009 Beyond-On-The-Way Control Measures

AIRS ID	Site Name	Jurisdiction	State	24-Hour 98th Percentile DVB					2009
				2000	2001	2002	2003	2004	DVF
24043009	Hagerstown	Washington	MD	39.9	41.6	42.7	34.3	39.2	31.3

Figure 9-12 shows the location of the Maryland monitors in the Hagerstown-Martinsburg, MD-WV NAA.

FIGURE 9-12: HAGERSTOWN-MARTINSBURG, MD-WV NONATTAINMENT AREA MARYLAND $PM_{2.5}$ MONITORS USED IN THE MODELING DEMONSTRATION



9.4.3 Unmonitored Area Analysis

The modeled attainment test does not address future air quality at locations where there is not a $PM_{2.5}$ 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 Maryland portion of the Hagerstown-Martinsburg, MD-WV NAA MDE currently operates one $PM_{2.5}$ monitor. This monitor was established as a State and Local Air Monitoring Station (SLAMS). This SLAMS monitor was selected based on the specific EPA monitoring objective of population exposure and EPA's neighborhood siting scale.

It is believed that this single monitor relieves the necessity of applying this additional analysis. Despite being confident that this single monitor is enough to cover the Maryland portion of the Hagerstown-Martinsburg, MD-WV NAA, 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 MDE will consider evaluating the MATS tool output, if warranted.

9.4.4 Local Area Analysis

Based on a 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 nonattainment of the NAAQS. At this time, no monitors within the Hagerstown-Martinsburg, MD-WV NAA that are projected to exceed the NAAQS so it does not appear to be 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 a "hot spot" monitor.

9.4.5 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 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.

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.

9.5 Weight of Evidence Demonstration

EPA modeling guidance allows for other supplemental evidence to be used in order to address the issue of model uncertainties so that a proper assessment of an area's probability to attain the annual and 24-hour $PM_{2.5}$ standards. These uncertainties associated with emissions inventories, meteorological data, and the model's $PM_{2.5}$ chemistry, all have the potential to lead to over or under predictions of modeled $PM_{2.5}$ concentrations.

According to EPA modeling guidance, basic supplemental analyses should be completed to confirm the outcome of the modeled attainment test if the results show modeled $PM_{2.5}$ concentrations below 14.5 $\mu g/m^3$ and 62 $\mu g/m^3$ for the $PM_{2.5}$ annual and 24-hour standards, respectively. Due to the fact that the modeling results presented in Tables 9-3 and 9-4 are well below the aforementioned "weight of evidence" thresholds established by EPA, a limited supplemental analysis was deemed necessary to support the 2009 attainment demonstration

This section will be primarily based on the work completed by the UMD.

This section will examine the state of the science of aerosols over the Mid-Atlantic region and focus on trends and both measurement and modeling uncertainties of $PM_{2.5}$. After examining all the supporting evidence presented in Appendix G-11, the conclusion will be reached that Maryland is pursing an effective and comprehensive $PM_{2.5}$ strategy, which will lead to attainment of the annual and 24-hour $PM_{2.5}$ NAAQS.

9.5.1 Trend in $PM_{2.5}$ Design Values

Figures 9-13 and 9-14 show trends in annual and daily $PM_{2.5}$ design values, respectively. It is clear from Figure 9-13 that there is a downward trend in annual $PM_{2.5}$ design value since the period 2000-2002. During the periods 2002-2004 and 2003-2005, the design value rose slightly but once again continued its downward trend during 2004-2006 time period. In addition, between the periods 2000-2002 and 2004-2006 the design value as always been below the annual $PM_{2.5}$ standard

Figure 9-14 shows the Maryland portion of the Hagerstown-Martinsburg, MD-WV NAA is well below the 24-hour $PM_{2.5}$ NAAQS of 65 $\mu g/m^3$ and that there is also a downward trend in the design value since the period 2000-2002, which has continued through the period 2004-2006.

