west virginia department of environmental protection

West Virginia
Regional Haze Second Period (2028)
State Implementation Plan
To
Preserve, Protect, and Improve
Visibility in Class I Federal Areas

Proposed
December 2021

West Virginia Division of Air Quality
601 57th Street, SE
Charleston, WV 25304

Promoting a healthy environment

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AEP	American Electric Power
AERR	Air Emission Reporting Rule
AFWA	Air Force Weather Agency
AIRMon	Atmospheric Integrated Research Monitoring Network (AIRMon)
AMoN	Ammonia Monitoring Network
AoI	Area of Influence
APCo	Appalachian Power Company
AQS	Air Quality System network
ARW	Advanced Research Weather Research and Forecasting model
AZ DEQ	Arizona Department of Environmental Quality
BART	best available retrofit technology
BEIS	Biogenic Emission Inventory System
BELD	Biogenic Emissions Land Use Database
b_{ext}	visibility impairment as extinction, Mm^{-1}
BLM	Bureau of Land Management
CAA	Clean Air Act
CAIR	Clean Air Interstate Rule
CAMD	Clean Air Markets Division
CAMx	Comprehensive Air Quality Model with Extensions
CASTNET	Clean Air Status and Trends Network
CC	Coordinating Committee
CENSARA	Central States Air Resource Agencies
CEMS	continuous emissions monitoring system
CFB	circulating fluidized bed
CM	course particle mass
CO	carbon monoxide
CONUS	continental U.S.
CoST	Control Strategy Tool
CPP	Clean Power Plan
CSA	North Carolina Clean Smokestacks Act
CSN	Chemical Speciation Network
CSAPR	Cross State Air Pollution Rule
CTG	control technique guideline
CWT	concentration weighted trajectory
d	distance (kilometers)
dv	deciview
E_CM	extinction from coarse matter
EC	elemental carbon
EGU	electric generating unit
EIA	Energy Information Administration
EIS	Emissions Inventory System
EPA	United States Environmental Protection Agency
ERTAC	Eastern Regional Technical Advisory Committee
EWRT	extinction-weighted residence time
FAA	Federal Aviation Administration
FB	Fractional Bias
FCCS	Fuel Characteristic Classification System
FCRS	fine crustal particulate (part of $PM_{2.5}$)
FDDA	four-dimensional data assimilation
FGD	flue gas desulfurization
FIA	Forest Inventory and Analysis
FIPS	Federal Information Processing Standard

FLM	federal land manager
FPRM	fine other primary particulate (part of $PM_{2.5}$)
FS	Forest Service
FSL	Forecast Systems Laboratory
FWS	Fish and Wildlife Service
g/bhp-hr	grams per brake horsepower-hour
GVWR	gross vehicle weight rating
HAP	hazardous air pollutant
HC	hydrocarbons
H_2SO_4	hydrogen sulfate
HMP	Hazard Mapping System
$(NH_4)HSO_4$	ammonium bisulfate
HYSPLIT	Hybrid Single Particle Lagrangian Integrated Trajectory Model
I/M	inspection and maintenance
ICI	industrial/commercial/institutional
IMPROVE	Interagency Monitoring of Protected Visual Environments
I/O API	Input/Output Applications Programming Interface
IPM	Integrated Planning Model
km	kilometer
KPCo	Kentucky Power Company
kW	kilowatts
LAC	light absorbing carbon
LADCO	Lake Michigan Air Directors Consortium
lbs/mmBtu	pounds per million British thermal units
LEV	California Low Emission Vehicle Standards
LN	low NO_X combustion technology
m	meters
m^2g^{-1}	meter squared per gram
MACT	maximum achievable control technology
MARAMA	Mid-Atlantic Regional Air Management Association
MANE-VU	Mid-Atlantic/Northeast Visibility Union
MATS	Mercury and Air Toxics Standard
MB	mean bias
MDA8	maximum daily 8-hour average
mb	millibar
MJO	multi-jurisdictional organizations
Mm^{-1}	Inverse Megameters
mmBtu/hr	million British thermal units per hour
MOVES	Motor Vehicle Emission Simulator
MW	megawatt
NAAQS	National Ambient Air Quality Standards
NACAA	National Association of Clean Air Agencies
NaCl	sodium chloride, sea salt
NA (Na)	sodium
NADP	National Acid Deposition Program
NAICS	North American Industry Classification System
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction
NEI	National Emissions Inventory
NEEDS	National Electric Energy Database Systems
NESCAUM	Northeast States for Coordinated Air Use Management
NH_3	ammonia
NH_4^+	ammonium ion

NH_4NO_3	ammonium nitrate
$(NH_4)_2SO_4$	ammonium sulfate
NLCD	National Land Cover Database
NMB	normalized mean bias
NME	normalized mean error
NMHC	non-methane hydrocarbons
NMIM	National Mobile Inventory Model
NTN	National Trends Network
NO	nitric oxide
NO_3^-	nitrate ion
NOAA	National Oceanic and Atmospheric Administration
NODA	notice of data availability
NO_X	nitrogen oxides
NPS	National Park Service
NSPS	New Source Performance Standards
OAQPS	Office of Air Quality Planning and Standards
OC	organic carbon
OM	organic matter
OMC	organic matter carbon
ORE	Onroad Emissions Program
OTR	Ozone Transport Region
PA DEP	Pennsylvania Department of Environmental Protection
PEC	primary elemental carbon
PCL	particulate chloride
PM	particulate matter
PM_{10}	coarse particulate matter with a nominal diameter ≤ 10 µm
$PM_{2.5}$	fine particulate matter with a nominal diameter ≤ 2.5 µm
PNH_4	particulate ammonium
PNO_3	particulate nitrate
POA	primary organic aerosols
POM	particulate organic matter
ppb	parts per billion
ppm	parts per million
ppmvd	parts per million volume dry
PQNG	pipeline quality natural gas
PSAT	Particulate Matter Source Apportionment Technology
PSO_4	particulate sulfate
PTE	potential to emit
Q	emissions, tons per year
RAAP	Radford Army Arsenal Plant
RACT	reasonably available control technology
RCU	Revised CSAPR Update
RFG	reformulated gasoline
RHR	Regional Haze Rule
RPG	reasonable progress goal
RPO	regional planning organization
RRF	relative reduction factor
RT	residence time
SAP	sulfuric acid plant
SCC	source category code
SCR	selective catalytic reduction
SIP	state implementation plan
SLEIS	State and Local Emissions Inventory System

SMAT-CE	EPA Software for Model Attainment Test – Community Edition
SMOKE	Sparse Matrix Operator Kernel Emissions model
SNCR	selective non-catalytic reduction
SLEIS	State and Local Emission Inventory System
SO_2	sulfur dioxide
SO_4^{-2}	sulfate ion
SOA	secondary organic aerosols
SOAP	secondary organic aerosol partitioning
TAF	Terminal Area Forecast System
TAWG	Technical Analysis Work Group
TECO	Tampa Electric Company
tpOS	tons per ozone season
tpy	tons per year
TVA	Tennessee Valley Authority
URP	uniform rate of progress
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USFS	United States Forest Service
VEPCO	Virginia Electric and Power Company
VISTAS	Visibility Improvement State and Tribal Association of the Southeast
VMT	vehicle miles traveled
VOC	volatile organic compound
WESTAR	Western States Air Resources Council
WRF	Weather Research and Forecasting
WVDAQ	West Virginia Division of Air Quality
WVDEP	West Virginia Department of Environmental Protection
WVU	West Virginia University
µm	micrometer
$\mu g/m^3$	microgram per cubic meter

EXECUTIVE SUMMARY

Regional haze is defined as the visibility impairment produced by a multitude of sources and activities which emit fine particles and their precursors to the atmosphere, and which are located across a broad geographic area. These emissions are transported over large regions, including national parks, forests, and wilderness areas ("Class I" federal areas). The Clean Air Act (CAA) mandates the protection of visibility in these Class I areas.

In 1999, the U.S. Environmental Protection Agency (EPA) finalized the Regional Haze Rule (RHR). The rule calls for state, tribal, and federal agencies to work together to improve visibility in Class I areas. States are required to develop and implement air quality protection plans (State Implementation Plans (SIPs)) to reduce emissions causing visibility impairment. These plans establish goals and emissions reduction strategies based on trends from various sources of visibility impairing air pollution including point, nonpoint, mobile (onroad and nonroad), commercial marine, rail, biogenic, wildfire, and agricultural. Under the RHR, states are required to develop SIPs to reduce visibility impairment in the Class I areas to natural conditions by 2064.

Five multi-state regional planning organizations (RPOs) have developed the technical basis used by states to establish strategies for evaluating visibility conditions, 2000-2004 baseline emissions, future emission trends, and to develop long-term strategies for making "reasonable progress" to improve 2028 visibility in the Class I areas. With the assistance of the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) RPO, West Virginia has developed a second implementation SIP to address 2028 visibility impairment in the federal Class I Dolly Sods and Otter Creek Wilderness Areas located in the northeastern mountains of West Virginia. In developing this SIP, West Virginia screened stationary sources responsible for the most sulfur dioxide (SO_2) and nitrogen oxide (NO_X) emissions, developed reasonable progress goals and long-term strategies, and examined the reasonableness of Best Available Retrofit Technology (BART) and Mercury and Air Toxics Standards (MATS) emission reductions from the state's electric generating units (EGUs).

For the 20 percent most impaired days, West Virginia projects a 2028 reasonable progress goal of 15.29 deciviews (dv), which is a 13.00 dv reduction below the 2000-2004 baseline and 7.75 dv below the uniform rate of progress needed to achieve a natural background condition by 2064. West Virginia projects a 2028 reasonable progress goal for the 20 percent best days of 7.55 dv, which is a 4.73 dv reduction in visibility impairment below the 2000-2004 baseline. These projected improvements in visibility are expected based on the implementation of existing and planned emission controls and measures, which will be discussed in further detail throughout this SIP document. The implementation of existing and future controls and measures by 2028 will result in a 20 percent most impaired days deciviews improvement equivalent to approximately the year 2045 on the Uniform Glide Path to 2064 natural conditions, and demonstrates West Virginia is making reasonable progress to meet the 2064 goal.

In addition to consultation among the VISTAS states, West Virginia has engaged in consultation with nearby states outside the VISTAS region and with federal stakeholders including Federal Land Managers (FLMs) responsible for the Class I areas and with the EPA.

1. INTRODUCTION

1.1. What Is Regional Haze?

Regional haze is defined as visibility impairment that is caused by atmosphere-entrained air pollutants emitted from numerous anthropogenic and natural sources located over a wide geographic area. These emissions are often transported long distances. Haze is caused when sunlight is absorbed or scattered by airborne particles which, in turn, reduce the clarity, contrast, color, and viewing distance of what is seen. Regional haze refers to haze that impairs visibility in all directions uniformly.

Pollution from particulate matter (PM) is the major cause of reduced visibility (haze) in the United States, including many of the country's national parks, forests, and wilderness areas (including 156 mandatory federal Class I areas as defined in 40 CFR Part 81.400). PM affects visibility through the scattering and absorption of light, and fine particles; particles similar in size to the wavelength of visible light are most efficient, per unit of mass, at reducing visibility. Fine particles are produced by a variety of natural and manmade sources. Fine particles may either be emitted directly or formed from emissions of precursors, the most significant of which are sulfur oxides such as sulfur dioxide (SO_2) and nitrogen oxides (NO_X). Reducing fine particles in the atmosphere is generally considered to be an effective method of reducing regional haze and thus improving visibility. Fine particles also adversely impact human health, especially respiratory and cardiovascular systems. The EPA has established national ambient air quality standards (NAAQS) for daily and annual levels of fine particles with a nominal diameter less than or equal to 2.5 micrometers (μm) ($PM_{2.5}$). In the southeast, the most prevalent sources of $PM_{2.5}$ and its precursors are coal-fired power plants, industrial boilers, process heaters, and other stationary combustion sources. Other significant contributors to $PM_{2.5}$ and visibility impairment include the following source categories: mobile, onroad, and nonroad engine emissions; stationary non-combustion emissions (area sources); wildfires and prescribed burning emission; and wind-blown dust.

1.2. What Are the Requirements Under the Clean Air Act for Addressing Regional Haze?

In Section 169A of the 1977 Amendments to the Clean Air Act (CAA), Congress set forth a program for protecting visibility in Class I areas that calls for the "prevention of any future, and the remedying of any existing, impairment of visibility caused by anthropogenic (manmade) air pollution." On December 2, 1980, the EPA promulgated regulations to address visibility impairment (45 FR 80084) that is "reasonably attributable" to a single source or small groups of sources. These regulations represented the first phase in addressing visibility impairment and deferred action on regional haze that emanated from a variety of sources until monitoring, modeling, and scientific knowledge about the relationships between pollutants and visibility impairment improved.

In the 1990 Amendments to the CAA, Congress added section 169B and called on EPA to issue regional haze rules. The regional haze rule that EPA promulgated on July 1, 1999, (64 FR 35713[1]) revised the existing visibility regulations to integrate provisions addressing regional haze impairment and established a comprehensive visibility protection program for mandatory federal Class I areas.[2] Each state was required to submit a state implementation plan (SIP) to the EPA by December 17, 2007, which set out that state's plan for complying with the regional haze rule for the first implementation period from 2007 to 2018. Each state was required to consult and coordinate with other states and with FLMs in developing its SIP. Paragraph 40 CFR 51.308(f) of the 1999 rule required states to submit periodic comprehensive revisions of their regional haze plans by July 31, 2018, and every ten years thereafter. However, on January 10, 2017, EPA revised, among other things, paragraph 40 CFR 51.308(f) of the regional haze rule to change the deadlines for submitting revisions and updates to regional haze plans to July 31, 2021, July 31, 2028, and every 10 years thereafter. This SIP was prepared for the second implementation period, which includes years 2021 to 2028.

The regional haze rule addressed the combined visibility effects of various pollution sources over a wide geographic region. This wide-reaching pollution net meant that many states – even those without mandatory federal Class I areas – would be required to participate in haze reduction efforts. Five regional planning organizations (RPOs) were formed to assist with the coordination and cooperation needed to address the visibility issue. These five RPOs are illustrated in Figure 1-1.[3] The Southeastern States Air Resource Managers, Inc. (SESARM) has been designated by EPA as the entity responsible for coordinating regional haze evaluations for the ten Southeastern states (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia), local air pollution control agencies, and tribal authorities. These parties collaborated through the organization known as Visibility Improvement - State and Tribal Association of the Southeast (VISTAS) to prepare the technical analyses and planning activities associated with visibility and related regional air quality issues supporting development of regional haze SIPs for the first and second implementation periods. For the second implementation period, local air pollution control agencies were represented by the Knox County, Tennessee local air pollution control agency and tribal authorities were represented by the Eastern Band of Cherokee Indians.

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1 URL: https://www.govinfo.gov/content/pkg/FR-1999-07-01/pdf/99-13941.pdf

2 The regional haze regulations were amended on July 6, 2005 (70 FR 39104), October 13, 2006 (71 FR 60612), June 7, 2012 (77 FR 33642), and January 10, 2017 (82 FR 3078).

3 URL: https://www.epa.gov/visibility/visibility-regional-planning-organizations

Figure 1-1: Geographical Areas of Regional Planning Organizations

1.3. General Overview of Regional Haze SIP Requirements

The regional haze rule at 40 CFR 51.308(d) requires all states to submit a SIP for regional haze. Paragraph 51.308(f) of the regional haze rule requires each state to periodically revise and submit revisions to its regional haze SIP. All regional haze SIPs must include the following:

1. reasonable progress goals (RPGs) for each mandatory federal Class I area located within the state;
2. natural, baseline, and current visibility conditions for each mandatory federal Class I area within the state;
3. a long-term strategy to address visibility for each mandatory federal Class I area within the state and for each mandatory federal Class I area located outside the state that may be affected by emissions from the state;
4. a monitoring strategy for measuring, characterizing, and reporting data that is representative of all mandatory federal Class I areas within the state; and
5. other requirements and analyses.

The regional haze rule requires states to establish RPGs, expressed in deciviews (dv), for the end of each implementation period (approximately ten years) that reflect the visibility conditions that are projected to be achieved by the end of the applicable implementation period as a result of enforceable measures required by the regional haze rule and other requirements of the CAA (40 CFR 51.308(f)(3)). The goals must provide for reasonable progress towards achieving natural visibility conditions by providing for improvement in visibility for the most impaired days and ensuring no degradation in visibility for the clearest days over each ten-year period.

The regional haze rule requires states to compute natural visibility conditions for both the 20% most impaired days and the 20% clearest days (40 CFR 51.308(f)(1)). For the 20% most impaired days, the regional haze rule directs each state with a Class I area to determine the uniform rate of progress (URP or "glide path") that would need to be maintained during each implementation period to attain natural visibility conditions for the Class I area by 2064. Data from the Interagency Monitoring of Protected Visual Environments (IMPROVE) network are used to establish baseline and natural visibility metrics.[4] States are to establish baseline visibility conditions using a five-year average of monitoring data for 2000-2004 and natural visibility conditions for 2064. A line is drawn between the two data points to determine the URP for the most impaired days. Days with the lowest 20% annual values of the daily haze index are used to represent the clearest days. The requirement of the regional haze rule for the 20% clearest days is to ensure that no degradation from the baseline (2000-2004) occurs. For the 20% clearest days, the regulatory requirements do not rely on a comparison to the estimated 2064 natural background conditions.

For this second implementation period, regional haze SIPs must include the current visibility conditions for the most impaired and clearest days, the actual progress made towards natural visibility since the baseline period, and the actual progress made during the previous implementation period. The period for calculating current visibility conditions is the most recent five-year period for which data are available. For this SIP, the current visibility conditions include data from years 2014 to 2018. The period for evaluating actual progress made is from the baseline period (2000 to 2004) up to and including the five-year period for calculating current visibility conditions (40 CFR 51.308(f)(1)(iii)-(iv)).

The 2028 RPGs for each Class I area must be met through measures contained in the state's long-term strategy. The long-term strategy must address regional haze visibility impairment for each mandatory federal Class I area within the state and for each mandatory federal Class I area located outside the state that may be affected by emissions from the state. The long-term strategy must include enforceable emissions limitations, compliance schedules, and other measures as necessary to make reasonable progress. Section 169B of the CAA requires a state to consider the four statutory factors (cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life) when developing the long-term strategy upon which it bases the RPGs for each Class I area. States are also required to consider the following additional factors in developing their long-term strategies: ongoing air

[4] URL: http://vista.cira.colostate.edu/Improve/

pollution control programs; measures to mitigate the impact of construction activities; source retirement and replacement schedules; smoke management programs for agriculture and forestry; and the anticipated net effect of visibility due to projected changes in point, area, and mobile source emissions over the period addressed by the long-term strategy (40 CFR 51.308(f)(2)).

States must include a monitoring strategy for measuring, characterizing, and reporting of regional haze visibility impairment data that is representative of all mandatory federal Class I areas within the state. The regional haze rule states that compliance with this requirement may be met through participation in the IMPROVE network (40 CFR 51.308(f)(6)).

The SIPs for this second implementation period cover long-term strategies for visibility improvement to the end of the second implementation period (2028). States are required to evaluate progress toward meeting RPGs every five years to assure that emissions controls are on track with emissions reduction forecasts in each SIP. On January 10, 2017, EPA amended 40 CFR 51.308(f) so that the plan revision for the second implementation period will also serve as a progress report and thus address the periodic report requirement specified in 40 CFR 51.308(g)(1) through (5). The next progress report will be due to EPA by January 31, 2025. If emissions controls are not on track to ensure reasonable progress, then states would need to take action to assure emissions controls by 2028 will be consistent with the SIP or to revise the SIP to be consistent with the revised emissions forecast (40 CFR 51.308(f) and 40 CFR 51.308(g)).

The EPA provided several guidance documents listed below to assist the states in implementation of the regional haze rule requirements, including documents that specifically address the second implementation period. All VISTAS states followed these guidance documents in developing the technical analyses reported in this plan.

- Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule (EPA-454/B-03-005, September 2003)

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

- Technical Guidance for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program (EPA, December 20, 2018)

- Guidance on Regional Haze State Implementation Plans for the Second Implementation Period (EPA, August 20, 2019)

- Technical Support Document for EPA’s 2028 Regional Haze Modeling (EPA, September 19, 2019)

- Recommendation for the Use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program (EPA, June 3, 2020)

1.4. Mandatory Federal Class I Areas in West Virginia

West Virginia has two mandatory Class I areas within its borders: Dolly Sods Wilderness Area and Otter Creek Wilderness Area. The West Virginia Department of Environmental Protection (DEP), Division of Air Quality (WVDAQ) is responsible for developing the regional haze SIP. This SIP establishes reasonable progress goals for visibility improvement at each of these mandatory federal Class I areas and a long-term strategy that will achieve those reasonable progress goals within the second regional haze implementation period. These two Class I Areas for West Virginia are described in 40 CFR 81.435 and are shown in Figure 1-2.

Figure 1-2: West Virginia's Mandatory Federal Class I Areas

As required by the regional haze rule, the WVDAQ considered the impacts of emission sources outside of West Virginia that may affect visibility on our Class I areas and West Virginia emission sources that may affect visibility on Class I areas in neighboring states. Through VISTAS, the southeastern states worked together to assess state-by-state contributions to visibility impairment in specific Class I areas, including those in West Virginia and those affected by emissions from West Virginia. This technical work is discussed further in Sections 5, 6, 7, and 7 below. Consultations to date between West Virginia and other states are summarized in Section 10; these consultations are ongoing.

1.5. Regional Planning and Coordination

Successful implementation of a regional haze program involves long-term regional coordination among states. SESARM formed VISTAS in 2001 to coordinate technical work and long-range planning for addressing visibility impairment in each of the eighteen mandatory federal Class I areas in the VISTAS region (see Figure 1-3 and Table 1-1). West Virginia participated as a member state in VISTAS during the first and second implementation periods. The objectives of VISTAS are as follows:

1. coordinate and document natural, baseline, and current conditions for each Class I area in the Southeast;
2. develop base year and future year emission inventories to support air quality modeling;
3. develop methodologies for screening sources and groups of sources for reasonable progress analysis;
4. conduct photochemical grid modeling to support development of RPGs for each Class I area; and
5. share information to support each state in developing the long-term strategy for its SIP.

In addition, VISTAS states also coordinated with other RPOs to share information and undertake consultation as needed to address visibility impairment associated with sources affecting Class I areas in the VISTAS region and sources in the VISTAS region potentially affecting visibility impairment in another region.

Figure 1-3: Mandatory Federal Class I Areas in the VISTAS Region

Table 1-1: Mandatory Federal Class I Areas in the VISTAS Region

State	Area Name	Acreage	Federal Land Manager
Alabama	Sipsey Wilderness Area	12,646	USDA-FS
Florida	Chassahowitzka Wilderness Area	23,360	USDI-FWS
Florida	Everglades National Park	1,397,429	USDI-NPS
Florida	St. Marks Wilderness Area	17,745	USDI-FWS
Georgia	Cohutta Wilderness Area	33,776	USDA-FS
Georgia	Okefenokee Wilderness Area	343,850	USDI-FWS
Georgia	Wolf Island Wilderness Area	5,126	USDI-FWS
Kentucky	Mammoth Cave National Park	51,303	USDI-NPS
North Carolina	Great Smoky Mountains National Park	273,551	USDI-NPS
North Carolina	Joyce Kilmer-Slickrock Wilderness Area	10,201	USDA-FS
North Carolina	Linville Gorge Wilderness Area	7,575	USDA-FS

State	Area Name	Acreage	Federal Land Manager
North Carolina	Shining Rock Wilderness Area	13,350	USDA-FS
North Carolina	Swanquarter Wilderness Area	9,000	USDI-FWS
South Carolina	Cape Romain Wilderness Area	28,000	USDI-FWS
Tennessee	Great Smoky Mountains National Park	241,207	USDI-NPS
Tennessee	Joyce Kilmer-Slickrock Wilderness Area	3,832	USDA-FS
Virginia	James River Face Wilderness Area	8,703	USDA-FS
Virginia	Shenandoah National Park	190,535	USDI-NPS
West Virginia	Dolly Sods Wilderness Area	10,215	USDA-FS
West Virginia	Otter Creek Wilderness Area	20,000	USDA-FS

1.6. State and FLM Coordination

As required by 40 CFR 51.308(i), the regional haze SIP must include procedures for continuing consultation between the states and FLMs on the implementation of the visibility protection program. Continuing consultation should encompass development and review of periodic implementation plan revisions and five-year progress reports as well as the implementation of other programs having the potential to contribute to impairment of visibility in any Class I area within the state. The three FLMs are the United States Department of Interior (USDI) Fish and Wildlife Service (FWS), the National Park Service (NPS), and the United States Department of Agriculture (USDA) Forest Service (FS).

West Virginia's obligation to periodically revise its regional haze SIP and to coordinate with the FLMs is also discussed in Section 11. The WVDAQ will follow the FLM consultation procedures as prescribed in 40 CFR 51.308(i) when making future implementation plan reviews and revisions.

The FLMs were involved in the preparation of this regional haze SIP. Documentation of the formal comments made by the FLMs and the WVDAQ response are located in Appendix H - Public Hearing Comment Summary and Agency Responses.

1.7. Cross-Reference to Regional Haze Regulatory Requirements

Table 1-2 identifies each section of the SIP that addresses regional haze rule requirements specified in 40 CFR 51.308(f), (g), and (i) for this second implementation period.

Table 1-2: Cross-Reference of Sections in the SIP to Regional Haze Rule Requirements Specified in 40 CFR 51.308(f) and (g)

Rule Section	Chapter/Section in SIP	Description
(f)	11	Requirements for periodic comprehensive revisions of implementation plans for regional haze

Rule Section	Chapter/Section in SIP	Description
(f)(1)	2.1, 2.2, 2.3, 2.4, 2.6, 3	Calculations of baseline, current, and natural visibility conditions; progress to date; and the uniform rate of progress
(f)(1)(i)	2.4	Baseline visibility conditions for the most impaired and clearest days
(f)(1)(ii)	2.3	Natural visibility conditions for the most impaired and clearest days
(f)(1)(iii)	2.6	Current visibility conditions for the most impaired and clearest days
(f)(1)(iv)	2.7	Progress to date for the most impaired and clearest days
(f)(1)(v)	2.7	Differences between current visibility condition and natural visibility condition
(f)(1)(vi)(A)	3	Uniform rate of progress
(f)(1)(vi)(B)	not applicable	Any adjustments to rate of progress
(f)(2)	7	Long-term strategy for regional haze
(f)(2)(i)	7	Emission reduction measures that are necessary to make reasonable progress
(f)(2)(ii)	10	Consult with those states that have emissions that are reasonably anticipated to contribute to visibility impairment in the mandatory federal Class I area
(f)(2)(ii)(A)	10	Demonstrate that it has included in its implementation plan all measures agreed to during state-to-state consultations
(f)(2)(ii)(B)	10	Consider the emission reduction measures identified by other states for their sources
(f)(2)(ii)(C)	10	In any situation in which a state cannot agree with another state on the emission reduction measures necessary to make reasonable progress in a mandatory federal Class I area, the state must describe the actions taken to resolve the disagreement
(f)(2)(iii)	2, 4, 5, 6, 7.2, 7.7, 7.8, 9, 10	Document the technical basis, including modeling, monitoring, cost, engineering, and emissions information, on which the State is relying to determine the emission reduction measures that are necessary to make reasonable progress in each mandatory federal Class I area
(f)(2)(vi)(A)	7.2	Emission reductions due to ongoing air pollution control programs, including measures to address reasonably attributable visibility impairment
(f)(2)(vi)(B)	7.9.2	Measures to mitigate the impacts of construction activities
(f)(2)(vi)(C)	7.2.2	Source retirement and replacement schedules
(f)(2)(vi)(D)	7.2.3, 7.9.1	Basic smoke management practices for prescribed fire used for agricultural and wildland vegetation management purposes and smoke management programs
(f)(2)(vi)(E)	8	The anticipated net effect on visibility due to projected changes in point, area, and mobile source emissions over the period addressed by the long-term strategy
(f)(3)(i)	8	Reasonable progress goals – The state must establish reasonable progress goals (expressed in dv) 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.
(f)(3)(ii)(A)	not applicable	If a state in which a mandatory federal Class I area is located establishes a reasonable progress goal for the most impaired days that provides for a slower rate of improvement in visibility than the uniform rate of progress calculated under paragraph (f)(1)(vi) of this section, the state must demonstrate, based on the analysis required by paragraph (f)(2)(i) of this section, that there are no additional emission reduction measures for anthropogenic sources or groups of sources in the state that may reasonably be anticipated to contribute to visibility impairment in the Class I area that would be reasonable to include in the long-term strategy
(f)(3)(ii)(B)	7	If a state contains sources which are reasonably anticipated to contribute to visibility impairment in a mandatory federal Class I area in another state for which a demonstration by the other State is required under (f)(3)(ii)(A), the

Rule Section	Chapter/Section in SIP	Description
		state must demonstrate that there are no additional emission reduction measures for anthropogenic sources or groups of sources in the State that may reasonably be anticipated to contribute to visibility impairment in the Class I area that would be reasonable to include in its own long-term strategy. The state must provide a robust demonstration, including documenting the criteria used to determine which sources or groups or sources were evaluated and how the four factors required by paragraph (f)(2)(i) were taken into consideration in selecting the measures for inclusion in its long-term strategy.
(f)(4)	not applicable	If the Administrator, Regional Administrator, or the affected Federal Land Manager has advised a state of a need for additional monitoring to assess reasonably attributable visibility impairment at the mandatory federal Class I area in addition to the monitoring currently being conducted, the State must include in the plan revision an appropriate strategy for evaluating reasonably attributable visibility impairment in the mandatory federal Class I area by visual observation or other appropriate monitoring techniques.
(f)(5)	13.5	An assessment of any significant changes in anthropogenic emissions within or outside of 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.
(f)(6)	9	Monitoring strategy and other implementation plan requirements – States must submit with the implementation plan a monitoring strategy for measuring, characterizing, and reporting of regional haze visibility impairment that is representative of all mandatory federal Class I areas within the state. Compliance with this requirement may be met through participation in the Interagency Monitoring of Protected Visual Environments network.
(f)(6)(i)	not applicable	The establishment of any additional monitoring sites or equipment needed to assess whether reasonable progress goals
(f)(6)(ii)	9	Procedures by which monitoring data and other information are used in determining the contribution of emissions from within the state
(f)(6)(iii)	9	For a state with no mandatory Class I federal areas, procedures by which monitoring data and other information are used in determining the contribution of emissions from within the State to regional haze visibility impairment at mandatory Class I federal areas in other states.
(f)(6)(iv)	9	The implementation plan must provide for the reporting of all visibility monitoring data to the Administrator at least annually for each mandatory federal Class I area in the state.
(f)(6)(v)	4, 7.2.4	A statewide inventory of emissions of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any mandatory federal Class I area
(f)(6)(vi)	9	Other elements, including reporting, recordkeeping, and other measures, necessary to assess and report on visibility.
(g)(1)	13.3	Periodic progress reports must contain at a minimum the following elements: (1) A description of the status of implementation of all measures included in the implementation plan for achieving reasonable progress goals for mandatory federal Class I areas both within and outside the State.
(g)(2)	13.5	(2) A summary of the emissions reductions achieved throughout the state through implementation of the measures described in paragraph (g)(1) of this section.

Rule Section	Chapter/Section in SIP	Description
(i)	10.4	State and federal land manager coordination.

1.8. Environmental Justice

West Virginia is a no-more-stringent-than-federal-regulations state by West Virginia Code §22-5-4(a)-4 and as such it must follow the air regulations as promulgated by the EPA. The WVDAQ rules apply equally across the State of West Virginia. To address the Title VI provisions of the Civil Rights Act of 1964 and other federal nondiscrimination laws, the West Virginia Department of Environmental Protection (WVDEP) has entered into a voluntary agreement with the EPA to carry out its responsibilities in a nondiscriminatory manner. In this agreement (Appendix I-1) the WVDEP is committed to the following:

- Notice of Non-Discrimination Under the Federal Non-Discrimination Laws
- Grievance Procedures to Process Discrimination Complaints Filed Under the Federal Non-Discrimination Laws
- Designation of a Non-Discrimination Coordinator
- Public Participation
- Plan to Ensure Meaningful Access to Programs and Activities for Persons with Limited English Proficiency
- Plan to Ensure Meaningful Access to Programs and Activities for Persons with Disabilities
- WVDEP Personnel Training

Additionally, WVDEP will adopt any future federal environmental justice regulations as promulgated and applicable to West Virginia.

On July 29, 2021, the EPA publicly introduced its Power Plants and Neighboring Communities Tool,[5] which is the agency's new environmental justice analysis tool demonstrating potential concerns for overburdened communities near existing fossil fuel fired electric generation units (EGUs). The tool compares the emissions from EGUs and the demographics within a three-mile radius of each EGU. Six demographics including low-income populations, people of color, population with less than high school education, linguistically isolated population, population under age 5, and population over age 64 were included in the tool. Also, the tool presents a

[5]URL: https://www.epa.gov/airmarkets/power-plants-and-neighboring-communities

demographic index (average of low-income and people of color populations). Maps and graphics generated by the tool highlight EGUs located in or near communities with one or more of the six key demographics at or above the 80th percentile as ranked nationally plus the demographic index. If a community is at or above the 80th percentile nationally, it means that community's population for a given demographic (e.g., low-income) is equal to or higher than where 80% of the U.S. population lives. Table 1-3 shows the results from the EPA's Power Plant and Neighboring Communities tool for West Virginia's coal-fired EGUs using the tool's latest data year of 2019. As compared to the EPA's 80th percentile demographic index, all of West Virginia percentiles are considerably less. The EGU with the highest demographic index percentile is Morgantown Energy Associates at 53%. However, the tool does not account for the fact that this facility no longer burns coal and has recently converted to combusting only natural gas. Further discussions concerning Morgantown Energy Associates are in Sections 7.2.2.2 and 7.6.4.

Table 1-3: Power Plant and Neighboring Communities Tool - West Virginia Summary Data Year 2019

West Virginia Fossil-Fuel Fired Power Plant[1]	Primary Fuel Type[1]	Total Population Within 3 Mile Radius	Demographic Index Within 3 Mile Radius of the Facility[2]	
			Percent	Percentile (National)
Mount Storm Power Station	Coal	215	17%	24th Percentile
Fort Martin Power Station	Coal	6,557	19%	28th Percentile
Longview Power	Coal	7,966	27%	45th Percentile
Morgantown Energy Facility	Coal	60,444	32%	53rd Percentile
Grant Town Power Plant	Coal	3,153	23%	38th Percentile
Harrison Power Station	Coal	6,087	19%	29th Percentile
Mitchell	Coal	2,369	17%	24th Percentile
Pleasants Power Station	Coal	1,833	20%	30th Percentile
Mountaineer	Coal	4,366	20%	30th Percentile
John E. Amos	Coal	9,224	16%	21st Percentile

1 Only captured Coal-Fired Facilities

2 The demographic index is the average of low-income and people of color populations.

Based on the EPA's tool and its environmental justice screening methodology, it appears that West Virginia's EGU fleet is not negatively affecting overburdened populations.

2. NATURAL BACKGROUND CONDITIONS AND ASSESSMENT OF BASELINE, MODELING BASE PERIOD, AND CURRENT CONDITIONS

The goal of the regional haze rule is to restore natural visibility conditions to the 156 Class I areas identified in the 1977 Clean Air Act Amendments. 40 CFR 51.301 contains the following definitions:

> *Natural conditions* reflect naturally occurring phenomena that reduce visibility as measured in terms of light extinction, visual range, contrast, or coloration, and may refer to the conditions on a single day or set of days. These phenomena include, but are not limited to, humidity, fire events, dust storms, volcanic activity, and biogenic emissions from soils and trees. These phenomena may be near or far from a Class I area and may be outside the United States.
>
> *Natural visibility* means visibility (contrast, coloration, and texture) on a day or days that would have existed under natural conditions. Natural visibility varies with time and location, is estimated or inferred rather than directly measured, and may have long-term trends due to long-term trends in natural conditions.
>
> *Natural visibility condition* means the average of individual values of daily natural visibility unique to each Class I area for either the most impaired days or the clearest days.

The regional haze SIPs must contain measures that make “reasonable progress” toward achieving natural visibility conditions by reducing anthropogenic, i.e., man-made emissions that cause haze.

An easily understood measure of visibility to most people is visual range. Visual range is the greatest distance, in kilometers or miles, at which a dark object can be viewed against the sky. For evaluating the relative contributions of pollutants to visibility impairment, however, the most useful measure of visibility impairment is light extinction, which affects the clarity and color of objects being viewed.

The measure used by the regional haze rule is the deciviews (dv) index, as required by 40 CFR 51.301. Deciviews are calculated directly from light extinction using the following logarithmic equation:

$$dv = 10 * ln\left(\frac{b_{ext}}{10 * Mm^{-1}}\right)$$

In this equation, the atmospheric light extinction coefficient, b_{ext}, is expressed in units of inverse megameters (Mm^{-1}).[6] The dv units are useful for tracking progress in improving visibility because each dv change is an equal incremental change in visibility perceived by the human eye. Most people can detect a change in visibility at one dv.

For each Class I area, there are three metrics of visibility that are part of the determination of reasonable progress:

- natural conditions,
- baseline conditions, and
- current conditions.

Each of the three metrics includes the concentration data of the visibility-impairing pollutants as different terms in the IMPROVE light extinction algorithm, with respective extinction coefficients and relative humidity factors. Total light extinction when converted to dv is calculated for the average of the 20% clearest and 20% most impaired days. The terminology for these two sets of days changed for the second round of regional haze planning owing to a focus on anthropogenically-induced visibility impairment.[7]

"Natural" visibility is determined by estimating the natural concentrations of visibility pollutants and then calculating total light extinction. "Baseline" visibility is the starting point for the improvement of visibility conditions. Baseline visibility is calculated from the average of the IMPROVE monitoring data for 2000 through 2004. The comparison of initial baseline conditions from 2000-2004 to natural visibility conditions indicates the amount of improvement necessary to attain natural visibility by 2064. Each state must estimate natural visibility levels for Class I areas within its borders in consultation with FLMs and other states as required by 40 CFR 51.308(f)(1).

Another important set of visibility monitoring data is the base period used for air quality modeling projections, in this case monitoring data from years 2009 through 2013. These

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6 Colorado State University, "The IMPROVE Algorithm." URL: http://vista.cira.colostate.edu/Improve/haze-metrics-converter/

7 EPA, "Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program", December 2018. URL: https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf

monitoring data are used in conjunction with inventory and meteorological data to project expected visibility parameters for each Class I area, as described in Section 5, Section 6, and Section 7.2.6.2.

"Current conditions" are assessed every five years as part of the regional haze planning process where actual progress in reducing visibility impairment is compared to the reductions delineated in the SIP. The five-year period comprising current conditions in this SIP is 2014-2018, inclusive.

2.1. IMPROVE Algorithm

The IMPROVE algorithm for estimating light extinction was adopted by EPA as the basis for the regional haze metric used to track progress in reducing haze levels and estimates light extinction, which is then converted to the dv haze index.

The IMPROVE equation accounts for the effect of particle size distribution on light extinction efficiency of sulfate, nitrate, and organic carbon; the equation also accounts for light extinction by sea salt and light absorption by gaseous nitrogen dioxide. Site-specific values are used for Rayleigh scattering to account for the site-specific effects of elevation and temperature. Separate relative humidity enhancement factors are used for small and large size distributions of ammonium sulfate and ammonium nitrate and for sea salt. A complete description of the terms in the IMPROVE equation is given on the IMPROVE website.[8]

The algorithm has been revised over the years to produce consistent estimates of light extinction for all remote area IMPROVE aerosol monitoring sites. It permits the individual particle component contributions to light extinction to be separate estimates. The current IMPROVE equation includes contributions from sea salt and an increase in the multiplier for contributions from particulate organic matter (POM) as compared to the previous IMPROVE algorithm.

In the IMPROVE algorithm, as described in the equation below, light extinction (b_{ext}) and Rayleigh scattering are described in units of Mm^{-1}. Dry mass extinction efficiency terms are in units of meter squared per gram (m^2g^{-1}). Water growth terms, *f(RH)*, are unitless. The total sulfate, nitrate, and organic compound concentrations are each split into two fractions, representing small and large size distributions of those components. For masses less than 20 $\mu g/m^3$, the fraction in the large mode is estimated by dividing the total concentration of the component by 20 $\mu g/m^3$. If the total concentration of a component exceeds 20 $\mu g/m^3$, all is assumed to be in the large mode. The small and large modes of sulfate and nitrate have relative

[8] Colorado State University, "The IMPROVE Algorithm", URL: http://vista.cira.colostate.edu/Improve/the-improve-algorithm/

humidity correction factors, $f_S(RH)$ and $f_L(RH)$, applied since these species are hygroscopic (i.e. absorb water), and their extinction efficiencies change with relative humidity.

$$b_{ext} \approx 2.2 \times f_S(RH) \times [Small\ Ammonium\ Sulfate] + 4.8 \times f_L(RH) \times [Large\ Ammonium\ Sulfate] + 2.4 \times f_S(RH) \times [Small\ Ammonium\ Nitrate] + 5.1 \times f_L(RH) \times [Large\ Ammonium\ Nitrate] + 2.8 \times [Small\ Organic\ Mass] + 6.1 \times [Large\ Organic\ Mass] + 10 \times [Elemental\ Carbon] + 1 \times [Final\ Soil] + 1.7 \times f_{SS}(RH) \times [Sea\ Salt] + 0.6 \times [Coarse\ Mass] + Rayleigh\ Scattering(Site\ Specific) + 0.33 \times [NO_2(ppb)]$$

More information on the IMPROVE algorithm may be found in Appendix E-1a and Appendix E-1b.

2.2. IMPROVE Monitoring Sites

Table 2-1 provides the VISTAS Class I areas and their associated IMPROVE monitoring site identification numbers. In certain instances, a Class I area may not have a monitoring site located within its boundaries. Such sites rely on data from nearby monitoring sites to act as surrogates within the analyses described in this SIP revision. For Class I areas in the Southeastern U.S., Joyce Kilmer-Slickrock Wilderness Area relies upon data from the Great Smoky Mountains National Park IMPROVE monitoring site (GRSM1), Otter Creek Wilderness Area relies on data from the Dolly Sods Wilderness Area IMPROVE monitoring site (DOSO1), and Wolf Island Wilderness Area relies on data from the Okefenokee Wilderness Area IMPROVE monitoring site (OKEF1). For the analyses described within this document, site-specific data such as elevation and location are used for these areas in combination with the monitoring data from the surrogate IMPROVE site. Table 2-1 provides the IMPROVE site identification number for the surrogate monitor in these situations.

Table 2-1: VISTAS Class I Areas and IMPROVE Site Identification Numbers

Class I Area	IMPROVE Site Identification Number
Cape Romain Wilderness Area	ROMA1
Chassahowitzka Wilderness Area	CHAS1
Cohutta Wilderness Area	COHU1
Dolly Sods Wilderness Area	DOSO1
Everglades National Park	EVER1
Great Smoky Mountains National Park	GRSM1
James River Face Wilderness Area	JARI1
Joyce Kilmer-Slickrock Wilderness Area	GRSM1
Linville Gorge Wilderness Area	LIGO1
Mammoth Cave National Park	MACA1

Class I Area	IMPROVE Site Identification Number
Okefenokee Wilderness Area	OKEF1
Otter Creek Wilderness Area	DOSO1
Shenandoah National Park	SHEN1
Shining Rock Wilderness Area	SHRO1
Sipsey Wilderness Area	SIPS1
St. Marks Wilderness Area	SAMA1
Swanquarter Wilderness Area	SWAN1
Wolf Island Wilderness Area	OKEF1

2.3. Estimating Natural Conditions for VISTAS Class I Areas

Natural background visibility, as defined in Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Program, EPA-454/B-03-005, September 2003,[9] is based on annual average concentrations of fine particle components. There are two separate methodologies to compute natural conditions: one methodology for the 20% clearest days and one for the 20% most impaired days. In the first implementation round of regional haze as well as the first mid-course review, these days were referred to as the 20% best and 20% worst days, respectively. These terms were updated to "clearest" and "most impaired" as part of two recent actions by EPA: a rule amending requirements for state plans finalized in January 2017,[10] and EPA guidance that updates recommended methodologies for tracking visibility impairment, issued in December 2018.[11] Also, as part of EPA's 2018 guidance, the recommended methodology for computing natural conditions for the 20% most impaired days changed, while no change was made for the 20% clearest days.

Natural background conditions using the current IMPROVE equation are calculated separately for each Class I area, and the methodology for calculating background conditions for the 20% most impaired days and the 20% clearest days are discussed in the preceding sections. Broadly speaking, however, the new calculation of natural background allows Rayleigh scattering to vary with elevation. Secondly, natural conditions are adjusted (as with the 20% most impaired days) to reflect impacts of natural events heretofore unrecognized in the computation of visibility under natural background conditions.

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[9] URL: https://www3.epa.gov/ttnamti1/files/ambient/visible/tracking.pdf

[10] Final Rule: Protection of Visibility: Amendments to Requirements for State Plans, 82 FR 3078, January 10, 2017.

[11] EPA, "Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program", December 2018. URL: https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf

2.3.1. Natural Background Conditions on 20% Clearest Days

EPA's 2018 guidance memo notes that days with the lowest 20% annual values of the daily haze index are used to represent the clearest days and are not selected based on the lowest anthropogenic impairment. The requirements of the regional haze rule for 20% clearest days are to ensure that no degradation from the baseline (2000-2004) occurs and do not rely on a comparison to the estimated natural background conditions on the 20% clearest days.

2.3.2. Natural Background Conditions on 20% Most Impaired Days

The methodology for computing natural background values for the 20% most impaired days separates observed visibility impairment into natural and anthropogenic contributions. The days with the highest anthropogenic visibility impairment contribution are what now comprise the 20% most impaired days, as opposed to the entirety of the visibility impairment portfolio that comprised the 20% haziest days previously. The reason for this change was to separate visibility impairment associated with significant natural events such as wildfires and dust storms, over which states have no control, from visibility impairment associated with anthropogenic emissions sources, which states may control. Further, the EPA notes that visibility conditions have never been measured without any anthropogenic impairment whatsoever, and so such conditions must be estimated.

Within these 20% most impaired days at a given Class I site, the natural visibility impairment for each day measured at said Class I site from 2000 to 2014, inclusive, are aggregated. That average value then becomes the natural background endpoint for the 20% most impaired days at the given Class I site. The 2018 EPA guidance (p. 15) notes that these new natural background visibility values are "consistently" lower than the prior natural values for 20% haziest days. The natural background conditions computed and utilized by VISTAS for the 20% most impaired days at Class I sites follow the 2018 EPA guidance without exception.

2.3.3. Summary of Natural Background Conditions for VISTAS Class I Areas

Table 2-2 provides a summary of the natural background conditions for VISTAS Class I areas.

Table 2-2: Average Natural Background Conditions for VISTAS Class I Areas

Class I Areas	Average for 20% Most Impaired Days*	Average for 20% Clearest Days*
Cape Romain Wilderness Area	9.79 dv	5.93 dv
Chassahowitzka Wilderness Area	9.03 dv	6.00 dv
Cohutta Wilderness Area	9.88 dv	4.42 dv
Dolly Sods Wilderness Area	8.92 dv	3.64 dv

Class I Areas	Average for 20% Most Impaired Days*	Average for 20% Clearest Days*
Everglades National Park	8.33 dv	5.22 dv
Great Smoky Mountains National Park	10.05 dv	4.62 dv
James River Face Wilderness Area	9.47 dv	4.39 dv
Joyce Kilmer-Slickrock Wilderness Area	10.05 dv	4.62 dv
Linville Gorge Wilderness Area	9.70 dv	4.07 dv
Mammoth Cave National Park	9.80 dv	5.00 dv
Okefenokee Wilderness Area	9.45 dv	5.43 dv
Otter Creek Wilderness Area	8.92 dv	3.64 dv
Shenandoah National Park	9.52 dv	3.15 dv
Shining Rock Wilderness Area	10.25 dv	2.49 dv
Sipsey Wilderness Area	9.62 dv	5.03 dv
St. Marks Wilderness Area	9.13 dv	5.37 dv
Swanquarter Wilderness Area	10.01 dv	5.71 dv
Wolf Island Wilderness Area	9.45 dv	5.43 dv

* Data taken from Table 1 in the EPA memorandum with subject: Technical addendum including updated visibility data through 2018 for the memo titled, "Recommendation for the use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program."[12]

2.4. Baseline Conditions

Baseline visibility conditions at each of West Virginia's Class I areas are estimated using sampling data collected at the Dolly Sods Wilderness Area IMPROVE monitoring site. Because of the close physical proximity of the Dolly Sods and Otter Creek Wilderness Areas, data from the Dolly Sods IMPROVE site is used for both Areas. A five-year average (2000 to 2004) was calculated for the 20% clearest days as well as the 20% most impaired days at each Class I site in accordance with 40 CFR 51.308(f)(1); Guidance for Tracking Progress Under the Regional Haze Rule, EPA-454-03-004, September 2003[13]; and the 2018 EPA guidance.

2.4.1. Baseline Conditions for 20% Clearest and 20% Most Impaired Days for VISTAS Class I Areas

Table 2-3 provides a summary of the baseline conditions (2000-2004) for the 20% clearest and 20% most impaired days at VISTAS Class I areas. The baseline dv index values for the 20% most impaired and 20% clearest days at these Class I areas are based on data included in Table 1

[12] URL: https://www.epa.gov/sites/production/files/2020-06/documents/memo_data_for_regional_haze_technical_addendum.pdf
[13] URL: https://www.epa.gov/sites/default/files/2021-03/documents/tracking.pdf

in the EPA memorandum with subject: Technical addendum including updated visibility data through 2018 for the memo titled, "Recommendation for the use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program."[14]

Table 2-3: Baseline Visibility Conditions for VISTAS Class I Areas (2000-2004)

Class I Areas	Average for 20% Most Impaired Days	Average for 20% Clearest Days
Cape Romain Wilderness Area	25.25 dv	14.29 dv
Chassahowitzka Wilderness Area Refuge	24.52 dv	15.60 dv
Cohutta Wilderness Area	29.12 dv	13.73 dv
Dolly Sods Wilderness Area	28.29 dv	12.28 dv
Everglades National Park	19.52 dv	11.69 dv
Great Smoky Mountains National Park	29.11 dv	13.58 dv
James River Face Wilderness Area	28.08 dv	14.21 dv
Joyce Kilmer-Slickrock Wilderness Area	29.11 dv	13.58 dv
Linville Gorge Wilderness Area	28.05 dv	11.11 dv
Mammoth Cave National Park	29.83 dv	16.51 dv
Okefenokee Wilderness Area	25.34 dv	15.23 dv
Otter Creek Wilderness Area	28.29 dv	12.28 dv
Shenandoah National Park	28.32 dv	10.93 dv
Shining Rock Wilderness Area	28.13 dv	7.70 dv
Sipsey Wilderness Area	27.69 dv	15.57 dv
St. Marks Wilderness Area	24.68 dv	14.34 dv
Swanquarter Wilderness Area	23.79 dv	12.34 dv
Wolf Island Wilderness Area	25.34 dv	15.23 dv

2.4.2. Pollutant Contributions to Visibility Impairment (2000-2004 Baseline Data)

The 20% most impaired visibility days at the Southern Appalachian sites (in West Virginia: Dolly Sods and Otter Creek Wilderness Areas) during the baseline period generally occurred in the period April to September, with sulfate being the largest component. To illustrate this, Figure 2-1 displays the 2000 – 2004 reconstructed extinction for the 20% most impaired days for the Dolly Sods Wilderness Area. During the baseline period, the peak visibility impairment days occur in the summer under stagnant weather conditions with high relative humidity, high temperatures, and low wind speeds. The 20% clearest days at the Southern Appalachian sites can occur at any time of year. At Swanquarter and other coastal sites, the 20% most impaired and clearest visibility days are distributed throughout the year.

[14] URL: https://www.epa.gov/sites/production/files/2020-06/documents/memo_data_for_regional_haze_technical_addendum.pdf

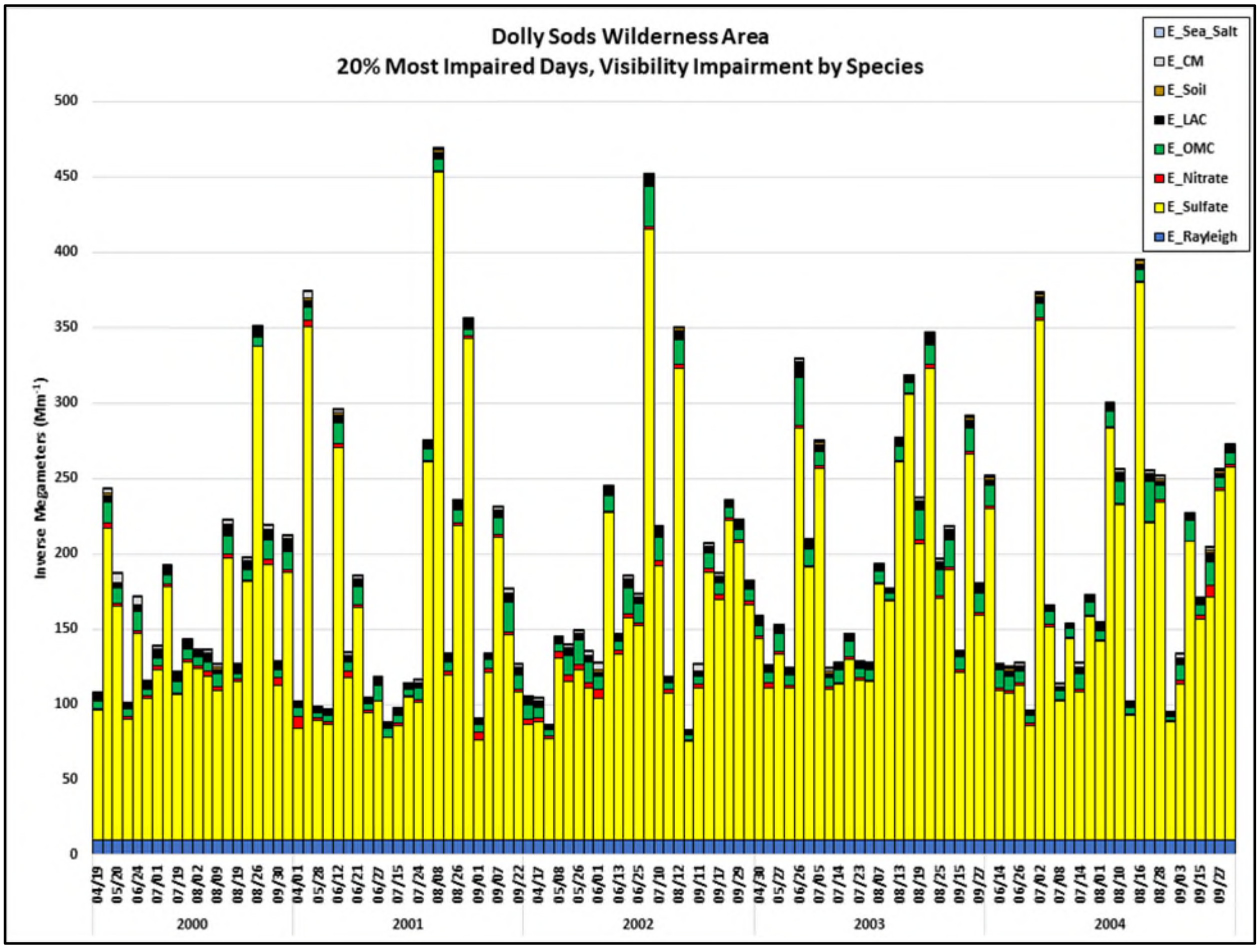

Figure 2-1: 2000-2004 Reconstructed Extinction for the 20% Most Impaired Days at the Dolly Sods Wilderness Area

Figure 2-2 displays the average light extinction for the 20% most impaired days during the baseline period (2000-2004) for each VISTAS Class I area and for nearby Class I areas. Figure 2-3 displays the average light extinction for the 20% clearest during the baseline period (2000-2004) for each VISTAS Class I area and for nearby Class I areas.

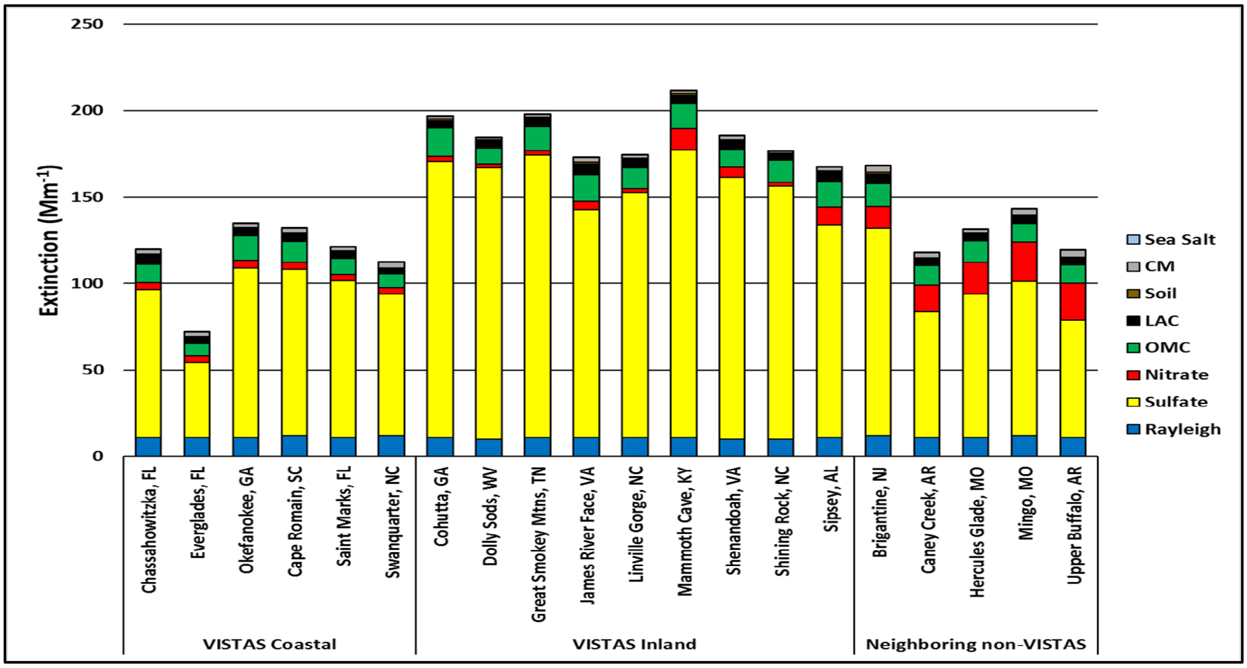

Figure 2-2: Average Light Extinction, 20% Most Impaired Days, 2000-2004, VISTAS and Neighboring Class I Areas

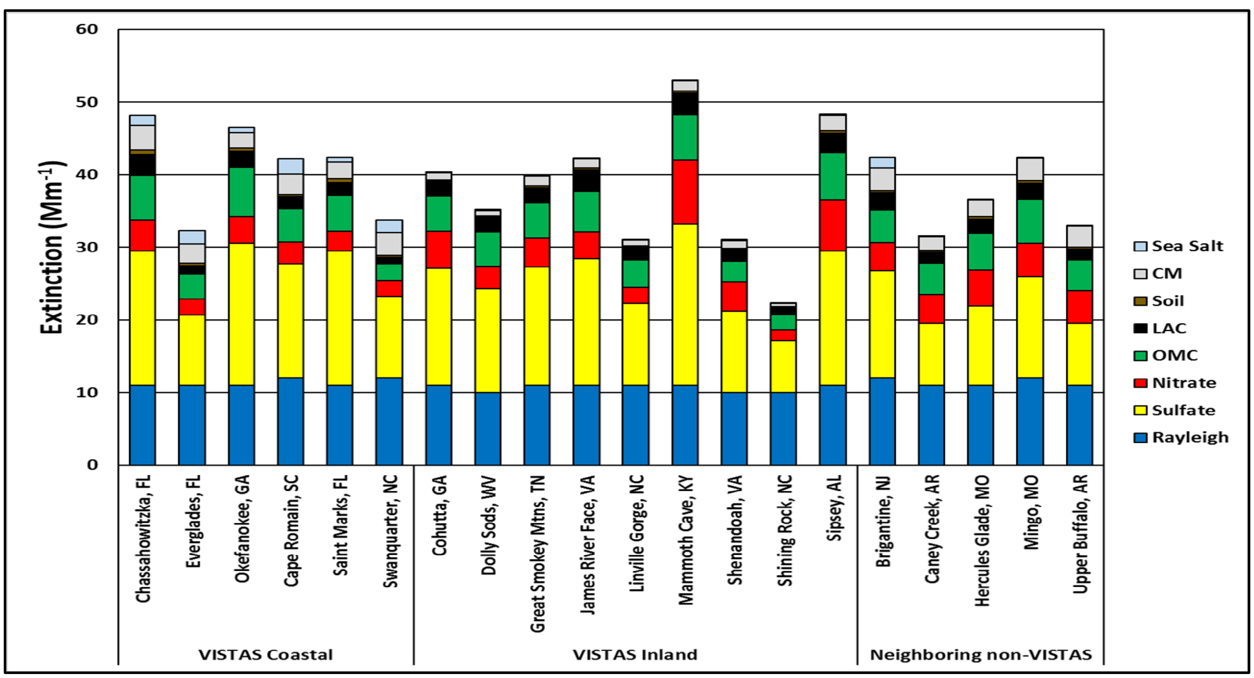

Figure 2-3: Average Light Extinction, 20% Clearest Days, 2000-2004, VISTAS and Neighboring Class I Areas

These bar charts (Figure 2-1, Figure 2-2, and Figure 2-3) are based on the IMPROVE data file called sia_impairment_daily_budgets_10_18.zip and therefore have not been updated with the patching and substitution algorithms described in EPA's June 3, 2020, guidance memorandum entitled, "Recommendation for the Use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program."[15] Changes to the daily data from the application of these routines is expected to be slight and will not change the conclusions of this SIP.

Ammonium sulfate, $(NH_4)_2SO_4$, is the most important contributor to visibility impairment and fine particle mass on the 20% most impaired and 20% clearest visibility days at both of the West Virginia Class I areas during the baseline period. During this period, sulfate levels on the 20% most impaired days accounted for over 80% of anthropogenically-driven visibility impairment. Sulfate particles are formed in the atmosphere from SO_2 emissions. Sulfate particles occur as hydrogen sulfate, H_2SO_4; ammonium bisulfate, $(NH_4)HSO_4$; and ammonium sulfate, $(NH_4)_2SO_4$, depending on the availability of ammonia, NH_3, in the atmosphere.

Across the VISTAS region, sulfate levels are higher at the Southern Appalachian sites than at the coastal sites (Figure 2-2). On the 20% clearest days, sulfate levels are more uniform across the region (Figure 2-3). For these two figures, levels at Great Smoky Mountains National Park are representative of levels at Joyce Kilmer-Slickrock Wilderness, levels at Okefenokee Wilderness are representative of Wolf Island Wilderness, and levels at Dolly Sods Wilderness are representative of levels at Otter Creek Wilderness.

The best average visibility and lowest sulfate values on the clearest days occurred at Shining Rock. Shining Rock, at 1621 meters elevation, is likely influenced on the clearest days by regional transport of air masses above the boundary layer.

The second most important contributor to fine particle mass and light extinction on the 20% most impaired and the 20% clearest days at the West Virginia Class I areas during the baseline period is Rayleigh scattering. Rayleigh scattering is the scattering of sunlight off random air molecules in the atmosphere and varies with the elevation of the monitoring site. This scattering of sunlight is what causes the sky to be blue and sunsets to be red. For VISTAS monitoring sites, this value varies from 10 to 12 Mm^{-1}.

Particulate Organic Matter (POM) is shown as organic matter carbon (OMC) in the figures. Days for which visibility impairment is associated with elevated levels of POM and elemental carbon are associated with natural events such as wildland fires and are largely removed from the

[15] URL: https://www.epa.gov/visibility/memo-and-technical-addendum-ambient-data-usage-and-completeness-regional-haze-program

20% most impaired days because they are regarded as natural sources. In the summer months more of the carbon mass is attributable to biogenic emissions from vegetation.

Ammonium nitrate (NH_4NO_3) is formed in the atmosphere by reaction of ammonia (NH_3) and NO_X. In the VISTAS region, nitrate formation is limited by availability of ammonia and by temperature. Ammonia preferentially reacts with SO_2 and sulfate before reacting with NO_X. Particle nitrate is formed at lower temperatures; at elevated temperatures nitric acid remains in gaseous form. For this reason, particle nitrate levels are very low in the summer and a minor contributor to visibility impairment during the baseline period of 2000-2004. Particle nitrate concentrations are higher on winter days and are more important for the coastal sites where the 20% most impaired days occur during the winter months.

Elemental Carbon (EC) is shown as light absorbing carbon (LAC) in this section's figures. EC is a comparatively minor contributor to visibility impairment in the baseline period. Sources include agriculture, prescribed, wildland, and wildfires and incomplete combustion of fossil fuels. EC levels are higher at urban monitors than at the Class I areas and suggest controls of primary PM at fossil fuel combustion sources would be more effective to reduce $PM_{2.5}$ in urban areas than to improve visibility in Class I areas

Soil fine particles are minor contributors to visibility impairment at most southeastern sites on most days in the baseline period. Occasional episodes of elevated fine soil can be attributed to Saharan dust episodes, particularly at Everglades, Florida. This dust is rarely seen in other VISTAS Class I areas and these contributions are now largely teased out as natural routine events. Due to its small contribution to anthropogenic visibility impairment in southeastern Class I areas, fine soil control strategies to improve visibility would not be effective.

Sea salt (NaCl) is observed at the coastal sites. During the baseline period, sea salt contributions to visibility impairment are most important on the 20% clearest days when sulfate and POM levels are low. Sea salt levels do not contribute significantly to visibility on the 20% most impaired visibility days. The new IMPROVE equation uses Chloride ion, Cl^-, from routine IMPROVE measurements to calculate sea salt levels. VISTAS used Cl^- to calculate sea salt contributions to visibility following IMPROVE guidance.

Coarse mass (CM) are particles with diameters between 2.5 and 10 microns. This component has a relatively small contribution to visibility impairment because the light extinction efficiency of coarse mass is very low compared to the extinction efficiency for sulfate, nitrate, and carbon.

2.5. Modeling Base Period (2009-2013)

Visibility projections discussed in Sections 5, 6, and 7.2.6 use IMPROVE data from 2009-2013 to estimate future year visibility at Class I areas. For each Class I area, estimated anthropogenic impairment observations from each IMPROVE site for the five-year period surrounding the 2011 modeling base year comprise the data representing the modeling base period. The year 2011 was selected as the modeling base year because the VISTAS 2028 emissions inventory is based on the 2011 Version 6 EPA modeling platform, which at the commencement of the VISTAS second round of implementation for regional haze was the most current, complete modeling platform available. For the analyses in this SIP, this period consists of those years surrounding 2011 (i.e. 2009-2013). While not required by the regional haze regulation, examination of these data provides insight into the future year visibility projections for the VISTAS Class I areas

2.5.1. Modeling Base Period (2009-2013) for 20% Clearest and 20% Most Impaired Days for VISTAS Class I Areas

Table 2-4 provides a summary of the conditions for the 20% clearest and 20% most impaired days at VISTAS Class I areas during 2009-2013, the period used as the modeling basis for this SIP revision projection analysis described in Sections 5, 6, and 7. The baseline light extinction and dv index values for the 20% most impaired and 20% clearest days at the Class I areas are based on data and calculations included in Appendix E-6 of this SIP (Task 9a, APP_C_SESARM_2028elv5_URP_20200903.xlsx).

Table 2-4: Modeling Base Period (2009-2013) Conditions for VISTAS Class I Areas

Class I Areas	Average for 20% Most Impaired Days	Average for 20% Clearest Days
Cape Romain Wilderness Area	21.48 dv	13.59 dv
Chassahowitzka Wilderness Area	19.96 dv	13.76 dv
Cohutta Wilderness Area	21.19 dv	10.94 dv
Dolly Sods Wilderness Area	21.59 dv	9.03 dv
Everglades National Park	16.30 dv	11.23 dv
Great Smoky Mountains National Park	21.39 dv	10.63 dv
James River Face Wilderness Area	21.37 dv	11.79 dv
Joyce Kilmer-Slickrock Wilderness Area	21.39 dv	10.63 dv
Linville Gorge Wilderness Area	20.39 dv	9.70 dv
Mammoth Cave National Park	24.04 dv	13.69 dv
Okefenokee Wilderness Area	20.70 dv	13.34 dv
Otter Creek Wilderness Area	21.59 dv	9.03 dv
Shenandoah National Park	20.72 dv	8.60 dv
Shining Rock Wilderness Area*	20.39 dv	9.70 dv
Sipsey Wilderness Area	21.67 dv	12.84 dv
St. Marks Wilderness Area	20.11 dv	13.34 dv
Swanquarter Wilderness Area	19.76 dv	11.76 dv
Wolf Island Wilderness Area	20.70 dv	13.34 dv

* The IMPROVE monitoring data at Shining Rock Wilderness Area is missing complete data for 2010 and 2011. After consultation with North Carolina, a three-year average of 2009, 2012, and 2013 IMPROVE data was used to calculate the visibility (dv) for both the 20% clearest and 20% most impaired days at Shining Rock.

2.5.2. Pollutant Contributions to Visibility Impairment (2009-2013 Modeling Base Period Data)

Figure 2-4 shows the 2009 – 2013 reconstructed extinction for the 20% most impaired days for the Dolly Sods Wilderness Area. During the modeling base period, the peak visibility impairment days continue to occur in the summer although winter episodes became more prevalent. On nearly all days, sulfate continues to be the dominant visibility impairing pollutant. Nitrate impacts are variable and are higher on a few of the 20% most impaired days. The figure also shows the improvement in visibility impairment when compared to Figure 2-1. While maximum values in Figure 2-1 are in the range of 450 Mm^{-1}, maximum values in Figure 2-4 are in the 250 Mm^{-1} range with fewer days approaching the maximum value. This data highlights the impact of the many control programs and measures implemented during the intervening period.

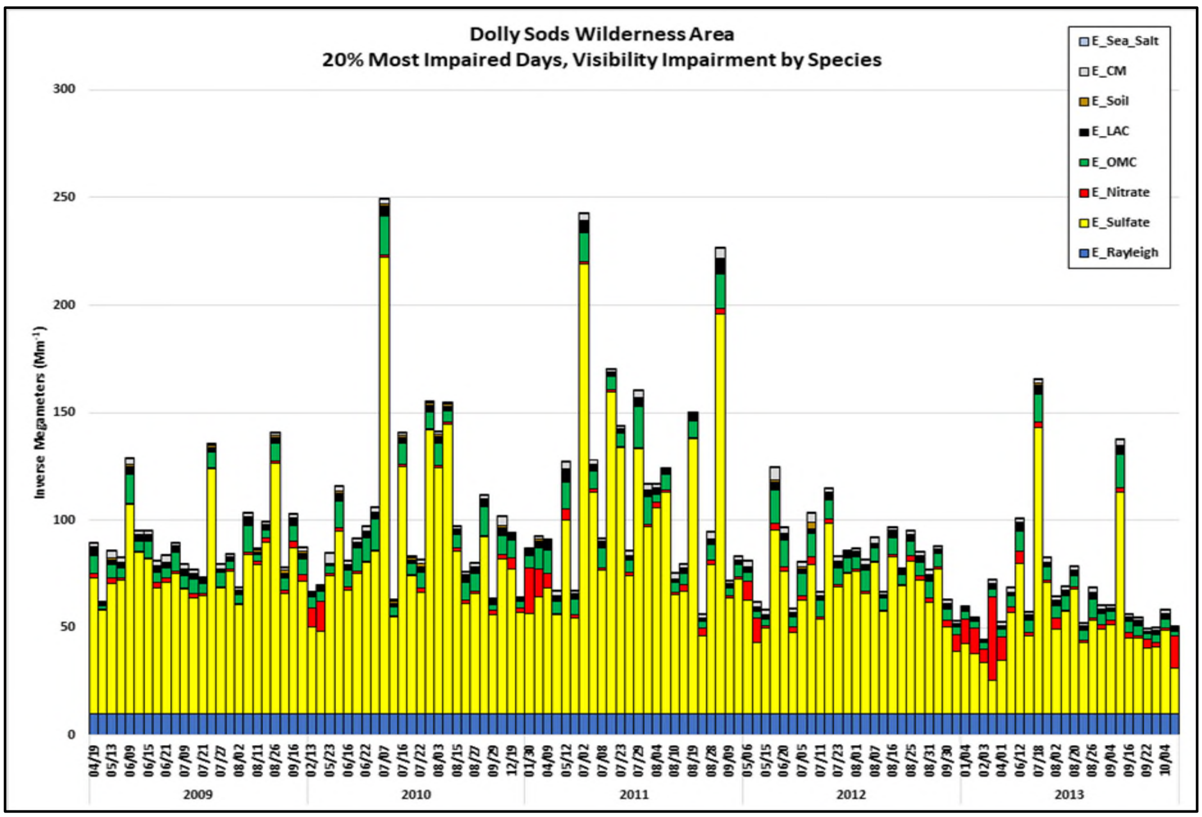

Figure 2-4: 2009-2013 Reconstructed Extinction for the 20% Most Impaired Days at the Dolly Sods Wilderness Area

Figure 2-5 displays the average light extinction for the 20% most impaired days during the modeling base period (2009-2013) for each VISTAS Class I area and for nearby Class I areas. Figure 2-5 shows that for the VISTAS Class I areas, sulfate continues to be the driver for 20% worst visibility days. In all VISTAS Class I areas except Mammoth Cave, organic matter is the second leading cause of visibility impairment on average during 20% most impaired days. In neighboring Class I areas and at Mammoth Cave, nitrate is the second leading cause of visibility impairment on average 20% most impaired days.

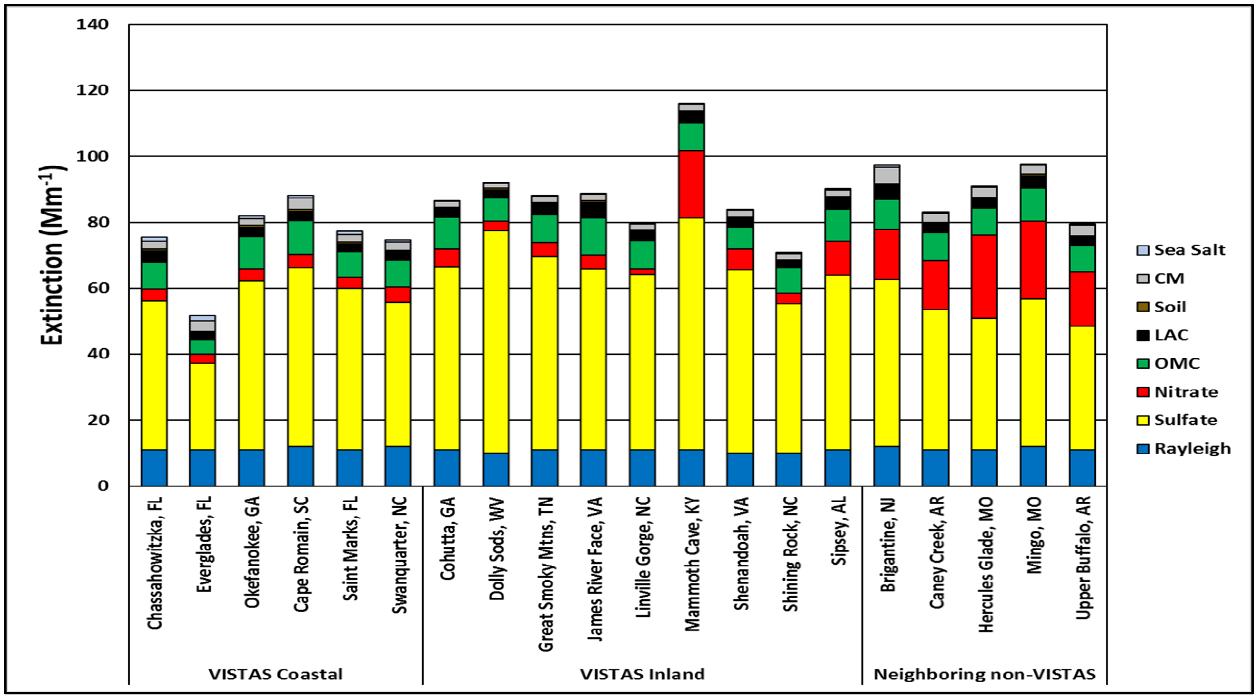

Figure 2-5: Average Light Extinction, 20% Most Impaired Days, 2009-2013, VISTAS and Neighboring Class I Areas

Figure 2-6 displays the average light extinction for the 20% clearest days during the modeling base period (2009-2013) for each VISTAS Class I area and for nearby Class I areas. On the 20% clearest days, sulfate continues to be the main component of visibility impairing pollution for VISTAS and nearby Class I areas. Comparison to Figure 2-3 shows that no degradation of visibility occurs between the 2000-2004 and 2009-2013 data sets, and in most cases improvement on 20% clearest days occurs.

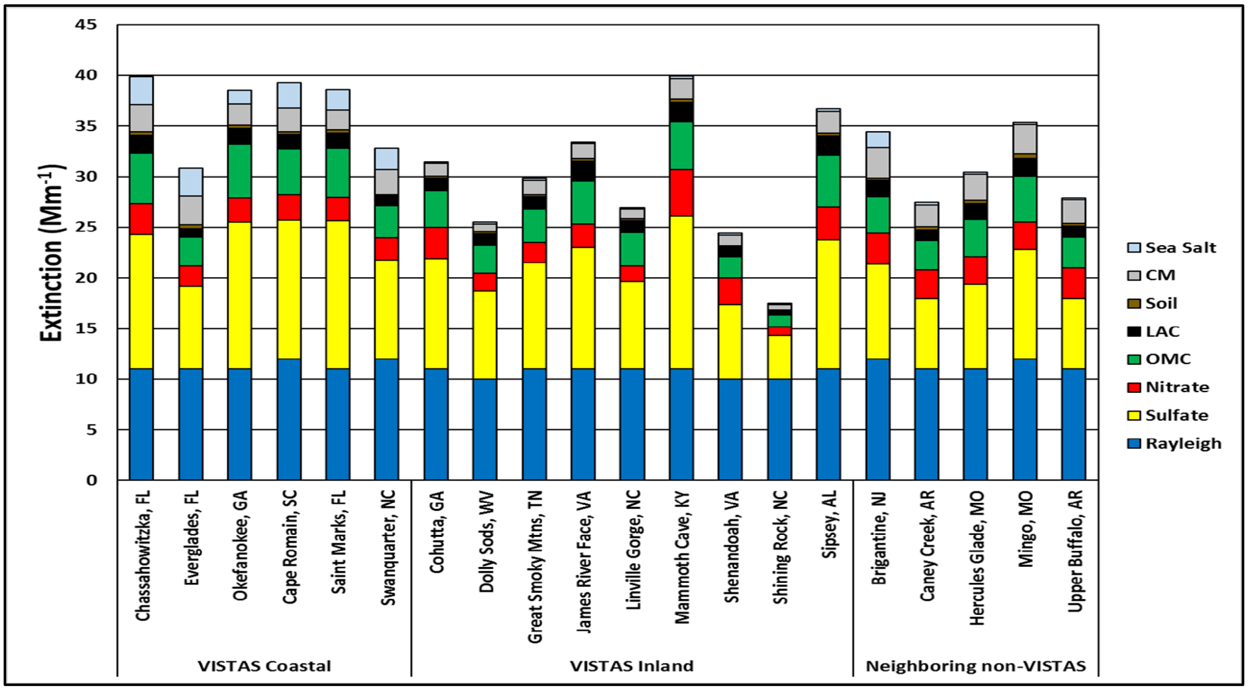

Figure 2-6: Average Light Extinction, 20% Clearest Days, 2009-2013, VISTAS and Neighboring Class I Areas

These bar charts (Figure 2-4, Figure 2-5, Figure 2-6) are based on the IMPROVE data file called sia_impairment_daily_budgets_10_18.zip and therefore have not been updated with the patching and substitution algorithms described in EPA's 2020 guidance memo. Changes to the daily data from the application of these routines is expected to be slight and will not change the conclusions of this SIP.

2.6. Current Conditions

The current visibility estimates are measurements from the five-year period between 2014 and 2018, inclusive.

2.6.1. Current Conditions (2014-2018) for 20% Clearest and 20% Most Impaired Days for VISTAS Class I Areas

Table 2-5 provides a summary of the current conditions (2014-2018) for the 20% clearest and 20% most impaired days at VISTAS Class I areas. These data reflect values included in Table 1 on the EPA memorandum with subject: Technical addendum including updated visibility data through 2018 for the memo titled, "Recommendation for the use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program."[16]

Table 2-5: Current Conditions (2014-2018) for VISTAS Class I Areas

Class I Areas	Average for 20% Most Impaired Days	Average for 20% Clearest Days
Cape Romain Wilderness Area	17.67 dv	11.80 dv
Chassahowitzka Wilderness Area	17.41 dv	12.41 dv
Cohutta Wilderness Area	17.37 dv	8.10 dv
Dolly Sods Wilderness Area	17.65 dv	6.68 dv
Everglades National Park	14.90 dv	10.37 dv
Great Smoky Mountains National Park	17.21 dv	8.35 dv
James River Face Wilderness Area	17.89 dv	9.47 dv
Joyce Kilmer-Slickrock Wilderness Area	17.21 dv	8.35 dv
Linville Gorge Wilderness Area	16.42 dv	7.61 dv
Mammoth Cave National Park	21.02 dv	11.31 dv
Okefenokee Wilderness Area	17.39 dv	11.57 dv
Otter Creek Wilderness Area	17.65 dv	6.68 dv
Shenandoah National Park	17.07 dv	6.85 dv
Shining Rock Wilderness Area*	15.49 dv	4.40 dv
Sipsey Wilderness Area	19.03 dv	10.76 dv
St. Marks Wilderness Area	17.39 dv	11.15 dv
Swanquarter Wilderness Area	16.30 dv	10.61 dv
Wolf Island Wilderness Area	17.39 dv	11.57 dv

2.6.2. Pollutant Contributions to Visibility Impairment (2014-2018 Current Data)

Figure 2-7 displays the 2014 – 2018 reconstructed extinction for the 20% most impaired days for the Dolly Sods Wilderness Area. For the VISTAS region and neighboring Class I areas, Figure 2-8 and Figure 2-9 show light extinction averaged from 2014-2018 IMPROVE data for the 20% most impaired and clearest days, respectively. These bar charts (Figure 2-7, Figure 2-8, and Figure 2-9) are based on the IMPROVE data file called sia_impairment_daily_budgets_10_18.zip for data through 2017. For 2018 data, the IMPROVE data file called sia_impairment_daily_budgets_4_20_2.zip was used. Therefore, the data through 2017 have not been updated with the patching and substitution algorithms described in EPA's 2020 guidance memo. Changes to the daily data from the application of these routines are expected to be slight and will not change the conclusions of this SIP.

These figures continue to demonstrate improved visibility when compared to the 2009-2013 data or the 2000-2004 data. Emissions of SO_2 and other visibility impairing pollutants are declining, as discussed in Section 7, and these reductions result in better visibility.

[16] URL: https://www.epa.gov/sites/production/files/2020-06/documents/memo_data_for_regional_haze_technical_addendum.pdf

Figure 2-8 presents average data for 20% most impaired days and shows on average sulfate continues to be the predominant visibility impairing pollutant. However, the data in Figure 2-7, which is daily monitoring values, shows that occasionally nitrate is the predominant visibility impairing pollutant on certain days, generally in the winter months.

