VERMONT STATE IMPLEMENTATION PLAN
COMPREHENSIVE REVISION
REGIONAL HAZE
SECOND IMPLEMENTATION PERIOD

STATE OF VERMONT
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
APRIL 11, 2024

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FOREWORD

This document fulfills U.S. Environmental Protection Agency's (EPA's) Regional Haze Rule 51.308(f) provision for the second implementation period (2018-28) to identify, for each in-state Federal Class I area: a) baseline, current and natural visibility conditions for the 20% most impaired days and the 20% clearest days; b) the state's long term strategy to address regional haze for the in-state Federal Class I area and each Federal Class I area outside the state that may be affected by emissions from the State; c) reasonable progress goals for attaining the visibility conditions that are projected to be achieved by the end of the implementation period; and d) an assessment of the current monitoring strategy. This document also contains elements to fulfill progress report requirements.

The Federal Class I areas that are addressed in this document are listed below along with the larger Federal area within which they are embedded:

MANE-VU Class I Areas

Acadia National Park, ME
Moosehorn Wilderness Area, ME (Moosehorn National Wildlife Refuge)
Roosevelt Campobello International Park, NB Canada
Great Gulf Wilderness Area, NH (White Mountain National Forest)
Presidential Range-Dry River Wilderness Area, NH (White Mountain National Forest)
Brigantine Wilderness Area, NJ (E.B. Forsythe National Wildlife Refuge)
Lye Brook Wilderness (Green Mountain National Forest)

Nearby Class I Areas

James River Face, VA (George Washington and Jefferson National Forests)
Shenandoah National Park, VA
Dolly Sods, WV (Monongahela National Forest)
Otter Creek, WV (Monongahela National Forest)

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EXECUTIVE SUMMARY

Section 169A of the Clean Air Act provides for the protection of visibility at mandatory Federal Class I areas. These designated areas include 156 national parks and wilderness areas located throughout the United States. Regional haze obscures vistas that are integral to the value of such areas. In 1999, the EPA adopted the Regional Haze Rule (published at 64 FR 35714 and codified at 40 CFR 51.300-309), which calls for state, tribal and federal agencies to work together to improve visibility in all Federal Class I areas. One of these areas – Lye Brook Wilderness Area– is located in Vermont's Green Mountain National Forest.

This document fulfills the EPA's Regional Haze Rule 51.308(f) provision for the second implementation period (2018-2028) to identify, for each Federal Class I area within the State: a) baseline, current and natural visibility conditions for the 20% most impaired days and the 20% clearest days; b) the state's long term strategy to address regional haze for each in-state Federal Class I area and each Federal Class I area outside the state that may be affected by emissions from the State; c) reasonable progress goals for attaining the visibility conditions that are projected to be achieved by the end of the implementation period; and d) an assessment of the current monitoring strategy. This document also serves as a second progress report for the first implementation period (2008-2018), as the first progress report (February 29, 2016) only had data to show progress to date, and not for the entire implementation period.

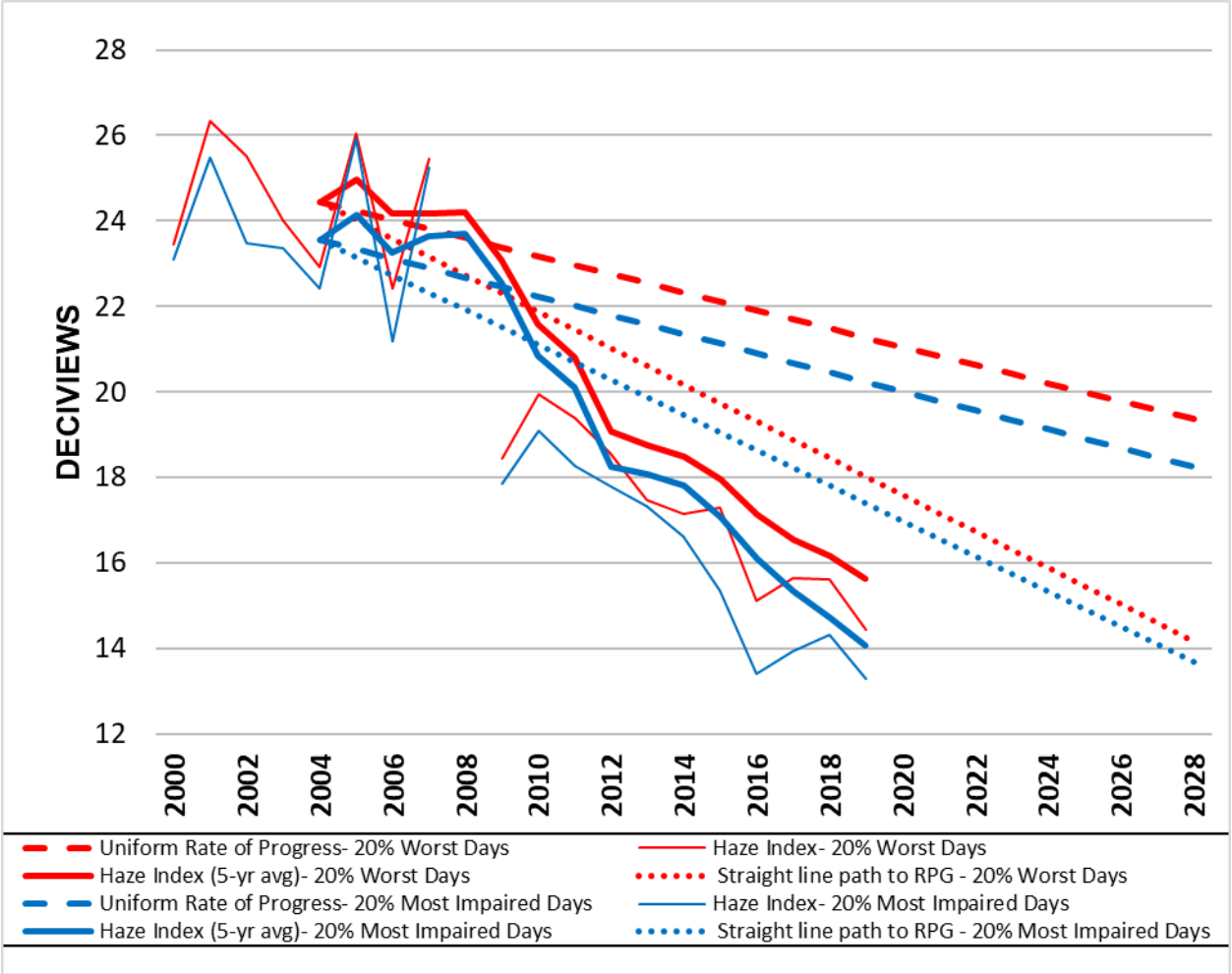
As a member of the Mid-Atlantic/Northeast Visibility Union (MANE-VU), Vermont has fulfilled the long-term strategy goals expressed in its EPA-approved Regional Haze SIP submission of June 2009 and subsequent progress report of February 2016. MANE-VU work has shown that sulfur dioxide (SO2) and oxides of nitrogen (NOx) are the most significant man-made pollutants creating regional haze in the MANE-VU region. A key emission reduction strategy for Vermont was the implementation of the low-sulfur fuel strategy, as well as seeking NOx reductions from several mobile source control measures. Vermont has also kept current with nitrous oxide reduction strategies (e.g. NOx RACT SIP submissions) that not only reduce ozone formation but also reduce regional haze pollutants. Vermont inventory results indicate that in 2017, point sources contribute only 3% of the total SO2 emissions, and only 2% of the NOx emissions, in the entire state.

The overriding goal of the Regional Haze Rule is to attain natural visibility conditions by 2064, which is reflected in the Uniform Rate of Progress. Visibility trends analyses in this document used EPA-recommended metrics in the December 2018 technical guidance at IMPROVE monitoring sites at Federal Class I areas in and adjacent to the MANE-VU[1] region. This document provides an analysis of visibility data collected at the IMPROVE monitoring site representing Vermont's Class I area, starting in the baseline period of 2000-2004 through 2015-2019, the most recent five-year period with available data. The results of this analysis show a definite reduction in overall haze levels at Lye Brook Wilderness (the haze index, measured in deciviews) and corresponding rate of improvement better than the uniform rate of progress visibility condition would be for 2028 for the 20% most impaired visibility days, as shown in

[1] MANE-VU includes the following member states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and the District of Columbia.

Figure E-1. Figure E-1 also shows the previous metric that was used to describe poor visibility days (20% worst days), prior to the most recent Regional Haze Rule changes (which now focus on anthropogenic emissions solely).

This SIP revision will demonstrate Vermont's and the MANE-VU region's additional progress and establish a long-term strategy (LTS) as well as Reasonable Progress Goals (RPG) for improving the 20% most impaired visibility days through the next planning cycle (2018-2028) and for attaining natural background levels by 2064. The Regional Haze Rule also specifies that the 20% clearest days be maintained (or improved) through 2064.



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ACRONYMS AND ABBREVIATIONS

$\mu g/m^3$	Microgram per cubic meter
AERR	Air Emissions Reporting Requirements
AMPD	Air Markets Program Data
BACT Technology	Best Available Control
BART Technology	Best Available Retrofit
BenMap	Benefits Mapping and Analysis Program
CAA	Clean Air Act
CAIR	Clean Air Interstate Rule
CAMD	Clean Air Markets Division
CASTNET	Clean Air Status and Trends Network
CenRAP	Central Regional Air Planning Association
CENSARA	Central States Air Resource Agencies
CFR	Code of Federal Regulations
CoST	Control Strategy Tool
CSAPR	Cross State Air Pollution Rule
CT DEEP	Connecticut Department of Energy and Environmental Protection
DC	District of Columbia
DLN	Dry low NOx
DOE	U.S. Department of Energy
DSCM	Dry stand cubic meter
DSI	Dry Sorbent Injection
dv	Deciview, a logarithmic scaled unit of visibility
EGU	Electric Generating Unit
EIS	Emissions Inventory System
EMF	Emissions Modeling Framework
EPA	Environmental Protection Agency
ESP	Electrostatic Precipitator
FED	Federal Land Manager Environmental Database
FGD	Flue gas desulfurization
FGR	Flue gas recirculation
FLM	Federal Land Manager
GHGER	Greenhouse Gas Emissions Reduction
GRGU	Great Gulf Wilderness Area
HYSPLIT	Hybrid Single-Particle Lagrangian Integrated Trajectory
IC	Internal Combustion
ICI	Industrial/Commercial/Institutional
I&M	Inspection and Maintenance
IMPROVE	Interagency Monitoring of Protected Visual Environments
km	Kilometer
LAC	Light Absorbing Carbon
LADCO	Lake Michigan Air Directors Consortium
LAER	Lowest Available Emission Rate
LNB	Low NOx Burner
MATS	Mercury and Air Toxics Standards
MANE-VU	Mid-Atlantic/Northeast Visibility Union
MARAMA	Mid-Atlantic Regional Air Management Association
ME DEP	Maine Department of Environmental Protection
Mm^{-1}	Inverse Megameter
MMBtu	1,000,000 British thermal units
MOVES Simulator	Motor Vehicle Emissions
MRPO	Midwest Regional Planning Organization
MW	Megawatt

NAAQS	National Ambient Air Quality Standards
NACAA	National Association of Clean Air Agencies
NEI	National Emissions Inventory
NESCAUM	Northeast States for Coordinated Air Use Management
NH_3	Ammonia
NHDES	New Hampshire Department of Environmental Services
NNSR	Nonattainment New Source Review
NO_3	Nitrate
NO_x	Oxides of Nitrogen
O_2	Oxygen
OCM	Organic Carbon Mass
OFA	Overfire Air
ORVR Recovery	Onboard Refueling Vapor
OTC	Ozone Transport Commission
OWB	Outdoor Wood Boiler
PAG	Policy Advisory Group
PSD	Prevention of Significant Deterioration
PM	Particulate Matter
$PM_{2.5}$	Fine Particulate Matter (particles with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers)
PM_{10}	Course Particulate Matter (particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers)
ppm	Parts per million
PSD	Prevention of Significant Deterioration
RACT	Reasonably Available Control Technology
RBLC	RACT/BACT/LAER Clearinghouse
RGGI Initiative	Regional Greenhouse Gas
RHR	Regional Haze Rule
RPG	Reasonable Progress Goal
RPO	Regional Planning Organization
RPS	Renewable Portfolio Standard
RSA	Revised Statutes Annotated
RWS	Residential Wood Stove
SESARM	Southeastern Air Pollution Control Agencies
SCC	Source Classification Code
SCR	Selective Catalytic Reduction
SIP	State Implementation Plan
SNCR	Selective Noncatalytic Reduction
SO_2	Sulfur Dioxide
SO_4	Sulfate
SO_x	Oxides of Sulfur
SOA	Secondary Organic Aerosol
STN	Speciation Trends Network
tpy	tons per year
TSC	Technical Support Committee
ULS	Ultra Low Sulfur
URP	Uniform Rate of Progress
U.S.C.	United States Code
VIEWS	Visibility Information Exchange Web System
VISTAS	Visibility Improvement State and Tribal Association of the Southeast
VOC	Volatile Organic Compounds
VT DEC	Vermont Department of Environmental Conservation
WMNF	White Mountain National Forest
WRAP	Western Regional Air Partnership
WSARC	Western States Air Resources Council

1 THE REGIONAL HAZE ISSUE

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

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

The affected Class I areas include many of our best-known natural places, including the Grand Canyon, Yosemite, Yellowstone, Mount Rainier, Shenandoah, the Great Smokies, Acadia, and the Everglades. In Vermont, the affected area is the Lye Brook Wilderness.

Section 169 also directed EPA to promulgate regulations to assure reasonable progress toward this national visibility goal and to require State Implementation Plan (SIP) revisions in states containing the affected Class I Federal Areas as well as in states, "the emissions from which may reasonably be anticipated to cause or contribute to impairment of visibility in any such [Class I] area". In 1980, EPA promulgated visibility regulations which focused primarily on impairment attributable to individual sources or small groups of sources ("plume blight"), but which also required long-term strategies to assure reasonable progress toward the national visibility goal.

In April 1986, the State of Vermont submitted a proposed SIP revision which determined that visibility in the Lye Brook Wilderness was not impaired by plume blight, but was severely impaired by regional haze, composed predominantly of sulfate aerosol transported from SO_2 sources in upwind states. The 1986 VT SIP revision included a summer seasonal sulfate standard of 2 $\mu g/m^3$ (roughly half the estimated prevailing concentration at that time) as an interim measure to assure reasonable progress toward the national visibility goal for Lye Brook. Vermont also requested that EPA implement an Eastern U.S. regional SO_2 emission reduction program to improve visibility in Lye Brook (and other eastern U.S. Class I areas), and also specifically requested that EPA require SIP revisions in 8 upwind states (OH, PA, WV, IN, IL, KY, TN & MI) which were estimated to account for more than half of the sulfate in VT and which could clearly be identified as states "the emissions from which may reasonably be anticipated to cause or contribute to impairment of visibility" in Lye Brook (and many other Eastern U.S. Class I areas).

In July 1987, EPA ruled on Vermont's proposed visibility SIP. Although it concurred that "Vermont's visibility impairment is predominantly due to out-of-state sulfur emissions", EPA took "no action" on any aspects of the VT proposal that attempted to reduce regional haze, including the state sulfate standards, regional SO_2 emission reductions, and requested SIP calls in major upwind contributing states. EPA argued that it had no current regulatory basis to address regional haze effects, and that substantial additional research was needed to develop the technical basis for such regulations.

SIP revisions continue to be a core requirement for states where a mandatory Federal Class I

area is located, including Vermont's Lye Brook Wilderness (Figure 1-1). In accordance with the Regional Haze Rule, Vermont submitted its State Implementation Plan revision in June 2009, which was subsequently approved by EPA. In addition, the Regional Haze Rule requires VTDEC to submit a report to EPA that evaluates progress toward the reasonable progress goal for the Class I area and also for those Class I areas in other states impacted by emissions from within the state. VTDEC submitted its first progress report on February 29, 2016.

When the CAA was amended in 1990, Congress included (Title IV) a phased program of SO_2 emission reductions in the Eastern US, similar to but somewhat less stringent than and with a longer time delay than what Vermont had requested in its 1986 SIP. The 1990 CAA Amendments also added Section 169B (42 U.S.C. 7492), authorizing further visibility research and periodic assessments of the progress made toward improving visibility in Class I areas that resulted from the required CAA emissions reductions.

In addition to authorizing creation of visibility transport commissions and setting forth their duties, Section 169B(f) of the 1990 CAA mandated creation of the Grand Canyon Visibility Transport Commission (GCVTC) to make recommendations to EPA for the region affecting the visibility of the Grand Canyon National Park. The Grand Canyon Visibility Transport Commission (Commission) submitted its report to EPA in June 1996, following four years of research and policy development. The Commission report, as well as the many research reports prepared by the Commission, contributed invaluable information to EPA in its development of the federal Regional Haze Rule.

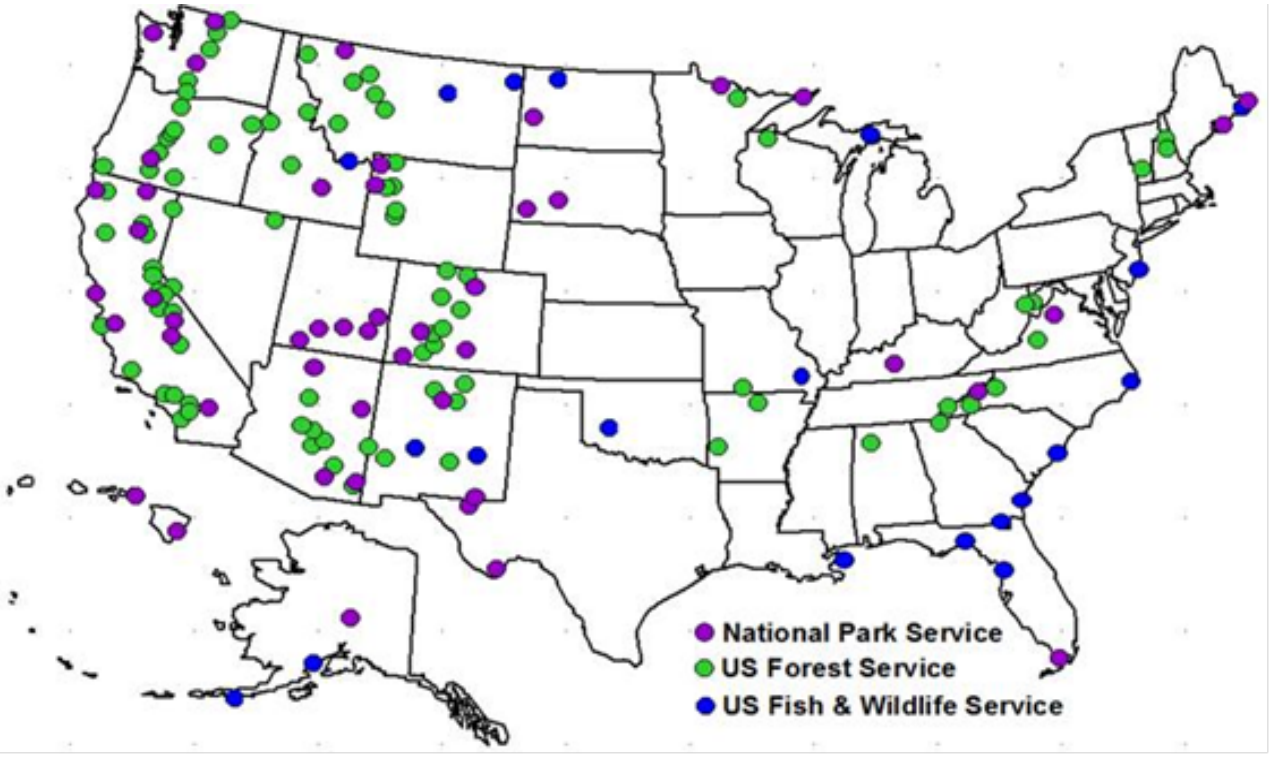


Figure 1-1: Locations of federally protected mandatory Class I areas.

In 1999, the EPA issued regulations (the Regional Haze Rule, or the Rule) to improve visibility in

156 national parks and wilderness areas across the United States (Class I areas). The Rule was further amended on December 14, 2016 and became effective January 10, 2017. This rule seeks to address the combined visibility effects of various pollution sources over a wide geographic region. This wide-reaching pollution net means that many states – including those without Class I Areas – are required to participate in haze reduction efforts. The overarching goal of the Regional Haze Rule is to reduce emissions such that visibility at Class I sites achieves natural conditions by 2064. This latest 2017 revision largely impacted administrative parts of the Rule, but one substantive change was the addition of the word "anthropogenic" to the definition of most impaired days (see 40 CFR 51.301), that is: "Most impaired days means the 20 percent of monitored days in a calendar year with the highest amounts of anthropogenic visibility impairment." Previously, visibility progress was tracked for the 20% worst visibility days, regardless of pollutant origin. Throughout this document, Vermont uses both approaches, referencing the haziest or "worst" days with respect to the first implementation period and "most impaired" or anthropogenic impairment only, for discussing the baseline and projections for the second implementation period. Comparisons of the two approaches are also made.

The Rule requires the states, in coordination with the EPA, the National Park Service, U.S. Fish and Wildlife Service, the U.S. Forest Service, among other interested parties, to develop and implement air quality protection plans to reduce the pollution that causes visibility impairments in national parks, national wilderness areas, and national memorial parks of a certain size (e.g. greater than 5000 acres). In consultation with the states and tribes, EPA designated Regional Planning Organizations (RPOs) to assist with the coordination and cooperation needed to address the Regional Haze issue. The Mid-Atlantic and Northeast states, including the District of Columbia, formed the Mid-Atlantic / Northeast Visibility Union (MANE-VU).

EPA's adoption of the Regional Haze Rule has not been without controversy. Numerous court cases, from numerous parties, have been filed in response to EPA defining how multiple states should proceed with emissions control of their sources, including those contributing to regional haze, from the Clean Air Implementation Rule (CAIR) to the Cross State Air Pollution Rule (CSAPR) now in effect since 2014. These issues remain not completely resolved. Market forces, primarily the decreased use of coal in lieu of other fossil fuels at power plants, have contributed to recent observed reductions of regional haze, and have benefitted downwind states such as Vermont. It is hoped, but it is not guaranteed, that these gains will become permanent.

EPA's regulations address visibility impairment in the form of regional haze. Haze is an atmospheric phenomenon that obscures the clarity, color, texture, and form of what we see. Haze in the eastern U.S. is caused primarily by anthropogenic pollutants (those originating from human activity) but can also be influenced by several natural phenomena, including wildfires, dust storms, and sea spray. The optical effects of these pollutants and natural substances result from the scattering and absorption of light by particles and gases, with the scattering of light by fine particles (less than 2.5 microns diameter) being the predominant contributor at most times and locations. Some haze-causing particles are emitted directly to the atmosphere by primary particle emission sources such as electric power plants, industrial/commercial/institutional facilities, vehicles, construction activities, and agricultural burning. Others occur when gases emitted to the air (particle precursors) interact to form

secondary particles. Some secondary particles, including sulfate and nitrate compounds, are hygroscopic and will bind with water and scatter light further as relative humidity increases.

Fine particles formed from multiple primary and secondary sources can combine over broad geographic areas and can be transported hundreds or thousands of miles. Consequently, regional haze occurs in every part of the nation. Because of the regional nature of haze, EPA's regulations require the states to consult with one another toward the national goal of improving visibility – specifically, improvement at the 156 parks and wilderness areas designated under the Clean Air Act as mandatory Class I Federal Areas.

The Regional Haze Rule calls for each state to establish reasonable progress goals (RPGs) for visibility improvement and to formulate a long-term strategy (LTS) for meeting these goals. These requirements apply to any state having a Class I area as well as any state that contributes to visibility impairment at any (downwind) Class I area. The visibility goals must be designed both to improve anthropogenic impairment to visibility on the haziest days and to ensure that no degradation occurs on the clearest days.

A state's long-term strategy must include enforceable emission reduction measures designed to meet its reasonable progress goals (RPGs). The first long-term strategy covered the period ending in 2018. This current revision is for the period 2018-2028, otherwise known as the Second Implementation Period. States are required to submit the next SIP revision (after this one) by July 31, 2028. States are also required to submit a progress report five years after a SIP revision and report on progress toward the RPGs for each applicable Class 1 Federal Area. These future progress reports are due by January 31, 2025, July 31, 2033, and every 10 years thereafter. EPA removed the requirement of these reports to be SIP revisions, but states must still consult with Federal Land Managers and must obtain public comment on the progress reports. In identifying the emission reduction measures to be included in the long-term strategy, states should address all types of anthropogenic emissions contributing to visibility degradation in Class I areas, including those from mobile (both on-road and off-road) sources; stationary sources (such as factories and power plants); smaller, so-called "area" (or non-point) sources (such as residential wood stoves and small boilers); and prescribed fires.

In developing their plans, states can account for emission reductions attributable to ongoing air pollution control programs at the state, regional, or national levels. For most states and regions of the country, however, additional emission control measures beyond those already "on the books" will be necessary if national visibility goals are to be achieved.

Vermont's SIP was developed after extensive consultations with other states and regional planning organizations. Vermont contributed to the analyses and reports produced by the member states of the Northeast States for Coordinated Air Use Management (NESCAUM), the Mid-Atlantic Regional Air Managers Association (MARAMA), and particularly the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Regional Planning Organization for the purpose of coordinated regional haze planning. Vermont also consulted with states outside the Northeast.

In creating its regional strategy, Vermont and the other MANE-VU states looked beyond the provisions of the federal CSAPR to identify additional emission control measures that could be effectively employed to mitigate regional haze. In this respect, Vermont and the rest of MANE-VU stand apart from some other states by asserting that additional measures beyond EPA's rulemaking are essential to meeting established visibility goals at MANE-VU's Class I Areas.

1.1 Basics of Regional Haze

Small particles and certain gaseous molecules in the atmosphere cause poor visibility by scattering and absorbing light, reducing the amount of visual information about distant objects that reaches an observer. Some light scattering by air molecules and naturally occurring aerosols occurs even under natural conditions. The distribution of particles in the atmosphere depends on meteorological conditions and leads to various forms of visibility impairment. When high concentrations of pollutants are well mixed in the atmosphere, they form a uniform haze. When temperature inversions trap pollutants near the surface, the result can be a sharply demarcated layer of haze.

Visibility impairment can be quantified using three different, but mathematically related measures: visual range (i.e., how far one can see); light extinction per unit distance (e.g., Mm-1, or inverse megameter which is equal to one over one thousand kilometers); and deciviews (dv), a useful metric for measuring increments of visibility change that are just perceptible to the human eye. Visibility impairment can be measured directly by nephelometer (light scattering) or transmissometer (light transmission – includes both scattering and absorption) and can also be calculated from color slide photographs using slide densitometry measurements, known target distances, and estimated inherent contrast measurements. Light extinction and other visibility metrics can also be estimated (i.e., reconstructed) from measured concentrations of ambient particle species components, considering their unique light-scattering (or absorbing) properties and making appropriate adjustments for relative humidity effects on hygroscopic species. Assuming natural conditions, visibility in the Northeast and Mid-Atlantic is estimated to be about 23 Mm-1, which corresponds to a visual range of about 170 kilometers (106 miles) or 8 dv (the lower the dv the better the visibility). At Lye Brook Wilderness over the 5-year period from 2000 through 2004, reconstructed extinction averaged 6.4 dv (visual range of 222 kilometers) on the 20 percent cleanest days and 24.5 dv (visual range of 38 kilometers) on the 20 percent haziest days. Currently, MANE VU averages light extinction from 103 Mm-1 in southern parts of the region, to 55Mm-1 in the north; this corresponds to a visual range from 24-44 miles (i.e., 23-17 dv). Updates to the Regional Haze Rule specify that dominant uncontrollable influences, such as volcanic activity or certain types of fires, can be removed from determination of worst visibility days for reporting progress. As a result, the Rule now focuses on a metric known as the 20% most impaired visibility days.

The small particles that commonly cause hazy conditions in the East are primarily particles composed of sulfate, nitrate, organic carbon, elemental carbon (soot), and crustal material (e.g., soil dust, sea salt, etc.). Of these constituents, only elemental carbon impairs visibility by absorbing visible light; the others scatter light. Sulfate, nitrate, and organic carbon particles are secondary pollutants that form in the atmosphere from precursor pollutants, primarily SO_2,

NO_X, and VOCs, respectively. By contrast, soot and crustal material and some organic carbon particles are released directly to the atmosphere. Particle constituents also differ in their relative effectiveness at reducing visibility. Sulfate- and nitrate-based particles, for example, contribute disproportionately to haze because of their chemical affinity for water. This property 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).

Monitoring data collected over the last 20 years show that fine particle[2] concentrations, and hence visibility impairment, are generally highest near industrial and highly populated areas of the Northeast and Mid-Atlantic. Particle concentrations are lower, and visibility conditions are better, at the more northerly Class I sites, where current visibility on the 20% clearest days[3] (4.7 dv)[4] is close to natural (3.73 dv), unpolluted conditions. Because there are naturally occurring visibility impairing emissions, the 20% most impaired days' metric is applicable to natural conditions. Natural visibility on the 20% most impaired of days at Lye Brook Wilderness is estimated to be 11.3 dv (compared to 2.79 dv on the best of days). Current visibility on 20% most impaired visibility days is 14.06 dv. About half of the worst visibility days in Lye Brook Wilderness occur in the summer when meteorological conditions are more conducive to the formation of sulfate from SO_2 and to the oxidation of organic aerosols. The remaining worst visibility days are divided nearly equally among spring, winter, and fall. In contrast to sulfate and organic carbon, the nitrate contribution is typically higher in the winter months. The crustal and elemental carbon fractions do not show a clear pattern of seasonal variation. In addition, winter and summer transport patterns are different, possibly leading to different contributions from upwind pollutant source regions.

1.2 Regulatory Framework

1.2.1 The Regional Haze Rule

The federal requirements that states must meet to achieve national visibility goals are contained in Title 40: Protection of Environment, Part 51 – Requirements for Preparation, Adoption, and Submittal of Implementation Plans, Subpart P – Protection of Visibility (40 CFR 51.300-309). Known more simply as the Regional Haze Rule, these regulations were adopted on July 1, 1999, and went into effect on August 30, 1999 (and were revised in 2017). The rule seeks to address the combined visibility effects of various pollution sources over a large geographic region. This wide-reaching pollution net means that many states – even those without Federal Class I areas – are required to participate in haze reduction efforts.

Regional haze regulations recognize that visibility impairment is fundamentally a regional phenomenon. Emissions from numerous sources over a broad geographic area commonly

[2] "Fine particles" refers throughout this report to particles less than or equal to 2.5 micrometers in diameter, consistent with EPA's fine particle NAAQS.

[3] "20% clearest visibility conditions" are defined throughout this report as the simple average of the lower 20th percentile of a cumulative frequency distribution of available data (expressed in dv).

[4] Five-year average, 2015-2019

create hazy conditions across large portions of the eastern U.S. because of the long-range transport of airborne particles and precursor pollutants in the atmosphere. The key sulfate precursor, SO_2, for example, has an atmospheric lifetime of several days and is known to be subject to transport distances of hundreds of miles. NO_X and some organic carbon species are also subject to long-range transport, as are small particles of soot and crustal material.

1.2.2 Revision to the Regional Haze Rule

States are required to submit periodic plans demonstrating how they have and will continue to make progress toward achieving their visibility improvement goals. The first state plans were due in December 2007 and covered the 2008-2018 planning period. The 2017 revision to the Regional Haze Rule addresses requirements for the second planning period, 2018-2028. The updated rule makes the following changes:

- Adjusts the SIP submittal deadline for the second planning period from July 31, 2018, to July 31, 2021.
- Adjusts interim progress report submission deadlines so that second and subsequent progress reports will be due by January 31, 2025, July 31, 2033, and every 10 years thereafter. This means that one progress report will be required midway through each planning period.
- Removes the requirement for interim progress reports to take the form of SIP revisions. States will be required to consult with Federal Land Managers and obtain public comment on their progress reports before submission to the EPA. These progress reports will be reviewed by the EPA, but the EPA will not formally approve or disapprove them.
- Clarifies EPA's long-standing interpretations of the 1999 Regional Haze Rule, including:
    - Requirements that reasonable progress goals be set based on the long-term strategy.
    - Obligations of states with mandatory Federal Class I areas and other states contributing to impairment at those areas.
    - Obligations on states setting reasonable progress goals that provide for a slower rate of progress than that needed to attain natural conditions by 2064.

Another key change in the 2017 revision is addition of the word "anthropogenic" to the definition of most impaired, that is: "Most impaired days means the twenty percent of monitored days in a calendar year with the highest amounts of **anthropogenic** visibility impairment." (emphasis added) (40 CFR 51.301). EPA guidance[5] states that the 20% most impaired days each year at each Class I area based on daily anthropogenic impairment. Previously, states and the EPA tracked visibility progress on the 20% worst visibility days, regardless of origin. Throughout this document, Vermont uses both approaches, referencing the haziest or "worst" days with respect to the first implementation period, and "most impaired," or anthropogenic impairment only, for discussing the baseline and projections for this implementation period plan.

[5] EPA, (December 2018). *Technical Guidance on Tracking Visibility Progress for the Second Implementation Period*. *EPA-454/R-18-010*.Available at:
https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf

1.2.3 State Implementation Plan

In accordance with 40 CFR 51.308(a) and (b), Vermont submits this SIP revision for the second planning period, to meet the requirements of EPA's Regional Haze Rule. This SIP addresses the core requirements of 40 CFR 51.308(f). In addition, this SIP addresses requirements pertaining to regional planning, and state/tribe and Federal Land Manager (FLM) coordination and consultation.

The State of Vermont is revising its Regional Haze SIP to establish long-term strategies to improve visibility and establish the 2028 reasonable progress goals for the Lye Brook Wilderness Class 1 area, for the second implementation period. Based on the work of the MANE-VU (of which Vermont is a member), it must be noted that Vermont does not significantly contribute to visibility impairment to Class 1 areas in any other state (except a very small contribution to NH's Class I site due to mobile source emissions). Nor does Vermont impact the Lye Brook Wilderness area. The Regional Haze Rule at 40 CFR 51.308(f) outlines the requirements for periodic comprehensive revisions of the implementation plans for regional haze: accordingly, Vermont will revise and submit its regional haze implementation plan revision to EPA by July 31, 2028, and every ten years thereafter.

The Regional Haze Rule requires (see 40 CFR 51.308(g)) the State of Vermont to submit periodic reports to EPA that evaluate progress toward the reasonable progress goal for each mandatory Class I area located within the state and each mandatory Class I area located outside the state that may be affected by emissions from within the state. Vermont acknowledges that the first progress report in the Second Implementation Period is due by January 31, 2025, and commits to submitting it as required by 40 CFR § 51.308(f) and (g). Vermont intends to make periodic updates to Vermont's emissions inventory, to coincide with the progress reports.

Pursuant to 40 CFR 51.308(h), Vermont will submit a determination of adequacy of its Regional Haze SIP revision whenever a progress report is submitted. Depending on the findings of its five-year review, Vermont will take one or more of the following actions at that time, whichever actions are appropriate or necessary:

- If Vermont determines that the existing State Implementation Plan requires no further substantive revision in order to achieve established goals for visibility improvement and emissions reductions, Vermont will provide to the EPA Administrator a negative declaration that further revision of the plan is not needed.

- If Vermont determines that its implementation plan is or may be inadequate to ensure reasonable progress as a result of emissions from sources in one or more other state(s) which participated in the regional planning process, Vermont will provide notification to the EPA Administrator and to those other state(s). Vermont will also collaborate with the other state(s) through the regional planning process for the purpose of developing additional strategies to address any such deficiencies in Vermont's plan.

