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Massachusetts Regional Haze State Implementation Plan Revision for the Second Implementation Period (2018-2028)

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Contents

Acronyms and Abbreviations

$\mu g/m^3$	Microgram per cubic meter
AERR	Air Emissions Reporting Requirements rule
AMPD	Air Markets Program Data
BART	Best Available Retrofit Technology
BOTW	Beyond on the Way (controls)
BSMP	Basis Smoke Management Practices
BTU	British Thermal Unit
CAA	Clean Air Act
CAIR	Clean Air Interstate Rule
CFR	Code of Federal Regulations
dv	Deciview
EGU	Electric Generating Unit
EPA	U.S. Environmental Protection Agency
FLM	Federal Land Manager of a Class I area
ICI	Industrial/Commercial/Institutional
IMPROVE	Interagency Monitoring of Protected Visual Environments
LTS	Long Term Strategy
MassDEP	Massachusetts Department of Environmental Protection
MANE-VU	Mid-Atlantic/Northeast Visibility Union
MARAMA	Mid-Atlantic Regional Air Management Association
Mm^{-1}	Inverse megameters
MMBtu	Million British Thermal Units
MW	Megawatt
MWh	Megawatt Hour
MWC	Municipal Waste Combustor
n/a	Not Applicable
NAAQS	National Ambient Air Quality Standards
NEI	National Emissions Inventory
NESCAUM	Northeast States for Coordinated Air Use Management
NH_3	Ammonia
NO_x	Oxides of Nitrogen
NO_2	Nitrogen dioxide
NO_3	Nitrate
NPS	National Park 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
RACT	Reasonably Available Control Technology
RH	Regional Haze
RPG	Reasonable Progress Goal
RPO	Regional Planning Organization
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
tpy	Tons per year
TSC	Technical Support Committee (of MANE-VU)
TSD	Technical Support Document
URP	Uniform Rate of Progress
VOC	Volatile Organic Compound

Executive Summary

The Massachusetts Department of Environmental Protection (MassDEP) has prepared this proposed revision to the Massachusetts State Implementation Plan (SIP) to address pollutants emitted by Massachusetts sources that contribute to regional haze.

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, which include some of our nation's most treasured public lands. Unfortunately, enjoyment of the scenic vistas in these pristine areas is impaired by regional haze. Regional haze is caused by fine particle pollution that impairs visibility over a large region by scattering or absorbing light.

In 1999, the U.S. Environmental Protection Agency (EPA) issued regulations, known as the Regional Haze Rule (40 CFR 51.300-309) that requires each state to develop a State Implementation Plans (SIP) to reduce haze-causing pollution to improve visibility in Class I areas, and to update these SIPs every 10 years. The goal of the regional haze program is to restore natural visibility conditions at Class I areas by 2064.

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 2012, MassDEP submitted a Regional Haze SIP for the first implementation period (2008-2018) under the Regional Haze Rule, which EPA approved in 2013. MassDEP has prepared this SIP revision to address the second implementation period (2018-2028), as required by EPA's Regional Haze Rule [40 CFR 51.308(f)].

EPA created regional planning organizations so that states could share the analytical work required to understand the causes of regional haze and evaluate options for addressing it. Massachusetts participates in this work as a member of the Mid-Atlantic Northeast Visibility Union (MANE-VU), which includes 10 other mid-Atlantic and Northeast states and the District of Columbia, as well as tribes, EPA, and Federal Land Managers (FLMs) for Class I areas. To better understand regional haze for the second implementation period, MANE-VU analyzed visibility data from Class I areas, the makeup of particles causing haze, and the sources of emissions of those particles and their precursors. Based on these analyses, MANE-VU developed screening criteria and identified the largest potential contributing sources to visibility impairment and evaluated reasonable control strategies. MANE-VU also facilitated consultations with states, tribes, and FLMs on development of reasonable progress goals and long-term strategies for reducing regional haze in the second implementation period. MassDEP participated fully in the MANE-VU process and consultations and conducted its own consultations with FLMs in developing this SIP revision.

MassDEP's Regional Haze SIP revision fulfills the requirements of EPA's Regional Haze Rule at 40 CFR 51.308(f) for the second implementation period by evaluating the current and future projected inventory of sources, assessing the measures necessary to reduce emissions from these sources during the implementation period, providing for consultation with other states, tribes and FLMs in establishing progress goals, and establishing a Massachusetts' long-term strategy to address regional haze for Federal Class I areas affected by emissions from within the state. MassDEP also continues to implement the long-term strategy in its first regional haze SIP, which has resulted in significant reductions in haze-causing emissions and has contributed to improvements in visibility at Class I areas.

1. Purpose and Background

1.1 Purpose

MassDEP must update its State Implementation Plan (SIP) for regional haze (RH) every ten years to address the requirements for improving visibility in mandatory Class I Federal areas potentially affected by emissions from sources in Massachusetts contained in 42 U.S.C. § 7491 (Sections 169 and 169A of the Clean Air Act) and the Federal Regional Haze Rule (RHR) at 40 CFR 51.308(f) *Requirements for periodic comprehensive revisions of implementation plans for regional haze*.

This RH SIP update describes Massachusetts' long-term strategy for reducing visibility-impairing air pollution from sources within its borders that may affect Class I areas. It contains commitments by Massachusetts to future actions as required under 40 C.F.R. 51.308(f) and (g). It assures reasonable progress is made toward the national goal of achieving natural visibility conditions in Class I areas by 2064.

MassDEP submitted a SIP addressing regional haze for the first 10-year implementation period (2008-2018) in 2012[1] and submitted a progress report in 2018.[2] EPA approved both of these into the Massachusetts SIP.[3] This revision updates the RH SIP for the second 10-year implementation period (2018-2028) as required by 40 CFR 51.308(f). It is based in part on documentation for the first implementation period that already is contained in the Massachusetts SIP. MassDEP's 2012 RH SIP contains further details on regional haze in the Mid-Atlantic and Northeast U.S. and the first implementation period SIPs for Massachusetts and other MANE-VU states.

1.2 Required Elements and Required Commitments

40 CFR 51.308(f) requires Massachusetts and all other states to submit revisions to their Regional Haze SIPs every ten years and defines the elements required in such updates. In 2017 EPA changed the due date for the SIPs for the 2018-2028 planning period from July 31, 2018

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[1] Massachusetts Regional Haze State Implementation Plan, MassDEP, August 9, 2012. (available at the MassDEP SIP webpage: https://www.mass.gov/lists/massachusetts-state-implementation-plans-sips)
2 Massachusetts Regional Haze Progress Report, MassDEP, February 9, 2018. (available at the MassDEP SIP webpage: https://www.mass.gov/lists/massachusetts-state-implementation-plans-sips)
3Approval and Promulgation of Air Quality Implementation Plans; Massachusetts; Regional Haze...Final Rule. EPA. Sep. 19, 2013. (78 FR 57487)
[3] Air Plan Approval; Massachusetts Regional Haze Five-Year Progress Report State Implementation Plan….Final Rule. EPA Mar. 29, 2019 (84 FR 11885).

(the start of the planning period) to July 31, 2021 to enable states to better coordinate regional haze planning with timelines in other federal rules.[4]

Table 1-1 lists the core elements required and where they are addressed in this SIP revision.

Table 1-1: Regional Haze SIP Revision Elements and Location in this SIP Revision

Regional Haze SIP Revision Elements - 40 CFR 51.308 *Regional haze program requirements*		
Paragraph	**Required Element**	**Location in SIP**
(f)	*Requirements for comprehensive periodic revisions of implementation plans for regional haze. . . The plan revision due on or before July 31, 2021, must include a commitment by the State to meet the requirements of paragraph (g)*	*Section 1.2 Required Elements and Required Commitments* (below)
(f)(1)	*Calculations of baseline, current, and natural visibility conditions.*	Not required for MA but provided for reference in *Section 2. Visibility Trends*
(f)(2)	*Long-term strategy for regional haze.*	*Section 6. Long-Term Strategy for Massachusetts*
(f)(3)	*Reasonable progress goals.*	Not required for MA but provided for reference in *Section 2. Visibility Trends*
(f)(4)	*…additional monitoring to assess reasonably attributable visibility impairment…*	Not required for MA.
(f)(5)	*So that the plan revision will serve also as a progress report, the State must address in the plan revision the requirements of paragraphs (g)(1) through (5). . .*	See below under (g)
(f)(6)	*Monitoring strategy and other implementation plan requirements.*	*Section 2.1 Visibility Monitoring and Section 4. Emissions Trends*
(g)	*Requirements for periodic reports describing progress towards the reasonable progress goals.*	
(g)(1)	*A description of the status of implementation of all measures included in the implementation plan for achieving reasonable progress goals for mandatory Class I Federal areas both within and outside the State.*	*Section 3. Progress Report*
(g)(2)	*A summary of emissions reductions achieved throughout the State through implementation of the measures [*for achieving reasonable progress goals*].*	*Section 3. Progress Report*
(g)(3)	*For each mandatory Class I Federal area within the State, the State must assess the following visibility conditions and changes.*	Not required for MA but provided for reference in *Section 2. Visibility Trends*
(g)(4)	*An analysis tracking the change . . . in emissions of pollutants contributing to visibility impairment from all sources and activities within the State.*	*Section 4. Emissions Trends*
(g)(5)	*An assessment of any significant changes in anthropogenic emissions.*	*Section 4. Emissions Trends*
(i)	*State and Federal Land Manager coordination*	*Section 7. Consultation*

[4] 40 CFR 51.308(f). Protection of Visibility: Amendments to Requirements for State Plans, ACTION: Final rule. EPA. January 10, 2017. 82 FR 3078).

Progress Reports – In addition to including a progress report in each 10-year SIP revision, 40 CFR 51.308(g) *Requirements for periodic reports describing progress towards the reasonable progress goals* requires MassDEP to submit a progress report to EPA in between each 10-year SIP revision that evaluates progress toward the reasonable progress goal for each Class I area that may be affected by emissions from sources in Massachusetts. The rule requires that MassDEP submit the reports by January 31, 2025, July 31, 2033, and every 10 years thereafter. 40 CFR 51.308(f) requires that 10-year SIP revisions contain a commitment to meeting the requirements of paragraph (g). MassDEP commits to submitting such progress reports according to the schedule and contents required in 40 CFR 51.308(g). In addition, pursuant to 40 CFR 51.308(h) *Determination of the adequacy of existing implementation plan*, MassDEP also will submit a determination of adequacy of its Regional Haze SIP whenever a progress report is submitted.

Inventory Updates – In addition to reporting emissions trends in SIP revisions and progress reports, 40 CFR 51.308(f)(6)(v) requires states to commit to making periodic updates to the inventory used in their SIPs. MassDEP commits to periodically updating its inventory of pollutants that are reasonably anticipated to cause or contribute to visibility impairment by fulfilling its triennial emissions inventory obligations under EPA's Air Emissions Reporting Requirements (AERR) rule[5] and the Regional Haze Rule (RHR) requirements for progress reports required under 40 CFR 51.308(g).

1.3 Regional Haze

Regional haze is visibility impairment caused by the cumulative emissions 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 particles also harm human health, especially the respiratory and cardiovascular systems of people at increased risk (e.g., children, the elderly, and people with heart or respiratory illness).

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). Soot, crustal material, and some organic carbon particles are released directly to the atmosphere. 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). Sulfates and nitrates contribute disproportionately to haze due to their chemical affinity for water, which allows them to grow rapidly in the presence of moisture to the optimal particle size for scattering light (i.e., 0.1 to 1 micrometer).[6] Sulfate, formed from SO_2 emissions, is the dominant contributor to fine particle pollution throughout the

[5] 40 CFR 51 Subpart A (also known as the Air Emissions Reporting Requirements rule or AERR).

[6] Regional Haze and Visibility in the Northeast and Mid-Atlantic States. NESCAUM. January 31, 2001.

eastern U.S. and therefore most control efforts in this region are directed at reducing SO_2 emissions.

To address haze pollution, Congress added Section 169 (42 U.S.C. 7491) to the Clean Air Act (CAA) in 1977 which sets 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.*

The "Class I" designation applies to 156 national parks, forests and wilderness areas including 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 had decreased from 106 miles (under natural conditions in the past) to 36-69 miles in 2000. Today that average visual range has improved somewhat to 69-97 miles.[7] Figure 1-1 illustrates this comparison between clean and hazy days.

In 1999, EPA issued regulations known as the Regional Haze Rule (RHR), which requires states to develop SIPs to reduce haze-causing pollution in order to improve visibility in Class I areas. The overall goal of the regional haze program is to restore natural visibility conditions on the 20% most impaired days at Class I areas by 2064.

Figure1-1: Acadia National Park on Clear and Hazy Days

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

Reasonable Progress – In the first round of regional haze SIPs, states with Class I areas set reasonable progress goals for 2008-2018 for improving visibility in their Class I areas. States

[7] Analysis from Tom Downs in email February 26, 2019, Maine Department of Environmental Protection from the MANE-VU 2000-17 Parameter and Extinction Data Analysis 11-5-18.xlsx. December 21, 2018. (https://otcair.org/manevu/Document.asp?fview=Reports)

affecting Class I areas (such as Massachusetts) submitted SIPs with long-term strategies to make reasonable progress towards achieving those goals. For the second implementation period (2018-2028) states must submit revisions to their SIPs that include updates to their long-term strategies. The objective of such revisions is to continue to make reasonable progress toward improving visibility in any Class I area affected by their emissions. Under the RHR, states must continue to update their RH SIPs every 10 years and must evaluate progress in between SIP updates.

1.4 Regional Planning Efforts

EPA established five regional planning organizations to coordinate regional haze efforts nationwide. Massachusetts is a member of one of these regional organizations, the Mid-Atlantic Northeast Visibility Union (MANE-VU). MANE-VU is comprised of Mid-Atlantic and Northeast states, tribes, and federal agencies (see Table 1-2 below). MassDEP develops its regional haze SIP by participating in a regional planning process coordinated by MANE-VU. Together the MANE-VU members establish baseline and natural visibility conditions, determine the primary contributors to regional haze, identify long-term strategies and reasonable progress goals, and consult with other states, regional planning organizations, and the federal land managers for Class I areas.

For the first implementation period, MANE-VU member states (including Massachusetts) adopted the "*Statement of MANE-VU Concerning a Request for a Course of Action by States Within MANE-VU Toward Assuring Reasonable Progress.*" This statement, known as the MANE-VU "Ask," outlined a strategy for reducing regional haze at MANE-VU Class I areas for the first 10-year implementation period (2008-2018) and formed the basis for the measures MassDEP included in its initial haze SIP. For the second implementation period (2018-2028), Massachusetts and other member states approved the MANE-VU *Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Concerning a Course of Action within MANE-VU toward Assuring Reasonable Progress for the Second Regional Haze Implementation Period (2018-2028)* (Appendix 15). This new Statement forms the basis for the long-term strategy MassDEP has included in this SIP revision.

Table 1-2: 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

1.5 Class I Areas

Although Massachusetts has no Class I areas, emissions from Massachusetts sources contribute to visibility degradation in the MANE-VU Class I areas. Figure 1-2 shows the location of MANE-VU Class I areas as well as other nearby Class I areas that MANE-VU examined. MANE-VU used certain areas (as noted below) to represent nearby Class I areas where monitors do not exist.[8]

MANE-VU CLASS I AREAS

- Lye Brook Wilderness Area (Vermont)
- Great Gulf Wilderness Area (New Hampshire) (used to represent Presidential/Dry River Wilderness Area)
- Presidential Range-Dry River Wilderness Area (New Hampshire)
- Acadia National Park (Maine)
- Moosehorn Wildlife Refuge (Maine) (used to represent Roosevelt Campobello International Park)
- Roosevelt Campobello International Park (Maine/Canada)
- Brigantine Wildlife Refuge (New Jersey)

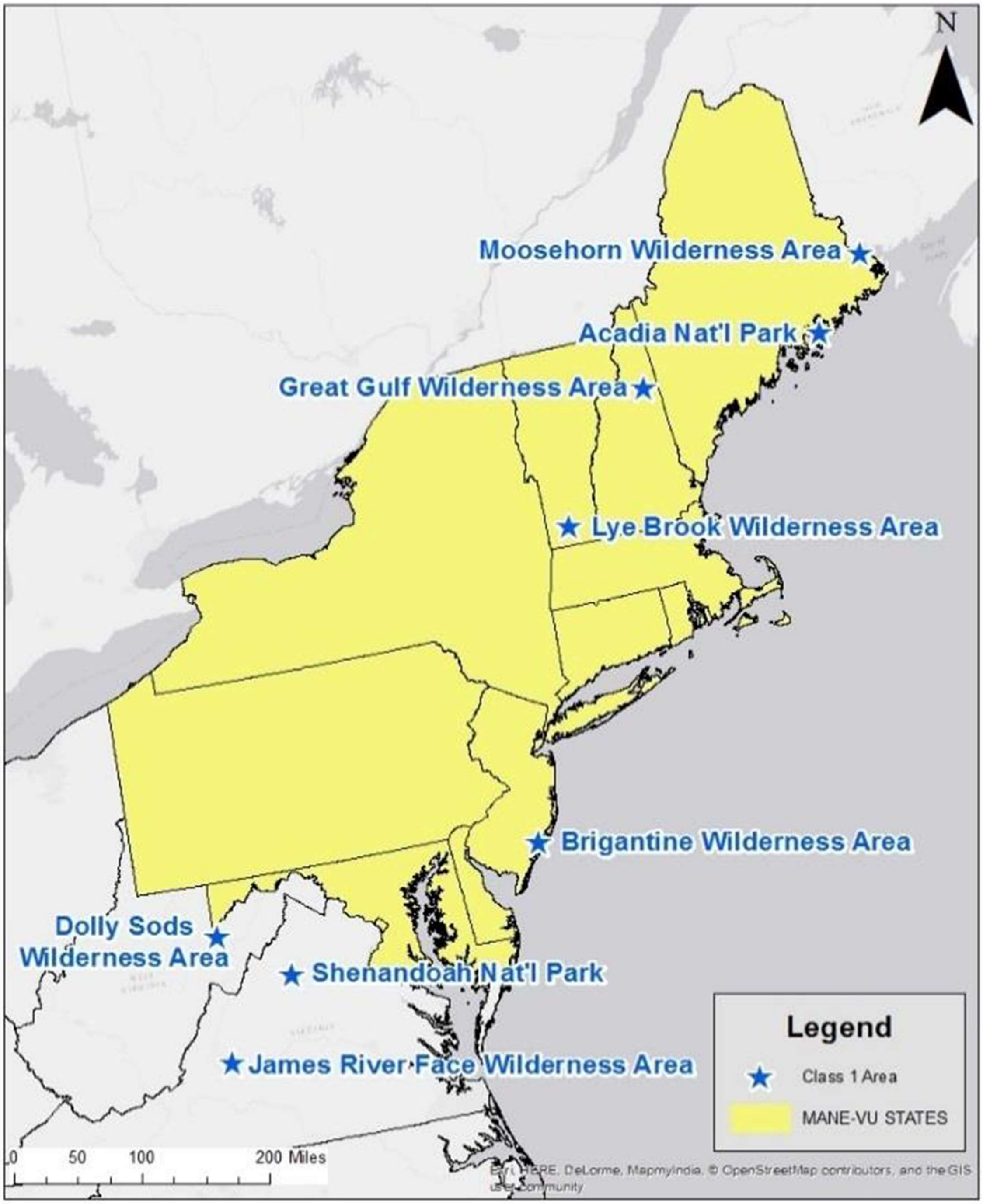
NEARBY CLASS I AREAS

- Dolly Sods Wilderness Area (West Virginia) (used to represent Otter Creek Wilderness Area)

[8] Mid-Atlantic/Northeast U.S. Visibility Data, 2004-2017 (2nd RH SIP Metrics). MANE-VU (prepared by Maine Department of Environmental Protection). December 18, 2018 revision. p.2-1 (Appendix 22)

- Shenandoah National Park (Virginia)
- James River Face Wilderness Area (Virginia)

Figure 1-2: Class I Areas with IMPROVE Monitors in and near MANE-VU States



Source: Regional Haze Metrics Trends and HYSPLIT Trajectory Analyses. MANE-VU. May 2017. Figure 1 (Appendix13)

2. Visibility Monitoring and Trends

EPA's Regional Haze Rule [40 CFR 51.308(f)(1)] 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 the Class I area. MANE-VU developed a regional visibility report to fulfill this requirement, which contains details on visibility calculations and trends.[9] Massachusetts does not contain any Class I areas; however, MassDEP is including in this section of its SIP revision a summary of visibility conditions from the MANE-VU report for reference.

40 CFR 51.308(f)(6) requires each state containing a Class I area to provide in its SIP revision a visibility monitoring strategy including additional monitoring as needed (308(f)(6)(i)) and provisions for annual reporting of data (308(f)(6)(iv)). Since Massachusetts does not contain any Class I areas, no monitoring strategy, additional monitoring, or annual reporting of data is required.

40 CFR 51.308(f)(6)(iii) requires states with no Class I area (such as Massachusetts) to include procedures by which monitoring data and other information are used in determining the contribution of emissions from within the state to visibility impairment at Class I areas in other states. Monitoring in Massachusetts that contributes data for assessing visibility is described below. Visibility data analysis procedures are described in the MANE-VU visibility data report;[10] other procedures and data used for determining Massachusetts contribution to visibility impairment are described in Section 5 and the MANE-VU documents referenced there.

2.1 Visibility Monitoring

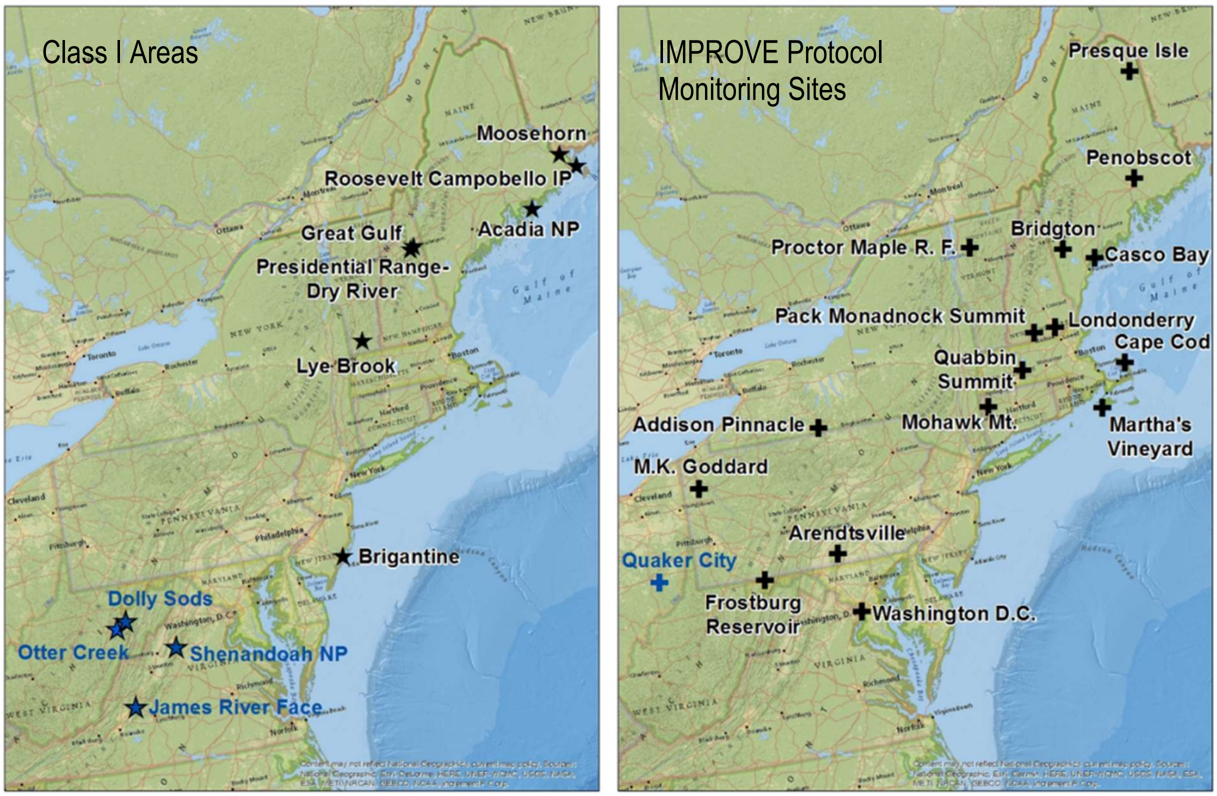
The Interagency Monitoring of Protected Visual Environments (IMPROVE) program[11] was established in 1985 to provide the data needed to assess current visibility, track changes in visibility, and help determine the causes of visibility impairment in Class I areas. IMPROVE is a collaborative of state, tribal, and federal agencies, and international partners. IMPROVE monitors in and near the MANE-VU region are shown in Figure 2-1.

In Massachusetts, three IMPROVE monitors have provided data to the IMPROVE program: 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 by the National Park Service. The MAVI IMPROVE monitor is located on Martha's Vineyard and is operated by the Wampanoag Tribe of Gay Head (Aquinnah). The QURE IMPROVE monitor

[9] *Mid-Atlantic/Northeast U.S. Visibility Data, 2004-2019 (2nd RH SIP Metrics)*. MANE-VU (prepared by Maine Department of Environmental Protection). January 21, 2021 revision. (Appendix 22) Available at https://otcair.org/manevu/Document.asp?fview=Reports
[10] Ibid.
[11] IMPROVE program website: http://vista.cira.colostate.edu/improve/.

was located at the Quabbin Reservoir in Ware and was operated by MassDEP. EPA eliminated funding for MassDEP's IMPROVE monitor at Quabbin Reservoir, and as a result, MassDEP discontinued IMPROVE monitoring at the end of 2015.[12]

Figure 2-1: Class I Areas and IMPROVE Monitoring Sites In and Adjacent to the MANE-VU Region



Source: Figure 1-1. *Mid-Atlantic/Northeast U.S. Visibility Data, 2004-2019 (2nd RH SIP Metrics)*. MANE-VU (prepared by Maine Department of Environmental Protection). January 21, 2021 revision. (Appendix 22)

2.2 Visibility Trends

Visibility impairment is expressed in deciviews (dv), where the higher the value, the greater the visibility impairment (i.e., higher dv values mean worse visibility). Generally, a one deciview change in the haze index is likely to be perceptible to the human eye. The IMPROVE program calculates deciviews from several different measurements collected by its monitors. MANE-VU used IMPROVE data to assess visibility conditions for Class I areas impacted by MANE-VU states. Table 2-1 shows data from the MANE-VU visibility report for Class I areas in and near MANE-VU (i.e., potentially affected by emissions from MANE-VU states). Figures 2-2 to 2-6 (also taken from the MANE-VU report) illustrate visibility trends for MANE-VU Class I areas

[12] Massachusetts 2016 Air Monitoring Network Plan. MassDEP Air Assessment Branch. November 2016. (https://www.mass.gov/lists/massdep-air-monitoring-plans-reports-studies)

potentially impacted by emissions from Massachusetts. The summary below is based on the findings of the MANE-VU report.

The goal for the RHR is natural background visibility – the conditions that would exist without anthropogenic pollution. MANE-VU calculated natural background for each Class I area for the both the 20% clearest days and the 20% of days with the most impaired visibility (see Table 2-1). The RHR requires states to compare natural background visibility to a baseline visibility for the 5-year period from 2000-2004 for both the 20% clearest days and 20% most impaired days. The straight-line between the baseline (in 2000) and natural conditions (in 2064) for the 20% most impaired days defines the uniform rate of progress (URP) line or "glide path" for each Class I area (shown in Figures 2-2 to 2-6).

The actual visibility for each year after the baseline period was calculated as rolling 5-year averages for both the 20% most impaired days and the 20% clearest days for each year (also shown in Figures 2-2 to 2-6). The values for the current 5-year period (2015-2019) are in Table 2-1 and in the figures.

The RHR requires states with Class I areas to determine reasonable progress goals (RPGs) for each area to be achieved by the end of the current implementation period (i.e., 2028 for the second implementation period). The RPGs are designed to: (1) at a minimum ensure no degradation in visibility from the baseline period for the 20% clearest days and (2) achieve reasonable progress toward natural conditions for the 20% most impaired days. MANE-VU Class I states determined the 2028 RPGs based on inventory projections and modeling based on expected reductions from state long-term strategies, including responses to the MANE-VU Ask. The 2028 RPGs are shown in Table 2-1 and Figures 2-2 to 2-6 with a straight-line from the baseline period so they may be compared to current progress and the URP. The RPGs from the first implementation period are also shown in Table 2-1 for comparison.

MANE-VU drew the following conclusions from the visibility data.

- The regional efforts to reduce emissions of visibility-impairing pollutants have had a beneficial effect at the region's Class I areas. Haze levels on the 20% clearest and 20% most impaired days from 2000 through 2019 have dropped across the entire region.

- States continue to be on track for keeping visibility levels significantly below the uniform rate of progress (i.e., straight-line visibility from 2000 to 2064). Current visibility at all MANE-VU and nearby Class I areas is better than the 2028 URP visibility condition for the 20% most impaired visibility days (i.e., current visibility is better than the URP glide path from 2000-2064).

- Current visibility data from all MANE-VU and nearby Class I areas show no degradation from the 2000-2004 baseline values for the 20% clearest days.

- All modeled RPGs for 2028 are well below the URP lines at 2028.
- Although current visibility impairment (2015-2019) at all areas is lower than the 2018 RPGs from the first implementation period, it remains higher than the 2028 RPGs at nearly all area as shown in Table 2-1.
- Further progress is needed to achieve modeled 2028 RPGs at all MANE-VU and nearby Class I areas. Class I areas in the MANE-VU region need 0.23 to 1.34 dv improvements to reach their modeled 2028 RPGs; Class I areas in Virginia and West Virginia need 2.86 to 3.53 dv improvements.

Table 2-1: Baseline, Current, and Reasonable Progress Goal Haze Index Levels for Class I Areas In or Adjacent to the MANE-VU Region

Class I Area	State	CLEAREST DAYS					MOST IMPAIRED DAYS						
		Baseline (2000-04) (dv)	RPG (2018)[1]	Current (2015-18) (dv)	MV[2] (2028) (dv)	Natural Conditions	Baseline (2000-04) (dv)	RPG (2018)[1]	Current (2015-19) (dv)	URP 2019 (dv)	URP 2028 (dv)	MV[2] (2028) (dv)	Natural Conditions
Acadia National Park	ME	8.78	8.3	6.36	6.33	4.66	22.01	19.4	14.24	19.11	17.36	13.35	10.39
Moosehorn Wilderness Area	ME	9.16	8.6	6.48	6.45	5.02	20.65	19.0	12.99	18.85	16.38	13.12	9.98
Roosevelt Campobello International Park	NB												
Great Gulf Wilderness Area	NH	7.65	7.2	4.70	5.06	3.73	21.88	19.1	12.33	18.85	17.07	12.00	9.78
Presidential Range/Dry River Wilderness Area													
Lye Brook Wilderness Area	VT	6.37	5.5	4.88	3.86	2.79	23.57	20.9	14.06	20.24	18.24	13.68	10.24
Brigantine Wilderness Area	NJ	14.33	14.3	10.81	10.47	5.52	27.43	25.1	18.53	23.24	20.73	17.97	10.68
Dolly Sods Wilderness Area†	WV	12.28		6.18	7.27	3.64	28.29		17.03	23.45	20.54	15.09	8.92
Otter Creek Wilderness Area†													
James River Face Area†	VA	14.21		8.99	9.36	4.39	28.08		17.28	23.43	20.64	15.31	9.47
Shenandoah National Park†	VA	10.96		6.54	6.83	3.15	28.32		16.38	23.62	20.80	14.25	9.52

NOTE: Natural haze values are not calculated for areas without 2000-04 baseline monitoring data or nearby representative IMPROVE site values. Visibility for the Presidential Range/Dry River Wilderness Area, Roosevelt Campobello International Park and Otter Creek Wilderness are represented by the IMPROVE monitors for Great Gulf, Moosehorn and Dolly Sods, respectively.

† Class I area adjacent to the MANE-VU region

URP = Uniform Rate of Progress

[1] RPG From the first implementation period. Tracking Visibility Progress: 2004-2011; NESCAUM, April 30, 2013 (Revised May 24, 2013) (Available at: http://www.nescaum.org/topics/regional-haze/regional-haze-documents)

[2] Modeled Visibility in 2028 with projected controls . MANE-VU. 2018a. Ozone Transport Commission/Mid-Atlantic Northeastern Visibility Union 2011 Based Modeling Platform Support Document - October 2018 Update (see Modeled Reasonable Progress Goal). (Appendix 21) Available at https://otcair.org/manevu/Document.asp?fview=Reports

Sources: Tables 2-2, 2-4, 2-5. Mid-Atlantic/Northeast U.S. Visibility Data, 2004-2019 (2nd RH SIP Metrics). January 21, 2021 revision (Appendix 22) and Massachusetts Regional Haze Progress Report. MassDEP. February 9, 2018.