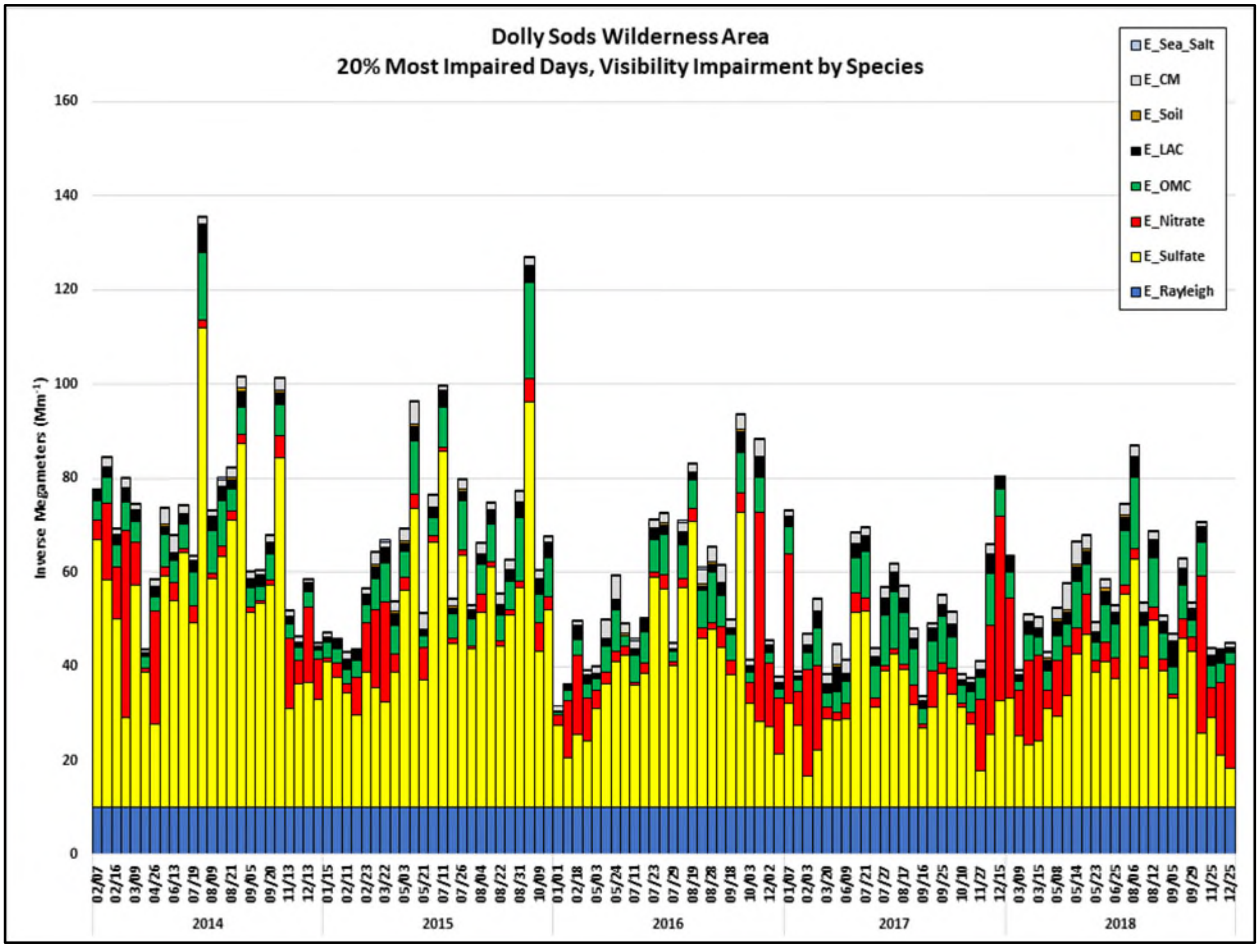

Figure 2-7: 2014-2018 Reconstructed Extinction for the 20% Most Impaired Days at the Dolly Sods Wilderness Area

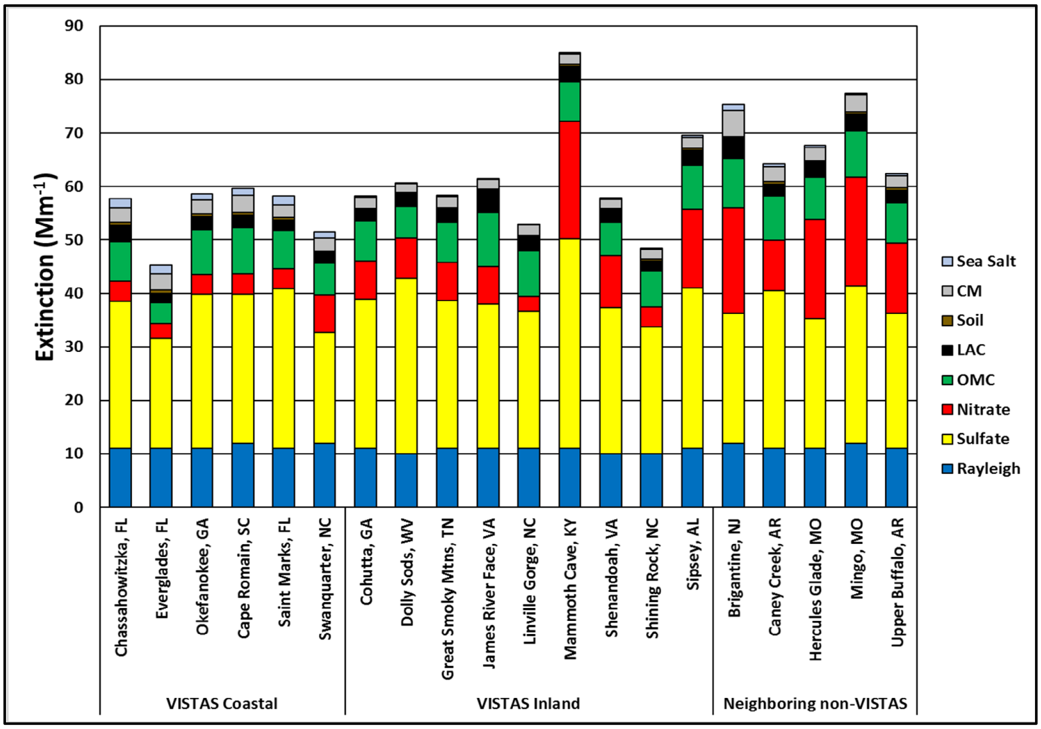

Figure 2-8: Average Light Extinction, 20% Most Impaired Days, 2014-2018, VISTAS and Neighboring Class I Areas

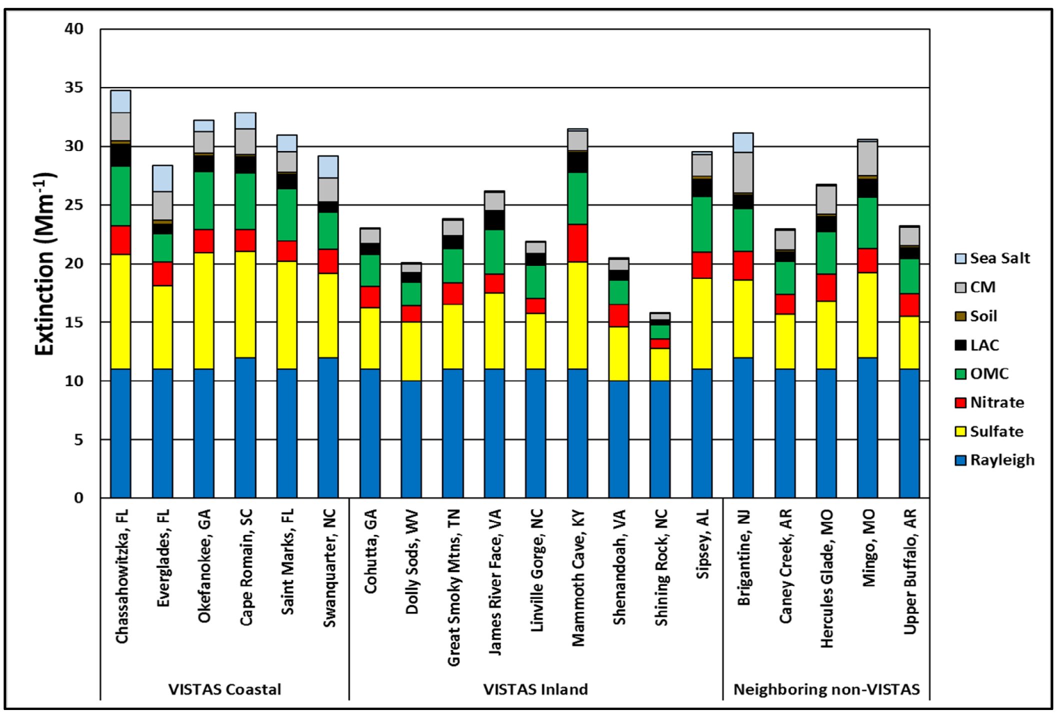

Figure 2-9: Average Light Extinction, 20% Clearest Days, 2014-2018, VISTAS and Neighboring Class I Areas

2.7. Comparisons of Baseline, Current, and Natural Background Visibility

The regional haze rule requires that SIPs include an evaluation of progress made since the baseline period toward improving visibility on the 20% most impaired days and 20% clearest days for each state's Class I areas (40 CFR 51.308(f)(1)(iv)). The rule also requires that the SIP enumerate the deciview value by which the current visibility condition exceeds the natural visibility condition, for each state's Class I areas on the 20% most impaired days and the 20% clearest days (40 CFR 51.308(f)(1)(v)). Table 2-6 summarizes this data for each Class I area located in VISTAS for the 20% most impaired days. On 20% most impaired days, data for current conditions show that significant progress has been made as compared to baseline conditions. In many cases, the improvement in visibility from baseline conditions demonstrated by the 2014-2018 visibility data is more than half of the improvement needed to achieve natural conditions.

Table 2-6: Comparison of Baseline, Current, and Natural Conditions for 20% Most Impaired Days

Class I Areas	2000-2004 Baseline Conditions	2014-2018 Current Conditions	Change in Visibility, Baseline to Current	Natural Background Conditions	Difference Between Current Conditions and Natural Background
Cape Romain Wilderness Area	25.25 dv	17.67 dv	7.58 dv	9.79 dv	7.88 dv
Chassahowitzka Wilderness Area	24.52 dv	17.41 dv	7.11 dv	9.03 dv	8.38 dv
Cohutta Wilderness Area	29.12 dv	17.37 dv	11.75 dv	9.88 dv	7.49 dv
Dolly Sods Wilderness Area	28.29 dv	17.65 dv	10.64 dv	8.92 dv	8.73 dv
Everglades National Park	19.52 dv	14.90 dv	4.62 dv	8.33 dv	6.57 dv
Great Smoky Mountains National Park	29.11 dv	17.21 dv	11.90 dv	10.05 dv	7.16 dv
James River Face Wilderness Area	28.08 dv	17.89 dv	10.19 dv	9.47 dv	8.42 dv
Joyce Kilmer-Slickrock Wilderness Area	29.11 dv	17.21 dv	11.90 dv	10.05 dv	7.16 dv
Linville Gorge Wilderness Area	28.05 dv	16.42 dv	11.63 dv	9.70 dv	6.72 dv
Mammoth Cave National Park	29.83 dv	21.02 dv	8.81 dv	9.80 dv	11.22 dv
Okefenokee Wilderness Area	25.34 dv	17.39 dv	7.95 dv	9.45 dv	7.94 dv
Otter Creek Wilderness Area	28.29 dv	17.65 dv	10.64 dv	8.92 dv	8.73 dv
Shenandoah National Park	28.32 dv	17.07 dv	11.25 dv	9.52 dv	7.55 dv
Shining Rock Wilderness Area	28.13 dv	15.49 dv	12.64 dv	10.25 dv	5.24 dv
Sipsey Wilderness Area	27.69 dv	19.03 dv	8.66 dv	9.62 dv	9.41 dv
St. Marks Wilderness Area	24.68 dv	17.39 dv	7.29 dv	9.13 dv	8.26 dv
Swanquarter Wilderness Area	23.79 dv	16.30 dv	7.49 dv	10.01 dv	6.29 dv
Wolf Island Wilderness Area	25.34 dv	17.39 dv	7.95 dv	9.45 dv	7.94 dv

Table 2-7 summarizes this data for each Class I area located in VISTAS for the 20% clearest days. On the 20% clearest days, data for current conditions show that visibility on these days has improved from the baseline conditions for all VISTAS Class I areas.

Table 2-7: Comparison of Baseline, Current, and Natural Conditions for 20% Clearest Days

Class I Areas	2000-2004 Baseline Conditions	2014-2018 Current Conditions	Change in Visibility, Baseline to Current	Natural Background Conditions	Difference Between Current Conditions and Natural Background
Cape Romain Wilderness Area	14.29 dv	11.801 dv	2.49 dv	5.93 dv	5.87 dv
Chassahowitzka Wilderness Area	15.60 dv	12.41 dv	3.19 dv	6.00 dv	6.41 dv
Cohutta Wilderness Area	13.73 dv	8.10 dv	5.63 dv	4.42 dv	3.68 dv
Dolly Sods Wilderness Area	12.28 dv	6.68 dv	5.60 dv	3.64 dv	3.04 dv
Everglades National Park	11.69 dv	10.37 dv	1.32 dv	5.22 dv	5.15 dv
Great Smoky Mountains National Park	13.58 dv	8.35 dv	5.23 dv	4.62 dv	3.73 dv
James River Face Wilderness Area	14.21 dv	9.47 dv	4.74 dv	4.39 dv	5.08 dv
Joyce Kilmer-Slickrock Wilderness Area	13.58 dv	8.35 dv	5.23 dv	4.62 dv	3.73 dv
Linville Gorge Wilderness Area	11.11 dv	7.61 dv	3.50 dv	4.07 dv	3.54 dv
Mammoth Cave National Park	16.51 dv	11.31 dv	5.20 dv	5.00 dv	6.31 dv
Okefenokee Wilderness Area	15.23 dv	11.57 dv	3.66 dv	5.43 dv	6.14 dv
Otter Creek Wilderness Area	12.28 dv	6.68 dv	5.60 dv	3.64 dv	3.04 dv
Shenandoah National Park	10.96 dv	6.85 dv	4.11 dv	3.15 dv	3.70 dv
Shining Rock Wilderness Area	7.70 dv	4.40 dv	3.30 dv	2.49 dv	1.91 dv
Sipsey Wilderness Area	15.57 dv	10.76 dv	4.81 dv	5.03 dv	5.73 dv
St. Marks Wilderness Area	14.34 dv	11.15 dv	3.19 dv	5.37 dv	5.78 dv
Swanquarter Wilderness Area	12.34 dv	10.61 dv	1.73 dv	5.71 dv	4.90 dv
Wolf Island Wilderness Area	15.23 dv	11.57 dv	3.66 dv	5.43 dv	6.14 dv

3. GLIDE PATHS TO NATURAL CONDITIONS IN 2064

In accordance with 40 CFR 51.308(f)(1)(vi)(A), each state must calculate a uniform rate of progress (URP), also known as a "glide path," for each mandatory federal Class I area located within that state. Starting with the baseline period of 2000-2004, states must analyze and determine the consistent rate of progress over time. States must compare the baseline visibility conditions (2000-2004) for the most impaired days to the natural visibility condition for the most impaired days to determine the uniform rate of visibility improvements needed to attain the natural visibility conditions by the end of 2064.

Glide paths were developed for each mandatory federal Class I area in the VISTAS region. The glide paths were developed in accordance with the EPA's guidance for tracking progress[17] and used data collected from the IMPROVE monitoring sites as described in Section 2 of this document. Glide paths are one of the indicators used in setting reasonable progress goals.

Figure 3-1 shows the glide path for the 20% most impaired days for Dolly Sods Wilderness Area assuming a uniform rate of progress toward natural conditions. Natural background visibility for the most impaired days at Dolly Sods is calculated to be 8.92 dv.

The data in Figure 3-1 is derived from Table 1 in the EPA memorandum with subject: Technical addendum including updated visibility data through 2018 for the memo titled, "Recommendation for the use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program."[18]

[17] URL: https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf
[18] URL: https://www.epa.gov/sites/production/files/2020-06/documents/memo_data_for_regional_haze_technical_addendum.pdf

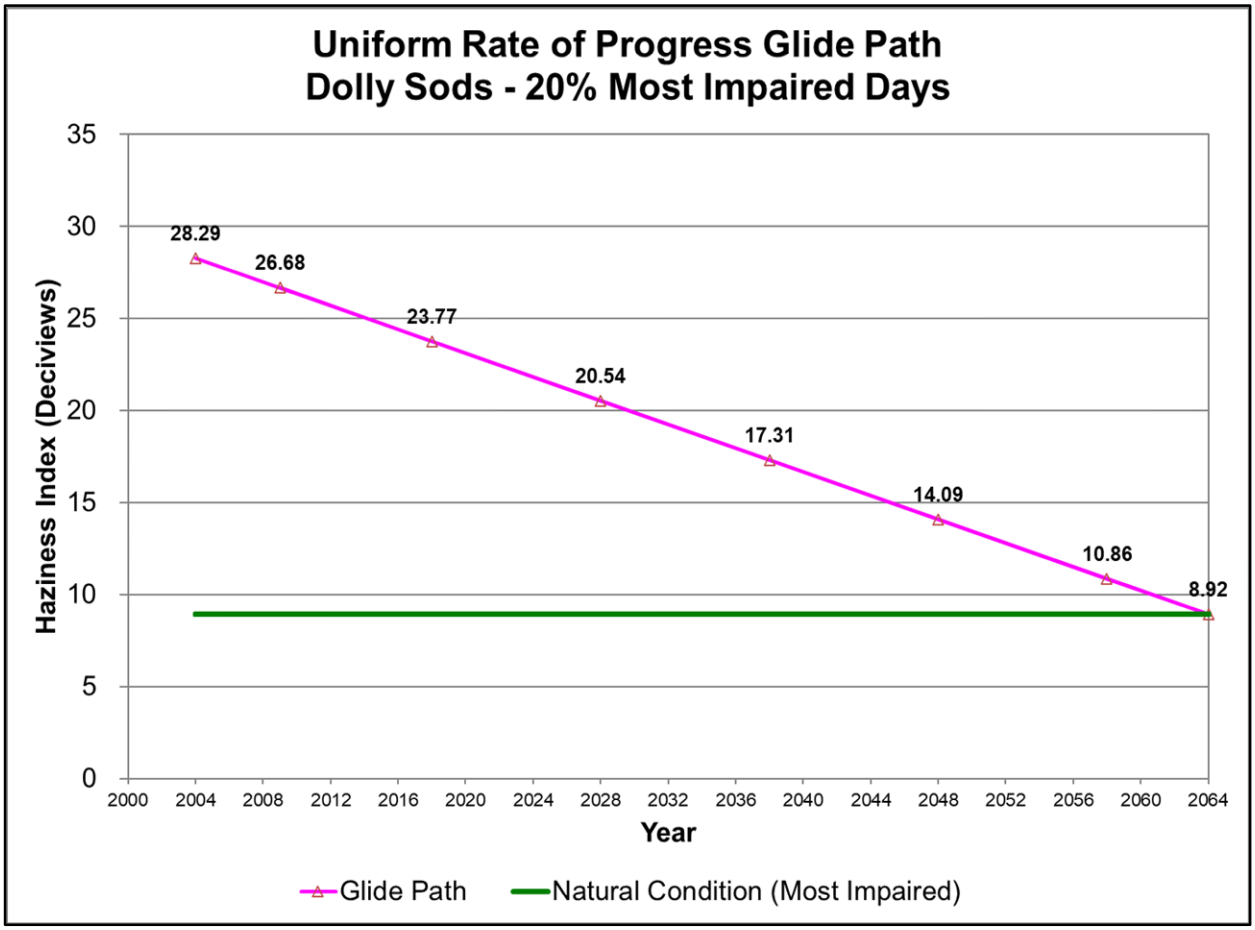

Figure 3-1: Uniform Rate of Progress Glide Path for 20% Most Impaired Days at Dolly Sods Wilderness Area

4. TYPES OF EMISSIONS IMPACTING VISIBILITY IMPAIRMENT IN WEST VIRGINIA CLASS I AREAS

4.1. Baseline Emissions Inventory

The regional haze rule at 51.308(f)(6)(v) requires a statewide emissions inventory of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any mandatory Class I area. The inventory must include emissions for the most recent year for which data are available and estimates of future projected emissions. West Virginia complies with the Air Emission Reporting Requirements (AERR) by submitting the required triannual and annual stationary point source inventories to EPA. Section 13.5.1 shows National Emission Inventory (NEI) data for 2014 and 2017 and Clean Air Markets Division (CAMD) data for 2018 and 2019. The same regional haze rule provision also requires states to commit to updating the inventory periodically, which West Virginia will continue to do in accordance with EPA regulations. This section describes how the projected emissions inventory for 2028 was developed, and Section 7.2.4 shows the 2028 projected emissions data. For the inventory, VISTAS used a baseline year of 2011 and a projected future year of 2028. The emission inventories include carbon monoxide[19] (CO), volatile organic compounds (VOCs), nitrous oxides (NO_X), fine particulate matter ($PM_{2.5}$), coarse particulate matter (PM_{10}), ammonia (NH_3), and sulfur dioxide (SO_2).

VISTAS contracted with ERG to perform emission inventory work as part of the air quality modeling analysis. ERG was directed by VISTAS to use EPA's 2011el-based air quality modeling platform, which includes emissions, meteorology, and other inputs for 2011, as the base year for the modeling described in EPA's TSD entitled "Documentation for the EPA's Preliminary 2028 Regional Haze Modeling."[20] EPA projected the 2011 base year emissions[21] to a 2028 future year base case scenario. These data were the foundation of the revised emissions used for this analysis as described elsewhere. The 2011 modeling platform and projected 2028 emissions were used to drive the 2011 base year and 2028 base case air quality model simulations. As noted in EPA's TSD, the 2011 base year emissions and methods for projecting these emissions to 2028 are in large part similar to the data and methods used by EPA in the final Cross-State Air Pollution Rule (CSAPR) Update[22] and the subsequent notice of data availability

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19 CO is not a visibility impairing pollutant, and thus, CO data was not evaluated for this regional haze plan.

20 EPA OAQPS, *Documentation for the EPA's Preliminary 2028 Regional Haze Modeling,* October 2017.

21 URL: https://www.epa.gov/air-emissions-modeling/2011-version-63-technical-support-document

22 URL: https://www.epa.gov/airmarkets/final-cross-state-air-pollution-rule-update

(NODA)[23] to support ozone transport for the 2015 ozone NAAQS. Appendix B-1a and Appendix B-2a contain complete reports from ERG detailing the emission inventory work.

There are six different emission inventory source classifications: stationary point sources, nonpoint (formerly called "stationary area") sources, nonroad and onroad mobile sources, biogenic sources, and point fires.[24] Stationary point sources are those sources that emit greater than a specified tonnage per year, with data provided at the facility level. Electric generating utilities and industrial sources are the major categories for stationary point sources. Nonpoint sources are those sources whose individual emissions are relatively small, but due to the large number of these sources, the collective emissions from the source category could be significant (e.g., dry cleaners, service stations, fuel combustion for residential heat, and agricultural sources). These types of emissions are estimated on a countywide level. Nonroad mobile sources are equipment that can move but do not use the roadways (e.g., lawn mowers, construction equipment, and railroad locomotives). The emissions from these sources, like nonpoint sources, are estimated on a countywide level. Onroad mobile sources include passenger cars, motorcycles, minivans, sport-utility vehicles, light-duty trucks, heavy-duty trucks, and buses that are normally operated on public roadways. The emissions from these sources are estimated by vehicle type and road type and are summed to the countywide level. Biogenic sources are the natural sources of emissions like trees, crops, grasses, and natural decay of plants. The emissions from these sources are estimated on a countywide level. The point fire sector includes both prescribed fires and wildfires.

4.1.1. Stationary Point Sources

Point source emissions are emissions from individual sources having a fixed location. Generally, these sources must have permits to operate, their emissions are inventoried on a regular schedule, and provided at the facility process level. In West Virginia, large, permitted sources of a criteria pollutant and/or a hazardous air pollutant (HAP) are inventoried annually. Some state and local agencies conduct emission inventories more frequently, use lower thresholds, and include HAPs. Smaller sources may be inventoried less frequently. The point source emissions data can be grouped as electricity generating unit (EGU) sources and other industrial point sources, also called non-EGUs. Airport-related sources; including aircraft, airport ground support equipment, and jet refueling; are also part of the point source sector. In previous modeling platforms, airport-related sources were included in the nonroad sector.

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23 URL: https://www.epa.gov/airmarkets/notice-data-availability-preliminary-interstate-ozone-transport-modeling-data-2015-ozone

24 Note that prescribed fires and wildfires are designated events in the National Emissions Inventory.

4.1.1.1. Electric Generating Units

The electric generating unit (EGU) sector contains emissions from EGUs in the 2011 NEI v2 point inventory that could be matched to units found in the National Electric Energy Database System (NEEDS) v5.15. In most cases, the base year 2011 inventory for the EGU sources used 2011 continuous emissions monitoring (CEM) data reported to the EPA's CAMD. These data provide hourly emissions profiles for SO_2 and NO_X that can be used in air quality modeling. Emissions profiles are used to estimate emissions of other pollutants (VOCs, CO, NH_3, $PM_{2.5}$) based on measured emissions of SO_2 and NO_X. The NEEDS database of units includes many smaller emitting EGUs that are not included in the CAMD hourly CEMS programs. Thus, there are more units in the NEEDS database than have CEMS data. Emissions from EGUs vary daily and seasonally as a function of variability in energy demand, utilization, and outage schedules. The temporalization of EGU units matched to CEMS is based on the base year CEMS data for those units, whereas regional profiles are used for the remaining units.

For projected year 2028 EGU point sources, the VISTAS states considered the EPA 2028el, the EPA 2023en, or 2028 emissions from the Eastern Regional Technical Advisory Committee (ERTAC) EGU projection tool from the most recent CONUS 2.7 run. The EPA 2028el emissions inventory for EGUs were created by the Integrated Planning Model (IPM) version 5.16. This scenario represents the implementation of the Revised Cross-State Air Pollution Rule (CSAPR), CSAPR Update, CSAPR, Mercury and Air Toxics Standards (MATS), Clean Power Plan (CPP) and the final actions the EPA has taken to implement the Regional Haze Rule, the Cooling Water Intakes Rule, and Combustion Residuals from Electric Utilities (CCR). The CPP was later vacated. Impacts of the CPP assumed that coal-fired EGUs would be shut down and replaced by natural gas-fired EGUs. Thus, the EPA 2028el projected emissions for EGU emissions are not reflective of probable emissions for 2028. The ERTAC EGU emissions did not consider the impacts of the CPP. After evaluating the different projection options, each VISTAS state determined the estimated emissions for each EGU for the projected year 2028. Appendix B contains a summary of the action items provided by each VISTAS state in preparing the 2028 EGU emissions inventory. For non-VISTAS states, the EPA 2028el EGU emissions were replaced with the 2028 ERTAC 2.7 EGU emissions, which uses base year 2011 operations and emissions. West Virginia used the ERTAC 16.0 to project 2028 EGU emissions, which uses base year 2016 operations and emissions.

4.1.1.2. Other Industrial Point Sources and Airport-Related Sources

The non-EGU sector uses annual emissions contained in the 2011 NEIv2. These emissions are temporally allocated to month, day, and hour using source category code (SCC)-based allocation factors. The Control Strategy Tool (CoST) was used to apply most non-EGU projection/growth factors, controls, and facility/unit/stack-level closures to the 2011 NEI-based emissions modeling inventories to create future year inventory for 2028. Like the EGU sector, each state was able to adjust the 2028 non-EGU inventory based on their knowledge of each facility. Airport-related source emissions for the base year 2011 were developed from the 2011 NEIv2. Aircraft emissions for 2011 are projected to the future year 2028 by applying activity growth using data on itinerant operations at airports. The itinerant operations are defined as aircraft take-offs or aircraft landings. The EPA used projected itinerant information available from the Federal Aviation Administration's (FAA) Terminal Area Forecast (TAF) System.

4.1.2. Nonpoint Sources

Nonpoint sources are those sources whose individual emissions are relatively small, but due to the large number of these sources, the collective emissions from the source category could be significant (e.g., dry cleaners, service stations, fuel combustion for residential heat, and agricultural sources). Emissions are estimated by multiplying an emission factor by some known indicator of collective activity, such as fuel usage, number of households, or population. Nonpoint source emissions are estimated at the countywide level. The base year 2011 nonpoint source inventory was developed from the 2011NEIv2. The CoST was used to apply most nonpoint projection/growth factors, controls, and facility/unit/stack-level closures to the 2011 NEI-based emissions modeling inventories to create future year inventory for 2028.

4.1.3. Nonroad Mobile Sources

Nonroad mobile sources are equipment that can move but do not use the roadways, such as construction equipment, railroad locomotives, commercial marine vessels, and lawn equipment. For most of the nonroad mobile sources, the emissions for 2011 were estimated using the EPA's National Mobile Inventory Model (NMIM, 2005). For the two source categories not included in the NMIM, i.e., railroad locomotives and commercial marine, more traditional methods of estimating the emissions were used.

For the source categories estimated using the EPA's NMIM model, the model growth assumptions were used to create the 2028 future year inventory. The NMIM model takes into consideration regulations affecting emissions from these source categories. The 2028 future-year commercial marine vessel and railroad locomotive emissions account for increased fuel consumption based on Energy Information Administration (EIA) fuel consumption projections for freight, and emissions reductions resulting from emissions standards from the Final Locomotive-Marine rule.

4.1.4. Onroad Mobile Sources

Onroad mobile sources include passenger cars, motorcycles, minivans, sport-utility vehicles, light-duty trucks, heavy-duty trucks, and buses that are normally operated on public roadways. For onroad vehicles, EPA's Motor Vehicle Emissions Simulator (MOVES) model (MOVES2014a) was used to develop base year 2011 emissions. Key inputs for MOVES include information on the age of vehicles on the roads, vehicle miles traveled, the average speeds on the roads, the mix of vehicles on the roads, any programs in place in an area to reduce emissions for motor vehicles (e.g., vehicle emissions inspection programs), and temperature. The MOVES model takes into consideration regulations that affect emissions from this source sector. The MOVES model was run for 2028 inventory using input data reflective of that year.

4.1.5. Biogenic Sources

Biogenic emissions for 2011 were developed using the Biogenic Emission Inventory System version 3.61 (BEIS3.61) within the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system; SMOKE is discussed further in Section 5.2.4.2. BEIS3.61 creates gridded, hourly, model-species emissions from vegetation and soil. BEIS3.61 includes the incorporation of Version 4.1 of the Biogenic Emissions Land use Database (BELD4) and the incorporation of a canopy model to estimate leaf-level temperatures. BELD version 4.1 is based on an updated version of the USDA-United States Forest Service (USFS) Forest Inventory and Analysis (FIA) vegetation speciation-based data from 2001 to 2014 in the FIA version 5.1. Canopy coverage is based on the Landsat satellite National Land Cover Database (NLCD) product from 2011. The 2011 biogenic emissions are used for the 2028 future year without any changes.

4.1.6. Point Fires

The point fires sector includes emissions from both prescribed fires and wildfires. The point fire sector excludes agricultural burning and other open burning sources that are included in the nonpoint sector. Fire emissions are specified at geographic coordinates (point locations) and have daily emissions values. Emissions are day-specific and include satellite-derived latitude/longitude of the fire's origin and other parameters associated with the emissions such as acres burned and fuel load, which allow estimation of plume rise.

Fire emissions for the base year 2011 were taken from the 2011 NEIv2. The point source day-specific emission estimates for 2011 fires rely on SMARTFIRE 2, which uses the National Oceanic and Atmospheric Administration's (NOAA's) Hazard Mapping System (HMS) fire location information as input. Additional inputs include the CONSUME v3.0 software application and the Fuel Characteristic Classification System (FCCS) fuel-loading database to estimate fire emissions from wildfires and prescribed burns daily. SMARTFIRE 2 estimates were used directly for all states except Georgia and Florida. For Georgia, the satellite-derived emissions were removed from the fire inventory and replaced with a separate state-supplied fire inventory. Adjustments were also made to Florida to rescale their emissions to match the total acres burned that Florida reported in the NEI. The 2011 fire emissions are used for the 2028 future year without any changes.

4.1.7. Summary 2011 Baseline Emissions Inventory for West Virginia

Table 4-1 is a summary of the 2011 baseline emission inventory for West Virginia. The complete inventory and discussion of the methodology is contained in Appendix B. The emissions summaries for other VISTAS states can also be found in Appendix B.

Table 4-1: 2011 Emissions Inventory Summary for West Virginia (tpy)

Sector	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
EGU	10,418	68	56,620	11,469	9,483	100,108	1,024
Non-EGU Point	34,111	216	24,888	5,109	3,156	15,710	8,830
Nonpoint	81,184	9,640	41,832	96,024	18,977	4,926	73,665
Onroad	185,437	734	41,840	2,101	1,269	179	20,493
Nonroad	84,687	10	6,495	856	808	19	15,158
Point-Fires	86,171	1,416	1,269	8,849	7,499	676	20,356
Total	**482,008**	**12,084**	**172,944**	**124,408**	**41,192**	**121,618**	**139,526**

4.1.8. Emissions Inventory Improvements Prior to Remodeling 2028 Future Year

The VISTAS initial emission inventory was completed in June 2018. The VISTAS initial modeling for the future year 2028 was completed in October 2019. VISTAS compared the VISTAS emission inventory information to EPA's modeling inventory, which was released in September 2019. The EPA used a base year of 2016 and a future year of 2028. One main difference between the VISTAS and the EPA modeling is that VISTAS used a base year of 2011 while the EPA used a base year of 2016. This is an important difference since the future year 2028 emissions are generally projected from the base year. VISTAS noted large differences in SO_2 and NO_X emissions, with the EPA's emissions being much lower. One reason for this difference was that VISTAS initial modeling used an older version of ERTAC, which accounted for fewer coal-fired EGU retirements and fuel switches. Table 4-2 below compares the 2028-point emissions used by VISTAS versus the latest 2028fh[25] emissions used by the EPA (projected from 2016). The emissions in Table 4-2 are extracted from the VISTAS12 modeling domain, which covers the eastern US. As shown in Table 4-2, the EPA's SO_2 emissions are 45.61% lower than the VISTAS estimates, and the EPA's NO_X emissions are 20.19% lower than the VISTAS estimates.

[25] The "f" represents the base year emissions modeling platform iteration, which shows that it is 2014 NEI based (whereas for 2011 NEI-based platforms, this letter was "e"); and the "h" stands for the eighth configuration of emissions modeling for a 2014-NEI based modeling platform).

Table 4-2: VISTAS 2028 versus New EPA 2028

Pollutant	VISTAS 2028 (tpy)	New EPA 2028 (tpy)	Difference (tpy)	Difference (%)
NO_X	2,641,463.83	2,108,115.50	533,348.33	-20.19%
SO_2	2,574,542.02	1,400,287.10	1,174,254.92	-45.61%

Tables 4-3 and 4-4 below compare the SO_2 and NO_X emissions for the older version of ERTAC (2.7opt) and the newer version of ERTAC (16.0), with the newer version of ERTAC having much lower emissions. The older version of ERTAC was used in the VISTAS modeling in the non-VISTAS states. As explained in Section 4.1.1 above, each VISTAS state determined the estimated emissions for each EGU in their state for the projected year 2028.

Table 4-3: SO_2 Old ERTAC (2.7opt) versus SO_2 New ERTAC (16.0)

RPO	16.0 2028 (tpy)	2.7opt 2028 (tpy)	Difference (tpy)	Difference (%)
CENSARA	367,683.7	760,828.2	-393,144.5	-51.67%
LADCO	266,047.0	379,577.5	-113,530.5	-29.91%
MANE-VU	78,657.0	196,672.6	-118,015.6	-60.01%
VISTAS	161,502.5	273,582.1	-112,079.6	-40.97%
Totals	**976,471.2**	**1,783,376.5**	**-806,905.3**	**-45.25%**

Table 4-4: NO_X Old ERTAC (2.7opt) versus NO_X New ERTAC (16.0)

RPO	16.0 2028 (tpy)	2.7opt 2028 (tpy)	Difference (tpy)	Difference (%)
CENSARA	244,499.3	354,795.1	-110,295.8	-31.09%
LADCO	166,429.4	198,966.9	-32,537.4	-16.35%
MANE-VU	56,315.3	83,432.5	-27,117.2	-32.50%
VISTAS	200,791.1	270,615.7	-69,824.6	-25.80%
Totals	**840,973.6**	**1,166,663.1**	**-325,689.5**	**-27.92%**

The Regional Haze rule and guidance indicate that future year projections should be as accurate as possible. Thus, after consulting with the EPA, VISTAS decided to model the future year 2028 again to have more accurate visibility projections. VISTAS made several improvements to the 2028 emissions inventory before remodeling the 2028 future year. These inventory improvements are detailed in the VISTAS emissions inventory report in Appendix B-2a. Each VISTAS state was given the opportunity to adjust any point source emissions in the 2028 inventory. For EGUs in the non-VISTAS states, ERTAC 2.7 emissions were replaced with the ERTAC 16.0 emissions, except for the LADCO states where ERTAC 2.7 emissions were replaced with ERTAC 16.1 emissions.

4.2. Summary of the 2028 Emissions Inventory and Assessment of Relative Contributions from Specific Pollutants and Source Categories

As noted in Section 2.4 for the years 2000-2004 and Section 2.6 for years 2014-2018, ammonium sulfate is the largest contributor to visibility impairment at the West Virginia Class I areas, and reduction of SO_2 emissions would be the most effective means of reducing ammonium sulfate. As illustrated in Figure 4-1, 91.2% of 2011 SO_2 emissions in the VISTAS states are attributable to electric generating facilities and industrial point sources. Similarly, in West Virginia the stationary point sources, consisting mostly of electric generating units and industrial point sources, contribute 95.2% of the SO_2 emissions in the state (see Table 4-5).

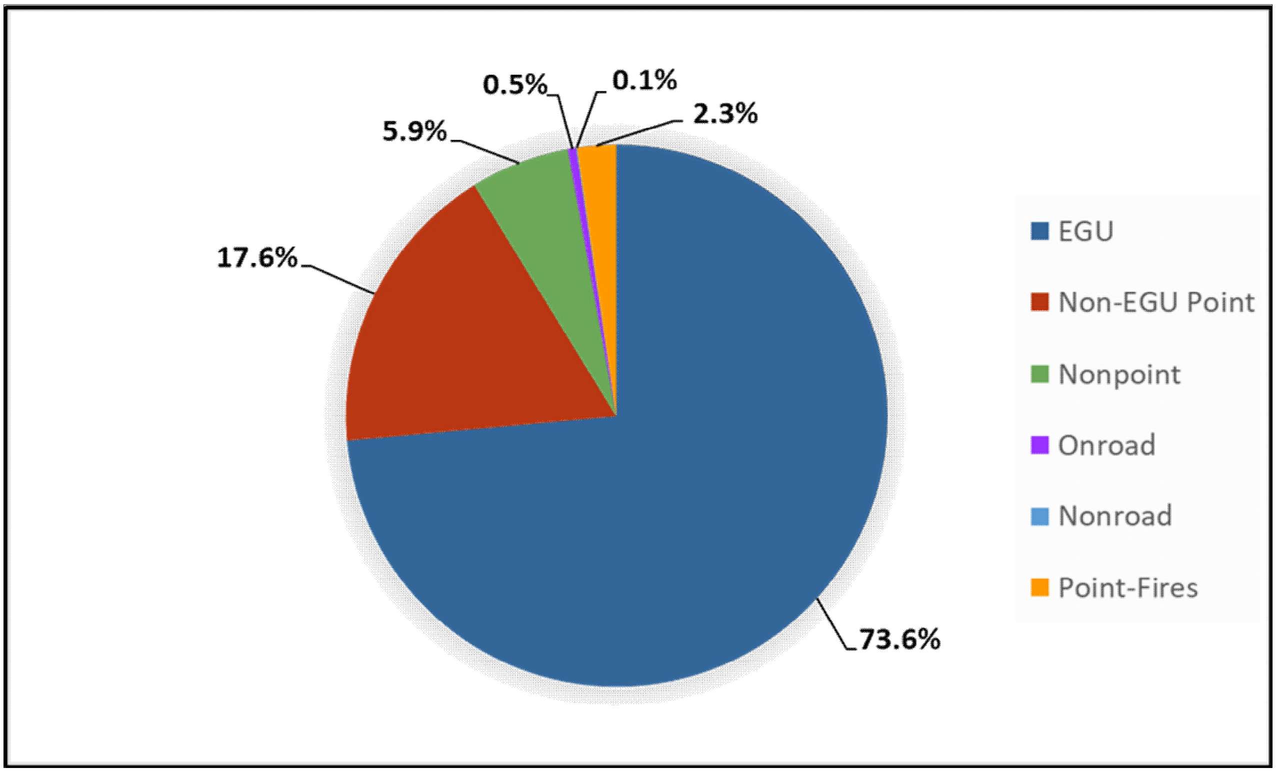

Figure 4-1: 2011 SO_2 Emissions in the VISTAS States

Table 4-5: 2011 SO_2 Emissions for West Virginia, tpy

Sector	SO_2, tpy	Percentage
Point	115,818	95.2%
Nonpoint	4,926	4.1%
Onroad	179	0.1%
Nonroad	19	0.0%
Point-Fires	676	0.6%
Totals	**121,618**	**100.0%**

Since the largest source of SO_2 emissions comes from stationary point sources, the focus of potential controls and the impacts for those controls was on this source sector. In West Virginia, the types of sources emitting SO_2, and thus contributing to the visibility impairment of the Class I areas, were predominantly coal-fired utilities and industrial boilers. Additionally, these coal-fired utilities and industrial boilers are also West Virginia's largest contributor of stationary point source NO_X emissions.

5. REGIONAL HAZE MODELING METHODS AND INPUTS

Modeling for regional haze was performed by VISTAS for the ten southeastern states, including West Virginia. The following sections outline the methods and inputs used by VISTAS for the regional modeling. Additional details are provided in Appendix E.

5.1. Analysis Method

The modeling analysis is a complex technical evaluation that begins by selection of the modeling system. For the most part, the modeling analysis approach for regional haze followed the EPA's 2011el-based air quality modeling platform, which includes emissions, meteorology, and other inputs for 2011 as the base year for the modeling described in their regional haze TSD (EPA, 2017). The EPA projected the 2011 base year emissions to a 2028 future year base case scenario. The EPA's work is the foundation of the emissions used in the VISTAS analysis, with significant revisions as described in Appendix B. As noted in the EPA's documentation, the 2011 base year emissions and methods for projecting these emissions to 2028 are in large part similar to the data and methods used by the EPA in the final CSAPR Update[26] and the subsequent NODA[27] to support ozone transport mandates for the 2015 ozone NAAQS. VISTAS decided to use the following modeling systems:

- Meteorological Model: The Weather Research and Forecasting (WRF) model is a mesoscale numerical weather prediction system designed to serve both operational forecasting and atmospheric research needs (Skamarock, 2004; 2006; Skamarock et al., 2005). The Advanced Research WRF (ARW) version of WRF was used in this regional haze analysis study. It features multiple dynamical cores, a three-dimensional variational (3DVAR) data assimilation system, and a software architecture allowing for computational parallelism and system extensibility. WRF is suitable for a broad spectrum of applications across scales ranging from meters to thousands of kilometers.

- Emissions Model: Emissions processing was completed using the SMOKE model for most source categories. The exceptions include EGUs for certain areas, as well as the biogenic and mobile sectors. For certain areas in the modeling domain, the ERTAC EGU Forecasting Tool[28] was used to grow base year hourly EGU emissions inventories into future projection years. The tool uses base year hourly EPA CAMD data, fuel specific growth rates, and other information to estimate future emissions. The BEIS model was

[26] URL: https://www.epa.gov/airmarkets/final-cross-state-air-pollution-rule-update
[27] URL: https://www.epa.gov/airmarkets/notice-data-availability-preliminary-interstate-ozone-transport-modeling-data-2015-ozone
[28] URL: https://marama.org/technical-center/ertac-egu-projection-tool/

used for biogenic emissions. Special processors were used for fires, windblown dust, lightning, and sea salt emissions. The 2014 MOVES onroad mobile source emissions model was used by EPA with SMOKE-MOVES to generate onroad mobile source emissions with the EPA generated vehicle activity data provided in the 2028 regional haze analysis.

- Air Quality Model: The Comprehensive Air Quality Model with Extensions (CAMx) Version 6.40 was used in this study, with the secondary organic aerosol partitioning (SOAP) algorithm module as the default. The CAMx photochemical grid model, which supports two-way grid nesting was used. The setup is based on the same WRF/SMOKE/CAMx modeling system used in the EPA 2011/2028el platform modeling. The Particulate Source Apportionment Technology (PSAT) tool of CAMx was selected to develop source contribution and significant contribution calculations.

Episode selection is an important component of any modeling analysis. The EPA's guidance recommends choosing time periods that reflect the variety of meteorological conditions representing visibility impairment on the 20% clearest and 20% most impaired days in the Class I areas being modeled. This is best accomplished by modeling a full year. For this analysis, VISTAS performed modeling for the full 2011 calendar year with 10 days of model spin-up in 2010.

Once base year model performance was deemed adequate, the future year emissions were processed. The air quality modeling results were used to determine a relative reduction in future visibility impairment, which was used to determine future visibility conditions and reasonable progress goals.

The complete modeling protocol used for this analysis can be found in Appendix E-1b.

5.2. Model Selection

To ensure that a modeling study is defensible, care must be taken in the selection of the models to be used. The models selected must be scientifically appropriate for the intended application and be freely accessible to all stakeholders. "Scientifically appropriate" means that the models address important physical and chemical phenomena in sufficient detail, using peer-reviewed methods. "Freely accessible" means that model formulations and coding are freely available for review and that the models are available to stakeholders, and their consultants, for execution and verification at no or low cost.

The following sections outline the criteria for selecting a modeling system that is both defensible and capable of meeting the study's goals. These criteria were used in selecting the modeling system for this modeling demonstration.

5.2.1. Selection of Photochemical Grid Model

5.2.1.1. Criteria

For a photochemical grid model to qualify as a candidate for use in a regional haze SIP, a state needs to show that it meets the same general criteria as a model for a NAAQS attainment demonstration. The EPA's current modeling guidelines lists the following criteria for model selection (EPA, 2018):

- It should not be proprietary;
- It should have received a scientific peer review;
- It should be appropriate for the specific application on a theoretical basis;
- It should be used with databases that are available and adequate to support its application;
- It should be shown to have performed well in past modeling applications;
- It should be applied consistently with an established protocol on methods and procedures;
- It should have a User's Guide and technical description;
- The availability of advanced features (e.g., probing tools or science algorithms) is desirable; and
- When other criteria are satisfied, resource considerations may be important and are a legitimate concern.

5.2.1.2. Overview of CAMx

The CAMx model[29] is a state-of-science "One-Atmosphere" photochemical grid model capable of addressing ozone, PM, visibility, and acid deposition at a regional scale for periods up to one year (Ramboll Environ, 2016). CAMx is a publicly available open-source computer modeling system for the integrated assessment of gaseous and particulate air pollution and meets all the

[29] URL: http://www.camx.com

photochemical grid model criteria above. Built on today's understanding that air quality issues are complex, interrelated, and reach beyond the urban scale, CAMx is designed to:

(a) simulate air quality over many geographic scales;

(b) treat a wide variety of inert and chemically active pollutants including ozone, inorganic and organic $PM_{2.5}$ and PM_{10}, mercury, and toxics;

(c) provide source-receptor, sensitivity, and process analyses; and

(d) be computationally efficient and easy to use.

The EPA has approved the use of CAMx for numerous ozone, PM, and regional haze SIPs throughout the U.S. and the agency has used this model to evaluate regional mitigation strategies including those for most recent regional-scale rules such as CSAPR.

5.2.2. Selection of Meteorological Model

5.2.2.1. Criteria

Meteorological models, either through objective, diagnostic, or prognostic analysis, extend available information about the state of the atmosphere to the grid upon which photochemical grid modeling is to be carried out. The criteria for selecting a meteorological model are based on both the model's ability to accurately replicate important meteorological phenomena in the region of study and the model's ability to interface with the rest of the modeling systems – particularly the photochemical grid model. With these issues in mind, the following criteria were established for the meteorological model to be used in this study:

- Non-hydrostatic formulation;
- Reasonably current, peer reviewed formulation;
- Simulates cloud physics;
- Publicly available at no or low cost;
- Output available in Input/Output Applications Programming Interface (I/O API) format;
- Supports four-dimensional data assimilation (FDDA); and
- Enhanced treatment of planetary boundary layer heights for air quality modeling.

5.2.3. Overview of WRF

The WRF[30] model is a mesoscale numerical weather prediction system designed to serve both operational forecasting and atmospheric research needs (Skamarock, 2004; 2006; Skamarock et al., 2005). The ARW version of WRF was used in this regional haze analysis study and meets all the meteorological model criteria above. It features multiple dynamical cores, a three-dimensional variational data assimilation system, and a software architecture allowing for computational parallelism and system extensibility. WRF is suitable for a broad spectrum of applications across scales ranging from meters to thousands of kilometers. The effort to develop WRF has been a collaborative partnership, principally among the National Center for Atmospheric Research (NCAR), NOAA, the National Centers for Environmental Prediction (NCEP) and the Forecast Systems Laboratory (FSL), the Air Force Weather Agency (AFWA), the Naval Research Laboratory, the University of Oklahoma, and the FAA. WRF allows researchers the ability to conduct simulations reflecting either real data or idealized configurations. WRF is a model that provides operational weather forecasting. It is flexible and computationally efficient while offering the advances in physics, numerics, and data assimilation contributed by the research community.

The configuration used for this modeling demonstration, as well as a more detailed description of the WRF model, can be found in the EPA's meteorological modeling report (EPA, 2014d).

5.2.4. Selection of Emissions Processing System

5.2.4.1. Criteria

The principal criterion for an emissions processing system is that it accurately prepares emissions files in a format suitable for the photochemical grid model being used. The following list includes clarification of this criterion and additional desirable criteria for effective use of the system.

- File system compatibility with the I/O API;
- File portability;
- Ability to grid emissions on a Lambert conformal projection;
- Report capability;

[30] URL: http://www.wrf-model.org/index.php

- Graphical analysis capability;
- MOVES mobile source emissions;
- BEIS version 3;
- Ability to process emissions for the proposed domain in a reasonable amount of time;
- Ability to process control strategies;
- No or low cost for acquisition and maintenance; and
- Expandable to support other species and mechanisms.

5.2.4.2. Overview of SMOKE

The SMOKE[31] modeling system is an emissions modeling system that generates hourly gridded speciated emission inputs of mobile, nonroad, nonpoint area, point, fire and biogenic emission sources for photochemical grid models (Coats, 1995; Houyoux et al., 1999) and meets all the emissions processing system criteria above. As with most "emissions models," SMOKE is principally an emissions processing system; its purpose is to provide an efficient modern tool for converting existing base emissions inventory data into the hourly gridded speciated formatted emission files required by a photochemical grid model. For biogenic, mobile, and EGU sources, external emission models/processors were used to prepare SMOKE inputs. MOVES2014 was the EPA's latest onroad mobile source emissions model used and was first released in July 2014 (EPA, 2014a; 2014b; 2014c). MOVES2014 includes the latest onroad mobile source emissions factor information. Emission factors developed by the EPA were used in this analysis. SMOKE-MOVES uses an emissions factor look-up table from MOVES, county-level gridded vehicle miles travelled (VMT) and other activity data, and hourly gridded meteorological data (typically from WRF) to generate hourly gridded speciated onroad mobile source emissions inputs. The ERTAC EGU Forecasting Tool[32] was developed through a collaborative effort to improve emission inventories among the Northeastern, Mid-Atlantic, Southeastern, and Lake Michigan area states; other member states; industry representatives; and multi-jurisdictional organization (MJO) representatives. The tool was used for some states to grow base year hourly EGU emissions inventories into future projection years. The tool uses base year hourly EPA CAMD data, fuel specific growth rates, and other information to estimate future emissions. Biogenic emissions were modeled by the EPA using version 3.61 of BEIS. First developed in 1988, BEIS estimates VOC emissions from vegetation and nitric oxide (NO) emissions from

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[31] URL: http://www.smoke-model.org/index.cfm

[32] URL: https://marama.org/technical-center/ertac-egu-projection-tool/

soils. Because of resource limitations, recent BEIS development has been restricted to versions that are built within the SMOKE system. Additional information about the SMOKE model is contained in Appendix E.

5.3. Selection of the Modeling Year

A crucial step to SIP modeling is the selection of the time period to model so air quality conditions may be well represented and so changes in air quality in response to changes in emissions may be projected.

The EPA's most recent regional haze modeling guidance (EPA, 2018) contains recommended procedures for selecting modeling episodes. The VISTAS regional haze modeling used the annual calendar year 2011 modeling period. Calendar year 2011 satisfies the criteria in the EPA's modeling guidance episode selection discussion and is consistent with the base year modeling platform. Specifically, the EPA's guidance recommends choosing a time period which reflects the variety of meteorological conditions that represent visibility impairment on the 20% clearest and 20% most-impaired days in the Class I areas being modeled (high and low concentrations necessary). This is best accomplished by modeling a full calendar year.

In addition, the 2011/2028 modeling platform was the most recent available platform when VISTAS started their modeling work. The EPA's 2016-based platform became available later after VISTAS had already invested a considerable amount of time and money into the modeling analysis. Using the 2016-based platform was not feasible from a monetary perspective, nor could such work be done in a timely manner.

5.4. Modeling Domains

5.4.1. Horizontal Modeling Domain

The VISTAS modeling used a 12-kilometer (km) continental U.S. (CONUS_12 or 12US2) domain. The 12-km nested grid modeling domain (Figure 5-1) represents the CAMx 12-km air quality and SMOKE/BEIS emissions modeling domain. As shown in the EPA's meteorological model performance evaluation document, the WRF meteorological modeling was run on a larger 12-km modeling domain than the 12-km domain that was used for CAMx (EPA, 2014d). The WRF meteorological modeling domains are defined larger than the air quality modeling domains because meteorological models can sometimes produce artifacts in the meteorological variables near the boundaries as the prescribed boundary conditions come into dynamic balance with the coupled equations and numerical methods in the meteorological model.

An additional VISTAS_12 domain was prepared that is a subset of the CONUS_12 domain. Development of the VISTAS_12 domain (also presented in Figure 5-1) requires the EPA CONUS_12 simulation to be run using the CAMx Version 6.40 model saving 3-dimensional concentration fields for extraction using the CAMx BNDEXTR program. Dimensions for both VISTAS_12 and CONUS_12 domains are provided in Table 5-1.

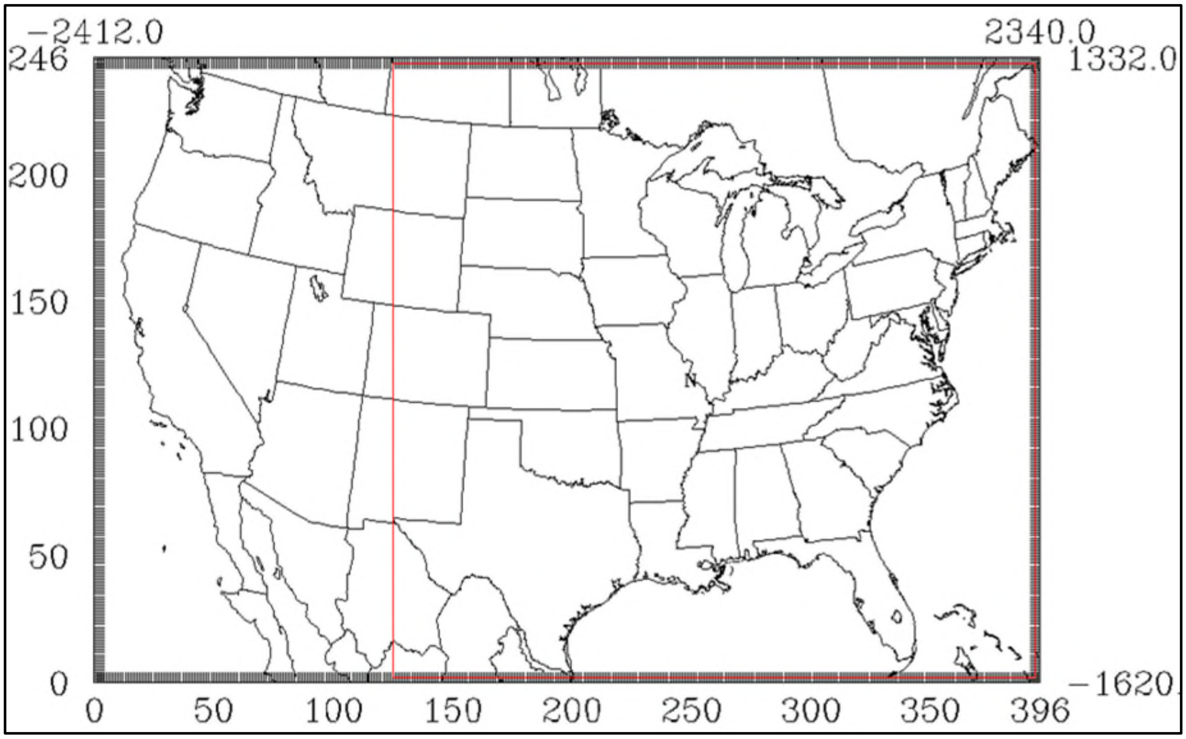


Figure 5-1: Map of 12-km CAMx Modeling Domains; VISTAS_12 Domain Represented as Inner Red Domain

Table 5-1: VISTAS II Modeling Domain Specifications

Domain	Columns	Rows	Vertical Layers	X Origin (km)	Y Origin (km)
CONUS_12	396	246	25	-2,412	-1,620
VISTAS_12	269	242	25	-912	-1,596

5.4.2. Vertical Modeling Domain

The CAMx vertical structure is primarily defined by the vertical layers used in the WRF meteorological modeling. The WRF model employs a terrain following coordinate system defined by pressure, using multiple layer interfaces that extend from the surface to 50 millibar (mb) (approximately 19 km above sea level). The EPA ran WRF using 35 vertical layers. A layer averaging scheme is adopted for CAMx simulations whereby multiple WRF layers are combined into one CAMx layer to reduce the air quality model computational time. Table 5-2 displays the approach for collapsing the 35 vertical layers in WRF to 25 vertical layers in CAMx. This approach is consistent with the EPA's draft 2028 regional haze modeling.[33]

Table 5-2: WRF and CAMx Layers and Their Approximate Height Above Ground Level

CAMx Layer	WRF Layers	Sigma P	Pressure (mb)	Approximate Height (meters above ground level)
25	35	0.00	50.00	17,556
25	34	0.05	97.50	14,780
24	33	0.10	145.00	12,822
24	32	0.15	192.50	11,282
23	31	0.20	240.00	10,002
23	30	0.25	382.50	7,064
22	29	0.30	335.00	7,932
22	28	0.35	382,50	7,064
21	27	0.40	430.00	6,275
21	26	0.45	477.50	5,553
20	25	0.50	525.00	4,885
20	24	0.55	572.50	4,264
19	23	0.60	620.00	3,683
18	22	0.65	667.50	3,136
17	21	0.70	715.00	2,619
16	20	0.74	753.00	2,226
15	19	0.77	781.50	1,941
14	18	0.80	810.00	1,665
13	17	0.82	829.00	1,485
12	16	0.84	848.00	1,308
11	15	0.86	867.00	1,134
10	14	0.88	886.00	964
9	13	0.90	905.00	797
9	12	0.91	914.50	714
8	11	0.92	924.00	632
8	10	0.93	933.50	551
7	9	0.94	943.00	470
7	8	0.95	952.50	390
6	7	0.96	962.00	311
5	6	0.97	971.50	232
4	5	0.98	981.00	154
4	4	0.99	985.75	115
3	3	0.99	985.75	115
2	2	1.00	995.25	38
1	1	1.00	997.63	19

[33] Table 2-2, EPA, 2017.

6. MODEL PERFORMANCE EVALUATION

The VISTAS 2011 modeling platform (VISTAS2011) used meteorological modeling files developed by the EPA. The evaluation of the meteorological modeling can be found in the EPA's document titled, "Meteorological Model Performance for Annual 2011 WRF v3.4 Simulation."[34] Overall, the meteorological modeling was deemed acceptable for regulatory applications.

In keeping with the one-atmosphere objective of the CAMx modeling platform, model performance was evaluated for ozone, fine particles, and acid deposition. For the model performance analysis, model predictions were paired in space and time with observational data from various monitoring networks. Modeled 8-hour ozone concentrations were compared to observations from the EPA's Air Quality System (AQS) network. Modeled 24-hour speciated PM concentrations were compared to observations from IMPROVE, CSN, and Clean Air Status and Trends Network (CASTNET) monitoring networks. Modeled weekly speciated wet and dry deposition species were compared to observations from the National Acid Deposition Program (NADP) and CASTNET.

6.1. Ozone Model Performance Evaluation

As indicated by the statistics in Table 6-1, bias and error for maximum daily 8-hour average (MDA8) ozone are relatively low in the region. Mean bias (MB) for MDA8 ozone ≥ 60 parts per billion (ppb) during each month (May through September) was within ±5 ppb at AQS sites in the VISTAS states, ranging from -0.13 ppb (September) to 3.79 ppb (July). The mean error (ME) is less than 10 ppb in all months. Normalized mean bias (NMB) is within ±5% for AQS sites in all months except July (5.63%). The mean bias and normalized mean bias statistics indicate a tendency for the model to over predict MDA8 ozone concentrations in the months of May through August and slightly under predict MDA8 ozone concentrations in September for AQS sites. The normalized mean error (NME) is less than 15% in the region across all months.

Table 6-1: Performance Statistics for MDA8 Ozone ≥ 60 ppb by Month for VISTAS States Based on Data at AQS Network Sites

Region	Month	# of Obs	MB (ppb)	ME (ppb)	NMB (%)	NME (%)
VISTAS	May	838	2.48	6.11	3.79	9.34
VISTAS	Jun	2028	1.73	7.11	2.57	10.55
VISTAS	Jul	1233	3.79	8.88	5.63	13.21
VISTAS	Aug	1531	2.38	6.94	3.59	10.48
VISTAS	Sep	681	-0.13	6.09	-0.19	9.08

[34] URL: https://www.epa.gov/sites/production/files/2020-10/documents/met_tsd_2011_final_11-26-14.pdf

Figure 6-1 through Figure 6-4 show the spatial variability in bias and error at monitor locations. Mean bias, as seen from Figure 6-1, is within ±5 ppb at most sites across the VISTAS12 domain with a maximum under-prediction of 23.44 ppb at one site (AQS monitor 550030010) in Ashland County, Wisconsin, and a maximum over-prediction of 17.95 ppb in York County, South Carolina (AQS monitor 450910006); both with small sample sizes (n=1 and n=7, respectively). A positive mean bias is generally seen in the range of 5 to 10 ppb with regions of 10 to 15 ppb over-prediction seen scattered throughout the domain. The model tends to underestimate in the western portion of the domain and overestimate in the eastern portion of the domain.

Figure 6-2 indicates that the normalized mean bias for days with observed MDA8 ozone ≥ 60 ppb is within ± 10% at most monitoring sites across the VISTAS12 modeling domain. Monitors in Ashland County, Wisconsin and York County, South Carolina again bookend the NMB range with 38.03% and 27.44%, respectively. There are regional differences in model performance, as the model tends to over predict at most sites in the eastern region of the VISTAS12 domain and generally under predict at sites in and around the western and northwestern borders of the domain.

The ME, as seen from Figure 6-3, is generally 10 ppb or less at most of the sites across the VISTAS12 modeling domain although the Ashland, Wisconsin and York County, South Carolina monitors show much higher ME of 23.44 and 17.95 ppb, respectively. VISTAS states show less than 10% of their monitors above 10 ppb model error, with the majority of those within this value. Figure 6-4 indicates that the NME for days with observed MDA8 ozone ≥ 60 ppb is less than 15% at most monitoring sites across the VISTAS12 modeling domain. Noted exceptions seen are monitors 450910006 (York County, South Carolina), 470370011 (Davidson County, Tennessee), and 120713002 (Lee County, Florida) with NMEs of 27.44%, 25.4%, and 23.07%, respectively. Somewhat elevated NMEs (> 15%) are seen in and around many of the VISTAS state metro areas.

Additional details on the ozone model performance evaluation can be found in Appendix E-5.

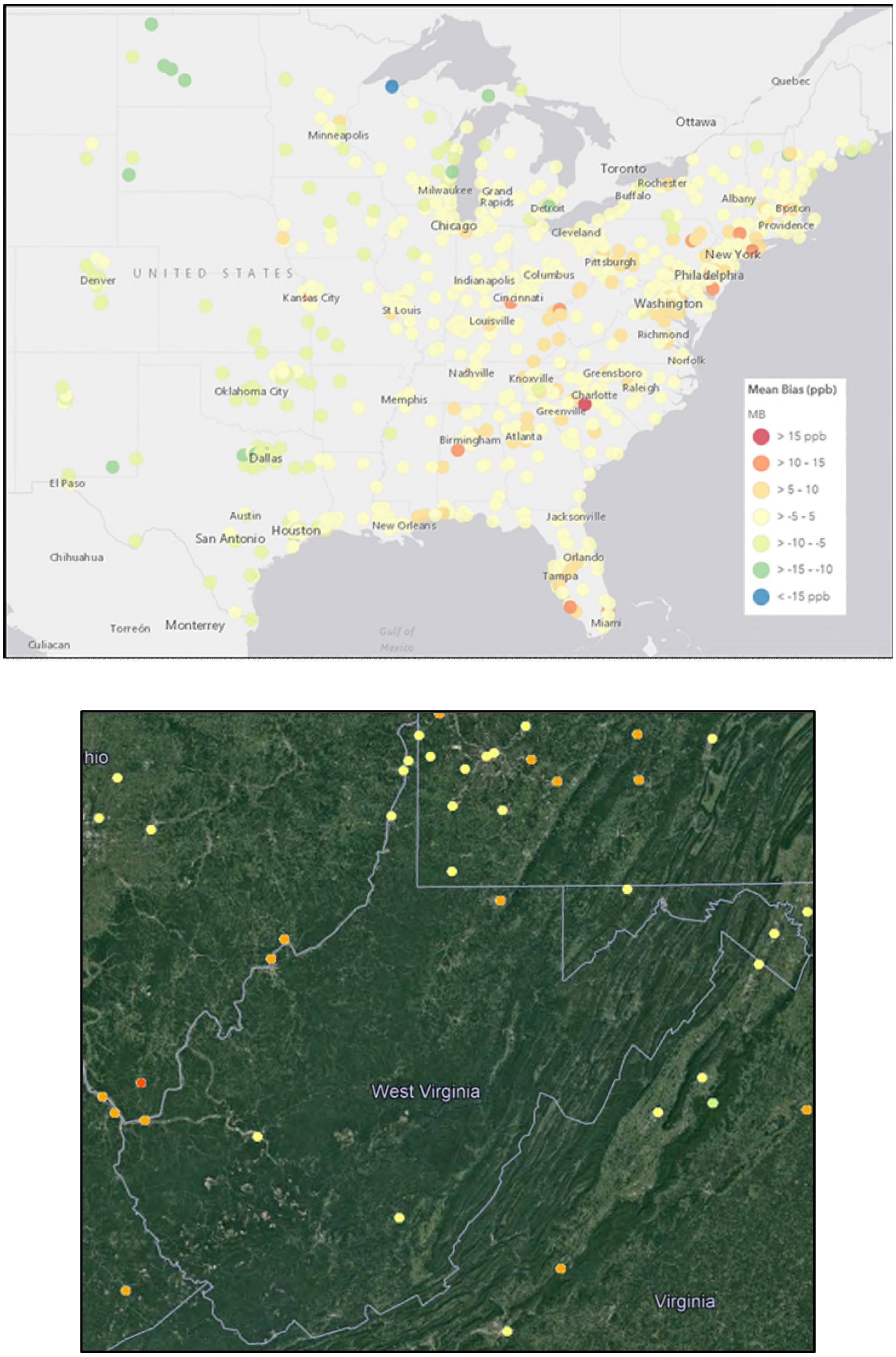


Figure 6-1: Mean Bias (ppb) of MDA8 Ozone ≥ 60 ppb Over the Period May-September 2011 at AQS Monitoring Sites in VISTAS12 Domain (top) and in West Virginia (bottom)

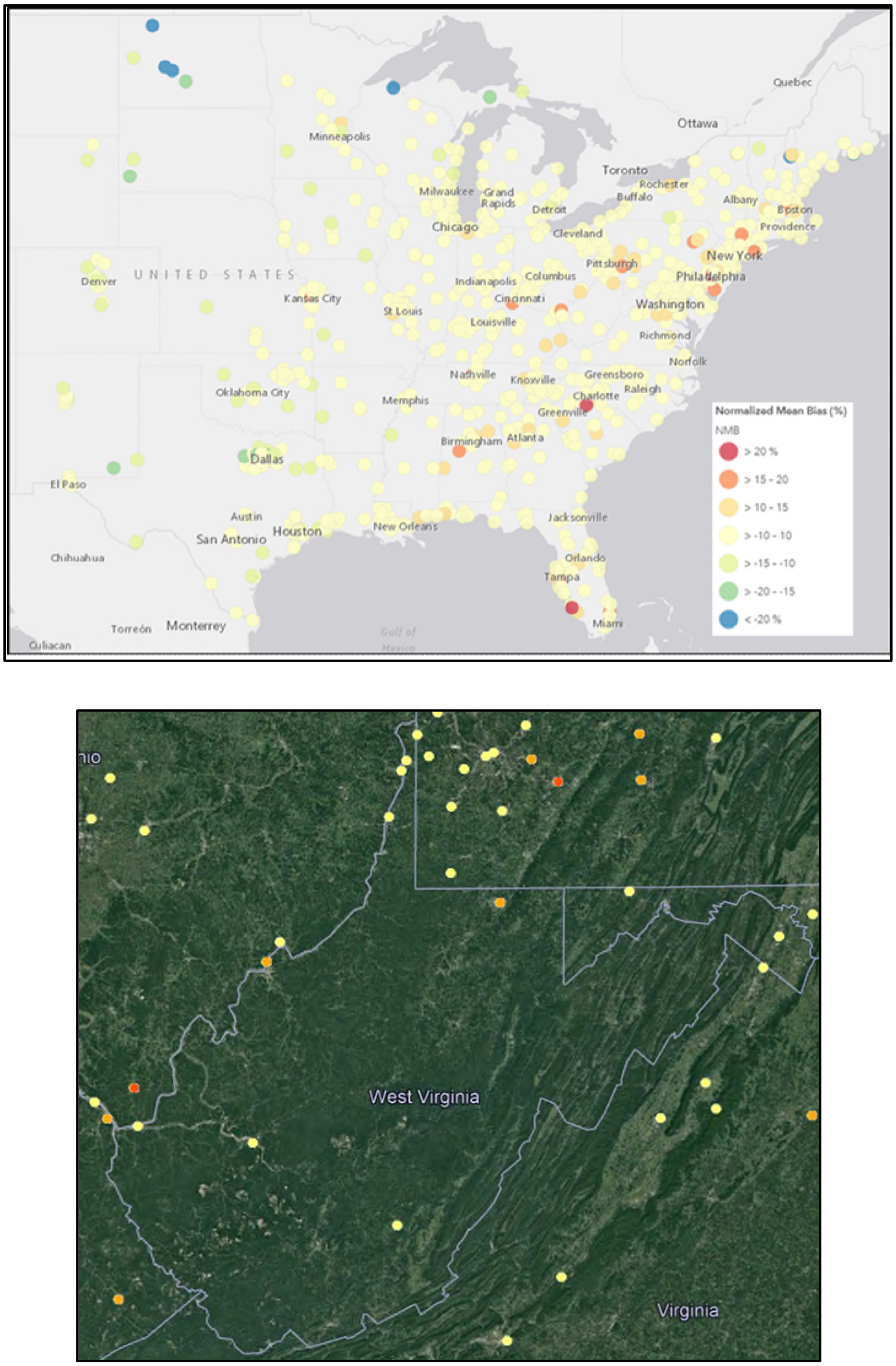
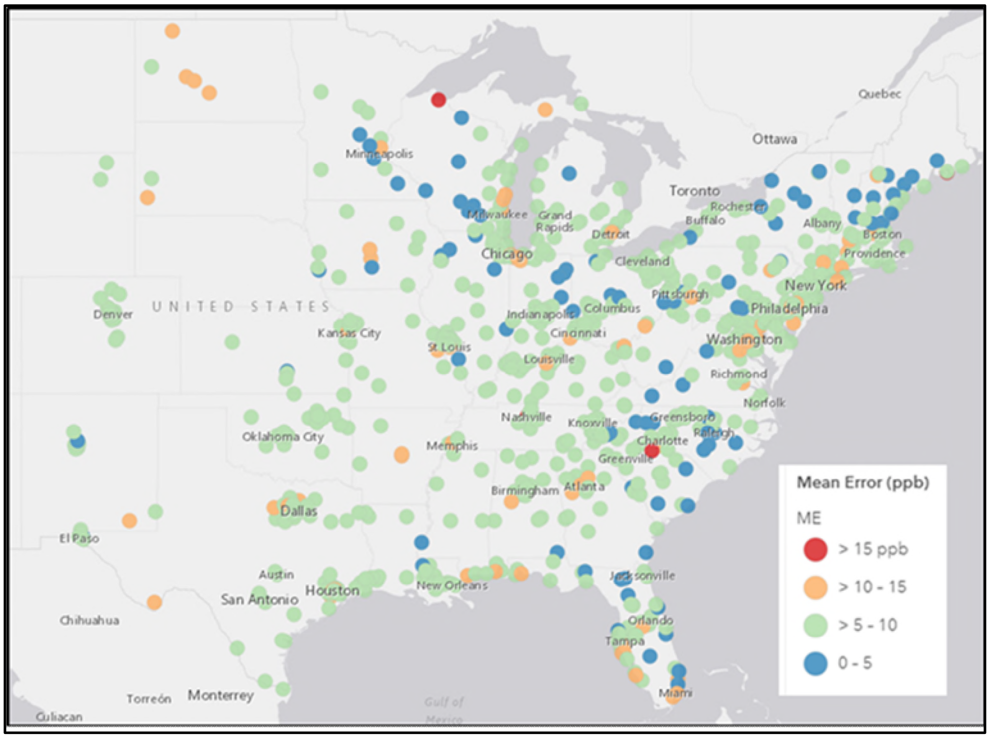


Figure 6-2: Normalized Mean Bias (%) of MDA8 Ozone ≥ 60 ppb Over the Period May-September 2011 at AQS Monitoring Sites in VISTAS12 Domain (top) and in West Virginia (bottom)



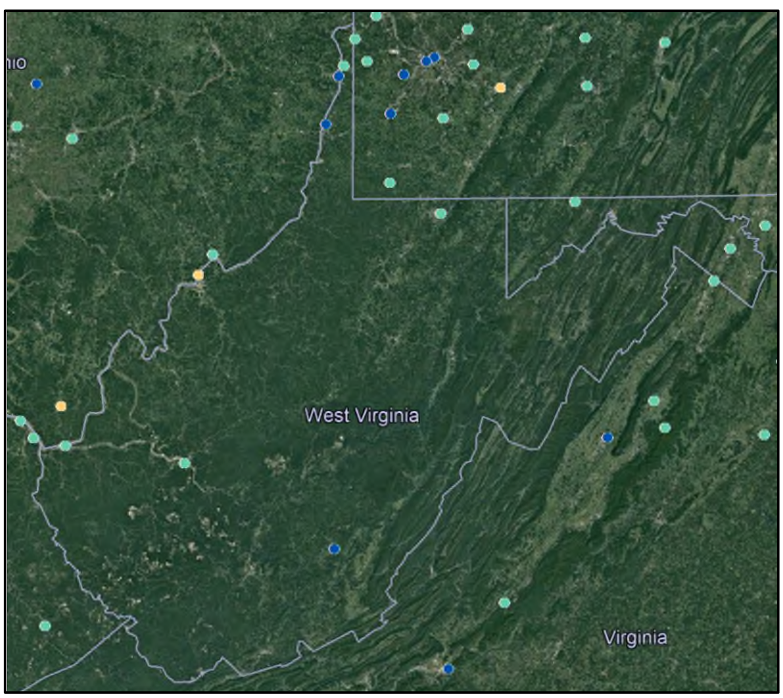


Figure 6-3: ME (ppb) of MDA8 Ozone ≥ 60 ppb Over the Period May-September 2011 at AQS Monitoring Sites in VISTAS12 Domain (top) and in West Virginia (bottom)

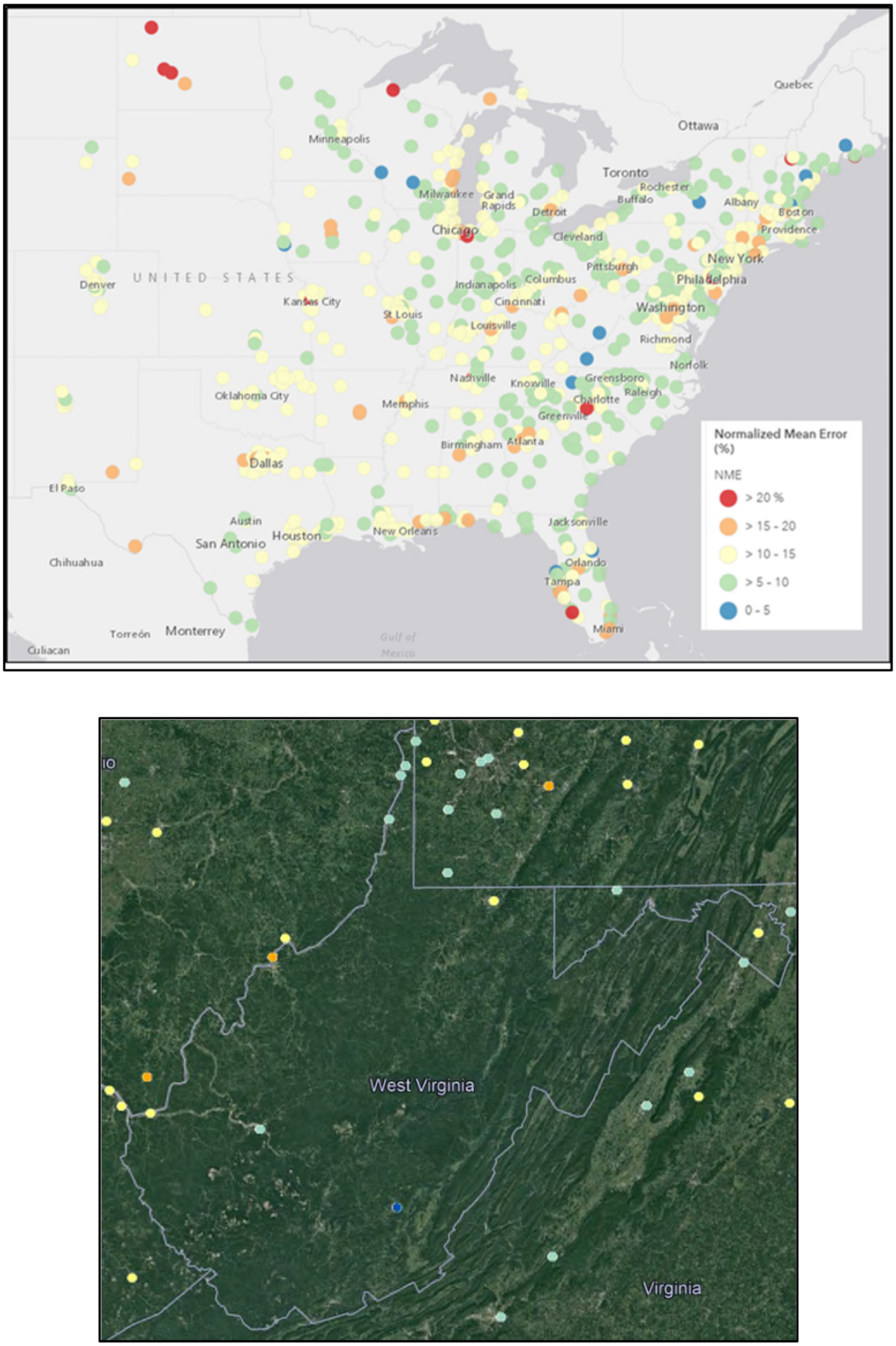


Figure 6-4: NME (%) of MDA8 Ozone ≥ 60 ppb Over the Period May-September 2011 at AQS Monitoring Sites in VISTAS12 Domain (top) and in West Virginia (bottom)

6.2. Acid Deposition Model Performance Evaluation

The primary source for deposition data is the National Atmospheric Deposition Program (NADP).[35] The NADP monitoring networks used in this evaluation include:

- National Trends Network (NTN)
- Atmospheric Integrated Research Monitoring Network (AIRMon)
- Ammonia Monitoring Network (AMoN)

Dry deposition information is also available from CASTNET. The data from NTN and AIRMon were used in the wet deposition MPE, and the data from CASTNET and AMoN were used for dry deposition MPE. The MPE focused on the monitors from these networks within the VISTAS 12-km modeling domain (Figure 6-5).

[35] National Atmospheric Deposition Program (NRSP-3). 2018. NADP Program Office, Wisconsin State Laboratory of Hygiene, 465 Henry Mall, Madison, WI 53706. URL: http://nadp.slh.wisc.edu/

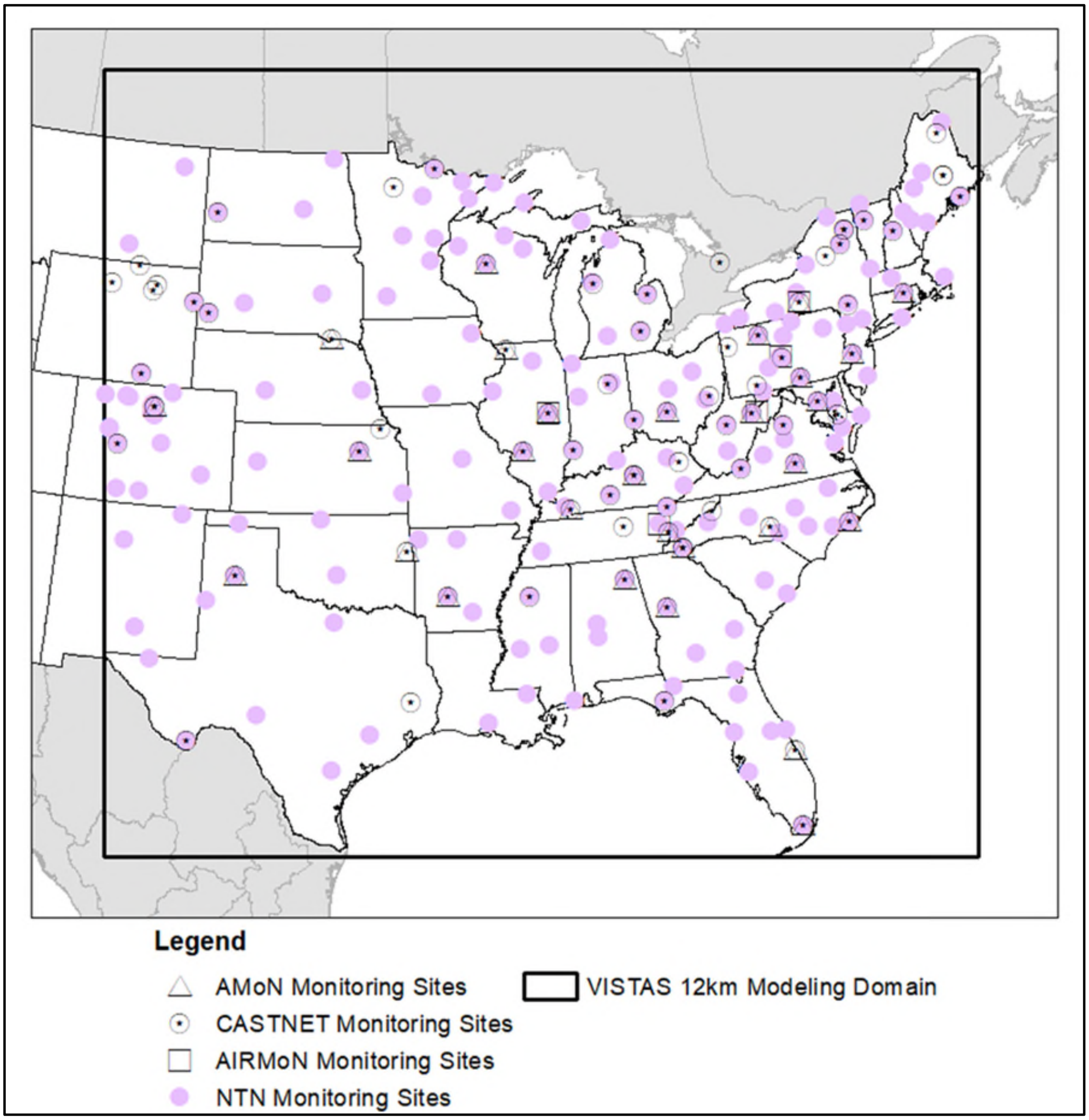


Figure 6-5: Deposition Monitors Included in the VISTAS 12 Domain

Table 6-2 summarizes the aggregated weekly MPE metrics for wet deposition in the VISTAS 12-km domain. The model demonstrates a negative mean bias for the ammonium ion (NH_4^+) and the sulfate ion (SO_4^{-2}) and a positive mean bias for the nitrate ion (NO_3^-) compared to the weekly NTN observations. The AIRMon sites have a larger positive mean bias for all pollutants.

Table 6-2: Weekly Wet Deposition MPE Metrics for NADP Sites in the VISTAS 12-km Domain

Network	Pollutant	n	MB (kg/ha)	ME (kg/ha)	NMB (%)	NME (%)	r (unitless)	MFB (%)	MFE (%)	RMSE (unitless)
NTN	NH_4^+	3,404	-0.025	0.045	-32%	58%	0.629	-19%	34%	0.092
NTN	NO_3^-	3,404	0.024	0.123	12%	62%	0.642	6%7	29%	0.242
NTN	SO_4^{-2}	3,404	-0.001	0.118	0%	57%	0.681	0%	29%	0.245
AIRMon	NH_4^+	158	-0.003	0.020	-31%	76%	0.534	-7%	41%	0.041
AIRMon	NO_3^-	158	0.051	0.097	67%	127%	0.398	25%	47%	0.192
AIRMon	SO_4^{-2}	158	0.018	0.091	20%	100%	0.352	9%	46%	0.197

When considering the total accumulated wet deposition for the calendar year, there is still under prediction of NH_4^+ and SO_4^{2-}, and a slight over prediction of NO_3^-. However, continued improvement is seen from the seasonal accumulated performance with respect to the NME and r values, as presented in Table 6-3.

Table 6-3: Accumulated Annual Wet Deposition MPE Metrics for NADP Sites in the VISTAS 12-km Domain

Pollutant	n	MB (kg/ha)	MGE (kg/ha)	NMB (%)	NME (%)	r (unitless)	MFB (%)	MFE (%)	RMSE (unitless)
NH_4^+	99	-1.245	1.246	-38%	38%	0.861	-23%	23%	1.536
NO_3^-	99	0.134	1.453	2%	17%	0.901	1%	8%	1.933
SO_4^{-2}	99	-0.585	1.604	-7%	18%	0.916	-3%	9%	2.142

The weekly dry deposition MB and ME presented in Table 6-4 would seem to suggest relatively good model performance for the CASTNET sites. The higher normalized mean and mean fractional bias and error values are due to small values in the denominator.

Table 6-4: Weekly Dry Deposition MPE Metrics for CASTNET Sites in the VISTAS 12-km Domain

Network	Pollutant	n	MB (kg/ha)	ME (kg/ha)	NMB (%)	NME (%)	r (unitless)	MFB (%)	MFE (%)	RMSE (unitless)
CASTNET	Cl^-	965	-0.001	0.001	-87%	89%	0.796	-77%	79%	0.004
CASTNET	NH_4^+	965	0.001	0.003	13%	51%	0.603	6%	24%	0.004
CASTNET	SO_4^{-2}	965	0.0004	0.007	3%	43%	0.650	1%	21%	0.009
CASTNET	SO_2	965	-0.031	0.031	-96%	96%	0.656	-93%	93%	0.052
CASTNET	NO_3^-	965	0.001	0.004	12%	80%	0.601	6%	37%	0.006
CASTNET	HNO_3	965	-0.062	0.062	-95%	95%	0.612	-90%	90%	0.077
AMoN	NH_3	355	-0.007	0.007	-95%	95%	0.463	%91	91%	0.013

As presented in Table 6-5, most pollutants, except for NO_3, are under predicted, based on the total accumulated dry deposition. SO_2 and HNO_3 have the worst under prediction of all the pollutants, followed by Cl^-.

Table 6-5: Accumulated Annual Wet Deposition MPE Metrics for CASTNET Sites in the VISTAS 12-km Domain

Pollutant	n	MB (kg/ha)	MGE (kg/ha)	NMB (%)	NME (%)	r (unitless)	MFB (%)	MFE (%)	RMSE (unitless)
Cl^-	19	-0.054	0.054	-88%	88%	0.981	-78%	78%	0.156
NH_4^+	19	-0.002	0.077	-1%	27%	0.688	0%	14%	0.090
SO_4^{-2}	19	-0.067	0.219	-8%	27%	0.537	-4%	14%	0.268
SO_2	19	-1.616	1.616	-97%	97%	0.869	-94%	94%	2.221
NO_3^-	19	0.001	0.113	1%	46%	0.572	0%	23%	0.154
HNO_3	19	-3.272	3.272	-95%.4	95%	0.607	-91%	91%	3.688

Additional details on the wet and dry acid deposition model performance evaluation can be found in Appendix E-4.

6.3. PM Model Performance Goals and Criteria

Because $PM_{2.5}$ is a mixture, the current EPA PM modeling guidance[36] recommends that a meaningful performance evaluation should include an assessment of how well the model is able to predict individual chemical components that constitute $PM_{2.5}$. Consistent with the EPA's performance evaluation of the regional haze 2028 analysis, in addition to total $PM_{2.5}$, the following components of $PM_{2.5}$ were also examined.

- Sulfate ion (SO_4^{-2})
- Nitrate ion (NO_3^-)
- Ammonium ion (NH_4^+)
- Elemental Carbon (EC)
- Organic Carbon (OC) and/or Organic Carbon Mass (OCM)
- Crustal (weighted average of the most abundant trace elements in ambient air)
- Sea salt constituents (Na^+ and Cl^-)

Recommended benchmarks for photochemical model performance statistics (Boylan, 2006; Emery, 2017) were used to assess the applicability of the VISTAS modeling platform for Regional Haze SIP purposes. The goal and criteria values noted in Table 6-6 and Table 6-7 below were used for this modeling. The original publication notes that the temporal scales for the

[36] URL: https://www.epa.gov/sites/production/files/2020-10/documents/o3-pm-rh-modeling_guidance-2018.pdf

24-hour total and speciated PM should not exceed 3 months (or 1 season) and the spatial scales should range from urban to less than or equal to 1,000 kilometers. This indicates that model performance should be evaluated based on the entire domain, as modeling discussed in Section 6.4, and not based on individual monitor performance as presented for Dolly Sods and Otter Creek Wilderness Areas, as presented in Section 6.5.

Table 6-6: Fine Particulate Matter Performance Goals and Criteria

Species	NMB, Goal	NMB, Criteria	NME, Goal	NME, Criteria	r, Goal	r, Criteria
24-hr $PM_{2.5}$ and sulfate	<± 10%	<± 30%	< 35%	< 50%	> 0.75	> 0.50
24-hr nitrate	<± 10%	<± 65%	< 65%	< 115%	> 0.70	> 0.40
24-hr OC	<± 15%	<± 50%	< 45%	< 65%	None	None
24-hr EC	<± 20%	<± 40%	< 50%	< 75%	None	None

Table 6-7: Fine Particulate Matter Performance Goals and Criteria

Species	FB, Goal	FB, Criteria	FE, Goal	FE, Criteria
24-hr $PM_{2.5}$ and sulfate	<± 30%	<± 60%	< 50%	< 75%
24-hr nitrate	<± 30%	<± 60%	< 50%	< 75%
24-hr OC	<± 30%	<± 60%	< 50%	< 75%
24-hr EC	<± 30%	<± 60%	< 50%	< 75%

The mapping of the CAMx species into the observed species is presented in Table 6-8.

