Final

Regional Haze State Implementation Plan

for

North Carolina Class I Areas

(2019 – 2028 Planning Period)

NORTH CAROLINA
Department of Environmental Quality

Prepared by

North Carolina Department of Environmental Quality

Division of Air Quality

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Preface: This document contains North Carolina's Regional Haze State Implementation Plan (SIP) for the second planning period (January 1, 2019 – December 31, 2028) for mandatory Federal Class I areas in the State. This SIP was prepared in accordance with the Federal Regional Haze Rule provisions specified in 40 CFR 51.308(f) and the U.S. Environmental Protection Agency's guidance for implementing the rule to comply with Section 169 of the Clean Air Act, as amended in 1990. This SIP also contains the second five-year progress report as required in 40 CFR 51.308(g) of the Regional Haze Rule.

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EXECUTIVE SUMMARY

Introduction

Pursuant to the requirements contained in Sections 169, 169A, and 169B of the Clean Air Act (CAA), and the subsequent implementing regulations contained in 40 CFR 51.308, the State of North Carolina, Department of Environmental Quality (DEQ), has developed this State Implementation Plan (SIP) revision for regional haze. The SIP revision represents commitments and actions taken by the state addressing the requirements of these regulations for the second planning period (January 1, 2019 through December 21, 2028) towards the goal of attaining natural visibility conditions in North Carolina's mandatory Federal Class I areas and those Class I areas in other states that may be affected by emissions from North Carolina.[1]

North Carolina has the following five Class I areas (as defined in 40 CFR Part 81.400) within its borders (see Figure Ex-1-1):

- Great Smoky Mountains National Park (GSMNP),
- Joyce Kilmer-Slickrock Wilderness Area (JOYC),
- Linville Gorge Wilderness Area (LIGO),
- Shining Rock Wilderness Area, (SHRO), and
- Swanquarter Wilderness Area (SWAN).

The Great Smoky Mountains National Park and Joyce Kilmer-Slickrock Wilderness Area are in both North Carolina and Tennessee.

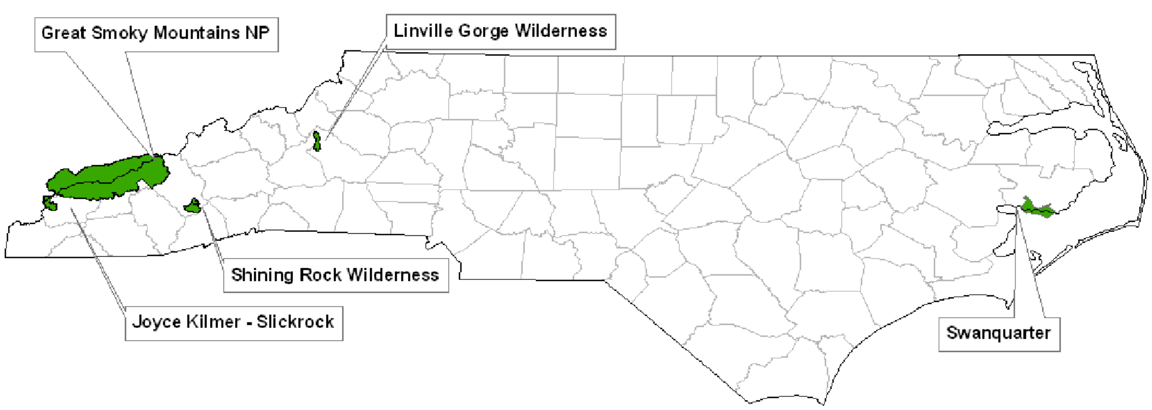

Figure Ex-1-1. Mandatory Federal Class I Areas in North Carolina

Regional Haze and Tracking Metrics

Regional haze is defined as visibility impairment that is caused by atmosphere-entrained air pollutants emitted from numerous anthropogenic (manmade) and natural sources located over a

[1] For brevity, mandatory Federal Class I area(s) is also referred to as "Class I area(s)" in this Executive Summary.

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. PM affects visibility through the scattering and absorption of light, and fine particles – particles similar in size to the wavelength of light – are most efficient, per unit of mass, at reducing visibility. Fine particles are produced by a variety of natural and anthropogenic 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.

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. 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 (RHR) is the deciview (dv) haze index, calculated directly from light extinction using a logarithmic scale. Light extinction is measured in units of inverse megameters (Mm^{-1}) by Interagency Monitoring of Protected Visual Environments (IMPROVE) monitors located in Class I areas. The Class I areas in North Carolina each have one IMPROVE monitor except for the Joyce Kilmer-Slickrock Wilderness Area which relies upon light extinction data measured by the IMPROVE monitor for the Great Smoky Mountains National Park.

For the current and future planning periods, the RHR requires states to track progress for the 20% most anthropogenically impaired and 20% clearest days. IMPROVE monitors are operated about every 3rd day (approximately 122 days per year). The number of days making up 20% of the days IMPROVE monitors are operated typically ranges from 22-24 days depending on the year and when the monitors are operated. For the 20% most impaired days, a state must demonstrate progress during the planning period toward achieving natural conditions in each Class I area. For the clearest days, a state must demonstrate no degradation in visibility from the baseline period (2000-2004). The most impaired and clearest days may change from one year to the next based on meteorology and emissions contributions from sources within and outside of North Carolina. Furthermore, the composition of the PM species contributing to visibility impairment changes as pollutants are controlled to reduce regional haze. Because of these dynamics, the RHR lays out an iterative process for states to develop and adjust their SIPs as needed to demonstrate ongoing progress toward attaining natural visibility conditions in Class I areas.

Overview of SIP

The data and analysis necessary to meet the requirements of the RHR are considerable and require a significant, regional coordinated effort. To develop this proposed SIP revision, North Carolina has relied on the work of the Southeast regional planning group VISTAS (Visibility Improvement State and Tribal Association of the Southeast). VISTAS is directed by the state air directors of ten southeastern states, including the eight U.S. Environmental Protection Agency (EPA) Region 4 states plus the EPA Region 3 states of Virginia and West Virginia. VISTAS also included the Eastern Band of Cherokee Indians who represented the tribal authorities, and the Knox County, Tennessee local air pollution control agency who represented the local air pollution control agencies, within the ten southeastern states.

The ten states, through VISTAS, completed most of the technical requirements using contracted resources. To help coordinate and direct the technical work, VISTAS created the Coordinating Committee, the Technical Analysis Workgroup, the Data Analysis Workgroup, and the SIP Template Workgroup. Each state had at least one representative participating in each group. These workgroups discussed and reviewed the work completed by the contractors used by VISTAS. These data and analyses produced by VISTAS form the technical basis for North Carolina's proposed SIP revision. Throughout the technical work and SIP development process, VISTAS and the individual states provided updates to EPA Regions 3 and 4; the federal land managers (FLMs) from the National Park Service, the U.S. Fish and Wildlife Service, and the U.S. Forest Service; and non-governmental and industrial trade organizations.

The following sections summarize the key elements of the North Carolina' proposed regional haze SIP.

1. Baseline, Current, and Natural Visibility Conditions

Table Ex-1-1 shows the baseline visibility conditions, current visibility conditions, and natural visibility conditions for the 20% most impaired days calculated for each Class I area. Also displayed are the levels of progress made between the baseline and 2018 and the additional visibility improvement needed to achieve natural conditions. A comparison of current to baseline visibility conditions shows a 41% improvement in the haze index for Great Smoky Mountains National Park, Joyce Kilmer-Slickrock Wilderness Area, and Linville Gorge Wilderness Area; 45% improvement for the Shining Rock Wilderness Area; and 31% improvement for the Swanquarter Wilderness Area.

Table Ex-1-1. Visibility Progress on 20% Most Impaired Days (dv)

Class I Area	Baseline (2000-2004)	Current Conditions (2014-2018)	Natural Conditions	Actual Progress to Date (Current – Baseline)*	Additional Progress Needed to Reach Natural Conditions (Natural – Current)*
Great Smoky Mountains National Park	29.11	17.21	10.05	-11.90	-7.16
Joyce Kilmer-Slickrock Wilderness Area	29.11	17.21	10.05	-11.90	-7.16
Linville Gorge Wilderness Area	28.05	16.42	9.70	-11.63	-6.72
Shining Rock Wilderness Area	28.13	15.49	10.25	-12.64	-5.24
Swanquarter Wilderness Area	23.79	16.30	10.01	-7.49	-6.29

* A negative value represents a reduction in deciviews and, therefore, indicates an improvement in visibility.

For the 20% clearest days, Table Ex-1-2 shows that from the baseline period through 2018 visibility has improved thus showing no degradation from the baseline visibility for each of North Carolina's Class I areas.

Table Ex-1-2. Visibility Progress on 20% Clearest Days (dv)

Class I Area	Baseline (2000-2004)	Current Conditions (2014-2018)	Actual Progress to Date (Current – Baseline)
Great Smoky Mountains National Park	13.58	8.35	-5.23
Joyce Kilmer-Slickrock Wilderness Area	13.58	8.35	-5.23
Linville Gorge Wilderness Area	11.11	7.61	-3.50
Shining Rock Wilderness Area	7.70	4.40	-3.30
Swanquarter Wilderness Area	12.34	10.61	-1.41

* A negative value represents a reduction in deciviews and, therefore, indicates an improvement in visibility.

2. Long-Term Strategy (LTS) for Regional Haze

North Carolina's LTS relies on several state and federal programs, reasonable progress analyses of point source facilities both within and out-of-state, and other actions which are expected to provide emissions reductions through the second planning period. The elements of the LTS developed for the second planning period include:

- Federal and State Foundation Control Programs
- Reasonable Progress and Four-Factor Analyses of North Carolina Facilities
- Reasonable Progress Analysis for Out-of-State Facilities
- Additional Programs and Initiatives Supporting Past and Future Emissions Reductions
- Emission Reductions Not Included in 2028 Emissions Projections and RPGs

North Carolina's LTS for the second planning period builds on the federal and state programs implemented during the first planning period to maintain and advance the progress achieved to date. Control measures implemented during the first planning period include, among other things, applicable Federal programs (e.g., mobile source rules, Maximum Achievable Control Technology (MACT) standards), Federal consent agreements, and Federal and State control strategies for power plants. North Carolina's Clean Smokestacks Act (CSA) significantly reduced SO_2 and NO_x emissions from coal-fired power plants and emission reductions from these sources have remained well below the CSA emissions caps. North Carolina's LTS for the second planning period includes additional Federal measures for stationary (e.g., boiler MACT for industrial, commercial, and institutional facilities) and mobile (e.g., Tier 3 vehicle and fuel standards) sources that have been implemented since the previous LTS as well as Federal consent decrees and State consent orders addressing emissions at individual point source facilities. It also includes the results of reasonable progress/four-factor analyses completed on

North Carolina facilities identified as having a significant contribution to visibility impairment at Class I areas in North Carolina.[2]

To select emissions sources to be examined for reasonable progress/four-factor analysis, North Carolina selected stationary source facilities with a ≥1.00% Particulate Source Apportionment Technology (PSAT) threshold for sulfate or nitrate to determine if additional controls are technically feasible and cost effective.[3] For Class I areas in North Carolina, a total of 19 facilities exceeded the ≥1.00% PSAT threshold for sulfate only. Three of these facilities are located in North Carolina, and the NCDAQ requested four-factor analyses from those facilities to evaluate the feasibility for additional SO_2 emission controls. The state also requested reasonable progress analyses for 16 additional facilities in 10 different states. There were no facilities in North Carolina identified as significantly contributing to out-of-state Class I areas.

Based on the four-factor analyses, no additional SO_2 control technologies were identified for implementation at Domtar. Both Blue Ridge Paper Products and PCS Phosphate installed controls from 2017 through 2019 that significantly reduced SO_2 emissions at these facilities, and the four-factor analyses for these two facilities did not identify any additional SO_2 controls that were technically feasible or cost effective.

3. Reasonable Progress Goals (RPGs)

Consistent with paragraph 40 CFR 51.308(f)(3) of the RHR, North Carolina developed the LTS to support establishing RPGs for 2028 for each Class I area within the state (expressed in dv). These goals demonstrate progress from the baseline period (2000-2004) towards achieving natural visibility conditions for the 20% most anthropogenically impaired days and ensure no degradation in visibility for the 20% clearest days. Table Ex-1-3 contains the 2028 RPGs developed for the most impaired and clearest days at each of North Carolina's Class I areas.

Table Ex-1-3. Comparison of 2028 RPGs to Current and Natural Conditions (dv)

Class I Area	20% Most Impaired Days			20% Clearest Days		
	Current Conditions	Natural Conditions	2028 RPG	Current Conditions	Natural Conditions	2028 RPG
Great Smoky Mountains National Park	17.28	10.05	15.03	8.40	4.62	8.96
Joyce Kilmer-Slickrock Wilderness Area	17.28	10.05	15.03	8.40	4.62	8.96
Linville Gorge Wilderness Area	16.40	9.70	14.25	7.61	4.07	8.21
Shining Rock Wilderness Area	15.51	10.01	13.31	4.40	4.07	4.54
Swanquarter Wilderness Area	16.17	9.79	15.27	10.59	5.46	10.77

[2] Section 169A(g)(1) of the CAA and paragraph 51.308(f)(2)(i) of the RHR 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.
[3] VISTAS used Comprehensive Air Quality Model with Extensions (CAMx) PSAT modeling to refine estimates of source contributions to modeled visibility impacts for individual Class I areas in 2028. 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).

4. Progress Report

This SIP also includes the second progress report for the first planning period which addresses paragraphs of the 40 CFR 51.308(g)(1) through (5) of the RHR. This progress report covers the period 2011 through 2018 but includes the RHR rule requirement to report 2019 emissions representing the most recent year for which North Carolina has submitted emissions inventory information to EPA. This progress report documents that all control measures outlined in North Carolina's first regional haze SIP have been implemented and that North Carolina has achieved the 2018 RPGs projected for each Class I area in the state. The LTS for the first planning period, in addition to unplanned emission reductions associated with the closure of facilities and economic forces, have reduced statewide SO_2, NO_x, Particulate matter with an aerodynamic diameter ≤2.5 micrometers ($PM_{2.5}$), and volatile organic compounds (VOC) emissions by 71%, 40%, 20%, and 13%, respectively, from calendar years 2011 to 2019.

The significant reductions in SO_2 and NO_x emissions achieved by North Carolina and neighboring states during the first planning period have significantly improved visibility by reducing ammonium sulfate as shown in Figures Ex-1-2 and Ex-1-3. These two figures show the change in light extinction by species at each IMPROVE monitoring site corresponding to Class I areas in North Carolina between the years 2008[4] and 2018 for the 20% most impaired and 20% clearest days, respectively. Since there is no IMPROVE monitor in Joyce Kilmer-Slickrock Wilderness Area, the IMPROVE monitor in Great Smoky Mountains National Park is used to estimate emissions for Joyce Kilmer-Slickrock Wilderness Area. Although ammonium nitrate contributions to light extinction have increased in recent years (i.e., 2016-2018), sulfate is still the highest contributor to visibility impairment in North Carolina's Class I areas. It is unclear why ammonium nitrate has started to increase at some but not all Class I areas when point and mobile source NO_x emissions have been declining. VISTAS modeling for 2028 suggests that sources outside of North Carolina may be the likely contributor. However, further research is needed to identify the emission sources and geographic location of those sources contributing to the ammonium nitrate fraction to identify cost-effective strategies for addressing this concern.

[4] Complete 2008 data was not available for Swanquarter, so 2009 was used for this comparison.

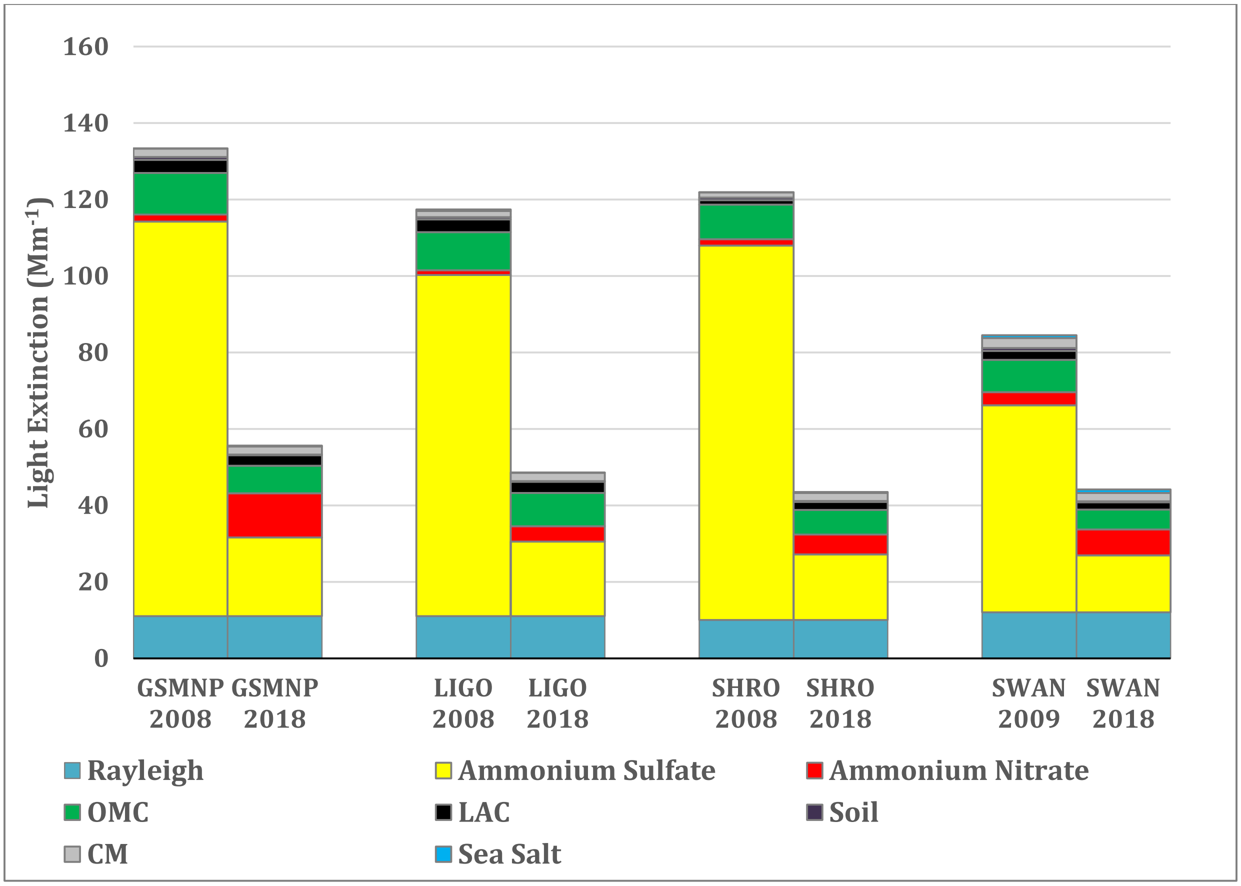

Figure Ex-1-2. Light Extinction by Species on 20% Most Impaired Days at the Beginning and End of First Planning Period at IMPROVE Monitoring Sites in North Carolina

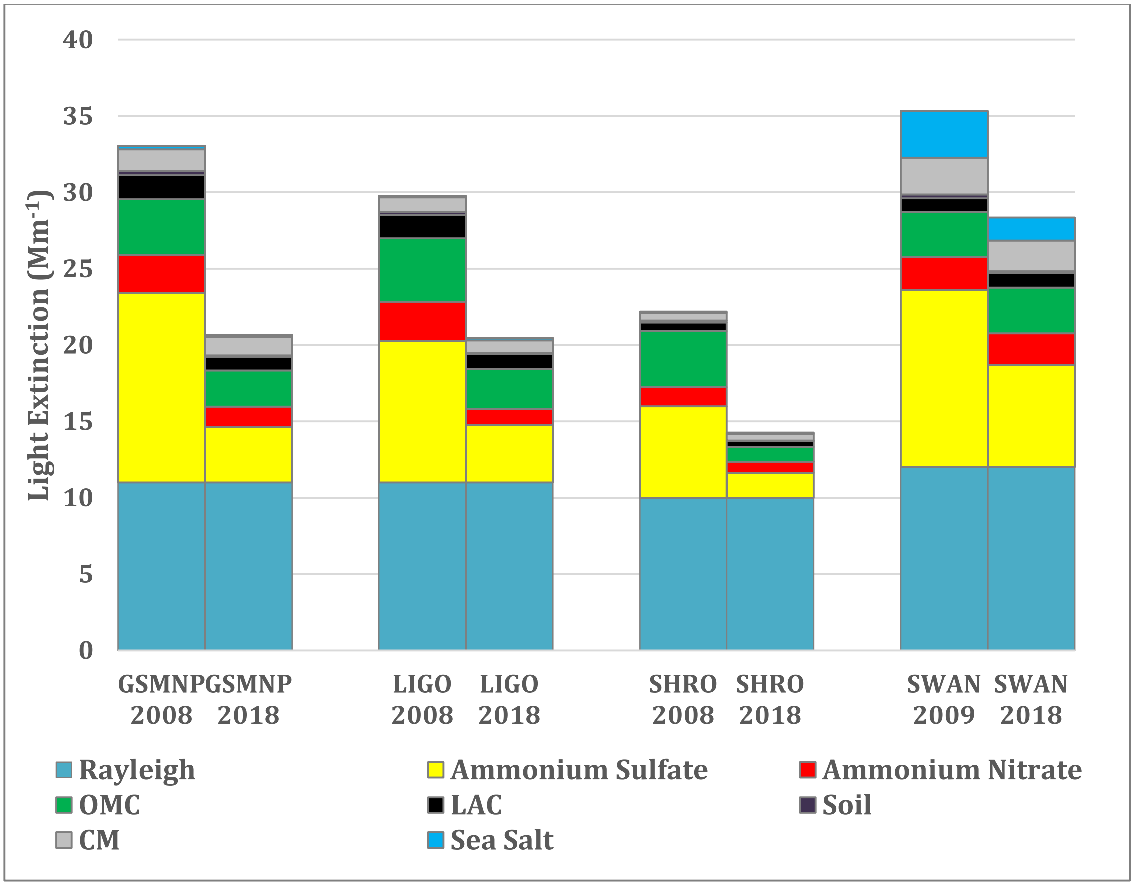

Figure Ex-1-3. Light Extinction by Species on 20% Clearest Days at the Beginning and End of First Planning Period at IMPROVE Monitoring Sites in North Carolina

5. Commitments

The NCDAQ commits to completing the next mid-point review of the LTS as required in the RHR (40 CFR 51.308(f)) due by January 31, 2025, to determine if any adjustments are needed to maintain progress toward achieving natural conditions for the 20% most impaired days and showing no degradation in visibility for the 20% clearest days. The NCDAQ also commits to completing the next comprehensive revision to its regional haze plan for the third planning period (2029-2038) due to EPA by July 31, 2028, and every ten years thereafter.

Conclusion

Visibility in North Carolina's Class I areas vastly improved in the first planning period and further improvements are expected to continue through the second planning period. For this second planning period, North Carolina has built on its LTS for the first planning period that continues to demonstrate significant progress toward achieving natural conditions in each Class I area. Figure Ex-1-4 and Table Ex-1-4 show the improvement in visual range in miles on the 20% most impaired days at each IMPROVE monitoring site corresponding to North Carolina's Class I areas. In Figure Ex-1-4, the uniform rate of progress (URP) is represented by the light gray bars in the foreground; the dark blue bars represent the 5-year average of IMPROVE monitoring data for 2000-2004, 2004-2008, and 2014-2018; and the light blue bars represent the projected RPGs for 2028. Based on the emission reductions that have occurred through 2018 and are projected to occur through 2028, visible range is expected to improve by about 41 miles for the Great Smoky Mountains National Park and Joyce Kilmer-Slickrock Wilderness Area, 44 miles for the Linville Gorge Wilderness Area, 49 miles for the Shining Rock Wilderness Area, and 30 miles for the Swanquarter Wilderness Area. These improvements place North Carolina Class I areas from 12 to 24 years ahead of the URP goal in 2028. Additionally, clearest day visibility conditions are expected to remain better than the baseline period for all North Carolina Class I areas.

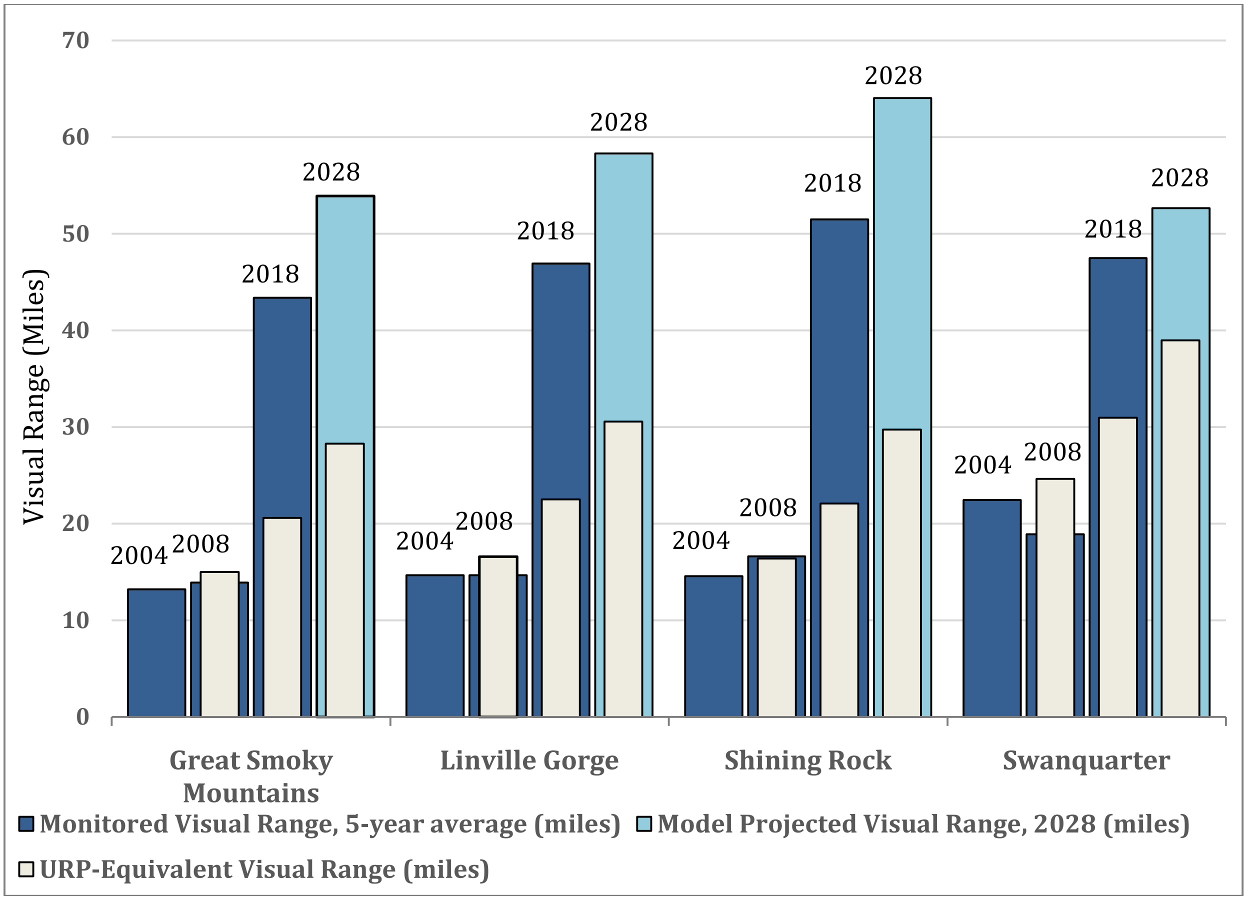

Figure Ex-1-4. Visual Range on 20% Most Impaired Days Compared to the URP

Table Ex-1-4. Improvement in Visual Range on 20% Most Impaired Days (Miles)

Class I Area	Average Visual Range, 2000-2004	Average Visual Range, 2004-2008	2008 URP	Average Visual Range, 2014-2018	2018 URP	Projected Visual Range, 2028	2028 URP
Great Smoky Mountains National Park	13.19	13.90	14.98	43.35	20.57	53.91	28.27
Joyce Kilmer-Slickrock Wilderness Area	13.19	13.90	14.98	43.35	20.57	53.91	28.27
Linville Gorge Wilderness Area	14.66	14.65	16.57	46.91	22.50	58.28	30.55
Shining Rock Wilderness Area	14.55	16.63	16.39	51.49	22.08	64.03	29.74
Swanquarter Wilderness Area	22.45	18.90	24.61	47.48	30.96	52.63	38.96

ACKNOWLEDGEMENTS

This regional haze SIP was produced by the North Carolina Division of Air Quality (NCDAQ), with significant help from the Visibility Improvement – State and Tribal Association of the Southeast VISTAS leadership. Below are the names of the staff involved in this process.

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Thank you to John Hornback for his tireless leadership and management support to the VISTAS member agencies to procure and manage the contract work from December 2017 through August 2020. Also thank you to Chad Lafontaine for a seamless transition in VISTAS leadership and management support to complete the regional haze project work.

The NCDAQ worked closely with the VISTAS state and local air programs and tribal authorities through technical coordination, technical discussions, and technical support. This regional haze plan could not have been completed without the combined efforts of the staff from these state agencies:

<u>VISTAS State Agencies:</u>

Alabama Department of Environmental Management

Florida Department of Environmental Protection

Georgia Department of Natural Resources

Kentucky Department of Environmental Protection

Mississippi Department of Environmental Quality

South Carolina Department of Health and Environmental Control

Tennessee Department of Environment and Conservation

Virginia Department of Environmental Quality

West Virginia Department of Environmental Protection

Contractors:

This work could not have been completed without the expertise and dedication of the VISTAS contractors that performed the technical work. **Eastern Research Group, Inc. (ERG)** provided support on updating the modeling inventory for 2028, development of the Area of Influence analyses, and overall contract management.

Stacie Enoch/ERG

Karla Faught/ERG

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Alpine Geophysics provided photochemical-grid air quality modeling support.

Gregory Stella/Alpine (Subcontract Lead)

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B-1a	VISTAS II Task 2A - Emission Inventory Updates Report (AOI and PSAT)	Included in combined file above
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E-7b	Comparison of original and updated modeling	Appendix_E-7b_VISTAS Emissions 2028 Comparisons Remodeling 200902.xlsx
E-7b	PSAT Percent Contribution Rankings	Appendix_E-7b_VISTAS PSAT Percent Contribution Rankings 02-09-2021 calcs.xlsx
E-7b	PSAT Percent Contribution Rankings	Appendix_E-7b_VISTAS PSAT Percent Contribution Rankings 02-09-2021.xlsx
E-8	SMAT 2028 Bulk- EPA 2019 Modeling with Graphics	Appendix_E-8_SMAT_2028_Bulk_for_SIP.pdf
F	Consultation	
F-1*	NC Letters to VISTAS States	Appendix F-1_for_SIP.pdf
F-2	VISTAS State to NonVISTAS State Consultation	
F-2a	VISTAS Consultation with AR Office of Air Quality	Appendix_F-2a.pdf
F-2b	VISTAS Consultation with IN Office of Air Quality	Appendix_F-2b.pdf

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F-2d	VISTAS Letter to OH Division of Air Pollution Control	Appendix_F-2d.pdf
F-2e	VISTAS Consultation with PA Bureau of Air Quality	Appendix_F-2e.pdf
F-2f	MDE Consultation with VERSO Corporation – Luke Mill	Appendix_F-2f.pdf
F-3	EPA_FLM_Stakeholder Outreach and Presentations	Appendix_F-3a_to_F-3n.pdf
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F-4a*	NC's Response to MANE-VU Comments on NC's Pre-hearing Draft RH SIP	Appendix_F-4a_NC_Response_to_MANE-VU_Comments_on_NC_Draft_RH_SIP.pdf
F-4b*	NC's Response to New Jersey's Comments on NC's Pre-hearing Draft RH SIP	Appendix_F-4b_NC_Response_to_NJ_Comment_on_NC_RH_SIP.pdf
F-4c*	NC's Comments on New Jersey's Draft RH SIP	Appendix_F-4c_NC_Comments_on_NJ_RH_SIP.pdf
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F-5a*	Western NC EJSCREEN Report	Included in combined file above
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G	NC Reasonable Progress Assessments	
G-1*	Reasonable Progress Assessment for Blue Ridge Paper Products, LLC – Canton, NC	Appendix_G-1_BRPP.pdf
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G-2a*	Four Factor Analysis for Domtar Paper Company, LLC – Plymouth, NC	Included in combined file above
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G-3*	Reasonable Progress Assessment for PCS Phosphate Company, Inc. – Aurora, NC	Appendix_G-3_PCS_Phosphate.pdf
G-3a*	Four-Factor Analysis for PCS Phosphate Company, Inc. – Aurora, NC	Included in combined file above
G-3b*	PCS Phosphate Company – Permit No. 04176T63	Included in combined file above
H*	Federal Land Manager Consultation and Comments	Appendix_H1-H3_For_SIP.pdf
H-1*	Consultation with FLM PowerPoint Presentation (April 20, 2021)	Included in combined file above
H-2*	Comments received from NPS Air Resources Division (June 4, 2021)	Included in combined file above
H-3*	Comments received from USFS (June 3, 2021)	Included in combined file above
I*	Public Comment Process, Comments	Appendix_I_for_SIP.pdf

List of Acronyms

The following acronyms are from either the SIP template dated August 28, 2020 or North Carolina's Round 1 SIP. Acronyms highlighted in red are from the final Blue Ridge Paper Products SIP. Until we go final with the pre-draft, it is ok to add acronyms you find as we prepare the pre-draft SIP but do not delete any. Please color code the added acronyms in something other than red. We will run a check on the final pre-draft and delete any unused acronyms (or add any acronyms missed). Note that the list in the following table can be sorted in alphabetical order.

Acronym	Definition
AEO	Annual Energy Outlook
AERR	Air Emissions Reporting Requirements
AFWA	Air Force Weather Agency
AIRMon	Atmospheric Integrated Research Monitoring Network
AL	Alabama
AMoN	Ammonia Monitoring Network
AoI	Area of Influence
AP-42	Compilation of Air Pollutant Emissions Factors
AQS	Air Quality System
ARRA	American Recovery and Reinvestment Act
ARW	Advanced Research WRF model
BART	Best Available Retrofit Technology
BEIS	Biogenic Emission Inventory System
BELD	Biogenic Emissions Land Use Database
b_{ext}	Visibility Impairment, Mm^{-1}
BLM	Bureau of Land Management
btu/kWh	British thermal unit per kilowatt hour
CAA	Clean Air Act
CAIR	Clean Air Interstate Rule
CAM	Compliance Assurance Monitoring
CAMD	Clean Air Markets Division
CAMx	Comprehensive Air Quality Model with Extensions
CART	Classification and Regression Tree
CASTNet	Clean Air Status and Trends Network
CEDS	Comprehensive Environmental Data System
CEM	Continuous Emissions Monitoring
CENRAP	Central Regional Air Planning Association
CERR	Consolidated Emissions Reporting Rule
CFR	Code of Federal Regulations
CM	Coarse Particle Mass
CMAQ	Community Multi-scale Air Quality Model
CMS	Continuous Monitoring Systems
CO	Carbon Monoxide
CONUS	Continental U.S.
CoST	Control Strategy Tool
CSA	Clean Smokestack Act
CSAPR	Cross-State Air Pollution Rule
CSN	Chemical Speciation Network
CTG	Control Technique Guideline
CWT	Concentration Weighted Trajectory
CY	Calendar Year
d	Distance (Kilometers)
DEC	Duke Energy Carolinas, LLC

Acronym	Definition
DEP	Duke Energy Progress, Inc.
DERA	Diesel Emissions Reduction Act
DRR	Data Requirements Rule
DSI	Dry Sorbent Injection
dv	Deciview
EC	Elemental Carbon
ECM	Extinction Coarse Mass
EGU	Electricity Generating Unit
EIA	Energy Information Administration
EIS	Emissions Inventory System
EJ	Environmental Justice
EMF	Emissions Modeling Framework
EMT	Environmental Mitigation Trust
EO	Executive Order
EPA	United States Environmental Protection Agency
ERTAC	Eastern Regional Technical Advisory Committee
ESP	Electrostatic Precipitator
EWRT	Extinction-Weighted Residence Time
FAA	Federal Aviation Administration
FCCS	Fuel Characteristic Classification System
FDDA	Four-Dimensional Data Assimilation
FGD	Flue Gas Desulfurization
FIA	Forest Inventory and Analysis
FL	Florida
FLM	Federal Land Manager
FRM	Federal Reference Method
FS	Forest Service
FSL	Forecast Systems Laboratory
FWS	United States Fish and Wildlife Service
g/bhp-hr	Grams per Brake Horsepower-Hour
GA	Georgia
GACT	Generally Available Control Technology
gal	Gallon
GEOS-Chem	Goddard Earth Observing System-Three-Dimensional Chemical Transport Model
GHG	Greenhouse Gas
gpm	Gallon Per Minute
GRSM1 (TN)	IMPROVE Site Designation for Great Smoky Mountains National Park and Joyce Kilmer-Slickrock Wilderness Area
GVWR	Gross Vehicle Weight Rating
$H_2(SO_4)$	Hydrogen Sulfate
HAP	Hazardous Air Pollutant
HC	Hydrocarbons
HCL	hydrochloric acid
HMP	Hazard Mapping System
HNH_4SO_4	Ammonium Bisulfate
HNH_4SO_4	Ammonium Bisulfate
hp	Horsepower
hr	Hour
HYSPLIT	Hybrid Single Particle Lagrangian Integration Trajectory Model
I&M	inspection and maintenance
I&M	Inspection and Maintenance
IBEAM	Internet-Based Environment for Application Management
ICI	Industrial/Commercial/Institutional
ID	Identification Code No.

Acronym	Definition
IDEM	Indiana Department of Environmental Management
IMPROVE	Interagency Monitoring of Protected Visual Environments
IPM	Integrated Planning Model
ITN	Itinerate Operations at Airports
Km	Kilometers
kW	Kilowatt
KY	Kentucky
LADCO	Lake Michigan Air Directors Consortium
lb	Pound
lb/MMBtu	Pound per Million British Thermal Units
LEV	California Low Emission Vehicle Standards
LIGO1 (NC)	IMPROVE Site Designation for Linville Gorge Wilderness Area
LLC	Limited Liability Company
LN	Low NO_x Combustion Technology
LTO	landing-and-take-off
m	Meter
m^3	Cubic Meter
MACT	Maximum Achievable Control Technology
MANE-VU	Mid-Atlantic/Northeast Visibility Union
MARAMA	Mid-Atlantic Regional Air Management Association
MATS	Mercury and Air Toxics Standard
MB	Mean Bias
mb	Millibar
MDA8	Maximum Daily 8-Hour Average
ME	Mean Error
MFB	Mean Fractional Bias
MFE	Mean Fractional Error
MGE	Mean Gross Error
MJO	Multi-Jurisdictional Organizations
Mm^{-1}	Inverse Megameters
MMBtu	Million British thermal unit
MMBtu/hr	Million British Thermal Units Per Hour
MMscf	Million Standard Cubic Feet
MOU	Memorandum of Understanding
MOVES	Motor Vehicle Emission Simulator model
MRR	Monitoring, Recordkeeping and Reporting
MS	Mississippi
MW	Megawatt
µg	Micrograms
µm	Micrometers
N_2O	Nitrous Oxide
NAAQS	National Ambient Air Quality Standard
NACAA	National Association of Clean Air Agencies
NaCl	sodium chloride, sea salt
NAD83	North American Datum of 1983
NADP	National Acid Deposition Program
NAICS	North American Industrial Classification System
NC	North Carolina
NCAC	North Carolina Administrative Code
NCAR	National Center for Atmospheric Research
NCASI	National Council for Air and Stream Improvement
NCDA&CS	North Carolina Department of Agriculture and Consumer Services
NCDAQ	North Carolina Division of Air Quality
NCDEQ	North Carolina Department of Environmental Quality

Acronym	Definition
NCDOT	North Carolina Department of Transportation
NCEP	National Centers for Environmental Prediction
NCFS	North Carolina Forest Service
NCGS	North Carolina General Statute
NCUC	North Carolina Utilities Commission
NED	National Elevation Data
NEEDS	National Electric Energy Database Systems
NEI	National Emissions Inventory
NESCAUM	Northeast States for Coordinated Air Use Management
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NH_3	Ammonia
NH_4^+	Ammonium Ion
$(NH_4)_2SO_4$	Ammonium Sulfate
NLCD	National Land Cover Database
NMB	Normalized Mean Bias
NME	Normalized Mean Error
NMHC	Non-Methane Hydrocarbons
NMIM	National Mobile Inventory Model
NO	Nitric Oxide
NO_3^-	Nitrate Ion
NOAA	National Oceanic and Atmospheric Administration
NODA	Notice Of Data Availability
NO_x	Oxides of Nitrogen
NPS	National Park Service
NSPS	New Source Performance Standards
NTN	National Trends Network
OAQPS	EPA Office of Air Quality Planning and Standards
OCM	Organic Carbon Mass
OMC	Organic Matter Carbon
OSBM	Office of State Budget and Management
OTC	Ozone Transport Commission
PM	Particulate Matter
PM_{10}	Particulate matter with an aerodynamic diameter $\leq$10 micrometers
$PM_{2.5}$	Particulate matter with an aerodynamic diameter $\leq$2.5 micrometers
POM	Particulate Organic Matter
ppb	Parts Per Billion
ppm	Parts Per Million
ppmvd	Parts Per Million Volume Dry
PSAT	Particulate Source Apportionment Technology
PSD	Prevention of Significant Deterioration
PTE	Potential-to-Emit
Q	Quantity of emissions, Tons Per Year
RACT	Reasonably Available Control Technology
RECS	Renewable Energy Credits
REPS	Renewable Energy and Energy Efficiency Portfolio Standard
RF	Recovery Furnace
RFG	Reformulated Gasoline
RHR	Regional Haze Rule
RICE	Reciprocating Internal Combustion Engine
RMSD	Root Mean Square Deviation
RMSE	Root Mean Square Error
RPG	Reasonable Progress Goal
RPO	Regional Planning Organization
RRF	Relative Reduction Factor

Acronym	Definition
RT	Residence Time
RTO	Regenerative Thermal Oxidizer
SAP	Sulfuric Acid Plant
SC	South Carolina
SCC	Source Classification Code
scf	Standard Cubic Feet
SCR	Selective Catalytic Reduction
SDT	Smelt Dissolving Tank
SEARCH	Southeastern Aerosol Research and Characterization
SHRO1 (NC)	Linville Gorge Wilderness Area Shining Rock Wilderness Area
SIA	Second IMPROVE Algorithm
SIP	State Implementation Plan
SL	State Law
SMOKE	Sparse Matrix Operator Kernel Emissions
SNCR	Selective Non-Catalytic Reduction
SO_2	Sulfur Dioxide
SO_4^{-2}	Sulfate Ion
SOAP	Secondary Organic Aerosol Partitioning
SOC	Special Order by Consent
STN	Speciated Trends Network
SUV	Sport Utility Vehicle
SWAN1 (NC)	Linville Gorge Wilderness Area Swanquarter Wilderness Area
TAFS	Terminal Area Forecast System
TCI	Total Capital Investment
TDM	Travel Demand Model
TIP	Tribal Implementation Plan
TN	Tennessee
TPY	Tons Per Year
TRS	Total Reduced Sulfur
TSD	Technical Support Document
TSM	Total Suspended Metals
TVA	Tennessee Valley Authority
ULSD	Ultra-Low Sulfur Diesel
URP	Uniform Rate of Progress
USDA	United States Department of Agriculture
USDA-FS	United States Department of Agriculture-Forest Service
USDI	United States Department of Interior
USDI-FWS	United States Department of Interior - Fish and Wildlife Service
USDI-NPS	United States Department of Interior – National Park Service
USF&WS	United States Fish and Wildlife Service
USFS	United States Forest Service
UTM	Universal Transverse Mercator
VA	Virginia
VISTAS	Visibility Improvement – State and Tribal Association of the Southeast
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compound
VW	Volkswagen
WESTAR	Western States Air Resources Council
WRF	Weather Research and Forecasting Model
WV	West Virginia
ZEV	Zero Emission Vehicle

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1.0 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 our national parks, forests, and wilderness areas (including 156 mandatory Federal Class I areas[5] 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 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 United States Environmental Protection Agency (EPA) has set national ambient air quality standards (NAAQS) for daily and annual levels of fine particles with an aerodynamic diameter $\leq$2.5 micrometers (μm) ($PM_{2.5}$). In the Southeast, the most important 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 non-road 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 emanates from a variety of sources until monitoring, modeling, and scientific knowledge about the relationships between pollutants and visibility impairment improved.

[5] For brevity, mandatory Federal Class I area(s) is also referred to as "Class I area(s)" in this document.

In the 1990 Amendments to the CAA, Congress added section 169B and called on EPA to issue regional haze rules. The regional haze rule (RHR) that EPA promulgated on July 1, 1999, (64 FR 35713) revised the existing visibility regulations to integrate provisions addressing regional haze impairment and establish a comprehensive visibility protection program for mandatory Federal Class I areas.[6] Each state was required to submit state implementation plans (SIPs) to EPA by December 17, 2007 which set out its plan for complying with the RHR for the first ten-year planning period covering 2008 – 2018. Each state was required to consult and coordinate with other states and with Federal Land Managers (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 RHR 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 planning period from January 1, 2019 through December 31, 2028.

The RHR 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 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.[7] 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 Regional Planning 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 planning periods. For the second planning 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.

[6] 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).
[7] EPA. "Visibility - Regional Planning Organizations", 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 RHR at 40 CFR 51.308(d) requires all states to submit a SIP for regional haze. Paragraph 51.308(f) of the RHR requires each state to periodically revise and submit revisions to its regional haze SIP. All regional haze SIPs must include the following:

- Reasonable Progress Goals (RPGs) for each Class I area located within the state;
- Natural, baseline, and current visibility conditions for each Class I area within the state;
- A long-term strategy (LTS) to address visibility for each Class I area within the state and for each Class I area located outside the state that may be affected by emissions from the state;
- A monitoring strategy for measuring, characterizing, and reporting that is representative of all Class I areas within the state; and
- Other requirements and analyses.

The RHR requires states to establish RPGs, expressed in deciviews (dv), for the end of each implementation period (approximately 10 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 RHR and other requirements of the CAA (40 CFR 51.308(f)(3)). The goals must show 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 RHR 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 RHR directs each state with a Class I area to construct the uniform rate of progress (URP or "glidepath") from 2000 to 2064 to use as a guide for evaluating progress toward attaining natural visibility conditions. Data from the Interagency Monitoring of Protected Visual Environments

(IMPROVE) network are used to establish baseline and natural visibility metrics.[8] States are to establish baseline visibility conditions using a 5-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 RHR for 20% clearest days is to ensure that no degradation from the baseline (2000-2004) occurs.

For this second planning 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 5-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 5-year period for calculating current visibility conditions (40 CFR 51.308(f)(1)(i)-(iv)).

The 2028 RPGs for each Class I area must be met through measures contained in the state's LTS. The LTS must address regional haze visibility impairment for each Class I area within the state and for each Class I area located outside the state that may be affected by emissions from the state. The LTS must include enforceable emissions limitations, compliance schedules, and other measures as necessary to demonstrate reasonable progress. Section 169A of the CAA requires a state to consider the four statutory factors (costs of compliance, time necessary for compliance, energy and non-air quality environmental impacts and remaining useful life) when developing the LTS upon which it bases the RPGs for each Class I area. States are also required to consider the following additional factors in developing their LTS: ongoing air 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 LTS (40 CFR 51.308(f)(2)(iv)).

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

States are required to evaluate progress toward meeting RPGs every 5 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 planning 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 reductions are not on track to ensure 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)).

[8] Colorado State University, IMPROVE data website. http://vista.cira.colostate.edu/Improve/.

The EPA provided several guidance documents listed below to assist the states in implementation of the RHR requirements, including documents that specifically address the second implementation period. North Carolina 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)

- Clarifications Regarding Regional Haze State Implementation Plans for the Second Implementation Period (July 8, 2021)

1.4 Mandatory Federal Class I Areas in North Carolina

North Carolina's Class I areas (see 40 CFR 81.422) include the Great Smoky Mountains National Park (GSMNP), Joyce Kilmer-Slickrock Wilderness Area, Linville Gorge Wilderness Area, Shining Rock Wilderness Area, and Swanquarter Wilderness Area (see Figure 1-3). The GSMNP and Joyce Kilmer – Slickrock Wilderness Area are located in both North Carolina and Tennessee. Therefore, North Carolina and Tennessee coordinated with each other to establish the RPGs for Great Smoky Mountains National Park and Joyce Kilmer-Slickrock Wilderness Area. Joyce-Kilmer Slickrock does not contain an IMPROVE site. Thus, the rate of progress for GSMNP is considered representative of Joyce Kilmer-Slickrock.

As required by the RHR, the NCDAQ has also considered the impacts of emission sources outside of North Carolina that may affect visibility at these North Carolina Class I areas and emission sources within North Carolina that may affect visibility at 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. This technical work is discussed further in Sections 4, 5, and 6 of this SIP. Consultations between North Carolina and other states are summarized in Section 10.

Figure 1-2. North Carolina's Mandatory Federal Class I Areas

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 Class I areas in the VISTAS region (see Figure 1-3 and Table 1-1). North Carolina participated as a member state in VISTAS during the first and second planning periods. The objectives of VISTAS are as follows:

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

In addition, VISTAS states also coordinated with regional haze planning conducted by other RPOs to share information and undertake consultation as needed to address visibility impairment associated with (1) sources impacting Class I areas in the VISTAS region, and (2) sources in the VISTAS region potentially impacting visibility impairment in another region.

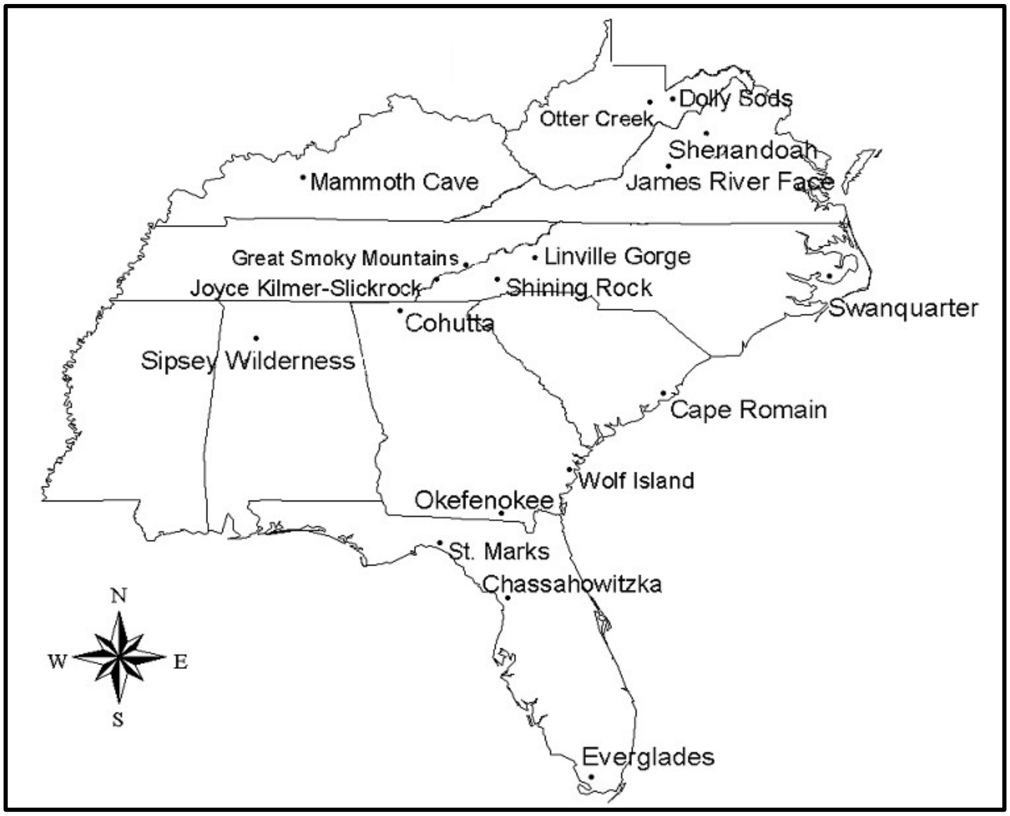

Figure 1-3. Mandatory Federal Class I Areas in the VISTAS Region

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
	Everglades National Park	1,397,429	USDI-NPS
	St. Marks Wilderness Area	17,745	USDI-FWS
Georgia	Cohutta Wilderness Area	33,776	USDA-FS
	Okefenokee Wilderness Area	343,850	USDI-FWS
	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
	Joyce Kilmer-Slickrock Wilderness Area	10,201	USDA-FS
	Linville Gorge Wilderness Area	7,575	USDA-FS
	Shining Rock Wilderness Area	13,350	USDA-FS
	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
	Joyce Kilmer-Slickrock Wilderness Area	3,832	USDA-FS
Virginia	James River Face Wilderness Area	8,703	USDA-FS
	Shenandoah National Park	190,535	USDI-NPS
West Virginia	Dolly Sods Wilderness Area	10,215	USDA-FS
	Otter Creek Wilderness Area	20,000	USDA-FS

1.6 State and FLM Coordination

As required by 40 CFR 51.308(i) and CAA Section 169A(d), the regional haze SIP must include procedures for continuing consultation between the states and FLMs on the implementation of the visibility protection program, including development and review of periodic implementation plan revisions and 5-year progress reports, and on 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 for Class I areas in North Carolina 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).

Coordination of North Carolina's obligations to periodically revise its regional haze SIP with the FLMs is also discussed in Section 11. The NCDAQ formally commits to follow the consultation procedures as prescribed in 40 CFR 51.308(i) in making these future implementation plan reviews and revisions. The NCDAQ also commits to ongoing consultation with the FLMs throughout the implementation process, including annual discussion of the implementation process and the most recent IMPROVE monitoring data. The FLMs were involved in the preparation of this regional haze SIP. Documentation of North Carolina's consultation with the FLMs is presented in Section 10.4 and Appendix H.

1.7 Cross-Reference to Regional Haze Rule Requirements

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

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

Rule Section	Chapter/Section in SIP	Description
(f)	11	Requirements for periodic comprehensive revisions of implementation plans for regional haze.
(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 by considering the four factors.
(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.

Rule Section	Chapter/Section in SIP	Description
(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, 7.9, 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 it affects.
(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)	7.2.3, 7.9.1	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, 7.9.2	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. State must establish reasonable progress goals (expressed in deciviews) that reflect the visibility conditions that are projected to be achieved by the end of the applicable implementation period as a result of those enforceable emissions limitations, compliance schedules, and other measures.
(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, 8	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 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.

Rule Section	Chapter/Section in SIP	Description
(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)	7.2.5, 13	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. 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 to address regional haze for all mandatory Federal Class I areas within the State are being achieved.
(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)	not applicable	For a state with no mandatory Class I federal areas, procedures by which monitoring data and other information are used to in determining the contribution of emissions from within the State to regional haze visibility impairment at mandatory Federal Class I 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)	13.2	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)	13.3	(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
(g)(3)	13.4	For each mandatory Federal Class I 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.
(g)(4)	13.5	An analysis tracking the change over the period since the period addressed in the most recent plan required under 40 CFR 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 emissions inventory information to the Administrator in compliance with the triennial reporting requirements of subpart A of this part as of a date 6 months preceding the required date of the progress report.
(g)(5)	13.6	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 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.
(g)(6)	13.7	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 RPGs for the period covered by the most recent plan required 40 CFR 51.308(f).
(g)(7)	13.8	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.
(g)(8)	13.9	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.
(i)	10.4	State and FLM coordination.

2.0 ESTIMATES OF NATURAL BACKGROUND CONDITIONS IN CLASS I AREAS AND ASSESSMENT OF BASELINE AND CURRENT CONDITIONS AND ESTIMATE OF NATURAL BACKGROUND CONDITIONS IN CLASS I AREAS

The goal of the RHR is to restore natural visibility conditions to the 156 Class I areas identified in the 1977 Clean Air Act Amendments. Section 40 CFR 51.301 of the RHR 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 demonstrate progress toward achieving natural visibility conditions by reducing anthropogenic (i.e., manmade, 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 RHR is the deciview index, as required by 40 CFR 51.301. Deciviews (dv) 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}).[9] The dv units are useful for tracking progress in improving visibility

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

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.

The RHR requires that the SIP present the following three visibility metrics for each Class I area in the state:

- 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.[10]

"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 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 monitoring data are used in conjunction with inventory and meteorological data to project expected visibility parameters for each Class I area, as described in Sections 4, 5, and 6.

"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.

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

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.[11]

The algorithm has been revised over the years to produce consistent estimates of light extinction for all remote-area IMPROVE aerosol monitoring sites, and it permits the individual particle component contributions to light extinction to be separately estimates. The current IMPROVE equation includes contributions from sea salt, and an increase in the multiplier in contribution 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 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 the original and revised modeling protocol provided in Appendix E-1a and Appendix E-1b, respectively.

2.2 IMPROVE Monitoring Sites

Table 2-1 provides the VISTAS Class I areas and their associated 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

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

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
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,[12] 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 round of regional haze planning 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,[13] and EPA guidance that updates recommended methodologies

[12] U.S. EPA. "Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Program", EPA-454/B-03-005. September 2003. https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1006X8H.TXT
[13] Final Rule: Protection of Visibility: Amendments to Requirements for State Plans, 82 FR 3078, January 10, 2017.

for tracking visibility impairment, issued in December 2018.[14] Also, as part of EPA's 2018 guidance memo, the recommended methodology for computing natural conditions for the 20% most impaired days changed, while no change was made for the 20% clearest days. The 2018 guidance memo provided IMPROVE monitoring data from 1990 through 2017.

Natural background conditions using the current IMPROVE equation are calculated separately for each Class I area, and the methodologies 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 current 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 that are unrecognized in the computation of visibility under natural background conditions.

2.3.1 Natural Background Conditions on 20% Clearest Days

The 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 RHR requirements 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.

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

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 (dv)*	Average for 20% Clearest Days (dv)*	Average for 20% Most Impaired Days (Mm^{-1})	Average for 20% Clearest Days (Mm^{-1})
Great Smoky Mountains National Park	10.05	4.62	27.32	15.87
Joyce Kilmer-Slickrock Wilderness Area	10.05	4.62	27.32	15.87
Linville Gorge Wilderness Area	9.70	4.07	26.38	15.02
Shining Rock Wilderness Area	10.25	2.49	27.87	12.83
Swanquarter Wilderness Area	10.01	5.71	27.21	17.70

* Data taken from Table 1 of reference in footnote 15.[15]

2.4 Baseline Conditions

Baseline visibility conditions at each North Carolina Class I area are estimated using sampling data collected at IMPROVE monitoring sites at four of the five Class I 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; and the 2018 EPA guidance. IMPROVE data records for Great Smoky Mountains National Park and Linville Gorge Wilderness Area for the period 2000 to 2004 meet the EPA requirements for data completeness (75% for the year and 50% for each quarter). IMPROVE data records for Shining Rock Wilderness Area and Swanquarter Wilderness Area had missing data in more than one year between 2000 to 2004. Data records for these sites were filled using data substitution procedures outlined in Appendix C-1. Data at Swanquarter were further amended due to a filter issue that was discovered to affect data from 2003-2005.[16] The IMPROVE monitor at Great Smoky Mountains National Park is used to represent visibility in the Joyce Kilmer Wilderness Area which does not have an IMPROVE monitor.

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[15] Richard A. Wayland, U.S. EPA to Regional Air Division Directors, Regions 1-10. 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". June 3, 2020. https://www.epa.gov/sites/default/files/2020-06/documents/memo_data_for_regional_haze_technical_addendum.pdf.

[16]Copeland, Scott. *Changes to IMPROVE RHR Calculations and Metrics since 12/2019 Version, April 23, 2020,* http://vista.cira.colostate.edu/DataWarehouse/IMPROVE/Data/SummaryData/RHR_2018/Updated/Changes%20to%20IMPROVE%20RHR%20Metric%20Data%20Processing%20since%2010_2019%20v5_20.pptx.

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% most impaired and 20% clearest days at North Carolina 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 and calculations included in Table 1 in the EPA technical addendum (including updated visibility data through 2018) to 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*."[17]

Table 2-3. Baseline Visibility Conditions for North Carolina Class I Areas (2000-2004)

Class I Areas	Average for 20% Most Impaired Days (dv)	Average for 20% Clearest Days (dv)	Average for 20% Most Impaired Days (Mm^{-1})	Average for 20% Clearest Days (Mm^{-1})
Great Smoky Mountains National Park	29.11	13.58	183.75	38.88
Joyce Kilmer-Slickrock Wilderness Area	29.11	13.58	183.75	38.88
Linville Gorge Wilderness Area	28.05	11.11	165.27	30.37
Shining Rock Wilderness Area	28.13	7.70	166.60	21.60
Swanquarter Wilderness Area	23.79	12.34	107.94	34.35

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

The 20% most impaired visibility days at the Southern Appalachian sites (in North Carolina: Great Smoky Mountains, Joyce Kilmer, Linville Gorge, and Shining Rock) during the baseline period generally occurred in the period April to September, with sulfate being the largest component. To illustrate this, Figure 2-1 through Figure 2-4 display the 2000 – 2004 reconstructed extinction for the 20% most impaired days for the Class I areas in North Carolina. Similar plots for the other VISTAS Class I areas can be found in Appendix C-2. 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.

[17] See footnote 15.

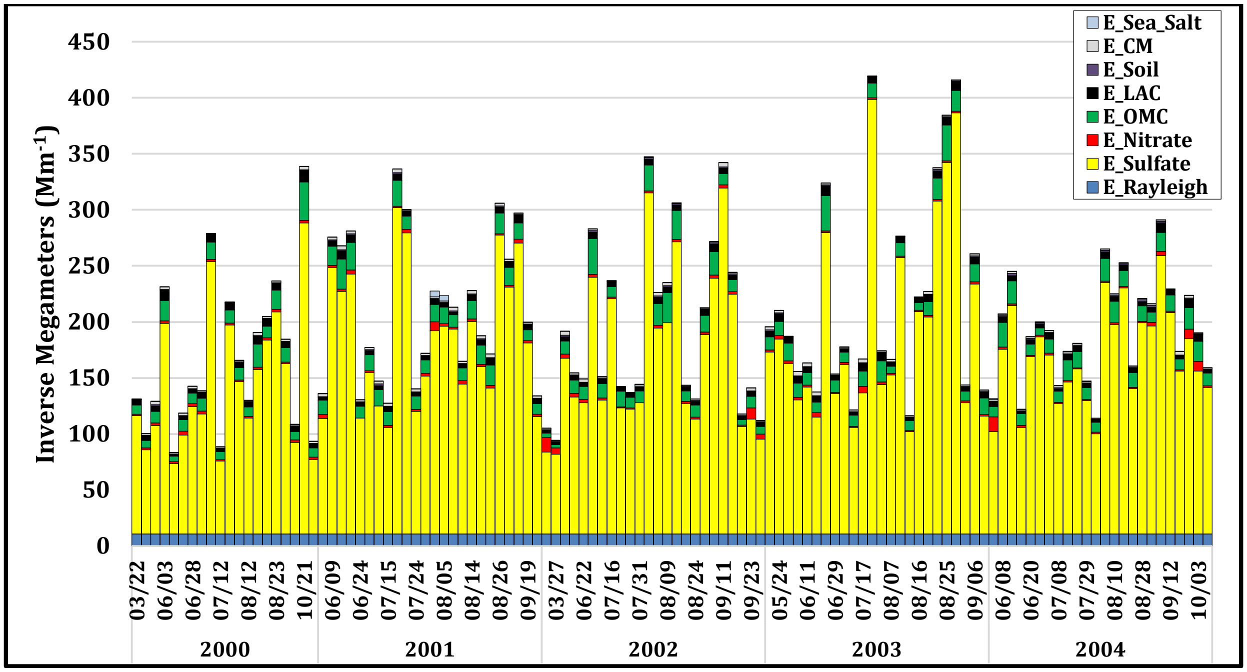

Figure 2-1. 2000-2004 Reconstructed Extinction for the 20% Most Impaired Days at the Great Smoky Mountains National Park and Joyce Kilmer – Slickrock Wilderness Area

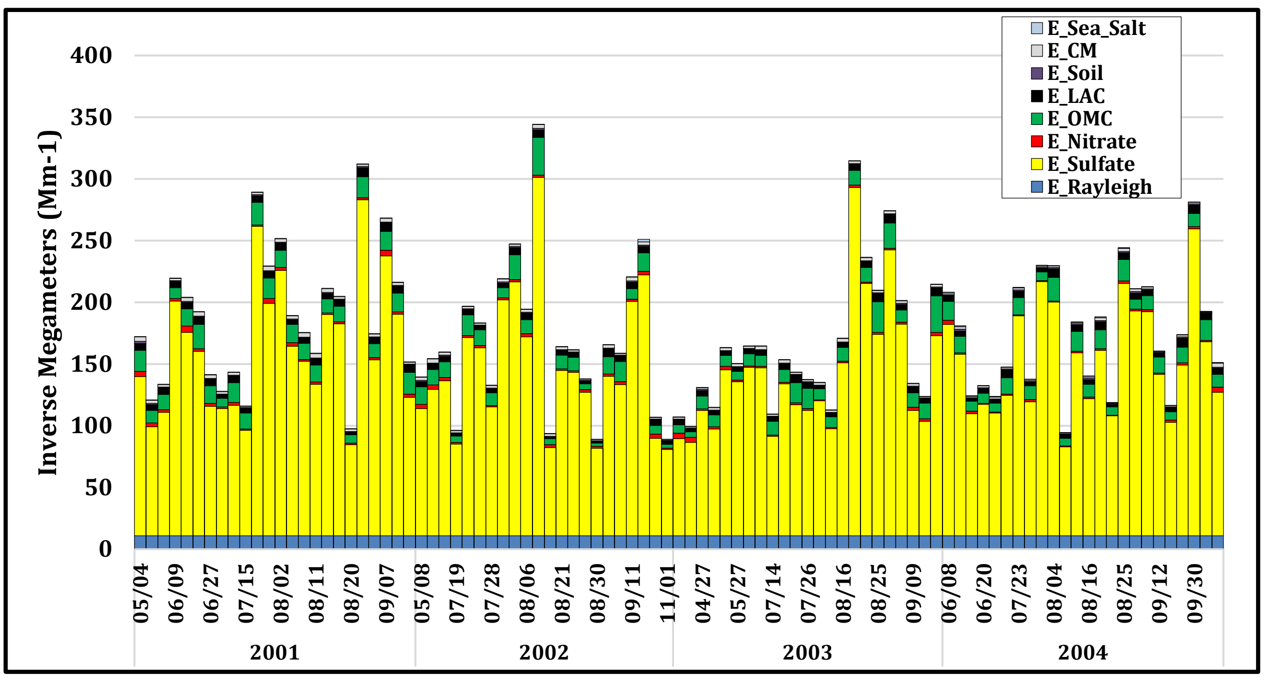

Figure 2-2. 2001-2004 Reconstructed Extinction for the 20% Most Impaired Days at Linville Gorge Wilderness Area

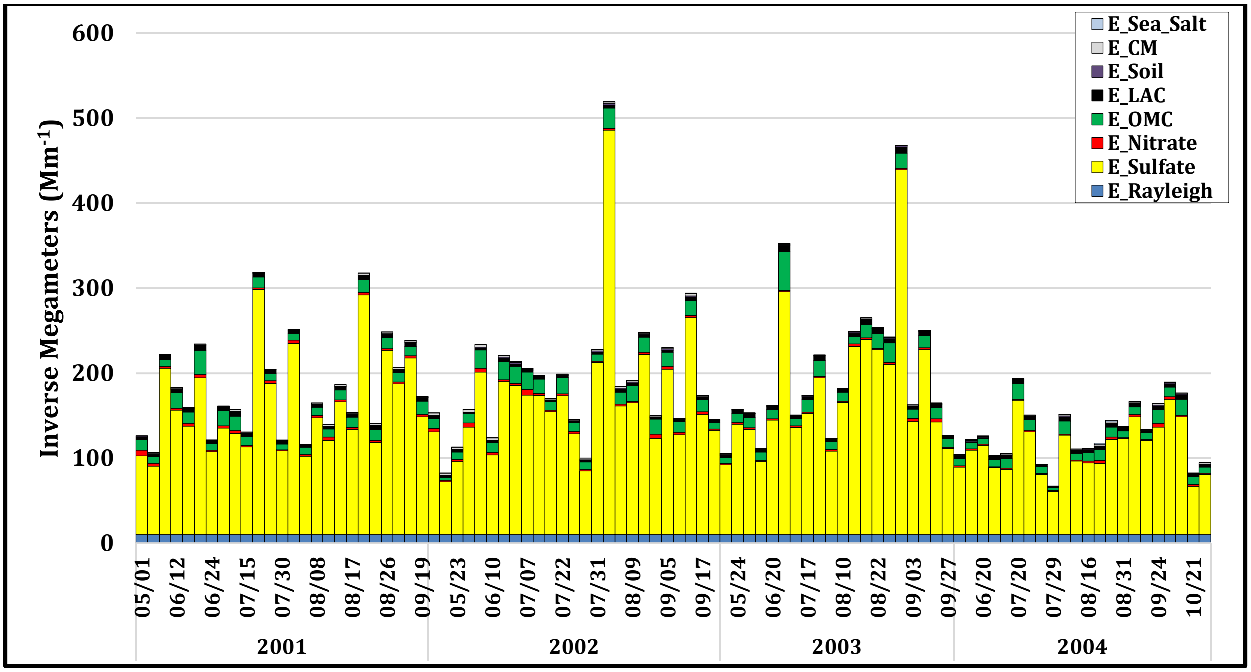

Figure 2-3. 2001-2004 Reconstructed Extinction for the 20% Most Impaired Days at Shining Rock Wilderness Area

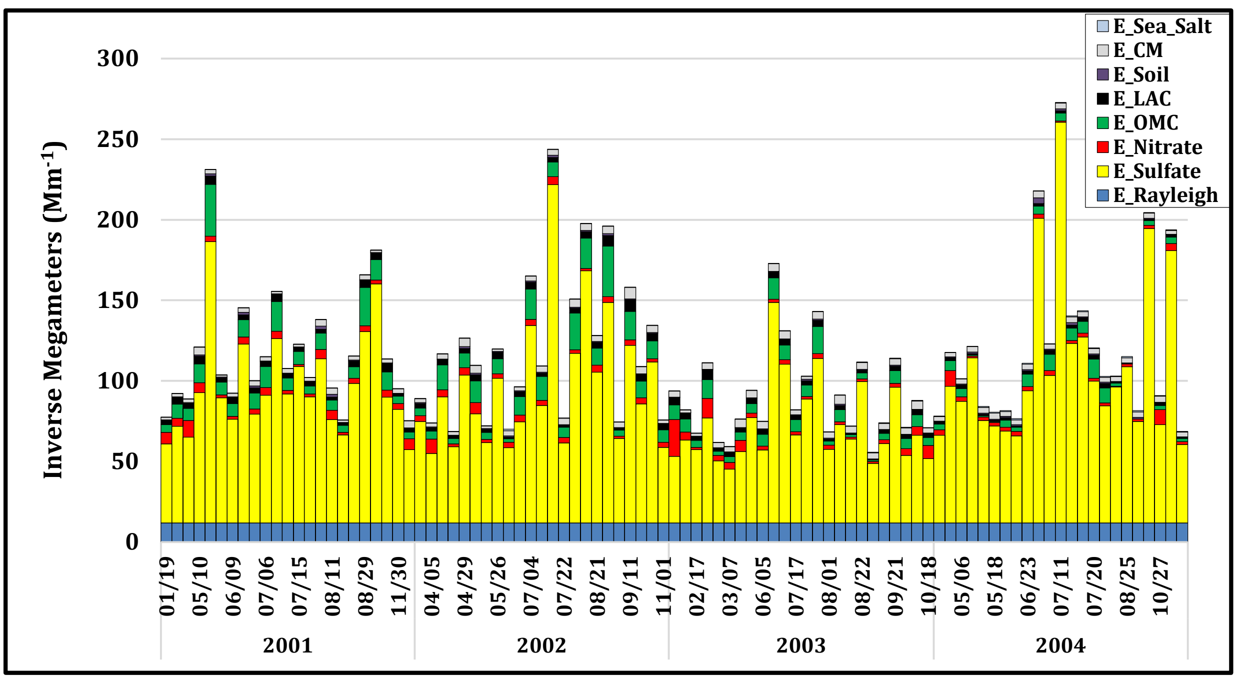

Figure 2-4. 2001-2004 Reconstructed Extinction for the 20% Most Impaired Days at Swanquarter Wilderness Area

Figure 2-5 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 2-6 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.

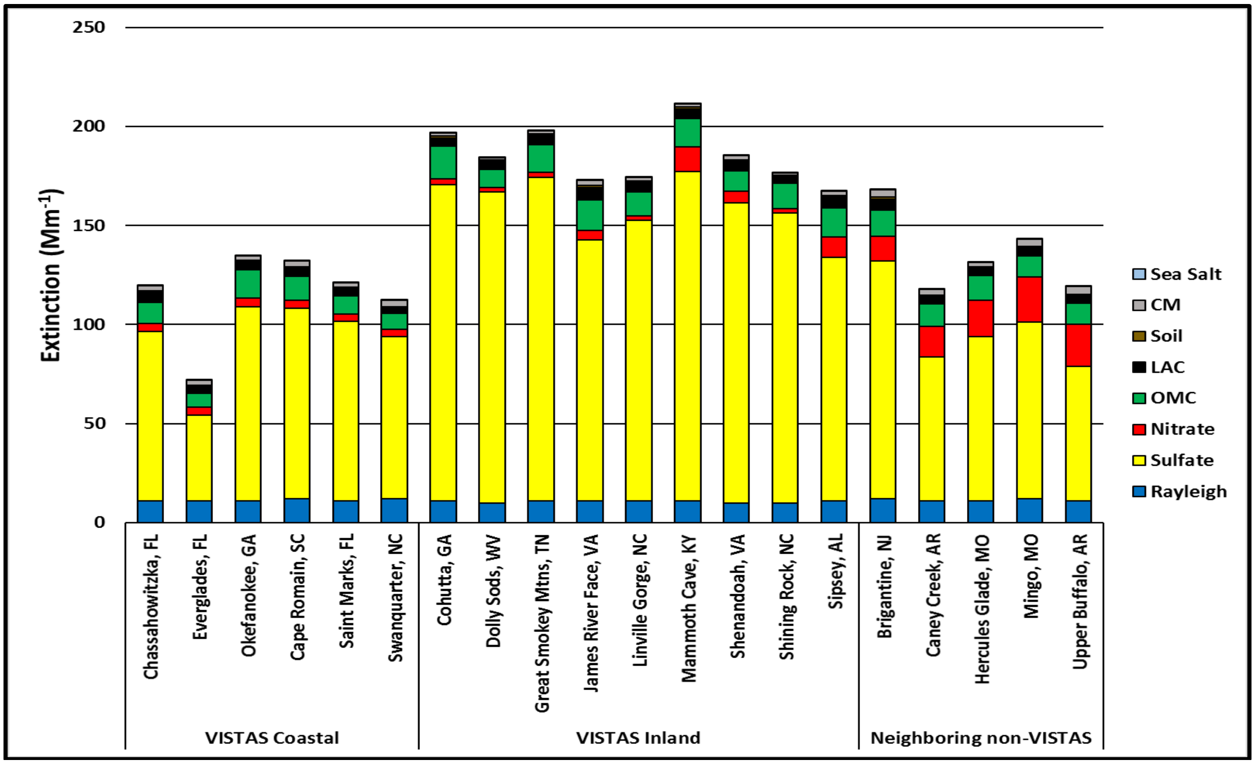

Figure 2-5. Average Light Extinction, 20% Most Impaired Days, 2000-2004, VISTAS and Neighboring Class I Areas

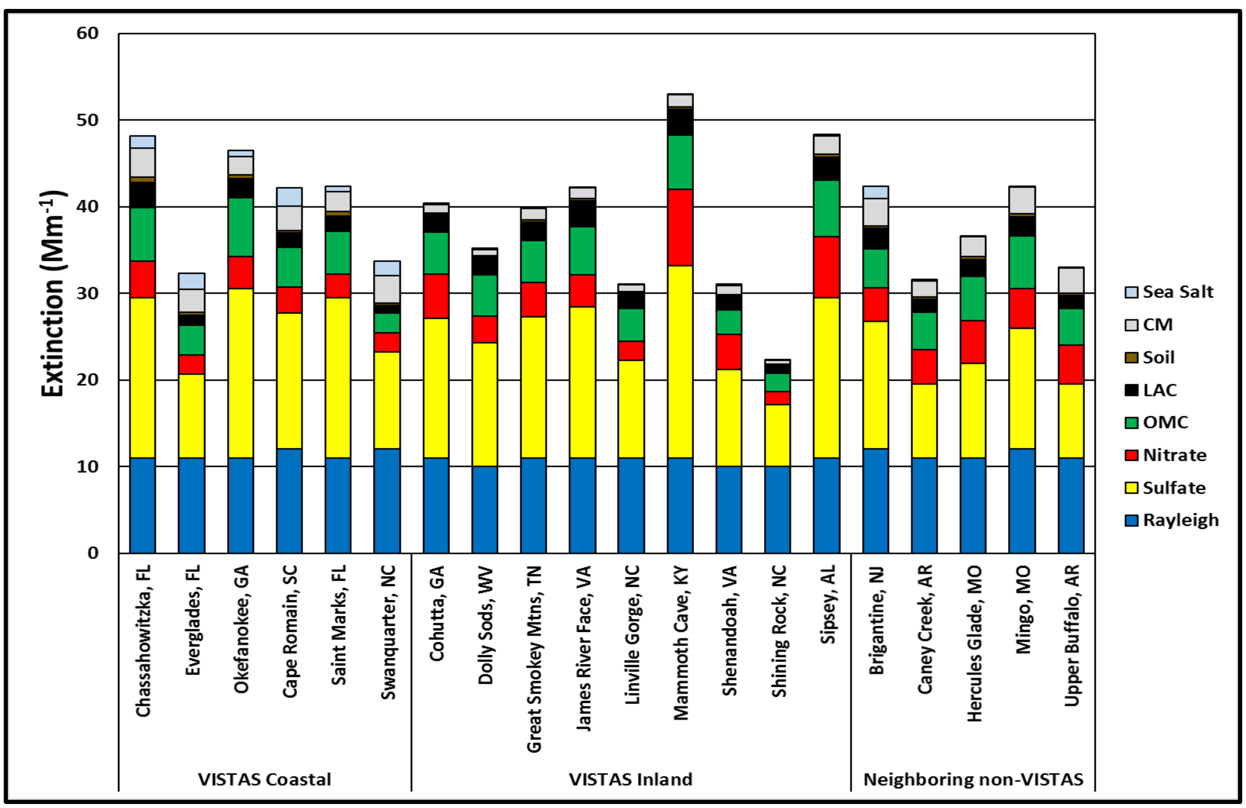

Figure 2-6. Average Light Extinction, 20% Clearest Days, 2000-2004, VISTAS and Neighboring Class I Areas

These bar charts (Figure 2-1 through 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 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."[18] 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 all the North Carolina Class I areas during the baseline period. During this time period, sulfate levels on the 20% most impaired days accounted for 75% to 90% 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, HNH_4SO_4; and ammonium sulfate, $(NH_4)_2SO_4$, depending on the availability of ammonia, NH_3, in the atmosphere. Sulfur dioxide emissions are primarily caused by the combustion of coal and some fuel oils; however, several industrial processes result in production and emission of SO_2, for example those employed in kraft pulp and paper production or phosphate manufacturing.

Across the VISTAS region, sulfate levels are higher at the Southern Appalachian sites than at the coastal sites (Figure 2-5). On the 20% clearest days, sulfate levels are more uniform across the region (Figure 2-6). [Note that in these two figures, levels at Great Smoky Mountains National Park should be considered to be representative of levels at Joyce Kilmer-Slickrock Wilderness, levels at Okefenokee Wilderness should be considered representative of Wolf Island Wilderness, and levels at Dolly Sods Wilderness should be considered 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 1,621 meters elevation, is likely influenced on the clearest days by regional transport of air masses above the boundary layer.

POM is shown as organic matter carbon (OMC) in the figures. POM is the second most important contributor to fine particle mass and light extinction on the 20% most impaired and the 20% clearest days at the North Carolina Class I areas during the baseline period. Days for which visibility impairment is associated with elevated levels of POM and elemental carbon (EC) which are associated with natural events such as wildland fires are largely removed from the 20% most impaired days because they are regarded as natural sources. Significant fire impacts are infrequent at Class I areas in North Carolina. In the fall, winter, and spring, more of the carbon is attributable to wood burning while in the summer months more of the carbon mass is attributable to biogenic emissions from vegetation.

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[18] U.S. EPA, "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," June 3, 2020, https://www.epa.gov/visibility/memo-and-technical-addendum-ambient-data-usage-and-completeness-regional-haze-program.

Ammonium nitrate (NH_4NO_3) is formed in the atmosphere by reaction of ammonia (NH_3) and NO_x. Nitrogen oxide emissions are overwhelmingly caused by any type of stationary or mobile source combustion. The heat of combustion causes atmospheric nitrogen to form oxides, so this byproduct occurs during the combustion of nearly any fuel. 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, but rarely are seen in other VISTAS Class I areas; 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) is also shown as extinction coarse mass (ECM). 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.

Rayleigh scattering is the scattering of sunlight off the molecules of the atmosphere and varies with the elevation of the monitoring site. For VISTAS monitoring sites, this value varies from 10 to 12 Mm^{-1}.

2.5 Modeling Base Period (2009-2013)

Visibility projections discussed in Sections 5, 6, and 7 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 planning 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 RHR, 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's 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.

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

Class I Areas	Average for 20% Most Impaired Days (dv)	Average for 20% Clearest Days (dv)	Average for 20% Most Impaired Days (Mm^{-1})	Average for 20% Clearest Days (Mm^{-1})
Great Smoky Mountains National Park	21.39	10.63	88.03	29.76
Joyce Kilmer-Slickrock Wilderness Area	21.39	10.63	88.03	29.76
Linville Gorge Wilderness Area	20.39	9.70	79.82	26.93
Shining Rock Wilderness Area*	20.39	9.70	67.19	17.09
Swanquarter Wilderness Area	19.76	11.76	75.64	32.75

* 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 2-7 through Figure 2-10 show the 2009 – 2013 reconstructed extinction for the 20% most impaired days for the Class I areas in North Carolina. Similar plots for the other VISTAS Class I areas can be found in Appendix C-2. 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 become more significant on some of the 20% most impaired days. The figures also show the improvement in visibility impairment when compared to Figure 2-1 through Figure 2-4. While maximum values in Figure 2-1 are in the range of 400 Mm^{-1}, for example, maximum values in Figure 2-4 are in the 180 Mm^{-1} range, highlighting the impact of the many control programs implemented during the intervening period.

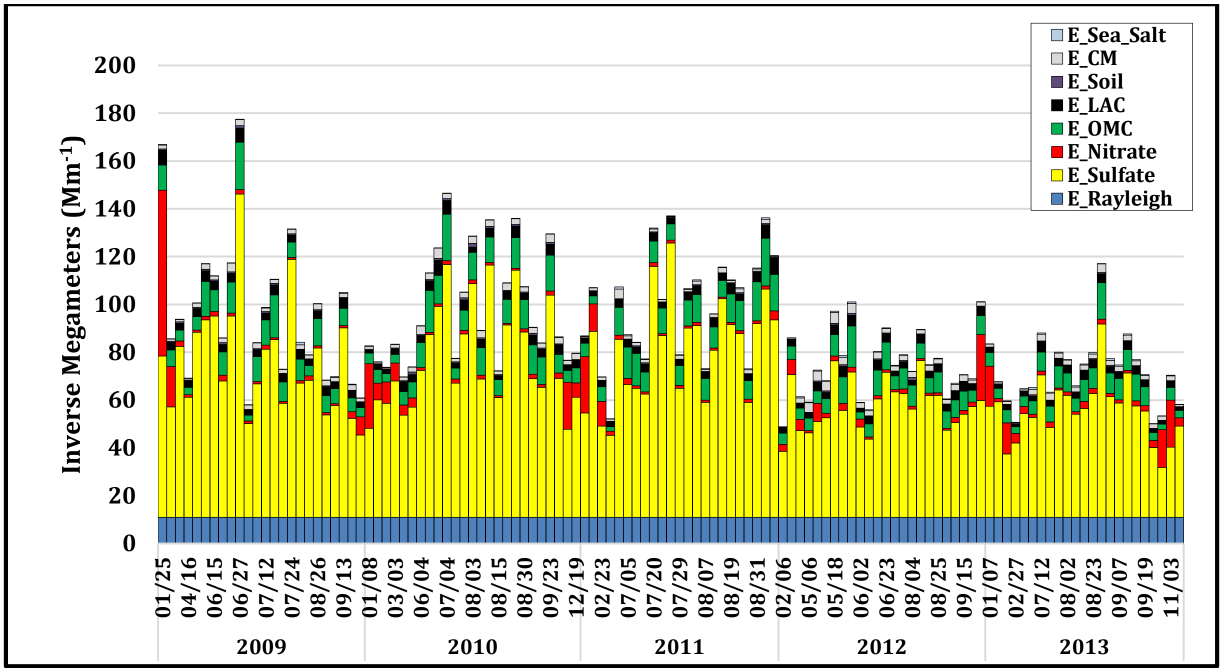

Figure 2-7. 2009-2013 Reconstructed Extinction for the 20% Most Impaired Days at the Great Smoky Mountains National Park and Joyce Kilmer-Slickrock Wilderness Area

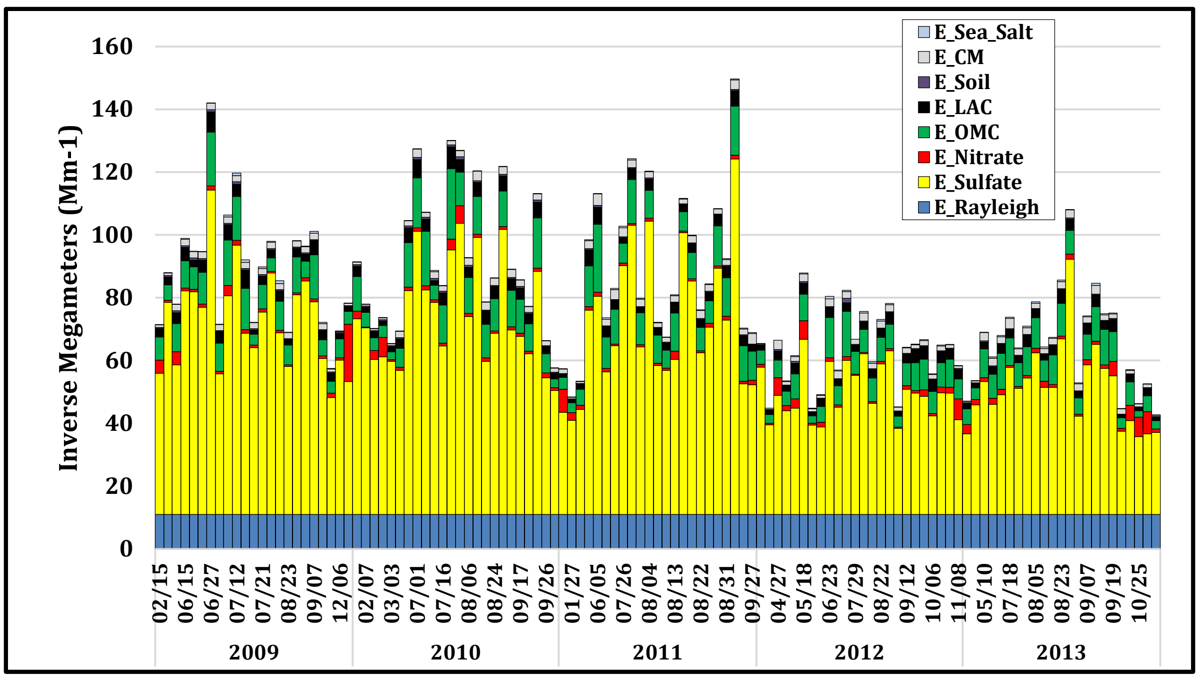

Figure 2-8. 2009-2013 Reconstructed Extinction for the 20% Most Impaired Days at Linville Gorge Wilderness Area

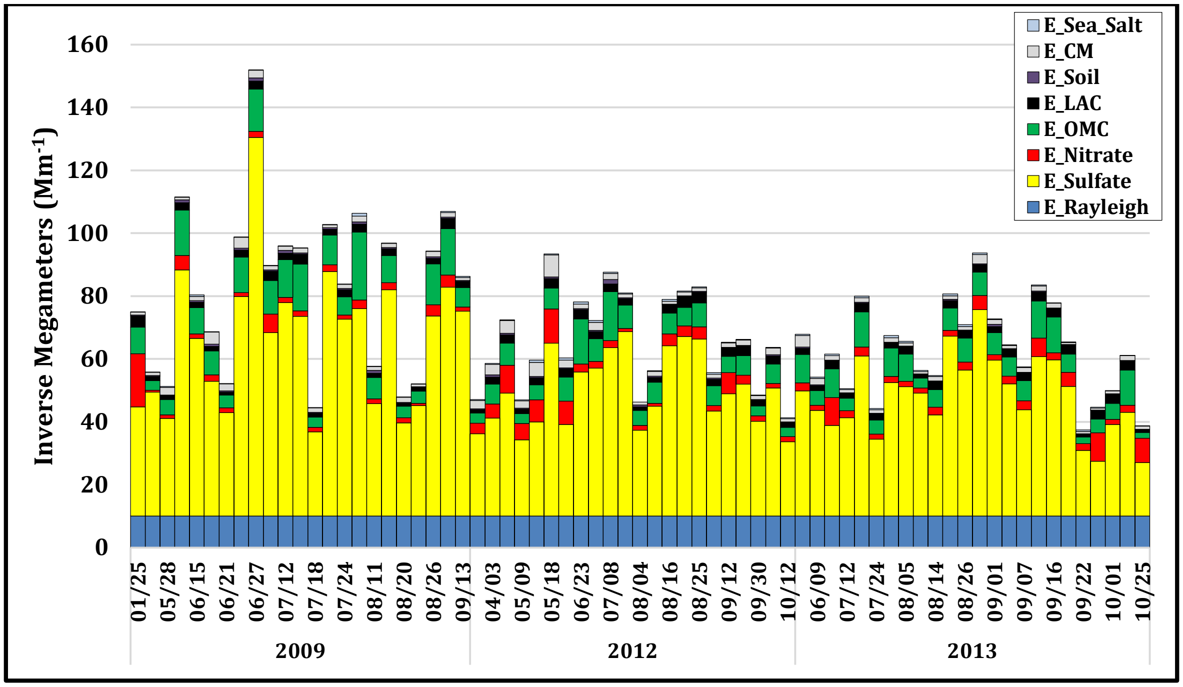

Figure 2-9. 2009-2013 Reconstructed Extinction for the 20% Most Impaired Days at Shining Rock Wilderness Area

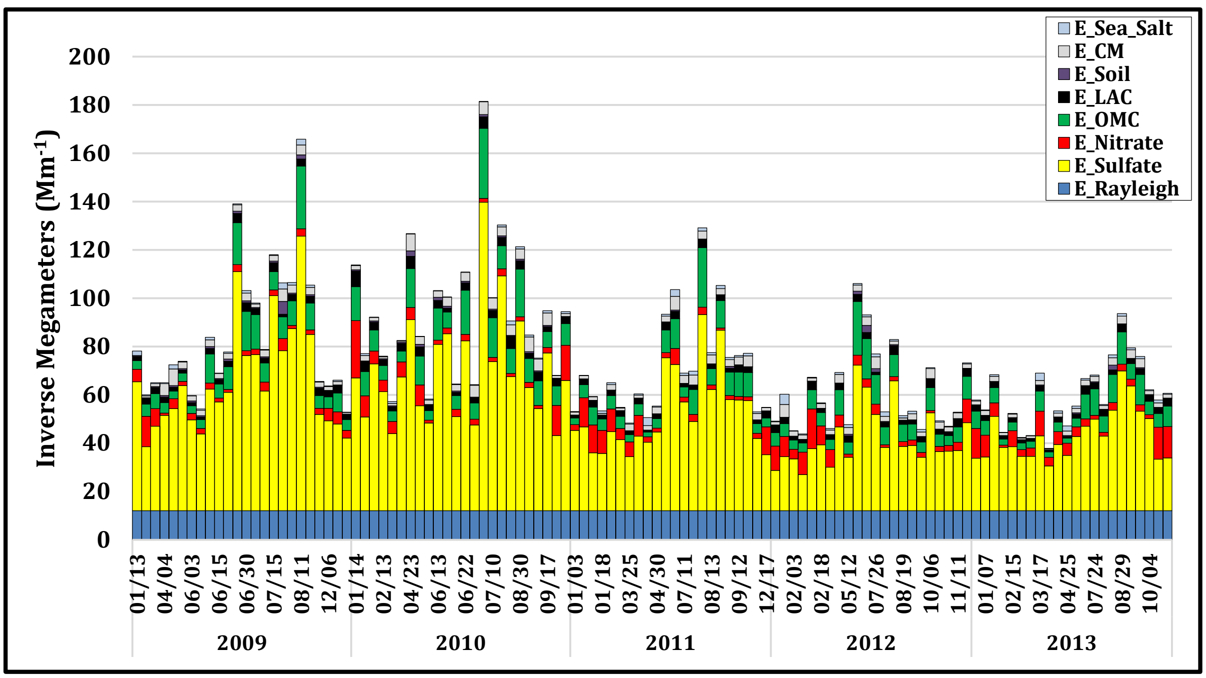

Figure 2-10. 2009-2013 Reconstructed Extinction for the 20% Most Impaired Days at Swanquarter Wilderness Area

Figure 2-11 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 2-11 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.

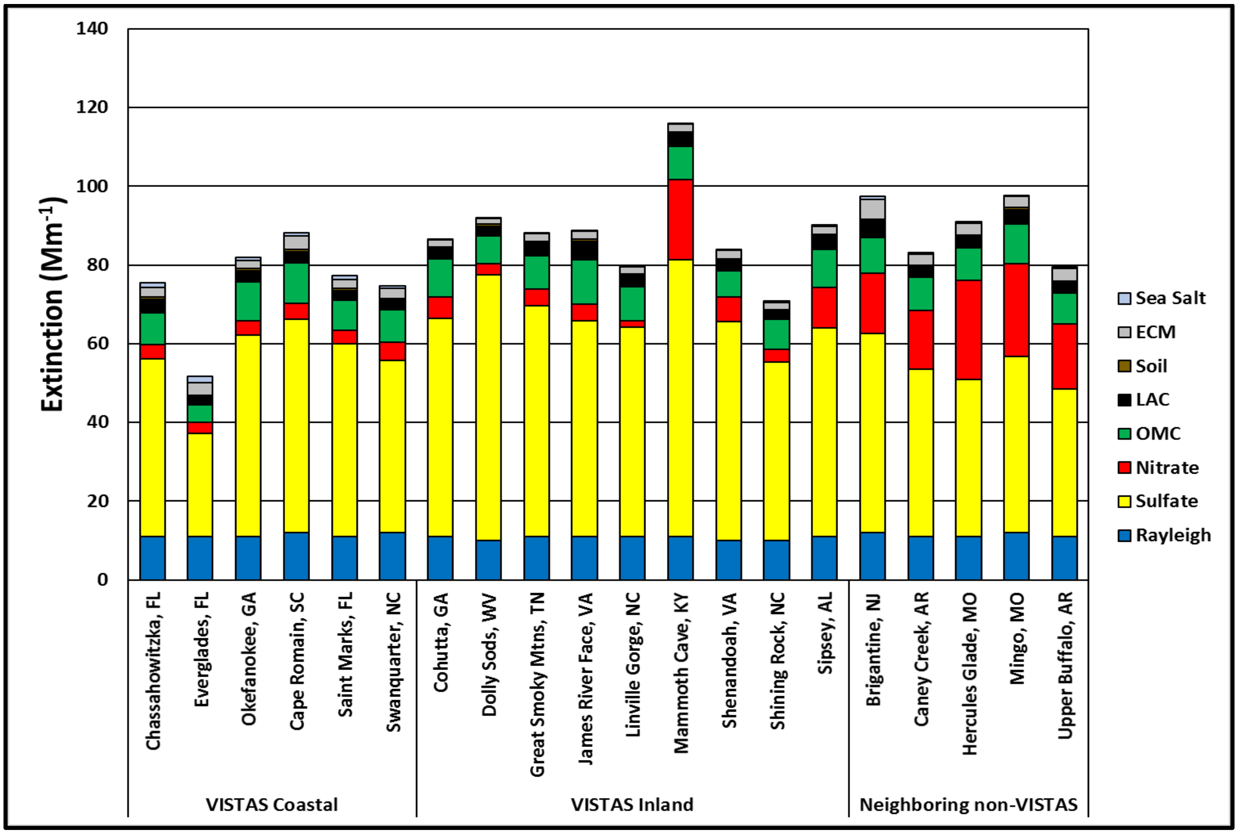

Figure 2-11. Average Light Extinction, 20% Most Impaired Days, 2009-2013, VISTAS and Neighboring Class I Areas

Figure 2-12 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 2-6 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.

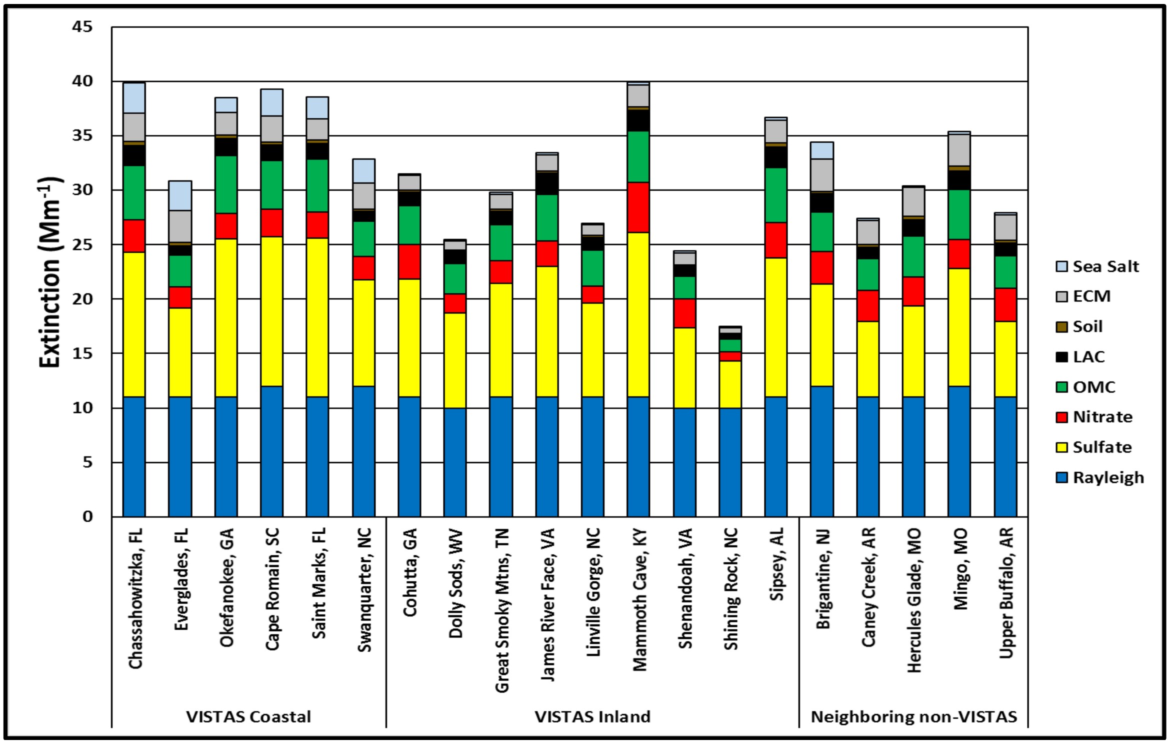

Figure 2-12. Average Light Extinction, 20% Clearest Days, 2009-2013, VISTAS and Neighboring Class I Areas

These bar charts (Figure 2-7 through Figure 2-12) 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 comprised of 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 of the EPA memorandum with subject: Technical addendum including updated visibility data through 2018 for the memo issued June 3, 2020 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."[19]

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[19] See footnote 18.

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

Class I Areas	Average for 20% Most Impaired Days (dv)	Average for 20% Clearest Days (dv)	Average for 20% Most Impaired Days (Mm^{-1})	Average for 20% Clearest Days (Mm^{-1})
Great Smoky Mountains National Park	17.21	8.35	55.90	23.05
Joyce Kilmer-Slickrock Wilderness Area	17.21	8.35	55.90	23.05
Linville Gorge Wilderness Area	16.42	7.61	51.65	21.40
Shining Rock Wilderness Area	15.49	4.40	47.07	15.53
Swanquarter Wilderness Area	16.30	10.61	51.04	28.89

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

Figure 2-13 through Figure 2-16 display the 2014 – 2018 reconstructed extinction for the 20% most impaired days for the Class I areas in North Carolina. For the VISTAS region and neighboring Class I areas, Figure 2-17 and Figure 2-18 show light extinction averaged from 2014-2018 IMPROVE data for the 20% most impaired and clearest days, respectively. These bar charts (Figure 2-13 through Figure 2-18) 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 reducing, as discussed in Section 7, and these reductions are resulting in better visibility.

Figure 2-17 presents average data for 20% most impaired days and shows that on average sulfate continues to be the predominant visibility impairing pollutant for Class I areas in North Carolina and the VISTAS region as a whole. However, the data in Figure 2-13 through Figure 2-16, which are daily monitoring values, show that occasionally nitrate is the predominant visibility impairing pollutant on certain days, generally in winter months. This occasional nitrate signal (observed most notably in 2017 and 2018) is a recent development and will be investigated further in the coming years to determine if any action needs to be taken in the next planning period of North Carolina's regional haze SIP. A more detailed discussion on nitrate contribution to visibility impairment in North Carolina's Class I areas is given in Section 7.4 of this SIP.

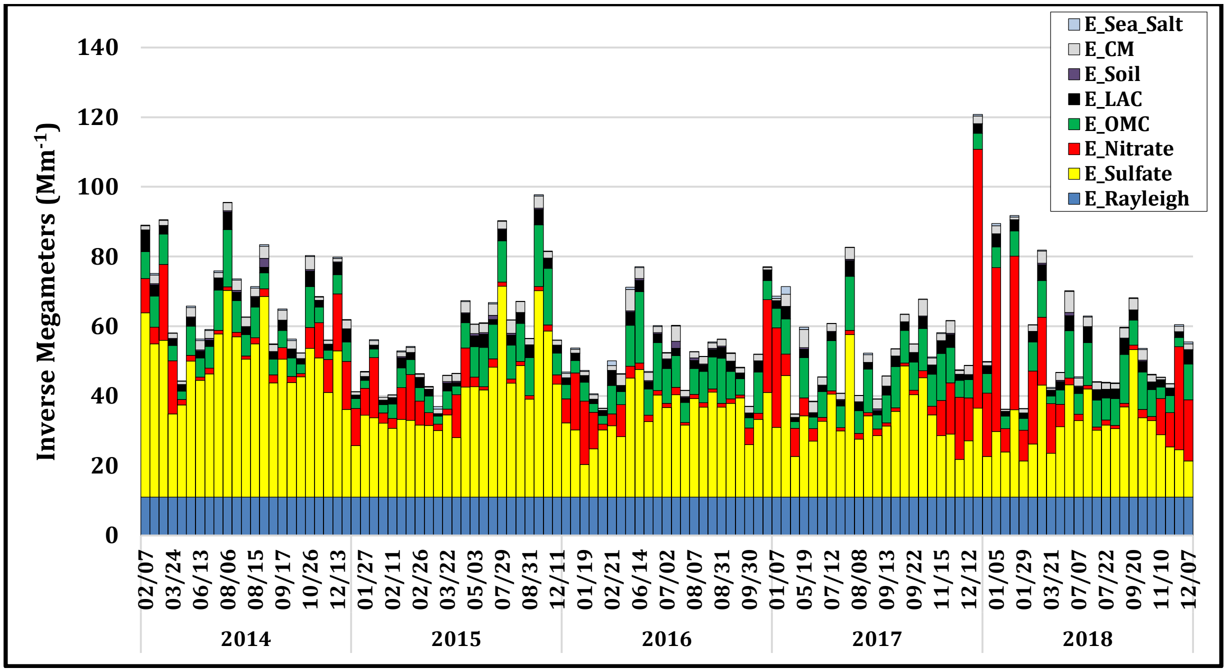

Figure 2-13. 2014-2018 Reconstructed Extinction for the 20% Most Impaired Days at the Great Smoky Mountains National Park and Joyce Kilmer-Slickrock Wilderness Area

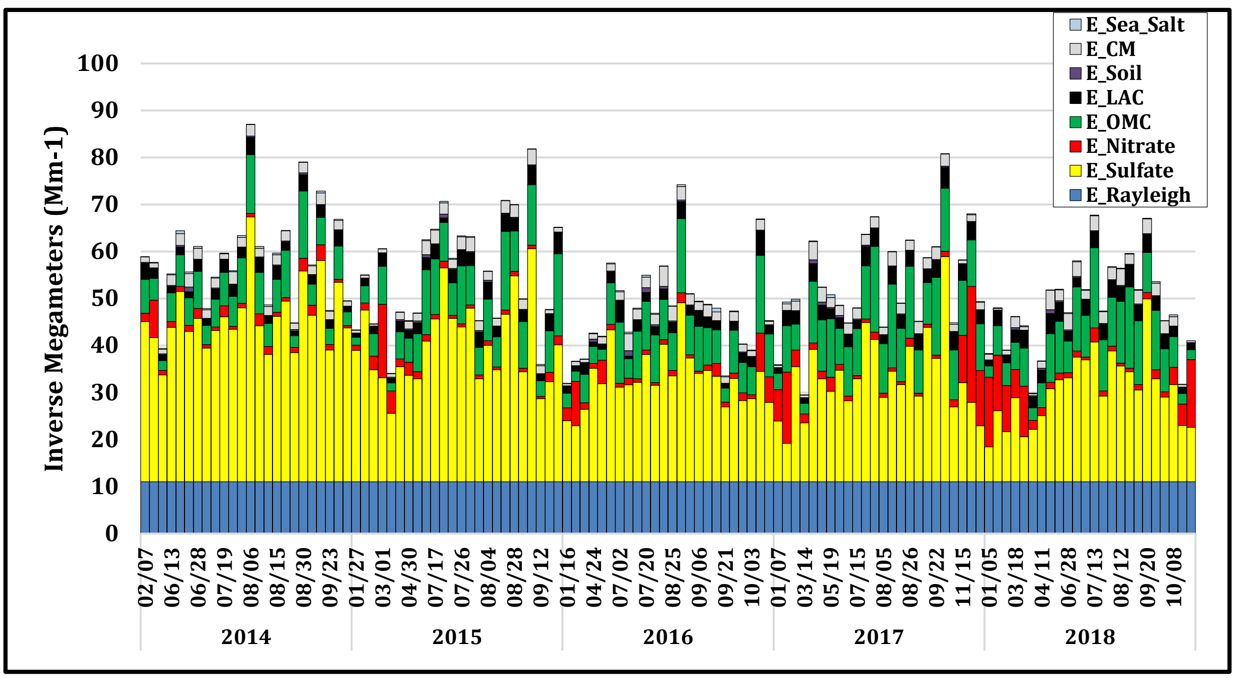

Figure 2-14. 2014-2018 Reconstructed Extinction for the 20% Most Impaired Days at the Linville Gorge Wilderness Area

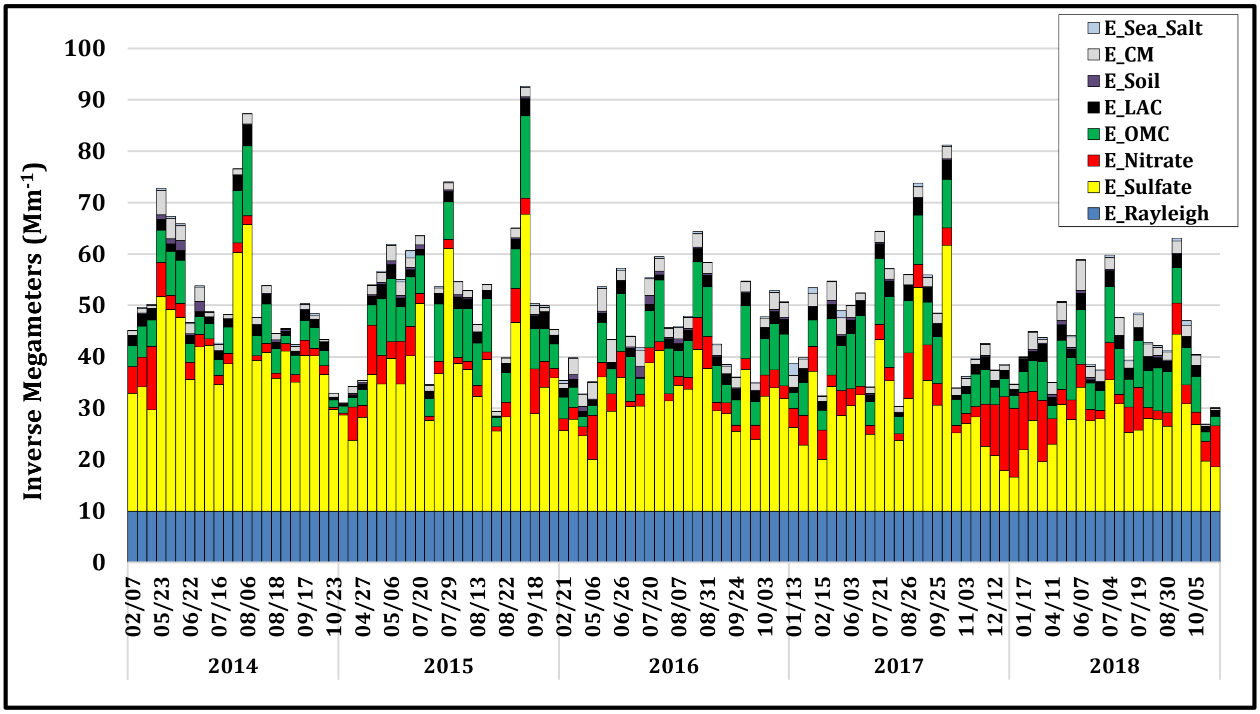

Figure 2-15. 2014-2018 Reconstructed Extinction for the 20% Most Impaired Days at the Shining Rock Wilderness Area

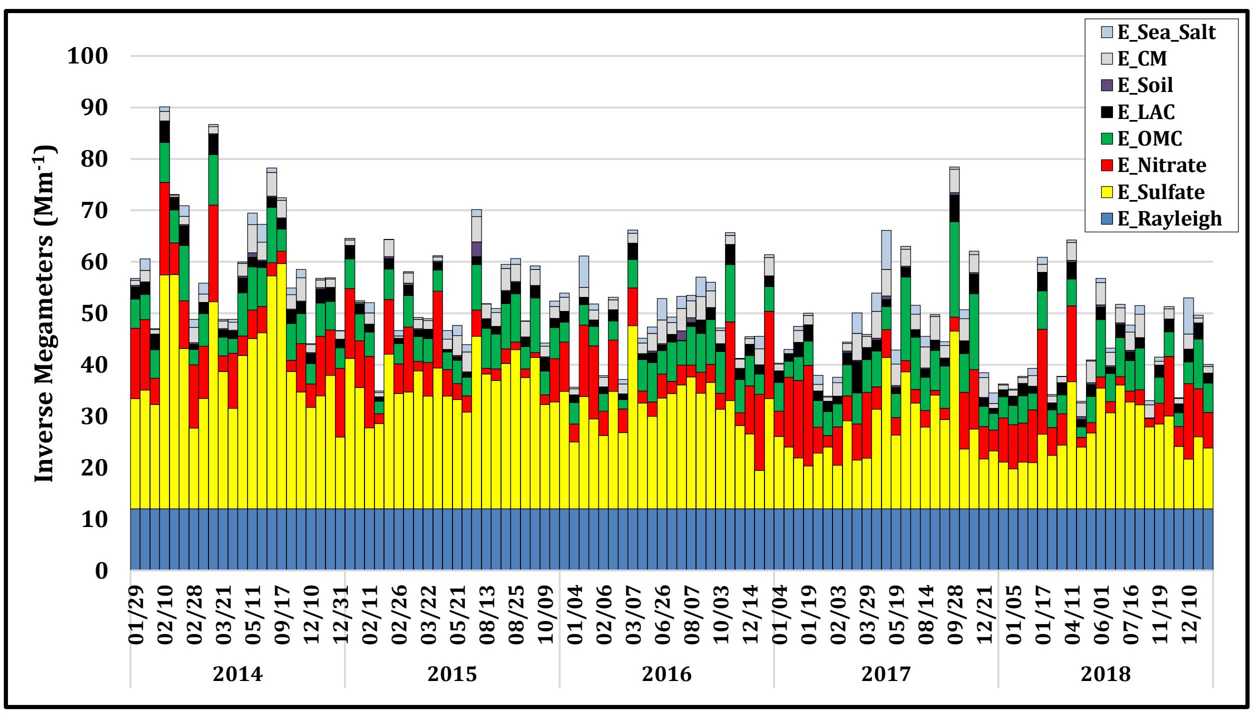

Figure 2-16. 2014-2018 Reconstructed Extinction for the 20% Most Impaired Days at the Swanquarter Wilderness Area

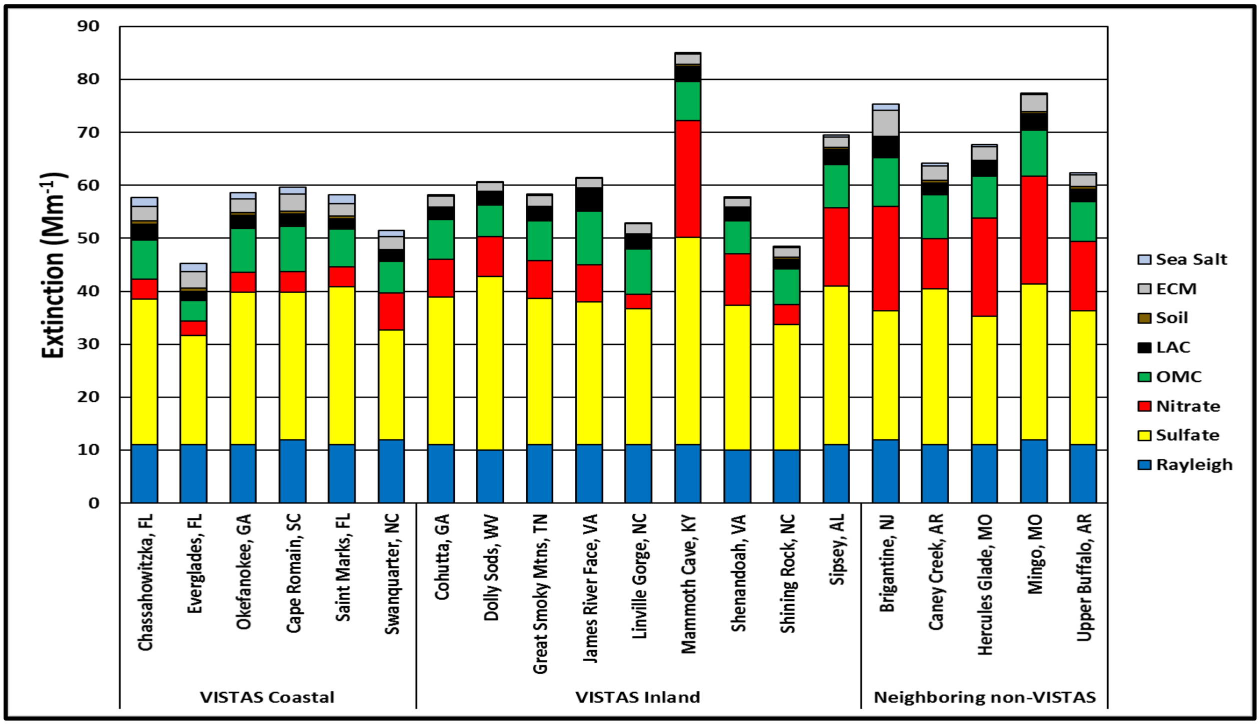

Figure 2-17. Average Light Extinction, 20% Most Impaired Days, 2014-2018, VISTAS and Neighboring Class I Areas

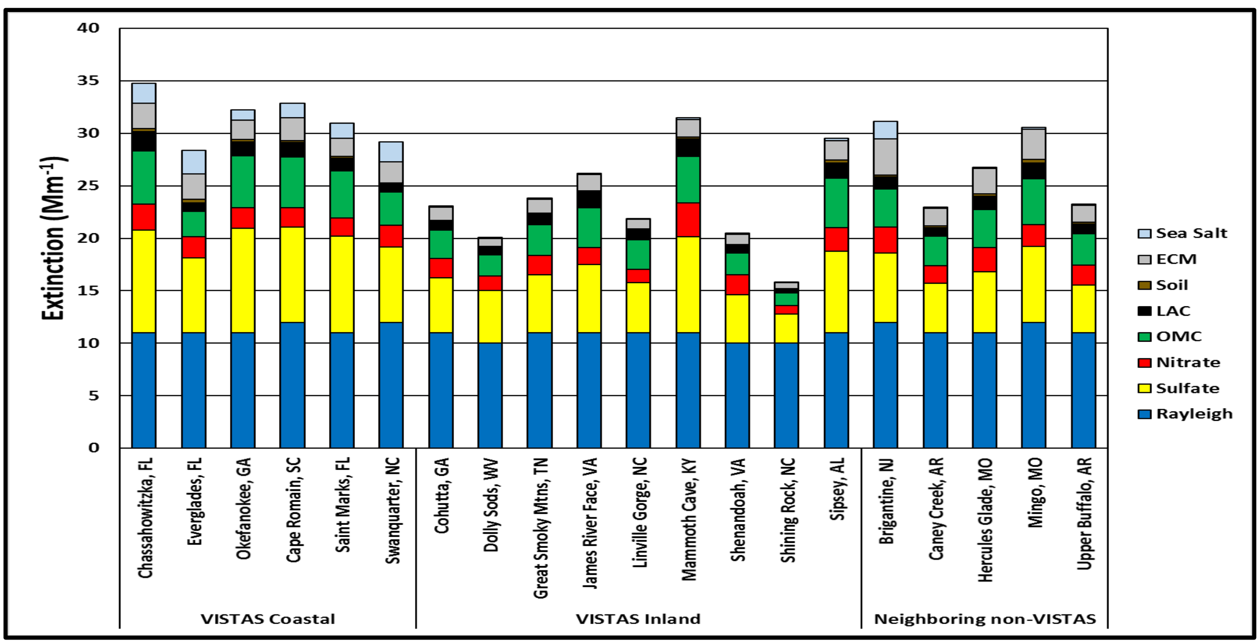

Figure 2-18. Average Light Extinction, 20% Clearest Days, 2014-2018, VISTAS and Neighboring Class I Areas

2.7 Comparisons of Baseline, Current, and Natural Background Visibility

The RHR 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 (dv)

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
Great Smoky Mountains National Park	29.11	17.21	11.90	10.05	7.16
Joyce Kilmer-Slickrock Wilderness Area	29.11	17.21	11.90	10.05	7.16
Linville Gorge Wilderness Area	28.05	16.42	11.63	9.70	6.72
Shining Rock Wilderness Area	28.13	15.49	12.64	10.25	5.24
Swanquarter Wilderness Area	23.79	16.30	7.49	10.01	6.29

Table 2-7 summarizes this data for each Class I area located in VISTAS for the 20% clearest days. On 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 (dv)

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
Great Smoky Mountains National Park	13.58	8.35	5.23	4.62	3.73
Joyce Kilmer-Slickrock Wilderness Area	13.58	8.35	5.23	4.62	3.73
Linville Gorge Wilderness Area	11.11	7.61	3.50	4.07	3.54
Shining Rock Wilderness Area	7.70	4.40	3.30	2.49	1.91
Swanquarter Wilderness Area	12.34	10.61	1.73	5.71	4.90

3.0 GLIDEPATHS 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 "glidepath," for each mandatory Federal Class I area located within that state. Starting at the baseline period of 2000-2004, the state must compare the baseline visibility condition for the most impaired days to the natural visibility condition for the most impaired days and determine the uniform rate of visibility improvement (measured in deciviews of improvement per year) that would need to be maintained during each implementation period in order to attain natural visibility conditions by the end of 2064.

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

Figure 3-1 through Figure 3-4 show the glidepaths for the 20% most impaired days for Great Smoky Mountains National Park, Joyce Kilmer-Slickrock Wilderness Area, Linville Gorge Wilderness Area, Shining Rock Wilderness Area, and Swanquarter Wilderness Area. Joyce Kilmer-Slickrock Wilderness Area relies upon data from the Great Smoky Mountains National Park IMPROVE monitoring site (GRSM1) because it does not have an IMPROVE monitor. Therefore, the glidepath chart for Great Smoky Mountains National Park is used to represent that of Joyce Kilmer-Slickrock Wilderness Area.

Natural background visibility at all five Class I areas is predicted to be between 9.70 and 10.25 deciviews. The Class I areas with the steepest slope from baseline to natural background conditions are Great Smoky Mountains National Park and Joyce Kilmer-Slickrock Wilderness Area, while the Swanquarter Wilderness Area has the gentlest slope from the baseline level of visibility impairment to natural conditions.

The data in Figure 3-1 through Figure 3-4 are derived from Table 1 in the EPA's June 3, 2020 memorandum titled: 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."[20]

[20] See footnote 15.

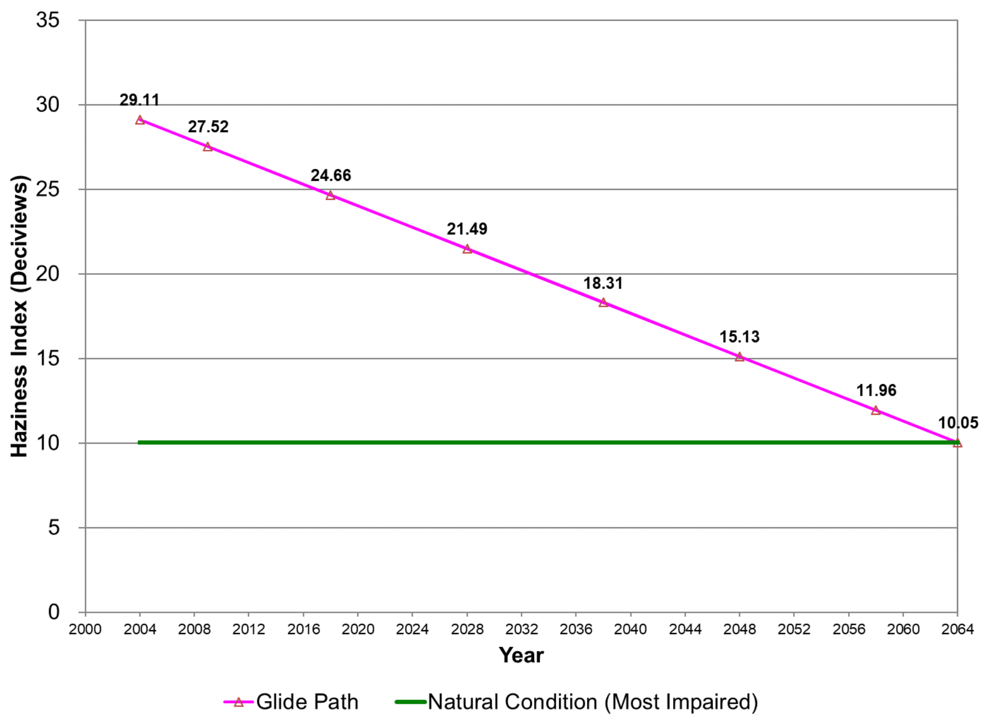

Figure 3-1. Uniform Rate of Progress Glidepath for 20% Most Impaired Days at Great Smoky Mountains National Park and Joyce Kilmer-Slickrock Wilderness Area

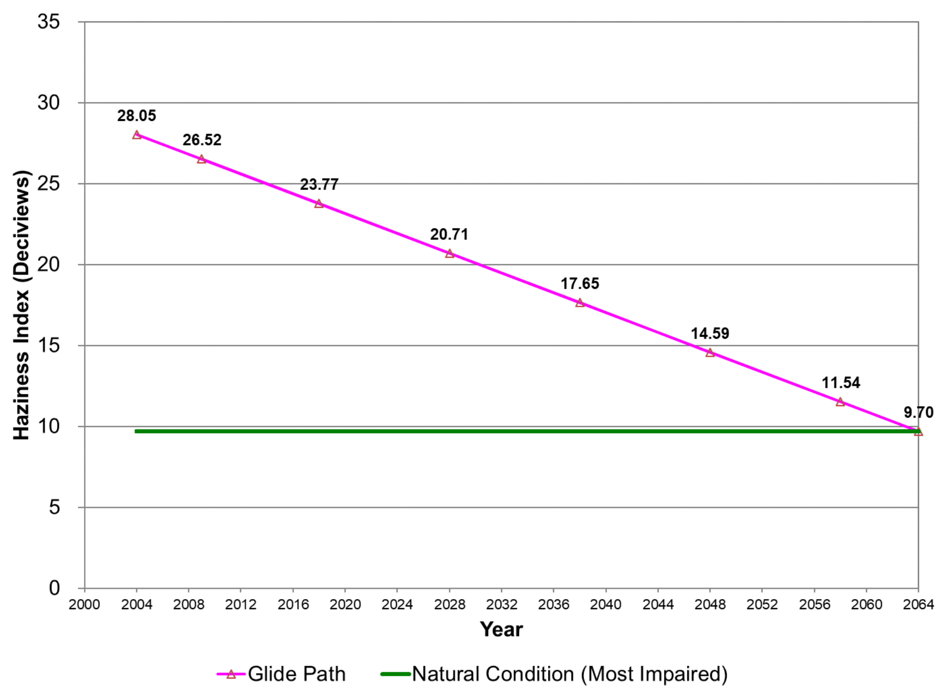

Figure 3-2. Uniform Rate of Progress Glidepath for 20% Most Impaired Days at Linville Gorge Wilderness Area

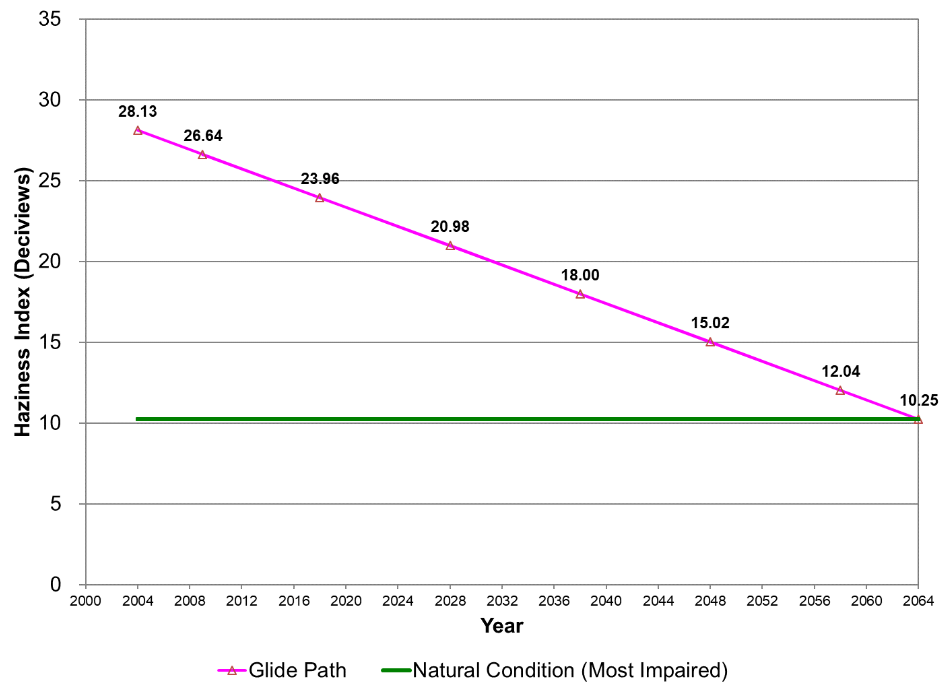

Figure 3-3. Uniform Rate of Progress Glidepath for 20% Most Impaired Days at Shining Rock Wilderness Area

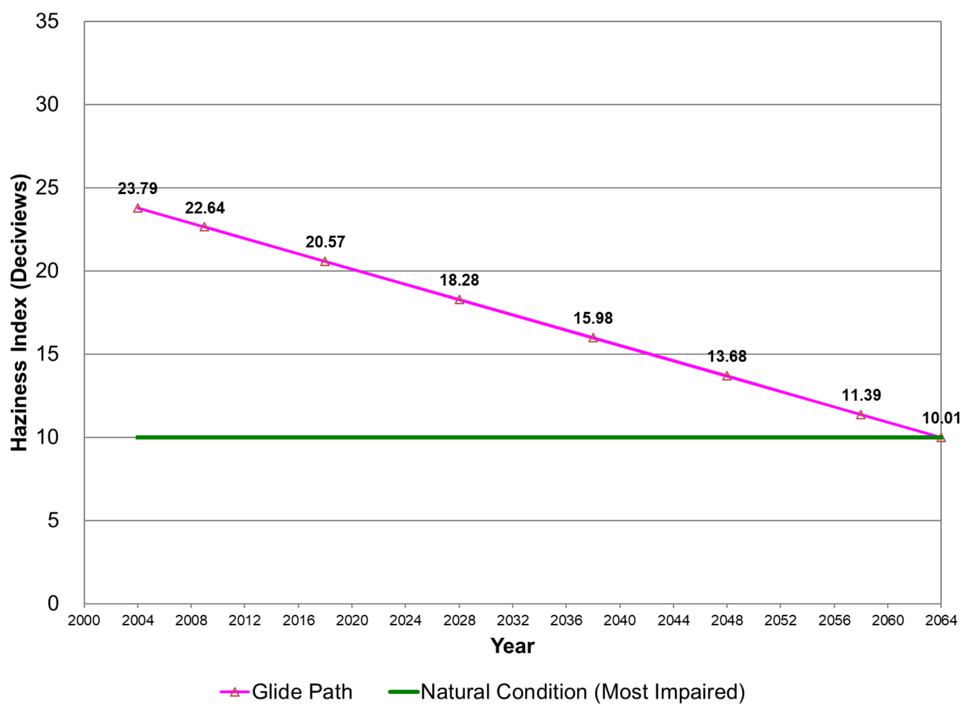

Figure 3-4. Uniform Rate of Progress Glidepath for 20% Most Impaired Days at Swanquarter Wilderness Area

4.0 EMISSION INVENTORIES USED FOR VISIBILITY ANALYSES

4.1 Overview

Section 51.308(f)(6)(v) of the RHR 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. North Carolina complies with the Air Emission Reporting Requirements (AERR) by submitting the required triennial and annual 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 RHR provision also requires states to commit to update the inventory periodically, which North Carolina commits to do.

In January 2018, VISTAS began work to identify a modeling platform to support regional haze modeling for 2028. After consultation with EPA, VISTAS selected EPA's 2011el-based air quality modeling platform with projections to 2028 because this was the latest available modeling platform at the time. VISTAS completed its initial modeling using the 2011el/2028 modeling platform in October 2019 and is labeled "elv3." The elv3 inventory was used to support the Area of Influence Analysis (AoI) analysis (see Section 7.5) and initial Particulate Source Apportionment Technology (PSAT) modeling (see Section 7.6).

Subsequently, after consulting with EPA, VISTAS revised the 2028 point source emissions inventory and modeling to reflect updated emissions projections that became available in late 2019 after VISTAS completed its elv3 modeling. This final inventory, labeled "elv5", was used to update the initial PSAT modeling and re-modeling of the RPGs for each Class I area. Table 4-1 identifies the uses for VISTAS' 2028 elv3 and elv5 modeling inventories and cites the documentation of the inventories and emissions processing of the emissions data.

Table 4-1. Uses and Documentation of VISTAS' Initial and Revised / Final 2028 Emissions Inventory for Regional Haze Modeling

Purpose	Initial 2028 Inventory (version = elv3)*	Revised / Final Inventory (version = elv5)*
Area of Influence Analysis (AoI)	Documentation provided in Appendices B-1a and B-1b of this SIP	Not Applicable
Initial PSAT Source Apportionment Modeling		
Adjusted PSAT Source Apportionment Modeling	Not Applicable	Documentation provided in Appendices B-2a and B-2b of this SIP
Modeling of Reasonable Progress Goals (RPGs) for 2028		

* The NCDAQ has included Appendix B-3 to provide additional documentation on the methods used to prepare 2028 emissions for the EGU and non-EGU point source sectors in North Carolina.

The following pollutants were included in the inventories and modeling: SO_2, NO_x, VOC, PM_{25}-PRI, PM_{10}-PRI, and NH_3. For combustion sources, the $PM_{2.5}$ and PM_{10} emissions included in the modeling inventories include both the filterable and condensable fractions. The modeling inventories also included carbon monoxide (CO) and are included in emissions tables in this SIP.

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

Section 4.2 provides a summary of the emission source sectors included in the 2011 base year inventory and methods used to develop the 2028 elv3 inventory for VISTAS modeling. VISTAS relied on the 2028 emissions projections included in EPA's 2011el-based modeling platform for all sectors except the point EGU and point non-EGU sectors for which VISTAS updated 2028 emissions. Section 4.3 provides an overview of revisions completed to the 2028 elv3 inventory to develop the final 2028 elv5 inventory for the point source sectors. Section 7.2.4 of this SIP provides further documentation of the VISTAS projected 2028 emissions inventory including comparisons of 2011 and 2028 emissions by state. Section 7.2.5 provides summaries comparing recent EPA inventories for 2014, 2016, and 2017.

4.2 2011 and 2028 elv3 Emissions Inventory

VISTAS contracted with ERG to perform emission inventory work as part of the air quality modeling analysis. VISTAS started with EPA's 2011el-based air quality modeling platform with projections to 2028 because this was the latest available modeling platform at the time. This modeling platform includes emissions, meteorology, and other inputs for 2011, as the base year for the modeling described in EPA's technical support document (TSD) entitled "Documentation for the EPA's Preliminary 2028 Regional Haze Modeling."[21] The VISTAS states did not revise the 2011 base year emissions inventory.

The EPA projected the 2011 base year emissions[22] to a 2028 future year base case scenario. 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[23] and the subsequent notice of data availability (NODA)[24] to support ozone transport for the 2015 ozone NAAQS. With the assistance of ERG, the VISTAS states revised the 2028 point source inventory.

There are six different emissions inventory source sectors: stationary point sources, nonpoint (formerly called "stationary area") sources, nonroad and onroad mobile sources, biogenic sources, and point fires, which are reported as events in the NEI. The following sections define each emissions inventory source sector and the emission estimation methods applied to estimate emissions for each sector.

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[21] U.S. EPA OAQPS, *Documentation for the EPA's Preliminary 2028 Regional Haze Modeling,* October 2017.

[22] U.S. EPA, 2011 Version 6.3 Technical Support Document, August 2016, https://www.epa.gov/air-emissions-modeling/2011-version-63-technical-support-document.

[23] U.S. EPA, Final Cross-State Air Pollution Rule Update webpage, https://www.epa.gov/airmarkets/final-cross-state-air-pollution-rule-update.

[24] U.S. EPA, Notice of Data Availability – Preliminary Interstate Ozone Transport Modeling Data for the 2015 Ozone NAAQS webpage, https://www.epa.gov/airmarkets/notice-data-availability-preliminary-interstate-ozone-transport-modeling-data-2015-ozone.

4.2.1 Stationary Point Sources

Point source emissions are emissions from individual sources having a fixed location. Generally, these sources must have permits to operate, and their emissions are inventoried on a regular schedule and provided at the facility level. In North Carolina, large sources emitting at least 100 tons per year (TPY) of a criteria pollutant, 10 TPY of a single hazardous air pollutant (HAP), or 25 TPY total HAPs are inventoried annually. Smaller sources are inventoried upon permit renewal and the current permit renewal cycle in North Carolina is eight years. The point source emissions data can be grouped as EGU and other industrial point sources 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.

4.2.1.1 Electricity Generating Units (EGUs)

The 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 EPA/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 and 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 projection 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 Cross-State Air Pollution Rule (CSAPR) Rule and CSAPR Update Rule, Mercury and Air Toxics (MATS) Rule, Clean Power Plan (CPP), EPA actions related to implementing the RHR during the first planning period, 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. For non-VISTAS states, the EPA 2028el EGU emissions were replaced with the 2028 ERTACv2.7 EGU emissions. North Carolina used ERTACv2.7 emissions data for its 2028 elv3 EGU inventory (see Appendix B-3).

4.2.1.2 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. Similar to the EGU sector, each state was able to adjust the 2028 non-EGU inventory based on their knowledge of each source. Airport-related source emissions for the base year 2011 were developed from the 2011 NEIv2. Aircraft emissions for 2011 are projected to future year 2028 by applying activity growth using data on itinerant (ITN) operations at airports. The ITN operations are defined as aircraft take-offs or aircraft landings. The EPA used projected ITN information available from the Federal Aviation Administration's (FAA) Terminal Area Forecast (TAF) System. For non-EGU point sources, North Carolina applied growth and control factors to 2016 emissions to estimate 2028 elv3 emissions (see Appendix B-3).

4.2.2 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, combustion of fuels for heating, 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 county 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.

4.2.3 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. The emissions from these sources, like nonpoint sources, are estimated at the county level. For the majority 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 vessels and railroad locomotives 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.

4.2.4 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. The emissions from these sources are estimated at the county level. For onroad vehicles, the Motor Vehicle Emission 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., emissions inspection programs), and temperature. The MOVES model takes into consideration regulations that affect emissions from this source sector. The MOVES model then was run for 2028 inventory using input data reflective of that year.

4.2.5 Biogenic Sources

Biogenic sources are natural sources of emissions like trees, crops, grasses, and natural decay of plants. The emissions from these sources are estimated at the county level. 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). 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 from 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.

4.2.6 Point Fires (Events)[25]

The point fires sector, which are reported as events in the NEI, 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 2011NEIv2. 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 CONSUMEv3.0 software application and the Fuel Characteristic Classification System (FCCS) fuel-loading database to estimate fire emissions from wildfires and prescribed burns on a daily basis. The 2011 fire emissions are used for the 2028 future year without any changes.

4.2.7 Summary of 2011 Base Year Emissions Inventory for North Carolina

In the 2011 base year emissions inventory for North Carolina, shown in Table 4-2, the majority of SO_2 emissions (89.3%) are emitted by point sources, the EGU sector (66.6%) and non-EGU Point (22.8%). NO_x emissions are spread throughout the sectors with the onroad sector contributing the highest percentage of the total NO_x emissions for the state at 55.2%, followed by the EGU sector at 13.2% and the Non-road sector at 12.7%. Appendix B provides documentation of 2011 inventory and emissions summaries for the VISTAS states.

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[25] In U.S. EPA's National Emissions Inventory, prescribed and wildfires are included in a category called "Events".

Table 4-2. 2011 Emissions Inventory Summary for North Carolina (TPY)

Sector	CO	NH_3	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
EGU	35,106	216	48,813	9,915	7,572	79,022	956
Non-EGU Point	43,994	1,471	35,138	10,129	6,982	27,050	37,172
Nonpoint	116,898	168,537	31,121	207,809	52,107	10,486	117,162
Onroad	1,145,623	4,486	204,008	10,447	5,510	1,082	112,173
Non-Road	462,851	62	46,950	4,799	4,568	131	61,753
Point-Fires	86,087	727	3,466	13,552	11,745	950	6,671
Total	**1,890,559**	**175,499**	**369,496**	**256,651**	**88,484**	**118,721**	**335,887**

4.3 2028 elv5 (Revision to 2028 elv3) Emissions Inventory

After completing modeling in October 2019, EPA completed work on a new 2016 base year modeling platform (2016v1) and prepared a 2028 projection year inventory for which it used to conduct regional haze modeling for 2028.[26] In addition, ERTAC revised the base year of the ERTAC EGU projections tool from 2011 to 2016 and developed new estimates of 2028 emissions from the 2016 base year.