Figure 2-2: Visibility Metrics Levels at Acadia National Park

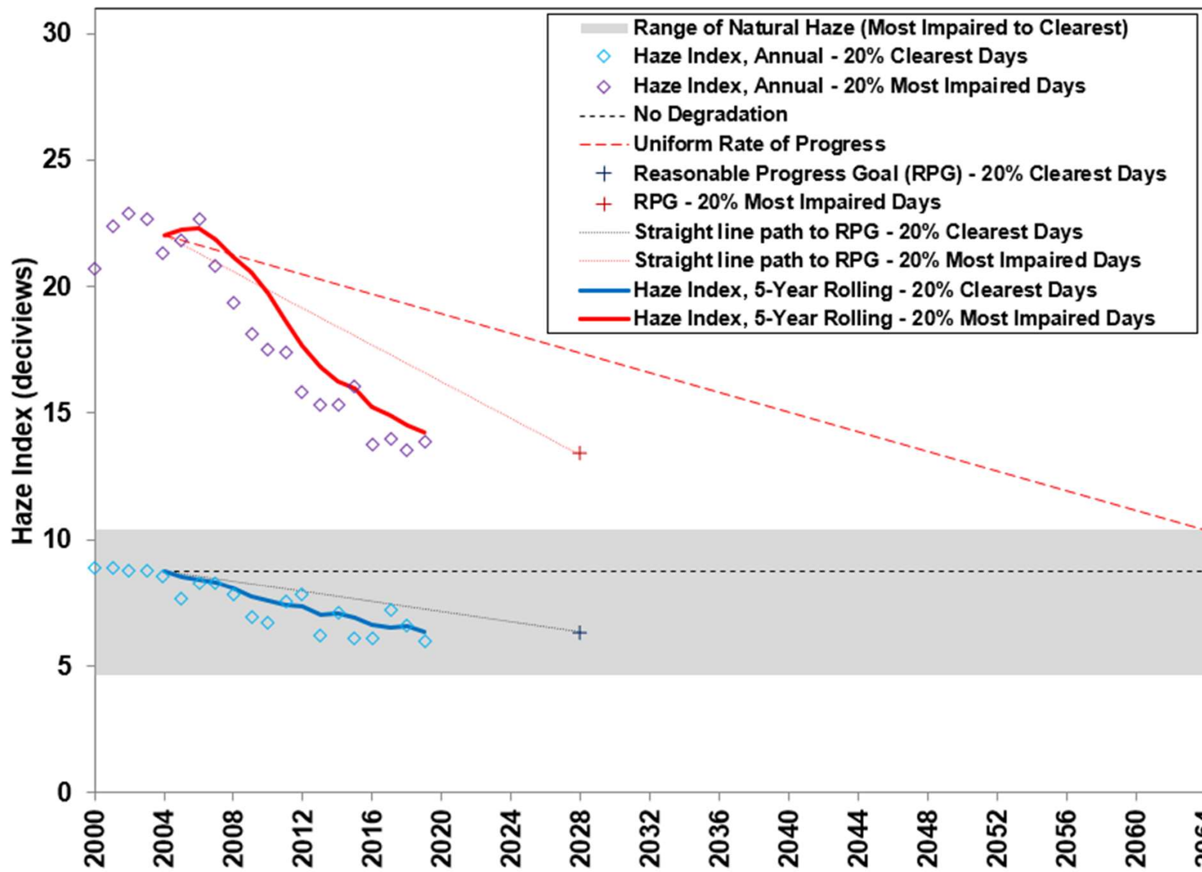


Figure 2-3: Visibility Metrics Levels at Moosehorn Wilderness Area

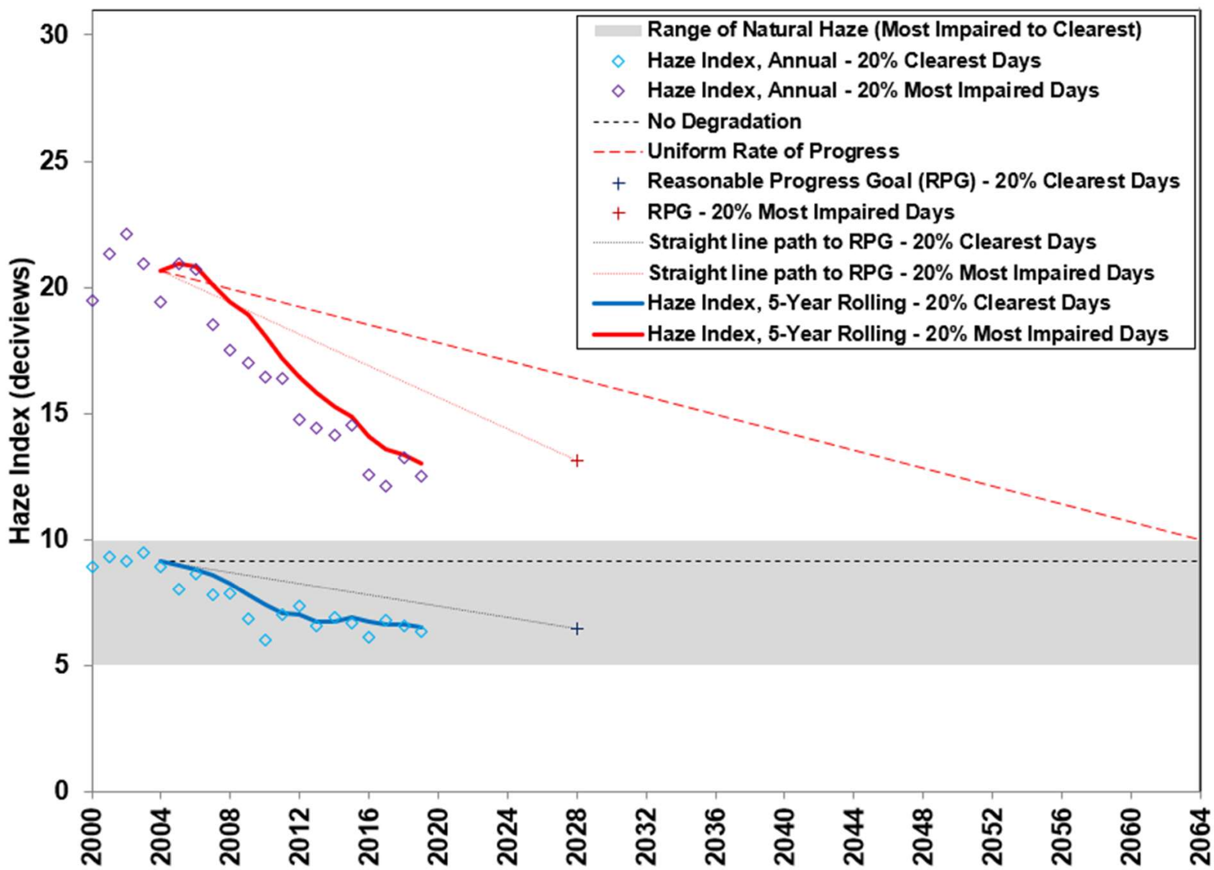


Figure 2-4: Visibility Metrics Levels at Great Gulf Wilderness Area

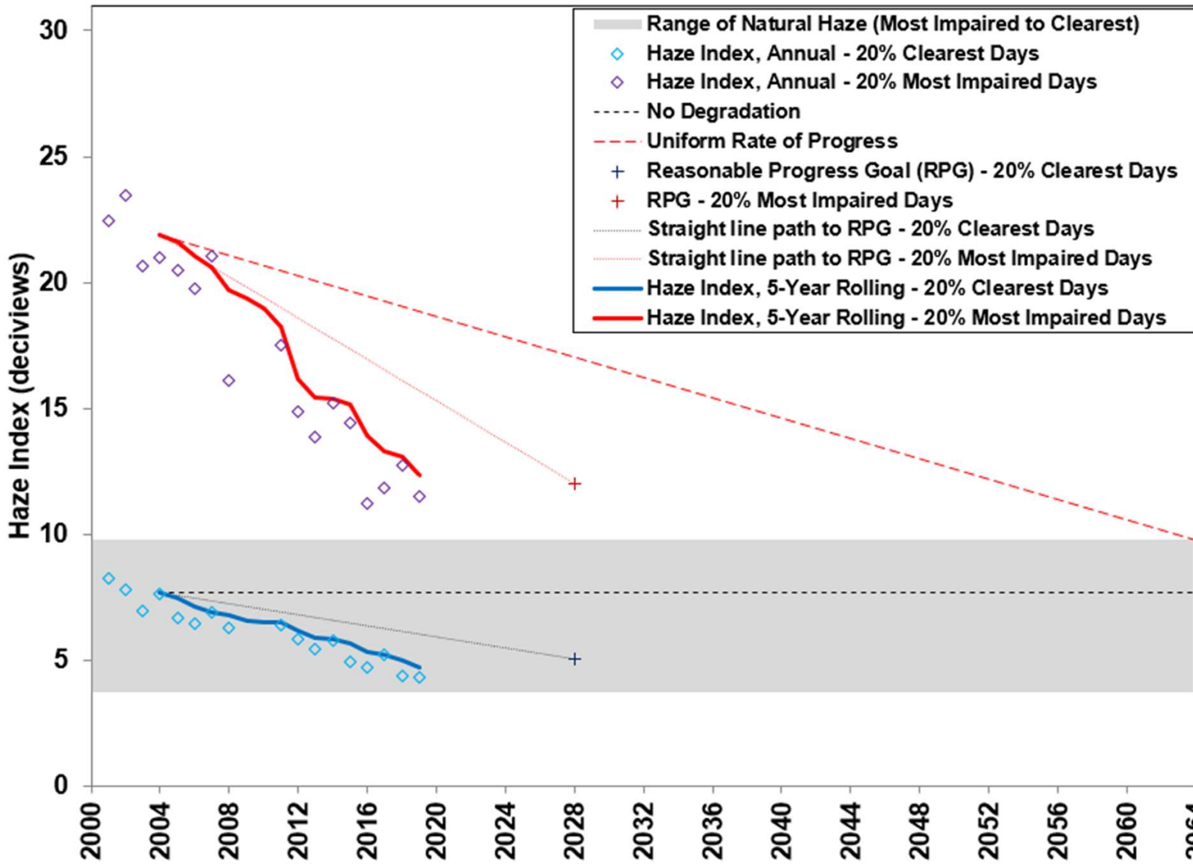


Figure 2-5: Visibility Metrics Levels at Lye Brook Wilderness Area

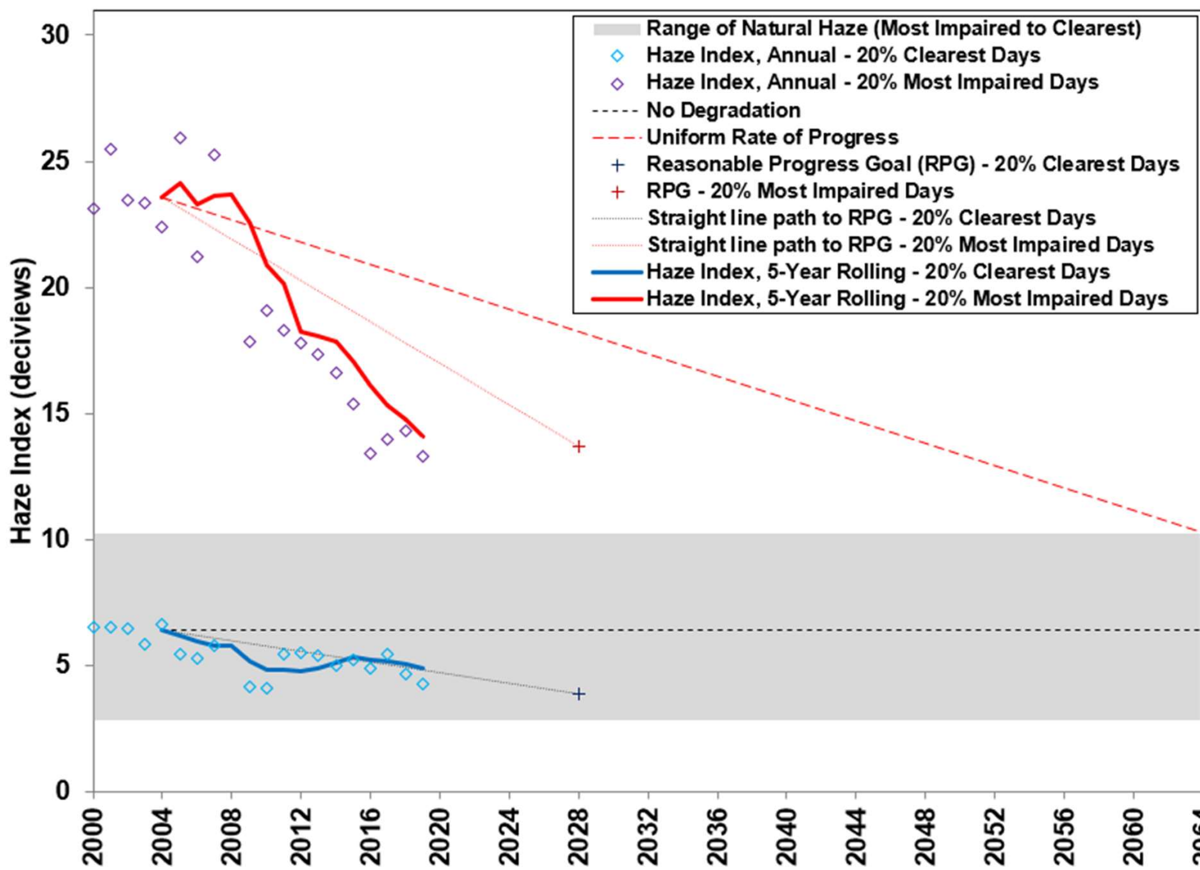
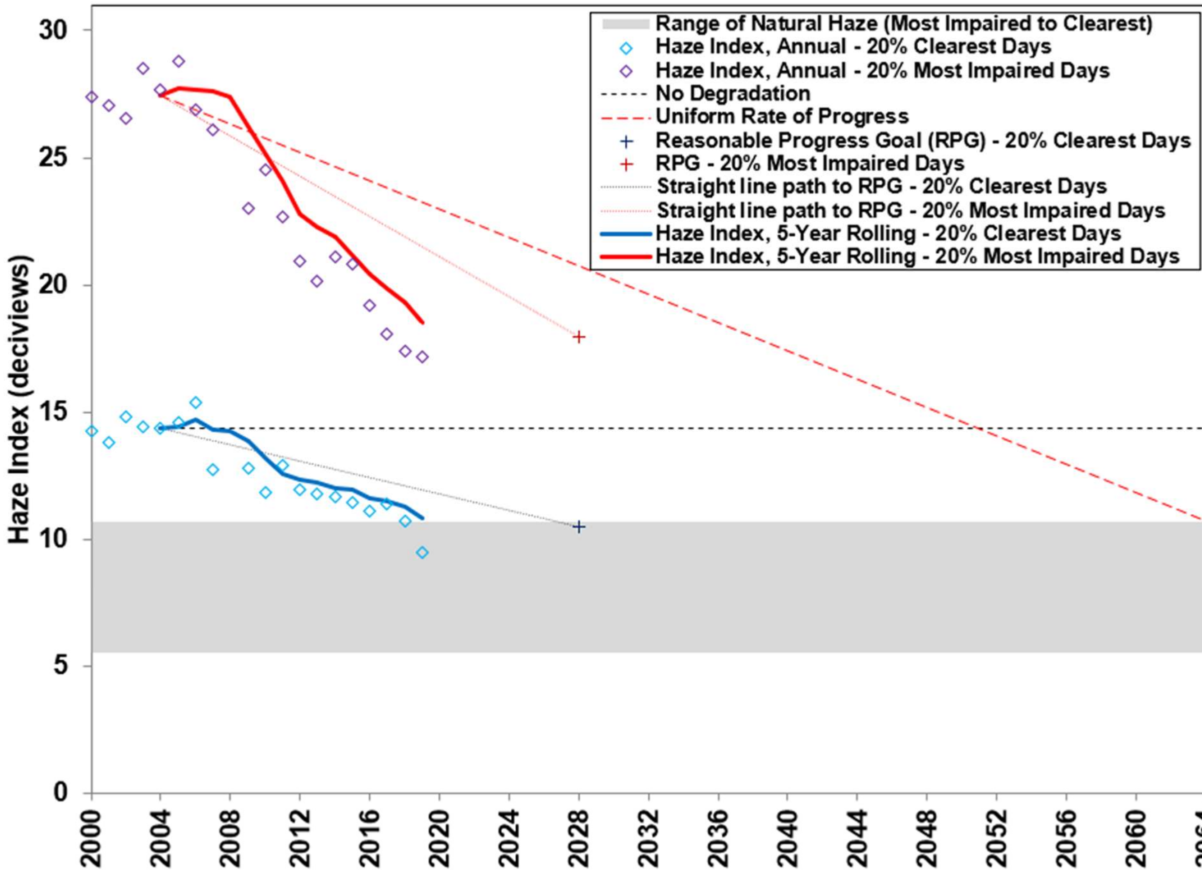


Figure 2-6: Visibility Metrics Levels at Brigantine Wilderness Area



Source for Figures 2-2-2-6: *Mid-Atlantic/Northeast U.S. Visibility Data, 2004-2019 (2nd RH SIP Metrics)*. MANE-VU (prepared by Maine Department of Environmental Protection). January 21, 2021 revision. (Appendix 22)

3. Progress Report

3.1 Progress Report Requirements

40 CFR 51.308(f)(5) requires MassDEP to provide a progress report in its SIP revision for the second implementation period. The topics required for that progress report are listed under 40 CFR 51.308(g) *Requirements for periodic reports describing progress towards the reasonable progress goals* and summarized below.

> (g)(1) A description of the status of the implementation of all measures included in the SIP for the first implementation period. This is addressed in this section.
>
> (g)(2) A summary of the emissions reductions achieved through implementation of the measures included in the SIP for the first implementation period. The progress made in Massachusetts is addressed in this section for specific facilities targeted in the first implementation period and in Section 4 for emissions from other sources.
>
> (g)(3) States with Class I areas must assess visibility changes. Massachusetts has no mandatory Class I area; a summary of visibility changes in the region is provided in Section 2 for reference.
>
> (g)(4) Tracking of the changes in emissions of pollutants contributing to visibility impairment from all sources and activities within Massachusetts by type of source or activity. Emissions trends data addressing this requirement are presented in Section 4. Facility specific data from the EPA Air Markets Program Data (AMPD) system for 2019 (the most recent year available as required by (g)(4) are presented in this section.
>
> (g)(5) An assessment of: (1) any significant changes in anthropogenic emissions within or outside Massachusetts; (2) whether or not these changes were anticipated in the SIP for the first implementation period; and (3) whether the changes have limited or impeded progress in reducing pollutant emissions and improving visibility. This is addressed in Section 4.

3.2 Massachusetts Regional Haze SIP for the First Implementation period

The key elements of the Massachusetts long-term strategy for the first implementation period (2008 – 2018) are summarized below.

Best Available Retrofit Technology – The RHR required the control of emissions from certain stationary sources placed into operation between 1962 and 1977 through the use of the Best Available Retrofit Technology (BART) or an alternative to BART that achieves greater emission reductions. MassDEP identified ten electricity generating units (EGU), one municipal waste combustor, and one industrial boiler as BART-eligible facilities whose baseline (2002) emissions contributed significantly to visibility impairment. For the EGUs, MassDEP adopted an alternative to BART program that achieved greater reductions than source-by-source BART. For the municipal waste combustor, MassDEP made a source-specific BART determination. For the industrial boiler, no BART determination was needed since the facility accepted an emissions cap that made it no longer BART-eligible.

Sulfur in Fuel Oil – For the first implementation period, MANE-VU determined that states could cost-effectively achieve significant reductions in SO_2 emissions by requiring lower sulfur content in #2 distillate oil (home heating oil) and #4 and #6 residual oils (used in power plants and industrial and commercial boilers). In 2012, Massachusetts adopted regulations that lowered sulfur content in fuel oil.

Targeted EGU strategy – MANE-VU identified 167 EGU stacks at power plants whose SO_2 emissions significantly impaired visibility at MANE-VU Class I areas and set a 90% reduction goal from 2002 to 2018 emission levels. These included stacks at five Massachusetts power plants. MassDEP demonstrated that SO_2 emissions reductions from these power plant stacks met the 90% reduction goal.

3.3 Status of Low Sulfur Oil Strategy

In July 2012 MassDEP adopted amendments to 310 CMR 7.05: *Fuels All Districts* to lower the sulfur content of fuel oil as shown below. This rule was fully implemented by July 1, 2018.

Massachusetts Low Sulfur Fuel Limits and Schedule

#2 Distillate Oil	500 ppm by 7/1/2014 15 ppm by 7/1/2018
#4 / #6 Residual Oil	1% by 7/1/2014 (0.5% for power plants) 0.5% by 7/1/2018

3.4 Status of BART and Alternative to BART

MWC BART Determination – For each of the two Wheelabrator-Saugus municipal waste combustor units, MassDEP determined that a NO_x emissions rate target of 185 ppm (30-day average), no further SO_2 controls, and a PM emissions limit of 25 milligrams per dry standard cubic meter (mg/dscm) represented BART. MassDEP issued a modified Emission Control Plan for Wheelabrator-Saugus with the BART NO_x, PM, SO_2 emission limits in March 2012, and EPA approved this control plan into the Massachusetts SIP.[13] Wheelabrator-Saugus was operating in accordance with its BART emissions limitations and therefore this control was fully

[13] 78 FR 57487. September 19, 2013.

implemented. In addition, on February 11, 2020, MassDEP issued a new Emission Control Plan that established a lower NO_x emission rate limit of 150 ppm (24-hour daily arithmetic average) under 310 CMR 7.08(2)(f)3. This Emission Control Plan is currently under appeal.

EGU Alternative to BART – MassDEP adopted an Alternative to BART that covers all BART-eligible EGUs plus all additional coal- and oil-fired EGUs subject to MassDEP regulation 310 CMR 7.29, *Emissions Standards for Power Plants*. MassDEP's Alternative to BART for EGUs included the measures below.

1. 310 CMR 7.29 *Emissions Standards for Power Plants*, which establishes NO_x and SO_2 emission rates (as well as mercury and carbon dioxide emissions limits) for certain EGUs.

2. The retirement of Somerset Power.

3. Permit restrictions for Brayton Point Station, Salem Harbor Station, and Mt. Tom Station that limit or retire SO_2 and/or NO_x emissions.

4. 310 CMR 7.19 *Reasonably Available Control Technology (RACT) for Sources of* NO_x, which establishes NO_x emission rates for various sources including EGUs.

5. 310 CMR 7.05 *Fuels All Districts*, which requires EGUs to limit the sulfur content of residual oil to 0.5% by weight beginning July 1, 2014.

MassDEP issued Emission Control Plans for Salem Harbor, Brayton Point, and Mt. Tom to implement the Alternative to BART. MassDEP submitted the Emission Control Plans as part of the 2012 RH SIP, and they remained in effect until each of those facilities was retired.

Table 3-1 lists the Alternative to BART measures and their status. Table 3-2 shows that in 2017 the EGUs subject to the Alternative to BART had achieved more emissions reductions than the original 2018 reduction targets from the 2012 RH SIP, primarily through retirements.

3.5 Status of Targeted EGU Strategy

For the first implementation period SIPs, MANE-VU identified 167 EGU sources whose 2002 emissions contributed significantly to visibility impairment in MANE-VU Class I areas. The MANE-VU Ask for the first implementation period called for a 90% reduction in SO_2 emissions at these sources by 2018. Massachusetts had ten EGUs on the 167 EGU stacks list. Table 3-3 shows that SO_2 emissions from these EGUs decreased by 99% in 2017, exceeding the 90% goal for 2018.

Table 3-1: Massachusetts BART and Alternative to BART with Current Status

Source Type	Source	Unit	BART- Eligible EGU or MWC	Description of BART Controls Implemented (Implementation Deadline)	Current Operation Status
BART (MWCs)					
MWC	Wheelabrator-Saugus	1, 2	Yes	Emission Control Plan with emission limits for: NO_x – < 150 ppm by volume at 7% O2 dry basis (24-hour daily arithmetic average) (March 10, 2020) PM – 25 milligrams per dry standard cubic meter (mg/dscm) and SO_2 – < 29 ppm by volume at 7% O2 dry basis or 75% reduction by weight or volume, whichever is less stringent (24-hour geometric mean) (March 2012)	Operating
Alternative to BART (EGUs)					
EGU	Cleary Flood	8, 9	Yes	Regulation 310 CMR 7.05, Fuels All Districts, requiring EGUs that burn residual oil to limit the sulfur content to 0.5% by weight (July 1, 2014)	Operating
EGU	Mystic Station	7	Yes	Regulation 310 CMR 7.05, Fuels All Districts, requiring EGUs that burn residual oil to limit the sulfur content to 0.5% by weight (July 1, 2014)	Operating
EGU	Canal Station	1, 2	Yes	Regulation 310 CMR 7.05, Fuels All Districts, requiring EGUs that burn residual oil to limit the sulfur content to 0.5% by weight (July 1, 2014)	Operating
EGU	Brayton Point	1, 2, 3, 4	Yes	Regulation 310 CMR 7.29 (existing) Prohibit the use of 310 CMR 7.29 SO_2 Early Reduction Credits and federal Acid Rain Allowances for compliance (June 1, 2014) Regulation 310 CMR 7.05, Fuels All Districts, requiring EGUs that burn residual oil to limit the sulfur content to 0.5% by weight (July 1, 2014)	Retired
EGU	Salem Harbor	4	Yes	Retirement (June 1, 2014)	Retired
EGU	Salem Harbor	1	No (Alternative to BART)	Regulation 310 CMR 7.29 (existing) Prohibit use of 310 CMR 7.29 SO_2 Early Reduction Credits and federal Acid Rain Allowances for compliance (June 1, 2014); An annual cap of 276 tons of NO_x	Retired
EGU	Salem Harbor	2	No (Alternative to BART)	Annual cap of 300 tons of SO_2 (June 1, 2014) Annual cap of 50 tons of NO_x	Retired

Source Type	Source	Unit	BART- Eligible EGU or MWC	Description of BART Controls Implemented (Implementation Deadline)	Current Operation Status
EGU	Salem Harbor	3	No (Alternative to BART)	Retirement (June 1, 2014)	Retired
EGU	Mont Tom Station	1	No (Alternative to BART)	Prohibit use of 310 CMR 7.29 SO_2 Early Reduction Credits and federal Acid Rain Allowances for compliance (May 15, 2009)	Retired
EGU	Somerset Power	8	No (Alternative to BART)	Retirement (2010)	Retired

3.6 Status of Controls on Outdoor Hydronic Heaters

Massachusetts included in its first implementation period SIP regulations to control emissions on outdoor hydronic heaters [310 CMR 7.26(50) through (54)]. These regulations require manufacturers to meet emissions standards to sell such heaters in Massachusetts and contain operational requirements for owners of existing and new heaters. MassDEP continues to implement these regulations.

Table 3-2: Alternative to BART Unit Emissions

Facility Name	Facility ID (ORISPL)	Unit ID	2002		2011		2017		2019	
			SO_2 (tons)	NO_x (tons)	SO_2 (tons)	NO_x (tons)	SO_2 (tons)	NO_x (tons)	SO_2 (tons)	NO_x (tons)
Brayton Point	1619	1	9,253.5	2,513.2	4,298.3	635.0	212.2	128.2		
Brayton Point	1619	2	8,852.7	2,270.3	3,535.0	827.0	144.5	269.4		
Brayton Point	1619	3	19,450.3	7,334.9	10,768.9	1,134.5	194.7	188.7		
Brayton Point	1619	4	2,036.9	552.0	46.2	40.0	0.006	0.9		
Canal Station	1599	1	13,065.9	3,338.8	99.1	20.2	46.3	11.6	59.5	12.0
Canal Station	1599	2	8,948.2	2,260.0	28.8	13.5	41.5	30.8	24.3	15.1
Cleary Flood	1682	8	39.2	12.5	21.8	6.7	7.5	3.6	1.0	0.5
Cleary Flood	1682	9	67.6	160.8	4.6	46.2	1.1	51.7	0.2	30.8
Mount Tom	1606	1	5,281.7	1,969.3	128.8	70.1				
Mystic	1588	7	3,727.3	804.5	21.7	66.8	381.0	123.3	72.3	27.5
Salem Harbor Station	1626	1	3,425.5	920.0	893.3	204.3				
Salem Harbor Station	1626	2	2,821.2	755.2	304.9	68.5				
Salem Harbor Station	1626	3	4,999.0	1,331.2	2,343.8	277.8				
Salem Harbor Station	1626	4	2,886.1	787.4	69.4	21.3				
Somerset	1613	8	4,399.0	1,444.9						
Totals			89,254	26,455	22,565	3,432	1,029	808	157.3	85.9
Reductions					66,689	23,023	88,225	25,647	89,097	26,369
Percent Reduction					75%	87%	99%	97%	99.8%	99.7%
Reduction Targets by 2018							*54,986*	*13,117*		

Source: AMPD for EGU emissions, and Massachusetts Regional Haze SIP (2012 revision), Table 17, and 19 for Reduction Targets by 2018.

Table 3-3: SO_2 Emissions at Massachusetts Targeted EGUs

Facility	Unit	2002	2011	2017	*2017 Reductions from 2002 (%)*	*2019*	*2018 Projected (90% Target)**
Brayton Point	1	9,254	4,298	212	97.7%	0	*925*
Brayton Point	2	8,853	3,535	145	98.4%	0	*885*
Brayton Point	3	19,450	10,769	195	99.0%	0	*1,945*
Canal Station	1	13,066	99	46	99.6%	59.5	*1,307*
Canal Station	2	8,948	29	42	99.5%	24.3	*895*
Mount Tom	1	5,282	129	0	100%	0	*528*
Salem Harbor	1	3,425	893	0	100%	0	*343*
Salem Harbor	3	4,999	2,344	0	100%	0	*500*
Salem Harbor	4	2,886	69	0	100%	0	*289*
Somerset	8	4,399	0	0	100%	0	*440*
Total		80,562	22,165	640	-	84	*8,057*
Reduction			58,396	79,922	-	80,478	*72,505*
Percent Reduction from 2002			72%	99%	99%	99.9%	*90%*

Source: AMPD data for 2017 and 2019 emissions, and Massachusetts Regional Haze SIP, Section 10, Long-Term Strategies, Table 25, for projected emissions and 2002 and 2011 data. See the SIP (2012 revision) for definitions of 2018 projection scenarios.
* From 2012 RH SIP.

4. Emissions Inventory and Trends

4.1 Emissions Data Requirements

40 CFR 51.308(f)(6)(v) requires MassDEP to include in its RH SIP revision a statewide emissions inventory of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any mandatory Class I area. This inventory must include emissions for the most recent year for which data are available and estimates of future projected emissions.

40 CFR 51.308(g)(4) requires MassDEP to document changes in emissions over time using its most recently submitted triennial emissions inventory and the most recent data for any facilities that have submitted to EPA through an EPA on-line system such as the Air Markets Program Division (AMPD) website.

40 CFR 51.308(f)(2)(iii) requires MassDEP to document the emissions information used to develop its long-term strategy.

This section summarizes the emissions data used by MassDEP and the other MANE-VU states for developing SIP revisions for the second planning period. This report is based on technical analyses developed through the MANE-VU regional planning process.[14]

4.2 Emissions Data Considered

This section summarizes emissions of visibility impairing pollutants from all sources and activities within Massachusetts from 2002-2017. For EGU sources that report to AMPD, 2019 data is provided.

2017 is the most recent year for which MassDEP has developed a triennial Periodic Emissions Inventory (PEI)[15] and has submitted emissions estimates to fulfill the requirements of 40 CFR 51 Subpart A (also known as the Air Emissions Reporting Requirements, or AERR). The AERR requires states to submit estimates for all emissions categories to EPA on a three-year cycle. EPA combines the state data with EPA's own estimates for other sources to form the National Emissions Inventory (NEI).

Most of the emission estimates for 2002-2017 were adopted from EPA's estimates for the NEI – see Massachusetts inventories for specific details.[16] Note that 2005 was a limited effort NEI, so that year is not shown for the MANE-VU and Ask states. However, MassDEP developed a 2005 PEI and those emissions are used in this summary to fill the gap between 2002 and 2008. The

[14] MANE-VU Emissions Inventory Data and Report Template Last Updated May27, 2020 (MANE-VU technical documentation web page: https://otcair.org/manevu/document.asp?Fview=Reports) (MA File: MANE-VU_EI_NEI & AMPD 5-7-20-KenS.xlsx)
[15] MassDEP Emissions Inventory website: https://www.mass.gov/lists/massdep-emissions-inventories
[16] Ibid. and EPA Emissions Inventory website https://www.epa.gov/air-emissions-inventories

emissions summary here was taken from the Massachusetts 2017 PEI Table 1.5 that presents the triennial trends starting in 1990. Because of improvements in methodologies during this period (e.g., for residential wood-burning, unpaved roads, and composting), MassDEP estimated the impact the newer methods would have had on older values to present a more realistic trend.[17]

This section provides estimates for emissions of nitrogen oxides (NO_x), particulate matter less than 10 microns (PM_{10}), particulate matter less than 2.5 microns ($PM_{2.5}$), sulfur dioxide (SO_2), volatile organic compounds (VOC), and ammonia (NH_3), all of which have the potential to contribute to regional haze. Source types include point, nonpoint, nonroad mobile, and onroad mobile, which are explained below.

NO_x and SO_2 emissions for larger EGU sources are also given for the years 2018 and 2019 because these are the most recent data available from the AMPD system.

Data are provided for Massachusetts, for all the MANE-VU states, and for the states identified by MANE-VU[18] as having the potential to contribute to visibility impairment in MANE-VU Class I areas, which include Alabama (AL), Florida (FL), Illinois (IL), Indiana (IN), Kentucky (KY), Louisiana (LA), Michigan (MI), Missouri (MO), North Carolina (NC), Ohio (OH), Tennessee (TN), Texas (TX), Virginia (VA), and West Virginia (WV). This latter group of states is referred to as the “Ask” states.

4.3 Source Types

Notes on the varying definitions of source types below apply to all the tables and figures in this section.

Point sources are stationary facilities that report their emissions directly to state and/or federal reporting programs. Point sources are larger facilities such as electric generating units (EGUs), factories, and heating plants for large schools and universities. In the tables and charts that follow, point source NO_x and SO_2 are further broken down into AMPD sources and non-AMPD sources (because more recent data is available for AMPD sources). Sources that report to EPA’s AMPD programs are generally EGUs (AMPD-EGUs) and so the AMPD values are a reasonable estimate of emissions from EGUs. Non-EGU point emissions are taken from MassDEP’s Source Registration reporting program.[19] The NEI’s non-AMPD point category included airports and

[17] MassDEP adopted EPA/E.H Pechan’s residential wood-burning (RWC) estimates for 2002 of 66,000 tons VOC. EPA/OMNI revised RWC to 9,000 tons in 2008. This 57,000-ton difference was subtracted from the 2002 and 2005 emissions in this report to avoid showing an artificial reduction in VOC or (to a much lesser extent) in NO_X. For unpaved roads, MassDEP has adopted EPA’s estimates since 2002, but corrected an overestimate for urban local roads for 2014. The 2014 unpaved road emissions were estimated for previous years using VMT growth from 2002-2014. EPA further revised the Unpaved roads PM for 2017 and the difference was applied to previous years. For composting, MassDEP estimated VOC and NH_3 for the first time in 2011 at 1,600 tons and 200 tons, respectively. These emissions were applied to previous years based on population growth to avoid any artificial increases in 2011 and 2014.

[18] Selection of States for MANE-VU Regional Haze Consultation (2018). MANE-VU TSC. September 5, 2017. (Appendix 16)

[19] 310 CMR 7.12; see Source Registration website: https://www.mass.gov/guides/massdep-source-registration-greenhouse-gas-reporting

railroad switchyards after 2002, but MassDEP reassigned these emissions to the nonroad category for its inventories to be consistent with previous PEI data.

Nonpoint sources (or area sources) are those that are too small, widespread, or numerous to be inventoried individually. Instead, emissions are estimated for these categories using surrogate activity data such as population, employment, and statewide fuel use (after subtracting fuel used by larger point sources). There is a wide range of nonpoint categories; examples include residential fuel combustion, commercial and institutional heating, printing, and solvent use by small businesses and consumers. MassDEP typically adopts EPA's estimates for a large portion of the nonpoint categories including residential wood-burning, portable fuel containers, open burning, wildfires, livestock ammonia (NH_3), and construction/road dust.

- Nonpoint in the NEI includes commercial marine vessels and underway rail for 2008 and later, but MassDEP reassigned these emissions to nonroad to be consistent with its previous inventories.
- Nonpoint included, prior to 2011, vehicle refueling at gasoline service stations; beginning with 2011 it was included in the onroad mobile sector.

Onroad mobile sources are vehicles that operate on roadways, including cars, trucks, buses, and motorcycles. EPA calculated the emissions with a new EPA model (MOVES) from 2008 to 2017, which was different than the model used for the 2002 inventory (MOBILE6). MassDEP submitted MOVES inputs to EPA for NEIs from 2008 onward and adopted the final NEI emissions.

- Onroad mobile sources include, beginning with the 2011 NEI, vehicle refueling at gasoline service stations.

Nonroad mobile sources are vehicles and equipment that are not designed to operate on roadways. Examples include aircraft, ships, locomotives, construction equipment, recreational vehicles, and lawn & garden equipment. For 2011, 2014, and 2017 MassDEP submitted MOVES-NONROAD inputs to EPA for the NEI and adopted all the EPA nonroad category NEI emissions. Prior to 2011, MassDEP estimated nonroad emissions using the EPA NONROAD model and developed the emissions for aircraft, ships and locomotives that are included in this summary.

EPA's NEI nonroad inventory included airports and railroad switchyards for 2002 and 2005 only; these categories were moved to point sources in later inventories (since these emissions occur at discrete locations). However, MassDEP reassigned airport and switchyard emissions to the nonroad sector to be consistent with previous inventories.

4.4 Nitrogen Oxides (NO_x)

Figure 4-1 and Table 4-1 show NO_x emissions in Massachusetts from all source types (point, nonpoint, nonroad, and onroad) from 2002 to 2017.

NO_x emissions in Massachusetts have declined 62% from 2002-2017.[20] This is primarily due to the approximately 102,000 tons reduction (71%) in onroad emissions for this period. Onroad mobile emissions reductions are due largely to Massachusetts requirements for low emitting vehicles (LEV)[21] and enhanced inspection and maintenance.[22] Tighter Federal NO_x standards for heavy duty diesel onroad engines also contributed to this decline.

Nonroad reductions are due to Federal programs for nonroad equipment including *Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel*,[23] *Control of Emissions from Air Pollution From Locomotive Engines and Marine Compression-Ignition Engines Less Than 30 Liters Per Cylinder*,[24] and *Control of Emissions from Nonroad Spark-Ignition Engines and Equipment*.[25] For both onroad and nonroad mobile sources, NO_x emissions are expected to continue declining as fleets turn over and older, more polluting vehicles and equipment are replaced by newer, cleaner ones.

For the AMPD-EGU sources, the 31,000 tons reduction (93%) from 2002 to 2017 in Massachusetts is mostly due to controls on EGUs that were part of the 2012 RH SIP, Reasonably Available Control Technology for NO_x (NO_x RACT), fuel switching from coal and oil to natural gas, and unit retirements.

[20] There was an increase in nonpoint NO_x emissions between 2011 and 2014 due in part to the use of a more accurate emission factor for engines. MassDEP applied the same increase to the years 2002-2011 to allow more accurate comparisons.
[21] 310 CMR 7.40 https://www.mass.gov/guides/massachusetts-low-emission-vehicle-lev-program
[22] 310 CMR 60.02 https://www.mass.gov/guides/transportation-air-quality#vehicle-emissions-inspections
[23] 69 FR 38958: https://www.gpo.gov/fdsys/pkg/FR-2004-06-29/pdf/04-11293.pdf
[24] 73 FR 37096: https://www.gpo.gov/fdsys/pkg/FR-2008-06-30/pdf/R8-7999.pdf
[25] 73 FR 59034: https://www.gpo.gov/fdsys/pkg/FR-2008-10-08/pdf/E8-21093.pdf

Figure 4-1: NO_x Emissions in Massachusetts by Source Type 2002-2017

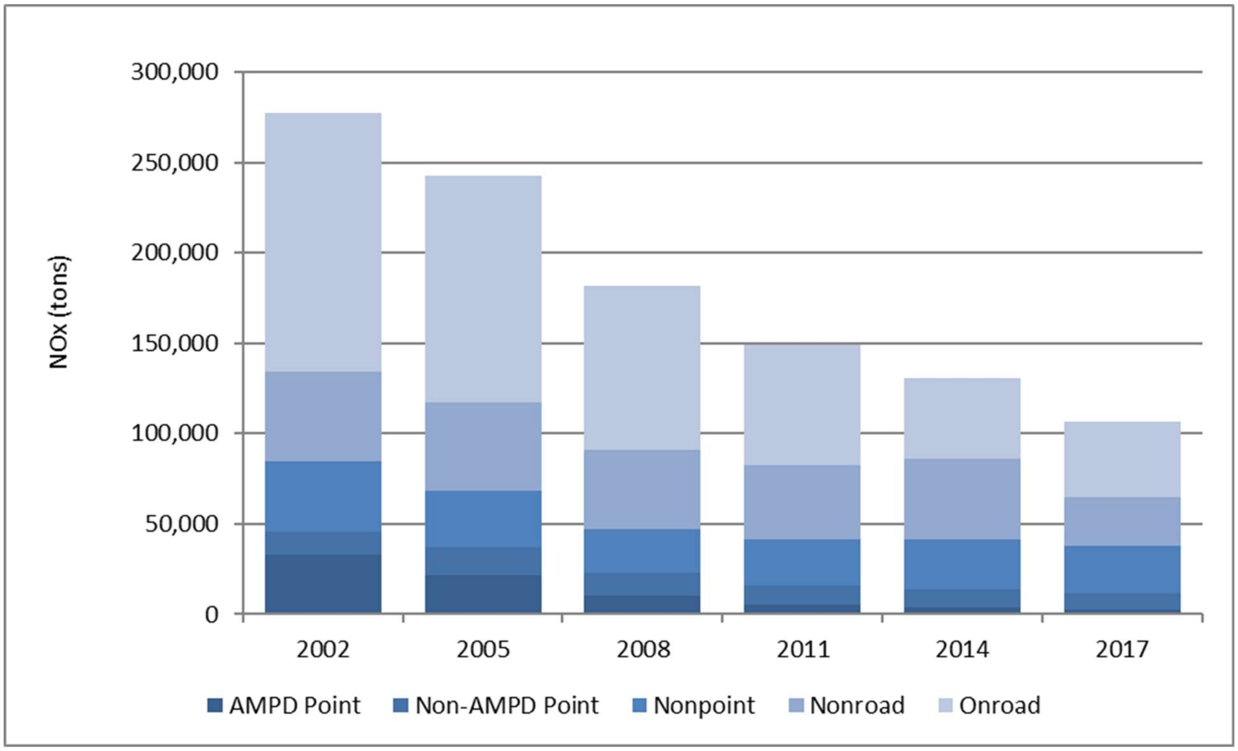


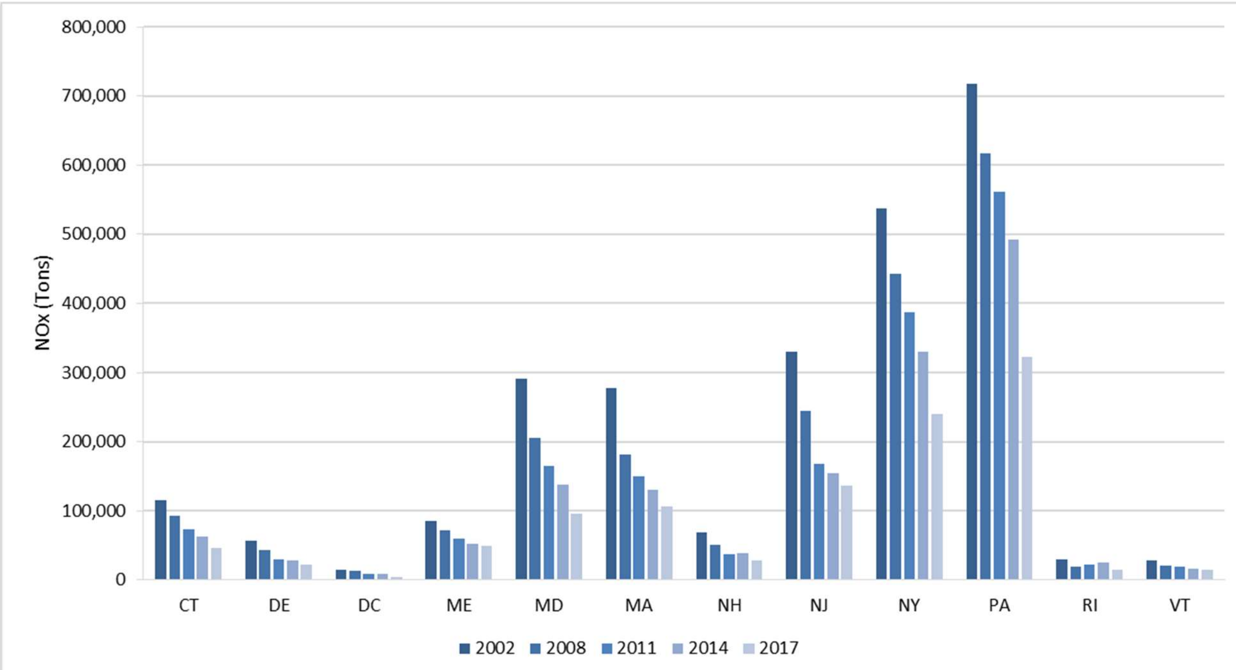
Table 4-1: NO_x Emissions in Massachusetts 2002-2017 by Source Type (tons per year)

	2002	2005	2008	2011	2014	2017	Change 2002-2017	% Change 2002-2017
AMPD Point	32,940	21,471	10,002	5,113	4,107	2,372	-30,568	-93%
Non-AMPD Point	12,650	15,394	12,926	10,573	9,379	7,211	-5,439	-43%
Nonpoint	38,920	40,971	24,471	25,765	28,115	26,108	-12,812	-33%
Nonroad	49,523	48,507	43,828	40,778	44,443	27,839	-21,684	-44%
Onroad	143,368	125,702	90,163	66,997	44,729	41,863	-101,505	-71%
TOTAL	277,401	252,045	181,390	149,226	130,773	105,393	-172,008	-62%

See notes in Section 4.3.