Figures 9-15 and 9-16 show the downward trend for the Martinsburg-Ballfield, WV monitor located in the West Virginia portion of the nonattainment area. Downward trends are exemplified in both the annual and 24-Hour PM2.5 data.

A downward trend in both annual and 24-hour $PM_{2.5}$ 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 9-13: ANNUAL $PM_{2.5}$ DESIGN VALUES FOR HAGERSTOWN, MD FROM 2002-2006. [27].

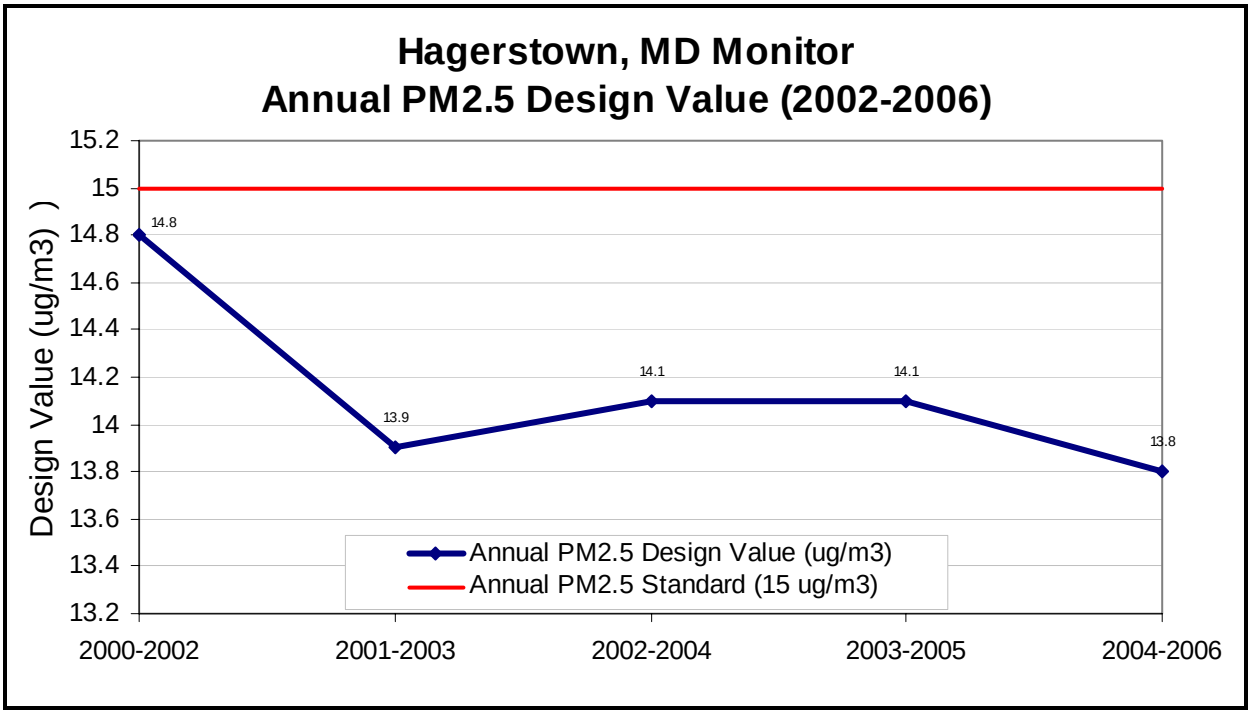
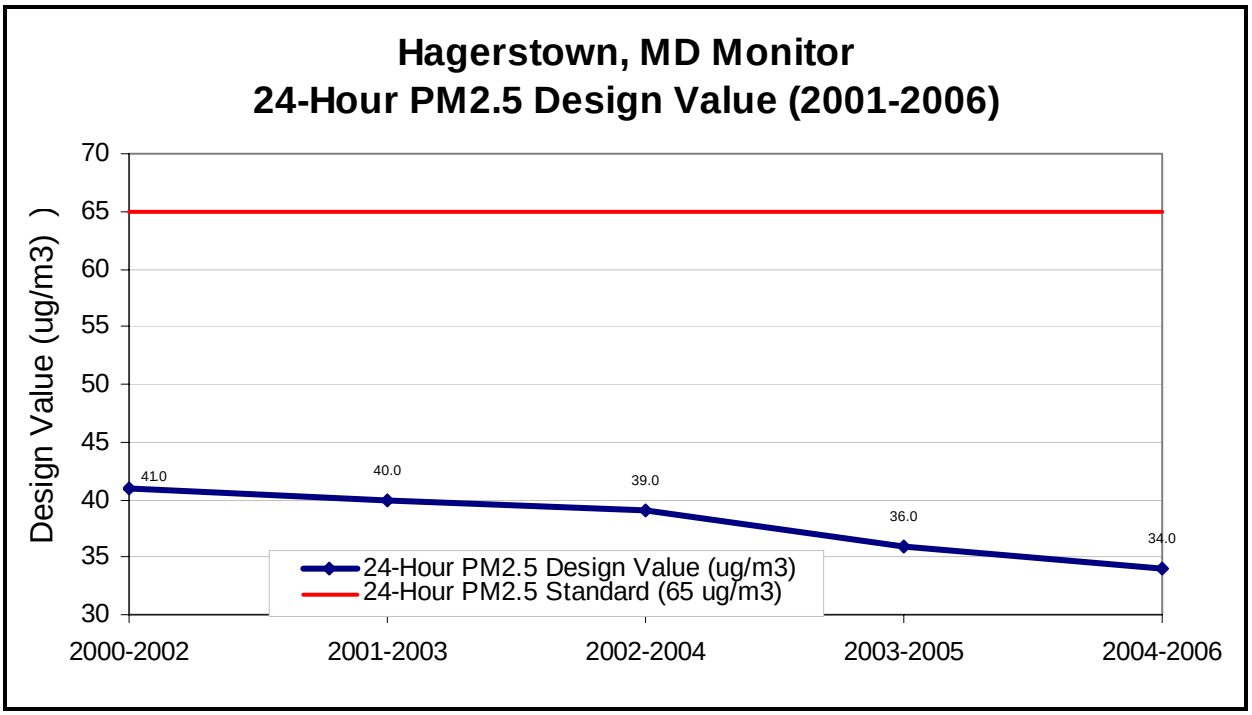