The RHR and guidance indicate that future year projections should be as accurate as possible. Therefore, for point sources, VISTAS compared the VISTAS 2028 elv3 projections to the EPA and ERTAC 2028 projections from a 2016 base year. Table 4-3 compares the 2028 point source emissions from VISTAS' elv3 inventory to the EPA's 2028 emissions (projected from EPA's 2016v1 platform).[27] The emissions in Table 4-3 were extracted from the VISTAS12 modeling domain, which covers the eastern U.S. As shown in Table 4-3, EPA's SO_2 emissions are 45.61% lower than VISTAS' elv3 estimates, and EPA's NO_x emissions are 20.19% lower than VISTAS' elv3 estimates.

Table 4-4 and Table 4-5 compare 2028 SO_2 and NO_x emissions, respectively, for ERTACv2.7 (2011 base year) and ERTACv16.0 (2016 base year) for the VISTAS and adjacent Regional Planning Organizations (RPOs). The ERTACv2.7 was used in the VISTAS' elv3 modeling for the non-VISTAS states in the VISTAS modeling domain. As explained in Section 4.2.1.1, each VISTAS state determined 2028 emissions for the EGUs in its state. These comparisons indicated that for EGUs, the 2028 emissions developed using ERTACv16.0 are significantly lower than the 2028 emissions developed using ERTACv2.7. For VISTAS, the 2028 ERTACv16.0 projections for SO_2 are about 41% lower than the 2028 ERTACv2.7 projections, and 2028 ERTACv16.0 projections for NO_x are 25.8% lower than the 2028 ERTACv2.7 projections.

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[26] The U.S. EPA's Technical Support Document for U.S. EPA'S Updated 2028 Regional Haze Modeling is available at: https://www.epa.gov/visibility/technical-support-document-epas-updated-2028-regional-haze-modeling.
[27] The U.S. EPA's 2016v1 modeling platform and 2016 Version 1 Technical Support Document are available at: https://www.epa.gov/air-emissions-modeling/2016-version-1-technical-support-document. The starting point for the 2016 inventory was the 2014 National Emissions Inventory (NEI), version 2 (2014NEIv2), although many inventory sectors were updated to represent the year 2016 through the incorporation of 2016-specific state and local data along with nationally-applied adjustment methods. For non-EGU point sources, North Carolina provided to EPA point source 2028 projections from 2016 bae year emissions. The U.S. EPA used the Integrated Planning Model to develop 2028 projections for EGUs.

The reasons for the large differences in the 2028 emissions between the VISTAS' elv3 inventory and EPA's 2016v1 platform (and between ERTACv2.7 and ERTACv16.0) are believed to be associated the retirement of coal-fired EGUs and industrial boilers as well as economic factors (e.g., conversion of coal to natural gas when natural gas prices became competitive with coal prices) not captured in the VISTAS' elv3 2028 projections from the 2011 base year.

Table 4-3. VISTAS 2028 versus New EPA 2028

Pollutant	VISTAS 2028 (TPY)	EPA 2016v1/2028 (TPY)	Difference (TPY)	Difference (%)
SO_2	2,574,542.02	1,400,287.10	1,174,254.92	45.61%
NO_x	2,641,463.83	2,108,115.50	533,348.33	20.19%

Table 4-4. Comparison of ERTACv16.0 to ERTACv2.7 SO_2 Emission Projections for 2028

RPO	v16.0 2028 (TPY)	v2.7 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%
Total	**976,471.2**	**1,783,376.5**	**-806,905.3**	**-45.25%**

Table 4-5. Comparison of ERTACv16.0 to ERTACv2.7 NO_x Emission Projections for 2028

RPO	v16.0 2028 (TPY)	v2.7 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%
Total	**840,973.6**	**1,166,663.1**	**-325,689.5**	**-27.92%**

Thus, after consulting with EPA, VISTAS decided to revise the 2028 elv3 point source inventory to use 2016 as the base year to incorporate SO_2 and NO_x emission reductions not previously captured in the 2028 elv3 inventory. These improvements to 2028 emissions are detailed in the VISTAS emissions inventory report in Appendix B-2a and Appendix B-2b.[28] Each VISTAS state was given the opportunity to adjust any point source emissions in the 2028 inventory. North Carolina used a combination of ERTACv16.0 and ERTACv2.7 emissions data to update the 2028 EGU inventory (see Appendix B-3). For EGUs in the non-VISTAS states, ERTACv2.7 2028 emissions were replaced with the ERTACv16.0 2028 emissions, except for the LADCO states where ERTACv2.7 2028 emissions were replaced with ERTACv16.1 2028 emissions.

[28] When comparing emissions processing results from the elv3 modeling and the subsequent elv5 modeling, several issues were identified within the elv3 modeling framework, including differences in modeled emissions being significantly different than expected emissions (i.e., the mass emissions used as inputs to the SMOKE emissions processor vs. after processing). These issues, which are documented in a memorandum included Appendix B-1b, affected the 2028 elv3 RPGs but did not affect the AOI or PSAT modeling results. Consequently, the RPGs modeled with the 2028 elv3 and elv5 inventories cannot be compared.

5.0 REGIONAL HAZE MODELING METHODS AND INPUTS

Modeling for regional haze was performed by VISTAS for the ten southeastern states, including North Carolina. The following sections outline the methods and inputs used by VISTAS for the regional modeling. Additional details are provided in the modeling protocol in Appendix E-1a (original modeling protocol) and Appendix E-1b (revised modeling protocol).

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 EPA's 2011el-based air quality modeling platform, which includes emissions, meteorology, and other inputs for 2011 as the base year for the modeling.[29] 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 to 2028 point source emissions as described in Appendix B. As noted in 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 EPA in the final CSAPR Update[30] and the subsequent NODA[31] to support ozone transport modeling 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.[32,33,34] 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.

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[29] Documentation for the EPA's Preliminary 2028 Regional Haze Modeling. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. October 2017, https://www.epa.gov/sites/default/files/2020-10/documents/2028_regional_haze_modeling-tsd.pdf.

[30] U.S. EPA, Final Cross-State Air Pollution Rule Update webpage, https://www.epa.gov/airmarkets/final-cross-state-air-pollution-rule-update.

[31] U.S. EPA, Notice of Data Availability – Preliminary Interstate Ozone Transport Modeling Data for the 2015 Ozone NAAQS webpage, https://www.epa.gov/airmarkets/notice-data-availability-preliminary-interstate-ozone-transport-modeling-data-2015-ozone.

[32] Skamarock, W. C. 2004. Evaluating Mesoscale NWP Models Using Kinetic Energy Spectra. Mon. Wea. Rev., Volume 132, pp. 3019-3032. December 2004, https://opensky.ucar.edu/islandora/object/articles:10255.

[33] Skamarock, W. C., Klemp, J. B., Dudhia, J., Gill, D. O., Barker, D. M., Wang, W., & Powers, J. G. (2005). A Description of the Advanced Research WRF Version 2 (No. NCAR/TN-468+STR). University Corporation for Atmospheric Research. doi:10.5065/D6DZ069T, https://opensky.ucar.edu/islandora/object/technotes:479 .

[34] Skamarock, W. C. 2006. Positive-Definite and Monotonic Limiters for Unrestricted-Time-Step Transport Schemes. Mon. Wea. Rev., Volume 134, pp. 2241-2242. June 2006, https://journals.ametsoc.org/view/journals/mwre/134/8/mwr3170.1.xml.

- 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[35] 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 Biogenic Emission Inventory System (BEIS) model was used to estimate 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 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 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 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.

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.

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[35] MARAMA, Documentation for ERTAC EGU Forecasting Tool, https://marama.org/technical-center/ertac-egu-projection-tool/.

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 national ambient air quality standard (NAAQS) attainment demonstration. The EPA's current modeling guidelines[36] lists the following criteria for model selection:

- 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[37] 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.[38] CAMx is a publicly available open-source computer modeling system for the integrated assessment of gaseous and particulate air pollution and meets all the 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} and mercury and toxics; (c) provide source-receptor, sensitivity, and process analyses; and (d) be computationally efficient and easy to use. EPA has approved the use of CAMx for numerous ozone, PM, and regional haze SIPs

[36] Richard A. Wayland, U.S. EPA to Regional Air Division Directors, Region 1-10, "Modeling Guidance for Demonstrating Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze". https://www.epa.gov/sites/default/files/2020-10/documents/o3-pm-rh-modeling_guidance-2018.pdf.
[37] Comprehensive Air Quality Model with Extensions (CAMx) Website, http://www.camx.com.
[38] Ramboll Environ, 2016. User's Guide Comprehensive Air Quality Model with Extensions Version 6.40, www.camx.com. Ramboll Environ International Corporation, Novato, CA.

throughout the U.S. and has used this model to evaluate regional mitigation strategies including those for most recent regional-scale rules (e.g., CSAPR and CSAPR Update).

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)
- Enhanced treatment of planetary boundary layer heights for AQ modeling

5.2.2.2 Overview of WRF

The WRF[39] model is a mesoscale numerical weather prediction system designed to serve both operational forecasting and atmospheric research needs.[40,41,42] 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

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[39] Weather Research and Forecasting Model Website, http://www.wrf-model.org/index.php.

[40] Skamarock, W. C. 2004. Evaluating Mesoscale NWP Models Using Kinetic Energy Spectra. Mon. Wea. Rev., Volume 132, pp. 3019-3032. December 2004, https://opensky.ucar.edu/islandora/object/articles:10255.

[41] Skamarock, W. C., Klemp, J. B., Dudhia, J., Gill, D. O., Barker, D. M., Wang, W., & Powers, J. G. (2005). A Description of the Advanced Research WRF Version 2 (No. NCAR/TN-468+STR). University Corporation for Atmospheric Research. doi:10.5065/D6DZ069T. https://opensky.ucar.edu/islandora/object/technotes:479.

[42] Skamarock, W. C. 2006. Positive-Definite and Monotonic Limiters for Unrestricted-Time-Step Transport Schemes. Mon. Wea. Rev., Volume 134, pp. 2241-2242. June 2006, https://journals.ametsoc.org/view/journals/mwre/134/8/mwr3170.1.xml.

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, numeric, 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.[43]

5.2.3 Selection of Emissions Processing System

5.2.3.1 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;
- 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.

5.2.3.2 Overview of SMOKE

The SMOKE[44] modeling system is an emissions modeling system that generates hourly gridded speciated emission inputs of mobile onroad, nonroad, nonpoint area, point, fire, and biogenic emission sources for photochemical grid models[45,46] 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

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[43] Meteorological Model Performance for Annual 2011 WRF v3.4 Simulation, https://www.epa.gov/sites/production/files/2020-10/documents/met_tsd_2011_final_11-26-14.pdf
[44]Sparse Matrix Operator Kerner Emissions (SMOKE) website, https://www.cmascenter.org/smoke/.
[45] Coats, C.J. 1995. Sparse Matrix Operator Kernel Emissions (SMOKE) Modeling System, MCNC Environmental Programs, Research Triangle Park, NC..
[46] Houyoux, M.R., Vukovich, J.M., Coats, C.J., Wheeler, N.J.M., Kasibhatla, P.S.,2000. Emissions Inventory Development and Processing for the Seasonal Model for Regional Air Quality. (SMRAQ) project, Journal of Geophysical Research – Atmospheres, 105(D7), 9079-9090.

photochemical grid model. For biogenic, mobile, and EGU sources, external emission models/processors were used to prepare SMOKE inputs. The EPA used MOVES2014a to prepare the mobile source inventory which was the latest version of MOVES available at the time. MOVES2014 includes the latest onroad mobile source emissions factor information. Emission factors developed by 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[47] 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 EPA using version 3.61 of BEIS. First developed in 1988, BEIS estimates VOC emissions from vegetation and nitric oxide (NO) emissions from soils. Because of resource limitations, recent BEIS development has been restricted to versions that are built within the SMOKE system.

5.3 Selection of the Modeling Year

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

The EPA's most recent regional haze modeling guidance[48] 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 EPA's modeling guidance episode selection discussion and is consistent with the base year modeling platform. Specifically, 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 its modeling work. The EPA's 2016-based platform became available at a later date 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.

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[47] MARAMA, Documentation for ERTAC EGU Forecasting Tool, https://marama.org/technical-center/ertac-egu-projection-tool/.

[48] Peter Tsirigotis to Regional Air Division Directors, "Guidance on Regional Haze State Implementation Plan for the Second Planning Period", Region 1-10, Aug 20, 2019, https://www.epa.gov/sites/production/files/2019-08/documents/8-20-2019_-_regional_haze_guidance_final_guidance.pdf.

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 EPA's meteorological model performance evaluation document,[49] the WRF meteorological modeling was run on a larger 12-Km modeling domain than the 12-Km domain that was used for CAMx. 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 CAMx Version 6.40 modeling 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.

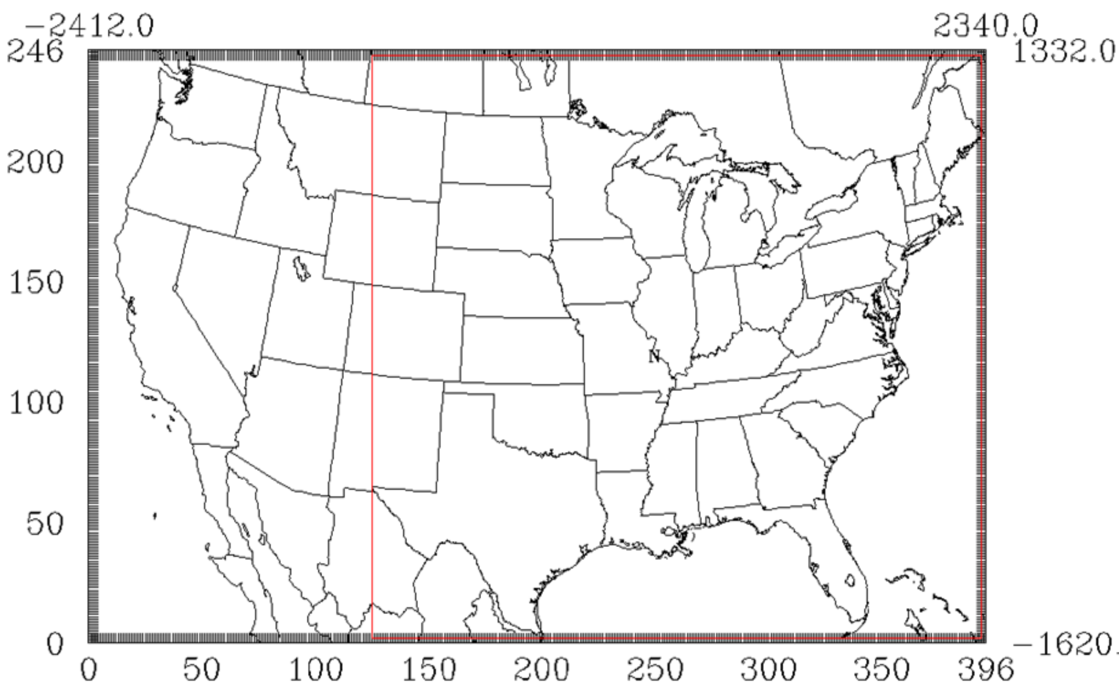

Figure 5-1. Map of 12Km CAMx Modeling Domains; VISTAS_12 Domain Represented as Inner Red Domain

[49] Meteorological Model Performance for Annual 2011 WRF v3.4 Simulation, https://www.epa.gov/sites/production/files/2020-10/documents/met_tsd_2011_final_11-26-14.pdf.

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 WRF 35 vertical layers to 25 vertical layers in CAMx and is consistent with EPA's draft 2028 regional haze modeling.[50]

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

[50] Richard A. Wayland, U.S. EPA, to Regional Air Division Directors, September 19, 2019, "Availability of Modeling Data and Associated Technical Support Document for the EPA's Updated 2028 Visibility Air Quality Modeling", Table 2-2, https://www.epa.gov/sites/default/files/2019-10/documents/updated_2028_regional_haze_modeling-tsd-2019_0.pdf.

CAMx Layer	WRF Layers	Sigma P	Pressure (mb)	Approximate Height (meters above ground level)
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

6.0 MODEL PERFORMANCE EVALUATION

Model performance evaluations (MPEs), which compare modeled concentrations to observed concentrations, are important for demonstrating confidence in the air quality modeling system. The MPE metrics were developed from the Model Performance Evaluation, Analysis, and Plotting Software (MAPS) tool.[51] For this evaluation, VISTAS selected the mean bias (MB), mean error (ME), normalized mean bias (NMB), and normalized mean error (NME) to characterize model performance, statistics which are consistent with the recommendations in Simon et al. (2012),[52] the photochemical modeling guidance,[53] and EPA's recent performance evaluation of the 2011en platform.[54] Mean fractional bias (MFB), mean fractional error (MFE), and root mean square error (RMSE) were also evaluated for the acid deposition MPE.

The VISTAS 2011 modeling platform (VISTAS2011) used meteorological modeling files developed by 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."[55]

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, Chemical Speciation Network (CSN) (formerly Speciation Trends Network), 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.

The following sections provide details on the MPE results for ozone, fine particles, and acid deposition. Performance assessed at the "one atmosphere" level was deemed acceptable for ozone, particulate matter (PM), and wet/dry deposition at various monitoring sites. Overall, the VISTAS2011 modeling platform was found to be representative and acceptable for use in regulatory modeling applications for ozone, PM, and regional haze.

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[51] McNally, D. and T. W. Tesche. 1993. Model Performance Evaluation, Analysis, and Plotting Software (MAPS). Alpine Geophysics, LLC. Arvada, CO.
[52] Simon, H., K. Baker and S. Phillips. 2012. Compilations and Interpretation of Photochemical Model Performance Statistics Published between 2006 and 2012. *Atmos. Env.* 61 (2012) 124-139. December.
[53] U.S. EPA, 2018. Modeling Guidance for Demonstrating Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze, https://www.epa.gov/sites/default/files/2020-10/documents/o3-pm-rh-modeling_guidance-2018.pdf.
[54] U.S. EPA. 2018. Air Quality Modeling Technical Support Document for the Updated 2023 Projected Ozone Design Values. Office of Air Quality Planning and Standards, United States Environmental Protection Agency. June 2018.
[55] U.S. EPA, Meteorological Model Performance for Annual 2011 WRF v3.4 Simulation, https://www.epa.gov/sites/production/files/2020-10/documents/met_tsd_2011_final_11-26-14.pdf.

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. The MB for MDA8 ozone is ≥ 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 ME is less than 10 ppb in all months. The NMB is within ±5% for AQS sites in all months except July (5.63%). The MB and NMB 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 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	#Observations	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

Figure 6-1 through Figure 6-4 show the spatial variability in bias and error at monitor locations. As shown in Figure 6-1, MB 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, WI and a maximum over-prediction of 17.95 ppb in York County, SC (AQS monitor 450910006); both with small sample sizes (n=1 and n=7, respectively). A positive MB 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 has a tendency to underestimate in the western portion of the domain and overestimate in the eastern portion of the domain.

As shown in Figure 6-2, NMB for days with observed MDA8 ozone ≥ 60 ppb is within ±10% at the majority of monitoring sites across the VISTAS12 modeling domain. Monitors in Ashland County, WI and York County, SC 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 underpredict at sites in and around the western and northwestern borders of the domain.

As shown in Figure 6-3, ME is generally 10 ppb or less at most of the sites across the VISTAS12 modeling domain although the Ashland, WI and York, SC 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. As shown in Figure 6-4 the NME for days with observed MDA8 ≥ 60 ppb is less than 15% at the vast majority of monitoring sites across the VISTAS12 modeling domain. Noted exceptions seen are monitors 450910006 (York County, SC), 470370011 (Davidson County, TN), and 120713002 (Lee County, FL) 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.

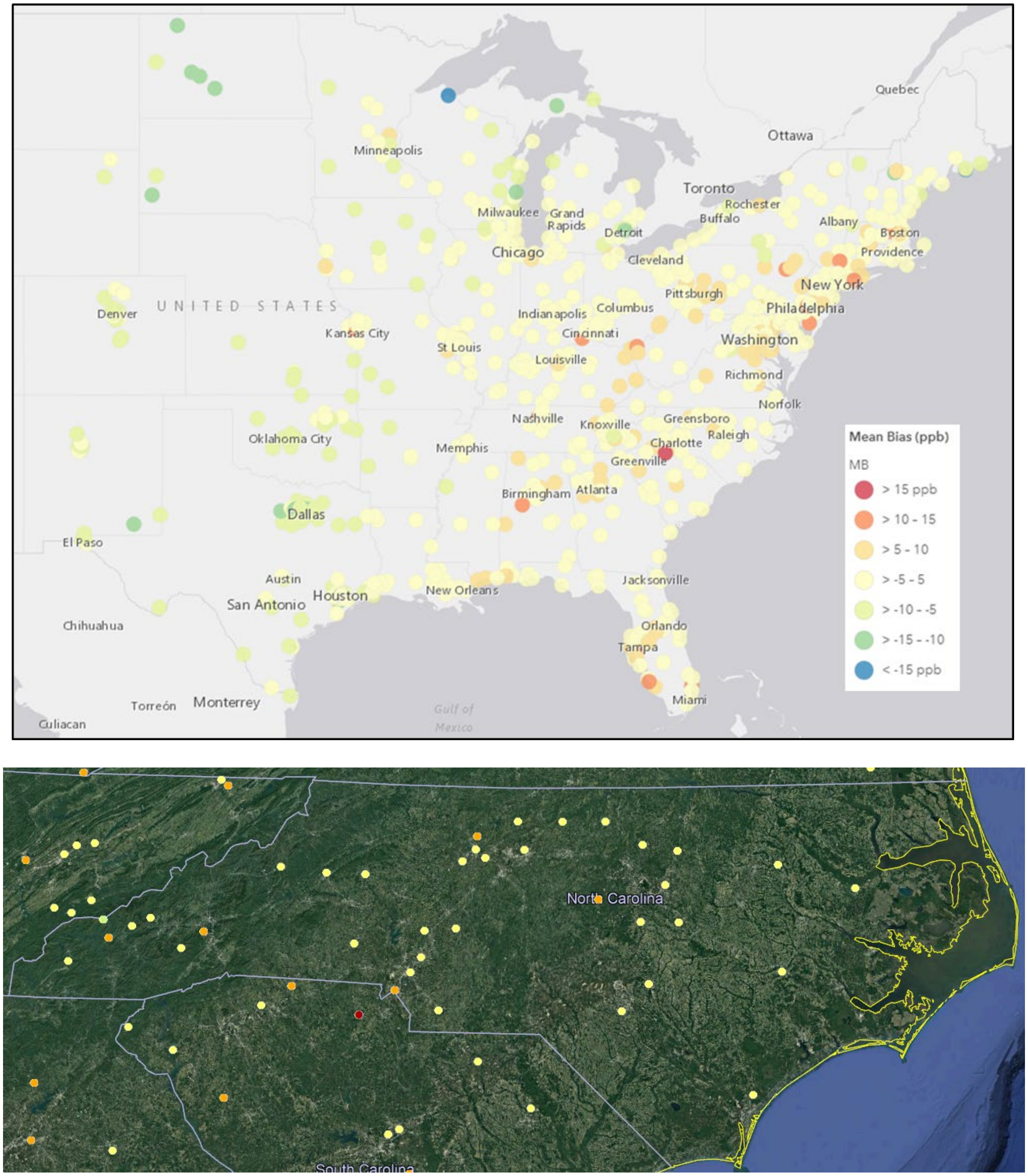

Figure 6-1. Mean Bias (ppb) of MDA8 Ozone ≥ 60 ppb Over the Period May-September 2011 at AQS Monitoring Sites in VISTAS12 Domain (top) and in North Carolina (bottom).

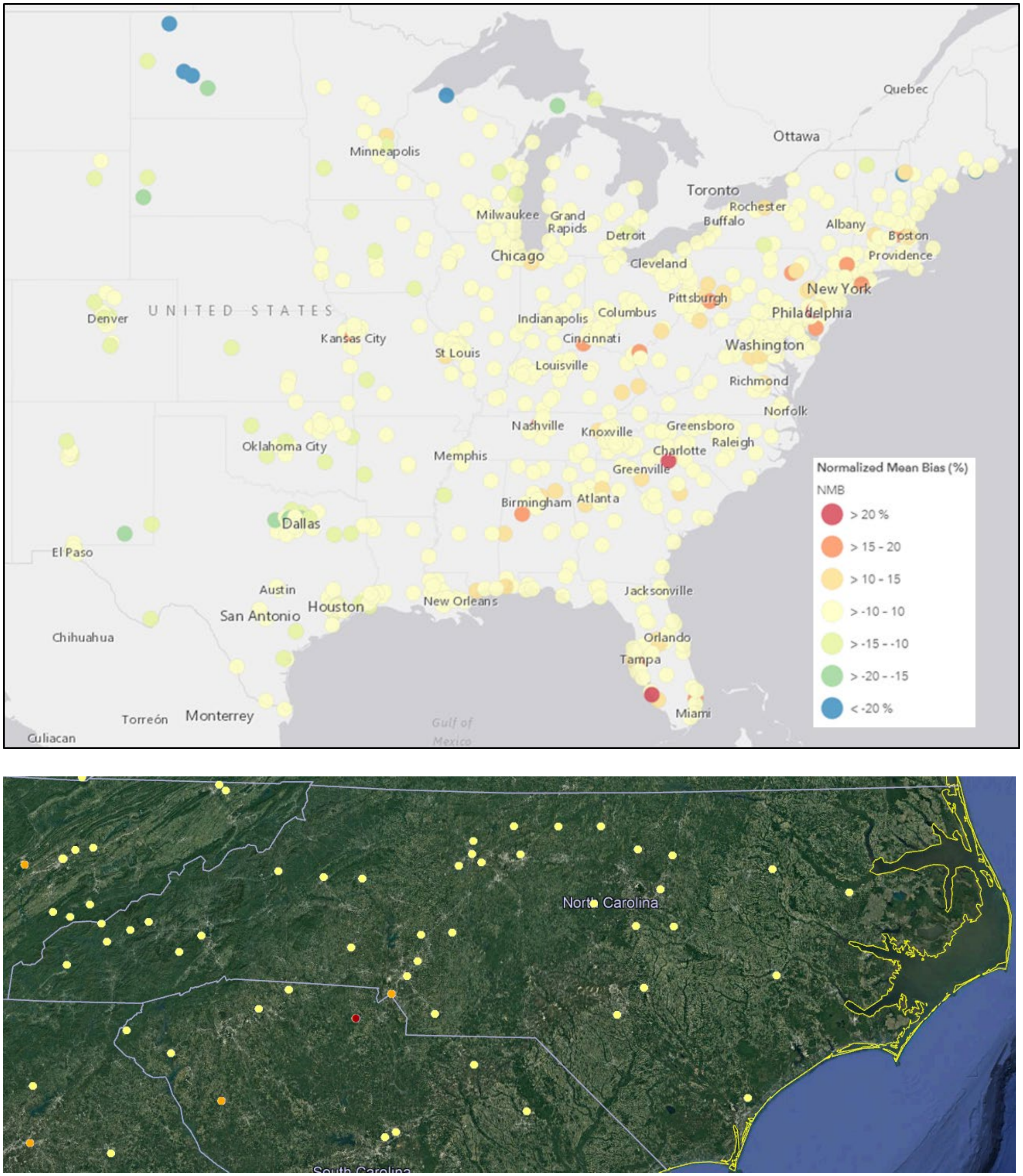

Figure 6-2. Normalized Mean Bias (%) of MDA8 Ozone ≥ 60 ppb Over the Period May-September 2011 at AQS Monitoring Sites in VISTAS12 Domain (top) and in North Carolina (bottom).

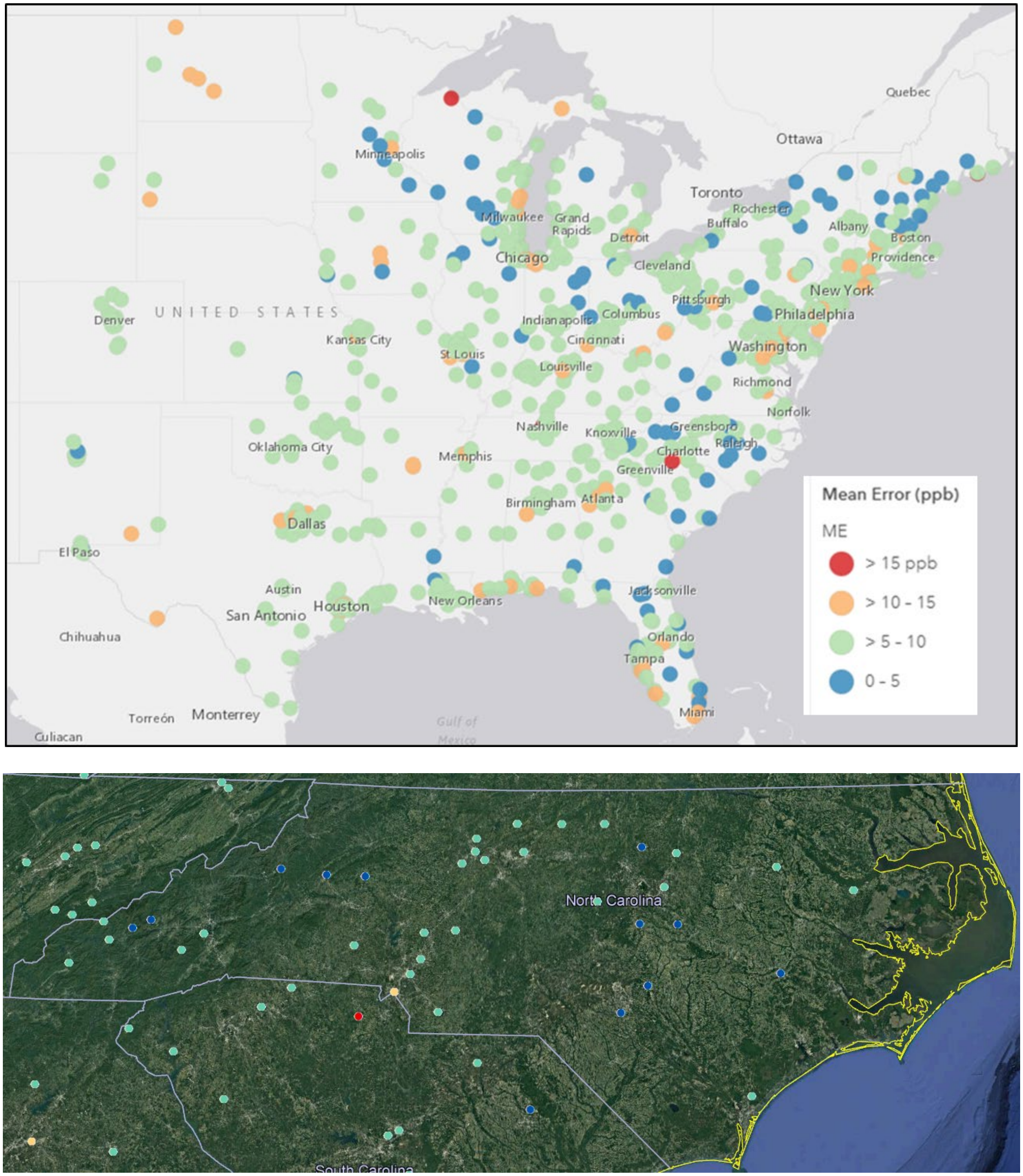

Figure 6-3. Mean Error(ppb) of MDA8 Ozone ≥ 60 ppb Over the Period May-September 2011 at AQS Monitoring Sites in VISTAS12 Domain (top) and in North Carolina (bottom).

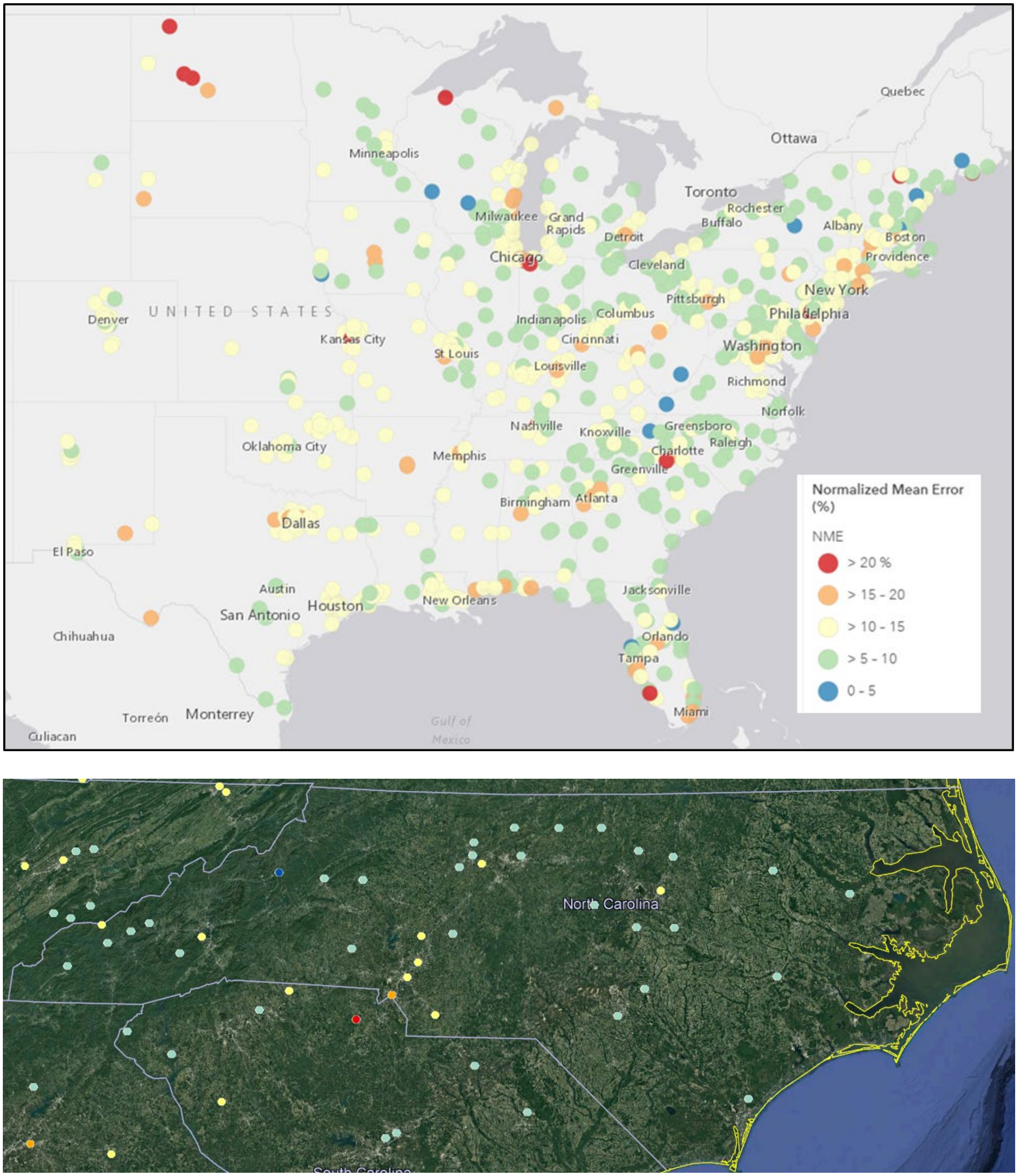

Figure 6-4. Normalized Mean Error (%) of MDA8 Ozone >= 60 ppb Over the Period May-September 2011 at AQS Monitoring Sites in VISTAS12 Domain(top) and in North Carolina (bottom)

6.2 Acid Deposition Model Performance Evaluation

The primary source for deposition data is the National Atmospheric Deposition Program (NADP).[56] 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).

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

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.

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 NMB, MFB, NME, and MFE values are due to small values in the denominator.

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^-.

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

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

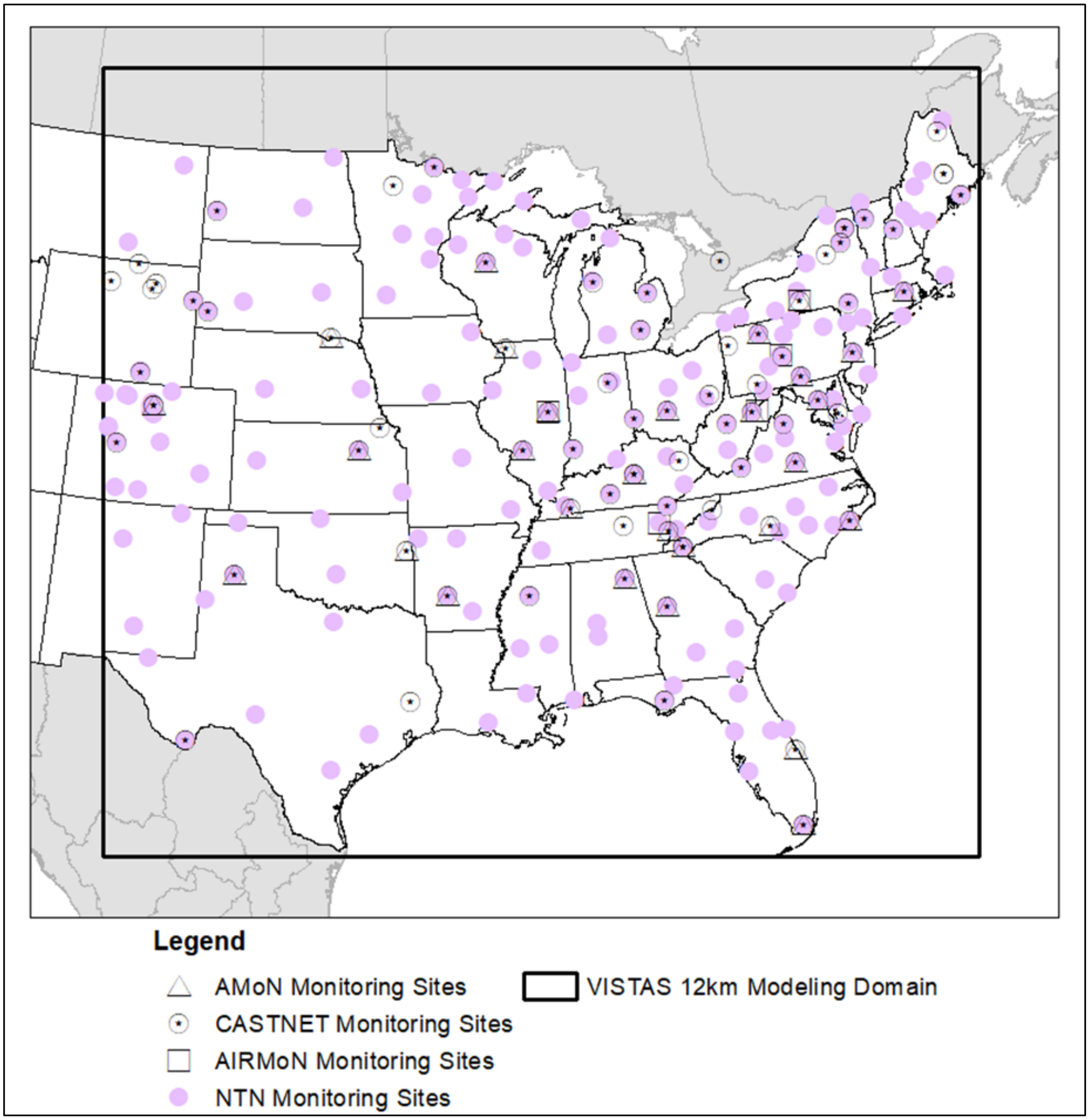

Figure 6-5. Deposition Monitors Included in the VISTAS II Database

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%	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

MB= mean bias, ME = mean error, NMB = normalized mean bias, NME = normalized mean error, MFB = mean fractional bias, MFE = mean fractional error, RMSE = root mean square error.

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

MB= mean bias, MGE = mean gross error, NMB = normalized mean bias, NME = normalized mean error, MFB = mean fractional bias, MFE = mean fractional error, RMSE = root mean square error.

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

MB= mean bias, ME = mean error, NMB = normalized mean bias, NME = normalized mean error, MFB = mean fractional bias, MFE = mean fractional error, RMSE = root mean square error.

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%	95%	0.607	-91%	91%	3.688

MB= mean bias, MGE = mean gross error, NMB = normalized mean bias, NME = normalized mean error, MFB = mean fractional bias, MFE = mean fractional error, RMSE = root mean square error.

6.3 PM Model Performance Goals and Criteria

Because $PM_{2.5}$ is a mixture, the current EPA PM modeling guidance[57] 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 EPA's performance evaluation of the regional haze 2028 analysis,[58] 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[59,60] 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 were used for this modeling. Based on EPA's guidance and the referenced publication, the temporal scales for the 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 Km. This indicates that model performance should be evaluated based on the entire domain and not based on a comparison of modeled to observed values for an individual Class I area.

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

Species	NMB, Goal	NMB, Criteria	NME, Goal	NME, Criteria
24-hr $PM_{2.5}$ and sulfate (SO_4)	<± 10%	<± 30%	< 35%	< 50%
24-hr nitrate (NO_3)	<± 10%	<± 65%	< 65%	< 115%
24-hr OC	<± 15%	<± 50%	< 45%	< 65%
24-hr EC	<± 20%	<± 40%	< 50%	< 75%

[57] U.S. EPA, Modeling Guidance for Demonstrating Air Quality Goals for Ozone, $PM_{2.5}$ and Regional Haze, November 29, 2018, https://www.epa.gov/sites/production/files/2020-10/documents/o3-pm-rh-modeling_guidance-2018.pdf.
[58] U.S. EPA, 2019: Technical Support Document for EPA's Updated 2028 Regional Haze Modeling, Office of Air Quality Planning and Standards United States Environmental Protection Agency, September 2019, https://www.epa.gov/sites/production/files/2019-10/documents/updated_2028_regional_haze_modeling-tsd-2019_0.pdf.
[59] Boylan, J.W., and A.G. Russell. 2006. PM and light extinction model performance metrics, goals, and criteria for three dimensional air quality models. Atmos. Environ. 40:4946– 59. doi:10.1016/j.atmosenv.2005.09.087.
[60] Emery, C.A., Z. Liu, A. Russell, M. Odman, G. Yarwood and N. Kumar. 2017. Recommendations on statistics and benchmarks to assess photochemical model performance, Journal of the Air & Waste Management Association, 67:5, 582-598, DOI: 10.1080/10962247.2016.1265027.

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

Species	MFB, Goal	MFB, Criteria	MFE, Goal	MFE, 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	PNO3
IMPROVE	SO_4	PSO4
IMPROVE	NH_4	PNH4
IMPROVE	OM = 1.8*OC	SOA1+SOA2+SOA3+SOA4 +SOPA+SOPB+POA
IMPROVE	EC	PEC
IMPROVE	SOIL	FPRM+FCRS
IMPROVE	$PM_{2.5}$	PSO4+PNO3+PNH4+SOA1+SOA2+SOA3+SOA4 +SOPA+SOPB+POA+PEC+FPRM+FCRS+NA+PCL
CSN	$PM_{2.5}$	PSO4+PNO3+PNH4+SOA1+SOA2+SOA3+SOA4 +SOPA+SOPB+POA+PEC+FPRM+FCRS+NA+PCL
CSN	NO_3	PNO3
CSN	SO_4	PSO4
CSN	NH_4	PNH4
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.
- Concentration performance plots (“bugle plots”) that display fractional bias or error as a function of concentration by species, region, monitoring network, and month.
- 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 focuses 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 PM, as good model performance of the component species will dictate good model performance of total or reconstituted fine PM. Model performance of the total fine PM and the resulting total light extinction was also examined to evaluate the overall model performance. Appendix E-3 provides a complete list of model performance statistics.

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 total $PM_{2.5}$ (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. Please see Table 6-6 (above) for values associated with the goal (blue line) and criteria values (red line).

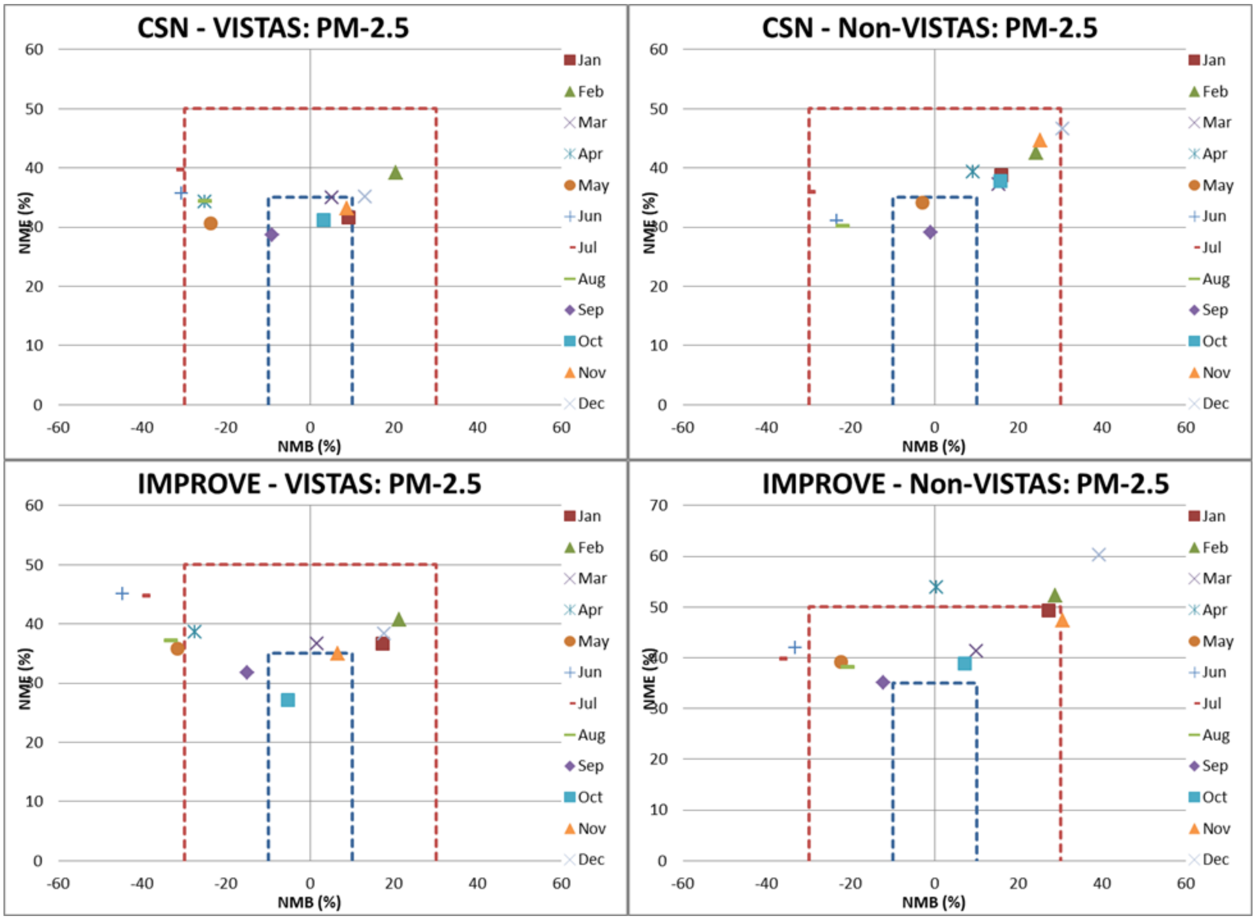

Figure 6-6. Soccer Plots of Total $PM_{2.5}$ by Network and Month for VISTAS and Non-VISTAS Sites

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.

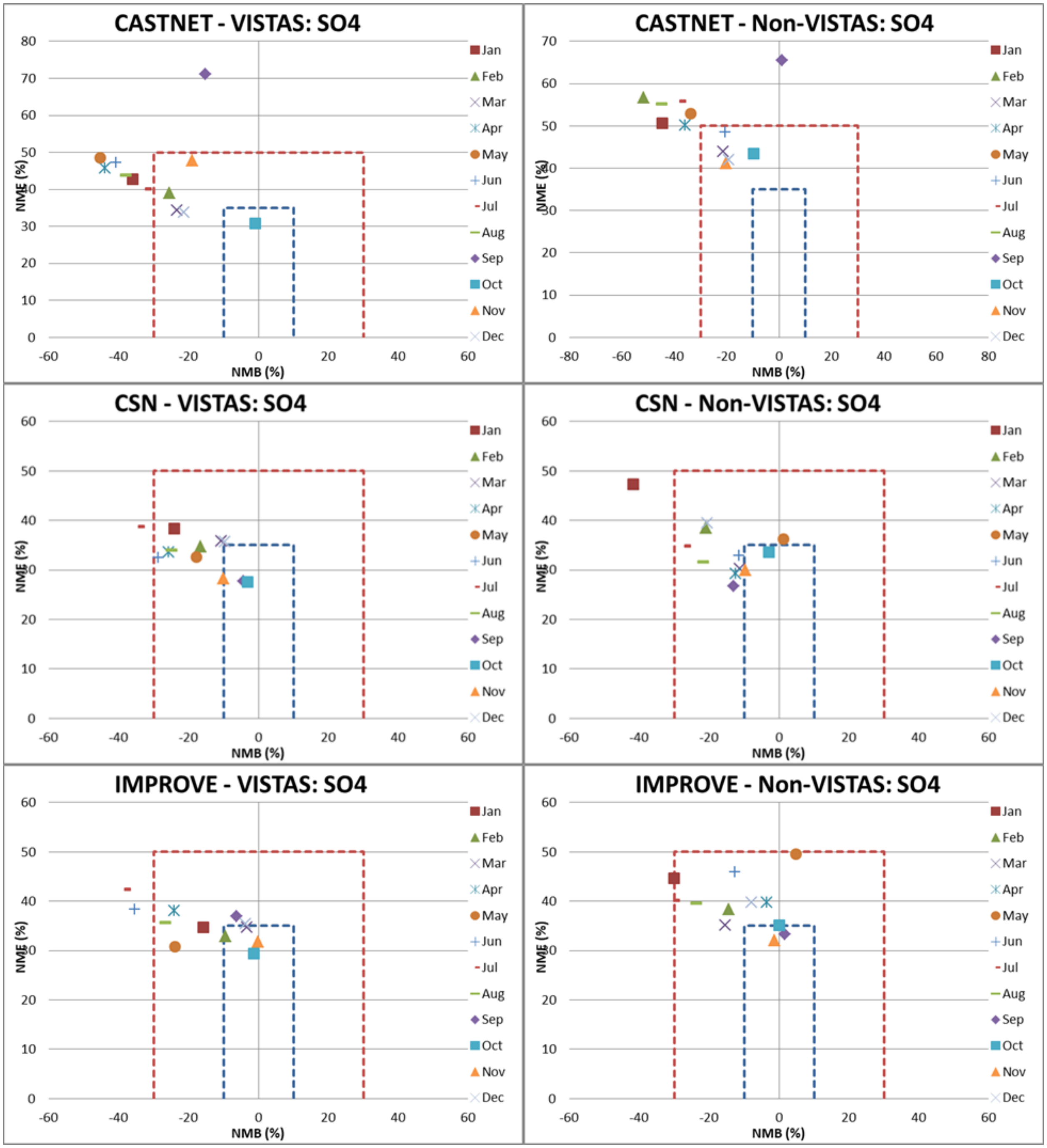

Figure 6-7. Soccer Plots by Network and Month for VISTAS and Non-VISTAS Sites

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.

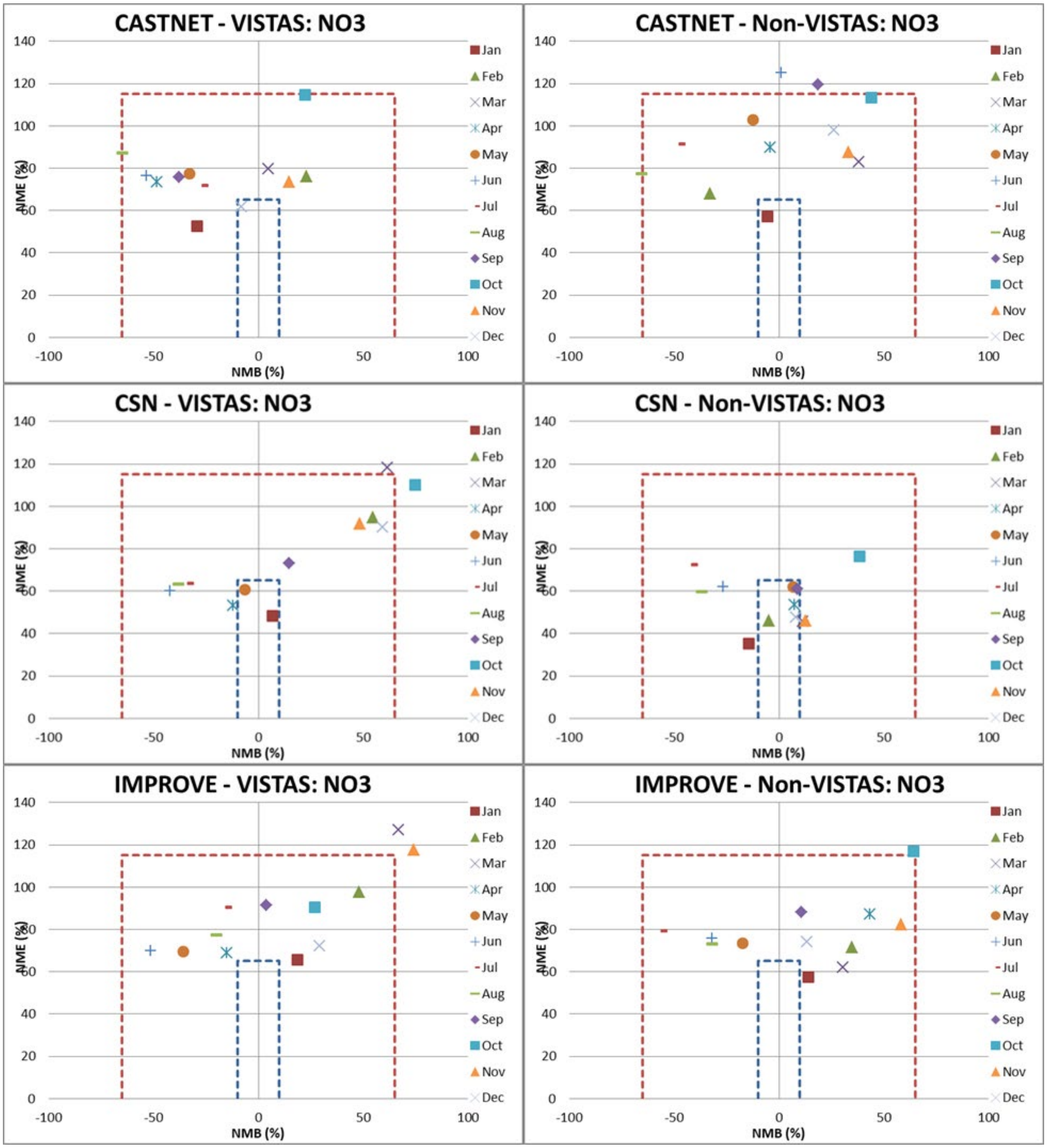

Figure 6-8. Soccer Plots of Nitrate by Network and Month for VISTAS and Non-VISTAS Sites

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.

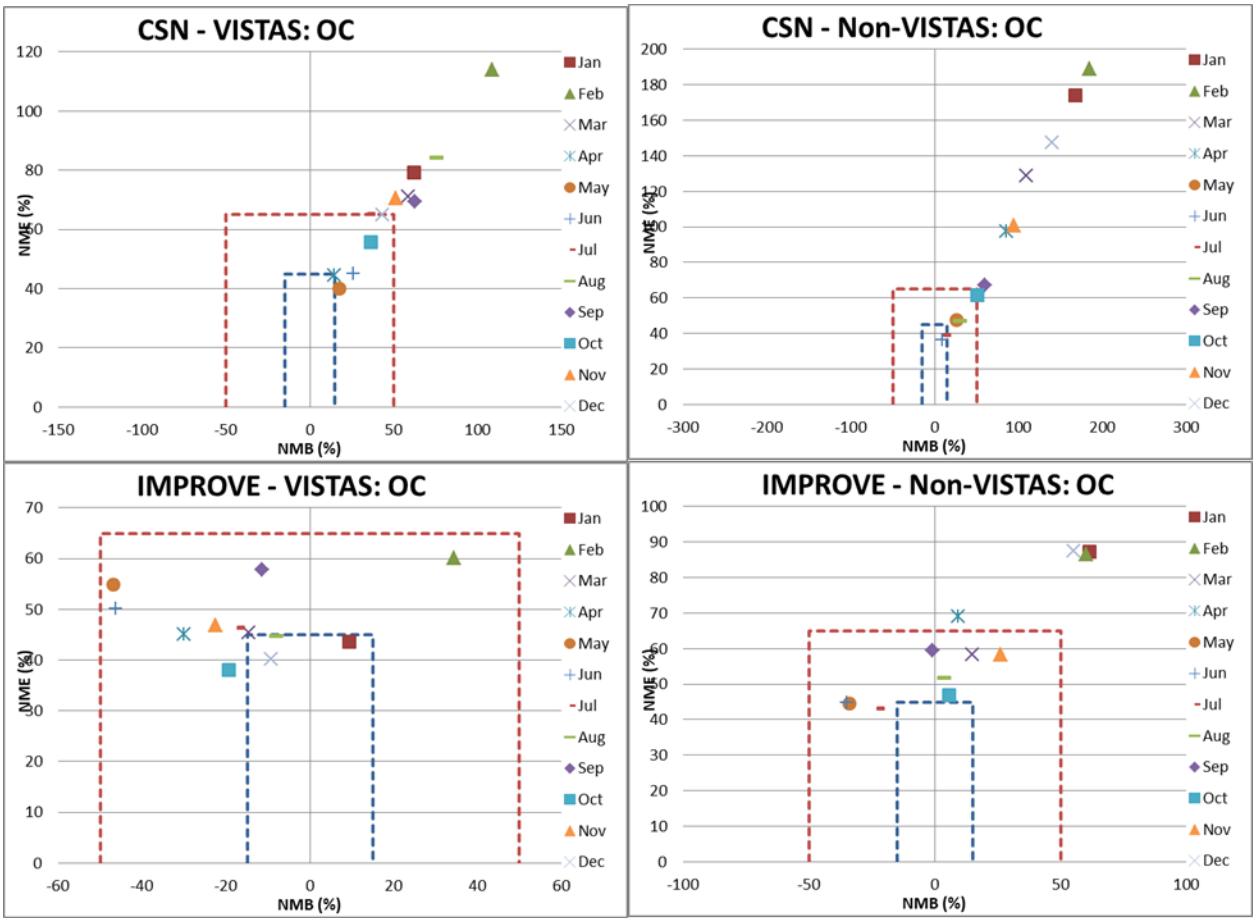

Figure 6-9. Soccer Plots of OC by Network and Month for VISTAS and Non-VISTAS Sites

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.

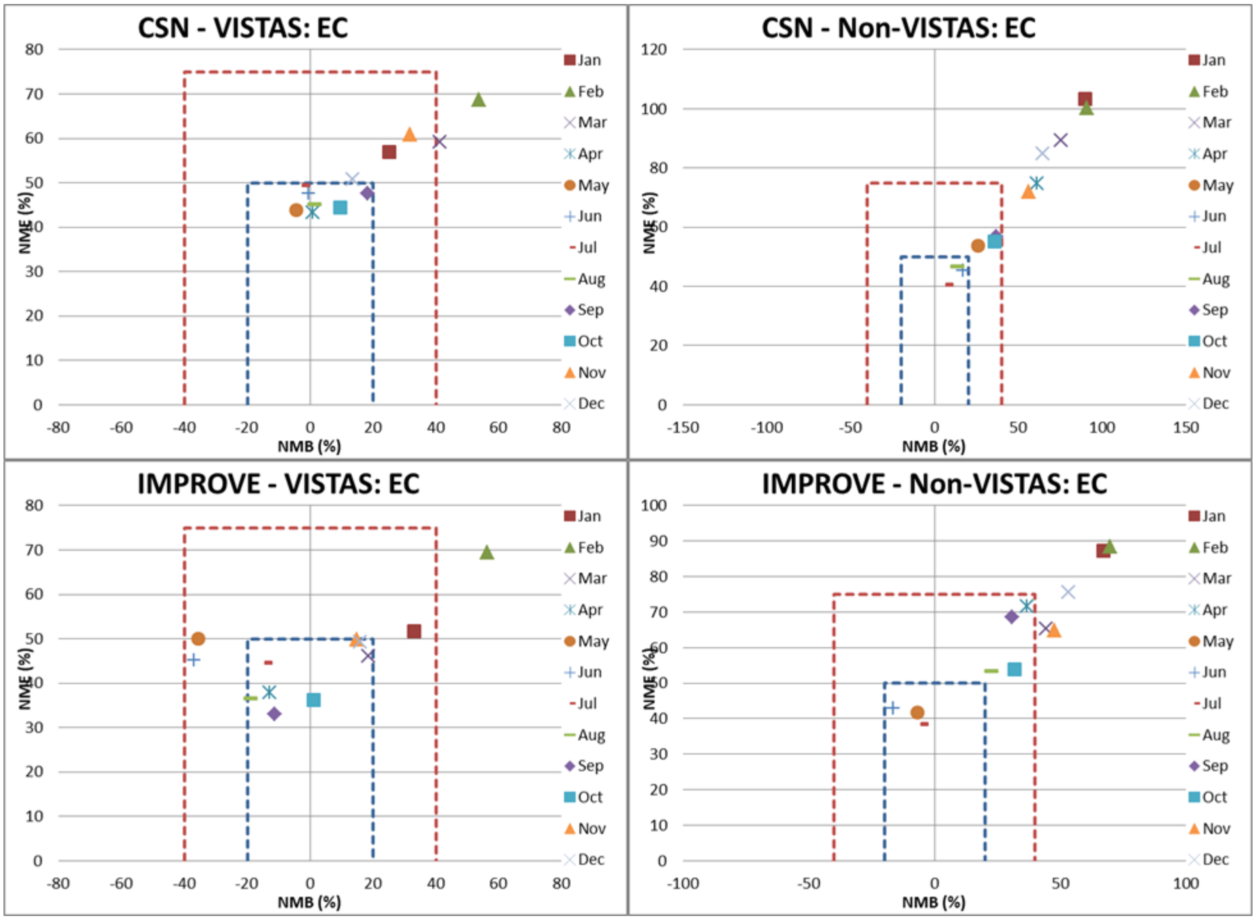

Figure 6-10. Soccer Plots of EC by Network and Month for VISTAS and Non-VISTAS Sites

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.

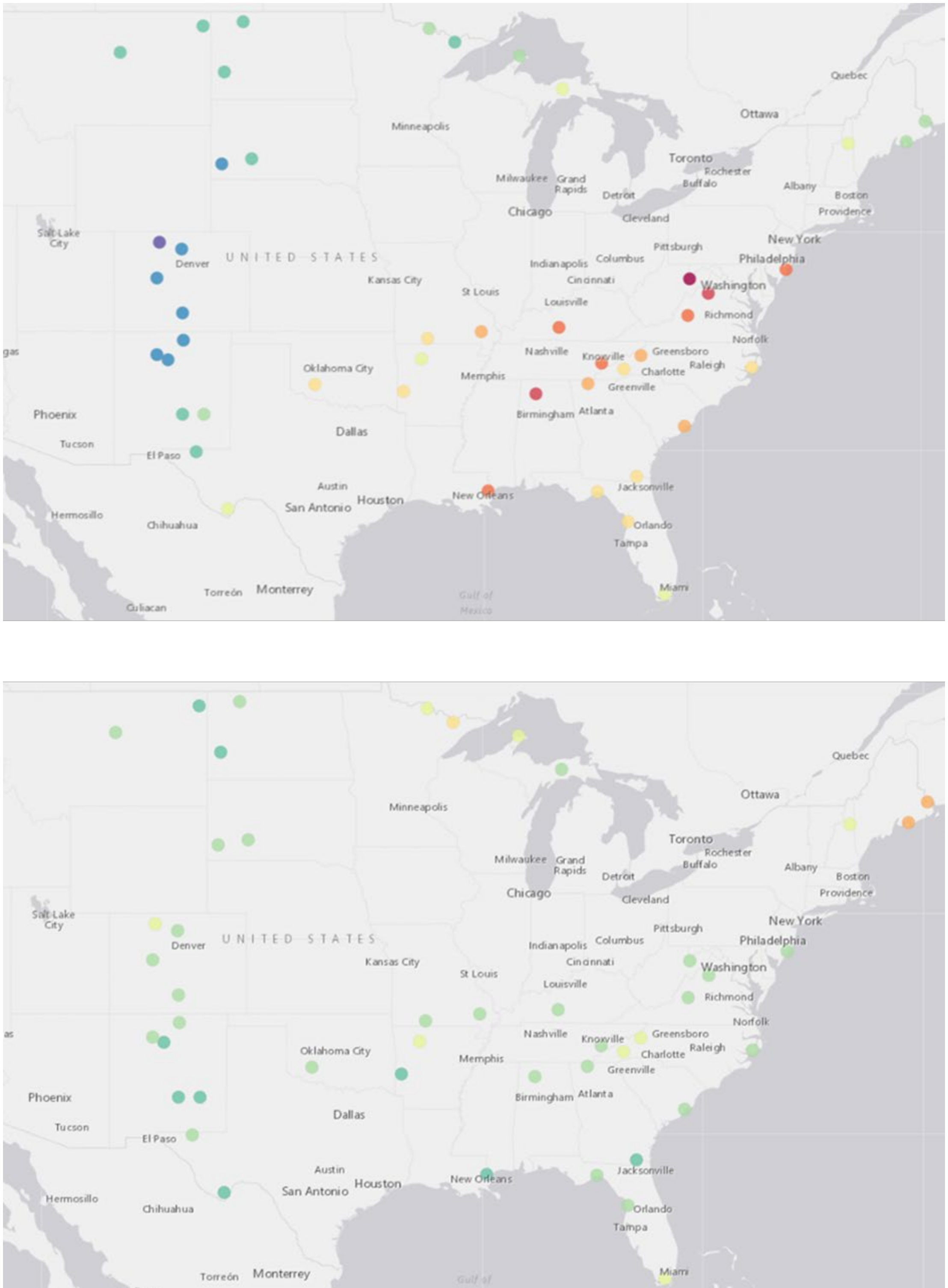

Figure 6-11. Observed Sulfate (Top) and Modeled NMB (Bottom) for Sulfate on the 20% Most-Impaired Days at IMPROVE Monitor Locations

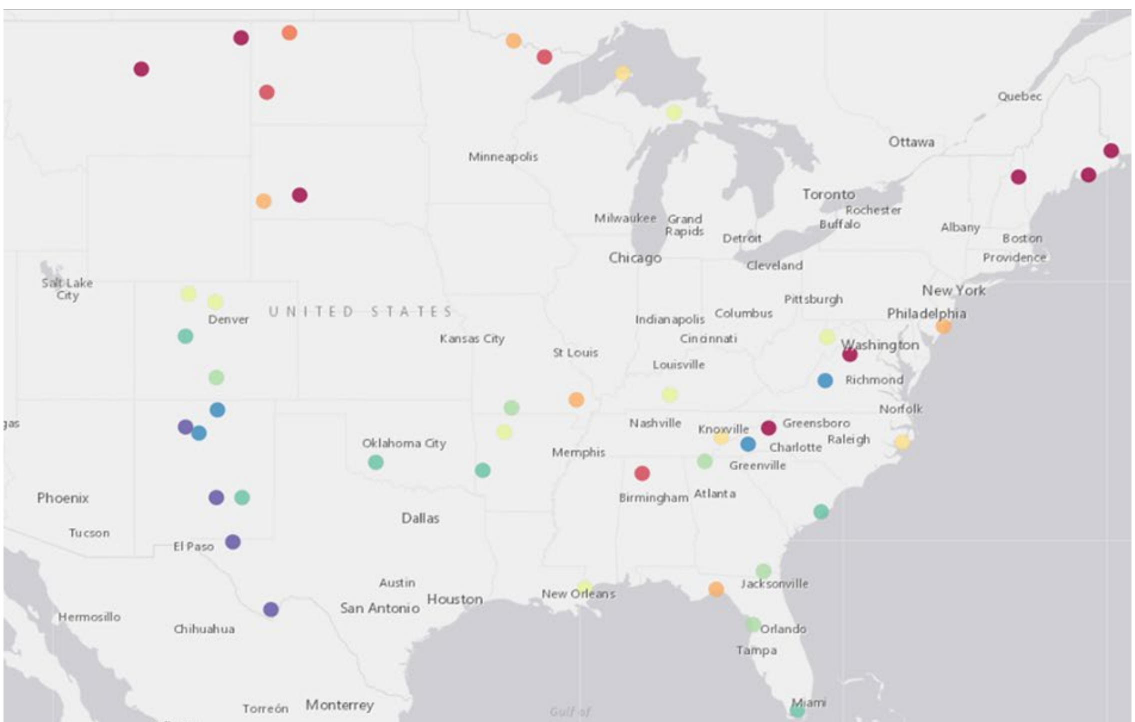

Figure 6-12. Observed Nitrate (Top) and Modeled NMB (Bottom) for Nitrate on the 20% Most Impaired Days at Improve Monitor Locations

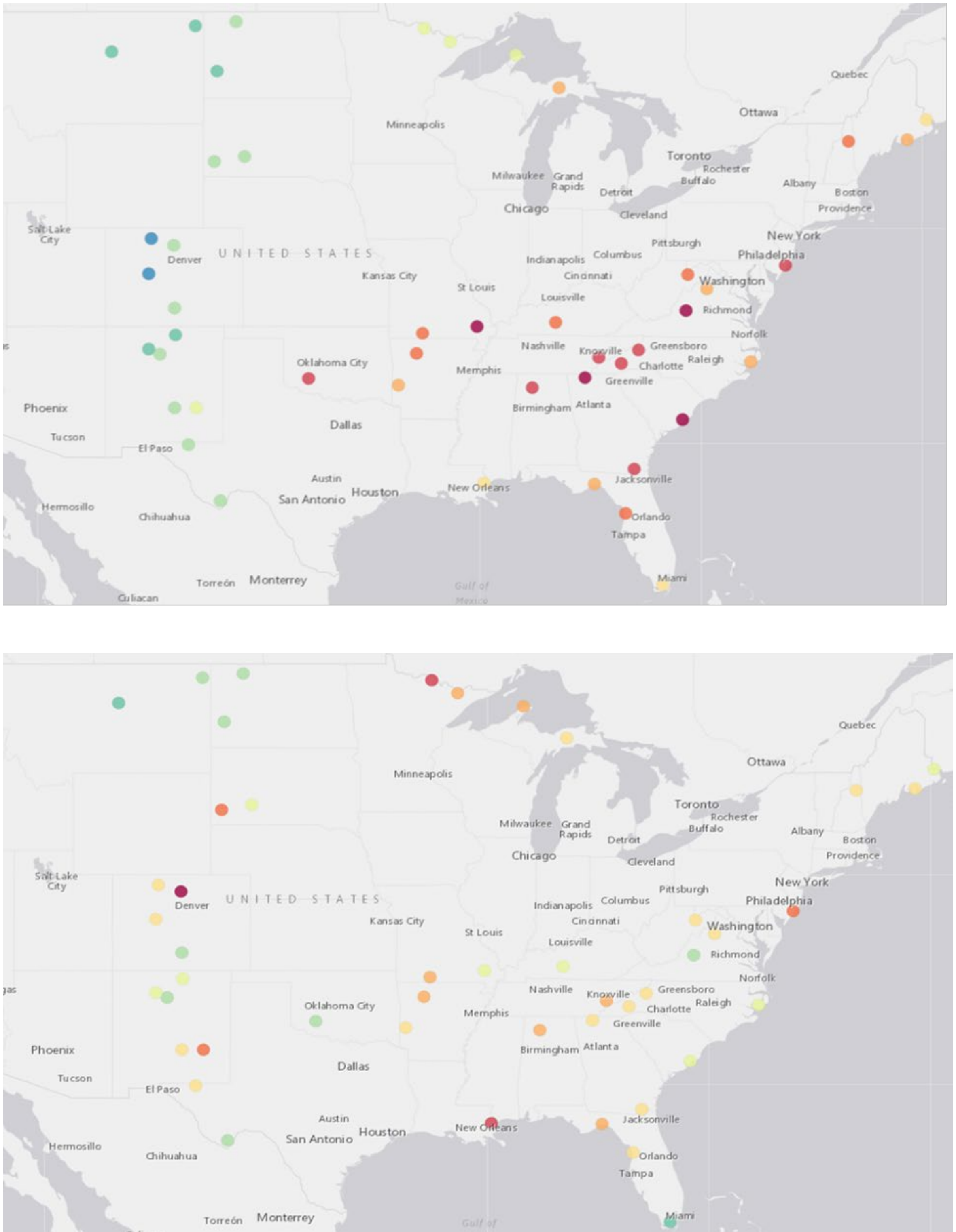

Figure 6-13. Observed OC (Top) and Modeled NMB (Bottom) for OC on the 20% Most-Impaired Days at IMPROVE Monitor Locations

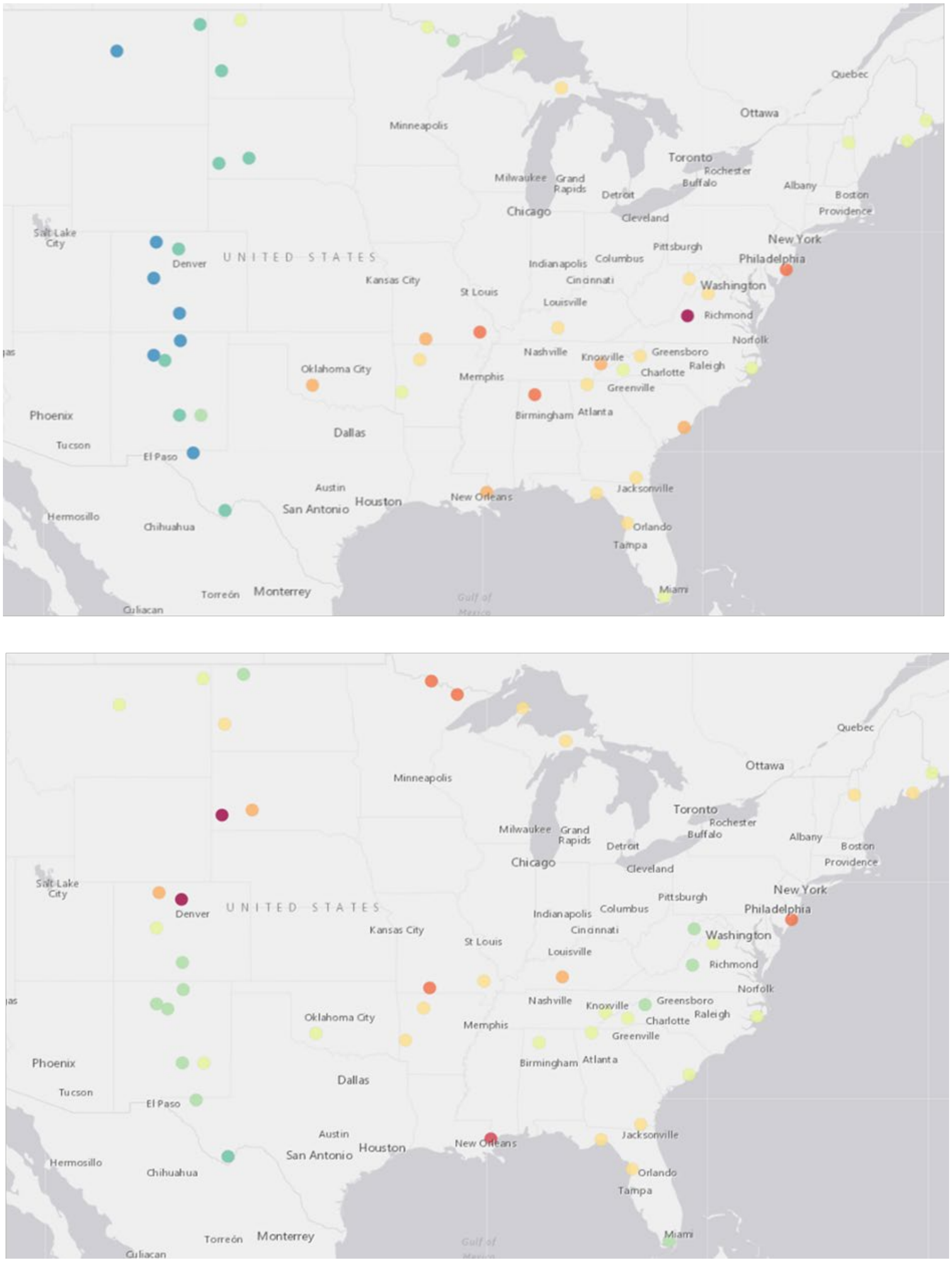

Figure 6-14. Observed EC (Top) and Modeled NMB (Bottom) for EC on the 20% Most-Impaired Days at IMPROVE Monitor Locations

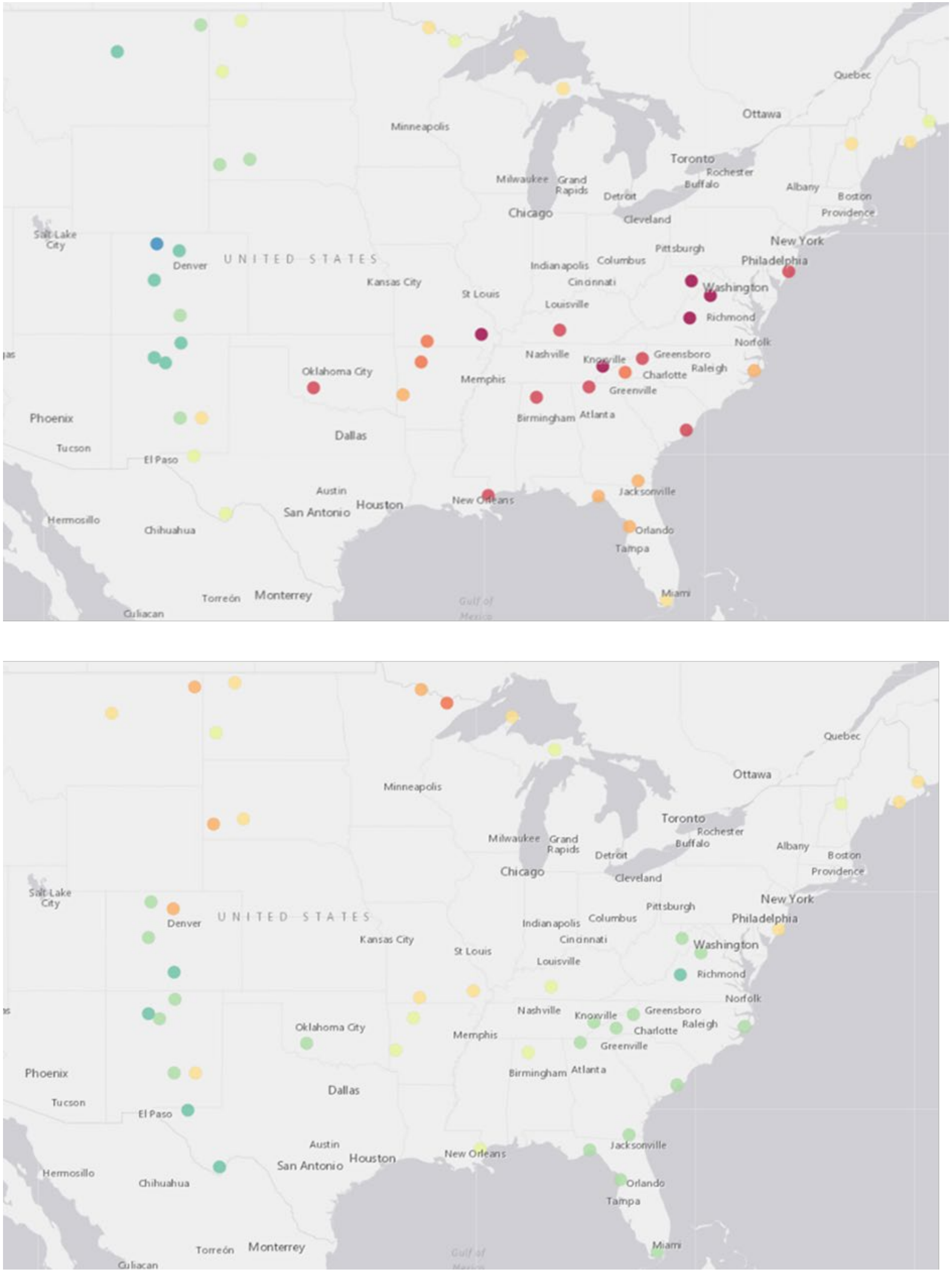

Figure 6-15. Observed Total $PM_{2.5}$ (Top) and Modeled NMB (Bottom) for Total $PM_{2.5}$ on the 20% Most-Impaired Days at IMPROVE Monitor Locations

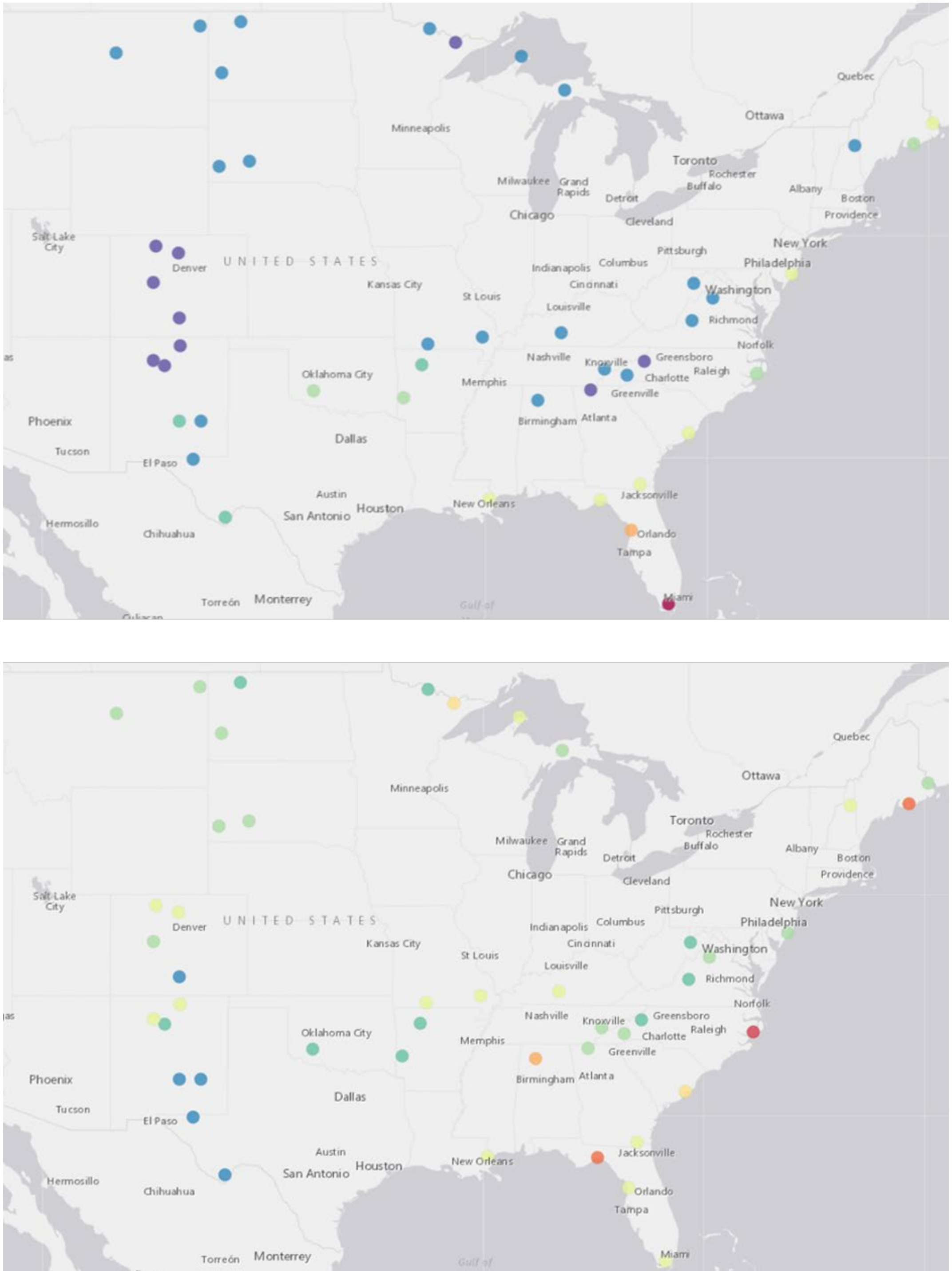

Figure 6-16. Observed Sea Salt (Top) and Modeled NMB (Bottom) for Sea Salt on the 20% Most-Impaired Days at IMPROVE Monitor Locations

6.5 PM Model Performance Evaluation for Class I Areas in North Carolina

The following section provides a detailed model performance evaluation for Great Smoky Mountains National Park, Joyce Kilmer-Slickrock Wilderness area, Linville Gorge Wilderness area, Shining Rock Wilderness Area, and Swanquarter 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. The Great Smoky Mountains National Park IMPROVE monitor was used to represent the Joyce Kilmer-Slickrock Wilderness Area and Shining Rock Wilderness Area. An IMPROVE monitor exists at Shining Rock Wilderness Area as well but observed data for 2011 failed to meet completeness criteria, which is why the evaluation for Great Smoky Mountains National Park was also used to represent the Shining Rock Wilderness Area in this report.

Figure 6-17 through Figure 6-19 contain the average stacked bar charts for Great Smoky Mountains National Park, Linville Gorge Wilderness Area, and Swanquarter Wilderness Area, respectively. All figures include (1) observed and modeled mass concentrations of PM constituents and (2) observed and modeled light extinctions constituents on the 20% most-impaired days and the 20% clearest days. It should be noted that values used for these stacked bar charts are from a 3x3 grid cell matrix around each IMPROVE monitor (not just the grid cell containing the monitor). 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 at Great Smoky Mountains National Park, Linville Gorge Wilderness Area, and Swanquarter Wilderness Area match well on 20% clearest days. Model performance for sulfate at all areas is biased low on 20% most-impaired days.

Figure 6-20 through Figure 6-23, Figure 6-24 through Figure 6-27, and Figure 6-28 through Figure 6-31 contain the day-by-day stacked bar charts for Great Smoky Mountains National Park, Linville Gorge Wilderness Area, and Swanquarter Wilderness Area, respectively. 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 PM 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. Sulfates and organic carbon are the largest contributors to light extinction in the North Carolina Class I areas on both the 20% most-impaired days and the 20% clearest days (see Figure 6-17 through Figure 6-31). 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.

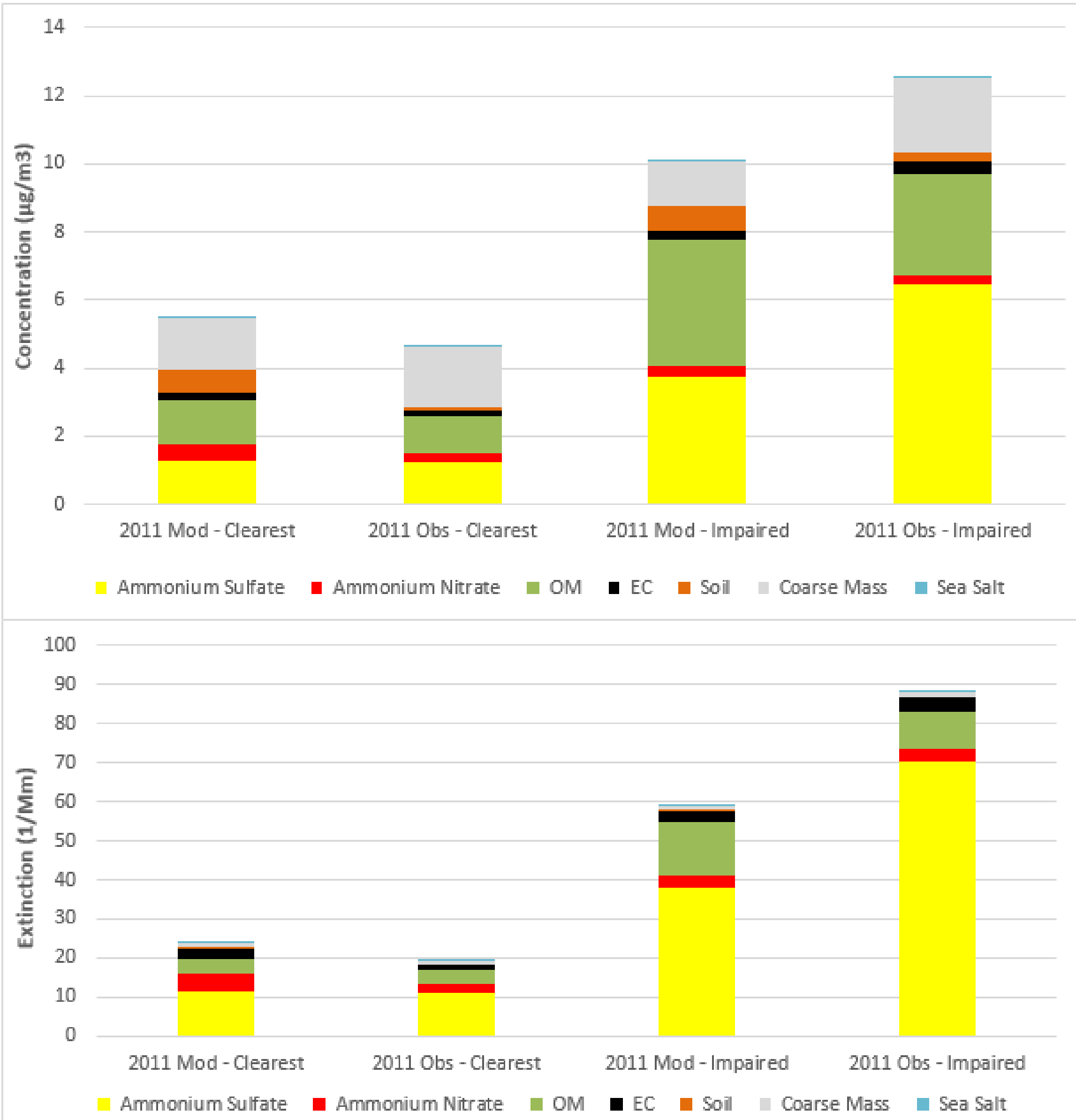

Figure 6-17. Stacked Bar Charts for Average $PM_{2.5}$ Concentrations (top) and Light Extinction (bottom) at Great Smoky Mountains National Park on the 20% Most Impaired days (1st and 2nd columns) and 20% Clearest Days (3rd and 4th columns): Observation (left) and Modeled (Right)

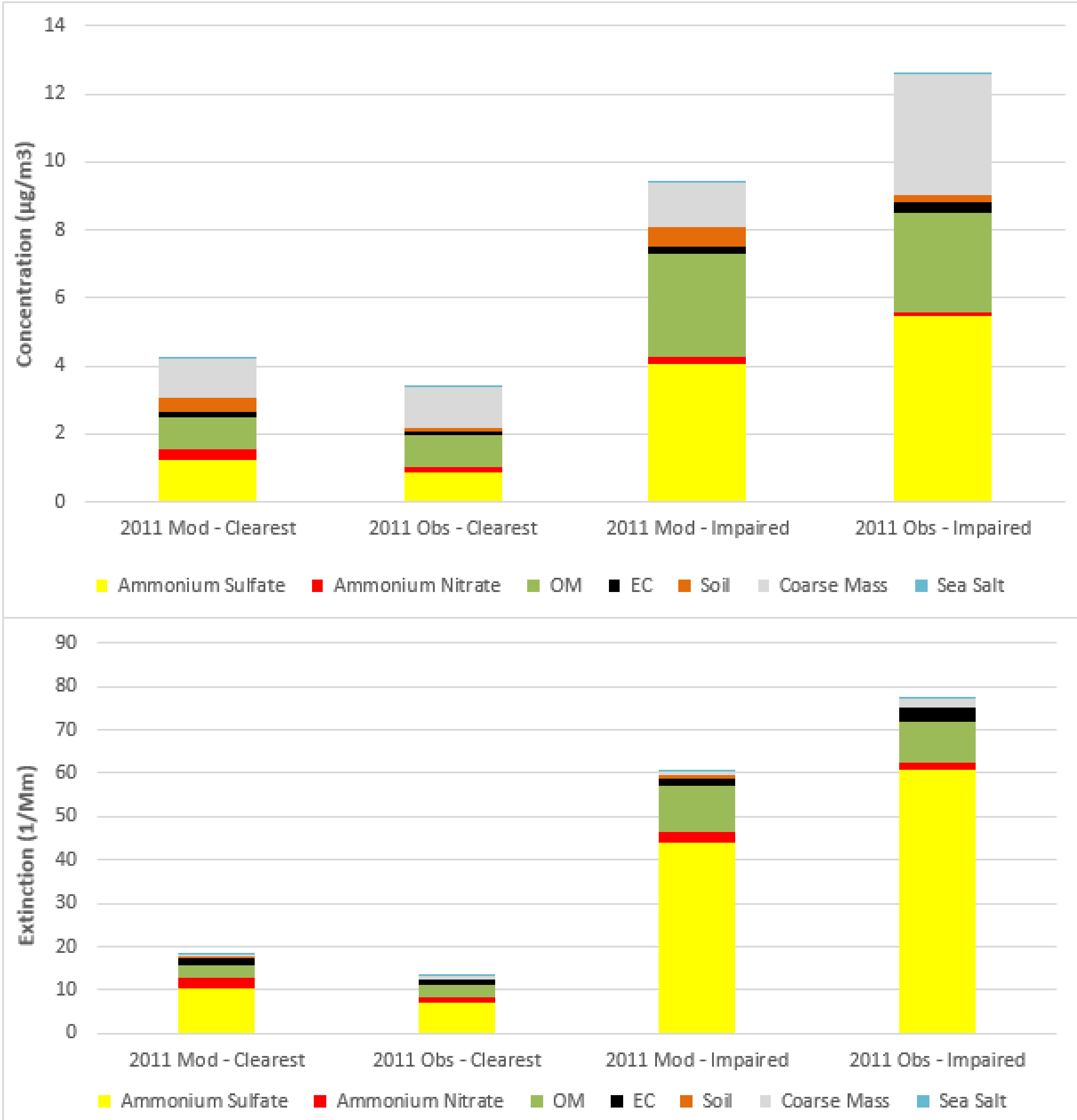

Figure 6-18. Stacked Bar Charts for Average $PM_{2.5}$ Concentrations (top) and Light Extinction (bottom) at Linville Gorge Wilderness Area on the 20% Most-Impaired days (1st and 2nd columns) and 20% Clearest Days (3rd and 4th columns): Observation (left) and Modeled (Right)

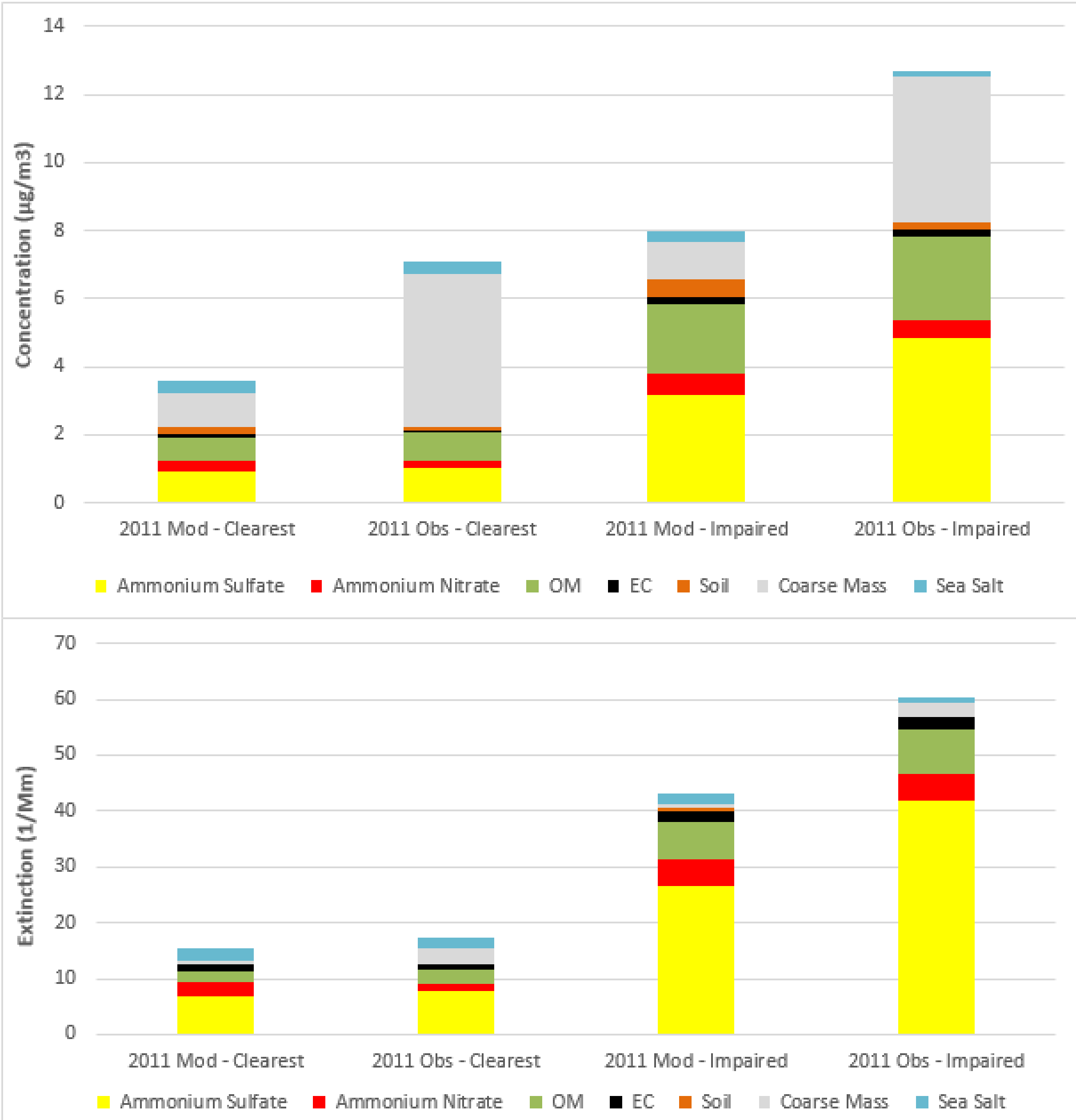

Figure 6-19. Stacked Bar Charts for Average $PM_{2.5}$ Concentrations (top) and Light Extinction (bottom) at Swanquarter Wilderness Area on the 20% Most-Impaired days (1st and 2nd columns) and 20% Clearest Days (3rd and 4th columns): Observation (left) and Modeled (Right)

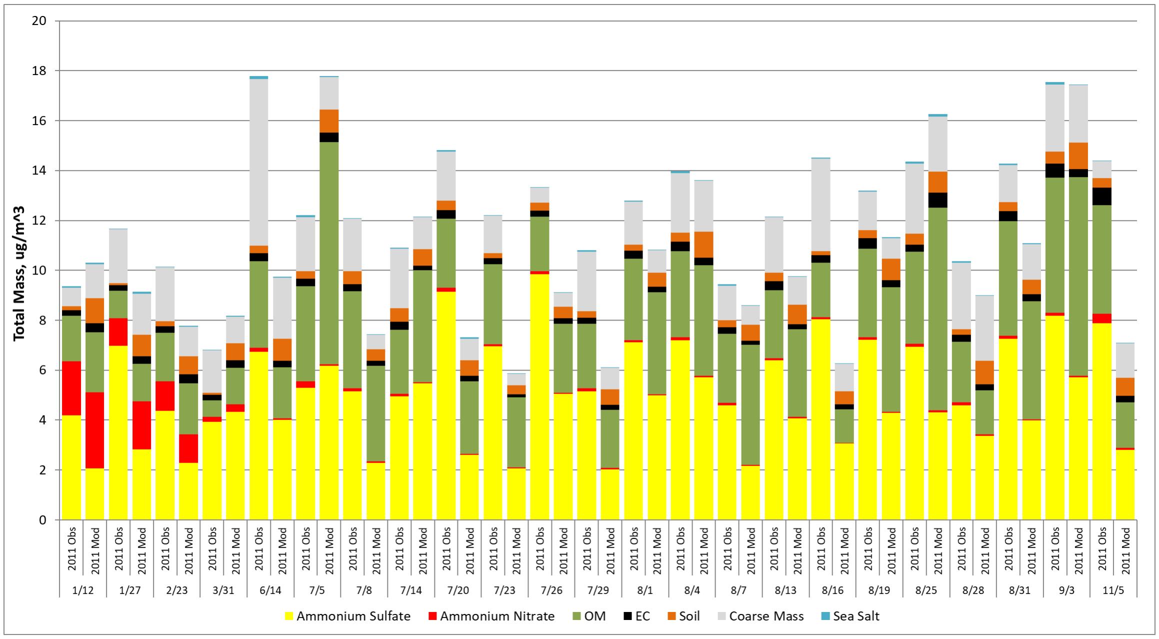

Figure 6-20. Stacked Bar Charts for Daily $PM_{2.5}$ Concentrations at Great Smoky Mountains National Park on the 20% Most Impaired Days: Observation (left) and Modeled (Right)

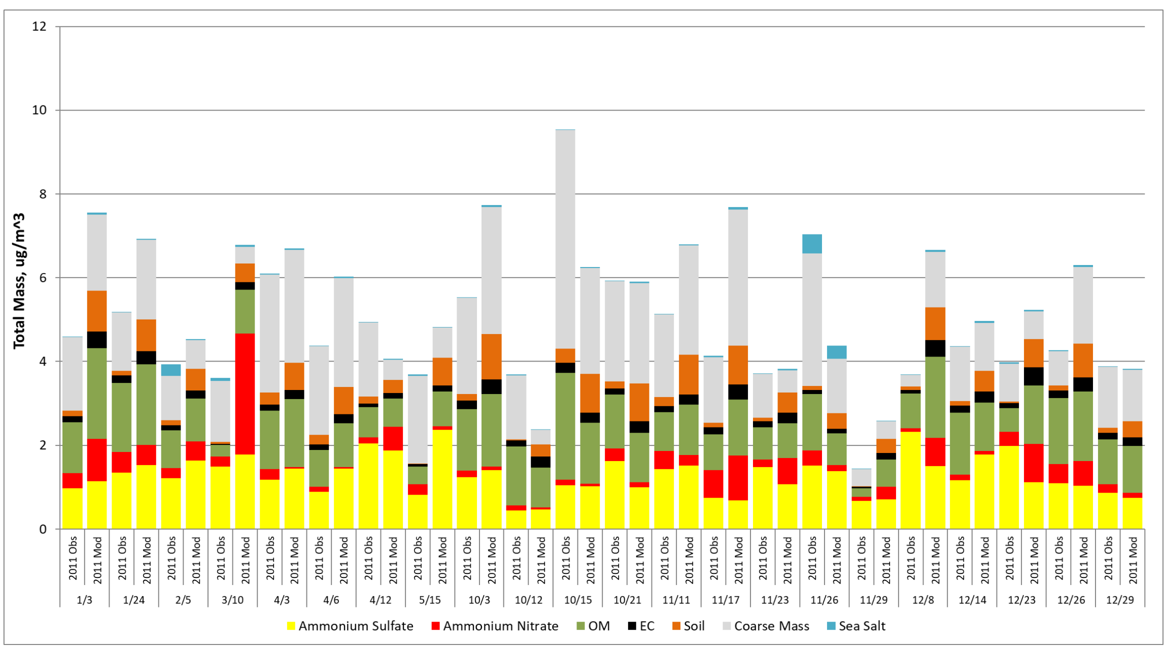

Figure 6-21. Stacked Bar Charts for Daily $PM_{2.5}$ Concentrations at Great Smoky Mountains National Park on the 20% Clearest Days: Observation (left) and Modeled (Right)

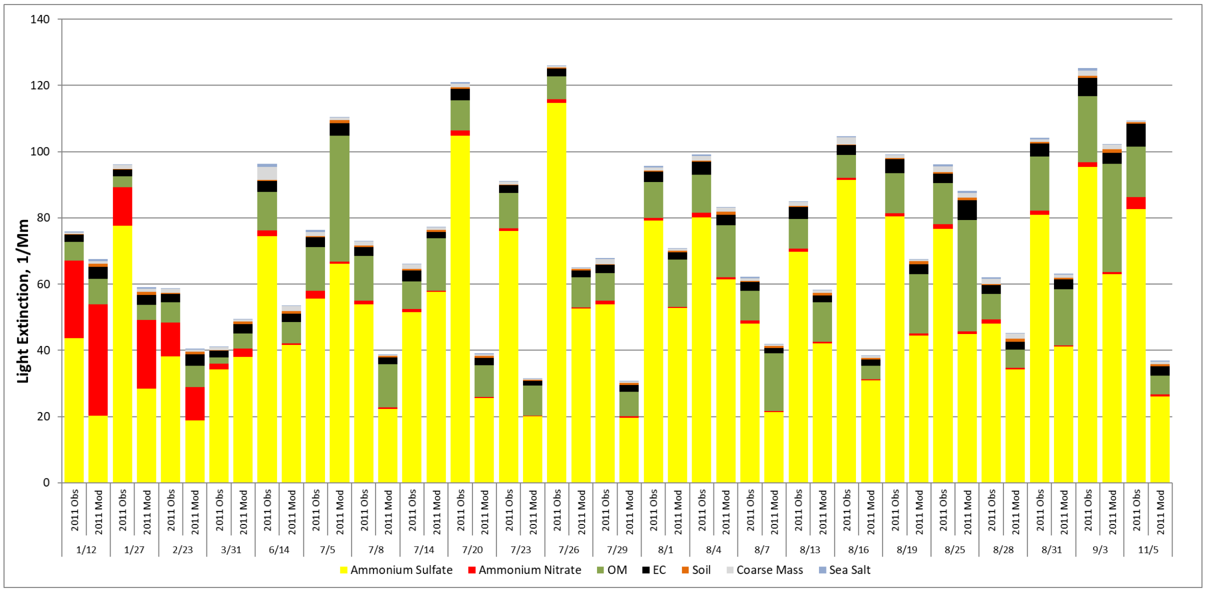

Figure 6-22. Stacked Bar Charts for Light Extinction at Great Smoky Mountains National Park on the 20% Most-Impaired Days: Observation (left) and Modeled (Right)

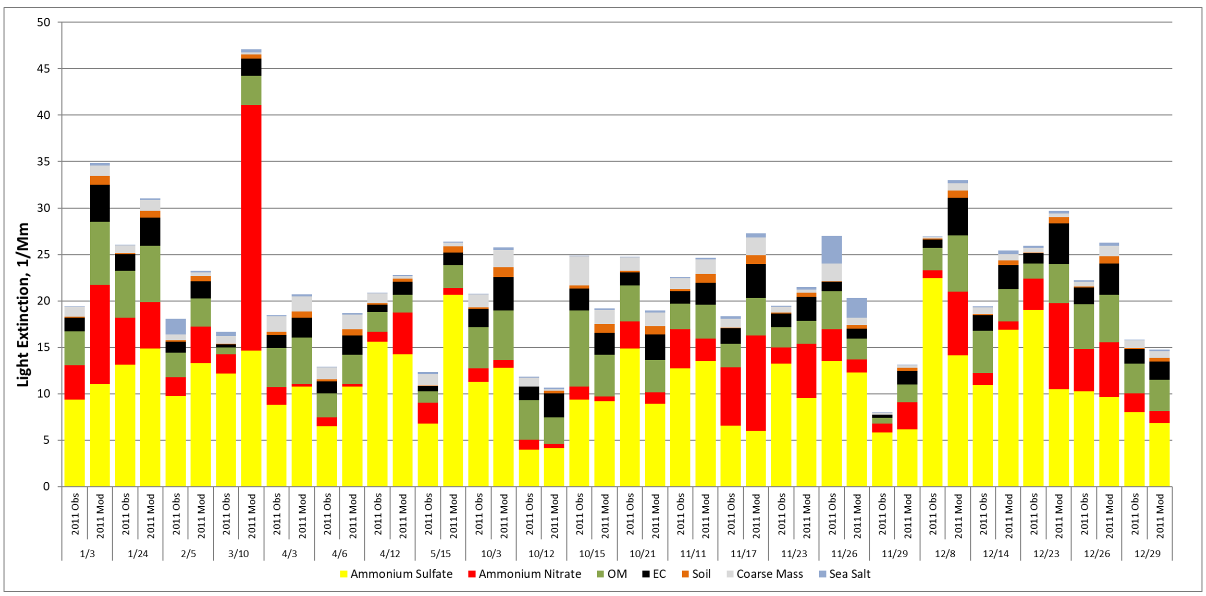

Figure 6-23. Stacked Bar Charts for Light Extinction at Great Smoky Mountains National Park on the 20% Clearest Days: Observation (left) and Modeled (Right)

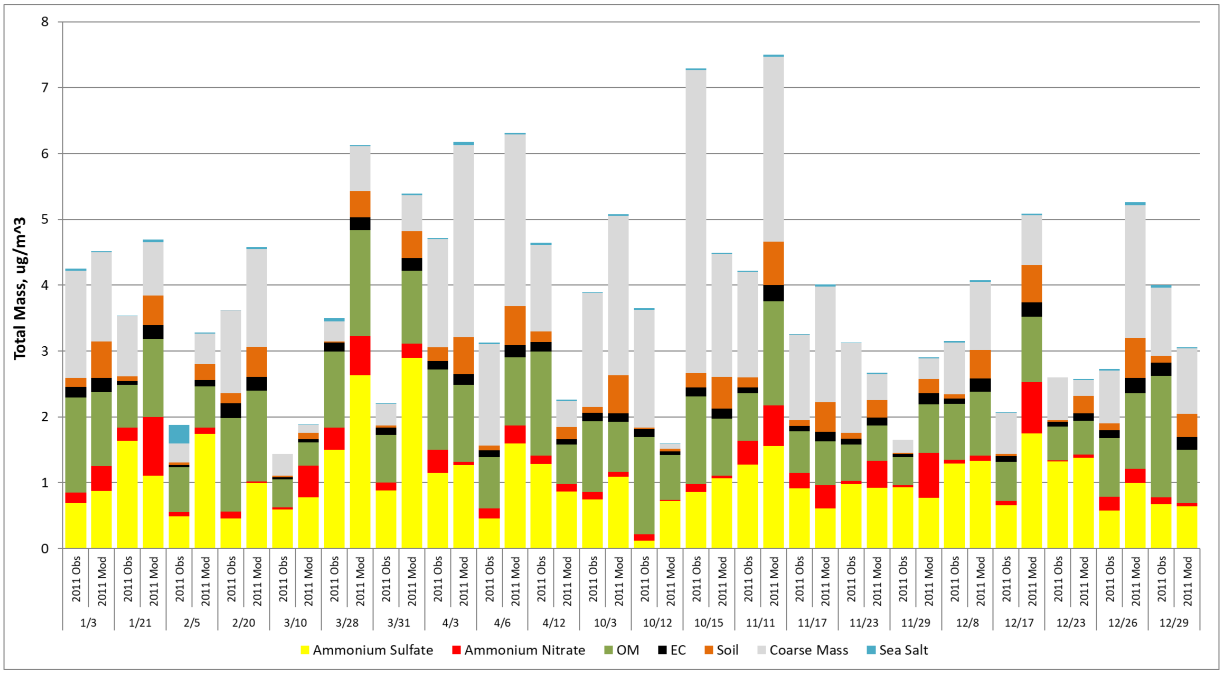

Figure 6-24. Stacked Bar Charts for Daily $PM_{2.5}$ Concentrations at Linville Gorge Wilderness Area on the 20% Most-Impaired Days: Observation (left) and Modeled (Right)

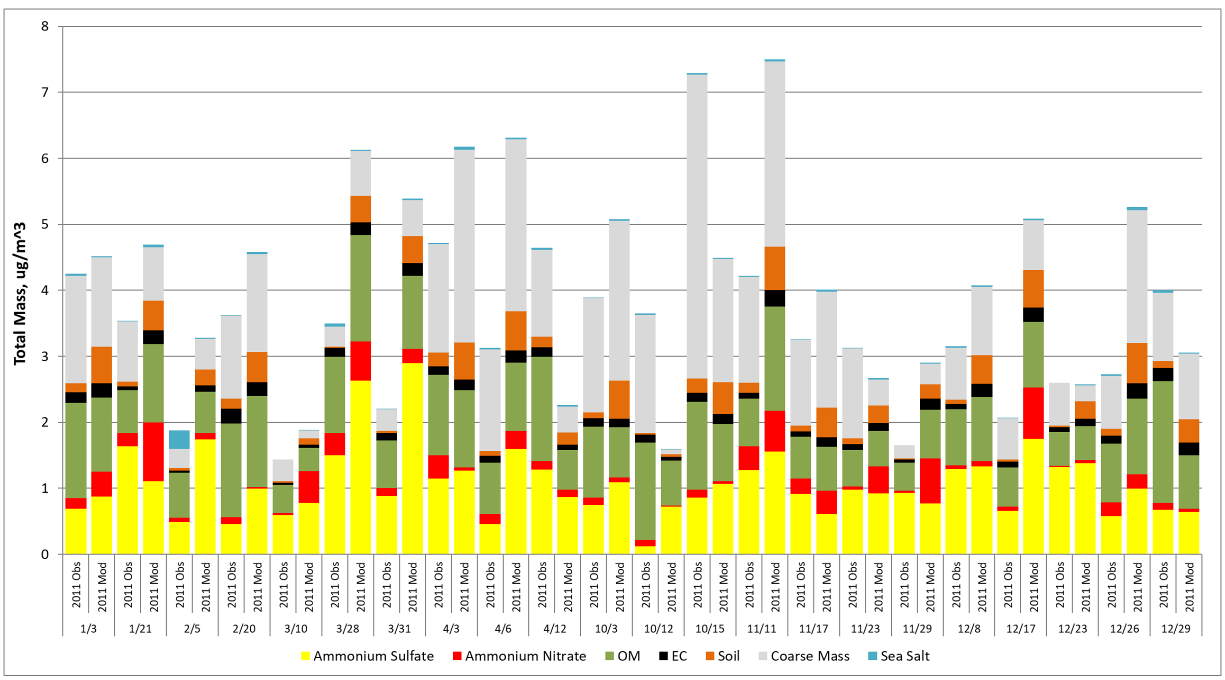

Figure 6-25. Stacked Bar Charts for Daily $PM_{2.5}$ Concentrations at Linville Gorge Wilderness Area on the 20% Clearest Days: Observation (left) and Modeled (Right)

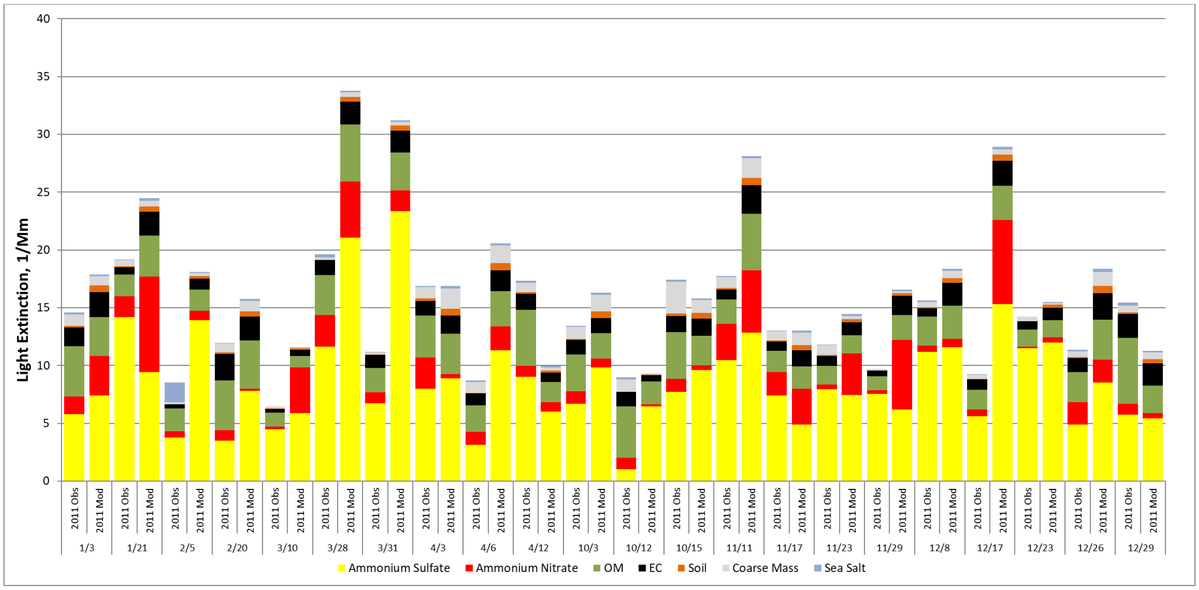

Figure 6-26 Stacked Bar Charts for Light Extinction at Linville Gorge Wilderness Area on the 20% Most-Impaired Days: Observation (left) and Modeled (Right)

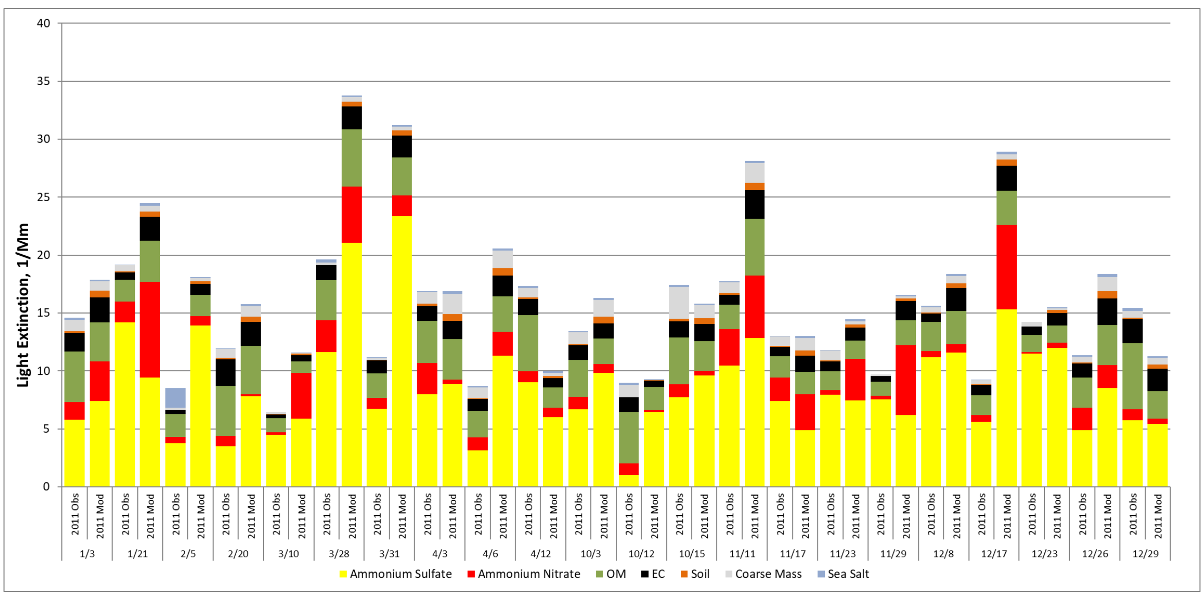

Figure 6-27 Stacked Bar Charts for Light Extinction at Linville Gorge Wilderness Area on the 20% Clearest Days: Observation (left) and Modeled (Right)

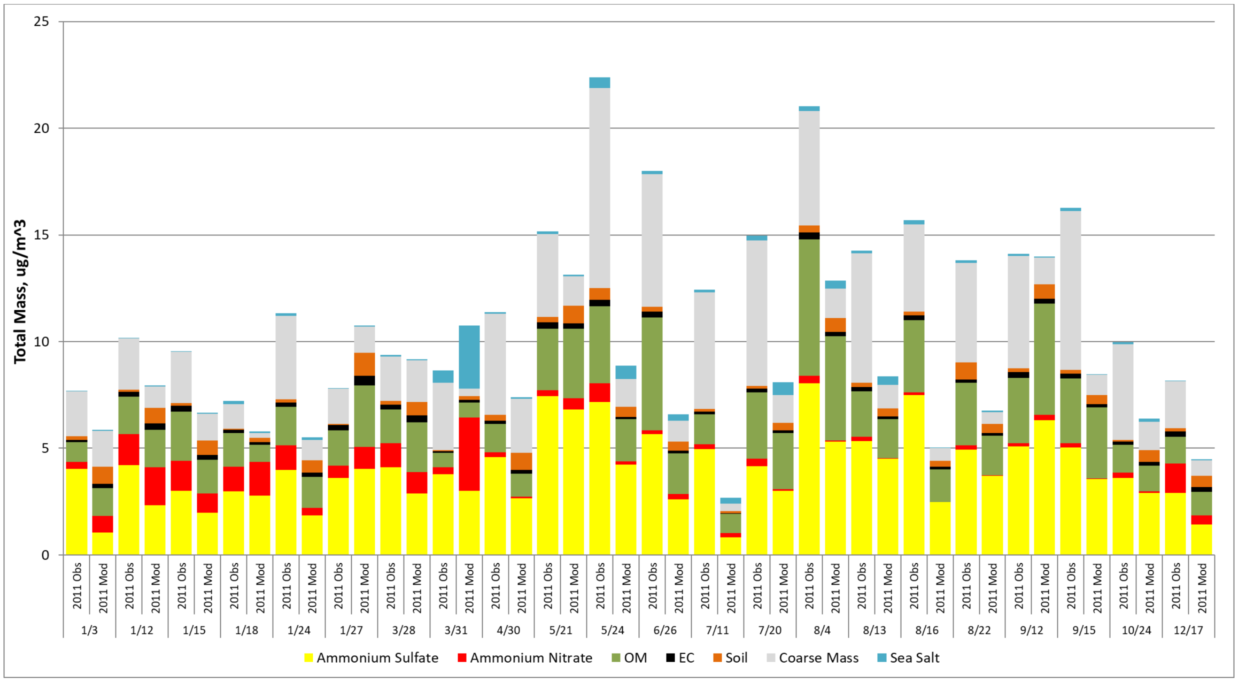

Figure 6-28. Stacked Bar Charts for Daily PM2.5 Concentrations at Swanquarter Wilderness Area on the 20% Most-Impaired Days: Observation (left) and Modeled (Right)

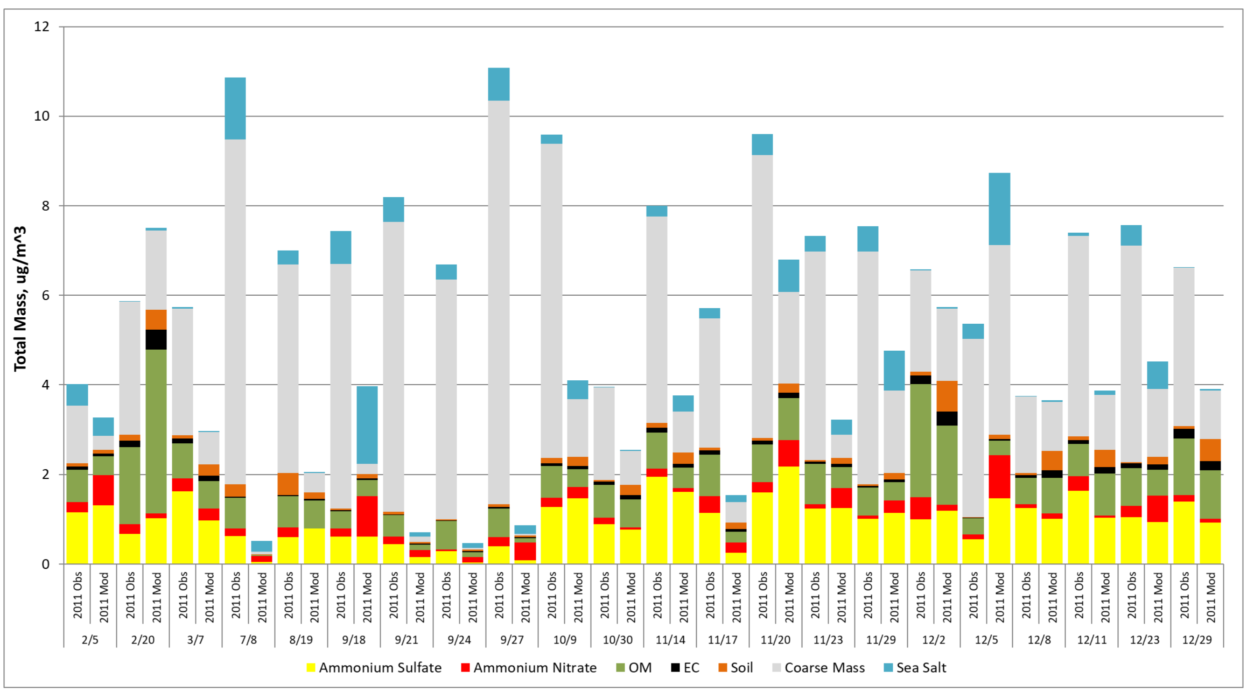

Figure 6-29. Stacked Bar Charts for Daily PM2.5 Concentrations at Swanquarter Wilderness Area on the 20% Clearest Days: Observation (left) and Modeled (Right)

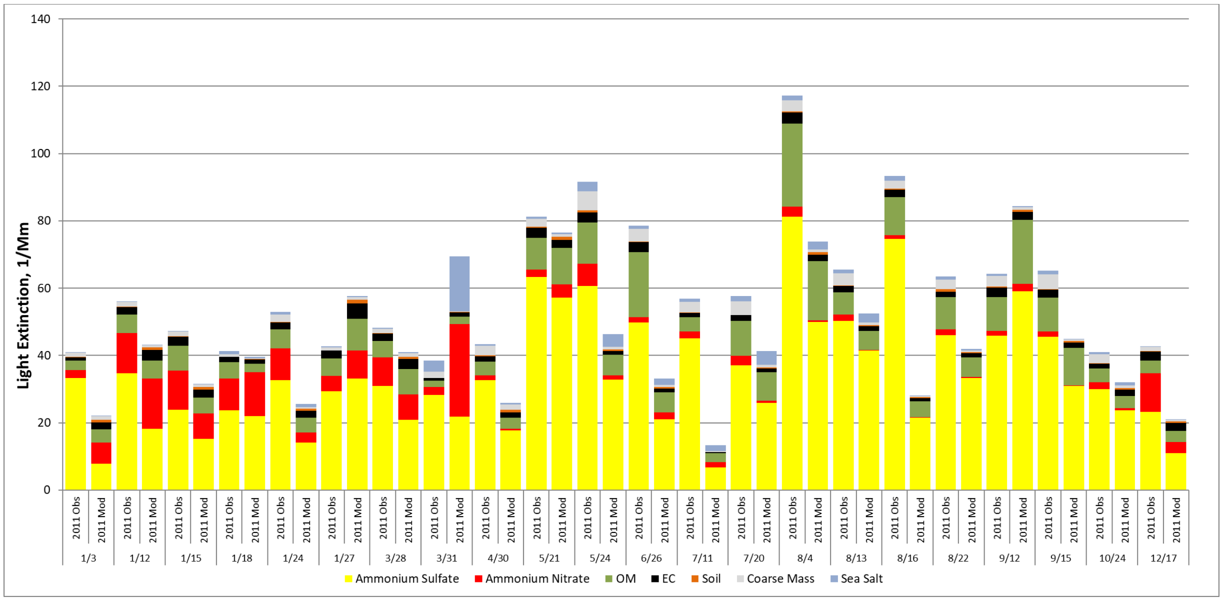

Figure 6-30. Stacked Bar Charts for Light Extinction at Swanquarter Wilderness Area on the 20% Most-Impaired Days: Observation (left) and Modeled (Right)

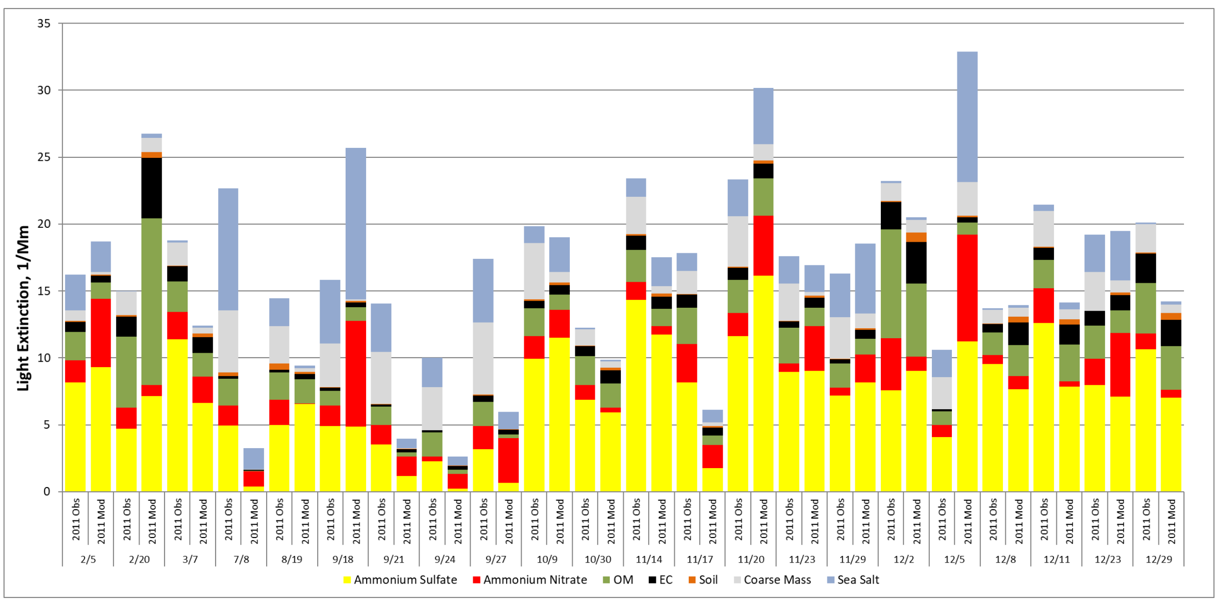

Figure 6-31. Stacked Bar Charts for Light Extinction at Swanquarter Wilderness Area on the 20% Clearest Days: Observation (left) and Modeled (Right)

Figure 6-32 and Figure 6-33 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) for Great Smoky Mountains National Park on the 20% most-impaired days. Nitrate, organic carbon, crustal was generally over predicted, while $PM_{2.5}$, sulfate, and coarse mass were generally under predicted. Elemental carbon, and sea salt show both over predictions and under predictions.

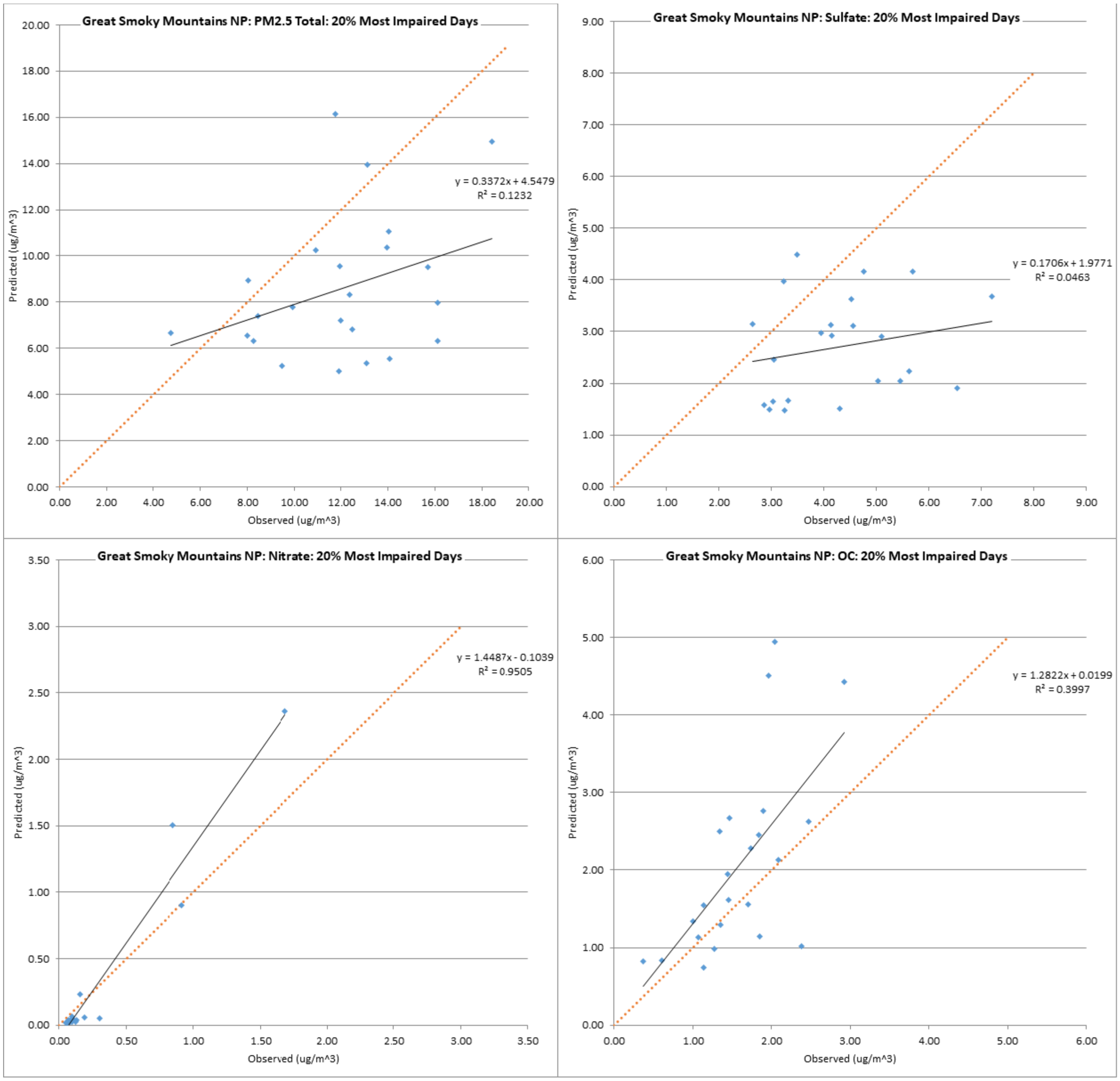

Figure 6-32. Scatter Plot for Daily $PM_{2.5}$ (top left), Sulfate (top right), Nitrate (bottom left), and Organic Carbon (bottom right) Concentrations at Great Smoky Mountains National Park on the 20% Most Impaired Days

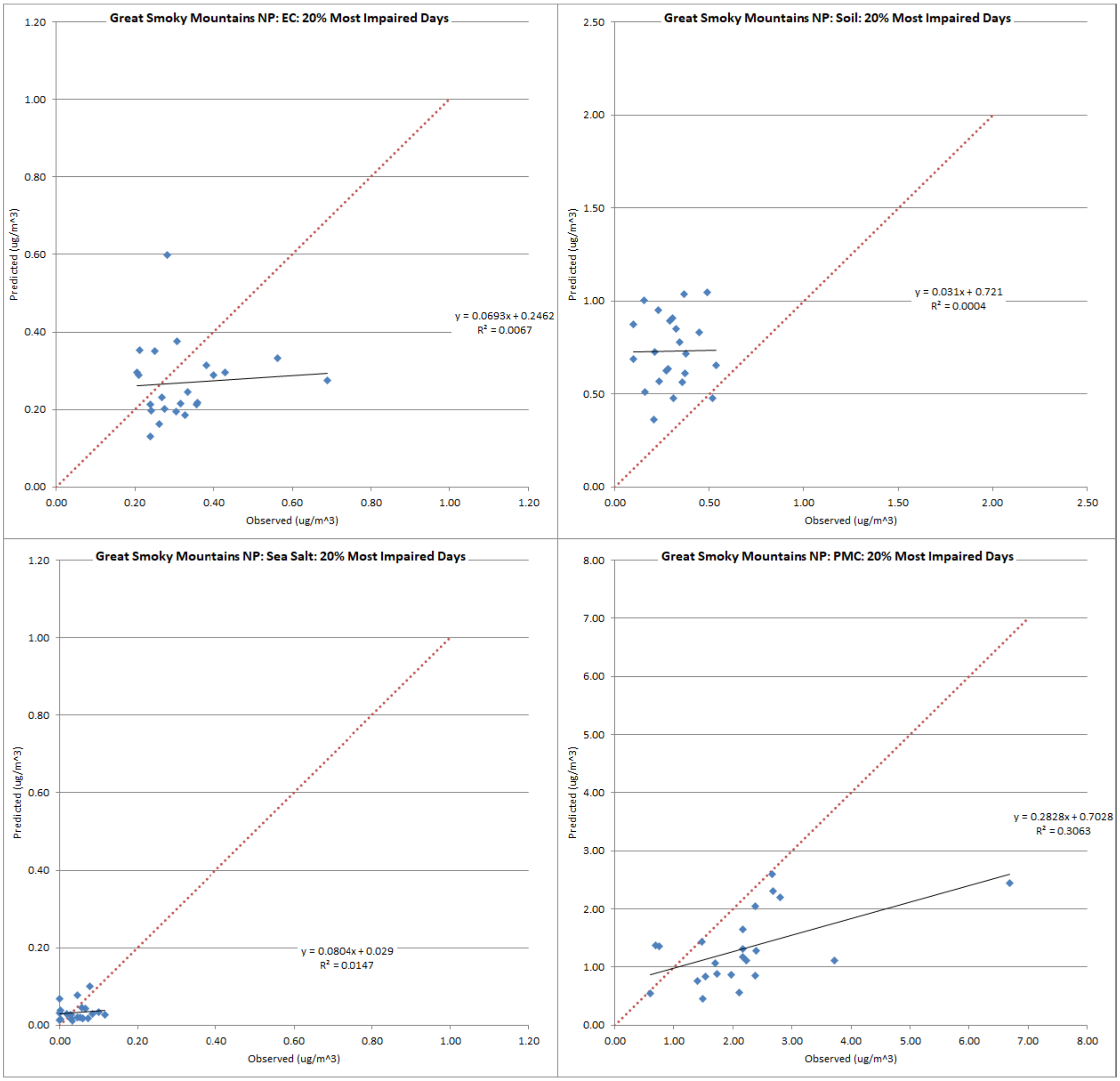

Figure 6-33. Scatter Plot for Daily Elemental Carbon (top left), Crustal (top right), Sea Salt (bottom left), and Coarse Mass (bottom right) Concentrations at Great Smoky Mountains National Park on the 20% Most Impaired Days

Figure 6-34 and Figure 6-35 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) for Great Smoky Mountains National Park on the 20% clearest days. $PM_{2.5}$, nitrate, elemental carbon, and crustal were generally over predicted. Sulfate, organic carbon, sea salt, and coarse mass show both over predictions and under predictions.

