REVISIONS TO THE STATE IMPLEMENTATION PLAN (SIP) CONCERNING REGIONAL HAZE

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
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PROJECT NO. 2007-016-SIP-NR

Adopted

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SECTION VI. CONTROL STRATEGY

A. Introduction (No change.)

B. Ozone (No change.)

C. Particulate Matter (No change.)

D. Carbon Monoxide (No change.)

E. Lead (No change.)

F. Oxides of Nitrogen (No change.)

G. Sulfur Dioxide (No change.)

H. Conformity with the National Ambient Air Quality Standards (No change.)

I. Site Specific (No change.)

J. Mobile Source Strategies (No change.)

K. Clean Air Interstate Rule (No change.)

L. Transport (Proposed.)

M. Regional Haze (New.)

EXECUTIVE SUMMARY

The Federal Clean Air Act (FCAA) and United States Environmental Protection Agency (EPA) regulations require states to submit State Implementation Plans (SIPs) to make "reasonable progress" in reducing visibility impairment at Federal Class I areas resulting from anthropogenic pollution. FCAA, 169A(a)(1), "declares as a national goal the prevention of any future, and the remedying of any existing impairment of visibility in mandatory Federal Class I areas which impairment results from man-made air pollution." Class I areas are national parks over 6,000 acres and wilderness areas over 5,000 acres. These SIPs must "contain such emission limits, schedules of compliance and other measures as may be necessary to make reasonable progress toward meeting the national goal" including requiring installation, operation, and maintenance of Best Available Retrofit Technology (BART), "as determined by the State" on certain existing stationary sources.

The EPA Regional Haze Rule strongly encourages states to work together in regional partnerships to reduce haze. There are five regional planning organizations in the United States. Texas is a member of the Central Regional Air Planning Association (CENRAP), which includes nine states, Texas, Louisiana, Oklahoma, Arkansas, Kansas, Missouri, Nebraska, Iowa, and Minnesota. CENRAP provides analysis, modeling results, and informational exchange among states, but each state submits its own regional haze SIP.

The FCAA, Section 169A and B require the EPA to adopt regulations to reduce visibility impairment resulting "from man-made air pollution" in 156 Federal Class I areas. The regulations require each state SIP to contain control measures, including BART, to make reasonable progress toward the national goal of natural visibility conditions by 2064 in all Class I areas. The two Class I areas in Texas are Big Bend and Guadalupe Mountains National Parks. Each state bordering Texas has one or more Federal Class I areas designated for visibility protection. Where Texas' emissions impact visibility in Federal Class I areas in other states, the Texas SIP must include plans to reduce Texas' visibility impacts in those areas too.

The EPA adopted Regional Haze regulations in 40 Code of Federal Regulations (CFR) Part 51, subpart P, on July 1, 1999, and adopted amendments to Subpart P and a new Appendix Y (BART guidelines) to Part 51 on July 6, 2005.

The 1990 FCAA Amendments together with EPA's Regional Haze Rule set the goal of reducing "man-made" impacts on visibility in Class I areas to zero (i.e., to "natural" conditions) by 2064 for the worst 20 percent visibility days and preventing any degradation for the best 20 percent visibility days. CENRAP and other Regional Air Planning Organizations have cooperated to calculate the base period (2000-2004) worst 20 percent and best 20 percent visibility for each Class I area. CENRAP has developed projections of visibility impairment in 2018, the initial year for which each state's long-term strategy is to be evaluated. The state must reduce its visibility impairment impact at all Class I areas it impacts by as much as is reasonable. The format of this SIP revision follows a prescribed template developed by the CENRAP states.

The TCEQ used a refined estimate of natural conditions for Class I areas in Texas as permitted by EPA guidance. These refined estimates account for natural dust storms, which explain a significant number of impaired days at the Texas Class I areas.

The Clean Air Interstate Rule (CAIR) program was designed to reduce interstate transport of emissions that affect fine particulate matter and ozone. Because these precursor emissions affect visibility, the CAIR program is also an integral part of reducing regional haze. Following the legislature's statutory direction, the TCEQ adopted CAIR requirements applicable to electric generating units in Texas. On July 11, 2008, the United States Court of Appeals for the District of Columbia Circuit vacated CAIR in its entirety. Upon a motion for rehearing, the appeals court issued a decision remanding CAIR to EPA to initiate rulemaking consistent with its opinion, but the court did not vacate CAIR, allowing it to remain in effect until replaced by EPA rule. The

TCEQ expects that a replacement program will be in place that makes comparable reductions in pollutants causing regional haze prior to 2018.

The commission has also adopted the requirements of the BART program, which requires certain older sources with a visibility impairment impact on a Class I area to apply BART to the source to reduce its impact on a nearby Class I area. This SIP revision contains a list of BART-eligible sources and another list of BART modeling outcomes. The appendix contains modeling summaries of sources that were reasonably anticipated to contribute to visibility impairment; however, after modeling, these sources were below the EPA threshold.

Each state must evaluate and determine if additional emissions reductions are necessary. The statute and EPA rules and guidance set criteria for determining whether additional reductions are reasonable. These criteria are based on the cost of controls and other related factors. The TCEQ has determined that no additional controls will be implemented with this SIP revision.

Reductions at Big Bend are dependent upon reducing emissions from Mexico and Central America. The TCEQ specifically asks the EPA for federal efforts to reduce the international transport impacts on regional haze coming into the United States across Texas' southern border. CENRAP modeling estimates of the base period visibility impairment at the two Texas Class I areas from the United States and foreign contributions indicate 52 percent of the visibility impairment at Big Bend National Park and 20 percent of the visibility impairment at Guadalupe Mountains National Park on the worst 20 percent of regional haze days comes from international transport. The preamble to the July 1, 1999, issuance of the Regional Haze Rule clearly says that states are not required to carry out compensatory overcontrol to make up for the lack of progress in reducing the impacts of international transport. The TCEQ expects that the EPA will pursue international emission reductions to improve visibility at Texas' Class 1 areas.

In conclusion, the TCEQ has implemented rules that limit and minimize emissions causing both Texas and regional visibility impairment. The Texas SIP includes numerous rules that minimize emissions that cause or contribute to Texas and regional visibility impairment. The TCEQ plans to continue to implement all these rules that protect visibility at Class I areas in Texas and other states.

SECTION V: LEGAL AUTHORITY

A. General

The TCEQ has the legal authority to implement, maintain and enforce the National Ambient Air Quality Standards (NAAQS) and to control the quality of the state's air, including maintaining adequate visibility.

The first air pollution control act, known as the Clean Air Act of Texas, was passed by the Texas Legislature in 1965. In 1967, the Clean Air Act of Texas was superseded by a more comprehensive statute, the Texas Clean Air Act (TCAA), found in Article 4477-5, Vernon's Texas Civil Statutes. The Legislature amended the TCAA in 1969, 1971, 1973, 1979, 1985, 1987, 1989, 1991, 1993, 1995, 1997, 1999, 2001, 2003 and 2005. In 1989, the TCAA was codified as Chapter 382 of the Texas Health & Safety Code.

Originally, the TCAA stated that the Texas Air Control Board (TACB) is the state air pollution control agency and is the principal authority in the state on matters relating to the quality of air resources. In 1991, the Legislature abolished the TACB effective September 1, 1993, and its powers, duties, responsibilities and functions were transferred to the Texas Natural Resource Conservation Commission (TNRCC). With the creation of the TNRCC, the authority over air quality is found in both the Texas Water Code and the TCAA. Specifically, the authority of the TNRCC is found in Chapters 5 and 7. Chapter 5, Subchapters A - F, H - J, and L, include the general provisions, organization and general powers and duties of the TNRCC, and the responsibilities and authority of the Executive Director. This Chapter also authorizes the TNRCC to implement action when emergency conditions arise and to conduct hearings. Chapter 7 gives the TNRCC enforcement authority. In 2001, the 77th Texas Legislature continued the existence of the TNRCC until September 1, 2013, and changed the name of the TNRCC to the Texas Commission on Environmental Quality (TCEQ).

The TCAA specifically authorizes the TCEQ to establish the level of quality to be maintained in the state's air and to control the quality of the state's air by preparing and developing a general, comprehensive plan. The TCAA, Subchapters A - D, also authorize the TCEQ to collect information to enable the commission to develop an inventory of emissions; conduct research and investigations; enter property and examine records; prescribe monitoring requirements; institute enforcement proceedings; enter into contracts and execute instruments; formulate rules; issue orders taking into consideration factors bearing upon health, welfare, social and economic factors, and practicability and reasonableness; conduct hearings; establish air quality control regions; encourage cooperation with citizens' groups and other agencies and political subdivisions of the state as well as with industries and the Federal Government; and establish and operate a system of permits for construction or modification of facilities.

Local government authority is found in Subchapter E of the TCAA. Local governments have the same power as the TCEQ to enter property and make inspections. They also may make recommendations to the commission concerning any action of the TCEQ that affects their territorial jurisdiction, may bring enforcement actions, and may execute cooperative agreements with the TCEQ or other local governments. In addition, a city or town may enact and enforce ordinances for the control and abatement of air pollution not inconsistent with the provisions of the TCAA or the rules or orders of the commission.

Subchapters F, G, and H of the TCAA authorize the TCEQ to establish low emission vehicle requirements for mass transit authorities, local government fleets, and private fleets; create a mobile emissions reduction credit program; establish vehicle inspection and maintenance programs in certain areas of the state, consistent with the requirements of the Federal Clean Air Act; establish gasoline volatility and low emission diesel standards; and fund and authorize participating counties to implement low-income vehicle repair assistance, retrofit and accelerated vehicle retirement programs.

B. Applicable Law

The following statutes and rules provide necessary authority to adopt and implement the SIP. The rules listed below have previously been submitted as part of the SIP.

Statutes

TEXAS HEALTH & SAFETY CODE, Chapter 382	September 1, 2005
TEXAS WATER CODE	September 1, 2005

All sections of each subchapter are included, unless otherwise noted.

Chapter 5: Texas Natural Resource Conservation Commission
Subchapter A: General Provisions
Subchapter B: Organization of the Texas Natural Resource Conservation Commission
Subchapter C: Texas Natural Resource Conservation Commission
Subchapter D: General Powers and Duties of the Commission
Subchapter E: Administrative Provisions for Commission
Subchapter F: Executive Director (except §§ 5.225, 5.226, 5.227, 5.2275, 5.232, and 5.236)
Subchapter H: Delegation of Hearings
Subchapter I: Judicial Review
Subchapter J: Consolidated Permit Processing
Subchapter L: Emergency and Temporary Orders (§§ 5.514, 5.5145 and 5.515 only)

Chapter 7: Enforcement
Subchapter A: General Provisions (§§ 7.001, 7.002, 7.0025, 7.004, 7.005 only)
Subchapter B: Corrective Action and Injunctive Relief (§ 7.032 only)
Subchapter C: Administrative Penalties
Subchapter E Criminal Offenses and Penalties: §§ 7.177, 7.179-7.181

Rules

All of the following rules are found in Title 30, Texas Administrative Code, as of the following effective dates:

Chapter 7, Memoranda of Understanding, §§ 7.110 and 7.119	May 2, 2002
Chapter 35, Subchapters A-C, K: Emergency and Temporary Orders and Permits; Temporary Suspension or Amendment of Permit Conditions	December 10, 1998
Chapter 39, Public Notice, §§ 39.201; 39.401; 39.403(a) and (b)(8)-(10); 39.405(f)(1) and (g); 39.409; 39.411 (a), (b)(1)-(6) and (8)-(10) and (c)(1)-(6) and (d); 39.413(9), (11), (12) and (14); 39.418(a) and (b)(3) and (4); 39.419(a), (b),(d) and (e); 39.420(a), (b) and (c)(3) and (4); 39.423 (a) and (b); 39.601; 39.602; 39.603; 39.604; and 39.605	August 15, 2002
Chapter 55, Request for Contested Case Hearings; Public Comment, §§ 55.1; 55.21(a) - (d), (e)(2), (3) and (12), (f) and (g); 55.101(a), (b), (c)(6) - (8); 55.103; 55.150; 55.152(a)(1), (2) and (6) and (b); 55.154; 55.156; 55.200; 55.201(a) - (h); 55.203; 55.205; 55.206; 55.209 and 55.211	August 29, 2002
Chapter 101: General Air Quality Rules	August 16, 2007

Chapter 106: Permits by Rule, Subchapter A	June 30, 2004
Chapter 111: Control of Air Pollution from Visible Emissions and Particulate Matter	July 19, 2006
Chapter 112: Control of Air Pollution from Sulfur Compounds	July 12, 2001
Chapter 113: Standards of Performance for Hazardous Air Pollutants and for Designated Facilities and Pollutants	June 15, 2005
Chapter 114: Control of Air Pollution from Motor Vehicles	July 19, 2007
Chapter 115: Control of Air Pollution from Volatile Organic Compounds	July 19, 2007
Chapter 116: Permits for New Construction or Modification	March 15, 2007
Chapter 117: Control of Air Pollution from Nitrogen Compounds	June 14, 2007
Chapter 118: Control of Air Pollution Episodes	March 5, 2000
Chapter 122, § 122.122: Potential to Emit	December 11, 2002
Chapter 122, § 122.215: Minor Permit Revisions	June 3, 2001
Chapter 122, § 122.216: Applications for Minor Permit Revisions	June 3, 2001
Chapter 122, § 122.217: Procedures for Minor Permit Revisions	December 11, 2002
Chapter 122, § 122.218: Minor Permit Revision Procedures for Permit Revisions Involving the Use of Economic Incentives, Marketable Permits, and Emissions Trading	June 3, 2001

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AEO	Annual Energy Outlook, forecasts by Department of Energy
AOI	Area of influence
B20%	Best 20 percent (days of visibility)
BACT	Best Available Control Technology
BADL	Badlands Wilderness Area
BAND	Bandelier Wilderness Area
BART	Best Available Retrofit Technology
BC	Boundary conditions
BEIS3	Biogenic Emissions Inventory System Version 3
Bext	Light extinction
BIBE	Big Bend National Park
bnatural	Clean natural conditions
BOAP	Bosque del Apache Wilderness Area
BOWA	Boundary Waters Canoe Area Wilderness
BRAVO	Big Bend Regional Aerosol and Visibility Observational study
BRET	Breton Wilderness Area
bsource	Total light extinction due to a source
CACR	Caney Creek Wilderness Area
CAIR	Clean Air Interstate Rule
CALPUFF	California Puff Model
CAMx	Comprehensive Air Quality Model with extensions
CENRAP	Central Regional Air Planning Association
CFR	Code of Federal Regulations
CM	Coarse mass
CMAQ	Community Multiscale Air Quality Modeling System
DRI	Desert Research Institute
dv	deciviews
EC	Elemental carbon
EGAS	Economic Growth Analysis System
EGU	Electric generating unit
ENVIRON	ENVIRON International Corporation
EPA	United States Environmental Protection Agency
ERCOT	Electric Reliability Council of Texas
f(RH)	Relative Humidity adjustment factor
FCAA	Federal Clean Air Act
FIPS	Federal Information Processing Standard
FLAG	Federal Land Managers' Air Quality Related Values Work Group
FLM	Federal Land Manager
FS	United States Forest Service
FWS	United States Fish and Wildlife Service
FR	Federal Register
GEOS-Chem	Goddard Earth Observing System - Chemistry model
GICL	Gila Wilderness Area
GRSA	Great Sand Dunes Wilderness Area
GUMO	Guadalupe Mountains National Park
HEGL	Hercules-Glades Wilderness Area
HI	Haze Index

IC	Initial conditions
IDNR	Iowa Department of Natural Resources
IMPROVE	Interagency Monitoring of Protected Visual Environments
IPM	Integrated Planning Model
ISLE	Isle Royale National Park
JPROC	Photolysis Rates Processor
km	kilometers
LAER	Lowest Achievable Emission Rate
LOST	Lostwood Wilderness Area
LTS	Long-term strategy
MACA	Mammoth Cave National Park
MATS	Modeled Attainment Test Software
mb	millibars
MEVE	Mesa Verde National Park
MING	Mingo Wilderness Area
Mm^{-1}	Inverse Megameters
MM5	Mesoscale Meteorological Model, 5th Generation (developed by Pennsylvania State University / National Center for Atmospheric Research PSU/NCAR)
MMS	Minerals Management Service
MOBILE5	MOBILE Vehicle Emission Modeling Software Version 5
MOZI	Mount Zirkel Wilderness Area
MPE	Model performance evaluation
MPI	Message passing interface
MRPO	Midwest Regional Planning Organization
NAAQS	National ambient air quality standards
NARSTO	North American Research Strategy for Tropospheric Ozone
NH_4	Ammonium
NO_3	Nitrate
NO_x	Nitrogen oxides
non-EGU	Non-electrical generating units
NPS	National Park Service, United States Department of the Interior
NSPS	New source performance standards
NSR	New Source Review
OC	Organic carbon
OMC	Organic mass carbon
PGM	Photochemical Grid Model
PiG	Plume-in-Grid
PLUVUE	Plume Visibility Model
PM	Particulate matter
PM_{10}	Particulate matter with aerodynamic diameters less than 10 microns
$PM_{2.5}$	Particulate matter with aerodynamic diameters less than 2.5 microns
POA	Primary organic aerosol
PPM	Piecewise-Parabolic Method
PSAT	Particulate Matter Source Apportionment Technology
PSD	Prevention of significant deterioration
PTE	Potential to emit

Q/D	Emissions over distance (to Class I area)
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Program Plan
RH	Relative Humidity
ROMO	Rocky Mountain National Park
RPG	Reasonable progress goal
RPO	Regional Planning Organization
RRF	Relative response factor
SACR	Salt Creek Wilderness Area
SAPE	San Pedro Parks Wilderness Area
SIP	State Implementation Plan
SIPS	Sipsey Wilderness Area
SMOKE	Sparse Matrix Operator Kernel Emissions
SO_2	Sulfur dioxide
SO_4	Sulfate
SOA	Secondary organic aerosol
SOAA	Secondary organic aerosols anthropogenic (human-made)
SOAB	Secondary organic aerosols biogenic (from plants)
TAC	Texas Administrative Code
TCAA	Texas Clean Air Act
TCEQ	Texas Commission on Environmental Quality
TEOM	Tapered Element Oscillating Microbalance
TERP	Texas Emissions Reduction Program
THRO	Theodore Roosevelt National Park
TIP	Tribal Implementation Plan
TOMS	Total Ozone Mapping Spectrometer satellite data
tpy	tons per year
TSD	Technical Support Document
TUV	Tropospheric Ultraviolet and Visible (Radiation Model)
UCR	University of California at Riverside
UPBU	Upper Buffalo Wilderness Area
URP	Uniform rate of progress
VIEWS	Visibility Information Exchange Web System
VISTAS	Visibility Improvement State and Tribal Association of the Southeast
VOC	Volatile organic compounds
VOYA	Voyageurs National Park
W20%	Worst 20 percent (days of visibility)
WEMI	Weminuche Wilderness Area
WHIT	White Mountain Wilderness Area
WHPE	Wheeler Peak Wilderness Area
WHRI	White River National Forest
WICA	Wind Cave National Park
WIMO	Wichita Mountains Wilderness Area
WRAP	Western Regional Air Partnership

CHAPTER 1. BACKGROUND AND OVERVIEW OF THE FEDERAL REGIONAL HAZE REGULATION

1.1 GENERAL BACKGROUND

Regional haze is visibility impairment that is produced by a multitude of sources and activities. These emission sources and activities are located across a broad geographical area. The emissions consist of fine particles and their precursors. Visibility impairment caused by air pollution occurs virtually all of the time at most Class I visibility protected national park and wilderness area monitoring stations (VIEWS 2007). A significant factor in visibility impairment is regional transport of fine particles that contribute to elevated particulate matter (PM) levels.

Haze-forming pollution comes from both human and natural sources. Windblown dust and soot from wildfires contribute to haze, as do motor vehicles, electric generating facilities, industrial fuel burning, and manufacturing operations. PM and PM precursor emissions are the major cause of reduced visibility (haze) in the United States and at many of our national parks and wilderness areas. Some haze-forming particles are directly emitted into the air. The usual term for directly emitted particles is primary particles. Secondary particles, created when emitted gases form particles downwind of the emission sources, usually dominate the causes of regional haze. Nitrates and sulfates, which result from NO_2 and SO_2 emissions, are examples of secondary particles that contribute to regional haze.

In many scenic areas, haze substantially reduces visual range. In eastern Class I areas, haze from human activity reduces average visual range from the natural condition of approximately 90 miles to 15-to-25 miles. In the West, haze from human activity reduces visual range from the natural condition of approximately 140 miles to 35-to-90 miles. Visibility impairment is expressed in deciviews (dv). A deciview is a unit of visibility impairment proportional to the logarithm of the atmospheric light extinction. One deciview is approximately the minimum amount of change in visibility that a human observer can detect.

1.2 VISIBILITY-IMPAIRING EMISSIONS

The Central Regional Air Planning Association (CENRAP) and the Texas Commission on Environmental Quality (TCEQ) data analysis and modeling show that several types of emissions are involved in reducing visibility, including sulfur dioxide (SO_2), nitrogen oxides (NO_X), and particulate matter (PM). Table 1-1: *Visibility-Impairing Pollutants* and Table 1-2: *Comparison of Ambient Fine Particles (Ultrafine plus Accumulation-Mode) and Coarse Particles* discuss some of the emissions, different variations of the molecules in the atmosphere, and various sources of the emissions. Unlike pollutants like ozone, $PM_{2.5}$, and carbon monoxide, visibility is not a measurable concentration for which a standard, like the national ambient air quality standard (NAAQS) could be set. Instead, the Regional Haze Rule sets out procedures states must follow to decide how much emissions reductions are reasonable to move toward the national goal that Congress has established under the Federal Clean Air Act (FCAA): returning Class I areas to natural visibility conditions. The United States Environmental Protection Agency (EPA) has set 2064 as the target date to reach the goal set by Congress to reach natural conditions at all Class I areas. To accomplish this goal, a state must first determine what “natural conditions” are and then plan how to reach those conditions.

Table 1-1 provides information about particulate matter components that contribute to regional haze.

Table 1-1: Visibility-Impairing Pollutants

Major Components of Particles	Symbol	Directly Emitted?	Formed in the Air?	Formed From	In which Size Range? micrometers (µm)	Major Sources
Sulfates	SO_4	(Yes)*	Yes	SO_2	$PM_{2.5}$	Coal-fired power plants, oil fields and refineries, paper mills
Nitrates	NO_3	(No)*	Yes	NO_2	$PM_{2.5}$	All combustion
Secondary Organic Carbon	OC	No	Yes	VOC**	$PM_{2.5}$	Gasoline, organic solvents, biogenics
Primary Organic Carbon	OC	Yes	No	--	$PM_{2.5}$	Incomplete combustion
Elemental Carbon (i.e., black carbon)	EC	Yes	No	--	$PM_{2.5}$	Incomplete combustion
Fine Soil Dust	FS	Yes	No	--	$PM_{2.5}$	Wind blowing over loose soil, motor vehicles running on paved and unpaved roads
Coarse Mass, which is normally ~ 100% Coarse Soil Dust	CM	Yes	No	--	PM_{COARSE}, i.e. $PM_{10-2.5}$	Wind blowing over loose soil, motor vehicles running on paved and unpaved roads

*There are few significant, direct sulfate sources; direct nitrate sources are rare.
**Volatile organic compounds

Table 1-2 provides additional information about particles. The table breaks down the fine particles into ultrafine particles that are less than 0.1 µm in diameter and accumulation mode particles that are generally between 0.1 and 1.0 µm in diameter. Ultrafine particles agglomerate to form accumulation mode particles. Some of the accumulation mode particles, most notably sulfates, grow above 1.0 µm in diameter, as the humidity becomes high. A relatively small percentage of the soil and dust particles are smaller than 2.5 µm in aerodynamic diameter, so samplers collect them with the fine particles. Table 1-1 lists only typical, major sources of each component. Table 1-2 provides a more inclusive listing of sources.

Table 1-2: Comparison of Ambient Fine Particles (Ultrafine plus Accumulation-Mode) and Coarse Particles

	Ultrafine	Accumulation	Coarse
Formation Processes:	Combustion, high-temperature processes, and atmospheric reactions		Break-up of large solids/droplets
Formed by:	• Nucleation • Condensation • Coagulation	• Condensation • Coagulation • Reactions of gases in or on particles • Evaporation of fog and cloud droplets in which gases have dissolved and reacted	• Mechanical disruption (crushing, grinding, abrasion of surfaces) • Evaporation of sprays • Suspension of dusts • Reactions of gases in or on particles
Composed of:	• Sulfate • Elemental carbon • Metal compounds • Organic compounds with very low saturation vapor pressure at ambient temperature	• Sulfate, nitrate ammonium, and hydrogen ions • Elemental carbon • Large variety of organic compounds • Metals: compounds of Pb, Cd, V, Ni, Cu, Zn, Mn, Fe, etc. • Particle-bound water	• Suspended soil or street dust • Fly ash from uncontrolled combustion of coal, oil, and wood • Nitrates/chlorides/sulfates from HNO_3,/HCI/SO_2 reactions with coarse particles • Oxides of crustal elements (Si, Al, Ti, Fe) • $CaCO_3$, $CaSO_4$, NaC1, sea salt • Pollen, mold, fungal spores • Plant and animal fragments • Tire, brake pad, and road wear debris
Sources:	• Combustion • Atmospheric transformation of SO_2 and some organic compounds • High temperature processes	• Combustion of coal, oil, gasoline, diesel fuel, wood • Atmospheric transformation products of NO_x, SO_2, and organic compounds, including biogenic organic species (e.g., terpenes) • High-temperature processes, smelters, steel mills, etc.	• Resuspension of industrial dust and soil tracked onto roads and streets • Suspension from disturbed soil (e.g., farming, mining, unpaved roads) • Construction and demolition • Uncontrolled coal and oil combustion • Ocean spray • Biological sources
Atmospheric half-life:	Minutes to hours	Days to weeks	Minutes to hours
Atmospheric Removal Processes:	• Grows into accumulation mode • Diffuses to raindrops	• Forms cloud droplets and rains out (Organic carbon and elemental carbon particles may not take up water until they have aged.) • Dry deposition	• Dry deposition by fallout • Scavenging by falling rain drops
Travel distance:	<1 to 10s of km	100s to 1000s of km	<1 to 10s of km (small size tail, 100s to 1000s in dust storms)

Source: Adapted from Wilson and Suh (1997), CD, p. 2-52.

1.3 HISTORY OF FEDERAL REGIONAL HAZE RULE

In the FCAA amendments of 1977, Congress added §169 (42 United States Code (USC), §7491), setting forth a national visibility goal of restoring natural conditions in certain national parks and wilderness areas. The EPA designated national parks and wilderness areas meeting certain criteria and containing vistas as an important feature, as Class I areas for visibility protection under regional haze state implementation plan (SIP) provisions.

In response to the 1977 FCAA amendments, the EPA required control measures to address plume blight and reasonably attributable visibility impairment. These plume blight and reasonably attributable visibility impairment control measures did little to address regional haze throughout the contiguous 48 states.

When Congress amended the FCAA again in 1990, it added §169B (42 USC, §§7492) requiring further research and regular assessments of the progress made toward visibility goals. In 1993, the National Academy of Sciences concluded that "current scientific knowledge is adequate and control technologies are available for taking regulatory action to improve and protect visibility" (NRC 1993).

In addition to authorizing the creation of visibility transport commissions and setting forth their duties, §169B(f) of the FCAA specifically mandated the creation of the Grand Canyon Visibility Transport Commission (GCVTC) to make recommendations to the EPA for the region affecting visibility in Grand Canyon National Park. After four years of research and policy development, the GCVTC submitted its report to the EPA in June 1996 (GCVTC 1996). This report, as well as other research reports prepared by the GCVTC, contributed information to the EPA's development of the federal Regional Haze Rule.

The EPA promulgated the Regional Haze Rule on July 1, 1999 (Appendix 1-1: *EPA Regional Haze Rule 1999)*. The federal rule's objective is to achieve the national visibility goal of restoring natural visibility conditions to Class I areas by 2064. Generally, the EPA's default estimates of natural conditions are 8 deciviews for the western states and 12 deciviews for the eastern states. States may calculate the natural conditions for each Class I area instead of using the default goal. Chapter 5: *Assessment of Baseline and Current Conditions and Estimate of Natural Conditions in Class I Areas* discusses natural conditions in more detail. The rulemaking addressed the combined visibility effects of sources over a broad geographic region, meaning that many states, including all those without Class I areas, must participate in haze reduction efforts.

The EPA designated five Regional Planning Organizations (RPOs) to assist with the coordination and cooperation needed to address visibility and haze issues. Those states and tribes that make up the midsection of the contiguous United States, including Texas, were designated as the CENRAP.

1.4 CLASS I AREAS

Texas has two Class I areas within its borders, both located in West Texas (Figure 1-1: *Regional Class I Areas*). Big Bend National Park (Big Bend), in Brewster County, borders the Rio Grande and Mexico. Guadalupe Mountains National Park (Guadalupe Mountains), in Culberson County, borders New Mexico. Chapter 11: *Long-Term Strategies* addresses Texas' impacts and long-term strategies for Class I areas outside of Texas.

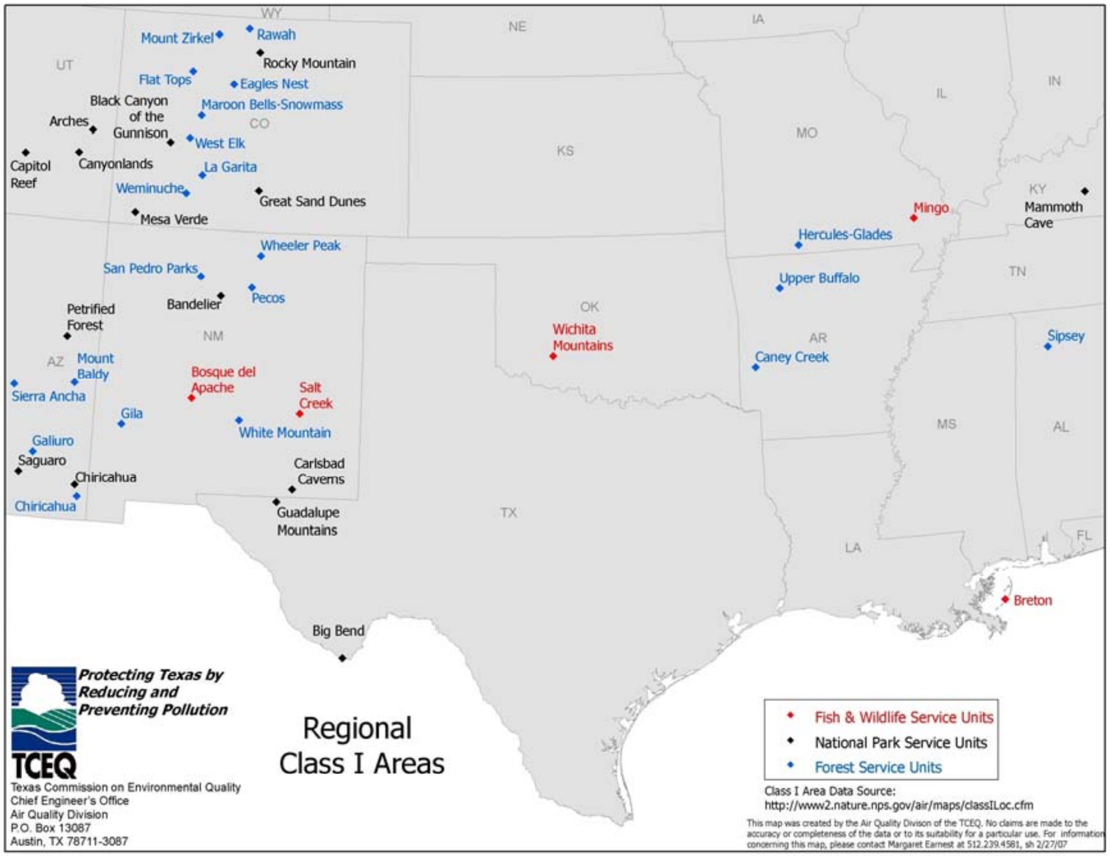


Figure 1-1: Regional Class I Areas

Big Bend National Park

Big Bend was authorized as a national park on June 20, 1935, and then established and signed into law on June 12, 1944, as the nation's 27th national park. The park gets its name from the course of the Rio Grande, which makes a great bend from a southeasterly to a northerly direction in the western portion of Texas. Big Bend receives approximately 350,000 visitors annually.

The park is slightly larger than Rhode Island and comprises more than 801,000 acres (1,252 square miles). The boundary includes 118 miles of the Rio Grande, which is also the international border between the United States and Mexico. In 1978, Congress designated a 196-mile portion of the Rio Grande, from the Chihuahua and Coahuila state line to the Terrell and Val Verde county line, as a Wild and Scenic River. The upper 69 miles are within the boundaries of Big Bend.

The park exhibits dramatic contrasts; its climate is one of extremes. As a result of the range in altitude from 1,700 feet along the river to 7,800 feet in the Chisos Mountains, a wide variation in available moisture and in temperatures exists throughout the park. These variations contribute to the great diversity in plant and animal habitats.

Big Bend has national significance as the largest protected area of Chihuahuan Desert in the continental United States. The park's river, desert, and mountain environments support an extraordinary richness of biological diversity and provide unparallel recreation opportunities. Few areas exceed the park's values for the protection and study of geologic and paleontologic resources. Archeologists have discovered artifacts estimated to be 9,000 years old, and historic buildings and landscapes offer graphic illustration of life along the international border at the turn of the century. Big Bend is rich in economic, cultural, and military history from its extensive use by the Comanches, miners, farmers, ranchers, United States cavalry units, and Poncho Villa's revolutionaries.

Big Bend was designated a Biosphere Reserve in 1976, under the Man and the Biosphere Program. Big Bend is one of only 250 such areas in the world whose ecosystems are particularly well preserved (National Park Service (NPS) 2007).

Guadalupe Mountains National Park

Guadalupe Mountains was established on September 30, 1972, and contains Guadalupe Peak, the highest point in Texas at 8,749 feet (2,667 meters) in elevation, as well as the next three highest peaks in the state. The park covers 86,416 acres and is in the same mountain range as Carlsbad Caverns National Park, which is located about 40 miles to the northeast in New Mexico. The park also contains a congressionally designated wilderness of 46,850 acres called the Guadalupe Mountains Wilderness. The terrain is rough and natural with mountain peaks steeply rising up to 3,000 feet above the canyon floors.

The mountains are a “sky island” rising more than a mile above the floor of the Salt Basin on the west. The slopes extend through three major ecological zones from desert to remnants of a high altitude forest. Ponderosa pine, Douglas fir, white pine, and quaking aspen grow side by side with desert species such as agaves and cacti. The altitude encourages relatively high amounts of rainfall that quickly drain into the porous limestone bedrock and recharge the Capitan Aquifer.

The Guadalupe Mountains preserve the 2,000-foot thick limestone layer of the Capitan Reef, one of the finest examples of an ancient marine fossil reef on earth. Outcrops in the park expose rocks from the entire range of associated depositional environments from shallow lagoon to reef, forereef debris slopes, and deep basin deposits. The park contains the world standard section that represents the middle part of the Permian Period of geologic time. Geologists from around the world study the 280 to 260 million year old rocks preserved there (NPS 2007).

CHAPTER 2. GENERAL PLANNING PROVISIONS

2.1 INTRODUCTION

In accordance with 40 CFR §51.308(a) and (b), the TCEQ submits this state implementation plan (SIP) revision to meet the requirements of the EPA's Regional Haze Rule. This plan addresses the core requirements of 40 CFR §51.308(d) and the Best Available Retrofit Technology (BART) components of 40 CFR §50.308(e). In addition, this SIP revision addresses coordination with regional planning groups, states and tribes, and the Federal Land Managers (FLMs). Texas also commits to plan revisions and adequacy determinations as outlined in this SIP.

2.2 PUBLIC HEARING AND COMMENT INFORMATION

The TCEQ provided notice to the public of the opportunity to comment on the proposed Regional Haze SIP after the commission approval for publication on December 5, 2007. The TCEQ announced and held a public hearing. Notice of both the public hearing and the comment period were published in newspapers around the state (Appendix 2-1: *Public Participation Process*). The public comment period began December 21, 2007, and ended February 22, 2008. The public hearing was held in Austin on February 19, 2008. The length of the comment period was longer to give sufficient time for the FLMs to provide recommendations on the proposed SIP revision that could be provided to the general public, as well as meet the requirement that FLMs are consulted at least 60 days prior to the public hearing on the SIP revision. The FLM comment period was November 16, 2007, through January 16, 2008. The TCEQ web site provided the complete FLM comments 30 days prior to the hearing date.

The TCEQ accepted comments electronically through the eComments system, fax, and mail. All comments referenced the "Regional Haze SIP" and project number 2007-016-SIP-NR. Comments went to:

Margaret Earnest
MC 206
State Implementation Plan Team, Chief Engineer's Office
Texas Commission on Environmental Quality
P. O. Box 13087
Austin TX 78711-3087
Fax: (512)-239-5687

Public Hearing

City	Date	Time	Location
Austin	February 19, 2008	2:00 PM	Texas Commission on Environmental Quality 12100 Park 35 Circles, Austin TX 78753 Building E, Room 201S

Public comments, including those made by staff of federal agencies, were summarized and addressed in Appendix 2-2: *Public Comments and Responses on SIP Draft*. The final SIP incorporated public comments as appropriate.

CHAPTER 3. REGIONAL PLANNING

3.1 OVERVIEW

In the preamble to the Regional Haze Rule, the EPA acknowledged the key role of regional pollutant transport in contributing to haze in federal Class I areas and recognized the value of multi-state coordination for planning and implementing regional haze programs (EPA 1999). The EPA established grant funding for five RPOs as follows:

- Central Regional Air Planning Association
- Western Regional Air Partnership
- Midwest Regional Planning Organization
- Visibility Improvement State and Tribal Association of the Southeast
- Mid-Atlantic/Northeast Visibility Union.

Figure 3-1: *Map of the Regional Planning Organizations* shows the geographic areas of the five RPOs. Texas is a member of CENRAP, as are Oklahoma, Louisiana, Arkansas, Missouri, Kansas, Nebraska, Iowa, and Minnesota. Some tribes, including the Alabama Coushatta of eastern Texas, also participate in CENRAP.

The CENRAP's planning process was initiated in late 1999 with the first in a series of workshops held to develop the organization's charter and bylaws, to conduct initial long-range planning, and to prepare its first grant application. The organization's charter can be found at CENRAP's web site: <www.cenrap.org>.

The CENRAP defines the purposes of the organization as follows.

- Identify regional, common air management issues, and develop and identify strategies to address these issues.
- Promote policies that ensure fair and equitable treatment of all participating members.
- Coordinate science and technology to support air quality policy issues in the central states.
- Promote the implementation of federal visibility rules.
- Recommend strategies on regional haze and other air quality issues for use by member states and tribes in developing implementation programs, regulations, and laws.
- Conduct research and undertake other activities as necessary to provide the membership with information to support the development of sound state and tribal air pollution policies.

In concurrence with EPA policy, the CENRAP's bylaws state that "the CENRAP has no regulatory authority and recognizes that its members, in accordance with existing law, retain all legal authority" (CENRAP 2000). While Texas participates in CENRAP and benefits from the technical work coordinated by the RPO, Texas has sole responsibility and authority for the development and content of its Regional Haze SIP.

Figure 3-1: Map of the Regional Planning Organizations

The Policy Oversight Group (POG) is the governing body for CENRAP. The POG establishes internal policies, protocols, strategies, and budgets and provides guidance to the various CENRAP workgroups. Voting membership on the POG includes:

- designee of governor or environmental commissioner from each member state; and
- one tribal representative for each of the EPA Regions V, VI, and VII.

Ex-officio membership on the POG includes the following:

- United States Secretary of the Interior or designee;
- United States Secretary of Agriculture or designee;
- Administrator of the EPA or designee;
- two representatives from local programs that are members of the Central States Air Resources Agencies (CenSARA); and
- additional tribal representatives designated in accordance with the bylaws

The POG established five CENRAP workgroups that work in particular disciplines and facilitate the development of the regional haze implementation plans. The workgroups are as follows.

- Modeling
- Emissions Inventory
- Monitoring
- Implementation and Control Strategies
- Communications

The Communications workgroup establishes internal communication protocols, assists with contract development, manages the CENRAP web site, and conducts public outreach. The other four workgroups conduct strategic planning for their subject matter areas and conduct and document the work of contractors or the in-kind services of CENRAP participants.

A Technical Steering Committee comprised of representatives from the states, tribes, and other stakeholder groups discusses complex technical issues and provides technical guidance to the workgroups. Also, representatives from CENRAP participate in discussions with other RPOs about issues that affect some or all of the RPOs and that require close communication among these organizations.

The POG and workgroups meet quarterly or biannually, depending on the need. The technical steering committee meets biannually. The POG usually holds conference calls once per month. The frequency of workgroup and steering committee conference calls varies.

The CENRAP may remain active following the initial submission of implementation plans by the states, since the Regional Haze Rule requires periodic progress reports and implementation plan revisions. The extent to which the CENRAP remains active will depend on the usefulness of the organization to its members and the availability of continuing, adequate funding to cover the organization's expenses.

3.2 HISTORY OF TEXAS PARTICIPATION

The TCEQ has participated in the planning process for regional haze since December 1999, when a workshop was convened by CenSARA to begin developing the charter, bylaws, and initial long-range plan for the CENRAP. After workgroups were formed, the TCEQ participated in the Modeling, Emissions Inventory, Monitoring, and Implementation and Control Strategies workgroups. The TCEQ designated appropriate workgroup representatives based on their areas of expertise. For approximately three years, a TCEQ staff member dedicated time as co-chair of the Emissions Inventory workgroup. For more than two years, four TCEQ staff members have dedicated time to monthly CENRAP conference calls with four of the technical workgroups and dedicated additional time to activities that include analyzing modeling changes, participating in quality control checks, and more. In addition, the TCEQ has one SIP coordinator dedicated solely to regional haze issues. The TCEQ has represented the state on the POG and technical steering committee from their inceptions.

Significant portions of this SIP were developed based on emissions inventories, modeling, and SIP protocols created by the CENRAP and its contractors. Through its participation, the TCEQ provided data to the CENRAP in order to produce emissions inventories and modeling that the states could use when drafting their Regional Haze SIPs.

The Regional Haze Rule does not require states and tribes to participate in RPOs. However, Texas will continue participation in the CENRAP as necessary to fulfill the state's legal obligations in meeting the requirements of the rule. Texas' continued participation is contingent on CENRAP's receiving continued, adequate funding from the EPA.

CHAPTER 4. STATE, TRIBE, AND FEDERAL LAND MANAGER CONSULTATION

4.1 INTRODUCTION

Title 40 CFR §51.308(i) requires each state to consult with identified FLMs prior to the proposal of the Regional Haze SIP. In development of this plan, the FLMs were consulted in accordance with the provisions of §51.308(i)(2). In developing its reasonable progress goals (RPGs), states are required to consult with other states reasonably anticipated to cause or contribute to visibility impairment in their Class I areas. If a state determines it has emissions that are reasonably anticipated to contribute to visibility impairment in any Class I area in another state, that state must consult with the other states when developing its long-term strategy. The TCEQ provided other states, tribes, FLMs, and other stakeholders an opportunity for consultation through teleconference calls and notified the FLMs of their opportunity to consult in person at least 60 days prior to holding public hearings.

During the consultation process, the states, FLMs, and stakeholders were given the opportunity to address the assessment of the visibility impairment in any Class I areas, materials presented to stakeholders prior to the consultation calls, recommendations on the development of RPGs, and recommendations on the development of strategies to address visibility impairment. Throughout the consultation calls, the TCEQ encouraged participants to continue coordination and consultation during the development of the SIP prior to adoption. The FLMs must be consulted in the following instances: development and review of implementation plan revisions; review of five-year progress reports; and development and implementation of other programs that may contribute to impairment of visibility in Class I areas.

4.2 CONSULTATION ON CLASS I AREAS IN TEXAS

The TCEQ held Regional Haze SIP consultation meetings by conference call with FLMs for the Class I visibility areas in Texas, Big Bend and Guadalupe Mountains, other states that impact the Texas Class I areas, the EPA, and stakeholders such as industry and environmental representatives. Table 4-1: *Consultation Calls* contains the dates and times of the consultation calls.

Table 4-1: Consultation Calls

Call	Date	Time
1st Consultation call	July 11, 2007	2:30-4:00 p.m.
2nd Consultation call	July 18, 2007	10:00-11:30 p.m.
3rd Consultation call	July 31, 2007	10:00-11:30 p.m.

The first consultation call primarily addressed four technical papers. These papers discussed natural conditions, the impacts of dust storms in Big Bend and Guadalupe Mountains, Integrated Planning Model (IPM) emission projections, and glide path and RPGs. A summary paper of these technical papers was provided to consultation participants.

The second and third consultation calls consisted of open dialogue between the states and FLMs to gather input on the content of the technical papers. Additionally, the FLMs suggested that the TCEQ revise the prevention of significant deterioration (PSD) permit process to include FLM notification provisions. Texas has committed to further consultations with the FLMs aimed at a mutually agreeable set of procedures to address their concerns about the Texas PSD program.

More detailed summaries from all three calls are provided in Appendix 4-1: *Summary of Three Texas Consultation Calls*.

A list of persons or entities contacted to participate in the consultation process is provided in Appendix 4-2: *Contact List for Consultation Calls*. Chapter 11 of this SIP also discusses the consultation process regarding development of the long-term strategy.

The TCEQ has determined which states contribute to visibility impairment at the Texas Class I area by using the results from the CENRAP particulate matter source apportionment technology (PSAT) modeling. These states are New Mexico, Oklahoma, Kansas, and Louisiana. Appendix 8-1: *Technical Support Document for CENRAP Emissions and Air Quality Modeling to Support Regional Haze State Implementation Plans* shows the pertinent modeling results. Texas is not requesting additional reductions from other states at this time.

4.3 CONSULTATIONS ON CLASS I AREAS IN OTHER STATES

The TCEQ has participated in the CENRAP since its inception in 1999. The TCEQ has cooperated with all CENRAP states, tribes, and FLMs that participated in:

- developing information on base period 2002 visibility impairment;
- developing projections of 2018 emissions and visibility impairment considering all adopted emissions reductions required in Texas and federal rules; and
- developing estimates of 2064 natural conditions.

Texas and federal rules that specifically reduce visibility-impairing pollutants include the Clean Air Interstate Rule (CAIR), BART requirements, the emissions reductions from the federal motor vehicle emission control program (FMVCP), the EPA refinery consent decrees, and the EPA requirements for cleaner non-road diesel and gasoline-powered engines.

The TCEQ participated in the Modeling, Emissions Inventory, Monitoring, and Implementation and Control Strategies workgroups of CENRAP. The TCEQ designated appropriate workgroup representatives based on their areas of expertise. For more than two years, the TCEQ has dedicated time to monthly technical workgroups through CENRAP conference calls. Since 1999, Texas has actively participated in regional planning (Chapter 3). The TCEQ also participated in inter-regional planning organization calls related to modeling. The FLMs, EPA, tribes, states, and industry were encouraged to participate in workgroup calls, workshops, and meetings.

The TCEQ reviewed CENRAP modeling to assess which Class I areas in other states might be impacted by Texas' emissions. Modeling indicated that Texas impacts Breton Wilderness Area in Louisiana, the Great Sand Dunes in Colorado, and several Class I sites in New Mexico. The TCEQ also consulted the adjacent states in which the modeling data indicated no significant impact by Texas, including Arkansas, Missouri, and Oklahoma.

Through conference calls, Arkansas and Missouri consulted with Texas about the impact of Texas' emissions on regional haze at the Class I areas in those states. They accepted Texas' planned emissions and regional haze impact reductions as adequate for their Class I areas for this initial SIP (Appendix 4-3).

Oklahoma invited Texas to consult about Oklahoma's Class I area, the Wichita Mountains National Wildlife Refuge. The TCEQ attended Oklahoma's three consultation calls held in August and September 2007. In August 2007, the TCEQ received a letter from Oklahoma regarding visibility improvements in the Wichita Mountains National Wildlife Refuge. The letter requested that Oklahoma be able to comment on best available control technology determinations for PSD sources that significantly impact Wichita Mountains and a request that Class I impact reviews by required for all proposed PSD sources within 300 kilometers of a Class I area. In an October 2007, response letter the TCEQ has agreed to notify Oklahoma, along with the relevant

FLM, whenever modeling indicates that a proposed source significantly impacts Wichita Mountains. In regards to the 300 kilometer request, the TCEQ is urging the EPA to adopt significant impact levels for Class I reviews so that there is a standard review process across the country. During the interim, the TCEQ is committed to working with the FLMs on mutually acceptable criteria for determining when a proposed PSD source should conduct a Class I review. Appendix 4-3: *Additional Consultation with States* contains a copy of these letters.

In response to comments from the EPA and FLMs in March 2008, the TCEQ sent consultation letters to Oklahoma, Louisiana, Missouri, Arkansas, Colorado and New Mexico. Included with the letters were a discussion and data of the CENRAP Particulate Matter Source Apportionment Technology (PSAT) modeling determining the contribution from each Texas source area to visibility impairment at Class I areas in the given state. The TCEQ participated fully in the analysis of this data, base period visibility impairment, natural visibility condition estimates, and 2018 projections based on current and anticipated future state and federal controls. The PSAT modeling indicates that the probable impact of Texas sources will be reduced by 2018 in all of the affected Class I Areas due to the expected emissions reductions from current and planned controls. Also included with the consultation letter, where applicable, were area of influence maps for each Class I area in the CENRAP states. For reference purposes, the map showed the portions of Texas that are in the first and second order sulfate and nitrate areas of influence for the given Class I Area. The sulfur dioxide and nitrogen oxide sources shown on the map are Texas sources the TCEQ identified as high priority due to the fact that they have an emissions over distance equal to or greater than five ($q/d \geq 5$) for one or more Class I areas. Also included was a table of sources of particular interest to the affected Class I Area(s) due to their emissions and their positions within the area of influence. The TCEQ also requested recipients of the letters to confirm they are not expecting any additional emission reductions. These letters and associated documents are included in Appendix 4-3.