FIGURE 9-14: 24-HOUR $PM_{2.5}$ DESIGN VALUE FOR HAGERSTOWN, MD FROM 2002-2006. [28]



27 Data from EPA Air Trends: Design Values Website at http://www.epa.gov/airtrends/values.html
28 Data from EPA Air Trends: Design Values Website at http://www.epa.gov/airtrends/values.html

FIGURE 9-15: ANNUAL $PM_{2.5}$ DESIGN VALUE FOR MARTINSBURG-BALLFIELD, WV MONITOR FROM 2002-2006. [29]

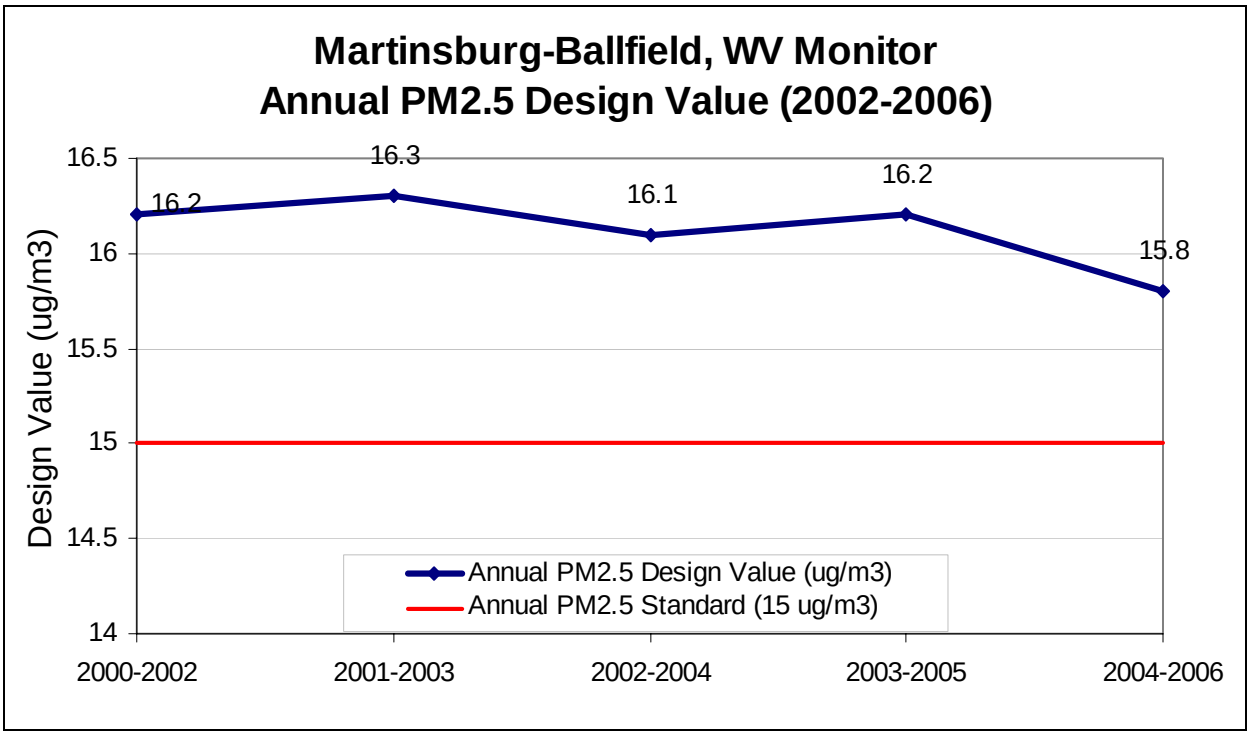
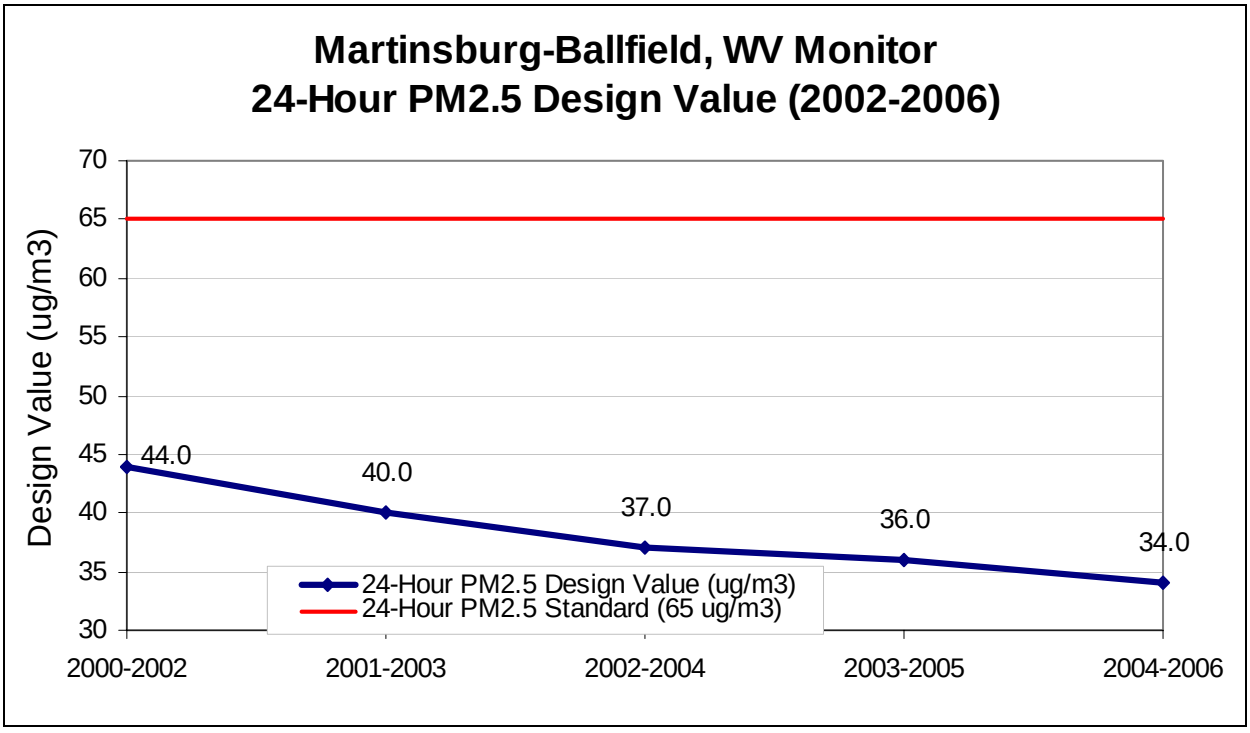