- If Vermont determines that its implementation plan is or may be inadequate to ensure

reasonable progress as a result of emissions from sources in another country, Vermont will provide notification, along with available information, to the EPA Administrator.

• If Vermont determines that the implementation plan is or may be inadequate to ensure reasonable progress as a result of emissions from sources within the state, Vermont will revise its implementation plan to address the plan's deficiencies within one year from this determination.

The core requirement for states where a mandatory Federal Class I area is located is the submission of an implementation plan containing the elements found in 40 CFR 51.308(d)(1) through (4). Vermont submitted its State Implementation Plan revision to meet these requirements in August 2009. It was approved by the EPA on May 22, 2012 [77 FR 30212]. In addition to the core requirements referenced above, the plan also addressed requirements pertaining to regional planning, and state/tribe and Federal Land Manager (FLM) coordination and consultation.

40 CFR 51.308(g) requires VTDEC to submit a report to EPA every 5 years that evaluates progress toward the reasonable progress goal for each mandatory Federal Class I area located within the state and each mandatory Federal Class I area located outside the state that may be affected by emissions from within the state. VTDEC submitted its first progress report on February 29, 2016, which was subsequently approved by EPA on December 18, 2017 (82 FR 59969). This SIP revision of 2022 provides an updated progress report for the First Implementation Period.

For the Progress Report incorporated into this SIP, Vermont is attesting to the fact that the existing State Implementation Plan (from the First Implementation Period) requires no further revision to meet the established goals for visibility improvement; they have in fact already been met. Therefore, this is a negative declaration that further revision is not needed.

EPA has provided guidance to the states, specifically the August 2019 on Regional Haze State Implementation Plans, on key steps that are needed in developing the Regional Haze SIP for the Second Implementation Period. This guidance, and the subsequent Clarifications Memo of 2021 were followed while developing this SIP.

The Lye Brook Wilderness Area, within the Green Mountain National Forest, is located east of Manchester Center and Sunderland in the southern Green Mountains of Vermont. It was designated wilderness by Congress in 1975 and is currently comprised of 17,841 acres. It is named after Lye Brook, which flows through the western half of the wilderness before emptying into the Batten Kill near Manchester. Elevation ranges from 900 feet to 2,900 feet above sea level, with most of the wilderness on a high plateau above 2,500 feet. Roughly 80% of the area is forested, with a mix of northern hardwoods with pockets of spruce/fir. The relatively flat southern section of the wilderness, known as Lye Brook Meadows, contains several bogs, ponds and marshy areas which form the headwaters of Lye Brook. The western section is extremely steep, descending rapidly from the Green Mountain plateau to the Valley of Vermont. Four and a half miles of Appalachian Trail and Long Trail pass through the northwest corner of the wilderness.

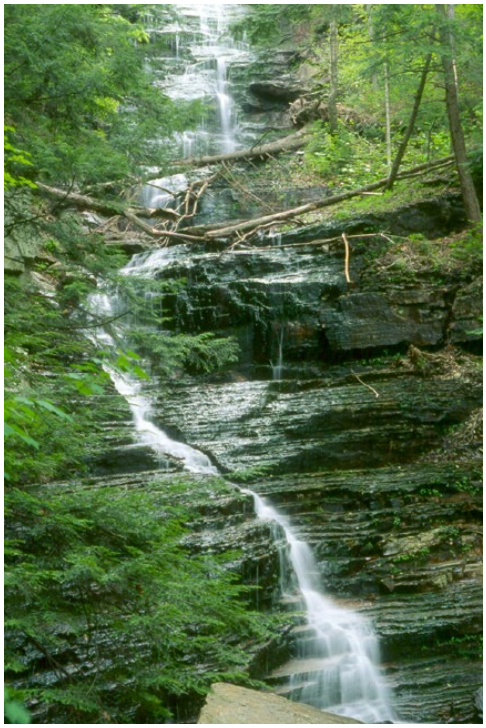


Figure 1-2: Bourne Pond in the Lye Brook Wilderness Area.

Figure 1-3: Trail signs in Lye Brook Wilderness Area.

Lye Brook is just over 100 miles southwest of the Great Gulf and Presidential Range Wilderness Areas in New Hampshire, roughly 250 miles west southwest of Acadia National Park in Maine, and 270 miles north of the Brigantine National Wildlife Refuge in New Jersey. The closest urban areas are Albany, New York, 50 miles to the Southwest and Boston MA, 110 miles to the east. New York City and Montreal are roughly 170 miles to the south and north, respectively.

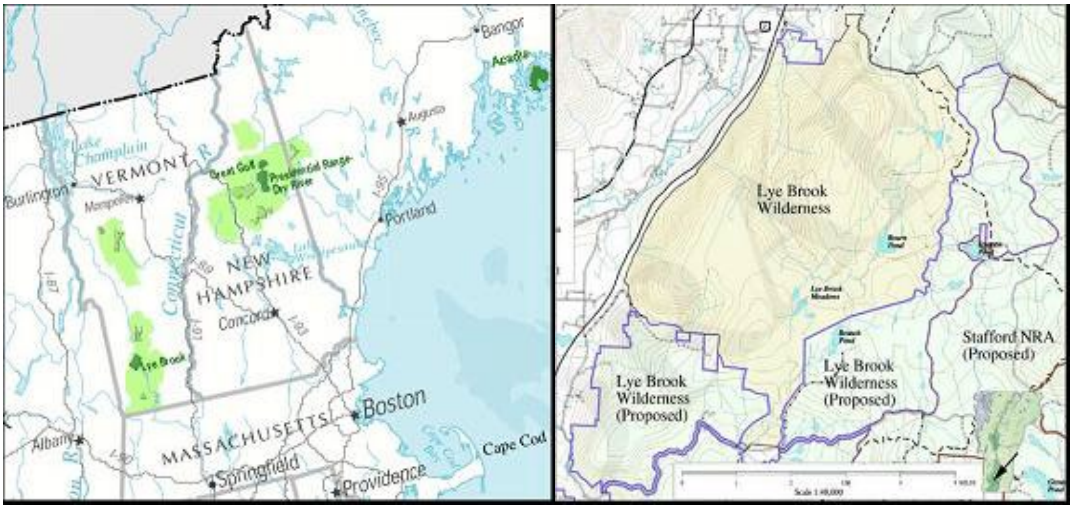


Figure 1-4: Lye Brook and nearby Class I areas. Figure 1-5: Extent of Lye Brook Wilderness area.

1.3 Recent Visibility Trends

Figure 1-6 depicts recent visibility trends (in annual average dv) at Lye Brook Wilderness for the 20% most and least visibility-impaired days for each year from 2000 to 2018. While visibility data was collected during the period of 2008 through 2011, equipment reliability issues prevented collection of sufficient data to develop annual summary statistics and is thus excluded from this chart. Trends were developed by staff from the ME DEP[6] for both the previously approved calculation method[7] looking at "20% worst" visibility days and EPA currently approved calculation method looking at the "20% most impaired" visibility days. The blue markings represent information based on revised calculation methodology and the red markings indicate data based on the previous methodology. Solid lines represent 1-year (thin line) and 5-year averages (bold line) of actual monitoring data. Dashed lines indicate the glideslope between the base period and 2064 goals with points along these lines representing the Uniform Rate of Progress (URP) for each year. Dotted lines represent uniform rates towards RPG that is informed by the state's long-term strategy. Actual 5-year monitoring averages (bold blue solid line) need to be equal or below the RPG (red dotted line) in 2028.

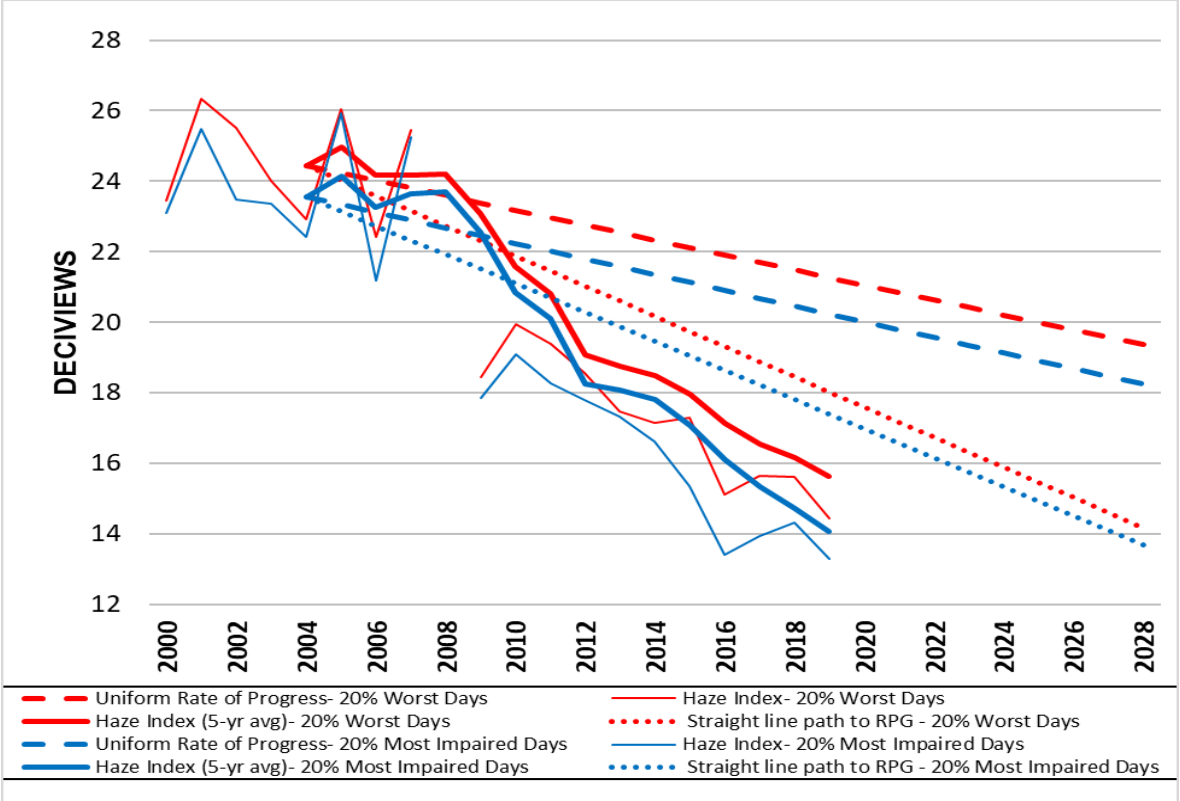


Figure 1-6: Visibility trends in deciviews at Lye Brook Wilderness Area.

Visibility trends for the Class I sites in Vermont, and out of state Class I sites potentially impacted by Vermont, are noted in Table 1-1. [8] This table depicts impairment by anthropogenic

[6] MANE-VU, (May 2017). *Regional Haze Metric Trends and HYSPLIT Trajectory Analyses.* Appendix A.
[7] EPA, (September 2003). *Guidance for Tracking Progress Under the Regional Haze Rule. EPA-454/B-03-004.* Available here.
[8] ME DEP, (January 2021). *Mid-Atlantic/Northeast U.S. Visibility Data 2004-2019 (2nd RH SIP Metrics)*, Appendix B.

sources only (the new calculation). It is noteworthy that visibility improvement as of the most recent 5-year average (2015-2019) at Lye Brook Wilderness Area is already much better than the 2028 Uniform Rate of Progress would have predicted, and further is very close to the 2028 Reasonable Progress Goal (RPG). This is largely due to energy market forces; natural gas has been cheaper than more-polluting coal and more widely used as a result.

Table 1-1: Visibility trends for IMPROVE monitors for Class I sites in MANE-VU (Observed Visibility vs. Reasonable Progress Goals, all values in dv).

Federal Class I Area IMPROVE Site	2000-2004 5-Year Average	2015-2019 Annual Average	2028 Uniform Rate of Progress	2028 Baseline / Reasonable Progress Goal[9]
20% Most Impaired Days				
Acadia National Park	22.01	14.24	17.36	13.44 / 13.35
Moosehorn Wilderness Area*	20.66	12.99	16.38	13.20 / 13.12
Great Gulf Wilderness Area**	21.88	12.33	17.04	12.13 / 12.00
Lye Brook Wilderness Area	**23.57**	**14.06**	**18.23**	**13.89 / 13.68**
Brigantine Wilderness Area	27.43	18.53	20.74	18.16 / 17.97
20% Clearest Days				
Acadia National Park	8.78	6.36	--	6.33 / 6.33
Moosehorn Wilderness Area	9.16	6.48	--	6.46 / 6.45
Great Gulf Wilderness Area	7.65	4.69	--	5.11 / 5.06
Lye Brook Wilderness Area	**6.37**	**4.88**	**--**	**3.90 / 3.86**
Brigantine Wilderness Area	14.33	10.81	--	10.55 / 10.47

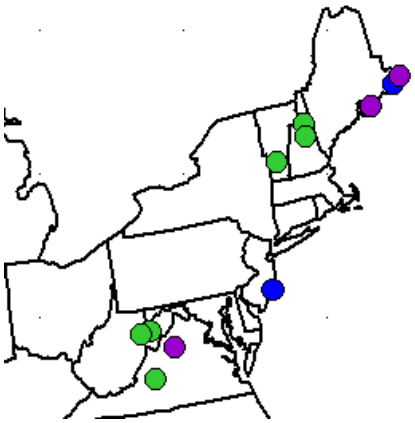
* IMPROVE site also represents Roosevelt Campobello International Park in New Brunswick, Canada.

** IMPROVE site also represents the Presidential Range-Dry River Wilderness Area.

[9] OTC, (October 2018). *Ozone Transport Commission/Mid-Atlantic Northeastern Visibility Union 2011 Based Modeling Platform Support Document – October 2018 Update.* Appendix V.

2 AREAS CONTRIBUTING TO REGIONAL HAZE

The Regional Haze Rule requires states to determine their contributions to visibility impairment at Federal Class I areas, and to determine the impact of emissions from outside the state on its Federal Class I areas. In coordination with its regional partners, Vermont has committed to implementing a long-term strategy to improve visibility at MANE-VU's seven Class I areas and nearby Federal Class I Areas shown in Figure 2-1.



MANE-VU Class I Areas

Maine: Acadia National Park, Moosehorn Wilderness Area, Roosevelt Campobello International Park (spans the border of Maine and New Brunswick, Canada)

New Hampshire: Great Gulf and Presidential-Dry River Wilderness Areas

Vermont: Lye Brook Wilderness

New Jersey: Brigantine Wilderness Area

Nearby Federal Class I Areas

West Virginia: Dolly Sods and Otter Creek Wilderness

Virginia: James River Face Wilderness Area and Shenandoah National Park

National Park Service **U.S. Forest Service** **U.S. Fish & Wildlife Service**

Figure 2-1: MANE-VU and nearby Federal Class I Areas.

Source apportionment screening modeling (using emissions to distance ratios and the CALPUFF model) was used to identify major contributors to regional haze at the MANE-VU and nearby Federal Class I areas. These tools were used to help identify the emission sources in the eastern and central United States and to help determine which states with whom Vermont shall consult.

VTDEC, in conjunction with NHDES, used the CALMET, CALPUFF and CALPOST programs to estimate pollutant concentrations and visibility impacts at eleven Class I areas in the northeastern U.S. This work enabled MANE-VU states to estimate and rank the relative impact of the sulfate and nitrate components of regional haze attributable to sulfur dioxide and nitrogen oxide emissions from individual large stationary point sources. Emission units were selected for CALPUFF modeling based on their emission magnitudes and proximity to MANE-VU Class I areas. At a minimum, the five largest EGU units in each eastern state were modeled. Other large emitting units were considered; thus, some states had many units modeled. ICI units were initially selected based on similar emission magnitude to EGUs being modeled for a state. Smaller ICI units were added in MANE-VU States near Federal Class I areas. Additional detail can be found in Appendix C.[10]

[10] MANE-VU, (April 2017). *2016 MANE-VU Source Contribution Modeling Report, CALPUFF Modeling of Large Electrical Generating Units and Industrial Sources*. Appendix C.

The modeling resulted in the following observations:

1. Emissions of SO_2 and NOx from EGUs are lower in 2015 compared to 2011 at many EGUs, however some show increased emissions.
2. Modeled sulfate, nitrate and visibility impacts for 95th percentile daily emissions produce substantially different results than modeling with annual emissions, especially for units with low operating hours.
3. The application of three different years of meteorology with identical emission rates can provide differing maximum sulfate, nitrate, and visibility impacts. In some cases, the difference is substantial.
4. Emission sources located close to Federal Class I areas typically show higher visibility impacts than similarly sized facilities further away. However, visibility degradation appears to be dominated overall by more distant emission sources.
5. Some industrial emission sources other than EGUs may have significant impacts on visibility at MANE-VU Class I areas. Several of these sources are in MANE-VU, while a few are in nearby states.

This screening modeling was not intended to determine the need for mandatory regulation on specific emission sources, but rather to identify emission units for further evaluation. The results of the modeling are discussed further in Section 2.1.

Additional modeling was conducted by members of the MANE-VU Technical Support Committee (CT DEEP) to estimate sulfate contributions to a receptor using the emissions over distance (Q/d) method.[11] The analysis was done using ARC MAP® software that utilized the empirical formula:

$$I = C_i \left({}^{Q}/_{d} \right)$$

where the strength of an emission source, Q, is linearly related to the impact, I, that it will have on a receptor located a distance, d, away (the term C_i is a specific adjustment factor for wind direction that was used in this analysis). The MANE-VU Class I areas with IMPROVE monitors – Acadia, Brigantine, Great Gulf, Lye Brook and Moosehorn and several nearby Federal Class I areas with IMPROVE monitors – Dolly Sods, James River Face and Shenandoah – were used as receptors. The results were compared with a similar study published in 2012.[12] The James River Face Wilderness was added in the 2015 analysis because it was considered close enough in proximity to MANE-VU states to be an important receptor to MANE-VU states. The locations of receptors analyzed in the 2015 analysis are shown in Figure 2-2.

A review of recent IMPROVE speciated visibility data shows the relative importance of sulfates compared to other pollutants regarding light extinction at the IMPROVE sites analyzed (see Figure 2-3). This led to the conclusion that SO_2 is the leading determinative pollutant for estimating the impact of

[11] MANE-VU Technical Support Committee, (April 2016). *MANE-VU Updated Q/d*C Contribution Assessment*. Appendix D.

[12] NESCAUM, (March 2012). *Contributions to Regional Haze in the Northeast and Mid-Atlantic United States: Preliminary Update through 2007*. Available at: http://www.nescaum.org/topics/regional-haze/regional-haze-documents.

states' emissions to the visibility impairment of the MANE-VU Class I areas. Emissions of NOx were considered in the final analysis and factored into Q/d calculations with chemistry information provided by CALPUFF modeling. Although nitrate generally accounts for a substantially smaller fraction of fine particle mass and related light extinction than sulfate and organic carbon at most northeastern Federal Class I areas, it may play a more important role in urban settings and in the wintertime. In addition, NO_X may have an indirect effect on summertime visibility by virtue of its role in the formation of ozone. Furthermore, it is worth examining nitrates emanating from the electric sector in the Midwest where power plants contribute significantly to NO_X emissions.

Figure 2-2: Receptors for the 2015 C_i(Q/d) Analysis.

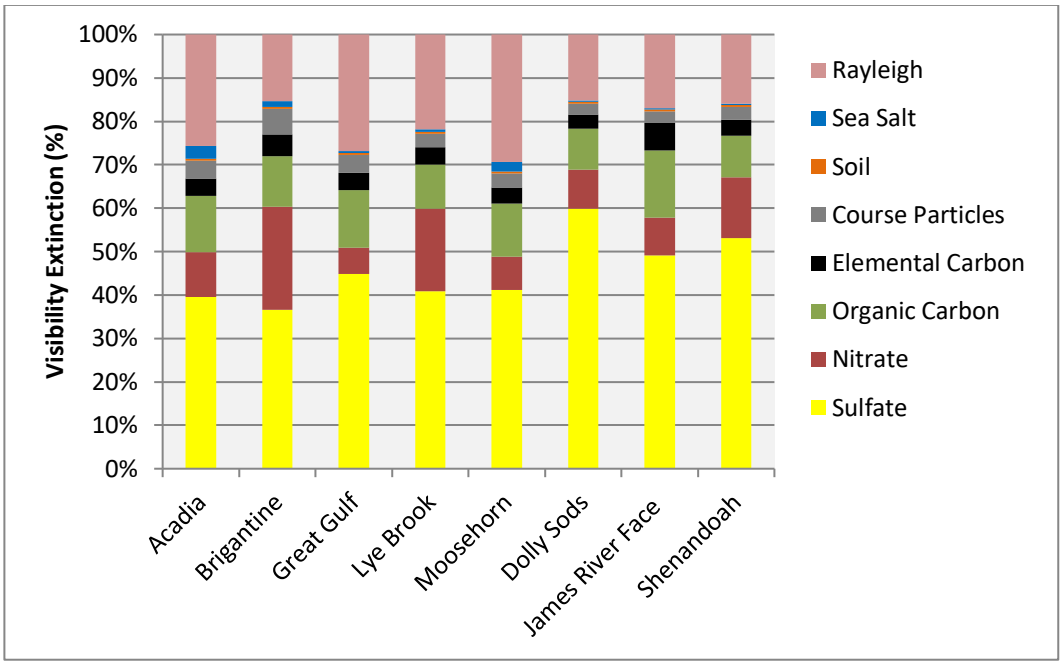


Figure 2-3: Percent visibility extinction, speciated by particle type plus Rayleigh scattering at MANE-VU and nearby Class I Areas. (IMPROVE 20% Most Impaired Visibility Summary 2012-2017 Average Extinction Fraction)

For the Lye Brook Wilderness, NOx (and so therefore nitrates) is the second most important factor for visibility extinction after sulfates, unlike most MANE-VU states with Class I areas where organic carbon is equally or more significant.

Ohio was determined to be one of the top two contributors for all the eight Federal Class I areas reviewed. Pennsylvania also continues to be one of the top three contributors for seven of the eight receptors. The majority of the top five contributors were very similar to a previous 2012 analysis,

however significant reshuffling of the top five is apparent thus indicating the emissions reductions achieved were not equally applied among the neighboring states. Table 2-1 displays the Q/d quantitative contributions to the MANE-VU and neighboring Federal Class I areas between the 2012 analysis (2007 emissions) and the 2015 analysis (2011 emissions).

Table 2-1: Top Five Contributing U.S. States for Total State SO2 Emissions over the Three Analyses (Q/d)[13]

Federal Class I Area (Receptor)	Rank	2012 Analysis (2007 emissions)	2015 Analysis (2011 emissions)
Acadia	1	Pennsylvania	Ohio
	2	Ohio	Pennsylvania
	3	Indiana	Indiana
	4	Michigan	Michigan
	5	Georgia	Illinois
Brigantine	1	Pennsylvania	Pennsylvania
	2	Maryland	Ohio
	3	Ohio	Maryland
	4	Indiana	Indiana
	5	West Virginia	Kentucky
Dolly Sods	1	Pennsylvania	Ohio
	2	Ohio	West Virginia
	3	West Virginia	Pennsylvania
	4	Indiana	Indiana
	5	North Carolina	Kentucky
Great Gulf / Presidential-Dry River	1	Pennsylvania	Ohio
	2	Ohio	Pennsylvania
	3	Indiana	Indiana
	4	Michigan	Michigan
	5	New York	Illinois
James River Face	1	New to analysis	Ohio
	2		Pennsylvania
	3		Indiana
	4		Kentucky
	5		West Virginia
Lye Brook	1	Pennsylvania	Pennsylvania
	2	Ohio	Ohio
	3	New York	Indiana
	4	Indiana	New York
	5	Michigan/West Virginia	Michigan
Moosehorn/ Campobello	1	Pennsylvania	Ohio
	2	Ohio	Indiana
	3	Indiana	Illinois
	4	Michigan	Michigan
	5	Texas/Missouri/Illinois/West Virginia/New York	Texas
Shenandoah	1	Pennsylvania	Ohio
	2	Ohio	Pennsylvania
	3	West Virginia	Indiana
	4	Maryland	West Virginia
	5	Indiana	Virginia

[13] MANE-VU Technical Support Committee, (April 2016). *MANE-VU Updated Q/d*C Contribution Assessment*. Appendix D.

2.1 States and Sources Contributing to Visibility Impairment in Vermont's Class I Areas

Modeling of point source (EGUs and industrial/institutional units) contributions to Federal Class I areas undertaken in 2016 by NHDES and VT DEC[14] was used to estimate the visibility impairment attributable to SO_2 and NOx on the 20% most impaired days that was contributed by states to MANE-VU's Federal Class I areas. Emissions used for the MANE-VU contribution assessment modeling included EPA's CAMD (2011 and 2015) 95th percentile of the maximum hourly 2015 EGU SO_2 and NOx emissions and the MARAMA 2011 typical daily industrial/institutional SO_2 and NOx emissions. For the purpose of determining states for consultation, a screening threshold of 3 Mm-1 was used for these two point source sectors. As with other Federal Class I areas in MANE-VU and nearby, emissions from Pennsylvania and Ohio have the largest impact; in Vermont mass contribution from those states is over 30% (Table 2-2). Table 2-2 shows that, from a mass basis, 3 states have contributed significantly (greater than 40% based on 2011 emissions) to Lye Brook's visibility impairment: Pennsylvania, Ohio, and New York, and to a lesser extent but still significantly, Indiana, Texas, West Virginia, Michigan and Kentucky.

Table 2-2: Percent mass-weighted 2011 sulfate and nitrate contribution for top 36 eastern states to all MANE-VU Class I areas: consolidated (maximum to any Class I area), individual MANE-VU Class I areas, and average contributed mass (mass factor).

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

[14] MANE-VU, (April 2017). *2016 MANE-VU Source Contribution Modeling Report, CALPUFF Modeling of Large Electrical Generating Units and Industrial Sources*. Appendix C.

Previously mentioned metrics analyses included speciation analyses for 2000-2015 and trajectory modeling analyses for the "most impaired" visibility days in 2002, 2011 and 2015 for Federal Class I areas in MANE-VU, and nearby Federal Class I areas in Virginia and West Virginia.[15] For MANE-VU states, 2002 is the modeling base year for the first round of regional haze SIPs; 2011 is the modeling base year for the current round of regional haze SIPs. Analysis years chosen were the same years used in the MANE-VU Source Contribution Modeling Report (i.e., CALPUFF and Q/d).[16]

CALPUFF modeling results used for comparison with the trajectory analyses include states having an impacting EGU or ICI source with at least a 1 Mm^{-1} light extinction impact to a Federal Class I area. Table 2-2 shows the results of this modeling for Vermont and other MANE-VU states' emissions sources**.** Due to concerns raised during consultation about CALPUFF performance at distances greater than 50 km, MANE-VU agreed to use the model only as a screening tool to identify contributing states and sources that may benefit from more detailed examination. For Vermont, these top contributors were Homer City facilities in PA, Avon Lake in Ohio, Muskingum River in Ohio, Yorktown Power in Virginia, and Big Sandy in Kentucky, among others.

2016 CALPUFF modeling was also performed in seven phases to include different combinations of emission type (EGU 95th percentile daily or annual, industrial typical daily), emission years (2011 or 2015) and meteorological data (2002, 2011, or 2015). The CALPUFF report provides a table of the top-ten 2011 and 2015 EGU emission sources and the top-five industrial/institutional sources impacting each of the eleven regional Class I areas.

2.2 Vermont Emission Sources Potentially Contributing to Visibility Impairment to Federal Class I Areas in Other States

Vermont emissions do not have significant impacts on other Class I areas in the MANE-VU region or in other RPO regions (see Table 2-2). When identifying whether a state might have impact, the MANE-VU Technical Support Workgroup decided on greater than 2% on a mass weight basis for any state emissions as significant contribution to regional haze at a Class 1 site. See Table 3-3 and Figure 3-2 for the selection of states for MANE VU regional haze consultation. No class I sites were impacted by Vermont by over 1%, except in New Hampshire where VT was determined to be at 2.1% for contribution to regional haze at NH Class I sites. This was due to the inclusion of state-wide NOx emissions from the mobile source sectors (off and on road sectors) and area sources, into the modeling.

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15 MANE-VU, (May 2017). *Regional Haze Metric Trends and HYSPLIT Trajectory Analyses.* Appendix A.

16 MANE-VU, (April 2017). *2016 MANE-VU Source Contribution Modeling Report, CALPUFF Modeling of Large Electrical Generating Units and Industrial Sources*. Appendix C, and MANE-VU Technical Support Committee, (April 2016). *MANE-VU Updated Q/d*C Contribution Assessment*. Appendix D.

3 REGIONAL PLANNING AND CONSULTATION

In accordance with 40 CFR 51.308(f)(2)(ii) Vermont must consult with States that have emissions that are reasonably anticipated to contribute to visibility impairment in the mandatory Federal Class I areas. Because the pollutants that lead to regional haze can originate from sources located across broad geographic areas, EPA has encouraged the States and Tribes across the U.S. to address visibility impairment from a regional perspective. In 1999, EPA and affected states/tribes agreed to create five RPOs to facilitate interstate coordination on SIPs addressing regional haze. The RPOs, and states/tribes within each RPO, are required to consult on emission management strategies toward visibility improvement in affected Federal Class I areas. As shown in Figure 3-1, the five RPOs were originally called MANE-VU, VISTAS, MRPO, CenRAP, and WRAP. MRPO, VISTAS and CenRAP operations have been absorbed into their parent organizations LADCO, SESARM and CENSARA, respectively. Vermont is a member of MANE-VU.

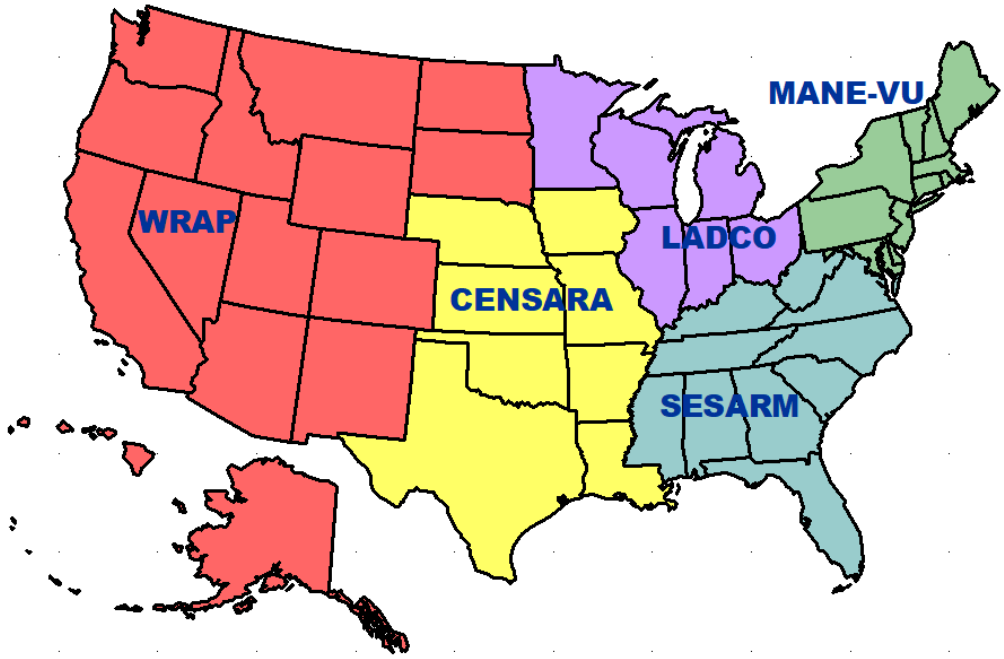

Figure 3-1: Regional Planning Organizations for regional haze.

These RPOs evaluate technical information to better understand how their states and tribes impact national parks and wilderness areas (Federal Class I areas) across the country, pursue the development of regional strategies to reduce emissions of particulate matter and other pollutants leading to regional haze, and help states meet the consultation requirements of the Regional Haze Rule.

3.1 Mid-Atlantic / Northeast Visibility Union (MANE-VU)

MANE-VU's work is managed by the OTC and carried out by OTC, MARAMA, and NESCAUM. The states, tribes and federal agencies comprising MANE-VU are listed in Table 3-1. Individuals from the member states, tribes and agencies, along with professional staff from OTC, MARAMA and NESCAUM, make up the various committees and workgroups. MANE-VU also established a Policy Advisory Group (PAG) to provide advice to decision-makers on policy questions. To fulfill the PAG function, state and tribal Air Directors meet on an as-needed basis with EPA and the FLMs.

Table 3-1: MANE-VU Members

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

*Non-voting members
~Also represents the U.S. portion of Roosevelt Campobello International Park

Since its inception on July 24, 2001, MANE-VU has employed an active committee structure to address both technical and non-technical issues related to regional haze. The primary committee is the TSC. While the work of the TSC is instrumental to policies and programs, all policy is reviewed by the MANE-VU Air Directors and decisions are ultimately made by the MANE-VU Board.

The TSC is charged with assessing the nature and magnitude of regional haze within MANE-VU, interpreting the results of technical work, and reporting on such work to the MANE-VU Board. This committee has evolved to function as a valuable resource on all technical projects and issues for MANE-VU. The TSC has established a process to ensure that important regional-haze-related projects are completed in a timely fashion, and members are kept informed of all MANE-VU tasks and duties. In addition to the formal working committees, ad hoc workgroups of the TSC may be used for purposes of evaluating emissions, monitoring, and modeling.

The Communications Committee is charged with developing approaches to inform the public about regional haze and making recommendations to the MANE-VU Board to facilitate that goal. This committee oversees the production of MANE-VU's newsletter and outreach tools, for both stakeholders and the public, regarding regional issues affecting MANE-VU's members.

3.2 Regional Consultation and the MANE-VU "Ask"

On May 10, 2006, MANE-VU adopted the Inter-RPO State/Tribal and FLM Consultation Framework [17] whose purpose is to "...delineate, by consensus, the basic consultation requirements for states, tribes, RPOs, and Federal Land Managers required under 40 CFR Part 51, during the regional haze State Implementation Plan development process." The basic principles set forth in the framework are presented in Table 3-2. The MANE-VU states and tribes applied these principles to the regional haze consultation and SIP development process. Issues addressed included regional haze baseline assessments, natural background levels, and development of reasonable progress goals. These are described at length in later sections of this SIP.

[17] MANE-VU, (May 2006). *Inter-RPO State/Tribal and FLM Consultation Framework*. Appendix F.