In an April 21, 2008, letter, Missouri's Department of Natural Resources responded that no further emissions reductions were requested of Texas (Appendix 4-3). In a June 10, 2008, letter, Arkansas' Department of Environmental Quality responded that no further emissions reductions were requested of Texas (Appendix 4-3). In a June 24, 2008 letter, Colorado's Department of Public Health and Environment responded that no further emissions reductions were requested of Texas at this time (Appendix 4-3). Louisiana sent confirmation that "the Louisiana Department of Environmental Quality has determined that emissions form the State of Texas do not contribute to visibility impairment at Breton Wilderness Class I Area." New Mexico has not responded to the letter as of December 2008.

CHAPTER 5. ASSESSMENT OF BASELINE AND CURRENT CONDITIONS AND ESTIMATE OF NATURAL CONDITIONS IN CLASS I AREAS

5.1 VISIBILITY REQUIREMENTS

The goal of the Regional Haze Rule is to restore natural visibility conditions to the 156 Class I areas identified in the 1977 Federal Clean Air Act Amendments. Title 40 Code of Federal Regulations (CFR) §51.301 defines natural conditions as including "naturally occurring phenomena that reduce visibility as measured in terms of light extinction, visual range, contrast, or coloration." State regional haze plans must contain measures that make "reasonable progress" toward this goal by reducing anthropogenic emissions that cause haze. Three metrics of visibility are part of the determination of progress toward this goal:

- baseline conditions, i.e., conditions observed during the baseline period, 2000 through 2004;
- natural conditions, i.e., those conditions existing in the absence of human-induced visibility impairment; and
- current conditions, i.e., conditions observed during the current period, which is the same as the baseline, for this initial period.

To calculate these metrics the concentrations of visibility-impairing pollutants are included as distinct terms in a light extinction algorithm with respective extinction coefficients and relative humidity factors. Total light extinction when converted to a haze index in deciviews is calculated for the average of the best 20 percent and worst 20 percent visibility days. Title 40 CFR §51.301 defines a deciview as "a haze index derived from calculated light extinction, such that uniform changes in haziness correspond to uniform incremental changes in perception across the entire range of conditions, from pristine to highly impaired."

Texas and other CENRAP states have elected to perform their primary visibility projections using the new Interagency Monitoring of Protected Visual Environments (IMPROVE) algorithm to calculate visibility metrics for developing RPGs because this algorithm is based on more recent science and the updated algorithm better fits the observed light extinction values. Appendix 5-1: *Discussion of the Original and Revised IMPROVE Algorithms* provides a discussion on the choice of the IMPROVE algorithm comparing the old and new equations. For more detailed documentation on the original (old) and revised (new) algorithm changes, please visit the IMPROVE web site at <http://vista.cira.colostate.edu/improve>.

Baseline visibility, the starting point for the improvement of visibility conditions, is the average obtained by using monitoring data for 2000 through 2004 and represents current visibility conditions for this initial period. Comparison of initial baseline conditions to natural visibility conditions shows the improvement necessary to attain natural visibility by 2064. Natural visibility is determined by estimating the natural concentrations of visibility-impairing pollutants and then calculating total light extinction with the chosen light extinction algorithm (Figure 5-1: *Generic Glide Path to Achieve Natural Conditions in 60 Years*). Each state must estimate natural visibility levels for Class I areas within its borders in consultation with FLMs and other states that impact the Class I areas (40 CFR §51.308(d)(2)). Current conditions are assessed every five years as part of the plan review where actual progress in reducing visibility impairment is compared to reduction commitments in the plan.

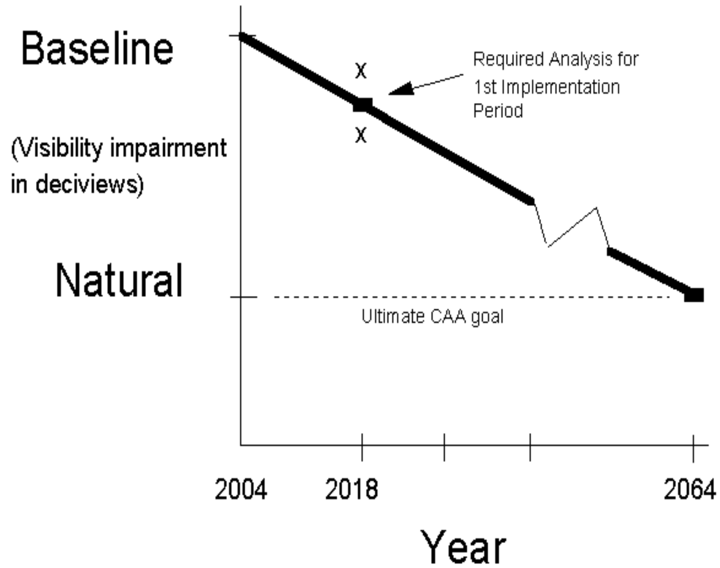


Figure 5-1: Generic Glide Path to Achieve Natural Conditions in 60 Years
Source: EPA

5.1.1 Default and Refined Values for Natural Visibility Conditions

The EPA's *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Program* (EPA 2003) provides states a "default" estimate of natural visibility. The default values of concentrations of visibility pollutants are based on a 1990 National Acid Precipitation Assessment Program report (Trijonis, 1990). In the EPA's guidance, the United States is divided into East and West regions approximately along the western boundary of the states one tier west of the Mississippi River. This division divides the CENRAP states into its own East region (Arkansas, Iowa, Louisiana, Minnesota, and Missouri), containing seven Class I areas, and West region (Kansas, Nebraska, Oklahoma, and Texas), containing three Class I areas. In comparing the two regions, only sulfate (SO_4) and organic carbon have different values, but the calculated deciview difference is significant.

However, the ultimate responsibility for calculating natural conditions lies with each state (40 CFR §51.308(d)(2)). The TCEQ determined that the default estimates were insufficiently accurate and that data and methods were available to improve these estimates. Therefore, TCEQ chose to develop its own refined estimates.

5.1.2 Consultation Regarding the Visibility Metrics

Consultation among states is required by the Regional Haze Rule. As part of a long-term strategy for regional haze, a state whose emissions are "reasonably anticipated" to contribute to impairment in other states' Class I areas must consult with those states (40 CFR §51.308(d)(3)). Likewise, states with Class I areas are to consult with any states whose emissions affect their Class I areas. Consultation among states is facilitated through RPOs, though some required consultations cross RPO boundaries. For example, Texas and New Mexico must collaborate on planning for the Guadalupe Mountains, though the two states participate in different RPOs.

A chief purpose of the RPOs is to provide a means for states to confer on all aspects of the regional haze issue, including consultation on RPGs and long-term strategies, which are based on the baseline, current, and natural visibility determinations. This process is described in Chapter 3: *Regional Planning*. The CENRAP provides a forum for member states and tribes to consult on determinations of baseline and natural visibility conditions in subject Class I areas. States in the CENRAP have also conferred with neighboring Class I area states outside CENRAP, both individually and by way of the appropriate RPO.

Title 40 CFR §51.308(i) requires Class I area states to coordinate with the FLMs, including consultation on implementation, assessment of visibility impairment, and recommendations regarding RPGs and strategies for improvement. This consultation requirement is discussed in Chapter 4: *State, Tribe, And Federal Land Manager Consultation*. Through participation in the CENRAP and individually, Texas has completed this regulatory requirement.

5.2 BASELINE VISIBILITY CONDITIONS

For the five-year baseline period, 2000 through 2004, sites are required to have three valid years of data from which baseline conditions can be constructed. The Visibility Information Exchange Web System (VIEWS) <http://vista.cira.colostate.edu/views/> has posted haze index values, based on the revised IMPROVE algorithm, for the 20 percent worst and best days for each complete year of the baseline period. From these values, the baseline haze index is calculated by averaging over the baseline period. Table 5-1: *Baseline Haze Indices* shows this calculation for both Big Bend and Guadalupe Mountains using the VIEWS summary data updated August 2007.

Baseline visibility for the Big Bend Class I area is 5.78 deciviews for the best 20 percent of the sample days and 17.30 deciviews for the worst 20 percent of the sample days. This baseline visibility is based on sampling data collected at the Big Bend IMPROVE monitoring site.

Baseline visibility for the Guadalupe Mountains Class I area is 5.95 deciviews for the best 20 percent of the sample days and 17.19 deciviews for the worst 20 percent of the sample days. This baseline visibility is based on sampling data collected at the Guadalupe Mountains IMPROVE monitoring site.

Table 5-1: Baseline Haze Indices

Class I Area	Site ID	Year	Haze Index (deciviews)	
			Most Impaired	Least Impaired
Big Bend*	BIBE1	2001	17.31	7.09
		2002	18.21	5.68
		2003	17.18	5.74
		2004	16.51	4.62
		Average	17.30	5.78
Guadalupe Mountains	GUMO1	2000	17.14	6.26
		2001	16.61	6.34
		2002	18.12	6.38
		2003	18.50	5.91
		2004	15.57	4.83
		Average	17.19	5.95

* The fourth quarter of 2000 for Big Bend was not sufficiently complete for use in calculating a baseline average for regulatory purposes: The fourth quarter had only ten complete days.

5.3 NATURAL VISIBILITY CONDITIONS

Using the revised IMPROVE algorithm and the methodology detailed in Appendix 5-2: *Estimate of Natural Visibility Conditions*, the TCEQ has determined, subject to significant uncertainties in natural concentrations of organic carbon, that natural visibility conditions for the Big Bend Class I area are best represented by 10.09 deciviews for the worst 20 percent days. The Guadalupe Mountains Class I area is best represented by 12.26 deciviews for the worst 20 percent days. Appendix 5-2 provides calculations, methodologies, a discussion of the reasons for the selection of the methodology, and a demonstration of the appropriateness of these values for both Class I areas. Table 5-2: *Visibility Metrics for the Class I Areas in Texas* reports the visibility metrics computed for Big Bend and Guadalupe Mountains.

Table 5-2: Visibility Metrics for the Class I Areas in Texas

Estimate of Natural Visibility Conditions		
Class I Area	Haze Index (deciviews)	
	Most Impaired	Least Impaired
Big Bend	10.09	2.19
Guadalupe Mountains	12.26	2.10
Baseline Visibility Conditions, 2000–2004		
Class I Area	Haze Index (deciviews)	
	Most Impaired	Least Impaired
Big Bend	17.30	5.78
Guadalupe Mountains	17.19	5.95
Estimate of Extent Baseline Exceeds Natural Visibility Conditions		
Class I Area	Haze Index (deciviews)	
	Most Impaired	Least Impaired
Big Bend	7.21	3.59
Guadalupe Mountains	4.93	3.85

Analysis of the dust storms that dominate high dust events at Guadalupe Mountains and significantly impact Big Bend suggests that the dust originates from dry desert and dry lake bed areas with little or no human activity, almost all of which are situated in the Chihuahuan Desert. For instance, Gill, et al. conclude that "Field campaigns revealed that … the vast majority of source points were natural desert landscapes" (Gill et al. 2005).

The times when human-caused dust is likely to be more important at these sites are on days with less visibility impairment than on the worst dust impaired days, since the most dust impaired days are dominated by dust storms and other blowing dust from the surrounding desert landscape. As shown in the dust storm paper of Appendix 5-2a, there are enough dust storm days at Guadalupe Mountains to make a reasonable estimate of the worst 20 percent natural visibility conditions. In other words, there were enough dust storms documented at Guadalupe Mountains to account for all of the worst 20 percent days. This lends credence to the assumption that natural dust dominates on those days and that human-caused dust is of minimal importance for the low visibility days.

The situation at Big Bend is a little more uncertain because the dust impact is less from major dust storms and more from "locally"[1] windblown dust, as shown by the studies by Kavouras, et al. (2006 and 2007). However, the area of the park is approximately 801,000 acres, and broad restrictions on human use of the park are in place to minimize human impact on its desert environment. Additionally, the Big Bend IMPROVE monitoring site is surrounded by the park, with the closest park boundary approximately ten miles away, while land use and soil erodibility indicates the landscape surrounding Big Bend (and even Guadalupe Mountains) is overwhelmingly dominated by highly erodible soils in scrub/scrubland areas.

As explained in Appendix 5-2: *Estimate of Natural Visibility Conditions*, the estimates for what portion of each visibility component is to be considered as natural, at least for the estimation of natural visibility values for Texas' Class I areas, is taken to be essentially the same as used by the Natural Conditions II (NC II) committee (Pitchford, et al. 2006), with the exception of fine soil (FS) and course mass (CM). As justified within that appendix and within the other referenced

[1] Note that "local" as used in the Kavouras work does not correspond with any distance measure, but with how well the dust dominated days in the 20 percent worst measured visibility days correlated with local wind speed and direction.

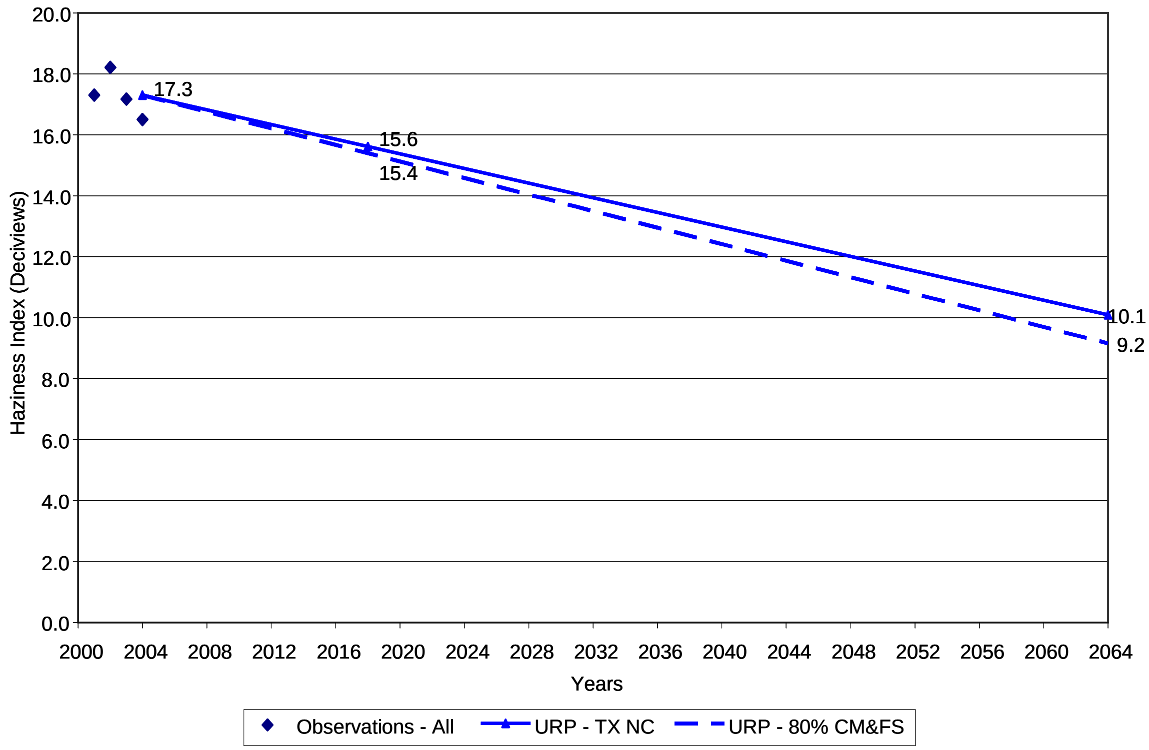


Figure 5-2: Big Bend Uniform Rate of Progress (URP)

TX NC is Texas' estimate of natural conditions.
80 % CM&FS is a comparison where 80 percent of fine soil and course mass is taken as natural.

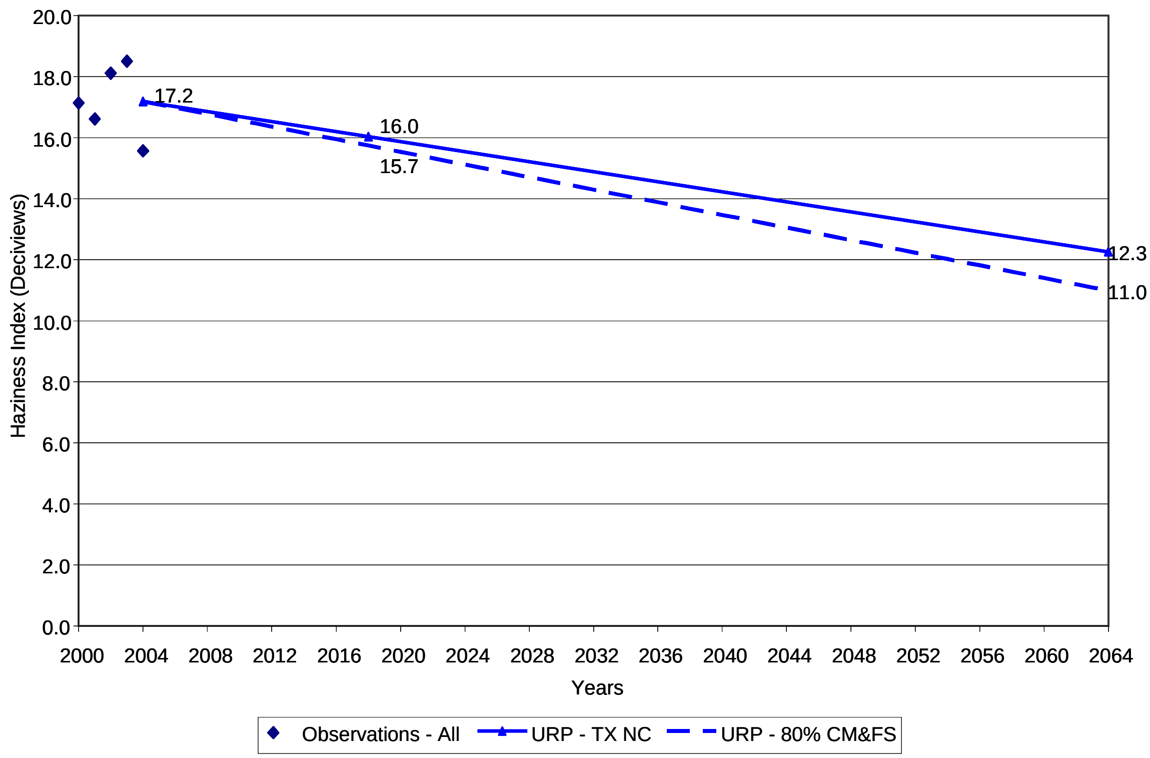


Figure 5-3: Guadalupe Mountains Uniform Rate of Progress

work, the TCEQ estimate takes essentially all fine soil and course mass concentrations to be approximated as natural, at least for the estimation of the least and most impaired natural visibility values for Texas' Class I areas. (The actual computations are carried out using each area's own data.)

Since the estimate has some degree of uncertainty, just as there is uncertainty in the estimates used by the NC II, the TCEQ provides in Figure 5-2: *Big Bend Uniform Rate of Progress (URP)* and Figure 5-3: *Guadalupe Mountains Uniform Rate of Progress* graphs of the Uniform Rate of Progress (URP) for the worst 20 percent days both with the estimate approximating 100 percent fine soil and course mass as natural (TX NC) along with a calculation treating only 80 percent fine soil and course mass as natural (80% CM&FS), for both Texas Class I areas. This 80 percent calculation is displayed due to a request from some Federal Land Managers to illustrate how sensitive this natural visibility estimate is to approximating 100 percent of the fine soil and course mass as natural; there is no other significance to this 80 percent calculation for this SIP.

5.4 NATURAL VISIBILITY CONDITIONS, AN ONGOING EFFORT

Because natural visibility estimates are calculated from complex environmental chemistry, require significant assumptions in the calculation and are ultimately calculated without a directly observable measurement, there remains considerable potential for improvement in estimation. Since the natural concentrations and statistics of all components important for Regional Haze have significant uncertainties, the TCEQ will be continuing to evaluate data, modeling, and any other sources of information, as well as potentially devising additional monitoring, sampling and/or analysis schemes, in order to further improve these estimates. Furthermore, the TCEQ plans to work with the EPA, FLMs, and other experts and researchers to refine natural conditions estimates for future five-year reports and major regional haze SIP revisions.

At this point, the component that most likely needs improved estimation is organic carbon.[2] Improved sampling and/or analysis techniques are likely methods in the pursuit of an improved characterization of the natural contributions to this component. However, the application of such methods will depend upon available resources and estimates of potential benefits.

[2] Additionally, there is significant regulatory uncertainty with regard to what prescribed fires should or should not be considered as "natural." When the EPA revises the *Interim Air Quality Policy on Wildland and Prescribed Fires*, it is expected such issues will be clarified.

CHAPTER 6. MONITORING STRATEGY

6.1 INTRODUCTION

Title 40 CFR §51.308(d)(4) of the Regional Haze Rule requires a monitoring strategy for measuring, characterizing, and reporting regional haze visibility impairment that is representative of all mandatory Class I areas within Texas. The monitoring strategy relies upon data from the Interagency Monitoring of Protected Visual Environments (IMPROVE) program. A steering committee with representatives from federal, regional, and state organizations governs the program. These organizations include the United States Environmental Protection Agency (EPA), the National Park Service (NPS), the United States Fish and Wildlife Service (FWS), the United States Forest Service, the Bureau of Land Management (BLM), the National Association of Clean Air Agencies, and other entities. The IMPROVE Steering Committee allocates IMPROVE monitoring resources, which come from a number of agencies including the EPA, NPS, FWS, and BLM. The IMPROVE program arranges for the operation of IMPROVE monitors, the analysis of samples from the monitors, and the validation and internet posting of the IMPROVE data as well as maintenance of the Visibility Information Exchange Web System (VIEWS) web site <http://vista.cira.colostate.edu/views>, which makes the data easily available to states, regional planning organizations, and the public. The state regional planning organizations (RPOs) contribute financial support to the VIEWS program and web site.

6.2 MONITORING AT CLASS I AREAS IN TEXAS

Currently, the IMPROVE program provides an IMPROVE monitor at each of the two Class I areas in Texas, Big Bend and Guadalupe Mountains. Because of their location, the monitors are appropriate for determining progress in reducing visibility impairment in the Texas Class I areas. The monitoring strategy relies on continuation of IMPROVE monitoring at these sites. The Texas Commission on Environmental Quality (TCEQ) plans to continue to participate in the IMPROVE network through the financial support of the EPA. The TCEQ also plans to continue supporting the VIEWS work and the VIEWS web site by urging CENRAP to continue its funding of VIEWS. No additional monitoring beyond the IMPROVE network is required or necessary for assessing visibility conditions at the two Class I areas in Texas or at the Class I areas that Texas' emissions affect in other states.

The IMPROVE program reviewed its aerosol monitoring sites in 2006 to set priorities for maintaining the sites, in the event of federal budget cuts affecting the IMPROVE program. This review determined that the IMPROVE aerosol samplers at Texas' two Class I areas represent conditions different from the conditions at the nearest Class I area IMPROVE monitors. Texas' two Class I IMPROVE monitors are not candidates for discontinuation since other IMPROVE monitors cannot represent conditions at Big Bend or Guadalupe Mountains.

The TCEQ considers that continued IMPROVE monitoring at all current Class I IMPROVE sites that Texas' emissions impact and continued VIEWS services are all centrally important to the effort to monitor reductions in anthropogenic haze impacts at these sites. If funding for these IMPROVE sites or the VIEWS program is threatened, the TCEQ plans to work closely with the EPA, the FLMs, and neighboring states to attempt to find the funding to continue the current Class I IMPROVE monitoring and VIEWS services for these sites.

6.3 ASSESSMENT OF VISIBILITY IMPROVEMENT AT CLASS I AREAS

Future assessments of visibility impairment and progress in reducing visibility impairment at Texas' two Class I areas, and at Class I areas in other states that Texas' emissions affect, will use the new IMPROVE equation and will use data as prescribed in the EPA's Regional Haze Rule (40 CFR Part 51, Subpart P). The assessment will follow, as appropriate, the EPA's official guidance including *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze* (EPA 2007).

6.4 REPORTING VISIBILITY MONITORING DATA TO THE ADMINISTRATOR

The TCEQ does not directly collect or handle IMPROVE data. The TCEQ plans to continue to participate in VIEWS through CENRAP. The TCEQ considers VIEWS to be a core part of the overall IMPROVE program. The TCEQ plans to continue to report IMPROVE data from the two Class I areas in Texas to the EPA by continuing to support its posting on the VIEWS web system. The TCEQ's support will be through continuing membership in CENRAP and through requesting that both the EPA and this multi-state organization continue to support VIEWS.

If Texas collects any visibility monitoring data through the state's air quality monitoring networks, the TCEQ will report those data to the EPA as specified under the Performance Partnership Grant agreement negotiated with the EPA Region 6. All validated data and data analysis results from any TCEQ visibility-related special studies are public information. TCEQ plans to continue its practice of sharing the data and information with the EPA, the Federal Land Managers, and the public.

The TCEQ currently has a TEOM (tapered element oscillating microbalance) continuous monitor for $PM_{2.5}$, an every-sixth-day chemical speciation monitor, and meteorological equipment operating at Big Bend. The data from these monitors is available from the TCEQ. Additionally, the TCEQ hosts the National Park Service's Big Bend ozone data on the TCEQ web site.

6.5 ASSESSING THE IMPACT OF EMISSIONS FROM TEXAS ON CLASS I AREAS

Chapters 5, 8, 10, and 11 describe the procedures used in developing this SIP revision. These chapters include the procedures to assess the quantitative impact of emissions from Texas on Class I areas in Texas and on Class I areas that Texas' emissions affect in other states.

Chapter 7 describes the procedures used for this SIP revision to produce the statewide emissions inventory of pollutants reasonably anticipated to cause or contribute to visibility impairment in all the mandatory Class I areas that Texas' emissions affect. Chapter 12 describes the plans for the five-year implementation plan review and for the 2018 regional haze SIP revision.

The Performance Partnership Grant agreement negotiated with the EPA Region 6 and the quality assurance procedures for collecting and reporting periodic emissions inventories to the EPA describe the collection, quality assurance, record keeping, maintenance, availability, and reporting of emissions and monitoring data to the EPA.

CHAPTER 7. EMISSIONS INVENTORY

Title 40 CFR §51.308(d)(4)(v) requires a statewide emissions inventory of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any Class I area. As specified in this section, the pollutants to be inventoried include volatile organic compounds (VOC), nitrogen oxides (NO_X), fine particulate matter ($PM_{2.5}$), particulate matter less than ten microns in diameter (PM_{10}), ammonia (NH_3), and sulfur dioxide (SO_2). In accordance with the EPA guidance, the TCEQ developed a baseline Texas inventory for the year 2002, and submitted the inventory to the Central Regional Air Planning Association (CENRAP) for use in photochemical modeling supporting the Regional Haze SIP. A summary of the CENRAP developed 2002 Texas inventory is provided in Table 7-1: *CENRAP's 2002 Base Year Emissions Inventory Summary for Texas*. Details for the 2002 emissions inventory are provided in Appendix 7-1: *Texas Emissions Inventory Development: Base Year 2002 and Projected Year 2018.*

Table 7-1: CENRAP's 2002 Base Year Emissions Inventory Summary for Texas

Category	CO (tpy)	NO_X (tpy)	SO_2 (tpy)	TOG* (tpy)	$PM_{2.5}$ (tpy)	PM_{10} (tpy)	NH_3 (tpy)
Area	908,407	280,811	111,853	1,163,549	347,490	1,552,824	380,057
Point	498,467	600,725	821,961	207,695	46,789	80,947	2,609
Non-Road	1,210,158	242,551	21,828	148,952	15,089	15,556	56
On-Road	4,098,391	664,163	18,814	309,707	11,275	15,476	21,599
Total	6,715,423	1,788,250	974,457	1,829,902	420,642	1,664,803	404,321

*TOG is total organic gas, which includes total hydrocarbons.

The 2002 baseline inventory is composed of several different categories. The point sources are defined as industrial, commercial, or institutional sites that meet the reporting requirements of 30 Texas Administrative Code (TAC) §101.10. Area sources include commercial, small-scale industrial, and residential categories of sources that use materials or operate processes that can generate emissions. These sources of emissions fall below the point source reporting levels and are too numerous or too small to identify individually. The area source fires inventory is also included in the area source category. This category includes agricultural burning, prescribed burning of forests, and prescribed burning of rangeland. The fugitive dust inventory includes dust from construction, mining, quarrying, bulk materials storage (such as coal and gravel), and feedlots.

The area source SO_2 emissions used by the CENRAP in their modeling are significantly higher than the 15,633 tons per year (tpy) reported by the TCEQ. The difference is industrial and residential coal combustion which was erroneously included in the CENRAP inventory. The TCEQ has been working with CENRAP to correct this error for future modeling, but there was not sufficient time to remodel with the more accurate TCEQ-supplied inventory. CENRAP's modeled emissions estimate is not expected to significantly impact visibility estimates for 2018 because of the relatively small contribution from these Texas sources on Class I areas.

Non-road mobile sources include aircraft operations, marine vessels, recreational boats, railroad locomotives, and a broad category of non-road equipment that include everything from 600-horsepower engines mounted on construction equipment to one-horsepower string trimmers.

On-road mobile sources of emissions consist of automobiles, trucks, motorcycles, and other motor vehicles traveling on public roadways. On-road mobile source emissions are usually categorized as either combustion-related emissions or evaporative hydrocarbon emissions. Combustion-related emissions are estimated for vehicle engine exhaust. Evaporative hydrocarbon emissions are estimated for the fuel tank and other evaporative leak sources on the vehicle.

Biogenic sources include hydrocarbon emissions from crops, lawn grass, and trees as well as a small amount of NO_X emissions from soils. These emissions are listed in Table 7-2: *Statewide Biogenic Emissions*.

Table 7-2: Statewide Biogenic Emissions

Biogenic	**Nitrogen Oxide (tpy)**	**Carbon Monoxide (tpy)**	**Volatile Organic Compounds (tpy)**
	184,896	755,941	4,033,760

Methodologies used in developing the 2002 emissions inventory are documented in Appendix 7-1. The technical support documents are available in Appendix 8-1: *Technical Support Document for CENRAP Emissions and Air Quality Modeling to Support Regional Haze SIP*.

The CENRAP projected the 2002 base year emissions for Texas and other central states to the 2018 future planning year primarily using the Economic Growth Analysis System (EGAS5) for non-electric generating unit point sources, area sources, and non-road mobile sources; MOBILE6 for on-road mobile sources; and the Integrated Planning Model Version (IPM) 2.19 for electric generating units (Appendix 7-2: *Integrated Planning Model Projections of Electric Generating Unit Emissions for the Regional Haze State Implementation Plan).* Emissions from recently permitted electric generating units were incorporated into the IPM file. Only the units that will be shut down under enforceable actions are removed from the future inventory.

From 2002 to 2018, the CENRAP projected point source emissions increases in the organic compounds, CO, and particulate matter (PM) categories. For non-EGU industrial sources, CENRAP predicted increases in all contaminant categories (ranging from slight increases in NO_X and SO_2 to significant increases in CO and organic compounds). The increases predicted by CENRAP's inventory are contra-indicated by the actual decreases represented in the annual inventory data collected between 2002 and 2005. See Appendix 7-2 for a summary of the 2005 inventory. Between 2002 and 2005, the historical data indicate actual source emissions have decreased or held approximately constant for the point sources in all categories except CO from EGUs. Based on historical decreases in emissions, CENRAP's predicted increase is considered conservative and likely over predicts Texas point source emissions for 2018. Statewide point source emissions have declined every year in Texas in an environment of significant economic growth. A summary of Texas emissions projected to 2018 is provided in Table 7-3: *CENRAP's 2018 Emissions Inventory Summary for Texas*.

Table 7-3: CENRAP's 2018 Emissions Inventory Summary for Texas

Category	CO (tpy)	NO_X (tpy)	SO_2 (tpy)	TOG (tpy)	$PM_{2.5}$ (tpy)	PM_{10} (tpy)	NH_3 (tpy)
Area	899,497	274,663	114,138	1,420,681	354,712	1,557,089	562,379
Point	542,128	525,174	625,068	283,290	80,577	121,733	6,790
Non-Road	1,921,674	167,451	6,988	119,855	10,588	11,498	239
On-Road	2,710,631	148,387	2,925	125,234	5,337	5,337	32,191
Total	6,073,930	1,115,676	749,119	1,949,060	451,214	1,695,657	601,598

*TOG is total organic gas, which includes total hydrocarbons

Methodologies used by the CENRAP in developing the 2018 emissions inventory are documented in Appendix 7-1. Technical support documents detailing the inventory development are available in Appendix 8-1. These documents are available at <www.tceq.state.tx.us/implementation/air/sip/bart/haze_appendices.html>. A comparison of the change in emissions by source category is shown in Figure 7-1: *Comparison of Base and Projected Annual Emissions by Source Category*. Even though $PM_{2.5}$ is a subcategory of PM_{10}, both are shown for purposes of comparison.

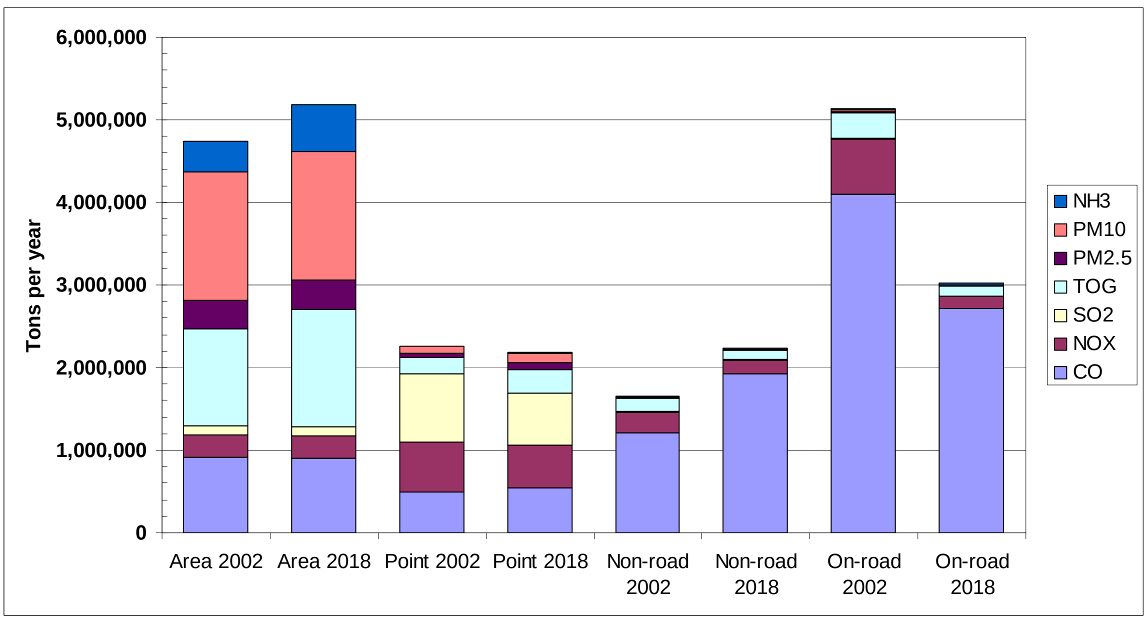


Figure 7-1: Comparison of Base and Projected Annual Emissions by Source Category

CHAPTER 8. MODELING ASSESSMENT

8.1 OVERVIEW

The Texas Commission on Environmental Quality (TCEQ) participated in the Central Regional Air Planning Association (CENRAP) regional planning process, as described in Chapter 3: *Regional Planning* and is using the technical work conducted by CENRAP in support of this state implementation plan (SIP) revision (Table 8-1: *Federal Mandated Class I Areas in the CENRAP States*). The CENRAP 2002 and projected 2018 annual emissions and air quality modeling was performed by the CENRAP modeling team. Where necessary, the TCEQ also conducted analyses specific to Texas. For instance, the TCEQ conducted Best Available Retrofit Technology (BART) screening modeling analyses independently from CENRAP, but used the databases developed by CENRAP as the basis for the analyses. The BART screening modeling analyses are described further in Chapter 9: *Best Available Retrofit Technology*.

This chapter describes CENRAP regional emissions and air quality modeling that was conducted to support the central states' regional haze SIPs. The information contained in this chapter draws from the Technical Support Document (TSD) developed by the CENRAP modeling team. The TSD, contained in Appendix 8-1: *Technical Support Document for CENRAP Emissions and Air Quality Modeling to Support Regional Haze SIP,* provides further detail on the modeling analyses. Chapter 1 of the TSD presents the background, an overview of the approach, and a summary of the results of the CENRAP meteorological, emissions, and air quality modeling. Appendix A of the TSD contains more details on the meteorological model evaluation. Details on the emissions modeling are provided in Chapter 2 and Appendix B of the TSD. The model performance evaluation is presented in Chapter 3 and Appendix C of the TSD. The 2018 visibility projections and comparisons with the 2018 uniform rate of progress (URP) point are provided in Chapter 4 of the TSD, with more details given in Appendix D. Chapter 5 of the TSD contains additional supporting analysis with details on the particulate matter (PM) source apportionment modeling and alternative projections provided in Appendices E and F of the TSD, respectively. Chapter 6 lists the references cited in TSD.

8.2 BACKGROUND

The 1977 Federal Clean Air Act (FCAA) amendments added the protection of visibility in Federal Class I areas and established the national goal for visibility protection. The FCAA requires states to submit SIPs containing emission limits and schedules of compliance. In response to these mandates, the United States Environmental Protection Agency (EPA) promulgated the Regional Haze Rule requiring states to establish goals that provide for reasonable progress towards achieving natural visibility conditions at Class I areas. CENRAP has used regional air quality models to determine the level of visibility improvement expected by 2018.

The CENRAP Emissions and Air Quality Modeling Team consists of staff from ENVIRON and University of California at Riverside (UCR), with assistance and coordination from the CENRAP states, tribes, federal agencies, and stakeholders. The team performed the emissions and air quality modeling simulations for states and tribes within the CENRAP region, which provided analytical results used in developing implementation plans under the Regional Haze Rule. The CENRAP team performed emissions and air quality modeling used by the TCEQ to determine the 2018 reasonable progress goals (RPGs).

Table 8-1: Federal Mandated Class I Areas in the CENRAP States

Class I Area	Acreage	Federal Land Manager	Public Law
Arkansas			
Caney Creek Wilderness Area	14,460	USDA-FS	93-622
Upper Buffalo Wilderness Area	12,018	USDA-FS	93-622
Louisiana			
Breton Wilderness Area	5,000+	USDI-FWS	93-632
Minnesota			
Boundary Waters Canoe Area Wilderness	810,088	USDA-FS	99-577
Voyageurs National Park	114,964	USDI-NPS	99-261
Missouri			
Hercules-Glades Wilderness Area	12,314	USDA-FS	94-557
Mingo Wilderness Area	8,000	USDI-FWS	95-557
Oklahoma			
Wichita Mountains Wilderness Area	8,900	USDI-FWS	91-504
Texas			
Big Bend National Park	708,118	USDI-NPS	74-157
Guadalupe Mountains National Park	76,292	USDI-NPS	89-667

8.3 CENRAP MODELING TEAM

The CENRAP goals included support to states and tribes to meet the requirements of the Regional Haze Rule and development of scientifically supportable, cost-effective control strategies that the states and tribes may adopt to reduce anthropogenic effects on visibility impairment at Class I areas. One component of CENRAP's support to states and tribes as part of compliance with the Regional Haze Rule is performing emissions and air quality modeling. The CENRAP implemented modeling projects to:

- obtain a better understanding of the causes of visibility impairment;
- identify potential mitigation measures for visibility impairment at Class I areas;
- evaluate the effects of alternative control strategies for improving visibility; and
- project future-year air quality and visibility conditions.

The CENRAP Emissions and Air Quality Modeling Team performed the following activities:

- emissions processing and modeling;
- air quality and visibility modeling simulations;
- analysis, display, and reporting of modeling results; and
- storage and quality assurance of the modeling input and output files.

The team performed work for the CENRAP Modeling Workgroup under the supervision from the CENRAP technical director, the CENRAP executive director, and the chair of the Modeling Workgroup.

8.4 THE 2002 ANNUAL EMISSIONS AND AIR QUALITY MODELING

The CENRAP 2002 annual emissions and air quality modeling started on October 16, 2004. The effort involved the preparation of numerous databases, model simulations, presentations, and reports. Many of the modeling analyses are posted on the CENRAP modeling website at: <http://pah.cert.ucr.edu/aqm/cenrap/index.shtml>. The TCEQ also has many of these modeling analyses available on request only, as these are very large files <http://www.tceq.state.tx.us/implementation/air/sip/sipcontact.html>.

8.4.1 Modeling Protocol

A modeling protocol following EPA guidance was prepared at the outset of the study to serve as an outline for performing the CENRAP emissions and air quality modeling and to communicate the modeling plans to the CENRAP participants. The modeling protocol took into account CENRAP's long-term plan (CENRAP 2003) and the modeling needs of the regional haze SIPs. This modeling protocol is included in this SIP revision as Appendix 8-2: *Modeling Protocol for the CENRAP 2002 Annual Emissions and Air Quality Modeling.*

8.4.2 Quality Assurance Project Plan (QAPP)

A QAPP was prepared for the CENRAP emissions and air quality modeling study (Appendix 8-3: *Quality Assurance Project Plan for Central Regional Air Planning Association Emissions and Air Quality Modeling*) and describes the quality management functions performed by the modeling team. The QAPP is based on the national consensus standards for quality assurance (ANSI/ASQC 1994). It follows EPA's guidelines for quality assurance project plans for modeling (EPA 2002) and for QAPPs (EPA 2001), and takes into account the recommendations from the North American Research Strategy for Tropospheric Ozone (NARSTO) Quality Handbook for modeling projects (NARSTO 1998). The EPA and NARSTO guidance documents were developed specifically for modeling projects, which have different quality assurance concerns than environmental monitoring data collection projects. The work performed in this project involved modeling at the basic research level and for regulatory and planning applications. In order to use model outputs for these purposes, the modeling team must establish that each model is scientifically sound, robust, and defensible by following a project planning process that incorporates the following elements as described in the EPA modeling guidance document.

- A systematic planning process including identification of assessments and related performance criteria.
- Peer-reviewed theory and equations.
- A carefully designed life-cycle development process that minimizes errors.
- Documentation of any changes from original plans.
- Clear documentation of assumptions, theory, and parameterization.
- Input data and parameters that are accurate and appropriate for the analysis.
- Output data.

A key component of the CENRAP emissions and air quality modeling QAPP is the graphical display of model inputs and outputs and multiple peer review of each step of the modeling process. Work products (e.g., emissions plots, model outputs, etc.) have been displayed on the CENRAP modeling website for review by the CENRAP modeling team, modeling workgroup, and others. This website is at: http://pah.cert.ucr.edu/aqm/cenrap/index.shtml.

8.4.3 Model Selection

The selection of the meteorological, emissions, and air quality models for the CENRAP regional haze modeling was based on a review of previous regional haze modeling studies performed in the CENRAP region (e.g., Pitchford et al. 2004; Pun, Chen, and Seigneur 2004; Tonnesen and Morris 2004) as well as elsewhere in the United States (e.g., Morris et al 2004a; Tonnesen et al. 2003; Baker 2004). The CENRAP emissions and air quality modeling protocol (Morris et al.

2004a) provides details on the justification for model selection and the formulation of the different models.

Based on previous work by other Regional Planning Organizations (RPOs) and EPA, CENRAP selected the following models for use in modeling PM and regional haze in the central states:

- **MM5:** The Pennsylvania State University/National Center for Atmospheric Research (PSU/NCAR) Mesoscale Meteorological Model (MM5 Version 3.6 Massively Parallel Processing (MPP)) is a non-hydrostatic, prognostic meteorological model routinely used for urban- and regional-scale photochemical, fine particulate, and regional haze regulatory modeling studies (Anthes and Warner 1978; Chen and Dudhia 2001; Stauffer and Seaman 1990, 1991; Xiu and Pleim 2000).
- **SMOKE:** The Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system is an emissions modeling system that generates hourly gridded speciated emission inputs of mobile, non-road, area, point, fire, and biogenic emission sources for photochemical grid models (Coats 1995; Houyoux and Vukovich 1999). As with most "emissions models," SMOKE is principally an *emission processing system* and not a true *emissions modeling system*. With the exception of mobile and biogenic sources, the purpose of SMOKE is to provide an efficient tool for converting existing base emissions inventory data into the hourly, gridded, speciated, and formatted emission files required by an air quality model.
- **CMAQ:** EPA's Models-3/Community Multiscale Air Quality (CMAQ) modeling system is a "One-Atmosphere" photochemical grid model capable of simulating ozone, PM, visibility, and acid deposition at a regional scale for extended periods of time (Dennis, et al. 1996; Byun et al. 1998a; Byun and Ching 1999; Pleim et al. 2003).
- **CAMx:** ENVIRON's Comprehensive Air Quality Model with Extensions (CAMx) modeling system is also a state-of-science "One-Atmosphere" photochemical grid model capable of simulating ozone, PM, visibility, and acid deposition at a regional scale for extended periods of time. (ENVIRON 2006).

8.4.4 MM5 Meteorological Model Configuration

The Iowa Department of Natural Resources (IDNR) performed the 2002 annual MM5 modeling on a 36 kilometer (km) grid for the continental United States (Johnson 2007). The TCEQ and EPA Region VII carried out MM5 modeling on a 12 km grid covering the central states for portions of 2002.

The MM5 Version 3.63 configuration used in the generation of the meteorological modeling datasets consists of the following (see Table 8-2: *MM5 34 Vertical Layer Definitions for more details*):

- 36 km grid with 34 vertical layers;
- 12 km nested grid for episodic modeling;
- Two-way nesting (without feedback) within the 36 km grid for 12 km runs;
- Initialization and boundary conditions were established using analysis fields generated by the Eta model. The Eta model is a hydrostatic mesoscale model that uses a pressure-based coordinate system, allowing for easier solutions to the equations of motion. The Eta model excels in capturing small-scale meteorological phenomena, especially those induced by terrain, thus improving precipitation forecasts compared to previous mesoscale models (Black 1994);
  - Eta 3D and surface analysis data (ds609.2);
  - NCEP global tropospheric SST data (ds083.0) not used;
  - Observational enhancement (LITTLE_R);
    - NCEP ADP surface obs (ds464.0);
    - NCEP ADP upper-air obs (ds353.4);
- Pleim-Xiu (P-X) land-surface model (LSM);

- Pleim-Chang Asymmetric Convective Mixing (ACM) PBL model;
- Kain-Fritsch 2 cumulus parameterization;
- Mixed phase (Reisner 1) cloud microphysics;
- Rapid Radiative Transfer Model (RRTM) radiation;
- No shallow convection (ISHALLO=0);
- Standard 3D FDDA analysis nudging outside of PBL; and
- Surface nudging of the winds only.

8.4.5 SMOKE Emissions Model Configuration

SMOKE supports area, mobile, fire, and point source emission processing and includes biogenic emissions modeling through a rewrite of the Biogenic Emission Inventory System, Version 3 (BEIS3) (see <http://www.epa.gov/ttn/chief/software.html#pcbeis>). SMOKE has been available since 1996, and has been used for emissions processing in a number of regional air quality modeling applications. In 1998 and 1999, SMOKE was redesigned and improved with the support of the EPA, for use with EPA's Models-3/CMAQ <http://www.epa.gov/asmdnerl/models3>. The primary purposes of the SMOKE redesign were support of: (a) emissions processing with user-selected chemical mechanisms; and (b) emissions processing for reactivity assessments.

As an emissions processing system, SMOKE has far fewer "science configuration" options compared with the MM5 and CMAQ models. Appendix 8-1 summarizes the version of the SMOKE system used and the sources of data used in constructing the required modeling inventories.

8.4.6 CMAQ Air Quality Model Configuration

CENRAP used CMAQ Version 4.5 with the "SOAmods enhancement," or modifications to the secondary organic aerosol (SOA) chemical mechanism as described below, and used the model configuration as shown in Table 8-4. The model was set up and exercised on the same 36 km RPO national grid that Western Regional Air Partnership (WRAP) and Visibility Improvements State and Tribal Association of the Southeast (VISTAS) used. CENRAP performed 12 km CMAQ sensitivity tests and found little change in model performance with a large penalty in computation time. Consequently, on February 7, 2006, the CENRAP Modeling Workgroup decided to proceed with the CENRAP emissions and air quality modeling using just the 36 km national RPO grid (Morris et al. 2006a).

Initial CMAQ 2002 simulations that VISTAS ran found that the model greatly underestimates organic mass carbon (OMC) concentrations, especially in the summer. A review of the CMAQ formulation found that it failed to treat SOA formation from sesquiterpenes and isoprene and also failed to account for the fact that SOA can become polymerized so that it is no longer volatile and stays in the particle form. Thus, VISTAS updated the CMAQ SOA module to include these missing processes and found much improved OMC model performance (Morris et al. 2006c). CENRAP tested the CMAQ Version 4.5 with SOA modification enhancement and found it performed much better for OMC than the standard versions of CMAQ Version 4.5. Therefore, CENRAP adopted CMAQ Version 4.5, with the enhanced SOA modifications (Morris et al. 2006c). CMAQ Version 4.5 is available from the CMAS center <www.cmascenter.org>.

8.4.7 CAMx Air Quality Model Configuration

The CENRAP used CAMx Version 4.40 options similar to those used for CMAQ. The CENRAP initially ran CAMx in side-by-side comparisons with CMAQ. The CENRAP reviewed comparative model performance results and other factors for CAMx Version 4 and CMAQ Version 4.4 with SOA modifications presented at the February 7, 2006, CENRAP Modeling Workgroup meeting. The results indicated that:

- No one model consistently performed better than the other over all species and averaging times;
- Both models performed well for sulfate;
- CMAQ's winter nitrate over-prediction tendency was not as large as CAMx's;
- CAMx performed slightly better than CMAQ for elemental carbon (EC);
- CMAQ performed much better than CAMx for OMC;
- Both models over-predicted fine soil and under-predicted coarse mass (CM);
- CMAQ ran faster than CAMx due to message passing interface (MPI) multi-processing capability;
- CAMx required much less disk space than CMAQ (Morris et al. 2006b).

Based on these factors, the CENRAP selected CMAQ as the lead air quality model for the CENRAP regional haze modeling with CAMx as the secondary corroborative model. However, CAMx also contained a PM Source Apportionment Technology (PSAT) capability that was used widely in the CENRAP modeling. CMAQ does not have this capability. Appendix 8-1 lists the main CAMx configuration for the annual modeling. The CENRAP selected it, in part, to be consistent with the CMAQ model configuration. One exception was that the CAMx PSAT simulations used the Bott advection solver rather than the Piecewise-Parabolic Method (PPM) advection solver. The PPM advection solver is typically used in the standard CAMx and CMAQ runs. However, the Bott advection solver is more computationally efficient and the high computational requirements of the CAMx PSAT runs dictated this choice.

