Massachusetts Regional Haze State Implementation Plan

December 30, 2011

MassDEP
Commonwealth of Massachusetts
Department of Environmental Protection

Executive Summary

The federal Clean Air Act, in sections 169A and 169B, contains requirements for the protection of visibility in 156 national parks, forests and wilderness areas that have been federally designated as Class I areas and include some of our nation's most treasured public lands. Unfortunately, enjoyment of the scenic vistas in these pristine areas is significantly impaired by regional haze. In the eastern U.S., the average visual range has decreased from 106 miles (under natural conditions) to 24 - 44 miles today.

In 1999, the U.S. Environmental Protection Agency (EPA) issued regulations known as the Regional Haze Rule, which requires states to develop State Implementation Plans to reduce haze-causing pollution to improve visibility in Class I areas. The overall goal of the regional haze program is to restore natural visibility conditions at Class I areas by 2064.

Regional haze is caused by fine particle pollution that impairs visibility over a large region by scattering or absorbing light. Fine particle pollution also adversely impacts human health, especially for children, the elderly, and people with heart or respiratory conditions. The Massachusetts Department of Environmental Protection (MassDEP) has prepared this final State Implementation Plan (SIP) to address Massachusetts sources that contribute to regional haze.

On January 11, 2011, MassDEP proposed its draft SIP for public comment and held two public hearings. The public comment period closed on February 21, 2011 (comments submitted and MassDEP's responses are in Appendix D). Certain sections of the draft SIP relied on emissions reductions in Massachusetts proposed in EPA's draft Transport Rule. However, EPA did not include Massachusetts in its final Transport Rule ("Cross State Air Pollution Rule," 76 FR 48208, August 8, 2011), which has necessitated revisions to this SIP. MassDEP intends to propose revisions to this SIP in February 2012, as described below, and to submit final revisions to this SIP in June 2012.

Class I Areas

Although Massachusetts has no Class I areas, emissions from Massachusetts sources contribute to visibility degradation in Class I areas in several other states. These include Lye Brook Wilderness Area (Vermont), Great Gulf Wilderness Area (New Hampshire), Presidential Range-Dry River Wilderness Area (New Hampshire), Acadia National Park (Maine), Moosehorn Wildlife Refuge (Maine), and Roosevelt Campobello International Park (Maine/Canada).

In the first round of SIPs, states with Class I areas must set reasonable progress goals for 2018 for improving visibility in their Class I areas. States affecting Class I areas (including Massachusetts) must submit SIPs with long-term strategies for meeting the 2018 reasonable progress goals. SIPs also must include control measures for certain existing sources placed into operation between 1962 and 1977 (known as Best Available Retrofit Technology or BART). States must update their SIPs in 2018 and every 10 years thereafter and must evaluate progress every 5 years.

Regional Planning Efforts

EPA established five regional planning organizations across the nation to coordinate regional haze efforts. Massachusetts is a member of one of these regional organizations, the Mid-Atlantic Northeast

Visibility Union (MANE-VU), comprised of Mid-Atlantic and Northeast states, tribes, and federal agencies. Massachusetts developed this SIP by participating in a regional planning process coordinated by MANE-VU. Together, the MANE-VU members established baseline and natural visibility conditions, determined the primary contributors to regional haze, identified reasonable progress goals and long-term strategies, and facilitated a consultation process with states, other regional planning organizations, and federal land managers.

As a MANE-VU member state, Massachusetts adopted the "*Statement of MANE-VU Concerning a Request for a Course of Action by States Within MANE-VU Toward Assuring Reasonable Progress*" at the MANE-VU Board meeting on June 7, 2007. This Statement outlines a strategy for reducing regional haze at MANE-VU Class I areas for the first ten-year planning period and forms the basis for the actions Massachusetts has included in this SIP.

Elements of Massachusetts' SIP for Regional Haze

In accordance with 40 CFR 51.308(b), Massachusetts submits this SIP to meet the requirements of EPA's Regional Haze Rule. This SIP addresses the core requirements of 40 CFR 51.308(d). These actions include:

<u>Best Available Retrofit Technology</u> - EPA's Regional Haze Rule requires the control of emissions from certain stationary sources placed into operation between 1962 and 1977 through the implementation of Best Available Retrofit Technology (BART) or an alternative to BART that achieves greater emission reductions. Massachusetts identified 5 electric generating unit (EGU) facilities, 1 municipal waste combustor, and 1 industrial boiler as BART-eligible facilities whose 2002 emissions (the baseline year for this SIP) contributed significantly to visibility impairment. MassDEP originally proposed to rely on EPA's draft Transport Rule as an Alternative to BART for EGUs. However, because Massachusetts is not included in EPA's final Cross-State Air Pollution Rule, MassDEP still must address BART requirements. For the EGUs, Massachusetts intends to propose BART determinations or an alternative to BART in early 2012. For the municipal waste combustor, Massachusetts has made a source-specific BART determination and will finalize a permit with that determination in early 2012. For the industrial boiler, no BART determination is needed since the facility has accepted an emissions cap that makes it no longer BART-eligible.

<u>Targeted EGU strategy</u> - MANE-VU identified 167 EGU stacks at power plants whose sulfur dioxide (SO_2) emissions significantly impaired visibility at one or more MANE-VU Class I areas, including stacks at 5 Massachusetts power plants. Massachusetts agreed to reduce SO_2 emissions from these specific power plants stacks by 90 percent from 2002 levels by 2018, or to pursue equivalent, alternative measures. Each of these EGUs already has reduced SO_2 emissions due to Massachusetts air quality regulations. MassDEP originally proposed to rely on EPA's draft Transport Rule to meet the EGU strategy. However, because Massachusetts is not included in EPA's final Cross-State Air Pollution Rule, MassDEP still must address this commitment. Therefore, MassDEP intends to propose a revised Targeted EGU Strategy in early 2012.

<u>Sulfur in Fuel Oil</u> - MANE-VU determined that states could cost-effectively achieve significant reductions in SO_2 emissions by requiring lower sulfur content fuel oils, including #2 distillate oil (home heating oil) and #4 and #6 residual oils (used in power plants and industrial and commercial boilers). Refineries already have made significant capital investments to produce low and ultra-low sulfur diesel,

which is the same product as #2 distillate oil, and lower sulfur residual oils also are readily available. MassDEP intends to implement the regional MANE-VU low sulfur fuel oil strategy by proposing regulations in early 2012 to lower allowable sulfur content in fuel oils, ultimately achieving 15 parts per million sulfur for #2 oil and 0.5 percent sulfur by weight for #4 and #6 residual oils by 2018.

The regulatory and technical basis for this proposed SIP is found in Sections 1 – 7. The prescriptive elements of this proposed SIP – BART, reasonable progress goals, and long-term strategy – are found in Sections 8 – 10.

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Acronyms and Abbreviations

ACAD1	Acadia National Park IMPROVE monitor
BART	Best Available Retrofit Technology
BEIS-3	Biogenic Emission Inventory System (3 version 0.9)
BOTW	Beyond on the Way (controls)
BTU	British Thermal Unit
CAA	Clean Air Act
CAIR	Clean Air Interstate Rule
CALGRID	California Grid Model
CEED	Center for Energy and Economic Development
CENRAP	Central Regional Air Planning Association
CERR	Consolidated Emission Reporting Rule
CFR	Code of Federal Regulations
CMAQ	Community Multi-scale Air Quality Modeling System
CO	Carbon Monoxide
dv	Deciview
EGU	Electric Generating Unit
EPA	Environmental Protection Agency
FLM	Federal Land Manager
GCVTC	Grand Canyon Visibility Transport Commission
GRGU1	Great Gulf Wilderness Area IMPROVE monitor; also monitors Presidential Range/Dry River Wilderness Area
HAP	Hazardous Air Pollutant
ICI	Industrial/Commercial/Institutional
IMPROVE	Interagency Monitoring of Protected Visual Environments
IPM	Integrated Planning Model
LADCO	Lake Michigan Air Directors Consortium
LYBR1	Lye Brook Wilderness Area IMPROVE monitor
MassDEP	Massachusetts Department of Environmental Protection
MANE-VU	Mid-Atlantic/Northeast Visibility Union
MARAMA	Mid-Atlantic Regional Air Management Association
MM5	Mesoscale Meteorological Model
MMBtu	Million British Thermal Units
MOOS1	Moosehorn Wilderness Area IMPROVE monitor; also monitors Roosevelt/Campobello International Park
MOBILE6.2	EPA’s On-Road Mobile Source Emissions Estimation Model
MRPO	Midwest Regional Planning Organization
MW	Megawatt
MWh	Megawatt Hour
MWC	Municipal Waste Combustor
N/A	Not Applicable
NAAQS	National Ambient Air Quality Standards
NCAR	National Center for Atmospheric Research
NEI	National Emissions Inventory
NET	National Emissions Trend
NESCAUM	Northeast States for Coordinated Air Use Management
NH_3	Ammonia
NOx	Oxides of Nitrogen
NONROAD	EPA’s Non-Road Emissions Estimation Model 2005 Version
NSPS	New Source Performance Standards
NTI	National Toxics Inventory
NYSDEC	New York State Department of Environmental Conservation
NWS	National Weather Service
OC	Organic Carbon
OTC	Ozone Transport Commission

OTB/W	On the Books/On the Way (controls)
$PM_{2.5}$	Fine Particulate Matter; particles with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers
PM_{10}	Particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers
QA	Quality Assurance
RACT	Reasonably Available Control Technology
REMSAD	Regional Modeling System for Aerosols and Deposition
RFP	Reasonable Further Progress
RH	Regional Haze
RPO	Regional Planning Organization
SIP	State Implementation Plan
SLAMS/ NAMS	State & Local Air Monitoring System and National Air Monitoring System
SCC	Source Category Code
SMOKE	Sparse Matrix Operator Kernel Emissions
SMP	Smoke Management Plan
SOA	Secondary Organic Aerosol
SO_2	Sulfur Dioxide
TPY	Tons per year
TSC	Technical Support Committee (of MANE-VU)
TSD	Technical Support Document
USEPA	United States Environmental Protection Agency
UMD	University of Maryland
VIEWS	Visibility Information Exchange Web System
VISTAS	Visibility Improvement State and Tribal Association of the Southeast
VOC	Volatile Organic Compound
WRAP	Western Regional Air Partnership

1. BACKGROUND AND OVERVIEW OF THE FEDERAL REGIONAL HAZE REGULATION

1.2. The Basics of Haze

Regional haze is visibility impairment caused by the cumulative emission of air pollutants from numerous sources over a wide geographic area. The primary cause of regional haze is the scattering and absorption of light by fine particles. Fine particle air pollution also adversely impacts human health, especially the respiratory and cardiovascular systems of people at increased risk, including children, the elderly, and people with heart or respiratory conditions.

Regional haze obscures views in pristine areas such as national parks, forests and wilderness areas (156 of which have been designated Federal Class I areas). In parks in the eastern U.S., the average visual range has decreased from 106 miles (under natural conditions) to 24- 44 miles today.

Visibility impairment can be quantified using three different, but mathematically related measures: visual range (i.e., how far one can see); light extinction per unit distance (e.g., Mm^{-1})[1]; and deciviews (dv), a useful metric for measuring increments of visibility change that are just perceptible to the human eye. Each can be estimated from the ambient concentrations of individual particle constituents, taking into account their unique light-scattering (or absorbing) properties, and making appropriate adjustments for relative humidity. Assuming natural conditions, visibility in the Northeast and Mid-Atlantic is estimated to be about 106 miles, which corresponds to 23 Mm^{-1} or 8 dv. Under current polluted conditions in the region, average visibility ranges from 24 miles in the south to 44 miles in the north; these values correspond to 103 Mm^{-1} to 55 Mm^{-1} or 23 to 17 dv, respectively. On the worst 20 percent of days, visibility impairment in Northeast and Mid-Atlantic Class I areas ranges from 21.7 to 29 dv (a visual range of about 30 to 14 miles).

The fine particles that commonly cause hazy conditions in the eastern U.S. are primarily composed of sulfate, nitrate, organic carbon, elemental carbon (soot), and crustal material (e.g., soil dust, sea salt, etc.). Sulfate, nitrate, and organic carbon are secondary pollutants that form in the atmosphere from precursor pollutants, primarily sulfur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compounds (VOCs), respectively. Sulfate, formed from SO_2 emissions, is the dominant contributor to fine particle pollution throughout the eastern U.S. and therefore most eastern regional control efforts are directed at reducing SO_2 emissions.

1.3. Regulatory Framework

In amendments to the Clean Air Act (CAA) in 1977, Congress added Section 169 (42 U.S.C. 7491) setting forth the following national visibility goal:

> *Congress hereby declares as a national goal the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I Federal areas which impairment results from man-made air pollution.*

[1] In units of inverse length. An inverse megameter (Mm^{-1}) is equal to one over one thousand kilometers.

The "Class I" designation was given to each of 158 areas in existence as of August 1977 that met the following criteria:

- all national parks greater than 6000 acres,
- all national wilderness areas and national memorial parks greater than 5000 acres, and
- one international park.

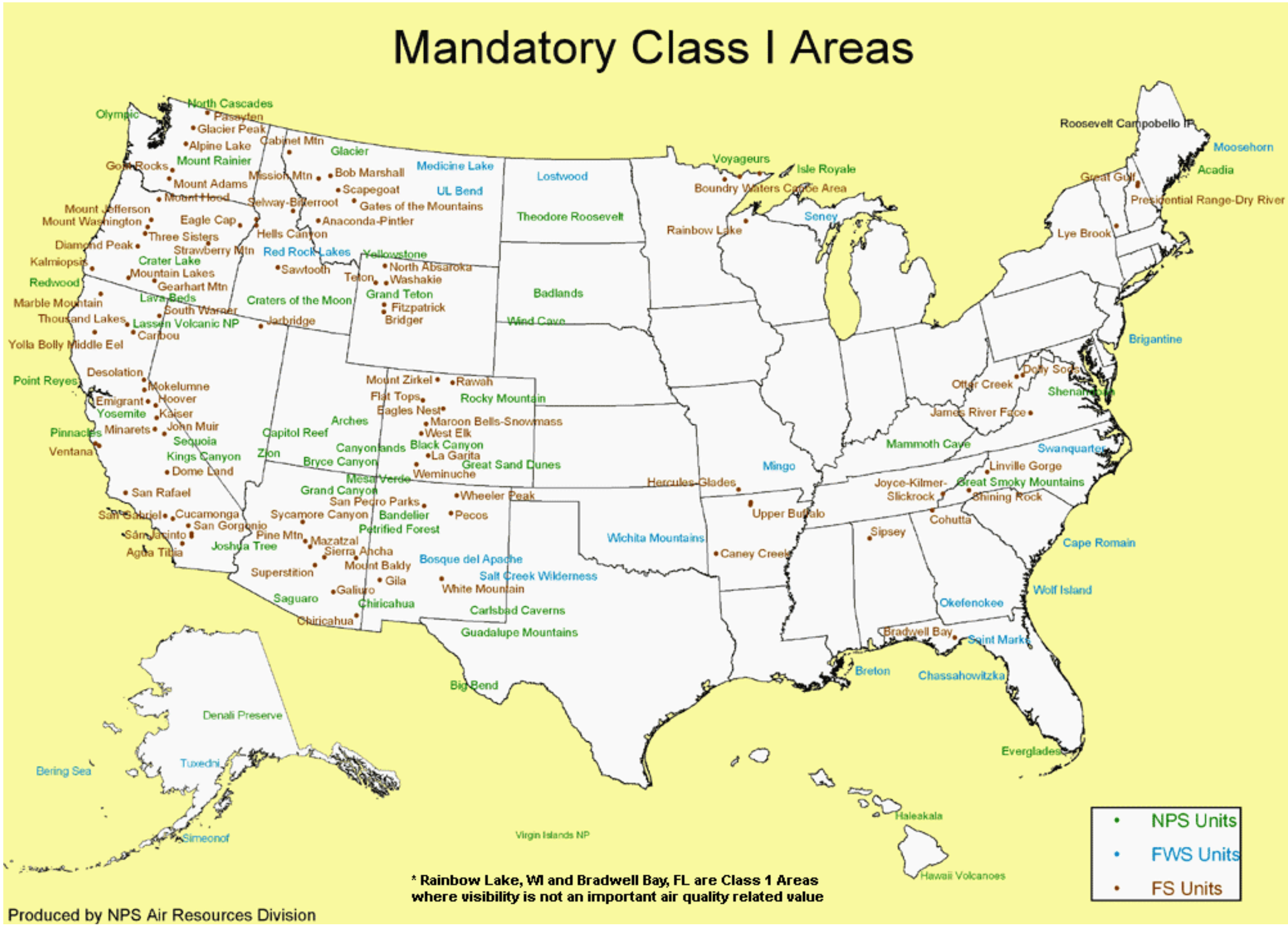
In 1980, Bradwell Bay, Florida, and Rainbow Lake, Wisconsin, were excluded for purposes of visibility protection as federal Class I areas. Today, 156 national park and wilderness areas remain as Class I visibility protection areas (Figure 1).

Over the following years, modest steps were taken to address the visibility problems in Class I areas. The control measures taken mainly addressed "plume blight" from specific pollution sources and did little to address regional haze issues in the Eastern United States.

When the CAA was amended in 1990, Congress added Section 169B (42 U.S.C. 7492), authorizing further research and regular assessments of the progress made. In 1993, the National Academy of Sciences concluded that "current scientific knowledge is adequate and control technologies are available for taking regulatory action to improve and protect visibility."

In addition to authorizing creation of visibility transport commissions and setting forth their duties, Section 169B(f) of the CAA mandated creation of the Grand Canyon Visibility Transport Commission (GCVTC) to make recommendations to the U.S. Environmental Protection Agency (EPA) for the region affecting the visibility of the Grand Canyon National Park. The GCVTC submitted its report to EPA in June 1996, following four years of research and policy development. This report, as well as the many research reports prepared by the Commission, contributed invaluable information to EPA in its development of regulations for visibility improvement.

Figure 1: Locations of Federally Protected Mandatory Class I Areas



History of Federal Regional Haze Rule

The federal requirements that states must meet to achieve national visibility goals are contained in Title 40: Protection of Environment, Part 51 – Requirements for Preparation, Adoption, and Submittal Of Implementation Plans, Subpart P – Protection of Visibility (40 CFR 51.300-309). Known more simply as the Regional Haze Rule, these regulations were adopted on July 1, 1999, and went into effect on August 30, 1999. The rule seeks to address the combined visibility effects of various pollution sources over a large geographic region. This wide-reaching pollution net means that many states – even those without Class I Areas – are required to participate in haze reduction efforts. The specific requirements for States' Regional Haze State Implementation Plans (SIPs) are set forth in 40 CFR 51.308, Regional Haze Program Requirements.

In consultation with the states and tribes, EPA designated five Regional Planning Organizations (RPOs) [2] to assist with the coordination and cooperation needed to address the haze issue. The Mid-Atlantic /

[2] A description of the RPOs is contained in the Regional Planning Section of this SIP.

Northeast states, including the District of Columbia, formed the Mid-Atlantic / Northeast Visibility Union (MANE-VU).[3]

EPA's adoption of the Regional Haze Rule was challenged by the American Corn Growers Association. On May 24, 2002, the U.S. Court of Appeals, D.C. District Court, ruled on the challenge and remanded to EPA the Best Available Retrofit Technology (BART) provisions of the rule, but denied industry's challenge to the haze rule's goals of natural visibility and no degradation requirements. On June 15, 2005, EPA finalized a rule addressing the court's remand.

On February 18, 2005, the Appeals Court issued another ruling vacating the Regional Haze Rule in part and sustaining it in part. For more information see *Center for Energy and Economic Development v. EPA*, # 03-1222, (D.C. Cir. Feb. 18, 2005; "*CEED* v. EPA"). In this case, the court granted a petition challenging provisions of the Regional Haze Rule governing the optional emissions trading program for certain Western States and Tribes (the WRAP Annex Rule).

EPA's subsequent final rulemaking provided the following changes to the Regional Haze Regulations:

1. Revised the regulatory text in 40 CFR 51.308(e)(2)(i) in response to the *CEED* court's remand to remove the requirement that the determination of BART "benchmark" be based on cumulative visibility analyses, and to clarify the process for making such determinations, including the application of BART presumptions for Electric Generating Units (EGUs) as contained in Appendix Y to 40 CFR 51.
2. Added new regulatory text in 40 CFR 51.308(e)(2)(vi) to provide minimum elements for cap and trade programs in lieu of BART.
3. Revised regulatory text in 40 CFR 51.309 to reconcile the optional framework for certain Western States and Tribes to implement the recommendations of the Grand Canyon Visibility Transport Commission with the *CEED* decision.

State Implementation Plan

In accordance with 40 CFR 51.308(b), Massachusetts submits this SIP to meet the requirements of EPA's Regional Haze Rule. This SIP addresses the core requirements of 40 CFR 51.308(d). Select Best Available Retrofit Technology (BART) requirements of 40 CFR 51.308(e) are reserved in this SIP and will be re-proposed in early 2012. In addition, this SIP addresses requirements pertaining to regional planning and state/tribe and Federal Land Manager (FLM) coordination and consultation.

Pursuant to 40 CFR 51.308(d)(4)(v), Massachusetts also commits to making periodic updates to the Massachusetts emissions inventory (Section 6). Massachusetts proposes to complete these updates to coincide with the progress reports.

40 CFR 51.308(f) requires Massachusetts to submit revisions to its Regional Haze SIP every ten years. The first milestone for reasonable progress is 2018. Massachusetts commits to submitting a revision to its Regional Haze SIP by July 31, 2018.

40 CFR 51.308(g) requires Massachusetts to submit a report to EPA every 5 years that evaluates progress toward the reasonable progress goal for each Class I area located within the state and each

[3] A description of MANE-VU and a full list of its members are described in the Regional Planning Section of this SIP.

mandatory Class I area located outside the state that may be affected by emissions from within the state. Massachusetts commits to submitting the first progress report in 2013.

Finally, pursuant to 40 CFR 51.308(h), Massachusetts will submit a determination of adequacy of its Regional Haze SIP whenever a progress report is submitted.

2. REGIONAL PLANNING AND STATE/TRIBE AND FEDERAL LAND MANAGER COORDINATION

2.2. Regional Planning

In 1999, EPA and affected states/tribes agreed to create five Regional Planning Organizations (RPOs) to facilitate interstate coordination on Regional Haze SIPs. Figure 2 shows a map of the five RPOs: MANE-VU (Mid-Atlantic/Northeast Visibility Union), VISTAS (Visibility Improvement State and Tribal Association of the Southeast), MRPO (Midwest Regional Planning Organization), CenRAP (Central Regional Air Planning Association), and WRAP (Western Regional Air Partnership). As part of regional planning, the RPOs and states and tribes within each RPO are required to consult on the development of emission management strategies.

Figure 2: US EPA Designated Regional Planning Organizations

2.3. Mid-Atlantic/Northeast Visibility Union (MANE-VU)

MANE-VU's work is managed by the Ozone Transport Commission (OTC) and carried out by the OTC, the Mid-Atlantic Regional Air Management Association (MARAMA), and the Northeast States for Coordinated Air Quality Management (NESCAUM). Members of MANE –VU are listed in Table 1. The states and tribes, along with federal agencies and professional staff from OTC, MARAMA and

NESCAUM, are members of the various committees and workgroups established by MANE-VU. Policy decisions are made by the MANE-VU Board of Directors, composed of senior staff from each member state, tribe, or agency.

Table 1: MANE-VU Members

Connecticut	Pennsylvania
Delaware	Penobscot Nation
District of Columbia	Rhode Island
Maine	St. Regis Mohawk Tribe
Maryland	Vermont
Massachusetts	U.S. Environmental Protection Agency*
New Hampshire	U.S. National Park Service*
New Jersey	U.S. Fish and Wildlife Service*
New York	U.S. Forest Service*

* Non-voting member

Since its inception on July 24, 2001, MANE-VU established an active committee structure to address both technical and non-technical issues related to regional haze. One of the primary committees is the Technical Support Committee (TSC), charged with assessing the nature and magnitude of the regional haze problem within MANE-VU, interpreting the results of technical work, and reporting on such work to the MANE-VU Board. It has three standing working groups, broken down by topic area: Emissions Inventory, Modeling, and Monitoring/Data Analysis Workgroups. The TSC has evolved to function as a valuable sounding board for all the technical projects and processes of MANE-VU and has established a process to ensure that important regional haze-related projects are completed in a timely fashion and members are kept informed of all MANE-VU tasks and duties.

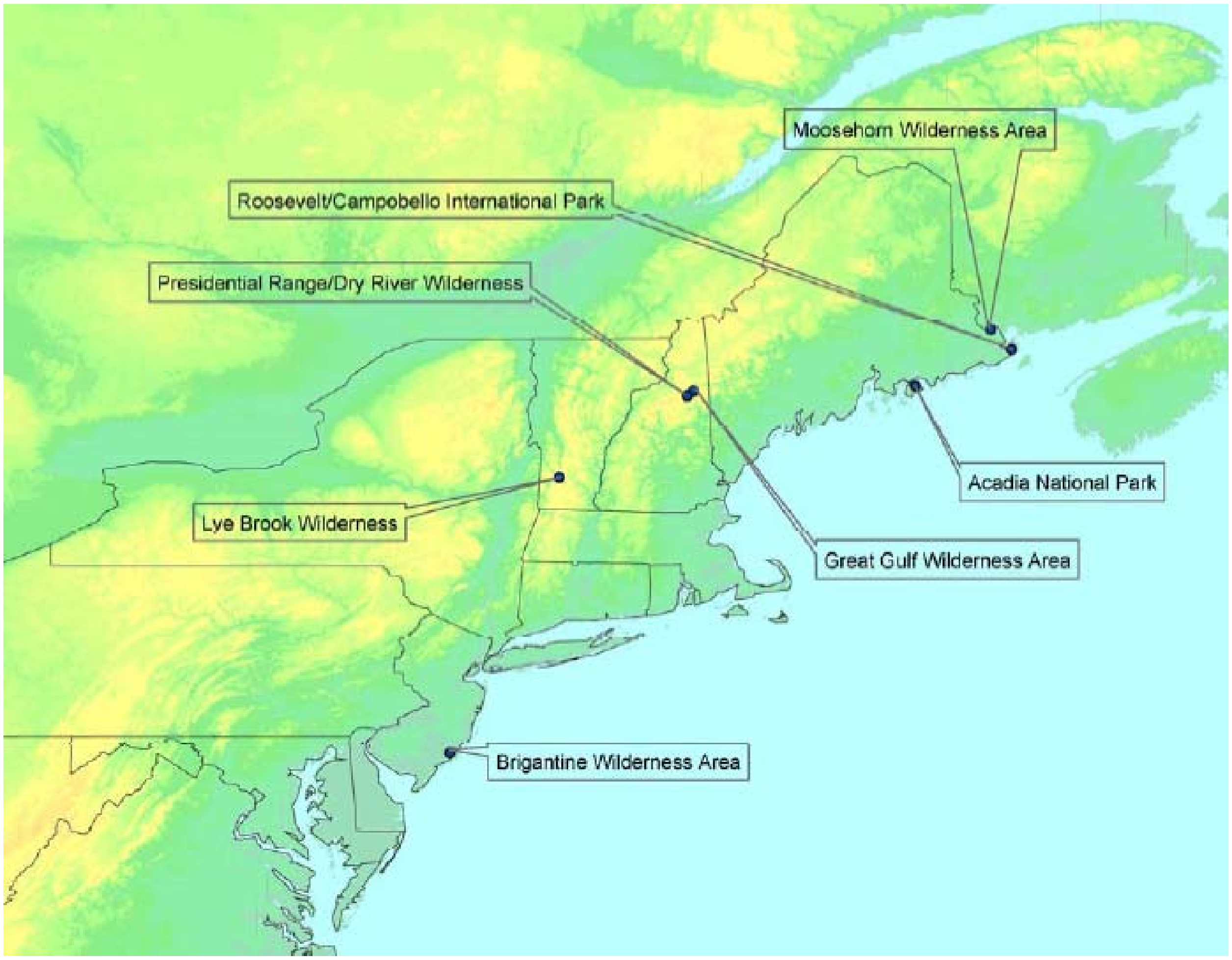
The second primary committee is the Communications Committee, charged with developing approaches to inform the public about the regional haze problem in the region and making any recommendations to the MANE-VU Board to facilitate that goal. It oversaw the development of MANE-VU's newsletter and outreach tools, both for stakeholders and for the public, regarding regional issues within MANE-VU.

Policy decisions are made by the MANE-VU Board. MANE-VU established a Policy Advisory Group to provide advice to decision-makers on policy questions. Federal Land Managers, EPA, states, and tribes are represented on the Policy Advisory Group, which met on an as-needed basis.

2.4. Class I Areas Within MANE-VU

MANE-VU contains seven Federal Class I areas in four states (Figure 3). Massachusetts does not contain any Class I areas.

Figure 3: Class I Areas within MANE-VU



2.5. Area of Influence for MANE-VU Class I Areas

40 CFR 51.308(d)(3) of the Regional Haze Rule requires states to determine their respective contribution to visibility impairment at Class I areas. Through source apportionment modeling (more fully described in Section 7), MANE-VU has identified and evaluated the major contributors to regional haze at MANE-VU Class I areas as well as Class I areas in nearby RPOs. The complete findings are contained in a report produced by the Northeast States for Coordinated Air Quality Management (NESCAUM) entitled, "*Contributions to Regional Haze in the Northeast and Mid-Atlantic United States*," otherwise known as the Contribution Assessment (Appendix A). Based on that work, MANE-VU concluded that it was appropriate to define an area of influence including all of the states participating in MANE-VU, plus other states that modeling indicated contributed at least 2 percent of the sulfate ion at MANE-VU Class I areas in 2002. MANE-VU identified the states in Table 2 as causing or contributing to visibility impairment in one or more of the following Class I areas: Acadia National Park, Brigantine Wildlife Refuge, Great Gulf Wilderness Area, Lye Brook Wilderness Area, Moosehorn Wildlife Refuge, Presidential Range-Dry River Wilderness Area, and Roosevelt-Campobello International Park.

Table 2: States that Contribute to Visibility Impairment at One or More of the MANE-VU Class I Areas of Acadia, Moosehorn, Roosevelt-Campobello, Great Gulf, Presidential Range-Dry River, Lye Brook, and Brigantine

State	RPO
Connecticut	MANE-VU
Delaware	MANE-VU
Maine	MANE-VU
Maryland	MANE-VU
Massachusetts	MANE-VU
New Hampshire	MANE-VU
New Jersey	MANE-VU
New York	MANE-VU
Pennsylvania	MANE-VU
Rhode Island	MANE-VU
Vermont	MANE-VU
Georgia	VISTAS
Kentucky	VISTAS
North Carolina	VISTAS
South Carolina	VISTAS
Tennessee	VISTAS
Virginia	VISTAS
West Virginia	VISTAS
Illinois	MRPO
Indiana	MRPO
Michigan	MRPO
Ohio	MRPO

2.6. Massachusetts Impact on MANE-VU Class I Areas

Emission sources within Massachusetts had measurable impacts on visibility at Class I areas within MANE-VU in the 2002 baseline year. The magnitude of these impacts is described in detail in Section 7 and MANE-VU's Contribution Assessment (Appendix A). Table 3 lists the Class I areas affected by emissions sources in Massachusetts.

Table 3: Class I Federal Areas Affected by Emissions from Massachusetts

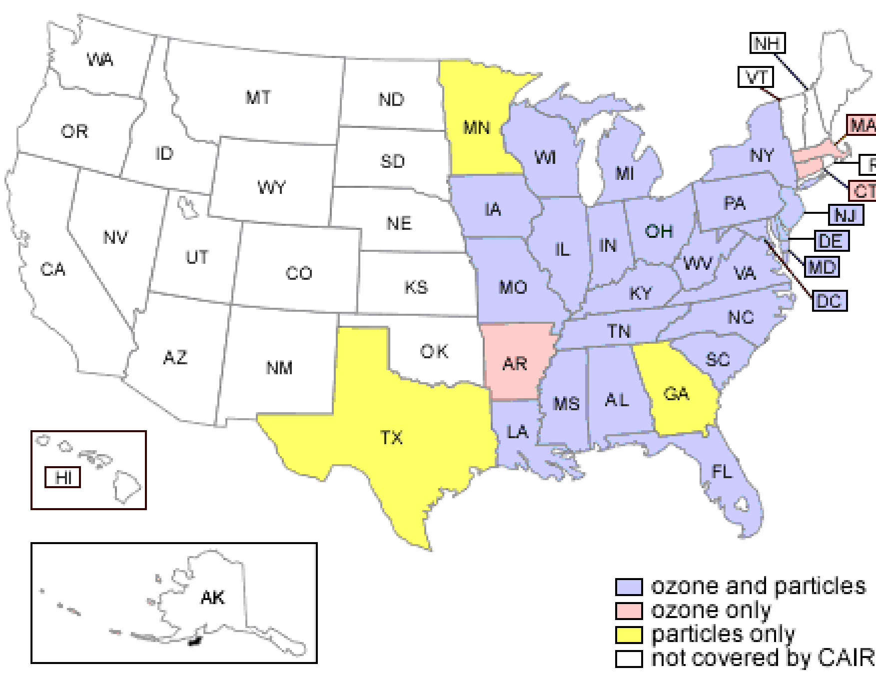
Class I Federal Area	State
Acadia National Park	Maine
Moosehorn Wildlife Refuge	Maine
Roosevelt Campobello International Park	Maine/Canada
Great Gulf Wilderness Area	New Hampshire
Presidential Range-Dry River Wilderness Area	New Hampshire
Lye Brook Wilderness Area	Vermont

2.7. Regional Haze Planning after the Remand of CAIR

On March 10, 2005, EPA issued the Clean Air Interstate Rule (CAIR). This important federal rule was designed to achieve major permanent reductions in SO_2 and NO_x emissions in the eastern United States through a cap-and-trade system using emission allowances. CAIR would permanently cap emissions originating in 28 eastern states and the District of Columbia (Figure 4). Although Massachusetts was only designated as a participating CAIR state for the ozone season, this program would have greatly affected future air quality in the state.

According to EPA's CAIR website, SO_2 emissions in the affected states would be reduced by more than 70 percent and NO_x emissions by more than 60 percent from 2003 levels upon full implementation of CAIR (see http://www.epa.gov/cair/).

Figure 4: Map of CAIR States



http://www.epa.gov/cair/

On July 11, 2008, the U.S. Court of Appeals for the District of Columbia Circuit found that CAIR violated basic provisions of the Clean Air Act. The court vacated CAIR in its entirety and remanded it to EPA in order to promulgate a new rule consistent with the court's opinion. EPA appealed the decision amid widespread concern that, despite its flaws, some form of CAIR was preferable to the sudden regulatory void created by the Court's decision. Upon reconsideration, on December 23, 2008, the Court stayed the vacatur of CAIR but maintained the remand to EPA to promulgate a new rule consistent with the Court's July 11, 2008, opinion.

Because CAIR formed the regulatory underpinnings for most of the emission reductions that were to produce visibility improvements in mandatory Class I areas, the vacatur of CAIR would have represented a major difficulty for the individual states in attempting to comply with the Regional Haze Rule. While all eastern states have depended in varying degree on CAIR in the preparation of their regional haze SIPs, some Southeast states have relied almost entirely on CAIR to demonstrate compliance with the rule. The vacatur of CAIR also called into question the validity of MANE-VU's (and other RPOs') emission inventories and air quality modeling studies already completed for the member states' Regional Haze SIPs.

The CAIR Phase I requirements remained in place through 2011. On August 8, 2011, EPA published the Cross-State Air Pollution Rule (CSAPR) to replace CAIR. CSAPR requires 28 states in the eastern half of the United States to significantly improve air quality by reducing SO_2 and NO_x emissions from power plant emissions that cross state lines and contribute to ground-level ozone and fine particle pollution in other states. Massachusetts is not included in CSAPR.

Future emission controls under CSAPR are similar to those as CAIR originally would have obtained. Therefore, Massachusetts expects that future emissions and air quality levels are likely to be not very different from values predicted by MANE-VU's completed modeling, even though that modeling was based on implementation of CAIR as it was before CSAPR. Consequently, the long-term strategy developed for Massachusetts' SIP represents a reasonable starting point from which to go forward with measures to improve visibility at MANE-VU's Class I Areas. These measures will be reviewed at the mid-point review in 2013 in consultation with Class I states, who may at that time reassess their reasonable progress goals.

2.8. Regional Consultation and the "Ask"

40 CFR Section 51.308(d)(3)(i) requires Massachusetts to consult with other states/tribes to develop coordinated emission management strategies. Massachusetts consulted with other states and tribes through participation in the MANE-VU and inter-RPO processes that developed the technical information necessary for the development of coordinated strategies.

On May 10, 2006, MANE-VU adopted the Inter-RPO State/Tribal and FLM Consultation Framework. A full copy of MANE-VU's *Final Interim Principles for Regional Planning* can be found in Appendix B. That document sets forth the principles listed in

Figure 5. MANE-VU states and tribes applied these principles to the regional haze consultation and SIP development processes. Issues addressed included regional haze baseline assessments, natural background levels, and development of reasonable progress goals – described at length in later sections of this SIP.

Figure 5: MANE-VU Principles for Regional Haze Planning

1) All State, Tribal, RPO, and Federal participants are committed to continuing dialogue and information sharing in order to create understanding of the respective concerns and needs of the parties.

2) Continuous documentation of all communications is necessary to develop a record for inclusion in the SIP submittal to EPA.

3) States alone have the authority to undertake specific measures under their SIP. This inter-RPO framework is designed solely to facilitate needed communication, coordination, and cooperation among jurisdictions, but does not establish binding obligation on the part of participating agencies.

4) There are two areas which require State-to-State and/or State-to-Tribal consultations ("formal" consultations): (i) development of the reasonable progress goal for a Class I area, and (ii) development of long-term strategies. While it is anticipated that the formal consultation will cover the technical components that make up each of these policy decision areas, there may be a need for the RPOs, in coordination with their State and Tribal members, to have informal consultations on these technical considerations.

5) During both the formal and informal inter-RPO consultations, it is anticipated that the States and Tribes will work collectively to facilitate the consultation process through their respective RPOs, when feasible.

6) Technical analyses will be transparent, when possible, and will reflect the most up-to-date information and best scientific methods for the decision needed within the resources available.

7) The State with the Class I area retains the responsibility to establish reasonable progress goals. The RPOs will make reasonable efforts to facilitate the development of a consensus between the State with a Class I area and other States affecting that area. In instances where the State with the Class I area cannot agree with such other States that the goal provides for reasonable progress, actions taken to resolve the disagreement must be included in the State's regional haze implementation plan (or plan revisions) submitted to the EPA Administrator as required under 40 CFR §51.308(d)(1)(iv).

8) All States whose emissions are reasonably anticipated to contribute to visibility impairment in a Class I area must provide the Federal Land Manager ("FLM") agency for that Class I area with an opportunity for consultation, in person, on their regional haze implementation plans. The States/Tribes will pursue the development of a memorandum of understanding to expedite the submission and consideration of the FLM's comments on the reasonable progress goals and related implementation plans. As required under 40 CFR §51.308(i)(3), the plan or plan revision must include a description of how the State addressed any FLM comments.

9) States/Tribes will consult with the affected FLMs to protect the air resources of the State/Tribe and Class I areas in accordance with the FLM coordination requirements specified in 40 CFR §51.308(i) and other consultation procedures developed by consensus.

10) The consultation process is designed to share information, define and document issues, develop a range of options, solicit feedback on options, develop consensus advice if possible, and facilitate informed decisions by the Class I States.

11) The collaborators, including States, Tribes and affected FLMs, will promptly respond to other RPO's/States'/Tribes' requests for comments.

The following points highlight many of the ways MANE-VU member states and tribes have cooperatively addressed regional haze:

- Budget Prioritization: MANE-VU developed a process to coordinate MARAMA, OTC, and NESCAUM staff in developing budget priorities, project rankings, and the eventual federal grant requests.
- Issue Coordination: MANE-VU established a conference call and meeting schedule for each of its committees and workgroups. In addition, MANE-VU Air Directors regularly discussed pertinent issues.
- SIP Policy and Planning: MANE-VU states/tribes collaborated on the development of a SIP Template.
- Capacity Building: To educate its staff and members, MANE-VU included technical presentations on conference calls and organized workshops with nationally recognized experts. Presentations on data analysis, BART work, inventory topics, modeling, control measures, etc., were an effective education and coordination tool.

- Routine Operations: MANE-VU staff at OTC, MARAMA, and NESCAUM established a coordinated approach to budgeting, grant deliverables/due-dates, workgroup meetings, inter-RPO feedback, etc.

In addition to having a set of guiding principles for consultation, MANE-VU needed a consistent technical basis for emission control strategies to reduce regional haze to meet the reasonable progress goals for 2018. After much research and analysis, on June 20, 2007, MANE-VU adopted the following pair of documents, which provide the technical basis for consultation among the interested parties and define the basic strategies for controlling pollutants that cause visibility impairment at Class I areas in the eastern United States. Together, these documents are known as the MANE-VU "Ask" (Appendix C).