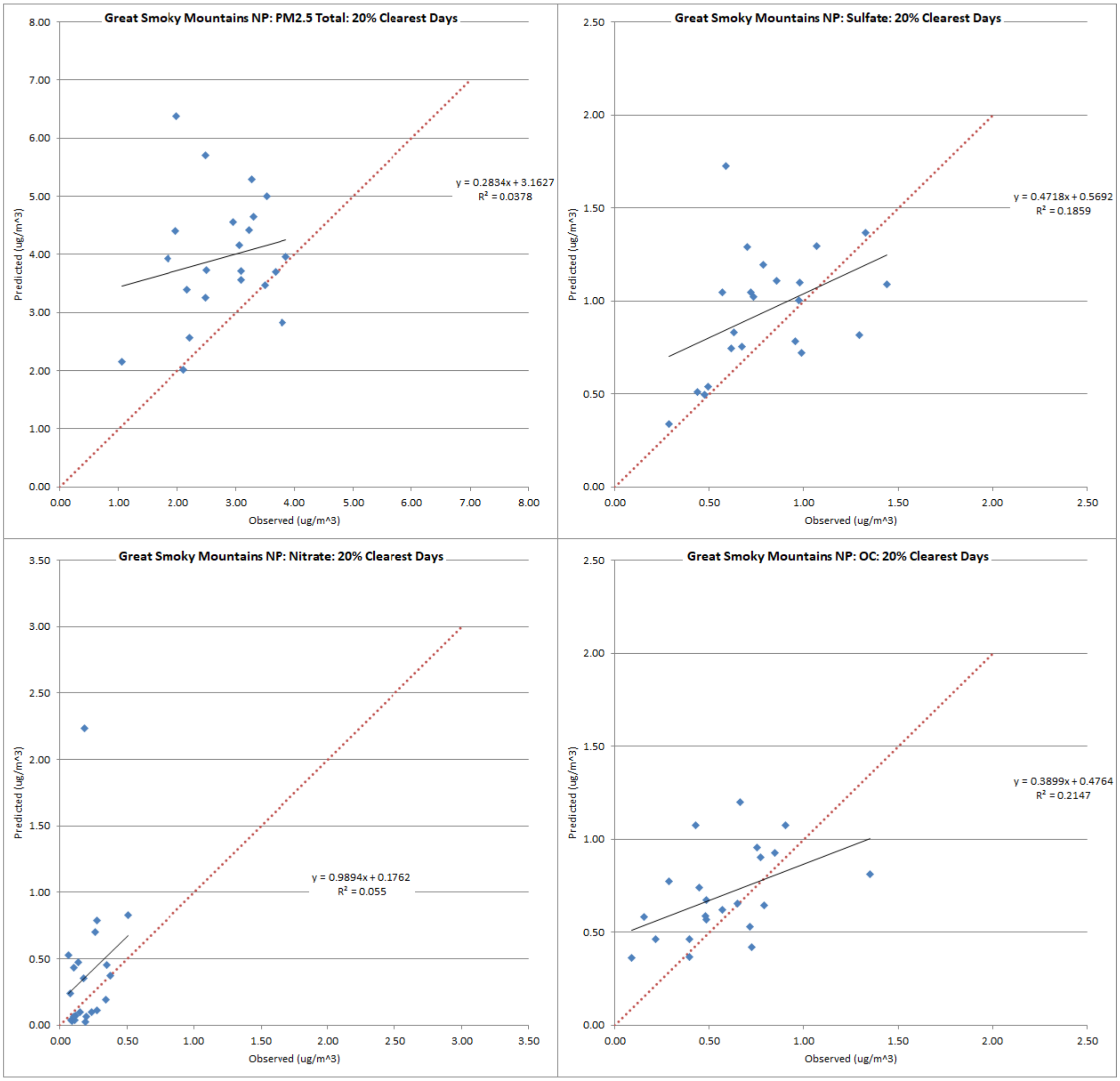

Figure 6-34. Scatter Plot for Daily $PM_{2.5}$ (top left), Sulfate (top right), Nitrate (bottom left), and Organic Carbon (bottom right) Concentrations at Great Smoky Mountains National Park on the 20% Clearest Days.

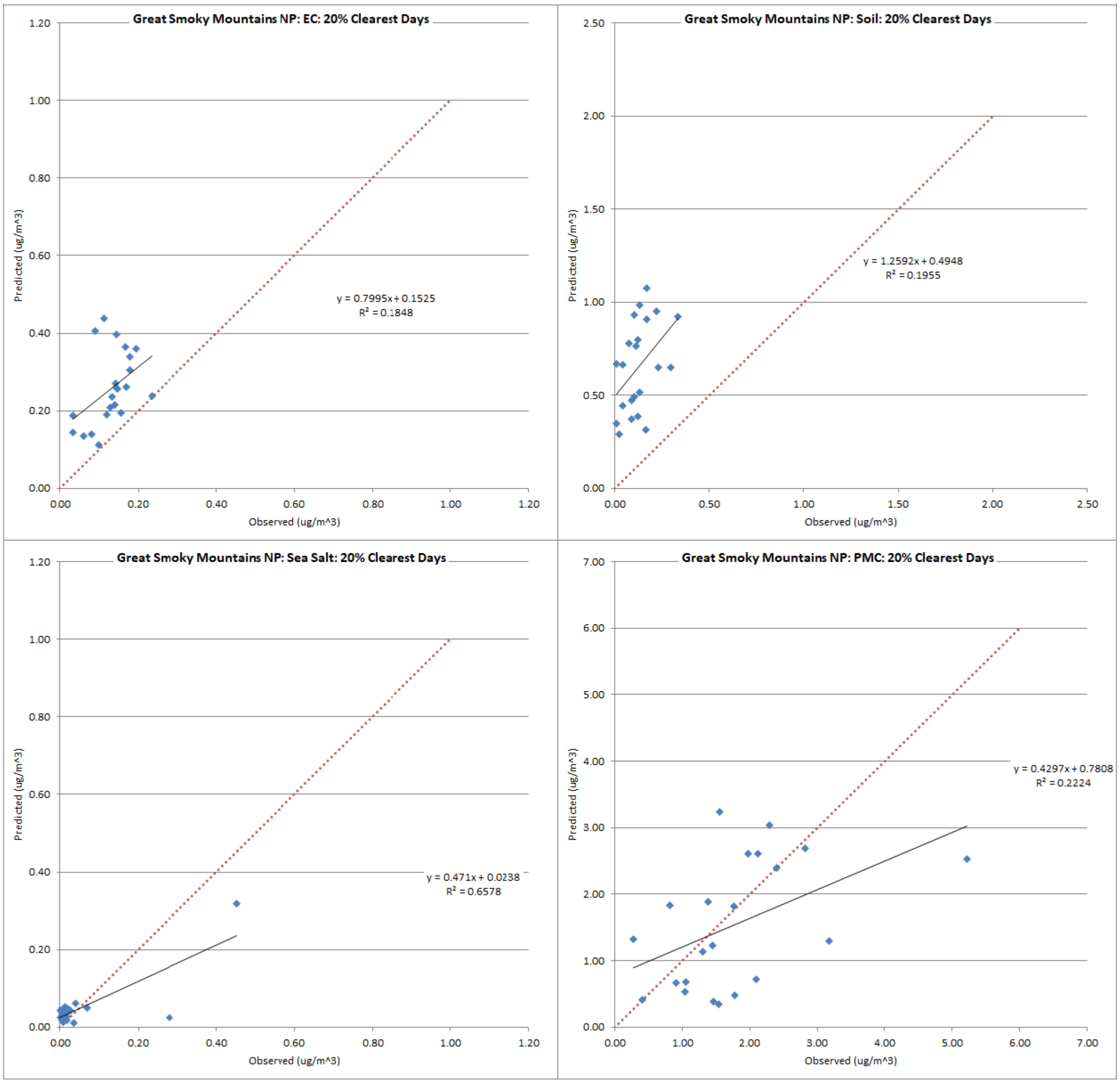

Figure 6-35 Scatter Plot for Daily Elemental Carbon (top left), Crustal (top right), Sea Salt (bottom left), and Coarse Mass (bottom right) Concentrations at Great Smoky Mountains National Park on the 20% Clearest Days

Figure 6-36 and Figure 6-37 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) for Linville Gorge Wilderness Area on the 20% most impaired days. Nitrate, crustal, and organic carbon was generally over predicted, while $PM_{2.5}$, sulfate, elemental carbon and coarse mass was generally under predicted. Organic carbon and sea salt show both over predictions and under predictions.

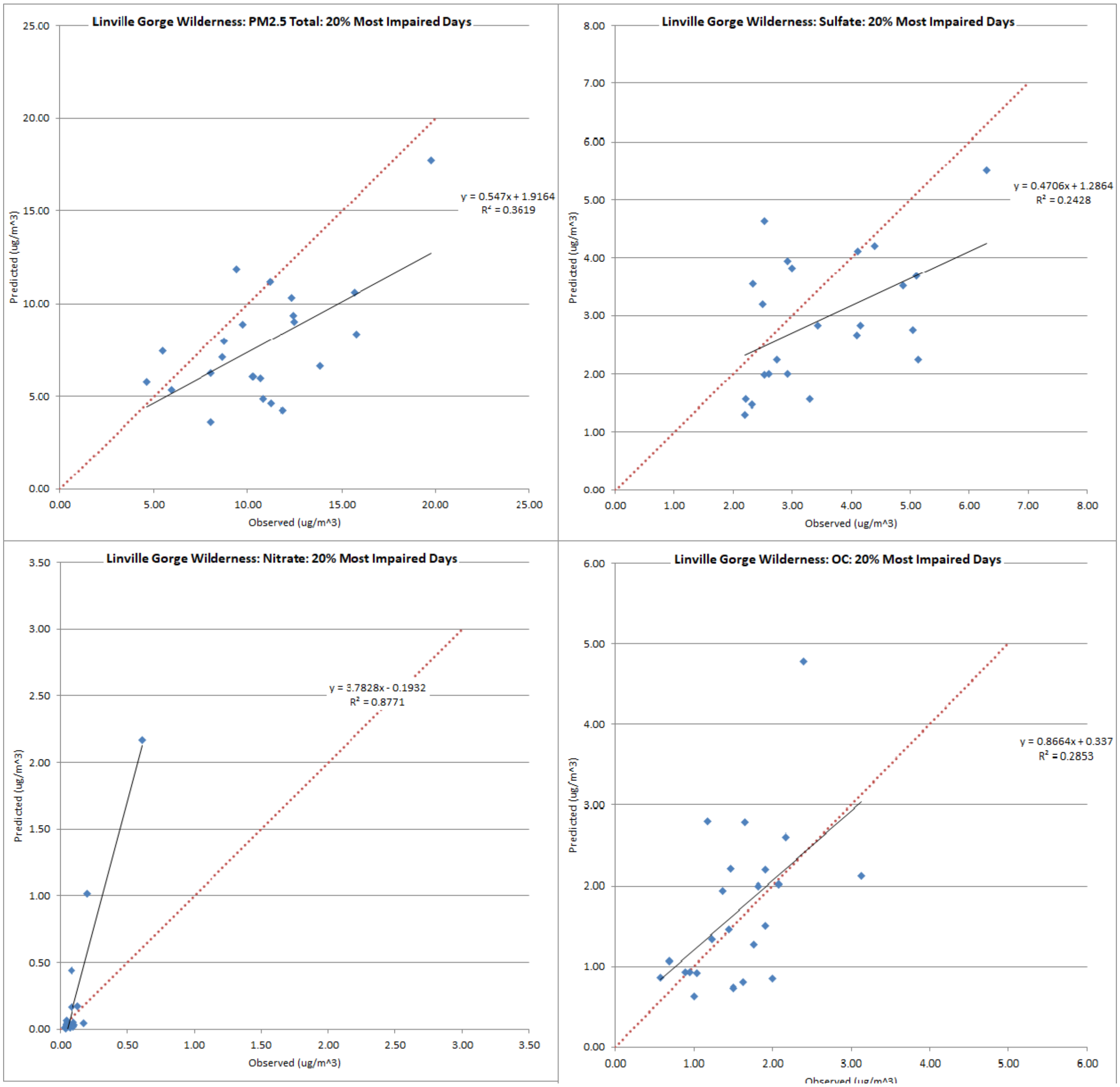

Figure 6-36. Scatter Plot for Daily $PM_{2.5}$ (top left), Sulfate (top right), Nitrate (bottom left), and Organic Carbon (bottom right) Concentrations at Linville Gorge Wilderness Area on the 20% Most Impaired Days

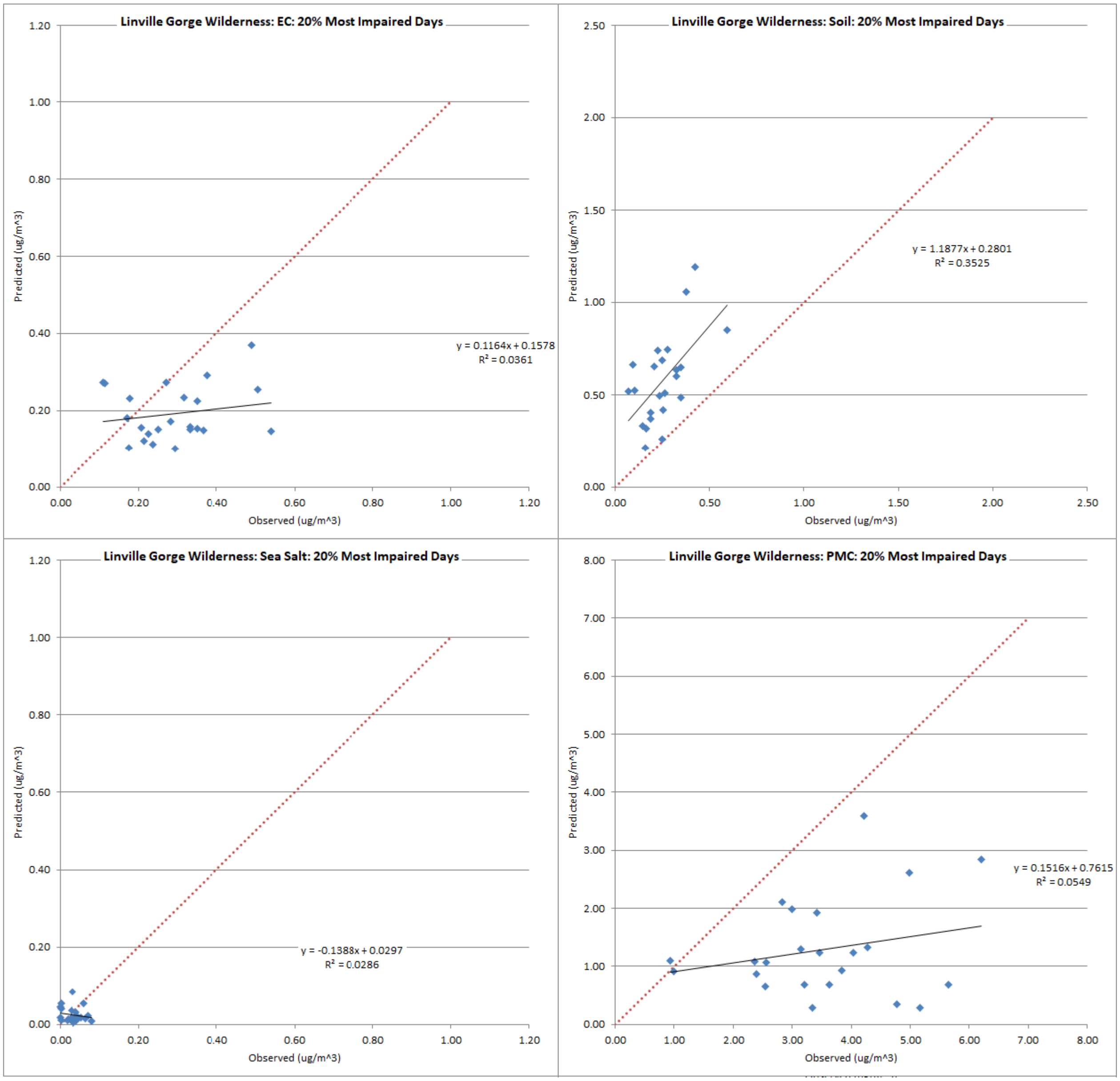

Figure 6-37. Scatter Plot for Daily Elemental Carbon (top left), Crustal (top right), Sea Salt (bottom left), and Coarse Mass (bottom right) Concentrations at Linville Gorge Wilderness Area on the 20% Most Impaired Days

Figure 6-38 and Figure 6-39 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) for Linville Gorge Wilderness Area on the 20% clearest days. $PM_{2.5}$, sulfate, nitrate, elemental carbon, and crustal were generally over predicted. Organic carbon, sea salt, and coarse mass show both over predictions and under predictions.

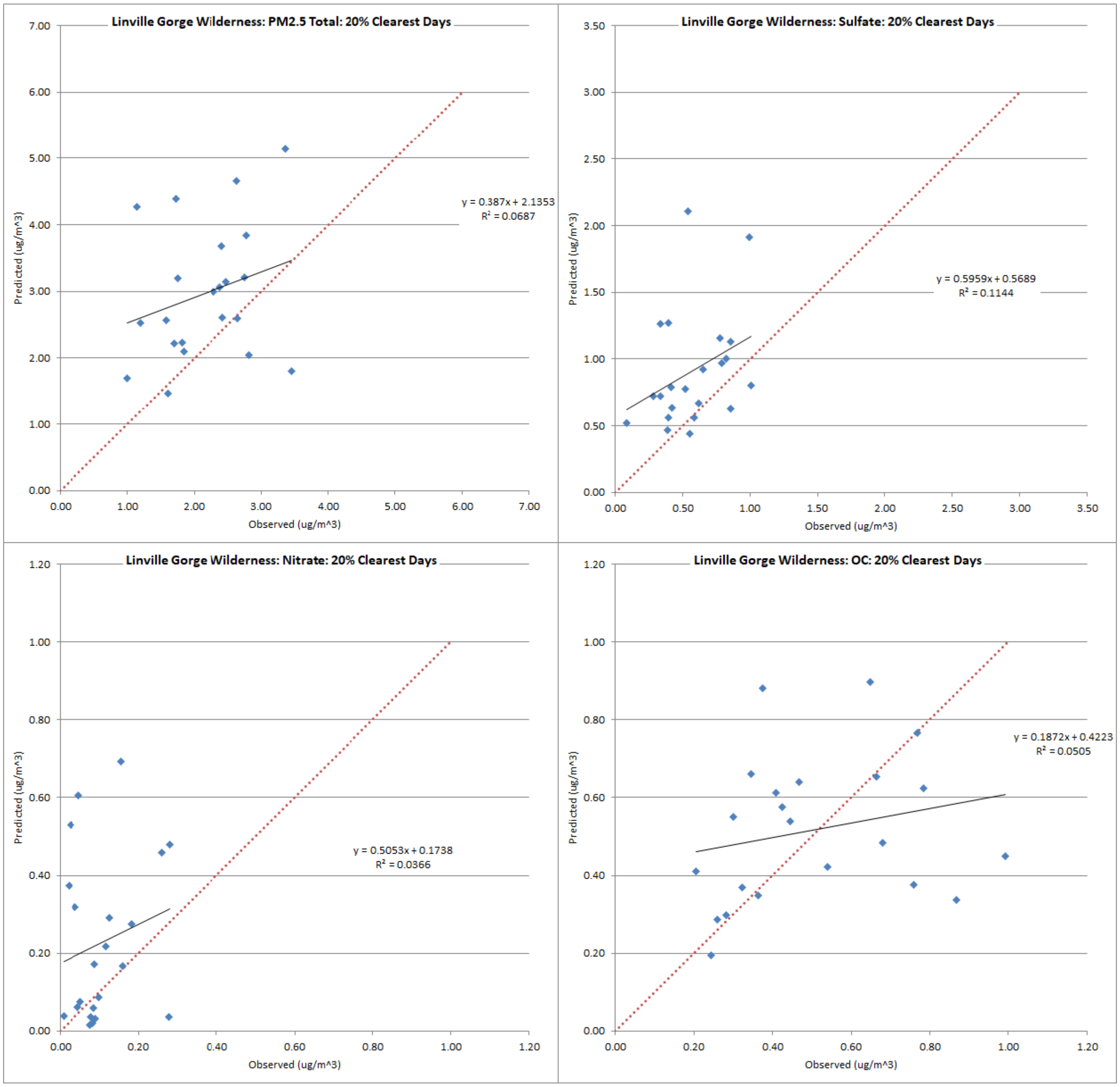

Figure 6-38. Scatter Plot for Daily $PM_{2.5}$ (top left), Sulfate (top right), Nitrate (bottom left), and Organic Carbon (bottom right) Concentrations at Linville Gorge Wilderness Area on the 20% Clearest Days

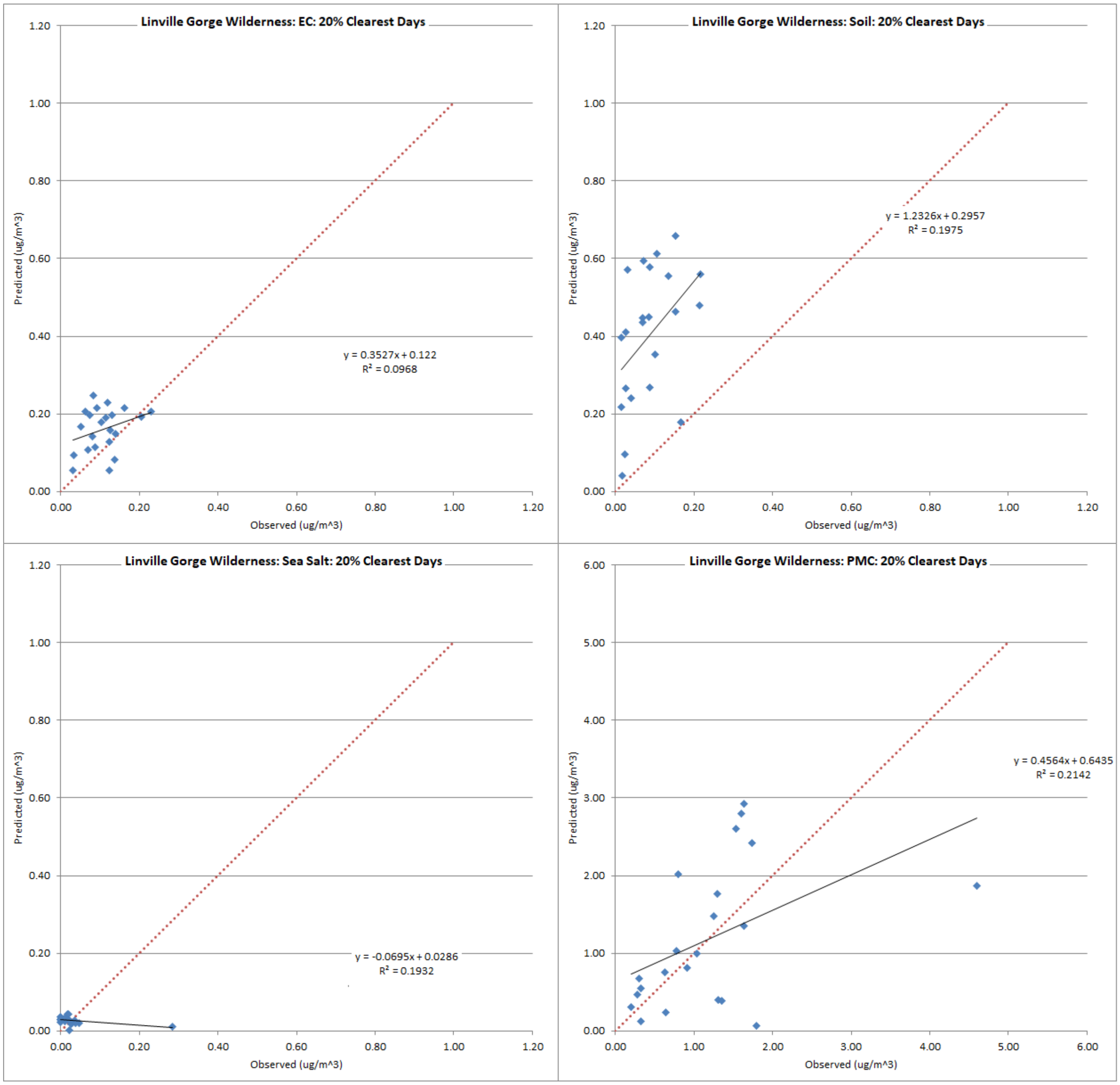

Figure 6-39. Scatter Plot for Daily Elemental Carbon (top left), Crustal (top right), Sea Salt (bottom left), and Coarse Mass (bottom right) Concentrations at Linville Gorge Wilderness Area on the 20% Clearest Days

Figure 6-40 and Figure 6-41 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) for Swanquarter Wilderness Area on the 20% clearest days. Sulfate and coarse mass were generally under predicted while sea salt was generally over predicted. $PM_{2.5}$, nitrate, organic carbon, elemental carbon, and crustal show both over predictions and under predictions.

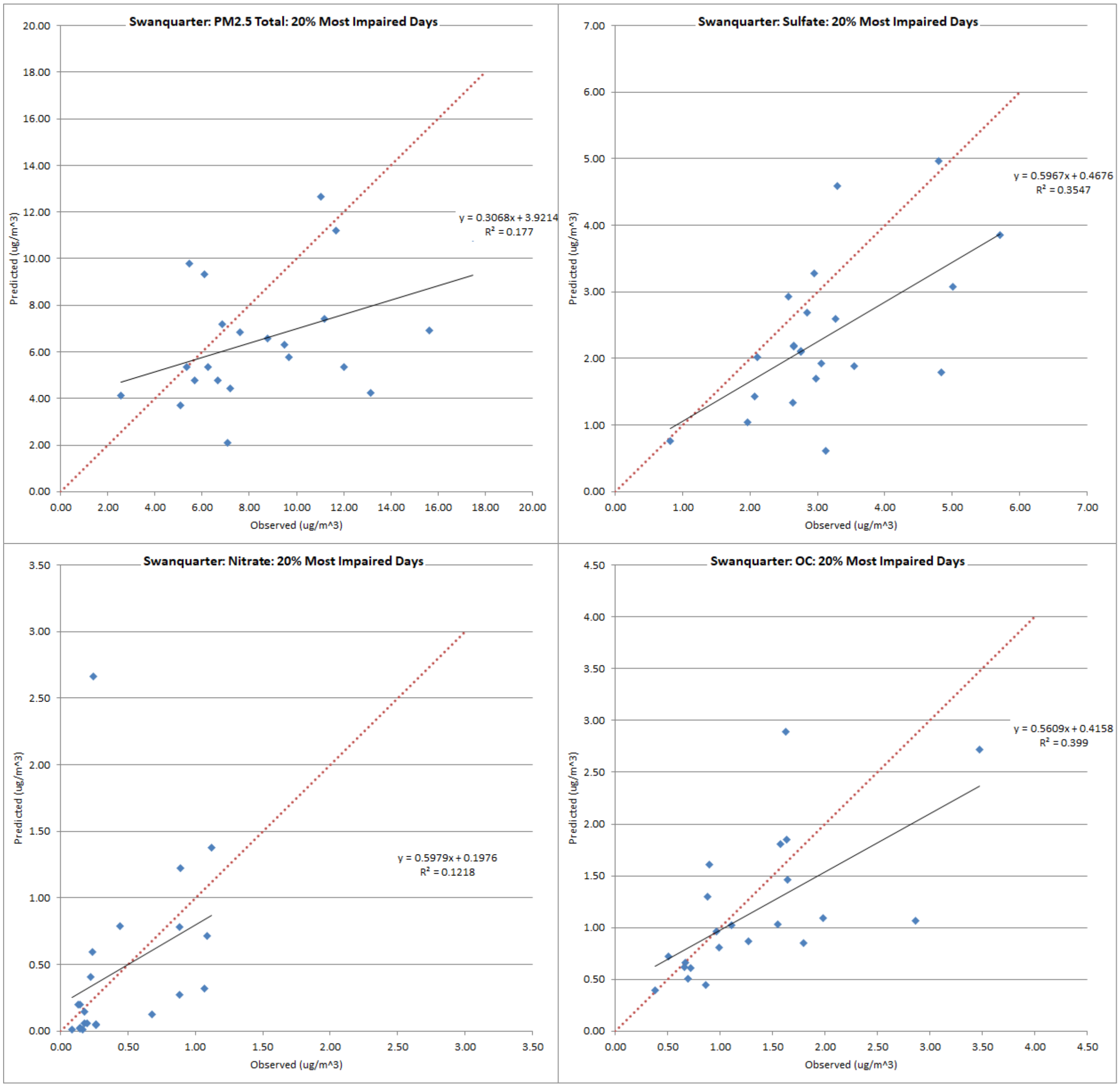

Figure 6-40. Scatter Plot for Daily $PM_{2.5}$ (top left), Sulfate (top right), Nitrate (bottom left), and Organic Carbon (bottom right) Concentrations at Swanquarter Wilderness Area on the 20% Most Impaired Days

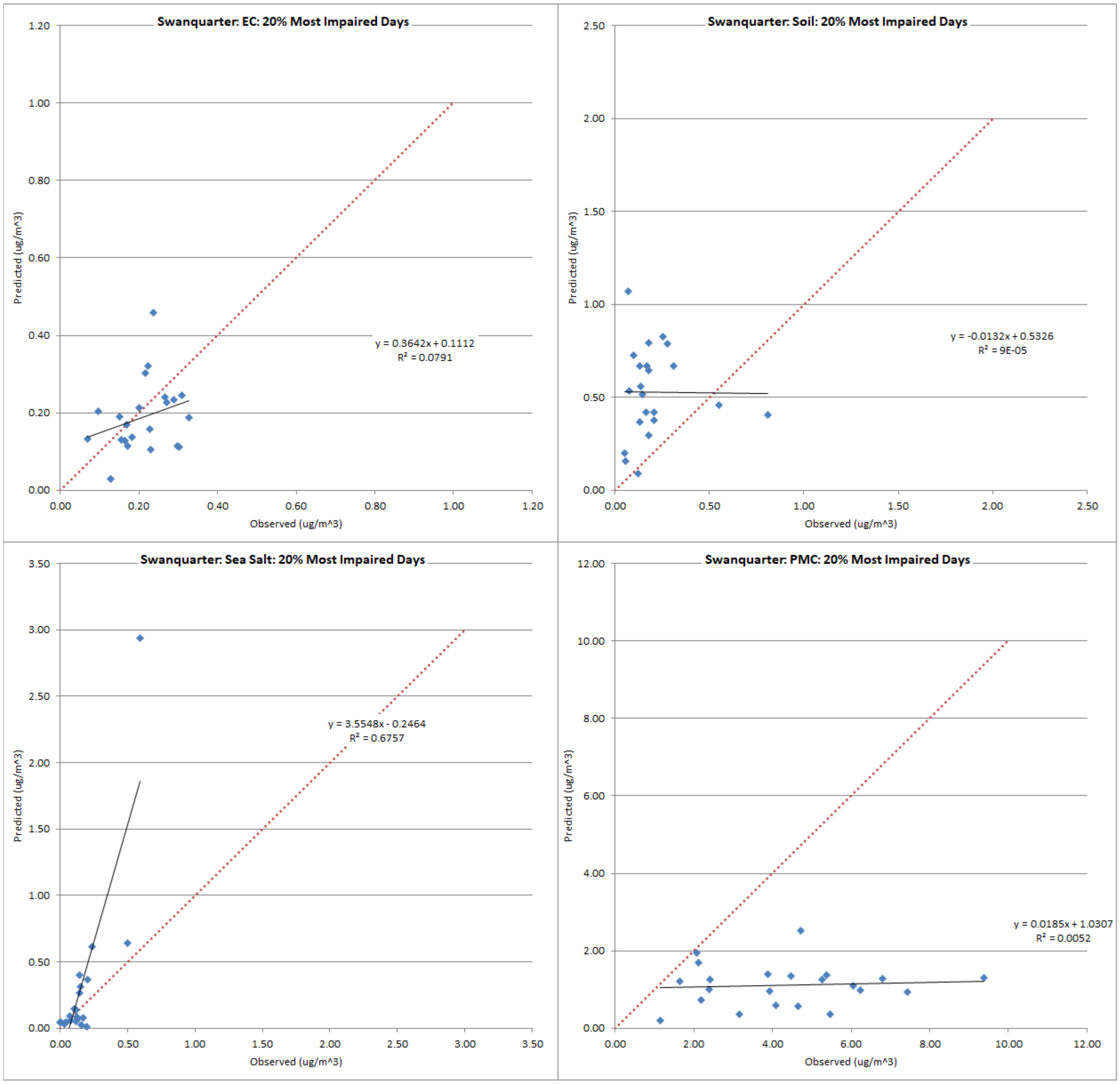

Figure 6-41. Scatter Plot for Daily Elemental Carbon (top left), Crustal (top right), Sea Salt (bottom left), and Coarse Mass (bottom right) Concentrations at Swanquarter Wilderness Area on the 20% Most Impaired Days

Figure 6-42 and Figure 6-43 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) for Swanquarter Wilderness Area on the 20% clearest days. Elemental Carbon was generally overpredicted while coarse mass was generally underpredicted. $PM_{2.5}$, sulfate, nitrate, organic carbon, crustal, and sea salt show both over predictions and under predictions.

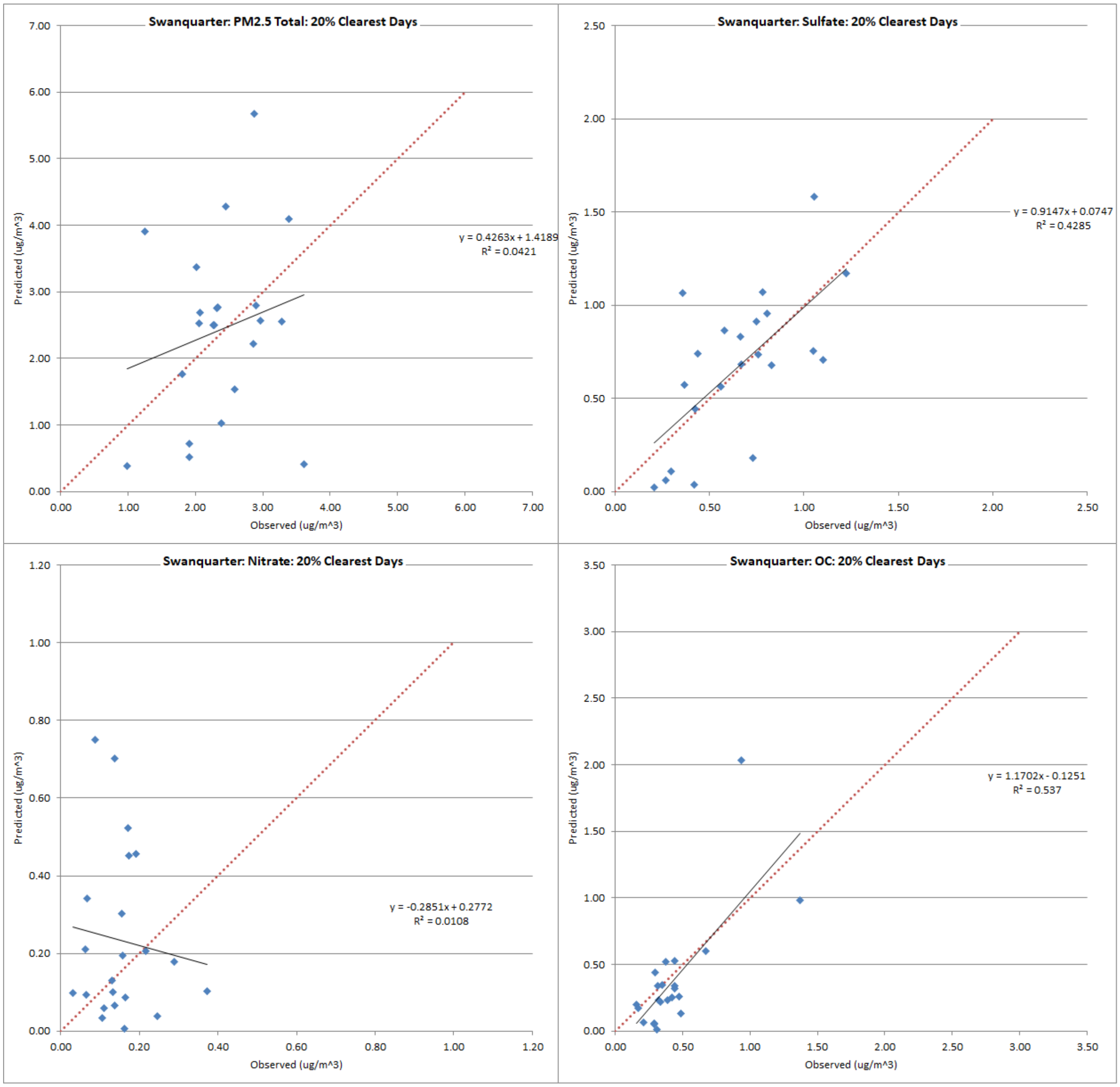

Figure 6-42. Scatter Plot for Daily $PM_{2.5}$ (top left), Sulfate (top right), Nitrate (bottom left), and Organic Carbon (bottom right) Concentrations at Swanquarter Wilderness Area on the 20% Clearest Days

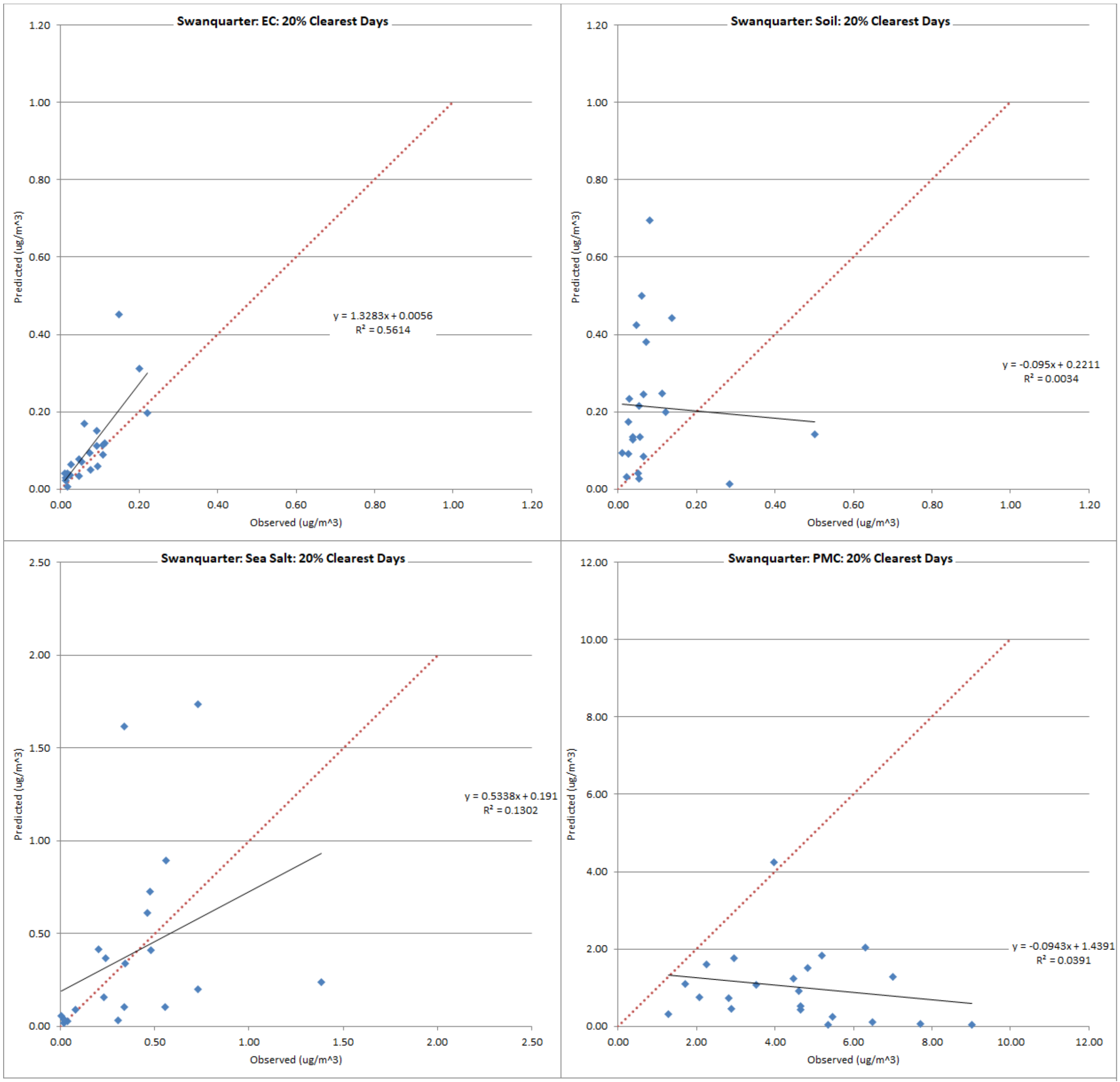

Figure 6-43. Scatter Plot for Daily Elemental Carbon (top left), Crustal (top right), Sea Salt (bottom left), and Coarse Mass (bottom right) Concentrations at Swanquarter Wilderness Area on the 20% Clearest Days

Figure 6-44 through Figure 6-49 are soccer plots showing NMB and NME for modeled sulfate, nitrate, organic carbon, elemental carbon, crustal, and coarse mass for Great Smoky mountains National Park, Linville Gorge Wilderness Area, and Swanquarter Wilderness Area on the 20% most impaired days and the 20% clearest days. For Great Smoky Mountains National Park 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. For Great Smoky Mountains National Park on the 20% clearest days, sulfate, organic carbon, and coarse mass meet the NMB and NME criteria while nitrate, elemental carbon, and crustal do not. For Linville Gorge Wilderness Area on the 20% most impaired days, sulfate, organic carbon, elemental carbon, and coarse mass meet the NMB and NME criteria while nitrate and crustal do not. For Linville Gorge Wilderness Area 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. For Swanquarter Wilderness Area on the 20% most impaired days, sulfate, nitrate, organic carbon, and elemental carbon meet the NMB and NME criteria while coarse mass and crustal do not. For Swanquarter Wilderness Area on the 20% clearest days, sulfate, nitrate, organic carbon, and elemental carbon meet the NMB and NME criteria while coarse mass and crustal do not.

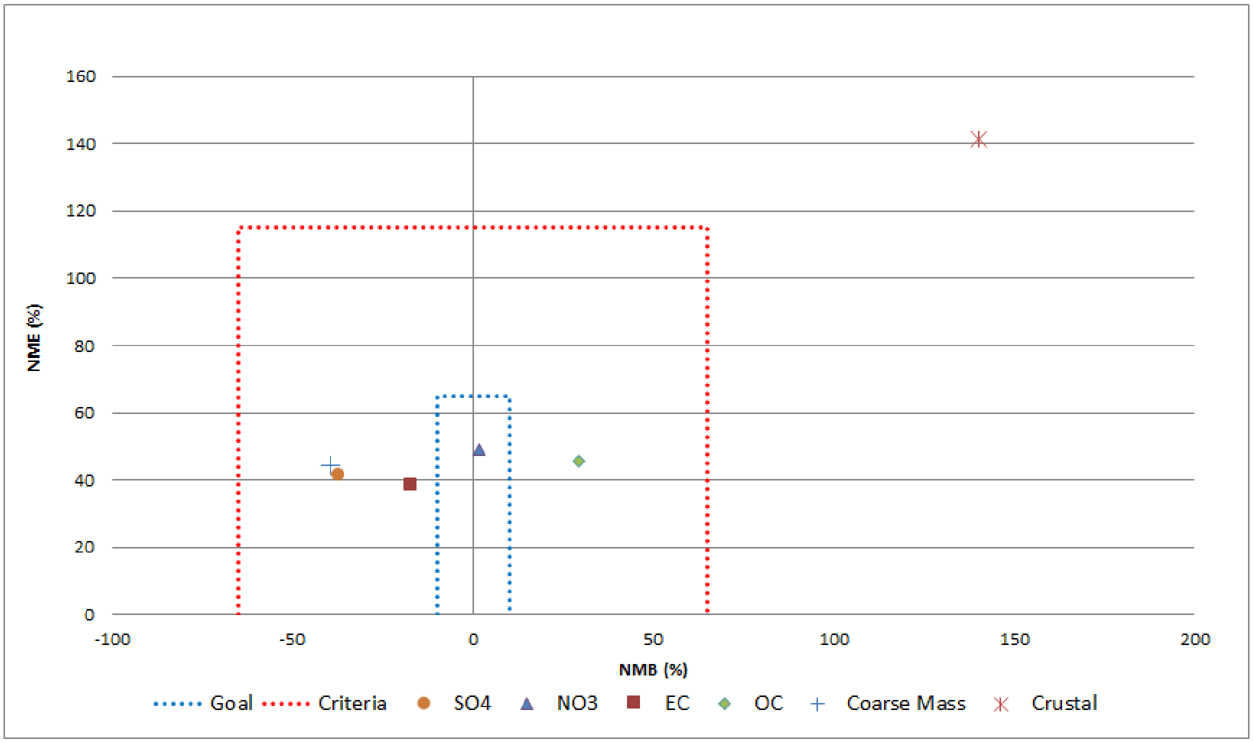

Figure 6-44. Soccer Plot for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Most Impaired Days at Great Smoky Mountains National Park

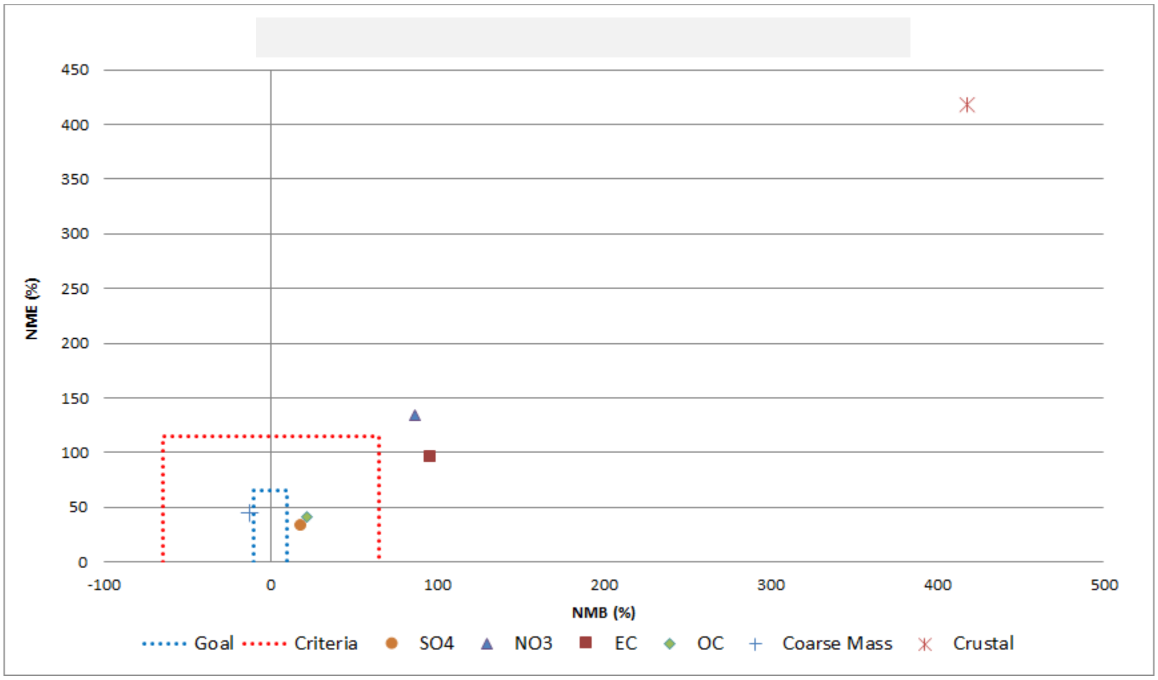

Figure 6-45. Soccer Plot for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Clearest Days at Great Smoky Mountains National Park

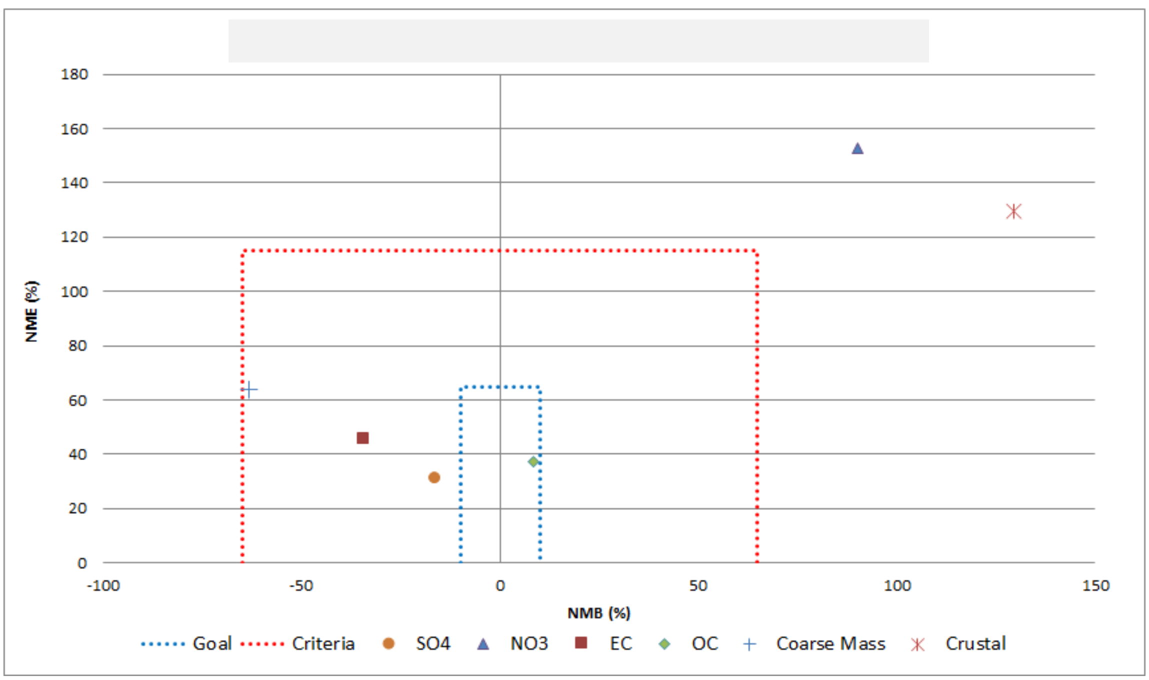

Figure 6-46. Soccer Plot for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Most Impaired Days at Linville Gorge Wilderness Area

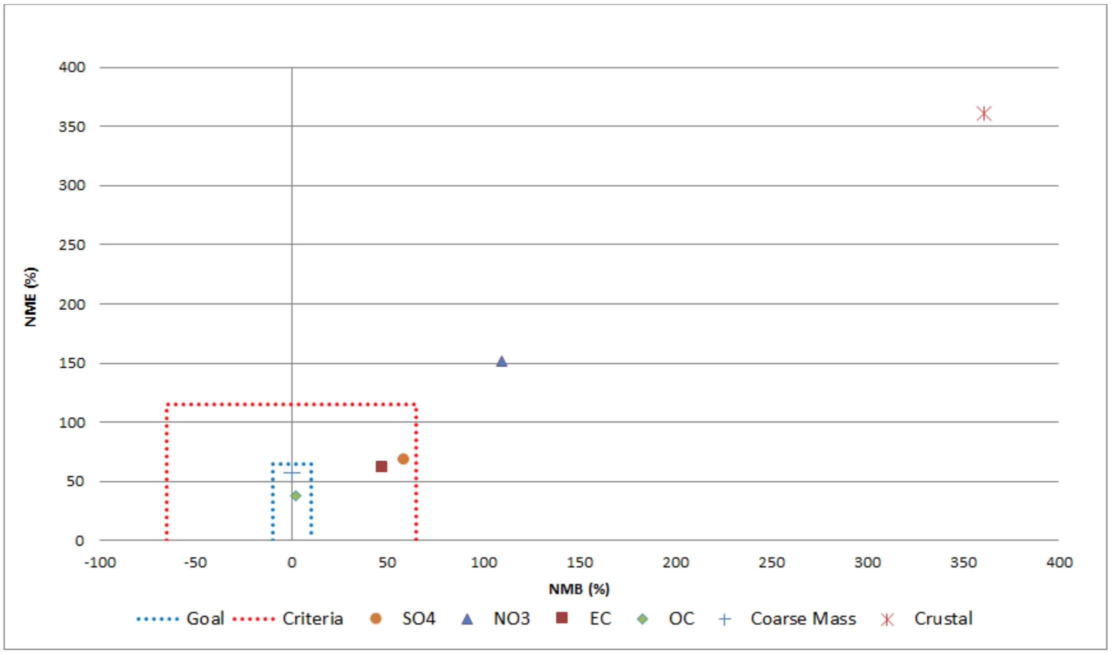

Figure 6-47. Soccer Plot for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Clearest Days at Linville Gorge Wilderness Area

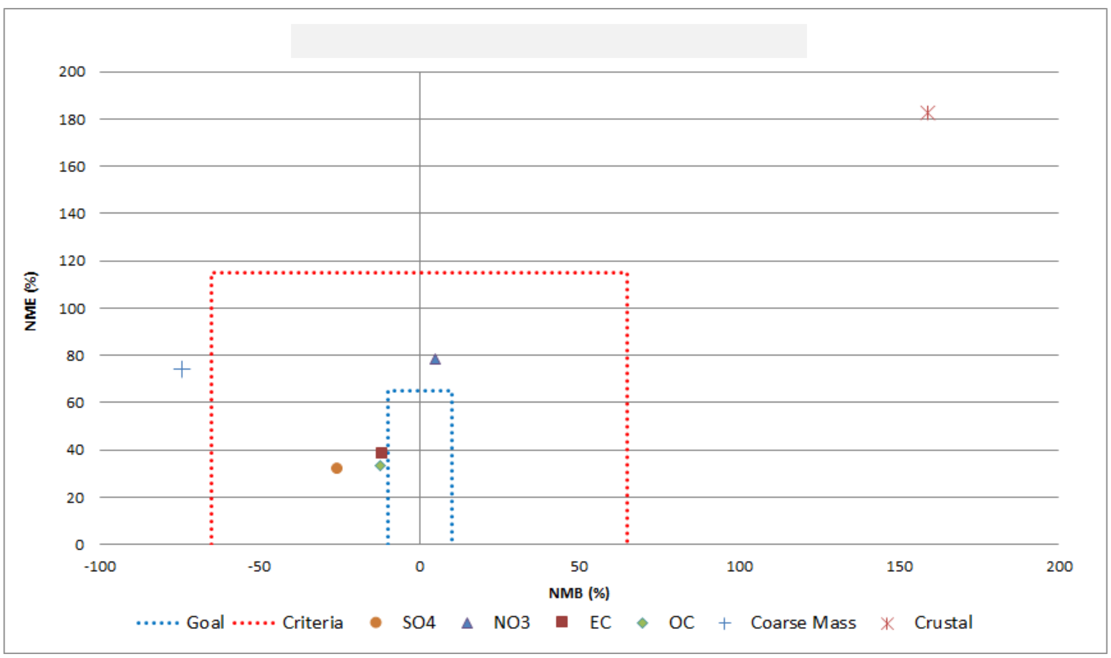

Figure 6-48. Soccer Plot for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Most Impaired Days at Swanquarter Wilderness Area

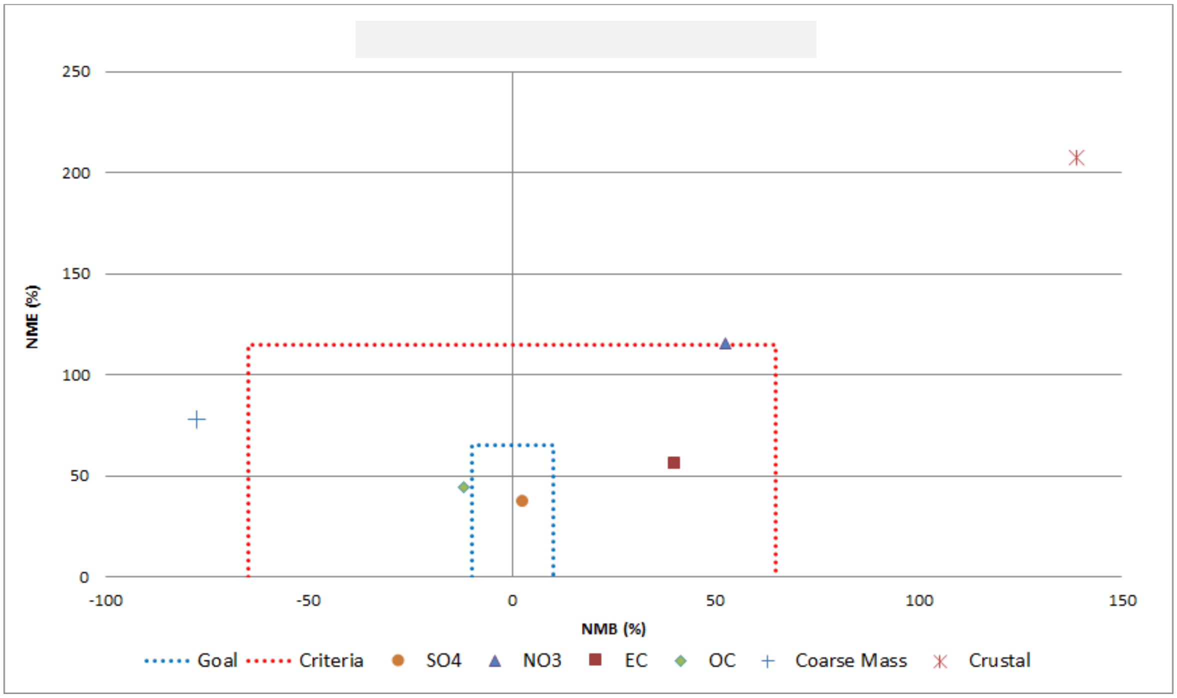

Figure 6-49. Soccer Plot for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Clearest Days at Swanquarter Wilderness Area

Figure 6-50 and Figure 6-51 are bugle plots showing MFB and MFE for modeled sulfate, nitrate, organic carbon, elemental carbon, crustal, and coarse mass for Great Smoky Mountains National Park on the 20% most impaired days and the 20% clearest days. On the 20% most impaired days, all species meet the MFB and MFE criteria (red line). On the 20% clearest days, all species meet the MFB and MFE goal (green line) and criteria (red line).

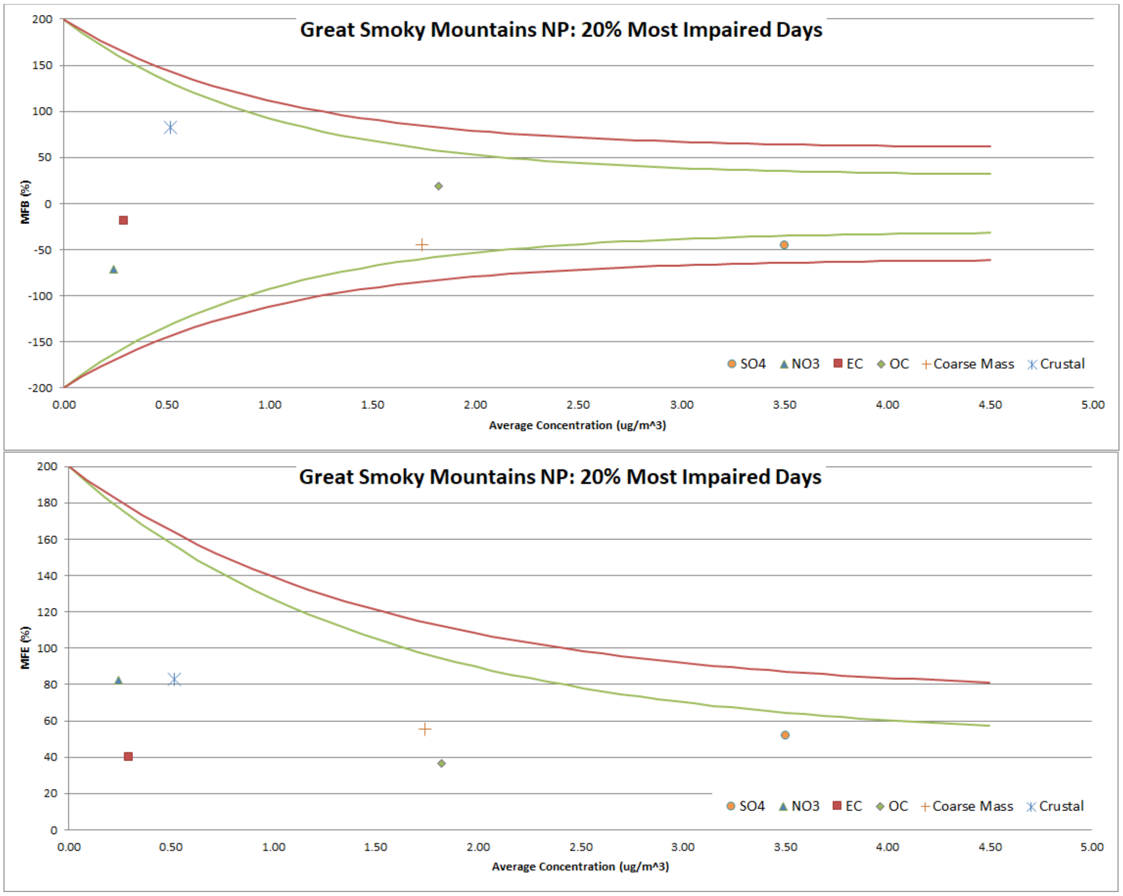

Figure 6-50. Bugle Plots of MFB (top) and MFE (bottom) for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Most Impaired Days at Great Smoky Mountains National Park

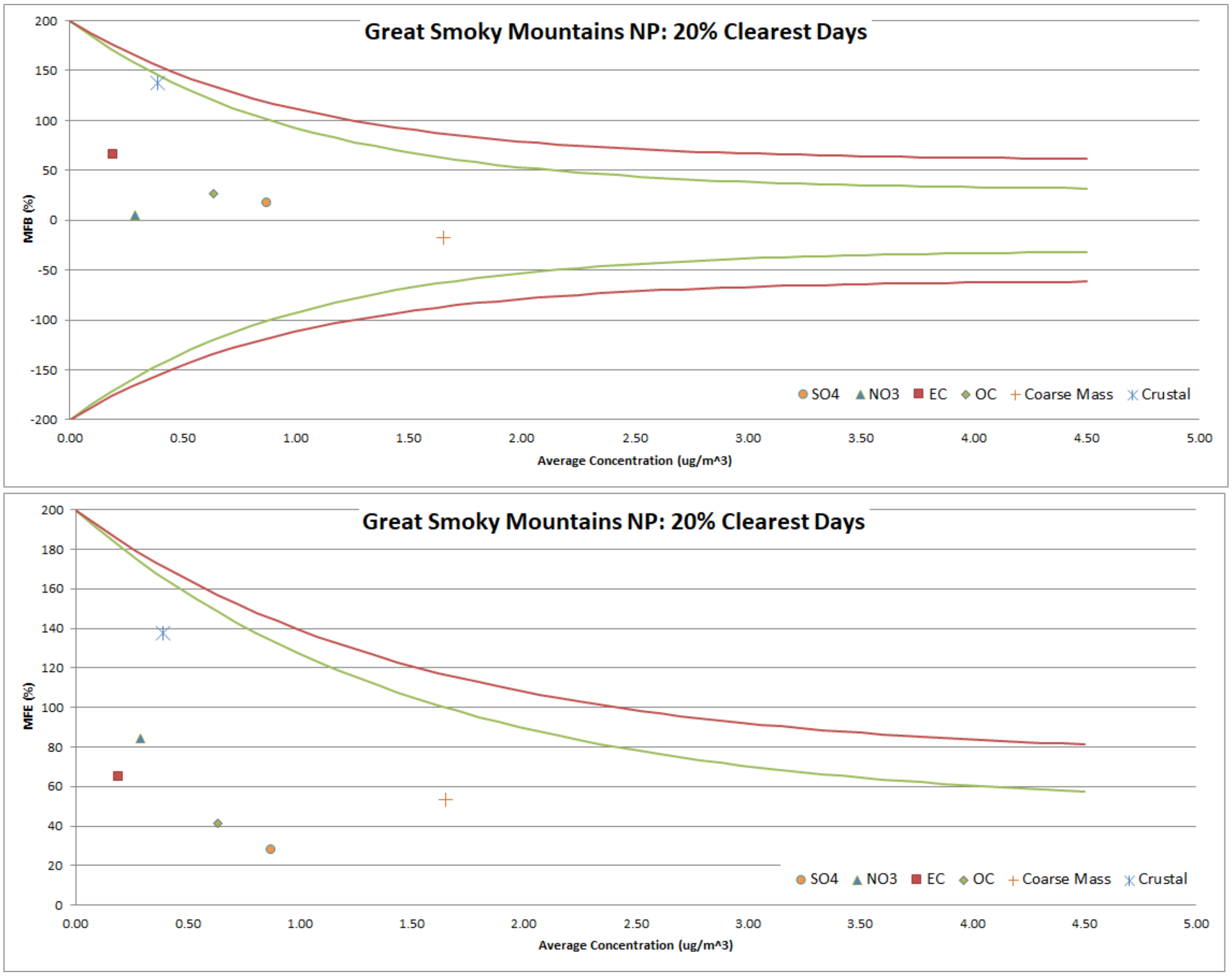

Figure 6-51. Bugle Plots of MFB (top) and MFE (bottom) for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Clearest Days at Great Smoky Mountains National Park

Figure 6-52 and Figure 6-53 are bugle plots showing MFB and MFE for modeled sulfate, nitrate, organic carbon, elemental carbon, crustal, and coarse mass for Linville Gorge Wilderness Area on the 20% most impaired days and the 20% clearest days. On the 20% most impaired days, sulfate, nitrate, elemental carbon, organic carbon, and crustal meet the MFB criteria (red line) while coarse mass does not. On the 20% most impaired days, all species meet the MFE criteria (red line). On the 20% clearest days, all species meet the MFB criteria (red line) and MFE goal (green line).

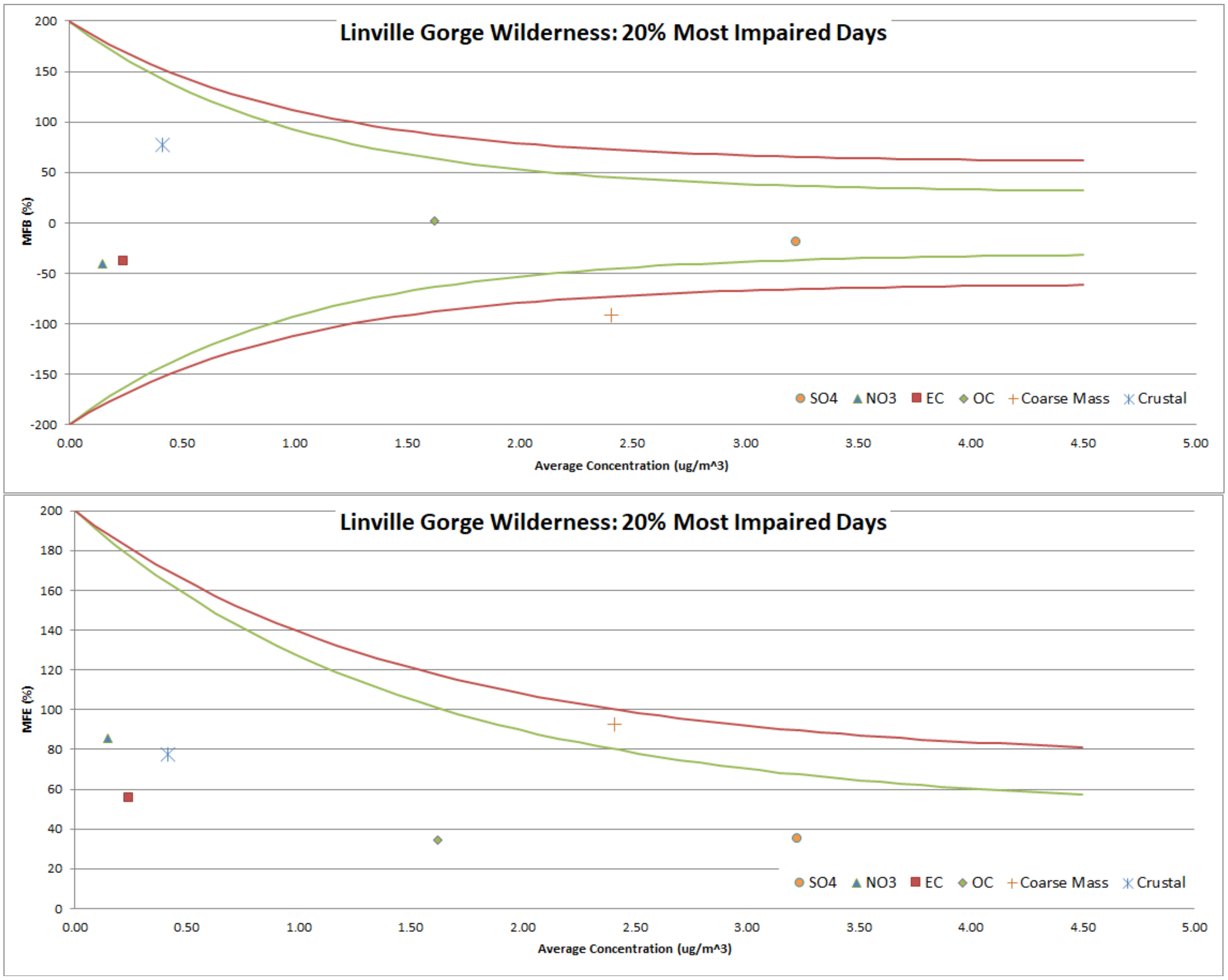

Figure 6-52. Bugle Plots of MFB (top) and MFE (bottom) for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Most Impaired Days at Linville Gorge Wilderness Area

Figure 6-53. Bugle Plots of MFB (top) and MFE (bottom) for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Clearest Days at Linville Gorge Wilderness Area

Figure 6-54 and Figure 6-55 are bugle plots showing MFB and MFE for modeled sulfate, nitrate, organic carbon, elemental carbon, crustal, and coarse mass for Swanquarter Wilderness Area on the 20% most impaired days and the 20% clearest days. On the 20% most impaired days, sulfate, nitrate, elemental carbon, organic carbon, and crustal meet the MFB and MFE criteria (red line) while coarse mass does not. On the 20% clearest days, sulfate, nitrate, elemental carbon, organic carbon, and crustal meet the MFB criteria (red line) and MFE goal (green line), while coarse mass does not.

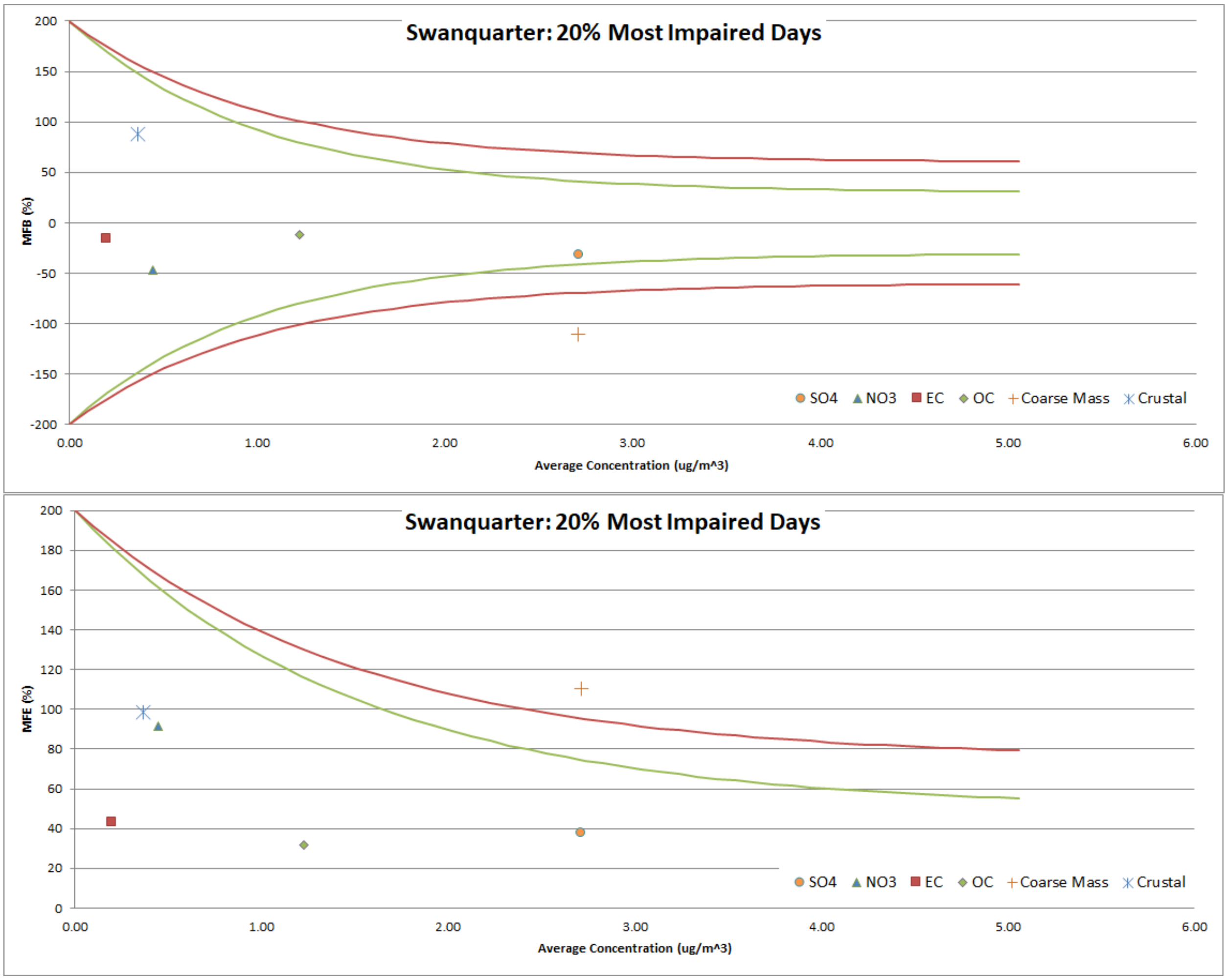

Figure 6-54. Bugle Plots of MFB (top) and MFE (bottom) for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Most Impaired Days at Swanquarter Wilderness Area

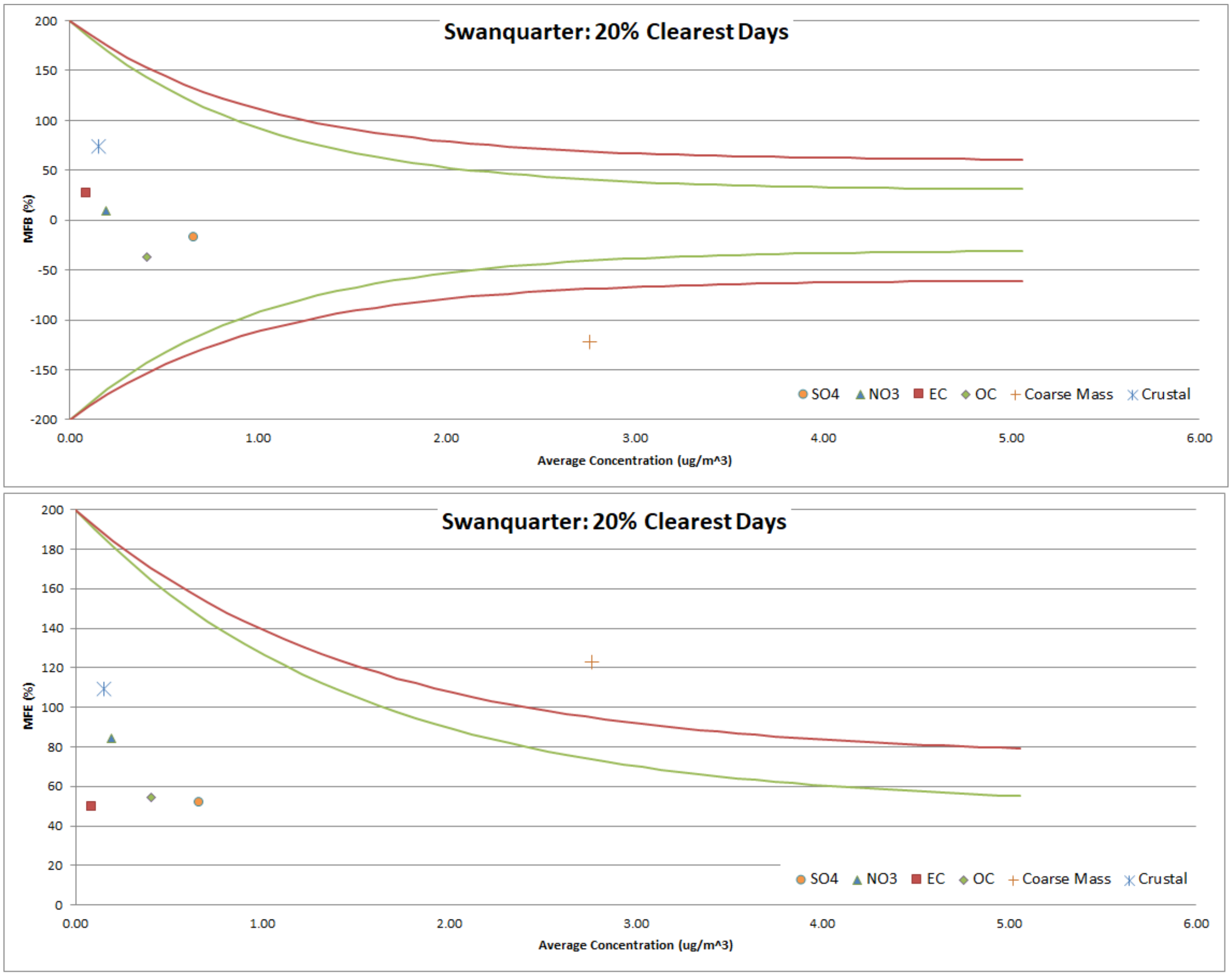

Figure 6-55. Bugle Plots of MFB (top) and MFE (bottom) for Sulfate, Nitrate, Elemental Carbon, Organic Carbon, Coarse Mass, and Crustal Concentrations on the 20% Clearest Days at Swanquarter Wilderness Area

6.6 Summary and Conclusions

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.[61] 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.[62] The EPA recommends that air agencies conduct a variety of performance tests and weigh them qualitatively to assess model performance.[63] In following EPA's guidance, VISTAS evaluated

[61] U.S. EPA, Modeling Guidance for Demonstrating Air Quality Goals for Ozone, $PM_{2.5}$ and Regional Haze, November 29,2018, https://www.epa.gov/sites/production/files/2020-10/documents/o3-pm-rh-modeling_guidance-2018.pdf.
[62] Ibid
[63] Ibid

the model performance statistics for all VISTAS Class I areas collectively. For example, Table 6-10 shows sulfate model performance statistics for the Class I areas in VISTAS and Class I areas closely surrounding VISTAS. The criterion for each statistic presented in Table 6-6 and Table 6-7 is listed in the first row of Table 6-10. The values highlighted in red in Table 6-10 indicate that the criteria were not met. 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 and the last row shows the average of all VISTAS Class I areas. Of the five statistics listed in the table, the NMB was only slightly outside of the criteria based on the overall average for all the Class I areas and the overall average for the VISTAS Class I areas. The other four statistics meet the criteria.

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

Class I Area	#Observations	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	-70.20	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	43.10	0.20
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	0.70
James River Face	24	-36.62	-44.57	36.89	44.88	0.52
Linville Gorge	23	-16.32	-19.66	30.87	35.20	0.49
Mammoth Cave	23	-38.26	-48.89	38.27	48.91	0.80
Mingo	19	-31.40	-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	48.30	65.37	0.37
Shenandoah	24	-24.34	-30.57	29.31	35.53	0.74
Shining Rock[64]	0	--	--	--	--	--
Sipsey	19	-35.37	-43.37	35.37	43.37	0.75
Swanquarter	22	-25.28	-32.13	31.56	37.56	0.60
Upper Buffalo	23	-17.00	-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**

In addition, when comparing modeled and observed values for individual monitors, bias and error are generally mitigated when using the RRF approach to estimate future-year impairment. The RRF method is used to estimate the percent change in each PM species associated with changes in emissions from the 2011 base year to the 2028 projection year. Thus, under or over

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

predictions of modeled concentrations for individual monitors are canceled when using the RRF approach. Furthermore, since it is important to estimate the change in visibility impairment from the base to the future year, it is important to hold other factors constant (e.g., temporal profiles for emissions sources) when applying the RRF approach.[65] For the VISTAS modeling, the percent change in PM species concentrations from 2011 to 2028 were applied to the 5-year average of observed speciated data, centered on the modeled base year (i.e., 2009 – 2013), to estimate the projected future year visibility impairment for each Class I area with an IMPROVE monitor. Use of the RRF approach applied to five years of monitoring data provides a reasonable estimate of future visibility impairment for Class I areas.

Overall, based on the weight of evidence approach recommended by EPA's photochemical grid modeling guidance, model performance at the "one atmosphere" level was deemed acceptable for ozone, wet/dry deposition, and PM species at various monitoring sites. The NCDAQ concludes that the one atmosphere modeling performed by VISTAS is representative of conditions in the southeastern states and is acceptable for use in regulatory modeling applications for ozone, PM, and regional haze for Class I areas in North Carolina.

[65] An exception would be if for an emissions source the permit is revised after the 2011 base year in a way that would change the temporal profile of how the emissions source is operated (e.g., only requiring a control on the source to be operated seasonally. For this situation, it would be appropriate to change the temporal profile in the future year to reflect how the control is operated on the emission source.

7.0 LONG-TERM STRATEGY (LTS)

Section 40 CFR 51.308(f)(2) of the RHR requires states to submit a long-term strategy (LTS) addressing regional haze visibility impairment for each Class I area within the state and for each Class I area located outside the state that may be affected by emissions from the state. The LTS must include the enforceable emissions limitations, compliance schedules, and other measures that are necessary to demonstrate ongoing progress toward attaining natural conditions for the 20% most impaired days and show no degradation in the 20% clearest days. Section 40 CFR 51.308(f)(3) of the RHR requires that states containing Class I areas establish RPGs expressed in deciviews (dv). These RPGs must reflect the visibility conditions that are projected to be achieved by the end of the applicable planning period as a result of those enforceable emission limitations, compliance schedules, and other measures established as part of the LTS. The RPGs for each Class I area must cover each ten-year planning period. The RPGs, while not directly federally enforceable, must be met through measures contained in the state's LTS through year 2028. This section discusses North Carolina's LTS for the first planning period (2008 – 2018) and the second planning period (2019 – 2028) that builds on the LTS for the first planning period.

7.1 Overview of the LTS Development Process

The monitor data and the modeling analyses included with the first regional haze SIP established that, for the VISTAS region, the key contributors to regional haze in the 2000-2004 baseline timeframe were large stationary sources of SO_2 emissions. In Section 2 of this SIP, Figure 2-1 through Figure 2-4 show the daily visibility data for the 20% most impaired days during the baseline period for North Carolina's Class I areas. Sulfate accounted for the majority of the pollutant impairing species on these days. 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 2-13 through Figure 2-16 of Section 2 of this SIP, sulfate continues to be the predominant visibility impairing species for North Carolina's Class I areas. 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 large organic matter or nitrate impacts at North Carolina's 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 North Carolina's Class I areas during the period 2014 to 2018 continue to be impacted most heavily by sulfate. The 2014 to 2018 IMPROVE data for other VISTAS Class I areas, provided in Appendix C-2, show similar trends. Therefore, reducing SO_2 emissions continues to be important for generating further visibility improvements for the second planning period. Keeping this conclusion in mind, this section addresses the following questions:

- Assuming implementation of existing federal and state air regulatory requirements in North Carolina and the VISTAS region, how much visibility improvement, compared to the glidepath, is expected in each of the Class I areas located in North Carolina by 2028?

- Which mandatory Class I areas located outside of North Carolina are significantly impacted by visibility impairing pollutants originating from within North Carolina?
- 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 Class I area?
- What additional emission controls represent continuing progress for those specific sources?

7.2 Expected Visibility in 2028 for North Carolina's Class I Areas Under Existing and Planned Emissions Control Programs

During the first SIP planning period (2008-2018), North Carolina's LTS along with economic factors resulted in unprecedented SO_2 and NO_x emission reductions that have improved visibility in North Carolina's Class I areas 20 or more years ahead of schedule. North Carolina's LTS for the second planning period (2019-2028) builds on the federal and state programs implemented during the first planning period to maintain and advance the progress achieved to date. Table 7-1 provides a summary of the foundation control programs included in the modeling of the RPGs for the first and second planning periods. Section 7.2.1 summarizes the federal and state control programs included in North Carolina's LTS for the first planning period. Section 7.2.2 summarizes control measures and programs North Carolina has added to its LTS for the second planning period (2019-2028).

Section 7.2.3 addresses Section 51.308(f)(2)(iv) of the RHR that requires states to consider five additional factors when developing the LTS. Section 7.2.4 documents the VISTAS 2028 emissions inventory and Section 7.2.5 discusses how the VISTAS inventory compares to EPA EPA's 2028 inventory. The 2028 RPG modeling projections for North Carolina's Class I areas is discussed in Section 7.2.6.

Section 7.2.7 identifies additional state programs and initiatives that have been supporting or are anticipated to support future emission reductions but are not federally enforceable and therefore not included in North Carolina's LTS. Section 7.2.8 identifies facility closures that occurred after development of the 2028 projection year inventory and modeling upon which North Carolina's RPGs are based. North Carolina has not revised the RPGs for its five Class I areas to account for these emission reductions. However, these additional emission reductions will support progress toward achieving the 2028 RPGs.

Table 7-1. Summary of Foundation Control Programs

Jurisdiction	Control Program	Initial Implementation Year(s)
Control Programs Included in RPG Modeling for First Planning Period (2008-2018)		
Federal	Tier 2 Vehicle and Fuel Standards	2004 - 2009
	Heavy-Duty Gasoline and Diesel Highway Vehicles Standards	2002 - 2010
	Large Nonroad Diesel Engines and Fuel Standards Rule	2007 - 2014
	Nonroad Spark-Ignition Engines and Recreational Engines Standards	2004 - 2012
	Reciprocating Internal Combustion Engines (RICE) National Emissions Standards for Hazardous Air Pollutants (NESHAP)	2013
	NO_x SIP Call, Clean Air Interstate Rule (CAIR), and Cross State Air Pollution Rule (CSAPR)	2004 - 2007, 2009 - 2010, 2015 - 2017
State	Clean Smokestacks Act (CSA)	2007 - 2013
	Alternative to Source Specific Best Available Retrofit Technology (BART) Demonstration for Electricity Generating Units (EGUs)	2016
	Clean Air Bill/Vehicle Emissions Inspection and Maintenance (I&M) Program	2003 -2006
Control Programs Included in RPG Modeling for Second Planning Period (2019-2028)		
Federal	Tier 3 Vehicle and Fuel Standards	2017 - 2025
	Medium and Heavy-Duty Gasoline and Diesel Highway Vehicle Standards	2014 - 2018
	Utility New Source Performance Standards (NSPS)*	2012
	Mercury and Air Toxics Standard (MATS)*	2015 - 2017
	Boiler NESHAP – Section 112(j) and Section 112(d)	2011 and 2019
	2010 1-Hour SO_2 NAAQS	2010 - 2020
	NO_x Emission Standards for Ocean-going Vessels	2016
	Consent Decree between EPA and Tennessee Valley Authority (TVA)	2018 - 2019
	Consent Decree between EPA and Duke Energy Corporation*	2015
	Consent Decree between EPA and PCS Subsidiaries	2014
	Consent Decree between EPA and Saint-Gobain Containers, Inc. / Ardagh Glass*	2010
State	Source-Specific SO_2 SIP for Evergreen Packaging / Blue Ridge Paper Products	2020
	Special Orders by Consent (SOC) for CPI USA North Carolina LLC	2021

* Some of the emissions for this measure may be included in the 2016 base year emissions used for preparing the 2028 emissions projections for modeling. However, the measure was not included in the LTS for North Carolina's SIP for the first planning period. Therefore, it is included in North Carolina's SIP for the second planning period.

7.2.1 Control Measures and Other Emission Reduction Actions for First Planning Period (2008-2018)

The LTS for the first planning period includes federally and state enforceable control programs. These programs will remain enforceable through the second RH planning period. Sources subject to these measures are prohibited from reducing the effectiveness of emission controls or removing emission controls to ensure no backsliding occurs. Any change must be approved by EPA as a revision to the North Carolina SIP, consistent with Section 110(l) of the CAA. Federal control programs impacting onroad and nonroad engines will continue to provide emission reductions beyond the first implementation period in which they were adopted because of fleet-vehicle and equipment turnover (i.e., replacement of older vehicles or equipment with newer vehicles or equipment). The reductions from these programs, as described below, are included in the 2028 future year estimates upon which visibility projections are based. In addition, federal control programs that were implemented during but not included in North Carolina's LTS for the first planning period are included in the LTS for the second planning period.

7.2.1.1 Federal Control Programs

- Tier 2 Vehicle and Fuel Standards: For new passenger cars and light light-duty trucks, the Tier 2 standards phase-in began in 2004, with full implementation in the 2007 model year. These standards required passenger vehicles in each manufacturer's fleet to meet an average standard of 0.07 grams of NO_x per mile by 2007. The Tier 2 standards also cover passenger vehicles over 8,500 pounds gross vehicle weight rating (i.e., larger pickup trucks and sport utility vehicles [SUVs]). For these vehicles, the standards were phased in beginning in 2008, with full compliance required by 2009. The Tier 2 standards require vehicles to be 77% to 95% cleaner. Fuel standards required that most refiners and importers meet a corporate average gasoline sulfur standard of 120 ppm and a cap of 300 ppm beginning in 2004. Additionally, in January 2006, the sulfur content of gasoline was required to be on average 30 ppm. Lower sulfur content gasoline assists in lowering NO_x emissions by increasing the efficiency of the catalytic converter. Most gasoline sold in North Carolina prior to January 2006 had a sulfur content of about 300 ppm. These emission reductions are federally enforceable.

- Heavy-duty Gasoline and Diesel Highway Vehicle Standards: Implementation of these standards, designed to reduce NO_x and VOC emissions from heavy-duty gasoline and diesel highway vehicles, began with model year 2004 vehicles with full implementation occurring in 2010.[66] The program was estimated to reduce NO_x emissions by 95% and required that the sulfur content of fuel ultimately be reduced to 15 ppm. These emission reductions are federally enforceable.

- Large Nonroad Diesel Engine Standards: EPA promulgated rules for new large nonroad diesel engines, such as those used in construction, agricultural and industrial equipment, to be phased in between 2008 and 2014. The EPA mandated reductions in sulfur content in nonroad diesel fuels, as follows: 500 ppm effective June 2007; and 15 ppm effective June 2010.[67] The combined engine and fuel requirements are estimated to reduce NO_x emissions by 90% and reduce the sulfur content in nonroad diesel fuel to 15 ppm. These emission reductions are federally enforceable.

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[66] As part of a consent decree related to high NO_x emissions from heavy-duty diesel engines during certain driving modes caused by an engine control strategy that U.S. EPA considered an illegal "emission defeat device," most engine manufacturers were required to comply with the 2004 emission standards by October 2002.

[67] The U.S. EPA also set the same diesel sulfur content requirements for locomotive and marine fuels.

- Nonroad Spark-ignition Engine and Recreational Engine Standards: Tier 1 of these standards was implemented in 2004 and Tier 2 began in 2007, with the final engine standards coming on-line in 2012. These engine standards apply to all new engines sold in the United States and all engines imported after these standards began, and apply to large spark-ignition engines (forklifts and airport ground service equipment), recreational vehicles (off-highway motorcycles and all-terrain-vehicles), and recreational marine diesel engines. These emission reductions are federally enforceable.

- RICE National Emissions Standards for Hazardous Air Pollutants (NESHAP): The RICE NESHAP has provided emission reductions of NO_x, VOC, PM, and SO_2. RICE owners and operators were required to comply with the NESHAP by May 3, 2013. These emission reductions are federally enforceable.

- NO_x SIP Call, Clean Air Interstate Rule (CAIR), and Cross State Air Pollution Rule (CSAPR) Rules: EPA promulgated the NO_x SIP Call in October 1998 to reduce ozone transport and precursor emissions from upwind states contributing to ozone attainment and maintenance issues in downwind states. A central component of the NO_x SIP Call included the Budget Trading Program, which was a cap-and-trade system to reduce NO_x emissions from EGUs and large industrial boilers during the ozone season (May 1 through September 30). In May 2005, EPA promulgated CAIR to reduce NO_x and SO_2 emissions from EGUs. In so doing, CAIR incorporated the EGUs and large boilers covered by the NO_x Budget Trading Program but did not incorporate budgets for other sectors covered by the NO_x Budget Trading Program (e.g., onroad and nonroad sources). On December 23, 2008, the United States Court of Appeals for the District of Columbia Circuit issued an opinion remanding the CAIR program to EPA without vacatur. Therefore, because of EPA's "anti-backsliding" rules, North Carolina remains subject to the NO_x SIP Call's ozone season EGU budgets.

  After the court challenges to CAIR, EPA issued CSAPR in July 2011. As amended, CSAPR required 28 states to limit their statewide emissions of SO_2 and/or NO_x in order to reduce or eliminate the states' contributions to fine particulate matter ($PM_{2.5}$) and/or ground-level ozone pollution in other states. The emissions limitations are defined in terms of maximum statewide "budgets" for emissions of annual SO_2, annual NO_x, and/or ozone-season NO_x by each state's large EGUs. The EPA excluded large industrial boilers from CSAPR, resulting in a group of "orphaned" industrial units that are still subject to the NO_x SIP call budget for these sources. North Carolina EGUs are subject to the Phase I and II annual NO_x and SO_2 budgets as of January 1, 2015 and January 1, 2017, respectively. However, it is important to note that North Carolina does not have an ozone season budget for EGUs under the CSAPR program. Although the state is not relying on CSAPR for ozone season reductions, CSAPR is a federally enforceable program that has yielded residual NO_x and SO_2 emissions reduction benefits. As of EPA's 2018 progress report for the power sector's air programs, CSAPR was estimated to reduce annual EGU SO_2 and NO_x emissions by 91% and 73% below 2005 levels, respectively.

7.2.1.2 State Control Programs

- Clean Smokestacks Act (CSA): This state law 2002-4 (SB 1078) required coal-fired power plants to reduce from 1998 emission levels annual NO_x emissions by 77% by 2009, and to reduce annual SO_2 emissions by 49% by 2009 and 73% by 2013.[68] This law set a NO_x emissions cap of 56,000 tons/year for 2009 and SO_2 emissions caps of 250,000 tons/year and 130,000 tons/year for 2009 and 2013, respectively. In 2013, the power plants subject to this law had combined NO_x emissions of 38,857 tons/year, well below the 56,000 tons/year cap. The emissions cap has been met in all subsequent years as well. With the requirement to meet annual emissions caps and disallowing the purchase of NO_x credits to meet the caps, the Clean Smokestacks Act reduces NO_x emissions beyond the requirements of the NO_x SIP Call. These emissions limits are enforceable at both the federal and state level.

  From 2002 through 2019, coal-fired EGUs subject to this legislation reduced total NO_x and SO_2 emissions by 117,782 tons (82%) and 443,889 tons (97%), respectively (see Figure 7.1). The state's coal-fired EGUs are among the most efficient and least polluting in the nation. Also, since 2005, the state significantly transitioned to cleaner burning natural gas for electric power generation and has continued to increase its renewable energy capacity under the Southeast's only Renewable Energy and Energy Efficiency Portfolio Standard. While coal accounted for 96% of North Carolina's total fossil-fueled electricity generation in 2005, coal use dropped to only 42% and 43% in 2018 and 2019, respectively. The state has also transitioned to become second in the nation for solar photovoltaic capacity.

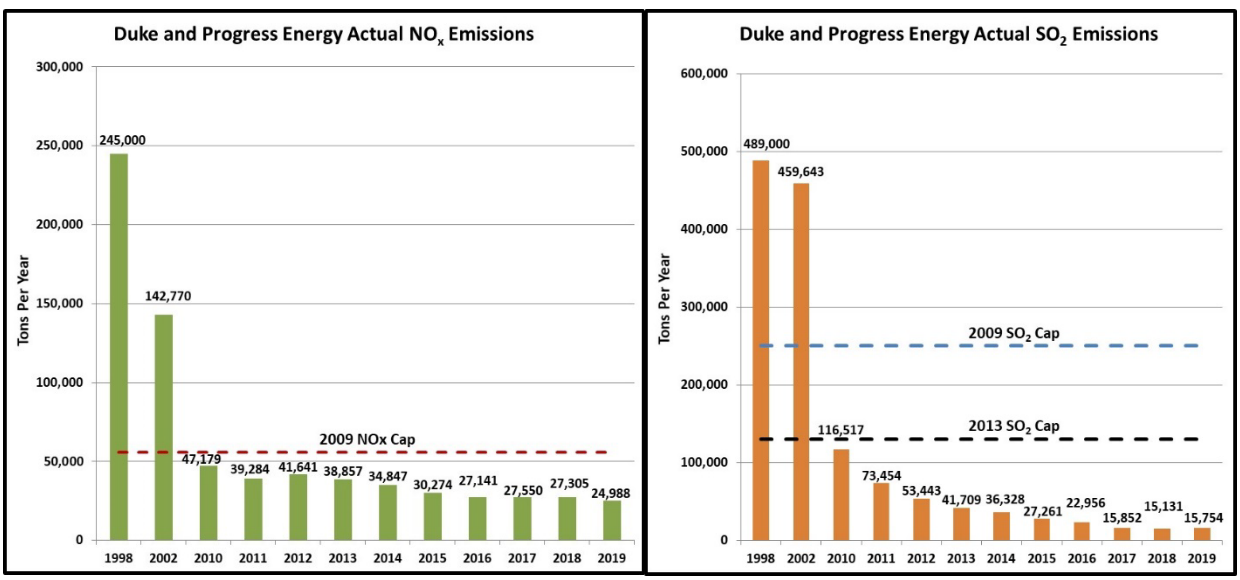

Figure 7-1. Clean Smokestacks Act Emissions Reductions

[68] The Clean Smokestacks Act, officially titled the Air Quality/Electric Utilities Act is available at https://www.ncleg.net/Sessions/2001/Bills/Senate/PDF/S1078v5.pdf.

- Best Available Retrofit Technology (BART) for EGUs: Pursuant to 40 CFR §51.308 of the RH rule, North Carolina prepared and submitted to EPA for approval a *Regional Haze SIP Revision for North Carolina Class I Areas - Alternative to Source Specific Best Available Retrofit Technology Demonstration (BART) for Electric Generating Units, October 31, 2014*. This SIP revision contained the technical information and data supporting North Carolina's Alternative to Source-Specific BART determinations for BART-eligible coal-fired EGUs. The SIP revision demonstrated that the North Carolina's CSA met the Alternative BART requirements and achieved greater emissions reductions of SO_2 and NO_x than otherwise would be achieved by applying BART to each individually affected EGU. The EPA approved the SIP revision on May 24, 2016.[69]

- Clean Air Bill/Vehicle Emissions Inspection and Maintenance (I&M) Program: In 1999, the North Carolina State Legislation passed the Clean Air Bill that expanded the on-road vehicle I&M program from 9 to 48 counties. This program reduces NO_x, VOC, and CO emissions. The rule for the I&M program was submitted to EPA for adoption into the SIP in August 2002 and was federally approved in October 2002. Therefore, these emission reductions are both state and federally enforceable. On February 5, 2015, EPA approved a change to North Carolina's I&M rules triggered by a state law which exempted plug-in vehicles and the three newest model year vehicles with less than 70,000 miles on their odometers from emission inspection in all areas in North Carolina where I&M is required.[70] In North Carolina's Section 110(l) demonstration, the state showed that the change in the compliance rate from 95% to 96% more than compensated for the NO_x and VOC emissions increase.

  The EPA's 2011/2028el modeling platform for onroad mobile sources does not account for revisions to North Carolina's I&M program starting in 2018 because the inventory was prepared before EPA approved the I&M SIP revisions. These revisions are documented in the following paragraphs for completeness. As documented in the EPA-approved Section 110(l) noninterference demonstration for each revision to the program, the I&M program benefits are minimal due to cleaner cars and cleaner fuels, and the following changes to the I&M SIP are not likely to interfere with any of the NAAQS or affect visibility in North Carolina's Class I areas.

  The 2017 session of the North Carolina General Assembly enacted Session Law 2017-10, Senate Bill 131 (An Act to Provide Further Regulatory Relief to the Citizens of North Carolina). Section 3.5.(a) of the Act amended *North Carolina General Statute (NCGS) §143-215.107A(c)* to remove 26 of 48 counties from North Carolina's I&M program. For the 22 counties remaining in the I&M program, Section 3.5.(b) of the Act also amended *NCGS §20-183.2(b)* by changing the vehicle model year coverage. Specifically, the Act requires the following changes to North Carolina's I&M program:

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[69] Final Rule: Air Plan Approval; North Carolina; Regional Haze (81 FR 32652, May 24, 2016).
[70] Approval and Promulgation of Implementation Plans; North Carolina; Inspection and Maintenance Program Updates, 80 FR, 6455.

Eliminate the following 26 counties from vehicle I&M requirements: Brunswick, Burke, Caldwell, Carteret, Catawba, Chatham, Cleveland, Craven, Edgecombe, Granville, Harnett, Haywood, Henderson, Lenoir, Moore, Nash, Orange, Pitt, Robeson, Rutherford, Stanly, Stokes, Surry, Wayne, Wilkes, and Wilson.

- Retain the vehicle I&M program in the following 22 counties: Alamance, Buncombe, Cabarrus, Cumberland, Davidson, Durham, Forsyth, Franklin, Gaston, Guilford, Iredell, Johnston, Lee, Lincoln, Mecklenburg, New Hanover, Onslow, Randolph, Rockingham, Rowan, Union, and Wake.
- For the 22 counties remaining in the program, change the model year vehicle coverage to: (i) a vehicle with a model year within 20 years of the current year and older than the three most recent model years, or (ii) a vehicle with a model year within 20 years of the current year and has 70,000 miles or more on its odometer. Previously, the program applied to (i) a 1996 or later model year vehicle and older than the three most recent model years, or (ii) a 1996 or later model year vehicle and has 70,000 miles or more on its odometer.

On September 25, 2018, EPA approved removal of the 26 counties from the I&M program (83 FR 48383) which became effective on December 1, 2018. On September 11, 2019, EPA approved revisions to the vehicle model year coverage for the 22 counties that remain subject to the I&M program (84 FR 47889) which became effective on December 1, 2019.

The 2020 session of the North Carolina General Assembly enacted Session Law 2020-05, House Bill 85 (An Act to Remove Lee, Onslow, and Rockingham Counties from the Motor Vehicle Emissions Inspection Program). Section 1 of the Act amended *North Carolina General Statue (NCGS) §143-215.107A(c)* to remove 3 of 22 counties from North Carolina's I&M program: Lee, Onslow, and Rockingham. Section 3 of the Act identifies that this change will become effective on the later of the following dates, and applies to motor vehicles inspected, or due to be inspected, on or after that effective date: (1) January 1, 2021; or (2) the first day of a month that is 60 days after the Secretary of the Department of Environmental Quality certifies to the Revisor of Statutes that EPA has approved this I&M program amendment to North Carolina's SIP. The I&M rules are state and federally enforceable.

7.2.2 Control Measures and Other Emission Reduction Actions for Second Planning Period (2019-2028)

7.2.2.1 Federal Control Programs

- Tier 3 Vehicle and Fuel Standards: Federal Tier 3 vehicle standards require all passenger vehicles in a manufacturer's fleet, including light-duty trucks and SUVs, to meet an average standard of 0.03 grams/per mile of NO_x. Heavy-duty passenger vehicles must meet average standards of 0.178 to 0.247 grams/per mile of NO_x depending on vehicle classification. Implementation began in 2017, with full compliance required by 2025. Compared to Tier 2, the Tier 3 tailpipe standards for light-duty vehicles are expected to reduce combined NO_x + non-methane organic gases by approximately 80%. Tier 3 vehicle standards also include evaporative standards using onboard diagnostics that result in a 50% reduction in VOC emissions over Tier 2. The rule reduced the sulfur content of gasoline to 10 ppm in January

2017. Reduced sulfur content in gasoline will also enable the controls on vehicles already in use to operate more effectively. These emission reductions are federally enforceable.

- Medium- and Heavy-duty Vehicle Fuel Consumption and Greenhouse Gas (GHG) Standards: In September 2011, EPA and the National Highway Traffic Safety Administration promulgated joint rules to reduce GHG emissions and improve fuel efficiency of combination tractor trucks, heavy-duty pickups and vans, and vocational trucks beginning with model year 2014 and applying to all model years by 2018. The decrease in fuel consumption is expected to result in a 7% to 20% decrease in NO_x emissions. These emission reductions are federally enforceable.

- Utility NSPS: On February 16, 2012, EPA published a final rule for the NSPS for fossil-fuel fired electric utility, industrial-commercial-institutional and small industrial-commercial-institutional steam generating units. In the NSPS, EPA revised the standards that new coal- and oil-fired power plants must meet for NO_x, SO_2, and PM. The emission standards apply to all applicable facilities that are constructed, reconstructed, or modified after May 3, 2011. The rule can be expected to result in the reduction of both NO_x and SO_2 emissions in addition to the reduction in mercury and other air toxic emissions. The emission reductions associated with the revised NSPS are federally enforceable.

- Utility Mercury and Air Toxics Standard (MATS): On February 16, 2012 (77 FR 9304), EPA promulgated the NESHAP 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. 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 often 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 control installation or an additional extension for reliability reasons with all sources required to comply by April 2017. The EGUs in NC are permitted for mercury using the mercury emission standards in the MATS rule. However, they initially met and continue to meet these standards as a result of the Clean Smokestacks Act (CSA) that was enacted in 2002. The controls used to reduce NO_x and SO_2 emissions that are required to meet the CSA requirements, also reduce mercury emissions.[71]

- Boiler NESHAP/MACT: Facilities with affected units were required to comply with the NESHAP by January 31, 2016 for all states except North Carolina which had a compliance date of May 20, 2019. Because of delays associated with EPA's promulgation of the boiler NESHAP, in 2009 North Carolina adopted and implemented equivalent emission limitations by permit under CAA Section 112(j). After EPA finalized the NESHAP, facilities subject to the Section 112(j) were required to revise their permits to comply with the Section 112(d)

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[71] Final Report of the Division of Air Quality to the Environmental Management Commission on the Control of Mercury Emissions from Coal-Fired Electric Steam Generating Units In accordance with 15A NCAC 02D .2509(b), July 1, 2012, https://deq.nc.gov/about/divisions/air-quality/air-quality-outreach/news/clean-air-legislation/clean-smokestacks-act.

requirements by May 20, 2020. Some facilities in North Carolina complied with the NESHAP by converting affected units from burning coal to natural gas resulting in additional reductions in NO_x, SO_2, CO, and PM emissions. These emission reductions are federally enforceable. Appendix B-3 to this SIP documents the methodologies the NCDAQ used to account for criteria air pollutant emission reductions associated with the boiler NESHAP when developing the 2028 projection year inventory to support regional haze modeling.

- 2010 1-Hour SO_2 NAAQS: On June 22, 2010 (75 FR 35520), EPA finalized a new primary 1-hour NAAQS of 75 ppb for SO_2. Using inventory and other technical data as support, EPA determined that anthropogenic SO_2 emissions originate chiefly from point sources, with fossil fuel combustion at EGUs accounting for 66% 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 air quality modeling and monitoring to determine compliance with the standard. Much of this work focused on the evaluation of point source emissions.

  For large SO_2 sources subject to the SO_2 Data Requirements Rule, North Carolina demonstrated compliance through modeling or monitoring.[72] Brunswick County was designated "unclassifiable" on July 12, 2016, as part of the EPA's Round 2 action. Subsequently, on December 31, 2017, EPA designated the majority of the state as "attainment/unclassifiable" as part of its Round 3 designation. North Carolina conducted source-oriented monitoring for one facility each in Limestone Township in Buncombe, Beaverdam Township in Haywood, and Cunningham Township in Person County for calendar years 2017 – 2019 to develop design values to support EPA's final Round 4 designations for the state. On December 21, 2020, EPA issued final "attainment/ unclassifiable" designations for these three remaining townships.[73]

- NO_x Emission Standards for Ocean-going Vessels: On April 4, 2014, new NO_x emission standards for ocean-going vessels became effective and applied to ships constructed after 2015. These standards are found in MARPOL Annex VI,[74] 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 coastline. The cleaner fuels will result in significant reductions in SO_2 and PM emissions from ocean-going vessels. 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

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[72] Data Requirements Rule for the 2010 1-Hour Sulfur Dioxide (SO_2) Primary National Ambient Air Quality Standard (NAAQS), Final Rule, 80 FR 51052, August 21, 2015, https://www.govinfo.gov/content/pkg/FR-2015-08-21/pdf/2015-20367.pdf.

[73] Air Quality Designations for the 2010 Primary Sulfur Dioxide (SO_2) National Ambient Air Quality Standard - Round 4, Final Rule, effective on April 30, 2021, https://www.epa.gov/sulfur-dioxide-designations/epa-completes-fourth-round-sulfur-dioxide-designations.

[74] U.S. EPA, Marpol Annis VI and the Act To Prevent Pollution From Ships (APPS), https://www.epa.gov/enforcement/marpol-annex-vi-and-act-prevent-pollution-ships-apps.

America, also known as the North American Emission Control Area.

- Federal Consent Decrees:

Tennessee Valley Authority (TVA) Consent Decree, January 11, 2017[75]
In January 2009, a federal court required TVA coal-fired EGUs to install controls to significantly reduce SO_2 and NO_x emissions. After an appeals court reversed the decision, North Carolina, TVA, and several other parties agreed to a settlement. The settlement caps NO_x and SO_2 emissions at all of TVA's coal-fired facilities to permanent levels of 52,000 tons of NO_x in 2018 and 110,000 tons of SO_2 in 2019. These emission reductions are federally enforceable.

Duke Energy Corporation (Civil No. 1:00 cv 1262), September 10, 2015[76]
A consent decree between EPA and Duke Energy Corporation was finalized in September 2015 to resolve CAA Prevention of Significant Deterioration (PSD) program violations at 13 EGUs at five the following five plants:

- GG Allen (Units 1 and 2) – ORIS ID 2718, EIS Facility ID 8137511, NC ID 3600039
- Buck (Units 3, 4, and 5) - ORIS ID 2720, EIS Facility ID 8506911, NC ID 8000004
- Cliffside (Units 1, 2, 3, and 4) - ORIS ID 2721, EIS Facility ID 8300611, NC ID 8100028
- Dan River (Unit 3) - ORIS ID 2723, EIS Facility ID 8009611, NC ID 7900015
- Riverbend (Units 4, 6, and 7) - ORIS ID 2732, EIS Facility ID 8176211, NC ID 3600040

The consent decree required 11 of 13 EGUs that had been shut down prior to finalizing the consent decree to be a permanent and an enforceable obligation. At the GG Allen plant, the consent decree requires Duke to permanently retire Units 1 and 2 (165 megawatts (MW) each) by 2024. In the interim, Duke must continuously operate existing NO_x pollution controls at Allen Units 1 and 2 and comply with a 365-day rolling average emission rate of 0.250 pound per million British Thermal Units (lb/MMBtu). Each unit must also meet a NO_x tonnage cap of 600 tons per year (TPY). Duke must also continuously operate existing SO_2 controls at GG Allen Units 1 and 2 and comply with a 365-day rolling average emission rate of 0.120 lb/MMBtu. Duke Energy has fulfilled the consent decree in part by permanently shutting down Units 2, 3, and 4 in 2021.[77,78]

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[75] The consent decree is available at EPA's website at: https://www.epa.gov/enforcement/consent-decree-tennessee-valley-authority-tva.
[76] The consent decree is available at EPA's website at: https://www.epa.gov/enforcement/duke-energy-corporation-clean-air-act-caa-settlement.
[77] Letter from Ms. Julie Turner, Vice President of Carolinas Coal Generation, Duke Energy to Mr. Mark Cuilla, Acting Permitting Section Chief, North Carolina DAQ, April 6, 2021, providing a Retired Unit Exemption Form as a notification that Unit 3 at GG Allen has been permanently removed from service effective March 31, 2021.
[78] Letter from Ms. Julie Turner, Vice President of Carolinas Coal Generation, Duke Energy to Mr. Mark Cuilla, Air Permitting Section Chief, North Carolina DAQ, January 18, 2022, providing a Retired Unit Exemption Form as a notification that the Unit 2 and Unit 4 at GG Allen have been permanently removed from service effective December 31, 2021.

In addition, to help mitigate the harm from the alleged violations, the settlement requires Duke to retire an additional 265 MW unit (i.e., Unit 3) at the GG Allen plant by 2024. The consent decree also requires Duke to spend at least $4.4 million on environmental mitigation projects. Some projects are mandatory, and some are optional as described in the consent decree. Table 7-2 summarizes actual criteria pollutant emissions for 2016-2019 and 2028 emissions (projected from 2016 emissions) used in the elv5 regional haze modeling for these Duke Energy facilities. The Riverbend facility air permit was inactivated on December 6, 2013 and the facility closed in 2014.

Table 7-2. Summary of Historical and 2028 Projected Emissions for Duke Energy Facilities affected by Federal Consent Decree (Tons)

Pollutant	2011	2014	2016	2017	2018	2019	2028
Duke Energy Carolinas, LLC - Allen Steam Station							
CO	1,804.34	984.77	718.46	454.95	380.10	414.92	364.95
NO_x	4,401.64	4,018.53	2,168.28	1,610.22	1,440.96	1,347.63	1,410.10
PM_{10}-PRI	534.51	291.49	88.05	65.21	64.89	71.51	165.51
PM25-PRI	485.14	263.31	67.57	48.82	49.56	57.02	100.95
SO_2	1,665.32	1,718.20	676.03	354.02	246.01	147.87	575.40
VOC	53.38	29.88	21.59	14.47	12.43	13.40	11.30
Duke Energy Carolinas, LLC - Buck Combined Cycle Facility							
CO	581.26	82.32	15.72	16.13	16.45	14.03	240.81
NO_x	656.25	656.25	147.41	150.67	156.38	130.13	266.71
PM_{10}-PRI	262.95	93.07	56.10	57.39	58.41	50.08	194.83
PM25-PRI	230.47	80.67	56.10	57.39	58.41	50.08	180.32
SO_2	3,840.47	7.90	10.40	10.60	10.90	9.10	22.80
VOC	11.52	33.24	9.27	9.52	9.70	8.30	42.73
Duke Energy Carolinas, LLC - Cliffside Steam Station							
CO	631.70	1,149.66	612.32	1,581.61	934.95	580.53	134.21
NO_x	712.01	2,106.74	1,172.36	1,645.65	1,953.62	2,488.59	326.63
PM_{10}-PRI	545.97	269.79	162.69	240.45	255.95	305.87	58.94
PM25-PRI	381.99	216.07	142.07	212.44	230.46	284.84	51.78
SO_2	310.05	1,253.94	585.91	858.48	1,350.45	1,383.06	160.99
VOC	32.19	19.19	14.16	11.94	23.55	46.03	3.99
Duke Energy Carolinas, LLC - Dan River Combined Cycle Facility							
CO	354.28	85.13	107.45	113.02	107.94	98.97	663.90
NO_x	539.90	116.61	232.60	259.83	249.18	272.76	422.28
PM_{10}-PRI	146.84	131.34	163.84	166.37	170.20	151.82	328.86
PM25-PRI	119.17	131.34	162.32	165.55	169.43	150.85	317.83
SO_2	1,947.81	8.21	10.39	10.36	10.96	9.72	31.93
VOC	4.59	29.70	36.61	42.28	36.81	33.10	83.60

Pollutant	2011	2014	2016	2017	2018	2019	2028
Duke Energy Carolinas, LLC - Riverbend Steam							
CO	760.21	0.00	0.00	0.00	0.00	0.00	0.00
NO_x	1,105.97	0.00	0.00	0.00	0.00	0.00	0.00
PM_{10}-PRI	547.20	0.00	0.00	0.00	0.00	0.00	0.00
PM25-PRI	463.14	0.00	0.00	0.00	0.00	0.00	0.00
SO_2	7,118.89	0.00	0.00	0.00	0.00	0.00	0.00
VOC	12.35	0.00	0.00	0.00	0.00	0.00	0.00
Total Emissions for Duke Energy Facilities							
CO	4,131.79	2,301.88	1,453.95	2,165.71	1,439.44	1,108.45	1,403.87
NO_x	7,415.77	6,898.13	3,720.65	3,666.37	3,800.14	4,239.11	2,425.72
PM_{10}-PRI	2,037.47	785.69	470.68	529.42	549.45	579.28	748.14
PM25-PRI	1,679.91	691.39	428.06	484.20	507.86	542.79	650.88
SO_2	14,822.54	2,988.25	1,282.73	1,233.46	1,618.32	1,549.75	791.12
VOC	114.03	112.01	81.63	78.21	82.49	100.83	141.63

PCS Subsidiaries - PCS Nitrogen Fertilizer, L.P., AA Sulfuric, Inc., and White Springs Agricultural) Chemicals, Inc. (Case No. 3:14-cv-00707-BAJ-SCR), November 6, 2014)[79]
The consent decree resolved claims that these PCS subsidiaries violated the CAA when they modified facilities in ways that released excess SO_2 emissions into surrounding communities. The settlement required PCS Nitrogen Fertilizer, AA Sulfuric Inc., and White Springs Agricultural Chemicals Inc. to install, upgrade, and operate state-of-the-art pollution reduction measures and install emissions monitors at eight sulfuric acid plants at facilities in Aurora, North Carolina (three plants), White Springs, Florida (four plants), and Geismar, Louisiana (one plant). It was estimated that the three companies would spend $50 million on these SO_2 control measures.

PCS Phosphate (EIS Facility ID 8479311, NC ID 0700071) in Aurora, North Carolina completed implementation of controls on the facility from 2017 – 2019. For the purpose of modeling future year emissions, it was assumed that the controls would be applied starting January 1 of the following year. Details on the controls installed on the three acid plants at the facility are documented in Section 7.8 of this SIP. Table 7-3 summarizes actual criteria pollutant emissions for 2016-2019 and 2028 emissions (projected from 2016 emissions) used in the elv5 regional haze modeling for the PCS Phosphate facility.

[79] The consent decree is available at U.S. EPA's website at: https://www.epa.gov/enforcement/pcs-nitrogen-fertilizer-clean-air-act-settlement.

Table 7-3. Summary of Historical and 2028 Projected Emissions for PCS Phosphate, Aurora, North Carolina (Tons)

Pollutant	2016	2017	2018	2019	2028
CO	620.80	527.70	424.30	390.70	655.93
NO_x	468.70	407.90	431.10	457.20	495.58
PM 10	900.83	900.13	803.52	818.98	952.07
PM 2.5	233.03	235.83	225.82	234.63	278.87
SO_2	5,193.68	3,139.72	3,439.36	2,307.21	4,845.90
VOC	175.97	155.90	277.50	160.20	186.00

Saint-Gobain Containers, Inc. (Civil Action No. 2:10-cv-00121-TSZ), May 7, 2010 (EIS Facility ID 8010411, NC ID 9100069)[80]

This global consent decree affected Saint-Gobain's Ardagh Glass, Inc. glass manufacturing facility in Henderson (Vance County), North Carolina. The consent decree and air quality permit (Permit No. 02834T26) for the facility were reviewed during development of the 2028 projection year inventory and it was identified that the emission reductions associated with NO_x controls for Furnace No. 1 (GF-1) were not reflected in the 2016 base year used as the starting point for preparing the 2028 inventory. For furnace No. 1, the facility received EPA approval to implement SCR instead of Oxyfuel Technology via letter from the EPA dated June 25, 2015. Therefore, an 80% control efficiency was applied to the 2016 base year emissions to estimate 2028 emissions. Controls for NO_x and SO_2 for other processes at the facility were installed prior to 2016 and the post control emissions were reflected in the 2016 base year inventory. Table 7-4 summarizes actual criteria pollutant emissions for 2016-2019 and 2028 emissions (projected from 2016 emissions) used in the elv5 regional haze modeling for the Ardagh Glass facility.

Table 7-4. Summary of Historical and 2028 Projected Emissions for Ardagh Glass, Henderson, North Carolina (Tons)

Pollutant	2016	2017	2018	2019	2028
CO	69.55	73.68	70.19	74.39	85.17
NO_x	488.12	307.70	283.45	289.67	376.90
PM 10	50.75	50.02	49.66	49.90	62.27
PM 2.5	50.74	50.01	49.65	49.89	62.26
SO_2	148.27	141.86	150.29	171.33	181.93
VOC	19.27	20.86	20.16	21.01	23.65

80 The consent decree is available at U.S. EPA's website at: https://www.epa.gov/enforcement/saint-gobain-containers-inc-clean-air-act-settlement.

7.2.2.2 State Control Programs

- Source-Specific SO_2 SIP for Evergreen Packaging / Blue Ridge Paper Products, LLC (BRPP) (EIS Facility ID 7920511, NC ID 4400159)

  BRPP, a subsidiary of Evergreen Packaging, is located in the City of Canton, Beaverdam Township, Haywood County, in western North Carolina. This facility is a vertically integrated pulp and paper mill that produces specialty paperboard packaging products. On October 9, 2017, the North Carolina Environmental Management Commission and Evergreen Packaging/BRPP entered into a Special Order by Consent (SOC 2017-002) to implement process modifications, upgrade existing control equipment, and install new control equipment to reduce SO_2 emissions and keep associated ambient concentrations below the 2010 1-hour SO_2 NAAQS.[81] The SOC required BRPP to submit a permit application and modeling analysis by March 1, 2018, to characterize the facility's emission sources and develop allowable SO_2 emission limitations based on modeled predictions of ambient SO_2 concentrations.

  The SOC also contained a timeline for the facility to complete planned changes in order to comply with the CAA Section 112(d) boiler maximum achievable control technology (MACT) rule by May 20, 2019 per the CAA Section 112(j) requirements in its permit.[82] To comply with the boiler MACT Section 112(d) rule, the facility invested approximately $50 million in planned improvements to install two new natural gas-fired boilers, permanently shut down two coal-fired boilers, and install new wet scrubbers and rebuild the electrostatic precipitators (ESPs) on two additional coal-fired boilers. Although the MACT standards control hazardous air pollutants (HAPs), these investments in controls for HAPs also significantly reduced SO_2 emissions.

  BRPP complied with the SOC and, as a result, reduced its annual SO_2 emissions to 405 tons or by 93% (5,470 tons) from 2017 to 2019. These emission reductions have led to corresponding reductions in ambient SO_2 concentrations near the facility. As demonstrated through the North Carolina's Title V permitting process, modeling of the emission limitations included in the permit show attainment of the NAAQS, and the monitoring, recordkeeping, and reporting requirements included in the permit support compliance with the emission limitations.

  On September 3, 2020, the North Carolina DEQ/DAQ submitted a request to EPA to revise the North Carolina SIP to incorporate into the SIP the more stringent SO_2 limits (than those currently contained in the SIP) and associated operating restrictions and monitoring, recordkeeping, reporting and testing requirements established in BRPP's Title V operating

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[81] Special Order by Consent (SOC 2017-002) Made and Entered into Pursuant to North Carolina General Statute 143-215.110 by and between Blue Ridge Paper Products, Inc., and the Environmental Management Commission, October 9, 2017.

[82] 40 CFR Subpart DDDDD, National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters (Sections 63.7480 - 63.7575).

permit (Permit No. 08961T29) as permanent and federally enforceable under Section 110(a) of the CAA. This request was completed to strengthen the SIP for complying with the 2010 1-hour SO_2 NAAQS in Beaverdam Township. The EPA subsequently approved the request on November 24, 2020.[83] On December 21, 2020, EPA designated Beaverdam Township "attainment/unclassifiable" for the 2010 1-hour SO_2 NAAQS.

Table 7-5 summarizes actual criteria pollutant emissions for 2016-2019 and 2028 emissions (projected from 2016 emissions) used in the elv5 regional haze modeling for BRPP.

Table 7-5. Summary of Historical and 2028 Projected Emissions for BRPP, Canton, North Carolina (Tons)

Pollutant	2016	2017	2018	2019	2028
CO	1,500.32	1,830.70	1,632.69	1,672.13	1,118.13
NO_x	4,224.22	3,418.59	3,006.74	2,967.74	2,926.78
PM 10	675.70	558.09	499.04	538.52	320.02
PM 2.5	530.71	476.00	414.46	441.06	251.40
SO_2	7,195.93	5,875.43	2,901.00	405.00	405.00
VOC	1,377.79	1,420.30	1,637.84	1,587.94	1,361.54

- <u>CPI USA North Carolina LLC - Special Orders by Consent (SOC)</u>

  CPI operated two EGU facilities, one in Person County and one in Brunswick County, to generate electricity for the power grid. At the Person County facility (EIS Facility ID 7826311, NC ID 7300056), CPI operated three steam generating boilers that burned wood/biomass and tire-derived fuel. At the Brunswick County facility (EIS Facility ID 8176711, NC ID 1000067), CPI operated six steam generating boilers that burned wood/biomass and tire-derived fuel.

  In 2020, the North Carolina Environmental Management Commission entered into SOCs with CPI USA North Carolina LLC concerning emission sources at the Person County facility (air permit number 05856, signed on May 12, 2020) and Brunswick County facility (air permit number 05884, signed on November 4, 2020) to resolve compliance issues and reduce SO_2 emissions as follows.

  - For the Person County facility (SOC 2020-001 signed May 12, 2020), CPI agreed to the following conditions to reduce SO_2 emissions at their facility:[84]
    - adhere to a revised emission limit of 0.95 pounds per million Btu (24-hour block average) and

[83] 85 FR 74884, Air Plan Approval; NC; Blue Ridge Paper SO_2 Emission Limits, Final Rule, November 24, 2020.
[84] Special Order by Consent (SOC 2020-001) Made and Entered into Pursuant to North Carolina General Statute 143-215.110 by and between CPI USA North Carolina LLC and the Environmental Management Commission, May 12, 2020.

- by no later than March 31, 2021, the company will cease operation of all emission sources and request rescission of their air permit.

- For the Brunswick County facility (SOC 2020-003 signed November 4, 2020), CPI agreed to the following conditions to reduce SO_2 emissions:[85]
  - adhere to a revised emission limit of 1.1 pounds per million Btu per unit (24-hour block average)
  - operate the facility in a manner that complies with the 1-hour NAAQS for SO_2, and
  - to cease operation of all emission sources and request rescission of the air permit for the Brunswick County facility by March 31, 2021.

For each facility, Table 7-6 summarizes actual criteria pollutant emissions for 2016-2019 and 2028 emissions (projected from 2016 emissions) used in the elv5 regional haze modeling. Based on 2019 annual emissions, closure of the two facilities will reduce SO_2 and NO_x emissions by over 5,500 tons and 1,300 tons, respectively. These SOCs were finalized after the 2028 modeling inventory was developed which, at that time, did not anticipate that the two facilities would close in 2021.

Table 7-6. CPI USA North Carolina LLC Facilities – Actual Emissions for 2016 – 2019 and Modeled Emissions for 2028

	Actual Annual Emissions (Tons)				Modeled Emissions (Tons)
Pollutant	**2016**	**2017**	**2018**	**2019**	**2028**
Brunswick County					
CO	1,585.09	1,210.70	1,312.51	1,227.97	17.49
NO_x	929.40	918.10	884.33	893.23	272.42
PM_{10}	95.96	90.88	96.85	107.23	20.50
$PM_{2.5}$	77.40	66.81	56.79	56.63	15.60
SO_2	4,609.00	3,616.10	3,295.60	3,297.80	119.83
VOC	9.21	8.54	8.65	8.80	1.73
Person County					
CO	834.91	733.16	737.54	746.34	10.13
NO_x	441.17	466.34	465.35	457.94	142.50
PM_{10}	59.22	62.99	60.81	27.29	10.07
$PM_{2.5}$	50.24	53.00	51.37	18.36	8.58
SO_2	2,315.30	2,410.10	2,306.40	2,237.00	66.34
VOC	11.40	12.01	11.57	11.33	0.75

[85] Special Order by Consent (SOC 2020-003) Made and Entered into Pursuant to North Carolina General Statute 143-215.110 by and between CPI USA North Carolina LLC and the Environmental Management Commission, November 4, 2020.

	Actual Annual Emissions (Tons)				Modeled Emissions (Tons)
Total Emissions for Brunswick and Person County					
CO	2,420	1,943.86	2,050.05	1,974.31	27.62
NO_x	1,370.57	1,384.44	1,349.68	1,351.17	414.93
PM_{10}	155.18	153.87	157.66	134.52	30.57
$PM_{2.5}$	127.64	119.81	108.16	74.99	24.17
SO_2	6,924.3	6,026.2	5,602	5,534.8	186.17
VOC	20.61	20.55	20.22	20.13	2.47

7.2.3 Construction Activities, Agricultural and Forestry Smoke Management

In addition to accounting for specific emission reductions due to ongoing air pollution programs as required under the regional haze regulation section 40 CFR 51.308(d)(3)(v)(A), states are also required to consider the air quality benefits of measures to mitigate the impacts of construction activities (40 CFR 51.308(f)(2)(iv)(B)) and agricultural and forestry smoke management (40 CFR 51.308(f)(2)(iv)(D)). Section 7.9.1 and Section 7.9.2 provide more information on these activities.

7.2.4 Projected VISTAS 2028 Emissions Inventory

The VISTAS emissions inventory for 2028 accounts for post-2011 emission reductions from federal, state, local, and site-specific control programs (see Section 7.2.2). The VISTAS 2028 emissions inventory is based on EPA's 2028el emissions inventory data sets.[86] Onroad and non-road mobile source emissions were created for 2028 using the MOVES2014a version of the 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 Clean Power Plan (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 estimated 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.

For non-EGU point source projections to year 2028, VISTAS states considered the EPA 2023en and EPA 2028el emissions and in some cases supplied their own emissions data. For example,

[86] The FTP site hosting these files as provided in the link above is available via U.S. EPA website "2011 Version 6.3 Platform", https://www.epa.gov/air-emissions-modeling/2011-version-63-platform.

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. North Carolina prepared its 2028 non-EGU point source emissions inventory by applying facility closures and growth and control factors to its 2016 base year (the most recent year available at the time and also used in EPA's 2016 modeling platform). Appendix B-3 provides documentation of the methods North Carolina used to develop 2028 emissions for EGU and non-EGU point sources.

These updates for 2028 are documented in the ERG emissions inventory report included in Appendix B-2a (Emission Inventory Updates Report (2028 Visibility Estimates)) and Appendix B-2b (Conversion of the Task 2B 2028 Point Source Remodeling Files for Emissions Processing with SMOKE). Figure 7-2 and Figure 7-3 show the expected decrease in SO_2 and NO_x emissions, respectively, across the VISTAS states from 2011 to 2028.

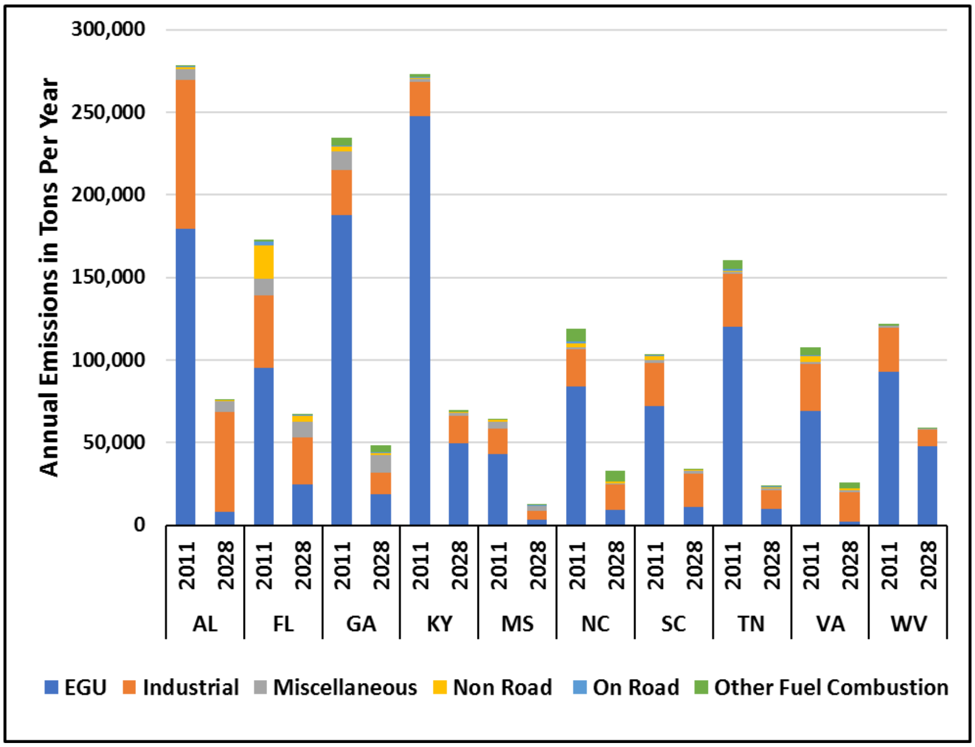

Figure 7-2. SO_2 Emissions for 2011 and 2028 for VISTAS States

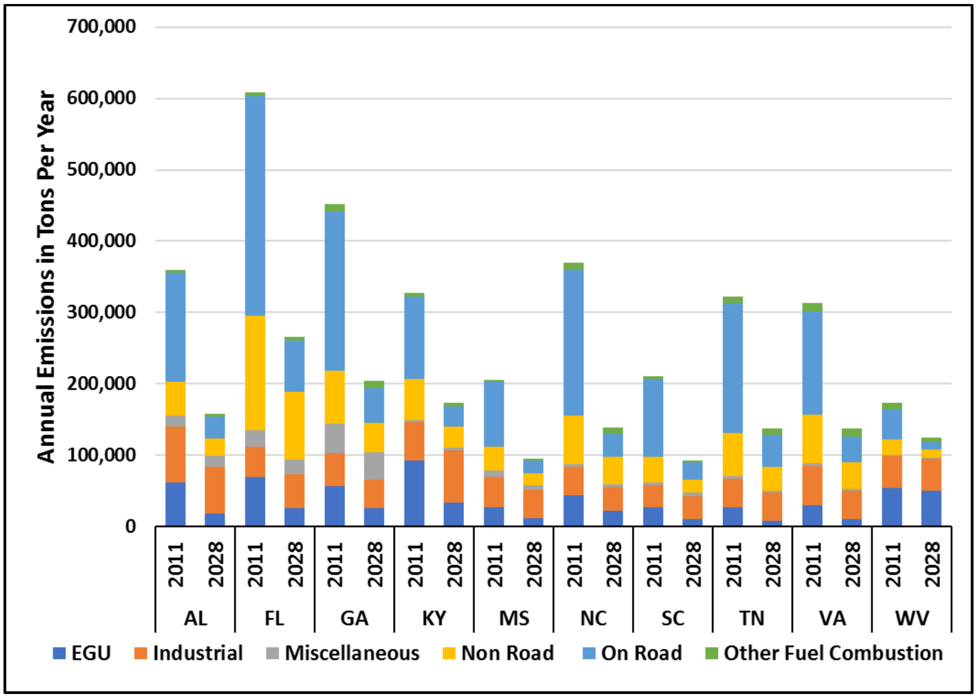

Figure 7-3. NO_x Emissions for 2011 and 2028 for VISTAS States

For SO_2 emissions, which are the largest contributors to haze in the Southeastern U.S., emissions across the VISTAS region 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. 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. The NO_x reductions from the EGU sector are also expected to continue although NO_x emissions from EGUs now make up a much smaller portion of the overall anthropogenic NO_x inventory as compared to inventories from prior the planning period. The expected SO_2 and NO_x emission reductions are due to state and federal control programs, the use of cleaner burning fuels (e.g., conversion of EGU and industrial boilers from coal to natural gas), the construction and operation of renewable energy sources, and economic factors.

Figure 7-4 and Figure 7-5 show 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.

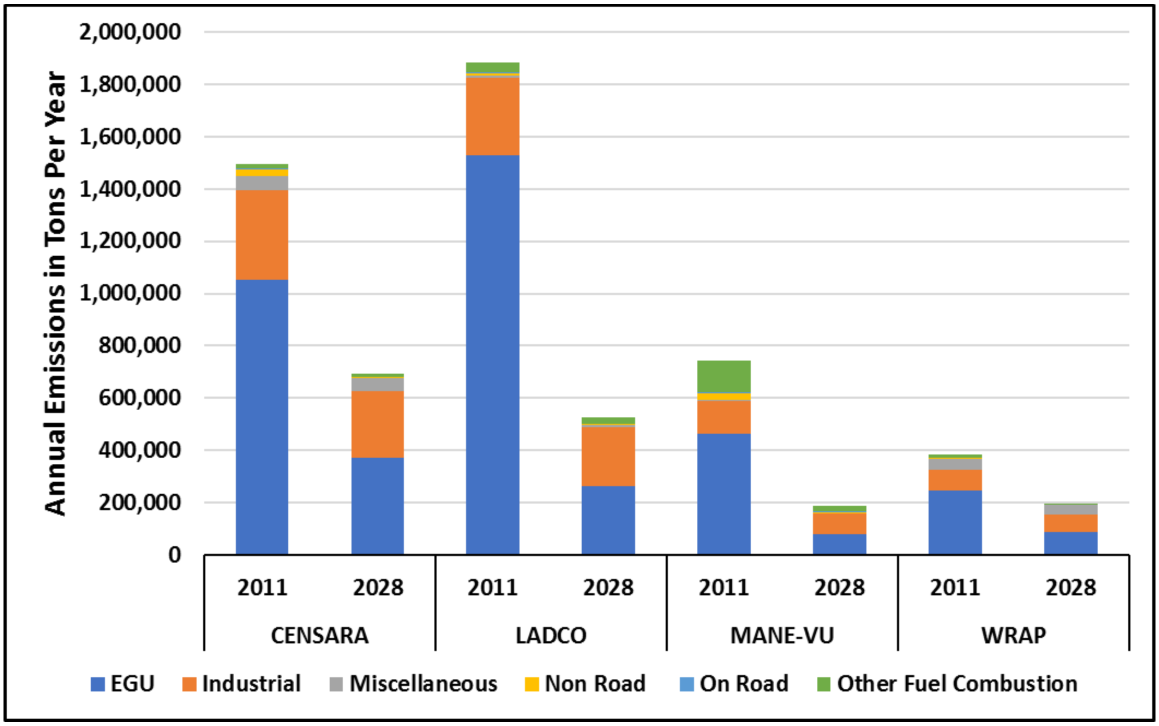

Figure 7-4. SO_2 Emissions for 2011 and 2028 for Other RPOs

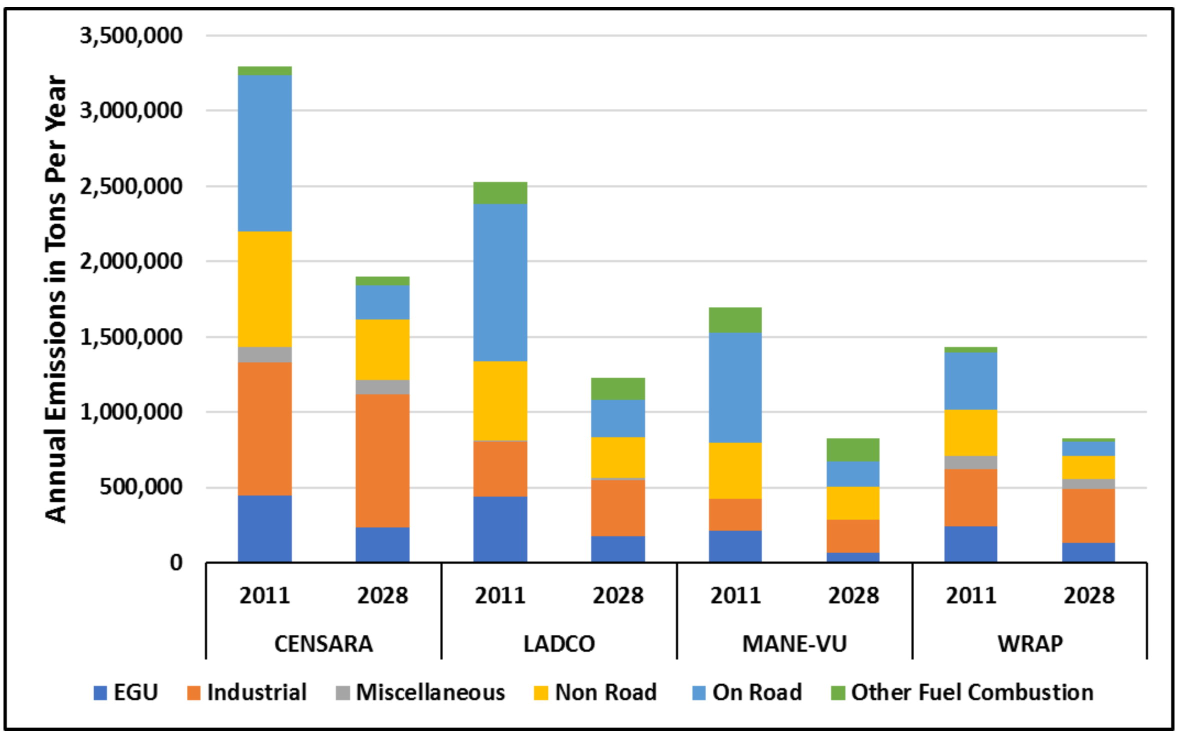

Figure 7-5. NO_x Emissions for 2011 and 2028 for Other RPOs

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 and Appendix B-2b.