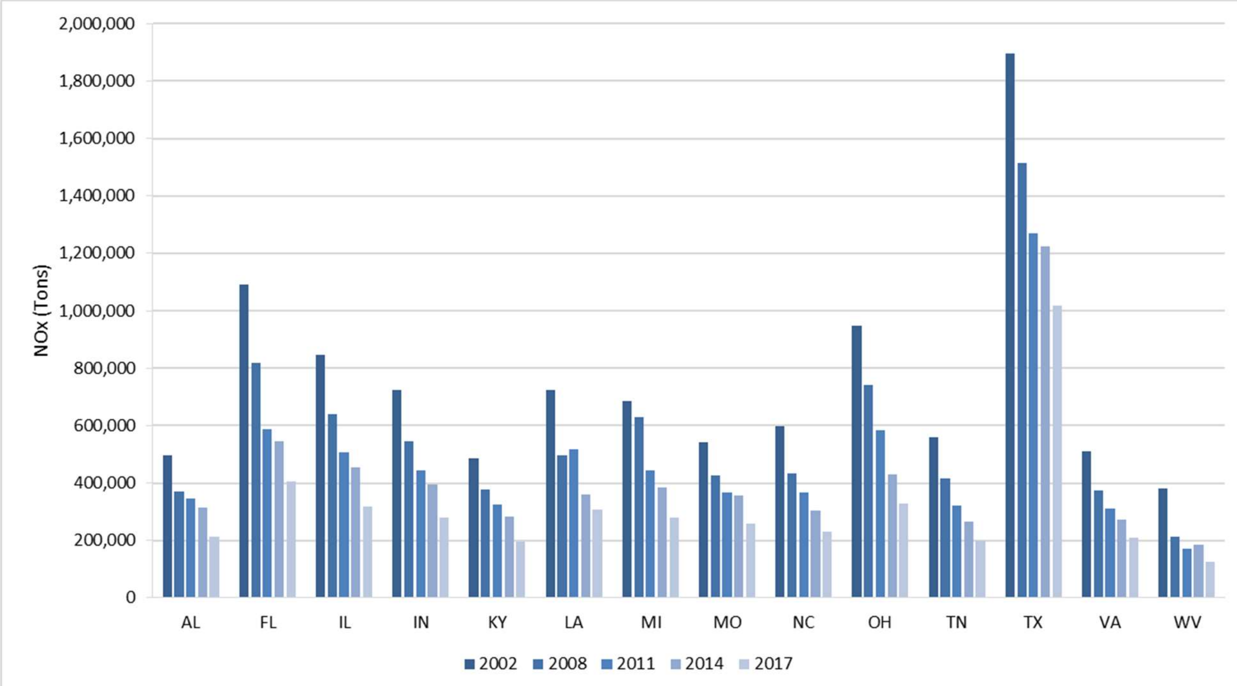
Similar to Massachusetts, almost all of the MANE-VU and Ask states showed substantial reductions in NO_x emissions from 2002-2017 (average of 58%) (see Figures 4-2 and 4-3). Much of this decline is due to the Federal and state control programs for nonroad and onroad mobile sources described earlier.[26] Other sources of NO_x reductions are individual states rules controlling EGU emissions and NO_x RACT.

Figure 4-2: NO_x Emissions in MANE-VU States from All Source Types 2002-2017



[26] For onroad vehicles, similar to Massachusetts, many neighboring MANE-VU states have adopted the California LEV standards and most are required to implement enhanced vehicle emissions inspections. Federal Tier 2 and Tier 3 standards for onroad vehicles also have contributed to reductions in all areas.

Figure 4-3: NO_x Emissions in the Ask States from All Source Types 2002-2017



For EGUs reporting to AMPD, NO_x data in Table 4-2 and Figures 4-4 and 4-5 show large reductions across the MANE-VU and Ask states between 2002 and 2019. In Massachusetts, the reduction from 2002 to 2019 was 93%, which is higher than the 89% reduction in the other large MANE-VU states. The Ask states experienced a smaller 81% reduction for the same period. This large reduction is due to controls on EGUs that were part of the first implementation period SIP and retirement of the largest older coal and oil burning EGUs. For participating states, some of the reduction in AMPD-EGU NO_x since 2002 is due to the NO_x Budget Trading Program[27] under the NO_x SIP Call and the Cross-State Air Pollution Rule (formerly Clean Air Interstate Rule)[28]. Other reductions are due to NO_x RACT, source retirements, and fuel switching due to the availability of less expensive natural gas.

[27] NO_x Budget Trading Program website: https://www.epa.gov/airmarkets/nox-budget-trading-program
[28] CSAPR and CAIR websites: https://archive.epa.gov/airmarkets/programs/cair/web/html/index.html and https://www.epa.gov/csapr

Table 4-2: NO_x Emissions in MANE-VU States from AMPD Sources 2002-2019 (tons per year)

State	2002	2008	2011	2014	2016	2017	2018	2019	NOx Reduction 2002-2019	Percent NOx Reduction 2002-2019	NOx Reduction 2011-2019	Percent NOx Reduction 2011-2019
CT	6,329	4,133	1,667	1,955	1,058	1,052	1,492	801	-5,528	-87%	-866	-52%
DC	798	291	320	108	68	67	96	76	-722	-90%	-244	-76%
DE	12,292	11,545	3,748	1,791	1,308	889	948	496	-11,797	-96%	-3,252	-87%
MA	32,940	10,002	5,113	4,107	2,883	2,372	1,646	1,007	-31,933	-97%	-4,106	-80%
MD	76,519	40,327	22,536	15,053	9,395	6,112	8,431	4,019	-72,500	-95%	-18,517	-82%
ME	1,154	680	575	539	288	263	327	138	-1,016	-88%	-437	-76%
NH	6,873	4,650	3,951	2,753	1,326	1,070	1,695	1,018	-5,855	-85%	-2,932	-74%
NJ	36,163	15,147	7,040	7,096	4,382	3,443	3,408	2,949	-33,213	-92%	-4,091	-58%
NY	85,989	47,556	31,075	22,214	16,222	11,253	11,702	7,844	-78,145	-91%	-23,231	-75%
PA	218,712	187,771	149,620	125,612	79,450	37,148	34,928	33,132	-185,579	-85%	-116,488	-78%
RI	640	462	630	518	448	470	513	453	-187	-29%	-177	-28%
VT	230	296	117	161	167	139	142	133	-97	-42%	16	14%
Total	478,640	322,858	226,393	181,908	116,995	64,278	65,326	52,066	-426,574	-89%	-174,326	-77%

Figure 4-4: NO_x Emissions in MANE-VU States from AMPD Sources 2002-2019

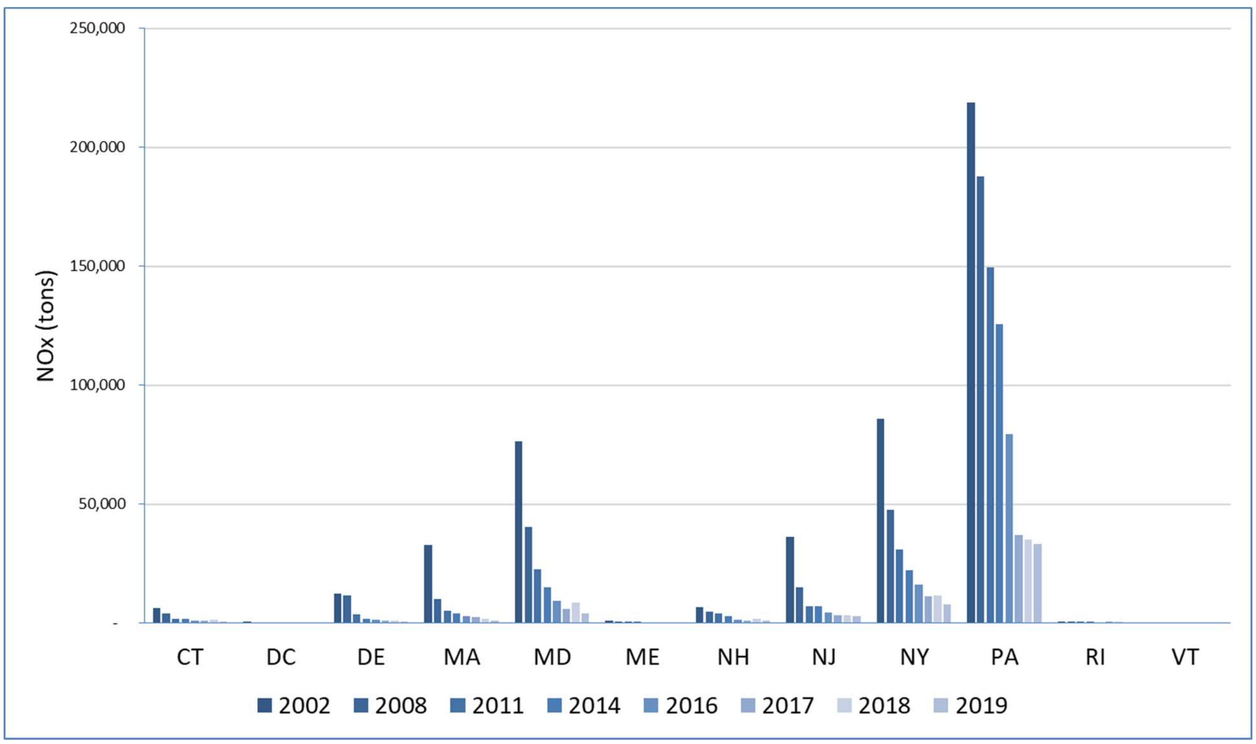
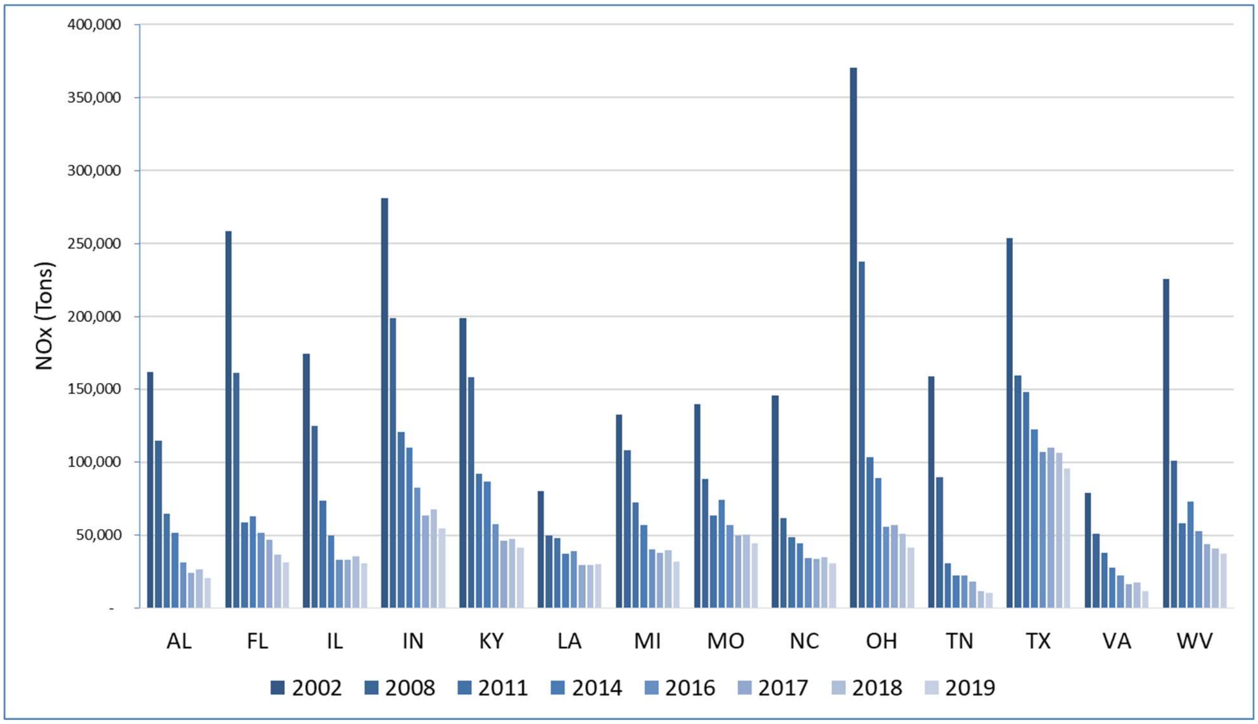


Figure 4-5: NO_x Emissions in Ask States from AMPD Sources 2002-2019



4.5 Particulate Matter Less Than 10 Microns (PM_{10})

Figure 4-6 and Table 4-3 show PM_{10} emissions from Massachusetts for all source types (point, nonpoint, nonroad, and onroad) from 2002-2017. Table 4-3 shows that there was a reduction of 16% from 2002-2017, most of which came from the nonpoint category due to fuel switching from oil to natural gas. The apparent increase in onroad mobile sources from 2005 to 2008 is due to switching from the older MOBILE6.2 model to the newer MOVES emission factor model.

Note that EPA revised the PM_{10} and $PM_{2.5}$ emissions from unpaved road downwards for 2017, to correct a problem in the calculations for the original NEI values. MassDEP also made this correction to previous years for accuracy.

Figure 4-6: PM_{10} Emissions in Massachusetts by Source Type 2002-2017

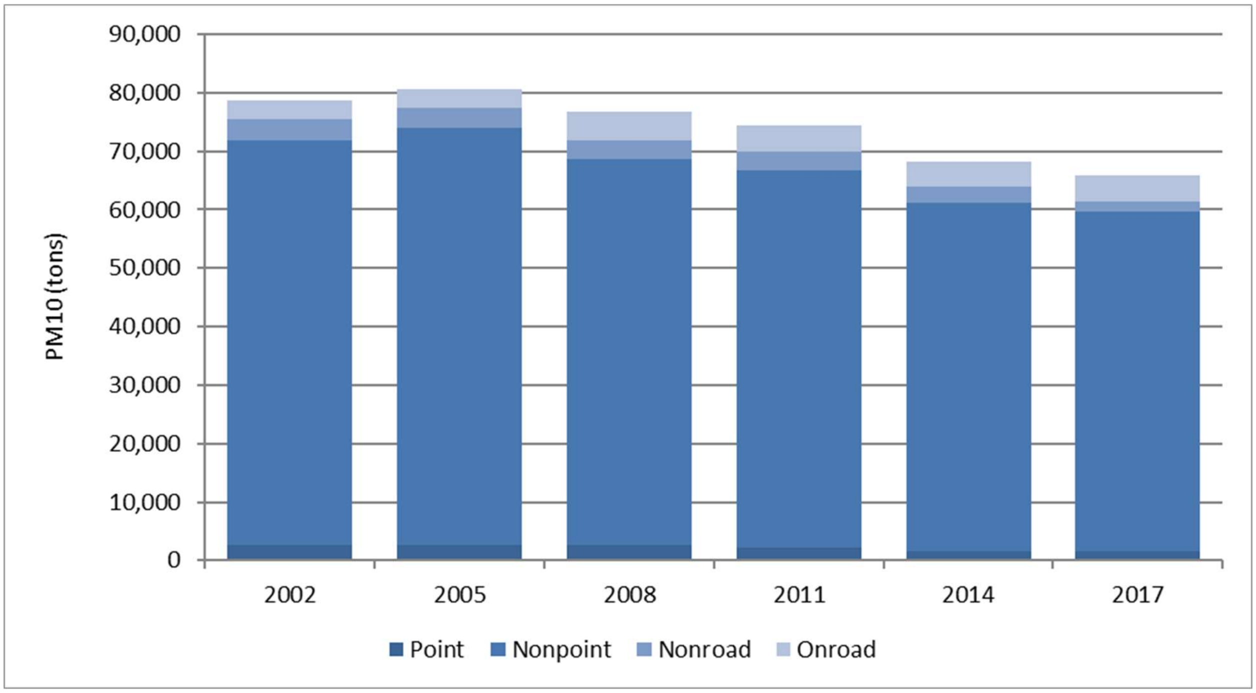


Table 4-3: PM_{10} Emissions in Massachusetts by Source Type 2002-2017 (tons per year)

	2002	2005	2008	2011	2014	2017	Change 2002-2017	% Change 2002-2017
Point	2,691	2,691	2,691	2,123	1,656	1,527	-1,164	-43%
Nonpoint	69,223	71,348	65,894	64,580	59,493	58,200	-11,023	-16%
Nonroad	3,450	3,349	3,162	3,179	2,779	1,565	-1,885	-55%
Onroad	3,408	3,247	4,907	4,463	4,282	4,629	1,221	36%
TOTAL	78,772	80,635	76,654	74,345	68,210	65,922	-12,850	-16%

See notes in Section 4.3.

Figures 4-7 and 4-8 show total PM_{10} emissions from all source types in the MANE-VU states and Ask states, respectively. PM_{10} emissions in the MANE-VU and Ask states show reductions of 49% and 32% respectively.

Figure 4-7: PM_{10} Emissions in MANE-VU States from all Source Types 2002-2017

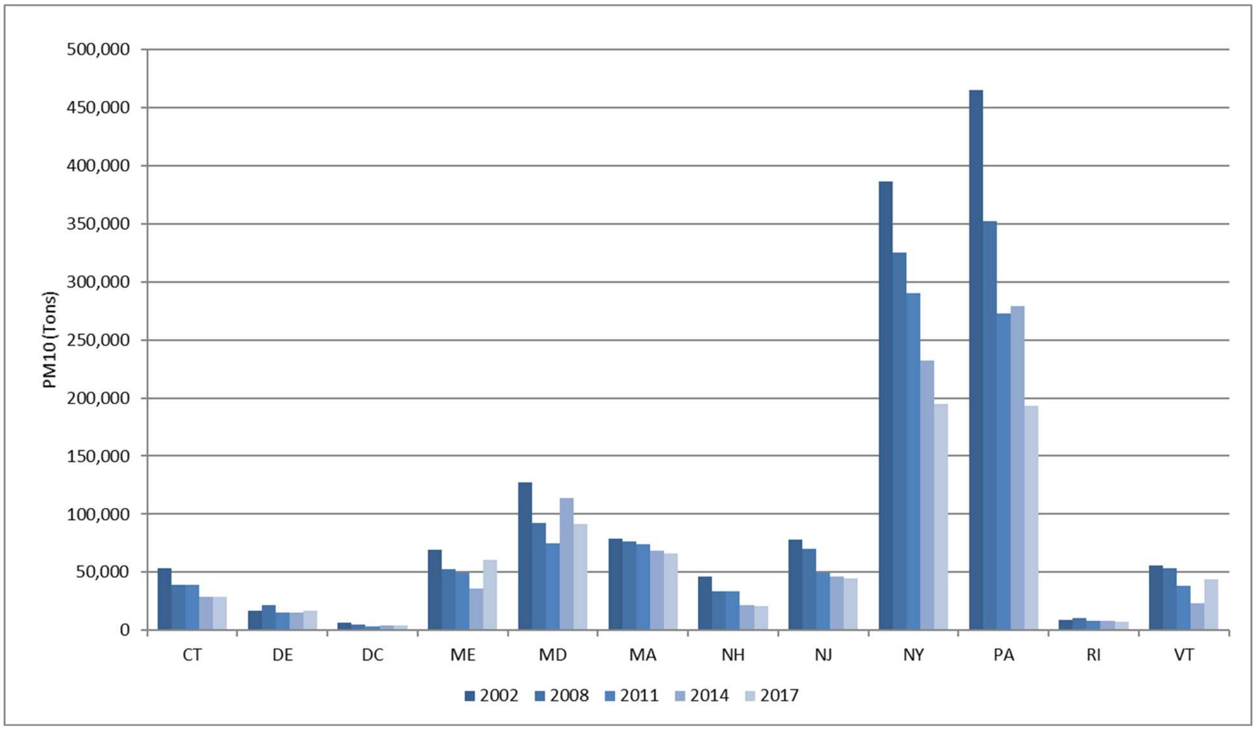
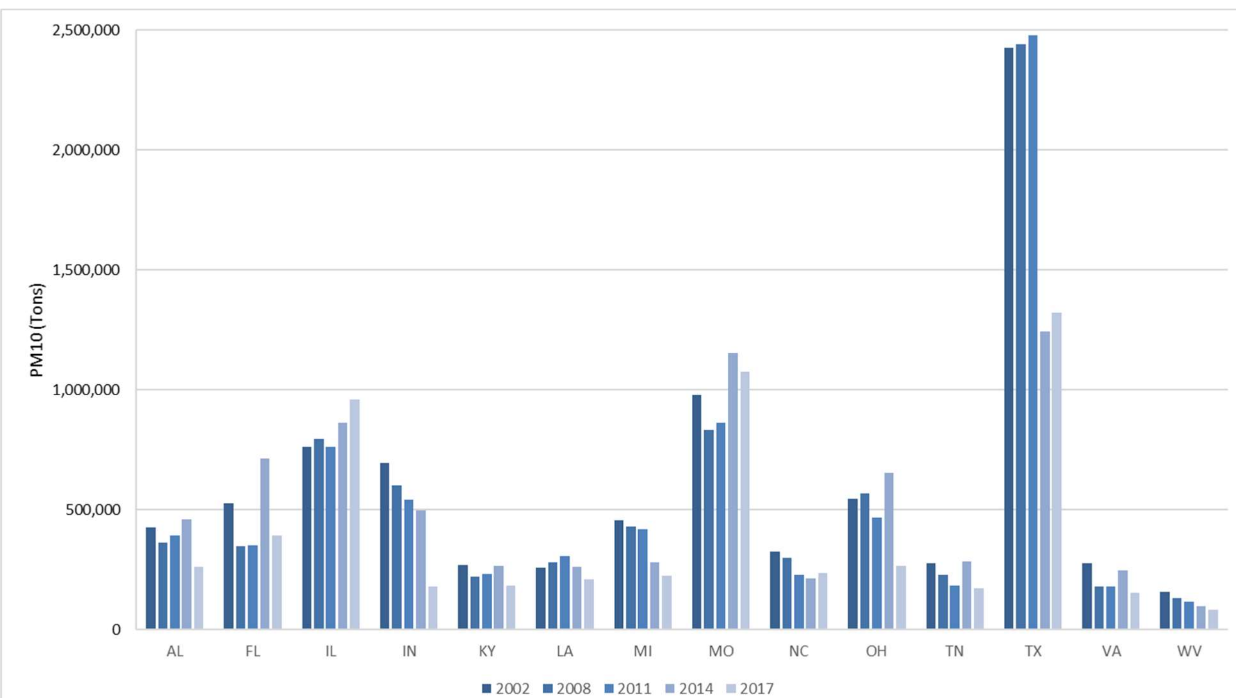


Figure 4-8: PM_{10} Emissions in the Ask States from all Source Types 2002-2017



4.6 Particulate Matter Less Than 2.5 Microns ($PM_{2.5}$)

Figure 4-9 and Table 4-4 show $PM_{2.5}$ emissions in Massachusetts from all source types from 2002-2017. Overall $PM_{2.5}$ emissions were reduced by 53% and, similar to PM_{10}, the majority of reductions came from the nonpoint category due to fuel combustion switching from oil to natural gas.

Figure 4-9: $PM_{2.5}$ Emissions in Massachusetts by Source Type 2002-2017

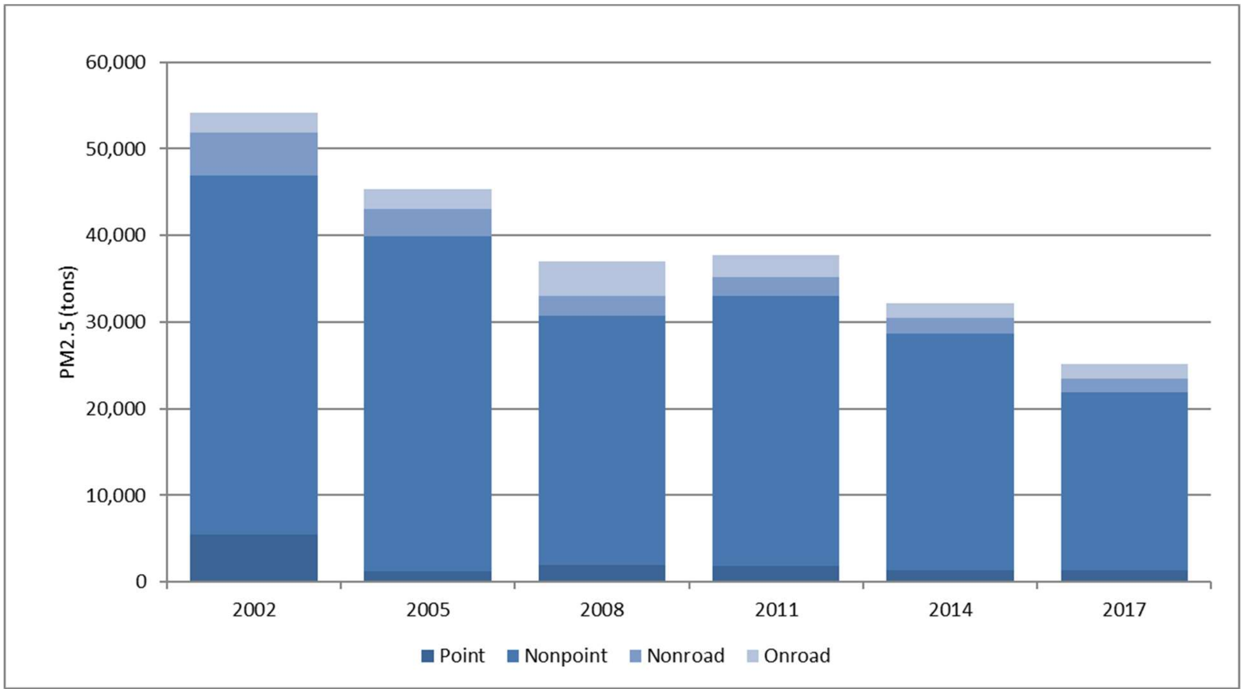


Table 4-4: $PM_{2.5}$ Emissions in Massachusetts by Source Type 2002-2017 (tons per year)

	2002	2005	2008	2011	2014	2017	Change 2002-2017	% Change 2002-2017
Point	5,439	1,231	1,969	1,835	1,392	1,349	-4,090	-75%
Nonpoint	41,464	38,672	28,786	31,190	27,227	20,593	-20,871	-50%
Nonroad	4,968	3,143	2,269	2,129	1,848	1,481	-3,487	-70%
Onroad	2,268	2,248	3,941	2,616	1,726	1,786	-483	-21%
TOTAL	54,140	45,294	36,965	37,770	32,192	25,209	-28,931	-53%

See notes in Section 4.3.

As with PM_{10}, EPA adjusted emissions from unpaved roads downwards for 2017. MassDEP also made this correction to previous years for accuracy.

Figures 4-10 and 4-11 show $PM_{2.5}$ emissions reduced from all source types in the MANE-VU and Ask states by 31% and 30% respectively.

Figure 4-10: $PM_{2.5}$ Emissions in MANE-VU States from all Source Types 2002-2017

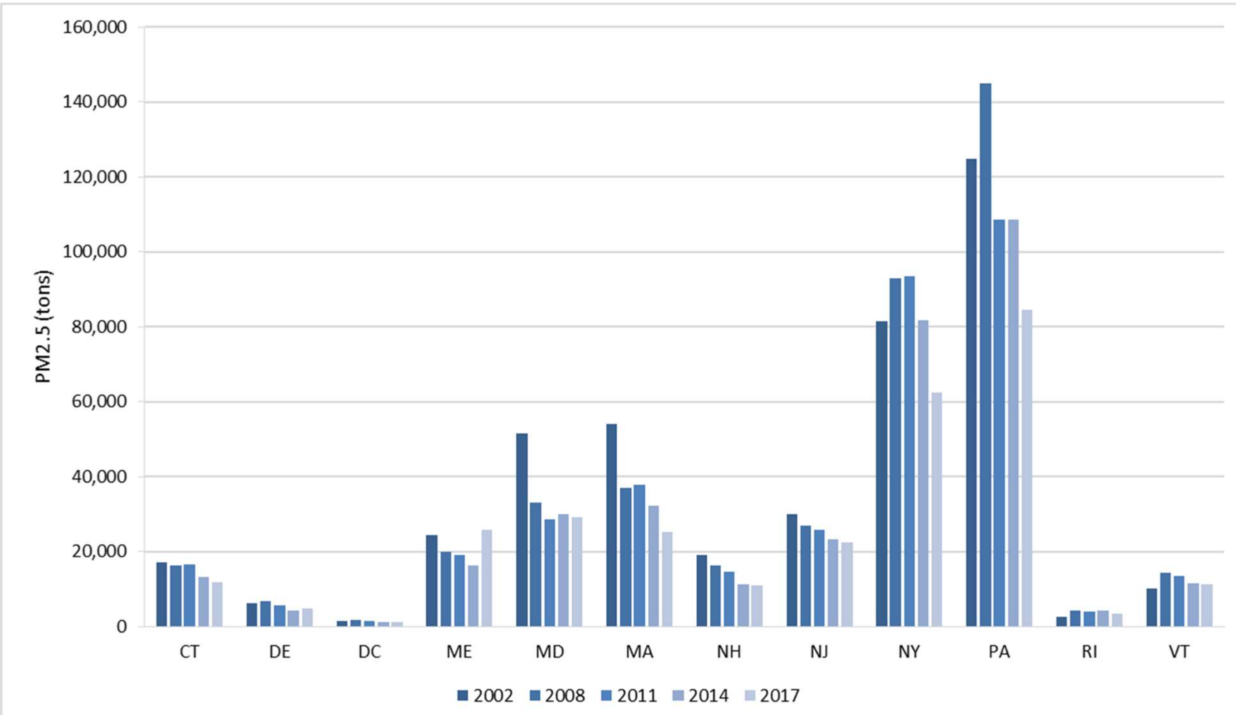
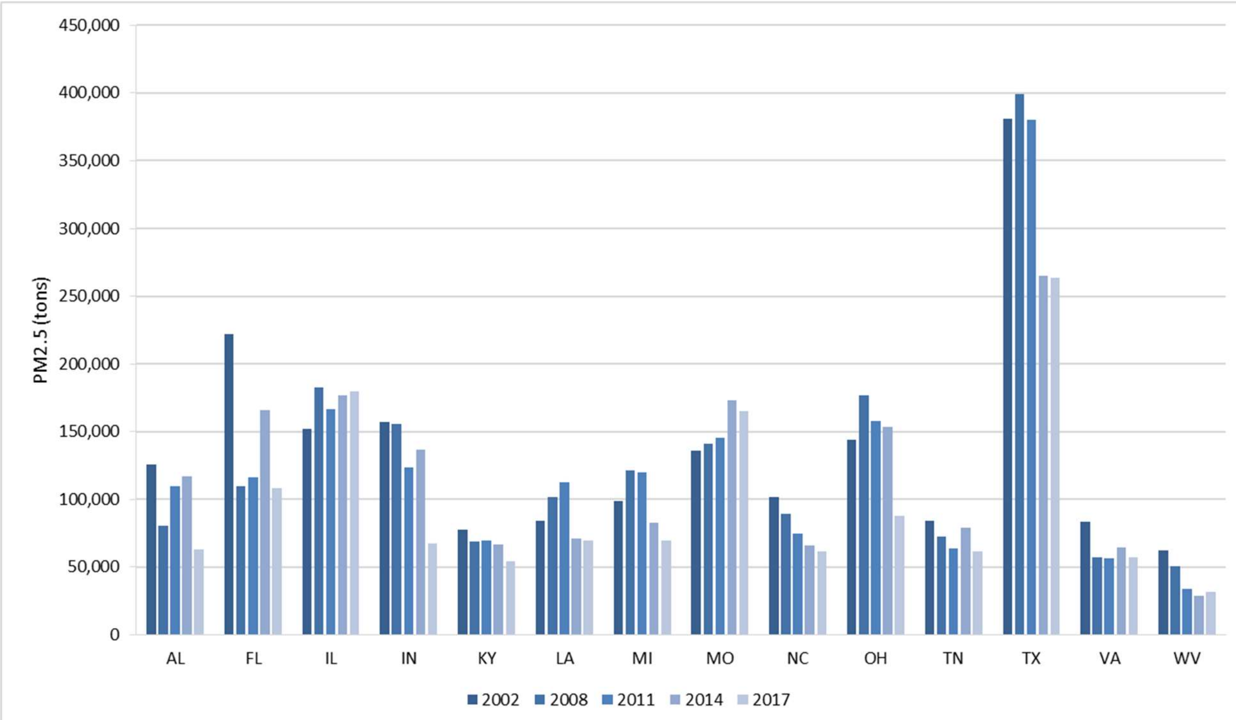


Figure 4-11: $PM_{2.5}$ Emissions in Ask States from all Source Types 2002-2017



4.7 Sulfur Dioxide (SO_2)

Figure 4-12 and Table 4-5 show a reduction of 96% (about 151,000 tons) in SO_2 emissions in Massachusetts from all source types from 2002-2017. This reduction is due to a 98.8% reduction (90,000 tons) in AMPD-EGU SO_2 emissions. These reductions are largely due to controls on EGUs that were part of the first implementation period SIP, fuel switching from coal and oil to natural gas, MassDEP's low sulfur fuel rule, and the retirement of several large older coal and oil burning EGUs.

Figure 4-13 shows a consistent decrease total in SO_2 emissions from all source types in the MANE-VU states from 2002-2017. This includes a 93% (1.8 million ton) reduction form point sources, primarily EGUs. Some of the decrease is due to the MANE-VU low sulfur fuel strategy and the 90% reduction goal for SO_2 emissions in the MANE-VU Ask for the first implementation period. Since some components of the MANE-VU low sulfur fuel strategy were not implemented until 2018, this downward trend will continue. Source retirements and fuel switching due to low natural gas prices also have contributed to the decline in SO_2 emissions.

Figure 4-14 shows SO_2 emissions from all source types in the Ask states for 2002-2017. Similar to the MANE-VU states, a consistent decline in SO_2 can be seen for all the Ask states.

Figure 4-12: SO_2 Emissions in Massachusetts by Source Type 2002-2017

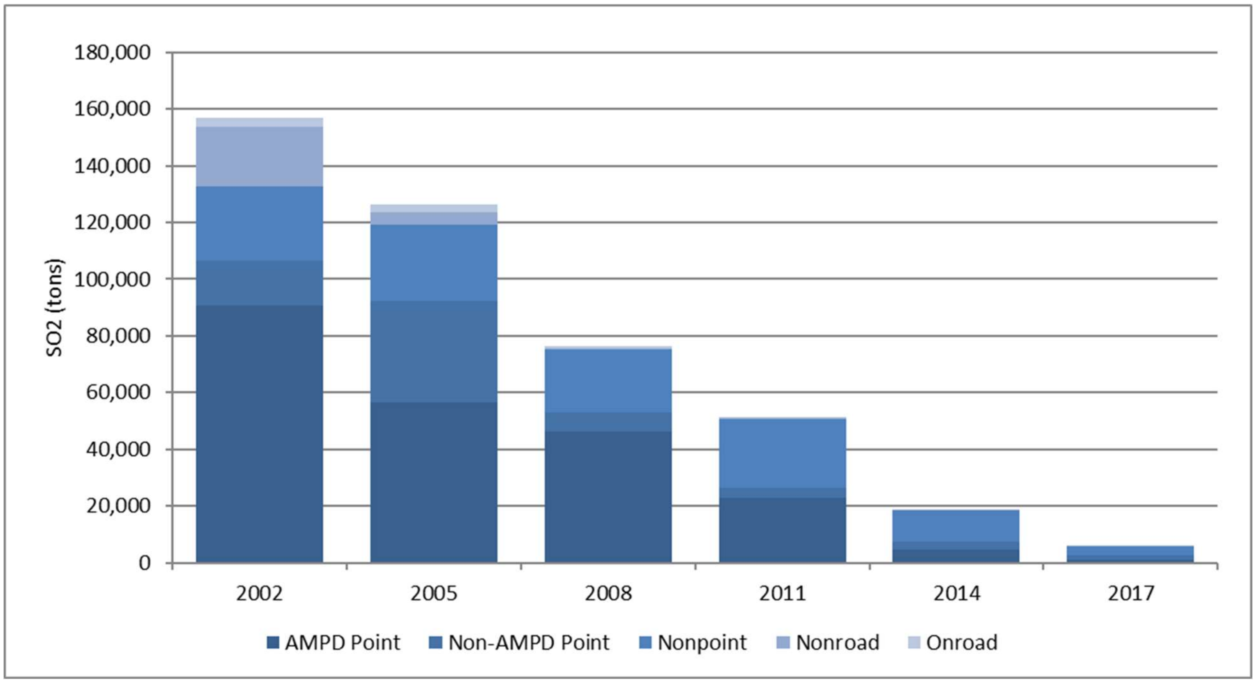


Table 4-5: SO_2 Emissions in Massachusetts by Source Type 2002-2017 (tons per year)

	2002	2005	2008	2011	2014	2017	Change 2002-2017	% Change 2002-2017
AMPD Point	90,727	56,523	46,347	22,701	4,670	1,083	-89,644	-99%
Non-AMPD Point	15,654	35,626	6,589	3,757	2,877	1,712	-13,943	-89%
Nonpoint	26,231	26,952	22,276	24,289	10,738	2,804	-23,427	-89%
Nonroad	20,994	4,521	419	65	49	34	-20,960	-100%
Onroad	3,172	2,936	625	524	555	623	-2,549	-80%
TOTAL	156,778	126,558	76,256	51,338	18,890	6,256	-150,523	-96%

See notes in Section 4.3.