8.4.8 Modeling Domains

The CENRAP conducted emissions and air quality modeling on the 36 km national RPO domain as depicted in Figure 8-1: *National Inter-RPO Modeling Domain*. This domain consists of a 148 by 112 array of 36 km by 36 km grid cells covering the continental United States. Sensitivity simulations were also performed for episodes on a 12 km modeling domain covering the central states; however, the results were very similar to the 36 km results so CENRAP elected to proceed with the 2002 annual modeling using the 36 km domain for computational efficiency (Morris et al. 2006a).

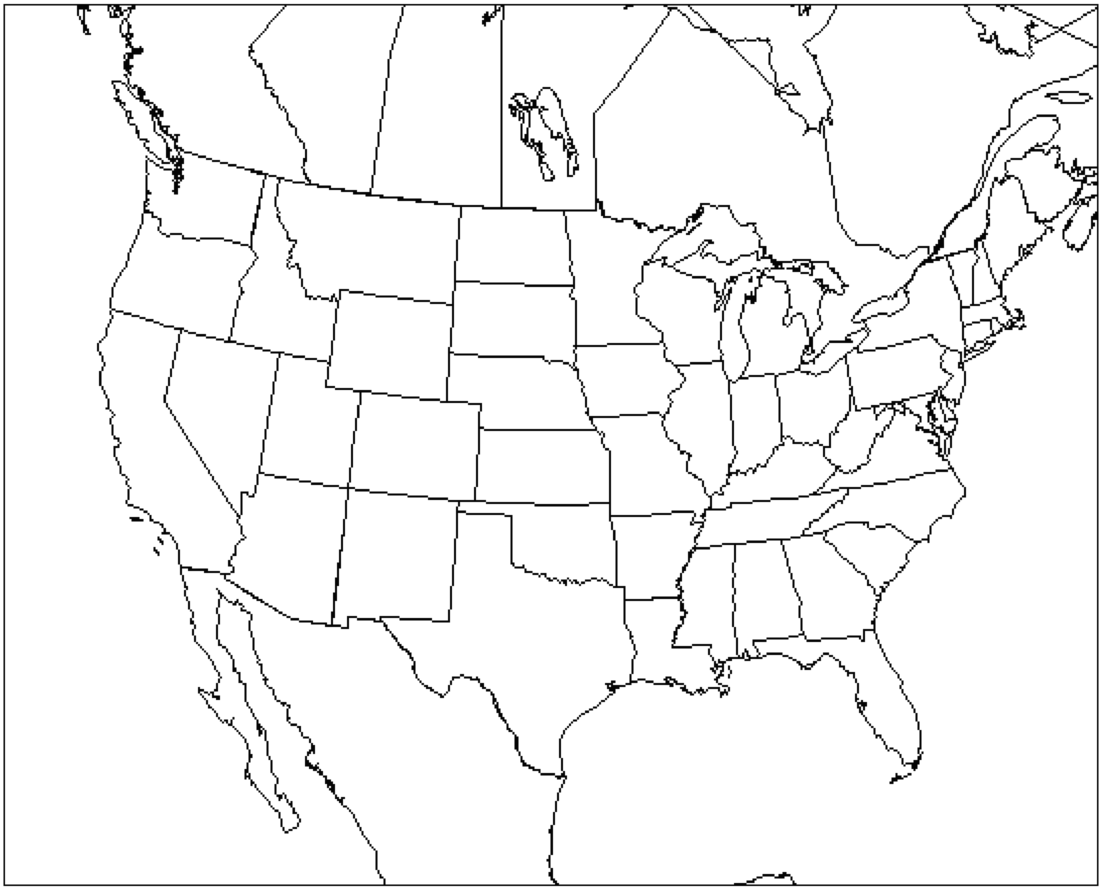


Figure 8-1: National Inter-RPO Modeling Domain
Note: 36 km grid used for the CENRAP 2002 annual SMOKE, CMAQ, and CAMx modeling

8.4.9 Vertical Structure of Modeling Domain

The MM5 meteorological model ran using 34 vertical layers from the surface to a pressure level of 100 millibars (mb) (approximately 15 km above ground level). Both the CMAQ and CAMx air quality models can employ layer collapsing in which vertical layers in the MM5 are combined in the air quality model, which improves computational efficiency. WRAP and VISTAS evaluated the sensitivity of the CMAQ model estimates to the number of vertical layers (Tonnesen et al. 2005, 2006; Morris et al. 2004a). CMAQ model simulations were performed with no layer collapsing (i.e., the same 34 layers as used by MM5) and with various levels of layer collapsing. These studies found that using 19 vertical layers up to 100 mb (i.e., same model top as MM5) and matching the eight lowest MM5 vertical layers near the surface produced nearly identical results as with no layer collapsing. They also found that very aggressive layer collapsing (e.g., 34 to 12 layers) produced results with substantial differences compared to no layer collapsing. Therefore, based on the WRAP and VISTAS sensitivity analysis, CENRAP adopted the 19 vertical layer configuration up to the 100 mb model top. Figure 8-2 displays the definition of the 34 MM5 vertical layers and how they collapsed to 19 vertical layers in the CENRAP air quality modeling.

Table 8-2: MM5 34 Vertical Layer Definitions

MM5					CMAQ 19L				
Layer	Sigma	Pres(mb)	Height(m	Depth(m)	Layer	Sigma	Pres(mb)	Height(m)	Depth(m)
34	**0.000**	**100**	**14662**	**1841**	**19**	**0.000**	**100**	**14662**	**6536**
33	0.050	145	12822	1466		0.050	145		
32	0.100	190	11356	1228		0.100	190		
31	0.150	235	10127	1062		0.150	235		
30	0.200	280	9066	939		0.200	280		
29	**0.250**	**325**	**8127**	**843**	**18**	**0.250**	**325**	**8127**	**2966**
28	0.300	370	7284	767		0.300	370		
27	0.350	415	6517	704		0.350	415		
26	0.400	460	5812	652		0.400	460		
25	**0.450**	**505**	**5160**	**607**	**17**	**0.450**	**505**	**5160**	**1712**
24	0.500	550	4553	569		0.500	550		
23	0.550	595	3984	536		0.550	595		
22	**0.600**	**640**	**3448**	**506**	**16**	**0.600**	**640**	**3448**	**986**
21	0.650	685	2942	480		0.650	685		
20	**0.700**	**730**	**2462**	**367**	**15**	**0.700**	**730**	**2462**	**633**
19	0.740	766	2095	266		0.740	766		
18	**0.770**	**793**	**1828**	**259**	**14**	**0.770**	**793**	**1828**	**428**
17	0.800	820	1569	169		0.800	820		
16	**0.820**	**838**	**1400**	**166**	**13**	**0.820**	**838**	**1400**	**329**
15	0.840	856	1235	163		0.840	856		
14	**0.860**	**874**	**1071**	**160**	**12**	**0.860**	**874**	**1071**	**160**
13	0.880	892	911	158	**11**	**0.880**	**892**	**911**	**158**
12	**0.900**	**910**	**753**	**78**	**10**	**0.900**	**910**	**753**	**155**
11	0.910	919	675	77		0.910	919		
10	**0.920**	**928**	**598**	**77**	**9**	**0.920**	**928**	**598**	**153**
9	0.930	937	521	76		0.930	937		
8	**0.940**	**946**	**445**	**76**	**8**	**0.940**	**946**	**445**	**76**
7	**0.950**	**955**	**369**	**75**	**7**	**0.950**	**955**	**369**	**75**
6	**0.960**	**964**	**294**	**74**	**6**	**0.960**	**964**	**294**	**74**
5	**0.970**	**973**	**220**	**74**	**5**	**0.970**	**973**	**220**	**74**
4	**0.980**	**982**	**146**	**37**	**4**	**0.980**	**982**	**146**	**37**
3	**0.985**	**986.5**	**109**	**37**	**3**	**0.985**	**986.5**	**109**	**37**
2	**0.990**	**991**	**73**	**36**	**2**	**0.990**	**991**	**73**	**36**
1	**0.995**	**995.5**	**36**	**36**	**1**	**0.995**	**995.5**	**36**	**36**
0	**1.000**	**1000**	**0**	**0**	**0**	**1.000**	**1000**	**0**	**0**

Note: Scheme for collapsing the 34 layers down to 19 layers for the CENRAP CMAQ, and CAMx 2002 annual modeling.

8.4.10 2002 Calendar Year Selection

The CENRAP selected the calendar year 2002 for regional haze annual modeling as described in the modeling protocol (Morris et al. 2004a). The EPA's applicable guidance on $PM_{2.5}$ and regional haze modeling at that time (EPA 2001) identified specific goals to consider when selecting modeling periods for use in demonstrating reasonable progress in attaining the regional haze goals. Since there is much in common with the goals for selecting episodes for annual and episodic $PM_{2.5}$ attainment demonstrations as well as regional haze, EPA's current guidance addresses all three in a common document (EPA 2007). At the time of the modeling period selection, EPA had also published an updated summary of $PM_{2.5}$ and Regional Haze Modeling Guidance (Timin 2002) that served, in some respects, as an interim placeholder until issuance of the final guidance as part of the $PM_{2.5}$ and regional haze National Ambient Air Quality Standards implementation process published in April 2007 (EPA 2007). The interim EPA modeling guidance for episode selection (EPA 2001; Timin 2002) was consistent with the final EPA regional haze modeling guidance (EPA 2007).

EPA recommends that the selection of a modeling period derive from three principal criteria:

- a variety of meteorological conditions should be covered that include the types of meteorological conditions that produce the worst 20 percent and best 20 percent visibility days at Class I areas in the CENRAP states during the 2000 through 2004 baseline period;
- to the extent possible, the modeling data base should include days for which enhanced databases (i.e., beyond routine aerometric and emissions monitoring) are available; and
- sufficient days should be available such that relative response factors (RRFs) can be based on several (i.e., >15) days.

For regional haze modeling, the guidance goes further by suggesting that the preferred approach is to model a full, *representative* year (EPA 2001, pg. 188). Moreover, calculations of the required RRF values should be based on model results averaged over the 20 percent worst and 20 percent best visibility days determined for each Class I area based on monitoring data from the 2000 through 2004 baseline period. More recent EPA guidance (Timin 2002) suggests that states should model at least the 10 worst and 10 best visibility days at each Class 1 area. EPA also lists several "other considerations" to bear in mind when choosing potential PM and regional haze episodes including:

- choose periods that have already been modeled;
- choose periods that are drawn from the years upon which the current design values are based;
- include weekend days among those chosen; and
- choose modeling periods that meet as many episode selection criteria as possible in the maximum number of nonattainment or Class I areas as possible.

Due to limited available resources, CENRAP modeled a single calendar year. The Regional Haze Rule uses the five-year baseline period of 2000 through 2004 as the starting point for projecting future-year visibility. Thus, the modeling year should be selected from this five-year baseline period. The CENRAP selected the 2002 calendar year, which lies in the middle of the 2000 through 2004 baseline, for the following reasons.

- Based on available information, 2002 appears to be a fairly typical year in terms of meteorology for the five-year baseline period of 2000 through 2004.
- 2003 and 2004 appeared to be colder and wetter than typical in the eastern United States.
- The enhanced Interagency Monitoring of Protected Visual Environments (IMPROVE) and IMPROVE protocol sites and supersites PM monitoring data were fully operational by 2002. Much less IMPROVE monitoring data was available during 2000 through 2001, especially in the CENRAP region.
- IMPROVE data for 2003 and 2004 were not yet available at the time that the CENRAP modeling was initiated.
- The other RPOs were using 2002.

8.4.11 Initial Concentrations and Boundary Conditions

The CMAQ and CAMx models were operated separately for each of four quarters of the 2002 year using an approximate 15-day spin-up period (i.e., the models started approximately 15 days before the first day of interest in each quarter to limit the influence of the assumed initial concentrations, e.g., start June 15 for the third quarter, whose first day of interest is July 1). Sensitivity simulations demonstrated that with fifteen initialization days, the influence of initial concentrations was minimal using the 36 km Inter-RPO continental United States modeling domain. Consequently, clean initial concentrations were specified in the CMAQ and CAMx modeling using a 15-day spin-up period.

Boundary conditions (i.e., the assumed concentrations along the later edges of the 36 km modeling domain, see Figure 8-1) used the results from a 2002 simulation by the GEOS-Chem global circulation/chemistry model. GEOS-Chem is a three-dimensional global chemistry model driven by assimilated meteorological observations from the Goddard Earth Observing System (GEOS) of the NASA Global Modeling and Assimilation Office. Research groups around the world apply it to a wide range of atmospheric composition problems, including future climates and planetary atmospheres using general circulation model meteorology to drive the model. The Atmospheric Chemistry Modeling Group at Harvard University provides central management and support of the model.

VISTAS coordinated a joint RPO study in which Harvard University applied the GEOS-Chem global model for the 2002 calendar year (Jacob, Park, and Logan 2005). The University of Houston was retained to process the 2002 GEOS-Chem output into boundary conditions for the CMAQ model (Byun 2004).

There were several quality assurance (QA) checks of the boundary conditions generated from the 2002 GEOS-Chem output. The first QA check was a range check to assure reasonable values. The boundary conditions were compared against the GEOS-Chem outputs to assure the mapping and interpolation were performed correctly. The University of Houston supplied the code to map the GEOS-Chem output to the CMAQ boundary conditions format. Environ reviewed the code and duplicated generation of the boundary conditions for several time periods during 2002.

8.4.12 Emission Input Preparation

The CENRAP SMOKE emissions modeling used updated 2002 emissions data for the United States (Pechan 2005c,e; Reid et al. 2004a,b), 1999 emissions data for Mexico (ERG 2006), and 2000 emissions data for Canada. These data were used to generate a final 2002 Base G Typical (Typ02G) annual emissions database. Numerous iterations of the emissions modeling were conducted using interim databases before arriving at the final Base G emission inventories (e.g., Morris et al. 2005). The 2018 Base G base case emissions (Base18G) for most source categories in the United States were based on projections of the 2002 inventory assuming growth and control (Pechan 2005d). 2018 EGU emissions were based on the run 2.1.9 of the Integrated Planning Model (IPM) updated by the CENRAP states. Canadian emissions for the Base18G scenario were based on a 2020 inventory. The Mexican 1999 inventory was held constant for 2018.

The Typ02G and Base18G emission inventories represent significant improvements to the preliminary emissions modeling CENRAP performed (Morris et al. 2005). While the preliminary 2002 modeling served to develop the infrastructure for modeling large emissions data sets and producing annual emissions simulations, much of the input data (both as inventories and ancillary data) were placeholders for actual 2002 data being prepared through calendar year 2005. As actual 2002 data sets became available, they were integrated into the SMOKE modeling and QA system that was developed during the preliminary modeling, to produce a high-quality emissions data set for use in the final CMAQ and CAMx modeling. The addition of entirely new inventory categories, like marine shipping, added complexity to the modeling. By the end of the emissions data collection phase, there were 23 separate emissions processing streams covering a variety of source categories necessary to generate model-ready emission inputs for the 2002 calendar year. Details on the emissions modeling are in Chapter 2 and Appendix B of the TSD (Appendix 8-1).

8.4.13 Meteorological Data Input Preparation

The IDNR conducted the 2002 36 km MM5 meteorological modeling and also performed a preliminary model performance evaluation (Johnson, 2007). CENRAP performed an additional MM5 evaluation of the CENRAP 2002 36 km MM5 simulation that included a comparative evaluation against the final VISTAS 2002 36 km MM5 and an interim WRAP 2002 36 km simulation (Kemball-Cook et al. 2004). Kemball-Cook and co-workers (2004) found the following in the comparative evaluation of the CENRAP, WRAP, and VISTAS 2002 36 km MM5 simulations (details in Appendix A of the TSD):

Surface Meteorological Performance within the CENRAP Region

- The three MM5 simulations (CENRAP, VISTAS, and WRAP) obtained comparable model performance for winds and humidity that were within model performance benchmarks.
- The WRAP MM5 simulation obtained better temperature model performance than the other two simulations due to the use of surface temperature data assimilation.
    - In the final WRAP MM5 simulation the use of surface temperature assimilation was dropped because it introduced instability in the vertical structure of the atmosphere.
- For all three runs, the northern portion of CENRAP domain (e.g. Minnesota) had a cold bias in winter and a warm bias in summer.

Surface Meteorological Performance outside the CENRAP Region

- All three runs had similar surface wind model performance in the western United States that was outside the model performance benchmarks.
- For temperature, the WRAP MM5 simulation had the best performance overall due to the surface temperature data assimilation that was dropped in the final WRAP run.
- The three runs had comparable humidity performance, although WRAP exhibited a larger wet bias in the summer and in the southwestern United States.

Upper-Air Meteorological Performance

- The VISTAS and CENRAP MM5 simulations were better able to reproduce the deep convective summer boundary layers compared to the WRAP MM5 simulations, which exhibited a smoother decrease in temperature with increase in altitude.
- CENRAP and VISTAS MM5 simulations better simulated the surface temperature inversions than WRAP.
- WRAP was better able to simulate the surface temperature.
- All three models exhibited similar vertical wind profiles.

Precipitation Performance

- In winter, all three MM5 simulations exhibited similar, fairly good performance in reproducing the spatial distribution and magnitudes of the monthly average observed precipitation.
- In summer, all runs had a wet bias, particularly in the desert southwest where the interim WRAP run had the largest wet bias.

In conclusion, the VISTAS simulation appeared to perform best, and the CENRAP MM5 model performance was generally between the VISTAS and WRAP performance, with performance more similar to VISTAS than WRAP. Although the interim WRAP MM5 simulation performed best for surface temperature due to the surface temperature data assimilation, the surface temperature assimilation degraded the MM5 upper-air performance including the ability to assimilate surface inversions and was ultimately dropped from the final WRAP MM5 simulations (Kemball-Cook et al. 2005).

The IDNR 12 km MM5 simulations were also evaluated and compared with the performance of the 36 km MM5 simulation (Johnson et al. 2007). The IDNR 36 km and 12 km MM5 model performance was similar (Johnson 2007), which supported the findings of the CMAQ and CAMx 36 and 12 km sensitivity simulations that there was little benefit of using a 12 km grid for simulating regional haze at rural Class I areas (Morris et al. 2006a). However, as noted by Tonnesen and co-workers (2005; 2006) and EPA modeling guidance (1991; 1999; 2001; 2007) this finding does not necessarily hold for eight-hour ozone and $PM_{2.5}$ modeling that is characterized by sharper concentration gradients and frequently occurs in the urban environment as compared to the more rural nature of regional haze.

8.4.14 Photolysis Rate Model Input

Several chemical reactions in the atmosphere are initiated by the photodissociation of various trace gases. To accurately represent the complex chemical transformations in the atmosphere, accurate estimates of these photodissociation rates must be made. The Models-3/CMAQ system includes the JPROC processor, which calculates a table of clear-sky photolysis rates (or J-values) for a specific date. JPROC uses default values for total aerosol loading and provides the option to use default ozone column data or to use measured total ozone column data. These data come from the Total Ozone Mapping Spectrometer (TOMS) satellite data. TOMS data that is available at 24-hour averages was obtained from http://toms.gsfc.nasa.gov/eptoms/ep.html. Day-specific TOMS data was used in the CMAQ radiation model (JPROC) to calculate photolysis rates. The TOMS data were missing or erroneous for several periods in 2002: August 2-12, June 10, and November 18-19. Thus, the TOMS data for August 1, 2002, was used for August 2-7 and TOMS data for August 13 was used for August 8-12. Similarly, TOMS data for June 9 was used for June 10 and data for August 17 was used for August 18-19. Note that the total column of ozone in the atmosphere is dominated by stratospheric ozone, which has very little day-to-day variability, so the use of TOMS data within a week or two of an actual day introduces minimal uncertainties in the modeling analysis.

JPROC produces a "look-up" table that provides photolysis rates as a function of latitude, altitude, and time (in terms of the number of hours of deviation from local noon, or hour angle). In the current CMAQ implementation, the J-values are calculated for six latitudinal bands (10º, 20º, 30º, 40º, 50º, and 60º N), seven altitudes (0 km, 1 km, 2 km, 3 km, 4 km, 5 km, and 10 km), and hourly values up to plus or minus 8 hours of deviation from local noon. During model calculations, photolysis rates for each model grid cell are estimated by first interpolating the clear-sky photolysis rates from the look-up table using the grid cell latitude, altitude, and hour angle, followed by applying a cloud correction (attenuation) factor based on the cloud inputs from MM5.

The photolysis rates input file was prepared as separate look-up tables for each simulation day. Photolysis files are ASCII files that were visually checked for selected days to verify that photolysis rates are within the expected ranges.

The Tropospheric Ultraviolet and Visible (TUV) Radiation Model (http://cprm.acd.ucar.edu/Models/TUV/) is used to generate the photolysis rates input file for CAMx. TOMS ozone data and land use data were used to develop the CAMx Albedo/Haze/Ozone input file for 2002. As for CMAQ, the missing TOMS data period in the fall of 2002 was filled in using observed TOMS data on either side of the missing period using the same procedures as described above for CMAQ. Default land use specific albedo values were used and a constant haze value used, corresponding to rural conditions over North America.

8.4.15 Air Quality Data Input Preparation

Air quality data used with the CMAQ and CAMx modeling systems include: (1) initial concentrations that are the assumed initial three-dimensional concentrations throughout the modeling domain; (2) the boundary conditions that are the concentrations assumed along the lateral edges of the RPO national 36 km modeling domain; and (3) air quality observations that are used in the model performance evaluation (MPE). The MPE is discussed in Chapter 3 and Appendix C of the TSD.

As previously noted, CMAQ default clean initial concentrations were used along with an approximately 15-day spin up (initialization) period to eliminate any significant influence of the initial concentrations on the modeled concentrations for the days of interest. The same initial concentrations were used with CAMx. Both CMAQ and CAMx were run for each quarter of the year. Each quarter's model run was initialized 15 days prior to the first day of interest (e.g., for the third quarter, July-August-September, the model was initialized on June 15, 2002, with the first modeling day of interest July 1, 2002). The CMAQ boundary conditions for the inter-RPO 36 km continental United States grid (Figure 8-1) were based on day-specific three-hour averages from the output of the GEOS-Chem global simulation model of 2002 (Jacob, Park, and Logan 2005). The 2002 GEOS-Chem output was mapped to the species and vertical layer structure of CMAQ and interpolated to the lateral boundaries of the 36 km grid shown in Figure 8-1 (Byun 2004).

Table 8-3 summarizes the surface air quality monitoring networks and the number of sites available in the CENRAP region that were used in the model performance evaluation. Data from these monitoring networks were also used to evaluate the CMAQ and CAMx models outside of the CENRAP region.

Table 8-3: Ground-level Ambient Data Monitoring Networks and Stations for 2002

Monitoring Network	Chemical Species Measured	Sampling Frequency; Duration	Approximate Number of Monitors
IMPROVE	Speciated $PM_{2.5}$ and PM_{10}	1 in 3 days; 24 hr	11
CASTNET	Speciated $PM_{2.5}$ and Ozone	Hourly, Weekly; 1 hr, 1 Week	3
NADP	Wet SO_4, Wet NO_3, and Wet NH_4	Weekly	23
EPA-STN	Speciated $PM_{2.5}$	Varies; Varies	12
AIRS/AQS	CO, NO, NO_2, NO_X, and Ozone	Hourly; Hourly	25

Note: Available in the CENRAP states for calendar year 2002 and used in the model performance evaluation.

8.4.16 2002 Base Case Modeling and Model Performance Evaluation

CENRAP's modeling contractors evaluated the CMAQ and CAMx modeling results against ambient measurements of PM species, gas-phase species, and wet deposition. Table 8-6 summarizes the networks used in the model evaluation, the species measured, and the averaging times and frequency of the measurements. CENRAP carried out numerous iterations of CMAQ and CAMx 2002 base case simulations and model performance evaluations during the course of the CENRAP modeling study. Most of them are posted on the CENRAP modeling website (http://pah.cert.ucr.edu/aqm/cenrap/cmaq.shtml), and summaries of the work are in previous reports and presentations for CENRAP (e.g., Morris et al. 2005; 2006a, b). Chapter 3 and Appendix C of the TSD provide details on the final 2002 Base F 36 km CMAQ base case modeling performance evaluation. Because of the similarity between 2002 Base F and 2002 Base G and resource constraints, CENRAP did not repeat the model evaluation for Base G. In general, the model performance of the CMAQ and CAMx models for sulfate (SO_4) and elemental carbon (EC) was good. Model performance for nitrate (NO_3) was variable, with a summer underestimation and winter overestimation bias. Performance for organic carbon mass (OMC) was also variable, with the inclusion of the SOA modification enhancement in CMAQ Version 4.5 greatly improving the CMAQ summer OMC model performance (Morris et al., 2006c). Model performance for soil and CM was generally poor. Part of the poor performance for fine soil and coarse mass appear to be due to measurement-model incommensurability. The

IMPROVE measured values are due, in part, to local blowing dust sources that are not captured in the model's emission inputs and the 36 km grid resolution is not conducive to modeling localized events. Also, the model usually fails to simulate locally high winds creating dust clouds in one part of the Chihuahuan Desert that later move with lower speed winds to affect Guadalupe Mountains National Park or other Class I areas. Figures 8-2 and 8-3 show the observed light extinction compared to the modeled light extinction at Big Bend National Park and Guadalupe Mountains National Park.

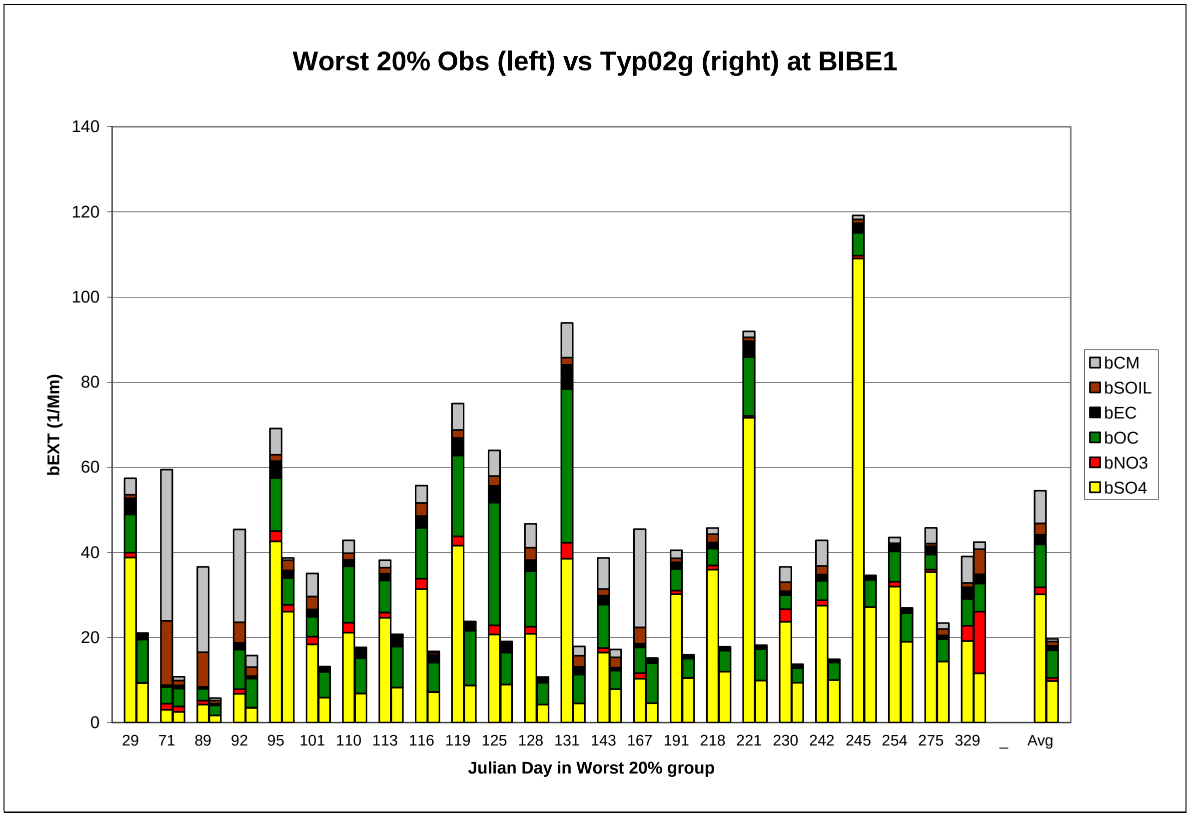


Figure 8-2: Observed and Base Case Modeled Concentrations at Big Bend

Note: Extinction calculated using the new IMPROVE equation using observed concentrations and base case modeled concentrations at Big Bend National Park. The new IMPROVE equation calculations relied on 2002 IMPROVE data for the worst 20 percent of monitored days and the modeling used the 2002 Base F emission inventory.

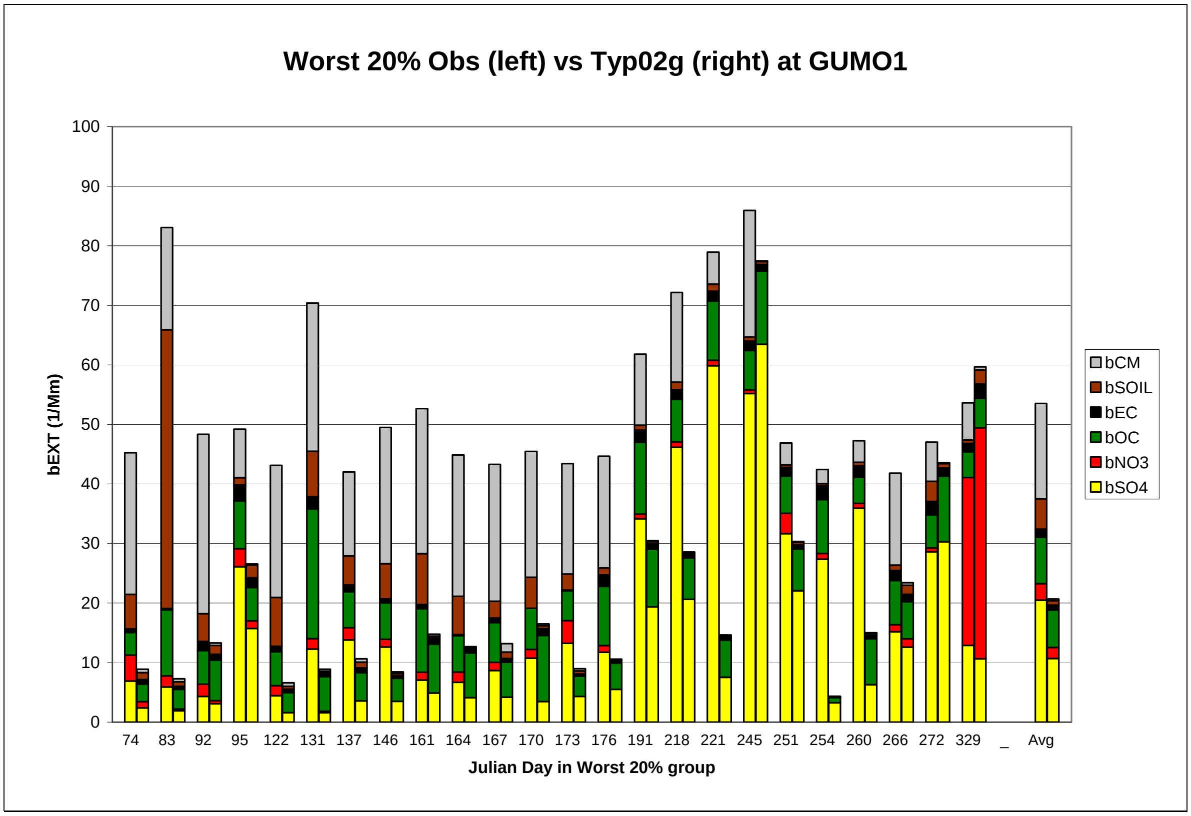


Figure 8-3: Observed and Base Case Modeled Concentrations at Guadalupe Mountains
Note: Extinction calculated using the new IMPROVE equation using observed concentrations and base case modeled concentrations at Guadalupe Mountains National Park. The new IMPROVE equation calculations relied on 2002 IMPROVE data for the worst 20 percent of monitored days and the modeling used the 2002 Base F emission inventory.

8.4.17 2018 Modeling and Visibility Projections

Emissions for the 2018 base case were generated following the procedures discussed in Chapter 2 of the TSD. Emissions in 2018 for electrical generating units (EGUs) were based on simulations of the Integrated Planning Model (IPM) that took into account the effects of the Clean Air Interstate Rule (CAIR) on emissions from EGUs in CAIR states using an IPM realization of a CAIR cap and trade program. For the purposes of this SIP revision, the TCEQ is assuming that the federal appellate court remand of CAIR to EPA will result in a replacement program providing comparable emissions reductions at EGUs before 2018. Emissions for on-road and non-road mobile sources were based on activity growth and emissions factors from the EPA MOBILE Vehicle Emission Modeling Software Version 6 (MOBILE6) and NONROAD models, respectively. Area sources and non-EGU point sources were grown to 2018 levels using Economic Growth Analysis System (EGAS) (Pechan 2005d). The Canadian year 2000 emissions inventory was replaced by a Canadian 2020 emissions inventory for the 2018 CMAQ/CAMx simulations.

The following sources were assumed to remain constant between the 2002 and 2018 base case simulations:

- biogenic VOC and NO_X emissions from the Biogenic Emissions Inventory System Version 3 (BEIS3) model;
- wind-blown dust associated with non-agricultural sources (i.e., natural wind-blown fugitive dust);

- off-shore emissions associated with off-shore marine and oil and gas production activities;
- emissions from wildfires;
- emissions from Mexico; and
- global transport (i.e., emissions due to boundary conditions from the 2002 GEOS-Chem global chemistry model).

The results from the 2002 and 2018 CMAQ and CAMx simulations were used to project 2018 PM levels from which 2018 visibility estimates were obtained. The 2002 and 2018 modeling results were used in a relative sense to scale the observed PM concentrations from the 2000 through 2004 baseline and the IMPROVE monitoring network to obtain the 2018 PM projections. The modeled scaling factors are called relative response factors (RRFs) and are constructed as the ratio of modeling results for the 2018 model simulation to the 2002 model simulation. Two important regional haze metrics are the average visibility for the worst 20 percent and best 20 percent days from the 2000 through 2004 five-year baseline. For the 2018 visibility projections, EPA guidance recommends developing Class I area and PM species specific RRFs using the average modeling results for the worst 20 percent days during the 2002 modeling period and the 2002 and 2018 emission scenarios. The results of the CENRAP 2018 visibility projections following EPA guidance procedures (EPA 2007a) are provided in Chapter 4 and Appendix D of the TSD in Appendix 8-1 of this SIP revision. CENRAP has also developed alternative procedures for visibility projections that are discussed in Chapter 5 and Appendix D of the TSD. For example, much of the CM impact at Class I area IMPROVE monitors are believed to be natural and primarily from local sources that are subgrid-scale to the modeled 36 km grid so are not represented in the modeling. Thus, one alternative visibility projection approach is to set the RRF for CM to 1.0. That is, the CM impacts in 2018 are assumed to be the same as in the observed 2000-2004 baseline. Similarly, the soil impacts at IMPROVE monitors are likely mainly due to local dust sources so another alternative approach is to set the RRFs for both CM and soil to 1.0.

The 2018 visibility projections for the worst 20 percent days are compared against a 2018 point on the uniform rate of progress (URP) glide path or the "2018 URP point." The 2018 URP point is obtained by constructing a linear visibility glide path in deciviews from the observed 2000 through 2004 baseline (EPA 2003a) for the worst 20 percent days to the 2064 natural conditions (EPA 2003b). Where the linear glide path crosses the year 2018 is the 2018 URP point. States may use the modeled 2018 visibility to help define their 2018 RPG in their Regional Haze SIPs. The 2018 URP point is used as a benchmark to help judge the 2018 modeled visibility projections and the state's RPG. However, as noted in EPA's RPG guidance, "The glide path is not a presumptive target, and states may establish a RPG that provides for greater, lesser, or equivalent visibility improvement as that described by the glide path" (EPA 2007b). Chapter 4 and Appendix D of the TSD present the 2018 visibility projections for the CENRAP Class I areas and their comparisons with the 2018 URP point using EPA default visibility projection procedures (EPA 2007a) and EPA default URP glide paths (EPA 2003a,b; 2007b).

Various techniques have been developed to display the 2018 visibility modeling results including "DotPlots" that display the 2018 visibility projections as a percentage of meeting the 2018 point on the URP glide path. A value of 100 percent on the DotPlot indicates that the Class I area is predicted to meet the 2018 point on the URP glide path. Over 100 percent means the 2018 visibility projection obtains more visibility improvements (reductions) than required to meet the 2018 point on the URP glide path (i.e., projected value is below the glide path). Less than 100 percent indicates that fewer visibility improvements are projected than are needed to meet the 2018 point URP on the glide path (i.e., above the glide path). Figure 8-4 displays a DotPlot that compares the 2018 visibility projections from the CENRAP 2018 Base G CMAQ simulation with the 2018 URP point using the EPA default RRFs and alternative RRFs that set the CM and soil RRFs to unity (i.e., assume CM and soil are natural so remain unchanged from the 2000-2004 baseline). For these results, the 2018 visibility projections at the Hercules Glades (HEGL1) Class I area meets the 2018 point on the URP glide path (100 percent), whereas the 2018 visibility projections at Caney Creek (CACR), Mingo (MING), and Upper Buffalo (UPBU) achieve more visibility improvements than needed to meet the 2018 URP point so are below the 2018 URP glide path. However, the 2018 visibility projections at Breton come up slightly short (approximately 5 percent) of meeting the 2018 point on the URP glide path and Wichita Mountains (WIMO) comes up approximately 40 percent short of meeting the 2018 point on the URP glide path. Class I areas at the northern (e.g., VOYA, BOWA, and ISLE) and southern (e.g., BIBE and GUMO) boundaries of the United States also fall short of achieving the 2018 URP point.

High contributions of international transport and/or natural sources (e.g., windblown dust) affect the ability of these Class I areas to be on the URP glide path calculated using the default estimates produced by the Natural Conditions II Committee (NC-II). Chapters 4 and 5 of the TSD in Appendix 8-1 discuss these issues in more detail.

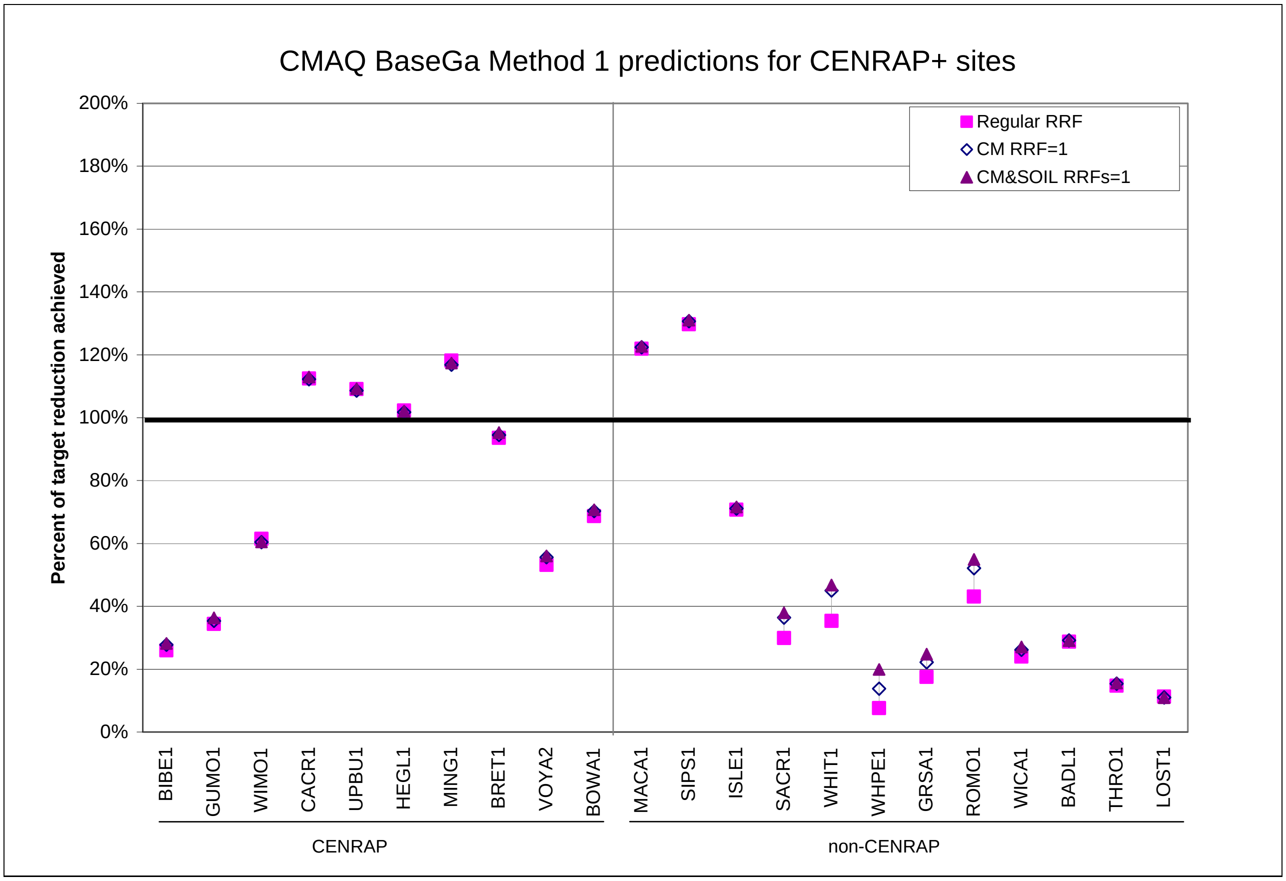


Figure 8-4: 2018 Visibility Projections Expressed as Percent of Meeting the 2018 URP Point

Note: Using the default NC-II estimates of natural conditions.

BADL	Badlands Wilderness Area
BOWA	Boundary Waters Canoe Area Wilderness
CACR	Caney Creek Wilderness Area
HEGL	Hercules-Glades Wilderness Area
ISLE	Isle Royale National Park
LOST	Lostwood Wilderness Area
MACA	Mammoth Cave National Park
SIPS	Sipsey Wilderness Area
THRO	Theodore Roosevelt National Park
UPBU	Upper Buffalo Wilderness Area
VOYA	Voyageurs National Park
WICA	Wind Cave National Park

8.4.18 Additional Supporting Analysis

CENRAP performed numerous supporting analyses of its modeling results including analyzing alternative glide paths and 2018 projection approaches and performing confirmatory analysis of the 2018 visibility projections. Details on the additional supporting analysis are contained in Chapter 5 of the TSD, which include:

- The CENRAP 2018 visibility projections were compared with those generated by VISTAS and MRPO. There was close agreement between the CENRAP and VISTAS 2018 visibility projections at almost all common Class I areas, with the exception of Breton Island where the CENRAP's projections were slightly more optimistic than VISTAS'. The MRPO 2018 visibility projections were less optimistic than CENRAP's at the four Arkansas-Missouri Class I areas. This difference may have been due to CENRAP's BART emission controls in CENRAP states that were not included in the 2018 MRPO inventory.
- Extinction based glide paths were developed and the CENRAP 2018 visibility projections were shown to produce nearly identical estimates of achieving the 2018 URP point when using total extinction glide paths as when the linear deciview glide paths were used. With the extinction based glide paths the analysis of 2018 URP could be made on a PM species-by-species basis where it was shown that 2018 extinctions due to SO_4 and, to a lesser extent, NO_3 and EC, achieve the URP, but the other species do not and, in fact, extinction due to soil and CM is projected to get worse.
- 2018 visibility projections were made using EPA's Modeled Attainment Test Software (MATS) and the CENRAP Typ02G and Base18G modeling results. The CENRAP 2018 visibility projections agreed with those generated by MATS with three exceptions: Breton, Boundary Waters, and Mingo Class I areas. At these three Class I areas MATS did not produce any 2018 visibility projections due to insufficient observed 2000-2004 data in the raw IMPROVE database to produce a valid baseline. CENRAP used filled data for these three Class I areas.
- PM PSAT modeling was conducted to estimate the contributions to visibility impairment at Class I areas by source region (e.g., states) and major source category. Source contributions were obtained for a 2002 and 2018 base case and the PSAT modeling results were implemented in a PSAT Visualization Tool that was provided to CENRAP states and others. Major findings from the PSAT source apportionment modeling include the following:
    - Sulfate from elevated point sources was the highest source category contribution to visibility impairment at CENRAP Class I areas for the worst 20 percent days.
    - International transport contributed significantly to visibility impairment at CENRAP Class I areas on the southern (BIBE and GUMO) and northern (BOWA and VOYA) borders of the United States and to a lesser extent at WIMO.
- Alternative visibility projections were made, assuming that CM alone, and CM and soil were natural in origin.
- Visibility projections were made using an alternative model (CAMx) that verified the projections made by CMAQ.
- The effects of international transport were examined several ways indicating that the inability of the 2018 visibility projections to achieve the 2018 URP point at the northern and southern border Class I areas was due to high contributions due to International Transport.

Visibility trends for the worst 20 percent days, best 20 percent days, and all monitored days were analyzed at CENRAP Class I areas using the period of record IMPROVE observations. At most Class I areas there were insufficient years of data to produce a discernable trend. In addition, there was significant year-to-year variability in visibility impairment with episodic events (e.g., wildfires and windblown dust) confounding the analysis.

CHAPTER 9. BEST AVAILABLE RETROFIT TECHNOLOGY

On July 6, 2005, the EPA published final amendments to its 1999 Regional Haze Rule including Appendix Y, the final guidance for Best Available Retrofit Technology (BART) determinations in the Federal Register (70 FR 39104-39172). The BART rule requires the installation of BART on emission sources that fit specific criteria and "may reasonably be anticipated to cause or contribute" to visibility impairment in any Class I area (Appendix 9-1: U.S. EPA BART Rule).

9.1 BART-ELIGIBLE SOURCES IN TEXAS

The Texas Commission on Environmental Quality's (TCEQ) BART rule adopted on January 10, 2007, identifies potentially affected sources as those:

- belonging to one of 26 industry source categories;
- having the potential to emit (PTE) 250 tons per year (tpy) or more of any visibility-impairing pollutant; and
- not operating prior to August 7, 1962, and in existence on August 7, 1977 (Appendix 9-2: *Texas BART Rule*).

The state is not required to make a determination of BART for SO_2 or NO_X if a BART-eligible source has the PTE less than 40 tons per year of such pollutant(s) or less than 15 tons per year for PM_{10}.

Texas has made the determination that participation in CAIR is equivalent to BART. This exempts EGUs impacted by CAIR from a BART analysis for SO_2 and NO_x. As of the date of this SIP revision, CAIR remains in effect until replaced by EPA rule consistent with the D.C. Circuit Court of Appeals' remand of CAIR back to EPA. As a result, EGUs subject to the cap and trade system established by CAIR have not been evaluated for BART for SO_2 and NO_x. The TCEQ will take appropriate action if CAIR is not replaced with a system that the US EPA considers to be equivalent to BART.

The TCEQ has also adopted the model plants, or option 2, developed by the EPA; this is an approach for using model plants to exempt individual sources with common characteristics (70 FR 39162-3). Sources which meet this model plant exemption are considered not to be negatively impacting visibility at Class I areas and are therefore not required to complete a BART analysis.

The TCEQ manages emissions and emissions-related data in the State of Texas Air Reporting System (STARS). The STARS was used to determine which sources were potentially BART-eligible. This database does not store any permit related information such as build dates or permitted allowable emission levels. As a result of these database limitations the TCEQ surveyed companies regarding their potential to emit and construction dates in order to complete the initial BART determination (Appendix 9-3: *A Sample Survey*).

Texas Source Survey

Each of the 26 BART source categories were addressed for Texas. The Standard Industrial Codes (SIC) as well as the applicable Source Classifications Codes (SCC) were identified by TCEQ staff using the 26 applicable source categories listed in Section III(H) of the 40CFR Part 51, Regional Haze Regulations. This list was compared with other states and regional planning organization lists for completeness. The initial survey population was based on this SIC/SCC list only.

As provided for in the EPA guidance document for BART, the TCEQ chose to adopt a model plant analysis to reasonably eliminate smaller sources of NO_X and SO_2 emissions which were distant from a Class I area. The EPA guidance provides exemption of sources from consideration if their actual emission of NO_X or SO_2 (or combination of NO_X and SO_2) were less than 500 tpy as long as they were located more than 50 kilometers (km) from any Class I area; sources were also exempted if their 2002 emissions of NO_X or SO_2 (or combination of NO_X and SO_2) were less than 1,000 tpy as long as they were located more than 100 km from any Class I area. The TCEQ reduced the emission threshold to 750 tpy for sources greater than 100 km and 375 tpy for sources greater than 50 km to capture sources that might not have met EPA's threshold based only on their 2002 emissions levels. Given their distance from Class I areas, the relatively low emissions from the screened out sources are unlikely to significantly impact visibility at those areas.

Based on an estimate by TCEQ staff, the actual emissions are typically 80 percent of the permitted amount. Using this estimate, staff assumed that companies with actual volatile organic compounds (VOC) emissions of 200 tpy would reasonably have a permitted potential to emit of 250 tpy. Companies with the applicable source categories and actual emissions at their sites of 200 tpy or more of VOC or PM_{10} were also asked to complete the survey. In 2002, $PM_{2.5}$ data were collected but a review of the database indicated that some companies did not fully report fine particulate matter until later inventories. As allowed by the BART guidelines, PM_{10} was used as a surrogate in order to fully capture sources of particulate matter.

A county level distance screen was employed to avoid removing sources that barely exceeded distance calculations. If any portion of the county was within the applicable distance to the nearest Class I area, then all the sites within that county were considered within the applicable distance. Additionally, all BART category sites within counties within 50 km of a Class I area were surveyed. The Class I areas considered for the Texas screening included the Guadalupe Mountains, Big Bend, Carlsbad Caverns, Wichita Mountains, Caney Creek, Breton Island, and Salt Creek.

As a result of the screening analysis, 254 sites (approximately 12 percent of the 2,165 sources in the 2002 emissions inventory) were identified as potentially BART-eligible based on distance and actual emissions. A survey was sent to these sites to ask for site representatives to help in identifying construction or reconstruction dates and whether the PTE of the BART-eligible equipment exceeded 250 tpy.