- "Statement of the Mid-Atlantic / Northeast Visibility Union (MANE-VU) Concerning a Course of Action within MANE-VU toward Assuring Reasonable Progress," and
- "Statement of the Mid-Atlantic / Northeast Visibility Union (MANE-VU) Concerning a Request for a Course of Action by States outside of MANE-VU toward Assuring Reasonable Progress."

The consultations among MANE-VU states and other states/tribes and provinces occurred through much of 2007. Documentation of consultation meetings and calls between MANE-VU Class I States and states/tribes both within and outside MANE-VU can found on the MANE-VU website at www.otcair.org/manevu/consultations.asp?fview=2. A summary of the consultation process follows.

- MANE-VU Intra-Regional Consultation, March 1, 2007
  - At this meeting, MANE-VU members reviewed requirements for regional haze plans, preliminary modeling results, work being done to prepare the MANE-VU report on reasonable progress factors, and control strategy options under review.
- MANE-VU Intra-State Consultation, June 7, 2007
  - At this meeting the MANE-VU Class I states adopted a statement of principles, and all MANE-VU members discussed draft statements concerning reasonable controls within and outside of MANE-VU. Federal Land Managers also attended the meeting, which was open to stakeholders.
- MANE-VU Conference Call, June 20, 2007
  - On this call, the MANE-VU states concluded discussions of statements concerning reasonable controls within and outside MANE-VU and agreed on the statements called the MANE-VU "Ask," including a statement concerning controls within MANE-VU, a statement concerning controls outside MANE-VU, and a statement requesting a course of action by EPA. Federal Land Managers also participated in the call. Upon approval, all statements as well as the statement of principles adopted on June 7 were posted and publicly available on the MANE-VU web site.
- MANE-VU Class I States' Consultation Open Technical Call, July 19, 2007
  - On this call, the MANE-VU / New Hampshire "Ask" was presented to states in other RPOs, RPO staff, and Federal Land Managers, and an opportunity was provided to request further information. This call was intended to provide information to facilitate informed discussion at follow-up meetings.
- MANE-VU Consultation Meeting with MRPO, August 6, 2007

    - This meeting was held at LADCO offices in Chicago, Illinois and was attended by representatives of MANE-VU and MRPO states, as well as staff. The meeting provided an opportunity to formally present the MANE-VU "Ask" to MRPO states and to consult with them regarding the reasonableness of the requested controls. Federal Land Manager agencies also attended the meeting.

- MANE-VU Consultation Meeting with VISTAS, August 20, 2007
    - This meeting was held at State of Georgia offices in Atlanta and was attended by representatives of MANE-VU and VISTAS states, as well as staff. The meeting provided an opportunity to formally present the MANE-VU "Ask" to VISTAS states and to consult with them regarding the reasonableness of the requested controls. Federal Land Manager agencies also attended the meeting.

- MANE-VU – Midwest RPO Consultation Conference Call, September 13, 2007
    - This call was a follow-up to the meeting held on August 6 in Chicago and provided an opportunity to further clarify what was being asked of the MRPO states, including explanation of the flexibility in the "Ask." Both MRPO and MANE-VU staff agreed to work together to facilitate discussion of further controls on ICI boilers and EGUs.

- MANE-VU Air Directors' Consultation Conference Call, September 26, 2007
    - This call allowed MANE-VU members to clarify their understanding of the "Ask" and to provide direction to modeling staff as to how to interpret the "Ask" for purposes of estimating visibility impacts of the requested controls.

- MANE-VU Air Directors' Conference Call, March 31, 2008
    - On this call, NESCAUM presented the results of the final 2018 modeling and described the methods used to represent the impacts of the measures agreed to by the Class I States. Federal Land Manager agencies also participated in this call.

2.9. Meeting the "Ask" – MANE-VU States

The member states of MANE-VU have stated their intention to meet the terms of the "Ask" in their SIPs. The "Ask" for member states commits each state to pursue the adoption and implementation of the following emission management strategies, as appropriate and necessary:

- timely implementation of BART requirements; and

- a low sulfur fuel oil strategy in the inner zone States (New Jersey, New York, Delaware and Pennsylvania, or portions thereof) to reduce the sulfur content of: distillate oil to 0.05 percent sulfur by weight (500 ppm) by no later than 2012, of #4 residual oil to 0.25 percent sulfur by weight by no later than 2012, of #6 residual oil to 0.3 – 0.5 percent sulfur by weight by no later than 2012, and to further reduce the sulfur content of distillate oil to 15 ppm by 2016; and

- a low sulfur fuel oil strategy in the outer zone States (the remainder of the MANE-VU region) to reduce the sulfur content of distillate oil to 0.05 percent sulfur by weight (500 ppm) by no later than 2014, of #4 residual oil to 0.25 – 0.5 percent sulfur by weight by no later than 2018, and of #6 residual oil to no greater than 0.5 percent sulfur by weight by no later than 2018, and to further reduce the sulfur content of distillate oil to 15 ppm by 2018, depending on supply availability; and

- A 90 percent or greater reduction in sulfur dioxide (SO_2) emissions from each of the top 100 electric generating units (EGUs) identified by MANE-VU (comprising a total of 167 stacks) as reasonably anticipated to cause or contribute to impairment of visibility in each mandatory Class I Federal area in the MANE-VU region. If it is infeasible to achieve that level of reduction from a unit, alternative measures will be pursued in such State; and

- continued evaluation of other control measures including energy efficiency, alternative clean fuels, and other measures to reduce SO_2 and nitrogen oxide (NOx) emissions from all coal-burning facilities by 2018 and new source performance standards for wood combustion. These measures and other measures identified will be evaluated during the consultation process to determine if they are reasonable and cost-effective.

Massachusetts supports the SIPs of each of its fellow MANE-VU states provided that these SIPs incorporate these commitments.

2.10. Meeting the "Ask" – Massachusetts

As a MANE-VU member state, Massachusetts also adopted the "Ask" at the MANE-VU Board meeting on June 7, 2007. Massachusetts intends to meet the terms of this agreement by implementing BART or an alternative to BART as described in Section 8, and by ensuring reductions in SO_2 emissions from the Massachusetts Targeted EGU stacks, pursuing the low-sulfur fuel oil strategy, and implementing controls on outdoor wood-fired boilers as described in Section 10. Massachusetts also will pursue other reasonable and cost-effective measures as needed.

2.11. Meeting the "Ask" – States Outside of MANE-VU

For consulting states outside the MANE-VU region, the MANE-VU "Ask" requests the pursuit of the adoption and implementation of the following control strategies, as appropriate and necessary:

- timely implementation of BART requirements;

- A 90 percent or greater reduction in sulfur dioxide (SO_2) emissions from each of the top 100 electric generating units (comprising a total of 167 stacks) impacting any mandatory Class I Federal area in the MANE-VU region, or an equivalent SO_2 reduction within each State;

- the application of reasonable controls on non-EGU sources resulting in a 28 percent reduction in non-EGU SO_2 emissions, relative to on-the-books, on-the-way 2018 projections used in regional haze planning, by 2018, which is equivalent to the projected reductions MANE-VU will achieve through its low sulfur fuel oil strategy;

- continued evaluation of other measures including measures to reduce SO_2 and nitrogen oxide (NO_x) emissions from all coal-burning facilities by 2018 and promulgation of new source performance standards for wood combustion. These measures and other measures identified will be evaluated through consultation processes to determine if they are reasonable.

Massachusetts recognizes that non-MANE-VU states may choose not to adopt the MANE-VU "Ask" due to associated costs, conflicts, and relative lack of benefit within their jurisdictions. During consultations, some non-MANE-VU states were considering not pursuing reductions beyond CAIR controls and other measures pertaining to BART. EPA's CSAPR will provide reductions similar to CAIR and it is hoped that states in the mid-west and southeast RPOs will adopt other additional controls. Ultimately, the approvability of all states' SIPs will be determined by EPA.

2.12. Technical Ramifications of Differing Approaches

MANE-VU states intended to develop a modeling platform that was common in terms of meteorology and emissions with each of the other nearby RPOs. The RPOs worked diligently to form a common set of emissions with similar developmental assumptions. Even with the best of intentions, it became difficult to keep up with each RPO's updates and corrections. Each rendition of emissions inventory improved its quality, but because each update made to one RPO's emissions meant that the other RPOs needed to incorporate the updates into the full emission set for all the RPOs and then reprocess them, there was a continuous modeling effort where each one outdated the last. Because each rendition put previous modeling efforts out of date, and a single modeling run could take more than a month to complete, inventory updates contributed to SIP delays. The emission inventory conflicts were excessively time consuming and caused most states to miss the official SIP filing date of December 17, 2007.

The RPOs also took differing perspectives on which version of the EGU dispatching model (Integrated Planning Model or IPM) to use. At the beginning of the process, IPM version 2.1.9 was available and EPA agreed to its use for emissions preparation. Since then, IPM version 3.0 became available and it became EPA's preferred version since it had updated fuel costs. MRPO adopted IPM v3.0 for its use, but VISTAS stayed with IPM v2.1.9. Rather than develop non-comparative datasets for its previous IPM analyses, MANE-VU also stayed with IPM v2.1.9. Therefore, of the three eastern RPOs, differing emissions assumptions eventually worked their way into the final set of modeling assumptions.

MANE-VU's best and final modeling not only considers on-the-way/on-the-books emissions programs for 2018 (listed in Section 10), but also includes additional reasonable controls in its region, including those contained in the MANE-VU "Ask". It should be noted that other RPOs may not have included such measures in their final modeling. In these cases, the modeling results of states in these RPOs will be inconsistent with meeting the terms of the MANE-VU "Ask" – a situation that may not be adequately addressed in their SIPs. These inconsistencies will need to be resolved by EPA.

2.13. Federal Land Manager Coordination

Massachusetts will continue to coordinate and consult with the Federal Land Managers (FLMs) during the development of future progress reports and plan revisions, as well as during the implementation of programs having the potential to contribute to visibility improvement in the Class I areas.

Section 51.308(i) of the Regional Haze Rule requires coordination between states/tribes and the FLMs. Opportunities have been provided by MANE-VU for FLMs to review and comment on each of the technical documents developed by MANE-VU and included in this SIP. Massachusetts has provided agency contacts to the FLMs as required. In the development of this Plan, the FLMs were consulted in accordance with the provisions of 51.308(i)(2).

MassDEP provided previous drafts of this SIP, or portions thereof, to FLMs and EPA for review and comment on November 25, 2008 and July 31, 2009, and published the draft SIP for public hearing and comment on January 11, 2011. MassDEP provided the FLMs an opportunity for consultation, in person and at least 60 days prior to holding a public hearing on the SIP. The comments submitted by the FLMs were both general and specific. The reviewing agencies found Massachusetts' draft Regional Haze SIP to be well written and comprehensive. The uncertainty surrounding CAIR and discrepancies in modeling (especially inclusion of the MANE-VU Ask) between MANE-VU and other RPOs were identified as broad topics for further discussion through the consultation process. Comments of a specific nature were focused primarily on requesting additional information in support of initial BART analyses. In accordance with 40 CFR 51.308(i)(3), MassDEP has addressed comments from FLMs regarding the SIP in Appendix D of this plan, as well as comments submitted by EPA.

Section 51.308(i)(4) requires procedures for continuing consultation between states/tribes and FLMs on the implementation of the visibility protection programs. In particular, consultations will be conducted with the designated visibility protection program coordinators for the National Park Service, the U. S. Fish and Wildlife Service, and the U.S. Forest Service. MassDEP will consult periodically with the FLMs as necessary on the status of the following implementation items:

1. Implementation of emissions strategies identified in the SIP as contributing to achieving improvement in the worst-day visibility.
2. Summary of major new source permits issued.
3. Status of Massachusetts actions to meet commitments for completing any future assessments or rulemakings on sources identified as likely contributors to visibility impairment, but not directly addressed in the most recent SIP revision.
4. Any changes to the status of the monitoring strategy or monitoring stations that may affect tracking of reasonable progress.
5. Work underway for preparing the 5-year review and / or 10-year revision.
6. Items for FLMs to consider or provide support for in preparation for any visibility protection SIP revisions (based on the 5-year review or the 10-year revision schedule).
7. Summaries of discussions (meetings, emails, other records) covered in ongoing communications between MassDEP and FLMs regarding implementation of the visibility program.

3. ASSESSMENT OF BASELINE AND NATURAL CONDITIONS

Under the Clean Air Act, the Regional Haze SIPs must contain measures to make reasonable progress toward the goal of achieving natural visibility. Section 51.308(d)(2) of EPA's Regional Haze Rule requires each state containing a Class I area to determine baseline and natural visibility conditions for their Class I area in consultation with FLMs and states identified as containing sources whose emissions contribute to visibility impairment in Class I areas. Comparing baseline conditions to natural visibility conditions determines the uniform rate of progress that must be considered as states set reasonable progress goals for each Class I area.

The requirement to assess baseline and natural conditions within Class I Areas is a responsibility of the state containing those areas. Massachusetts does not contain any Class I Areas; however, assessment of baseline and natural visibility conditions for MANE-VU Class I Areas is included here as reference.

3.2. Calculation Methodology

The Interagency Monitoring of Protected Visual Environments (IMPROVE) program was established in 1985 to provide the data needed to assess current visibility conditions, track changes in visibility, and help determine the causes of visibility impairment in Class I Areas (see Section 4 for more detailed information about IMPROVE). IMPROVE data was used to calculate baseline and natural conditions for MANE-VU Class I areas.

The IMPROVE monitors listed in Table 4 provide data that are representative of Class I Areas in MANE-VU. As described in the Monitoring Section (Section 4) of this SIP, Massachusetts accepts IMPROVE designation of these sites as representative of Class I areas in accordance with 40 CFR 51.308(d)(2)(i).

Table 4: IMPROVE Monitors for MANE-VU Class I Areas

Class I Area	IMPROVE Site	Location (latitude and longitude)	State
Acadia National Park	ACAD1	44.38, -68.26	Maine
Moosehorn Wilderness Area	MOOS1	45.13, -67.27	Maine
Roosevelt/Campobello International Park	MOOS1	45.13, -67.27	Maine
Great Gulf Wilderness Area	GRGU1	44.31, -71.22	New Hampshire
Presidential Range/Dry River Wilderness	GRGU1	44.31, -71.22	New Hampshire
Lye Brook Wilderness Area	LYBR1	43.15, -73.13	Vermont
Brigantine Wilderness Area	BRIG1	39.47, -74.45	New Jersey

Source: VIEWS (http://vista.cira.colostate.edu/views/), prepared on 7/06/06

In September 2003, EPA issued guidance for the calculation of natural background and baseline visibility conditions. The guidance provides a default method and describes certain refinements that states may wish to evaluate to tailor these estimates to a specific Class I area if it is poorly represented by the default method. At that time, MANE-VU calculated natural visibility for each of the MANE-VU Class I areas using the default method for the 20 percent best and worst visibility days. MANE-VU also evaluated ways to refine the estimates. Potential refinements included: increasing the multiplier used to calculate impairment attributed to carbon, adjusting the formula used to calculate the 20 percent best and worst visibility days, and accounting for visibility impairment due to sea salt at coastal sites. However, MANE-VU found that these refinements did not significantly improve the accuracy of the estimates, and MANE-VU states desired a consistent approach. Therefore, default estimates were used with the understanding that this would be reconsidered when better scientific knowledge warranted.

Once the technical analysis was complete, MANE-VU provided an opportunity to comment to federal agencies and stakeholders. The proposed approach was posted on the MANE-VU website on March 17, 2004 and a stakeholder briefing was held on the same day. Comments were received from the Electric Power Research Institute, the Midwest Ozone Group, the Appalachian Mountain Club, the National Parks Conservation Association, the National Park Service, and the US Forest Service.

Several comments supported the proposal and other comments addressed four main topics: the equation used to calculate visibility, the statistical technique used to estimate the 20 percent best and worst visibility days, the inclusion of transboundary effects and fires, and the timing of when new information should be included. All comments were reviewed and summarized by MANE-VU. The MANE-VU Board was briefed on comments and proposed response options.

The MANE-VU position on natural background conditions was issued in June 2004, and stated that, “Refinements to other aspects of the default method (e.g., refinements to the assumed distribution or treatment of Rayleigh extinction, inclusion of sea salt, and improved assumptions about the chemical composition of the organic fraction) may be warranted prior to submission of SIPs depending on the degree to which scientific consensus is formed around a specific approach…”

In 2006, the IMPROVE Steering Committee adopted an alternative reconstructed extinction equation to revise certain aspects of the default method. The aspects revised were scientifically well understood, and the Committee determined that revisions improved the performance of the equation at reproducing observed visibility at Class I sites.

In 2006, NESCAUM conducted an assessment of the default and alternative approaches for calculation of baseline and natural background conditions at MANE-VU Class I areas. (See the MANE-VU document, *Baseline and Natural Background Visibility Conditions: Considerations and Proposed Approach to the Calculation of Baseline and Natural Background Visibility Conditions at MANE-VU Class I Areas*, Appendix E.) Corresponding visibility improvement targets for 2018 using each approach also were presented in the document (see Table 3-3 of Appendix E). Results suggest that the alternative approach leads to very similar uniform rates of progress in New England with slightly greater visibility improvement required in the Mid-Atlantic region relative to the default approach. Based on that assessment, in December 2006, MANE-VU recommended adoption of the alternative reconstructed extinction equation for use in SIPs. MANE-VU will continue to participate in further research efforts on this topic and will reconsider the calculation methodology as scientific understanding evolves.

3.3. MANE-VU Baseline and Natural Visibility

The IMPROVE program has calculated the 20 percent best and 20 percent worst baseline (2000-2004) and natural visibility conditions using the EPA-approved alternative method described above for each MANE-VU Class I Area. The data are posted on the Visibility Information Exchange Web System (VIEWS) operated by the regional planning organizations. The information can be accessed at http://vista.cira.colostate.edu/views/ and is summarized in Table 5 below. Units are expressed in deciviews, a log function of the light scattering and absorption extinction coefficient, as required by 40 CFR 51.308(d)(2). Generally, a one deciview change in the haze index is likely to be perceptible under ideal conditions regardless of background visibility conditions. Displayed are the five-year average baseline visibility values for the period 2000-2004, natural visibility levels, and the difference between baseline and natural visibility values for each of the MANE-VU Class I areas. The difference columns (best and worst) are of particular interest because they describe the magnitude of visibility impairment attributable to manmade emissions, which are the focus of the Regional Haze Rule.

The five-year averages for 20 percent best and worst visibility were calculated in accordance with 40 CFR 51.308(d)(2), as detailed in NESCAUM's Baseline and Natural Background document found in Appendix E.

Table 5: Summary of Baseline Visibility and Natural Visibility Conditions for the 20 Percent Best and 20 Percent Worst Visibility Days at MANE-VU Class I Areas

Class I Area(s)	2000-2004 Baseline (deciviews)		Natural Conditions (deciviews)		Difference (deciviews)	
	Best 20%	Worst 20%	Best 20%	Worst 20%	Best 20%	Worst 20%
Acadia National Park	8.8	22.9	4.7	12.4	4.1	10.5
Moosehorn Wilderness and Roosevelt Campobello International Park	9.2	21.7	5.0	12.0	4.1	9.7
Great Gulf Wilderness and Presidential Range - Dry River Wilderness [4]	7.7	22.8	3.7	12.0	3.9	10.8
Lye Brook Wilderness	6.4	24.5	2.8	11.7	3.6	12.7
Brigantine Wilderness	14.3	29.0	5.5	12.2	8.8	16.8

Source: VIEWS (http://vista.circa.colostate.edu/views/), prepared on 6/22/2007

[4] Based on 4-year average for 2001-2004 (data collection in 2000 was for summer only).

4. MONITORING STRATEGY

Section 51.308(d)(4) of EPA's Regional Haze Rule requires a monitoring strategy for measuring, characterizing, and reporting of regional haze visibility impairment that is representative of Class I areas within a state, and allows compliance with this requirement to be met through participation in the Interagency Monitoring of Protected Visual Environments (IMPROVE) program.

In the mid-1980's, the IMPROVE program was established to measure visibility impairment in mandatory Class I areas throughout the United States. The monitoring sites are operated and maintained through a formal cooperative relationship between EPA, National Park Service, U.S. Fish and Wildlife Service, Bureau of Land Management, and U.S. Forest Service. In 1991, several additional organizations joined the effort: State and Territorial Air Pollution Program Administrators, the Association of Local Air Pollution Control Officials (which now goes by The National Association of Clean Air Agencies), Western States Air Resources Council, Mid-Atlantic Regional Air Management Association, and Northeast States for Coordinated Air Use Management.

4.2. IMPROVE Program Objectives

The IMPROVE program provides scientific documentation of the visual air quality of America's wilderness areas and national parks. Many individuals and organizations – land managers, industry planners, scientists (including university researchers), public interest groups, and air quality regulators – use the data collected at IMPROVE sites to understand and protect the visual air quality resources in Class I areas. Major objectives of the IMPROVE program include:

- Establish current visibility and aerosol conditions in mandatory Class I areas,
- Identify chemical species and emission sources responsible for existing anthropogenic visibility impairment,
- Document long-term trends for assessing progress towards national visibility goals,
- Provide regional haze monitoring representing all visibility-protected federal Class I areas where practical, as required by EPA's Regional Haze Rule.

4.3. Monitoring Information for Massachusetts

Section 51.308(d)(4)(iii) of the Regional Haze Rule requires for a state with no Class I areas, such as Massachusetts, the inclusion of procedures by which monitoring data and other information are used in determining the contribution of emissions from within the state to regional haze visibility impairment at Class I areas outside the state. Massachusetts' contribution is documented in the contribution assessment analysis completed by NESCAUM entitled, *Contributions to Regional Haze in the Northeast and Mid-Atlantic States* (Contribution Assessment) found in Appendix A. The NESCAUM study used various tools and techniques to assess the contributions of individual states and regions to visibility degradation in Class I areas within and outside MANE-VU.

Massachusetts agrees that NESCAUM is providing quality technical information by using the IMPROVE program data and the Visibility Information Exchange Web System (VIEWS) site. Information about the use of the default and alternative approaches to the calculation of baseline and natural background conditions can be found in Section 3 of this SIP.

Massachusetts does not contain any Class I Areas; therefore no monitoring plan is required under Section 51.308(d)(4) or Section 51.30 of the Regional Haze Rule. Massachusetts does, however, have three IMPROVE monitors that were used in the regional haze modeling: Cape Cod (CACO), Martha's Vineyard (MAVI), and Quabbin summit (QURE). The CACO IMPROVE monitor is located at Cape Cod National Seashore in Truro and is operated and maintained by the National Park Service. It is located near MassDEP's monitoring site at latitude 41:58 and longitude -70:01. The QURE IMPROVE monitor is located at the Quabbin Reservoir in Ware, at latitude 42:17 and longitude –72:20, and is operated and maintained by MassDEP. The MAVI IMPROVE monitor is located on Martha's Vineyard and is operated by the Wampanoag Tribe of Gay Head (Aquinnah). Massachusetts commits to continuing these monitoring programs and to working with the National Park Service, Wampanoag Tribe, and EPA towards this end.

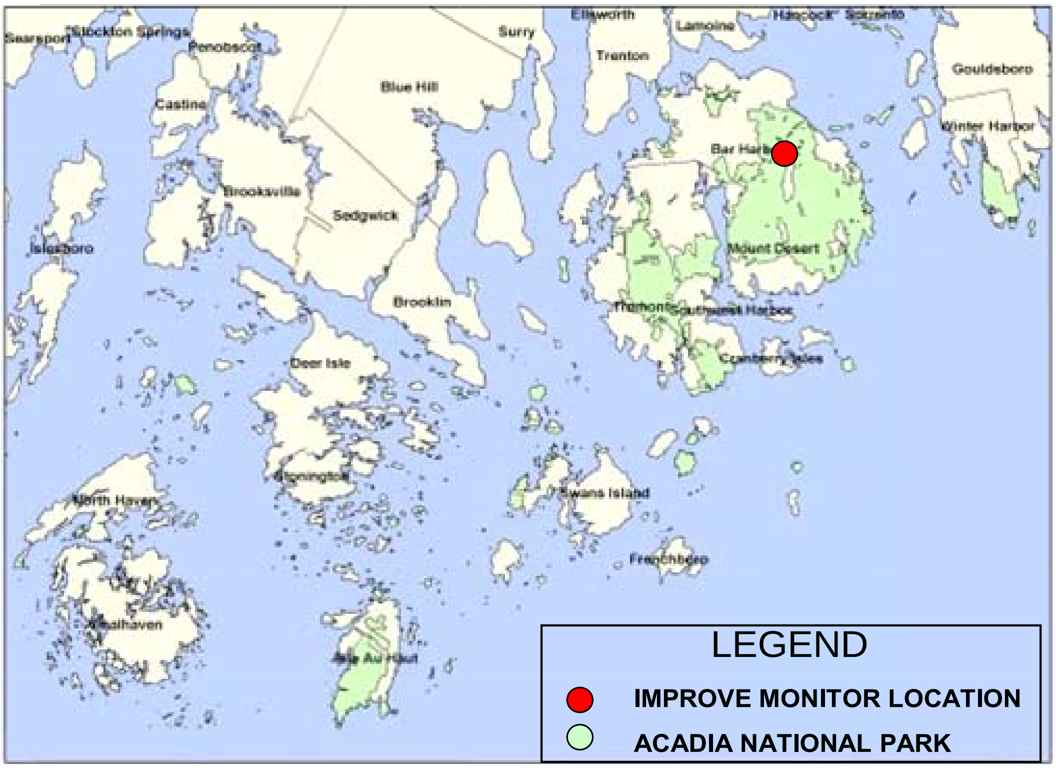
The following information is for monitoring within Class I areas determined to be impacted by Massachusetts sources by the Contribution Assessment contained in Appendix A.

4.4. Monitoring Information for MANE-VU Class I Areas Impacted by Emissions from Massachusetts

Acadia National Park, Maine

The IMPROVE monitor for Acadia National Park (ACAD1) is located at park headquarters near Bar Harbor, Maine, at elevation 157 meters, latitude 44.38˚, and longitude -68.26˚ (see Figure 6). This monitor is operated and maintained by the National Park Service. Massachusetts considers the ACAD1 site as adequate for assessing reasonable progress toward visibility goals at Acadia National Park, and no additional monitoring sites or equipment are necessary at this time.

Figure 6: Map of Acadia National Park Showing Location of IMPROVE Monitor



Created by Tom Downs, MEDEP 4/17/07

http://www.maine.gov/dep/air/meteorology/images/Acadia.jpg

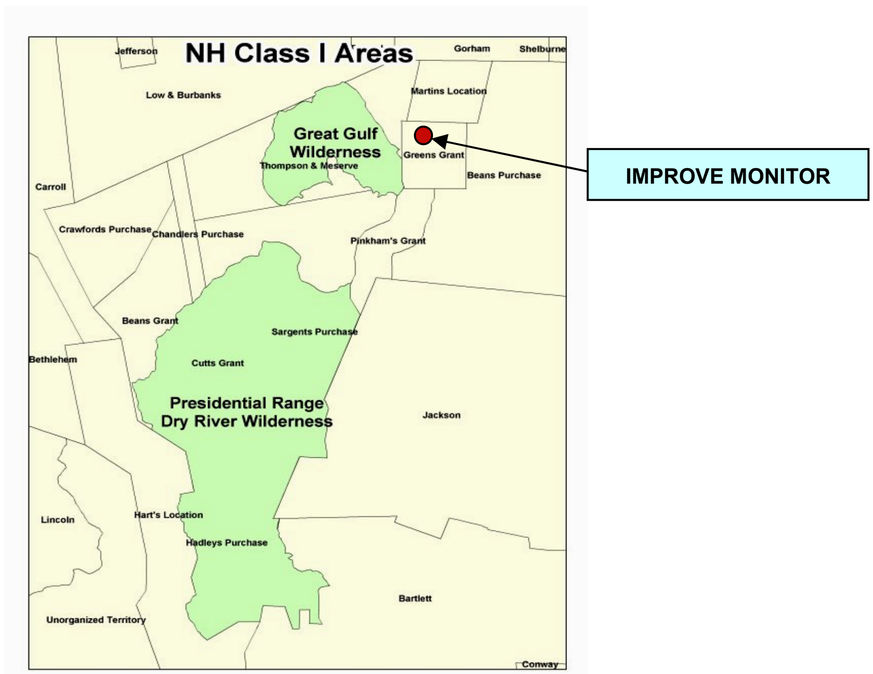
Figure 7: Acadia National Park on Clear and Hazy Days

http://www.hazecam.net/class1/acadia.html

Great Gulf Wilderness Area, New Hampshire

The IMPROVE monitor for the Great Gulf Wilderness (GRGU1) is located at Camp Dodge in the mid-northern area of Greens Grant in the White Mountain National Forest. The monitor site lies just east and south of where Route 16 crosses the Greens Grant / Martins Location boundary, south of Gorham, New Hampshire, at elevation 454 meters, latitude 44.31˚, and longitude of -71.22˚ (see Figure 8). This monitor, which also represents the Presidential Range - Dry River Wilderness (see Figure 8), is operated and maintained by the U.S. Forest Service. Massachusetts considers the GRGU1 site as adequate for assessing reasonable progress toward visibility goals at the Great Gulf Wilderness, and no additional monitoring sites or equipment are necessary at this time.

Figure 8: Map of Great Gulf and Presidential Range - Dry River Wilderness Areas Showing IMPROVE Monitor Location



http://www.maine.gov/dep/air/meteorology/images/NHclass1.jpg

Figure 9: Great Gulf Wilderness Area on Clear and Hazy Days

http://www.wilderness.net/

Presidential Range - Dry River Wilderness, New Hampshire

The IMPROVE monitor for the Presidential Range - Dry River Wilderness is also the monitor for Great Gulf Wilderness (GRGU1), as described above. Massachusetts considers the GRGU1 site as adequate for assessing reasonable progress toward visibility goals at the Presidential Range - Dry River Wilderness, and no additional monitoring sites or equipment are necessary at this time.

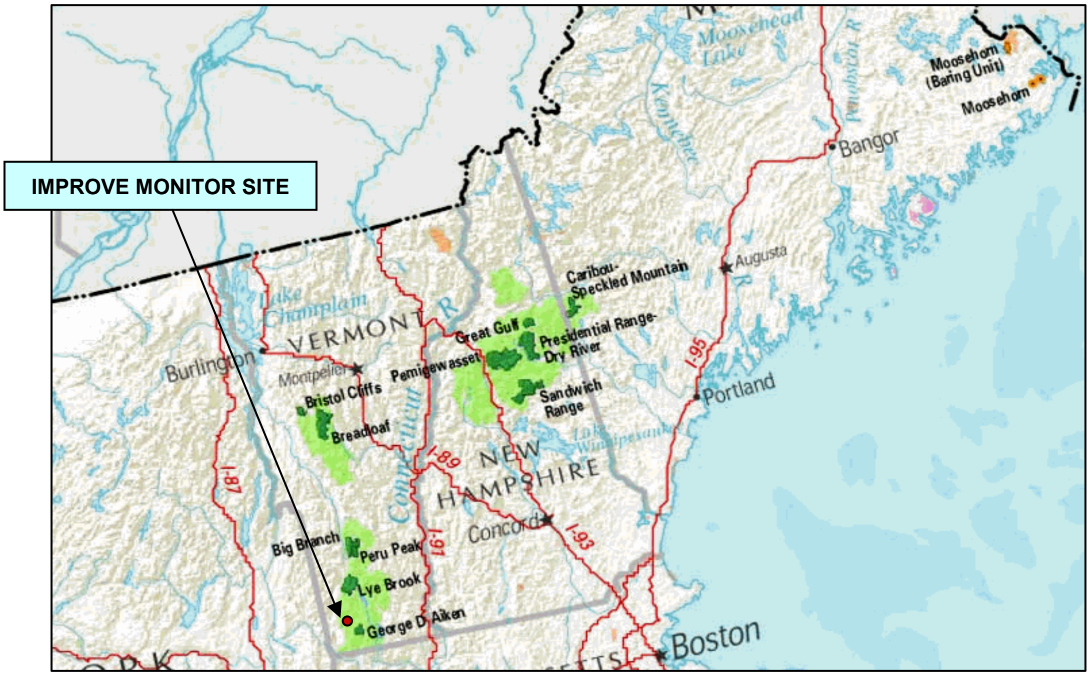
Presidential Range - Dry River Wilderness in Autumn

http://www.wilderness.net

Lye Brook Wilderness, Vermont

The IMPROVE monitor for the Lye Brook Wilderness (LYBR1) is located on Mount Equinox at the windmills in Manchester, Vermont, at elevation 1015 meters, latitude 43.15˚, and longitude of -73.13˚ (see Figure 10). The monitor does not lie within the wilderness area but is situated on a mountain peak across the valley to the west of the wilderness area. The IMPROVE site and the Lye Brook Wilderness are at similar elevations. The monitor is operated and maintained by the U.S. Forest Service. Massachusetts considers the LYBR1 site as adequate for assessing reasonable progress toward visibility goals at the Lye Brook Wilderness, and no additional monitoring sites or equipment are necessary at this time.

Figure 10: Location of Lye Brook Wilderness Monitor



http://www.wilderness.net/index.cfm?fuse=NWPS&sec=stateView&state=NH&map=menhvt

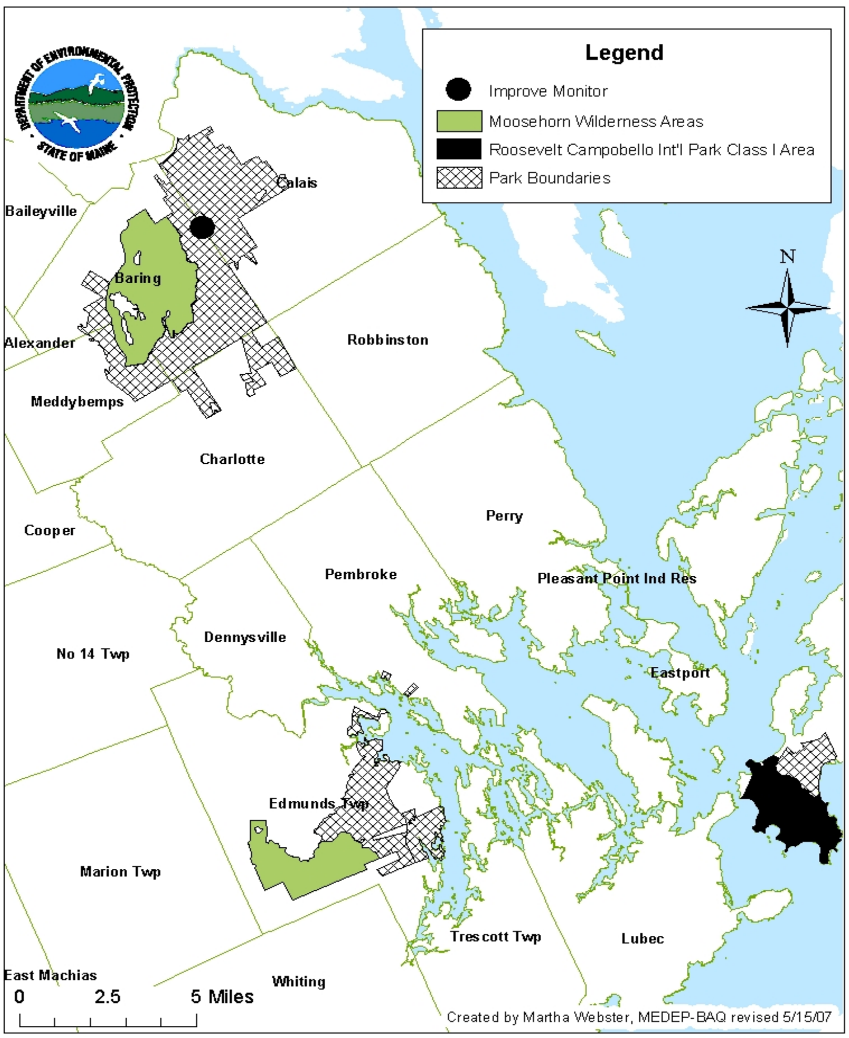
Figure 11: Lye Brook Wilderness Area on Clear and Hazy Days

http://www.hazecam.net/class1/lye.html

Moosehorn Wilderness Area, Maine

The IMPROVE monitor for the Moosehorn Wilderness (MOOS1) is located near McConvey Road, about one mile northeast of the National Wildlife Refuge Baring (ME) Unit Headquarters, at elevation 78 meters, latitude 45.13˚, and longitude -67.27˚ (see Figure 12). This monitor also represents the Roosevelt Campobello International Park in New Brunswick, Canada. The monitor is operated and maintained by the U.S. Fish & Wildlife Service. Massachusetts considers the MOOS1 site as adequate for assessing reasonable progress toward visibility goals at the Moosehorn Wilderness, and no additional monitoring sites or equipment are necessary at this time.

Figure 12: Map of the Baring and Edmunds Divisions of the Moosehorn National Wildlife Refuge Showing the IMPROVE Monitor Location



source: The Refuge Manager at Moosehorn Wilderness

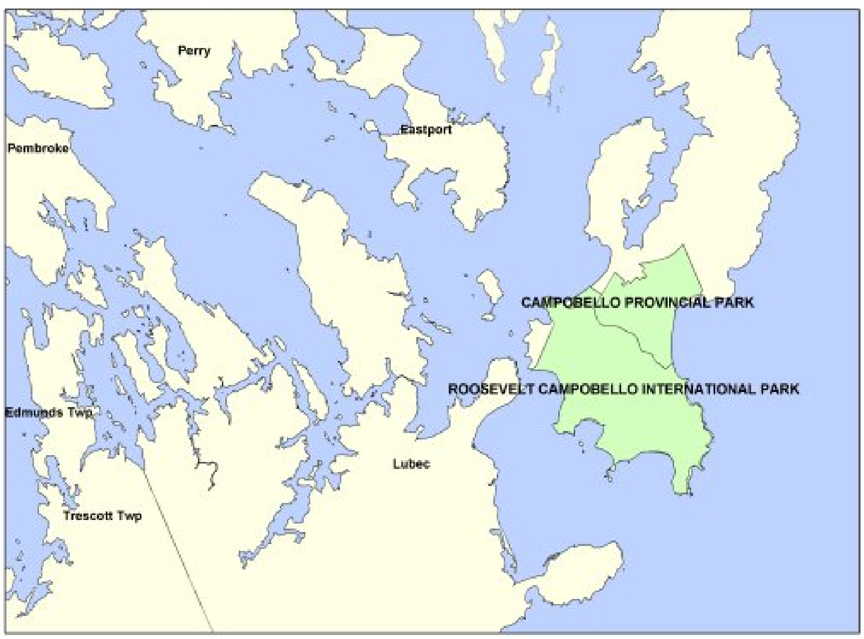
Figure 13: Moosehorn Wilderness Area on a Clear and a Hazy Day

source: Martha Webster, Maine Department of Environmental Protection – Bureau of Air Quality

Roosevelt/Campobello International Park, New Brunswick, Canada

The IMPROVE monitor for Roosevelt Campobello International Park is also the monitor for the Moosehorn Wilderness (MOOS1), as described above. Massachusetts considers the MOOS1 site as adequate for assessing reasonable progress toward visibility goals at Roosevelt Campobello International Park, and no additional monitoring sites or equipment are necessary at this time.

Figure 14: Map of Roosevelt/Campobello International Park



http://www.maine.gov/dep/air/meteorology/images/rcip.jpg

Figure 15: Roosevelt/Campobello International Park on Clear and Hazy Days

source: Chessie Johnson, Roosevelt Campobello International Park Commission

5. MODELING

Section 51.308(d)(3)(iii) of the Regional Haze Rule requires states to document the technical basis, including modeling, monitoring and emissions information, on which the state is relying to determine its apportionment of emissions reduction obligations necessary for achieving reasonable progress in each Class I area it affects.

Air quality modeling to assess regional haze has been done cooperatively between Massachusetts and its regional planning organization, MANE-VU, with major modeling efforts being conducted by NESCAUM[5] and screening modeling being conducted by the New Hampshire Department of Environmental Services.[6] These modeling efforts include emissions processing, meteorological input analysis, and chemical transport modeling to conduct regional air quality simulations for calendar year 2002 and several future periods, including the primary target period for this SIP, calendar year 2018. Modeling was conducted in order to assess contribution from upwind areas, as well as Massachusetts' contribution to Class I areas in downwind states. Further, the modeling evaluated visibility benefits of control measures being considered for achieving reasonable progress goals and establishing a long-term emissions management strategy for MANE-VU Class I areas.

The modeling tools utilized for these analyses include the following:

- The Fifth-Generation Pennsylvania State University/National Center for Atmospheric Research (NCAR) Mesoscale Model (MM5) was used to derive the required meteorological inputs for the air quality simulations.
- The Sparse Matrix Operator Kernel Emissions (SMOKE) emissions modeling system was used to process and format the emissions inventories for input into the air quality models.
- The Community Mesoscale Air Quality model (CMAQ) was used for the primary SIP modeling.
- The Regional Model for Aerosols and Deposition (REMSAD) was used during contribution apportionment.
- The California Grid Model (CALGRID) and its associated EMSPROC6 emissions processor were used to screen specific control strategies.
- The California Puff Model (CALPUFF) was used to assess the contribution of individual states' emissions to sulfate levels at selected Class I receptor sites.