Figure 4-13: SO_2 Emissions in MANE-VU States for All Source Types 2002-2017

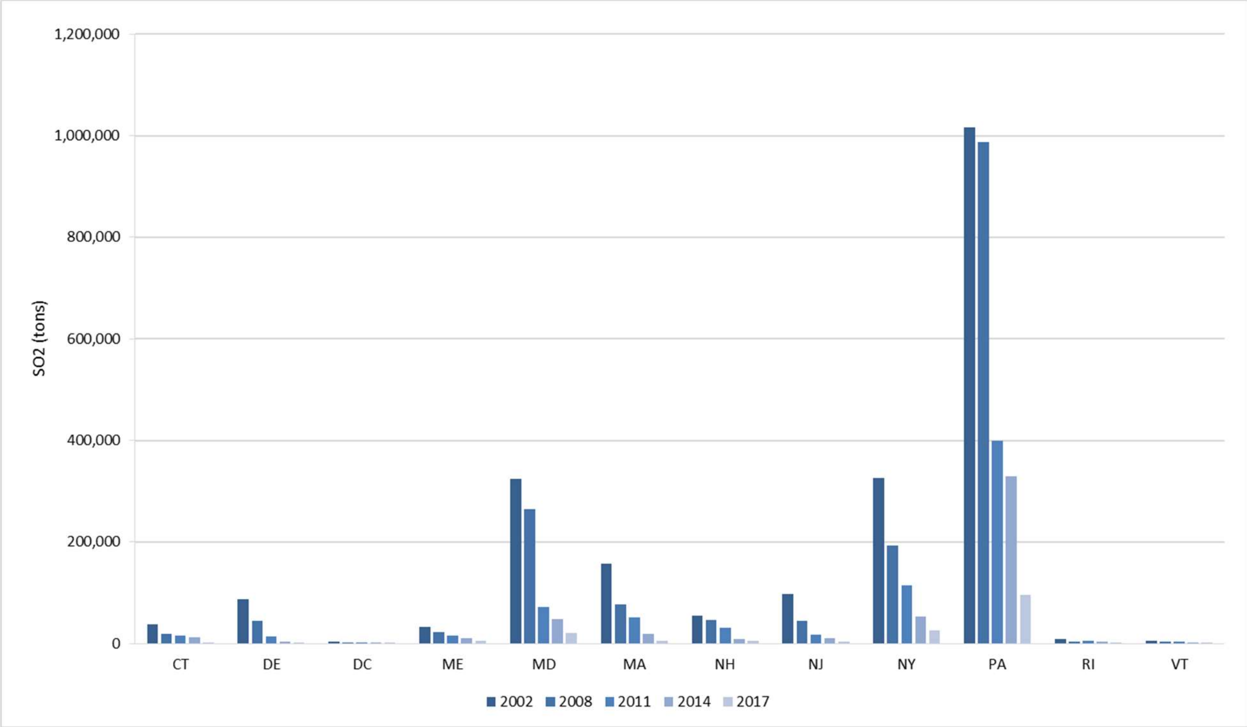


Figure 4-14: SO_2 Emissions in Ask States for All Source Types 2002-2017

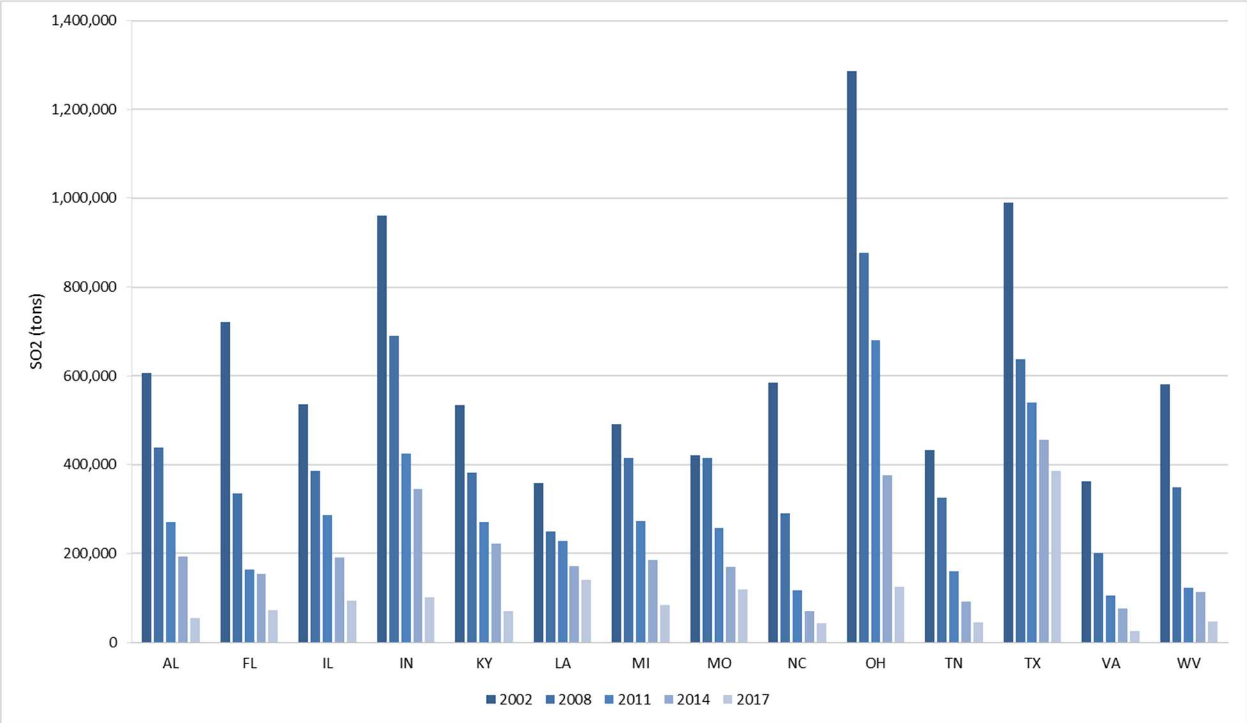


Table 4-6 and Figures 4-15 and 4-16 show SO_2 emissions for AMPD sources in the MANE-VU states and in the Ask states from 2002-2019. The newer 2019 AMPD SO_2 emissions show that the declining trend in SO_2 continues throughout MANE-VU and the Ask states. SO_2 from these sources has been reduced by 96% in MANE-VU and 90% in the Ask states. In Massachusetts, the reduction from 2002 was 99.8%, which is similar to the other large MANE-VU states. For Massachusetts, this large reduction is due to controls on EGUs that were part of the first implementation period SIP, low sulfur fuel requirements, and the retirement of most large older coal and oil burning EGUs. For participating states, some of the SO_2 reductions for AMPD sources is due to CSAPR[29] (formerly CAIR), which requires NO_x and/or SO_2 emissions reductions from EGUs in 27 states in the eastern and central U.S.

Table 4-6: SO_2 Emissions in MANE-VU States from AMPD Sources 2002-2019 (tons per year)

State	2002	2008	2011	2014	2016	2017	2018	2019	SO2 Reduction 2002-2019	Percent SO2 Reduction 2002-2019	SO2 Reduction 2011-2019	Percent SO2 Reduction 2011-2019
CT	10,814	3,955	752	1,478	362	421	690	132	-10,682	-99%	-621	-82%
DC	1,087	261	723	-	-	-	-	-	-1,087	-100%	-723	-100%
DE	32,236	31,808	9,306	829	513	545	644	279	-31,957	-99%	-9,027	-97%
MA	90,727	46,347	22,701	4,670	1,717	1,083	742	194	-90,533	-99.8%	-22,507	-99.1%
MD	255,360	227,198	32,275	23,553	16,729	8,087	11,325	5,572	-249,787	-98%	-26,703	-83%
ME	2,022	1,041	470	856	369	444	643	50	-1,973	-98%	-420	-89%
NH	43,947	36,895	24,445	2,636	573	473	1,197	417	-43,530	-99%	-24,028	-98%
NJ	48,269	21,204	5,414	2,655	1,725	1,722	1,433	1,250	-47,019	-97%	-4,165	-77%
NY	231,985	65,427	40,756	16,676	4,533	2,561	4,889	1,972	-230,013	-99%	-38,784	-95%
PA	889,766	831,915	330,539	270,332	98,006	69,790	69,018	52,394	-837,372	-94%	-278,146	-84%
RI	12	18	20	17	14	18	22	16	4	31%	-4	-20%
VT	6	2	1	2	1	1	1	1	-4	-79%	0	-21%
Total	1,606,230	1,266,072	467,404	323,704	124,543	85,145	90,604	62,277	-1,543,954	-96%	-405,127	-87%

[29] CSAPR website: https://www.epa.gov/csapr

Figure 4-15: SO_2 Emissions in MANE-VU States from AMPD Sources 2002-2019

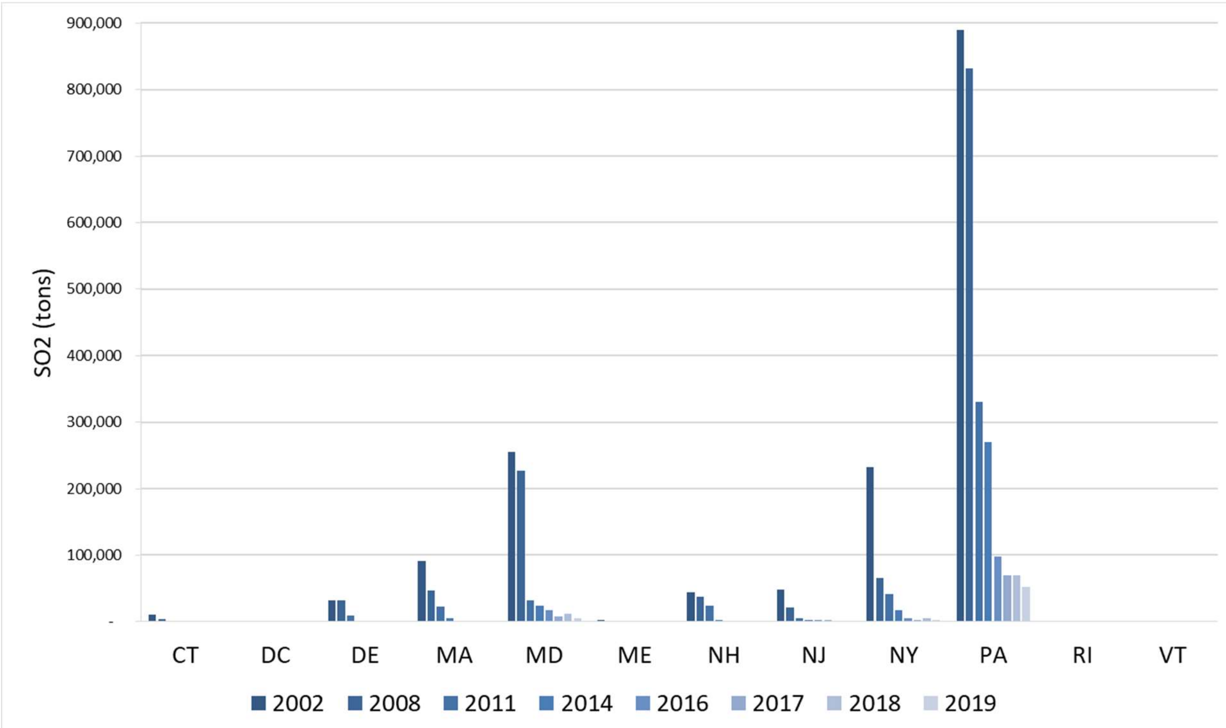
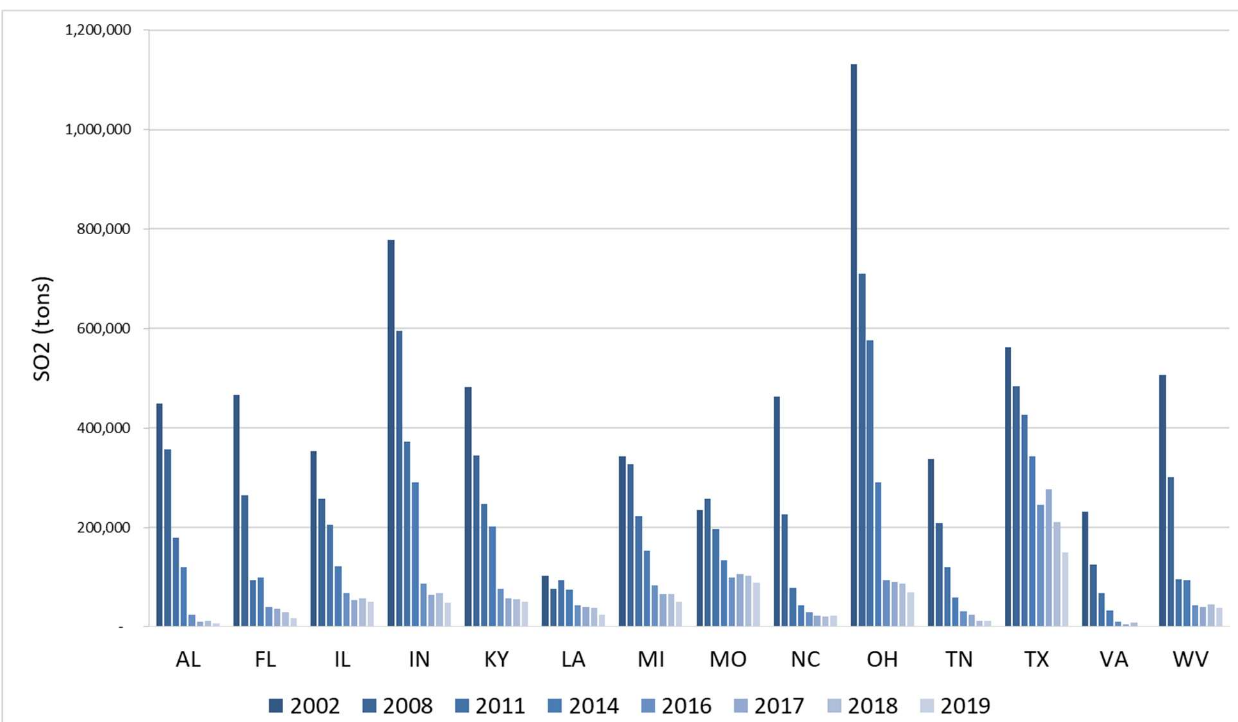


Figure 4-16: SO_2 Emissions in Ask States from AMPD Sources 2002-2019



4.8 Volatile Organic Compounds (VOC)

Figure 4-17 and Table 4-7 show VOC emissions from all source types in Massachusetts from 2002-2017. VOC emissions decreased for all sources by 51% (over 110,000 tons). This reduction is due primarily to the 58% reduction in onroad and 65% reduction in nonpoint emissions.

Note that MassDEP adjusted nonpoint VOC emissions downwards for 2002 and 2014 because a new methodology for residential wood-burning in 2017 resulted in substantially lower emissions (5,000 tons), thereby eliminating the appearance of an artificial reduction.

Figure 4-17: VOC Emissions in Massachusetts by Source Type 2002-2017

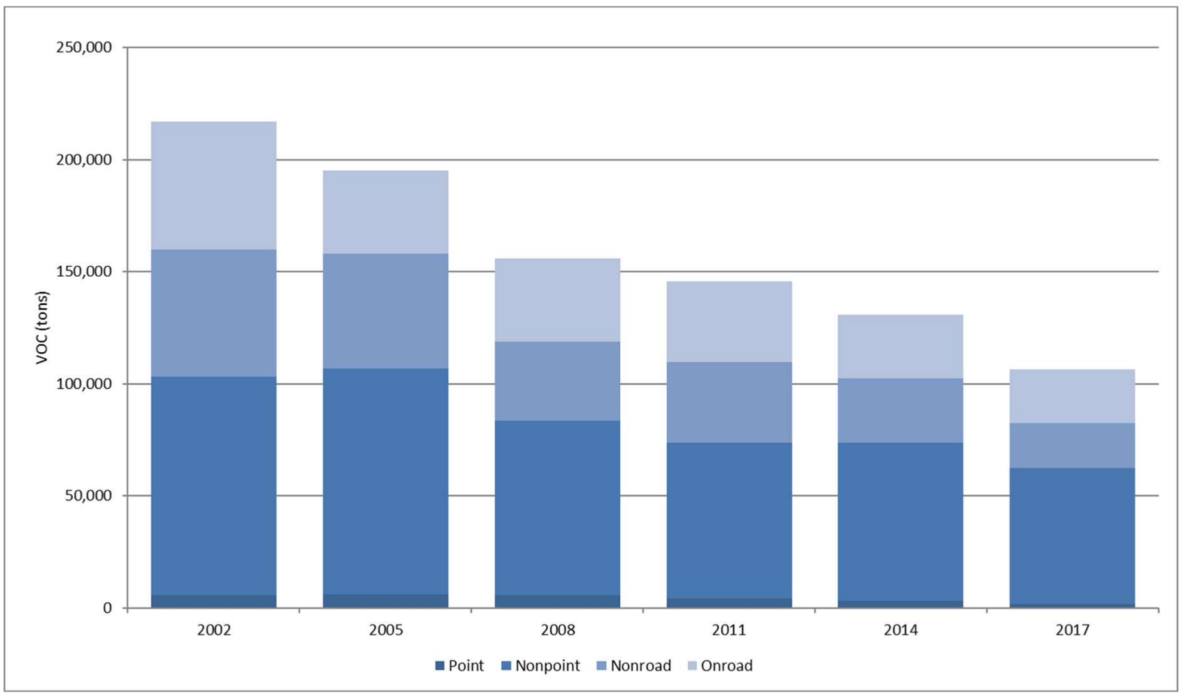


Table 4-7: VOC Emissions in Massachusetts by Source Type 2002-2017 (tons per year)

	2002	2005	2008	2011	2014	2017	Change 2002-2017	% Change 2002-2017
Point	5647	6038	5587	4119	3151	1764	-3,883	-69%
Nonpoint	97580	100531	77962	69697	70593	60546	-37,034	-38%
Nonroad	56577	51532	35232	35856	28769	19894	-36,683	-65%
Onroad	57184	37029	37024	35866	28219	24149	-33,035	-58%
TOTAL	216,988	195,130	155,805	145,538	130,732	106,353	-110,635	-51%

See notes in Section 4.3.

Figure 4-18 shows VOC emissions from all source types for MANE-VU states from 2002-2017. VOC emissions have declined in all MANE-VU states. The 51% reduction in Massachusetts is comparable to the overall reduction for MANE-VU of 49%. Note that the decrease may be overstated for many MANE-VU states because of improvements in estimation methodologies resulted in lower emissions in 2017 for nonpoint categories such as residential wood combustion.

Much of the decrease in VOC is due to federal and state rules for evaporative sources such as portable fuel containers; architectural, industrial, and maintenance coatings; consumer products; and solvent degreasing. Many states' rules for these categories are based on Ozone Transport Commission (OTC) Model Rules.[30] Evaporative VOC emissions from these types of sources are expected to continue to decline as more states adopt rules based on the OTC Model Rules. Other decreases are due to state VOC RACT rules. Evaporative VOC emissions from onroad mobile sources have decreased due to state motor vehicle inspection and maintenance programs and the increasing prevalence of on-board refueling vapor recovery (ORVR) equipped vehicles in the fleet. VOC emissions from nonroad and onroad mobile sources are expected to continue decreasing as older, more polluting vehicles are replaced by newer, cleaner ones.

VOC emissions from all source types from Ask states are shown in Figure 4-19. VOC emissions have declined by 37% in the Ask states, compared to a 49% decline in the MANE-VU states. Some Ask states show little change (or even increases) in total VOC emissions from 2002-2017. Some of these increases could be artificial due to methodology improvements.

[30] Ozone Transport Commission (OTC) model rule webpage: http://otcair.org/document.asp?Fview=modelrules

Figure 4-18: VOC Emissions in MANE-VU States for all Source Types 2002-2017

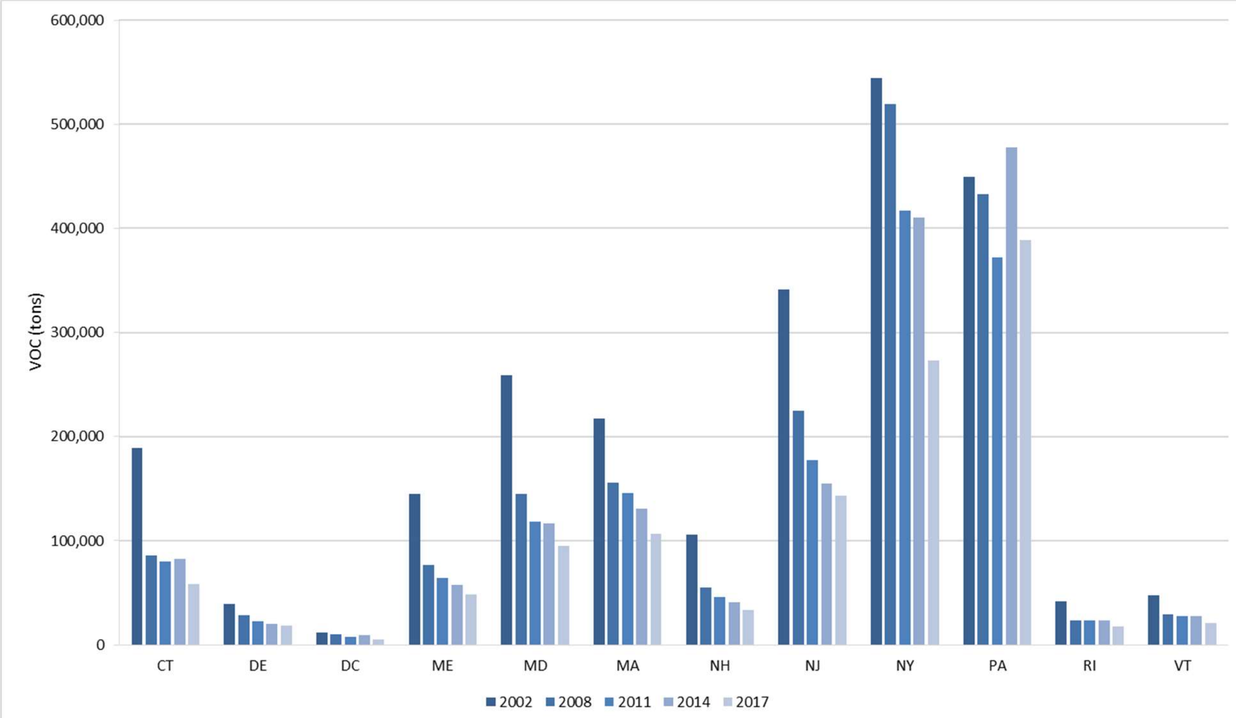
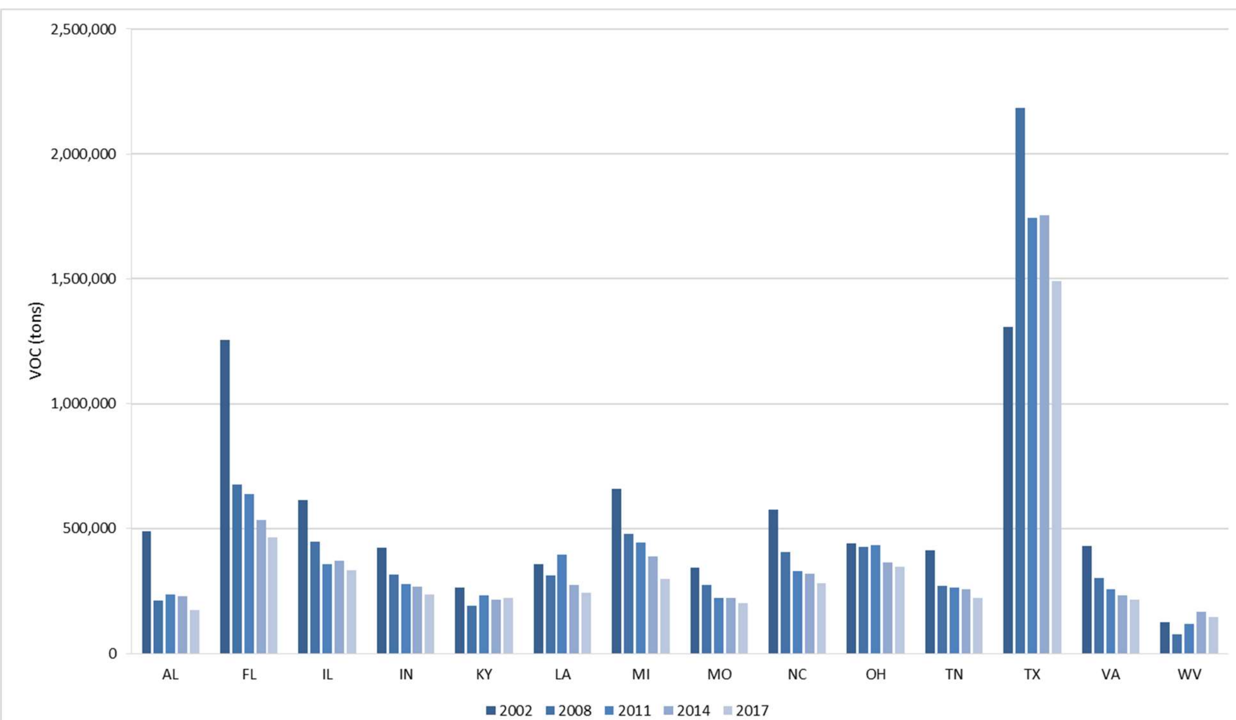


Figure 4-19: VOC Emissions in Ask States from all Source Types 2002-2017



4.9 Ammonia (NH_3)

Figure 4-20 and Table 4-8 show NH_3 emissions from all source types in Massachusetts for 2002-2017. Although slight year to year variability can be seen in some categories, there is an overall downward trend in NH_3 emissions in Massachusetts.

The overall NH_3 reduction in Massachusetts from all sources combined is 26%; this is primarily due to a 68% reduction from onroad mobile sources and a 67% reduction from point sources. Note that MassDEP inventories include NH_3 from livestock, human population, household pets, wild animals, and soils.[31] However, since 2002, EPA NEI only include livestock waste.

Note that MassDEP first estimated NH_3 emissions from composting for 2011. To avoid showing an artificial increase from previous years, MassDEP back-cast the composting estimates to 2002 using population growth.

Figure 4-24 shows NH_3 emissions for MANE-VU states from all source types with an overall reduction of 36% from 2002 and 2017.

Figure 4-25 shows NH_3 emissions for all source types for Ask states and shows an overall reduction of 10% from 2002 to 2017.

[31] The 2002 EPA NEI included NH_3 emissions derived from a Carnegie Mellon University (CMU) study (CMU 2002 Ammonia Emissions Model Inventory Version 3.6, October 2004. http://www.cmu.edu/ammonia). This study estimated NH_3 emissions from livestock, humans, pets, wild animals, and soils, but after 2002 EPA only included the livestock emissions in EPA's NEI. MassDEP has continued to include the other categories, growing the human and pet emissions since 2002 using human population and keeping the wild animals and soils constant. EPA's NOn-point Method ADvisory Committee (NOMAD) SharePoint site includes the Agricultural Livestock category emissions that MassDEP adopted for 2014. EPA used the University of Delaware Department of Agriculture data to grow the CMU livestock emissions from 2002 for the 2014 NEI Version 2 emissions.

Figure 4-20: NH_3 Emissions in Massachusetts from All Source Types 2002-2017

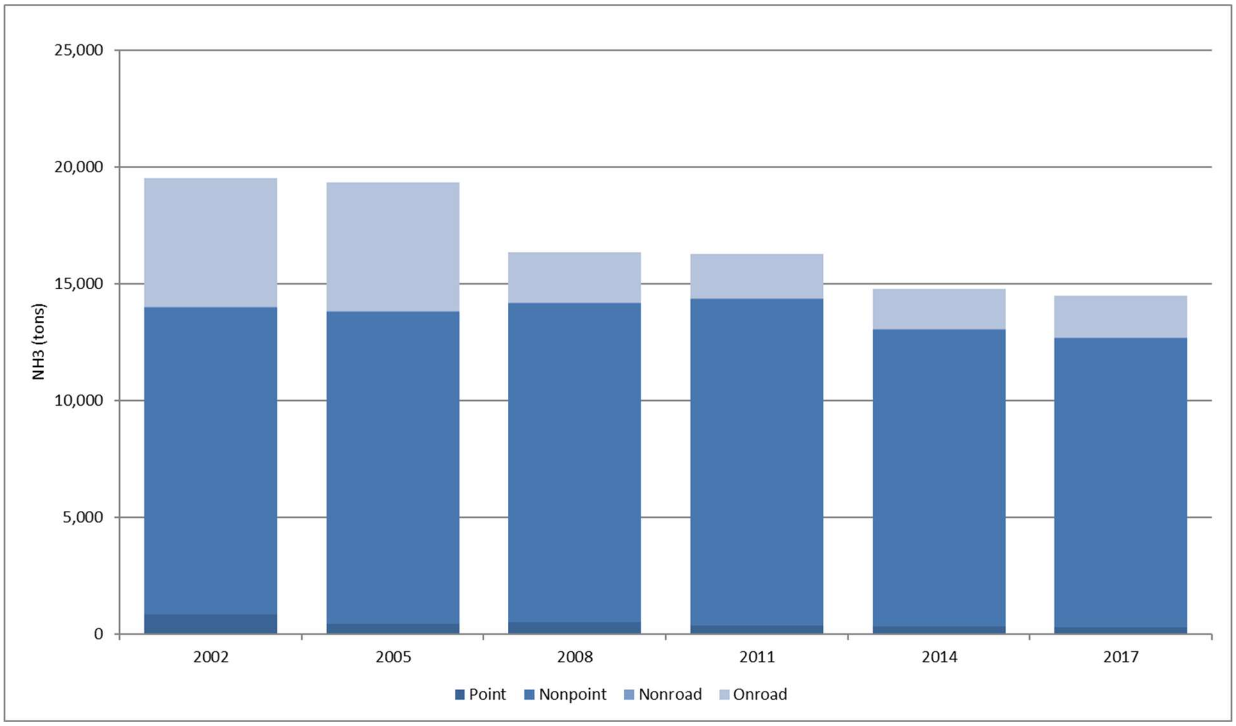


Table 4-8: NH_3 Emissions in Massachusetts from All Source Types 2002-2017 (tons per year)

	2002	2005	2008	2011	2014	2017	Change 2002-2017	% Change 2002-2017
Point	862	427	522	355	340	283	-579	-67%
Nonpoint	13127	13382	13628	13989	12676	12398	-729	-6%
Nonroad	29	28	33	40	34	29	0	-1%
Onroad	5499	5493	2149	1888	1736	1783	-3,716	-68%
TOTAL	19,517	19,330	16,332	16,272	14,786	14,492	-5,025	-26%

See notes in Section 4.3.

Figure 4-21: NH_3 Emissions in MANE-VU States from All Source Types 2002-2017

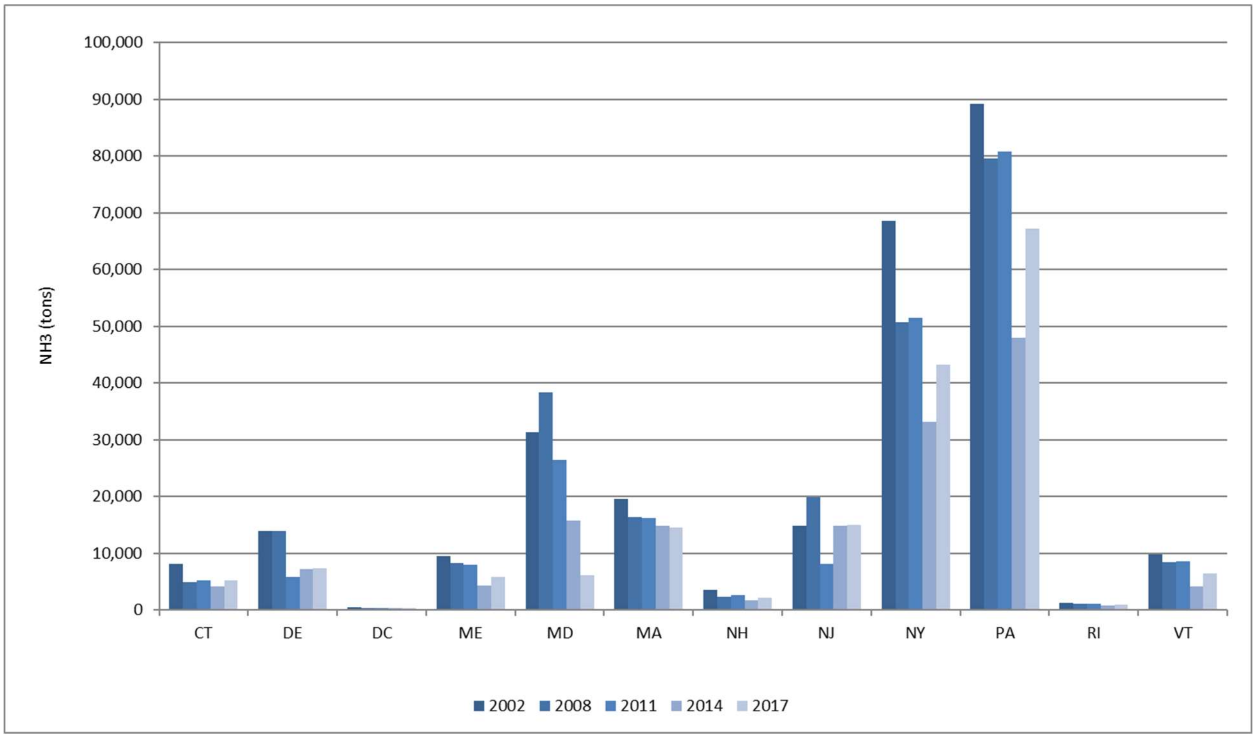
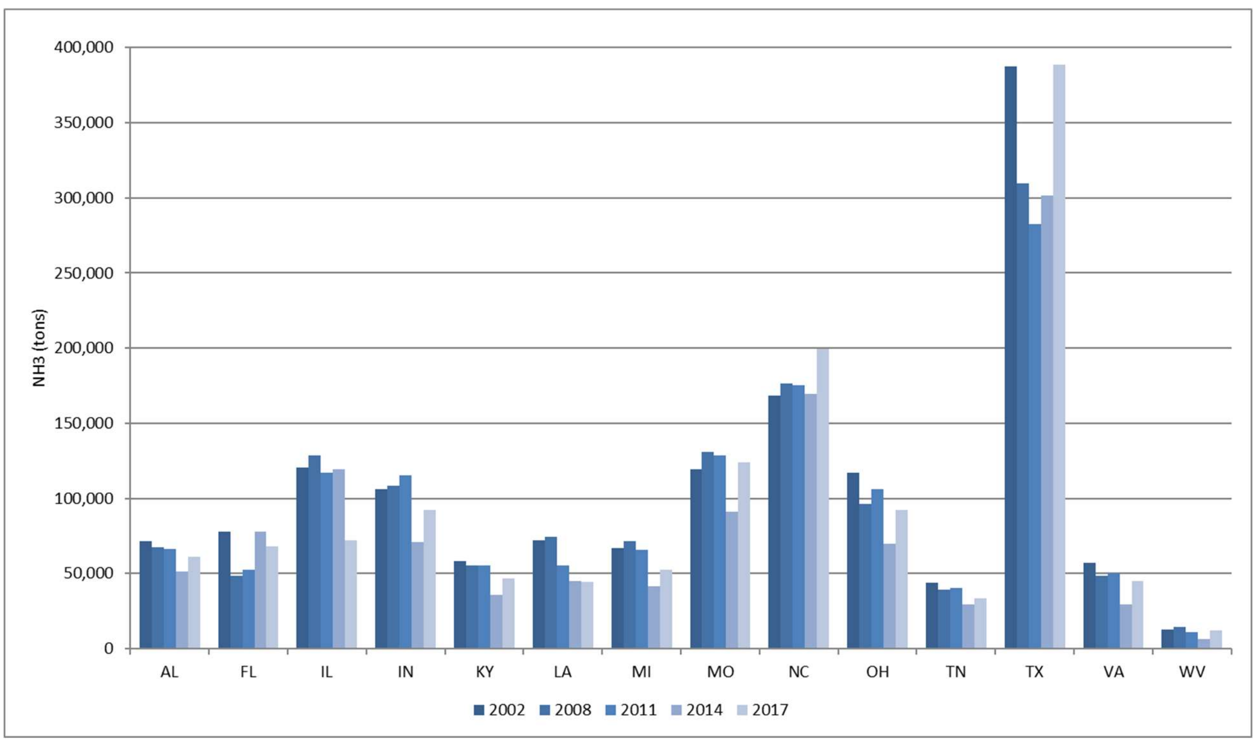


Figure 4-22: NH_3 Emissions in Ask States from all Source Types 2002-2017



4.10 Assessment of Changes in Emissions that Have Impeded Progress

40 CFR 51.308(g)(5) requires MassDEP to assess: (1) any significant changes in anthropogenic emissions within or outside the state that have occurred since the period addressed in the most recent plan (i.e., SIP revision) required under paragraph (f), (2) whether or not these changes in were anticipated in that most recent plan, and (3) whether they have limited or impeded progress in reducing emissions and improving visibility. EPA guidance[32] indicates that a significant change could be either: (1) a significant unexpected increase that was not projected in the analysis of the previous SIP; or (2) a significant reduction in emissions projected in the previous SIP that did not occur.

The data presented in this section show consistently declining emissions of haze-causing pollutants in Massachusetts and other states. This parallels the improved visibility at all Class I areas as shown in Section 2. Overall emissions reductions have been greater than anticipated in the RH SIP for the first implementation period. Although not all states implemented all components of the previous Asks, a shift to natural gas from coal and oil for electricity generation and an increase in solar and wind generation has led to significant decreases in emissions. In addition, many coal burning EGUs have retired. Therefore, no significant changes have occurred that have impeded progress in reducing emissions and improving visibility since the previous RH SIP.

4.11 Projections

MANE-VU used the 2011 Gamma Inventory as a baseline for modeling future year visibility. This inventory was developed by the Mid-Atlantic Regional Air Management Association (MARAMA), the Eastern Regional Technical Advisory Committee (ERTAC) EGU Workgroup, and EPA.

The basis for the 2011 Gamma Inventory is the 2011 NEI, with some slight variations. As the States, EPA and air agencies developed the 2011 modeling inventory, certain changes were made from the base NEI to reflect corrections or improvements.