The emissions represented by the surveyed sites are summarized in Table 9-1: *Emissions from Companies Surveyed as a Percentage of State Total Point Source Emissions*. Sources emitting a large percentage of the actual emissions in the state were in the survey population. Emissions covered in the survey ranged from 61.7 percent of the 2002 VOC inventory to 97.7 percent of the SO_2 inventory.

Table 9-1: Emissions from Companies Surveyed as a Percentage of State Total Point Source Emissions

Source	Emissions (tpy)			
	PM_{10}	SO_2	NO_X	VOC
BART Survey	49,638	786,274	467,534	95,442
2002 State Total	66,064	805,133	601,447	154,665

Surveys were sent to 254 companies. The survey was a two step process. Companies were first asked to identify if they have any equipment built or reconstructed during the applicable time period or if the PTE of their site were less than 250 tpy. Companies that did not have BART applicable equipment based on low emissions or construction dates were not asked to supply any further information and were considered not BART-eligible.

If the site did possibly have BART applicable equipment, they were asked to complete a detailed survey of all operating and idle equipment at each site. The detailed survey asked whether each piece of equipment at the site was built or reconstructed between the applicable dates. The companies were asked if the PTE of their BART-eligible equipment exceeded the 250 tpy threshold for the applicable emissions. Any source with a PTE from equipment built during the applicable period was considered BART-eligible.

Based on results from the surveys completed by potentially BART-eligible sources and submitted to the TCEQ in 2005, over 100 sources were identified as BART-eligible. Table 9-2: *BART-Eligible Sources Based on Results of TCEQ Survey* presents the sources that were determined to be BART-eligible.

Table 9-2: BART-Eligible Sources Based on Results of TCEQ Survey

No.	Account	Source	Regulated Entity	SIC
1	AC0017B	ABITIBI CONSOLIDATED CORP	RN100220110	2621
2	TG0044C	AEP TEXAS	RN101531226	4911
3	CD0013K	AEP TEXAS CENTRAL COMPANY	RN102560687	4911
4	NE0024E	AEP TEXAS CENTRAL COMPANY	RN100642040	4911
5	NE0026A	AEP TEXAS CENTRAL COMPANY	RN100552181	4911
6	JI0030K	AEP TEXAS NORTH COMPANY	RN100215557	4911
7	CB0003M	ALCOA ALUMINA & CHEMICALS	RN100242577	2819
8	MM0001T	ALCOA INC	RN100221472	3334
9	HT0011Q	ALON USA LP	RN100250869	2911
10	ED0034O	ASH GROVE (formerly NORTH TEXAS CEMENT)	RN100225978	3241
11	HG0558G	ATOFINA CHEMICALS INC	RN100209444	2869
12	BL0021O	BASF CORPORATION	RN100218049	2869
13	GB0001R	BP AMOCO CHEMICAL COMPANY	RN102536307	2869
14	GB0004L	BP PRODUCTS NORTH AMERICA IN TEXAS	RN102535077	2911
15	GH0003Q	CABOT CORPORATION	RN100221761	2895
16	BG0045E	CAPITOL CEMENT DIV CAPITOL	RN100211507	3241
17	GH0004O	CELANESE CHEMICAL	RN101996395	2869
18	MH0009H	CELANESE LIMITED	RN100258060	2869
19	ED0011D	CHAPARRAL STEEL MIDLOTHIAN	RN100216472	3312
20	BJ0001T	CHEMICAL LIME LTD	RN100219856	3274
21	HG0310V	CHEVRON PHILLIPS CHEMICAL	RN103919817	2869
22	BL0758C	CHEVRON PHILLIPS CHEMICAL	RN100825249	2869
23	HW0013C	CHEVRON PHILLIPS CHEMICAL CO	RN102320850	2869
24	NE0027V	CITGO REFINING & CHEMICALS	RN102555166	2911
25	BG0057U	CITY PUBLIC SERVICE	RN100217975	4911
26	BG0186I	CITY PUBLIC SERVICE	RN100217835	4911
27	HW0018P	CONOCO PHILLIPS (formerly PHILLIPS 66)	RN102495884	2911
28	CR0020C	COPANO PROCESSING LP	RN101271419	1321
29	AB0012W	DCP (formerly DUKE ENERGY FIELD SERVICES)	RN100218684	1321
30	HW0008S	DEGUSSA ENGINEERED CARBONS	RN100209659	2895
31	HGA005E	DOW	RN104150123	2869
32	HG0126Q	DOW	RN100227016	2869

33	CI0022A	DYNEGY MIDSTREAM SERVICES	RN100222900	1321
34	HH0042M	EASTMAN CHEMICAL COMPANY	RN100219815	2869
35	HG0218K	EI DUPONT	RN100225085	2869
36	OC0007J	EI DUPONT DENEMOURS & CO	RN100542711	2869
37	EE0029T	EL PASO ELECTRIC CO	RN100211309	4911
38	TH0004D	ELECTRIC UTILITY DEPT	RN100219872	4911
39	CG0012C	ENBRIDGE PIPELINES	RN102166964	1321
40	MQ0009F	ENTERGY GULF STATES INC	RN100226877	4911
41	OC0013O	ENTERGY GULF STATES INC	RN102513041	4911
42	BL0113I	EQUISTAR	RN100218601	2869
43	BL0268B	EQUISTAR CHEMICALS LP	RN100237668	2821
44	HG0033B	EQUISTAR CHEMICALS LP	RN100542281	2869
45	HG0228H	EXXON CHEMICAL CO	RN102212925	2869
46	JE0065M	EXXON MOBIL CHEMICAL CO	RN100211903	2821
47	HG0229F	EXXONMOBIL CHEMICAL CO	RN102574803	2869
48	HG0232Q	EXXONMOBIL CORP	RN102579307	2911
49	JE0067I	EXXONMOBIL OIL CORP	RN102450756	2911
50	NE0120H	FLINT HILLS RESOURCES	RN102534138	2911
51	NE0122D	FLINT HILLS RESOURCES LP	RN100235266	2911
52	JE0052V	HUNTSMAN CORPORATION	RN100219252	2869
53	JE0135Q	HUNTSMAN PETROCHEMICAL CORP	RN100217389	2869
54	EB0057B	HUNTSMAN POLYMERS	RN101867554	2869
55	BL0002S	INEOS OLEFINS & POLYMERS	RN100238708	2869
56	CG0010G	INTERNATIONAL PAPER CO	RN100543115	2621
57	OCA002B	INVISTA	RN104392626	2869
58	VC0008Q	INVISTA (formerly DU PONT DE NEMOURS)	RN102663671	2869
59	WE0005G	LAREDO POWER	RN100213909	4911
60	MB0123F	LEHIGH CEMENT COMPANY	RN100218254	3241
61	NE0025C	LON C HILL POWER	RN100215979	4911
62	BC0015L	LOWER COLORADO RIVER AUTHORITY	RN102038486	4911
63	FC0018G	LOWER COLORADO RIVER AUTHORITY	RN100226844	4911
64	HG1575W	LYONDELL CHEMICAL	RN100633650	2869
65	HG0048L	LYONDELL CITGO REFINING	RN100218130	2911
66	GB0055R	MARATHON ASHLAND PETROLEUM	RN100210608	2911
67	HH0019H	NORIT AMERICAS INC	RN102609724	2819
68	GB0037T	NRG TEXAS (formerly TEXAS GENCO LP)	RN101062826	4911
69	ED0051O	OWENS CORNING	RN100223585	3296
70	HG1451S	OXYVINYLSLP	RN102518065	2821
71	HG0175D	PASADENA REFINING	RN100716661	2911
72	JE0042B	PREMCOR REFINING GROUP	RN102584026	2911
73	MC0002H	REGENCY TILDEN GAS (formerly ENBRIDGE)	RN100216621	2819
74	HG0697O	RHODIA INC	RN100220581	2819
75	HG0632T	ROHM & HAAS TEXAS	RN100223205	2869
76	HG0659W	SHELL OIL CO	RN100211879	2911
77	HW0017R	SID RICHARDSON CARBON	RN100222413	2895
78	HT0027B	SID RICHARDSON CARBON CO	RN100226026	2895
79	BL0038U	SOLUTIA INC	RN100238682	2869
80	TF0012D	SOUTHWESTERN ELECTRIC POWER	RN100213370	4911
81	GJ0043K	SOUTHWESTERN ELECTRIC POWER	RN102156916	4911
82	ME0006A	SOUTHWESTERN ELECTRIC POWER	RN100542596	4911
83	PG0040T	SOUTHWESTERN PUBLIC SERVICE	RN100224641	4911
84	PG0041R	SOUTHWESTERN PUBLIC SERVICE	RN100224849	4911

85	LN0081B	SOUTHWESTERN PUBLIC SERVICE	RN100224765	4911
86	JE0091L	SUN MARINE TERMINAL	RN100214626	4226
87	WN0042V	TARGA	RN102552387	1311
88	CY0019H	TARGA (formerly DYNEGY MIDSTREAM)	RN102551785	1311
89	OC0019C	TEMPLE-INLAND	RN100214428	2621
90	CI0012D	TEXAS GENCO LP	RN100825371	4911
91	FG0020V	TEXAS GENCO LP	RN100888312	4911
92	HK0014M	TEXAS LEHIGH CEMENT CO	RN102597846	3241
93	HG0562P	TEXAS PETROCHEMICALS LP	RN100219526	2869
94	BL0082R	THE DOW CHEMICAL CO	RN100225945	2869
95	JE0039N	THE GOODYEAR TIRE AND RUBBER CO	RN102561925	2822
96	NE0022I	TICONA POLYMERS INC	RN101625721	2869
97	JE0005H	TOTAL PETROCHEMICALS	RN102457520	2911
98	ED0066B	TXI OPERATIONS LP	RN100217199	3241
99	FI0020W	TXU BIG BROWN COMPANY LP	RN101198059	4911
100	DB0251U	TXU ELECTRIC COMPANY	RN101559854	4911
101	FB0025U	TXU GENERATION COMPANY LP	RN102285855	4911
102	HQ0012T	TXU GENERATION COMPANY LP	RN100664812	4911
103	MB0116C	TXU GENERATION COMPANY LP	RN102566494	4911
104	MM0023J	TXU GENERATION COMPANY LP	RN102147881	4911
105	MO0014L	TXU GENERATION COMPANY LP	RN102285848	4911
106	RL0020K	TXU GENERATION COMPANY LP	RN102583093	4911
107	TA0352I	TXU GENERATION COMPANY LP	RN100693308	4911
108	WC0028Q	TXU GENERATION COMPANY LP	RN102183969	4911
109	YB0017V	TXU GENERATION COMPANY LP	RN102563426	4911
110	TF0013B	TXU GENERATION COMPANY LP	RN102285921	4911
111	GB0076J	UNION CARBIDE CORP	RN100219351	2869
112	CB0028T	UNION CARBIDE CORPORATION	RN102181526	2869
113	HR0018T	VALENCE MIDSTREAM LTD	RN100213685	1321
114	GB0073P	VALERO REFINING CO TEXAS	RN100238385	2911
115	NE0043A	VALERO REFINING COMPANY	RN100211663	2911
116	MR0008T	VALERO MCKEE	RN100210517	2911
117	WH0014S	VETROTEX WICHITA FALLS PLANT	RN100218601	3229
118	VC0003D	VICTORIA POWER	RN100214980	4911
119	JB0016M	VINTAGE PETROLEUM INC	RN100214592	1311
120	JC0003K	WESTVACO	RN102157609	2631

9.2 DETERMINATION OF SOURCES SUBJECT TO BART

Under the EPA's BART guidelines, the state has two options regarding its BART-eligible sources:

- make BART determinations for all sources; or
- consider exempting some sources from BART because they do not cause or contribute to visibility impairment in a Class I area.

The TCEQ chose the second option that considers exempting some sources.

When exempting sources from BART because they do not cause or contribute to visibility impairment in a Class I area, the guidelines suggest three sub-options for determining that certain sources are not subject to BART:

- the use of model plants to exempt sources with common characteristics (70 FR 39162-3);
- a cumulative modeling analysis to show that groups of sources are not subject to BART;
- and finally; an individual source attribution approach.

The TCEQ exercised all three sub-options above to determine which sources were subject to BART. These options are explained further below, in the order in which the TCEQ and the sources performed the analyses.

Section 9.2.1 describes the cumulative modeling analyses that the TCEQ performed for the sources identified as BART-eligible. Since there was such a large number of BART-eligible sources in Texas, the TCEQ performed cumulative modeling analyses using CAMx PSAT technology. Once the TCEQ had completed the CAMx modeling analysis, several BART-eligible sources were determined to be insignificant (screened out) and several remained potentially BART-eligible (did not screen out). Screening out is a process that further examines and evaluates sources for inclusion or exclusion in the BART program. Sources that did not screen out through the cumulative modeling analysis were required to perform source-specific screening modeling analyses using either the CALPUFF or the CAMx model setup developed by the TCEQ. These source-specific modeling analyses are described in Section 9.2.2. BART-eligible sources that did not screen out in any of the modeling analyses had the option of reducing the emissions from their BART-eligible units using an enforceable mechanism, such as a permit, or performing an engineering analysis. The BART-eligible sources that chose to reduce potential emissions are discussed in Section 9.3. The emission reductions are presented in Section 9.5.

9.2.1 Cumulative Modeling Using CAMx PSAT

The TCEQ conducted screening modeling analyses as described in the CAMx modeling protocol, *Screening Analysis of Potentially BART-Eligible Sources in Texas,* and the final CAMx modeling report, *Final Report, Screening Analysis of Potential BART-Eligible Sources in Texas,* presented in Appendixes 9-3 and 9-4, respectively. In addition to the CAMx modeling, the TCEQ developed Texas model plants based on the CAMx modeling results. The model plants are discussed in the addendums to the CAMx modeling report, Addendum I, *BART Exemption Screening Analysis,* and Addendum II, *BART Exemption Screening Analysis.* Both addendums are contained in Appendix 9-5. Sources that successfully screened out in the CAMx screening modeling analyses or by using the Texas model plants were required to review the modeling analysis and data used and to certify that they agree with the screening modeling analyses and inputs. Copies of these certifications are contained in Appendix 9-6. Table 9-3 shows the BART-eligible sources that successfully screened out in the cumulative modeling analyses. BART-eligible sources that did not screen out of the cumulative modeling were required to conduct their own screening modeling analysis using either the CALPUFF or the CAMx modeling setup developed by the TCEQ. The single source modeling analyses are outlined in Section 9.2.2.

Table 9-3: BART-Eligible Sources Screened Out Using Cumulative CAMx Modeling

No.	Account	Source	Regulated Entity	SIC
1	TG0044C	AEP TEXAS	RN101531226	4911
2	CD0013K	AEP TEXAS CENTRAL COMPANY	RN102560687	4911
3	NE0024E	AEP TEXAS CENTRAL COMPANY	RN100642040	4911
4	NE0026A	AEP TEXAS CENTRAL COMPANY	RN100552181	4911
5	JI0030K	AEP TEXAS NORTH COMPANY	RN100215557	4911
6	CB0003M	ALCOA ALUMINA & CHEMICALS	RN100242577	2819
7	HG0558G	ATOFINA CHEMICALS INC	RN100209444	2869
8	BL0021O	BASF CORPORATION	RN100218049	2869
9	GB0001R	BP AMOCO CHEMICAL COMPANY	RN102536307	2869
10	MH0009H	CELANESE LIMITED	RN100258060	2869
11	ED0011D	CHAPARRAL STEEL MIDLOTHIAN	RN100216472	3312
12	BJ0001T	CHEMICAL LIME LTD	RN100219856	3274
13	BL0758C	CHEVRON PHILLIPS CHEMICAL	RN100825249	2869
14	HG0310V	CHEVRON PHILLIPS CHEMICAL	RN103919817	2869
15	HW0013C	CHEVRON PHILLIPS CHEMICAL	RN102320850	2869
16	BG0057U	CITY PUBLIC SERVICE	RN100217975	4911
17	BG0186I	CITY PUBLIC SERVICE	RN100217835	4911
18	CR0020C	COPANO PROCESSING LP	RN101271419	1321
19	CI0022A	DYNEGY MIDSTREAM SERVICES	RN100222900	1321
20	HG0218K	EI DUPONT	RN100225085	2869
21	EE0029T	EL PASO ELECTRIC CO	RN100211309	4911
22	TH0004D	ELECTRIC UTILITY DEPT	RN100219872	4911
23	MQ0009F	ENTERGY GULF STATES INC	RN100226877	4911
24	OC0013O	ENTERGY GULF STATES INC	RN102513041	4911
25	BL0113I	EQUISTAR	RN100218601	2869
26	BL0268B	EQUISTAR CHEMICALS LP	RN100237668	2821
27	HG0228H	EXXON CHEMICAL CO	RN102212925	2869
28	JE0065M	EXXON MOBIL CHEMICAL CO	RN100211903	2821
29	HG0229F	EXXONMOBIL CHEMICAL CO	RN102574803	2869
30	NE0120H	Flint Hills Resources	RN102534138	2911
31	NE0122D	FLINT HILLS RESOURCES LP	RN100235266	2911
32	JE0052V	HUNTSMAN CORPORATION	RN100219252	2869
33	JE0135Q	HUNTSMAN PETROCHEMICAL	RN100217389	2869
34	BL0002S	Ineos Olefins & Polymers	RN100238708	2869
35	WE0005G	LAREDO POWER	RN100213909	4911
36	MB0123F	LEHIGH CEMENT COMPANY	RN100218254	3241
37	NE0025C	LON C HILL POWER	RN100215979	4911
38	BC0015L	Lower Colorado River Authority	RN102038486	4911
39	FC0018G	Lower Colorado River Authority	RN100226844	4911

No.	Account	Source	Regulated Entity	SIC
40	HG1575W	Lyondell Chemical	RN100633650	2869
41	HG1451S	OXYVINYLSLP	RN102518065	2821
42	JE0042B	PREMCOR REFINING GROUP	RN102584026	2911
43	HG0632T	ROHM & HAAS TEXAS	RN100223205	2869
44	BL0038U	SOLUTIA INC	RN100238682	2869
45	GJ0043K	SOUTHWESTERN ELECTRIC POWER	RN102156916	4911
46	LN0081B	SOUTHWESTERN PUBLIC SERVICE (FORMERLY XCEL)	RN100224765	4911
47	ME0006A	SOUTHWESTERN ELECTRIC POWER	RN100542596	4911
48	PG0040T	SOUTHWESTERN PUBLIC SERVICE	RN100224641	4911
49	PG0041R	SOUTHWESTERN PUBLIC SERVICE	RN100224849	4911
50	JE0091L	SUN MARINE TERMINAL	RN100214626	4226
51	WN0042V	TARGA	RN102552387	1311
52	CI0012D	TEXAS GENCO LP	RN100825371	4911
53	FG0020V	TEXAS GENCO LP	RN100888312	4911
54	HG0562P	TEXAS PETROCHEMICALS LP	RN100219526	2869
55	BL0082R	THE DOW CHEMICAL CO	RN100225945	2869
56	NE0022I	TICONA POLYMERS INC	RN101625721	2869
57	FI0020W	TXU BIG BROWN COMPANY LP	RN101198059	4911
58	DB0251U	TXU ELECTRIC COMPANY	RN101559854	4911
59	FB0025U	TXU GENERATION COMPANY LP	RN102285855	4911
60	HQ0012T	TXU GENERATION COMPANY LP	RN100664812	4911
61	MB0116C	TXU GENERATION COMPANY LP	RN102566494	4911
62	MM0023J	TXU GENERATION COMPANY LP	RN102147881	4911
63	MO0014L	TXU GENERATION COMPANY LP	RN102285848	4911
64	RL0020K	TXU GENERATION COMPANY LP	RN102583093	4911
65	TA0352I	TXU GENERATION COMPANY LP	RN100693308	4911
66	WC0028Q	TXU GENERATION COMPANY LP	RN102183969	4911
67	YB0017V	TXU GENERATION COMPANY LP	RN102563426	4911
68	GB0076J	UNION CARBIDE CORP	RN100219351	2869
69	CB0028T	UNION CARBIDE CORPORATION	RN102181526	2869
70	GB0073P	VALERO REFINING CO TEXAS	RN100238385	2911
71	VC0003D	VICTORIA POWER	RN100214980	4911
72	JB0016M	VINTAGE PETROLEUM INC	RN100214592	1311

Distances from the BART-eligible sources to Class I areas were determined and are shown in Table 9-4 that follows.

Table 9-4: BART-Eligible Source Distance to Each Class I

Regulated Entity	Company	Distance to Class I (km)									
		Big Bend	Breton Isle	Caney Creek	Carls-bad Caverns	Guada-lupe Mtns	Salt Creek	Upper Buffalo	Wheeler Peak	White Mtn	Wichita Mtns
RN100220110	ABITIBI CONSOLIDATED CORP	851	580	343	937	968	946	514	1148	1070	533
RN102560687	AEP TEXAS CENTRAL CO	652	957	979	945	953	1054	1152	1374	1132	962
RN100642040	AEP TEXAS CENTRAL CO	608	862	815	860	874	951	988	1255	1041	805
RN100552181	AEP TEXAS CENTRAL CO	590	865	797	838	852	926	970	1229	1018	780
RN100215557	AEP TEXAS NORTH CO	497	1071	556	460	495	455	681	688	579	257
RN101531226	AEP TEXAS NORTH CO	351	1125	684	393	420	442	821	733	549	408
RN100221472	ALCOA INC	609	792	510	731	758	769	679	1022	884	490
RN100242577	ALCOA WORLD ALUMINA LLC	652	759	680	859	878	927	854	1209	1030	708
RN100250869	ALON USA LP	373	1223	720	295	329	316	837	604	431	372
RN100225978	ASH GROVE TEXASLP	693	827	342	710	744	700	496	893	827	294
RN100209444	ATTOFINA CHEMICALS INC	780	609	526	932	957	972	698	1217	1086	647
RN100219872	AUSTIN ENERGY	553	843	563	690	715	738	731	1005	849	505
RN100218049	BASF CORPORATION	760	641	613	942	965	996	785	1258	1105	711
RN102536307	BP AMOCO CHEMICAL CO	804	590	566	969	993	1014	736	1264	1127	697
RN102535077	BP PRODUCTS NORTH AMERICA	805	562	564	970	994	1014	735	1264	1127	696
RN100221761	CABOT CORPORATION	721	1296	642	497	535	377	686	414	494	225
RN100211507	CAPITOL CEMENT DIV	466	924	677	652	672	724	843	1017	824	579
RN101996395	CELANESE CHEMICAL	717	1297	645	492	531	373	689	413	489	226
RN100258060	CELANESE LTD	702	703	642	894	915	955	816	1227	1061	703
RN100216472	CHAPARRAL STEEL	687	828	348	707	741	699	503	894	825	299
RN100219856	CHEMICAL LIME LTD	603	858	443	658	689	672	601	901	793	354
RN103919817	CHEVRON PHILLIPS CHEMICAL	805	584	515	953	979	990	686	1231	1106	654
RN102320850	CHEVRON PHILLIPS CHEMICAL	733	1332	676	494	531	365	715	379	477	261
RN100825249	CHEVRON PHILLIPS CHEMICAL	726	673	612	908	930	964	785	1229	1072	690
RN102555166	CITGO REFINING & CHEMICALS	557	866	798	837	852	926	971	1229	1018	781
RN100217975	CITY PUBLIC SERVICE	475	917	693	673	692	748	861	1044	847	606
RN100217835	CITY PUBLIC SERVICE	470	923	701	671	689	748	868	1045	845	611
RN102495884	CONOCO PHILLIPS	732	1333	677	492	530	363	716	378	475	262
RN101271419	COPANO PROCESSING LP	640	751	598	813	835	868	771	1138	977	619
RN100218684	DCP MIDSTREAM LP	350	1355	837	167	204	198	943	519	303	457

Regulated Entity	Company	Distance to Class I (km)									
		Big Bend	Breton Isle	Caney Creek	Carls-bad Caverns	Guada -lupe Mtns	Salt Creek	Upper Buffalo	Wheeler Peak	White Mtn	Wichita Mtns
RN100209659	DEGUSSA ENG CARBONS	728	1337	683	486	524	357	722	373	469	266
RN100227016	DOW CHEMICAL CO	791	600	539	947	972	988	710	1235	1102	665
RN104150123	DOW CHEMICAL CO	796	598	536	951	975	987	717	1238	1113	668
RN100222900	DYNEGY MIDSTREAM SERVICES	807	583	513	954	980	991	684	1231	1107	653
RN100219815	EASTMAN CHEMICAL COMPANY	886	623	224	927	960	915	397	1084	1042	452
RN100225085	EI DUPONT DE NEMOURS & CO	794	596	530	947	972	987	701	1232	1102	660
RN100542711	EI DUPONT DE NEMOURS & CO	918	472	484	1053	1080	1080	646	1303	1199	699
RN100211309	EL PASO ELECTRIC CO	428	1689	1178	178	146	260	1273	518	175	778
RN102166964	ENBRIDGE PIPELINES LP	940	647	135	952	987	924	308	1067	1053	428
RN100226877	ENTERGY GULF STATES INC	753	643	461	878	906	908	634	1143	1026	565
RN102513041	ENTERGY GULF STATES INC	907	484	487	1043	1070	1071	650	1295	1190	695
RN100210574	EQUISTAR	777	619	582	948	971	996	753	1252	1108	694
RN100237668	EQUISTAR CHEMICALS LP	777	618	582	948	972	997	754	1252	1108	695
RN100542281	EQUISTAR CHEMICALS LP	787	603	517	935	961	973	688	1216	1088	643
RN100211903	EXXON MOBIL CHEMICALS	889	501	482	1024	1051	1053	647	1279	1171	680
RN102212925	EXXONMOBIL CHEMICAL CO	796	594	524	947	972	986	695	1229	1101	655
RN102574803	EXXONMOBIL CHEMICAL CO	795	594	525	947	972	986	696	1229	1101	656
RN102579307	EXXONMOBIL CORP	796	598	526	944	970	982	697	1236	1112	658
RN102450756	EXXONMOBIL OIL CORP	888	502	482	1023	1050	1052	647	1278	1170	679
RN102534138	FLINT HILLS RESOURCES LP	590	865	798	838	852	927	971	1230	1018	781
RN100235266	FLINT HILLS RESOURCES LP	580	874	800	829	843	918	972	1222	1009	777
RN100219252	HUNTSMAN CORP	899	491	492	1037	1064	1067	656	1293	1185	694
RN100217389	HUNTSMAN CORP	897	493	501	1038	1065	1069	666	1297	1187	700
RN101867554	HUNTSMAN POLYMERS CORP	293	1303	819	212	241	277	936	600	373	467
RN100238708	INEOS USA LLC	779	617	584	951	974	1000	756	1255	1111	698
RN100543115	INTERNATIONAL PAPER CO	974	619	128	988	1023	960	296	1099	1089	460
RN104392626	INVISTA	918	472	484	1053	1080	1080	646	1303	1199	700
RN102663671	INVISTA S.A.R.L.	614	797	693	824	842	896	866	1182	996	696
RN100213909	LAREDO WLE LP	411	1069	918	703	710	818	1086	1145	890	802
RN100218254	LEHIGH CEMENT COMPANY	623	820	438	694	725	712	601	942	832	388
RN100215979	LON C HILL LP	571	882	802	820	834	911	974	1216	1001	774

Regulated Entity	Company	Distance to Class I (km)									
		Big Bend	Breton Isle	Caney Creek	Carls-bad Caverns	Guada -lupe Mtns	Salt Creek	Upper Buffalo	Wheeler Peak	White Mtn	Wichita Mtns
RN102038486	LCRA	583	810	559	727	752	775	729	1040	886	529
RN100226844	LCRA	630	760	558	783	807	831	730	1094	942	568
RN100633650	LYONDELL CHEMICAL CO	787	603	518	936	962	975	690	1218	1090	645
RN100218130	LYONDELL CITGO REFINING	775	615	529	928	953	969	703	1216	1083	648
RN100210608	MARATHON PETROLEUM	806	587	564	971	995	1015	734	1265	1128	697
RN102609724	NORIT AMERICAS INC	915	603	209	954	988	940	381	1104	1067	470
RN101062826	NRG TEXAS LP	799	593	552	960	984	1003	723	1251	1117	682
RN100223585	OWENS-CORNING	701	811	336	724	758	717	494	910	843	310
RN102518065	OXY VINYLS LP	789	601	528	941	966	981	699	1226	1096	654
RN100716661	PASADENA REFINING SYSTEM	777	613	528	930	955	971	703	1217	1085	649
RN102584026	PREMCOR REFINING GROUP	897	493	505	1039	1066	1070	669	1299	1188	703
RN100216621	REGENCY FS (FIELD SERVICES)	468	953	788	711	725	804	957	1113	892	705
RN100223205	RHODIA, INC.	797	593	524	948	973	987	695	1230	1102	657
RN100223205	ROHM & HAAS TEXAS	788	602	528	940	965	980	699	1225	1095	654
RN100211879	SHELL OIL CO	785	604	530	938	964	979	701	1224	1093	654
RN100222413	SID RICHARDSON CARBON	727	1337	683	486	524	357	722	373	468	266
RN100226026	SID RICHARDSON CARBON	218	1407	945	142	153	275	1063	618	329	590
RN100238682	SOLUTIA INC	777	618	582	948	972	997	754	1252	1108	695
RN102156916	SOUTHWESTERN ELEC POWER	888	616	231	932	965	921	403	1092	1048	461
RN100542596	SOUTHWESTERN ELEC POWER	915	632	178	941	975	921	351	1077	1049	440
RN100213370	SOUTHWESTERN ELEC POWER	900	668	165	914	949	890	338	1041	1019	404
RN100224641	SOUTHWESTERN PUBLIC SERV	679	1346	705	435	473	308	754	362	423	281
RN100224849	SOUTHWESTERN PUBLIC SERV	681	1347	705	436	474	309	754	361	424	282
RN100224765	SOUTHWESTERN PUBLIC SERV	490	1282	712	304	344	248	803	477	377	309
RN100214626	SUN MARINE TERMINAL	896	494	505	1038	1065	1070	670	1299	1188	703
RN102551785	TARGA MIDSTREAM SERVICES	251	1327	859	196	219	288	979	621	370	513
RN102552387	TARGA MIDSTREAM SERVICES	684	925	361	647	684	617	488	786	745	182
RN100214428	TEMPLE-INLAND	921	471	466	1050	1077	1074	628	1293	1194	687
RN100888312	TEXAS GENCO	736	656	565	901	925	949	738	1205	1060	653
RN100825371	TEXAS GENCO	804	585	523	955	980	993	694	1236	1109	660
RN102597846	TEXAS LEHIGH CEMENT CO	525	867	599	678	701	734	767	1009	841	528

Regulated Entity	Company	Distance to Class I (km)									
		Big Bend	Breton Isle	Caney Creek	Carls-bad Caverns	Guada -lupe Mtns	Salt Creek	Upper Buffalo	Wheeler Peak	White Mtn	Wichita Mtns
RN100219526	TEXAS PETROCHEMICALS LP	772	617	534	927	952	968	706	1216	1083	649
RN102561925	THE GOODYEAR TIRE & RUBBER	874	516	492	1013	1040	1044	659	1273	1161	679
RN101625721	TICONA POLYMERS INC	562	911	839	824	836	920	1011	1230	1006	803
RN102457520	TOTAL PETROCHEMICALS USA	904	485	493	1043	1070	1072	657	1298	1190	698
RN100217199	TXI OPERATIONS LP	688	827	347	708	742	700	503	895	826	299
RN101198059	TXU BIG BROWN CO LP	741	719	340	802	833	806	511	1010	930	409
RN101559854	TXU GENERATION COMPANY	720	841	312	716	751	695	459	871	823	257
RN102285855	TXU GENERATION COMPANY	809	822	227	781	818	745	366	887	874	250
RN100664812	TXU GENERATION COMPANY	630	886	402	645	678	640	550	846	765	277
RN102566494	TXU GENERATION COMPANY	651	797	413	719	750	733	578	957	854	389
RN102147881	TXU GENERATION COMPANY	610	791	509	732	758	770	679	1022	884	490
RN102285848	TXU GENERATION COMPANY	403	1178	674	343	376	355	793	627	473	336
RN102583093	TXU GENERATION COMPANY	889	604	242	939	972	930	414	1104	1057	474
RN100693308	TXU GENERATION COMPANY	680	865	352	680	715	665	498	852	792	256
RN102285921	TXU GENERATION COMPANY	885	685	170	897	932	872	342	1024	1001	387
RN102183969	TXU GENERATION COMPANY	255	1360	884	162	186	261	1001	599	339	528
RN102563426	TXU GENERATION COMPANY	612	991	441	567	603	541	563	730	669	180
RN102181526	UNION CARBIDE CORP	634	783	702	848	867	921	876	1208	1021	718
RN100219351	UNION CARBIDE CORP	802	591	565	967	991	1012	735	1262	1125	695
RN100213685	VALENCE MIDSTREAM	842	717	204	853	888	831	372	990	959	356
RN100210517	VALERO MCKEE	751	1387	728	490	527	350	760	326	453	316
RN100238385	VALERO REFINING CO TEXAS	806	588	565	971	995	1015	735	1265	1128	697
RN100211663	VALERO REFINING CO TEXAS	559	867	798	836	851	925	971	1229	1017	780
RN100218601	VETROTEX AMERICA	671	1019	419	587	625	539	521	690	668	99
RN100214980	VICTORIA WLE LP	607	799	682	813	832	883	855	1169	985	682
RN100214592	VINTAGE PETROLEUM LLC	646	761	669	847	867	914	842	1195	1017	693
RN102157609	WESTVACO	891	503	451	1016	1044	1040	617	1260	1160	656

9.2.2 Individual Source Attribution Approach

One of the air quality modeling approaches suggested by the EPA in the BART guidance is an individual source attribution approach. Specifically, this entails modeling source-specific BART-eligible units and comparing modeled impacts to a particular deciview threshold.

CALPUFF

The CALPUFF modeling protocol, *Best Available Retrofit Technology (BART) Modeling Protocol to Determine Sources Subject to BART in the State of Texas*, developed by the TCEQ for determining which sources are subject to BART is included in Appendix 9-7: *CALPUFF Modeling Guidelines*. Appendix 9-7 also contains a summary report for each modeling demonstration. Table 9-5: *BART-Eligible Sources Exempt Based on CALPUFF Modeling Results* lists the BART-eligible sources that are exempt from BART based on CALPUFF modeling results.

Table 9-5: BART-Eligible Sources Exempt Based on CALPUFF Modeling Results

Regulated Entity	Account	Source	SIC
RN100221472	MM0001T	ALCOA INC	3334
RN100250869	HT0011Q	ALON USA LP	2911
RN100225978	ED0034O	ASH GROVE (formerly NORTH TEXAS CEMENT)	3241
RN100221761	GH0003Q	CABOT CORPORATION	2895
RN101996395	GH0004O	CELANESE CHEMICAL	2869
RN102495884	HW0018P	CONOCO PHILLIPS (formerly PHILLIPS 66 CO)	2911
RN100218684	AB0012W	DCP (formerly DUKE ENERGY FIELD SERVICES)	1321
RN100209659	HW0008S	DEGUSSA ENGINEERED CARBONS	2869
RN100219815	HH0042M	EASTMAN CHEMICAL COMPANY	2869
RN100542281	HG0033B	EQUISTAR CHEMICALS LP	2869
RN102579307	HG0232Q	EXXONMOBIL CORP	2911
RN102450756	JE0067I	EXXONMOBIL OIL CORP	2911
RN101867554	EB0057B	HUNTSMAN POLYMERS	2869
RN100543115	CG0010G	INTERNATIONAL PAPER CO	2621
RN104392626	OCA002B	INVISTA	2869
RN102663671	VC0008Q	INVISTA (formerly DU PONT DE NEMOURS)	2869
RN101062826	GB0037T	NRG TEXAS (formerly TEXAS GENCO LP)	4911
RN100223585	ED0051O	OWENS CORNING	3296
RN100220581	HG0697O	RHODIA INC	2819
RN100211879	HG0659W	SHELL OIL CO	2911
RN100222413	HW0017R	SID RICHARDSON CARBON	2895
RN100226026	HT0027B	SID RICHARDSON CARBON CO	2895
RN100213370	TF0012D	SOUTHWESTERN ELECTRIC POWER	4911
RN100214428	OC0019C	TEMPLE-INLAND	2621
RN102597846	HK0014M	TEXAS LEHIGH CEMENT CO	3241
RN102457520	JE0005H	TOTAL PETROCHEMICALS INC (formerly ATOFINA PETROCHEMICALS INC)	2911
RN100217199	ED0066B	TXI OPERATIONS LP	3241
RN102285921	TF0013B	TXU GENERATION COMPANY LP	4911
RN102157609	JC0003K	WESTVACO	2631

CAMx

The CAMx modeling guideline, *Guidance for the Application of the CAMx Hybrid Photochemical Grid Model to Assess Visibility Impacts of Texas BART Sources at Class I Areas*, developed by the TCEQ is in Appendix 9-8. This appendix also contains the modeling summary reports for each modeling demonstration. Table 9-6 presents the BART-eligible sources that screened out on an individual basis using CAMx.

Table 9-6: BART-Eligible Sources Screened Out on Individual Basis Using CAMx

Reference Number	Reference Number	Nearest Class I Area	Distance to Nearest Class I area (km)	Emission Rate Data Source	Highest Impact (dv)	Class I Area with Highest Impact
RN102535077	BP Products North American	BRET	562	Permit Allowables	0.28	CACR
RN102555166	CITGO Corpus Christi Refinery	BIBE	557	Permit Allowables	0.16	BIBE
RN104150123	Dow Chemical Company	CACR	536	Permit Allowables	0.21	BRET
RN100218130	Houston Refining LP	CACR	529	PTE, Permit Allowables	0.10	UPBU/ CACR
RN100716661	Pasadena Refining System Inc.	CACR	528	Permit Allowables	0.42	CACR
RN100211663	Valero Corpus Christi East Plant	BIBE	554	Facility Wide Emission Cap	0.11	BIBE/ CACR

9.3 SITES REMOVED FROM FURTHER BART CONSIDERATION

The TCEQ BART rule was published January 10, 2007. Companies requested removal from further BART consideration per the exemptions in the rule or based on updated information on the site. To be removed from the list, a site had to be exempted for all potential haze causing pollutants, NO_X, SO_2, and fine particulate matter. A site may be exempted if the combined NO_X and SO_2 potential to emit are less than 1,000 tpy, and the site is greater than 100 km from a Class I area. Some sites may be exempted if the combined NO_X and SO_2 potential to emit are less than 500 tpy, and the site is greater than 50 km from a Class I area. Several sites requested exemption for combined SO_X and NO_X limits and certified that the TCEQ-sponsored modeling adequately represented particulate emissions. One site requested $PM_{2.5}$ exemption due to de minimis levels of emissions.

Updated site information included construction dates and potential emission rates of equipment. Two sites requested removal because the operating equipment did not meet a BART category. The results of granted exclusions are also shown in Table 9.7: *Sites Removed From BART Due to Exemption Requests*.

Table 9-7: Sites Removed From BART Due to Exemption Requests

No.	Regulated Entity	Company	Reason	Account	SIC
1	RN100220110	ABITIBI CONSOLIDATED CORP	PTE*<1,000, de minimis PM	AC0017B	2621
2	RN102559291	BMC HOLDINGS INC	PTE<1,000, PM certification	JE0343H	2869
3	RN100211507	CAPITOL CEMENT	Shut down kiln	BG0045E	3241
4	RN100227016	CELANESE	PTE<250	HG0126Q	2869
5	RN100825249	CHEVRON PHILLIPS CHEMICAL	met TCEQ model plant	BL0758C	2869
6	RN100542711	EI DUPONT DENEMOURS & CO	PTE<1,000, PM certification	OC0007J	2869
7	RN102166964	ENBRIDGE PIPELINES	PTE<250	CG0012C	1321
8	RN104579487	INEOS USA	PTE<250	GBA007G	2869
9	RN100212018	J.L. DAVIS GAS PROCESSING	No BART sources	CA0011B	1321
10	RN100213719	JOHNS MANVILLE INTERNATIONAL	PTE<250	JH0025O	3296
11	RN100633650	LYONDELL PETROCHEMICAL	PTE<1,000, PM certification	HG1575W	2869
12	RN100210608	MARATHON ASHLAND PETROLEUM	PTE<250	GB0055R	2911
13	RN102609724	NORIT AMERICAS INC	PTE<1,000, PM certification	HH0019H	2819
14	RN102643327	PUEBLO MIDSTREAM GAS CORP	recheck dates, not BART	AG0024G	1321
15	RN100211408	REGENCY GAS SERVICES	No BART equip	PE0024Q	1321
16	RN100216621	REGENCY TILDEN GAS	PTE<1,000, PM certification	MC0002H	2819
17	RN102551785	TARGA	Shut down	CY0019H	1311
18	RN102561925	THE GOODYEAR TIRE AND RUBBER CO	PTE<250	JE0039N	2822
19	RN100213685	VALENCE MIDSTREAM LTD	plant shut down	HR0018T	1321
20	RN100210517	VALERO MCKEE REFINERY	PTE<1,000, PM certification	MR0008T	2911
21	RN100219310	VALERO REFINING TEXAS LP	PTE<1,000, PM certification	HG0130C	2911
22	RN100218601	VETROTEX AMERICA ST. GOBAIN	PTE<500, PM certification	WH0014S	3229

Note: *PTE is potential to emit

9.4 DETERMINATION OF BART FOR SOURCES SUBJECT TO BART

Upon conclusion of all BART screening analyses and review of exclusion requests, no Texas sources remained subject to BART. Some EGUs may become subject to BART pending resolution of CAIR at the federal level. Table 9-8: *Summary of BART-Eligible Source Determination* summarizes where a determination was made for all sources in the BART determination process. Several sources were added to the process after the BART survey, either at the site's request or as a result of recent activity at the site. Their status is reflected in this table. Site activity included transfer of equipment or corporate reorganization resulting in site splits. Although not used thus far for any sources, the TCEQ's Engineering Analysis Guidance and forms are in Appendix 9-9.

Table 9-8: Summary of BART-Eligible Source Determinations

Account	Company	BART-eligible[1]	Reason for Removal			
			Cum. Model CAMx	CAL-PUFF	Single Source CAMx	Exemp-tion Request
TG0044C	AEP TEXAS	y	y			
CD0013K	AEP TEXAS CENTRAL COMPANY	y	y			
NE0024E	AEP TEXAS CENTRAL COMPANY	y	y			
NE0026A	AEP TEXAS CENTRAL COMPANY	y	y			
JI0030K	AEP TEXAS NORTH COMPANY	y	y			
CB0003M	ALCOA ALUMINA & CHEMICALS	y	y			
BL0002S	INEOS OLEFINS & POLYMERS	y	y			
HG0558G	ATOFINA CHEMICALS INC	y	y			
BL0021O	BASF CORPORATION	y	y			
GB0001R	BP AMOCO CHEMICAL COMPANY	y	y			
MH0009H	CELANESE LIMITED	y	y			
ED0011D	CHAPARRAL STEEL MIDLOTHIAN	y	y			
BJ0001T	CHEMICAL LIME LTD	y	y			
HG0310V	CHEVRON PHILLIPS CHEMICAL	y	y			
HW0013C	CHEVRON PHILLIPS CHEMICAL CO	y	y			
BG0057U	CITY PUBLIC SERVICE	y	y			
BG0186I	CITY PUBLIC SERVICE	y	y			
CR0020C	COPANO PROCESSING LP	y	y			
CI0022A	DYNEGY MIDSTREAM SERVICES	y	y			
WN0042V	TARGA	y	y			
HG0218K	EI DUPONT	y	y			
EE0029T	EL PASO ELECTRIC CO	y	y			
TH0004D	ELECTRIC UTILITY DEPT	y	y			
MQ0009F	ENTERGY GULF STATES INC	y	y			
OC0013O	ENTERGY GULF STATES INC	y	y			
BL0113I	EQUISTAR	y	y			
BL0268B	EQUISTAR CHEMICALS LP	y	y			
HG0033B	EQUISTAR CHEMICALS LP	y			y	
HG0228H	EXXON CHEMICAL CO	y	y			
JE0065M	EXXON MOBIL CHEMICAL CO	y	y			
HG0229F	EXXONMOBIL CHEMICAL CO	y	y			
NE0122D	FLINT HILLS RESOURCES LP	y	y			
JE0052V	HUNTSMAN CORPORATION	y	y			
JE0135Q	HUNTSMAN PETROCHEMICAL	y	y			

Account	Company	BART-eligible[1]	Reason for Removal			
			Cum. Model CAMx	CAL-PUFF	Single Source CAMx	Exemp-tion Request
	CORP					
EB0057B	HUNTSMAN POLYMERS	y		y		
GBA007G	INEOS					y
NE0120H	FLINT HILLS RESOURCES LP	y	y			
WE0005G	LAREDO POWER	y	y			
MB0123F	LEHIGH CEMENT COMPANY	y	y			
NE0025C	LON C HILL POWER	y	y			
BC0015L	LOWER COLORADO RIVER AUTHORITY	y	y			
FC0018G	LOWER COLORADO RIVER AUTHORITY	y	y			
HG1575W	LYONDELL CITGO REFINING	y	y			y
HG1451S	OXYVINYLSLP	y	y			
JE0042B	PREMCOR REFINING GROUP	y	y			
HG0632T	ROHM & HAAS TEXAS	y	y			
BL0038U	SOLUTIA INC	y	y			
GJ0043K	SOUTHWESTERN ELECTRIC POWER	y	y			
ME0006A	SOUTHWESTERN ELECTRIC POWER	y	y			
PG0040T	SOUTHWESTERN PUBLIC SERVICE	y	y			
PG0041R	SOUTHWESTERN PUBLIC SERVICE	y	y			
JE0091L	SUN MARINE TERMINAL	y	y			
CI0012D	TEXAS GENCO LP	y	y			
FG0020V	TEXAS GENCO LP	y	y			
GB0037T	NRG Texas	y		y		
HG0562P	TEXAS PETROCHEMICALS LP	y	y			
BL0082R	THE DOW CHEMICAL CO	y	y			
NE0022I	TICONA POLYMERS INC	y	y			
ED0066B	TXI OPERATIONS, L.P.	y		y		
FI0020W	TXU BIG BROWN COMPANY LP	y	y			
DB0251U	TXU ELECTRIC COMPANY	y	y			
FB0025U	TXU GENERATION COMPANY LP	y	y			
HQ0012T	TXU GENERATION COMPANY LP	y	y			
MB0116C	TXU GENERATION COMPANY LP	y	y			
MM0023J	TXU GENERATION COMPANY LP	y	y			
MO0014L	TXU GENERATION COMPANY LP	y	y			
RL0020K	TXU GENERATION COMPANY LP	y	y			
TA0352I	TXU GENERATION COMPANY LP	y	y			
WC0028Q	TXU GENERATION COMPANY LP	y	y			
YB0017V	TXU GENERATION COMPANY LP	y	y			
GB0076J	UNION CARBIDE CORP	y	y			
CB0028T	UNION CARBIDE CORPORATION	y	y			
GB0073P	VALERO REFINING CO TEXAS	y	y			
VC0003D	VICTORIA POWER	y	y			
JB0016M	VINTAGE PETROLEUM, INC.	y	y			
LN0081B	SOUTHWESTERN PUBLIC SERVICE	y	y			
AC0017B	ABITIBI CONSOLIDATED CORP	y				y

Account	Company	BART-eligible[1]	Reason for Removal			
			Cum. Model CAMx	CAL-PUFF	Single Source CAMx	Exemp-tion Request
TF0012D	SOUTHWESTERN ELECTRIC POWER	y		y		
MM0001T	ALCOA INC	y		y		
HT0011Q	ALON USA LP	y		y		
ED0034O	ASH GROVE	y		y		
JE0343H	BMC HOLDINGS INC					y
GB0004L	BP PRODUCTS NORTH AMERICA IN TEXAS	y			y	
GH0003Q	CABOT CORPORATION	y		y		
BG0045E	CAPITOL CEMENT DIV CAPITOL	y				y
GH0004O	CELANESE CHEMICAL	y			y	
BL0758C	CHEVRON PHILLIPS CHEMICAL	y				y
NE0027V	CITGO REFINING & CHEMICALS	y			y	
HW0018P	CONOCOPHILLIPS	y		y		
AB0012W	DCP	y		y		
HW0008S	DEGUSSA ENGINEERED CARBONS	y		y		
MR0008T	DIAMOND SHAMROCK REFINING	y				y
HGA005E	DOW	y			y	
HG0126Q	DOW	y				y
HH0042M	EASTMAN CHEMICAL COMPANY	y		y		
OC0007J	EI DUPONT DENEMOURS & CO	y				y
MC0002H	ENBRIDGE PIPELINE					y
CG0012C	ENBRIDGE PIPELINES	y				y
HG0033B	EQUISTAR CHEMICALS LP			y		
HG0232Q	EXXONMOBIL CORP - Baytown	y		y		
JE0067I	EXXONMOBIL OIL CORP - Beaumont	y		y		
EB0057B	HUNTSMAN POLYMERS			y		
CG0010G	INTERNATIONAL PAPER CO	y		y		
OCA002B	INVISTA	y		y		
VC0008Q	INVISTA	y		y		
JH0025O	JOHNS MANVILLE INTERNATIONAL					y
HG0048L	LYONDELL CITGO REFINING	y			y	
GB0055R	MARATHON ASHLAND PETROLEUM	y				y
HH0019H	NORIT AMERICAS INC	y				y
GB0037T	NRG Texas			y		
ED0051O	OWENS CORNING	y		y		
HG0175D	PASADENA REFINING	y		y		
AG0024G	PUEBLO MIDSTREAM GAS CORP					y
PE0024Q	REGENCY GAS SERVICES					y
HG0697O	RHODIA, INC.	y		y		
HG0659W	SHELL OIL CO	y		y		
HW0017R	SID RICHARDSON CARBON	y		y		
HT0027B	SID RICHARDSON CARBON	y		y		
CY0019H	TARGA	y				y
OC0019C	TEMPLE-INLAND	y		y		
HK0014M	TEXAS LEHIGH CEMENT CO	y		y		

Account	Company	BART-eligible[1]	Reason for Removal			
			Cum. Model CAMx	CAL-PUFF	Single Source CAMx	Exemp-tion Request
JE0039N	THE GOODYEAR TIRE AND RUBBER CO	y				y
JE0005H	TOTAL PETROCHEMICALS	y		y		
ED0066B	TXI OPERATIONS, L.P.			y		
TF0013B	TXU GENERATION COMPANY LP	y		y		
HR0018T	VALENCE MIDSTREAM LTD	y				y
NE0043A	VALERO REFINING COMPANY	y			y	
HG0130C	VALERO REFINING TEXAS LP					y
WH0014S	VETROTEX WICHITA FALLS PLANT	y				y
JC0003K	WESTVACO	y		y		

Note:
1. Some sources were added to the determination process after the BART survey, either by their request or as a result of equipment transfers. These are indicated with a blank.