Each of these tools has been evaluated and found to perform adequately. The pertinent SIP modeling underwent full performance testing and the results were found to meet the specifications of EPA modeling guidance.

For more details on the regional haze modeling, please refer to the NESCAUM report *MANE-VU Modeling for Reasonable Progress Goals, Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits* (Appendix F). The detailed modeling approach for the best and final 2018 projected scenario can be found in the NESCAUM report *2018 Visibility Projections* (Appendix G).

[5] Along with the NYSDEC, NJDEP/Rutgers, VADEQ, and UMD.
[6] Along with the VTDEP and MDEQ.

5.2. Meteorology

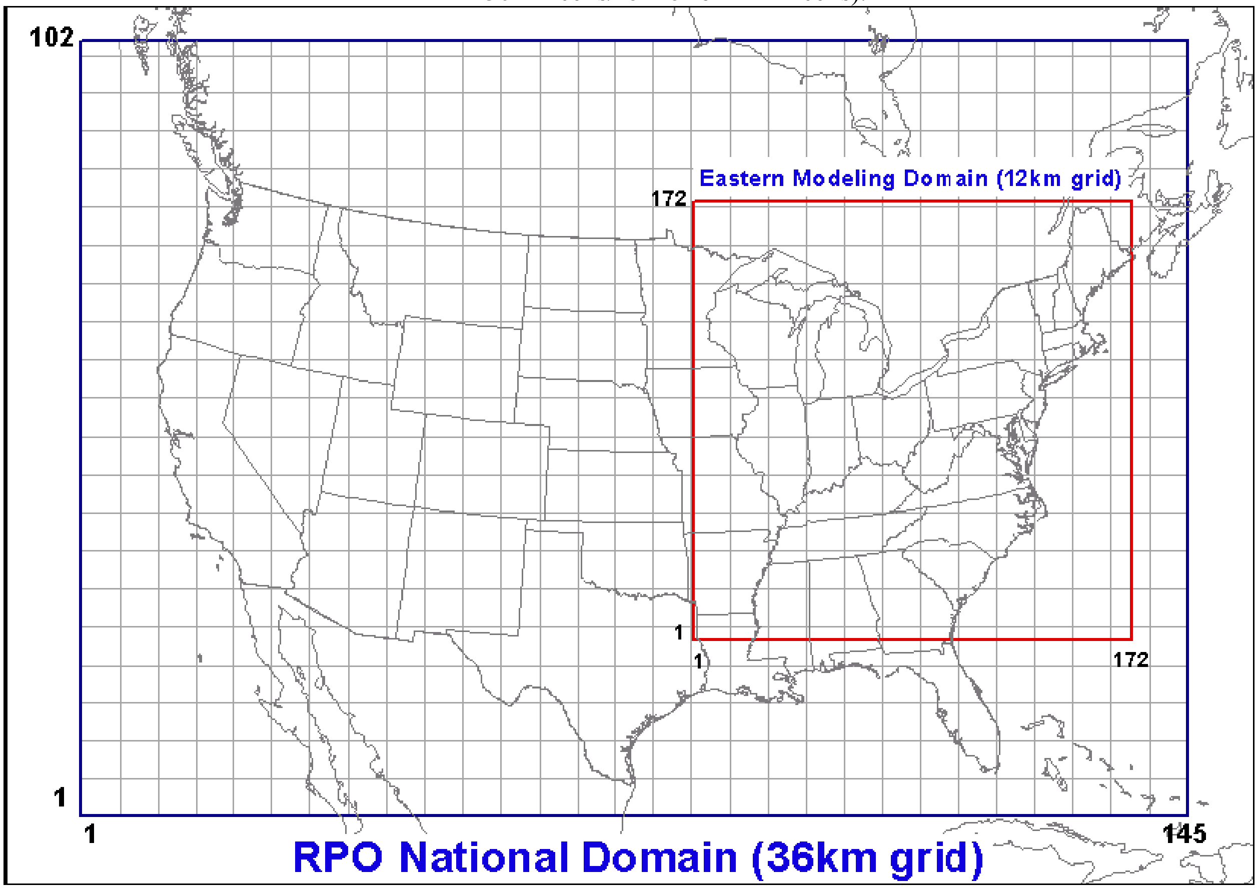
The meteorological inputs for the air quality simulations were developed by the University of Maryland (UMD) using the MM5 meteorological modeling system. Meteorological inputs were generated for 2002 to correspond with the baseline emissions inventory and analysis year. The MM5 simulations were performed on a nested grid as illustrated in Figure 16. As shown in the figure, the modeling domain is comprised of a 36-km, 145 x 102 continental grid and a nested 12-km, 172 x 172 grid encompassing the eastern United States and parts of Canada. In cooperation with the New York State Department of Conservation (NYSDEC), an assessment was made to compare the MM5 predictions with observations from a variety of data sources, including:

- surface observations from the National Weather Service (NWS) and the Clean Air Status and Trends Network (CASTNet),
- wind-profiler measurements from the Cooperative Agency Profilers (CAP) network,
- satellite cloud image data from the UMD Department of Atmospheric and Oceanic Science, and
- precipitation data from the Earth Observing Laboratory at NCAR. This assessment was performed for the period covering May through September 2002.

Further details regarding the MM5 meteorological processing and the modeling domain can be found in Appendix H, NYSDEC's *Meteorological Modeling Using Penn State/NCAR 5th Generation Mesoscale Model* and Appendix F, NESCAUM's *MANE-VU Modeling for Reasonable Progress Goals.*

Figure 16: Modeling domains used in MANE-VU air quality modeling studies with CMAQ.

Outer (blue) domain grid is 36 km and inner (red) domain is 12 km grid. The gridlines are shown at 180 km intervals (5x5 for 36 km cells/15×15 for 12 km cells).

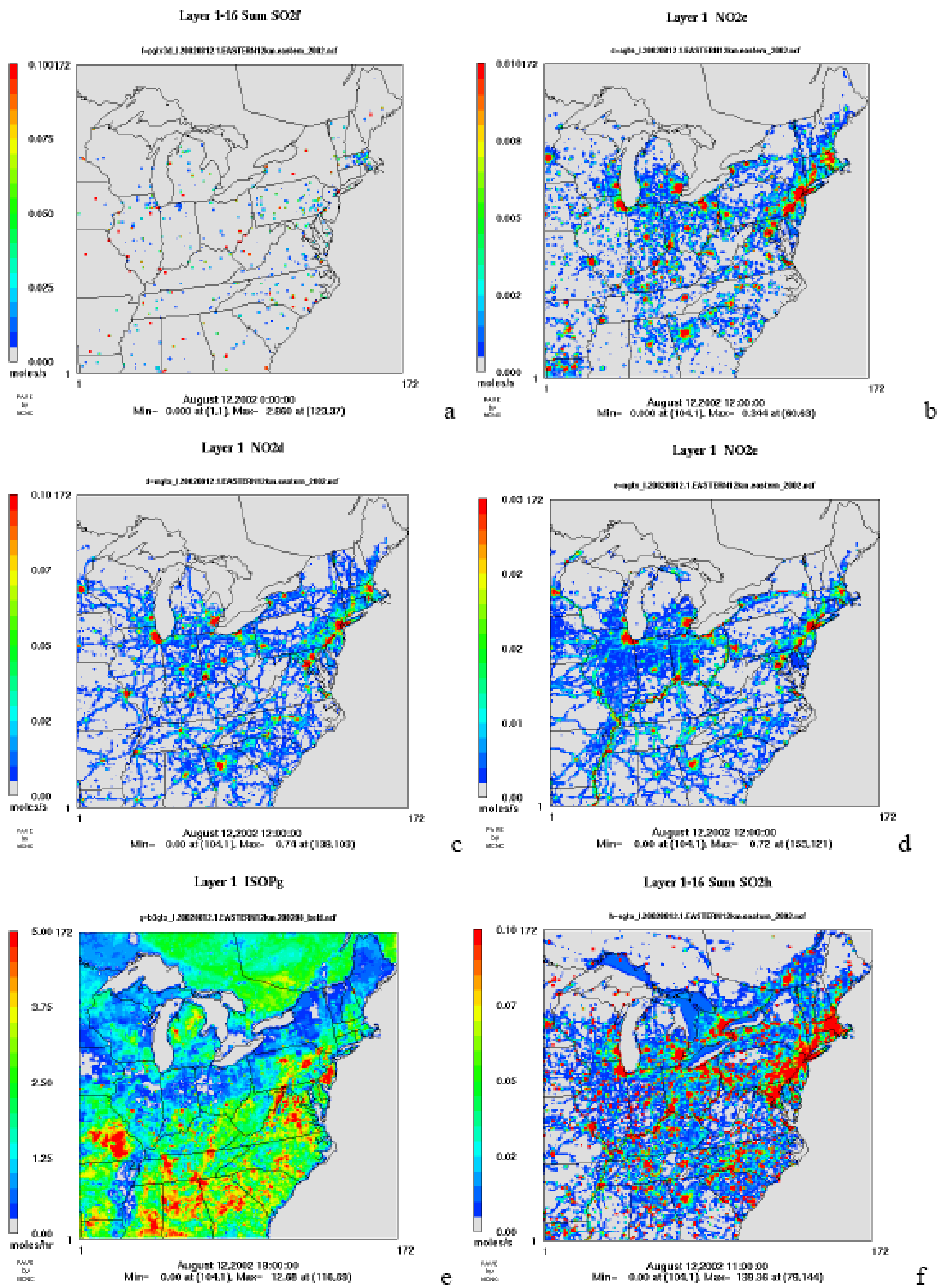


5.3. Emissions Data Preparations

Emissions data were prepared for input into the CMAQ and REMSAD air quality models using the SMOKE emissions modeling system. SMOKE supports point, area, mobile (both on-road and non-road), and biogenic emissions. The SMOKE emissions modeling system uses flexible processing to apply chemical speciation as well as temporal and spatial allocation to the emissions inventories. SMOKE incorporates the Biogenic Emission Inventory System (BEIS) and EPA's MOBILE6 motor vehicle emission factor model to process biogenic and on-road mobile emissions, respectively. Vector-matrix multiplication is used during the final processing step to merge the various emissions components into a single model-ready emissions file. Examples of processed emissions outputs are shown in Figure 17.

Further details on the SMOKE processing that was done in support of the air quality simulations is provided in Appendix H and Appendix I, NYSDEC's *Emission Processing for the Revised 2002 OTC Regional and Urban 12 km Base Case Simulations.* Additional details on the emission inventory preparation can be found in Section 6.

Figure 17: Examples of processed model-ready emissions: a) SO_2 from Point, b) NO_2 from Area, c) NO_2 from On-road, d) NO_2 from Non-road, e) ISOP from Biogenic, f) SO_2 from all source categories



5.4. Model Platforms

Two regional-scale air quality models, CMAQ and REMSAD, were used for the air quality simulations that directly supported the Regional Haze SIP effort. CMAQ was developed by EPA and was used to perform the primary SIP-related modeling. The CMAQ modeling simulations also were an important tool for the 8-hour ozone SIP process. REMSAD was developed by ICF Consulting/Systems Applications International with support from EPA. REMSAD was used by NESCAUM to perform a source apportionment analysis. All of the air quality simulations that were used in the SIP efforts were performed on the 12-km eastern modeling domain shown in Figure 16 above.

NESCAUM performed a model performance evaluation for $PM_{2.5}$ species, aerosol extinction coefficient, and the haze index, which is provided in Appendix F. NYSDEC also performed a model performance analysis to evaluate CMAQ model predictions against observations of ozone, $PM_{2.5}$, and other chemical species, which is contained in Appendix J, *CMAQ Model Performance and Assessment, 8-Hr OTC Ozone Modeling.*

CMAQ

The CMAQ air quality simulations were performed cooperatively between five modeling centers, including NYSDEC, the New Jersey Department of Environmental Protection (NJDEP) in association with Rutgers University, the Virginia Department of Environmental Quality (VADEQ), UMD, and NESCAUM. NYSDEC also performed an annual 2002 CMAQ simulation on the 36-km domain shown in Figure 16; this simulation was used to derive the boundary conditions for the inner 12-km eastern modeling domain. Boundary conditions for the 36-km simulations were obtained from a run of the GEOS-Chem (Goddard Earth Observing System) global chemistry transport model that was performed by researchers at Harvard University. The technical options that were used in performing the CMAQ simulations are described in detail in Appendix K, NYSDEC's *Eight-Hour Ozone Modeling using the SMOKE/CMAQ system.* Further technical details regarding the CMAQ model and its execution are also provided in Appendix F.

REMSAD

The REMSAD modeling simulations were used to satisfy the haze rule requirement that a pollution apportionment be performed to assess contribution to visibility improvement by geographic region or source sector. REMSAD's species tagging capability makes it an important tool for this purpose. This allowed for a rough estimation of the total contribution from elevated point sources in each state to simulated sulfate concentrations at eastern receptor sites. Using identical emission and meteorological inputs to those prepared for the Integrated SIP (CMAQ) platform, REMSAD was used to simulate the annual average impact of each state's SO_2 emission sources on the sulfate fraction of $PM_{2.5}$ over the northeastern United States using the same 12-km eastern modeling domain as shown in Figure 16. Appendix F further describes the REMSAD model and its application to the Regional Haze SIP efforts.

CALGRID

In addition to the SIP-quality modeling platforms described above, an additional modeling platform was developed for use as a screening tool to evaluate additional control strategies or to perform sensitivity analyses. The CALGRID model was selected as the basis for this platform. CALGRID is a grid-based photochemical air quality model that is designed to be run in a Windows environment. In order to make the CALGRID model the best possible tool to supplement the SIP-quality CMAQ and REMSAD modeling, the current version of the CALGRID platform was set up to be run with the same set of inputs as the SIP-quality models. The CALGRID air quality simulations were run on the same 12-km eastern modeling domain that was used for CMAQ and REMSAD. This model's performance was relative to the performance of the already evaluated CMAQ and REMSAD models and was thus determined to perform adequately.

Conversion utilities were developed to re-format the meteorological inputs, the boundary conditions, and the emissions for use with the CALGRID modeling platform. Pre-merged SMOKE emissions files were obtained from the modeling centers and re-formatted for input into EMSPROC6, the emissions pre-processor for the CALGRID modeling system. EMSPROC6 allows the CALGRID user to adjust emissions temporally, geographically, and by emissions category for control strategy analysis. The pre-merged SMOKE files that were obtained from the modeling centers were broken down into the biogenic, point, area, non-road, and on-road emissions categories. These files by component were then converted for use with EMSPROC6, thus giving CALGRID users the flexibility to analyze a wide variety of emissions control strategies. Additional information on the CALGRID modeling platform can be found in Appendix L, NHDES' *Modeling Protocol for the OTC CALGRID Screening-Level Modeling Platform for the Evaluation of Ozone.*

CALPUFF

CALPUFF is a non-steady-state Lagrangian puff model that simulates the dispersion, transport, and chemical transformation of atmospheric pollutants. Two parallel CALPUFF modeling platforms were developed by the Vermont Department of Environmental Conservation (VTDEC) and the Maryland Department of the Environment (MDE). The VTDEC CALPUFF modeling platform utilized meteorological observation data from the National Weather Service (NWS) to drive the CALMET meteorological model. The MDE platform utilized the same MM5 meteorological inputs that were used in the modeling done in support of the ozone and Regional Haze SIPs. These two platforms were run in parallel to evaluate individual states' contributions to sulfate levels at Northeast and Mid-Atlantic Class I areas. The CALPUFF modeling effort is described in detail in Appendix A.

6. EMISSIONS INVENTORY

Section 51.308(d)(4)(v) of the Regional Haze Rule requires a statewide emission inventory of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any mandatory Class I area. The inventory must include emissions for a baseline year, future (projected) year, and the most recent year for which data are available. Massachusetts' baseline year is 2002. The pollutants inventoried by Massachusetts for 2002 include volatile organic compounds (VOCs), nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), fine particles ($PM_{2.5}$), coarse particles (PM_{10}), and ammonia (NH_3). The emission inventory consists of the following source categories: stationary point, area, on-road mobile, off-road mobile, and biogenics. These source categories are discussed further below and in Section 7.

6.2. Baseline and Future Year Emission Inventories for Modeling

Section 51.308(d)(3)(iii) of EPA's Regional Haze Rule requires Massachusetts to identify the baseline emission inventory on which strategies are based. The baseline inventory is used to assess progress in making emissions reductions. Based on EPA guidance entitled, *2002 Base Year Emission Inventory SIP Planning: 8-hour Ozone, $PM_{2.5}$, and Regional Haze Programs,* which identifies 2002 as the anticipated baseline emission inventory year for regional haze, MANE-VU and Massachusetts used 2002 as the baseline year. Future year inventories were developed for the years 2009 and 2018 based on the 2002 base year. These future year emission inventories include emissions growth due to projected increases in economic activity, as well as the emissions reductions due to the implementation of control measures. In many instances, states already have submitted their 2002 base year SIP inventories to EPA due to their planning obligations under the ozone and/or PM programs. Massachusetts submitted its 2002 inventory to EPA on January 31, 2008.

Emission inventories are not static documents, but are constantly revised and updated to reflect the input of better emission estimates as they become available. Therefore, even though the 2002 "SIP" inventories and the 2002 "modeling" inventories both represent emissions from 2002, they may contain slightly different emission estimates due to the different time frames they were made available, and the different purposes each serves.

Accurate baseline and future emissions inventories are crucial to the analyses required for the Regional Haze SIP process. These emissions inventories were used to drive the air quality modeling simulations that were performed to assess the visibility improvement of potential control measures. Air quality modeling also was used to perform a pollution apportionment, which evaluates the contribution to visibility impairment by geographic region and by emission sector. In order to be used in the air quality modeling simulations, the baseline and future year emissions inventories were processed with SMOKE emissions pre-processor for subsequent input into CMAQ and REMSAD air quality models that were described in Section 5.

MANE-VU Regional Baseline Inventory

The starting point for the 2002 baseline emissions inventory was the 2002 inventory submittals that were made to EPA by state and local agencies as part of the Consolidated Emissions Reporting Rule (CERR). With contractor assistance (E.H. Pechan & Associates), MANE-VU coordinated and quality assured the 2002 inventory data, and prepared it for input into the SMOKE emissions model. The 2002 emissions from non-MANE-VU areas within the modeling domain were obtained from other Regional Planning Organizations for their corresponding areas. These RPOs included VISTAS, MWRPO, and CenRAP.

The 2002 baseline inventory went through several iterations. Work on Version 1 of the 2002 MANE-VU inventory began in April 2004, and the final inventory and SMOKE input files were finalized during January 2005. Work on Version 2 (used from April through September 2005) involved incorporating revisions requested by some MANE-VU state/local agencies on the point, area, and on-road categories. Work on Version 3 (used from December 2005 through April 2006) included additional revisions to the point, area, and on-road categories as requested by some states. Thus, the Version 3 inventory for point, area, and on-road sources was built upon Versions 1 and 2. This work also included development of the biogenic inventory. In Version 3, the non-road inventory was completely redone because of changes that EPA made to the NONROAD2005 non-road mobile emissions model.

Version 3 of the 2002 base year emissions inventory was used in the regional air quality modeling simulations. Further description of the data sources, methods, and results for this version of the 2002 baseline inventory is presented in a technical support document, Appendix M. Emissions inventory data files are available on the MARAMA website at www.marama.org/visibility/EI_Projects/index.html.

After release of Version 3.0 of the MANE-VU 2002 inventory, Massachusetts revised its inventory of area source heating oil emissions due to two changes. First, the sulfur percent used to derive the emissions factors was adjusted from 1.0 to 0.3 because the Massachusetts draft 2002 SO_2 emissions methodology for commercial and residential distillate fuel used the EPA default sulfur content of 1% instead of the correct 0.3% value that was implemented in 2001 according Massachusetts regulation 310 CMR 7.05(1) and (2). Second, the latest DOE-EIA 2002 fuel use data was used instead of the previous version used in 2001. These two changes significantly altered the 2002 SO_2 emissions for area source heating oil combustion. Massachusetts provided revised 2002 PE and EM tables, which MACTEC used in preparing the 2009/2012/2018 projection inventories.

Massachusetts Baseline Inventory

Massachusetts submitted to EPA in January 2008 its comprehensive 2002 Base Year Emissions Inventory that serves as a baseline for its 8-Hour Ozone, Carbon Monoxide (CO), and Regional Haze SIPS. The 2002 Inventory was estimated for a typical summer day for the ozone precursors VOC, NO_x and CO. CO also was estimated for a typical winter day for the CO SIP. Annual emissions were estimated for VOCs, NO_x, CO, SO_2, $PM_{2.5}$, PM_{10}, and NH_3, as required as a baseline for this Regional Haze SIP.

The complete MA 2002 Base Year Inventory is part of the Massachusetts 8-Hour Ozone Attainment Demonstration SIP and is available on MassDEP's web site at: http://www.mass.gov/dep/air/priorities/sip.htm. It contains an extensive narrative explaining the methodology for the development of the inventory and the extensive data files supporting the emission estimates.

Massachusetts originally submitted emissions inventory data electronically to the EPA National Emissions Inventory (NEI) system and subsequently made revisions as a result of Quality Assurance (QA) procedures. The point source submittal included detailed facility level information, activity data down to the segment level, and annual VOCs, NO_x, CO, SO_2, $PM_{2.5}$, PM_{10}, and NH_3 emissions. Massachusetts also electronically submitted area source activity data, emission factors, temporal factors, control factors, annual emissions for all pollutants, and typical summer day (VOC, NO_x and CO) and winter day (CO only) emissions. Emissions data for point and area sources were submitted to EPA in its required NEI format.

For on-road and off-road mobile emissions, Massachusetts estimated typical summer and winter day emissions in the 2002 Base Year Inventory. However, for annual emissions Massachusetts relied on MANE-VU contractors to perform the twelve monthly model runs from EPA'S MOBILE6.2 for on-road emissions and the NONROAD model for off-road emissions. In order to estimate annual emissions from on-road mobile sources, Massachusetts submitted to the MANE-VU contractor the necessary MOBILE6.2 inputs such as monthly temperature and I/M scenarios together with other transportation parameters such as daily vehicle miles travelled, vehicle registration data, and speeds by county roadway class. Massachusetts also provided temperature and other inputs to MANE-VU contractors for running the NONROAD model in order to estimate annual emissions. The resulting on-road mobile and off-road mobile annual emissions generated by the MANE-VU contractor were used in the 2002 Base Year Emissions Inventory.

EPA estimated 2002 Biogenic emissions for all counties in the US using its Biogenic Emissions Inventory System (BEIS-3) and Massachusetts used these summer day and annual emissions in the 2002 Base Year Emission Inventory for VOC, NO_x, and CO.

The emissions data submitted to EPA-NEI was accessed, analyzed, and summarized by the MANE-VU contractors and modelers initially as part of the QA process and modeling for 8-hour Ozone and Regional Haze.

A summary of the Massachusetts 2002 Base Year Emission Inventory is presented in Table 8, which is contained in Section 6.5. The 2018 projected Massachusetts emissions in Table 8 were adapted from a MANE-VU summary based on growth and control factors from 2002.

Future Year Emission Control Inventories

A technical support document for the future year inventories is included in Appendix N and explains the data sources, methods, and results for future year emission forecasts for three years, five emission sectors, three emission control scenarios, seven pollutants, and eleven states plus the District of Columbia. The following is a summary of the future year inventories that were developed:

- ***Projection years*:** 2009, 2012, and 2018;
- ***Emission source sectors*:** point-source electric generating units (EGUs), point-source non-electric generating units (non-EGUs), area sources, non-road mobile sources, and on-road mobile sources.
- ***Emission control scenarios*:**
    - A combined on-the-books/on-the-way (OTB/OTW) control strategy accounting for emission control regulations already in place as of June 15, 2005, as well as some emission control regulations that were not yet finalized, but were expected to achieve additional emission reductions by 2009; and
    - A beyond-on-the-way (BOTW) scenario to account for controls from potential new regulations that may be necessary to meet attainment and other regional air quality goals, mainly for ozone.

- An updated scenario (sometimes referred to as "best and final") to account for additional potentially reasonable control measures. For the MANE-VU region, these include: SO_2 reductions at a set of 167 EGU stacks that were identified as contributing to visibility impairment at northeast Class I areas; implementation of a low-sulfur fuel strategy for non-EGU sources; and implementation of a BART strategy for BART-eligible sources not controlled under other programs.

(Note: Refer to Section 10, Long-Term Strategy, for detailed descriptions of specific control strategies, including the uncertainty inherent in OTB and BOTW strategies)

- ***Pollutants*:** ammonia, carbon monoxide (CO), oxides of nitrogen (NO_X), sulfur dioxide (SO_2), volatile organic compounds (VOCs), fine particulate matter ($PM_{2.5}$, sum of filterable and condensable components), and coarse particulate matter (PM_{10}, sum of filterable and condensable components).
- ***States*:** Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont, plus the District of Columbia (all members of the MANE-VU region).

6.3. Emission Processor Selection and Configuration

The SMOKE Processing System is principally an emissions processing system, as opposed to a true emissions inventory preparation system, in which emissions estimates are simulated from "first principles." This means that, with the exception of mobile and biogenic sources, its purpose is to provide an efficient, modern tool for converting emissions inventory data into the formatted emissions files required for a photochemical air quality model. (SMOKE does generate emissions for on-road mobile and biogenic emissions, however, by driving the MOBILE6 and BEIS emissions models.)

Inside the MANE-VU region, the modeling inventories were processed by NYSDEC and NESCUAM using the SMOKE (Version 2.1) processor to provide inputs for the CMAQ model. A detailed description of all SMOKE input files such as area, mobile, fire, point and biogenic emissions files, and the SMOKE model configuration are provided in Appendix K.

6.4. Inventories for Specific Source Types

There are five emission source classifications in the emissions inventory:

- stationary point
- stationary area
- non-road mobile
- on-road mobile
- biogenic

Stationary point sources are large sources that emit greater than a specified tonnage per year. *Stationary area sources* are those whose emissions from individual sources are relatively small, but due to the large number of these sources the collective emissions could be significant (i.e., dry cleaners, service stations, agricultural sources, fire emissions, etc.). *Non-road mobile sources* are equipment that can move, but do not use the roadways (i.e., lawn mowers, construction equipment, railroad locomotives, aircraft, etc.) *On-road mobile sources* are automobiles, trucks, and motorcycles that use the roadway system. The emissions from these sources are estimated by vehicle type and road type. *Biogenic sources* are natural sources like trees, crops, grasses, and the natural decay of plants. For stationary point sources, emissions data is tracked at the facility level. For all other source types, emissions are summed on the county level. All emissions were prepared for modeling in accordance with EPA guidance.

Stationary Point Sources

Point source emissions are emissions from large individual sources. Generally, point sources have permits to operate and their emissions are individually calculated based on source specific factors on a regular schedule. The largest point sources are inventoried annually. These are considered to be major sources having emissions of ≥ 50 to100 tons per year (tpy) of a criteria pollutant, ≥ 10 tpy of a single hazardous air pollutant (HAP) or ≥ 25 tpy of total HAPs. Emissions from smaller stationary point sources in Massachusetts also are calculated individually, but less frequently, on a triennial basis. Point sources are grouped into EGU sources and other non-EGU industrial point sources.

6.5. Electric Generating Units

The base year inventory for EGU sources used 2002 continuous emissions monitoring (CEM) data reported to EPA in compliance with the Acid Rain program or 2002 hourly emission data provided by stakeholders. These data provide hourly emissions profiles that can be used in the modeling of SO_2 and NO_x emissions from these large sources. Emission profiles are used to estimate emissions of other pollutants (volatile organic compounds, carbon monoxide, ammonia, and fine particles) based on measured emissions of SO_2 and NO_x.

Future year inventories of EGU emissions for 2009 and 2018 were developed using the IPM model to forecast growth in electric demand and replacement of older, less efficient and more polluting power plants with newer, more efficient and cleaner units. While the output of the IPM model predicts that a certain number of older plants will be replaced by newer units to meet future electricity growth and state-by-state NO_x and SO_2 caps, Massachusetts did not directly rely upon the closure of any particular plant in establishing the 2018 inventory upon which the reasonable progress goals were set.

The IPM model results are not the basis upon which to reliably predict plant closures. Preliminary modeling was thus performed with unchanged IPM 2.1.9 model results. However, prior to the Best and Final Modeling (Appendix G), future year EGU inventories were modified.

First, IPM predictions were reviewed by MANE-VU permitting and enforcement staff. In many cases, staff felt that the IPM shutdown predictions were unlikely to occur. In particular, IPM predicted that many oil-fired EGUs in urban areas would be shutdown. Similar source information was solicited from states in both VISTAS and MRPO. As a result of this model validation, the IPM modeling output was adjusted before the Best and Final modeling (Appendix G) to reflect staff knowledge of specific plant status in MANE-VU, VISTAS, and MRPO states. Where EGU operating status was contrary to what was predicted by IPM modeling, the future year emissions inventory was adjusted to reflect the operation of those plants expected by state staff.

Second, as a result of inter- and intra- RPO consultations, MANE-VU agreed to pursue certain control measures as described in the Long-Term Strategy section. For EGUs, the agreed upon approach was to reduce emissions from 167 stacks located in MANE-VU, MRPO and VISTAS by 90 percent, as described further in the Long-Term Strategy.

6.6. Non-EGU Point Sources

The primary basis for the 2002 baseline non-EGU emissions were those that were reported by state and local agencies for the CERR. As described above, MANE-VU's contractor, E.H. Pechan & Associates (Pechan) coordinated the QA of the inventory and prepared the necessary files for input into the SMOKE emissions model. Further information on the preparation of the MANE-VU 2002 baseline point source modeling emissions inventory can be found in Chapter II of the *Technical Support Document for 2002 MANE-VU SIP Modeling Inventories* (Appendix M).

Projected non-EGU point source emissions were developed for the MANE-VU region by MACTEC Federal Programs, Inc. under contract to MARAMA. The specific methodologies that were used are described in Appendix N, *Development of Emissions Projections For 2009, 2012, and 2018 For NonEGU Point, Area, and Nonroad Source In the MANE-VU Region*. MACTEC used state-supplied growth factor data where available to project future year emissions. Where state-supplied data was not available, MACTEC used EPA's Economic Growth and Analysis System Version 5.0 (EGAS 5.0) to develop applicable growth factors for the non-EGU component. MACTEC also incorporated the applicable federal and state emissions control programs to account for the expected emissions reductions that will take place under the OTB/OTW and BOTW scenarios.

Stationary Area Sources

Stationary area sources include sources whose individual emissions are relatively small but due to the large number of these sources, their collective emissions are significant. Some examples include dry cleaners, service stations, and the combustion of fuels for heating. Area source emissions are estimated by multiplying an emission factor by some known indicator of collective activity, such as fuel use, number of households, or population.

The area source emissions inventory submittals made for the CERR became the basis for the area source portion of the 2002 baseline inventory. Similar to the point source category, Pechan, on behalf of MANE-VU, prepared the area source modeling inventory using the CERR submittals as a starting point. Pechan quality assured the inventory and augmented it with additional data, including MANE-VU-sponsored inventories for categories such as residential wood combustion and open burning. Detailed information on the preparation of the MANE-VU 2002 baseline area source modeling emissions inventory can be found in Chapter III of Appendix M.

Similar to non-EGU point sources, future year area source emissions were projected for the MANE-VU region by MACTEC. The specific methodologies used are described in Section 3 of Appendix N. MACTEC applied growth factors to the 2002 baseline area source inventory using state-supplied data where available or by using the EGAS 5.0 growth factor model. MACTEC also accounted for the appropriate control strategies in the future year projections.

Non-Road Mobile Sources

Non-road mobile sources are equipment that can move but do not use the roadways, such as construction equipment, aircraft, railroad locomotives, and lawn and garden equipment. For the majority of non-road mobile sources, emissions are estimated using the EPA's NONROAD model. Aircraft, railroad locomotives, and commercial marine vessels are not included in the NONROAD model, and their emissions are estimated using applicable references and methodologies. Again, Pechan prepared the

2002 baseline modeling inventory using the state and local CERR submittals as a starting point. Details on the preparation of the 2002 baseline non-road inventory are described in Chapter IV of Appendix M.

Future year non-road mobile source emissions were projected for the MANE-VU region by MACTEC. The methodologies that were used are discussed in Section 4 of Appendix N. In summary, MACTEC used EPA's NONROAD2005 non-road vehicle emissions model as contained in EPA's National Mobile Inventory Model. Since calendar year is an explicit input into the NONROAD model, future year emissions for non-road vehicles could be calculated for the applicable projection years. For the non-road vehicle types that are not included in the NONROAD model (i.e. aircraft, locomotives, and commercial marine vessels), MACTEC used the 2002 baseline inventory and the projected inventories that EPA developed for these categories for the Clean Air Interstate Rule (CAIR) to develop emission ratios and subsequent combined growth and control factors. Since the future years for the CAIR projections did not directly match those required for the purposes of ozone, particulate matter, and regional haze analyses (i.e., 2009, 2012, and 2018), MACTEC used linear interpolation to develop factors for the required future years.

On-Road Mobile Sources

The on-road emissions source category is comprised of those vehicles that are meant to travel on public roadways, including cars, trucks, buses, and motorcycles. The basic methodology used for on-road mobile source calculations is to multiply vehicle-miles-traveled (VMT) data by emission factors developed using EPA's MOBILE6 motor vehicle emission factors model. Unlike the other emissions source categories, the on-road mobile category requires that SMOKE model inputs be prepared, rather than emissions data in SMOKE/IDA format that the other categories require. Therefore, for the 2002 baseline inventory, Pechan prepared the necessary VMT and MOBILE6 inputs in SMOKE format.

Projected on-road mobile source inventories were developed by NESCAUM for the MANE-VU region for ozone, particulate matter, and Regional Haze SIP purposes. As with the other emissions source categories, projected on-road mobile inventories were developed for calendar years 2009, 2012, and 2018. As part of this effort, MANE-VU member states were asked to provide VMT data and MOBILE6 model inputs for the applicable calendar years. Using the inputs supplied by the MANE-VU member states, NESCAUM compiled and generated the required SMOKE/MOBILE6 emissions model inputs. Further details regarding the on-road mobile source projection can be found in Appendix O, *Development of MANE-VU Mobile Source Projection Inventories for SMOKE/MOBILE6 Application*.

Biogenic Emission Sources

For the purposes of the 2002 baseline modeling emissions inventory, biogenic emissions were calculated for the modeling domain by the New York State Department of Environmental Conservation (NYSDEC). NYSDEC used the BEIS Version 3.12 as contained within the SMOKE emissions processing model. Biogenic emissions estimates were made for CO, nitrous oxide (NO) and VOC. Further details about the biogenic emissions processing can be found in NYSDEC's Technical Support Document 1c, Emission Processing for the Revised 2002 OTC Regional and Urban 12 km Base Case Simulations, September 19, 2006, and in Chapter VI (Biogenic Sources) of the Technical Support Document for 2002 MANE-VU SIP Modeling Inventories, Version 3, November 20, 2006. Biogenic emissions were assumed to remain constant for the future analysis years.

6.7. Summary of MANE-VU 2002 and 2018 Emissions Inventory

Table 6 and Table 7 summarize the emissions inventories for the MANE-VU region compiled for 2002 and projected for 2018.[7] The amount of pollutants (in tons per year) emitted from the various source categories is presented. This information was useful in setting reasonable progress goals by states containing Class I areas (Section 9) and in determining the long-term strategy (Section 10) to address the contribution of Massachusetts to regional haze in Class 1 areas.

Table 6: MANE-VU 2002 Emissions Inventory Summary (tons)

	VOC	NO_x	CO	$PM_{2.5}$	PM_{10}	NH_3	SO_2
Point	97,300	673,660	367,645	55,447	89,150	6,194	1,907,634
Area	1,528,141	262,477	1,325,853	332,729	1,455,311	249,795	316,357
On-Road Mobile	789,560	1,308,233	11,749,819	22,107	31,561	52,984	40,091
Non-Road Mobile	572,751	431,631	4,553,124	36,084	40,114	287	57,257
Biogenics	2,575,232	28,396	274,451	-	-	-	-
TOTAL	5,562,984	2,704,397	18,260,892	446,367	1,616,136	309,260	2,321,339

Source: Pechan, 2006. "*Technical Support Document for 2002 MANE-VU SIP Modeling Inventories, Version 3*." November 20, 2006. Appendix M

[7] Tables 6-8 are based upon the 2002 MANE-VU Regional Baseline Inventory, version 3. See Appendix M for details.

Table 7: MANE-VU 2018 Emissions Inventory Summary (in tons)

	VOC	NO_x	$PM_{2.5}$	PM_{10}	NH_3	SO_2
Point	114,290	374,952	93,267	128,483	11,136	598,520
Area	1,334,038	263,031	243,321	720,462	341,746	129,656
On-Road Mobile	269,981	303,955	9,189	9,852	66,476	8,757
Non-Road Mobile	380,076	271,181	23,933	27,055	360	8,643
Biogenics	2,575,232	28,396	-	-	-	-
TOTAL	4,673,617	1,241,515	369,710	885,852	419,718	745,576

Source: MACTEC, 2007. "*Development of Emission Projections for 2009, 2012, and 2018 for non-EGU Point, Area, and Nonroad Sources in the MANE-VU Region*." February 28, 2007. Appendix N
EGU Point Emissions: VISTAS_PC_1f IPM Run, Appendix W

6.8. Summary of Massachusetts 2002 Base and 2018 Projected Emissions and Reductions

Table 8 presents the Massachusetts inventories for the 2002 base year[8] and for the 2018 projected emissions and expected reductions. The MANE-VU 2002 and 2018 emission summary and reductions, derived from Table 6 and Table 7, also are presented for comparison. Table 8 shows that Massachusetts' overall projected reduction of total regional haze pollutants between 2002 and 2018 is 38 percent. This is closely comparable to MANE-VU's overall reduction of 36 percent for the same period. Thus, actions taken to reduce Massachusetts' emissions are projected to meet the objectives of the MANE-VU Reasonable Progress Goals.

Table 8: Massachusetts 2002 Base Year and 2018 Projected Emissions and Reductions (in tons)

	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	NH_3	RH TOTAL[9]
MA 2002 BASE YEAR								
POINT > 1 TPY[1]	5,647	45,590	21,403	101,049	5,852	4,161	1,526	
AREA[2]	159,753	34,371	137,278	25,585	191,369	43,203	16,786	
ON-ROAD MOBILE[3]	57,186	143,368	1,039,100	4,399	3,408	2,410	5,499	
OFF-ROAD MOBILE[4]	56,749	42,769	461,514	3,791	3,531	3,226	28	
BIOGENICS[5]	113,957	1,257	11,594	-	-	-	-	
MA 2002 ANTHROPOGENIC	**279,335**	**266,098**	**1,659,295**	**134,824**	**204,160**	**53,000**	**23,839**	
MA 2002 WITH BIOGENICS	**393,292**	**267,355**	**1,670,889**	**134,824**	**204,160**	**53,000**	**23,839**	**1,076470**

[8] Massachusetts 2002 Baseline Emission Inventory. Available online: http://www.mass.gov/dep/air/priorities/aqdata.htm
[9] Excludes CO, which is not a regional haze pollutant.