FIGURE 9-16: 24-HOUR $PM_{2.5}$ DESIGN VALUE FOR MARTINSBURG-BALLFIELD, WV MONITOR FROM 2002-2006. [30]



29 Data from EPA Air Trends: Design Values website at: http://www.epa.gov/airtrends/values.html.
30 Data from EPA Air Trends: Design Values website at: http://www.epa.gov/airtrends/values.html.

9.5.2 The Composition of $PM_{2.5}$

The observations indicate that the chemical composition, spatial distribution, and seasonal cycle of $PM_{2.5}$ are reasonably well understood. This information can be used to determine if the right aerosols and $PM_{2.5}$ precursors are being controlled in the right places and at the right times. Measurements of $PM_{2.5}$ show, in the context of abatement strategy, uniformity in composition and concentration across the Mid-Atlantic region. Sulfate peaks in the summer and nitrate peaks in the winter, but regionally during the course of a year, the makeup and levels of aerosols are reasonably consistent with the bulk of the mass identified. In round numbers (to the nearest 5%), and in decreasing importance, an analysis of the IMPROVE data identifies the main contributors to $PM_{2.5}$ as ammonium sulfate (50%), organic matter (25%), ammonium nitrate (10%), mineral dust (5%), and BC (5%). The EPA /State CSN data show ammonium sulfate (40%), organic matter (40%), ammonium nitrate (15%), mineral dust (5%), and BC (5%). The winter peak in nitrate indicates that NO_x controls should be utilized year-round. The small fraction of total $PM_{2.5}$ mass attributable to mineral dust suggests that control of local emissions of crustal elements from construction activities for example, can have only a minor impact on the annual $PM_{2.5}$ concentrations. Maryland and the surrounding States have been working through various control programs to lower year-round regional emissions of SO_2, NO_x, primary OC (including BC), and VOC's, and this approach appears to be targeting the right species in the appropriate spatial and temporal scales. Appendix G-10, Section I, examines the typical values and variability in chemical composition, spatial distribution, and seasonal cycle of $PM_{2.5}$ its major chemical constituents.

9.5.3 Review of Literature on $PM_{2.5}$

The scientific literature on $PM_{2.5}$, especially as it relates to $PM_{2.5}$ in Maryland indicates that the $PM_{2.5}$ problem is regional in nature. With this in mind some of the sources hundreds of km's away are providing much of the problem of the aerosols in Maryland. Sulfate dominates the regional picture, though local $PM_{2.5}$ and precursor sources are also important.

The $PM_{2.5}$ problem in Maryland is part of a broader regional problem, thus the focus on regional controls, especially regional SO_2 controls, in the Maryland SIP is a step in the right direction. It should also be mentioned that local and regional VOC controls as well as NO_x controls should also have some impact on $PM_{2.5}$. In all, direct observations, modeling, source apportionment, back trajectory and clustering techniques have been used to create a coherent picture of the $PM_{2.5}$ problem in the East, especially as it applies to Maryland. Sulfate emerges as the dominant contributor and is responsible for a large share of the $PM_{2.5}$ problem and an even larger share of the visibility problem, while OC and nitrate are smaller, but still significant contributors to the $PM_{2.5}$ problem. Reductions in SO_2 and NO_x emissions have been conclusively linked to reductions in sulfate and nitrate.