Table 3-2: MANE-VU Consultation Principles for Regional Haze Planning

1.	All State, Tribal, RPO, and Federal participants are committed to continuing dialogue and information sharing in order to create understanding of the respective concerns and needs of the parties.
2.	Continuous documentation of all communications is necessary to develop a record for inclusion in the SIP submittal to EPA.
3.	States alone have the authority to undertake specific measures under their SIP. This inter-RPO framework is designed solely to facilitate needed communication, coordination and cooperation among jurisdictions but does not establish binding obligation on the part of participating agencies.
4.	There are two areas that require State-to-State and/or State-to-Tribal consultations ("formal" consultations): (i) development of the reasonable progress goal for a Class I area, and (ii) development of long-term strategies. While it is anticipated that the formal consultation will cover the technical components that make up each of these policy decision areas, there may be a need for the RPOs, in coordination with their State and Tribal members, to have informal consultations on these technical considerations.
5.	During both the formal and informal inter-RPO consultations, it is anticipated that the States and Tribes will work collectively to facilitate the consultation process through their respective RPOs, when feasible.
6.	Technical analyses will be transparent, when possible, and will reflect the most up-to-date information and best scientific methods for the decision needed within the resources available.
7.	The State with the Class I area retains the responsibility to establish reasonable progress goals. The RPOs will make reasonable efforts to facilitate the development of a consensus among the State with a Class I area and other States affecting that area. In instances where the State with the Class I area cannot agree with such other States that the goal provides for reasonable progress, actions taken to resolve the disagreement must be included in the State's regional haze implementation plan (or plan revisions) submitted to the EPA Administrator as required under 40 CFR §51.308(d)(1)(iv).
8.	All States whose emissions are reasonably anticipated to contribute to visibility impairment in a Class I area, must provide the FLM agency for that Class I area with an opportunity for consultation, in person, on their regional haze implementation plans. The States/Tribes will pursue the development of a memorandum of understanding to expedite the submission and consideration of the FLMs' comments on the reasonable progress goals and related implementation plans. As required under 40 CFR §51.308(i)(3), the plan or plan revision must include a description of how the State addressed any FLM comments.
9.	States/Tribes will consult with the affected FLMs to protect the air resources of the State/Tribe and Class I areas in accordance with the FLM coordination requirements specified in 40 CFR §51.308(i) and other consultation procedures developed by consensus.
10.	The consultation process is designed to share information, define and document issues, develop a range of options, solicit feedback on options, develop consensus advice if possible, and facilitate informed decisions by the Class I States.
11.	The collaborators, including States, Tribes and affected FLMs, will promptly respond to other RPOs/States'/Tribes' requests for comments.

Through this process, Vermont consulted with other states by participating in the MANE-VU intra-RPO, inter-RPO, and EPA/FLM consultations that led to the creation of coordinated strategies, or "Asks" on regional haze. These strategies were consolidated in three "Ask" statements that identify a recommended course of action for: a) states within MANE-VU; b) states outside of MANE-VU; and c) the EPA and FLM for the current regional haze planning period, 2018-2028, described in Section 4.2 of this document. All MANE-VU states participated in the MANE-VU Intra-RPO consultations, as did Federal Land Managers represented by the National Park Service, the Forest Service and the Fish and Wildlife Service. A summary of the consultations is found in Appendix G.[18]

[18] MANE-VU Technical Support Committee, (July 2018). *MANE-VU Regional Haze Consultation Report*. Appendix G.

3.3 Selections of States for MANE-VU Inter-RPO Regional Haze Consultation

As described below, MANE-VU had a selection process[19] to determine which states were contributing to its regional haze issues, and therefore needed to be consulted. EPA's guidance document[20] calls for a process for determining what states, sources, or sectors reasonably contribute to visibility impairment. It begins with analyzing monitored emissions data on the 20% most impaired days to determine what pollution is leading to anthropogenic visibility impacts. This is followed by screening for sources or source sectors that lead to most of that impact. The results of this analysis lead to the identification of which sources or sectors need a further analysis (known as a four-factor analysis which is described below) performed and with which states consultation should occur.

As part of this process, MANE-VU concluded, after developing a conceptual model that was influenced by monitoring data, that the sulfates from SO_2 emissions were still the primary driver behind visibility impairment in the region, though nitrates from NOx emission sources do play a more significant role than they had in the first planning period. Because of this, MANE-VU chose an approach for contribution assessments that focused on sulfates and included nitrates as appropriate technically.

Next, MANE-VU examined annual inventories of emissions to find sectors that should be considered for further analysis.[21] See also Figures 3-3 and 3-4. EGUs emitting SO_2 and NOx and industrial point sources emitting SO_2 were found to be point source sectors with emissions levels that warranted further scrutiny. Mobile sources were also found to be an important sector in terms of NOx emissions.

After this initial work, MANE-VU initiated a screening process using two tools, Q/d and CALPUFF to determine baseline visibility impacts to identify potential sources or source categories that could be subject to four-factor analysis. MANE-VU limited this work to only these two screening analyses to determine which upwind states should be consulted. Results of this contribution analysis were then compared to air mass trajectories for 20% most impaired days at the MANE-VU Class I areas.

Vermont recognizes the concerns of EPA and the FLMs that CALPUFF is no longer a recommended model for longer distance visibility impacts, but at the time this work was conducted, it was still listed as recommended. This matter was discussed during consultation and the MANE-VU states agreed to use the modeling only as a screening tool to identify emissions sources for further analysis. No direct requests for emission control resulted from CALPUFF modeling in the MANE-VU Ask.

In accordance with EPA guidance, MANE-VU considered only the four statutory factors to determine whether control measures were necessary to achieve reasonable progress. Visibility benefits were not weighed against the four statutory factors to identify appropriate control measures. Rather, for each source or source category that is selected for further analysis during the screening process, MANE-VU would require whatever control measures were determined to be reasonable after considering the four statutory factors alone.

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[19] MANE-VU Technical Support Committee, (September 2017). *Selection of States for MANE-VU Regional Haze Consultation (2018)*. Appendix E.

[20] EPA, (December 2018). *Technical Guidance on Tracking Visibility Progress for the Second Implementation Period*. *EPA-454/R-18-010*. Available at: https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf.

[21] Memo from MANE-VU Technical Support Committee to MANE-VU Air Directors, (October 2016). *RE: Contribution Assessment Preliminary Inventory Analysis*. Appendix H.

The four factors are:

1. Costs of compliance.
2. Time necessary for compliance.
3. Energy and non-air quality environmental impacts.
4. Remaining useful life of affected sources.

MANE-VU considered emissions from EGUs and ICI boilers predominately, but also included statewide emissions to account for the impact of area and mobile sources. Since impairment from winter nitrates have increased as a percentage in several MANE-VU Class I areas, SO_2 and NOx emissions were both considered. Modeling initially included 2011 emissions because it corresponds to the base year of the modeling platform used to establish reasonable progress goals (RPGs). Emissions in 2015 were either directly considered or estimated so that recent changes in the make-up of more recent emissions inventory would be considered. When these factors were considered, states that contributed 2% or more of the visibility impairment and had an average mass impact of over 1% (0.01 µg/m^3) were determined to be necessary to consult with as part of the regional haze SIP process. This resulted in 14 upwind states of three upwind RPOs in Table 3-3 being considered necessary to consult with. States specifically identified for Vermont consultation are listed in blue type. A visual representation for contributing states for Lye Brook based on mass weighting analysis is shown in Figure 3-2.

Table 3-3: States in each upwind RPO that are considered contributing to a MANE-VU Class I area.

MRPO	**Illinois**	**Indiana**	**Michigan**	**Ohio**			
VISTAS	**Alabama**	Florida	**Kentucky**	**N. Carolina**	Tennessee	**Virginia**	**W. Virginia**
CENRAP	**Louisiana**	**Missouri**	**Texas**				

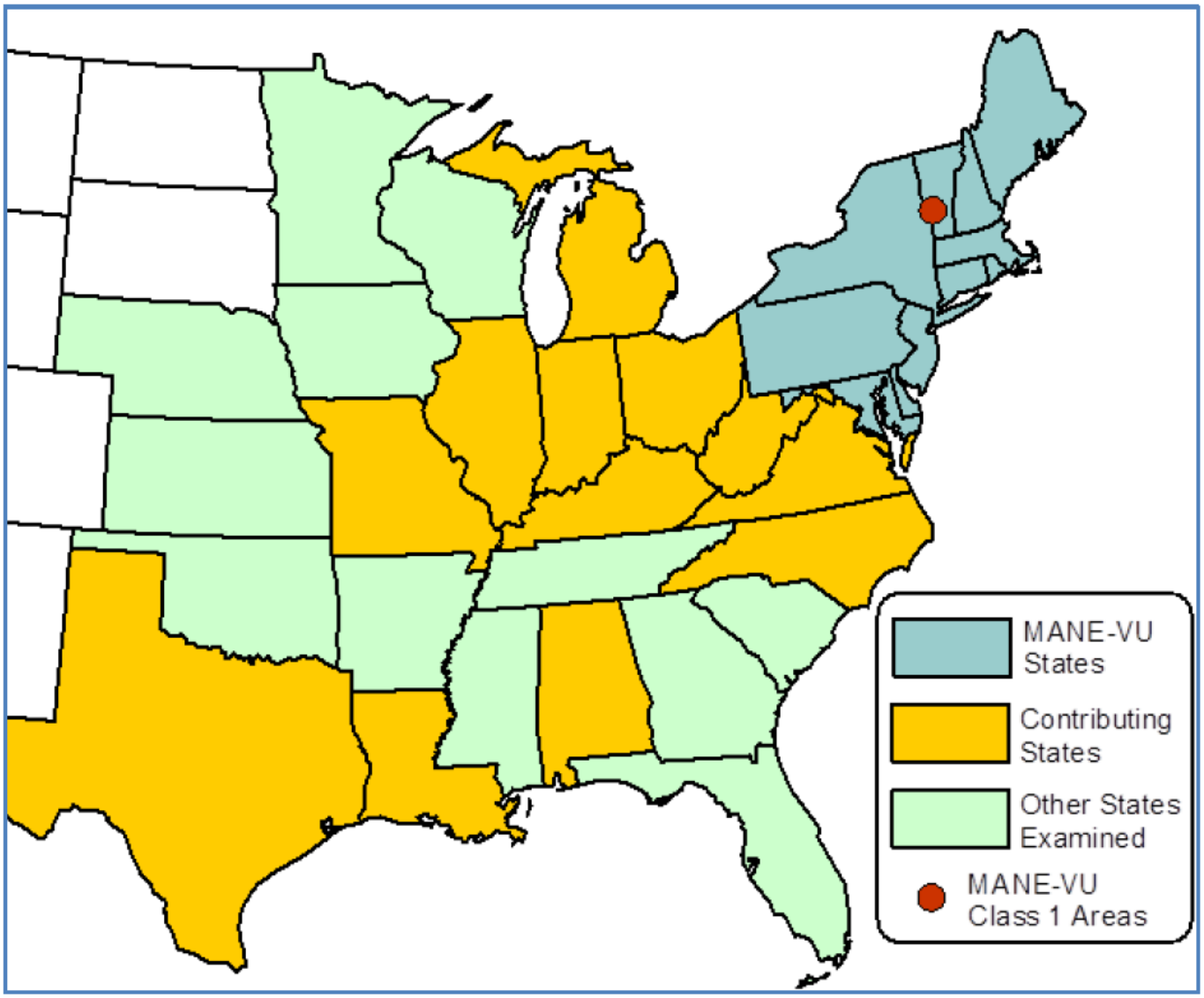

Figure 3-2: States contributing to visibility impairment at Lye Brook Wilderness Area based on mass weighting analysis.

Figures 3-3 and 3-4 show emission inventories for the MANE-VU states and other states invited for consultation with Vermont and MANE-VU.

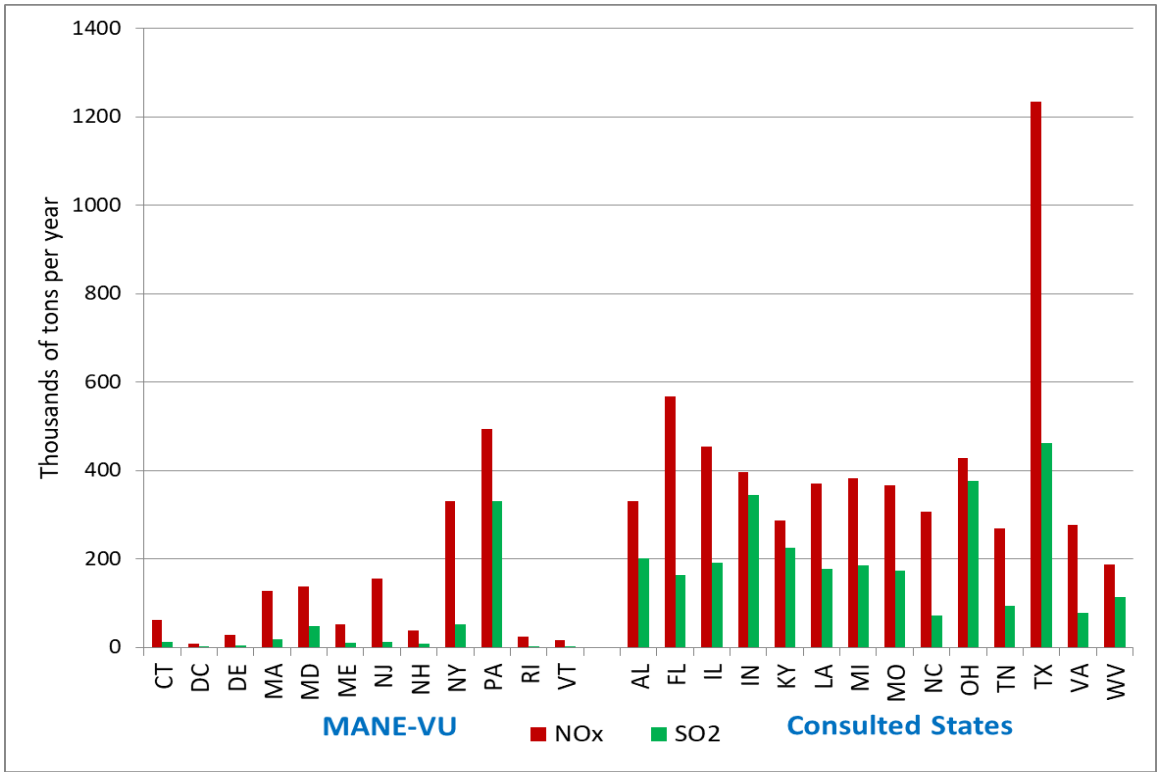

Figure 3-3: 2014 NEI statewide NOx and SO_2 emissions for states selected by MANE-VU for consultation.

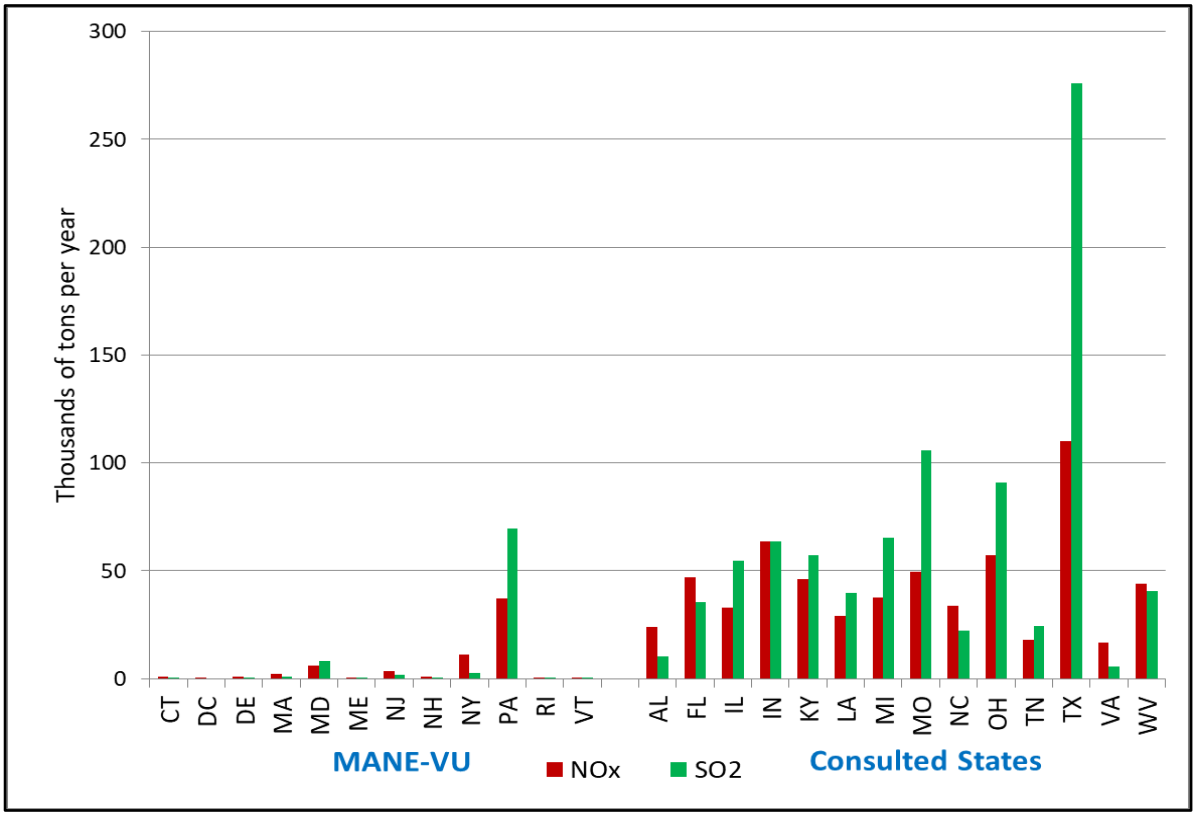

Figure 3-4: 2017 AMPD sources NOx and SO2 emissions for states selected by MANE-VU for consultation.

3.4 Vermont Specific Consultation

40 CFR 51.308(f)(2)(ii) of the Regional Haze Rule requires the State of Vermont to consult with other states/tribes to develop coordinated emission management strategies. This requirement applies both when emissions from a state/tribe are reasonably anticipated to contribute to visibility impairment in Federal Class I areas outside the state/tribe and when emissions from other states/tribes are reasonably anticipated to contribute to visibility impairment at mandatory Federal Class I areas within a state/tribe.

Vermont consulted with other states/tribes by participating in the MANE-VU intra-RPO and inter-RPO processes leading to the creation of coordinated strategies on regional haze. This coordinated effort considered the individual and aggregated impacts of states'/tribes' emissions on Federal Class I areas within and outside the states/tribes.

To maintain consistency within MANE-VU, every MANE-VU member was requested to consult with Vermont. Several states outside MANE-VU were also requested to join this consultation in response to the findings of MANE-VU's evaluations. All MANE-VU states with Federal Class I areas have similarly requested consultation with Vermont on the regional haze issue.

Throughout the consultation process, Vermont was guided by the principles contained in a resolution adopted by the MANE-VU Class I states on June 7, 2007 (Table 3-2). In the resolution, the Class I states agreed to set reasonable progress goals for 2018 that would provide visibility improvement at least as great as that which would be achieved under a uniform rate of progress to reach natural visibility conditions by 2064. The goals would be set by the Class I states at levels reflecting implementation of

measures determined to be reasonable after consultation with the contributing states. At the same time, Class I states recognized that each state should be given the flexibility to choose other measures that achieve the same or greater benefits.

Vermont provided the Federal Land Managers opportunity to review the draft SIP during a 60-day review period in August and September 2022. No substantial comments were made regarding the reasonable progress goal or long-term strategy. The FLMs responses to the draft SIP can be found in Appendix X.

Neither the FLMs or other states with which Vermont consulted identify any Vermont sources or measures for four-factor analysis.

The results of Vermont's consultation efforts will ultimately rest with the individual states and the EPA as they develop and implement their own regional haze SIPs. The other MANE-VU states have agreed to incorporate certain control measures into their SIPs, but most of these plans are still under development. For the non-MANE-VU states, Vermont has the expectation that the same or equivalent control measures will be included in those states plans. Further, Vermont depends on EPA and the FLMs to fulfill the "Ask" requested of them and to ensure the MANE-VU Asks are adequately addressed in the SIPs of all contributing states.

4 ASSESSMENT OF BASELINE, CURRENT, AND NATURAL VISIBILITY (40 CFR 51.308(f))

4.1 Ambient Data Analysis - Calculations of Baseline, Current, and Natural Visibility (40 CFR 51.308(f)(1))

The Regional Haze Rule requires (40 CFR 51.308(f)(1)) that states determine baseline, current, and natural visibility conditions for each Class I area within their jurisdictions, for the most impaired and clearest days (and quantified in deciviews, or dv). Determination of current conditions must reflect actual progress since the baseline period and during the previous implementation period. The difference between current and natural visibility conditions for the most impaired and clearest days must also be quantified. Finally, the Uniform Rate of Progress from baseline conditions to natural visibility must be quantified. This information allows states to assess current levels of visibility degradation and provides a basis for setting reasonable progress goals toward restoration of natural visibility conditions in Class I areas.

The effectiveness of any plan to reduce regional haze in Class I areas is dependent on the availability of reliable data. The Interagency Monitoring of Protected Visual Environments (IMPROVE) program was established in 1985 to provide the data necessary to support the creation of Federal and State implementation plans for the protection of visibility in Class I areas. IMPROVE has made it possible to assess current visibility conditions, track changes in visibility, and identify the chemical species and emission sources responsible for visibility impairment. IMPROVE data were used to calculate baseline, actual progress currently, and natural conditions for MANE-VU Class I Areas. Visibility monitoring at Lye Brook Wilderness is accomplished with instruments located at Mount Snow. This monitoring station measures and records light scattering, aerosols, and relative humidity. The collected data are compiled and sorted to ascertain visibility levels on the 20% clearest and most impaired days. This information is tracked over time to look for trends. Vermont accepts designation of this monitoring site as representative of the Lye Brook Wilderness area.

For the first implementation period, states selected the least and most impaired days as the monitored days with the lowest and highest actual deciview levels regardless of the source of the particulate matter causing the visibility impairment. EPA, in its Regional Haze Rule revision, stated that focusing on anthropogenic impairment is a more appropriate method for determining most impaired days because it will more effectively track whether states are making progress in controlling anthropogenic sources. This approach is also more consistent with the definition of visibility impairment in 40 CFR 51.301 and with the national goal established in the CAA. While not changing the wording, EPA made clear that going forward, most impaired days would refer to those with the greatest anthropogenic visibility impairment. The approach for the 20% of days with the best visibility to represent good visibility conditions for RPG and tracking purposes would remain the same but would instead be referred to as the 20% clearest days rather than the 20% least impaired days.

EPA's Regional Haze Guidance[22] method to track changes in visibility for the 20% most impaired days to the baseline (2000-2004) and current (2015-2019) visibility levels shows values for both the updated definition to calculate most impaired days and the method used to calculate 20% worst days in the first

[22] EPA, (December 2018). *Technical Guidance on Tracking Visibility Progress for the Second Implementation Period*. *EPA-454/R-18-010*. Available at: https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf.

Regional Haze report, that included contributions from non-anthropogenic sources. Methods are the same for the 20% best and 20% clearest days. Regional haze data from the following databases for 2000-2019 were downloaded from the FED[23] for all Federal Class I areas listed in Section 2.1:

- IMPROVE AEROSOL, RHR II (New Equation)
- IMPROVE Natural Conditions II, Baseline (01-05).

4.2 Baseline, Natural and Current Visibility Conditions for the Most Impaired and Clearest Days

The five-year average (2000-2004) baseline visibility (in deciviews, or dv) was calculated by MANE-VU for each Class I federal area, for the 20% clearest days and the 20% most impaired days, as required by the Regional Haze Rule and as detailed in *Tracking Visibility Progress* 2004-2016 (MANE-VU, November 2018). Table 4.2 presents these values for each IMPROVE monitoring site at select Class I areas (i.e., Lye Brook and nearby Class I areas). These values were calculated in accordance with EPA's June 2020 memorandum regarding data completeness.

Table 4-1: Baseline visibility for the 20% most impaired days and 20% clearest days (2000-2004) in MANE-VU mandatory Class I Federal areas.

Class I Area(s)	Clearest Days (deciviews)	Most Impaired Days (deciviews)	Difference (deciviews)
Acadia National Park	8.78	22.01	13.23
Moosehorn Wilderness and Roosevelt Campobello International Park	9.16	20.65	11.49
Great Gulf Wilderness and Presidential Range – Dry River Wilderness	7.65	21.88	14.23
Lye Brook Wilderness	**6.37**	**23.57**	**17.20**
Brigantine Wilderness	14.33	27.43	13.10

Source: Mid-Atlantic/Northeast Trends, 2004-2019 Report (2cnd RH SIP Metrics) , prepared on 1/21/2021

As indicated in the table above, the 2001-2004 baseline visibility for the Lye Brook Wilderness was 6.37 deciviews for the 20 percent clearest days and 23.57 deciviews for the 20 percent most impaired visibility days.

Natural background refers to the visibility conditions that existed before human activities affected air quality in the region. Consistent with the stated visibility goals of the Clean Air Act, natural background is identified as the visibility target to be reached by 2064 in each Federal Class I area.

The Lye Brook Wilderness Area has an estimated natural background visibility of 2.79 deciviews on the 20 percent clearest days and 10.24 deciviews on the 20 percent most impaired days, as shown in Table 4-2.

[23] Federal Land Manager Environmental Database. Available at: http://views.cira.colostate.edu/fed/.

Table 4-2: Visibility under natural conditions and difference between baseline and natural conditions for the 20% most impaired days and 20% clearest days in MANE-VU mandatory Class I Federal areas.

Class I Area(s)	Clearest Days (deciviews)	Most Impaired Days (deciviews)	Difference Baseline/Natural (deciviews)	
			Clearest	Most Impaired
Acadia National Park	4.66	10.39	4.12	11.62
Moosehorn Wilderness and Roosevelt Campobello International Park	5.02	9.98	4.14	10.67
Great Gulf Wilderness and Presidential Range – Dry River Wilderness	3.73	9.78	3.92	12.10
Lye Brook Wilderness	**2.79**	**10.24**	**3.58**	**13.33**
Brigantine Wilderness	5.52	10.68	8.81	16.75

Source: Mid-Atlantic/Northeast Trends, 2004-2019 Report (2cnd RH SIP Metrics) , prepared on 1/21/2021

The differences between baseline visibility and natural visibility provide the parameters for determining the uniform rate of progress "glide path" that indicates progress to meet the goal of natural visibility by 2064 for Class I areas, as required by the Regional Haze Rule. The uniform rate of progress is a benchmark for determining the Reasonable Progress Goal (RPG) that need to be established in state SIPs, and the measures that will be taken to meet the RPGs of the various states impacting Class I areas' visibility.

According to 40 CFR 51.308(f)(1)(iii), the period for calculating the current visibility conditions is the most recent 5-year period for which data are available. The current visibility condition for the most impaired or the clearest days is the average of the respective annual values. Table 4-3 shows the comparison between baseline and current visibility for Lye Brook and other Class I areas in or near MANE-VU.

Table 4-3: Baseline, current, and reasonable progress goal haze index levels for Class I areas in or adjacent to the MANE-VU Region.

Class I Area	IMPROVE SITE DATA CODE(S)	State	CLEAREST DAYS			MOST IMPAIRED DAYS				
			Baseline (2000-04) (dv)	Current (2015-19) (dv)	RPG^ (2028) (dv)	Baseline (2000-04) (dv)	Current (2015-19) (dv)	URP* 2019 (dv)	URP* 2028 (dv)	RPG^ (2028) (dv)
Acadia National Park	ACAD	ME	8.78	6.36	6.33	22.01	14.24	19.11	17.36	13.35
Moosehorn Wilderness Area	MOOS	ME NB	9.16	6.48	6.45	20.65	12.99	17.98	16.38	13.12
Roosevelt Campobello International Park										
Great Gulf Wilderness Area	GRGU	NH	7.65	4.70	5.06	21.88	12.33	18.85	17.04	12.00
Presidential Range/Dry River Wilderness Area										
Lye Brook Wilderness Area	**LYBR RHTS**	**VT**	**6.37**	**4.88**	**3.86**	**23.57**	**14.06**	**20.24**	**18.24**	**13.68**
Brigantine Wilderness Area	BRIG	NJ	14.33	10.81	10.47	27.43	18.53	23.24	20.73	17.97
Dolly Sods Wilderness Area†	DOSO	WV	12.28	6.18	7.27	28.29	17.03	23.45	20.54	15.09
Otter Creek Wilderness Area†										
James River Face Area†	JARI	VA	14.21	8.99	9.36	28.08	17.28	23.43	20.64	15.31
Shenandoah National Park†	SHEN	VA	10.96	6.54	6.83	28.32	16.38	23.62	20.80	14.25

4.3 Progress to Date for the Most Impaired and Clearest Days

Actual progress made towards the natural visibility condition since the baseline period, and actual progress made during the previous implementation period for both the most impaired and the clearest days represents progress to date. IMPROVE data for 2019 represents the most recent available and thus the period of 2015 to 2019 is the most recent 5-year period available. Current conditions reflect a 9.51 dv improvement from Baseline on the 20% most impaired days and 1.49 dv on the 20% clearest days.

As of the most recent 5-year period (2015-2019), the current visibility condition in the Lye Brook Wilderness exceeds natural visibility conditions by 2.09 dv on the 20% clearest days and by 3.82 dv on the 20% most impaired days.

4.4 Uniform Rate of Progress

As a benchmark to aid in developing reasonable progress goals, MANE-VU compared baseline visibility conditions to natural visibility conditions at each MANE-VU Class I area. The 'uniform rate of progress' defines, in deciviews per year, the steady rate of visibility improvement that would need to be maintained in order to attain natural visibility conditions by the end of 2064 (as the Regional Haze Rule requires). This measure is called the URP line (or glide path) between baseline conditions and 2064. The difference between baseline and natural visibility conditions for the 20 percent most impaired days was used to determine the uniform rate of progress that would be needed during each implementation period. For the first planning period (until 2018), Vermont's calculations showed that rate to be 0.212 deciviews per year, and stated that the reasonable progress goals established for Lye Brook Wilderness

area was expected to provide visibility improvements in excess of that rate, which in fact did occur.

Table 4-4: Uniform rate of progress calculation (values in deciviews) - First Implementation Period

Class I Area	2000-2004 Baseline Visibility (20% Worst Days)	Natural Visibility (20% Worst Days)	Total Improvement Needed by 2018	Total Improvement Needed by 2064	Uniform Annual Rate of Improvement
Acadia National Park	22.9	12.4	2.4	10.5	0.174
Moosehorn Wilderness and Roosevelt-Campobello International Park	21.7	12.0	2.3	9.7	0.162
Great Gulf Wilderness and Presidential Range - Dry River Wilderness	22.8	12.0	2.5	10.8	0.180
Lye Brook Wilderness	**24.5**	**11.7**	**3.0**	**12.8**	**0.212**
Brigantine Wilderness	29.0	12.2	3.9	16.8	0.280

Note: Both natural conditions and baseline visibility for the 5-year period from 2000 through 2004 were calculated in conformance with an alternative method recommended by the IMPROVE Steering Committee.[24]

For the second implementation period (2018-2028) the monitoring data for the period of 2000 to 2004 was used to establish the Lye Brook baseline information (2000-2004) as required by EPA guidance. The URP is now based on 'most impaired' and not 'worst days'. Therefore, the baseline for 20% most impaired days is 23.57 dv and for 20% clearest days it is 6.37 dv. Natural visibility is now 10.24 for the most impaired days, or a difference of 13.33 dv. Over the 60 year period from 2004 background to 2064 natural visibility deadline, the URP would then be calculated to be 0.222 dv/year. As shown in Table 4-4 and in Figure 4-1, the Lye Brook Wilderness area is well below the URP in the first implementation period and with the chosen RPG will continue to be for the second SIP planning period.

24* "Baseline and Natural Visibility Conditions, Considerations and Proposed Approach to the Calculation of Baseline and Natural Visibility Conditions at MANE-VU Class I Areas," NESCAUM, December 2006. See Appendix I.

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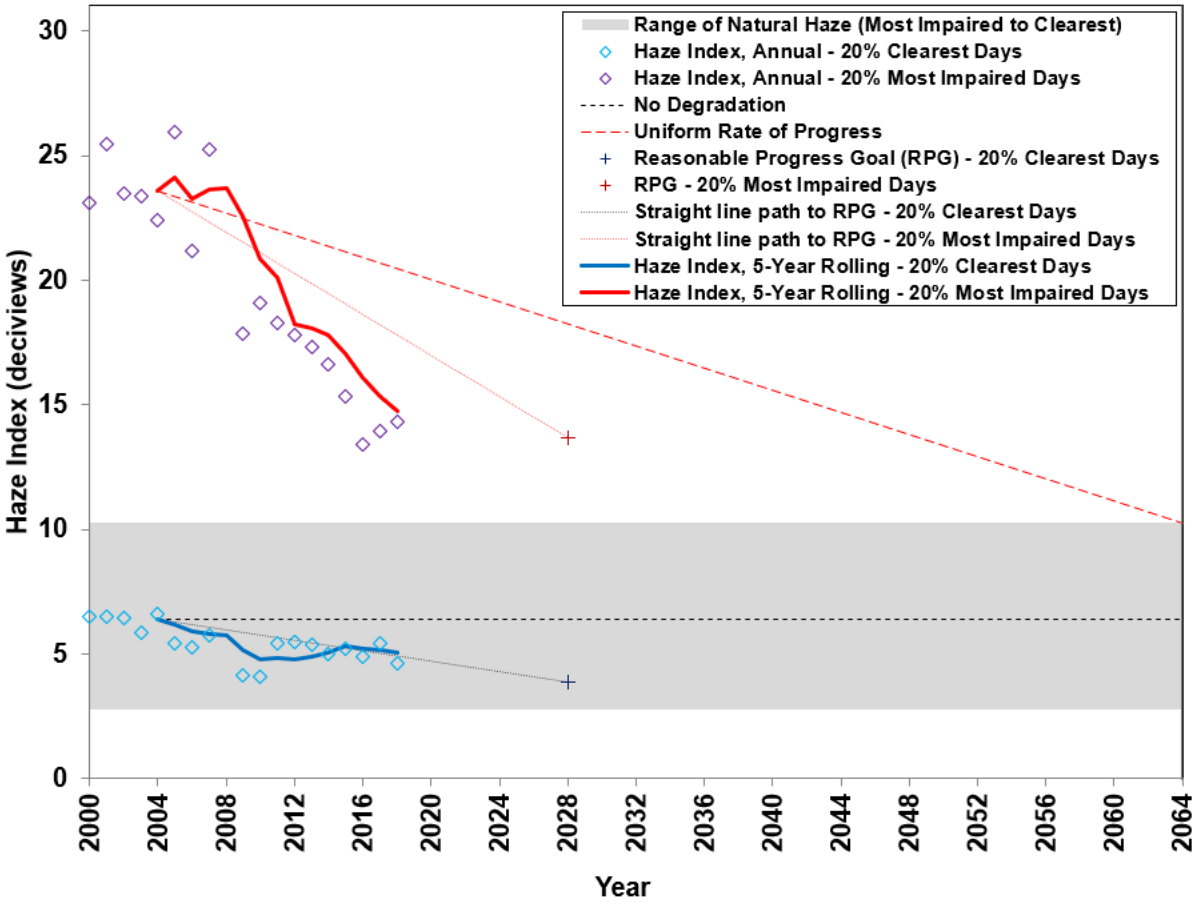

Figure 4-1: Visibility metrics at Lye Brook Wilderness Area.

The reasonable progress goals established for MANE-VU's Class I Areas, described later in Subsection 6 are expected to provide visibility improvements in excess of the uniform rates of progress shown above.

5 LONG-TERM STRATEGY FOR REGIONAL HAZE (40 CFR 51.308(f)(2))

According to 40 CFR 51.308(f)(2)(i), states must submit a Long-Term Strategy (LTS) that addresses regional haze visibility impairment for each mandatory Federal Class I area within the State and for each Federal Class I area located outside the State that may be affected by emissions from the State. In developing its LTS, states must determine the emission reduction measures that are necessary to make reasonable progress in visibility improvement. This assessment must consider four factors: the costs of compliance, the time necessary for compliance, the energy and non-air quality environmental impacts of compliance, and the remaining useful life of any potentially affected sources (40 CFR 51.308(f)(2)(i)). Vermont developed its long-term strategy with the MANE-VU, but also looked at its individual emissions to decide on what should proceed under a four-factor analysis.