MA 2018 PROJECTED YEAR

POINT > 1 TPY[6]	10,902	40,458	27,286	55,878	9,137	6,827	1,622	
AREA[7]	134,963	36,199	125,205	1,804	82,027	31,237	19,552	
ON-ROAD MOBILE[8]	17,056	22,813	515,460	1,937	893	840	5,817	
OFF-ROAD MOBILE[9]	36,306	27,040	546,373	442	2,246	2,052	36	
BIOGENICS[10]	113,958	1,257	11,594	-	-	-	-	
MA 2018 ANTHROPOGENIC	**199,227**	**126,510**	**1,214,324**	**60,061**	**94,303**	**40,956**	**27,027**	
MA 2018 WITH BIOGENICS	**313,185**	**127,767**	**1,225,918**	**60,061**	**94,303**	**40,956**	**27,027**	**663,299**
MA 2002-2018 REDUCTION	80,107	139,588	444,971	74,763	109,857	12,044	(3,188)	**413,171**
MA 2002-2018 REDUCTION %	***20.4%***	***52.2%***	***26.6%***	***55.5%***	***53.8%***	***22.7%***	***-13.4%***	***38.4%***
MANEVU 2002 WITH BIOGENICS[11]	**5,562,984**	**2,704,397**	**18,260,892**	**2,321,339**	**1,616,136**	**446,367**	**309,260**	**12,960,483**
MANEVU 2018 WITH BIOGENICS[11]	**4,673,617**	**1,241,515**	**13,728,087**	**745,576**	**885,852**	**369,710**	**419,718**	**8,335,988**
MANEVU 2002-18 REDUCTION %	***16.0%***	***54.1%***	***24.8%***	***67.9%***	***45.2%***	***17.2%***	***-35.7%***	***35.7%***

1. VOC & NOx Point emissions are from MA 2002 Base Year Inventory with cut-offs at >10 TPY. Because CO, SO2, PM10, PM2.5 and NH3 Point emissions cut-off was 100 TPY for the MA 2002 Inventory, Massachusetts used MANE-VU's Point emissions that were counted down to 1 TPY. MANE-VU used EPA-NEI, in which EPA 'gap-filled' and augmented the Primary PM10 and PM2.5 emissions to include condensables (which most states do not report). This is explained in EPA's Point Source Inventory Documentation: http://www.epa.gov/ttn/chief/net/2002inventory.html (EI QA and Data Augmentation)
2. Area Source 2002 emissions from MA 2002 Base Year Inventory. MA original Area fuel SO2 was 54,924 TPY and was revised to 25,585 TPY. This revision was due to a change in the assumed sulfur content, but was not included in MANE-VU Version 3 inventory; hence the original value was modeled.
3. From Pat Davis (MARAMA) April 25 2006 e-mail attachments 'V3 2002 MANEVU OnRoad Source filed in ks/MANEVU-Projections.
4. From MACTEC 2009-12-18 Projections, Tables 4.2a to 4.8c, Feb.07 http://marama.org/visibility/Inventory%20Summary/FutureEmissionsInventory.htm
5. 2002 emissions- MA 2002 Base Year Emission Inventory -Originally from Pat Davis 4/25/2006 e-mail attachment "V3 2002 MANE-VU Biogenic Sources"
6. Non-EGU from MACTEC 2009, 2012 & 2018 Projections Report Tables 5-6 to 5-12, Feb.2007 http://marama.org/visibility/inventory%20Summary/ Future/EmissionsInventory.htm. EGU projections from MACTEC FTP Website & http://marama.org/visibility/EI-Projects/index.html StateLevelSummarym02.xls Emissions 08/04/2005.
7. From MARAMA/MACTEC 2009, 2012 & 2018 Projections Report Tables 5-17 to 5-23, Feb.2007. SO2 and other pollutants were adjusted for the effects of RPG Low Sulfur %. Pat Davis 3/28/08 e-mail attachment: 2108 Best & Final-All-Pollutants-Emiss-032808.xls. Julie McDill 3/17/2008 e-mail re RPG.
8. From Pat Davis e-mail Mar-11-2008 NESCAUM 2018 MOBILE6.2 annual runs. File:ks/RH-SIP-Mobile-2018-sum-MV.
9. From MACTEC 2009-12-18 Projections, Tables 4.2a to 4.8c, Feb.07 http://marama.org/visibility/Inventory%20Summary/FutureEmissionsInventory.htm
10. From MA 2002 Base Year Emission Inventory -originally from Pat Davis 4/25/2006 e-mail attachment "V3 2002 MANE-VU Biogenic Sources"
11. From MANE- VU Draft SIP Inventory Template Section 7.6, October 2007. From MACTEC 2/07 "Development Emissions Projections 2009, 2012 & 2018 & Julie McDill's (MARAMA) 3/17/08 e-mail with revised 2018 SO2 emissions due to RPG low sulfur %.

7. UNDERSTANDING THE SOURCES OF VISIBILITY-IMPAIRING POLLUTANTS

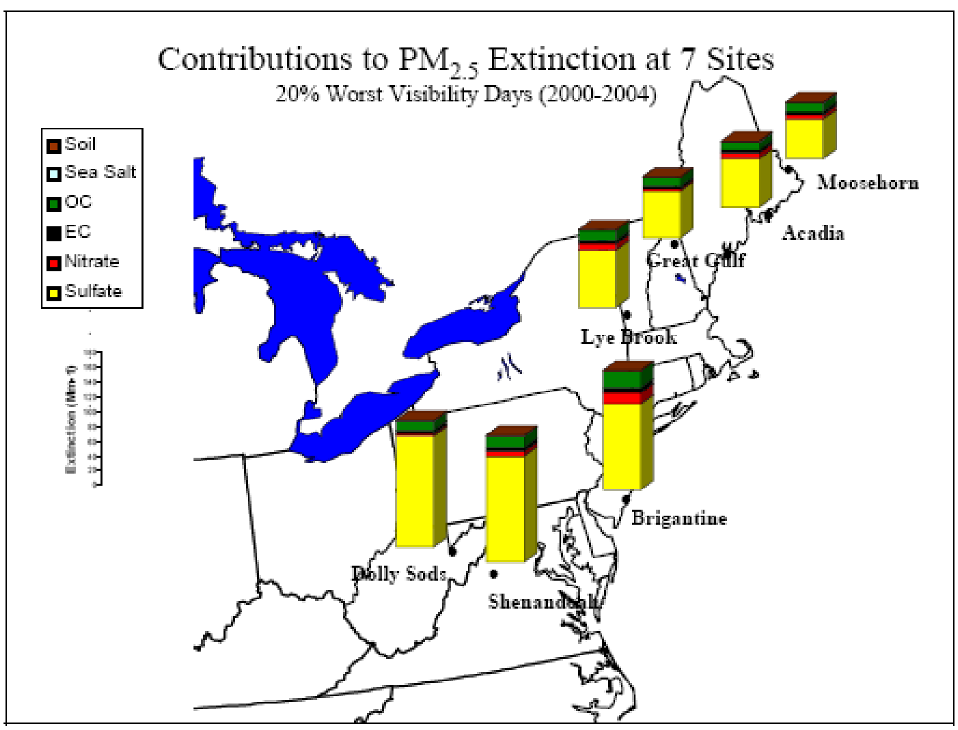
This section explores the origins, quantities, and roles of visibility-impairing pollutants emitted in the eastern United States and Canada that contribute significantly to regional haze at MANE-VU's mandatory Class I areas.

7.2. Visibility-Impairing Pollutants

The pollutants primarily responsible for fine particle formation, and thus contributing to regional haze, include SO_2, NO_x, VOCs, NH_3, PM_{10}, and $PM_{2.5}$. The MANE-VU Contribution Assessment (Appendix A), finalized in August 2006, reflects a conceptual model in which sulfate emerges as the most important single constituent of haze-forming fine particle pollution and the principle cause of visibility impairment across the Northeast region. Sulfate alone accounts for anywhere from one-half to two-thirds of total fine particle mass on the 20 percent haziest days at MANE-VU Class I sites. This translates to about two-thirds to three-fourths of visibility extinction on those days. Organic carbon was shown to be the second largest contributor to haze. As a result of the dominant role of sulfate in the formation of regional haze in the Northeast and Mid-Atlantic Regions, MANE-VU concluded that an effective emissions management approach would rely heavily on broad-based regional SO_2 control measures in the eastern United States.

Visibility extinction is a measure of the ability of particles to scatter and absorb light. Extinction is expressed in units of inverse mega-meters (Mm^{-1}). Figure 18 shows the dominance of sulfate (bottom yellow bar) in visibility extinction calculated from 2000-2004 baseline data.

Figure 18: Contributions to $PM_{2.5}$ Extinction at Seven Class I Sites



Contributing States and Regions

The MANE-VU Contribution Assessment used various modeling techniques, air quality data analysis, and emissions inventory analysis to identify source categories and states that contribute to visibility impairment in MANE-VU Class I areas. With respect to sulfate, based on estimates from four different techniques, the Contribution Assessment estimated that emissions from within MANE-VU in 2002 were responsible for about 25-30 percent of the sulfate at MANE-VU and nearby Class I areas. (Emissions from other regions, Canada, and outside the modeling domain also were important). Table 9 shows the results of one of the four methods of assessing state-by-state contributions to sulfate impacts (the REMSAD model). This table highlights the importance of emissions from outside the MANE-VU region. Note that percentage contributions differ between methods.

Table 9: Percent of Annual Average Modeled Sulfate Due to Emissions from Listed States[10]

Contributing States or Areas	Acadia, Maine (%)	Brigantine, New Jersey (%)	Dolly Sods, West Virginia (%)	Great Gulf and Presidential Range Dry River, New Hampshire (%)	Lye Brook, Vermont (%)	Moosehorn and Roosevelt Campobello, Maine (%)	Shenandoah, Virginia (%)
Connecticut	0.76	0.53	0.04	0.48	0.55	0.56	0.08
Delaware	0.96	3.20	0.30	0.63	0.93	0.71	0.61
District of Columbia	0.01	0.04	0.01	0.01	0.02	0.01	0.04
Maine	6.54	0.16	0.01	2.33	0.31	8.01	0.02
Maryland	2.20	4.98	2.39	1.92	2.66	1.60	4.84
Massachusetts	10.11	2.73	0.18	3.11	2.45	6.78	0.35
New Hampshire	2.25	0.60	0.04	3.95	1.68	1.74	0.08
New Jersey	1.40	4.04	0.27	0.89	1.44	1.03	0.48
New York	4.74	5.57	1.32	5.68	9.00	3.83	2.03
Pennsylvania	6.81	12.84	10.23	8.30	11.72	5.53	12.05
Rhode Island	0.28	0.10	0.01	0.11	0.06	0.19	0.01
Vermont	0.13	0.06	0.00	0.41	0.95	0.09	0.01
MANE-VU	36.17	34.83	14.81	27.83	31.78	30.08	20.59
Midwest RPO	11.98	18.16	30.26	20.10	21.48	10.40	26.84
VISTAS	8.49	21.99	36.75	12.04	13.65	6.69	33.86
Other	43.36	25.02	18.18	40.03	33.09	52.83	18.71

Figures 19 and 20 are from the Contribution Assessment and show another method used to identify and rank states' contributions to sulfate at MANE-VU and nearby Class I areas using 2002 data. This simple technique for deducing the relative impact of emissions from specific point sources on a specific receptor site involves calculating the ratio of annual emissions (Q) to source-receptor distance (d). This

[10] Percentages based on 2002 annual average sulfate impact estimated with REMSAD model as described in MANE-VU Contribution Assessment Chapter 4 and summarized on page 8-2 of the Contribution Assessment (Appendix A).

Q/d ratio is then multiplied by a factor designed to account for the effects of prevailing winds and to convert units. The use of this technique is explained in the Contribution Assessment.

Based on the results of the Q/d technique, Figures 19 and 20 show the resulting rankings across a set of northern and southern Class I areas in or near MANE-VU. Figure 19 covers the four northern Class I areas in MANE-VU (Lye Brook, Great Gulf, Acadia, and Moosehorn). Figure 20 covers one Class I area in the southern part of MANE-VU (Brigantine) as well as two neighboring Class I areas in the VISTAS region (Dolly Sods and Shenandoah). Massachusetts ranks tenth in annual average sulfate contributions to Northeast Class I areas in Figure 19 and 23rd for the Mid-Atlantic Class I areas in Figure 20. For more details about the methods used to identify contributing states and regions, please see the Contribution Assessment. Note the importance of emissions from Canada and from various states outside of the MANE-VU region.

Figure 19: Ranked state percent sulfate contributions to Northeast Class I receptors based on emissions divided by distance (Q/d) results

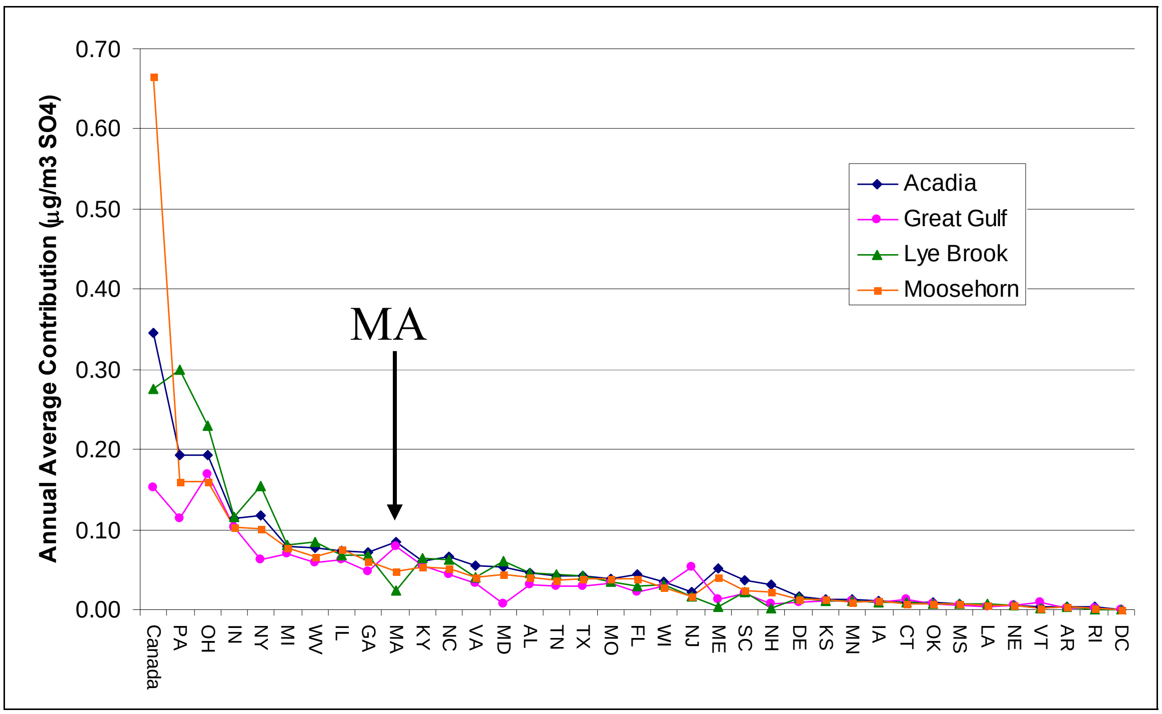
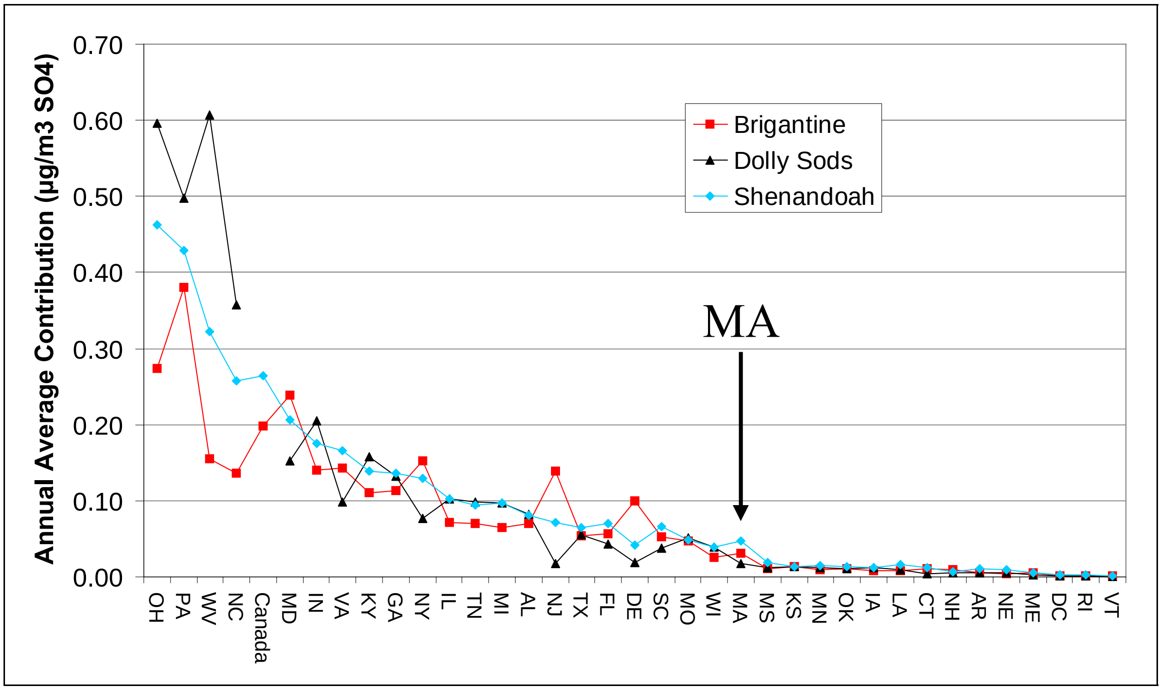


Figure 20: Ranked state percent sulfate contributions to Mid-Atlantic Class I receptors based on emissions divided by distance (Q/d) results



The ranking of emission contributions to visibility impairment in the MANE-VU Class I areas by methods such as these has direct relevance to the consultation process described previously in Section 3. Using results from the REMSAD model, MANE-VU applied the following three criteria to identify states and regions for the purposes of consultation on regional haze:

1. Any state/region that contributed 0.1 $\mu g/m^3$ sulfate or greater on the 20 percent worst visibility days in the base year (2002)
2. Any state/region that contributed at least 2 percent of total sulfate observed on the 20 percent worst visibility days in 2002
3. Any state/region among the top ten contributors on the 20 percent worst visibility days in 2002.

For the purposes of deciding how broadly to consult, the MANE-VU States settled on the second of the three criteria: any state/region that contributed at least 2 percent of total sulfate observed on the 20 percent worst visibility days in 2002.

In the following seven figures, states and regions meeting the three listed criteria are identified graphically for seven Class I areas: Shenandoah and Dolly Sods are Class I areas in the VISTAS region that are impacted by emissions from MANE-VU states; the other five Class I areas are in MANE-VU. Note that the IMPROVE monitor at Great Gulf also represents the Presidential Range - Dry River Wilderness, and the IMPROVE monitor at Moosehorn also represents Roosevelt Campobello International Park. Each figure has three components:

- On the left is a single bar graph of the IMPROVE-monitored $PM_{2.5}$ mass concentration ($\mu g/m^3$) by constituent species for the baseline years 2000-2004. The bottom (yellow) portion of the bar represents the measured sulfate concentration.
- The middle component of each figure provides a bar graph of the 2002 total sulfate contribution of each state or region as estimated by REMSAD.
- Finally, the right segment contains three maps showing which states meet the criteria described above. The three arrows from the bar graph in the middle component indicate the cut-offs for state inclusion in the maps in the right segment.

Connecticut, Rhode Island, Vermont, and the District of Columbia were not identified as being among the political or regional units contributing at least 2 percent of sulfate at any of the seven Class I areas. However, as participants in MANE-VU, those entities have agreed to pursue adoption of regional control measures aimed at visibility improvement on the haziest days and prevention of visibility degradation on the clearest days.

Based on the MANE-VU Contribution Assessment, emissions from Massachusetts contribute to visibility degradation in the following Class I areas: Acadia National Park, Great Gulf Wilderness, Lye Brook Wilderness, Presidential Range/Dry River Wilderness, Moosehorn Wilderness, and Roosevelt/Campobello International Park. Figure 21,

Figure 26, and Figure 27, respectively, illustrate that emissions from Massachusetts do not contribute greater than 0.1 µg/m^3 sulfate or 2% of sulfate to the Brigantine, Shenandoah, and Dolly Sods Class I areas.

Figure 21: Modeled 2002 Contributions to Sulfate by State at Brigantine

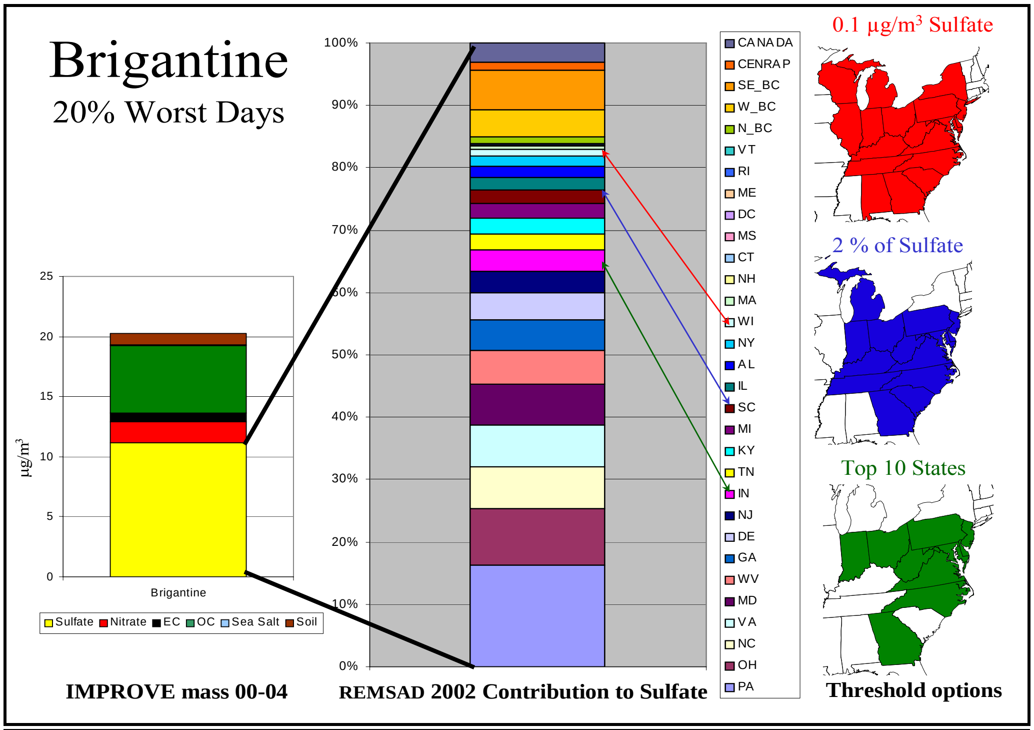


Figure 22: Modeled 2002 Contributions to Sulfate by State at Lye Brook

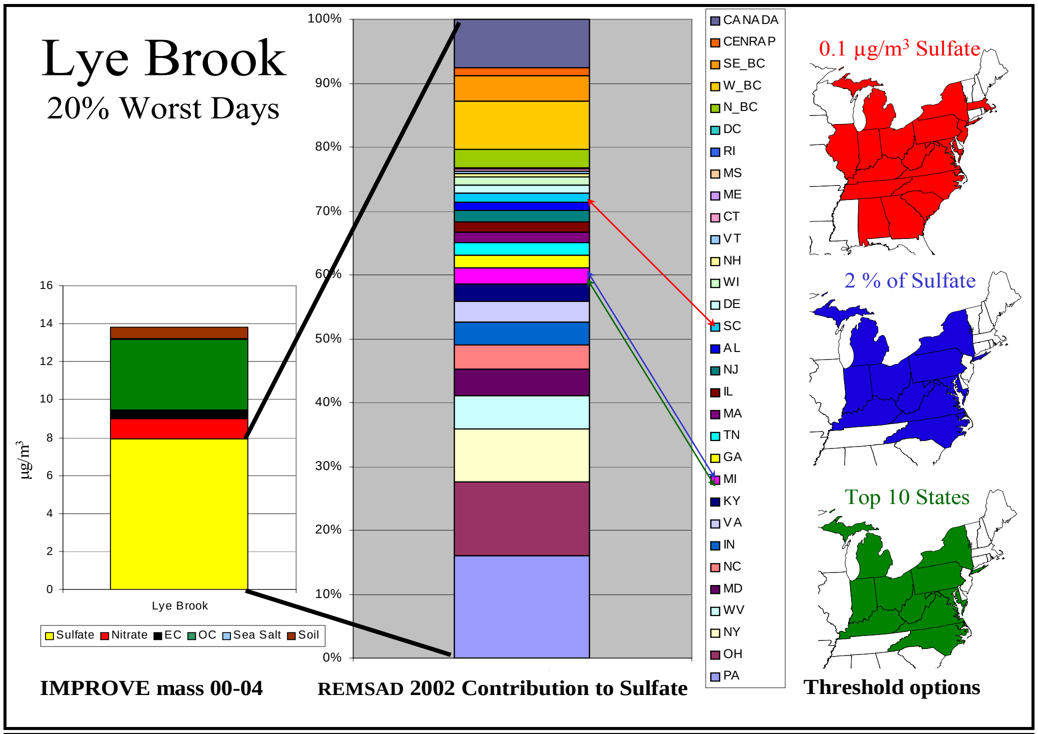


Figure 23: Modeled 2002 Contributions to Sulfate by State at Great Gulf and Presidential Range/Dry River Wilderness

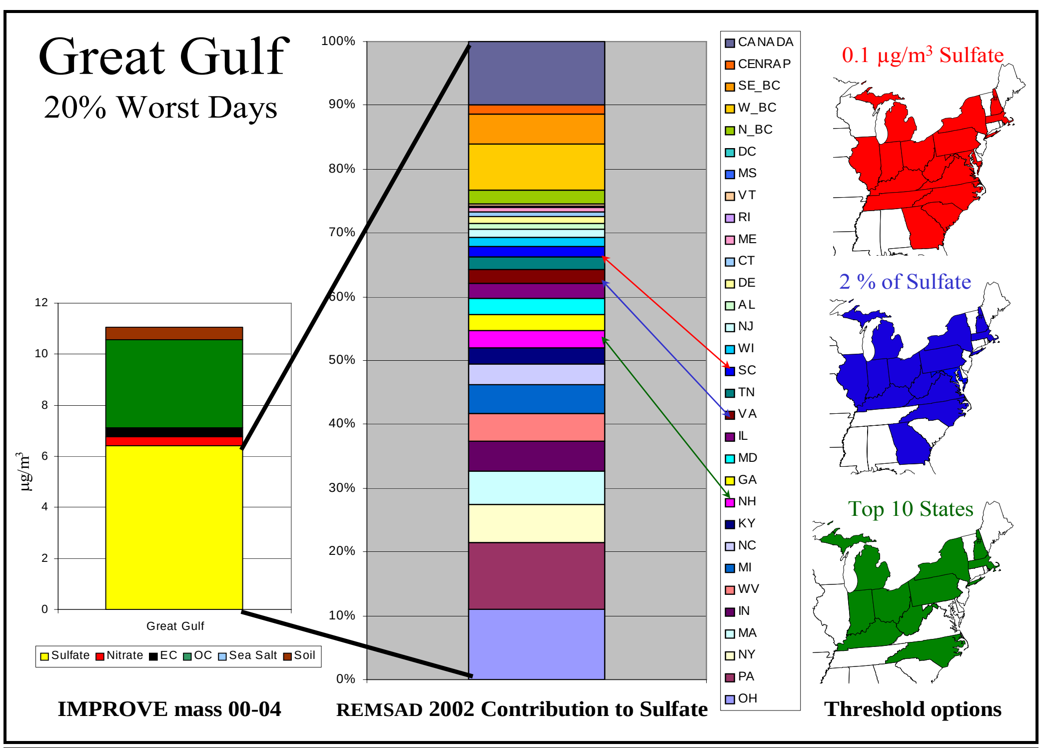


Figure 24: Modeled 2002 Contributions to Sulfate by State at Acadia

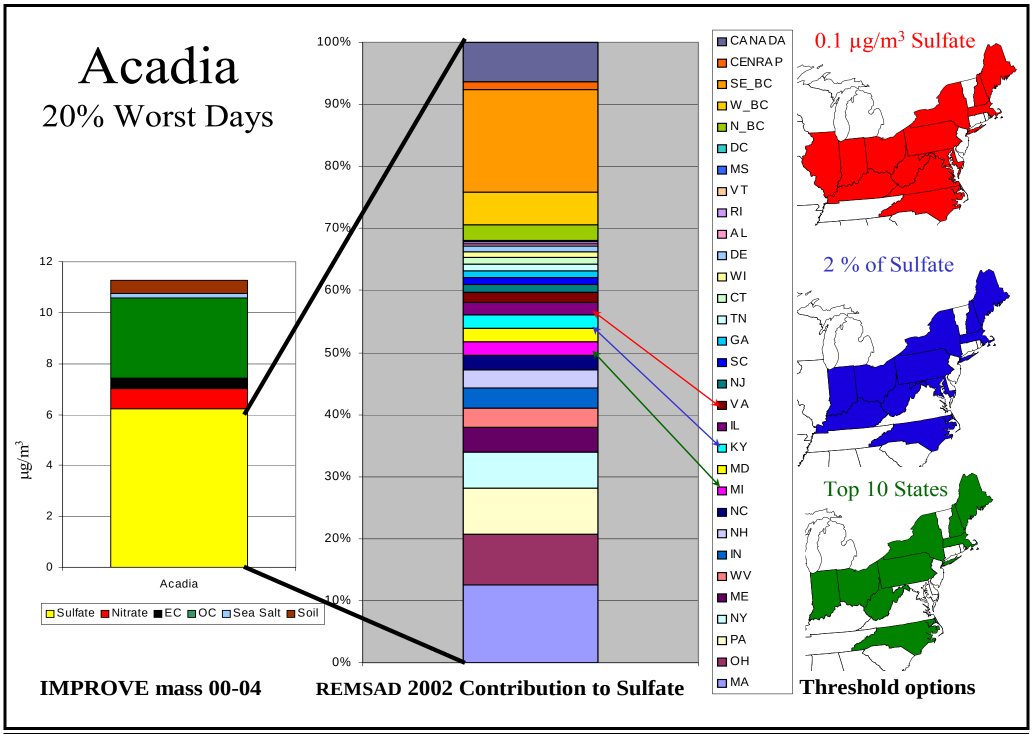


Figure 25: Modeled 2002 Contributions to Sulfate by State at Moosehorn and Roosevelt Campobello International Park

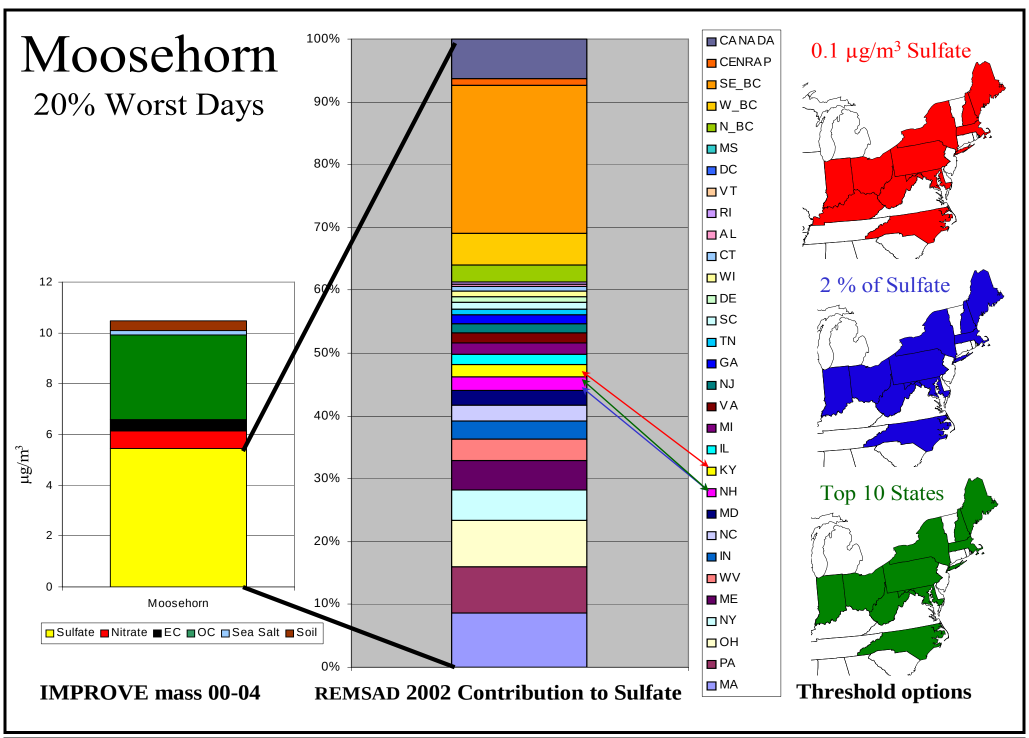


Figure 26: Modeled 2002 Contributions to Sulfate by State at Shenandoah

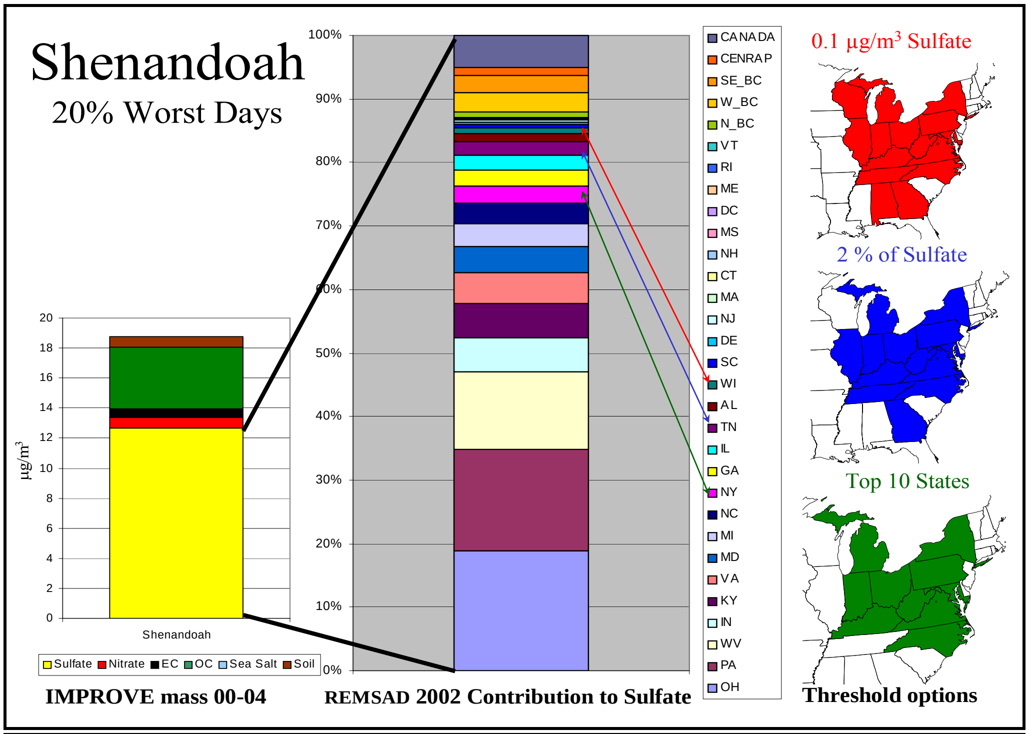
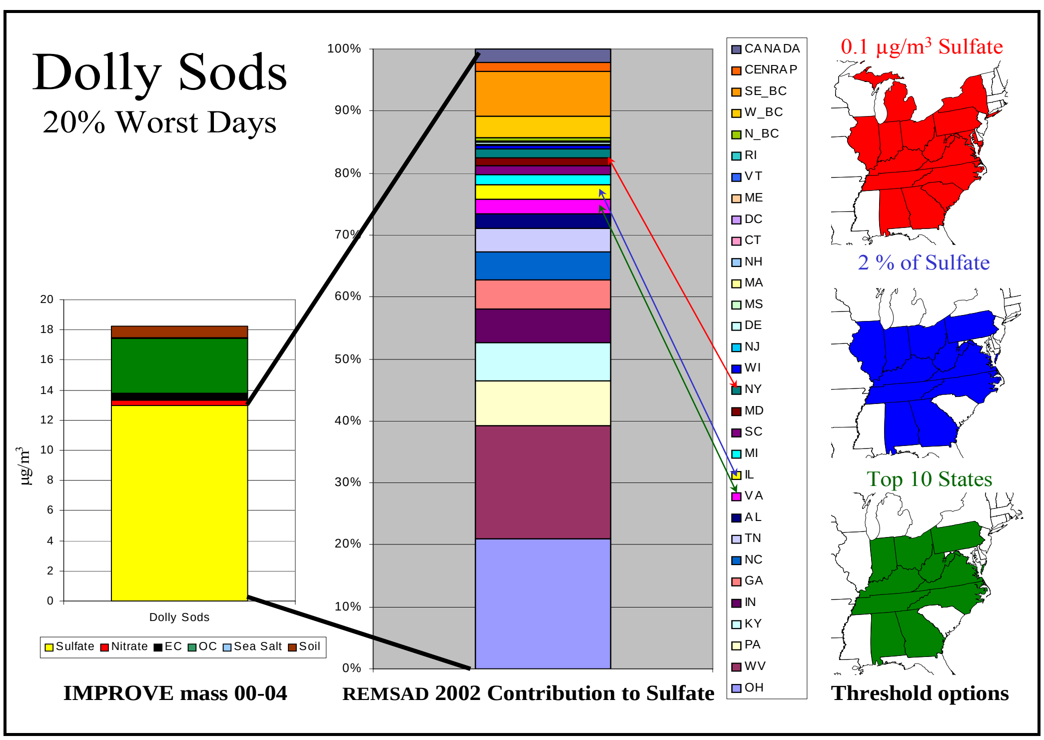


Figure 27: Modeled 2002 Contributions to Sulfate by State at Dolly Sods



7.3. Emissions Sources and Characteristics

The major pollutants responsible for regional haze are SO_2, NO_X, VOCs, NH_3, PM_{10}, and $PM_{2.5}$. The following is a description of the sources (e.g., point, area, and mobile) and characteristics of pollutant emissions contributing to haze in the eastern United States. Emissions data and graphics presented in this section are taken from the MANE-VU 2002 Baseline Emissions Inventory, Version 2.0 (note that the more recent MANE-VU 2002 Baseline Emissions Inventory, Version 3.0, released in April 2006, has superseded Version 2.0 for modeling purposes). Although the emissions inventory database also includes carbon monoxide (CO), this primary pollutant is not considered here because it does not contribute to regional haze.

In addition to the MANE-VU inventory, useful emissions inventories include the 1996 EPA National Emissions Trends database (NET) and the 1999 National Emissions Inventory (NEI)[11]. Trends among the three emissions inventories – NET 1996, NEI 1999, and MANE-VU 2002 – are highlighted in the text and graphics presented below.

Sulfur Dioxide (SO_2)

SO_2 is the primary precursor pollutant for sulfate particles. Sulfate particles commonly account for more than 50 percent of particle-related light extinction at northeastern Class I areas on the clearest days and for as much as or more than 80 percent on the haziest days. Hence, SO_2 emissions are an obvious target for reducing regional haze in the eastern United States. Combustion of coal and, to a lesser extent, of certain petroleum products accounts for most anthropogenic SO_2 emissions. In fact, in 1998 a single source category, coal-burning power plants, was responsible for two-thirds of total SO_2 emissions nationwide (Appendix P).

[11] EPA's Emission Factor and Inventory Group (EFIG) / Office of Air and Radiation (OAR) / Office of Air Quality Planning and Standards (OAQPS) / Emissions, Monitoring and Analysis Division (EMAD) prepares a national database of air emissions information with input from numerous state and local air agencies, from tribes, and from industry. This database contains information on stationary and mobile sources that emit criteria air pollutants and their precursors, as well as hazardous air pollutants (HAPs). The database includes estimates of annual emissions, by source, of air pollutants in each area of the country on an annual basis. The NEI includes emission estimates for all 50 states, the District of Columbia, Puerto Rico, and the Virgin Islands. Emission estimates for individual point or major sources (facilities), as well as county-level estimates for area, mobile, and other sources, are available currently for years 1985 through 2005 for criteria pollutants, and for years 1996 and 2005 for HAPs. Data from the NEI help support air dispersion modeling, regional strategy development, setting regulations, air toxics risk assessment, and tracking trends in emissions over time. For emission inventories prior to 1999, the National Emission Trends (NET) database maintained criteria pollutant emission estimates, and the National Toxics Inventory (NTI) database maintained HAP emission estimates. Beginning with 1999, the NEI began preparing criteria and HAP emissions data in a more integrated fashion to take the place of the NET and the NTI.

Figure 28 shows SO_2 emissions trends in the MANE-VU states extracted from the NEI for the years 1996, 1999, and from the 2002 MANE-VU inventory[12]. Most of the states show declines in year 2002 annual SO_2 emissions as compared to 1996 emissions. The decline can be attributed to implementation of the second phase of the EPA Acid Rain Program, which in 2000 further reduced allowable emissions and extended emissions limits to more power plants.