Table 6-8: Species Mapping from CAMx into Observation Network

Network	Observed Species	CAMx Species
IMPROVE	NO_3	PNO_3
IMPROVE	SO_4	PSO_4
IMPROVE	NH_4	PNH_4
IMPROVE	OM = 1.8*OC	SOA1+SOA2+SOA3+SOA4 +SOPA+SOPB+POA
IMPROVE	EC	PEC
IMPROVE	SOIL	FPRM+FCRS
IMPROVE	$PM_{2.5}$	PSO_4+PNO_3+PNH_4+SOA1+SOA2+SOA3+SOA4 +SOPA+SOPB+POA+PEC+FPRM+FCRS+NA+PCL
CSN	$PM_{2.5}$	PSO_4+PNO_3+PNH_4+SOA1+SOA2+SOA3+SOA4 +SOPA+SOPB+POA+PEC+FPRM+FCRS+NA+PCL
CSN	NO_3	PNO_3
CSN	SO_4	PSO_4
CSN	NH_4	PNH_4
CSN	OM = 1.4*OC	SOA1+SOA2+SOA3+SOA4 +SOPA+SOPB+POA
CSN	EC	PEC

Several graphic displays of model performance were prepared, including:

- Performance goal plots (“soccer plots”) that summarize model performance by species, region, and season. Soccer plots graphically show plot bias versus error with performance lines in a shape that resembles a soccer goal.

- Concentration performance plots (“bugle plots”) that display fractional bias or error as a function of concentration by species, region, monitoring network, and month. Bugle plots include curves for representing performance goals, and their shape resembles that of a bugle or half bugle.

- Scatter plots of predicted and observed concentrations by species, monitoring network, and month.

- Time series plots of predicted and observed concentrations by species, monitoring site, and month.

- Spatially averaged time series plots.

- Time series plots of monthly fractional bias and error by species, region, and network.

Both soccer plots and bugle plots offer a convenient way to examine model performance with respect to set goals and criteria. The bugle plots have the added benefit of adjusting the goals and criteria to consider the concentration of the species. Analysis of bugle plots generally suggests that greater emphasis should be placed on performance of those components with the greatest contribution to PM mass and visibility impairment (e.g., sulfate and organic carbon) and that greater bias and error could be accepted for components with smaller contributions to total PM mass (e.g., elemental carbon, nitrate, and soil).

6.4. PM Model Performance Evaluation for the VISTAS Modeling Domain

Further discussion of model performance in this document will focus on the comparison of observational data from the CASTNET, CSN, and IMPROVE monitors (Table 6-9) in the VISTAS12 modeling domain and model output data from the VISTAS2011 annual air quality modeling.

Table 6-9: Overview of Utilized Ambient Data Monitoring Networks

Monitoring Network	Chemical Species Measured	Sampling Period
IMPROVE	Speciated $PM_{2.5}$ and PM_{10}; light extinction data	1 in 3 days; 24-hour average
CASTNET	Speciated $PM_{2.5}$, and O_3	1-week average
CSN	Speciated $PM_{2.5}$	24-hour average

The evaluation primarily focused on the air quality model's performance with respect to individual components of fine particulate matter, as good model performance of the component species will dictate good model performance of total or reconstituted fine particulate matter. Model performance of the total fine particulate matter and the resulting total light extinction was also examined to discuss the overall model performance. A full list of model performance statistics is found in Appendix E-3.

The soccer plots for all VISTAS and non-VISTAS monitors are included here for summary purposes. Plots have been developed for the monthly average performance statistics for the most significant light scattering component species (i.e., sulfate, nitrate, organic carbon, and elemental carbon).

The soccer plots of monthly concentrations show values for $PM_{2.5}$ (Figure 6-6) at CSN, IMPROVE monitors and sulfate (Figure 6-7), nitrate (Figure 6-8), organic carbon (Figure 6-9), and elemental carbon (Figure 6-10) at CSN, IMPROVE, CASTNET monitors in VISTAS and non-VISTAS states in the modeling domain. $PM_{2.5}$ is mostly inside the NMB and NME criteria for CSN/VISTAS, CSN/non-VISTAS, IMPROVE/VISTAS, and IMPROVE/non-VISTAS. Sulfate is mostly inside the NMB and NME criteria for CSN/VISTAS, CSN/non-VISTAS, IMPROVE/VISTAS, and IMPROVE/non-VISTAS; but mostly outside the NMB and NME criteria for CASTNET/VISTAS and CASTNET/non-VISTAS. Nitrate is mostly inside the NMB and NME criteria for CASTNET/VISTAS, CASTNET/non-VISTAS, CSN/VISTAS, CSN/non-VISTAS, IMPROVE/VISTAS, and IMPROVE/non-VISTAS. Organic carbon is mostly inside the NMB and NME criteria for IMPROVE/VISTAS and IMPROVE/non-VISTAS; but mostly outside the NMB and NME criteria for CSN/VISTAS and CSN/non-VISTAS. Elemental carbon is mostly inside the NMB and NME criteria for CSN/VISTAS, IMPROVE/VISTAS, and IMPROVE/non-VISTAS; but mostly outside the NMB and NME criteria for and CSN/non-VISTAS.

Figure 6-6 contains soccer plots of NMB and NME for total $PM_{2.5}$ at CSN and IMPROVE monitors. Most CSN values are within the NMB and NME criteria. For IMPROVE, four months are outside the NMB and NME criteria for the VISTAS states and six months are outside the NMB and NME criteria for the non-VISTAS states.

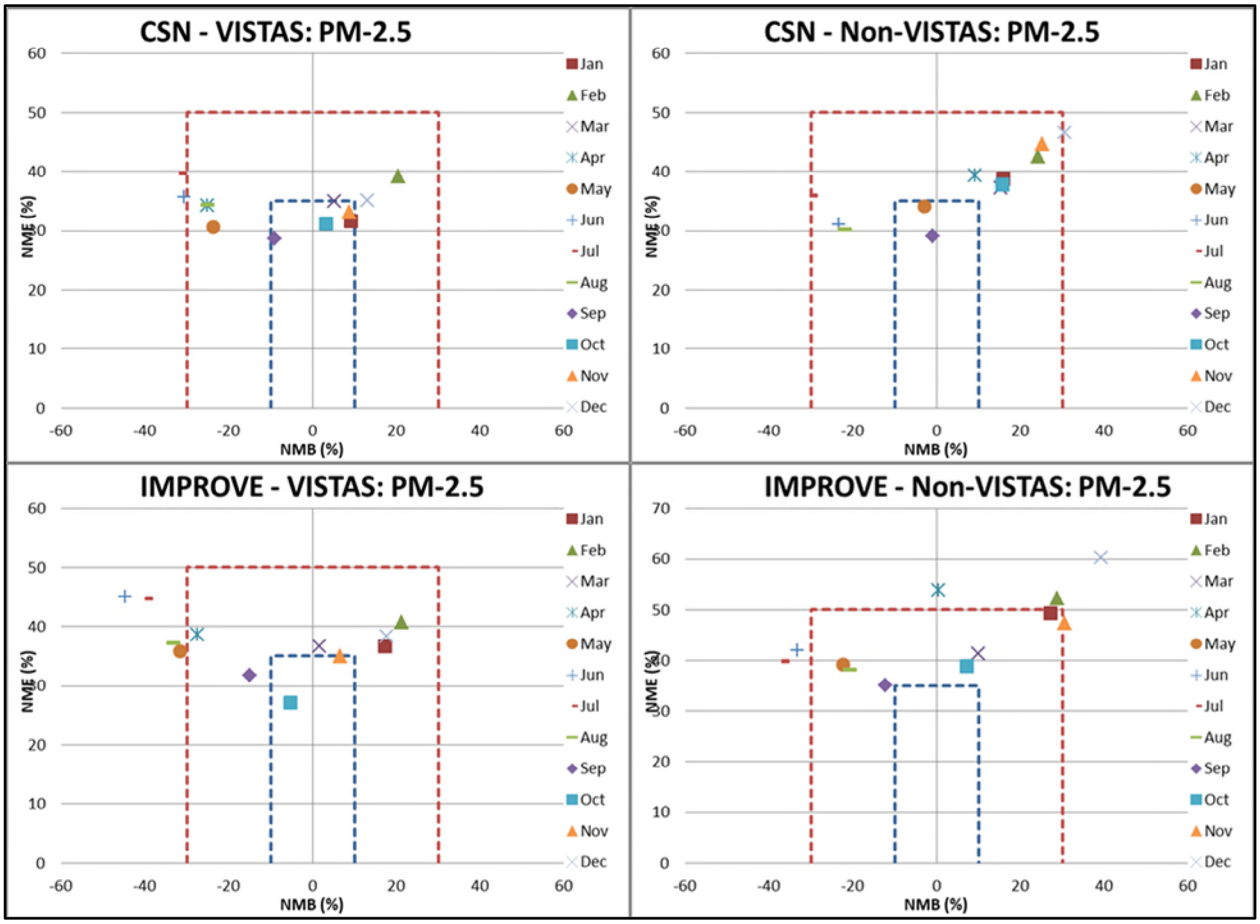


Figure 6-6: Soccer Plots of Total $PM_{2.5}$ by Network and Month for VISTAS and Non-VISTAS Sites

Figure 6-7 contains soccer plots of NMB and NME for sulfate at CASTNET, CSN, and IMPROVE monitors. For CASTNET, seven months are outside the NMB and NME criteria for the VISTAS states and seven months are outside the NMB and NME criteria for the non-VISTAS states. Most CSN values are within the NMB and NME criteria. For IMPROVE, two months are outside the NMB and NME criteria for the VISTAS states and no months are outside the NMB and NME criteria for the non-VISTAS states.

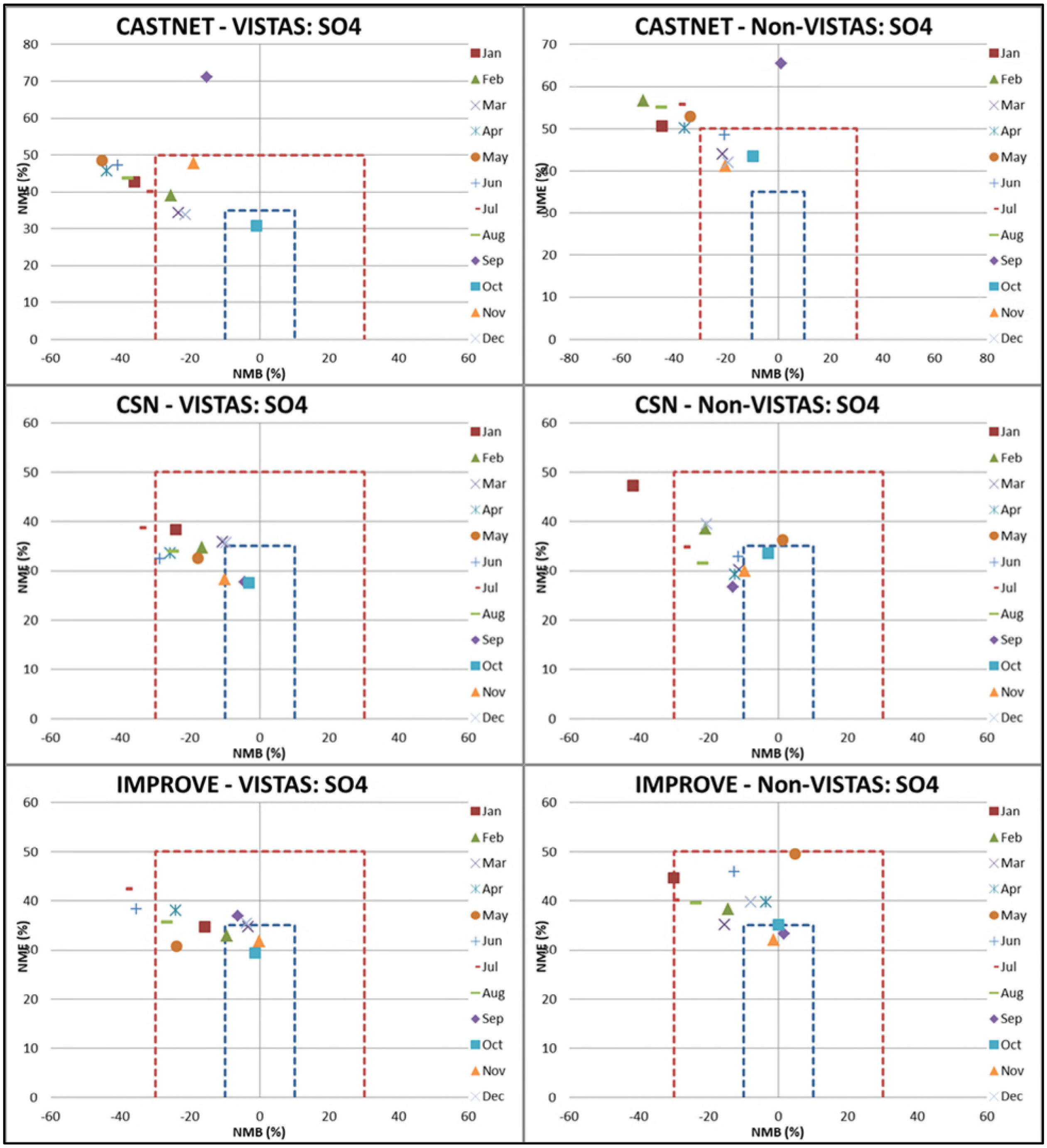


Figure 6-7: Soccer Plots by Network and Month for VISTAS and Non-VISTAS Sites

Figure 6-8 contains soccer plots of NMB and NME for nitrate at CASTNET, CSN, and IMPROVE monitors. Most CASTNET and CSN values are within the NMB and NME criteria. For IMPROVE, two months are outside the NMB and NME criteria for the VISTAS states and one month is outside the NMB and NME criteria for the non-VISTAS states.

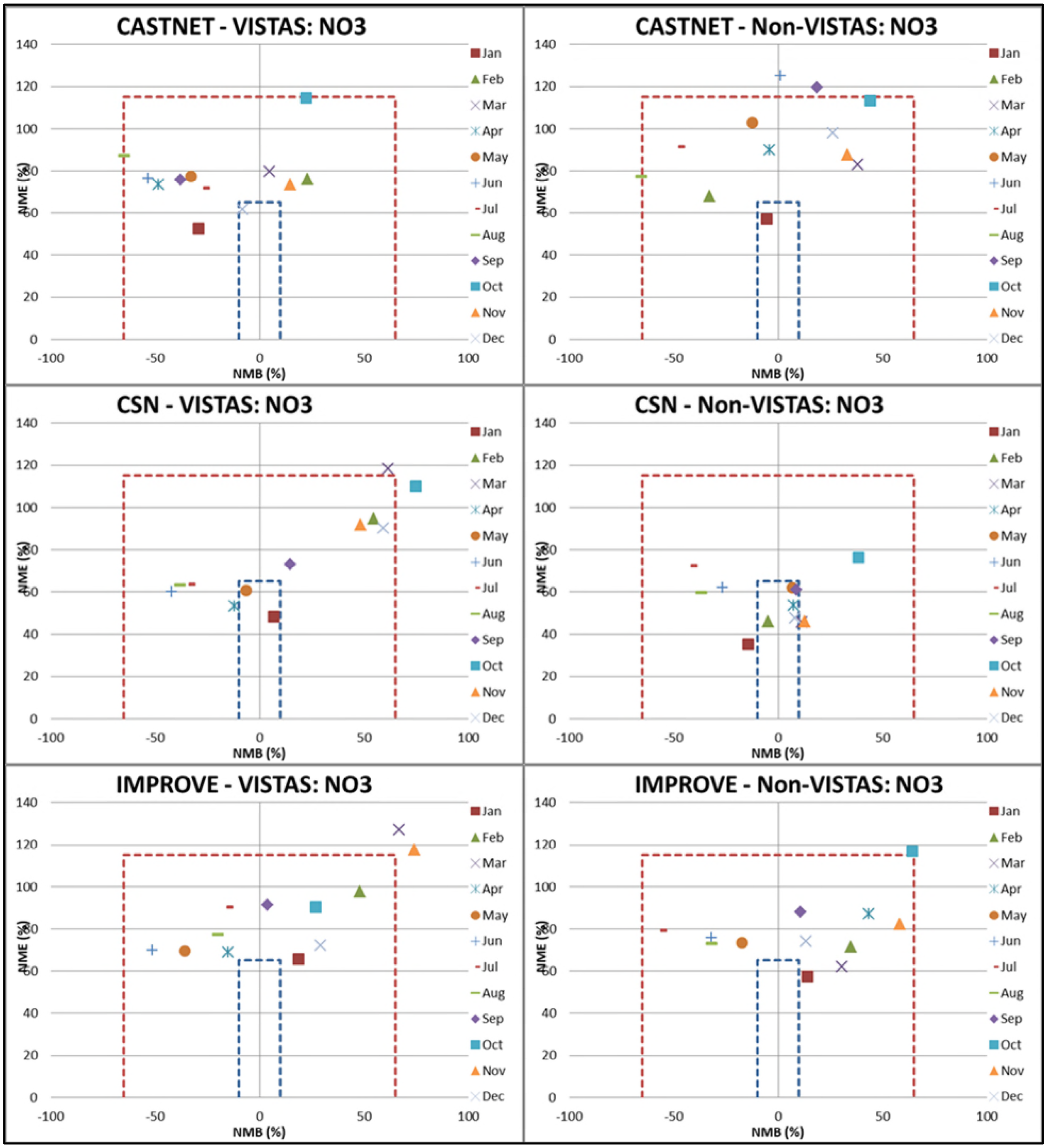


Figure 6-8: Soccer Plots of Nitrate by Network and Month for VISTAS and Non-VISTAS Sites

Figure 6-9 contains soccer plots of NMB and NME for organic carbon at CASTNET, CSN, and IMPROVE monitors. Most CSN values are outside the NMB and NME criteria. For IMPROVE, no months are outside the NMB and NME criteria for the VISTAS states and four months are outside the NMB and NME criteria for the non-VISTAS states.

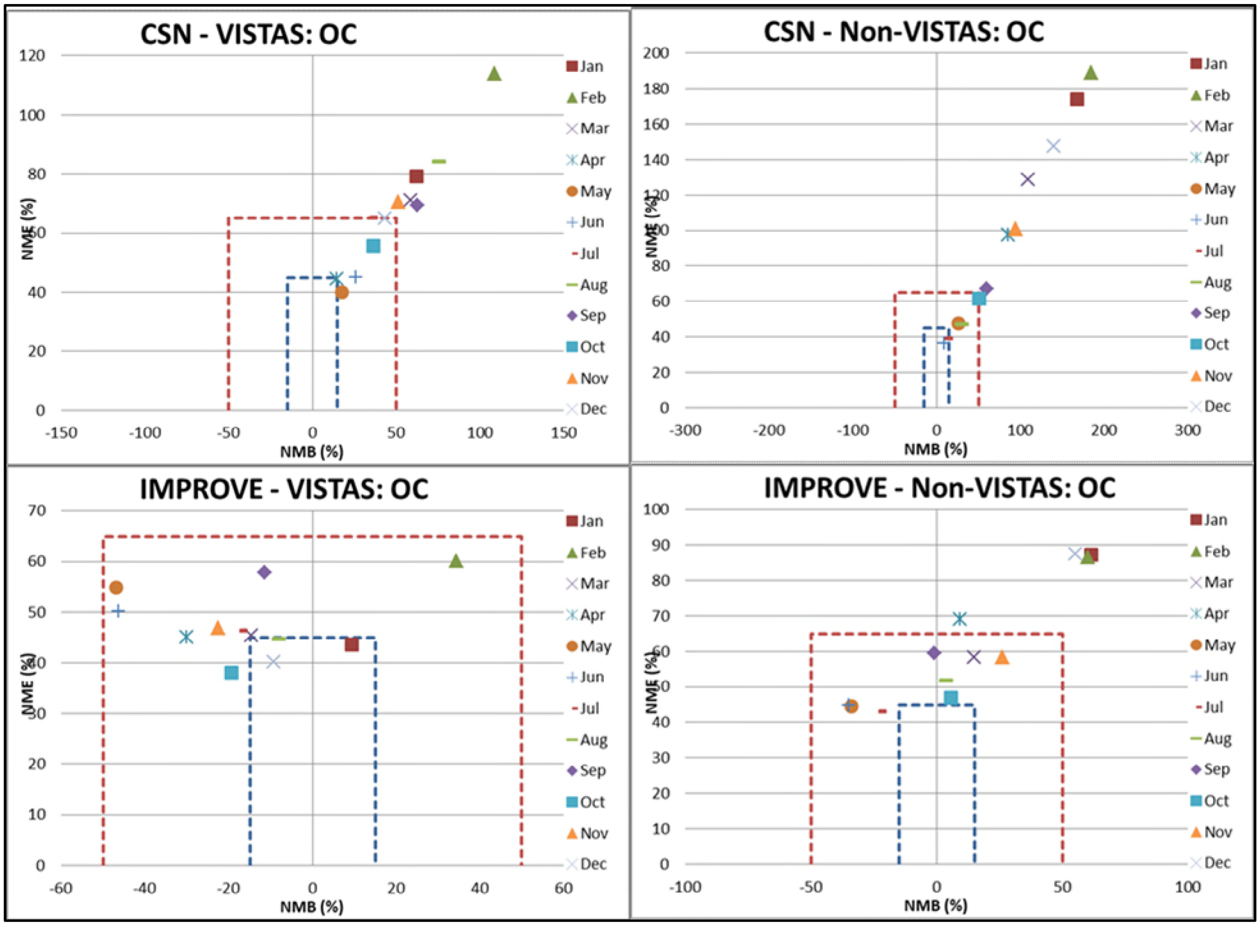


Figure 6-9: Soccer Plots of OC by Network and Month for VISTAS and Non-VISTAS Sites

Figure 6-10 contains soccer plots of NMB and NME for elemental carbon at CASTNET, CSN, and IMPROVE monitors. For CSN, two months are outside the NMB and NME criteria for the VISTAS states and six months are outside the NMB and NME criteria for the non-VISTAS states. For IMPROVE, one month is outside the NMB and NME criteria for the VISTAS states and five months are outside the NMB and NME criteria for the non-VISTAS states.

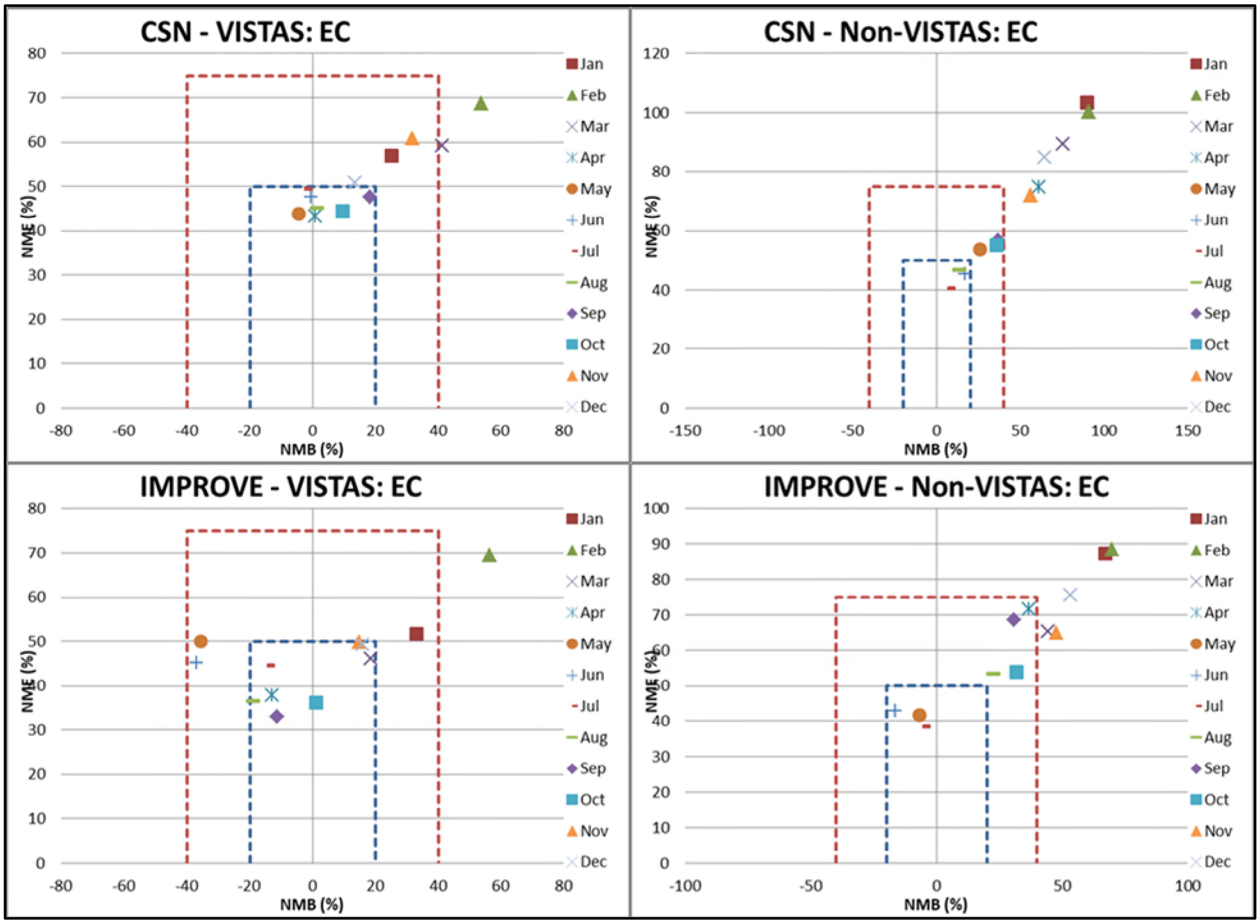


Figure 6-10: Soccer Plots of EC by Network and Month for VISTAS and Non-VISTAS Sites

Spatial plots summarizing IMPROVE observations and model NMB on the 20% most-impaired days are shown in Figure 6-11 through Figure 6-16. In each figure the top graphic presents the observed concentration, and the bottom graphic presents the NMB.

For sulfate (Figure 6-11), predictions on the 20% most-impaired days are biased low across all regions, with the most significant percentage under predictions occurring in the southwest quarter of the VISTAS12 modeling domain. Some isolated over predictions are observed in a few Class I areas near the outer domain boundaries and in the northeast.

Predictions of nitrate (Figure 6-12) on the 20% most-impaired days in the VISTAS12 modeling domain are mixed with a high positive bias in the north and a mix of negative and positive bias in the southeast.

A general positive bias of OC (Figure 6-13) is observed across the region on the 20% most-impaired days. In the SESARM states the OC has approximately the same NMB at monitors with high observed concentrations as monitors with lower observed concentrations. For EC

(Figure 6-14) the model shows a slight under prediction at monitors in the northern portion of the SESARM states and a positive bias at monitors in the southern SESARM region.

On the 20% most-impaired days, model performance for total $PM_{2.5}$ (Figure 6-15) is overall biased low across most quadrants of the VISTAS12 modeling domain (corresponding closely to the sulfate performance). A slight over prediction of $PM_{2.5}$ on those days is observed in the Northern Plains and Upper Midwest, primarily along the Canadian border (corresponding closely to high nitrate concentrations and performance).

Sea salt (Figure 6-16) is generally over-predicted along boundaries with ocean water bodies (Atlantic Ocean and Gulf of Mexico) and is expectedly under-predicted across the rest of the VISTAS12 modeling domain.

Table 6-10 shows model performance statistics for the Class I Areas in VISTAS and closely surrounding VISTAS. The criterion for each statistic is listed in the first row. These criteria are listed in Table 6-6 and Table 6-7. The values in red text in Table 6-10 indicate that the criteria were not met. As stated previously, the model performance statistics should be looked for all of the VISTAS Class I Areas collectively. As such, the averages of the statistics were calculated. The second to last row of Table 6-10 shows the average of all the Class I Areas in the table and the last row shows the average of all the VISTAS Class I Areas. Of the five statistics listed in the table, only one (NMB) average did not meet the criteria and it was only slightly above the criteria. The other four statistics meet the criteria.

The EPA guidance states that it is not appropriate to assign "bright line" criteria that distinguish between adequate and inadequate model performance with a single model performance test.[37] The EPA guidance recommends that a "weight of evidence" approach be used to determine whether a particular modeling application is acceptable for use in regulatory demonstrations.[38] The EPA recommends that air agencies conduct a variety of performance tests and weigh them qualitatively to assess model performance.[39]

Overall, based on the weight of evidence approach recommended by EPA's guidance document, TDEC-APC found model performance to fall within acceptable limits. In conclusion, performance assessed at the "one atmosphere" level was deemed acceptable for ozone, wet/dry deposition, and particulate matter at various monitoring sites. TDEC-APC further asserts the one atmosphere modeling performed by the VISTAS contractors is representative of conditions in the

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[37] EPA Modeling Guidance for Demonstrating Air Quality Goals for Ozone, $PM_{2.5}$ and Regional Haze, November 2018

[38] Ibid.

[39] Ibid.

southeastern states and is acceptable for use in regulatory modeling applications for ozone, particulate matter, and regional haze.

Table 6-10: Sulfate Model Performance Criteria for 20% Most Impaired Days in 2011

Class I Area	# Obs.	NMB (<±30%)	MFB (<±60%)	NME (<50%)	MFE (<75%)	r (>0.4)
Breton	22	-41.83	-60.47	47.93	65.77	0.27
Brigantine	23	-32.93	-39.18	32.93	39.18	0.79
Caney Creek	11	-46.01	-70.2	52.63	75.57	0.49
Cape Romain	24	-28.85	-36.98	36.03	44.17	0.62
Chassahowitzka	24	-39.37	-48.96	44.06	54.49	-0.06
Cohutta	18	-28.18	-32.67	33.06	38.07	0.14
Dolly Sods	24	-27.18	-30.24	34.55	37.86	0.63
Everglades	14	-12.14	-19.56	38.62	43.1	0.2
Great Smoky Mountains	23	-36.92	-46.25	41.47	51.74	0.22
Hercules - Glade	20	-31.75	-41.93	37.76	47.55	0.7
James River Face	24	-36.62	-44.57	36.89	44.88	0.52
Linville Gorge	23	-16.32	-19.66	30.87	35.2	0.49
Mammoth Cave	23	-38.26	-48.89	38.27	48.91	0.8
Mingo	19	-31.4	-38.96	31.88	39.67	0.64
Okefenokee	22	-41.42	-58.55	43.98	61.54	0.52
Saint Marks	22	-40.16	-56.91	48.3	65.37	0.37
Shenandoah	24	-24.34	-30.57	29.31	35.53	0.74
Shining Rock[40]	0	--	--	--	--	--
Sipsey	19	-35.37	-43.37	35.37	43.37	0.75
Swanquarter	22	-25.28	-32.13	31.56	37.56	0.6
Upper Buffalo	23	-17	-27.18	30.66	37.22	0.71
AVERAGE - ALL	**424**	**-31.82**	**-40.97**	**37.27**	**46.7**	**0.62**
AVERAGE - VISTAS	**306**	**-31.33**	**-39.76**	**36.93**	**45.95**	**0.63**

[40] Shining Rock did not have valid monitoring data for 2011

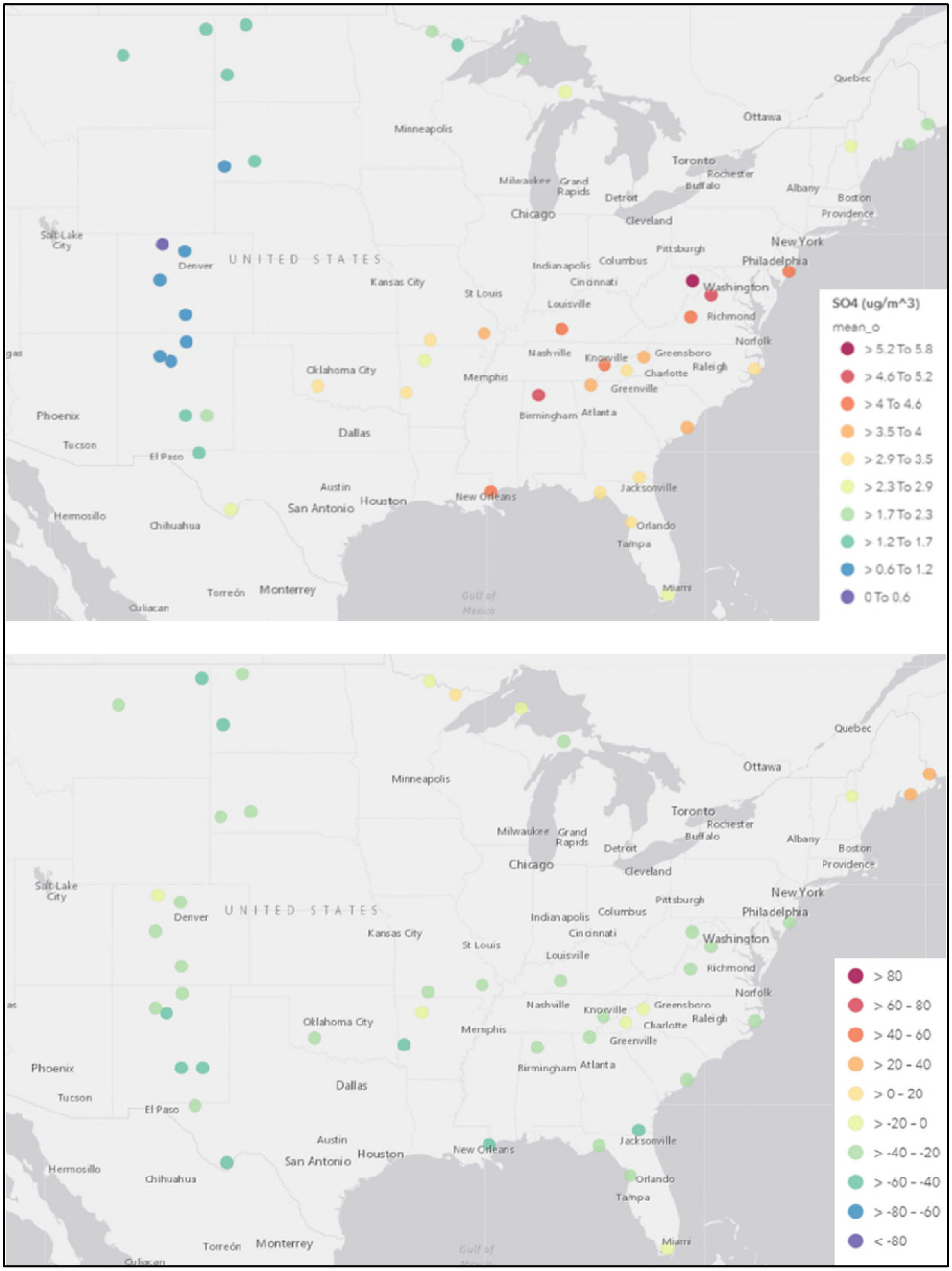

Figure 6-11: Observed Sulfate (Top) and Modeled NMB (Bottom) for Sulfate on the 20% Most-Impaired Days at IMPROVE Monitor Locations

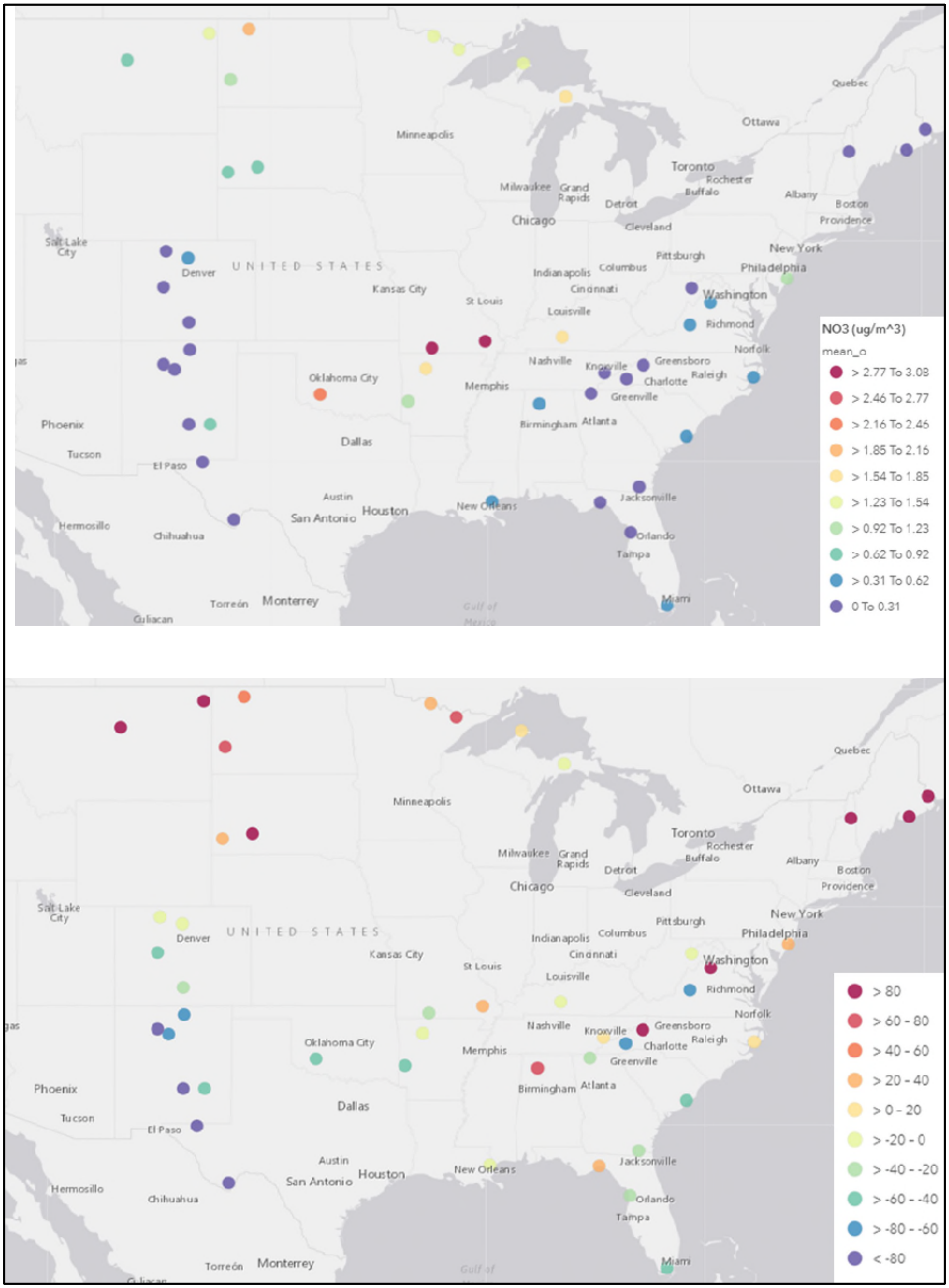

Figure 6-12: Observed Nitrate (Top) and Modeled NMB (Bottom) for Nitrate on the 20% Most Impaired Days at Improve Monitor Locations

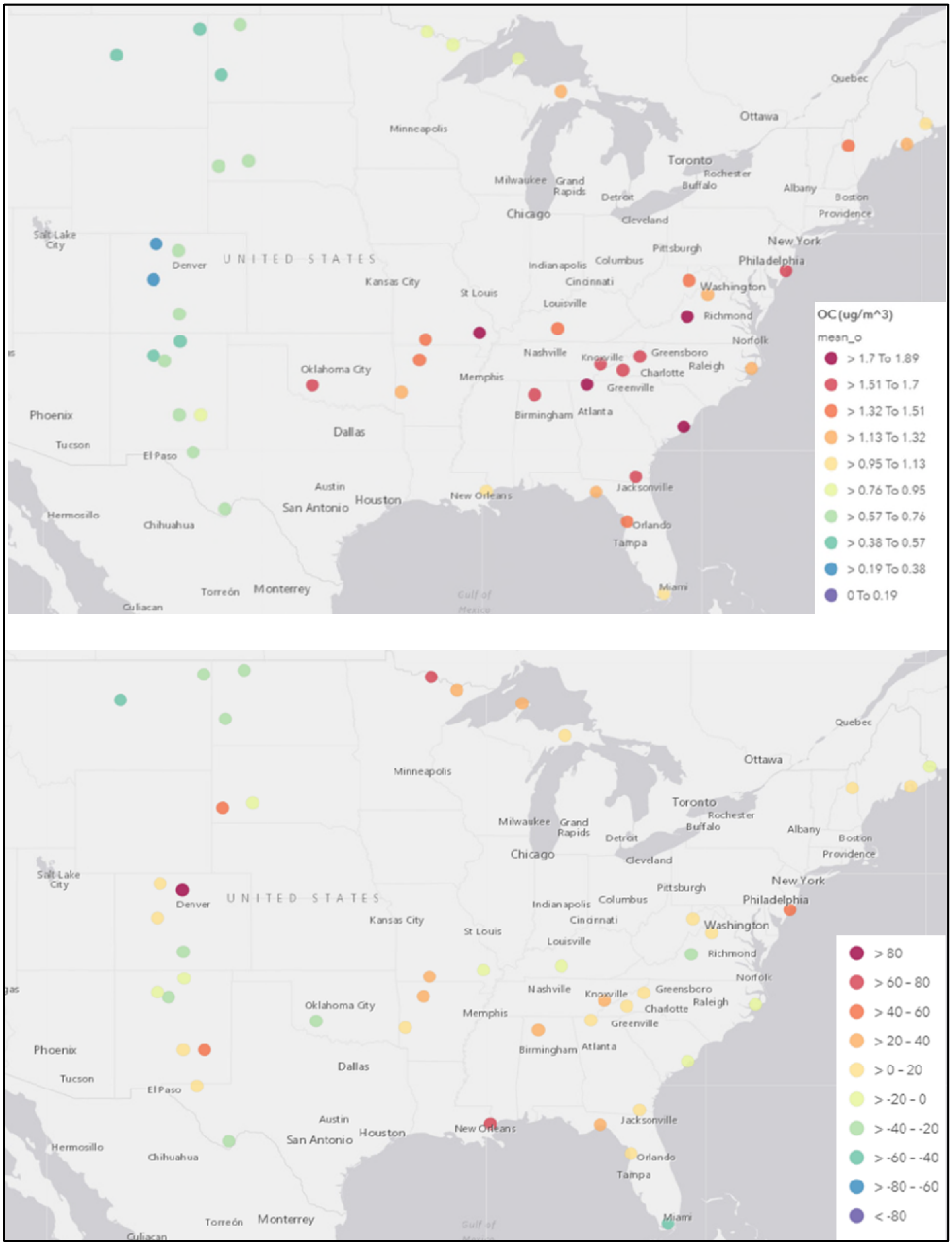

Figure 6-13: Observed OC (Top) and Modeled NMB (Bottom) for OC on the 20% Most-Impaired Days at IMPROVE Monitor Locations

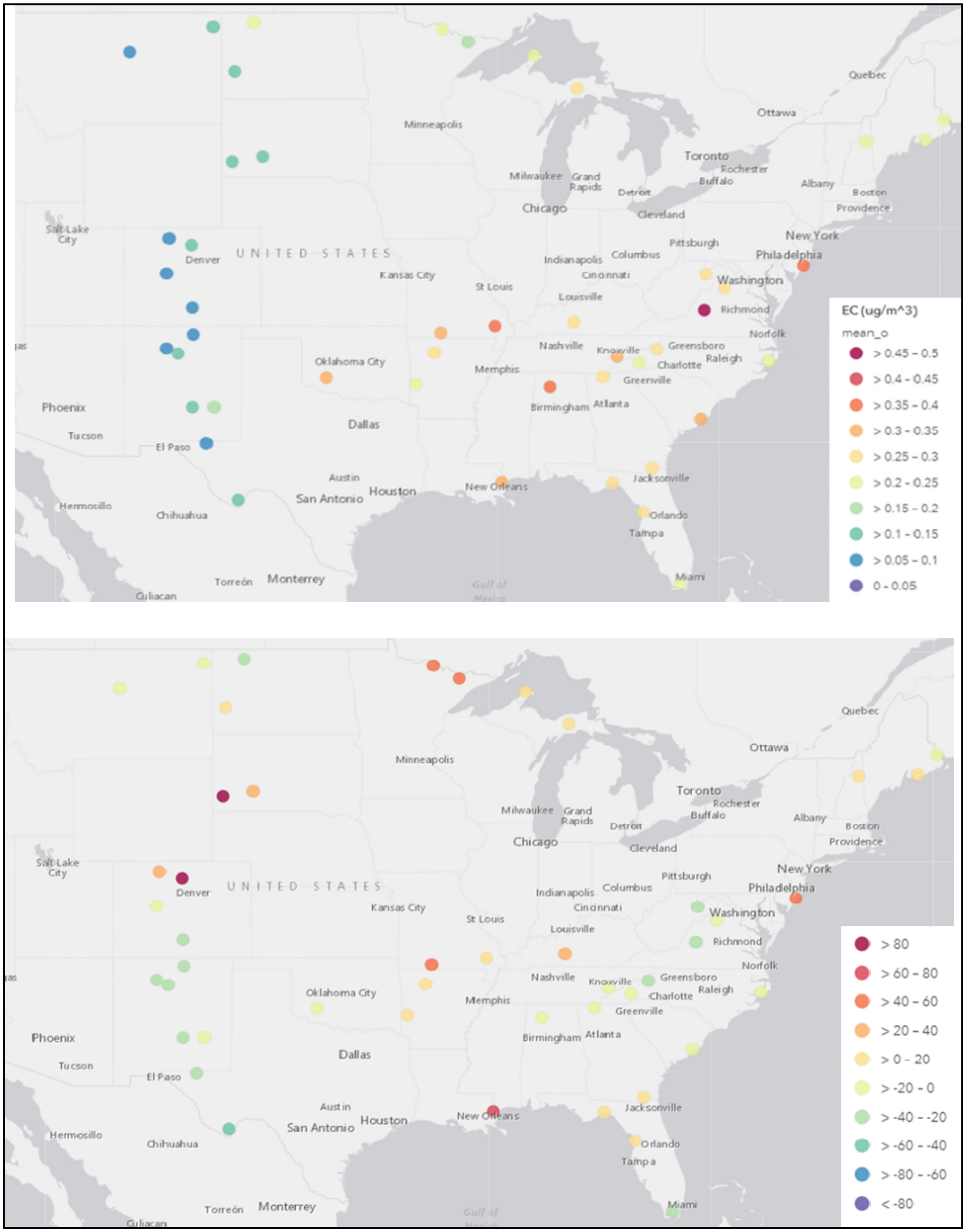

Figure 6-14: Observed EC (Top) and Modeled NMB (Bottom) for EC on the 20% Most-Impaired Days at IMPROVE Monitor Locations

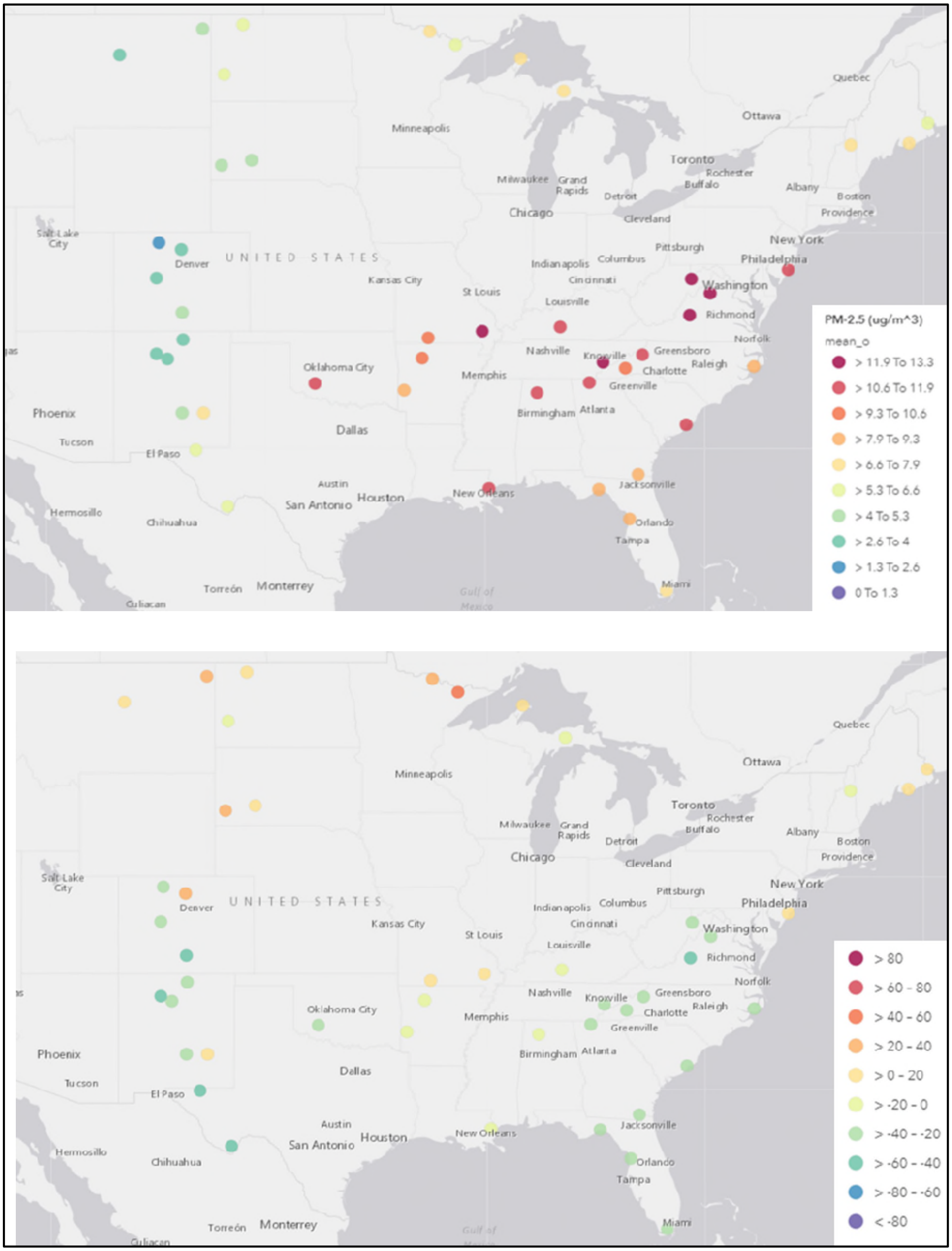

Figure 6-15: Observed Total $PM_{2.5}$ (Top) and Modeled NMB (Bottom) for Total $PM_{2.5}$ on the 20% Most-Impaired Days at IMPROVE Monitor Locations

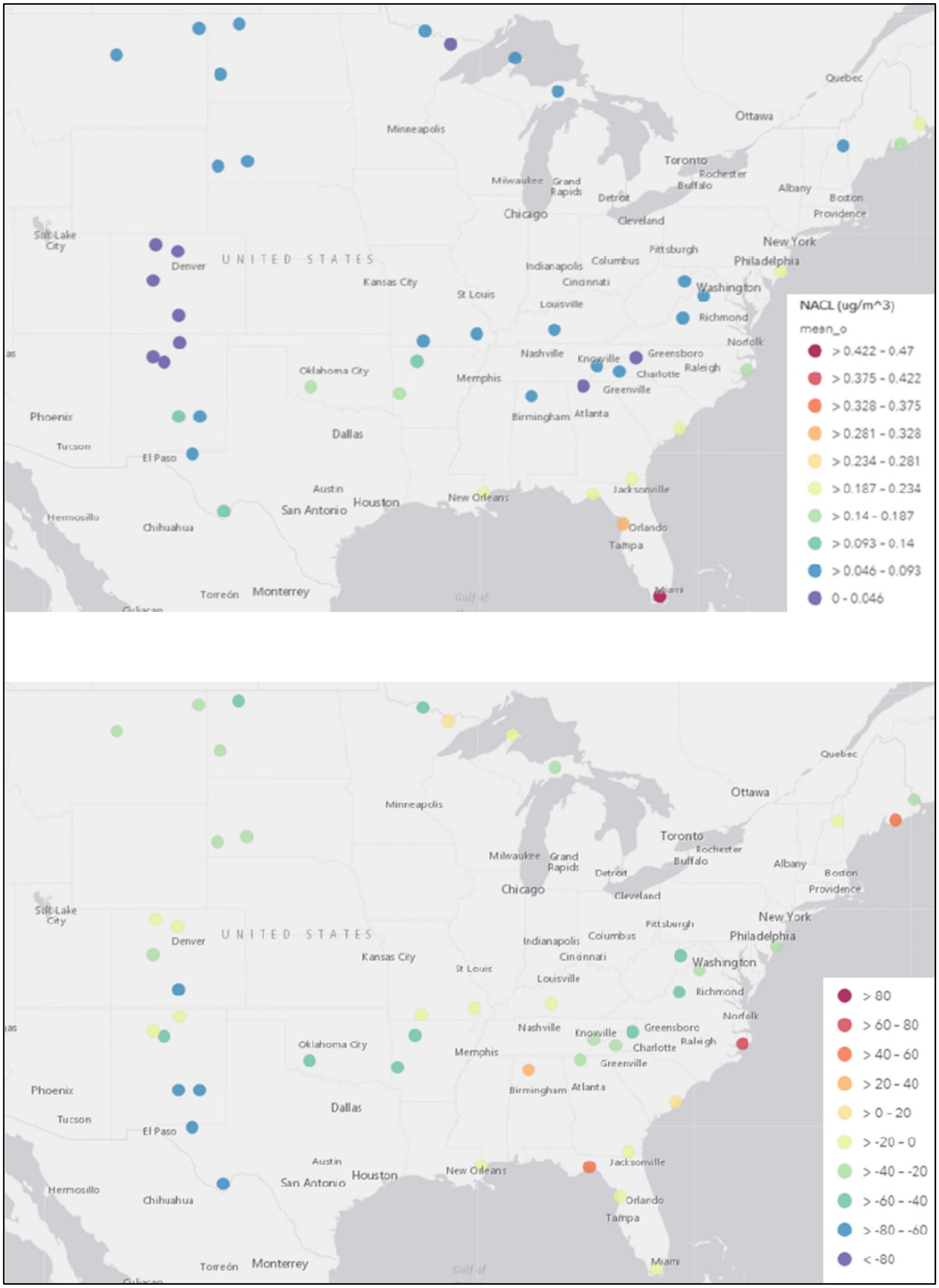

Figure 6-16: Observed Sea Salt (Top) and Modeled NMB (Bottom) for Sea Salt on the 20% Most-Impaired Days at IMPROVE Monitor Locations

6.5. PM Model Performance Evaluation for Class I Areas in West Virginia

The following section provides a detailed model performance evaluation for the Dolly Sods Wilderness Area, which represents the Otter Creek Wilderness Area. This evaluation includes average stacked bar charts, day-by-day stacked bar charts, scatter plots, soccer plots, and bugle plots for the 20% most-impaired days and 20% clearest days.

Figures 6-17 and 6-18 contain the average stacked bar charts representing both the Dolly Sods and Otter Creek Wilderness Areas. These figures include (1) observed and modeled mass concentrations of particulate matter constituents and (2) observed and modeled light extinctions constituents on the 20% most-impaired days and the 20% clearest days. The color codes for the stacked bars are:

- Yellow = mass concentrations of or light extinction due to sulfates
- Red = mass concentrations of or light extinction due to nitrates
- Green = mass concentrations of or light extinction due to organic carbon
- Black = mass concentrations of or light extinction due to elemental carbon
- Brown = mass concentrations of or light extinction due to soil
- Blue = mass concentrations of or light extinction due to sea salt
- Gray = mass concentrations of or light extinction due to coarse mass

Overall, modeled and observed $PM_{2.5}$ concentrations and light extinctions match reasonably well on both 20% most-impaired days and clearest days. Model performance for sulfate is biased low on 20% most-impaired days.

Figures 6-19 and 6-20 contain the day-by-day stacked bar charts representing both the Dolly Sods and Otter Creek Wilderness Areas. These charts allow a side-by-side comparison of observed and modeled speciated PM concentrations and speciated light extinctions on each 20% most-impaired and 20% clearest days. The speciated components are presented in the same order for both the observations (left bar) and modeled data (right bar) to help identify specific days when the predicted mass concentrations or light extinction for the components differ from the observed values. The total height of the bar provides the total particulate matter mass concentrations or the total reconstructed light extinction values. It should be noted that values used for these stacked bar charts are from the grid cell where each IMPROVE monitor is located.

According to Figure 6-17 through Figure 6-22, sulfates and organic carbon are the largest contributors to light extinction in the West Virginia Class I areas on both the 20% most-impaired days and the 20% clearest days. The stacked bar charts also suggest that nitrates can be important on the 20% clearest days. Model performance discussion for individual species were further examined with scatter plots.

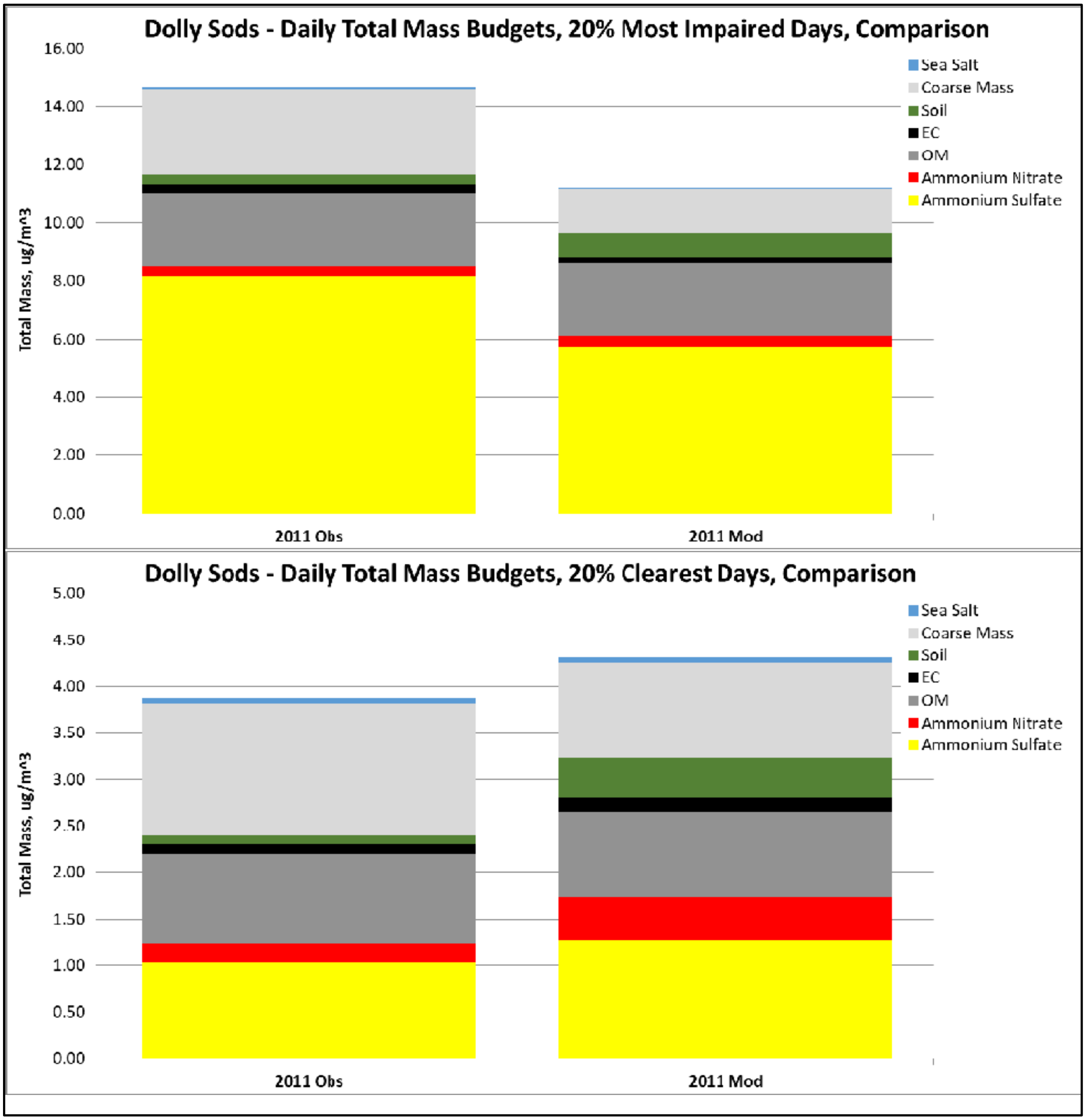

Figure 6-17: Stacked Bar Charts for Average $PM_{2.5}$ Concentrations on the 20% Most Impaired Days (top) and 20% Clearest Days (bottom) at Dolly Sods

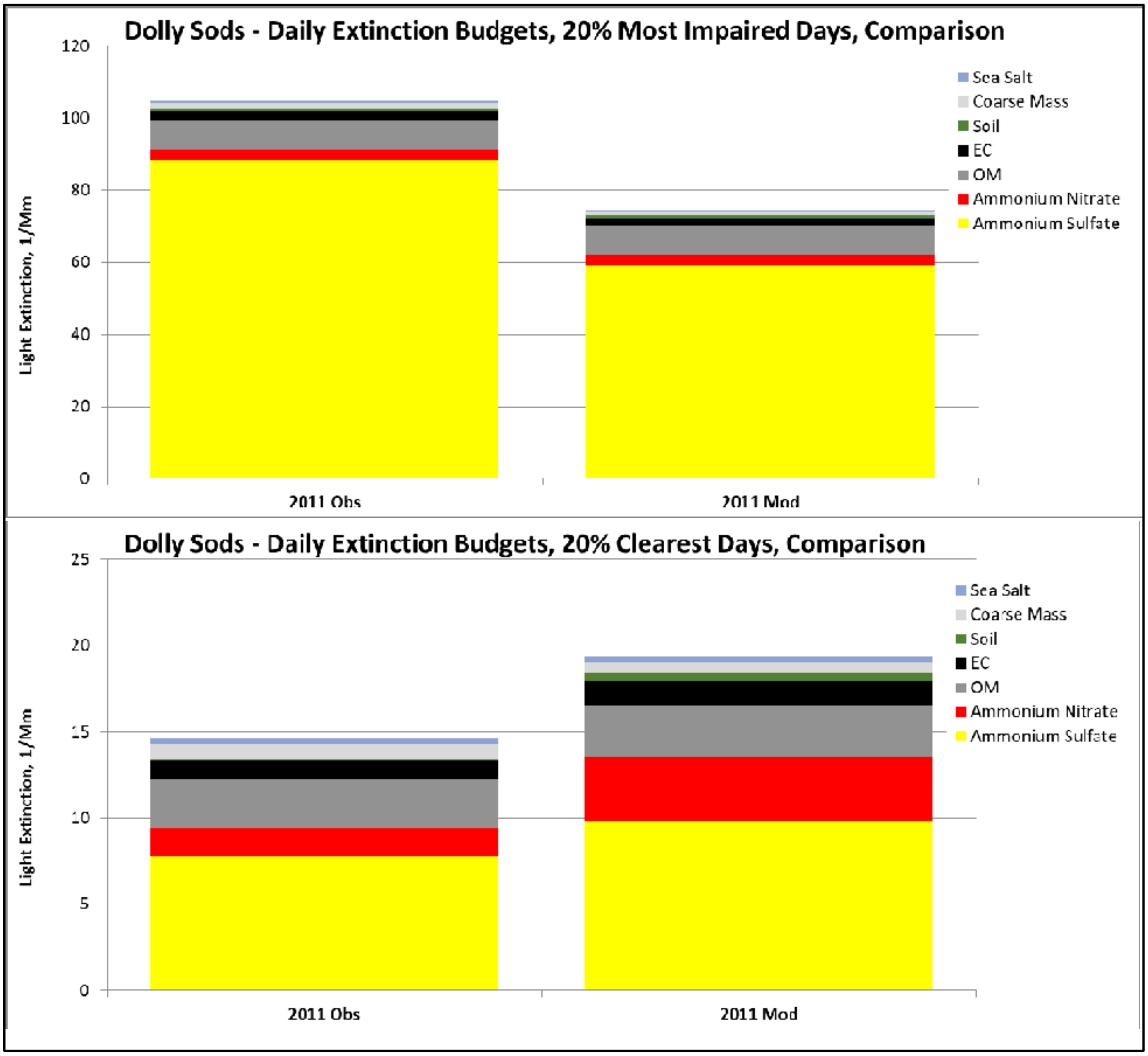

Figure 6-18: Stacked Bar Charts for Average Light Extinction on the 20% Most Impaired Days (top) and 20% Clearest Days (bottom) at Dolly Sods

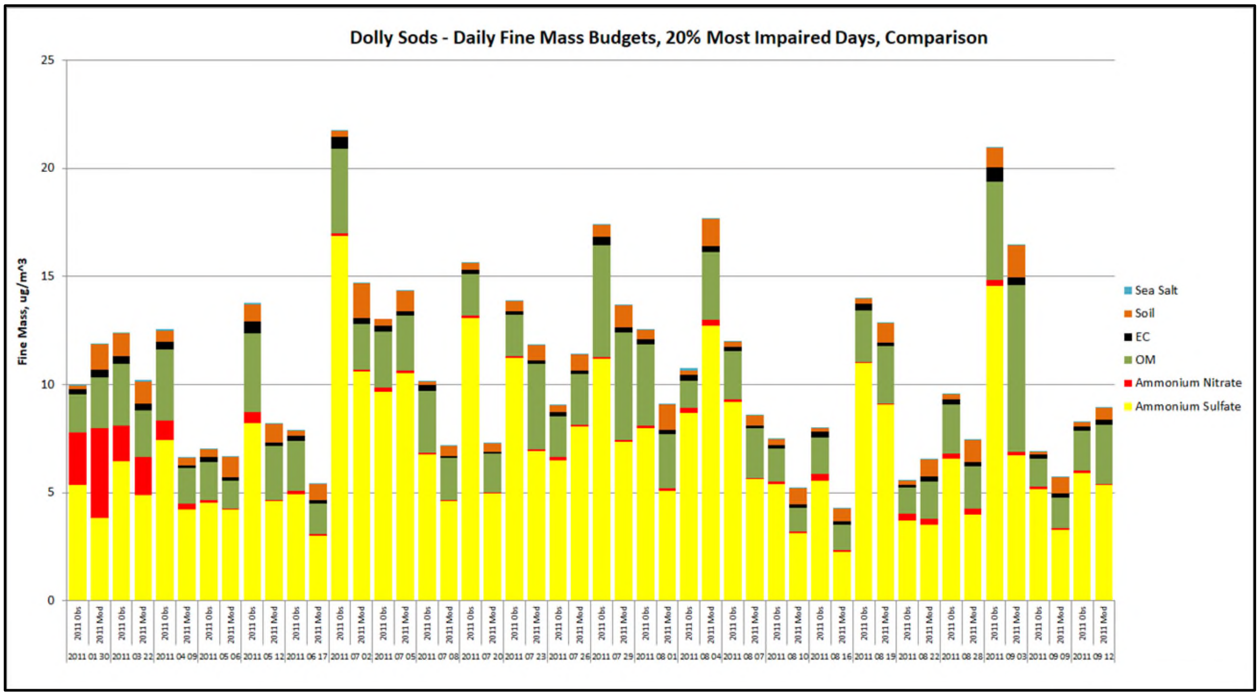

Figure 6-19: Stacked Bar Charts for Daily $PM_{2.5}$ Concentrations at Dolly Sods on the 20% Most Impaired Days, Observed (left, "2011 Obs") and Modeled (Right, "2011 Mod")

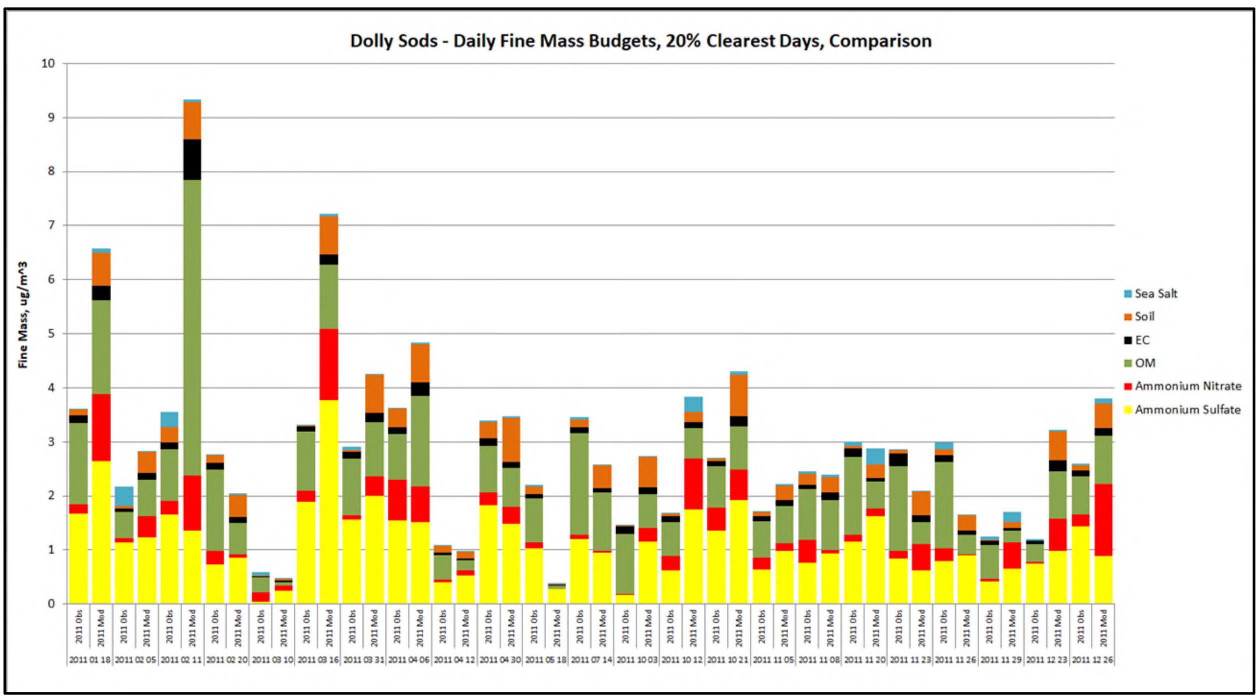

Figure 6-20: Stacked Bar Charts for Daily $PM_{2.5}$ Concentrations at Dolly Sods on the 20% Clearest Days, Observed (left, "2011 Obs") and Modeled (Right, "2011 Mod")

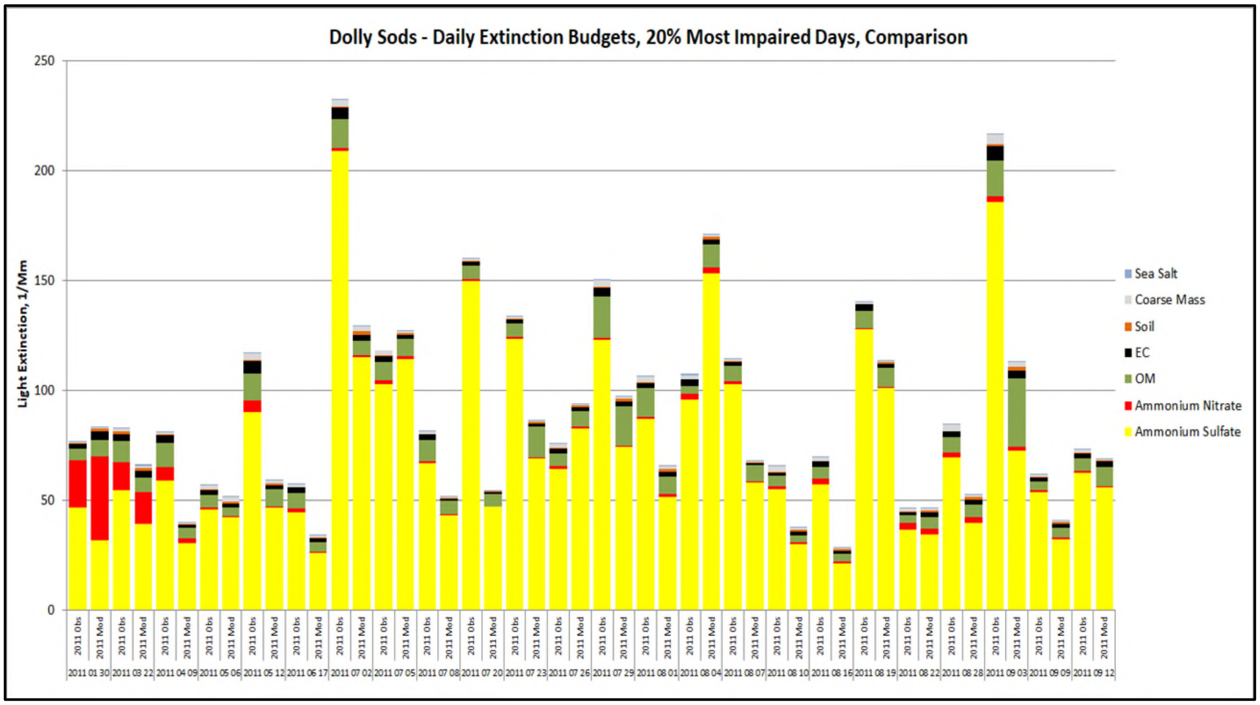

Figure 6-21: Stacked Bar Charts for Light Extinction at Dolly Sods on the 20% Most-Impaired Days, Observed (left, "2011 Obs") and Modeled (Right, "2011 Mod")

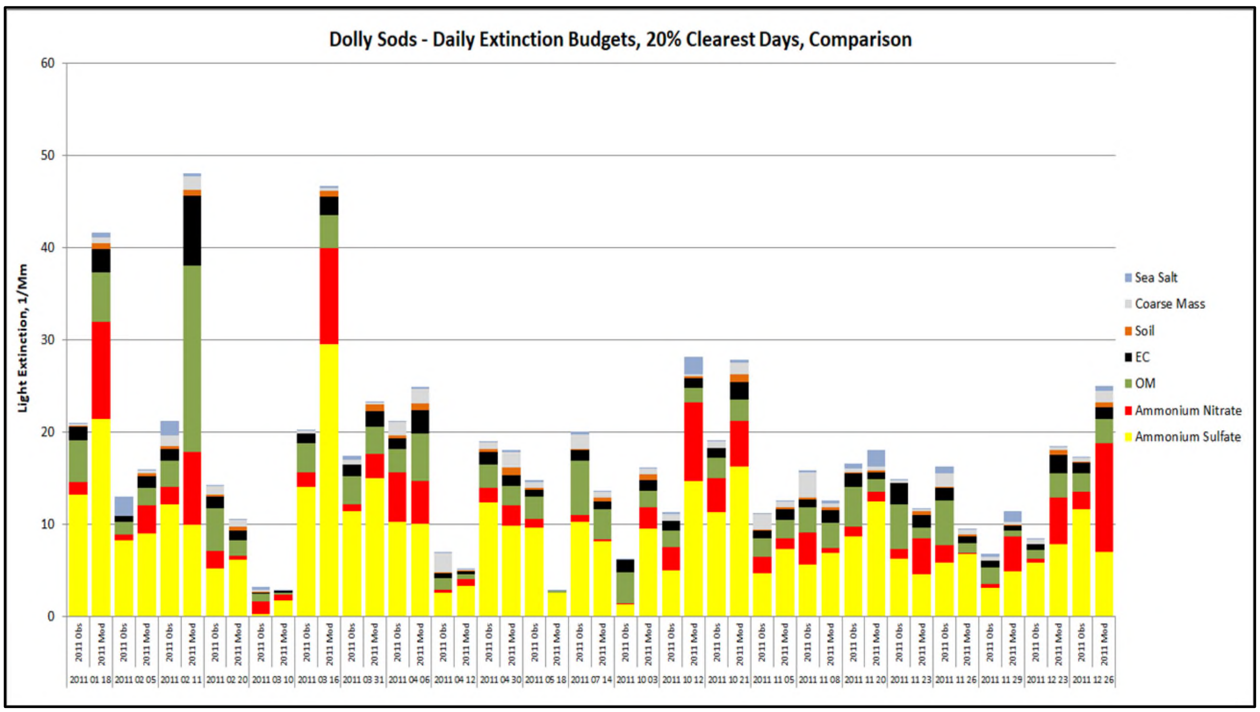

Figure 6-22: Stacked Bar Charts for Light Extinction at Dolly Sods on the 20% Clearest Days, Observed (left, "2011 Obs") and Modeled (Right, "2011 Mod")

Figures 6-23 and 6-24 contain scatter plots of daily observations vs. modeled concentration for $PM_{2.5}$, sulfate, nitrate, organic carbon, elemental carbon, crustal (labeled as soil), sea salt, and coarse mass representing both Dolly Sods and Otter Creek on the 20% most-impaired days. $PM_{2.5}$, sulfate, nitrate, and coarse mass (labeled as PMC) were generally under predicted while crustal was generally over predicted. Organic carbon, elemental carbon, and sea salt show both over predictions and under predictions.

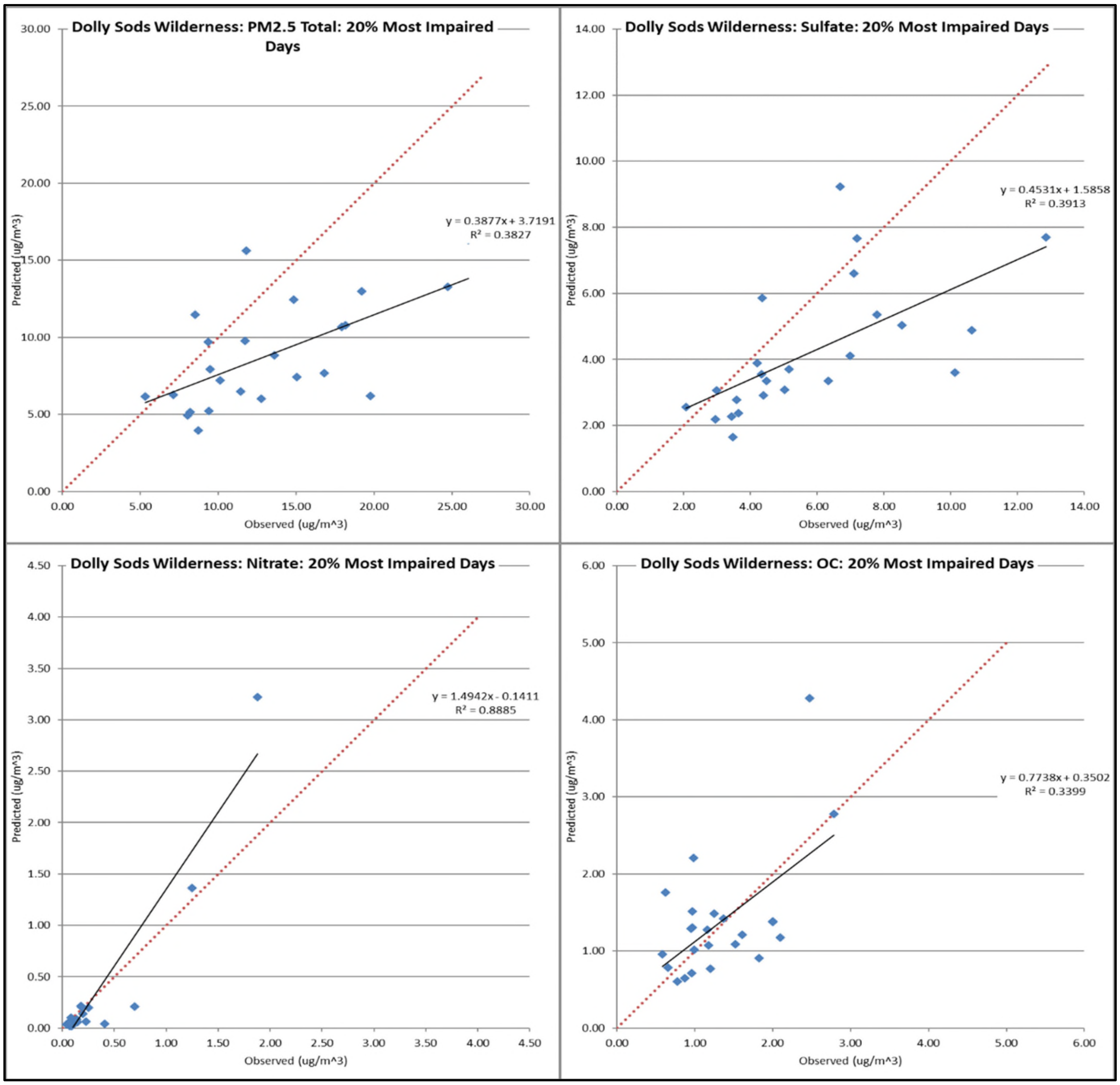

Figure 6-23: Scatter Plot for Daily $PM_{2.5}$ (top left), Sulfate (top right), Nitrate (bottom left), and Organic Carbon (bottom right) Concentrations at Dolly Sods on the 20% Most Impaired Days

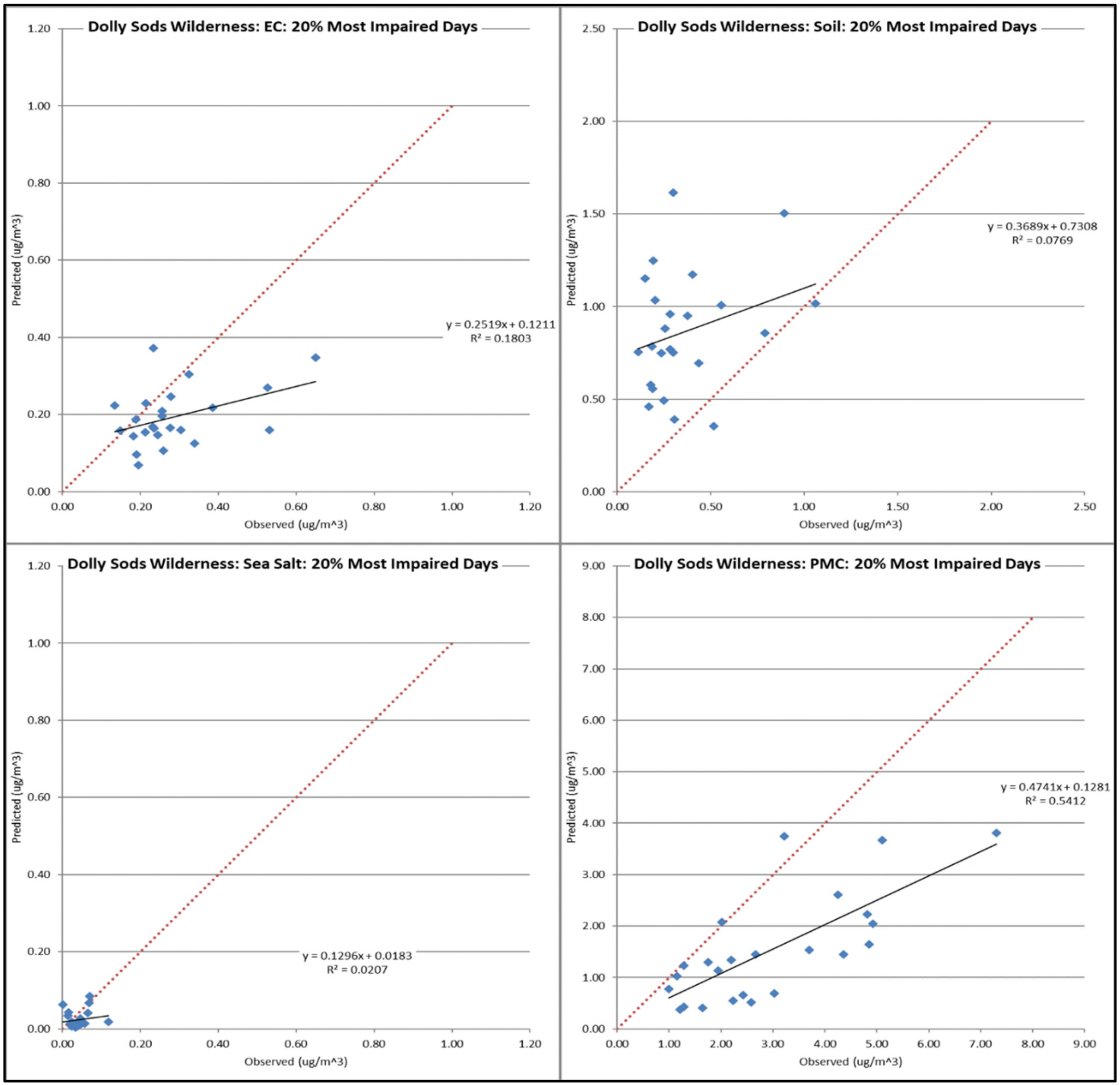

Figure 6-24: Scatter Plot for Daily Elemental Carbon (top left), Crustal (top right), Sea Salt (bottom left), and Coarse Mass (bottom right, labeled as PMC) Concentrations at Dolly Sods on the 20% Most Impaired Days

Figures 6-25 and 6-26 contain scatter plots of daily observations vs. modeled concentration for $PM_{2.5}$, sulfate, nitrate, organic carbon, elemental carbon, crustal (labeled as soil), sea salt, and coarse mass (labeled as PMC) representing both Dolly Sods and Otter Creek on the 20% clearest days. $PM_{2.5}$, sulfate, elemental carbon, and crustal were generally over predicted. Nitrate, organic carbon, sea salt, and coarse mass show both over predictions and under predictions.

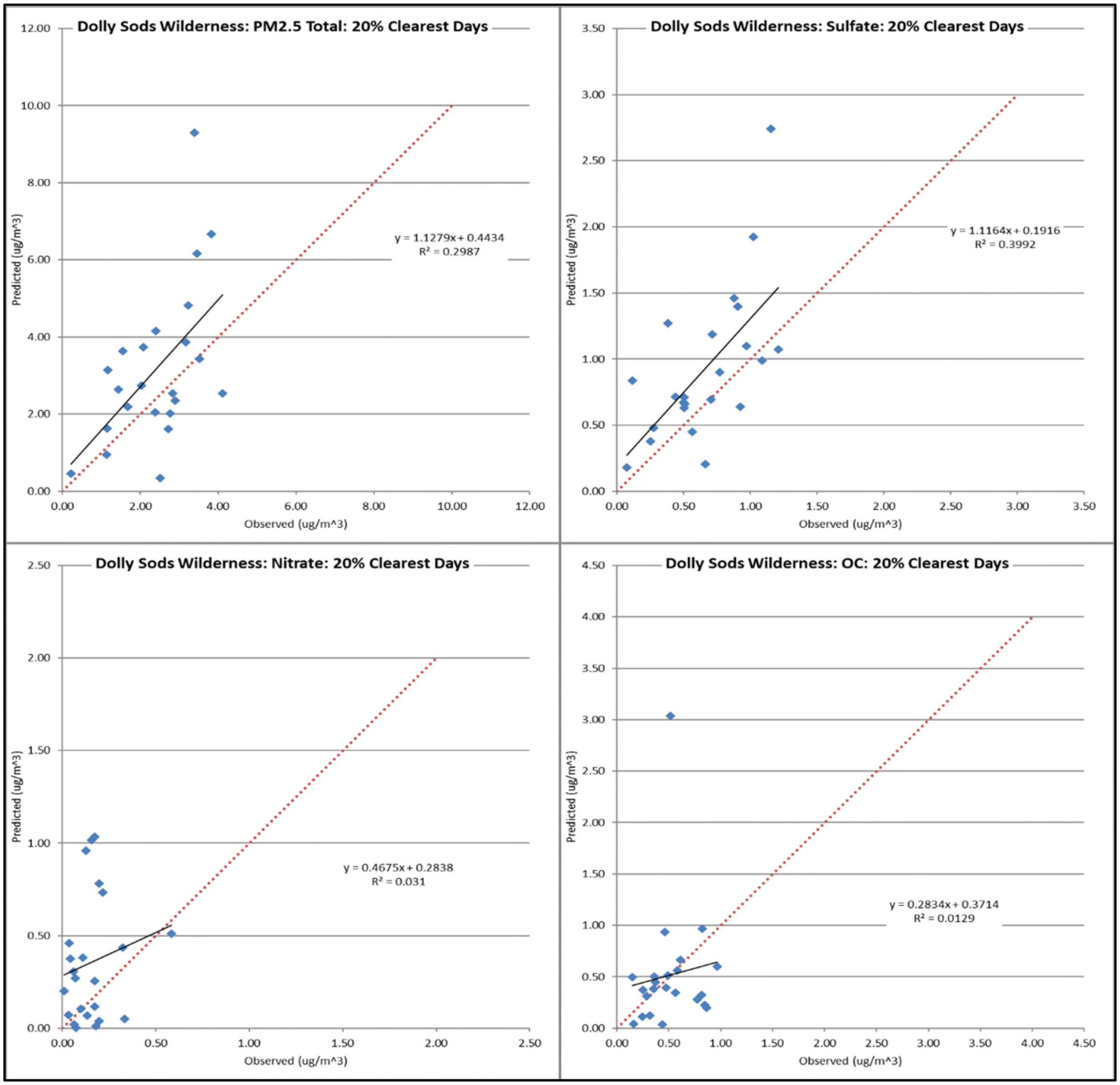

Figure 6-25: Scatter Plot for Daily $PM_{2.5}$ (top left), Sulfate (top right), Nitrate (bottom left), and Organic Carbon (bottom right) Concentrations at Dolly Sods on the 20% Clearest Days.