Vermont believes the MANE-VU approach outlined below is a reasonable assessment for quantifying the impact of Vermont emissions on downwind states. Vermont has brought forward no specific point sources for analysis of control measures to make reasonable progress, because the highest NOx and SO2 emitters in the state have already been controlled by issuance of enforceable state air permits, which

require the use of ultra-low fuel oil, NOx RACT controls and other air pollution control technologies on a case-by-case basis. Based on a 5-year average (2013-2017), Vermont point sources contribute approximately 2% (approximately 328 tpy) of the state's NOx emissions, and 3% (approximately 74 tpy) of the SO2 emissions. See Section 5.7 for additional information on Vermont sources.

Class I states must have information that will be considered by contributing states so that during the interstate consultation process they can make reasonable asks for controls to be implemented. To achieve these two ends the MANE-VU Four-Factor/Contribution Assessment Workgroup, a subset of the Technical Support Committee, worked to collect the information and summarized it in a memo.[25]

As described in the above referenced memo, six sectors had emissions that were reasonably anticipated to contribute to visibility degradation in the MANE-VU region during the first regional haze planning cycle: EGUs, ICI boilers, cement kilns, heating oil use, residential wood combustion, and outdoor wood boilers.[26]

For the second implementation period, the MANE-VU Technical Support Committee began by analyzing monitored emissions data on the 20% most impaired days to determine what pollution is leading to anthropogenic visibility impacts. This was followed by screening for sources or source sectors that are leading to a majority of that impact. The results of this analysis would lead to the sources or source sectors for which a four-factor analysis was needed and which contributing states should be included in the interstate consultation process.

MANE-VU developed a conceptual model that aligns with IMPROVE data that indicates sulfates from sulfur dioxide (SO_2) emissions remain the primary driver behind visibility impairment in the region, while nitrates from NOx emissions play a more significant role than they had in the first planning period. MANE-VU chose to assess the contribution to visibility impairment by focusing on sulfates and including nitrates when feasible technically.

MANE-VU also examined annual inventories of emissions to find sectors that should be considered for further analysis.[27] EGUs emitting SO_2 and NOx and industrial point sources emitting SO_2 were found to be point source sectors of high emissions that warranted further scrutiny. Mobile sources were also found to be an important sector in terms of NOx emissions.

MANE-VU then initiated a process of screening states and sectors for contribution using two tools, Q/d and CALPUFF. Results of this contribution analysis were then compared to air mass trajectories for 20% most impaired days at the MANE-VU Class I Areas. The process is described in detail in Appendix E.

5.1 Sectors that Reasonably Contribute to Visibility Impairment

A state's LTS must include enforceable emission reduction measures necessary to make reasonable progress. The first long-term strategy covered the period ending in 2018, and subsequent revisions are to be completed every 10 years. A state's LTS should address all types of anthropogenic emissions contributing to visibility degradation in Federal Class I areas, including those from mobile sources;

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[25] Memo from MANE-VU Technical Support Committee to MANE-VU Air Directors, (March 2017). *Re: Four-Factor Data Collection* March 30, 2017. Appendix K.

[26] MARAMA, Mid Atlanta Regional Air Management Association, Inc., (July 2007). *Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas Final Report*. Available at https://marama.org/library/.

[27] Memo from MANE-VU Technical Support Committee to MANE-VU Air Directors, (October 2016). *RE: Contribution Assessment Preliminary Inventory Analysis*. Appendix H.

stationary sources (such as power plants and factories); smaller, so-called "area" sources (such as residential wood stoves and small boilers); and prescribed fires, then determine what reduction measures, if any, are needed to make reasonable progress. Sector level information needed to assess the four factors for emission sectors such as EGUs were updated through a contract with SRA International, Inc. and were posted to MARAMA's website (Sabo, E., January 2016)[28]

For the second planning period, MANE-VU found that the top emitters were the same source categories initially selected during the first planning period. Since a four-factor analysis was already performed for these sources in the first planning phase, MANE-VU, using a 2015 MARAMA analysis, updated the existing four-factor analysis and used it for the second planning period. This is consistent with EPA's 2019 guidance document, which states that a state may use a four-factor analysis from the first planning period. MANE-VU applied the four factors to a series of emission control measures (see Appendix K). During consultation with MANE-VU member states as well as contributing states, it was agreed that reasonable progress at this time can be achieved for EGUs, ICI boilers, reducing energy demand and encouraging clean energy development and use, in conjunction with a wider adoption of ultra-low sulfur fuel oil.

EGUs

Following an initial round of CALPUFF modeling using CAMD 2011 reported emissions, information was collated on the 444 EGUs that were determined to warrant further scrutiny based on their 2011 and 2015 emissions of SO_2 and NO_X. The 95th percentile of the maximum hourly 2015 emissions was used as the most recent information available at the time. Selection criteria are described in Appendix C.[29] Several sources of data were available to rely on for information on the capacity and installed controls on individual units. This included information from NEEDS v5.15,[30] ERTAC EGU v2.5L2,[31] data collection on NO_X controls conducted by Maryland Department of Environment, and MANE-VU's "167 Stack Retrospective."[32] The individual facility information is in the spreadsheet titled "EGU Data for Four-factor Analyses (Only CALPUFF Units)."[33] A synopsis of the collected information included in the 167-stack analysis is provided in Figure 5-1. A map that shows the locations of the EGUs assessed in the MANE-VU CALPUFF modeling is located in Figure 5-2.

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28 *2016 Updates to the Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas*. Appendix L.

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

30 EPA, (August 2015). *NEEDS v.5.15 User Guide, August 2015*. Available at: https://www.epa.gov/sites/production/files/2015-08/documents/needs_v515_user_guide_august_2015.pdf.

31 ERTAC, (December 2016). *Documentation of ERTAC EGU CONUS Versions 2.5 and 2.5L2*. Available at: https://marama.org/technical-center/ertac-egu-projection-tool/.

32 MANE-VU, (July 2016). *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*. Appendix M.

33 MANE-VU, (April 2017). *2016 MANE-VU Source Contribution Modeling Report: CALPUFF Modeling of Large Electrical Generating Units and Industrial Sources*. Available at: https://otcair.org/MANEVU/Upload/Publication/Reports/MANE-VU%20CALPUFF%20Modeling%20Report%20Draft%2004-4-2017.pdf

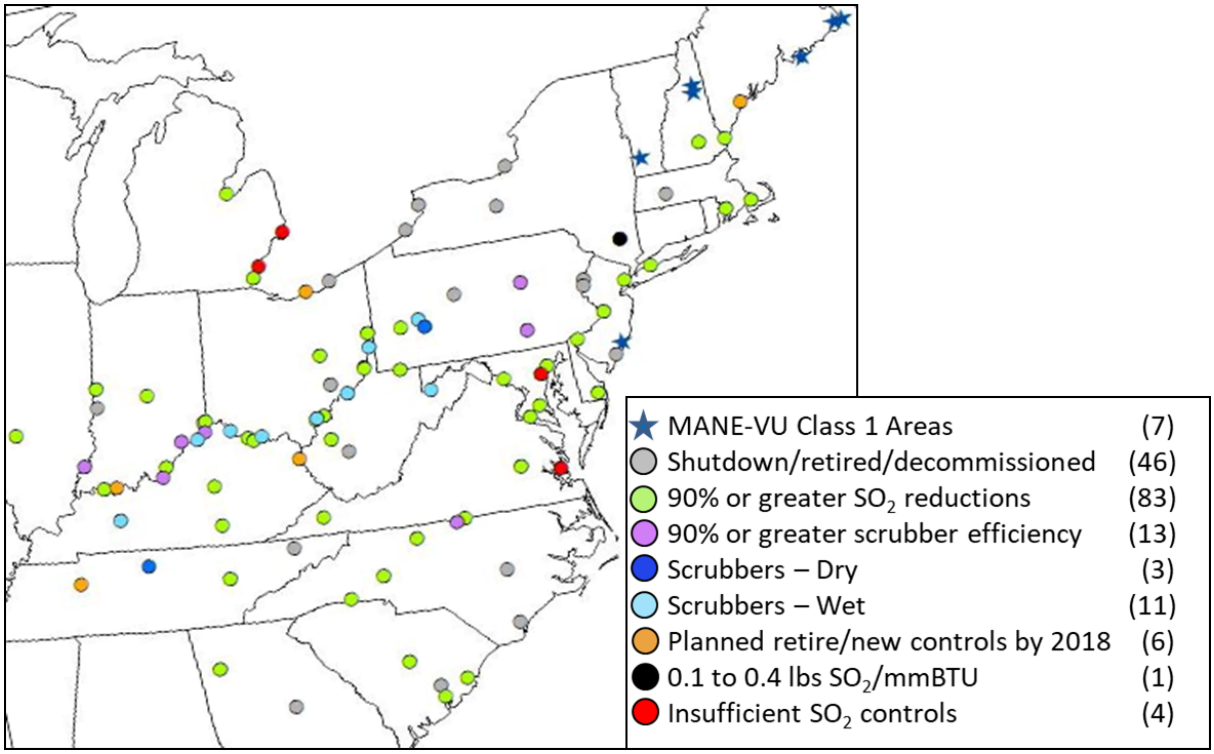

Figure 5-1: Status of controls at top 167 EGUs.

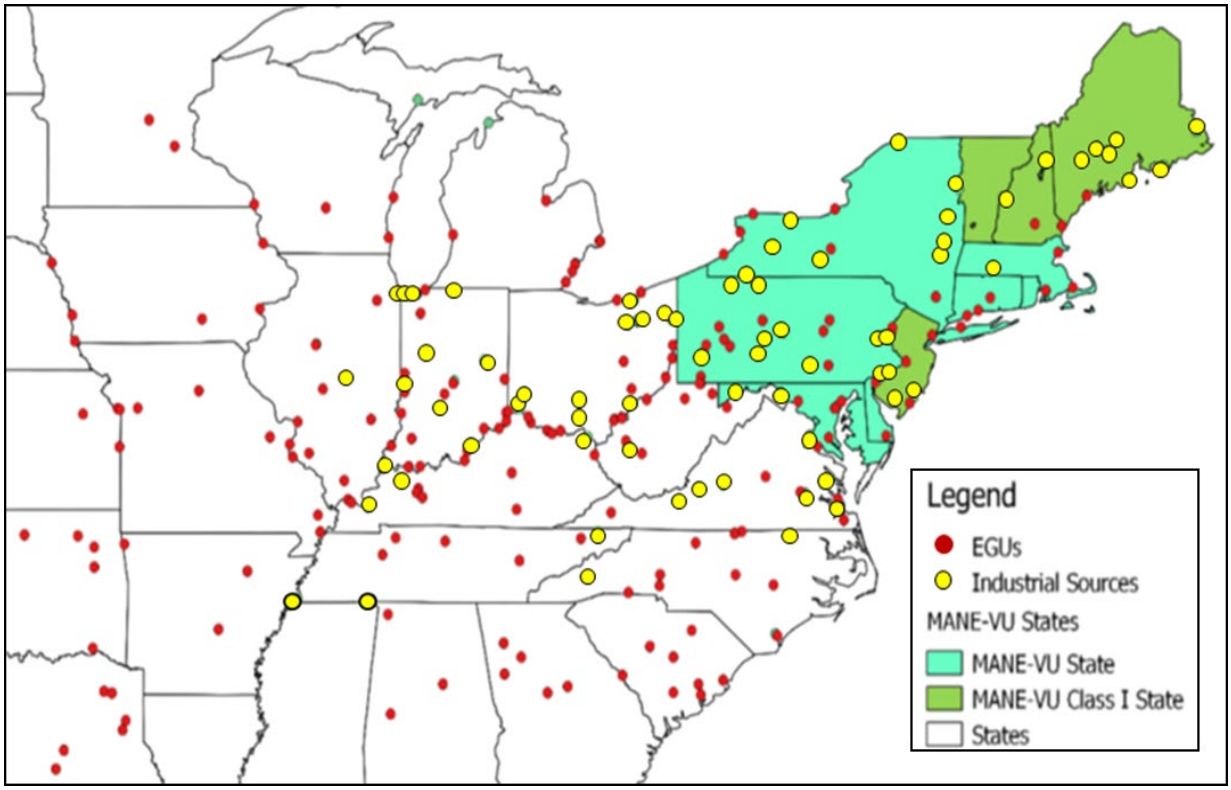

Figure 5-2: EGUs and industrial sources included in information request.

ICI Boilers

Information was also collected for facilities with ICI boilers that had emissions comparable to EGU units modeled for contributing states. Additional units were added based on close proximity to a MANE-VU Federal Class I area, which comprised a top 50 list. Later in the data collection process, the number of sources was limited to only sources that cumulatively contributed to roughly 50% of the impairment. The facilities are listed in Table 5-1 with information on 2011 SO_2 and NOx emissions and number of Class I sites affected. These facilities were then modeled for Class I visibility impacts with CALPUFF based on 2011 estimated typical daily emissions. See Figure 5-2 for location of the facilities.

Cement Kilns

Control factors are the defaults for cement kilns found in MARAMA's installation of the EMF system and represent control costs found in EPA's CoST Manual.[34] Concerning data for individual point sources, cement kilns were included in the Q/d analysis to determine the industrial sources with the most impact on Federal Class I areas. As a result, data were collected on individual cement kilns and the cement kilns in the list of the 82 industrial sources modeled with CALPUFF. Cement kilns were also modeled with estimated 2011 typical daily emissions.

Table 5-1 - 82 Industrial Sources Evaluated for Impact at MANE-VU Class I Areas.

State	Facility ID	Facility Name	2011 SO_2 (tons)	2011 NO_X (tons)	#Sites Top 50[a]	#Sites ≥ 50%[b]
IL	7793311	Tate & Lyle Ingredients Americas, LLC	3,992.3	374.8	5	3
IL	8065311	Aventine Renewable Energy Inc.	12,200.6	1,518.9	5	5
IN	3986511	Indiana Harbor East	2,873.8	4,812.7	5	0
IN	4553211	Indiana University	1,443.9	325.5	1	0
IN	4873211	Ball State University	2,046.0	251.0	4	0
IN	4885311	Citizens Thermal	4,348.8	1,422.6	5	4
IN	5552011	University of Notre Dame Du Lac	1,643.9	579.3	2	0
IN	7364611	Sabic Innovative Plastics Mt. Vernon, LLC	4,915.6	1,798.9	5	4
IN	7376411	Tate & Lyle, Lafayette South	2,296.5	491.3	4	0
IN	7376511	ArcelorMittal Burns Harbor Inc.	13,842.8	8,289.3	5	5
IN	8181811	Alcoa Inc., Warrick Operations	3,897.8	331.6	5	2
IN	8192011	US Steel, Gary Works	4,201.8	4,313.5	5	3
IN	8198511	ESSROC Cement Corp	1,544.6	1,152.5	1	0
IN	8223611	Eli Lilly & Co., Clinton Labs	1,775.1	592.5	2	0
KY	6096411	E I DuPont, Inc.	1,519.1	3.9	1	0
KY	7352311	Century Aluminum Sebree, LLC	4,193.4	74.9	5	2
KY	7365311	Isp Chemicals Inc.	1,976.0	288.2	1	0
MA	7236411	Solutia, Inc.	629.7	332.0	2	0
MD	6117011	Naval Support Facility, Indian Head	510.0	130.0	1	0
MD	7763811	Luke Paper Company	22,659.8	3,607.0	5	5
MD	8239711	Sparrows Point, LLC	870.6	1,165.6	1	1
ME	5253911	Madison Paper	755.3	179.6	2	0

[34] EPA, (June 9, 2010 updated February 23, 2016). *Control Strategy Tool (CoST) Development Documentation*. Available at: https://www3.epa.gov/ttn/ecas/docs/CoST_DevelopmentDoc_02-23-2016.pdf#:~:text=The%20Control%20Strategy%20Tool%20%28CoST%29%20is%20a%20software,generate%20emission%20inventories%20with%20the%20control%20scenarios%20applied.

State	Facility ID	Facility Name	2011 SO_2 (tons)	2011 NO_X (tons)	#Sites Top 50[a]	#Sites ≥ 50%[b]
ME	5691611	Huhtamaki Inc., Waterville	202.1	33.8	1	0
ME	5692011	FMC Biopolymer	558.7	171.9	2	0
ME	5974211	Woodland Pulp, LLC	489.7	1,096.9	2	0
ME	7764711	Verso Paper, Androscoggin Mill	449.6	928.8	2	0
ME	7945211	The Jackson Laboratory	19.7	12.9	1	0
ME	8200111	Sappi, Somerset	766.3	2,061.4	2	0
MI	8126511	Escanaba Paper Company	2,196.2	2,553.3	2	0
MI	8160611	St. Mary's Cement, Inc. (U.S.)	1,942.3	1,996.1	2	0
MI	8483611	US Steel, Great Lake Works	5,603.9	2,141.6	5	5
NC	7920511	Blue Ridge Paper Products, Canton Mill	8,511.9	3,955.5	5	5
NC	8048011	KapStone Kraft Paper Corporation	880.8	1,412.9	1	0
NC	8122511	DAK Americas, LLC	2,028.3	1,112.6	1	0
NH	7199811	Dartmouth College	308.9	113.2	1	0
NH	7866711	Gorham Paper & Tissue, LLC	127.0	42.8	1	0
NJ	12804611	Gerresheimer Moulded Glass	102.9	252.3	1	0
NJ	8093211	Atlantic County Utilities Authority Landfill	21.5	10.9	1	0
NY	7814711	Morton Salt Division	1,332.5	212.5	4	1
NY	7968211	Alcoa, Massena Operations (West Plant)	2,468.0	196.1	4	2
NY	7991711	International Paper Ticonderoga Mill	1,045.6	698.9	4	3
NY	8090911	Norlite Corporation	124.9	80.7	1	0
NY	8091511	Kodak Park Division	4,291.9	2,592.8	5	5
NY	8105211	Lafarge Building Materials, Inc.	9,570.0	4,926.5	5	5
NY	8176611	Cargill Salt Co – Watkins Glen Plant	908.8	184.9	3	0
NY	8325211	Finch Paper LLC	309.6	1,828.7	1	1
OH	15485811	Fluor-B&W Portsmouth LLC	1,495.2	175.9	1	0
OH	7219511	Youngstown Thermal	1,063.3	122.5	1	0
OH	7416411	Cargill, Incorporated - Salt Division (Akron)	1,516.3	140.1	4	0
OH	7997111	Morton Salt, Inc.	4,434.0	194.7	5	5
OH	8008811	AK Steel Corporation	2,046.0	2,276.2	4	0
OH	8063611	BDM Warren Steel Operations, LLC	1,918.0	238.2	5	0
OH	8130511	Kraton Polymers U.S. LLC	2,207.5	560.4	5	1
OH	8131111	P. H. Glatfelter Company - Chillicothe Facility	19,696.9	2,093.3	5	5
OH	8170411	City of Akron Steam Generating	1,728.9	253.7	5	0
OH	8252111	The Medical Center Company	2,133.1	204.1	5	2
OH	9301711	DTE St. Bernard, LLC	2,033.1	737.4	3	0
PA	3186811	Penn State University	1,444.6	243.0	5	0
PA	3881611	Hercules Cement CO LP/Stockertown	1,420.0	988.8	5	1
PA	4966711	United Refining CO/Warren PLT	992.0	370.5	2	0
PA	6463511	PPG Ind/Works No 6	680.9	4,592.7	1	0
PA	6532511	Amer Ref Group/Bradford	1,018.7	295.8	3	0
PA	6582111	Intl Waxes Inc./Farmers Valley	1,754.7	433.8	5	3
PA	6582211	Keystone Portland Cement/East Allen	983.5	828.3	3	0
PA	6652211	Phila Energy Sol Ref/PES	297.1	1,315.1	1	0
PA	7409311	USS Corp/Edgar Thompson Works	1,279.0	275.1	4	0
PA	7872711	MILL Appleton Papers/Spring Mill	1,046.4	394.4	2	0
PA	7873611	Sunoco Inc. (R&M)/Marcus Hook Refinery	2,043.7	1,490.4	5	2
PA	8204511	USS/Clairton Works	1,467.5	3,074.9	4	0

State	Facility ID	Facility Name	2011 SO_2 (tons)	2011 NO_X (tons)	#Sites Top 50[a]	#Sites ≥ 50%[b]
PA	9248211	Team Ten/Tyrone Paper Mill	2,181.0	285.6	5	1
TN	3982311	Eastman Chemical Company	22,024.2	9,113.4	5	5
TN	4963011	Packaging Corporation of America	2,400.6	1,534.0	1	0
TN	5723011	Cargill Corn Milling	3,007.0	566.8	2	0
VA	4182011	Smurfit Stone Container Corporation - West Point	907.9	1,906.4	1	0
VA	4183311	GP Big Island LLC	1,143.3	481.2	1	0
VA	4938811	Huntington Ingalls Incorporated -NN Shipbldg Div	805.1	301.0	1	0
VA	5039811	Roanoke Cement Company	1,917.7	1,652.1	4	1
VA	5748611	Radford Army Ammunition Plant	2,888.0	1,274.0	5	1
VA	5795511	Philip Morris USA Inc. - Park 500	681.1	438.2	1	0
WV	4878911	Dupont Washington Works	2,102.5	1,089.5	5	1
WV	4987611	Capitol Cement – ESSROC Martinsburg	1,280.1	1,495.5	3	1
WV	5782411	Bayer Cropscience	2,265.4	1,826.5	5	1

a Number of monitored MANE-VU Class I areas for which the facility is in the top 50 contributors

b Number of monitored MANE-VU Class I areas for which the facility made up 50% of the contribution

Heating Oil, Residential Wood Stoves, and Outdoor Wood-fired Boilers

Sector level information needed to assess the four factors for heating oil, residential wood stoves and outdoor wood-fired boilers was updated. As part of the contract to update MARAMA's EMF system, information on the cost of controls was updated to allow for states to have access to more recent information if they opt to use EMF for this purpose. The full list of updated control factors are included in Appendix L, "2016 Updates to the Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas."[35] Since heating oil, RWS and OWB are area sources, no specific point source data were collected.

5.2 Interstate Consultation

Vermont consulted with other states as identified in Section 3.2.1 in accordance with 40 CFR 51.308(f)(ii) which reads, *"State must consult with those States that have emissions that are reasonably anticipated to contribute to visibility impairment in the mandatory Class I Federal area to develop coordinated emission management strategies containing the emission reductions necessary to make reasonable progress."* The consultation process undertaken for the second implementation period is described in detail in Appendix G.

According to the Regional Haze Rule (40 CFR 51.308 (f)(2)(i) through (iv)), all states must consider, in their regional haze SIPs, the emission reduction measures identified by Class I States as being necessary to make reasonable progress in any Federal Class I area. After reviewing the four-factor analysis, each MANE-VU Class I member states determined its reasonable measures to begin consultation with all MANE-VU states (Intra-RPO consultation) and then with other contributing states (Inter-RPO consultation). These measures (identified as reasonable by the MANE-VU Class I states) were the basis of the MANE-VU "Asks" to be discussed during consultation. The "Ask" was divided into three parts, the

35 Sabo E., (January 2016). *2016 Updates to the Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas*. Appendix L.

"Intra-RPO Ask" for Intra-MANE-VU consultation, the "Inter-RPO Ask" for consultation with non-MANE-VU contributing states, and the Ask specific to FLMs and EPA. These Asks were adopted by MANE-VU Class I States on August 25, 2017, and are included in Appendices N, O and P.

The MANE-VU Ask focuses on what MANE-VU Class I states identified as reasonable measures to apply over the Northeast region and contributing states. The states focused on controls for SO_2 and NOx emissions (which also form particles) as being the most reasonable measures to apply at this time while Federal Class I areas are already ahead of their uniform rate of progress requirements. Additional measures for other emissions sources, including visibility-impairing particulate matter emission sources, can be assessed individually by states, EPA and the FLMs.

Vermont has included in this implementation plan all measures agreed to during state-to-state consultations and emission reduction measures identified by other states. During consultation, other states did not disagree with the MANE-VU requests nor raised objections about the ability to complete them.

5.3 The MANE-VU Intra-RPO "Ask"

The "Intra-RPO Ask" is intended for the MANE-VU states and tribes that contribute to MANE-VU's Class I Areas and should be addressed in those state's regional haze SIP updates.[36] Portions of the Intra-RPO Ask are shown below:

"To address the impact on mandatory Class I Federal areas within the MANE-VU region, the Mid-Atlantic and Northeast States will pursue a coordinated course of action designed to assure reasonable progress toward preventing any future, and remedying any existing impairment of visibility in mandatory Class I Federal areas and to leverage the multi-pollutant benefits that such measures may provide for the protection of public health and the environment. Per the Regional Haze Rule, being on or below the uniform rate of progress for a given Class I area is not a factor in deciding if a State needs to undertake reasonable measures."

"In addressing the emission reduction strategies in the Ask, the MANE-VU states will need to harmonize any activity on the strategies in the Ask with other federal or state requirements that affect the sources and pollutants covered by the Ask. These federal and state requirements include, but are not limited to:

- The 2010 SO_2 standard,
- The Regional Greenhouse Gas Initiative (RGGI), if applicable,
- The Mercury and Air Toxics Standards (MATS), and
- The new 2015 ozone standard.

Because of this need for cross-program harmonization and because of the formal public process required by the federal CAA and state rulemaking processes, it is expected that there will be opportunities for stakeholders and the public to comment on how states intend to address the measures in the Ask.

Therefore, the course of action for pursuing the adoption and implementation of measures necessary to meet the 2028 reasonable progress goal for regional haze include the following "emission management"

[36] MANE-VU, (August 2017). *Statements of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) States Concerning a Course of Action within MANE-VU Toward Assuring Reasonable Progress for the Second Regional Haze Implementation Period (2018-2028)*. Appendix N.

strategies:

1. *Electric Generating Units (EGUs) with a nameplate capacity larger than or equal to 25MW with already installed NOx 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[37], or obtain equivalent alternative emission reductions;*
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 perform a four-factor analysis for reasonable installation or upgrade to emission controls;"*

The MANE-VU states set a visibility-impairment threshold of three inverse megameter (Mm^{-1}) at any MANE-VU Class I area to differentiate the largest sources potentially affecting visibility at any MANE-VU Class I area. By requesting a four-factor analysis of these sources, a planned shutdown, or other factors, may be considered when determining what installation or upgrade of controls would be reasonable.

Additional elements of the Intra-RPO Ask include:

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.*
4. *EGUs and other large point emission sources greater 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;*
5. *Where emission rules have not been adopted, control NOx emissions for peaking combustion turbines that have the potential to operate on high electric demand days by:*
    a. *Striving to meet NOx 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 NOx 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[38], 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."*

Ask #5 is only directed to the MANE-VU states and is not included in the "Ask" directed to upwind, potentially contributing states. It targets relatively small electric generating units that operate during a small proportion of the year on high electric demand days, but that tend to have higher emission rates per unit of energy produced. Targeting these units is considered reasonable due to MANE-VU analyses

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37 MANE-VU TSC (November 2017). *Impact of Wintertime SCR/SNCR Optimization on Visibility Impairing Nitrate Precursor Emissions.* Appendix Q.

38 This emission level was determined by MANE-VU to be a reasonable threshold based on emission requirements already developed by member states.

that show correlation between high electric demand days and the 20% most impaired days [39]. The values included in the Ask are consistent with values used by MANE-VU states that have already tightened emission requirements of such units. While this reasonable measure was developed to assist in achieving the ozone NAAQS, it also has added benefits to reducing visibility impairing pollutants as well and should be considered a reasonable measure for regional haze reduction as well.

Finally, the Intra-RPO Ask includes:

> *"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."* [40]

5.4 The MANE-VU Inter-RPO "Ask"

MANE-VU identified the following states outside of MANE-VU as contributing to visibility impairment at MANE-VU Class I areas: Alabama, Florida, Illinois, Indiana, Kentucky, Louisiana, Michigan, Missouri, North Carolina, Ohio, Tennessee, Texas, Virginia and West Virginia. Therefore, these states should address the MANE-VU Inter-RPO "Ask" in their regional haze SIP updates in addition to any other Federal Class I area state "Ask".[41] Contributing state methodology is documented in Section 3 and the MANE-VU report, *Selection of States for MANE-VU Regional Haze Consultation (2018)* (Appendix E), using actual 2015 emissions for EGUs and 2011 for other emission sources.

The text of the Inter-RPO Ask is as follows:

"In addressing the emission reduction strategies in the Ask, states will need to harmonize any activity on the strategies in the Ask with other federal or state requirements that affect the sources and pollutants covered by the Ask. These federal and state requirements include, but are not limited to:

- The 2010 SO_2 standard,
- The Regional Greenhouse Gas Initiative (RGGI), if applicable,
- The Mercury and Air Toxics Standards (MATS), and
- The new 2015 ozone standard.

Because of the need for cross-program harmonization and because of the formal public process required by the federal CAA and state rulemaking processes, it is expected that there will be opportunities for stakeholders and the public to comment on how states intend to address the measures in the Ask.

To address the impact on mandatory Class I Federal areas within the MANE-VU region, the Mid-Atlantic and Northeast States will pursue a coordinated course of action designed to assure reasonable progress toward preventing any future, and remedying any existing impairment of visibility in mandatory Class I Federal areas and to leverage the multi-pollutant benefits that such measures may provide for the protection of public health and the environment.

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39 MANE-VU, (December 2017). *High Electric Demand Days and Visibility Impairment in MANE-VU*. Appendix R.

40 MANE-VU TSC, (March 2016). *Benefits of Combined Heat and Power Systems for Reducing Pollutant Emissions in MANE-VU States*. Appendix S.

41 MANE-VU, (August 2017). *Statements of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) States Concerning a Course of Action in Contributing States Located Upwind of MANE-VU Toward Assuring Reasonable Progress for the Second Regional Haze Implementation Period (2018-2028)*. Appendix O.

Therefore, the course of action for pursuing the adoption and implementation of measures necessary to meet the 2028 reasonable progress goal for regional haze include the following "emission management" strategies:

1. *Electric Generating Units (EGUs) with a nameplate capacity larger than or equal to 25MW with already installed NOx 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;*
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 table 5-2] – perform a four-factor analysis for reasonable installation or upgrade to emission controls;"*

Table 5-2: 14 EGU and Industrial Units Located Outside the MANE-VU Region with MANE-VU Screening Modeling Exceeding 3.0Mm^{-1} at a MANE-VU Class I Area

State	Facility Name	Facility/ORIS ID	Unit IDs	MANE-VU Class 1 Maximum Extinction (dv)
IN	Rockport	6166	MB1, MB2	3.8
KY	Big Sandy	1353	BSU1, BSU2	3.5
MI	Belle River		2	4.0
MI	Belle River		1	3.7
MI	St. Clair	1743	1,2,3,4,5,6	3.1
OH	Avon Lake Power Plant	2836	12	9.2
OH	Gen J M Gavin	8102	1	3.3
OH	Gen J M Gavin	8102	2	3.1
OH	Muskingum River	2872	5	7.7
OH	Muskingum River	2872	1,2,3,4	4.4
VA	Yorktown Power Station	3809	3	10.9
VA	Yorktown Power Station	3809	1,2	7.0
WV	Harrison Power Station		1 (25%), 2 (20%)	7.0
WV	Kammer	3947	1,2,3	3.2

3. *States should pursue an ultra-low sulfur fuel oil standard similar to the one adopted by the MANE-VU States in 2007 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.*
4. *EGUs and other large point emission sources greater 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;*

5. *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."* [42]

5.5 The MANE-VU EPA and FLM "Ask"

The transport range of visibility impairing pollutants has been demonstrated to be extensive and well beyond the MANE-VU region. For example, recent wildfires in the western U.S. in 2021 brought visibility impairing fine particulate matter and ozone over 3,000 miles into the region at concentrations that contributed to exceedances of the health standard in some locations. Clearly, states located beyond those that MANE-VU chose to consult for regional haze can potentially influence visibility at the MANE-VU Class I areas. Further, while on-road vehicles produce a significant portion of the visibility impairing pollutants that affect our Class I areas, they are beyond the states' authority to regulate. Therefore, the MANE-VU Class I area states need additional help from the Environmental Protection Agency and Federal Land Managers in pursuing important reasonable emission control measures.[43] These include, but are not limited to, the following requests contained in the 2017 MANE-VU letter regarding actions that EPA and the FLMs can take to help MANE-VU further improve visibility in our Class I areas:

1. *Federal Land Managers to consult with MANE-VU Class I area states when scheduling prescribed burns and ensure that these burns do not impact nearby IMPROVE visibility measurements and do not impact potential 20 percent most and least visibility impaired days;*
2. *EPA to develop measures that will further reduce emissions from heavy-duty on-road vehicles; and*
3. *EPA to ensure that Class I Area state "Asks" are addressed in "contributing"' state SIPs prior to approval. In the case of this "Ask", contributing states are defined as those that the MANE-VU Class I area states requested for consultation.*

5.6 Technical Basis for the MANE-VU "Ask"

The MANE-VU TSC in conjunction with the OTC Modeling Committee, performed photochemical modeling in support of MANE-VU's Regional Haze objectives and to fulfill the technical basis requirement of 40 CFR 51.308(f)(2)(iii). Modeling to determine the RPGs for Lye Brook Wilderness included measures documented in the Asks and documented in the modeling Technical Support Document.[44] Modeled RPGs are shown in Figure 4-1 earlier in this document.

In addition to modeling 2028 visibility improvement resulting from implementation of the Asks, MANE-VU expects those incremental reductions in $PM_{2.5}$ and ozone will result in improved public health and a

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42 MANE-VU TSC, (March 2016). *Benefits of Combined Heat and Power Systems for Reducing Pollutant Emissions in MANE-VU States*. Appendix S.

43 MANE-VU, (August 2017). *Statements of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) States Concerning a Course of Action by the Environmental Protection Agency and Federal Land Managers Toward Assuring Reasonable Progress for the Second Regional Haze Implementation Period (2018-2028)*. Appendix P.

44 OTC/MANE-VU, (October 2018). *Ozone Transport Commission/Mid-Atlantic Northeastern Visibility Union 2011 Based Modeling Platform Support Document – October 2018 Update*. Available at: https://otcair.org/MANEVU/Upload/Publication/Reports/OTC MANE-VU 2011 Based Modeling Platform Support Document October 2018 - Final.pdf. See also Appendix U.

lower mortality rate in contributing states as well as MANE-VU states with Class I areas.

5.7 Additional Factors Considered in Developing the LTS

In accordance with 40 CFR 51.308(f)(2)(iv), Vermont considered the following additional factors:

Emission reductions due to ongoing air pollution control programs, including measures to address reasonably attributable visibility impairment.

Vermont adopted federal *Nitrogen Oxides (NOx) Reasonably Available Control Technology (RACT)*. The amended rule was submitted to the EPA as a SIP revision and approved by EPA November 26, 2019 (84 FR 65009). Vermont point source emissions of NOx amounted to only 2% of all NOx emissions in the state even before adoption of NOx RACT.

NOx RACT has been employed for the McNeil electrical generating station (fired with wood, distillate fuel oil, and natural gas), using selective catalytic reduction (SCR). McNeil is the largest NOx emitter in the state, at 130 tpy (2013-2017 average), which is 10-100 lower emissions of NOx than other point source emissions used in the modeling. See Appendix W for the McNeil Operating Permit, which has extensive discussion on the use of air pollution controls.

Regarding sulfur dioxide, the top five SO2 emitters in the state combined emit 75 tpy. Vermont has long recognized that residential combustion of fuel oil is a significant contributor in Vermont (at approximately 84% as of 2017). Accordingly, Vermont committed to adopt the MANE-VU low-sulfur fuel oil strategy put forth in Vermont's Regional Haze SIP for the first implementation period. New limitations on sulfur in fuel were adopted on September 28, 2011, in Vermont's Air Pollution Control Regulations (VT APCR §5-221(1), to take effect in two phases. The first phase began in 2014 and lowered the allowable concentration of sulfur in No. 2 and lighter distillate fuels to 0.05% (500ppm) by weight. The second phase took effect in 2018 (i.e. the beginning of the Second Implementation Period), which further lowered the sulfur limit to 0.0015% (15 ppm) by weight, lowered the sulfur limit for No. 4 residual oils to 0.25% (2500 ppm) by weight and lowered the sulfur limit for No. 5 and No. 6 residual oils, heavier residual oils, and used oils to 0.5% (5000 ppm) by weight.