[12] EPA (2005) http://www.epa.gov/ttn/chief/eiinformation.html and MARAMA (2004) http://www.marama.org/visibility/2002%20NEI/index.html

Figure 28: Trends in Annual Sulfur Dioxide Emissions by State

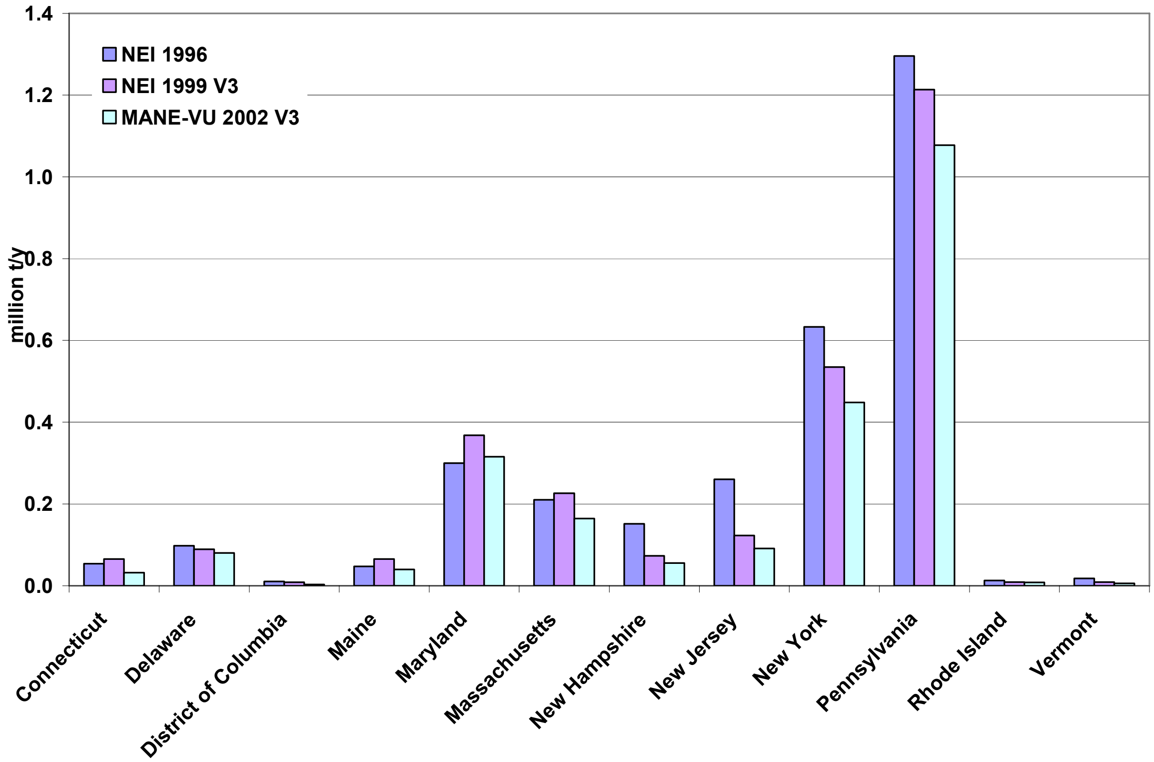
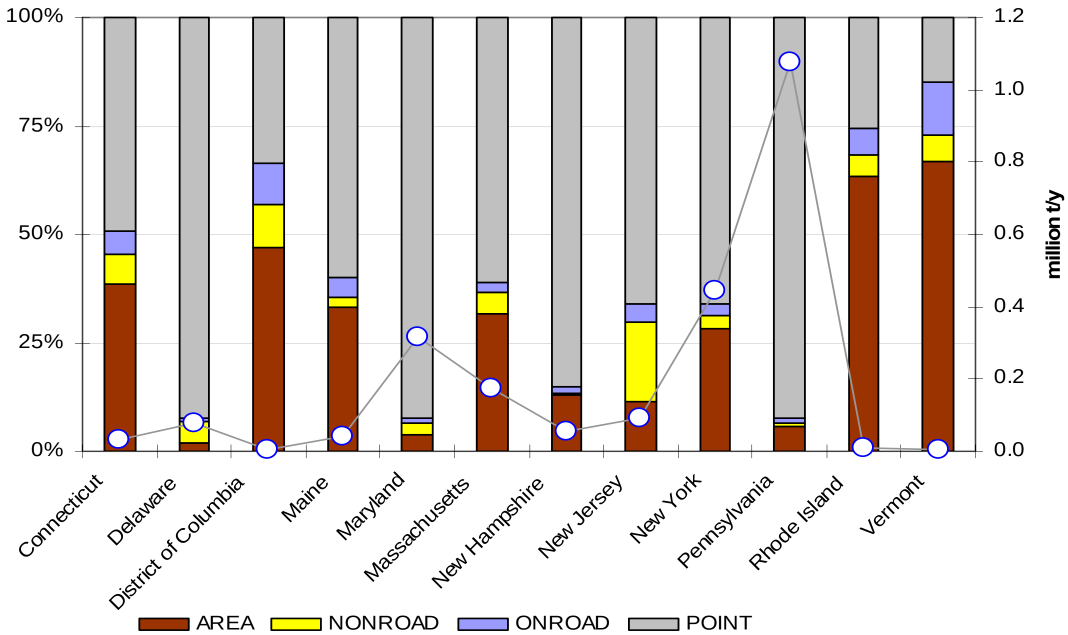


Figure 29 shows the percent contribution from different source categories to overall, annual 2002 SO_2 emissions in the MANE-VU states. The chart shows that point sources dominate SO_2 emissions, which primarily consist of stationary combustion sources for generating electricity, industrial energy, and heat. Smaller stationary combustion sources called "area sources" (primarily commercial and residential heating, and smaller industrial facilities) are another important source category in the MANE-VU states. By contrast, on-road and non-road mobile sources make only a relatively small contribution to overall SO_2 emissions in the region (Appendix P).

Figure 29: 2002 Sulfur Dioxide Emissions (SO_2) by State



Bar Graph: Percentage Fractions of the Four Source Categories

(-o-) Line Graph: Total State Annual Emissions (10^6 tpy)

Volatile Organic Compounds (VOCs)

Existing emissions inventories generally refer to volatile organic compounds (VOCs) for hydrocarbons whose volatility in the atmosphere makes them particularly important from the standpoint of ozone formation. From a regional haze perspective, there is less concern with the volatile organic gases emitted directly to the atmosphere and more with the secondary organic aerosol (SOA) that the VOCs form after condensation and oxidation processes. Thus the VOC inventory category is of interest primarily because of the organic carbon component of $PM_{2.5}$.

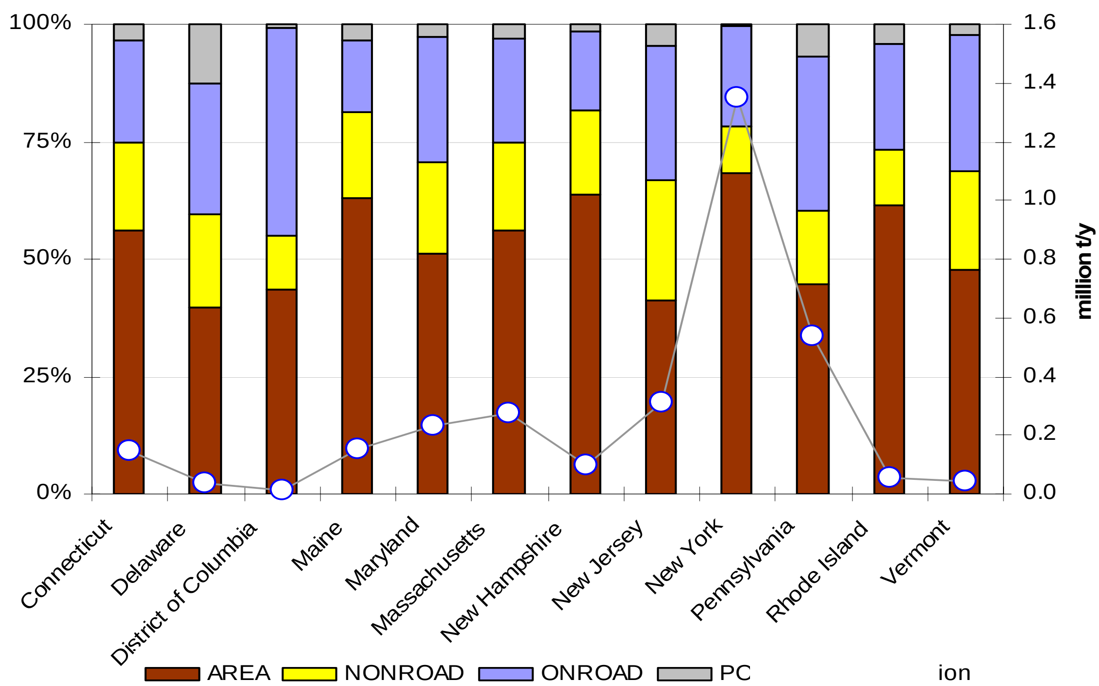
After sulfate, organic carbon (OC) generally accounts for the next largest share of fine particle mass and particle-related light extinction at northeastern Class I sites. The term organic carbon encompasses a large number and variety of chemical compounds that may come directly from emission sources as a part of primary PM or may form in the atmosphere as secondary pollutants. The organic carbon present at Class I sites includes a mix of species, including pollutants originating from anthropogenic (i.e., manmade) sources as well as biogenic hydrocarbons emitted by vegetation. Recent efforts to reduce manmade organic carbon emissions have been undertaken primarily to address summertime ozone formation in urban centers. Future efforts to further reduce organic carbon emissions may be driven by programs that address fine particles and visibility. Massachusetts will continue to evaluate methods to reduce the contribution of organic carbon emissions to regional haze; however, significant visibility improvements will not occur until sulfate-dominated visibility impairment has been reduced.

Understanding the transport dynamics and source regions for organic carbon in northeastern Class I areas is likely to be more complex than for sulfate. This is partly because of the large number and variety of OC species, the fact that their transport characteristics vary widely, and the fact that a given species may undergo numerous complex chemical reactions in the atmosphere. Thus, the organic carbon contribution to visibility impairment at most Class I sites in the East is likely to include manmade pollution transported from a distance and from nearby sources, and biogenic emissions, especially terpenes, from coniferous forests

As shown in Figure 30, the VOC emissions inventory is dominated by mobile and area sources. On-road mobile sources of VOCs include exhaust emissions from gasoline passenger vehicles and diesel-powered heavy-duty vehicles, as well as evaporative emissions from transportation fuels. VOC emissions also may originate from a variety of area sources (including solvents, architectural coatings, and dry cleaners) and from some point sources (e.g., industrial facilities and petroleum refineries).

Biogenic VOCs may play an important role within the rural settings typical of Class I sites. The oxidation of hydrocarbon molecules containing seven or more carbon atoms is generally the most significant pathway for the formation of light-scattering organic aerosol particles[13]. Smaller reactive hydrocarbons that may contribute significantly to urban smog (ozone) are less likely to play a role in organic aerosol formation, though it was noted that high ozone levels can have an indirect effect on visibility by promoting the oxidation of other available hydrocarbons, including biogenic emissions (Appendix P). In short, further work is needed to characterize the organic carbon contribution to regional haze in the Northeast and Mid-Atlantic states and to develop emissions inventories that will be of greater value for visibility planning purposes.

Figure 30: 2002 Volatile Organic Carbon (VOC) Emissions by State



Bar Graph: Percentage Fractions of the Four Source Categories

(-o-) Line Graph: Total State Annual Emissions (10^6 tpy)

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13 Odum, J.R., Jungkamp, T.P.W., Griffin, R.J., Flagan, R.C., and Seinfeld, J.H. (1997) "The Atmospheric Aerosol-forming Potential of Whole Gasoline Vapor." 276: 96-99.

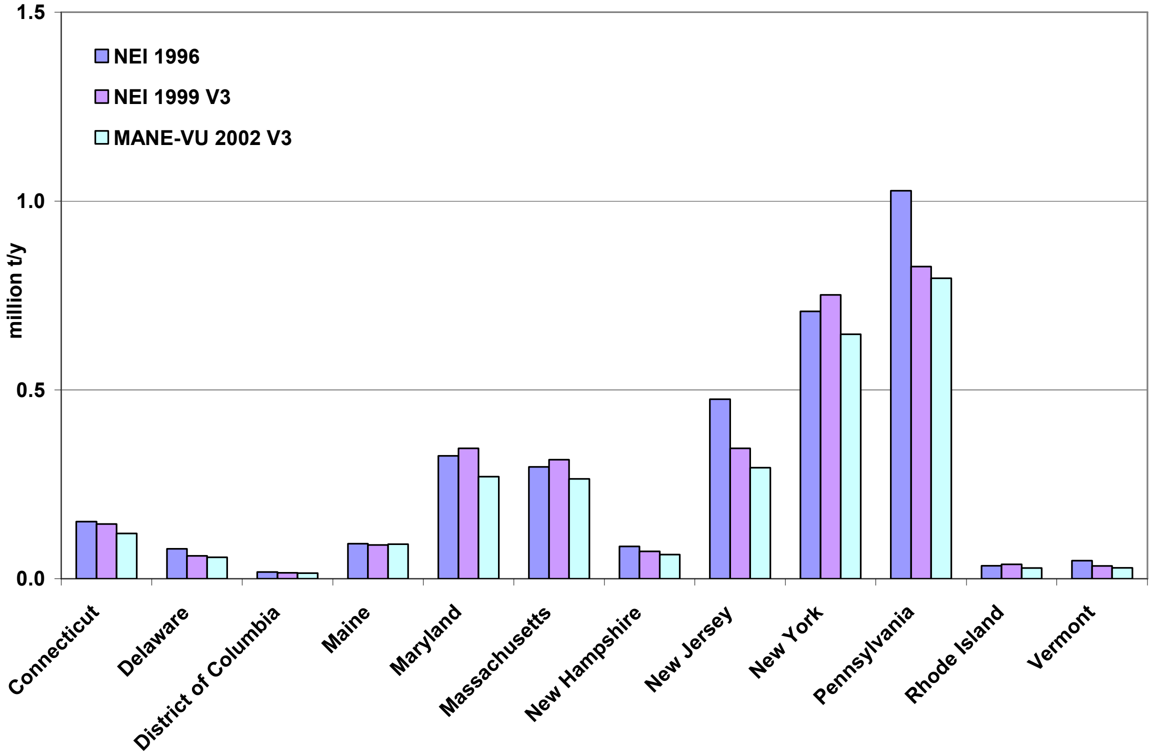
Oxides of Nitrogen (NO_X)

NO_x emissions contribute to visibility impairment in the eastern U.S. by forming light-scattering nitrate particles. Nitrate generally accounts for a substantially smaller fraction of fine particle mass and related light extinction than sulfate and organic carbon at northeastern Class I sites. Notably, nitrate may play a more important role at urban sites and in the wintertime. In addition, NO_x may have an indirect effect on summertime visibility by virtue of its role in the formation of ozone, which in turn promotes the formation of secondary organic aerosols (Appendix P).

Figure 31 shows NO_x emissions in the MANE-VU region at the state level. Since 1980, nationwide emissions of NO_x from all sources have shown little change. In fact, emissions increased by 2 percent between 1989 and 1998[14]. This increase is most likely due to industrial sources and the transportation sector, since power plant combustion sources had implemented modest emissions reductions during the same time period. Most states in the MANE-VU region experienced declining NO_X emissions from 1996 through 2002. Exceptions include Massachusetts, Maryland, New York, and Rhode Island, which show an increase in NO_x emissions in 1999 before declining in 2002 to levels below 1996 emissions. For Massachusetts, the increase in NO_x emissions from 1996 to 1999 was due largely to increases in emissions from off-road and stationary point sources. The subsequent decline in NO_x emissions from 1999 to 2002 is mainly attributable to controls in the on-road mobile category, including Enhanced Inspection and Maintenance (I/M) and California Low Emission Vehicle (CA-LEV) programs. There also were significant reductions in the stationary point source category, mainly power plants, that are attributable to NO_x RACT.

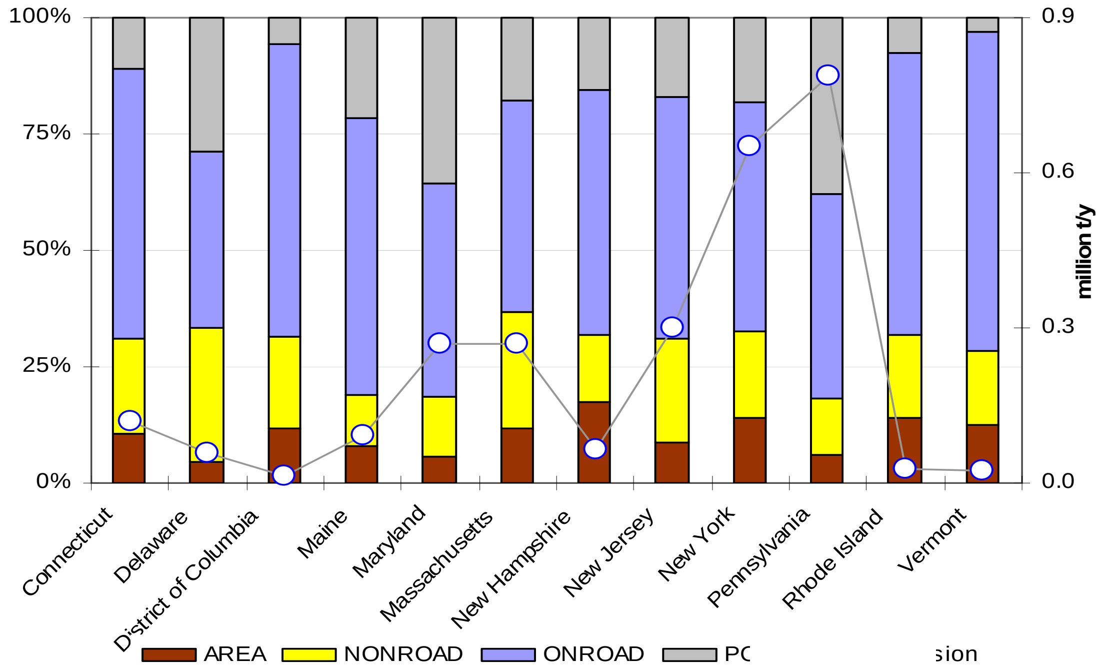
[14] EPA. (2000) *National Air Quality and Emission Trends Report, 1998*, EPA 454/R-00-003, available online: http://www.epa.gov/oar/aqtrnd98/.

Figure 31: Trends in Annual Nitrogen Oxide (NO_x) Emissions by State



Power plants and mobile sources generally dominate state and national NO_x emissions inventories. Nationally, power plants account for more than one-quarter of all NO_x emissions, amounting to over six million tons. The electric sector plays an even larger role, however, in parts of the industrial Midwest where high NO_x emissions have a particularly significant power plant contribution. By contrast, mobile sources dominate the NO_x inventories for more urbanized Mid-Atlantic and New England states to a far greater extent, as shown in Figure 32. In these states, on-road mobile sources represent the most significant NO_x source category. Emissions from non-road mobile sources, primarily diesel-fired engines, also represent a substantial fraction of the inventory. While there are fewer uncertainties associated with available NO_x estimates than in the case of other key haze-related pollutants, including primary fine particle and ammonia emissions, further efforts could improve current inventories in a number of areas (Appendix P).

Figure 32: 2002 Nitrogen Oxide (NO_x) Emissions by State



Bar Graph: Percentage Fractions of the Four Source Categories

(-o-) Line Graph: Total State Annual Emissions (10^6 tpy)

Primary Particle Matter (PM_{10} and $PM_{2.5}$)

Directly emitted or "primary" particles include both filterable and condensable particulates. These are distinct from secondary particles that form in the atmosphere through chemical reactions involving precursor pollutants like SO_2 and NO_X. Both primary and secondary particles can contribute to regional haze. For regulatory purposes, a distinction is made between particles with an aerodynamic diameter less than or equal to 10 micrometers and smaller particles with an aerodynamic diameter less than or equal to 2.5 micrometers (i.e., primary PM_{10} and $PM_{2.5}$, respectively). Figure 33 and Figure 34 show PM_{10} and $PM_{2.5}$ emissions for the MANE-VU states for the years 1996, 1999, and 2002. Most states show a steady decline in annual PM_{10} emissions over this time period, with the exception of Maine. By contrast, emission trends for primary $PM_{2.5}$ are more variable. For Massachusetts, both PM_{10} and $PM_{2.5}$ emissions increased from 1996 to 1999, then declined to 2002. Similar to trends in NO_x emissions, the increase was due largely to increases in emissions from off-road and stationary point sources. The subsequent decline in PM emissions from 1999 to 2002 is mainly attributable to controls in the on-road mobile category, including Enhanced I/M and CA-LEV. There also were significant reductions in the stationary point source category, mainly power plants, that are attributable to NO_x RACT.

Figure 33: Trends in Primary Coarse Particle (PM_{10}) Emissions by State

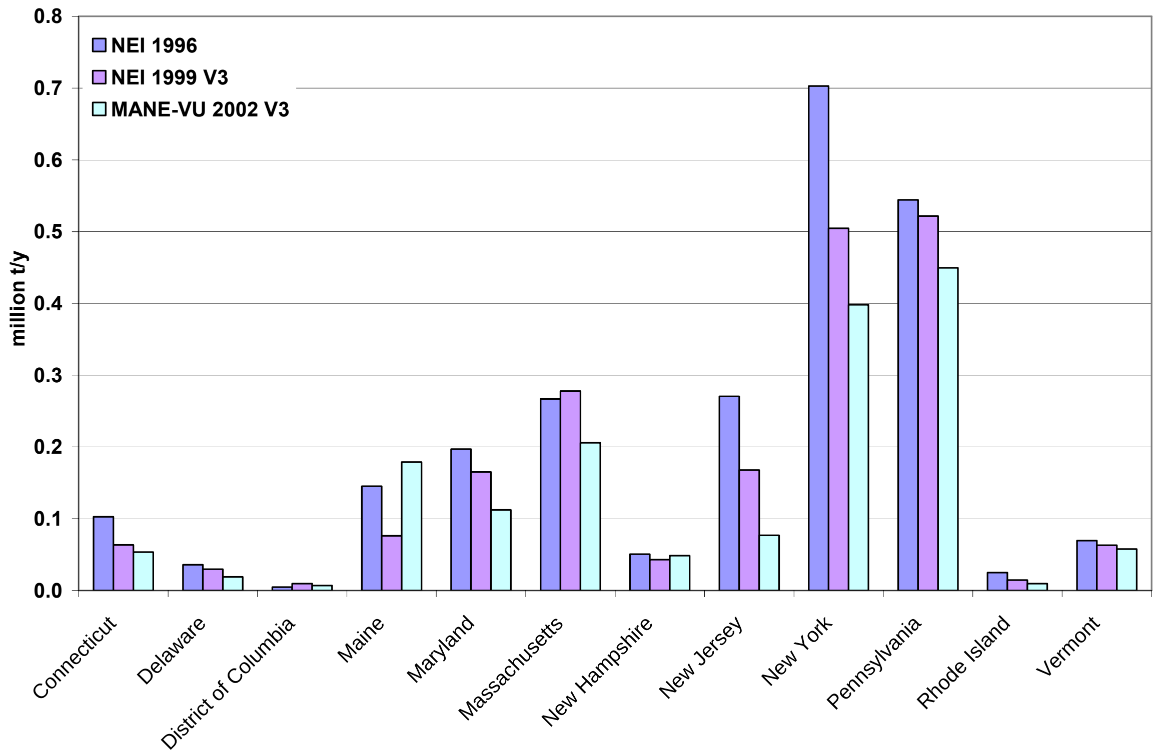
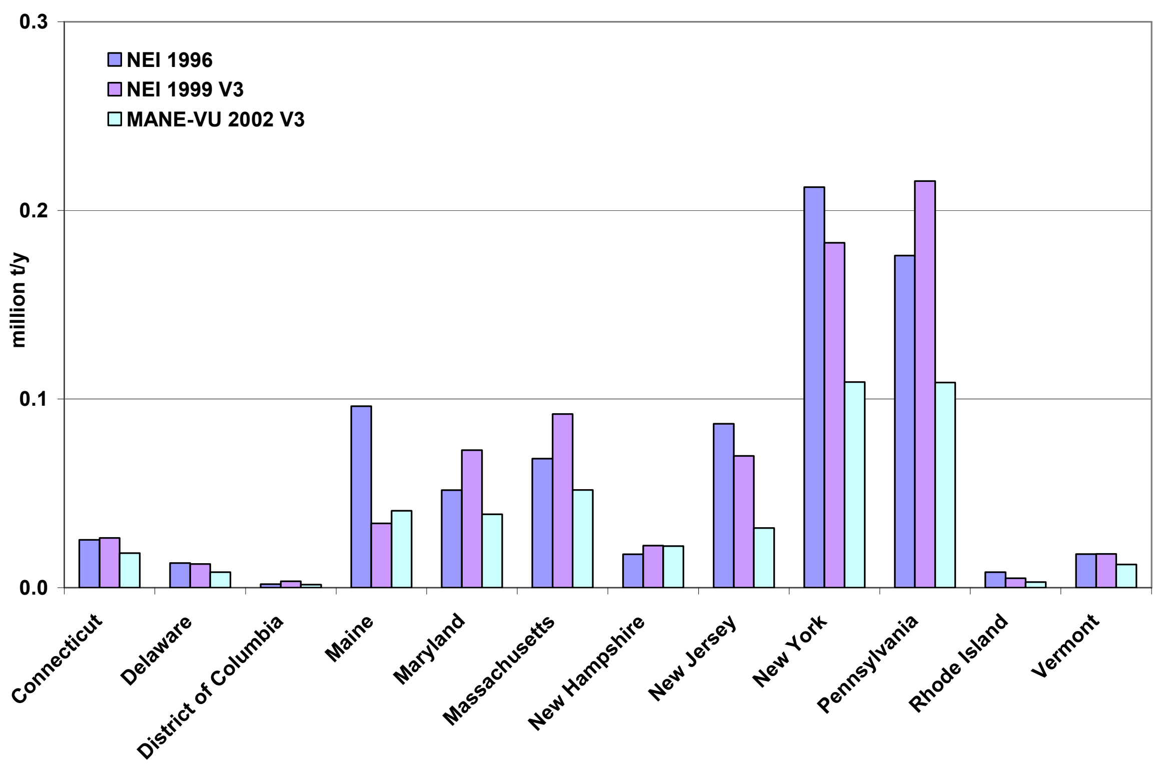


Figure 34: Trends in Primary Fine Particle ($PM_{2.5}$) Emissions by State



Crustal sources are significant contributors of primary PM emissions. This category includes fugitive dust emissions from construction activities, paved and unpaved roads, and agricultural tilling. Typically, monitors estimate PM_{10} emissions from these types of sources by measuring the horizontal flux of particulate mass at a fixed downwind sampling location within perhaps 10 meters of a road or field. Comparisons between estimated emission rates for fine particles using these types of measurement techniques and observed concentrations of crustal matter in the ambient air at downwind receptor sites suggest that physical or chemical processes remove a significant fraction of crustal material relatively quickly. As a result, it rarely entrains into layers of the atmosphere where it can transport to downwind receptor locations. Because of this discrepancy between estimated emissions and observed ambient concentrations, modelers typically reduce estimates of total $PM_{2.5}$ emissions from all crustal sources by applying a factor of 0.15 to 0.25 to the total $PM_{2.5}$ emissions before including it in modeling analyses.

From a regional haze perspective, crustal material generally does not play a major role. On the 20 percent best-visibility days during the baseline period (2000-2004), it accounted for six to eleven percent of particle-related light extinction at MANE-VU Class 1 sites. On the 20 percent worst-visibility days, however, crustal material generally plays a much smaller role relative to other haze-forming pollutants, ranging from two to three percent. Moreover, the crustal fraction includes material of natural origin (such as soil or sea salt) that is not targeted under the Regional Haze Rule. Of course, the crustal fraction can be influenced by certain human activities, such as construction, agricultural practices, and road maintenance (including wintertime salting), and thus to the extent that these types of activities are found to affect visibility at northeastern Class I sites, control measures targeted at crustal material may prove beneficial.

Experience from the western United States, where the crustal component has generally played a more significant role in driving overall particulate levels, may be helpful to the extent that it is relevant in the eastern context. In addition, a few areas in the Northeast, such as New Haven, Connecticut and Presque Isle, Maine, have some experience with the control of dust and road-salt as a result of regulatory obligations stemming from their past non-attainment status with respect to the National Ambient Air Quality Standard (NAAQS) for PM_{10}.

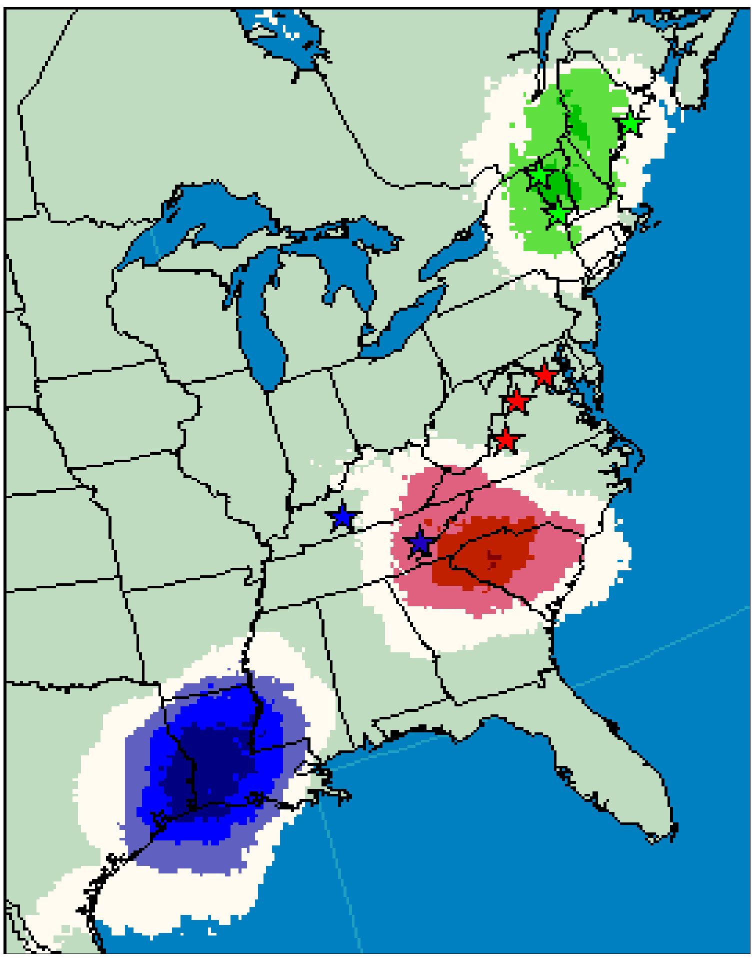
Current emissions inventories for the entire MANE-VU area indicate residential wood combustion represents 25 percent of primary fine particulate emissions in the region. This implies that rural sources can play an important role in addition to the contribution from the region's many highly populated urban areas. An important consideration in this regard is that residential wood combustion occurs primarily in the winter months, while managed burning activities occur largely in other seasons. Managed burning includes agricultural and prescribed fires, as well as use of naturally ignited fires to achieve resource benefits and slash burning of logging debris (which is prohibited in Massachusetts). Particulate emissions from managed burns can be limited by confining burning activities to times when favorable meteorological conditions can efficiently disperse the emissions.

Wood smoke impacting MANE-VU Class I areas is more local in origin than sources of SO_2, except for major transport events. Figure 35 below is from the MANE-VU Contribution Assessment (Appendix A; see Appendix B) and represents the results of source apportionment and trajectory analyses. It illustrates that the impacts of wood smoke on MANE-VU Class I areas are more likely due to emissions from within MANE-VU and Canada. The green-highlighted portion of the map depicts the wood smoke source region in the Northeast states. The stars on the map represent air monitor sites (including those at several Class I areas) whose data sets were determined to be useful to the modeling analysis used to attribute wood smoke impacts.

The MANE-VU *Technical Support Document on Agricultural and Forestry Smoke Management in the MANE-VU Region* (Appendix Q) concluded that fire from land management activities (agricultural, prescribed, and slash burning, and managed wildfires) was not a major contributor to regional haze in MANE-VU Class I areas, and that the majority of emissions from fires were from residential wood combustion.

Although data are currently lacking, Massachusetts is concerned about the growing use of residential wood stoves by homeowners seeking alternatives to petroleum-based fuels for home heating. Recent, localized problems with smoke emissions from outdoor wood boilers (wood-fired hydronic heaters) led MassDEP to promulgate regulations that tighten requirements on the sale, installation, and use of these devices. MassDEP will keep close watch on smoke emissions from the residential sector to determine whether additional control measures on this source category may be necessary in the next few years.

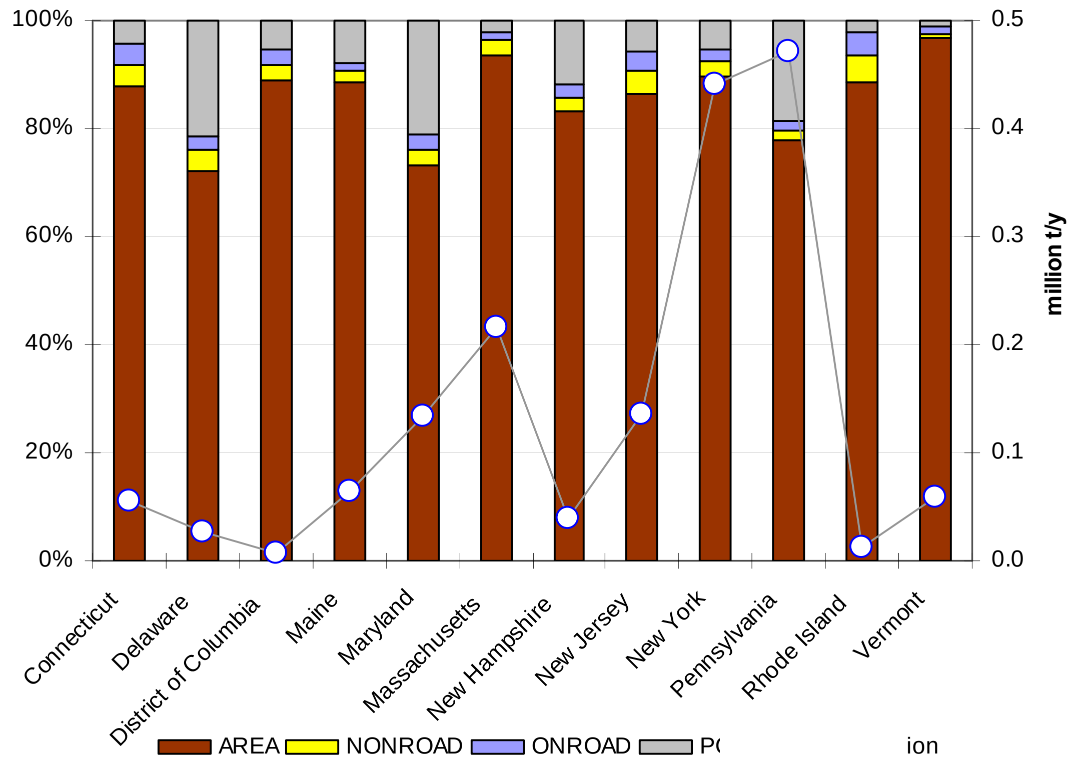
Figure 35: Wood Smoke Source Regional Aggregations



NE: ACAD, PMRC, LYBR
MA: WASH, SHEN, JARI
SE: GRSM, MACA

Figure 36 and Figure 37 show that area and mobile sources dominate primary PM emissions. (The NEI inventory categorizes residential wood combustion and some other combustion sources as area sources.) The relative contribution of point sources is larger in the primary $PM_{2.5}$ inventory than in the primary PM_{10} inventory since the crustal component (which consists mainly of larger or "coarse-mode" particles) contributes mostly to overall PM_{10} levels. At the same time, pollution control equipment commonly installed at large point sources is usually more efficient at capturing coarse-mode particles.

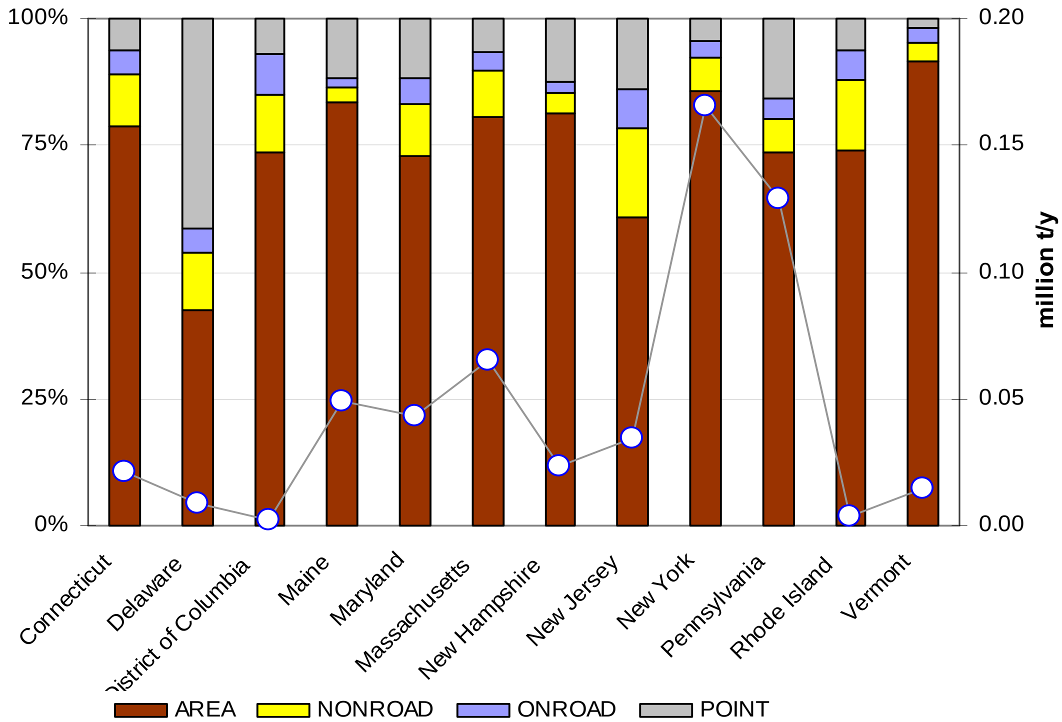
Figure 36: 2002 Primary PM_{10} Emissions by State



Bar Graph: Percentage Fractions of the Four Source Categories

(-o-) Line Graph: Total State Annual Emissions (10^6 tpy)

Figure 37: 2002 Primary $PM_{2.5}$ Emissions by State



Bar Graph: Percentage Fractions of the Four Source Categories

(-o-) Line Graph: Total State Annual Emissions (10^6 tpy)

Ammonia Emissions (NH_3)

Because ammonium sulfate [$(NH_3)_2SO_4$]and ammonium nitrate (NH_3NO_3) are significant contributors to atmospheric light scattering and fine particle mass, knowledge of ammonia emission sources is important to the development of effective regional haze reduction strategies. According to 1998 estimates, livestock agriculture and fertilizer use accounted for approximately 86 percent of all ammonia emissions to the atmosphere[15]. However, better ammonia inventory data is needed for the photochemical models used to simulate fine particle formation and transport in the eastern United States. States were not required to include ammonia in their air emissions data collection efforts until fairly recently (see Consolidated Emissions Reporting Rule, 67 FR 39602; 6/10/2002), and so it will take time for the quality of ammonia inventory data to match the quality of the data for the other criteria pollutants.

Ammonium ion (formed from ammonia emissions to the atmosphere) is an important constituent of airborne particulate matter, typically accounting for 10–20 percent of total fine particle mass. Reductions in ammonium ion concentrations can be extremely beneficial because a more-than-proportional reduction in fine particle mass can result. Ansari and Pandis[16] showed that a 1 $\mu g/m^3$ reduction in ammonium ion could result in up to a 4 $\mu g/m^3$ reduction in fine particulate matter. Decision

[15] EPA 454/R-00-002. (2000) *National Air Pollutant Trends, 1900 – 1998.* Available online: http://www.epa.gov/ttn/chief/trends/trends98/trends98.pdf.

[16] Ansari, A. S., and Pandis, S.N. (1998) "Response of inorganic PM to precursor concentrations," *Environ Sci Technol*, 32: 2706-2714.

makers, however, must weigh the benefits of ammonia reduction against the significant role it plays in neutralizing acidic aerosol.[17]

To address the need for improved ammonia inventories, MARAMA, NESCAUM, and EPA funded researchers at Carnegie Mellon University (CMU) in Pittsburgh to develop a regional ammonia inventory.[18] This study focused on three issues with respect to current emissions estimates: (1) a wide range of ammonia emission factor values, (2) inadequate temporal and spatial resolution of ammonia emissions estimates, and (3) a lack of standardized ammonia source categories.

The CMU project established an inventory framework with source categories, emissions factors, and activity data that are readily accessible to the user. With this framework, users can obtain data in a variety of formats[19] and can make updates easily, allowing additional ammonia sources to be added or emissions factors to be replaced as better information becomes available.[10]

Figure 38 shows that estimated ammonia emissions were fairly stable in the 1996 NEI, 1999 NEI, and 2002 Version 3 MANE-VU inventories for MANE-VU states, with some slight increases observed for most states in MANE-VU. This apparent increase in emissions from 1999 to 2002 is due to a difference in the models used to generate the emissions data.[20] 1999 emissions were generated using an EPA model, whereas the 2002 emissions were generated using the CMU ammonia model described above. The CMU ammonia model incorporates categories such as humans, house pets, wild animals, fertilizers, soils, and miscellaneous animals that are not incorporated into the EPA model.

Area and on-road mobile sources dominate ammonia emissions (Figure 39). Specifically, emissions from agricultural sources and livestock production account for the largest share of estimated ammonia emissions in the MANE-VU region, except in the District of Columbia. The two remaining sources with a significant emissions contribution are wastewater treatment systems and gasoline exhaust from highway vehicles.

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[17] SO_2 reacts in the atmosphere to form sulfuric acid (H_2SO_4). Ammonia can partially or fully neutralize this strong acid to form ammonium bisulfate or ammonium sulfate. If planners focus future control strategies on ammonia and do not achieve corresponding SO_2 reductions, fine particles formed in the atmosphere will be substantially more acidic than those presently observed.