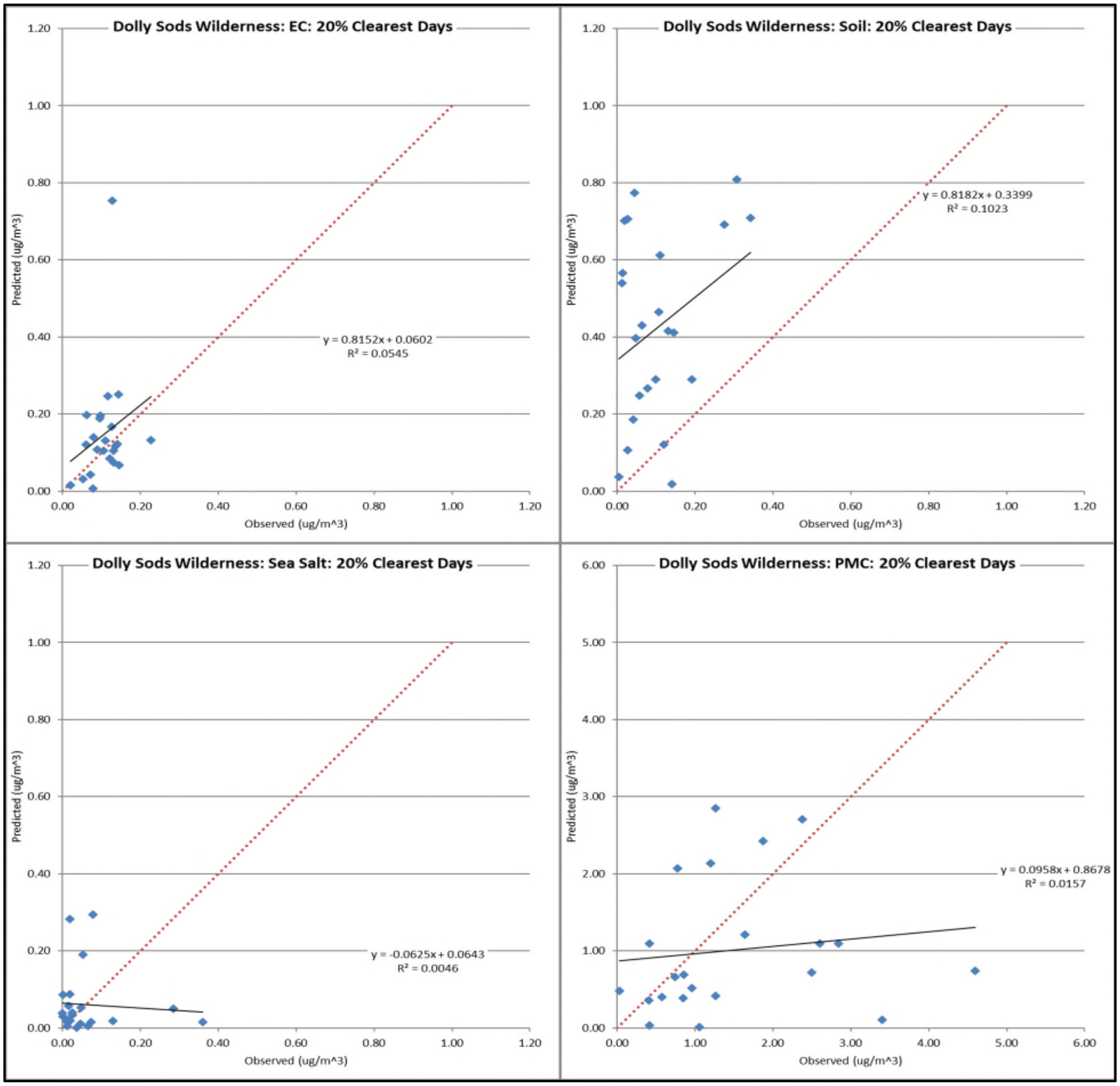

Figure 6-26: Scatter Plot for Daily Elemental Carbon (top left), Crustal (top right), Sea Salt (bottom left), and Coarse Mass (bottom right, labeled as PMC) Concentrations at Dolly Sods on the 20% Clearest Days

Figures 6-27 and 6-28 are soccer plots showing NMB and NME for modeled sulfate, nitrate, organic carbon, elemental carbon, crustal, and coarse mass representing both Dolly Sods and Otter Creek on the 20% most impaired days and the 20% clearest days. On the 20% most impaired days, sulfate, nitrate, organic carbon, elemental carbon, and coarse mass meet the NMB and NME criteria while crustal does not. On the 20% clearest days, sulfate, organic carbon, elemental carbon, and coarse mass meet the NMB and NME criteria while nitrate and crustal do not.

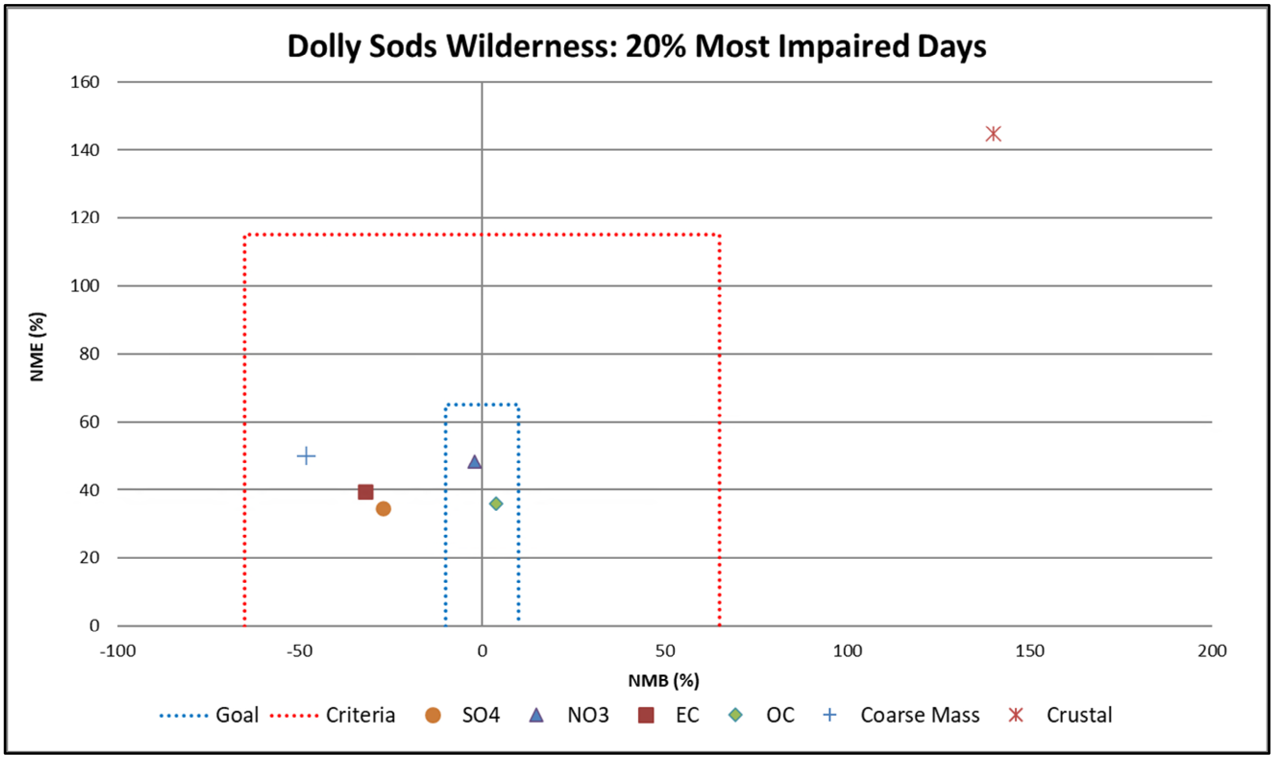

Figure 6-27: Soccer Plot for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Most Impaired Days at Dolly Sods

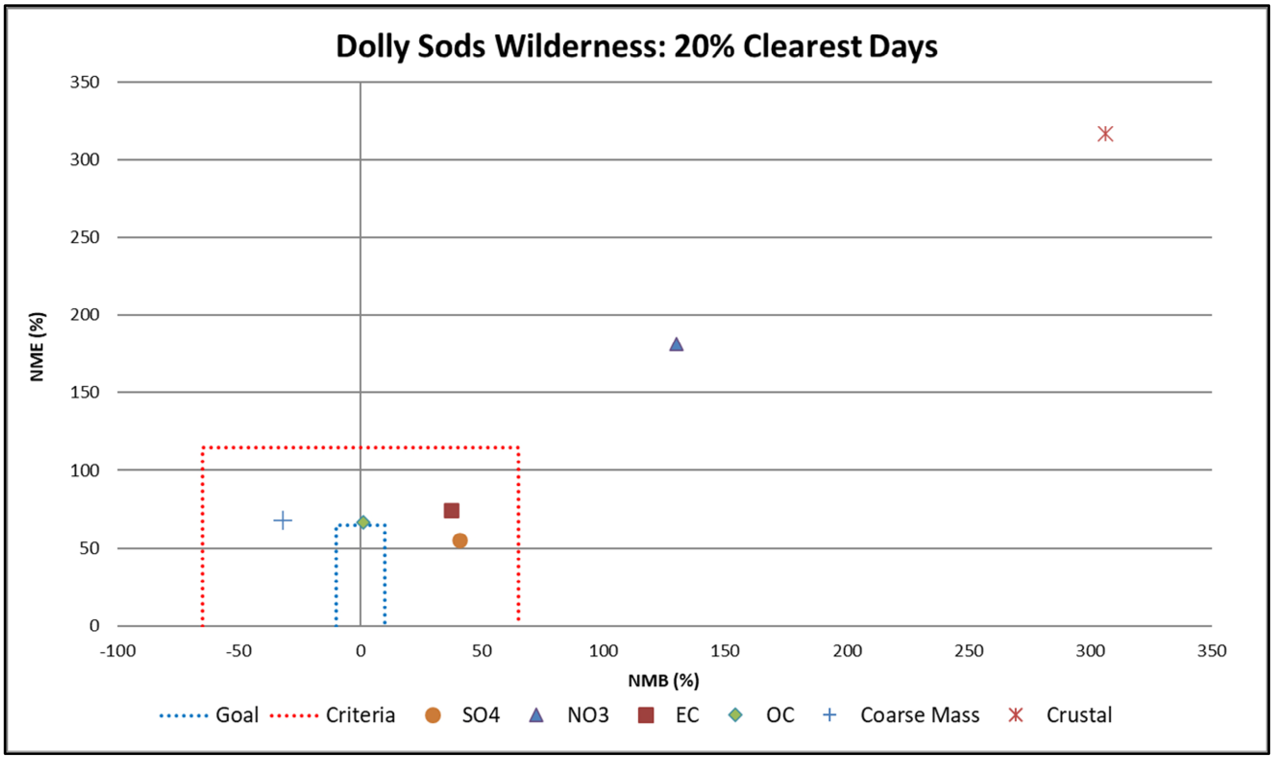

Figure 6-28: Soccer Plot for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Clearest Days at Dolly Sods

Figures 6-29 and 6-30 are bugle plots showing MFB and MFE for modeled sulfate, nitrate, organic carbon, elemental carbon, crustal, and coarse mass representing both Dolly Sods and Otter Creek on the 20% most impaired days and the 20% clearest days. On the 20% most impaired days and the 20% clearest days, all species meet the MFB and MFE criteria (red line). On the 20% most impaired days and the 20% clearest days, all species (except coarse mass MFB on 20% most impaired days) meet the MFB and MFE goal (green line).

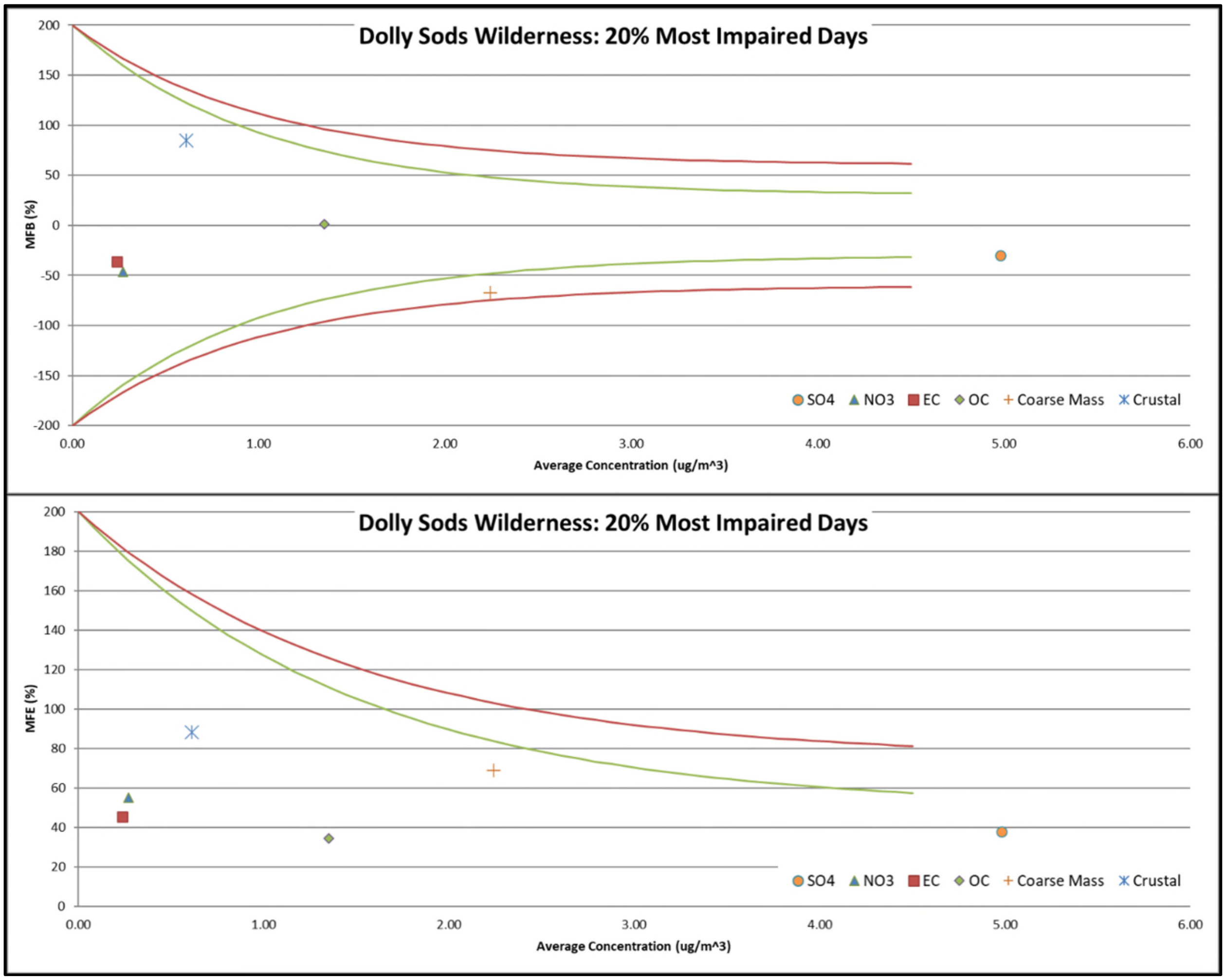

Figure 6-29: Bugle Plots of MFB (top) and MFE (bottom) as a Function of Average Concentration for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Most Impaired Days at Dolly Sods; the MFB and MFE Criteria are Represented by the Red Lines, and the MFB and MFE Goals are Represented by the Green Lines

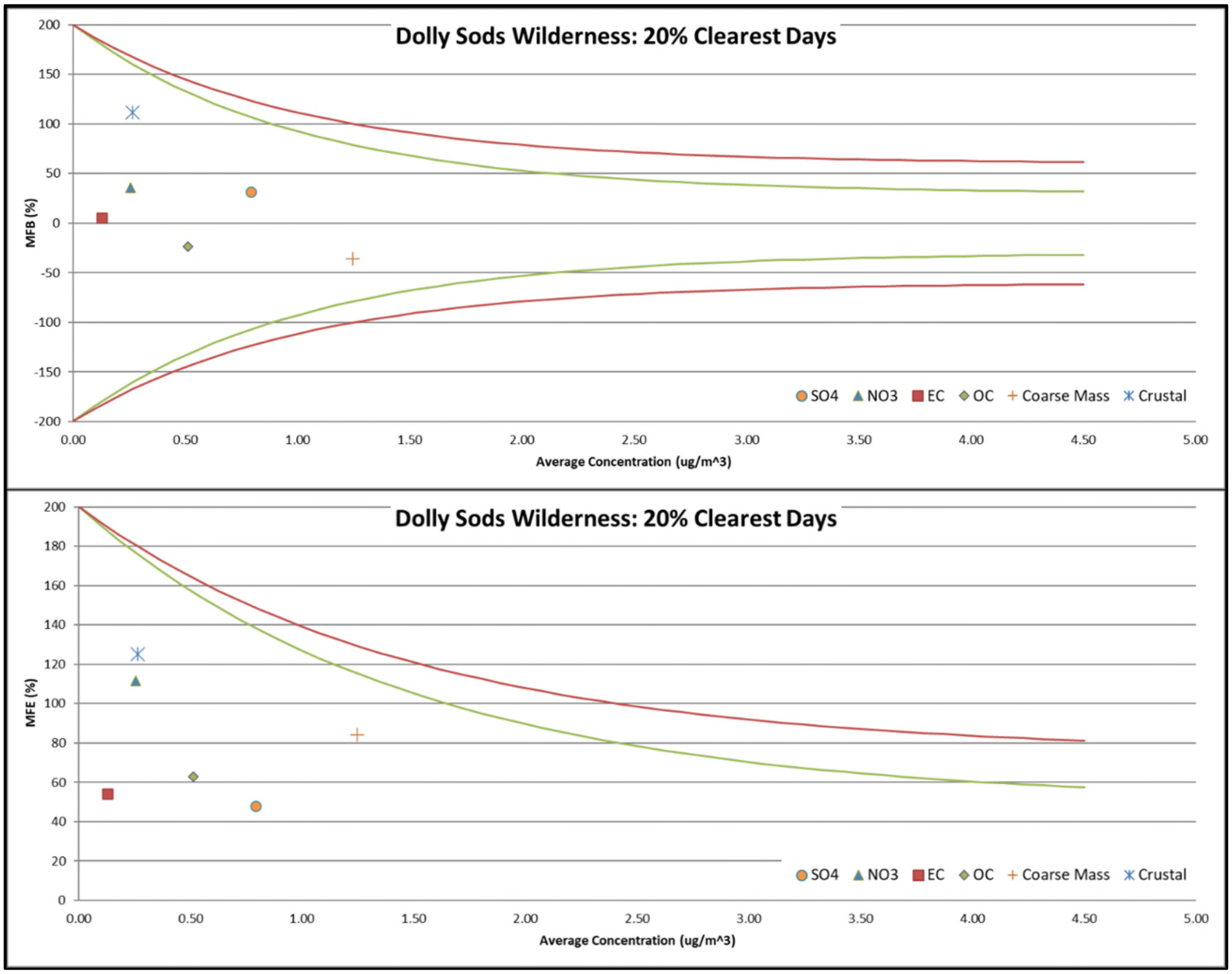

Figure 6-30: Bugle Plots of MFB (top) and MFE (bottom) as a Function of Average Concentration for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Clearest Days at Dolly Sods; the MFB and MFE Criteria are Represented by the Red Lines, and the MFB and MFE Goals are Represented by the Green Lines

Overall, West Virginia found model performance to fall within acceptable limits. West Virginia further asserts the one atmosphere modeling performed by the VISTAS contractors is representative of conditions in the southeastern states and is acceptable for use in regulatory demonstrations to support West Virginia's Regional Haze SIP.

7. LONG-TERM STRATEGY

The regional haze regulation per 40 CFR 51.308(f)(2) requires states to submit a long-term strategy addressing regional haze visibility impairment for each mandatory federal Class I area within the state and for each mandatory federal Class I area located outside the state that may be affected by emissions from sources within the state. The long-term strategy must include the enforceable emissions limitations, compliance schedules, and other measures that are necessary to make reasonable progress. The regional haze regulation also requires per 40 CFR 51.308(f)(3) that states containing mandatory federal Class I areas must establish RPGs expressed in dv. These RPGs must reflect the visibility conditions that are projected to be achieved by the end of the applicable implementation period because of those enforceable emission limitations, compliance schedules, and other measures established as part of the long-term strategy as well as the implementation of other CAA requirements. The RPGs, while not directly federally enforceable, must be met through measures contained in the state's long-term strategy through the year 2028. This section discusses development of West Virginia's long-term strategy.

7.1. Overview of the Long-Term Strategy Development Process

The monitor data and the modeling analyses included with the first regional haze SIP established that within the VISTAS region the key contributors to regional haze in the 2000-2004 baseline time frame were large stationary sources of SO_2 emissions. Sulfate accounted for most of the pollutant impairing species at the Dolly Sods and Otter Creek Wilderness Areas in the 20% most impaired days during the baseline period as shown in Figure 2-1. Visibility data for the baseline period for most VISTAS Class I areas showed this same trend.

More current speciation data for years 2014 through 2018 show significant visibility improvement on the 20% most impaired days. As shown in Figure 2-7 for the Dolly Sods and Otter Creek Wilderness Areas, sulfate continues to be the predominant visibility impairing species. Unlike the data for the baseline period of 2000 to 2004, where nearly all days with poor visibility were heavily dominated by sulfate impairment, the 2014 to 2018 data show some 20% most impaired days having organic matter or nitrate impacts at West Virginia Class I areas. The organic matter components on poor visibility days are associated with episodic events while the nitrate components are associated with anthropogenic emissions. However, the visibility during the majority of 20% most impaired days at West Virginia Class I areas during the period 2014 to 2018 continue to be impacted most heavily by sulfate. Therefore, reducing SO_2 emissions continues to be important for generating further visibility improvements. Keeping this conclusion in mind, this section addresses the following questions:

- Assuming implementation of existing federal and state air regulatory requirements in West Virginia and the VISTAS region, how much visibility improvement, compared to the glide path, is expected at Dolly Sods and Otter Creek by 2028?
- Which mandatory federal Class I areas located outside of West Virginia are significantly impacted by visibility impairing pollutants originating from within West Virginia?
- If additional emission reductions were needed, from what pollutants and source categories would the greatest visibility benefits be realized by 2028?
- Where are these pollutants and source categories located?
- Which specific individual sources in those geographic locations have the greatest visibility impacts at a given mandatory federal Class I area?
- What additional emission controls represent reasonable progress for those specific sources?

7.2. Expected Visibility in 2028 for West Virginia Class I Areas Under Existing and Planned Emissions Controls

Several significant control programs reduce emissions of visibility impairing pollutants between the base year 2011 and the future year projection year of 2028. These programs are described in more detail below.

7.2.1. Federal Control Programs Included in the 2028 Projection Year

Federal control programs impacting onroad and off-road engines as well as industrial and EGU facilities have reduced, and will continue to reduce, emissions of SO_2 and NO_X. Except for the 2021 promulgated Revised CSAPR Update Rule, the reductions from these programs described below, are included in the 2028 future year estimates upon which visibility projections are based.

7.2.1.1. Federal EGU and Industrial Unit Trading Programs

The CAA requires each upwind state to ensure that it does not interfere with either the attainment of a NAAQS or continued compliance with a NAAQS at any downwind monitor. This section of the CAA, § 110(a)(2)(D)(i)(I), is called the "Good Neighbor" provision. The EPA has implemented rules enforcing the Good Neighbor provision for a variety of NAAQS.

The EPA finalized CSAPR on August 8, 2011 (76 FR 48208[41]). This rule required 28 states to reduce SO_2, annual NO_X, and ozone season NO_X from fossil fuel fired EGUs in support of the 1997 and 2006 $PM_{2.5}$ NAAQS and the 1997 ozone NAAQS. CSAPR relied on a trading program to achieve these reductions and became effective January 1, 2015, as set forth in an October 23, 2014, decision by the U.S. Court of Appeals for the D.C. Circuit. Phase 1 of the program began January 2015 for annual programs and May 2015 for the ozone season program. Phase 2 began January 2017 for the annual programs and May 2017 for the ozone season program. Total emissions allowed in each compliance period under CSAPR equals the sum of the affected state emission budgets in the program. The 2017 budgets for these programs, exclusive of new unit set asides and tribal budgets, are:

- SO_2 Group 1 – 1.37 million tons,
- SO_2 Group 2 – 892,000 tons,
- Annual NO_X – 1.21 million tons, and
- Ozone Season NO_X – 586,000 tons

The EPA published revised CSAPR ozone season NO_X budgets to address the 2008 ozone NAAQS on October 26, 2016 (81 FR 74504[42]). This rule, called the CSAPR Update, reduced state budgets for NO_X during the ozone season to 325,645 tons in 2017 and 330,526 tons in 2018 and later years, exclusive of new unit set aside and tribal budgets. This rule applies to all VISTAS states except North Carolina, South Carolina, Georgia, and Florida and continues to encourage NO_X emissions reductions from fossil fuel fired EGUs. The U.S. Court of Appeals for the D.C. Circuit remanded, but did not vacate, the CSAPR Update requiring the EPA to address the court's holding that the rule unlawfully allows significant contributions to continue beyond downwind attainment deadlines. Therefore, the reductions required by the CSAPR Update rule remain in effect.

Furthermore, on October 30, 2020 (85 FR 68964[43]), the EPA proposed the Revised CSAPR Update Rule for the 2008 Ozone NAAQS in response to a September 2019 ruling by the United States Court of Appeals of the D.C. Circuit, *Wisconsin v. EPA.* Starting in the 2021 ozone season, the proposed rule would further reduce NO_X allocated emissions from power plants in 12 states. West Virginia was included as one of the 12 states for which EPA proposed to issue Federal Implementation Plans (FIP) to revise previously established Group 2 NO_X emission allocations implementing Group 3 NO_X emissions reductions from EGUs. For West Virginia

[41] URL: https://www.govinfo.gov/content/pkg/FR-2011-08-08/pdf/2011-17600.pdf
[42] URL: https://www.govinfo.gov/content/pkg/FR-2016-10-26/pdf/2016-22240.pdf
[43] URL: https://www.govinfo.gov/content/pkg/FR-2020-10-30/pdf/2020-23237.pdf

EGUs, when compared to the Group 2, Group 3 NO_X allocations are 24% less. Reductions from this rule were not included in West Virginia's regional haze modeling.

On March 15, 2021, the EPA finalized the proposed Revised CSAPR Update Rule and the final rule appeared in the Federal Register on April 30, 2021 (86 FR 23054[44]).

7.2.1.2. MATS Rule

On February 16, 2012 (77 FR 9304[45]), the EPA promulgated the National Emission Standards for Hazardous Air Pollutants from Coal- and Oil-Fired Electric Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units. This rule is often called the Mercury and Air Toxics Standard (MATS). The standard applies to EGUs burning fossil fuel and sets standards for certain HAP emissions, many of which are acid gases. Control of these acid gases have the co-benefit of reducing SO_2 emissions. Sources had until April 16, 2015, to comply with the rule unless granted a one-year extension for controls installation or an additional extension for reliability reasons.

7.2.1.3. 2010 SO_2 NAAQS

On June 22, 2010 (75 FR 35520[46]), the EPA finalized a new primary NAAQS for SO_2. This regulation significantly strengthened the short-term requirements by lowering the standard to 75 ppb on a one-hour basis. Using inventory and other technical data as support, the EPA determined that anthropogenic SO_2 emissions originate chiefly from point sources, with fossil fuel combustion at electric utilities accounting for 66% of total anthropogenic SO_2 emissions and fossil fuel combustion at other industrial facilities accounting for 29% of total anthropogenic SO_2 emissions. The EPA simultaneously revised ambient air monitoring requirements for SO_2, requiring fewer monitors due to the use of a hybrid approach combining monitoring with air quality modeling to determine compliance with the new standard. Much of this work focuses on the evaluation of point source emissions. To ensure compliance with the 2010 SO_2 NAAQS, reductions in SO_2 emissions have occurred and further reductions may be necessary at certain point sources.

In 2019 and 2020, West Virginia determined the two remaining areas originally designated as non-attainment for the 2010 SO_2 NAAQS were meeting the standard and requested the EPA to designate the areas as attainment, as ambient air monitoring and modeling results in these areas

[44] URL: https://www.govinfo.gov/content/pkg/FR-2021-04-30/pdf/2021-05705.pdf
[45] URL: https://www.govinfo.gov/content/pkg/FR-2012-02-16/pdf/2012-806.pdf
[46] URL: https://www.govinfo.gov/content/pkg/FR-2010-06-22/pdf/2010-13947.pdf

demonstrated SO_2 concentrations were as low as half of the standard. Based on West Virginia's demonstration, the EPA agreed with the state and on July 13, 2020, EPA approved the redesignation request and maintenance plan for the Steubenville SO_2 nonattainment area (85 FR 41925[47]). Similarly, on October 26, 2020, EPA approved the redesignation request and maintenance plan for the Marshall SO_2 nonattainment area (85 FR 67661[48]). These actions resulted in the entire State of West Virginia as being in attainment with the 2010 SO_2 NAAQS standard.

7.2.1.4. Onroad and Nonroad Programs

The CAA authorizes the EPA to establish emission standards for motor vehicles under § 202 and the authority to establish fuel controls under § 211. The CAA generally prohibits states other than California from enacting emission standards for motor vehicles under § 209(a) and for nonroad engines under § 209(e). States may choose to adopt California requirements or meet federal requirements. Federal programs to reduce emissions from onroad and nonroad engines are critical to improving both visibility and air quality, especially since these sources are one of the largest overall sources of NO_X emissions in the nation and in West Virginia.

Several of the programs discussed below address SO_2 emissions by reducing allowable sulfur contents in various fuels. As well as reducing SO_2 emissions, reduced sulfur content improves the efficiency of NO_X controls on existing engines and facilitates the use of state-of-the-art NO_X controls on new engines.

7.2.1.4.1. 2007 Heavy-Duty Highway Rule

In Subpart P of 40 CFR Part 86, the EPA set limitations for heavy-duty engines, which became effective between 2007 and 2010. This rule limited NO_X to 0.20 grams per brake horsepower-hour (g/bhp-hr) and limited non-methane hydrocarbons to 0.14 g/bhp-hr. The rule also required the sulfur content of diesel fuel not exceed 0.0015% by weight to facilitate the use of modern pollution control technology on these engines. These standards continue to provide benefits as older vehicles are replaced with newer models.

7.2.1.4.2. Tier 3 Motor Vehicle Emissions and Fuel Standards

The federal Tier 3 program under Subpart H of 40 CFR Part 80, 40 CFR Part 85, and 40 CFR Part 86 reduces tailpipe and evaporative emissions from passenger cars, light-duty trucks, medium-duty passenger vehicles, and some heavy-duty vehicles. The tailpipe standards include different phase-in schedules that vary by vehicle class and begin to apply between model years

[47] URL: https://www.govinfo.gov/content/pkg/FR-2020-07-13/pdf/2020-13452.pdf
[48] URL: https://www.govinfo.gov/content/pkg/FR-2020-10-26/pdf/2020-21757.pdf

2017 and 2025. The Tier 3 gasoline sulfur standard, which reduced the allowable sulfur content to 10 parts per million (ppm) in 2017, allows manufacturers to comply across the fleet with the more stringent Tier 3 emission standards. Reduced sulfur content in gasoline will also enable the control devices on vehicles already in use to operate more effectively. Compared to older standards, the non-methane organic gases and NO_X tailpipe standards for light duty vehicles in this rule are 80% less than the existing fleet average. The heavy-duty tailpipe standards are 60% less than the existing fleet average.

7.2.1.4.3. Nonroad Diesel Emissions Programs

The EPA promulgated a series of control programs in 40 CFR Part 89, Part 90, Part 91, Part 92, and Part 94 that implemented limitations by 2012 on compression ignition engines, spark-ignition nonroad engines, marine engines, and locomotive engines. Future environmental benefits from these programs will continue as consumers replace older engines with newer engines that have improved fuel economy and more stringent emissions standards. These regulations also required the use of cleaner fuels.

7.2.1.4.4. Emission Control Area Designation and Commercial Marine Vessels

On April 4, 2014, new standards for ocean-going vessels became effective and applied to ships constructed after 2015. These standards are found in MARPOL Annex VI,[49] the international convention for the prevention of pollution from ocean-going ships. These requirements also mandate the use of significantly cleaner fuels by all large ocean-going vessels when operated near the coastlines. The cleaner fuels lower SO_2 emission rates as well as emissions of other criteria pollutants since the engines operate more efficiently on the cleaner fuel. These requirements apply to vessels operating in waters of the United States as well as ships operating within 200 nautical miles of the coast of North America, also known as the North American Emission Control Area.

7.2.2. State Control Programs Included in the 2028 Projection Year

Under the North Carolina Clean Smokestacks Act, coal-fired power plants in North Carolina were required to achieve a 77% cut in NO_X emissions by 2009 and a 73% cut in SO_2 emissions by 2013.

Georgia Rule 391-3-1-.02(2)(sss) "Multi-Pollutant Control for Electric Utility Generating Units" established a schedule for the installation and operation of NO_X and SO_2 pollution control systems on many of the coal-fired power plants in Georgia. This rule, adopted in 2007, required

[49] URL: https://www.epa.gov/sites/production/files/2016-09/documents/resolution-mepc-251-66-4-4-2014.pdf

controls for all affected units to be in place before June 1, 2015. The rule reduced SO_2 emissions by approximately 90%, NO_X emissions by approximately 85%, and mercury emissions by approximately 79%.

Consent agreements also impose specific controls that were included in this inventory development process:

- Lehigh Cement Company/Lehigh White Cement Company (US District Court, Eastern District of Pennsylvania): EPA reached a settlement with these companies on December 3, 2019, to settle alleged violations of the CAA. The settlement will reduce emissions of NO_X and SO_2 and applies to facilities located in several states, including Alabama.

- VEPCO (US District Court, Eastern District of Virginia): Virginia Electric and Power Company (also known as Virginia-Dominion Power) agreed to spend $1.2 billion by 2013 to eliminate 237,000 tons of SO_2 and NO_X emissions each year from eight coal-fired electricity generating plants in Virginia and West Virginia.

- Anchor Glass Container (US District Court for the Middle District of Florida): On August 3, 2018, Anchor agreed to convert six of its furnaces to oxyfuel furnaces and will meet NO_X emission limits at these furnaces that are consistent or better than best available control technology. On remaining furnaces, Anchor agreed to install oxygen enriched air staging and meet more stringent emission limits. To control SO_2, Anchor agreed to install dry or semi-dry scrubber systems on two furnaces. Remaining furnaces must achieve batch optimization and meet enforceable emissions limits. Anchor also agreed to install NO_X and SO_2 continuous emissions monitoring systems at all furnaces. The expected emission reductions from the agreement are 2,000 tpy of NO_X and 700 tpy of SO_2 at facilities located in Florida, Georgia, Indiana, Minnesota, New York, and Oklahoma.

West Virginia included several emission reductions in the 2028 inventory projections. The following paragraphs discuss these emission reductions.

7.2.2.1. Coal-Fired EGU Permanent Shutdowns

Since the 2011 emissions inventory, several coal-fired EGUs have been permanently shut down in West Virginia. These shutdowns have resulted in a great reduction in West Virginia SO_2 (46,119 tpy) and NO_X (9,782 tpy) emissions and includes the following facilities:

- Appalachian Power Company Kanawha River Station – Glasgow, WV
- Appalachian Power Company Philip Sporn Plant – New Haven, WV
- AEP Generation Resources, Inc. Kammer Plant – Cresap, WV

- Monongahela Power Company Albright Power Station – Albright, WV
- Monongahela Power Company Willow Island Power Station – Willow Island, WV

Table 7-1 below provides the actual 2011 SO_2 and NO_X emissions reported to West Virginia and shows the magnitude of these reductions since they have ceased operations.

Table 7-1: Permanent EGU Shut Down Emission Reductions

Facility	2011 SO_2 (tpy)	2011 NO_X (tpy)
AP Kanawha River	10,337	2,494
AP Philip Sporn	11,042	2,064
AEP Kammer	16,712	3,590
Mon. Power Albright	6,454	920
Mon. Power Willow Island	1,574	714
Total Reductions:	**46,119**	**9,782**

Data Source: WVDAQ-State and Local Emissions Inventory System (SLEIS) Database

Since 2005, ten coal-fired EGU facilities have been shut down in West Virginia. More coal-fired EGU shutdowns in West Virginia are expected in the future due to the life expectancies of older units and increased regulatory challenges. As an example, in January 2021, Appalachian Power Company filed a notice with the Public Service Commission of West Virginia stating they will cease operations of their Mitchell coal-fired facility in Marshall County in 2028 if the company chooses to retire the plant rather than making additional investments to comply with federal wastewater limits. Possible SO_2 and NO_X emissions from shutting down the Mitchell plant were not included in the 2028 emission projections.

7.2.2.2. Morgantown Energy Associates

Morgantown Energy Associates (MEA) located in Morgantown, West Virginia provides steam to West Virginia University (WVU). MEA operated two circulating fluidized bed (CFB) boilers burning coal and waste coal to produce steam. Additionally, the facility produced electricity as a by-product which was purchased through an agreement with Allegheny Power and delivered to the electric grid.

In January 2020, MEA filed a permit application with the WVDAQ to shut down its two existing CFB boilers. With this application, MEA would no longer produce electricity; however, the facility would continue to produce and sell steam to WVU. This would be accomplished by increasing the heat capacity of the two existing smaller natural gas auxiliary boilers and installing two new industrial boilers to meet WVU's steam demand. These boilers were permitted to utilize natural gas as the primary fuel and ultra-low sulfur diesel as a backup fuel limited to 2,400 hours per year or 25% of the annual capacity of each boiler. These boilers are equipped with low-NO_X burners.

This change in operations resulted in a net NO_X emissions decrease of 1,075 tons per year from burning coal and limited MEA's overall SO_2 emissions to less than a ton per year. Since actual emissions from these boilers were not available at the time of preparing the 2028 emissions inventory for modeling, the facility's permitted maximum emission limits were used instead.

7.2.2.3. Non-EGU Fuel Conversions

Non-EGUs include larger steam boilers located at industrial facilities. Although these facilities may generate some electricity for internal use, their primary purpose is to generate steam for process operations. Historically, many of the larger boilers burned coal to produce steam. Through the years, emissions of SO_2 and NO_X have decreased either via facility shutdowns or fuel conversions. There are no industrial non-EGU coal-fired boilers currently operating in West Virginia, as all remaining operational non-EGU boilers that were coal-fired have been shut down, converted to natural gas or replaced with new natural gas units. Those facilities where shutdowns and fuel conversions have occurred are further discussed below.

7.2.2.3.1. Former Bayer CropScience Institute (Currently Altivia Services Institute)

The former Bayer CropScience facility located at Institute, West Virginia is a large chemical manufacturing complex. Steam used in process operations was produced by the No. 1 and No. 2 Powerhouses. The No. 1 Powerhouse originally contained eight large steam boilers and the No. 2 Powerhouse contained three large steam boilers. All boilers were originally coal-fired.

Over the years, and with changes in the plant's operations, all the original boilers have been shut down and removed from the site. Most notable is the permanent shutdown of the three largest coal-fired boilers in the No. 2 Powerhouse. These boilers were replaced with two new permitted natural gas boilers that meet the plant's current steam needs and comply with federal and state regulations and air pollution control technologies. These two new boilers are natural gas fired with low-NO_X burners. Altivia Services, LLC is the current owner and operator of these boilers.

Table 7-2 below compares previous 2011 SO_2 and NO_X actual emissions when the three coal-fired boilers in the No. 2 Powerhouse were operational to the 2019 emissions inventory data for the two new natural gas boilers. These fuel conversions have resulted in an actual SO_2 emission decrease of 2,222 tons per year and a NO_X emission decrease of 1,749 tons per year.

Table 7-2: Former Bayer CropScience Institute Boiler Emissions Comparison

Boilers	2011 SO_2 (tpy)	2019 SO_2 (tpy)	2011 NO_X (tpy)	2019 NO_X (tpy)
Original Coal-Fired Boilers	2,223	0	1,774	0
New Natural Gas Boilers	0	0.5	0	25

Data Source: WVDAQ-SLEIS

In addition to the shutdown of these boilers, the facility has experienced significant shutdowns of chemical manufacturing units. All of Bayer CropScience's pesticide manufacturing processes ceased operations and were demolished. Although not as great as the shutdown of the boilers, these process shutdowns have also resulted in an additional reduction in SO_2 and NO_X emissions not accounted for in this table from fuel combustion, process emissions, and combustion-based controls including flares and thermal oxidizers.

7.2.2.3.2. Chemours Washington Works

Chemours Washington Works (Chemours) is a large chemical manufacturing facility located in Parkersburg, West Virginia. As part of the federal requirements of 40 CFR 51 Subpart BB – Data Requirement for Characterizing Air Quality for Primary SO_2 NAAQS, the WVDAQ was required to identify any facilities in the 2010 SO_2 NAAQS nonattainment areas that emitted more than 2,000 tons per year of SO_2 emissions. Chemours facility-wide SO_2 emissions were greater than the 2,000-ton threshold. As a result, Chemours elected to accept a federally enforceable limit with SO_2 emissions below the 2,000-ton threshold.

Chemours' operations included six boilers used to provide steam to the site's production facilities. Five of these boilers were coal-fired and the sixth was natural gas-fired. In January 2018, the WVDAQ entered into a consent order with Chemours. This Order required Chemours to shut down the five coal-fired boilers by December 21, 2021. In addition, Chemours was required to submit a permit application with the WVDAQ to construct three new natural gas-fired boilers equipped with low-NO_X burners to replace the five-existing coal-fired boilers. Chemours met the Consent Order requirements and shut down the last remaining coal boiler on March 22, 2021, nine months earlier than the consent order deadline.

The three new natural gas boilers were not operational for VISTAS's 2028 modeling period, therefore, 2028 SO_2 and NO_X emissions were based on the projection of 2011 emissions, which are much higher than the facility's permitted emission limits. Table 7-3 below compares the total SO_2 and NO_X permitted emissions from the existing coal-fired boilers to those from the new permitted natural gas boilers. These revisions have resulted in a 9,573 tons per year NO_X reduction and a SO_2 emission reduction of 456 tons per year.

Table 7-3: Chemours Fuel Conversion Permitted Emission Comparison

Pollutant	5 Coal Boilers (tpy)	3 Natural Gas Boilers (tpy)	Difference (tpy)
Permitted SO_2	9,575	1.9	-9,573
Permitted NO_X	1,110	654	-456

Data Source: Chemours Title V and WV 45CSR13 Air Permits

7.2.2.4. Eagle Natrium

Eagle Natrium (Eagle) is a chemical manufacturing facility located in Proctor, West Virginia. Steam was provided to the facility's production processes by three coal-fired boilers and a natural gas-fired boiler. To comply with the federal requirements of 40 CFR 63 Subpart DDDDD – National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters, Eagle elected to shut down one coal-fired boiler and convert the other two coal-fired boilers to natural gas. Modifications were also made to these two boilers to increase the design heat input capacity to meet the facility's steam demand. Each boiler is equipped with low-NO_X burners.

As a result of these modifications and fuel conversions, SO_2 and NO_X emissions from Eagle's boilers have been greatly reduced. Table 7-4 below compares actual 2011 SO_2 and NO_X emission from the original three coal-fired boilers to the reported 2019 calendar year emissions from the two boilers converted to natural gas. Because of these fuel conversions, actual SO_2 emissions have decreased 6,727 tons per year and NO_X emissions have decreased 1,433 tons per year.

Table 7-4: Eagle Natrium Boiler Emissions Comparison

Boilers	2011 SO_2 (tpy)	2019 SO_2 (tpy)	2011 NO_X (tpy)	2019 NO_X (tpy)
Original Three Coal-Fired Boilers	6,730	0	2,008	0
Two Converted Natural Gas Boilers	0	2.7	0	575

Data Source: WVDAQ-SLEIS

7.2.2.5. Ox Paperboard – Halltown Mill

Ox Paperboard (Ox) operates a mill located at Halltown, West Virginia. This mill manufactures recycled paperboard products from recovered paper. Steam needed to support the mill's manufacturing operations was provided by an industrial coal-fired boiler. In 2015 to meet the federal requirements of 40 CFR 63 Subpart JJJJJJ - National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers Area Sources, Ox requested a federally enforceable permit with an annual heat input capacity limit of 40% of capacity and to install controls to meet Subpart JJJJJJ.

Operating the coal-fired boiler at 40% capacity proved to be inefficient and costly. In 2018, Ox requested an air permit modification to replace the existing coal-fired boiler with a smaller natural gas-fired boiler capable of supplying the facility's steam demand. The new boiler is equipped with a low-NO_X burner system.

Table 7-5 below compares the 2011 SO_2 and NO_X emissions from the originally operated coal-fired boiler prior to limiting its heat capacity to the 2019 emissions from the new natural gas boiler. With this fuel conversion, actual SO_2 emissions were reduced by approximately 364 tons per year and NO_X by 48 tons per year.

Table 7-5: Ox Paperboard Boiler Emissions Comparison

Boilers	2011 SO_2 (tpy)	2019 SO_2 (tpy)	2011 NO_X (tpy)	2019 NO_X (tpy)
Original Coal-Fired Boilers	364	0	53	0
New Natural Gas Boilers	0	0.1	0	5

Data Source: WVDAQ-SLEIS

7.2.2.6. Alliant Techsystems Operations, LLC - Allegheny Ballistics Laboratory (Rocket Center)

Alliant Techsystems Operations, LLC operates a manufacturing facility in Rocket Center, West Virginia on behalf of the US Navy. This facility fabricates rocket motor and warhead cases, including necessary propellants and explosives, for military and space applications. Steam to support facility operations and to maintain minimum winter temperatures for the storage of unstable explosives was once supplied by one coal-fired and two oil-fired boilers. In 2015 the coal and oil boilers were replaced with ten smaller but more operationally flexible primary natural gas with diesel backup boilers which significantly reduced SO_2 emissions. Potential SO_2 emissions were reduced from more than 318 tpy to less than 34 tpy, while potential NO_X emissions decreased from more than 124 tpy to just over 41 tpy. The boiler replacement project removed major source status from this facility for the two primary stationary source pollutants that are responsible for the majority of anthropogenic visibility impairment.

Table 7-6 below compares the 2011 SO_2 and NO_X facility-wide emissions when the original coal and oil-fired boilers were in operation with the 2019 SO_2 and NO_X facility-wide emissions after the replacement of the original boilers with the natural gas with diesel backup units. Although overall reported facility-wide annual NO_X emissions increased in this time, annual SO_2 emissions have dramatically decreased to almost zero. SO_2 is the primary anthropogenic pollutant driving visibility impairment in the VISTAS modeling.

Table 7-6: Rocket Center Facility-Wide Emissions Comparison

Pollutant	2011 Emissions (tons, Original Coal and Oil Boilers)	2019 Emissions (tons, New Natural Gas/Diesel Boilers)
SO_2	220	0.18
NO_X	5.03	24.2

Data Source: WVDAQ-SLEIS

7.2.2.7. Former Luke Paper Company

The former Luke Paper Company (Luke) primary operations were in Luke, Maryland with supporting operations on the West Virginia side of the Potomac River in Mineral County. Luke's mill produced graphic papers used primarily in the commercial printing, media and marketing applications, including magazines, catalogs, books, direct mail, and corporate marketing collateral. In June 2019, the mill was permanently shut down and its active federally enforceable air permits were terminated with an effective date of May 7, 2020.

Luke was selected as part of the VISTAS modeling effort as a facility potentially impacting visibility at West Virginia's Dolly Sods and Otter Creek Wilderness Areas. Obviously, with the closure the Luke facility will no longer impact these areas. The mill was projected to emit 22,660 tons per year of SO_2 emissions and 3,607 tons per year of NO_X emissions in 2028.

7.2.2.8. Other Shutdowns and Operational Changes

In developing West Virginia's 2028 emissions inventory utilized in VISTAS's 2028 modeling, the WVDAQ incorporated known or expected emission changes having occurred or expected to occur by 2028. The major emission changes have been discussed above. Facility operational changes affecting emissions occur for various reasons such as market conditions, equipment revisions, process improvements, regulatory requirements, etc. Based on the best available information, the WVDAQ incorporated both emission increases and decreases in this inventory. However, most emission changes were the result of facility or process shutdowns and decreased emissions due to process or equipment revisions.

Operational changes were most notable in the Oil and Gas industry. On an annual basis, natural gas wells produce the greatest volume of gas in the first year of operation. Over the first year, gas well production volumes substantially decrease. Equipment installed to handle the initial volumes becomes oversized once the production volume decreases. Smaller or less equipment is required for ongoing operations. As an example, natural gas compressors originally installed for higher gas volumes are replaced with smaller compressors using smaller horse-power engines and/or the number of compressors and engines needed are reduced. These types of revisions often involve newer equipment with more efficient emission controls and are required to meet more stringent environmental regulatory requirements. The promulgation of more regulations applicable to the Oil and Gas industry have also driven the requirement for more and better air pollution control techniques, which have resulted particularly in NO_X emission decreases since the 2011 emissions inventory; this was reflected in the 2028 projected emission inventory as significant.

7.2.3. Projected VISTAS 2028 Emissions Inventory

The VISTAS emissions inventory for 2028 account for post-2011 emission reductions from promulgated federal, state, local, and site-specific control programs, many of which are described in Section 7.2.1 and Section 7.2.2. The VISTAS 2028 emissions inventory is based on EPA's 2028el emissions inventory data sets.[50] Onroad and nonroad mobile source emissions were created for 2028 using the MOVES model. Nonpoint area source emissions were prepared using growth and control factors simulating changes in economic conditions and environmental regulations anticipated to be fully implemented by calendar year 2028. For EGU sources in projected year 2028, VISTAS states considered the EPA 2028el, the EPA 2023en, or 2028 emissions from the ERTAC EGU projection tool CONUS2.7 run and CONUS16.0 run. The EPA 2028el emissions inventory for EGUs considered the impacts of the CPP, which was later vacated. Additionally, the EPA 2028el EGU emissions inventory used results from IPM. IPM assumes units may retire or sit idle in future years based solely on economic decisions determined within the tool. Impacts of the CPP, IPM economic retirements, and IPM economic idling resulted in many coal-fired EGUs being shut down. Thus, the EPA 2028el projected emissions for EGUs are not reflective of probable emissions for 2028. The ERTAC EGU tool outputs do not consider the impacts of the CPP. For states outside of VISTAS, EGU estimates were derived from CONUS16.0 and CONUS16.1 outputs. West Virginia EGU estimates for 2028 were based on the ERTAC CONUS16.0 tool projections. For non-EGU point source projections to the year 2028, VISTAS states considered the EPA 2023en and EPA 2028el emissions and in some cases supplied their own emissions data. This is the approach used by West Virginia. North Carolina developed their own 2028 non-EGU point source emissions inventory based on application of growth and control factors to their most recent year (2016) non-EGU point source inventory. Georgia used 2016 emissions (or 2014 emissions if 2016 was not available) to represent 2028 emissions for the 33 non-EGU facilities with over 100 tpy of SO_2 in 2011, exclusive of Hartsfield-Jackson Atlanta International Airport.

These updates for 2028 are documented in the ERG emissions inventory reports included in Appendix B-2a.

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[50] URL: https://www.epa.gov/air-emissions-modeling/updates-2011-and-2028-emissions-version-63-technical-support-document

Figure 7-1 and Figure 7-2 show the expected decrease in emissions of SO_2 and NO_X, respectively, across the VISTAS states from 2011 to 2028.

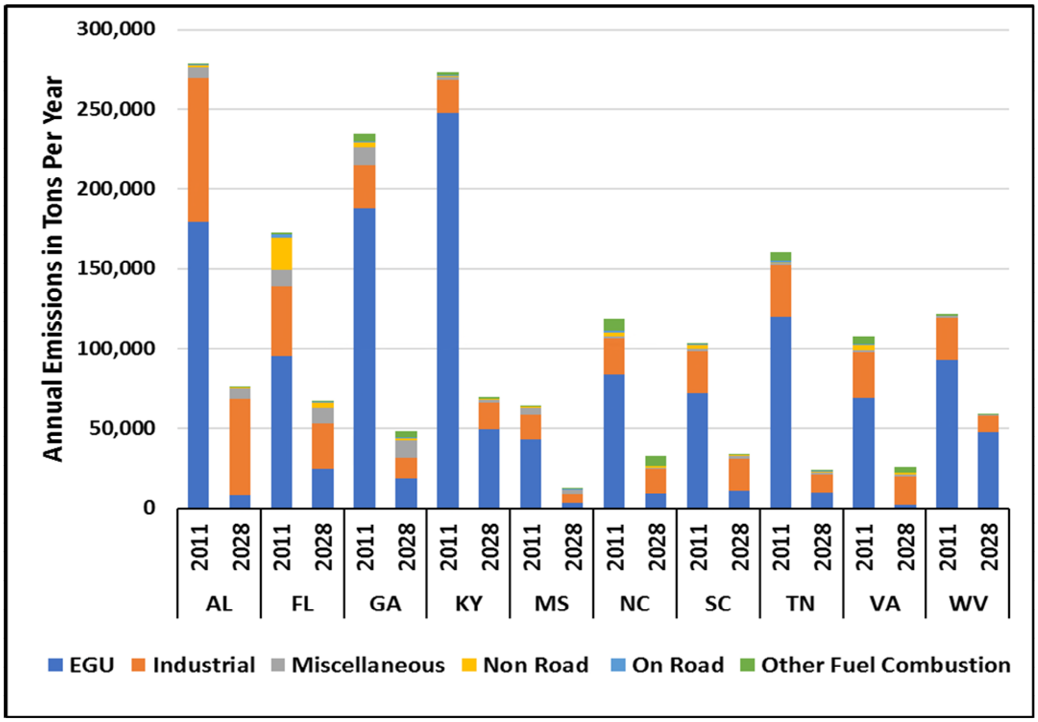

Figure 7-1: SO_2 Emissions for 2011 and 2028 for VISTAS States

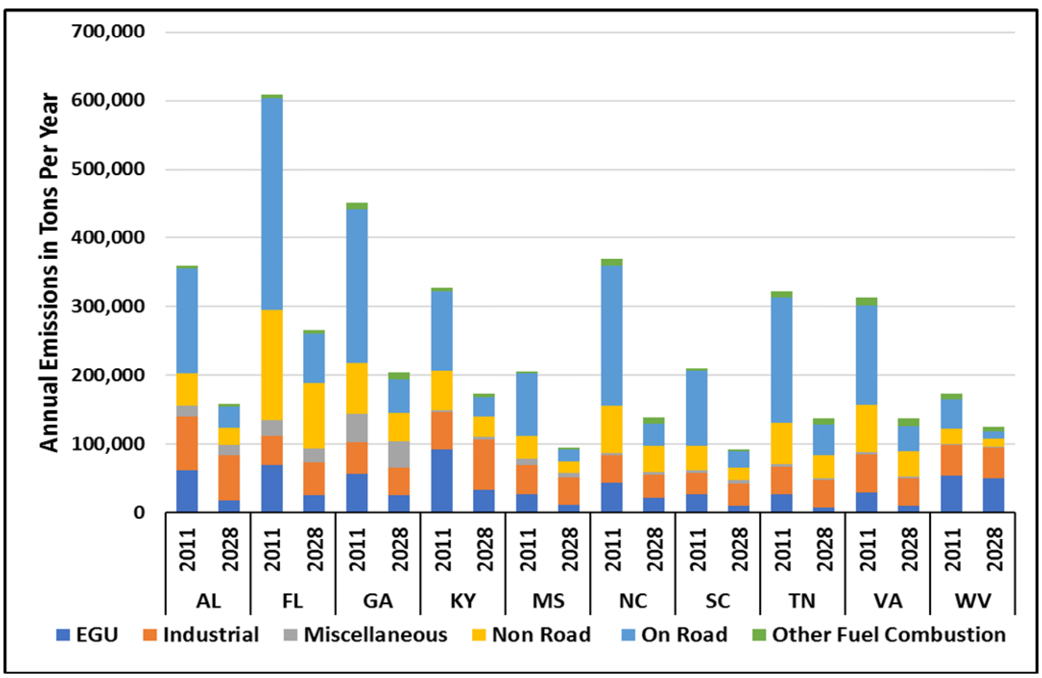

Figure 7-2: NO_X Emissions for 2011 and 2028 for VISTAS States

For SO_2 emissions, the largest contributors to haze across VISTAS, are expected to decrease from 1,633,000 tons in 2011 to 448,000 tons in 2028, a 73% decrease. The EGU sector accounts for most of the reductions although in some states industrial SO_2 emissions are also expected to decrease significantly. As discussed above, significant industrial SO_2 emissions have already been realized in West Virginia. Emissions of NO_X in VISTAS are projected to drop from 3,343,000 tons in 2011 to 1,528,000 tons in 2028, a 54% reduction. Most of these reductions come from the onroad sector, and such reductions are heavily dependent on federal control programs due to the CAA prohibition regarding state regulation of engine controls. The NO_X reductions from the EGU sector are also expected to continue although NO_X from EGUs now make up a much smaller portion of the overall anthropogenic NO_X inventory as compared to inventories from prior to the implementation period. The expected SO_2 and NO_X emission reductions are due to state and federal control programs, the construction and operation of renewable energy sources and very efficient combined cycle generating units, the use of cleaner burning fuels, and other factors.

Figure 7-3 and Figure 7-4 illustrate the 2011 and 2028 emissions for SO_2 and NO_X, respectively, in other areas of the country. These data show significant drops in both pollutants from all other RPOs. For Class I areas that are disproportionately impacted by emissions from states in RPOs other than VISTAS, these reductions will help improve visibility impairment by 2028.

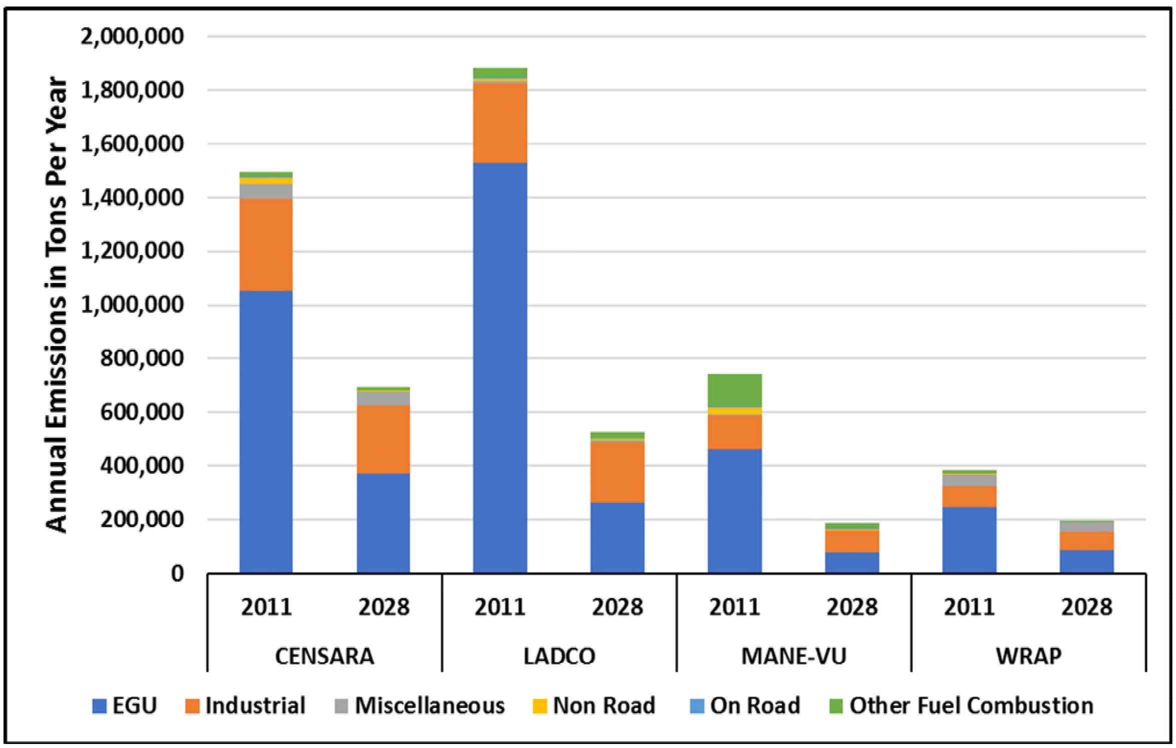

Figure 7-3: SO_2 Emissions for 2011 and 2028 for Other RPOs

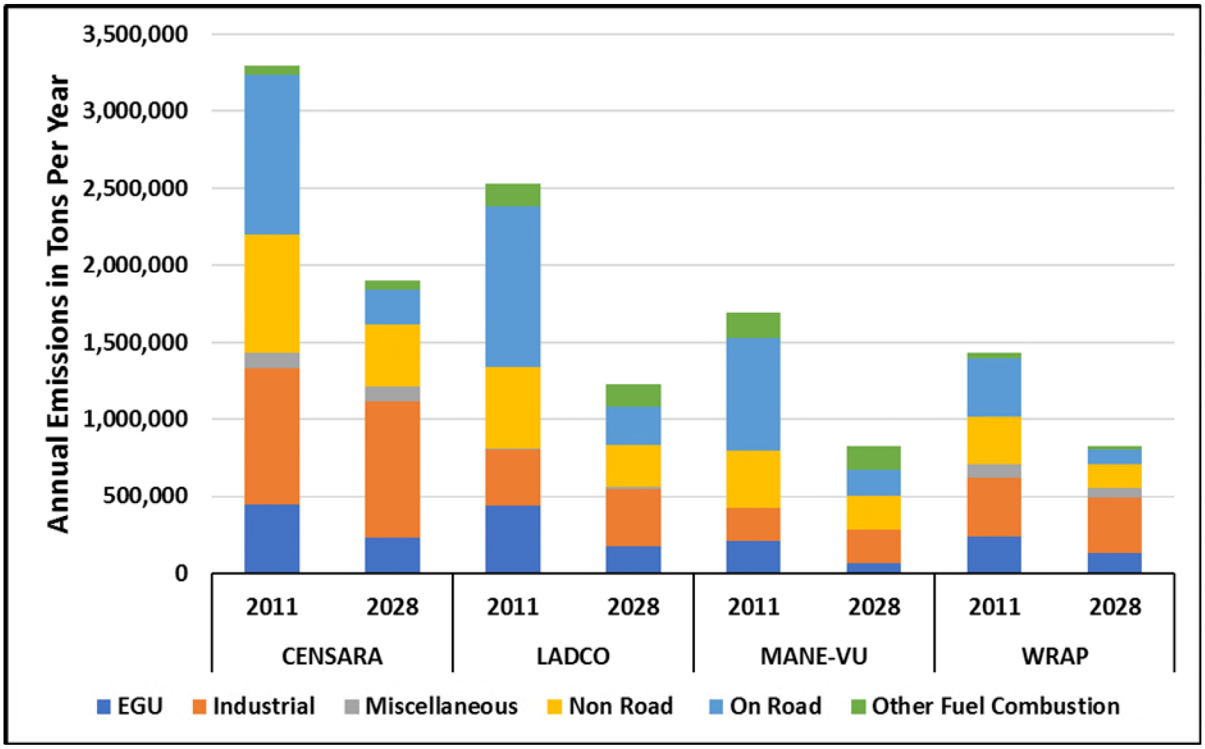

Figure 7-4: NO_X Emissions for 2011 and 2028 for Other RPOs

Table 7-7 summarizes criteria pollutant emissions by state and Tier 1 NEI source sector from the 2011 and 2028 emissions inventories. The complete inventories and discussion of the methodology are contained in Appendix B-2a.

Table 7-7: 2011 and 2028 Criteria Pollutant Emissions, VISTAS States

State	Tier 1 Sector	2011 CO (tpy)	2028 CO (tpy)	2011 NO_X (tpy)	2028 NO_X (tpy)	2011 PM_{10} (tpy)	2028 PM_{10} (tpy)	2011 $PM_{2.5}$ (tpy)	2028 $PM_{2.5}$ (tpy)	2011 SO_2 (tpy)	2028 SO_2 (tpy)	2011 VOC (tpy)	2028 VOC (tpy)
AL	Chemical & Allied Product Mfg	3,123	3,122	2,411	2,409	704	704	650	650	6,559	6,583	1,629	1,576
AL	Fuel Comb. Elec. Util.	9,958	6,748	61,687	18,098	7,323	1,714	4,866	1,190	179,323	7,965	1,152	910
AL	Fuel Comb. Industrial	71,865	73,890	35,447	27,842	46,274	47,304	34,664	39,088	41,322	18,806	3,283	3,413
AL	Fuel Comb. Other	12,104	11,352	4,229	4,100	1,689	1,584	1,654	1,549	417	193	2,038	1,796
AL	Highway Vehicles	701,397	182,602	152,732	30,113	8,001	4,984	4,611	1,322	683	262	75,523	15,013
AL	Metals Processing	10,991	10,759	5,947	5,434	5,359	4,326	4,647	3,844	13,298	13,072	1,843	1,550
AL	Miscellaneous	670,765	666,279	14,735	14,567	445,039	494,515	108,297	113,981	6,746	6,679	159,034	158,720
AL	Off-Highway	261,788	253,400	47,801	25,355	3,584	1,781	3,369	1,653	1,074	193	43,396	22,709
AL	Other Industrial Processes	19,708	18,908	21,546	20,732	17,032	16,269	8,749	8,095	9,569	15,773	14,327	13,927
AL	Petroleum & Related Industries	14,882	9,353	11,226	7,416	373	310	354	292	19,196	3,365	22,103	15,109
AL	Solvent Utilization	124	119	135	120	83	74	61	54	1	1	46,790	46,658
AL	Storage & Transp.	65	65	51	51	870	823	653	604	2	2,767	18,726	12,302
AL	Waste Disposal & Recycling	45,712	45,712	1,876	1,876	7,885	7,885	6,531	6,531	175	175	3,620	3,620
AL	**Subtotals:**	**1,822,482**	**1,282,309**	**359,823**	**158,113**	**544,216**	**582,273**	**179,106**	**178,853**	**278,365**	**75,834**	**393,464**	**297,303**
FL	Chemical & Allied Product Mfg	117	117	1,393	1,279	415	337	348	295	21,948	14,260	1,231	1,230
FL	Fuel Comb. Elec. Util.	36,344	25,254	69,049	26,425	11,621	8,680	9,607	7,973	95,087	24,565	1,931	1,497
FL	Fuel Comb. Industrial	72,200	78,811	31,291	29,867	33,061	38,121	28,979	33,504	15,715	8,477	4,576	3,617
FL	Fuel Comb. Other	25,015	23,851	4,601	4,590	3,498	3,278	3,448	3,248	1,183	303	4,330	3,860
FL	Highway Vehicles	1,784,678	679,511	308,752	72,019	21,329	19,834	9,377	4,412	2,104	823	183,609	51,019
FL	Metals Processing	742	480	80	80	199	192	165	159	337	31	62	49
FL	Miscellaneous	992,515	960,190	22,844	21,346	384,091	466,941	129,258	138,297	10,473	9,727	231,259	228,825
FL	Off-Highway	1,120,490	1,125,776	159,796	94,782	14,009	6,737	13,181	6,231	20,051	2,973	166,582	88,560
FL	Other Industrial Processes	13,065	13,065	8,885	12,313	28,504	28,693	11,836	12,042	4,338	4,315	14,485	14,315
FL	Petroleum & Related Industries	802	828	279	293	92	93	63	64	211	211	2,847	2,252
FL	Solvent Utilization	3	3	2	2	34	33	30	30	<0.5	<0.5	151,477	151,367
FL	Storage & Transport	104	104	154	154	1,177	971	592	528	29	29	101,966	68,391
FL	Waste Disposal & Recycling	27,944	28,108	1,240	2,301	4,151	4,199	3,492	3,534	1,224	1,265	2,707	2,734
FL	**Subtotal:**	**4,074,019**	**2,936,098**	**608,366**	**265,451**	**502,181**	**578,109**	**210,376**	**210,317**	**172,700**	**66,979**	**867,062**	**617,716**

State	Tier 1 Sector	2011 CO (tpy)	2028 CO (tpy)	2011 NO_X (tpy)	2028 NO_X (tpy)	2011 PM_{10} (tpy)	2028 PM_{10} (tpy)	2011 $PM_{2.5}$ (tpy)	2028 $PM_{2.5}$ (tpy)	2011 SO_2 (tpy)	2028 SO_2 (tpy)	2011 VOC (tpy)	2028 VOC (tpy)
GA	Chemical & Allied Product Mfg	502	476	959	931	476	406	408	353	1,580	1,054	2,571	2,399
GA	Fuel Comb. Elec. Util.	13,543	10,611	56,037	25,481	9,061	5,150	6,298	4,242	188,009	18,411	1,195	1,016
GA	Fuel Comb. Industrial	21,837	19,771	22,274	17,788	3,198	2,672	2,752	2,311	21,358	9,769	1,737	1,618
GA	Fuel Comb. Other	20,021	19,536	11,233	10,857	2,204	1,998	2,152	1,950	4,660	4,187	3,056	2,730
GA	Highway Vehicles	1,018,645	305,264	223,223	48,973	12,518	8,914	6,829	2,289	1,088	443	109,005	25,629
GA	Metals Processing	344	344	149	149	156	156	82	82	92	92	57	57
GA	Miscellaneous	1,022,524	984,133	40,646	39,003	858,861	998,804	220,258	232,719	11,424	10,688	78,048	75,220
GA	Off-Highway	471,960	477,533	74,217	40,838	5,923	2,974	5,594	2,769	2,562	967	60,843	36,837
GA	Other Industrial Processes	24,548	17,280	15,893	13,130	47,506	45,021	17,925	15,808	3,705	2,268	22,763	20,583
GA	Petroleum & Related Industries	6	6	none reported	none reported	23	22	11	13	none reported	none reported	132	131
GA	Solvent Utilization	25	24	30	28	31	31	30	30	<0.5	<0.5	84,352	83,997
GA	Storage & Transport	49	49	21	21	1,015	1,014	511	502	none reported	none reported	33,985	23,439
GA	Waste Disposal & Recycling	227,703	227,696	7,636	7,628	26,852	26,851	26,222	26,221	223	222	17,363	17,361
GA	**Subtotals:**	**2,821,707**	**2,062,723**	**452,318**	**204,827**	**967,824**	**1,094,013**	**289,072**	**289,289**	**234,701**	**48,101**	**415,107**	**291,017**
KY	Chemical & Allied Product Mfg	62	62	241	241	817	816	708	708	1,663	393	2,202	2,189
KY	Fuel Comb. Elec. Util.	15,547	12,253	92,756	33,258	13,874	7,409	9,495	5,781	247,556	49,728	1,749	1,067
KY	Fuel Comb. Industrial	10,848	10,870	20,009	17,876	2,247	2,505	1,981	2,214	5,774	4,819	1,422	1,031
KY	Fuel Comb. Other	48,175	43,582	5,765	5,477	6,891	6,158	6,781	6,072	1,868	1,166	8,390	7,183
KY	Highway Vehicles	498,702	157,636	115,685	27,819	5,480	3,448	3,345	1,015	502	209	50,326	12,938
KY	Metals Processing	61,446	61,446	1,611	1,611	4,151	4,111	3,402	3,383	6,021	3,200	2,081	2,081
KY	Miscellaneous	190,510	180,432	3,486	3,034	204,775	230,661	44,517	47,310	1,742	1,528	43,514	42,725
KY	Off-Highway	201,625	193,150	56,646	29,793	3,573	1,557	3,392	1,464	641	402	31,999	17,094
KY	Other Industrial Processes	4,985	4,992	5,682	5,662	26,177	25,483	9,042	8,737	6,468	6,465	31,759	31,489
KY	Petroleum & Related Industries	31,312	67,128	24,707	47,426	683	2,795	633	2,745	522	1,561	31,085	44,846
KY	Solvent Utilization	3	3	5	5	83	81	73	72	<0.5	<0.5	44,118	44,031
KY	Storage & Transport	23	23	6	6	2,005	1,804	484	427	3	3	22,606	16,169
KY	Waste Disposal & Recycling	25,288	25,288	1,156	1,156	5,335	5,330	4,532	4,527	161	161	2,352	2,352
KY	**Subtotals:**	**1,088,526**	**756,865**	**327,755**	**173,364**	**276,091**	**292,158**	**88,385**	**84,455**	**272,921**	**69,635**	**273,603**	**225,195**

State	Tier 1 Sector	2011 CO (tpy)	2028 CO (tpy)	2011 NO_X (tpy)	2028 NO_X (tpy)	2011 PM_{10} (tpy)	2028 PM_{10} (tpy)	2011 $PM_{2.5}$ (tpy)	2028 $PM_{2.5}$ (tpy)	2011 SO_2 (tpy)	2028 SO_2 (tpy)	2011 VOC (tpy)	2028 VOC (tpy)
MS	Chemical & Allied Product Mfg	7,477	7,454	1,864	1,841	487	481	430	428	1,377	49	1,317	1,316
MS	Fuel Comb. Elec. Util.	6,154	4,172	26,602	12,229	2,084	1,457	1,627	1,120	43,259	3,237	487	416
MS	Fuel Comb. Industrial	14,794	16,135	32,381	27,363	3,448	3,458	2,935	2,820	6,397	1,631	3,428	3,253
MS	Fuel Comb. Other	7,450	7,009	2,885	2,848	1,029	967	997	935	50	50	1,200	1,056
MS	Highway Vehicles	433,332	117,589	91,026	17,788	4,491	3,100	2,538	814	405	165	46,084	9,317
MS	Metals Processing	1,313	2,021	381	1,446	549	371	546	364	124	1,366	127	156
MS	Miscellaneous	372,960	325,044	9,080	6,803	996,316	1,211,587	142,022	160,523	4,248	3,165	81,272	77,346
MS	Off-Highway	153,473	143,429	33,132	16,707	2,493	1,074	2,353	999	1,029	143	29,662	14,770
MS	Other Industrial Processes	5,127	5,046	3,204	2,591	8,129	7,605	5,372	4,901	678	652	10,915	10,632
MS	Petroleum & Related Industries	4,592	5,412	3,641	4,105	257	322	200	270	6,240	1,407	28,840	24,313
MS	Solvent Utilization	31	30	39	37	115	113	105	104	<0.5	<0.5	38,358	37,486
MS	Storage & Transport	368	368	71	71	109	103	70	66	42	42	29,068	20,947
MS	Waste Disposal & Recycling	42,760	42,760	1,591	1,591	6,657	6,657	5,392	5,392	91	91	3,780	3,843
MS	**Subtotals:**	**1,049,831**	**676,469**	**205,897**	**95,420**	**1,026,164**	**1,237,295**	**164,587**	**178,736**	**63,940**	**11,998**	**274,538**	**204,851**
NC	Chemical & Allied Product Mfg	7,188	693	1,286	879	738	1,184	472	462	5,507	5,056	2,756	3,712
NC	Fuel Comb. Elec. Util.	32,828	10,563	43,911	21,401	8,790	3,190	6,921	2,867	83,925	8,976	934	1,095
NC	Fuel Comb. Industrial	16,197	14,319	24,394	16,775	3,828	2,910	2,899	2,430	12,354	5,139	1,500	1,172
NC	Fuel Comb. Other	29,163	28,846	9,652	9,791	4,724	4,604	4,323	4,246	7,757	5,970	4,611	4,302
NC	Highway Vehicles	1,145,623	252,167	204,008	30,968	10,447	6,512	5,510	1,646	1,082	311	112,173	21,709
NC	Metals Processing	2,675	2,122	324	454	355	547	308	471	556	433	1,493	1,005
NC	Miscellaneous	101,890	86,087	4,047	3,500	195,376	221,483	45,672	49,500	1,068	956	7,851	6,672
NC	Off-Highway	479,335	471,127	68,433	39,379	5,742	2,994	5,435	2,798	2,472	1,055	63,283	37,520
NC	Other Industrial Processes	5,731	11,412	10,261	12,529	14,515	18,192	6,970	8,780	3,279	4,105	15,218	20,374
NC	Petroleum & Related Industries	773	1,007	263	305	249	295	160	263	432	412	306	354
NC	Solvent Utilization	53	79	72	103	145	177	121	165	31	8	95,419	110,199
NC	Storage & Transport	2,174	278	125	128	590	654	306	412	7	11	24,731	15,117
NC	Waste Disposal & Recycling	66,928	67,028	2,720	2,772	11,151	11,153	9,386	9,420	251	213	5,613	5,800
NC	**Subtotals:**	**1,890,558**	**945,728**	**369,496**	**138,984**	**256,650**	**273,895**	**88,483**	**83,460**	**118,721**	**32,645**	**335,888**	**229,031**

State	Tier 1 Sector	2011 CO (tpy)	2028 CO (tpy)	2011 NO_X (tpy)	2028 NO_X (tpy)	2011 PM_{10} (tpy)	2028 PM_{10} (tpy)	2011 $PM_{2.5}$ (tpy)	2028 $PM_{2.5}$ (tpy)	2011 SO_2 (tpy)	2028 SO_2 (tpy)	2011 VOC (tpy)	2028 VOC (tpy)
SC	Chemical & Allied Product Mfg	1,217	1,217	165	165	132	131	77	76	9	4	2,110	1,843
SC	Fuel Comb. Elec. Util.	16,809	13,527	26,752	10,993	10,851	3,290	8,604	2,672	71,899	10,762	607	573
SC	Fuel Comb. Industrial	19,560	21,191	17,924	17,505	10,314	11,286	8,273	9,498	15,748	9,386	1,103	1,117
SC	Fuel Comb. Other	12,508	11,800	3,283	3,351	1,701	1,580	1,660	1,546	339	309	2,128	1,867
SC	Highway Vehicles	475,876	155,913	109,374	23,263	6,618	4,504	3,766	1,152	504	215	51,164	12,546
SC	Metals Processing	53,733	53,811	780	861	572	581	480	489	5,139	5,182	457	457
SC	Miscellaneous	214,147	200,969	4,602	4,033	280,281	341,123	51,363	56,686	1,978	1,902	48,908	47,771
SC	Off-Highway	240,507	233,340	35,569	19,154	3,036	1,477	2,856	1,369	2,268	360	35,104	19,097
SC	Other Industrial Processes	17,912	17,827	10,251	11,697	7,581	7,311	4,149	3,897	5,223	5,724	15,036	14,754
SC	Petroleum & Related Industries	none reported	none reported	none reported	none reported	none reported	none reported	none reported	none reported	none reported	none reported	31	29
SC	Solvent Utilization	7	7	1	1	14	14	13	12	<0.5	<0.5	41,039	39,341
SC	Storage & Transport	39	39	26	26	346	282	139	119	1	1	30,397	21,258
SC	Waste Disposal & Recycling	48,668	48,667	1,817	1,806	7,055	7,042	5,746	5,735	140	139	4,073	4,059
SC	**Subtotals:**	**1,100,983**	**758,308**	**210,544**	**92,855**	**328,501**	**378,621**	**87,126**	**83,251**	**103,248**	**33,984**	**232,157**	**164,712**
TN	Chemical & Allied Product Mfg	14,866	14,862	811	804	755	755	426	426	492	489	4,412	4,397
TN	Fuel Comb. Elec. Util.	5,529	3,771	27,156	8,006	5,191	2,618	4,172	2,444	120,170	10,059	769	585
TN	Fuel Comb. Industrial	18,910	22,671	27,988	25,234	10,632	12,293	9,018	10,691	27,778	8,076	1,129	1,239
TN	Fuel Comb. Other	25,945	23,479	9,207	8,441	3,470	3,044	3,182	2,928	5,441	779	5,168	4,906
TN	Highway Vehicles	739,041	233,423	182,796	44,927	9,927	6,734	5,778	1,811	769	338	80,463	20,483
TN	Metals Processing	5,066	5,066	611	611	1,492	1,492	1,251	1,251	572	681	2,923	2,923
TN	Miscellaneous	133,301	124,792	2,840	2,450	150,164	165,066	36,986	39,404	1,347	1,162	31,052	30,344
TN	Off-Highway	309,062	298,569	60,384	33,596	4,242	2,032	4,010	1,898	767	625	46,292	25,501
TN	Other Industrial Processes	5,668	6,244	7,449	8,189	11,527	11,224	6,034	5,779	2,550	1,468	15,672	14,828
TN	Petroleum & Related Industries	2,706	4,956	1,812	3,193	189	307	160	278	243	149	3,559	3,517
TN	Solvent Utilization	72	72	84	84	328	328	288	288	15	15	67,091	67,091
TN	Storage & Transport	56	56	37	29	520	393	238	184	5	4	29,921	19,812
TN	Waste Disposal & Recycling	26,959	26,959	1,392	1,392	5,710	5,710	4,813	4,813	174	137	2,549	2,839
TN	**Subtotals:**	**1,287,181**	**764,920**	**322,567**	**136,956**	**204,147**	**211,996**	**76,356**	**72,195**	**160,323**	**23,982**	**291,000**	**198,465**

State	Tier 1 Sector	2011 CO (tpy)	2028 CO (tpy)	2011 NO_X (tpy)	2028 NO_X (tpy)	2011 PM_{10} (tpy)	2028 PM_{10} (tpy)	2011 $PM_{2.5}$ (tpy)	2028 $PM_{2.5}$ (tpy)	2011 SO_2 (tpy)	2028 SO_2 (tpy)	2011 VOC (tpy)	2028 VOC (tpy)
VA	Chemical & Allied Product Mfg	83	83	7,707	1,734	169	169	73	73	203	203	486	485
VA	Fuel Comb. Elec. Util.	4,984	6,232	30,213	10,677	5,794	3,858	1,157	1,456	69,077	1,903	742	448
VA	Fuel Comb. Industrial	13,713	11,294	22,048	13,962	5,883	5,071	4,817	4,376	14,349	5,776	950	871
VA	Fuel Comb. Other	77,919	74,900	11,470	11,034	11,302	10,748	11,002	10,507	4,884	3,264	12,940	11,877
VA	Highway Vehicles	566,315	232,611	145,507	35,427	7,106	4,302	4,368	1,309	711	279	63,152	18,550
VA	Metals Processing	3,016	3,016	812	812	859	858	724	723	5,196	5,196	270	270
VA	Miscellaneous	167,730	164,877	3,186	3,077	141,777	156,214	33,384	36,128	1,487	1,439	39,308	39,107
VA	Off-Highway	383,506	391,290	67,844	37,836	5,029	2,576	4,747	2,398	3,355	892	48,417	30,266
VA	Other Industrial Processes	5,644	7,256	12,766	10,337	12,394	12,839	5,001	5,400	7,028	5,294	6,937	7,107
VA	Petroleum & Related Industries	12,445	12,993	9,618	9,748	406	541	284	424	59	65	8,525	12,152
VA	Solvent Utilization	<0.5	0	<0.5	0	66	68	61	63	<0.5	<0.5	85,760	93,969
VA	Storage & Transport	5	6	2	2	351	353	286	301	<0.5	<0.5	23,556	16,224
VA	Waste Disposal & Recycling	33,103	33,192	2,283	2,305	5,745	5,758	4,925	4,932	1,469	1,483	4,317	4,380
VA	**Subtotals:**	**1,268,463**	**937,750**	**313,456**	**136,951**	**196,881**	**203,355**	**70,829**	**68,090**	**107,818**	**25,794**	**295,360**	**235,706**
WV	Chemical & Allied Product Mfg	247	249	402	278	330	296	246	229	145	106	2,000	1,036
WV	Fuel Comb. Elec. Util.	10,106	8,663	54,289	49,885	11,066	6,822	9,100	5,462	93,080	47,746	1,011	1,162
WV	Fuel Comb. Industrial	4,424	3,896	16,592	10,820	1,977	1,291	1,086	492	16,306	6,241	540	581
WV	Fuel Comb. Other	19,471	18,115	8,661	6,695	2,893	2,751	2,803	2,671	760	677	4,059	3,472
WV	Highway Vehicles	185,437	55,258	41,840	10,124	2,101	1,273	1,269	375	179	72	20,493	5,208
WV	Metals Processing	24,179	24,088	1,806	1,839	1,468	1,362	1,046	973	2,069	1,956	520	499
WV	Miscellaneous	86,791	86,171	1,296	1,277	76,122	76,051	15,876	15,810	684	677	20,396	20,356
WV	Off-Highway	89,194	89,372	22,397	11,934	1,428	696	1,341	649	204	35	15,934	8,932
WV	Other Industrial Processes	2,726	2,616	2,464	1,941	21,016	20,439	3,655	3,664	1,983	1,350	1,283	1,443
WV	Petroleum & Related Industries	27,645	42,008	22,041	29,242	692	1,514	594	1,511	6,144	191	47,734	130,121
WV	Solvent Utilization	<0.5	<0.5	<0.5	none reported	13	2	13	2	<0.5	none reported	14,315	13,610
WV	Storage & Transp.	2	2	4	21	465	220	182	74	<0.5	<0.5	8,621	5,687
WV	Waste Disposal & Recycling	31,785	31,786	1,152	1,152	4,840	4,840	3,981	3,981	63	63	2,622	2,606
WV	**Subtotals:**	**482,007**	**362,224**	**172,944**	**125,208**	**124,411**	**117,557**	**41,192**	**35,893**	**121,617**	**59,114**	**139,528**	**194,713**
VISTAS	**Totals:**	**16,885,757**	**11,483,394**	**3,343,166**	**1,528,129**	**4,427,066**	**4,969,272**	**1,295,512**	**1,284,539**	**1,634,354**	**448,066**	**3,517,707**	**2,658,709**

7.2.4. EPA Inventories

The EPA created a 2016 base year emissions inventory for modeling purposes in a collaborative effort with states and RPOs. The 2016 emissions inventory data for the point source and EGU sectors originated with state submissions to the EIS and, for those units subject to 40 CFR Part 75 monitoring requirements, unit level reporting to CAMD. Other source sector data were estimated by the EPA, through emissions inventory tools, or estimates based upon state supplied input. This data set includes a full suite of 2016 base year inventories and projection year data for 2023 and 2028.[51] The 2023 and 2028 projections from 2016 relied upon IPM for estimates of EGU activity and emissions. The EPA has provided emission summaries of this information at state and SCC levels for both the 2016 base year and EPA's previous 2014 base year. The EPA used the 2014 NEI data to create the 2014 base year data set. Point source and EGU sector information for the 2014 NEI originated with state submissions or from unit level reporting to CAMD. Other sectors in the 2014 NEI were created by the EPA based on tool inputs supplied by state staff, contractor estimates, and additional sources. Evaluation of these data sets show trends that are similar to those in the VISTAS emissions inventory.

The EPA has also prepared and published the 2017 NEI[52] based on point source and EGU sector data that originated with state EIS submissions or unit level reporting to CAMD. The EPA developed other emissions sectors of the 2017 NEI using state-supplied input files for emission estimation tools, contractor estimates, and additional sources of data. These data represent the January 2021 version of this database, which includes all sectors and pollutants for emissions across the United States.