While Vermont is limited in its authority over mobile source emissions, Vermont adopted in December 2022 amendments to the Low Emission Vehicle (LEV) and Zero Emission Vehicle (ZEV) rules, which incorporate by reference California's motor vehicle emission standard regulations. Vermont has also adopted the California Advance Clean Cars II, Advanced Clean Trucks, Low NOx Heavy-Duty Omnibus and the Phase 2 Greenhouse Gas rules. When performing modeling of emission impacts in the MANE-VU region, it was estimated that Vermont NOx emissions from the mobile source sector could have a small impact on New Hampshire's Class I sites. Vermont is committed to reducing mobile source emissions to reduce greenhouse gas emissions, hazardous air contaminants, and visibility effects, both in Vermont and to reduce impacts to other states.

Measures to mitigate the impacts of construction activities.

The construction industry is already subject to requirements for controlling pollutants that contribute to visibility impairment. For example, federal regulations require the reduction of SO_2 emissions from construction vehicles. Generally, crustal material plays a very small role in visibility impairment in Lye Brook Wilderness. Vermont has considered additional measures to

mitigate the impacts of construction activities but has decided to defer evaluation of further controls.

Source retirement and replacement schedules.

Vermont point source emissions were considered too small to have a significant impact on Class I sites in MANE-VU. Any source retirement or replacement will result in incremental local benefits but not impact Class I sites.

Basic smoke management practices for prescribed fires.

Based on emission inventories, fine particulate matter associated with wood smoke is largely due to residential wood combustion, open burning, and industrial/commercial/institutional wood combustion. Wildfire emissions within Vermont and other MANE-VU states are also relatively small and infrequent contributors to regional PM emissions. However, Lye Brook and other MANE-VU Class I areas are impacted by wildfire smoke emissions from other regions, such as from the numerous western and Canadian wildfires of the last several years. Vermont will continue to review the impacts from agricultural use of fire and prescribed fire for forest and ecosystem management. If these impacts become important for maintaining reasonable progress in the future, revisions to the SIP will include a smoke management plan. Vermont will continue to consult with the U.S. Forest Service regarding potential impacts of prescribed fire on visibility in the Lye Brook Wilderness.

The anticipated net effect on visibility due to projected changes in point, area, and mobile source emissions.

As the new mobile source regulations stated above go into effect, emissions of NOx will decrease by 2028 and into the next implementation period. The Global Warming Solutions Act will impact area source emissions as well. These reductions will provide reasonable progress in improving visibility in downwind states.

5.8 Vermont's Long-Term Strategy - Meeting the "Ask" and reducing NOx and SO2 emissions

Analysis of top five SO2 and NOx emitters in Vermont (2013-2017 actual emissions, averaged) was done to determine whether additional controls could be employed. The top SO2 emitter is **Coventry Clean Energy Corporation**, which converts collected landfill gas (LFG) to electricity, with the engines functioning as a control device for LFG generated by the Coventry Landfill, the only operating municipal landfill in Vermont. The engines are used as control devices for LFG and non-methane organic compounds (NMOCs) contained in the LFG, with a specified 98% in the amounts of LFG and NMOCs. This facility meets Federal municipal landfill requirements as well as Vermont's requirements. The engines used for electricity generation are 2005 vintage or newer, and fired with landfill gas that is dried, filtered, and treated to remove some portion of the siloxanes in the LFG. The removal of all the siloxanes is not technically possible, given their variable concentrations and compositions in the LFG. The permit limits SO2 emissions to less than 40 tons per year, and the facility averages 22 tpy for actual emissions. This facility is also the fifth highest NOx emitter in the state, with actuals currently estimated at 33 tons per year as compared to the permit limit of less than 99 tpy. Controls at this facility are considered the best available currently. New England Waste Services of Vermont (NEWSVT) is currently proposing to install an H_2S removal system on the LFG supply system to the engines, to ensure that sulfur containing materials recently disposed of

in the Landfill after this summer's flooding do not result in the exceedance of the 40 ton/year SO_2 limit. The second highest emitter of SO2 is **Kent Nutrition Group, LLC**, which manufactures animal feed. The boilers used in the process are fired by LPG, natural gas, and fuel oils #2 and #6; low sulfur fuels are required. Cyclones and baghouses are used for particulate control. The permit limits sulfur dioxide to 24 tpy, and NOx to 7 tpy, and actual emissions are less than that. Given permitted controls on the amount of product produced and the annual heat input used and pollution control equipment already employed, further reduction of air pollutants would be limited. The third highest emitter of SO2 is **Blue Spruce Farm Inc.**, which uses a 2019 LPG-fired animal incinerator. SO2 emitted averages 12 tons per year. Currently, Blue Spruce Farm is operating a biological scrubber which has shown an average reduction in H2S concentration of 60 percent or greater. Other anaerobic digesters in Vermont have been experimenting with dosing the digester with ferric chloride in an attempt to reduce hydrogen sulfide concentrations. **Berkshire Cow Power, LLC** is the fourth highest emitter of SO2 at 12 tpy. This facility has a manure digester that turns methane into biogas to produce electricity, using 2 engines and a flare for destruction of air pollutants when the engines are not operating. There is no scrubber at Berkshire Cow Power. The Agency is not aware of whether the farm is employing ferric chloride dosing of the digester at this time. **Vermont Technical College** uses boilers primarily firing #4 oil at their heating plant and is required to use low sulfur fuel oil. As the fifth highest emitter of SO2, they emit 11 tons per year.

The top NOx emitter is **Burlington Electric Department (J. McNeil Electric Generating Station)**, at 130 tpy, is a multi-fueled (wood, oil, natural gas) electric power generating station. McNeil has selective catalytic reduction for NOx control (NOx RACT), to qualify for Class I renewable energy credits in New England. Low NOx burners are in use when firing natural gas. Emission limitations for NOx are set at 0.075 lbs/MMBtu. SO2 control is due to use of wood as primary fuel and low sulfur #2 fuel oil, at 0.0015 lbs/MMBtu.
The second highest NOx emitter is **Ryegate Associates, LLC**, at 82 tpy, and it is a wood-fired electric power generating station, which has NOx RACT installed (SNCR and SCR) to qualify for Class I renewable energy credits in New England. Emission limitation is 0.15 lbs/MMBtu. The third highest NOx emitter, at 49 tpy, is **Middlebury College**, burns primarily biomethane and natural gas. The facility has emission limitations of 0.48 lbs/MMBtu for 3 of the boilers, and 0.37 lbs/MMBtu for the low NOx burner on a fourth boiler. The wood chip boiler has no limitation of the rate of NOx emissions but does have filter fabric particulate matter controls. Fourth is **Westrock Converting LLC**, a paperboard manufacturer that uses natural gas and #6 oil, and averages 34 tpy of NOx emissions. Westrock plans to replace the existing boilers with new units in 2024 and will no longer have capability of firing #6 fuel oil. Fifth is the Coventry Clean Energy facility, discussed above. The presence of siloxanes in the LFG would likely render any SCR treatment for NOx reductions ineffective after a short period of time. When they are oxidized, siloxanes deposit a coating of silicon dioxide on catalyst surfaces, preventing the catalyst from facilitating the reduction reactions of air contaminants.

Vermont's Long-Term Strategy incorporates MANE-VU work, and reductions from its mobile source program. As part of meeting the MANE-VU Ask, Vermont compiled a list of emission sources and energy conserving programs that meet the specifications cited in the Ask. VTDEC evaluated the current regulatory requirements, enforceable emission limitations contained in permits and RACT Orders and existing control equipment in place at these sources. Finally, VTDEC requested additional information including a four-factor analysis from Green Mountain Power (see Appendix T). The MANE-VU Ask as it applies to Vermont seeks full implementation by 2028.

Ask 1

Vermont DEC identified McNeil Generating Station of the Burlington Electric Department, a biomass-fired EGU, as the only source in Vermont meeting the criteria of Ask #1, having a nameplate capacity of 50 MW and already installed NOx and SO_2 controls. McNeil is required to operate its control technologies on a year-round basis. At all times, including periods of startup, shutdown, and malfunction, owners and operators shall, to the extent practicable, maintain and operate any affected facility including associated air pollution control equipment in a manner consistent with good air pollution control practice for minimizing emissions. The operating permit for McNeil Generating Station contains a discussion of NOx RACT (see Appendix W). Vermont has met Ask #1 because applicable sources already effectively use NOx and SO_2 controls year-round.

Ask 2

Vermont has no sources modeled by MANE-VU to impact visibility at any Class I Federal area by 3.0 Mm-1 or more; therefore, Vermont has met "Ask 2."

Ask 3

Vermont has fully implemented an ultra-low sulfur fuel oil standard meeting Ask #3, as described in Section 5.7; therefore, Vermont has met Ask #3.

Ask 4

There are no sources in Vermont that meet the criteria of Ask #4.

Ask 5

Vermont has not adopted emission rules that meet the stringency of item 5.a. of the MANE-VU Ask; therefore, the Vermont DEC investigated which sources in the state match the definition of peaking combustion turbine in the Ask and determined that Green Mountain Power gas turbine Unit No. 5 in Berlin, VT (Berlin 5) and Unit No. 16 in Colchester, VT (Gorge 16) meet the criteria. Vermont DEC requested information on these units in a letter dated November 16, 2020. On December 19, 2020, Green Mountain Power responded with a four-factor analysis of the units prepared by Trinity Consultants (Appendix T). Berlin 5 consists of two simple-cycle combustion turbines (Berlin 5A and Berlin 5B) that are analyzed independently as each engine would require its own controls. See Appendix T for the units' specifications. Air permits for both Colchester and Berlin units can be found in Appendix V.

According to the four-factor analysis from Trinity Consultants, Berlin 5A and Berlin 5B were operated 10.9 and 11.4 hours, respectively, in calendar year 2019, with total NOx emissions of 0.91 and 0.71 tons. Gorge 16 was operated for 28.9 hours in calendar year 2019 and emitted 1.31 tons of NOx. The lowest cost effectiveness value for a control option was calculated at more than $30,000/ton. Trinity Consultants concluded that no control requirements should be applied to these units for the second planning period of the Regional Haze Rule.

Although 2019 emissions were used for the analysis as requested, upon review Vermont DEC found that 2019 emissions were among the lowest annual emissions for the ten-year period from 2014-2023. Annual emissions from these units ranged from a minimum of 0.6 tons per year to a maximum of 13.5 tons per

year for Berlin 5A in 2020 and Gorge 16 in 2017, respectively (Table 5-3). Rather than choose a single year as representative of typical operations, Vermont DEC recalculated the cost effectiveness of adding controls based on the median (50th percentile) annual emissions for the ten-year period from 2013 to 2024 using the same methodology as the Trinity Consultants four-factor analysis. In order to do so, heat input was back-calculated by multiplying reported emissions by the unit-specific emission factor used in the four-factor analysis.

The Berlin 5A, Berlin 5B, and Gorge 16 units emitted median annual emissions of 3.0, 2.8, and 2.9 tons per year, respectively. The ten-year averages (arithmetic mean) for these units were 3.4, 2.8, and 3.8 tons per year. Being in the center of the dataset, the median gives a better indication of "typical" annual emissions (Figure 5-3). The cost effectiveness values of adding controls based on the median annual emissions ranged from $17,074 per ton (Water injection 0.05) to $48,842,067 per ton (SCR).

Due to the combination of low hours of operation, low annual emissions generated, the limited expected lifespan of the units, possible non-air quality environmental effects of waste products from controls, and the cost per ton of emissions reduced, Vermont DEC concurs with the results of Trinity Consultants four-factor analysis that requiring the installation of emission controls is not reasonable for the second regional haze planning period.

Vermont has met Ask #5 through the analysis of sources within the state that meet the specified criteria and by the completion of the four-factor analyses conducted of peaking combustion turbines meeting those criteria. In conclusion, Vermont does not require controls on the three sources that were the focus of the four-factor analyses for reasonable progress towards the visibility goals.

Table 5-3: Annual NOx emissions for Gorge 16, Berlin 5A, and Berlin 5B in tons per year (tpy) for the 2014-2023 period, the median (50th percentile) annual emissions, and the average annual emissions (arithmetic mean of 2014-2023 annual emissions).

Year	Gorge 16 (tpy)	Berlin 5A (tpy)	Berlin 5B (tpy)
2014	1.0	4.2	4.1
2015	3.2	1.2	1.5
2016	3.4	3.2	3.3
2017	13.5	7.0	5.8
2018	2.6	2.3	2.2
2019	1.3	0.8	0.7
2020	1.0	0.6	0.6
2021	2.1	5.1	3.3
2022	6.3	7.3	4.7
2023	3.3	2.7	1.7
Median	2.9	3.0	2.8
Average	3.8	3.4	2.8

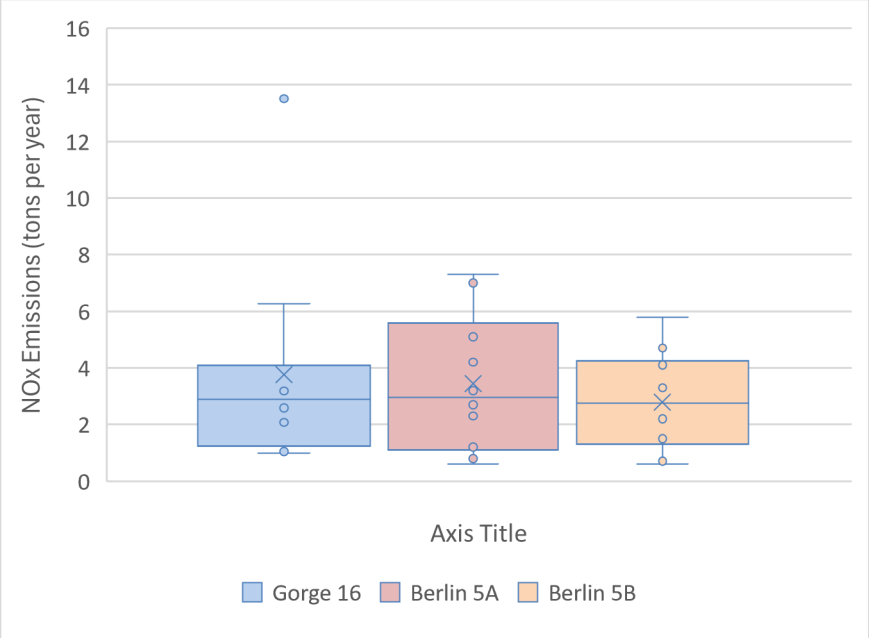


Figure 5-3:

Distribution of annual NOx emissions in tons from peaking combustion engines Gorge 16, Berlin 5A, and Berlin 5B, for the years 2014-2023, arranged in a box-and-whisker plot. The bottom of each box represents the 25th percentile, the middle line the 50th percentile (or median), and the top the 75th percentile. The X is the level of the arithmetic mean. Top and bottom "whiskers" extend to the maximum and minimum of the dataset, respectively, not including outliers. One outlier, greater than 1.5 times the interquartile range plus the level of the 75th percentile, occurred for Gorge 16 (2017 emissions of 13.5 tons), marked by a circle outside the range of the whiskers. Other data values than those mentioned are marked by additional circles.

Ask 6

Vermont is considering how to best address cleaner technologies when implementing the Global Warming Solutions Act, now under active management by ANR's Climate office. To what extent cleaner technologies will reduce greenhouse gas emissions has not yet been quantified.

Besides the implementation efforts for the Global Warming Solutions Act, Vermont has a Comprehensive Energy Plan that outlines strategies for decreased energy demand through the use of energy efficiency and modernizing the electric grid to handle distributed energy resources. Through Efficiency Vermont, residential energy efficiency investments have been encouraged through rebates and technical assistance, amounting to 13 million tons of decreased carbon dioxide emissions since 2000. For more information, a copy of the most recent Climate Action report can be found here: https://outside.vermont.gov/agency/anr/climatecouncil/Shared%20Documents/VT%20CAP%20Summary%20FINAL.pdf
A copy of the Vermont 2022 Comprehensive Energy Plan can also be found here: https://publicservice.vermont.gov/sites/dps/files/documents/2022VermontComprehensiveEnergyPlan_0.pdf

Further LTS measures

In summary, given the controls Vermont has already implemented for SO2 and NOx emissions, no new existing measures are needed for reasonable progress. The existing measures that Vermont is relying on include use of low sulfur fuel (which reduces area source emissions, i.e. residential heating emissions) and reduction of NOx emissions from mobile source programs as well as continued implementation of NOx RACT for point sources.

In addition to meeting the MANE-VU "Asks", Vermont considers its mobile source emission reduction strategies (see Section 5.7) as the most viable way to reduce NOx emissions in the state that may be impacting New Hampshire Class I areas, that will provide reasonable progress in improving visibility. The effects of these strategies will start in this second implementation period, with the more significant reductions occurring in the third implementation period and beyond.

With the MANE-VU "Asks" Vermont believes it is in a good position to meet the reasonable progress goal (RPG) as discussed in the next section. Mobile source emission reductions will provide more assurance that New Hampshire's Class I RPG will be met.

6 REASONABLE PROGRESS GOALS (40 CFR 51.308(f)(3))

40 CFR 51.308 (f)(3) of the Regional Haze Rule requires Vermont to establish, for each Federal Class I area within the state, reasonable progress goals (RPG) that reflect the visibility conditions in 2028 that are expected to result from the measures outlined in the LTS. Vermont set an RPG of 13.68 deciviews for the 20% most impaired days, and 3.86 deciviews for the clearest days.

In August 2019, the EPA released guidance[45] to be used by states in setting reasonable progress goals. The goals must provide for visibility improvement on the days of greatest visibility impairment, specifically, when anthropogenic emissions impair visibility and away from days when wildfires and natural dust storms are the greatest contributors to visibility impairment and ensure no visibility degradation on the days of least visibility impairment for the duration of the SIP period.

As provided in 40 CFR 51.308 (f)(3)(i):

> *"A state in which a mandatory Class I Federal area is located must establish reasonable progress goals (expressed in deciviews) that reflect the visibility conditions that are projected to be achieved by the end of the applicable implementation period as a result of those enforceable emissions limitations, compliance schedules, and other measures required under paragraph (f)(2) of this section that can be fully implemented by the end of the applicable implementation period, as well as the implementation of other requirements of the CAA. The long-term strategy and the reasonable progress goals must provide for an improvement in visibility for the most impaired days since the baseline period and ensure no degradation in visibility for the clearest days since the baseline period."*

Table 6-1 summarizes the existing visibility conditions and metrics, and the proposed reasonable goals as described in this section; this is also seen in Figure 4-1.

Table 6-1: Visibility Goals for the Lye Brook Wilderness Area

Conditions	Deciviews
Natural Background on 20% most impaired visibility days (Goal in 2064)	10.24
Average Baseline Visibility on the 20% clearest days (2000-2004)	6.37
Average Baseline Visibility on the 20% most impaired days (2000-2004)	23.57
Visibility value with Uniform Rate of Progress for 2018 on the 20% most impaired days*	20.24
Current 20% Most Impaired Days (2015-2019)	14.06
Visibility value with Uniform Rate of Progress for 2028 on the 20% most impaired days*	18.24
Modeled Reasonable Progress Goal (2028)*	13.89[d]

* Average annual value

[d] Modeled without the MANE-VU Ask measures (Appendix U)

MANE-VU predicts 2028 RPG values of 13.89 dv without the MANE-VU Ask. Vermont has chosen an RPG of 13.89 dv for Lye Brook Wilderness as a reasonable progress goal for 2028. Vermont's Long-Term Strategy also includes the existing measures of reducing mobile source emissions, which have been

[45] EPA, (August 2019). *Guidance on Regional Haze State Implementation Plans for the Second Implementation Period, EPA-457/B-19-003*. Available at: https://www.epa.gov/sites/production/files/2019-08/documents/8-20-2019_-_regional_haze_guidance_final_guidance.pdf

identified as influencing visibility for New Hampshire's Class I area.

Vermont consulted with states identified as contributing to visibility impairment at Lye Brook Class I area and with states that requested consultation with Vermont regarding visibility conditions at their Federal Class I areas. Vermont worked closely with the other MANE-VU states to ensure consistency of approach in setting reasonable progress goals. A description of the consultation process is found in Section 3. Should other Federal Class I area states that have not yet completed their consultation processes request consultation with Vermont as well as request that additional emission measures be considered, then VTDEC will address the matter in a SIP update, permit, or rule as needed and appropriate.

7 ADDITIONAL MONITORING (40 CFR 51.308(f)(4))

As described in earlier sections, visibility monitoring at Lye Brook Wilderness is accomplished with instruments located at a single site at Mount Snow and is funded by EPA and operated by the National Forest Service. This monitoring station, which represents the Lye Brook wilderness area, measures and records light scattering, aerosols and relative humidity. The collected data are compiled and sorted to ascertain visibility levels on the 20% most impaired and clearest days, and this information is tracked over time to look for trends in visibility. The State has not been advised by the Administrator, Regional Administrator, or affected Federal Land Manager that additional monitoring is required pursuant to 40 CFR 51.308(f)(4). Therefore, Vermont has no current plans to alter the current strategy as long as this monitoring continues to be federally supported.

8 PROGRESS REPORT (40 CFR 51.308(f)(5)) AND PERIODIC REPORTS (40 CFR 51.308)(g)

Each state must periodically submit a report to the Administrator evaluating progress towards the reasonable progress goal for the Class I area. Vermont commits to periodically submitting reports to the Administrator evaluating progress towards the reasonable progress goal for the mandatory Class I Federal area located within the State and in each mandatory Class I Federal area located outside the State that may be affected by emissions from within the State. Subsequent progress reports will be submitted January 31, 2025, July 31, 2033, and every 10 years thereafter. Progress reports will be made available for public inspection and comment for at least 30 days prior to submission to EPA and all comments received from the public will be submitted to EPA along with the subsequent progress report, along with an explanation of any changes to the progress report made in response to those comments.

The Regional Haze Rule at 40 CFR 51.308(f)(5) states "So 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 (g)(5) of this section." The first progress report was submitted February 29, 2016. The following section serves as a progress report for the first implementation period.

8.1 Status of Approved Measures of State Implementation Plan 40 CFR 51.308(g)(1)

Measures to combat regional haze were developed by the MANE-VU states after much research and analysis that culminated on June 20, 2007, with the adoption of two documents that provide the technical basis for consultation among the interested parties and define the basic strategies for controlling pollutants that cause visibility impairment at Federal Class I areas in the eastern U.S. These documents, "Statement of the Mid-Atlantic / Northeast Visibility Union (MANE-VU) Concerning a Course of Action within MANE-VU toward Assuring Reasonable Progress," and "Statement of the Mid-Atlantic / Northeast Visibility Union (MANE-VU) Concerning a Request for a Course of Action by States outside of MANE-VU toward Assuring Reasonable Progress" are known as the MANE-VU "Ask.

During the first implementation period, Vermont, as a MANE-VU member state, agreed to and adopted the strategies for controlling pollutants that cause visibility impairment outlined in the first planning period Ask. This "Ask" consisted of the following strategies:

- **Timely implementation of BART requirements.** Vermont has no BART sources.
- **A targeted EGU strategy:** VT has no large EGU sources determined by MANE-VU to have significant effect on regional haze.
- **A low sulfur fuel oil strategy.** Vermont promulgated regulations requiring a phased-in approach to using low sulfur fuel oil in the state. This was described in Section 5.7.
- **Continued evaluation of other control measures.** Vermont continues its participation in "Clean Cities," the DOE's program that advances the nation's economic, environmental and energy security by supporting local actions to cut petroleum use in transportation.

8.2 Summary of Emission Reductions Achieved 51.308(g)(2)

Section 51.303(g)(2) calls for summary of the emissions reductions achieved throughout the State through implementation of the measures of the first implementation period, as also described in Sections 5.7 and 5.8. The fuel strategy has been implemented, and NOx RACT has been adopted.

Continuing reductions of NOx, VOCs and air toxics have also occurred due to mobile source emission controls, and more are anticipated due to Vermont's December 2022 adoption of updated California vehicle regulations. Other efforts to reduce air pollution from mobile sources include adoption of inspection and maintenance of vehicle emissions control systems, enhancement of emissions control technology, upgrading programs for diesel engines, and participation in regional and state-specific efforts to build and incentivize zero emission vehicle infrastructure and ownership. Based on the NEI, total statewide NOx emissions were approximately 20,000 tpy in 2011 and are projected to be 11,000 tpy in 2023; these emissions have shown a steady decline since 2011 (see Figure 2 of Vermont's Ozone Good Neighbor SIP, https://dec.vermont.gov/sites/dec/files/aqc/planning/documents/Proposed_Vermont_2015_ozone_ISIP_20191018.pdf).

The NEI shows that significant SO2 reductions have occurred due to implementation of Vermont's (and MANE-VU's) low sulfur fuel strategy, with more expected as the 2018 milestone in the regulations is manifested in the second implementation period. See Section 8.4.4 for further information on sulfur dioxide emissions in Vermont. Since 2002 there has been a 10-fold decrease in emissions. Currently, point sources (combined) contribute 22 tpy (i.e., 3%) to total SO2 emissions in Vermont, with non-point sources/area sources contributing 84% (2017 data). The remaining 13% are from mobile sources.

It is expected that Vermont's Global Warming Solutions Act, which is focusing on both the residential heating sector as well as mobile sources, will result in further reductions of NOx, SO2, and other pollutants as well. These cannot yet be quantified because defined actions, while under active discussion, are not yet implemented.

8.3 Assessment of Visibility Conditions 51.308(g)(3)

Haze Index and individual constituent light extinction annual results were analyzed for each IMPROVE monitoring site in and adjacent to the MANE-VU region for years between 2000 and 2019. This work was completed by the Maine Department of Environmental Protection on behalf of MANE-VU[46] to determine baseline, current and natural visibility conditions for the 20% most impaired days and the 20% clearest days, for each in-state and out-of-state Federal Class I area for states in the MANE-VU region.

Visibility trends analyses used EPA recommended metrics[47] at IMPROVE monitoring sites at federal Class I including Vermont's Federal Class I areas. The results of the analysis showed the following:

- There continues to be definite downward trends in overall haze levels at all Federal Class I areas in and adjacent to the MANE-VU region and at IMPROVE Protocol monitoring sites.

- Based on rolling-five year averages demonstrating progress since the 2000-2004 baseline period, all MANE-VU and nearby Federal Class I area visibility conditions are currently better than the 2028 URP visibility condition for the 20% most impaired visibility days and below baseline conditions for the 20% clearest days. Trends are mainly driven by large reductions in sulfate light

[46] ME DEP, (January 2021). *Mid-Atlantic/Northeast U.S. Visibility Data 2004-2019 (2nd RH SIP Metrics)*, Appendix B.

[47] EPA, (December 2018). *Technical Guidance on Tracking Visibility Progress for the Second Implementation Period. EPA-454/R-18-010.* Available at: https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf.

extinction, and to a lesser extent, nitrate light extinction.

- Levels of organic carbon mass (OCM) and light absorbing carbon (LAC) appear to be approaching natural background levels at most of the MANE-VU Class I areas.

- The percent contribution of nitrate light extinction has been significantly increasing at some of the MANE-VU Class I areas, not just due to lower sulfate contributions but due to more winter days and fewer summer days in the mix of 20% most impaired days. This is a significant trend at Lye Brook Wilderness.

Visibility metrics for Federal Class I areas in and adjacent to MANE-VU are given in Table 8-1. For the Lye Brook Wilderness, these metrics are presented graphically in Figure 8-2. As shown, visibility trends for the 20% most impaired days are well below the uniform rate of progress line as an annual average as well as a five-year rolling average.

Table 8-1: Baseline, Current and Reasonable Progress Goal Haze Index Levels for Federal Class I Areas In or Adjacent to the MANE-VU Region

Federal Class I Area	IMPROVE SITE DATA CODE(S)	State	CLEAREST DAYS			MOST IMPAIRED DAYS				
			Baseline (2000-04) (dv)	Current (2015-19) (dv)	RPG (2028) (dv)	Baseline (2000-04) (dv)	Current (2015-19) (dv)	URP* 2028 (dv/yr)	URP* 2028 (dv)	RPG (2028) (dv)
Acadia National Park	ACAD	ME	8.78	6.36	6.33[c] 6.33[d]	22.01	14.24	0.194	17.36	13.35[c] 13.44[d]
Moosehorn Wilderness Area Roosevelt Campobello International Park	MOOS	ME NB	9.16	6.48	6.45[c] 6.46[d]	20.65	12.99	0.178	16.38	13.12[c] 13.20[d]
Great Gulf Wilderness Area Presidential Range/Dry River Wilderness Area	GRGU	NH	7.65	4.69	5.06[c] 5.11[d]	21.88	12.33	0.202	17.04	12.00[c] 12.13[d]
Lye Brook Wilderness Area	LYBR_ LYEB	VT	6.37	4.88	3.86[c] 3.90[d]	23.57	14.06	0.222	18.23	13.68[c] 13.89[d]
Brigantine Wilderness Area	BRIG	NJ	14.33	10.81	10.47[c] 10.55[d]	27.43	18.53	0.279	20.74	17.97[c] 18.16[d]
Dolly Sods Wilderness Area† Otter Creek Wilderness Area†	DOSO	WV	12.28	6.18	7.27[c] 7.33[d]	28.29	17.03	0.323	20.54	15.09[c] 15.30[d]
James River Face Area†	JARI	VA	14.21	8.99	9.36[c] 9.45[d]	28.08	17.28	0.315	20.83	15.31[c] 15.48[d]
Shenandoah National Park†	SHEN	VA	10.93	6.54	6.83[c] 7.00[d]	28.32	16.38	0.313	20.80	14.25[c] 14.54[d]

† Federal *Class I area adjacent to the MANE-VU region;*
* *Uniform Rate of Progress;*
[c] *Modeled Reasonable Progress Goal with MANE-VU Ask Measures (MANE-VU 2018a)*

[d] *Modeled Reasonable Progress Goal without MANE-VU Ask Measures (MANE-VU 2018a)*

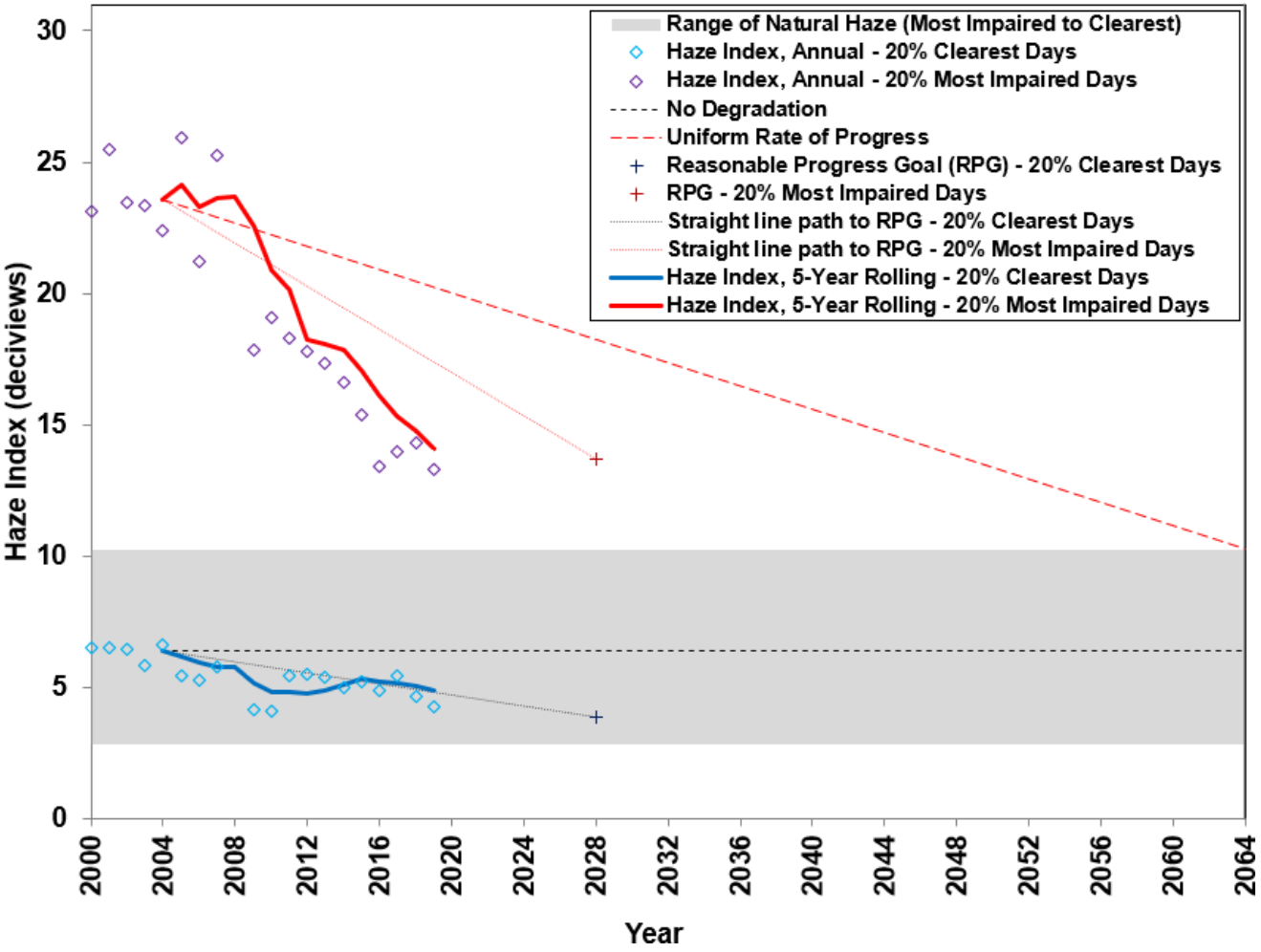


Figure 8-1: Visibility metrics at Lye Brook Wilderness Area.

While Figure 8.1 shows overall visibility improvement, it is instructive to see which aerosols were responsible for the improvement. Analyses of visibility by species help policy decision makers determine what control strategies to consider for the second regional haze implementation planning period. Figure 8.2 shows the trends in aerosol light extinction, from the baseline of early 2000s to the current 5-year period of 2015-2019, showing the percentage contributions of individual aerosol species to that extinction. Figure 8.3, for the 5-year period 2010-2014, indicates the progress from the First Implementation Period SIP to the time of the progress report (submitted in 2016). Sulfate is the largest anthropogenic contributor to haze on the clearest days; improvement on clear days has been due to a reduction in sulfate on these days over the 20-year period. On the haziest 20% days, sulfate continues to be the dominant contributor to haze, with nitrates now a significantly more important component of haze currently. Since Vermont's 2016 Progress Report, nitrate has increased from 11% to 23% of the 20% most impaired days and is beginning to rival sulfate contribution (which is currently at 31%). For improved visibility in the future, sulfate and nitrate as well as organic carbon will need to be reduced.