[18] Davidson, C., Strader, R., Pandis, S., and Robinson, A. Preliminary *Proposal to MARAMA and NESCAUM: Development of an Ammonia Emissions Inventory for the Mid-Atlantic States and New England.* Carnegie Mellon University, Pittsburgh, PA. January, 1999.

[19] For example, the user will have the flexibility to choose the temporal resolution of the output emissions data or to spatially attribute emissions based on land-use data.

[20] The NEI 1999 V.3 NH3 emissions were developed by EPA for a limited amount of livestock. (ftp://ftp.epa.gov/EmisInventory/finalnei99ver3/criteria/documentation/area/area_99nei_finalv3_0204.pdf)
In contrast, the MANE-VU 2002 V.3 NH3 emissions were developed by the Carnegie Mellon University (CMU) Ammonia Model that is more comprehensive than EPA's 1999 method.

Figure 38: Trends in Ammonia Emissions by State

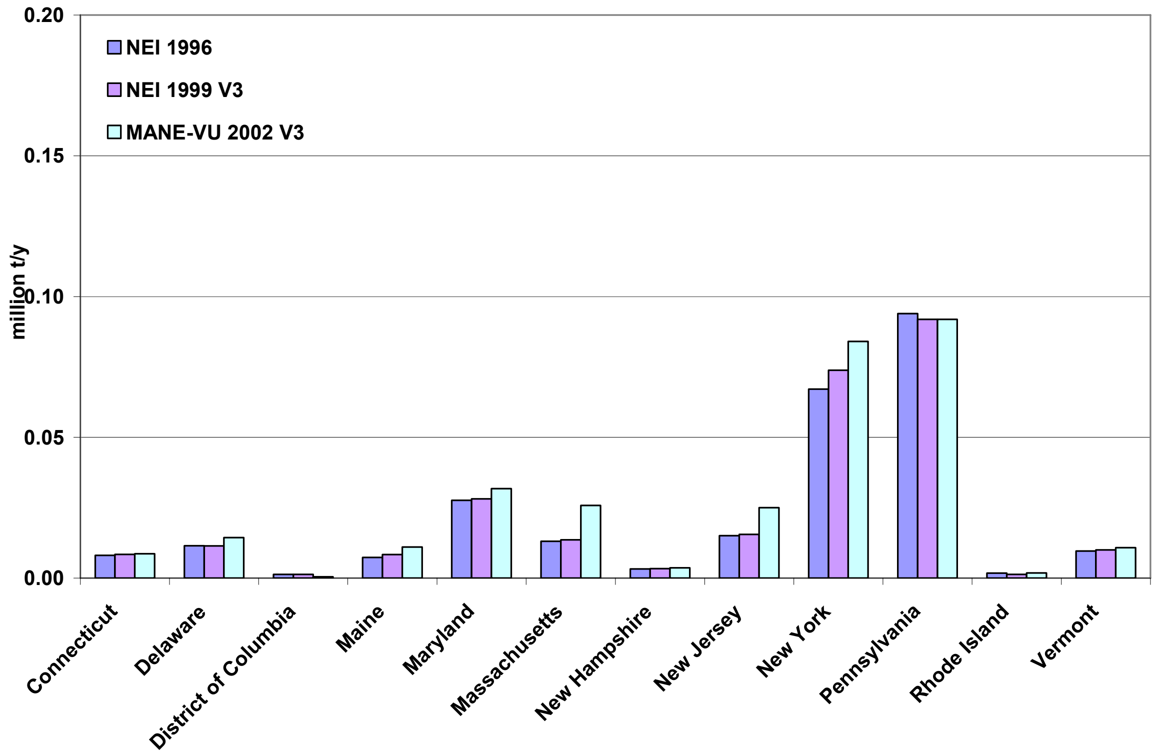
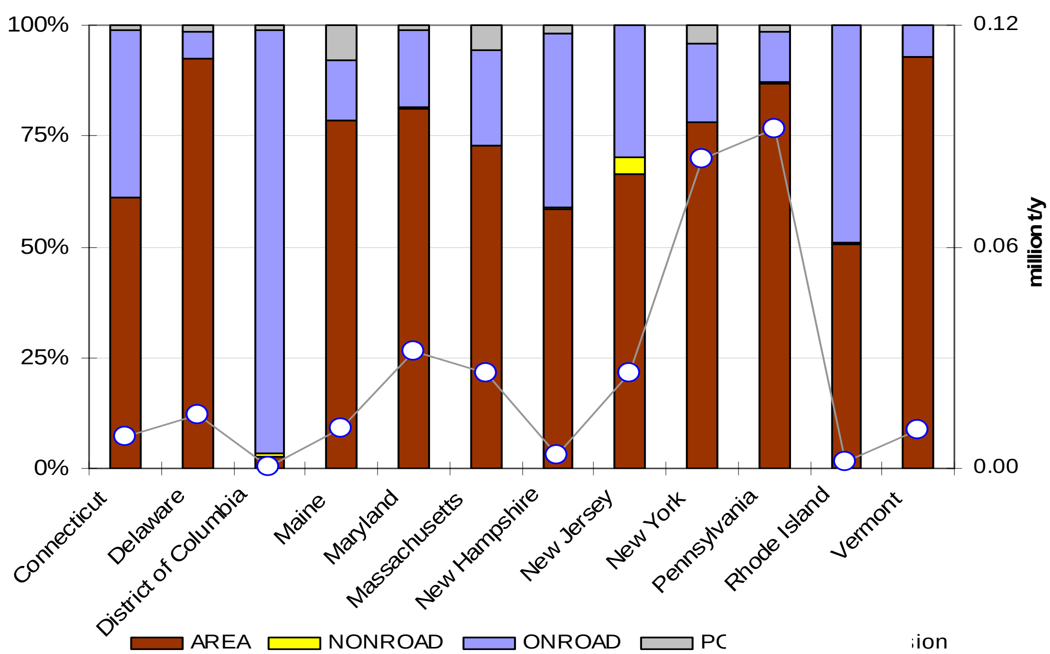


Figure 39: 2002 NH_3 Emissions by State



Bar Graph: Percentage Fractions of the Four Source Categories

(-o-) Line Graph: Total State Annual Emissions (10^6 tpy)

8. BEST AVAILABLE RETROFIT TECHNOLOGY

In the Regional Haze Rule, EPA included provisions designed specifically to reduce emissions of visibility-impairing pollutants from large sources that, because of their age, were exempted from new source performance standards (NSPS) established under the Clean Air Act. These provisions, known as Best Available Retrofit Technology, or BART, are located at 40 CFR 51.308(e).

Massachusetts is required by 40 CFR 51.308(e) to submit an implementation plan containing emission limits representing BART and schedules for compliance with BART for each eligible source that may reasonably be anticipated to cause or contribute to any impairment of visibility in any mandatory Class I Federal area. This requirement applies unless Massachusetts demonstrates that an emission trading program or other alternative will achieve greater reasonable progress toward natural visibility conditions.

BART requirements apply to 26 specified major point source categories, including power plants, industrial boilers, paper and pulp plants, cement kilns, and other large stationary sources.[21] To be considered BART-eligible, emission units from these specified categories must have commenced operation or come into existence in the 15-year period prior to August 7, 1977 (the date of passage of the 1977 Clean Air Act Amendments, which first required new source performance standards). In addition, the cumulative "potential to emit" levels of all BART-eligible units at a facility must be at least 250 tons per year of any visibility-impairing pollutant.[22] Visibility-impairing pollutants include, but are not limited to, sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter less than or equal to 10 microns in diameter (PM_{10}), volatile organic chemicals (VOCs), and ammonia.

8.2. BART Overview

The BART program is intended to reduce visibility-impairing emissions of the pollutants from large stationary sources that were not required to meet certain emission control requirements at the time the CAA was amended in 1977. Under Section 169A, States must consider five statutory factors when determining BART control requirements for BART-eligible units:

- Cost of compliance,
- Energy and non-air quality environmental impacts of compliance,
- Existing pollution control technology in use at the source,
- Remaining useful life of the source, and
- Degree of improvement in visibility reasonably anticipated from use of BART.

In June 2005, EPA adopted the final BART rule.[23] Under the final rule, the BART program requires states to develop an inventory of sources within each state that could be subject to control. Specifically, the rule:

[21] A full list of the 26 source categories can be found in 40 CFR Part 51 Appendix Y: Guidelines for BART Determinations Under the Regional Haze Rule.
[22] "Source" can refer to an emission unit or to a facility and is used in the Clean Air Act and in EPA's Guidance on Regional Haze.
[23] 40 CFR Part 51 Appendix Y: Guidelines for BART Determinations Under the Regional Haze Rule.

- Outlined methods to determine if a source is “reasonably anticipated to cause or contribute to haze;”
- Defined the methodology for conducting a BART control analysis;
- Provided presumptive control limits for electricity generating units (EGUs) larger than 750 Megawatts (i.e. “presumptive BART”);
- Provided a justification for the use of the Clean Air Interstate Rule (CAIR) as BART for CAIR state EGUs.[24]

Beyond the specific elements listed above, EPA provided the states with a great degree of flexibility in how they choose to implement the BART program.

As set forth in 40 CFR 51.308(e)(2), states may choose to implement or require participation by BART sources in an emissions trading program or an alternative measure that will achieve greater reasonable progress than BART implementation at all sources subject to BART. In addition, if such alternative measure has been designed primarily to meet a Federal or State requirement other than BART, a more simplified approach can be used to demonstrate that the alternative measure will make greater reasonable progress than implementing BART alone.

8.3. BART-Eligible Sources in Massachusetts

Massachusetts identified its BART-eligible sources using the methodology in the Guidelines for Best Available Retrofit Technology (BART) Determinations under the Regional Haze Rule, 40 CFR Part 51, Appendix Y. Seventeen sources were found to be eligible for BART and are listed in Table 10. These include nine electric generating units (EGUs), four industrial/commercial/ institutional (ICI) boilers/chemical processing plants, one municipal waste combustor (MWC), and three petroleum storage facilities.

[24] On August 8, 2011, EPA promulgated the Cross-State Air Pollution Rule to replace CAIR.

Table 10: BART-Eligible Facilities in Massachusetts

I.D.	Source	Units	Type
1190012	Boston Generating - New Boston	Unit 1	EGU
1190128	Boston Generating – Mystic	Unit 7	EGU
1190491	Braintree Electric	Unit 3	EGU
1200061	Dominion - Brayton Point	Units 1, 2, 3, and 4	EGU
1190194	Dominion - Salem Harbor	Unit 4	EGU
1190092	Harvard University - Blackstone	Units 11 and 12	EGU
1200054	Mirant - Canal Station	Units 1 and 2	EGU
1190093	Mirant - Kendall LLC	Units 1 and 2	EGU
1200067	Taunton Municipal Light Plant (TMLP) - Cleary Flood	Units 8 and 9	EGU
1190175	Eastman Gelatin	Units 1, 2, 3 and 4	ICI Boilers/Chemical Processing
1190138	General Electric Aircraft - Lynn	Unit 3	ICI Boilers/Chemical Processing
420086	Solutia	Units 9 and 10	ICI Boilers/Chemical Processing
1190507	Trigen - Kneeland St	Unit 3	ICI Boilers/Chemical Processing
1197654	Wheelabrator – Saugus	Units 1 and 2	Municipal Incinerator
1190484	Exxon Mobil – Everett	All Process Units	Petroleum Storage
1190487	Global Petroleum – Revere	All Process Units	Petroleum Storage
1190483	Gulf Oil – Chelsea	All Process Units	Petroleum Storage

8.4. Determination of which BART-eligible sources are subject to BART

Massachusetts is a member of the Mid-Atlantic/Northeast Visibility Union (MANE-VU). As part of the consultation process among MANE-VU states a policy decision was made by the MANE-VU Board in June 2004 that all BART-eligible sources are subject to BART. As such, no BART exemptions will be given, meaning all BART-eligible sources are included in the BART review process.

8.5. Pollutants Covered by BART

As allowed under BART, Massachusetts has determined that SO_2, NO_x and PM are the contributing visibility-impairing pollutants most appropriate to target under its BART approach. Massachusetts did not include either VOCs or ammonia because of the lack of tools to estimate emissions and subsequently to model VOCs and ammonia, and because Massachusetts is aggressively addressing VOCs through its ozone SIPs. This conclusion is consistent with discussions in the MANE-VU consultation process. Therefore, Massachusetts did not further consider BART for the three petroleum storage facilities identified in Table 10 above.

8.6. Modeling of BART Visibility Impacts

MANE-VU conducted modeling analyses of BART-eligible sources using CALPUFF in order to provide a regionally-consistent foundation for assessing the degree of visibility improvement which could result from installation of BART controls (see Attachment R).

MANE-VU modeled BART visibility impacts using 2002 emissions of SO_2, NO_x, and PM_{10} from all BART-eligible units in the region, including all BART-eligible sources in Massachusetts.[25] The NWS and MM5 meteorological platforms were both used to model each BART-eligible unit's maximum 24-hr, 8^{th} highest 24-hr, and annual average impact at the Class I area most heavily impacted, as well as the total impact from all BART sources on each Class I area. These visibility impacts were modeled relative to 20 percent best days, 20 percent worst days, and annual average natural background conditions. For the purposes of this analysis, MANE-VU examined the 24-hr maximum visibility impact relative to the 20 percent best days. In accordance with EPA guidance, which allows the use of either estimates of the 20 percent best or annual average natural background visibility conditions as the basis for calculating the deciview difference that individual sources would contribute for BART modeling purposes, MANE-VU opted to use the more conservative best conditions estimates approach because it is more protective to the region.

In addition to modeling the maximum potential improvement from BART, MANE-VU also determined that 98 percent of the cumulative visibility impact from all MANE-VU BART eligible sources corresponds to a maximum 24-hr impact of 0.22 dv from the NWS-driven data and 0.29 dv from the MM5 data. As a result, MANE-VU concluded that, on the average, a range of 0.2 to 0.3 dv would represent a significant impact at MANE-VU Class I areas, and sources having less than 0.1 dv impact are unlikely to warrant additional controls under BART.[26]

8.7. Visibility Impacts of Massachusetts BART-Eligible Sources

The results of CALPUFF modeling using MM5 and NWS meteorological platforms for Massachusetts BART-eligible facilities (excluding VOC sources) are found in Table 11 and Table 12, respectively. These results display facility-wide impacts on the worst day at the site experiencing the largest impact relative to the 20 percent best natural background conditions.

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[25] Emissions information was gathered from the MANE-VU 2002 Version 2 (Base A) emissions inventory. Since then, the MANE-VU 2002 Version 3 (Base B) emissions inventory has been developed which includes several changes made by the OTC modeling committee.

[26] As an additional demonstration that sources whose impacts were below the 0.1 dv level were too small to warrant BART controls, the entire MANE-VU population of these units was modeled together to examine their cumulative impacts at each Class I site. The results of this modeling demonstrated that the maximum 24-hour impact at any Class I area of all modeled sources with individual impacts below 0.1 dv was only a 0.35 dv change relative to the estimated best days natural conditions at Acadia National Park. This value is well below the 0.5 dv impact recommended by EPA for exemption modeling and used by most other RPOs.

Table 11: CALPUFF Visibility Modeling Results using MM5 Platform

	MM5- Impact on Worst Day Relative to 20 Percent Best Natural Conditions (delta deciview; ddv)				
Facility	*Class I Site*	*Total*	*SO4*	*NO3*	*PM10*
Dominion - Brayton Point	Acadia	11.152	9.740	3.354	0.031
Mirant - Canal Station	Acadia	6.643	6.018	1.310	0.000
Mystic Station	Moosehorn Wilderness	1.023	0.943	0.117	0.002
Dominion - Salem Harbor	Moosehorn Wilderness	0.982	0.886	0.151	0.001
Trigen - Kneeland Station	Acadia	0.146	0.023	0.127	0.001
Wheelabrator-Saugus	Acadia	0.250	0.026	0.232	0.000
General Electric Aircraft - Lynn	Acadia	0.239	0.148	0.092	0.000
TMLP - Cleary Flood	Acadia	0.103	0.028	0.076	0.003
Mirant - Kendall	Acadia	0.095	0.015	0.082	0.000
Harvard University - Blackstone	Acadia	0.060	0.039	0.027	0.001
New Boston	Presidential Range	0.044	0.000	0.044	0.000
Braintree Electric	Acadia	0.031	0.004	0.029	0.000
Eastman Gelatin	Acadia	0.029	0.002	0.026	0.000
Solutia	Presidential Range	0.003	0.000	0.003	0.000

Table 12: CALPUFF Visibility Modeling Results using NWS Platform

	NWS- Impact on Worst Day Relative to 20 Percent Best Natural Conditions (ddv)				
Facility	*Class I Site*	*Total*	*SO4*	*NO3*	*PM10*
Dominion - Brayton Point	Moosehorn Wilderness	7.200	6.206	1.754	0.026
Mirant - Canal Station	Acadia	3.485	3.251	0.427	0.000
Mystic Station	Moosehorn Wilderness	0.660	0.556	0.108	0.003
Dominion - Salem Harbor	Acadia	0.545	0.488	0.108	0.001
Trigen - Kneeland Station	Lye Brook Wilderness	0.097	0.005	0.092	0.002
Wheelabrator - Saugus	Lye Brook Wilderness	0.183	0.004	0.179	0.000
General Electric Aircraft - Lynn	Acadia	0.159	0.118	0.085	0.000
TMLP – Cleary Flood	Moosehorn Wilderness	0.061	0.022	0.037	0.002
Mirant - Kendall	Lye Brook Wilderness	0.059	0.003	0.057	0.000
Harvard University - Blackstone	Acadia	0.034	0.023	0.010	0.001
New Boston	Lye Brook Wilderness	0.028	0.000	0.027	0.001
Eastman Gelatin	Acadia	0.025	0.002	0.024	0.000
Braintree Electric	Moosehorn Wilderness	0.014	0.002	0.012	0.000
Solutia	Acadia	0.003	0.000	0.003	0.000

8.8. Overview of Massachusetts BART-Eligible Sources

There are three categories of BART-eligible sources in Massachusetts that emit SO_2, NO_x, and PM: a "cap out" source, sources with de minimis visibility impacts, and sources that contribute significantly to visibility impairment.

"Cap Out" Source

BART eligibility is limited to sources in one of 26 source categories that had units installed and operating between 1962 and 1977 with the current cumulative potential to emit more than 250 tons per year of a visibility impairing pollutant. EPA guidance allows BART-eligible sources to adopt a federally enforceable permit limit to permanently limit emissions of visibility impairing pollutants to less than 250 tons per year, thereby "capping-out" of BART. General Electric – Lynn has actual emissions of visibility impairing pollutants of fewer than 250 tons per year and was BART-eligible only because its potential emissions exceed the statutory BART threshold of 250 tons per year. MassDEP has issued a permit to General Electric – Lynn establishing caps of less than 250 tpy for NO_x and SO_2 emissions from Unit 3 in order to cap-out of BART requirements (Appendix BB); PM_{10} potential emissions already are less than 250 tpy. Therefore, General Electric – Lynn Unit 3 is no longer BART-eligible.

Sources with De Minimis Impacts on Visibility

According to the 2005 Regional Haze Rule, once a state has compiled its list of BART-eligible sources, it needs to determine whether to make BART determinations for all of the sources or to consider exempting some of them from BART because they may not reasonably be anticipated to cause or contribute to any visibility impairment in a Class I area. MANE-VU has identified a set of sources whose potential "degree of visibility improvement" is so small (<0.1 ddv) that no reasonable weighting could justify additional controls under BART. (Note that the cumulative impact of all of these MANE-VU sources combined is lower than EPA's guidance, which states that the threshold for determining whether a source "contributes" to visibility impairment should be ≤0.5 dv.) A description of this modeling can be found in Appendix R, Section 4.1, and the modeling results can be found in Appendices R-1 and R-2. MANE-VU has termed these sources to have a "de minimis visibility impact."

For Massachusetts, sources meeting this criterion are listed in Table 13. Trigen – Kneeland has been added to this list, despite its modeled impact of 0.146 ddv (0.127 ddv from NO_3) using the MM5 modeling platform, due to two significant errors in the 2002 input data used by MANE-VU to screen facilities for their impact on visibility. First, Units 1-4 were included in the modeling when only Unit 3 is BART-eligible. Second, the 2002 modeled NO_x emissions from Unit 3 were 396 tons, rather than the actual 96 tons of NO_x emissions. Massachusetts believes that modeling using the corrected 2002 NO_x emissions from Trigen - Kneeland would indicate a total visibility impact of <0.1 ddv; therefore Trigen – Kneeland is being considered a source with de minimis impact on visibility.

Table 13: Massachusetts Sources with De Minimis Visibility Impact

I.D.	Source	Type
1190491	Braintree Electric	EGU
1190092	Harvard University - Blackstone	EGU
1190093	Mirant - Kendall LLC	EGU
1190012	New Boston	EGU
1190175	Eastman Gelatin	ICI Boilers/Chemical Process
420086	Solutia	ICI Boilers/Chemical Process
1190507	Trigen - Kneeland	ICI Boilers

MassDEP has determined that the visibility improvement that would be achieved by the installation of BART controls at these sources does not justify the installation of such controls.

Sources that Contribute to Visibility Impairment

Massachusetts BART-subject sources with greater than a de minimis impact on visibility include three coal-fired EGUs (Brayton Point Units 1-3), seven oil-fired EGUs (Brayton Point Unit 4, Canal Station Units 1-2, Mystic Station Unit 7, Salem Harbor Unit 4, and Cleary Flood Units 8 and 9) and two MWC units (Wheelabrator – Saugus). An overview of these sources is contained in Table 14.

It should be noted that all of these sources are subject to MassDEP pollution control requirements that limit SO_2 and NO_x. All of the these sources, except Cleary Flood and Wheelabrator-Saugus, are subject to 310 CMR 7.29, *Emissions Standards for Power Plants*, which MassDEP adopted in 2001 to control the emissions of NO_x, SO_2, mercury, and carbon dioxide from the state's largest EGUs. In addition, these sources, as well as Cleary Flood, are subject to MassDEP's NO_x RACT rules and ozone season MassCAIR control program, 310 CMR 7.32.[27] Wheelabrator-Saugus is subject to 310 CMR 7.08(2): Municipal Waste Combustors and 310 CMR 7.19(9) (NO_x RACT for Municipal Waste Combustor Units).

The Regional Haze Rule allows Massachusetts to either make individual BART determinations or to implement an alternative that will achieve greater reasonable progress toward natural visibility conditions. Massachusetts has developed a BART determination for Wheelabrator that will be implemented through a permit revision and will address the remaining BART sources through BART determinations or under an alternative to BART program.

Table 14: Overview of BART-Eligible EGUs & MWCs

Source Type	Source	Unit	Subject to Presumptive BART?	Primary Fuel	Secondary Fuel(s)	Unit Type	Built Year
EGU	Brayton Point	1	yes	Coal (1.5%S)	Natural Gas, Residual Oil	Tangentially-fired	1963
EGU	Brayton Point	2	yes	Coal (1.5%S)	Natural Gas, Residual Oil	Tangentially-fired	1964
EGU	Brayton Point	3	yes	Coal (1.5%S)	Natural Gas, Residual Oil	Dry bottom wall-fired boiler	1969
EGU	Brayton Point	4	yes	Residual Oil	Natural Gas	Dry bottom wall-fired boiler	1974
EGU	Canal Station	1	yes	Residual Oil	Diesel Oil	Dry bottom wall-fired boiler	1970
EGU	Canal Station	2	yes	Residual Oil	Diesel Oil, Natural Gas	Dry bottom wall-fired boiler	1976
EGU	Mystic Station	7	yes	Residual Oil	Natural Gas	Tangentially-fired	1974
EGU	Salem Harbor	4	yes	Residual Oil		Dry bottom wall-fired boiler	1972
EGU	Cleary Flood	8	no	Residual Oil	Diesel Oil	Dry bottom wall-fired boiler	1966

[27] MassCAIR cannot be implemented beginning with the 2012 ozone season because Massachusetts was not included in EPA's Cross-State Air Pollution Rule. MassDEP is developing a replacement to MassCAIR that will continue to limit ozone season NO_x emissions.

EGU	Cleary Flood	9	no	Natural Gas	Diesel Oil, Residual Oil	Other boiler	1976
MWC	Wheelabrator - Saugus	1	no	Municipal Solid Waste		Mass burn waterwall boiler	1975
MWC	Wheelabrator - Saugus	2	no	Municipal Solid Waste		Mass burn waterwall boiler	1975

8.9. BART Determination for Wheelabrator - Saugus

Massachusetts has one BART-eligible incinerator, Wheelabrator – Saugus, which contains two mass burn incinerators with water wall boilers, each rated at 325 MMBtu/hr heat input. Each boiler can produce up to 195,000 lbs/hr of steam at 650 psi and 850º F. Both incinerator units are BART-eligible, with reported combined 2002 emissions of 84 tons of SO_2 and 721 tons of NO_x[28]

Wheelabrator – Saugus is subject to MassDEP's 1995 NO_x Reasonably Available Control Technology (RACT) regulation, 310 CMR 7.19(9). Wheelabrator – Saugus also is subject to more stringent NO_x emissions limitations in MassDEP's Municipal Waste Combustor regulation, 310 CMR.7.08(2), which was promulgated in 1998 (and amended in 2001) to implement EPA's 1995 Emissions Guidelines for existing large (greater than 250 tons) Municipal Waste Combustors pursuant to Sections 111(d) and 129 of the federal Clean Air Act.[29] Section 129 requires that these guidelines must be based on Maximum Achievable Control Technology (MACT). In 2006, EPA revised its Emissions Guidelines for large Municipal Waste Combustors, lowering the PM emission guidelines (as well as for other non-BART relevant pollutants), but leaving the SO_2 and NO_x emissions guidelines unchanged. In 2012, MassDEP plans to revise 310 CMR 7.08(2) to adopt the lowered 2006 Emissions Guidelines. In addition, MassDEP has committed in its 2008 Ozone SIP to conduct additional analysis as to whether existing NO_x controls still constitute RACT, and will consider including more stringent NO_x limits in 310 CMR 7.19 when it proposes revisions to 310 CMR 7.08(2) in 2012. Wheelabrator – Saugus will be required to comply with any more stringent emissions limits included in 310 CMR 7.08(2) and 310 CMR 7.19.

NO_x

Wheelabrator has NO_x control equipment for both units that includes low-NO_x burners and Selective Non-Catalytic Reduction (SNCR). Wheelabrator's permitted NO_x emission limit under 310 CMR 7.08(2)(f)3 is 205 ppm (by volume at 7 percent oxygen dry basis, 24-hr daily arithmetic average). Compliance is determined by continuous emissions monitors (CEMs). MassDEP's regulatory limit is consistent with EPA's Emissions Guidelines (both 1995 and 2006). However, MassDEP believes that the capabilities of current NO_x control technologies can achieve emissions lower than EPA's MACT.

At MassDEP's request, Wheelabrator performed furnace gas temperature profiling and conducted SNCR optimization testing to determine the capability of further reducing NO_x emissions while minimizing ammonia slip (see Appendix Z). The optimization test results indicate that a reduced NO_x emissions target of 185 ppm (dry, 7% O_2) at current boiler operating loads of approximately 150,000 lbs/hr could be achieved with the existing SNCR system. Based on MassDEP's review of Wheelabrator – Saugus' existing control technologies, MassDEP has determined that the NO_x emissions rate target of 185 ppm (30-day average) for each of Wheelabrator's units represents BART.

[28] No data was reported for PM emissions.
[29] EPA recalculated and changed the emissions limits for some of the pollutants in the Emissions Guidelines in a direct final rule in 1997.

As described in Tables 11 and 12, Wheelabrator – Saugus' visibility impacts on Class I areas based on 2002 emissions was 0.232 ddv and 0.179 ddv, depending on the modeling platform, which are close to MANE-VU's de minimis level (0.1 ddv) and are well below EPA's threshold guidance of 0.5 ddv for determining whether a source "contributes" to visibility impairment. Therefore, no detailed visibility modeling was performed to determine the benefit of achieving the lower NO_x emission rate, although MassDEP expects a modest visibility improvement to result from a lower NO_x emission rate.

Additional technologies and costs were not evaluated because MassDEP believes that low-NO_x burners and SNCR are state of the art for municipal waste combustors, and through optimization can achieve a NO_x emissions limit lower than the current federal MACT limit.

MassDEP intends to propose a permit for Wheelabrator with the NOx limit in February 2012 and finalize the permit for incorporation into this SIP in June 2012.

SO_2

Wheelabrator's existing control technology for SO_2 emissions includes a spray dry absorber (SDA) with lime slurry injection. Wheelabrator's permitted SO_2 emission limit under 310 CMR 7.08(2)(f)2 is 29 ppm (by volume at 7 percent oxygen dry basis) or 75 percent reduction by weight from uncontrolled SO_2 levels. Compliance is based on a 24-hour geometric mean. MassDEP's regulatory limit is consistent with EPA's Emissions Guidelines (both 1995 and 2006).

CALPUFF modeling suggests that visibility impacts from 2002 SO_2 emissions from Wheelabrator - Saugus are below 0.1 ddv on the worst day at any Class I area (see Tables 11 and 12). MassDEP has determined that further controls for SO_2 are not warranted given the additional cost required to install supplementary SO_2 controls because Wheelabrator already has control equipment equivalent to MACT and the degree of visibility improvement that could be achieved (<0.1 ddv) is de minimis.

PM

Each of Wheelabrator's units are equipped with 10-module fabric filters (baghouses) and are subject to 310 CMR 7.08 (2)(f)2 limits for PM of 27 mg/dscm or less at 7 percent oxygen (dry basis). This emissions limit is consistent with EPA's 1995 Emissions Guidelines for MWCs. In 2006, EPA lowered the Emissions Guideline for PM to 25 mg/dscm. MassDEP intends to propose to adopt this lower PM emissions limit in revisions to 310 CMR 7.08(2) planned for 2012 and believes this MACT limit represents BART. Once finalized, Wheelabrator – Saugus will be required to comply with the lower PM emissions rate.

MassDEP has determined that a PM emissions limit lower than 25 mg/dscm is not warranted given the additional cost required to install supplementary PM controls because Wheelabrator already has control equipment equivalent to MACT and the degree of visibility improvement that could be achieved is de minimis.

Energy and Non-air Quality Impacts

There are no significant energy and non-air quality impacts associated with the proposed BART for Wheelabrator-Saugus. One environmental benefit of a lower NO_x emissions limit, in addition to improved visibility, is the impact on acid deposition in Massachusetts and Northern New England. Reductions in ambient concentrations of NO_x will reduce acid deposition as well as excess nitrogen deposition, thereby reducing the acidification of lakes, streams and soils and material damage to buildings, and the eutrophication of inland and coastal waters.

Remaining Useful Life

As a member of MANE-VU, Massachusetts has determined that a BART-eligible source that is found to have reasonable control options available to it should either control emissions from that BART-eligible source prior to July 1, 2013, or accept a federally enforceable permit limitation or retirement date prior to adoption of this SIP.

Schedule for BART determination and Federal Enforceability

40 CFR 51.308(e)(1)(iv) requires that BART controls must be in operation for each applicable source no later than five years after EPA SIP approval. MassDEP will require Wheelabrator to comply with the lower NO_x and PM emissions limits as expeditiously as practicable but in no case later than March 31, 2014. BART determinations are required to be federally enforceable. MassDEP will require that Wheelabrator-Saugus modify its emissions control plans pursuant to 310 CMR 7.08(2) to make the lower BART NO_x and PM emissions rates state and federally enforceable.

8.10. BART or Alternative to BART for Remaining Sources [Reserved]

This Section is reserved; MassDEP intends to re-propose this Section in early 2012.

8.11. Reasonably Attributable Visibility Impairment

40 CFR 51.302(c) provides for general plan requirements in cases where the affected Federal Land Manager has notified the state that Reasonably Attributable Visibility Impairment (RAVI) exists in a Class I Area in the state. Based on the modeling conducted by MANE-VU and consultations with Federal Land Managers, there are no RAVI sources in Massachusetts or the other MANE-VU states.

9. REASONABLE PROGRESS GOALS

For each Class I area within a State/Tribe, 40 CFR Section 51.308(d)(1) requires the State/Tribe to establish reasonable progress goals (expressed in deciviews) that provide for reasonable progress towards achieving natural visibility. EPA released guidance on June 7, 2007 to use in setting reasonable progress goals. The goals must provide improvement in visibility for the most impaired days and ensure no degradation in visibility for the least impaired days over the SIP period. The State/Tribe also must provide an assessment of the number of years it would take to attain natural visibility conditions if improvement continues at the rate represented by the reasonable progress goals.

Under 40 CFR Section 51.308(d)(1)(iv), consultation is required in developing reasonable progress goals. The rule states:

> *In developing each reasonable progress goal, the State must consult with those States which may reasonably be anticipated to cause or contribute to visibility impairment in the mandatory Class I Federal area. In any situation in which the State cannot agree with another such State or group of States that a goal provides for reasonable progress, the State must describe in its submittal the actions taken to resolve the disagreement. In reviewing the State's implementation plan submittal, the Administrator will take this information into account in determining whether the State's goal for visibility improvement provides for reasonable progress towards natural visibility conditions.*

In developing the reasonable progress goal, the Class I State/Tribe also must consider four factors (cost of compliance, time needed for compliance, energy and non-air quality environmental impacts, and remaining useful life of any affected source). The State/Tribe also must show that it considered the uniform rate of progress and the emission reduction measures needed to achieve reasonable progress for the period covered by the implementation plan, and if the state proposes a rate of progress slower than the uniform rate of progress, assess the number of years it would take to attain natural conditions if visibility improvement continues at the rate proposed.

Because Massachusetts does not contain any Class I areas, it did not determine reasonable progress goals but did consult with states it impacts. Massachusetts consulted with Maine, New Hampshire, and Vermont, which have Class I areas impacted by emissions from sources within Massachusetts. Massachusetts agrees with the reasonable progress goals established by these states through the MANE-VU planning process for their Class I areas.

As a benchmark to aid in developing reasonable progress goals, MANE-VU compared baseline visibility conditions to natural visibility conditions at each MANE-VU Class I area. The difference between baseline and natural visibility conditions for the 20 percent worst days was used to determine the uniform rate of progress that would be needed during each implementation period in order to attain natural visibility conditions by 2064. Table 21 presents baseline visibility, natural visibility, and required uniform rate of progress for the MANE-VU Class I areas affected by emissions from sources within Massachusetts. Visibility values are expressed in deciviews (dv), where each single-unit deciview decrease would represent a barely perceptible improvement in visibility.

Table 15: Uniform Rate of Progress Calculation (all values in deciviews)

Class I Area	2000-2004 Baseline Visibility (20% Worst Days)	Natural Visibility (20% Worst Days)	Total Improvement Needed by 2018	Total Improvement Needed by 2064	Uniform Annual Rate of Improvement
Acadia National Park	22.9	12.4	2.4	10.5	0.174
Moosehorn Wilderness and Roosevelt Campobello International Park	21.7	12.0	2.3	9.7	0.162
Great Gulf Wilderness and Presidential Range - Dry River Wilderness	22.8	12.0	2.5	10.8	0.180
Lye Brook Wilderness	24.5	11.7	3.0	12.8	0.212

Note: Both natural conditions and baseline visibility for the 5-year period from 2000 through 2004 were calculated in conformance with an alternative method recommended by the IMPROVE Steering Committee.[30]

The reasonable progress goals established for each of the Class I areas are expected to provide greater visibility improvements than the uniform rate of progress shown in Table 21. A summary of the reasonable progress goals are shown in Tables 22 and 23.

Table 16: Reasonable Progress Goals - 20% Worst Days (all values in deciviews)

Visibility Condition	2000-2004 Baseline Visibility	2018 Reasonable Progress Goal	Visibility Improvement by 2018	Natural Visibility
Acadia National Park	22.9	19.4	3.5	12.4
Moosehorn Wilderness Area/ Roosevelt Campobello International Park	21.7	19.0	2.7	12.0
Great Gulf Wilderness	22.8	19.1	3.7	12.0
Presidential Range – Dry River Wilderness	22.8	19.1	3.7	12.0
Lye Brook Wilderness	24.4	20.9	3.5	11.7

[30] "Baseline and Natural Visibility Conditions, Considerations and Proposed Approach to the Calculation of Baseline and Natural Visibility Conditions at MANE-VU Class I Areas," NESCAUM, December 2006.

Table 17: Reasonable Progress Goals - 20% Best Days (all values in deciviews)

Visibility Condition	2000-2004 Baseline Visibility	2018 Reasonable Progress Goal	Visibility Improvement by 2018	Natural Visibility
Acadia National Park	8.8	8.3	0.5	4.7
Moosehorn Wilderness Area/ Roosevelt Campobello International Park	9.2	8.6	0.6	5.0
Great Gulf Wilderness	7.7	7.2	0.5	3.7
Presidential Range – Dry River Wilderness	7.7	7.2	0.5	3.7
Lye Brook Wilderness	6.4	5.5	0.9	2.8

10. LONG-TERM STRATEGY

40 CFR Section 51.308(d)(3) requires Massachusetts to submit a long-term strategy that addresses regional haze visibility impairment for each mandatory Class I Federal area within and outside the state that may be affected by emissions from within the state. The long-term strategy must include enforceable emissions limitations, compliance schedules, and other measures necessary to achieve the reasonable progress goals established by states where the Class I areas are located. Consultation between states affecting and/or containing Class I areas must be performed to develop coordinated emission management strategies. The state must demonstrate that it has included all measures necessary to obtain its share of the emission reductions needed to meet the progress goal for the area. If the state has participated in a regional planning process, the state must include measures needed to achieve its obligations agreed upon through that process.

This section describes the long-term strategy that Massachusetts will pursue to address visibility impairment for each of the following Class I areas that are affected by emissions from within Massachusetts: Acadia National Park, Great Gulf Wilderness, Lye Brook Wilderness, Presidential Range/Dry River Wilderness, Moosehorn Wilderness, and Roosevelt/Campobello International Park.

The long-term strategy includes enforceable emissions limitations, compliance schedules, and other measures necessary to achieve the reasonable progress goals established for the Class I areas. To the extent that it is practicable, Massachusetts commits to adopting these measures before submitting a report on reasonable progress to EPA in 2013. Additional measures may be reasonable to adopt at a later date after further consideration and review.

10.2. Overview of the Long-Term Strategy Development Process

As a participant in MANE-VU, Massachusetts supported a regional approach towards deciding which control measures to pursue for regional haze based on technical analyses documented in the following reports:

- *Contributions to Regional Haze in the Northeast and Mid-Atlantic United States* (called the Contribution Assessment, Appendix A),
- *Five-Factor Analysis of BART-Eligible Sources: Survey of Options for Conducting BART Determinations* (Appendix R),
- *Comparison of CAIR and CAIR Plus Proposal using the Integrated Planning Model®* (called the CAIR+ Report, Appendix S),
- *Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas* (called the Reasonable Progress Report, Appendix T), and
- *Assessment of Control Technology Options for BART-Eligible Sources: Steam Electric Boilers, Industrial Boilers, Cement Plants and Paper and Pulp Facilities* (Appendix U).

The regional strategy development process identified reasonable measures that would reduce emissions contributing to visibility impairment at Class I areas affected by emissions from within the MANE-VU region by 2018 or earlier. The technical basis for the long-term strategy is discussed in the following section, which describes the process of identifying potential emission reduction strategies.

MANE-VU reviewed a wide range of potential control measures to reduce emissions from sources contributing to visibility impairment in affected Class I areas. The process by which MANE-VU arrived at a set of proposed regional haze control measures to pursue for the 2018 milestone started in late 2005 in conjunction with efforts to identify measures to reduce ozone pollution. The Ozone Transport Commission (OTC) selected a contracting firm to assist with the analysis of ozone and regional haze control measure options. OTC provided the contractor with a "master list" of some 900 potential control measures, based on experience and previous state implementation plan work. With the help of an internal OTC control measure workgroup, the contractor also identified available regional haze control measures for MANE-VU's further consideration.

MANE-VU then developed an interim list of control measures, which for regional haze included: beyond-CAIR sulfate reductions from EGUs, low-sulfur heating oil (residential and commercial), and controls on ICI boilers (both coal and oil-fired), lime and cement kilns, residential wood combustion, and outdoor burning (including outdoor wood boilers).

The next step in the regional haze control measure selection process was to further refine the interim list. The CAIR+ Report (Appendix S) documents the analysis of the cost of additional SO_2 and NO_x controls at EGUs in the Eastern U.S. The Reasonable Progress Report (Appendix T) documents the assessment of control measures for EGUs and the other source categories selected for analysis. Further analysis is provided in the NESCAUM document entitled, "*Assessment of Control Technology Options for BART-Eligible Sources: Steam Electric Boilers, Industrial Boilers, Cement Plants and Paper and Pulp Facilities*" (Appendix 0).

The beyond-CAIR EGU strategy continued to stay on the list since EGU sulfate emissions have, by far, the largest impact on visibility in the MANE-VU Class I areas. Likewise, a low-sulfur oil strategy gained support after a NESCAUM-initiated conference with refiners and fuel-oil suppliers concluded that such a strategy could realistically be implemented in the 2014 timeframe. The low-sulfur heating oil and the oil-fired ICI boiler sector control measures merged into an overall low-sulfur oil strategy for distillate and residual oils for both the residential and commercial heating and oil-fired ICI boiler source sectors.