9.5 POST-BART EMISSIONS REDUCTIONS

Subsequent to the 2002 base year inventory, some BART-eligible sources reduced their permitted emissions. Documentation of the emission reductions is in Appendix 9-11: *Documentation of Emission Reductions*. The sources and the estimated reductions are presented in Table 9-9. Reduction estimates are conservative because they are from the 2002 actual emissions level to a potential to emit level. Capitol Cement shut down their BART units. The final list of all BART-eligible sources is in Appendix 9-13: *BART-Eligible List*.

Table 9-9: Post-BART Emissions Reductions at Texas Sources

No.	Regulated Entity	Source	Account*	NO_X Reduced from Baseline 2002 (tpy)	SO_2 Reduced from Baseline 2002 (tpy)	PM Reduced from Baseline 2002 (tpy)
1	RN100211507	CAPITOL CEMENT DIV	BG0045E	1,328	1,193	100
2	RN100227016	DOW	HG0126Q	694	0	0
3	RN102450756	EXXONMOBIL OIL***	JE0067I	2.7	290	0
4	RN102609724	NORIT AMERICAS INC	HH0019H**	16.6	+5.4	0
5	RN100216621	REGENCY TILDEN GAS (FORMERLY ENBRIDGE PIPELINE)	MC0002H	2	2,276	0.2
6	RN102551785	TARGA (FORMERLY DYNEGY MIDSTREAM SERVICES)	CY0019H	336	0.3	0.5
7	RN102561925	THE GOODYEAR TIRE AND RUBBER CO	JE0039N	89.1	+11.3	2.9
8	RN100213685	VALENCE MIDSTREAM LTD	HR0018T	247.1	2,743.5	5.6
9	RN100218601	VETROTEX AMERICA ST. GOBAIN	WH0014S	62.6	16.4	59.0
Total estimated reductions in haze emissions = 9,485.2 tpy				2,778.1	6,535.9	168.2

*The first two letters in account number are the abbreviation for the source's county location. See Appendix 9-11 for the list of county abbreviations.

**Company has permit limiting combined SO_2 and NO_X to 841 tpy on previously grandfathered BART sources. This limit is lower than actual emissions in previous years. For example, the facility emitted 1,266 tpy of NO_X and SO_2 in 1990.

***ExxonMobil numbers are preliminary and subject to change. These estimates are based on reductions from the 2002 EI and pre- and post-BART hourly emissions rates submitted. (Emission reductions as a result of the completion of permit 49138 (FCCU) will be updated when they become available.)

CHAPTER 10. REASONABLE PROGRESS GOALS

10.1 INTRODUCTION

The national goal for regional haze is to achieve natural visibility levels at Class I areas by 2064. The Texas Commission on Environmental Quality (TCEQ) must show reasonable progress toward the national goal by 2018. The uniform rate of progress (URP) named in the United States Environmental Protection Agency (EPA) guidance (described as uniform rate of improvement in 40 Code of Federal Regulations (CFR) §51.308(d)(1)(i)(B)) is a straight line between base period conditions on the worst 20 percent days and estimated natural visibility conditions. Chapter 5: *Assessment of Baseline and Current Conditions and Estimate of Natural Conditions in Class I Areas* details the calculation of base period conditions and estimations of 2064 natural conditions. The URP is a tool for comparing the reasonable progress goals (RPGs) set by the state with the visibility improvement that would be needed to reach natural conditions by 2064. Table 10-1: *Uniform Rate of Progress for Class I Areas in Texas (Worst 20 Percent Days)* shows the URP 2018 deciview values for the two Texas Class I areas.

Table 10-1 shows Texas' calculation of natural conditions using the approximation that 100 percent of the dust (coarse mass and fine soil) at both Big Bend and Guadalupe Mountains National Parks is natural. As Chapter 5 discusses in more detail, analysis indicated that the approximation that all the dust is natural is a better approximation than an estimate using any substantively lower percentage.

The TCEQ plans to work with the EPA, Federal Land Managers (FLMs), and other experts and researchers as Texas continues to refine natural condition estimates for future five-year reports and ten-year Regional Haze SIP revisions.

Table 10-1: Uniform Rate of Progress for Class I Areas in Texas (Worst 20 Percent Days)

Class I Area	Improvement Needed by 2018 Assuming URP (dv)	Annual Progress Needed to Meet URP (dv)	Improvement Needed by 2064 (dv)
Big Bend	1.7	0.12	7.2
Guadalupe Mountains	1.2	0.08	4.9

10.2 REASONABLE PROGRESS GOALS FOR TEXAS CLASS I AREAS

The TCEQ has determined that the rate of visibility improvement by 2018, shown in Table 10-2: *Reasonable Progress Goals for Class I Areas (Worst 20 Percent Days)*, is reasonable and will be implemented as the RPGs for the listed Class I areas.

Table 10-2: Reasonable Progress Goals for Class I Areas (Worst 20 Percent Days)

Class I Area	Improvement Projected by 2018 using RPG (dv)	Improvement by 2018 at URP (dv)	Projected Improvement by 2064 (dv)	Date Natural Visibility Attained at RPG Rate
Big Bend	0.7	1.7	2.9	2155
Guadalupe Mountains	0.9	1.2	3.8	2081

These RPGs are derived from the CENRAP modeling and reflect emissions reductions programs already in place, including CAIR and additional refinery SO_2 reductions as a result of the EPA refinery consent decrees. These RPGs assume that either CAIR will remain in place or will be replaced by a comparable program to reduce visibility impairing pollution from EGUs in Texas and in the eastern United States. As Chapter 11: *Long-Term Strategy to Reach Reasonable Progress Goals* details, the TCEQ's emissions reduction requirements have often gone beyond the Federal Clean Air Act (FCAA) requirements for the past 35 years and continue to go beyond many federal requirements today. Texas programs include:

- opacity limits on grandfathered facilities;
- Best Available Control Technology (BACT) requirements that typically go beyond EPA's New Source Performance Standards (NSPS) for new and modified sources;
- extensive NO_X emission limits on existing and new sources including major, minor, and area sources including some on a statewide basis;
- Texas Emissions Reduction Program (TERP), which provides financial incentives to accelerate the implementation of new, cleaner diesel engine technologies in on-road and non-road applications; and
- Air Check Texas Repair and Replacement Assistance Program, which provides financial incentives for scrappage of older gasoline-powered on-road vehicles.

The reasonable progress goals were developed after considering the statutory factors: cost and time of compliance, the energy and non-air quality impacts of compliance, and the remaining useful life of existing sources. Appendix 10-1: *Analysis of Control Strategies and Determination of Reasonable Progress Goals* provides an analysis showing that these goals are reasonable.

The TCEQ focused its control strategy analysis on point source emissions of SO_2 and NO_X. Chapter 11: *Long-Term Strategy to Reach Reasonable Progress Goals* demonstrates that these are the main anthropogenic pollutants that affect visibility at Class I areas in Texas and in neighboring states. For SO_2, point sources make up over 90 percent of the projected 2018 statewide emissions. Point sources are clearly the issue for this pollutant. For NO_X, point sources comprise over 45 percent of the projected statewide emissions. This is the largest single component. The next largest is area sources. Of that, the greatest component also has the greatest uncertainty: emissions from upstream oil and gas production. Working with CENRAP, the TCEQ plans to refine its understanding of those emissions and options for controls over the next few years. Nevertheless, Texas is moving aggressively to reduce those emissions through the $4 million grant program to pay for retrofits on rich burn compressor engines. Texas is going beyond federal requirements in an effort to reduce NO_X emissions from on-road and non-road mobile sources through the Texas Emissions Reduction Program (TERP). As a result, the TCEQ elected to focus the control strategy analysis on point sources.

Figures 10-1: *Glide Path for Big Bend Worst 20 Percent Days* and 10-2: *Glide Path for Guadalupe Mountains Worst 20 Percent Days* graphically illustrate how these RPGs compare to the URP or the glide path for the Texas Class I areas.

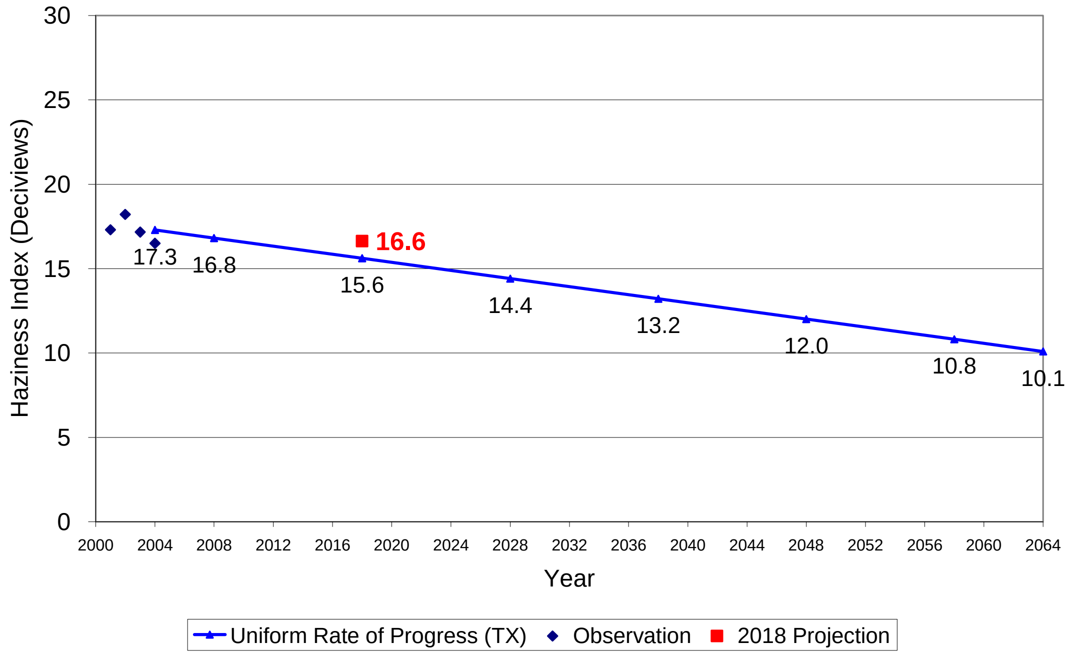


Figure 10-1: Glide Path for Big Bend Worst 20 Percent Days

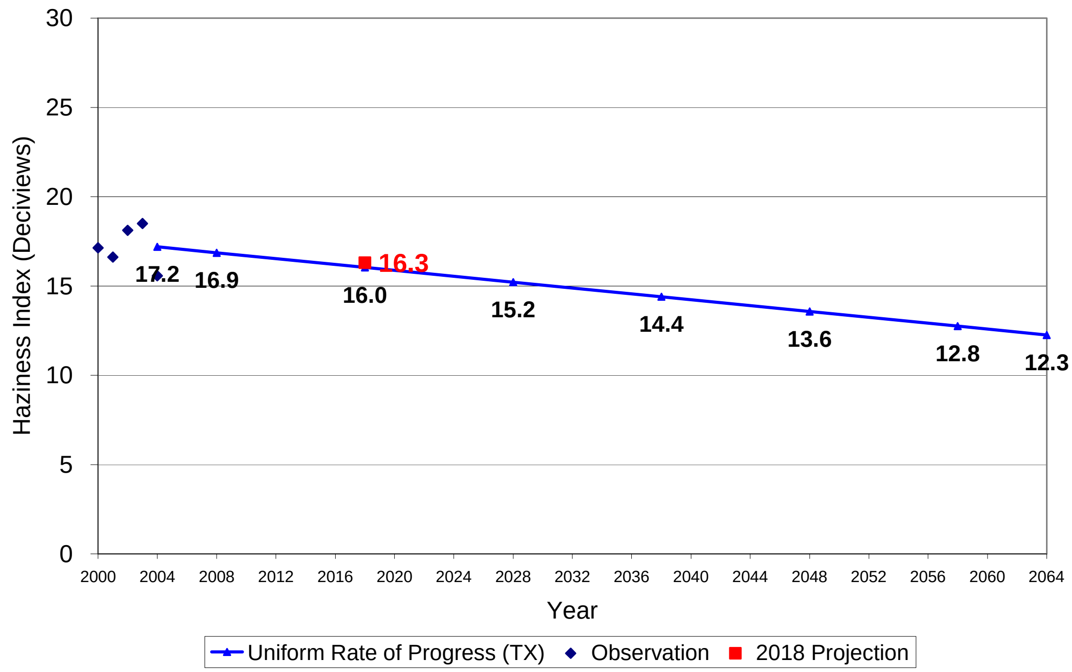


Figure 10-2: Glide Path for Guadalupe Mountains Worst 20 Percent Days

The figures and tables above address the TCEQ's RPGs for the worst 20 percent days at Big Bend and Guadalupe Mountains. These figures use the TCEQ's refined estimate for natural conditions, rather than the EPA default values. Appendix 10-3: *Uniform Rate of Progress Curves Using Default Natural Conditions Estimates* shows the glide paths using the EPA default values. The natural condition estimate was not a factor in setting the RPG. Table 10-3:

Reasonable Progress Goals for Class I Areas (Best 20 Percent Days) provides the state's RPGs for the 20 percent days with the best visibility at the Texas Class I areas.

Table 10-3: Reasonable Progress Goals for Class I Areas (Best 20 Percent Days)

Class I Area	Baseline Visibility (dv)	Projected 2018 Visibility (RPG) (dv)	Improvement by 2018 at RPG (dv)
Big Bend	5.8	5.6	0.2
Guadalupe Mountains	5.9	5.7	0.2

These RPGs reflect visibility improvements from emissions reductions associated with the FCAA, the Texas Clean Air Act, Texas' ozone SIP revisions and rules, and agreements between EPA and oil refineries for SO_2 emissions reductions. These RPGs do not include additional emissions reductions from implementing the Texas BART rule and new rules adopted in the recent May 23, 2007, Dallas-Fort Worth eight-hour ozone attainment demonstration SIP revision. The TCEQ considered additional controls beyond those already adopted. Given the cost and imperceptible effect of additional controls, and significant international sources of visibility impairment (all discussed in the following section), it is not reasonable to require additional controls at this time to reduce the impact of Texas' emissions on the two Class I areas in Texas.

10.3 CONSIDERATION OF ADDITIONAL POLLUTION CONTROL

Development of Area of Influence (AOI) Based Cost Data

The TCEQ participated in its regional air planning organization, CENRAP, to develop emission inventories for 2002 and 2018, model the results of the emission reductions for each state, and draw areas of influence for each Class I area in the CENRAP domain. To draw the areas of influence CENRAP combined results from three techniques: 1) residence time difference plots for each pollutant that has a substantial effect on visibility impairment at each Class I area, 2) a combination of backward trajectory analysis, emissions information, and monitored concentrations, and 3) tagged species source apportionment within reactive photochemical grid modeling. Appendix 10-1: *Analysis of Control Strategies RPG* provides more detailed information about CENRAP's work to define areas of influence.

For the Class I areas that emissions from Texas affect, the main visibility impairing pollutants resulting from human activity are sulfate and nitrate. The emissions that react to form these pollutants are, respectively, sulfur dioxide and nitrogen oxides. Because of the differences between conditions that lead to high sulfate and high nitrate conditions, the areas of influence for sulfur dioxide and nitrogen oxides are substantially different for several Class I areas that Texas emissions affect.

The TCEQ used the control strategy analysis completed by the CENRAP as the starting point for the analysis of additional controls. The CENRAP analysis used the EPA AirControlNET tool to develop cost per ton estimates for the relevant pollutants. The TCEQ reviewed this information and made changes based on knowledge of the particular facilities and agency experience with implementing ozone control strategies. The analysis focused on moderate cost controls for sources that were likely to contribute to visibility impairment at Class I areas.

Texas assessed the costs of potential controls and reductions for Texas sources at ten Class I areas. These are Big Bend, Breton Island, Caney Creek, Carlsbad Caverns, Guadalupe Mountains, Salt Creek, Upper Buffalo, Wheeler Peak, White Mountain, and Wichita Mountains.

Texas used the second level area of influence for each Class I area to determine sources that met the emissions over distance threshold and were within that Class I area's AOI. The cost associated with potential controls for each Class I area are listed in Table 10-4: *Cost of Controls for Class I Areas*. The significant point sources within each AOI are in Appendix 4-3: *Additional Consultation Letters to Adjacent States*. A master list of potential additional control costs associated with these units for each Class I area were determined and are in Appendix 10-1.

Table 10-4: Cost of Controls for Class I Areas

Class 1	**Big Bend**	**Breton Isle**	**Caney Creek**	**Carlsbad Caverns**	**Guadalupe Mountains**
NOx	$ 24,100,000	$ 27,000,000	$ 28,600,000	$ 24,100,000	$ 33,800,000
SO_2	$215,900,000	$231,000,000	$245,900,000	$255,500,000	$254,900,000
Class 1	**Salt Creek**	**Upper Buffalo**	**Wheeler Peak**	**White Mountain**	**Wichita Mountains**
NOx	$ 27,000,000	$ 24,100,000	$ 22,700,000	$ 23,000,000	$ 28,100,000
SO_2	$251,900,000	$233,800,000	$229,500,000	$244,500,000	$269,500,000

Many of these controls are in more than one area of influence. The total cost of all state-wide point source controls are summarized in Table 10-5: *TCEQ Point Source Control Strategy Summary*.

Table 10-5: TCEQ Point Source Control Strategy Summary

Pollutant	**Tons Per Year (tpy) Reduced**	**Estimated Cost**
Sulfur Dioxide (SO_2)	155,873	$270,800,000
Nitrogen Oxides (NO_X)	27,132	$53,500,000
Total Costs		$324,300,000

The TCEQ used the CENRAP modeling to estimate the impact that the control strategy would have on the Class I areas impacted by Texas' emissions. The CENRAP conducted a modeling analysis presuming an aggressive set of additional controls above and beyond CAIR and BART Texas used the results of this modeling analysis to determine an effectiveness ratio for NO_x and SO_2 reductions. The effectiveness ratio provides an estimate of improvement in visibility for every ton of NO_X and SO_2 reduced. Using these ratios, the TCEQ was able to develop an order-of-magnitude estimate of the likely visibility improvements resulting from the point source control strategy (see Table 10-6: *Estimated Haze Index Improvements for Affected Class I Areas*). This analysis can be found in Appendix 10-2: *Estimating Visibility Impacts from Additional Point Source Controls* and in Appendix 10-4: *Detailed Calculations for Estimating Visibility Impacts*.

Table 10-6: Estimated Haze Index Improvements for Affected Class I Areas

Class 1	Big Bend	Breton Isle	Caney Creek	Carlsbad Caverns	Guadalupe Mountains
Haze Index Improvement (dv)	0.16	0.05	0.33	0.22	0.22
Class 1	**Salt Creek**	**Upper Buffalo**	**Wheeler Peak**	**White Mountain**	**Wichita Mountains**
Haze Index Improvement (dv)	0.18	0.16	0.04	0.24	0.36

As Tables 10-5 and 10-6: *Estimated Haze Index Improvements for Affected Class I Areas* show, the analysis identified controls costing well over $300 million, yet the projected benefit of those controls on each Class I is not perceptible. A single (1.0) deciview is the smallest perceptible improvement in visibility. In the TCEQ's Best Available Retrofit Technology (BART) rule, the state considered 0.5 deciviews as the threshold under which a facility was not considered to meaningfully contribute to visibility impairment. A difference improvement of 0.05 deciviews is well within the uncertainty of the modeling techniques and is much lower than perceptible.

10.4 FOUR FACTOR ANALYSIS

The Federal Regional Haze Rule requires states to set reasonable progress goals (RPGs) toward meeting a national goal of natural visibility conditions in Class I areas by the year 2064. The first RPG is to be established for the planning period 2008 to 2018. The State of Texas worked with CENRAP to develop RPGs for Texas Class I areas.

The Federal Regional Haze Rule (§51.308(d)(1)(i)(A)) requires states to consider the factors listed in section 169A(g)(1) of the FCAA when setting reasonable progress goals. These factors are the cost of compliance, the time for compliance, the energy and non-air quality impacts of compliance, and the remaining useful life of any potentially affected sources (EPA 1999).

- **Cost of Compliance**
  The cost of compliance is a factor used to determine whether compliance costs for sources are reasonable compared to the emission reduction and visibility improvement they will achieve.

- **Time Necessary for Compliance**
  The time necessary for compliance factor may be used to adjust the reasonable progress goals to reflect the degree of improvement achievable within the first planning period, as opposed to the improvement expected at full implementation of a control measure.

- **Energy and Non-Air Quality Environmental Impacts of Compliance**
  The energy and non-air quality environmental impacts of compliance factor is meant to consider whether the energy requirements of the control technology result in energy penalties or benefits, or whether there are non-air quality impacts such as water quality and solid waste impacts resulting from the technology.

- **Remaining Useful Life of the Source**
  The remaining useful life of the source factor is applicable only to those measures which would require retrofitting of control devices (or possibly production changes) at *existing* sources. Shutdowns of sources were only counted if the shutdowns were enforceable.

10.4.1 Applying the Statutory Factors

Because the pollutants of primary concern were determined to be SO_2 and NO_X from point sources, the 2018 emissions inventory was assessed to determine the sources that would have the most impact on Class I areas from these pollutants. All units in the inventory were assessed. An emissions over distance to any Class I area analysis ratio with a threshold of five or greater ($Q/d \geq 5$ in tpy/kilometers) was applied to the projected 2018 emissions for both SO_2 and NO_X to eliminate sources so far away from a Class I area that any reduction in emissions would be unlikely to have a perceptible impact on visibility. Also, any source with predicted 2018 emissions less than 100 tpy was excluded, since the regulatory and logistical overhead associated with controlling these small sources would not be justified by the likely benefit.

The TCEQ also excluded additional NO_X controls on cement kilns from consideration since Texas has already required all the measures determined to be reasonable to control NO_X emission from these sources in the latest Dallas-Fort Worth ozone SIP revision. See Appendix 10-1: *Analysis of Control Strategies and Determination of Reasonable Progress Goals* for further discussion of Texas cement kilns.

Determination of Proposed Controls

The 2018 inventory included the on-the-books controls for each of the states in the CENRAP region. The list of proposed controls is for controls beyond those already included in the baseline level used in the modeling. This is necessary to provide a frame of reference to estimate the amount of emissions available for additional control and estimate the effect of control measures. Additionally, the progress toward the RPG with only on-the-books controls can also be assessed.

CENRAP used the latest revised version of the EPA AirControlNET model (Alpine 2007) to analyze potential add-on control device strategies. AirControlNET is a control technology analysis tool developed to support the EPA in analyses of air pollution policies and regulations. The tool provides data on emission sources, potential pollution control measures and emission reductions, and the costs of implementing those controls. Every available SO_2 and NO_X control strategy in AirControlNET was run against the electric generating units (EGUs) and non-EGU point source inventories to develop a master list of available incremental control strategies for the entire CENRAP 36 kilometer domain.

Texas reviewed the resulting data curves and some additional individual sources were selected from source-types that were not part of the CENRAP AirControlNET dataset. The analyses of these facilities were designed to ensure that opportunities for cost-effective visibility improvements were not overlooked. The first step in the technical evaluation of control measures for a source category was to establish the future emissions baseline with on-the-books regulations. This baseline was used to assess the potential emissions reductions with the proposed control. The TCEQ added flue gas desulfurization at nine carbon black units based on this analysis.

10.4.2 Four Factor Analysis Process

Cost of Compliance

At a total estimated cost exceeding $300 million and no perceptible visibility benefit, Texas has determined that it is not reasonable to implement additional controls at this time. All units in Texas that met the emissions over distance threshold were assessed. The cost per ton of controls from EPA CAIR and existing TCEQ control programs were used as a threshold value for determining a proposed set of controls. The EPA estimated the cost of implementing CAIR was up to $2,700 per ton. This limiting threshold was used to limit the proposed controls group to cost effective measures. The annualized cost values, additional emissions reductions based on proposed efficiency, as listed in the AirControlNET files, were used. Modifications for Texas included the consideration of flue gas desulfurization for carbon black units.

Time Necessary for Compliance

The time necessary for compliance was not a critical factor for the determination of applicable additional controls for Texas sources. The focus of the time necessary for compliance analysis for on-the-books controls will be to quantify the magnitude of emissions reductions that will occur prior to 2018. The EPA in its CAIR regulatory impact statement estimated that approximately 30 months is required to design, build, and install SO_2 scrubbing technology for a single EGU boiler. The total time for a single facility to comply with one of the NO_X caps would be about five years. Shortage of skilled labor as a result of increased design and construction of pollution control units required to meet deadlines in CAIR or its eventual replacement could increase times for some construction but completion by 2018 would still be anticipated.

For mobile sources, MOBILE and NONROAD model runs were completed for the 2018 emissions inventory. These model runs incorporate the degree of fleet and expected engine replacement prior to 2018. The completion of other proposed controls are anticipated by 2018.

Energy and Non-Air Quality Environmental Impacts of Compliance

To the extent energy impacts are quantifiable for a particular control, they have been included in the cost estimates. Including impacts on a source-by-source basis would have added further weight against finding that the potential additional controls were reasonable to apply.

Scrubbers, Selective Catalytic Reduction (SCR) systems, and Selective Non-Catalytic Reduction (SNCR) systems installed under the EGU control strategies would require electricity to operate fans and other ancillary equipment. In addition, steam would be required for some scrubbers and SCR systems. Additional fuel will be consumed at the utilities to produce this electricity and steam, resulting in the lowering of the energy efficiency of the plant. Estimates have given the electricity and steam required by controls installed to meet SO_2 and NO_X emission caps would be less than 1 percent of the total electricity and steam production of EGUs (EPA 1999).

Source-by-source review of the non-air quality impacts of the potential controls would possibly have lead to a different determination about the unreasonableness of the set of potential additional controls. Scrubbers, coal washing, and spray dryers will require additional safeguards for fuel handling and waste handling systems to avoid additional non-air environmental impacts such as increased effluents in waste water discharges and storm water runoff. Solid waste disposal and wastewater treatment costs are expected to be less than five percent of the total operating costs of pollution control equipment. These factors will need to be considered specific to individual sources.

Pilot testing of SNCR on wet and dry kilns in 2006 demonstrated that 30 to 40 percent reductions were achievable without hazardous by-product formation. In July 2006, ERG submitted a report to TCEQ entitled *Assessment of NO_X Emissions Reduction Strategies for Cement Kilns - Ellis County: Final Report* (ERG 2006).

Some low-NO_X combustion technologies require electricity for turbo charging, or steam for steam injection. Systems that require only modifications to alter fuel-air mixing and combustion temperatures are not expected to produce any additional electricity or steam demands, or generate wastewater or solid waste.

Remaining Useful life

CENRAP considered remaining useful life in modeling for mobile sources that assumes reduced emissions per vehicle mile traveled due to the turnover of the on-road mobile source fleet. For sources with a relatively short remaining useful life, this consideration would have weighed more heavily against a determination that controlling those sources would have been reasonable. In general, this factor is not critical for sector analyses for the 2018 timeline. For the purposes of initial analyses, no limited useful equipment life was assumed. A site-specific analysis would be needed to determine any units with limited useful life. Only units that were scheduled for shutdown under enforceable decrees were eliminated from the 2018 inventory and further analysis.

10.5 UNCERTAINTY IN THE REASONABLE PROGRESS GOALS

The majority of the emissions reductions underlying the predicted visibility improvements are from the CAIR program or its eventual replacement. The TCEQ presumes that any eventual replacement for CAIR will include interstate trading of emissions allowances. Although CAIR or its replacement program should result in substantial reductions in SO_2 and NO_X emissions from EGUs, there is uncertainty regarding how visibility will be improved at individual Class I areas because of trading of emissions allowances. Because emission allowances can be purchased by EGUs relatively close to the Texas Class I areas from EGUs far from the Texas Class I areas, the visibility improvement may not be as great as predicted by the CENRAP's modeling. Conversely, nearby EGUs may elect to control beyond their emission caps and sell emission allowances out of state, resulting in reduced emissions closer to the Texas Class I areas.

CENRAP used the Integrated Planning Model (IPM) that the EPA employed to predict the emissions reductions expected from CAIR in 2018. This SIP revision presumes that those results would be comparable under any program to replace CAIR. The IPM model predicts the effect of emission trading programs considering economics, logistics, and the specific regulatory environment for each EGU. Table 10-7: *Comparison of Sulfur Dioxide Emissions* compares current emissions of SO_2 to the CAIR caps and the IPM results for the 2018 planning year.

Table 10-7: Comparison of Sulfur Dioxide Emissions

SO_2 Emissions	Texas SO_2 Emissions (tpy)*
Current (2002 base case)	550,000
EPA's CAIR budget for Texas EGUs for 2015	225,000
IPM projection CENRAP modeled for 2018	350,000

Sources: EPA, CENRAP
*Rounded to the nearest thousand

The CAIR cap is the total allowable emissions of SO_2 from EGUs in Texas under CAIR. The IPM model analysis used by CENRAP predicts that by 2018 EGUs in Texas will purchase approximately 125,000 tpy of emissions allowances from out of state. The TCEQ requested that key EGUs in Texas review and comment on the predictions of the IPM model. However, no EGU made an enforceable commitment to any particular pollution control strategy and preferred to retain the flexibility offered by the CAIR program.

In the five-year periodic progress report required by 40 CFR §51.308(g), the TCEQ plans to review emissions inventory and permit information to evaluate the accuracy of the predicted emissions used in the CENRAP modeling.

10.6 INTERNATIONAL SOURCES OF VISIBILITY IMPAIRMENT

The Texas Class I areas are close to Mexico, and international transport of emissions from Mexico and Central America significantly influence regional haze at these areas. CENRAP conducted a Particulate Matter Source Apportionment Technology (PSAT) analysis on the modeling conducted for the 2018 projections. The PSAT modeling apportioned all the particulate pollutant contributions to extinction except for secondary organic aerosol. The pollutants apportioned by geographic areas are sulfate, nitrate, primary organic carbon, elemental carbon, fine soil, and coarse mass. Table 10-8: *Contributions to Visibility in the Texas Class I Areas on Worst 20 Percent Day* summarizes the contribution from these areas to visibility impairment at the Texas Class I areas.

Table 10-8: Contributions to Visibility in the Texas Class I Areas on Worst 20 Percent Days

Contribution by Area	Big Bend (%)	Guadalupe Mountains (%)
Texas	24.8	34.8
Mexico	26.7	16.5
Boundary Conditions	25.7	8.7
Other US	11.9	18.9
Miscellaneous	5.8	9.6
Neighboring States	5.1	11.5

Boundary conditions are the conditions at the model's geographic boundaries. These are visibility-impairing emissions from Central Mexico and further south into Central America. The analysis indicates that 52 percent of the impairment at Big Bend and 25 percent of the impairment at Guadalupe Mountains is from Mexico and further south. The national goal of natural visibility at these Class I areas cannot be met without substantial reductions in emissions from outside of the United States.

10.7 REDUCTIONS REQUIRED TO MEET THE UNIFORM RATE OF PROGRESS

The TCEQ's analysis of point source reductions can be extrapolated to estimate the amount of reductions that would be required for the RPG to meet the URP for the Texas Class I areas.

Table 10-9: Emissions Reductions Required to Meet Uniform Rate of Progress

Class I Area	Additional Improvement Needed to Meet URP (dv)	Approximate Additional Pollutant Reductions SO_2 and NO_X (tpy)	Estimated Cost of Additional Reductions
Big Bend	1.0	3,700,000	$6,500,000,000
Guadalupe Mountains	0.3	1,100,000	$1,900,000,000

Table 10-9: *Emissions Reductions Required to Meet Uniform Rate of Progress* assumes that all of the reductions needed to meet the URP would come from Texas. These additional reductions would require significant over-control in order to compensate for the impacts of international pollution. The preamble to the July 1, 1999, issuance of the Regional Haze Rule clearly says that states are not required to carry out compensatory over-control to make up for the lack of progress in reducing the impacts of international transport.

Table 10-9 illustrates that to meet the goal of natural visibility at Big Bend a better understanding of how pollutants are brought into the area is needed so that the correct sources can be addressed. This also reinforces the point that progress at the Texas Class I areas, especially at Big Bend, is dependent upon reducing emissions from Mexico and Central America. In Chapter 11: *Long-Term Strategy to Reach Reasonable Progress Goals*, the TCEQ specifically asks the EPA for federal efforts to reduce the international transport impacts on regional haze coming into the United States across Texas' southern border.

Given the significant impact from international emissions, the uncertainty in the impact of CAIR and the poor cost-effectiveness of additional, reasonable point source controls, the TCEQ has determined that additional controls for regional haze are not appropriate at this time.

10.8 CONSULTATION

In determining a reasonable progress rate for each Class I area discussed previously, the TCEQ has consulted with the other states and tribes that are reasonably anticipated to cause or contribute to visibility impairment in each of the Texas Class I areas. Similarly, the TCEQ has consulted with other states whose Class I areas are impacted by pollution sources in Texas. The TCEQ invited tribes in the CENRAP states to the consultation calls, but no tribes participated in the consultation on Big Bend and Guadalupe Mountains. A full description of the consultation process is in Chapter 4: *State, Tribe, and Federal Land Manager Consultation*.

10.9 REPORTING

The TCEQ will report progress to the EPA Administrator every five years in accordance with 40 CFR §51.308(g). Chapter 12: *Comprehensive Periodic Implementation Plan Revisions and Adequacy of the Existing Plan*, provides more detail on five-year reporting and ten-year SIP submittal requirements.

CHAPTER 11. LONG-TERM STRATEGY TO REACH REASONABLE PROGRESS GOALS

11.1 INTRODUCTION

The long-term strategy for the Regional Haze SIP revision incorporates planning for the next ten years, from 2008 through 2018. Title 40 CFR §51.308.308(d)(3) specifies the requirements for the long-term strategy for regional haze (Appendix 1-1).

The main anthropogenic emissions that affect visibility in Class I areas in Texas and neighboring states are SO_2 and NO_X. There is a much smaller anthropogenic particulate matter (PM) impact in Texas from stack, engine exhaust, and fine soil emissions compared to SO_2 and NO_X. Although the contribution of anthropogenic VOC to the formation of secondary organic carbon PM is small, there is a contribution. The impact of coarse mass and fine soil at the two Texas Class I areas comes primarily from natural dust storms and dust blowing from the Chihuahuan Desert, which the modeling does not represent well. Chapter 5: *Assessment of Baseline and Current Conditions and Estimate of Natural Conditions in Class I Areas* discusses and documents the predominance of these natural impacts. The modeled impact of wild fire and prescribed burning emissions on primary organic carbon is uncertain because of questions about the accuracy of fire emission inventories. However, the modeled projections show that fires are the main source of the impacts.

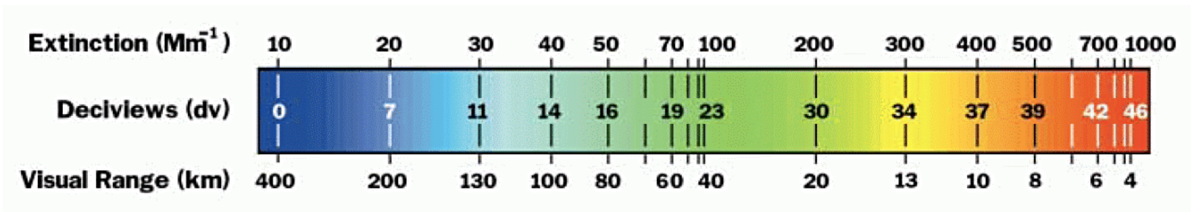
Bar charts in this chapter show the apportioned impact of different areas and pollutants to visibility impairment at Big Bend and Guadalupe Mountains National Parks and at the Class I areas Texas emissions impact in other states (Figures 11-2 through 11-31). There are separate graphs to show the impacts of different source areas on the worst 20 percent of monitored days and on the best 20 percent of monitored days in 2002. The apportioned impacts shown in the figures use the modeling results scaled to measured pollutant concentrations according to the EPA's modeling guidelines as detailed in Chapter 8: *Modeling Assessment*. As Chapter 5 explains, the projections for 2018 set the relative response factors (RRFs) for coarse mass (dust) and fine soil equal to one based on analysis showing that dust storms and wind blown desert dust are the dominant cause of the coarse mass and fine soil pollution at Big Bend and Guadalupe Mountains National Parks. Since the dominant source of these pollutants is natural, the TCEQ does not expect that to change between the base period and 2018.

The primary organic carbon and elemental carbon (i.e., black carbon) captured in the modeling are largely from fire. The term "primary" refers to a pollutant emitted directly to the atmosphere. The term "secondary" refers to a pollutant formed in the atmosphere by reaction, condensation, or both. The modeling indicates that primary organic carbon and black carbon at Big Bend on the worst 20 percent days come overwhelmingly from boundary conditions, which include the areas of southern Mexico, the Yucatan, and Central America with extensive agricultural burning and sometimes wildfire emissions each April and May. The TCEQ's air pollution meteorologists have documented many of these episodes over the past decade. The data and satellite images of the smoke moving into Texas confirm the large impact of smoke from the fires in southern Mexico, the Yucatan, and Central America.

The haze pollutants shown in the bar graphs and tables include: sulfate (SO_4), nitrate (NO_3), primary organic aerosols (POA), elemental carbon (EC), other inorganic fine particulate matter (soil), coarse mass (CM), anthropogenic secondary organic aerosols (SOAA) , which result from human activity, and biogenic secondary organic aerosols (SOAB), which form from hydrocarbon emissions from vegetation. Initial conditions (IC) are the assumed initial three-dimensional concentrations throughout the modeling domain. Except on the first few days of the model runs, the contribution of initial conditions is vanishingly small. Boundary conditions (BC) are the concentrations imported into the modeling domain along the lateral edges and the top of the

CENRAP modeling domain. These boundary conditions come from a year-long run of the global model GEOS-Chem.

Figures 11-2 through 11-31 also refer to extinction (abbreviated as B_{ext}) and Rayleigh. In the case of visibility, extinction or B_{ext} refers to the loss of image-forming light as it passes from an object to the observer. Rayleigh scattering is the scattering of light by air molecules (Malm 1999). Figure 11-1 compares extinction to deciviews (dv) and visual range (in kilometers).



Source: William Malm, *Introduction to Visibility*, 1999, National Park Service

Figure 11-1: Comparison of Extinction, Deciviews and Visual Range

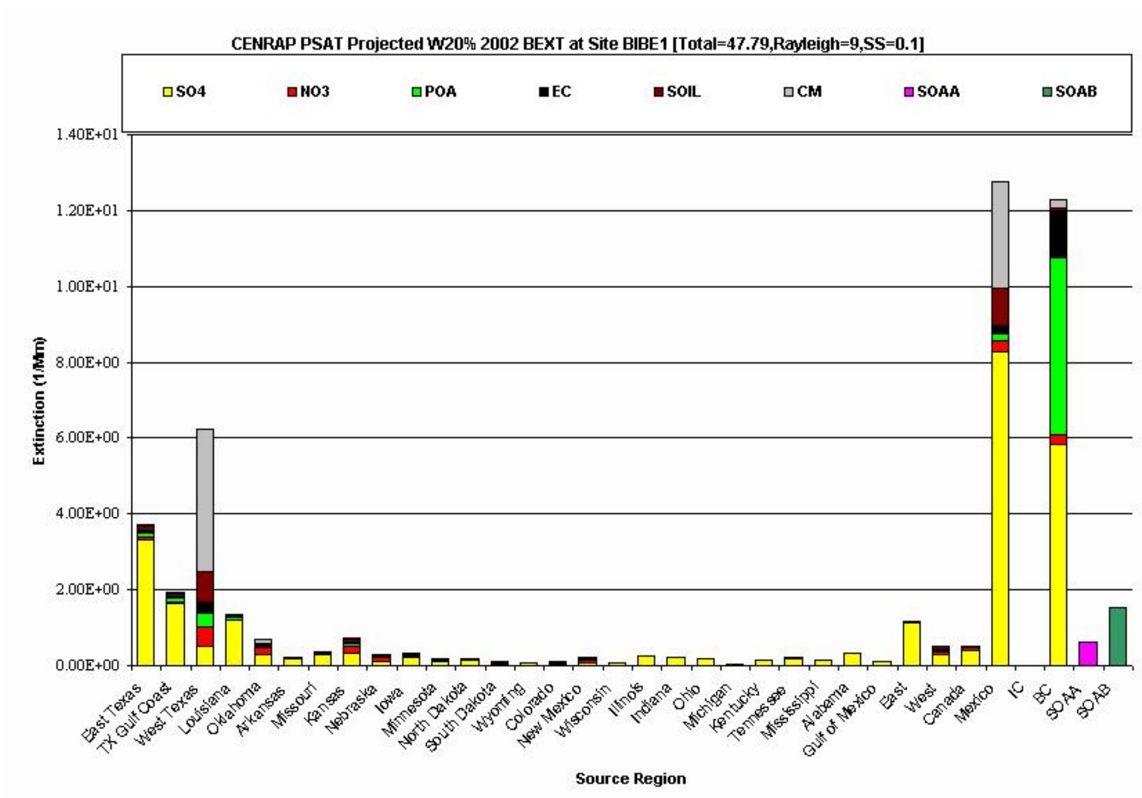


Figure 11-2: Areas and Pollutants Causing Regional Haze at Big Bend (BIBE) on Worst 20 Percent Days in 2002

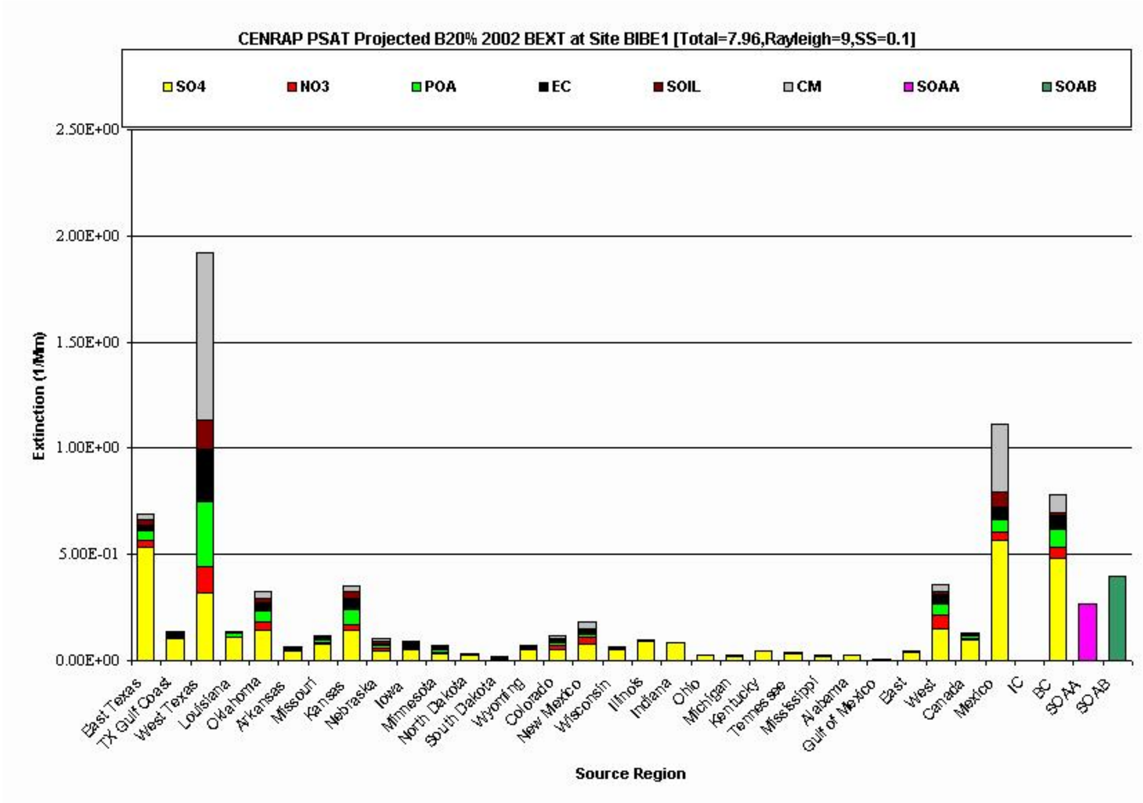


Figure 11-3: Areas and Pollutants Causing Regional Haze at Big Bend (BIBE) on Best 20 Percent Days in 2002

Note the change in scale on the y-axis.

Table 11-1: Pollutant Contributions to Extinction at Big Bend from Texas and from All Areas on Worst 20 Percent Days in 2002 and 2018

Particulate Matter Constituent	2002 Impacts at Big Bend (inverse megameters)		2018 Impacts at Big Bend (inverse megameters)	
	Texas Total	Total, All Source Areas	Texas Total	Total, All Source Areas
Sulfate	5.50	26.10	3.95	23.00
Nitrate	0.59	2.05	0.56	1.99
Primary Organic Aerosol	0.55	5.81	0.41	5.61
Elemental Carbon	0.42	2.12	0.20	1.81
Fine Soil	0.99	2.54	0.98	2.54
Coarse Mass	3.82	7.03	3.87	7.03
Secondary Organic Aerosol, Anthropogenic	not available1	0.64	not available1	0.59
Secondary Organic Aerosol, Biogenic	not available1	1.52	not available1	1.49
Total	11.87	47.79	9.97	44.06

[1] The CENRAP PSAT modeling did not apportion either the anthropogenic or the biogenic secondary organic aerosol (SOA). The reasons are (1) that sulfate and nitrate are generally the main causes of visibility impairment resulting from human activity and (2) that tracking the multiple volatile organic compound constituents and reaction products necessary to apportion SOA would have extended the modeling run times far beyond the time that was available for the modeling.

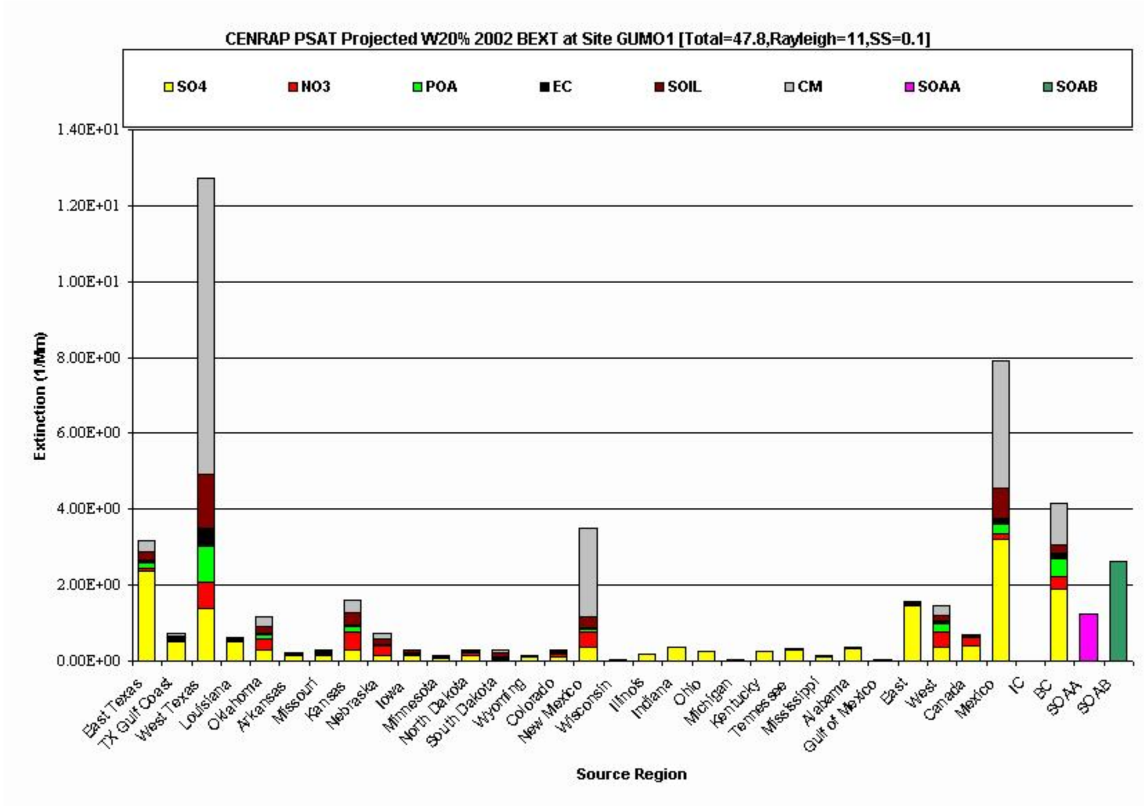


Figure 11-4: Areas and Pollutants Causing Regional Haze at Guadalupe Mountains (GUMO) on the Worst 20 Percent Days in 2002

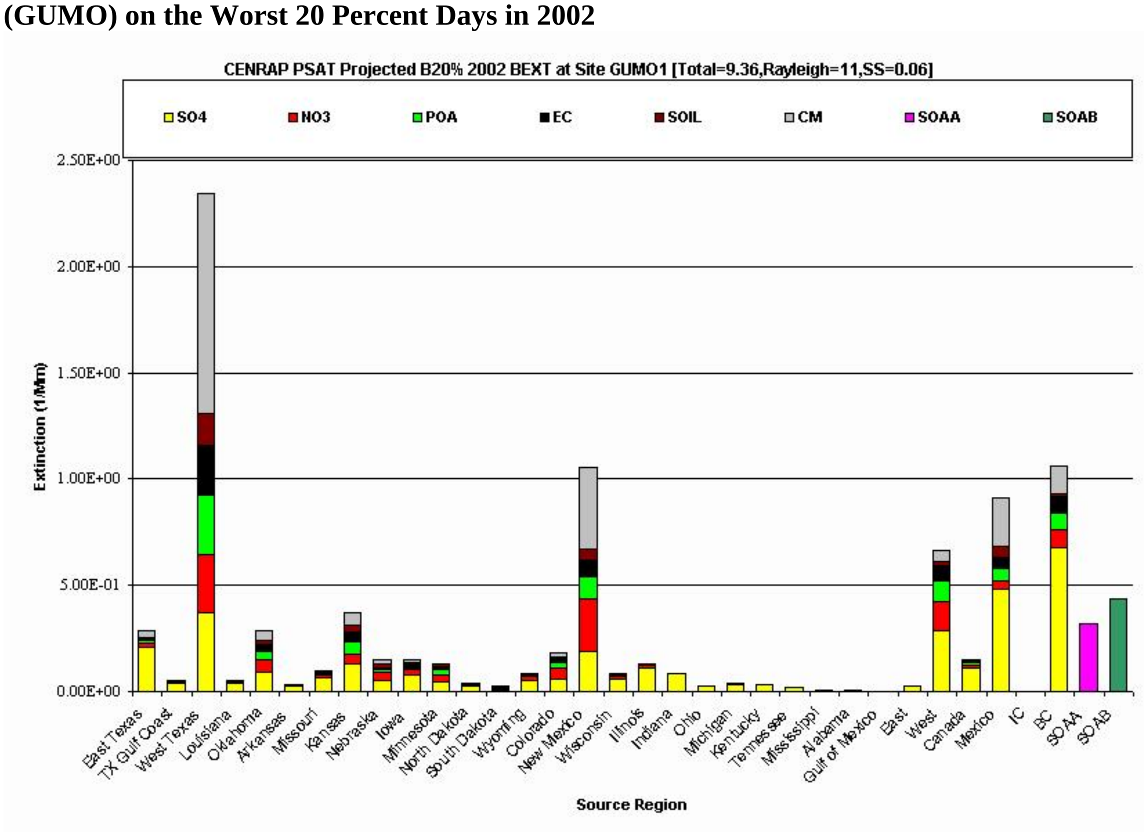


Figure 11-5: Areas and Pollutants Causing Regional Haze at Guadalupe Mountains (GUMO) on Best 20 Percent Days in 2002

Note the change on the y-axis.