The literature review in Appendix G-11, Section II, discusses experimental campaigns in Maryland first, then regional campaigns and lastly data analysis efforts. Based on this literature review it can be concluded that controlling SO_2 (especially on the regional scale), VOC's, and NO_x should lead to continued significant reductions in $PM_{2.5}$ over Maryland.

9.5.4 $PM_{2.5}$ Trends Over the Mid-Atlantic Region

Monitors over the Mid-Atlantic region show a decrease in $PM_{2.5}$ concentrations ranging from 0.117 to 0.360 micrograms per-cubic meter per-year ($\mu g\ m^{-3}\ yr^{-1}$), with a mean trend of ~0.25 $\mu g\ m^{-3}\ yr^{-1}$. The trends are statistically significant at each site ($p < 0.05$) and at all sites together ($p < 0.01$). At all locations investigated as part of this study, sulfate was the $PM_{2.5}$ species that contributed the most to the decrease in $PM_{2.5}$, and was responsible for ~50% of the $PM_{2.5}$ decrease on average. Similarly, organic carbon accounts for ~25% of the decrease and ammonium ~15%. Nitrate, dust and elemental carbon contribute to the trend in a smaller way. While definitively quantifying the regional signal of $PM_{2.5}$ is a complex problem, the homogeneity in the trend of $PM_{2.5}$ and $PM_{2.5}$ species suggests all monitors in this study share a common regional "load" of $PM_{2.5}$. Comparison of the urban and rural monitors suggests the regional load may account for roughly 60%-75% of the total observed $PM_{2.5}$ (see http://www.epa.gov/air/airtrends/aqtrnd03/pdfs/2_chemspecofpm25.pdf).

Inspection of seasonal cycles suggests the regional contribution may increase during parts of the summer season, but the seasonality of the species distribution in fact has changed little over the past ten years. Recently implemented regional control strategies, which target sulfur, nitrogen and VOC emissions, should continue the current trend of further reducing $PM_{2.5}$ concentrations on the worst air quality days in Maryland. While there is site to site and year to year variability in $PM_{2.5}$ readings, this consistent decrease in $PM_{2.5}$ concentrations suggests that Maryland and the surrounding areas are targeting the appropriate $PM_{2.5}$ species at the appropriate locations.

In Appendix G-11, Section III temporal trends of $PM_{2.5}$ over the Mid-Atlantic region are assessed in order to describe the current state and future projections regarding air quality over Maryland.

9.5.5 $PM_{2.5}$ Composition As it Relates to Effectiveness of Controls

Several source apportionment and highly time resolved analyses of $PM_{2.5}$ episodes in Maryland have revealed that in many instances SO_2 from electric utilities and VOCs from mobile sources are responsible for the sulfate and the organic portion of $PM_{2.5}$. Other studies have shown that in Maryland and the Northeast region, sulfate is the largest contributor to $PM_{2.5}$, and that sulfate and nitrate respond positively to reductions in SO_2 and NO_x emissions. An analysis of the 2002 NEI and the 2009 projected emissions inventory for Maryland and MANE-VU shows that the emissions controls that will go into place in and surrounding Maryland are geared towards reducing SO_2, NO_x, and VOC emissions from electric utility and mobile sources. Given the historical trend of decreasing emissions of SO_2, NO_x, and VOC's coupled with decreases in sulfate, nitrate, organic matter, and $PM_{2.5}$, it can be expected that $PM_{2.5}$ in Maryland will decline substantially in the future.

Appendix G-11, Section IV will examine emissions reductions in Maryland and the MANE-VU region to determine the effectiveness of reducing $PM_{2.5}$ and to determine if these emissions reductions projected for 2009 target the correct $PM_{2.5}$ constituent and source.