The Gamma Inventory contains emissions projections for 2028 that include emissions growth due to higher activity levels as well as emission reductions due to planned controls. The future year 2028 inventory was developed using a combination of state data for stationary sources and

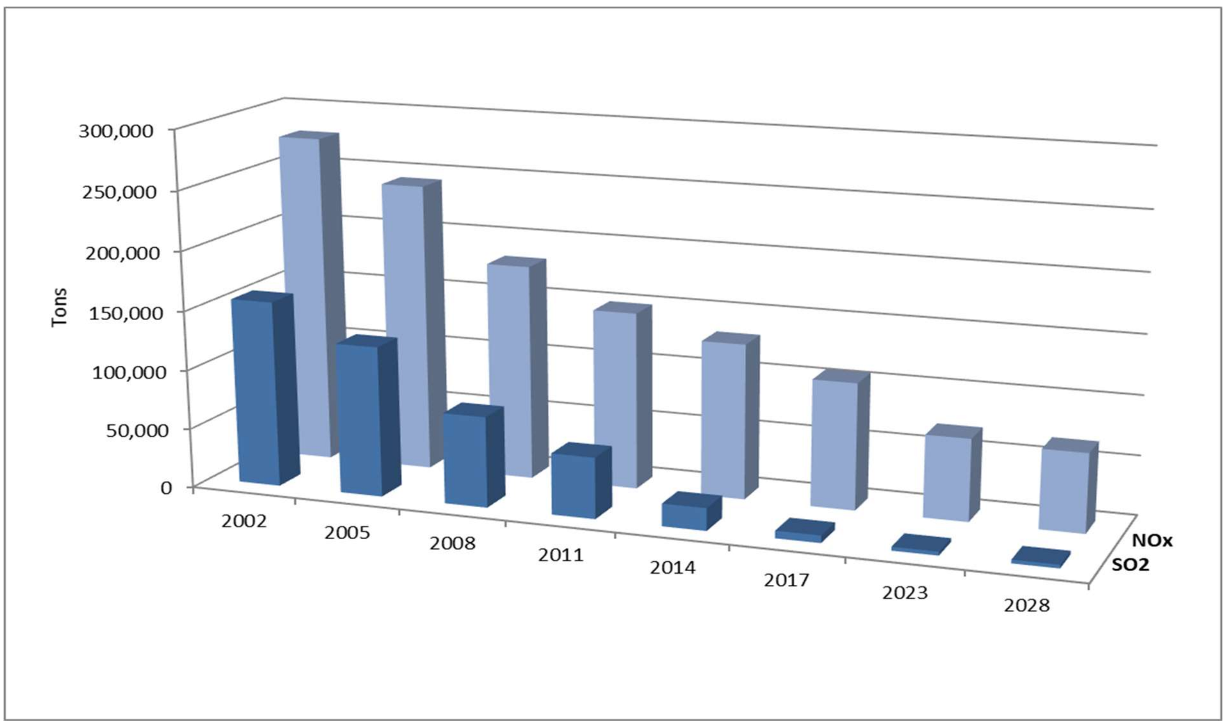
[32] General Principles for the 5-Year Regional Haze Progress Reports for the Initial Regional Haze State Implementation Plans (Intended to Assist States and EPA Regional Offices in Development and Review of the Progress Reports). EPA. April 2013.

EPA's 2028 Modeling Platform for mobile source projections. See the Gamma Inventory and modeling technical support documents for further details.[33,34]

Table 4-8 summarizes the Gamma Inventory 2028 projections for MANE-VU states, including Massachusetts. Figure 4-26 illustrates the continued downward trend in emissions projected by the Gamma Inventory.

Note that more recent emissions data than 2011 is available and has been considered by MANE-VU states in developing RH SIPs for the second implementation period. Specifically, 2014 and 2017 emissions inventory data were described earlier and 2015 data was used in the MANE-VU screening models outlined in Section 5. MANE-VU concluded, however, that for modeling future visibility the 2011 Gamma Inventory was still the most appropriate choice and documented the reasons for that choice.[35]

Figure 4-23: SO_2 and NO_x Emissions and Projected Emissions in Massachusetts from all Source Types 2002-2028



Source: 2002-2017 data are from EPA NEI and Massachusetts emissions inventories; 2023/2028 projections are from MANE-VU Gamma Inventory.

[33] Technical Support Document Emission Inventory Development For 2011 And Projections To 2020 And 2023 For The Northeastern U.S. Gamma Version. Mid-Atlantic Regional Air Management Association, Inc. (MARAMA). January 29, 2018. (Appendix 19)
[34] Ozone Transport Commission/Mid-Atlantic Northeastern Visibility Union 2011 Based Modeling Platform Support Document – October 2018 Update. Ozone Transport Commission/MANE-VU. October 2018. (Appendix 21)
[35] Future Modeling Platform Base Year Determination. MANE-VU. October 9, 2013 FINAL. (Appendix 5)

Table 4-9: 2028 Gamma Emissions Inventory Projections – MANE-VU States and Massachusetts

MANE-VU States	VOC	NOX	PM2.5	PM10	NH3	SO2
EGU Point	4,871	85,182	15,060	19,115	3,114	196,760
Non-EGU Point	54,371	148,416	28,329	37,522	5,123	82,813
Area	659,063	177,995	150,922	167,001	13,641	28,159
Nonroad	219,807	193,233	13,773	14,752	475	1,967
Onroad	111,151	165,746	9,216	35,845	12,632	1,642
Oil/Gas	49,830	70,737	3,101	3,196	16	6,369
Other	22,084	1,384	29,956	147,913	169,064	771
Anthropogenic Total	1,121,177	842,691	250,357	425,343	204,066	318,481
Biogenics	2,064,088	30,564				
Total 2028	3,185,265	873,256	250,357	425,343	204,066	318,481
Massachusetts	VOC	NOX	PM2.5	PM10	NH3	SO2
EGU Point	100	781	261	260	97	51
Non-EGU Point	3,459	12,525	1,351	1,108	442	1,872
Area	69,484	18,852	14,726	14,163	2,254	571
Nonroad	20,214	20,026	1,450	1,356	49	259
Onroad	10,832	13,003	3,600	848	1,149	141
Oil/Gas	67	176	27	27	6	6
Other	1,151	61	28,413	3,574	2,316	35
Anthropogenic Total	105,306	65,424	49,829	21,337	6,313	2,934
Biogenics	104,270	910				
Total 2028	209,576	66,335	49,829	21,337	6,313	2,934

NOTES:
Non-EGU point includes airports and railroad switch yards
Area includes: adjusted fugitive dust, Stage I refueling and residential wood burning (does not include marine and rail as in the NEI summaries)
Nonroad includes commercial marine vessels and underway railroad
Onroad includes Stage II refueling
Other includes agricultural ammonia and fires, prescribed and wild-fires and adjusted fugitive dust
Source: Technical Support Document Emission Inventory Development For 2011 And Projections To 2020 And 2023 For The Northeastern U.S. Gamma Version. Mid-Atlantic Regional Air Management Association, Inc. (MARAMA). January 29, 2018. (Appendix 19) (http://marama.org/technical-center/emissions-inventory/2011-gamma-inventory-and-projections)

5. Sources of Visibility-Impairing Pollutants

Section 5 identifies the visibility-impairing pollutants that contribute to regional haze at Class I and quantifies the potential impact from emissions sources in Massachusetts relative to other states and their sources.

5.1 Visibility-Impairing Pollutants

The pollutants responsible for fine particle formation (and thus regional haze) are SO_2, NO_x, VOCs, NH_3, PM_{10}, and $PM_{2.5}$. MANE-VU's Contribution Assessment for the first implementation period found that sulfate was the most important single constituent of haze-forming fine particle pollution and the principal cause of visibility impairment across the Northeast region.[36] Sulfate alone accounted for one-half to two-thirds of total fine particle mass on the 20% 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 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, for the first implementation period MANE-VU focused on regional SO_2 control measures as the most effective emissions management approach to reduce haze.

Figure 5-1 illustrates the dominance of sulfate (bottom yellow bar) in visibility extinction during the 2000-2004 baseline period.

5.2 Second Implementation Period Analysis of Pollutants

For the second implementation period, MANE-VU examined speciation data to identify changes in the contributions of individual constituents to visibility impairment.[37] Results clearly showed a significant reduction in the contribution at all Class I areas from sulfates for the 20% most impaired days with varying levels of increases for other species. The reduction in visibility extinction due to sulfates from 2000-2019 ranged from 51-70%.[38]

Figures 5-2 and 5-3 illustrate these trends by comparing baseline speciated extinction (2000-2004) with current (2013-2019) extinction levels for the 20% best and 20% worst (most impaired) days for all Class I sites. This shows that visibility improvement on all days was primarily due to sulfate reductions. As sulfate contributions declined the relative nitrate contributions increased at many sites. Also, during the winter, nitrate contributions to visibility impairment are much higher than summer. Because more winter days are now in the 20% worst

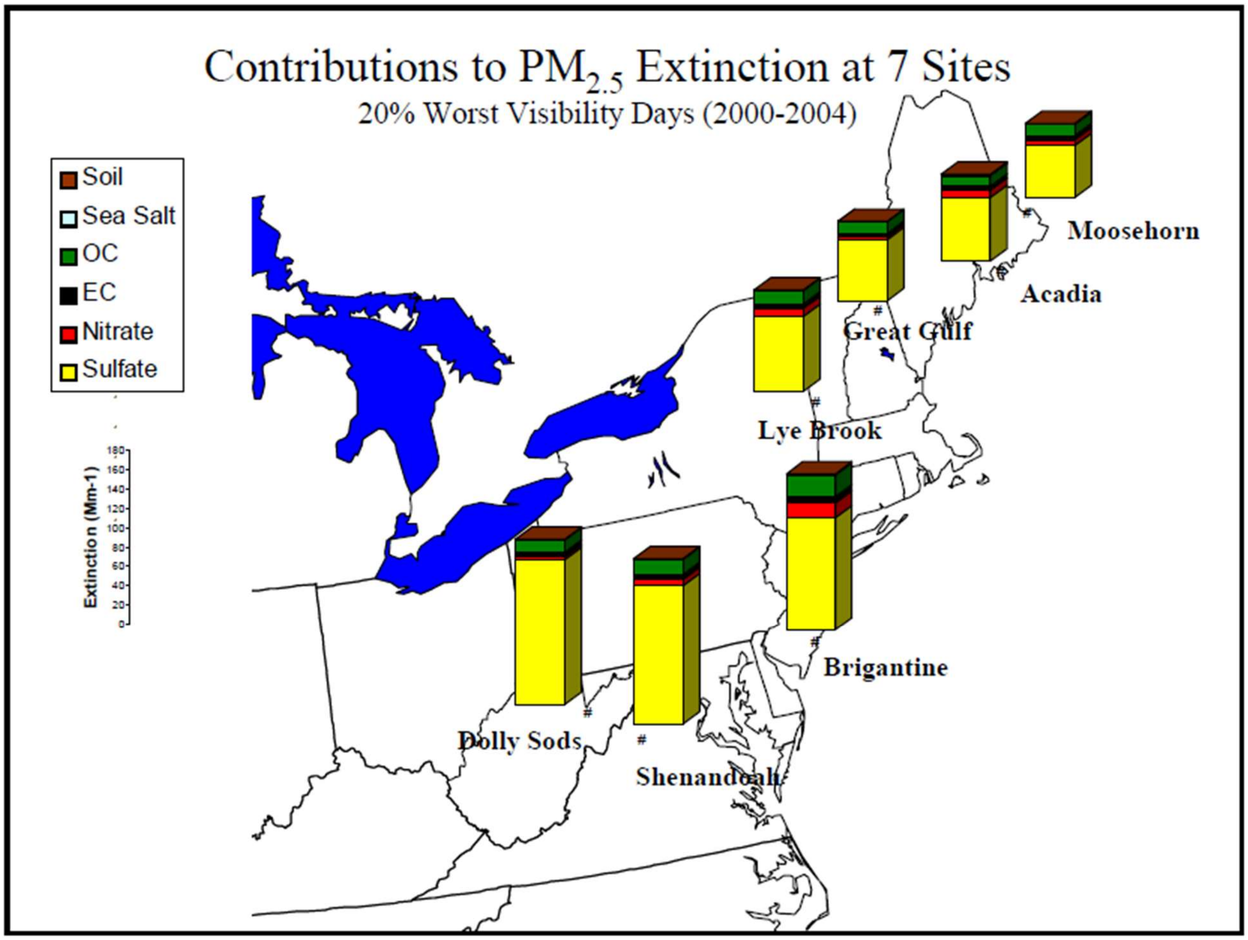
[36] Contributions to Regional Haze in the Northeast and Mid-Atlantic United States: Mid-Atlantic/Northeast Visibility Union (MANE-VU) Contribution Assessment. NESCAUM. August 2006. (Appendix 2)

[37] *Mid-Atlantic/Northeast U.S. Visibility Data, 2004-2019 (2nd RH SIP Metrics)*. MANE-VU (prepared by Maine Department of Environmental Protection). January 21, 2020 revision. (Appendix 22)

[38] Source file: TD MANE-VU sites analysis 2000-19 summary 2nd SIP 1-21-21.xlsx (5-yr plot Data, 20% clearest day extinction (Mm-1))

days, the relative contribution of nitrates increased. Both trends are especially visible at the Brigantine Wilderness Class I area.

Figure 5-1: Contributions to $PM_{2.5}$ Extinction at Seven Class I Sites

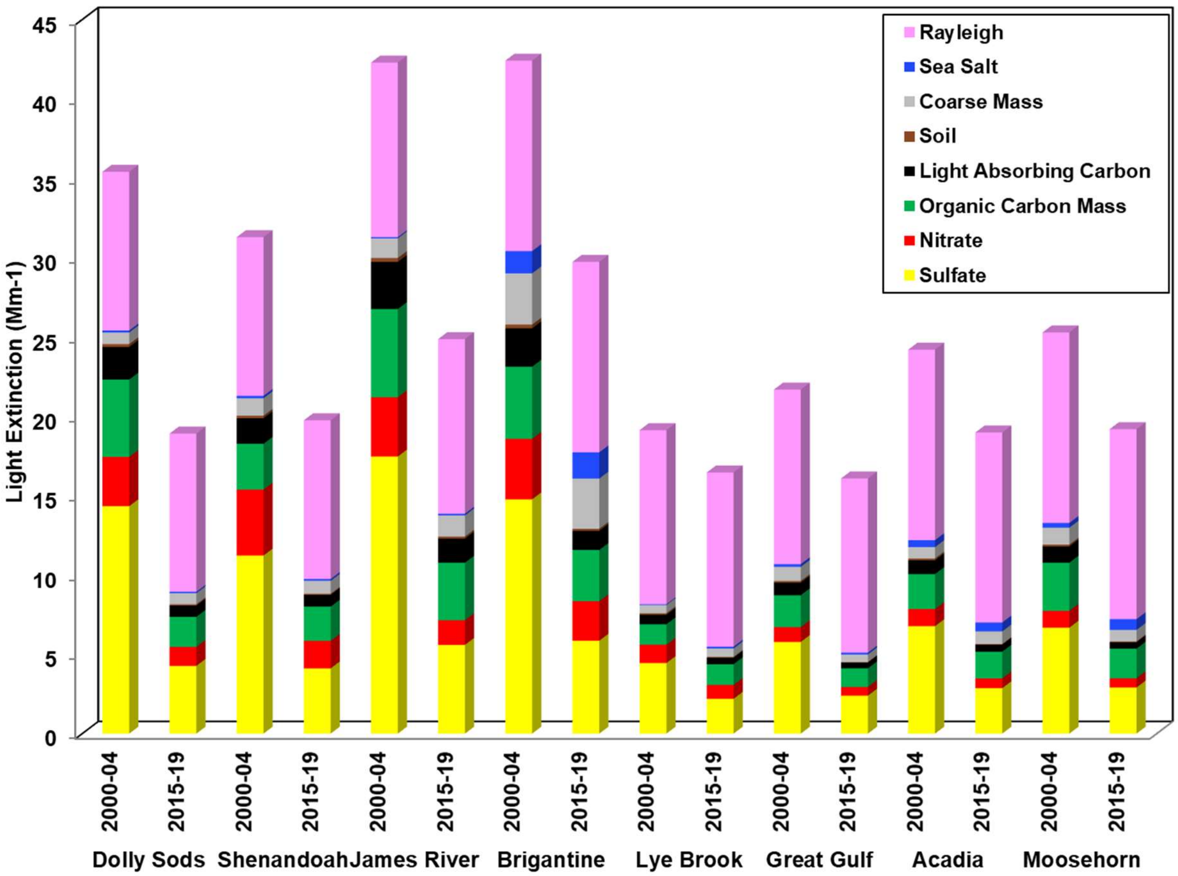


NOTE: Visibility extinction is a measure of the ability of particles (such as fine particles known as PM2.5) to scatter and absorb light. Extinction is expressed in units of inverse mega-meters (Mm^{-1}). A speciation analysis divides light extinction impacts into the following components: sulfates, nitrates, coarse mass, organic carbon mass (OC), light absorbing carbon, soil, sea salt and Rayleigh scattering.

For the second implementation period, MANE-VU concluded that: (1) sulfates from SO_2 emissions remain the most significant contributor to visibility impairment at all Class I areas in and adjacent to the MANE-VU region on the most impaired days; and (2) nitrates from NO_x emission sources now are more significant than in the first implementation period.

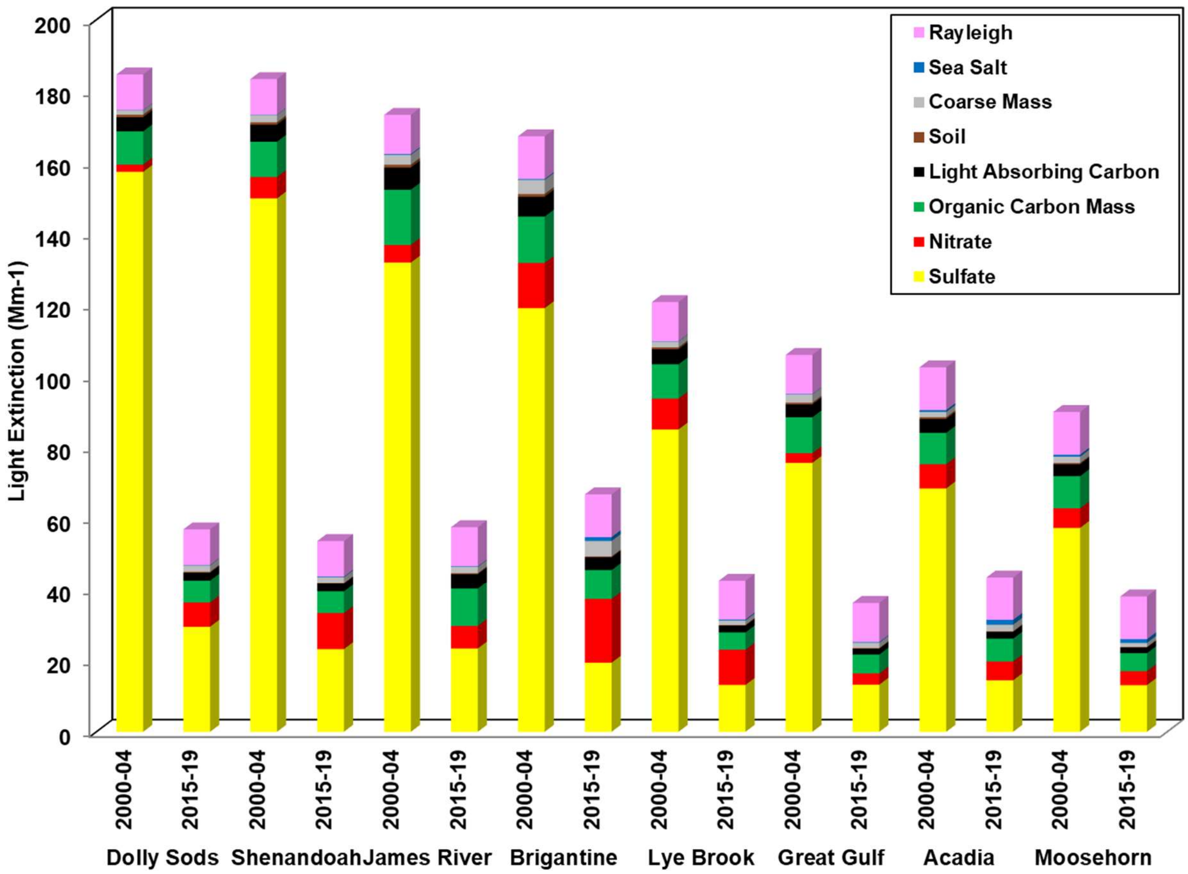
Based on these results, MANE-VU chose an approach for contribution assessments that continued to focus on sulfates and included nitrates when they could be included in a technically sound fashion.

Figure 5-2: Current (2013-19) and Baseline (2000-04) 5-Year Average Light Extinction at Class I Sites on 20% Clearest Visibility Days



Source: Mid-Atlantic/Northeast U.S. Visibility Data 2004-2019 (second RH SIP Metrics). MANE-VU (prepared by Maine Department of Environmental Protection). January 21, 2021. (Figure 3-9) (Appendix 22)

Figure 5-3: Current (2013-19) and Baseline (2000-04) 5-Year Average Light Extinction at Class I Sites on 20% Most Impaired Visibility Days



Source: Mid-Atlantic/Northeast U.S. Visibility Data 2004-2019 (second RH SIP Metrics). MANE-VU (prepared by Maine Department of Environmental Protection). January 21, 2021. (Figure 3-9) (Appendix 22)

5.3 Contributing Sectors, States, and Sources

For the second implementation period, MANE-VU assessed the contribution of states, sources, and sectors to visibility impairment.[39] This work produced a quantitative estimate of the impact of emissions from Massachusetts sources on Class I areas.

MANE-VU first examined emissions inventories to find sectors that should be considered for further analysis.[40] This analysis also included projections to 2018 that considered rules that were going into effect between 2011 and 2018 and known unit shutdowns and fuel switches. Since

[39] Selection of States for MANE-VU Regional Haze Consultation (2018). MANE-VU Technical Support Committee. September 5, 2017. (Appendix 16)

[40] Contribution Assessment Preliminary Inventory Analysis. Memo from MANE-VU Technical Support Committee. October 10, 2016. (Appendix 11)

the proportion of impairment from winter nitrates has increased in several MANE-VU Class I areas, both SO_2 and NO_x emissions were considered. That analysis concluded that EGUs emitting SO_2 and NO_x and industrial point sources emitting SO_2 were the point source sectors with emissions high enough to warrant further scrutiny. Heavy duty diesel vehicles also were found to be an important sector for NO_x emissions.[41] Since power plants and mobile sources generally dominate state and regional NO_x emissions inventories, only non-EGU sources emitting SO_2 were selected for further analysis. MANE-VU analyzed the point sectors further as described below.

Although SO_2 emissions from marine engines potentially have significant visibility impacts, MANE-VU did not further consider this sector because the implementation of 1000 ppm sulfur limits for marine fuel oil to comply with the North American Emission Control Area[42] were projected to reduce SO_2 emissions from the sector substantially beginning in 2015. MANE-VU also did not carry forward NO_x emissions from nonroad equipment because Tier 4 emission standards were projected to reduce NO_x emissions from the sector substantially beginning in 2014.[43] SO_2 emissions from residential fuel oil combustion was again determined to be important and confirmed the value of the MANE-VU low sulfur fuel oil strategy.

Next, MANE-VU screened states and sectors for contribution using two tools: Q/d and CALPUFF modeling. [44,45,46] Q/d is the ratio of the quantity of emissions from a source to the distance from a Class I area (which was then multiplied by a factor to account for prevailing winds). MANE-VU previously employed Q/d for the first implementation period[47,48] CALPUFF simulates atmospheric transport, transformation, and dispersion through the treatment of emissions from stacks or area sources as a series of discrete puffs. Results were then compared to air mass trajectories for the 20% most impaired days at MANE-VU Class I areas.

The screening was performed for selected Class I areas in MANE-VU states and nearby states (Dolly Sods, James River Face, Otter Creek, and Shenandoah). MANE-VU primarily considered emissions from EGUs and industrial/commercial/institutional (ICI) units, but also included state-wide emissions to account for the impact of area and mobile sources. Since the relative percent of impairment from winter nitrates has increased in several MANE-VU Class I areas, SO_2 and

[41] Mobile sources were addressed in the 2017 MANE-VU Ask to EPA rather than in the 2017 Ask for MANE-VU states.
[42] 75 FR 22896
[43] 40 CFR 1039.101
[44] Q/d performed by CTDEP and CALPUFF modeling performed by NHDES with meteorological inputs developed by VTDEC.
[45] MANE-VU Updated Q/d*C Contribution Assessment. MANE-VU Technical Support Committee. April 6, 2016. (Appendix 9)
[46] 2016 MANE-VU Source Contribution Modeling Report, CALPUFF Modeling of Large Electrical Generating Units and Industrial Sources. MANE-VU. April 4, 2017. (Appendix 8)
[47] Contribution to Regional Haze in the Northeast and Mid-Atlantic United States. NESCAUM. 2006. (http://www.nescaum.org/topics/regional-haze/regional-haze-documents)
[48] Contributions to Regional Haze in the Northeast and Mid-Atlantic United States: Preliminary Update through 2007. NESCAUM. 2012. (Appendix 2)

NO_x emissions were both considered. To ensure consideration of recent changes in the emissions inventory, MANE-VU used 2015 emissions directly or estimated 2015 emissions.

MANE-VU selected states that contributed 2% or more of the visibility impairment and had an average mass impact of over 1% (0.01µg/m^3) for consultation as part of the regional SIP planning process. In addition, MANE-VU identified specific emissions units as significant contributors if their estimated impact on visibility at any Class I area was greater than 3 Mm^{-1}. An overview of this work is provided below along with specific results for Massachusetts.

CALPUFF – The CALPUFF estimates for EGUs were based on 95th percentile daily NO_x and SO_2 emissions for 2015 and three years of meteorology (2002, 2011, and 2015) with the maximum value from the three years of meteorology used to assess contribution. Typical day emissions for 2011 from ICI units were modeled with the three years of meteorology because 2015 data was not available for those units.

Q/d – The Q/d analysis used state-wide 2011 SO_2 emissions emanating from the state centroid. State-wide data were chosen to include emissions from mobile and area sources. The 2011 state-wide SO_2 emissions were then scaled to 2015 levels for use in the impact analysis. Nitrate impacts were estimated from the ratio of NO_3/SO_4 taken from the 2015 CALPUFF statewide averages – this ratio was applied to the estimated 2015 SO_4 Q/d results to yield the nitrate value. This ratio was chosen to approximate the differing chemistry between NO_3 and SO_4 formation which is captured in the CALPUFF results.

Contributions – Both techniques (Q/d and CALPUFF) provided estimates for potential visibility impacting masses. Rather than relying solely on one technique, MANE-VU included both by averaging each relative contribution calculation for NO_3 and SO_4. Since nitrates and sulfates produce similar visibility impairment for similar ambient air concentrations, they weighted equally in the impact calculations. The Q/d and CALPUFF results were also equally weighed when both were available.

Table 5-1 (taken from the MANE-VU 2017 contribution analysis) provides average relative percent contributions of sulfate and nitrate from each state to each of the five MANE-VU Class I areas.[49] The scores for the 36 states total 100 (or 100%). States listed towards the top of the table (in orange shading) are each estimated to contribute 3% or more of the 36 state total contribution. States in the pink shade contribute 2-3%, and states in the green shade contribute less than 2%. The Maximum column provides the maximum percentage that a state contributes to any Class I area in MANE-VU. The farthest right column gives the average mass estimated by the four methods.

[49] Selection of States for MANE-VU Regional Haze Consultation (2018). MANE-VU Technical Support Committee. September 5, 2017. p.6-7. (Appendix 16) The contribution is the average of the four percentage contribution values from: CALPUFF SO4, CALPUFF NO3, Q/d SO4, and Q/d NO3 (estimated). The CALPUFF contributions were the maximum contribution from the 3 years of meteorology modeled. Data was 2015 (for EGUs) or 2011 scaled to 2015 (all other sources).

If a state contributed 2% or more at any of the five Class I Areas, MANE-VU deemed it a significantly contributing state. The 2% criteria were the same as was used by the MANE-VU states in the first implementation period SIPs. States were removed from consideration if their mass factor was below 1% (0.01 $\mu g/m^3$).

To validate these results MANE-VU evaluated wind trajectories for the 20% most impaired days from 2002, 2011, and 2015. The wind trajectory data supported the findings from the modeling for the 14 states outside of MANE-VU that were identified as significant contributors to MANE-VU Class I areas.[50]

Massachusetts Contributions – The results indicated that emissions from Massachusetts contributed significantly (> 2%) to visibility impairment at Acadia and Moosehorn Class I areas. The screening showed that Massachusetts did not significantly contribute (< 2%) to Brigantine, Great Gulf, and Lye Brook. This was an improvement from the previous 2006 contribution assessment which had found that Massachusetts had contributed more than 2% of the visibility-impairing emissions at Brigantine, Great Gulf, and Lye Brook.[51] The overall contribution from Massachusetts to visibility extinction at Acadia compared to other states is illustrated in Figures 5-1 and 5-2.

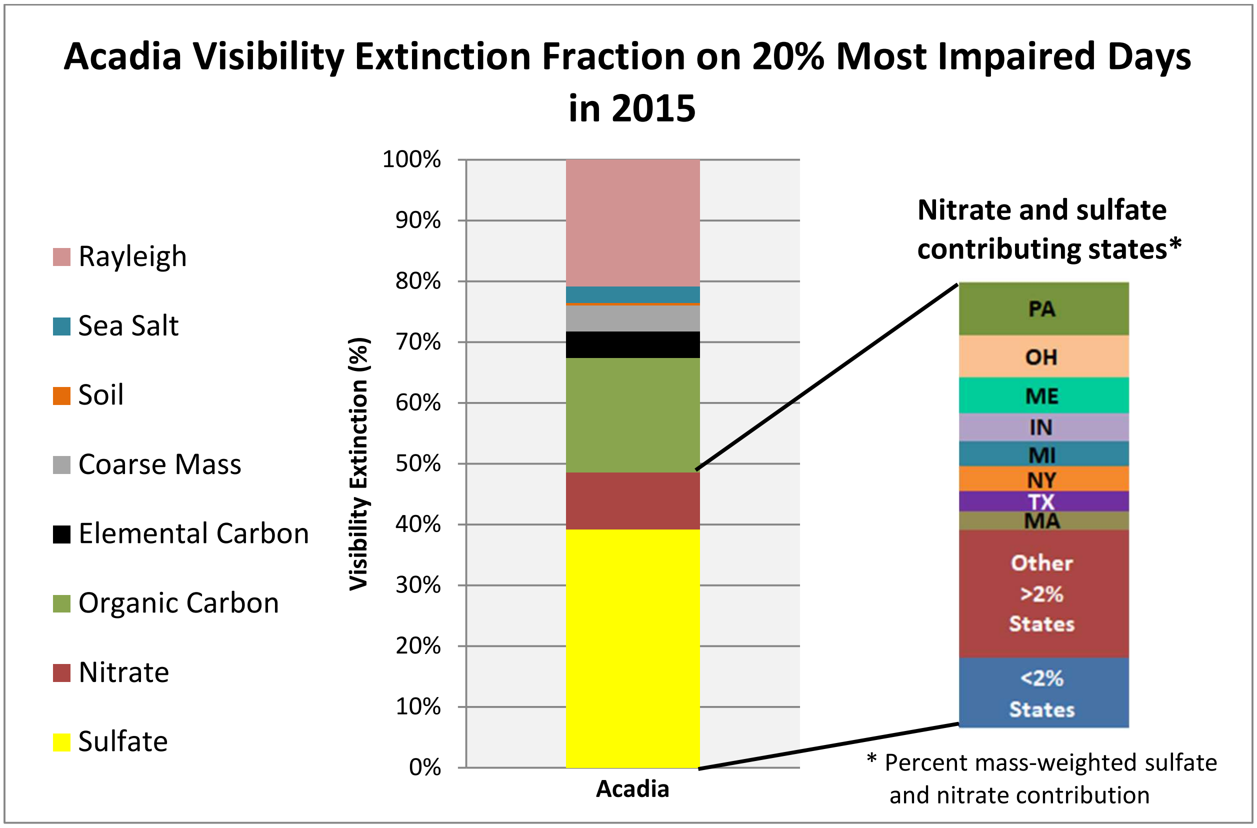
[50] Ibid. p.11
[51] Massachusetts 2012 RH SIP, Table 9.

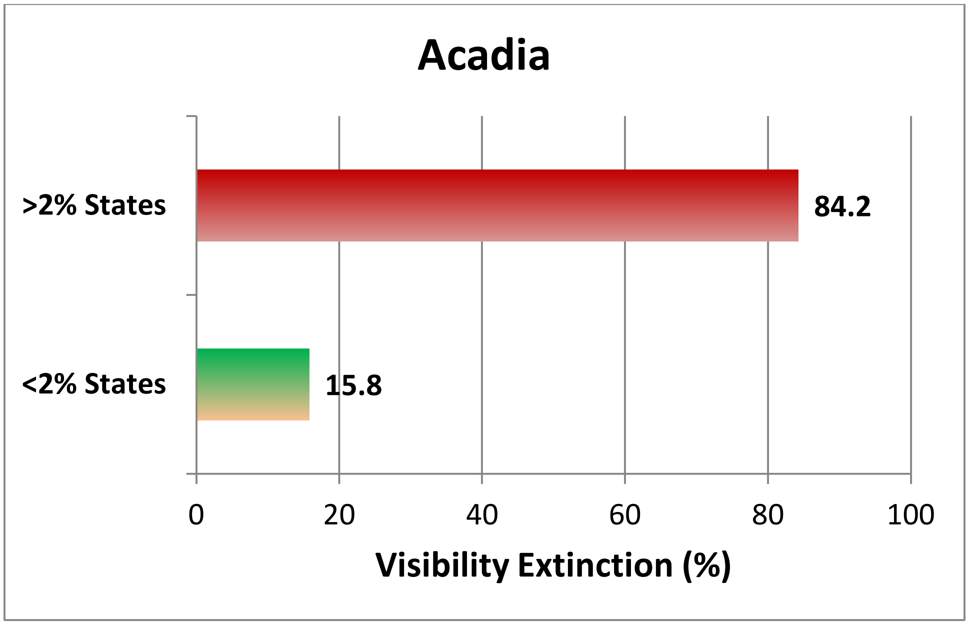
Table 5-1: Percent Mass-Weighted Sulfate and Nitrate Contribution for top 36 Eastern States to All MANE-VU Class I Areas

Rank	Maximum		Acadia		Brigantine		Great Gulf		Lye Brook		Moosehorn		Mass Factor	
1	PA	20.0	PA	12.4	PA	19.9	PA	15.6	PA	20.0	PA	10.5	PA	2.11
2	OH	11.3	OH	10.1	OH	8.8	OH	10.9	OH	11.3	OH	10.2	OH	1.06
3	NY	10.0	ME	8.3	MD	6.5	IN	8.0	NY	10.0	IN	8.0	IN	0.64
4	ME	8.3	IN	6.9	WV	6.4	NY	7.6	IN	7.4	TX	6.3	WV	0.61
5	IN	8.0	MI	6.0	NY	6.1	MI	6.6	TX	5.4	MI	6.0	MI	0.54
6	MI	6.6	NY	5.8	IN	5.4	TX	4.9	WV	5.3	NY	5.9	VA	0.47
7	MD	6.5	TX	4.7	TX	5.1	WV	4.7	MI	5.1	ME	5.6	KY	0.47
8	WV	6.4	MA	4.4	VA	4.8	IL	3.7	KY	4.2	WV	4.8	TX	0.44
9	TX	6.3	WV	3.9	KY	4.7	NH	3.7	IL	2.7	KY	4.2	NY	0.42
10	VA	4.8	NH	3.4	MI	4.5	KY	3.6	MO	2.5	IL	3.9	MD	0.40
11	KY	4.7	KY	3.4	NC	2.7	MO	3.1	LA	2.4	MA	3.4	NC	0.34
12	MA	4.4	IL	2.8	AL	2.6	ME	2.9	VA	2.4	MO	3.3	MA	0.27
13	IL	3.9	NC	2.7	LA	2.5	WI	2.6	NC	2.3	NH	3.1	NH	0.26
14	NH	3.7	MD	2.7	NJ	2.2	LA	2.2	MD	2.3	LA)	2.8	ME	0.25
15	MO	3.3	VA	2.5	IL	2.1	VA	2.1	AL	2.03	MD	2.6	AL	0.22
16	LA	2.8	MO	2.4	TN	2.01	NC	2.1	WI	1.9	AL	2.5	LA	0.21
17	NC	2.7	AL	2.2	GA	1.97	MD	2.1	OK	1.6	VA	2.4	TN	0.18
18	AL	2.6	FL	2.1	MO	1.9	VT	2.1	ME	1.6	NC	2.2	GA	0.17
19	WI	2.6	LA	2.1	FL	1.5	AL	1.8	TN	1.5	OK	1.8	MO	0.16
20	NJ	2.2	GA	1.9	MA	1.4	OK	1.8	GA	1.3	WI	1.8	FL	0.13
21	FL	2.1	WI	1.8	OK	1.4	MA	1.8	IA	1.2	TN	1.7	IL	0.12
22	VT	2.1	TN	1.5	NH	1.1	GA	1.8	MA	1.2	GA	1.7	OK	0.12
23	TN	2.01	IA	1.5	NE	1.0	IA	1.7	CT	1.2	IA	1.5	VT	0.09
24	GA	1.97	CT	1.3	AR	1.0	AR	1.3	AR	1.2	CT	1.4	NJ	0.09
25	OK	1.8	OK	1.2	CT	1.0	TN	1.3	NH	1.1	AR	1.4	IA	0.07
26	IA	1.7	AR	1.2	WI	0.9	KS	1.0	MN	1.0	KS	1.2	WI	0.07
27	CT	1.4	NJ	1.0	ME	0.9	NE	0.8	FL	1.0	NJ	0.9	CT	0.07
28	AR	1.4	MN	0.9	IA	0.9	CT	0.7	KS	0.8	MS	0.8	MS	0.07
29	KS	1.2	KS	0.8	SC	0.8	MS	0.7	NJ	0.8	NE	0.8	AR	0.06
30	NE	1.0	NE	0.8	MS	0.8	SC	0.5	MS	0.7	VT	0.8	SC	0.05
31	MN	1.0	SC	0.8	DE	0.6	MN	0.5	NE	0.6	SC	0.8	MN	0.04
32	MS	0.8	MS	0.6	KS	0.6	FL	0.5	SC	0.5	FL	0.7	NE	0.03
33	SC	0.8	VT	0.6	MN	0.6	NJ	0.4	VT	0.3	MN	0.5	RI	0.02
34	DE	0.6	RI	0.5	RI	0.3	RI	0.2	RI	0.2	DE	0.2	KS	0.02
35	RI	0.5	DE	0.2	DC	0.2	DE	0.2	DE	0.1	RI	0.1	DE	0.02
36	DC	0.2	DC	0.1	VT	0.2	DC	0.1	DC	0.1	DC	0.1	DC	0.016

Maximum – consolidated maximum to any Class I area
Mass Factor – average contributed mass in μg/m^3
Contribution values sum to 100 (100%)
Source: Selection of States for MANE-VU Regional Haze Consultation (2018). MANE-VU Technical Support Committee. September 5, 2017. (Appendix 16) p.6-7 Table 7

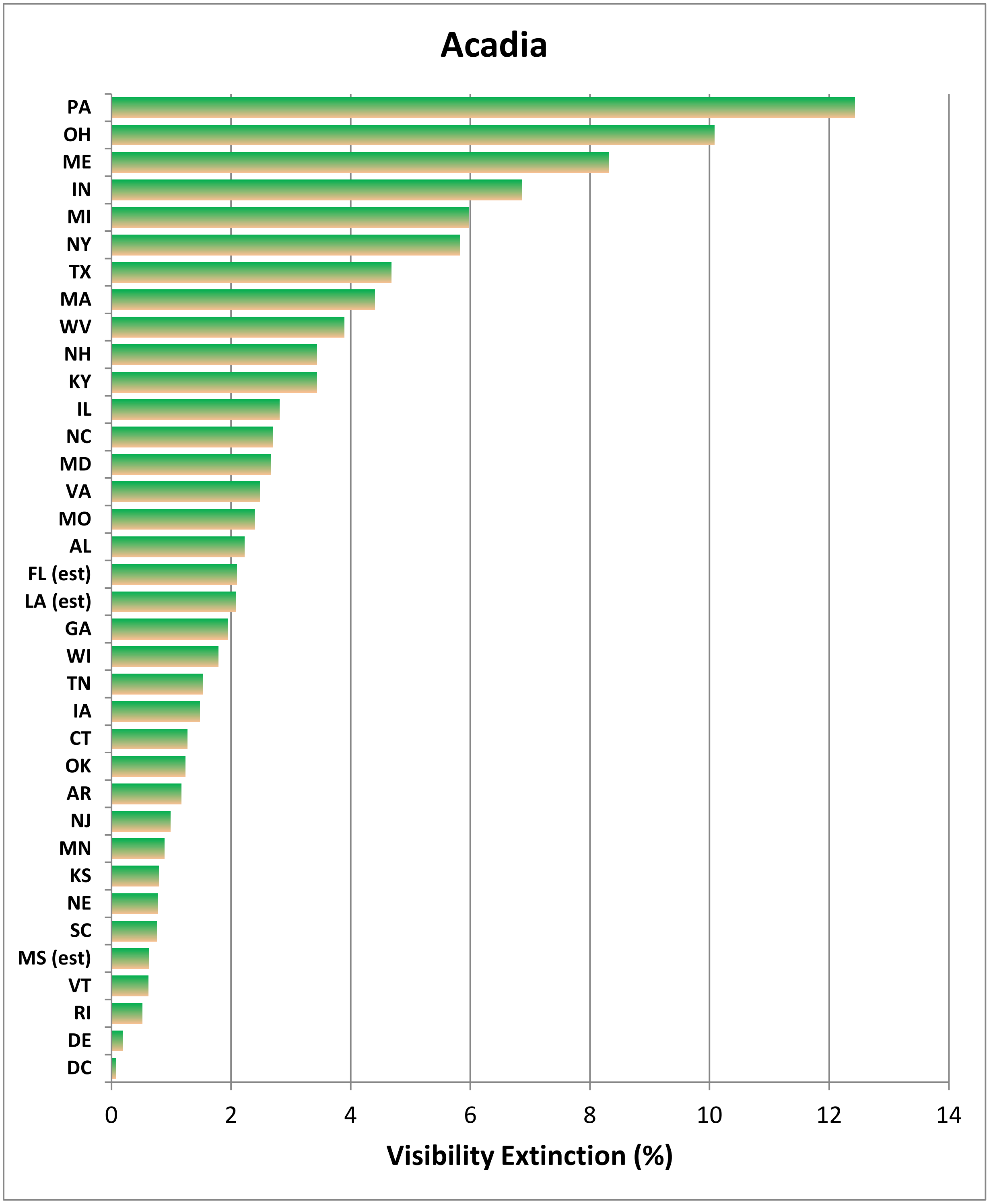
Figure 5-1: Visibility Extinction and Fraction in Acadia by State – 2015 Emissions





Source: NH Department of Environmental Services

Figure 5-2: Percent Mass Weighted Sulfate and Nitrate Contribution for Acadia by State – 2011-2015 Emissions



NOTE: Only states at or above 1% contribution are shown.
Source: NH Department of Environmental Services

5.4 Contributing Emission Units in Massachusetts

The CALPUFF modeling also estimated the contribution from specific EGU and ICI sources within each contributing state.[52] The CALPUFF analyses considered 500 EGU units throughout the eastern U.S.[53] The MANE-VU TSC also identified 82 ICI facilities located within the CALPUFF modeling domain that either have emissions similar in magnitude to the EGUs modeled in this exercise, or are close enough to a Class I area that they would have the potential for visibility impacts.[54] Later in the data collection process the number of sources was limited to only sources that cumulatively contributed to 50% of the impairment.