Figure 7-5 provides the estimated actual SO_2 emissions within the EPA inventories for 2014, 2016, and 2017 by Tier 1 category within the ten VISTAS states; the emissions inventories for years 2023 and 2028, projected from the base year 2016 data by the EPA; and the 2011 and 2028 VISTAS inventories used in the RPG modeling. The 2011 and 2014 data show that SO_2 emissions were predominantly emitted from electric utility fuel combustion and industrial fuel combustion within the VISTAS region. Significant SO_2 reductions occurred by 2016, and additional reductions occurred in 2017. These SO_2 reductions are most pronounced in the electric utility fuel combustion category. The EPA's 2023 and 2028 data forecast continued declines in SO_2 emissions from this category. The VISTAS 2028 data also project additional SO_2 emission reductions across the VISTAS states although these projections are higher than the EPA 2028 projections.

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[51] URL: https://www.epa.gov/air-emissions-modeling/2016v1-platform

[52] URL: https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data

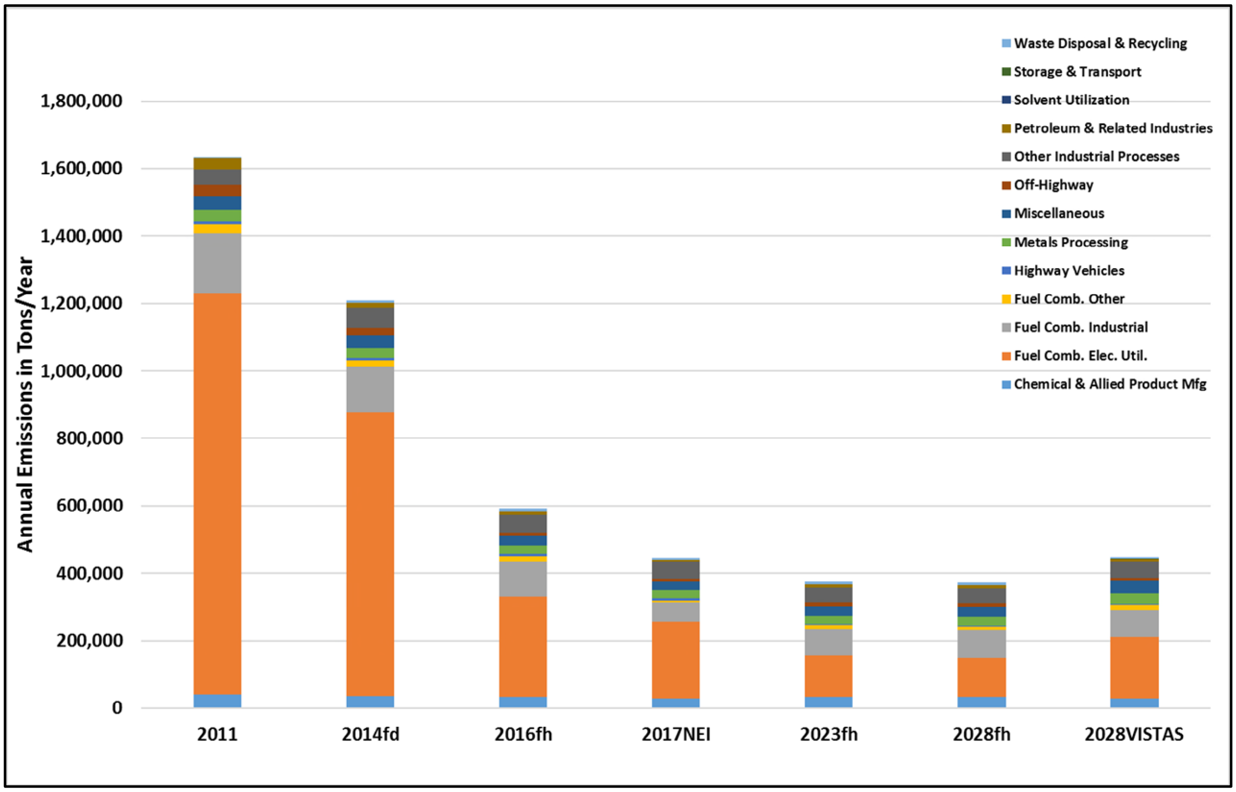


Figure 7-5: SO_2 Emissions from VISTAS States

Figure 7-6 provides the estimated actual NO_X emissions within the EPA inventories for 2014, 2016, and 2017 by Tier 1 category within the ten VISTAS states; the emissions inventories for years 2023 and 2028, projected from the base year 2016 data by the EPA; and the 2011 and 2028 VISTAS inventories used in the RPG modeling. The 2011, 2014, and 2016 data show that NO_X emissions were predominantly emitted from onroad and off-highway source sectors. Significant reductions in NO_X occurred by 2016 as compared to 2011. During this period reductions in emissions from onroad and off-highway source sectors as well as the electrical utility fuel combustion sector contributed to this drop. The EPA's 2023 and 2028 projections forecast continued declines in NO_X emissions, most notably from the onroad and off-highway source sectors. The VISTAS 2028 data also project additional NO_X emission reductions across the VISTAS states although the estimated reductions are not as great as those from the EPA.

The VISTAS 2028 data is higher than the EPA 2028 projections largely due to differences in projection methodologies for EGUs and some non-EGUs. For example, the EPA relied upon IPM results that generally have lower SO_2 and NO_X emissions than ERTAC results. The IPM tool may retire, or idle coal-fired EGUs, and certain coal-fired industrial boilers that occasionally provide electricity to the grid due to economic assumptions within the model. ERTAC projections do not use economic decisions to forecast retirements or idling of units in future years. Rather, states provide estimated retirement dates based on information provided by the facility owners, consent decrees, permits, or other types of documentation. The ERTAC projections, therefore, tend to be more conservative.

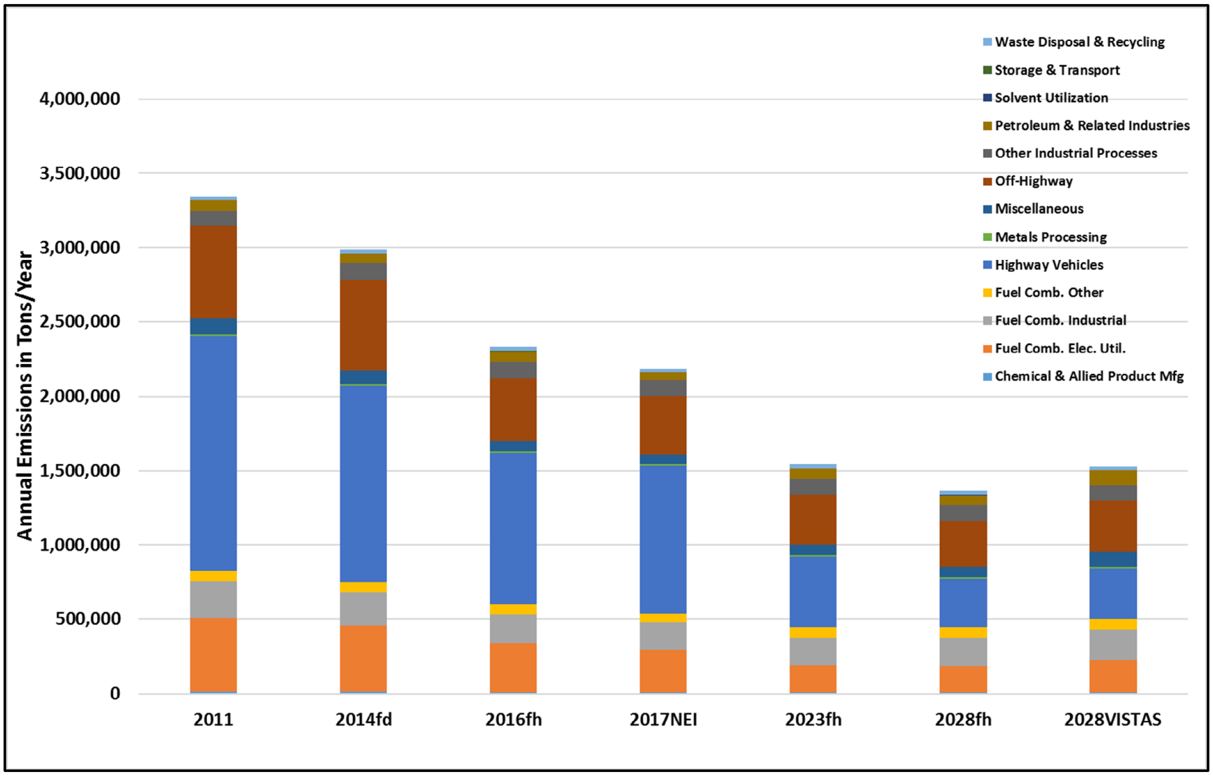


Figure 7-6: NO_X Emissions from VISTAS States

The data for West Virginia in the EPA inventories also forecast significant declines in both SO_2 and NO_X emissions. Figure 7-7 provides the EPA's estimates of West Virginia's actual SO_2 emissions from 2011, 2014, 2016, and 2017 as well as EPA's projected values for 2023 and 2028 and the VISTAS projected value for 2028. The EPA estimated just over 120,000 tons per year of SO_2 emissions from West Virginia in 2011. The EPA expects that SO_2 emissions in West Virginia will drop to just under 50,000 tons per year by 2028, a near 60% reduction. The VISTAS projection for West Virginia shows that emissions of SO_2 should drop to less than 60,000 tons per year by 2028, a more than 50% reduction.

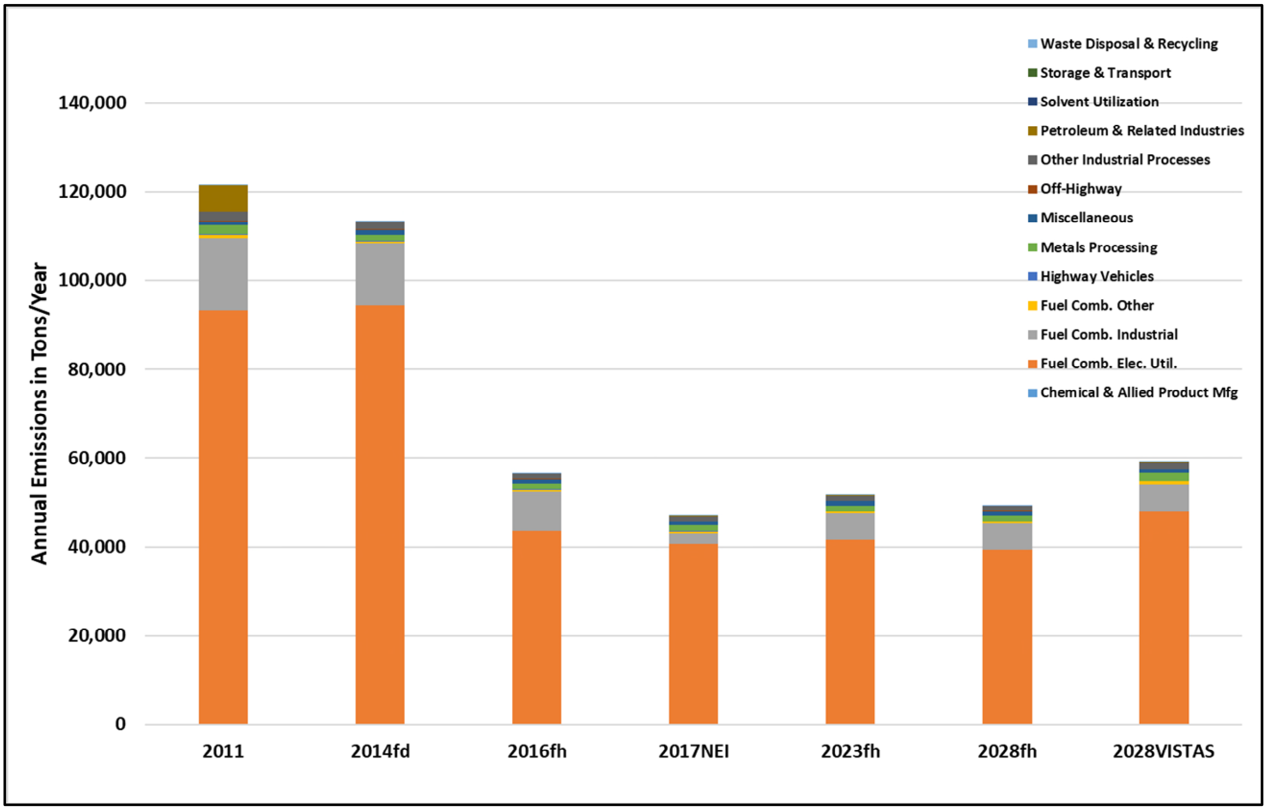


Figure 7-7: West Virginia SO_2 Emissions

Figure 7-8 provides the EPA's estimates of actual NO_X emissions in West Virginia from 2011, 2014, 2016, and 2017. The figure also shows EPA's projected values for 2023 and 2028, using 2016 as the base year, and the VISTAS projections for 2028. The EPA estimated nearly 173,000 tons of NO_X emissions from West Virginia in 2011. The EPA expects that NO_X emissions in West Virginia will drop to just over 120,000 tons per year by 2028, a more than 30% reduction. The VISTAS projections estimate that West Virginia NO_X emissions will drop to just over 125,000 tons per year by 2028, a nearly 28% reduction.

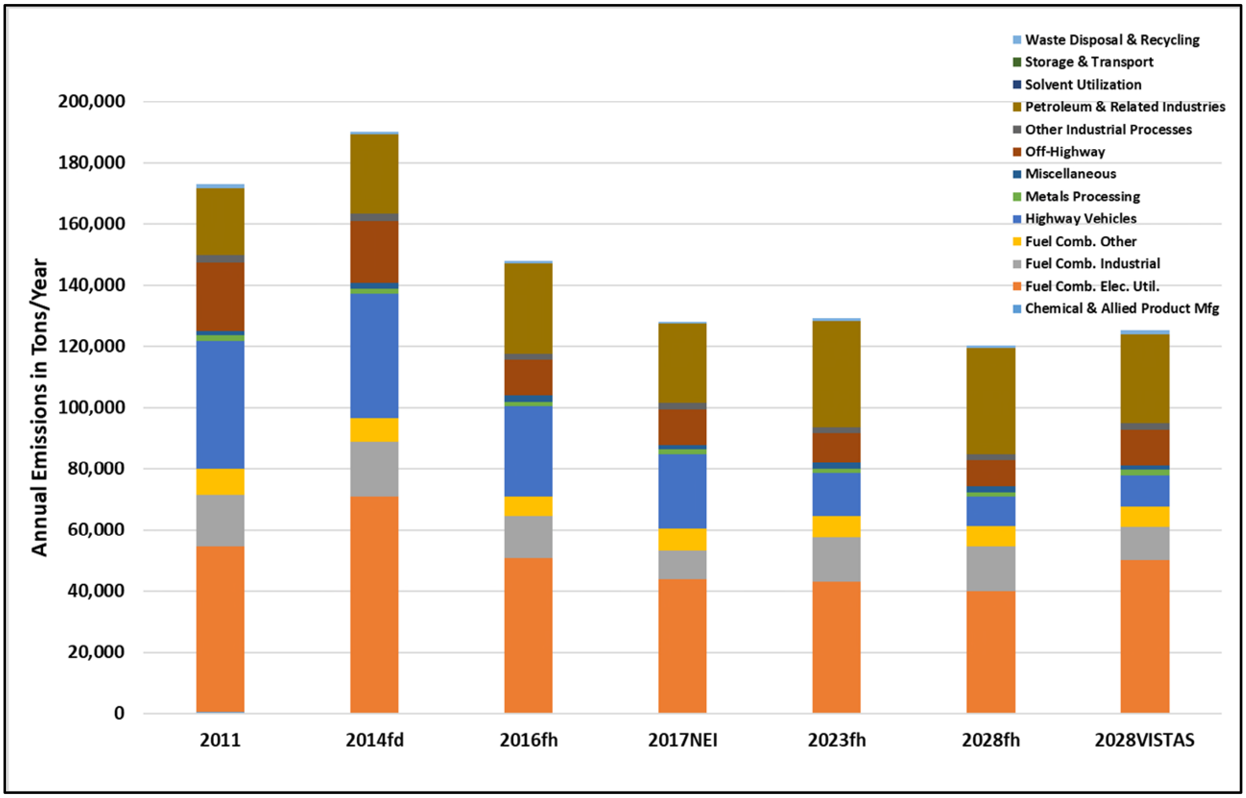


Figure 7-8: West Virginia NO_X Emissions

The VISTAS 2028 projections do not include reductions from programs noted in Section 8.2 so that the estimates are likely conservative and actual 2028 emissions of SO_2 and NO_X should be lower than those noted.

7.2.5. VISTAS 2028 Model Projections

The VISTAS states used emissions modeling, as described in Section 5 and Section 6, to project visibility in 2028 using a 2028 emissions inventory as described in Section 4. The EPA Software for Model Attainment Test – Community Edition (SMAT-CE) tool was used to calculate 2028 deciview values on the 20% most impaired and 20% clearest days at each Class I area IMPROVE monitoring site. SMAT-CE[53] is an EPA software tool that implements the procedures in the "Modeling Guidance for Demonstrating Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze," (SIP modeling guidance)[54] to project visibility in the future year. The SMAT-CE tool outputs individual year and five-year average base year and future year deciview values on the 20% most impaired days and the 20% clearest days.

53 URL: https://www.epa.gov/scram/photochemical-modeling-tools

54 URL: https://www.epa.gov/sites/production/files/2020-10/documents/o3-pm-rh-modeling_guidance-2018.pdf

7.2.5.1. Calculation of 2028 Visibility Estimates

The visibility projections follow the procedures in Section 5 of the SIP modeling guidance. Based on recommendations in the SIP modeling guidance, the observed base period visibility data is linked to the modeling base period. In this case, for a base modeling year of 2011, the 2009-2013 IMPROVE data for the 20% most impaired days and 20% clearest days were used as the basis for the 2028 projections. Section 2.5 discusses the IMPROVE monitoring data during the modeling base period of 2009-2013.

The visibility calculations use the IMPROVE equation discussed in Section 2.1. As noted in Section 2.1, the IMPROVE algorithm uses PM species concentrations and relative humidity data to calculate visibility impairment as extinction (b_{ext}) in units of inverse megameters.

The 2028 future year visibility on the 20% most impaired days and the 20% clearest days at each Class I area is estimated by using the observed IMPROVE data from years 2009-2013 and the relative percent modeled change in PM species between 2011 and 2028. The following steps describe the process. The SIP modeling guidance contains more detailed description and examples.

- Step 1 - For each Class I area (i.e., IMPROVE site), estimate anthropogenic impairment (Mm^{-1}) on each day using observed speciated $PM_{2.5}$ data plus PM_{10} data (and other information) for each of the five years comprising the modeling base period (2009-2013) and rank the days on this indicator.[55] This ranking will determine the 20% most impaired days. For each Class I area, also rank observed visibility (in deciviews) on each day using observed speciated $PM_{2.5}$ data plus PM_{10} data for each of the five years comprising the modeling base period. This ranking will determine the 20% clearest days.

- Step 2 - For each of the five years comprising the base period, calculate the mean deciviews for the 20% most impaired days and the 20% clearest days. For each Class I area, calculate the five-year mean deciviews for the 20% most impaired and the 20% clearest days from the five year-specific values.

- Step 3 - Use an air quality model to simulate air quality with base period (2011) emissions and future year (2028) emissions. Use the resulting information to develop monitor site-specific relative response factors (RRFs) for each component of PM identified in the "revised" IMPROVE equation. The RRFs are an average percent change in species concentrations based on the measured 20% most impaired days and 20%

[55] EPA, "Technical Guidance on Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program", December 2018. URL: https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf

clearest days from 2011 to 2028. The calendar days from 2011 identified from the IMPROVE data above are matched by day to the modeled days. RRFs are calculated separately for sulfate, nitrate, organic carbon mass, elemental carbon, fine soil mass, and coarse mass. The observed sea salt is primarily from natural sources that are not expected to be year-sensitive, and the modeled sea salt is uncertain. Therefore, the sea salt RRF for all monitor sites is assumed to be 1.0.

- Step 4 – For each monitor site, multiply the species-specific RRFs by the measured daily species concentration data during the 2009-2013 base period for each day in the measured 20% most impaired day data set and each day in the 20% clearest day data set. This results in daily future year 2028 PM species concentration data.

- Step 5 - Using the results in Step 4 and the IMPROVE algorithm described in Section 2.1, calculate the future daily extinction coefficients for the previously identified 20% most impaired days and 20% clearest days in each of the five base years.

- Step 6 - Calculate daily deciview values (from total daily extinction) and then compute the future year (2028) average mean deciviews for the 20% most impaired days and 20% clearest days for each year. Average the five years together to get the final future mean deciview values for the 20% most impaired days and 20% clearest days.

In cases where an IMPROVE monitor is located within a Class I area, the five-year average modeling base period visibility is used with modeled concentrations from the grid cell containing the IMPROVE monitor to calculate future year RRFs and visibility results. In cases within VISTAS states where an IMPROVE monitor is not located within a Class I Area, surrogate IMPROVE monitors are assigned to establish modeling base period visibility values. See Section 2.2 for a description and listing of these sites. When using a surrogate IMPROVE monitor site, the five-year average modeling base period visibility from the surrogate location is used with modeled concentrations from the actual modeled grid cell at the centroid of the Class I area to calculate future year RRFs and visibility results. In Class I areas outside of the VISTAS states, surrogate monitor modeling base period data and RRFs are used to project future year visibility.

7.2.5.2. 2028 Visibility Projection Results

Table 7-8 provides the 2028 visibility projections for VISTAS Class I areas and nearby Class I areas. More information on these projections may be found in Appendix E-6.

Table 7-8: 2028 Visibility Projections for VISTAS and Nearby Class I Areas

Class I Area	Site ID	State	2028 20% Clearest Days (dv)	2028 20% Clearest Days (Mm^{-1})	2028 20% Most Impaired Days (dv)	2028 20% Most Impaired Days (Mm^{-1})
Cape Romain Wilderness Area	ROMA1	SC	12.11	33.87	16.64	53.81
Chassahowitzka Wilderness Area	CHAS1	FL	12.54	35.28	16.79	54.50
Cohutta Wilderness Area	COHU1	GA	9.15	25.51	14.90	45.63
Dolly Sods Wilderness Area	DOSO1	WV	7.55	21.79	15.29	47.82
Everglades National Park	EVER1	FL	10.64	29.13	15.52	47.87
Great Smoky Mountains National Park	GRSM1	TN	8.96	25.02	15.03	46.08
James River Face Wilderness Area	JARI1	VA	9.80	27.13	15.87	50.46
Joyce Kilmer-Slickrock Wilderness Area	GRSM1	TN	8.97	25.02	14.88	45.36
Linville Gorge Wilderness Area	LIGO1	NC	8.21	23.06	14.25	42.61
Mammoth Cave National Park	MACA1	KY	11.66	32.50	19.27	70.87
Okefenokee Wilderness Area	OKEF1	GA	11.58	32.14	16.90	55.59
Otter Creek Wilderness Area	DOSO1	WV	7.55	21.80	15.26	47.66
Shenandoah National Park	SHEN1	VA	7.27	21.20	14.47	44.02
Shining Rock Wilderness Area	SHRO1	NC	4.54	15.74	13.31	37.86
Sipsey Wilderness Area	SIPS1	AL	11.11	30.75	16.62	54.13
St. Marks Wilderness Area	SAMA1	FL	11.59	32.18	16.43	53.05
Swanquarter Wilderness Area	SWAN1	NC	10.77	29.61	15.27	47.42
Wolf Island Wilderness Area	OKEF1	GA	11.55	32.05	16.75	54.71
Breton Wilderness	BRIS1	LA	12.13	34.21	18.39	65.06
Brigantine Wilderness Area	BRIG1	NJ	11.07	30.54	18.40	65.20
Caney Creek Wilderness Area	CACR1	AR	8.79	24.75	18.32	64.25
Hercules Glade Wilderness Area	HEGL1	MO	9.75	26.88	18.80	67.92
Mingo Wilderness Area	MING1	MO	11.14	30.87	19.69	74.03
Upper Buffalo Wilderness Area	UPBU1	AR	8.93	25.07	17.82	60.73

7.2.6. Model Results for the VISTAS 2028 Inventory Compared to the URP Glide Paths for West Virginia Class I Areas

Using 2000 through 2004 IMPROVE monitoring data, the dv values for the 20% clearest days in each year were averaged together, producing a single average dv value for the clearest days during that period. Similarly, the dv values for the 20% most impaired days in each year were averaged together, producing a single average dv value for the days with the most anthropogenic visibility impairment during that period. These values form the base line for visibility at each Class I area and are used to gauge improvements. In this second round of visibility implementation, 2011 represents the base year for air quality modeling projections. To develop an average 2011 impairment suitable for use in air quality projections, 2009 through 2013 IMPROVE monitoring data were used. The dv values for the 20% clearest days in each year are averaged together to produce a single average dv value for the clearest days. The 20% most impaired days were also averaged from this timeframe to produce a single value for the 20% most impaired days.

Figure 7-9 illustrates the predicted visibility improvement on the 20% most impaired days by 2028, compared to the URP glide paths for Dolly Sods; Otter Creek and Dolly Sods share an IMPROVE monitor and thus this figure applies to both wilderness areas. The pink line represents the Class I area's URP. The URP starts at the 2000-2004 average of the 20% most impaired days and ends in 2064 at the area's estimated natural condition value. This line shows a uniform, linear progression between the 2000-2004 baseline and the target natural condition in 2064. The model projections shown in blue triangles start at 2011 (the observed 2009-2013 average of the visibility on the 20% most impaired days) and end at the 2028 projected visibility values for the 20% most impaired days based on existing and planned emissions controls during the period of the long-term strategy associated with this round of implementation. The blue diamonds represent the Class I area's IMPROVE monitoring data on the 20% most impaired days and the brown line denotes the five-year rolling average of each set of IMPROVE monitoring data.

At both Dolly Sods and Otter Creek Wilderness Areas, visibility improvements on the 20% most impaired days are expected to be significantly better than the uniform rate of progress glide path by 2028.

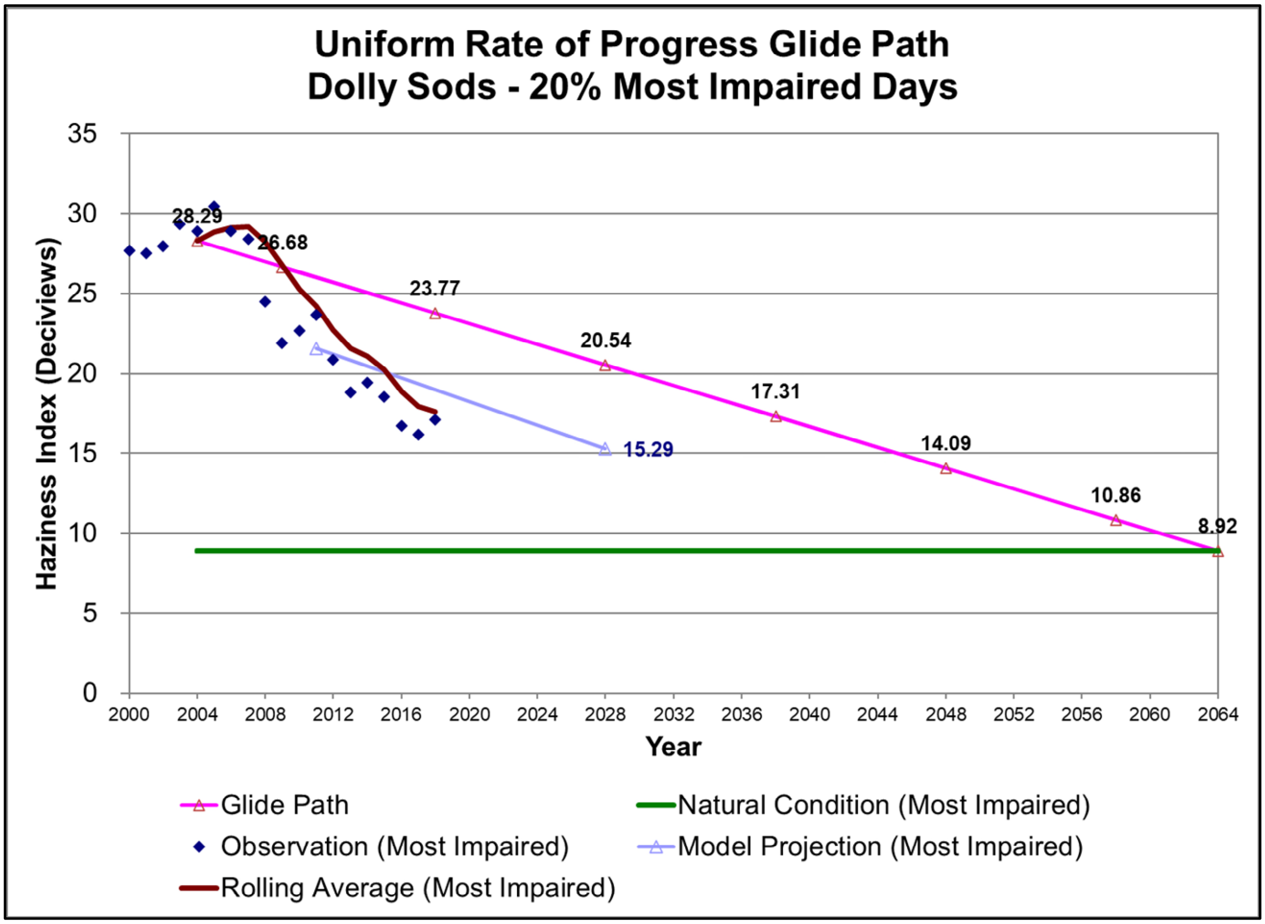


Figure 7-9: Dolly Sods URP on the 20% Most Impaired Days

As illustrated in Figure 7-10, visibility improvements at all the VISTAS Class I areas except the Everglades are projected to be better than the uniform rate of progress. In Figure 7-10, the percentage displayed represents the difference between the 2028 projected visibility value from the VISTAS modeling analyses and the expected visibility improvement by 2028 on the URP. Because this calculation is based on the level of haze in dv, negative percentages indicate that the 2028 projected visibility value is better than the expected visibility by 2028 on the URP while positive percentages indicate that the 2028 projected visibility value is worse than the expected visibility by 2028 on the URP. For example, haze in the Dolly Sods Wilderness Area is projected to be nearly 26% lower than the expected visibility for 2028 on the URP. Likewise, for the Otter Creek Wilderness Area, haze is similarly anticipated to be lower than the expected visibility for 2028 on the URP. For these areas, visibility improvements are well ahead of the timeline noted on the URP.

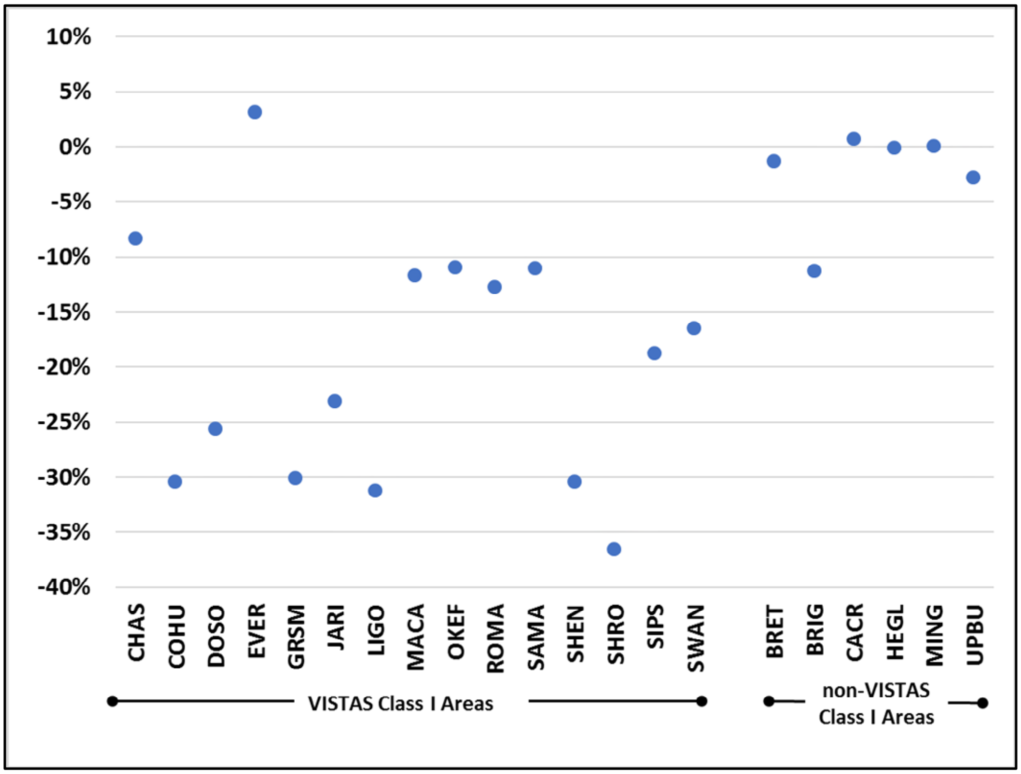


Figure 7-10: Percent of URP in 2028

Figure 7-11 illustrates the visibility improvement in 20% most impaired days. These figures show scenery at the Dolly Sods Wilderness Area impacted at levels equivalent to the 2000-2004 baseline conditions on the 20% most impaired days, the 2028 projections based on the VISTAS inventory, and natural conditions.

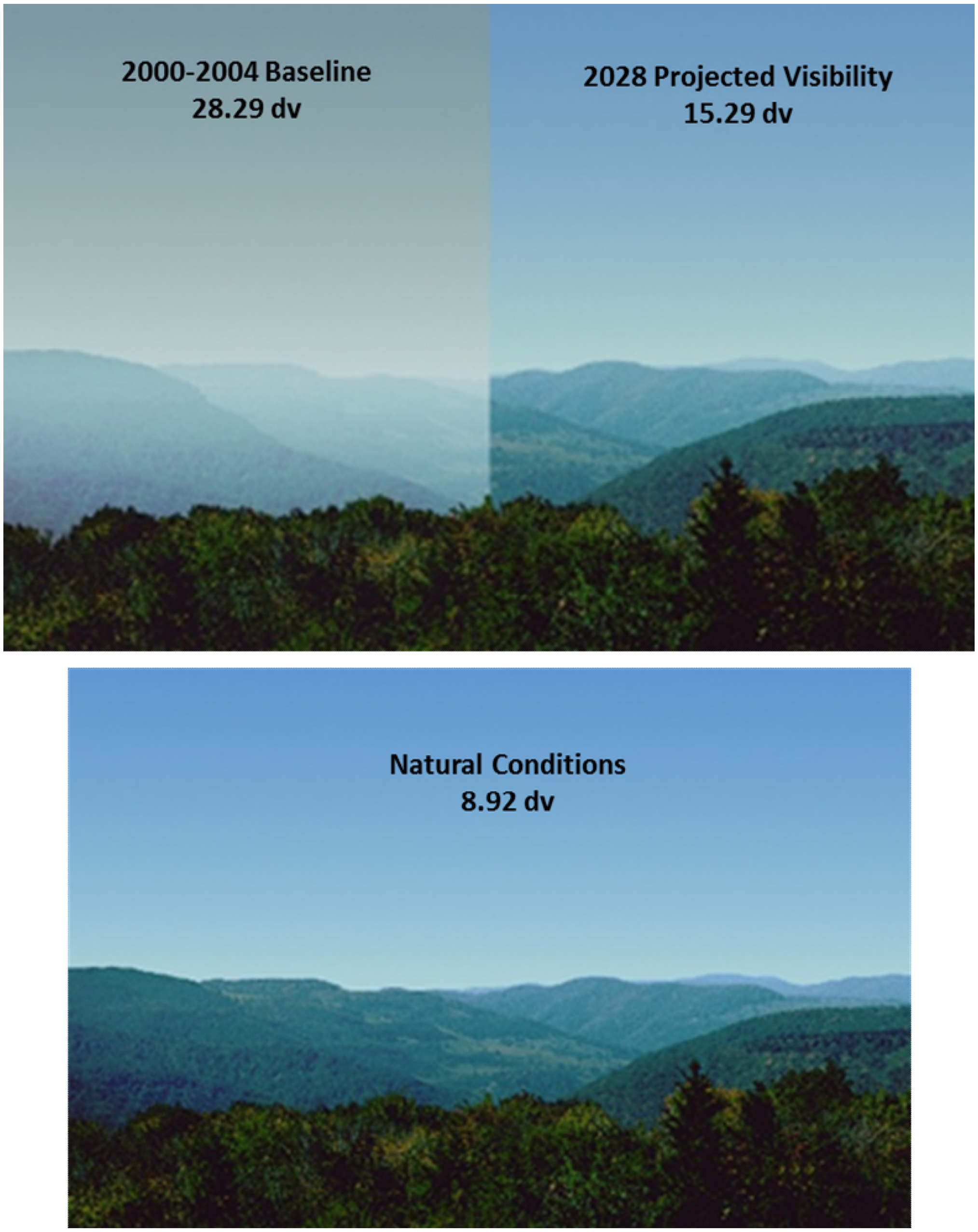


Figure 7-11: Dolly Sods Wilderness Area 20% Most Impaired Days in 2000-2004, 20% Most Impaired Days in 2028, and Natural Conditions

In addition to improving visibility on the 20% most impaired visibility days, states are also required to protect visibility on the 20% clearest days at the Class I areas to ensure no degradation of visibility on these clearest days occurs. Figure 7-12 shows the improvements expected on the 20% clearest visibility days using the VISTAS emissions inventory and associated reductions. The pink line represents the 2000-2004 average baseline conditions for the 20% clearest days. The model projections shown in blue triangles start at 2011 (the observed

2009-2013 average of the visibility on the 20% clearest days) and end at the 2028 projected visibility values for the 20% clearest days based on existing and planned emissions controls during the period of the long-term strategy associated with this round of implementation. The blue diamonds depict IMPROVE monitoring data values, and the gray lines denote IMPROVE monitoring data five-year averages. As noted in these figures, visibility conditions in 2028 on the 20% clearest visibility days are expected to continue to improve at both the Dolly Sods and Otter Creek Wilderness Areas.

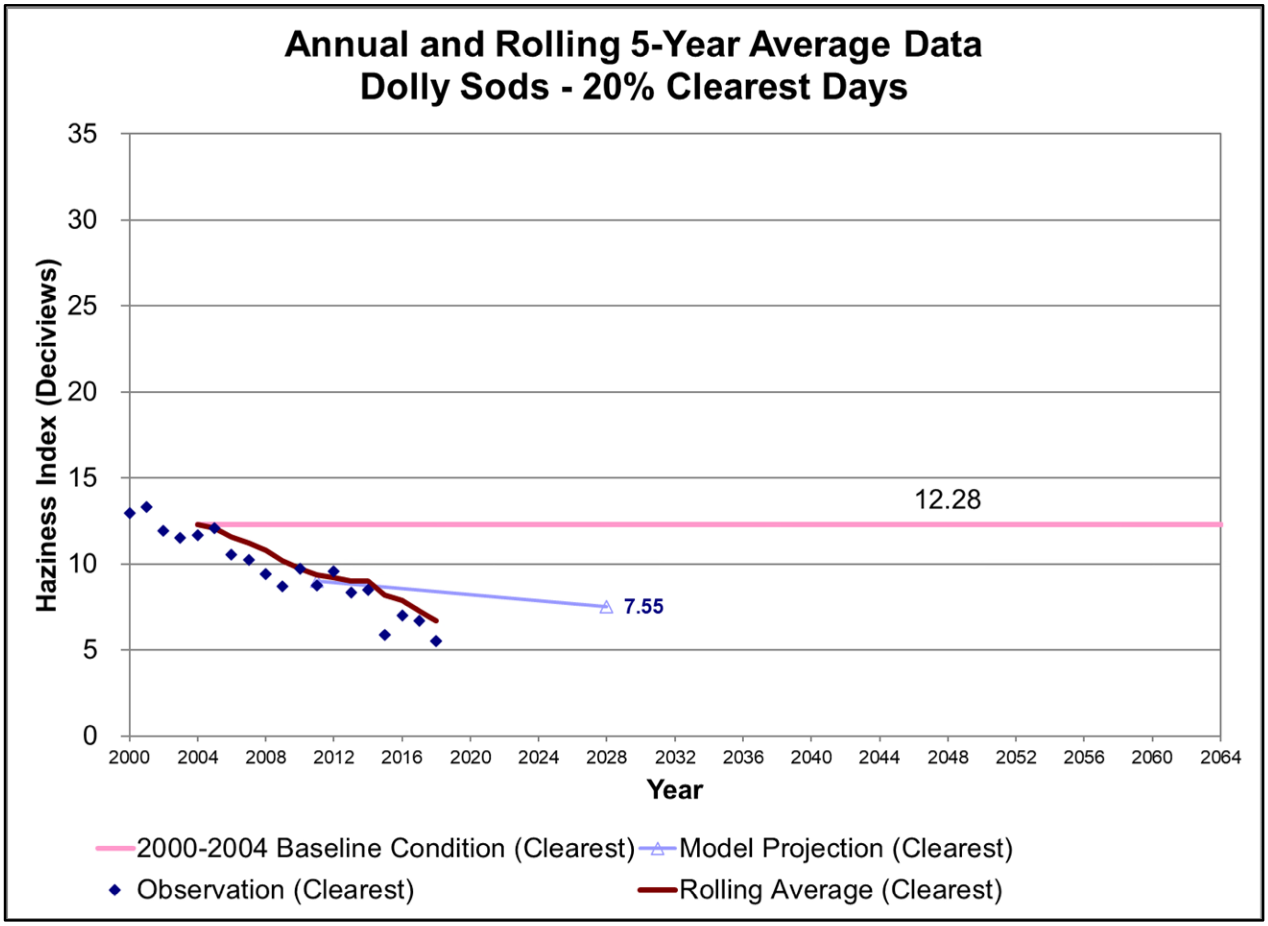


Figure 7-12: 20% Clearest Days Rate of Progress for Dolly Sods

As illustrated in Figure 7-13, visibility on the 20% clearest days is projected to improve in 2028 at all VISTAS and non-VISTAS Class I areas because of the emission control programs included in the VISTAS 2028 emissions inventory. In this figure, a zero percent change indicates no change in visibility. A negative percentage indicates improvement in projected visibility while a positive change indicates visibility degradation. The percent improvement on 20% clearest days is projected to be -38.5% for the Dolly Sods Wilderness Area and similar for the Otter Creek Wilderness Area.

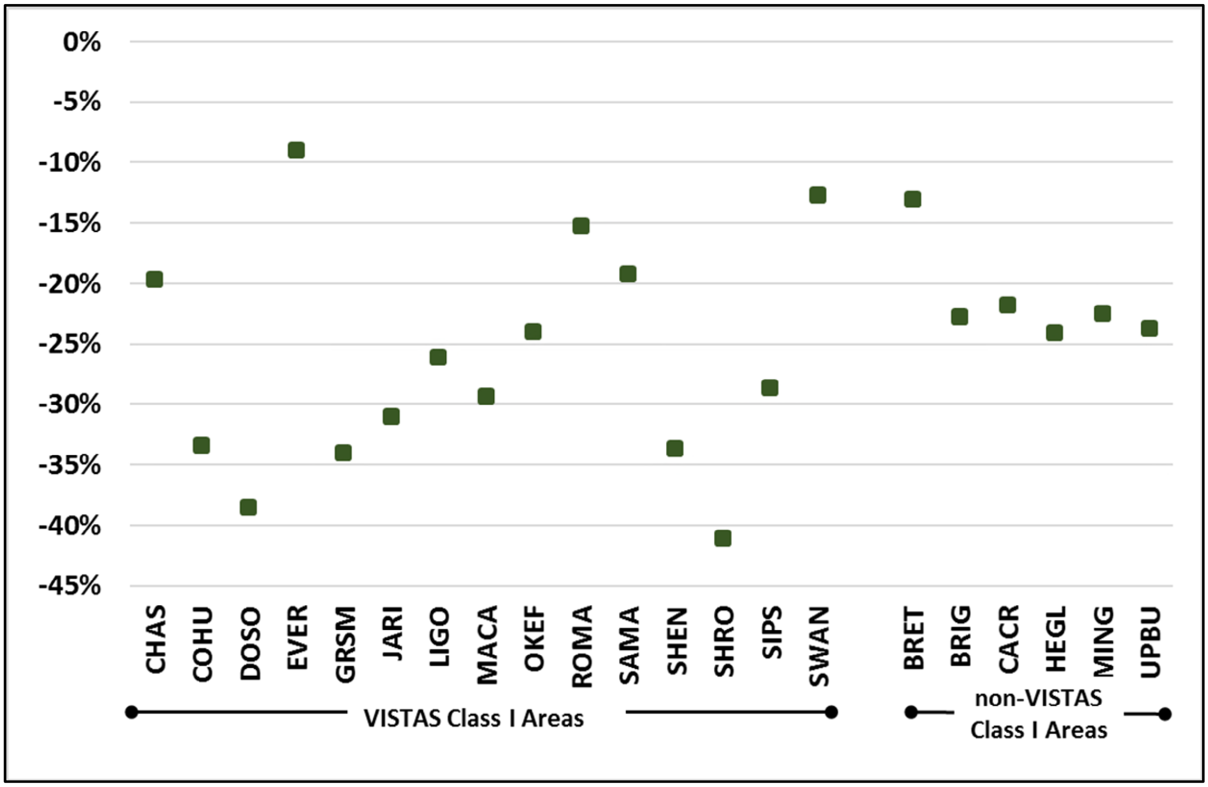


Figure 7-13: Percent Visibility Improvement on 20% Clearest Days

7.3. Relative Contribution from International Emissions to Visibility Impairment in 2028 at VISTAS Class I Areas

International anthropogenic emissions are beyond the control of states preparing regional haze SIPs. Therefore, the regional haze rule at 40 CFR 51.308(f)(1)(vi)(B) allows states to optionally propose an adjustment of the 2064 uniform rate of progress endpoint to account for international anthropogenic impacts if the adjustment has been developed using scientifically valid data and methods. On September 19, 2019, the EPA released Technical Support Document for EPA's Updated 2028 Regional Haze Modeling.[56] This document provides the results of EPA's updated 2028 visibility modeling analyses and includes projections of both domestic and international source contributions. The EPA used source apportionment results to calculate the estimated source contribution of international anthropogenic emissions to visibility impairment at Class I areas on the 20% most impaired days. The EPA used these estimated contributions to derive adjusted glide path endpoints for each federal Class I area.

[56] https://www.epa.gov/visibility/technical-support-document-epas-updated-2028-regional-haze-modeling

In this study, the EPA used the CAMx PSAT tool to tag certain sectors. The EPA processed each sector through the SMOKE model and tracked each sector in PSAT as an individual source tag. The EPA tracked sulfate, nitrate, ammonium, secondary organic aerosols, and primary PM in this manner. International anthropogenic emissions within this study include anthropogenic emissions from Canada and Mexico, C3 commercial marine emissions outside of the emissions control area as described in Section 7.2.1.4.4, and international anthropogenic boundary conditions.

Results from this study shows international anthropogenic boundary conditions account for a sizable fraction of sulfate concentrations in the west in certain months, and to a lesser extent nitrate. Estimated international anthropogenic visibility impairment ranges from 3.0 Mm^{-1} to 19.7 Mm^{-1}. For Class I areas located in VISTAS, total international anthropogenic emissions impacts range from 4.10 Mm^{-1} to 8.80 Mm^{-1}. Table 7-9 provides the estimated international anthropogenic visibility impacts to VISTAS Class I area from the EPA's study.

Table 7-9: VISTAS Class I Area International Anthropogenic Emissions 2028 Impairment, Mm^{-1}

Class I Area Name	State	Site ID	Non-US C3 Marine	Canada	Mexico	Boundary International	Total International Anthropogenic
Cape Romain Wilderness Area	SC	ROMA	0.50	0.81	1.24	3.68	6.23
Chassahowitzka Wilderness Area	FL	CHAS	1.30	0.62	1.01	3.81	6.75
Cohutta Wilderness Area	GA	COHU	0.10	1.31	0.68	3.20	5.29
Dolly Sods Wilderness Area	WV	DOSO	0.05	2.11	0.53	2.31	4.99
Everglades National Park	FL	EVER	2.28	0.48	0.36	4.65	7.77
Great Smoky Mountains National Park	NC/TN	GRSM	0.09	1.38	0.54	2.83	4.48
James River Face Wilderness Area	VA	JARI	0.04	2.01	0.38	2.56	4.99
Joyce Kilmer-Slickrock Wilderness Area	NC/TN	JOYC	0.09	1.38	0.54	2.83	4.84
Linville Gorge Wilderness Area	NC	LIGO	0.04	1.42	0.39	2.26	4.10
Mammoth Cave National Park	KY	MACA	0.02	3.34	0.30	3.28	6.94
Okefenokee Wilderness Area	GA	OKEF	0.99	0.98	2.23	4.60	8.80
Otter Creek Wilderness Area	WV	OTCR	0.05	2.11	0.53	2.31	4.99
Shenandoah National Park	VA	SHEN	0.02	1.98	0.30	2.42	4.72
Shining Rock Wilderness Area	NC	SHRO	0.09	1.01	1.00	2.61	4.70
Sipsey Wilderness Area	AL	SIPS	0.09	1.45	0.74	2.83	5.12
St. Marks Wilderness Area	FL	SAMA	0.59	0.76	1.43	3.78	6.57
Swanquarter Wilderness Area	NC	SWAN	0.16	1.91	0.65	2.42	5.13
Wolf Island Wilderness Area	GA	WOLF	0.99	0.98	2.23	4.60	8.80

West Virginia's Class I areas are expected to be well beneath the 2028 uniform rate of progress goal based on VISTAS modeling, which includes current and forthcoming control programs. The estimated international emissions impact for both the Dolly Sods Wilderness Area is 4.99 Mm^{-1}; similarly, the estimated international emissions impact for Otter Creek Wilderness Area is also 4.99 Mm^{-1}. Adjustments to the 2028 uniform rate of progress goal based on these estimated visibility impairment contributions of international anthropogenic emissions would not change the conclusion that these areas will experience visibility improvements that are significantly better than those on the uniform rate of progress. Therefore, in this round of regional haze implementation, West Virginia is not updating the 2028 uniform rate of progress goals based on the EPA's contribution study of international anthropogenic emissions.

7.4. Relative Contributions to Visibility Impairment: Pollutants, Source Categories, and Geographic Areas

To determine what areas and emissions source sectors impact VISTAS mandatory federal Class I areas, VISTAS relied on PSAT results examining the impacts of sulfate and nitrate from the following geographic areas and emissions sectors:

- Total SO_2 and NO_X emissions from each VISTAS state;
- Total SO_2 and NO_X emissions from the CENSARA, MANE-VU, and LADCO regional planning organizations;
- Total SO_2 and NO_X emissions from EGUs from each VISTAS state;
- Total SO_2 and NO_X emissions from EGUs from CENSARA, MANE-VU, and LADCO regional planning organizations;
- Total SO_2 and NO_X emissions from non-EGU point sources from each VISTAS state; and
- Total SO_2 and NO_X emissions from non-EGU point sources from CENSARA, MANE-VU, and LADCO regional planning organizations.

Visibility impacts in 2028 estimated by PSAT for each region (10 individual VISTAS states plus three RPOs), emission sector (total, EGU, and non-EGU), and pollutant (SO_2 and NO_X) at each mandatory federal Class I area are available for comparison.

Figure 7-14 shows the 2028 nitrate impairment from each region at mandatory federal Class I areas within VISTAS. Most mandatory federal Class I areas in VISTAS show contributions of less than 4 Mm^{-1} from nitrate in 2028, with the exceptions being Mammoth Cave National Park, Sipsey Wilderness Area, Cape Romain Wilderness Area, and Swanquarter Wilderness Area. All the mandatory federal Class I areas in VISTAS show total contributions to nitrate impairment from the CENSARA, LADCO, and the MANE-VU sources (dark grey, medium grey, and light grey, respectively) that are larger than home state contributions, except for Everglades National Park and Okefenokee Wilderness Area.

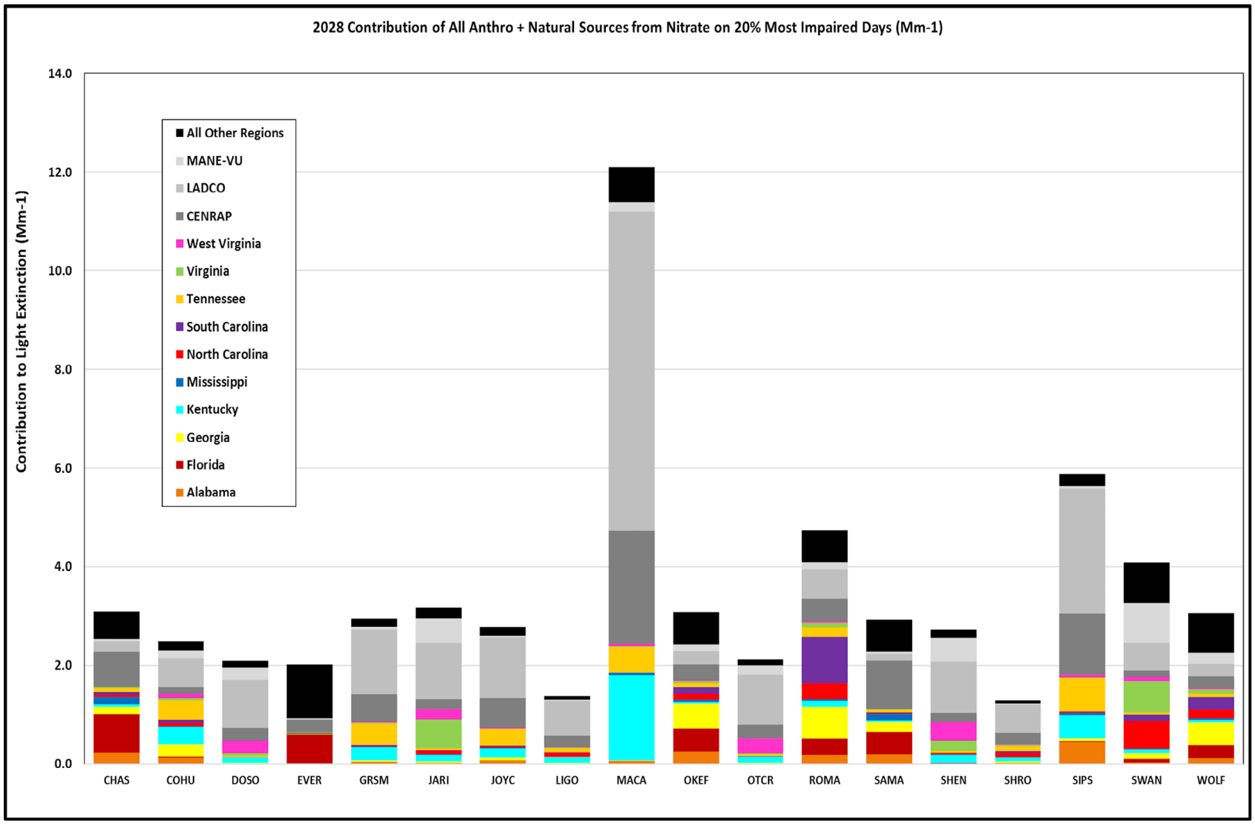


Figure 7-14: 2028 Nitrate Visibility Impairment, 20% Most Impaired Days, VISTAS Class I Areas

Figure 7-15 shows the 2028 sulfate impairment from each region at mandatory federal Class I areas within VISTAS. All areas, except for Everglades National Park, show sulfate impacts of at least 10 Mm^{-1}. All of the mandatory federal Class I areas in VISTAS show contributions to sulfate impairment from CENSARA, LADCO, and MANE-VU sources (dark grey, medium grey, and light grey, respectively) that are larger than home state contributions, with the exception of Everglades National Park.

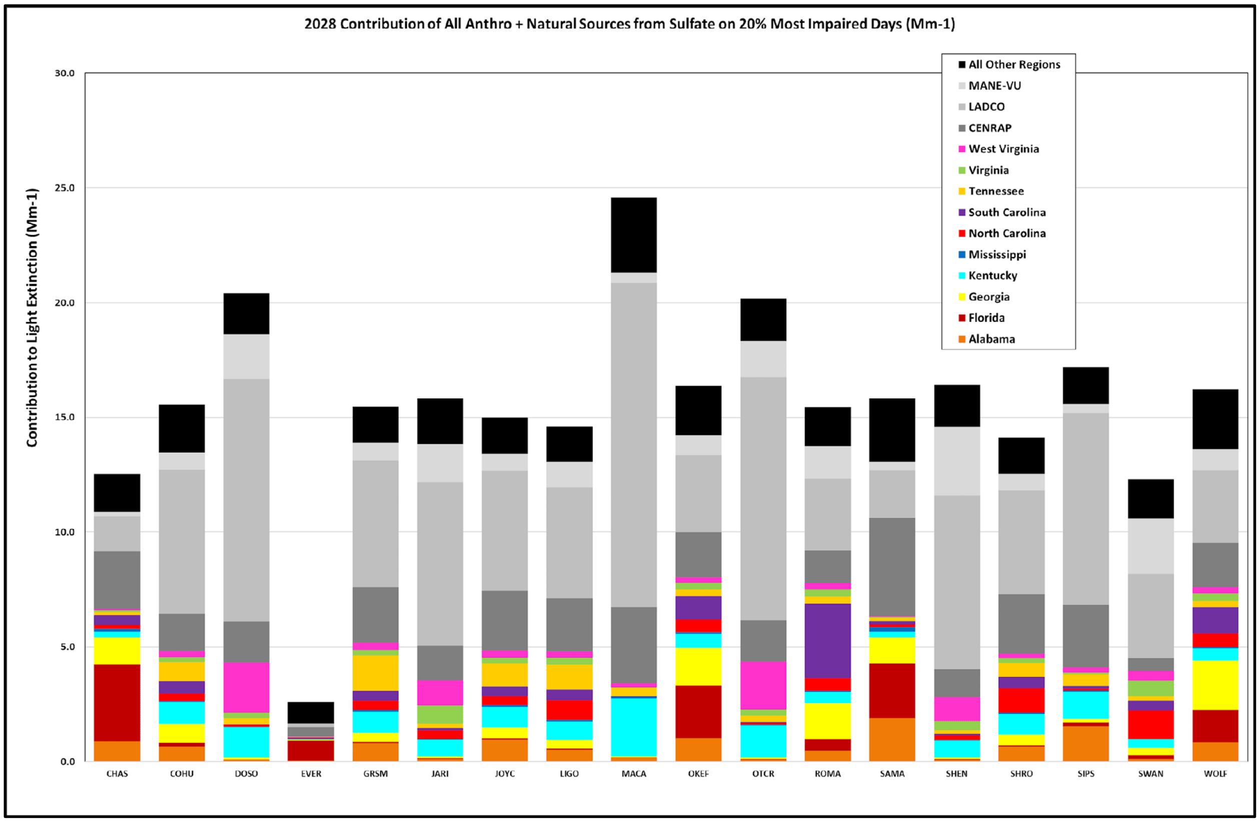


Figure 7-15: 2028 Sulfate Visibility Impairment, 20% Most Impaired Days, VISTAS Class I Areas

These figures indicate that sulfate continues to be the primary driver of visibility impairment in most mandatory federal VISTAS Class I areas. These figures also show that emissions from sources located outside of the home state and outside of VISTAS have a significant impact on visibility in mandatory federal VISTAS Class I areas.

Figure 7-16 and Figure 7-17 provide comparisons of projected light extinction from sulfate and nitrate in 2028 at mandatory federal Class I areas in VISTAS. These figures show the light extinction associated with all emissions within the pollutant inventory, the light extinction caused by emissions from the EGU sector, and light extinction caused by emissions from the non-EGU point source sector.

Figure 7-16 shows these data for sulfate visibility impairment. Comparison of bar heights in this figure demonstrates that sulfate visibility impairment from the EGU and non-EGU point source sectors comprise the majority of the total sulfate visibility impairment at all mandatory federal Class I areas within VISTAS except Everglades National Park. Figure 7-16 also shows that for some VISTAS mandatory federal Class I areas, visibility impairment due to sulfate from the EGU sector is significantly higher than visibility impairment due to sulfate from the non-EGU sector. Exceptions to this observation are Everglades National Park, Okefenokee Wilderness

Area, Cape Romain Wilderness Area, St. Marks Wilderness Area, and Wolf Island Wilderness Area. In the case of Everglades National Park, total sulfate impairment in 2028 is expected to be less than 5 Mm^{-1}, and EGU and non-EGU sulfate contributions are minimal. Projections for Okefenokee, Cape Romain, St. Marks, and Wolf Island show that EGU and non-EGU sulfate contributions are most of the sulfate impairment but that the relative impacts from each sector are similar.

Figure 7-17 provides nitrate light extinction data in 2028 for mandatory federal Class I areas in VISTAS. In all but four cases, the total nitrate light extinction estimated for 2028 is well beneath 4 Mm^{-1}. In the case of Mammoth Cave National Park, Cape Romain Wilderness Area, Sipsey Wilderness Area, and Swanquarter Wilderness Area, total nitrate impairment is more than 4 Mm^{-1}, but the contributions from the EGU and non-EGU point source sectors are well under half of the total nitrate contribution.

A comparison of Figure 7-16 and Figure 7-17 show that sulfates generally contribute more to light extinction in 2028 at VISTAS mandatory federal Class I areas than nitrates and that sulfates from EGU and non-EGU point source sectors contribute the majority of the sulfate light extinction at most of these areas. Results in Figure 7-17 also show that most of the nitrate light extinction is not caused by NO_X emissions from EGU and non-EGU point sources. This illustrates mobile sources contribute more haze-forming nitrate than all point sources combined.

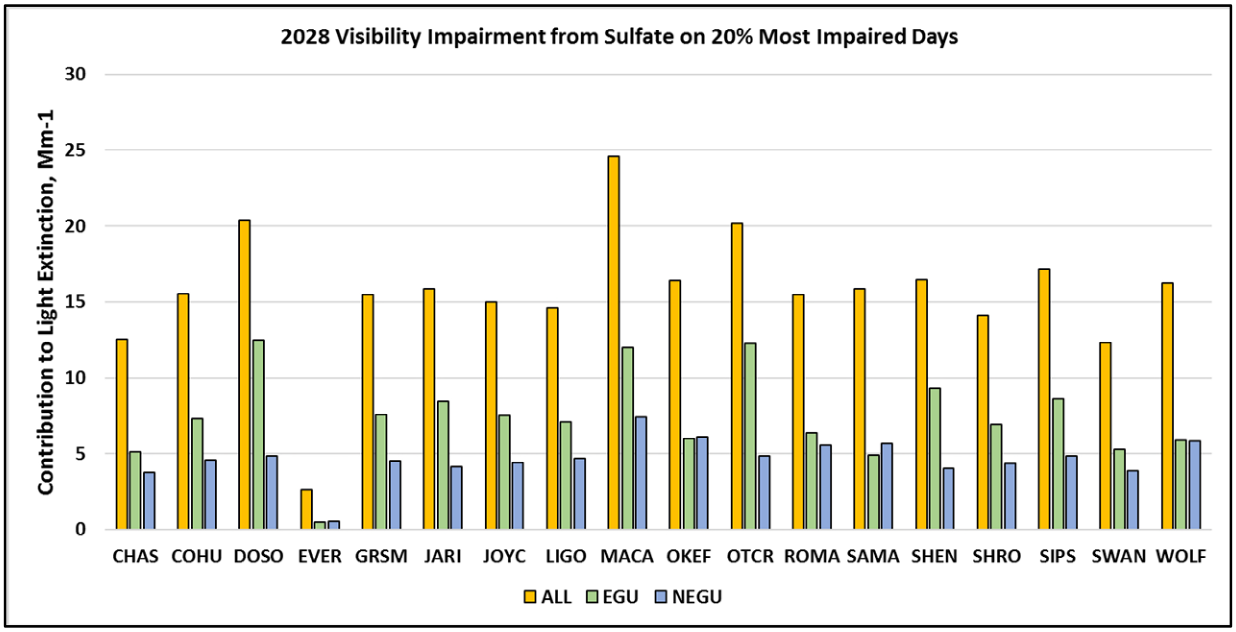


Figure 7-16: 2028 Visibility Impairment from Sulfate on 20% Most Impaired Days, VISTAS Class I Areas

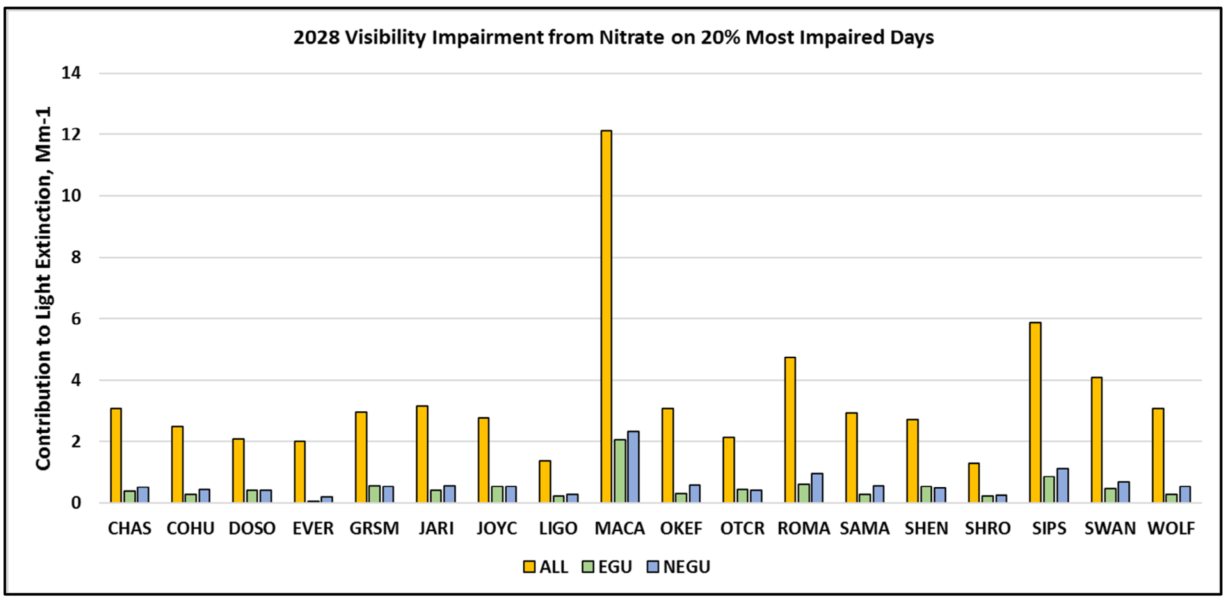


Figure 7-17: 2028 Visibility Impairment from Nitrate on 20% Most Impaired Days, VISTAS Class I Areas

These PSAT analyses support the following conclusions concerning the visibility impairing emissions, the source categories responsible for these emissions, and the locations of the pollutant emitting activities:

- Sulfate will generally be a much larger contributor to visibility impairment in 2028 at VISTAS mandatory federal Class I areas than nitrates.

- Emissions from other regional planning organizations (MANE-VU, LADCO, and CENSARA) generally have higher contributions to 2028 visibility impairment at mandatory federal Class I areas in VISTAS than the emissions from the home state.

- Emissions from EGUs and non-EGU point sources contribute the majority of the total sulfate contributions to visibility impairment in 2028 at mandatory Class I areas in VISTAS.

Figure 7-18 and Figure 7-19 provide more detailed comparisons for the Dolly Sods and the Otter Creek Wilderness Areas, respectively. These figures show that projected light extinction in 2028 from total sulfate is significantly larger than light extinction from total nitrate. At both the Dolly Sods and Otter Creek Wilderness Areas, projected total sulfate extinction is greater than 23 Mm^{-1} while total projected nitrate extinction is less than 2.5 Mm^{-1}. These figures also show that sulfate from EGUs and non-EGUs account for most of the total sulfate impact at these mandatory federal Class I areas in West Virginia. At Dolly Sods Wilderness Area, the 2028 sulfate extinction from EGUs and non-EGU point sources is 17.4 Mm^{-1} while the total sulfate extinction is 23.5 Mm^{-1}. Therefore, EGU and non-EGU point sources account for 74% of the total sulfate impact at Dolly Sods Wilderness Area. At Otter Creek Wilderness Area, the 2028 sulfate extinction from EGUs and non-EGU point sources is 17.1 Mm^{-1} while the total sulfate extinction is 23.3 Mm^{-1}. Therefore, EGU and non-EGU point sources account for 73.3% of the total sulfate impact at Otter Creek Wilderness Area. Lastly, these figures show that sulfates originating in the LADCO region contribute substantially to the estimated 2028 sulfate impairment at these mandatory federal Class I areas in West Virginia. At Dolly Sods Wilderness Area, sulfates originating within LADCO contribute 10.6 Mm^{-1} to visibility impairment in 2028, or 45% of the total sulfate impact. At Otter Creek Wilderness Area, sulfates originating within LADCO contribute 10.6 Mm^{-1} to visibility impairment in 2028, or 45% of the total sulfate impact. Additionally, sources in MANE-VU contribute nearly the same amount of visibility impairment in 2028 to West Virginia's Class I areas as do the West Virginia sources.

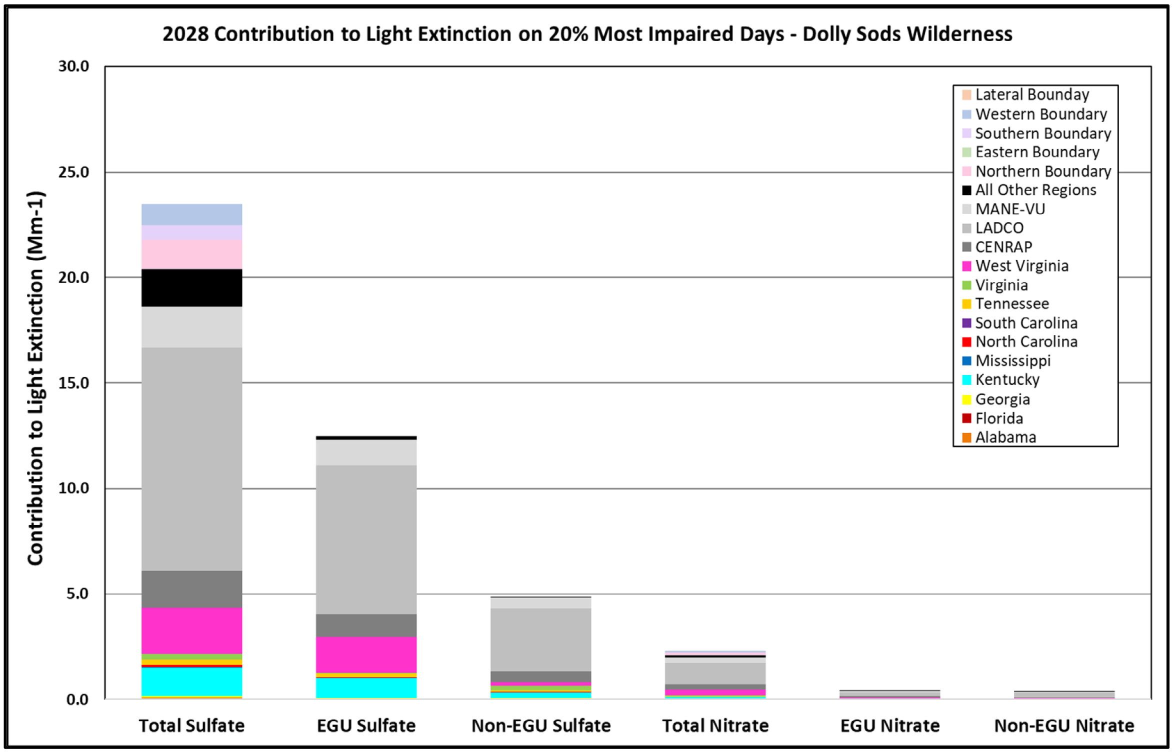


Figure 7-18: 2028 Contribution to Light Extinction on the 20% Most Impaired Days at Dolly Sods

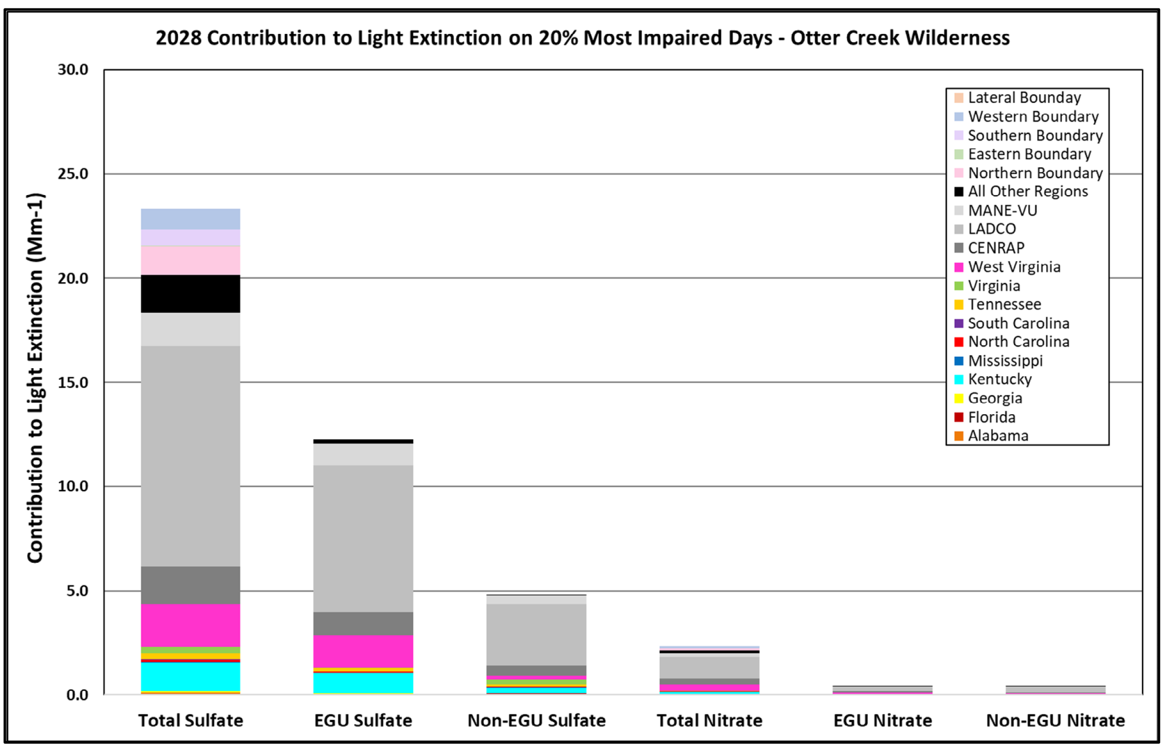


Figure 7-19: 2028 Contribution to Light Extinction on the 20% Most Impaired Days at Otter Creek

The EPA released an updated 2028 visibility air quality modeling study in September 2019.[57] The goal of this effort was to project 2028 visibility conditions for each mandatory federal Class I area. This effort used the EPA's 2016 modeling platform as the basis for the 2028 projections. The EPA provided VISTAS an output file from the SMAT-CE tool showing visibility impairment at each Class I area by visibility impairing species. Figure 7-20 provides these outputs graphically for the VISTAS mandatory federal Class I area with an IMPROVE monitoring site. This figure, based on the EPA's September 2019 modeling study, also shows sulfates will continue to be the prevailing visibility impairing species in 2028 at VISTAS Class I areas and is consistent with a similar analysis of baseline conditions shown in Figure 2-2 and of current conditions shown in Figure 2-8. Figure 7-20 shows that sulfates, depicted by the yellow bars, have more than double the impact at each VISTAS Class I area as compared to nitrates, the next most prevalent species and depicted by the red bars, in all cases except Mammoth Cave National Park. At Mammoth Cave National Park, the projected 2028 sulfate to nitrate ratio is just under 2.0. These results corroborate the findings of the VISTAS study and indicate that focusing resources on the control of SO_2 is appropriate for this round of regional haze implementation. Appendix E-8 provides the data supplied by the EPA from their 2019 modeling study.

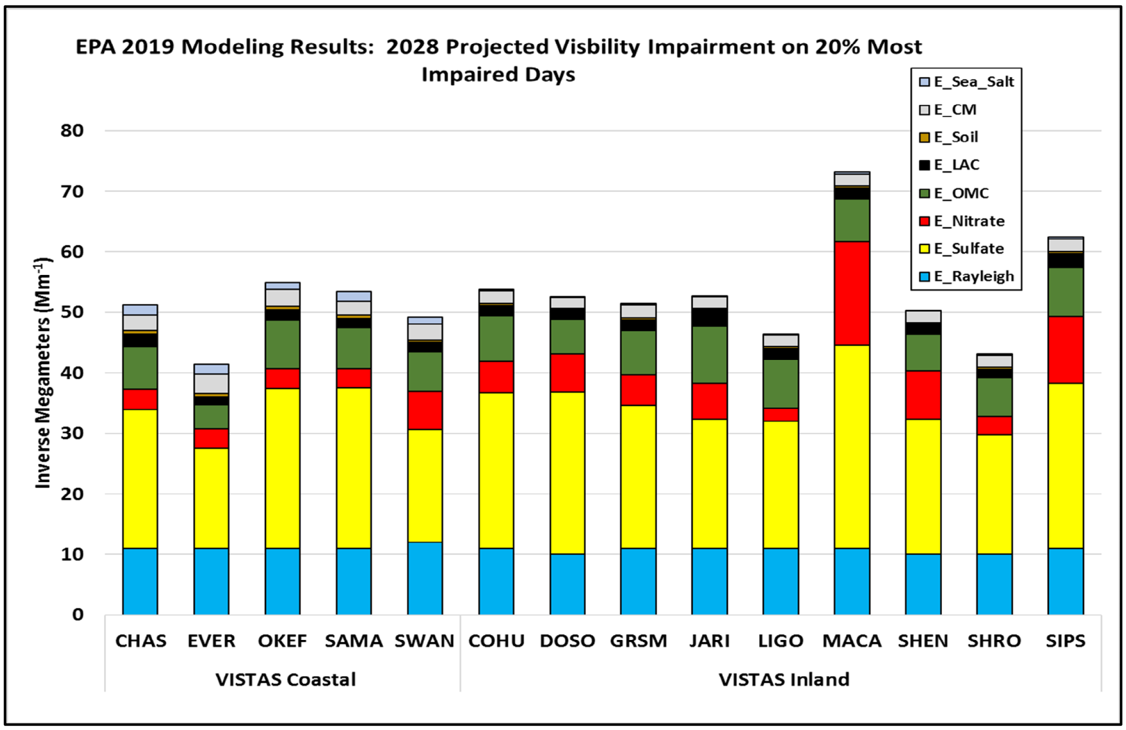


Figure 7-20: 2028 Projected Visibility Impairment by Pollutant Species, EPA 2019 Modeling Results

[57] URL: https://www.epa.gov/visibility/technical-support-document-epas-updated-2028-regional-haze-modeling

7.5. Area of Influence Analyses for West Virginia Class I Areas

Once the key pollutants and source categories contributing to visibility impairment at each Class I area were identified, it is necessary to focus on the greatest contributing sources. Facility-level SO_2 and NO_X area of influence (AoI) analyses were performed for each Class I area to determine the relative visibility impact from each facility. These facilities were then ranked by their sulfate and nitrate visibility contribution at each Class I area. For West Virginia, a 0.2% contribution was selected to include both in and out of state sources that could significantly contribute to Class I areas. In addition, county-level AoI analyses were performed to confirm that SO_2 emissions from EGU and non-EGU point sources are the greatest contributors to visibility impairment at VISTAS Class I areas. The following sections contain a broad overview of the steps in the AoI analyses. See Appendix D for a more detailed discussion of these analyses and plots for additional Class I areas.

7.5.1. Back Trajectory Analyses

The first step was to generate Hybrid Single Particle Lagrangian Integration Trajectory (HYSPLIT)[58] back trajectories for IMPROVE monitoring sites in West Virginia and neighboring Class I areas for 2011-2016 on the 20% most impaired days. Back trajectory analyses use interpolated measured or modeled meteorological fields to estimate the most likely central path of air masses that arrive at a receptor at a given time. The method essentially follows a parcel of air backward in hourly steps for a specified length of time.

The HYSPLIT model runs included starting heights of 100 meters (m), 500 m, 1,000 m, and 1,500 m. Trajectories were modeled 72 hours backwards in time for each height at each location, with model run start times of 12:00 a.m. (midnight of the start of the day), 6:00 a.m., 12:00 p.m., 6:00 p.m., and 12:00 a.m. (midnight at the end of the day) local time.

Figure 7-21 and Figure 7-22 contain the 100-meter back trajectories for the 20% most impaired visibility days (2011-2016) at the Dolly Sods and Otter Creek Wilderness Areas. Figure 7-23 contains the 100-meter, 500-meter, 1,000-meter, and 1,500-meter back trajectories for the 20% most impaired visibility days (2011-2016) at the Dolly Sods and Otter Creek Wilderness Areas. These back trajectories for the 20% most impaired days were then used to develop residence time (RT) plots.