9.5.6 Monitoring Data From Surface-Based Speciation Sites

The concentrations of $PM_{2.5}$ and its speciated components have been monitored at several sites in and around Maryland for several years. The overall accuracy of the instruments used in these analyses has been assessed. Daily measurement of $PM_{2.5}$ (based on a side-by-side comparison of FRM and CSN filter-based 24-hr average) or its major constituents can be taken with 95% confidence limit within about 30% of the actual value. Precision is substantially better than absolute accuracy, and long-term averages are accurate to better than 20%. Chemically speciated $PM_{2.5}$ and associated trace gases (including NH_3, HNO_3, CO, SO_2, and NOy) reflect both local and regional sources. Day-to-day and seasonal variations in the $PM_{2.5}$ chemical composition reflect changes in both the weather and in the contribution from various sources.

Appendix G-11, Section V examines the origins, properties, and statistical distributions of $PM_{2.5}$ at several monitoring sites in and around Maryland.

9.5.7 CMAQ $PM_{2.5}$ Modeling

The performance of CMAQ was examined and found to be acceptable for use in Maryland's $PM_{2.5}$ attainment demonstration. In particular, for Maryland, the largest changes in any $PM_{2.5}$ species are projected to occur in sulfate, and this is the one species where CMAQ's performance is at its best. Most other species show relatively more modest improvements in fine particle concentrations. CMAQ's performance is poorest for soil/crustal material and organic matter. The poor performance for soil/crustal material is only a minor concern since soil/crustal material only comprises 3-6% of $PM_{2.5}$ in the Mid-Atlantic region. The underestimation of summertime organic matter concentrations by CMAQ is of more concern since organic matter is an important part of the $PM_{2.5}$ budget at some Mid-Atlantic locations. Much of the bias is likely due to an underestimation of secondary organic aerosols, most of which have a biogenic source. Since changes in biogenic emissions are expected to be small over the next decade, CMAQ-calculated relative response factors for organic matter is not crucial. In addition, following EPA guidance, the impact of this bias is minimized by normalizing model predicted changes in organic matter by observed $PM_{2.5}$ partitioning. Therefore CMAQ's $PM_{2.5}$ modeling performance is acceptable for this modeling demonstration. Biases in CMAQ and the Beyond OTB/OTW inventory used in the model are such that the calculated future design values are somewhat higher than they would likely be in reality. These calculations are therefore conservative with regard to Maryland's $PM_{2.5}$ attainment status.

$PM_{2.5}$ concentrations were calculated for all Maryland monitors. Based on these calculations, Maryland will be in attainment for all applicable $PM_{2.5}$ NAAQS by 2009. The highest Maryland monitor is calculated to continue to be the Old Town monitor in downtown Baltimore. This monitor is predicted to have a 2009 design value range of 14.0-14.4 $\mu g\ m^{-3}$, a range that is just below the lower threshold of the weight of evidence range (14.5 – 15.5 $\mu g\ m^{-3}$). In the future, it appears that Maryland will continue to make steady progress in reducing $PM_{2.5}$ concentrations after the 2009 attainment deadline. Should the annual $PM_{2.5}$ standard be tightened in the future, Maryland will be well positioned for continued attainment of the $PM_{2.5}$ NAAQS.

Appendix G-11, Section VI discusses and quantifies all biases that are identified in the CMAQ model. It also examines how well CMAQ simulates $PM_{2.5}$ concentrations over the Mid-Atlantic region.

9.6 Summary and Conclusions of Attainment Demonstration

The results from the modeling as well as the weight of evidence supplemental analyses present overwhelming evidence that the Hagerstown-Martinsburg, MD-WV NAA will attain the 24-hour and annual $PM_{2.5}$ NAAQS (1997) by April 5, 2010. 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 $\mu g/m^3$ for annual $PM_{2.5}$ and 65 $\mu g/m^3$ for 24-hour $PM_{2.5}$.