During MANE-VU's internal consultation meeting in March 2007, member states reviewed the interim list of control measures to make further refinements. States determined, for example, that there are too few coal-fired ICI boilers in the MANE-VU states to be considered a "regional" control strategy, but could be a sector pursued by individual states. They also determined that control of lime and cement kilns, of which there are few in the MANE-VU region, would likely be handled in each state's BART determination process. Residential wood burning and outdoor wood boilers remained a strategy for those states where localized visibility impacts may be of concern even though emissions from these sources are primarily organic carbon and direct particulate matter. Finally, outdoor wood burning also was determined to be better left as a sector to be examined and controlled further by individual states, due to issues of enforceability and penetration of existing state regulations.

10.3. Technical Basis for Strategy Development

40 CFR Section 51.308(d)(3)(iii) requires states to document the technical basis for the state's apportionment of emission reductions necessary to meet reasonable progress goals in each Class I area affected by the state's emissions. Massachusetts relied on technical analyses developed by MANE-VU to demonstrate that its emission reductions, when coordinated with those of other states, are sufficient to achieve reasonable progress goals in Class I areas affected by Massachusetts.

The emission reductions necessary to meet reasonable progress goals in each Class I area affected by Massachusetts are summarized in the following sections of this SIP and are described in the following documents:

- *Contributions to Regional Haze in the Northeast and Mid-Atlantic United States* (called the Contribution Assessment, Appendix A)
- *Baseline and Natural Background Visibility Conditions—Considerations and Proposed Approach to the Calculation of Baseline and Natural Background Visibility Conditions at MANE-VU Class I Areas* (Appendix E)
- *MANE-VU Modeling for Reasonable Progress Goals: Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits* (Appendix F)
- *2018 Visibility Projections* (Appendix G)
- *Five-Factor Analysis of BART-Eligible Sources: Survey of Options for Conducting BART Determinations* (Appendix R)
- *Comparison of CAIR and CAIR Plus Proposal using the Integrated Planning Model®* (called the CAIR+ Report, Appendix S)
- *Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas* (called the Reasonable Progress Report) (Appendix T)
- *Assessment of Control Technology Options for BART-Eligible Sources: Steam Electric Boilers, Industrial Boilers, Cement Plants and Paper and Pulp Facilities* (Appendix 0)
- *The Nature of the Fine Particle and Regional Haze Air Quality Problems in the MANE-VU Region: A Conceptual Description* (Appendix V)

In addition, Massachusetts relied on analyses conducted by neighboring RPOs, including the following documents, which are available upon request but are not incorporated into this SIP:

- VISTAS Reasonable Progress Analysis Plan by VISTAS, dated September 18, 2006
- Reasonable Progress for Class I Areas in the Northern Midwest-Factor Analysis, by EC/R, dated July 18, 2007

Massachusetts worked with other members of the Ozone Transport Commission and MANE-VU, as described in Section 2, to consider a wide variety of potential emission reduction strategies covering a wide range of sources of SO_2 and other pollutants contributing to regional haze. 40 CFR 51.308(d)(1) requires states to consider several factors in developing their long-term strategies. Using available information about emissions and potential impacts, the MANE-VU Reasonable Progress Workgroup selected the following source categories for detailed analysis:

- Coal and oil-fired electric generating units (EGUs);
- Point and area source industrial, commercial and institutional boilers;
- Cement kilns;
- Lime kilns;
- The use of low-sulfur heating oil; and
- Residential wood combustion and open burning.

These efforts led to the selection of the emission reduction strategies presented in this SIP.

10.4. 2018 Emission Reductions Due to Ongoing Air Pollution Controls

40 CFR Section 51.308(d)(3)(v)(A) requires states to consider emission reductions from ongoing pollution control programs. In developing its long-term strategy, Massachusetts considered emission control programs being implemented between the 2002 baseline period and 2018, as discussed below. Many of the emission reduction programs represent commitments already made by Massachusetts and other states to implement air pollution control measures for EGU point sources, non-EGU point sources, and area sources, respectively. These control measures are the same measures that were included in the 2018 emissions inventory and used in the modeling. While these control measures were not designed expressly for the purpose of improving visibility, the pollutants they control include those that contribute to visibility impairment in MANE-VU Class I Areas.

MANE-VU's 2018 "beyond on the way" (BOTW) emissions inventory accounts for emission controls that are already in place, as well as those that are not yet finalized but are likely to achieve additional reductions by 2009. The BOTW inventory was developed based on the MANE-VU 2002 Version 3.0 inventory and the MANE-VU 2018 on the books/on the way (OTB/OTW) inventory. Inventories used for other RPOs also reflect anticipated emissions controls that will be in place by 2018. The inventory is termed "beyond on the way" because it includes control measures that were developed for ozone SIPs that are not yet on the books in some states. For some states, it also included controls that were under consideration for Regional Haze SIPs that have not yet been adopted. Given the uncertainty inherent in the BOTW emissions inventory due to lack of enforceability, Massachusetts is continuing to evaluate these measures to determine whether they are reasonable to adopt and implement by 2018 and expects to make that determination in the progress report it will submit in 2013.

More information may be found in the following documents:

- *MANE-VU Modeling for Reasonable Progress Goals: Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits* (Appendix F)
- *2018 Visibility Projections* (Appendix G)
- *Development of Emissions Projections for 2009, 2012, and 2018 for Non-EGU Point, Area, and Non-road Sources in the MANE-VU Region* (Appendix N)
- *Documentation of 2018 Emissions from Electric Generating Units in the Eastern U.S. for MANE-VU's Regional Haze Modeling* (Appendix W)

EGU Emissions Controls Expected by 2018

The following EGU emission reduction programs were included in the modeling used to develop the reasonable progress goals and as the basis for the long-term strategy:

<u>Clean Air Interstate Rule (CAIR)</u>. The CAIR program was intended to permanently cap emissions of SO_2 and NO_x in the eastern United States by 2015 and reduce SO_2 emissions in the CAIR region by more than 70 percent and NO_x emissions by more than 60 percent from 2003 levels. However, CAIR was vacated by the U.S. Court of Appeals on July 11, 2008. A subsequent remand to EPA for remedy occurred on December 23, 2008. CAIR remained in place through 2011. On August 8, 2011, EPA promulgated the Cross State Air Pollution Rule, effective beginning January 1, 2012. The IPM® model

was used to predict future emissions from EGUs after implementation of CAIR.[31] All MANE-VU Class I states used CAIR as a basis for modeling progress towards the reasonable progress goals in their Regional Haze SIPs. For the short-term, this modeling is still valid. MANE-VU will incorporate the details of EPA's CSAPR into future modeling.

Modifications to the output of IPM® made to better represent anticipated controls are described in the report *Documentation of 2018 Emissions from Electric Generating Units* (Appendix W). Controls considered in making these modifications include the following:

Connecticut EGU Regulations: Connecticut adopted the following regulations governing EGU emissions:

- Regulations of Connecticut State Agencies (RCSA) section 22a-174- 19a, limiting the SO_2 emission rate to 0.33 lb SO_2/MMBtu for fossil fuel-fired EGUs greater than 15 MW that also are Title IV sources. (Implementation status - 2007)
- RCSA section 22a-174-22, limiting the non-ozone seasonal NO_x emission rate to 0.15 lb NO_x/MMBtu for fossil fuel-fired EGUs greater than 15 MW. (Implementation status - 2007)
- Connecticut General Statutes section 22a-199, limiting the mercury (Hg) emission rate to 0.0000006 lb Hg/MMBtu for all coal-fired EGUs, or alternatively coal-fired EGUs can meet a 90% Hg emission reduction. (Implementation status - 2008)

Delaware EGU Regulations: Delaware adopted the following regulations governing EGU emissions:

1. *Reg. 1144, Control of Stationary Generator Emissions*, SO_2, PM, VOC and NO_x emission control, Statewide, Effective January 2006.
2. *Reg. 1146, EGUs, Electric Generating Unit (EGU) Multi-Pollutant Regulation,* SO_2 and NO_x emission control, Statewide, Effective December 2007. SO_2 reductions will be more than regulation specifies.
3. *Regulation No. 1148, Control of Stationary Combustion Turbine Electric Generating Unit Emissions*, SO_2, $NO_{x,}$ and $PM_{2.5}$ emission control, Statewide, Effective January 2007.

Delaware estimates that these regulations will result in the following emission reductions for affected units:

SO_2 2002 levels of 32,630 tons to 8,137 tons in 2018 (75 percent decrease)
NO_x 2002 levels of 8,735 tons to 3,740 tons in 2018 (57 percent decrease)

Delaware Consent Decree: Valero Refinery Delaware City, DE (formerly Motiva, Valero Enterprises). 2002 SO_2 levels of 29,747 tons will decrease to 608 tons in 2018 (98 percent decrease). NO_x 2002 levels of 1,022 tons will decrease to 102 tons in 2018 (90 percent decrease).

Maine EGU Regulations: Maine adopted the following regulations governing EGU emissions:

[31] Although the IPM® model runs also anticipated the implementation of EPA's Clean Air Mercury Rule (CAMR), that rule has since been vacated by the courts. However, it is anticipated the adjustments to the predicted SO_2 emissions from EGUs used in the air quality modeling, which were based on state-specific comments on the amount of SO_2 controls that will actually be installed due to state-specific regulations and EPA's CAIR rule, will have more of an impact on the air quality modeling analysis conducted for this SIP than the vacatur of the CAMR rule. MANE-VU believes the adjustments based on state-specific comments improved the reliability of the inventory and made the modeling results more dependable.

Chapter 145 NO_x Control Program, which limits the NO_x emission rate to 0.22 lb NO_x/MMBtu for fossil fuel-fired units greater than 25 MW built before 1995 with a heat input capacity between 250 and 750 MMBtu/hr and also limits the NO_x emission rate to 0.15 lb NO_x/MMBtu for fossil fuel-fired units greater than 25 MW built before 1995 with a heat input capacity greater than 750 MMBtu/hr. (Implementation - 2007)

Massachusetts EGU Regulations: Massachusetts adopted 310 CMR 7.29, *Emissions Standards for Power Plants,* in 2001, which:

- Applies to six of the largest fossil fuel-fired power plants in Massachusetts, including Brayton Point (Units 1, 2, 3, 4), Mystic (Units 4, 5, 6, 7, 81, 82, 93, and 94), NRG Somerset (Units 8), Mount Tom (Unit 1), Canal Station (Units 1 and 2), and Salem Harbor (Units 1, 2, 3, and 4).
- Limits SO_2 emissions to 6.0 lbs/MWh each month and 3.0 lbs/MWh as a rolling average incorporating allowances and early reduction credits.
- Limits NO_x emissions to 3.0 lbs/MWh each month and 1.5 lbs/MWh as a rolling average.
- Limits mercury (Hg) emissions to 85% Hg reduction or 0.0075 lbs Hg/GWh in 2008 and 90% Hg reduction or 0.0025 lbs Hg/GWh in 2012.
- Limits CO_2 emissions to 1,800 lbs CO_2/MWh.

These regulations will achieve an approximately 50 percent reduction in NO_x emissions and 50 - 75 percent reduction in SO_2 emissions.

New Hampshire EGU Regulations: New Hampshire adopted the following regulations governing EGU emissions:

1. Chapter Env-A 2900, which caps NOx emissions on all existing fossil steam units to 3,644 tons NO_x per year, SO_2 emissions on all existing fossil steam units to 7,289 tons SO_2 per year, and CO_2 emissions on all existing fossil steam units to 5,425,866 tons CO_2 per year. (Implementation - 2007)

2. Chapter Env-A 3200, which limits NO_x emissions on all fossil fuel-fired EGUs greater than 15 MW to 0.15 lb NO_x/MMBtu. (Implementation - 2007)

New Jersey New Source Review Settlement Agreements: The New Jersey settlement agreement with PSEG required the following actions:

1. Repower Bergen Unit #2 to combined cycle by December 31, 2002.

2. For Hudson Unit #2, install Dry FGD or approved alternative technology by Dec. 31, 2006 to control SO_2 emissions and operate the control technology at all times the unit operates to limit SO_2 emissions to 0.15 lb SO_2/MMBtu; install SCR or approved alternative technology by May 1, 2007 to control NO_x emissions and operate the control technology year-round to limit NO_x emissions to 0.1 lb NO_x/MMBtu; and install a baghouse or approved alternative technology by May 1, 2007 to control PM emissions and limit PM emissions to 0.015 lb PM/MMBtu. The settlement also requires coal with a monthly average sulfur content no greater than 2% at units operating an FGD.

3. For Mercer Unit #1: install Dry FGD or approved alternative technology by Dec. 31, 2010 to control SO_2 emissions and operate the control technology at all times the unit operates to limit SO_2 emissions to 0.15 lb SO_2/MMBtu and install SCR or approved alternative technology by 2005 to

control NO_x emissions and operate the control technology ozone season only in 2005 and year-round by May 1, 2006 to limit NO_x emissions to 0.13 lb NO_x/MMBtu. The settlement also requires coal with a monthly average sulfur content no greater than 2% at units operating an FGD.

4. For Mercer Unit #2: install Dry FGD or approved alternative technology by Dec. 31, 2012 to control SO_2 emissions and operate the control technology at all times the unit operates to limit SO_2 emissions to 0.15 lb SO_2/MMBtu and install SCR or approved alternative technology by 2004 to control NO_x emissions and operate the control technology ozone season only in 2004 and year-round by May 1, 2006 to limit NO_x emissions to 0.13 lb NOx/MMBtu. The settlement also requires coal with a monthly average sulfur content no greater than 2% at units operating an FGD.

<u>New York EGU Regulations</u>: New York adopted the following regulations governing EGU emissions:

Part 237, which limits NO_x emissions from all fossil fuel-fired EGUs greater than 25 MW to a non-ozone season cap of 39,908 tons in 2007 and annual SO_2 emissions from all fossil fuel-fired EGUs greater than 25 MW to an annual cap of 197,046 tons SO_2/year starting in 2007 and an annual cap of 131,364 tons SO_2/year starting in 2008.

<u>North Carolina Clean Smokestacks Act</u>: Under the act, enacted in 2002, coal-fired power plants (EGUs) in North Carolina must achieve a 77 percent cut in NO_x emissions by 2009 and a 73 percent cut in SO_2 emissions by 2013. This legislation establishes annual caps on both SO_2 and NO_x emissions for the two primary utility companies in North Carolina, Duke Energy and Progress Energy. These reductions must be made in North Carolina, and allowances are not saleable.

<u>Consent Agreements in the VISTAS region</u>: The impacts of the following consent agreements in the VISTAS states were reflected in the emissions inventory used for those states:

- Santee Cooper: A 2004 consent agreement calls for Santee Cooper in South Carolina to install and commence operation of continuous emission control equipment for PM/SO_2/NO_x emissions; comply with system-wide annual PM/SO_2/NO_x emissions limits; agree not to buy, sell or trade SO_2/NO_x allowances allocated to Santee Cooper System as a result of said agreement; and to comply with emission unit limits of said agreement.
- TECO: Under a settlement agreement, by 2008, Tampa Electric in the state of Florida will install permanent emissions control equipment to meet stringent pollution limits; implement a series of interim pollution-reduction measures to reduce emissions while the permanent controls are designed and installed; and retire pollution emission allowances that Tampa Electric or others could use, or sell to others, to emit additional NO_x, SO_2 and PM.
- VEPCO: Virginia Electric and Power Co. agreed to spend $1.2 billion between by 2013 to eliminate 237,000 tons of SO_2 and NO_x emissions each year from eight coal-fired electricity-generating plants in Virginia and West Virginia.
- Gulf Power 7: A 2002 agreement calls for Gulf Power to upgrade its operation to cut NO_x emission rates by 61 percent at its Crist 7 generating plant by 2007 with major reductions beginning in early 2005. The Crist plant is a significant source of nitrogen oxide emissions in the Pensacola Florida area.

Non-EGU Point Source Controls Expected by 2018

Control factors were applied to the 2018 MANE-VU inventory to represent the following national, regional, and state control measures:

- NO_x SIP Call Phase I (NO_x Budget Trading Program)
- NO_x SIP Call Phase II
- NO_x RACT in 1-hour Ozone SIPs
- NO_x OTC 2001 Model Rule for ICI Boilers
- 2-, 4-, 7-, and 10-year MACT Standards
- Combustion Turbine and RICE MACT
- Industrial Boiler/Process Heater MACT[32]
- EPA's Refinery Enforcement Initiative

In addition, states provided specific control measure information about specific sources or regulatory programs in their state. MANE-VU used the state-specific data to the extent it was available.

For other regions, MANE-VU used inventories developed by the RPOs for those regions, including VISTAS Base G2, MRPO's Base K, and CenRAP's emissions inventory. (Emissions for CenRAP states in the MANE-VU modeling domain were taken from the VISTAS Base G2 inventory.) Non-EGU source controls incorporated into the modeling include the following consent agreements reflected in the VISTAS inventory:

- Dupont: A 2007 agreement calls for E. I. Dupont Nemours & Company's James River plant to install dual absorption pollution control equipment by September 1, 2009, resulting in emission reductions of approximately 1,000 tons SO_2 annually. The James River plant is a non-EGU located in the state of Virginia.
- Stone Container: A 2004 agreement calls for the West Point Paper Mill in Virginia owned by Smurfit/Stone Container to control with a wet scrubber the SO_2 emissions of the #8 Power Boiler. This control device should result in reductions of over 3,500 tons of SO_2 in 2018.

Area Source Controls Expected by 2018

For area sources within MANE-VU, Massachusetts relied on MANE-VU's Version 3.0 Emissions Inventory for 2002. In general, the 2018 inventory for area sources was developed by MANE-VU applying growth and control factors to the 2002 Version 3.0 inventory. Area source control factors were developed for the following national and regional control measures:

- OTC VOC Model Rules (Consumer products, architectural and industrial maintenance coatings, portable fuel containers, mobile equipment repair and refinishing, and solvent cleaning)
- Federal On-board Vapor Recovery
- New Jersey Post-2002 Area Source Controls
- Residential Woodstove NSPS

[32] The inventory was prepared before the MACT for Industrial Boilers and Process Heaters was vacated. Control efficiency was assumed to be at 4 percent for SO_2 and 40 percent for PM.

The following additional control measures were included in the 2018 analysis to reduce VOC emissions for the following area source categories for some states (as identified below):

- NO_x measures (natural gas, No. 2 fuel oil, No. 4 and 6 fuel oil, and coal; only in CT, NJ, and NY);
- VOC measures: adhesives and sealants (all MANE-VU states except VT);
- emulsified and cutback asphalt paving (all MANE-VU states except DE, ME, and VT);
- consumer products (all MANE-VU states except VT); and
- portable fuel containers (all MANE-VU states except VT).

As noted above, the inventory information used for other regions was obtained from those regions' RPOs.

Onroad Mobile Source Controls Expected by 2018

For the onroad mobile source emission inventory, Massachusetts relied on MANE-VU's Version 3.0 emissions inventory that included the following emission control measures in MANE-VU states:

Heavy Duty Diesel (2007) Engine Standard: EPA set a PM emissions standard for new heavy-duty engines of 0.01 grams per brake-horsepower-hour (g/bhp-hr), to take full effect for diesel engines in the 2007 model year. This rule also includes standards for NO_x and non-methane hydrocarbons (NMHC) of 0.20 g/bhp-hr and 0.14 g/bhp-hr, respectively. These NO_x and NMHC standards will be phased in together between 2007 and 2010 for diesel engines. Sulfur in diesel fuel must be lowered to enable modern pollution-control technology to be effective on these trucks and buses. EPA will require a 97 percent reduction in the sulfur content of highway diesel fuel from its current level of 500 parts per million (low-sulfur diesel, or LSD) to 15 parts per million (ultra-low sulfur diesel, or ULSD).

Tier 2 Motor Vehicle Standards: Tier 2 is a fleet averaging program, modeled after the California LEV II standards. Manufacturers can produce vehicles with emissions ranging from relatively dirty to zero, but the mix of vehicles a manufacturer sells each year must have average NO_x emissions below a specified value. Tier 2 standards became effective in the 2005 model year and are included in the assumptions used for calculating mobile source emissions inventories used for 2018.

Large Spark Ignition and Recreational Vehicle Rule: EPA has adopted new standards for emissions of NO_x, hydrocarbons (HC), and carbon monoxide (CO) from several groups of previously unregulated nonroad engines. Included in these are large industrial spark-ignition engines and recreational vehicles. Nonroad spark-ignition engines are those powered by gasoline, liquid propane, or compressed natural gas rated over 19 kilowatts (kW) (25 horsepower). These engines are used in commercial and industrial applications, including forklifts, electric generators, airport baggage transport vehicles, and a variety of farm and construction applications. Nonroad recreational vehicles include snowmobiles, off-highway motorcycles, and all terrain vehicles. These rules were initially effective in 2004 and were assumed to be fully phased-in by 2012.

Nonroad Sources Controls Expected by 2018

Massachusetts used Version 3.0 of the MANE-VU 2002 Emissions Inventory. Since the NONROAD Model used to develop the nonroad source emissions did not include aircraft, commercial marine, and locomotives, MANE-VU's contractor, MACTEC, developed the inventory for these categories. Nonroad mobile source emissions for the 2018 emission inventory were calculated with EPA's NONROAD2005 emissions model as incorporated in the NMIM2005 (National Mobile Inventory Model) database. The NONROAD model accounts for the emissions benefits associated with Federal non-road equipment emissions control measures such as the following:

- "Control of Air Pollution; Determination of Significance for Nonroad Sources and Emissions Standards for New Nonroad Compression Ignition Engines At or Above 37 Kilowatts," 59 FR 31306, June 17, 1994.
- "Control of Emissions of Air Pollution From Nonroad Diesel Engines," 63 FR 56967, October 23, 1998.
- "Control of Emissions From Nonroad Large Spark-Ignition Engines and Recreational Engines (Marine and Land-Based); Final Rule," 67 FR 68241, November 8, 2002.
- "Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel; Final Rule," April, 2004. This rule sets standards that will reduce emissions by more than 90 percent from nonroad diesel equipment and reduce sulfur levels by 99 percent from current levels in nonroad diesel fuel starting in 2007. This step will apply to most nonroad diesel fuel in 2010 and to fuel used in locomotives and marine vessels in 2012.

As noted above, the inventory information used for other regions was obtained from those regions' RPOs.

Additional Controls Analyzed as Part of Ozone SIPs

Additional control measures were considered by several states as part of ozone planning. These control measures were included in the inventory used for regional haze modeling analysis. The states may or may not have committed to adopting these measures in the ozone SIP. For specific states, the measures included in this analysis reduce emissions for the following pollutants and non-EGU point source categories due to strategies developed for purposes of reducing ozone in the Ozone Transport Region (OTR):

- NO_x measures:
  - Asphalt production plants in CT, DC, NJ, and NY
  - Cement kilns in ME, MD, NY, PA
  - Glass and fiberglass furnaces in MD, MA, NJ, NY, PA
- VOC measure: adhesives and sealants application (all MANE-VU states except NJ[33] and VT)

These measures were included in the "Beyond on the Way" inventory for the states identified.

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[33] Note that New Jersey indicated that the reductions from the adhesives and sealants application control measure should only apply to area sources—no reductions for point sources (SCC 4-02-0007-xx) were included due to inventory double counting issues, not due to rule change issues.

The following additional control measures were included in the 2018 analysis to reduce VOC emissions for the following area source categories for some states (as identified below):

- NO_x measures (natural gas, No. 2 fuel oil, No. 4 and 6 fuel oil, and coal) (Only CT, NJ, and NY)
- VOC measures: adhesives and sealants (except VT)
- emulsified and cutback asphalt paving (except ME and VT)
- consumer products (except VT)
- portable fuel containers (except VT)

10.5. Additional Reasonable Strategies

In developing reasonable progress goals as required by 40 CFR 51.308(d)(1), Massachusetts and the MANE-VU states identified specific emission control measures - beyond those which individual states or RPOs have already made commitments to implement - that would be reasonable to undertake as part of a concerted strategy to mitigate regional haze. The proposed additional control measures were incorporated into the regional strategy adopted by MANE-VU on June 20, 2007, to meet the reasonable progress goals established by the Class I states. The basic elements of this strategy are described in the MANE-VU "Ask" (see below). States targeted for coordinated actions toward achieving these goals include all of the MANE-VU states plus Georgia, Illinois, Indiana, Kentucky, Michigan, North Carolina, Ohio, South Carolina, Tennessee, Virginia and West Virginia[34].

In addition to proposed emission controls in the U.S., the MANE-VU Class I states determined that it was reasonable to include anticipated emission reductions in Canada in the modeling used to set reasonable progress goals. This determination was based on evaluations conducted before and during the consultation process. Specifically, the modeling accounts for six coal-burning EGUs in Canada having a combined output of 6,500 MW that are scheduled to be shut down and replaced by nine natural gas turbine units with selective catalytic reduction (SCR) by 2018.

Rationale for Determining Reasonable Controls

40 CFR 51.308(d)(1)(i)(A) requires that, in establishing reasonable progress goals for each Class I area, the State must consider the costs of compliance, the time necessary for compliance, the energy and non-air quality environmental impacts of compliance, and the remaining useful life of any potentially affected sources. The SIP must include a demonstration showing how these factors were taken into consideration in setting the reasonable progress goals. These factors are sometimes termed the "four statutory factors," since their consideration is required by the Clean Air Act.

Focus on SO_2**:** MANE-VU conducted a Contribution Assessment (Appendix A) and developed a conceptual model that indicated particulate sulfate formed from emissions of SO_2 was the dominant contributor to visibility impairment at all sites and during all seasons in the base year. While other pollutants, including organic carbon and NO_x, will need to be addressed in order to achieve the national visibility goals, MANE-VU's contribution assessment suggested that an early emphasis on SO_2 will yield the greatest near-term benefit. Therefore, it is reasonable to conclude that the additional measures considered in establishing reasonable progress goals require reductions in SO_2 emissions.

[34] In addition, the State of Vermont identified at least one source in the State of Wisconsin as a significant contributor to visibility impairment at the Lye Brook Wilderness Class I Area.

Contributing Sources: The MANE-VU Contribution Assessment indicates that emissions in 2002 from within the MANE-VU region were responsible for about 25 to 30 percent of the sulfate at MANE-VU Class I areas. Sources in the Midwest and Southeast regions were responsible for about 15 to 25 percent each, respectively. Point sources dominated the inventory of SO_2 emissions. Therefore, the MANE-VU's long-term strategy includes additional measures to control sources of SO_2 both within the MANE-VU region and in other states that were determined to contribute to regional haze at MANE-VU Class I areas.

The Contribution Assessment documented the source categories most responsible for visibility degradation at MANE-VU Class I areas. As described earlier, there was a collaborative effort between the Ozone Transport Commission and MANE-VU to evaluate a large number of potential control measures. Several measures that would reduce SO_2 emissions were identified for further study.

These efforts led MANE-VU to prepare the report entitled, "Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas" MACTEC, July 9, 2007 otherwise known as the Reasonable Progress Report (Appendix T), which documented an analysis of the four statutory factors for five major source categories. Table 24 summarizes the results of MANE-VU's Reasonable Progress Report, which considered EGUs, ICI boilers, cement kilns, heating oil and residential wood combustion.

The MANE-VU states reviewed the four-factor analysis presented in the Reasonable Progress Report, consulted with each other about the measures, and concluded by adopting the statements known as the MANE-VU "Ask" on June 20, 2007. These statements identify the control measures that would be pursued toward improving visibility in the region and that were included in the modeling used to establish reasonable progress goals.

Table 18: Summary of Results from the Four-Factor Analysis

Source Category	Primary Regional Haze Pollutant	Control Measure(s)	Average Cost in 2006 dollars (per ton of pollutant reduction)	Compliance Timeframe	Energy and Non-Air Quality Environmental Impacts	Remaining Useful Life
Electric Generating Units	SO_2	Switch to a low sulfur coal (generally <1% sulfur), switch to natural gas (virtually 0% sulfur), coal cleaning, Flue Gas Desulfurization (FGD): Wet, Spray Dry, or Dry.	IPM®* v.2.1.9 predicts $775-$1,690. $170-$5,700 based on available literature	2-3 years following SIP submittal	Fuel supply issues, potential permitting issues, reduction in electricity production capacity, wastewater issues	50 years or more
Industrial, Commercial, Institutional Boilers	SO_2	Switch to a low sulfur coal (generally <1% sulfur), switch to natural gas (virtually 0% sulfur), switch to a lower sulfur oil, coal cleaning, combustion control, Flue Gas Desulfurization (FGD): Wet, Spray Dry, or Dry.	$130-$11,000 based on available literature. Depends on size.	2-3 years following SIP submittal	Fuel supply issues, potential permitting issues, control device energy requirements, wastewater issues	10-30 years
Cement and Lime Kilns	SO_2	Fuel switching, Dry Flue Gas Desulfurization: Spray Dryer Absorption (FGD), Wet Flue Gas Desulfurization (FGD), Advanced Flue Gas Desulfurization (FGD).	$1,900-$73,000 based on available literature. Depends on size.	2-3 years following SIP submittal	Control device energy requirements, wastewater issues	10-30 years
Heating Oil	SO_2	Lower the sulfur content in the fuel. Depends on the state.	$550-$750 based on available literature. There is a high uncertainty associated with this cost estimate.	Currently feasible. Capacity issues may influence timeframe for implementation of new fuel standards	Increases in furnace/boiler efficiency, decreased furnace/boiler maintenance requirements	18-25 years
Residential Wood Combustion	PM	State implementation of NSPS, ban on resale of uncertified devices, installer training certification or inspection program, pellet stoves, EPA Phase II certified RWC devices, retrofit requirement, accelerated changeover requirement, accelerated changeover inducement.	$0-$10,000 based on available literature	Several years - dependent on mechanism for emission reduction	Reduce greenhouse gas emissions, increase efficiency of combustion device	10-15 years

*Integrated Planning Model®

MANE-VU Statement of June 20, 2007

The reasonable progress goals adopted by the MANE-VU Class I states represent implementation of the regional course of action set forth by MANE-VU on June 20, 2007 entitled "*Statement of the Mid-Atlantic/Northeast Visibility union (MANE-VU) Concerning a Course of Action within MANE-VU toward Assuring Reasonable Progress*." As such, these reasonable progress goals are intended to reflect the pursuit by MANE-VU states of a course of action including pursuing the adoption and implementation of the following "emission management" strategies, as appropriate and necessary:

a. Timely implementation of BART requirements; and

b. A low sulfur fuel oil strategy in the inner zone states (New Jersey, New York, Delaware, and Pennsylvania, or portions thereof) to reduce the sulfur content of:
   - Distillate oil to 0.05 percent sulfur by weight (500 ppm) by no later than 2012,
   - #4 residual oil to 0.25 percent sulfur by weight by no later than 2012,
   - #6 residual oil to 0.3 – 0.5 percent sulfur by weight by no later than 2012, and
   - Further reduce the sulfur content of distillate oil to 15 ppm by 2016; and

c. A low sulfur fuel oil strategy in the outer zone states (the remainder of the MANE-VU region) to reduce the sulfur content of:
   - Distillate oil to 0.05 percent sulfur by weight (500 ppm) by no later than 2014,
   - #4 residual oil to 0.25 percent-0.50 percent sulfur by weight by no later than 2018,
   - #6 residual oil to no greater than 0.5 percent sulfur by weight by no later than 2018, and
   - Further reduce the sulfur content of distillate oil to 15 ppm by 2018 depending on supply and availability; and

d. A 90 percent or greater reduction in SO_2 emissions from each of the 167 EGU stacks identified by MANE-VU as reasonably anticipated to cause or contribute to impairment of visibility in each mandatory Class I Federal area in the MANE-VU region. If it is infeasible to achieve that level of reduction from a unit, alternative measures will be pursued in such State; and

e. Continued evaluation of other control measures including energy efficiency, alternative clean fuels, and other measures to reduce SO_2 and NO_x emissions from all coal-burning facilities by 2018 and new source performance standards for wood combustion.

This long-term strategy to reduce and prevent regional haze will lead each state to pursue adoption and implementation of reasonable and cost-effective NO_x and SO_2 control measures as appropriate and necessary. While some measures that states pursue may not represent enforceable commitments immediately, they may become enforceable in the future as new laws are passed, rules are written, and facility permits are issued. Massachusetts will provide an update on the implementation of the strategies listed in the "Ask" in the 2013 mid-term review.

This suite of additional control measures are those that the MANE-VU states have agreed to pursue for the purpose of mitigating regional haze. The corollary is that the MANE-VU Class I states (Maine, New Hampshire, Vermont, and New Jersey) asked states outside of the MANE-VU region that contribute to visibility impairment inside the region to pursue similar measures. The control measures that non-MANE-VU states choose to pursue may be directed toward the same emission source sectors identified by MANE-VU for its own emission reductions, or they may be equivalent measures targeting other source sectors.

Best Available Retrofit Technology

Implementation of the BART provisions of the Regional Haze Rule [40 CFR 51.308(e)] is one of the reasonable strategies included in this SIP. BART controls in Massachusetts are described in Section 8 of this SIP.

Additional emission reductions will occur at many other BART-eligible facilities within MANE-VU as a result of controls achieved by other programs that serve as BART but are not specifically identified as such (e.g., RACT control measures). While not specifically identified as being attributable to BART, these additional emission reductions were fully accounted for in the 2018 CMAQ modeling.

Additional visibility benefits are likely to result from installation of new emission controls at BART-eligible facilities located in neighboring RPOs. However, the MANE-VU modeling did not account for BART controls in other RPOs and, consequently, did not include visibility improvements at MANE-VU Class I Areas that would be likely to accrue from such measures.

Low-Sulfur Fuel Oil Strategy

The important assumption underlying MANE-VU's low-sulfur fuel oil strategy is based on the production and use of home heating and fuel oils that contain 50% less sulfur for the heavier grades (#4 and #6 residual), and a minimum of 75% and a maximum of 99.25% less sulfur in #2 fuel oil (also known as home heating oil, distillate, or diesel fuel) at an acceptably small increase in price to the end user. As much as three-fourths of the total sulfur reductions achieved by this strategy come from using the low-sulfur #2 distillate for space heating in the residential and commercial sectors. The costs of these emission reductions are estimated at $550 to $750 per ton, as documented in the MANE-VU Reasonable Progress Report. In some seasons and some locations, low-sulfur diesel is actually cheaper than regular diesel fuel. NESCAUM's report, "Low Sulfur Heating Oil in the Northeast States: An Overview of Benefits, Costs, and Implementation Issues," December 2005 (Appendix Y) notes that the incremental cost of low-sulfur (500 ppm) highway diesel fuel has averaged 1.5 cents per gallon more than the cost of heating oil over the past decade. However, any increased cost would be more than offset by the avoided maintenance costs resulting from the reduced rate of equipment fouling when using low-sulfur oil.

A recent study developed for the National Oilheat Research Alliance (NORA)[35] uses data from the U.S. Energy Information Administration to evaluate the potential for suppliers to bring 15 ppm sulfur content heating oil into widespread use in the Northeast by 2018. While the study acknowledges that additional refining capacity is needed to meet the increased demand in 2018 and beyond, it concludes that, given appropriate advance notice, the refining industry can supply the necessary fuels with minimal market disruptions and price impacts. In the short-term, excess production capacity of ultra-low sulfur diesel (ULSD) exists in the region. In the longer term, the transition to ULSD in the transportation sector, combined with clear signals from regulatory agencies that similar requirements will be widespread for heating oil in the coming years, will support a move toward greater availability of 15 ppm sulfur content heating oil.

[35] Ultra-low Sulfur Diesel Fuel/Heating Oil Market Study, Kevin J. Lindemer, LLC, prepared for the National Oilheat Research Alliance, April 2010 (http://www.nora-oilheat.org/site20/uploads/lowsstudy.pdf).

The study projects a wholesale price differential between ULSD and higher sulfur heating oil of 1-3 cents per gallon, suggesting that the incremental cost of providing 15 ppm sulfur content heating oil will not be significant compared to normal price fluctuations. The study also notes that the incremental cost to consumers will be more than offset by cost savings associated with lower maintenance costs and higher fuel efficiency. For example, a typical consumer who uses 800 gallons of fuel per year would spend an additional $24 per year if per-gallon fuel costs increased by $0.03. However, the same consumer could expect to save approximately $50 per year in avoided maintenance costs (cleaner fuel reduces the frequency with which equipment must be serviced) and another $50 in avoided fuel costs from higher efficiency. This is because existing equipment generally operates more efficiently with lower sulfur fuels, so less fuel is required to produce the same amount of heat; even larger efficiency gains are possible using newer furnaces specifically designed to use lower sulfur fuels.

The sulfur content of residual fuel oils burned by power plants and other large sources also can be cost-effectively reduced. Residual oil is a byproduct of the refining process, and is produced in several grades that can be blended to meet a specified fuel sulfur content limit. In April 2011, MANE-VU published an Addendum to its 2007 "Assessment of Reasonable Progress" Report that evaluated residual oil (Appendix T-1). The report averaged monthly price averages to compute annual prices and price differentials in cents per gallon for the years 2006 – 2009. For these years in the Northeast, lower sulfur No. 6 residual oil (≤ 1%) ranged from 8.9 to 12.9 cents per gallon more than higher sulfur No. 6 residual oil (> 1%). The additional expense would be at least partially offset by reduced maintenance costs with the use of lower sulfur oil. Low sulfur oil is cleaner burning and emits less particulate matter than higher sulfur oil; this reduces the rate of fouling of heating units substantially and permits longer time intervals between cleanings. The decreased deposits also would enable a more efficient transfer of heat, thereby reducing fuel use. Thus, there are potential costs savings for switching to lower sulfur residual oil. Reducing the sulfur content of residual fuel is a cost-effective SO_2 reduction strategy; a simple calculation using a price differential of $0.089 – $0.129 suggests that a 78% reduction in SO_2 emissions (by converting from 2.2 percent to 0.5 percent sulfur residual oil) is achievable at an approximate cost of $800 - $1,100 per ton of SO_2 removed. This cost per ton removal compares favorably to the costs of other pollution controls typically required by environmental agencies and is well within the range considered to be cost-effective for SO_2 reductions.

While the costs of the low-sulfur oil strategy will vary depending on market conditions, they are reasonable when compared to the costs of controlling other sectors. Importantly, a January 2008 Public Health Benefits study prepared by NESCAUM shows that the low-sulfur fuel strategy will result in billions of dollars in public health benefits for the region (see Appendix AA). Controlling the fuel-sulfur content to 500 ppm leads to health benefits of almost 3.4 billion dollars in MANE-VU and controlling the fuel-sulfur content to 15 ppm could lead to an additional 431 million dollars in benefits, bringing the total benefits to 3.7 billion dollars.

The MANE-VU states agreed through consultations to pursue a low-sulfur fuel oil strategy within the region. The MANE-VU low-sulfur fuel strategy will be implemented in two phases; however, both components of the strategy are to be fully implemented by 2018. The first phase of the MANE-VU low-sulfur fuel strategy requires the lowering of fuel sulfur content in distillate (#1 and #2 oil) from current levels that range between 2,000 and 2,300 ppm down to 500 ppm. The second phase of the strategy further reduces the fuel-sulfur content of the distillate fraction to 15 ppm sulfur. It also requires the lowering of sulfur content in residual oil to 0.5 percent sulfur by weight.

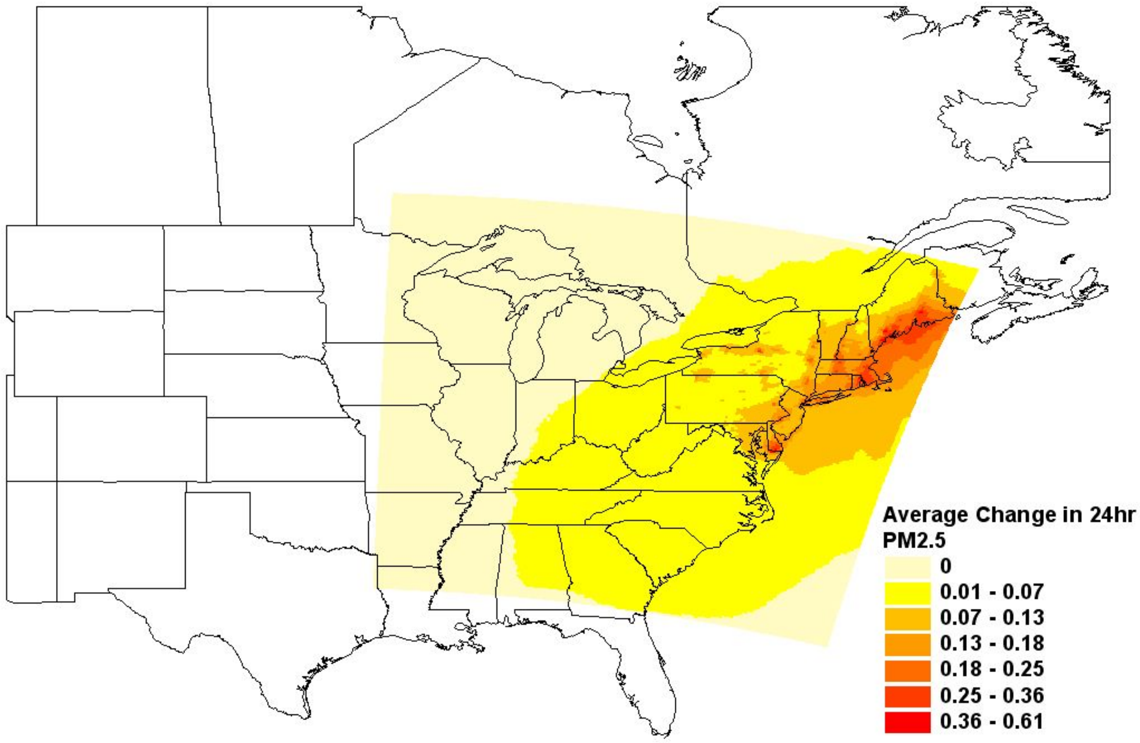
The two phases of the MANE-VU low-sulfur fuel strategy are to be implemented in sequence with slightly different timing for an "inner zone"[36] and the remainder of MANE-VU. All MANE-VU states have agreed that a low-sulfur oil strategy is reasonable to pursue by 2018 as appropriate and necessary. Based on the fuel sulfur limits within the first phase of the strategy, MANE-VU estimated a decrease of 140,000 tons of SO_2 emitted from distillate combustion and a decrease of 40,000 tons of SO_2 from residual combustion in MANE-VU. In the second phase in which distillate fuel sulfur limits are lowered from 500 ppm to 15 ppm, MANE-VU estimated an additional reduction of 27,000 tons of SO_2 emissions in MANE-VU in 2018.