Emissions inputs for EGUs were derived from continuous emissions monitoring system (CEMS) data in EPA's AMPD. MANE-VU chose to model 95th percentile daily emissions to represent high emission days while at the same time eliminating outlying high emissions due to occasional events such as start-ups and shut-downs. Annual emissions also were modeled to show how the predicted visibility impacts differ (especially for units that are infrequently operated). Emissions for ICI units were derived from reported annual emissions adjusted to a typical hourly emission estimate based on emission unit operational statistics.

Calculated 95th percentile 2011 and 2015 EGU emissions for SO_2 and NO_x were modeled for each day of the year to assess the maximum 24-hour impact to each of eleven Class I areas. Similarly, annual 2011 and 2015 EGU emissions were modeled for the entire year for each Class I area. This process was carried out for each of the years of meteorology (2002, 2011, and 2015). The typical hourly emissions for ICI sources (2011 emissions) were also modeled with 2002, 2011 and 2015 meteorology.

The results (including 24-hour maximum sulfate [SO_4] and nitrate [NO_3] concentrations, extinction, and deciviews), were used to rank emission units by their extinction value at each Class I area.[55] Massachusetts EGUs had a larger impact on Acadia than other Class I areas. The rankings for Massachusetts EGUs for their impact on Acadia are given in Table 5-2.

The report also found that some industrial emissions sources (other than EGUs) may have significant impacts on visibility at MANE-VU Class I areas. Several of these sources are located in MANE-VU, while a few are located in nearby states. The only Massachusetts industrial source deemed by MANE-VU to have the potential for significant impact on Class I areas in 2011 was Solutia, Inc., (at that time a coal- and oil-fired chemical plant), and its greatest impact was to Lye Brook. Solutia ranked 14th in the list of industrial/institutional sources that had potential impacts on Lye Brook. The maximum extinction estimated for Solutia at Lye Brook,

52 2016 MANE-VU Source Contribution Modeling Report, CALPUFF Modeling of Large Electrical Generating Units and Industrial Sources. MANE-VU. April 4, 2017. (Appendix 8)

53 Selection of States for MANE-VU Regional Haze Consultation (2018). MANE-VU Technical Support Committee. 9/5/2017. p.3. (Appendix 16)

54 2016 MANE-VU Source Contribution Modeling Report, CALPUFF Modeling of Large Electrical Generating Units and Industrial Sources. MANE-VU. April 4, 2017. p.14 (Appendix 8)

55 Ibid. For individual rankings see Appendix F (F.1-F.33): Ranking of Visibility-Impairing Sources to Class I Areas to the report above.

however, was less than 1 Mm^{-1}. Solutia has since repowered from coal/oil to natural gas and so is no longer a source of SO_2

Overall, MANE-VU found that emission sources located close to Class I areas typically show higher visibility impacts than similarly sized facilities further away. But visibility degradation appears to be dominated by the more distant emission sources due to their larger emissions.[56]

Table 5-2: Rankings of Massachusetts EGUs for Modeled Impact on Visibility at Acadia – 2015

Source	Rank for 2015	Overall Max Extinction (Mm^{-1})
Brayton #1	84	0.57
Brayton #2	57	0.95
Brayton #3	65	0.82
Brayton #4	7	4.31
Canal #1	9	3.01
Canal #2	17	2.35

Note: Salem Harbor also showed impacts for 2011 but was retired before 2015 and therefore is not included in the list above.
Source: 2016 MANE-VU Source Contribution Modeling Report, CALPUFF Modeling of Large Electrical Generating Units and Industrial Sources. MANE-VU. April 4, 2017. Table 34 and Appendix F. (Appendix 8)

56 Ibid. p.60

6. Long-Term Strategy for Massachusetts

6.1 Requirements for the Long-Term Strategy

40 CFR Section 51.308(f)(2) requires MassDEP to submit a long-term strategy (LTS) that addresses regional haze visibility impairment for each Class I area that may be affected by emissions from Massachusetts. This section describes the LTS that MassDEP will pursue in the second implementation period to address visibility impairment in those Class I areas.

Note that, although the current visibility for all of MANE-VU's Class I areas is better than their uniform rates of progress (as described in Section 2), the Regional Haze Rule requires that each state adopt measures that make reasonable progress in reducing visibility impairment regardless of whether (or by how much) the current visibility at any affected Class I area is below its uniform rate of progress. This ensures continued progress towards natural visibility.

MassDEP's LTS for the second implementation period is based on (and is in part a continuation of) the LTS in MassDEP's Regional Haze SIP for the first implementation period, which EPA approved. As a member of MANE-VU, MassDEP adopted a regional approach towards deciding which additional control measures to pursue for regional haze based on technical analyses developed by MANE-VU. MassDEP adopted the analysis and determinations from that process including the course of action for member states to make reasonable progress for the second regional haze implementation period. The 2017 MANE-VU Statement (Appendix 15) documented the measures (or steps to determine measures) that MANE-VU (including MassDEP) considers reasonable for the 2018-2028 implementation period.

40 CFR Section 51.308(f)(2) requires MassDEP to include in its LTS enforceable emissions limitations, compliance schedules, and other measures necessary to make the reasonable progress. Many of these were already included in MassDEP's 2012 Regional Haze SIP EPA approved for the first implementation period and will continue into the second period. Additional measures are addressed in this section under MassDEP's implementation of the 2017 MANE-VU Statement.

40 CFR Section 51.308(f)(2)(i) requires MassDEP to evaluate and determine the emission reduction measures that are necessary to make reasonable progress by considering 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 anthropogenic sources of visibility impairment (a.k.a. the "four factors"). MassDEP must include in the SIP a description of the criteria it used to determine which sources or groups of sources it evaluated and how the four factors were taken into consideration in selecting the measures for inclusion in its long-term strategy. MassDEP considered these factors as part of the MANE-VU process for developing the measures (and approaches to defining measures) that MANE-VU identified as

necessary to make reasonable progress (i.e., the 2017 MANE-VU Statement) and as described in the 2012 Regional Haze SIP for those parts of the LTS that are continuing. The evaluation and screening of sources are described in the MANE-VU reports supporting the development of the 2017 MANE-VU Statement as summarized in Section 5 and below.

40 CFR Section 51.308(f)(2)(ii) requires MassDEP to consult with states containing Class I areas to develop the coordinated emission management strategies needed to make reasonable progress. MassDEP must demonstrate that it has included all measures agreed to during state-to-state consultations or a regional planning process, or measures that will provide equivalent visibility improvement. MassDEP must also consider the emission reduction measures identified by other states for their sources as being necessary to make reasonable progress. MassDEP consulted with other states during the MANE-VU process to develop the 2017 Statement and has met the 2017 Statement as described in this section.

40 CFR Section 51.308(f)(2)(iii) requires MassDEP to document the technical basis, including modeling, monitoring, cost, engineering, and emissions information, on which it is relying to determine the emission reduction measures that are necessary to make reasonable progress in each Class I area it affects. MassDEP is relying on the technical analyses developed by MANE-VU as included in this SIP and in the previous approved 2012 Regional Haze SIP.

40 CFR Section 51.308(f)(2)(iv) requires MassDEP to consider, at a minimum, the following additional factors in developing its long-term strategy.

- Emission reductions due to ongoing air pollution control programs. These are incorporated into the emissions inventories summarized in Section 4 and described in the MANE-VU inventory and modeling documentation (see technical basis below).

- Measures to mitigate the impacts of construction activities. These are addressed in this section.

- Source retirement and replacement schedules. These are incorporated into the Progress Report data in Section 3, emissions inventories summarized in Section 4, and described in the MANE-VU inventory and modeling documentation (see technical basis below).

- Basic smoke management practices for prescribed fire used for agricultural and wildland vegetation management purposes and smoke management programs as currently exist within Massachusetts for these purposes. This is addressed in this section.

- The anticipated net effect on visibility due to projected changes in point, area, and mobile source emissions over the period addressed by the long-term strategy. Changes in emissions were projected in the MANE-VU inventories and modeled as described in the MANE-VU modeling documentation; see Section 2 for modeled visibility projections.

6.2 Long-Term Strategy Development Process

First Implementation Period – MassDEP's 2012 Regional Haze SIP describes in detail the process by which the LTS for the first implementation period was developed. This work formed the basis for the LTS development process for the second implementation period and is summarized below.

Using information about emissions, costs, and potential impacts, the MANE-VU Reasonable Progress Workgroup for the first implementation period selected the following source categories for detailed analysis:[57]

- Coal and oil-fired EGUs;
- point and area source ICI boilers;
- cement and lime kilns;
- low-sulfur heating oil; and
- residential wood combustion and open burning.

The analysis that produced this list is described in detail in the *Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas* (2007).[58] That report summarizes MANE-VU's assessment of pollutants and associated source categories affecting visibility in Class I areas in and near MANE-VU, lists possible control measures for those pollutants and source categories, and considered the four factors to help MANE-VU members determine which emission control measures were needed to make reasonable progress in improving visibility. MANE-VU later extended that assessment with the *Addendum for Residual Oil* which provided a four-factor analysis for the low sulfur fuel oil strategy.[59]

MANE-VU then developed an interim list of control measures including: 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). Member states determined that there were 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

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[57] MACTEC Federal Programs, Inc., Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas, July 9, 2007. (Appendix to the 2012 RH SIP). Updated: 2016 Updates to the Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas. MARAMA. January 31, 2016. (Appendix 6)

[58] Included in Massachusetts 2012 RH SIP.

[59] Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas: Methodology for Source Selection, Evaluation of Control Options and Four Factor Analysis – ADDENDUM FOR RESIDUAL OIL. MANE-VU. April 2011. (Appendix 1)

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 which are less important for regional haze). 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.

These efforts led to the selection of the emission reduction strategies presented in the MANE-VU Statement for the first implementation period.[60] MassDEP adopted those strategies (or equivalent alternatives) as its LTS,[61] which EPA approved in 2013. MassDEP fully met the Statement for the first implementation period by implementing an alternative to BART, ensuring reductions in SO_2 emissions from the Massachusetts Targeted EGU stacks, implementing low-sulfur fuel oil regulations, and implementing controls on outdoor wood-fired boilers. These measures are the basis for development of the Massachusetts LTS for the second implementation period.

Second Implementation Period – For the second implementation period SIPs, MANE-VU began by examining how upwind states implemented control programs to address the Statement from the first implementation period[62] and specifically how the 167 stacks from the first implementation period reduced emissions[63]. MANE-VU then reviewed the measures outlined in *Beyond Sulfate: Maintaining Progress towards Visibility and Health Goals*[64] and carried several of them forward to further examine the engineering requirements and cost-effectiveness in *2016 Updates to the Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas* (Appendix 6).[65] In that document MANE-VU updated and expanded the components listed below and considered the four factors required under the RHR.

- Cost information in the following chapters: Chapter 2 - Source Category Analysis: EGUs; Chapter 4 - Source Category Analysis: Industrial, Commercial, and Institutional Boilers; Chapter 8 - Heating Oil; Chapter 9 - Residential Wood Combustion; Chapter 10 - Outdoor Wood Fired Boilers.

- Chapters on EGUs and ICI boilers (expanded to describe NO_x emissions control options and costs).

MANE-VU conducted the Q/d and CALPUFF screening process (described in Section 5) to identify specific sources for further analysis and upwind states for consultation.

[60] See Massachusetts 2012 RH SIP for further details on the Ask for the first implementation period.
[61] MassDEP along with other states adopted the Ask at the MANE-VU Board meeting on June 7, 2007.
[62] Miller, Paul. Overview of state and federal actions relative to MANE-VU Asks (March 28, 2013)
[63] Status of the Top 167 Electric Generating Units (EGUs) That Contributed to Visibility Impairment at MANE-VU Class I Areas during the 2008 Regional Haze Planning Period, July 25, 2016. (Appendix 10)
[64] *Beyond Sulfate: Maintaining Progress towards Visibility and Health Goals*. NESCAUM. December 17, 2012. (Appendix 4)
[65] 2016 Updates to the Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas. MARAMA. January 31, 2016. (Appendix 6).

MANE-VU considered the results of the new work in light of the previous findings and previous Statement and developed a new Statement[66] to define the emissions management strategies that are necessary to make reasonable progress for the second implementation period. MANE-VU states agreed to this Statement in August 2017. Further details for each component of the Statement are provided with MassDEP's implementation of the Statement below.

6.3 Implementing the 2017 MANE-VU Statement

This section lists the emission management strategies or "Asks" in the MANE-VU Statement (items 1-6) and how MassDEP has addressed each of them. In developing the Statement as part of MANE-VU and in responding to the Statement, MassDEP considered the reduction measures identified by other states as being necessary to make reasonable progress in all Class I areas impacted by emissions from Massachusetts. MassDEP's implementation of the 2017 MANE-VU Statement shows that all components of the LTS are in place and no further regulatory action is required at this time.

***Ask 1**: Electric Generating Units (EGUs) with a nameplate capacity larger than or equal to 25 MW with already installed NO_x and/or SO_2 controls - ensure the most effective use of control technologies on a year-round basis to consistently minimize emissions of haze precursors, or obtain equivalent alternative emission reductions;*

MANE-VU observed that EGUs often only run NO_x emissions controls to comply with ozone season trading programs and consequently, NO_x sources may be uncontrolled during the winter and non-peak summer days. MANE-VU found that: (1) running existing installed controls [selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR)] is one of the most cost-effective ways to control NO_x emissions from EGUs; and (2) that running existing controls year round could substantially reduce the NO_x emissions in many of the states upwind of Class I areas in MANE-VU that lead to visibility impairment during the winter from nitrates.[67] MANE-VU included this as an emission management strategy because large EGUs had already been identified as dominant contributors to visibility impairment and the low cost of running already installed controls made it reasonable.

MassDEP identified 53 EGU units in Massachusetts that meet the criteria of 25 MW or larger with installed controls – see Appendix 23. All of these units have NO_x controls. Permits that MassDEP has issued for these units set short-term NO_x emissions limits in lbs/hr or concentration. The permits require the facilities to operate their controls to meet the permit

[66] MANE-VU developed three separate Asks, one each for states in MANE-VU, for states outside of MANE-VU that impact Class 1 areas in MANE-VU states, and for EPA and FLMs. This document only addresses the Ask relevant for Massachusetts as a state within MANE-VU (see Appendix 15). All of the Asks are available at the MANE-VU website: https://otcair.org/manevu/document.asp?fview=Formal%20Actions
[67] Impact of Wintertime SCR/SNCR Optimization on Visibility Impairing Nitrate Precursor. MANE-VU Technical Support Committee. November 20, 2017. (Appendix 17)

limits at all times except during start-up. The permits also require the performance of the unit and its controls to be verified.

Therefore, MassDEP has met this strategy and will continue to do so for new units that begin operation during the second planning period based on the rules now in effect.

Ask 2*: Emission sources modeled by MANE-VU that have the potential for 3.0 Mm^{-1} or greater visibility impacts at any MANE-VU Class I area, as identified by MANE-VU contribution analyses (see attached listing[68]) - perform a four-factor analysis for reasonable installation or upgrade to emission controls;*

After examining the visibility impact modeling results (described in Section 5) MANE-VU concluded that a 3 Mm^{-1} cutoff captured the group of sources contributing the largest percentage of visibility impairing pollutants to Class I areas. However, the determination of reasonability for controls on each unit was left to the individual states to allow for unit-specific consideration of the four factors.

The Statement identified 2 units in Massachusetts with potential impacts of 3.0 Mm^{-1} or greater based on 2015 emissions: Brayton Point 4 and Canal Station 1.

Brayton 4

Brayton Point was a coal-fired EGU facility (ORISPL 01619; MassDEP AQID 1200061). All units at Brayton Point ceased operation in 2017 and the permits were revoked on December 6, 2017.[69]

Canal Station 1

Canal Station (ORISPL 1599; MassDEP AQID 1200054) operates two steam electric generating units. Unit 1 is a Babcock & Wilcox boiler that fires No. 6 fuel oil, with a permitted maximum sulfur content of 0.5 percent by weight (wt%) as the sole operational fuel, with No. 2 fuel oil as a startup/ignition fuel. Unit 1 has an approximate maximum heat input rate of 5,083 million British thermal units per hour (MMBtu/hr) and a generating capacity of approximately 560 (net) megawatts (MW). Unit 1 is equipped with low-NO_x burners, overfire air ports, flue gas recirculation (FGR), and Selective Catalytic Reduction (SCR) for the control of NO_x emissions. PM emissions are controlled by an Electrostatic Precipitator (ESP).

The emission controls installed on Unit 1 are necessary to achieve compliance with the applicable emission limits under 310 CMR 7.29 and air plan approvals issued pursuant to 310

[68] See Appendix 15 for list.
[69] MassDEP letter from Thomas Cushing, Chief, Permit Section, Bureau of Air & Waste to Robert Vasconcelos, Director, Brayton Point Energy, LLC. December 6, 2017 (Appendix 37)

CMR 7.03. The governing NO_x, SO_2, and PM emission limits for Unit 1 are summarized in Table 6-1 below.

Table 6-1: Permit Limits for Canal Station Unit 1

Pollutant	Limit	Averaging Period	Applicable Requirement
NO_x	1.5 lbs/MW-hr (net) 3.0 lbs/MW-hr (net) 0.28 lbs/MMBtu 0.15 lbs/MMBtu*	Rolling 12-Months Monthly Calendar Day Calendar Day	310 CMR 7.29 310 CMR 7.29 Plan Approval 310 CMR 7.19(4)(b)3.b.
SO_2	3.0 lbs/MW-hr (net) 6.0 lbs/MW-hr (net)	Rolling 12-Months Monthly	310 CMR 7.29
PM	0.02 lbs/MMBtu	Three 60-minute test run average	Plan Approval

* Applies if Unit 1 annual capacity factor exceeds 10% averaged over a three-year period (310 CMR 7.19(1)(d).

In recent years Unit 1 has operated with low capacity factors, well below 10%. Given its fuel mix, the Independent System Operator New England's (ISO-NE's) capacity mix, as well as ISO-NE's initiatives on energy security, it is not expected that Unit1's capacity factor will increase significantly in future years.

The NO_x and PM emission limits are readily met through the use of the installed emission controls. The sulfur content of No. 6 oil is limited to 0.5 wt% in accordance with 310 CMR 7.05 but the facility purchases 0.3 wt% sulfur No. 6 to meet the 6.0 lbs/MW-hr monthly, 3.0 lbs/MW-hr rolling 12-month SO_2 limit applicable under 310 CMR 7.29.

Table 6-2 shows Canal Unit 1's actual emissions in 2015 along with MANE-VU projected emissions for the 2028 base case and for the control case under Ask 2.

Table 6-2: Actual 2015 and Projected 2028 emissions (tons per year) from Canal Station Unit 1

Canal Station Unit 1	NO_x	SO_2	Heat Input
Actual			
Emissions 2015	75	305	1,648,168
Projections			
Emissions 2028 Base Case	0.67	3.25	16,401
Emissions 2028 Control Case (Ask 2, 3)*	0.67	0.55	16,401
Emissions Reductions 2028 (Ask 2, 3)*	0	2.69	
Emission Reduction % 2028 Base to Control		83%	

* The case was for both Ask 2 and Ask 3, but all of the reductions in the projections are due to Ask 2 since Ask 3 (0.5% sulfur fuel) has no impact since Canal already is burning 0.3% sulfur fuel.
Source: AMPD for actual emissions (MassDEP File tbl CAMD 2011-18 ALL Annual Emission_08-24-2018_154634287-rev.xls)
Projections from MANE-VU ERTAC projection file: HazeERTACModelingDailyResults.accdb. MassDEP qry All Results MA reductions.xlsx (tab qry_All Results MA CANAL 1). Also, MANE-VU ERTAC projections spreadsheet: ERTAC Ask Modeling-1.xlsx (tab: Unit Summaries filtered for Oil 2028) ver 2.7)

On July 9, 2020, MassDEP sent a letter to the current owner of Canal Unit 1 requesting a four-factor analysis (see Appendix 30). On September 18, 2020, a four-factor analysis was submitted to MassDEP (see Appendix 31). This four-factor analysis concluded as follows:

- Canal Unit 1's existing NO_x controls (low NO_x burners, overfire air ports, flue gas recirculation, and selective catalytic reductions) are the most stringent available, and there are no other add-on controls commercially available to reduce NO_x emissions from Canal Unit 1.
- Canal Unit 1 would be subject to the lower NO_x limit in MassDEP's NO_x RACT regulations (310 CMR 7.19) if its capacity factor exceeded 10%. However, Canal Unit 1 is unlikely to exceed 10% capacity factor based on recent and anticipated operations. If Canal Unit 1 were to exceed 10% capacity factor, the higher number of hours would result in better performance of the SCR with a reduction in NO_x emissions of at least 50% below the current permitted NO_x limits.
- Due to its low capacity factor, meeting NOx emission limits below the existing 310 CMR 7.29 limits would be difficult due to emissions that occur during startup prior to operation of the SCR. Infrequent operation limits the effectiveness of the existing controls and therefore no further reduction is achievable.
- Conversion to natural gas is not technically feasible due to supply limitations.
- Use of 0.3% sulfur No.6 fuel oil rather than the 0.5% sulfur required by 310 CMR 7.05 is technically feasible and reduces SO_2 by 40% at a cost of $10,000 per ton of SO_2 reduced. Given the projected low utilization of Unit 1, the cost of using 0.3 wt% sulfur No. 6 oil would not be considered reasonable. However, because the MANE-VU Regional Haze Consultation Report identifies sulfates from SO_2 emissions as the

primary driver behind visibility impairment in the region, Canal will commit to purchasing 0.3 wt% No. 6 fuel oil following the depletion of the current fuel inventory.

- Use of ultra-low sulfur diesel (ULSD) is technically feasible. However, the cost of switching to ULSD would be $22,000 per ton of SO2 reduced and would not be considered reasonable. Additional costs would be incurred for tank modifications and other fuel handling equipment. ULSD also has an 8% lower heat content and would therefore reduce the generating output of Unit 1 and result in further costs from lost generating and capacity payments.
- Retrofitting a spray dry absorber for SO_2 control is technically feasible. The cost would be conservatively estimated at $21,000 per ton of SO_2 reduced. In addition, there would be an efficiency reduction of 1% due to parasitic load resulting in lower electricity output and payments.
- Particulate matter emissions are well controlled with an electrostatic precipitator (ESP) and burning 0.3 wt% sulfur fuel. Addition of a fabric filter is feasible as well as use of ULSD, with costs of $50,000 and $170,000 per ton of SO_2 reduced, respectively. The ESP would reduce the efficiency of the unit by 0.5% and generate 52 tons of waste per year.
- Time to compliance and energy and non-air impacts are not significant.
- There is no planned retirement date and Unit 1 is in good condition so operation through 2028 is assumed.

MassDEP concludes that visibility impairing pollutants from Canal Unit 1 are highly controlled; however, Canal has committed to purchasing 0.3 wt% No. 6 fuel oil following the depletion of the current fuel inventory. Therefore, MassDEP has requested the owner of Canal Unit 1 to submit an application to modify its Plan Approval to require use of 0.3% sulfur content oil. Once MassDEP approves the plan application, MassDEP will submit the Plan Approval to EPA for approval into the SIP. If Canal Unit 1 should operate above 10% capacity factor in the future, existing NO_x RACT regulations (310 CMR 7.19) will further limit the NO_x emissions. MassDEP will evaluate any changes in the operation of Canal Unit 1 in the next progress report.

Ask 3: *Each MANE-VU State that has not yet fully adopted an ultra-low sulfur fuel oil standard as requested by MANE-VU in 2007 - pursue this standard as expeditiously as possible and before 2028, depending on supply availability, where the standards are as follows:*

a. distillate oil to 0.0015% sulfur by weight (15 ppm);

b. #4 residual oil within a range of 0.25 to 0.5% sulfur by weight

c. #6 residual oil within a range of 0.3 to 0.5% sulfur by weight

MANE-VU included the low sulfur fuel measure in the 2017 Ask because some states had not implemented it yet and the justifications for it determined in the first implementation period remained valid.

As described in Section 3, MassDEP met the requirements of Ask 3 during the first implementation period by adopting low-sulfur oil regulations.

Ask 4: *EGUs and other large point emission sources larger than 250 MMBTU per hour heat input that have switched operations to lower emitting fuels – pursue updating permits, enforceable agreements, and/or rules to lock-in lower emission rates for SO_2, NOx and PM. The permit, enforcement agreement, and/or rule can allow for suspension of the lower emission rate during natural gas curtailment;*

MANE-VU chose this measure because the lower cost of natural gas had made switching to natural gas reasonable for many facilities resulting in significant visibility improvements. Also, the FLMs had recommended during consultation that MANE-VU secure these visibility gains. The threshold of 250 MMBTU per hour heat input was based on prior BART analysis.

Because there are no longer any large coal burning units in Massachusetts, this Ask pertains only to oil burning units. MassDEP identified no dual/multi-fuel units larger than 250 mmbtu/hr that had made a physical change to switch to a cleaner fuel. All such dual/multi-fuel units are either continuing to burn a mix of fuels or are choosing to maintain their ability to do so in the future.

Ask 5: Where emission rules have not been adopted, control NO_x emissions for peaking combustion turbines that have the potential to operate on high electric demand days by:

a. *Striving to meet NO_x emissions standard of no greater than 25 ppm at 15% O_2 for natural gas and 42 ppm at 15% O_2 for fuel oil but at a minimum meet NO_x emissions standard of no greater than 42 ppm at 15% O_2 for natural gas and 96 ppm at 15% O_2 for fuel oil, or*

b. *Performing a four-factor analysis for reasonable installation or upgrade to emission controls, or*

c. *Obtaining equivalent alternative emission reductions on high electric demand days.*

> *High electric demand days are days when higher than usual electrical demands bring additional generation units online, many of which are infrequently operated and may have significantly higher emission rates than the rest of the generation fleet. Peaking combustion turbine is defined for the purposes of this "Ask" as a turbine capable of generating 15 megawatts or more, that commenced operation prior to May 1, 2007, is used to generate electricity all or part of which is delivered to the electric power distribution grid for commercial sale and that operated less than or equal to an average of 1752 hours (or 20%) per year during 2014 to 2016;*

MANE-VU found a correlation between high electric demand days (HEDDs) and the 20% most impaired days at Class I areas.[70] Because smaller turbines have the ability to respond to peak electrical demand and some of these units are not well controlled by existing rules (i.e., have a higher emission rates per unit of energy), MANE-VU found that controlling these units (or providing equivalent reductions on HEDDs) was a reasonable strategy for reducing NO_x emissions on the most impaired days.

MassDEP identified 25 turbines rated at 15 MW or higher that were operational prior to 2007 that sold electricity to the grid and that operated less than an average of 1752 hours per year during 2014-2016. These 25 turbines are listed in Table 6-3 along with their current emission limits.

[70] High Electric Demand Days and Visibility Impairment in MANE-VU. December 20, 2017. (Appendix 18)

Table 6-3: Turbines Subject to Ask 5 and their Emission Limits and Capacity Factors

AMPD Facility Name	Facility ID (ORISPL)	AMPD Unit ID	MassDEP AQID	MassDEP Unit ID	Town	Installed Date	Capacity (mmbtu/hr)	Nameplate Capacity (MW)	Average of Operating Time 2014-2016*	Capacity Factor 2017-2019 (%)	Unit Type	Fuel Type (Primary)	Fuel Type (Secondary)	Current NO_x Emission Limit - OIL (ppm at 15% O_2)	Current NOx Emission Limit - GAS (ppm at 15% O_2)	Meets ASK STRIVING (25 ppm gas and 42 ppm oil)	Meets Ask MIN (42 ppm gas and 96 ppm oil)	Reference for Current Limits
Waters River	1678	1	1190015	1	PEABODY	15-Dec-70	321.9	21.3	379.8	1.05	Combustion turbine	Pipeline Natural Gas	Diesel Oil	100	65	NO	NO	RACT(averaging with EU2 + ERC)
Waters River	1678	2	1190015	2	PEABODY	05-Nov-90	485.9	43.6	94.6	1.41	Combustion turbine	Pipeline Natural Gas	Diesel Oil	42	25	YES	YES	BACT
Medway Station	1592	J3T1	1200133	5	MEDWAY	01-Jan-70	392	45	47.8	0.53	Combustion turbine	Diesel Oil	Pipeline Natural Gas	100	65	NO	NO	RACT(averaging + ERC)
Medway Station	1592	J1T1	1200133	1	MEDWAY	01-Jan-70	392	45	54.1	0.44	Combustion turbine	Diesel Oil	Pipeline Natural Gas	100	65	NO	NO	RACT(averaging + ERC)
Medway Station	1592	J1T2	1200133	2	MEDWAY	01-Jan-70	392	45	45.3	0.37	Combustion turbine	Diesel Oil	Pipeline Natural Gas	100	65	NO	NO	RACT(averaging + ERC)
Medway Station	1592	J2T2	1200133	4	MEDWAY	01-Jan-70	392	45	45.1	0.25	Combustion turbine	Diesel Oil	Pipeline Natural Gas	100	65	NO	NO	RACT(averaging + ERC)
Medway Station	1592	J3T2	1200133	6	MEDWAY	01-Jan-70	392	45	44	0.42	Combustion turbine	Diesel Oil	Pipeline Natural Gas	100	65	NO	NO	RACT(averaging + ERC)
Medway Station	1592	J2T1	1200133	3	MEDWAY	01-Jan-70	392	45	57.6	0.28	Combustion turbine	Diesel Oil	Pipeline Natural Gas	100	65	NO	NO	RACT(averaging + ERC)
South Boston Combustion Turbines	10176	A	1191667	1	BOSTON	01-May-79	396	69	41.1	0.34	Combustion turbine	Other Oil		55		NO	YES	BACT
South Boston Combustion Turbines	10176	B	1191667	2	BOSTON	01-Feb-95	396		37.9	0.18	Combustion turbine	Other Oil		55		NO	YES	BACT
Woodland Road	1643	10	1170166	1	LEE	01-Jan-69	230	20.4	12.3	0.14	Combustion turbine	Diesel Oil		308		NO	NO	RES[1]
Doreen	1631	10	1170167	1	PITTSFIELD	01-Jan-69	230	21.1	9.3	0.11	Combustion turbine	Diesel Oil		308		NO	NO	RES[1]
Potter	1660	3	1190491	3	BRAINTREE	01-Apr-77	975.5	76	78.5	0.78	Combined cycle	Pipeline Natural Gas	Diesel Oil	65	42	NO	YES	RACT(ERC)[2]
West Springfield	1642	CTG2	0420117	2	WEST SPRINGFIELD	01-Jun-02	462.6	60	427.1	1.69	Combustion turbine	Pipeline Natural Gas	Diesel Oil	6	3.5	YES	YES	BACT
West Springfield	1642	CTG1	0420117	1	WEST SPRINGFIELD	01-Jun-02	462.6	60	431	1.60	Combustion turbine	Pipeline Natural Gas	Diesel Oil	6	3.5	YES	YES	BACT
West Springfield	1642	10	0420117	4	WEST SPRINGFIELD	27-Nov-68	244	17	13.2	0.09	Combustion turbine	Diesel Oil		100		NO	NO	RACT
Pittsfield Generating	50002	3	1170006	3	PITTSFIELD	26-Jul-90	430	40.7	1488.4	6.87	Combined cycle	Pipeline Natural Gas	Diesel Oil	14	10	YES	YES	BACT[3]
Pittsfield Generating	50002	1	1170006	1	PITTSFIELD	23-Jul-90	430	40.7	1416.8	6.41	Combined cycle	Pipeline Natural Gas	Diesel Oil	14	10	YES	YES	BACT[3]
Pittsfield Generating	50002	2	1170006	2	PITTSFIELD	18-Jul-90	430	40.7	1529.6	7.14	Combined cycle	Pipeline Natural Gas	Diesel Oil	14	10	YES	YES	BACT[3]
Stony Brook	6081	5	0420001	5	LUDLOW	01-Nov-82	952	85	44.1	0.28	Combustion turbine	Diesel Oil		75		NO	YES	BACT
Stony Brook	6081	4	0420001	4	LUDLOW	01-Nov-82	952	85	41.8	0.31	Combustion turbine	Diesel Oil		75		NO	YES	BACT
Stony Brook	6081	3	0420001	3	LUDLOW	01-Nov-81	952	85	851.4	3.78	Combined cycle	Diesel Oil	Pipeline Natural Gas	65	42	NO	YES	RACT
Stony Brook	6081	2	0420001	2	LUDLOW	01-Nov-81	952	85	68.5	0.64	Combined cycle	Diesel Oil	Pipeline Natural Gas	65	42	NO	YES	RACT
Stony Brook	6081	1	0420001	1	LUDLOW	01-Nov-81	952	85	1033.7	3.83	Combined cycle	Diesel Oil	Pipeline Natural Gas	65	42	NO	YES	RACT
Kendall Green Energy LLC	1595	S6	1190093	6	CAMBRIDGE	01-Sep-70	308	20	28.3	0.42	Combustion turbine	Diesel Oil		100		NO	NO	RACT

Notes:

Blue shading indicates current unit emissions limits meet Ask 5 requirements.

RACT for these units means the 1995 RACT that does not meet Ask 5 for simple cycle turbines.

* For Woodland, Doreen, West Springfield, Kendall the average of operating hours and capacity factor in this table underestimates true operating hours and capacity factors for these units because they only report 5-6 months to EPA's AMPD. Their annual emissions as reported in MassDEP Source Registration for 2017-2018 range from 0.16% to 0.39%. Therefore, they will not exceed the Ask 5 limit of 1720 hours or the 2018 RACT 10% capacity exemption.

[1]Woodland, Doreen: RES (restricted emissions status). These units are less than 25 MW and therefore not Acid Rain Units. The facility's emissions are capped at below major source thresholds and therefore are not subject to RACT. Source Registration indicates 1.2lb NOx/mmbtu for ozone season which converts to 308 ppm using 0.00389 from 310 CMR 7.19(14)c (40 CFR 60.45).

[2]Potter 3: Emissions over-controlled to generate emission reduction credits (ERCs) for emission unit 2 (now decommissioned) which had no emission controls.

[3]Pittsfield Generating 1-2-3: Permit limits in lbs/hour, converted based on max heat input, F factor.

Kendall and West Springfield are less than 25 MW and therefore not Acid Rain Units. However, since they are collocated with other Acid Rain Units and their facilities are not capped below major so they are subject to RACT.

2018 Ask 5 - STRIVING (25 ppm gas and 42 ppm oil); MINIMUM (42 ppm gas and 96 ppm oil)

Sources:

- MassDEP permit files.
- MassDEP Source Registration.
- EPA AMPD.

On March 9, 2018, MassDEP revised 310 CMR 7.19 Reasonably Available Control Technology (RACT) for Sources of Oxides of Nitrogen (NO_x) to establish more stringent emissions limits for stationary turbines at major sources. With these revisions Massachusetts RACT now meets Ask 5 "striving" limits for combined cycle turbines and "minimum" limits for simple cycle turbines. However, the 2018 RACT rule also included an exemption for units with a capacity factor less than 10% based on the most recent 3-year average. [310 CMR 7.19(1)(d)].

As shown in Table 6-3, almost all turbines subject to Ask 5 fall below the 10% capacity factor because they all run very infrequently. If in the future they exceed the 10% capacity factor limit then they will be subject to the RACT limits of 310 CMR 7.19 and will therefore meet Ask 5 (except for Woodland 10 and Doreen 10 which are not located at facilities that are major sources and are therefore not subject to 310 CMR 7.19).