Table 11-2: Pollutant Contributions to Extinction at Guadalupe Mountains from Texas and from All Areas on Worst 20 Percent Days in 2002 and 2018

Particulate Matter Constituent	2002 Impacts at Guadalupe Mountains (inverse megameters)		2018 Impacts at Guadalupe Mountains (inverse megameters)	
	Texas Total	Total, All Source Areas	Texas Total	Total, All Source Areas
Sulfate	4.28	15.94	3.65	13.65
Nitrate	0.78	3.67	0.68	3.32
Primary Organic Aerosol	1.16	2.75	0.87	2.38
Elemental Carbon	0.53	1.19	0.28	0.86
Fine Soil	1.71	4.37	1.66	4.37
Coarse Mass	8.16	16.04	8.19	16.02
Secondary Organic Aerosol, Anthropogenic	not available1	1.23	not available1	1.16
Secondary Organic Aerosol, Biogenic	not available1	2.61	not available1	2.56
Total	16.62	47.80	15.33	44.32

11.1.1 Reasonably Attributable Visibility Impairment

Reasonably attributable visibility impairment (RAVI) is a specifically defined term from EPA's early efforts to protect visibility at Class I areas. Limitations in RAVI requirements for improving visibility at many Class I areas led to provisions in the 1990 Clean Air Act Amendments that added the broader requirements for to reduce regional haze impacts at Class I areas. The EPA implemented these provisions in the Regional Haze Regulations first issued July 1, 1999.

The FLMs for Big Bend and Guadalupe Mountains National Parks have not identified any reasonably attributable visibility impairment from Texas or other United States sources. The FLMs for the Class I areas that Texas' emissions impact in other states have not identified any reasonably attributable visibility impairment caused by Texas sources. For these reasons, the TCEQ does not have any measures in place or a requirement to address reasonably attributable visibility impairment.

11.2 CONSULTATION

The TCEQ has participated in the CENRAP since its inception in 1999. The TCEQ has cooperated with all CENRAP states and tribes through participation in the process of developing information on base period emission inventories and visibility impairment, estimates of 2064 natural conditions, and projections of 2018 emissions and visibility impairment considering all emission reduction requirements in Texas, including state and federal rules. These rules include the Clean Air Interstate Rule (CAIR), BART requirements, emission reductions from the Federal Motor Vehicle Emission Control Program (FMVCP), EPA refinery consent decrees, and EPA requirements for cleaner non-road diesel and gasoline-powered engines. Detailed information on consultation is in Chapter 3: *Regional Planning* and Chapter 4: *State, Tribe, and Federal Land*

Manager Consultation. Information on base period emissions inventory development is in Chapter 7: *Emissions Inventory*, and information on modeling is in Chapter 8: *Modeling Assessment*.

11.2.1 Consultation on Class I Areas in Texas

The TCEQ used CENRAP Particulate Matter Source Apportionment Technology (PSAT) modeling to determine that the states contributing to visibility impairment at Texas' Class I areas are Kansas, Louisiana, New Mexico, and Oklahoma. Each of these states has adopted or is in the process of adopting emissions reductions it has determined to be reasonable under the factors listed in 40 CFR §51.308(d)(1), Reasonable Progress Goals. Based on their plans and commitments elicited through the consultation process, the commission has determined that the emissions reductions these states are projecting are reasonable for contributing to progress in reducing their contributions to visibility impairment at the two Class I areas in Texas. Chapter 4 discusses consultations with these states in detail.

11.2.2 Consultation on Class I Areas Impacted by Emissions from Texas

Arkansas, Missouri, and Oklahoma have each included Texas in consultations concerning regional haze impacts on the Class I areas in these states. The TCEQ reviewed CENRAP PSAT modeling to assess how Texas' emissions might affect other states' Class I areas. Pursuant to this review, Texas has written to Arkansas, Missouri, Oklahoma, New Mexico, Louisiana, and Colorado to ask whether emission reductions projected in Texas by 2018 are sufficient to meet Texas' apportionment of the impact reduction needed to meet the reasonable progress goal for each Class I area in each state. Texas has completed its consultation with Louisiana, Arkansas, Missouri, Oklahoma, and Colorado, and none of these states has asked Texas for further emission reductions to help the state meet its reasonable progress goals for its Class I area(s). Chapter 4 discusses these consultations in more detail. Appendix 4-3 contains the official communications from these states to Texas.

11.2.3 Texas' Impacts and 2018 Impact Reduction for Class I Areas Outside Texas

The TCEQ's review of the CENRAP PSAT modeling results to assess how Texas' emissions might affect other states' Class I areas in 2002 indicated that Texas' emissions affect one or more Class I areas in New Mexico, Oklahoma, Colorado, Arkansas, Missouri, and Louisiana. This subsection presents the results of this review.

11.2.3.1 New Mexico

Emissions from the western portion of Texas account for most of Texas' impact on the Class I areas in New Mexico. The following graph in Figure 11-6 shows the impacts of the western portion of Texas on the Class I areas in New Mexico that are included in the CENRAP PSAT modeling. The graph provides the basis for choosing the New Mexico Class I areas for more detailed examination of Texas' impacts. Carlsbad Caverns National Park is not included in this graph since it has no regional haze monitor; instead, it uses data measured at Guadalupe Mountains National Park to assess the impact of regional haze on the park.

On February 13, 2008, the TCEQ approved the renewal of Air Quality Permit Number 20345 for the American Smelting and Refining Company (ASARCO) El Paso copper smelter. On February 6, 2009, the TCEQ received confirmation from ASARCO LLC that it intends to close the smelter and requests that TCEQ void all air permits and pending applications for the plant. The TCEQ voided these permits and applications on February 9, 2009 (See Appendix 11-4: *ASARCO El Paso*).

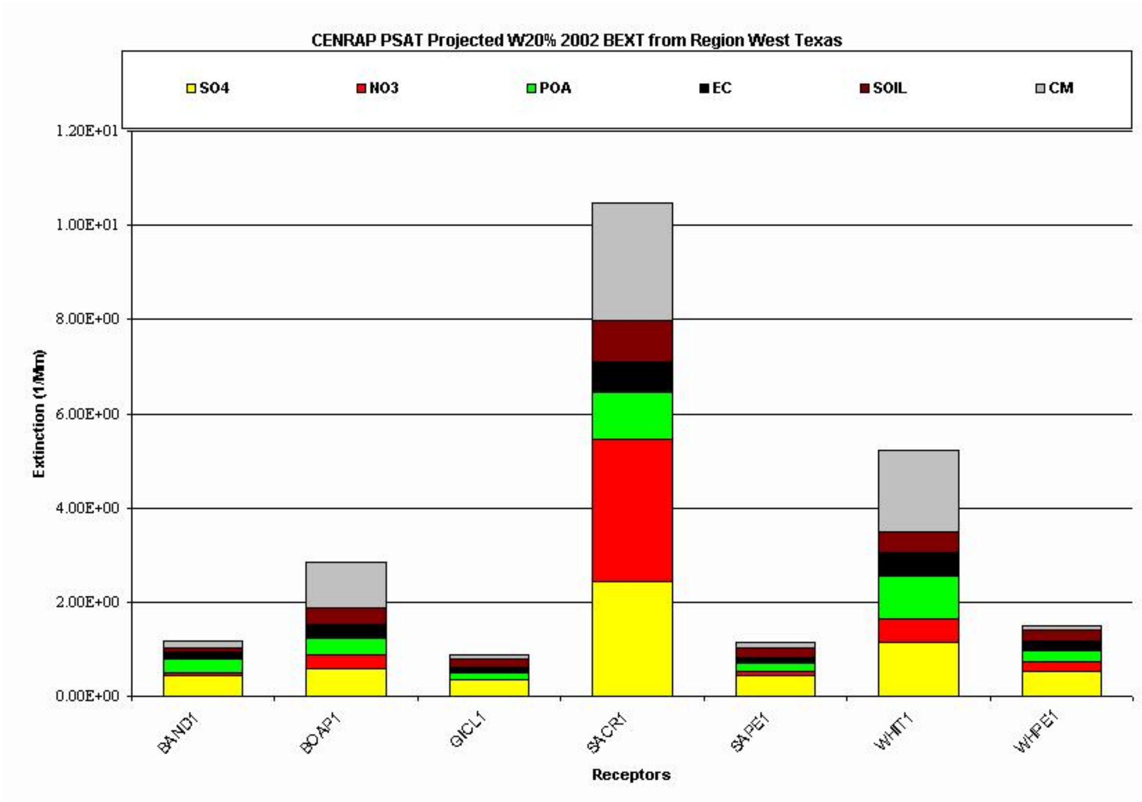


Figure 11-6: Calculated Regional Haze Impacts of Emissions from Western Areas of Texas at Class I Areas in New Mexico on Worst 20 Percent Days in 2002

BAND1 - Bandelier National Monument
BOAP1 - Bosque del Apache Wilderness Area
GICL1 - Gila Wilderness Area
SACR1 - Salt Creek Wilderness Area
SAPE1 - San Pedro Parks Wilderness Area
WHIT1 - White Mountain Wilderness Area
WHPE1 - Wheeler Peak Wilderness Area

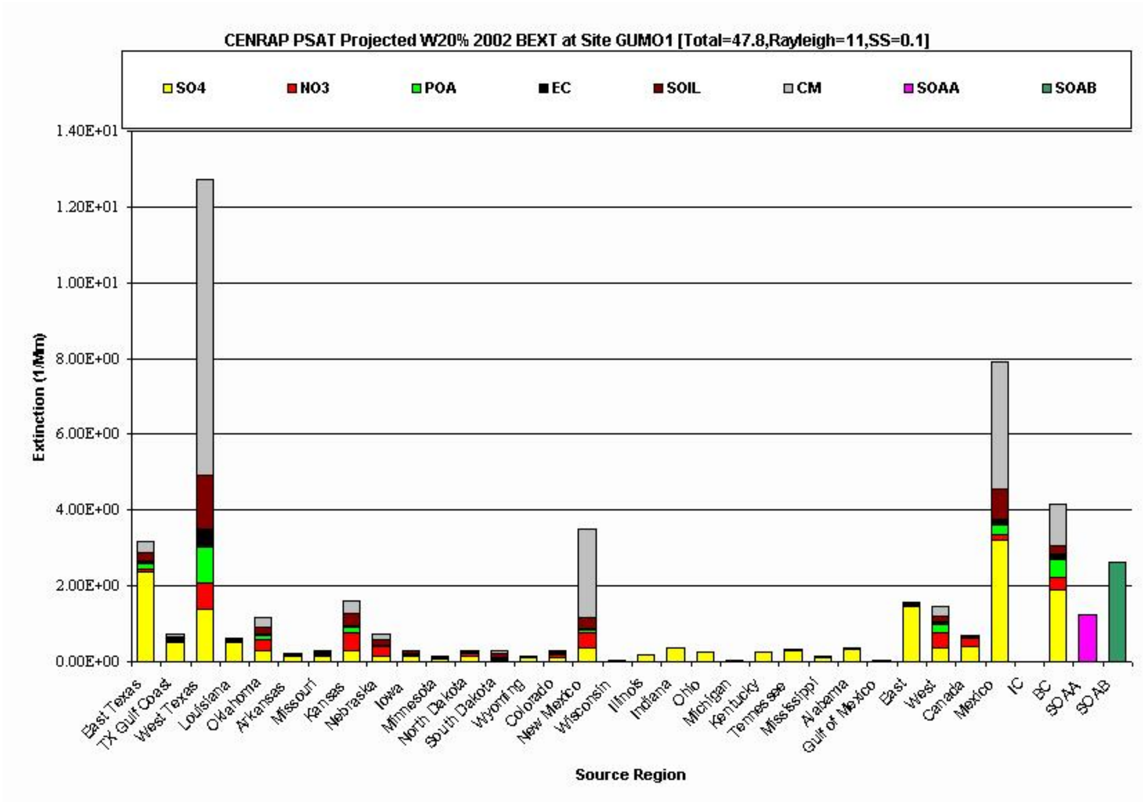


Figure 11-7: Areas and Pollutants Causing Regional Haze at Carlsbad Caverns National Park on Worst 20 Percent Days in 2002

Note: The impacts at Carlsbad Caverns National Park are calculated using the CENRAP PSAT tool for Guadalupe Mountains but using the EPA guidance for applying relative response factors (RRFs) since New Mexico is using modeled apportionment of coarse mass (CM) and fine soil (soil or FS). These calculations do not use the Texas assumptions for Guadalupe Mountains and Big Bend National Parks that the RRFs for CM and FS both equal one.

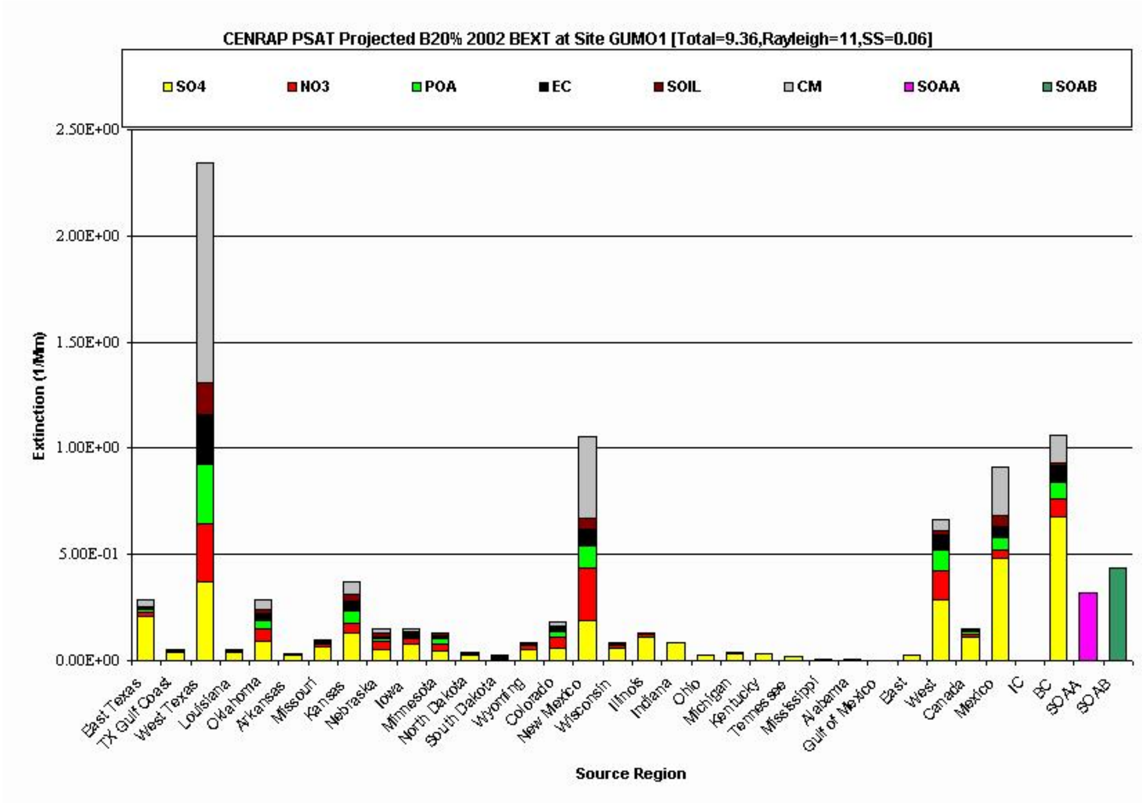


Figure 11-8: Areas and Pollutants Causing Regional Haze at Carlsbad Caverns National Park on Best 20 Percent Days in 2002

Note the change on the y-axis.

Table 11-3: Texas' Apportioned Contribution to the Measured 2002 and Projected 2018 Total Visibility Extinction at Carlsbad Caverns National Park on Worst 20 Percent Days

Particulate Matter Constituent	2002 Impacts at Carlsbad Caverns[2] (inverse megameters)		2018 Impacts at Carlsbad Caverns[2] (inverse megameters)	
	Texas Total	Total, All Source Areas	Texas Total	Total, All Source Areas
Sulfate	4.28	15.94	3.65	13.65
Nitrate	0.78	3.67	0.68	3.32
Primary Organic Aerosol	1.16	2.75	0.87	2.38
Elemental Carbon	0.53	1.19	0.28	0.86
Fine Soil	1.71	4.37	1.66	4.37
Coarse Mass	8.16	16.04	8.24	16.13
Secondary Organic Aerosol, Anthropogenic	not available[1]	1.23	not available[1]	1.16
Secondary Organic Aerosol, Biogenic	not available[1]	2.61	not available[1]	2.56
Total	16.62	47.80	15.39	44.43

[1] The CENRAP PSAT modeling did not apportion either the anthropogenic or the biogenic secondary organic aerosol (SOA). The reasons are (1) that sulfate and nitrate are generally the main causes of visibility impairment resulting from human activity and (2) that tracking the multiple volatile organic compound constituents and reaction products necessary to apportion SOA would have extended the modeling run times far beyond the time that was available for the modeling.

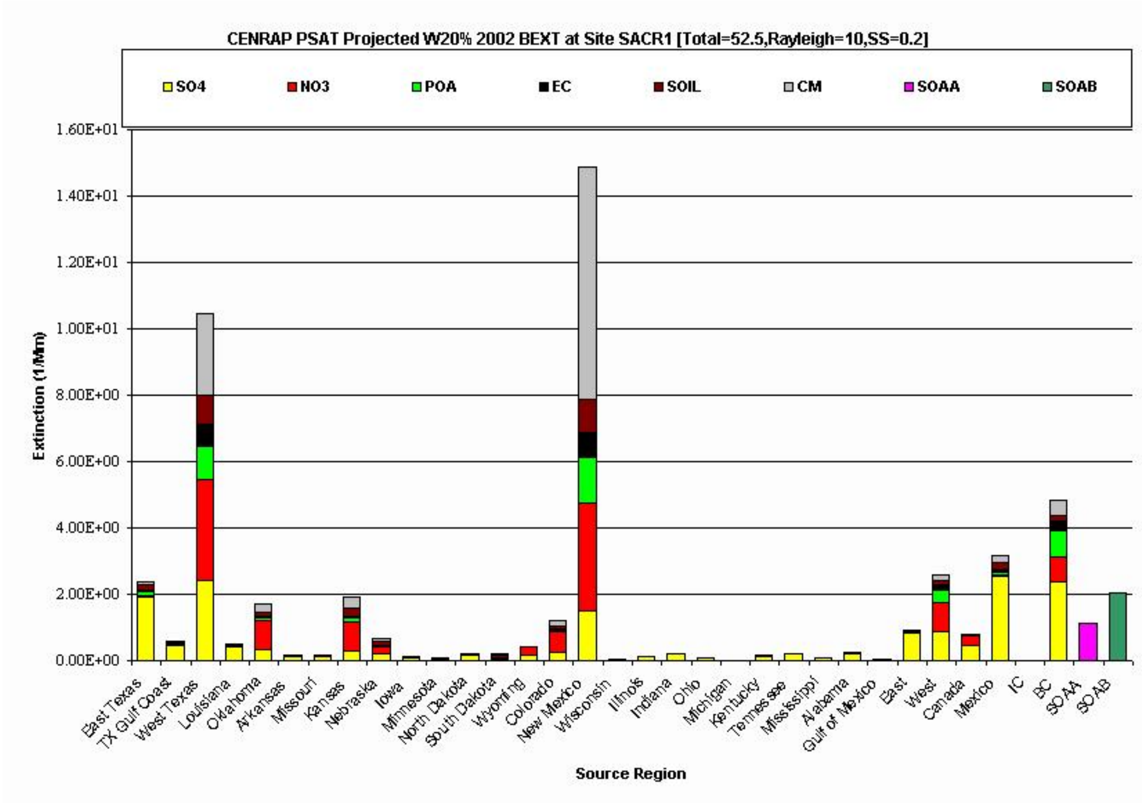


Figure 11-9: Areas and Pollutants Causing Regional Haze at Salt Creek (SACR) in New Mexico on Worst 20 Percent Days in 2002

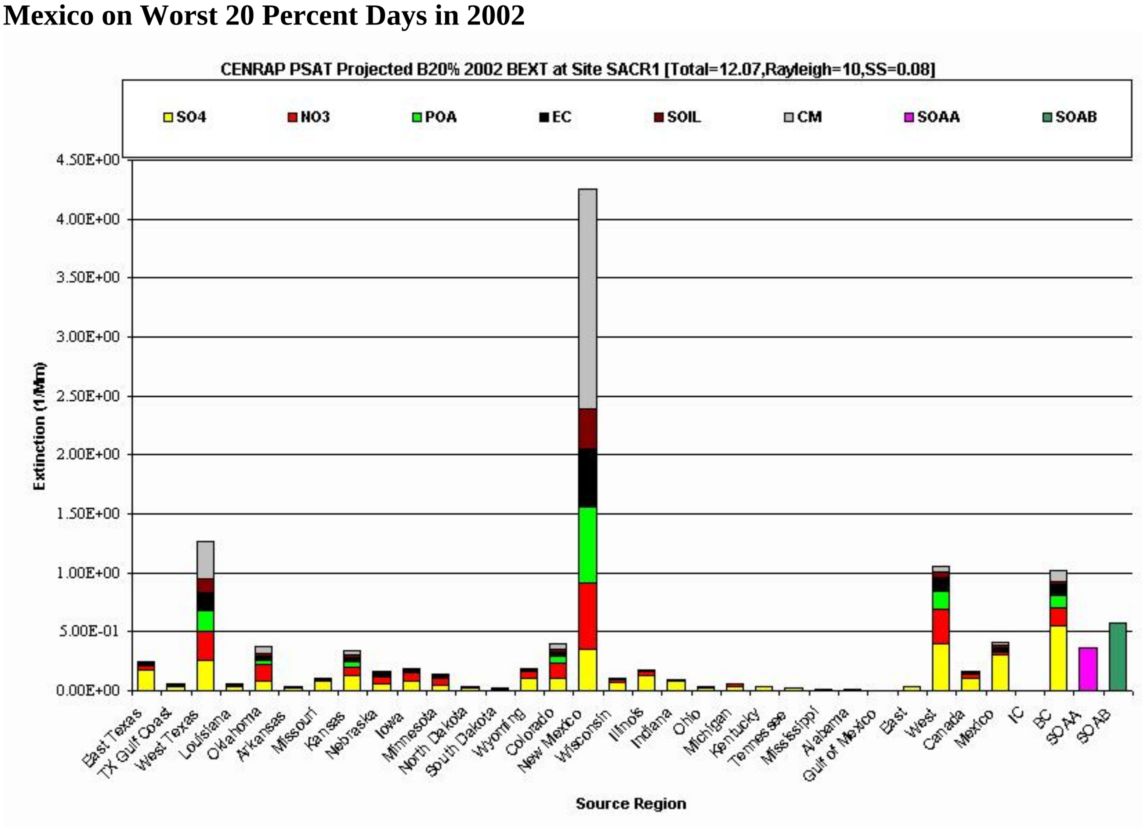


Figure 11-10: Areas and Pollutants Causing Regional Haze at Salt Creek (SACR) in New Mexico on Best 20 Percent Days in 2002

Note the change in scale on the y-axis.

Table 11-4: Texas' Apportioned Contribution to the Measured 2002 and Projected 2018 Total Visibility Extinction at Salt Creek Wilderness Area on Worst 20 Percent Days

Particulate Matter Constituent	2002 Impacts at Salt Creek (inverse megameters)		2018 Impacts at Salt Creek (inverse megameters)	
	Texas Total	Total, All Source Areas	Texas Total	Total, All Source Areas
Sulfate	4.79	16.75	3.50	13.75
Nitrate	3.05	11.15	2.43	9.81
Primary Organic Aerosol	1.17	4.31	0.69	2.99
Elemental Carbon	0.76	2.31	0.30	1.23
Fine Soil	1.06	3.34	0.96	3.41
Coarse Mass	2.58	11.47	2.36	12.52
Secondary Organic Aerosol, Anthropogenic	not available[1]	1.12	not available[1]	1.00
Secondary Organic Aerosol, Biogenic	not available[1]	2.06	not available[1]	1.95
Total	13.41	52.50	10.24	46.67

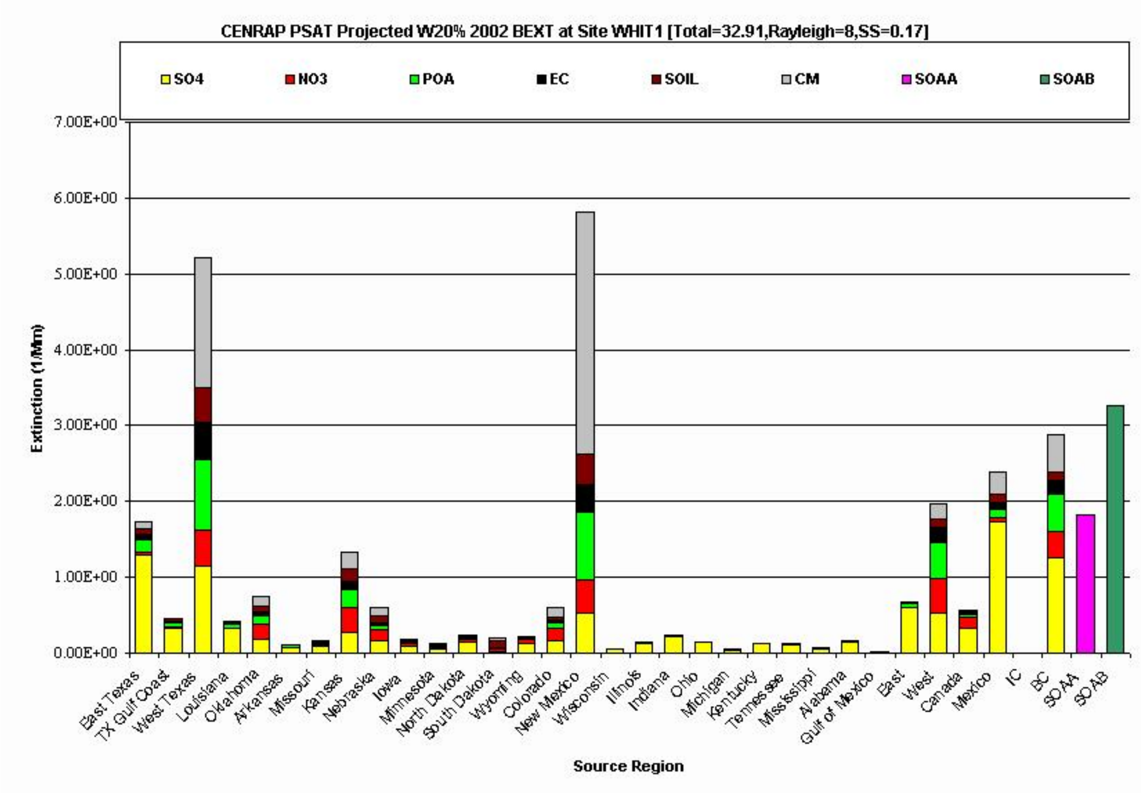


Figure 11-11: Areas and Pollutants Causing Regional Haze at White Mountain (WHIT) in New Mexico on Worst 20 Percent Days in 2002

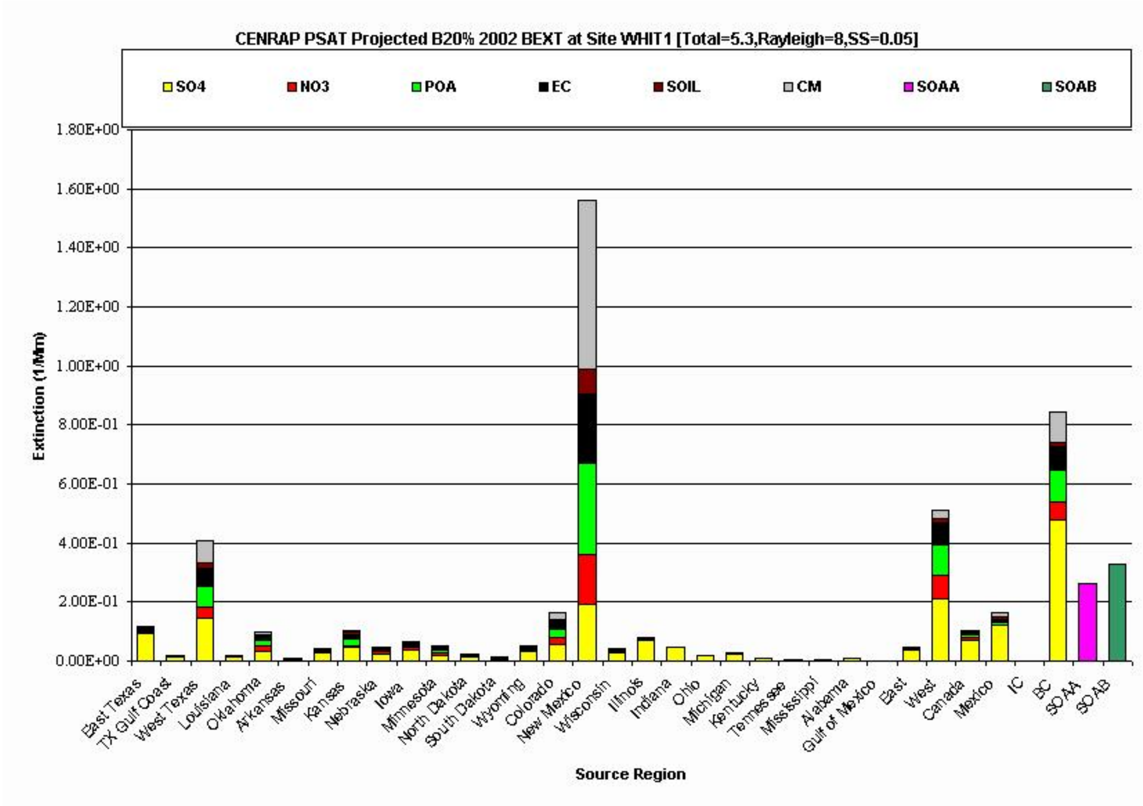


Figure 11-12: Areas and Pollutants Causing Regional Haze at White Mountain (WHIT) in New Mexico on Best 20 Percent Days in 2002

Note the change in scale on the y-axis.

Table 11-5: Texas' Apportioned Contribution to the Measured 2002 and Projected 2018 Total Visibility Extinction at White Mountain Wilderness Area on Worst 20 Percent Days

Particulate Matter Constituent	2002 Impacts at White Mountain (inverse megameters)		2018 Impacts at White Mountain (inverse megameters)	
	Texas Total	Total, All Source Areas	Texas Total	Total, All Source Areas
Sulfate	2.78	10.51	2.37	8.92
Nitrate	0.53	3.05	0.47	2.68
Primary Organic Aerosol	1.14	3.87	0.78	3.13
Elemental Carbon	0.59	1.82	0.27	1.08
Fine Soil	0.55	1.89	0.53	1.95
Coarse Mass	1.81	6.68	1.80	7.29
Secondary Organic Aerosol, Anthropogenic	not available[1]	1.83	not available[1]	1.64
Secondary Organic Aerosol, Biogenic	not available[1]	3.27	not available[1]	3.11
Total	7.40	32.91	6.22	29.80

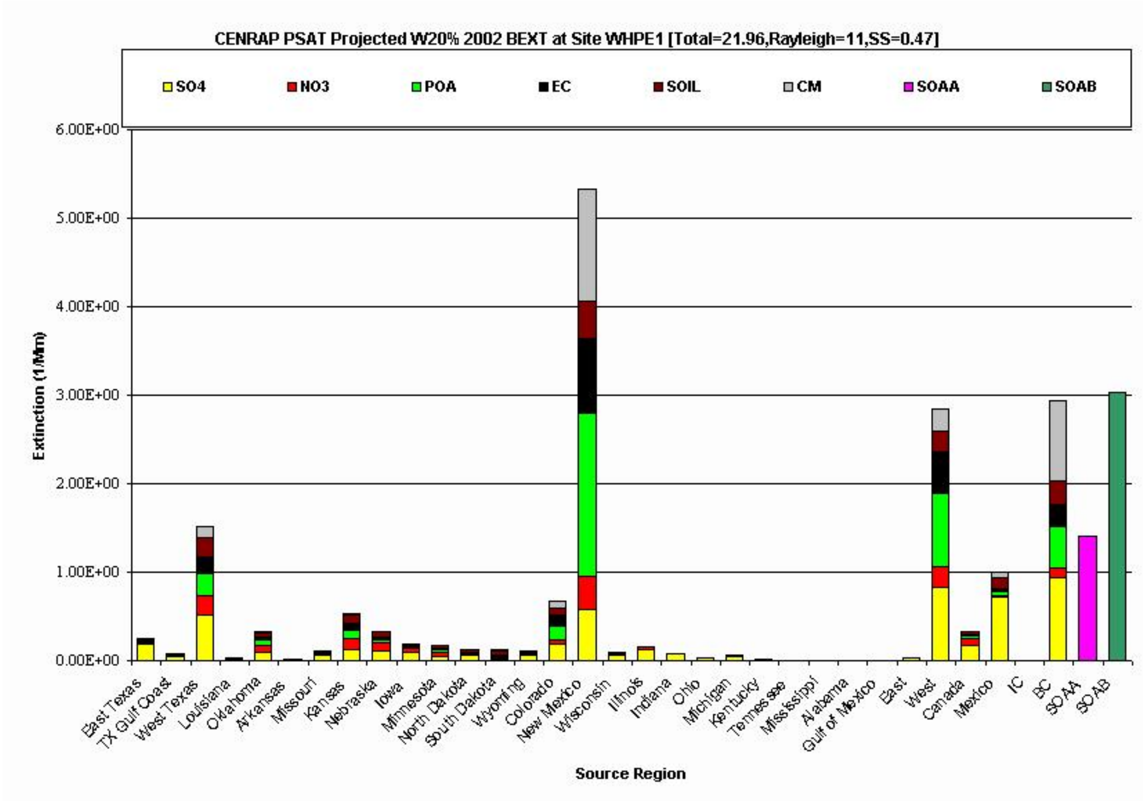


Figure 11-13: Areas and Pollutants Causing Regional Haze at Wheeler Peak Wilderness Area on Worst 20 Percent Days in 2002

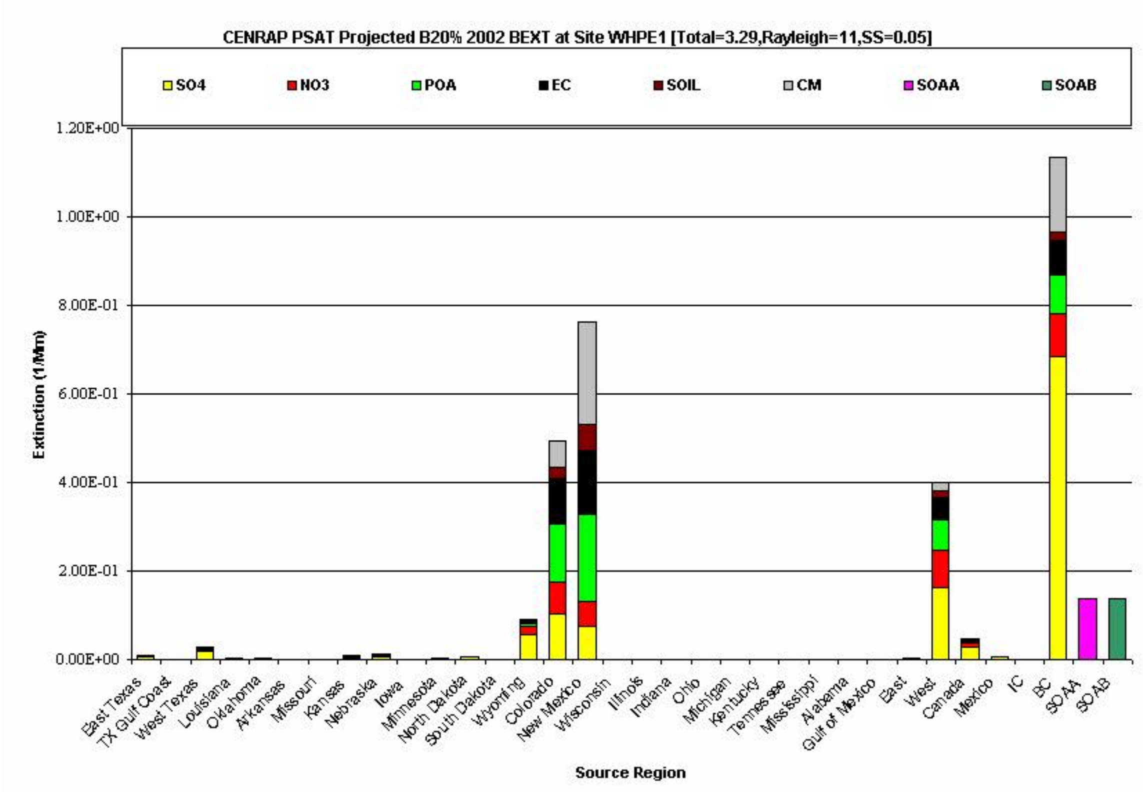


Figure 11-14: Areas and Pollutants Causing Regional Haze at Wheeler Peak Wilderness Area on Best 20 Percent Days in 2002

Note the change in scale on the y-axis.

Table 11-6: Texas' Apportioned Contribution to the Measured 2002 and Projected 2018 Total Visibility Extinction at Wheeler Peak Wilderness Area on Worst 20 Percent Days

Particulate Matter Constituent	2002 Impacts at Wheeler Peak (inverse megameters)		2018 Impacts at Wheeler Peak (inverse megameters)	
	Texas Total	Total, All Source Areas	Texas Total	Total, All Source Areas
Sulfate	0.76	5.27	0.79	5.00
Nitrate	0.22	1.64	0.19	1.48
Primary Organic Aerosol	0.28	3.93	0.18	3.64
Elemental Carbon	0.21	2.18	0.08	1.48
Fine Soil	0.25	1.75	0.23	1.88
Coarse Mass	0.12	2.77	0.12	3.09
Secondary Organic Aerosol, Anthropogenic	not available[1]	1.41	not available[1]	1.28
Secondary Organic Aerosol, Biogenic	not available[1]	3.03	not available[1]	2.96
Total	1.85	21.96	1.59	20.80

11.2.3.2 Oklahoma

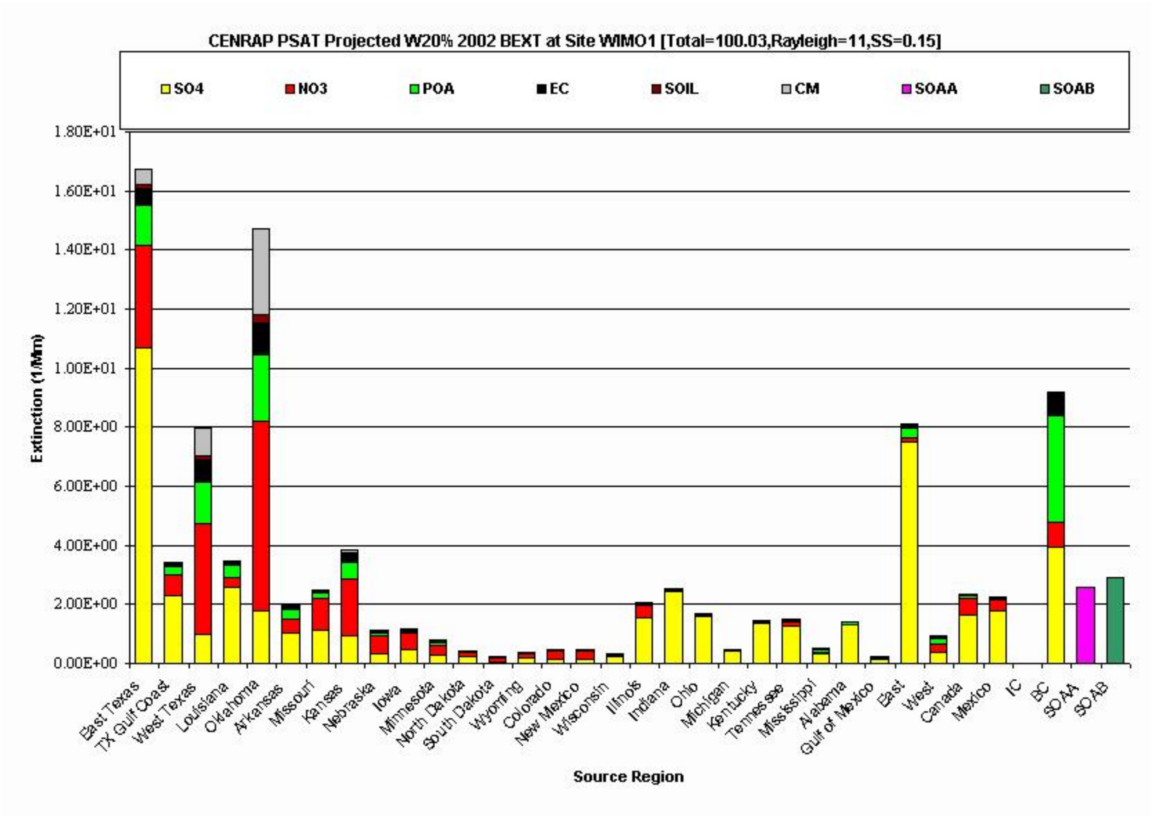


Figure 11-15: Areas and Pollutants Causing Regional Haze at Wichita Mountains (WIMO) in Oklahoma on Worst 20 Percent Days in 2002

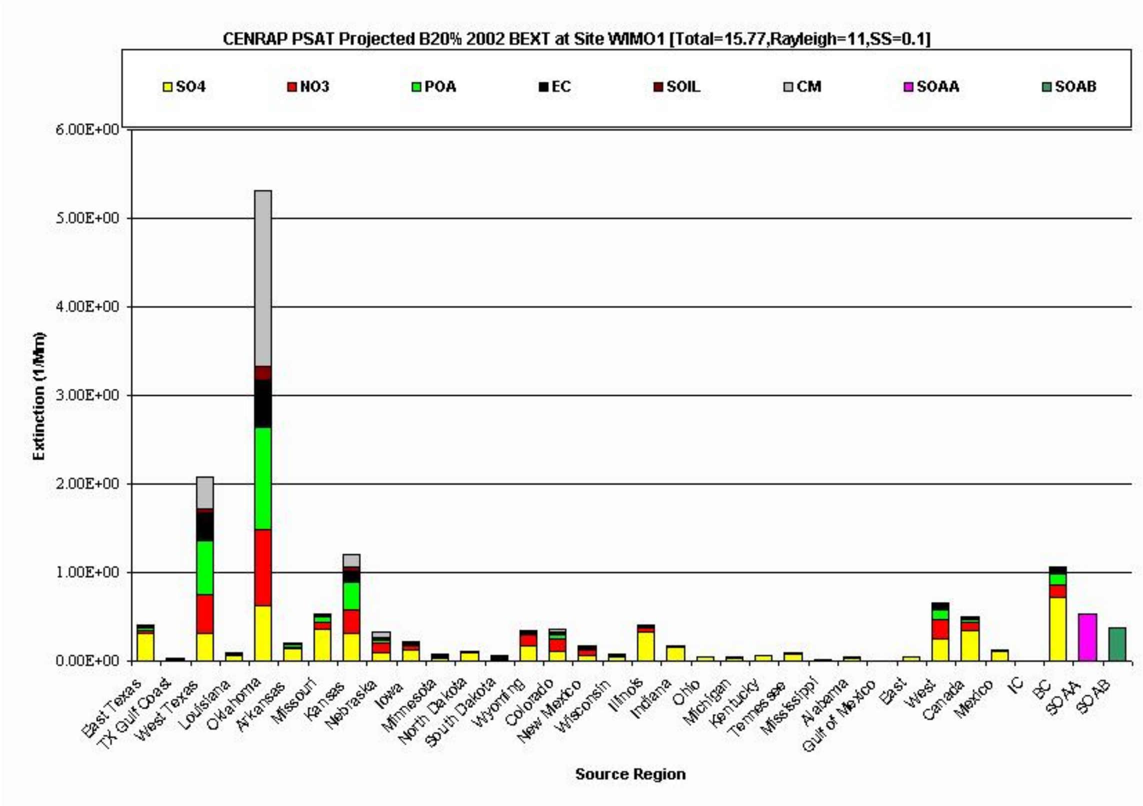


Figure 11-16: Areas and Pollutants Causing Regional Haze at Wichita Mountains (WIMO) in Oklahoma on Best 20 Percent Days in 2002
Note the change in scale on the y-axis.

Table 11-7: Texas' Apportioned Contribution to the Measured 2002 and Projected 2018 Total Visibility Extinction at Wichita Mountains Wilderness Area on Worst 20 Percent Days

Particulate Matter Constituent	2002 Impacts at Wichita Mountains (inverse megameters)		2018 Impacts at Wichita Mountains (inverse megameters)	
	Texas Total	Total, All Source Areas	Texas Total	Total, All Source Areas
Sulfate	13.98	49.12	9.68	33.33
Nitrate	7.89	23.72	6.08	18.10
Primary Organic Aerosol	3.05	11.81	2.57	10.92
Elemental Carbon	1.42	4.47	0.68	3.00
Fine Soil	0.29	0.79	0.30	0.79
Coarse Mass	1.51	4.64	1.49	4.35
Secondary Organic Aerosol, Anthropogenic	not available[1]	2.57	not available[1]	2.22
Secondary Organic Aerosol, Biogenic	not available[1]	2.91	not available[1]	2.84
Total	28.15	100.03	20.79	75.56

11.2.3.3 Colorado

Emissions from the western portion of Texas account for most of Texas' impact on the Class I areas in Colorado. The following graph in Figure 11-17 shows the impacts of the western portion of Texas on the Class I areas in Colorado that are included in the CENRAP PSAT modeling. The graph is to show the basis for choosing Great Sand Dunes as the Colorado Class I area for more detailed examination of Texas' impacts.