[58] Stein, A. F., Draxler, R. R., Rolph, G. D., Stunder, B. J. B., Cohen, M. D., and Ngan, F., (2015). NOAA's HYSPLIT atmospheric transport and dispersion modeling system, Bull. Amer. Meteor. Soc., 96, 2059-2077, http://dx.doi.org/10.1175/BAMS-D-14-00110.1

Class1 site: 11 Year: 2011-2016 Height: 100.00

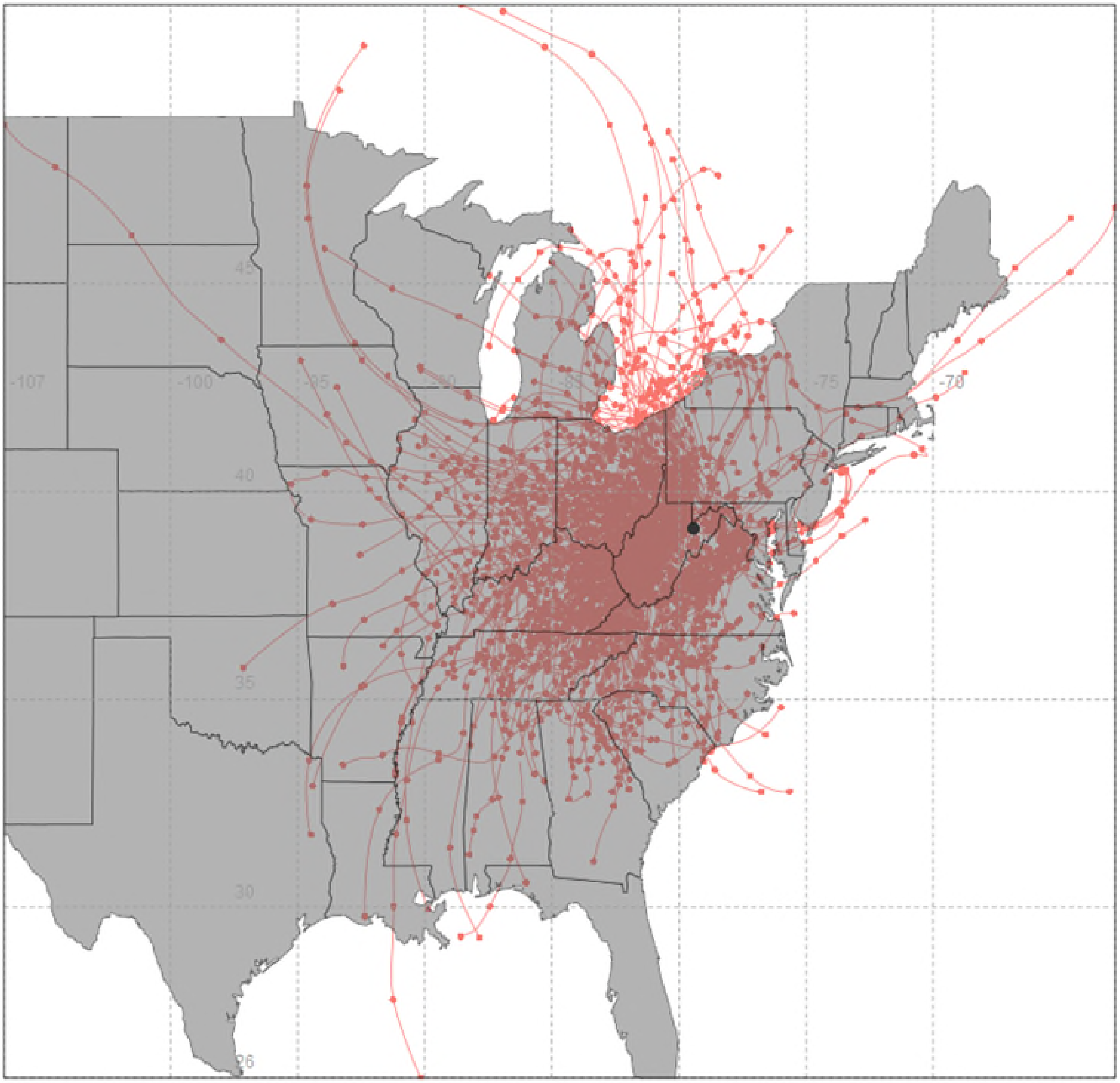


Figure 7-21: HYSPLIT 100-Meter Back Trajectories for the 20% Most Impaired Visibility Days (2011-2016), from Dolly Sods and Otter Creek Wilderness Areas

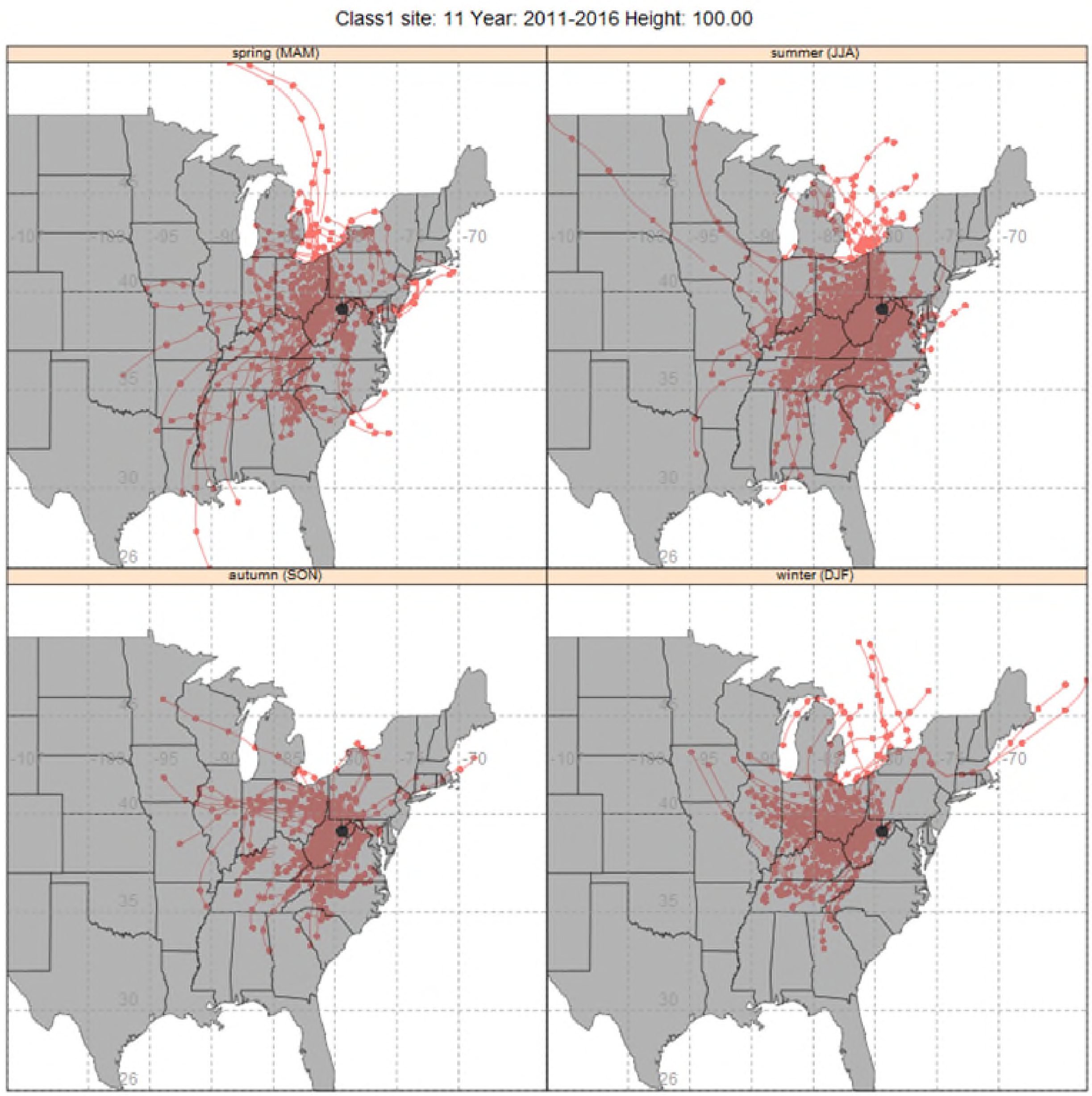


Figure 7-22: HYSPLIT 100-Meter Back Trajectories by Season for the 20% Most Impaired Visibility Days (2011-2016) from Dolly Sods and Otter Creek Wilderness Areas

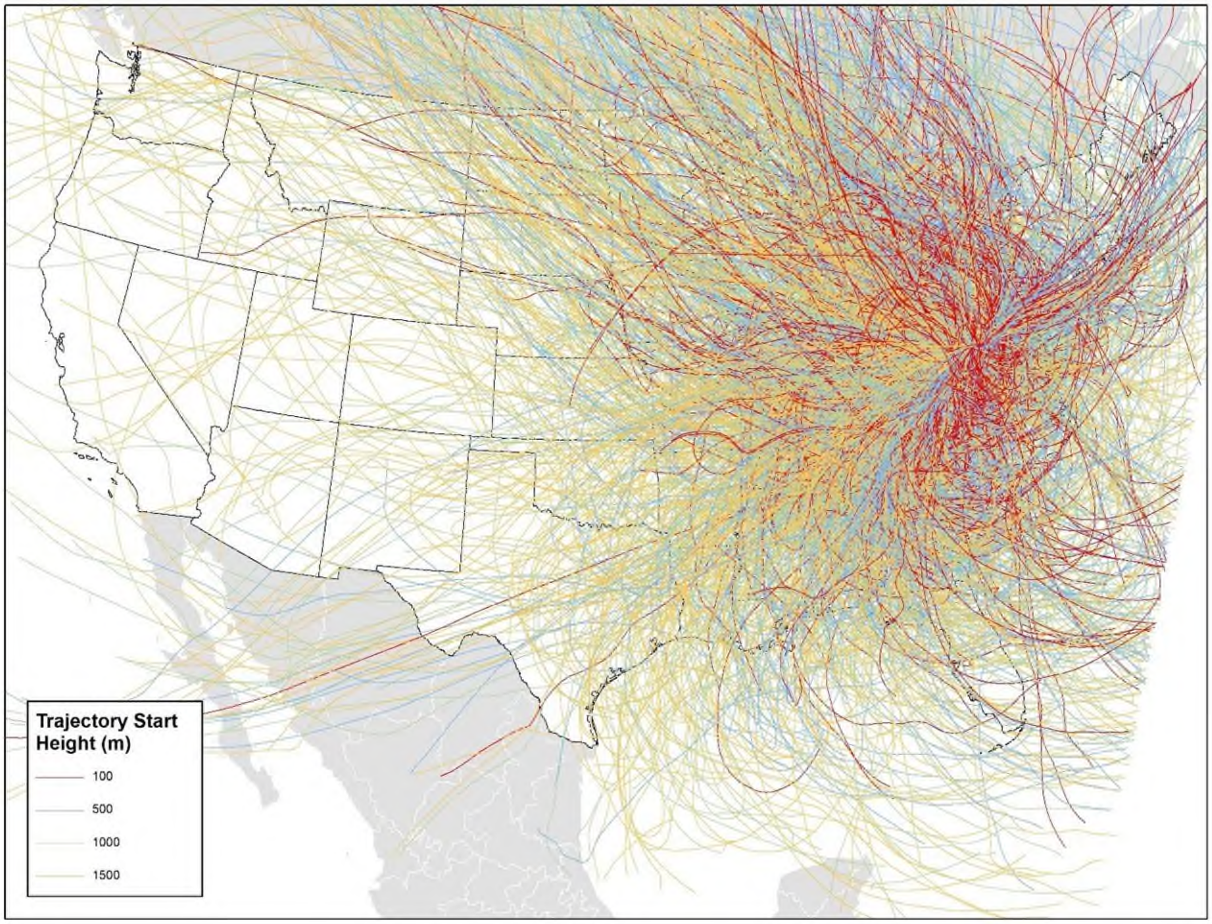
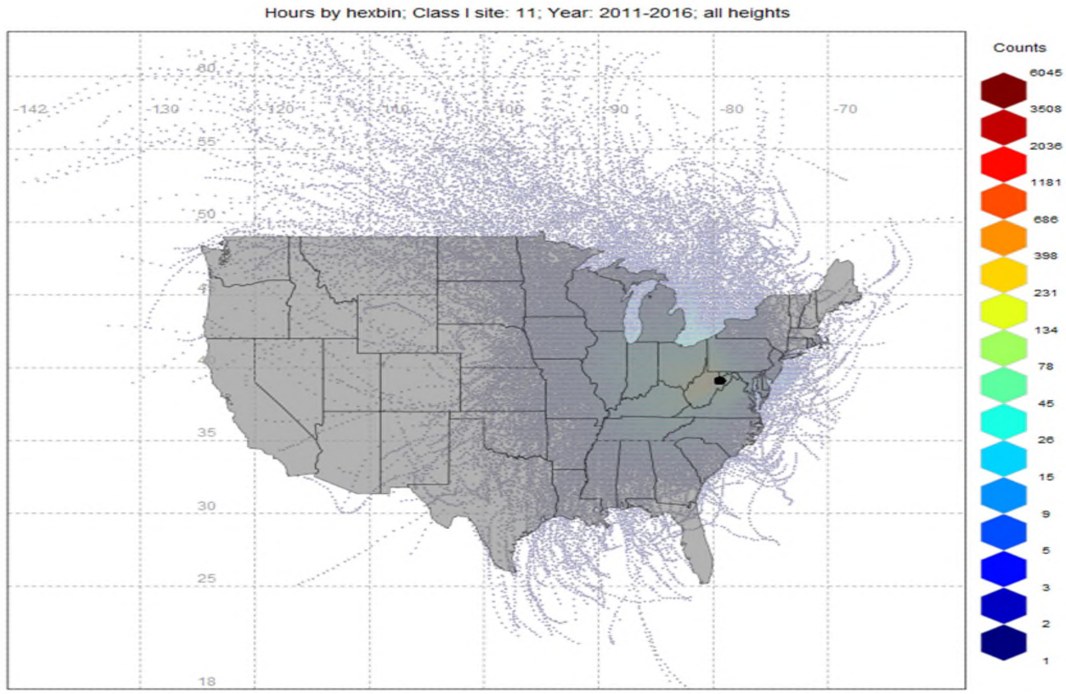


Figure 7-23: HYSPLIT 100-Meter, 500-Meter, 1000-Meter, and 1500-Meter Back Trajectories for the 20% Most Impaired Days (2011-2016) from Dolly Sods and Otter Creek Wilderness Areas

7.5.2. Residence Time Plots

The next step was to plot residence time (RT) for each Class I area using six years of back trajectories for the 20 % most impaired visibility days in 2011-2016. Residence time is the frequency that winds pass over a specific geographic area (model grid cell or county) on the path to a Class I area. Residence time plots include all trajectories for each Class I area.

Figure 7-24 contains the RT (counts per 12-km modeling grid cell) for Dolly Sods and Otter Creek Wilderness Areas. Figure 7-25 contains the residence time (percent of total counts per 12-km modeling grid cell) for these two Areas. As illustrated in these figures, winds influencing both Dolly Sods and Otter Creek Wilderness Areas on the 20% most impaired days come from all directions. and there is no single predominant wind direction influencing the 20% most impaired visibility days.



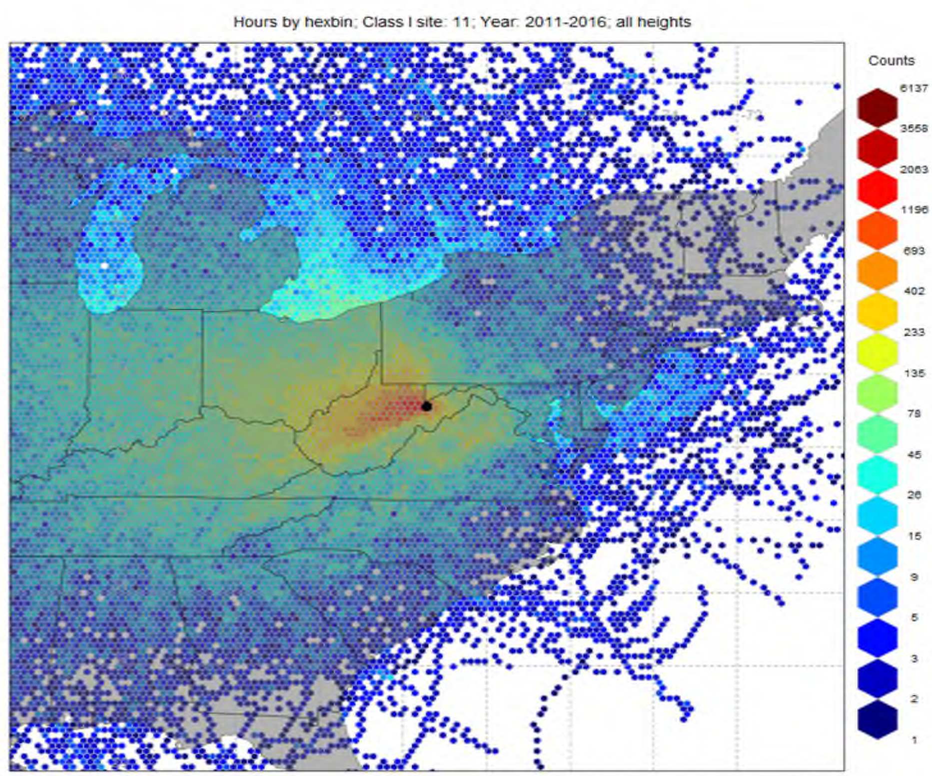


Figure 7-24: Residence Time (Counts per 12km Modeling Grid Cell) for Dolly Sods and Otter Creek Wilderness Areas – Full View (top) and Class I Zoom (bottom)

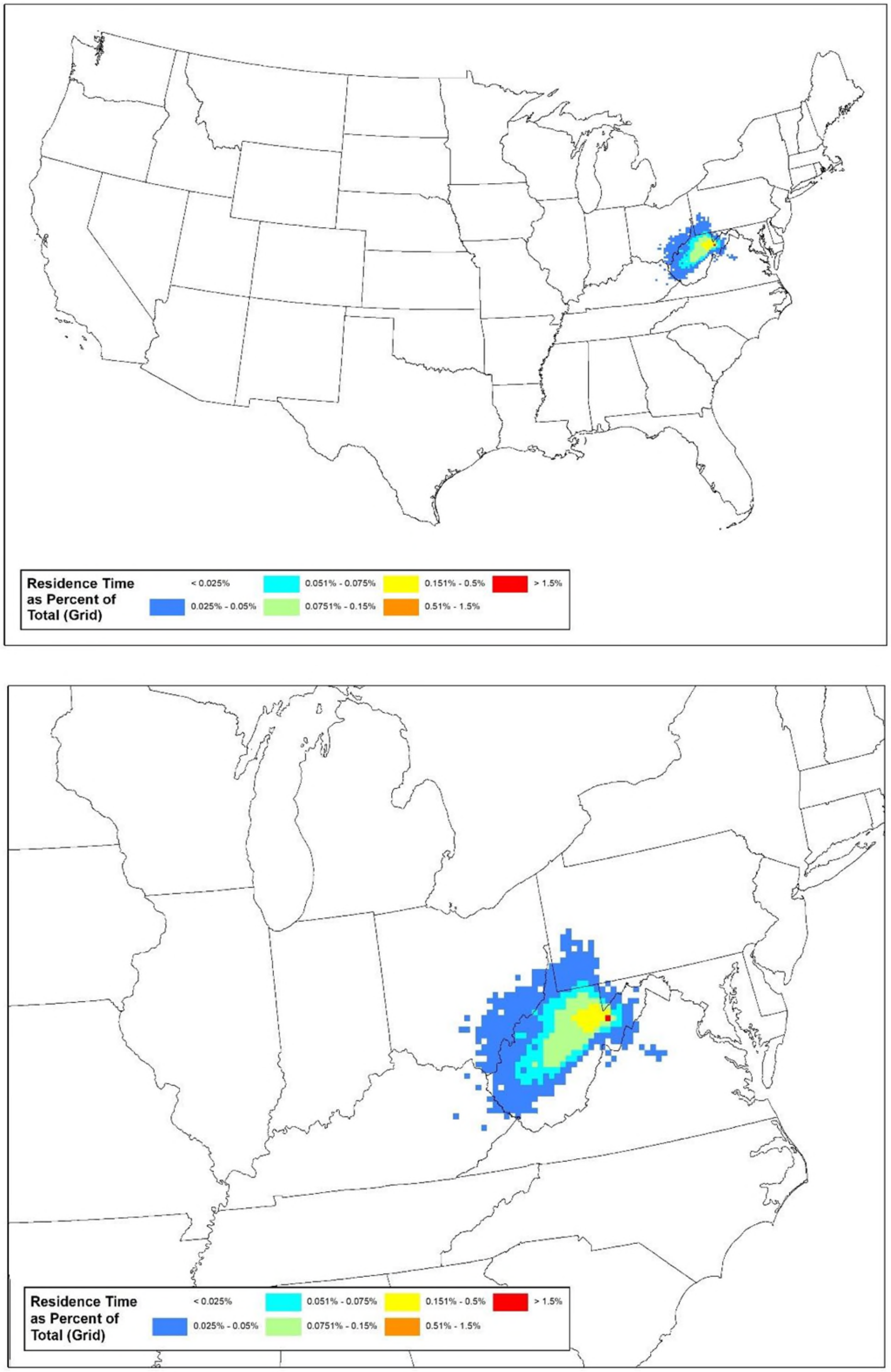


Figure 7-25: Residence Time (% of Total Counts per 12km Modeling Grid Cell for Dolly Sods and Otter Creek Wilderness Areas – Full View (top) and Class I Zoom (bottom)

7.5.3. Extinction-Weighted Residence Time Plots

The next step was to develop sulfate and nitrate extinction-weighted residence time (EWRT) plots. Each back trajectory was weighted by ammonium sulfate and ammonium nitrate extinction for that day and used to produce separate sulfate and nitrate EWRT plots. This allows separate analyses for sulfate and nitrate.

The concentration weighted trajectory (CWT)[59] approach was used to develop the EWRT, substituting the extinction values for the concentration. The extinction attributable to each pollutant is paired with the trajectory for that day. The mean weighted extinction of the pollutant species for each grid cell is calculated according to the following formula:

$$\overline{E}ij = EWRT = \frac{1}{\sum_{k=1}^{N} \tau_{ijk}} \sum_{k=1}^{N} (bext_k)\tau_{ijk}$$

Where:

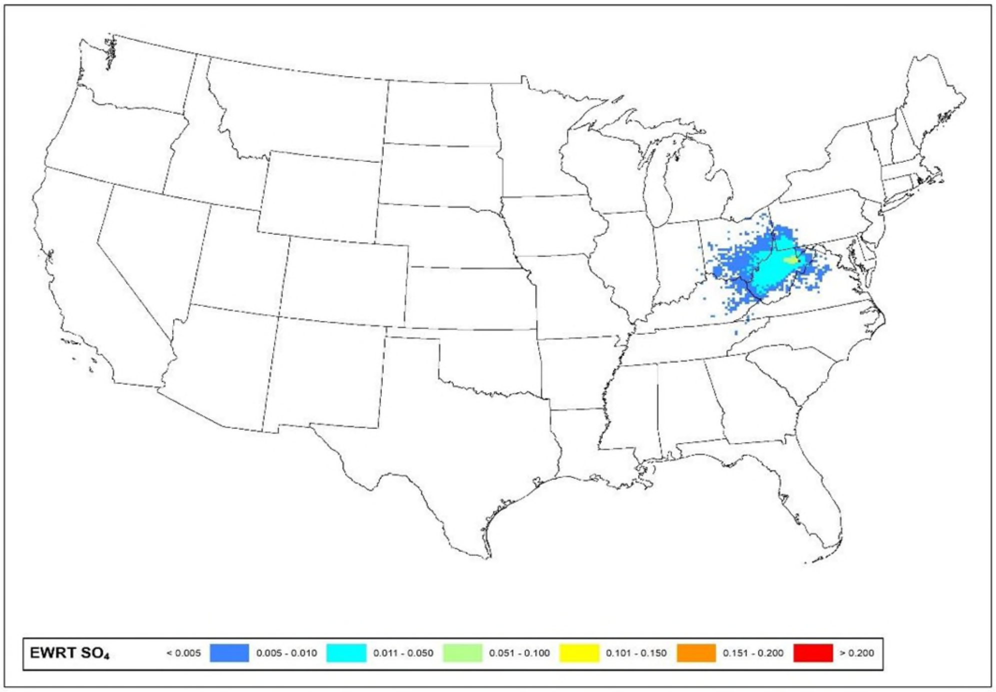
- i and j are the indices of the grid;
- k is the index of the trajectory;
- N is the total number of trajectories used in the analysis;
- b_{ext} is the 24-hour extinction attributed to the pollutant measured upon arrival of trajectory k; and
- τ_{ijk} is the number of trajectory hours that pass through each grid cell (i, j), where i is the row and j is the column.

The higher the value of the EWRT ($\overline{E}_{ij}$), the more likely the air parcels passing over cell (i, j) would cause higher extinction at the receptor site for that light extinction species. Since this method uses the extinction value for weighting, trajectories passing over large sources are more discernible than those passing over moderate sources.

Figure 7-26 contains the sulfate extinction weighted residence time (sulfate EWRT per 12-km modeling grid cell) for the Dolly Sods and Otter Creek Wilderness Areas for the 20% most impaired days from 2011 to 2016. Figure 7-27 contains the nitrate extinction weighted residence time (nitrate EWRT per 12-km modeling grid cell) for the Dolly Sods and Otter Creek Wilderness Areas for the 20% most impaired days from 2011 to 2016. It should be noted that the sulfate extinction weighted residence times are significantly higher (approximately ten times

[59] Hsu, Y.-K., T. M. Holsen and P. K. Hopke (2003). "Comparison of hybrid receptor models to locate PCB sources in Chicago". In: Atmospheric Environment 37.4, pp. 545–562. DOI: 10.1016/S1352-2310(02)00886-5

higher) than the nitrate extinction weighted residence times, demonstrating the importance of focusing on SO_2 emission reductions.



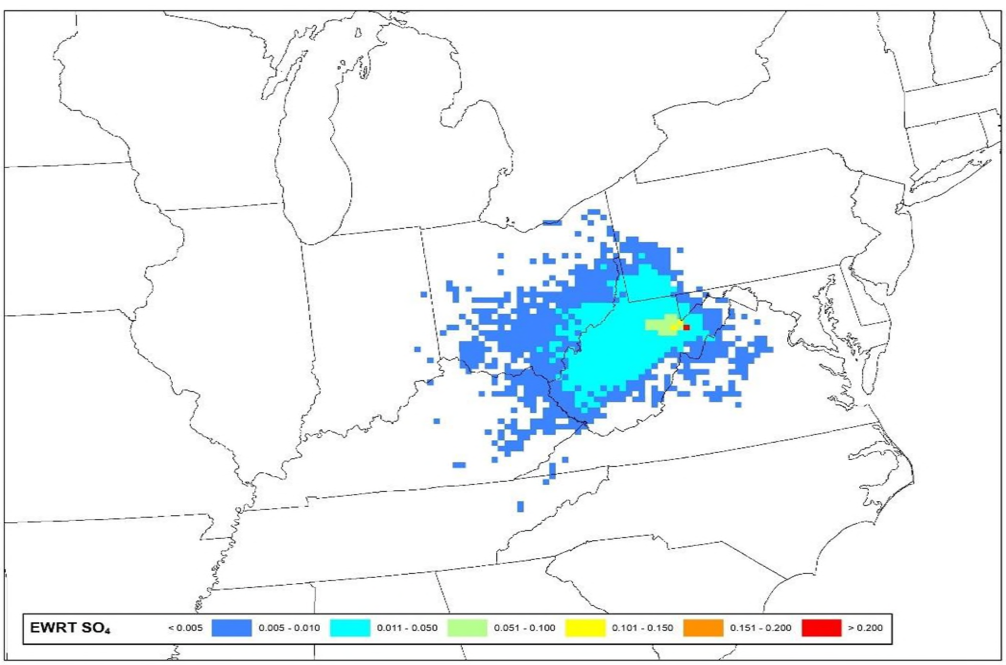
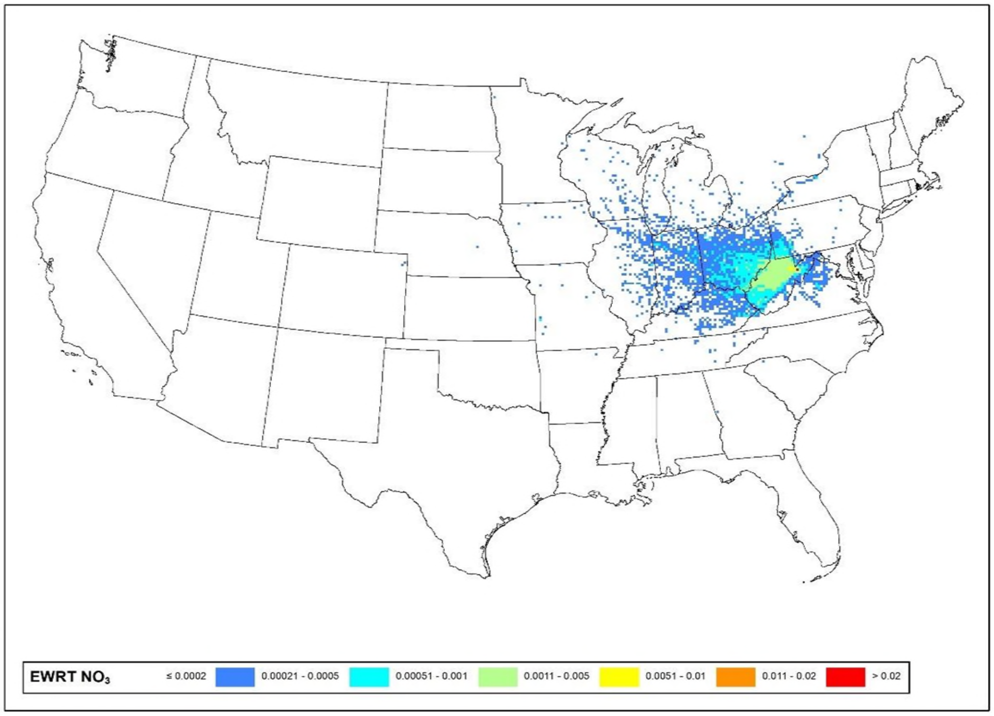


Figure 7-26: Sulfate Extinction Weighted Residence Time (Sulfate EWRT per 12km Modeling Grid Cell) for Dolly Sods and Otter Creek Wilderness Areas - Full View (top) and Class I Zoom (bottom)



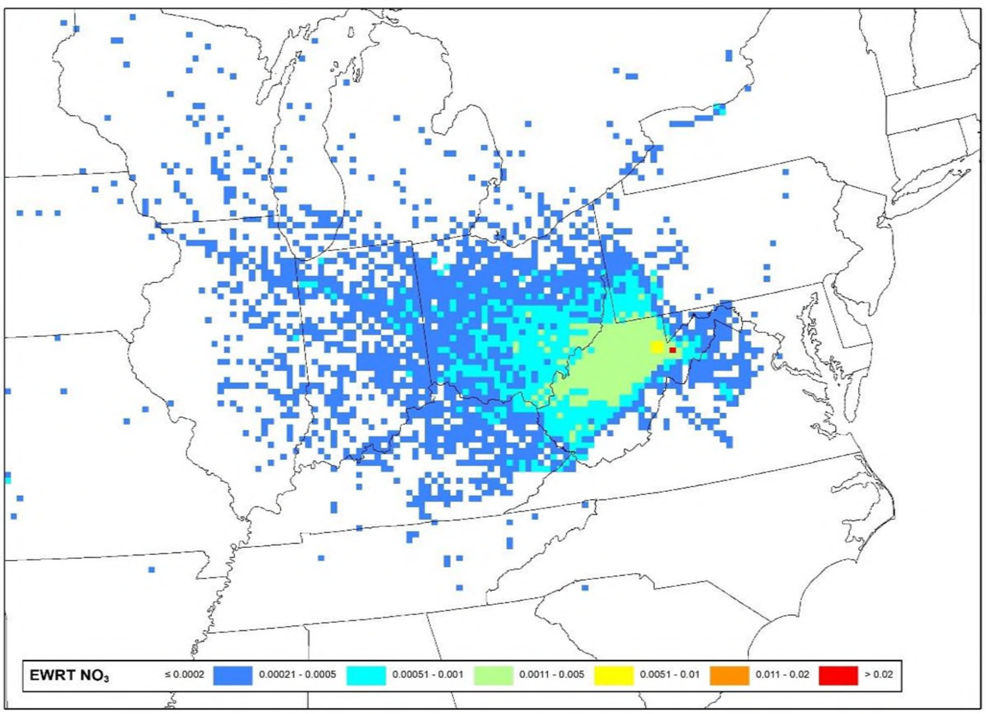


Figure 7-27: Nitrate Extinction Weighted Residence Time (Nitrate EWRT per 12-km Modeling Grid Cell) for the Dolly Sods and Otter Creek Wilderness Areas - Full View (top) and Class I Zoom (bottom)

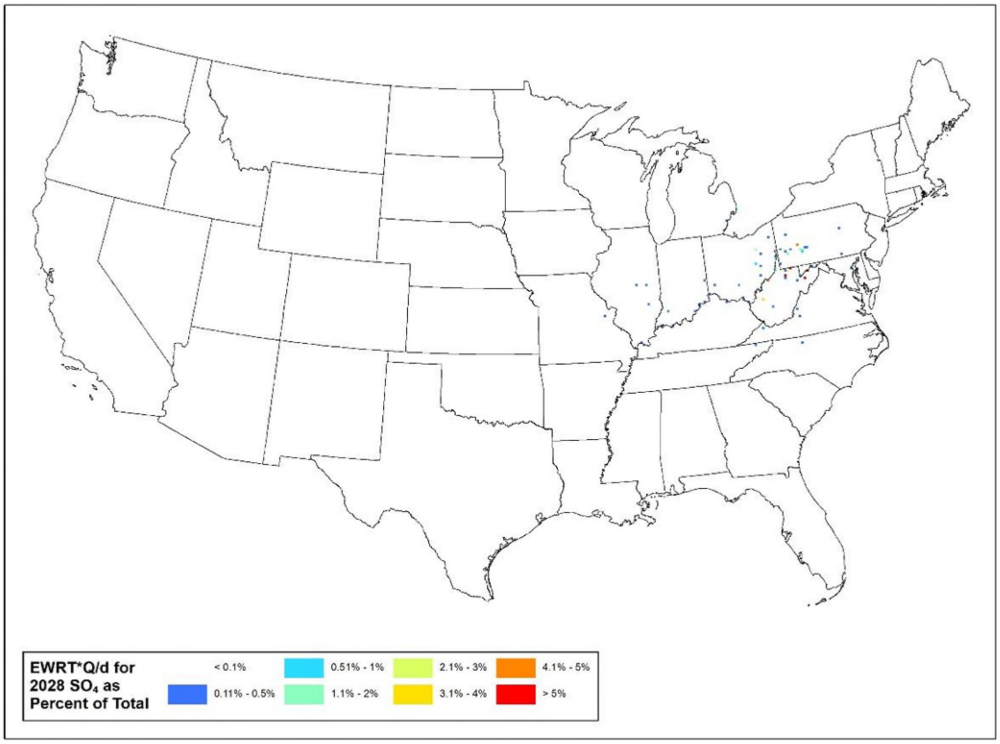
7.5.4. Emissions/Distance Extinction Weighted Residence Time Plots

Extinction weighted residence times were then combined with 12-km gridded SO_2 and NO_X emissions from the 2028 emissions inventory. As a way of incorporating the effects of transport, deposition, and chemical transformation of point source emissions along the path of the trajectories, these data were weighted by 1/d, where d was calculated as the distance, in kilometers, between the center of the grid cell in which a source is located and the center of the grid cell in which the IMPROVE monitor is located. For Class I areas without an IMPROVE monitor (WOLF, JOYC, and OTCR), the grid cell for the centroid of the Class I area was used.

The grid cell total point SO_2 or NO_X emissions (Q, in tons per year) were divided by the distance (d, in kilometers) to the trajectory origin; for a final value (Q/d). This value was then multiplied by the sulfate or nitrate EWRT grid values (i.e., EWRT*(Q/d)) on a grid cell by grid cell basis. Next, the sulfate and nitrate EWRT *(Q/d) values were normalized by the domain-wide total and displayed as a percentage. This information allows the individual facilities to be ranked from highest to lowest based on sulfate and/or nitrate contributions. It should be noted that if non-normalized EWRT*(Q/d) values had been used to rank facilities from highest to lowest, the order would have been identical to the ranking from the normalized EWRT*(Q/d) values.

Figure 7-28 contains the sulfate emissions/distance extinction weighted residence time (percent of total Q/d*EWRT per 12-km modeling grid cell) for the Dolly Sods and Otter Creek Wilderness Areas. Figure 7-29 contains the nitrate emissions/distance extinction weighted residence time (percent of total Q/d*EWRT per 12-km modeling grid cell) for the Dolly Sods and Otter Creek Areas. These maps help visualize where the sources of the largest visibility impacts are located.

Figure 7-28 and Figure 7-29 illustrate the relative importance of West Virginia sources of SO_2 and NO_X, respectively, compared to sources in neighboring states.



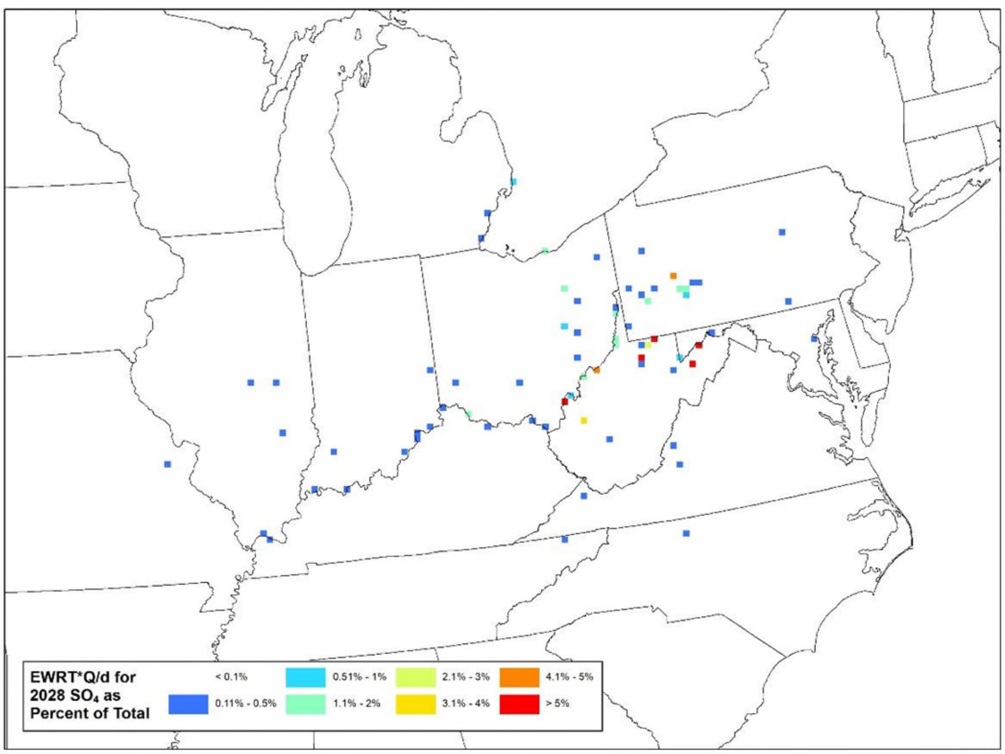


Figure 7-28: Sulfate Emissions/Distance Extinction Weighted Residence Time (% of Total Q/d*EWRT per 12km Modeling Grid Cell) for the Dolly Sods and Otter Creek Wilderness Areas – Full View (top) and Class I Zoom (bottom)

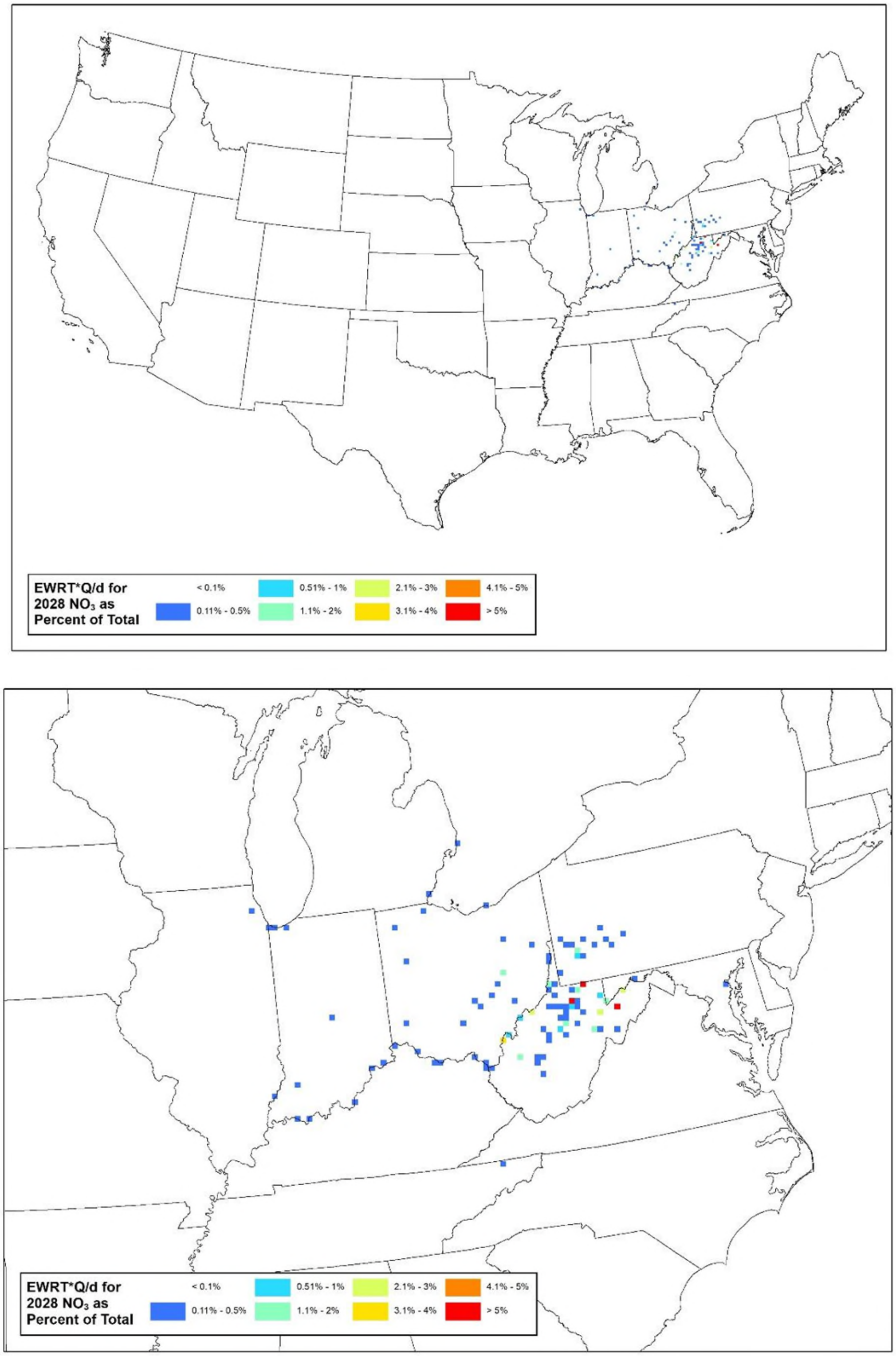


Figure 7-29: Nitrate Emissions/Distance Extinction Weighted Residence Time (% of Total Q/d*EWRT per 12km Modeling Grid Cell) for the Dolly Sods and Otter Creek Wilderness Areas – Full View (top) and Class I Zoom (bottom)

7.5.5. Ranking of Sources for West Virginia Class I Areas

The Q/d*EWRT data was further paired with additional point source metadata that defined the facility. Such data included facility identification numbers, facility names, state and county of location, Federal Information Processing Standard (FIPS) codes, North American Industry Classification System (NAICS) codes, and industry description. Spreadsheets for individual Class I areas were then exported from the database for further analysis by the states. This information allows the individual facilities to be ranked from highest to lowest based on sulfate and/or nitrate contributions.

It should be noted that while point sources account for most of the sulfate extinction, these sources only account for a portion of the nitrate extinction. Much of the nitrate extinction can be attributable to the onroad and nonpoint sectors. As such, a similar analysis for county level data was conducted, that included county total point source contributions. This allows the point source contribution to be directly compared to the other source categories.

Similar analyses were conducted to rank SO_2 and NO_X emissions contributions for the county-level sources (nonpoint, onroad, nonroad, fires, and total point source sectors). The process was similar to the process for point sources previously described, except calculations of RT and EWRT were completed at the county-level as opposed to grid cells. The calculation of "d" was from the centroid of the county to the trajectory origin, in km. Like point sources, the final spatial join was made between the county-level EWRT, emissions, and source information for each sector.

Table 7-10 contains the NO_X and SO_2 source contributions to visibility impairment on the 20% most impaired days at Dolly Sods Wilderness Area. Table 7-11 contains the NO_X and SO_2 source contributions to visibility impairment on the 20% most impaired days at Otter Creek Wilderness Area. Based on these contributions, SO_2 from point sources is the dominant source category at Dolly Sods Wilderness Area (80.79%), and Otter Creek Wilderness Area (77.87%).

Table 7-10: NO_X and SO_2 Source Contributions to Visibility Impairment on the 20% Most Impaired Days at Dolly Sods Wilderness Area

Category	NO_X	SO_2	Total
Nonpoint	2.87%	6.97%	9.84%
Nonroad, MAR	0.63%	0.11%	0.74%
Nonroad, Other	0.65%	0.04%	0.69%
Onroad	1.31%	0.16%	1.47%
Point	5.86%	80.79%	86.65%
Pt_Fires_Prescribed	0.07%	0.54%	0.61%
Totals	**11.40%**	**88.60%**	**100.00%**

Table 7-11: NO_X and SO_2 Source Contributions to Visibility Impairment on the 20% Most Impaired Days at Otter Creek Wilderness Area

Category	NO_X	SO_2	Total
Nonpoint	3.75%	7.46%	11.22%
Nonroad, MAR	0.73%	0.10%	0.83%
Nonroad, Other	0.67%	0.05%	0.72%
Onroad	1.44%	0.17%	1.61%
Point	7.14%	77.87%	85.01%
Pt_Fires_Prescribed	0.06%	0.55%	0.61%
Totals	**13.81%**	**86.19%**	**100.00%**

To compare the contributions from counties on a relative basis, an additional analysis was conducted by adding new columns to normalize the EWRT*(Q/d) by the area of each county to develop a metric to compare the contributions from counties on a relative basis. The previous calculation (prior to being normalized by area) had a propensity to attribute higher contributions to larger counties simply because they typically contained more emission sources and more hourly trajectory end points. Normalizing the contribution by the area of the county (i.e., EWRT*(Q/d) per square kilometer) provides a sense of the source emission density within the county. This allows county contributions to be directly compared, without large counties being weighted more heavily by simply having more emission sources and more hourly trajectory end points. County contributions (normalized or non-normalized by area) can be found in Appendix D.

All county and emissions source identifying information were joined in an Access database with calculations of Q/d, EWRT, EWRT*(Q/d), fraction and sum contributions, and any other source information. The database was then used to generate individual spreadsheets for each Class I area.

Table 7-12 contains the AoI NO_X and SO_2 facility contributions to visibility impairment on the 20% most impaired days at Dolly Sods Wilderness Area. Table 7-13 contains the AoI NO_X and SO_2 facility contributions to visibility impairment on the 20% most impaired days at Otter Creek Wilderness Area. These tables only show the facilities contributing more than 1.00% sulfate + nitrate. The full list of all facilities can be found in Appendix D. The lists of individual facilities identified by the AoI analysis for each Class I area were used to determine which facilities were tagged in the PSAT source contribution analysis.

Table 7-12: AoI NO_X and SO_2 Facility Contributions to Visibility Impairment on the 20% Most Impaired Days at Dolly Sods Wilderness Area

State	Facility ID	Facility Name	Distance (km)	2028 NO_X (tpy)	2028 SO_2 (tpy)	Nitrate (%)	Sulfate (%)	Sulfate + Nitrate (%)
WV	54033-6271711	ALLEGHENY ENERGY SUPPLY CO, LLC-HARRISON	83.6	11,830.9	10,082.9	1.36%	13.58%	14.94%
WV	54023-6257011	Dominion Resources, Inc. - MOUNT STORM POWER STATION	17.5	1,984.1	2,123.6	0.35%	10.57%	10.92%
OH	39053-8148511	General James M. Gavin Power Plant (0627010056)	233.8	8,122.5	41,595.8	0.10%	7.62%	7.72%
WV	54061-6773611	MONONGAHELA POWER CO.- FORT MARTIN POWER	79.8	13,743.3	4,881.9	1.07%	6.53%	7.61%
MD	24001-7763811	Luke Paper Company	51.7	3,607.0	9,876.0	0.13%	5.35%	5.48%
WV	54073-4782811	MONONGAHELA POWER CO-PLEASANTS POWER STA	163.9	5,497.4	16,817.4	0.16%	4.64%	4.81%
PA	42005-3866111	GENON NE MGMT CO/KEYSTONE STA	172.8	6,578.5	56,939.2	0.01%	4.12%	4.13%
WV	54079-6789111	APPALACHIAN POWER COMPANY - JOHN E AMOS PLANT	219.8	4,878.1	10,984.2	0.11%	3.56%	3.67%
WV	54061-16320111	LONGVIEW POWER	81.2	1,556.6	2,313.7	0.12%	3.04%	3.16%
WV	54049-4864511	AMERICAN BITUMINOUS POWER-GRANT TOWN PLT	81.3	1,245.1	2,210.3	0.11%	2.48%	2.60%
OH	39093-8130811	Avon Lake Power Plant (0247030013)	347.6	3,600.7	21,188.9	0.01%	1.53%	1.54%
WV	54051-6902311	MITCHELL PLANT	144.2	2,719.6	5,372.4	0.07%	1.45%	1.51%
OH	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station (1413090154)	416.9	7,150.0	22,133.9	0.02%	1.40%	1.42%
OH	39081-8115711	Cardinal Power Plant (Cardinal Operating Company) (0641050002)	163.9	2,467.3	7,460.8	0.03%	1.36%	1.39%
WV	54061-6773811	MORGANTOWN ENERGY ASSOCIATES	75.1	655.6	828.6	0.05%	1.18%	1.23%
PA	42063-3005211	HOMER CITY GEN LP/ CENTER TWP	157.5	5,216.0	11,865.7	0.02%	1.12%	1.14%
PA	42063-3005111	NRG WHOLESALE GEN/SEWARD GEN STA	148.4	2,254.6	8,880.3	0.01%	1.01%	1.02%
OH	39169-3950711	Department of Public Utilities, City of Orrville, Ohio (0285010188)	278.2	1,901.9	13,038.0	0.01%	0.99%	1.00%

Table 7-13: AoI NO_X and SO_2 Facility Contributions to Visibility Impairment on the 20% Most Impaired Days at Otter Creek Wilderness Area

State	Facility ID	Facility Name	Distance (km)	2028 NO_X (tpy)	2028 SO_2 (tpy)	Nitrate (%)	Sulfate (%)	Sulfate + Nitrate (%)
WV	54033-6271711	ALLEGHENY ENERGY SUPPLY CO, LLC-HARRISON	72.8	11,830.9	10,082.9	1.81%	17.37%	19.18%
OH	39053-8148511	General James M. Gavin Power Plant (0627010056)	214.2	8,122.5	41,595.8	0.18%	10.46%	10.64%
WV	54073-4782811	MONONGAHELA POWER CO-PLEASANTS POWER STA	148.3	5,497.4	16,817.4	0.30%	8.19%	8.49%
WV	54061-6773611	MONONGAHELA POWER CO.- FORT MARTIN POWER	82.7	13,743.3	4,881.9	0.92%	4.98%	5.90%
WV	54079-6789111	APPALACHIAN POWER COMPANY - JOHN E AMOS PLANT	198.0	4,878.1	10,984.2	0.12%	4.36%	4.48%
PA	42005-3866111	GENON NE MGMT CO/KEYSTONE STA	186.5	6,578.5	56,939.2	0.03%	3.73%	3.76%
WV	54049-4864511	AMERICAN BITUMINOUS POWER-GRANT TOWN PLT	77.0	1,245.1	2,210.3	0.09%	2.63%	2.72%
WV	54061-16320111	LONGVIEW POWER	83.4	1,556.6	2,313.7	0.10%	2.34%	2.44%
OH	39081-8115711	Cardinal Power Plant (Cardinal Operating Company) (0641050002)	162.7	2,467.3	7,460.8	0.05%	1.94%	1.99%
WV	54023-6257011	Dominion Resources, Inc. - MOUNT STORM POWER STATION	39.9	1,984.1	2,123.6	0.06%	1.89%	1.96%
MD	24001-7763811	Luke Paper Company	73.2	3,607.0	9,876.0	0.04%	1.83%	1.87%
WV	54051-6902311	MITCHELL PLANT	136.8	2,719.6	5,372.4	0.06%	1.56%	1.62%
OH	39031-8010811	Conesville Power Plant (0616000000)	232.8	9,957.9	6,356.2	0.17%	1.12%	1.29%
OH	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station (1413090154)	397.5	7,150.0	22,133.9	0.02%	1.12%	1.15%
OH	39111-7983111	Ormet Primary Aluminum Corp. (0656000001)	129.6	0.4	2,470.8	0.00%	1.14%	1.14%
OH	39093-8130811	Avon Lake Power Plant (0247030013)	345.6	3,600.7	21,188.9	0.01%	1.12%	1.13%
OH	39053-7983011	Ohio Valley Electric Corp., Kyger Creek Station (0627000003)	215.3	9,143.8	3,400.1	0.20%	0.85%	1.05%
OH	39167-8130511	Kraton Polymers U.S. LLC (0684010011)	175.1	555.8	2,061.8	0.02%	1.02%	1.04%
OH	39167-8130611	Orion Engineered Carbons LLC (0684010049)	169.6	391.8	1,933.3	0.02%	0.99%	1.00%

7.6. Screening of Sources for Reasonable Progress Analysis

To gain a better understanding of the source contributions to modeled visibility, VISTAS used CAMx PSAT modeling. PSAT uses multiple tracer families to track the fate of both primary and secondary PM. PSAT allows emissions to be tracked (tagged) for individual facilities as well as various combinations of sectors and geographic areas (e.g., by state).

VISTAS states used the NO_X and SO_2 facility contributions from the AoI analysis to help select sources to be tagged with PSAT. Each state submitted their list of facilities to be tagged. In the end, SO_2 and NO_X emissions for 87 individual facilities were tagged and the visibility contributions (Mm^{-1}) for the 20% most impaired days were determined at all Class I areas in the VISTAS_12 domain. In addition, PSAT tags previously discussed in Section 7.4 include total sulfate and nitrate contributions from EGU + non-EGU point sources at each Class I area. This allows a percent contribution (individual facility contribution divided by the total sulfate and nitrate contributions from EGU + non-EGU point sources) to be determined for each facility at each Class I area. If the sulfate contribution was greater than or equal to 1.00%, then the facility was considered for an SO_2 reasonable progress analysis. If the nitrate contribution was greater than or equal to 1.00%, then the facility was considered for a NO_X reasonable progress analysis. Details of the PSAT modeling can be found in Appendix E-7a and details of the percent contribution calculations can be found in Appendix E-7b.

7.6.1. Selection of Sources for PSAT Tagging

West Virginia used the NO_X and SO_2 facility contributions from the AoI analysis to help select sources to be tagged with PSAT. West Virginia requested that all in-state facilities with an AoI contribution of 0.2% or more be tagged with PSAT. Also, West Virginia requested that all out-of-state facilities with an AoI contribution of 0.2% or more be tagged with PSAT. West Virginia felt that this would capture the most important nearby sources as well as any large sources outside West Virginia. Based on these criteria, West Virginia selected the sources listed in Table 7-14 for PSAT tagging.

Table 7-14: Facilities Selected by West Virginia for PSAT Tagging

State	Facility ID	Facility Name	NO_X and/or SO2
WV	54033-6271711	ALLEGHENY ENERGY SUPPLY CO, LLC-HARRISON	SO_2, NO_X
WV	54049-4864511	AMERICAN BITUMINOUS POWER-GRANT TOWN PLT	SO_2, NO_X
WV	54079-6789111	APPALACHIAN POWER COMPANY - JOHN E AMOS PLANT	SO_2, NO_X
WV	54023-6257011	Dominion Resources, Inc. - MOUNT STORM POWER STATION	SO_2, NO_X
WV	54041-6900311	EQUITRANS - COPLEY RUN CS 70	NO_X
WV	54083-6790711	FILES CREEK 6C4340	NO_X
WV	54083-6790511	GLADY 6C4350	NO_X
WV	54093-6327811	KINGSFORD MANUFACTURING COMPANY	SO_2, NO_X
WV	54061-16320111	LONGVIEW POWER	SO_2, NO_X

State	Facility ID	Facility Name	NO_X and/or SO2
WV	54051-690231	MITCHELL PLANT	SO_2, NO_X
WV	54061-6773611	MONONGAHELA POWER CO.- FORT MARTIN POWER	SO_2, NO_X
WV	54073-4782811	MONONGAHELA POWER CO-PLEASANTS POWER STA	SO_2, NO_X
WV	54061-6773811	MORGANTOWN ENERGY ASSOCIATES	SO_2, NO_X
MD	24001-7763811	Luke Paper Company	SO_2, NO_X
OH	39081-8115711	Cardinal Power Plant (Cardinal Operating Company) (0641050002)	SO_2, NO_X
OH	39053-8148511	General James M. Gavin Power Plant (0627010056)	SO_2, NO_X
OH	39053-7983011	Ohio Valley Electric Corp., Kyger Creek Station (0627000003)	SO_2, NO_X
PA	42063-3005211	HOMER CITY GEN LP/ CENTER TWP	SO_2, NO_X

In addition, other VISTAS states selected sources for PSAT tagging. The detailed PSAT selection process for each VISTAS state is provided in their individual regional haze SIPs.

Based on the sources selected by West Virginia and the other VISTAS states, VISTAS selected 87 facilities for SO_2 and NO_X PSAT tagging. Some of the 87 facilities were selected by multiple states. Table 7-15 lists PSAT tags selected for facilities in Alabama and Florida. Table 7-16 lists PSAT tags selected for facilities in Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee. Table 7-17 lists PSAT tags selected for facilities in Virginia and West Virginia. Table 7-18 lists PSAT tags selected for facilities in Arkansas, Missouri, Pennsylvania, Illinois, Indiana, and Ohio. The contributions from all 87 PSAT tags were evaluated at all Class I areas in the VISTAS_12 domain.

A detailed description of the PSAT modeling and post-processing for creating PSAT contributions for Class I areas is contained in Appendix E-7a and Appendix E-7b.

Table 7-15: PSAT Tags Selected for Facilities in AL and FL

State	RPO	Facility ID	Facility Name	SO_2 (TPY)	NO_X (TPY)
AL	VISTAS	01097-949811	Akzo Nobel Chemicals Inc	3,335.72	20.71
AL	VISTAS	01097-1056111	Ala Power - Barry	6,033.17	2,275.76
AL	VISTAS	01129-1028711	American Midstream Chatom, LLC	3,106.38	425.87
AL	VISTAS	01073-1018711	DRUMMOND COMPANY, INC.	2,562.17	1,228.55
AL	VISTAS	01053-7440211	Escambia Operating Company LLC	18,974.39	349.32
AL	VISTAS	01053-985111	Escambia Operating Company LLC	8,589.60	149.64
AL	VISTAS	01103-1000011	Nucor Steel Decatur LLC	170.23	331.24
AL	VISTAS	01109-985711	Sanders Lead Co	7,951.06	121.71
AL	VISTAS	01097-1061611	Union Oil of California - Chunchula Gas Plant	2,573.15	349.23
FL	VISTAS	12123-752411	BUCKEYE FLORIDA, LIMITED PARTNERSHIP	1,520.42	1,830.71
FL	VISTAS	12086-900111	CEMEX CONSTRUCTION MATERIALS FL. LLC.	29.51	910.36
FL	VISTAS	12017-640611	DUKE ENERGY FLORIDA, INC. (DEF)	5,306.41	2,489.85
FL	VISTAS	12086-900011	FLORIDA POWER & LIGHT (PTF)	13.05	170.61
FL	VISTAS	12033-752711	GULF POWER - Crist	2,615.65	2,998.39
FL	VISTAS	12086-3532711	HOMESTEAD CITY UTILITIES	0.00	97.09
FL	VISTAS	12031-640211	JEA	2,094.48	651.79
FL	VISTAS	12105-717711	MOSAIC FERTILIZER LLC	7,900.67	310.42
FL	VISTAS	12057-716411	MOSAIC FERTILIZER, LLC	3,034.06	159.71
FL	VISTAS	12105-919811	MOSAIC FERTILIZER, LLC	4,425.56	141.02
FL	VISTAS	12089-845811	RAYONIER PERFORMANCE FIBERS LLC	561.97	2,327.10
FL	VISTAS	12089-753711	ROCK TENN CP, LLC	2,606.72	2,316.77
FL	VISTAS	12005-535411	ROCKTENN CP LLC	2,590.88	1,404.89
FL	VISTAS	12129-2731711	TALLAHASSEE CITY PURDOM GENERATING STA.	2.86	121.46
FL	VISTAS	12057-538611	TAMPA ELECTRIC COMPANY (TEC)	6,084.90	2,665.03
FL	VISTAS	12086-899911	TARMAC AMERICA LLC	9.38	879.70
FL	VISTAS	12047-769711	WHITE SPRINGS AGRICULTURAL CHEMICALS, INC	3,197.77	112.41

Table 7-16: PSAT Tags Selected for Facilities in GA, KY, MS, NC, SC, and TN

State	RPO	Facility ID	Facility Name	SO_2 (TPY)	NOx (TPY)
GA	VISTAS	13127-3721011	Brunswick Cellulose Inc	294.20	1,554.51
GA	VISTAS	13015-2813011	Ga Power Company - Plant Bowen	10,453.41	6,643.32
GA	VISTAS	13103-536311	Georgia-Pacific Consumer Products LP (Savannah River Mill)	1,860.18	351.52
GA	VISTAS	13051-3679811	International Paper – Savannah	3,945.38	1,560.73
GA	VISTAS	13115-539311	TEMPLE INLAND	1,791.00	1,773.35
KY	VISTAS	21183-5561611	Big Rivers Electric Corp - Wilson Station	6,934.16	1,151.95
KY	VISTAS	21091-7352411	Century Aluminum of KY LLC	5,044.16	197.66
KY	VISTAS	21177-5196711	Tennessee Valley Authority - Paradise Fossil Plant	3,011.01	3,114.52
KY	VISTAS	21145-6037011	Tennessee Valley Authority (TVA) - Shawnee Fossil Plant	19,504.75	7,007.34
MS	VISTAS	28059-8384311	Chevron Products Company, Pascagoula Refinery	741.60	1,534.12
MS	VISTAS	28059-6251011	Mississippi Power Company, Plant Victor J Daniel	231.92	3,829.72
NC	VISTAS	37087-7920511	Blue Ridge Paper Products - Canton Mill	1,127.07	2,992.37
NC	VISTAS	37117-8049311	Domtar Paper Company, LLC	687.45	1,796.49
NC	VISTAS	37035-8370411	Duke Energy Carolinas, LLC - Marshall Steam Station	4,139.21	7,511.31
NC	VISTAS	37013-8479311	PCS Phosphate Company, Inc. - Aurora	4,845.90	495.58
NC	VISTAS	37023-8513011	SGL Carbon LLC	261.64	21.69
SC	VISTAS	45015-4834911	ALUMAX OF SOUTH CAROLINA	3,751.69	108.08
SC	VISTAS	45043-5698611	INTERNATIONAL PAPER GEORGETOWN MILL	2,767.52	2,031.26
SC	VISTAS	45019-4973611	KAPSTONE CHARLESTON KRAFT LLC	1,863.65	2,355.82
SC	VISTAS	45015-4120411	SANTEE COOPER CROSS GENERATING STATION	4,281.17	3,273.47
SC	VISTAS	45043-6652811	SANTEE COOPER WINYAH GENERATING STATION	2,246.86	1,772.53
SC	VISTAS	45015-8306711	SCE&G WILLIAMS	392.48	992.73
TN	VISTAS	47093-4979911	Cemex - Knoxville Plant	121.47	711.50
TN	VISTAS	47163-3982311	EASTMAN CHEMICAL COMPANY	6,420.16	6,900.33
TN	VISTAS	47105-4129211	TATE & LYLE, Loudon	472.76	883.25
TN	VISTAS	47001-6196011	TVA BULL RUN FOSSIL PLANT	622.54	964.16
TN	VISTAS	47161-4979311	TVA CUMBERLAND FOSSIL PLANT	8,427.33	4,916.52
TN	VISTAS	47145-4979111	TVA KINGSTON FOSSIL PLANT	1,886.09	1,687.38

Table 7-17: PSAT Tags Selected for Facilities in VA and WV

State	RPO	Facility ID	Facility Name	SO_2 (TPY)	NO_X (TPY)
VA	VISTAS	51027-4034811	Jewell Coke Company LLP	5,090.95	520.17
VA	VISTAS	51580-5798711	Meadwestvaco Packaging Resource Group	2,115.31	1,985.69
VA	VISTAS	51023-5039811	Roanoke Cement Company	2,290.17	1,972.97
WV	VISTAS	54033-6271711	ALLEGHENY ENERGY SUPPLY CO, LLC-HARRISON	10,082.94	11,830.88
WV	VISTAS	54049-4864511	AMERICAN BITUMINOUS POWER-GRANT TOWN PLT	2,210.25	1,245.10
WV	VISTAS	54079-6789111	APPALACHIAN POWER COMPANY - JOHN E AMOS PLANT	10,984.24	4,878.10
WV	VISTAS	54023-6257011	Dominion Resources, Inc. - MOUNT STORM POWER STATION	2,123.64	1,984.14
WV	VISTAS	54041-6900311	EQUITRANS - COPLEY RUN CS 70	0.10	511.06
WV	VISTAS	54083-6790711	FILES CREEK 6C4340	0.15	643.35
WV	VISTAS	54083-6790511	GLADY 6C4350	0.11	343.29
WV	VISTAS	54093-6327811	KINGSFORD MANUFACTURING COMPANY	16.96	140.88
WV	VISTAS	54061-16320111	LONGVIEW POWER	2,313.73	1,556.57
WV	VISTAS	54051-6902311	MITCHELL PLANT	5,372.40	2,719.62
WV	VISTAS	54061-6773611	MONONGAHELA POWER CO.- FORT MARTIN POWER	4,881.87	13,743.32
WV	VISTAS	54073-4782811	MONONGAHELA POWER CO-PLEASANTS POWER STA	16,817.43	5,497.37
WV	VISTAS	54061-6773811	MORGANTOWN ENERGY ASSOCIATES	828.64	655.58

Table 7-18: PSAT Tags Selected for Facilities in AR, MO, PA, IL, IN, and OH

State	RPO	Facility ID	Facility Name	SO_2 (TPY)	NO_X (TPY)
AR	CENSARA	05063-1083411	ENTERGY ARKANSAS INC-INDEPENDENCE PLANT	32,050.48	14,133.10
MO	CENSARA	29143-5363811	NEW MADRID POWER PLANT-MARSTON	16,783.71	4,394.10
MD	MANE-VU	24001-7763811	Luke Paper Company	22,659.84	3,607.00
PA	MANE-VU	42005-3866111	GENON NE MGMT CO/KEYSTONE STA	56,939.25	6,578.47
PA	MANE-VU	42063-3005211	HOMER CITY GEN LP/ CENTER TWP	11,865.70	5,215.96
PA	MANE-VU	42063-3005111	NRG WHOLESALE GEN/SEWARD GEN STA	8,880.26	2,254.64
IL	LADCO	17127-7808911	Joppa Steam	20,509.28	4,706.35
IN	LADCO	18173-8183111	Alcoa Warrick Power Plt Agc Div of AL	5,071.28	11,158.55
IN	LADCO	18051-7363111	Gibson	23,117.23	12,280.34
IN	LADCO	18147-8017211	INDIANA MICHIGAN POWER DBA AEP ROCKPORT	30,536.33	8,806.77
IN	LADCO	18125-7362411	INDIANAPOLIS POWER & LIGHT PETERSBURG	18,141.88	10,665.27
IN	LADCO	18129-8166111	Sigeco AB Brown South Indiana Gas & Ele	7,644.70	1,578.59
OH	LADCO	39081-8115711	Cardinal Power Plant (Cardinal Operating Company) (0641050002)	7,460.79	2,467.31
OH	LADCO	39031-8010811	Conesville Power Plant (0616000000)	6,356.23	9,957.87
OH	LADCO	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station (1413090154)	22,133.90	7,149.97
OH	LADCO	39053-8148511	General James M. Gavin Power Plant (0627010056)	41,595.81	8,122.51
OH	LADCO	39053-7983011	Ohio Valley Electric Corp., Kyger Creek Station (0627000003)	3,400.14	9,143.84

7.6.2. PSAT Contributions at West Virginia Class I Areas

The original PSAT results were determined based on the initial 2028 SO_2 and NO_X point emissions, which may be found in Appendix B-1a and Appendix B-1b. As described in Section 4.1.8 and Section 7.2.4, the 2028 EGU and non-EGU point emissions were updated for a new 2028 model run (Task 2B and Task 3B reports), but the original PSAT runs were not redone. Details of the updated emissions may be found in Appendix B-2a and Appendix B-2b. Instead, the original PSAT results were linearly scaled to reflect the updated 2028 emissions. The details of the PSAT adjustments can be found in Appendix E-7b.

The adjusted PSAT results were used to calculate the percent contribution of each tagged facility to the total sulfate and nitrate point source (EGU + non-EGU) contribution at each Class I area. Then, the facilities were sorted from highest impact to lowest impact.

Table 7-19 contains PSAT results for the Dolly Sods Area. Fifteen (15) facilities where sulfate contributions are ≥1.00% are included in the table and address nearly 36.5% of the entire sulfate plus nitrate point source visibility impact in 2028. Table 7-20 contains PSAT results for the Otter Creek Wilderness Area. Fourteen (14) facilities where sulfate contributions are ≥1.00% are included in the table and address more than 34.7% of the entire sulfate plus nitrate point source visibility impact in 2028.

Table 7-21 through Table 7-27 contain the PSAT results for five West Virginia facilities significantly impacting (sulfate contributions of ≥1.00%) Acadia National Park (Maine), James River Face Wilderness Area (Virginia), Lye Brook Wilderness Area (Vermont), Moosehorn Wilderness Area (Maine), Roosevelt Campobello International Park (Maine/New Brunswick), Shenandoah National Park (Virginia), and Swanquarter Wilderness Area (North Carolina), respectively.

Allegheny Energy Supply Co LLC – Harrison (54033-6271711) impacts eight Class I areas (two inside West Virginia and six outside West Virginia), Monongahela Power Co. – Pleasants Power Station (54073-4782811) impacts six Class I areas (two inside West Virginia and four outside West Virginia), Mitchell Plant (54051-6902311) impacts four Class I areas (two inside West Virginia and two outside West Virginia), Monongahela Power Co. – Fort Martin Power (54061-6773611) impacts three Class I areas (two inside West Virginia and one outside West Virginia), Appalachian Power Company – John E. Amos Plant (54079-6789111) impacts three Class I areas (two inside West Virginia and one outside West Virginia), and American Bituminous Power – Grant Town Plant (54049-4864511) impacts one Class I area (one inside West Virginia).

The full list of tagged facilities and their contributions to each Class I area can be found in Appendix E-7b.

Table 7-19: PSAT Results for Dolly Sods Wilderness Area

State	Facility ID	Facility Name	Distance (km)	Final Revised Sulfate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Sulfate PSAT, %	Final Revised Nitrate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Nitrate PSAT, %
WV	54033-6271711	Allegheny Energy Supply Co, LLC-Harrison	83.6	1.390	18.173	7.65%	0.059	18.173	0.33%
OH	39053-8148511	General James M. Gavin Power Plant (0627010056)	233.8	0.945	18.173	5.20%	0.009	18.173	0.05%
WV	54073-4782811	MONONGAHELA POWER CO-PLEASANTS POWER STA	163.9	0.810	18.173	4.46%	0.020	18.173	0.11%
OH	39081-8115711	Cardinal Power Plant (Cardinal Operating Company) (0641050002)	163.9	0.778	18.173	4.28%	0.007	18.173	0.04%
OH	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station (1413090154)	416.9	0.288	18.173	1.58%	0.010	18.173	0.05%
WV	54051-6902311	MITCHELL PLANT	144.2	0.276	18.173	1.52%	0.009	18.173	0.05%
MD	24001-7763811	Luke Paper Company	51.7	0.265	18.173	1.46%	0.002	18.173	0.01%
PA	42005-3866111	GENON NE MGMT CO/KEYSTONE STA	172.8	0.246	18.173	1.36%	0.001	18.173	0.00%
OH	39053-7983011	Ohio Valley Electric Corp., Kyger Creek Station (0627000003)	234.9	0.229	18.173	1.26%	0.003	18.173	0.02%
WV	54079-6789111	APPALACHIAN POWER COMPANY - JOHN E AMOS PLANT	219.8	0.221	18.173	1.22%	0.006	18.173	0.03%
WV	54061-6773611	MONONGAHELA POWER CO.-FORT MARTIN POWER	79.8	0.218	18.173	1.20%	0.044	18.173	0.24%
KY	21145-6037011	Tennessee Valley Authority (TVA) - Shawnee Fossil Plant	847.6	0.204	18.173	1.12%	0.003	18.173	0.02%
IN	18051-7363111	Gibson	729.5	0.192	18.173	1.06%	0.008	18.173	0.05%
WV	54049-4864511	AMERICAN BITUMINOUS POWER-GRANT TOWN PLT	81.3	0.189	18.173	1.04%	0.006	18.173	0.03%
IN	18147-8017211	INDIANA MICHIGAN POWER DBA AEP ROCKPORT	676.3	0.187	18.173	1.03%	0.006	18.173	0.03%

Table 7-20: PSAT Results for Otter Creek Wilderness Area

State	Facility ID	Facility Name	Distance (km)	Final Revised Sulfate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Sulfate PSAT, %	Final Revised Nitrate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Nitrate PSAT, %
WV	54033-6271711	Allegheny Energy Supply Co, LLC-Harrison	72.8	1.242	17.919	6.93%	0.059	17.919	0.33%
OH	39053-8148511	General James M. Gavin Power Plant (0627010056)	214.2	1.001	17.919	5.59%	0.011	17.919	0.06%
WV	54073-4782811	MONONGAHELA POWER CO-PLEASANTS POWER STA	148.3	0.809	17.919	4.52%	0.023	17.919	0.13%
OH	39081-8115711	Cardinal Power Plant (Cardinal Operating Company) (0641050002)	162.7	0.727	17.919	4.05%	0.008	17.919	0.05%
OH	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station (1413090154)	397.5	0.302	17.919	1.69%	0.012	17.919	0.07%
WV	54051-6902311	MITCHELL PLANT	136.8	0.297	17.919	1.66%	0.010	17.919	0.06%
WV	54079-6789111	APPALACHIAN POWER COMPANY - JOHN E AMOS PLANT	198.0	0.249	17.919	1.39%	0.007	17.919	0.04%
OH	39053-7983011	Ohio Valley Electric Corp., Kyger Creek Station (0627000003)	215.3	0.242	17.919	1.35%	0.004	17.919	0.02%
KY	21145-6037011	Tennessee Valley Authority (TVA) - Shawnee Fossil Plant	826.5	0.207	17.919	1.16%	0.003	17.919	0.02%
IN	18051-7363111	Gibson	709.7	0.193	17.919	1.08%	0.009	17.919	0.05%
WV	54061-6773611	MONONGAHELA POWER CO.-FORT MARTIN POWER	82.7	0.192	17.919	1.07%	0.046	17.919	0.26%
IN	18147-8017211	INDIANA MICHIGAN POWER DBA AEP ROCKPORT	655.7	0.191	17.919	1.07%	0.007	17.919	0.04%
PA	42005-3866111	GENON NE MGMT CO/KEYSTONE STA	186.5	0.190	17.919	1.06%	0.001	17.919	0.00%
MD	24001-7763811	Luke Paper Company	73.2	0.180	17.919	1.00%	0.001	17.919	0.01%

Table 7-21: PSAT Results for West Virginia Facilities Significantly Impacting Acadia National Park (ME)

State	Facility ID	Facility Name	Distance (km)	Final Revised Sulfate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Sulfate PSAT, %	Final Revised Nitrate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Nitrate PSAT, %
WV	54033-6271711	Allegheny Energy Supply Co, LLC-Harrison	1143.1	0.035	3.363	1.04%	0.003	3.363	0.10%

Table 7-22: PSAT Results for West Virginia Facilities Significantly Impacting James River Face Wilderness Area (VA)

State	Facility ID	Facility Name	Distance (km)	Final Revised Sulfate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Sulfate PSAT, %	Final Revised Nitrate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Nitrate PSAT, %
WV	54033-6271711	Allegheny Energy Supply Co, LLC-Harrison	207.6	0.526	13.557	3.88%	0.020	13.557	0.15%
WV	54073-4782811	MONONGAHELA POWER CO-PLEASANTS POWER STA	248.0	0.325	13.557	2.40%	0.007	13.557	0.05%
WV	54079-6789111	APPALACHIAN POWER COMPANY - JOHN E AMOS PLANT	223.5	0.278	13.557	2.05%	0.016	13.557	0.12%
WV	54051-6902311	MITCHELL PLANT	269.6	0.156	13.557	1.15%	0.006	13.557	0.04%

Table 7-23: PSAT Results for West Virginia Facilities Significantly Impacting Lye Brook Wilderness Area (VT)

State	Facility ID	Facility Name	Distance (km)	Final Revised Sulfate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Sulfate PSAT, %	Final Revised Nitrate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Nitrate PSAT, %
WV	54073-4782811	MONONGAHELA POWER CO-PLEASANTS POWER STA	808.2	0.088	8.708	1.01%	0.003	8.708	0.04%

Table 7-24: PSAT Results for West Virginia Facilities Significantly Impacting Moosehorn Wilderness Area (ME)

State	Facility ID	Facility Name	Distance (km)	Final Revised Sulfate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Sulfate PSAT, %	Final Revised Nitrate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Nitrate PSAT, %
WV	54033-6271711	Allegheny Energy Supply Co, LLC-Harrison	1238.9	0.032	2.821	1.13%	0.003	2.821	0.09%

Table 7-25: PSAT Results for West Virginia Facilities Significantly Impacting Roosevelt Campobello International Park (NB)

State	Facility ID	Facility Name	Distance (km)	Final Revised Sulfate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Sulfate PSAT, %	Final Revised Nitrate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Nitrate PSAT, %
WV	54033-6271711	Allegheny Energy Supply Co, LLC-Harrison	1238.9	0.032	2.821	1.13%	0.003	2.821	0.09%

Table 7-26: PSAT Results for West Virginia Facilities Significantly Impacting Shenandoah National Park (VA)

State	Facility ID	Facility Name	Distance (km)	Final Revised Sulfate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Sulfate PSAT, %	Final Revised Nitrate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Nitrate PSAT, %
WV	54033-6271711	Allegheny Energy Supply Co, LLC-Harrison	189.7	0.636	14.387	4.42%	0.070	14.387	0.49%
WV	54073-4782811	MONONGAHELA POWER CO-PLEASANTS POWER STA	265.0	0.339	14.387	2.35%	0.043	14.387	0.30%
WV	54051-6902311	MITCHELL PLANT	251.8	0.155	14.387	1.08%	0.025	14.387	0.17%
WV	54061-6773611	MONONGAHELA POWER CO.- FORT MARTIN POWER	184.4	0.149	14.387	1.04%	0.093	14.387	0.64%

Table 7-27: PSAT Results for West Virginia Facilities Significantly Impacting Swanquarter Wilderness Area (NC)

State	Facility ID	Facility Name	Distance (km)	Final Revised Sulfate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Sulfate PSAT, %	Final Revised Nitrate PSAT (Mm^{-1})	Final Revised EGU+NEG (Mm^{-1})	Final Revised Nitrate PSAT, %
WV	54033-6271711	Allegheny Energy Supply Co, LLC-Harrison	568.6	0.186	10.292	1.81%	0.013	10.292	0.12%
WV	54073-4782811	MONONGAHELA POWER CO-PLEASANTS POWER STA	625.7	0.127	10.292	1.24%	0.005	10.292	0.05%

7.6.3. AoI versus PSAT Contributions

After the PSAT modeling was completed, a comparison was made of PSAT results to AoI results. The PSAT results used in this comparison did not incorporate any PSAT adjustments discussed in Appendix E-7b to better match the emissions used in the AoI analysis. Only PSAT contributions greater than or equal to 1.00% were included in the analysis. Figure 7-30 shows the ratio of AoI/PSAT contributions for sulfate as a function of distance from the facility to the Class I area. Figure 7-31 shows the fractional bias (FB) for sulfate as a function of distance from the facility to the Class I area. FB is equal to 2*(AoI – PSAT)/(AoI + PSAT). Fractional bias gives equal weight to over predictions and under predictions. If FB equals 100%, then the AOI contribution is three times higher than the PSAT contribution.

Based on Figure 7-30 and Figure 7-31, AoI tends to overestimate impacts for facilities near the Class I area. In fact, if the facility is less than 100 km from the Class I area, the AoI results are almost always at least three times higher than the PSAT results. As a result, some sources near a Class I area were tagged for PSAT but were found to not have a significant contribution to visibility impairment. PSAT is the most reliable modeling tool for tracking facility contributions to visibility impairment at Class I areas. Therefore, AoI impacts for nearby sources can be adjusted downward to remove the systematic bias in the contributions. Also, AoI tends to underestimate impacts for facilities in other states that are far away from the Class I area. Although AoI may underestimate the impact of some far away sources, the visibility impairment of those sources was likely included in the PSAT analysis and found to be significantly contributing to visibility impairment in the Class I area because they were tagged for PSAT analysis by states with Class I areas that are closer to those sources.

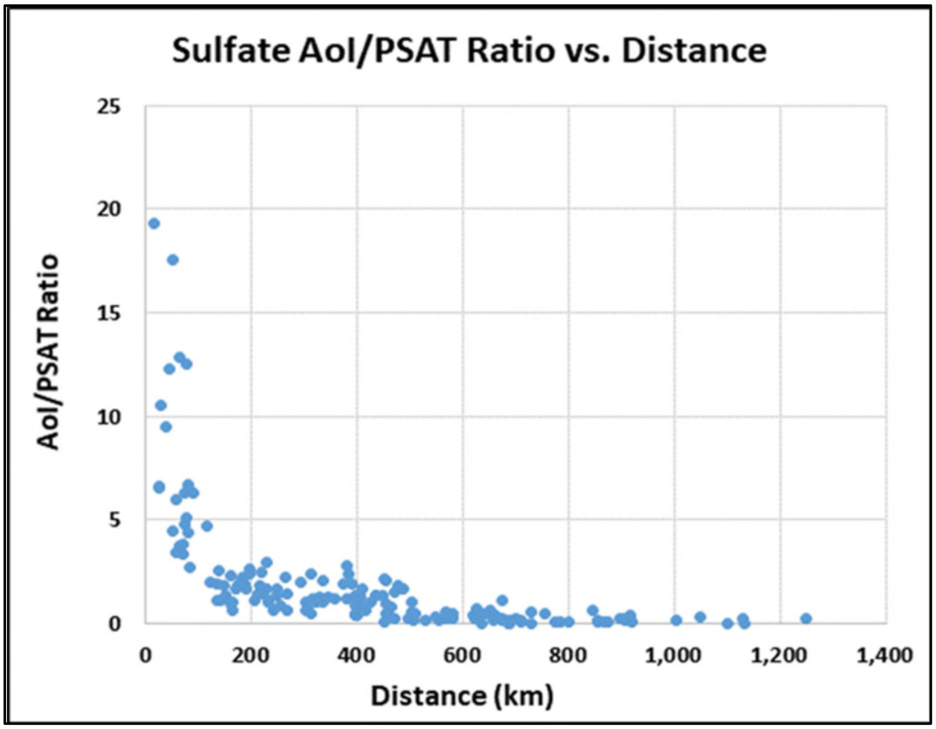


Figure 7-30: Ratio of AoI/PSAT % Contributions for Sulfate as a Function of Distance from the Facility to the Class I Area

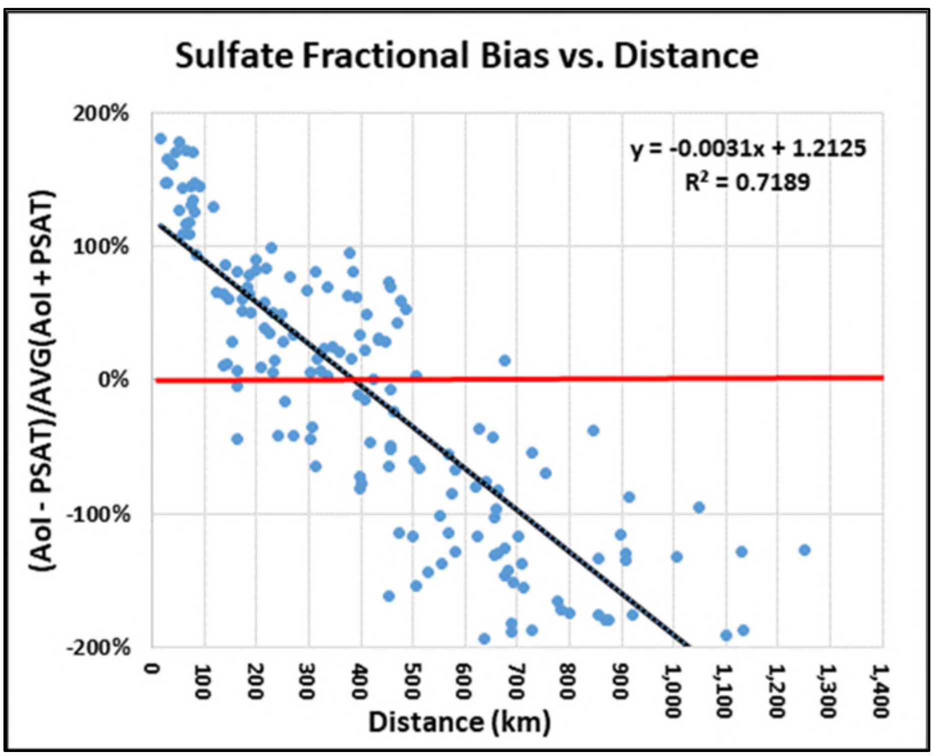


Figure 7-31: Fractional Bias for Sulfate as a Function of Distance from the Facility to the Class I Area

Although many facilities were tagged with PSAT, there are some facilities identified by AoI with a sulfate + nitrate contribution over 1% that were not tagged.

Table 7-28 lists AoI NO_X and SO_2 facility contributions to visibility impairment on the 20% most impaired days at the Dolly Sods Wilderness Area; there are seven facilities in the table that were not tagged with PSAT and are identified as such. Table 7-29 lists AoI NO_X and SO_2 facility contributions to visibility impairment on the 20% most impaired days at the Otter Creek Wilderness Area; there are eight facilities in the table that were not tagged with PSAT, and these are also identified.

Table 7-28: AoI NO_X and SO_2 Facility Contributions to Visibility Impairment on the 20% Most Impaired Days at Dolly Sods Wilderness Area

State	Facility ID	Facility Name	Distance (km)	2028 NO_X (tpy)	2028 SO_2 (tpy)	Nitrate (%)	Sulfate (%)	Sulfate + Nitrate (%)
WV	54033-6271711	ALLEGHENY ENERGY SUPPLY CO, LLC-HARRISON	83.6	11,830.9	10,082.9	1.36%	13.58%	14.94%
WV	54023-6257011	Dominion Resources, Inc. - MOUNT STORM POWER STATION(1)	17.5	1,984.1	2,123.6	0.35%	10.57%	10.92%
OH	39053-8148511	General James M. Gavin Power Plant (0627010056)	233.8	8,122.5	41,595.8	0.10%	7.62%	7.72%
WV	54061-6773611	MONONGAHELA POWER CO.- FORT MARTIN POWER	79.8	13,743.3	4,881.9	1.07%	6.53%	7.61%
MD	24001-7763811	Luke Paper Company	51.7	3,607.0	9,876.0	0.13%	5.35%	5.48%
WV	54073-4782811	MONONGAHELA POWER CO-PLEASANTS POWER STA	163.9	5,497.4	16,817.4	0.16%	4.64%	4.81%
PA	42005-3866111	GENON NE MGMT CO/KEYSTONE STA	172.8	6,578.5	56,939.2	0.01%	4.12%	4.13%
WV	54079-6789111	APPALACHIAN POWER COMPANY - JOHN E AMOS PLANT	219.8	4,878.1	10,984.2	0.11%	3.56%	3.67%
WV	54061-16320111	LONGVIEW POWER(1)	81.2	1,556.6	2,313.7	0.12%	3.04%	3.16%
WV	54049-4864511	AMERICAN BITUMINOUS POWER-GRANT TOWN PLT	81.3	1,245.1	2,210.3	0.11%	2.48%	2.60%
OH	39093-8130811	Avon Lake Power Plant (0247030013) (1)	347.6	3,600.7	21,188.9	0.01%	1.53%	1.54%
WV	54051-6902311	MITCHELL PLANT	144.2	2,719.6	5,372.4	0.07%	1.45%	1.51%
OH	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station (1413090154)	416.9	7,150.0	22,133.9	0.02%	1.40%	1.42%
OH	39081-8115711	Cardinal Power Plant (Cardinal Operating Company) (0641050002)	163.9	2,467.3	7,460.8	0.03%	1.36%	1.39%
WV	54061-6773811	MORGANTOWN ENERGY ASSOCIATES(1)	75.1	655.6	828.6	0.05%	1.18%	1.23%
PA	42063-3005211	HOMER CITY GEN LP/ CENTER TWP(1)	157.5	5,216.0	11,865.7	0.02%	1.12%	1.14%
PA	42063-3005111	NRG WHOLESALE GEN/SEWARD GEN STA(1)	148.4	2,254.6	8,880.3	0.01%	1.01%	1.02%
OH	39169-3950711	Department of Public Utilities, City of Orrville, Ohio (0285010188) (1)	278.2	1,901.9	13,038.0	0.01%	0.99%	1.00%

(1) These facilities had <1.00% sulfate or nitrate total visibility impacts in the PSAT analysis.

Table 7-29: AoI NO_X and SO_2 Facility Contributions to Visibility Impairment on the 20% Most Impaired Days at Otter Creek Wilderness Area

State	Facility ID	Facility Name	Distance (km)	2028 NO_X (tpy)	2028 SO_2 (tpy)	Nitrate (%)	Sulfate (%)	Sulfate + Nitrate (%)
WV	54033-6271711	ALLEGHENY ENERGY SUPPLY CO, LLC-HARRISON	72.8	11,830.9	10,082.9	1.81%	17.37%	19.18%
OH	39053-8148511	General James M. Gavin Power Plant (0627010056)	214.2	8,122.5	41,595.8	0.18%	10.46%	10.64%
WV	54073-4782811	MONONGAHELA POWER CO-PLEASANTS POWER STA	148.3	5,497.4	16,817.4	0.30%	8.19%	8.49%
WV	54061-6773611	MONONGAHELA POWER CO.- FORT MARTIN POWER	82.7	13,743.3	4,881.9	0.92%	4.98%	5.90%
WV	54079-6789111	APPALACHIAN POWER COMPANY - JOHN E AMOS PLANT	198.0	4,878.1	10,984.2	0.12%	4.36%	4.48%
PA	42005-3866111	GENON NE MGMT CO/KEYSTONE STA	186.5	6,578.5	56,939.2	0.03%	3.73%	3.76%
WV	54049-4864511	AMERICAN BITUMINOUS POWER-GRANT TOWN PLT(1)	77.0	1,245.1	2,210.3	0.09%	2.63%	2.72%
WV	54061-16320111	LONGVIEW POWER(1)	83.4	1,556.6	2,313.7	0.10%	2.34%	2.44%
OH	39081-8115711	Cardinal Power Plant (Cardinal Operating Company) (0641050002)	162.7	2,467.3	7,460.8	0.05%	1.94%	1.99%
WV	54023-6257011	Dominion Resources, Inc. - MOUNT STORM POWER STATION(1)	39.9	1,984.1	2,123.6	0.06%	1.89%	1.96%
MD	24001-7763811	Luke Paper Company	73.2	3,607.0	9,876.0	0.04%	1.83%	1.87%
WV	54051-6902311	MITCHELL PLANT	136.8	2,719.6	5,372.4	0.06%	1.56%	1.62%
OH	39031-8010811	Conesville Power Plant (0616000000) (1)	232.8	9,957.9	6,356.2	0.17%	1.12%	1.29%
OH	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station (1413090154)	397.5	7,150.0	22,133.9	0.02%	1.12%	1.15%
OH	39111-7983111	Ormet Primary Aluminum Corp. (0656000001) (1)	129.6	0.4	2,470.8	0.00%	1.14%	1.14%
OH	39093-8130811	Avon Lake Power Plant (0247030013) (1)	345.6	3,600.7	21,188.9	0.01%	1.12%	1.13%
OH	39053-7983011	Ohio Valley Electric Corp., Kyger Creek Station (0627000003)	215.3	9,143.8	3,400.1	0.20%	0.85%	1.05%
OH	39167-8130511	Kraton Polymers U.S. LLC (0684010011) (1)	175.1	555.8	2,061.8	0.02%	1.02%	1.04%
OH	39167-8130611	Orion Engineered Carbons LLC (0684010049) (1)	169.6	391.8	1,933.3	0.02%	0.99%	1.00%

(1) These facilities had <1.00% sulfate or nitrate total visibility impacts in the PSAT analysis.