Figure 40 shows the combined impact of both phases of the MANE-VU low-sulfur fuel strategy relative to the On The Books/On The Way baseline. NESCAUM used the concentration changes illustrated in Figure 40 to estimate the visibility benefits for this strategy. Because the fuel sulfur program only affects sources within MANE-VU, that region sees the largest $PM_{2.5}$ reduction and the greatest visibility benefits.

Massachusetts commits to pursue the implementation of the low sulfur fuel strategy with 500 ppm percent sulfur by weight for distillate oil and 1.0% sulfur by weight for residual oils by 2014, with further respective reductions to 15 ppm and 0.5% by 2018. Massachusetts plans to amend 310 CMR 7.05: Fuels to incorporate these limits as part of this SIP.

[36] The inner zone includes New Jersey, Delaware, New York City, and potentially portions of eastern Pennsylvania.

Figure 40: Average Change in 24-hr $PM_{2.5}$ Due to Low Sulfur Fuel Strategies Relative to OTB/OTW ($\mu g/m^3$)



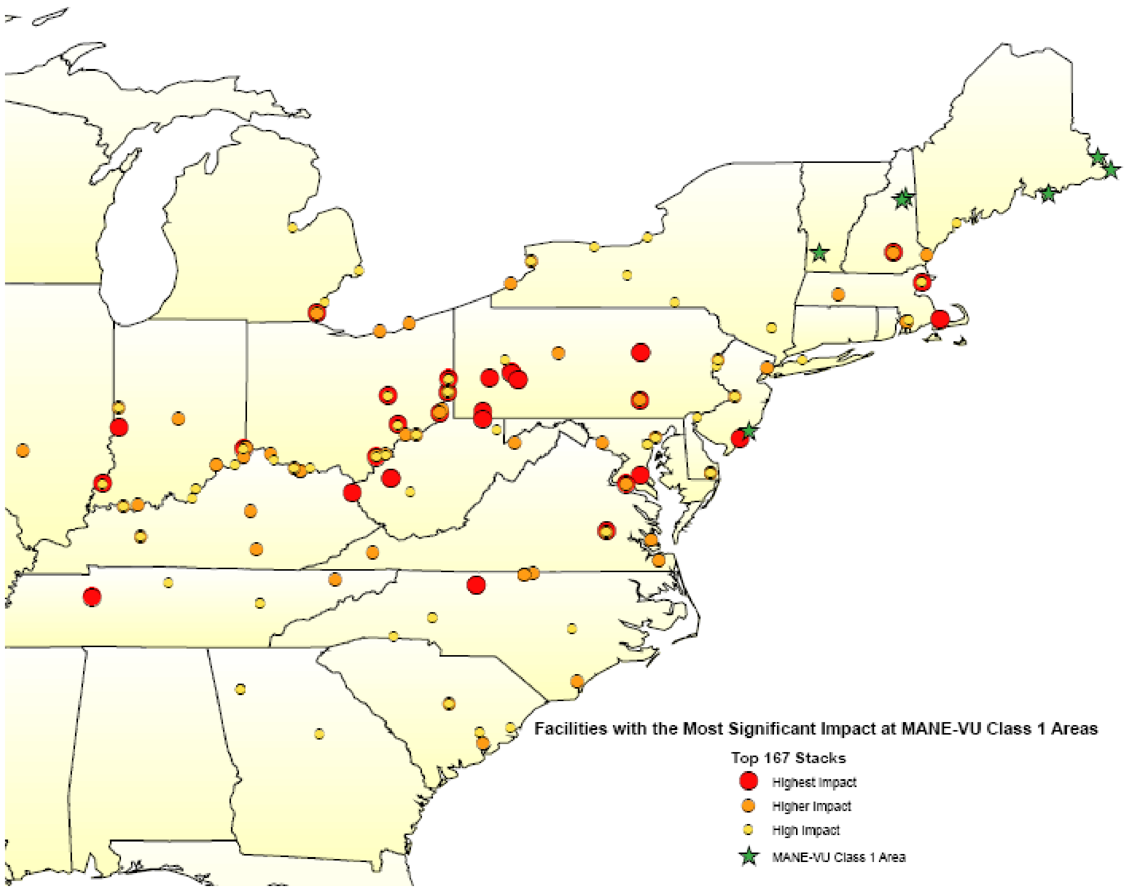
Targeted EGU Strategy

SO_2 emissions from power plants (electric generating units or EGUs) are the single largest sector contributing to the visibility impairment experienced in the Northeast's Class I areas. The SO_2 emissions from power plants continue to dominate the inventory. Sulfate formed through atmospheric processes from SO_2 emissions are responsible for over half the mass and approximately 70-80 percent of the light extinction on the worst visibility days (Contribution Assessment, Appendix A).

In order to properly target controls on EGUs, modeling was conducted to identify those EGUs with the greatest impact on visibility in MANE-VU. A list was developed that includes the 100 largest impacts at each MANE-VU Class I site during 2002. These emissions were from 167 EGU stacks and are illustrated below (a complete list can be found in Appendix W; see Appendix A). Some of the stacks identified as important were outside the states identified as contributing at least 2 percent of the sulfate at MANE-VU Class I areas and were dropped from the list. Massachusetts sources identified in the list include Brayton Point, Canal Station, Mount Tom, Salem Harbor, and Somerset Station. Given the magnitude of their potential impact, controlling emissions from these stacks is important to improving visibility at MANE-VU Class I areas.

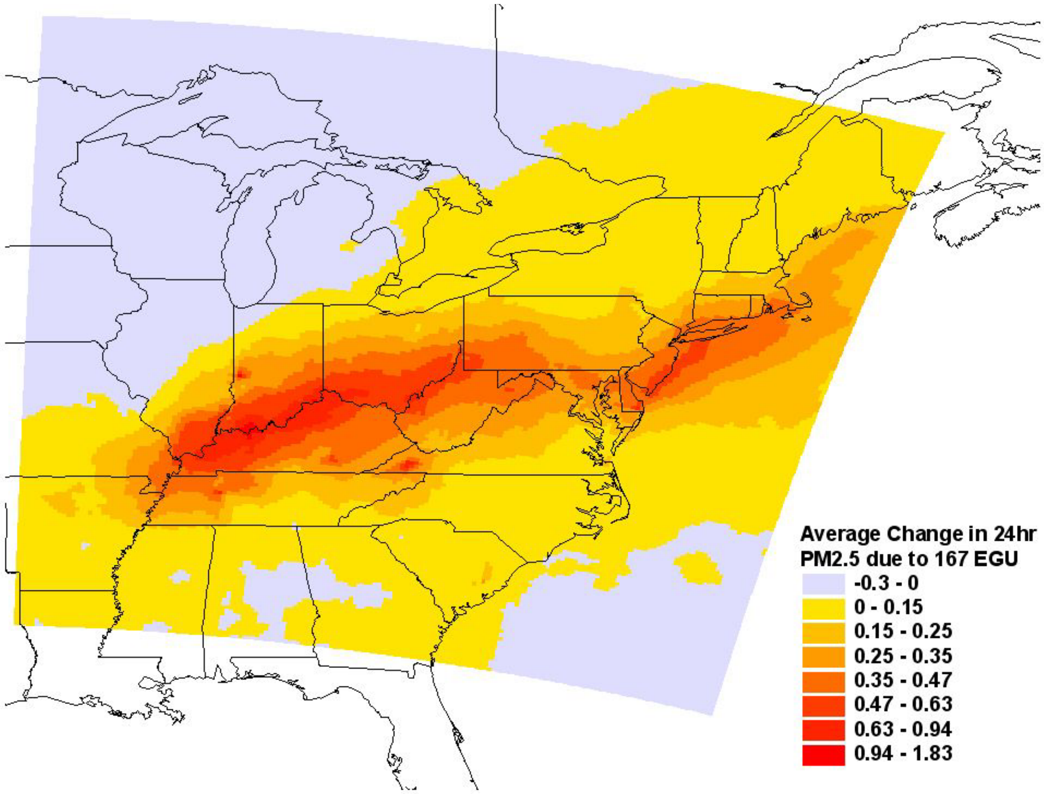
MANE-VU's agreed to regional approach for the EGU sector is to pursue a 90 percent reduction in SO_2 emissions (from 2002 emissions) from these 167 targeted stacks by 2018 as appropriate and necessary. MANE-VU concluded that pursuing this level of sulfur reduction is both reasonable and cost-effective. Even though current wet scrubber technology can achieve sulfur reductions greater than 95 percent, historically a 90 percent sulfur reduction level includes lower average reductions from dry scrubbing technology. The cost for SO_2 emissions reductions will vary by unit, and the MANE-VU Reasonable Progress report (Appendix T) summarizes the various control methods and costs available, ranging from $170 to $5,700 per ton, depending on site-specific factors such as the size and type of unit, combustion technology, and type of fuel used.

Figure 41: 167 Targeted EGU Stacks Affecting MANE-VU Class I Areas



To evaluate the impact of reducing emissions from the 167 EGU stacks, NESCAUM used CMAQ to model sulfate concentrations in 2018 after implementation of this control program. 2018 SO_2 emissions for these stacks were modeled at levels equal to 10 percent of their 2002 SO_2 emissions; sulfate concentrations were then converted to $PM_{2.5}$ concentrations. This preliminary modeling showed that requiring SO_2 emissions from the 167 EGU stacks to be reduced by 90 percent from 2002 emission levels could reduce 24-hour $PM_{2.5}$ concentrations. Figure 43 shows the reduction in fine particle pollution in the Eastern U.S. that would result from implementing the targeted EGU SO_2 strategy. Improvements in $PM_{2.5}$ concentrations would occur throughout the MANE-VU region as well as for portions of the VISTAS and Midwest RPO regions, especially the Ohio River Valley.

Figure 42: Average Change in 24-hr $PM_{2.5}$ due to 90 Percent Reduction in SO_2 Emissions from 167 EGU Stacks Affecting MANE-VU



Although the reductions are potentially large, MANE-VU determined, after consultation with affected states, that it was unreasonable to expect that the full 90-percent reduction in SO_2 emissions would be achieved by 2018. Therefore, additional modeling was conducted to assess the more realistic scenario in which emissions would be controlled by the individual facilities and/or states to levels already projected to take place by that date. At some facilities, the actual emission reductions are anticipated to be greater or less than the 90 percent benchmark. For details, see Appendix W "*Documentation of 2018 Emissions from Electric Generating Units in the Eastern United States for MANE-VU's Regional Haze Modeling*."

Massachusetts has five sources with a total of 10 EGUs on the 167 Stacks list, including Brayton Point (units 1-3), Canal Station (units 1-2), Mount Tom (unit 1), Salem Harbor (units 1, 3, 4), and Somerset Station (unit 8). Each of these facilities is subject to MassDEP's 310 CMR 7.29, which limits SO_2 emissions facility-wide.

Several stacks at Massachusetts sources already have installed SO_2 controls or are planning additional SO_2 controls to help them meet 310 CMR 7.29 limits. Brayton Point has installed SDA on Units 1 and 2 and will be installing and operating an SDA on Unit 3 by 2014, and Mount Tom has installed a dry scrubber and baghouse. Salem Harbor is currently using low-sulfur coal to meet its 310 CMR 7.29 limits but plans to shut down all units by June 2014. Somerset Station has shut down.

MassDEP originally proposed to rely on EPA's draft Transport Rule to meet the Targeted EGU strategy. However, because Massachusetts is not included in EPA's final Cross-State Air Pollution Rule, MassDEP still must address this commitment. Therefore, MassDEP intends to propose a revised Targeted EGU strategy in February 2012 and submit a final strategy to EPA in June 2012.

Several states have implemented state-specific EGU emission reduction programs. These commitments, identified below, are included in the long-term strategy as reasonable measures to meet MANE-VU's reasonable progress goals and were used in the Best and Final 2018 CMAQ modeling (Appendix G).

Maryland Healthy Air Act: Maryland adopted the following requirements governing EGU emissions:

1. For NOx:
    a. Phase I (2009): Sets unit-specific annual caps (totaling 20,216 tons) and ozone season caps (totaling 8,900 tons).
    b. Phase II (2012): Sets unit-specific annual caps (totaling 16,667 tons) and ozone season caps (totaling 7,337 tons).
2. For SO_2:
    a. Phase I (2010): Sets unit-specific annual caps (totaling 48,818 tons).
    b. Phase II (2013): Sets unit-specific annual caps (totaling 37,235 tons).
3. For mercury:
    a. Phase I (2010): 12-month rolling average of a minimum of 80% removal efficiency.
    b. Phase II (2013): 12-month rolling average of a minimum of 90% removal efficiency.

The specific EGUs covered are: Brandon Shores (Units 1 and 2), C.P.Crane (Units 1 and 2), Chalk Point (Units 1, and 2), Dickerson (Units 1, 2, and 3), H.A. Wagner (Units 2 and 3) Morgantown (Units 1 and 2) and R. Paul Smith (Units 3 and 4). No out-of-state trading, no inter-company trading, and no banking from year to year is permitted.

New Hampshire EGU Regulations: New Hampshire adopted the following regulations governing EGU emissions: Chapter Env-A 2900 requires the installation of scrubbers on Merrimack Station (Units 1 and 2) by July 1, 2013 to control SO_2 and mercury emissions with state-level SO_2 credits for over- or early-compliance.

New Jersey Hg MACT Rule: All coal-fired EGUs must have a mercury removal efficiency of 90%.

Consent Agreements in the VISTAS region: The impacts of the additional following consent agreements in the VISTAS states were reflected in the emissions inventory used for those states:

- EKPC: A July 2, 2007 consent agreement between EPA and East Kentucky Power Cooperative requires the utility to reduce its emissions of SO_2 by 54,000 tons per year and its emissions of NO_x by 8,000 tons per year by installing and operating selective catalytic reduction (SCR) technology, low-NOx burners, and PM and mercury Continuous Emissions Monitors at the utility's Spurlock, Dale and Cooper Plants. According to EPA, total emissions from the plants will decrease between 50 and 75 percent from 2005 levels. As with all federal consent decrees, EKPC is precluded from using reductions required under other programs, such as CAIR, to meet the reduction requirements of the consent decree. EKPC is expected to spend $654 million to install pollution controls.
- AEP: American Electric Power agreed to spend $4.6 billion dollars to eliminate 72,000 tons of NO_x emissions each year by 2016 and 174,000 tons of SO_2 emissions each year by 2018 from sixteen plants located in Indiana, Kentucky, Ohio, Virginia, and West Virginia.

10.6. Source Retirement and Replacement Schedules

40 CFR Section 51.308(d)(3)(v)(D) requires Massachusetts to consider source retirement and replacement schedules in developing reasonable progress goals. Source retirement and replacement were considered in developing the 2018 emissions inventory described in Appendix N, Appendix B-5.

10.7. Measures to Mitigate the Impacts of Construction Activities

40 CFR Section 51.308(d)(3)(v)(B) requires States to consider measures to mitigate the impacts of construction activities. A description of MANE-VU's consideration of measures to mitigate the impacts of construction can be found in the MANE-VU document entitled, *Technical Support Document on Measures to Mitigate the Visibility Impacts of Construction Activities in the MANE-VU Region* (Appendix X). The following statements summarize the main points of this technical support document:

- Although a temporary source, fugitive dust and diesel emissions from construction activities can affect local air quality.
- While construction activities are responsible for a relatively large fraction of direct $PM_{2.5}$ and PM_{10} emissions in the region, the contribution of construction activities to reduced visibility is much smaller because dust settles out of the air relatively close to the sources.
- Ambient air quality data shows that soil dust makes up only a minor fraction of the $PM_{2.5}$ measured in MANE-VU Class I areas. Furthermore, the impacts of diesel emissions in these rural areas are a small part of the total $PM_{2.5}$.
- The use of measures such as clean fuels, retrofit technology, best available technology, specialized permits, and truck staging areas (to limit the adverse impacts of idling) can help decrease the effects of diesel emissions on local air quality.
- MANE-VU states have rules in place to mitigate potential impacts of construction activities on visibility in Class I areas.

MassDEP requires contractors working on certain state-financed projects to install retrofit pollution controls in their construction equipment engines. In addition, Massachusetts regulation 310 CMR 7.09 regulates dust from construction and demolition activities. 7.09(3) states, "No person responsible for an area where construction or demolition has taken place shall cause, suffer, allow, or permit particulate emissions therefrom to cause or contribute to a condition of air pollution…" Furthermore, the construction or demolition of large buildings requires a written notification to MassDEP ten working days prior to operations. Due to the lower visibility impact of particulate matter from Massachusetts at Class I areas (relative to SO_2 and NO_x emissions), MassDEP concludes that its regulations are currently sufficient to mitigate the impacts of construction activities.

10.8. Agricultural and Forestry Smoke Management

40 CFR Section 51.308(d)(3)(v)(E) requires States to consider smoke management techniques for the purposes of agricultural and forestry management. A description of MANE-VU's analysis of smoke management in the context of Regional Haze SIPs can be found in the MANE-VU Smoke Management TSD entitled, "*Technical Support Document on Agricultural and Forestry Smoke Management in the MANE-VU Region*" (Appendix Q).

This technical support document concluded that Smoke Management Programs (SMPs) are only required when smoke impacts from fires managed for resource benefits contribute significantly to regional haze. Massachusetts does not currently have a smoke management program. The results of the emissions inventory indicate that emissions from agricultural, managed, and prescribed burning are very minor source categories (totaling 1.34% of $PM_{2.5}$ emissions in the MANE-VU region). Source apportionment results show that wood smoke is a moderate contributor to visibility impairment at some Class I areas in the MANE-VU region; however, smoke is not an especially important contributor to MANE-VU Class I areas on either the 20% best or 20% worst visibility days. Most of the wood smoke is attributable to residential wood combustion and it is unlikely that fires for agricultural or forestry management cause large impacts on visibility in any of the Class I areas in the MANE-VU region. On rare occasions, smoke from major fires degrades the air quality and visibility in the MANE-VU area. However, these fires are generally unwanted wildfires that are not subject to SMPs.

MassDEP's air regulations include 310 CMR 7.00, which bans open burning entirely in 22 urban municipalities and prohibits the use of open burning to clear commercial or institutional land for non-agricultural purposes. Burning for "activities associated with the normal pursuit of agriculture" and the open burning of brush and debris between January 14 and April 30, "except during periods of adverse meteorological conditions," are currently allowed. Prescribed burning also is allowed under 310 CMR 7.07(3)(f) upon specific permission from MassDEP. Massachusetts considers these efforts to be sufficient to protect visibility in the Class I areas affected by emissions from Massachusetts sources, including agricultural and forestry smoke.

Regulation of Outdoor Hydronic Heaters

On December 26, 2008, MassDEP finalized new regulations, 310 CMR 7.26(50) through (54), to control emissions from outdoor hydronic heaters (OHHs, also known as outdoor wood-fired boilers or OWBs), which are included in Appendix CC as part of this SIP. The regulations are based in part on a NESCAUM model rule developed in January 2007 and have requirements for manufacturers, sellers, and owners of OHHs. Manufacturers must meet stringent performance standards in order to sell OHHs in Massachusetts. The Phase I emission standard is 0.44 lb/MMBtu for units sold after October 1, 2008, and the Phase II emission standard is 0.32 lb/MMBtu for units sold after March 31, 2010. Owners of current and new OHHs are subject to regulations regarding the operation of their OHHs. Massachusetts concludes that adoption of these proposed regulations will reduce future smoke and particulate emissions from OHHs.

10.9. Estimated Impacts of Long-Term Strategy on Visibility

Preliminary modeling was conducted to estimate the impact of various elements of the MANE-VU "Ask." This modeling is described in NESCAUM's report entitled *MANE-VU Modeling for Reasonable Progress Goals* (Appendix F). NESCAUM also conducted additional revised modeling to assess combined impacts. This modeling is described in NESCAUM's report entitled *2018 Visibility Projections* (Appendix G). The following information about the effects of specific strategies is taken from those reports. As with all modeling, emissions estimates and modeling results for 2018 entail uncertainty, and further evaluation may be conducted as part of the progress report required in five years under 40 CFR Section 51.308(g).

Additional Measures Included in Best and Final Modeling

In addition to the measures described in Section 10.5 (BART controls within MANE-VU, low-sulfur fuel within MANE-VU, and controls on specific EGUs), MANE-VU asked neighboring RPOs to consider further non-EGU emissions reductions comparable to those achieved through MANE-VU's low-sulfur fuel strategies. Prior modeling indicated that the MANE-VU low-sulfur fuel strategy is expected to achieve a greater than 28 percent reduction in non-EGU SO_2 emissions in 2018. After consultation with other states and consideration of comments received, the MANE-VU Class I states decided that the Best and Final modeling would include implementation of measures to match MANE-VU's 28 percent reduction in non-EGU SO_2 emissions in the VISTAS and MRPO regions. In order to model the impact of this strategy on visibility at MANE-VU Class I areas, additional emissions reductions in the VISTAS and MRPO states were assumed to occur, resulting in a modeled 28 percent reduction in non-EGU SO_2 emissions in those regions. These reductions include:

For both Southeast and Midwest States:

- Coal-Fired ICI Boilers: emissions were reduced by 60 percent
- Oil-Fired ICI boilers: emissions were reduced by 75 percent
- ICI Boilers lacking fuel specification: emissions were reduced by 50 percent

Additional controls only in the Southeast States:

- Emissions from Other Area Oil-Combustion sources were reduced by 75 percent (Used the same SCCs identified in MANE-VU Oil strategies list.)

In addition, NESCAUM removed SO_2 emissions from 6500 MW of six coal-burning EGUs in Canada that are scheduled to be shut down for the Best and Final Modeling.[37] It is expected that these units will be replaced with nine natural gas turbine units with selective catalytic reduction controls. NESCAUM based estimated emission rates for modeled pollutants on a combination of factors, including recommendations from the State of New Hampshire, a NYSERDA study, and AP-42 ratios among pollutants. Emissions were reduced by more than 144,000 tons per year as a result of this measure.

Visibility Impacts of Additional Reasonable Controls from Best and Final Modeling

40 CFR Section 51.308(d)(3)(v)(G) requires states to address the net effect on visibility resulting from changes projected in point, area and mobile source emissions by 2018. The starting point for indicating progress achieved by measures included in this SIP and other MANE-VU-member SIPs is the 2000-2004 baseline visibility at affected Class I areas. To calculate the baseline visibility for affected Class I areas, using 2000-2004 IMPROVE monitoring data, the deciview value for the 20 percent best days in each year were averaged together, producing a single average deciview value for the best days. Similarly, the deciview values for the 20 percent worst days in each year were averaged together, producing a single average deciview value for the worst days.

Initial modeling (Appendix F) was then performed to identify reasonable progress goals. Results of this modeling showed that sulfate aerosol – the dominant contributor to visibility impairment in the Northeast's Class I areas on the 20 percent worst visibility days – has significant contributions from states in all three of the eastern RPOs. These emissions are projected to continue in future years. An assessment of potential control measures identified a number of promising strategies, including the adoption of a low-sulfur fuel oil strategy, the implementation of BART requirements, and additional controls on select EGUs, as well as a 28 percent reduction in non-EGU SO_2 emissions in VISTAS and MRPO states. These strategies were predicted to yield significant visibility benefits beyond the uniform rate of progress and, in fact, significantly beyond the projected visibility conditions that would result from "on the books/on the way" air quality protection programs.

[37] NESCAUM's 2018 Visibility Projections report cited a November 2006 paper by the Ontario Power Authority, "Ontario's Integrated power System Plan Discussion Paper 7: Integrating the Elements—A Preliminary Plan. See http://www.powerauthority.on.ca/ipsp/Storage/32/2734_DP7_IntegratingTheElements.pdf

NESCAUM conducted modeling for MANE-VU to document the impacts of the long-term strategy on visibility at affected Class I areas. This "Best and Final" modeling is documented in the report *2018 Visibility Projections* (Appendix G), and estimates the composite visibility benefits of all strategies within and outside MANE-VU. Emissions inventory adjustments were made for this modeling in order to better represent the likely outcome of efforts to pursue the BART, low-sulfur oil, and EGU control measures included in the MANE-VU June 20, 2007 statements.

Figure 43 to Figure 46 illustrate the predicted visibility improvement by 2018 resulting from the implementation of the MANE-VU regional long-term strategy (the short green line above the year 2018). This improvement is compared to the Uniform Rate of Progress for affected Class I areas (shown as the diagonal purple line). No degradation is represented by the dashed line, blue dots at the upper left indicate the 20 percent worst observed visibility days, and the pink line at bottom left indicate the 20 percent best observed visibility days. All MANE-VU sites are projected to meet or exceed the uniform rate of progress for 2018. In addition, no site anticipates increases in best-day visibility relative to the baseline.

Figure 43: Projected Visibility Improvement at Acadia National Park Based on 2018 Visibility Projections

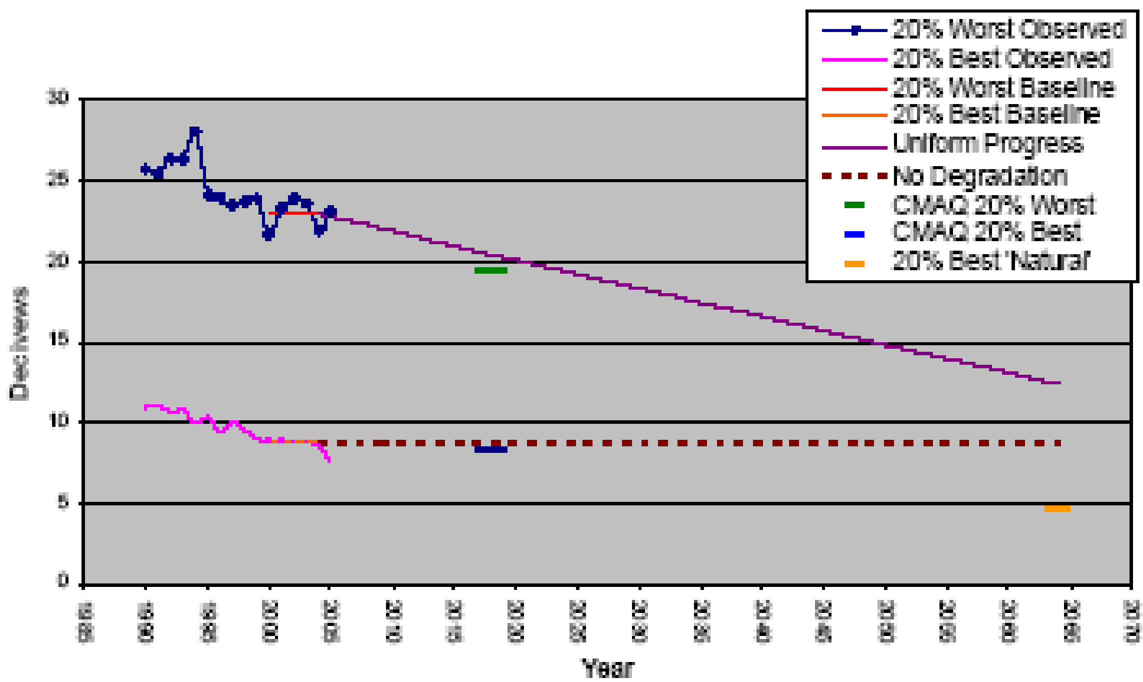


Figure 44: Projected Visibility Improvement at Great Gulf Wilderness Area Based on 2018 Visibility Modeling[38]

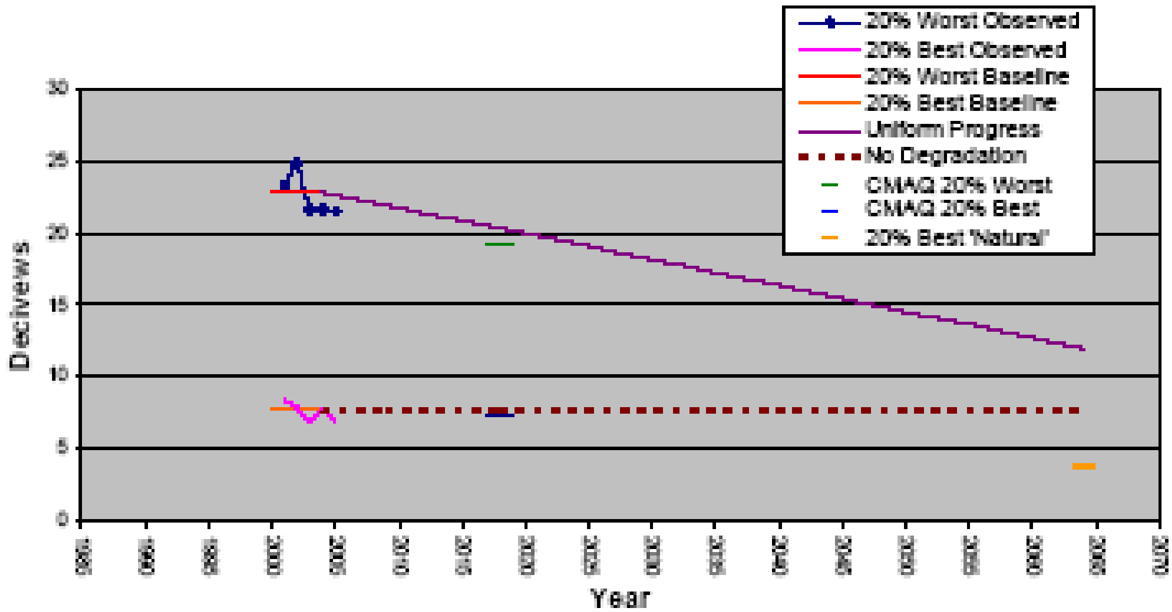
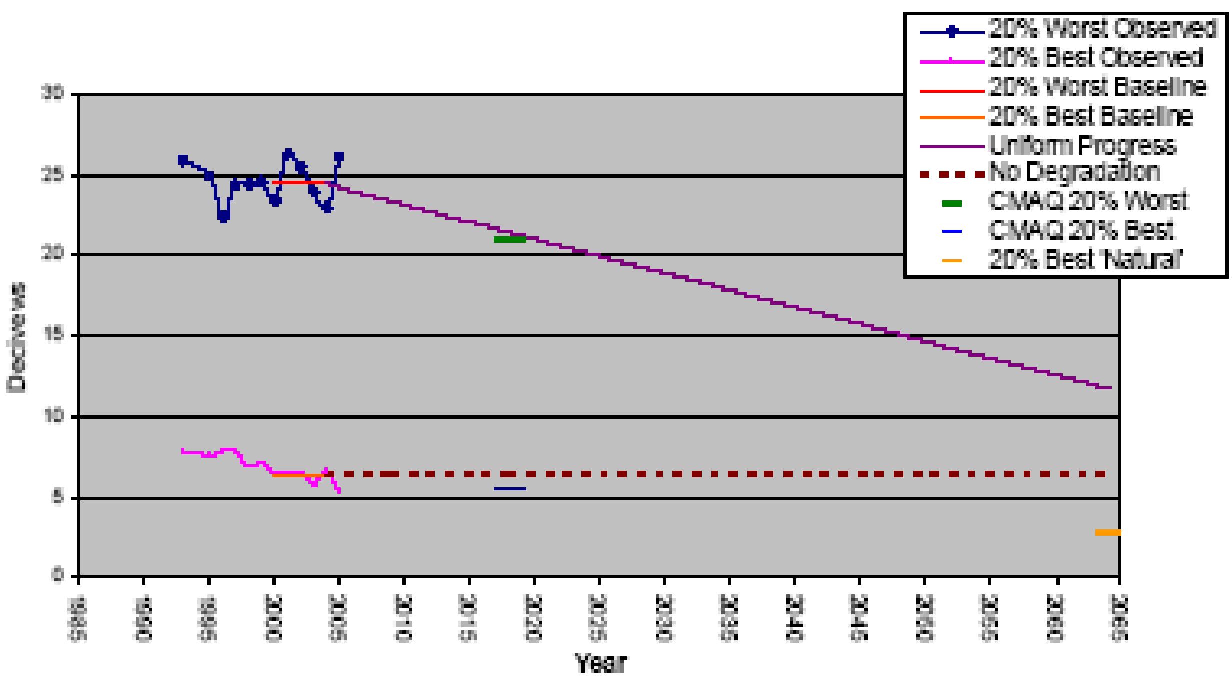
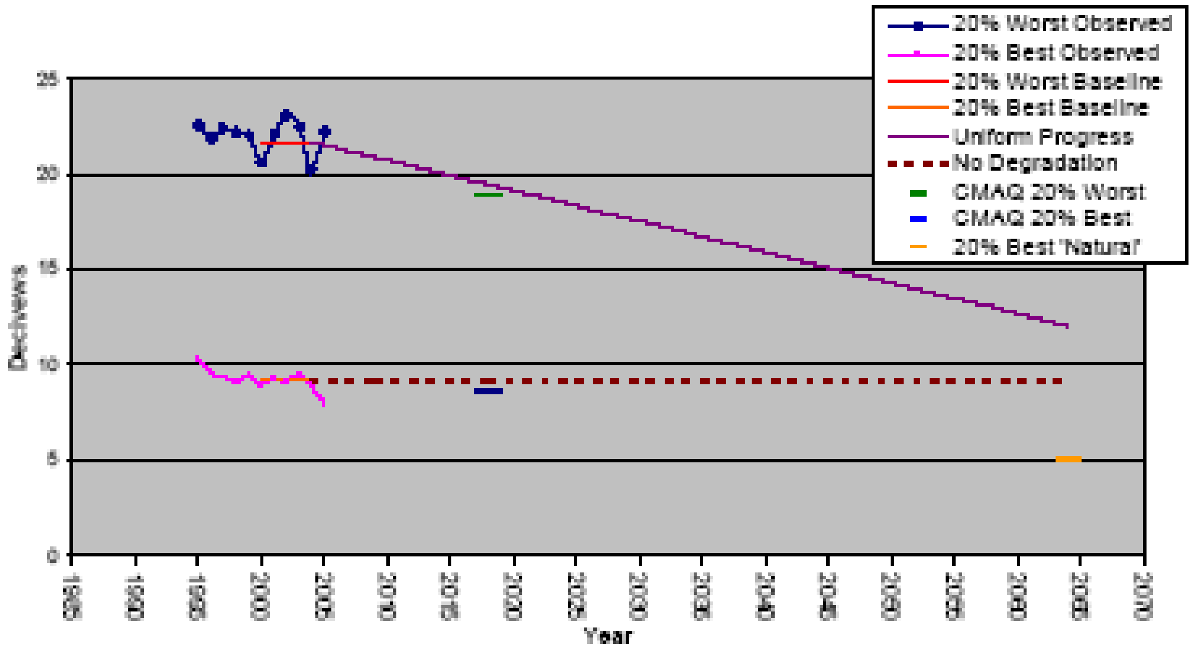


Figure 45: Projected Visibility Improvement at Lye Brook Wilderness Area Based on 2018 Visibility Modeling



[38] The estimate for Great Gulf Wilderness Area also serves to provide an estimate for the Presidential Range/Dry River Wilderness Area

Figure 46: Projected Visibility Improvement at Moosehorn Wilderness Area Based on 2018 Visibility Modeling [39]



10.10. Massachusetts' Share of Emissions Reduction

40 CFR Section 51.308(d)(3)(ii) requires states to demonstrate that its implementation plan includes all measures necessary to obtain its share of emission reductions needed to meet reasonable progress goals. The control measures included in this SIP represent the contribution of Massachusetts towards achieving the reasonable progress goals of Class I states by 2018.

Table 8 in Section 6.8 shows that Massachusetts' overall projected reduction of total regional haze pollutants between 2002 and 2018 is 31 percent. This is closely comparable to MANE-VU's overall reduction of 29 percent for the same period. In addition, MANE-VU modeling demonstrates that Massachusetts' long-term strategy, when coordinated with other states' strategies as defined by the MANE-VU statement, is sufficient to meet the reasonable progress goals of Class I states. Thus, Massachusetts is contributing its share of emissions reductions needed to meet reasonable progress goals.

The MANE-VU statement of June 20, 2007 provided that each state will have up to 10 years to pursue adoption and implementation of reasonable NO_x and SO_2 control measures as appropriate and necessary. This SIP is consistent with that statement.

10.11. Emission Limitations and Compliance Schedules

40 CFR 51.308(d)(3)(v)(C) requires Massachusetts to consider emission limitations and compliance schedules to achieve reasonable progress goals. Emission limitations and compliance schedules are

[39] The estimate for Moosehorn Wilderness Area also serves to provide an estimate for Roosevelt/Campobello International Park.

already in place for the Massachusetts programs outlined in Subsection 10.4. MassDEP intends to amend 310 CMR 7.05: Fuels to establish emissions limitations and compliance schedules for the low sulfur fuel oil strategy consistent with the MANE-VU Ask. MassDEP will establish emissions limitations and compliance schedules for Wheelabrator – Saugus that will require implementation of BART and/or NO_x RACT by July 2012. In early 2012, MassDEP intends to re-propose BART or an alternative to BART and a Targeted EGU Strategy that will address emissions limitations and compliance schedules for the BART-eligible EGU sources and Targeted EGUs. All emissions limitations will be in place by 2018 in order to achieve the reasonable progress goals. MassDEP will provide a status update on emissions limitations and compliance schedules in the 2013 regional haze SIP progress report.

10.12. Enforceability of Emission Limitations and Control Measures

40 CFR 51.308(d)(3)(v)(F) requires Massachusetts to consider the enforceability of emissions limitations and control measures. Emissions reductions due to ongoing air pollution controls described in Section 10.4 are or will be enforceable by 2018. For the additional reasonable strategies identified above, MassDEP already promulgated new regulations, 310 CMR 7.26(50) through (54), to control emissions from outdoor hydronic heaters, and includes these regulations in this SIP. MassDEP intends to propose regulatory revisions to 310 CMR 7.05 in 2012 to implement the low sulfur fuel strategy in accordance with the MANE-VU Statement, and will submit final regulations to EPA as a SIP revision. For the BART determination for Wheelabrator – Saugus, the emissions limitation reflecting BART and/or NO_x RACT will be incorporated into the facility's permit in 2012 to make it enforceable.

10.13. Prevention of Significant Deterioration

The Prevention of Significant Deterioration (PSD) program applies to all new major stationary sources (or existing major stationary sources making a major modification) located in an area that is in attainment or is unclassified for a pollutant with a NAAQS. A major source is an emissions source that has the potential to emit more than 100 tons per year of a regulated pollutant in a listed category or 250 tons per year in any other category. One of the intentions of the PSD program is to protect air quality in national parks, wilderness areas, and other areas of special natural, scenic, or historic value. The PSD permitting process requires a technical air quality analysis and additional analyses to assess the potential impacts on soils, vegetation and visibility at Class I areas.

MassDEP accepted delegation of the federal PSD program in 1982. In 2003, consistent with its delegation agreement, MassDEP returned the program to EPA and EPA Region I assumed the responsibility for issuing PSD permits for Massachusetts facilities. In April 2011, MassDEP took back delegation of the PSD program, and is developing state regulatory adoption of the PSD program for inclusion in the federally enforceable Massachusetts State Implementation Plan.

In addition, MassDEP has retained its state new source review program, which permits new and modified sources of emissions under 310 CMR 7.02 – Plan Approval and Emission Limitations. This regulation requires Best Available Control Technology (BACT) for all pollutant emissions and a determination that the new or modified source will not cause or contribute to a violation of a NAAQS. Depending upon the specific pollutant, the new or modified source also may be subject to non-attainment review under 310 CMR 7.00 Appendix A – Emissions Offsets and Non-Attainment Review, which requires Lowest Achievable Emissions Rate (LAER).