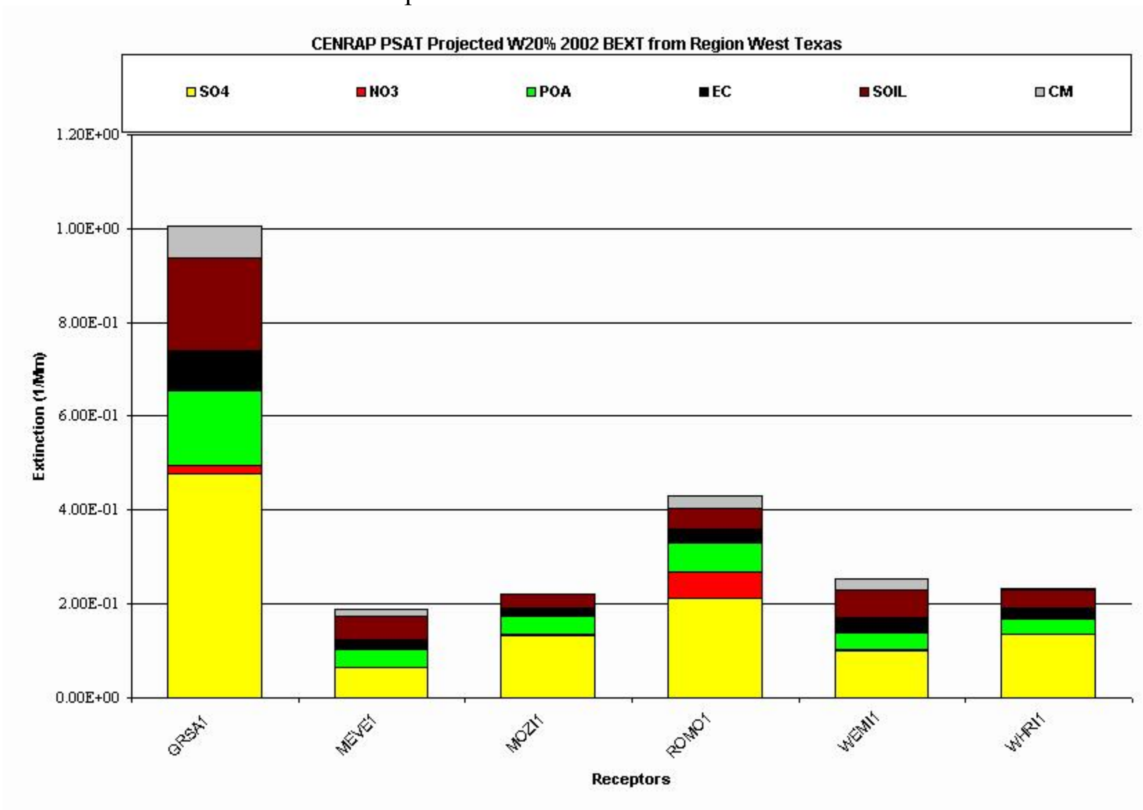


Figure 11-17: Calculated Regional Haze Impacts of West Texas Emissions at Each Class I Area in Colorado Included in CENRAP PSAT Modeling on Worst 20 Percent Days in 2002

GRSA - Great Sand Dunes National Park
MEVE - Mesa Verde National Park
MOZI - Mount Zirkel Wilderness Area
ROMO - Rocky Mountain National Park
WEMI - Weminuche Wilderness Area
WHRI - White River National Forest

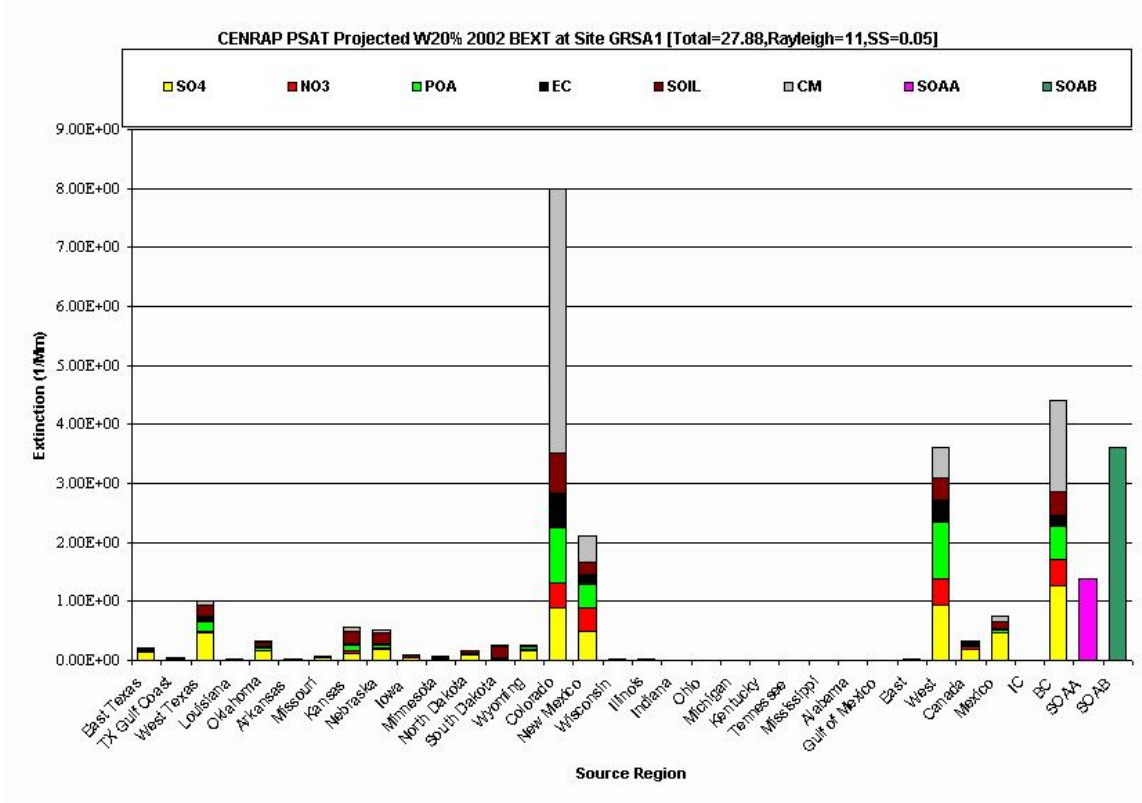


Figure 11-18: Areas and Pollutants Causing Regional Haze at Great Sand Dunes (GRSA) in Colorado on Worst 20 Percent Days in 2002

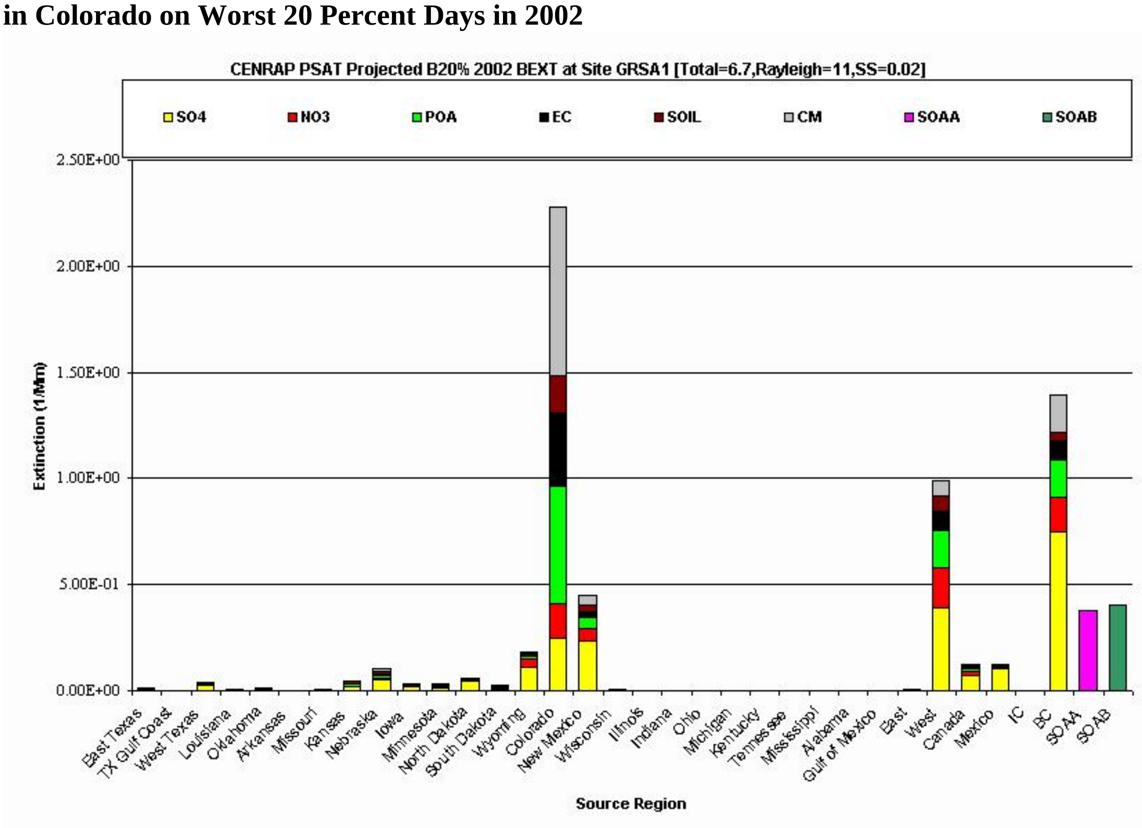


Figure 11-19: Areas and Pollutants Causing Regional Haze at Great Sand Dunes (GRSA) in Colorado on Best 20 Percent Days in 2002

Note the change in scale on the y-axis.

Table 11-8: Texas' Apportioned Contribution to the Measured 2002 and Projected 2018 Total Visibility Extinction at Great Sand Dunes Wilderness Area on Worst 20 Percent Days

Particulate Matter Constituent	2002 Impacts at Great Sand Dunes (inverse megameters)		2018 Impacts at Great Sand Dunes (inverse megameters)	
	Texas Total	Total, All Source Areas	Texas Total	Total, All Source Areas
Sulfate	0.66	5.84	0.65	5.32
Nitrate	0.02	1.94	0.02	1.83
Primary Organic Aerosol	0.18	3.34	0.12	3.07
Elemental Carbon	0.10	1.57	0.04	1.08
Fine Soil	0.23	2.84	0.21	2.95
Coarse Mass	0.07	7.36	0.07	7.69
Secondary Organic Aerosol, Anthropogenic	not available[1]	1.38	not available[1]	1.28
Secondary Organic Aerosol, Biogenic	not available[1]	3.61	not available[1]	3.56
Total	1.25	27.88	1.11	26.77

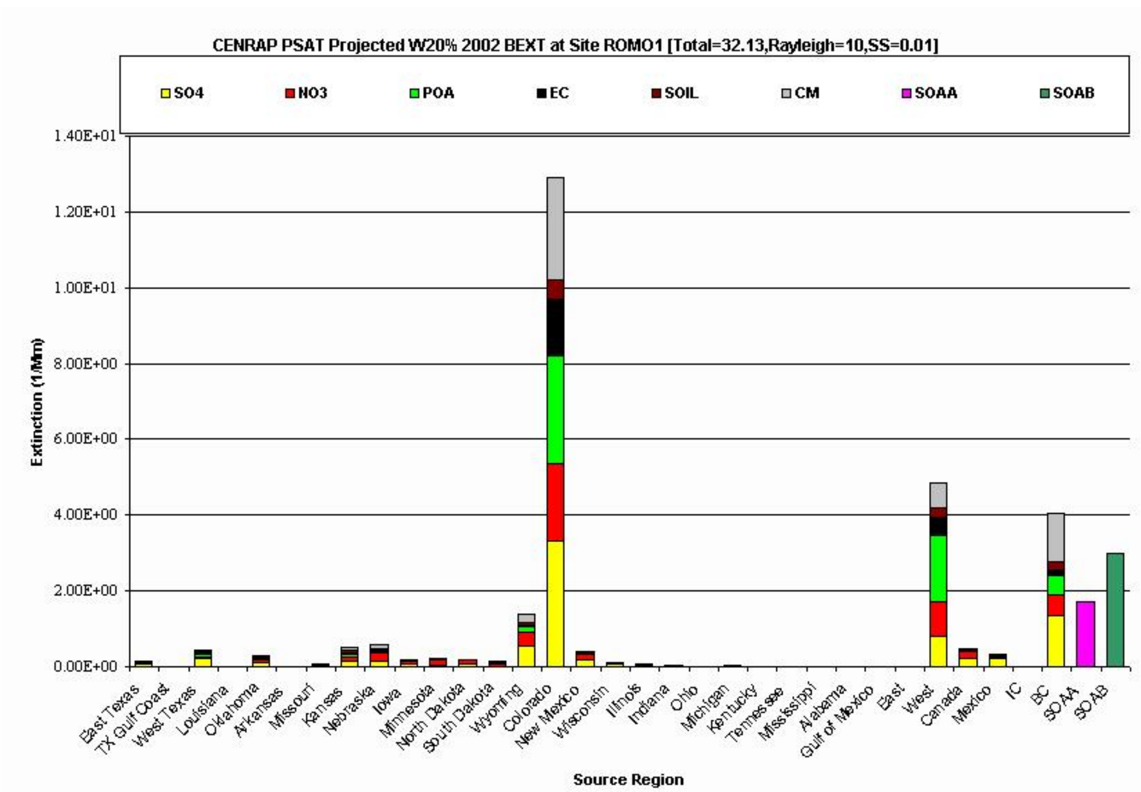


Figure 11-20: Areas and Pollutants Causing Regional Haze at Rocky Mountains National Park (ROMO) in Colorado on Worst 20 Percent Days in 2002

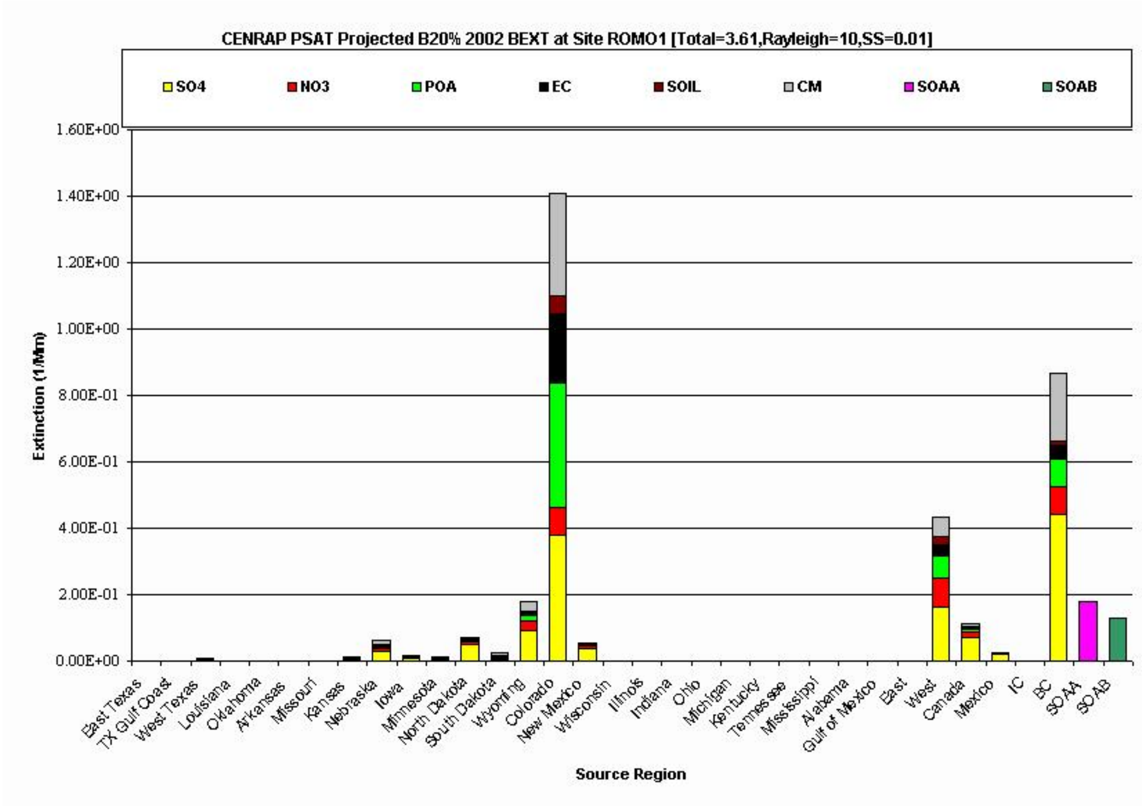


Figure 11-21: Areas and Pollutants Causing Regional Haze at Rocky Mountains National Park (ROMO) in Colorado on Best 20 Percent Days in 2002
Note the change in scale on the y-axis.

Table 11-9: Texas' Apportioned Contribution to the Measured 2002 and Projected 2018 Total Visibility Extinction at Rocky Mountain National Park on Worst 20 Percent Days

Particulate Matter Constituent	2002 Impacts at Rocky Mountain National Park (inverse megameters)		2018 Impacts at Rocky Mountain National Park (inverse megameters)	
	Texas Total	Total, All Source Areas	Texas Total	Total, All Source Areas
Sulfate	0.30	7.69	0.30	6.52
Nitrate	0.08	5.17	0.06	4.28
Primary Organic Aerosol	0.07	5.65	0.05	5.37
Elemental Carbon	0.03	2.33	0.02	1.54
Fine Soil	0.06	1.39	0.05	1.52
Coarse Mass	0.03	5.17	0.03	5.66
Secondary Organic Aerosol, Anthropogenic	not available[1]	1.73	not available[1]	1.60
Secondary Organic Aerosol, Biogenic	not available[1]	3.00	not available[1]	2.91
Total	0.58	32.13	0.51	29.41

11.2.3.4 Arkansas

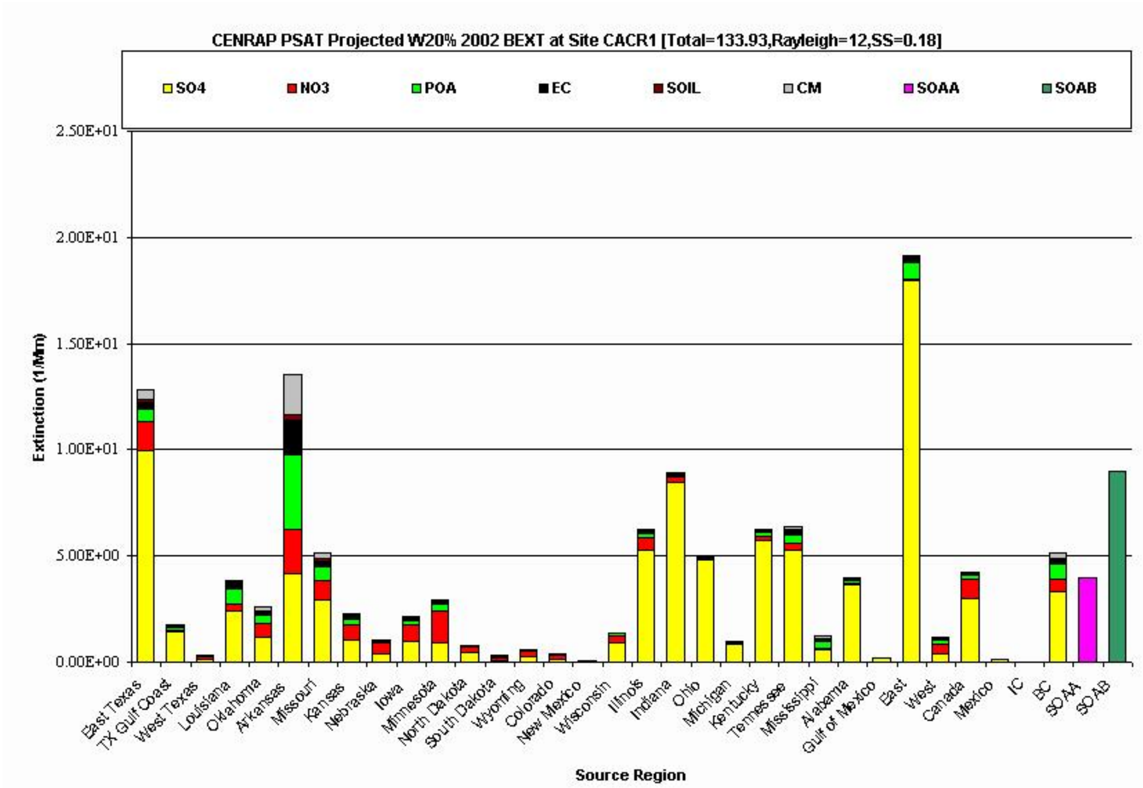


Figure 11-22: Areas and Pollutants Causing Regional Haze at Caney Creek (CACR) in Arkansas on Worst 20 Percent Days in 2002

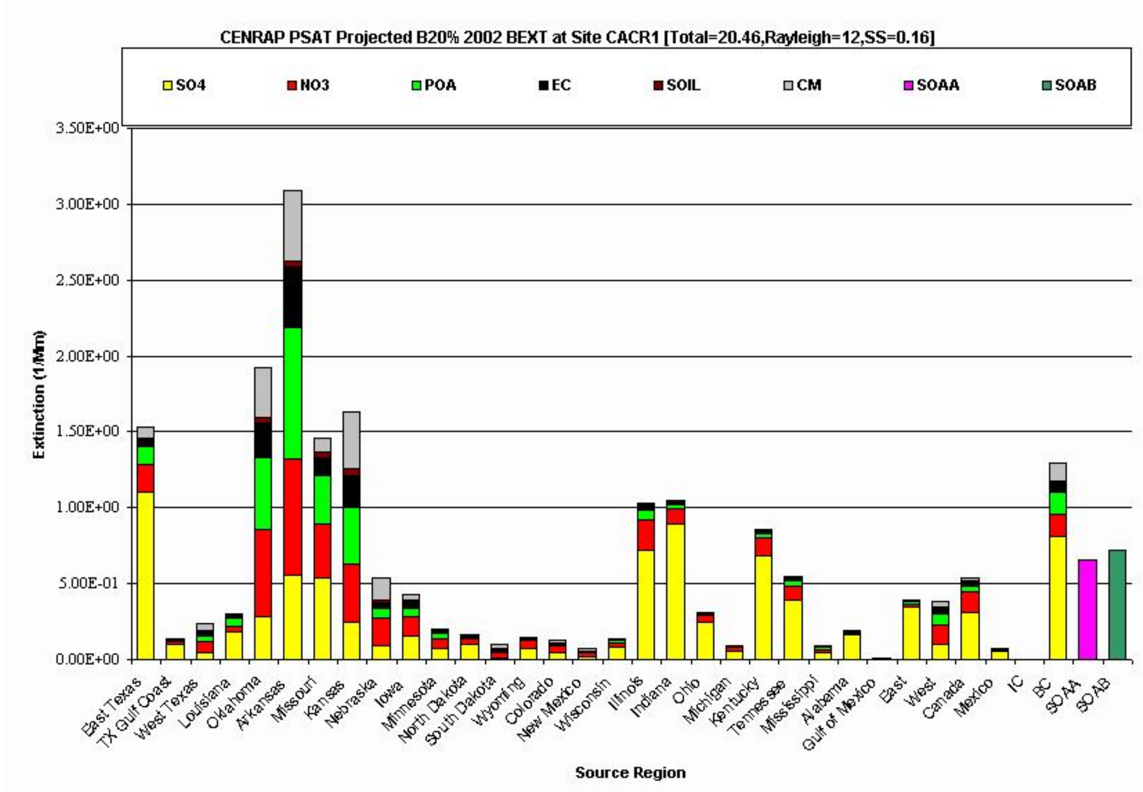


Figure 11-23: Areas and Pollutants Causing Regional Haze at Caney Creek (CACR) in Arkansas on Best 20 Percent of Days in 2002
Note the change in scale on the y-axis.

Table 11-10: Texas' Apportioned Contribution to the Measured 2002 and Projected 2018 Total Visibility Extinction at Caney Creek Wilderness Area on Worst 20 Percent Days

Particulate Matter Constituent	2002 Impacts at Caney Creek (inverse megameters)		2018 Impacts at Caney Creek (inverse megameters)	
	Texas Total	Total, All Source Areas	Texas Total	Total, All Source Areas
Sulfate	11.55	87.05	7.24	48.95
Nitrate	1.49	13.78	0.83	7.57
Primary Organic Aerosol	0.83	10.50	0.83	9.93
Elemental Carbon	0.36	4.80	0.20	3.17
Fine Soil	0.15	1.12	0.17	1.29
Coarse Mass	0.50	3.73	0.47	3.58
Secondary Organic Aerosol, Anthropogenic	not available[1]	3.94	not available[1]	3.21
Secondary Organic Aerosol, Biogenic	not available[1]	9.00	not available[1]	8.14
Total	14.89	133.93	9.74	85.84

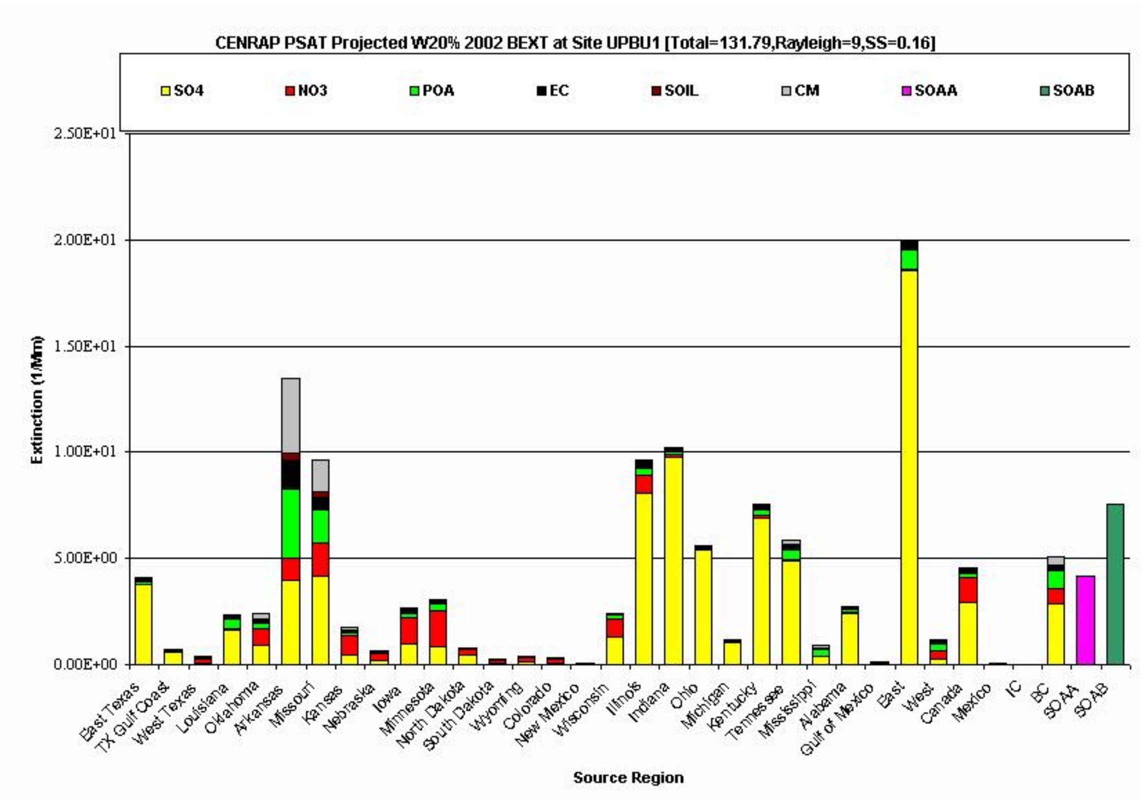


Figure 11-24: Areas and Pollutants Causing Regional Haze at Upper Buffalo (UPBU) in Arkansas on Worst 20 Percent Days in 2002

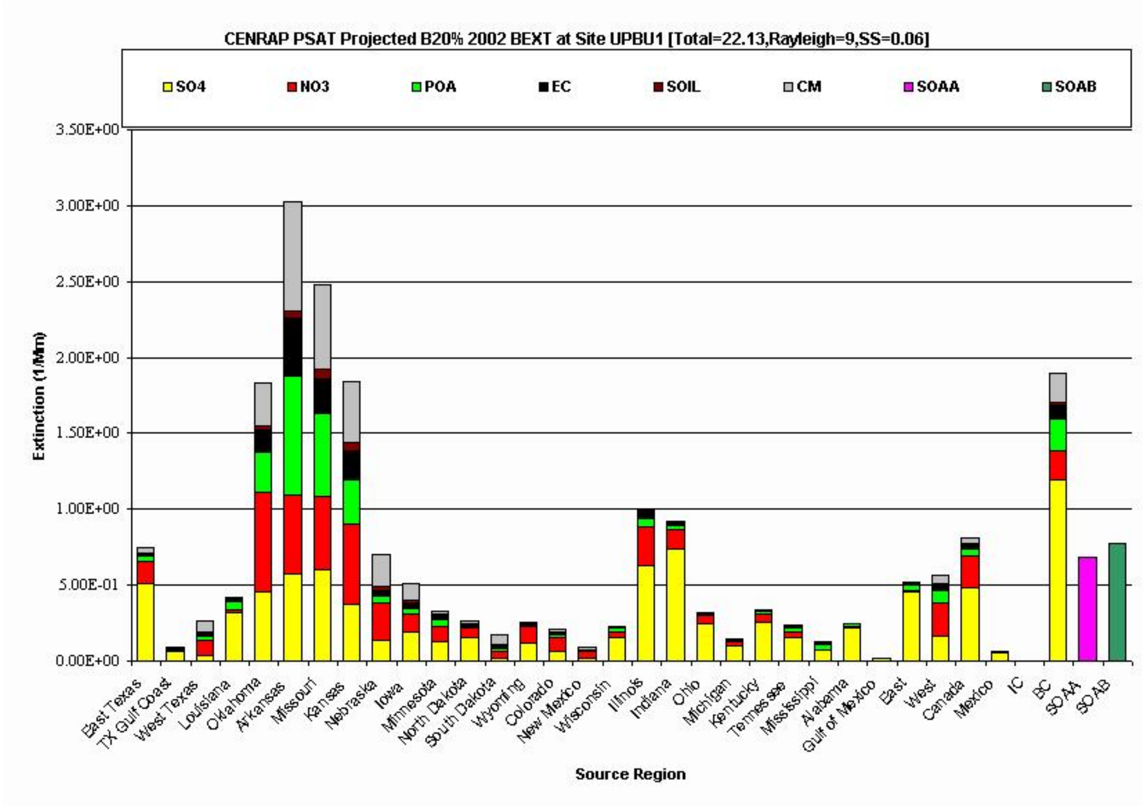


Figure 11-25: Areas and Pollutants Causing Regional Haze at Upper Buffalo (UPBU) in Arkansas on Best 20 Percent Days in 2002

Note the change in scale on the y-axis.

Table 11-11: Texas' Apportioned Contribution to the Measured 2002 and Projected 2018 Total Visibility Extinction at Upper Buffalo Wilderness Area on Worst 20 Percent Days

Particulate Matter Constituent	2002 Impacts at Upper Buffalo (inverse megameters)		2018 Impacts at Upper Buffalo (inverse megameters)	
	Texas Total	Total, All Source Areas	Texas Total	Total, All Source Areas
Sulfate	4.41	83.18	2.74	45.38
Nitrate	0.27	13.30	0.18	9.22
Primary Organic Aerosol	0.24	10.85	0.24	10.17
Elemental Carbon	0.10	4.72	0.05	3.07
Fine Soil	0.04	1.21	0.05	1.40
Coarse Mass	0.12	6.85	0.11	6.53
Secondary Organic Aerosol, Anthropogenic	not available[1]	4.14	not available[1]	3.36
Secondary Organic Aerosol, Biogenic	not available[1]	7.55	not available[1]	7.02
Total	5.19	131.79	3.38	86.16

11.2.3.5 Missouri

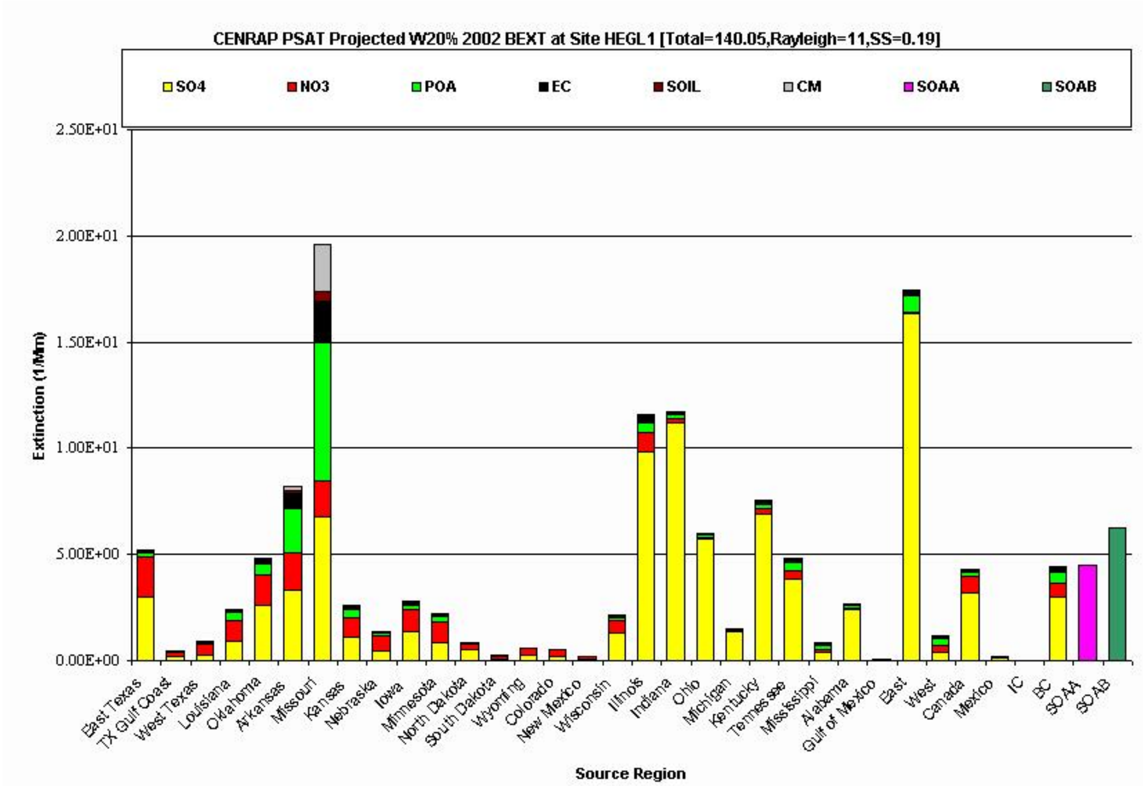


Figure 11-26: Areas and Pollutants Causing Regional Haze at Hercules-Glades (HEGL) in Missouri on Worst 20 Percent Days in 2002

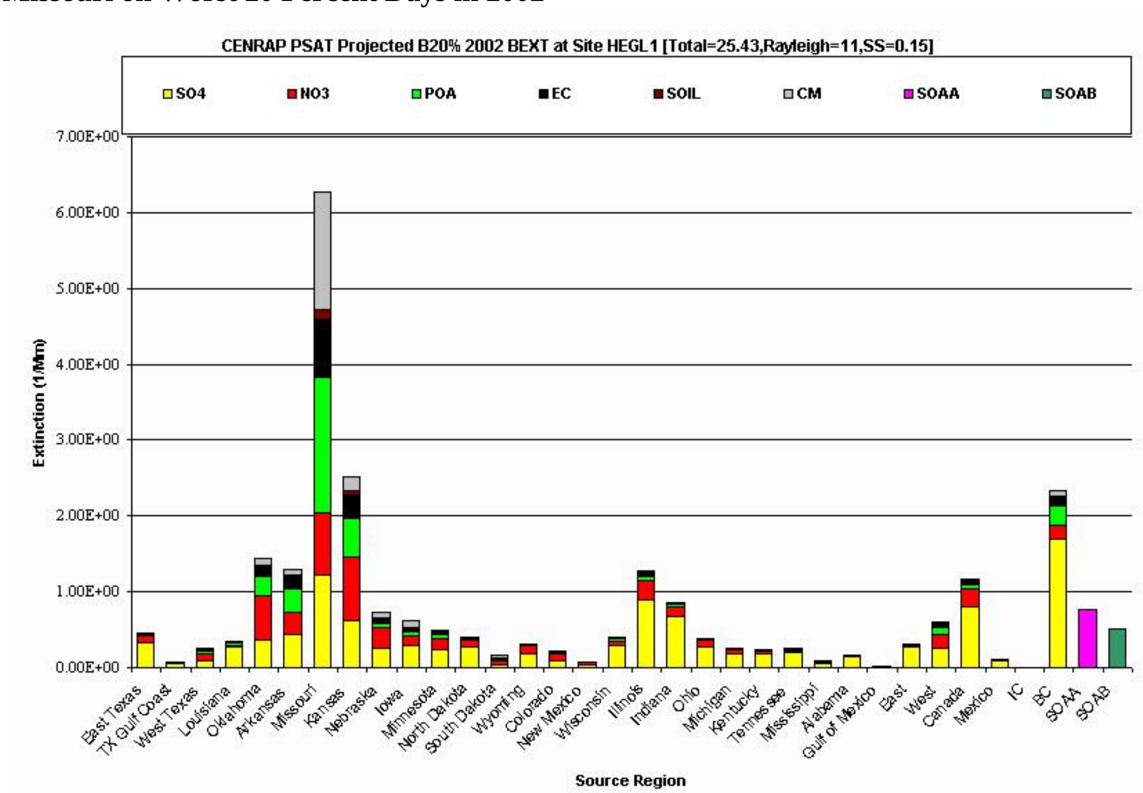


Figure 11-27: Areas and Pollutants Causing Regional Haze at Hercules-Glades (HEGL) in Missouri on the Best 20 Percent of Days 2002

Note the change in scale on the y-axis.

Table 11-12: Texas' Apportioned Contribution to the Measured 2002 and Projected 2018 Total Visibility Extinction at Hercules-Glades Wilderness Area on Worst 20 Percent Days

Particulate Matter Constituent	2002 Impacts at Hercules-Glades (inverse megameters)		2018 Impacts at Hercules-Glades (inverse megameters)	
	Texas Total	Total, All Source Areas	Texas Total	Total, All Source Areas
Sulfate	3.48	87.94	2.51	50.63
Nitrate	2.56	17.91	1.51	12.35
Primary Organic Aerosol	0.33	14.55	0.28	12.95
Elemental Carbon	0.12	5.22	0.06	3.51
Fine Soil	0.03	0.92	0.03	1.00
Coarse Mass	0.06	2.78	0.06	2.48
Secondary Organic Aerosol, Anthropogenic	not available[1]	4.50	not available[1]	3.76
Secondary Organic Aerosol, Biogenic	not available[1]	6.22	not available[1]	5.83
Total	6.59	140.05	4.45	92.49

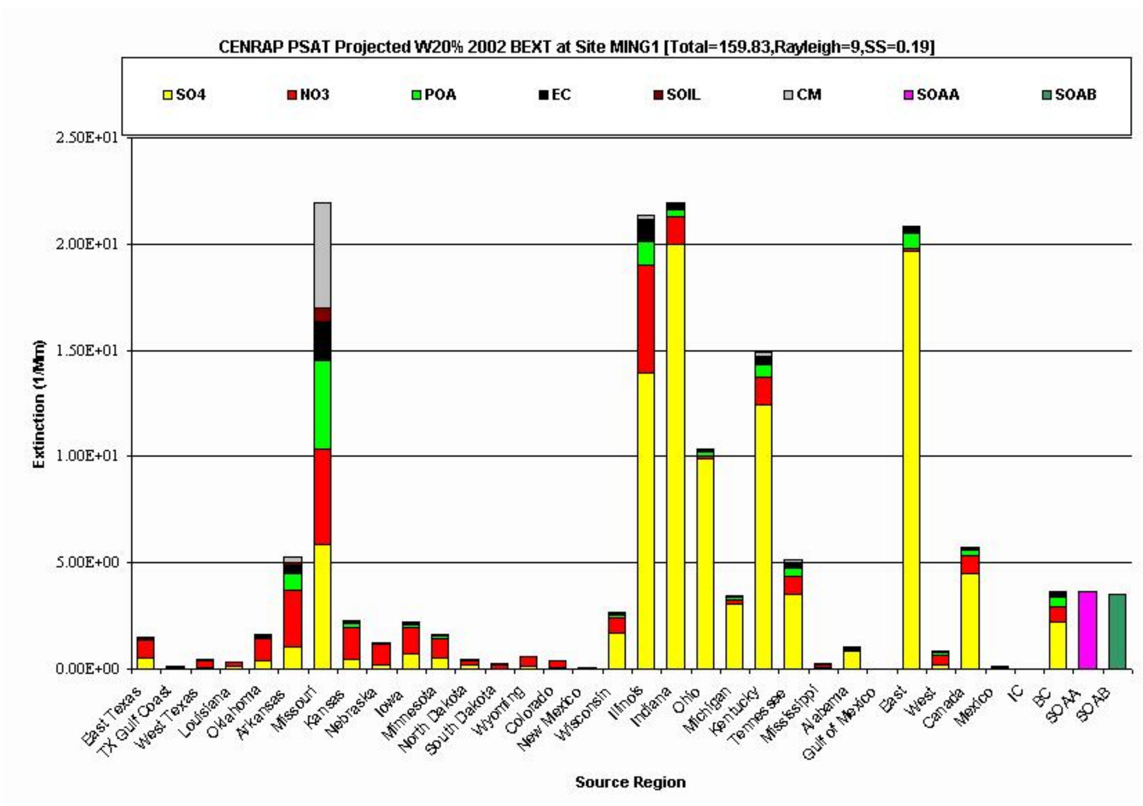


Figure 11-28: Areas and Pollutants Causing Regional Haze at Mingo (MING) in Missouri on Worst 20 Percent Days in 2002

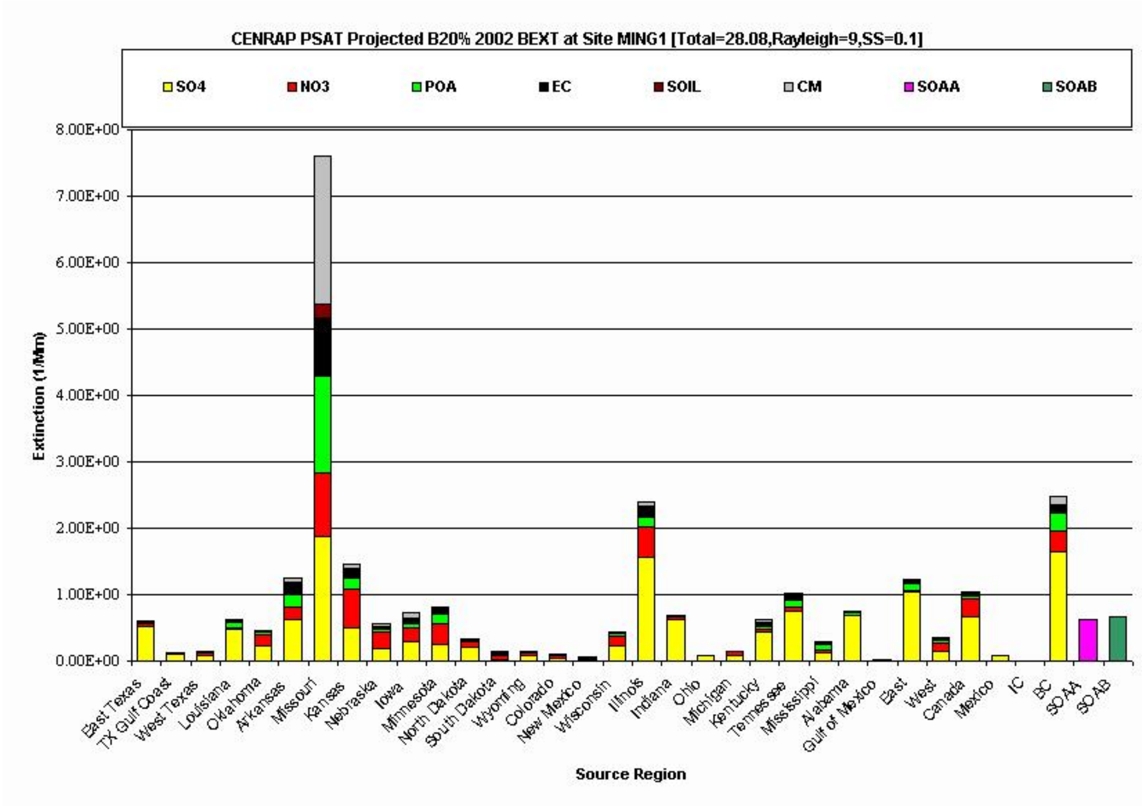


Figure 11-29: Areas and Pollutants Causing Regional Haze at Mingo (MING) in Missouri on Best 20 Percent Days in 2002
Note the change in scale on the y-axis.

Table 11-13: Texas' Apportioned Contribution to the Measured 2002 and Projected 2018 Total Visibility Extinction at Mingo Wilderness Area on Worst 20 Percent Days

Particulate Matter Constituent	2002 Impacts at Mingo (inverse megameters)		2018 Impacts at Mingo (inverse megameters)	
	Texas Total	Total, All Source Areas	Texas Total	Total, All Source Areas
Sulfate	0.69	102.52	0.53	54.45
Nitrate	1.18	27.24	0.64	19.14
Primary Organic Aerosol	0.07	10.21	0.06	9.09
Elemental Carbon	0.03	5.49	0.02	3.53
Fine Soil	0.01	1.26	0.01	1.44
Coarse Mass	0.02	5.95	0.02	5.31
Secondary Organic Aerosol, Anthropogenic	not available[1]	3.66	not available[1]	3.04
Secondary Organic Aerosol, Biogenic	not available[1]	3.50	not available[1]	3.25
Total	2.01	159.83	1.28	99.24

11.2.3.6 Louisiana

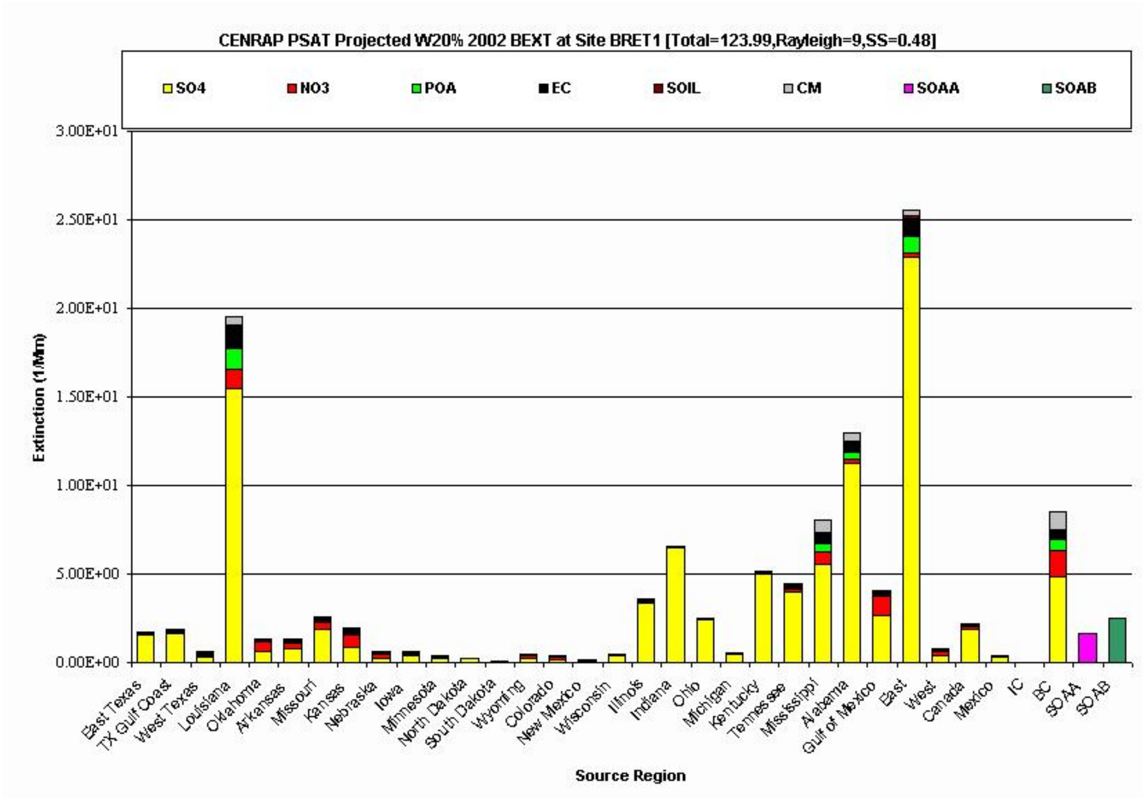


Figure 11-30: Areas and Pollutants Causing Regional Haze at Breton Wilderness Area (BRET) in Louisiana on Worst 20 Percent Days in 2002

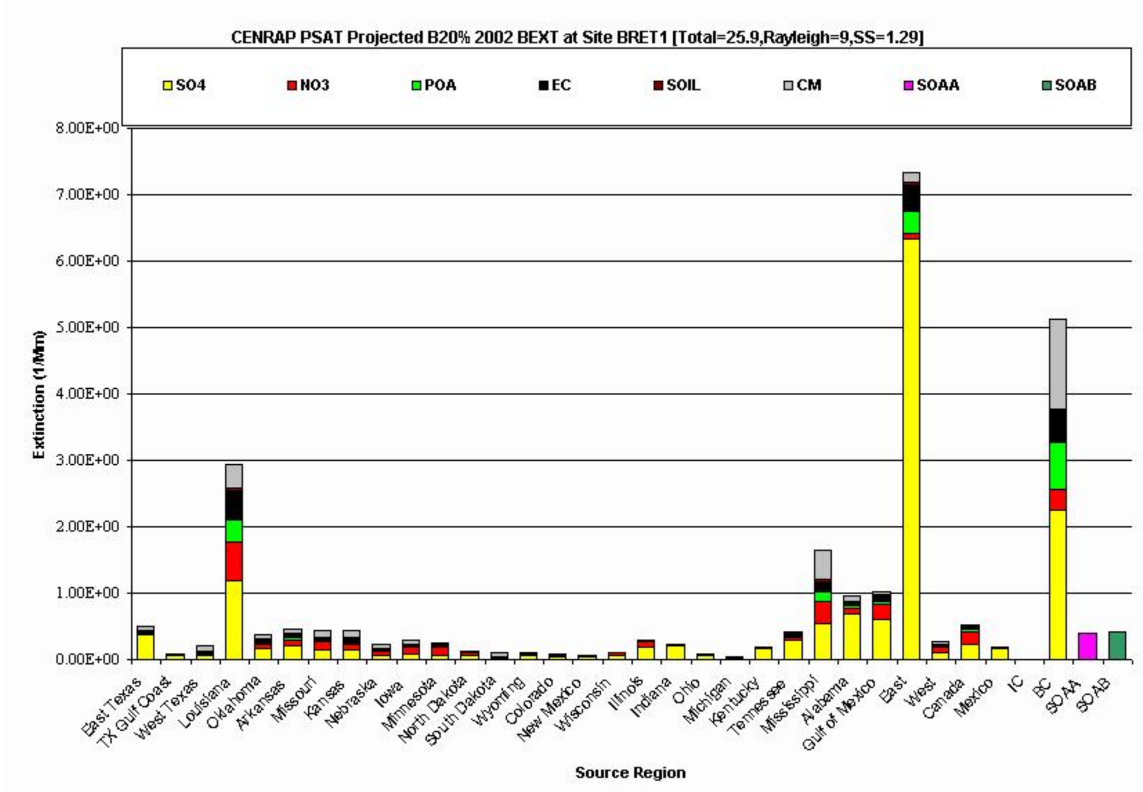


Figure 11-31: Areas and Pollutants Causing Regional Haze at Breton Wilderness Area (BRET) in Louisiana on Best 20 Percent Days in 2002

Note the change in scale on the y-axis.

Table 11-14: Texas' Apportioned Contribution to the Measured 2002 and Projected 2018 Total Visibility Extinction at Breton Wilderness Area on Worst 20 Percent Days

Particulate Matter Constituent	2002 Impacts at Breton Wilderness Area (inverse megameters)		2018 Impacts at Breton Wilderness Area (inverse megameters)	
	Texas Total	Total, All Source Areas	Texas Total	Total, All Source Areas
Sulfate	3.55	96.83	2.66	68.63
Nitrate	0.15	8.29	0.16	8.20
Primary Organic Aerosol	0.12	4.71	0.11	4.37
Elemental Carbon	0.14	5.40	0.06	3.92
Fine Soil	0.05	0.95	0.05	1.16
Coarse Mass	0.19	3.70	0.18	3.95
Secondary Organic Aerosol, Anthropogenic	not available[1]	1.63	not available[1]	1.38
Secondary Organic Aerosol, Biogenic	not available[1]	2.48	not available[1]	2.46
Total	4.20	123.99	3.23	94.06

11.3 REQUEST FOR FEDERAL EFFORTS TO REDUCE INTERNATIONAL TRANSPORT

Figures 11-2 and 11-4 show the CENRAP PSAT results apportioning the causes of 2000-2004 regional haze on the worst 20 percent visibility days at Big Bend and Guadalupe Mountains, based on the 2002 base period modeling. The figures show large contributions from anthropogenic sources categorized as from Mexico and from the boundary conditions outside the CENRAP modeling domain. The boundary conditions domain includes some of central Mexico, all of southern Mexico, most of the Mexican Yucatan, and all of Central America. Chapter 8: *Modeling Assessment* describes the modeling in more detail. These results are directionally consistent with federal studies that have previously found substantial international pollutant transport impacts on regional haze at Big Bend. These studies include the Big Bend Regional Aerosol and Visibility Observational (BRAVO) study of regional haze impacts at Big Bend and a number of National Park Service (NPS) studies in the 1990s that relied on back trajectory analysis to determine where air accumulated regional haze on its way to Big Bend (NPS et al. 2004). Figure 11-4 shows that the CENRAP PSAT modeling calculates that international transport contributes over 25 percent of the regional haze on the worst 20 percent of days during the base period at Guadalupe Mountains. Figures 11-9 and 11-15 show that international transport contributes over ten percent of the regional haze on the worst 20 percent of days at Salt Creek and Wichita Mountains. At Caney Creek, the international transport contribution to regional haze on the worst 20 percent of days is over five percent of the total (after discounting coarse mass, which the model does not represent reliably) (ENVIRON 2007).