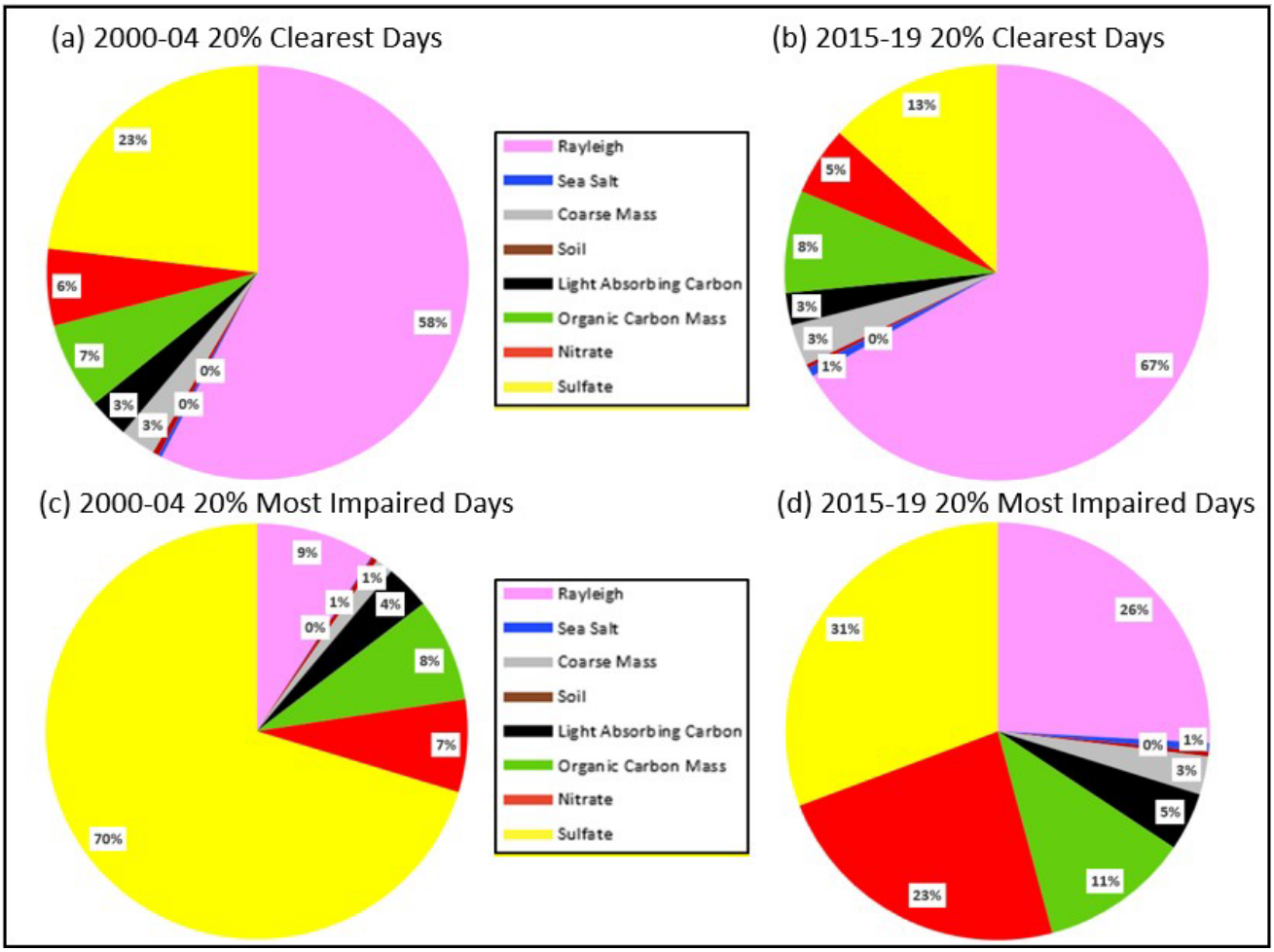


Figure 8-2: Species percent contribution to baseline (2001-04) and current (2015-2019) haze index levels at Lye Brook Wilderness Area.

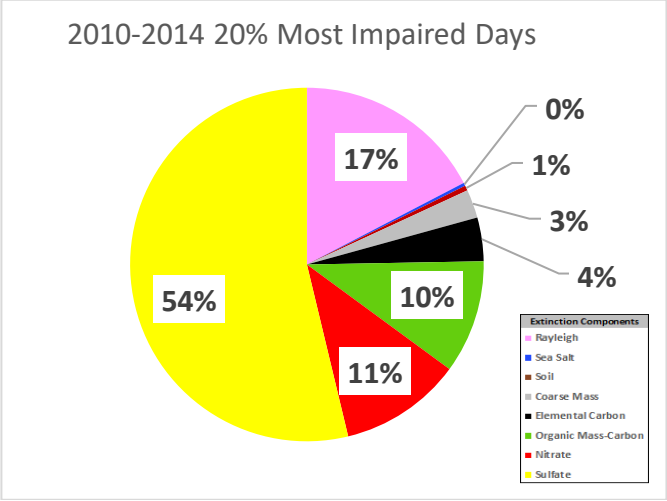


Figure 8-3: Species percent contribution of 2016 First Implementation Period progress report (2010-2014) haze index levels at Lye Brook Wilderness Area.

Another way of evaluating the reduction in regional haze is to examine the year-by-year values (in deciviews) of the various aerosols that make up regional haze, as is shown in Figure 8-4. On the clearest days, the values have decreased modestly over time due to sulfate reductions. On the most impaired days, substantial reductions in sulfate are the predominant factor for improving visibility, with proportionally increasing nitrate.

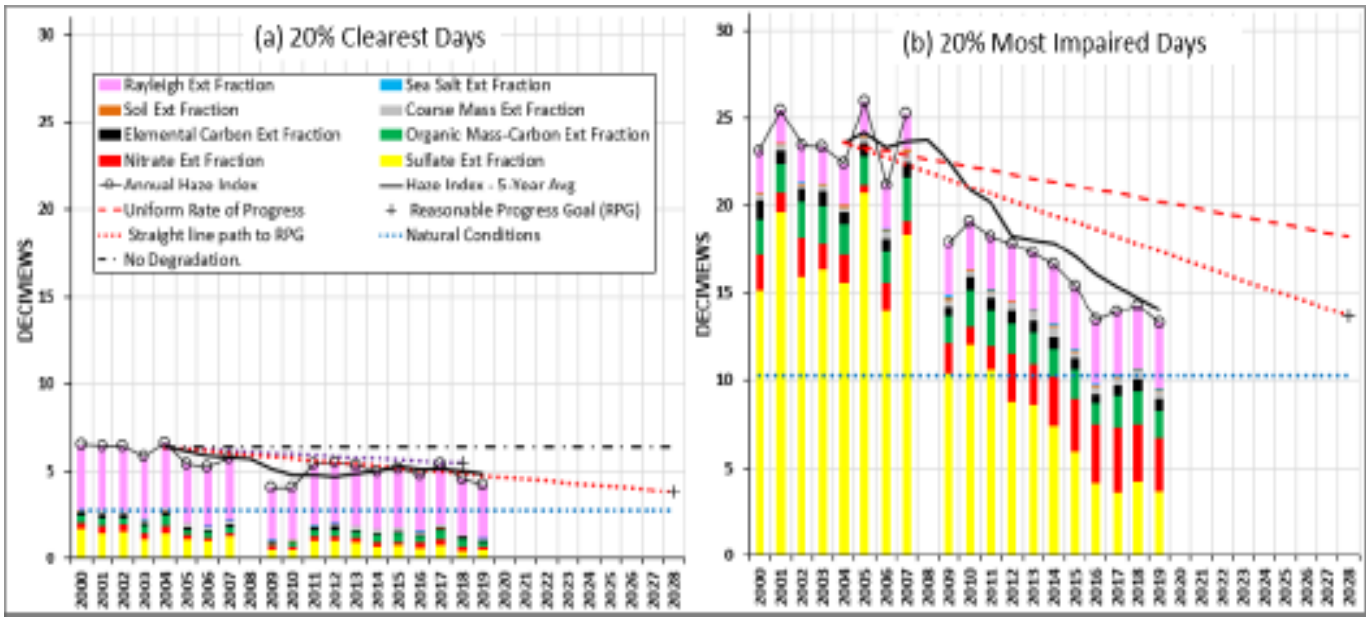


Figure 8-4: Species percent contribution to baseline (2001-04) and current (2015-2019) haze index levels at Lye Brook Wilderness Area.

8.4 Change in Emissions of Pollutants Contributing to Visibility Impairment 51.308(g)(4)

This section is intended to satisfy paragraph 40 CFR 51.308(g)(4) of the Regional Haze Program Requirements. Paragraph 51.308(g)(4) requires:

> "An analysis tracking the change over the period since the period addressed in the most recent plan[48] required under paragraph (f) of this section in emissions of pollutants contributing to visibility impairment[49] from all sources and activities within the State. Emissions changes should be identified by type of source or activity. With respect to all sources and activities, the analysis must extend at least through the most recent year for which the state has submitted emission inventory information to the Administrator in compliance with the triennial reporting requirements of subpart A of this part as of a date 6 months preceding the required date of the progress report… The State is not required to back cast previously reported emissions to be consistent with more recent emissions estimation procedures, and may draw attention to actual or possible inconsistencies created by changes in estimation procedures."

[48] Plan means an implementation plan approved or promulgated under section 110 of 172 of the Act.

[49] Visibility impairment or anthropogenic visibility impairment means any humanly perceptible difference due to air pollution from anthropogenic sources between actual visibility and natural visibility on one or more days. Because natural visibility can only be estimated or inferred, visibility impairment also is estimated or inferred rather than directly measured.

Therefore, Vermont has provided a summary of emissions of visibility impairing pollutants from all sources and activities within the state for the period from 2002 to 2017. 2017 is the most recent year for which Vermont has submitted emissions estimates to fulfill the requirements of 40 CFR 51 Subpart A – Air Emissions Reporting Requirements. In this summary, Vermont has provided estimates for NOx, PM_{10}, $PM_{2.5}$, SO_2, VOC, and NH_3, all of which have the potential to contribute to regional haze formation. The data were obtained from EPA's NEI.[50] Data categories include point sources, nonpoint sources, nonroad mobile sources, and on-road mobile sources. A brief description of each of these categories is provided below:

- NEI Point sources are discrete facilities that generally report their emissions directly via state and/or Federal permitting and reporting programs. Point sources usually represent larger facilities such as EGUs, factories, and heating plants for large schools and universities. In the tables and charts that follow, point source NOx and SO_2 are further broken down into AMPD sources and non-AMPD sources. The majority of sources that report to one or more of EPA's AMPD programs are EGUs. Therefore, the AMPD point category is a reasonable representation of emissions from EGUs.
- NEI Nonpoint sources are those emissions categories that are too small, widespread, or numerous to be inventoried individually. Therefore, emissions are estimated for these categories using aggregate activity data such as population, employment, and statewide fuel use (after accounting for the fuel used by point sources). There is a wide range of nonpoint categories, but examples include residential fuel combustion and commercial & consumer solvent use. As of 2008, the EPA includes emissions from the mobile source nonroad categories for commercial marine vessels and underway rail emissions in the nonpoint NEI. Prior to 2011, EPA included vehicle refueling at gasoline service stations in the area sector and beginning with 2011 it was included in the onroad sector.
- NEI Nonroad mobile sources represent vehicles and equipment that are not designed to operate on roadways. Examples include aircraft, ships, locomotives, construction equipment, recreational vehicles, and lawn & garden equipment (note, however, that emissions from airports and some large rail yards are inventoried as point sources since these emissions occur at discrete locations). As discussed above, beginning in 2008 the NEI emissions from airports and railroad switchyards are inventoried as point sources and emissions from other railroad activities and commercial marine vessels are inventoried as nonpoint sources.
- NEI On-road mobile sources represent vehicles that operate on roadways, including cars, trucks, buses, and motorcycles. Emissions were calculated with the EPA model (MOVES) in 2007, 2011 and 2017, which was different from the model used for the 2002 inventory (MOBILE6). As of 2011, NEI v2, EPA includes vehicle refueling at gasoline service stations in the onroad sector instead of the area or nonpoint sector.

The summary data were taken from EPA's NEI. Under the AERR, states are required to submit estimates for all emissions categories to EPA on a three-year cycle. The state submittals are combined with EPA's

[50] EPA Emissions Inventory System (EIS) Gateway. Available at: https://www.epa.gov/air-emissions-inventories/emissions-inventory-system-eis-gateway.

own estimates to form the NEI. Note that 2005 was a limited effort NEI, so that year is not shown. A brief discussion of the trends in emissions, based on the EPA NEI grouping, is provided in the section for each pollutant. Inconsistencies due to changes in estimation procedures and grouping are also pointed out, where applicable.

Paragraph 51.308(g)(4) also states, "With respect to sources that report directly to a centralized emissions data system operated by the Administrator, the analysis must extend through the most recent year for which the Administrator has provided a State-level summary of such reported data or an internet-based tool by which the State may obtain such a summary as of a date 6 months preceding the required date of the progress report." Vermont has no AMPD has no AMPD sources for the years 2016 through 2019.

In addition to the Vermont-specific data, 2002 – 2017 summaries of emissions from all sectors, as well as summaries of 2016 through 2019 NOx and SO_2 emissions for AMPD sources are provided for all the MANE-VU states, including CT, DE, DC, ME, MD, MA, NH, NJ, NY, PA, RI, and VT. Similar summaries are also shown for the states listed in the MANE-VU Inter-RPO Ask[51] as having the potential to contribute to visibility impairment in MANE-VU Class I areas. These states include AL, FL, IL, IN, KY, LA, MI, MO, NC, OH, TN, TX, VA, and WV. This group of states is referred to hereinafter as the "Ask states."

8.4.1 Nitrogen Oxides

Figure 8-5 shows a summary of NOx emissions from all data categories – point, nonpoint, non-road, and on-road – for the period from 2002 to 2017 in Vermont.

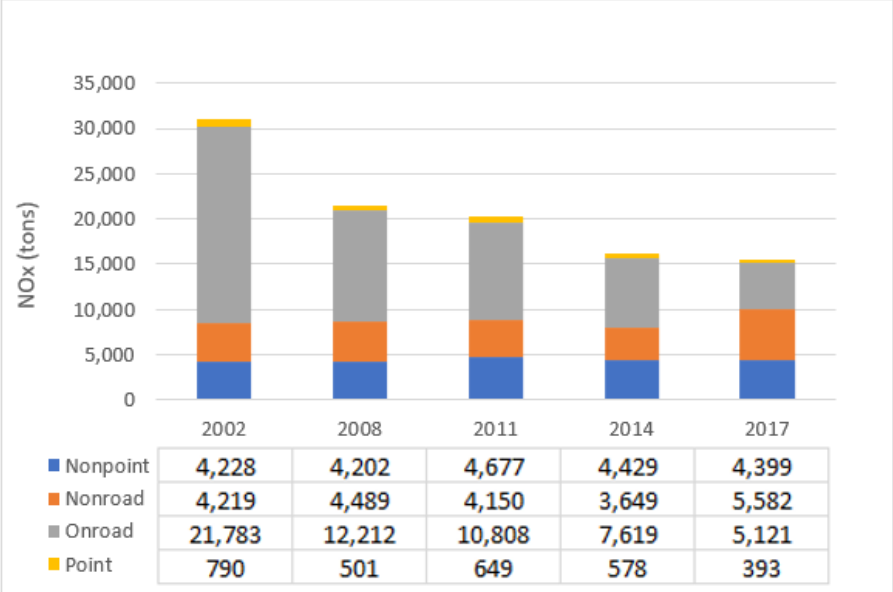


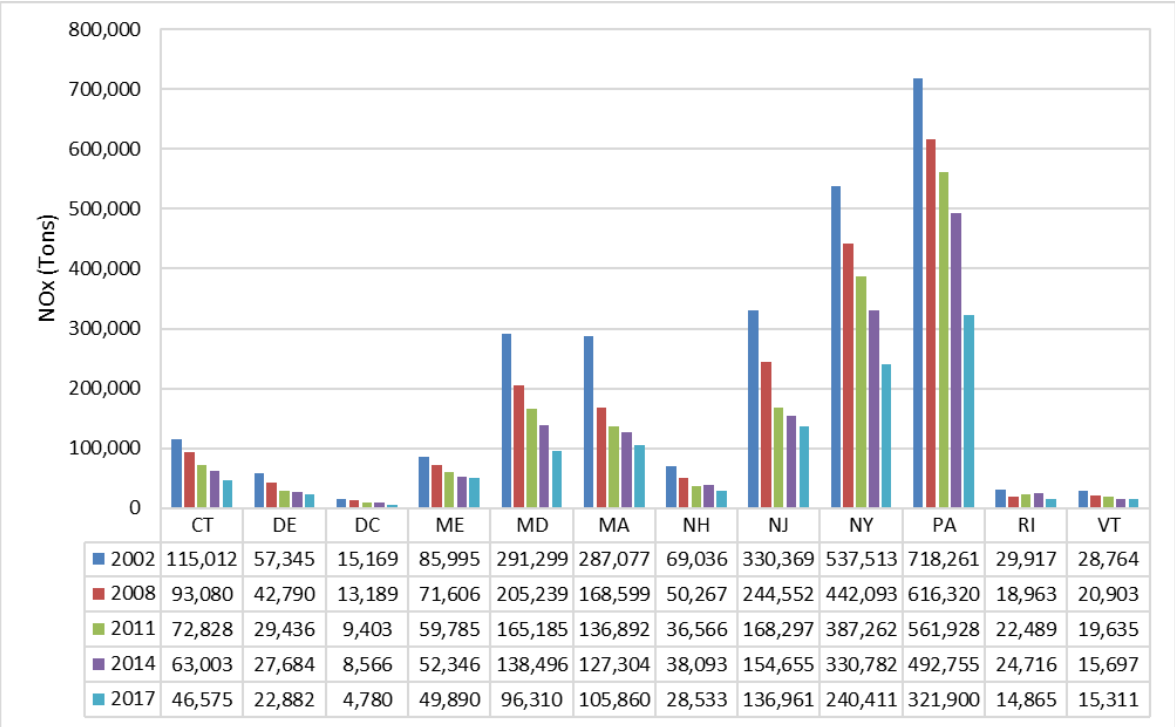
Figure 8-5: NOx emissions in Vermont by source type, 2002-2017 (tons per year).

NOx emissions have shown a steady decline in Vermont over the period from 2002 to 2017, particularly in the on-road mobile sector. There were some reductions in non-road emissions that are due to a wide

[51] MANE-VU, (August 2017). *Statements of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) States Concerning a Course of Action in Contributing States Located Upwind of MANE-VU Toward Assuring Reasonable Progress for the Second Regional Haze Implementation Period (2018-2028).* Appendix O.

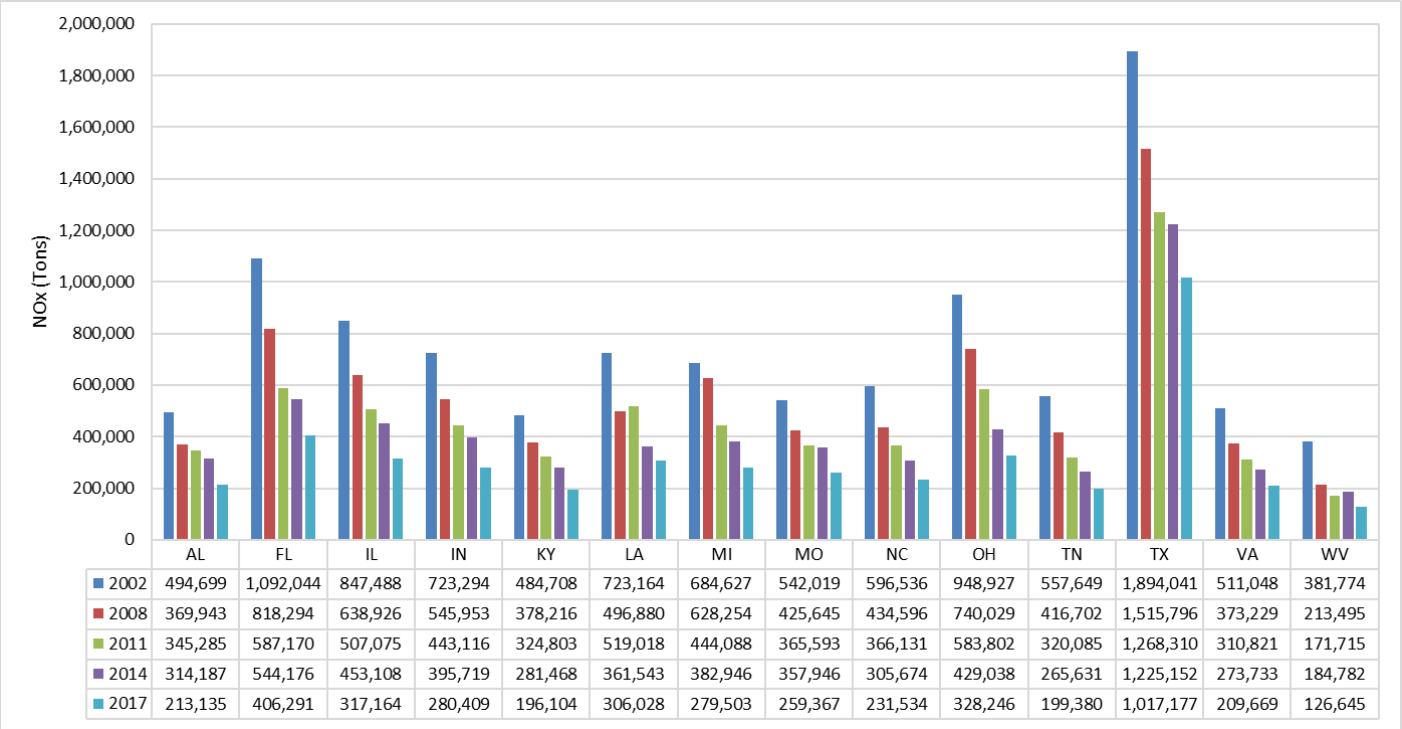
range of Federal rules to reduce emissions from non-road vehicles and equipment. A few examples of regulatory programs that have reduced, and/or will continue to reduce, emissions from non-road vehicles and equipment include: 40 CFR Parts 9, 69, et al. *Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel*, 40 CFR Parts 9, 85, et al. *Control of Emissions of Air Pollution From Locomotive Engines and Marine Compression-Ignition Engines Less Than 30 Liters per Cylinder*, and 40 CFR Parts 9, 60, 80 et al. *Control of Emissions From Nonroad Spark-Ignition Engines and Equipment*. Reductions in non-road emissions are, however, difficult to discern in the data due to methodology changes within the non-road model, the incorporation of the non-road model into the EPA MOVES model, and updates to default data and emission factors over time. On-road mobile emissions reductions are due in part to Vermont's adoption of the California Low Emission Vehicle (LEV) and Zero Emission Vehicle (ZEV) standards. The California standards ensure that vehicles sold in the state meet increasingly stringent emissions requirements through time, driving emissions reductions in the on-road sector. There have also been initiatives in Vermont to reduce NOx emissions through the use of funding from the Volkswagen Environmental Mitigation trust. Projects included a pilot project for electrifying school and transit buses, the installation of electric vehicle supply equipment to help support and accelerate electric vehicle adoption, and several ongoing heavy-duty vehicle electrification projects. Both non-road and on-road mobile sources, NOx emissions are expected to continue to decrease as fleets turn over and older more polluting vehicles and equipment are replaced by newer, cleaner ones.

Similar to Vermont, Figures 8-6 and 8-7 show a steady decline in NOx emissions from 2002 to 2017 for almost all of the MANE-VU states and the Ask states (average of 57% and 58%, respectively). Much of this decline in NOx emissions is due to the Federal control programs for non-road and on-road mobile sources described earlier. Other NOx reductions are from individual states' rules for NOx RACT.



	CT	DE	DC	ME	MD	MA	NH	NJ	NY	PA	RI	VT
2002	115,012	57,345	15,169	85,995	291,299	287,077	69,036	330,369	537,513	718,261	29,917	28,764
2008	93,080	42,790	13,189	71,606	205,239	168,599	50,267	244,552	442,093	616,320	18,963	20,903
2011	72,828	29,436	9,403	59,785	165,185	136,892	36,566	168,297	387,262	561,928	22,489	19,635
2014	63,003	27,684	8,566	52,346	138,496	127,304	38,093	154,655	330,782	492,755	24,716	15,697
2017	46,575	22,882	4,780	49,890	96,310	105,860	28,533	136,961	240,411	321,900	14,865	15,311

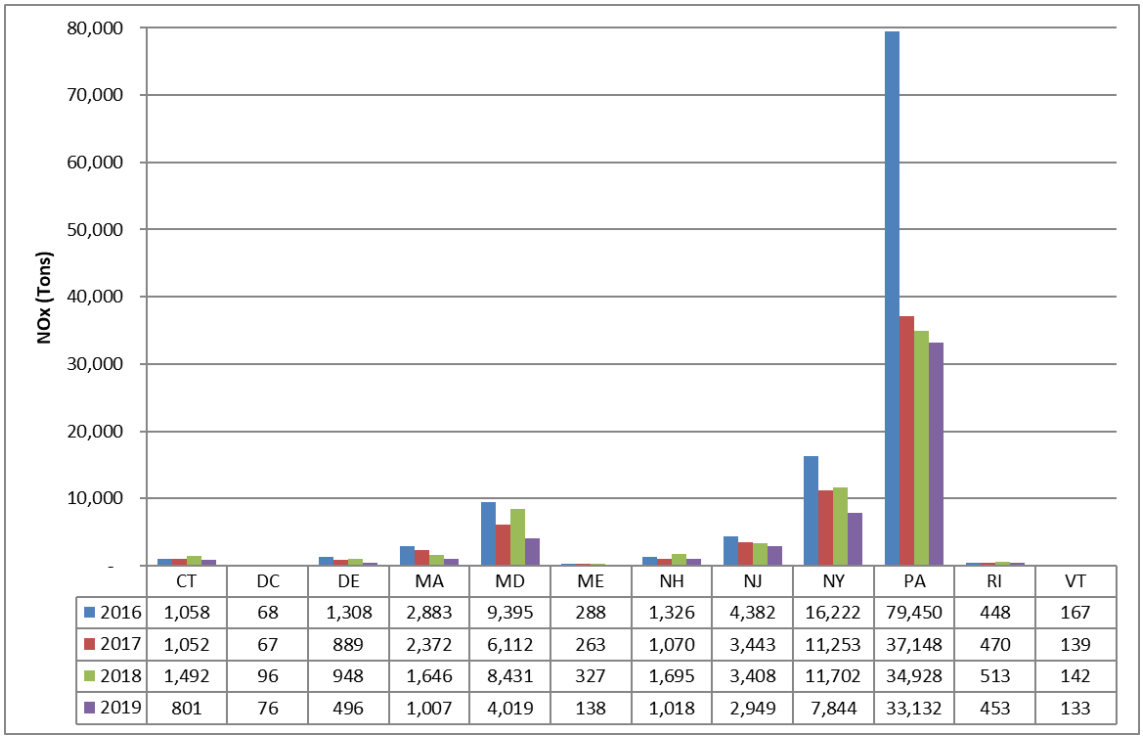
Figure 8-6: NOx emissions in MANE-VU states by source type, 2002-2017 (tons per year).



	AL	FL	IL	IN	KY	LA	MI	MO	NC	OH	TN	TX	VA	WV
2002	494,699	1,092,044	847,488	723,294	484,708	723,164	684,627	542,019	596,536	948,927	557,649	1,894,041	511,048	381,774
2008	369,943	818,294	638,926	545,953	378,216	496,880	628,254	425,645	434,596	740,029	416,702	1,515,796	373,229	213,495
2011	345,285	587,170	507,075	443,116	324,803	519,018	444,088	365,593	366,131	583,802	320,085	1,268,310	310,821	171,715
2014	314,187	544,176	453,108	395,719	281,468	361,543	382,946	357,946	305,674	429,038	265,631	1,225,152	273,733	184,782
2017	213,135	406,291	317,164	280,409	196,104	306,028	279,503	259,367	231,534	328,246	199,380	1,017,177	209,669	126,645

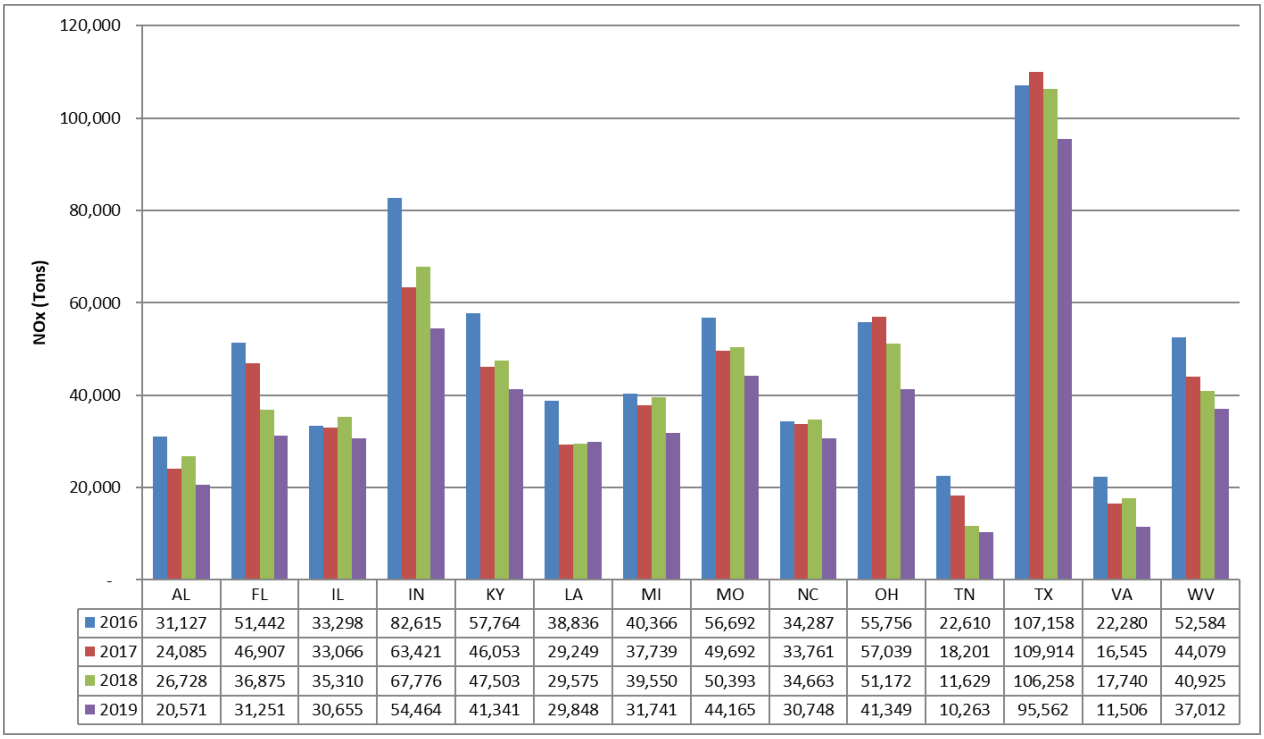
Figure 8-7: NOx emissions in Ask States by source type, 2002-2017 (tons per year).

AMPD NOx data for 2016 through 2019 from the MANE-VU states and for the Ask states is shown below in Figures 8-8 and 8-9, and indicates decreases in NOx emissions in both groups of states. For applicable states, some of the reduction in AMPD NOx since 2002 is attributable to the NOx Budget Trading Program under the NOx SIP Call and CAIR (replaced by CSAPR). Other reductions are attributable to source retirements and fuel switching due to the availability of less expensive natural gas in recent years.



	CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT
2016	1,058	68	1,308	2,883	9,395	288	1,326	4,382	16,222	79,450	448	167
2017	1,052	67	889	2,372	6,112	263	1,070	3,443	11,253	37,148	470	139
2018	1,492	96	948	1,646	8,431	327	1,695	3,408	11,702	34,928	513	142
2019	801	76	496	1,007	4,019	138	1,018	2,949	7,844	33,132	453	133

Figure 8-8: NOx emissions from AMPD sources in MANE-VU states, 2016-2019 (tons per year).



	AL	FL	IL	IN	KY	LA	MI	MO	NC	OH	TN	TX	VA	WV
2016	31,127	51,442	33,298	82,615	57,764	38,836	40,366	56,692	34,287	55,756	22,610	107,158	22,280	52,584
2017	24,085	46,907	33,066	63,421	46,053	29,249	37,739	49,692	33,761	57,039	18,201	109,914	16,545	44,079
2018	26,728	36,875	35,310	67,776	47,503	29,575	39,550	50,393	34,663	51,172	11,629	106,258	17,740	40,925
2019	20,571	31,251	30,655	54,464	41,341	29,848	31,741	44,165	30,748	41,349	10,263	95,562	11,506	37,012

Figure 8-9: NOx emissions from AMPD sources in Ask States, 2016-2019 (tons per year).

8.4.2 Particulate Matter Less Than 10 Microns

Figure 8-10 shows a summary of PM_{10} emissions from all data categories – point, nonpoint, non-road, and on-road – for the period from 2002 to 2017 in Vermont. Emissions of PM_{10} showed a steady decline in Vermont from 2002 to 2014 but showed an increase in 2017. This increase in the 2017 NEI data was driven by the unpaved road dust sector, the emissions estimates of which went up dramatically between 2014 and 2017. This increase was likely due to a difference in calculation methodology between the 2014 and 2017 NEI calculations that is related to the allocation of vehicle miles traveled to unpaved roads. PM_{10} emissions from residential wood combustion, the second largest source in the state, actually declined in 2017.