7.6.4. Selection of Sources for Reasonable Progress Evaluation

The EPA has made clear that each state has the authority to select the sources to evaluate for reasonable progress analysis and to determine the factors used in making such selection as long as the factors used in the process are explained and justified in the state's plan. Subsection 169A(b) requires the EPA to "provide guidelines to the **States**" [emphasis added] and "require **each applicable implementation plan for a State**" [emphasis added] to address reasonable progress including the requirement for long-term strategies. In promulgating its regional haze rules, the EPA stated that "**The State must include in its implementation plan a description of the criteria it used to determine which sources or groups of sources** it evaluated and how the four factors were taken into consideration in selecting the measures for inclusion in its long-term strategy." [emphasis added] The EPA's August 20, 2019, guidance on Regional Haze SIPs for the second implementation period, goes on to clearly state that the selection of emission sources for analysis is the responsibility of the state. The EPA guidance states the following:

> The Regional Haze Rule does not explicitly list factors that a state must or may not consider when selecting the sources for which it will determine what control measures are necessary to make reasonable progress. A state opting to select a set of its sources to analyze must reasonably choose factors and apply them in a reasonable way given the statutory requirement to make reasonable progress towards natural visibility. Factors could include, but are not limited to, baseline source emissions, baseline source visibility impacts (or a surrogate metric for the impacts), the in-place emission control measures and by implication the emission reductions that are possible to achieve at the source through additional measures, the four statutory factors (to the extent they have been characterized at this point in SIP development), potential visibility benefits (also to the extent they have been characterized at this point in SIP development), and the five additional required factors listed in 40 CFR 51.308(f)(2)(iv).

The EPA guidance further discusses which pollutants to consider. The guidance discusses methods for estimating baseline visibility impacts for selected sources, including residence time analysis and photochemical modeling, both of which were used by West Virginia and other VISTAS states. The selection of pollutants to consider and the residence time analysis are discussed in Section 7.4 and Section 7.5 of this SIP. The use of photochemical modeling to better understand source contribution to modeled visibility and further refine the sources selected is discussed in Section 7.6.

The EPA guidance also discussed using estimates of visibility impacts to select sources including the use of a visibility impact threshold level for selecting sources. West Virginia, as well as the other VISTAS states, have used a two-step process for selecting sources. The first step was a screening analysis using the NO_X and SO_2 source category and facility contributions from the AoI analysis described in Section 7.5. The second step was CAMx PSAT modeling of the sources selected in the first step. Sources were then selected for reasonable progress analysis. This two-step process was used to select sources having the largest contribution to visibility impairment, and thus, greatest opportunity for reasonable progress improvement at Class I areas. This process also resulted in selecting sources that West Virginia, and states that contribute to West Virginia Class I areas, could analyze with the limited resources available to the state. Sources selected for analysis by West Virginia include sources that contribute to visibility impairment in both West Virginia and non-West Virginia Class I areas. Thresholds selected for each of the steps are discussed in this document. As explained in Section 7.6.3, PSAT modeling resulted in significantly different results than the AoI analysis. Therefore, it is appropriate to have different percentage thresholds for these two steps in the selection process. The EPA's guidance states, "Whatever threshold is used, the state must justify why the use of that threshold is a reasonable approach…" The justification for the thresholds used in both steps of the selection process are described in this plan.

In the regional haze SIPs developed for the first round of implementation, many VISTAS states used the AoI approach and a 1% threshold <u>by unit</u>. In this second round of implementation for regional haze SIPs, all VISTAS states are using the AoI/PSAT approach and a ≥1.00% PSAT threshold <u>by facility</u> for screening sources for reasonable progress evaluation. Using a facility basis for emission estimates includes more facilities as compared to a unit basis for emission estimates. During the first round of regional haze SIP development, 2018 emissions were used as the starting point and 2018 Class I visibility impacts were used in the denominator of the percent contribution calculations. In this second round of implementation for regional haze, VISTAS states are using projected 2028 SO_2 and NO_X emissions in the denominator of the percent contribution calculations. As a result, more facilities with smaller visibility impacts (in Mm^{-1}) were examined as compared to the first round of regional haze implementation. Overall, the VISTAS screening approach results in a reasonable number of sources that can be evaluated with limited state resources and focuses on the sources and pollutants with the largest impacts.

Based on the PSAT results presented in Table 7-19 and Table 7-20, all facilities with a greater than or equal to 1.00% PSAT threshold for sulfate or nitrate were examined for reasonable progress (fifteen facilities for the Dolly Sods Wilderness Area and fourteen facilities for the Otter Creek Wilderness Areas). One facility, American Bituminous Power - Grant Town Plant, exceeded the 1.00% PSAT threshold for the Dolly Sods Wilderness Area and was not considered for a further reasonable progress review. This decision and justification are discussed further below.

American Bituminous Power - Grant Town Plant (54049-4864511)

The Grant Town Power Plant is located approximately 81 km from the Dolly Sods Wilderness Area and 77 km from the Otter Creek Wilderness Area. Unlike other EGUs in the state, this facility operates an eastern bituminous coal refuse-fired boiler. The facility consists of two CFB boilers, which are designed to combust the low Btu coal refuse. Limestone is introduced directly into the combustion area to capture and remove SO_2. Combustion temperatures for this type of boiler are approximately 1,000 degrees less than more conventional boilers and result in the lesser formation of thermal NOx. Under the MATS rules, for Grant Town's type of operation, the boilers are allowed an SO_2 emission rate of 0.6 lbs/mmBtu. In its Title V permit (R30-04900026-2020(SM01)), Grant Town accepted an annual SO_2 emission rate limit of 0.46 lbs/mmBtu or a potential-to-emit of 2,206.5 tons per year. In the PSAT modeling 2,210 tons per year of SO_2 was used to determine Grant Town's percent contribution to visibility, which was more than Grant Town's permit limit and represented a PSAT contribution of 1.04% for Dolly Sods as shown in Table 7-19. The percent contribution to Otter Creek was less than 1.00%. Grant Town's highest SO_2 emissions in the last three years was 1,685 tons. The 2028 SO_2 emissions were projected from the 2011 base year; therefore, the more recent emissions better predict the facility's future emissions. Scaling the AoI sulfate contribution to Dolly Sods of 2.48%, as shown in Table 7-12, by the ratio of the most recent higher SO_2 emissions to the projected 2028 emissions (1,685/2,210) results in a revised AoI sulfate contribution of 1.89%. According to Section 7.6.3, if a facility is less than 100 km for the Class I Area, the AoI results are always at least three times higher than the PSAT result. Reducing the AoI contribution by the conservative factor of three results in a predicted PSAT contribution of 0.63%. Therefore, based on the Title V SO_2 permit limits, PSAT modeling results and the discussion above, this facility was not selected for a reasonable progress analysis as the weight of evidence supports the conclusion that this facility is not a significant contributor to visibility impairment at the Dolly Sods and Otter Creek Wilderness Areas. Further discussion of Grant Town is included below in Section 7.8, Reasonable Progress for Individual Sources to be Included in the Long-Term Strategy.

Table 7-17 list facilities that were tagged for a PSAT analysis based on exceeding West Virginia's 0.2% AoI contribution threshold but did not exceed or equal the 1.00% PSAT threshold for sulfate or nitrate. These facilities are discussed below as further justification why they were not selected for a reasonable progress analysis.

Dominion Resources Mount Storm Power Station (54023-6257011)

Mount Storm Power Station (Mount Storm) is located approximately 18 km from the Dolly Sods Wilderness Area and 40 km from the Otter Creek Wilderness Area, and northeast of these areas. Based on HYSPLIT evaluations and generally prevailing winds, meteorological conditions limit Mount Storm's visibility contribution to these areas. Additionally, all three-unit boilers are equipped with BART, Clean Air Interstate Rule (CAIR), and MATS pollution controls. These controls include a Flue Gas Desulfurization (FGD) system for SO_2 control and low-NO_X burners and a Selective Catalytic Reduction (SCR) system for NO_X control. Per the facility's current federally enforceable Title V permit (R30-022300003-2016), which includes all applicable Consent Decrees, each unit boiler must meet a 30-day rolling average NO_X emission rate of 0.110 lb/mmBtu. Each unit boiler must also meet a 30-day rolling average 95% percent or better SO_2 removal, meet an emission rate of 0.20 lb/mmBtu, and the FGD must be operated at all times when the unit it serves is operational. This facility is also subject to a multi-state VEPCO Consent Decree with additional VEPCO system wide SO_2 and NO_X limits and conditions. See sections 7.2.2 and 13.3.1.1.3 for additional discussions concerning this Consent Decree. Furthermore, Mount Storm is subject to the EPA's Group 3 Revised CSAPR Update rule Federal Implementation Plan (FIP) which mandates lower NO_X emission allocations than the previous CSAPR rules. For West Virginia, the CSAPR Group 3 NO_X allocations are 24% less than the previous Group 2 allocations. Therefore, based on the PSAT modeling visibility contribution results and the discussion above, this facility was not selected for a reasonable progress analysis as the weight of evidence supports the conclusion that this facility is not a significant contributor to visibility impairment at the Dolly Sods and Otter Creek Wilderness Areas.

Longview Power (54061-16320111)

Longview Power (Longview) is located approximately 81 km from the Dolly Sods Wilderness Area and 83 km from the Otter Creek Wilderness Area. The facility is the newest of West Virginia's EGU fleet built in 2007. The facility operates one boiler that has historically been the most efficient coal-fired operating facility in the United States. BART, CAIR, and MATS applicable air pollution control devices are employed by the facility, which are used to control SO_2 and NO_X emissions. Low-NO_X burners and a selective catalytic reduction (SCR) system are used to control NO_X emissions and a flue gas desulfurization system is used to control SO_2 emissions. Longview's current federally enforceable Title V permit (R30-06100134-2018) limits NO_X emissions from the boiler to a rate of 0.065 lb/mmBtu and SO_2 emissions to a rate of 0.095 lb/mmBtu. The boiler is subject to the National Emission Standards for Hazardous Air Pollutants (NESHAP): Coal- and Oil-Fired Electric Utility Steam Generating Units (40 CFR 63, Subpart UUUUU). This NSPS limits SO_2 emissions to a rate of 0.20 lb/mmBtu. The SO_2 emission rate established by the Title V permit is substantially less than the NESHAP limit. Furthermore, Longview is subject to the EPA's Group 3 Revised CSAPR Update rule Federal Implementation Plan (FIP) which mandates lower NO_X emission allocations than the previous

CSAPR rules. For West Virginia, the CSAPR Group 3 NO_X allocations are 24% less than the previous Group 2 allocations. Therefore, based on the PSAT modeling visibility contribution results and the discussion above, this facility was not selected for a reasonable progress analysis as the weight of evidence supports the conclusion that this facility is not a significant contributor to visibility impairment at the Dolly Sods and Otter Creek Wilderness Areas.

Morgantown Energy Associates (54061-6773811)

Morgantown Energy Associates (MEA) is located approximately 75 km from the Dolly Sods Wilderness Area and 76 km from the Otter Creek Wilderness Area. The facility historically operated two CFB boilers to provide steam to West Virginia University (WVU) and electricity via the electrical grid to FirstEnergy subsidiary Allegheny Power. In January 2020, MEA filed a permit application to cease operations of these two boilers. Although these boilers are shut down, facility SO_2 and NO_X emissions were still included in the PSAT modeling. See Section 7.2.2.2 for more details on MEA. Therefore, based on the PSAT modeling visibility contribution results and the shutdown of these boilers, this facility was not selected for a reasonable progress analysis as the weight of evidence supports the conclusion that this facility is not a significant contributor to visibility impairment at the Dolly Sods and Otter Creek Wilderness Areas.

Equitrans - Copley Run Compressor Station #70 (54041-6900311)

Copley Run Compressor Station #70 (Copley Run) is a natural gas dehydration and compression transmission facility located approximately 96 km from the Dolly Sods Wilderness Area and 76 km from the Otter Creek Wilderness Area. The facility operates five two-stroke lean burn reciprocating engines with integral natural gas compressors per the conditions of a federally enforceable Title V permit (R30-04100029-2018). Since the facility utilizes pipeline quality natural gas (PQNG) for fuel and the sulfur content of the gas is extremely low, SO_2 emissions are also low. The facility was tagged for PSAT modeling because AoI NO_X emissions were greater than West Virginia's 0.2% threshold contribution. Natural gas compressor engine exhaust stacks are typically about 25 feet tall. As compared to EGU stacks and other industrial stacks that are hundreds of feet tall, compressor engine stacks are short. Because of these short stacks, and the comparatively low stack exhaust temperatures, emissions from these engines are not likely to travel great distances. This is particularly true when West Virginia's mountainous topography is considered. With the stack characteristics and the complex mountainous terrain, NO_X emissions from these engines have a greater local impact than a transport impact. Therefore, based on the PSAT modeling visibility contribution results and the discussion above, this facility was not selected for a reasonable progress analysis as the weight of evidence supports the conclusion that this facility is not a significant contributor to visibility impairment at the Dolly Sods and Otter Creek Wilderness Areas. In addition, as discussed in Section 2.4.2, sulfate emissions have a significantly greater visibility impact than nitrate emissions.

Files Creek 6C4340 (54083-6790711)

Files Creek 6C4340 (Files Creek) is a natural gas compression transmission facility located approximately 48 km from the Dolly Sods Wilderness Area and 26 km from the Otter Creek Wilderness Area. The facility operates four two-cycle lean burn reciprocating engines with integral natural gas compressors and four gas turbine driven natural gas compressors equipped with SoLoNO$_X$ NO$_X$ controls. The facility operates per a federally enforceable Title V permit (R30-08300019-2018 (SM01)) which limits emissions, and PQNS is burned as fuel in these engines. This natural gas is extremely low in sulfur content; therefore, SO_2 emissions from the engines are also low. Files Creek was tagged for PSAT modeling because it exceeded West Virginia's 0.2% AoI contribution threshold for NO_X emissions. Emission stacks associated with these compressor engines are typically about 25 feet tall. When compared to EGU and other industrial stacks which are hundreds of feet tall, these stacks are very short. With these short stacks, and comparatively low stack temperatures, engine emissions are not expected to travel great distances. In addition, because West Virginia is very mountainous, the state's topography greatly reduces the transport of emissions from short stacks with low plume rise. As a result, NO_X emissions from these engines would have a more localized effect instead of impacting further downwind areas. Therefore, based on the PSAT modeling visibility contribution results and the discussion above, this facility was not selected for a reasonable progress analysis as the weight of evidence supports the conclusion that this facility is not a significant contributor to visibility impairment at the Dolly Sods and Otter Creek Wilderness Areas. In addition, as discussed in Section 2.4.2, sulfate emissions have a significantly greater visibility impact than nitrate emissions.

Glady 6C4350 (54083-6790511)

Glady 6C4350 (Glady) is a natural gas dehydration and compression transmission facility located approximately 43 km from the Dolly Sods Wilderness Area and 24 km from the Otter Creek Wilderness Area. The facility operates three four-cycle lean burn reciprocating engines with integral natural gas compressors per a federally enforceable Title V permit (R30-08300017-2018 (MM01 and MM02)). Pipeline quality natural gas is used for fuel in these engines, which contains an extremely low sulfur content; consequently, SO_2 emissions from these engines are also low. The facility was tagged for PSAT modeling because it exceeded West Virginia's 0.2% AoI contribution threshold for NO_X emissions. Compressor engine stacks are typically about 25 feet tall, which is short compared to EGU and other industrial stack heights that are hundreds of feet tall. Because of the short stacks, and comparatively low stack temperature, emissions from these engine stacks are not expected to travel any great distances. When coupled with West Virginia's mountainous terrain, emissions from these engines are physically hampered from traveling far. As a result, NO_X emissions from these engines would have a more localized effect instead of affecting areas at a greater distance. Therefore, based on the PSAT modeling visibility contribution results and the discussion above, Glady was not selected for a reasonable progress analysis as the weight of evidence supports the conclusion that this facility is not a significant contributor to visibility impairment at the Dolly Sods and Otter Creek Wilderness Areas. In addition, as discussed in Section 2.4.2, sulfate emissions have a significantly greater visibility impact than nitrate emissions.

Kingsford Manufacturing Company (54093-6327811)

The Kingsford Manufacturing Company (Kingsford) in Parsons, West Virginia is located approximately 23 km from the Dolly Sods Wilderness Area and 9 km from the Otter Creek Wilderness Area. The facility's predominant SO_2 and NO_X emissions are from their wood dryer/retort furnace, which is used to produce charcoal briquets. The facility was tagged for PSAT modeling because AoI SO_2 and NO_X emissions contributed more than West Virginia's 0.2% threshold contributions at 0.35% and 2.84%, respectively. Based on HYSPLIT evaluations and generally prevailing winds, meteorological conditions limit Kingsford's visibility contribution to these areas and the PSAT modeling results indicated that Kingsford was less than the 1.00% VISTAS contribution threshold. For Dolly Sods, Kingsford PSAT contribution was 0.051% for SO_2 and 0.0037% for NO_X. At Otter Creek, the PSAT contribution was 0.037% for SO_2 and 0.0037% for NO_X. Kingsford operates under a federally enforceable Title V permit (R30-09300004-2019 (MM01)) which limits facility maximum SO_2 and NO_X emissions. This permit limits facility wide SO_2 emissions to 64.94 tons per year and NO_X emissions to 250.79 tons per year. Projected 2028 SO_2 and NO_X emissions used in the PSAT modeling were 16.96 tons of SO_2 and 140.88 tons of NO_X, which represent typical annual emissions. To evaluate PSAT contribution and the maximum potential-to-emit permitted levels, a ratio of the permitted limit SO_2 (64.94/16.96) and NO_X (250.79/140.88) to the projected 2028 emissions can be used to estimate the PSAT percent contribution at the permitted levels. Based on these ratios, the maximum SO_2 and NO_X PSAT percent contribution at Dolly Sods would be 0.30% and 0.0067%, respectively. At Otter Creek, the SO_2 PSAT contribution would be 0.22% and NO_X would be 0.0067%. In all cases, the PSAT percent contribution even at the maximum permitted levels would still be significantly lower than VISTAS's 1.00% threshold. Therefore, based on the PSAT modeling visibility contribution results and the discussion above, Kingsford was not selected for a reasonable progress analysis as the weight of evidence supports the conclusion that this facility is not a significant contributor to visibility impairment at the Dolly Sods and Otter Creek Wilderness Areas. In addition, as discussed in Section 2.4.2, sulfate emissions have a significantly greater visibility impact than nitrate emissions.

One West Virginia coal-fired EGU was not tagged for the PSAT modeling; however, it was evaluated to determine if a reasonable progress analysis was warranted. This facility is further discussed below.

Mountaineer Plant (54053-6760811)

The Mountaineer Plant (Mountaineer) is located 218 km from the Dolly Sods Wilderness Area and 198 km from the Otter Creek Wilderness Area. The facility is a coal-fired EGU that operates one boiler. This boiler is equipped with low-NO_X burners and a selective catalytic reduction (SCR) system to control NO_X emissions and a fluidized gas desulfurization (FGD) system to control SO_2 emissions. These controls comply with the BART, CAIR, and MATS regulations. Mountaineer operates under a federally enforceable Title V permit (R30-05300009-2020), which limits the boiler to an SO_2 emission rate of 1.0 lb/mmBtu on a 3-hour block average. Additionally, the boiler must meet a 0.20 lb/mmBtu SO_2 emission rate limit on a 30-boiler operating day rolling average and requires the FGD to be always operational when the boiler is operating normally. Mountaineer's NO_X emission rate is also permit-limited to 0.70 lb/mmBtu on a 3-hour rolling average. Likewise, the SCR must be continuously operated when the boiler is operating normally. Furthermore, Mountaineer is subject to the EPA's Group 3 Revised CSAPR Update (RCU) rule Federal Implementation Plan (FIP) which mandates lower NO_X emission allocations than the previous CSAPR rules. For West Virginia, the CSAPR Group 3 NO_X allocations are 24% less than the previous Group 2 allocations. Therefore, based on the PSAT modeling visibility contribution results and the discussion above, this facility was not selected for a reasonable progress analysis as the weight of evidence supports the conclusion that this facility is not a significant contributor to visibility impairment at the Dolly Sods and Otter Creek Wilderness Areas.

In addition to the 0.2% AoI visibility contribution threshold West Virginia used to select facilities for PSAT modeling, the appropriateness of that selection can be based on a facility's Q/d as compared to the total Q/d for all West Virginia facilities contributing to the Dolly Sods and Otter Creek Wilderness Areas visibility. Table 7-30 shows the Q/d for each West Virginia facility in Table 7-17 that exceeded the 0.2% contribution threshold for SO_2 and NO_X in the projected year 2028. Each facility was then compared to the total Q/d for all contributing West Virginia facilities and expressed as a percent of the total. For Dolly Sods, the total Q/d from all facilities was 608 for SO_2 and 717 for NO_X and represents 303 contributing facilities. The 13 selected facilities represented 92.23% of the total Q/d for SO_2 and 80.63% of the NO_X total Q/d. This data further verifies that these selected facilities best represent those facilities potentially impacting visibility at Dolly Sods and were the right facilities to tag for the PSAT modeling. Including additional facilities would have had limited impact on potential visibility improvement and would have tasked limited resources.

Table 7-30: Facilities AoI > 0.2% Share of Total Q/d at Dolly Sods Wilderness Area

Facility ID	Facility Name	2028 SO_2 Facility Q/d	2028 SO_2 Percent of Total Q/d	2028 NO_X Facility Q/d	2028 NO_X Percent of Total Q/d
54023-6257011	Dominion Resources, Inc. - MOUNT STORM POWER STATION	122	20	114	15.85
54033-6271711	ALLEGHENY ENERGY SUPPLY CO, LLC-HARRISON	121	19.84	142	19.74
54073-4782811	MONONGAHELA POWER CO-PLEASANTS POWER STA	103	16.87	33.5	4.67
54061-6773611	MONONGAHELA POWER CO.- FORT MARTIN POWER	61.2	10.07	172	24.03
54079-6789111	APPALACHIAN POWER COMPANY - JOHN E AMOS PLANT	50	8.22	22.2	3.1
54051-6902311	MITCHELL PLANT	37.3	6.13	18.9	2.63
54061-16320111	LONGVIEW POWER	28.5	4.69	19.2	2.67
54049-4864511	AMERICAN BITUMINOUS POWER-GRANT TOWN PLT	27.2	4.47	15.3	2.14
54061-6773811	MORGANTOWN ENERGY ASSOCIATES	11	1.81	8.73	1.22
54093-6327811	KINGSFORD MANUFACTURING COMPANY	0.73	0.12	6.03	0.84
54041-6900311	EQUITRANS - COPLEY RUN CS 70	0.001	0	5.32	0.74
54083-6790711	FILES CREEK 6C4340	0.003	0	13.5	1.89
54083-6790511	GLADY 6C4350	0.003	0	7.93	1.11
	Totals:	**578**	**92.23%**	**561**	**80.63%**
	Total Q/d from All WV Facilities Contributing to Visibility:	**608**		**717**	
	Number of WV Facilities Contributing:	**303**		**303**	

Table 7-31 shows the Q/d comparison for the Otter Creek Wilderness Area. The same methodology and calculations used in Table 7-30 were used for this comparison. For Otter Creek, the total Q/d from all facilities was 577 for SO_2 and 714 for NO_X and represents 303 contributing facilities. The 13 selected facilities represented 91.50% of the total Q/d for SO_2 and 78.94% of the NO_X total Q/d. Again, this data further verifies that these selected facilities best represent those facilities potentially impacting visibility at Otter Creek and were the right facilities to tag for the PSAT modeling. Including additional facilities would have had limited impact on potential visibility improvement and would have tasked limited resources.

Table 7-31: Facilities AoI > 0.2% Share of Total Q/d at Otter Creek Wilderness Area

Facility ID	Facility Name	2028 SO_2 Facility Q/d	2028 SO_2 Percent of Total Q/d	2028 NO_X Facility Q/d	2028 NO_X Percent of Total Q/d
54033-6271711	ALLEGHENY ENERGY SUPPLY CO, LLC-HARRISON	139	24	163	22.8
54073-4782811	MONONGAHELA POWER CO-PLEASANTS POWER STA	113	19.7	37.1	5.19

Facility ID	Facility Name	2028 SO_2		2028 NO_X	
		Facility Q/d	Percent of Total Q/d	Facility Q/d	Percent of Total Q/d
54061-6773611	MONONGAHELA POWER CO.- FORT MARTIN POWER	59	10.2	166	23.3
54079-6789111	APPALACHIAN POWER COMPANY - JOHN E AMOS PLANT	55.5	9.61	24.6	3.45
54023-6257011	Dominion Resources, Inc. - MOUNT STORM POWER STATION	53.2	9.21	49.7	6.96
54051-6902311	MITCHELL PLANT	39.3	6.81	19.9	2.78
54049-4864511	AMERICAN BITUMINOUS POWER-GRANT TOWN PLT	28.7	4.98	16.2	2.27
54061-16320111	LONGVIEW POWER	27.7	4.81	18.7	2.61
54061-6773811	MORGANTOWN ENERGY ASSOCIATES	10.9	1.88	8.59	1.2
54093-6327811	KINGSFORD MANUFACTURING COMPANY	1.72	0.3	14.3	2
54041-6900311	EQUITRANS - COPLEY RUN CS 70	0.001	0	6.72	0.94
54083-6790711	FILES CREEK 6C4340	0.006	0	25.2	3.53
54083-6790511	GLADY 6C4350	0.005	0	14.1	1.97
Totals:		**564**	**91.50%**	**528**	**78.94%**
Total Q/d from All WV Facilities Contributing to Visibility:		**577**		**714**	
Number of WV Facilities Contributing:		**303**		**303**	

Based on the analysis above, 15 facilities were identified to evaluate additional controls for reasonable progress for West Virginia's Class I areas. Table 7-32 contains a list of facilities in West Virginia selected for reasonable progress analysis. Table 7-33 contains a list of facilities in VISTAS states but not located in West Virginia selected for reasonable progress analysis. Table 7-34 contains a list of facilities in non-VISTAS states selected for reasonable progress analysis.

Table 7-32: Facilities in West Virginia Selected for Reasonable Progress Analysis

State	Facility ID	Facility Name
WV	54033-6271711	ALLEGHENY ENERGY SUPPLY CO, LLC-HARRISON
WV	54049-4864511	AMERICAN BITUMINOUS POWER-GRANT TOWN PLT
WV	54061-6773611	MONONGAHELA POWER CO.- FORT MARTIN POWER
WV	54073-4782811	MONONGAHELA POWER CO-PLEASANTS POWER STA
WV	54051-6902311	MITCHELL PLANT
WV	54079-6789111	APPALACHIAN POWER COMPANY - JOHN E AMOS PLANT

Table 7-33: Facilities in VISTAS States (not including West Virginia) Selected for Reasonable Progress Analysis

State	Facility ID	Facility Name
KY	21145-6037011	Tennessee Valley Authority (TVA) - Shawnee Fossil Plant

Table 7-34: Facilities Located Outside of VISTAS States Selected for Reasonable Progress Analysis

State	Facility ID	Facility Name
MD	24001-7763811	Luke Paper Company
IN	18051-7363111	Gibson
IN	18147-8017211	INDIANA MICHIGAN POWER DBA AEP ROCKPORT
OH	39081-8115711	Cardinal Power Plant (Cardinal Operating Company) (0641050002)
OH	39053-8148511	General James M. Gavin Power Plant (0627010056)
OH	39053-7983011	Ohio Valley Electric Corp., Kyger Creek Station (0627000003)
OH	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station (1413090154)
PA	42005-3866111	GENON NE MGMT CO/KEYSTONE STA

7.6.5. Evaluation of Recent Emission Inventory Information

The regional haze rule at 40 CFR 51.308(f)(2)(iii) requires the state to document the emissions information on which the state is relying to determine the emission reduction measures that are necessary to make reasonable progress in each mandatory federal Class I area it affects. The emissions information must include, but need not be limited to, information on emissions in a year at least as recent as the most recent year for which the state has submitted emission inventory information to the EPA Administrator in compliance with the triennial reporting requirements.

West Virginia examined the 2017, 2018, and 2019 emission information that has been reported to the EPA and compared these emissions to the 2028 emissions that were used in the modeling. Table 7-35 shows all the facilities with SO_2 emissions greater than 100 tpy in 2017 and Table 7-36 shows all the facilities with NO_X emissions greater than 100 tpy in 2017. Table 7-35 is sorted from highest SO_2 in 2017 to lowest. Table 7-36 is sorted from highest NO_X in 2017 to lowest. In addition to 2017 emissions, the tables have 2018 and 2019 emissions, if available. Projected emissions for 2028 are also shown as the 2028 original values used in the first model and as the 2028 remodel values used in the second model run. The last three columns show the difference between the 2028 remodel emissions and 2017, 2018, and 2019 emissions, respectively. A total emissions summary is shown at the bottom of each table.

Facilities with large differences (±1,000 tpy) between 2028 and 2017/18/19 emissions were noted. These large differences are all associated with West Virginia's coal-fired EGUs. EGUs were originally modeled using ERTAC2.7 and later remodeled using ERTAC16.0. ERTAC16.0 incorporated the latest known facility operational information in addition to projected regional coal usages based on the U.S. Energy Information Administration's Annual Energy Outlook. With West Virginia having some of the most efficient and best controlled coal-fired units in the nation, it is not surprising to see higher SO_2 and NO_X emission projections. As other coal-fired EGUs in the nation are shutting down, West Virginia facilities are expected to be dispatched more frequently to meet regional electric power demand.

ERTAC models emissions regionally. Therefore, not all West Virginia EGUs included in ERTAC are modeled in the same region. One such example is Dominion's Mount Storm facility which is modeled with other states' EGUs such as Virginia. For Mount Storm, projected 2028 SO_2 and NO_X emissions are expected to be lower than the 2017-2019 emissions inventory data due to different modeling parameters than the other West Virginia EGUs. An expected decrease in 2028 emissions is also supported by Mount Storm's SO_2 and NO_X emission decreases from 2017-2019 of approximately 1,000 tpy for each pollutant over the three-year reporting period.

To the extent possible, the WVDAQ updated the non-EGU facility SO_2 and NO_X emissions based on our knowledge of current and future operations and emissions. Section 7.2.2 discusses further process operational changes, such as shutdowns and fuel conversions, and emissions changes for both EGUs and non-EGUs.

The 2017-2019 SO_2 and NO_X emissions versus the 2028 remodeled emission comparisons in Tables 7-35 and 7-36 are considered reasonable by the WVDAQ. Total 2017-2019 SO_2 and NO_X emissions are at the bottom of Tables 7-35 and 7-36. Overall, total 2028 remodeled emissions are greater than the three-year period totals. Although the modeled emissions are greater, the WVDAQ believes these emissions provide a conservative estimate of visibility at any Class I area. Therefore, this emissions data review does not change West Virginia's conclusion regarding reasonable progress or the long-term strategy.

Table 7-35: SO_2 Emissions Comparison Between 2017, 2018, 2019, and 2028

EIS Facility ID	Facility	SO_2 2017 (tpy)	SO_2 2018 (tpy)	SO_2 2019 (tpy)	SO_2 2028 Original (tpy)	SO_2 2028 Remodel (tpy)	SO_2 2028 Remodel minus 2017 (tpy)	SO_2 2028 Remodel minus 2018 (tpy)	SO_2 2028 Remodel minus 2019 (tpy)
4782811	Pleasants Power Station	10,821	11,191	7,044	16,817	11,502	681	311	4,458
6271711	MONONGAHELA POWER CO. - HARRISON	7,944	12,381	11,153	10,083	10,356	2,412	-2,025	-797
6789111	APPALACHIAN POWER COMPANY - JOHN E AMOS PLANT	5,717	4,714	3,518	1,094	6,098	381	1,384	2,580
6760811	APPALACHIAN POWER - MOUNTAINEER PLANT	4,111	3,365	4,600	2,214	6,362	2,251	2,997	1,762
6902311	KENTUCKY POWER COMPANY - MITCHELL PLANT	3,236	2,494	2,062	5,372	4,230	994	1,736	2,168
6257011	Dominion Resources, Inc. - MOUNT STORM POWER STATION	2,749	2,189	1,879	2,124	954	-1,795	-1,235	-925
4864511	AMERICAN BITUMINOUS POWER-GRANT TOWN PLT	1,964	1,685	1,685	2,211	2,824	860	1,139	1,139
16320111	LONGVIEW POWER	1,739	2,044	2,158	2,314	2,337	598	293	179
17634211	Chemours Washington Works	1,626	1,629	1,474	1,602	1,602	-24	-27	128
6773611	MONONGAHELA POWER CO.- FORT MARTIN POWER	1,552	4,931	4,240	4,882	3,056	1,504	-1,875	-1,184
4985711	WEST VIRGINIA ALLOYS, INC.	1,121	1,134	1,276	745	1,080	-41	-54	-196
6773811	MORGANTOWN ENERGY FACILITY	703	583	541	829	3	-700	-580	-538
4987611	ARGOS USA - MARTINSBURG	528	596	676	531	637	109	41	-39
6883611	OX PAPERBOARD, LLC - HALLTOWN MILL	385	371	14	349	349	-36	-22	335
9015711	MARION COUNTY MINE PREPARATION PLANT	312	279	115	379	379	67	100	264
4864311	MOUNTAIN STATE CARBON, LLC	299	438	547	648	598	299	160	51
13396911	Felman Production Inc. - NEW HAVEN PLANT	120	164	116	532	532	412	368	416
6773711	MONONGALIA COUNTY MINE PREPARATION PLANT	120	141	144	121	121	1	-20	-23
	Total Emissions:	**45,049**	**50,329**	**43,240**	**52,847**	**53,020**	**7,971**	**2,691**	**9,780**

Table 7-36: NO_X Emissions Comparison Between 2017, 2018, 2019, and 2028

EIS Facility ID	Facility	NO_X 2017 (tpy)	NO_X 2018 (tpy)	NO_X 2019 (tpy)	NO_X 2028 Original (tpy)	NO_X 2028 Remodel (tpy)	NO_X 2028 Remodel minus 2017 (tpy)	NO_X 2028 Remodel minus 2018 (tpy)	NO_X 2028 Remodel minus 2019 (tpy)
6773611	MONONGAHELA POWER CO.- FORT MARTIN POWER	9,498	8,607	9,393	13,743	11,998	2,500	3,391	2,605
6271711	MONONGAHELA POWER CO. - HARRISON	8,057	8,348	5,669	11,831	10,017	1,960	1,669	4,348
6789111	APPALACHIAN POWER COMPANY - JOHN E AMOS PLANT	6,240	6,067	4,667	4,878	7,293	1,053	1,226	2,626
4782811	Pleasants Power Station	5,921	5,853	4,524	5,497	5,729	-192	-124	1,205
6902311	KENTUCKY POWER COMPANY - MITCHELL PLT	3,487	2,354	2,278	2,720	3,967	480	1,613	1,689
6760811	APPALACHIAN POWER - MOUNTAINEER PLANT	3,291	2,535	3,589	2,590	4,773	1,482	2,238	1,184
6257011	Dominion Resources, Inc. - MOUNT STORM POWER STATION	2,980	2,444	1,875	1,984	965	-2,015	-1,479	-910
4864511	AMERICAN BITUMINOUS POWER-GRANT TOWN PLT	1,672	1,459	1,459	1,245	1,736	64	277	277
16320111	LONGVIEW POWER	1,208	1,425	1,533	1,557	2,237	1,029	812	704
6773811	MORGANTOWN ENERGY FACILITY	1,142	1,123	1,091	656	216	-926	-907	-875
4985711	WEST VIRGINIA ALLOYS, INC.	1,066	1,079	1,049	680	1,019	-47	-60	-30
4987611	ARGOS USA - MARTINSBURG	1,007	1,038	1,108	1,007	938	-69	-100	-170
17634211	Chemours Washington Works	844	846	778	840	840	-4	-6	62
6341411	Columbia Gas - CEREDO 4C3360	662	749	726	727	727	65	-22	1
4878711	Eagle Natrium, LLC	594	398	605	573	413	-181	15	-192
4864311	MOUNTAIN STATE CARBON, LLC	502	529	579	856	837	335	308	258
6790511	Columbia Gas - GLADY 6C4350	492	429	545	343	343	-149	-86	-202
6256711	Columbia Gas - GLENVILLE 4C1170	440	393	224	440	440	0	47	216

EIS Facility ID	Facility	NO_X 2017 (tpy)	NO_X 2018 (tpy)	NO_X 2019 (tpy)	NO_X 2028 Original (tpy)	NO_X 2028 Remodel (tpy)	NO_X 2028 Remodel minus 2017 (tpy)	NO_X 2028 Remodel minus 2018 (tpy)	NO_X 2028 Remodel minus 2019 (tpy)
6341511	Columbia Gas - KENOVA 4C3350	433	416	375	476	476	43	60	101
6900411	DOMINION - CAMDEN COMPRESSOR STATION	371	335	268	454	454	83	119	186
6885211	Columbia Gas - COCO 4C1150	361	361	383	322	322	-39	-39	-61
6885411	DOMINION - CORNWELL COMPRESSOR STN	350	43	193	345	345	-5	302	152
6760611	Columbia Gas - ADALINE 7C6600	327	220	208	332	332	5	112	124
6885011	Columbia Gas - LANHAM 4C4590	325	217	14	127	127	-198	-90	113
6900311	Equitrans, L.P. - COPLEY RUN CS 70	324	266	279	511	511	187	245	232
6214811	DOMINION - OSCAR NELSON COMPRESSOR STN	295	354	374	460	460	165	106	86
6776911	Columbia Gas - TERRA ALTA 6C4360	276	180	294	241	241	-35	61	-53
6776011	Greer Industries, Inc. dba Greer Lime Company - Riverton FACILITY	264	246	237	232	232	-32	-14	-5
6255811	DOMINION - YELLOW CREEK CS	262	242	293	300	300	38	58	7
6328011	DOMINION - DEEP VALLEY COMPRESSOR STN	258	235	230	195	195	-63	-40	-35
6900611	DOMINION - SWEENEY COMPRESSOR STATION	253	353	318	249	249	-4	-104	-69
6214911	DOMINION - LOUP CREEK COMP. STN	247	167	129	260	260	13	93	131
6256011	Equitrans, L.P. - WEST UNION CS 53	219	45	35	139	139	-80	94	104
6884211	Chemours - Belle	217	266	268	319	319	102	53	51
6327111	DOMINION - CRAIG COMPRESSOR STATION	209	184	180	171	171	-38	-13	-9
6233711	Cranberry Pipeline Corporation - DANVILLE COMPRESSOR STATION	200	186	198	247	247	47	61	49
6234211	BURNSVILLE COMPRESSOR STATION #71	196	106	148	163	75	-121	-31	-73
6271511	DOMINION - SARDIS COMPRESSOR STATION	188	150	195	262	262	74	112	67

EIS Facility ID	Facility	NO_X 2017 (tpy)	NO_X 2018 (tpy)	NO_X 2019 (tpy)	NO_X 2028 Original (tpy)	NO_X 2028 Remodel (tpy)	NO_X 2028 Remodel minus 2017 (tpy)	NO_X 2028 Remodel minus 2018 (tpy)	NO_X 2028 Remodel minus 2019 (tpy)
6328311	DOMINION - PEPPER COMPRESSOR STATION	170	162	156	117	175	5	13	19
6342511	DOMINION - HASTINGS COMPRESSOR STATION	157	107	108	161	161	4	54	53
9015711	MARION COUNTY MINE PREPARATION PLT	147	131	54	134	134	-13	3	80
5768711	CONSTELLIUM ROLLED PRODUCTS - RAVENSWOOD	141	135	131	136	136	-5	1	5
6256811	DOMINION - JONES COMPRESSOR STATION	138	111	126	182	182	44	71	56
6235811	Steel Dynamics, Inc. - SWVA, INC.	137	143	138	130	130	-7	-13	-8
6214511	Pinnacle Mining Company, LLC - Pinnacle Preparation Plant	134	135	0	135	135	1	0	135
6271411	DOMINION - WILSONBURG COMPRESSOR STATION	134	129	136	132	132	-2	3	-4
6153111	ARCELORMITTAL WEIRTON LLC	131	104	90	40	40	-91	-64	-50
6271611	DOMINION - LAW COMPRESSOR STATION	125	150	223	171	171	46	21	-52
6327811	KINGSFORD MANUFACTURING COMPANY - Parsons	120	110	113	141	141	21	31	28
6255911	DOMINION - ORMA COMPRESSOR STATION	119	88	119	180	180	61	92	61
4958611	WEYERHAEUSER NR COMPANY - SUTTON OSB	115	110	115	53	53	-62	-57	-62
6776411	PLEASANTS ENERGY, LLC	106	106	150	102	102	-4	-4	-48
4781911	ERGON - WEST VIRGINIA, INC.	102	118	88	99	99	-3	-19	11
	Total Emissions:	**56,653**	**52,087**	**48,057**	**59,885**	**62,176**	**5,523**	**10,089**	**14,119**

7.7. Evaluating the Four Statutory Factors for Specific Emissions Sources

Section 169A(g)(1) of the CAA and the regional haze rule at 40 CFR 51.308(f)(2)(i) require a state to evaluate the following four "statutory" factors when establishing the RPG for any Class I area within a state: (1) cost of compliance, (2) time necessary for compliance, (3) energy and non-air quality environmental impacts of compliance, and (4) remaining useful life of any existing source subject to such requirements.

On August 20, 2019, EPA issued a memorandum entitled "Guidance on Regional Haze State Implementation Plan for the Second Implementation Period." This memorandum included guidance for characterizing the four statutory factors including which emission control measures to consider, selection of emission information for characterizing emissions-related factors, characterizing the cost of compliance (statutory factor 1), characterizing the time necessary for compliance (statutory factor 2), characterizing energy and non-air environmental impacts (statutory factor 3), characterizing remaining useful life of the source (statutory factor 4), characterizing visibility benefits, and reliance on previous analysis and previously approved approaches. The memorandum also contains guidance on decisions on what control measures are necessary to make reasonable progress. This guidance was used in evaluating the four statutory factors for the facilities in West Virginia selected for reasonable progress analysis as identified in Table 7-29. The results of these analyses are found in Section 7.8.

7.8. Reasonable Progress for Individual Sources to be Included in the Long-Term Strategy

The following discussion relates to the process for determining reasonable progress for West Virginia sources, which includes reasonable progress assessments for all units with modeled PSAT contributions ≥1.00% to any Class I area in West Virginia or in neighboring states.

<u>Reasonable Progress Evaluations and Four Factor Analyses</u>

On November 4, 2020, the WVDAQ requested reasonable progress evaluations from five of the six West Virginia facilities listed in Table 7-32, and if the facility considered a control to be technically feasible then also a four-factor analysis for that additional SO_2 control. All of these facilities are coal or coal waste fired EGUs, and as such are already subject to and in compliance with many federal and state air pollution regulatory programs, including MATS, Continuous Emission Monitoring (40 CFR 75), and CSAPR. Because of this, high quality emissions data from these facilities is regularly reported to EPA CAMD. These six facilities and their respective responses to the WVDAQ requests are discussed in more detail below. The WVDAQ's facility requests and the facility responses are in Appendix G.

Monongahela Power Company – Harrison Power Station (54033-6271711)

Harrison Power Station (Harrison), now owned by FirstEnergy subsidiary Monongahela Power Company (MonPower), consists of three coal-fired EGUs, each equipped with high efficiency wet lime SO_2 FGD scrubbers. The FGD systems commenced operation in 1994 and improvements were completed prior to 2016 for compliance with MATS. MonPower responded to WVDAQ's reasonable progress analysis request via email on February 1, 2021. In its response, MonPower stated neither a formal SO_2 controls four-factor analysis nor an SO_2 permit limit were necessary or appropriate for Harrison for regional haze purposes for multiple reasons. First, MonPower claimed the mandatory federal Class I areas where the VISTAS PSAT modeling predicted greater than 1.00% visibility impacts from the facility are presently well below the URP glide paths, proving already implemented past measures have been and continue to be successful. MonPower also stated the ERTAC model emission predictions overestimate 2028 emissions from Harrison and thus the modeled visibility impacts are overstated. MonPower further claimed the Harrison FGD systems demonstrated a 97.1% average removal efficiency for 2017 through 2019, which exceeds the 95% control deemed as BART by EPA in 40CFR51, Appendix Y "Guidelines for BART Determinations Under the Regional Haze Rule". MonPower further stated Harrison averaged 0.16 pounds per mmBtu SO_2 emissions from 2015 through 2020. This is in compliance with the 0.2 pounds per mmBtu SO_2 emission limit of the MATS rule for coal-fired EGUs, which the company claims is adequate to meet the exemption outlined in EPA's August 20, 2019 Guidance on Regional Haze State Implementation Plans for the Second Implementation Period memo, which states on page 23 "...EPA believes it may be reasonable for a state not to select a particular source for further analysis:...For the purpose of SO_2 control measures, [if] an EGU that has add-on flue gas desulfurization (FGD) and that meets the applicable alternative SO_2 emission limit of the 2012 Mercury Air Toxics Standards (MATS) rule for power plants. The two limits in the rule (0.2 lb/mmBtu for coal-fired EGUs or 0.3 lb/mmBtu for EGUs fired with oil-derived solid fuel) are low enough that it is unlikely that an analysis of control measures for a source already equipped with a scrubber and meeting one of these limits would conclude that even more stringent control of SO_2 is necessary to make reasonable progress." MonPower contends Harrison is subject to and meets the limits of the CSAPR FIP, and EPA and the courts have previously determined CSAPR is better than BART. As such, MonPower stated that additional SO_2 controls would be neither necessary nor economically feasible at Harrison.

American Bituminous Power (AmBit) – Grant Town Power Plant (54049-4864511)

Grant Town Power Plant (Grant Town) consists of one coal waste fired EGU that utilizes a mixture of reclaimed coal refuse (gob) and pond fines as fuel, which are burned in two CFB steam generators that together supply steam to a common single turbine generator set. Since the facility is already subject to a federally enforceable Title V permit (R30-04900026-2020) that limits SO_2 emissions to less than the quantity projected to exceed the 1.00% visibility threshold of the VISTAS PSAT modeling, it was determined that a reasonable progress analysis or a four-factor analysis request for Grant Town was not warranted; therefore, WVDAQ did not contact the facility to request such an analysis. However, Grant Town does utilize fluidized bed limestone injection mixed with the fuel delivered into the CFB steam generators for control of SO_2 emissions, which is measured via in-stack CEMS and reported to EPA CAMD. Grant Town maintains adequate SO_2 emissions credits from CAMD for its SO_2 emissions, and the facility is subject to the CSAPR SO_2 budget. According to AmBit, the company expects to retire the facility no later than 2036 when its power purchase agreement with FirstEnergy expires. Considering the above, it is expected that additional SO_2 controls would not be economically feasible for such a small and unique facility with a looming anticipated retirement date.

Monongahela Power Company – Fort Martin Power Station (54061-6773611)

Fort Martin Power Station (Fort Martin), now owned by FirstEnergy subsidiary MonPower, consists of two coal-fired EGUs, each equipped with high efficiency wet lime FGD systems for SO_2 control. The FGD systems commenced operation in 2009 and improvements were completed prior to 2016 for compliance with MATS. MonPower responded to WVDAQ's reasonable progress analysis request via email on February 1, 2021. In its response, MonPower stated that neither a formal SO_2 controls four-factor analysis nor an SO_2 permit limit were necessary or appropriate for Fort Martin for regional haze purposes for multiple reasons. First, MonPower claimed the mandatory federal Class I areas where the VISTAS PSAT modeling predicted greater than one percent visibility impacts from the facility are presently well below the URP glide paths, proving already implemented past measures have been and continue to be successful. MonPower also stated the ERTAC model emission predictions overestimate 2028 emissions from Fort Martin and thus the modeled visibility impacts are overstated. MonPower further claimed Fort Martin FGD systems demonstrated a 97.5% average removal efficiency for 2017 through 2019, which exceeds the 95% control deemed as BART by EPA in 40CFR51, Appendix Y "Guidelines for BART Determinations Under the Regional Haze Rule". MonPower further stated Fort Martin averaged 0.11 pounds per mmBtu SO_2 emissions from 2015 through 2020. This is in compliance with the 0.2 pounds per mmBtu SO_2 emission limit of the MATS rule for coal-fired EGUs, which the company claims is adequate to meet the exemption outlined in EPA's August 20, 2019 Guidance on Regional Haze State Implementation Plans for the Second Implementation Period memo, which states on page 23 "...EPA believes it may be reasonable for a state not to select a particular source for further analysis:...For the purpose of SO_2 control measures, [if] an EGU that has add-on flue gas desulfurization (FGD) and that meets the applicable alternative SO_2 emission limit of the 2012 Mercury Air Toxics Standards (MATS) rule for power plants. The two limits in the rule (0.2 lb/mmBtu for coal-fired EGUs or 0.3 lb/mmBtu for EGUs fired with oil-derived solid fuel) are low enough that it is unlikely that an analysis of control measures for a source already equipped with a scrubber and meeting one of these limits would conclude that even more stringent control of SO_2 is necessary to make reasonable progress." MonPower contends Fort Martin is subject to and meets the limits of the CSAPR FIP, and EPA and the courts have previously determined CSAPR is better than BART.

As such, MonPower stated that additional SO_2 controls would be neither necessary nor economically feasible at Fort Martin.

Energy Harbor – Pleasants Power Station (54073-4782811)

Pleasants Power Station (Pleasants), formerly owned by Monongahela Power Company and now an asset of Energy Harbor, consists of two coal-fired EGUs, each equipped with high efficiency lime slurry FGD systems for SO_2 control. The FGD systems commenced operations in 1979 at facility commissioning, but initially only treated 85% of the flue gas stream. In 2008 the FGD systems were upgraded and 100% of the flue gas stream was routed through the FGD SO_2 control systems. Energy Harbor responded to WVDAQ's reasonable progress analysis request via email on January 29, 2021, with a technical feasibility analysis for eight SO_2 reduction options, all of which except one were determined to be technically infeasible at Pleasants. The single feasible technology was then subjected to a four-factor analysis to determine cost effectiveness; this is discussed further below. Within its technical feasibility analysis, Pleasants considered three pre-combustion and five post-combustion control scenarios. Each of these scenarios also has variable potential to reduce the quantity and quality of the existing lime FGD gypsum by-product, which provides an additional revenue stream supporting operations at Pleasants and must be taken into economic consideration. Further, Energy Harbor noted installation of any replacement SO_2 control system must consider the time required to engineer, construct, and commission such systems, during which Pleasants would not be fully operational and generating its primary revenue stream from electricity sales. Pre-combustion control options considered included: (1) utilization of lower sulfur coals; (2) fuel blending with limestone; and (3) and coal cleaning, all of which are already utilized to a certain extent at Pleasants. Lower sulfur fuels would adversely affect current SO_2 control efficiencies and cause an increased danger of coal storage pile and coal bunker fires. Fuel blending with limestone and other SO_2 reducing additives is already performed on a limited basis, but this process is not practical in pulverized coal boilers in quantities capable of controlling SO_2 emissions to the levels required to bring the facility below the PSAT modeled 1.00% visibility threshold. Coal cleaning is extremely water intensive, and the facility coal supplier already cleans coal prior to delivery; as such, additional cleaning would not provide much benefit at considerably increased energy and non-air quality environmental impacts. Post-combustion controls considered include: (1) wet limestone scrubbers, also known called limestone forced oxidation scrubbers (LSFO); (2) spray dry absorbers (SDA); (3) dry sorbent injection (DSI); (4) circulating dry scrubbers with fabric filters (DS/FF); and (5) hydrated ash reinjection (HAR). LSFO is similar to the existing wet lime scrubbers but would require a significant capital investment in additional equipment, a higher heat rate (lost thermal efficiency, which is an increased energy impact), and considerably more operation and maintenance costs for a minimal potential efficiency gain over the existing wet lime scrubbers. However, LFSO utilizes a cheaper reagent than the existing lime FGD systems, and LFSO can achieve a potential SO_2 reduction of 90-95%, similar to the existing lime scrubbing systems. Because of these factors and its similarity to the existing limestone FGD systems, LFSO is the only control system considered by Energy Harbor to be technically feasible. The four-factor analysis of LFSO as developed by Energy Harbor is discussed below. SDA also requires a significant capital investment in additional equipment, an even higher heat rate than LFSO, and more operation and maintenance costs than the existing system. Additionally, SDA can only achieve a potential SO_2 reduction of 60-90%, which is less than the currently installed limestone slurry FGD. DSI involves the injection of powdered or hydrated sorbent into the flue gas, which absorbs acid gases for removal via the particulate control systems. Energy Harbor estimates this control method would have lower capital, operational, and maintenance costs than the two previously discussed methods, but it is also difficult to implement and control and its potential SO_2 removal efficiencies are only 50-80% dependent on the sorbent utilized, significantly less than the current wet lime FGD systems. Also, DSI sorbent mixed within flyash has the potential to leach heavy metals from the coal combustion residuals, potentially causing a non-air quality (water) environmental impact. DS/FF is a circulating dry scrubber system similar to the SDA system and with additional fabric filters, but it also incurs higher capital, operational, and maintenance costs. Efficiencies are 80-90%, which are less than the existing wet lime FGD systems. HAR is a modified dry FGD process that is similar to the other dry systems but with an even lower potential SO_2 removal efficiency of 50%, which is considerably less than the existing system. Once the technical feasibility of the potential SO_2 control systems were considered, the only remaining technically feasible option, LFSO, was then considered in a four-factor analysis for adoption at Pleasants. Energy Harbor determined such a system would achieve a 95% SO_2 removal efficiency as compared to the current system capable of 92.5% SO_2 removal efficiency. Energy Harbor estimates the capital investment for an LFSO system would be nearly $45 million with an annual operations and maintenance cost of almost $22 million. This latter cost is 8.33% less than the existing lime FGD system. However, the estimated cost-effectiveness of the LFSO system is $11,292.95 per ton, or $9,931.94 per ton for one scrubber. Energy Harbor estimates the installation time for an LFSO system at Pleasants to be approximately 5 years with 2-3 years of plant non-operation, which is insurmountable lost revenue. Energy Harbor concluded the remaining useful life of Pleasants is not long enough to justify the high cost and lost revenue of installing LSFO for minimal potential benefit, especially considering the remaining useful life of the existing wet lime FGD system is expected to exceed the remaining useful life of the steam generators. Considering these factors, Energy Harbor determined that LFSO is not economically feasible to install. Also in its response, Energy Harbor noted the mandatory federal Class I areas where the VISTAS PSAT modeling predicted greater than 1.00% threshold visibility impacts from the facility are presently well below the URP glide paths, demonstrating already implemented past emissions reductions measures have been and continue to be successful.

Kentucky Power Company – Mitchell Power Plant (54051-6902311)

The Mitchell Power Plant (Mitchell), operated by American Electric Power subsidiary Kentucky Power Company (KPCo), consists of two coal-fired EGUs, each equipped with high efficiency wet limestone FGD scrubbers for SO_2 control. The FGD systems were installed to satisfy the requirements of a 2007 federal consent decree resulting from the settlement of an NSR violations lawsuit brought by EPA; these controls commenced operations at the facility in 2007. KPCo responded to WVDAQ's reasonable progress analysis via email on January 27, 2021. Within its response, KPCo noted that the rate of progress at the mandatory federal Class I areas identified by the VISTAS PSAT modeling as having visibility impacts of more than 1.00% from Mitchell emissions were well ahead of the uniform rate of progress goals to natural background visibility. KPCo further claimed continuing emissions reductions and retirements of coal-fired EGUs within the eastern United States, including within the AEP system, would provide for continuing progress within the planning period without the need for additional SO_2 emissions reductions from Mitchell. KPCo also stated that Mitchell already employs the most effective type of SO_2 controls available, which are designed to achieve a minimum of 98% emissions reduction. In its response, KPCo highlighted Mitchell SO_2 emissions have steadily decreased from 3,236 tons in 2017 to 2,061 tons in 2019, which is less than half of the VISTAS 2028 projections of 4,230 tons SO_2. KPCo further outlined that first CAIR and then CSAPR were previously determined by EPA to be better than BART, and Mitchell is in compliance with the CSAPR emissions trading program. KPCo further asserted the recently signed RCU reduces West Virginia's OS NO_X budget without considering existing NO_X controls were already nearly optimized, which will serve to force the coal EGU fleet to reduce operations to comply and in turn will also very likely reduce SO_2 emissions from the reduced operations. KPCo also stated in its response Mitchell has always achieved the 0.2 pounds SO_2 per million Btu limit implemented by the MATS rule as a surrogate compliance emission limit, often by less than half this amount on an annual basis. KPCo highlighted in its recent risk and technology review of the MATS rule, EPA determined no recent technological developments existed which support a more stringent standard, making it also unlikely that further controls for regional haze compliance were readily and reasonably available. Finally, KPCo asserted EPA's own guidance states sources which were selected for analysis in the first planning period, and which installed BART controls could be excluded from analysis for the second planning period. Because of these facts, KPCo concluded the AEP fleet will continue to contribute to improving visibility at the mandatory federal Class I areas throughout the region and no further evaluation of Mitchell nor additional SO_2 controls are necessary.

Appalachian Power Company – John E. Amos Power Plant (54079-6789111)

The John E. Amos Power Plant (Amos), operated by American Electric Power subsidiary Appalachian Power Company (APCo), consists of three coal-fired EGUs, each equipped with high efficiency wet limestone FGD scrubbers for SO_2 control. The FGD systems were installed to satisfy the requirements of a 2007 federal consent decree resulting from the settlement of an NSR violations lawsuit brought by EPA; these controls commenced operations at the facility in 2009 on Unit 3 and they were fully operational on Units 1 and 2 by 2011. APCo responded to WVDAQ's reasonable progress analysis via email on January 27, 2021. Within its response, APCo noted the rate of progress at the mandatory federal Class I areas identified by the VISTAS PSAT modeling as having visibility impacts of more than 1.00% from Amos emissions were well ahead of the uniform rate of progress goals to natural background visibility. APCo further claimed continuing emissions reductions and retirements of coal-fired EGUs within the eastern United States, including within the AEP system, would provide for continuing progress within the planning period without the need for additional SO_2 emissions reductions from Amos. APCo also stated Amos already employs the most effective type of SO_2 controls available, which are designed to achieve a minimum of 98% emissions reduction. In its response, APCo highlighted Amos SO_2 emissions have steadily decreased from 5,718 tons in 2017 to 3,517 tons in 2019, which is less than 60% of the VISTAS 2028 projections of 6,099 tons SO_2. APCo further outlined that first CAIR and then CSAPR were previously determined by EPA to be better than BART, and Amos is in compliance with the CSAPR emissions trading program. APCo further asserted the recently signed RCU reduces West Virginia's OS NO_X budget without considering existing NO_X controls were already nearly optimized, which will serve to force the coal EGU fleet to reduce operations to comply and in turn will also very likely reduce SO_2 emissions from the reduced operations. APCo also stated in its response Amos has always achieved the 0.2 pounds SO_2 per million Btu limit implemented by the MATS rule as a surrogate compliance emission limit, often by well less than half this amount on an annual basis. APCo highlighted in its recent risk and technology review of the MATS rule, EPA determined no recent technological developments existed which support a more stringent standard, making it also unlikely further controls for regional haze compliance were readily and reasonably available. Finally, APCo asserted EPA's own guidance states sources which were selected for analysis in the first planning period, and which installed BART controls could be excluded from analysis for the second planning period. Because of these facts, APCo concluded the AEP fleet will continue to contribute to improving visibility at the mandatory federal Class I areas throughout the region and no further evaluation of Amos nor additional SO_2 controls are necessary.

7.9. Consideration of Five Additional Factors

Section 51.308(f)(2(iv) of the Regional Haze Rule requires that states must consider five additional factors when developing a long-term strategy. These five additional factors are:

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

B. Measures to mitigate the impacts of construction activities;

C. Source retirement and replacement schedules;

D. Basic smoke management practices for prescribed fire used for agricultural and wildland vegetation management purposes and smoke management programs; and

E. The anticipated net effect on visibility due to projected changes in point, area, and mobile source emissions over the period addressed by the long-term strategy.

Factors B and D are addressed below in Section 7.9.2 and Section 7.9.1, respectively.

Factor A and Factor C are addressed in other sections of this document. For Factor A, the emission reductions from ongoing air pollution control programs, including, where applicable, measures to address reasonably attributable visibility impairment, are included in the baseline and 2028 emission inventories discussed in Section 4. For Factor C, specific existing and planned emission controls are explained in Section 7.2.

For Factor E, the anticipated net effect on visibility due to projected changes in point, area, and mobile source emissions over the period addressed by the long-term strategy is reflected in the reasonable progress goals discussion located in Section 8.

7.9.1. Smoke Management

As discussed in Section 2.4.2 and shown in Figures 2-1, 2-4, and 2-7 carbon sources (such as agricultural fires, prescribed fires, and wildfires) are a relatively minor contributor to visibility impairment at the Dolly Sods and Otter Creek Wilderness Areas. Since carbon is a minor contributor to visibility impairment, WVDAQ is not proposing to adopt additional requirements for controls on these sources during this review period. Nevertheless, West Virginia's rule 45 CSR 6 – Control Air Pollution from Combustion of Refuse [last federally SIP approved 3/25/09 74 FR 12530[60]] prohibits open burning, unless specific conditions are met, and contains provisions for prescribed burning. Prescribed burning includes the controlled application of fire to vegetation under specified environmental conditions and precautionary measures, which allows the fire to be confined to a predetermined area for the purpose of accomplishing specifically planned wildlife and forest management objectives. Prescribed burning must be in accordance with a written prescribed fire plan approved by the West Virginia Division of Forestry, or in the case of federal lands, approved by the appropriate Agency Administrator and endorsed by the West Virginia Division of Forestry prior to ignition for specific wildlife, forest, and associated land management purposes. For this rule, Agency Administrator includes National Park Service Park Superintendent, Bureau of Indian Affairs Agency Superintendent,

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[60] URL: https://www.govinfo.gov/content/pkg/FR-2009-03-25/pdf/E9-6615.pdf

U.S. Forest Service Forest Supervisor, Bureau of Land Management District Manager, Fish and Wildlife Service Refuge Manager, State Forest
Officer, Fire Chief, or an authorized designee thereof.

7.9.2. Dust and Fine Soil from Construction Activities

As discussed in Section 2.4.2 and demonstrated in Figure 2-1, fine soils were a relatively minor contributor to visibility impairment at the Class I areas in West Virginia during the baseline period of 2000-2004. Figure 2-2, and Figure 2-3 show that no VISTAS Class I areas experienced significant visibility impairment from soils during this timeframe. Figure 2-7 shows that fine soils continue to be only a minor contributor to visibility at the Class I areas in West Virginia during the most current period of monitoring data (2014-2018). Figure 2-8 and Figure 2-9 show that no VISTAS Class I areas experienced significant visibility impairment from soils during the 2014-2018 timeframe.

However, regarding construction activities, the WVDAQ has rule 45 CSR 17 – To Prevent and Control Particulate Matter Air Pollution from Materials Handling, Preparation, Storage and Other Sources of Fugitive Particulate Matter. This rule prohibits the discharge beyond the boundary lines of the property lines on which the discharge originates or at any public or residential location, which causes or contributes to statutory air pollution. A copy of this rule is included in Appendix H.

In addition, the WVDAQ has several rules requiring the control of fugitive dust within plant boundaries. These rules include the following:

- 45 CSR 2 – To Prevent and Control Particulate Air Pollution from Combustion of Fuel in Indirect Heat Exchangers [last federally SIP approved October 10, 2003; 68 FR 47473[61]];

- 45 CSR 3 – To Prevent and Control Air Pollution from the Operation of Hot Mix Asphalt Plants [last federally SIP approved December 10, 2002; 67 FR 63270[62]];

- 45 CSR 5 – To Prevent and Control Air Pollution from the Operation of Coal Preparation Plants, Coal Handling Operations and Coal Refuse Disposal Areas [last federally SIP approved December 6, 2002; 67 FR 62379[63]];

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[61] URL: https://www.govinfo.gov/content/pkg/FR-2003-08-11/pdf/03-20304.pdf
[62] URL: https://www.govinfo.gov/content/pkg/FR-2002-10-11/pdf/02-25852.pdf
[63] URL: https://www.govinfo.gov/content/pkg/FR-2002-10-07/pdf/02-25291.pdf

- 45 CSR 7 – To Prevent and Control Particulate Matter Air Pollution from Manufacturing Processes and Associated Operations [last federally SIP approved August 4, 2003; 68 FR 33010[64]]; and

- 45 CSR 17 – To Prevent and Control Particulate Matter Air Pollution from Materials Handling, Preparation, Storage and Other Sources of Fugitives Particulate Matter.

[64] URL: https://www.govinfo.gov/content/pkg/FR-2003-06-03/pdf/03-13709.pdf

8. Reasonable Progress Goals

The rule at 40 CFR 51.308(f)(3) requires states to establish RPGs in units of dv for each Class I area within the state that reflect the visibility conditions projected to be achieved by the end of the applicable implementation period (2028), as a result of those enforceable emissions limitations, compliance schedules, and other measures required that can be fully implemented by the end of the applicable implementation period (2028), as well as the implementation of other requirements of the CAA. The long-term strategy and the RPGs 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.

If a state in which a mandatory federal Class I area is located establishes an RPG for the most impaired days that provides for a slower rate of improvement in visibility than the URP, the state must demonstrate, based on the analysis required by 40 CFR 51.308(f)(2)(i), that there are no additional emission reduction measures for anthropogenic sources in the state that may reasonably be anticipated to contribute to visibility impairment in the Class I area that would be reasonable to include in the long-term strategy. (See 40 CFR 51.308(f)(3)(ii)(A) for additional requirements.)

Further, if a state contains sources that are reasonably anticipated to contribute to visibility impairment in a mandatory federal Class I area in another state for which that state has established an RPG that provides for slower rate of improvement in visibility than the URP, the state must demonstrate that there are no additional emission reduction measures for anthropogenic sources or groups of sources in the state that may reasonably be anticipated to contribute to visibility impairment in the Class I area that would be reasonable to include in its own long-term strategy. (See 40 CFR 51.308(f)(3)(ii)(B).)

It is notable that the RPGs established in this SIP are not directly enforceable, but the RPGs can be used to evaluate whether the SIP is adequately providing reasonable progress towards achieving natural visibility. (See 40 CFR 51.308(f)(3)(iii).)

8.1. RPGs for Class I Areas within West Virginia

In accordance with the requirements of 40 CFR 51.308(f)(3), this regional haze SIP establishes RPGs for the Dolly Sods and Otter Creek Wilderness Areas. To calculate the rate of progress represented by each goal, West Virginia compared baseline visibility conditions (2000 to 2004) to natural visibility conditions in 2064 and determined the uniform rate of visibility improvement (in dv) that would need to be maintained during each implementation period to attain natural visibility conditions by 2064. Through the VISTAS modeling, West Virginia estimated the expected visibility improvements by 2028 in the Dolly Sods and Otter Creek Wilderness Areas resulting from existing federal and state regulations, known facility or process shutdowns, and fuel conversions expected to occur by 2028 or sooner in West Virginia. The VISTAS baseline modeling demonstrated that the 2028 base case control scenario provides for an improvement in visibility below than the URP for the Dolly Sods and Otter Creek Wilderness Areas for the 20% most impaired days and ensures no degradation in visibility for the 20% clearest days over the 2000 to 2004 baseline period. These controls and facility closures, to the extent known and quantifiable, were modeled as part of the long-term strategy. The results of this modeling are shown in Section 7.2.6.

As detailed in Section 7.6, six facilities were identified for reasonable progress analysis based on PSAT modeling. Five facilities are located in West Virginia and one facility is located in Kentucky. These analyses did not result in any further emission reductions beyond that quantified in the baseline 2028 modeling.

Table 8-1 provides the RPGs for the Dolly Sods and Otter Creek Wilderness Areas. The table lists the 2028 reasonable progress goals, the uniform rates of progress for 2028, and natural visibility conditions. The numbers in brackets contain the projected improvement from the baseline, the amount of improvement from the baseline needed to meet the 2028 uniform rate of progress, and the additional improvement needed to achieve natural conditions, respectively. Since there is not an IMPROVE monitor located at the Otter Creek Wilderness Area, the Dolly Sods Wilderness Area uniform rate of progress and reasonable progress goals are being used as a surrogate for Otter Creek. Table 8-2 provides the expected visibility in 2028 on 20% clearest days as compared to the 2000-2004 baseline 20% clearest day values. This table shows that projected visibility on the 20% clearest days will not degrade but rather will improve significantly by 2028. The number in the brackets indicates the projected improvement from baseline conditions.

Table 8-1: West Virginia RPGs – 20% Most Impaired Days

Class I Area	**2000-2004 Baseline Visibility (dv)[(1)]**	**2028 Reasonable Progress Goals (dv)** [2004 – 2028 decrease, (dv)]	**2028 Uniform Rate of Progress (dv)** [2004 – 2028 decrease to meet uniform progress, (dv)]	**Natural Visibility (dv)** [2028 – 2064 decrease needed from 2028 goal]
Dolly Sods Wilderness Area	28.29	15.29 [13.00]	20.54 [7.75]	8.92 [6.37]
Otter Creek Wilderness Area	28.29	15.29 [13.00]	20.54 [7.75]	8.92 [6.37]

(1) The 2000-2004 baseline visibility data reflect values included in Table 1 in the EPA memorandum with subject: Technical addendum including updated visibility data through 2018 for the memo titled, "Recommendation for the use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program."[65]

Table 8-2: West Virginia Class I Area 20% Clearest Day Comparisons

Class I Area	2000-2004 Baseline Visibility (dv)(1)	2028 Reasonable Progress Goal (dv) [2004 – 2028 improvement goal]
Dolly Sods Wilderness Area	12.28	7.55 [4.73]
Otter Creek Wilderness Area	12.28	7.55 [4.73]

(1) The 2000-2004 baseline visibility data reflect values included in Table 1 in the EPA memorandum with subject: Technical addendum including updated visibility data through 2018 for the memo titled, "Recommendation for the use of Patched and Substituted Data and Clarification of Data Completeness for Tracking Visibility Progress for the Second Implementation Period of the Regional Haze Program."[66]

West Virginia has determined that the RPGs will be at least as stringent as the expected glide path prediction for Dolly Sods and Otter Creek Wilderness Areas.

8.2. Reductions Not Included in the 2028 RPG Analysis

Additional reductions in visibility impairing pollutants have occurred since VISTAS conducted the modeling analyses for the 2028 RPGs. These reductions, described below, will help to ensure the West Virginia Class I areas will meet these projected RPGs and that additional visibility improvement is likely.

8.2.1. Out of State Reasonable Progress Evaluation Reductions

Table 7-31 and Table 7-32 provide the list of facilities estimated to impact West Virginia's Class I areas located outside of West Virginia and outside of VISTAS. As required by the Regional Haze Rule (RHR), West Virginia or VISTAS notified these states of the findings of significant contribution and asked those states for information regarding the results of the reasonable progress evaluations performed at those facilities. Section 10.1 provides a description of each response. These reductions were not included in the VISTAS 2028 RPG modeling and thus will help ensure that the RPGs provided in Table 8-1 are met for 20% most impaired days and that no visibility degradation on the 20% clearest days occurs.

65 URL: https://www.epa.gov/sites/production/files/2020-06/documents/memo_data_for_regional_haze_technical_addendum.pdf
66 URL: https://www.epa.gov/sites/production/files/2020-06/documents/memo_data_for_regional_haze_technical_addendum.pdf

8.2.2. Other Control Programs

West Virginia's emissions inventory is rapidly changing due to economic pressures, aging equipment, new policy and legislation, operational changes, evolving energy market forces, and other factors. These changes generally decrease emissions. Several such changes were not included in the elv5 modeling inventory since they were not known at the time of the inventory development or were not well documented and supported. These forthcoming emission reductions should continue to improve visibility in Class I areas as well as improve air quality across West Virginia.

8.2.2.1. Revised CSAPR Update

On October 30, 2020 (85 FR 68964[67]), the EPA proposed the Revised CSAPR Update Rule for the 2008 Ozone NAAQS in response to a September 2019 ruling by the United States Court of Appeals of the D.C. Circuit, *Wisconsin v. EPA.* Starting in the 2021 ozone season, the proposed rule would further reduce NO_X emissions from power plants in 12 states. West Virginia is included as one of the 12 states for which EPA proposed to issue Federal Implementation Plans (FIP) to revise previously established NO_X emission budgets that reflect additional NO_X emissions reductions from EGUs. On March 15, 2021, the EPA administrator signed the final Revised CSAPR Update Rule making it effective on June 29, 2021 (86 FR 23054[68]). This revised rule will reduce West Virginia's Group 3 NO_X allocation budget by 24 percent when compared to the Group 2 CSAPR Update Rule.

The NO_X emission reductions due to this Rule obviously have not been included in the emission inventory used for 2028 modeling. However, since the Rule is effective for the 2021 Ozone Season and will reduce NO_X emission allowances for each year through 2024 and beyond, these emission reductions will have a positive impact on 2028 Class I visibility. Overall, this rule reduces West Virginia's EGU fleet NO_X allocation by 24 percent.

8.2.2.2. Proposed Consent Decree, Clean Air Act Citizen Suit

On July 29, 2021, the EPA published in the Federal Register (86 FR 40825[69]) a notice for a proposed consent decree concerning a complaint filed by several northeast states and the City of New York alleging the EPA failed to perform certain non-discretionary duties in accordance with the Clean Air Act to take final action to approve or disapprove, in whole or in part, the 2015

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[67] URL: https://www.govinfo.gov/content/pkg/FR-2020-10-30/pdf/2020-23237.pdf
[68] URL: https://www.govinfo.gov/content/pkg/FR-2021-04-30/pdf/2021-05705.pdf
[69] URL: https://www.govinfo.gov/content/pkg/FR-2021-07-29/pdf/2021-16155.pdf

ozone NAAQS infrastructure SIPs from several states, including West Virginia, which addressed the State's good neighbor provisions. The consent decree would require the EPA to act on these SIPs by April 30, 2022. West Virginia's good neighbor SIP was submitted to the EPA on February 4, 2019.

The Revised CSAPR Update rule, and associated FIP, discussed in Section 8.2.2.1 above was promulgated by the EPA to address 12 states 2008 ozone NAAQS good neighbor infrastructure SIP provisions. Through this rule and FIP, NO_X allocations for the state's coal-fired EGUs were established by creating a Group 3 allocation budget which was lower than the previous CSAPR Update rule's Group 2 allocations. It is uncertain at this time how the EPA will address this consent order and what actions the agency will take concerning West Virginia's SIP submittal. However, given the EPA's previous actions, it is expected that the agency may ultimately promulgate or revise a current rule which will have a similar emissions effect as the Revised CSAPR Update rule. If so, West Virginia's coal-fired EGUs should expect a further tightening of NO_X emissions. Any NO_X emission reductions resulting from the EPA's actions to this consent decree will have further positive impacts on Dolly Sods and Otter Creek Wilderness Area's visibility.

8.2.2.3. Chemours Washington Works Fuel Conversion

As discussed in Section 7.2.2.3.2, Chemours Washington Works entered into a Consent Order with the WVDAQ in January 2018 to shut down its five existing coal-fired boilers by December 21, 2021 and install three new natural gas-fired boilers with low-NO_X burners. Emissions from these new boilers were not available at the time of the PSAT modeling and the coal-fired boilers 2011 emissions projected to 2028 were used instead. A federally enforceable permit was issued by the WVDAQ for the new boilers limiting SO_2 and NO_X emissions. When compared to the previously permitted emissions from the five existing coal-fired boilers, permitted SO_2 and NO_X emissions have been reduced by 9,573 tpy and 456 tpy, respectively.

8.2.2.4. Oil and Gas Industry

As discussed in Section 7.2.2.7, changes in the Oil and Gas Industry are always occurring and if not due to anything else but the number of facilities in operation, the type and size of equipment used to process the natural gas, and the volume of natural gas that a well produces over time. Operational, equipment and production changes, in addition to complying with more stringent environmental regulations, generally decrease emissions from this industry sector. The WVDAQ provided emissions data available at the time for the PSAT modeling. Since then, changes continue to occur in this sector. Although not easily quantifiable because of the nature and frequency of these changes, they generally result in an overall decrease in NO_X emissions; therefore, resulting in improved air quality and visibility.

9. MONITORING STRATEGY

The SIP is to be accompanied by a strategy for monitoring regional haze visibility impairment. Specifically, the Rule states at 40 CFR 51.308(f)(6):

> (6) The State must submit with the implementation plan a monitoring strategy for measuring, characterizing, and reporting of regional haze visibility impairment that is representative of all mandatory Class I Federal areas within the State. Compliance with this requirement may be met through participation in the Interagency Monitoring of Protected Visual Environments network. The implementation plan must also provide for the following:
>
> > (i) The establishment of any additional monitoring sites or equipment needed to assess whether reasonable progress goals to address regional haze for all mandatory Class I Federal areas within the State are being achieved.
> >
> > (ii) Procedures by which monitoring data and other information are used in determining the contribution of emissions from within the State to regional haze visibility impairment at mandatory Class I Federal areas both within and outside the State.
> >
> > (iii) For a State with no mandatory Class I Federal areas, procedures by which monitoring data and other information are used in determining the contribution of emissions from within the State to regional haze visibility impairment at mandatory Class I Federal areas in other States.
> >
> > (iv) The implementation plan must provide for the reporting of all visibility monitoring data to the Administrator at least annually for each mandatory Class I Federal area in the State. To the extent possible, the State should report visibility monitoring data electronically.
> >
> > (v) A statewide inventory of emissions of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any mandatory Class I Federal area. The inventory must include emissions for the most recent year for which data are available and estimates of future projected emissions. The State

must also include a commitment to update the inventory periodically.

(vi) Other elements, including reporting, recordkeeping, and other measures, necessary to assess and report on visibility.

Such monitoring is intended to provide the data needed to satisfy four objectives:

- Track the expected visibility improvements resulting from emissions reductions identified in this SIP.
- Better understand the atmospheric processes of importance to haze.
- Identify chemical species in ambient particulate matter and relate them to emissions from sources.
- Evaluate regional air quality models for haze and construct RRFs for using those models.

The primary monitoring network for regional haze, both nationwide and in West Virginia is the IMPROVE network. Given that IMPROVE monitoring data from 2000-2004 serves as the baseline for the regional haze program, the future regional haze monitoring strategy must be based on, or directly comparable to, IMPROVE. The IMPROVE measurements provide the only long-term record available for tracking visibility improvement or degradation. Therefore, West Virginia will rely on the IMPROVE network for complying with the regional haze monitoring requirement in the rule.

As shown in Table 9-1, there is currently one IMPROVE site in West Virginia located in the Dolly Sods Wilderness Area. Since the Otter Creek Wilderness Area is physically located close to Dolly Sods, the Dolly Sods IMPROVE monitor is used as a surrogate for Otter Creek. Figure 9-1 shows the IMPROVE monitoring network for the VISTAS Region.

Table 9-1: West Virginia Class I Areas and Representative IMPROVE Monitors

Class I Area	IMPROVE Site Designation
Dolly Sods Wilderness Area	DOSO 1
Otter Creek Wilderness Area	DOSO 1

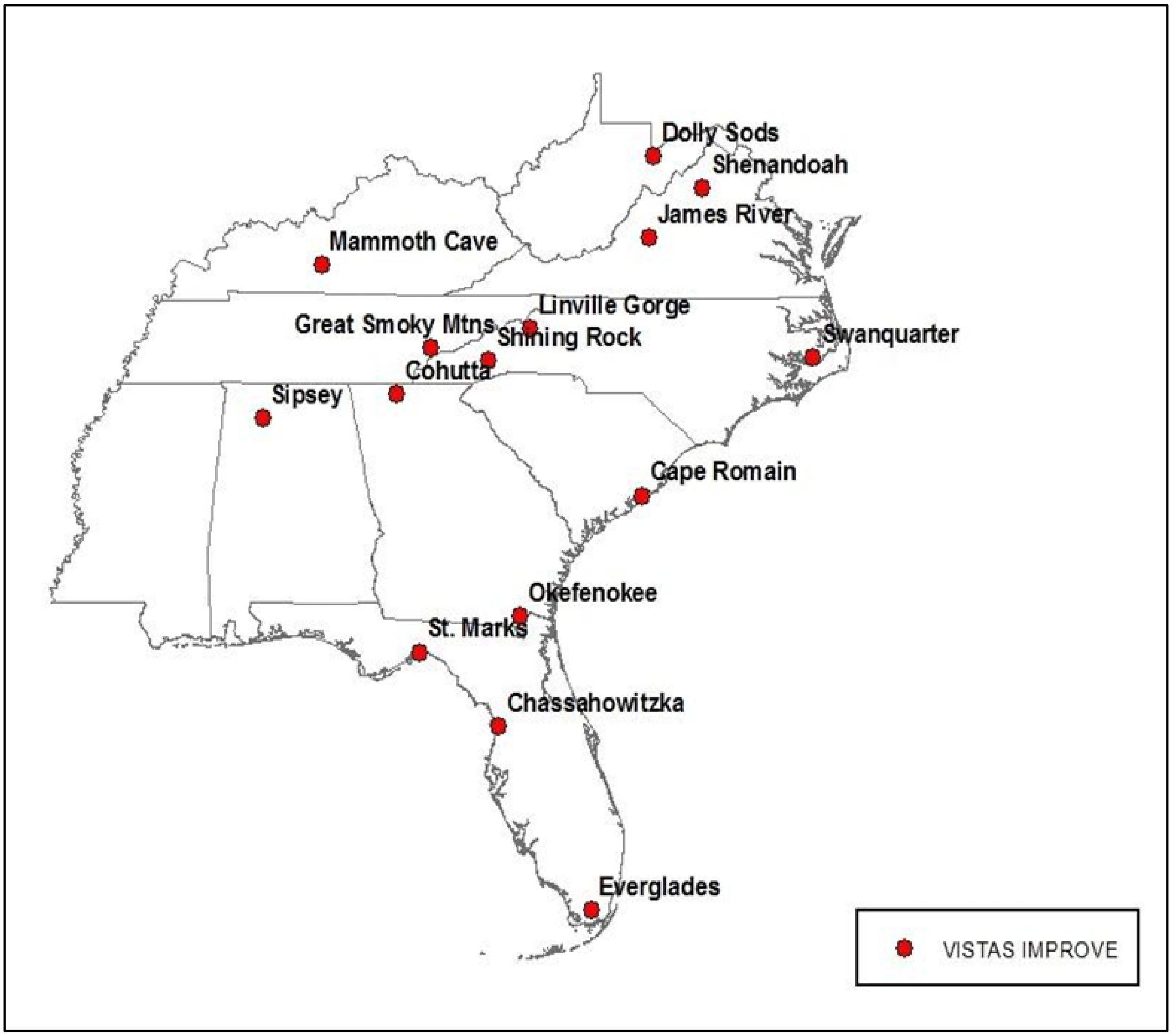

Figure 9-1: VISTAS States IMPROVE Monitoring Network

The Dolly Sods IMPROVE monitor measurements are central to West Virginia's regional haze monitoring strategy because the IMPROVE monitor represents West Virginia's unique air shed. Without the IMPROVE monitor, it would be difficult to meet the above listed objectives. Any reduction in the scope of the IMPROVE network in West Virginia and neighboring Class I areas would jeopardize the state's ability to demonstrate reasonable progress toward visibility improvement in its Class I areas and to plan appropriate future programs. West Virginia's regional haze strategy relies on emission reductions resulting from federal and West Virginia and neighboring state programs, which occur on different time scales and will most likely not be spatially uniform. Continued monitoring at the Class I areas is important as it documents reasonable progress in air quality as emission reductions in those unique air sheds occur during the second implementation period.

Because the current West Virginia IMPROVE monitor represents our unique air shed, and a significant component of the visibility contribution is regional, any reduction or shutting down of the IMPROVE monitoring network impedes the tracking progress or planning improvements at the Class I areas. If any of these IMPROVE monitors are shut down, West Virginia in consultation with the EPA and FLMs will develop an alternative approach for meeting the tracking goal.

Data produced by the IMPROVE monitoring network will be used for preparing the five-year progress reports and the 10-year comprehensive SIP revisions, each of which relies on analysis of the preceding five years of data. Consequently, the monitoring data from the IMPROVE sites needs to be readily available and up to date. Presumably, the IMPROVE network will continue to process information from its own measurements at about the same pace and with the same attention to quality as it has shown to date. A website has been maintained by Colorado State University, FLMs, and RPOs to provide ready access to the IMPROVE data and data analysis tools. These databases provide a valuable resource for states and the funding and necessary upkeep of the repository is crucial.

The remainder of this section addresses the requirements of 40 CFR 51.308(f)(6). West Virginia relies on the IMPROVE monitoring network to fulfill the requirements in paragraphs 40 CFR 51.308(f)(6)(i) through (iv) and paragraph (vi).

- 51.803(f)(6)(i): West Virginia believes the existing IMPROVE monitor for the State's Class I areas is adequate and we do not believe any additional monitoring sites or equipment is needed to assess whether RPGs for all mandatory Class I Federal areas within the state are being achieved.

- 51.308(f)(6)(ii): Data produced by the IMPROVE monitoring network will be used for preparing the five-year progress reports and the 10-year comprehensive SIP revisions, each of which rely on analysis of the preceding five years of IMPROVE monitor data.

- 51.308(f)(6)(iii): This provision is for states with no mandatory Class I Federal areas and does not apply to West Virginia.

- 51.308(f)(6)(iv): West Virginia believes the existing IMPROVE monitors for the State's Class I areas are sufficient for the purposes of this SIP revision. IMPROVE is a cooperative measurement effort managed by a Steering Committee that consists of representatives from various organizations (EPA, NPS, USFS, FWS, BLM, NOAA, four organizations representing state air quality organizations (NACAA, WESTAR, NESCAUM, and MARAMA), and three Associate Members: AZ DEQ, Env. Canada, and the South Korea Ministry of Environment). West Virginia is a member of MARAMA. The IMPROVE program establishes current visibility and aerosol conditions in mandatory Class I areas; identifies chemical species and emission sources responsible for existing man-made visibility impairment; documents long-term trends in visibility; and provides regional haze monitoring at mandatory federal Class I areas[70]. The National Park Service manages and oversees the IMPROVE monitoring network. The IMPROVE monitoring network samples particulate matter from which the chemical composition of the sampled particles is determined. The measured chemical composition is then used to calculate visibility. Samples are collected and data are reviewed, validated, and verified by NPS/NPS contractors before submission to EPA's Air Quality System (AQS)[71]. The network also posts raw[72] and summary data[73] to assist states and local air agencies and multijurisdictional organizations. Details about the IMPROVE monitoring network, procedures, and archived historical data are hosted online by Colorado State University[74].

- 51.308(f)(6)(v): The requirements of 40 CFR 51.308(f)(6)(v) are addressed in Section 4, Section 7.2.4, and Section 13.1 of the SIP. West Virginia will continue to participate in SESARM/VISTAS efforts for projecting future emissions and continue to comply with the requirements of the AERR to periodically update emissions inventories.

- 51.308(f)(6)(vi): There are no elements, including reporting, recordkeeping, or other measures, necessary to address and report on visibility for West Virginia Class I areas or Class I areas outside the state that are affected by sources in West Virginia.

[70] URL: http://vista.cira.colostate.edu/Improve/improve-program/
[71] URL: https://www.epa.gov/aqs
[72] URL: http://views.cira.colostate.edu/fed/
[73] URL: http://vista.cira.colostate.edu/Improve/rhr-summary-data/
[74] URL: http://vista.cira.colostate.edu/Improve/

10. CONSULTATION PROCESS

The VISTAS states have jointly developed the technical analyses that define the amount of visibility improvement that can be achieved by 2028 as compared to the uniform rate of progress for each Class I area. VISTAS initially used an AoI analysis to identify the areas and source sectors most likely contributing to poor visibility in Class I areas. This AoI analysis involved running the HYSPLIT Model to determine the origin of the air parcels affecting visibility within each Class I area. This information was then spatially combined with emissions data to determine the pollutants, sectors, and individual sources that are most likely contributing to the visibility impairment at each Class I area. This information indicated that the pollutants and the sector with the largest impact on visibility impairment in 2028 were SO_2 and NO_X from point sources. Next, VISTAS states used the results of the AoI analysis to identify sources to be "tagged" for PSAT modeling. PSAT modeling uses "reactive tracers" to apportion particulate matter among different sources, source categories, and regions. PSAT was implemented with the CAMx photochemical model to determine visibility impairment due to individual sources. PSAT results showed that in 2028 most of the visibility impairment at VISTAS Class I areas will continue to be from point source SO_2 and NO_X emissions, with SO_2 being the predominant pollutant affecting visibility. Using the PSAT data, VISTAS states identified, for the reasonable progress analyses, sources shown to have a sulfate or nitrate impact on one or more Class I areas greater than or equal to 1.00% of the total sulfate plus nitrate point source visibility impairment on the 20% most impaired days for each Class I area. The states collectively accept the conclusions of these analyses for use in evaluating reasonable progress.