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 & Transport	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 & Transport	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

7.2.5 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 for SO_2 and NO_x emissions. Other source sector data were estimated by 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.[87] 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 source classification code (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 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 based on point source and EGU sector data that originated with state EIS submissions and unit-level reporting to CAMD.[88] 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 7-6 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 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.

Figure 7-7 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 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

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[87] U.S. EPA, 2016v1 Platform, https://www.epa.gov/air-emissions-modeling/2016v1-platform.
[88] U.S. EPA, 2017 National Emissions Inventory (NEI) Data, https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data.

reductions in NO_x occurred by 2016 as compared to 2011. During this time 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 EPA.

The VISTAS 2028 data are higher than the EPA 2028 projections largely due to differences in projection methodologies for EGUs and some non-EGUs. For example, 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.

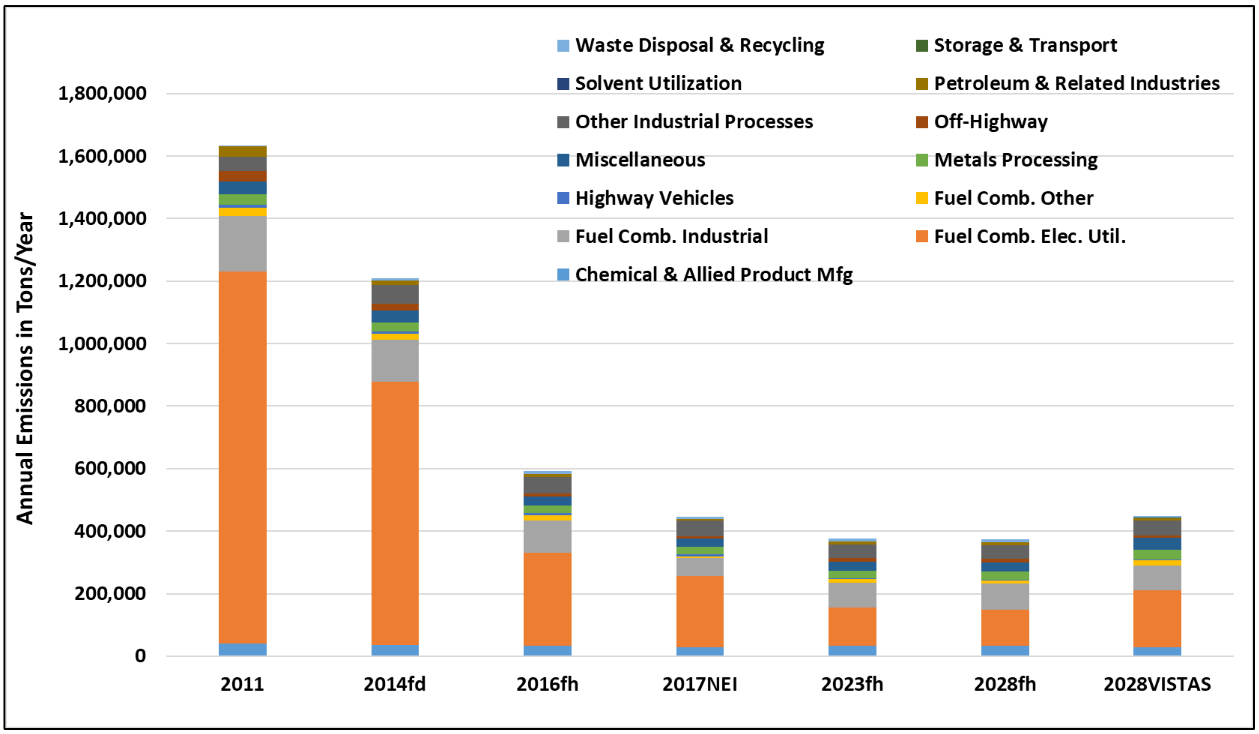

Figure 7-6. SO_2 Emissions from VISTAS States

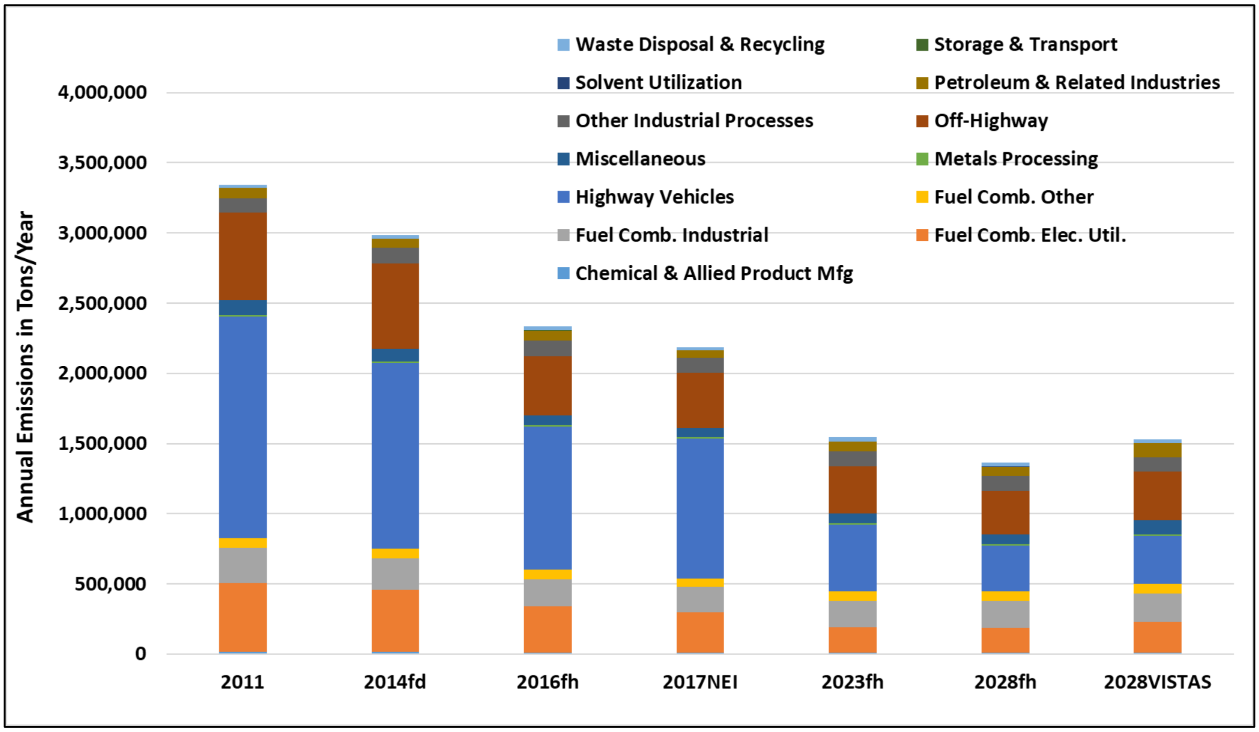

Figure 7-7. NO_x Emissions from VISTAS States

The data for North Carolina in the EPA inventories also forecast significant declines in both SO_2 and NO_x emissions. Figure 7-8 provides EPA's estimates of North Carolina'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 under 120,000 tons of SO_2 emissions from North Carolina in 2011. The EPA expects that SO_2 emissions in North Carolina will drop to just under 30,000 tons by 2028, a 75% reduction. The VISTAS projection for North Carolina shows that emissions of SO_2 should drop to around 32,600 tons by 2028, a 73% reduction.

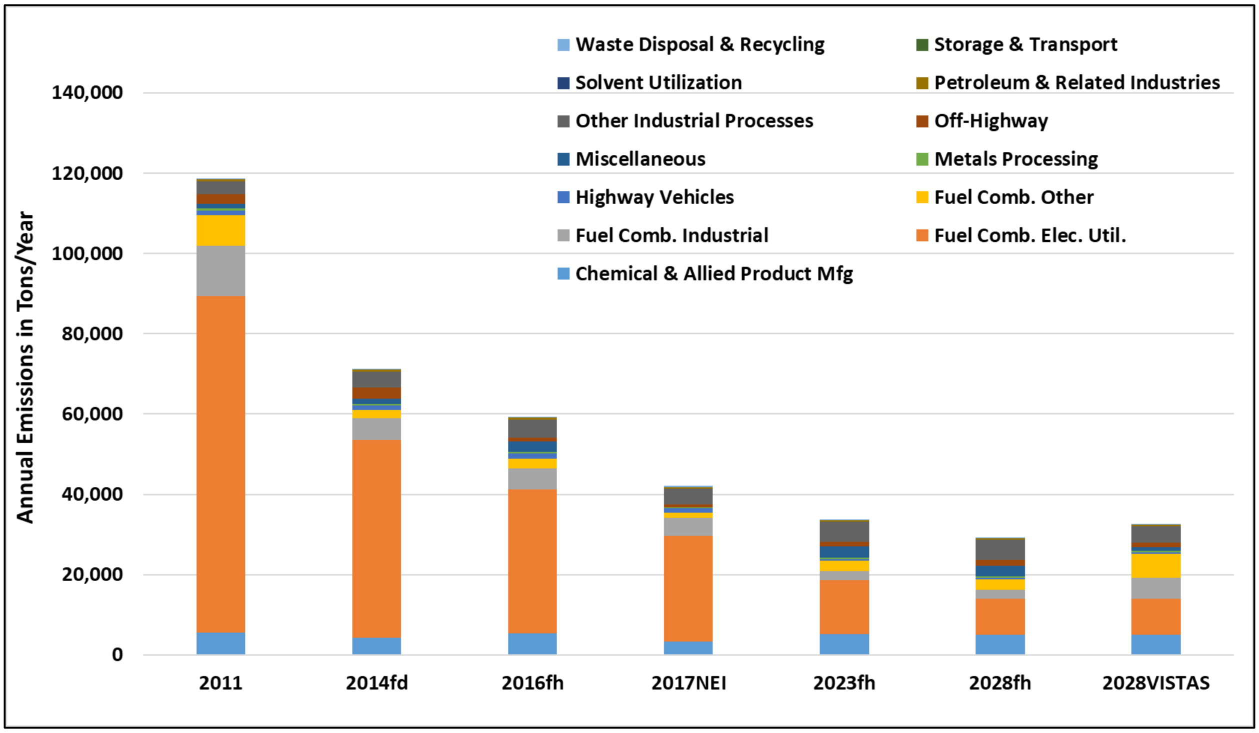

Figure 7-8. North Carolina SO_2 Emissions

Figure 7-9 provides EPA's estimates of actual NO_x emissions in North Carolina 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 about 369,500 tons of NO_x emissions from North Carolina in 2011. The EPA expects that NO_x emissions in North Carolina will drop to under 150,000 tons by 2028, a 59% reduction. The VISTAS projections estimate that North Carolina NO_x emissions will drop to about 139,000 tons by 2028, a 62% reduction.

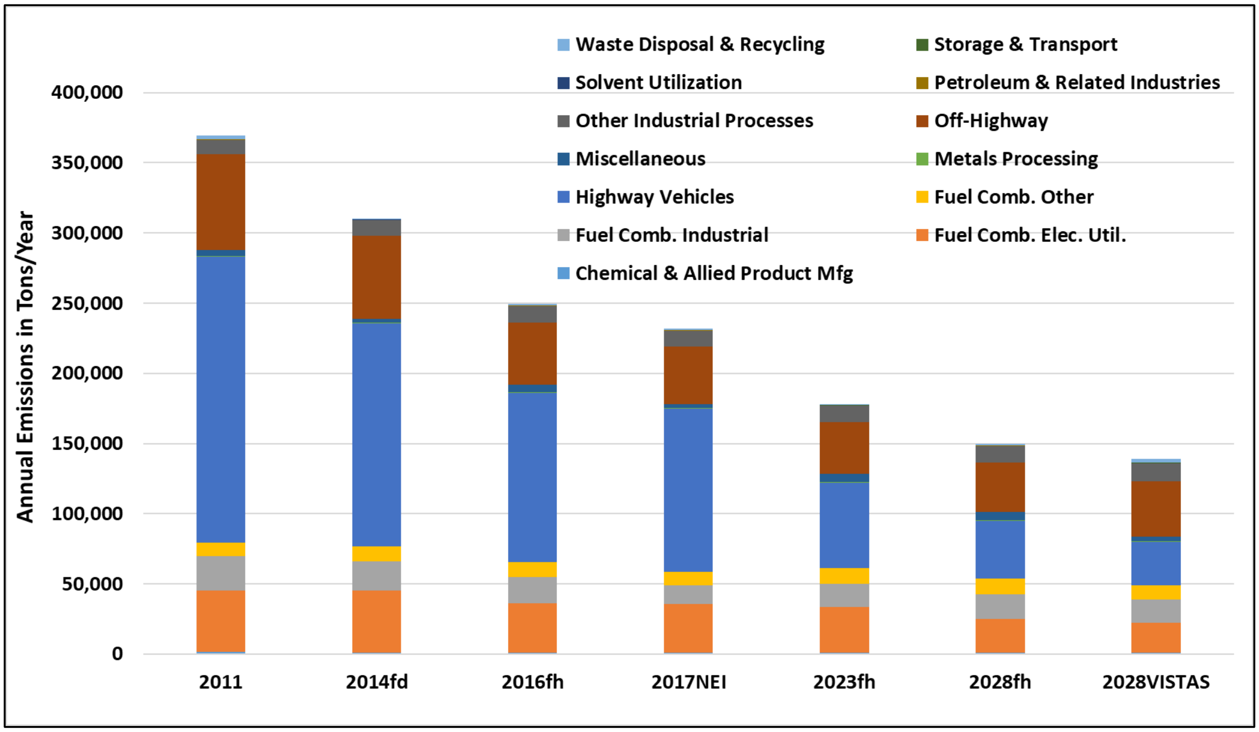

Figure 7-9. North Carolina NO_x Emissions

7.2.6 2028 Model Projections

VISTAS states used emissions modeling, as described in Section 4 and Section 5, 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[89] 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) [90] 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.

7.2.6.1 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 of this SIP 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

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[89] U.S. EPA, Photochemical Modeling Tools, https://www.epa.gov/scram/photochemical-modeling-tools.
[90] U.S. EPA, Modeling Guidance for Demonstrating Air QualityGoals for Ozone, $PM_{2.5}$ and Regional Haze, November 29, 2018, https://www.epa.gov/sites/default/files/2020-10/documents/o3-pm-rh-modeling_guidance-2018.pdf.

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.[91] 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% clearest days from 2011 to 2028. The calendar days from 2011 identified from the IMPROVE data 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, 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.

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

- 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.

7.2.6.2 Calculation of 2028 Visibility Projection Results

Table 7-8 provides the 2028 visibility projections for North Carolina's five Class I areas. More information on these projections may be found in Appendix E-6 (Future Year Model Projections).

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

Class I Area	Site ID	2028 20% Clearest Days (dv)	2028 20% Clearest Days (Mm^{-1})	2028 20% Most Impaired Days (dv)	2028 20% Most Impaired Days (Mm^{-1})
Great Smoky Mountains National Park	GRSM1	8.96	25.02	15.03	46.08
Joyce Kilmer-Slickrock Wilderness Area	GRSM1	8.97	25.02	14.88	45.36
Linville Gorge Wilderness Area	LIGO1	8.21	23.06	14.25	42.61
Shining Rock Wilderness Area	SHRO1	4.54	15.74	13.31	37.86
Swanquarter Wilderness Area	SWAN1	10.77	29.61	15.27	47.42

7.2.6.3 Model Results for the VISTAS 2028 Inventory Compared to the URP Glide Paths for North Carolina 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 time 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 time 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 planning, 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 7-10 through Figure 7-13 illustrate the predicted visibility improvement on the 20% most impaired days by 2028, compared to the URP glide paths for each North Carolina Class I area. The pink line represents the URP at each Class I area. The URP starts at the 2000-2004 average of the 20% most impaired days and ends in 2064 at the estimated natural condition value for each Class I area. 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 planning. Blue diamonds on these figures represent IMPROVE monitoring data on the 20% most impaired days at each Class I area, and the brown lines denote the five-year rolling average of each set of IMPROVE monitoring data.

At all five Class I areas in North Carolina, visibility improvements on the 20% most impaired days are expected to be significantly better than the uniform rate of progress glide path by 2028.

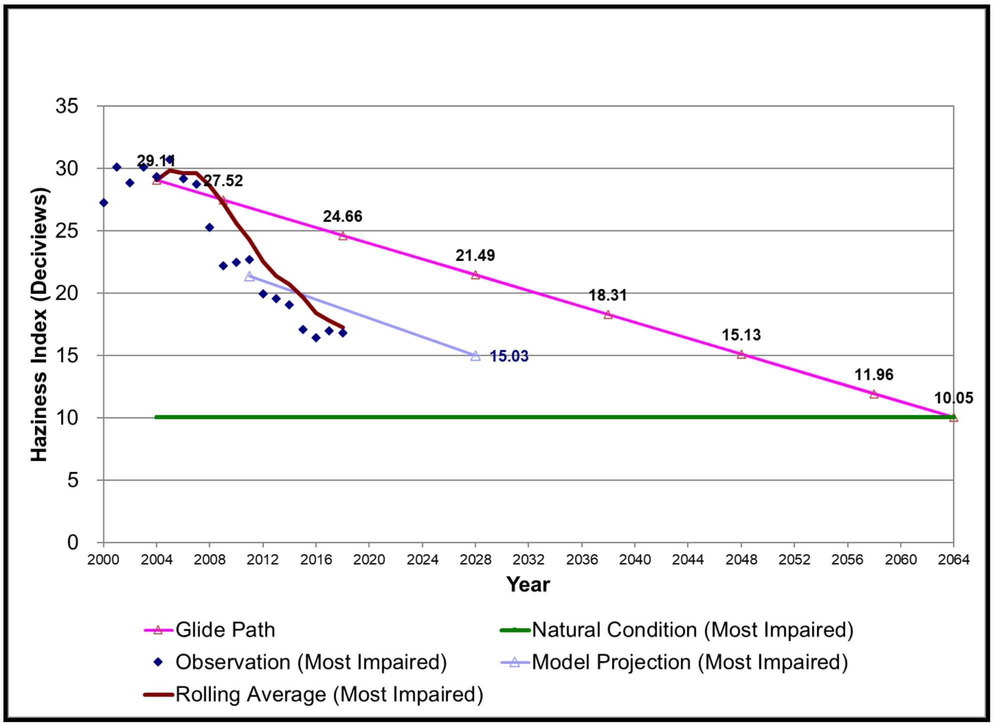


Figure 7-10. Great Smoky Mountains National Park and Joyce Kilmer-Slickrock Wilderness Area URP on the 20% Most Impaired Days

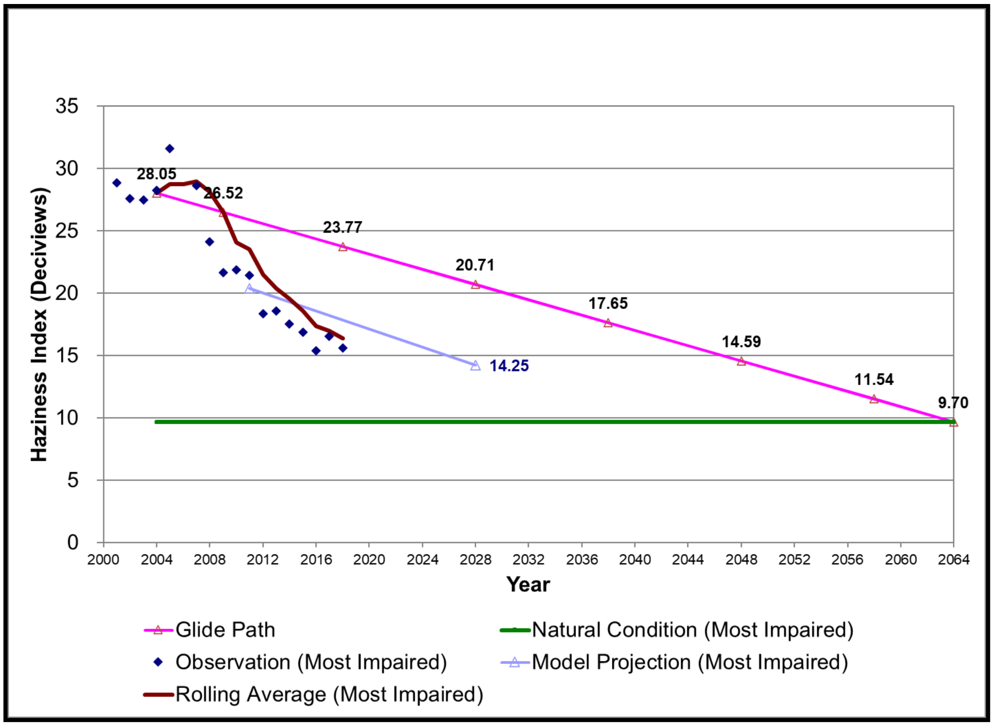


Figure 7-11. Linville Gorge Wilderness Area URP on the 20% Most Impaired Days

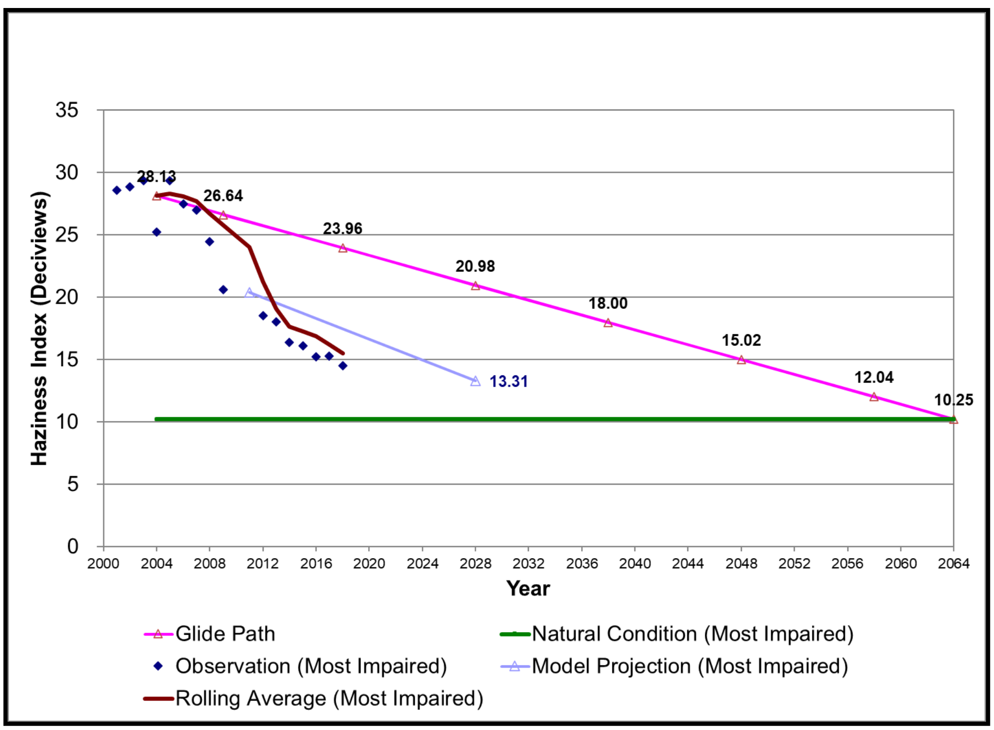


Figure 7-12. Shining Rock Wilderness Area URP on the 20% Most Impaired Days

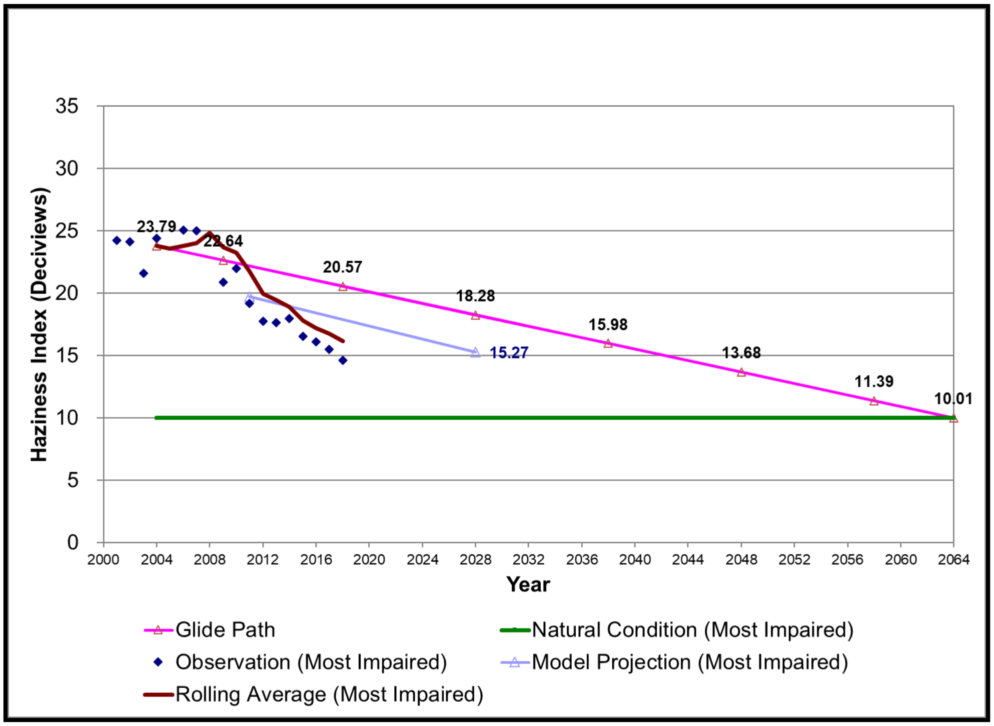


Figure 7-13. Swanquarter Wilderness Area URP on the 20% Most Impaired Days

As illustrated in Figure 7-14, 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 7-14, the percentage displayed represents the difference between the 2028 projected visibility value from and the VISTAS modeling analyses and the expected visibility improvement by 2028 on the URP. Because this calculation is based on level of haze, in deciviews, 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 Great Smoky Mountains National Park is projected to be 30% lower than the expected visibility for 2028 on the URP. Likewise, for Linville Gorge Wilderness Area it is 31%, for Shining Rock Wilderness Area it is 36%, and for Swanquarter Wilderness Area is 18%. For these areas, visibility ranges from 18% to 36% better than the URP by 2028, resulting in visibility improvements that are well ahead of the timeline noted on the URP.

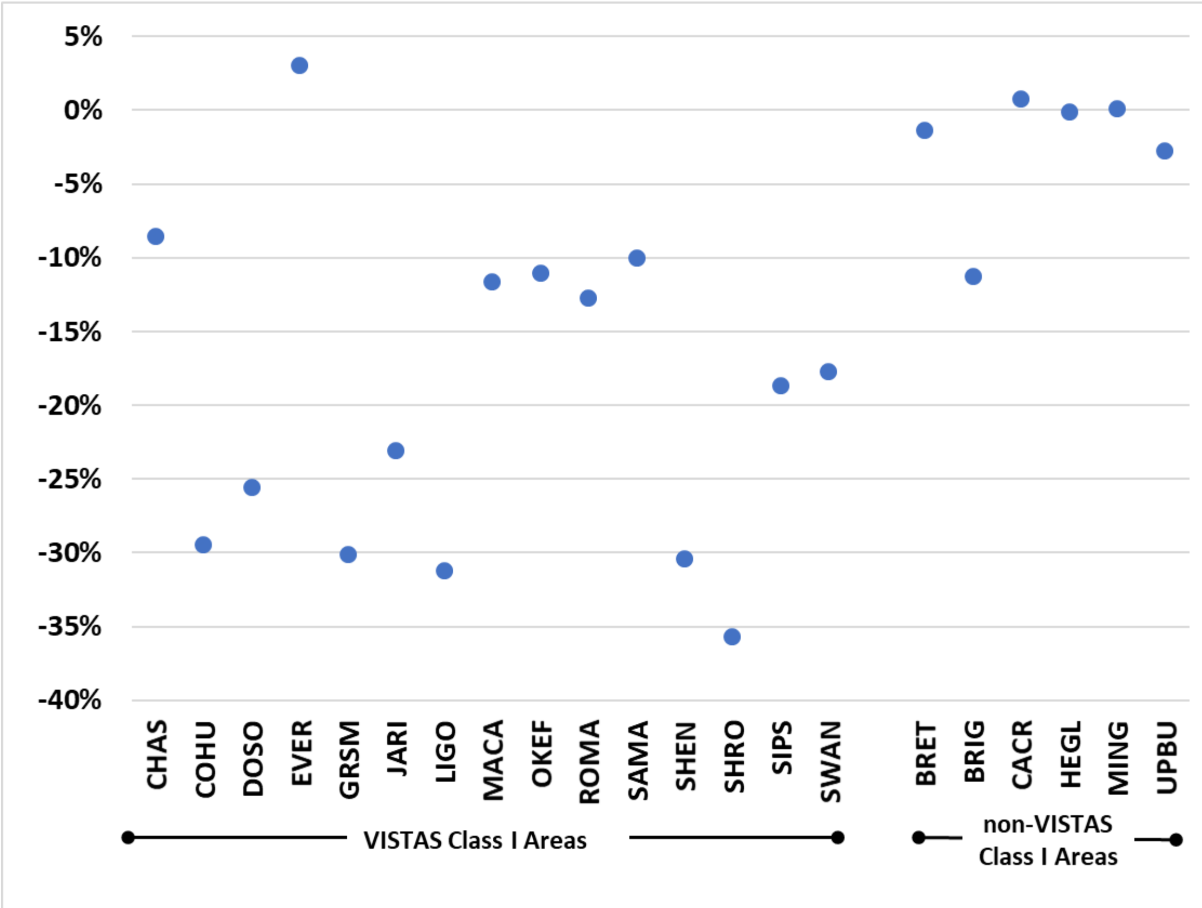


Figure 7-14. Percent of URP in 2028

Figure 7-15 through Figure 7-17 illustrate the visibility improvement in 20% most impaired days. These figures show scenery at the Great Smoky Mountains National Park, Linville Gorge Wilderness Area, and Shining Rock 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.

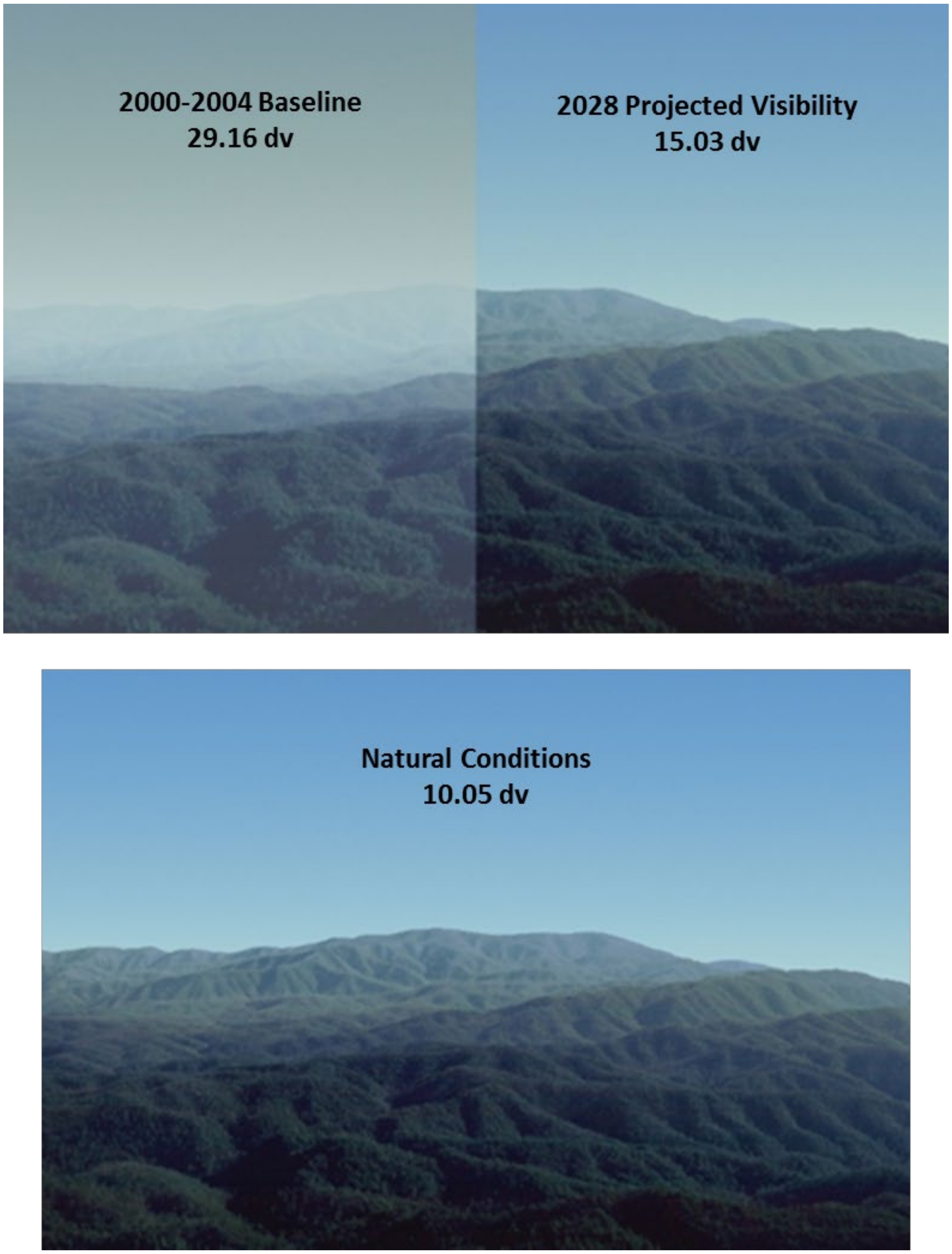
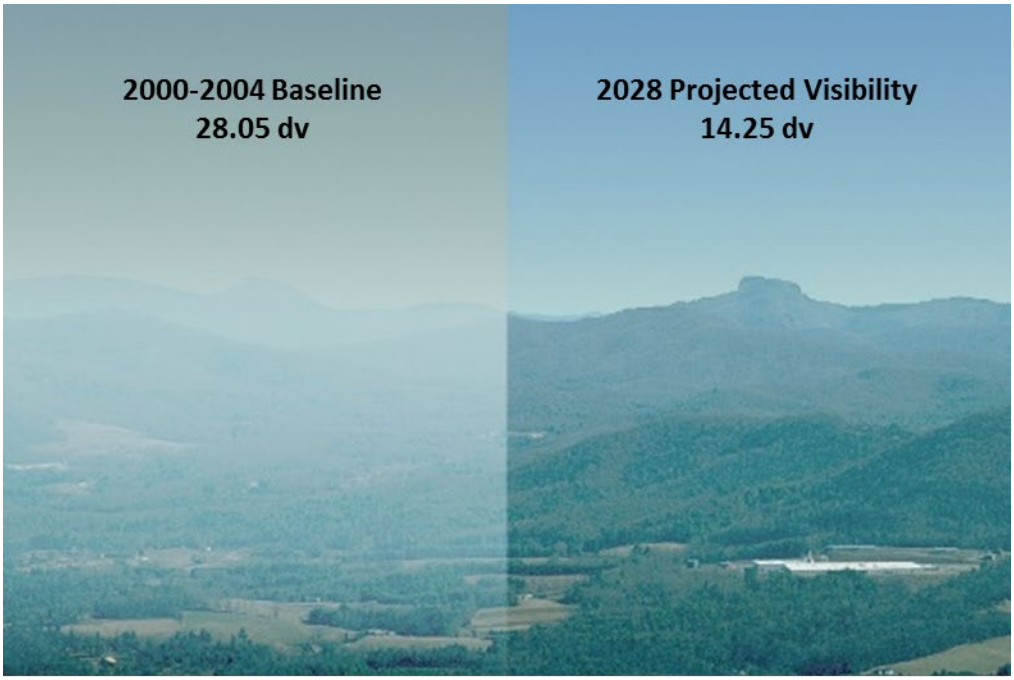


Figure 7-15. Great Smoky Mountains National Park 20% Most Impaired Days in 2000-2004, 20% Most Impaired Days in 2028, and Natural Conditions



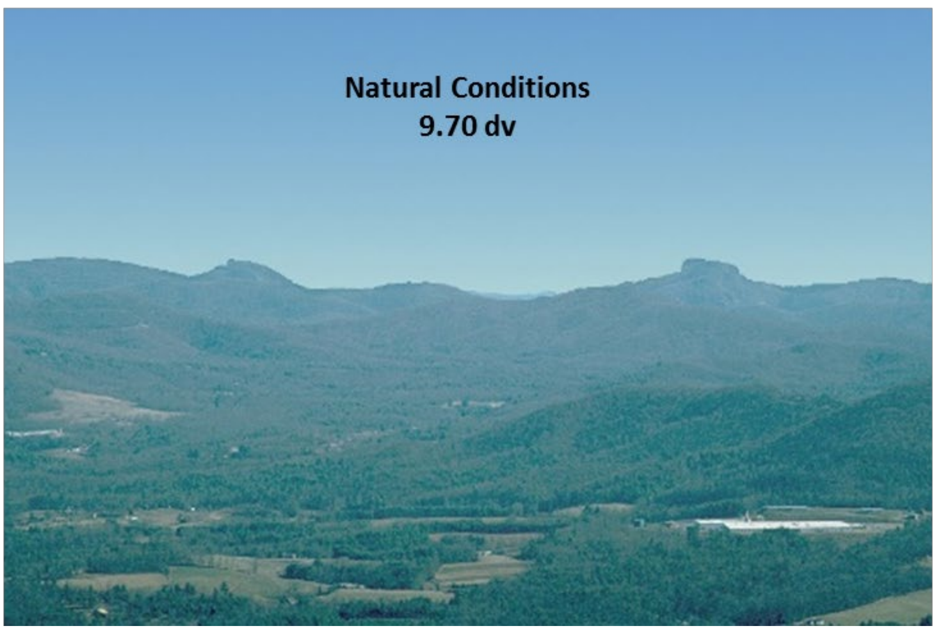


Figure 7-16. Linville Gorge Wilderness Area 20% Most Impaired Days in 2000-2004, 20% Most Impaired Days in 2028, and Natural Conditions

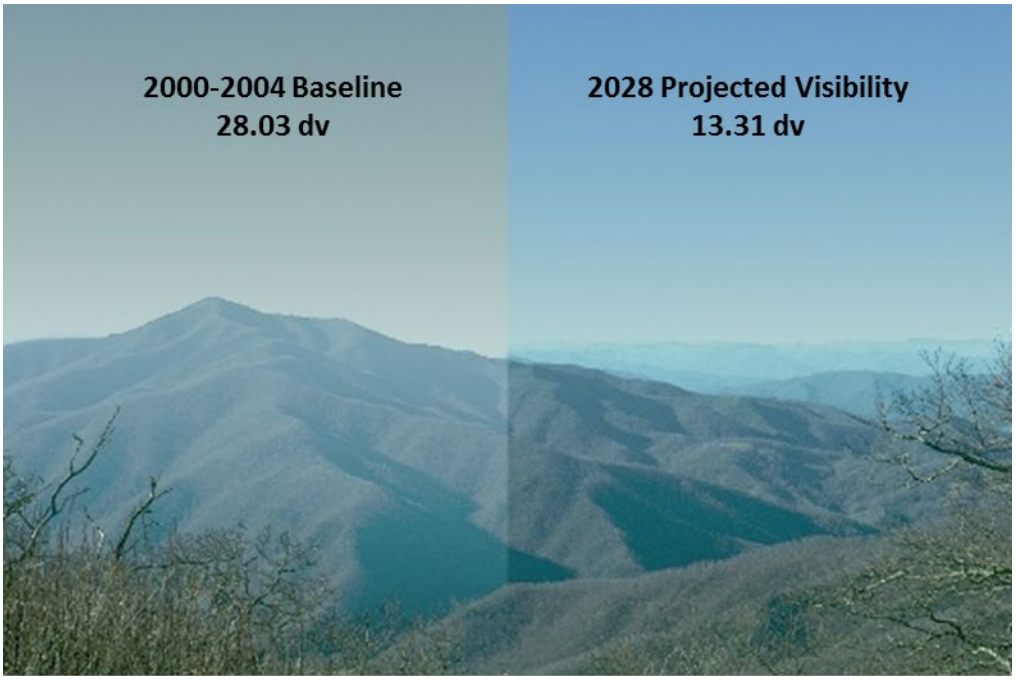


Figure 7-17. Shining Rock Wilderness Area 20% Most Impaired Days in 2000-2004, 20% Most Impaired Days in 2028, and Natural Conditions

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 7-18 through Figure 7-21 show the improvements expected on the 20% clearest visibility days using the VISTAS emissions inventory and associated reductions. The green 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 planning. Blue diamonds depict IMPROVE monitoring data values, and the gray line denotes 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 each site.

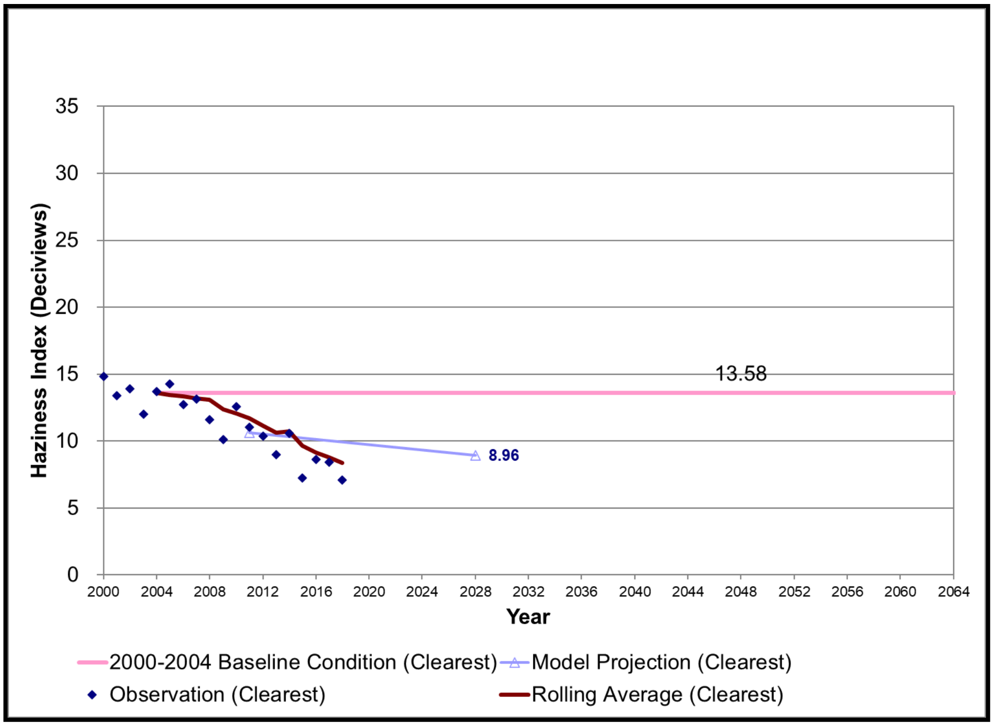


Figure 7-18. 20% Clearest Days Rate of Progress for Great Smoky Mountains National Park and Joyce Kilmer – Slickrock Wilderness Area

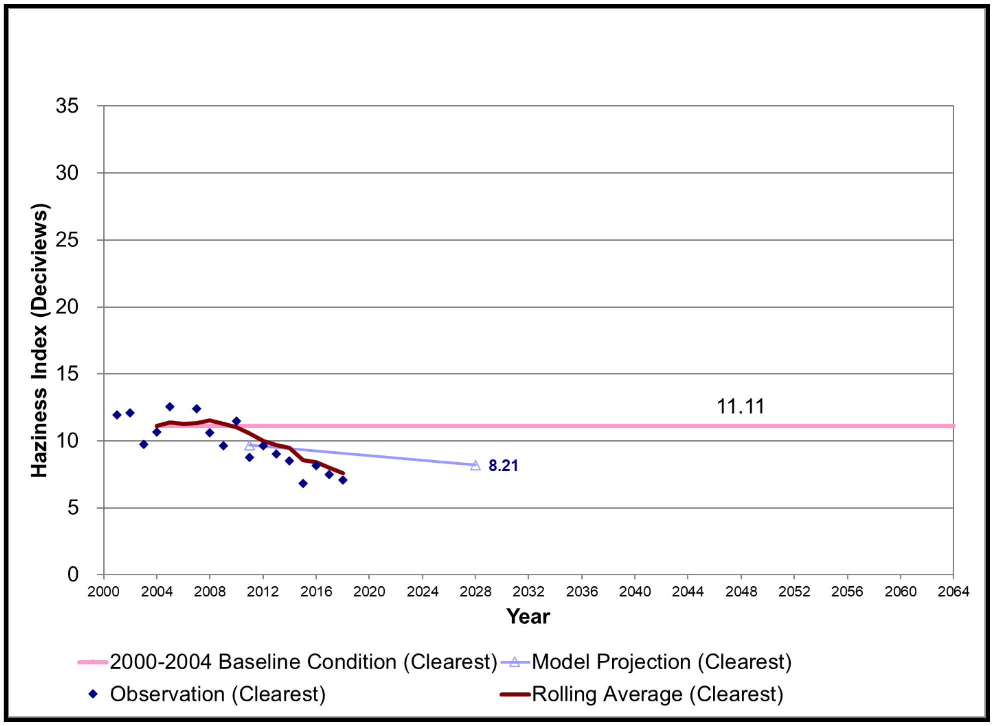


Figure 7-19. 20% Clearest Days Rate of Progress for Linville Gorge Wilderness Area

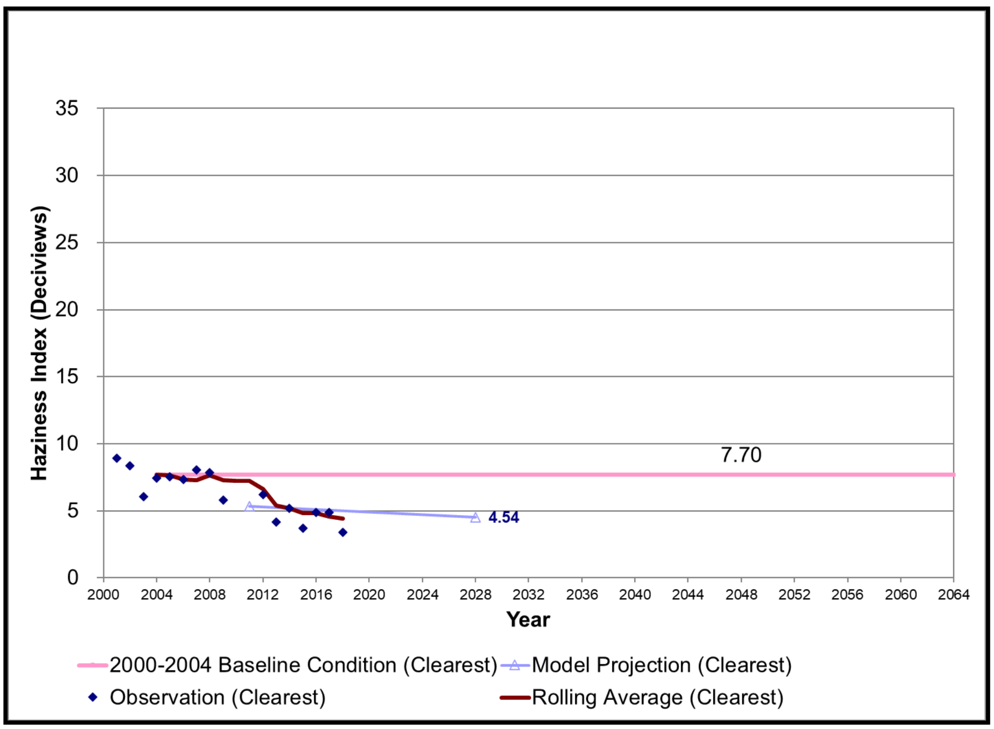


Figure 7-20. 20% Clearest Days Rate of Progress for Shining Rock Wilderness Area

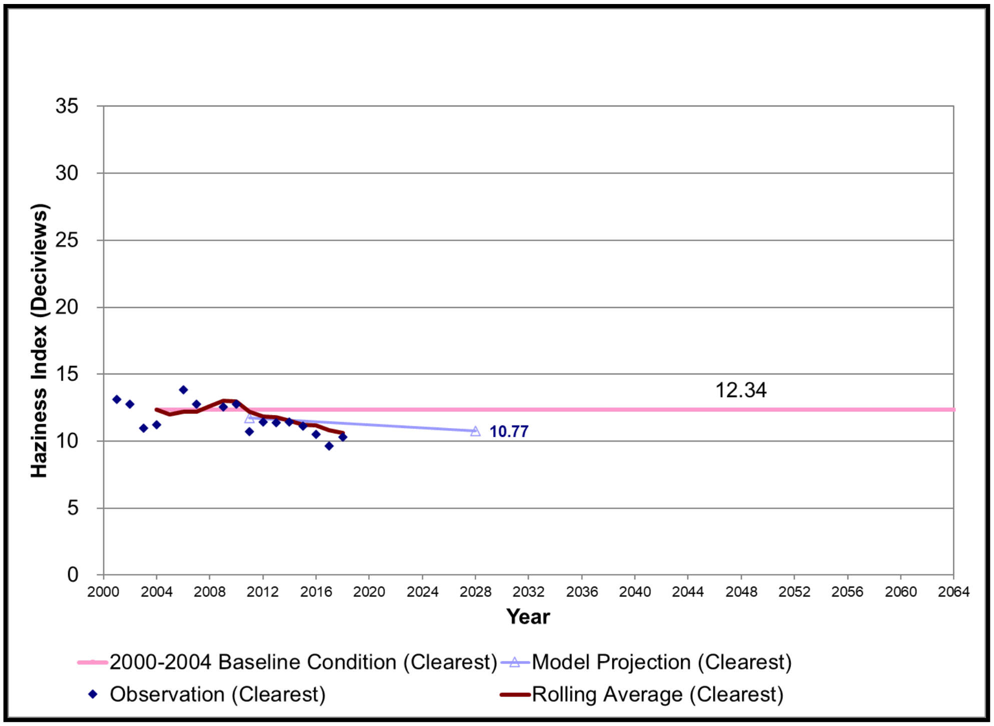


Figure 7-21. 20% Clearest Days Rate of Progress for Swanquarter Wilderness Area

As illustrated in Figure 7-22, visibility on the 20% clearest days is projected to improve in 2028 at all VISTAS and non-VISTAS Class I areas as a result 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 -34% for the Great Smoky Mountains National Park, -26% for Linville Gorge Wilderness Area, -41% for Shining Rock Wilderness Area, and -12% for Swanquarter Wilderness Area.

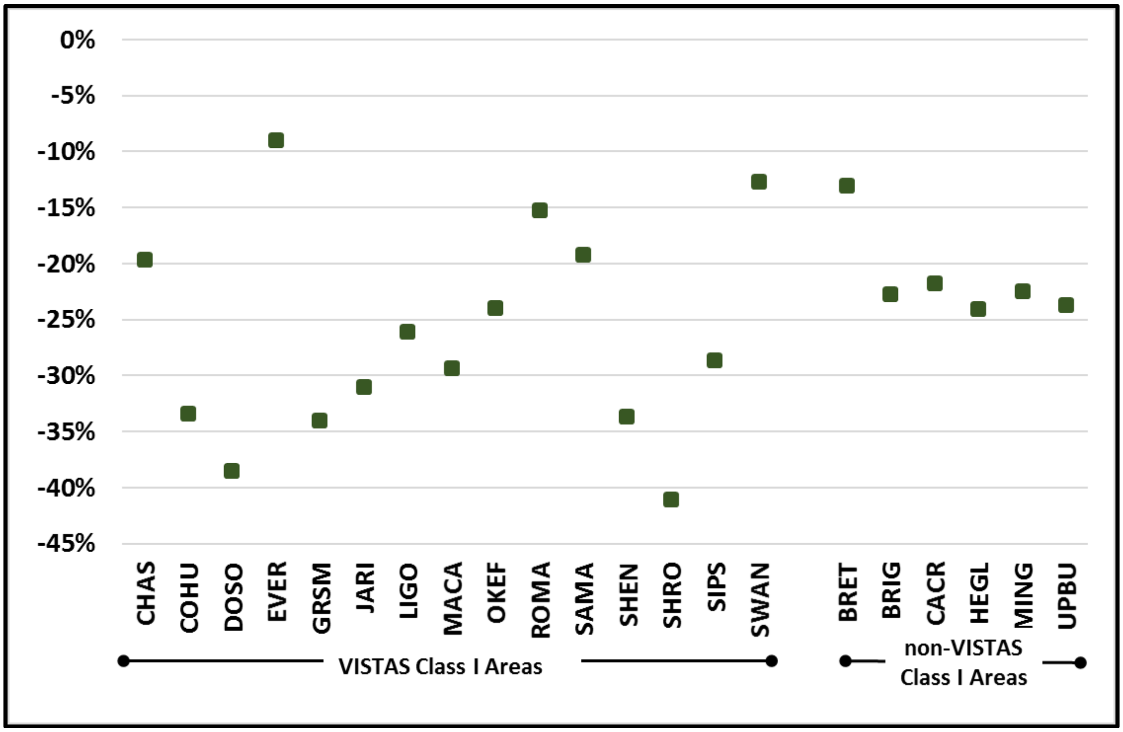


Figure 7-22. Percent Visibility Improvement on 20% Clearest Days

7.2.7 Additional Programs and Initiatives Supporting Past and Future Emissions Reductions

This section discusses additional programs and initiatives that support efforts to continue to control SO_2, NO_x, and other criteria air pollutant emissions throughout North Carolina. These programs are important for maintaining statewide compliance with the NAAQS as well as supporting progress toward improving visibility in Class I areas in North Carolina as well as neighboring states. Table 7-9 identifies the programs and initiatives as well as when they were implemented in the state.

Table 7-9. Summary of Additional Programs and Initiatives

Control Program	Year(s) of Initial Implementation
State Programs Supporting Control of Criteria Air Pollutant and GHG Emissions	
Open Burning Rule	First adopted 1971; last amended 2016
Grant Program	1995 - 2020
Renewable Energy and Energy Efficiency Portfolio Standard (REPS)	2008 - 2019
Air Awareness Program	2008
Advance Program	2019
Volkswagen Settlement	2020 and future years
Executive Order 80 (EO-80) and Clean Energy Plan GHG Emissions Reduction Goals	2025 and 2050
EO-246 GHG Emissions Reduction Goals	2030 and 2050
State Law (SL) 2021-165 (House Bill 951) for Controlling Carbon Dioxide (CO2) Emissions from Duke Energy Facilities	
CO_2 Emissions Reduction Goals	2030 and 2050

7.2.7.1 State Programs Supporting Control of Criteria Air Pollutant and GHG Emissions

This section provides a summary of state programs that have been implemented in North Carolina to support maintenance of the NAAQS and to improve visibility in North Carolina's Class I areas. Although these are important programs for North Carolina, they have not been relied upon as federally enforceable measures for controlling visibility impairment in Class I areas.

- Renewable Energy and Energy Efficiency Portfolio Standard (REPS): On August 20, 2007, with the signing of Session Law 2007-397 (Senate Bill 3),[92] North Carolina became the first state in the Southeast to adopt a REPS. Under this new law, investor-owned utilities in North Carolina are required to meet up to 12.5% of their energy needs through renewable energy resources or energy efficiency measures. Rural electric cooperatives and municipal electric suppliers are subject to a 10% REPS requirement. The final rules implementing the REPS law were adopted by the North Carolina Utilities Commission on February 29, 2008.[93]

  Although the law sets forth a number of details, electric power suppliers generally may comply with the REPS requirement in several ways, including the use of renewable fuels in existing electric generating facilities, the generation of power at new renewable energy facilities, the purchase of power from renewable energy facilities, the purchase of renewable energy certificates, or the implementation of energy efficiency measures. Renewable energy facilities include facilities that generate electric power by the use of a renewable energy resource, combined heat and power systems, and solar thermal energy facilities. Renewable energy resource includes a solar electric, solar thermal, wind, hydropower, geothermal, or ocean current or wave energy resource; a biomass resource, including agricultural waste, animal waste, wood waste, spent pulping liquors, combustible residues, combustible liquids, combustible gases, energy crops, or landfill methane; waste heat derived from a renewable energy resource and used to produce electricity or useful, measurable thermal energy at a retail electric customer's facility; or hydrogen derived from a renewable energy resource.

  North Carolina has made great strides toward diversifying its energy portfolio in a manner that meets the needs of consumers and businesses, provides greater energy diversification, and grows the economy. Since 2008, renewable energy credits (RECS) generated by renewable energy and energy efficiency programs has avoided substantial SO_2, NO_x, and CO_2 emissions. These avoided emissions are displayed in Table 7-10.

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[92] Session Law 2007-397 (Senate Bill 3), https://www.ncleg.net/Sessions/2007/Bills/Senate/PDF/S3v6.pdf.
[93] Final Rules for Implementing Senate Bill 3, https://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=6e5009d5-491e-4d3e-8ce0-9ff6fe493cdd.

Table 7-10 Total Avoided Emissions in 2008 – 2019 Due to REPS

	RECS (MWh)		Emissions Avoided (tons)		
Year	Non-Emitting RE*	EE	CO_2	NO_x	SO_2
2008	539,142	22,907	336,037	251	1,128
2009	790,184	80,008	503,208	316	857
2010	829,824	504,289	787,834	562	1,272
2011	719,672	1,134,040	1,036,715	777	1,367
2012	773,196	1,288,141	1,088,383	860	1,075
2013	1,420,290	2,119,916	1,801,727	1,348	1,532
2014	1,687,381	2,722,860	2,160,432	1,517	1,517
2015	2,131,664	6,218,251	3,855,939	2,601	2,365
2016	3,634,409	4,069,988	3,341,555	2,150	1,714
2017	4,848,953	4,812,048	4,026,254	2,618	1,869
2018	5,794,734	5,572,279	4,544,373	2,990	1,870
2019	6,445,573	5,658,772	4,839,148	3,183	1,991

* Non-Emitting sources include hydropower, solar, and wind projects.

- Executive Order (EO) 80: In 2018, the Governor of North Carolina signed Executive Order 80 (EO-80) in support of the goals of the 2015 Paris Agreement and the U.S. Climate Alliance. EO-80 sets out the achievement of the following objectives by 2025:
  - Reduce state GHG emissions to 40% below 2005 levels.
  - Increase the number of registered zero-emission vehicles to a minimum of 80,000.
  - Reduce energy consumption per square foot in state-owned buildings by at least 40% from fiscal year 2002-2003 levels.

- Clean Energy Plan: EO-80 includes a provision for the development of a Clean Energy Plan (CEP). The purpose of the CEP is to encourage the use of clean energy resources in North Carolina, including energy efficiency, solar, wind, energy storage and other innovative technologies, and the integration of these resources in the development of a modern/resilient electric grid. The CEP was released in October 2019, and outlines several CEP goals, and key recommendations.[94] These goals/recommendations are identified below.

  Goals
  - Reduce electric power sector GHG emissions 70% below 2005 levels by 2030 and attain carbon neutrality by 2050.
  - Foster long-term energy affordability and price stability for North Carolina's residents and businesses by modernizing regulatory and planning processes.
  - Accelerate clean energy innovation, development, and deployment to create economic opportunities for both rural and urban areas of the state.

  Key Recommendations
  - Develop carbon reduction policy designs for accelerated retirement of uneconomic coal assets and other market-based and clean energy policy options.

[94] NC DEQ, State Energy Office, "North Carolina Clean Energy Plan, Transitioning to a 21st Century Electricity System, Policy and Action Recommendations," October 2019, available from https://files.nc.gov/ncdeq/climate-change/clean-energy-plan/NC_Clean_Energy_Plan_OCT_2019_.pdf.

   - Develop and implement policies and tools such as performance-based mechanisms, multi-year rate planning, and revenue decoupling, that better align utility incentives with public interest, grid needs, and state policy.
   - Modernize the grid to support clean energy resource adoption, resilience, and other public interest outcomes.

- EO-246: On January 7, 2022, Governor Cooper signed EO-246 (North Carolina's Transformation to A Clean, Equitable Economy) that establishes the following additional GHG emission reduction goals for the State:[95]
  - Reduce statewide GHG emissions to at least 50 percent below 2005 levels by 2030 and achieve net-zero emissions as soon as possible, no later than 2050; and
  - Increase the total number of registered zero emission vehicles (ZEVs) to at least 1,250,000 by 2030 and increase the sale of ZEVs so that 50 percent of in-state sales of new vehicles are zero-emission by 2030.

- Air Awareness Program: The North Carolina Air Awareness Program is a public outreach and education program of the NCDAQ. The goal of the program is to reduce air pollution though voluntary actions by individuals and organizations. The program seeks to educate individuals about (1) the sources of air pollution; (2) the health effects of air pollution and how these effects can be mitigated by modification of outdoor activities on ozone action days; and (3) simple "action tips", such as carpooling, vehicle maintenance and energy conservation that reduce individual contributions to air pollution. One of the major program components is the daily air quality forecast. The NCDAQ produces the 8-hour ozone forecasts and corresponding air quality index for the 1997 8-hour ozone nonattainment area from March 1 through October 31 of each year.[96]

- Advance Program: The NCDAQ joined the EPA Advance program in September 2017. The EPA Advance Program encourages collaborations between state, local, and community organizations to encourage emissions reductions in areas that are currently in attainment of the ozone and $PM_{2.5}$ NAAQS. The program provides a flexible framework for organizations who want closer involvement and support from the NCDAQ and EPA in achieving these emission reductions. In 2019, the NCDAQ developed a set of Advance Program plans that could be used to leverage Air Awareness Program projects in support of continued NAAQS maintenance.[97]

- Open Burning Rule (15A NCAC 02D .1903): This rule prohibits open burning of man-made materials throughout the state. Additionally, the rule prohibits nearly all types of open burning in a county that the NCDAQ, or the Forsyth County Office of Environmental Assistance and Protection, has forecasted to be in an Air Quality Action Day Code "Orange" or above during the 24-hour time period covered by that Air Quality Action Day. Daily

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[95] State of North Carolina, Governor Roy Cooper, Executive Order No. 246, "North Carolina's Transformation To A Clean, Equitable Economy," January 7, 2022, https://governor.nc.gov/media/2907/open.
[96] NCDAQ, "N.C. Air Awareness," available from https://deq.nc.gov/ncairawareness.
[97] NCDAQ, "Ozone and Particulate Matter Advance Programs Path Forward," October 2019.

forecasts are issued for $PM_{2.5}$ for each day of the year and daily ozone forecasts are issued from March 1 through October 31 of each year. The open burning rule reduces NO_x, VOC, CO, $PM_{2.5}$, and PM_{10}.

- Grant Programs: The NCDAQ has offered multiple forms of grant funding from state and federal funds to help cover the costs associated with emission reduction projects across the state. These projects include diesel engine replacements, diesel oxidation catalyst retrofits, marine diesel repowers, replacing gasoline vehicles with electric vehicles, vehicle replacement and many more. Grant projects that have been awarded have helped to reduce PM, NO_x, CO, and VOC emissions from mobile sources, and have included federal funds from the Diesel Emissions Reduction Act (DERA) and the American Recovery and Reinvestment Act (ARRA). The DERA and ARRA funds have been used to retrofit, repower or replace existing diesel engines from on-road and nonroad mobile source vehicles/equipment. Even though these emission reductions are voluntary and not enforceable, they still represent permanent reductions.

- Volkswagen Settlement: In 2015, Volkswagen (VW) publicly admitted that it had secretly and deliberately installed defeat-device software designed to cheat emissions tests and deceive federal and state regulators in approximately 590,000 model year 2009 to 2016 motor vehicles containing 2.0- and 3.0-liter diesel engines. The United States Department of Justice filed a complaint against VW, alleging that the company had violated the CAA. In October 2016 and May 2017, the U.S. District Court, Northern District of California ("Court"), approved two partial settlements related to the affected 2.0- and 3.0-liter vehicles, respectively, totaling $14.9 billion ("the VW Settlement").

  The VW Settlement is being implemented through the First Partial Consent Decree and Second Partial Consent Decree. Under these consent decrees, VW has agreed to: (1) dedicate $10 Billion to the recall of at least 85% of the affected 2.0- and 3.0-liter vehicles; (2) invest $2 Billion in zero-emission vehicle infrastructure and promotion ("Zero Emission Vehicle Investment Plan"); and (3) establish a $2.9 Billion Environmental Mitigation Trust (EMT) to mitigate the environmental effects of the excess NO_x emissions from the affected vehicles. The purpose of the EMT is to execute environmental mitigation projects that reduce emissions of NO_x. In accordance with the EMT goal, North Carolina will use the funds to achieve significant NO_x emissions reductions across the state by soliciting for projects from all eligible mitigation actions.

  Based on the distribution of violating vehicles registered across the state, North Carolina plans to allocate the funds between urban/suburban counties (68%) and rural counties (32%). North Carolina will select projects throughout the state that will reduce or eliminate emissions of NO_x focusing on the most cost-effective projects, the quantity of NO_x emission reductions and other factors. North Carolina has submitted its mitigation plan for the state's $92 million share of the EMT on August 22, 2018. This plan details how the state will invest the first 33% ($30.6 million) of the state's allocation in Phase 1 on projects to significantly reduce NO_x emissions and improve air quality. Project solicitations for Phase 1 for the Diesel Bus & Vehicle and the Direct Current (DC) Fast Charging Infrastructure Programs, the solicitation closed on September 30, 2019.

116 applications were received with a total of 102 applications eligible for funding between the two programs with an approximate total of $46.8 million in requests for projects. Seventy applications were selected for full or partial funding with 69 project awards accepted totaling $26 million. A total of 27.7 annual tons of NO_x is estimated to be mitigated when projects are completed for the two programs.

On November 17, 2020, the Request for Proposals was released for the Phase 1 Level 2 Charging Infrastructure Rebate Program with approximately $1.15 million available to install Zero Emission Vehicle (ZEV) Level 2 charging infrastructure. The primary goal of this program is to continue the state's goal to increase use of ZEVs in the state and available charging infrastructure.

North Carolina will start Phase 2 planning of the Volkswagen Settlement Program in 2021 with a revised Mitigation Plan and a stakeholder process for input on how the remaining funds should be used.

7.2.7.2 State Law (SL) 2021-165 (House Bill 951) for Controlling Carbon Dioxide (CO_2) Emissions from Duke Energy Facilities[98]

On October 13, 2021, Governor Cooper signed bipartisan legislation SL 2021-165 that authorizes the North Carolina Utilities Commission (NCUC) to:

- Take all reasonable steps to achieve a 70% reduction in CO_2 emissions emitted in the State from electric public utilities from 2005 levels by the year 2030, and carbon neutrality by the year 2050,[99]
- Authorize performance-based regulation of electric public utilities,
- Proceed with rulemaking on securitization of certain costs and other matters, and
- Allow potential modification of certain existing power purchase agreements with eligible small power producers.

Part I, Section 1.(1) of SL 2021-165 requires the NCUC to "Develop a plan, no later than December 31, 2022, with the electric public utilities, including stakeholder input, for the utilities to achieve the authorized reduction goals, which may, at a minimum, consider power generation, transmission and distribution, grid modernization, storage, energy efficiency measures, demand-side management, and the latest technological breakthroughs to achieve the least cost path consistent with this section to achieve compliance with the authorized carbon reduction goals (the "Carbon Plan"). The Carbon Plan shall be reviewed every two years and may be adjusted as

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[98] State Law 2021-165 (House Bill 951), chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/viewer.html?pdfurl=https%3A%2F%2Fncleg.gov%2FSessions%2F2021%2FBills%2FHouse%2FPDF%2FH951v6.pdf&clen=186699&chunk=true
[99] SL 2021-165 allows 5% of the 2050 CO_2 reductions to be met with offsets.

necessary in the determination of the Commission and the electric public utilities." The electric public utilities affected by SL 2021-165 include Duke Energy Progress and Duke Energy Carolinas in North Carolina.[100] Achieving these CO_2 emission reduction goals will most likely require Duke Energy to change its power generation fleet to move away from coal toward cleaner and renewable fuels which will also have the effect of further reducing SO_2 and NO_x emissions.

7.2.8 Emissions Reductions Not Included in the 2028 RPG Modeling

From March 25, 2018 through Dec. 31, 2020, a total of 96 non-EGU point source facilities have closed and for which the air permits have been rescinded after the NCDAQ prepared the 2028 inventory from the 2016 base year inventory. Table 7-11 shows the total annual criteria air pollutant emissions reported by the facilities in 2016 and projected 2028 emissions for the facilities.

Table 7-11. Historical and 2028 Projected Annual Emissions Associated with Facility Closures not included in 2028 Emissions Projections (Tons)

Pollutant	Actual 2016	Projected 2028
CO	217.85	239.30
NO_x	248.24	287.11
PM_{10}-PRI	136.26	184.67
PM25-PRI	87.44	110.22
SO_2	204.13	208.34
VOC	1,448.94	1,649.41

In addition, Edgecombe Genco Power Station, LLC (ORIS ID 10384, EIS Facility ID 8124311, NC ID 3300146), Battleboro, North Carolina, was a co-generation facility with steam generating units permitted to burn various fuels (i.e., coal/natural gas/No. 2 fuel oil/No. 4 fuel oil/tire derived fuel (TDF)/wood chips). This facility discontinued operation in 2018 and the NCDAQ rescinded the air quality permit for the facility on July 20, 2020.[101] Table 7-12 summarizes recent historical emissions (2016-2019) and projected 2028 emissions for the Edgecombe Genco Power Station. Although this facility generated electricity for the power grid, it was not included in the ERTAC projections because it was a co-generation facility and therefore was included in the 2028 projections for non-EGU point sources. The emissions in Table 7-12 are not included in Table 7-11.

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[100] For purposes of Part I, Section 1.(1) of SL 2021-165, "electric public utility" means any electric public utility as defined in G.S. 62-3(23) serving at least 150,000 North Carolina retail jurisdictional customers as of January 1, 2021.

[101] This facility was not included in the ERTAC EGU projections tool.

Table 7-12. Summary of Historical and 2028 Projected Emissions for Edgecombe Genco Power Station, Battleboro, North Carolina (Tons)

Pollutant	Actual 2016	Actual 2017	Actual 2018	Actual 2019	Projected 2028
CO	23.50	18.28	20.50	0.00	23.50
NO_x	450.46	355.14	399.60	0.00	450.47
PM_{10}-PRI	5.93	3.99	4.14	0.00	5.50
PM25-PRI	0.42	0.35	0.38	0.00	0.58
SO_2	31.03	28.14	51.88	0.00	31.03
VOC	1.22	1.06	1.13	0.00	1.17

On January 14, 2021, the USEPA entered into a consent decree[102] with Pilkington North America, Inc., which owns and operates a float glass manufacturing facility in Laurinburg, North Carolina. The consent decree mandates, among other things, the installation and operation of control equipment for NO_x, SO_2, and PM, as well as emission limits for each of these pollutants. The compliance date set forth in the consent decree is March 31, 2023. There is also a requirement that the facility must request either a federally enforceable permit or revision the North Carolina's SIP to make these requirements and limits permanent and enforceable by March 31, 2024. To control NO_x, the Pilkington is required to install an SCR or ceramic filter system with 90% control efficiency and to meet an emission limit of 80% control. To control SO_2 emissions, the plant is required to install a dry scrubber or ceramic filter system to meet an emission limit of 1.2 lb/ton glass produced. To control PM emissions, the plant is required to install a particulate control device to meet the emission limit of 0.45 lb/ton glass produced.

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 RHR 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, EPA released Technical Support Document for EPA's Updated 2028 Regional Haze Modeling.[103] This document provides the results of EPA's updated 2028 visibility modeling analyses and includes projections of both domestic and international source contributions. 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. EPA used these estimated contributions to derive adjusted glidepath endpoints for each Class I area.

In this study, EPA used the CAMx PSAT tool to tag certain sectors. EPA processed each sector through the SMOKE model and tracked each sector in PSAT as an individual source tag. The

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[102] The consent decree is available at https://www.justice.gov/file/1359731/download.

[103] U.S. EPA, Technical Support Document for U.S. EPA's Updated 2028 Regional Haze Modeling, https://www.epa.gov/visibility/technical-support-document-epas-updated-2028-regional-haze-modeling.

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, Type C3-class commercial marine emissions outside of the emissions control area as described in Section 7.2.2, and international anthropogenic boundary conditions.

Results from this study show that 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 7-13 provides the estimated international anthropogenic visibility impacts to VISTAS Class I area from EPA's study.

Table 7-13. 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	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	GA	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	VA	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

North Carolina's Class I areas are expected to be well beneath the 2028 URP goal based on VISTAS modeling, which includes current and forthcoming control programs. The estimated international emissions impact is 4.48 Mm^{-1} for the for Great Smoky Mountains National Park, 4.84 Mm^{-1} for the Joyce Kilmer-Slickrock Wilderness Area, 4.10 Mm^{-1} for the Linville Gorge Wilderness Area, 4.70 Mm^{-1} for the Shining Rock Wilderness Area, and 5.13 Mm^{-1} for the Swanquarter Wilderness Area. Adjustments to the 2028 URP 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 URP. Therefore, in this round of regional haze planning, North Carolina is not updating the 2028 uniform rate of progress goals based on 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 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 CENRAP, 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 CENRAP, 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 CENRAP, 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 Class I area are available for comparison.

Figure 7-23 shows the 2028 nitrate impairment from each region at Class I areas within VISTAS. Most 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 mandatory Class I areas in VISTAS (except Everglades National Park and Okefenokee Wilderness Area) show contributions to nitrate impairment from the CENRAP, LADCO, and MANE-VU sources (dark gray, gray, and light gray, respectively), as well as the sum of the other VISTAS states, that are larger than home state contributions.

Figure 7-24 shows the 2028 sulfate impairment from each region at Class I areas within VISTAS. All areas, except Everglades National Park, show sulfate impacts of at least 10 Mm^{-1}. All Class I areas in VISTAS (except Everglades National Park) show contributions to sulfate impairment from CENRAP, LADCO, and MANE-VU sources (dark gray, gray, and light gray, respectively), as well as the sum of the other VISTAS states, that are larger than home state contributions.

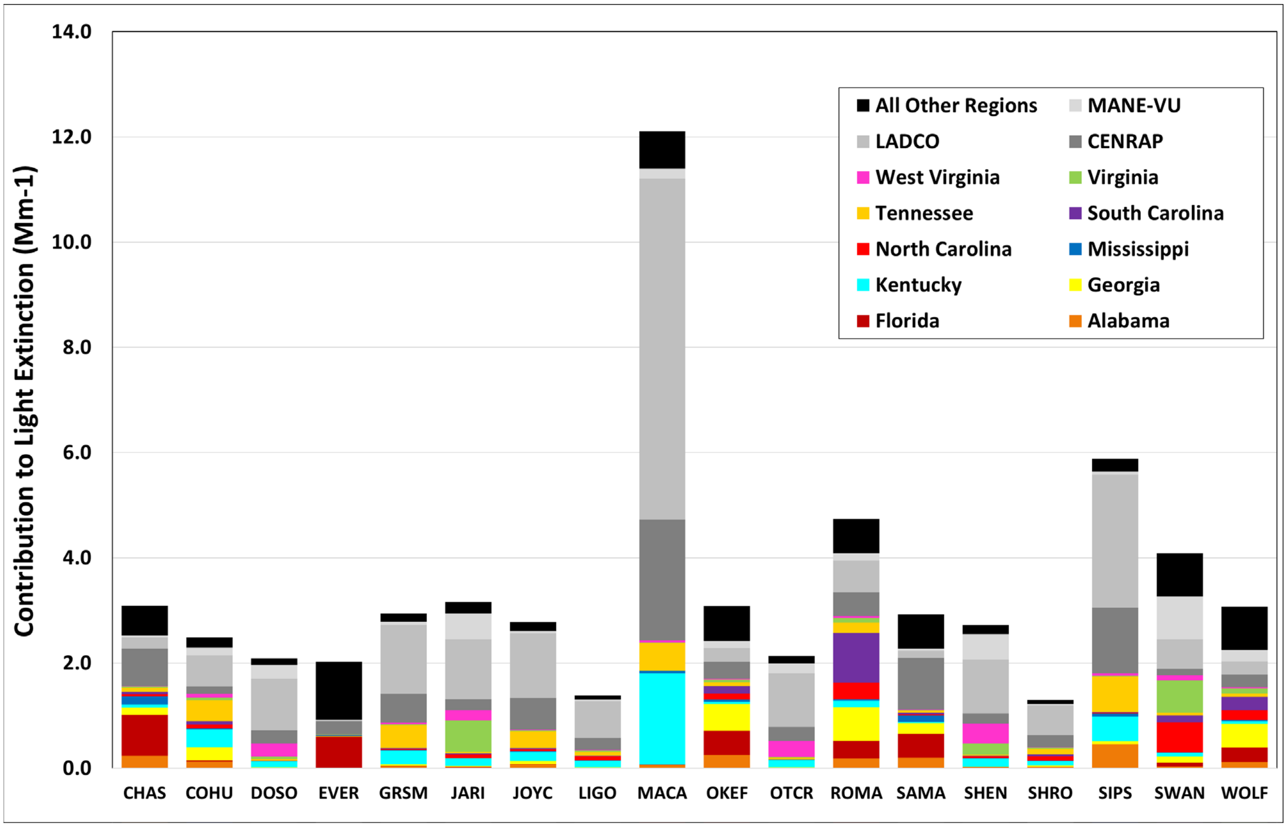

Figure 7-23. 2028 Nitrate Visibility Impairment, 20% Most Impaired Days, VISTAS Class I Areas

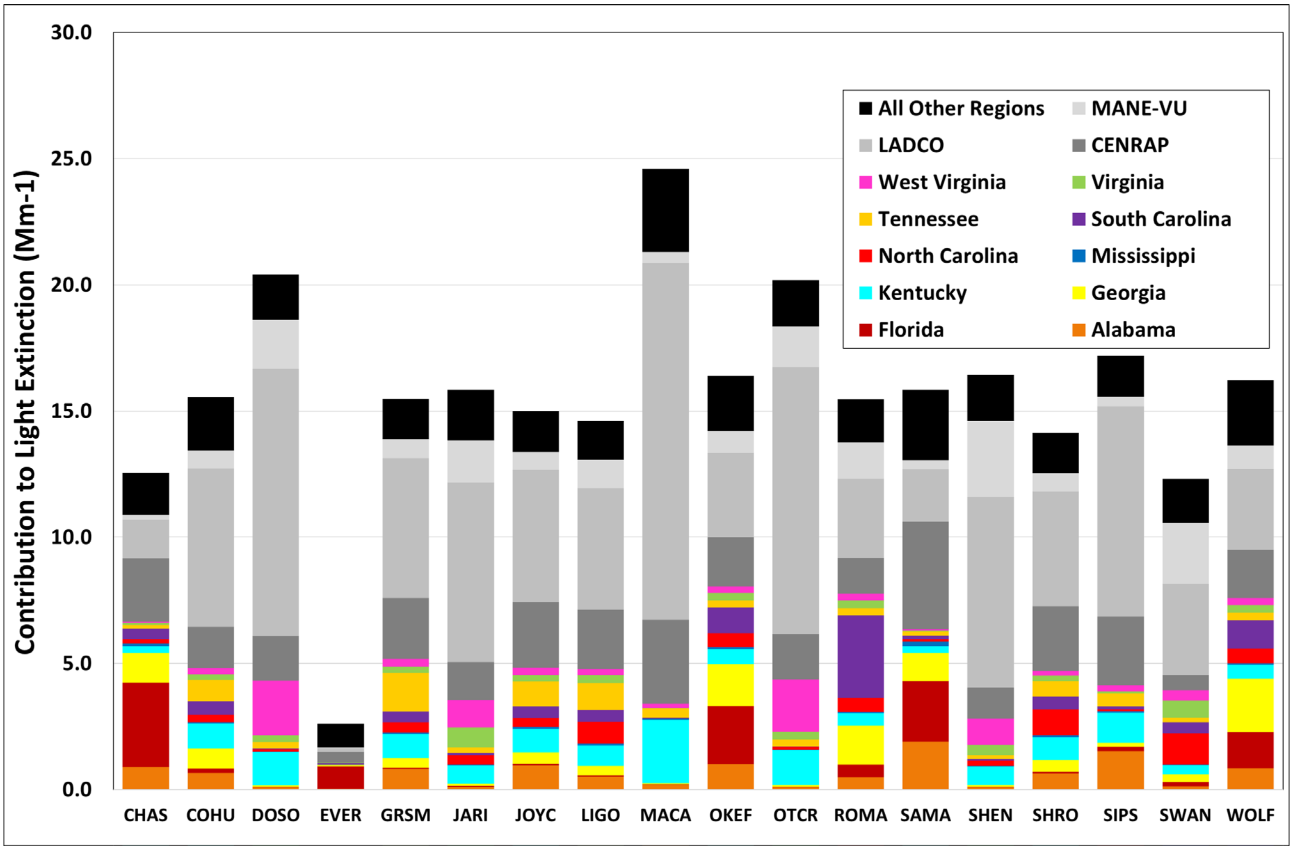

Figure 7-24. 2028 Sulfate Visibility Impairment, 20% Most Impaired Days, VISTAS Class I Areas

These data in these figures indicate that sulfate will continue to be the primary driver of visibility impairment in most VISTAS Class I areas, much more so than nitrate. These data also show that emissions from sources located outside of the home state and outside VISTAS have a significant impact on visibility in VISTAS Class I areas.

Figure 7-25 and Figure 7-26 provide comparisons of projected light extinction from sulfate and nitrate in 2028 at 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 7-25 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 Class I areas within VISTAS except Everglades National Park. Figure 7-25 also shows that for some VISTAS 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 the majority of sulfate impairment but that the relative impacts from each sector are similar.

Figure 7-26 provides nitrate light extinction data in 2028 for 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. Across all VISTAS Class I areas, nitrate contributions from point sources – both EGU and non-EGU – constitute a small percentage of total nitrate contributions. In North Carolina in particular, the majority of the state's current NO_x emission portfolio comes from the mobile sector (cars, trucks, etc.) because in-state point-source NO_x emissions (from EGU's in particular) have significantly decreased over the last 25 years.[104]

Figure 7-25 and Figure 7-26 show that sulfates generally contribute more to light extinction in 2028 at VISTAS federal mandatory 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 7-26 also show that the majority of nitrate light extinction is not caused by NO_x emissions from EGU and non-EGU point sources.

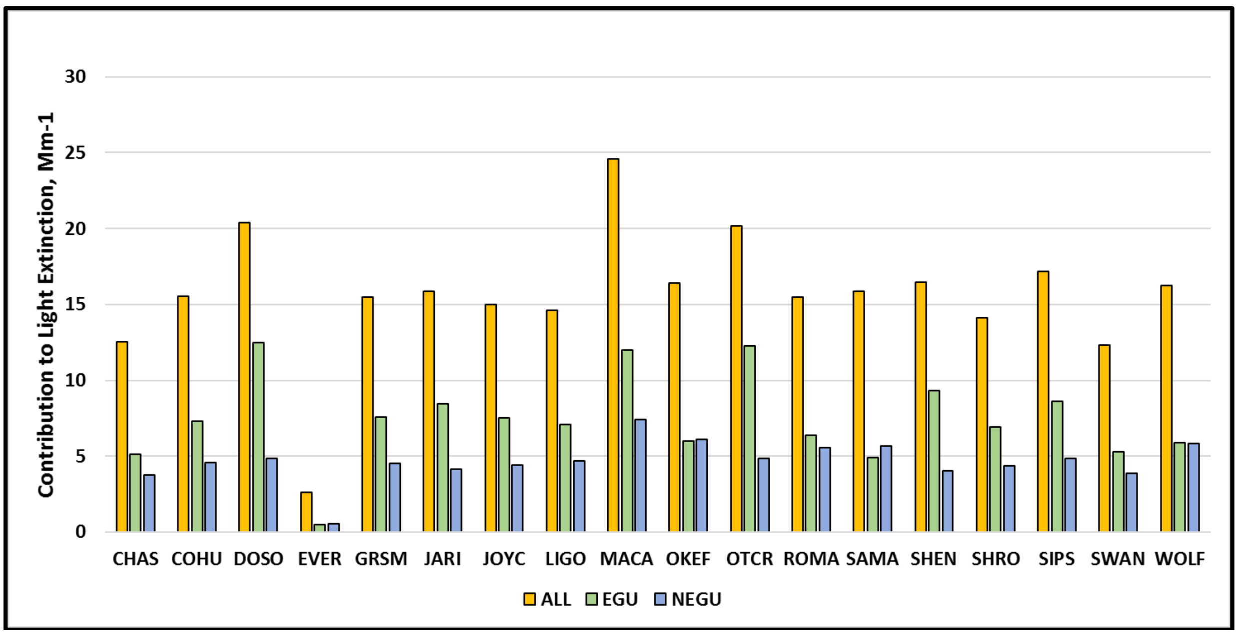

Figure 7-25. 2028 Visibility Impairment from Sulfate on 20% Most Impaired Days, VISTAS Class I Areas

[104] NC DEQ, "Air Quality Trends in North Carolina", October 2020, https://files.nc.gov/ncdeq/Air%20Quality/planning/Air_Quality_Trends_in_North_Carolina_2020.pdf.

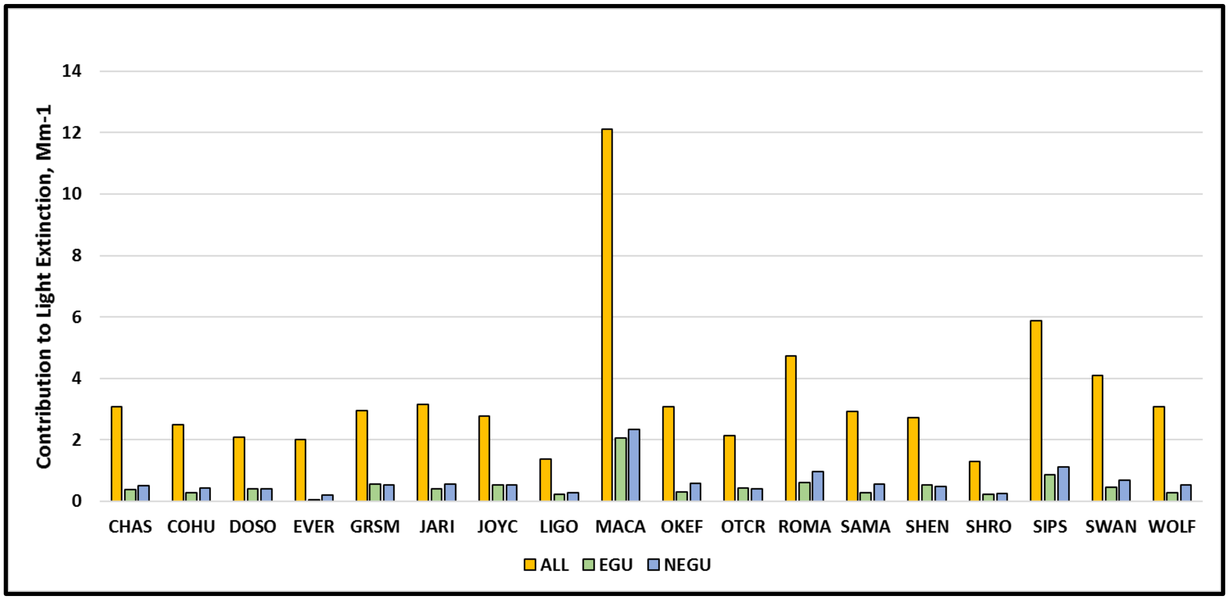

Figure 7-26. 2028 Visibility Impairment from Nitrate on 20% Most Impaired Days, VISTAS Class I Areas

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 Class I areas than nitrates.
- Emissions from other regional planning organizations (MANE-VU, LADCO, and CENRAP) generally have higher contributions to 2028 visibility impairment at 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 Class I areas in VISTAS.

Figure 7-27 through Figure 7-31 provide more detailed comparisons for the Swanquarter Wilderness Area, Shining Rock Wilderness Area, Linville Gorge Wilderness Area, Joyce Kilmer-Slickrock Wilderness Area, and the Great Smokies National Park, respectively. These figures show that projected light extinction in 2028 from total sulfate is significantly larger than light extinction from total nitrate. Across the interior Class I areas (e.g., Shining Rock National Park, Linville Gorge, Joyce Kilmer-Slickrock, and the Great Smokies National Park), projected total sulfate extinction is greater than 17 Mm^{-1} while total projected total nitrate extinction is less than 3.5 Mm^{-1}. At Swanquarter, the projected sulfate extinction is 16.6 Mm^{-1} with projected nitrate extinction is 4.5 Mm^{-1}. Of these nitrate contributions, North Carolina sources contribute a small percentage to total nitrate impairment in all cases, anywhere from less than 1% of all nitrate visibility impairment at Great Smokies National Park to 13% at Swanquarter.

These figures also show that sulfate from EGUs and non-EGUs account for the majority of the total sulfate impact at these Class I areas in North Carolina. For Great Smoky Mountains National Park, the 2028 sulfate extinction from EGUs and non-EGU point sources is 11.2 Mm^{-1}, comprising 63.8% of the total sulfate extinction of 19.0 Mm^{-1}; for Joyce Kilmer-Slickrock

Wilderness, the 2028 sulfate extinction from EGUs and non-EGU point sources is 12.0 Mm^{-1}, comprising 64.5% of the total sulfate extinction of 18.6 Mm^{-1}; for Linville Gorge, the 2028 sulfate extinction from EGUs and non-EGU point sources is 11.8 Mm^{-1}, comprising 65.7% of the total sulfate extinction of 17.9 Mm^{-1}; for Shining Rock, the 2028 sulfate extinction from EGUs and non-EGU point sources is 11.3 Mm^{-1}, comprising 64% of the total sulfate extinction of 17.6 Mm^{-1}; finally, for Swanquarter Wilderness Area, the 2028 sulfate extinction from EGUs and non-EGU point sources is 9.1 Mm^{-1}, comprising 54.9% of the total sulfate extinction of 16.7 Mm^{-1}.

Lastly, these figures show that sulfates originating in the LADCO region contribute substantially to the estimated 2028 sulfate impairment at these Class I areas in North Carolina. For Great Smoky Mountains National Park, sulfates originating within LADCO contribute 10.7 Mm^{-1} to visibility impairment in 2028, or 57% of the total sulfate impact; for Joyce Kilmer-Slickrock Wilderness, 10.2 Mm^{-1} or 55% of total sulfate impact; for Linville Gorge, 9.4 Mm^{-1} or 52% of total sulfate impact; for Shining Rock, 8.8 Mm^{-1} or 50% of total sulfate impact; finally, for Swanquarter Wilderness Area, 6.9 Mm^{-1} or 42% of total sulfate impact.

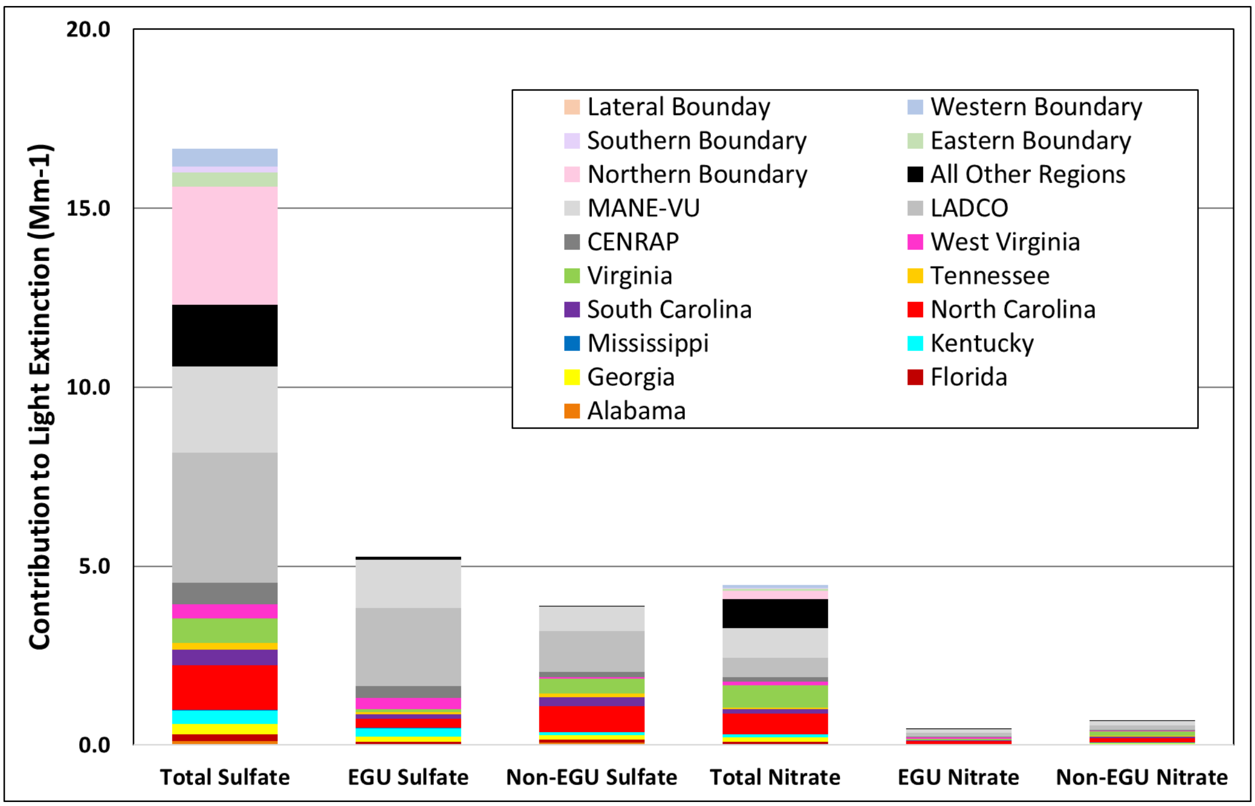

Figure 7-27. 2028 Contribution to Light Extinction on the 20% Most Impaired Days at Swanquarter

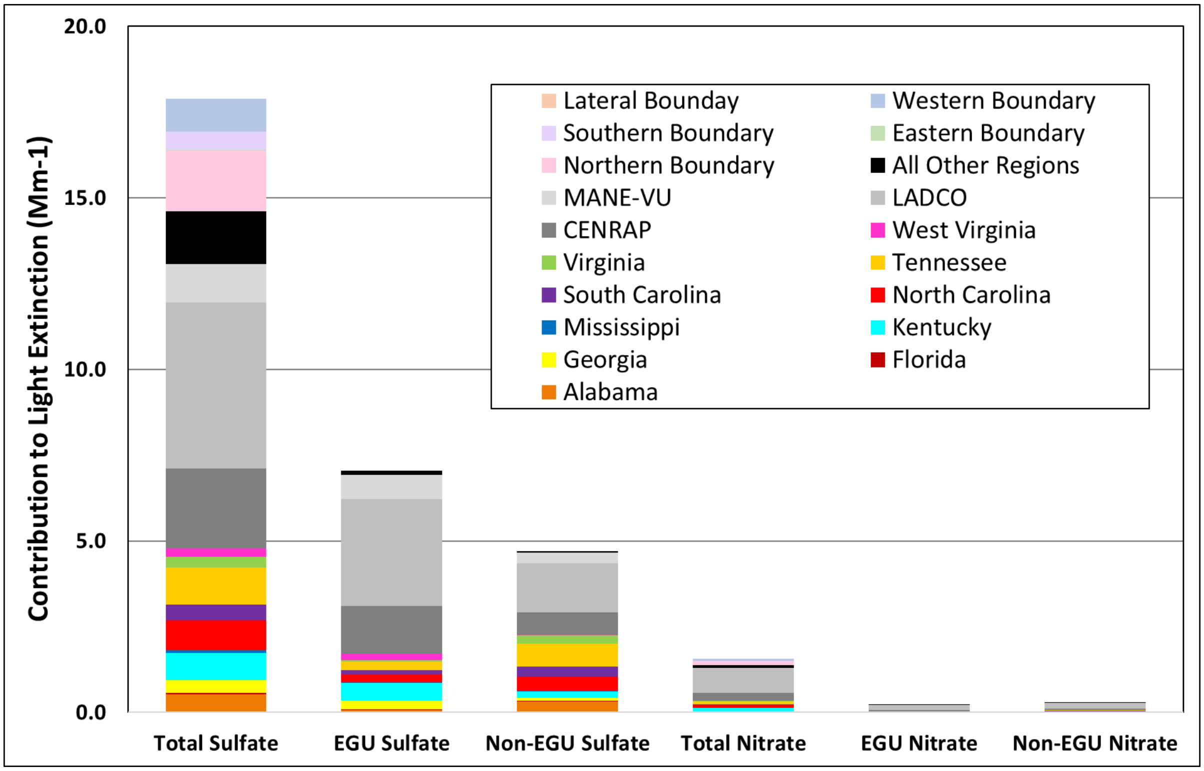

Figure 7-28. 2028 Contribution to Light Extinction on the 20% Most Impaired Days at Shining Rock

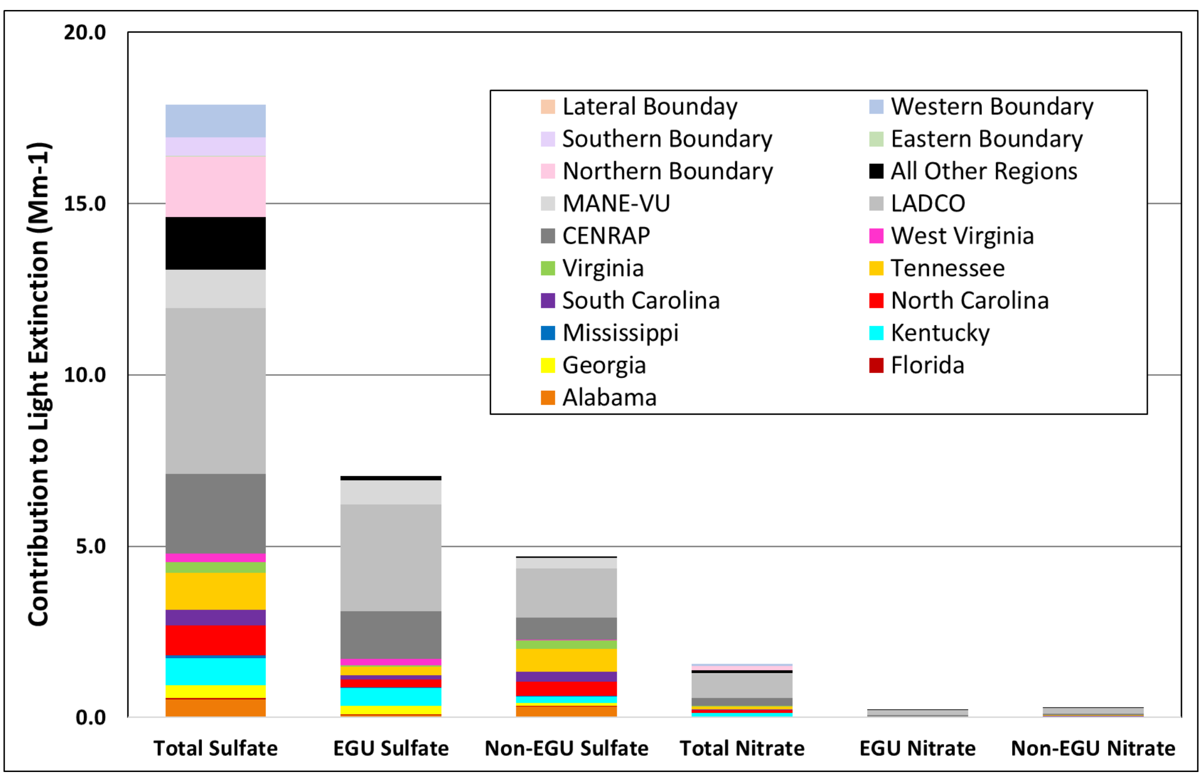

Figure 7-29. 2028 Contribution to Light Extinction on the 20% Most Impaired Days at Linville Gorge

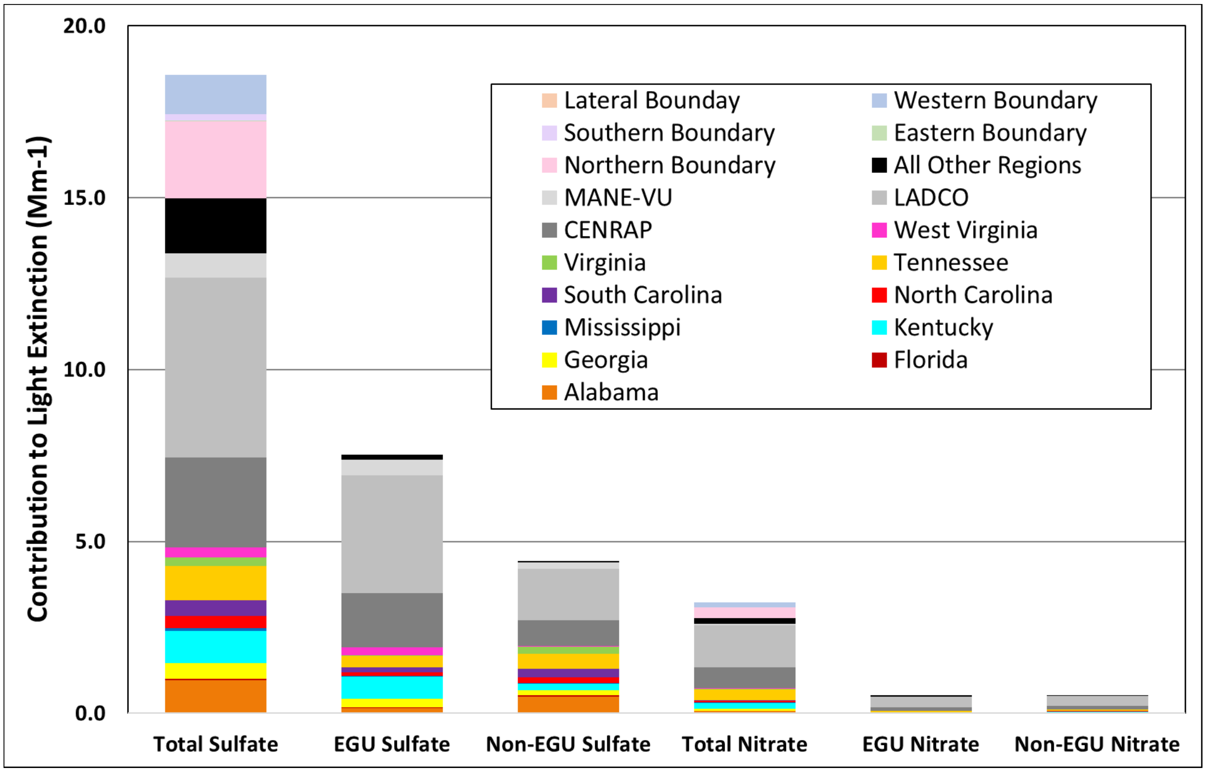

Figure 7-30. 2028 Contribution to Light Extinction on the 20% Most Impaired Days at Joyce Kilmer-Slickrock

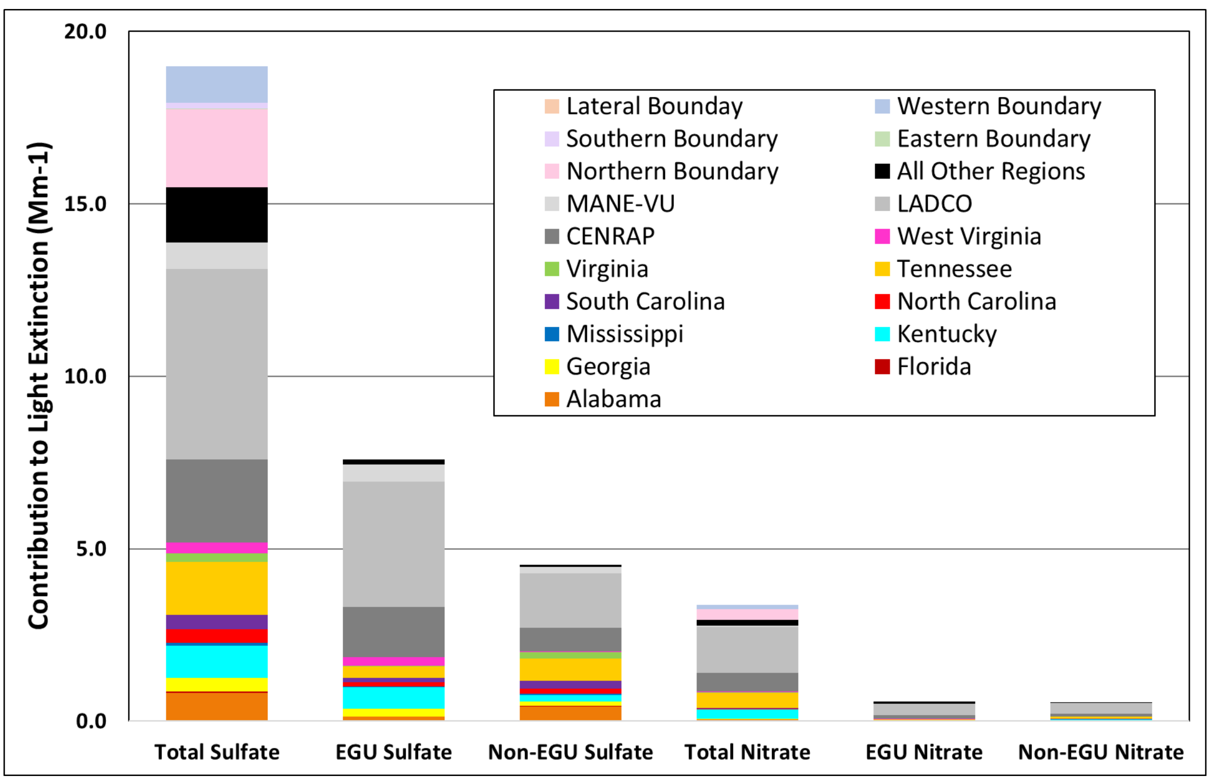

Figure 7-31. 2028 Contribution to Light Extinction on the 20% Most Impaired Days at Great Smoky Mountains

Table 7-14 presents the results of PSAT modeling VISTAS conducted to estimate the projected impact of statewide SO_2 and NO_x emissions in 2028 on total light extinction for the 20% most impaired days in all Class I areas in the VISTAS modeling domain (see Section 5.4 of this SIP). The results, shown in the fourth column of Table 7-14, show total impairment for all pollutants (including SO_2, NO_x, and PM) combined and the fifth column shows total impairment for SO_2 and NO_x combined for each Class I area. Total impairment in the fourth and fifth columns include visibility impairment that come from outside of the VISTAS modeling domain, including the remainder of the WRAP region, are accounted for via the boundary contributions which are provided in Appendix E-7a. North Carolina's statewide sulfate plus nitrate contribution to total impairment is provided in the sixth column in the table followed by the sulfate plus nitrate contribution from the nine remaining VISTAS states and the states located in CENRAP, LADCO, and MANE-VU. The last column in the table represents the sulfate plus nitrate contribution from boundary conditions and all other regions that fall within the VISTAS modeling domain (see Figure 5-1). All of the visibility impairment values shown in Table 7-14 are rounded to two significant figures.

North Carolina's total sulfate plus nitrate contribution to total visibility impairment in Class I areas in the VISTAS, MANE-VU, LADCO, CENRAP, and WRAP states (within the VISTAS modeling domain) is 8.82 Mm^{-1}, 0.81 Mm^{-1}, 0.15 Mm^{-1}, 0.05 Mm^{-1}, and <0.01 Mm^{-1}, respectively. The total sulfate plus nitrate contribution to Class I areas in the VISTAS states is 3.59 Mm^{-1} if the five Class I areas in North Carolina are excluded. Pursuant to 40 CFR 51.308(f)(2)(ii), North Carolina completed consultation with the VISTAS states (see Appendix F-1) and MANE-VU states (see Section 10.3 and Appendix F-4) which contain Class I areas located nearest to North Carolina and to which North Carolina's emissions had the highest sulfate plus nitrate contribution to total sulfate plus nitrate impairment. The state did not consult with states with Class I areas in the LADCO, CENRAP, and WRAP regions because none of the states in these regions contacted North Carolina for consultation, and also because the statewide sulfate plus nitrate contribution to total sulfate plus nitrate impairment in the Class I areas in these regions was relatively low (i.e., ranging from 0.00% to 0.12% of total sulfate plus nitrate impairment).

Table 7-14. North Carolina Statewide Contributions of 2028 SO_2 and NO_x Emissions for all Source Sectors to Total Visibility Impairment for the 20% Most Impaired Days for Class I Areas in the VISTAS Modeling Domain (Mm-1)

				Sulfate + Nitrate Impairment						
RPO	**State**	**Class I Area**	**Total Impairment (All Pollutant Species)**	**Total Impairment**	**NC**	**All Other VISTAS States**	**CENRAP Region**	**LADCO Region**	**MANE-VU Region**	**Boundary & all other Regions within VISTAS Modeling Domain**
CENRAP	AR	CACR	63.20	38.21	0.02	0.87	16.80	3.10	0.06	17.36
CENRAP	AR	UPBU	60.59	35.58	0.03	1.14	15.29	3.22	0.09	15.81
CENRAP	LA	BRET2	63.36	38.05	0.04	4.22	11.34	4.40	0.08	17.97
CENRAP	MO	HEGL	65.88	41.00	0.02	1.17	18.92	6.89	0.09	13.91
CENRAP	MO	MING	70.75	42.63	0.04	3.32	11.67	14.70	0.18	12.72

				Sulfate + Nitrate Impairment						
RPO	**State**	**Class I Area**	**Total Impair-ment (All Pollutant Species)**	**Total Impair-ment**	**NC**	**All Other VISTAS States**	**CENRAP Region**	**LADCO Region**	**MANE-VU Region**	**Boundary & all other Regions within VISTAS Modeling Domain**
CENRAP	OK	WIMO	62.62	35.74	<0.01	0.27	15.27	1.24	<0.01	18.96
CENRAP	TX	BIBE	41.72	20.29	<0.01	0.05	1.96	0.07	<0.01	18.21
CENRAP	TX	CAVE	34.39	13.87	<0.01	0.10	2.71	0.09	<0.01	10.97
CENRAP	TX	GUMO	34.39	13.87	<0.01	0.10	2.71	0.09	<0.01	10.97
LADCO	MI	ISLE	47.51	26.75	0.01	0.35	6.19	7.88	0.20	12.12
LADCO	MI	SENE	56.63	34.54	0.04	0.89	4.63	14.63	0.70	13.65
LADCO	MN	BOWA	42.54	23.76	<0.01	0.19	8.72	3.65	0.11	11.09
MANE-VU	ME	ACAD	45.50	23.70	0.13	0.56	0.51	1.45	2.96	18.09
MANE-VU	ME	MOOS	43.29	22.21	0.05	0.32	0.45	1.24	1.96	18.19
MANE-VU	ME	ROCA	43.29	22.21	0.05	0.32	0.45	1.24	1.96	18.19
MANE-VU	NH	GRGU	35.56	14.85	0.05	0.66	1.13	3.18	1.91	7.92
MANE-VU	NH	PRRA	35.56	14.85	0.05	0.66	1.13	3.18	1.91	7.92
MANE-VU	NJ	BRIG	63.05	34.05	0.34	1.68	1.63	8.48	9.96	11.96
MANE-VU	VT	LYBR2	42.30	21.61	0.14	1.26	1.39	4.67	5.10	9.05
VISTAS	AL	SIPS	52.88	28.29	0.09	5.83	3.98	10.86	0.46	7.07
VISTAS	FL	CHAS	53.92	27.94	0.21	8.00	3.21	1.76	0.22	14.54
VISTAS	FL	EVER	47.70	25.52	0.02	1.68	0.68	0.17	0.03	22.94
VISTAS	FL	SAMA	52.91	28.75	0.12	7.34	5.26	2.21	0.39	13.43
VISTAS	GA	COHU	45.28	21.58	0.38	5.85	1.76	6.88	0.87	5.84
VISTAS	GA	OKEF	54.66	28.97	0.67	9.07	2.27	3.60	1.01	12.35
VISTAS	GA	WOLF	53.59	28.12	0.78	8.35	2.15	3.44	1.15	12.25
VISTAS	KY	MACA	68.18	45.52	0.01	5.82	5.61	20.62	0.63	12.83
VISTAS	NC	LIGO	42.52	19.47	0.95	4.19	2.55	5.54	1.15	5.09
VISTAS	NC	SHRO	42.09	19.20	1.13	3.97	2.80	5.11	0.75	5.44
VISTAS	NC	SWAN	46.39	21.14	1.83	3.87	0.72	4.19	3.23	7.30
VISTAS	NC/TN	GRSM	45.75	24.17	0.89	9.77	1.87	3.74	1.57	6.33
VISTAS	NC/TN	JOYC	45.12	22.48	0.43	5.62	2.96	6.84	0.82	5.81
VISTAS	SC	ROMA	52.82	22.35	0.41	5.16	3.21	6.46	0.76	6.35
VISTAS	VA	JARI	49.09	23.14	0.45	4.21	1.70	8.26	2.15	6.37
VISTAS	VA	SHEN	43.05	22.72	0.24	3.43	1.43	8.57	3.48	5.57
VISTAS	WV	DOSO	46.13	25.79	0.10	4.69	2.03	11.56	2.20	5.21
VISTAS	WV	OTCR	46.00	25.66	0.11	4.77	2.08	11.58	1.81	5.31
WRAP	CO	EANE	17.23	5.08	<0.01	0.00	0.04	<0.01	0.00	5.04

				Sulfate + Nitrate Impairment						
RPO	**State**	**Class I Area**	**Total Impair-ment (All Pollutant Species)**	**Total Impair-ment**	**NC**	**All Other VISTAS States**	**CENRAP Region**	**LADCO Region**	**MANE-VU Region**	**Boundary & all other Regions within VISTAS Modeling Domain**
WRAP	CO	FLTO	17.23	5.08	<0.01	0.00	0.04	<0.01	0.00	5.04
WRAP	CO	GRSA	23.22	6.02	<0.01	<0.01	0.41	<0.01	<0.01	5.61
WRAP	CO	MABE	17.23	5.08	<0.01	0.00	0.04	<0.01	0.00	5.04
WRAP	CO	MOZI	17.64	5.56	<0.01	0.00	0.07	0.00	0.00	5.49
WRAP	CO	RAWA	17.64	5.56	<0.01	0.00	0.07	0.00	0.00	5.49
WRAP	CO	ROMO	23.72	7.71	<0.01	<0.01	0.48	<0.01	0.00	7.23
WRAP	CO	WEEL	17.23	5.08	<0.01	0.00	0.04	<0.01	0.00	5.04
WRAP	MT	MELA	51.88	34.71	<0.01	0.00	1.12	0.52	0.02	33.05
WRAP	MT	ULBE	32.66	16.72	<0.01	0.00	0.37	0.39	0.00	15.96
WRAP	ND	THRO	46.07	28.46	<0.01	<0.01	1.49	0.50	0.02	26.45
WRAP	NM	BAND	25.33	8.17	<0.01	<0.01	0.68	0.02	0.00	7.47
WRAP	NM	BOAP	30.33	8.98	<0.01	0.02	0.93	<0.01	<0.01	8.03
WRAP	NM	PECO	19.67	5.98	<0.01	<0.01	0.54	<0.01	0.00	5.44
WRAP	NM	SACR	46.02	19.53	<0.01	0.04	4.48	0.06	<0.01	14.95
WRAP	NM	SAPE	19.58	5.96	<0.01	<0.01	0.29	<0.01	0.00	5.67
WRAP	NM	WHIT	28.18	9.42	<0.01	0.05	1.50	0.06	<0.01	7.81
WRAP	NM	WHPE	19.67	5.98	<0.01	<0.01	0.54	<0.01	0.00	5.44
WRAP	SD	BADL	37.55	19.76	<0.01	0.02	4.32	1.03	<0.01	14.39
WRAP	SD	WICA	31.66	15.54	<0.01	<0.01	2.37	0.31	0.00	12.86

7.5 Area of Influence Analyses for North Carolina Class I Areas

As discussed in Section 2, analysis of the IMPROVE monitoring data for the modeling base period (2009-2013) and current conditions (2014-2018) shows sulfate as the most important pollutant (followed by nitrate) contributing to visibility impairment in VISTAS Class I areas. Therefore, the area of influence (AoI) analysis focused on sulfate and nitrate for the purpose of identifying the sectors and emission sources with the potentially highest contribution to visibility impairment in VISTAS and non-VISTAS Class I. Consistent with the regional haze guidance for source-selection analyses, VISTAS used 2028 emissions for the AoI analysis.[105]

The AoI analysis was performed for each Class I area for source sectors (EGU, non-EGU point, onroad, nonroad, and fires) at the county-level. This analysis identified EGU and non-EGU point sources as the sectors that accounted for the vast majority of visibility impairment in VISTAS Class I areas in 2028. Then, the AoI analysis was conducted for all EGU and non-EGU facilities in the modeling domain to determine the relative visibility impairment impacts at each Class I area associated with sulfate and nitrate. The results of the facility-level AoI analyses were then used to rank and prioritize facilities for further evaluation.

The following sections explain the steps followed to develop the AoI analyses. Appendix D-1 (Area of Influence Analyses) provides a detailed discussion of the AoI methods and results. Appendix D-2 provides AoI and HYSPLIT graphics for the VISTAS and Nearby Class I areas.

7.5.1 Back Trajectory Analyses

The first step was to generate Hybrid Single Particle Lagrangian Integration Trajectory (HYSPLIT)[106] back trajectories for IMPROVE monitoring sites in North Carolina 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 runs included starting heights of 100 meters (m), 500 m, 1000 m, and 1500 m. Trajectories were run 72 hours backwards in time for each height at each location. Trajectories were run with 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 7-32 through Figure 7-36 contain the 100-meter back trajectories for the 20% most impaired visibility days (2011-2016) at the Great Smoky Mountains National Park, Joyce Kilmer-Slickrock Wilderness Area, Linville Gorge Wilderness Area, Shining Rock Wilderness Area, and Swanquarter Wilderness Area, respectively. Figure 7-37 through Figure 7-41 contain

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[105] U.S.EPA, Guidance on Regional Haze State Implementation Plans for the Second Implementation Period, August 20, 2019, p. 17, https://www.epa.gov/sites/production/files/2019-08/documents/8-20-2019_-_regional_haze_guidance_final_guidance.pdf.

[106] 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.

the 100-meter back trajectories by season for the 20% most impaired visibility days (2011-2016) at the Great Smoky Mountains National Park, Joyce Kilmer-Slickrock Wilderness Area, Linville Gorge Wilderness Area, Shining Rock Wilderness Area, and Swanquarter Wilderness Area, respectively. Figure 7-42 through Figure 7-46 contain the 100-meter, 500-meter, 1000-meter, and 1500-meter back trajectories for the 20% most impaired visibility days (2011-2016) at the Great Smoky Mountains National Park, Joyce Kilmer-Slickrock Wilderness Area, Linville Gorge Wilderness Area, Shining Rock Wilderness Area, and Swanquarter Wilderness Area, respectively. These back trajectories for the 20% most impaired days were then used to develop residence time (RT) plots.