The turbines that are exempt from the 2018 RACT limits are still subject to MassDEP's 1995 RACT limits. Table 6-4 compares the 1995 and 2018 RACT limits to Ask 5. For combined cycle turbines the 1995 RACT limits meet Ask 5 minimum limits for oil and gas, but the simple cycle limits do not.

Table 6-4: Comparison of MassDEP RACT Limits for Turbines with Ask 5 Limits

	Fuel	1995 RACT	2018 RACT	Ask 5 – striving	Ask 5 -- minimum
Combined cycle	Gas	**42**	**25**	25	42
Combined cycle	Oil	**65**	**42**	42	96
Simple cycle	Gas	65	**40**	25	42
Simple cycle	Oil	100	**50**	42	96

Numbers in **bold** meet the Ask limits. All ppm at 15% O2.

Table 6-3 shows the 14 turbines that already met the Ask 5 limits in 2018 through either the 1995 RACT limits for combined cycle turbines or through BACT permit limits. The limits for 11 of the units do not meet Ask 5.

Ask 5 provides the option of achieving equivalent alternative emission reductions on HEDDs. In addition, the RHR at 40 CFR 51.301(f)(2)(ii)(A) provides that a state has the option to address "all measures agreed to during state-to-state consultations or a regional planning process" by including in its SIP "measures that will provide equivalent visibility improvement."

In 2017 Brayton Point Station units 1, 2, and 3 (Brayton 1-2-3) permanently retired and in 2015 the coal-fired Boiler 11 at Solutia was re-powered to natural gas. Each of these permanent changes yields reductions in SO_2 and NO_x emissions sufficient to offset all of the emissions from these 11 turbines both on HEDDs and annually, and therefore provides "equivalent visibility improvement" as allowed under the RHR and the Ask.

The following analysis establishes the retirement of Brayton Point 1-2-3 and repowering of Solutia 11 as sources of equivalent alternative emissions reductions on HEDDs. For this analysis reductions in SO_2 and NO_x emissions are counted as providing equivalent visibility improvement.

Emissions on HEDDs. HEDDs were defined generally in Ask 5 but more specifically in the MANE-VU HEDD report.[71] The analysis here uses the criteria for a HEDD from the MANE-VU report to identify HEDDs.

> *"HEDD are defined as the 85th percentile of the daily peak demand.[2] The 85th percentile was chosen to evaluate HEDD in part to be consistent with the analyses of the surrounding ISOs/RTOs and in part because it approximates the value which was determined to be an appropriate definition of HEDD for the New Jersey HEDD rule."*

Using this definition, MassDEP identified HEDDs for ISO-NE for 2011-2015. The period 2011-2015 was chosen because it includes the years used in the MANE-VU screening analyses (2011 and 2015) and provides enough data to gauge the typical operation of all of the units on HEDDs.

The NO_x emissions on HEDDs from the turbines not meeting Ask 5 are shown in Table 6-5. About half of the NO_x emissions from these turbines occurred on HEDDs with an average of 25 tons of NO_x on HEDDs per year. Also shown in Table 6-5 are the MANE-VU emissions projections to 2028 for base and Ask 5 control scenarios. Note that the emissions reductions estimated from these turbines in 2028 are very small because they run infrequently and because some of the units have limits that are very close to the limits specified in the Ask (e.g., Medway Station where the Ask 5 NO_x limit for oil-fired operation is 96 ppm and the limit for the units is 100 ppm, a 4% difference). This analysis conservatively uses the turbine emissions from 2011-2015 rather than their much lower projected emissions.

[71] High Electric Demand Days and Visibility Impairment in MANE-VU. MANE-VU Technical Support Committee 12/20/2017. https://otcair.org/manevu/Document.asp?fview=Reports (Appendix 18)

Table 6-5: Emissions from Massachusetts Turbines Not Meeting Ask 5 on HEDDs

Facility	ORISPL	Unit	2011-2015 Total NO_x Emissions on HEDDs	2011-2015 Total NO_x Emissions	2011-2015 Percent of Emissions that Occurred on HEDDs	2028 NO_x Emissions Base Case	2028 NO_x Emissions Control Case	2028 NO_x Emissions Reductions
Turbines Not Meeting Ask 5								
Doreen[1]	1631	10	4	9	42%	0.0185	0.0057	0.0128
Kendall Green Energy LLC[1]	1595	S6	11	17	66%	0.0329	0.0328	0.0001
Medway Station	1592	J1T1	11	22	49%	0.0401	0.0250	0.0151
Medway Station	1592	J1T2	11	22	49%	0.0871	0.0523	0.0348
Medway Station	1592	J2T1	8	17	44%	0.0569	0.0494	0.0075
Medway Station	1592	J2T2	7	16	43%	0.0514	0.0371	0.0144
Medway Station	1592	J3T1	10	23	41%	0.0660	0.0447	0.0213
Medway Station	1592	J3T2	8	20	41%	0.0535	0.0382	0.0153
Waters River	1678	1	41	79	52%	7.9096	4.0401	3.8695
West Springfield[1]	1642	10	8	20	40%	0.2879	0.0890	0.1989
Woodland Road[1]	1643	10	5	8	54%	0.1702	0.0526	0.1176
Total			123	254	48%	8.7741	4.4668	4.3072
Total Emissions Per Year			25	51	48%	8.7741	4.4668	4.3072

[1] HEDD values are 5/6 month HEDD emissions for these units because they do not report to AMPD for a full year. The non-HEDD annual values, however, are 12-month values from the MassDEP Source Registration program.

Sources: AMPD for actual daily emissions. (MassDEP files \Reference\qry_CAMD Daily 2011-15 HEDD SUM by unit-2-rev2.xlsx and \Reference\CAMD Daily Alt Em Rdx 2011-15 EPADownload.mdb (qry_CAMD Daily 2015 HEDD SUM by unit)

MANE-VU database HazeERTACModelingDailyResults.accdb [Table: All Results; Query: qry_All Results MA reductions]

2028 Projections: MANE-VU modeling (see Appendix 21), MANE-VU database HazeERTACModeling.accdb [Query: HEDD_units_not_meeting_ask] (MassDEP file \Reference\ERTAC Runs\qry_All Results MA reductions.xlsx)

Solutia Repowering. Solutia is a chemical plant in Springfield that is powered by 3 boilers, the largest of which is Boiler 11. Boiler 11 was a 249 mmbtu/hr Foster Wheeler Type S Spreader Stoker burning coal with overfire air and baghouse. In late 2015, Boiler 11 was repowered with natural gas and low NO_x burners. The emissions from the unit fell substantially in subsequent years (as shown in Table 6-6) while total heat input remained relatively consistent at about 96% of the average of the 10 years prior to the repowering.

The permitted emission rates for the repowered Boiler 11 also decreased as shown in Table 6-7.[72] The new permit limits will maintain the lower emissions permanently.

Solutia Boiler 11 emissions for 2015 were 284 tons NO_x and 523 tons SO_2. Following the repowering, the SO_2 emissions for Solutia were essentially eliminated with the average value from 2017-2018 being less than 1 ton. This reduction alone more than offsets all 2011-2015 NO_x emissions from the 11 turbines that do not meet the Ask 5 emissions limits. In addition, NO_x emissions from Solutia Boiler 11 fell to an average of 91 tons for 2017-2018, a reduction of 193 tons/year. The combined annual NO_x and SO_2 emissions reductions from Solutia Boiler 11 were 14 times larger than the average annual emissions from the 11 turbines (51 tons/year). To estimate emissions from Solutia Boiler 11 on HEDDs the total annual emissions for 2015 were averaged over 365 days (2 tons/day) and then summed for the average annual number of HEDDs that occurred in 2011-2015 (55 days). The repowering of Solutia Boiler 11 produced 128 tons/year combined SO_2 and NO_x emissions reductions on HEDDs as shown in Table 6-6.

Table 6-6: Solutia Boiler 11 Emissions 2008-2018 and Annual Emissions Reduction

Solutia Boiler 11 (MassDEP EU4/EU157)	SO2 (tons)	NO2 (tons)	Heat Input (mmbtu)
2005	623	309	1,279,516
2006	727	276	1,499,596
2007	701	365	1,499,428
2008	747	374	1,582,952
2009	450	223	952,588
2010	667	359	1,420,020
2011	630	329	1,384,796
2012	658	303	1,428,084
2013	699	314	1,528,072

72 AIR QUALITY OPERATING PERMIT Issued by the Massachusetts Department of Environmental Protection (“MassDEP") to Solutia Inc. (Application No.: 1-O-09-020). October 25, 2018. (Appendix 26)

2014	668	284	1,443,820
2015	523	284	1,248,098
2016	0.27	62	911,854
2017	0.38	88	1,297,638
2018	0.40	94	1,377,328
Average 2011-2015	636	303	1,406,574
Average 2017-2018	0.39	91	1,337,483
Reduction	635	212	
Reduction %	99.9%	70%	
Per day reduction	1.7	0.6	
Average annual HEDDs	55	55	
Total annual reduction on HEDDs	96	32	

Sources: Source Registration reporting by facility to MassDEP.
AQID: 0420086 EU4 /EU157 (POWER HOUSE - BOILER #11)

Table 6-7: Emission Limits for Solutia Boiler 11

Authority	NO_x	SO_2
Before repowering (2015)		
DEP Approval #1-E-94-106 (10/28/1996) and 310 CMR 7.19(12) Misc. RACT SO_2 – 310 CMR 7.22 (Acid Rain)	0.40 lb/MMBtu 343 tons/year rolling 12-month total	1.2 lb SO_2/MMBtu (calendar year avg.)
After repowering		
MassDEP Approval #WE-14-013 (2/4/2015) Table 3(ii) – Powerhouse	≤0.20 lb/MMBtu of heat input (based on one (1) hour average)	≤ 0.0006 lb SO_2/MMBtu of heat input
Reduction %	50%	~100%

Sources:
Pre-2016 - AIR QUALITY OPERATING PERMIT Issued by the Massachusetts Department of Environmental Protection ("The Department") to Solutia Inc. (Application No.: 1-O-95-060) January 26, 2005. (Appendix 27)
Current - AIR QUALITY OPERATING PERMIT Issued by the Massachusetts Department of Environmental Protection ("MassDEP") to Solutia Inc. (Application No.: 1-O-09-020). October 25, 2018. (Appendix 26)

Brayton 1-2-3 Retirement. Brayton 1-2-3 were large (2,250, 2,250, 5,655 mmbtu/hr, respectively; and 255, 255, 633 MW, respectively) multi-fuel EGUs fired primarily by coal. Their emissions were controlled with Selective Catalytic Reduction (SCR), R-C electrostatic precipitators, low NO_x burners with overfire air, management of lower sulfur fuels, spray dryer absorbers, fabric filter baghouses, and powder activated carbon.[73]

The annual SO_2 emissions from Brayton 1-2-3 in 2015 were 1,032 tons, or nearly 20 times larger than the average annual emissions from the 11 turbines (Table 6-8).[74] The SO_2 emissions from Brayton 1-2-3 on HEDDs in 2015 were 206 tons (Table 6-8). This value was used to represent Brayton SO_2 emissions reductions on HEDDs for comparison to the turbine NO_x emissions on HEDDs. Note that the proportion of Brayton 1-2-3 emissions that occurred on HEDDs from 2011-2015 was 26%. Therefore, the proportion for 2015 (20%) used here for establishing emissions reductions is more conservative.

Table 6-8: Comparison of Brayton 1-2-3 Emissions Reductions on HEDDs to Emissions from Turbines Not Meeting Ask 5 on HEDDs

	2015 SO_2 Emissions on HEDDs	2015 Annual SO_2 Emissions
Brayton 1-2-3 SO_2 Emissions	206	1032
Compensating Unit Adjustment	0.99	0.99
Remaining Brayton 1-2-3 Emissions After Adjustment for Compensating Unit Emissions	203	1020
Adjustment for Reduced Coal Use in 2028	0.23	0.23
Remaining Brayton Emissions After Adjustment for Reduced Coal Use	156	785
Annual NO_x Emissions from Turbines Not Meeting Ask 5	25	51
Average Annual Turbine Emissions as % of Adjusted 2015 Brayton 1-2-3 Emissions	16%	6%

Sources: AMPD for actual daily emissions.

[73] FINAL AIR QUALITY OPERATING PERMIT Issued by the Massachusetts Department of Environmental Protection (MassDEP) to Dominion Energy Brayton Point, LLC. (Application No. 4V04019; Transmittal No. W051616) July 25, 2011.
[74] The 1,142 tons NOx reductions from Brayton 1-2-3 are not considered in this analysis because they have been used to credit emissions offsets required by federal New Source Review permits for offshore wind energy projects.

To provide a conservative estimate of the emissions reduction potential from this retirement the emissions reductions from Brayton 1-2-3 were adjusted for: (1) potential emissions increases from other sources that will increase electricity production to compensate for the loss of electricity production from Brayton 1-2-3, and (2) the impact of the long-term decline in coal use as a proportion of the electricity generation sector. The results of the adjustments are shown in Table 6-8 and explained below.

Compensating Sources Adjustment. The electricity deficit produced by the Brayton retirements will be compensated for by other sources that are generally newer and cleaner. The new EGU units that have been permitted in Massachusetts are primarily turbines burning natural gas. Table 6-9 shows fossil fuel EGU units permitted in the past ten years by MassDEP and their emissions limits. Of the 11 units permitted and in the past ten years that are operational (or where construction has begun) all were turbines burning natural gas.[75]

The Footprint Power project in Salem is the largest new EGU in Massachusetts. Footprint is an example of the limits that would be imposed on future units permitted in Massachusetts. The emissions limits for SO_2 for turbines 1 and 2 at Footprint are shown in Table 6-10. The limits represent worst case scenario emissions.[76] Even with these conservative assumptions the permitted Footprint rates are far less than the actual and permitted emissions rates from Brayton in 2015 also shown in Table 6-10. The combined Brayton 1-2-3 emissions rates from 2015 are over 80 times the maximum allowable SO_2 rate for Footprint.

Based on this evidence, MassDEP expects that future compensating fossil fuel units will be similar to Footprint and fueled with natural gas. This assumption aligns with the trend toward cleaner sources for the entire ISO-NE power supply shown in Figure 6-1 taken from the latest ISO-NE emissions report.[77] ISO-NE reports that since 2009, the annual average NO_x emission rate has decreased by 35% and SO_2 by 92%.

To account for the likely compensating power sources, Brayton emissions reductions available to address the Ask were adjusted downward based on the ratio of the Footprint permit limits to the average Brayton emission rate for 2015 (i.e., multiplied by 1-compensating unit rate/Brayton 1-2-3 2015 rate). The adjustment to the Brayton 1-2-3 2015 emissions is shown in Table 6-11.

[75] EIA. Annual Electric Generator Report (EIA-860) Data Files for 2017.
File: 3_1_Generator_Y2017_Early_Release.xlsx Link: https://www.eia.gov/electricity/data/eia860/

[76] AIR QUALITY PLAN APPROVAL issued to Footprint Power Salem Harbor Development LP (Transmittal No.: X254064 Application No.: NE-12-022 Class: OP119 FMF No. 546374). Issued by MassDEP: January 30, 2014 (Table 7 Note 2]

[77] DRAFT 2017 ISO New England Electric Generator Air Emissions Report. ISO New England Inc. System Planning. JANUARY 2019. Figure 5-4: New England system annual average NOX, SO2, and CO2 emission rates, 2007 to 2016 (lb/MWh).

Table 6-9: New EGU Units in Massachusetts in the Past 10 Years

Plant Code	Plant Name	Utility Name	Gen ID	Technology	Unit Code	Nameplate Capacity (MW)	Status	Operating Year
Proposed								
1678	Waters River (MMWEC)[1]	City of Peabody - (MA)	3	Natural Gas Fired Combustion Turbine		60.0	Planned, not permitted	
Commenced Operation after 2007								
1599	Canal	NRG Canal LLC	3	Natural Gas Fired Combustion Turbine		330.0	Operating	2019
1615	Nantucket	Nantucket Electric Co	18	Petroleum Liquids		15.4	Operating	2019
59882	Exelon West Medway II LLC	Exelon Power	4	Natural Gas Fired Combustion Turbine		100.0	Operating	2019
59882	Exelon West Medway II LLC	Exelon Power	5	Natural Gas Fired Combustion Turbine		100.0	Operating	2019
60903	Salem Harbor Station NGCC	Footprint Salem Harbor Development LP	1&3	Natural Gas Fired Combined Cycle	1	399.1	Operating	2017
60903	Salem Harbor Station NGCC	Footprint Salem Harbor Development LP	2&4	Natural Gas Fired Combined Cycle	2	399.1	Operating	2018
1660	Potter Station 2	Town of Braintree - (MA)	WAT1	Natural Gas Fired Combustion Turbine		58.0	Operating	2009
1660	Potter Station 2	Town of Braintree - (MA)	WAT2	Natural Gas Fired Combustion Turbine		58.0	Operating	2009
52026	Dartmouth Power Associates LP	Morris Energy Operations Company, LLC	GEN3	Natural Gas Fired Combustion Turbine		24.7	Operating	2009
54586	Tanner Street Generation	Bicent Power	TRENT	Natural Gas Fired Combined Cycle	CC1	57.9	Operating	2008

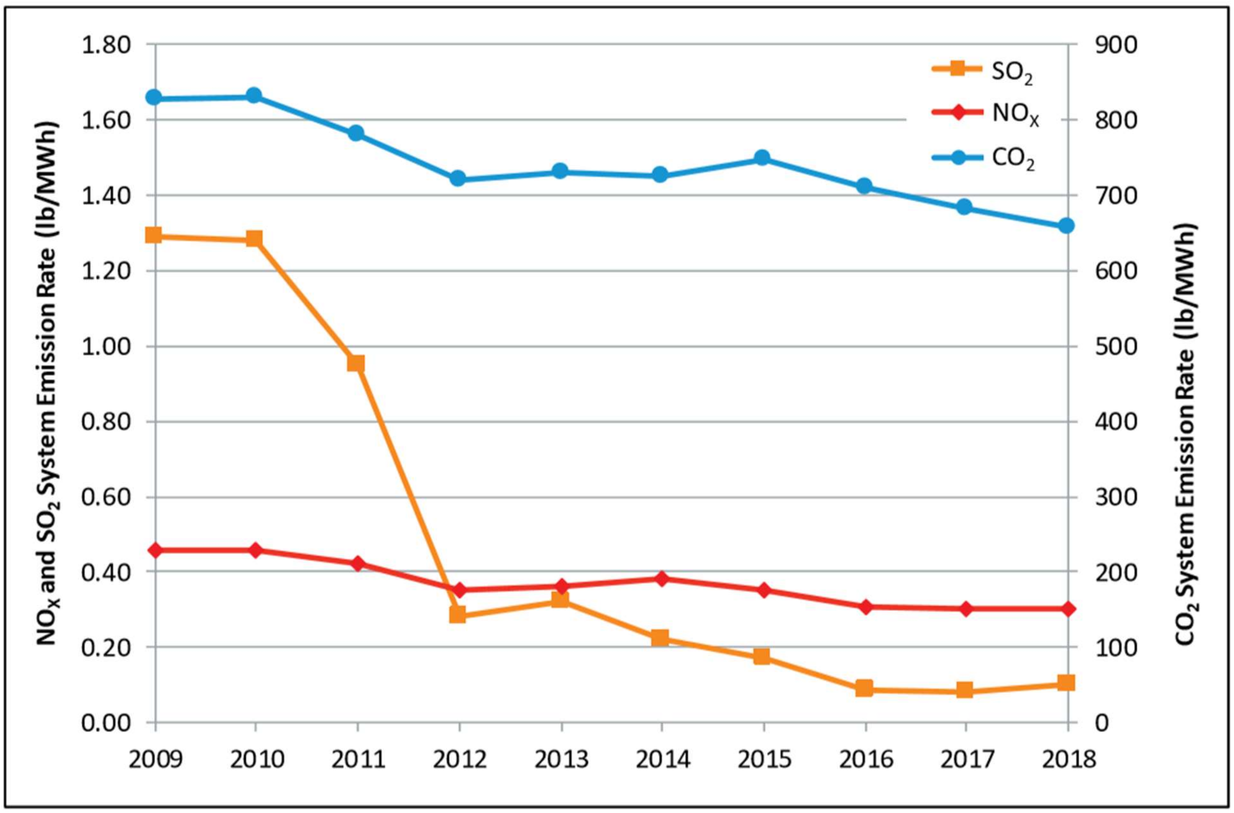
Source: EIA. Annual Electric Generator Report (EIA-860) Data Files for 2018, AMPD, and MassDEP Source Registration.
File: 3_1_Generator_Y2018.xlsx Link: https://www.eia.gov/electricity/data/eia860/
[1] Massachusetts Municipal Wholesale Electric Company

Table 6-10: Comparative EGU Emission Rates per MWh

		Emission Rates (lbs/MWh)	Emissions from compensating sources as % of Brayton actual emissions rate
		SO_2	SO_2
Brayton Point 1-2-3	2015 Actual	0.83	
New MA gas units -- Footprint	Permit	0.01	1%

Sources: EPA AMPD for actual emissions from Brayton 1-2-3.
AIR QUALITY PLAN APPROVAL issued to Footprint Power Salem Harbor Development LP (Transmittal No.: X254064 Application No.: NE-12-022 Class: OP119 FMF No. 546374). Issued by MassDEP: January 30, 2014 (Table 3 Footprint permit limits: < 0.010 lb SO2/MW-hr)

Figure 6-1: ISO-NE Emissions Rate Trends 2008-2018



Source: 2018 ISO New England Electric Generator Air Emissions Report. ISO New England Inc. System Planning. MAY 2020. (Figure 5 4: ISO New England system annual average generator emission rates, 2008 to 2018 (lb/MWh).) (https://www.iso-ne.com/system-planning/system-plans-studies/emissions).

Table 6-11: Annual Emissions Reductions from Brayton 1-2-3 Retirement

Facility	Unit ID	SO_2 Emissions 2015
Brayton Point	1	372
Brayton Point	2	307
Brayton Point	3	354
Sum of Emissions Brayton 1-2-3		1,032

Adjustment for Compensating Units		SO_2 (lbs/MWh)
Brayton 1-2-3 Emissions Rate 2015		0.83
Compensating Emissions Rate New Unit Permit Limit (Footprint)	1 / 2	0.01
		(< 0.010 lb/MW-hr)
Rate as % of Brayton Rate		1.2%
Brayton 2015 Emissions Less Estimated Compensating Unit Emissions		1,021
Reduction in Coal Use from 2011 to 2028 in NESCAUM States		23%
Brayton 1-2-3 Emissions Adjusted for Reduced Coal Use		785

Source: EPA AMPD for actual emissions

Coal Use Adjustment. Coal-fired EGUs run less now than in the past and MANE-VU modeling anticipates them running even less often in the future. MANE-VU modeled 2028 heat input for coal-fired plants in the MANE-VU states at 23% less than the base year 2011 heat input (see Table 6-12). Therefore, the emissions from Brayton 1-2-3 were adjusted down 23% to account for the anticipated reduction in use of a coal plant. The adjusted emissions are shown in Table 6-11. Although Brayton 1-2-3 could burn oil, no adjustment was made for burning low sulfur oil because historic use rates of oil at Brayton were negligible.[78]

Results. After adjusting the Brayton 1-2-3 emissions for estimated compensating sources and future reduced coal use, the 2015 SO_2 emissions reductions from Brayton 1-2-3 are 785 tons annually (Table 6-11). When the adjustments are applied to Brayton 1-2-3 emissions on HEDDs the result is 156 tons per year of reductions on HEDDs (Table 6-8).

[78] Brayton 1-2-3 were permitted to burn oil, but only as a backup fuel (see operating permit 2011). MassDEP SR records indicate that none of these units combusted fuel oil from 2011 to 2015 except for Unit 2 which burned 2.274111 million gal of residual oil in 2014. The amounted to 5% of the total heat input for that unit for 2014, and 1% for Brayton 1-2-3 for the same year. The oil consumption amounted to 0.24% of the total heat input for Brayton 1-2-3 for 2011-2015. The sulfur content of this fuel would have been limited to 1%. In future years, Brayton 1-2-3 may have burned oil again, but the sulfur content after 2018 would have been 0.5% due to the MassDEP's low sulfur fuel oil rule. Therefore, a small portion of the sulfur emissions for Brayton in future years would have been reduced by half due to the MassDEP's rule. For this analysis that potential reduction in emissions would be negligible.

Table 6-12: Projected Heat Input for Coal Units in MANE-VU 2028 vs. Base Year 2011

Sum of Future year heat input (mmbtu)	
1,150,307,453	MANE-VU coal only FY Heat Input
1,487,565,719	MANE-VU coal only BY Heat Input
337,258,266	Difference (i.e., reduction in coal unit use)
23%	Reduction in coal use from 2011 to 2028

Source: MANE-VU ERTAC Ask modeling. File: ERTAC Runs\ERTAC Ask Modeling-1.xlsx (State Summaries filtered for Coal) ver 2.7

Even with these adjustments the remaining 2015 Brayton 1-2-3 HEDD SO_2 emissions (156 tons SO_2) are 6 times greater than the 25 tons total average annual NO_x emissions on HEDDs from all of the turbines that do not meet Ask 5. Note that the remaining 2015 adjusted SO_2 emissions from all days (not just HEDDs) from Brayton 1-2-3 (785 tons) are equivalent to 15 times the annual average NO_x emissions from all the turbines on all days combined (51 tons) (Table 6-8).

Note on turbine emissions data: Some turbines report to EPA's AMPD for only 5-6 months of the year: Woodland Road Unit 10, Doreen Unit 10, West Springfield Unit 10, and Kendall Green Unit S6. In Table 6-5 the HEDD values are 5- or 6-month HEDD emissions for these units. The 5- or 6-month values used in this analysis inherently underestimate the true HEDD emissions for 2011-2015. This underestimate is likely to be small because, for 2011-2015, 81% of the HEDDs occurred in the 5-month ozone season (May - September).

In addition, the proportion of non-ozone season emissions from these units is much smaller than their ozone season emissions. Table 6-11 also shows the total 2011-2015 NO_x emissions for these turbines which are the 12-month values from MassDEP Source Registration reports (i.e., they are reported annual values and not underestimates). The proportion of annual emissions from these units that occurred during their AMPD reporting season ranged from 74 to 93% (that is, their non-ozone season emissions ranged from 7 to 26% of their annual total).

The small portion of emissions in the non-reporting season taken together with the small proportion of HEDDs in the non-reporting season suggest that the underestimation of HEDD emissions for these units is likely small. The impact of this underestimate to the overall conclusion is further mitigated because the equivalent alternative emissions reductions are sufficient to offset all HEDD emissions from these units throughout the year (that is, the adjusted Brayton 1-2-3 2015 HEDD emissions – 156 tons – are greater than the total annual average for all the turbines – 51 tons – which takes into account the full 12 months of emissions for these seasonal units).

Conclusion. The retirement of Brayton Point 1-2-3 and repowering of Solutia Boiler 11 each provide equivalent alternative SO_2 or NO_x emission reductions, respectively, on HEDDs that are far larger than any NO_x reductions possible from the turbines that do not already meet Ask 5 (156 and 128 tons/year vs. 25 tons/year). Furthermore, the annual SO_2 emission reductions from Brayton Point 1-2-3 (785 tons/year) and Solutia Boiler 11 (847 tons/year combined SO_2 and NO_x) are each sufficiently large to offset all the annual turbine NO_x emissions (51 tons per year). Therefore, the permanent retirement of Brayton 1-2-3 and repowering of Solutia Boiler 11 each satisfies the Ask for the remaining 11 turbines not covered by the most recent MassDEP RACT rule.

Because the Solutia Boiler 11 repowering and Brayton 1-2-3 retirements offset over 100% of the emissions from the 11 turbines on HEDDs, they exceed the visibility improvement requirements of Ask 5 and therefore no four-factor analysis is needed to determine what reductions might be reasonable from further controls on these turbines.

In addition, because MassDEP has permitted new units (e.g., Footprint 1/2, Canal 3, and West Medway 4/5) that are much cleaner than the 11 turbines, these new units likely will displace some of the power generating capacity of the older turbines units and thereby further reduce HEDD emissions from the turbines that do not meet Ask 5.

Ask 6: *Each State should consider and report in their SIP measures or programs to: a) decrease energy demand through the use of energy efficiency, and b) increase the use within their state of Combined Heat and Power (CHP) and other clean Distributed Generation technologies including fuel cells, wind, and solar.*

Massachusetts has taken numerous actions to decrease energy demand through energy efficiency and has been named the most energy efficient state in the nation by the American Council for an Energy-Efficient Economy (ACEEE) for nine consecutive years.[79] Massachusetts ranks second in electric efficiency program spending per capita (at over four times the national average).[80] Massachusetts energy efficiency efforts will continue through the second regional haze implementation period and will achieve emissions reductions beyond those required in the MANE-VU Statement. Key features of the Massachusetts energy efficiency strategy and efforts to expand non-polluting sources of energy are highlighted below. Though not part of the SIP, they already have achieved substantial emissions reductions and will continue to contribute to visibility improvements in Class I areas through 2028 and beyond.

Energy Efficiency

Energy efficiency is a mandate of the Massachusetts Green Communities Act (GCA), signed into law in 2008. The GCA requires Massachusetts gas and electric distribution companies and

[79] The 2019 State Energy Efficiency Scorecard. Report U1908. American Council for an Energy-Efficient Economy. October 1, 2019. (https://www.aceee.org/research-report/u1908 and https://www.aceee.org/state-policy/scorecard)
[80] Ibid. Appendix B and F

municipal aggregators to deliver measurable, verifiable energy savings according to 3-year plans approved by the Department of Public Utilities (DPU). The GCA also created the Massachusetts Energy Efficiency Advisory Council (EEAC) to guide, monitor, and evaluate these plans. The goals and costs in the current Three-Year Plan (2019-2021) were approved by DPU on January 29, 2019.[81] One focus area for the current plan that in particular will benefit visibility is reducing peak electricity demand.

The EEAC evaluation of the 2013-15 period showed a reduction of 1,468 GWh and 26.2 million therms for 2015 alone.[82] The plan reduced electricity use at a cost of 3.4 cents per kilowatt-hour, when that same electricity would otherwise have been supplied at an average retail rate of 16.9 cents per kilowatt-hour.

The natural gas efficiency programs are funded by an Energy Efficiency Surcharge (EES) on gas customers' bills. The electric energy efficiency programs in 2013-2015 were funded primarily (86%) by: (1) a System Benefit Charge (SBC) of 2.5 mills ($0.0025) per kilowatt-hour for all electric consumers (except those served by a municipal lighting plant); and (2) the Energy Efficiency Reconciliation Factor (EERF) which recovers costs from electric customers in proportion to the costs of programs directed at each sector (i.e., residential, commercial and industrial). A small portion of the funding came from Regional Greenhouse Gas Initiative (RGGI) auction proceeds (5%) and Forward Capacity Market (FCM) payments from ISO-NE (3%).

Clean Energy

Massachusetts Renewable Energy Portfolio Standard (RPS).[83,84] The RPS was created by the Electricity Restructuring Act of 1997. It was one of the first programs in the nation that required a certain percentage of the state's electricity to come from renewable energy.

The RPS requires retail electricity suppliers (both regulated distribution utilities and competitive suppliers, but not municipal light districts) to obtain a percentage of the electricity they serve to their customers from qualifying renewable energy facilities. The RPS requirements began in 2003 with an obligation of 1% of total retail electricity sales, which increased by 0.5% annually until it reached 4% in 2009. The RPS Class I obligation has increased by 1% annually since 2009 (between 2020 and 2029 it will increase by 2% annually).

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[81] 2019-2021 Three-Year Energy Efficiency Plans Order 1.29.19. DPU. (See DPU website: https://www.mass.gov/guides/energy-efficiency-three-year-plans-orders-and-guidelines)

[82] 2015 ANNUAL REPORT With Data from the 2013-2015 Plan Term, Cost-Effective Energy Efficiency for Residents, Businesses and Institutions. Massachusetts Energy Efficiency Advisory Council. See: http://ma-eeac.org/wordpress/wp-content/uploads/EEAC-Year-2015-Annual-Report-the-the-Legislature.pdf

[83] See: https://www.mass.gov/service-details/program-summaries

[84] Massachusetts 2017 Renewable Portfolio Standard (RPS) and Alternative Portfolio Standard (APS) Annual Compliance Report. Massachusetts Department of Energy Resources. March 12, 2020.

Suppliers meet their annual RPS obligations by acquiring a sufficient quantity of RPS-qualified renewable energy certificates (RECs). One REC is created each time a qualified facility generates 1 megawatt hour (MWh) of electricity. In 2020, all suppliers will be required to acquire RECs equal to 15% of the total electricity they serve in Massachusetts.

The RPS Class I requirement is met through electricity production from qualified new renewable energy facilities. New renewable energy facilities are those that began commercial operation after 1997 and generate electricity using any of the following technologies.

- Solar photovoltaic
- Solar thermal electric
- Wind energy
- Small hydropower
- Landfill methane and anaerobic digester gas
- Marine or hydrokinetic energy
- Geothermal energy
- Eligible biomass fuel

In 2017, wind accounted for approximately 57% of the total RPS Class I RECs while solar contributed 35%.[85] Landfill gas supplied 5%. The remaining 3% came from hydroelectric and anaerobic digester facilities.

Solar Carve-Out. Starting in 2010, a portion of the RPS Class I renewable energy requirement must come from solar photovoltaic (PV) energy. This feature was originally designed to support new PV installations until 1,600 MW of capacity was installed across the entire state – expected by 2020. This goal, however, was met in 2016. DOER extended the program until the successor incentive program described below was launched in November 2018.

Solar Massachusetts Renewable Target (SMART) Program.[86] The Solar Massachusetts Renewable Target (SMART) Program is the newest program established to support the development of solar in Massachusetts. The Massachusetts Department of Energy Resources (DOER) issued regulations (225 CMR 20.00) for the program in August 2017 and began accepting applications in November 2018.

The SMART Program is a 3200 MW declining block incentive program – that is, the amount of incentive declines as the total amount of installed solar capacity increases by 200 MW blocks. Eligible projects must be interconnected by one of three investor-owned utility companies in

[85] Massachusetts 2017 Renewable Portfolio Standard (RPS) and Alternative Portfolio Standard (APS) Annual Compliance Report. Massachusetts Department of Energy Resources. March 12, 2020. (See DOER website: https://www.mass.gov/service-details/important-documents-and-publications)
[86] See SMART program website: https://www.mass.gov/info-details/solar-massachusetts-renewable-target-smart-program#general-information-

Massachusetts: Eversource, National Grid, and Unitil. Each utility has established blocks that decline in incentive rate between each block.

Unlike the RPS solar carve out where solar renewable energy credits (SRECs) are traded at fluctuating market value, SMART incentives are fixed for the duration of the program. Similar to the previous SREC program, the incentive for small-scale projects of less than 25 kW (i.e., residential systems) would run for ten years. For larger projects, the incentive would last for 20 years.

Clean Energy Standard (310 CMR 7.75).[87] The Clean Energy Standard (CES) requires retail electricity sellers (except for Municipal Electric Departments (MEDs) and Municipal Light Boards (MLBs)) to annually demonstrate the use of new clean energy to generate a specified percentage of their electricity sales. MassDEP first issued the CES regulations in 2017 pursuant to the Global Warming Solutions Act (GWSA) and Executive Order 569. The minimum percentage began at 16% in 2018 and increases 2% annually to 80% in 2050. The CES is met through acquisition of Clean Energy Credits (CECs) or by making an Alternative Compliance Payment. In 2020, MassDEP finalized the "CES-E," which addresses existing resources by requiring utilities and competitive suppliers to continue procuring a set amount of electricity from these sources each year from 2021 until 2050.

To qualify as new clean energy, a unit must possess an RPS Class I statement of qualification (or emit less than 50 percent of the lifecycle emissions of a new natural gas combined cycle facility), have started operation after December 31, 2010, and not be committed to any control area other than ISO New England (or be located in an adjacent control area and utilize new transmission capacity). Renewable generation or alternative compliance credits used for compliance with RPS Class I may also be used to comply with the CES in a given year.

Regional Greenhouse Gas Initiative (RGGI). RGGI is a CO_2 budget and trading program that allows for the auctioning and trading of CO_2 allowances among fossil fueled EGUs (≥ 25 MW) in its nine member states. Starting in 2009, each state set a declining CO_2 budget to reduce the overall amount of combustion required for electricity generation in the state. States then invested the proceeds from the CO_2 allowance auctions in programs to improve energy efficiency and accelerate the deployment of renewable energy technologies. Massachusetts is a charter member of RGGI and its regulations are at 310 CMR 7.70: CO_2 Budget Trading Program Regulations and 225 CMR 13.00: DOER CO_2 Budget Trading Program Auction Regulation.

As a whole, the RGGI states have reduced power sector CO_2 pollution over 50% since 2005, while the region's gross domestic product has continued to grow.[88] MassDEP recently updated its regulations to set a 33% reduction in the budget from 2018 to 2030.[89] This will inherently

[87] See CES website: https://www.mass.gov/guides/clean-energy-standard-310-cmr-775
[88] The Investment of RGGI Proceeds in 2018. RGGI. July 2020. (See: https://www.rggi.org/investments/proceeds-investments)
[89] 310 CMR 7.70(5)(a) Massachusetts CO_2 Budget Trading Program Base Budget

result in lower emissions of NO_2 and SO_2. MANE-VU found that RGGI will result in substantial reductions in emissions of SO_2 and NO_x and that member states will likely achieve greater emissions reductions through RGGI than those envisioned in other portions of the 2017 Ask.[90]

Massachusetts has invested the majority (81%) of its RGGI funds in energy efficiency through the Massachusetts' statewide Three-Year Energy Efficiency Investment Plans and other State programs managed by DOER (such as the Green Communities Designation and Grant Program).[91] The statewide Energy Efficiency Investment Plans are implemented through the Commonwealth's investor-owned utilities under the MassSave® brand with a mission to deliver cost-effective energy savings to Massachusetts residences and businesses. The remaining 20% of net funding has been used under the Massachusetts Green Communities program to implement clean energy projects including energy efficiency improvements and to fund consumer rebates for plug in vehicles under the MOR-EV program.

Combined Heat and Power (CHP)

Alternative Energy Portfolio Standard (APS). The APS was established in January 2009 under the Green Communities Act. The APS offers an incentive for installing alternative energy systems that are not necessarily renewable but increase energy efficiency and reduce the need for conventional fossil fuel power generation. Similar to the RPS, APS requires a certain percentage of the state's electric load to be met by eligible technologies, which for APS include Combined Heat and Power (CHP), flywheel storage, and efficient steam technologies. Eligible facilities generate Alternative Energy Certificates (AECs) and the annual percentage requirement increases by 0.25% per year indefinitely.

***Streamlined permitting of CHP systems*.** MassDEP created the Environmental Results Program (ERP) (310 CMR 7.26(40)-(45)) for engines and turbines in 2006 to streamline permitting for small units (e.g., turbines less than or equal to 10 MW). The purpose of 310 CMR 7.26(45) is to encourage the installation of CHP systems by allowing them credit for their efficiency against the emissions standards of the ERP program at 310 CMR 7.26(43)(b). The credit is calculated from the emissions that would have been created by a conventional separate system used to generate the same thermal output. The credit is then subtracted from the actual CHP system emissions for the purpose of calculating compliance with the emission limitations contained. This allows CHP units that could not otherwise meet the ERP standards to use the streamlined permit system and avoid case-by-case BACT.