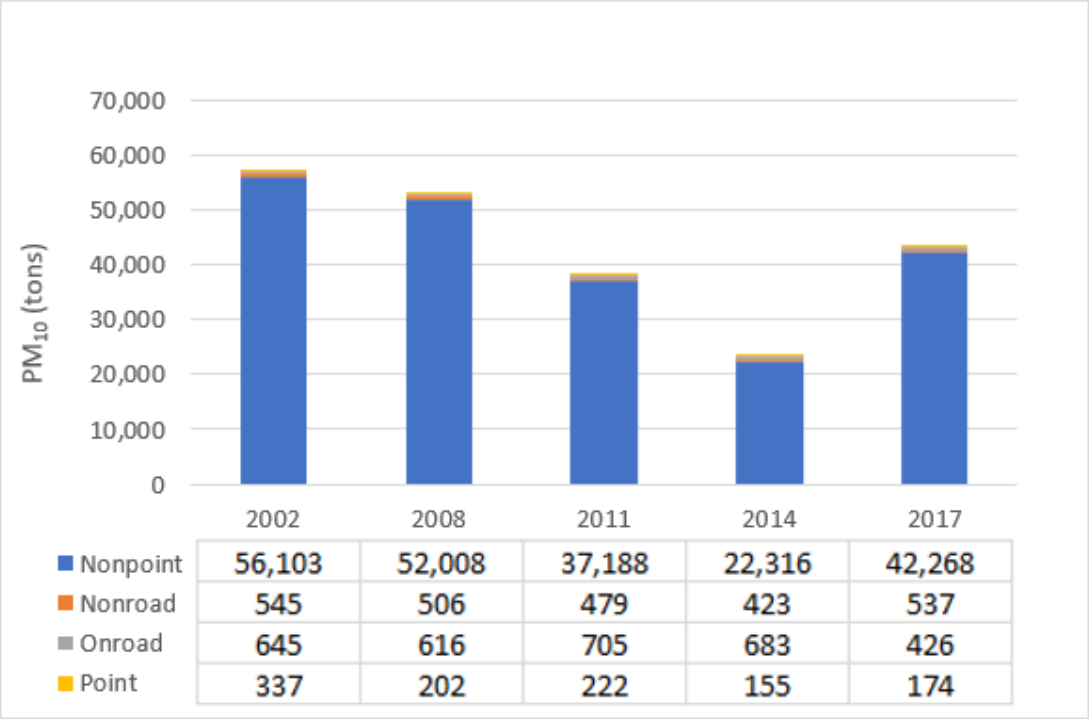
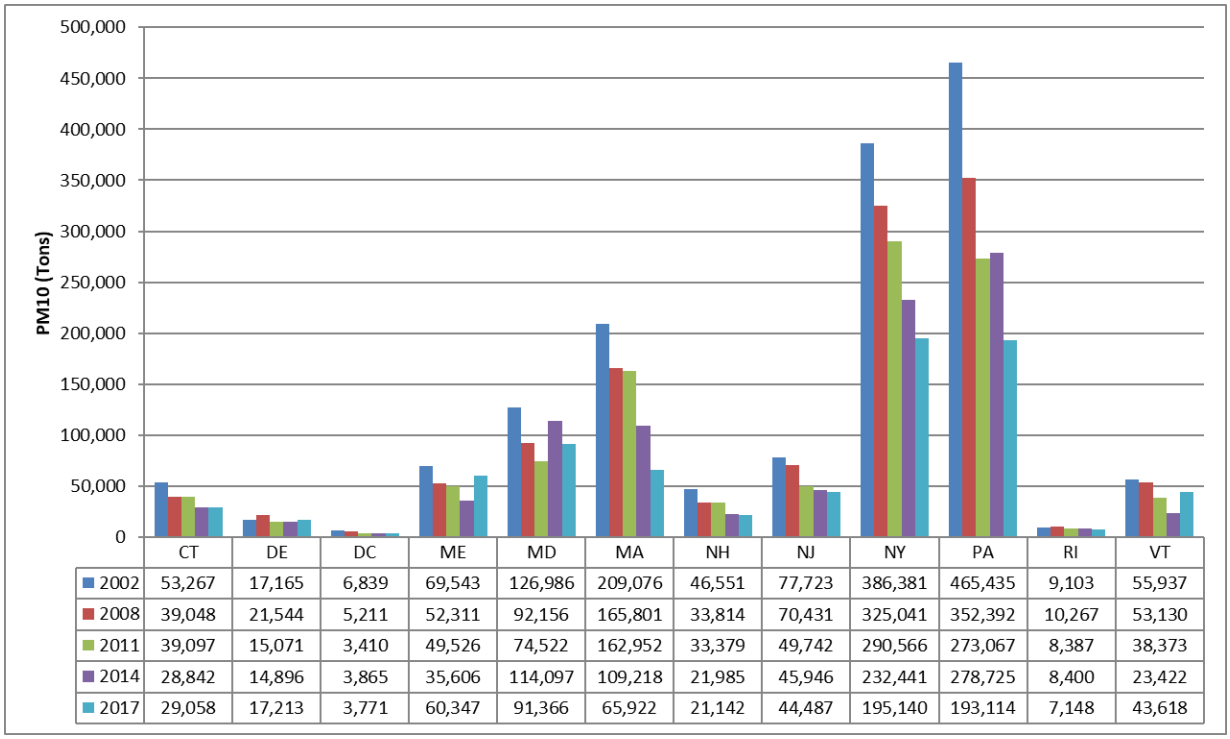


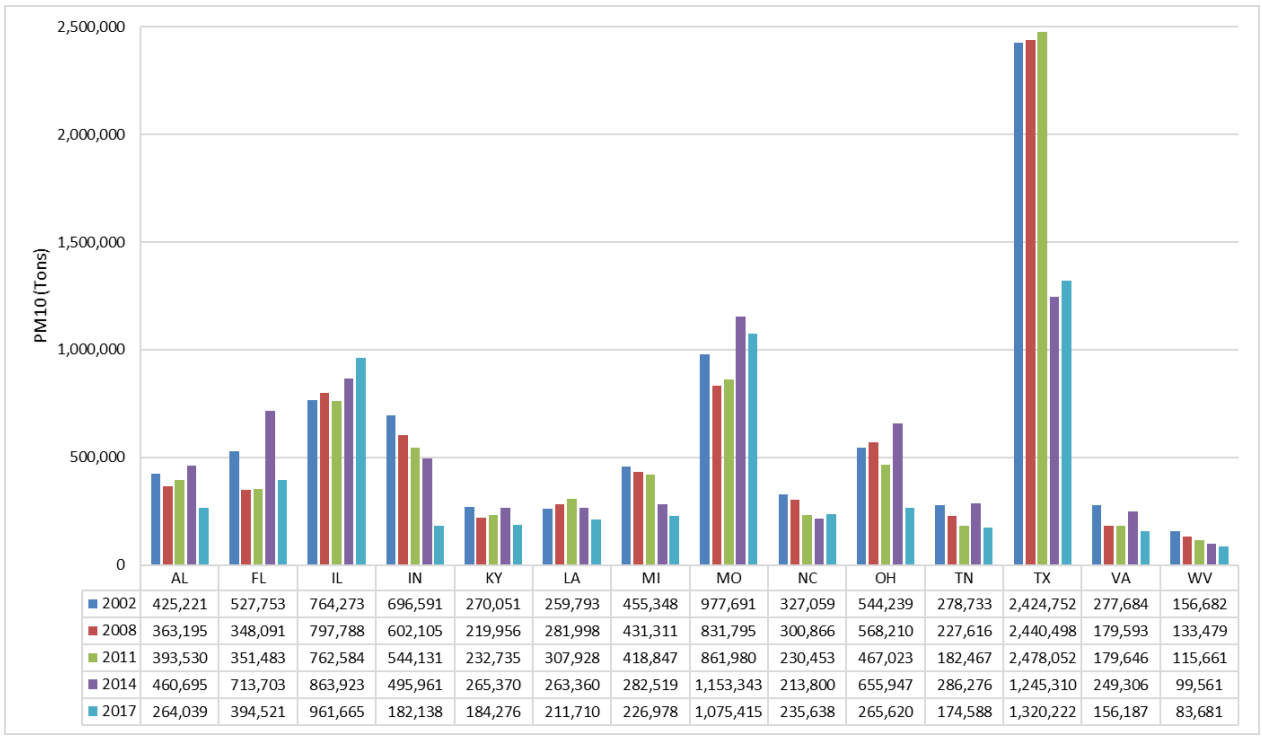
Figure 8-10: PM_{10} emissions in Vermont by source type, 2002-2017 (tons per year).

Figure 8-11 shows total PM_{10} emissions from all data categories in the MANE-VU states, Figure 8-12 from the Ask states. PM_{10} emissions in some of the MANE-VU and Ask states show no particular pattern over the 2002 to 2017 period. Some of the large declines in PM_{10} emissions from 2002 to subsequent years, as well as some of the increases in 2014, could be due to changes in estimation methodologies for categories such as yard waste burning, paved and unpaved road dust, and residential wood combustion.



	CT	DE	DC	ME	MD	MA	NH	NJ	NY	PA	RI	VT
2002	53,267	17,165	6,839	69,543	126,986	209,076	46,551	77,723	386,381	465,435	9,103	55,937
2008	39,048	21,544	5,211	52,311	92,156	165,801	33,814	70,431	325,041	352,392	10,267	53,130
2011	39,097	15,071	3,410	49,526	74,522	162,952	33,379	49,742	290,566	273,067	8,387	38,373
2014	28,842	14,896	3,865	35,606	114,097	109,218	21,985	45,946	232,441	278,725	8,400	23,422
2017	29,058	17,213	3,771	60,347	91,366	65,922	21,142	44,487	195,140	193,114	7,148	43,618

Figure 8-11: PM_{10} emissions in MANE-VU states by source type, 2002-2017 (tons per year).



	AL	FL	IL	IN	KY	LA	MI	MO	NC	OH	TN	TX	VA	WV
2002	425,221	527,753	764,273	696,591	270,051	259,793	455,348	977,691	327,059	544,239	278,733	2,424,752	277,684	156,682
2008	363,195	348,091	797,788	602,105	219,956	281,998	431,311	831,795	300,866	568,210	227,616	2,440,498	179,593	133,479
2011	393,530	351,483	762,584	544,131	232,735	307,928	418,847	861,980	230,453	467,023	182,467	2,478,052	179,646	115,661
2014	460,695	713,703	863,923	495,961	265,370	263,360	282,519	1,153,343	213,800	655,947	286,276	1,245,310	249,306	99,561
2017	264,039	394,521	961,665	182,138	184,276	211,710	226,978	1,075,415	235,638	265,620	174,588	1,320,222	156,187	83,681

Figure 8-12: PM_{10} emissions in Ask States by source type, 2002-2017 (tons per year).

8.4.3 Particulate Matter Less Than 2.5 Microns

Figure 8-13 shows a summary of $PM_{2.5}$ emissions from all data categories for the period from 2002 to 2017 in Vermont. Unlike emissions of PM_{10}, emissions of $PM_{2.5}$ show a steady decrease from 2008 to 2017. The trend in the emissions from unpaved road dust seen in the data for PM_{10} are still present in the totals for PM2.5, however, the contribution of unpaved road dust is significantly less for PM2.5 and so is overshadowed by the emissions of residential wood combustion. It is difficult to determine a reliable trend for emissions of $PM_{2.5}$ or PM_{10} due to the changes in methodologies between NEI datasets and the uncertainty in both the vehicle miles traveled data and in the estimates of wood combusted in residential appliances.

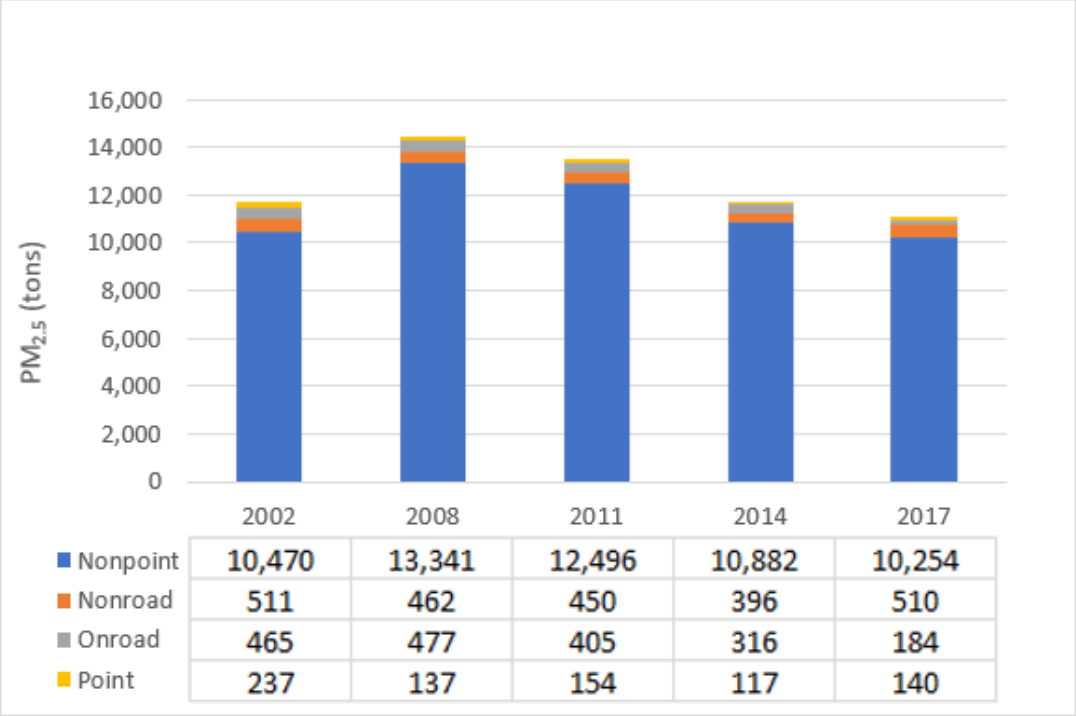
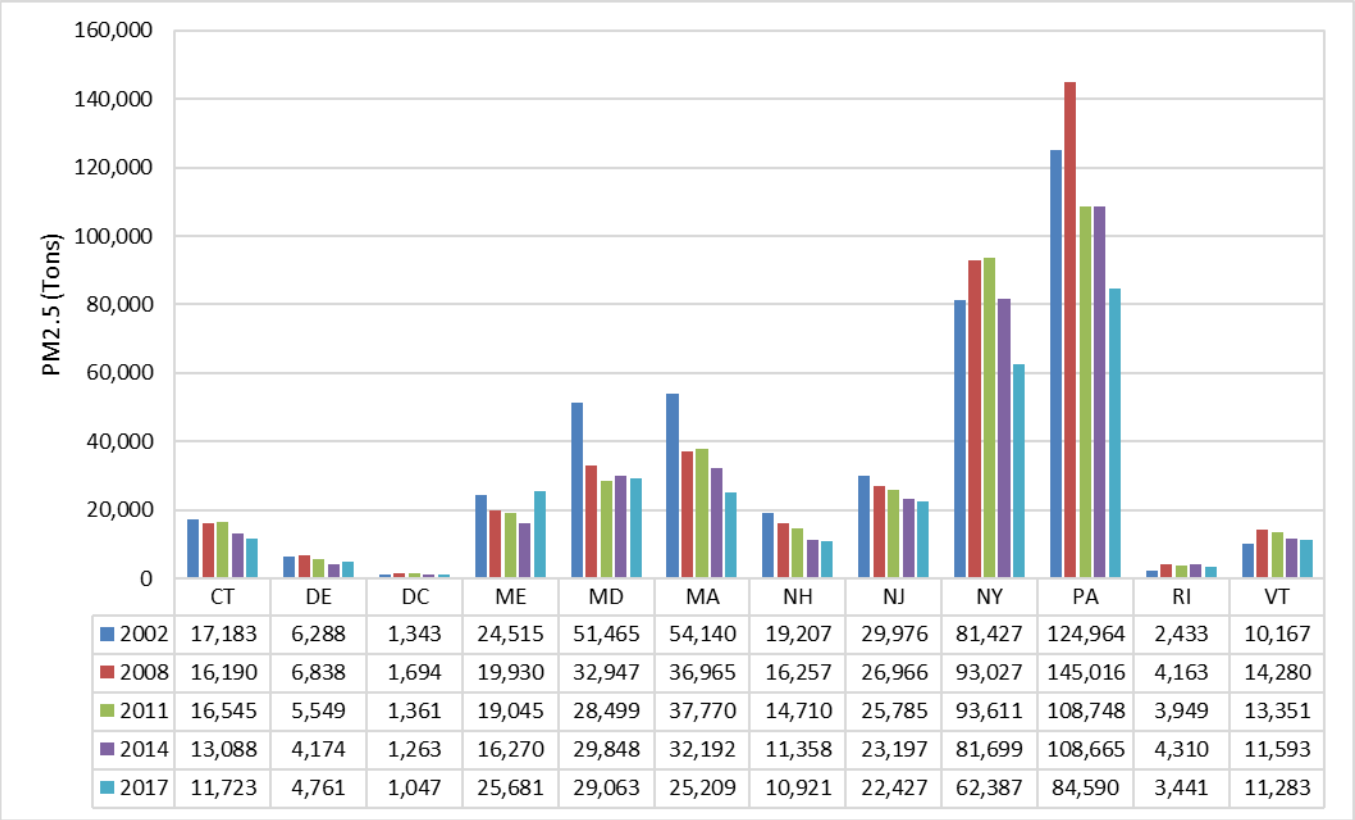


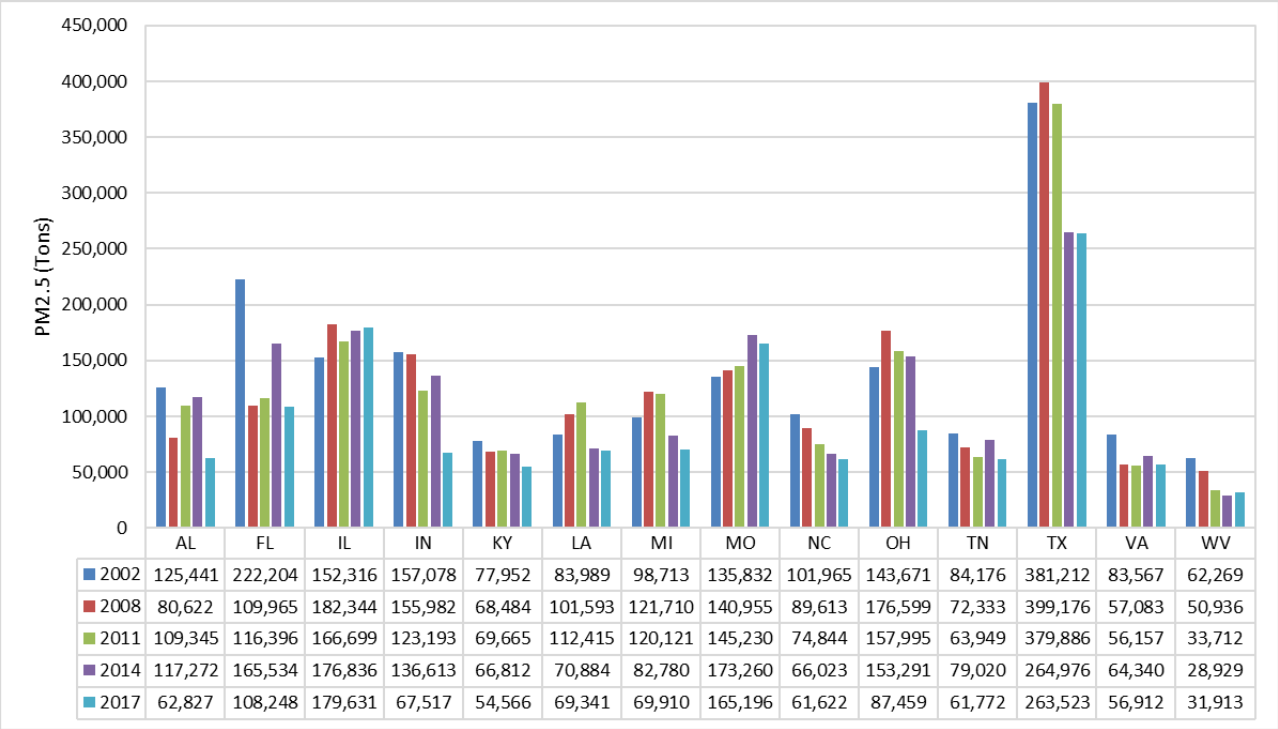
Figure 8-13: $PM_{2.5}$ emissions in Vermont by source type (tons per year).

Figures 8-14 and 8-15 below show total $PM_{2.5}$ emissions from all data categories in the MANE-VU and Ask states. These emissions show no particular pattern over the 2002 to 2017 period. In some states, emissions have declined or remained constant; in others, there are increases. As with PM_{10}, some of the large declines in $PM_{2.5}$ emissions from 2002 to subsequent years, as well as some of the increases in 2014, could be due to changes in estimation methodologies for categories such as yard waste burning, paved and unpaved road dust, and residential wood combustion.



	CT	DE	DC	ME	MD	MA	NH	NJ	NY	PA	RI	VT
2002	17,183	6,288	1,343	24,515	51,465	54,140	19,207	29,976	81,427	124,964	2,433	10,167
2008	16,190	6,838	1,694	19,930	32,947	36,965	16,257	26,966	93,027	145,016	4,163	14,280
2011	16,545	5,549	1,361	19,045	28,499	37,770	14,710	25,785	93,611	108,748	3,949	13,351
2014	13,088	4,174	1,263	16,270	29,848	32,192	11,358	23,197	81,699	108,665	4,310	11,593
2017	11,723	4,761	1,047	25,681	29,063	25,209	10,921	22,427	62,387	84,590	3,441	11,283

Figure 8-14: $PM_{2.5}$ emissions in MANE-VU states by source type, 2002-2017 (tons per year).

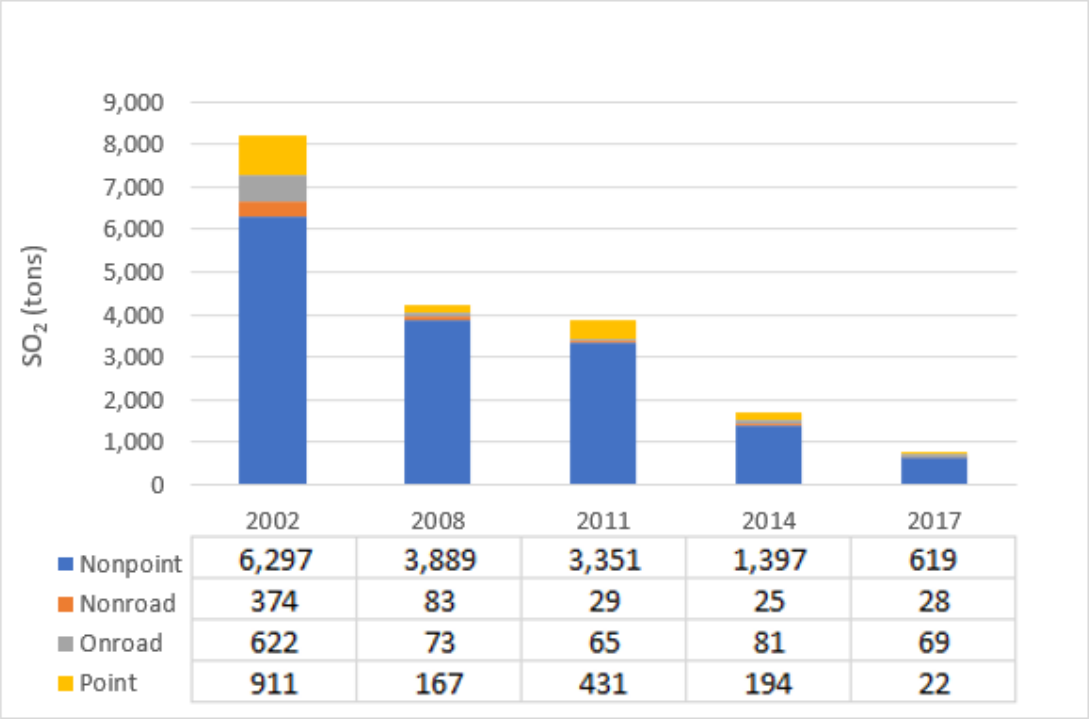


	AL	FL	IL	IN	KY	LA	MI	MO	NC	OH	TN	TX	VA	WV
2002	125,441	222,204	152,316	157,078	77,952	83,989	98,713	135,832	101,965	143,671	84,176	381,212	83,567	62,269
2008	80,622	109,965	182,344	155,982	68,484	101,593	121,710	140,955	89,613	176,599	72,333	399,176	57,083	50,936
2011	109,345	116,396	166,699	123,193	69,665	112,415	120,121	145,230	74,844	157,995	63,949	379,886	56,157	33,712
2014	117,272	165,534	176,836	136,613	66,812	70,884	82,780	173,260	66,023	153,291	79,020	264,976	64,340	28,929
2017	62,827	108,248	179,631	67,517	54,566	69,341	69,910	165,196	61,622	87,459	61,772	263,523	56,912	31,913

Figure 8-15: $PM_{2.5}$ emissions in Ask States by source type, 2002-2017 (tons per year).

8.4.4 Sulfur Dioxide

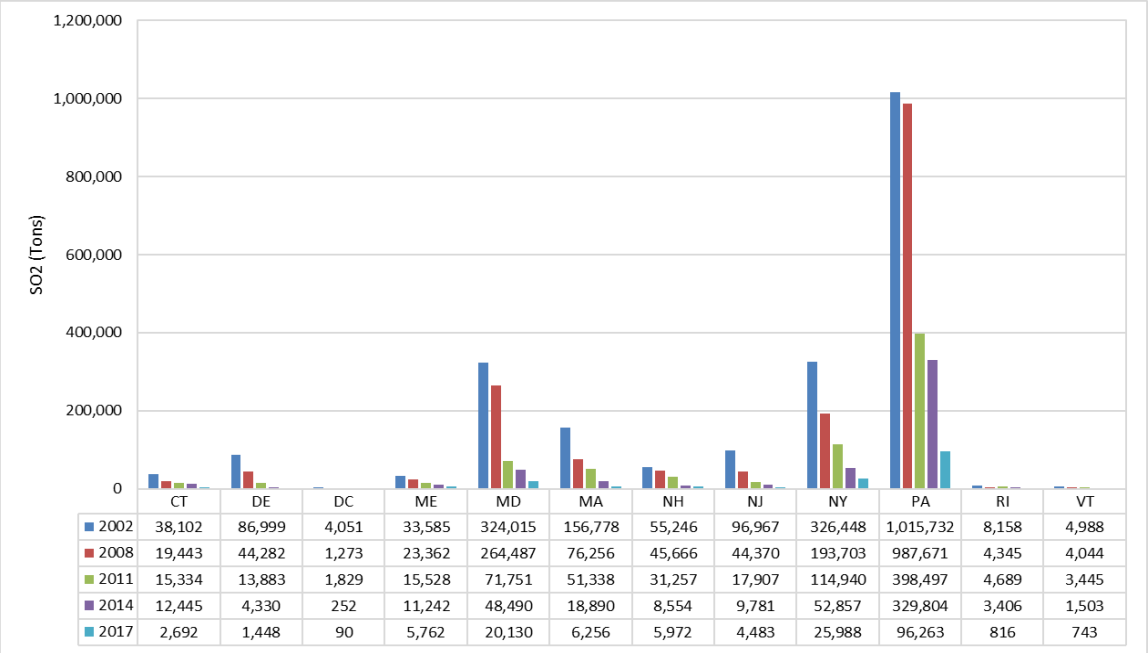
Figure 8-16 shows SO_2 emissions in Vermont for all data categories for the period from 2002 to 2017. Decreases in emissions of SO2 in Vermont are attributed to the both the Federal onroad and non-road diesel fuel standards and to a regulation adopted as a part of a regional air pollution control strategy to reduce the sulfur content in heating oil used, purchased, or sold in the state. This regulation contributes to the drastic decreases in SO_2 emissions in the nonpoint sector, specifically in the use of oil in residential appliances and industrial boilers. The regulation required the sulfur content of No.2 and lighter distillate oils to not exceed 500ppm sulfur content by July 1, 2014 and 15ppm sulfur content starting July 1, 2018. No.4 and No.5/No.6 residual fuel oils are also regulated, though with somewhat higher sulfur content limits.



	2002	2008	2011	2014	2017
Nonpoint	6,297	3,889	3,351	1,397	619
Nonroad	374	83	29	25	28
Onroad	622	73	65	81	69
Point	911	167	431	194	22

Figure 8-16: SO_2 emissions in Vermont by source type, 2002-2017 (tons per year).

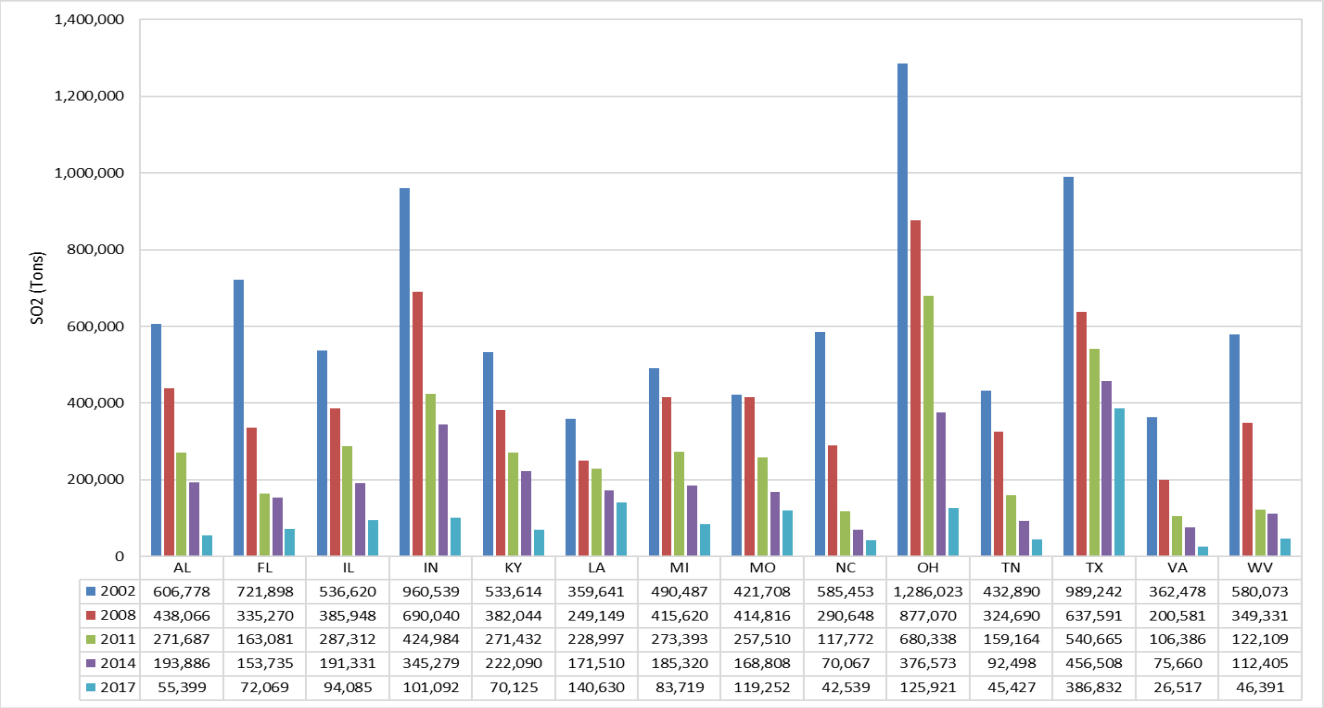
Figure 8-17 shows total SO_2 emissions from all data categories in the MANE-VU states for 2002 to 2017. A steady decrease in SO_2 emissions can be seen for each MANE-VU state over this period. Some of these decreases are attributable to the low sulfur fuel strategy and the 90% or greater reduction in SO_2 emissions at 167 EGU stacks (both inside and outside of MANE-VU) requested in the MANE-VU "Ask" for states within MANE-VU for the first regional haze planning period. Since some components of the MANE-VU low sulfur fuel strategy have milestones of 2014, 2016 and 2018, and as MANE-VU states continue to adopt rules to implement the strategy, SO_2 emissions reductions are expected to continue well beyond the 2002 to 2017 timeframe shown in Figure 8-17. Other SO_2 emissions decreases are due to source shutdowns and fuel switching due to the availability of less expensive natural gas in recent years.



	CT	DE	DC	ME	MD	MA	NH	NJ	NY	PA	RI	VT
2002	38,102	86,999	4,051	33,585	324,015	156,778	55,246	96,967	326,448	1,015,732	8,158	4,988
2008	19,443	44,282	1,273	23,362	264,487	76,256	45,666	44,370	193,703	987,671	4,345	4,044
2011	15,334	13,883	1,829	15,528	71,751	51,338	31,257	17,907	114,940	398,497	4,689	3,445
2014	12,445	4,330	252	11,242	48,490	18,890	8,554	9,781	52,857	329,804	3,406	1,503
2017	2,692	1,448	90	5,762	20,130	6,256	5,972	4,483	25,988	96,263	816	743

Figure 8-17: SO_2 emissions in MANE-VU states by source type, 2002-2017 (tpy)

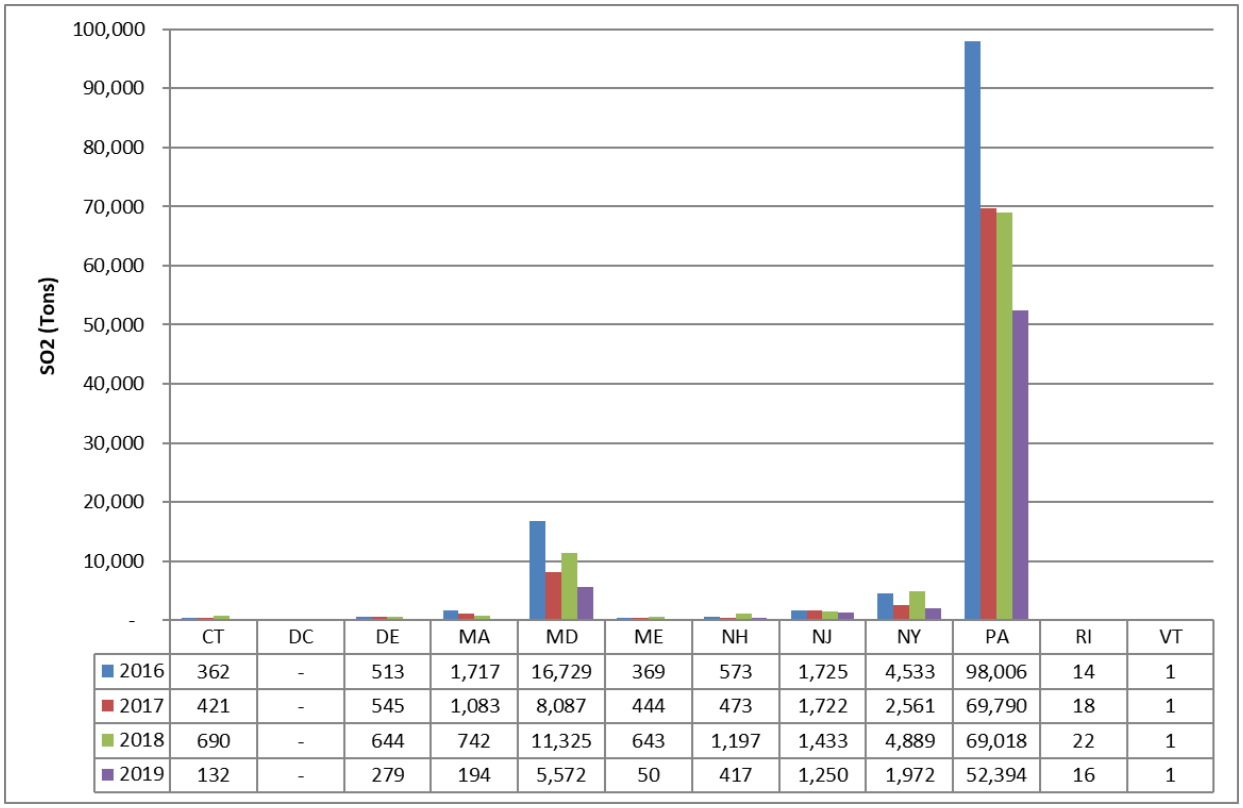
Figure 8-18 shows total SO_2 emissions from all data categories in the Ask states for 2002 to 2017. Similar to the MANE-VU states, decreases in SO_2 can be seen for all the Ask states over this period. Some of these decreases are attributable to the control measures requested in the MANE-VU Ask for states outside of MANE-VU for the first regional haze planning period, including timely implementation of BART requirements and a 90% or greater reduction in SO_2 emissions at 167 stacks inside and outside of MANE-VU.