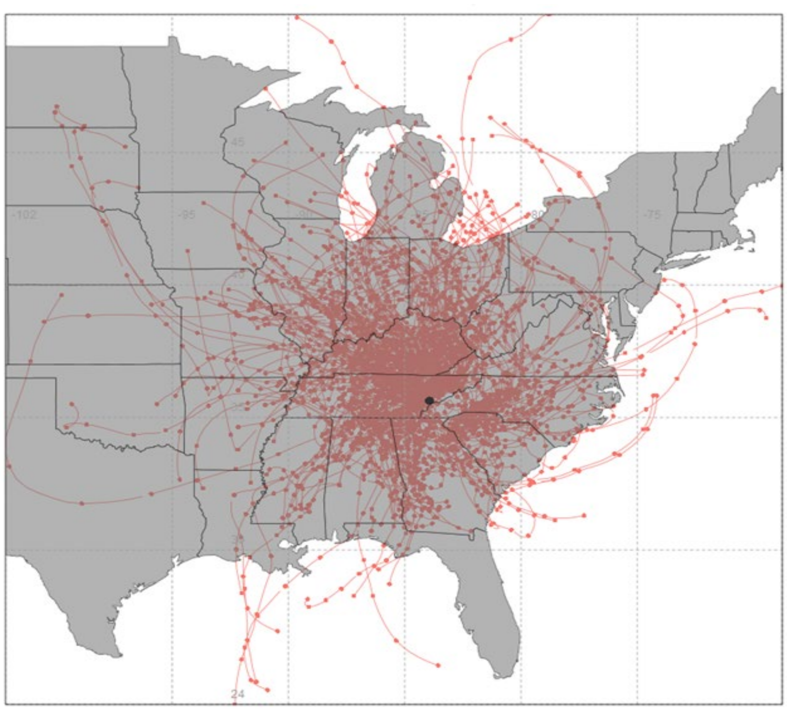


Figure 7-32. 100-Meter Back Trajectories for the 20% Most Impaired Visibility Days (2011-2016) from Great Smoky Mountains National Park

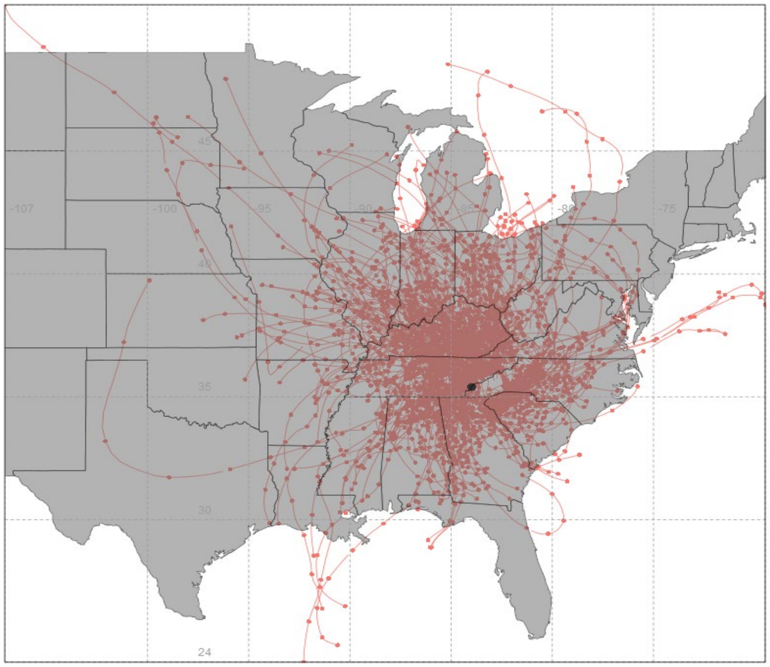


Figure 7-33. 100-Meter Back Trajectories for the 20% Most Impaired Visibility Days (2011-2016) from Joyce Kilmer-Slickrock Wilderness Area

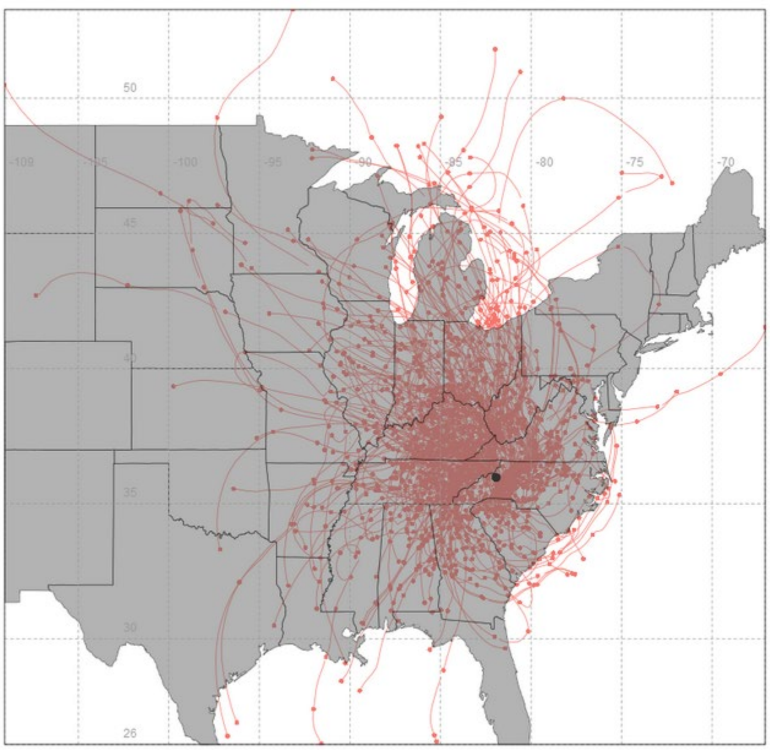


Figure 7-34. 100-Meter Back Trajectories for the 20% Most Impaired Visibility Days (2011-2016) from Linville Gorge Wilderness Area

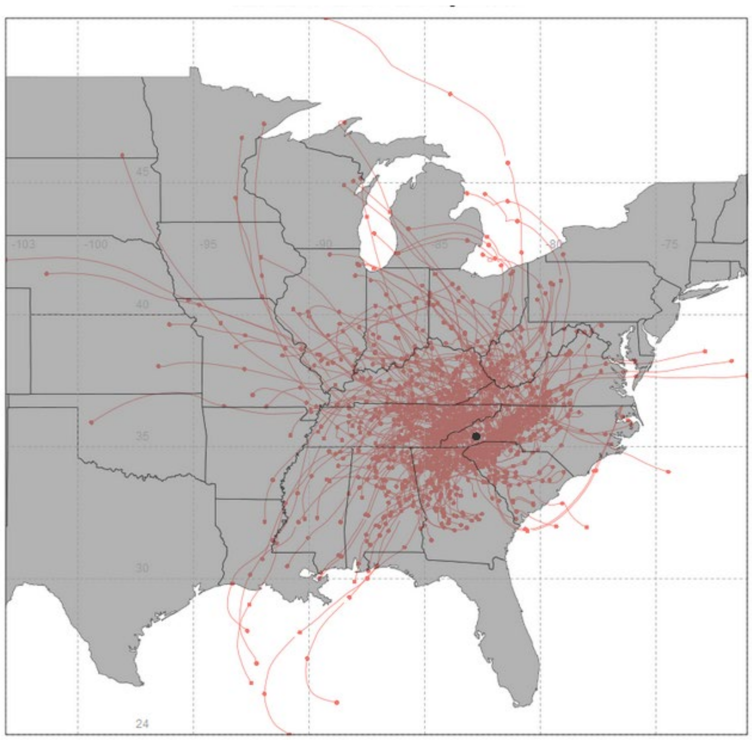


Figure 7-35. 100-Meter Back Trajectories for the 20% Most Impaired Visibility Days (2011-2016) from Shining Rock Wilderness Area

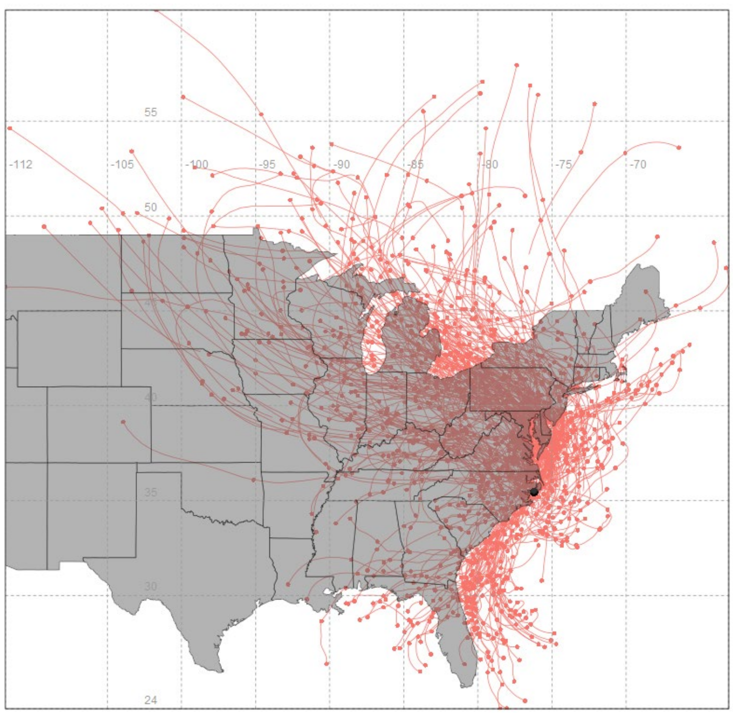


Figure 7-36. 100-Meter Back Trajectories for the 20% Most Impaired Visibility Days (2011-2016) from Swanquarter Wilderness Area

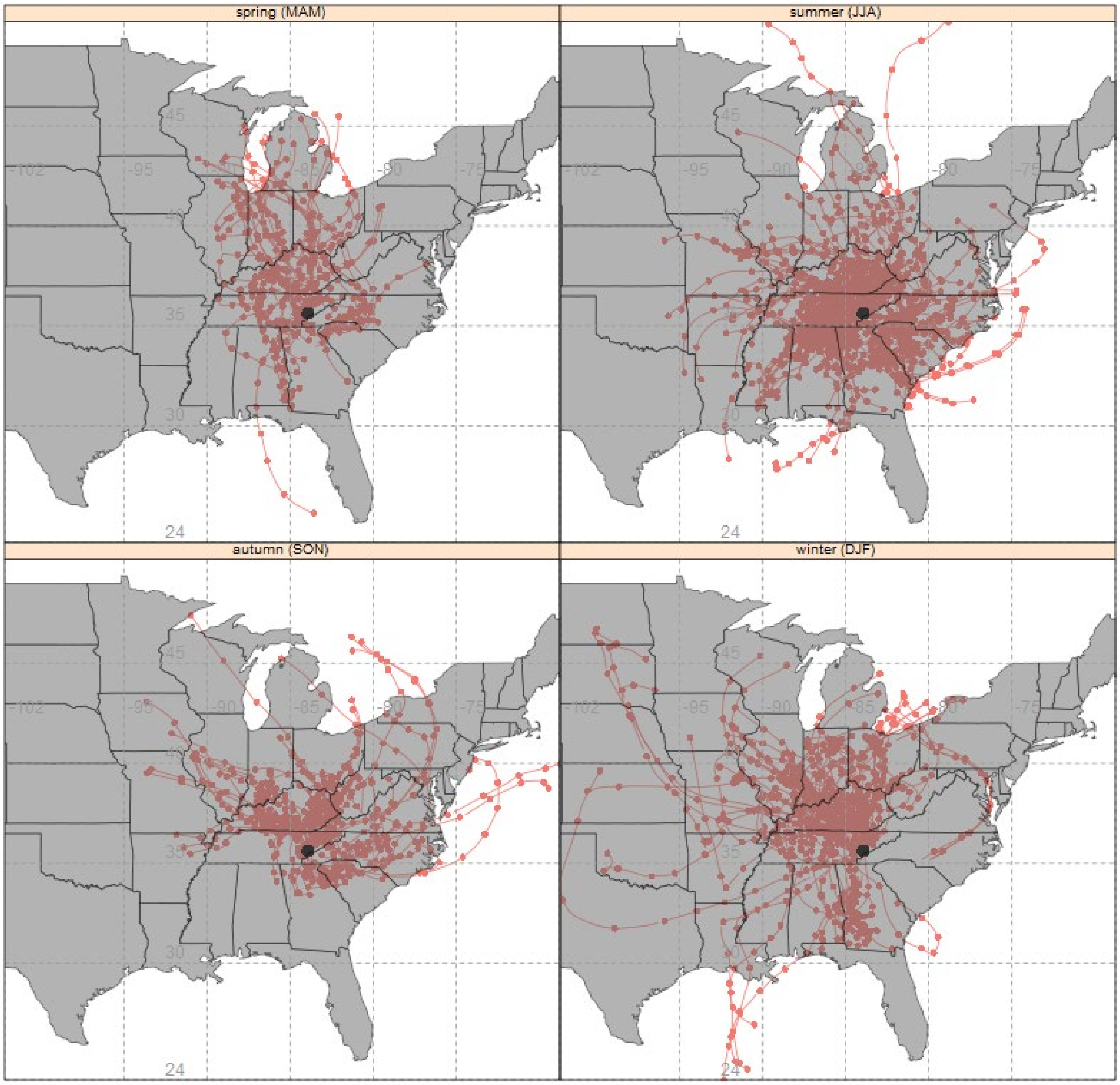


Figure 7-37. 100-Meter Back Trajectories by Season for the 20% Most Impaired Visibility Days (2011-2016) from Great Smoky Mountains National Park

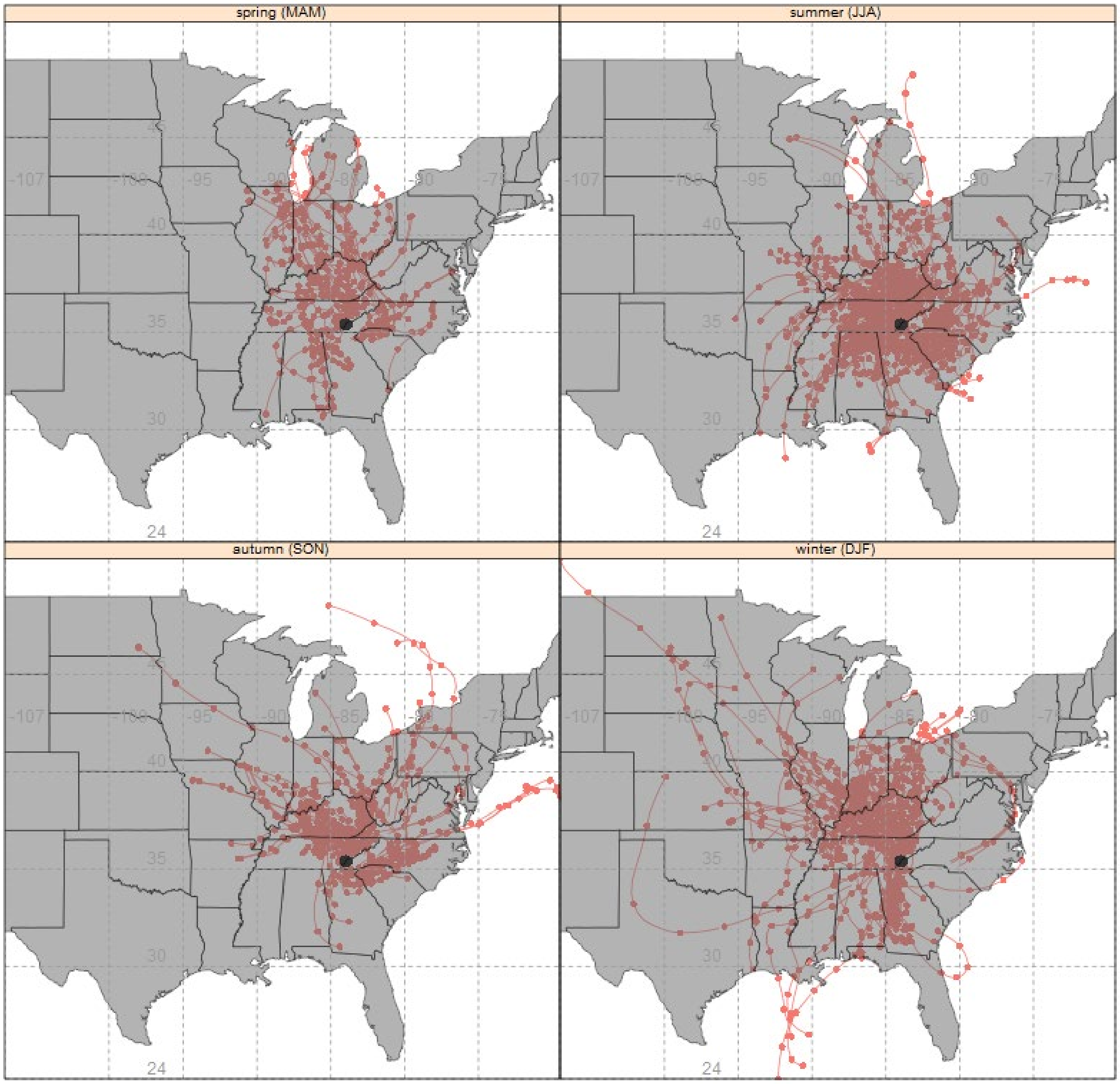


Figure 7-38. 100-Meter Back Trajectories by Season for the 20% Most Impaired Visibility Days (2011-2016) from Joyce Kilmer-Slickrock Wilderness Area

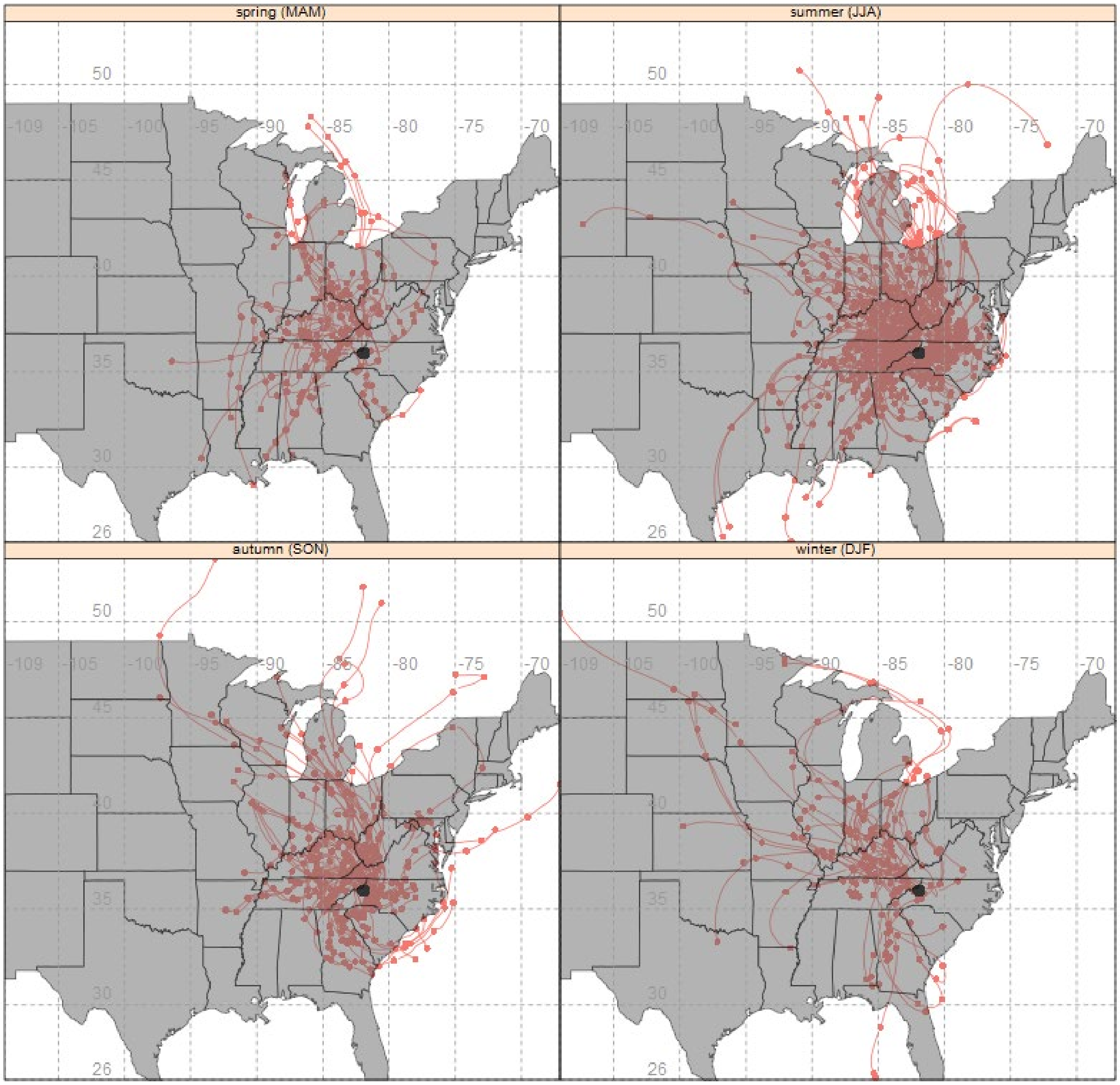


Figure 7-39. 100-Meter Back Trajectories by Season for the 20% Most Impaired Visibility Days (2011-2016) from Linville Gorge Wilderness Area

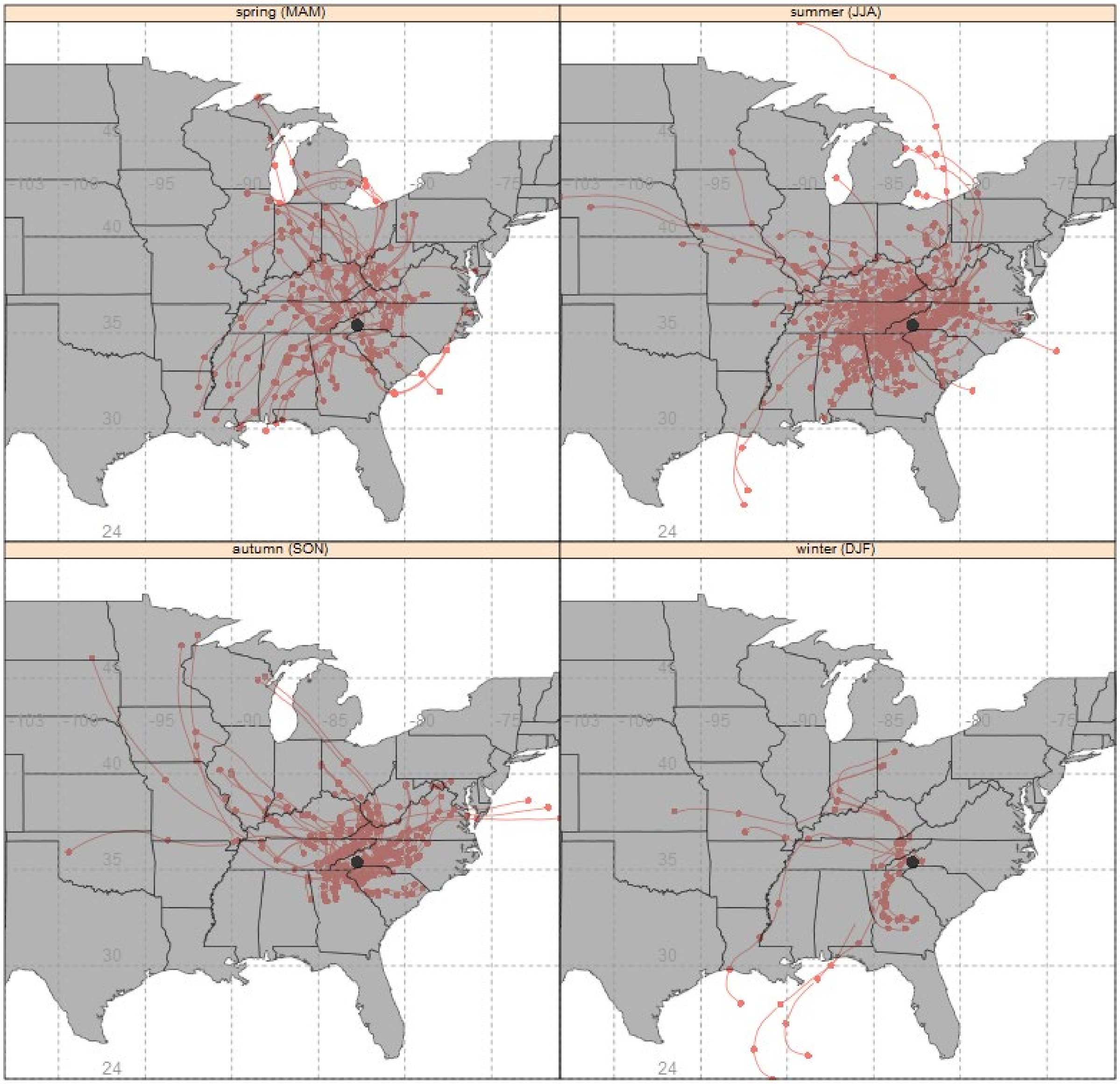


Figure 7-40. 100-Meter Back Trajectories by Season for the 20% Most Impaired Visibility Days (2011-2016) from Shining Rock Wilderness Area

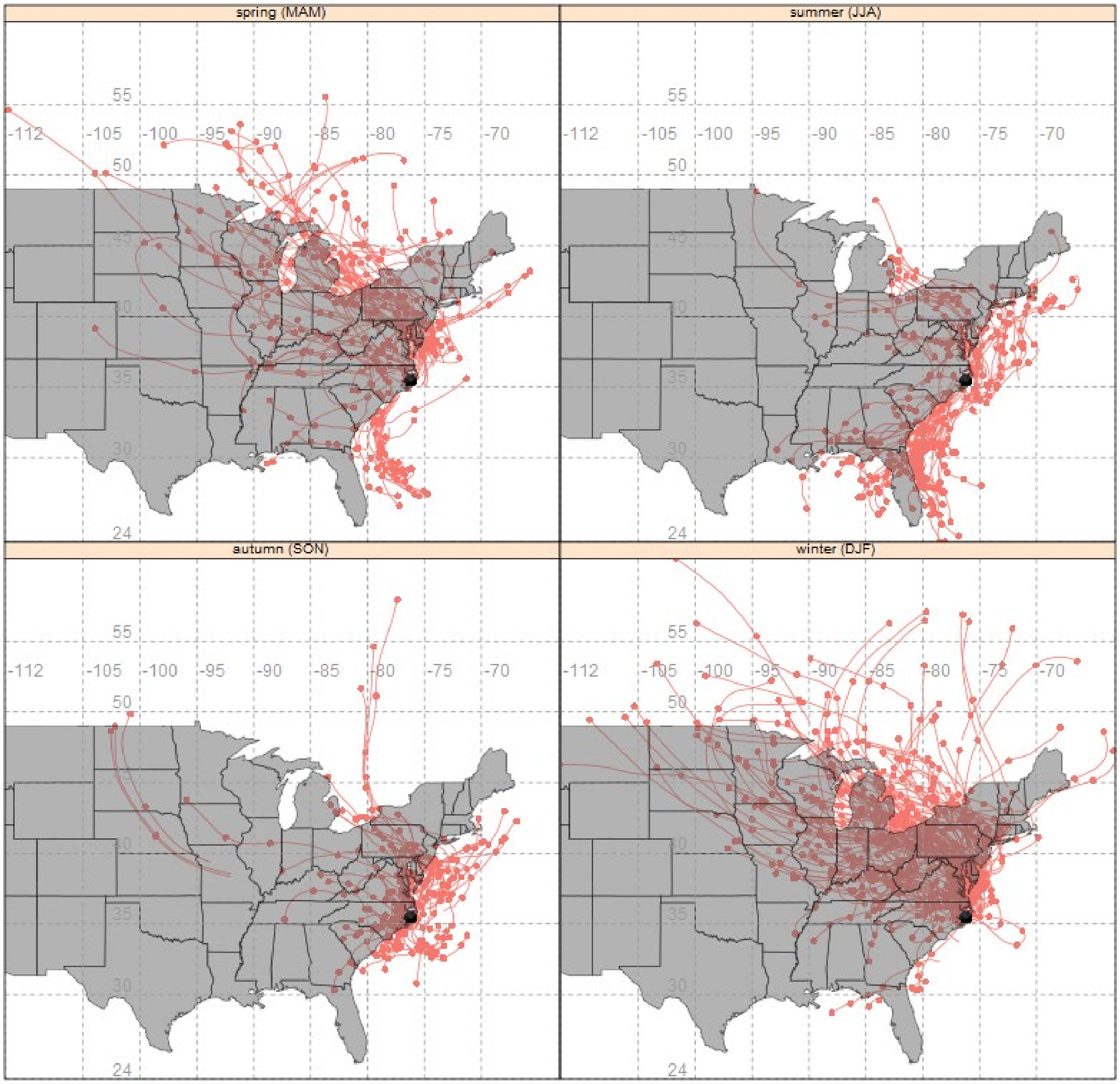


Figure 7-41. 100-Meter Back Trajectories by Season for the 20% Most Impaired Visibility Days (2011-2016) from Swanquarter Wilderness Area

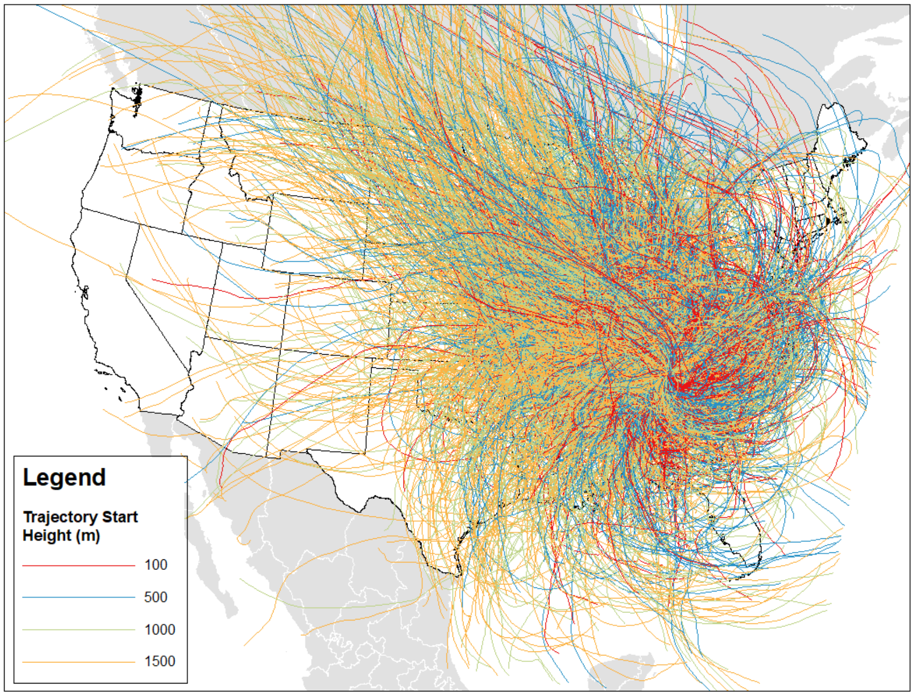


Figure 7-42. 100-Meter, 500-Meter, 1000-Meter, and 1500-Meter Back Trajectories for the 20% Most Impaired Days (2011-2016) from Great Smoky Mountains National Park

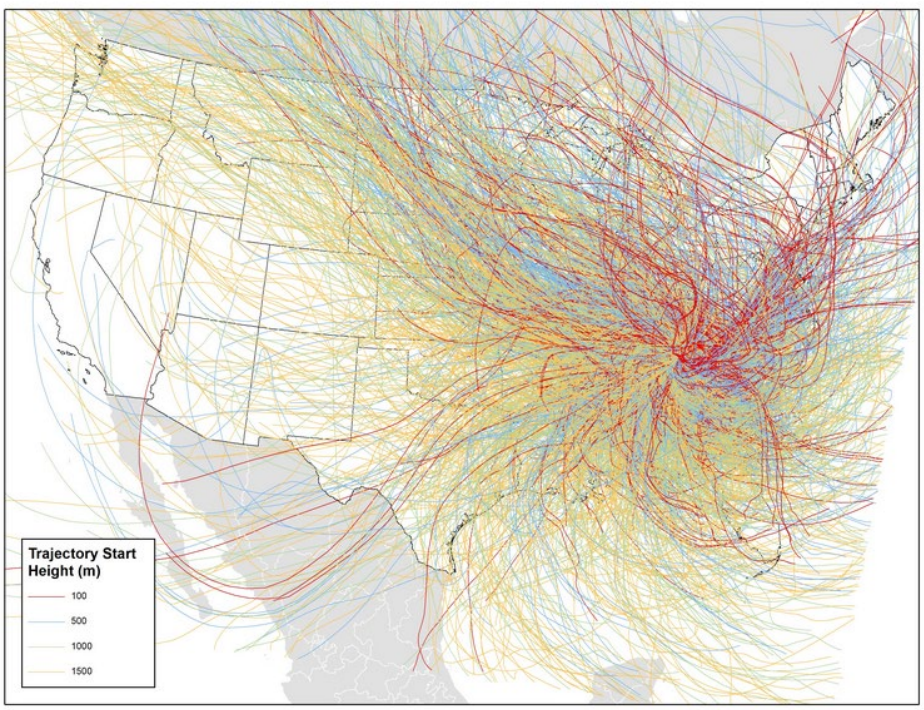


Figure 7-43. 100-Meter, 500-Meter, 1000-Meter, and 1500-Meter Back Trajectories for the 20% Most Impaired Days (2011-2016) from Joyce Kilmer-Slickrock Wilderness Area

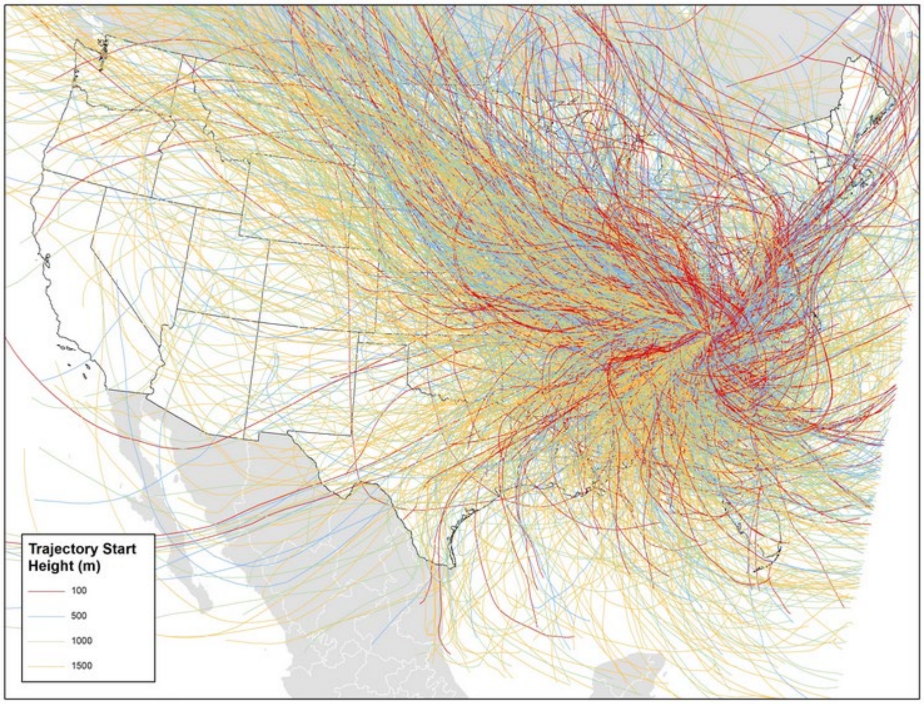


Figure 7-44. 100-Meter, 500-Meter, 1000-Meter, and 1500-Meter Back Trajectories for the 20% Most Impaired Days (2011-2016) from Linville Gorge Wilderness Area

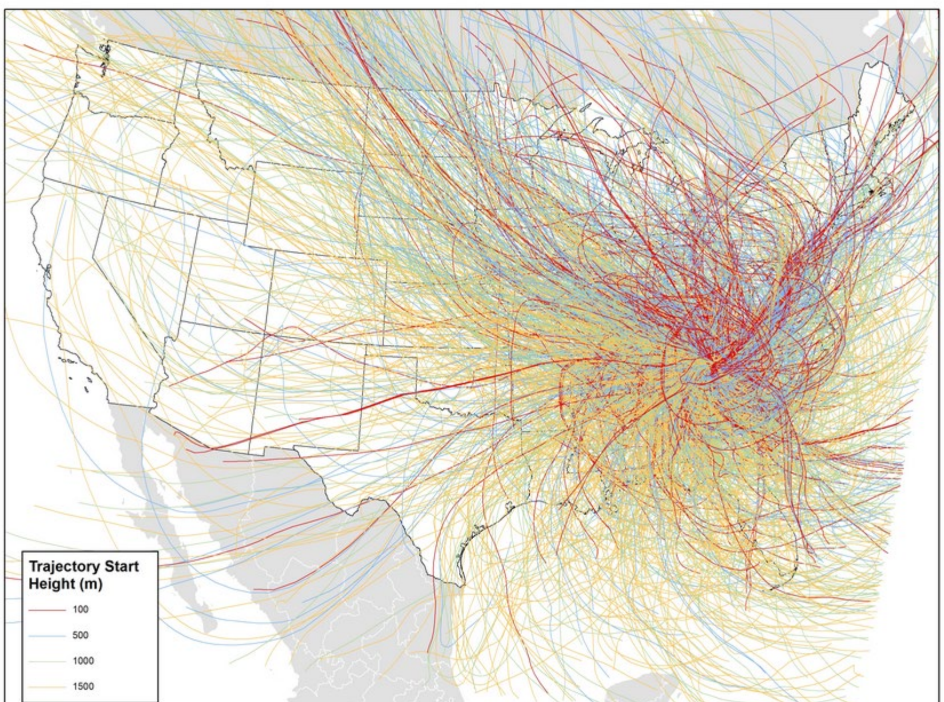


Figure 7-45. 100-Meter, 500-Meter, 1000-Meter, and 1500-Meter Back Trajectories for the 20% Most Impaired Days (2011-2016) from Shining Rock Wilderness Area

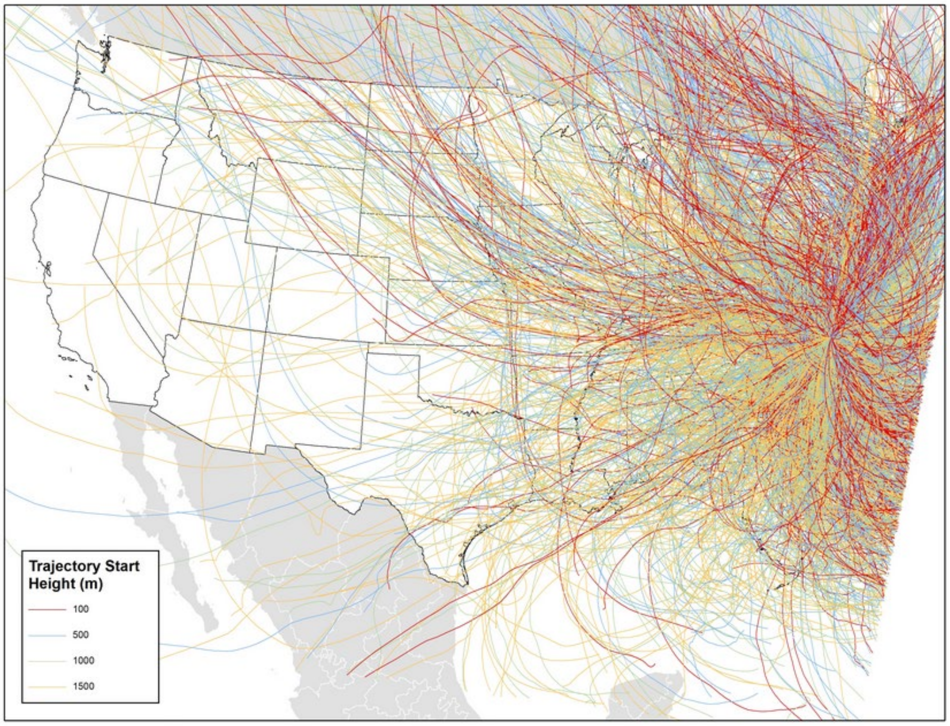


Figure 7-46. 100-Meter, 500-Meter, 1000-Meter, and 1500-Meter Back Trajectories for the 20% Most Impaired Days (2011-2016) from Swanquarter Wilderness Area

7.5.2 Residence Time Plots

The next step was to plot 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 7-47 through Figure 7-56 contain the RT plots (counts per 12-Km modeling grid cell, and percent of total counts per 12-Km modeling grid cell) for Great Smoky Mountains National Park, Joyce Kilmer-Slickrock Wilderness Area, Linville Gorge Wilderness Area, Shining Rock Wilderness Area, and Swanquarter Wilderness Area, respectively. As illustrated in these figures, winds influencing all five 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. It should be noted that there are lower RTs in western North Carolina in grid cells that are east, southeast, and northeast of Great Smoky Mountains National Park and nearby Joyce Kilmer-Slickrock Wilderness Area due to the meteorological impacts associated with the Southern Appalachian Mountains.

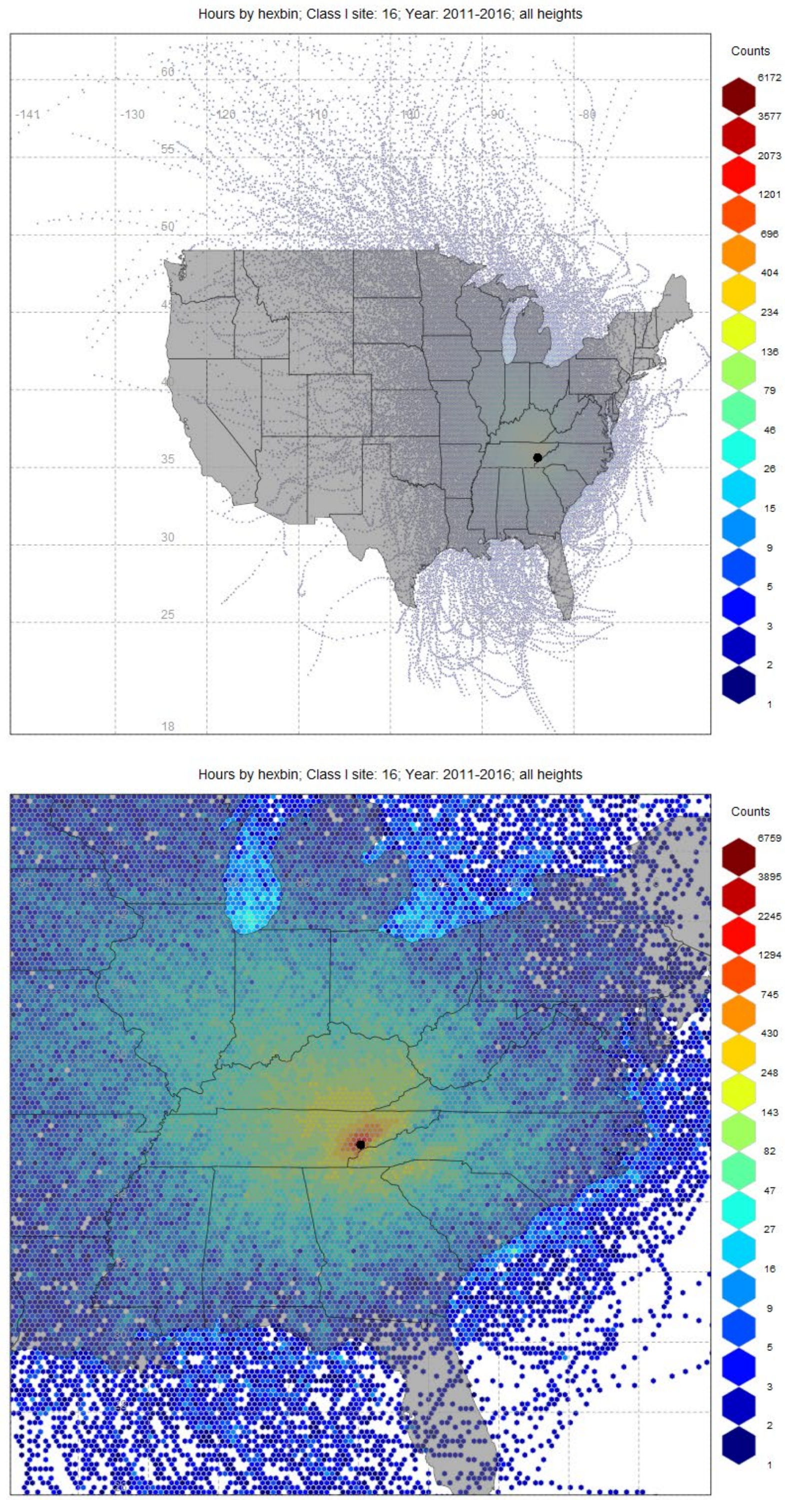
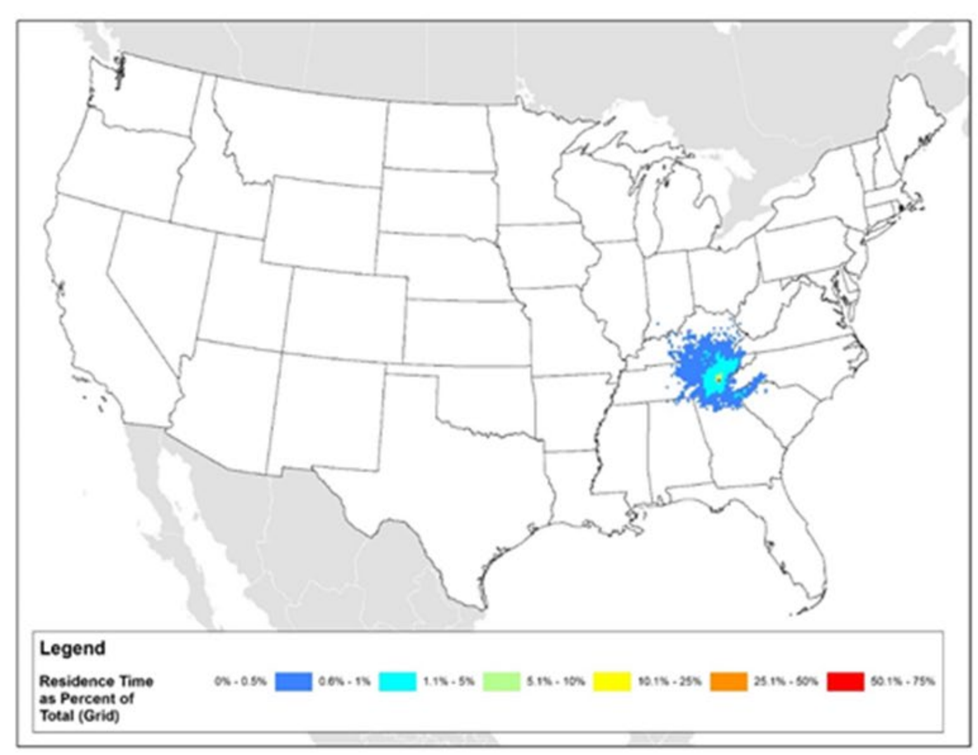


Figure 7-47. Residence Time (Counts per 12-Km Modeling Grid Cell) for Great Smoky Mountains National Park – Full View (top) and Class I Zoom (bottom)



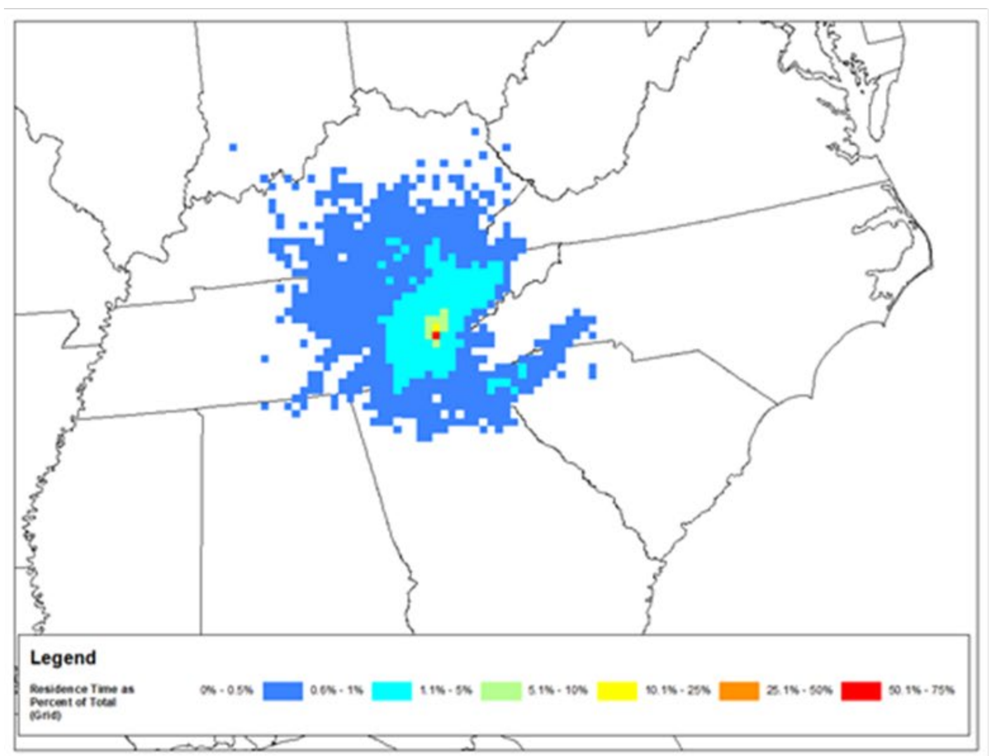


Figure 7-48. Residence Time (% of Total Counts per 12-Km Modeling Grid Cell for Great Smoky Mountains National Park – Full View (top) and Class I Zoom (bottom)

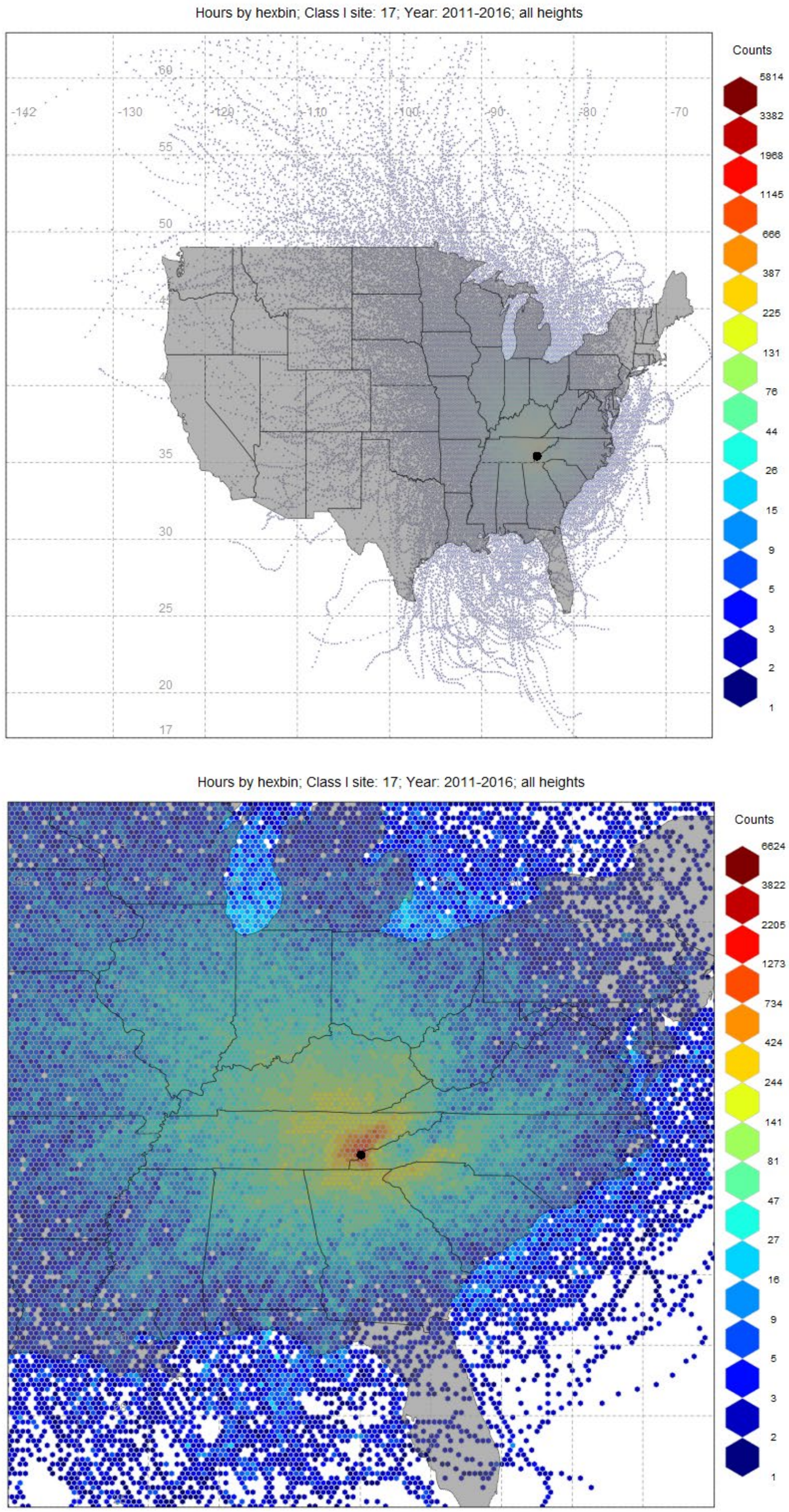
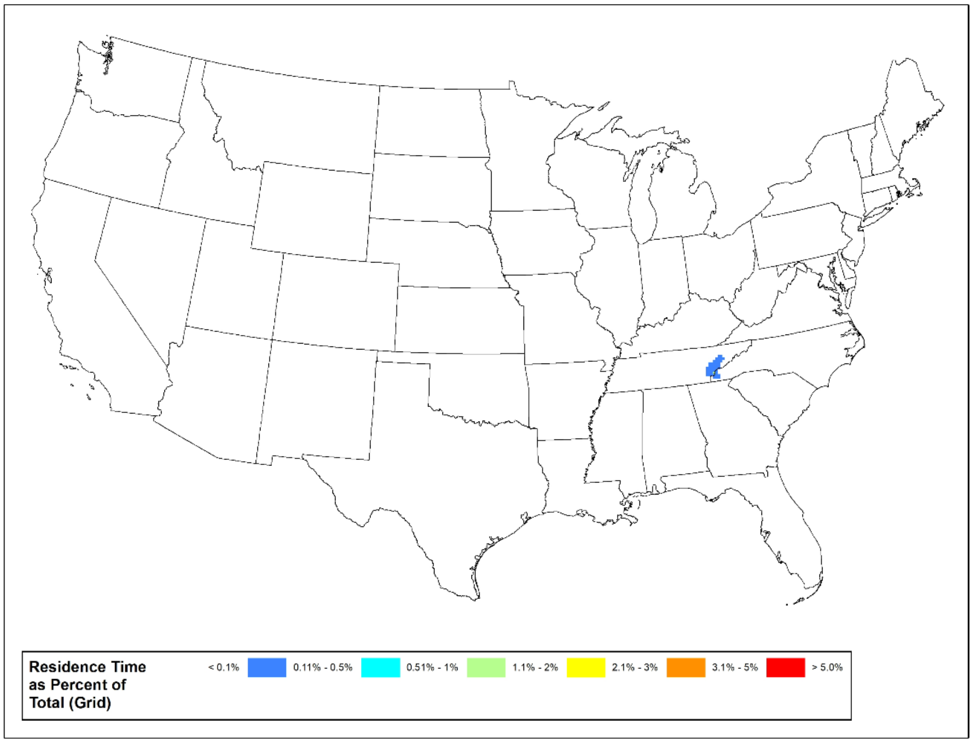


Figure 7-49. Residence Time (Counts per 12-Km Modeling Grid Cell) for Joyce Kilmer-Slickrock Wilderness Area – Full View (top) and Class I Zoom (bottom)



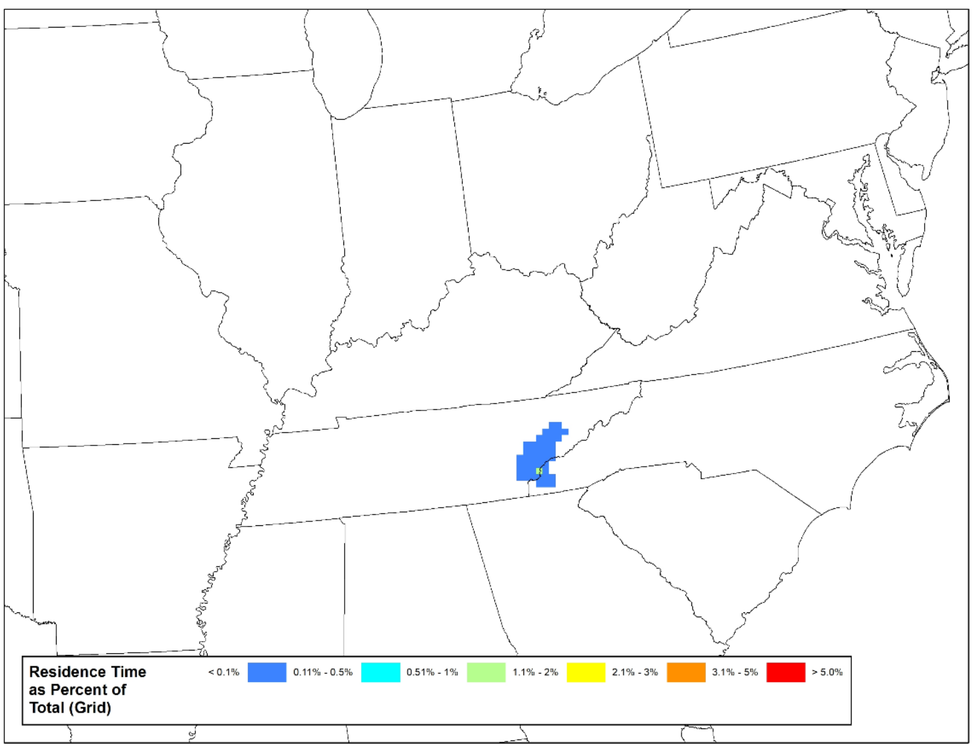
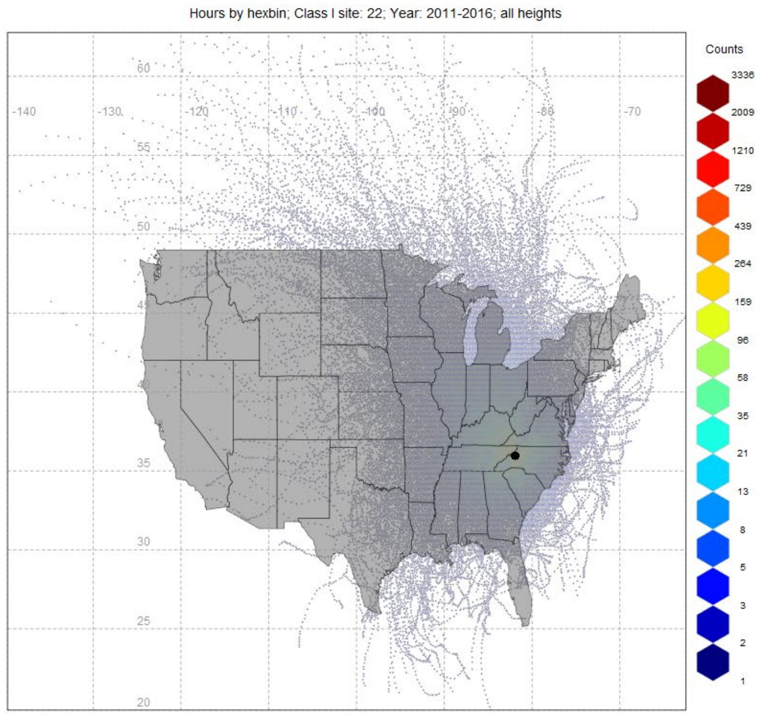


Figure 7-50. Residence Time (% of Total Counts per 12-Km Modeling Grid Cell for Joyce Kilmer-Slickrock Wilderness Area – Full View (top) and Class I Zoom (bottom)



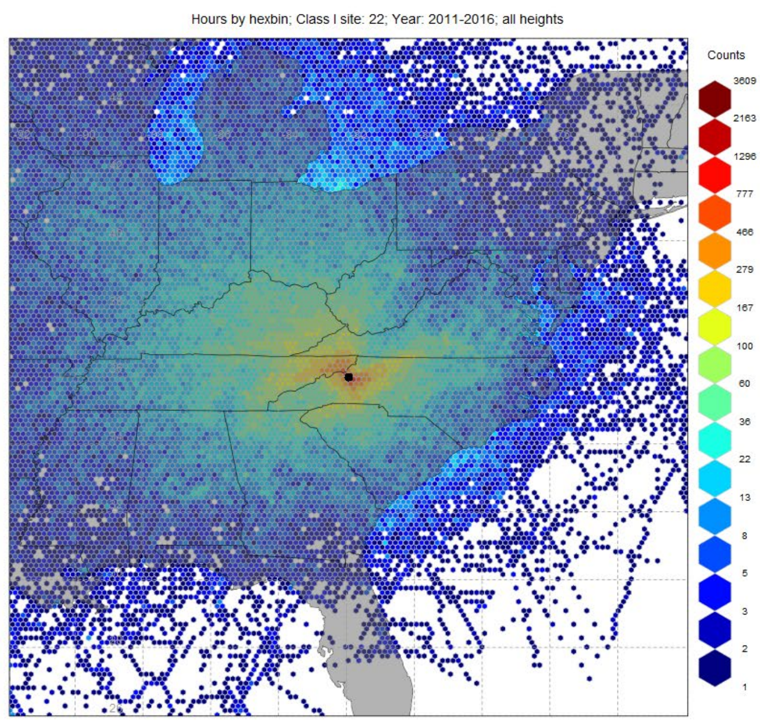
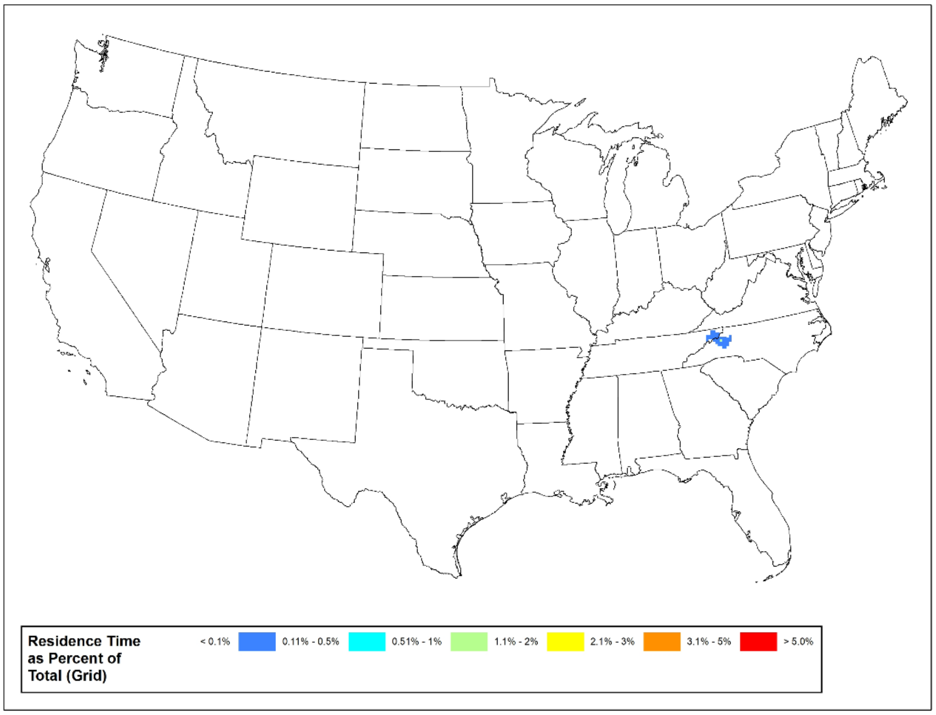


Figure 7-51. Residence Time (Counts per 12-Km Modeling Grid Cell) for Linville Gorge Wilderness Area – Full View (top) and Class I Zoom (bottom)



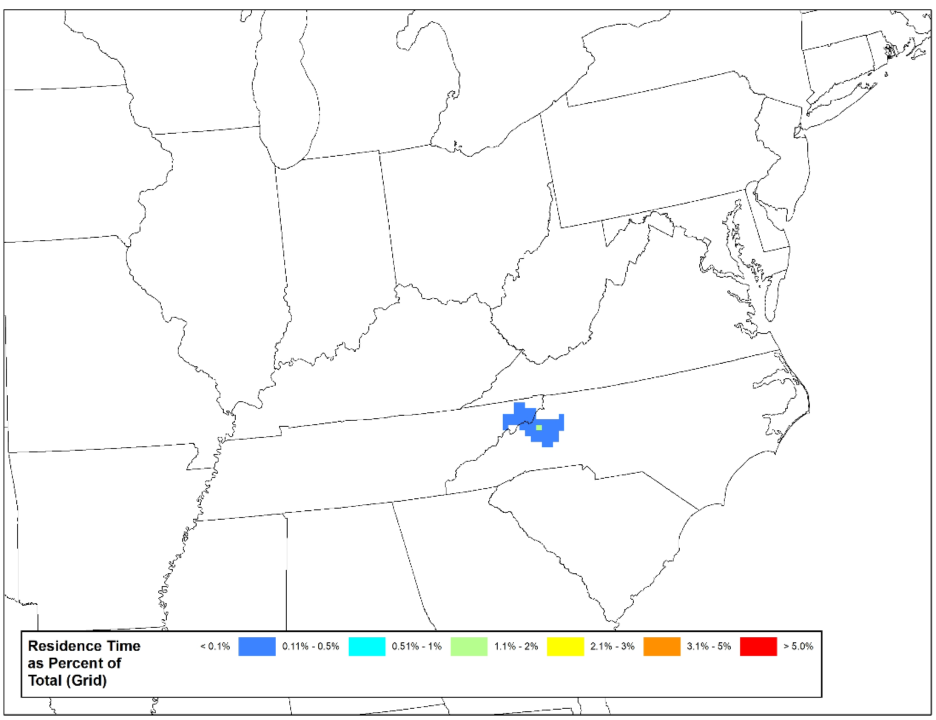


Figure 7-52. Residence Time (% of Total Counts per 12-Km Modeling Grid Cell for Linville Gorge Wilderness Area – Full View (top) and Class I Zoom (bottom)

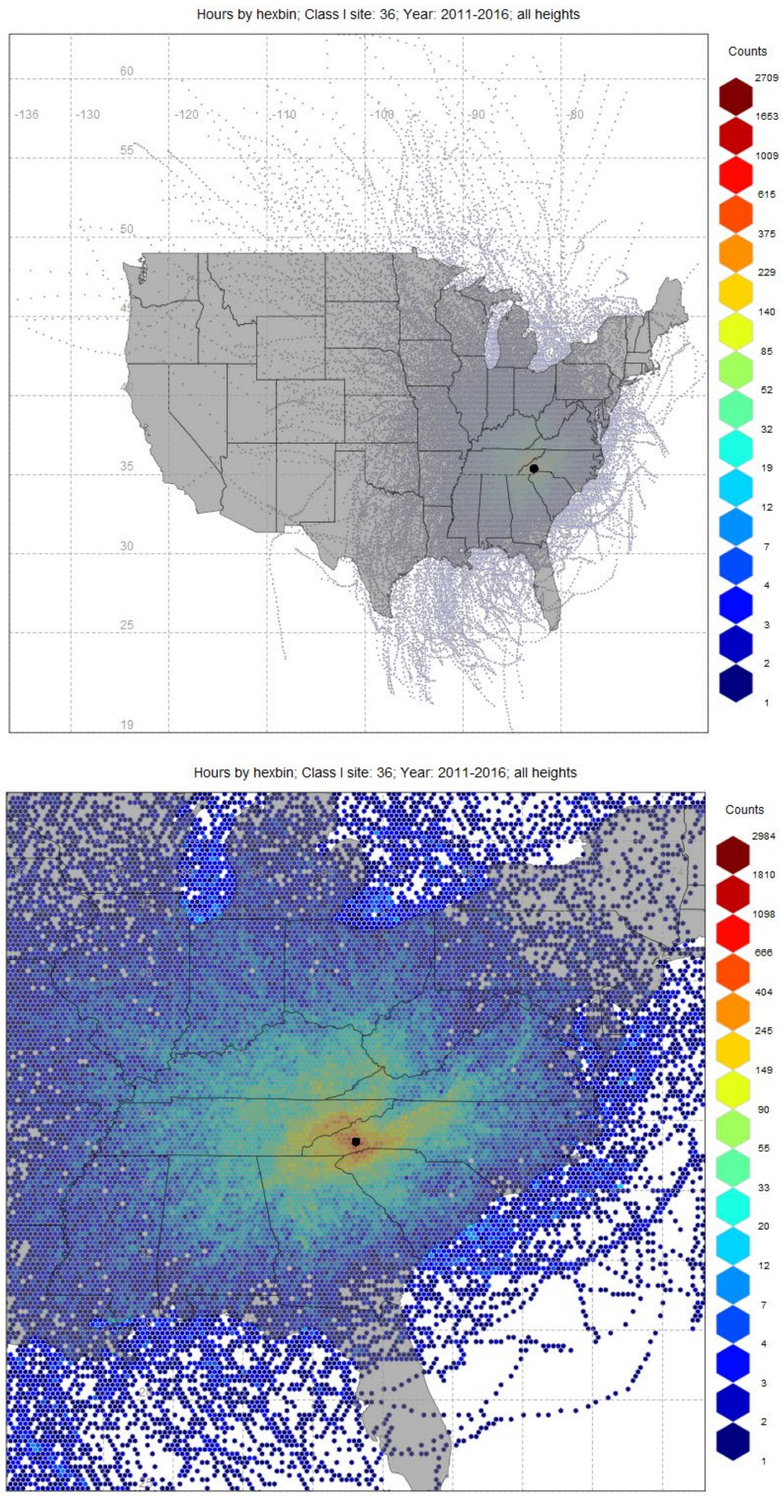


Figure 7-53. Residence Time (Counts per 12-Km Modeling Grid Cell) for Shining Rock Wilderness Area – Full View (top) and Class I Zoom (bottom)

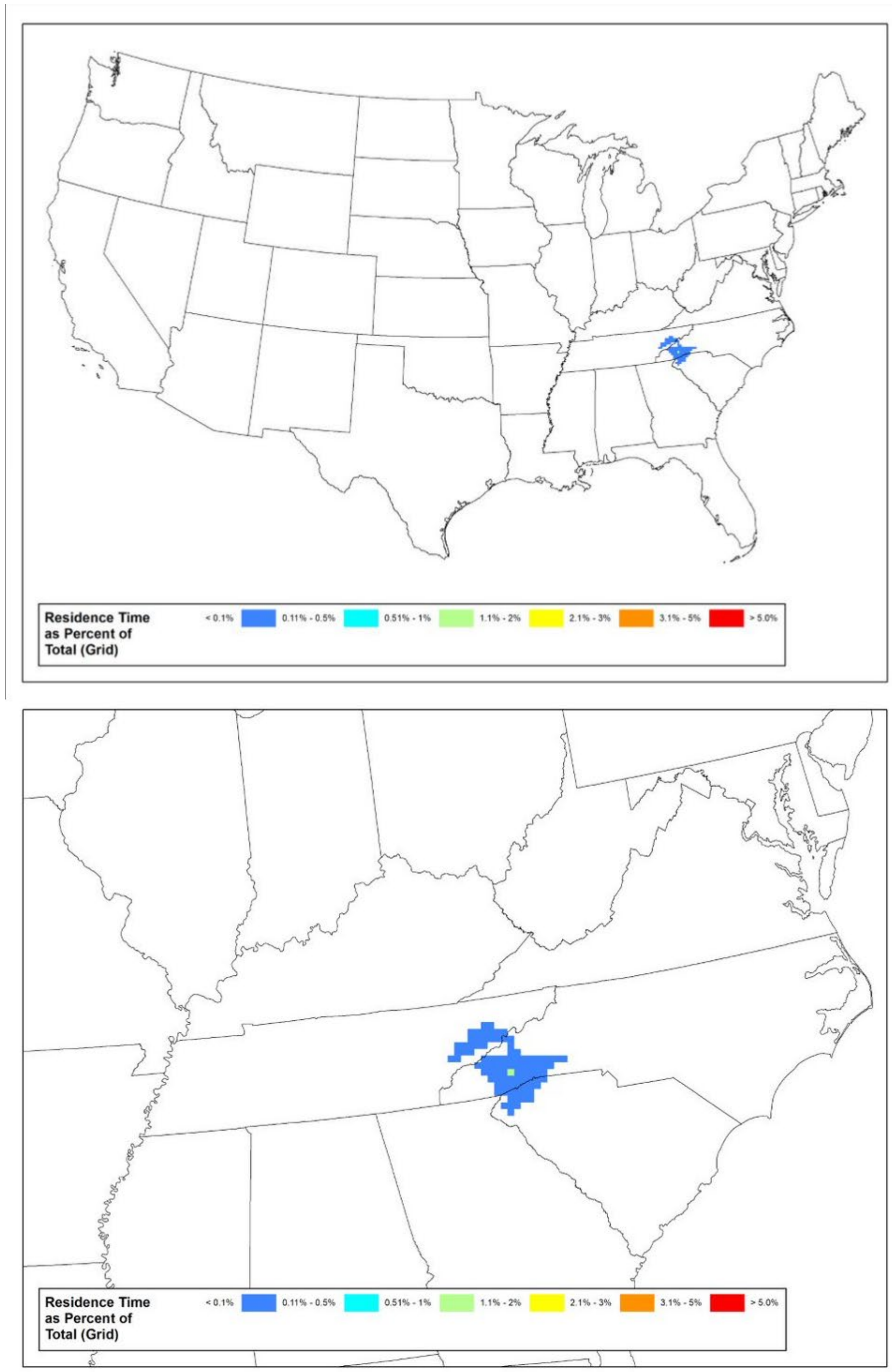


Figure 7-54. Residence Time (% of Total Counts per 12-Km Modeling Grid Cell for Shining Rock Wilderness Area – Full View (top) and Class I Zoom (bottom)

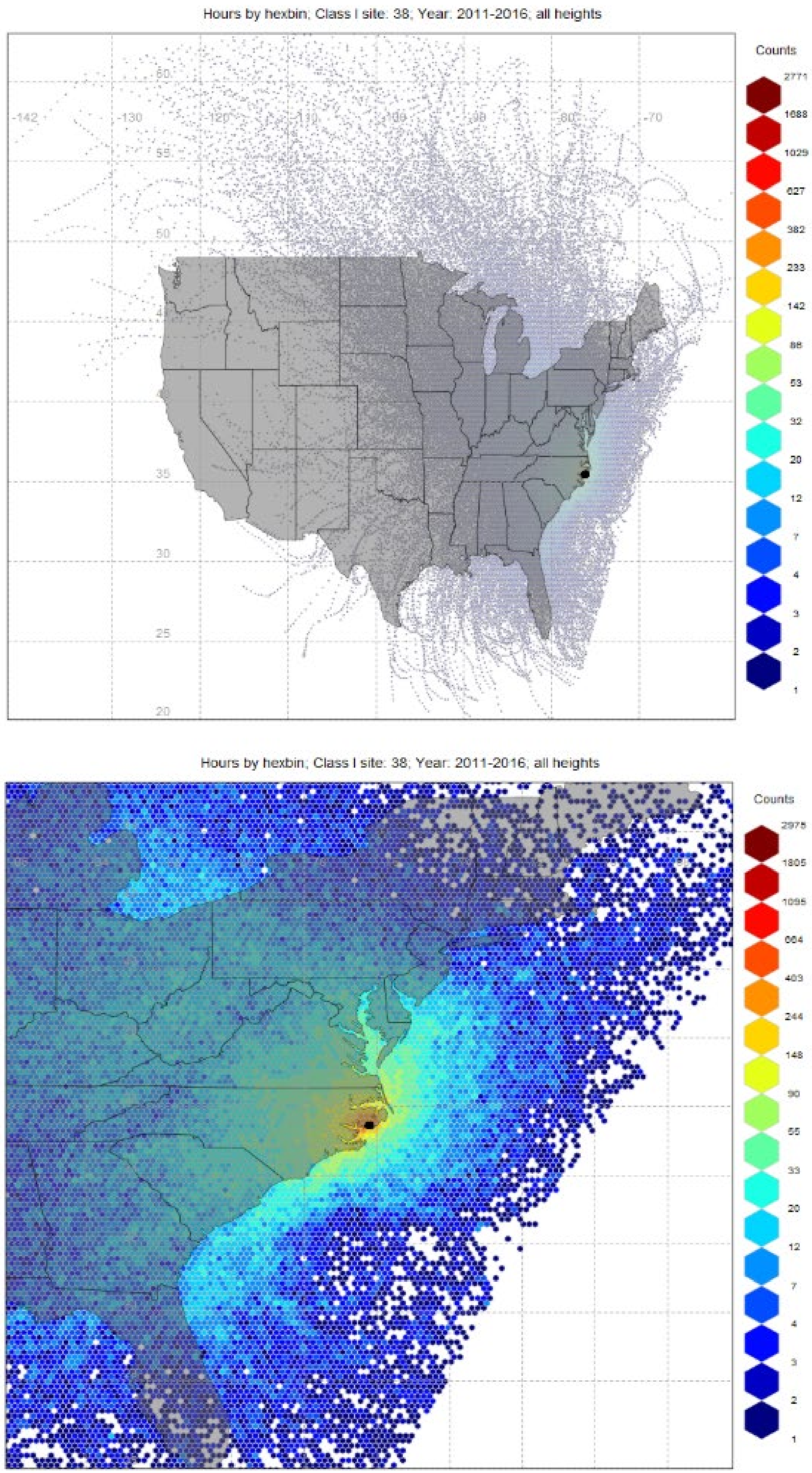
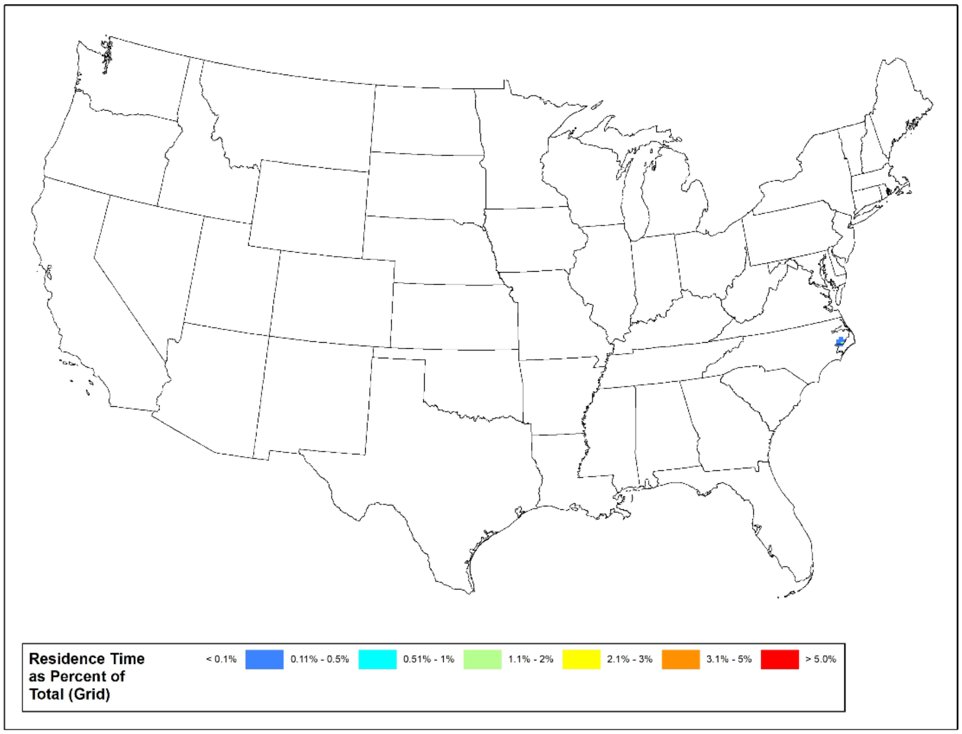


Figure 7-55. Residence Time (Counts per 12-Km Modeling Grid Cell) for Swanquarter Wilderness Area – Full View (top) and Class I Zoom (bottom)



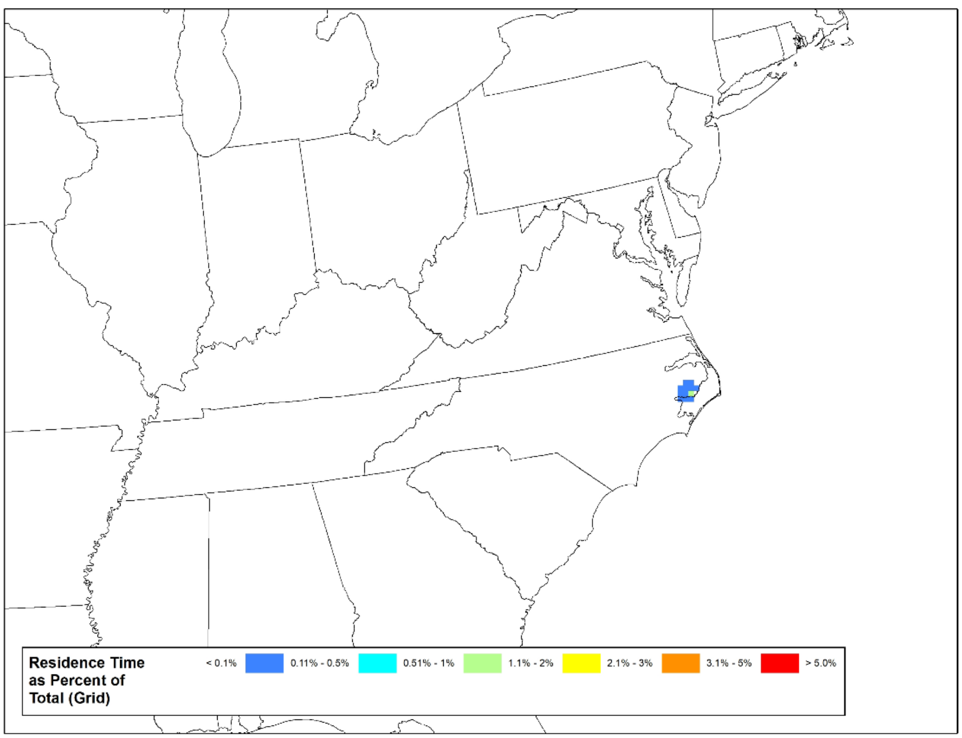


Figure 7-56. Residence Time (% of Total Counts per 12Km Modeling Grid Cell for Swanquarter Wilderness Area – Full View (top) and Class I Zoom (bottom)

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)[107] 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 that 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 7-57 through Figure 7-66 contain the sulfate and nitrate EWRT (sulfate and nitrate EWRT per 12-Km modeling grid cell) for Great Smoky Mountains National Park, Joyce Kilmer-Slickrock Wilderness Area, Linville Gorge Wilderness Area, Shining Rock Wilderness Area, and Swanquarter Wilderness Area, respectively, for the 20% most impaired days from 2011 to 2016. It should be noted that the sulfate EWRT values are significantly higher (approximately ten times higher) than the nitrate EWRT values, demonstrating the importance of focusing on SO_2 emission reductions for reducing visibility impairment for the 20% most impaired days during the second implementation period. For this reason, Figure 7-57 through Figure 7-66 utilize different scales for sulfate and nitrate.

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[107] 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.

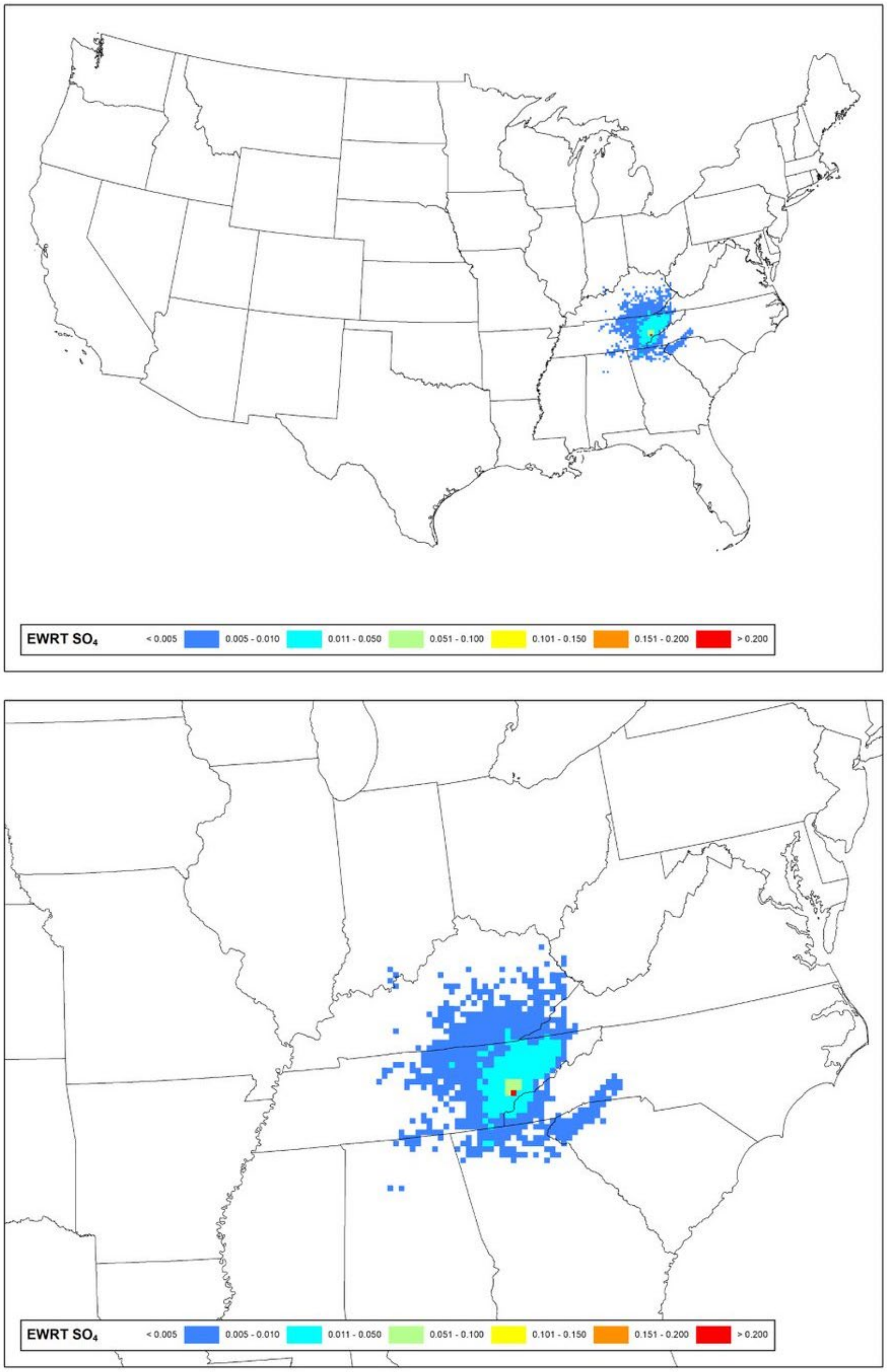


Figure 7-57. Sulfate Extinction Weighted Residence Time (Sulfate EWRT per 12Km Modeling Grid Cell) for Great Smoky Mountains National Park - Full View (top) and Class I Zoom (bottom)

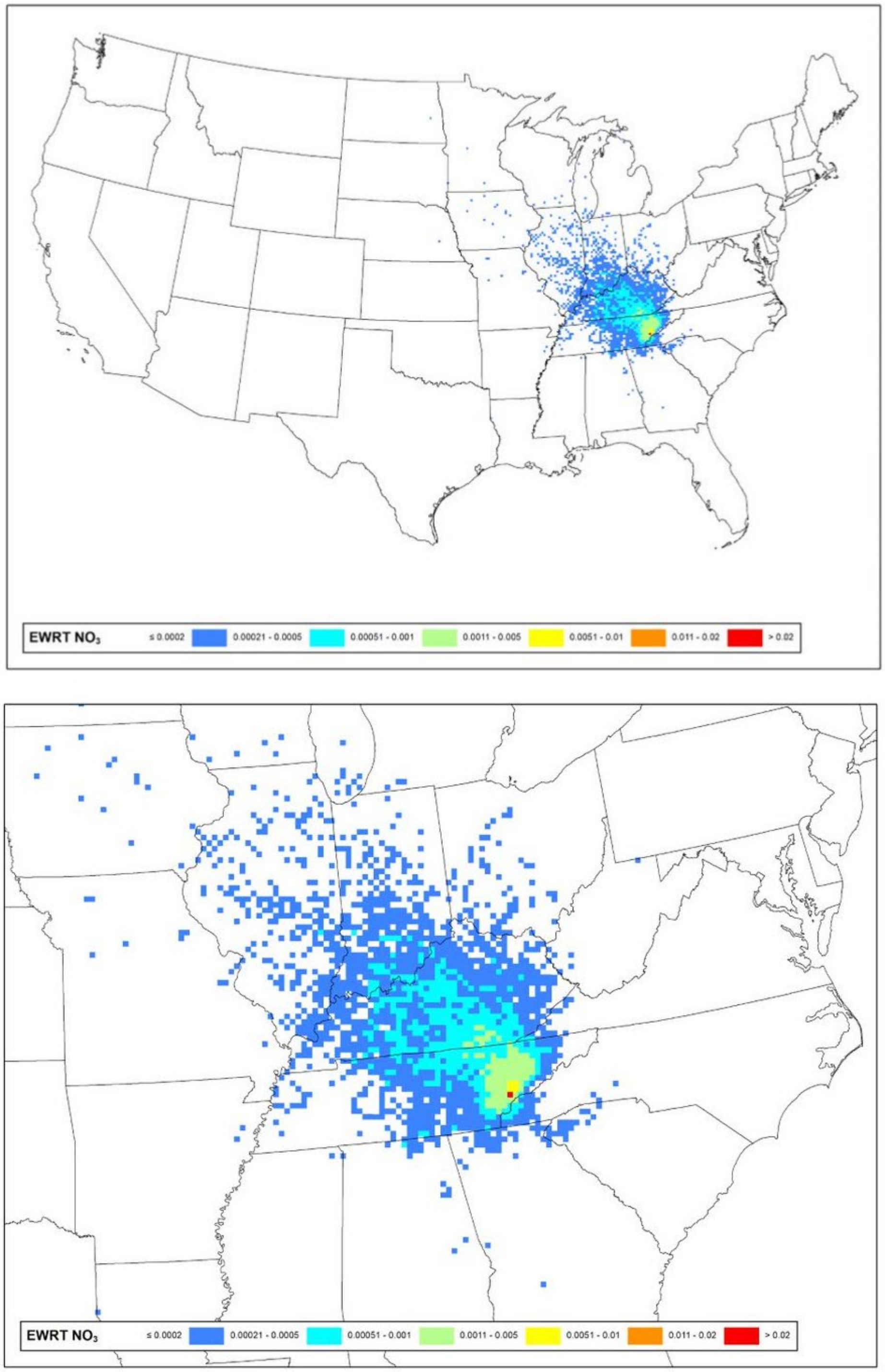


Figure 7-58. Nitrate Extinction Weighted Residence Time (Nitrate EWRT per 12-Km Modeling Grid Cell) for Great Smoky Mountains National Park - Full View (top) and Class I Zoom (bottom)

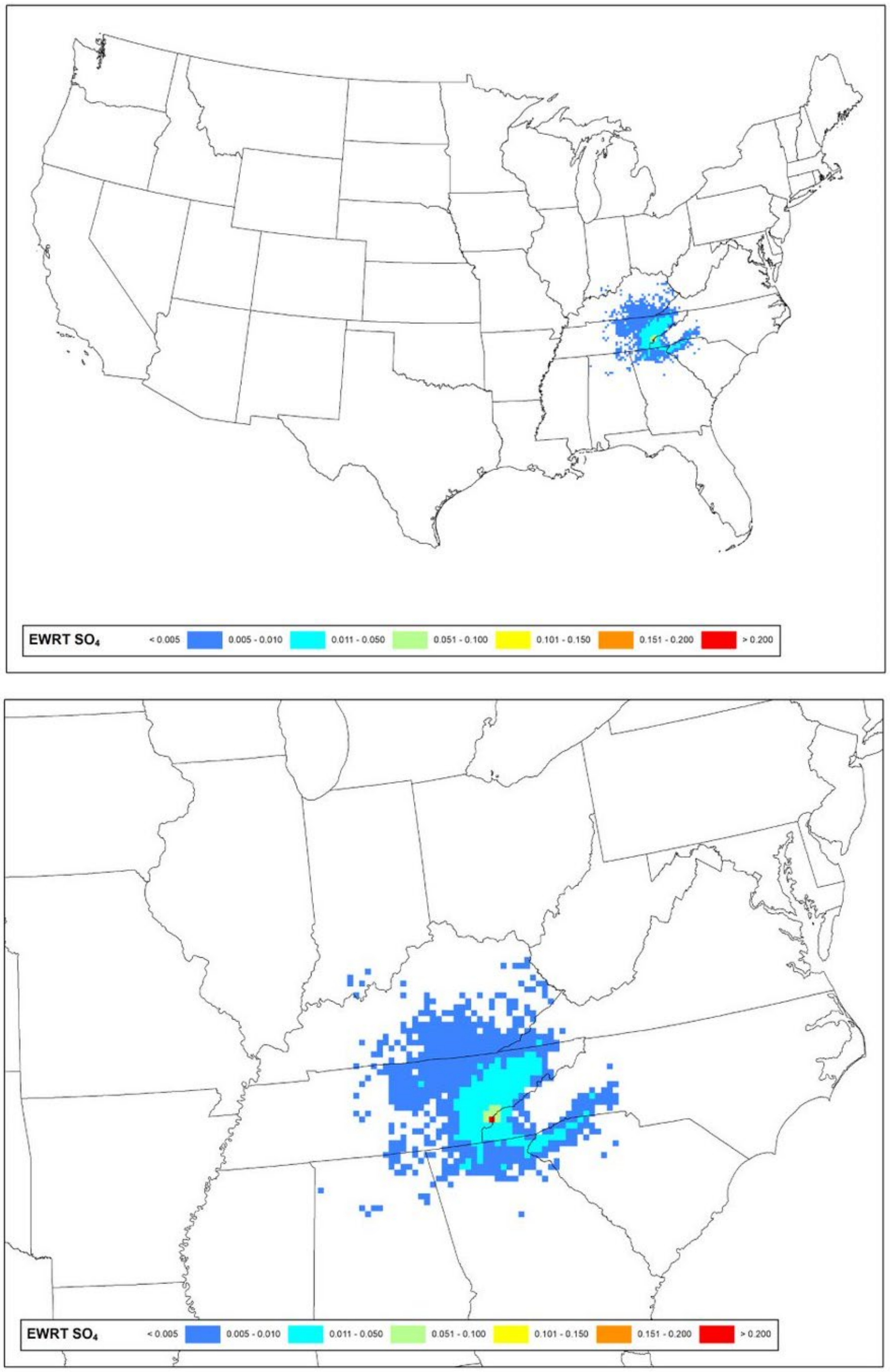


Figure 7-59. Sulfate Extinction Weighted Residence Time (Sulfate EWRT per 12Km Modeling Grid Cell) for Joyce Kilmer-Slickrock Wilderness Area - Full View (top) and Class I Zoom (bottom)

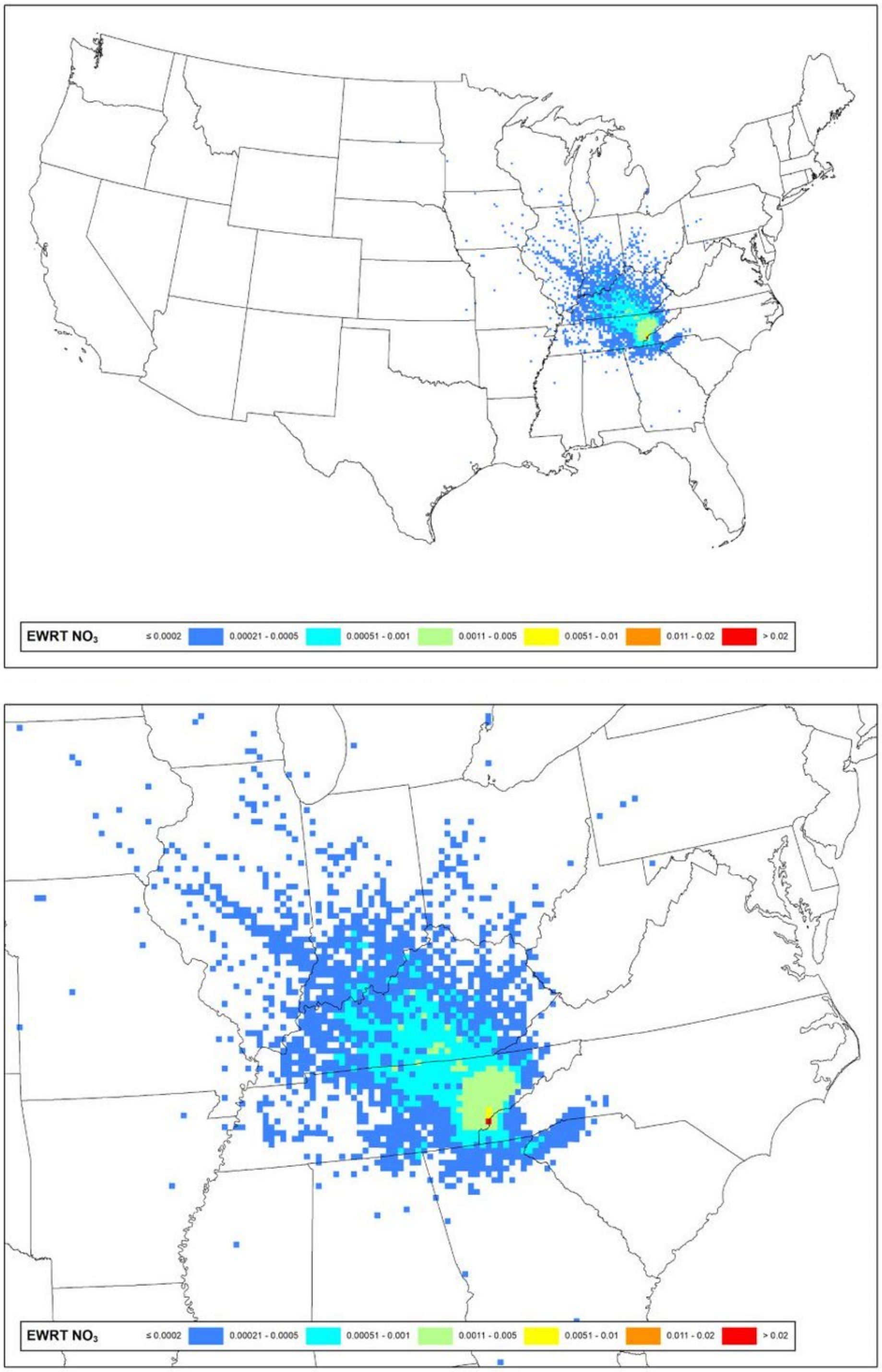


Figure 7-60. Nitrate Extinction Weighted Residence Time (Nitrate EWRT per 12-Km Modeling Grid Cell) for Joyce Kilmer-Slickrock Wilderness Area - Full View (top) and Class I Zoom (bottom)

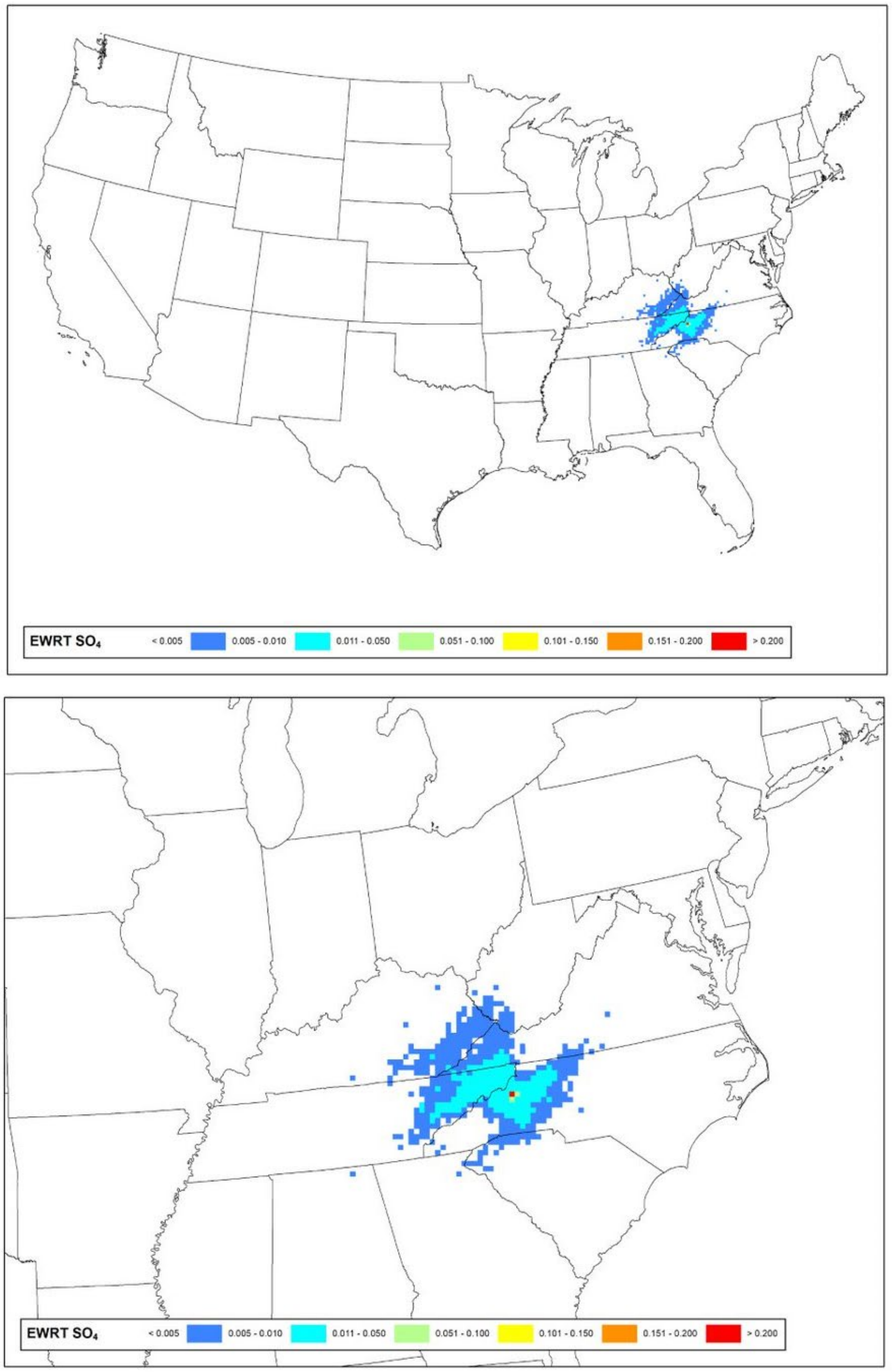


Figure 7-61. Sulfate Extinction Weighted Residence Time (Sulfate EWRT per 12Km Modeling Grid Cell) for Linville Gorge Wilderness Area - Full View (top) and Class I Zoom (bottom)

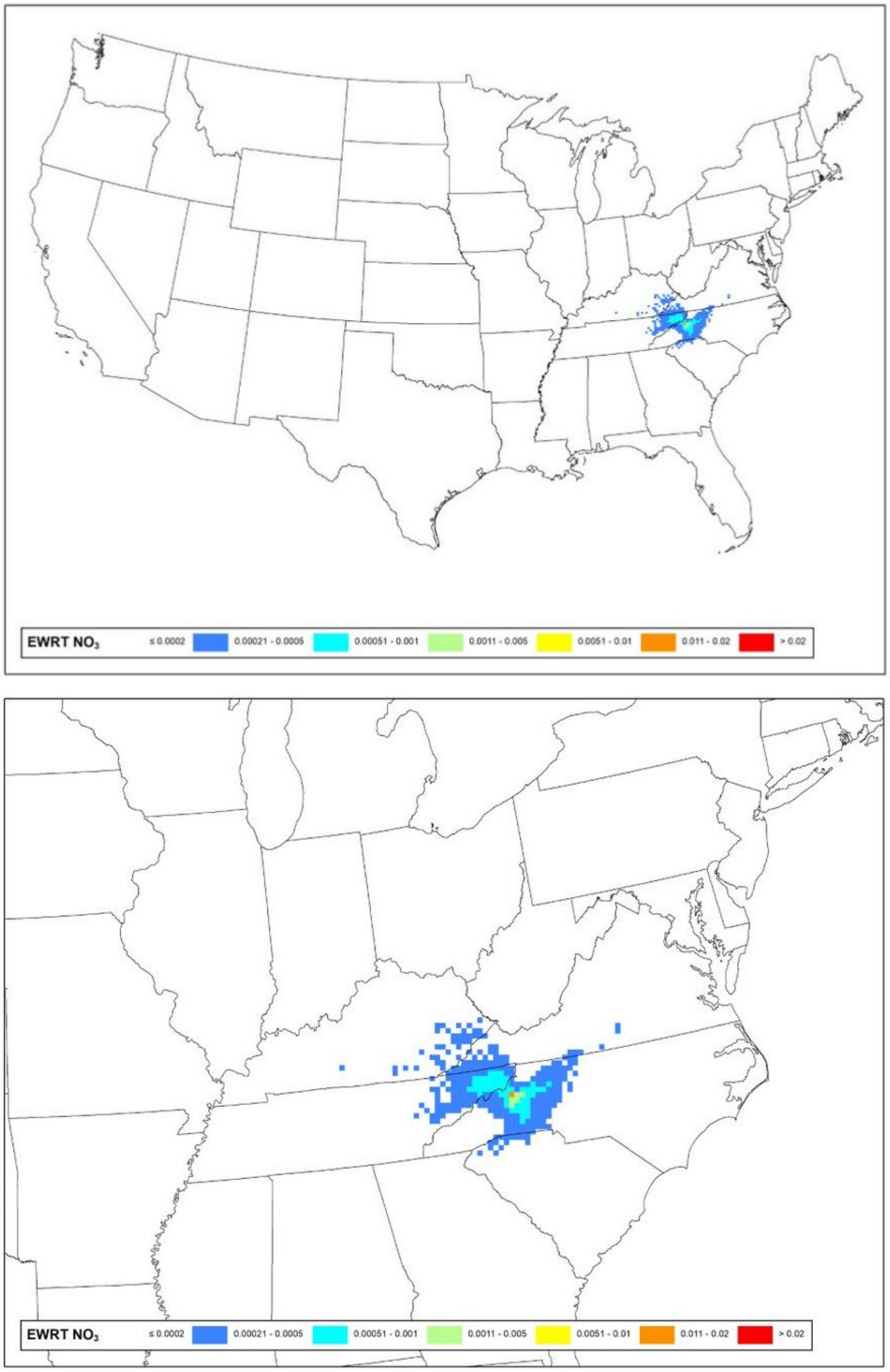


Figure 7-62. Nitrate Extinction Weighted Residence Time (Nitrate EWRT per 12-Km Modeling Grid Cell) for Linville Gorge Wilderness Area - Full View (top) and Class I Zoom (bottom)

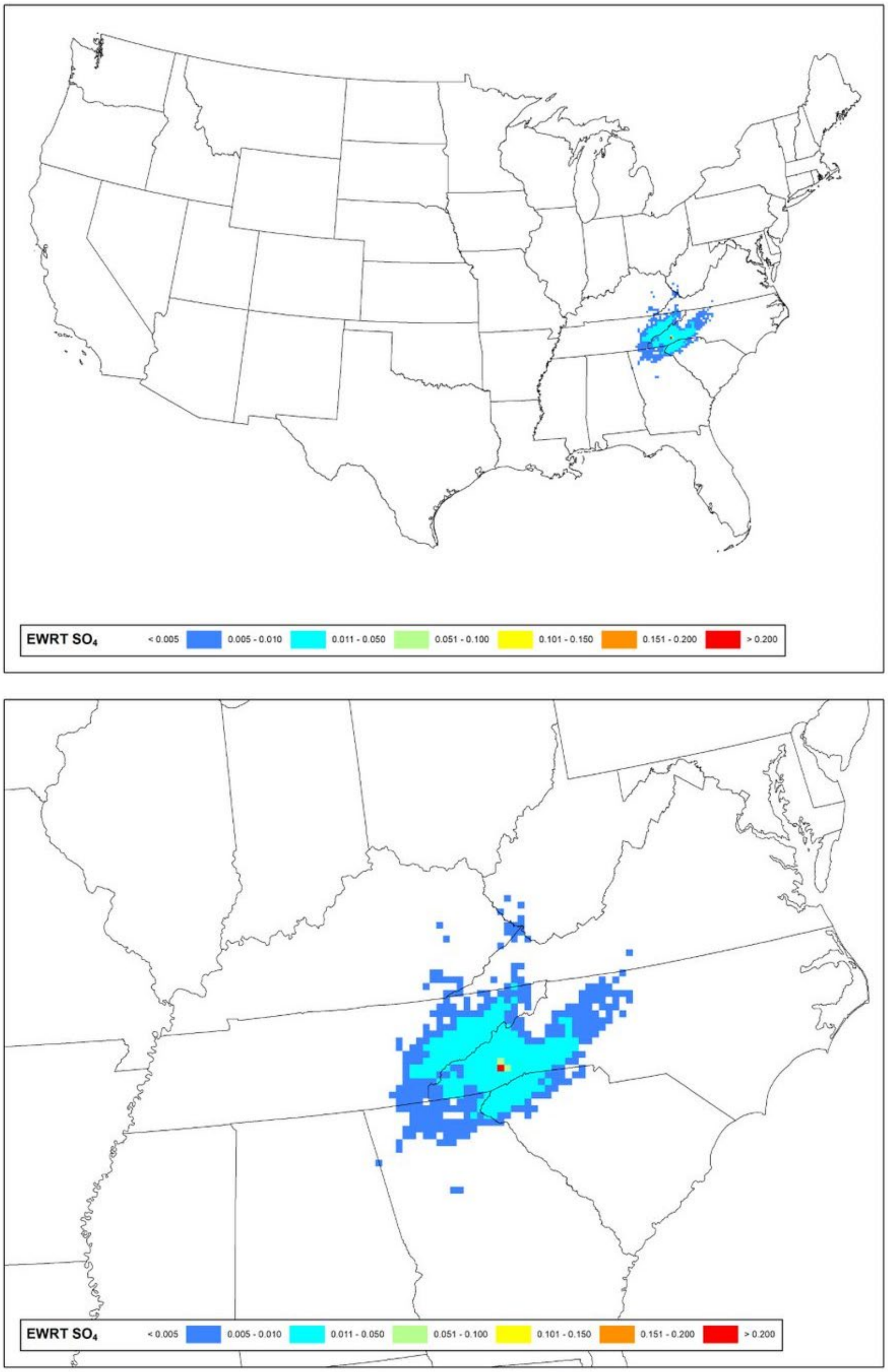


Figure 7-63. Sulfate Extinction Weighted Residence Time (Sulfate EWRT per 12Km Modeling Grid Cell) for Shining Rock Wilderness Area - Full View (top) and Class I Zoom (bottom)

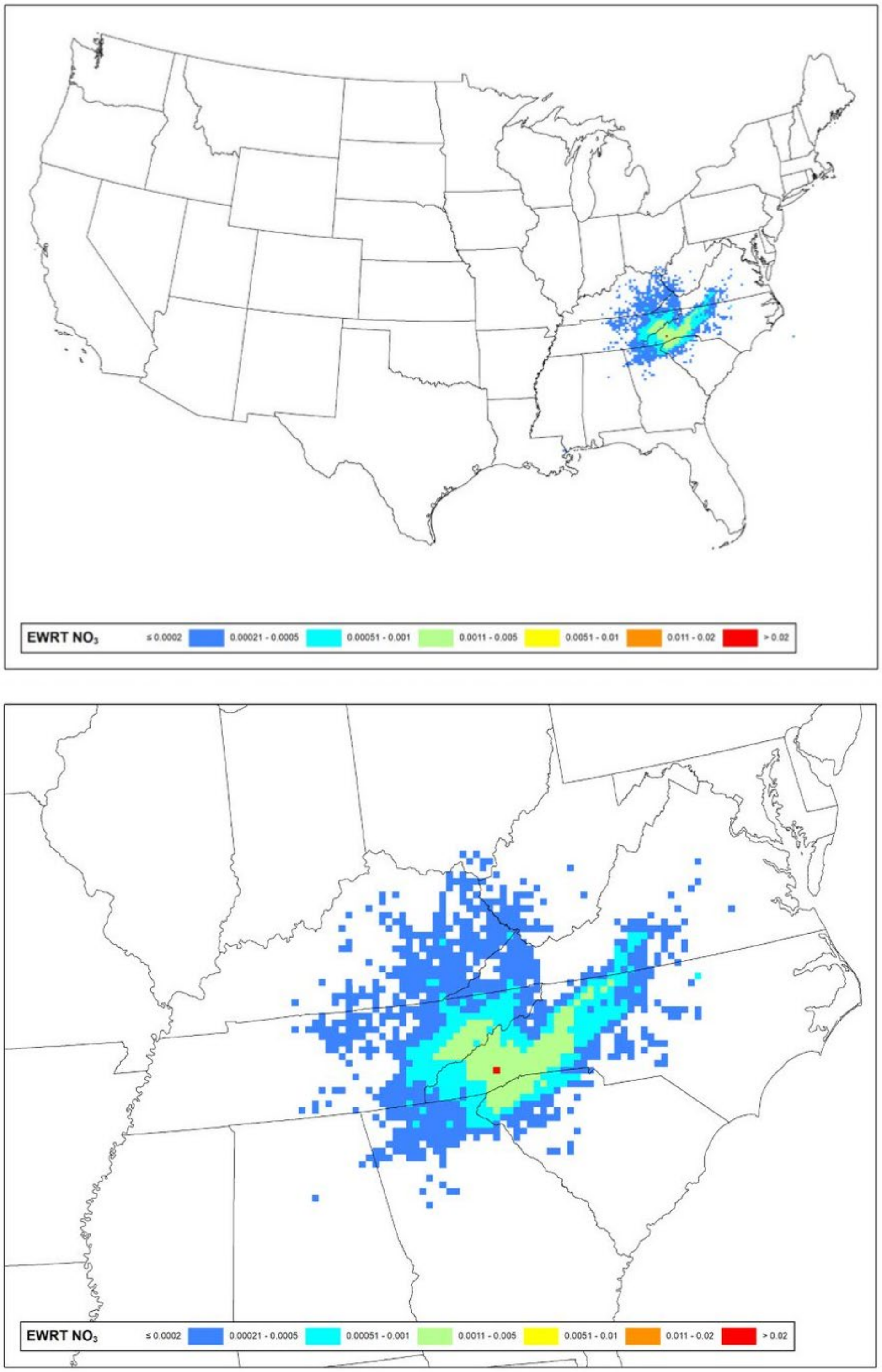


Figure 7-64. Nitrate Extinction Weighted Residence Time (Nitrate EWRT per 12-Km Modeling Grid Cell) for Shining Rock Wilderness Area - Full View (top) and Class I Zoom (bottom)

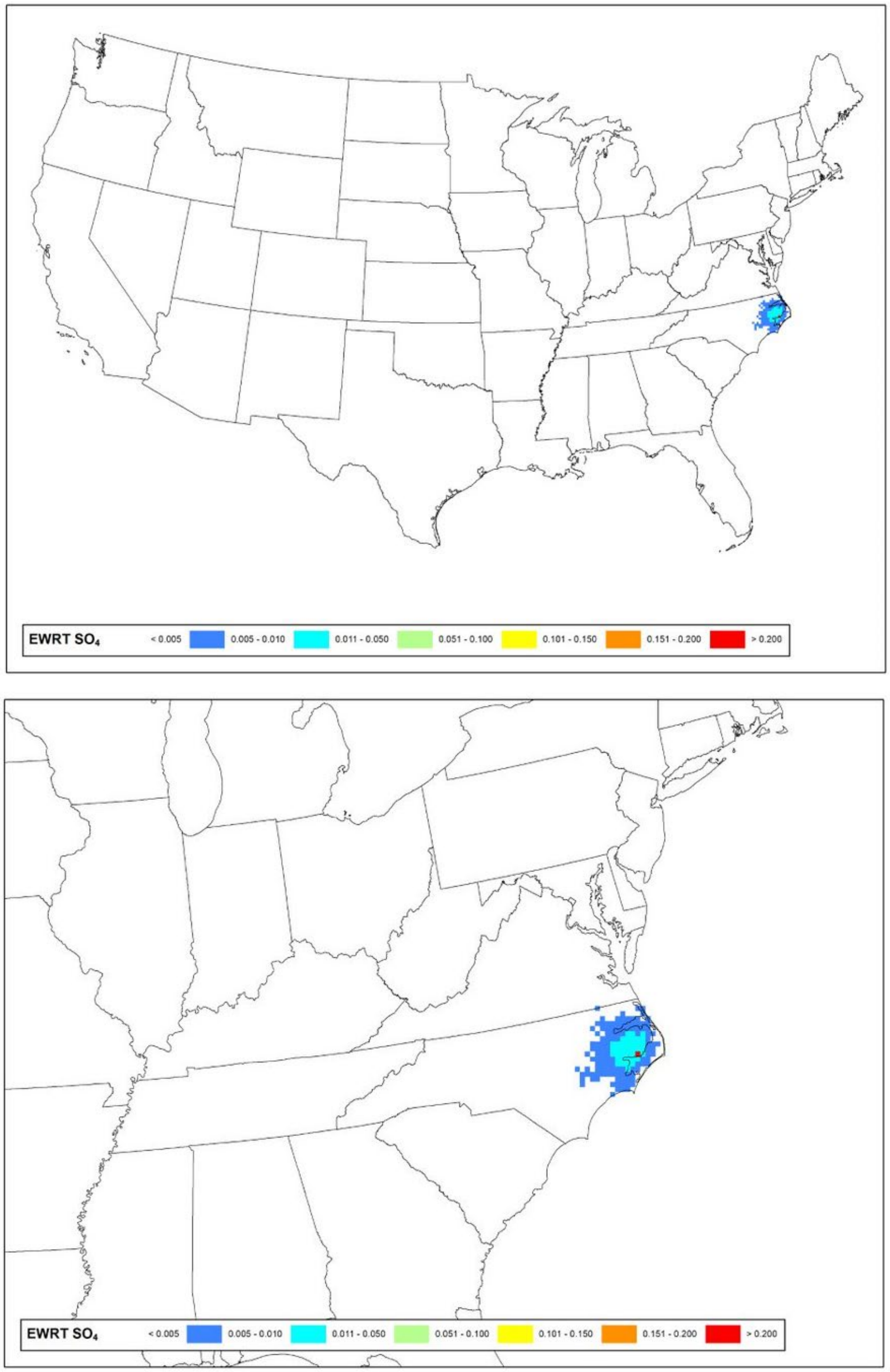
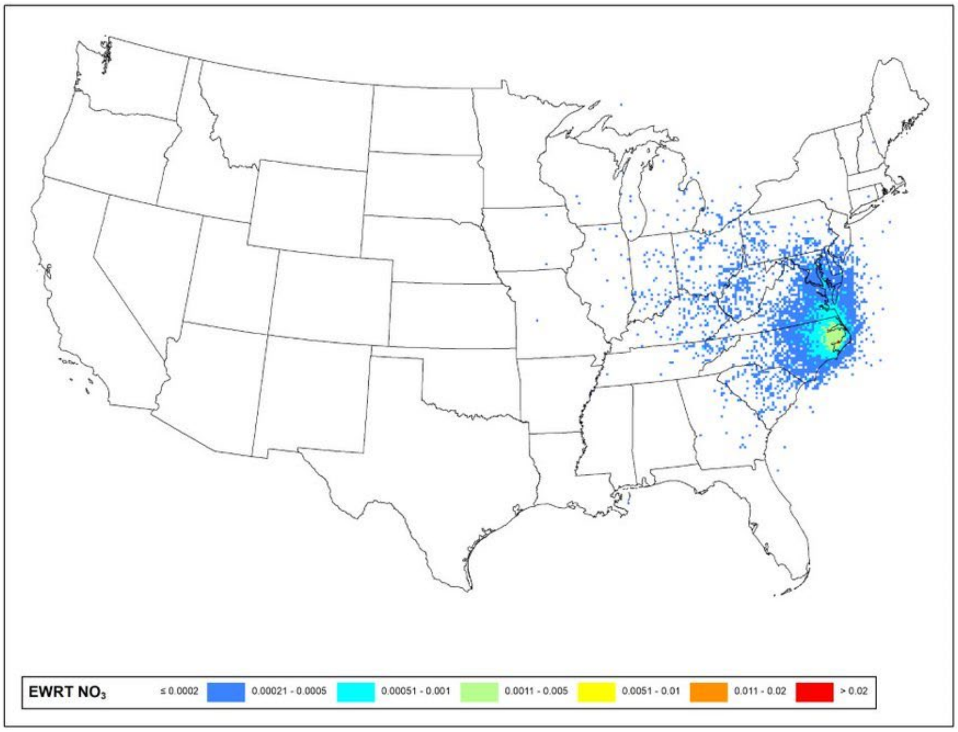


Figure 7-65. Sulfate Extinction Weighted Residence Time (Sulfate EWRT per 12Km Modeling Grid Cell) for Swanquarter Wilderness Area - Full View (top) and Class I Zoom (bottom)



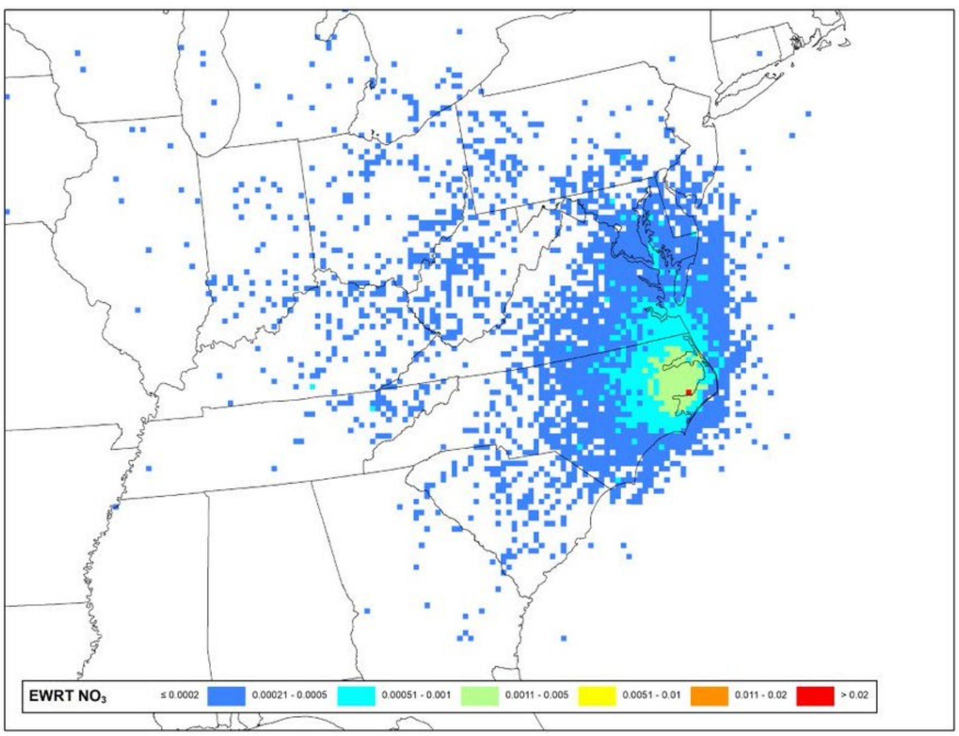


Figure 7-66. Nitrate Extinction Weighted Residence Time (Nitrate EWRT per 12-Km Modeling Grid Cell) for Swanquarter Wilderness Area - Full View (top) and Class I Zoom (bottom)

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 (i.e., Joyce Kilmer-Slickrock Wilderness Area), 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.

Figure 7-67 through Figure 7-76 contain the sulfate and nitrate emissions/distance times EWRT values (percent of total Q/d*EWRT per 12-Km modeling grid cell) for Great Smoky Mountains National Park, Joyce Kilmer-Slickrock Wilderness Area, Linville Gorge Wilderness Area, Shining Rock Wilderness Area, and Swanquarter Wilderness Area, respectively. These maps help visualize the location of the sources of the largest visibility impacts associated with sulfate and nitrate for each Class I area.

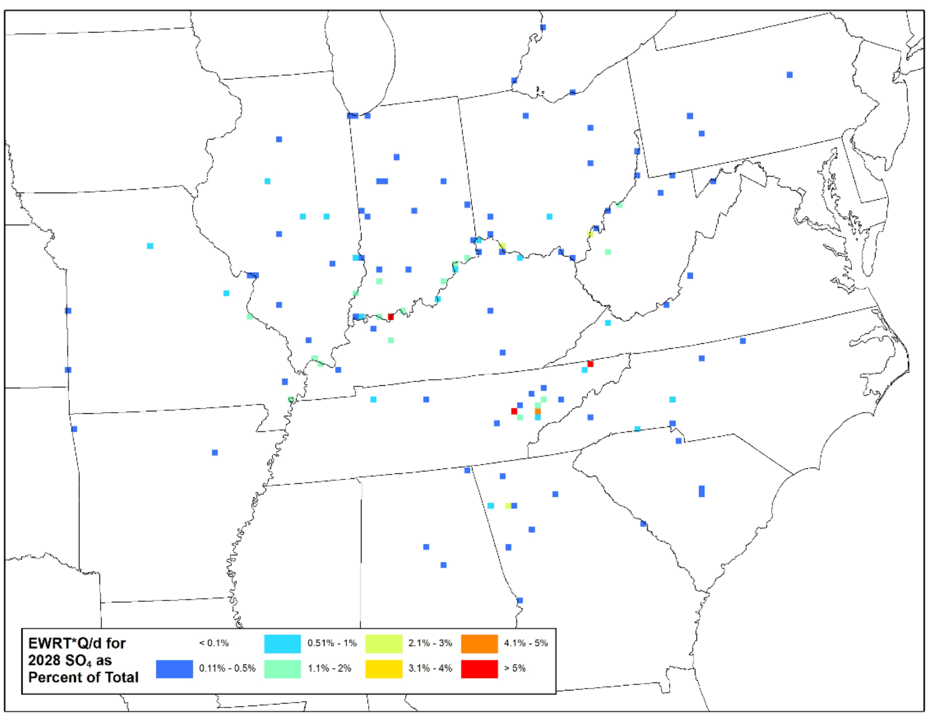


Figure 7-67. Sulfate Emissions/Distance Extinction Weighted Residence Time (% of Total Q/d*EWRT per 12Km Modeling Grid Cell) for Great Smoky Mountains National Park

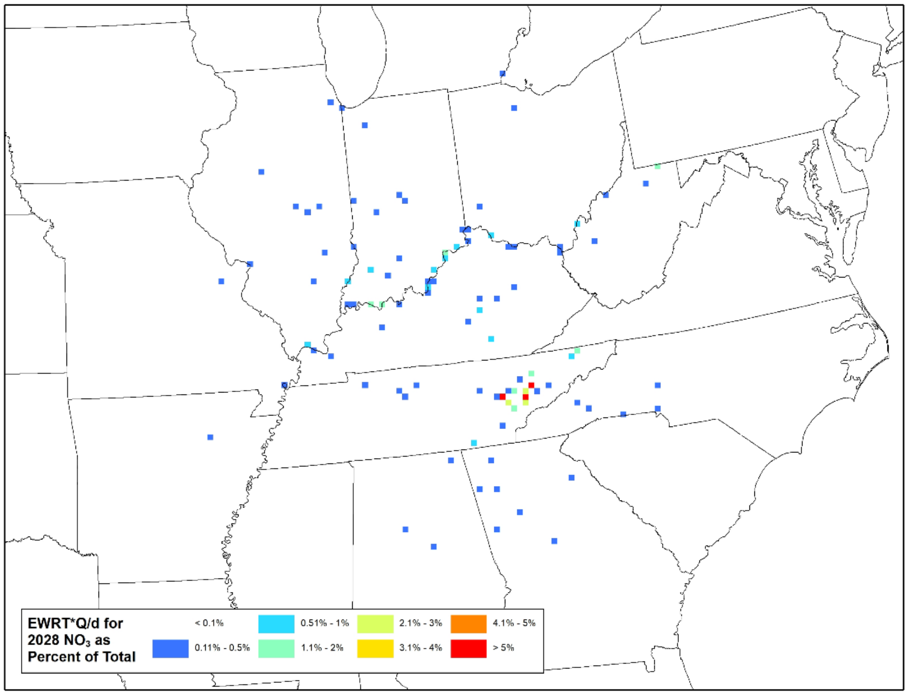


Figure 7-68. Nitrate Emissions/Distance Extinction Weighted Residence Time (% of Total Q/d*EWRT per 12Km Modeling Grid Cell) for Great Smoky Mountains National Park

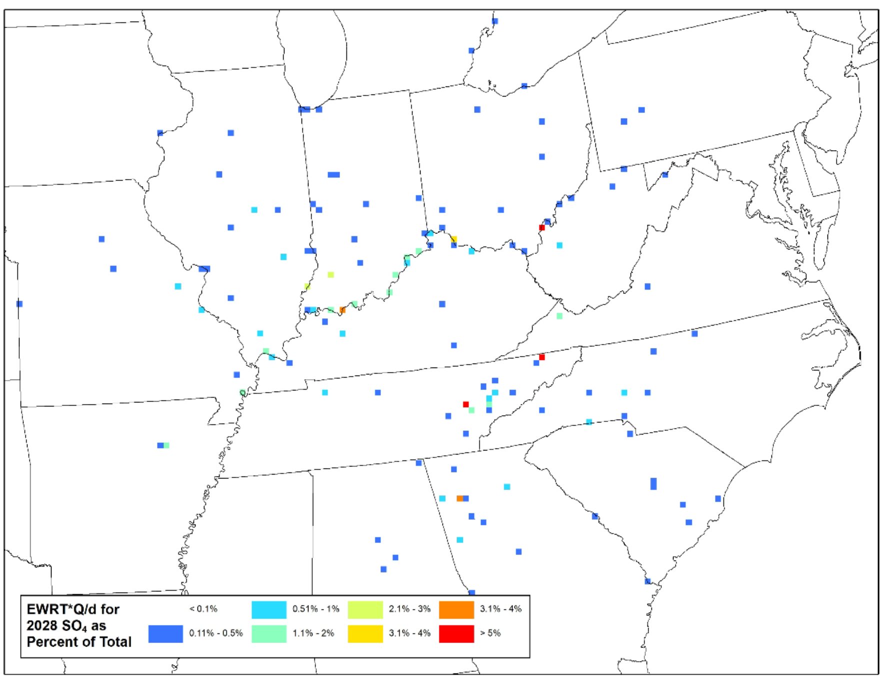


Figure 7-69. Sulfate Emissions/Distance Extinction Weighted Residence Time (% of Total Q/d*EWRT per 12Km Modeling Grid Cell) for Joyce Kilmer-Slickrock Wilderness Area

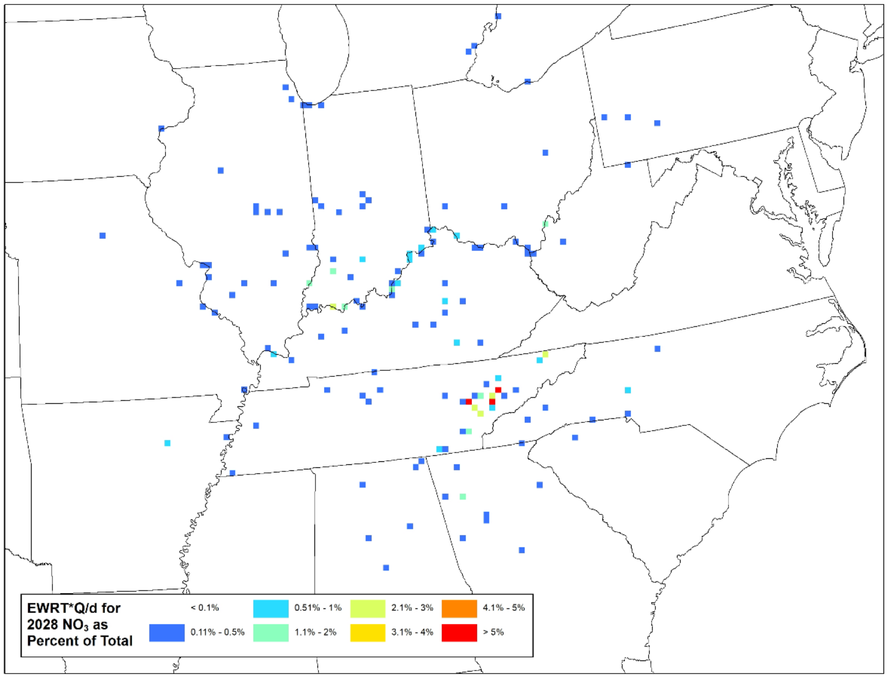


Figure 7-70. Nitrate Emissions/Distance Extinction Weighted Residence Time (% of Total Q/d*EWRT per 12Km Modeling Grid Cell) for Joyce Kilmer-Slickrock Wilderness Area–Full View (top) and Class I Zoom (bottom)

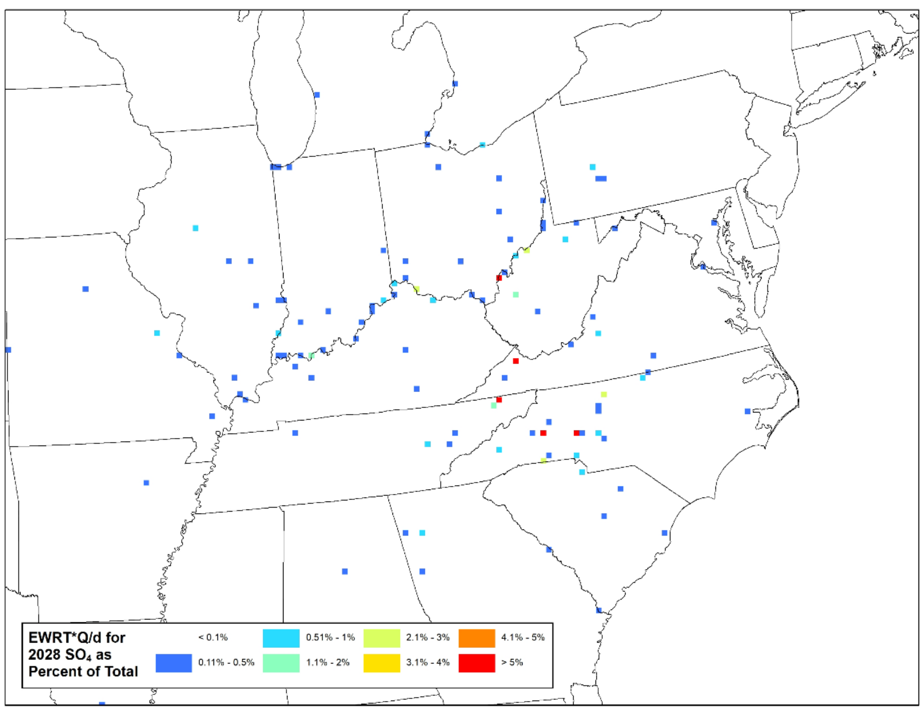


Figure 7-71. Sulfate Emissions/Distance Extinction Weighted Residence Time (% of Total Q/d*EWRT per 12Km Modeling Grid Cell) for Linville Gorge Wilderness Area

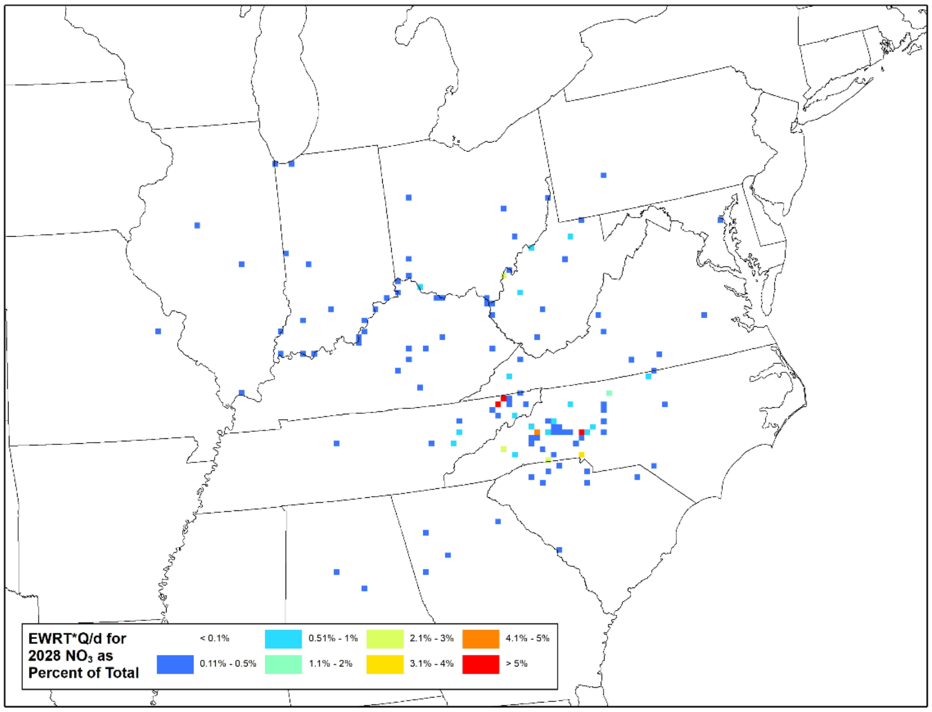


Figure 7-72. Nitrate Emissions/Distance Extinction Weighted Residence Time (% of Total Q/d*EWRT per 12Km Modeling Grid Cell) for Linville Gorge Wilderness Area

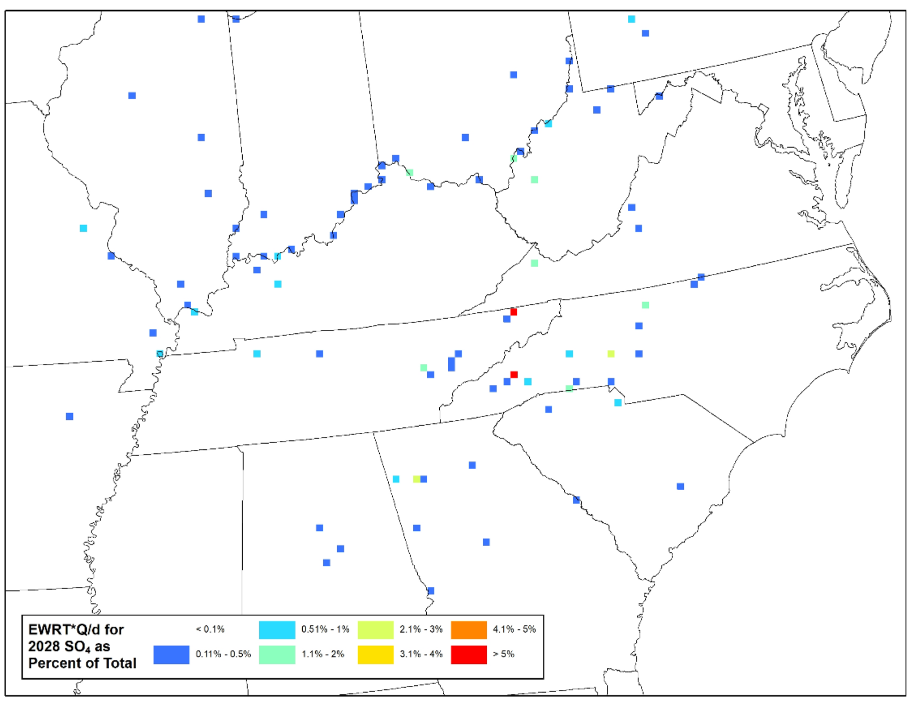


Figure 7-73. Sulfate Emissions/Distance Extinction Weighted Residence Time (% of Total Q/d*EWRT per 12Km Modeling Grid Cell) for Shining Rock Wilderness Area

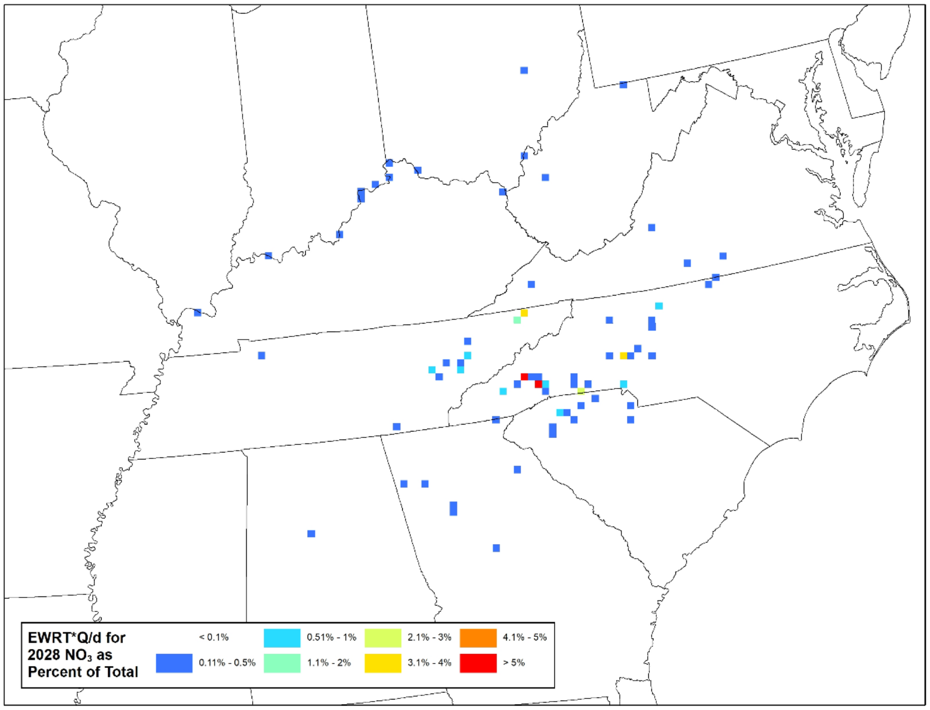


Figure 7-74. Nitrate Emissions/Distance Extinction Weighted Residence Time (% of Total Q/d*EWRT per 12Km Modeling Grid Cell) for Shining Rock Wilderness Area

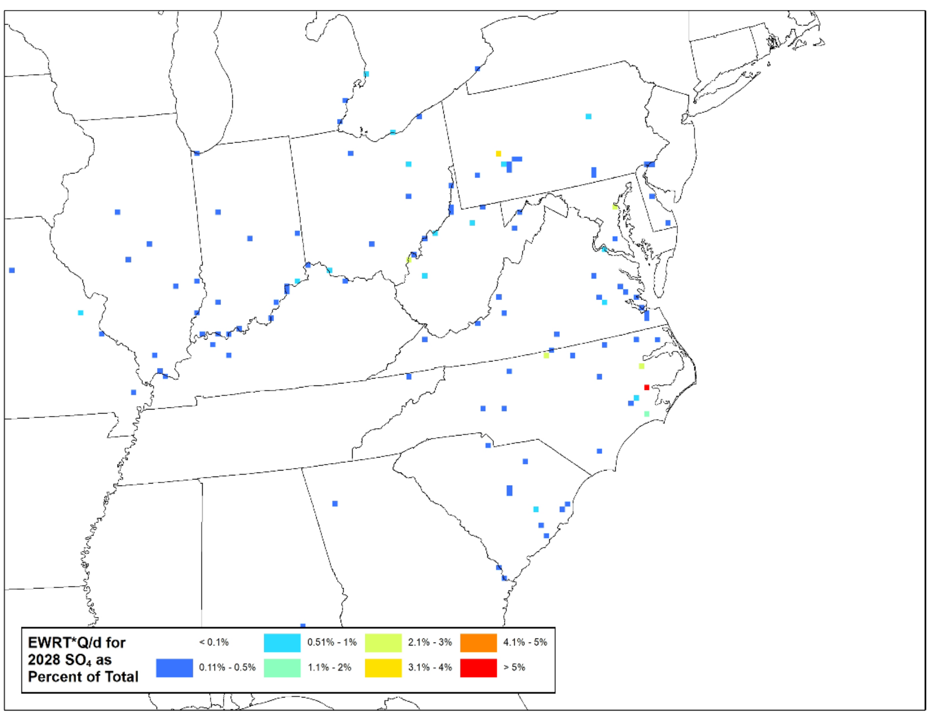


Figure 7-75. Sulfate Emissions/Distance Extinction Weighted Residence Time (% of Total Q/d*EWRT per 12Km Modeling Grid Cell) for Swanquarter Wilderness Area

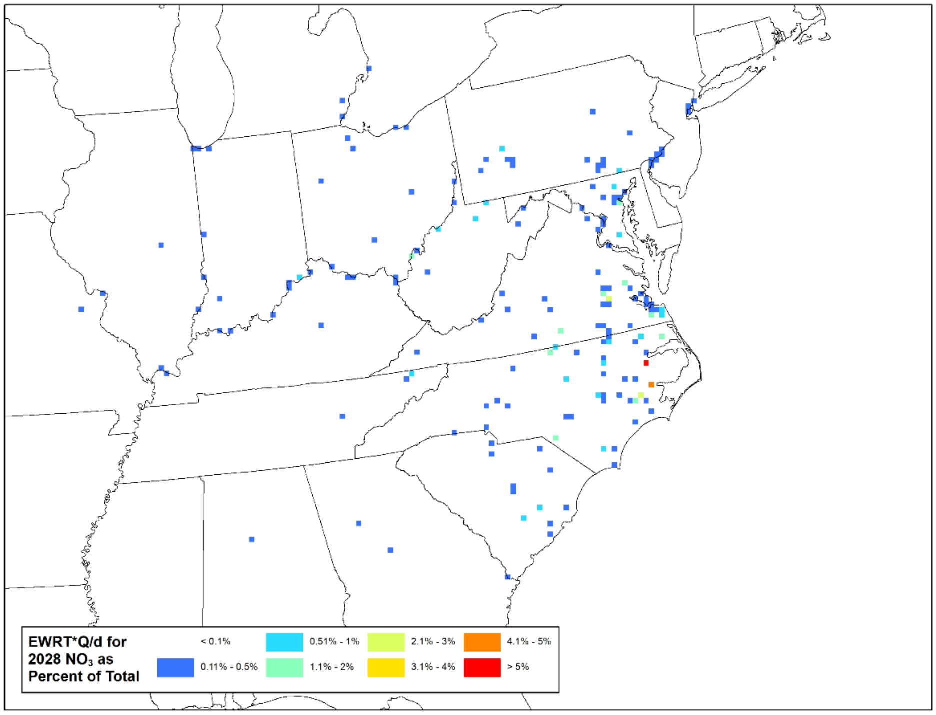


Figure 7-76. Nitrate Emissions/Distance Extinction Weighted Residence Time (% of Total Q/d*EWRT per 12Km Modeling Grid Cell) for Swanquarter Wilderness Area

7.5.5 Ranking of Sources for North Carolina 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, non-road, 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. Similar to point sources, the final spatial join was made between the county-level EWRT, emissions, and source information for each sector.

Table 7-15 through Table 7-19 show the NO_x and SO_2 source contributions to visibility impairment on the 20% most impaired days at Great Smoky Mountains National Park, Joyce Kilmer-Slickrock Wilderness Area, Linville Gorge Wilderness Area, Shining Rock Wilderness Area, and Swanquarter Wilderness Area, respectively. Based on the sector contributions given in the tables below, it is clear that SO_2 from point sources is the dominant source category at all North Carolina Class I areas.

Table 7-15. NO_x and SO_2 Source Contributions to Visibility Impairment on the 20% Most Impaired Days at Great Smoky Mountains National Park

Category	NO_x	**SO_2**	**Total**
Nonpoint	8.49%	10.71%	19.21%
Non-Road, MAR	3.14%	0.10%	3.24%
Non-Road, Other	4.73%	0.29%	5.02%
Onroad	11.57%	1.52%	13.09%
Point	6.96%	49.86%	56.81%
Pt_Fires_Prescribed	0.31%	2.32%	2.63%
Total	35.20%	64.80%	100.00%

Table 7-16. NO_x and SO_2 Source Contributions to Visibility Impairment on the 20% Most Impaired Days at Joyce Kilmer-Slickrock Wilderness Area

Category	**NO_x**	**SO_2**	**Total**
Nonpoint	4.76%	7.69%	12.45%
Non-Road, MAR	2.25%	0.11%	2.36%
Non-Road, Other	2.71%	0.21%	2.92%
Onroad	7.34%	0.84%	8.18%
Point	6.21%	64.07%	70.28%
Pt_Fires_Prescribed	0.44%	3.37%	3.81%
Total	23.71%	76.29%	100.00%

Table 7-17. NO_x and SO_2 Source Contributions to Visibility Impairment on the 20% Most Impaired Days at Linville Gorge Wilderness Area

Category	**NO_x**	**SO_2**	**Total**
Nonpoint	1.70%	9.97%	11.67%
Non-Road, MAR	0.60%	0.13%	0.73%
Non-Road, Other	0.79%	0.14%	0.93%
Onroad	1.87%	0.53%	2.39%
Point	3.05%	79.90%	82.95%
Pt_Fires_Prescribed	0.09%	1.24%	1.33%
Total	8.09%	91.91%	100.00%

Table 7-18. NO_x and SO_2 Source Contributions to Visibility Impairment on the 20% Most Impaired Days at Shining Rock Wilderness Area

Category	NO_x	SO_2	Total
Nonpoint	4.23%	12.29%	16.52%
Non-Road, MAR	1.12%	0.07%	1.18%
Non-Road, Other	2.70%	0.17%	2.87%
Onroad	5.95%	0.67%	6.62%
Point	9.68%	61.52%	71.20%
Pt_Fires_Prescribed	0.24%	1.37%	1.60%
Total	23.92%	76.08%	100.00%

Table 7-19. NO_x and SO_2 Source Contributions to Visibility Impairment on the 20% Most Impaired Days at Swanquarter Wilderness Area

Category	NO_x	SO_2	Total
Nonpoint	3.59%	4.22%	7.81%
Non-Road, MAR	3.54%	0.31%	3.85%
Non-Road, Other	8.79%	0.16%	8.95%
Onroad	4.18%	0.23%	4.41%
Point	7.30%	66.52%	73.82%
Pt_Fires_Prescribed	0.33%	0.82%	1.16%
Total	27.74%	72.26%	100.00%

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

Table 7-20 through Table 7-24 contains the AoI NO_x and SO_2 facility contributions to visibility impairment on the 20% most impaired days at Great Smoky Mountains National Park, Joyce Kilmer-Slickrock Wilderness Area, Linville Gorge Wilderness Area, Shining Rock Wilderness Area, and Swanquarter Wilderness Area, respectively. 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 the facilities to tag in the PSAT source contribution analysis.

Table 7-20. Facilities with ≥1.00% Sulfate + Nitrate AoI Contribution to Visibility Impairment on the 20% Most Impaired Days at Great Smoky Mountains National Park

State	Facility ID	Facility Name	Distance (Km)	2028 NO_x (TPY)	2028 SO_2 (TPY)	Nitrate (%)	Sulfate (%)	Sulfate + Nitrate (%)
TN	47145-4979111	TVA Kingston Fossil Plant	60.0	1687.4	1,886.1	0.71%	7.38%	8.09%
TN	47009-9159211	Mc Ghee Tyson	19.7	594.7	78.6	3.01%	4.31%	7.32%
TN	47163-3982311	Eastman Chemical Company	160.1	6900.3	6,420.2	0.19%	6.01%	6.20%
IN	18147-8017211	Indiana Michigan Power - Rockport	375.5	8806.8	30,536.3	0.21%	4.66%	4.87%
TN	47093-4979911	Cemex - Knoxville Plant	44.3	711.5	121.5	0.90%	1.71%	2.62%
OH	39053-8148511	General James M. Gavin Power Plant	400.5	8122.5	41595.8	0.04%	2.25%	2.29%
GA	13015-2813011	Ga Power Company - Plant Bowen	189.7	6643.3	10453.4	0.04%	2.10%	2.14%
OH	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station	360.0	7150.0	22133.9	0.09%	1.84%	1.93%
IN	18077-7744211	Indiana Kentucky Electric Corporation	368.7	6188.5	9038.1	0.13%	1.60%	1.72%
IL	17127-7808911	Joppa Steam	474.4	4706.3	20509.3	0.04%	1.62%	1.67%
IN	18125-7362411	Indianapolis Power & Light Petersburg	435.6	10665.3	18141.9	0.12%	1.48%	1.60%
KY	21041-5198511	KY Utilities Co - Ghent Station	359.2	7939.9	10169.3	0.09%	1.43%	1.52%
TN	47105-4129211	TATE & LYLE, Loudon	36.1	252.5	110.2	0.23%	1.22%	1.45%
KY	21145-6037011	TVA - Shawnee Fossil Plant	465.3	7007.3	19504.7	0.02%	1.34%	1.35%
IN	18051-7363111	Gibson	456.3	12280.3	23117.2	0.07%	1.25%	1.32%
KY	21183-5561611	Big Rivers Electric Corp - Wilson Station	345.8	1151.9	6934.2	0.03%	1.17%	1.20%
WV	54073-4782811	Monongahela Power Co – Pleasants Power Station	475.9	5497.4	16817.4	0.02%	1.06%	1.08%
KY	21091-7352411	Century Aluminum of KY LLC	360.5	197.7	5044.2	0.00%	1.07%	1.07%
WV	54079-6789111	Appalachian Power Company - John E Amos Plant	367.1	4878.1	10,984.2	0.01%	1.05%	1.06%
TN	47009-4143611	ALCOA Inc. - South Plant	16.4	109.4	5.3	0.66%	0.35%	1.01%

Table 7-21. Facilities with ≥1.00% Sulfate + Nitrate AoI Contribution to Visibility Impairment on the 20% Most Impaired Days at Joyce Kilmer-Slickrock Wilderness Area

State	Facility ID	Facility Nae	Distance (Km)	2028 NO_x (TPY)	2028 SO_2 (TPY)	Nitrate (%)	Sulfate (%)	Sulfate + Nitrate (%)
TN	47145-4979111	TVA Kingston Fossil Plant	73.7	1,687.4	1,886.1	0.57%	7.86%	8.42%
TN	47163-3982311	Eastman Chemical Company	179.2	6,900.3	6,420.2	0.16%	5.88%	6.05%
OH	39053-8148511	General James M. Gavin Power Plant	425.1	8,122.5	41,595.8	0.05%	4.73%	4.78%
IN	18147-8017211	Indiana Michigan Power - Rockport	391.2	8,806.8	30,536.3	0.14%	4.33%	4.47%
GA	13015-2813011	Ga Power Company - Plant Bowen	166.2	6,643.3	10,453.4	0.10%	3.61%	3.71%
OH	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station	385.1	7,150.0	22,133.9	0.06%	3.63%	3.69%
IN	18125-7362411	Indianapolis Power & Light Petersburg	453.0	10,665.3	18,141.9	0.14%	2.16%	2.30%
IN	18051-7363111	Gibson	471.7	12,280.3	23,117.2	0.11%	2.00%	2.10%
TN	47009-9159211	Mc Ghee Tyson	44.3	594.7	78.6	0.69%	1.34%	2.03%
AR	05063-1083411	Entergy Arkansas Inc. - Independence Plant	674.4	14,133.2	32,050.5	0.05%	1.58%	1.63%
KY	21091-7352411	Century Aluminum of KY, LLC	377.1	197.7	5,044.2	<0.01%	1.59%	1.59%
TN	47093-4979911	Cemex - Knoxville Plant	69.7	711.5	121.5	0.51%	0.84%	1.36%
KY	21111-7353711	Louisville Gas & Electric Co., Mill Creek Station	340.9	4,169.1	4,335.3	0.12%	1.21%	1.33%
TN	47105-4129211	TATE & LYLE, Loudon	48.1	252.5	110.2	0.18%	1.01%	1.19%
KY	21041-5198511	KY Utilities Co - Ghent Station	383.0	7,939.9	10,169.3	0.07%	1.10%	1.17%
IN	18077-7744211	Indiana Kentucky Electric Corporation	391.6	6,188.5	9,038.1	0.04%	1.06%	1.10%
IN	18019-8198511	ESSROC Cement Corp	369.5	2,365.0	4,681.2	0.04%	1.03%	1.07%
IL	17127-7808911	Joppa Steam	482.1	4,706.3	20,509.3	<0.01%	1.03%	1.04%

Table 7-22. Facilities with ≥1.00% Sulfate + Nitrate AoI Contribution to Visibility Impairment on the 20% Most Impaired Days at Linville Gorge Wilderness Area

State	Facility ID	Facility Name	Distance (Km)	2028 NO_x (TPY)	2028 SO_2 (TPY)	Nitrate (%)	Sulfate (%)	Sulfate + Nitrate (%)
TN	47163-3982311	Eastman Chemical Company	81.9	6,900.3	6,420.2	0.68%	19.21%	19.90%
NC	37035-8370411	Duke Energy Carolinas, LLC - Marshall Steam Station	97.2	7,511.3	4,139.2	0.41%	6.33%	6.73%
OH	39053-8148511	General James M. Gavin Power Plant	329.2	8,122.5	41,595.8	0.04%	5.90%	5.94%
VA	51027-4034811	Jewell Coke Company LLP	140.4	520.2	5,090.9	0.01%	5.34%	5.35%
NC	37023-8513011	SGL Carbon LLC	32.5	21.7	261.6	0.01%	4.05%	4.06%
OH	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station	380.3	7,150.0	22,133.9	0.03%	2.82%	2.85%
NC	37161-8300611	Duke Energy Carolinas, LLC - Cliffside Steam Station	85.3	1,947.7	1,082.3	0.11%	2.38%	2.49%
WV	54073-4782811	Monongahela Power Co – Pleasants Power Station	381.0	5,497.4	16,817.4	0.03%	2.04%	2.07%
NC	37169-8514011	Duke Energy Carolinas, LLC - Belews Creek Steam Station	172.2	5,264.3	4,946.1	0.08%	1.93%	2.01%
TN	47073-2934811	AGC Industries - Greenland Plant	94.7	2,068.1	441.6	0.24%	1.74%	1.98%
WV	54079-6789111	Appalachian Power Company - John E Amos Plant	277.7	4,878.1	10,984.2	<0.01%	1.78%	1.80%
IN	18147-8017211	Indiana Michigan Power - Rockport	503.5	8,806.8	30,536.3	0.01%	1.18%	1.19%

Table 7-23. Facilities with ≥1.00% Sulfate + Nitrate AoI Contribution to Visibility Impairment on the 20% Most Impaired Days at Shining Rock Wilderness Area

State	Facility ID	Facility Name	Distance (Km)	2028 NO_x (TPY)	2028 SO_2 (TPY)	Nitrate (%)	Sulfate (%)	Sulfate + Nitrate (%)
NC	37087-7920511	Blue Ridge Paper Products - Canton Mill	16.9	2,992.4	1,127.1	6.65%	41.29%	47.93%
TN	47163-3982311	Eastman Chemical Company	126.9	6,900.3	6,420.2	0.40%	4.43%	4.83%
NC	37035-8370411	Duke Energy Carolinas, LLC - Marshall Steam Station	166.0	7,511.3	4,139.2	0.49%	2.19%	2.68%
NC	37021-NEW_2706	Asheville	22.6	848.5	17.0	1.97%	0.37%	2.33%
NC	37161-8300611	Duke Energy Carolinas, LLC - Cliffside Steam Station	94.1	1,947.7	1,082.3	0.28%	1.57%	1.85%
GA	13015-2813011	Ga Power Company - Plant Bowen	241.6	6,643.3	10,453.4	0.07%	1.70%	1.77%
NC	37169-8514011	Duke Energy Carolinas, LLC - Belews Creek Steam Station	264.4	5,264.3	4,946.1	0.14%	1.42%	1.56%
TN	47145-4979111	TVA Kingston Fossil Plant	167.7	1,687.4	1,886.1	0.10%	1.40%	1.50%
OH	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station	406.7	7,150.0	22,133.9	0.03%	1.37%	1.40%
OH	39053-8148511	General James M. Gavin Power Plant	397.3	8,122.5	41,595.8	0.01%	1.39%	1.40%
VA	51027-4034811	Jewell Coke Company LLP	214.7	520.2	5,090.9	<0.01%	1.33%	1.34%
WV	54079-6789111	Appalachian Power Company - John E Amos Plant	352.1	4,878.1	10,984.2	0.04%	1.22%	1.25%

Table 7-24. Facilities with ≥1.00% Sulfate + Nitrate AoI Contribution to Visibility Impairment on the 20% Most Impaired Days at Swanquarter Wilderness Area

State	Facility ID	Facility Name	Distance (Km)	2028 NO_x (TPY)	2028 SO_2 (TPY)	Nitrate (%)	Sulfate (%)	Sulfate + Nitrate (%)
NC	37013-8479311	PCS Phosphate Company, Inc. - Aurora	52.5	495.6	4,845.9	0.57%	37.89%	38.47%
NC	37117-8049311	Domtar Paper Company, LLC	69.0	1,796.5	687.4	1.02%	2.27%	3.29%
PA	42005-3866111	Genon NE Mgmt Co/Keystone Station	640.2	6,578.5	56,939.2	0.08%	3.00%	3.08%
NC	37145-7826011	Duke Energy Progress, LLC - Roxboro Steam Electric Plant	282.6	4,527.9	6,665.5	0.18%	2.05%	2.23%
MD	24003-6084311	Raven Power Fort Smallwood LLC	414.7	4,387.8	10,942.9	0.16%	1.76%	1.92%
OH	39053-8148511	General James M. Gavin Power Plant	651.5	8,122.5	41,595.8	0.06%	1.77%	1.83%
NC	37049-8504911	Marine Corps Air Station - Cherry Point	88.4	201.1	607.8	0.05%	1.31%	1.36%

7.6 PSAT Modeling

VISTAS used CAMx PSAT modeling to refine estimates of source contributions to modeled visibility impacts for individual Class I areas in 2028. 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 used the SO_2 and NO_x facility contributions from the AoI analysis to help select sources to be tagged with PSAT. Each state used the AoI results to develop its initial list of facilities for tagging. The VISTAS states then compared their lists and collaborated on developing the final list of facilities in both the VISTAS and non-VISTAS states for which AoI impacts were significant enough to warrant further evaluation. 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 modeling domain. Some of the 87 facilities were selected by more than one state. 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%, the facility was considered for reasonable progress analysis for SO_2. If the nitrate contribution was greater than or equal to 1.00%, then the facility was considered for reasonable progress analysis for NO_x. Details of the PSAT modeling can be found in Appendix E-7a (PSAT Report) and details of the percent contribution calculations can be found in Appendix 7-6b (Roadmap).