[90] Statement of the Mid-Atlantic / Northeast Visibility Union (MANE-VU) Concerning a Course of Action with MANE-VU toward Assuring Reasonable Progress for the Second Regional Haze Implementation Period (2018-2028). MANE-VU. August 25, 2017. (Appendix 15)
[91] The Investment of RGGI Proceeds in 2018. RGGI. July 2020. (See: https://www.rggi.org/investments/proceeds-investments)

In addition, 310 CMR 7.70 Massachusetts CO_2 Budget Trading Program provides incentive for CHP by allowing CHP systems to deduct from their compliance obligation the emissions created for generating useful thermal energy.[92]

Clean Peak Energy Standard (CPS)

Part of the 2018 An Act to Advance Clean Energy (MGL Section 17. (a)) requires every retail electric supplier providing service under contracts executed or extended after December 31, 2018, to provide a minimum percentage of kilowatt-hour sales to end-use customers in the Commonwealth from clean peak resources.[93] The CPS is a market mechanism designed to shift clean energy to peak and reduce demand at peak, thereby decreasing emissions and costs. By 2030, Massachusetts will have a substantial amount of clean energy, however that generation will not necessarily coincide with our peak demands. The CPS will send a market signal to clean energy generation to invest in storage technologies to deliver energy to load users to reduce demand during peak periods, thereby reducing the emissions and costs associated with these periods. The CPS will thereby permanently reduce emissions on the HEDD identified as a priority by MANE-VU.

Clean Peak Resources are defined in statute as below.

- New renewables
- Existing renewables that pair with new energy storage
- New energy storage that charges primarily from renewables
- Demand response resources

Any eligible resource that generate, dispatch or discharge energy during a Seasonal Peak Period will generate Clean Peak Energy Certificates (CPECs). CPECs can be sold to retail electricity suppliers, which are required to purchase a certain amount each year to meet the minimum standard obligation. Massachusetts was the first in the nation to approve and implement a CPS.

Each year the Department of Environmental Resources (DOER) will reduce minimum percentage of kilowatt-hours sales to end-use customers from existing clean peak resources during the seasonal peak load hours by not less than an additional 0.25 per cent. For 2020, DOER has determined that 1.5 percent of sales by retail electricity suppliers in the Commonwealth shall be met with Clean Peak Energy Certificates.[94]

[92] 310 CMR 7.70 . . . (h) Exemption for Any Combined Heat and Power CO_2 Budget Source. 1. Applicability. Notwithstanding 310 CMR 7.70(1)(d), any entity owning, operating, or controlling a combined heat and power CO_2 budget source that sells its useful net thermal energy shall comply with all of the provisions of 310 CMR 7.70, except that it may subtract from its total CO_2 emissions recorded for compliance under 310 CMR 7.70(6) the amount of CO_2 emissions attributable to the production of useful net thermal energy as long as it complies with all of the provisions in 310 CMR 7.70(1)(h).

[93] Per the statute, municipal lighting plants are exempt from the Clean Peak Energy Standard.

[94] Clean Peak Energy Standard Notices and Updates (https://www.mass.gov/service-details/clean-peak-energy-standard-notices-and-updates)

Offshore Wind Power

Massachusetts laws authorize the purchase of 3,200 MW of offshore wind power.[95] Massachusetts has selected 800 MW from the Vineyard Wind project and 800 MW from Mayflower Wind, which would provide approximately 12% of the total Massachusetts energy demand. Bids for the remaining 1,600 MW are anticipated in 2022 and 2024 based on a 2019 study.[96] DOER also announced plans in 2020 for a solicitation for a main transmission system that future generation projects would tie into.[97] In addition, Massachusetts has made substantial investments in offshore wind development including the New Bedford Marine Commerce Terminal (a multi-purpose facility designed to support the construction, assembly, and deployment of offshore wind projects) and the Wind Technology Testing Center for certifying turbine blades.[98]

Hydroelectric Power

In 2019, the Massachusetts Department of Public Utilities (DPU) approved long-term contracts for 9,554,940 megawatt hours (MWh) annually of clean energy between H.Q. Energy Services (U.S.) Inc. (HQUS) and the Commonwealth's Electric Distribution Companies through the New England Clean Energy Connect 100% Hydro project (NECEC Hydro). These contracts stem from *An Act Relative to Energy Diversity*.[99] The project has been permitted by the State of Maine, but still requires permits from the U.S. Army Corps of Engineers and the Department of Energy. It is scheduled to be operational in 2022. This project represents the largest procurement of clean energy in Massachusetts history, increasing to nearly half the portion of the state's electricity coming from clean energy resources.

Massachusetts also provides incentives for more local hydroelectric power projects through the Commonwealth Hydropower Program managed by the Massachusetts Clean Energy Center.[100] First authorized in 2009, the program provides grants for construction projects and feasibility studies for eligible hydropower facilities. Applicants may request funding in the following activity areas:

- Upgrade of existing hydropower facilities to increase energy generation, such as turbine replacement or refurbishment; installation or upgrade of automated controls; replacement

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95 DOER (https://www.mass.gov/service-details/offshore-wind-study); Energy Diversity Act, Chapter 188 of the Acts of 2016 (https://malegislature.gov/laws/sessionlaws/acts/2016/chapter188); An Act to Advance Clean Energy, Chapter 227 of the Acts of 2018, (https://malegislature.gov/Laws/SessionLaws/Acts/2018/Chapter227)

96 Offshore Wind Study, DOER, May 2019 (https://www.mass.gov/service-details/offshore-wind-study)

97 Offshore Wind Transmission Letter, DOER, July 28, 2020 (https://www.mass.gov/doc/offshore-wind-transmission-letter-07-28-20/download)

98 See https://www.mass.gov/news/baker-polito-administration-announces-agreements-with-vineyard-wind-and-mayflower-wind-for-new

99 An Act to Advance Clean Energy, Chapter 227 of the Acts of 2018 (https://malegislature.gov/Laws/SessionLaws/Acts/2018/Chapter227)

100 Massachusetts Clean Energy Center (https://www.masscec.com/hydropower-0)

of wooden flashboards with rubber skirt/inflatable crest gate systems; enhanced fish or eel passage (in conjunction with measures to increase generation)

- Development of new conduit hydropower facilities
- Feasibility studies for any of the types of projects listed above

6.4 Technical Basis for Long-Term Strategy

40 CFR 51.308(f)(2)(iii) requires MassDEP to document the technical basis (including modeling, monitoring, cost, engineering, and emissions information) on which it relied to determine the emission reduction measures that are necessary to make reasonable progress in each Class I area it affects. MassDEP relied primarily on the technical analyses developed by MANE-VU to determine the emission reduction measures that are necessary to make reasonable progress as allowed for in the Regional Haze Rule.[101] The technical basis also includes the analyses listed in MassDEP's 2012 Regional Haze SIP. The MANE-VU technical documents for the second implementation period are included as appendices to this SIP revision.

6.5 Emission Reductions Due to Ongoing Air Pollution Controls

40 CFR 51.308(f)(2)(iv)(A) requires MassDEP to consider emission reductions due to ongoing air pollution control programs. MassDEP considered these reductions as part of the MANE-VU process that generated emission inventories and projections that reflect ongoing programs and were incorporated into the modeling for the RPGs (see Appendix 5 for controls included in the inventories and Section 2 for the RPGs). These also were considered in the emissions rates used in the CALPUFF and Q/d screening models and in reviewing the controls and emission limits on the Massachusetts units subject to the MANE-VU Ask.

6.6 Measures to Mitigate the Impacts of Construction Activities

40 CFR 51.308(f)(2)(iv)(B) requires that MassDEP consider measures to mitigate the impacts of construction activities. A description of how MANE-VU considered measures to mitigate the impacts of construction for the first implementation period 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 to the 2012 Regional Haze SIP).

MassDEP requires contractors working on certain state-financed projects to install retrofit pollution controls in their construction equipment engines. In addition, MassDEP 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,

[101] 40 CFR 51.308(f)(2)(C)(iii) provides the option for a state to address the technical basis for its long-term strategy requirement through a regional analysis.

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) established during the first implementation period, MassDEP concluded that its regulations are sufficient to mitigate the impacts of construction activities. EPA approved this portion of the 2012 Massachusetts RH SIP based on the discussion above.[102] There has been no large positive or negative change in construction activity since then nor has MassDEP adopted any significant measure to mitigate impacts of construction activity since the previous SIP revision.

The new MANE-VU speciation analyses[103] and contribution assessment[104] for the second implementation period found that crustal material does not play a major role in visibility impairment at Class I areas. In addition, the Massachusetts 2017 inventory shows $PM_{2.5}$ emissions from construction totaled 1,093 tons, or only 4% of the Massachusetts total $PM_{2.5}$ emissions inventory. Because the contribution to visibility impairment from construction dust is small, MassDEP has determined that no change in its regulatory program for construction dust is necessary to make reasonable progress.

6.7 Source Retirement and Replacement Schedules

40 CFR Section 51. 308(f)(2)(iv)(C) requires MassDEP to consider source retirement and replacement schedules in developing its LTS. MassDEP considered source retirement and replacement in developing the emissions inventories described in Section 4 and as described in the Gamma Inventory technical support documentation in Appendix 19, and in MassDEP's implementation of the 2017 MANE-VU Statement.

6.8 Agricultural and Forestry BSMPs and Smoke Management Programs

40 CFR Section 51. 308(f)(2)(iv)(D) requires MassDEP to consider basic smoke management practices (BSMPs) for prescribed fire used for agricultural and wildland vegetation management purposes and smoke management programs in developing its long-term strategy.

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* developed for the first implementation period SIP. [105]

[102] Approval and Promulgation of Air Quality Implementation Plans; Massachusetts; Regional Haze, Final Rule. EPA. September 19, 2013 (78 FR 57487)
[103] Regional Haze Metric Trends and HYSPLIT Trajectory Analyses. MANE-VU. May 2017. (Appendix 13) p.51: "Organic mass carbon, sea salt, coarse mass, light absorbing carbon, and soil contribution changes from the base period were all less than 5% at all Class I sites."
[104] Selection of States for MANE-VU Regional Haze Consultation (2018). MANE-VU Technical Support Committee. September 5, 2017. (Appendix 16)
[105] Appendix Q to the 2012 RH SIP.

This TSD concluded that emissions from agricultural, managed, and prescribed burning are minor source categories (totaling 1.34% of $PM_{2.5}$ emissions in the MANE-VU region[106]). It noted that source apportionment results showed that wood smoke was a moderate contributor to visibility impairment at some Class I areas in the MANE-VU region but that smoke is not an especially important contributor to MANE-VU Class I areas on either the 20% best or 20% worst visibility days. It concluded that 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. The report observed that while, on rare occasions, smoke from major fires degrades the air quality and visibility in the MANE-VU area, these fires are generally unwanted wildfires that are not subject to BSMPs.

For the second implementation period, the MANE-VU technical analyses confirmed the primary sources of visibility impairment found in the first implementation period (see Section 5). The 2017 emissions inventory confirmed that prescribed forest and agricultural fires emissions estimates remain a small portion of the total Massachusetts $PM_{2.5}$ and PM_{10} inventories (0.032% and 0.017%).[107] Therefore, MassDEP concludes that no substantial change has occurred that would alter the conclusions of the previous SIP regarding the sources of visibility impairment, and therefore no change to Massachusetts smoke management practices is needed to make reasonable progress.

Massachusetts Regulation of Open Burning

Massachusetts does not currently have a smoke management program. However, MassDEP's air regulation at 310 CMR 7.07 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. The regulations do allow burning for "activities associated with the normal pursuit of agriculture" and the open burning of brush and debris from January 15 to May 1, "except during periods of adverse meteorological conditions." Prescribed burning also is allowed under 310 CMR 7.07(3)(f) upon specific permission from MassDEP. MassDEP 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.

6.9 Anticipated Net Effect on Visibility

40 CFR 51.308(f)(2)(iv)(E) requires MassDEP to consider in developing the LTS the anticipated net effect on visibility due to projected changes in point, area, and mobile source emissions over the period addressed by the LTS (i.e., 2018 - 2028).

[106] Table 2. Technical Support Document on Agricultural and Forestry Smoke Management in the MANE-VU Region. MANE-VU. September 1, 2006.

[107] Prescribed fires = 9.4 tons PM2.5 and 11.1 tons PM10. Data Set: 2017NEI_Apr2020_sectors_Agricultural Fires, Wildfires & Prescribed Fires (EPA EIS Gateway).

MANE-VU developed inventory projections and modeling for visibility impact for 2028 that incorporated the Ask for MANE-VU states as well as the Asks developed for upwind states and EPA/FLMs. These projections and modeling incorporated both the Massachusetts LTS from the first implementation period and estimates of the impact of additional LTS measures for the second implementation period. The results of that modeling are shown as RPGs on the graphs in Section 2 and detailed in the presentation of RPGs in the MANE-VU visibility report.[108]

The 2028 inventory projections demonstrate a substantial reduction in emissions. The modeling shows that projected visibility at all potentially impacted Class I areas will remain well below the URP line in 2028 for the most impaired days and that there will be no degradation in visibility for the least impaired days (see Section 2).

6.10 Federally Enforceable Components of the Long-Term Strategy

40 CFR 51.308(f)(2) requires MassDEP to include in its LTS "the enforceable emissions limitations, compliance schedules, and other measures that are necessary to make reasonable progress . . ." The federally enforceable components of the LTS are listed below.

Table 6-13: Federally Enforceable Components of the Long-Term Strategy

Canal Station Unit 1 limits	310 CMR 7.29 (previously submitted) 310 CMR 7.19(4)(b)3.b. (previously submitted with RACT SIP) Operating Permit (included as Appendix 39)
Brayton Point retirement	Revocation of permits (included as Appendix 37)
Solutia repowering	Operating Permit (included as Appendix 26)
RACT limits	310 CMR 7.19 (previously submitted with RACT SIP)
Low sulfur fuel	310 CMR 7.05 (submitted with previous haze SIP)
MWC RACT Emission Limits	NO_x emission limits for large MWCs in 310 CMR 7.08(2) and for small MWCs in 310 CMR 7.19(9) (previously submitted with RACT SIP)

[108] *Mid-Atlantic/Northeast U.S. Visibility Data, 2004-2017 (2nd RH SIP Metrics)*. MANE-VU (prepared by Maine Department of Environmental Protection). December 18, 2018 revision (Appendix 22)

7. Consultation

7.1 Consultation with Other States/Tribal Nations

40 CFR Section 51.308(f)(2)(ii) requires MassDEP to consult with other states/tribal nations to develop coordinated emission management strategies and measures to make reasonable progress to improve visibility. MassDEP consulted with other states and tribes through participation in the MANE-VU consultations and processes that developed the technical information necessary for the coordinated strategies and measures. This consultation process is documented in the *MANE-VU Regional Haze Consultation Report* (Appendix 20).[109]

7.2 Consultation with Federal Land Managers on Long-Term Strategy

40 CFR Section 51.308(i) requires MassDEP to consult with Federal Land Managers (FLMs) responsible for managing Class I areas that are potentially affected by emissions from Massachusetts. Specifically, it provides that:

> *(2) The State must provide the Federal Land Manager with an opportunity for consultation, in person at a point early enough in the State's policy analyses of its long-term strategy emission reduction obligation so that information and recommendations provided by the Federal Land Manager can meaningfully inform the State's decisions on the long-term strategy.*

The relevant FLMs for this SIP are National Park Service (NPS), U.S. Forest Service (USFS), and U.S. Fish and Wildlife Service (FWS). MassDEP and other MANE-VU states provided FLMs with this consultation in part through the opportunity for the FLMs to participate throughout the MANE-VU planning process, including regular meetings/calls of the MANE-VU Technical Support Committee (which provides oversight and guidance to that process). In addition, MANE-VU conducted webinars specifically for additional FLM consultation early in the SIP planning process concurrent with state-to-state consultations that began in February 2017, well before public hearings or other public comment opportunities for individual state SIPs. The FLMs were invited to attend the intra- and inter-RPO consultations among states and did attend seven intra-RPO meetings and all inter-RPO meetings. In addition, a consultation webinar with the FLMs was held on April 21, 2017 prior to the in-person consultation at the May 2017 MANE-VU Air Directors meeting. A briefing document was provided to the FLMs prior to the last webinar held on March 23, 2018 reviewing the technical and policy progress to date. This consultation process with the FLMs is documented in the *MANE-VU Regional Haze Consultation Report* (Appendix 20).[110]

[109] MANE-VU Regional Haze Consultation Report. MANE-VU Technical Support Committee. July 27, 2018. (Appendix 20)
[110] Ibid.

On October 22, 2018 the National Park Service (NPS) sent a letter to MassDEP that included a list of ten facilities for consideration for 4-factor analyses and requested information on how emissions from those facilities would change between 2018 and 2028 and which facilities would be evaluated as part of the Massachusetts LTS.[111]

On December 10, 2018 MassDEP held a conference call with NPS to discuss its letter. On December 11, 2018 MassDEP followed-up by sending updated information on some of the facilities as well as recently promulgated MassDEP NO_x RACT regulations that required further emissions reduction from some of the facilities. On December 18, 2018 NPS sent a revised list of seven facilities for consideration for four-factor analyses.[112]

After further discussions, on July 17, 2020 NPS sent a revised list based on updated information that indicated that four MWC facilities were the primary concern.[113] In response, on July 28, 2020 MassDEP sent NPS updated information on Emissions Control Plans that had been issued to the MWC facilities that would implement the lower NO_x emissions in MassDEP's RACT regulation.[114]

7.3 Consultation with FLMs on Draft RH SIP

In addition to consulting with FLMs on the development of the long-term strategy for the Regional Haze SIP, 40 CFR Section 51.308(i)(2) requires MassDEP to consult with FLMs on its implementation plan no less than 60 days prior to any public hearing or other public comment opportunity.

On November 13, 2020 MassDEP sent its pre-proposal draft SIP revision to FLMs for review and consultation and requested comments by January 15, 2021. On November 23, 2020 NPS sent its final list of four MWC facilities and requested information regarding the effectiveness of the SO_2 and NO_x controls on the four units.[115] In response, MassDEP provided the requested information to the FLMs.[116] On December 21, 2020 USFS requested information on Mystic Station and the Covanta Haverhill MWC. In response, MassDEP provided the requested information. MassDEP noted that the Mystic Unit was scheduled to close in May 2021.[117] The MWC data MassDEP provided is summarized in Tables 7-1, 7-2, 7-3, and 7-4.

[111] NPS letter to MassDEP with attachment. October 22, 2018. (Appendix 24)
[112] MassDEP email to NPS December 11, 2018 and NPS email to MassDEP December 19, 2018 (Appendix 25)
[113] NPS email to MassDEP July 17, 2020 (Appendix 28)
[114] MassDEP email to NPS July 28, 2020 (Appendix 29)
[115] NPS email to MassDEP November 23, 2020 (Appendix 32)
[116] MassDEP email to NPS December 16, 2020 (Appendix 33)
[117] Communications between USFS and MassDEP December 2020 - January 2021 (Appendix 34); memo from ISONE to NEPOOL Reliability Committee (Appendix 38)

On January 5, 2021 MassDEP held a conference call with NPS and USFS, which also was attended by EPA Region 1. After the call NPS and USFS submitted comments by January 15, 2021.[118] [119] Below is a summary of the comments received and MassDEP's responses.

National Park Service Comments Summary: Based on the updated information MassDEP provided to NPS, NPS reduced the list of sources that the NPS initially recommended for 4-factor analysis from 10 to just the four MWC facilities. NPS recognized that MassDEP's new Reasonably Available Control Technology (RACT) regulations will reduce emissions from MWCs once permits issued under these regulations are finalized; however, NPS maintained that four-factor analyses under the Regional Haze rule may identify further reasonable emission reductions from MWCs that are technically feasible and cost effective. NPS requested that MassDEP undertake formal 4-factor analyses on the MWCs to determine whether the MWCs could further reduce NO_x emissions in this planning period. NPS provided examples of similar MWC facilities in Maryland and Virginia that have permits with significantly lower NO_x emissions than the Massachusetts MWC facilities. NPS requested that MassDEP analyze the feasibility of achieving similar emission reductions through four-factor analyses. The MWCs are:

1. SEMASS Resource Recovery
2. Wheelabrator Millbury
3. Wheelabrator North Andover
4. Wheelabrator Saugus

NPS recognized that Massachusetts expects to achieve additional NO_x emission reductions through implementation of state climate programs (e.g., electrification of transportation and residential heating), and suggested that MassDEP document and make federally enforceable NO_x emission reductions that will be secured as a result of these programs. If they are substantive enough and secure enough (federally enforceable), this documentation may negate the need for full four factor analyses.

MassDEP Response:

MassDEP recognizes that MWCs are significant sources of NO_x emissions. MassDEP did not select MWCs for 4-factor analyses for the 2018 – 2028 planning period because, through the MANE-VU process, the MANE-VU states decided to focus on source categories that had larger numbers of sources and overall emissions, specifically EGUs, ICI boilers, and fuel oil combustion.[120] While not a focus of MANE-VU for this planning period, in 2018 MassDEP

[118] Letter from NPS to MassDEP January 15, 2021 (Appendix 35)
[119] Letter from U.S. Forest Service to MassDEP January 13, 2021 (Appendix 36)
[120] EPA's Regional Haze Guidance gives states the flexibility to select which sources to evaluate in each planning period. The next planning period will provide an opportunity to address sources not included for 2018-2028. EPA's guidance states "A key flexibility of the regional haze program is that a state is not required to evaluate all sources of emissions in each implementation period. Instead, a state may reasonably

adopted lower NO_x limits for MWCs in updated Reasonably Available Control Technology (RACT) regulations [310 CMR 7.08(2)] and has incorporated those regulations into the Massachusetts SIP. In February 2020, MassDEP issued updated Emission Control Plans (ECPs) to the MWCs with the lower NO_x emission limits. These ECPs currently are under appeal and are not yet final. Once the ECPs are final, the NO_x emissions limits for the MWCs will be reduced from 205 ppm to a range from 146 to 150 ppm on a 24-hour basis.

Given that the MWCs will be substantially controlled under the RACT regulations, MassDEP is not requiring the MWCs to conduct 4-factor analyses at this time but will continue to evaluate opportunities to further reduce NO_x emissions from MWCs and will provide an update on these efforts in the Regional Haze Progress Report due in 2025. MassDEP is participating in an Ozone Transport Commission (OTC) workgroup that is evaluating the feasibility of lower NO_x emission limits for MWCs and will consider the outcome of this work. In addition, this issue also will be addressed in MassDEP's 2030 Solid Waste Master Plan, which will be issued later this year.

U.S. Forest Service Comments Summary: USFS indicated that it was satisfied with the information MassDEP provided in response to its questions and had no further comment.[121]

7.4 Continuing Consultation with FLMs

40 CFR Section 51.308(i)(4) requires MassDEP to provide procedures for continuing consultation with the FLMs on the implementation of its RH SIP, SIP revisions, progress reports, and on the implementation of other programs having the potential to contribute to impairment of visibility in Class I areas. MassDEP will continue to consult with the designated visibility protection program coordinators for the FLMs through the following processes:

- MANE-VU's planning process, including participation in regular Technical Support Committee meetings that include FLM participation in the development of progress reports and the regional strategy for future RH SIP revisions.
- MassDEP regulatory and permit notification emails that provide notification of air quality regulation amendments, SIP revisions, major new source review permits, ambient air monitoring plans.
- MassDEP air quality advisory committee meetings.

select a set of sources for an analysis of control measures. The guidance that an analysis of control measures is not required for every source in each implementation period is based on CAA section 169A(b)(2), which requires each SIP to contain emission limits, schedules of compliance, and other measures as may be necessary to make reasonable progress, but (in marked contrast to the statutory provision for BART) does not provide direction regarding the particular sources or source categories to which such emission limits, etc., must apply. Selecting a set of sources for analysis of control measures in each implementation period is also consistent with the Regional Haze Rule, which sets up an iterative planning process and anticipates that a state may not need to analyze control measures for all its sources in a given SIP revision."

[121] Communications between US Forest Service and MassDEP. December 2020 - January 2021 (Appendix 36)

Table 7-1: Effectiveness of SO_2 and NO_x Controls on MWCs Identified by FLMs

Facility Name	Current Controls	SO_2 limits / Control effectiveness	NO_x limits / Control effectiveness*	Notes
SEMASS PARTNERSHIP	ECP approved 2/11/20 All units: SNCR, SDA Acid Gas Control	Less stringent of 29 ppm or 75% reduction	146 ppm (est. 45% reduction)	ECP under appeal (unrelated to SO2 / NOx limits)
WHEELABRATOR MILLBURY INC	ECP approved 2/11/20 All units: SNCR, SDA Acid Gas Control	Less stringent of 29 ppm or 75% reduction	150 ppm (est. 35% reduction)	ECP under appeal (unrelated to SO2 / NOx limits)
WHEELABRATOR NORTH ANDOVER INCORPORATED	ECP approved 2/11/20 Both units: SNCR, SDA Acid Gas Control	Less stringent of 29 ppm or 75% reduction	150 ppm (est. 35% reduction)	ECP under appeal (unrelated to SO2 / NOx limits)
WHEELABRATOR SAUGUS INC	ECP approved 2/11/20 Both units: SNCR, SDA Acid Gas Control	Less stringent of 29 ppm or 75% reduction	150 ppm (est. 35% reduction)** 185 ppm (30-day)(BART) (est. 20% reduction)	ECP under appeal (unrelated to SO2 / NOx limits)
COVANTA HAVERHILL	ECP approved 2/11/20 Both units: SNCR, SDA Acid Gas Control	Less stringent of 29 ppm or 75% reduction	150 ppm (est. 35% reduction)	ECP under appeal (unrelated to SO_2 / NO_x limits)

* NO_x control effectiveness is minimum effectiveness needed to reduce estimated uncontrolled emissions to meet the emissions limit. The basis for control effectiveness is uncontrolled values of 265 ppm (Rdf - SEMASS) and 231 ppm (mass burn – Wheelabrator units) derived from AP-42 Ch 2 Sec 1. Note that the facilities over-control to maintain a margin of compliance so that actual control effectiveness is likely greater than shown.

** Wheelabrator Saugus is allowed to use Emission Reduction Credits to meet 150 ppm emissions limit.

Table 7-2: MWC SO_2 and NO_x Emissions 2008 - 2019 (tons/yr)

Facility Name	AQID	Pollutant	2008	2011	2015	2018	2019
SEMASS PARTNERSHIP – SE	1200001	SO_2	523	451	192	362	378
WHEELABRATOR MILLBURY INC – CE	1180419	SO_2	139	225	224	166	147
WHEELABRATOR NORTH ANDOVER INCORPORATED – NE	1210261	SO_2	58	38	51	72	82
WHEELABRATOR SAUGUS INC – NE	1197654	SO_2	55	31	54	16	33
COVANTA HAVERHILL -- NE	1210007	SO_2	71	74	12	96	104
SEMASS PARTNERSHIP	1200001	NO_X	1384	1259	1249	1511	1434
WHEELABRATOR MILLBURY INC	1180419	NO_X	814	865	873	865	863
WHEELABRATOR NORTH ANDOVER INCORPORATED	1210261	NO_X	781	768	738	743	815
WHEELABRATOR SAUGUS INC	1197654	NO_X	722	705	667	640	578
COVANTA HAVERHILL -- NE	1210007	NO_X	897	1021	986	996	989

Source: MassDEP Source Registration data

Table 7-3: MWC Unit SO_2 and NO_x Emission Rates for 2018 (lbs/ton)

2018 Actual Emissions							
Facility Name	AQID	Design Capacity	Pollutant	2018 Actual Emissions All Units, TPY	2018 Unit Specific Actual Emissions, TPY	2018 Unit Specific MSW Burned, TPY	2018 Unit Specific Emission Rate, lb/Ton MSW Burned
SEMASS PARTNERSHIP – SE	1200001	3 units, 375 MMBtu/hr each	SO_2	362	U1 - 149.9 U2 - 133.0 U3 - 79.4	U1 – 338,213 U2 – 362,002 U3 – 375,297	U1 - 0.8820 U2 – 0.7280 U3 – 0.4220
WHEELABRATOR MILLBURY INC – CE	1180419	2 units, 323 MMBtu/hr each	SO_2	166	U1 - 82.4 U2 - 83.2	U1 - 236,036 U2 - 245,428	U1 - 0.6985 U2 - 0.6781
WHEELABRATOR NORTH ANDOVER INCORPORATED – NE	1210261	2 units, 288.4 MMBtu/hr each	SO_2	72	U1 - 28.8 U2 - 43.0	U1 - 229,001 U2 - 227,852	U1 - 0.2516 U2 - 0.3772
WHEELABRATOR SAUGUS INC – NE	1197654	2 units, 325 MMBtu/hr each	SO_2	16	U1 - 9.1 U2 - 7.0	U1 - 211,926 U2 - 219,763	U1 - 0.0861 U2 - 0.0636
COVANTA HAVERHILL -- NE	1210007	2 units, 381.56 MMBtu/hr each	SO_2	96	U1 - 49.5 U2 - 46.6	U1 - 295,011 U2 - 299,073	U1 - 0.3356 U2 - 0.3116
SEMASS PARTNERSHIP	1200001	3 units, 375 MMBtu/hr each	NO_x	1511	U1 – 569.4 U2 – 550.2 U3 – 389.3	U1 – 338,213 U2 – 362,002 U3 – 375,297	U1 – 3.3890 U2 – 3.0360 U3 – 2.0700
WHEELABRATOR MILLBURY INC	1180419	2 units, 323 MMBtu/hr each	NO_x	865	U1 – 431.9 U2 – 430.9	U1 - 236,036 U2 - 245,428	U1 – 3.6592 U2 – 3.5113
WHEELABRATOR NORTH ANDOVER INCORPORATED	1210261	2 units, 288.4 MMBtu/hr each	NO_x	743	U1 – 363.6 U2 – 379.0	U1 - 229,001 U2 - 227,852	U1 – 3.1758 U2 – 3.3271
WHEELABRATOR SAUGUS INC	1197654	2 units, 325 MMBtu/hr each	NO_x	640	U1 – 304.1 U2 – 323.7	U1 - 211,926 U2 - 219,763	U1 – 2.8697 U2 – 2.9459
COVANTA HAVERHILL -- NE	1210007	2 units, 381.56 MMBtu/hr each	NO_x	996	U1 – 499.2 U2 – 494.4	U1 - 295,011 U2 - 299,073	U1 – 3.3843 U2 – 3.3062

Source: MassDEP Source Registration data

Table 7-4: MWC Facility Emission Rates for 2018 (lbs/MMBtu)

2018 Actual Emissions							
Facility Name	AQID	Design Capacity	Pollutant	2018 Actual Emissions All Units, TPY	2018 MSW Burned All Units, TPY	2018 MSW Heat Input, MMBtu	2018 Actual Emission Rate, lb/MMBtu
SEMASS PARTNERSHIP – SE	1200001	3 units, 375 MMBtu/hr each	SO_2	362	1,075,512	9,679,608	0.0748
WHEELABRATOR MILLBURY INC – CE	1180419	2 units, 323 MMBtu/hr each	SO_2	166	481,464	4,333,176	0.0766
WHEELABRATOR NORTH ANDOVER INCORPORATED – NE	1210261	2 units, 288.4 MMBtu/hr each	SO_2	72	456,853	4,111,677	0.0350
WHEELABRATOR SAUGUS INC – NE	1197654	2 units, 325 MMBtu/hr each	SO_2	16	431,689	3,885,201	0.0082
COVANTA HAVERHILL -- NE	1210007	2 units, 381.56 MMBtu/hr each	SO_2	96	594,084	5,346,756	0.0359
SEMASS PARTNERSHIP	1200001	3 units, 375 MMBtu/hr each	NO_x	1511	1,075,512	9,679,608	0.3122
WHEELABRATOR MILLBURY INC	1180419	2 units, 323 MMBtu/hr each	NO_x	865	481,464	4,333,176	0.3992
WHEELABRATOR NORTH ANDOVER INCORPORATED	1210261	2 units, 288.4 MMBtu/hr each	NO_x	743	456,853	4,111,677	0.3614
WHEELABRATOR SAUGUS INC	1197654	2 units, 325 MMBtu/hr each	NO_x	640	431,689	3,885,201	0.3295
COVANTA HAVERHILL -- NE	1210007	2 units, 381.56 MMBtu/hr each	NO_x	996	594,084	5,346,756	0.3726

Assumes 4,500 Btu/lb MSW from AP-42
Source: MassDEP Source Registration data

8. Appendices

All appendices are available on MassDEP's SIP webpage: https://www.mass.gov/lists/massachusetts-state-implementation-plans-sips. The MANE-VU documents listed below also are available at the MANE-VU website publications section: https://otcair.org/manevu/index.asp. Documents that already have been included in the Massachusetts SIP are not duplicated here – see 2012 Massachusetts Regional Haze SIP on the MassDEP SIP webpage.

1. *Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas: Methodology for Source Selection, Evaluation of Control Options and Four Factor Analysis – ADDENDUM FOR RESIDUAL OIL*. MANE-VU. April 2011.
2. *Contributions to Regional Haze in the Northeast and Mid-Atlantic United States: Preliminary Update Through 2007*. NESCAUM. March 2012. Available at the NESCAUM website: http://www.nescaum.org/topics/regional-haze/regional-haze-documents
3. *The Nature of the Fine Particle and Regional Haze Air Quality Problems in the MANE-VU Region: A Conceptual Description.* NESCAUM. November 2, 2006; First Update August 2010; Second Update July 2012.
4. *Beyond Sulfate: Maintaining Progress towards Visibility and Health Goals.* NESCAUM. December 17, 2012.
5. *Future Modeling Platform Base Year Determination*. MANE-VU. October 9, 2013 FINAL.
6. *2016 Updates to the Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas.* MARAMA. January 31, 2016.
7. *Benefits of Combined Heat and Power Systems for Reducing Pollutant Emissions in MANE-VU States.* MANE-VU Technical Support Committee. March 9, 2016.
8. *2016 MANE-VU Source Contribution Modeling Report - CALPUFF Modeling of Large Electrical Generating Units and Industrial Sources*. MANE-VU TSC. April 4, 2017.
9. *MANE-VU Updated Q/d*C Contribution Assessment*. MANE-VU TSC. April 6, 2016.

10. *Status of the Top 167 Electric Generating Units (EGUs) that Contributed to Visibility Impairment at MANE-VU Class I Areas during the 2008 Regional Haze Implementation period*. MANE-VU TSC. July 25, 2016.

11. *MANE-VU Technical Support Committee Memo to MANE-VU Air Directors, "RE: Contribution Assessment Preliminary Inventory Analysis," Mid-Atlantic Northeast Visibility Union*. October 10, 2016.

12. *EGU Data for Four-Factor Analyses (Only CALPUFF Units).* MANE-VU TSC. January 10, 2017.

13. *Regional Haze Metric Trends and HYSPLIT Trajectory Analyses*. MANE-VU TSC. May 2017.

14. *Memo from MANE-VU Technical Support Committee to MANE-VU Air Directors, "RE: Four-Factor Data Collection*. MANE-VU TSC. March 30, 2017.

15. *Statement of the Mid-Atlantic / Northeast Visibility Union (MANE-VU) Concerning a Course of Action with MANE-VU toward Assuring Reasonable Progress for the Second Regional Haze Implementation Period (2018-2028)*. MANE-VU. August 25, 2017.

16. *Selection of States for MANE-VU Regional Haze Consultation (2018)*. MANE-VU TSC. September 5, 2017.

17. *Impact of Wintertime SCR/SNCR Optimization on Visibility Impairing Nitrate Precursor Emissions*. MANE-VU Technical Support Committee. November 20, 2017.

18. *High Electric Demand Days and Visibility Impairment in MANE-VU.* December 20, 2017.

19. *Technical Support Document Emission Inventory Development For 2011 And Projections To 2020 And 2023 For The Northeastern U.S. Gamma Version.* Mid-Atlantic Regional Air Management Association, Inc. (MARAMA). January 29, 2018.

20. *MANE-VU Regional Haze Consultation Report*. MANE-VU Technical Support Committee. July 27, 2018.

21. *Ozone Transport Commission/Mid-Atlantic Northeastern Visibility Union 2011 Based Modeling Platform Support Document – October 2018 Update.* Ozone Transport Commission. 2nd Version October 18, 2018.

22. *Mid-Atlantic/Northeast U.S. Visibility Data, 2004-2019 (2nd RH SIP Metrics)*. MANE-VU (prepared by Maine Department of Environmental Protection). January 21, 2021 revision.

23. *Massachusetts Facilities Subject to Ask 1: EGUs ≥ 25MW with Controls*. MassDEP. (source file: qry CAMD Facility Max Yr x-walk 2016b EGU 25MW Controlled.xlsx TAB: 25 MW CONTROLLED)

24. Letter from C. McCoy, National Park Service, to C. Kirby, MassDEP with attachments. October 22, 2018.

25. Emails from MassDEP December 11, 2018 and from National Park Service December 19, 2018 with attachments.

26. AIR QUALITY OPERATING PERMIT Issued by the Massachusetts Department of Environmental Protection ("MassDEP") to Solutia Inc. (Application No.: 1-O-09-020). October 25, 2018.

27. AIR QUALITY OPERATING PERMIT Issued by the Massachusetts Department of Environmental Protection ("The Department") to Solutia Inc. (Application No.: 1-O-95-060) January 26, 2005.

28. Email from National Park Service July 17, 2020 with attachments.

29. Email from MassDEP to National Park Service July 28, 2020.

30. Letter from MassDEP to Stonepeak Infrastructure Partners requesting four-factor analysis for Canal Generating Station Unit 1. July 9, 2020.

31. Four Factor Analysis Canal Unit 1, Canal Generating Station, Sandwich, MA. Tetra Tech, Inc. September 2020. (Cover letter from Jeffrey Araujo, Plant Manager, Canal Generating to Glenn Keith dated September 18, 2020).

32. Email from National Park Service to MassDEP November 23, 2020 with attachment.

33. Email from MassDEP to National Park Service December 16, 2020 with attachment.

34. Communications between US Forest Service and MassDEP December 2020 -January 2021.

35. Letter from National Park Service to MassDEP January 15, 2021 with attachments.

36. Letter from the U.S. Forest Service to MassDEP January 13, 2021.

37. Revocation of Brayton Point permits. MassDEP letter from Thomas Cushing, Chief, Permit Section, Bureau of Air & Waste to Robert Vasconcelos, Director, Brayton Point Energy, LLC. December 6, 2017.

38. ISO-NE memo to NEPOOL Reliability Committee regarding retirement of Mystic Station. July 27, 2020.

39. FINAL AIR QUALITY OPERATING PERMIT issued by MassDEP to NRG Canal, LLC. January 9, 2009 (rev. June 12, 2013).

40. Testimony by the National Parks Conservation Association. May 11, 2021.

41. Comments by EPA. May 14, 2021.

42. Comments by the National Parks Conservation Association and Appalachian Mountain Club. May 14, 2021.

43. Summary of Public Comments and MassDEP responses.