10.1. Interstate Consultation

In evaluating controls needed to assess reasonable progress, VISTAS states with a Class I area initiated a consultation process with other VISTAS states with one or more facilities identified as having greater than or equal to 1.00% of the total sulfate plus nitrate point source visibility impairment on the 20% most impaired days. The letter requested that the VISTAS state provide a response indicating its plans for conducting a reasonable progress analysis for each facility.

In addition, VISTAS sent a letter to each non-VISTAS state with one or more facilities identified as having greater than or equal to 1.00% of the total sulfate plus nitrate point source visibility impairment on the 20% most impaired days in one or more VISTAS Class I areas. The letter requested that the non-VISTAS state verify if the 2028 SO_2 and NO_X emissions modeled for each facility identified in the letter were correct. If the emissions have decreased since the modeling was initiated, the non-VISTAS state was asked to provide updated emissions so that the facility contribution could be adjusted using the PSAT results to determine if additional analysis of controls would be necessary. If a non-VISTAS state did not decrease the 2028 emissions modeled, the non-VISTAS state was asked to provide a response indicating its plans for conducting a reasonable progress analysis for each facility.

There are several sources PSAT modeled indicating a contribution to visibility impairment of equal to or greater than 1.00% for sulfate in one or more of West Virginia's Class I areas. For the facilities within the VISTAS states, the WVDAQ sent a letter requesting reasonable progress assessments. The only VISTAS state sent a letter was Kentucky. For sources outside of the VISTAS states, a similar letter was sent by VISTAS to obtain the analyses.

Table 10-1 provides a summary of the VISTAS and non-VISTAS states where a letter was sent and identifies the total number of facilities impacting each Class I area in West Virginia. Because the Dolly Sods and Otter Creek Wilderness Areas are located close together, the same facilities impact both Areas and the number of facilities is not additive. Table 10-2 identifies each facility and its PSAT contribution to each Class I area in West Virginia. Appendix F-1 provides the consultation letter from the WVDAQ to Kentucky and the responses to the letter. Appendix F-2 provides the consultation letters from VISTAS to each non-VISTAS state and the responses to the letters.

Table 10-1: Number of Out-of-State Facilities with ≥ 1.00% Sulfate Contribution to West Virginia Class I Areas in 2028

Class I Area	Region	States
Dolly Sods	VISTAS	KY
	Non-VISTAS	MD, IN, PA, OH
	Total States	5
	Total Facilities	9
Otter Creek	VISTAS	KY
	Non-VISTAS	MD, IN, PA, OH
	Total States	5
	Total Facilities	9

Table 10-2: Out-of-State Facilities with ≥1.00% Sulfate Contributions in 2028 in West Virginia Class I Areas

Facility	State	Class I Area Impacted	Percent Impairment Impact	Letter Sent by and Date	Response Received
Duke Energy Indiana, LLC - Gibson Generating Station	IN	Dolly Sods	1.06%	VISTAS, June 22, 2020	
		Otter Creek	1.08%		
Indiana Michigan Power Company - Rockport	IN	Dolly Sods	1.03%	VISTAS, June 22, 2020	
		Otter Creek	1.07%		
Tennessee Valley Authority - Shawnee Fossil Plant	KY	Dolly Sods	1.12%	WV, November 6, 2020	
		Otter Creek	1.16%		
Verso Luke LLC - Luke Paper Company	MD	Dolly Sods	1.46%	(1)	(1)
		Otter Creek	1.08%		

Facility	State	Class I Area Impacted	Percent Impairment Impact	Letter Sent by and Date	Response Received
Cardinal Operating Company - Cardinal Power Plant	OH	Dolly Sods	4.28%	VISTAS, June 22, 2020	October 29, 2020
		Otter Creek	4.05%		
Lightstone Generation LLC - General James M. Gavin Power Plant	OH	Dolly Sods	5.20%	VISTAS, June 22, 2020	October 29, 2020
		Otter Creek	5.59%		
Ohio Valley Electric Corp. - Kyger Creek Generating Station	OH	Dolly Sods	1.26%	VISTAS, June 22, 2020	October 29, 2020
		Otter Creek	1.35%		
Duke Energy Ohio - William. H. Zimmer Power Station	OH	Dolly Sods	1.58%	VISTAS, June 22, 2020	October 29, 2020
		Otter Creek	1.69%		
Keystone Operating, LLC - Keystone Generating Station	PA	Dolly Sods	1.36%	VISTAS, June 22, 2020	July 8, 2020
		Otter Creek	1.06%		

(1) Although Luke Paper was highlighted as a facility impacting West Virginia's Class I Areas, the facility was permanently shut down prior to sending a letter.

The following dialogues summarize responses received for each facility or includes a discussion concerning the known announced future of operations at the facility.

Duke Energy Indiana, LLC - Gibson Generating Station, IN

Gibson Generating Station (Gibson) is a coal-fired electric power generating facility with five coal-fired EGUs. Each unit is controlled for SO_2 with wet limestone FGD systems, and for NO_X with low-NO_X burners, overfired air, and SCR systems. LADCO has been remodeling Gibson emissions and VISTAS is awaiting a response to its request.

Indiana Michigan Power Company - Rockport Generating Station, IN

Rockport Generating Station (Rockport) is a coal-fired electric power generating facility with two coal-fired EGUs. Each unit is controlled for SO_2 with dry sorbent injection (sodium bicarbonate), and controlled for NO_X with low-NO_X burners, overfired air, and SCR systems. LADCO has been remodeling Rockport emissions and VISTAS is awaiting a response to its request. However, on July 18, 2019, Indiana Michigan Power Company announced a decision to retire Unit 1 by the end of 2028[75], and on April 22, 2021 the company announced the retirement of Unit 2 also by the end of 2028[76].

Tennessee Valley Authority (TVA) – Shawnee Fossil Plant, KY

The Shawnee Fossil Plant (Shawnee) is an electric power generating facility with nine operational coal-fired EGUs. Two of the operating EGUs, Units 1 and 4, are controlled for SO_2 emissions with dry lime injection FGD systems and controlled for NO_X with low-NO_X burners and SCR systems, while the other seven operating units have no SO_2 controls, but NO_X

[75] URL: https://www.powermag.com/aep-will-close-1300-mw-indiana-coal-unit/

[76] URL: https://www.powermag.com/more-coal-cuts-aep-mississippi-power-detail-closures/

emissions are controlled with low-NO_X burners. A reasonable progress analysis developed by TVA for Shawnee and provided via the Kentucky Division for Air Quality asserts that since Units 1 and 4 meet the MATS requirements with effective control efficiencies of at least 95%, then these units are effectively controlled. Additionally, Shawnee states that Units 2, 3, 5, 6, 7, 8, and 9 will not be operational after 2033 and Shawnee will accept a facility-wide SO_2 emission limitation of not more than 8,719 tons per 12-month rolling total starting on December 31, 2034.

Verso Luke LLC - Luke Paper Company, MD

Luke Paper Company (Luke) is a Kraft process paper manufacturer with multiple steam boilers which combust coal, recovered black liquor, and natural gas. As such the facility is a major source of SO_2 emissions. Although Luke was modeled as one of the non-VISTAS facilities impacting West Virginia's Dolly Sods and Otter Creek Wilderness Areas visibility, the facility was permanently shut down in June 2019 and the facility's federally enforceable air permits were terminated on May 7, 2020. Therefore, no reasonable progress analysis request letter was sent to the company.

Cardinal Operating Company - Cardinal Power Plant, OH

A reasonable progress analysis for the Cardinal Power Plant provided by the state of Ohio asserts that due to the presence of an FGD system and SCR system of at least 90% effectiveness each, this facility is considered effectively controlled. Boilers B001, B002, and B003 have federally enforceable SO_2 emissions limits of 1.056 lb/mmBtu, 1.056 lb/mmBtu, and 0.66 lb/mmBtu, respectively. Boilers B001, B002, and B009 are required to be continuously controlled by FGD systems with an effective control efficiency of 95%.

Lightstone Generation LLC - General James M. Gavin Power Plant, OH

The General James M. Gavin Power Plant (Gavin) is an electric power generating facility with two coal-fired EGUs. A reasonable progress analysis for Gavin provided by Lightstone Generation LLC via the Ohio EPA asserts that due to the operation of wet lime FGD systems for SO_2 control and low-NO_X burners and SCR systems for NO_X control of at least 90% efficiency, this facility is considered to be effectively controlled. Boilers B003 and B004 have federally enforceable SO_2 emissions limits of 7.41 lb/mmBtu. Both boilers are required to be continuously controlled by FGD systems with an effective control efficiency of 95%. The Ohio EPA has requested a four-factor analysis from the facility.

Ohio Valley Electric Corporation - Kyger Creek Generating Station, OH

The Kyger Creek Generating Station (Kyger Creek) is an electric power generating facility with five coal-fired EGUs. All units are controlled for SO_2 emissions with wet limestone FGD systems. The Ohio EPA provided a reasonable progress analysis for Kyger Creek which states the five coal-fired boilers (B001, B002, B003, B004 and B005) are considered effectively controlled for SO_2 and NO_X having FGD/SCR systems with at least 90% effectiveness. SCR systems with 90% control efficiency were installed October 1, 2002, on B001, December 1, 2002 on B002, February 1, 2003 on B003, April 1, 2003 on B004 and June 1, 2003 on B005. Each of these controls operate year-round. Recent NO_X emission rates are 0.24 lb/mmBtu or less. FGD systems with 98% control efficiency are installed on all five boilers that operate year-round and have a federally enforceable SO_2 emissions limit of 1.2 lb/mmBtu.

Vistra Energy - William H. Zimmer Power Station, OH

The William H. Zimmer Power Station (Zimmer) is an electric power generating facility with one coal-fired EGU. The unit is controlled for SO_2 with wet lime FGD and controlled for NO_X with low-NO_X burners and an SCR system. According to the Ohio EPA, the Zimmer Power Station has announced a planned shutdown in 2027; the intention of the state of Ohio is to make this commitment sufficiently federally enforceable to avoid the need for a four-factor analysis. However, on July 19, 2021, Zimmer owner Vistra Energy announced the facility would cease operations earlier with a planned closure date of May 31, 2022[77].

Keystone Operating, LLC - Keystone Generating Station, PA

The Keystone Generating Station (Keystone) is an electric power generating facility with two coal-fired EGUs. The units are controlled for SO_2 with wet lime FGD systems and controlled for NO_X with low-NO_X burners, overfired air, and SCR systems. The Pennsylvania Department of Environmental Protection (PA DEP) requested a 4-factor analysis for Keystone Units 1 and 2. The 2019 FGD SO_2 control efficiencies for Units 1 and 2 were 90.7% and 92.7%, respectively. Average NO_X emissions in 2019 from Units 1 and 2 were 0.104 and 0.103 lb/mmBtu, respectively, which equates to an overall NO_X control efficiency of 85%. PA DEP concluded that the existing SO_2 and NO_X controls are the best available emission control options and no other technically feasible, more efficient controls have been identified. The combination of the FGD and SCR also provides for effective emissions control for compliance with the MATS Rule. Therefore, for Keystone, no additional controls are needed for PA DEP to meet its reasonable progress goal.

10.2. Outreach

The VISTAS states participated in national conferences and consultation meetings with other states, RPOs, FLMs, and EPA throughout the SIP development process to share information. VISTAS held calls and webinars with FLMs, EPA, RPOs and their member states, and other stakeholders (industry and non-governmental organizations) to explain the overall analytical approach, methodologies, tools, and assumptions used during the SIP development process and

[77] URL: https://investor.vistracorp.com/2021-07-19-Vistra-Accelerates-Closure-of-Ohio-Coal-Plant-to-Mid-2022,-Years-Earlier-Than-Planned

considered their comments in the SIP development process. The chronology of these meetings and conferences is presented in Table 10-3.

Table 10-3: Summary of VISTAS Consultation Meetings and Calls

Date	Meetings and Calls	Participants
December 5-7, 2017	Denver, CO, National Regional Haze Meeting – VISTAS States gave several presentations	FLMs; EPA OAQPS[1], Region 3, Region 4; RPOs; various VISTAS agency attendees
January 31, 2018	Teleconference and VISTAS Presentation	FLMs, EPA Region 4
August 1, 2018	Teleconference and VISTAS Presentation	FLMs, EPA OAQPS, Region 3, Region 4
September 5, 2018	Teleconference and VISTAS Presentation	RPOs, CC[2]/TAWG[3]
June 3, 2019	Teleconference and VISTAS Presentation	FLMs; EPA OAQPS, Region 3, Region 4; CC/TAWG
October 28-30, 2019	St Louis, MO, National Regional Haze Meeting – VISTAS States gave presentations	FLMs; EPA OAQPS, Region 3, Region 4; RPOs; various VISTAS agency attendees
April 2, 2020	Teleconference and VISTAS Presentation	FLMs; EPA OAQPS, Region 3, Region 4; CC/TAWG
April 21, 2020	Webinar and VISTAS Presentation	RPOs, CC/TAWG
May 11, 2020	Webinar and VISTAS Presentation	FLMs; EPA OAQPS, Region 3, Region 4; CC/TAWG
May 20, 2020	Webinar and VISTAS Presentation	Stakeholders; FLMs; EPA OAQPS, Region 3, Region 4; RPOs; and member states, STAD, CC/TAWG
August 4, 2020	Webinar and VISTAS Presentation	FLMs; EPA OAQPS, Region 3, Region 4; RPOs and Member States; CC/TAWG
October 26, 2020	Fall 2020 EPA Region 4 and State Air Directors Call - Webinar and VISTAS Presentation	EPA Region 3, EPA Region 4

[1]Office of Air Quality Planning and Standards (OAQPS)
[2]VISTAS Coordinating Committee (CC)
[3]VISTAS Technical Advisory Work Group (TAWG)

Beginning in January 2018, VISTAS held the first of several formal consultation calls with EPA and the FLMs to review the methodologies used to evaluate source lists for four-factor analyses. The development of AoIs for each Class I area with the HYSPLIT model was presented to identify source regions for which additional controls might be considered and that are likely to have the greatest impact on each Class I area. Additionally, information was shared on how states identified specific facilities within the AoIs to be tagged by the CAMx photochemical model to further identify impacts associated with those facilities on each Class I area. Based on the results of these two analyses, each state agreed to evaluate reasonable control measures for sources that met or exceeded individual state thresholds for four-factor analyses. Each state would consider sources within their state and would identify sources in neighboring states for consideration. States acknowledged that the review process would differ among states since some Class I areas are projected to see visibility improvements near the uniform rate of progress while most Class I areas are projected to have greater improvements than the uniform rate of progress.

Subsequent calls were held with EPA, FLMs and stakeholders to share revised analyses of sources in their state and neighboring states for each Class I area, as well as their criteria for listing sources and their plans for further interstate consultation. Documentation of these calls can be found in Appendix F-3.

Additionally, West Virginia along with the VISTAS states attended a National Regional Haze Conference in St. Louis, Missouri in October 2019 to discuss national and regional modeling to date and to plan next steps for submitting 2028 regional haze SIPs. West Virginia was part of a southeastern state breakout session with FLMs and EPA discussing the modeling and future expectations from all parties.

10.3. Consultation with MANE-VU

The following information documents VISTAS states participation in Mid-Atlantic/Northeast Visibility Union (MANE-VU) consultation meetings. Table 10-4 provides the correspondence and meetings that occurred during the consultation process. MANE-VU prepared the *MANE-VU Regional Haze Consultation Report*, which contains a record of the consultation meetings, comments received, and responses to comments.[78] Appendix F-4 provides documentation of North Carolina's consultation with MANE-VU including North Carolina's and VISTAS' comments on the MANE-VU Ask.

On October 16, 2016, MANE-VU notified Alabama, Florida, Kentucky, North Carolina, Tennessee, Virginia, and West Virginia that its analysis of upwind emissions from these states may contribute to visibility impairment at one or more MANE-VU Class I areas located in Maine, New Hampshire, New Jersey, and Vermont. MANE-VU invited each aforementioned VISTAS state to participate in its consultation process involving five conference calls from October 20, 2017, to March 23, 2018, to explain their methodologies, data sources, and assumptions used in its contribution analyses. MANE-VU's technical analyses were based on

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[78] "MANE-VU Regional Haze Consultation Report," July 27, 2018, MANE-VU Technical Support Committee, URL: https://otcair.org/MANEVU/Upload/Publication/Correspondence/MANE-VU_RH_ConsultationReport_Appendices_ThankYouLetters_08302018.pdf

actual 2015 emissions for EGUs and actual 2011 emissions for other emission sources. MANE-VU's criteria for identifying upwind states for consultation included:

- Point Source Emissions Analysis: Kentucky, North Carolina, Virginia, and West Virginia were identified as having at least one facility estimated to contribute greater than or equal to 3 Mm^{-1} to light extinction in at least one MANE-VU Class I area based on CALPUFF modeling of the facility's SO_2 and NO_X emissions.

- Statewide Emissions Analysis for all Sectors: Alabama, Florida, Kentucky, North Carolina, Tennessee, Virginia, and West Virginia were estimated to contribute greater than or equal to 2% of the visibility impairment at one or more MANE-VU Class I areas and/or an average mass impact of over 1% (0.01 $\mu g/m^3$). This methodology involved a weight-of-evidence approach based on emissions (tons per year) divided by distance (kilometers) (Q/d) calculations, CALPUFF modeling, and the use of HYSPLIT back trajectories as a quality check.

All seven named VISTAS states participated in MANE-VU's five consultation calls and reviewed the technical information supporting MANE-VU's conclusions. On January 27, 2018, VISTAS submitted a letter to MANE-VU documenting its appreciation for the opportunity to participate in the consultation process and identified the following concerns and recommendations:

- **Timing:** At the time the consultation calls were held, the MANE-VU states indicated their plans to submit regional haze SIPs to EPA by the original July 2018 deadline. VISTAS noted that its states planned to complete their regional haze technical analysis in 2019 with the intention of submitting regional haze SIPs by July 31, 2021. The differing schedules resulted in the seven VISTAS states included in MANE-VU's Ask being requested to assess the MANE-VU analysis without the benefit of the forthcoming VISTAS technical work. Subsequently, schedules were delayed, and VISTAS has shared the results of its emissions inventory and modeling analyses with the MANE-VU states during consultation calls in 2020 (see Table 10-4). VISTAS's technical analyses, which are based on more recent emissions inventory data and robust modeling tools, indicate that VISTAS state contributions to MANE-VU Class I areas are below the thresholds established by MANE-VU.

- **Technical Analysis – Inventories, Modeling, and Evaluation:** The MANE-VU states' analysis used emission inventories that are inconsistent with the recent EPA regional haze modeling platform. These inventories do not fully reflect emission reductions expected from southeastern EGUs by 2028 and other sources as well. Modeling results derived from use of the outdated emissions inventories may not allow conclusive determinations of impacts, if any, from VISTAS states on Class I areas in the MANE-VU region.

In many cases, the sources of the alleged contributions to downwind receptors are located thousands of miles away from the MANE-VU Class I areas. The MANE-VU states used the CALPUFF model and the Q/d screening approach to identify contributions that they allege are significant. CALPUFF should not be used for transport distances greater than 300 km since there are serious conceptual concerns with the use of puff dispersion models for very long-range transport which can result in overestimations of surface concentrations by a factor of three to four.[79]

The preamble to the recent Revisions to the Guideline on Air Quality Models that modified Appendix W of 40 CFR Part 51 states, in part, "the EPA has fully documented the past and current concerns related to the regulatory use of the CALPUFF modeling system and believes that these concerns, including the well documented scientific and technical issues with the modeling system, support the EPA's decision to remove it as a preferred model in Appendix A of the Guideline."[80]

The reliability of the Q/d screening approach diminishes over distance and especially beyond 300 km. If the MANE-VU states wish to evaluate emission impacts more than 300 km downwind from sources, a scientifically reliable approach is essential such as the CAMx model with the PSAT source apportionment method.

In response to VISTAS concerns about inaccuracies in the MANE-VU analysis that were shared during the December 18, 2018 technical call, the MANE-VU states suggested that the seven VISTAS states could reassess contributions using their own information to correct the MANE-VU analysis. The VISTAS states affirmed their commitment to conduct a thorough technical review of emission impacts during their forthcoming analysis. However, it was incumbent on the MANE-VU states to correct the errors inherent in their own analysis and reassess the states with which consultation would be necessary.

The MANE-VU Ask included year-round use of effective control technologies on EGUs; a four-factor analysis on sources with potential for visibility impacts of greater than or equal to 3.0 Mm^{-1} at any MANE-VU Class I area; establishment of an ultra-low sulfur

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[79] *Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts* (December 1998).

[80] *Federal Register, Vol.* 82, No. 10, Tuesday, January 17, 2017, Page 5195; URL: https://www.govinfo.gov/content/pkg/FR-2017-01-17/pdf/2016-31747.pdf

fuel oil standard; updated permits, enforceable agreements, and/or rules to lock in lower emission rates for EGUs and other large emission sources that had recently reduced emissions or were scheduled to do so; and efforts to decrease energy demand through use of energy efficiency and increased use of combined heat and power and other clean distributed generation technologies. The MANE-VU Ask failed to recognize fully the improved controls, fuel switches, retirements, and energy demand reductions that had already been achieved in the Southeast. Further, the MANE- VU states suggested that the Southeast adopt control measures that would produce little if any visibility improvement at MANE-VU Class I areas. VISTAS recommended that the MANE-VU states refine their analyses and establish a sound basis for any actions requested of the seven VISTAS states and incorporate such expectations in MANE-VU SIPs.

- **Permanent and Enforceable:** Regional haze SIPs (including the reasonable progress goals that are set for each Class I area) should only include emission reductions that are permanent, quantifiable, and enforceable. Therefore, the MANE-VU states should only include in their regional haze SIPs emission control presumptions for the seven VISTAS states that are clearly necessary and effective and have been made permanent and enforceable via state rulemaking or permit revisions. For MANE-VU states to include within their regional haze SIPs emission controls in other states that are not permanent and enforceable, and which the state in question has no intention of adopting, would be inconsistent with the CAA and RHR and could result in adverse comments from the seven VISTAS states during the MANE-VU regional haze SIP public comment period.

During the consultation process, Florida, North Carolina, Tennessee, Virginia, and West Virginia submitted to MANE-VU updated information on emissions associated with facilities identified in the MANE-VU Ask and documenting concerns with MANE-VU's approach and conclusions. As a result of their active participation in the MANE-VU consultation process, the VISTAS states fulfilled the consultation requirements specified in the RHR (51.308(f)(2)(ii)).

Table 10-4 lists the MANE-VU consultation correspondences and meetings with the VISTAS states.

Table 10-4: MANE-VU Consultation with VISTAS States - Correspondence and Meetings

Date	Description
October 16, 2017	Letter from Dave Foerter, Executive Director, MANE-VU/OTC, to Director Lance LeFleur, Alabama Department of Environmental Management. Purpose: Invitation to join State-to-State consultation meetings starting October 20, 2017.
October 16, 2017	Letter from Dave Foerter, Executive Director, MANE-VU/OTC, to Secretary Noah Valenstein, Florida Department of Environmental Protection. Purpose: Invitation to join State-to-State consultation meetings starting October 20, 2017.

Date	Description
October 16, 2017	Letter from Dave Foerter, Executive Director, MANE-VU/OTC, to Commissioner Aaron Keatley, Kentucky Department of Environmental Protection. Purpose: Invitation to join State-to-State consultation meetings starting October 20, 2017.
October 16, 2017	Letter from Dave Foerter, Executive Director, MANE-VU/OTC, to Secretary Michael Regan, North Carolina Department of Environmental Quality (NCDEQ) (formerly Department of Environment and Natural Resources). Purpose: Invitation to join State-to-State consultation meetings starting October 20, 2017.
October 16, 2017	Letter from Dave Foerter, Executive Director, MANE-VU/OTC, to Commissioner Bob Martineau, Tennessee Department of Environment and Conservation. Purpose: Invitation to join State-to-State consultation meetings starting October 20, 2017.
October 16, 2017	Letter from Dave Foerter, Executive Director, MANE-VU/OTC, to Director David Paylor, Virginia Department of Environmental Quality. Purpose: Invitation to join State-to-State consultation meetings starting October 20, 2017.
October 16, 2017	Letter from Dave Foerter, Executive Director, MANE-VU/OTC, to Secretary Austin Caperton, West Virginia Department of Environmental Protection. Purpose: Invitation to join State-to-State consultation meetings starting October 20, 2017.
October 20, 2017	MANE-VU Conference Call. Inter-RPO Consultation #1, Introduction and Overview of MANE-VU Analyses and Ask.
December 1, 2017	MANE-VU Conference Call. Inter-Regional Consultation #2, Discussion of the Ask and listening to upwind states and FLM questions.
December 18, 2017	MANE-VU Conference Call. Inter-Regional Consultation #3, Overview of technical analyses behind the Ask, source contributions, 4-factor analysis, and available technical products.
December 29, 2017	Letter from Laura Mae Crowder, WV Division of Air Quality, Deputy Director/Assistant Director of Planning, to Dave Foerter, Executive Director, MANE-VU/OTC. Purpose: Provide technical information on emission sources.
December 22, 2017	Email from Mark A. Reynolds, Environmental Consultant, Tennessee Department of Environment and Conservation to Joseph Jakuta, MANE-VU/OTC. Purpose: Provided additional information on EGU emissions and Cargill Corn Milling facility.
January 12, 2018	MANE-VU Conference Call. Inter-Regional Consultation #4, Reasonable Progress Overview.
January 18, 2018	Email from Doris McLeod, Air Quality Planner, Virginia Department of Environmental Quality to Joseph Jakuta, MANE-VU/OTC. Purpose: Information on closure of coal-fired boilers at Radford Army Ammunition Plant.
January 19, 2018	Letter from Jeffery F. Koerner, Director, Division of Air Resource Management, Florida Department of Environmental Protection. Purpose: Comments on MANE-VU Inter-RPO Ask regarding flaws in analysis for North Carolina emissions sources.
January 27, 2018	Letter from John E. Hornback, Executive Director, Metro 4/SESARM/VISTAS, to Dave Foerter, Executive Director, MANE-VU/OTC. Purpose: Comments on timing; technical analysis – inventories, modeling, and evaluation; and permanence and enforceability of control measures not adopted by VISTAS states.
January 30, 2018	Email from Randy Strait, Supervisor of Attainment Planning Branch, Division of Air Quality, NCDEQ to Joseph Jakuta, Program Manager, MANE-VU/OTC, and David Healy, Air Quality Analyst/Modeler, New Hampshire Dept. of Environmental Services. Purpose: Documentation of errors with CALPUFF for KapStone Kraft Paper and documentation showing that 2016 SO_2 emissions were 95% lower and 2016 NO_X emissions were 18% lower than in the 2011 emissions used in MANE-VU's modeling. Email reply from Dave Healy on January 31, 2018, confirmed that there was an error in the Ask and that KapStone Kraft Paper's contribution is $<3Mm^{-1}$.

Date	Description
February 16, 2018	Letter from Michael Abraczinskas, Director, Division of Air Quality, NCDEQ to Dave Foerter, Executive Director, MANE-VU/OTC. Purpose: Comments on MANE-VU Inter-RPO Ask regarding flaws in analysis for North Carolina emissions sources.
March 23, 2018	MANE-VU Conference Call. Inter-RPO Consultation #5. Executive Summaries, SIP submittal plans, and perspectives from upwind states.
May 8, 2018	Letter from Clark Freise, MANE-VU Chair (NH DES) and David Foerter, MANE-VU Executive Director, to Director Lance LeFleur, Alabama Department of Environmental Management. Purpose: Acknowledgement of participation in MANE-VU consultation calls and receipt of comments on MANE-VU Ask.
May 8, 2018	Letter from Clark Freise, MANE-VU Chair (NH DES) and David Foerter, MANE-VU Executive Director, to Commissioner Aaron Keatley, Kentucky Department of Environmental Protection. Purpose: Acknowledgement of participation in MANE-VU consultation calls and receipt of comments on MANE-VU Ask.
May 8, 2018	Letter from Clark Freise, MANE-VU Chair (NH DES) and David Foerter, MANE-VU Executive Director, to Secretary Noah Valenstein, Florida Department of Environmental Protection. Purpose: Acknowledgement of participation in MANE-VU consultation calls and receipt of comments on MANE-VU Ask.
May 8, 2018	Letter from Clark Freise, MANE-VU Chair (NH DES) and David Foerter, MANE-VU Executive Director, to Secretary Michael Regan, North Carolina NCDEQ. Purpose: Acknowledgement of participation in MANE-VU consultation calls and receipt of comments on MANE-VU Ask.
May 8, 2018	Letter from Clark Freise, MANE-VU Chair (NH DES) and David Foerter, MANE-VU Executive Director, to Commissioner Bob Martineau, Tennessee Department of Environment and Conservation. Purpose: Acknowledgement of participation in MANE-VU consultation calls and receipt of comments on MANE-VU Ask.
May 8, 2018	Letter from Clark Freise, MANE-VU Chair (NH DES) and David Foerter, MANE-VU Executive Director, to Director David Paylor, Virginia Department of Environmental Quality. Purpose: Acknowledgement of participation in MANE-VU consultation calls and receipt of comments on MANE-VU Ask.
May 8, 2018	Letter from Clark Freise, MANE-VU Chair (NH DES) and David Foerter, MANE-VU Executive Director, to Cabinet Secretary Austin Caperton, West Virginia Department of Environmental Protection. Purpose: Acknowledgement of participation in MANE-VU consultation calls and receipt of comments on MANE-VU Ask.

In addition to the MANE-VU consultation with the VISTAS states, West Virginia provided written comments on New Jersey's and New Hampshire's RHR SIPs during the respective public comment periods. These comments were identical or much in line with those provided during the MANE-VU consultation. Comments provided focused on West Virginia. Most notable was both states' continued utilization of the CALPUFF model to calculate impacts from upwind states. As discussed in the Technical Analysis Section above, CALPUFF is not an acceptable method for modeling long-range impacts greater than 300 kilometers and the EPA's removal of CALPUFF as a preferred model in Appendix W of Part 51.

Furthermore, both states used actual 2015 emissions data for EGUs and actual 2011 emissions data for non-EGU sources instead of using projected 2028 source emissions as required by the EPA. Using these emission data created errors in the facility modeling results since some of the facilities identified as impacting MANE-VU Class I areas had been permanently shut down.

In Section 4.2 of both the New Jersey and New Hampshire proposed RHR SIPs, five Asks were listed for upwind states. Many of these Asks were discussed during the MANE-VUs consultation and were commented on by West Virginia. The Technical Analysis and Permanent and Enforceable Section discussions above discuss inventory, modeling, data evaluation, and the proposed presumptive rules or regulations that cannot be enforced by an upwind state and which are contained in these Asks. Copies of West Virginia's comment letters on these states' proposed SIP are in Appendix F-4.

Table 10-5 lists the comment letters sent to New Jersey and New Hampshire concerning their proposed RHR SIPs.

Table 10-5: WV Comment Letters to NJ and NH Proposed RHR SIPs

Date	Description
October 21, 2019	Letter from Laura M. Crowder, WVDAQ Director, to Director Francis Steitz, New Jersey Department of Environmental Protection. Purpose: Comments on New Jersey's State Implementation Plan for Regional Haze.
December 18, 2019	Letter from Laura M. Crowder, WVDAQ Director, to Director Craig Wright, New Hampshire Department of Environmental Services. Purpose: Comments on New Hampshire's Regional Haze Plan Periodic Comprehensive Revision.

10.4. State and Federal Land Manager Consultation

This section is a hold spot to be completed after FLM consultation and will include virtual meetings, letters, exchanged emails, and other correspondence with FLM staff as appropriate. However, some FLM consultation documents and comments can already be found in Appendix F-3o, F-3p, and F-3q. These documents and comments were provided to West Virginia following an October 19, 2021 consultation call between NPS, FS, FWS, EPA Region 3, and WVDAQ. West Virginia will provide response to these comments after the public comment period has closed.

11. COMPREHENSIVE PERIODIC IMPLEMENTATION PLAN REVISIONS

40 CFR Section 51.308(f) requires West Virginia to revise its regional haze SIP and submit a plan revision to the EPA by July 31, 2021, July 31, 2028, and every ten years thereafter. This plan is submitted to comply with the July 31, 2021 requirement. In accordance with the requirements listed in Section 51.308(f) of the RHR, West Virginia plans to revise and submit this regional haze SIP by July 31, 2028, and every ten years thereafter.

In addition, Section 51.308(g) requires periodic reports evaluating progress towards the RPGs established for each mandatory Class I area. The periodic reports are due by January 31, 2025, July 31, 2033, and every ten years thereafter. West Virginia plans to meet all the requirements for 40 CFR 51.308(g), including revising and submitting a regional haze progress report by January 31, 2025, July 31, 2033, and every ten years thereafter.

The progress report will evaluate the progress made towards the RPG for each of the mandatory federal Class I areas located within West Virginia and in each mandatory federal Class I area located outside West Virginia that may be affected by emissions from West Virginia sources. All requirements listed in Section 51.308(g) shall be addressed in the periodic report.

The requirements listed in 51.308(g) include the following:

(1) A description of the status of implementation of all measures included in the implementation plan for achieving reasonable progress goals for mandatory Class I Federal areas both within and outside the state.

(2) A summary of the emissions reductions achieved throughout the state through implementation of the measures described in paragraph 51.308(g)(1).

(3) For each mandatory Class I Federal area within the state, the state must assess the following visibility conditions and changes, with values for most impaired, least impaired and/or clearest days as applicable expressed in terms of 5-year averages of these annual values. The period for calculating current visibility conditions is the most recent 5-year period preceding the required date of the progress report for which data are available as of a date 6 months preceding the required date of the progress report.

    (i) The current visibility conditions for the most impaired and clearest days;

(ii) The difference between current visibility conditions for the most impaired and clearest days and baseline visibility conditions;

(iii) The change in visibility impairment for the most impaired and clearest days over the period since the period addressed in the most recent plan required under paragraph 51.308(f).

(4) An analysis tracking the change over the period since the period addressed in the most recent plan required under paragraph 51.308(f) in emissions of pollutants contributing to visibility impairment 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 40 CFR 51 as of a date six months preceding the required date of the progress report. 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 six months preceding the required date of the progress report. The state is not required to backcast 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.

(5) 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 40 CFR 51.308(f) including whether 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.

(6) An assessment of whether the current implementation plan elements and strategies are sufficient to enable the state, or other states with mandatory Class I Federal areas affected by emissions from the state, to meet all established reasonable progress goals for the period covered by the most recent plan required under 40 CFR 51.308(f).

(7) For progress reports for the first implementation period only, a review of the state's visibility monitoring strategy and any modifications to the strategy, as necessary.

(8) For a state with a long-term strategy that includes a smoke management program for prescribed fires on wildland that conducts a periodic program assessment, a summary of

the most recent periodic assessment of the smoke management program including conclusions if any that were reached in the assessment as to whether the program is meeting its goals regarding improving ecosystem health and reducing the damaging effects of catastrophic wildfires.

More specifically, the five-year Progress Report (due by January 31, 2025, July 31, 2033, and every 10 years thereafter) will examine the effect of emission reductions as well as seek to evaluate the effectiveness of emission management measures implemented. Therefore, this Progress Report will provide for a comparison of emission inventories, ultimately expressing the change in visibility for the most impaired and least impaired days over the past five years.

Moreover, due to the uncertainty of some measures, this Progress Report will also provide the opportunity to evaluate the overall effectiveness of proposed measures to reduce visibility impairment to include the effect of state and federal measures.

In keeping with the EPA's requirements and recommendations related to consultation, each five-year review will also enlist the support of appropriate state, local, and tribal air pollution control agencies as well as the corresponding FLMs.

12. DETERMINATION OF THE ADEQUACY OF THE EXISTING PLAN

At the same time West Virginia is required to submit any progress reports to EPA, depending on the findings of the five-year progress report, West Virginia plans to take one of the actions listed in 40 CFR Section 51.308(h). The findings of the five-year progress report will determine which action is appropriate and necessary.

List of Possible Actions - 40 CFR Section 51.308(h)

(1) If West Virginia determines that the existing SIP requires no further substantive revision to achieve established goals, it will provide to the EPA a declaration that further revision of the SIP is not needed.

(2) If West Virginia determines that the existing SIP may be inadequate to ensure reasonable progress due to emissions from other states that participated in the regional planning process, it will provide notification to the EPA and collaborate with the states that participated in regional planning to address the SIP's deficiencies.

(3) If West Virginia determines that the current SIP may be inadequate to ensure reasonable progress due to emissions from another country, it will provide notification of such, along with available information making such a demonstration, to the EPA.

(4) If West Virginia determines that the existing SIP is inadequate to ensure reasonable progress due to emissions within the state, it will revise its SIP to address the plan's deficiencies within one year after submitting such notification to the EPA.

13. PROGRESS REPORT

13.1. Background

On June 18, 2008, West Virginia submitted its first-round regional haze SIP to EPA Region 3 for approval. West Virginia's regional haze plan documents the state's long-term plan for improving visibility in the state's two federal Class I areas as well as assisting with improvement of visibility in Class I areas located outside of the state. The SIP includes specific RPGs for visibility improvement at milestones starting in 2018. The goal is to reach background visibility levels in the Class I areas by 2064. West Virginia's Class I areas are the Dolly Sods and Otter Creek Wilderness Areas.

Subparagraph 40 CFR 51.308(g) of the regional haze rule requires states to report on the success of the long-term strategy at specific intervals. On April 24, 2016, West Virginia submitted the first regional haze progress report to EPA, which demonstrated that West Virginia was on track to meet the RPGs set in the regional haze SIP.

This progress report, in accordance with EPA's requirements, contains the following elements:

- Status of implementation of the control measures included in the original SIP;
- Summary of the emissions reductions achieved through the above-referenced control measures;
- Assessment of visibility conditions and changes for each Class I area located within the state;
- Analysis tracking the change over the past five years in emissions of pollutants contributing to visibility impairment from all sources and activities within West Virginia;
- Assessment of any significant changes in anthropogenic emissions within the past five years that have limited or impeded progress in reducing pollutant emissions and improving visibility;
- An assessment of whether the current implementation plan elements and strategies are sufficient to enable the state, or other states with mandatory federal Class I areas affected by emissions from the state, to meet all established reasonable progress goals; and
- A review of the state's visibility monitoring strategy and any modifications to the strategy as necessary.

Although future planning periods will focus on the most anthropogenically impaired ("most impaired") visibility days, the work completed in the first planning period and the development of the 2018 RPGs focused on the worst visibility days. In order to properly compare current conditions to the 2018 RPGs, this progress report includes visibility data for the 20% worst visibility days, in addition to visibility data for the 20% most impaired days as required by the regional haze rule.

13.1.1. West Virginia's Long-term Strategy for Visibility Improvement

In Section 7.4 of West Virginia's Regional Haze Plan, atmospheric ammonium sulfate was identified as the largest contributor to visibility impairment in Class I areas throughout the southeastern United States during the baseline period. Emissions sensitivity modeling performed for VISTAS determined that the most effective ways to reduce ammonium sulfate were to reduce SO_2 emissions from EGUs and, with an important but smaller impact, to reduce SO_2 emissions from non-utility industrial point sources. Reductions of SO_2 emissions from point sources were identified as the focus of West Virginia's long-term strategy for visibility improvement.

The bar charts in Figure 13-1 show the speciated average light extinction for West Virginia's Class I areas and demonstrate sulfates continue to be a significant contributor to light extinction since submission of the last progress report, although the relative contribution from sulfates is decreasing over time.

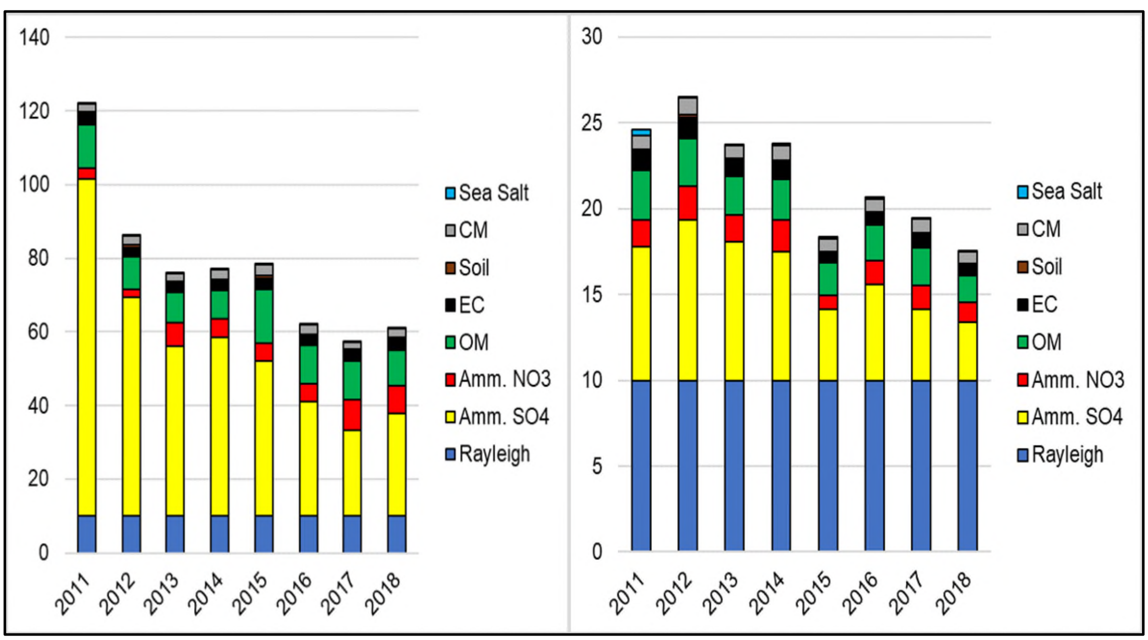

Figure 13-1: Annual Average Light Extinction for the 20% Worst Visibility Days (left) and the 20% Clearest Visibility Days (right) at Dolly Sods

13.1.2. 2018 Reasonable Progress Goals for West Virginia's Class I Areas

Table 13-1 and Table 13-2 show the 2018 RPGs for West Virginia's Class I areas on the 20% worst and 20% best visibility days, respectively. To properly compare current conditions to the 2018 RPGs, this report continues to look at visibility impairment for the 20% worst visibility days. As seen in these tables, both of West Virginia's Class I areas have met the 2018 RPGs.

Table 13-1: 2018 RPGs for Visibility Impairment in West Virginia's Class I Areas, 20% Worst Days

Class I Area	Baseline Average dv (2000-2004)	2018 Average dv (2014-2018)	2018 Goal (dv)	Natural Background (dv)
Dolly Sods	29.05	18.77	21.7	10.39
Otter Creek	29.05	18.77	21.7	10.39

Table 13-2: 2018 RPGs for Visibility Impairment in West Virginia's Class I Areas, 20% Clearest Days

Class I Area	Baseline Average dv (2000-2004)	2018 Average dv (2014-2018)	2018 Goal (dv)	Natural Background (dv)
Dolly Sods	12.28	6.68	≤12.28*	3.64
Otter Creek	12.28	6.68	≤12.28*	3.64

*The regional haze requirement for the 20% clearest days is to maintain the visibility impairment at or below the baseline impairment.

13.2. Requirements for the Periodic Progress Report

The requirements for periodic reports are outlined in 40 CFR 51.308(g). Each state must submit a report to the EPA every five years evaluating the progress towards the reasonable progress goal for each Class I area located within the state and in each Class I area located outside the state which may be affected by emissions from within the state.

The EPA's revised regional haze rule no longer requires the progress report to be a formal SIP submittal. At a minimum, the progress report must cover the first year not covered by the previously submitted progress report through the most recent year of data available prior to submission. West Virginia's previous progress report included data through the year 2013. Therefore, this progress report covers years since 2013. For the purposes of this periodic review (included as part of this regional haze plan revision), the most recent data available are used to highlight the progress made. This review includes NEI data through 2017, visibility data through 2018, and stationary source data through 2019. Section 51.308(f)(5) of the Regional Haze Rule requires that this regional haze plan revision address the progress report requirements of paragraphs 51.308(g)(1) through (5):

(1) A description of the status of implementation of all measures included in the SIP for achieving reasonable progress goals for Class I areas both within and outside the State.

(2) A summary of the emission reductions achieved throughout the State through implementation of the measures described in (1) above.

(3) For each Class I area within the State, the State must assess the following visibility conditions and changes, with values for most impaired and least impaired days expressed in terms of five-year averages of these annual values:

    (i) The current visibility conditions for the most impaired and least impaired days;

    (ii) The difference between current visibility conditions for the most impaired and least impaired days and baseline visibility conditions;

    (iii) The change in visibility impairment for the most impaired and least impaired days over the past five years;

(4) An analysis tracking the change over the past five years in emissions of pollutants contributing to visibility impairment from all sources and activities within the state. Emissions changes should be identified by type of source or activity. The analysis must be based on the most recently updated emissions inventory, with estimates projected forward as necessary and appropriate to account for emissions changes during the applicable five-year period.

(5) An assessment of any significant changes in anthropogenic emissions within or outside the State that have occurred over the past five years that have limited or impeded progress in reducing pollutant emissions and improving visibility.

13.3. Status of Implementation of Control Measures

This section provides the implementation status for the emission reduction measures that were included in the original regional haze SIP starting in the year 2014 to 2019, as required by 40 CFR 51.308(g)(1). These measures include Federal programs, State requirements for EGUs, and State requirements for non-EGU point sources. As required by 40 CFR 51.308(g)(2), West Virginia has estimated the SO_2 emissions reductions achieved through 2019 from measures implemented by the state.

This section also describes other strategies that were not included in the regional haze SIP. At the time of the best and final inventory development process, these measures were not fully documented or had not yet been published in final form; therefore, the benefits of these measures were not included in the 2018 inventory. Emission reductions from these measures have helped each Class I area meet the RPG set in the regional haze SIP for 2018.

13.3.1. Emissions Reduction Measures Included in the Regional Haze SIP

West Virginia's regional haze SIP included the following types of measures for achieving reasonable progress goals:

- Federal programs and
- State reasonable progress and BART control measures

These emissions reduction strategies were included as inputs to the VISTAS modeling. The status of the implementation of these measures is summarized in the following paragraphs and an estimate of the SO_2 emissions reductions achieved is presented.

13.3.2. Federal and Other State Programs

The emissions reductions associated with the Federal and other state programs that are described in the following paragraphs were included in the VISTAS future year emissions estimates for the first implementation period. Descriptions contain qualitative assessments of emissions reductions associated with each program, and where possible, quantitative assessments. In cases where delays or modification have altered emissions reduction estimates such that the original estimates of emissions are no longer accurate, information is also provided on the effects of these alterations.

13.3.3. Clean Air Interstate Rule

On May 12, 2005, the EPA promulgated CAIR, which required reductions in emissions of NO_X and SO_2 from large fossil fuel fired EGUs. Due to court rulings, CAIR was remanded to the EPA to revise elements that were deemed unacceptable and was ultimately replaced by CSAPR. This was later updated through the CSAPR Update rule. Additionally, the Revised CSAPR Update rule was published on June 29, 2021 (86 FR 23054[81]) and is effective for the 2021 Ozone Season, further reducing NO_X emissions from coal-fired EGUs.

However, at the time that the states were developing their regional haze plans, challenges to CSAPR had left CAIR in place until residual issues were decided by the D.C. Circuit and the EPA had resolved implementation issues. Therefore, states included CAIR in the regional haze SIP. The 2018 projected emissions used in the regional haze analysis reflect a modified IPM solution based on the state's best estimate of that year.

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[81] URL: https://www.govinfo.gov/content/pkg/FR-2021-04-30/pdf/2021-05705.pdf

Although different from the CAIR solution projected in the regional haze analysis, CSAPR, CSAPR Update, and the Revised CSAPR Update have continued emission reductions from large EGUs.

13.3.4. NO_X SIP Call

Phase I of the NO_X SIP Call was included in the regional haze SIP. This applies to certain EGUs and large non-EGUs, including large industrial boilers and turbines, and cement kilns. Those states affected by the NO_X SIP call in the VISTAS region have developed rules for the control of NO_X emissions that have been approved by the EPA. The NO_X SIP Call has resulted in a significant reduction in NO_X emissions from large stationary combustion sources. For the first regional haze SIP, the emissions from the NO_X SIP Call affected sources were capped at 2007 levels and carried forward to the 2009 and 2018 inventories.

13.3.5. Consent Agreements (TECO, VEPCO, AEP) and Gulf Power Crist 7 Voluntary Agreement

Under a settlement agreement, Tampa Electric Company (TECO) converted units at the TECO Gannon Station Power Plant (now TECO Bayside Power Station) from coal to natural gas and installed permanent emissions-control equipment to meet stringent pollution limits.

Under a settlement agreement, VEPCO agreed to spend $1.2 billion by 2013 to eliminate 237,000 tons of SO_2 and NO_X emissions each year from eight coal-fired electricity generating plants in Virginia and West Virginia.

American Electric Power agreed to spend $4.6 billion dollars to eliminate 72,000 tons of NO_X emissions each year by 2016 and 174,000 tons of SO emissions each year by 2018 from sixteen plants located in Indiana, Kentucky, Ohio, Virginia, and West Virginia.

Under a 2002 voluntary agreement, Gulf Power upgraded controls and operations at its Crist Plant to significantly cut NO_X emissions. In 2020 the facility was converted to fire completely on natural gas and was renamed the Gulf Clean Energy Center. SO_2 and NO_X emissions will decrease substantially with this fuel switch.

13.3.6. 2007 Heavy-Duty Highway Rule (40 CFR Part 86, Subpart P)

In this regulation, the EPA set a PM emissions standard for new heavy-duty engines of 0.01 g/bhp-hr, which took full effect for diesel engines in the 2007 model year. This rule also included standards for NO_X and non-methane hydrocarbons (NMHC) of 0.20 g/bhp-hr and 0.14 g/bhp-hr, respectively. These diesel engine NO_X and NMHC standards were successfully phased in together between 2007 and 2010. The rule also required that sulfur in diesel fuel be reduced to facilitate the use of modern pollution-control technology on trucks and buses. The EPA required a 97% reduction in the sulfur content of highway diesel fuel, from levels of 500 ppm (low sulfur diesel) to 15 ppm (ultra-low sulfur diesel). These requirements were successfully implemented on the timeline in the regulation. This program applies to all areas of the country, including West Virginia, thus, more directly affecting West Virginia Class I areas.

13.3.7. Tier 2 Vehicle and Gasoline Sulfur Program (40 CFR Part 80 Subpart H; Part 85; Part 86)

The EPA's Tier 2 fleet averaging program for onroad vehicles, modeled after the California Low Emission Vehicle (LEV) II standards, became effective in the 2005 model year. The Tier 2 program allows manufacturers to produce vehicles with emissions ranging from relatively dirty to very clean, but the mix of vehicles a manufacturer sells each year must have average NO_X emissions below a specified value. Mobile emissions continue to be reduced by this program as motorists replace older, more polluting vehicles with cleaner vehicles. The Tier 2 program applies nationwide, including West Virginia, and has a direct impact on West Virginia Class I areas.

13.3.8. Large Spark Ignition and Recreational Vehicle Rule

The EPA has adopted new standards for emissions of NO_X, hydrocarbons (HC), and CO from several groups of previously unregulated nonroad engines. Included in these are large industrial spark-ignition engines and recreational vehicles. Nonroad spark-ignition engines are those powered by gasoline, liquid propane gas, or compressed natural gas rated over 19 kW (25 horsepower). These engines are used in commercial and industrial applications, including forklifts, electric generators, airport baggage transport vehicles, and a variety of farm and construction applications. Nonroad recreational vehicles include snowmobiles, off-highway motorcycles, and all-terrain-vehicles. These rules were initially effective in 2004 and were fully phased-in by 2012. These rules apply nationwide, including West Virginia, and directly impacts West Virginia's Class I areas.

13.3.9. Nonroad Mobile Diesel Emissions Program (40 CFR Part 89)

The EPA adopted standards for emissions of NO_X, HC, and CO from several groups of nonroad engines, including industrial spark-ignition engines and recreational nonroad vehicles. Industrial spark-ignition engines power commercial and industrial applications and include forklifts, electric generators, airport baggage transport vehicles, and a variety of farm and construction applications. Nonroad recreational vehicles include snowmobiles, off-highway motorcycles, and all-terrain vehicles. These rules were initially effective in 2004 and were fully phased-in by

2012. Nonroad mobile emissions continue to benefit from this program as motorists replace older, more polluting nonroad vehicles with cleaner vehicles.

The nonroad diesel rule set standards that reduced emissions by more than 90% from nonroad diesel equipment and, beginning in 2007, the rule reduced fuel sulfur levels by 99% from previous levels. The reduction in fuel sulfur levels applied to most nonroad diesel fuel in 2010 and applied to fuel used in locomotives and marine vessels in 2012. This is a nationwide program and impacts West Virginia sources and directly the visibility at West Virginia's Class I areas.

13.3.10. Maximum Achievable Control Technology (MACT) Programs (40 CFR Part 63)

VISTAS applied controls to future year VOC, SO_2, NO_X, and PM emission estimates for source categories where MACT regulation controls were installed on or after 2002.

Table 13-3 describes the MACTs used as control strategies for the non-EGU point source emissions in the regional haze SIP. The table notes the pollutants where controls were applied as well as the promulgation dates and the compliance dates for existing sources.

Table 13-3: MACT Source Categories

MACT Source Category	40CFR63 Subpart	Original Promulgation Date	Compliance Date (Existing Sources)	Pollutants Affected
Hazardous Waste Combustion (Phase I)	EEE (63), 261 and 270	9/30/1999	9/30/2003	PM
Portland Cement Manufacturing	LLL	6/14/1999	6/10/2002	PM
Secondary Aluminum Production	RRR	3/23/2000	3/24/2003	PM
Lime Manufacturing	AAAAA	1/5/2004	1/5/2007	PM, SO_2
Taconite Iron Ore Processing	RRRRR	10/30/2003	10/30/2006	PM, SO_2
Industrial Boilers, Institutional/ Commercial Boilers and Process Heaters	DDDDD	9/13/2004	9/13/2007	PM, SO_2
Reciprocating Internal Combustion Engines	ZZZZ	6/15/2004	6/15/2007	NO_X, VOC

The Industrial/Commercial/Institutional (ICI) boiler MACT standard (40 CFR 63 Subpart DDDDD) was vacated by the U.S. Court of Appeals and remanded the regulation to the EPA on June 8, 2007. VISTAS chose, however, to leave the emissions reductions associated with this regulation in place as the CAA required use of alternative control methodologies under Section 112(j) for uncontrolled source categories. The applied MACT control efficiencies were 4% for SO_2 and 40% for PM_{10} and $PM_{2.5}$ to account for the co-benefit from installation of acid gas scrubbers and other control equipment to reduce HAPs.

The EPA finalized the revised ICI Boiler MACT on March 21, 2011. The EPA subsequently reconsidered certain aspects of the rule and proposed changes on December 2, 2011. The rules were re-promulgated on January 31, 2013. The final compliance date for ICI boilers at major sources was 2016, with the option to request an additional year. The EPA's estimate of nationwide SO_2 emissions reductions from this rule is over 500,000 tpy, as compared to an estimate of 113,000 tpy in the analysis for the 2004 rule (78 FR 7138[82] and 69 FR 55218[83]). On November 5, 2015, the EPA finalized additional revisions to the Boiler MACT and projected that these updates would not significantly change the emissions reductions expected from the rule. Therefore, it is reasonable to conclude the 2012 rule has brought about more SO_2 reductions in West Virginia than were modeled in West Virginia's first-round Regional Haze Plan.

13.3.11. State EGU Control Measures

Emissions from EGUs have been regulated through state measures in North Carolina and Georgia, which were included in the regional haze SIP modeling. Reductions associated with these measures were used to estimate the 2018 visibility improvements at the VISTAS Class I areas.

13.3.12. North Carolina Clean Smokestacks Act

In June of 2002, the North Carolina General Assembly enacted the Clean Smokestacks Act (CSA), which required significant actual emissions reductions from coal-fired power plants in North Carolina. These reductions were included as part of the VISTAS 2018 Best and Final modeling effort. Under the CSA, power plants were required to reduce their NO_X emissions by 77% in 2009 and their SO_2 emission by 73% in 2013. Actions taken to date by facilities subject to these requirements comply with the provisions of the CSA, and compliance plans and schedules will allow these entities to achieve the emissions limitations set out by the Act. This program has been highly successful. In 2009, regulated entities emitted less than the 2013 system annual cap of 250,000 tons of SO_2 and less than the 2009 system annual cap of 56,000 tons of NO_X. In 2002, the sources subject to CSA emitted 459,643 tons of SO_2 and 142,770 tons of NO_X. In 2011, these sources emitted only 73,454 tons of SO_2 and 39,284 tons of NO_X, well below CSA's system caps.

This legislation established annual caps on both SO_2 and NO_X emissions for the two primary utility companies in North Carolina, Duke Energy and Progress Energy. Duke Energy and

[82] URL: https://www.govinfo.gov/content/pkg/FR-2013-01-31/pdf/2012-31646.pdf
[83] URL: https://www.govinfo.gov/content/pkg/FR-2004-09-13/pdf/04-11221.pdf

Progress Energy have produced emissions reductions beyond what was required which further improved regional visibility.

13.3.13. Georgia Multi-Pollutant Control for Electric Utility Steam Generating Units

Georgia rule 391-3-1.02(2)(sss), enacted in 2007, requires flue-gas desulphurization (FGD) and SCR controls on large coal-fired EGUs in Georgia. Reductions from this regulation were included as part of the VISTAS 2018 Best and Final modeling effort. These controls reduced SO_2 emissions from the affected emissions units by at least 95% and reduced NO_X emissions by approximately 85%. Control implementation dates vary by EGU, starting with December 31, 2008, and ending with December 31, 2015.

13.3.14. West Virginia Reasonable Progress and BART Control Measures

West Virginia completed source-specific reasonable progress and BART determinations for applicable sources in the first-round regional haze SIP. West Virginia identified 22 BART-eligible sources. Nineteen of these BART facilities were able to demonstrate exemption via modeling showing a less than 0.5 deciviews contribution to a Class I area. Also, West Virginia identified 17 units at 9 facilities as reasonable progress sources impacting West Virginia's Class I area visibility having at least 1.0% Q/d*RTMax SO_2 contribution to visibility. Two of these 9 facilities, representing 3 units, were in other states. Maryland's Luke Paper Mill was one of these facilities. Luke permanently ceased all operations in 2019, including two units impacting West Virginia, and surrendered the facility's federally enforceable air permits in 2020. Section 7.2 discusses Luke's SO_2 and NO_X emissions reductions associated with this closure. The other out of state facility was MeadWestvaco Packaging Resource Group in Covington, Virginia (now called WestRock).

Additionally, one West Virginia facility, Capitol Cement (now known as Argos USA LLC), was identified with a greater than 1.0% SO_2 contribution to the Shenandoah National Park in Virginia but did not significantly contribute to West Virginia's Class I areas' visibility. Capitol Cement was also a BART eligible source.

PPG, now Eagle Natrium, was not able to model below BART's 0.5 deciviews impact on multiple Class I areas. Instead, in 2008 PPG elected to accept a permit limit on its BART eligible boiler which reduced its visibility impact below the exemption threshold. Since the last process report, PPG has shut down or converted its coal-fired boilers to natural gas. Section 7.2 discusses these and other facility operational changes and the resulting emission reductions.

All sources in West Virginia selected for reasonable progress were also BART eligible sources. Except for Capitol Cement, all sources in West Virginia contributing greater than 1.0% visibility to a Class I area and selected for reasonable progress in the first implementation period SIP were EGUs.

Table 13-4 lists the West Virginia facilities and associated units which a reasonable progress determination was made and the current compliance status. All facilities required to implement controls or operational adjustment measures have met their compliance date. The table compares the modeled 2018 SO_2 emissions to the actual 2018 emissions for these sources. The 2019 emissions are also available and have been included in the table as another point of reference.

Since the last progress report, three reasonable progress units at two facilities have shut down, with 12 reasonable progress units still in operation. At of the end of the first implementation period (2018), actual SO_2 emissions from all existing facilities (37,039 tons from six facilities, 12 units) are significantly lower (less than half) of the emissions modeled in the SIP for 2018 (78,454 tons from eight facilities, 15 units). In 2019, actual total SO_2 emissions from the units still operating totaled 30,753 tons.

Table 13-4: Current Status of WV Reasonable Progress/BART Sources from the First Implementation Period

Plant Name	Unit ID	Current Status of SO_2 Controls/Reductions	Met Compliance Date?	BART Eligible?	Modeled 2018 SO_2 Emissions	Actual 2018 SO_2 Emissions	Actual 2019 SO_2 Emissions
Mount Storm Power Plant	001	FGD – in operation	Y	Y	3,191	915	728
Mount Storm Power Plant	002	FGD – in operation	Y	Y	3,191	692	735
Mount Storm Power Plant	003	FGD – in operation	Y	Y	5,908	577	411
Mon. Power - Harrison	001	FGD – in operation	Y	Y	5,908	2,608	3,148
Mon. Power - Harrison	002	FGD – in operation	Y	Y	5,954	4,062	3,709
Mon. Power - Harrison	003	FGD – in operation	Y	Y	5,998	5,710	4,295
North Branch Power Station	001	Shutdown	Y	Y	1,004	0	0
North Branch Power Station	002	Shutdown	Y	Y	1,018	0	0
Mon. Power – Pleasants Power	001	FGD – in operation	Y	Y	6,334	4,511	2,665
Mon. Power – Pleasants Power	002	FGD – in operation	Y	Y	6,165	6,679	4,379
Mon. Power – Fort Martin Power	001	FGD – in operation	Y	Y	4,922	2,405	1,885
Mon. Power – Fort Martin Power	001	FGD – in operation	Y	Y	4,890	2,517	2,349
APCO – Amos Power Station	003	FGD – in operation	Y	Y	10,821	3,000	1,849
APCO – Mountaineer Plant	001	FGD – in operation	Y	Y	11,433	3,363	4,600
Capitol Cement Corporation	010	#7 Kiln - shutdown	Y	Y	1,717	0	0
				Totals:	**78,454**	**37,039**	**30,753**

13.3.15. Emission Reduction Measures Not Included in the Regional Haze SIP

Several regulations and requirements have been promulgated that were not included in West Virginia's original SIP submittal. These measures provided additional emission reductions to allow VISTAS Class I areas to meet their reasonable progress goals.

- The International Maritime Organization has strengthened the standards for sulfur in marine fuel (discussed in Section 7.2.1.4.4).
- New source performance standards (NSPS) for stationary compression ignition internal combustion engines and stationary spark ignition internal combustion engines, contained in 40 CFR Part 60 Subpart IIII and Subpart JJJJ, respectively, have generated a significant decrease in NO_X emissions from these sources.
- EPA's Mercury and Air Toxics Standards (discussed in Section 7.2.1.2) and the 2010 SO_2 NAAQS (discussed in Section 7.2.1.3) have further reduced emissions from EGUs.

13.4. Visibility Conditions

40 CFR 51.308(g)(3) requires the state to assess the visibility conditions for the most impaired and least impaired days expressed in terms of five-year averages. The visibility conditions that must be reviewed include: (1) the current visibility conditions; (2) the difference between current visibility conditions compared to the baseline; and (3) the change in visibility impairment for the most and least impaired days over the past five years.

Table 13-5 and Table 13-6 show the current visibility conditions and the difference between the current visibility and the baseline condition expressed in terms of five-year averages of observed visibility impairment for the 20% worst days and the 20% clearest days, respectively. The baseline conditions are for 2000 through 2004 and the current conditions are for 2014 through 2018. Because the RPGs in the first implementation period were calculated for the 20% worst days, the table includes a comparison of the baseline average and current average for the 20% worst days. Table 2-6 shows the current visibility conditions and the difference between the current visibility and the baseline condition for the 20% most impaired days.

The data shows that all Class I areas saw an improvement in visibility on the 20% worst days, the 20% most improved days, and on the 20% clearest days. The current observed 5-year average values for each area on the 20% worst days are below the 2018 goal. On the 20% clearest days, the current observed 5-year average values for each area are below the 2018 goal of no degradation.

Table 13-5: Current Observed Visibility Impairment, Change from Baseline, and Comparison to 2018 RPGs, 20% Worst Days

Class I Area	Baseline Average dv (2000-2004)	Current Average, dv (2014-2018)	Change, current – baseline, (dv)	2018 Goal (dv)	Difference, current – goal, (dv)
Dolly Sods	29.05	18.77	-10.28	21.7	-2.93
Otter Creek	29.05	18.77	-10.28	21.7	-2.93

Table 13-6: Current Observed Visibility Impairment, Change from Baseline, and Comparison to 2018 RPGs, 20% Clearest Days

Class I Area	Baseline Average dv (2000-2004)	Current Average, dv (2014-2018)	Change, current – baseline, (dv)	2018 Goal (dv)	Difference, current – goal, (dv)
Dolly Sods	12.28	6.68	-5.6	<12.28	-5.6
Otter Creek	12.28	6.68	-5.6	<12.28	-5.6

The previous progress report covered visibility through 2013. Table 13-7 through Table 13-9 show the change in visibility impairment for the 20% worst days, 20% most impaired days, and 20% clearest days since 2013 through 2018. The data shows that each Class I area saw an improvement in visibility on the 20% worst, 20% most impaired, and 20% clearest days.

Table 13-7: Observed Visibility Impairment for Five-Year Periods Through 2018, 20% Worst Days

Class I Area	2010-2014	2011-2015	2012-2016	2013-2017	2014-2018
Dolly Sods	22.02	21.27	19.99	19.17	18.77
Otter Creek	22.02	21.27	19.99	19.17	18.77

Table 13-8: Observed Visibility Impairment for Five-Year Periods Through 2018, 20% Most Impaired Days

Class I Area	2010-2014	2011-2015	2012-2016	2013-2017	2014-2018
Dolly Sods	21.11 dv	20.34 dv	18.94 dv	17.99 dv	17.65 dv
Otter Creek	21.11 dv	20.34 dv	18.94 dv	17.99 dv	17.65 dv

Table 13-9: Observed Visibility Impairment for Five-Year Periods Through 2018, 20% Clearest Days

Class I Area	2010-2014	2011-2015	2012-2016	2013-2017	2014-2018
Dolly Sods	8.99	8.22	7.87	7.24	6.68
Otter Creek	8.99	8.22	7.87	7.24	6.68

Figure 13-2 and Figure 13-3 illustrates the data listed in Table 13-5 through Table 13-8 for the 20% worst days, 20% most impaired days, and the 20% clearest days, as well as the URP towards natural background for the 20% worst days. The URP and 2018 RPGs in the first implementation period were based on the 20% worst days; therefore, the figures below continue to look at the 20% worst days. Figure 7-9 shows the URP and observed visibility impairment for the 20% most impaired days.

Figure 13-2 shows the observed five-year average impairment values for the 20% worst days in Dolly Sods, as well as the associated glide slope and the predicted impairment from the regional haze SIP. The 2018 RPG is included in the graph. The observed five-year average impairment for 2018 is below both the glide path and the predicted impairment.

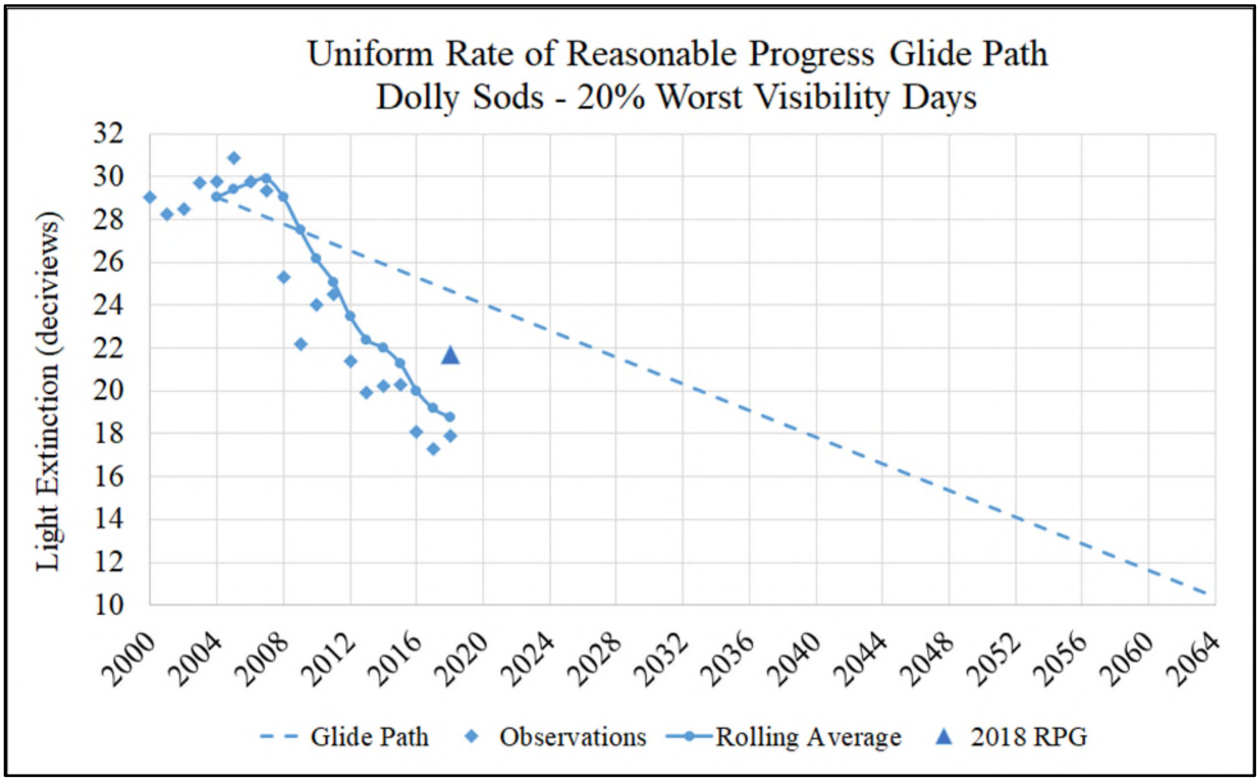

Figure 13-2: Dolly Sods Visibility Impairment on the 20% Worst Visibility Days, Glide Path, and 2018 RPG

Figure 13-3 shows the observed five-year average impairment values for the 20% clearest days in Dolly Sods, as well as the predicted impairment from the regional haze SIP. The observed five-year average impairment for the 20% clearest days of 2018 is below both the baseline and the predicted impairment.

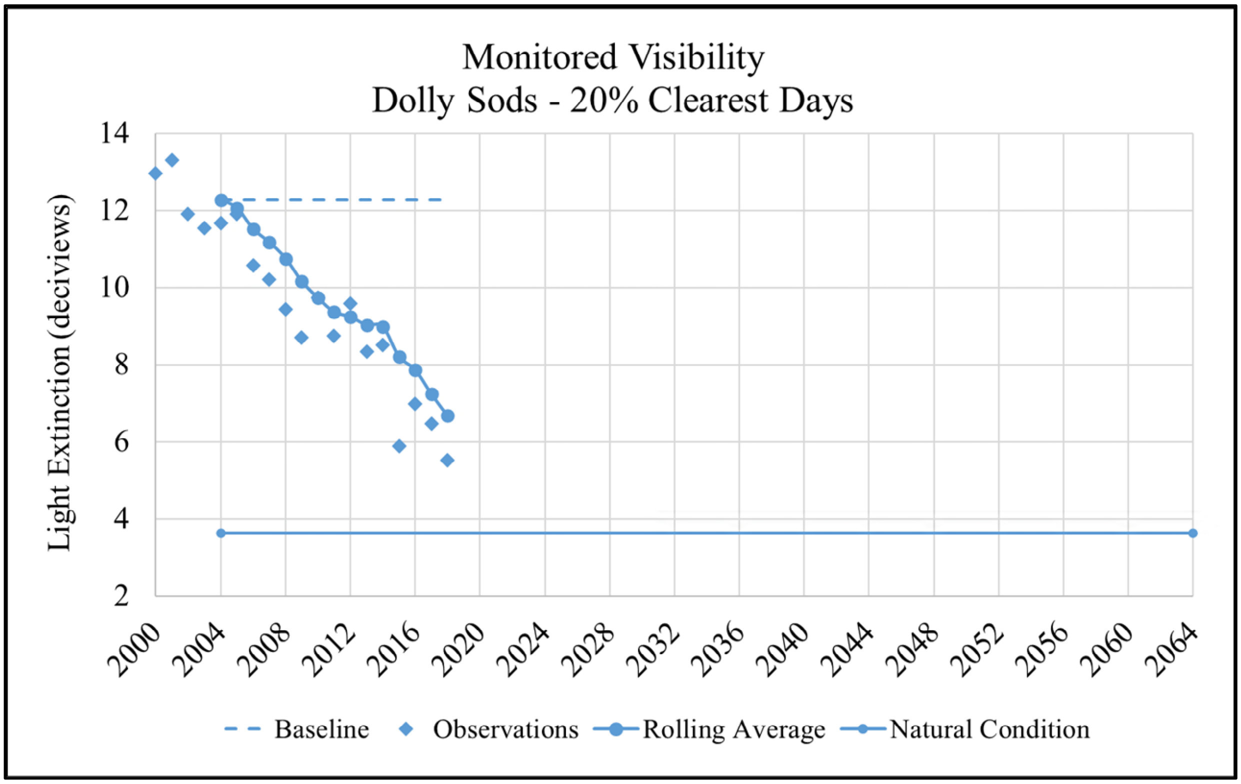

Figure 13-3: Dolly Sods Visibility Impairment on the 20% Clearest Days and Natural Conditions

13.5. Emissions Analysis

This section includes an analysis tracking the change since 2013 in pollutant emissions contributing to visibility impairment from all sources and activities within the state, as required by 40 CFR 51.308(g)(4). Because SO_2 was the significant pollutant contributing to visibility impairment during the first implementation period, the emissions analysis will focus mostly on SO_2 emissions. This section also includes an assessment of changes in anthropogenic emissions since 2013, as required by 40 CFR 51.308(g)(5).

13.5.1. Change in $PM_{2.5}$, NO_X, and SO_2 Emissions from All Source Categories

There are six emissions inventory source categories: stationary point, area (nonpoint), nonroad mobile, onroad mobile, fires, and biogenic sources.

- Stationary point sources are those sources that emit greater than a specified tonnage per year, with data provided at the facility level. Electricity generating utilities and industrial sources are the major categories for stationary point sources.
- Stationary area sources are those sources whose individual emissions are relatively small, but due to the large number of these sources, the collective emissions from the source

category could be significant. These types of emissions are estimated on a countywide level.

- Nonroad mobile sources are equipment that can move, but do not use the roadways (i.e., lawn mowers, construction equipment, marine vessels, railroad locomotives, aircraft). The emissions from these sources, like stationary area sources, are estimated on a countywide level.

- Onroad mobile sources are automobiles, trucks, and motorcycles that use the roadway system. The emissions from these sources are estimated by vehicle type and road type and are summed to the countywide level.

- Fire emissions include prescribed fire and wildfire emissions and can be summed to a countywide level or reported as a point source.

- Biogenic sources are natural sources like trees, crops, grasses, and natural decay of plants. The biogenic emissions are not included in this review since they were held constant as part of the original regional haze SIP modeling and are not controllable emissions.

To evaluate recent emissions changes and progress, West Virginia used the 2014 NEI, the 2017 NEI, and the state's annual point source emissions inventory data. When available, data after 2017 was also used. For comparison purposes, the tables below include the 2018 emissions projected by VISTAS in the first regional haze SIP.

Table 13-10 shows how $PM_{2.5}$ emissions for each source category have changed. The table also includes the VISTAS 2018 emissions projections developed in the first implementation period for comparison. Compared to the VISTAS 2018 emission projections, $PM_{2.5}$ emissions were higher in the 2017 NEI for the area source, onroad, and fires categories, with the fires category more than 18 times more than the VISTAS 2018 projection. This single sector caused overall $PM_{2.5}$ emissions across all categories in the 2017 NEI to be 10.6% higher than what VISTAS projected for 2018. Sector emission increases are often due to improved EPA calculation methodologies and the inclusion of additional sources and data not included in earlier years emission calculations. These reasons are particularly true for all sectors except point. Point source emissions are based on long term acceptable engineering principals, stack testing, continuous monitoring results, and established emission factors.

Table 13-10: West Virginia $PM_{2.5}$ Emissions (tons) for the 2014 NEI, 2017 NEI, and 2018 VISTAS Inventories

$PM_{2.5}$ Sector	NEI 2014 (tpy)	NEI 2017 (tpy)	VISTAS 2018G4 (tpy)
Point	9,171	8,469	12,240
Area	17,728	22,348	21,490
Onroad	1,337	704	405
Nonroad	693	392	1,198
Fires	12,676	7,625	418
Total	**41,604**	**39,538**	**35,751**

Table 13-11 illustrates the significant decreases in each NO_X source category from 2014 to 2017. The 2017 NEI emissions for area, onroad, and fires categories are higher than the 2018 projected emissions. Again, the fires sector was significantly more in the 2017 NEI than the VISTAS 2018 projections, with NO_X emissions more than 13 times more than projected. However, the overall NO_X emissions from all categories for 2017 were more than 16% lower than the 2018 projections.

Table 13-11: West Virginia NO_X Emissions (tons) for the 2014 NEI, 2017 NEI, and 2018 VISTAS Inventories

NO_X Sector	NEI 2014 (tpy)	NEI 2017 (tpy)	VISTAS 2018G4 (tpy)
Point	94,245	60,220	94,754
Area	44,290	38,634	14,828
Onroad	40,880	24,336	17,247
Nonroad	5,367	3,414	25,710
Fires	1,965	1,455	108
Total	**186,747**	**128,059**	**152,647**

Table 13-12 shows SO_2 emissions comparisons, and point sources had the most significant decrease since 2014. Actual 2017 SO_2 emissions from point sources are approximately 73% lower than the projected 2018 emissions. This is largely due to the installation and operation of controls, efforts to meet federal regulations including MATS, CSAPR, and the Data Requirement Rule, the use of cleaner burning fuels, and the retirement of uncontrolled units. Overall, SO_2 emissions across all categories for 2017 were 74% below the 2018 projections.

Table 13-12: West Virginia SO_2 Emissions (tons) for the 2014 NEI, 2017 NEI, and 2018 VISTAS Inventories

SO_2 Sector	NEI 2014 (tpy)	NEI 2017 (tpy)	VISTAS 2018G4 (tpy)
Point	109,614	45,540	167,901
Area	2,601	683	12,849
Onroad	176	153	253
Nonroad	14	8	56
Fires	1,094	732	29
Total	**113,499**	**47,117**	**181,088**

West Virginia's actual emissions from the EGU sector have continued to decrease significantly due to installation of SO_2 scrubbers and other controls. Repowering or shifting to natural gas, reduced utilization of coal-fired EGUs as many have gone from base-load electric suppliers to load-following, increased utilization of natural gas EGUs, and increased renewable energy generation have also significantly reduced SO_2 emissions. Table 13-13 shows the CAMD emissions from 2014 to 2019, which decreased by almost 59% during the five-year period.

Table 13-13: West Virginia EGU SO_2 Emissions for CAMD (2014-2019)

SO_2 Emissions	2014	2015	2016	2017	2018	2019
CAMD	94,3350	58,9605	43,693	40,545	45,778	38,741

Figure 13-4 below depicts the trends for West Virginia units reporting annual SO_2 and NO_X emissions to CAMD. Since 2014, heat input has remained steady with a decrease of about 20% over this period.

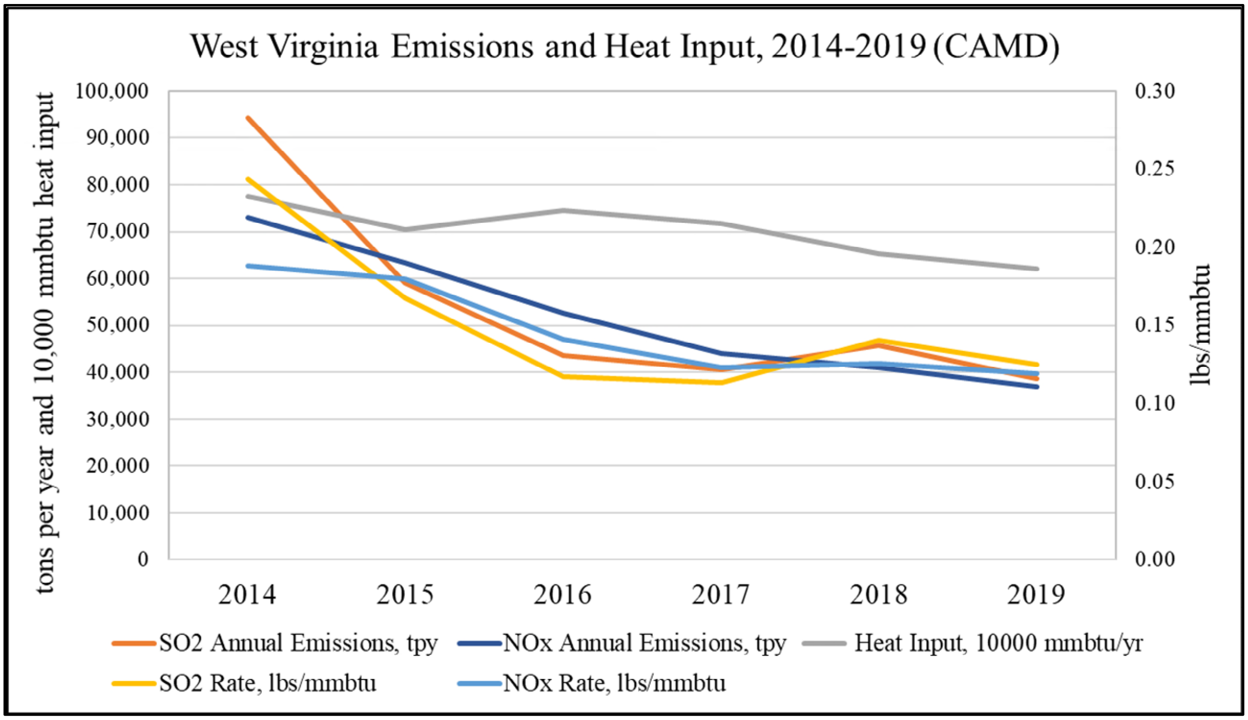

Figure 13-4: West Virginia CAMD Emissions and Heat Input Data *(Source: EPA CAMD Database)*

The SO_2 emissions from these units decreased from 94,335 tons annually in 2014 to 38,741 tons annually in 2019, a decrease of 59%. The average SO_2 emission rate from these units decreased from 0.244 lbs/mmBtu in 2014 to 0.125 lbs/mmBtu in 2019, a reduction of 49%. The significant emission reductions are attributable to several factors, but mostly due to the installation and operation of controls, the use of cleaner burning fuels, and the retirement of uncontrolled units. Over the same period, NO_X emissions decreased from 72,970 tpy to 37,012 tpy, a decline of 49%.

Figure 13-5 shows the trends for units reporting to CAMD across all VISTAS states.

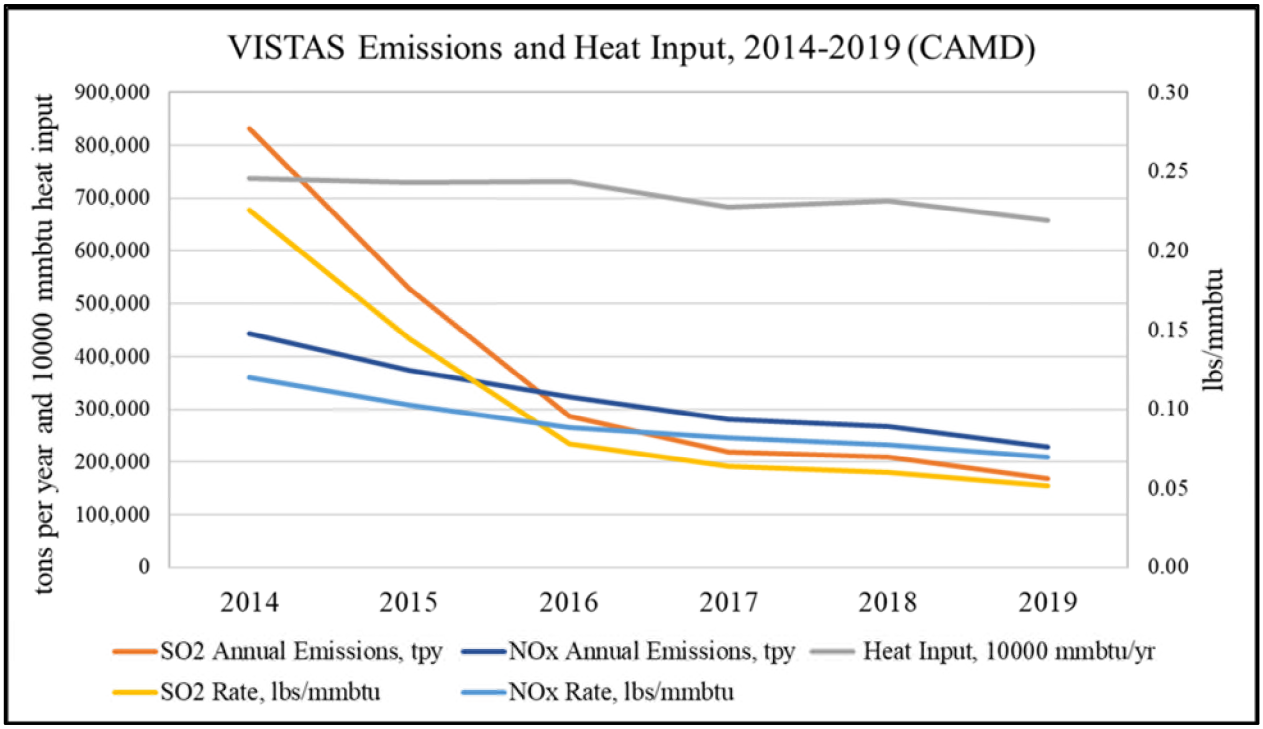

Figure 13-5: VISTAS CAMD Emissions and Heat Input Data *(source: EPA CAMD Database)*

Between 2014 and 2019, heat input to these units decreased approximately 11%. However, the emissions from these units and the emission rates decreased more significantly. Emissions of SO_2 decreased from 831,079 to 169,013 tons annually, a reduction of 80%. The average SO_2 emission rate from these units decreased from 0.225 lb/mmBtu in 2014 to 0.051 lb/mmBtu in 2019, a drop of 77%. Additional controls installed on certain units to meet the stringent requirements of MATS has further reduced the emission rates of those units. Over the same period, NO_X emissions decreased from 442,412 tpy to 228,673 tpy, a drop of 48%.

The figures above reflect the fact that the reductions in SO_2 and NO_X are generally a result of permanent changes at EGUs using control technology and fuel switching, not heat input reductions alone. Thus, visibility improvements from reduced sulfate and nitrate contribution should continue even if the demand for power and the heat input to these units may have moderate increases. In addition, there are new federal rules and impending FIPs that will affect the energy sector. Also, as natural gas and renewable energy sources consume more of the market share, the economics are forcing coal-fired EGUs to shift units from the traditional baseload to load-following operations, which has resulted in fewer operating hours and operating at reduced capacity.

13.5.2. Assessments of Changes in Anthropogenic Emissions

There does not appear to be any significant changes in anthropogenic emissions within West Virginia that would limit or impede progress in reducing pollutant emissions or improving visibility. Most notably SO_2 emissions from point sources have significantly decreased since 2014. There have also been decreases in emissions of NO_X and $PM_{2.5}$ since 2014.

13.6. Conclusion

This progress report documents all control measures outlined in West Virginia's regional haze SIP have been implemented and West Virginia has met all RPGs projected for 2018. Reductions in SO_2 emissions have been significant and greater than VISTAS originally projected. Despite significant reduction in SO_2, sulfates continue to be the most significant species in visibility impairment, especially for the most anthropogenically impaired days. As SO_2 emissions continue to drop in future planning periods and compete less against NO_X in reactions with atmospheric ammonia, nitrates may begin to have a larger relative impact on regional haze. The next regional haze progress report is due by January 31, 2025; it will address progress in the second implementation period.