Table 7-25 through Table 7-28 identify by state the 87 facilities that were tagged for PSAT modeling. The tables also compare 2028 SO_2 and NO_x emissions from the VISTAS elv3 inventory used for the AoI analysis and initial PSAT modeling to the revised 2028 SO_2 and NO_x emissions from the VISTAS elv5 inventory used to adjust the PSAT results and for the RPG modeling. Table 7-25 lists PSAT tags selected for facilities in AL and FL. Table 7-26 lists PSAT tags selected for facilities in GA, KY, MS, NC, SC, and TN. Table 7-27 lists PSAT tags selected for facilities in VA and WV. Table 7-28 lists PSAT tags selected for facilities in AR, MO, PA, IL, IN, and OH. The contributions from all 87 PSAT-tagged facilities 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 7-25. PSAT Tags Selected for Facilities in AL and FL

				2028 Emissions for AoI Analysis (TPY)		2028 Emissions for Revised PSAT Analysis (TPY)		Difference (PSAT minus AOI)	
State	RPO	Facility ID	Facility Name	SO_2	NO_x	SO_2	NO_x	SO_2	NO_x
AL	VISTAS	01097-949811	Akzo Nobel Chemicals Inc	3,335.72	20.7127	3,335.72	20.7127	0.00	0.00
AL	VISTAS	01097-1056111	Ala Power - Barry	6,025.60	2181.928	3,007.57	2275.757	-3,018.02	93.83
AL	VISTAS	01129-1028711	American Midstream Chatom, LLC	3,106.38	425.873	0.00	0	-3,106.38	-425.87
AL	VISTAS	01073-1018711	Drummond Company, Inc.	2,562.17	1228.549	2,562.17	1228.549	0.00	0.00
AL	VISTAS	01053-7440211	Escambia Operating Company LLC	18,974.39	349.323	3,782.18	349.323	-15,192.21	0.00
AL	VISTAS	01053-985111	Escambia Operating Company LLC	8,589.60	149.6403	88.01	0	-8,501.59	-149.64
AL	VISTAS	01103-1000011	Nucor Steel Decatur LLC	170.23	331.2415	170.23	331.2415	0.00	0.00
AL	VISTAS	01109-985711	Sanders Lead Co	7,951.06	121.71	7,951.06	121.71	0.00	0.00
AL	VISTAS	01097-1061611	Union Oil of California - Chunchula Gas Plant	2,573.15	349.2253	0.00	0	-2,573.15	-349.23
FL	VISTAS	12123-752411	Buckeye Florida, Limited Partnership	1,520.42	1830.714	1,520.42	1830.714	0.00	0.00
FL	VISTAS	12086-900111	CEMEX Construction Materials FL. LLC.	29.51	910.359	29.51	2599.99	0.00	1,689.63
FL	VISTAS	12017-640611	Duke Energy Florida, Inc. (DEF)	5,306.41	2489.847	2,613.52	1048.136	-2,692.90	-1,441.71
FL	VISTAS	12086-900011	Florida Power & Light (PTF)	13.05	170.614	13.05	170.6135	0.00	0.00
FL	VISTAS	12033-752711	Gulf Power - Crist	2,615.65	2998.389	572.17	1146.823	-2,043.48	-1,851.57
FL	VISTAS	12086-3532711	Homestead City Utilities	0.00	97.09	0.00	97.0895	0.00	0.00
FL	VISTAS	12031-640211	JEA	2,094.48	651.7859	2,150.50	1037.028	56.01	385.24
FL	VISTAS	12105-717711	Mosaic Fertilizer, LLC	7,900.67	310.4175	4,490.96	310.4176	-3,409.70	0.00
FL	VISTAS	12057-716411	Mosaic Fertilizer, LLC	3,034.06	159.7073	1,804.38	168.7565	-1,229.68	9.05
FL	VISTAS	12105-919811	Mosaic Fertilizer, LLC	4,425.56	141.0243	4,300.52	141.0243	-125.04	0.00
FL	VISTAS	12089-845811	Rayonier Performance Fibers LLC	561.97	2327.098	561.97	2327.098	0.00	0.00
FL	VISTAS	12089-753711	Rock Tenn CP, LLC	2,606.72	2316.773	2,606.72	2316.772	0.00	0.00
FL	VISTAS	12005-535411	Rock Tenn CP, LLC	2,590.88	1404.893	2,590.88	1404.893	0.00	0.00
FL	VISTAS	12129-2731711	Tallahassee City Purdom Generating Station	2.86	121.457	2.86	121.4573	0.00	0.00
FL	VISTAS	12057-538611	Tampa Electric Company (TEC)	6,084.90	2665.034	6,084.90	2665.034	0.00	0.00
FL	VISTAS	12086-899911	Tarmac America LLC	9.38	879.699	9.38	2376	0.00	1,496.30
FL	VISTAS	12047-769711	White Springs Agricultural Chemicals, Inc.	3,197.77	112.4077	1,557.04	102.1919	-1,640.73	-10.22

Table 7-26. PSAT Tags Selected for Facilities in GA, KY, MS, NC, SC, and TN

				2028 Emissions for AoI Analysis (TPY)		2028 Emissions for Revised PSAT Analysis (TPY)		Difference (PSAT minus AoI)	
State	**RPO**	**Facility ID**	**Facility Name**	**SO_2**	**NO_x**	**SO_2**	**NO_x**	**SO_2**	**NO_x**
GA	VISTAS	13127-3721011	Brunswick Cellulose Inc	294.20	1554.51	294.20	1554.51	0.00	0.00
GA	VISTAS	13015-2813011	Georgia Power Company - Plant Bowen	10,453.41	6643.316	10,453.41	6643.316	0.00	0.00
GA	VISTAS	13103-536311	Georgia-Pacific Consumer Products LP (Savannah River Mill)	1,860.18	351.518	1,860.18	351.5183	0.00	0.00
GA	VISTAS	13051-3679811	International Paper – Savannah	3,945.38	1560.73	3,945.38	1560.73	0.00	0.00
GA	VISTAS	13115-539311	Temple Inland	1,791.00	1773.352	1,791.00	1773.352	0.00	0.00
KY	VISTAS	21183-5561611	Big Rivers Electric Corp - Wilson Station	6,934.16	1151.95	6,934.16	1151.95	0.00	0.00
KY	VISTAS	21091-7352411	Century Aluminum of KY LLC	5,044.16	197.6568	2,223.56	197.6568	-2,820.60	0.00
KY	VISTAS	21177-5196711	TVA - Paradise Fossil Plant	2,990.23	2927.425	13.20	740.7	-2,977.03	-2,186.73
KY	VISTAS	21145-6037011	TVA - Shawnee Fossil Plant	19,504.75	7007.342	19,504.75	7007.342	0.00	0.00
MS	VISTAS	28059-8384311	Chevron Products Company, Pascagoula Refinery	741.60	1534.122	741.60	1534.122	0.00	0.00
MS	VISTAS	28059-6251011	Mississippi Power Company, Plant Victor J Daniel	224.40	3736.469	231.92	3829.723	7.53	93.25
NC	VISTAS	37087-7920511	Blue Ridge Paper Products - Canton Mill	1,127.07	2992.369	404.70	2926.777	-722.37	-65.59
NC	VISTAS	37117-8049311	Domtar Paper Company, LLC	687.45	1796.493	687.45	1796.494	0.00	0.00
NC	VISTAS	37035-8370411	Duke Energy Carolinas, LLC - Marshall Steam Station	4,139.21	7511.305	2,654.15	5355.788	-1,485.05	-2,155.52
NC	VISTAS	37013-8479311	PCS Phosphate Company, Inc. - Aurora	4,845.90	495.5774	4,845.90	495.5774	0.00	0.00
NC	VISTAS	37023-8513011	SGL Carbon LLC	261.64	21.689	261.64	21.68888	0.00	0.00
SC	VISTAS	45015-4834911	ALUMAX of South Carolina	3,751.69	108.0817	3,751.69	108.0817	0.00	0.00
SC	VISTAS	45043-5698611	International Paper Georgetown Mill	2,767.52	2031.263	2,767.52	2031.263	0.00	0.00
SC	VISTAS	45019-4973611	Kapstone Charleston Kraft, LLC	1,863.65	2355.817	1,863.65	2355.817	0.00	0.00
SC	VISTAS	45015-4120411	Santee Cooper Cross Generating Station	4,281.17	3273.466	4,281.17	3273.466	0.00	0.00
SC	VISTAS	45043-6652811	Santee Cooper Winyah Generating Station	2,246.86	1772.533	2,246.86	1772.533	0.00	0.00
SC	VISTAS	45015-8306711	SCE&G Williams	392.48	992.735	392.48	992.7348	0.00	0.00
TN	VISTAS	47093-4979911	Cemex - Knoxville Plant	121.47	711.5	121.47	711.5	0.00	0.00
TN	VISTAS	47163-3982311	Eastman Chemical Company	6,420.16	6900.333	6,420.16	6900.333	0.00	0.00
TN	VISTAS	47105-4129211	TATE & LYLE, Loudon	472.76	883.2545	166.61	230.3145	-306.15	-652.94
TN	VISTAS	47001-6196011	TVA Bull Run Fossil Plant	622.54	964.1556	0.00	0	-622.54	-964.16
TN	VISTAS	47161-4979311	TVA Cumberland Fossil Plant	8,427.33	4916.515	8,427.33	4916.514	0.00	0.00
TN	VISTAS	47145-4979111	TVA Kingston Fossil Plant	1,886.09	1687.38	424.37	379.6604	-1,461.72	-1,307.72

Table 7-27. PSAT Tags Selected for Facilities in VA and WV

State	RPO	Facility ID	Facility Name	2028 Emissions for AoI Analysis (TPY)		2028 Emissions for Revised PSAT Analysis (TPY)		Difference (PSAT minus AoI)	
				SO_2	NO_x	SO_2	NO_x	SO_2	NO_x
VA	VISTAS	51027-4034811	Jewell Coke Company LLP	5,090.95	520.17	5,090.95	520.17	0.00	0.00
VA	VISTAS	51580-5798711	Meadwestvaco Packaging Resource Group	2,115.31	1985.69	2,115.31	1985.69	0.00	0.00
VA	VISTAS	51023-5039811	Roanoke Cement Company	2,290.17	1972.966	2,290.17	1972.97	0.00	0.00
WV	VISTAS	54033-6271711	Allegheny Energy Supply Co, LLC - Harrison	10,082.9 4	11830.88	10,356.24	10017.31	273.30	-1,813.57
WV	VISTAS	54049-4864511	American Bituminous Power-Grant Town Plant	2,210.25	1245.102	2,823.63	1735.70	613.37	490.60
WV	VISTAS	54079-6789111	Appalachian Power Company - John E Amos Plant	10,984.2 4	4878.096	6,098.36	7292.59	-4,885.88	2,414.49
WV	VISTAS	54023-6257011	Dominion Resources, Inc. - Mount Storm Power Station	2,123.64	1984.136	954.03	965.28	-1,169.61	-1,018.84
WV	VISTAS	54041-6900311	Equitrans - Copley Run CS 70	0.10	511.0605	0.10	511.06	0.00	0.00
WV	VISTAS	54083-6790711	Files Creek 6C4340	0.15	643.3533	0.15	643.35	0.00	0.00
WV	VISTAS	54083-6790511	Glady 6C4350	0.11	343.2882	0.11	343.29	0.00	0.00
WV	VISTAS	54093-6327811	Kingsford Manufacturing Company	16.96	140.883	16.96	140.89	0.00	0.00
WV	VISTAS	54061-16320111	Longview Power	2,313.73	1556.573	2,336.89	2237.24	23.16	680.67
WV	VISTAS	54051-6902311	Mitchell Plant	5,372.40	2719.623	4,230.41	3966.73	-1,141.99	1,247.11
WV	VISTAS	54061-6773611	Monongahela Power Co.- Fort Martin Power	4,881.87	13743.32	3,056.87	11997.76	-1,825.00	-1,745.56
WV	VISTAS	54073-4782811	Monongahela Power Co – Pleasants Power Station	16,817.4 3	5497.37	11,501.78	5729.00	-5,315.65	231.63
WV	VISTAS	54061-6773811	Morgantown Energy Associates	828.64	655.5805	3.30	216.02	-825.34	-439.56

Table 7-28. PSAT Tags Selected for Facilities in AR, MO, MD, PA, IL, IN, and OH

State	RPO	Facility ID	Facility Name	2028 Emissions for AoI Analysis (TPY)		2028 Emissions for Revised PSAT Analysis (TPY)		Difference (PSAT minus AoI)	
				SO_2	NO_x	SO_2	NO_x	SO_2	NO_x
AR	CENRAP	05063-1083411	Entergy Arkansas Inc. - Independence Plant	32,050.49	14133.211	13,643.45	4486.266	-18,407.04	-9,646.95
MO	CENRAP	29143-5363811	New Madrid Power Plant-Marston	16,783.71	4394.099	11,158.33	4054.043	-5,625.38	-340.06
MD	MANE-VU	24001-7763811	Luke Paper Company	9,876.00	3607.004	9,876.00	3607.004	0.00	0.00
PA	MANE-VU	42005-3866111	Genon NE Mgmt Co/Keystone Station	56,939.25	6578.469	21,066.37	5086.296	-35,872.88	-1,492.17
PA	MANE-VU	42063-3005211	Homer City Gen LP/Center TWP	11,865.70	5215.958	9,274.88	4962.31	-2,590.82	-253.65
PA	MANE-VU	42063-3005111	NRG Wholesale GEN/Seward Gen Station	8,880.26	2254.634	6,813.94	1632.909	-2,066.32	-621.73
IL	LADCO	17127-7808911	Joppa Steam	20,509.28	4706.348	8,041.13	1994.888	-12,468.15	-2,711.46
IN	LADCO	18173-8183111	Alcoa Warrick Power Plt Agc Div of AL	5,071.28	11158.555	1,459.43	3024.678	-3,611.85	-8,133.88
IN	LADCO	18051-7363111	Gibson	23,117.23	12280.34	12,999.61	8620.009	-10,117.62	-3,660.33
IN	LADCO	18147-8017211	Indiana Michigan Power - Rockport	30,536.33	8806.768	10,779.01	8475.081	-19,757.32	-331.69
IN	LADCO	18125-7362411	Indianapolis Power & Light Petersburg	18,141.88	10665.27	9,422.13	5355.617	-8,719.75	-5,309.65
IN	LADCO	18129-8166111	Sigeco AB Brown South Indiana Gas & Ele	7,644.70	1578.591	0.16	28.95738	-7,644.54	-1,549.63
OH	LADCO	39081-8115711	Cardinal Power Plant - Cardinal Operating Company	7,460.79	2467.306	9,891.89	4044.845	2,431.10	1,577.54
OH	LADCO	39031-8010811	Conesville Power Plant (0616000000)	6,356.23	9957.873	0.00	0	-6,356.23	-9,957.87
OH	LADCO	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station	22,133.90	7149.97	10,346.34	5864.068	-11,787.56	-1,285.90
OH	LADCO	39053-8148511	General James M. Gavin Power Plant	41,595.81	8122.51	21,838.61	7982.595	-19,757.20	-139.92
OH	LADCO	39053-7983011	Ohio Valley Electric Corp., Kyger Creek Station	3,400.14	9143.837	4,278.04	6267.251	877.91	-2,876.59

7.6.1 Selection of Facilities for PSAT Modeling for Class I Areas in North Carolina

Since SO_2 and NO_x emissions from point sources were estimated to have the largest AoI contribution to visibility impairment at the Class I areas in North Carolina (see Table 7-15 through Table 7-19), North Carolina used the fraction of total sulfate plus nitrate visibility impairment (projected to 2028) from individual point source facilities as the metric for which an AoI threshold would be chosen to select sources for PSAT tagging.

The NCDAQ approached selecting North Carolina facilities for tagging from a regional perspective. Based on the AoI results, several of the facilities with the highest AoI impacts at Class I areas in North Carolina are located outside of North Carolina. This is in part attributable to the Clean Smokestacks Act North Carolina adopted in 2002 that required coal-fired power plants to reduce annual NO_x emissions by 77% by 2009, and to reduce annual SO_2 emissions by 49% by 2009 and 73% by 2013. North Carolina is the only state that adopted a state law requiring power plants to install controls to reduce NO_x and SO_2 emissions for improving visibility and controlling acid deposition in the region. Therefore, it is not unexpected that several power plants outside of North Carolina have higher AoI impacts on North Carolina Class I areas than power plants in North Carolina.

The NCDAQ reviewed the 37 facilities identified in Table 7-20 through Table 7-24 with an AoI contribution of ≥1% for sulfate and nitrate combined for one or more of the Class I areas in North Carolina. Based on this review, and consultation with Tennessee and the other VISTAS states, the NCDAQ selected North Carolina facilities with an AoI contribution of ≥3% for sulfate and nitrate combined for PSAT analysis which is consistent with the threshold selected by Tennessee. The 3% AoI threshold identified the five facilities shown in Table 7-29 with the highest AoI contributions to North Carolina Class I areas and Class I areas in nearby states. Each state within VISTAS established an AoI threshold specific to that state to select sources for PSAT modeling. For the facilities selected for PSAT analysis by other VISTAS states, 8 facilities had an AoI contribution of ≥3% and an additional 11 facilities had an AoI contribution of ≥1% and ≤3% for one or more Class I areas in the Southeast or neighboring regions. Thus, a total of 24 facilities were selected by the VISTAS States for further analysis using PSAT modeling to better understand each facility's contribution to visibility impairment for Class I areas in North Carolina.

Section 7.7.3 of this SIP provides information on why additional facilities were not selected for PSAT modeling including five North Carolina facilities with an AoI contribution of between 1% and 3% for one or more Class I areas in North Carolina. In addition, the NCDAQ considered the fact that emissions are continuing to decline early in the second planning period and are expected to maintain a rate that is parallel with the URP for each of North Carolina's Class I areas based on the federal and state control programs and actions discussed in Section 7.2 of this SIP[108].

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[108] U.S. EPA, "Guidance on Regional Haze State Implementation Plans for the Second Implementation Period," EPA-457/B-19-003, August 20, 2019, page 22, accessed from https://www.epa.gov/visibility/guidance-regional-haze-state-implementation-plans-second-implementation-period

Given these considerations, and the fact that the regional haze planning is an iterative process that requires the state to evaluate and adjust the LTS as needed during future planning periods, the NCDAQ believes that the facilities selected by North Carolina and other VISTAS states for PSAT modeling is a reasonable number of facilities for which to evaluate further for reasonable progress analyses.

Table 7-29. Facilities Selected by North Carolina for PSAT Tagging

State and County FIPS - Facility ID	Facility Name	Class I Area	Distance to Class I Area (Km)	AoI Contribution for Sulfate + Nitrate
37087-7920511	Blue Ridge Paper Products - Canton Mill	Shining Rock Wilderness Area	16.9	47.93%
37023-8513011	SGL Carbon LLC	Linville Gorge Wilderness Area	32.5	4.06%
37035-8370411	Duke Energy Carolinas, LLC - Marshall Steam Station	Linville Gorge Wilderness Area	97.2	6.73%
		Shining Rock Wilderness Area	166.0	2.68%
37013-8479311	PCS Phosphate Company, Inc. - Aurora	Swanquarter Wilderness Area	52.5	38.47%
37117-8049311	Domtar Paper Company, LLC	Swanquarter Wilderness Area	69.0	3.29%

* Distance from centroid of facility to location of IMPROVE monitor.

7.6.2 PSAT Contributions at North Carolina Class I Areas

The original PSAT results were based on the initial 2028 SO_2 and NO_x point source emissions, which may be found in Appendix B-1 (Task 2A and Task 3A reports). As previously discussed, the 2028 EGU and non-EGU point emissions were updated for a new 2028 model run, but PSAT modeling was not redone with the revised emissions because of time and resource constraints. Details of the updated emissions may be found in Appendix B-2 (Task 2B and Task 3B reports). 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 (Roadmap).

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 7-30 shows the adjusted PSAT results for the five facilities in North Carolina. The full list of facilities and their contributions to each Class I area can be found in Appendix E-7.

Table 7-31 through Table 7-35 contain PSAT results for Great Smoky Mountains National Park, Joyce Kilmer-Slickrock Wilderness Area, Linville Gorge Wilderness Area, Shining Rock Wilderness Area, and Swanquarter Wilderness Area, respectively. Only facilities that have a non-zero absolute visibility impact to the given Class I area are listed in each table. The total sulfate plus nitrate point source visibility impact in 2028 was projected to be:

-28.90% of the total visibility impairment on the 20% most impaired days at Great Smoky Mountains National Park;

-28.88% of the total visibility impairment on the 20% most impaired days at Joyce Kilmer-Slickrock Wilderness Area;

-28.85% of the total visibility impairment on the 20% most impaired days at Linville Gorge Wilderness Area;

-27.90% of the total visibility impairment on the 20% most impaired days at Shining Rock Wilderness Area;

-22.20% of the total visibility impairment on the 20% most impaired days at Swanquarter Wilderness Area;

Table 7-30. Revised Final PSAT Results for North Carolina Facility Sulfate and Nitrate Impacts on North Carolina Class I Areas

Facility Name	Distance (Km)	Sulfate (Mm^{-1})	EGU+Non-EGU (Mm^{-1})	Sulfate, %	Nitrate (Mm^{-1})	EGU+Non-EGU (Mm^{-1})	Nitrate, %
Great Smoky Mountains National Park							
Blue Ridge Paper Products	100.3	0.0136	13.23	0.1032	0.0020	13.23	0.0148
PCS Phosphate	650.3	0.0180	13.23	0.1361	0.0000	13.23	0.0000
Duke Energy Marshall	270.0	0.0430	13.23	0.3248	0.0007	13.23	0.0054
SGL Carbon	200.8	0.0010	13.23	0.0076	0.0000	13.23	0.0000
Domtar Paper Company	648.1	0.0030	13.23	0.0227	0.0000	13.23	0.0000
Joyce Kilmer-Slickrock Wilderness Area							
Blue Ridge Paper Products	104.0	0.0140	13.03	0.1075	0.0020	13.03	0.0150
PCS Phosphate	653.8	0.0200	13.03	0.1535	0.0000	13.03	0.0000
Duke Energy Marshall	274.3	0.0455	13.03	0.3494	0.0007	13.03	0.0055
SGL Carbon	207.1	0.0010	13.03	0.0077	0.0000	13.03	0.0000
Domtar Paper Company	653.7	0.0040	13.03	0.0307	0.0000	13.03	0.0000
Linville Gorge Wilderness Area							
Blue Ridge Paper Products	95.40	0.0169	12.27	0.1376	0.0010	12.27	0.0080
PCS Phosphate	471.2	0.0200	12.27	0.1630	0.0000	12.27	0.0000
Duke Energy Marshall	97.20	0.1064	12.27	0.8678	0.0036	12.27	0.0291
SGL Carbon	32.50	0.0300	12.27	0.2446	0.0000	12.27	0.0000
Domtar Paper Company	465.2	0.0050	12.27	0.0408	0.0000	12.27	0.0000
Shining Rock Wilderness Area							
Blue Ridge Paper Products	16.90	0.1332	11.75	1.1341	0.0117	11.75	0.0999
PCS Phosphate	544.7	0.0200	11.75	0.1703	0.0000	11.75	0.0000
Duke Energy Marshall	166.0	0.0859	11.75	0.7315	0.0021	11.75	0.0182
SGL Carbon	102.1	0.0020	11.75	0.0170	0.0000	11.75	0.0000
Domtar Paper Company	545.4	0.0050	11.75	0.0426	0.0000	11.75	0.0000
Swanquarter Wilderness Area							
Blue Ridge Paper Products	601.9	0.0043	10.29	0.0419	0.0029	10.29	0.0285
PCS Phosphate	52.5	0.3290	10.29	3.1967	0.0070	10.29	0.0680
Duke Energy Marshall	431.5	0.0641	10.29	0.6230	0.0150	10.29	0.1455
SGL Carbon	501.1	0.0020	10.29	0.0194	0.0000	10.29	0.0000
Domtar Paper Company	69.00	0.1090	10.29	1.0591	0.0220	10.29	0.2138

Table 7-31. PSAT Results for Great Smoky Mountains National Park

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 (%)
OH	39053-8148511	General James M. Gavin Power Plant	400.53	0.5198	13.2255	3.93	0.0029	13.2255	0.02
KY	21145-6037011	Tennessee Valley Authority (TVA) - Shawnee Fossil Plant	465.29	0.1830	13.2255	1.38	0.0110	13.2255	0.08
TN	47163-3982311	Eastman Chemical Company	160.12	0.1700	13.2255	1.29	0.0070	13.2255	0.05
PA	42005-3866111	Genon Ne Mgmt Co/Keystone Sta	688.19	0.1661	13.2255	1.26	0.0008	13.2255	0.01
IN	18147-8017211	Indiana Michigan Power Dba Aep Rockport	375.48	0.1656	13.2255	1.25	0.0346	13.2255	0.26
IN	18051-7363111	Gibson	456.28	0.1462	13.2255	1.11	0.0372	13.2255	0.28
OH	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station	359.99	0.1360	13.2255	1.03	0.0025	13.2255	0.02
WV	54033-6271711	Allegheny Energy Supply Co, LLC-Harrison	524.75	0.1294	13.2255	0.98	0.0025	13.2255	0.02
GA	13015-2813011	GA Power Company - Plant Bowen	189.71	0.1250	13.2255	0.95	0.0010	13.2255	0.01
WV	54073-4782811	Monongahela Power Co-Pleasants Power Sta	475.85	0.1231	13.2255	0.93	0.0021	13.2255	0.02
MD	24001-7763811	Luke Paper Company	606.24	0.1220	13.2255	0.92	0.0000	13.2255	0.00
OH	39081-8115711	Cardinal Power Plant (Cardinal Operating Company)	587.50	0.1167	13.2255	0.88	0.0000	13.2255	0.00
OH	39053-7983011	Ohio Valley Electric Corp., Kyger Creek Station	398.42	0.1120	13.2255	0.85	0.0007	13.2255	0.01
IN	18125-7362411	Indianapolis Power & Light Petersburg	435.64	0.1085	13.2255	0.82	0.0281	13.2255	0.21
VA	51027-4034811	Jewell Coke Company LLP	246.41	0.1030	13.2255	0.78	0.0000	13.2255	0.00
AR	05063-1083411	Entergy Arkansas Inc-Independence Plant	675.93	0.1005	13.2255	0.76	0.0006	13.2255	0.00
MO	29143-5363811	New Madrid Power Plant-Marston	516.00	0.0997	13.2255	0.75	0.0009	13.2255	0.01
KY	21183-5561611	Big Rivers Electric Corp - Wilson Station	345.81	0.0840	13.2255	0.64	0.0040	13.2255	0.03
TN	47161-4979311	TVA Cumberland Fossil Plant	344.96	0.0800	13.2255	0.60	0.0040	13.2255	0.03
WV	54079-6789111	Appalachian Power Company - John E Amos Plant	367.15	0.0744	13.2255	0.56	0.0030	13.2255	0.02

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 (%)
IL	17127-7808911	Joppa Steam	474.38	0.0717	13.2255	0.54	0.0021	13.2255	0.02
SC	45015-4120411	Santee Cooper Cross Generating Station	432.03	0.0640	13.2255	0.48	0.0000	13.2255	0.00
PA	42063-3005211	Homer City Gen Lp/ Center TWP	682.88	0.0586	13.2255	0.44	0.0010	13.2255	0.01
TN	47145-4979111	TVA Kingston Fossil Plant	60.03	0.0535	13.2255	0.40	0.0036	13.2255	0.03
AL	01073-1018711	Drummond Company, Inc.	345.58	0.0480	13.2255	0.36	0.0000	13.2255	0.00
AL	01109-985711	Sanders Lead Co	466.40	0.0430	13.2255	0.33	0.0000	13.2255	0.00
NC	37035-8370411	Duke Energy Carolinas, LLC - Marshall Steam Station	270.00	0.0430	13.2255	0.32	0.0007	13.2255	0.01
PA	42063-3005111	Nrg Wholesale Gen/Seward Gen Sta	682.76	0.0407	13.2255	0.31	0.0000	13.2255	0.00
WV	54051-6902311	Mitchell Plant	541.01	0.0354	13.2255	0.27	0.0015	13.2255	0.01
GA	13115-539311	Temple Inland	198.78	0.0350	13.2255	0.26	0.0000	13.2255	0.00
SC	45015-4834911	Alumax Of South Carolina	458.13	0.0310	13.2255	0.23	0.0000	13.2255	0.00
SC	45043-6652811	Santee Cooper Winyah Generating Station	492.36	0.0300	13.2255	0.23	0.0000	13.2255	0.00
WV	54061-6773611	Monongahela Power Co.- Fort Martin Power	574.41	0.0294	13.2255	0.22	0.0035	13.2255	0.03
WV	54049-4864511	American Bituminous Power-Grant Town Plt	548.80	0.0281	13.2255	0.21	0.0000	13.2255	0.00
SC	45043-5698611	International Paper Georgetown Mill	494.72	0.0280	13.2255	0.21	0.0000	13.2255	0.00
AL	01097-1056111	Ala Power - Barry	637.87	0.0275	13.2255	0.21	0.0000	13.2255	0.00
IN	18173-8183111	Alcoa Warrick Power Plt Agc Div of Al	394.61	0.0262	13.2255	0.20	0.0198	13.2255	0.15
GA	13051-3679811	International Paper - Savannah	470.33	0.0250	13.2255	0.19	0.0000	13.2255	0.00
VA	51023-5039811	Roanoke Cement Company	407.38	0.0230	13.2255	0.17	0.0000	13.2255	0.00
VA	51580-5798711	Meadwestvaco Packaging Resource Group	426.66	0.0210	13.2255	0.16	0.0000	13.2255	0.00
KY	21091-7352411	Century Aluminum of KY LLC	360.46	0.0185	13.2255	0.14	0.0000	13.2255	0.00
NC	37013-8479311	PCS Phosphate Company, Inc. - Aurora	650.31	0.0180	13.2255	0.14	0.0000	13.2255	0.00
SC	45019-4973611	Kapstone Charleston Kraft LLC	475.41	0.0170	13.2255	0.13	0.0000	13.2255	0.00

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 (%)
TN	47093-4979911	Cemex - Knoxville Plant	44.25	0.0150	13.2255	0.11	0.0060	13.2255	0.05
AL	01097-949811	Akzo Nobel Chemicals Inc	641.75	0.0140	13.2255	0.11	0.0000	13.2255	0.00
AL	01053-7440211	Escambia Operating Company LLC	598.46	0.0138	13.2255	0.10	0.0000	13.2255	0.00
NC	37087-7920511	Blue Ridge Paper Products - Canton Mill	100.26	0.0136	13.2255	0.10	0.0020	13.2255	0.01
WV	54061-16320111	Longview Power	572.53	0.0121	13.2255	0.09	0.0000	13.2255	0.00
FL	12005-535411	Rocktenn Cp LLC	628.66	0.0120	13.2255	0.09	0.0000	13.2255	0.00
TN	47105-4129211	Tate & Lyle, Loudon	36.10	0.0092	13.2255	0.07	0.0016	13.2255	0.01
GA	13103-536311	Georgia-Pacific Consumer Products Lp (Savannah River Mill)	445.14	0.0080	13.2255	0.06	0.0000	13.2255	0.00
WV	54023-6257011	Dominion Resources, Inc. - Mount Storm Power Station	572.64	0.0072	13.2255	0.05	0.0000	13.2255	0.00
SC	45015-8306711	Sce&G Williams	469.69	0.0050	13.2255	0.04	0.0000	13.2255	0.00
AL	01103-1000011	Nucor Steel Decatur LLC	307.31	0.0050	13.2255	0.04	0.0000	13.2255	0.00
FL	12089-753711	Rock Tenn Cp, LLC	596.04	0.0050	13.2255	0.04	0.0000	13.2255	0.00
FL	12031-640211	Jea	619.61	0.0041	13.2255	0.03	0.0000	13.2255	0.00
NC	37117-8049311	Domtar Paper Company, LLC	648.15	0.0030	13.2255	0.02	0.0000	13.2255	0.00
FL	12123-752411	Buckeye Florida, Limited Partnership	618.36	0.0020	13.2255	0.02	0.0000	13.2255	0.00
FL	12017-640611	Duke Energy Florida, Inc. (DEF)	749.25	0.0020	13.2255	0.01	0.0000	13.2255	0.00
FL	12047-769711	White Springs Agricultural Chemicals,Inc	585.86	0.0019	13.2255	0.01	0.0000	13.2255	0.00
MS	28059-6251011	Mississippi Power Company, Plant Victor J Daniel	710.94	0.0010	13.2255	0.01	0.0000	13.2255	0.00
FL	12057-538611	Tampa Electric Company (TEC)	881.37	0.0010	13.2255	0.01	0.0000	13.2255	0.00
FL	12089-845811	Rayonier Performance Fibers LLC	597.48	0.0010	13.2255	0.01	0.0000	13.2255	0.00
GA	13127-3721011	Brunswick Cellulose Inc	543.51	0.0010	13.2255	0.01	0.0000	13.2255	0.00
NC	37023-8513011	SGL Carbon LLC	200.78	0.0010	13.2255	0.01	0.0000	13.2255	0.00
MS	28059-8384311	Chevron Products Company, Pascagoula Refinery	724.47	0.0010	13.2255	0.01	0.0000	13.2255	0.00
FL	12033-752711	Gulf Power - Crist	640.08	0.0007	13.2255	0.00	0.0000	13.2255	0.00
FL	12105-717711	Mosaic Fertilizer LLC	882.90	0.0006	13.2255	0.00	0.0000	13.2255	0.00
AL	01053-985111	Escambia Operating Company LLC	597.02	0.0003	13.2255	0.00	0.0000	13.2255	0.00

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 (%)
KY	21177-5196711	Tennessee Valley Authority - Paradise Fossil Plant	326.56	0.0002	13.2255	0.00	0.0010	13.2255	0.01
IN	18129-8166111	Sigeco Ab Brown South Indiana Gas & Ele	420.67	0.0000	13.2255	0.00	0.0001	13.2255	0.00

Table 7-32. PSAT Results for Joyce Kilmer-Slickrock 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 (%)
OH	39053-8148511	General James M. Gavin Power Plant	400.53	0.4725	13.0309	3.63	0.0020	13.0309	0.02
KY	21145-6037011	Tennessee Valley Authority (TVA) - Shawnee Fossil Plant	465.29	0.1890	13.0309	1.45	0.0140	13.0309	0.11
TN	47163-3982311	Eastman Chemical Company	160.12	0.1780	13.0309	1.37	0.0030	13.0309	0.02
PA	42005-3866111	Genon Ne Mgmt Co/Keystone Sta	688.19	0.1539	13.0309	1.18	0.0000	13.0309	0.00
IN	18147-8017211	Indiana Michigan Power dba Aep Rockport	375.48	0.1539	13.0309	1.18	0.0298	13.0309	0.23
GA	13015-2813011	GA Power Company - Plant Bowen	189.71	0.1520	13.0309	1.17	0.0010	13.0309	0.01
IN	18051-7363111	Gibson	456.28	0.1395	13.0309	1.07	0.0288	13.0309	0.22
OH	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station	359.99	0.1370	13.0309	1.05	0.0016	13.0309	0.01
WV	54073-4782811	Monongahela Power Co-Pleasants Power Sta	475.85	0.1204	13.0309	0.92	0.0010	13.0309	0.01
MD	24001-7763811	Luke Paper Company	606.24	0.1160	13.0309	0.89	0.0000	13.0309	0.00
WV	54033-6271711	Allegheny Energy Supply Co, LLC-Harrison	524.75	0.1140	13.0309	0.87	0.0008	13.0309	0.01
VA	51027-4034811	Jewell Coke Company LLP	246.41	0.1140	13.0309	0.87	0.0000	13.0309	0.00
AR	05063-1083411	Entergy Arkansas Inc-Independence Plant	675.93	0.1111	13.0309	0.85	0.0010	13.0309	0.01

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 (%)
OH	39081-8115711	Cardinal Power Plant (Cardinal Operating Company)	587.50	0.1034	13.0309	0.79	0.0000	13.0309	0.00
MO	29143-5363811	New Madrid Power Plant-Marston	516.00	0.1011	13.0309	0.78	0.0009	13.0309	0.01
IN	18125-7362411	Indianapolis Power & Light Petersburg	435.64	0.0992	13.0309	0.76	0.0221	13.0309	0.17
OH	39053-7983011	Ohio Valley Electric Corp., Kyger Creek Station	398.42	0.0969	13.0309	0.74	0.0007	13.0309	0.01
KY	21183-5561611	Big Rivers Electric Corp - Wilson Station	345.81	0.0830	13.0309	0.64	0.0040	13.0309	0.03
TN	47161-4979311	TVA Cumberland Fossil Plant	344.96	0.0790	13.0309	0.61	0.0060	13.0309	0.05
IL	17127-7808911	Joppa Steam	474.38	0.0729	13.0309	0.56	0.0030	13.0309	0.02
WV	54079-6789111	Appalachian Power Company - John E Amos Plant	367.15	0.0688	13.0309	0.53	0.0015	13.0309	0.01
SC	45015-4120411	Santee Cooper Cross Generating Station	432.03	0.0660	13.0309	0.51	0.0000	13.0309	0.00
AL	01073-1018711	Drummond Company, Inc.	345.58	0.0570	13.0309	0.44	0.0000	13.0309	0.00
PA	42063-3005211	Homer City Gen Lp/ Center TWP	682.88	0.0555	13.0309	0.43	0.0000	13.0309	0.00
TN	47145-4979111	TVA Kingston Fossil Plant	60.03	0.0535	13.0309	0.41	0.0043	13.0309	0.03
AL	01109-985711	Sanders Lead Co	466.40	0.0490	13.0309	0.38	0.0000	13.0309	0.00
NC	37035-8370411	Duke Energy Carolinas, LLC - Marshall Steam Station	270.00	0.0455	13.0309	0.35	0.0007	13.0309	0.01
GA	13115-539311	Temple Inland	198.78	0.0430	13.0309	0.33	0.0010	13.0309	0.01
PA	42063-3005111	Nrg Wholesale Gen/Seward Gen Sta	682.76	0.0376	13.0309	0.29	0.0000	13.0309	0.00
SC	45015-4834911	Alumax Of South Carolina	458.13	0.0330	13.0309	0.25	0.0000	13.0309	0.00
AL	01097-1056111	Ala Power - Barry	637.87	0.0329	13.0309	0.25	0.0000	13.0309	0.00
SC	45043-6652811	Santee Cooper Winyah Generating Station	492.36	0.0320	13.0309	0.25	0.0000	13.0309	0.00
WV	54051-6902311	Mitchell Plant	541.01	0.0315	13.0309	0.24	0.0000	13.0309	0.00
SC	45043-5698611	International Paper Georgetown Mill	494.72	0.0300	13.0309	0.23	0.0000	13.0309	0.00
GA	13051-3679811	International Paper - Savannah	470.33	0.0270	13.0309	0.21	0.0000	13.0309	0.00
WV	54061-6773611	Monongahela Power Co.- Fort Martin Power	574.41	0.0269	13.0309	0.21	0.0009	13.0309	0.01

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	54049-4864511	American Bituminous Power-Grant Town Plt	548.80	0.0256	13.0309	0.20	0.0000	13.0309	0.00
IN	18173-8183111	Alcoa Warrick Power Plt Agc Div of Al	394.61	0.0250	13.0309	0.19	0.0163	13.0309	0.12
VA	51023-5039811	Roanoke Cement Company	407.38	0.0230	13.0309	0.18	0.0000	13.0309	0.00
VA	51580-5798711	Meadwestvaco Packaging Resource Group	426.66	0.0220	13.0309	0.17	0.0000	13.0309	0.00
NC	37013-8479311	PCS Phosphate Company, Inc. - Aurora	650.31	0.0200	13.0309	0.15	0.0000	13.0309	0.00
SC	45019-4973611	Kapstone Charleston Kraft LLC	475.41	0.0180	13.0309	0.14	0.0000	13.0309	0.00
KY	21091-7352411	Century Aluminum of KY LLC	360.46	0.0176	13.0309	0.14	0.0000	13.0309	0.00
AL	01097-949811	Akzo Nobel Chemicals Inc	641.75	0.0170	13.0309	0.13	0.0000	13.0309	0.00
AL	01053-7440211	Escambia Operating Company LLC	598.46	0.0165	13.0309	0.13	0.0000	13.0309	0.00
NC	37087-7920511	Blue Ridge Paper Products - Canton Mill	100.26	0.0140	13.0309	0.11	0.0020	13.0309	0.02
TN	47093-4979911	Cemex - Knoxville Plant	44.25	0.0140	13.0309	0.11	0.0040	13.0309	0.03
FL	12005-535411	Rocktenn Cp Llc	628.66	0.0130	13.0309	0.10	0.0000	13.0309	0.00
WV	54061-16320111	Longview Power	572.53	0.0121	13.0309	0.09	0.0000	13.0309	0.00
GA	13103-536311	Georgia-Pacific Consumer Products Lp (Savannah River Mill)	445.14	0.0090	13.0309	0.07	0.0000	13.0309	0.00
TN	47105-4129211	Tate & Lyle, Loudon	36.10	0.0081	13.0309	0.06	0.0013	13.0309	0.01
WV	54023-6257011	Dominion Resources, Inc. - Mount Storm Power Station	572.64	0.0072	13.0309	0.06	0.0000	13.0309	0.00
SC	45015-8306711	Sce&G Williams	469.69	0.0060	13.0309	0.05	0.0000	13.0309	0.00
AL	01103-1000011	Nucor Steel Decatur LLC	307.31	0.0060	13.0309	0.05	0.0000	13.0309	0.00
FL	12089-753711	Rock Tenn Cp, LLC	596.04	0.0060	13.0309	0.05	0.0000	13.0309	0.00
FL	12031-640211	Jea	619.61	0.0051	13.0309	0.04	0.0000	13.0309	0.00
NC	37117-8049311	Domtar Paper Company, LLC	648.15	0.0040	13.0309	0.03	0.0000	13.0309	0.00
FL	12047-769711	White Springs Agricultural Chemicals,Inc	585.86	0.0024	13.0309	0.02	0.0000	13.0309	0.00
MS	28059-6251011	Mississippi Power Company, Plant Victor J Daniel	710.94	0.0021	13.0309	0.02	0.0000	13.0309	0.00
FL	12123-752411	Buckeye Florida, Limited Partnership	618.36	0.0020	13.0309	0.02	0.0000	13.0309	0.00

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 (%)
FL	12017-640611	Duke Energy Florida, Inc. (DEF)	749.25	0.0020	13.0309	0.02	0.0000	13.0309	0.00
FL	12057-538611	Tampa Electric Company (TEC)	881.37	0.0010	13.0309	0.01	0.0000	13.0309	0.00
FL	12089-845811	Rayonier Performance Fibers LLC	597.48	0.0010	13.0309	0.01	0.0000	13.0309	0.00
GA	13127-3721011	Brunswick Cellulose Inc	543.51	0.0010	13.0309	0.01	0.0000	13.0309	0.00
NC	37023-8513011	SGL Carbon LLC	200.78	0.0010	13.0309	0.01	0.0000	13.0309	0.00
MS	28059-8384311	Chevron Products Company, Pascagoula Refinery	724.47	0.0010	13.0309	0.01	0.0000	13.0309	0.00
FL	12105-919811	Mosaic Fertilizer, LLC	877.97	0.0010	13.0309	0.01	0.0000	13.0309	0.00
FL	12033-752711	Gulf Power - Crist	640.08	0.0009	13.0309	0.01	0.0000	13.0309	0.00
FL	12105-717711	Mosaic Fertilizer Llc	882.90	0.0006	13.0309	0.00	0.0000	13.0309	0.00
AL	01053-985111	Escambia Operating Company LLC	597.02	0.0004	13.0309	0.00	0.0000	13.0309	0.00
KY	21177-5196711	Tennessee Valley Authority - Paradise Fossil Plant	326.56	0.0002	13.0309	0.00	0.0008	13.0309	0.01
IN	18129-8166111	Sigeco Ab Brown South Indiana Gas & Ele	420.67	0.0000	13.0309	0.00	0.0001	13.0309	0.00

Table 7-33. PSAT Results for Linville Gorge 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 (%)
TN	47163-3982311	Eastman Chemical Company	160.12	0.5220	12.2663	4.26	0.0130	12.2663	0.11
OH	39053-8148511	General James M. Gavin Power Plant	400.53	0.4457	12.2663	3.63	0.0020	12.2663	0.02
MD	24001-7763811	Luke Paper Company	606.24	0.2490	12.2663	2.03	0.0000	12.2663	0.00
PA	42005-3866111	Genon Ne Mgmt Co/Keystone Sta	688.19	0.2349	12.2663	1.92	0.0000	12.2663	0.00
KY	21145-6037011	Tennessee Valley Authority (TVA) - Shawnee Fossil Plant	465.29	0.1720	12.2663	1.40	0.0020	12.2663	0.02
TN	47161-4979311	TVA Cumberland Fossil Plant	344.96	0.1540	12.2663	1.26	0.0010	12.2663	0.01
GA	13015-2813011	GA Power Company - Plant Bowen	189.71	0.1460	12.2663	1.19	0.0000	12.2663	0.00

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 (%)
IN	18147-8017211	Indiana Michigan Power Dba Aep Rockport	375.48	0.1423	12.2663	1.16	0.0115	12.2663	0.09
IN	18051-7363111	Gibson	456.28	0.1378	12.2663	1.12	0.0084	12.2663	0.07
MO	29143-5363811	New Madrid Power Plant-Marston	516.00	0.1343	12.2663	1.09	0.0000	12.2663	0.00
VA	51027-4034811	Jewell Coke Company LLP	246.41	0.1320	12.2663	1.08	0.0000	12.2663	0.00
AR	05063-1083411	Entergy Arkansas Inc-Independence Plant	675.93	0.1107	12.2663	0.90	0.0003	12.2663	0.00
NC	37035-8370411	Duke Energy Carolinas, LLC - Marshall Steam Station	270.00	0.1064	12.2663	0.87	0.0036	12.2663	0.03
IN	18125-7362411	Indianapolis Power & Light Petersburg	435.64	0.1059	12.2663	0.86	0.0065	12.2663	0.05
WV	54073-4782811	Monongahela Power Co-Pleasants Power Sta	475.85	0.0944	12.2663	0.77	0.0010	12.2663	0.01
OH	39053-7983011	Ohio Valley Electric Corp., Kyger Creek Station	398.42	0.0856	12.2663	0.70	0.0014	12.2663	0.01
OH	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station	359.99	0.0846	12.2663	0.69	0.0033	12.2663	0.03
PA	42063-3005211	Homer City Gen Lp/ Center TWP	682.88	0.0750	12.2663	0.61	0.0000	12.2663	0.00
WV	54079-6789111	Appalachian Power Company - John E Amos Plant	367.15	0.0744	12.2663	0.61	0.0015	12.2663	0.01
OH	39081-8115711	Cardinal Power Plant (Cardinal Operating Company)	587.50	0.0742	12.2663	0.61	0.0000	12.2663	0.00
KY	21183-5561611	Big Rivers Electric Corp - Wilson Station	345.81	0.0730	12.2663	0.60	0.0010	12.2663	0.01
PA	42063-3005111	Nrg Wholesale Gen/Seward Gen Sta	682.76	0.0691	12.2663	0.56	0.0000	12.2663	0.00
IL	17127-7808911	Joppa Steam	474.38	0.0639	12.2663	0.52	0.0004	12.2663	0.00
WV	54033-6271711	Allegheny Energy Supply Co, Llc-Harrison	524.75	0.0596	12.2663	0.49	0.0000	12.2663	0.00
SC	45015-4120411	Santee Cooper Cross Generating Station	432.03	0.0480	12.2663	0.39	0.0000	12.2663	0.00
AL	01109-985711	Sanders Lead Co	466.40	0.0370	12.2663	0.30	0.0000	12.2663	0.00
GA	13115-539311	Temple Inland	198.78	0.0320	12.2663	0.26	0.0000	12.2663	0.00
NC	37023-8513011	SGL Carbon LLC	200.78	0.0300	12.2663	0.24	0.0000	12.2663	0.00

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 (%)
SC	45043-5698611	International Paper Georgetown Mill	494.72	0.0280	12.2663	0.23	0.0000	12.2663	0.00
WV	54051-6902311	Mitchell Plant	541.01	0.0276	12.2663	0.22	0.0000	12.2663	0.00
IN	18173-8183111	Alcoa Warrick Power Plt Agc Div of Al	394.61	0.0268	12.2663	0.22	0.0052	12.2663	0.04
SC	45015-4834911	Alumax Of South Carolina	458.13	0.0260	12.2663	0.21	0.0000	12.2663	0.00
AL	01097-1056111	Ala Power - Barry	637.87	0.0260	12.2663	0.21	0.0000	12.2663	0.00
SC	45043-6652811	Santee Cooper Winyah Generating Station	492.36	0.0250	12.2663	0.20	0.0000	12.2663	0.00
TN	47145-4979111	TVA Kingston Fossil Plant	60.03	0.0225	12.2663	0.18	0.0002	12.2663	0.00
KY	21091-7352411	Century Aluminum of KY LLC	360.46	0.0225	12.2663	0.18	0.0000	12.2663	0.00
AL	01073-1018711	Drummond Company, Inc.	345.58	0.0220	12.2663	0.18	0.0000	12.2663	0.00
VA	51023-5039811	Roanoke Cement Company	407.38	0.0220	12.2663	0.18	0.0000	12.2663	0.00
NC	37013-8479311	PCS Phosphate Company, Inc. - Aurora	650.31	0.0200	12.2663	0.16	0.0000	12.2663	0.00
AL	01053-7440211	Escambia Operating Company LLC	598.46	0.0187	12.2663	0.15	0.0000	12.2663	0.00
VA	51580-5798711	Meadwestvaco Packaging Resource Group	426.66	0.0180	12.2663	0.15	0.0000	12.2663	0.00
WV	54061-6773611	Monongahela Power Co.- Fort Martin Power	574.41	0.0169	12.2663	0.14	0.0009	12.2663	0.01
NC	37087-7920511	Blue Ridge Paper Products - Canton Mill	100.26	0.0169	12.2663	0.14	0.0010	12.2663	0.01
WV	54023-6257011	Dominion Resources, Inc. - Mount Storm Power Station	572.64	0.0157	12.2663	0.13	0.0000	12.2663	0.00
AL	01097-949811	Akzo Nobel Chemicals Inc	641.75	0.0150	12.2663	0.12	0.0000	12.2663	0.00
GA	13051-3679811	International Paper - Savannah	470.33	0.0120	12.2663	0.10	0.0000	12.2663	0.00
SC	45019-4973611	Kapstone Charleston Kraft LLC	475.41	0.0120	12.2663	0.10	0.0000	12.2663	0.00
WV	54049-4864511	American Bituminous Power-Grant Town Plt	548.80	0.0102	12.2663	0.08	0.0000	12.2663	0.00
FL	12005-535411	Rocktenn Cp LLC	628.66	0.0080	12.2663	0.07	0.0000	12.2663	0.00
NC	37117-8049311	Domtar Paper Company, LLC	648.15	0.0050	12.2663	0.04	0.0000	12.2663	0.00
TN	47093-4979911	Cemex - Knoxville Plant	44.25	0.0050	12.2663	0.04	0.0010	12.2663	0.01
GA	13103-536311	Georgia-Pacific Consumer Products Lp (Savannah River Mill)	445.14	0.0050	12.2663	0.04	0.0000	12.2663	0.00

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 (%)
TN	47105-4129211	Tate & Lyle, Loudon	36.10	0.0042	12.2663	0.03	0.0000	12.2663	0.00
SC	45015-8306711	Sce&G Williams	469.69	0.0040	12.2663	0.03	0.0000	12.2663	0.00
FL	12031-640211	Jea	619.61	0.0031	12.2663	0.03	0.0000	12.2663	0.00
FL	12089-753711	Rock Tenn Cp, LLC	596.04	0.0030	12.2663	0.02	0.0000	12.2663	0.00
AL	01103-1000011	Nucor Steel Decatur LLC	307.31	0.0020	12.2663	0.02	0.0000	12.2663	0.00
FL	12123-752411	Buckeye Florida, Limited Partnership	618.36	0.0020	12.2663	0.02	0.0000	12.2663	0.00
FL	12017-640611	Duke Energy Florida, Inc. (DEF)	749.25	0.0020	12.2663	0.02	0.0000	12.2663	0.00
FL	12047-769711	White Springs Agricultural Chemicals,Inc	585.86	0.0015	12.2663	0.01	0.0000	12.2663	0.00
MS	28059-6251011	Mississippi Power Company, Plant Victor J Daniel	710.94	0.0010	12.2663	0.01	0.0000	12.2663	0.00
FL	12057-538611	Tampa Electric Company (TEC)	881.37	0.0010	12.2663	0.01	0.0000	12.2663	0.00
FL	12089-845811	Rayonier Performance Fibers LLC	597.48	0.0010	12.2663	0.01	0.0000	12.2663	0.00
GA	13127-3721011	Brunswick Cellulose Inc	543.51	0.0010	12.2663	0.01	0.0000	12.2663	0.00
MS	28059-8384311	Chevron Products Company, Pascagoula Refinery	724.47	0.0010	12.2663	0.01	0.0000	12.2663	0.00
FL	12105-919811	Mosaic Fertilizer, LLC	877.97	0.0010	12.2663	0.01	0.0000	12.2663	0.00
FL	12033-752711	Gulf Power - Crist	640.08	0.0007	12.2663	0.01	0.0000	12.2663	0.00
FL	12105-717711	Mosaic Fertilizer LLC	882.90	0.0006	12.2663	0.00	0.0000	12.2663	0.00
AL	01053-985111	Escambia Operating Company LLC	597.02	0.0004	12.2663	0.00	0.0000	12.2663	0.00
KY	21177-5196711	Tennessee Valley Authority - Paradise Fossil Plant	326.56	0.0002	12.2663	0.00	0.0003	12.2663	0.00

Table 7-34. PSAT Results for Shining Rock 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 (%)
OH	39053-8148511	General James M. Gavin Power Plant	400.53	0.2972	11.7463	2.53	0.0010	11.7463	0.01
KY	21145-6037011	Tennessee Valley Authority (TVA) - Shawnee Fossil Plant	465.29	0.2010	11.7463	1.71	0.0030	11.7463	0.03
TN	47161-4979311	TVA Cumberland Fossil Plant	344.96	0.1620	11.7463	1.38	0.0020	11.7463	0.02
GA	13015-2813011	GA Power Company - Plant Bowen	189.71	0.1590	11.7463	1.35	0.0010	11.7463	0.01
MO	29143-5363811	New Madrid Power Plant-Marston	516.00	0.1576	11.7463	1.34	0.0009	11.7463	0.01
IN	18147-8017211	Indiana Michigan Power dba Aep Rockport	375.48	0.1564	11.7463	1.33	0.0115	11.7463	0.10
PA	42005-3866111	Genon Ne Mgmt Co/Keystone Sta	688.19	0.1513	11.7463	1.29	0.0000	11.7463	0.00
IN	18051-7363111	Gibson	456.28	0.1513	11.7463	1.29	0.0084	11.7463	0.07
MD	24001-7763811	Luke Paper Company	606.24	0.1410	11.7463	1.20	0.0000	11.7463	0.00
NC	37087-7920511	Blue Ridge Paper Products - Canton Mill	100.26	0.1332	11.7463	1.13	0.0117	11.7463	0.10
OH	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station	359.99	0.1290	11.7463	1.10	0.0016	11.7463	0.01
AR	05063-1083411	Entergy Arkansas Inc-Independence Plant	675.93	0.1286	11.7463	1.09	0.0006	11.7463	0.01
TN	47163-3982311	Eastman Chemical Company	160.12	0.1280	11.7463	1.09	0.0030	11.7463	0.03
IN	18125-7362411	Indianapolis Power & Light Petersburg	435.64	0.1008	11.7463	0.86	0.0095	11.7463	0.08
NC	37035-8370411	Duke Energy Carolinas, LLC - Marshall Steam Station	270.00	0.0859	11.7463	0.73	0.0021	11.7463	0.02
KY	21183-5561611	Big Rivers Electric Corp - Wilson Station	345.81	0.0800	11.7463	0.68	0.0010	11.7463	0.01
IL	17127-7808911	Joppa Steam	474.38	0.0725	11.7463	0.62	0.0004	11.7463	0.00
WV	54073-4782811	Monongahela Power Co-Pleasants Power Sta	475.85	0.0657	11.7463	0.56	0.0000	11.7463	0.00
OH	39053-7983011	Ohio Valley Electric Corp., Kyger Creek Station	398.42	0.0654	11.7463	0.56	0.0007	11.7463	0.01
WV	54033-6271711	Allegheny Energy Supply Co, LLC-Harrison	524.75	0.0585	11.7463	0.50	0.0000	11.7463	0.00

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 (%)
OH	39081-8115711	Cardinal Power Plant (Cardinal Operating Company)	587.50	0.0583	11.7463	0.50	0.0000	11.7463	0.00
VA	51027-4034811	Jewell Coke Company LLP	246.41	0.0580	11.7463	0.49	0.0000	11.7463	0.00
AL	01109-985711	Sanders Lead Co	466.40	0.0560	11.7463	0.48	0.0000	11.7463	0.00
SC	45015-4120411	Santee Cooper Cross Generating Station	432.03	0.0550	11.7463	0.47	0.0000	11.7463	0.00
PA	42063-3005211	Homer City Gen Lp/ Center TWP	682.88	0.0485	11.7463	0.41	0.0000	11.7463	0.00
WV	54079-6789111	Appalachian Power Company - John E Amos Plant	367.15	0.0461	11.7463	0.39	0.0015	11.7463	0.01
PA	42063-3005111	Nrg Wholesale Gen/Seward Gen Sta	682.76	0.0422	11.7463	0.36	0.0000	11.7463	0.00
GA	13115-539311	Temple Inland	198.78	0.0350	11.7463	0.30	0.0000	11.7463	0.00
SC	45015-4834911	Alumax Of South Carolina	458.13	0.0290	11.7463	0.25	0.0000	11.7463	0.00
IN	18173-8183111	Alcoa Warrick Power Plt Agc Div of Al	394.61	0.0271	11.7463	0.23	0.0057	11.7463	0.05
SC	45043-6652811	Santee Cooper Winyah Generating Station	492.36	0.0270	11.7463	0.23	0.0000	11.7463	0.00
SC	45043-5698611	International Paper Georgetown Mill	494.72	0.0270	11.7463	0.23	0.0000	11.7463	0.00
AL	01097-1056111	Ala Power - Barry	637.87	0.0255	11.7463	0.22	0.0000	11.7463	0.00
VA	51023-5039811	Roanoke Cement Company	407.38	0.0250	11.7463	0.21	0.0000	11.7463	0.00
AL	01073-1018711	Drummond Company, Inc.	345.58	0.0240	11.7463	0.20	0.0000	11.7463	0.00
TN	47145-4979111	TVA Kingston Fossil Plant	60.03	0.0216	11.7463	0.18	0.0007	11.7463	0.01
GA	13051-3679811	International Paper - Savannah	470.33	0.0210	11.7463	0.18	0.0000	11.7463	0.00
AL	01053-7440211	Escambia Operating Company LLC	598.46	0.0205	11.7463	0.17	0.0000	11.7463	0.00
NC	37013-8479311	Pcs Phosphate Company, Inc. - Aurora	650.31	0.0200	11.7463	0.17	0.0000	11.7463	0.00
VA	51580-5798711	Meadwestvaco Packaging Resource Group	426.66	0.0200	11.7463	0.17	0.0000	11.7463	0.00
WV	54051-6902311	Mitchell Plant	541.01	0.0197	11.7463	0.17	0.0000	11.7463	0.00
KY	21091-7352411	Century Aluminum of KY LLC	360.46	0.0190	11.7463	0.16	0.0000	11.7463	0.00
FL	12005-535411	Rocktenn Cp LLC	628.66	0.0170	11.7463	0.14	0.0000	11.7463	0.00
WV	54061-6773611	Monongahela Power Co.- Fort Martin Power	574.41	0.0157	11.7463	0.13	0.0009	11.7463	0.01
SC	45019-4973611	Kapstone Charleston Kraft LLC	475.41	0.0150	11.7463	0.13	0.0000	11.7463	0.00
AL	01097-949811	Akzo Nobel Chemicals Inc	641.75	0.0140	11.7463	0.12	0.0000	11.7463	0.00

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	54049-4864511	American Bituminous Power-Grant Town Plt	548.80	0.0102	11.7463	0.09	0.0000	11.7463	0.00
WV	54023-6257011	Dominion Resources, Inc. - Mount Storm Power Station	572.64	0.0085	11.7463	0.07	0.0000	11.7463	0.00
GA	13103-536311	Georgia-Pacific Consumer Products Lp (Savannah River Mill)	445.14	0.0070	11.7463	0.06	0.0000	11.7463	0.00
NC	37117-8049311	Domtar Paper Company, LLC	648.15	0.0050	11.7463	0.04	0.0000	11.7463	0.00
SC	45015-8306711	Sce&G Williams	469.69	0.0050	11.7463	0.04	0.0000	11.7463	0.00
FL	12031-640211	Jea	619.61	0.0041	11.7463	0.03	0.0000	11.7463	0.00
FL	12089-753711	Rock Tenn Cp, LLC	596.04	0.0040	11.7463	0.03	0.0000	11.7463	0.00
TN	47093-4979911	Cemex - Knoxville Plant	44.25	0.0040	11.7463	0.03	0.0020	11.7463	0.02
TN	47105-4129211	Tate & Lyle, Loudon	36.10	0.0039	11.7463	0.03	0.0003	11.7463	0.00
AL	01103-1000011	Nucor Steel Decatur Llc	307.31	0.0030	11.7463	0.03	0.0000	11.7463	0.00
FL	12123-752411	Buckeye Florida, Limited Partnership	618.36	0.0030	11.7463	0.03	0.0000	11.7463	0.00
FL	12047-769711	White Springs Agricultural Chemicals,Inc	585.86	0.0024	11.7463	0.02	0.0000	11.7463	0.00
FL	12057-538611	Tampa Electric Company (TEC)	881.37	0.0020	11.7463	0.02	0.0000	11.7463	0.00
NC	37023-8513011	SGL Carbon LLC	200.78	0.0020	11.7463	0.02	0.0000	11.7463	0.00
FL	12017-640611	Duke Energy Florida, Inc. (DEF)	749.25	0.0020	11.7463	0.02	0.0000	11.7463	0.00
FL	12105-717711	Mosaic Fertilizer Llc	882.90	0.0011	11.7463	0.01	0.0000	11.7463	0.00
MS	28059-6251011	Mississippi Power Company, Plant Victor J Daniel	710.94	0.0010	11.7463	0.01	0.0000	11.7463	0.00
FL	12089-845811	Rayonier Performance Fibers LLC	597.48	0.0010	11.7463	0.01	0.0000	11.7463	0.00
GA	13127-3721011	Brunswick Cellulose Inc	543.51	0.0010	11.7463	0.01	0.0000	11.7463	0.00
MS	28059-8384311	Chevron Products Company, Pascagoula Refinery	724.47	0.0010	11.7463	0.01	0.0000	11.7463	0.00
FL	12105-919811	Mosaic Fertilizer, LLC	877.97	0.0010	11.7463	0.01	0.0000	11.7463	0.00
FL	12033-752711	Gulf Power - Crist	640.08	0.0009	11.7463	0.01	0.0000	11.7463	0.00
FL	12057-716411	Mosaic Fertilizer, LLC	874.26	0.0006	11.7463	0.01	0.0000	11.7463	0.00
AL	01053-985111	Escambia Operating Company LLC	597.02	0.0005	11.7463	0.00	0.0000	11.7463	0.00
KY	21177-5196711	Tennessee Valley Authority - Paradise Fossil Plant	326.56	0.0002	11.7463	0.00	0.0005	11.7463	0.00

Table 7-35. PSAT Results for Swanquarter 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 (%)
MD	24001-7763811	Luke Paper Company	606.24	0.4380	10.2918	4.26	0.0080	10.2918	0.08
PA	42005-3866111	Genon Ne Mgmt Co/Keystone Sta	688.19	0.3752	10.2918	3.65	0.0093	10.2918	0.09
NC	37013-8479311	PCS Phosphate Company, Inc. - Aurora	650.31	0.3290	10.2918	3.20	0.0070	10.2918	0.07
OH	39053-8148511	General James M. Gavin Power Plant	400.53	0.2195	10.2918	2.13	0.0049	10.2918	0.05
OH	39081-8115711	Cardinal Power Plant (Cardinal Operating Company)	587.50	0.2029	10.2918	1.97	0.0066	10.2918	0.06
WV	54033-6271711	Allegheny Energy Supply Co, LLC-Harrison	524.75	0.1859	10.2918	1.81	0.0127	10.2918	0.12
PA	42063-3005211	Homer City Gen Lp/ Center TWP	682.88	0.1509	10.2918	1.47	0.0076	10.2918	0.07
WV	54073-4782811	Monongahela Power Co-Pleasants Power Sta	475.85	0.1272	10.2918	1.24	0.0052	10.2918	0.05
GA	13015-2813011	GA Power Company - Plant Bowen	189.71	0.1120	10.2918	1.09	0.0030	10.2918	0.03
NC	37117-8049311	Domtar Paper Company, LLC	648.15	0.1090	10.2918	1.06	0.0220	10.2918	0.21
PA	42063-3005111	Nrg Wholesale Gen/Seward Gen Sta	682.76	0.1021	10.2918	0.99	0.0029	10.2918	0.03
KY	21145-6037011	Tennessee Valley Authority (TVA) - Shawnee Fossil Plant	465.29	0.0990	10.2918	0.96	0.0020	10.2918	0.02
IN	18147-8017211	Indiana Michigan Power Dba Aep Rockport	375.48	0.0907	10.2918	0.88	0.0048	10.2918	0.05
IN	18051-7363111	Gibson	456.28	0.0849	10.2918	0.83	0.0056	10.2918	0.05
WV	54051-6902311	Mitchell Plant	541.01	0.0787	10.2918	0.77	0.0073	10.2918	0.07
TN	47163-3982311	Eastman Chemical Company	160.12	0.0750	10.2918	0.73	0.0050	10.2918	0.05
IN	18125-7362411	Indianapolis Power & Light Petersburg	435.64	0.0737	10.2918	0.72	0.0035	10.2918	0.03
WV	54061-6773611	Monongahela Power Co.- Fort Martin Power	574.41	0.0657	10.2918	0.64	0.0244	10.2918	0.24
NC	37035-8370411	Duke Energy Carolinas, LLC - Marshall Steam Station	270.00	0.0641	10.2918	0.62	0.0150	10.2918	0.15

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 (%)
SC	45015-4120411	Santee Cooper Cross Generating Station	432.03	0.0640	10.2918	0.62	0.0060	10.2918	0.06
VA	51027-4034811	Jewell Coke Company LLP	246.41	0.0620	10.2918	0.60	0.0010	10.2918	0.01
OH	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station	359.99	0.0589	10.2918	0.57	0.0016	10.2918	0.02
WV	54079-6789111	Appalachian Power Company - John E Amos Plant	367.15	0.0566	10.2918	0.55	0.0060	10.2918	0.06
WV	54049-4864511	American Bituminous Power-Grant Town Plt	548.80	0.0460	10.2918	0.45	0.0042	10.2918	0.04
OH	39053-7983011	Ohio Valley Electric Corp., Kyger Creek Station	398.42	0.0440	10.2918	0.43	0.0027	10.2918	0.03
VA	51023-5039811	Roanoke Cement Company	407.38	0.0430	10.2918	0.42	0.0030	10.2918	0.03
SC	45043-5698611	International Paper Georgetown Mill	494.72	0.0410	10.2918	0.40	0.0040	10.2918	0.04
KY	21183-5561611	Big Rivers Electric Corp - Wilson Station	345.81	0.0390	10.2918	0.38	0.0010	10.2918	0.01
SC	45015-4834911	Alumax Of South Carolina	458.13	0.0370	10.2918	0.36	0.0000	10.2918	0.00
VA	51580-5798711	Meadwestvaco Packaging Resource Group	426.66	0.0370	10.2918	0.36	0.0030	10.2918	0.03
TN	47161-4979311	TVA Cumberland Fossil Plant	344.96	0.0340	10.2918	0.33	0.0010	10.2918	0.01
MO	29143-5363811	New Madrid Power Plant-Marston	516.00	0.0339	10.2918	0.33	0.0009	10.2918	0.01
IL	17127-7808911	Joppa Steam	474.38	0.0333	10.2918	0.32	0.0004	10.2918	0.00
SC	45043-6652811	Santee Cooper Winyah Generating Station	492.36	0.0320	10.2918	0.31	0.0050	10.2918	0.05
GA	13051-3679811	International Paper - Savannah	470.33	0.0290	10.2918	0.28	0.0030	10.2918	0.03
SC	45019-4973611	Kapstone Charleston Kraft LLC	475.41	0.0240	10.2918	0.23	0.0040	10.2918	0.04
AR	05063-1083411	Entergy Arkansas Inc-Independence Plant	675.93	0.0200	10.2918	0.19	0.0006	10.2918	0.01
FL	12031-640211	Jea	619.61	0.0185	10.2918	0.18	0.0016	10.2918	0.02
WV	54023-6257011	Dominion Resources, Inc. - Mount Storm Power Station	572.64	0.0184	10.2918	0.18	0.0024	10.2918	0.02
FL	12089-753711	Rock Tenn Cp, LLC	596.04	0.0180	10.2918	0.17	0.0040	10.2918	0.04

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 (%)
IN	18173-8183111	Alcoa Warrick Power Plt Agc Div of AL	394.61	0.0150	10.2918	0.15	0.0024	10.2918	0.02
KY	21091-7352411	Century Aluminum of KY LLC	360.46	0.0141	10.2918	0.14	0.0000	10.2918	0.00
AL	01109-985711	Sanders Lead Co	466.40	0.0120	10.2918	0.12	0.0000	10.2918	0.00
FL	12057-538611	Tampa Electric Company (TEC)	881.37	0.0110	10.2918	0.11	0.0010	10.2918	0.01
FL	12105-717711	Mosaic Fertilizer LLC	882.90	0.0108	10.2918	0.10	0.0000	10.2918	0.00
GA	13103-536311	Georgia-Pacific Consumer Products LP (Savannah River Mill)	445.14	0.0100	10.2918	0.10	0.0010	10.2918	0.01
FL	12105-919811	Mosaic Fertilizer, LLC	877.97	0.0097	10.2918	0.09	0.0000	10.2918	0.00
GA	13115-539311	Temple Inland	198.78	0.0070	10.2918	0.07	0.0010	10.2918	0.01
TN	47145-4979111	TVA Kingston Fossil Plant	60.03	0.0054	10.2918	0.05	0.0004	10.2918	0.00
FL	12047-769711	White Springs Agricultural Chemicals,Inc	585.86	0.0054	10.2918	0.05	0.0000	10.2918	0.00
AL	01073-1018711	Drummond Company, Inc.	345.58	0.0050	10.2918	0.05	0.0000	10.2918	0.00
FL	12123-752411	Buckeye Florida, Limited Partnership	618.36	0.0050	10.2918	0.05	0.0010	10.2918	0.01
FL	12017-640611	Duke Energy Florida, Inc. (DEF)	749.25	0.0049	10.2918	0.05	0.0004	10.2918	0.00
NC	37087-7920511	Blue Ridge Paper Products - Canton Mill	100.26	0.0043	10.2918	0.04	0.0029	10.2918	0.03
AL	01053-7440211	Escambia Operating Company LLC	598.46	0.0042	10.2918	0.04	0.0000	10.2918	0.00
SC	45015-8306711	SCE&G Williams	469.69	0.0040	10.2918	0.04	0.0020	10.2918	0.02
FL	12005-535411	Rocktenn CP LLC	628.66	0.0040	10.2918	0.04	0.0000	10.2918	0.00
FL	12089-845811	Rayonier Performance Fibers LLC	597.48	0.0040	10.2918	0.04	0.0040	10.2918	0.04
GA	13127-3721011	Brunswick Cellulose Inc	543.51	0.0040	10.2918	0.04	0.0020	10.2918	0.02
FL	12057-716411	Mosaic Fertilizer, LLC	874.26	0.0036	10.2918	0.03	0.0000	10.2918	0.00
AL	01097-949811	Akzo Nobel Chemicals Inc	641.75	0.0030	10.2918	0.03	0.0000	10.2918	0.00
AL	01097-1056111	Ala Power - Barry	637.87	0.0025	10.2918	0.02	0.0000	10.2918	0.00
NC	37023-8513011	SGL Carbon LLC	200.78	0.0020	10.2918	0.02	0.0000	10.2918	0.00
TN	47105-4129211	Tate & Lyle, Loudon	36.10	0.0014	10.2918	0.01	0.0003	10.2918	0.00
WV	54061-16320111	Longview Power	572.53	0.0010	10.2918	0.01	0.0000	10.2918	0.00

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 (%)
AL	01103-1000011	Nucor Steel Decatur LLC	307.31	0.0010	10.2918	0.01	0.0000	10.2918	0.00
TN	47093-4979911	Cemex - Knoxville Plant	44.25	0.0010	10.2918	0.01	0.0010	10.2918	0.01
WV	54093-6327811	Kingsford Manufacturing Company	536.29	0.0010	10.2918	0.01	0.0000	10.2918	0.00
MS	28059-8384311	Chevron Products Company, Pascagoula Refinery	724.47	0.0010	10.2918	0.01	0.0000	10.2918	0.00
FL	12033-752711	Gulf Power - Crist	640.08	0.0002	10.2918	0.00	0.0004	10.2918	0.00
AL	01053-985111	Escambia Operating Company LLC	597.02	0.0001	10.2918	0.00	0.0000	10.2918	0.00
WV	54061-6773811	Morgantown Energy Associates	566.59	0.0001	10.2918	0.00	0.0003	10.2918	0.00
KY	21177-5196711	Tennessee Valley Authority - Paradise Fossil Plant	326.56	0.0000	10.2918	0.00	0.0003	10.2918	0.00
WV	54041-6900311	Equitrans - Copley Run CS 70	479.37	0.0000	10.2918	0.00	0.0010	10.2918	0.01
WV	54083-6790511	Glady 6C4350	513.26	0.0000	10.2918	0.00	0.0010	10.2918	0.01
WV	54083-6790711	Files Creek 6C4340	507.74	0.0000	10.2918	0.00	0.0010	10.2918	0.01
MS	28059-6251011	Mississippi Power Company, Plant Victor J Daniel	710.94	0.0000	10.2918	0.00	0.0010	10.2918	0.01

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 (Roadmap for PSAT Scaled Adjustments) 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 7-77 shows three plots of the ratio of AoI/PSAT contributions for sulfate, nitrate, and sulfate + nitrate, respectively, as a function of distance from the facility to the Class I area. Figure 7-78 shows three plots of the fractional bias (FB) for sulfate, nitrate, and sulfate + nitrate, respectively, as a function of distance from the facility to the Class I area. The FB is equal to 2*(AoI – PSAT)/(AoI + PSAT). The FB 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 7-77 and Figure 7-78, AoI tends to overestimate impacts for facilities near the Class I area. This appears to be the case for both sulfates and nitrates. In fact, if the facility is <100 Km from the Class I area, the AoI results are generally (with a few exceptions for nitrates) three times or more higher than the PSAT results. Even in those exceptions, those AoI-computed nitrate impacts for facilities close to a Class I area were always higher than PSAT-computed nitrate impacts.

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.

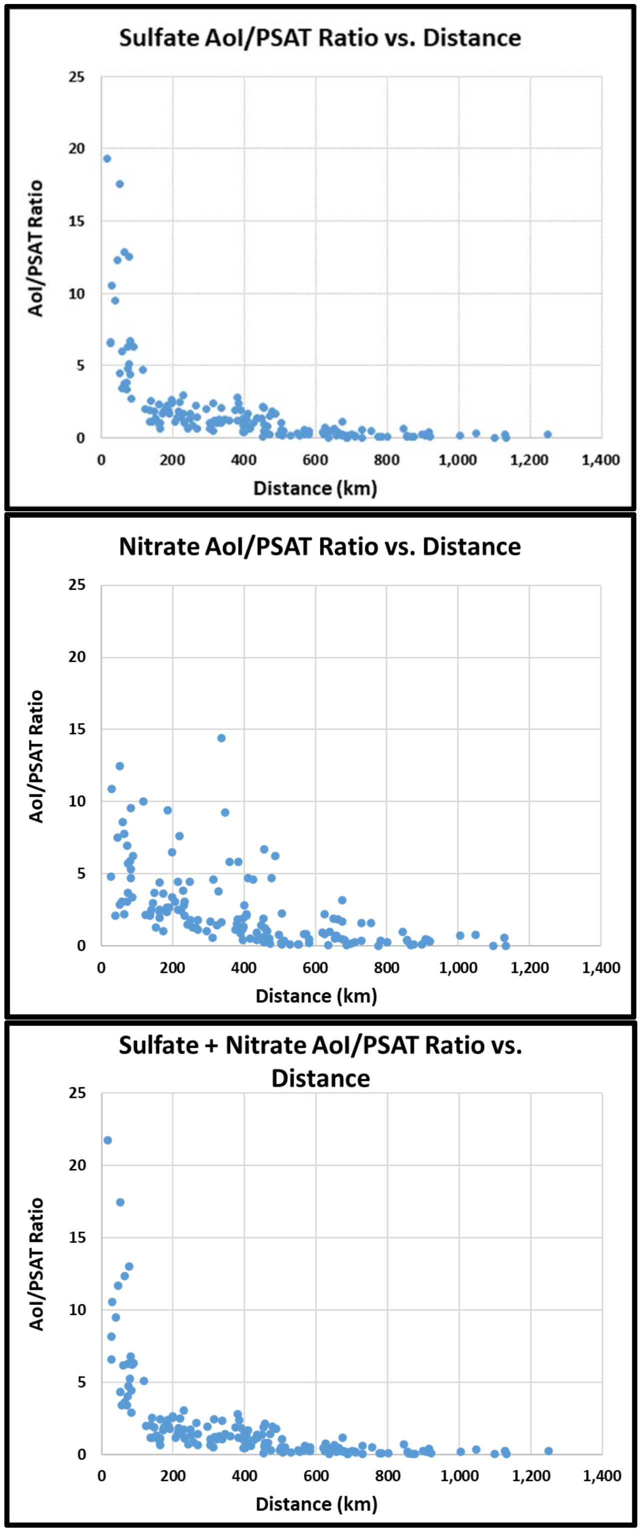

Figure 7-77. Ratio of AoI/PSAT % Contributions for Sulfate as a Function of Distance from the Facility to the Class I Area

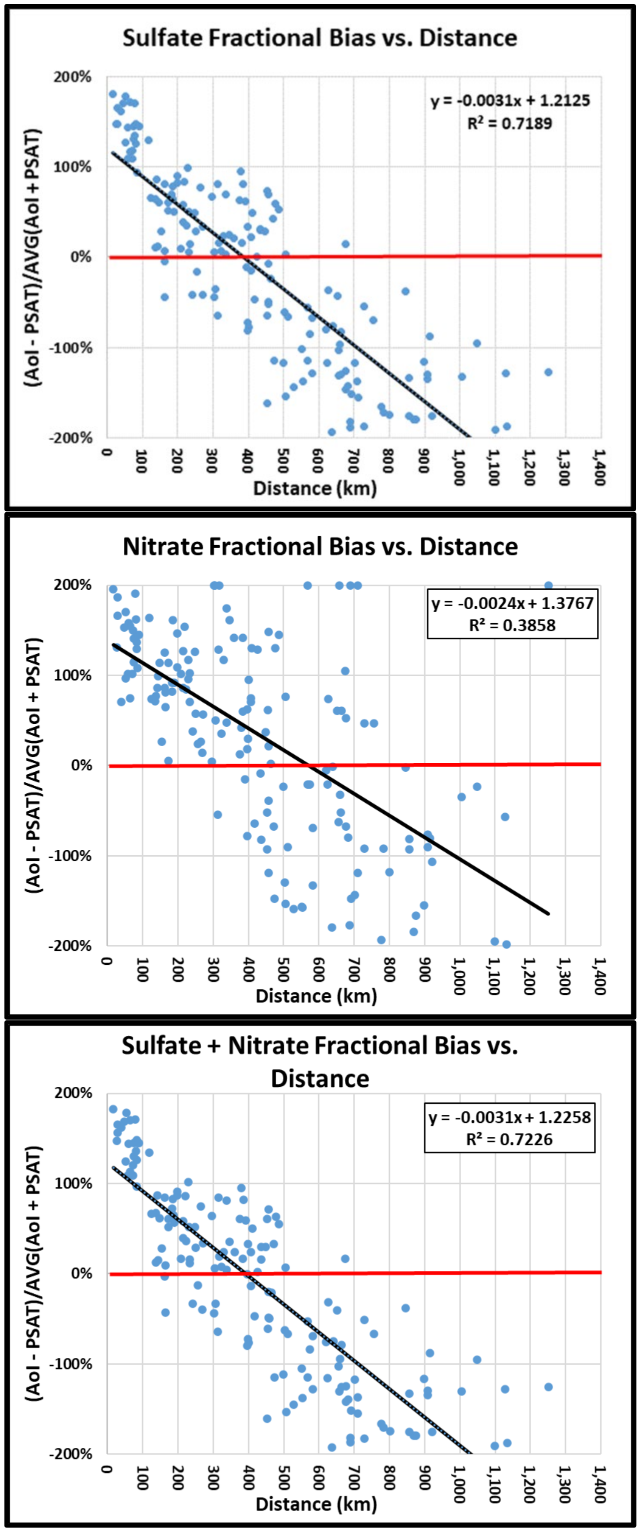

Figure 7-78. Fractional Bias for Sulfate as a Function of Distance from the Facility to the Class I Area

7.7 Selection of Sources for Reasonable Progress Evaluation

7.7.1 Overview of the Selection Process

The EPA has made clear 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 to select sources so long as the factors used in the process are explained and justified in the state's plan. Section 169A(b) requires 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 RHR, 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. *Guidance on Regional Haze State Implementation Plans for the Second Implementation Period* (August 2019). This 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)."[109]

The 2019 EPA guidance goes on to discuss 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 North Carolina 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. This Section (7.6) discusses the use of photochemical modeling to better understand source contribution to modeled visibility and further refine the sources selected for a reasonable progress analysis.

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. North Carolina, as well as the

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[109] U.S. EPA, Guidance on Regional Haze State Implementation Plans for the Second Implementation Period, EPA-457/B-19-003, August 20, 2019, page 10, https://www.epa.gov/sites/default/files/2019-08/documents/8-20-2019_-_regional_haze_guidance_final_guidance.pdf?VersionId=QC2nPZHuAH1VYmm3EuhV9ABIGm5rQynb.

other VISTAS states, used a two-step process for selecting sources. The first step was a screening analysis using the SO_2 and NO_x 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 that have the largest contribution to visibility impairment, and thus, greatest opportunity for improvement, at Class I areas. This process also resulted in selecting several sources that North Carolina, and sources in states that contribute to North Carolina Class I areas, could analyze with the limited resources available to the states. 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 planning, many VISTAS states used the AoI approach and a 1% threshold by emission unit. In this second round of planning for regional haze SIPs, all VISTAS states used the AoI/PSAT approach and a ≥ 1.00% PSAT threshold by facility for screening sources for reasonable progress evaluation. Using a facility basis for emission estimates pulled in more facilities as compared to an emission unit-by-unit basis for emission estimates. As a result, more facilities with smaller visibility impacts (in Mm^{-1}) were examined as compared to the first round of regional haze planning. 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.

7.7.2 Selection of Facilities Impacting Class I Areas in North Carolina

Based on the PSAT results presented in Table 7-30 through Table 7-35, the VISTAS states agreed that all facilities with a ≥ 1.00% PSAT threshold for sulfate or nitrate would be examined for reasonable progress analysis. For Class I areas in North Carolina, a total of 19 facilities exceeded the ≥ 1.00% PSAT threshold. Table 7-36 lists the facilities in North Carolina selected for reasonable progress analysis, Table 7-37 lists the facilities in VISTAS States (not including North Carolina) selected for reasonable progress analysis, and Table 7-38 lists the facilities in non-VISTAS states selected for reasonable progress analysis.

The NCDAQ requested that each of the three facilities in North Carolina complete a four-factor analysis. Section 7.8 documents the four-factor analysis and responses. The NCDAQ sent a letter to each state with a facility listed in Table 7-37 and Table 7-38 to request a reasonable progress analysis for each facility. The request letters and responses are provided in Section 10 of this SIP.

For Great Smoky Mountains National Park (see Table 7-31), the total sulfate plus nitrate point source visibility impact in 2028 (13.2255 Mm^{-1}) was 28.70% of the total visibility impairment on the 20% most impaired days (46.08 Mm^{-1}; see Table 7-8). Of this total point source facility impact, the seven (7) facilities have a sulfate contribution ≥1.00% and account for 11.3% of the point source sulfate plus nitrate visibility impact in 2028.

For Joyce Kilmer-Slickrock Wilderness Area (see Table 7-32), the total sulfate plus nitrate point source visibility impact in 2028 (13.0309 Mm^{-1}) was 28.73% of the total visibility impairment on the 20% most impaired days (45.36 $Mm^{-1;}$ see Table 7-8). Of this total point source facility impact, the eight (8) facilities have a sulfate contribution ≥1.00% and account for 12.1% of the point source sulfate plus nitrate visibility impact in 2028.

For Linville Gorge Wilderness Area (see Table 7-33), the total sulfate plus nitrate point source visibility impact in 2028 (12.2663 Mm^{-1}) was 28.79% of the total visibility impairment on the 20% most impaired days (42.61 $Mm^{-1;}$ see Table 7-8). Of this total point source facility impact, the eleven (11) facilities have a sulfate contribution ≥1.00% and account for 20.1% of the point source sulfate plus nitrate visibility impact in 2028.

For Shining Rock Wilderness Area (see Table 7-34), the total sulfate plus nitrate point source visibility impact in 2028 (11.7463 Mm^{-1}) was 31.03% of the total visibility impairment on the 20% most impaired days (37.86 $Mm^{-1;}$ see Table 7-8). Of this total point source facility impact, the thirteen (13) facilities have a sulfate contribution ≥1.00% and account for 17.8% of the point source sulfate plus nitrate visibility impact in 2028.

For Swanquarter Wilderness Area (see Table 7-35), the total sulfate plus nitrate point source visibility impact in 2028 (10.2918 Mm^{-1}) was 21.57% of the total visibility impairment on the 20% most impaired days (47.72 $Mm^{-1;}$ see Table 7-8). Of this total point source facility impact, the ten (10) facilities have a sulfate contribution ≥1.00% and account for 21.90% of the point source sulfate plus nitrate visibility impact in 2028.

In summary, for Class I areas in North Carolina, a total of 19 facilities exceeded the ≥ 1.00% PSAT threshold for sulfate. The NCDAQ reviewed facilities with <1% sulfate or <1% nitrate contribution to one or more of the Class I areas in North Carolina (see Section 7.7.3). Based on this review, the NCDAQ did not identify any uncontrolled or lightly controlled facilities that were large contributors to anthropogenic light extinction at any of North Carolina's Class I areas. As previously discussed in Section 7.6.1, point source facilities (particularly power plants) outside North Carolina had higher impacts than many of the largest point source facilities within North Carolina due to the significant SO_2 and NO_x emission reductions that occurred during the first planning period due to the state's adoption of the Clean Smokestacks Act. Thus, NCDAQ concludes that the 1% PSAT threshold captured a reasonable number of facilities for reasonable progress analysis for their potential impacts on Class I areas in North Carolina.

Table 7-36. Facilities in North Carolina Selected for Reasonable Progress Analysis

State	Facility ID	Facility Name
NC	37087-7920511	Blue Ridge Paper Products - Canton Mill
NC	37117-8049311	Domtar Paper Company, LLC
NC	37013-8479311	PCS Phosphate Company, Inc. - Aurora

Table 7-37. Facilities in VISTAS States (not including North Carolina) Selected for Reasonable Progress Analysis

State	Facility ID	Facility Name
GA	13015-2813011	Georgia Power Company – Plant Bowen
KY	21145-6037011	TVA – Shawnee Fossil Plant
TN	47161-4979311	TVA – Cumberland Fossil Plant
TN	47163-3982311	Eastman Chemical Company
VA	51027-4034811	Jewell Coke Company LLP
WV	54033-6271711	Allegheny Energy Supply Co, LLC - Harrison
WV	54073-4782811	Monongahela Power Co – Pleasants Power Station

Table 7-38. Facilities Located Outside of VISTAS States Selected for Reasonable Progress Analysis

State	Facility ID	Facility Name
AR	05063-1083411	Entergy Arkansas Inc. - Independence Plant
IN	18051-7363111	Gibson
IN	18147-8017211	Indiana Michigan Power - Rockport
MO	29143-5363811	New Madrid Power Plant-Marston
PA	42063-3005211	Homer City Gen LP/Center TWP
PA	42005-3866111	Genon NE Mgmt Co/Keystone Station
OH	39081-8115711	Cardinal Power Plant - Cardinal Operating Company
OH	39053-8148511	General James M. Gavin Power Plant
OH	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station

7.7.3 Review of Facilities Not Selected for Reasonable Progress Analysis

This section provides a summary of why certain facilities were not selected for a reasonable progress analysis.

7.7.3.1 Facilities with <1.00% PSAT Contribution

Table 7-39 shows the original emissions and PSAT modeling results for Duke Energy Marshall and SGL Carbon to the revised 2028 emissions and adjusted PSAT modeling results. These two facilities were screened out for further analysis for the following reasons.

SGL Carbon

For non-EGU point sources, the NCDAQ started with North Carolina's 2016 base year inventory (the most recent base year available when the 2028 inventory was prepared) and applied facility and emission unit closure information along with growth and control factors to estimate 2028 emissions. SGL Carbon has two natural gas-fired boilers that are subject to GACT and MACT requirements.

The 2028 emissions from the original to the revised inventory did not change; therefore, the PSAT modeling results did not change. However, given that the total modeled emissions inventory was updated between the original and revised modeling, the relative contribution is slightly different as indicated in Table 7-39. Based on SO_2 emissions of 261.6 tpy, PSAT modeling for SGL Carbon indicates that the highest impact is 0.24% for sulfate at the Linville Gorge Wilderness Area (LIGO). At 32.5 km away, it is closest to this Class I area, and therefore has the highest impact at this Class I area. However, as discussed in section 7.6.3, PSAT modeling is regarded as more reliable than the AoI analysis for estimating visibility impacts. In fact -- when analyzing projected sulfate visibility impairment -- the difference between AoI and PSAT modeling is at least threefold when looking at facilities located <100km to a given Class I area. A comparison of projected sulfate AOI vs PSAT results at LIGO shows that SGL Carbon's AoI impacts are actually over 16x higher than PSAT impacts. Given that PSAT modeling is more reliable than AoI modeling (including the underestimation of impacts from distant sources with AoI modeling) this facility was not considered for a reasonable progress / four-factor analysis because its PSAT contribution to the nearest Class I area is <1.00% for sulfate. Note that there were no NO_x impacts due to the low NO_x emission rates for this facility (21.7 tpy).

Duke Energy Marshall

The original 2028 emissions for this facility were based on ERTACv2.7 projections from 2011 to 2028. The revised emissions are based in part on ERTACv16.0 projections from 2016 to 2028. Based on the original (higher) SO_2 emissions of 4,139.2 tpy, PSAT modeling for Duke Energy Marshall indicates the highest impact is 0.91% for sulfate at the Linville Gorge Wilderness Area because it is closest to this Class I area. Based on revised SO_2 emissions of 2,654.2 tpy, PSAT modeling for Duke Energy Marshall indicates the impact is 0.87% for sulfate at the Linville Gorge Wilderness Area. Therefore, this facility was not considered for reasonable further analysis because its PSAT contribution to the nearest Class I area was <1.00% for sulfate and <1.00% for nitrate.

Table 7-39. Original and Revised Emissions and PSAT Contributions for Duke Energy Marshall and SGL Carbon

Facility Name	Distance (Km)	Original 2028 Emissions (Tons)		Original PSAT Impact (%)		Revised 2028 Emissions (Tons)		Revised PSAT Impact (%)	
		SO_2	NO_x	SO_2	NO_x	SO_2	NO_x	SO_2	NO_x
Great Smoky Mountains National Park									
Duke Energy Marshall	270.0	4,139.2	7,511.3	0.35	0.01	2,654.2	5,355.8	0.32	0.01
SGL Carbon	200.8	261.6	21.7	0.01	<0.01	261.6	21.7	0.01	<0.01
Joyce Kilmer-Slickrock Wilderness Area									
Duke Energy Marshall	274.3	4,139.2	7,511.3	0.37	0.01	2,654.2	5,355.8	0.35	0.01
SGL Carbon	207.1	261.6	21.7	0.01	<0.01	261.6	21.7	0.01	<0.01
Linville Gorge Wilderness Area									
Duke Energy Marshall	97.20	4,139.2	7,511.3	0.91	0.03	2,654.2	5,355.8	0.87	0.03
SGL Carbon	32.50	261.6	21.7	0.17	<0.01	261.6	21.7	0.24	<0.01
Shining Rock Wilderness Area									
Duke Energy Marshall	166.0	4,139.2	7,511.3	0.77	0.02	2,654.2	5,355.8	0.73	0.02
SGL Carbon	102.1	261.6	21.7	0.01	<0.01	261.6	21.7	0.02	<0.01
Swanquarter Wilderness Area									
Duke Energy Marshall	431.5	4,139.2	7,511.3	0.66	0.14	2,654.2	5,355.8	0.62	0.15
SGL Carbon	501.1	261.6	21.7	0.01	<0.01	261.6	21.7	0.02	<0.01

7.7.3.2 Facilities Not Selected for PSAT Modeling

The NCDAQ reviewed facilities with an AoI between 1% and 3% to Class I areas in North Carolina that were not selected for PSAT modeling (see Table 7-40). In addition, the NCDAQ also compared recent emissions for 2017, 2018, and 2019 to projected 2028 emissions used to support the RPG modeling. Facilities with more than a 1,000-ton difference between recent and projected 2028 SO_2 and NO_x emissions were identified for further review (see Table 7-41 and Table 7-42, respectively). These tables also include non-EGU facilities for which the National Park Service and a third party requested to be reviewed.

EGU (Duke Energy) Facilities

Table 7-43 provides a summary of the Duke Energy facilities with coal units showing SO_2 and NO_x controls, operating status as of 2021, and applicable federal rules. Acronyms and abbreviations used in Table 7-43 are defined in Table 7-45.

The NCDAQ reviewed existing SO_2 and NO_x controls for the Duke Energy facilities and determined that existing controls will remain in place and serve to support continued progress for the second planning period. As noted in Section 7.6.3, AoI results for sulfates are at least three times higher than the PSAT results for facilities that are <100 Km from a given Class I area. In North Carolina's case, such facilities include Duke Energy's Cliffside Steam Station and Asheville Steam Electric Plant, both of which had combined sulfate and nitrate AoI values of less than 3%. Other sources that are further away from Class I areas like Roxboro and Belews Creek are unlikely to be significantly contributing based on AoI (which are less than 3% combined sulfate and nitrate) and the analysis presented in Section 7.6.3 indicates that combined AoI impacts are generally higher than PSAT impacts out to 300 Km (see Figure 7-78). In addition, as noted in Section 7.2.7 of this SIP, it is likely that North Carolina's EGU fleet will undergo changes to mitigate CO_2 emissions that will require moving away from coal to less carbon intensive fuels which has not been accounted for in the EGU projections supporting the AoI and PSAT analyses. Specifically, Belews Creek Units 1 & 2 and Marshall Units 3 & 4 have completed co-firing projects allowing firing of 40-50% natural gas, while Cliffside 6 is now capable of burning 100% natural gas. Based on current controlled and projected 2028 emissions, the NCDAQ concluded that it was not necessary to request that the facilities complete a reasonable progress / four-factor analysis to demonstrate progress toward achieving the modeled 2028 RPGs discussed in Section 8 of this SIP. The NCDAQ will continue to track the impact on visibility in North Carolina's Class I areas from SO_2 and NO_x emissions associated with the EGU point and non-EGU point source facilities and will evaluate progress during the next five-year progress report for regional haze.

Non-EGU Facilities

For other non-EGU facilities identified in Table 7-40 through Table 7-42, Table 7-44 provides a summary of unit-level SO_2 and NO_x emission controls, operating status as of 2021, and applicable federal rules. Acronyms and abbreviations used in Table 7-44 are defined in Table 7-45.

The NCDAQ reviewed existing SO_2 and NO_x controls for these facilities and determined that existing controls will remain in place and serve to support continued progress for the second planning period. Some facilities like Craven County Wood Energy are <100 Km from the Class I area indicating that the AoI results – for sulfates -- for these facilities would be at least three times higher than expected had the facilities been modeled with PSAT. Nitrate-based AoI results for these facilities were all very low, and based on the data analysis given in Section 7.6.3 comparing AoI results vs PSAT results for nitrates as well as nitrates + sulfates, there was no concern that any of these facilities were significantly contributing to visibility impairment at any Class I area. Based on the current and projected 2028 emissions and current control information, the NCDAQ concluded that it was not necessary to request that the facilities complete a reasonable progress / four-factor analysis to demonstrate continued progress toward achieving the modeled 2028 RPGs. As with the EGU sector, the NCDAQ will continue to track the impact of SO_2 and NO_x emissions associated with these facilities on visibility in North Carolina's Class I areas and evaluate progress during the next five-year progress report for regional haze.

Table 7-40. Facilities Not Selected for PSAT Modeling with AoI Between 1% and 3% for Sulfate and Nitrate Combined

State	Facility ID	Facility Name	Distance (Km)	2028 NO_x (TPY)	2028 SO_2 (TPY)	Nitrate (%)	Sulfate (%)	Sulfate + Nitrate (%)
Linville Gorge Wilderness Area								
NC	37161-8300611	Duke Energy Carolinas, LLC - Cliffside Steam Station	85.3	1,947.7	1,082.3	0.11%	2.38%	2.49%
NC	37169-8514011	Duke Energy Carolinas, LLC - Belews Creek Steam Station	172.2	5,264.3	4,946.1	0.08%	1.93%	2.01%
Shining Rock Wilderness Area								
NC	37021-NEW_2706	Duke Energy Progress, Inc. - Asheville Steam Electric Plant	22.6	848.5	17.0	1.97%	0.37%	2.33%
NC	37161-8300611	Duke Energy Carolinas, LLC - Cliffside Steam Station	94.1	1,947.7	1,082.3	0.28%	1.57%	1.85%
NC	37169-8514011	Duke Energy Carolinas, LLC - Belews Creek Steam Station	264.4	5,264.3	4,946.1	0.14%	1.42%	1.56%
Swanquarter Wilderness Area								
NC	37145-7826011	Duke Energy Progress, LLC - Roxboro Steam Electric Plant	282.6	4,527.9	6,665.5	0.18%	2.05%	2.23%
NC	37049-8504911	Marine Corps Air Station - Cherry Point	88.4	201.1	607.8	0.05%	1.31%	1.36%

Table 7-41. Comparison of SO_2 Emissions between 2017, 2018, 2019, and 2028

EIS Facility ID	Facility	Distance to Nearest Class I Area (Km)	2017 (TPY)	2018 (TPY)	2019 (TPY)	2028 Original (TPY)	2028 Remodel (TPY)	2028 Remodel minus 2017 (TPY)	2028 Remodel minus 2018 (TPY)	2028 Remodel minus 2019 (TPY)	Sulfate AoI Contribution (%)	Sulfate + Nitrate AoI Contribution (%)
8514011	Duke Energy Carolinas, LLC - Belews Creek Steam Station	LIGO (172.19)	4,522	4,115	3,370	4,946	1,385	-3,137	-2,730	-1,985	1.93%	2.01%
7826011	Duke Energy Progress - Roxboro Plant	LIGO (263.38)	3,414	3,604	4,142	6,665	2,258	-1,156	-1,346	-1,884	0.92%	0.96%
7826111	Duke Energy Progress, Inc. - Mayo Facility	SWAN (269.89)	1,511	1,413	1,123	1,770	2,274	763	861	1,151	0.31%	0.37%
8506811	Carolina Stalite Company	LIGO (154.05)	1,440	1,164	947	1,972	1,972	532	808	1,025	0.63%	0.64%
8122711	International Paper - Riegelwood Mill	SWAN (220.08)	1,285	1,611	1,341	649	649	-636	-962	-692	0.29%	0.34%
8300611	Duke Energy Carolinas, LLC - Cliffside Steam Station	LIGO (85.32)	858	1,350	1,383	1,082	161	-697	-1,189	-1,222	2.38%	2.49%
8392811	Duke Energy Progress , Inc. - Asheville Steam Electric Plant	SHRO (22.86)	791	780	711	17	39	-752	-741	-672	0.01%	0.06%
8376711	Pilkington North America, Inc.	LIGO (267.6)	383	385	414	506	506	123	121	92	0.05%	0.07%
8137511	Duke Energy Carolinas, LLC - Allen Steam Station	LIGO (120.47)	354	246	148	476	575	221	329	427	0.31%	0.34%

EIS Facility ID	Facility	Distance to Nearest Class I Area (Km)	2017 (TPY)	2018 (TPY)	2019 (TPY)	2028 Original (TPY)	2028 Remodel (TPY)	2028 Remodel minus 2017 (TPY)	2028 Remodel minus 2018 (TPY)	2028 Remodel minus 2019 (TPY)	Sulfate AoI Contribution (%)	Sulfate + Nitrate AoI Contribution (%)
8048011	KapStone Kraft Paper Corporation	SWAN (172.52)	327	572	676	10	10	-317	-562	-666	0.00%	0.04%
8137011	Owens-Brockway Glass Container Plt 6	LIGO (154.75)	287	289	243	350	350	63	61	108	0.19%	0.20%
8505111	Craven County Wood Energy	SWAN (94.24)	149	294	381	47	47	-102	-247	-334	0.11%	0.29%
8010411	Saint-Gobain Containers	SWAN (155.6)	142	150	171	182	182	40	32	11	0.15%	0.17%
8298611	Cardinal Fg Flat Glass Plant	LIGO (110.33)	122	169	91	218	218	96	49	127	0.20%	0.23%

Table 7-42. Comparison of NO_x Emissions between 2017, 2018, 2019, and 2028

EIS Facility ID	Facility	Distance to Nearest Class I Area (Km)	2017 (TPY)	2018 (TPY)	2019 (TPY)	2028 Original (TPY)	2028 Remodel (TPY)	2028 Remodel minus 2017 (TPY)	2028 Remodel minus 2018 (TPY)	2028 Remodel minus 2019 (TPY)	Nitrate AoI Contribution (%)	Sulfate + Nitrate AoI Contribution (%)
8514011	Duke Energy Carolinas, LLC - Belews Creek Steam Station	LIGO (172.19)	7,054	7,303	5,668	5,264	1,867	-5,187	-5,436	-3,801	0.08%	2.01%
7826011	Progress Energy - Roxboro Plant	LIGO (263.38)	5,774	5,614	4,886	4,528	1,532	-4,242	-4,082	-3,354	0.04%	0.96%
8376711	Pilkington North America, Inc.	LIGO (267.6)	3,614	3,697	3,552	4,797	4,797	1,183	1,100	1,245	0.02%	0.07%
8300611	Duke Energy Carolinas, LLC - Cliffside Steam Station	LIGO (85.32)	1,646	1,954	2,486	1,948	327	-1,319	-1,627	-2,159	0.11%	2.49%
8122711	International Paper - Riegelwood Mill	SWAN (220.08)	1,620	1,711	1,603	1,175	1,175	-445	-536	-428	0.06%	0.34%
8137511	Duke Energy Carolinas, LLC - Allen Steam Station	LIGO (120.47)	1,610	1,441	1,346	1,125	1,410	-200	-31	64	0.03%	0.34%
7826111	Duke Energy Progress, Inc. - Mayo Facility	SWAN (269.89)	1,305	1,584	1,280	1,395	1,680	375	96	400	0.06%	0.37%
7265811	Duke Energy Progress - H.F. Lee Steam Electric Plant	SWAN (171.04)	1,095	1,204	951	1,212	2,295	1,200	1,091	1,344	0.08%	0.10%
8048011	KapStone Kraft Paper Corporation	SWAN (172.52)	987	929	893	419	419	-568	-510	-474	0.03%	0.04%

EIS Facility ID	Facility	Distance to Nearest Class I Area (Km)	2017 (TPY)	2018 (TPY)	2019 (TPY)	2028 Original (TPY)	2028 Remodel (TPY)	2028 Remodel minus 2017 (TPY)	2028 Remodel minus 2018 (TPY)	2028 Remodel minus 2019 (TPY)	Nitrate AoI Contribution (%)	Sulfate + Nitrate AoI Contribution (%)
8506811	Carolina Stalite Company	LIGO (154.05)	708	590	617	853	853	145	263	236	0.01%	0.64%
8505111	Craven County Wood Energy	SWAN (94.24)	630	488	507	508	508	-122	20	1	0.18%	0.29%
8392811	Duke Energy Progress , Inc. - Asheville Steam Electric Plant	SHRO (22.86)	628	902	776	874	2,035	1,407	1,133	1,259	0.06%	0.00%
7980211	Weyerhaeuser NR Company Vanceboro Pulp	SWAN (86.80)	521	512	562	722	722	201	210	160	0.24%	0.98%
8137011	Owens-Brockway Glass Container Plt 6	LIGO (154.75)	431	435	599	527	527	96	92	-72	0.01%	0.20%
8298611	Cardinal Fg Flat Glass Plant	LIGO (110.33)	429	467	222	795	795	366	328	573	0.02%	0.23%
8311911	Nucor Steel Hertford	SWAN (114.17)	384	298	336	409	409	25	111	73	0.09%	0.28%
8010411	Saint-Gobain Containers	SWAN (155.6)	308	283	290	377	377	69	94	87	0.02%	0.17%
7377911	PPG Industries Fiber Glass Products, Inc.	LIGO (151.54)	128	112	98	198	198	70	86	100	0.00%	0.03%
7732911	Baxter Healthcare Corporation	LIGO (16.11)	125	124	132	124	124	-1	0	-8	0.18%	0.62%
8299711	Jackson Paper Manufacturing Company	SHRO (40.28)	101	106	107	119	119	18	13	12	0.07%	0.01%

Table 7-43. Controls, Operating Status, and Federal Rules for Duke Energy Facilities

					Federal Rules		
EIS ID	**Facility Name**	**SO_2 Controls**	**NO_x Controls**	**Operating Status (as of 2021) / Retirement Date**	**NSPS**	**MACT Part 63**	**PSD**
8370411	Duke Energy Carolinas, LLC - Marshall Steam Station	Units 1, 2, 4-wet FGD system, flue gas conditioning; Unit 3-wet FGD system	Units 1, 2, 4-SNCR and SOFA/LOFIR; Unit 3-SCR and SOFA/LOFIR	Operating. Based on Duke's 2020 Integrated Resource Plan (IRP) Projections, Units 1, 2, 3, and 4 are projected to be retired in 2035.	IIII, OOO, Y	6C, 5U, 4Z	Class-Major, Units 1, 2, 3, 4-PSD avoidance limit for PM/PM_{10}.
8300611	Duke Energy Carolinas, LLC - Cliffside Steam Station	Units 5, 6-wet FGD system and flue gas conditioning	Unit 5-SCR and ammonia injection; Unit 6-SCR	Operating, Unit 5 permitted to operate on NG, startup date=10/31/2018. Unit 6 permitted to co-fire NG, startup date=11/25/2018. Based on Duke's 2020 Integrated Resource Plan (IRP) Projections, Unit 5 is projected to be retired in 2026 and Unit 6 is projected to be retired in 2049.	Da, Db, IIII, OOO, Y	5D, 5U, 4Z	Class-Major, Unit 5, 6 and associated equipment for each unit-PSD avoidance limit for SO_2, NO_x
8137511	Duke Energy Carolinas, LLC - Allen Steam Station	Units 1, 2-Wet FGD system; Units 3, 4 and 5-Wet FGD system and flue gas conditioning	Units 1, 2, 3, 4, 5-SNCR	Operating, Coal unit 1 under EPA consent order to cease operation by Dec. 31, 2024; however, units 2, 3, and 4 were permanently shut-down in 2021. Based on Duke's 2020 IRP Projections, Unit 5 is projected to be retired in 2024.	Dc, IIII, JJJJ, OOO	5D, 5U, 4Z	Class-Major, Units 1, 2, 3, 4, 5-PSD avoidance limits for $PM/PM_{10}/PM_{2.5}$; dry flyash system-PSD avoidance limit for PM_{10}.
8392811	Duke Energy Progress , Inc. - Asheville Steam Electric Plant	Permanently shut down 2 coal boilers Jan. 29, 2020.		Operating, two coal boilers replaced by two NGCC units, unit 5 began commercial operation on August 8, 2019 and unit 7 began commercial operation on September 3, 2019.			

					Federal Rules		
EIS ID	**Facility Name**	**SO_2 Controls**	**NO_x Controls**	**Operating Status (as of 2021) / Retirement Date**	**NSPS**	**MACT Part 63**	**PSD**
7826011	Duke Energy Progress, LLC - Roxboro Steam Electric Plant	Units 1, 2, 3, 4-FGD system	Units 1, 2, 3, 4-SCR and low NO_x burners	Operating, Duke 2020 IRP Projections: Units 1 and 2 are projected to be retired in 2029. Units 3 and 4 are projected to be retired in 2028.	D, Db, IIII, OOO, Y	5U, 4Z	PSD Major, Units 4A, 4B-PSD avoidance for $PM/PM_{10}/PM_{2.5}$, SO_2, NO_x, VOC, CO, Pb and GHG as CO_2e.
7826111	Duke Energy Progress, LLC - Mayo Electric Generating Plant	Units 1a, 1b-FGD and sorbent injection	Units 1a, 1b-SCR	Operating, Duke 2020 IRP Projections: Unit 1 is projected to be retired in 2029.	D, OOO, Y	5U, 4Z	Class-Major, Unit 1A, 1B, PSD for SO_2, NO_x, PM, PSD avoidance limit for $PM_{2.5}$.
8514011	Duke Energy Carolinas, LLC - Belews Creek Steam Station	Units 1, 2-FGD and flue gas conditioning	Units 1, 2-SCR, low NO_x burner with OFA and ammonia injection	Operating, Duke 2020 IRP Projections: Units 1 and 2 are projected to be retired in 2039.	IIII, JJJJ, OOO	5D, 5U, 4Z	PSD Major, Units 1, 2-PSD avoidance limits for NO_x, PM/PM_{10} $/PM_{2.5}$, SO_2, HF, Pb and GHG as CO_2e; 2 NG-fired boilers and natural gas supply line heaters-PSD avoidance limits for CO and VOC; dry flyash handling project-PSD avoidance limits for PM; limestone rail unloading and handling operations-PSD avoidance limit for PM.

					Federal Rules		
EIS ID	**Facility Name**	**SO_2 Controls**	**NO_x Controls**	**Operating Status (as of 2021) / Retirement Date**	**NSPS**	**MACT Part 63**	**PSD**
7265811	Duke Energy Progress, LLC - H.F. Lee Steam Electric Plant		Units 1a, 1b, 1c-SCR; Unit 14-dry low NO_x combustor and water injection	Operating, Only NG emissions reported in 2019, Units 5, 6, 7 did not operate in 2019. Units 10, 11, 12, 13 did not report SO_2 emissions and have no controls reported.	Dc, GG, IIII, Kb, KKKK	5D, 5U, 4Y, 4Z	Class-Major, Units 10, 11, 12, 13-PSD for NO_x, SO_2, CO, VOC, PM/PM_{10} and sulfuric acid; Units 14-PSD avoidance limits for NO_x, SO_2, sulfuric acid and PM/PM_{10}; Units 1A, 1B, 1C-PSD avoidance limits for NO_x, SO_2, $PM/PM_{10}/PM_{2.5}$, CO, VOC, Sulfuric acid and Pb; flyash feed stock processing reactor-PSD avoidance limits for $PM/PM_{10}/PM_{2.5}$, CO, and VOC.

Table 7-44. Controls, Operating Status, and Federal Rules for Other Facilities

					Federal Rules		
EIS ID	Facility Name	SO_2 Controls	NO_x Controls	Operating Status (as of 2021)/ Retirement Date	NSPS	MACT Part 63	PSD
8298611	Cardinal FG Company	P01 glass melting furnace-Dry sorbent injection	P01 glass melting furnace-Ammonia injection	Operating.	CC, IIII	4Z	Status-Minor, P01-PSD avoidance limits for SO_2, CO, NO_x; Annealing lehr-PSD avoidance limit for SO_2.
8299711	Jackson Paper Manufacturing Company	PSD avoidance limit for SO_2		Operating.		6J	Status-Minor, JP-021 (boiler) - PSD avoidance limits for CO and SO_2
8506811	Carolina Stalite Company	Kilns 1, 3, 4, 5, 6-lime slurry injection; Kiln 2-lme slurry injection, pack bed scrubber; Kiln 17-lime slurry injection, packed-bed wet scrubber (NaOH sorbent)		Operating.	UUU	6C	Status-Major, ES-1 through ES-6 and ES-14 (kilns)-PSD for PM and SO_2.
8376711	Pilkington North America, Inc.	PSD avoidance limit for SO_2		Operating.		5D, 4Z	Status-Major, ES-2 consisting of a melter glass refiner and annealing lehr-PSD for PM and SO_2.
8122711	International Paper - Riegelwood Mill	No 2 and No 5 Power Boilers-Venturi scrubbers; Lime kiln 3, 4-wet scrubber venturi type	PSD avoidance limit for NO_x	Operating	BB, Kb	5D, MM, S, 4Z	Status-Major, No. 2 and No. 5 Power Boilers, No. 15 and 18 paper machines with dryers-PSD for PM_{10}, SO_2 and NO_x; lime kilns 3, 4-PSD avoidance limit for NO_x; 2 temporary package boilers-PSD avoidance limits for various pollutants including SO_2 and NO_x,

					Federal Rules		
EIS ID	**Facility Name**	**SO_2 Controls**	**NO_x Controls**	**Operating Status (as of 2021)/ Retirement Date**	**NSPS**	**MACT Part 63**	**PSD**
8048011	WestRock Kraft Paper, LLC. (formerly KapStone Kraft Paper Corporation)	No 1 Power Boiler-Venturi Scrubber	PSD avoidance limit for NO_x	Operating.	BB, Db, IIII	5D, MM, S, 4Z	Status-Major, No. 7 Recovery furnace-PSD avoidance limits for various pollutants including SO_2 and NO_x.
8010411	Ardagh Glass Inc. (formerly Saint-Gobain Containers)	Combustion sources subject to SO_2 emission limit in 15A NCAC 2D .0516	GF-1-Filtration system consisting of ceramic filter media with embedded catalyst	Operating.	CC, IIII	6S, 4Z	Status-Major, did not trigger PSD tracking for any pollutants. GF-1 subject to 15A NCAC 2D .0516 Sulfur Dioxide Emissions From Combustion Sources.
8504911	Marine Corps Air Station - Cherry Point	Combustion sources subject to SO_2 emission limit in 15A NCAC 2D .0516	Central Heating Plant Boilers 1-4 – low NO_x burners and flue gas recirculation	Operating. No controls on boilers.	Dc, IIII	Boiler-112J, DDDDD, GG, ZZZZ	Status-Major, 12 boilers and 95 emergency generators and fire pumps contribute over 95% of SO_2 emissions. All combustion sources subject to 15A NCAC 2D .0516 Sulfur Dioxide Emissions From Combustion Sources.
8137011	Owens-Brockway Glass Container Inc.	PSD avoidance limit for SO_2	PSD avoidance limit for NO_x	Operating.	IIII	6S, ZZZZ	Status-Major, three NG-fired furnaces and three NG-fired molten glass refiners-PSD avoidance limits or NO_x, SO_2 and $PM/PM_{10}/PM_{2.5}$.
8505111	Craven County Wood Energy, L.P.		PSD avoidance limit for NO_x	Operating.	Db	6J, ZZZZ	Status-Major, one biomass, NG, Propane and used oil-fired boiler and associated sources-PSD avoidance limits for PM/PM_{10}, VOC, CO, and NO_x.

					Federal Rules		
EIS ID	**Facility Name**	**SO_2 Controls**	**NO_x Controls**	**Operating Status (as of 2021)/ Retirement Date**	**NSPS**	**MACT Part 63**	**PSD**
8311911	Nucor Steel - Hertford	PSD avoidance limit for SO_2	PSD avoidance limit for NO_x	Operating.	AAa, Dc, IIII, JJJJ	6C, YYYYY, ZZZZ	Status-Major, Electric arc furnace, ladle metallurgy furnace, continuous slab caster and non-vented NG-fired combustion sources-PSD avoidance limits for PM_{10}/$PM_{2.5}$, SO_2, NO_x, CO and VOC.
7732911	Baxter Healthcare Corporation	PSD avoidance limit for SO_2	Wood-fired boiler-OFA	Operating.	Dc, IIII	6J, ZZZZ	Status-Minor, Wood-fired boiler, No.2 fuel oil-fired boiler, 7 No. 2 fuel oil-fired peak shaver generators, 2 NG/No. 2 fuel oil-fired boilers-PSD avoidance limits for PM, SO_2, NO_x and CO.
7980211	International Paper - New Bern Mill (formerly Weyerhaeuser NR Company Vanceboro Pulp)	No. 2 Power Boiler-Caustic Scrubber, chevron-type mist eliminator	PSD avoidance limit for NO_x	Operating.	BB, BBa, Db, IIII	DDDDD, MM, S, ZZZZ	Status-Major, No.1 power boiler-PSD avoidance limits for PM/PM_{10} filterable only, SO_2, and NO_x.
7377911	Electric Glass Fiber America, LLC (formerly PPG Industries Fiber Glass Products, Inc)	PSD avoidance limit for SO_2	PSD avoidance limit for NO_x	Operating.	CC	DDDDD, ZZZZ	Status-Major, Single level fiberglass furnace 502-PSD avoidance limits for PM/PM_{10}, Fluorides and SO_2; Double level fiberglass furnace 507-PSD avoidance limits for PM/ PM_{10}, Fluorides, NO_x, CO, Pb, and SO_2.

Table 7-45. Acronyms for Controls, Operating Status and Federal Rules for Duke Energy and Other Facility Tables

Acronym/Abbreviation	Description
FGD	Flue Gas Desulfurization
FSI	Furnace Sorbent Injection
LOFIR	LOwered FIRed Low NO_x Technology
MACT	Maximum Achievable Control Technology
MATS	Mercury and Air Toxics Standards
NCAC	North Carolina Administrative Code
NG	Natural Gas
NSPS	New Source Performance Standards
OFA	OverFire Air
ROFA	Rotating OverFire Air
SCR	Selected Catalytic Reduction
SNCR	Selected Non-Catalytic Reduction
SOFA	Separated OverFire Air
MACT (40 CFR 63) Subpart	
AA	National Emission Standards for Hazardous Air Pollutants from Phosphoric Acid Manufacturing Plants
BB	National Emission Standards for Hazardous Air Pollutants from Phosphate Fertilizers Production Plants
Boiler-112(j)	40 CFR 63.55(a) Maximum achievable control technology (MACT) determinations for affected sources subject to case-by-case determination of equivalent emission limitations.
CCCCCC/6C	National Emission Standards for Hazardous Air Pollutants for Source Category: Gasoline Dispensing Facilities
DDDDD/5D (Boiler MACT)	National Emission Standards for Hazardous Air Pollutants for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters
GG	National Emission Standards for Aerospace Manufacturing and Rework Facilities
H	National Emission Standards for Organic Hazardous Air Pollutants for Equipment Leaks
JJJJJJ/6J	National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers Area Sources
MM	National Emission Standards for Hazardous Air Pollutants for Chemical Recovery Combustion Sources at Kraft, Soda, Sulfite, and Stand-Alone Semichemical Pulp Mills
S	National Emission Standards for Hazardous Air Pollutants from the Pulp and Paper Industry

Acronym/Abbreviation	Description
SSSSSS/6S	National Emission Standards for Hazardous Air Pollutants for Glass Manufacturing Area Sources
UUUUU/5U (MATS)	National Emission Standards for Hazardous Air Pollutants: Coal- and Oil-Fired Electric Utility Steam Generating Units
YYYY/4Y	National Emission Standards for Hazardous Air Pollutants for Stationary Combustion Turbines
YYYYY/5Y	National Emission Standards for Aerospace Manufacturing and Rework Facilities
ZZZZ/4Z	National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines
NSPS (40 CFR 60) Subpart	
AAa	Standards of Performance for Steel Plants: Electric Arc Furnaces and Argon-Oxygen Decarburization Vessels Constructed After August 17, 1983
BB	Standards of Performance for Kraft Pulp Mills
BBa	Standards of Performance for Kraft Pulp Mill Affected Sources for Which Construction, Reconstruction, or Modification Commenced After May 23, 2013
CC	Standards of Performance for Glass Manufacturing Plants
D	Standards of Performance for Fossil-Fuel-Fired Steam Generators
Da	Standards of Performance for Electric Utility Steam Generating Units (Boilers)
Db	Standards of Performance for Industrial-Commercial-Institutional Steam Generating Units
Dc	Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units
GG	Standards of Performance for Stationary Gas Turbines
H	Standards of Performance for Sulfuric Acid Plants
IIII	Standards of Performance for Stationary Compression Ignition Internal Combustion Engines
JJJJ	Standards of Performance for Stationary Spark Ignition Internal Combustion Engines
Kb	Standards of Performance for Volatile Organic Liquid Storage Vessels Including Petroleum Storage Vessels
KKKK	Standards of Performance for Stationary Combustion Turbines
OOO	Standards of Performance for Nonmetallic Mineral Processing Plants
UUU	Standards of Performance for Calciners and Dryers in Mineral Industries
Y	Standards of Performance for Coal Preparation and Processing Plants

7.8 Evaluating Reasonable Progress using the Four Statutory Factors for Specific Emission Sources

Section 169A(g)(1) of the CAA and the RHR at 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.

Based on the PSAT modeling analysis (see Section 7.6), North Carolina selected a facility for reasonable progress evaluation if the facility was estimated to have ≥1.00% sulfate or ≥1.00% nitrate contribution to visibility impairment in 2028 in at least one of North Carolina's Class I areas. As a result, North Carolina identified the following three facilities for a reasonable progress assessment for sulfate based on the results presented in Section 7.7. The NCDAQ followed EPA's August 20, 2019, guidance in in evaluating the four statutory factors for the facilities in North Carolina selected for reasonable progress analysis as identified in Table 7-36.

<u>Shining Rock Wilderness Area</u>

- Blue Ridge Paper Products, LLC – Canton, NC (BRPP), Haywood County (Facility ID 7920511)

<u>Swanquarter Wilderness Area</u>

- Domtar Paper Company, LLC – Plymouth, NC (Domtar), Martin County, (Facility ID 8049311)
- PCS Phosphate Company, Inc. – Aurora, NC (PCS Phosphate), Beaufort County (Facility ID 8479311)

Based on PSAT modeling, no other facilities within North Carolina were identified to have ≥1.00% sulfate or ≥1.00% nitrate contribution to visibility impairment in 2028 in any of North Carolina's Class I areas nor Class I areas outside of North Carolina. In addition, no other state contacted the NCDAQ requesting a reasonable progress evaluation or four-factor analysis for a stationary source facility within North Carolina.

North Carolina also identified 12 facilities in eight states (AR, GA, IN, KY, MO, OH, PA, and VA) that were estimated to have ≥1.00% sulfate to visibility impairment in 2028 in at least one of North Carolina's Class I areas. The consultation process with the states is documented in Section 10 of this SIP.

7.8.1 Reasonable Progress Evaluation of North Carolina Facilities

For each of the three North Carolina facilities identified for a reasonable progress evaluation, the NCDAQ requested that the facility review the 2028 SO_2 emissions used to support the initial PSAT modeling based on the elv5 emissions inventory. Each facility reviewed the emissions and provided revisions. The NCDAQ updated the PSAT contribution based on a ratio of the modeled and revised emissions provided by the facility and determined that each facility's potential contribution to visibility impairment remained at ≥1.00% for SO_2 for at least one of

North Carolina's Class I areas. The NCDAQ then requested that each facility complete a four-factor analysis on the emission units that accounted for the majority of SO_2 emissions in 2016 and 2028. Table 7-46 identifies the facilities and their initial and revised PSAT contribution to the Class I area to which their potential contribution to visibility impairment in 2028 was ≥1.00% sulfate contribution.

Table 7-46. Initial PSAT Modeling Results Based on VISTAS 2028elv5 Emissions

		Initial 2028elv5		**2028elv5 Revised by Facility**	
Facility Name	**Class I Area**	**Inverse Megameters (Mm^{-1})**	**Percent Contribution**	**Inverse Megameters (Mm^{-1})**	**Percent Contribution**
BRPP	Shining Rock	0.133	1.08%	0.160	1.30%
Domtar	Swanquarter	0.109	1.00%	0.176	1.61%
PCS Phosphate	Swanquarter	0.329	3.02%	0.207	1.91%

Subsequently, the PSAT contributions were adjusted to account for issues imbedded in the modeled emissions for elv3 (see Appendix B of this SIP).[110] The revised PSAT contributions are shown in Table 7-47. This revised PSAT contributions did not change the selection of facilities for a reasonable progress assessment for North Carolina.

Table 7-47. Revised PSAT Modeling Results Based on 2028elv5 Modeled Emissions

		Initial		**Revised**	
Facility Name	**Class I Area**	**Inverse Megameters (Mm^{-1})**	**Percent Contribution**	**Inverse Megameters (Mm^{-1})**	**Percent Contribution**
BRPP	Shining Rock	0.133	1.13%	0.160	1.36%
Domtar	Swanquarter	0.109	1.06%	0.176	1.70%
PCS Phosphate	Swanquarter	0.329	3.20%	0.207	2.03%

The NCDAQ requested that each facility use the following five-step approach for each SO_2 emissions unit identified for a four-factor analysis to identify control measures with the highest level of control effectiveness that are both technically feasible and cost effective:

Step 1: Identify all control technologies;

Step 2: Eliminate technically infeasible options;

Step 3: Rank remaining control technologies by control effectiveness;

Step 4: Application of the four statutory factors (cost of compliance, time necessary for compliance, energy and non-air quality environmental impacts, and remaining useful life of existing source) to control technologies identified in Step 3 and document the results; and

[110] See Appendix B (Task 6 – Benchmark Run #7 Report Review and 2028 elv3 Reassessment) of the Task 3A report.

Step 5: Select control technology and control effectiveness.

For each of the three facilities, the following documents the initial and revised emissions for 2028, a description of the SO_2 emission units evaluated, a summary of control measures identified and eliminated from further consideration, a summary of the results of the four-factor analysis completed for each SO_2 control technically determined to be technically feasible, and the NCDAQ's decision on if additional controls are warranted (i.e., technically feasible and cost effective). Appendix G provides the correspondence between the NCDAQ and each facility and each facility's reasonable progress assessment and four-factor analysis.

7.8.1.1 Blue Ridge Paper Products, LLC (BRPP)

From 2017 to 2019, BRPP implemented SO_2 controls on existing processes and replaced two coal fired boilers with new natural gas fired boilers to comply with an SOC between the North Carolina Environmental Management Commission and BRPP. The controls were installed in part to comply with the boiler MACT but also to strengthen North Carolina's SIP for demonstrating compliance with the 2010 1-hour SO_2 standard for Beaverdam Township where the facility is located. The NCDAQ submitted a source specific SIP for this facility on (include date submitted) containing permitted allowable SO_2 limits for the more significant sources of SO_2 emissions. The EPA approved the source specific SIP on November 25, 2020.[111] The EPA has approved these permitted allowable SO_2 limits into the North Carolina SIP; therefore, making the limits permanent and federally enforceable. These limits are included in Table 7-48.

For the initial PSAT modeling, the NCDAQ estimated 2028 emissions as equal to 2019 actual emissions reflecting actual emissions after BRPP complied with the SOC. The initial PSAT modeling showed the facility contribution to visibility impairment at Shining Rock Wilderness Area to be 1.08% in 2028 for sulfate. BRPP provided revised 2028 emissions which were 78.4 tons more than the 2028 emissions upon which the initial PSAT modeling was based. The NCDAQ revised the PSAT contribution based on the ratio of the initial and revised 2028 emissions which increased BRPP's contribution to Shining Rock Wilderness Area from 1.08% to 1.30% in 2028. The NCDAQ identified the Riley Coal Boiler, No. 4 Power Boiler, and Riley Bark Boiler as the most significant sources of SO_2 emissions after BRPP implemented SO_2 controls from 2017 to 2019 and requested that BRPP complete a four-factor analysis of controls for the three emission units. Therefore, the NCDAQ requested that BRPP complete a four-factor analysis for the three emission units.

For each of the three emission units, Table 7-48 shows 2019, initial 2028, and revised 2028 SO_2 emissions. The table also shows total SO_2 emissions for the facility (upon which the initial PSAT modeling was conducted) and the total emissions for the three units as a percentage of total facility emissions. The three boilers accounted for about 90% of total facility emissions in 2016 and these boilers are estimated to account for 92% of total facility emissions in 2028.

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[111] Final Rule: Air Plan Approval; NC; Blue Ridge Paper SO_2 Emission Limits, 85 FR 74884, November 24, 2020, https://www.govinfo.gov/content/pkg/FR-2020-11-24/pdf/2020-25464.pdf.

Table 7-48. Summary of Annual SO_2 Emissions for BRPP

Unit	Federally Enforceable SO_2 Limit (lb/hr)	2019 Emissions (Tons)	Projected 2028 Emissions, Initial (Tons)	Projected 2028 Emissions, Revised (Tons)
Riley Coal Boiler	61.32	115.08	115.08	183.77
No. 4 Power Boiler	82.22	195.21	195.21	195.21
Riley Bark Boiler	68.00	55.07	55.07	64.75
Totals for 3 Units	-	365.36	365.36	443.73
Total Facility Emissions	-	405	405	483
Total Emissions for 3 units as a Percentage of Total Facility Emissions	-	90.2%	90.2%	91.8%

Description of SO_2 Emission Units

1. Riley Coal; ID No. G25, 399 MMBtu/hr: This unit is equipped with natural gas/kerosene ignitors and burns pulverized coal during normal operation. This unit is subject to boiler Maximum Achievable Control Technology (MACT) Subpart DDDDDD. It is equipped with an ESP and a wet scrubber. The unit and wet scrubber are operated to achieve an SO_2 control efficiency of 90%.

2. No. 4 Power Boiler; ID No. G66, 535 MMBtu/hr: This unit is equipped with natural gas startup burners and burns pulverized coal during normal operation. This unit is subject to boiler MACT Subpart DDDDDD and a New Source Performance Standard (NSPS) Sulfur limit of 1.2 lb SO_2/million BTU. It is equipped with an ESP and a wet scrubber. The unit and wet scrubber are operated to achieve an SO_2 control efficiency of 90%.

3. Riley Bark; ID No. G66: This unit is a hybrid suspension/grate design and burns a mixture of biomass and coal during normal operation at an average rate of 60% coal to 40% biomass. It is equipped with a wet scrubber that achieves about 90% control of SO_2 emissions.

Summary of Recent SO_2 Reductions and Visibility Impacts

From 2017-2019, BRPP significantly reduced actual SO_2 emissions by 93% (5,470 tons). The NCDAQ evaluated the SO_2 emission reductions the facility achieved from 2017-2019 and associated improvements in visibility at the Shining Rock Wilderness Area. As shown in Table 7-49, projected 2028 total visibility impairment -- anthropogenic and natural -- at the Shining Rock Wilderness Area is 39.658 Mm^{-1} (13.78 dv) for the 20% most impaired days. Based on PSAT modeling, the controls installed by the facility from 2017-2019 reduced the facility's visibility impairment impact at the Shining Rock Wilderness Area by about 92% (from 1.938 Mm^{-1} to 0.160 Mm^{-1} for sulfate, or 0.46 dv). This translates to an increase in the visible range of about 2.87 miles. This information is included solely as supplementary information and is not relied upon by the State for its conclusions as noted in Section 7.8.2.1.

Table 7-49. Summary of Visibility Impacts from BRPP on Shining Rock Wilderness Area for the 20% Most Impaired Days

	Projected BRPP 2028 Emissions Before Controls	Projected 2028 Emissions with Controls
Total Facility Emissions (tons)	5,875	485
Projected 2028 Facility-Specific Visibility Impairment to Shining Rock Wilderness Area (Mm^{-1})	1.938	0.160
Projected 2028 Total Visibility Impairment at the Shining Rock Wilderness Area (Mm^{-1})	39.658	37.88
Projected 2028 RPG at the Shining Rock Wilderness Area (dv)*	13.78	13.32
Visual Range (miles)*	61.11	63.98

* Represents projected 2028 total (anthropogenic and natural) visibility impairment computed using the IMPROVE Haze Metrics Converter (http://vista.cira.colostate.edu/Improve/haze-metrics-converter/).

Table 7-50 shows the impact of the SO_2 emission reductions for the Great Smoky Mountains National Park. Projected 2028 total visibility impairment -- anthropogenic and natural -- at the Great Smoky Mountains National Park is 45.95 Mm^{-1} (15.25 dv) for the 20% most impaired days. Based on PSAT modeling, the controls installed by the facility from 2017-2019 reduced the facility's visibility impairment impact at the Great Smoky Mountains National Park by about 92% (from 0.194 Mm^{-1} to 0.016 Mm^{-1} for sulfate, or 0.04 dv). This translates to an increase in the visible range of about 0.23 miles.

Table 7-50. Summary of Visibility Impacts from BRPP on the Great Smoky Mountains National Park for the 20% Most Impaired Days

	Projected BRPP 2028 Emissions Before Controls	Projected 2028 Emissions with Controls
Total Facility Emissions (tons)	5,875	485
Projected 2028 Facility-Specific Visibility Impairment to Great Smoky Mountains National Park (Mm^{-1})	0.194	0.016
Projected 2028 Total Visibility Impairment at the Great Smoky Mountains National Park (Mm^{-1})	45.95	45.75
Projected 2028 RPG at the Great Smoky Mountains National Park (dv)*	15.25	15.21
Visual Range (miles)*	52.74	52.97

* Represents projected 2028 total (anthropogenic and natural) visibility impairment computed using the IMPROVE Haze Metrics Converter http://vista.cira.colostate.edu/Improve/haze-metrics-converter/).

Control Technology Evaluation

Table 7-51 identifies the control technologies identified and evaluated for technical feasibility for controlling SO_2 emissions for the Riley Coal Boiler, No. 4 Power Boiler, and Riley Bark Boiler.

Table 7-51. BRPP's Boiler Control Technologies Identified and Evaluated for Technical Feasibility

Control Technology	Feasible	Explanation
Convert to natural gas	No	Insufficient local/regional supply to fuel any of the three boilers.
Convert to biomass	No	For the Riley Coal and No. 4 Power Boilers, the boiler designs preclude replacing coal with biomass.
Wet scrubber	No	Wet scrubbers with 90% control efficiency already installed on all three boilers. It was considered technically infeasible to add additional caustic to exceed the design limitations of the scrubbers. In the case of the Riley Coal Boiler, increasing the pH would increase scaling and plugging of the scrubber, reducing its effectiveness and availability.
Convert coal to ultra-low sulfur diesel (ULSD)	Yes	Completed four-factor analysis for all three boilers.
Dry sorbent injection (DSI)	Yes (for 2 units)	Completed four-factor analysis for Riley Coal and No. 4 Power Boilers. Considered infeasible for Riley Bark Boiler because this unit does not have any dry control device for PM. Adding DSI would overload the wet scrubber and increase PM emissions.
Convert Riley Bark Boiler to 100% biomass	No	The design of the over-fire air system as well as the size and limited potential for expansion of the biomass storage, delivery and feed systems prevent the firing of 100% biomass. Co-firing coal also promotes stable boiler operation and more uniform and efficient combustion because the biomass characteristics (moisture content, size and shape, etc.) can exhibit short-term variability, impacting boiler efficiency.

Four-Factor Analysis

Replacing Coal with Ultra-Low Sulfur Diesel (ULSD) Conversion

1. Cost of compliance – Based on information provided by Blue Ridge Paper, the cost per ton of SO_2 removed by switching to ULSD for the 3 boilers ranged from \$126,060 to \$185,565 (see Table 7-52). This analysis did not include the capital cost of installing ULSD burners and relies solely on the current price difference between ULSD and coal as well as the projected amount of coal to be burned in the units in 2028.
2. Time necessary for compliance – At least three years, due to corporate funding approval, permitting, re-engineering, and planned outage scheduling.
3. Remaining useful life of source – Twenty-five years or more.
4. Energy and non-air quality environmental impacts – No significant impacts.