9.7 Procedural Requirements

9.7.1 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.

9.7.2 Data Archival and Transfer of Modeling Files

All relevant data sets, model codes, scripts, and related software required by any project participant necessary to corroborate the study findings (e.g., performance evaluations, control strategy runs) will be provided in an electronic format approved by the MANE-VU RPO within the framework of the MANE-VU RPO. The MANE-VU RPO 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

The General Preamble and EPA guidance defines the requirements for identification of contingency measures for attainment demonstrations. For attainment demonstrations, contingency measures may reduce emissions of NO_X, SO_2, or $PM_{2.5}$ direct. Contingency measures are required for each milestone year. Air quality plans must include sufficient contingency measures to account for one year of reductions needed to attain.

10.1 Contingency Measures for the Attainment Demonstration

10.1.1 Background

EPA requires the Washington County, MD region to include a contingency plan containing adopted measures that qualify as contingency measures for the Attainment Demonstration. This section fulfills the requirement for the Attainment contingency.

10.1.2 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 per year)			
	2002	2009	2002-2009	Contingency Requirement Calculation (2002-2009)/7
NO_X	3,469.57	3,017.58	451.99	64.57
SO_2	5,005.36	5,954.22	(948.87)	None*
$PM_{2.5}$ Direct	224.31	265.35	(41.04)	None*

* = No contingency measures required because emissions increase between 2002 and 2009.

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 F). Using sensitivity analyses created by Visibility Improvement of State and Tribal Association of the Southeast (VISTAS) and Georgia Tech (see Appendix F). 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 Washington County, MD non-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.

10.1.3 Identified Contingency Measures

Table 10-2 lists the contingency measure identified by the State of Maryland for the Attainment Demonstration. This measure delivers a total benefit of more than 4,479.09 tons per year (tpy) SO_2. The reduction is greater than the required contingency reductions, therefore meeting the contingency measure requirement calculated in Table 10-1. The contingency measures for the Washington County, MD attainment plan are well in excess of the equivalency ratios described in Section 10.1.2 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 2008 $PM_{2.5}$ Attainment
(Tons per Year)

Ref. No.	Contingency Measure	SO_2 (tons/year)	NO_X (tons/year)
5.2.2	Tier 2 Motor Vehicle Emission Standards	0	
5.2.1	Healthy Air Act SO_2 Reductions	4,479.09	0
TOTAL REDUCTIONS			

In accordance with EPA's guidance encouraging early implementation of contingency measures to guard against failure to either meet a milestone or attain, the Maryland 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 vis-à-vis the Attainment demonstration contained 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.

APPENDICES

Appendix A – Base Year Emission Inventory
- Appendix A-1: Base Year Emission Inventory Methodologies
- Appendix A-2: Point Source Base Year Inventory
- Appendix A-3: Quasi-Point Source Base Year Inventory
- Appendix A-4: Area Source Base Year Inventory
- Appendix A-5: Mobile Source Base Year Inventory
- Appendix A-6: Nonroad Source Base Year Inventory

Appendix B –Projection Year Methodologies

Appendix C – Reasonably Available Control Measures (RACM) Analysis

Appendix D –Mobile Budget Documentation

Appendix E – OTC MOU

Appendix F – Contingency Synopsis of the ASIP Sensitivity Study

Appendix G – Attainment Modeling
- Appendix G-1: Conceptual Model
- Appendix G-2: Modeling Domain Boundary
- Appendix G-3: Horizontal Grid Definitions for MM5 and CMAQ Modeling Domain
- Appendix G-4: Vertical Layer Definitions for MM5 and CMAQ Modeling Domain
- Appendix G-5: MM5 Model Configuration
- Appendix G-6: MM5 Model Performance Evaluation
- Appendix G-7: SMOKE Processing Description and Configuration
- Appendix G-8: CMAQ Configuration
- Appendix G-9: CMAQ Model Performance
- Appendix G-10: Additional Information on Design Value Calculations
- Appendix G-11: Weight of Evidence Report