	AL	FL	IL	IN	KY	LA	MI	MO	NC	OH	TN	TX	VA	WV
2002	606,778	721,898	536,620	960,539	533,614	359,641	490,487	421,708	585,453	1,286,023	432,890	989,242	362,478	580,073
2008	438,066	335,270	385,948	690,040	382,044	249,149	415,620	414,816	290,648	877,070	324,690	637,591	200,581	349,331
2011	271,687	163,081	287,312	424,984	271,432	228,997	273,393	257,510	117,772	680,338	159,164	540,665	106,386	122,109
2014	193,886	153,735	191,331	345,279	222,090	171,510	185,320	168,808	70,067	376,573	92,498	456,508	75,660	112,405
2017	55,399	72,069	94,085	101,092	70,125	140,630	83,719	119,252	42,539	125,921	45,427	386,832	26,517	46,391

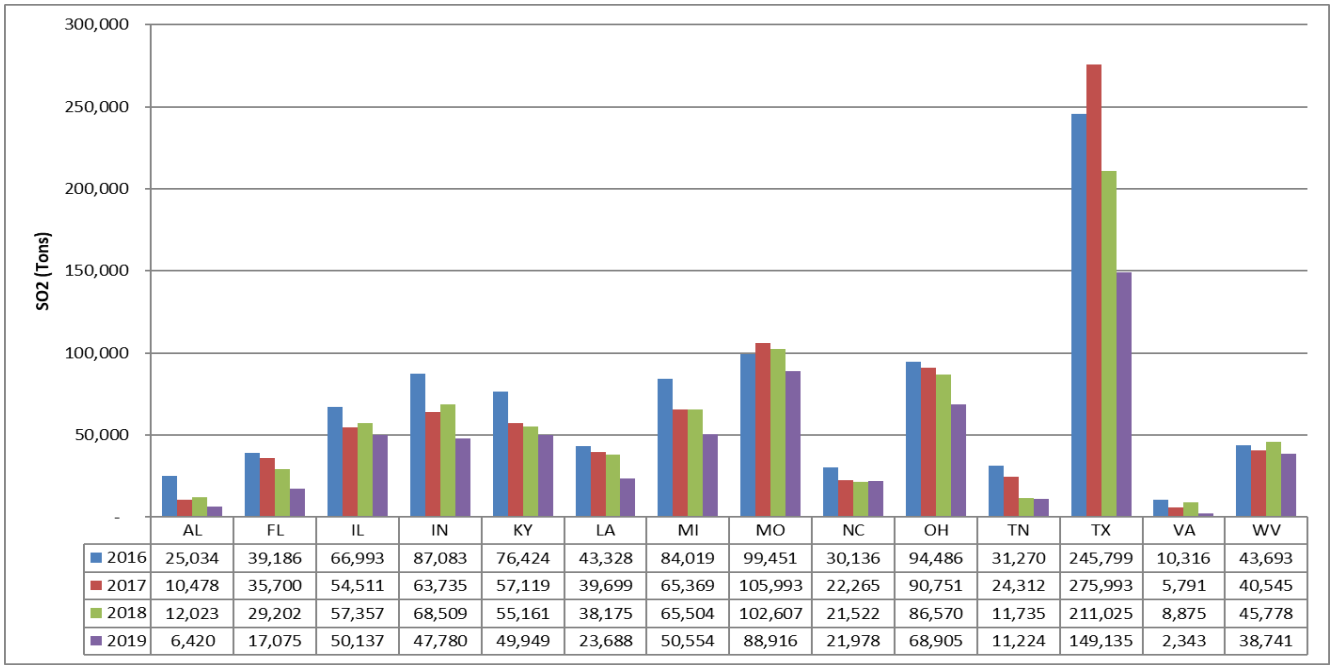
Figure 8-18: SO_2 emissions in Ask States by source type, 2002-2017 (tons per year).

Figures 8-19 and 8-20, respectively, show 2016 through 2019 SO_2 emissions for AMPD sources in the MANE-VU states and in the Ask states. AMPD SO_2 emissions in 2019 are lower than the corresponding 2016 emissions for almost every MANE-VU and Ask state. However, a few MANE-VU and Ask states show slight increases in AMPD SO_2 emissions between 2016 and 2017. Despite the handful of state increases, total AMPD SO_2 emissions for 2017 are well below the corresponding 2016 total for both the MANE-VU states and the Ask states. For applicable states, some of the SO_2 reduction for AMPD sources is attributable to CSAPR, which requires NOx and/or SO_2 emissions reductions from EGUs in 27 states in the eastern and central US.



	CT	DC	DE	MA	MD	ME	NH	NJ	NY	PA	RI	VT
2016	362	-	513	1,717	16,729	369	573	1,725	4,533	98,006	14	1
2017	421	-	545	1,083	8,087	444	473	1,722	2,561	69,790	18	1
2018	690	-	644	742	11,325	643	1,197	1,433	4,889	69,018	22	1
2019	132	-	279	194	5,572	50	417	1,250	1,972	52,394	16	1

Figure 8-19: SO_2 emissions from AMPD sources in MANE-VU states, 2016-2019 (tons per year).



	AL	FL	IL	IN	KY	LA	MI	MO	NC	OH	TN	TX	VA	WV
2016	25,034	39,186	66,993	87,083	76,424	43,328	84,019	99,451	30,136	94,486	31,270	245,799	10,316	43,693
2017	10,478	35,700	54,511	63,735	57,119	39,699	65,369	105,993	22,265	90,751	24,312	275,993	5,791	40,545
2018	12,023	29,202	57,357	68,509	55,161	38,175	65,504	102,607	21,522	86,570	11,735	211,025	8,875	45,778
2019	6,420	17,075	50,137	47,780	49,949	23,688	50,554	88,916	21,978	68,905	11,224	149,135	2,343	38,741

Figure 8-20: SO_2 emissions from AMPD sources in Ask States, 2016-2019 (tons per year).

8.4.5 Volatile Organic Compounds

Figure 8-21 shows VOC emissions from all data categories in Vermont over the 2002 to 2017 period. In general, VOC emissions have declined during this period. However, the sharp decrease in nonpoint VOC between 2002 and subsequent years is partly due to a revised methodology for residential wood combustion. Therefore, the decrease in nonpoint VOC between 2002 and subsequent years is artificially overstated. Reductions seen in the nonroad sector in 2017 are likely due to changes to the nonroad model methodologies and incorporation in the EPA MOVES model between the 2014 and 2017 NEIs and to updates to vehicle populations and emission factors.

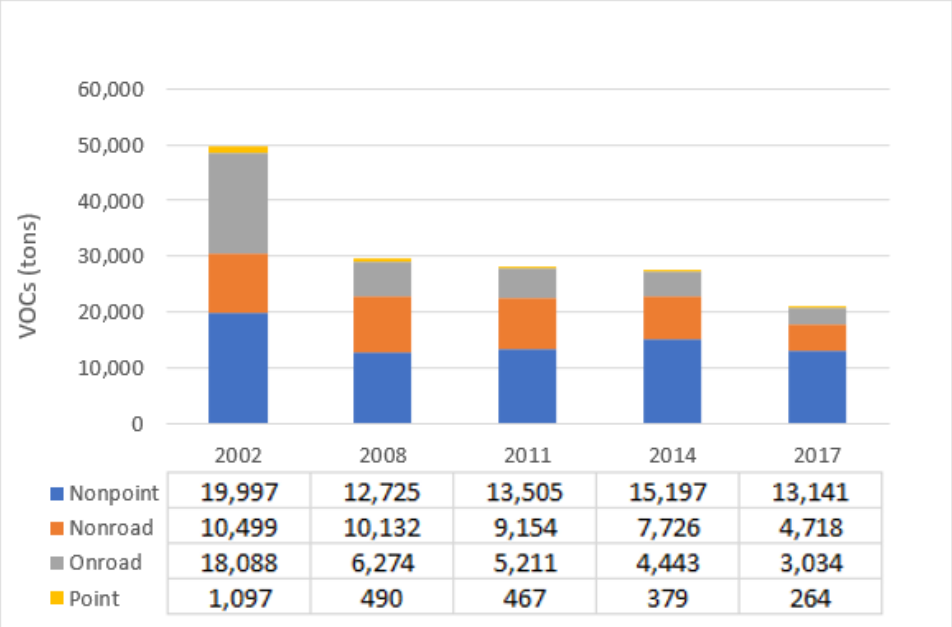
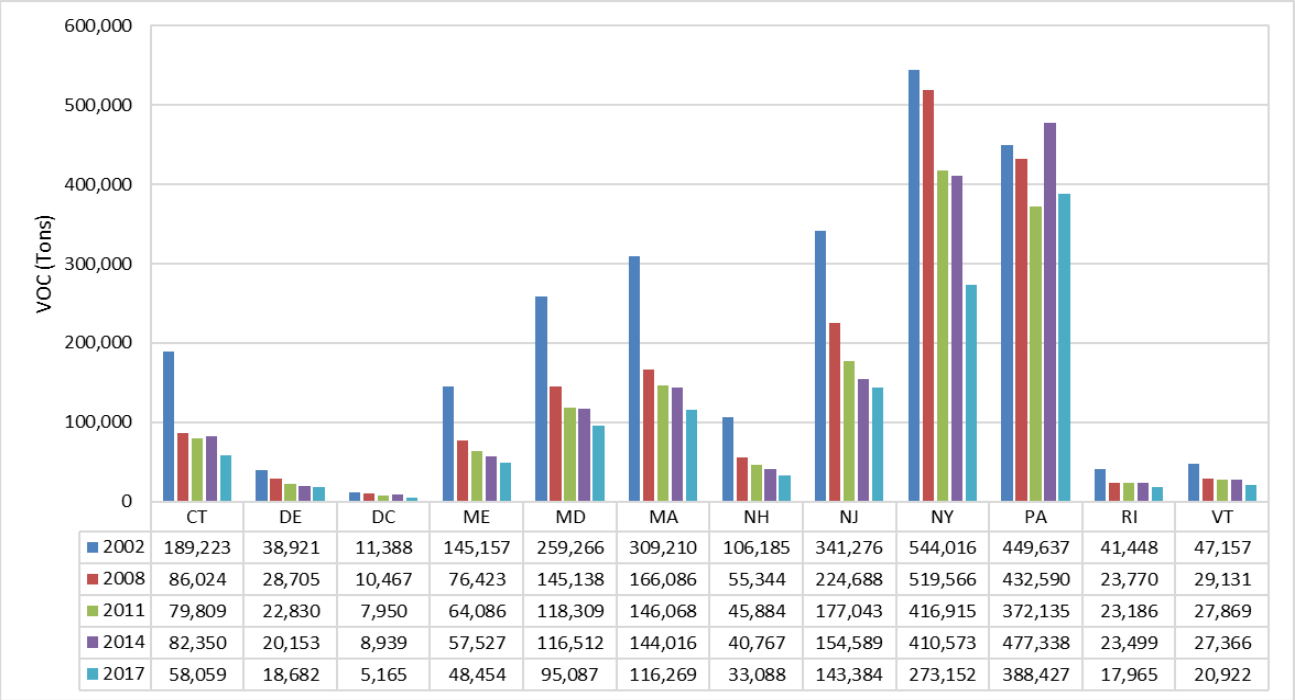


Figure 8-21: VOC emissions in Vermont by source type, 2002-2017 (tons per year).

Figure 8-22 shows total VOC emissions from all data categories for the MANE-VU states during the period from 2002 to 2017. Except for CT, PA, and RI, VOC emissions have declined in all MANE-VU states during this period. Similar to Vermont, the decrease between 2002 and subsequent years is likely artificially overstated for many states because of changes in estimation methodologies for nonpoint categories such as residential wood combustion and yard waste burning.

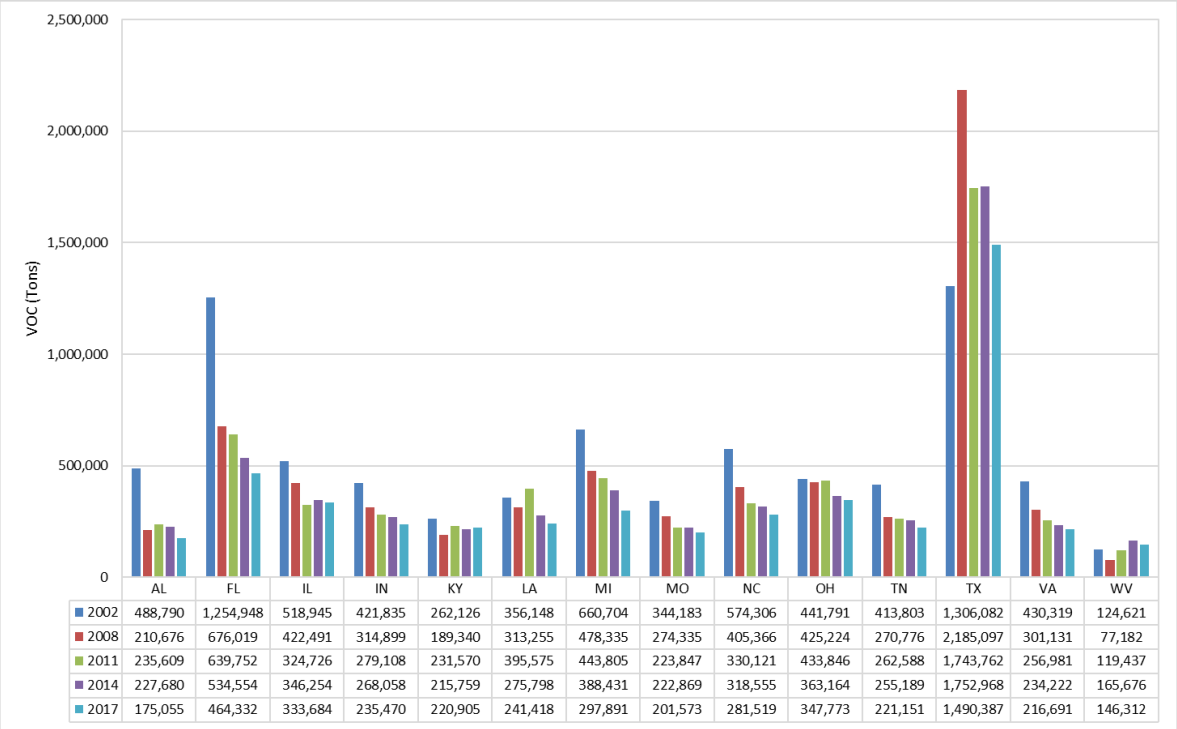
Much of the decrease in VOC is attributable to Federal and state rules for evaporative sources of VOC emissions such as portable fuel containers; architectural, industrial, and maintenance coatings; consumer products; and solvent degreasing. Many states rules for these types of categories are based on the OTC Model Rules. 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 states' VOC RACT rules. Evaporative VOC emissions from on-road mobile sources have decreased due to state motor vehicle I&M programs and the permeation of more ORVR equipped vehicles into the fleet. VOC emissions from non-road and on-road mobile sources are expected to continue to decrease as older, more polluting vehicles are replaced by newer, cleaner ones.



	CT	DE	DC	ME	MD	MA	NH	NJ	NY	PA	RI	VT
2002	189,223	38,921	11,388	145,157	259,266	309,210	106,185	341,276	544,016	449,637	41,448	47,157
2008	86,024	28,705	10,467	76,423	145,138	166,086	55,344	224,688	519,566	432,590	23,770	29,131
2011	79,809	22,830	7,950	64,086	118,309	146,068	45,884	177,043	416,915	372,135	23,186	27,869
2014	82,350	20,153	8,939	57,527	116,512	144,016	40,767	154,589	410,573	477,338	23,499	27,366
2017	58,059	18,682	5,165	48,454	95,087	116,269	33,088	143,384	273,152	388,427	17,965	20,922

Figure 8-22: VOC emissions in MANE-VU states by source type, 2002-2017 (tons per year).

VOC emissions from all data categories from the Ask states are shown in Figure 8-23. In general, VOC emissions have declined in the Ask states, although some states show little change, or even increases, in total VOC emissions from 2002 to 2014/2017. Some of these increases, or the sharp decreases evident in AL and FL between 2002 and subsequent years, could be artificial due to methodology changes. Despite the increases in some individual states, overall total VOC emissions in the Ask states have declined from 2002 to 2017.



	AL	FL	IL	IN	KY	LA	MI	MO	NC	OH	TN	TX	VA	WV
2002	488,790	1,254,948	518,945	421,835	262,126	356,148	660,704	344,183	574,306	441,791	413,803	1,306,082	430,319	124,621
2008	210,676	676,019	422,491	314,899	189,340	313,255	478,335	274,335	405,366	425,224	270,776	2,185,097	301,131	77,182
2011	235,609	639,752	324,726	279,108	231,570	395,575	443,805	223,847	330,121	433,846	262,588	1,743,762	256,981	119,437
2014	227,680	534,554	346,254	268,058	215,759	275,798	388,431	222,869	318,555	363,164	255,189	1,752,968	234,222	165,676
2017	175,055	464,332	333,684	235,470	220,905	241,418	297,891	201,573	281,519	347,773	221,151	1,490,387	216,691	146,312

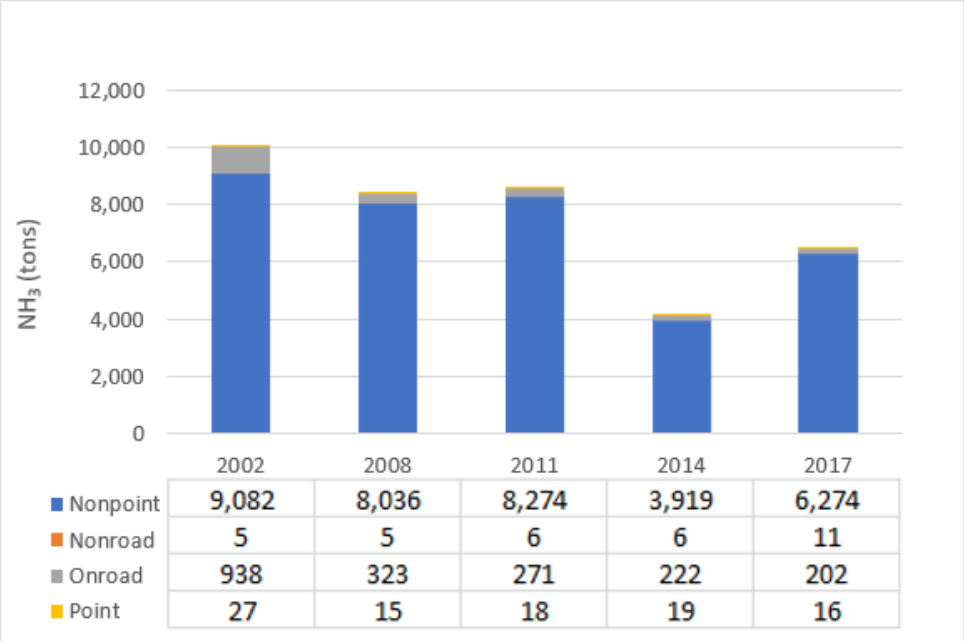
Figure 8-23: VOC emissions in Ask States by source type, 2002-2017 (tons per year).

8.4.6 Ammonia

Figure 8-24 shows ammonia emissions for all data categories in Vermont for 2002 to 2017. Although some year-to-year variability can be seen, there is still a general downward trend in ammonia emissions for Vermont. The sharp decrease in emissions of NH_3 in 2014 could potentially be due to changes in the calculation methodology for the largest contributing sector, agricultural livestock waste, between the 2011 NEI and the 2014 NEI. Emissions in this sector for the 2011 NEI were based on an ammonia model that used a monthly temporal profile and county-level animal populations and emission factors, whereas the 2014 NEI utilized daily emission factors and regionally specific information on manure management practices.

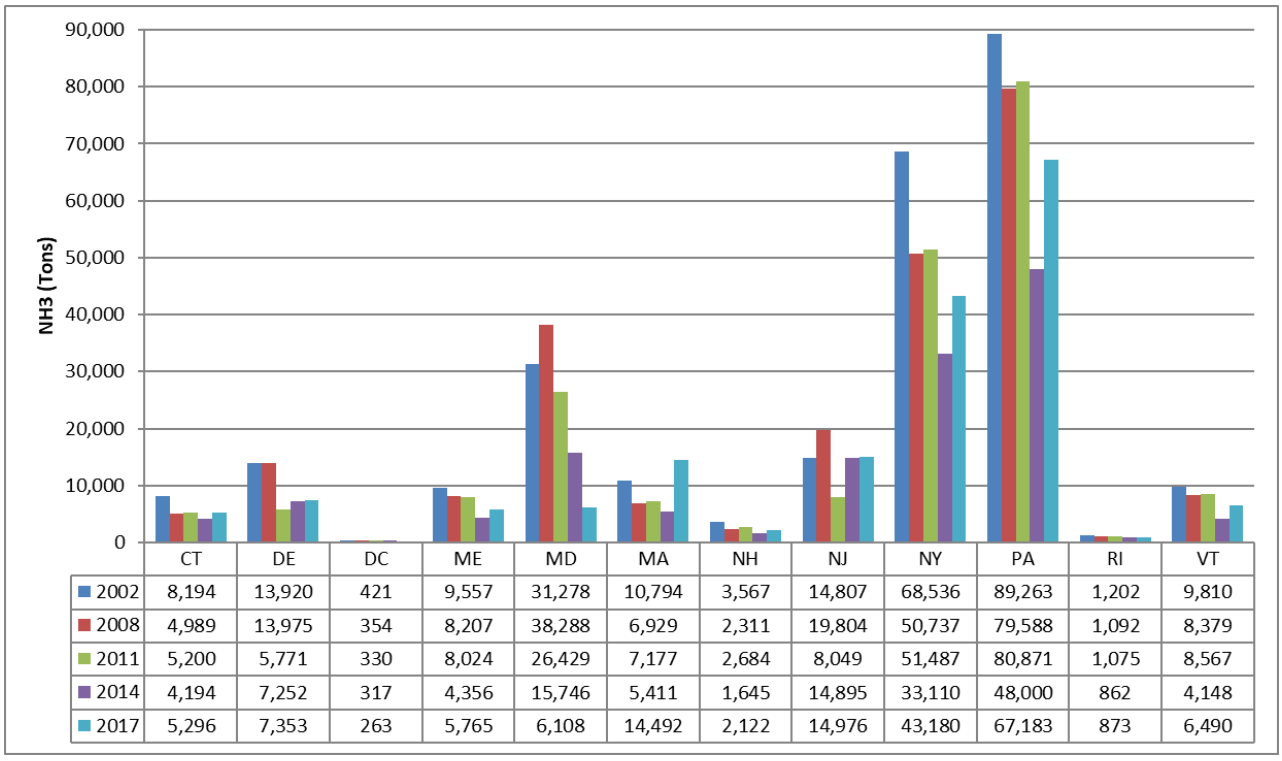
Figure 8-25 shows total ammonia emissions for all data categories combined for the MANE-VU states. Similar to Vermont, some year-to-year variability can be seen. For many MANE-VU states, ammonia emissions for 2014 and 2017 are lower than they were for earlier years. Most MANE-VU states saw increases in 2017 relative to 2014; this could be the result of estimation methodology changes.

Total ammonia emissions for all data categories for the Ask states are shown in Figure 8-26. Again, some year-to-year variability in ammonia emissions can be seen. In most of the Ask states, 2014 emissions are lower than they were for previous years. For every Ask state, 2014 emissions are lower than they were for at least one of the earlier years. 2017 saw an uptick in ammonia emissions for some of the Ask states; again, this could be due to changes in emissions estimation methods.



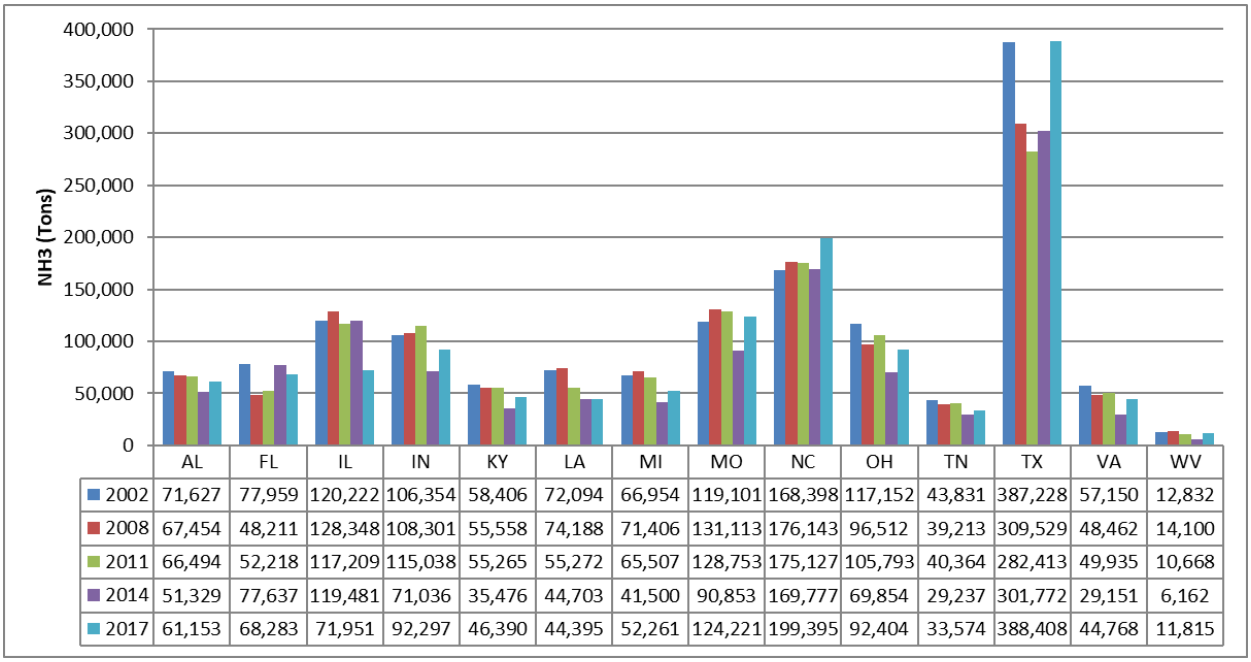
	2002	2008	2011	2014	2017
Nonpoint	9,082	8,036	8,274	3,919	6,274
Nonroad	5	5	6	6	11
Onroad	938	323	271	222	202
Point	27	15	18	19	16

Figure 8-24: NH_3 emissions in Vermont by source type, 2002-2017 (tons per year).



	CT	DE	DC	ME	MD	MA	NH	NJ	NY	PA	RI	VT
2002	8,194	13,920	421	9,557	31,278	10,794	3,567	14,807	68,536	89,263	1,202	9,810
2008	4,989	13,975	354	8,207	38,288	6,929	2,311	19,804	50,737	79,588	1,092	8,379
2011	5,200	5,771	330	8,024	26,429	7,177	2,684	8,049	51,487	80,871	1,075	8,567
2014	4,194	7,252	317	4,356	15,746	5,411	1,645	14,895	33,110	48,000	862	4,148
2017	5,296	7,353	263	5,765	6,108	14,492	2,122	14,976	43,180	67,183	873	6,490

Figure 8-25: NH_3 emissions in MANE-VU states by source type, 2002-2017 (tons per year).



	AL	FL	IL	IN	KY	LA	MI	MO	NC	OH	TN	TX	VA	WV
2002	71,627	77,959	120,222	106,354	58,406	72,094	66,954	119,101	168,398	117,152	43,831	387,228	57,150	12,832
2008	67,454	48,211	128,348	108,301	55,558	74,188	71,406	131,113	176,143	96,512	39,213	309,529	48,462	14,100
2011	66,494	52,218	117,209	115,038	55,265	55,272	65,507	128,753	175,127	105,793	40,364	282,413	49,935	10,668
2014	51,329	77,637	119,481	71,036	35,476	44,703	41,500	90,853	169,777	69,854	29,237	301,772	29,151	6,162
2017	61,153	68,283	71,951	92,297	46,390	44,395	52,261	124,221	199,395	92,404	33,574	388,408	44,768	11,815

Figure 8-26: NH_3 emissions in Ask States by source type, 2002-2017 (tons per year).

8.5 Assessment of Anthropogenic Sources that Have Impeded Progress 51.308(g)(5)

Paragraph 51.308(g)(5) requires an assessment of any significant changes in anthropogenic emissions within or outside the State that have occurred since the period addressed in the most recent plan required under paragraph (f) of this section including whether or not these changes in anthropogenic emissions were anticipated in that most recent plan and whether they have limited or impeded progress in reducing pollutant emissions and improving visibility. Further, paragraph 51.308(f)(5) states the following: So that the plan revision will also serve as a progress report, the State must address in the plan revision the requirements of paragraphs (g)(1) through (5) of this section. However, the period to be addressed for these elements shall be the period since the most recent progress report. Vermont's most recent progress report was drafted in August 2014[52] and covered the period from baseline through 2014

Paragraph 51.308(g) does not specifically define what would constitute a significant change in emissions that would limit or impede progress in reducing pollutant emissions or improving visibility. There are no new sources or existing sources in Vermont that have significantly increased emissions of haze-causing pollutants. Further, in Vermont and upwind states, there has been a shift to cleaner generation of electricity using more renewable sources or natural gas in place of dirtier fuels such as coal or oil. This trend is driven by economics and the availability of less expensive natural gas supplies rather than by any regulatory mechanism. It is not known if this economic situation will continue into the future, therefore MANE-VU states are pursuing Item 4 of the current Intra-RPO Ask (i.e. the enforceable "locking-in" of the emission rates associated with the burning of cleaner fuels.

[52] VTDEC, (February 2016). *Vermont Regional Haze 5-Year Progress Report*. Available at: https://www.des.nh.gov/organization/divisions/air/do/asab/rhp/documents/rh-progress-report.pdf.

9 MONITORING STRATEGY (40 CFR 51.308(f)(6))

In their periodic comprehensive revisions, states must identify their strategy for measuring, characterizing, and reporting regional haze visibility impairment that is representative of the Federal Class I areas within their states. Compliance with this requirement may be met through participation in the IMPROVE network. The IMPROVE program provides scientific documentation of the visual air quality of America's Federal wilderness areas and national parks.

The IMPROVE program consists of monitoring sites operated and maintained through a formal cooperative relationship between the EPA, National Park Service, U.S. Fish and Wildlife Service, Bureau of Land Management and U.S. Forest Service. Several other organizations have joined the program since its inception in the mid-1980s. These are State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Officials (which have since merged under the name NACAA), WSARC, MARAMA, and NESCAUM.

Vermont's monitoring strategy relies on participation in the IMPROVE network and FED. VTDEC evaluates the monitoring network periodically and makes appropriate adjustments to it as necessary. Vermont's commitment to following this strategy and providing continuing assessments of progress toward national visibility goals at mandatory Federal Class I areas will remain contingent on sufficient federal funding in support of monitoring program requirements and associated databases. In the event that existing funding sources are eliminated or curtailed, Vermont will consult with the FLMs on the most practicable course of action. Other implementation plan requirements related to the monitoring strategy are addressed in the following sections.

9.1 Additional Requirements Related to Monitoring

- **40 CFR 51.308(f)(6)(i)** *The establishment of any additional monitoring sites or equipment to assess whether reasonable progress goals are being achieved.*

  At this time, the existing monitors are sufficient to make this assessment. Vermont's commitment to maintain the current level of monitoring, and to expand monitoring or analysis should such action become necessary, will remain contingent on federal funding assistance.

- **40 CFR 51.308(f)(6)(ii)** *Procedures by which monitoring data and other information are used in determining contributions to regional haze visibility impairments to Class I Federal areas both within and outside of the State.*

  In order to determine which states should be consulted an analysis must be conducted to define what states, sources, or sectors reasonably contribute to visibility impairment. EPA's guidance document calls for a process for determining which sources or source sectors should be considered. The procedures that VTDEC used to make this determination were described earlier in Section 3.

- **40 CFR 51.308(f)(6)(iv)** *Provide for the reporting of all visibility monitoring data to the Administrator at least annually for Class I Federal areas within the state.*

  The Federal Land Manager submits the data, and the data are posted on the FED website.

- **40 CFR 51.308(f)(6)(v)** *Provide a statewide inventory of emissions of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in mandatory Class I areas within Vermont.*

  In Section 8, VTDEC has provided statewide emissions estimates of NOx, SO_2, $PM_{2.5}$, VOCs, and NH_3 for most recent year for which data are available (2014 for all categories and 2017 for those facilities that report to EPA's AMPD). VTDEC commits to update its statewide emissions inventory periodically.

- **40 CFR 51.308(f)(6)(vi)** *requires that SIPs provide other elements, including reporting, recordkeeping, and other measures necessary to assess and report on visibility.*

  VTDEC believes the current IMPROVE network is sufficient to adequately measure and report progress toward the regional haze goals set for Vermont's and other Federal Class I areas. Additional monitoring information can be useful in assessing patterns of regional visibility and fine particle pollution. Examples of these data sources include:

  - The NESCAUM RAIN network, which provides continuous, speciated information on rural aerosol characteristics and visibility parameters.
  - The EPA CASTNET program, which has provided complementary rural fine particle speciation data at non-Class I sites.
  - The EPA Speciation Trends Network (STN), which provides speciated, urban fine particle data to help develop a comprehensive picture of local and regional sources.
  - State-operated rural and urban speciation sites using IMPROVE or STN methods (the latter program comprising 54 monitoring stations located mainly in or near larger metropolitan areas).
  - The Supersites program, which has undertaken special studies to expand knowledge of the processes that control fine particle formation and transport in the region.

Assuming that these resources will continue to be available and that fiscal reality allows, Vermont will continue using these and other data sources for the purposes of understanding visibility impairment and documenting progress toward national visibility goals for Federal Class I areas under the Regional Haze Rule. Vermont's IMPROVE monitoring site representing the Lye Brook Wilderness is located at Mount Snow, and is pictured below in Figure 9-1.

Figure 9-1: Lye Brook Aerosol and Nephelometer IMPROVE Monitoring Station.

10 PUBLIC COMMENT PROCESS

Federal Land Managers were provided a 60-day review of the draft State Implementation Plan, as required by the Regional Haze Rule. Replies to this review are found in Appendix X.

Vermont is offering this State Implementation Plan for a 60-day public comment period and will hold a public hearing on this plan should one be requested. Vermont will document the public participation process, including formal comments submitted to the State of Vermont by the Federal Land Managers, the EPA or any member of the public. Responses to comments will be included as an Appendix to this SIP and any appropriate or necessary changes to the SIP will be made based upon acceptable and meaningful public comments.

11 CONCLUSION

As required by 40 CFR 51.308(h), Vermont is submitting, as part of the progress report for the First Implementation Period, a negative declaration that a revision of the 2009 SIP was not required, and continues to not be required, to meet the goals for visibility improvement.

This SIP revision for the Second Implementation Period represents the culmination of years' worth of technical work performed in partnership with member states, tribes, EPA and the federal land managers (FLMs). The technical work for this current SIP update was completed according to the original SIP update timeline of 2018, rather than 2021. Because much of the technical work investment has already been made and funding is not expected to be available to redo it with data that are more recent, MANE-VU members elected to submit the SIPs with the completed work. Concerns were raised during consultation about using more up to date data, but this leads into a cycle where no data will ever represent the most recent possible because emission inventories take years to calculate and finalize before they can be used. Using a 2011 NEI based modeling platform for a 2018 SIP submittal represents the same time delay as a 2014 NEI platform for a 2021 SIP submittal.

It is important to note that many of the concerns about using the latest emissions inventory can be put into a perspective that it is not a critical factor during this SIP update. Currently, Federal Class I areas in the MANE-VU region are monitoring visibility improvement that are better than the rate of progress requirements for 2018 and most are also already monitoring benefits in excess of the 2028 rate of progress requirements. Therefore, the emissions inventories used for photochemical modeling are not likely to determine that additional measures will be required to meet rate of progress goals. Instead, the primary direction of this SIP update is to consider another provision of the Regional Haze Rule, the determination of other measures that can improve visibility that can be reasonably implemented during this 10-year planning cycle. Photochemical modeling based on the 2011 NEI was not used to determine how reasonable those measures are, but rather to demonstrate the benefit that may occur if those additional measures are implemented. If an emission source has updated its operations and reduced emissions, then that would be considered during the requested analysis prior to SIP inclusion.

It is noteworthy that the additional measures included in the MANE-VU Ask (and this SIP update) were selected because they were already analyzed and implemented by at least one-member state. Thus, in application, they were found to be reasonable. After further examination by the MANE-VU technical support committee, MANE-VU states agreed that the measures are reasonable to pursue at this time to benefit visibility at MANE-VU Class I areas. The measures are expected to benefit Federal Class I areas outside the MANE-VU region as well.

Because Vermont finds the measures included in this SIP to be reasonable to pursue at this time, they are included in this SIP update along with appropriate technical analysis, rulemaking and public review. As result, Vermont expects visibility at its Federal Class I area, and nearby Federal Class I areas that Vermont emissions might affect, to continue to improve over the next 10 years. Further, because most visibility impairing pollutants are small particles, further reducing their concentrations is expected to produce incremental public health benefits.