Table 7-52. ULSD Conversion Cost-Effectiveness Calculation for BRPP Boilers

	Riley Coal Boiler	No. 4 Power Boiler	Riley Bark Boiler
Annualized Cost for Coal Firing	$8,541,000	$12,914,965	$4,863,578
Annualized Cost for Equivalent ULSD Firing Cost	$31,461,384	$45,069,344	$15,068,975
Annualized Cost Difference	$22,920,384	$32,154,379	$10,205,397
Annual Emission Reduction	181.82 tons	192.42 tons	55.00 tons
Cost-effectiveness	$126,060/ton	$167,107/ton	$185,565/ton

<u>Trona DSI Conversion</u>

1. Cost of compliance – Dry sorbent injection (DSI) in the form of trona injection prior to the dry PM control device was evaluated for the units equipped with ESPs (Riley Coal and No. 4 Power Boiler). This evaluation cites a 2017 Sargent and Lundy report which indicates that 50% SO_2 control can be achieved by injecting trona ahead of the ESP without increasing PM emissions. The cost of removing the SO_2 in this way was calculated to be $13,477 for the Riley Coal boiler and $14,752 for the No. 4 Power boiler (see Table 7-53).
2. Time necessary for compliance – At least three years, due to corporate funding approval, permitting, re-engineering, and planned outage scheduling.
3. Remaining useful life of source – Twenty-five years or more.
4. Energy and non-air quality environmental impacts – Adding DSI would increase energy usage as well as PM emissions from materials handling and landfill operations. It would also decrease the useful life of the mill landfill and increase truck traffic on local streets.

Table 7-53. DSI System Cost-Effectiveness Calculation for BRPP Boilers

	Riley Coal Boiler	No. 4 Power Boiler
Capital Cost	$5,413,330	$5,404,505
Annualized Cost	$1,372,032	$1,573,329
Annual Emission Reduction	91.9 tons	97.6 tons
Cost-effectiveness	$13,477/ton	$14,752/ton

Table 7-54 provides a summary of the costs-effectiveness of ULSD conversion and trona DSI controls for the Riley Coal and No. 4 Power Boilers and ULSD conversion for the Riley Bark Boiler.

Table 7-54. Summary of Four-Factor Analysis Results for BRPP Boilers

Unit	2028 Emissions (tons SO_2)	Control Technology	SO_2 Reduction (%)	Cost Effectiveness of Control ($/ton SO_2)
Riley Coal Boiler	183.77	ULSD Conversion	99%	$126,061
		Trona DSI	50%	$13,477
No. 4 Power Boiler	195.21	ULSD Conversion	99%	$167,105
		Trona DSI	50%	$14,752
Riley Bark Boiler	64.75	ULSD Conversion	85%	$185,553

The assumptions made when calculating the capital recovery factors include an interest rate of 3.25% and 30 years remaining useful life of the control. The calculations were done using 2020 dollars.

Over the past 3 years (2017 through 2019), BRPP has completed significant capital investments in boilers and recovery furnaces (including new emissions controls) that have significantly reduced SO_2 emissions by 93% (5,470 tons). These emissions units were chosen for emissions reductions because they had a more significant modeled impact on compliance with the SO_2 NAAQS than other emission units at the mill. Much of the SO_2 emission reductions have occurred during the past 2 years, during which time the facility reduced emissions by 86% (2,497 tons). These emissions reductions have been made federally enforceable through inclusion in the site-specific SIP for BRPP.

7.8.1.2 Domtar

The NCDAQ requested that Domtar complete a reasonable progress assessment for the hog fuel boilers at its Plymouth, North Carolina facility. Table 7-55 shows 2016 base year SO_2 emissions, initial 2028 projected emissions upon which the initial PSAT and final RPG modeling is based, and revised 2028 emissions provided by the facility used to prepare the revised PSAT contributions to visibility impairment to the Swanquarter Wilderness Area. The facility has altered usage of No. 1 Hog Fuel Boiler to preclude firing of non-condensible gases (NCGs); therefore, revised 2028 emissions for this unit are projected based on the current configuration as of 2020. The two boilers accounted for over 98% of total facility emissions in 2016 and the No. 2 Hog Fuel Boiler is estimated to account for 91% of total facility emissions in 2028.

Table 7-55. Summary of Annual SO_2 Emissions for Domtar

Unit	2016 Emissions (tons)	Projected 2028 Emissions, Initial (tons)	Projected 2028 Emissions, Revised (tons)
No. 1 Hog Fuel Boiler	174.83	167.84	12.00
No. 2 Hog Fuel Boiler	526.28	505.23	1,009.57
Total Emissions for 2 Units	701.11	673.07	1,021.57
Total Facility Emissions	715.26	687.45	1,120.41
Total Emissions for 2 units as a Percentage of Total Facility Emissions	98%	98%	91%

Description of SO_2 Emission Units

1. No. 1 Hog Fuel Boiler; 1,021 MMBtu/hr (any combination of fuels) or 835 MMBtu/hr (hog fuel with any other fuels). This unit is permitted to burn lignin, natural gas, biomass, no.2 fuel oil, used oil, or sludge. It is controlled for PM by electroscrubbers and for SO_2 by low-sulfur fuels and inherent bark scrubbing. This unit is subject to MACT Subpart DDDDD and NSPS Subpart D. This unit is permitted to combust high-volume low-concentration (HVLC) pulp mill gases but cannot currently do so because the supply lines have been physically severed. The

plant intends to maintain this disconnection indefinitely. Since the boiler now burns only low-sulfur fuels, it is no longer a significant source of SO_2 emissions. These fuel restrictions and emissions decreases are not state or federally enforceable, but they can be used to inform a reasonable projection of the actual emission level for 2028. For this reason, No. 1 Hog Fuel Boiler is considered to be effectively controlled for SO_2 and was not included in the four-factor analysis evaluation.

To reduce emissions to meet the requirements of the Boiler MACT, the mill has transitioned the No. 1 Hog Fuel Boiler to fire primarily natural gas and No. 2 fuel oil while discontinuing combustion of HVLC at this boiler and has upgraded the PM control device on the No. 2 Hog Fuel Boiler as part of a plant optimization project. As a result of this optimization project, the No. 1 Hog Fuel Boiler is no longer a significant source of SO_2.

2. No. 2 Hog Fuel Boiler; 889 MMBtu/hr. This unit is permitted to burn lignin, natural gas, biomass, No.2 fuel oil, used oil, or sludge. It is controlled for PM by ESP and for SO_2 by low-sulfur fuels and inherent bark scrubbing. This unit is subject to MACT Subpart DDDDD and NSPS Subpart D. A primary use of this unit is to combust HVLC and low-volume high-concentration (LVHC) pulp mill gases as well as stripper off-gases (SOG) to satisfy the HAP control requirements of 40 CFR 63 Subpart S. As a backup control of HVLC gas, the plant has installed a Thermal Oxidizer in 2019 which operates only when the No. 2 Hog Fuel Boiler is unavailable for HVLC control. Average emissions from the Thermal Oxidizer are 47 tons SO_2/year.

No. 1 Hog Fuel Boiler Demonstration that Current Measures Are Not Necessary for Reasonable Progress

Section 4.1 of the July 8, 2021 EPA regional haze clarification memo[112] states, "Specifically, if a state can demonstrate that a source will continue to implement its existing measures and will not increase its emission rate, it may not be necessary to require those measures under the regional haze program in order to prevent future emission increases." No. 1 Hog Fuel Boiler has been disconnected from the HVLC collection system and is no longer a primary control device for those gases. It did not operate at all in 2020, and in any future operation it is expected to fire natural gas or biomass. Projected 2028 emissions for this unit are 12 tons of SO_2 based on the conservative assumption of a 100% biomass-fired operating scenario. Projected 2028 emissions for No. 1 Hog Fuel Boiler are based on the maximum annual firing rate of the boiler on biomass (835 MMBtu/hr, 8,760 hr/yr) and the SO_2 median emission factor from Table 10.4 of National Council for Air and Stream Improvement (NCASI) Technical Bulletin 1020 (3.18E-03 lb/MMBtu), representing the fuel that results in the highest annual SO_2 emissions. This rate is far below the permit emissions limits of 2.3 lb/MMBtu and 0.8 lb/MMBtu.

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[112] U.S. EPA guidance memorandum, "Clarifications Regarding Regional Haze State Implementation Plans for the Second Implementation Period", July 8, 2021, https://www.epa.gov/system/files/documents/2021-07/clarifications-regarding-regional-haze-state-implementation-plans-for-the-second-implementation-period.pdf.

Table 7-56 contains emissions and emission rate data for the boiler from 2015 through 2020. It is evident from the steep decline in 2019 following disconnection of HVLC lines that the current and future SO_2 emissions from this unit are expected to be insignificant. Because the unit is expected to produce SO_2 emissions well below its historical emissions and existing permit limits for the duration of the second planning period and beyond, no active measures are necessary to make reasonable progress for this unit.

Table 7-56. Domtar No. 1 Hog Fuel Boiler Historical Emissions and Emission Rates

	2015	2016	2017	2018	2019	2020	2028 (expected)
Emissions (tons)	183.89	174.83	200.10	223.12	58.22	0.00	12.00
Emissions rate (lb/MMBtu)	0.114	0.114	0.114	0.114	0.063	0.00	0.00318

No. 2 Hog Fuel Boiler Control Technology Evaluation

Table 7-57 identifies the control technologies identified and evaluated for technical feasibility for controlling SO_2 emissions for the No. 2 Hog Fuel Boiler. The No.1 Hog Fuel Boiler was not included in the control technology evaluation because it is currently equipped to burn only natural gas and biomass, with No. 2 fuel oil as a backup fuel, all of which are low sulfur fuels. Domtar intends to retain the unit in case there is a need for additional steam in the future. This informed the conservative estimate of 12 tons of SO_2 emissions in 2028.

Table 7-57. Domtar No. 2 Hog Fuel Boiler Control Technology Identified and Evaluated for Technical Feasibility

Control Technology	Feasible	Explanation
Low-sulfur fuels	No	The boiler is permitted to burn natural gas, No. 2 fuel oil, and biomass are low-sulfur fuels. However, an important function of the boiler is to burn high-sulfur fuels (i.e., HVLC, LVHC, and SOG) to comply with the HAP control requirements of 40 CFR 63 Subpart S.
Wet scrubber	Yes	Completed four-factor analysis.
Dry sorbent injection (DSI)	Yes	Completed four-factor analysis.

Four-Factor Analysis

<u>Wet Scrubber Installation</u>

1. Cost of compliance – Citing a capital cost exceeding $14 million and a cost-effectiveness value of $3,660/ton of SO_2 removed (see Table 7-58). The assumptions made when calculating the capital recovery factor include an interest rate of 3.25% and 30 years remaining useful life of the control. The calculation was done using 2020 dollars.
2. Time necessary for compliance – At least three years, due to corporate funding approval, permitting, re-engineering, and planned outage scheduling.

3. Remaining useful life of source – The No. 2 Hog Fuel Boiler has a remaining useful life of twenty years or more.
4. Energy and non-air quality environmental impacts – Additional electricity and water would be needed to run a wet scrubber and additional fan power would be required overcome the additional pressure drop through the wet scrubber. Other environmental and energy impacts associated with operating a wet scrubber include generation and disposal of wastewater.

Dry Sorbent Injection with Trona

1. Cost of compliance – Citing a capital cost exceeding \$13 million and a cost-effectiveness value of \$22,092/ton of SO_2 removed (see Table 7-58). The assumptions made when calculating the capital recovery factor include an interest rate of 3.25% and 30 years remaining useful life of the control. The calculation was done using 2020 dollars.
2. Time necessary for compliance – At least three years, due to corporate funding approval, permitting, re-engineering, and planned outage scheduling.
3. Remaining useful life of source – The No. 2 Hog Fuel Boiler has a remaining useful life of twenty years or more.
4. Energy and non-air quality environmental impacts – Additional electricity would be needed to operate a DSI system, and it would create additional solid waste.

Table 7-58. Cost-Effectiveness of Controls for No. 2 Hog Fuel Boiler

	Wet Scrubber	Dry Sorbent Injection
Year of Dollars	2020	2020
Capital Cost	\$14,527,766	\$13,813,979
Annualized Cost	\$3,509,946	\$11,151,907
SO_2 Reduction (%)	95%	50%
Annual Emission Reduction	959.1 tons	504.8 tons
Cost-effectiveness	\$3,660/ton	\$22,092/ton

The NCDAQ evaluated the SO_2 emission reductions and associated improvements in visibility at the Swanquarter Wilderness Area associated with the wet scrubber control option for the No. 2 Hog Fuel Boiler. This information is included solely as supplementary information and is not relied upon by the State for its conclusions as noted in Section 7.8.2.2. As shown in Table 7-59, projected 2028 total visibility impairment -- anthropogenic and natural -- at the Swanquarter Wilderness Area is 46.107 Mm^{-1} (15.28 dv) for the 20% most impaired days. Based on PSAT modeling, use of a wet scrubber on the No. 2 Hog Fuel Boiler to reduce SO_2 emissions by 95% reduction would reduce the facility's visibility impairment impact at the Swanquarter Wilderness Area by about 86% (from 0.176 Mm^{-1} to 0.024 Mm^{-1} for sulfate). However, the reduced emissions would only improve the visibility index by 0.03 dv and visual range by about 0.16 mile because the facility's relative impact to total visibility impairment at the Swanquarter Wilderness Area is very low (i.e., 0.176/46.107 Mm^{-1} or 0.38% of total impairment). The wet scrubber would reduce the facility's contribution to total impairment by only 0.152 Mm^{-1} (0.33%).

Table 7-59. Summary of Visibility Impacts from Domtar for 20% Most Impaired Days

	Projected Domtar 2028 Emissions Without Additional Controls	Projected 2028 Emissions with Wet Scrubber Installed on No. 2 Hog Fuel Boiler
Total Facility Emissions (tons)	1,108.41	149.32
Projected 2028 Facility-Specific Visibility Impairment to Swanquarter Wilderness Area (Mm^{-1})	0.176	0.024
Projected 2028 Total Visibility Impairment at the Swanquarter Wilderness Area (Mm^{-1})	46.107	45.955
Projected 2028 RPG at the Swanquarter Wilderness Area (dv)*	15.28	15.25
Visual Range (miles) *	52.58	52.74

* Represents projected 2028 total (anthropogenic and natural) visibility impairment computed using the IMPROVE Haze Metrics Converter (URL: http://vista.cira.colostate.edu/Improve/haze-metrics-converter/).

7.8.1.3 PCS Phosphate

The NCDAQ requested that PCS Phosphate complete a reasonable progress assessment for each of the three sulfuric acid plants at its Aurora, North Carolina facility. Table 7-60 shows 2016 base year SO_2 emissions, initial 2028 projected emissions upon which the initial PSAT and final RPG modeling is based, and revised 2028 emissions provided by the facility used to prepare the revised PSAT contributions to visibility impairment to the Swanquarter Wilderness Area. The three sulfuric acid plants accounted for over 97% of total facility emissions in 2016 and are estimated to account for 94% of total facility emissions in 2028.

Table 7-60. Summary of Annual SO_2 Emissions for PCS Phosphate

Unit	2016 Emissions (tons)	Projected 2028 Emissions, Initial (tons)	Projected 2028 Emissions, Revised (tons)
Sulfuric Acid Plant No. 5	1,609	1,495	792
Sulfuric Acid Plant No. 6	1,818	1,689	852
Sulfuric Acid Plant No. 7	1,607	1,493	1,232
Total Emissions for 3 Acid Plants	5,033	4,677	2,876
Total Facility Emissions	5,193.68	4,845.90	3,044.89
Total Emissions for 3 units as a Percentage of Total Facility Emissions	97%	97%	94%

Description of SO_2 Emission Units

Three dual-absorption sulfuric acid plants (Nos. 5, 6, and 7): sulfur dioxide is formed at the sulfuric acid plants when elemental sulfur is oxidized in the presence of oxygen at elevated temperature in a horizontal spray-type burner. The SO_2 is converted to sulfur trioxide (SO_3). The percentage of SO_2 that is converted to SO_3 increases through each pass through a catalytic conversion system, such that well over 99% of SO_2 gases passing through the converter system are converted to SO_3. The converted SO_3 passes through a series of absorption towers containing water to produce concentrated sulfuric acid. Minimization of SO_2 emissions is achieved by increasing the amount of conversion of SO_2 to SO_3. Catalyst is typically replaced on a three-year cycle to maintain desired conversion rates.

Summary of Recent SO_2 Reductions and Visibility Impacts

To satisfy New Source Review (NSR) requirements at certain sulfuric acid plants, PCS Phosphate entered into a federal consent decree with EPA and Louisiana Department of Environmental Quality to reduce SO_2 emissions at several of the company's facilities including the facility located in Aurora, North Carolina.[113] In response to the consent decree, from 2017-2019, PCS Phosphate implemented significant upgrades to enhance the SO_2 conversions in the catalytic systems on Sulfuric Acid Plants Nos. 5, 6 and 7 pursuant to air quality permitting completed in 2015 at its Aurora, North Carolina facility. These upgrades included utilization of enhanced catalyst and significant increases to the surface area available for reaction in certain passes of the catalytic systems. The NCDAQ has revised the Title V permit (Permit No. 04176T62) for the facility to include the SO_2 emission limits for the three acid plants that PCS established with EPA per the consent decree. The Title V permit prohibits relaxation of these emissions limits after the consent decree has been terminated and specifies that the limits are federally enforceable.

PCS conducted an evaluation of emissions before and after the catalyst upgrades made between 2017 and 2019. Significant SO_2 emission reductions were realized by all three plants as shown in Table 7-61. Continuous emission monitoring system (CEMS) records before and after the catalyst system upgrades show a reduction of SO_2 (on a basis of lb SO_2/ton acid produced) of 63%, 51%, and 24% in Plants 5, 6 and 7, respectively. Plant 7 had already implemented aspects of the enhanced system, which accounts for this plant having the lowest reduction. The resulting emission rate for each plant is 1.1, 1.2, and 1.2 lb SO_2/ton acid, respectively. The average emissions from all three sulfuric acid plants over the first six months following changeouts were approximately 70% below the NSPS limit.

[113] PCS Subsidiaries - PCS Nitrogen Fertilizer, L.P., AA Sulfuric, Inc., and White Springs Agricultural) Chemicals, Inc. (Case No. 3:14-cv-00707-BAJ-SCR), November 6, 2014). The consent decree is available at U.S. EPA's website at: https://www.epa.gov/enforcement/pcs-nitrogen-fertilizer-clean-air-act-settlement.

Table 7-61. Catalyst Performance Before and After Upgrades for Acid Plants at PCS Phosphate

Description	Emissions ($lb\ SO_2$/ton acid)			% Lower than NSPS (4 lb SO_2/ton acid)		
	Plant 5	Plant 6	Plant 7	Plant 5	Plant 6	Plant 7
180-Day Average Following Standard Turnaround	3.0	2.5	1.6	24%	36%	61%
180-Day Average Following Upgrade Turnaround	1.1	1.2	1.2	72%	69%	70%
Emissions Reduction from Upgrade	63%	51%	24%			

Relative to the NCDAQ's original 2028 emissions projections, these capital improvements decreased 2028 SO_2 emissions by 39% (1,801 tons) for the three sulfuric acid plants combined or by 37% for the entire facility. As shown in the Table 7-62, projected 2028 total visibility impairment -- anthropogenic and natural -- at the Swanquarter Wilderness Area is 46.107 Mm^{-1} (15.28 dv) for the 20% most impaired days. Based on PSAT modeling, the controls installed by the facility reduced the facility's visibility impairment impact at the Swanquarter Wilderness Area by about 37% (from 0.329 Mm^{-1} to 0.207 Mm^{-1} for sulfate, or 0.02 dv). However, the reduced emissions would only improve the visibility index by 0.02 dv and visual range by about 0.11 mile because the facility's relative impact to total visibility impairment at the Swanquarter Wilderness Area is very low (i.e., 0.329/46.107 Mm^{-1} or 0.71% of total impairment). Thus, the controls installed from 2017-2019 are estimated to reduce the facility's contribution to total impairment by only 0.122 Mm^{-1} (0.26%). This information is included solely as supplementary information and is not relied upon by the State for its conclusions as noted in section 7.8.2.3.

Table 7-62. Summary of Visibility Impacts from PCS for 20% Most Impaired Days for PCS Phosphate

	Original Projected 2028 Emissions	Projected 2028 Emissions with Upgraded Controls
Total Facility Emissions (tons)	4,845.90	3,044.89
Projected 2028 Facility-Specific Visibility Impairment to the Swanquarter Wilderness Area (Mm^{-1})	0.329	0.207
Projected 2028 Total Visibility Impairment at the Swanquarter Wilderness Area (Mm^{-1})	46.107	45.985
Projected 2028 RPG at the Swanquarter Wilderness Area (Mm^{-1})*	15.28	15.26
Visual Range (miles)*	52.58	52.69

* Represents projected 2028 total (anthropogenic and natural) visibility impairment computed using the IMPROVE Haze Metrics Converter (URL: http://vista.cira.colostate.edu/Improve/haze-metrics-converter/).

The PSAT modeling based on projected 2028 SO_2 emissions after the installation of controls from 2017-2019 indicated that the facility's sulfate contribution was ≥1.00% relative to all other point source facilities included in the VISTAS modeling domain. Therefore, the NCDAQ identified the three sulfuric acid plants as the most significant remaining sources of SO_2 emissions and requested that PCS Phosphate complete a four-factor analysis of controls for the three emission units. The three acid plants account for about 97% of total facility SO_2 emissions in 2016 and the are estimated to account for about 94% of total facility emissions in 2028.

Control Technology Evaluation

Table 7-63 identifies the control technologies identified and evaluated for technical feasibility for controlling SO_2 emissions from each of the three sulfuric acid plants which would have the potential to provide incremental SO_2 reductions beyond those already achieved via the catalysts upgrade. PCS was unable to identify any technically feasible control technologies. The facility opted to submit an evaluation of its recently-installed controls (dual absorption process with cesium catalyst) in the framework of a four-factor analysis, though this was not required and does not represent an applicable control measure for additional reductions during the second planning period.

Table 7-63. PCS's Sulfuric Acid Plant Control Technologies Identified and Evaluated for Technical Feasibility

Control Technology	Technically Feasible	Explanation
Sodium sulfite-bisulfite scrubbing	No	Has not been demonstrated commercially as providing reliable emissions control at a sulfur-burning sulfuric acid manufacturing plant.
Molecular sieve	No	Has not been commercially demonstrated, so it was considered technically infeasible for reducing SO_2 emissions in this application.
Ammonia scrubbing	No	Commercially undemonstrated on dual absorption plants because (1) many similar projects across the country have been shut down due to operational difficulties, and (2) it is unknown whether additional control of SO_2 emissions would be achieved by a retrofit with this type of system.

7.8.2 Summary and Conclusions

The following discusses the basis for the NCDAQ's conclusions regarding the results of the four-factor analysis for each of the three facilities.

7.8.2.1 <u>BRPP</u>

Based on the four-factor analysis, BRPP identified no cost-effective control measures to further reduce SO_2 emissions for the three boilers evaluated. Thus, given that the facility has already significantly reduced its SO_2 emissions at the beginning of the second implementation period, the NCDAQ concludes additional controls are not needed for the purpose of remedying any existing anthropogenic visibility impairment at the Shining Rock Wilderness Area. To prevent any future anthropogenic visibility impairment at the Shining Rock Wilderness Area, EPA has previously adopted existing SO_2 measures for the Riley Coal Boiler, No. 4 Power Boiler, and Riley Bark Boiler into the SIP at 40 CFR 52.1770(d) as "EPA-Approved North Carolina Source-Specific Requirements." Therefore, the NCDAQ requests that EPA accept this action as fulfilling the requirements of Section 169A(b)(2) of the CAA.

7.8.2.2 Domtar

To determine the measures necessary for reasonable progress for the two hog fuel boilers at Domtar, each boiler was evaluated independently because they are operated differently. A four-factor analysis was not performed on the No. 1 Hog Fuel Boiler, because SO_2 emissions have dropped to very low levels from 2019 onward following the disconnection NCG supply lines to the unit. The boiler was not operated in 2020 and is expected to be operated infrequently, if at all, in the foreseeable future. If operated, the boiler is configured to burn only natural gas or biomass. Emissions from this unit are not expected to exceed 12 tons of SO_2 annually in its current configuration. Based on these projections, the NCDAQ has provided a demonstration in Section 7.8.1.2 showing that current measures in place at the boiler are not necessary for reasonable progress.

In its four-factor analysis of the No. 2 Hog Fuel Boiler, Domtar identified the use of a wet scrubber and DSI as technically feasible SO_2 control options and completed a four-factor analysis for each option. The wet scrubber was estimated to achieve 95% reduction in SO_2 emissions at $3,660 per ton of SO_2 reduction (based on 2020 dollars). The DSI option was estimated to achieve 50% reduction in SO_2 emissions at $22,092 per ton of SO_2 reduction (based on 2020 dollars). The NCDAQ has determined that there are no cost-effective control measures available based on the results of the four-factor analysis, and additional controls are not needed for the purpose of remedying any existing anthropogenic visibility impairment at the Swanquarter Wilderness Area for the second planning period. For the purpose of preventing any future anthropogenic visibility impairment at the Swanquarter Wilderness Area, the NCDAQ is proposing that the existing measures be adopted into the SIP as presented in Section 7.8.3.1 as required by Section 169A(b)(2) of the CAA.

7.8.2.3 PCS Phosphate

Based upon the four-factor analysis, PCS Phosphate identified no technically feasible control measures to further reduce SO_2 emissions for the three sulfuric acid plants evaluated. Thus, given that the facility has already significantly reduced its SO_2 emissions at the beginning of the second implementation period, the NCDAQ concludes additional controls are not available for the purpose of remedying any existing anthropogenic visibility impairment at the Swanquarter Wilderness Area. For the purpose of preventing any future anthropogenic visibility impairment at the Swanquarter Wilderness Area, the NCDAQ is proposing that the existing measures for Sulfuric Acid Plant No. 5, No. 6, and No. 7 be adopted into the SIP as presented in Section 7.8.3.2 as required by Section 169A(b)(2) of the CAA.

7.8.3 Materials Proposed for Adoption into the Regulatory Portion of the North Carolina SIP

7.8.3.1 Domtar

Per Section 169A(b)(2) of the CAA, the NCDAQ requests that EPA adopt into the regulatory portion of the North Carolina SIP the following portions of Section 2.1 A. from Permit 04291T50 to include the SO_2 emission rate limitations; and monitoring, recordkeeping, and reporting requirements for the No. 2 Hog Fuel Boiler at the Domtar Paper Company (Domtar) in Plymouth, North Carolina. The facility has already demonstrated compliance and shall continue to demonstrate compliance with the SO_2 requirements in Sections 2.1 A.4, 2.1 A.6, and 2.1 A.7. The portions of the federally enforceable permit referenced are conditions developed to demonstrate compliance with SIP approved rules in the North Carolina Administrative Code. While not requesting that EPA include the *entire* permit in the SIP, a copy of Permit 04291T50 is included in Appendix G-2 for reference only. The NCDAQ requests that EPA adopt into the regulatory portion of the SIP the following permit conditions written in *italics*. The NCDAQ requests that EPA exclude from the regulatory portion of SIP text marked in ~~strikethrough~~.

- ***Section 2.1 A.4.* – Sulfur Dioxide Emissions from Combustion Sources -** The following emission sources and emission limitations from Section 2.1 A.4.:
  - ~~*a.*~~ *Emissions of sulfur dioxide when firing wood or natural gas in the No*~~*s*~~*.* ~~*1 and*~~ *2 Hog Fuel Boiler*~~*s*~~ *(ID No*~~*s*~~*.* ~~*ES-64-25-0290 and*~~ *ES-65-25-0310) shall not exceed 2.3 pounds per million Btu heat input. Sulfur dioxide formed by the combustion of sulfur in fuels, wastes, ores, and other substances shall be included when determining compliance with this standard, and shall include the sulfur dioxide formed by the combustion of sulfur-containing gases* ~~*in the:*~~
    - ~~*i. HVLC Gas Collection System identified in Section 2.1 J;*~~
    - ~~*ii. LVHC Gas Collection System identified in Section 2.1 K (when burned No. 2 Hog Fuel Boiler);*~~
    - ~~*iii. SOG Collection System identified in Section 2.1 L (when burned in the No. 2 Hog Fuel Boiler);*~~
    - ~~*iv. LSRP Sources (ID Nos. ES-09-27-1100, ES-09-27-1200, ES-09-27-1400, ES-09-27-1800, ES-09-27-2000, ES-09-27-2100, ES-09-27-2300, ES-09-27-2400, ES-09-27-2500, ES-09-27-2600, ES-09-27-2610, ES-09-27-2620, ES-09-27-2660, ES-09-27-2700, ES-09-27-2770, ES-09-27-2800, ES-09-27-3200) prior to startup of normal operations of the two-phased packed tower caustic scrubber (ID No. CD-09-27-3800) as specified in Section 2.1 Q.1 below*~~
    - ~~*v. LSRP Sources (ID Nos. ES-09-27-1400, ES-09-27-2700, ES-09-27-2770) after startup of normal operation of the two-phased packed bed scrubber (ID No. CD-09-27-3800) as specified in Section 2.1 T.1 below*~~

Monitoring and Recordkeeping – To ensure the SO_2 emission limitations in Section 2.1 A.4.a will not be exceeded, the Permittee shall be subject to the following requirements from Section 2.1 A.4. for No. 2 Hog Fuel Boiler:

c. *Monitoring, recordkeeping and reporting are not required for the combustion of wood residue and natural gas in the~~se~~ boiler~~s~~.*

- ***Section 2.1 A.7.* – Prevention of Significant Deterioration -** The following emission sources and emission limitations from Section 2.1 A.7.:

a. *The following Best Available Control Technology (BACT) shall not be exceeded:*

Emission Source	Fuel Fired	Regulated NSR Pollutant	BACT	Control Method
~~No. 1 Hog Fuel Boiler (ID No. ES-64-25-0290)~~	~~HVLC gases being fired with wood/lignin~~	~~carbon monoxide~~	~~1,646 pounds per hour~~	~~Good combustion practices~~
No. 2 Hog Fuel Boiler (ID No. ES-65-25-0310)	~~HVLC gases being fired with wood/lignin~~	~~carbon monoxide~~	~~1,433 pounds per hour~~	~~Good combustion practices~~
	~~All fuels~~	~~PM_{10}~~	~~0.10 pounds per million~~	~~Series installation of multicyclone and electrostatic precipitator~~
	Oil and wood/lignin	Sulfur dioxide	0.80 pounds per million Btu heat input	Combination firing of oil with bark/wood/lignin residue
	~~LVHC gases and SOG~~	~~H_2SO_4 mist~~	~~339 pounds per consecutive 24-hour period~~	~~Good combustion practices~~
	~~LVHC gases and SOG~~	~~Total reduced sulfur~~	~~235 pounds per consecutive 24-hour period~~	~~LVHC and SOG: Good combustion practices; and LVHC Only: White liquor scrubber except for periods of scrubber maintenance~~

Monitoring and Recordkeeping - To ensure the SO_2 emission limitations in Section 2.1 A.7.a will not be exceeded, the Permittee shall be subject to the following requirements from Section 2.1 A.7. for No. 2 Hog Fuel Boiler as they apply to SO_2 emissions:

d. *The Permittee shall follow the monitoring and recordkeeping requirements for sulfur dioxide ~~and particulate matter~~ in Section 2.1 A.6.e and A.6.i through A.6.m~~, above~~. The Permittee shall be deemed in noncompliance with 15A NCAC 02D .0530 if the monitoring required for ~~PM10 and~~ sulfur dioxide emissions from the No. 2 Hog Fuel Boiler is not maintained as required.*

f. *The Permittee shall record and maintain records of the amounts of each fuel fired in the No. 1 Hog Fuel Boiler each month and the amounts of each fuel fired in the No. 2 Hog Fuel Boiler each month and make these records available to an authorized representative of DAQ upon request. The Permittee shall be deemed in noncompliance with 15A NCAC 02D .0530 if the amounts of fuels fired each month are not recorded.*

Reporting – To ensure the SO_2 emission limitations in Section 2.1 A.7.a will not be exceeded, the Permittee shall be subject to the following requirements from Section 2.1 A.7. for No. 2 Hog Fuel Boiler, as they apply to SO_2 emissions:

g. *The Permittee shall submit a semiannual summary report, acceptable to the Regional Air Quality Supervisor, of monitoring and recordkeeping activities given in Section 2.1 A.7.d through A.7.f, above, postmarked on or before January 30 of each calendar year for the preceding six-month periods between July and December, and July 30 of each calendar year for the preceding six-month period between January and June. The report shall identify all periods of noncompliance from the requirements of this permit or a statement that no periods of noncompliance occurred during the reporting period.*

- ***Section 2.1 A.6.* – New Source Performance Standards -** The following monitoring and recordkeeping requirements from Section 2.1 A.6.:

Monitoring - To ensure the SO_2 emission limitations in Section 2.1 A.7.a will not be exceeded, the Permittee shall be subject to the following referenced requirements from Section 2.1 A.6. for No. 2 Hog Fuel Boiler as they apply to SO_2 emissions:

e. *The Permittee shall demonstrate compliance with the sulfur dioxide emission limit for the No. 1 and No. 2 Hog Fuel Boilers (ID Nos. ES-64-25-0290 and ES-65-25-0310) by fuel sampling and analysis. [40 CFR 60.45(b)(2)] The Permittee shall be deemed in noncompliance with 15A NCAC 02D .0524 if the fuel supplier certification records demonstrate that the potential sulfur dioxide emissions exceed the limit in Section 2.1 A.6.b, above.*

i. *Particulate emissions from the Nos. 1 and 2 Hog Fuel Boilers (ID Nos. ES-64-25-0290 and ES-65-25-0310) shall be controlled as follows: i. POS Only: Particulate matter emissions from the combustion of lignin, biomass fuel, sludge, and HVLC gases in the No. 1 Hog Fuel Boiler shall be controlled by primary and secondary multicyclones (ID Nos. CD-64-45- 0100 and CD-64-45-0230) operating in series with exhaust from the secondary multicyclone controlled by three electroscrubbers (ID Nos. CD-64-60-0120, CD-64-60-0420, and CD-64-60-0720) operating in parallel. At least two of the three electroscrubbers shall be in operation and at least 75% of total elements of the two electroscrubbers must have voltage applied at no less than 1 kilovolt per module each time a boiler operates. To ensure compliance, the Permittee shall monitor and record the following information once per day when the boiler is in operation: (A) the secondary voltage (in kilovolts) per module in service; and (B) the total number*

~~*of modules in service. ii. Particulate matter emissions from the No. 2 Hog Fuel Boiler shall be controlled by the multicyclone (ID No. CD-65-45-0100) followed by an electrostatic precipitator (ID No. CD-65-58-2000). The ESP shall be in operation at all times the boiler is operating with a minimum of 1.5 of its installed electrical fields in operation at any time. To ensure compliance, the Permittee shall comply with the COMS monitoring requirements specified in Section 2.1 A.6.f and A.6.g, above. iii. AOS Only: No monitoring is required when firing only No. 2 fuel oil or natural gas is fired in the No. 1 Hog Fuel Boiler. The Permittee shall be deemed in noncompliance with 15A NCAC 02D .0524 if the monitoring requirements are not met as specified above.*~~

j. ~~*To ensure compliance with the particulate matter limits while firing lignin, biomass fuel, used oil, sludge and HVLC gases in the No. 1 Hog Fuel Boiler, POS only, (ID No. ES-64-25-0290) and when firing all fuels in the No. 2 Hog Fuel Boiler (ID No. ES-65-25-0310), the Permittee shall perform inspections and maintenance as specified in the approved Basic Care Route or as recommended by the manufacturer. The dates and the results of inspection and maintenance, including any corrective measures taken, shall be maintained in written or electronic format on-site and made available to an authorized representative upon request. The Permittee shall, at a minimum, perform the inspections as follows: i. a monthly external visual inspection of the system ductwork, and material collection unit for leaks; ii. an internal inspection of the structural integrity of each multicyclone to be conducted when the boiler is internally inspected to receive its operating certificate; and iii. an internal inspection of each electroscrubber module installed on the No. 1 Hog Fuel Boiler and the electrostatic precipitator installed on the No. 2 Hog Fuel Boiler at a frequency dictated by excess opacity, operational performance trends and/or monthly external inspection and at a minimum of once every ten years. The inspection shall include a check of the electroscrubber packing material and the cleaning/calibration of all associated instrumentation. iv. When operating under the AOS, monthly external inspections and internal inspections of the electroscrubber modules associated with the No. 1 Hog Fuel Boiler are not required when only No. 2 fuel oil or natural gas is fired. The Permittee shall be deemed in noncompliance with 15A NCAC 02D .0524 if the multicyclones, electroscrubbers and electrostatic precipitator are not operated and maintained as specified above.*~~

Recordkeeping - To ensure the SO_2 emission limitations in Section 2.1 A.7.a will not be exceeded, the Permittee shall be subject to the following referenced requirements from Section 2.1 A.6. for No. 2 Hog Fuel Boiler as they apply to SO_2 emissions:

k. *Pursuant to 40 CFR 60.7(b), the Permittee shall maintain records of the occurrence and duration of any startup, shutdown, or malfunction in the operation of the No*~~*s*~~*.* ~~*1 and*~~ *2 Hog Fuel Boiler*~~*s*~~ *(ID No*~~*s*~~*.* ~~*ES-64-25-0290 and*~~ *ES 65-25-0310) and any malfunctions of the air pollution control equipment, or any periods during which a continuous monitoring system or monitoring device is* *inoperative [40 CFR 60.7(b)]. The Permittee shall be deemed in noncompliance with 15A NCAC 02D .0524 if the startup, shutdown, or malfunction records and records of air pollution control equipment malfunctions are not maintained as specified.*

l. *The Permittee shall maintain a file of all measurements, including continuous monitoring system, monitoring device, and performance testing measurements; all continuous monitoring system performance evaluations; all continuous monitoring system or monitoring device calibration checks; adjustments and maintenance performed on these systems or devices; and all other information required by 40 CFR 60 recorded in a permanent form suitable for inspection in a manner consistent with the requirements of 40 CFR 60.7(f) [40 CFR 60.7(f)]. The Permittee shall be deemed in noncompliance with 15A NCAC 02D .0524 if these records are not maintained as specified.*

m. *The Permittee shall record and maintain records of the amount and type of each fuel burned during each day and keep fuel receipts from the supplier that certify potential sulfur dioxide content of fuel oil fired in the hog fuel boiler*~~*s*~~ *as specified in Section 2.1 A.6.e*~~*, above*~~*. The Permittee shall be deemed in noncompliance with 15A NCAC 02D .0524 if the fuel records are not maintained as specified.*

7.8.3.2 PCS Phosphate

Per Section 169A(b)(2) of the CAA, the NCDAQ requests that EPA adopt into the regulatory portion of the North Carolina SIP the following portions of Section 2.5 A.1. from Permit 04176T66 to include the SO_2 emission rate limitations; and monitoring, recordkeeping, and reporting requirements for Sulfuric Acid Plant No. 5, No. 6, and No. 7 at the PCS Phosphate plant located in Aurora, North Carolina. The facility has already demonstrated compliance and shall continue to demonstrate compliance with the SO_2 requirements in Section 2.5. While not requesting that EPA include the *entire* permit in the SIP, a copy of Permit 04176T66 is included in Appendix G-3 for reference only. The NCDAQ requests that EPA adopt into the regulatory portion of the SIP the following permit conditions written in *italics*. The NCDAQ requests that EPA exclude from the regulatory portion of SIP text marked in ~~strikethrough~~.

- ***Section 2.5 A.1.*****b through d, f – Emission Limitations -** The following emission sources and emission limitations from Section 2.5 A.1:
  - *a.* ~~*By no later than the compliance deadline specified in Section 2.5 A.1.g, below,*~~ *the sulfur dioxide emissions from Sulfuric Acid Plant No. 5 (ID No. S-5) shall not exceed the following emissions limitations:*
    - *i.* *Short-Term Limit: 3.2 pounds per ton of 100 percent sulfuric acid production on a 3-hour rolling average basis.*
    - *ii.* *Long-Term Limit: 2.5 pounds per ton of 100 percent sulfuric acid production on a 365-day rolling average basis.*
  - *b.* ~~*By no later than the compliance deadline specified in Section 2.5 A.1.g, below,*~~ *the*

sulfur dioxide emissions from Sulfuric Acid Plant No. 6 (ID No. S-6) shall not exceed the following emissions limitations:

- i. *Short-Term Limit: 3.3 pounds per ton of 100 percent sulfuric acid production on a 3-hour rolling average basis.*
- ii. *Long-Term Limit: 2.5 pounds per ton of 100 percent sulfuric acid production on a 365-day rolling average basis.*

c. *~~By no later than the compliance deadline specified in Section 2.5 A.1.g, below,~~ the sulfur dioxide emissions from Sulfuric Acid Plant No. 7 (ID No. S-7) shall not exceed the following emissions limitations:*

- i. *Short-Term Limit: 3.0 pounds per ton of 100 percent sulfuric acid production on a 3-hour rolling average basis.*
- ii. *Long-Term Limit: 1.75 pounds per ton of 100 percent sulfuric acid production on a 365-day rolling average basis. ~~PCS shall commence monitoring to determine compliance with the long-term limit beginning January 1, 2019, but compliance with the limit shall not be determined until one year later. This limit is subject to future adjustment as described in Paragraph 9.e of Consent Decree Civil Action No. 14-707-BAJ-SCR. If the limit is adjusted, the Permittee shall comply with a new long-term emission limit immediately upon written notification by EPA. Except as provided in Paragraph 9.e of Consent Decree Civil Action No. 14-707-BAJ-SCR, this emission limit shall not be relaxed.~~*

f. *The emission limits in Section 2.5 A.1.b through A.1.d, above, shall never be relaxed, even after termination of the consent decree.*

- ***Section 2.5 A.1.*h & i – Startup, Shutdown, and Malfunction Requirements -** To ensure the emission limitations in Section 2.5 A.1.b through f will not be exceeded, the Permittee shall be subject to the following requirements:

  h. *The short-term sulfur dioxide emission limits in Section 2.5 A.1.b, A.1.c, and A.1.d, above, do not apply during periods of startup, shutdown, or malfunction.*

  i. *The long-term sulfur dioxide emission limits in Section 2.5 A.1.b, A.1.c, and A.1.d, above, apply at all times, including during periods of startup, shutdown, or malfunction.*

- ***Section 2.5 A.1.*k through p – Emissions Monitoring Requirements** - To ensure the emission limitations in Section 2.5 A.1.b through f will not be exceeded, the Permittee shall be subject to the following requirements from Section 2.5 A.1:

  k. *~~After the compliance dates listed in Section 2.1.1 A.6.g, above,~~ the Permittee shall conduct a Relative Accuracy Test Audit (RATA) at least once every four calendar quarters at each of the Sulfuric Acid Plants No. 5, No. 6, and No. 7 (ID Nos. S-5, S-6, and No. 7) per the procedures of 40 CFR 60.85 for sulfur dioxide and oxygen concentrations and pounds sulfur dioxide per ton of 100 percent sulfuric acid produced as required by 40 CFR Part 60 Appendix F, Procedure 1, 5.1.1.*

  l. *~~Beginning with the initial RATA as required by Section 2.1.1 A.6.k, above, and thereafter~~ for every triennial RATA (i.e., year 1, 4, 7, etc.), the Permittee shall utilize the reference methods and procedures specified in 40 CFR 60.85(b) to generate the*

Reference Method values for calculating the relative accuracy. In intervening years (i.e., year 2, 3, 5, 6, etc.) the Permittee may use the alternative method specified in 40 CFR 60.85(c) to calculate the Reference Method values

m. *~~By no later than the compliance deadlines listed in Section 2.5 A.1.g, above,~~ the Permittee shall monitor sulfur dioxide emissions from each of the sulfuric acid plants (ID Nos. S-5, S-6, and S-7), in accordance with the SO_2 CEMS Plan ~~(see Attachment 2 of this permit)~~ and following procedures:*

   i. *The Permittee shall measure the sulfur dioxide concentration (lb/DSCF or ppmvd) and oxygen concentration (percent by volume) at the exit stack at least once every 15 minutes using a sulfur dioxide analyzer and oxygen analyzer.*
   ii. *During routine calibration checks and adjustments of any analyzer, the pre-calibration level shall be used to fill in any analyzer data gaps that occur pending completion of the calibration checks and adjustments.*
   iii. *If any one or more than one analyzer is/are not operating, a like-kind replacement (i.e. a redundant analyzer) may be used as a substitute.*
   iv. *If any one or more than one analyzer is/are not operating for a period of 24 hours or greater and no redundant analyzer is available, data gaps in the array involving the non-operational analyzer(s) shall be filled is as follows:*

      (A) *Exit stack gas shall be sampled and analyzed for sulfur dioxide at least once every three hours, while the relevant sulfuric acid plant is operating. Sampling shall be conducted by Reich test or other established method (e.g., portable analyzer). The most recent 3-hour average reading shall be substituted for the four 15-minute average measurements that would otherwise be utilized if the analyzer were operating normally.*
      (B) *Oxygen in the exit stack gas shall be sampled and analyzed at least once every three hours, while the relevant sulfuric acid plant is operating. Sampling shall be conducted by Orsat test or other method (e.g., portable analyzer). The most recent 3-hour average reading shall be substituted for the four 15- minute average measurements that would otherwise be utilized if the analyzer were operating normally.*
   ~~v. The sulfur dioxide analyzers and oxygen analyzers shall meet the specifications of Table 1 in Attachment 2.~~

n. *If any one or more than one analyzer is/are not operating for a period of less than 24 hours, the Permittee shall either:*
   i. *Follow the requirements set forth for a 24-hour or greater period of downtime to fill in the data gaps; or*
   ii. *Use the data recorded for the 3-hour average immediately preceding the affected analyzer's(s') stoppage to fill in the data gap.*

o. The 15-minute analyzer data shall be used to determine the 3-hour rolling averages and 365-day rolling averages ~~per Attachment 2 of this permit~~ to demonstration compliance with the short-term and long-term sulfur dioxide limits. ~~All calculations associated with these rolling averages shall be rounded using procedures specified in Attachment 2.~~

- ***Section 2.5 A.1.*q – Recordkeeping Requirements** - To ensure the emission limitations in Section 2.5 A.1.b through f will not be exceeded, the Permittee shall be subject to the following requirements:

q. The Permittee shall retain, and instruct its contractors and agents to preserve, all data generated by its sulfur dioxide analyzers, oxygen analyzers, and production rate analyzers including all data generated during startup, shutdown, and/or malfunction for five years after the termination of the Consent Decree. At the conclusion of the information-retention period, the Permittee shall notify the EPA at least 90 days prior to the destruction of any documents, records, or other information subject to these requirements.

7.9 Consideration of Five Additional Factors

Section 51.308(f)(2)(iv) of the RHR 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 in Section 7.9.1 and Section 7.9.2, respectively. Factor A and Factor C are addressed in Section 7.2. Factor E is addressed in Section 8.

7.9.1 Dust and Fine Soil from Construction Activities

The primary visibility impairing pollutant associated with construction activities is fine dust and soil (a component of $PM_{2.5}$). As discussed in Section 2.4 of this SIP, based on a summary of IMPROVE monitoring data for North Carolina's Class I areas, fine soils (shown as "Soil" in the Section 2.4 figures) have been a relatively minor contributor to visibility impairment on the 20% most impaired days from the base period (2000-2004) through 2018.

Actions that specifically address Section 308(f)(2)(iv)(B) of the RHR regarding construction activities include NCDOT Division of Highways regulations addressing control of erosion, siltation, and pollution from construction activities. Section 107-13(E) of the Division of Highways General Contract Specifications, Division 1 General Requirements, reads as follows:

(E) Dust Control[114]
"*The Contractor shall control dust throughout the life of the project within the project area and at all other areas affected by the construction of the project, including, but not specifically limited to, unpaved secondary roads, haul roads, access roads, disposal sites, borrow and material sources, and production sites. Dust control shall not be considered effective where the amount of dust creates a potential or actual unsafe condition, public nuisance, or condition endangering the value, utility, or appearance of any property.*

The Contractor will not be directly compensated for any dust control measures necessary, as this work will be considered incidental to the work covered by the various contract items."

In addition, North Carolina rule 15A NCAC 02D .0540 (Particulates from Fugitive Dust Emission Sources) is a SIP-approved rule that requires subject facilities to control PM from fugitive dust emission sources generated within plant boundaries from activities such as "unloading and loading areas, process areas, stockpiles, stock pile working, plant parking lots, and plant roads (including access roads and haul roads)."[115] Note that benefits from the rule and the NCDOT dust ordinance have not been included in the VISTAS modeling for 2028.

7.9.2 Smoke Management

The primary visibility impairing pollutant associated with wildfires, prescribed wildland fires, and agricultural burning is EC (a component of $PM_{2.5}$). As discussed in Section 2.4 of this SIP, based on a summary of IMPROVE monitoring data for North Carolina's Class I areas, EC (shown as "LAC" in the Section 2.4 figures) has been a relatively minor contributor to visibility impairment on the 20% most impaired days from the base period (2000-2004) through 2018. Days for which visibility impairment is associated with elevated levels of POM and elemental carbon (EC) have been associated with natural events such as wildland fires and have largely been removed from the 20% most impaired days because they are regarded as natural sources. The North Carolina Department of Agriculture and Consumer Services (NCDA&CS) and North Carolina Forest Service (NCFS) are responsible for managing prescribed burning on agricultural and forest lands in North Carolina, and coordinating with other State, Local, and Federal agencies to control wildfires. The NCDAQ has an excellent working relationship with the NCDA&CS and NCFS to support prescribed burning while mitigating the impacts of smoke on air pollution statewide. To specifically address Section 308(f)(2)(iv)(D) of the RHR as well as to coordinate statewide compliance with the NAAQS and mitigate local impacts of smoke, the

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[114] NCDOT Division of Highways General Contract Specifications, Division 1 General Requirements, page 1-66, https://connect.ncdot.gov/resources/Specifications/2006DrawingsEnglishUnits/2006%20Standard%20Spec%20Book.pdf.
[115] 15A NCAC 02D .0540 is available at https://files.nc.gov/ncdeq/Air%20Quality/rules/rules/15A-NCAC-02D-.0540.pdf.

NCDAQ and NCDA&CS established a Memorandum of Understanding (MOU) in July 2009 to establish the principles of the working relationship between the agencies and to educate the public about North Carolina's open burning rules.[116] The MOU was updated in August 2017 to reflect that the NCFS was transferred from the former North Carolina Department of Environment and Natural Resources to the NCDA&CS, clarify roles and responsibilities, and define on-going coordination of information and training.[117]

Since the submittal of North Carolina's first regional haze SIP in December 2007, the NCFS prepared Guidelines for Managing Smoke from Forestry Burning Operations which lays out a framework for prescribed burners to follow to mitigate $PM_{2.5}$ emissions and regional haze impacts associated with prescribed burning.[118] The guidelines were most recently updated in May 2020 to incorporate the latest information available to support prescribed burners.

Finally, the NCDAQ and the NCFS have also participated in the Southeastern Prescribed Fire and Smoke Management Summit since its inception in 2013. Participating in the Summit has been extremely valuable for sharing information to foster understanding and cooperation toward achieving both air quality and prescribed fire goals throughout the Southeast.

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[116] Memorandum of Understanding Between the North Carolina Department of Environment and Natural Resources, Division of Air Quality, and the North Carolina Department of Agriculture on the Open Burning of Agricultural Lands for Agricultural Management Practices under Title 15A North Carolina Administrative Code 2D .1903, July 29, 2009.

[117] Memorandum of Understanding Between the North Carolina Department of Environmental Quality Division of Air Quality and the North Carolina Department of Agriculture and Consumer Services on Open Burning Without An Air Quality Permit Pursuant to Title 15A North Carolina Administrative Code 2D .1900, August 30, 2017, https://files.nc.gov/ncdeq/Air%20Quality/enf/openburn/Open_Burning_MOU_NCDAQ_with_NCDACS.pdf.

[118] North Carolina Department of Agriculture and Consumer Services, North Carolina Forest Service, *The North Carolina Smoke Management Program, Guidelines for Managing Smoke from Forestry Burning Operations*, Revised May 15, 2020, https://www.ncforestservice.gov/fire_control/pdf/SMP_REVISION_2020.pdf.

8.0 REASONABLE PROGRESS GOALS (RPGs) for 2028

Consistent with the RHR at 40 CFR 51.308(f)(3), North Carolina developed a LTS to support establishing RPGs for 2028 for each Class I area within the state (expressed in dv) that, from the baseline period (2000-2004), demonstrates progress towards achieving natural visibility conditions for the 20% most anthropogenically impaired days, and ensures no degradation in visibility for the 20% clearest days. The NCDAQ followed EPA's August 20, 2019 guidance in developing the 2028 RPGs for the following Class I areas in North Carolina:

- Great Smoky Mountains National Park (GSMNP)
- Joyce Kilmer-Slickrock Wilderness Area
- Linville Gorge Wilderness Area
- Shining Rock Wilderness Area
- Swanquarter Wilderness Area

Both the GSMNP and Joyce Kilmer-Slickrock Wilderness Area are in North Carolina and Tennessee. Through the VISTAS regional haze planning process, North Carolina and Tennessee worked together to share information and agree to the RPGs for these two Class I areas.

8.1 2028 RPGs for 20% Most Impaired and 20% Clearest Days

The 2028 RPGs are based on the VISTAS modeling previously discussed in Section 7.2.6 of this SIP. Although the RPGs are not directly federally enforceable, they do provide an estimate of the progress expected during the next few years to maintain a path toward achieving natural visibility conditions by the year 2064.

For the 20% most impaired days, Table 8-1 shows baseline, current, and natural visibility conditions; the uniform rate of progress (URP) for 2028; and modeled RPGs for 2028 for each Class I area. The RPGs modeled for 2028 are well below baseline conditions as well as the 2028 URP (ranging from 69% to 84% of the 2028 URP) thus demonstrating continued progress toward achieving natural conditions by the year 2064. The 2028 RPGs place each Class I area from 10 to 20 years ahead of where they would need to be to meet the URP goals in the future.

Table 8-2 shows baseline (2000-2004), current (2014-2018), and natural visibility conditions, and estimated RPGs for the 20% clearest days in 2028. The 2028 RPGs range from 59% to 87% of baseline visibility conditions, and these values ensure no degradation of visibility in 2028 on the 20% clearest days at any of the North Carolina Class I areas, as required per 40 CFR 51.308(f)(3)(i). The projected VISTAS 2028 RPGs for the 20% clearest days are slightly greater than current conditions for 2014-2018. The NCDAQ reviewed EPA's modeling using a 2016 base year and found that the 2028 RPG values modeled by VISTAS for North Carolina Class I areas are slightly higher than EPA's 2028 RPG values. Regardless, both modeling studies demonstrate no degradation of visibility in 2028 beyond baseline values (2000-2004) on the 20% clearest days at North Carolina Class I areas.

Table 8-1. Baseline, Current, and Natural Visibility Conditions and 2028 RPGs for 20% Most Impaired Days for North Carolina Class I Areas (deciviews)

Class I Area	Baseline (2000-2004)[1]	2028 URP[2]	Current Conditions (2014-2018)[2]	2028 RPG[3]	Baseline minus 2028 RPG	2028 URP minus 2028 RPG (Percent of URP)	Natural Conditions[2]
GSMNP	29.11	21.49	17.21	15.03	14.08	6.46 (70%)	10.05
Joyce Kilmer-Slickrock	29.11	21.49	17.21	15.03	14.08	6.46 (70%)	10.05
Linville Gorge	28.05	20.71	16.42	14.25	13.80	6.46 (69%)	9.70
Shining Rock	28.13	20.98	15.49	13.31	14.82	7.67 (63%)	10.01[4]
Swanquarter	23.79	18.28	16.30	15.27	8.52	3.01 (84%)	9.79

[1] The baseline data in Table 8-1 are derived from the 2018 data set on the IMPROVE website (sia_impairment_group_means_04_20_2.zip).[119]
[2] From “V6_GlidePath_MI20_unitDeciview_Rev.xlsm” spreadsheet. Improvement values are the difference between the baseline visibility for each glide path chart and the 2028 projected value.
[3] Value is based on the data set supporting EPA 2018 Guidance Memo for IMPROVE data, Dec. 20, 2018.

Table 8-2. Baseline, Current, and Natural Visibility Conditions and 2028 RPGs for 20% Clearest Days for North Carolina Class I Areas (deciviews)

Class I Area	Baseline (2000-2004)[1]	2028 RPG[2]	Current Conditions (2014-2018)[2]	Baseline minus 2028 RPG	Percent of Baseline	Natural Conditions[2]
GSMNP	13.58	8.96	8.35	4.62	66%	4.62
Joyce Kilmer-Slickrock	13.58	8.96	8.35	4.62	66%	4.62
Linville Gorge	11.11	8.21	7.61	2.90	74%	4.07
Shining Rock	7.70	4.54	4.40	3.16	59%	2.49
Swanquarter	12.34	10.77	10.61	1.57	87%	5.71

[1] The baseline data in Table 8-2 are derived from the 2018 data set on the IMPROVE website (sia_group_means_04_20_2.zip).[120]
[2] From “V6_GlidePath_20C_unitDeciview_Rev.xlsm” spreadsheet. Improvement values are the difference between the baseline visibility for each glide path chart and the 2028 projected value.
[4] Value is based on the data set supporting EPA 2018 Guidance Memo for IMPROVE data, Dec. 20, 2018.

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[119] Colorado State University, IMPROVE archived data, http://vista.cira.colostate.edu/Improve/rhr-archived-data/.
[120] Colorado State University, IMPROVE archived data, http://vista.cira.colostate.edu/Improve/rhr-archived-data/.

8.2 Uncertainties Associated with RPG Estimates

An important element in developing the RPGs is the accuracy of the emissions estimated for 2028 that support the modeling. For North Carolina, estimated visibility improvements by 2028 in each Class I area are based on (1) estimated emissions reductions associated with existing federal and state measures implemented or expected to be implemented during the second planning period, (2) emissions reductions associated with facility closures that occurred after the 2016 point source emissions base year (i.e., January 1, 2017 through November 18, 2018), and (3) estimates of emissions changes associated with economic growth and other factors. In preparing the 2028 emissions for point sources, North Carolina started with a 2016 base year inventory which include emission reductions associated with federal and state control programs and consent decrees included in the LTS for the first planning period. By using this approach, the LTS for the second planning period builds on the LTS for the first planning period. For EGUs, North Carolina relied on the ERTAC forecast tool to estimate emissions for 2028. However, as we have learned since the EGU modeling was completed in 2020, the EGU projections can change depending on modeling assumptions, responses to market forces, and future federal and state policies.[121]

For the 20% clearest days, the RPGs for North Carolina's Class I areas show an improvement in visibility in 2028 relative to current visibility. These goals, based on the modeling results, are discussed in greater detail in Section 7.2.6. The modeling performance for North Carolina Class I areas is slightly better over the 20% most impaired days as opposed to the 20% clearest days, but the final report on the modeling informing the RPG's provided in this report makes clear that the modeling performance overall is satisfactory to use in regulatory modeling (see Appendix E-2f). Additionally, much of the model bias is to the high side across the clearest days (see Appendix E-3), which suggests that 2028 visibility might be lower than modeled. Based on this information, the NCDAQ has good confidence that future visibility values in North Carolina Class I areas will be better than current visibility conditions.

Thus, the 2028 emission estimates and modeling include uncertainty because of assumptions about economic factors that affect emissions growth, unanticipated facility closures, and future control programs that are not defined well enough to model. North Carolina cannot control how emissions control programs are implemented in other states; however, North Carolina is committed to implementing the federal and state control programs included in its LTS (see Section 7.2) and coordinating with neighboring states regarding emissions activity that may affect Class I areas in North Carolina.

[121] U.S. EPA "Regional Haze Guidance on Regional Haze State Implementation Plans for the Second Implementation Period," EPA-457/B-19-003, August 2019, page 17, accessed from https://www.epa.gov/visibility/guidance-regional-haze-state-implementation-plans-second-implementation-period. See Appendix B-3 of this SIP that documented 2028 emissions projections for North Carolina EGU and non-EGU point sources.

8.3 Long Term Strategy (LTS)

North Carolina's LTS builds on the structure of the LTS used for its SIP for the first planning period. This section provides a summary of North Carolina's LTS for the second planning period which includes the following elements that are discussed in more detail in Section 7 and Section 10 of this SIP:

- Federal and State Foundation Control Programs (Section 7.2)
- Reasonable Progress and Four-Factor Analyses of North Carolina Facilities (Section 7.8)
- Reasonable Progress Analysis for Out-of-State Facilities (Section 10)
- Additional Programs and Initiatives Supporting Past and Future Emissions Reductions (Section 7.2.7)
- Emission Reductions Not Included in 2028 Emissions Projections and RPGs (see Section 7.2.8)

8.3.1 Federal and State Foundation Control Programs

North Carolina's LTS includes the federal and state control programs and consent decrees documented in Section 7.2 of this SIP for the second planning period. Once approved by EPA, these programs will be federally enforceable for the purpose of fulfilling Section 40 CFR 40 CFR 51.308(f)(3) of the RHR rule. The NCDAQ believes that its LTS for the second planning period will keep each of its Class I areas on a path to continue to improve visibility through 2028. North Carolina is committed to implementing its LTS for the second planning period and will evaluate progress during the next 5-year progress report.

8.3.2 Reasonable Progress and Four-Factor Analyses for North Carolina Facilities

North Carolina's LTS also addresses the four statutory factors in accordance with Section 40 CFR 51.308(f)(2) of the RHR. North Carolina requested that three facilities complete a reasonable progress/four-factor analysis for SO_2 emissions based on their estimated contribution to visibility impairment at Shinning Rock Wilderness Area (Blue Ridge Paper Products) and Swanquarter Wilderness Area (PCS Phosphate and Domtar) (see Section 7.8 of this SIP). The NCDAQ determined that because BRPPs and PCS Phosphate installed controls and significantly reduced SO_2 emissions from 2017 through 2019, that existing controls demonstrate progress for the second planning period. For the reasons discussed in Section 7.8, the NCDAQ decided not to require Domtar to install and operate a wet scrubber on the No. 2 Hog Fuel Boiler. North Carolina considered the results of the analyses in selecting the RPGs for the most impaired and clearest days for each Class I area. As a result, given that the RPGs demonstrate continued progress for the purpose of this second planning period, North Carolina decided not to adjust the RPGs based on the four-factor analyses for the three facilities.

For point sources, North Carolina was not contacted by another state to request consultation regarding contributions to visibility impairment in a Class I area outside of North Carolina. MANE-VU requested consultation regarding statewide emissions contributions for all sectors to Class I areas in their states. The NCDAQ participated in MANE-VU's consultation process which is documented in Section 10 of this SIP. As a result of this consultation process, the NCDAQ believes that its LTS is sufficient to address MANE-VU's concerns and will continue an ongoing dialogue with MANE-VU to determine if in the future North Carolina would need to adopt any measures to further reduce emissions to assist with improving visibility impairment in MANE-VU Class I areas.

8.3.3 Reasonable Progress Analysis for Out-of-State Facilities

The following provides a summary of the responses North Carolina has received requesting each state with a facility with ≥1.00% sulfate contribution to Class I areas in North Carolina to complete a reasonable progress analysis for the facility. The NCDAQ expects each state to which a letter was sent will address the request in its regional haze SIP, including those states that are unable to provide a response prior to North Carolina completing its SIP for submittal to EPA. The out-of-state consultation process is documented in Section 10 of this SIP.

8.3.3.1 Great Smoky Mountains National Park and Joyce Kilmer – Slickrock Wilderness Area

Seven (7) out-of-state facilities were selected for reasonable progress analysis because their sulfate contribution to visibility impairment in Great Smoky Mountains National Park is ≥1.00% (see Table 7-31). Eight (8) facilities, including the same 7 selected for Great Smoky Mountains plus Georgia Power Company - Plant Bowen, were selected for their ≥1.00% sulfate contribution visibility impairment at the Joyce Kilmer – Slickrock Wilderness Area (see Table 7-32). No North Carolina facilities were identified with a ≥1.00% sulfate or ≥1.00% nitrate contribution to the Great Smoky Mountains National Park or Joyce Kilmer – Slickrock Wilderness Area.

Of the out-of-state facilities, Eastman Chemical Company in Tennessee had the third highest contribution to Great Smoky Mountains National Park and highest contribution to Joyce Kilmer – Slickrock Wilderness Area (1.29% and 1.37%, respectively, for sulfate). This facility has agreed to shut down 3 coal-fired boilers by December 31, 2028 and has agreed to an SO_2 emissions limit of 1,396 tons per year for 2 additional boilers after a dry sorbent injection system installation is completed. Another source impacting both Class I areas is Wm. H Zimmer station in Ohio, which has committed to shutting down in 2027.

Reasonable progress analyses of the remaining Ohio and Pennsylvania facilities have indicated that the facilities were unable to identify any reasonable control measures beyond their existing controls. Responses from the facilities in Georgia, Kentucky, and Indiana are still outstanding.

8.3.3.2 Linville Gorge Wilderness Area

Eleven (11) facilities out-of-state were selected for reasonable progress analysis because their sulfate contribution to visibility impairment to the Linville Gorge Wilderness Area is ≥1.00% (see Table 7-33). No North Carolina facilities were identified with a sulfate or nitrate contribution ≥1.00% to the Linville Gorge Wilderness Area.

Eastman Chemical Company had the highest contribution to visibility impairment at Linville Gorge (4.26% for sulfate), and it has committed to reductions as described in Section 8.3.3.1. Luke Paper Company in Maryland had the third highest contribution (2.03% for sulfate), and this facility has closed, and its air quality permit has been rescinded by the state (see Section 10 of this SIP).

Reasonable progress analyses of the remaining Ohio, Pennsylvania, Tennessee, and Virginia facilities have indicated that the facilities were unable to identify any reasonable control measures beyond their existing controls. Responses from the facilities in Georgia, Kentucky, Missouri, and Indiana are still outstanding.

8.3.3.3 Shining Rock Wilderness Area

One (1) North Carolina facility and twelve (12) out-of-state facilities were selected for reasonable progress analysis because their sulfate contribution to visibility impairment to the Shining Rock Wilderness Area is ≥1.00% (see Table 7-34). The North Carolina facility (Blue Ridge Paper Products) completed a four-factor analysis (see Section 7.8 of this SIP).

Regarding the twelve out-of-state facilities, Luke Paper Company and Wm. H. Zimmer Station had the ninth and eleventh highest contributions (1.20% and 1.10%, respectively, for sulfate), and these facilities are or will be shut down as described in Sections 8.3.3.1 and 8.3.3.2 above. Eastman Chemical Company is another contributor to the visibility impairment at Shining Rock that has committed to making SO_2 reductions in the second planning period. Arkansas has provided a four-factor analysis for the Entergy Arkansas Inc-Independence Plant (1.09% sulfate contribution at Shining Rock). Entergy has also entered into a consent decree[122] with Sierra Club under which the Independence Plant is obligated to comply with an SO_2 limit of 0.60 lb/MMBtu and to cease coal burning operations by December 31, 2030.

Reasonable progress analyses of the remaining Ohio, Pennsylvania, and Tennessee facilities have indicated that the facilities were unable to identify any reasonable control measures beyond their existing controls. Responses from the facilities in Georgia, Kentucky, Missouri, and Indiana are still outstanding.

8.3.3.4 Swanquarter Wilderness Area

Two (2) North Carolina facilities and eight (8) out-of-state facilities were selected for reasonable progress analysis because their sulfate contribution to visibility impairment to the Swanquarter Wilderness Area is ≥1.00% (see Table 7-35). The two North Carolina facilities (PCS Phosphate and Domtar) completed a four-factor analysis (see Section 7.8 of this SIP).

Of the remaining 8 out-of-state facilities, Luke Paper Company in Maryland had the highest contribution (≥4.26% for sulfate), and this facility has closed as described in Section 8.3.3.2. Reasonable progress analyses of the remaining Ohio and Pennsylvania facilities have indicated

[122] Sierra Club and National Parks Conservation Association vs. Entergy Arkansas, Inc., Entergy Power, LLC, and Entergy Mississippi, Inc., Case No. 4:18cv854, Entered by Court March 11, 2021.

that the facilities were unable to identify any reasonable control measures beyond their existing controls. Responses from the facilities in Georgia and West Virginia are still outstanding.

8.3.4 Additional Programs and Initiatives Supporting Past and Future Emissions Reductions

Section 7.2.7 of this SIP describes several additional State programs and initiatives supporting past and future emissions reductions. During the second planning period, the NCDAQ anticipates that the REPS will continue to provide emission reductions from the electric power sector. The state is also investing significant resources to implement Governor Cooper's Executive Order 80 (EO-80) and Clean Energy Plan by working with the power generation and consumption sectors and EO-246 by working with the transportation and other sectors to reduce CO_2 and other GHG emissions statewide.

On October 13, 2021, Governor Cooper signed bipartisan legislation SL 2021-165 that authorizes the NCUC to adopt a Carbon Plan by December 2022 that will require Duke Energy facilities in North Carolina to take all reasonable steps to achieve a 70% reduction in CO_2 emissions from 2005 levels by the year 2030, and achieve carbon neutrality by the year 2050,[123] Thus, it is anticipated that the power sector will need to change its power generation fleet to move away from coal toward cleaner and renewable fuels which will further reduce SO_2 and NO_x emissions.

8.3.5 Emission Reductions Not Included in 2028 Emissions Projections and RPGs

As discussed in Section 7.2.8 of this SIP, the NCDAQ anticipates additional emission reductions during the second planning period that were either not known at the time the NCDAQ prepared its 2028 emissions inventory or are associated with programs and initiatives for which it is difficult to estimate emission reductions at the time this SIP was prepared. For example, as shown in Table 7-11, since preparing the 2028 non-EGU point source inventory, an additional 96 non-EGU point source facilities have permanently closed from March 25, 2018 through December 31, 2020. These facility closures have decreased 2016 and projected 2028 SO_2 emissions by 204.13 and 208.34 tons, respectively. The facility closures have decreased 2016 and projected 2028 NO_x emissions by 248.24 and 287.11 tons, respectively.

8.4 Summary and Conclusions

For each of North Carolina's Class I areas, the VISTAS modeling demonstrated that the modeled 2028 RPGs provide for an improvement in visibility better than the URP for the 20% most impaired days and ensures no degradation in visibility for the 20% clearest days over the 2019 - 2028 planning period. The modeled RPGs incorporate estimates of emission reductions associated with the federal and state control measures and consent decrees included in North Carolina's LTS, as well as estimates of emission reductions associated with control programs

[123] SL 2021-165 allows 5% of the 2050 CO_2 reductions to be met with offsets.

and consent decrees implemented in other states that contribute to visibility impairment in North Carolina's Class I areas.

The LTS will reduce SO_2 and NO_x emissions to keep the state on track toward achieving the RPGs. North Carolina will also continue to work with the states to which the NCDAQ sent consultation letters to determine the extent to which emissions can be reduced from the out-of-state facilities identified as having a significant contribution to visibility impairment to Class I areas in North Carolina.

9.0 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 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. 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 Class I 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 Class I 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 Class I 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 Class I 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 Class I 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 North Carolina, 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 necessarily be based on, or directly comparable to, IMPROVE. The IMPROVE measurements provide the only long-term record available for tracking visibility improvement or degradation, and, therefore, North Carolina relies on the IMPROVE network for complying with the regional haze monitoring requirement in the rule.

As shown in Table 9-1 and Figure 9-1, there are currently three IMPROVE sites in North Carolina (two sites at different locations in the mountains and one on the coast). The Great Smoky Mountains National Park is in North Carolina and Tennessee and the IMPROVE monitor for the Park is located just across the border in Tennessee at Look Rock. The Joyce Kilmer-Slickrock Wilderness Area relies on data from the Great Smoky Mountains National Park IMPROVE monitoring site (GRSM1) because it does not have an IMPROVE monitor. Figure 9-2 shows the IMPROVE monitoring network for the VISTAS region.

Table 9-1. North Carolina Class I Areas and Representative IMPROVE Monitor

Class I Area	IMPROVE Site Designation
Great Smoky Mountains National Park	GRSM1 (TN)
Joyce Kilmer-Slickrock Wilderness Area	GRSM1 (TN)
Linville Gorge Wilderness Area	LIGO1 (NC)
Shining Rock Wilderness Area	SHRO1 (NC)
Swanquarter Wilderness Area	SWAN1 (NC)

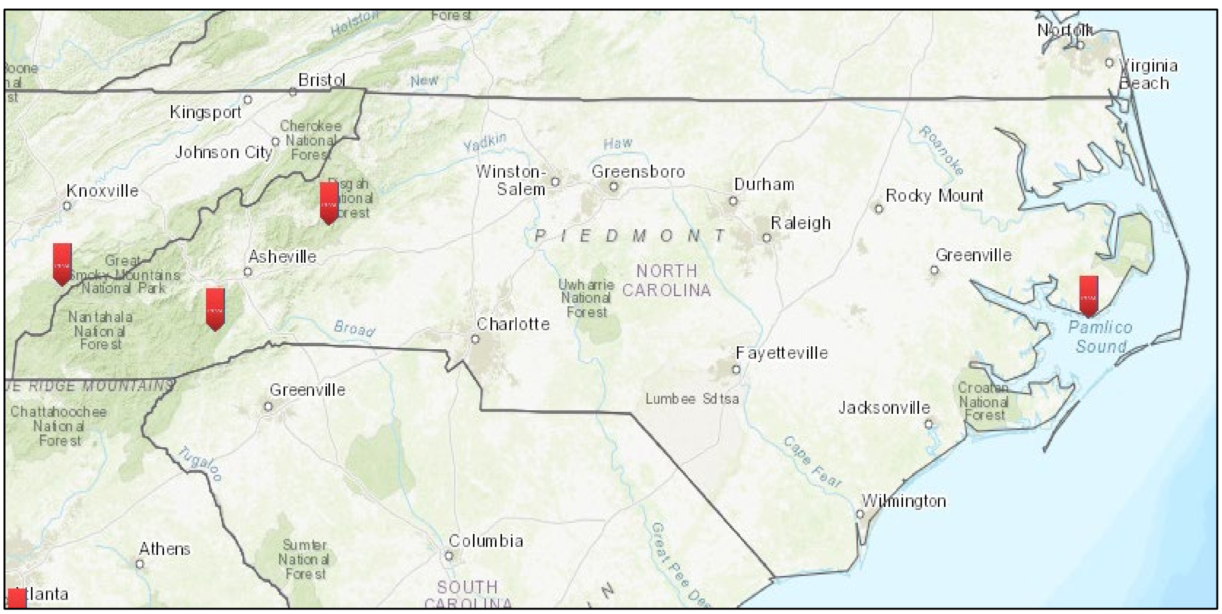

Figure 9-1. IMPROVE Monitoring Network in North Carolina

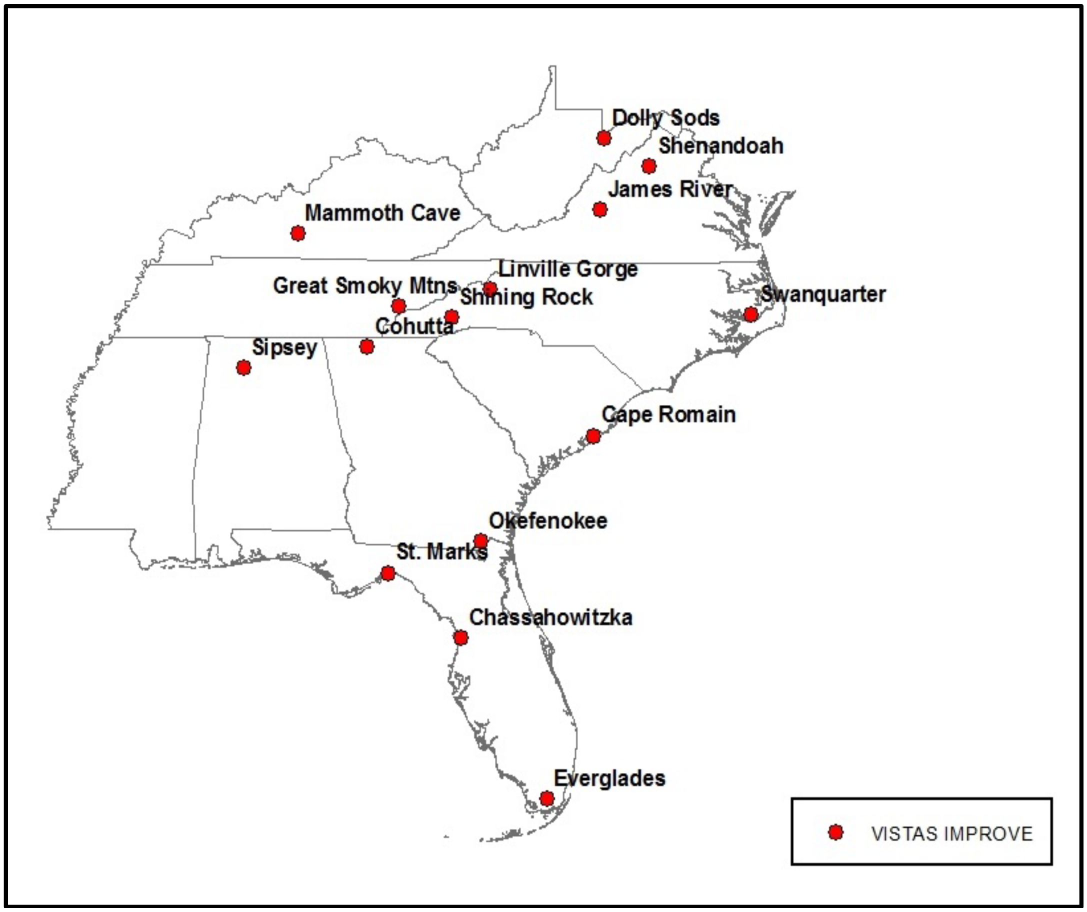

Figure 9-2. VISTAS IMPROVE Monitoring Network

The IMPROVE measurements are central to North Carolina's regional haze monitoring strategy because the current IMPROVE monitors in North Carolina represent unique air sheds and it is difficult to visualize how the objectives listed above could be met without the monitoring provided by IMPROVE network. Any reduction in the scope of the IMPROVE network in North Carolina and neighboring Class I areas would jeopardize the state's ability to demonstrate progress toward visibility improvement in its Class I areas and plan for appropriate future programs. In particular, North Carolina's regional haze strategy relies on emission reductions that will result from federal and state programs in North Carolina and in neighboring states, which occur on different time scales and will most likely not be spatially uniform. Monitoring at Class I areas is important to document the different air quality responses to the emissions reductions that occur in those unique air sheds during the second implementation period to assess progress toward attaining natural visibility conditions.

Because each IMPROVE monitor in North Carolina represents a unique airshed and a significant component of the contributions are regional, any reduction of the IMPROVE network by shutting down these monitoring sites impedes tracking progress or planning improvements at the affected Class I areas. If any one of the three IMPROVE monitors are shut down, North Carolina, in consultation with the EPA and FLMs, will develop an alternative approach for meeting the tracking goal, perhaps by seeking contingency funding to carry out limited monitoring or by relying on data from nearby urban monitoring sites to demonstrate trends in speciated $PM_{2.5}$ mass.

Data produced by the IMPROVE monitoring network will be used for preparing the 5-year progress reports and the 10-year comprehensive SIP revisions, each of which relies on analysis of the preceding five years of IMPROVE monitor data. Consequently, the monitoring data from the IMPROVE sites need 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). North Carolina 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): North Carolina believes the existing IMPROVE monitors for the state's Class I areas are adequate and does not believe any additional monitoring sites or equipment are needed to assess whether RPGs for all Class I 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 for states with no Class I areas does not apply to North Carolina.

  51.308(f)(6)(iv): North Carolina 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, National Park Service (NPS), USFS, USF&WS, Bureau of Land Management (BLM), National Oceanic and Atmospheric Administration (NOAA), four organizations representing state air quality organizations (National Association of Clean Air Agencies (NACAA), Western States Air Resources Council (WESTAR), Northeast States for Coordinated Air Use Management (NESCAUM), and MARAMA), and three Associate Members: Arizona Department of Environmental Quality (DEQ), Environment Canada, and the South Korea Ministry of Environment). North Carolina believes that participation of the state organizations in the IMPROVE Steering Committee adequately represents the needs of the state. 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 Class I Federal areas.[124] The NPS 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 the NPS and NPS contractors before submission to EPA's Air Quality System (AQS),.[125] The network also posts raw and summary data () to assist states and local air agencies and multijurisdictional organizations.[126, 127] Details about the IMPROVE monitoring network and procedures are available online.[128]

- 51.308(f)(6)(v): The requirements of 40 CFR 51.308(f)(6)(v) are addressed in Section 4 and Section 7.2.4 of the SIP. North Carolina will continue to participate in SESARM/VISTAS efforts for projecting future emissions and continue to comply with the Air Emissions Reporting Requirements (AERR) rule 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 North Carolina 's Class I areas or Class I areas outside the state that are affected by sources in North Carolina.

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[124] Colorado State University, IMPROVE Program website, http://vista.cira.colostate.edu/Improve/improve-program/.
[125] U.S. EPA, Air Qualty System (AQS) website, https://www.epa.gov/aqs.
[126] Colorado State University, Federal Land Manager Environmental Database, http://views.cira.colostate.edu/fed/.
[127] Colorado State University, IMPROVE RHR Summary Data, http://vista.cira.colostate.edu/Improve/rhr-summary-data/.
[128] Colorado State University, IMPROVE website, http://vista.cira.colostate.edu/Improve/.

10.0 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 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 "tag" 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 the majority of visibility impairment at VISTAS Class I areas will continue to be from point source SO_2 and NO_x emissions. 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 accepted the conclusions of these analyses for use in evaluating reasonable progress.

10.1 Interstate Consultation

This section addresses paragraph 40 CFR 51.308(f)(2) of the RHR that requires each state to addresses in its LTS visibility impairment for each Class I area located outside the State that may be affected by emissions from the State. The LTS must include the enforceable emissions limitations, compliance schedules, and other measures that are necessary to make reasonable progress, as determined pursuant to paragraphs 40 CFR 51.308(f)(2)(i) through (iv). Subsection 10.1.1 documents North Carolina's consultation with other states with emission sources with impact Class I Areas in North Carolina, and Section 10.1.2 addresses North Carolina impacts on Class I areas outside of the state.

10.1.1 Emission Sources in Other States with Impacts on Class I Areas in North Carolina

In evaluating controls, each VISTAS state with a Class I area initiated a consultation process by sending a letter to each other 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. 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 facilities for which PSAT modeling indicated a contribution to visibility impairment of ≥1.00% for sulfate in one or more of North Carolina's Class I areas. The NCDAQ sent letters to each state requesting a reasonable progress analysis of the facilities. 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 to which a letter was sent and identifies the total number of facilities impacting each Class I area in North Carolina. Table 10-2 identifies each facility and its PSAT contribution to each Class I area in North Carolina. Appendix F-1 provides the consultation letters from NCDAQ to each VISTAS state and the responses to the letters. Appendix F-2 provides the consultation letters from VISTAS to each non-VISTAS state and the responses to the letters. Note that when the letters were sent that the final PSAT values were not completed. The information in Table 10-1 and Table 10-2 is based on the final PSAT results. The final PSAT results did not change the facilities in VISTAS and Non-VISTAS states for which North Carolina requested a reasonable progress analysis.

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

Class I Area	Region	States
GSMNP	VISTAS	KY, TN
	Non-VISTAS	IN, PA, OH
	Total States	5
	Total Facilities	7
Joyce Kilmer –Slickrock (JOYC)	VISTAS	GA, KY, TN
	Non-VISTAS	IN, PA, OH
	Total States	6
	Total Facilities	8
Linville Gorge	VISTAS	VA, TN, KY, GA
	Non-VISTAS	IN, MD, MO, PA, OH
	Total States	9
	Total Facilities	11
Shining Rock	VISTAS	TN, KY, GA
	Non-VISTAS	AR, IN, MD, MO, PA, OH
	Total States	9
	Total Facilities	13
Swanquarter	VISTAS	GA, WV
	Non-VISTAS	MD, PA, OH
	Total States	5
	Total Facilities	10

Table 10-2. Out-of-State Facilities with ≥1.00% Sulfate PSAT Contribution in 2028 in North Carolina Class I Areas

Facility	State	Class 1 Area Impacted	Percent Impairment Impact	Letter Sent by and Date	Response Received
North Carolina Letters Sent to VISTAS States					
Georgia Power Company – Plant Bowen	GA	Joyce Kilmer-Slickrock	1.17%	TN, October 23, 2020	None
		Linville Gorge	1.19%	NC, January 22, 2021	None
		Shining Rock	1.35%	NC, January 22, 2021	None
		Swanquarter	1.09%	NC, January 22, 2021	None
Tennessee Valley Authority – Shawnee Fossil Plant	KY	Great Smoky Mountains	1.38%	NC, February 1, 2021	None
		Joyce Kilmer-Slickrock	1.45%		
		Linville Gorge	1.40%		
		Shining Rock	1.71%		
TVA Cumberland Fossil Plant	TN	Linville Gorge	1.26%	NC, February 1, 2021	February 18, 2021 July 7, 2021
		Shining Rock	1.38%		
Eastman Chemical Company	TN	Great Smoky Mountains	1.29%	NC, February 1, 2021	February 18, 2021 July 7, 2021
		Joyce Kilmer-Slickrock	1.37%		
		Shining Rock	1.09%		
		Linville Gorge	4.26%		
Jewell Coke Company LLP	VA	Linville Gorge	1.08%	NC, November 6, 2020	None
Allegheny Energy Supply Co, LLC - Harrison	WV	Swanquarter	1.80%	NC, January 25, 2021	None
Monongahela Power Co – Pleasants Power Station	WV	Swanquarter	1.24%	NC, January 25, 2021	None
VISTAS Letters Sent to Non-VISTAS States					
Entergy Arkansas Inc-Independence Plant	AR	Shining Rock	1.09%	VISTAS, June 22, 2020	July 7, 2020 (email response) September 22, 2021 (email response)
Gibson	IN	Great Smoky Mountains	1.11%	VISTAS, June 22, 2020	None
		Joyce Kilmer-Slickrock	1.07%		
		Linville Gorge	1.12%		
		Shining Rock	1.29%		

Facility	State	Class 1 Area Impacted	Percent Impairment Impact	Letter Sent by and Date	Response Received
Indiana Michigan Power	IN	Great Smoky Mountains	1.25%	VISTAS, June 22, 2020	None
		Joyce Kilmer-Slickrock	1.18%		
		Shining Rock	1.33%		
		Linville Gorge	1.16%		
New Madrid Power Plant-Marston	MO	Linville Gorge	1.09%	VISTAS, June 22, 2020	October 19, 2020
		Shining Rock	1.34%		
Homer City Gen LP/Center TWP	PA	Swanquarter	1.47%	VISTAS, June 22, 2020	July 8, 2020
Genon NE Mgmt Co/Keystone Station	PA	Great Smoky Mountains	1.26%	VISTAS, June 22, 2020	July 8, 2020
		Joyce Kilmer-Slickrock	1.18%		
		Linville Gorge	1.92%		
		Shining Rock	1.29%		
		Swanquarter	3.65%		
Cardinal Power Plant - Cardinal Operating Company	OH	Swanquarter	1.97%	VISTAS, June 22, 2020	October 29, 2020
General James M. Gavin Power Plant	OH	Great Smoky Mountains	3.93%	VISTAS, June 22, 2020	October 29, 2020
		Joyce Kilmer-Slickrock	3.63%		
		Linville Gorge	3.63%		
		Shining Rock	2.53%		
		Swanquarter	2.13%		
Duke Energy Ohio, Wm. H. Zimmer Station	OH	Great Smoky Mountains	1.03%	VISTAS, June 22, 2020	October 29, 2020
		Joyce Kilmer-Slickrock	1.05%		
		Shining Rock	1.10%		

Responses from VISTAS States

The following briefly summarizes the response received for each facility. The NCDAQ expects each state to which a letter was sent will address the request in its regional haze SIP, including those states that are unable to provide a response prior to North Carolina completing its SIP for submittal to EPA.

Tennessee - TVA Cumberland Fossil Plant

TVA Cumberland submitted a four-factor analysis to Tennessee on July 29, 2020. In that analysis, TVA concluded that no further SO_2 reductions are necessary or reasonably cost effective for reasonable progress because the coal units at the plant are controlled with wet FGD systems that provide 97% SO_2 control which are the most efficient means of SO_2 control for coal boilers.

Two possible upgrades to the FGD systems were evaluated: wall rings installation and spray header redesign. The SO_2 control cost effectiveness of installing wall rings was estimated to be $3,100/ton, and that of the spray header project was estimated to be $6,500/ton. Additionally, TVA Cumberland calculated a visibility improvement cost effectiveness ($/dv), based upon a modeled improvement of 0.008 deciviews[129] if both improvements were implemented. This resulted in cost-effectiveness values of more than $500 million/deciview for the wall rings and more than $1 billion/deciviews for the spray nozzle upgrade. Based on these values as well as expected retirement of the plant prior to 2035, TVA Cumberland does not consider either upgrade to its SO_2 controls to be reasonably cost effective. On July 7, 2021, the Tennessee DAPC sent a consultation letter to NCDAQ stating that the Tennessee draft SIP will not require any further controls to TVA Cumberland because DAPC concluded that no further SO_2 controls are necessary or cost effective for reasonable progress. The NCDAQ agrees with this conclusion.

Tennessee - Eastman Chemical Company

Eastman Chemical Company submitted a four-factor analysis to Tennessee on August 13, 2020. In that analysis, Eastman stated that they plan to cease operation of boilers 18, 19, and 20, and are in the process of installing a dry sorbent injection system for the control of SO_2 from boilers 23 and 24. In a letter dated February 8, 2021, Eastman proposed to shut down boilers 18, 19, and 20 by December 31, 2028, and agreed to a limit of 1,396 tons per year for boilers 23 and 24. On July 7, 2021, the Tennessee DAPC sent a consultation letter to NCDAQ stating that the Tennessee draft SIP will require Eastman to cease operations of the boilers 18, 19, and 20 and will require them to install a dry sorbent injection system to control SO_2 emissions from boilers 23 and 24. The NCDAQ agrees with this conclusion.

West Virginia – Harrison Power Station

West Virginia Division of Air Quality (WVDAQ) provided the results of the reasonable progress assessment for Harrison Power Station on September 28, 2021. The WVDAQ determined that the facility is effectively controlled for SO_2 based on an average removal efficiency of 97.1% of SO_2 by the Harrison FGD system and an average emission rate of 0.16 lb/MMBtu from 2015

[129] Potential visibility improvement was modeled for four Class I areas impacted by emissions from TVA Cumberland: Mammoth Cave – 0.006 dv; Sipsey Wilderness Area – 0.008 dv; Shining Rock Wilderness Area – 0.006 dv; Linville Gorge Wilderness Area – 0.005 dv.

through 2020 which satisfies the 0.2 lb/MMBtu limits of the MATS rule for coal-fired EGUs. The NCDAQ agrees with this conclusion.

West Virginia – Pleasants Power Station

The WVDAQ provided the results of the reasonable progress assessment for Pleasants Power Station on September 28, 2021. The facility evaluated eight control options for SO_2 and identified one option that was technically feasible. After completing the four-factor analysis, this control technology, limestone forced oxidation scrubbers (LSFO), were determined to not economically feasible based on a cost effectiveness of $11,292.95 per ton ($9,931.94 for one scrubber). This conclusion was also supported by the fact that the remaining useful life of the existing wet lime FGD system already exceeds the RUL of the steam generators.

The WVDAQ determined that the facility is effectively controlled for SO_2 based on these results of the four-factor analysis. The NCDAQ agrees with this conclusion.

Responses from Non-VISTAS States

Arkansas - Entergy Arkansas Inc-Independence Plant

Arkansas has provided a four-factor analysis for the Entergy Arkansas Inc-Independence Plant (1.09% sulfate contribution at Shining Rock). Entergy is required to comply with an emission limit of 0.60 lb SO_2/MMBTU for Independence Unit 1 and Unit 2 two on a thirty-boiler-operating-day rolling average based on fuel switching to lower sulfur coal by August 7, 2021, pursuant to an agreed order between DEQ and Entergy as part of the Arkansas 2018 Phase II Regional Haze SIP revision. The SO_2 limit is contained in the Arkansas draft SIP.

Entergy has also entered into a consent decree with Sierra Club under which the Independence Plant is obligated to cease coal burning operations by December 31, 2030. This consent decree was signed on March 11, 2021. Arkansas DEQ proposes that existing controls satisfy Regional Haze Planning Period II requirements for Independence based on these requirements. The NCDAQ agrees with this conclusion.

Missouri - New Madrid Power Plant-Marston, MO

Missouri Department of Natural Resources' Air Pollution Control Program responded to the NCDAQ's request indicating that they have requested that the facility complete a four-factor analysis. In a July 30, 2021 letter to VISTAS, Missouri forwarded their draft Regional Haze SIP for review and comment. In the draft SIP, it is stated that as a result of the four-factor analysis, no new control measures were required to be installed at New Madrid. Specifically, potential control options for SO_2 evaluated included DSI, spray dryer adsorber (SDA) FGD, and wet FGD systems, all of which were determined to be technically feasible but not cost effective. However, Missouri and the plant entered into a consent agreement and the limits and requirements of this agreement are included in the Missouri draft SIP. The limitations include a requirement to burn primarily western sub-bituminous coal to limit SO_2 emissions and requirements to continuously operate separated over-fire air and SCR to control NO_X. The NCDAQ defers to the decision of the Missouri Department of Natural Resources' Air Pollution Control Program in their conclusions regarding reasonable progress at the New Madrid Power Plant.

Pennsylvania - Homer City Gen LP/Center TWP

Homer City Generating Station submitted a four-factor analysis to Pennsylvania on October 30, 2020. Homer City indicated that the units are currently controlled by BACT-level controls for SO_2, NO_x, and PM which meet the low emitting EGU threshold set forth in the MATS rule. In the four-factor analysis, Homer City evaluated several technically feasible upgrades to the controls in place for SO_2 and NO_x emissions. For SO_2, potential controls measures included conversion to low sulfur coal, an upgrade/replacement to novel integrated desulfurization system (NIDS), and partial natural gas conversion. SO_2 cost per ton estimates for these measures ranged from $7,245 to $15,580. For NO_x, potential controls measures included replacing the low NO_x burners/separated over-fired air (LNB/SOFA), replacement of selective catalytic reduction (SCR) system, and new NH_3 vaporizers. NO_x cost per ton estimates for these measures ranged from $8,170 to $43,883. Homer City concluded that these costs, when considered alongside lengthy times to implement and increases in energy consumption and other pollutants, were not reasonable. The NCDAQ agrees with this conclusion.

Pennsylvania - Genon NE Mgmt Co/Keystone Station

Keystone Generating Station submitted a four-factor analysis to Pennsylvania on July 29, 2020, and they submitted a revision to this analysis on January 11, 2021. Keystone indicated that the units are currently controlled by BACT-level controls for SO_2 and NO_x. Keystone did not identify any technically feasible controls for SO_2, because the units are already controlled by wet FGD and dry sorbent injection. For NO_x control, Keystone did evaluate potential tuning and upgrading of the low NO_x burners installed the units. The cost effectiveness of this upgrade was estimated to be $16,322/ton NO_x removed. Keystone did not identify any reasonable control measures for NO_x or SO_2 as a result of the four-factor analysis. The NCDAQ agrees with this conclusion.

Ohio - Cardinal Power Plant - Cardinal Operating Company

A reasonable progress analysis provided by the state of Ohio indicated that due to the presence of an FGD and SCR system of at least 90% effectiveness, this facility is considered to be 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. Boilers B001, B002, and B009 are required to be continuously controlled by FGD systems with an effective control efficiency of 95%. The NCDAQ agrees with this conclusion.

Ohio - General James M. Gavin Power Plant, OH

A reasonable progress analysis provided by the state of Ohio indicated that due to the presence of an FGD and SCR system of at least 90% effectiveness, 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%. Ohio has requested a four-factor analysis from the facility. The NCDAQ is satisfied with this consultation.

Ohio - Duke Energy Ohio, Wm. H. Zimmer Station, OH

According to the state of Ohio, Zimmer Power Station has announced a planned shutdown in 2027. On July 9, 2021, Ohio EPA issued a Director's Final Findings and Orders requiring Zimmer Power Station to permanently shut down all coal burning activities by January 1, 2028. This shutdown is also evidenced by a notice filed with the regional transmission organization (RTO) showing a closure date of May 31, 2022. The NCDAQ agrees with this conclusion.

Indiana Michigan Power - Rockport and Duke Energy Indiana, LLC – Gibson

Indiana Michigan Power – Rockport (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. Duke Energy Indiana, LLC – Gibson (Gibson) is a five-unit coal power plant in southwestern Indiana. Each unit is equipped with a wet FGD and an SCR which control SO_2 and NO_X by 93% and 81%, respectively.

The Indiana Department of Environmental Management (IDEM) did not provide a response to the June 22, 2020, VISTAS letter requesting four-factor analyses of these facilities to indicate that such an analysis would be performed or that other factors obviated the need for such an analysis. Review of the September 2021 Indiana pre-hearing draft SIP revealed that a four-factor analysis was not performed for Rockport or Gibson, nor was there sufficient justification for omitting such an analysis from the SIP. On November 10, 2021, the NCDAQ submitted comments on the pre-hearing draft requesting Indiana either perform four-factor analyses or provide some reasonable justification for omitting them.

In a letter to VISTAS dated December 22, 2021, IDEM stated that they are not requiring four-factor analyses from Indiana's EGUs. In their letter, IDEM states that "IDEM is intently evaluating other emission sectors for this second implementation period to determine their visibility impacts on Class I areas. IDEM will conduct a review of all its emission sources, with focus on the EGU sector, for its January 31, 2025, progress report; pursuant to 40 CFR 51.308(g). IDEM will evaluate EGUs for the third implementation period of the RH rule, as necessary, to be submitted in 2028." Additionally, IDEM cites the EPA's 2019 Guidance that states a "key flexibility of the regional haze program is that a state is not required to evaluate all sources of emissions in each implementation period." IDEM submitted their final Regional Haze SIP to EPA on December 30, 2021.

While IDEM did not conduct the analyses requested by the NCDAQ, the EPA guidance does provide states with the flexibility in determining which facilities to evaluate during each implementation period. Therefore, he NCDAQ defers to IDEM regarding their decision to evaluate EGUs during a later implementation period.

10.1.2 North Carolina Emission Source Impacts on Class I Areas in Other States

The NCDAQ evaluated the impacts of North Carolina's statewide SO_2 and NO_x emissions on Class I areas outside of North Carolina. North Carolina consulted with each VISTAS state during the development of its LTS and none of the VISTAS states requested consultation with North Carolina regarding North Carolina's statewide impacts on Class I areas and none of the VISTAS states requested a reasonable progress analysis for any of North Carolina's emission sources. As discussed in Section 10.2 of this SIP, VISTAS held a webinar on April 21, 2020, to present to the RPOs and their member states the VISTAS modeling analysis and results to make them aware of the impacts on Class I areas in their states. This information was also made available upon request from states outside of VISTAS and provided on the SESARM website. Based on these modeling results, no other non-VISTAS states with Class I areas requested consultation with North Carolina or a reasonable progress analysis of North Carolina emission sources.

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 considered their comments along the way. 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
September 5, 2018	Teleconference and VISTAS Presentation	RPOs, CC[2]/TAWG[3]
January 31, 2018	Teleconference and VISTAS Presentation	FLMs, EPA Region 4, CC/TAWG
August 1, 2018	Teleconference and VISTAS Presentation	FLMs; EPA OAQPS, Region 3, Region 4; CC/TAWG
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

Date	Meetings and Calls	Participants
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
September 15, 2020	Webinar and VISTAS Presentation	NPS

[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 AoI values 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 AoI values 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.

Additionally, the NCDAQ 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. North Carolina was part of a southeastern state breakout session with FLMs and EPA discussing the modeling and future expectations from all parties. Documentation of these meetings/calls can be found in Appendix F-3.

10.3 Consultation with MANE-VU

The following documents the 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* in which it documented consultation meetings, comments received, and responses to comments which is available from MANE-VU's website.[130] 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.

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 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 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.
January 12, 2018	MANE-VU Conference Call. Inter-Regional Consultation #4, Reasonable Progress Overview.
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}.
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 Secretary Michael Regan, North Carolina NCDEQ. Purpose: Acknowledgement of participation in MANE-VU consultation calls and receipt of comments on 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 VISTAS state to

[130] MANE-VU Regional Haze Consultation Report, July 27, 2018, MANE-VU Technical Support Committee, https://otcair.org/MANEVU/Upload/Publication/Correspondence/MANE-VU_RH_ConsultationReport_Appendices_ThankYouLetters_08302018.pdf.

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 actual 2015 emissions for EGUs and 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 ≥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 ≥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 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 that they planned to submit their 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 10-3). 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.[131]

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."[132]

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 ≥3.0 Mm^{-1} at any MANE-VU Class I area; establishment of an ultra-low sulfur 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

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[131] *Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts* (December 1998).
[132] Federal Register, Vol. 82, No. 10, Tuesday, January 17, 2017, Page 5195.

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-VUs approach and conclusions. As a result of their active participation the MANE-VU consultation process, the VISTAS states fulfilled the consultation requirements specified in the RHR (51.308(f)(2)(ii)).

10.4 Federal Land Manager Consultation

The NCDAQ provided a draft of this regional haze SIP to the FLMs for the formal 60-day consultation process from April 5 through June 5, 2021. On April 20, the NCDAQ held a consultation meeting with the FLMs to provide an overview of the draft SIP, analytical approaches for source selection analysis, and results of the four-factor analysis for North Carolina facilities. The NPS initiated a consultation call with the NCDAQ to provide its preliminary comments on May 14 and its final comments on May 25. The USFS and USF&WS were invited to these calls. The USFS and NPS provided written comments on June 3 and June 4, respectively. The USF&WS did not provide any comments during the consultation period. The following provides a summary of comments provided by the NPS (regarding the GSMNP) and USFS (regarding Joyce Kilmer-Slickrock, Linville Gorge, and Shining Rock Wilderness Areas) and the NCDAQ's responses to the comments. Appendix H to this SIP includes the full set of comments provided by the NPS and USFS.

10.4.1 Exclusion of NO_x from Four-Factor Analysis

NPS Comment

Ammonium nitrate from NO_x emissions is a significant anthropogenic haze causing pollutant. Over the past ten years the importance of ammonium nitrate on the 20% most-impaired days has increased for many Class I areas in the VISTAS region, including at Great Smoky Mountains NP. As SO_2 emissions decline and the seasonality of most-impaired days shifts, NO_x emissions are increasingly important for many VISTAS Class I areas.

The North Carolina rationale for excluding NO_x emissions from reasonable progress four-factor analyses is based on an outdated modeling base year (2011) and associated inaccurate assumptions about the current and future distribution of most-impaired days in the modeling assessment. We recognize that the modeling methods follow EPA guidance and are technically correct, however the result is not representative of current conditions. The importance of ammonium nitrate and the distribution of most-impaired days has changed significantly since the 2011 base year. In 2011, ammonium sulfate-dominated extinction on the 20% most-impaired days which occurred mostly during the warmer, summer months. Currently, ammonium nitrate extinction which is highest during the cooler months of the year is now included among the 20% most-impaired days. As a result, 2028 projections based on the 2011 most-impaired days miss the importance of ammonium nitrate extinction. This is supported by the past five-years of IMPROVE monitoring data.

The NPS recommends that North Carolina acknowledge more recent monitoring data in their source selection process and consider NO_x emission reduction opportunities as relevant to addressing regional haze during this planning period. Reducing NO_x emissions would have additional regional co-benefits for ozone and nitrogen deposition. Great Smoky Mountains NP is currently part of two limited maintenance plans for ozone and has 12 acidified streams on the Clean Water Act 303(d) list for pH-impaired surface waters from excessive atmospheric nitrogen and sulfur deposition. A total maximum daily load (TMDL) of nitrogen and sulfur deposition was established to restore these streams which will require additional nitrogen and sulfur reductions to reach these protective critical loads. While much of the region's NO_x emissions come from mobile sources, emissions inventories also show a significant quantity of NO_x emissions from point sources in North Carolina that could be addressed under the regional haze program.

USFS Comments

The draft RH SIP only evaluates SO_2 emission sources for reasonable progress evaluations / four-factor analyses. USDA Forest Service appreciates the discussion within the draft RH SIP regarding nitrate formation in the VISTAS region. We understand that nitrate formation in the VISTAS region is limited by the availability of ammonia (which preferentially reacts with SO_2 and sulfates before reacting with NO_x) and by temperature, with particle nitrate concentrations highest in the winter months. We also recognize that sulfates have been the main contributor to visibility impairment at Class I Areas within the southern US. Additionally, the substantial emission reductions of both SO_2 and NO_x from coal-fired power plants over the past decade within NC as a result of the Clean Smokestacks Act are admirable and a model for other states. The emissions data show that most NO_x emissions within NC are from the mobile sector. However, the nitrate contribution to visibility impairment is increasing as sulfur dioxide emissions decrease, and there are still significant NO_x sources within the point sector in NC. We request that NCDAQ consider evaluating NO_x sources, along with SO_2 sources, for reasonable progress during this planning period.

NCDAQ Response

In preparing its response to these comments, the NCDAQ documents in the following sections its review of the IMPROVE monitoring data, SO_2 and NO_x emissions trends from 2011 – 2028, and PSAT modeling for 2028 for Class I areas in North Carolina. The NCDAQ's summary and conclusions of the data regarding these comments is presented at the end of this section. Note that after reviewing the monitoring data supporting development of this SIP, NCDAQ obtained the 2019 IMPROVE data from the USF&WS in May of 2021, and it is considered in this response.[133] Therefore, the NCDAQ has included 2019 IMPROVE data in this response. Because IMPROVE monitoring data from GSMNP is used to represent visibility impairment at Joyce Kilmer-Slickrock Wilderness Area (see Section 1.4), the discussion of the IMPROVE monitoring data for the GSMNP also applies to the Joyce Kilmer-Slickrock Wilderness Area, except where noted.

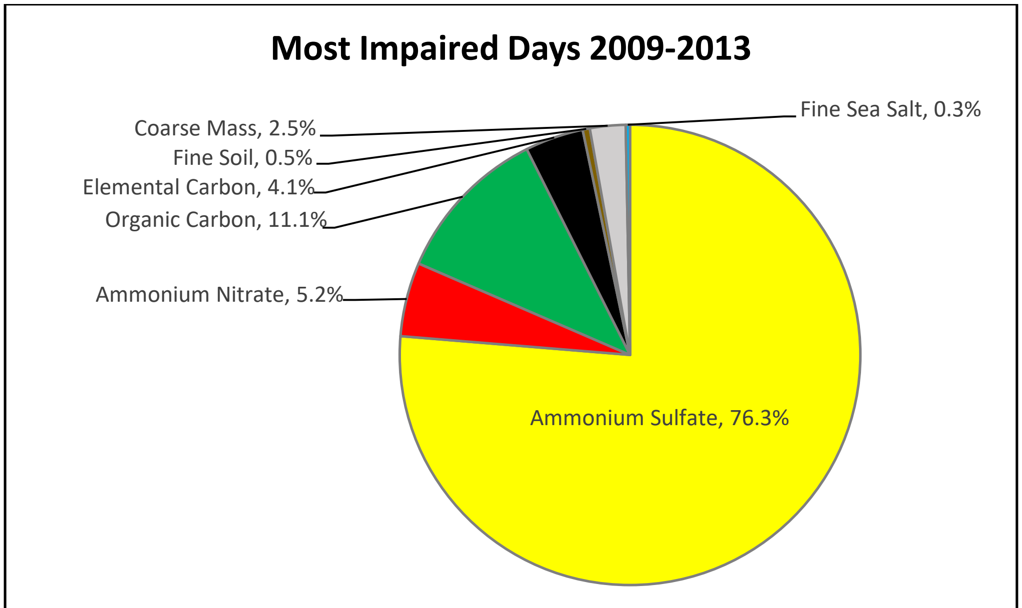
Review of IMPROVE Monitor Data for Great Smoky Mountains National Park and Linville Gorge and Shining Rock Wilderness Areas

For each of the three Class I areas, Figure 10-1 through Figure 10-3 compare the relative particle contributions to light extinction for the five-year average of 2009 – 2013 and 2015 – 2019 measured by IMPROVE monitors for the 20% most impaired days. When preparing the projected RPGs for 2028, based on EPA's modeling guidance, the species-specific RRFs were applied to the 2009 – 2013 average measured by the monitor for each Class I area. Comparison of these five-year periods show that while total impairment has declined significantly in each of the three Class I areas, the relative percentage of PM species contributions has also changed somewhat. The relative ammonium nitrate and organic carbon contributions have increased from the first to the second five-year period for the Great Smoky Mountains National Park and the Linville Gorge and Shining Rock Wilderness Areas. During the 2015 – 2019 period, the ammonium nitrate and organic carbon contributions are equal for the Great Smoky Mountains, but organic carbon contributions at the Linville Gorge and Shining Rock Wilderness Areas are much higher than the ammonium nitrate contributions to total visibility impairment. However, during the 2015 – 2019 period, ammonium sulfate continues to be the dominant visibility impairing species at all three Class I areas.

For each of the three Class I areas, Figure 10-4 through Figure 10-6 show particle contributions to light extinction from 2011 through 2019 for the 20% most impaired days. For the Great Smoky Mountains National Park, ammonium nitrate levels increased in 2017 and 2018 but returned to 2015 levels in 2019. A similar trend is observed for the Shining Rock Wilderness Areas where the ammonium nitrate increased in 2017 and 2018 but returned to 2016 levels in 2019. For the Linville Gorge Wilderness Area, ammonium nitrate levels also increased slightly in 2017 and 2018 and declined slightly in 2019. It is unclear why the ammonium nitrate

[133] IMPROVE monitoring data for 2019 were downloaded from a temporary Google Drive link provided in an email from Scott Copeland of the USDA Forest Service. As of July 31, 2021, these data had not been officially published on the IMPROVE website alongside data for previous years.

contribution to total impairment has fluctuated in recent years and further research is needed to understand the factors contributing (e.g., emission sources, weather, and meteorology) to the nitrate fraction at these three Class I areas.



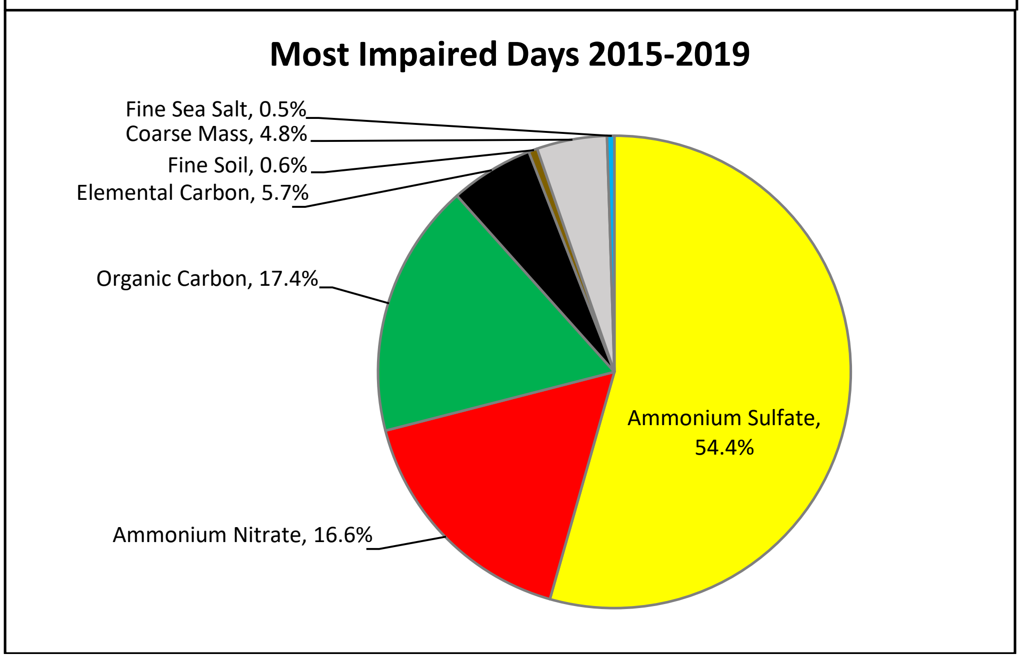


Figure 10-1. Comparison of Five-Year Average (2009-2013 vs. 2015-2019) Particle Contributions to Light Extinction for 20% Most Impaired Days at Great Smoky Mountains National Park

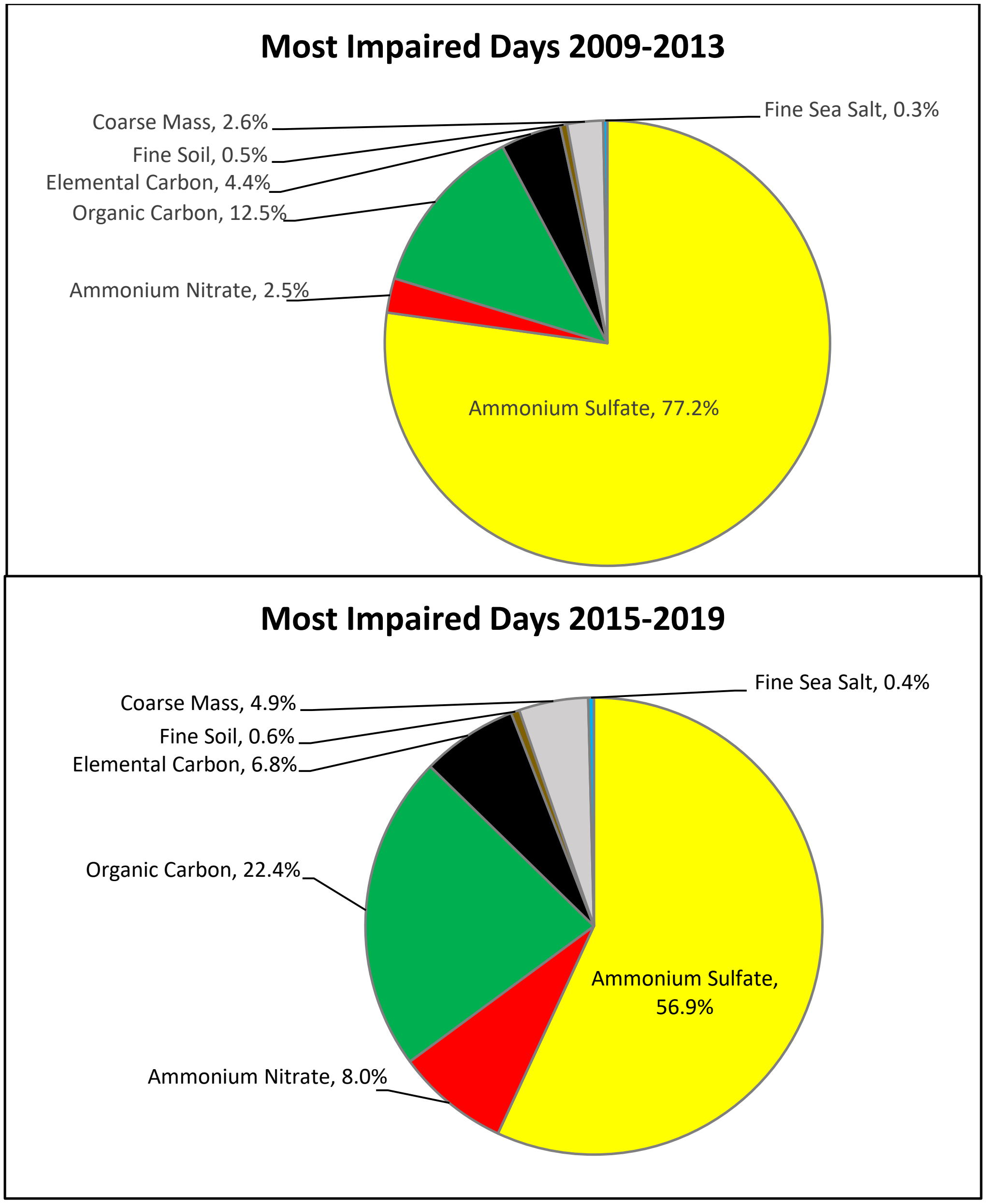
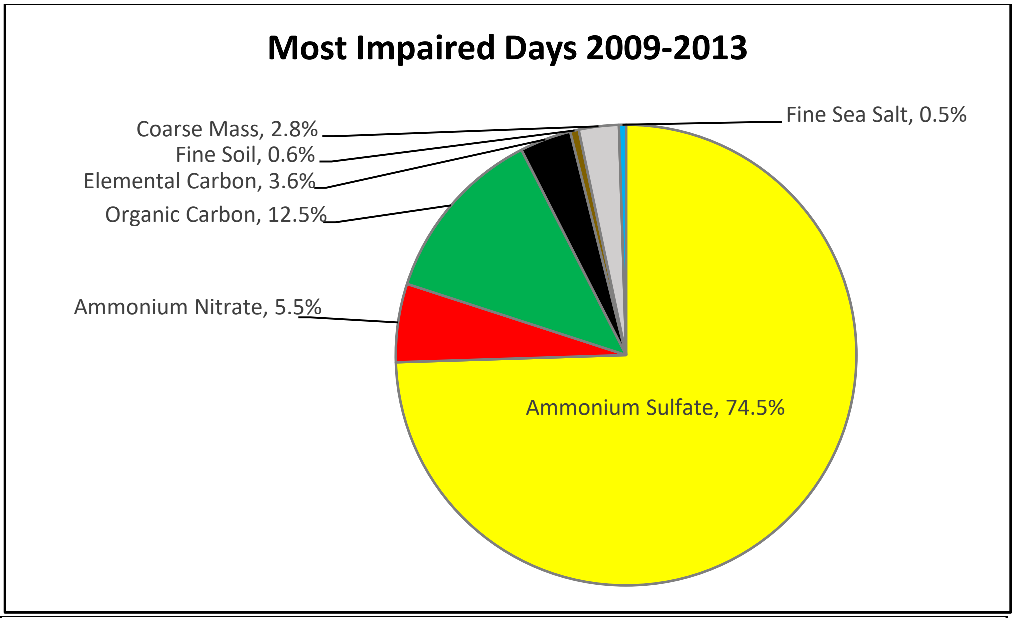


Figure 10-2. Comparison of Five-Year Average (2009-2013 vs. 2015-2019) Particle Contributions to Light Extinction for 20% Most Impaired Days at Linville Gorge Wilderness Area



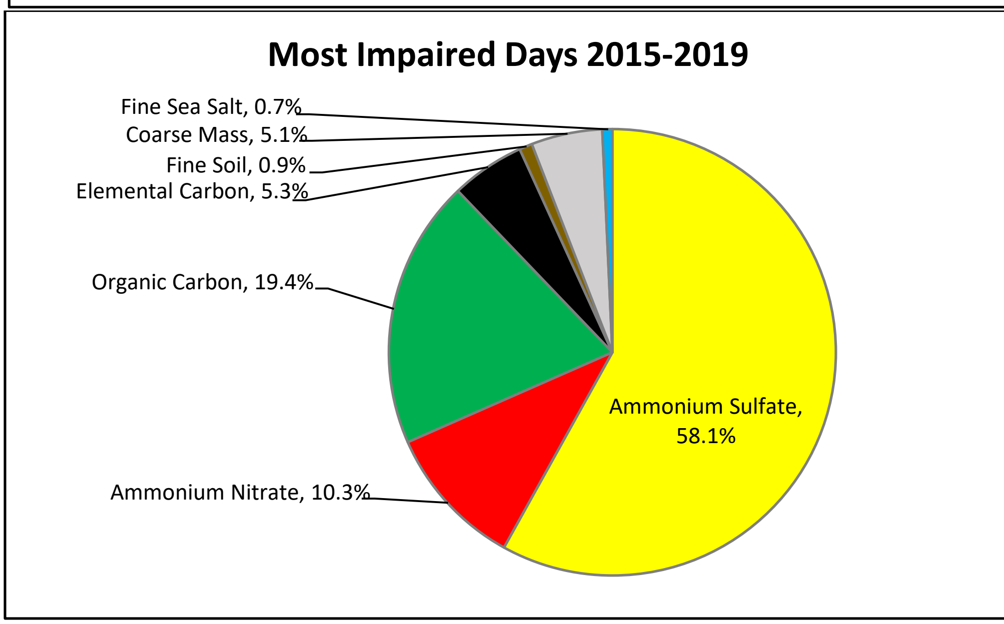


Figure 10-3. Comparison of Five-Year Average (2009-2013 vs. 2015-2019) Particle Contributions to Light Extinction for 20% Most Impaired Days at Shining Rock Wilderness Area

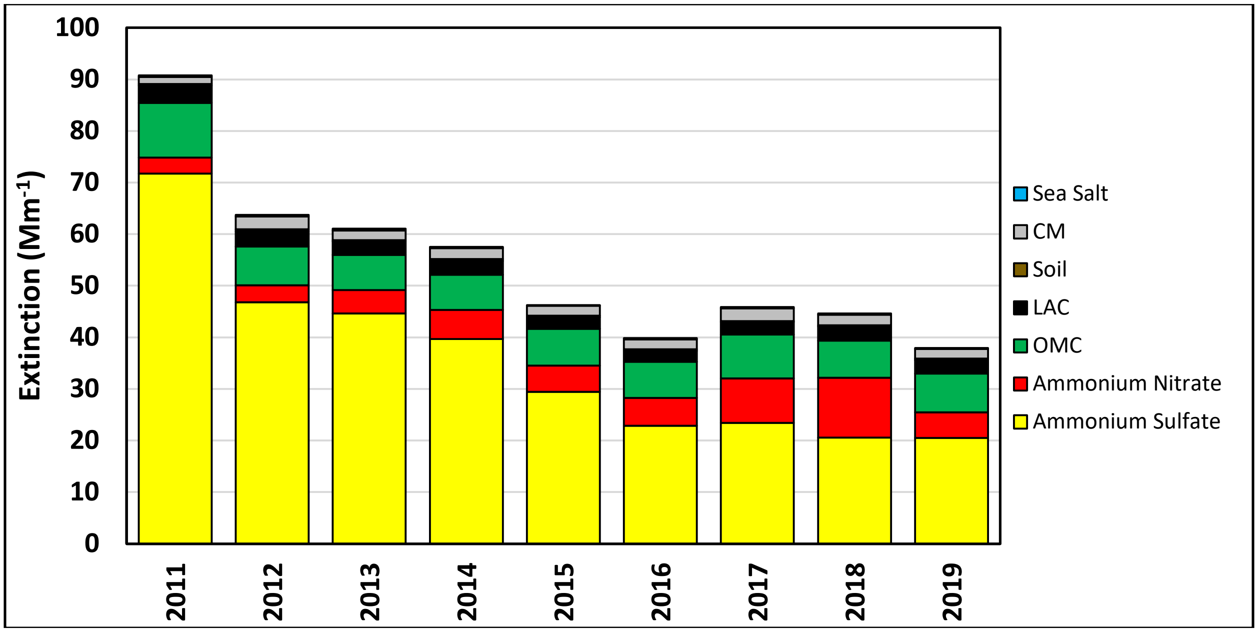


Figure 10-4. Particle Contributions to Light Extinction for 20% Most Impaired Days at Great Smoky Mountains National Park for 2011-2019

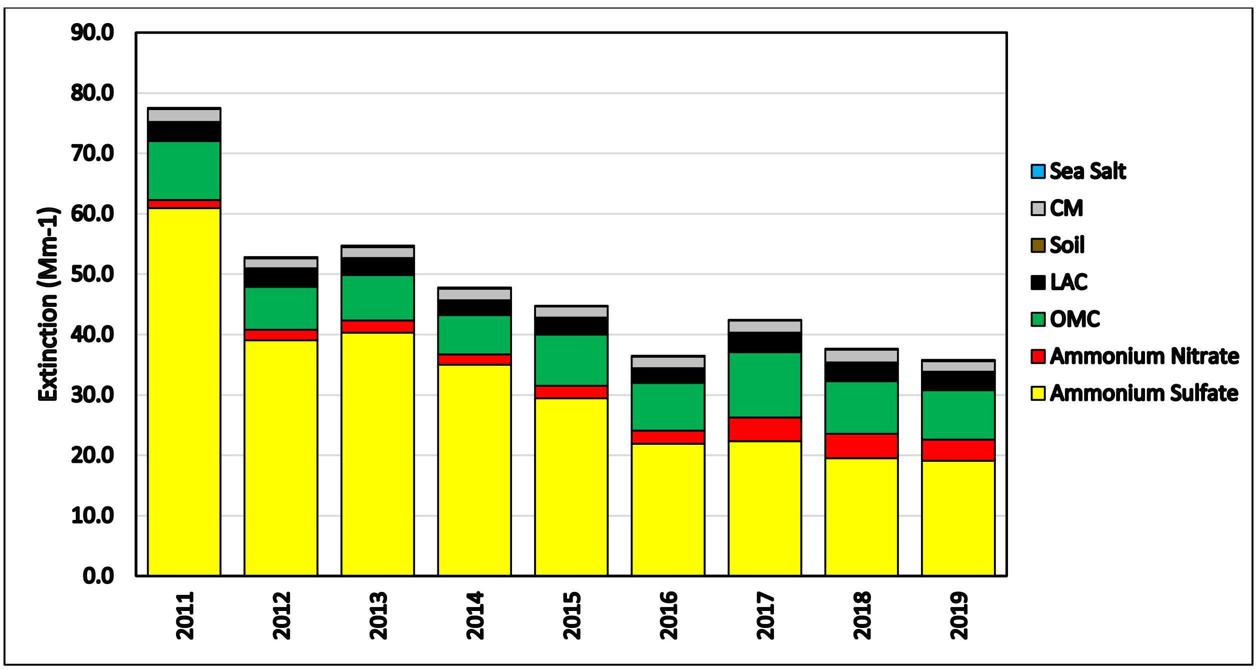


Figure 10-5. Particle Contributions to Light Extinction for 20% Most Impaired Days at Linville Gorge Wilderness Area for 2011-2019

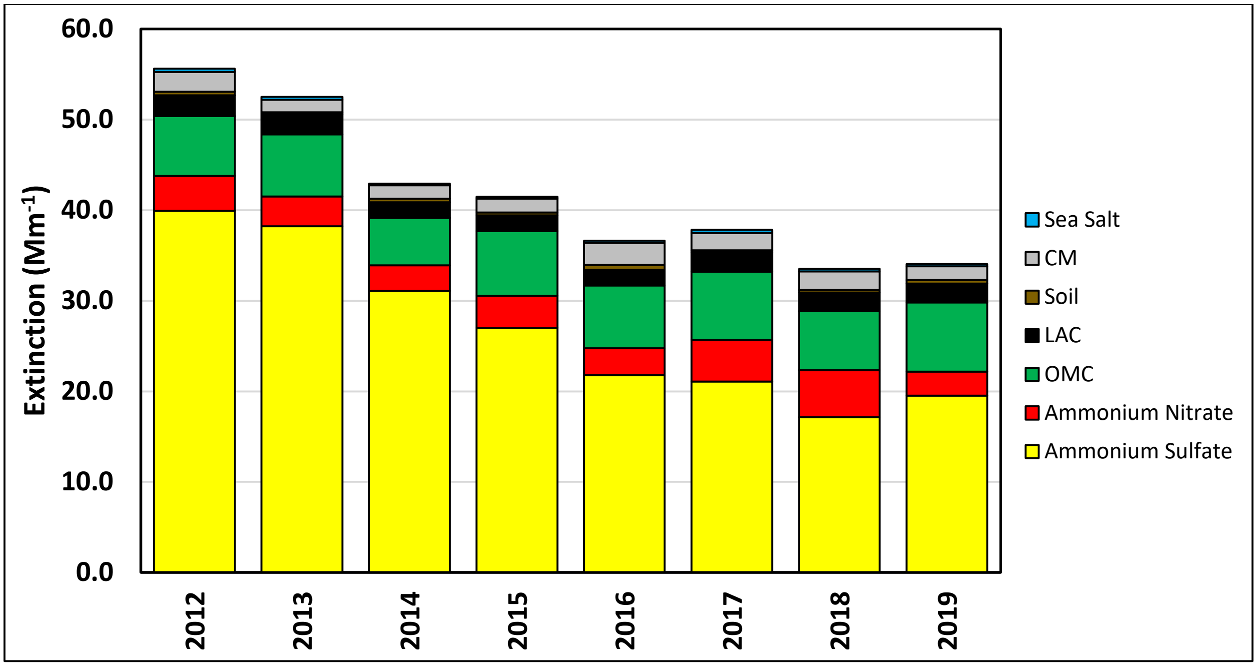


Figure 10-6. Particle Contributions to Light Extinction for 20% Most Impaired Days at Shining Rock Wilderness Area for 2011-2019

Figure 10-7 compares the five-year average of 2009 – 2013 and 2015 – 2019 for ammonium sulfate and ammonium nitrate contributions to visibility impairment for all Class I areas in the VISTAS region. These data clearly show that although ammonium nitrate contributions have increased slightly for some Class I areas, ammonium sulfate remains as the dominant visibility impairment species through 2019.

The NPS points to the shift in the 20% most impaired days from primarily summer months to fall, winter, and spring months which is illustrated in Table 10-5. Table 10-6 shows the number of days where nitrate exceeded sulfate concentrations. They note that use of 2011 as the basis for the 20% most impaired days does not reflect current trends. Although the days and seasons that make up the 20% most impaired days have shifted somewhat from 2011 to 2016 – 2019, the total number of days that are dominated by sulfate still exceeds the total number of days dominated by nitrate for each year. For example, 23 days of IMPROVE monitoring data make up the 20% most impaired days for the Great Smoky Mountains National Park. In 2011, all 23 days were dominated by sulfate. In 2016, 2017, 2018, and 2019 the total number of days where nitrate exceeded sulfate impairment were 1, 3, 7, and 5 days, respectively. At nearby Linville Gorge and Shining Rock Wilderness Areas, no days in 2016 were nitrate dominant, and no more than 4 days were nitrate dominant from 2017 – 2019. This illustrates that sulfate is still the dominant visibility impairing pollutant for these three Class I areas for this second planning period. Additional research will be needed to understand why nitrate contributions are fluctuating from year to year and shifting between seasons within a given year. This fluctuation does not necessarily mean that the higher nitrate fractions are associated with EGU and non-EGU point sources.

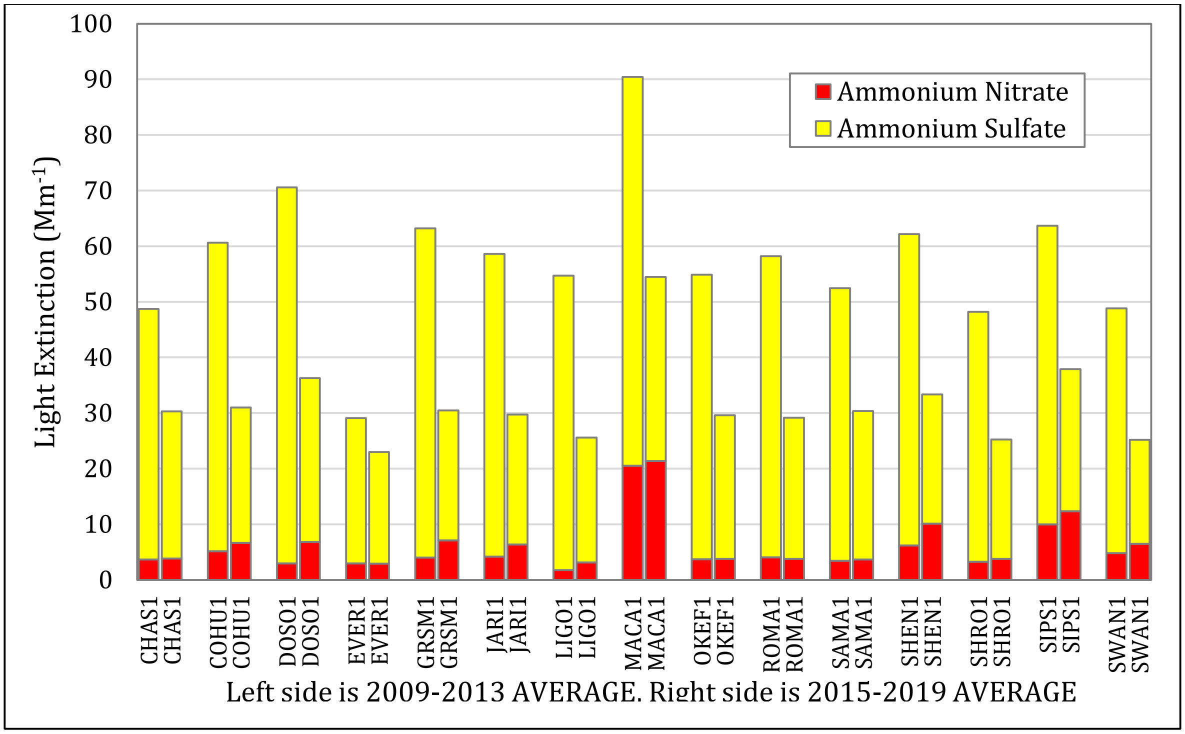


Figure 10-7. Comparison of Ammonium Sulfate and Ammonium Nitrate Five-Year Average (2009 – 2013 vs. 2015 – 2019) Contributions to Visibility Impairment for 20% Most Impaired Days at Great Smoky Mountains National Park

Table 10-5. Number of Days by Month Included in 20% Most Impaired Days for 2011 and 2016 – 2019 for Great Smoky Mountains National Park and Linville Gorge and Shining Rock Wilderness Areas

	Winter			Spring			Summer			Fall			Total
Year	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Days**
Great Smoky Mountains National Park													
2011		2	1	1			1	7	9	1		1	23
2016		3	3			2	3	2	5	3	1	1	23
2017	4	1	1	1		2	1	3	3	5		2	23
2018	1	5		3	1	1		5	1	2	1	3	23
2019		2	1	4		1		2	4	7	1	1	23
Linville Gorge													
2011		2	1			1	2	3	11	3			23
2016		1	1	1	1	1	1	5	4	6	2	1	24
2017	2	2	1	1		3	2	3	4	4		2	24
2018		2		3	2	1	2	5	2	3	2	2	24
2019	1	1		3		1	2	4	4	7	1		24
Shining Rock													
2011	Not available due to incomplete data for 2011												
2016			1	1	1	2	2	4	5	5	2	1	24
2017	3	1	3			2	1	4	2	4	1	2	23
2018		2		2	1	2	3	5	2	2	1	2	22
2019			1	1		1		4	4	9	1		21

Table 10-6. Days on Which Nitrate Exceeded Sulfate Concentrations for the 20% Most Impaired Days for Great Smoky Mountains National Park and Linville Gorge and Shining Rock Wilderness Areas

Class I Area	2011	2016	2017	2018	2019
Great Smoky Mountains National Park					
		Jan. 19	Jan. 7	Jan. 2, 5, & 17	Jan. 15 & 24
			Dec. 12 & 15	Mar. 9 & 21	Mar. 7 & 22
				Nov. 28	Nov. 20
				Dec. 2	
Total Days	0	1	3	7	5
Linville Gorge					
			Jan. 10	Jan. 5	Jan. 12
			Dec. 15	Mar. 24	Mar. 7 & 22
				Nov. 28	Dec. 8
Total Days	0	0	2	3	4
Shining Rock					
			Dec. 15	Jan.5	
				Mar. 24	
Total Days	N/A	0	1	2	0

Emissions Trends and PSAT Modeling for 2028

For North Carolina, Figure 10-8 and Figure 10-9 show statewide sector-level contributions to total emissions for SO_2 and NO_x, respectively. The 2011 and 2028 emissions are from the modeling platform used for modeling RPGs for Class I areas in North Carolina. The 2017 emissions are from the 2017 National Emissions Inventory (NEI). Table 10-7 summarizes the emissions by the major source categories [i.e., mobile (onroad and nonroad), stationary point (all point sources), and miscellaneous (includes predominately prescribed fires and wildfires)]. From 2011 – 2017, SO_2 and NO_x emissions have been reduced by 65% and 37%, respectively. From 2017 – 2028, SO_2 and NO_x emissions are projected to decline an additional 22% and 40%, respectively, due to federal and state control programs. Point sources that combust coal and oil containing sulfur (EGUs and non-EGUs) and industries that emit SO_2 (e.g., pulp and paper) are the major sources of SO_2 emissions and, therefore, can be easily linked to sulfate contributions at Class I areas. However, NO_x emissions are associated with fuel combustion in both the mobile and stationary source sectors. Unlike SO_2, it is difficult to identify the specific sources of NO_x that contribute to nitrate at an IMPROVE monitor on a given day of the year. For North Carolina, in 2017, highway (onroad) and off-highway (nonroad) vehicles considered together account for about 68% of total statewide emissions for all sectors.

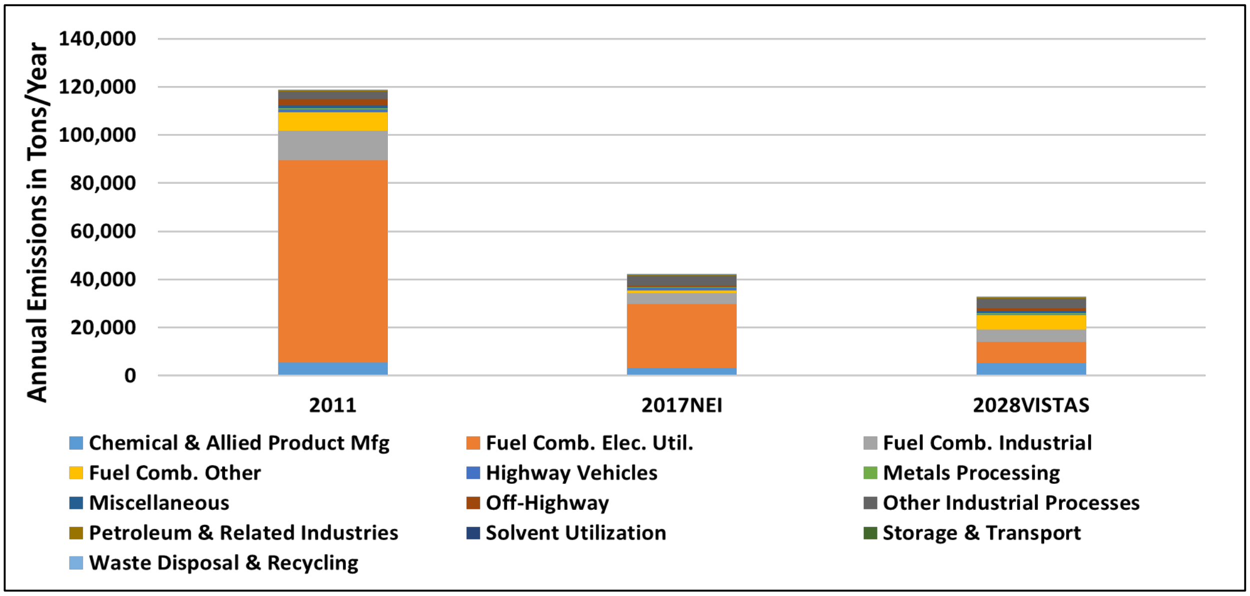


Figure 10-8. North Carolina SO_2 Emissions Trends by Sector

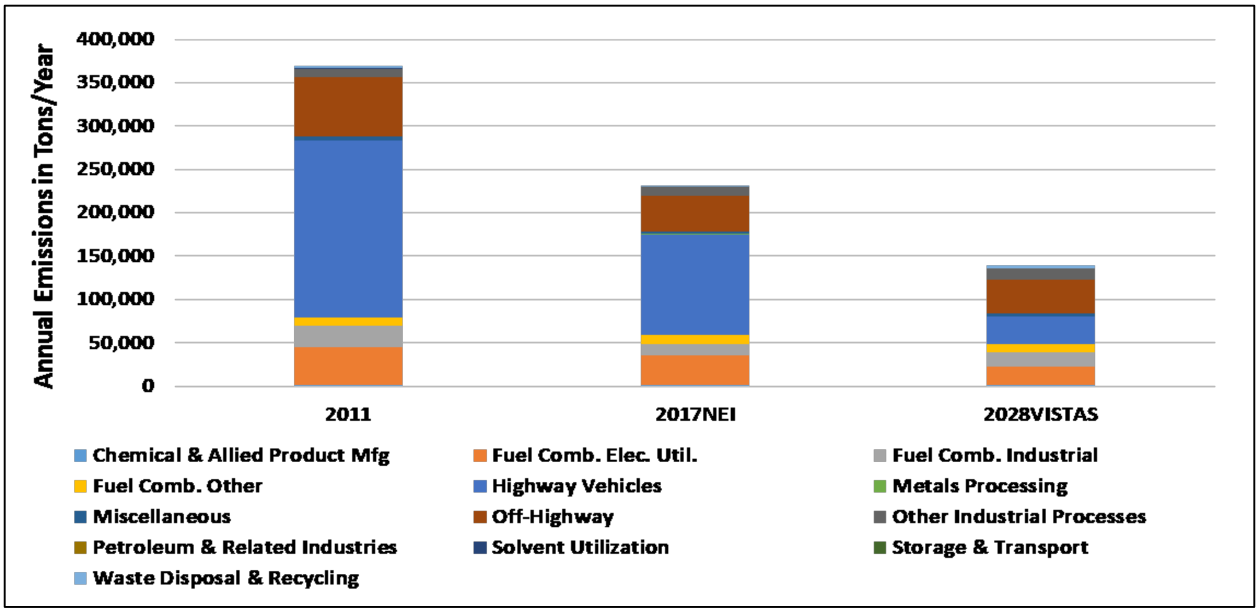


Figure 10-9. North Carolina NO_x Emissions Trends by Sector

Table 10-7. Comparison of Emission Sectors for 2011, 2017 and 2028 Emissions and Total Reductions

Emission Inventory Year	Onroad and Nonroad	Stationary Point	Miscel-laneous*	Total Emissions	Onroad and Nonroad	Stationary Point	Miscel-laneous*
	NO_x Emissions (TPY)				**Percent of Total Emissions**		
2011	272441	93008	4047	369496	74%	25%	1%
2017 NEI	157428	71619	2631	231679	68%	31%	1%
2028 VISTAS	70347	65137	3500	138984	51%	47%	3%
	SO_2 Emissions (TPY)						
2011	3554	114099	1068	118721	3%	96%	1%
2017 NEI	1826	40246	0	42073	4%	96%	0%
2028 VISTAS	1366	30323	956	32645	4%	93%	3%
			NO_x	**SO_2**			
Total Reduction from 2011 to 2017			37%	65%			
Total Reduction from 2017 to 2028			40%	22%			

* Miscellaneous emissions include predominately prescribed fires and wildfires.

Section 7.4 (Relative Contributions to Visibility Impairment: Pollutants, Source Categories, and Geographic Areas) of this SIP presents the PSAT modeling results for 2028 for the most impaired days for Class I areas in the VISTAS region. Figure 7-23 (2028 Nitrate Visibility Impairment, 20% Most Impaired Days, VISTAS Class I Areas) shows that contributions to nitrate impairment from the CENRAP, LADCO, and MANE-VU sources, as well as the sum contributions from the other VISTAS states, are significantly larger than contributions from North Carolina sources. Figure 7-31 (2028 Contribution to Light Extinction on the 20% Most Impaired Days at Great Smoky Mountains) shows that in 2028 the nitrate contribution is associated primarily with mobile (onroad and nonroad) and nonpoint stationary sources and point sources (EGU and non-EGU) outside of North Carolina. As shown in the right-most two columns in this figure, nitrate contributions from point sources (EGU or non-EGU) in North Carolina are negligible. This finding also applies to the Linville Gorge, Shining Rock, and Joyce Kilmer-Slickrock (see Figure 7-28 through Figure 7-30). Requiring additional NO_x controls on point sources in North Carolina would have little to no impact on improving visibility in the Great Smoky Mountains National Park and Linville Gorge and Shining Rock Wilderness Areas. Further research is needed to understand which sources are contributing to the nitrate fraction both in North Carolina and out-of-state.

Table 7-14 presents the PSAT-modeled visibility impairment for 2028 for all Class I areas within the VISTAS modeling domain. This table shows combined sulfate and nitrate visibility impairment across all emissions sectors, for North Carolina and all other regions within the modeling domain. As presented in Table 7-14, the modeling results show that North Carolina contributes less than 0.89 Mm^{-1} to Class I areas in neighboring states. Subsequent analysis of these data show that North Carolina contributed no more than 0.59 Mm^{-1} in sulfates *or* nitrates to Class I areas in neighboring states.

Summary and Conclusions

The NCDAQ reviewed all available IMPROVE monitoring data for the Class I areas in North Carolina during the development of this SIP. Both SO_2 and NO_x emissions sources (both stationary and mobile) were analyzed during the AoI and PSAT modeling work to consider in the source selection step. The NCDAQ also considered the flexibilities provided to the states in deciding how to prioritize pollutants and emission sources for improving visibility during the second planning period as documented in EPA's 2019 regional haze guidance. In so doing, for the second planning period, the NCDAQ concluded that ammonium sulfate is the dominant pollutant followed by organic carbon and ammonium nitrate.

The NPS stated in their comments that "The North Carolina rationale for excluding NO_x emissions from reasonable progress four-factor analyses is based on an outdated modeling base year (2011) and associated inaccurate assumptions about the current and future distribution of most-impaired days in the modeling assessment." However, the NCDAQ disagrees with this comment for the following reasons:

- Emissions and modeling work needs to begin three years before SIPs are due because of the significant amount of time required to complete the work one year in advance of preparing the SIPs. For this planning period, funds were not available to the states to build a new modeling platform with a more recent base year. Consequently, the 2011 base year modeling platform was selected because it was the best platform available at the time the modeling work began in early 2018. VISTAS discussed the selection of modeling platforms with EPA prior to starting this work and EPA agreed that using EPA's 2011 modeling platform was the latest available at the time and was sufficient to support the development of regional haze SIPs for the second planning period.

- About 18 months after VISTAS started its modeling using the 2011 platform, EPA released a new platform with a 2016 base year and then decided to conduct regional haze modeling for 2028 using the 2016 platform. The EPA modeling used 2016 meteorology and calculated RRFs (percent reduction between 2016 and 2028) were applied to 2014 – 2017 IMPROVE data to calculate RPGs for 2028. Figure 10-10 compares the projected speciated modeling results from the EPA and VISTAS modeling for the three Class I areas. The 2028 visibility impairment projection for the 20% most impaired days are generally similar, not only the sum of all the pollutants -- the RPG -- but also how much visibility impairment comes from each species. A common takeaway from both model projections is ammonium sulfate is expected to remain the dominant pollutant through 2028, and by a factor of 4 or greater, over ammonium nitrate at Class I areas in North Carolina. It is also worth noting that VISTAS' projected total light extinction for 2028 that is lower than EPA's projected 2028 visibility at all North Carolina Class I areas (which is due to differences in the emission projections and size of the modeling domains). However, this analysis demonstrates that sulfate remains the dominant pollutant and will remain so over the coming planning period, whether 2011 or 2016 meteorology, and associated 20% most impaired days, are used.

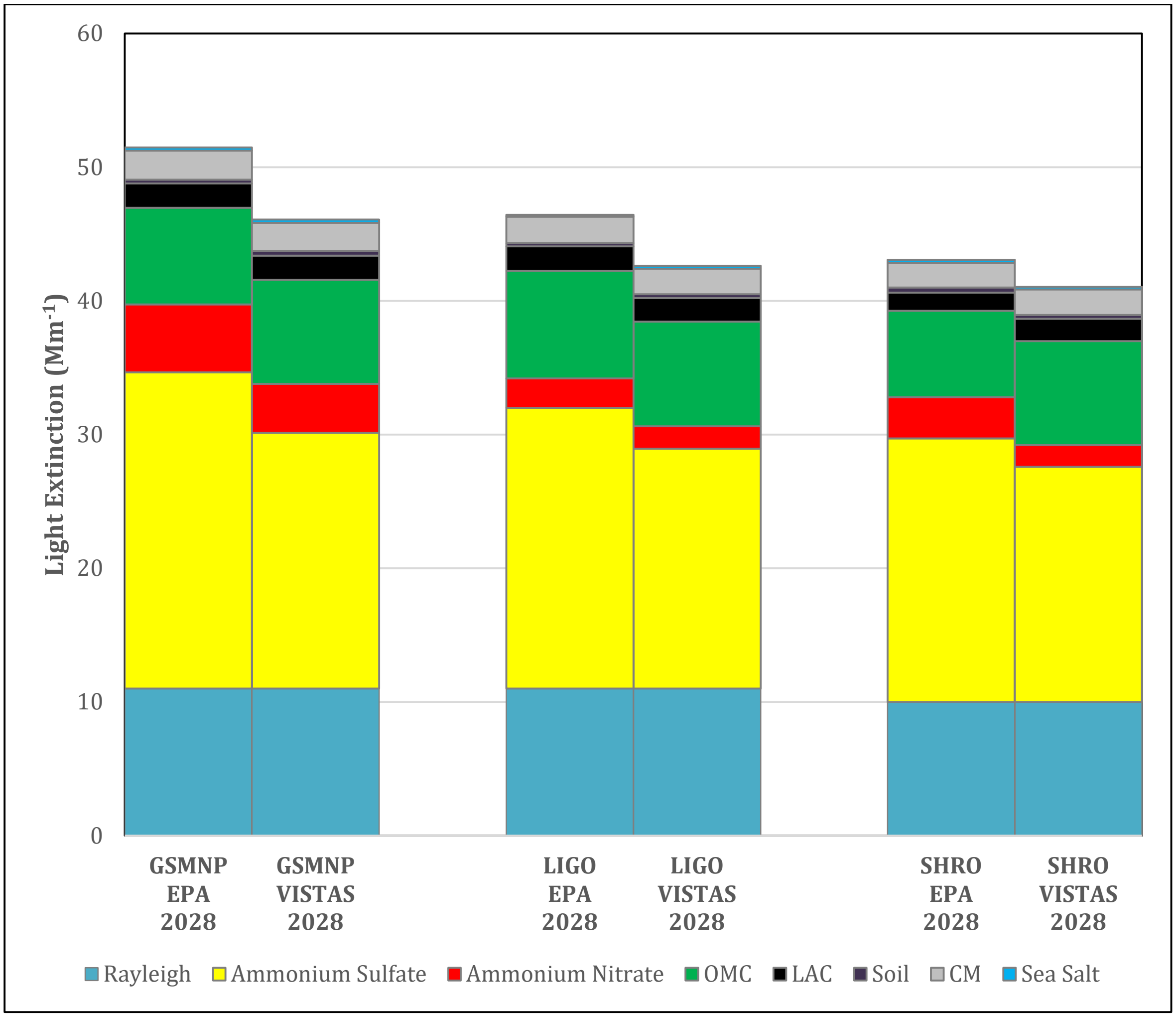


Figure 10-10. Projected 2028 Speciated Visibility Impairment for 20% Most Impaired Days at Great Smoky Mountains National Park (GSMNP), and Linville Gorge Wilderness Area (LIGO), and Shining Rock Wilderness Area (SHRO)

- The NCDAQ analyzed visibility impairment per ton of sulfate and nitrate emissions, respectively, at all North Carolina facilities selected for PSAT analysis (see Table 7-29), as well as all facilities outside of North Carolina selected by the NCDAQ for reasonable progress analysis (see Tables 7-37 and 7-38). The visibility impairment per ton of emissions for sulfate was compared against the same for nitrate as a ratio as follows:

$$ratio(facility, Class\ I\ area) = \frac{\left[\frac{Sulfate\ Visibility\ Impairment\ in\ Mm-1}{2028\ SO2\ Emissions\ in\ tpy}\right]}{\left[\frac{Nitrate\ Visibility\ Impairment\ in\ Mm-1}{2028\ NOx\ Emissions\ in\ tpy}\right]}$$

The sulfate to nitrate ratios by facility to the Great Smoky Mountains National Park and Joyce Kilmer-Slickrock, Linville Gorge, and Shining Rock Wilderness Areas are shown in Table 10-8 (the cells with "N/A" indicate a nitrate PSAT visibility impact of zero associated with NO_x emissions). Visibility impacts from sulfate as a function of Mm^{-1} per ton are universally higher than the same for nitrate, in some cases by a factor of 100 or more. These results indicate that reducing one ton of SO_2 has a significantly higher impact on improving visibility at these Class I areas rather than controlling one ton of NO_x supporting the NCDAQ's decision, in part, to focus on requesting facilities to perform four-factor analyses on only SO_2 emissions for this second planning period.

Table 10-8. Facility-Level Comparison of Sulfate versus Nitrate Visibility Impairment for the Great Smoky Mountains National Park and Linville Gorge and Shining Rock Wilderness Areas

Facility	Great Smoky Mountains National Park	Joyce Kilmer-Slickrock Wilderness Area	Linville Gorge Wilderness Area	Shining Rock Wilderness Area
Blue Ridge Paper Products - Canton Mill	50.4	51.8	124.8	82.1
Domtar Paper Company, LLC	N/A	N/A	N/A	N/A
Duke Energy Carolinas, LLC - Marshall Steam Station	121.6	128.8	60.2	81.1
PCS Phosphate Company, Inc. - Aurora	N/A	N/A	N/A	N/A
SGL Carbon LLC	N/A	N/A	N/A	N/A
Genon NE Mgmt Co/Keystone Station	51.9	N/A	N/A	N/A
TVA – Cumberland Fossil Plant	11.7	7.7	89.8	47.3
Georgia Power Company – Plant Bowen	79.4	96.6	N/A	101.0
TVA – Shawnee Fossil Plant	6.0	4.9	30.9	24.1
Eastman Chemical Company	26.1	63.8	43.2	45.9
Jewell Coke Company LLP	N/A	N/A	N/A	N/A
Allegheny Energy Supply Co, LLC-Harrison	49.3	130.2	N/A	N/A
Monongahela Power Co – Pleasants Power Station	29.4	57.5	45.1	N/A
Entergy Arkansas Inc. - Independence Plant	52.0	38.4	114.7	66.6
New Madrid Power Plant-Marston	39.3	39.8	N/A	62.0
Homer City Gen LP/Center TWP	33.0	N/A	N/A	N/A
Gibson	2.6	3.2	10.8	11.9
Indiana Michigan Power - Rockport	3.8	4.1	9.7	10.6
Cardinal Power Plant - Cardinal Operating Company	N/A	N/A	N/A	N/A
Duke Energy Ohio, Wm. H. Zimmer Station	31.3	47.3	14.6	44.6
General James M. Gavin Power Plant	64.4	87.9	82.9	110.5

[1] "N/A" indicates a nitrate PSAT visibility impact of zero associated with NO_x emissions.

- The regional haze planning process is iterative (with SIPs due every 10 years and progress reports due every 5 years) which provides an opportunity to further evaluate source contributions and meteorological conditions that contribute to the nitrate concentrations on specific days at each Class I area. The NCDAQ believes that further research is needed to understand what emission sources and meteorology conditions are contributing to the variability in the nitrate from 2016 – 2019. Further research is also needed to understand what emission sources and meteorology conditions are contributing to the organic carbon fraction as well. The 2028 PSAT modeling completed for this SIP indicates that EGUs and non-EGU facilities in North Carolina have an insignificant contribution to the ammonium nitrate fraction at Class I areas in North Carolina. The modeling suggests that mobile sources in-state and out-of-state and point sources located out-of-state are the main contributors to the nitrate fraction. During the next planning period, the NCDAQ commits to working with the NPS and other interested state and federal agencies to understand the emission sources that are contributing to nitrate and organic carbon concentrations at Class I areas in North Carolina.

10.4.2 Source Selection

NPS Comment

When identifying emission sources to evaluate for haze reduction opportunities, VISTAS and NC evaluated the potential visibility effects of individual facilities on Class I areas using extinction weighted residence times (EWRT) combined with emissions over distance (Q/d) for individual facilities in an area of influence analysis (AoI). Despite NPS concerns regarding 2028 projections (discussed above), we find this approach is more robust than dividing emissions by distance (Q/d) approach, as it accounts for meteorology on the 20% most-impaired days. In June 2019 NPS recommended that North Carolina evaluate 20 facilities based upon Q/d).

Our source selection concern stems from the screening thresholds used that resulted in the selection of very few sources for analysis and offers less protection for the more-impacted Class I areas. We advised VISTAS states of this concern in April 2020. VISTAS states, including North Carolina, used a two-part screening process. Both steps used an individual-facility-percent-of-total-impact screening metric. This type of metric biases the results against the more-visually-impacted Class I areas. In fact, source impacts would have to be 80 times larger to identify a source for analysis in the most-visually-impaired VISTAS Class I area compared to the least-visually-impaired Class I area. The absolute value of the VISTAS thresholds to identify a source affecting Great Smoky Mountains NP is 19 times higher than was needed to identify a source affecting Everglades NP in Florida (the least-visually-impaired VISTAS Class I area).

USFS Comment

Section 7.8 of NC’s draft RH SIP discusses the methodology that NCDAQ used to determine which sources to analyze for additional controls. Sources both within and out of North Carolina were included in the screening (i.e., in the ‘denominator’ of the contribution evaluation), and a source was selected for reasonable progress evaluation / four-factor analysis if the facility was estimated to have a ≥ 1.00% sulfate or ≥ 1.00% nitrate contribution to visibility impairment in 2028 at one or more NC Class I Areas. Three NC facilities were selected for further evaluation, and 12 additional out-of-state facilities were identified as having a ≥ 1.00% sulfate contribution to visibility impairment. USDA Forest Service understands and recognizes that EPA has afforded states the flexibility to screen facilities for additional analysis if that screening is based on reasonable methods. However, we request that NC consider only in-state facilities in the denominator of the contribution equation when screening for sulfate and nitrate visibility contributions at a Class I Area. This methodology would result in a more robust reasonable progress evaluation by focusing on sources permitted by NCDAQ. Additionally, since evaluations / four-factor analyses are time consuming and require additional resources, we would also suggest that NCDAQ consider conducting four-factor analysis on a source category basis rather than on an individual facility basis when warranted.

NCDAQ Response

The NCDAQ appreciates the analyses the NPS prepared using the Q/d*EWRT values generated by VISTAS. This approach is superior to the Q/d approach which does not account for meteorology or properly weight SO_2 vs. NO_x impacts on visibility impairment. At some locations, 1 ton of SO_2 reduction can have anywhere from twice to more than 100 times the impact on visibility impairment as 1 ton of NO_x reduction (see Section 10.4.1 and Table 10-8).

The NCDAQ reviewed the NPS analysis and, although it is informative, has taken a different approach to source selection. This approach does recognize the significant progress North Carolina has and is expected to achieve in the future toward improving visibility in its Class I areas which is consistent with EPA's August 20, 2019 guidance. Regarding the selection of sources for analysis (Step 3), EPA states:

> Page 5, Table 1: *Select the emission sources for which an analysis of emission control measures will be completed in the second implementation period and explain the bases for these selections. For the purpose of this source selection step, a state may consider estimated visibility impacts (or surrogate metrics for visibility impacts), the four statutory factors, the five required factors listed in section 51.308(f)(2)(iv), and other factors that are reasonable to consider.*
>
> Page 9: "*A key flexibility of the regional haze program is that a state is not required to evaluate all sources of emissions in each implementation period. Instead, a state may reasonably select a set of sources for an analysis of control measures. The guidance that an analysis of control measures is not required for every source in each implementation period is based on CAA section 169A(b)(2), which requires each SIP to contain emission limits, schedules of compliance, and other measures as may be necessary to make reasonable progress, but …does not provide direction regarding the particular sources or source categories to which such emission limits, etc., must apply. Selecting a set of sources for analysis of control measures in each implementation period is also consistent with the Regional Haze Rule, which sets up an iterative planning process and anticipates that a state may not need to analyze control measures for all its sources in a given SIP*

revision. Specifically, section 51.308(f)(2)(i) of the Regional Haze Rule requires a SIP to include a description of the criteria the state has used to determine the sources or groups of sources it evaluated for potential controls. Accordingly, it is reasonable and permissible for a state to distribute its own analytical work, and the compliance expenditures of source owners, over time by addressing some sources in the second implementation period and other sources in later periods. For the sources that are not selected for an analysis of control measures for purposes of the second implementation period, it may be appropriate for a state to consider whether measures for such sources are necessary to make reasonable progress in later implementation periods."

Consistent with the RHR, North Carolina followed a process (documented in Sections 7.7 and 7.8) for narrowing the list of sources to consider for selecting for a four-factor analysis. In so doing, the NCDAQ relied on the latest available tools (i.e., PSAT) to understand source impacts on visibility impairment in each Class I area. From the comparison of AoI to PSAT modeling of stationary sources, it became apparent that the AoI methodology overstates impacts close to Class I areas (i.e., <100 Km) and understates impacts associated with stationary sources located further away (i.e., >100 Km) from Class I areas.

To prepare for the Round 1 SIP, North Carolina is the only state in the U.S. that evaluated and adopted a rule (i.e., CSA) to significantly control SO_2 and NO_x emissions from the entire EGU sector. This early action along with significant SO_2 and NO_x emission reductions from federal and state measures implemented after the CSA has significantly improved visibility throughout North Carolina and border states. These actions have led to the situation that exists today where, as demonstrated from the PSAT modeling, stationary sources outside of North Carolina have a much higher impact on Class I areas in North Carolina than sources in the state. The NCDAQ selected facilities for a reasonable progress/four-factor analysis if the facility's PSAT contribution was $\geq$1.00% for sulfate or nitrate. This threshold identified 16 out-of-state facilities in 10 states and 3 North Carolina facilities for reasonable progress/four-factor analysis. Given that this is a "regional" program, the NCDAQ determined that selection of a total of 19 facilities impacting North Carolina Class I areas is reasonable and that it is important to engage with the 10 states with facilities with some of the highest impacts on Class I areas in North Carolina.

The factors that contribute to visibility impairment in each Class I area are unique to each Class I area. These factors include geographic location (coastal plain vs. mountains), meteorological patterns, location of emission sources relative to the Class I area, and the types and amounts of the pollutants from both anthropogenic and natural sources. For example, the factors that influence visibility impairment in the Everglades National Park are much different than the factors that impact the Great Smoky Mountains National Park. These are the reasons why the baseline condition (2000-2004) varies between Class I areas.

Table 10-9 shows baseline conditions, 2018 observed conditions vs. the URP, and 2028 modeled visibility vs. the URP for the Everglades National Park and Class I Areas in North Carolina. The baseline condition for the Everglades National Park ranges from about 8.6 to 9.6 dv lower than baseline conditions for the Great Smoky Mountains National Park and the Linville Gorge and Shining Rock Wilderness Areas. Although natural conditions for the Everglades National Park ranges from about 1.4 to 2 dv lower than natural conditions for the Great Smoky Mountains National Park and the Linville Gorge and Shining Rock Wilderness Areas, the Class I areas in North Carolina still need to achieve a much more significant reduction in emissions to achieve natural conditions as compared to other areas like the Everglades National Park.[134] North Carolina recognized this challenge early on which is reflected in the significant improvement in visibility in the Class I areas in the state. For example, in comparing the difference between the 2018 URP minus observed data for each Class I area, the Class I areas in North Carolina have achieved from about 5.3 to 6.4 dv more improvement than the Everglades National Park. For 2028, the Everglades National Park is just 1.57 dv below the URP. The 2028 modeled RPGs for the Class I areas in North Carolina are less than the 2028 URP for the Everglades National Park. Thus, for a given Class I area, it is reasonable for a state to select more sources for four-factor analysis if the Class I area is just below or at the URP, and to select fewer sources if the Class I area is well below the URP[135]. The last column of Table 10-9 shows the amount of visibility improvement projected for 2028 relative to the 2028 URP for each Class I area. These data show that the Class I areas in North Carolina are expected to continue to achieve significantly more progress than the Everglades National Park. Thus, the NCDAQ does not agree that the methods it used for source selection resulted in any bias toward Class I areas in North Carolina.

Table 10-9. Comparison of Baseline Conditions to 2018 Observed and 2028 Modeled Visibility for 20% Most Impaired Days for Everglades National Park versus Class I Areas in North Carolina

Class I Area	Baseline Average (2000-2004)	2014-2018 Average Observed[1]	2018 URP	2018 URP minus Observed	2028 Modeled RPG	2028 URP	2028 URP minus Modeled
Everglades National Park	19.52	14.82	16.91	2.09	13.95[2]	15.52	1.57
Great Smoky Mountains National Park	29.11	17.28	24.66	7.38	15.03	21.49	6.46
Linville Gorge	28.05	16.40	23.77	7.37	14.25	20.71	6.46
Shining Rock	28.13	15.51	23.96	8.45	13.31	20.98	7.76

[1] These values represent the average of IMPROVE monitoring data for 2014-2018.
[2] Based on EPA's regional haze modeling for 2028.

[134] Table 2-2 and Table 2-3 of this SIP present natural and baseline conditions for Class I areas in North Carolina, respectively. Baseline and natural conditions for the Everglades National Park can be found in Table 4-1 of Appendix E-6.
[135] U.S. EPA, "Guidance on Regional Haze State Implementation Plans for the Second Implementation Period," EPA-457/B-19-003, August 20, 2019, page 22, accessed from https://www.epa.gov/visibility/guidance-regional-haze-state-implementation-plans-second-implementation-period

10.4.3 Evaluation of NO_x Controls for Duke Energy Facilities

NPS Comment

We recommend that North Carolina reconsider their source selection decisions by using the underlying VISTAS EWRT*Q/d analysis and applying different thresholds. As we shared during our consultation meeting, this approach identifies five Duke Energy facilities in addition to Blue Ridge Paper Products (already identified by North Carolina) as affecting visibility at Great Smoky Mountains NP. We agree that Blue Ridge Paper Products and the Duke Energy sources identified are already effectively controlled for SO_2. However, our initial evaluation indicates that NO_x controls at these facilities could be improved. Specifically, we recommend that North Carolina evaluate options to improve on the current NO_x control efficiencies, especially the 35–39% NO_x emission control efficiency achieved by the existing SNCR at Duke Energy Marshall Steam Station units 1, 2, and 4. There were existing NO_x controls associated with these units when the SNCR was added. This percent control efficiency represents the additional control efficiency that the SNCR contributed. These numbers do not represent the overall control efficiency associated with these units.

NCDAQ Response

The NPS requested a four-factor analysis for NO_x for the following Duke Energy facilities:

- Duke Energy Carolinas, LLC - Belews Creek Steam Station
- Duke Energy Carolinas, LLC - Cliffside Steam Station
- Duke Energy Progress, LLC - Roxboro Steam Electric Plant
- Duke Energy Progress, LLC - Mayo Electric Generating Plant
- Duke Energy Carolinas, LLC - Marshall Steam Station

Table 7-42 (Comparison of NO_x Emissions between 2017, 2018, 2019, and 2028) and Table 7-43 (Controls, Operating Status, and Federal Rules for Duke Energy Facilities) in Section 7.7.3 of this SIP document show actual and projected NO_x emissions and NO_x controls, respectively, for the coal boilers at the facilities. All coal units at the Belews Creek, Cliffside, and Roxboro are controlled with SCR and combustion controls which represent the best available NO_x control systems for coal fired boilers. In addition, projected 2028 NO_x emissions are to decrease below recent actual emissions for 2017 through 2019. The two coal fired units at Mayo are also controlled with SCR. The NO_x emissions for Mayo are projected to increase somewhat relative to 2017-2019 levels.

For the Marshall Steam Station, the NCDAQ reviewed the NO_x controls for coal fired units 1, 2, and 4. These units were equipped with SNCR to reduce NO_x emissions as part of Duke Energy's overall NO_x control program to comply with the CSA. In addition to SNCR, all three units are also equipped with combustion controls including a low NO_x concentric firing system and overfire air/lowered fired low NO_x technologies (SOFA/LOFIR). For these three units, the NO_x control efficiency ranges from 38-44% for combustion controls (concentric firing system with SOFA/LOFIR) and an additional 32-39% for SNCR. The combined combustion control plus SNCR control efficiency for these units ranges from 58 to 66%. Unit 4 is equipped with combustion controls and SCR. Coal units 3 and 4 currently have the capability to burn natural gas and coal units 1 and 2 are scheduled to be upgraded to burn natural gas in the fall of 2021. The NO_x rate is typically less when burning natural gas verses coal. As discussed in Section 7.7.3.1 of this SIP, the PSAT modeling results for total NO_x emissions for this facility ranged from 0.01% to 0.03% on Class I areas in North Carolina which is well below the 1.00% threshold the NCDAQ used to select sources for a four-factor analysis.

Overall, all sources of NO_x have been decreasing during the recent period that nitrates have increased. This is to some extent associated with more ammonia available to react with nitric acid as the proportion of SO_2 to NO_x emissions declines; however, further research is needed to confirm this since the change in the nitrate fraction relative to the sulfate fraction appears to be variable from year to year. The PSAT modeling for 2028 shows that the main contributors to the nitrate fraction in Class I areas in North Carolina not associated with EGUs and non-EGU point sources in North Carolina. All the Duke Energy facilities are well controlled for NO_x. Considering this information, along with the fact that sulfates are still the dominate species contributing to light extinction in Class I areas in North Carolina, it is not reasonable to request facilities that are already well-controlled for NO_x emissions to conduct a four-factor analysis.

10.4.4 Prescribed Fire Emissions

USFS Comment

Fire plays an important role in shaping the vegetation and landscape in western North Carolina. Recurring fire has been a part of the landscape for thousands of years. Aggressive fire suppression, coupled with an array of other disturbances (e.g., logging and chestnut blight), has changed the historic composition and structure of the forests. Periodic prescribed burning and other vegetation management can recreate the ecological role of fire in a controlled manner. Fire and fuels management supports a variety of desired conditions and objectives across the Forests (e.g., community protection, hazardous fuels reduction, native ecosystems restoration, historic fire regimes restoration, wildlife openings, and open woodland creation, etc.). The Land Management Plan for the Pisgah and Nantahala National Forests calls for an increase in the use of prescribed fire to increase forest resilience. The 2017 Regional Haze Rule includes a provision to allow states to adjust the glidepath to account for prescribed fire. The draft NC RH SIP states that prescribed fire emissions were taken from the 2011 National Emissions Inventory (NEI) and were carried forward into the 2028 future year emissions without any changes. Recent data on prescribed fire activity, especially within the USDA Forest Service, show that the number of acres burned in prescribed fires during 2011 were lower than all other recent years. For example, within the southern region of the Forest Service a total of 749,080 acres were treated with prescribed fire in 2011, while the average number of acres treated annually from the years 2007-2019 was 980,422. The 2021 target for treatment by prescribed fire within the USDA Forest Service southern region is well over 1 million acres. Furthermore, the Land Management Plans for each of the southern Forests call for a cumulative total of up to 2.1 million acres per year to be treated with prescribed fire in the future. Therefore, keeping prescribed fire emissions steady from to 2028 undercounts emissions in the VISTAS states by up to fifty percent. At this point in the draft RH SIP review process, a quantitative analysis to adjust the glidepaths for actual prescribed fire projections is not practical. While prescribed fire is currently a minor contributor to visibility impairment on the 20% most impaired days, the USDA Forest Service would like assurances that NCDAQ will continue to recognize the important ecological role of prescribed fire and in the future adjust the glidepath to account for prescribed fire emissions accordingly.

NCDAQ Response

The NCDAQ has been a long-time supporter of the use of prescribed fire as a landscape management tool throughout North Carolina. As discussed in Section 7.9.2 (Smoke Management) of this SIP, the NCDAQ works closely with other state and federal agencies to share information and resources and provide consistent messaging in support of prescribed burning and will continue to do so. Using this approach, the NCDAQ has been effective with managing air quality during periods of prescribed fire activity in North Carolina.

The EPA's revised method for selecting the 20% most impaired days to a large extent eliminates days where light extinction is primarily associated with fire activity. This methodology helps to minimize impacts associated with fire activity in the 20% most impaired days evaluated during the development of this SIP. For future planning periods, should the 20% most impaired days show a significant increase in organic carbon that can be attributed to prescribed burning activity, the NCDAQ will consult with the USFS and other North Carolina state and federal agencies as well as with Tennessee to determine if an adjustment to the glidepath in 2064 is necessary for Class I areas in the state.

Finally, each year the NCDAQ works closely with the NCFS and federal agencies to collect activity data for prescribed burning and wildfires statewide. During years when EPA prepares the NEI, the NCDAQ submits the activity data for the NEI year to EPA who then calculates the emissions using the SMARTFIRE2-Bluesky modeling framework. Projection of emissions associated with prescribed burning and wildfires is very difficult to do because the amount of activity is highly variable depending on weather conditions and other factors. In addition, projections of increased activity relative to a base year would require creating new fires with assigned location coordinates, fuel type, and the size of each burn which is impractical. Thus, it is standard practice to carry the base year emissions forward to the projection year. Since 2011, the NCDAQ has coordinated with state and federal agencies to improve the collection of activity data which will better reflect the location, size, and duration of fires in the state.

10.5 Public Comment Process, Comments Received, and Responses to Comments

Appendix I of this SIP documents the public comment and hearing process (including the public notice), comments received, and responses to the comments. The NCDAQ issued a public notice announcement, in accordance with 40 CFR 51.102, indicating that the pre-hearing draft of the *Regional Haze State Implementation Plan (SIP) for North Carolina Class I Areas for the Second Planning Period (2019 – 2028),* was available for public comment and posted on the NCDAQ website for review. The draft SIP was released to the public for a 45-day comment period from Monday, August 30, 2021, through Friday, October 15, 2021. A public hearing was held digitally via Cisco's WebEx teleconferencing service on Wednesday, October 6 starting at 6:05

pm EDT. The public hearing was held digitally to address North Carolina Office of State Human Resources guidance to help minimize the spread of COVID-19 at the time of the hearing. During the public hearing seven members of the public spoke and their comments were recorded and documented in a summary of the public hearing which is included in Appendix I.

During the public comment period, the NCDAQ received 213 pages of written comments from 19 federal, state, non-governmental, and industry organizations; 7 pages from individuals submitted via email; 351 pages of effectively equivalent "form letter" comments submitted by individuals via email, and 77 effectively equivalent post cards submitted by individuals through the National Parks Conservation Association (NPCA). Several of the comments received via form letters and post cards were received from the same individuals. The NCDAQ has summarized and prepared responses to the comments in Appendix I.

10.6 The NCDEQ Environmental Justice Program and Outreach Plan Regarding the Regional Haze SIP

Environmental justice (EJ) is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (US EPA).

The EJ Program in the North Carolina Department of Environmental Quality (NCDEQ) was in place for several years and matured to its current role and function in the Department under the direction and support of the Cooper Administration.

NCDEQ's EJ Program is responsible for assessing the sociodemographic composition of communities in locations proximate to projects pursuing regulatory action with the Department. Sociodemographic data at the state-, county-, census tract-, and local-level are pulled from the US EPA's EJSCREEN Tool, NCDEQ's Community Mapping System and EJ Tool, and the US Census Bureau. Generally, the EJ Program conducts these analyses when certain types of permit applications or modifications are under NCDEQ review.

If a proposed project is identified as being located within or near a potentially underserved community, an EJ Report is prepared which helps informs the outreach conducted in that community. NCDEQ defines a potentially underserved community as follows:

Racial composition:

- Share of nonwhites is over fifty percent OR
- Share of nonwhites is at least ten percent higher than county or state share;

AND

Poverty rate:

- Share of population experiencing poverty is over twenty percent AND

- Share of households in poverty is at least five percent higher than the county or state share

The NCDEQ's Public Participation Plan outlines some of the options for tailored outreach and engagement the Department will conduct in potentially underserved communities. Additionally, the Limited English Proficiency Plan outlines the process of conducting outreach to individuals and communities who may need language assistance in the form of translation or interpretation services.

The NCDEQ also works to maintain an open dialogue and line of communication with environmental justice communities, by providing outreach to individuals on an EJ Listserv and through the Department's work and support of the Secretary's Environmental Justice and Equity Advisory Board that was established in 2018.

Based on these available tools used by the EJ program, the following EJ evaluation has been conducted to inform the specific EJ focused outreach for this program:

1) Overlaid the Class 1 areas with the most up-to-date map of potentially underserved block groups. The Class 1 areas within North Carolina's borders are Joyce Kilmer – Slickrock Wilderness Area, Great Smoky Mountains National Park, Shining Rock Wilderness Area, Linville Gorge Wilderness Area, and Swanquarter Wilderness Area. (Figures 10-11 and 10-12)
2) Consulted the Commission of Indian Affairs statewide map to identify potential overlay with federally and state recognized tribes. (Figure 10-13)
3) Run preliminary EJSCREEN reports around the Class 1 areas.[136] (Appendix F-5)

Based on the results of the above screenings, the following outreach will be conducted to ensure opportunity for meaningful involvement during the comment period of the Regional Haze State Implementation Plan for North Carolina.

1) Specific outreach to known communities within potentially underserved block groups that overlap or are within 1 mile of the Class 1 areas.
2) Provide project information and updates to the Eastern Band of the Cherokee Nation.
3) Include the DEQ Secretary's EJ and Equity Advisory Board as well as the EJ listserv on communications about the comment period and associated public hearing.
4) Provide a phone number in the case of limited internet access for rural and hard to reach communities, for both the comment period and public hearing.
5) Include a contact for requests for translation services.

[136] The Great Smoky Mountains Class 1 area was too large to perform the EJSCREEN analysis so that area was not included in this portion of the analysis.

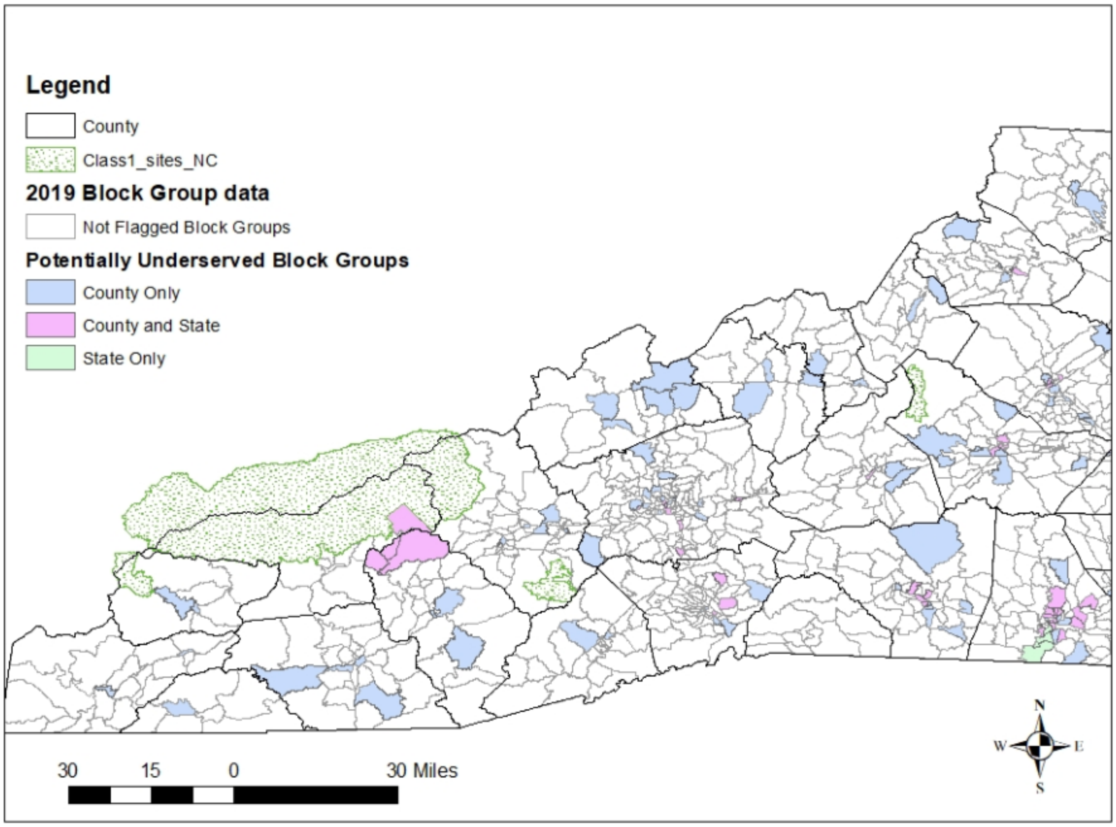


Figure 10-11. Map of Potentially Underserved Communities for Great Smoky Mountains National Park, Joyce Kilmer-Slickrock Wilderness Area, Linville Gorge Wilderness Area and Shining Rock Wilderness Area

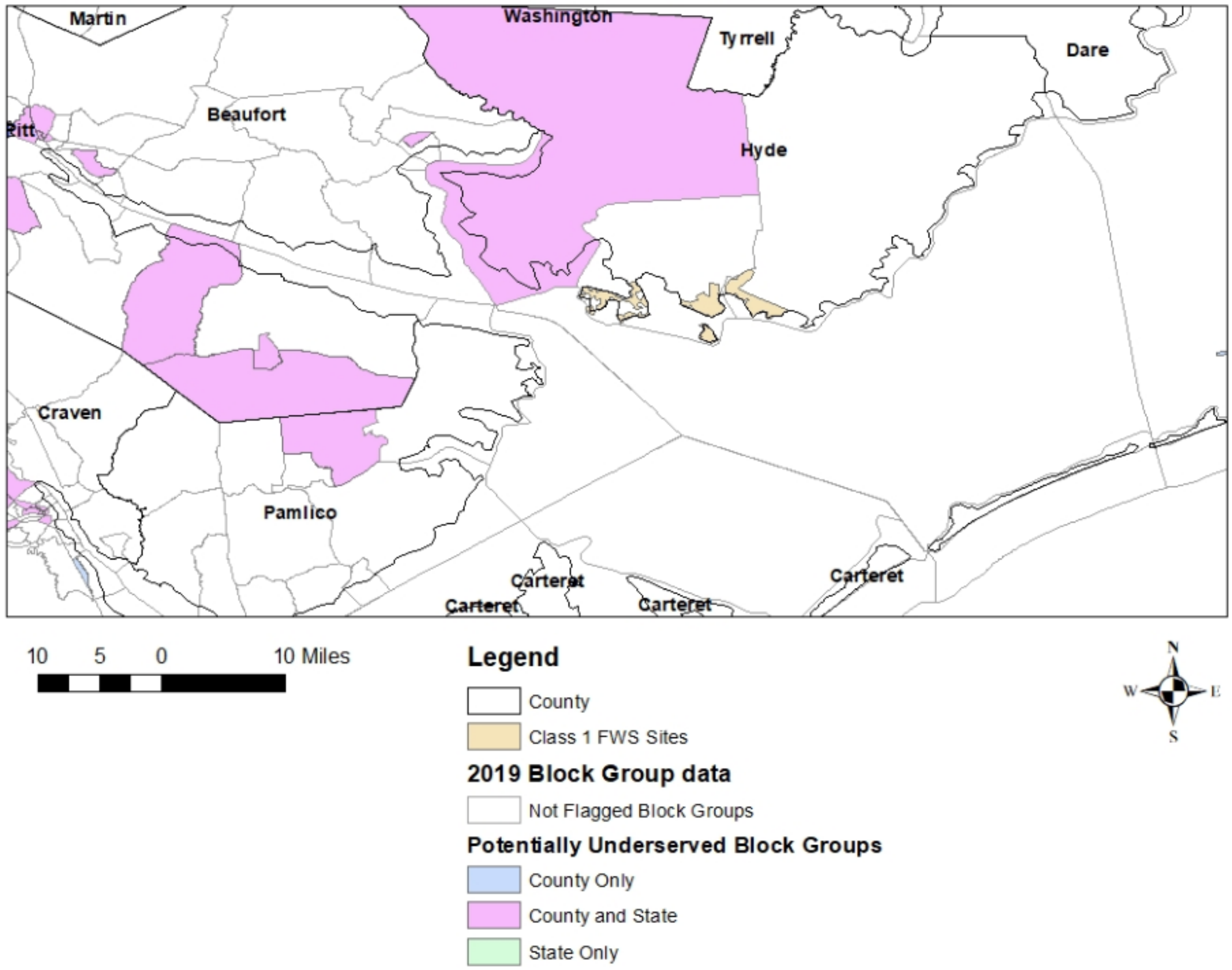


Figure 10-12. Map of Potentially Underserved Communities for Swanquarter Wilderness Area.

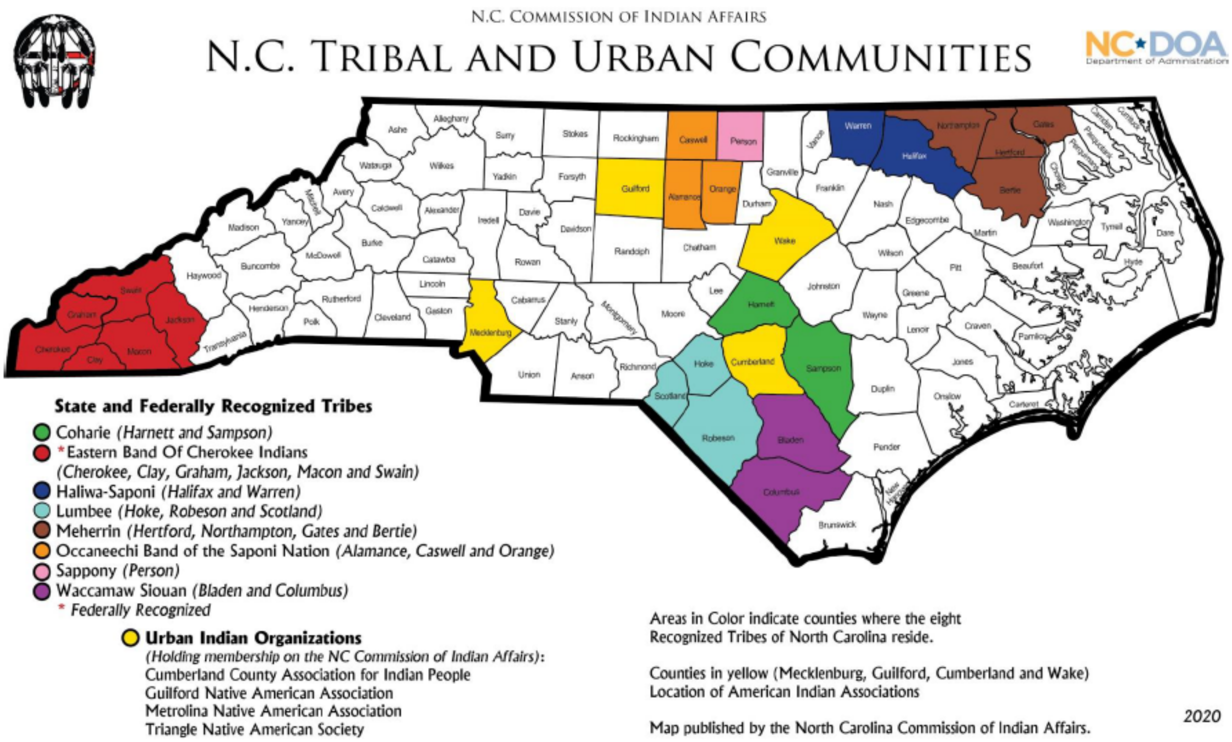


Figure 10-13. The Commission of Indian Affairs Statewide Map

11.0 COMPREHENSIVE PERIODIC IMPLEMENTATION PLAN REVISIONS

40 CFR Section 51.308(f) of the RHR requires North Carolina to revise its regional haze SIP and submit a plan revision to EPA by July 31, 2021, July 31, 2028, and every ten years thereafter. This plan is submitted to meet the July 31, 2021 requirement. In accordance with the requirements listed in Section 51.308(f), North Carolina commits to revising and submitting this regional haze SIP by July 31, 2028, and every ten years thereafter.

In addition, Section 51.308(g) of the RHR 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. North Carolina commits to meeting all the requirements for 40 CFR 51.308(g), including revising and submitting this 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 Class I areas located within North Carolina and in each Class I area located outside North Carolina that may be affected by emissions from North Carolina 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 Class I 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 (g)(1) of this section.

(3) For each Class I 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 emissions 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 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.

(6) An assessment of whether the current implementation plan elements and strategies are sufficient to enable the state, or other states with Class I 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 initial 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.

The NCDAQ believes that its New Source Review regulations for both nonattainment areas as well as the prevention of significant deterioration will address emissions from new sources that may be located near a Class I area, or increase emissions from major modifications to existing sources. In addition to the NCDAQ regulations that would govern these sources, consultation with the FLMs is also required for sources that are subject to the new source review regulations.

The NCDAQ also commits to ongoing consultation with the FLMs throughout the implementation process, including annual discussion of the implementation process and the most recent IMPROVE monitoring data.

12.0 DETERMINATION OF ADEQUACY OF THE EXISTING PLAN

At the same time North Carolina is required to submit any progress reports to EPA, depending on the findings of the 5-year progress report, North Carolina commits to taking one of the actions listed in 40 CFR Section 51.308(h). The findings of the 5-year progress report will determine which action is appropriate and necessary.

List of Possible Actions - 40 CFR Section 51.308(h):

(1) If North Carolina determines that the existing SIP requires no further substantive revision to achieve established goals, it will provide to EPA a declaration that further revision of the SIP is not needed.

(2) If North Carolina 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 EPA, and collaborate with the states that participated in regional planning to address the SIP's deficiencies.

(3) If North Carolina 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 EPA.

(4) If North Carolina 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 EPA.

13.0 PROGRESS REPORT

13.1 Background

On December 17, 2007, North Carolina submitted to EPA for approval its SIP for regional haze to the EPA Region 4.[137] The EPA finalized the limited approval of a revision to North Carolina's SIP on June 13, 2012.[138] In a separate action published on June 7, 2012, EPA finalized a limited disapproval of this same SIP for relying on the Clean Air Interstate Rule (CAIR) as being equal to or better than Best Available Retrofit Technology (BART) and concerns about a long-term strategy sufficient to achieve RPGs.[139] To correct the deficiency, on October 31, 2014, North Carolina submitted to EPA for approval a SIP revision based on the requirements specified in the RHR (70 FR 39104) and Alternative BART Final Rulemaking (71 FR 60612).[140] On June 23, 2016, EPA approved the SIP revision because the SIP revision corrected the deficiencies that led to EPA's limited disapproval of the State's regional haze SIP on June 7, 2012, and converted its June 27, 2012, limited approval to a full approval.[141]

Paragraph 40 CFR 51.308(g) of the RHR requires that states report on the success of the long-term strategy at specific intervals. Each state must submit a report to EPA every five years evaluating the progress towards the RPG 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. 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. The revised RHR no longer requires the progress report to be a formal SIP submittal; however, a state is required to provide an opportunity for public comment on each progress report before submitting the final to EPA.

On June 15, 2016, North Carolina submitted the first regional haze progress report to EPA, which demonstrated that North Carolina was on track to meet the RPGs set in the regional haze SIP.[142]

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[137] Regional Haze State Implementation Plan for North Carolina Class I Areas, December 17, 2007.
[138] Final Rule: Approvals and Promulgations of Implementation Plans: State of North Carolina; Regional Haze State Implementation Plan (77 FR 38185, June 27, 2012). Signed June 13, 2012, by Mr. Stanley Meiburg, Acting Regional Administrator, EPA Region 4, with an effective date of July 27, 2012.
[139] Final Rule: Air Plan Approval; North Carolina; Regional Haze Progress Report (81 FR 58400, August 25, 2016). Signed May 30, 2012, by Ms. Lisa P. Jackson, U.S. EPA Administrator, with an effective date of August 6, 2012.
[140] Regional Haze SIP Revision for North Carolina Class I Areas - Alternative to Source Specific Best Available Retrofit Technology Demonstration (BART) for Electric Generating Units, October 31, 2014.
[141] Final Rule: Air Plan Approval; North Carolina; Regional Haze (81 FR 32652, May 24, 2016). Signed May 12, 2016, by Ms. Heather McTeer Toney, Regional Administrator, EPA Region 4, with an effective date of June 23, 2016.
[142] Regional Haze 5-Year Periodic Review State Implementation Plan for North Carolina Class I Areas, May 31, 2013.

The EPA approved this progress report on August 25, 2016.[143] This previous progress report covered the period from 2006-2010.

In accordance with 40 CFR 51.308(f)(5) of the RHR rule, this progress report addresses the requirements specified in 40 CFR 51.308(g)(1) through (g)(5) of the RHR rule for the period 2011-2018.

13.2 Status of Implementation of Control Measures (40 CFR 51.308 (g)(1))

Paragraph 40 CFR 51.308(g)(1) of the RHR requires a state to provide *a description of the status of implementation of all measures included in the implementation plan for achieving reasonable progress goals for Class I areas both within and outside the State.*

Table 13-1 provides a list of key control measures and other emission reduction actions by source sector included in North Carolina's long-term strategy (LTS) for the first planning period (2008-2018). The table also identifies actions that were not anticipated when North Carolina prepared the LTS for its first regional haze SIP but contributed to emission reductions during the first planning period. The measures include, among other things, applicable Federal programs (e.g., mobile source rules, Maximum Achievable Control Technology standards), Federal consent agreements, and Federal and state control strategies for EGUs. Section 7.2.1 of this SIP provides a brief description of each measure/action except for the extensive list of MACT standards which are identified in Table 13-2.

The point source sectors in the following tables include Industrial Processes, Fuel Combustion Electric Utility, and Fuel Combustion Industrial. The Fuel Combustion Other category also includes point source fuel combustion from institutional and commercial sources. The Miscellaneous sector includes bulk gas terminals, gas stations, commercial cooking, dust from unpaved roads and agriculture, fires (prescribed, agricultural, and wildfires) and non-industrial not elsewhere classified (NEC). Each pollutant is discussed individually in the following sections. Included in the discussion is the most significant contributing sector and noted anomalies in the data.

[143] Final Rule: Air Plan Approval; North Carolina; Regional Haze Progress Report (81 FR 58400, August 25, 2016). Signed August 15, 2016, by Ms. Heather McTeer Toney, Regional Administrator, EPA Region 4, with an effective date of September 26, 2016.

Table 13-1. Key Control Measures and Other Emission Reduction Actions by Source Sector

Sector	Implementing Authority (Federal/State)	Control Measure / Action	Included in Modeling for SIP
Fuel Comb. Elec. Util.	Federal	Reciprocating Internal Combustion Engines (RICE) National Emissions Standards for Hazardous Air Pollutants (NESHAP)	√
	Federal	NO_x SIP Call, Clean Air Interstate Rule (CAIR), and Cross State Air Pollution Rule (CSAPR)	√
	State	Clean Smokestacks Act (CSA)	√
	State	Alternative to Source Specific Best Available Retrofit Technology (BART) Demonstration for Electricity Generating Units (EGUs)	√
	Federal	Maximum Achievable Control Technology Programs (40 CFR Part 63)	√
	Federal	2010 SO_2 NAAQS	
Industrial Processes	Federal	Maximum Achievable Control Technology Programs (40 CFR Part 63)	√
	Federal	Reasonable Available Control Techniques (RACT)	
	Federal	2010 SO_2 NAAQS	
Fuel Comb. Industrial and Fuel Comb. Other	Federal	Reciprocating Internal Combustion Engines (RICE) National Emissions Standards for Hazardous Air Pollutants (NESHAP)	√
	Federal	Boiler NESHAP – Section 112(j) and Section 112(d)	√
	Federal	Maximum Achievable Control Technology Programs (40 CFR Part 63)	√
	Federal	2010 SO_2 NAAQS	
Highway Vehicles	Federal	Tier 2 Vehicle and Fuel Standards	√
	Federal	Heavy-Duty Gasoline and Diesel Highway Vehicle Standards	√
	State	Clean Air Bill/Vehicle Emissions Inspection and Maintenance (I&M) Program	√
	Federal	2007 Heavy-Duty Highway Rule (40 CFR Part 86, Subpart P	√
Off-Highway	Federal	Large Nonroad Diesel Engines and Fuel Standards Rule	√
	Federal	Nonroad Spark Ignition Engines and Recreational Engines Standards	√
Waste Disposal & Recycling	Federal	Maximum Achievable Control Technology Programs (40 CFR Part 63)	√
Miscellaneous		None	

Table 13-2. MACT Source Categories with Compliance Dates on or after 2002

MACT Source Category	40CFR63 Subpart	Date Promulgated	Existing Source Compliance Date	Pollutants Affected
Hazardous Waste Combustion (Phase I)	Parts 63(EEE), 261 and 270	9/30/99	9/30/03	PM
Oil & Natural Gas Production	HH	6/17/99	6/17/02	VOC
Polymers and Resins III	OOO	1/20/00	1/20/03	VOC
Portland Cement Manufacturing	LLL	6/14/99	6/10/02	PM
Publicly Owned Treatment Works (POTW)	VVV	10/26/99	10/26/02	VOC
Secondary Aluminum Production	RRR	3/23/00	3/24/03	PM
Combustion Sources at Kraft, Soda, and Sulfite Pulp & Paper Mills (Pulp and Paper MACT II)	MM	1/12/01	1/12/04	VOC
Municipal Solid Waste Landfills	AAAA	1/16/03	1/16/04	VOC
Coke Ovens	L	10/27/93	Phased from 1995-2010	VOC
Coke Ovens: Pushing, Quenching, and Battery Stacks	CCCCC	4/14/03	4/14/06	VOC
Asphalt Roofing Manufacturing and Asphalt Processing (two source categories)	LLLLL	4/29/03	5/1/06	VOC
Metal Furniture (Surface Coating)	RRRR	5/23/03	5/23/06	VOC
Printing, Coating, and Dyeing of Fabrics	OOOO	5/29/03	5/29/06	VOC
Wood Building Products (Surface Coating)	QQQQ	5/28/03	5/28/06	VOC
Lime Manufacturing	AAAAA	1/5/04	1/5/07	PM, SO_2
Site Remediation TSDF	GGGGG	10/8/03	10/8/06	VOC
Iron & Steel Foundries	EEEEE	4/22/04	04/23/07	VOC
Taconite Iron Ore Processing	RRRRR	10/30/03	10/30/06	PM, SO_2
Miscellaneous Coating Manufacturing	HHHHH	12/11/03	12/11/06	VOC
Metal Can (Surface Coating)	KKKK	11/13/03	11/13/06	VOC
Plastic Parts and Products (Surface Coating)	PPPP	4/19/04	4/19/07	VOC

MACT Source Category	40CFR63 Subpart	Date Promulgated	Existing Source Compliance Date	Pollutants Affected
Miscellaneous Metal Parts and Products (Surface Coating)	MMMM	1/2/04	1/2/07	VOC
Industrial, Commercial, and Institutional Boilers and Process Heaters for Major Sources [c]	DDDDD	1/31/13	1/31/16	PM SO_2
Industrial, Commercial, and Institutional Boilers and Process Heaters for Area Sources	JJJJJJ	2/1/13	3/21/14	PM SO_2
Plywood and Composite Wood Products	DDDD	7/30/04	10/1/07	VOC
Reciprocating Internal Combustion Engines	ZZZZ	6/15/04	6/15/07	NO_x, VOC
Auto and Light-Duty Truck (Surface Coating)	IIII	4/26/04	4/26/07	VOC
Wet Formed Fiberglass Mat Production	HHHH	4/11/02	4/11/05	VOC
Metal Coil (Surface Coating)	SSSS	6/10/02	6/10/05	VOC
Paper and Other Web Coating (Surface Coating)	JJJJ	12/4/02	12/4/05	VOC
Petroleum Refineries	UUU	4/11/02	4/11/05	VOC
Miscellaneous Organic Chemical Production (MON)	FFFF	11/10/03	05/10/08	VOC

The following Section 13.3, Section 13.5, and Section 13.6 provide documentation of the emission reductions associated with the implementation of the measures included in the long-term strategy for the first planning period. North Carolina's previous progress report documents the implementation of measures by other states (e.g., Florida, Georgia, Indiana, Kentucky, Maryland, South Carolina, Ohio, Tennessee, Virginia, and West Virginia) to reduce EGU and non-EGU point source emissions that may have improved visibility in Class I areas in North Carolina.

13.3 Summary of Emission Reductions Achieved (40 CFR 51.308(g)(2))

Paragraph 40 CFR 51.308(g)(2) of the RHR specifies that a state must provide *a summary of the emissions reductions achieved throughout the State through implementation of the measures described in 40 CFR 51.308(g)(1).*

This section provides a summary of emissions reduced as a result of implementation measures described in Section 13-2. It specifically focuses on SO_2 emission reductions because, for the first planning period, ammonium sulfate has been determined to be the most important contributor to visibility impairment and fine particle mass on the 20% worst and 20% best visibility days at all the North Carolina Class I areas. Sulfate particles are formed in the atmosphere from SO_2 emissions. Additional discussion on pollutant contributions to visibility impairment is provided in Section 2.5 and Section 2.6 of this SIP.

13.3.1 EGU SO_2 Emission Reductions

Table 13-3 lists the coal-fired EGUs in North Carolina that were previously projected to have controls installed by 2018 in the original regional haze SIP. This table compares actual 2011 to the Integrated Planning Model (IPM) predicted 2018 emissions used in the modeling for the original regional haze SIP, as well as actual 2018 that have become available after the previous progress report was prepared in 2013 covering the period 2006-2010. The actual 2011 and 2018 emissions data for these sources was obtained from the USEPA's Clean Air Markets (CAMD) database. The table also identifies the EGU the retirement date, if applicable.

As shown in Table 13-3, the 2018 projections SO_2 emissions were estimated to increase by 27% relative to 2011 emissions; however, a comparison of 2011 to 2018 actual emissions show a decrease of 79%. Duke Energy Progress (DEP) and Duke Progress Carolinas (DEC) facilities together emitted a total of 73,456 tons of SO_2 emissions in 2011 and 15,130 tons in 2018. Since the EGU sector represents over 50% of statewide SO_2 emissions from stationary sources, this is a clear sign that the Class I areas in North Carolina are on track to meet or exceed their emission reduction goals. For NO_x emissions, both utilities emitted a total of 39,285 tons in 2011 and 27,305 tons in 2018 from their coal-fired EGUs in North Carolina. Their statewide NO_x emissions dropped over 11,980 tons representing a 30% reduction from 2011-2018.

The state's CSA is one of the most important actions that North Carolina implemented to achieve early reductions for improving visibility in North Carolina's Class I areas. The state law required the coal-fired EGUs subject to the CSA (identified in Table 13-3) to reduce annual NO_x emissions by 77% by 2009, and to reduce annual SO_2 emissions by 49% by 2009 and 73% by 2013. This law set a NO_x emissions cap of 56,000 TPY starting in 2009, and SO_2 emissions caps of 250,000 TPY and 130,000 tons/year starting in 2009 and 2013, respectively. The affected EGUs were equipped with flue-gas desulfurization scrubbers to control SO_2 and either selective catalytic reduction or non-selective catalytic reduction to control NO_x emissions. In 2011, the affected EGUs were 16,176 tons (30%) below the 2009 NO_x cap and 56,546 tons (43%) below the 2013 SO_2 cap. In 2018, the CSA affected EGUs were 28,695 tons (51%) below the 2009 NO_x cap and 114,869 tons (88%) below the 2013 SO_2 cap. Thus, the affected EGUs have continued to remain well below the NO_x and SO_2 emission caps.

Table 13-3. Comparison of 2011 and 2018 Emissions for Coal-Fired EGUs Evaluated During First Planning Period (TPY)

Company - Facility	Emission Unit	Actual Emissions (2011 CAMD)	VISTAS IPM Projections (2018)	Difference (2011-2018 VISTAS)	Actual Emissions (2018 CAMD)	Difference (2011 CAMD - 2018 CAMD)	Retirement Date (2011 - 2018)
DEP - Asheville	1	1,039	576	463	390	649	1/29/2020
	2	1,203	499	704	388	815	1/29/2020
DEP - Cape Fear	5	3,415	3,379	36	0	3,415	9/30/2012
	6	4,688	4,300	388	0	4,688	9/30/2012
DEP - H.F. Lee	1	1,545	2,918	-1,373	0	1,545	9/30/2012
	2	1,015	2,363	-1,348	0	1,015	9/30/2012
	3	7,047	6,976	71	0	7,047	9/30/2012
DEP - Mayo	1A	4,053	954	3,099	784	3,269	
	1B	3,182	953	2,229	628	2,554	
DEP - Roxboro	1	1,650	999	651	444	1,206	
	2	1,864	2,438	-574	1,207	657	
	3A	1,383	1,071	312	442	941	
	3B	1,336	1,071	265	471	865	
	4A	1,610	1,253	357	571	1,039	
	4B	1,491	1,253	238	470	1,021	
DEP - L.V. Sutton	1	2,048	2,357	-309	0	2,048	11/27/2013
	2	2,083	3,711	-1,628	0	2,083	11/27/2013
	3	8,850	1,037	7,813	0	8,850	11/27/2013
DEP - Weather-spoon	1	226	912	-686	0	226	1/20/2012
	2	545	1,151	-606	0	545	1/20/2012
	3	1,143	2,756	-1,613	0	1,143	1/20/2012
DEC - GG Allen	1	225	173	52	23	202	
	2	202	216	-14	25	177	
	3	366	741	-375	38	328	
	4	400	728	-328	42	358	
	5	472	715	-243	118	354	
DEC - Buck	5	0	1,104	-1,104	0	0	5/14/2011
	6	0	1,064	-1,064	0	0	5/14/2011
	7	0	610	-610	0	0	5/14/2011
	8	1,932	3,155	-1,223	0	1,932	3/31/2013
	9	1,907	4,001	-2,094	0	1,907	3/31/2013
DEC - Cliffside	1	0	1,049	-1,049	0	0	10/1/2011
	2	0	882	-882	0	0	10/1/2011
	3	0	1,962	-1,962	0	0	10/1/2011
	4	0	2,014	-2,014	0	0	10/1/2011

Company - Facility	Emission Unit	Actual Emissions (2011 CAMD)	VISTAS IPM Projections (2018)	Difference (2011-2018 VISTAS)	Actual Emissions (2018 CAMD)	Difference (2011 CAMD - 2018 CAMD)	Retirement Date (2011 - 2018)
	5	308	1,952	-1,644	441	-133	
	6*	0	0	0	908	-908	
DEC - Dan River	1	438	3,464	-3,026	0	438	3/31/2012
	2	440	1,498	-1,058	0	440	3/31/2012
	3	1,069	1,837	-768	0	1,069	3/31/2012
DEC - Marshall	1	577	2,243	-1,666	485	92	
	2	681	2,208	-1,527	345	336	
	3	1,291	485	806	1,440	-149	
	4	1,305	470	835	1,351	-46	
DEC - Riverbend	7	1,128	2,592	-1,464	0	1,128	3/31/2013
	8	1,204	1,511	-307	0	1,204	3/31/2013
	9	2,381	3,973	-1,592	0	2,381	3/31/2013
	10	2,406	3,973	-1,567	0	2,406	3/31/2013
DEC - Belews Creek	1	1,676	2,536	-860	2,460	-784	
	2	1,632	3,218	-1,586	1,659	-27	
Totals		73,456	93,301	-19,845	15,130	58,326	
Percent Reduction in Actual Emissions from 2011 to 2018						79%	

* New coal unit started up January 24, 2012.

13.3.2 Non-EGU SO_2 Emission Reductions

In the previous progress report, the NCDAQ reported on the status of SO_2 emissions for the following five non-EGU facilities: Blue Ridge Paper Products - Canton Mill; Domtar Paper Company - Plymouth Mill; International Paper - New Bern Mill; PCS Phosphate - Aurora; and Coastal Carolina Clean Power – Kenansville. These five facilities were identified during development of the first regional haze SIP for a reasonable progress evaluation. Based on that evaluation, no additional SO_2 controls were required of the facilities at the time. The previous 5-year progress report, prepared in 2013, presented actual 2011 and estimated 2018 emissions used for modeling (which were higher than 2011 actual emissions for all five facilities). We now have actual 2018 emissions for these facilities which are compared to actual 2011 emissions in Table 13-4. Except for Domtar Paper Company, SO_2 emissions were significantly reduced or eliminated as the results of installing SO_2 controls or because the facility closed. Overall, there has been a 58% reduction in SO_2 emissions associated with the five facilities.

Table 13-4. Comparison of 2011 and 2018 Emissions for Non-EGU Facilities Evaluated During First Planning Period (TPY)

Company - Facility	EIS Facility ID	Actual Emissions (2011)	VISTAS Projections (2018)	Difference (2011-2018 VISTAS)	Actual Emissions (2018)	Difference (2011 – 2018 Actual)	Notes
Blue Ridge Paper Products - Canton Mill	7920511	8,512	10,147	-1,635	4,495	4,017	
PCS Phosphate - Aurora	8479311	5,395	6,059	-664	3,439	1,956	
Domtar Paper Company - Plymouth Mill	8049311	711	3,865	-3,154	872	-161	Formerly Weyerhaeuser - Plymouth Mill
International Paper - New Bern Mill	8122711	506	1,200	-694	1	505	Formerly Weyerhaeuser – New Bern/Vanceboro Mill
Coastal Carolina Clean Power - Kenansville	8003211	107	1,834	-1,727	0	107	Formerly Cogentrix. Facility permanently closed effective 6/27/2017
Totals		15,231	23,105	-7,874	8,807	6,424	
Percent Reduction in Actual Emissions from 2011 to 2018						58%	

13.4 Assessment of Visibility Conditions (40 CFR 51.308(g)(3))

Paragraph 40 CFR 51.308(g)(3) of the RHR specifies that a state document the following: *For each Class I 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.*

13.4.1 Reasonable Progress Goals for 2018

Table 13-5 compares baseline visibility to the 2018 RPGs for Class I areas in North Carolina for the 20% worst and 20% best visibility days, which were the metrics used in the first regional haze planning period (see Section 13.4.2 for the rationale for this). The 2018 RPGs are based on the revised RPGs presented in Table 4-2 of North Carolina's first "Regional Haze 5-Year Periodic Review State Implementation Plan for North Carolina Class I Areas" dated May 31, 2013. An IMPROVE monitor is not located in the Joyce Kilmer-Slickrock Wilderness Area so the visibility data from the IMPROVE monitor located in the Great Smoky Mountains National Park are used to represent visibility conditions for the Joyce Kilmer-Slickrock Wilderness Area.

Table 13-5. 2018 RPGs for Visibility Impairment in North Carolina's Class I Areas, 20% Worst and Best/Clearest Days (dv)*

Class 1 Area	Baseline Visibility for 20% Worst Days	2018 RPG 20% Worst Days	Baseline Visibility for 20% Best Days	2018 RPG 20% Best Days
Great Smoky Mountains National Park	30.3	23.5	13.6	12.1
Joyce Kilmer-Slickrock	30.3	23.5	13.6	12.1
Linville Gorge	28.6	21.7	11.1	9.6
Shining Rock	28.5	21.9	8.2	6.9
Swanquarter	24.7	20.3	12.0	11.0

* The baseline values are from Table 4-1 and the RPGs are from Table 4-2 of North Carolina's first "Regional Haze 5-Year Periodic Review State Implementation Plan for North Carolina Class I Areas, May 31, 2013.

13.4.2 Visibility Conditions

Paragraph 40 CFR 51.308(g)(3) of the RHR 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. Section 2 of this SIP presents baseline, current, and natural visibility conditions using the metrics (i.e., 20% most anthropogenically impaired and 20% clearest days) for tracking progress specified in the revised RHR and these metrics are being used for this second planning period and future planning periods (see Table 2-6 and Table 2-7). However, the work completed in the first planning period and the development of the 2018 RPGs focused on the worst visibility days and best days. To properly compare current conditions to the 2018 RPGs, this 5-year progress report incorporates a review of visibility impairment for the 20% worst days, in addition to the 20% most impaired and 20% best (now known as the 20% clearest) days.

Table 13-6 and Table 13-7 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% best days, respectively. The baseline conditions are for 2000 through 2004 and the current conditions are for 2014 through 2018. Data for the 20% most impaired days are also incorporated in Table 13-6 for reference.

The data show that all Class I areas in North Carolina saw an improvement in visibility on the 20% worst days and on the 20% best days. The current 5-year average values calculated from IMPROVE monitoring data for 2014-2018 show that all areas are well below the 2018 RPG for the 20% worst days. On the 20% best days, the observed 5-year average values for 2014-2018 show that all areas are below the 2018 goal of no degradation.

Table 13-6. Current Observed Visibility Impairment, Change from Baseline, and Comparison to 2018 RPGs, 20% Worst & 20% Most Impaired Days (dv)

Class I Area	Baseline Average (2000-2004)	Current Average (2014-2018)	Difference, Current – Baseline	2018 RPG	Difference, Current – RPG
20% Worst Days					
Great Smoky Mountains National Park	30.3	18.7	-11.6	23.5	-4.8
Joyce Kilmer-Slickrock	30.3	18.7	-11.6	23.5	-4.8
Linville Gorge	28.6	18.3	-10.3	21.7	-3.4
Shining Rock	28.5	17.5	-11.0	21.9	-4.4
Swanquarter	24.7	18.2	-6.5	20.3	-2.1
20% Most Impaired Days					
Great Smoky Mountains National Park	29.11	17.21	-11.90	N/A	N/A
Joyce Kilmer-Slickrock	29.11	17.21	-11.90	N/A	N/A
Linville Gorge	28.05	16.42	-11.63	N/A	N/A
Shining Rock	28.13	15.49	-12.64	N/A	N/A
Swanquarter	23.79	16.30	-7.49	N/A	N/A

Table 13-7. Current Observed Visibility Impairment, Change from Baseline, and Comparison to 2018 RPGs, 20% Best/Clearest Days

Class I Area	Baseline Average (2000-2004)	Current Average (2014-2018)	Difference, Current – Baseline	2018 RPG	Difference, current – RPG
Great Smoky Mountains National Park	13.6	8.4	-5.2	12.1	-3.7
Joyce Kilmer-Slickrock	13.6	8.4	-5.2	12.1	-3.7
Linville Gorge	11.1	7.6	-3.5	9.5	-1.9
Shining Rock	8.2	4.4	-3.8	6.9	-2.5
Swanquarter	12.0	10.6	-1.4	10.9	-0.3

The Swanquarter Wilderness Area observed a slight degradation in visibility for the 20% best days during the initial 2006-2010 evaluation period. The NCDAQ documented in its 2013 progress report that visibility at Swanquarter during the 20% best days was expected to improve in the coming years and no additional actions were needed. Based on an evaluation of the IMPROVE data, visibility has since improved at Swanquarter and 2018 values are both below the baseline and below the 2018 RPG.

13.4.3 Visibility Trends

Table 13-8 shows the change in visibility impairment for the 20% worst, 20% most impaired, and 20% best days over the past 5 years in terms of the 5-year averages. For the 20% worst days, the overall trend is towards improvement in visibility, although it should be noted that a slight increase in 20% worst day impairment in the Shining Rock Wilderness area occurred in

2016 due to unprecedented wildfire activity upwind of the region (see Figure 13-5). On the 20% most impaired days and 20% best days, a similar trend towards improvement is seen. Note that the change in visibility impairment for the 20% most impaired days for each Class I area in North Carolina is presented in Sections 3 and 7 (see Figure 7-10 Through Figure 7-13).

Table 13-8. Observed Visibility Impairment for Five-Year Periods through 2018, 20% Worst Days, 20% Most Impaired Days, 20% Best/Clearest Days (dv)

	2010 - 2014	2011 - 2015	2012 - 2016	2013 - 2017	2014 - 2018
20% Worst Days					
Great Smoky Mountains National Park	21.9	20.9	19.7	19.1	18.7
Joyce Kilmer-Slickrock	21.9	20.9	19.7	19.1	18.7
Linville Gorge	20.9	20.0	19.2	18.8	18.3
Shining Rock	18.9	18.5	18.7	18.0	17.5
Swanquarter	21.4	20.5	19.1	18.6	18.2
20% Most Impaired Days					
Great Smoky Mountains National Park	20.8	19.7	18.4	17.8	17.3
Joyce Kilmer-Slickrock	20.8	19.7	18.4	17.8	17.3
Linville Gorge	19.6	18.6	17.4	17.0	16.4
Shining Rock	17.7	17.3	16.9	16.2	15.5
Swanquarter	18.9	17.8	17.2	16.8	16.2
20% Best/Clearest Days					
Great Smoky Mountains National Park	10.7	9.7	9.2	8.8	8.4
Joyce Kilmer-Slickrock	10.7	9.7	9.2	8.8	8.4
Linville Gorge	9.5	8.5	8.4	8.0	7.6
Shining Rock	5.2	4.8	4.8	4.6	4.4
Swanquarter	11.5	11.2	11.2	10.8	10.6

The following figures show the data in Table 13-8, as well as the URP for the 20% worst and 20% best days for the Class I areas in North Carolina. For the 20% worst day figures, the blue diamonds are the average annual visibility impairment, the thin burgundy line is the rolling 5-year average, the pink line is the URP, the light purple line with triangles is the modeled predictions used to establish the RPGs listed in Table 13-6, and the thick green line represents predicted natural conditions in 2064. For the 20% best day figures, the blue diamonds are the average annual visibility impairment, the thin burgundy line is the rolling 5-year average, and the light purple line with triangles is the modeled predictions used to establish the RPGs listed in Table 13-7. Note that Section 7.2.6.3 present similar charts for the 20% most anthropogenically impaired and 20% clearest days.

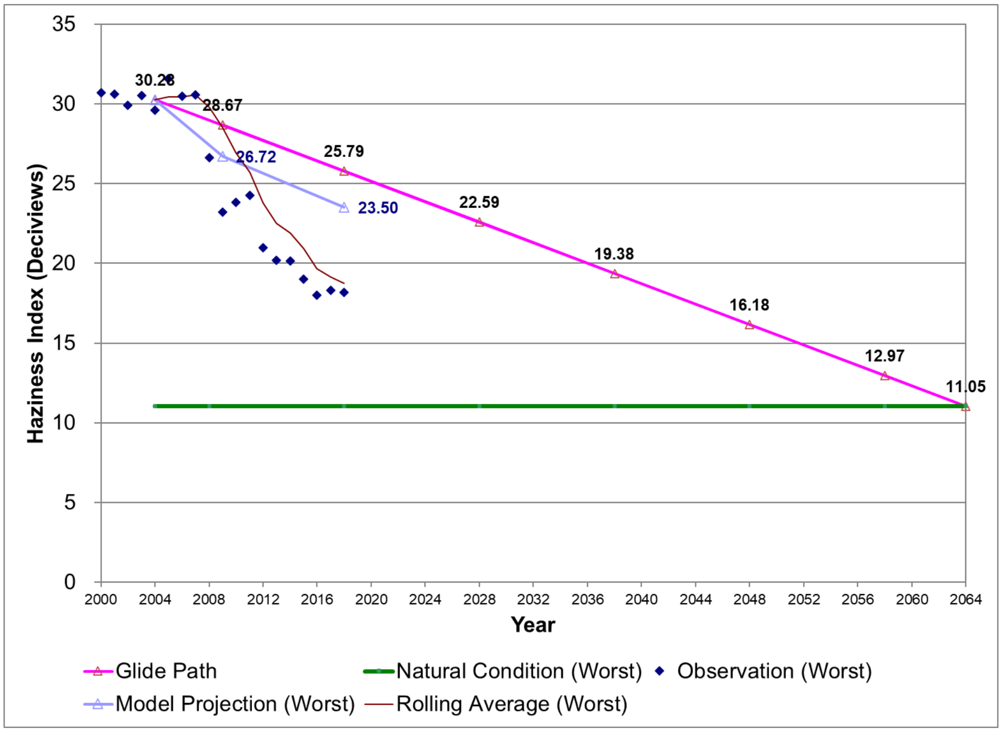

Figure 13-1. Visibility Conditions at Great Smoky Mountains National Park and Joyce Kilmer-Slickrock Wilderness Area for the 20% worst days

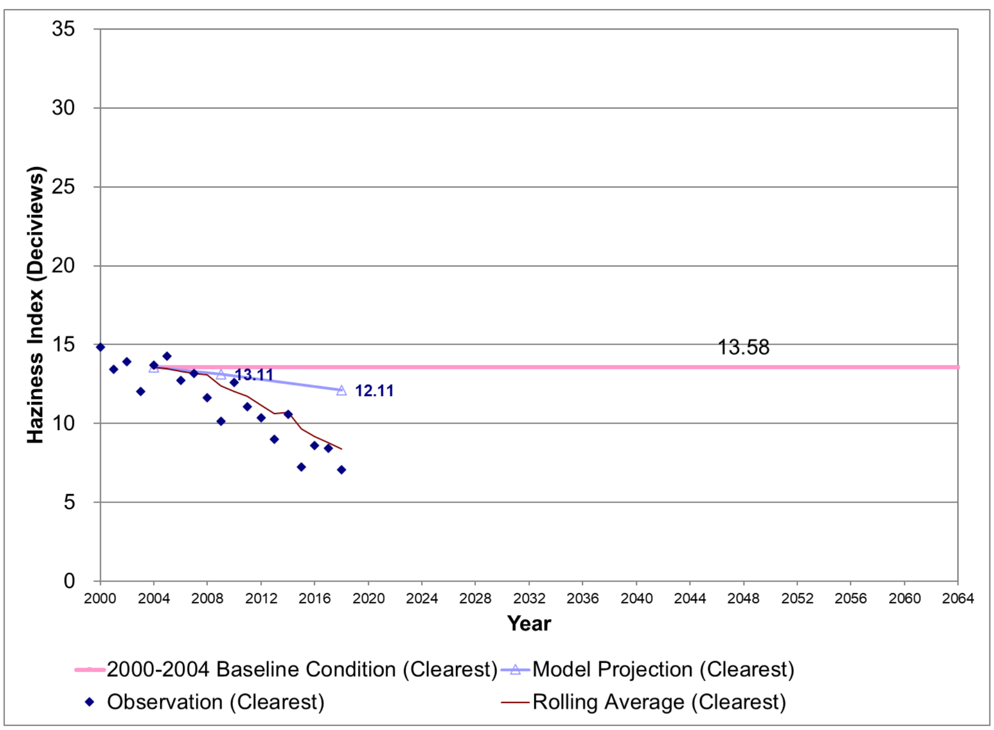

Figure 13-2. Visibility Conditions at Great Smoky Mountains National Park and Joyce Kilmer-Slickrock Wilderness Area for the 20% best days

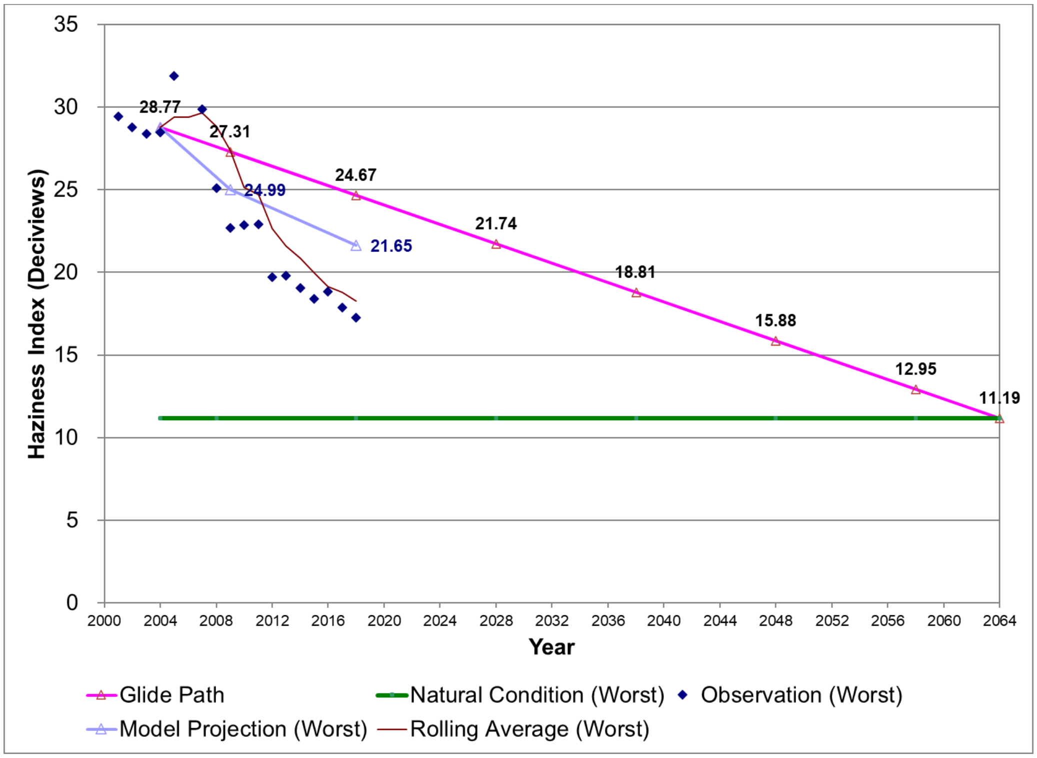

Figure 13-3. Visibility Conditions at Linville Gorge Wilderness Area for the 20% worst days

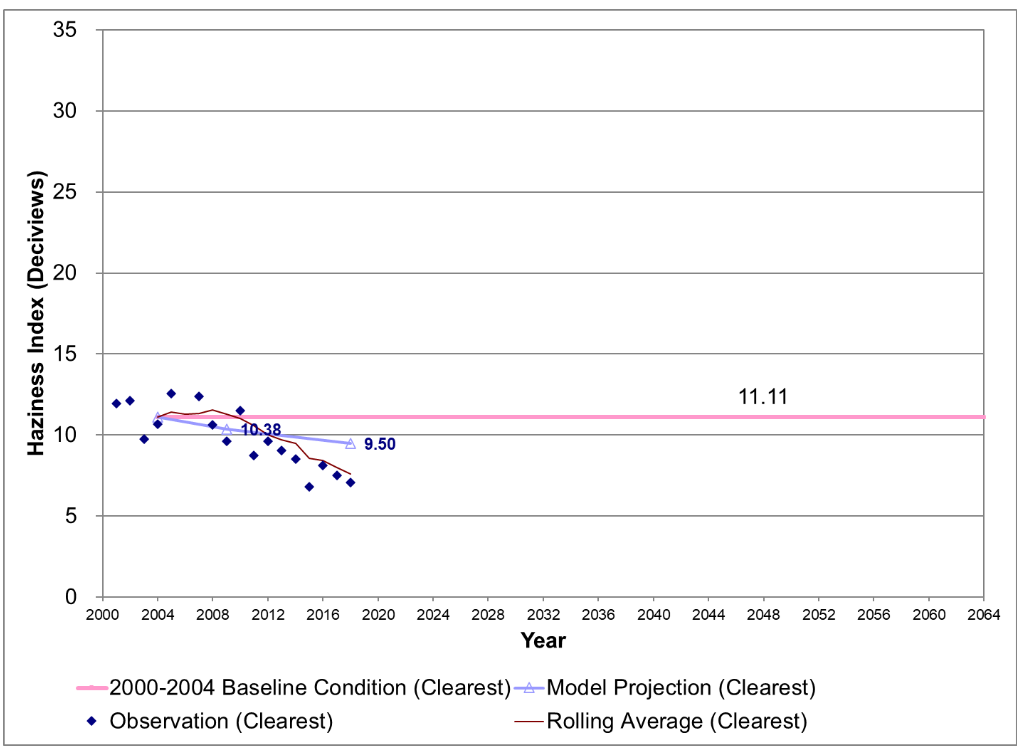

Figure 13-4. Visibility Conditions at Linville Gorge Wilderness Area for the 20% best days

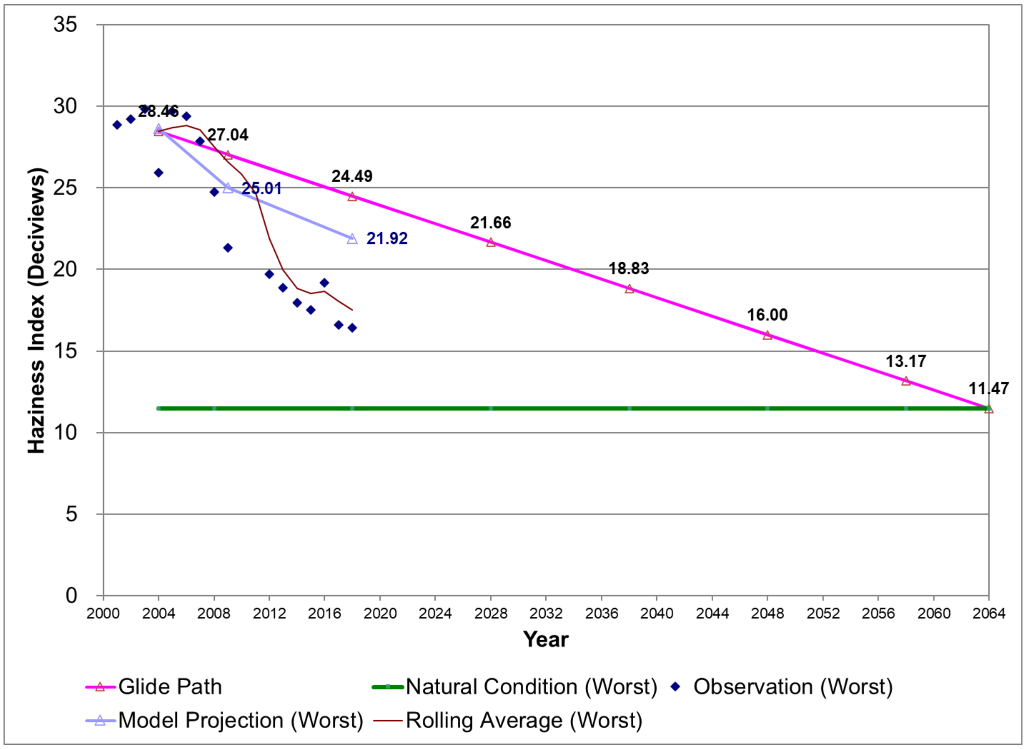

Figure 13-5. Visibility Conditions at Shining Rock Wilderness Area for the 20% worst days

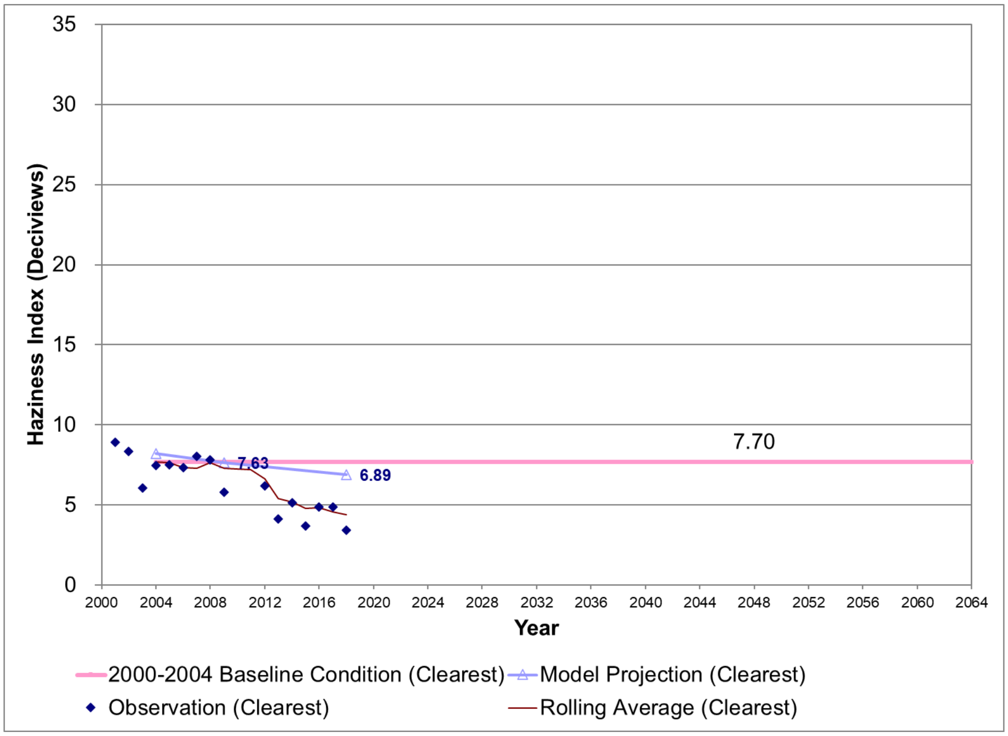

Figure 13-6. Visibility Conditions at Shining Rock Wilderness Area for the 20% best days

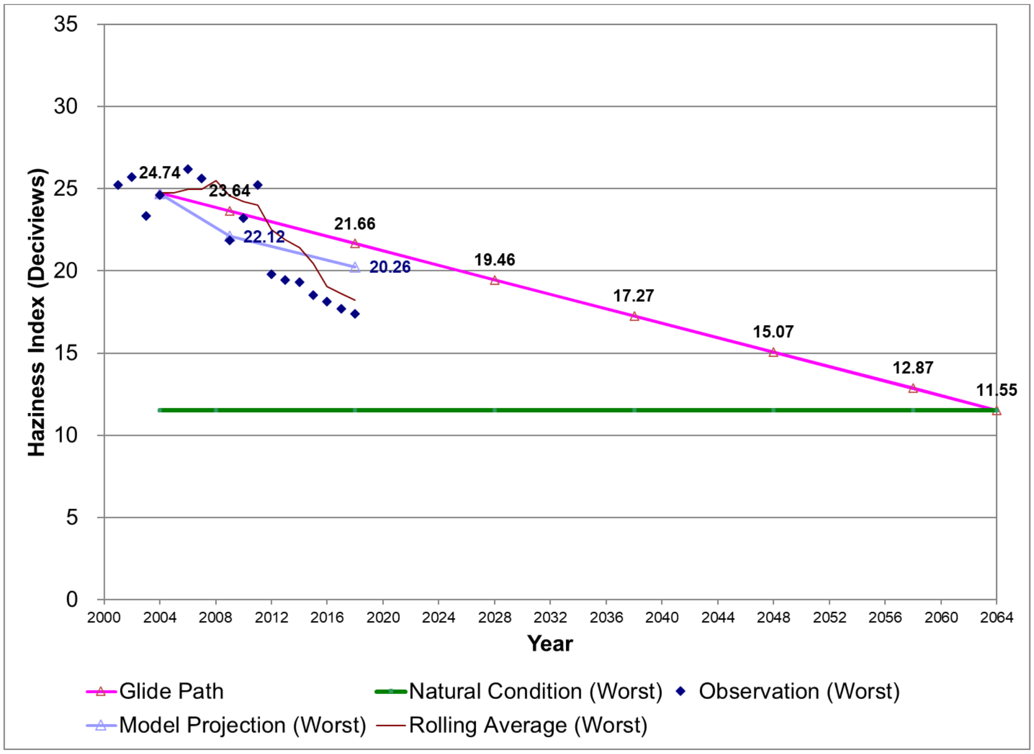

Figure 13-7. Visibility Conditions at Swanquarter Wilderness Area for the 20% worst days

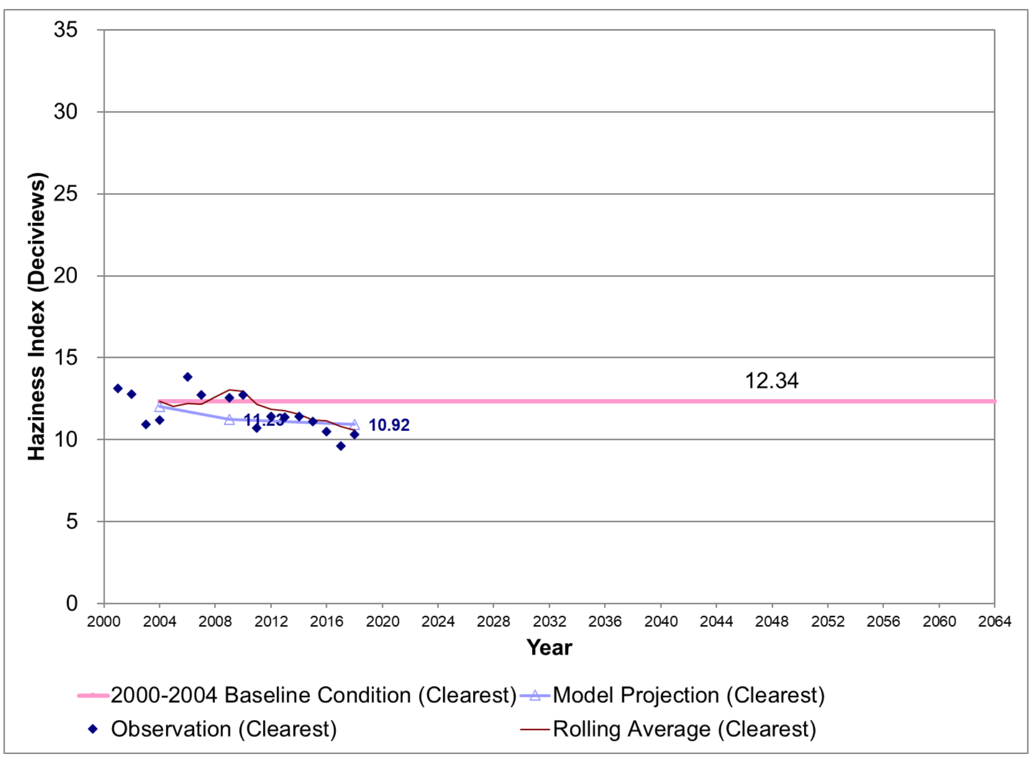

Figure 13-8. Visibility Conditions at Swanquarter Wilderness Area for the 20% best days

13.5 Analyses of Emissions (40 CFR 51.308(g)(4))

Paragraph (g)(4) requires of the RHG requires the state to present a*n analysis tracking the change over the period since the period addressed in the most recent plan required under 40 CFR 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 this part as of a date 6 months preceding the required date of the progress report.*

Therefore, this section documents anthropogenic emission reductions throughout the state of North Carolina by sector from 2011 through 2019 (the most recent year for which emissions inventory data were available). The long-term strategy for the first planning period, in addition to unplanned emission reductions associated with the closure of facilities and economic forces, have resulted in significant statewide emission reductions in all sectors for all pollutants that contribute to visibility impairment. The percentage of emission reductions for visibility impairing pollutants from CY2011 to CY2019 are:

- SO_2 emissions have been reduced by 71%.
- NO_x emissions have been reduced by 40%.
- $PM_{2.5}$ emissions have been reduced by 20%.
- VOC emissions have been reduced by 13%.
- PM_{10} emissions have been reduced by 4%.

The data shown in the following tables and figures are from the following data sources:[144]

- 2011 NEI (https://www.epa.gov/air-emissions-inventories/2011-national-emissions-inventory-nei-data)
- 2014 NEI (2014fd, https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-data)
- 2016 Modeling Platform (2016fh, https://www.epa.gov/air-emissions-modeling/2016v1-platform), The starting point for the 2016 inventory was the 2014 National Emissions Inventory (NEI), version 2 (2014NEIv2), although many inventory sectors were updated to represent the year 2016 through the incorporation of 2016-specific state and local data along with nationally-applied adjustment methods.
- 2017 NEI - CY2017 NEI data used in the following tables and charts was obtained from the most recent version posted in January 2021 of the CY2017 NEI.

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[144] Comparisons of emission inventories from different calendar years have inherent discrepancies that may affect emission trends. Advances in technology, improved modeling information, and changes in emission factors and methodology can affect the emissions reported for the different sectors. Models estimating emissions from aircraft and mobile sources have been improved and implemented during this period.

(https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data)

- 2018 EIS and 2019 EIS - For CYs 2018 and 2019 emissions from EIS, these emission inventories were constructed from each year's point source emissions submitted by NCDAQ and NC's three Local Programs as required by AERR and submitted to EIS plus emissions for highway vehicles (onroad mobile), off-highway (nonroad mobile), and miscellaneous were pulled forward from the CY2017 triennial NEI.

13.5.1 SO_2 Emissions (2011-2019)

Table 13-9 and Figure 13-9 show statewide anthropogenic SO_2 emission trends and reductions from 2011 through 2019. The dominate source of SO_2 emissions in North Carolina are originating from the electric utility sector which accounted for 71% and 62% of total statewide SO_2 emissions in 2011 and 2019, respectively. Emissions from this sector have been steadily decreasing since 2011 along with other fuel combustion sources. Sulfur dioxide emissions from other sectors have been consistently decreasing since 2011.

Table 13-9. Annual Anthropogenic SO_2 Emissions Trends for NC (2011-2019)

Sector	2011	2014	2016	2017	2018	2019
Industrial Processes	9,812	9,181	10,641	8,224	9,063	5,715
Fuel Comb. Elec. Util.	83,925	49,258	35,768	26,413	25,448	21,597
Fuel Comb. Industrial	12,354	5,374	5,215	4,196	4,923	3,483
Fuel Comb. Other	7,757	2,086	2,520	1,211	1,109	569
Highway Vehicles	1,082	1,108	1,245	1,132	1,132	1,132
Miscellaneous	1,068	1,299	2,671	1,317	1,317	1,317
Off-Highway	2,472	2,760	1,027	694	694	694
Waste Disposal & Recycling	251	216	201	203	205	205
Statewide Sector Totals	118,721	71,282	59,288	43,389	43,891	34,712
Percent Reduction from 2011		40%	50%	63%	63%	71%

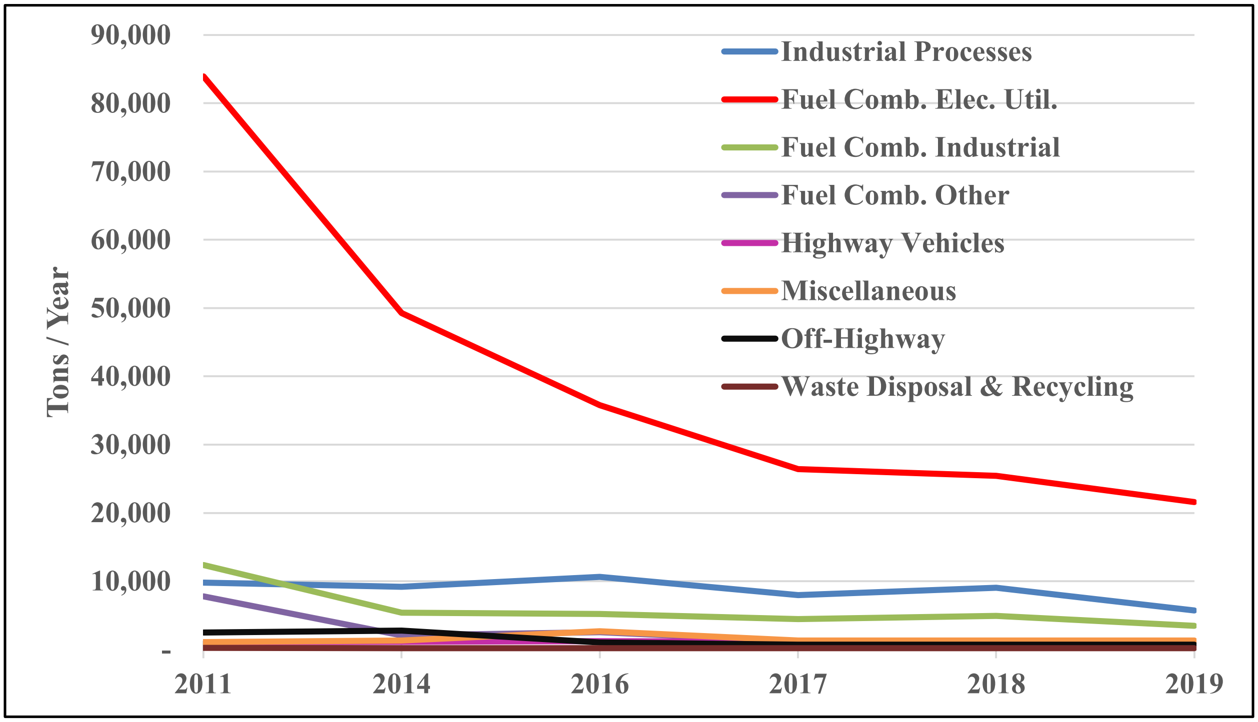

Figure 13-9. Annual Anthropogenic SO_2 Emissions Trends for NC (2011-2019)

13.5.2 NO_x Emissions (2011-2019)

Table 13-10 and Figure 13-10 show statewide anthropogenic NO_x emission trends and reductions from 2011 through 2019. The highway vehicle sector accounts for approximately 50% and off-highway vehicle sectors account for nearly 20% of the total NO_x emissions for the state of North Carolina. The percent of total NO_x for highway vehicles ranges from 48% in CY2016 to 55% in CY2011. Off-highway vehicles account for 19% for CY2011 and CY2014 and 18% for CYs 2017 through 2019. Emissions from vehicles are declining as the vehicle fleet moves toward cleaner vehicles and fuels.

The fuel combustion sectors including the electric utility sector NO_x emissions have declined overall from 77,957 tons in 2011 to 50,267 tons in 2019. NO_x controls added to the electric utility sector account for 30% of the emission reductions in these sectors. Higher NO_x emissions from fuel combustion electric utility in CY2018 may be attributed to temperatures that contributed to the top ten warmest annual temperature recorded at monitors[145] in four major cities:

- Asheville-highest recorded annual temperature in 63 years of record,
- Charlotte-sixth highest in 77 years of record,

[145] NOAA National Climate Report - Annual 2018, 2018 Record Setters, https://www.ncdc.noaa.gov/sotc/national/201813/supplemental/page-1

- Raleigh-ninth highest in 74 years of record and
- Greensboro-tenth highest in 90 years of record.

Industrial process emission fluctuations from CYs 2011 to 2019 are probably linked to the economy. Miscellaneous emissions show an increase in CY2016 due to increased emissions from prescribed fires and wildfires but otherwise emissions from this sector are steady. Waste Disposal and Recycling sector emissions have remained relatively steady after a drop in emissions between CY2011 and CY2014.

Table 13-10. Annual Anthropogenic NO_x Emissions Trends for NC (2011-2019)

Sector	2011	2014	2016	2017	2018	2019
Industrial Processes	12,331	13,351	13,316	13,504	13,538	11,986
Fuel Comb. Elec. Util.	43,911	44,185	35,444	35,056	39,346	35,444
Fuel Comb. Industrial	24,394	20,572	18,727	12,366	10,368	7,545
Fuel Comb. Other	9,652	10,728	10,340	9,716	7,393	7,278
Highway Vehicles	204,008	159,301	120,721	116,228	116,228	116,228
Miscellaneous	4,047	2,445	5,409	2,715	2,715	2,715
Off-Highway	68,433	59,069	44,446	41,200	41,200	41,200
Waste Disposal & Recycling	2,720	830	830	895	888	868
Statewide Sector Totals	369,496	310,481	249,233	231,679	231,676	223,264
Percent Reduction from 2011		16%	33%	37%	37%	40%

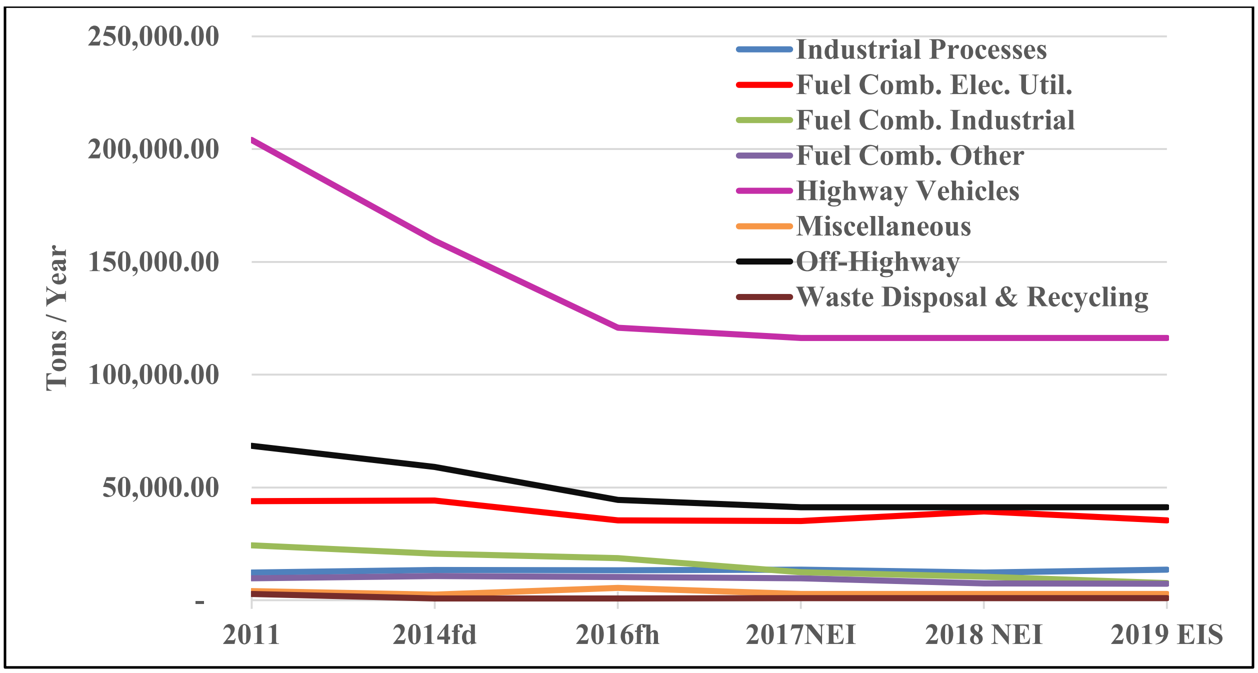

Figure 13-10. Annual Anthropogenic NO_x Emissions Trends for NC (2011-2019)

13.5.3 $PM_{2.5}$ Emissions (2011-2019)

Table 13-11 and Figure 13-11 show statewide anthropogenic $PM_{2.5}$ emission trends and reductions from 2011 through 2019. Over 50% of the $PM_{2.5}$ emissions in North Carolina are emitted by the miscellaneous sector. Miscellaneous particulate emissions are steady except for CY2016. The increase in $PM_{2.5}$ emissions from this sector is driven by emissions from prescribed fires and wildfires that are more than double the emissions reported in CY2011. Agricultural dust increased slightly and agricultural fires decreased during this same period.

The higher $PM_{2.5}$ emissions for fuel combustion industrial sector for CYs 2014 and 2016 which were based on CY2014 emissions, are due to biomass fuel use industrial boilers. In CY2017, emissions from biomass fuel use for the industrial fuel combustion had been reduced by 90% resulting in the decrease in $PM_{2.5}$ emissions in CY2017.

The majority of emissions in fuel combustion other sector are attributed to residential wood combustion (8,949 tons) for CYs 2017-2019. A major change in emission estimation method from 2014NEI to 2017NEI increased emissions from residential wood combustion source for numerous states including North Carolina. CY2016 emissions were similar to the 2014NEI emissions since the CY2016 were estimated based on the 2014NEI.

The slight increase in waste disposal and recycling is attributed to nonpoint waste sources and this increase may be due to updates in emission estimation methodology. All other sectors have remained steady or decreased during this period.

Table 13-11. Annual Anthropogenic $PM_{2.5}$ Emissions Trends for NC (2011-2019)

Sector	2011	2014	2016	2017	2018	2019
Industrial Processes	8,337	9,847	9,593	6,761	6,786	4,184
Fuel Comb. Elec. Util.	6,921	4,694	3,453	3,105	3,175	2,736
Fuel Comb. Industrial	2,899	10,970	10,349	1,725	1,673	1,115
Fuel Comb. Other	4,323	5,980	6,016	9,225	9,232	9,087
Highway Vehicles	5,510	4,591	3,245	3,115	3,115	3,115
Miscellaneous	45,672	43,060	56,450	43,443	43,443	43,443
Off-Highway	5,435	4,406	3,381	3,179	3,179	3,179
Waste Disposal & Recycling	9,386	2,288	2,309	3,830	3,828	3,788
Statewide Sector Totals	88,483	85,836	94,796	74,383	74,431	70,647
Percent Reduction from 2011		3%	-7%	16%	16%	20%

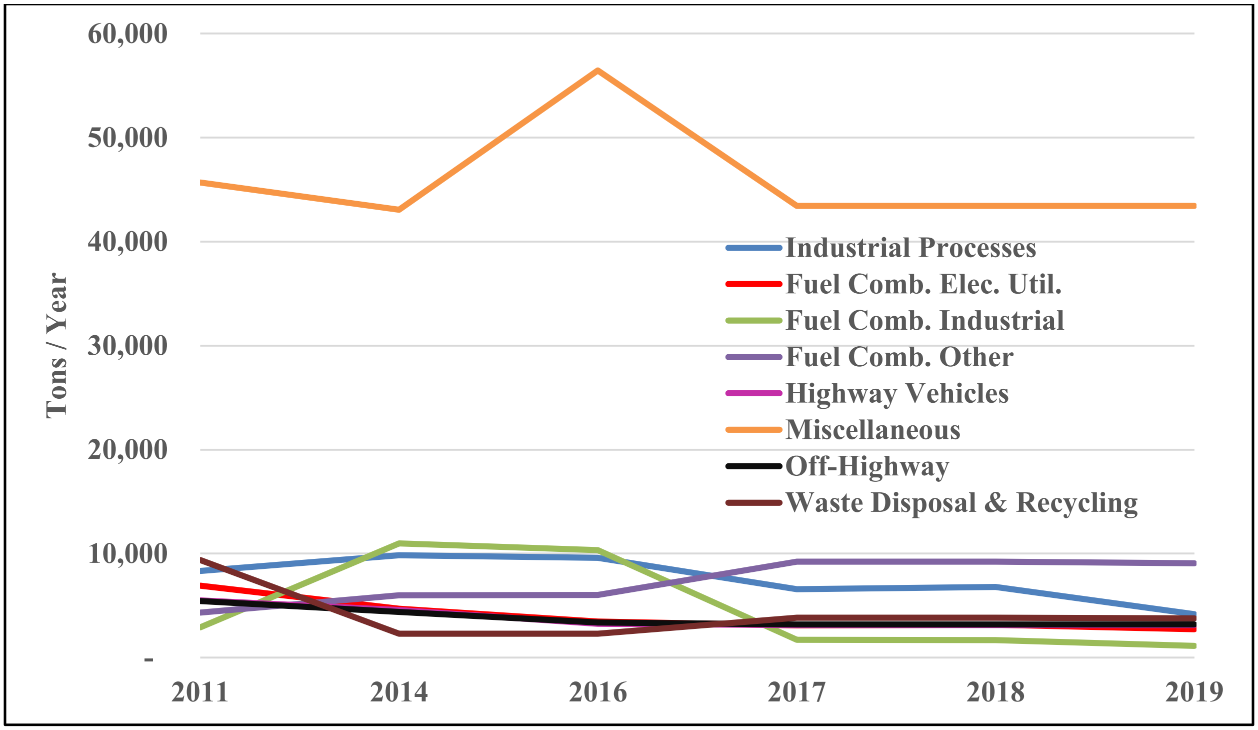

Figure 13-11. Annual Anthropogenic $PM_{2.5}$ Emissions Trends for NC (2011-2019)

13.5.4 PM_{10} Emissions (2011-2019)

Table 13-12 and Figure 13-12 show statewide anthropogenic PM_{10} emission trends and reductions from 2011 through 2019. Similar to trends in $PM_{2.5}$ emissions, miscellaneous emissions are the driving sector for PM_{10} emissions and PM_{10} emissions from this sector are steady from CY2014 to CY2019 except for CY2016. Increased emissions from prescribed fires and wildfires are the contributing factor to this increase. Also, in the miscellaneous sector, agricultural dust emissions increased slightly, and agricultural fires decrease in CY2016. Larger PM_{10} emissions in CYs 2014 and 2016 are due to biomass fuel use in industrial boilers and a 90% decrease in CY2017 for emissions from this fuel category. Increases in fuel combustion other are attributed to residential wood combustion. As noted with $PM_{2.5}$, this increase is due to a change in emission estimation methodology from 2014NEI to 2017NEI. Slight increase in waste disposal and recycling is attributed to nonpoint waste sources and this increase may be due to updates in emission estimation methodology.

Emissions from highway vehicles, off-highway vehicles, fuel combustion from electric utilities have been decreasing since CY2011.

Table 13-12. Annual Anthropogenic PM_{10} Emissions Trends for NC (2011-2019)

Sector	2011	2014	2016	2017	2018	2019
Industrial Processes	16,592	17,557	17,089	14,835	14,792	10,829
Fuel Comb. Elec. Util.	8,790	5,190	3,751	3,287	3,323	2,951
Fuel Comb. Industrial	3,828	12,729	12,029	1,984	1,913	1,216
Fuel Comb. Other	4,724	6,149	6,181	9,344	9,336	9,121
Highway Vehicles	10,447	9,032	7,189	7,045	7,045	7,045
Miscellaneous	195,376	214,381	233,318	206,628	206,628	206,628
Off-Highway	5,742	4,671	3,575	3,367	3,367	3,367
Waste Disposal & Recycling	11,151	2,724	2,732	4,215	4,212	4,167
Statewide Sector Totals	256,650	272,433	285,864	250,705	250,616	245,324
Percent Reduction from 2011		-6%	-11%	2%	2%	4%

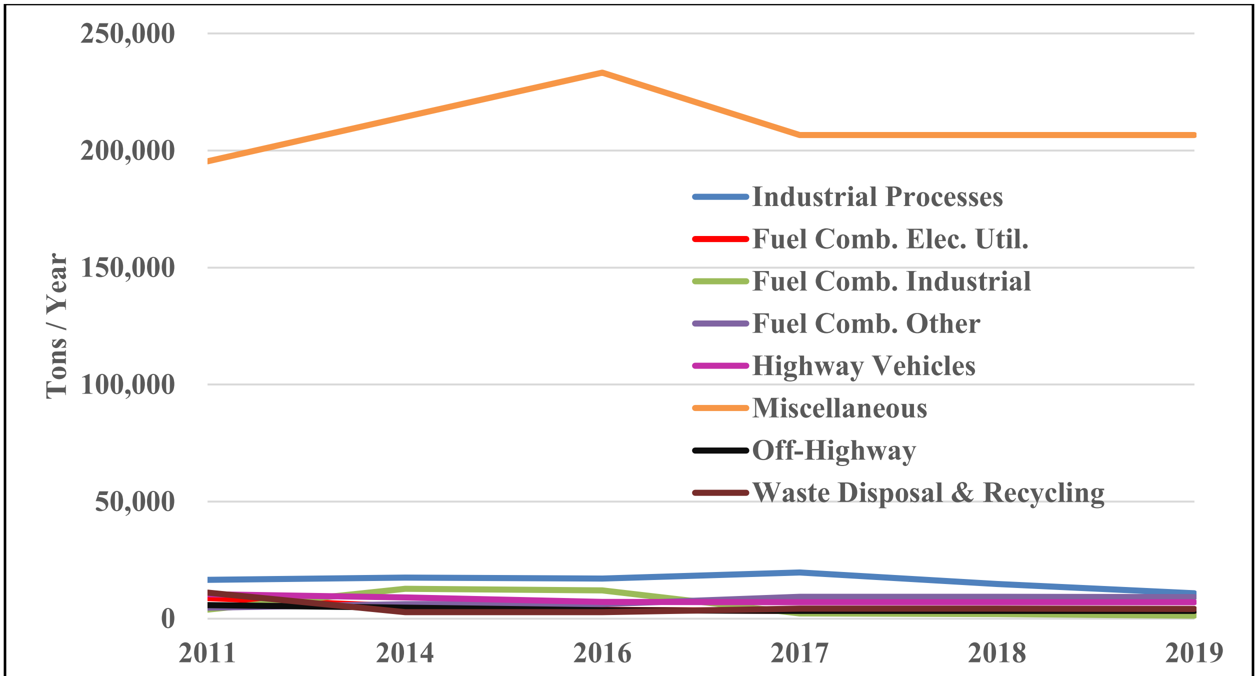

Figure 13-12. Annual Anthropogenic PM_{10} Emissions Trends for NC (2011-2019)

13.5.5 VOC Emissions (2011-2019)

Table 13-13 and Figure 13-13 show statewide anthropogenic VOC emission trends and reductions from 2011 through 2019. Industrial processes are the most significant contributor to anthropogenic VOC emissions. Contributions range from 42% to 50% of the statewide total VOC emissions. Highway and off-highway sectors are the second and third highest contributors to VOC emission. However, emissions from these sectors have been steadily decreasing as cleaner vehicles enter the fleet.

One anomaly in decreasing or steady VOC emissions among the other sectors is the miscellaneous sector for CY2016. Emissions from prescribed fires and wildfires which are included in the miscellaneous sector show over a tenfold increase from CY2011 to CY2016 (2011en-6671, 2016fh-71360).

Table 13-13. Annual Anthropogenic VOC Emissions Trends for NC (2011-2019)

Sector	2011	2014	2016	2017	2018	2019
Industrial Processes	139,923	159,799	161,047	151,103	152,922	140,465
Fuel Comb. Elec. Util.	934	866	988	863	926	795
Fuel Comb. Industrial	1,500	1,670	1,454	1,016	972	723
Fuel Comb. Other	4,611	6,823	6,866	10,861	10,876	10,773
Highway Vehicles	112,173	84,601	67,076	57,863	57,863	57,863
Miscellaneous	7,851	50,709	86,468	44,299	44,299	44,299
Off-Highway	63,283	49,459	37,862	35,301	35,301	35,301
Waste Disposal & Recycling	5,613	2,600	2,644	2,784	2,838	2,850
Statewide Sector Totals	335,888	356,527	364,405	304,090	305,997	293,069
Percent Reduction from 2011		-6%	-8%	9%	9%	13%

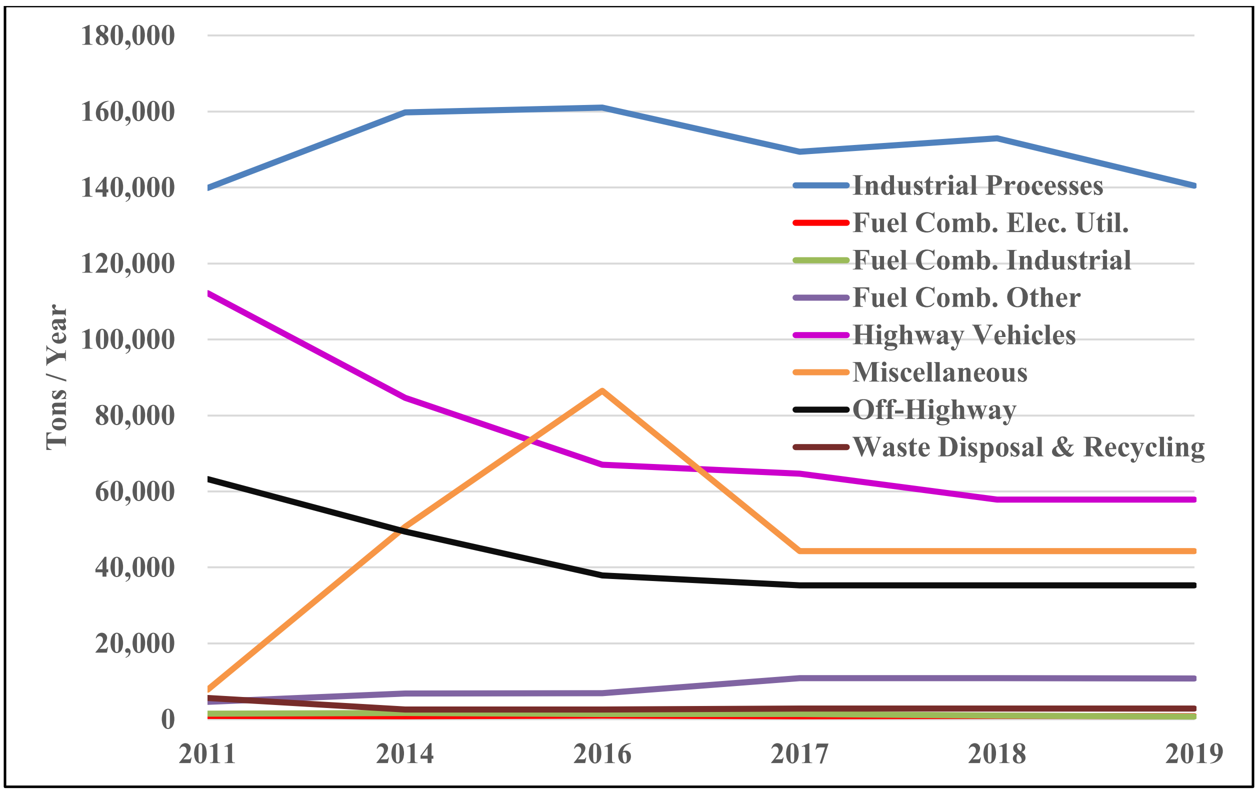

Figure 13-13. Annual Anthropogenic VOC Emissions Trends for NC (2011-2019)

13.6 Changes to Anthropogenic Emissions (40 CFR 51.308(g)(5))

Paragraph 40 CFR 51.308(g)(4) of the RHR specifies that a state assess if a*ny 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 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*.

To address this paragraph, the NCDAQ reviewed anthropogenic SO_2 and NO_x emissions trends for the VISTAS states and each of the Regional Planning Organizations (RPOs) based on emissions included in the 2011, 2014, and 2017 NEI. The emissions trends are shown in Table 13-14, and the data in this table are presented in bar charts in Figure 13-14 and Figure 13-15 for SO_2 and NO_x emissions, respectively. These data show a significant decline in both SO_2 and NO_x emissions during the 2011 through 2018 period covered by this progress report both within North Carolina, each VISTAS state, and non-VISTAS states included in the RPOs covering the rest of the U.S.

Table 13-14. Annual Anthropogenic SO_2 and NO_x Emissions Trends by RPO and VISTAS States (2011, 2014, and 2017)

	SO_2 Emissions (TPY)			NO_x Emissions (TPY)		
RPO/State	**2011**	**2014**	**2017**	**2011**	**2014**	**2017**
CENSARA	1,552,522	1,215,472	966,258	3,668,137	3,197,228	2,614,611
LADCO	1,899,157	1,250,232	486,481	2,664,749	2,259,264	1,608,532
WESTAR/WRAP	595,077	450,132	445,217	3,015,273	2,610,400	2,197,499
MANE-VU	739,180	503,720	169,617	1,661,320	1,468,719	1,067,962
VISTAS	1,634,354	1,210,228	446,961	3,343,166	2,984,899	2,184,753
VISTAS States						
AL	278,365	201,422	59,519	359,823	339,558	221,815
FL	172,700	164,434	78,173	608,366	583,991	414,369
GA	234,701	102,155	38,188	452,318	349,908	290,072
KY	272,921	224,782	71,804	327,755	299,784	198,435
MS	63,940	108,445	12,724	205,897	179,687	138,059
NC	118,721	71,282	42,073	369,496	310,480	231,679
SC	103,248	52,795	23,440	210,544	179,663	153,314
TN	160,323	94,202	46,738	322,567	272,996	200,581
VA	107,818	77,210	27,188	313,456	278,652	208,371
WV	121,617	113,500	47,117	172,944	190,181	128,059

For North Carolina, a significant reduction in SO_2 and NO_x emissions was anticipated as a result of the CSA and other control measures included in its long-term strategy for the first planning period. However, unanticipated facility closures and economic forces (such as natural gas prices becoming competitive with coal prices) have contributed to the transition from coal to natural gas in the EGU and non-EGU point source sectors which has contributed to lower SO_2 emissions as well. North Carolina has significantly transitioned to cleaner burning natural gas for electric power generation and has continued to increase its renewable energy capacity under the Southeast's only Renewable Energy and Energy Efficiency Portfolio Standard. The state has also transitioned to become third in the nation for solar photovoltaic capacity.

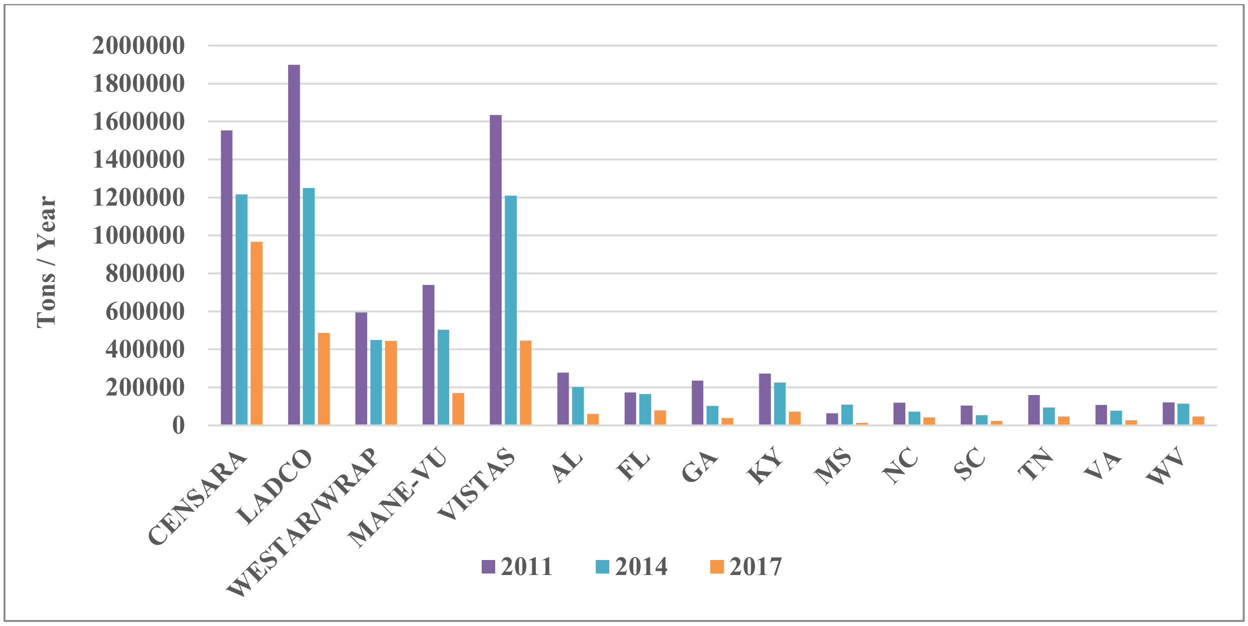

Figure 13-14. Annual Anthropogenic SO_2 Emissions Trends by RPO and VISTAS States

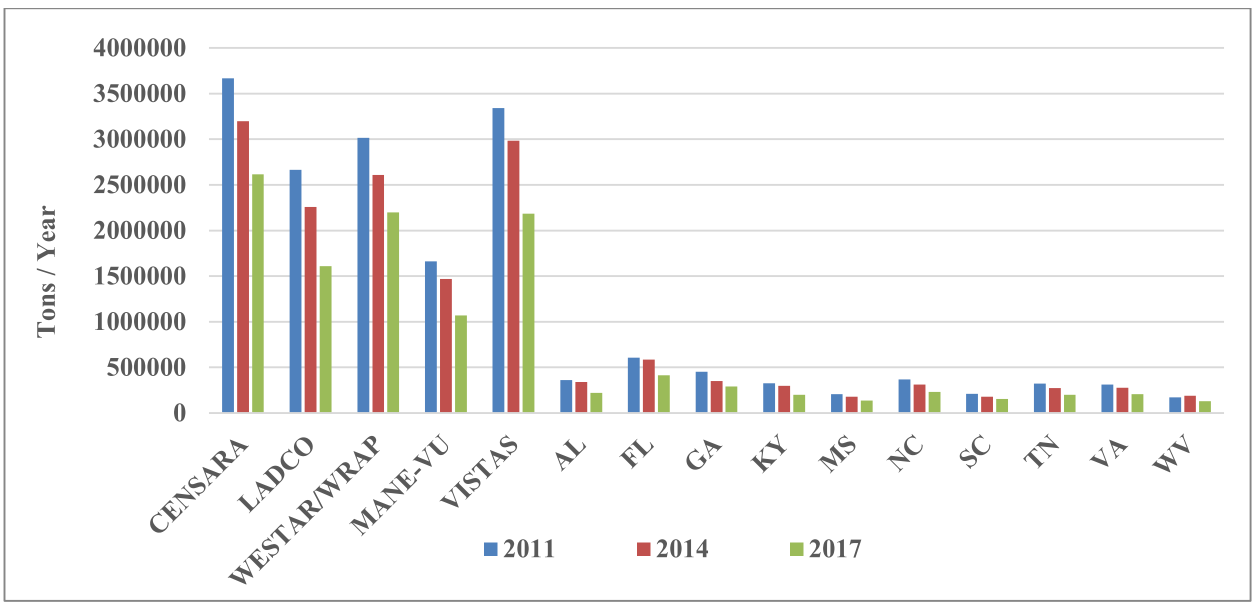

Figure 13-15. Annual Anthropogenic NO_x Emissions Trends by RPO and VISTAS States

Figure 13-16 shows the average light extinction for the 20% worst days over the 5-year period 2011 through 2018 for all Class I areas in the Southeast. Figure 13-17 shows the average light extinction for the 20% most impaired days over the 5-year period 2011 through 2018 for all Class I areas in the Southeast. These figures demonstrate that on the 20% worst days and 20% most impaired days in the Class I areas in North Carolina, sulfates (SO_4) continue to be the major concern during the first planning period, which is formed from the SO_2 emissions from stationary point sources. As shown in Figure 13-16 and Figure 13-17, the significant reduction in SO_2 and NO_x emissions in North Carolina as well as neighboring states has resulted in significant improvements in visible range in Class I areas in North Carolina as well as Class I areas in nearby states. Based on these data, there does not appear to be any anthropogenic emissions within North Carolina that would have limited or impeded progress in reducing pollutant emissions or improving visibility.

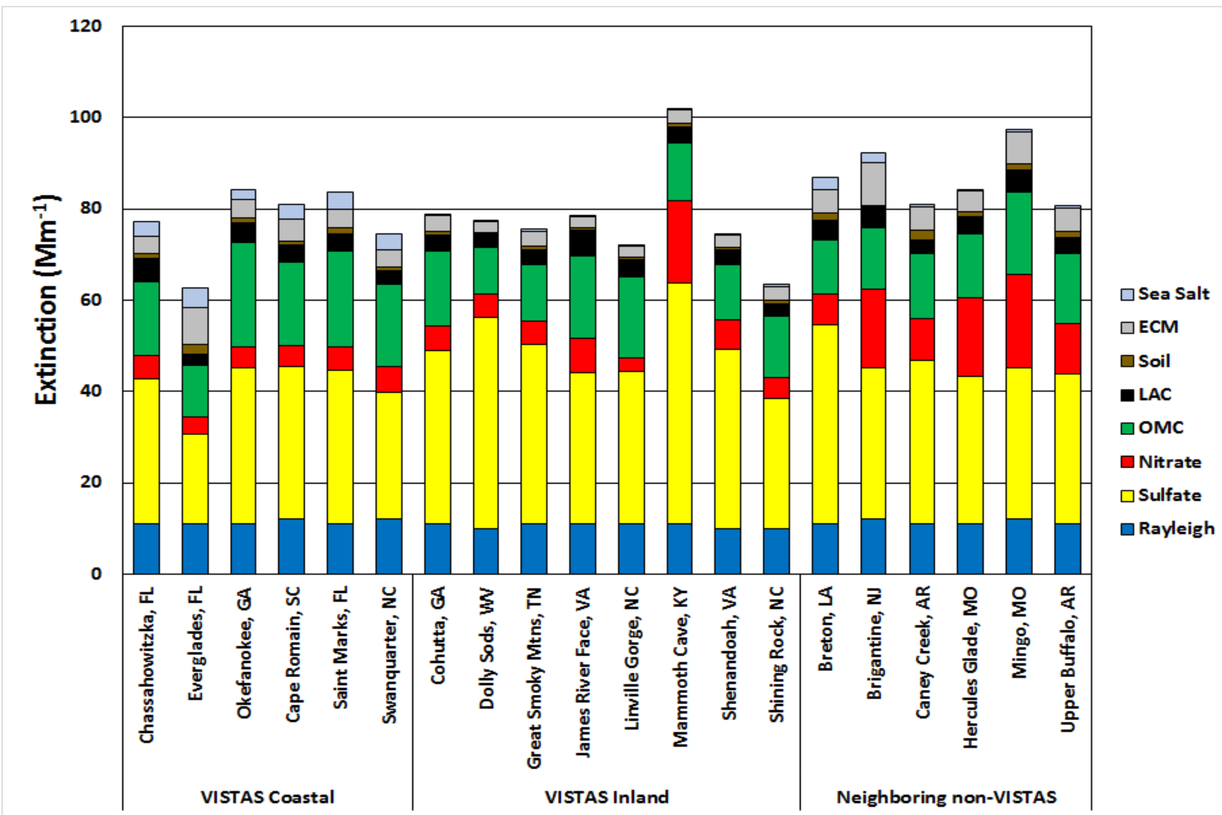

Figure 13-16. Average light extinction for the 20% Worst Days in 2011-2018 at Southeast and Neighboring Class I Areas

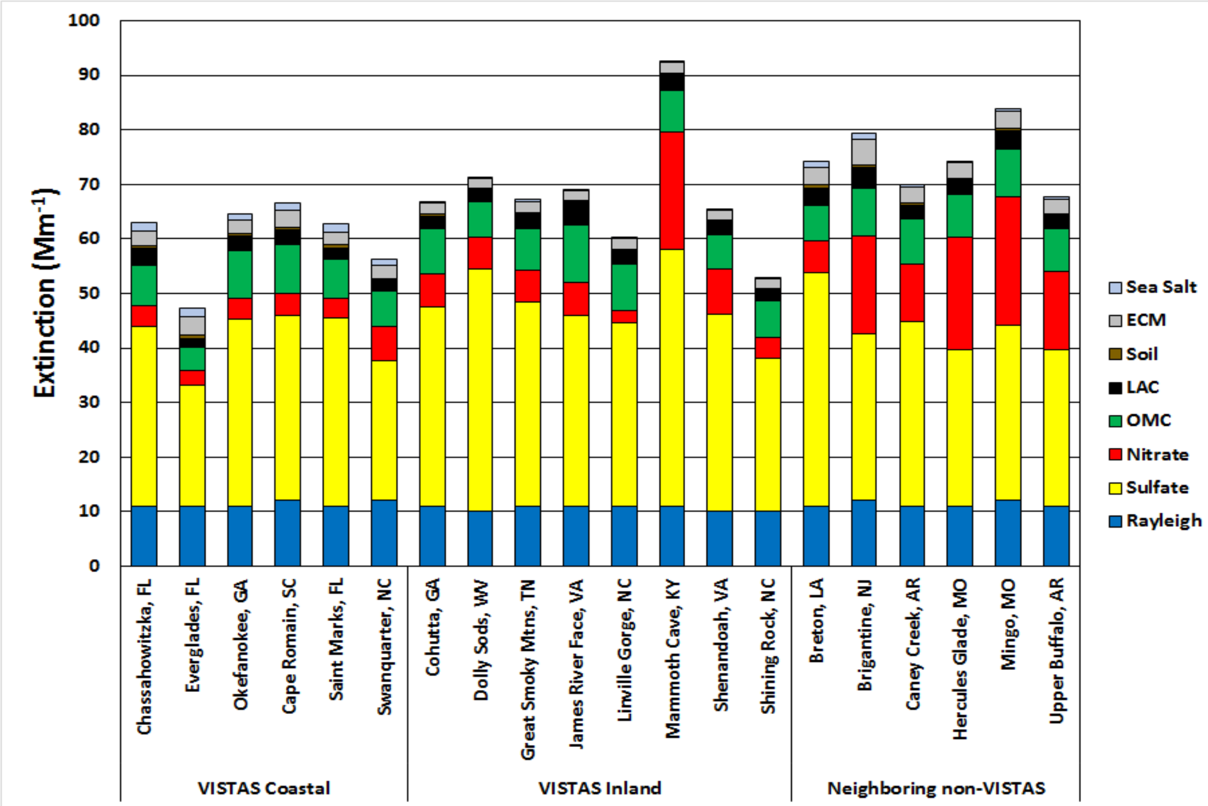

Figure 13-17. Average light extinction for the 20% Most Impaired Days in 2011-2018 at Southeast and Neighboring Class I Areas

13.7 Conclusions

This progress report documents that all control measures outlined in North Carolina's regional haze SIP have been implemented and that North Carolina has exceeded all RPGs projected for 2018. Reductions in SO_2 emissions have been significant and greater than VISTAS projected. In spite of significant reduction in SO_2, sulfates continue to play a significant role in visibility impairment, especially for 20% most anthropogenically impaired days. As SO_2 emissions continue to drop in future planning periods, nitrates may begin to have a larger relative impact on regional haze in Class I areas. The next regional haze progress report is due in July 2025 and will cover progress in the second implementation period.