CENRAP modeling estimates of the base period visibility impairment at Big Bend from the United States and foreign contributions indicate 52 percent of the light extinction at Big Bend on the worst 20 percent of regional haze days comes from international transport. The concentrations are adjusted to match the visibility extinction measured for the 2000 through 2005 base period.

Due to the large impact of international transport on anthropogenic regional haze in Texas, it will be impossible to reach natural conditions at the two Class I areas in Texas without reductions in international impacts to parallel the reductions in United States anthropogenic regional haze impacts on Texas' two Class I areas. Although the impact of international transport on Class I areas in the states bordering Texas is approximately ten percent or less of the total impairment, reductions in international transport of anthropogenic regional haze will also be needed for the Class I areas in these states to reach the natural conditions goal.

The TCEQ requests that the EPA initiate and pursue federal efforts to reduce international transport of visibility impairing pollutants into Texas.

11.4 MINIMIZING VISIBILITY IMPAIRMENT FROM TEXAS EMISSIONS

The TCEQ has implemented rules that limit and minimize emissions causing both local and regional visibility impairment. The Texas SIP includes numerous rules that minimize emissions that cause or contribute to local and regional visibility impairment. The TCEQ plans to continue to implement all these rules that protect visibility at Class I areas in Texas and other states (Appendices 11-2 and 11-3).

11.4.1 Opacity Limitations

Title 30 TAC Chapter 111, Control of Air Pollution from Visible Emissions and Particulate Matter, limits visible emissions and mass emissions from industrial and power plant stacks, motor vehicles, and incinerators. Together with opacity limits in many preconstruction permits, these rules limit the emissions of PM from a wide variety of sources. The TCEQ continues to enforce both the rule and permit limits on opacity and PM emissions from electric generating units (EGUs) and other sources.

11.4.2 Sulfur Emission Limitations

Title 30 TAC Chapter 112 Control of Air Pollution from Sulfur Compounds limits sulfur dioxide, hydrogen sulfide, total reduced sulfur compounds, and sulfuric acid from a variety of sources including EGUs, sulfuric acid plants, smelters, and sulfur recovery units. These rules, together with many lower limitations in permits for new and modified sources, limit the impacts of ammonium sulfate from Texas on the Class I areas in Texas and at the Class I areas in other states that Texas' emissions impact.

11.4.3 Best Available Control Technology (BACT) Requirements

BACT requirements have been in effect since 1972 for new and modified sources of air pollution for SO_2, NO_X, PM, and VOC. While federal new source review (NSR) rules requiring BACT apply only to major new sources or modifications, Texas law requires BACT for all emissions increases at new or modified units. The basic requirement is that each new and modified source of air pollution built in Texas use BACT to minimize or eliminate emissions of all pollutants subject to the national ambient air quality standards (NAAQS). This includes all the emissions from human activity that contribute to regional haze, including NO_X, SO_2, PM, and VOC. Title 30 TAC Chapter 116: Control of Air Pollution by Permits for New Construction or Modification contains these requirements.

Each applicable source must obtain a construction permit before beginning construction. Issuance of a construction permit can occur only after an engineering determination that the facility will use BACT. In some cases, the BACT requirements apply through permits by rule or standard permits rather than through case-by-case review of each new or modified source of air pollution.

11.4.4 Programs to Manage Smoke Impacts on Class I Areas

The Texas Forest Service (TFS) coordinates fire and smoke management issues in Texas. The 34th Texas Legislature created the TFS in 1915. The legal mandate of the TFS includes the responsibility to "assume direction of all forest interests and all matters pertaining to forestry within the jurisdiction of the state." The TFS has developed a voluntary approach called the Texas Forest Service Smoke Management System, under which all land managers in Texas, including the NPS, inform the TFS before performing prescribed burns. The TFS dispatch office maintains communications with the TCEQ.

Examination of the data and modeling for the worst 20 percent visibility days at both Big Bend and Guadalupe Mountains indicates that smoke from agricultural burning and wildfires in Texas is not a large contributor to visibility impairment in Texas. There is no indication that agricultural burning and wildfires in Texas are significant contributors to regional haze on the worst 20 percent days at Class I areas that Texas impacts outside the state. For these reasons, the current rules, policies and plans listed below, along with the NPS smoke management plans, and the smoke management plans of other federal agencies responsible for Class I areas that Texas impacts, are adequate to meet the long-term strategy requirements. Appendix 11-1 contains documents in the following list. The TCEQ provides the documents as examples of the fire management plans that the responsible agencies maintain. This SIP revision does not incorporate the non-TCEQ documents. The outdoor burning rules are currently approved in to the Texas SIP.

- Texas Wildfire Protection Plan (TFS 2007)
- Texas Forest Service Smoke Management System (TFS 1995)
- 30 TAC Chapter 111, Subchapter B: Outdoor Burning (TCEQ 2006)
- Big Bend National Park Fire Management Plan (NPS 2005a)
- Guadalupe Mountains National Park Fire Management Plan (NPS 2005b)
- Big Thicket National Preserve Fire Management Plan (NPS 2004a)
- Lyndon B. Johnson National Historical Park Fire Management Plan (NPS 2005c)
- Padre Island National Seashore Fire Management Plan (NPS 2004b)
- San Antonio Missions National Historical Park Fire Management Plan (NPS 2004c).

A significant component of preventing wildfires is the authority that Texas counties have to prohibit open burning in times of drought. The counties get their authority from §352.081 and §352.082 of the Texas Local Government Code, relating to outdoor burning. Another component in reducing wildfire hazards is the red flag warnings that the National Weather Service issues in times of drought, low humidity, and windy conditions. The broadcast media routinely publicize these warnings, especially during times of drought and outdoor burning bans.

Because of the relatively low contribution of smoke from Texas to worst 20 percent day visibility impairment at Texas' Class I areas and the Class I areas Texas' emissions affect in other states, the TCEQ is not certifying a smoke management plan as part of this SIP revision.

11.4.5 Program to Lower the Impact of Construction Activity on Air and Water Quality

The main regulatory requirements that the TCEQ uses to minimize the air and water quality impacts of dust and soil from construction activity in Texas are under water pollution control requirements to prevent pollution from storm water runoff and mud and dirt tracked from construction sites. The reduction in silt-bearing runoff on paved roads and in mud and dirt tracked onto paved roads around construction sites reduces the amount of fine soil material suspended in the air from traffic in these areas.

The TCEQ's Texas Pollutant Discharge Emission System (TPDES) General Permit TXR150000 regulates activities at construction sites one acre or larger. The size threshold applies to single projects or multiple projects as part of a larger development plan. The TCEQ issued this permit March 5, 2003, pursuant to §26.040 of the Texas Water Code and §402 of the Clean Water Act.

State rule 30 TAC §111.145, Construction and Demolition, provides additional authority and states:

“For the purpose of this section, the following restrictions apply if the area of land affected by the listed activities is more than one acre in size, except for the City of El Paso, where restrictions shall apply regardless of the size of the area of land affected. No person may cause, suffer, allow, or permit a structure, road, street, alley, or parking area to be constructed, altered, repaired, or demolished, or land to be cleared without taking at least the following precautions to achieve control of dust emissions:

(1) Use of water or of suitable oil or chemicals for control of dust in the demolition of structures, in construction operations, in work performed on a road, street, alley, or parking area, or in the clearing of land.”

11.5 FEDERAL PROGRAMS THAT REDUCE EMISSIONS

The Federal Motor Vehicle Control Program (FMVCP) has produced and is continuing to produce large reductions in motor vehicle emissions of NO_X, PM, and VOCs. The increasingly lower federal limits on sulfur content for gasoline and diesel fuel are continuing to reduce the sulfur input to total sulfur emissions from internal combustion engines. They are enabling lower NO_X, PM, and VOC emission limits for on-road motor vehicles, both diesel and gasoline, as well as for non-road engines. The lower sulfur fuel content is also enabling implementation of lower emission limits on new on-road and non-road engines.

The following lists several significant programs:

Federal On-Road Measures

- Federal Phase II reformulated gasoline (RFG) Dallas-Fort Worth (DFW) and Houston-Galveston-Brazoria (HGB)
- Tier 2 vehicle emission standards and federal low-sulfur gasoline
- National low emissions vehicle standards (NLEV)
- Heavy-duty diesel standards

Federal Non-Road Measures

- Lawn and garden equipment
- Tier 2 heavy-duty diesel equipment
- Locomotive engine standards
- Compression ignition standards for vehicles and equipment
- Recreational marine engine standards

Appendix 11-2: *Federal and Texas Programs Related to On-Road and Non-Road Mobile Sources* lists the federal and state rules and programs in considerable detail.

11.5.1 Texas Vehicle Inspection and Maintenance Programs

Motor vehicle inspection and maintenance programs are in place to maintain the effectiveness of the FMVCP in the HGB, DFW, Austin, and El Paso areas. The Department of Public Safety administers the programs and TCEQ maintains oversight of the programs including collecting and analyzing data directly from the equipment at the inspection stations.

11.5.2 Air Check Texas Repair and Replacement Assistance Program

In 2002, the TCEQ established a financial assistance program for qualified owners of vehicles that fail the emissions test. The Low Income Vehicle Repair Assistance, Retrofit, and Accelerated Vehicle Retirement Program (LIRAP) provisions of House Bill 2134, 77th Texas Legislature 2001, created the program. House Bill 1611 passed in the 79th Legislature 2005, modified the program. The LIRAP applies only to counties that implement a vehicle inspection and maintenance program and have elected to implement LIRAP provisions.

By enacting Senate Bill 12, the 80th Texas Legislature expanded the LIRAP program and appropriated $45 million for LIRAP for fiscal year 2008 and an additional $45 million for fiscal year 2009. The purpose of this voluntary program is to remove older, more polluting vehicles from Texas roadways in certain counties with high ozone. Under Senate Bill 12, residents of certain Texas counties who meet income criteria and whose vehicles meet certain registration criteria may be eligible to receive vouchers for up to $3,500 toward the purchase of a new or no more than three-year-old qualifying vehicle from participating auto dealers. A motor vehicle scrappage facility must certify that the engine from a retired vehicle has been destroyed for the vehicle owner to be eligible for the voucher. Accelerated retirement of older, higher polluting vehicles will reduce NO_X, fine PM, and VOC emissions.

11.6 EMISSION REDUCTIONS SINCE ISSUANCE OF THE REGIONAL HAZE RULE

Since July 1, 1999, the TCEQ has implemented substantial programs that reduce Texas' regional haze impact at Class I areas in Texas and in surrounding states. Appendix 11-3: *Major Point Source NO_X Rules and Reductions Promulgated in Texas Since 2000* provides a detailed list of the TCEQ rule provisions that regulate NO_X and PM emissions .

11.6.1 NO_X Emission Reduction Requirements in the Texas Ozone SIP Revisions

Texas' SIP revisions from 2000 forward include required NO_X emission reductions for the following regions: HGB, DFW, Beaumont-Port Arthur, Austin, and Northeast Texas as well as one for East Texas. In addition, the SIP includes the Texas low emission diesel requirements for East and Central Texas in 30 TAC Chapter 114. The rules for control of NO_X emissions from stationary sources for the Texas ozone SIP are included in Chapter 117. Recent NO_X control measures adopted in Chapter 117 address a wide range of point and area sources at major and minor sources of NO_X. Some of these rules implemented the NO_X reduction requirements of Senate Bill 7, for grandfathered EGUs, as discussed in more detail in Section 11.6.2 The TCEQ has submitted all of the Chapter 117 NO_X limitations and requirements as well as the Chapter 114 low emission diesel fuel requirements to the EPA as revisions to the Texas SIP.

11.6.2 SO_2 and NO_X Reduction Requirements under Senate Bill 7

Senate Bill 7 required the following emission reductions from grandfathered EGUs: for $NO_{X,}$ a 50 percent reduction of the 1997 emission level by May 1, 2003, and for SO_2, a 25 percent reduction of the 1997 emission level by May 1, 2003, accompanied by an in-state emissions cap and trade program. Grandfathered EGUs are the EGUs built before Texas' BACT emission control requirements for new and modified sources of air pollution went into effect in 1972. These requirements produced reductions approximately a decade before the BART emissions reductions will be effective in states without CAIR requirements. They were effective approximately six and seven years before the Phase I CAIR requirements will be effective in states that implement CAIR NO_X and SO_2 emission reductions. Phase I of CAIR becomes effective in 2009 for NO_X and in 2010 for SO_2. Phase II of CAIR will become effective in 2015, at which time it will become the limiting requirement for SO_2 and NO_X for most EGUs in Texas. This SIP revision presumes that either CAIR will be finally upheld by the courts or will be replaced with a federal program that achieves comparable reductions in emissions. On December 23, 2008, the U.S. Circuit Court of Appeals for the District of Columbia Circuit issued a decision remanding CAIR to EPA to initiate rulemaking consistent with its opinion, but the court did not vacate CAIR.

11.6.3 CAIR Reductions for NO_X and SO_2

On March 10, 2005, the EPA issued the CAIR, requiring reductions in SO_2 and NO_X emissions from EGUs in 28 states and the District of Columbia (70 FR 25162-25405). These include states in the Northeast, the South, and along the Mississippi River plus Texas, the only largely western state subject to the CAIR emissions reductions requirements. Figure 11-32 shows that the CAIR emissions reductions requirements in Texas apply more than 480 miles west of the areas where

CAIR requirements apply in other states. The map also shows that Texas is the only state where CAIR applies in the next tier of states west of the states that border the Mississippi River.

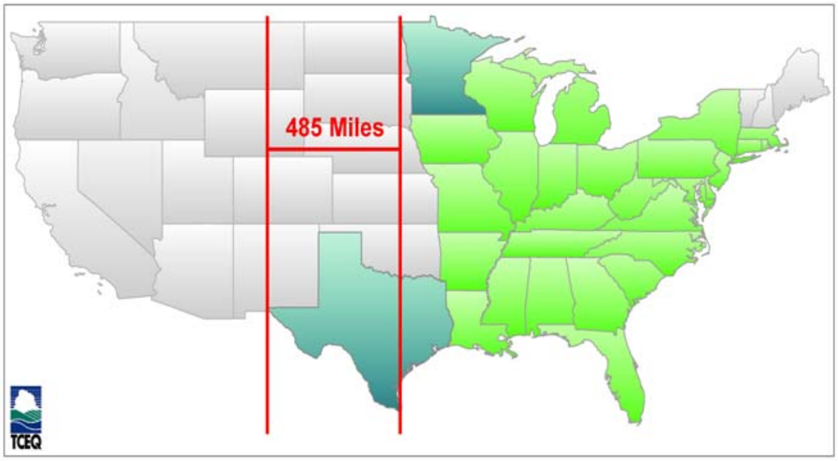


Figure 11-32: CAIR Emission Reduction States
Note: States shown in green have CAIR emission reductions requirements
Source: TCEQ 2007

CAIR applies to SO_2 in all CAIR areas except in Arkansas, Delaware, New Jersey, and New England. In states where CAIR applies to SO_2, CAIR will reduce SO_2 emission allowances by over 60 percent from 2003 federal acid rain cap levels. In all CAIR states, the program will reduce NO_X emission allowances by over 60 percent from 2003 federal acid rain cap levels. CAIR establishes an EPA-administered cap-and-trade program for EGUs in which states may participate as a means of meeting these requirements. The Texas Legislature directed the TCEQ to participate in this interstate cap-and-trade system. SO_2 and NO_X reductions will occur in two phases under a cap-and-trade system established by the EPA. SO_2 emission caps will be lowered in 2010 and again in 2015. NO_X emission allowables will decrease in 2009 and again in 2015. Table 11-15 shows the emission allowances for EGUs in Texas under the CAIR program.

Table 11-15: EGU Emission Allowances in Texas under the CAIR Program

Annual NO_X Cap (tons)			
State	2003 Acid Rain Emissions Inventory	2009 CAIR Phase I Budget	2015 CAIR Phase II Budget
Texas	211,000	181,014	150,845
Annual SO_2 Cap (tons)			
State	2003 Acid Rain Emissions Inventory	2010 CAIR Phase I Budget	2015 CAIR Phase II Budget
Texas	578,000	320,946	224,662

Source: EPA

The TCEQ has submitted to the EPA as a revision to the Texas SIP its rules that implement the CAIR requirements. The following links provide further information on the CAIR SIP revisions and CAIR requirements for Texas.

The Texas CAIR SIP -
<http://www.tceq.state.tx.us/assets/public/implementation/air/sip/cair-camr/05048CAIRSIP_adoption_final.pdf>
The Texas CAIR Rule -
<http://www.tceq.state.tx.us/assets/public/implementation/air/sip/cair-camr/05046101_ado_clean.pdf>
The Texas CAIR/CAMR Web Page -
<http://www.tceq.state.tx.us/implementation/air/sip/caircamr.html>

11.6.4 Best Available Retrofit Technology (BART) Requirements

The commission adopted the final BART Rule (30 TAC Chapter 116, Subchapter M) January 10, 2007. It is available at: <http://info.sos.state.tx.us/pls/pub/readtac$ext.ViewTAC?tac_view=5&ti=30&pt=1&ch=116&sch=M&rl=Y>. Because most sources reviewed under the BART rule are a long distance from the nearest Class I federal area, a large percentage fell below the *de minimis* level for impacting all Class I areas, so they did not have to proceed to a BART engineering analysis. Chapter 9: *Best Available Retrofit Technology* details the implementation of the BART program in Texas in Table 9-7.

11.6.5 Comparison of the NO_X Emission Limits for EGUs with CAIR Limits

The following table shows the relationship among the requirements.

Table 11-16: Texas Electric Generating Utility NO_X Control Strategies Compared to CAIR

Facility Type	State Emission Rate Requirements	CAIR 2009	CAIR 2015
Utility Electric Generation in Ozone Nonattainment Areas Emission Specifications for Attainment Demonstrations			
Houston-Galveston-Brazoria	Pounds of NO_X/MMBtu	Pounds of NO_X/MMBtu	Pounds of NO_X/MMBtu
Gas-Fired Utility Boilers	0.030 lb	0.15 lb	0.125 lb
Coal-Fired Utility Boilers	0.050 lb (wall-fired) 0.045 lb (tangential-fired)	0.15 lb	0.125 lb
Oil-Fired Utility Boilers	0.050 lb (wall-fired) 0.045 lb (tangential-fired)	0.15 lb	0.125 lb
Auxiliary Steam Utility Boilers	0.030 lb	0.15 lb	0.125 lb
Stationary Gas Turbines	0.032 lb	0.15 lb	0.125 lb
Dallas-Fort Worth			
Large Utility Boilers	0.033 lb	0.15 lb	0.125 lb
Small Utility Boilers	0.06 lb	0.15 lb	0.125 lb
Beaumont-Port Arthur			
All Utility Boilers	0.10 lb	0.15 lb	0.125 lb
Utility Electric Generation in East and Central Texas			
Gas-Fired Utility Boilers	0.14 lb	0.15 lb	0.125 lb
Coal-Fired Utility Boilers	0.165 lb	0.15 lb	0.125 lb
Senate Bill 7			
East Texas Region Grandfathered Facilities	0.14 lb	0.15 lb	0.125 lb
West Texas and El Paso Region Grandfathered Facilities	0.195 lb	0.15 lb	0.125 lb

Source: TCEQ, current as of February 23, 2007

11.6.6 Sulfur Dioxide Reductions under the EPA Refinery Consent Decrees

The EPA refinery consent decrees cover both SO_2 and NO_X. The NO_X reductions are generally company-wide reduction requirements, and the details of which emission points will have reductions and the amount of the reductions are not yet available.

The EPA has provided specifics of the SO_2 reductions by emission point for refineries. In addition, information is available regarding SO_2 emission reductions at a large sulfuric acid plant at the western end of the Houston Ship Channel. The following table combines these SO_2 emission reduction data. The projected growth from 2002 to 2018 are estimates from CENRAP's emission inventory contractor (Pechan 2005). Since the TCEQ's new and modified source permitting requirements prohibit an increase in allowable emissions without a construction permit, which requires use of BACT, the projected emission increases between 2002 and 2018 may be substantially over estimated.

Table 11-17: Annual SO_2 Emissions at Consent Decree Impacted Sources

SO_2 Emissions	2002 (tpy)	2018 (tpy)
Pre-decree levels	48,868	62,229
Reduction estimate*	45,453	56,433
Difference (remaining emissions)	3,415	5,796

*Reductions estimate applied to 2002 actual emissions to show theoretical impact. Controls will be in place before 2018.
Source: EPA 1999

11.6.7 Texas Low Emissions Diesel (TxLED) Program

The goal of the TxLED program is to lower emissions of NO_X and other pollutants from diesel-powered motor vehicles and non-road equipment. It applies to diesel fuel producers, importers, common carriers, distributors, transporters, bulk terminal operators, and retailers. The rules cover 110 counties in eastern Texas, including the ozone nonattainment areas of Beaumont-Port Arthur, DFW, and HGB. The rules require that diesel fuel as defined under 30 TAC §114.6 produced for delivery and ultimate sale to the consumer for both on- and non-road use must contain less than 10 percent by volume of aromatic hydrocarbons and have a cetane number of 48 or greater. The rules, which took effect October 1, 2005, allow some compliance options (30 TAC 114, Subchapter A, §114.6 and Subchapter H, Division 2, §§114.312 - 114.319).

11.6.8 The Texas Emission Reduction Plan (TERP)

TERP is a comprehensive set of incentive programs aimed at improving air quality in Texas. The TCEQ administers TERP grants and other TERP financial incentives. The Texas Legislature established the TERP in 2001 through enactment of Senate Bill 5. The TERP includes a number of voluntary financial incentive programs, as well as other assistance programs, to help improve the air quality in Texas. The goals of the TERP are to:

- assure that the air in this state is safe to breathe and meets minimum federal standards established under the FCAA (42 USC §7407);
- develop multi-pollutant approaches to solving the state's environmental problems; and
- adequately fund research and development that will make the state a leader in new technologies that can solve its environmental problems while creating new business and industry in the state.

The primary objective of the TERP has been to reduce NO_X emissions to aid in attaining the NAAQS for ozone. By encouraging replacement of older on-road and non-road engines with newer engines, the TERP has also decreased fine PM emissions from the motor vehicles and equipment using these engines. As of January 2007, the TCEQ had approved over $406 million in grants under the TERP since the program started in 2001.

The Texas Legislature approved over $143 million for fiscal year 2008 and $146 million for fiscal year 2009 to increase TERP grants aimed at NO_X emission reductions in Texas. The program also reduces fine PM emissions by accelerating the replacement of older diesel engines with newer engines that have much lower PM emission rates.

CHAPTER 12. COMPREHENSIVE PERIODIC IMPLEMENTATION PLAN REVISIONS AND ADEQUACY OF THE EXISTING PLAN

Title 40 CFR §51.308(f) requires states to revise and submit to the EPA a comprehensive regional haze implementation plan revision every 10 years until 2064. In addition, 40 CFR §51.308(g) requires periodic reports in the form of a SIP revision that evaluates progress towards the reasonable progress goals established for each Class I area. In accordance with the requirements, the TCEQ plans to submit a report to the EPA on reasonable progress every five years following the initial submittal of the Regional Haze SIP. The report will be in the form of a SIP revision and will evaluate the progress made towards the reasonable progress goal for each Class I area located within Texas, and in each Class I area located outside of Texas that may be affected by emissions from within Texas. The TCEQ will consult with the Federal Land Managers during the SIP revision development process. All requirements listed in 40 CFR §51.308(g) will be addressed in the SIP revision for demonstrating reasonable progress.

Depending on the findings of its five-year progress report, the TCEQ will examine the actions listed in 40 CFR §51.308(h). The findings of the five-year progress report may determine which action the state may choose as appropriate.

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Due to the public interest in Appendix 10, only this appendix will be directly attached to this Regional Haze SIP. Appendix 10-4 has a large spreadsheet that is not easily printed and will be available on line with all the other appendixes.

All appendixes are available on the web site
<http://www.tceq.state.tx.us/implementation/air/sip/bart/haze_appendices.html>.
If you have problems accessing, please contact:

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Appendix 10-1: Analysis of Control Strategies And Determination of Reasonable Progress Goals

APPENDIX 10-1: ANALYSIS OF CONTROL STRATEGIES AND DETERMINATION OF REASONABLE PROGRESS GOALS

10-1.1 IDENTIFICATION OF KEY POLLUTANTS

Chapter 11: *Long-Term Strategy to Reach Reasonable Progress Goals* demonstrates that NO_x and SO_2 are the main anthropogenic pollutant emissions that affect visibility at Class I areas in Texas and in neighboring states. Table 1 summarizes the percentage contribution of various pollutants at the Texas Class I areas and those Class I areas in other states that PSAT modeling indicates receive more than 20 percent of their visibility impairing haze from Texas emissions in the 2002 base case modeling.

Table 1: Pollutant Impacts on Visibility at the Class I Areas with a 20 Percent or Greater Impact from Texas Emissions

Source	BIBE*	GUMO*	WIMO*	SACR*	WHIT*
SO_4	49.7	57.7	54.7	43.2	52.9
NO_3	4.4	10.2	22.5	26.1	14.7
POA	16.4	6.1	6.2	8.2	7.1
EC	9.1	6.6	5.3	7.4	7.4
Soil	6.7	6.8	4.6	6.0	6.8
CM	7.1	4.0	3.8	2.9	1.8
SOAA	1.9	2.7	1.4	2.2	3.4
SOAB	4.6	5.8	1.5	4.1	5.9

* Big Bend, Guadalupe Mountains, Wichita Mountains, Salt Creek, and White Mountain areas

As the table indicates, sulfur dioxide (SO_2) emissions, which form sulfate (SO_4), are clearly the most important contributor to visibility impairment at these Texas-impacted Class I areas. In every case except for Big Bend, nitrate (NO_3), which forms from NO_X emissions is the second most important pollutant.

The situation at Big Bend is less clear, as shown in Table 2 shows.

Table 2: Source Categories Contributing to Regional Haze at Big Bend National Park

Source	Elevated Point	Low Level Point	Natural	On Road	Non Road	Area	IC	BC	SOAA	SOAB	total
SO_4	32.0	1.3	0.0	0.5	0.8	3.4	0.0	11.5			49.7
NO_3	1.1	0.1	0.7	0.8	0.5	0.6	0.0	0.6			4.4
POA	0.3	0.0	0.2	0.1	0.3	2.5	0.0	13.0			16.4
EC	0.0	0.0	0.1	0.4	1.4	1.9	0.0	5.2			9.1
SOIL	0.7	0.1	3.0	0.0	0.0	2.7	0.0	0.3			6.7
CM	0.0	0.0	5.6	0.0	0.1	1.2	0.0	0.2			7.1
SOAA									1.9		1.9
SOAB										4.6	4.6

After sulfur, Primary Organic Aerosols (POA) constitutes the next biggest source of impairment at Big Bend; however, the vast majority of POA is from the model's boundary conditions (BC), which include southern Mexico and Central and South America. Therefore, this source is not controllable by Texas. Elemental carbon (EC) is also dominated by the boundary conditions. The next two sources, soil and coarse mass (CM), are most likely from natural dust storm events. For these reasons, even at Big Bend, NO_3 becomes the second most important pollutant for Texas to consider in its regional haze SIP.

10-1.2 IDENTIFICATION OF SOURCES FOR CONTROL

Once the main types of pollutants affecting visibility in Texas-impacted Class I areas have been determined, the next step is to determine what kinds of sources emit these pollutants. That is, should the control strategy focus on point sources only or should area sources and mobile sources be considered as well? Table 3 shows the sources of these pollutants in the 2002 base case PSAT modeling for the two Class I areas in Texas. The numbers are in percentages. For example, 67.1 percent of the SO_4 impacting Big Bend can be attributed to point sources.

Table 3: Source Category Contributions to SO_4 and NO_3 at the Five Class I Areas Texas Affects the Most (by percent)

	Big Bend			Guadalupe Mountains		
	Point	Mobile	Area	Point	Mobile	Area
SO_4	67.1	2.8	6.9	75.6	3.5	8.5
NO_3	26.6	28.6	14.3	29.2	36.5	13.9

	Wichita Mountains			Salt Creek			White Mountain		
	Point	Mobile	Area	Point	Mobile	Area	Point	Mobile	Area
SO_4	78.2	3.7	9.2	73.8	3.9	8.1	75.2	4.1	8.1
NO_3	28.1	44.7	13.4	35.8	29.9	17.1	27.9	40.3	12.0

As Table 3 shows, sulfur emissions affecting visibility in the Class I areas are clearly dominated by point sources. The mobile source contribution will be reduced as much as feasible through federal fuel sulfur rules already on the books. As for area source sulfur, the TCEQ has significant concerns about the emissions inventory accuracy. For example, the CENRAP inventory for area source sulfur compound emissions is more than seven times higher than the TCEQ estimate for that category. For this reason, our control strategy analysis will focus on point sources of sulfur compounds.

Nitrogen oxide emissions are more evenly distributed among point, mobile, and area sources. As described in Chapters 10 and 11, Texas is already going well beyond the federal requirements to reduce both on-road and non-road mobile emissions. Furthermore, the states have very limited authority to reduce mobile source emissions. Control of mobile source NO_X emissions is principally a federal responsibility. Area source NO_X is of concern to Texas both for our ozone SIP and for the Regional Haze SIP. The biggest source of area source NO_X is upstream oil and gas production. The TCEQ is taking all steps it has determined are reasonable at this time to control these sources in the Dallas-Fort Worth ozone SIP. In addition, the State of Texas is investing $4,000,000 in a grant program to assist with the retrofitting of gas-fired, rich burn compressor engines[1]. The TCEQ will continue its research analysis of emissions from oil and gas production. We will re-examine these sources in the five-year update of the Regional Haze SIP. By that time, we expect to have much improved information on the inventory and the economic and technical feasibility of additional controls. Given these considerations, the TCEQ decided to focus on point sources of NO_X when considering additional controls to improve visibility at Class I areas. It is important to note that Texas has already implemented substantial controls on point source NO_X as part of its ozone SIPs. These are described in more detail in Chapter 11: Long Term Strategy.

10-1.3 SELECTION OF SOURCES FOR POSSIBLE ADDITIONAL CONTROLS

Having narrowed the scope of the review to point sources of SO_2 and NO_X, the next step is to develop a high-level estimate of the costs and reductions associated with a set of potentially reasonable additional controls to reduce regional haze. The TCEQ developed a set of possible controls focusing on sources that had the potential to affect visibility at Class I areas and that had the least costly available controls on a cost per ton basis. The CENRAP conducted a large-scale study of control options using the EPA's AirControlNet Model. This study served as the basis for the Texas analysis.

[1] http://www.tceq.state.tx.us/implementation/air/sip/sb2003.html

The CENRAP used the latest revised version of the U.S. EPA's AirControlNet model to analyze potential add-on control device strategies for appropriate emissions generating units (Alpine 2007). AirControlNet is a PC-based database tool for conducting pollutant emissions control strategy and cost analysis. The study overlaid a detailed EPA control measure database on CENRAP's emissions inventories to compute source- and pollutant-specific emission reductions and associated costs at various geographic levels. For Texas, the 2002 Texas point source emissions inventory was the basis for the analysis.

The potential strategies, estimated capital costs, and costs per ton reduced were summarized and distributed to each of the CENRAP states. In many cases more than one strategy was proposed for a type of unit. In these cases, the least costly control, on a dollar per ton cost basis, was assumed to be implemented first, with the incremental cost of adding the additional strategy included. In addition to the CENRAP proposed controls, TCEQ added flue gas desulfurization as a potential control for nine units at three carbon black plants.

The best candidate sources for proposed control strategies were identified with a two step process. First, sources with potential control strategy costs greater than $2,700 per ton SO_2 for NO_X were initially screened out to limit the population to potential sources with relatively cost effective control strategies. The group of sources was further reduced to eliminate sources that are so distant from any of the ten Class I areas that any reduction in emissions would be unlikely to have a perceptible impact on visibility. The list was restricted to those sources with a ratio of estimated projected 2018 base annual emissions (tons) to distance (kilometers) greater than five to any Class I area. Also, any source with predicted 2018 emissions less than 100 tons per year was excluded. The regulatory and logistical overhead associated with controlling these small sources would not be justified by the likely benefit.

The TCEQ also excluded additional NO_X controls on cement kilns from consideration since the TCEQ has already required all the measures it has determined are reasonable to control NO_X emissions from these sources in the latest Dallas-Fort Worth ozone SIP revision. A study performed for the SIP (July 2006, a report entitled "Assessment of NO_X Emissions Reduction Strategies for Cement Kilns) evaluated the applicability, availability and cost effectiveness of potential NO_X control technologies for the ten cement kilns located at three Ellis County sites. The report focused on selective catalytic reduction (SCR), selective non-catalytic reduction (SNCR), and low temperature oxidation (LoTOx). Based on the results of the study, the TCEQ conducted modeling sensitivity analyses at two levels of control to evaluate potential ozone reduction benefits from possible cement kiln control strategies. One modeling sensitivity assumed a range of 35 to 50 percent NO_X control on cement kilns depending upon kiln type; the second assumed a range of 80 to 85 percent. After reviewing the report of the kiln study, the modeling sensitivity results, and all other available information, the TCEQ determined that the 35 to 50 percent control range was the most appropriate control level. The TCEQ develop a source cap that will require a reduction of approximately 9.69 tpd of NO_X emissions from the cement kilns in Ellis County starting March 2009. The source cap approach does not require a specific technology, but provides flexibility for kiln operators to comply in the most effective, technically sound, and expeditious manner possible, while forcing sizeable NO_X emission reductions from all cement kilns in the area. In most cases, the commission anticipates that the limitations will be attainable with SNCR and will not require costly and time consuming research and development of other technologies. Pilot testing of SNCR on wet and dry kilns in 2006 demonstrated that 30 to 40 percent reductions were achievable without hazardous by-product formation. Finally, before an increase in NO_X emissions from a change in operation from one unit of the installation of new kiln could occur, a corresponding and equivalent decrease in NO_X emissions would be required from another existing unit.

This analysis relied on the CENRAP estimates of control costs and feasibility. The costs presented in this study are estimates based on categories of units. A site-specific analysis would be necessary to determine actual costs and whether a particular control device is not feasible at a particular unit due to physical or process constraints.

10-1.4 PROPOSED CONTROLS

The types of industry and controls considered are listed below. These controls would go beyond what is already expected due to the Clean Air Interstate Rule (CAIR), BART controls planned for ozone SIPs.

- SO_2 control at 24 facilities from 15 sites
  - Natural Gas Transmission - flue gas desulfurization (FGD)
  - Crude Petroleum - Sulfur recovery and/or tail gas treatment
  - Inorganic chemical plants - coal washing and spray dryer absorber (SDA) on boilers, increase efficiency of sulfuric acid plants
  - Electric Generating Units (EGU) - coal washing and FGD wet scrubbing
  - Carbon black – FGD

- NO_X control for 24 facilities at 15 sites
  - Natural Gas Transmission- Low NO_X burners (LNB), SCR + LNB
  - EGU - LNB with close coupled over-fired air (LNC1), and with both close-coupled and separated over-fired air (LNC3)
  - Flat Glass - LNB, SCR
  - Paper Mills SNCR and oxygen trim (OT) with water injection
  - Chemical Plant Boiler - selective catalytic reduction (SCR)

Tables 6 through 10 provide details on the sources, costs, and control results expected from the set of point source controls considered to determine whether they are reasonable. Table 4 below summarizes the cost and emissions reductions expected from this analysis. Table 5 provides the estimated visibility improvement for each Class I. The basis for this estimate is provided in Appendix 10-2.

Table 4: Summary of Additional Point Source Controls Considered for Reasonableness

Pollutant	Tons Per Year Reduced	Estimated Annualized Cost ($2005)
Sulfur Dioxide	155,873	$270,800,000
Nitrogen Oxides	27,132	$53,500,000
Total Costs		$324,300,000

Table 5: Estimated Haze Index Improvements for Affected Class I Areas From Additional Controls

Class 1	Big Bend	Breton Isle	Caney Creek	Carlsbad Caverns	Guadalupe Mountains
HI Improvement (deciview)	0.16	0.05	0.33	0.22	0.22
Class 1	**Salt Creek**	**Upper Buffalo**	**Wheeler Peak**	**White Mountain**	**Wichita Mountains**
HI Improvement (dv)	0.18	0.16	0.04	0.24	0.36

As explained in Chapter 10, the TCEQ has determined that it is not reasonable to pursue additional controls at this time. The control set defined in this appendix yielded too little benefit for the cost.

10-1.5 Area of Influence Determination

To determine Texas' apportioned contribution to measured 2002 and predicted 2018 visibility extinction and impact of proposed controls, the area of influence (AOI) curves developed for CENRAP were used as a starting point. Working at CENRAP's direction, Alpine Geophysics (Alpine, 2006) used Residence Time Difference plots (DRI, 2005c), the Probability of Regional Source Contribution to Haze (PORSCH) plots (Raffuse *et al*., 2005), the Tagged Species Source Apportionment (TSSA) results (Tonnesen and Wang, 2004; UCR, 2006), and engineering judgment to construct a consistent set of AOIs for each area.

The Residence Time Difference (RTD) plots are based on the Back Trajectory Residence Time (BTRT) plots. Back trajectory analyses use meteorological fields to estimate the geographical path an air mass traversed to end at a particular receptor. The Desert Research Institute (DRI) (2005b) developed the BTRT estimates used in this study by employing the NOAA HYSPLIT back trajectory model (Draxler and Hess, 1997; NOAA, 2006). BTRT plots give the fraction of total hours that an air parcel resided over each specific geographical area. The RTD plots for each pollutant come from by subtracting the map for all days at a site from the map for the 20 percent worst days for the respective pollutant pollutant. This process produced RTD plots for the twenty percentile worst sulfate, nitrate, organic carbon, elemental carbon, fine soil, and coarse mass days for each area CENRAP considered. The RTD maps show the areas that air was over more frequently (positive numbers) on worst case days compared to all days.

The PORSCH system is a suite of GIS tools that combines modeled backward wind trajectories, monitored concentrations, meteorological conditions, and emissions estimates to estimate probable regions of influence. PORSCH combines ensemble backward trajectories with chemically speciated emissions data to estimate the trajectory-emissions density-weighted area that is likely to affect a receptor site. PORSCH can do this for a single day or a suite of days. This study used only data relevant to the 20 percent worst haze days.

As the name implies Tagged Species Source Apportionment (TSSA) uses "Tagged Chemical Species," or tracers, to track chemical transformations and transport of each chemical species or precursor species during an air quality model run. Key chemical species are identified. These tagged chemical species for specific emissions source regions and source categories are tracked during all phases of the air quality modeling run. The end results show the sources contributing to the final chemical species for any grid cell in model domain.

Because RTD plots were available for the entire suite of twenty-one areas, they served as the primary basis from which Alpine produced the AOIs. Alpine examined the RTD plots for each area and each pollutant to identify “break points” between the most significant and lower level areas of influence contributing to the high concentrations of each pollutant. Alpine examined the PORSCH and TSSA results to refine the area of influence contours. Alpine then compared the Level 1 areas of influence for the different pollutants for each area and for nearby areas to determine whether the Level 1 areas of influence could be combined for pollutants and for nearby areas. Alpine repeated the process for Level 2 and further level AOIs. This process produced the AOIs the TCEQ has used in developing the list of sources and four-factor analysis used to determine whether additional controls on Texas sources are reasonable to reduce the visibility impact of Texas’ emissions on each area they affect.

The TCEQ used the second order of influence for ten Class I areas within Texas and adjoining states to define the geographic area of concern for significant NO_X and SO_2 emitting sources. The Class I areas considered were Caney Creek, Carlsbad Caverns, Big Bend, Guadalupe Mountains, Salt Creek, Upper Buffalo, Wheeler Peak, White Mountain, and Wichita Mountains. The population of sources determined from the entire state was apportioned to each Class I based on these curves. This list of sources for each Class I area was sent to appropriate state as part of the consultation process. This correspondence and lists of sources are in Appendix 4-3.

Table 6: Proposed SO_2 Controls Based on CENRAP Modeling

Acct No	FIN	Source Type for Control	Control Measure	2018 Base Case SO2 -- Tons	Cntrl -- Tons Reduced	Cntrl -- CE (%)	Controls -- Annualized Cost ($2005)	Controls -- Cost Per Total Ton Reduced	Qbase /5d
BG0057U	BOILER1	Utility Boilers - Coal-Fired	Coal Washing	10,836	3,793	35	$1,824,685	$481	4.93
BG0057U	BOILER1	Utility Boilers - Medium Sulfur Content	FGD Wet Scrubber	10,836	9724	90	$25,000,104	$2,564	4.93
BG0057U	BOILER2	Utility Boilers - Coal-Fired	Coal Washing	10,658	3,730	35	$1,794,818	$481	4.85
BG0057U	BOILER2	Utility Boilers - Medium Sulfur Content	FGD Wet Scrubber	10,658	9,593	90	$25,000,104	$2,606	4.85
CG0012C	INCIN	Tail Gas Incinerator	FGD	1,328	1,195	90	$1,703,960	$1,425	2.00
FI0020W	B1	Utility Boilers - Medium Sulfur Content	FGD Wet Scrubber	23,142	20,828	90	$32,766,310	$1,573	13.77
FI0020W	B2	Utility Boilers - Medium Sulfur Content	FGD Wet Scrubber	23,641	21,277	90	$32,766,310	$1,540	14.07
GF0002R	B-1	Utility Boilers - Coal-Fired	Coal Washing	16,096	5,634	35	$2,710,461	$481	5.82
GF0002R	B-1	Utility Boilers - Medium Sulfur Content	FGD Wet Scrubber	16,096	14,486	90	$36,014,449	$2,486	5.82
GH0004O	BLR0009A01	Bituminous/Sub-bituminous Coal (Industrial Boilers)	SDA	1,960	1,764	90	$4,687,674	$2,658	1.76
GH0004O	BLR0010A01	Utility Boilers - Coal-Fired	Coal Washing	1,160	406	35	$195,408	$481	1.04
HG0659W	H600	Cat Cracker Heater	FGD	5,491	4,942	90	$8,474,217	$1,715	2.09

Acct No	FIN	Source Type for Control	Control Measure	2018 Base Case SO2 -- Tons	Cntrl -- Tons Reduced	Cntrl -- CE (%)	Controls -- Annualized Cost ($2005)	Controls -- Cost Per Total Ton Reduced	Qbase /5d
HG0697O	PIR-2	Sulfuric Acid Plants - Contact Absorber (98% Conversion)	Increase % Conversion to Meet NSPS (99.7)	4,101	3,486	85	$670,008	$192	1.55
HG0697O	U-8	Sulfuric Acid Plants - Contact Absorber (98% Conversion)	Increase % Conversion to Meet NSPS (99.7)	7,005	5,954	85	$2,510,927	$422	2.65
HR0018T	H-8*	Sulfur Plant Incinerator	FGD	3,590	3,231	90	$6,865,014	$2,124	3.60
RF0009N	INCIN-COMB	Incinerator	FGD	4,059	3,653	90	$8,153,168	$2,232	5.25
TF0013B	B1	Utility Boilers - Medium Sulfur Content	FGD Wet Scrubber	19,144	17,230	90	$32,196,462	$1,869	23.06
TF0013B	B2	Utility Boilers - Medium Sulfur Content	FGD Wet Scrubber	19,695	17,725	90	$32,196,462	$1,816	23.73

*Unit Planned Shutdown March 2007

Table 7: Location and Program Status Details For Emission Units With CENRAP Proposed SO_2 Controls

County	Acct No	Company	Plant Name	FIN	BART	CAIR	Industrial Code Description	Nearest Area	Distance (km)
Bexar	BG0057U	CPS	SOMMERS DEELY SPRUCE PWR	BOILER1	No	Yes	Electric Services	Big Bend	440
Bexar	BG0057U	CPS	SOMMERS DEELY SPRUCE PWR	BOILER2	No	Yes	Electric Services	Big Bend	440
Cass	CG0012C	Enbridge	BRYANS MILL PLANT	INCIN	No	No	Nat'l Gas Liq	Caney Creek	133
Freestone	FI0020W	TXU	BIG BROWN	B1	No	Yes	Electric Services	Caney Creek	336
Freestone	FI0020W	TXU	BIG BROWN	B2	No	Yes	Electric Services	Caney Creek	336
Goliad	GF0002R	AEP	COLETO CREEK PLANT	B-1	No	Yes	Electric Services	Big Bend	553
Gray	GH0004O	Celanese	CHEMICAL MANUFACTURING	BLR0009A01	Yes	No	Industrial Organic Chemicals	Wichita Mtns	222
Gray	GH0004O	Celanese	CHEMICAL MANUFACTURING	BLR0010A01	Yes	No	Industrial Organic Chemicals	Wichita Mtns	222
Harris	HG0659W	Shell	DEER PARK PLANT	H600	Yes	No	Petroleum Refining	Caney Creek	526
Harris	HG0697O	Rhodia	HOUSTON PLANT	PIR-2	Yes	No	Industrial Inorganic Chemicals	Caney Creek	529
Harris	HG0697O	Rhodia	HOUSTON PLANT	U-8	Yes	No	Industrial Inorganic Chemicals	Caney Creek	529
Hopkins	HR0018T	Valence	COMO PLT	H-8	No*	No	Nat'l Gas Liq	Caney Creek	199
Reeves	RF0009N	El Paso Natr'l Gas	WAHA PLANT	INCIN-COMB	No	No	Natural Gas Transmission	Carlsbad	155
Titus	TF0013B	TXU	MONTICELLO STM ELE STN	B1	No	Yes	Electric Services	Caney Creek	166
Titus	TF0013B	TXU	MONTICELLO STM ELE STN	B2	No	Yes	Electric Services	Caney Creek	166

* site was exempted for BART

Table 8: Proposed SO_2 Control For Carbon Black Units

County	Acct No.	Company	Site	FIN	BART	Description	2018 Base Case SO2 (tons)	Control Measure	Cntrl CE (%)	Cntrl – Tons Reduced	dist. (km)	Nearest	Qbase/ 5d
Howard	HT0027B	Sid Richard-son	BIG SPRING	PR1002	No	MAIN PROCESS VENT,CO BOILER, and INCINERATION	3,890	FGD	80	3,112	295	Carlsbad	2.6
Howard	HT0027B	Sid Richard-son	BIG SPRING	DRYER22	No	PELLET DRYER	1,454	FGD	80	1,163	295	Carlsbad	1.0
Howard	HT0027B	Sid Richard-son	BIG SPRING	PR1004	No	MAIN PROCESS VENT,CO BOILER, INCINERATION	3,890	FGD	80	3,112	295	Carlsbad	2.6
Howard	HT0027B	Sid Richard-son	BIG SPRING	DRY1006	Yes	PELLET DRYER	1,790	FGD	80	1,432	295	Carlsbad	1.2
Howard	HT0027B	Sid Richard-son	BIG SPRING	DRYER24	No	PELLET DRYER	1,454	FGD	80	1,163	295	Carlsbad	1.0
Howard	HT0027B	Sid Richard-son	BIG SPRING	DRYER23	No	PELLET DRYER	1,454	FGD	80	1,163	295	Carlsbad	1.0
Howard	HT0027B	Sid Richard-son	BIG SPRING	PR1007	Yes	MAIN PROCESS VENT,CO BOILER, and INCINERATION	3,890	FGD	80	3,112	295	Carlsbad	2.6
Hutchin-son	HW0017R	Sid Richard-son	BORGER	B119N	No	INDUSTRIAL NATURAL GAS 10-100MMBTU/HR	4,262	FGD	80	3,410	238	Wichita Mtns	3.6
Orange	OC0020R	Degussa	ECHO	I-1	No	MAIN PROCESS VENT,CO BOILER, and INCINERATION	3,354	FGD	80	2,683	430	Breton Isle	1.6
						Total				20,350			

Table 9: Proposed NO_X Controls Based on CENRAP Modeling

Account	Plant Name	FIN	Source Type for Control	Control Measure	2018 Base Case NOx (Tons)	Control -- Tons Reduced	Controls - - CE (%)	Controls -- Annualized Cost ($2005)	Control -- Cost Per Ton Reduced	Qbase/ 5d
BG0057U	SOMMERS DEELY SPRUCE PWR	P-5	Utility Boiler - Coal/Tangential	LNC1	2,431	1,052	43.3	$813,312	$773	1.11
BG0057U	SOMMERS DEELY SPRUCE PWR	P-5	Utility Boiler - Coal/Tangential	LNC3	2,431	1,417	58.3	$1,400,066	$988	1.11
CG0010G	TEXARKANA MILL	PB02	ICI Boilers - Wood/Bark/Stoker - Large	SNCR - Urea Based	824	453	55	$907,290	$2,001	1.33
CG0010G	TEXARKANA MILL	RB02	Sulfate Pulping - Recovery Furnaces	OT + WI	822	535	65	$368,011	$689	1.32
C20005I	GUADALUPE COMPRESSOR STATION	C-1	Combustion Turbines - Natural Gas	Dry Low NOx Combustor	850	714	84	$153,587	$215	26.34
C20005I	GUADALUPE COMPRESSOR STATION	C-1	Combustion Turbines - Natural Gas	SCR + LNB	850	799	94	$1,031,230	$1,291	26.34
FC0018G	FAYETTE POWER PROJECT	3-1B	Utility Boiler - Coal/Tangential - POD10	LNC3	2,764	843	58.3	$1,049,562	$1,245	1.00
FI0020W	BIG BROWN	B1	Utility Boiler - Coal/Tangential	LNC3	3,574	593	58.3	$1,518,941	$2,560	2.13
FI0020W	BIG BROWN	B2	Utility Boiler - Coal/Tangential	LNC3	3,725	618	58.3	$1,518,941	$2,456	2.22
GH0003Q	PAMPA PLANT	P-1KATUINC	Indust. Incinerators	SNCR	1,230	553	45	$1,345,248	$2,431	1.11
GH0004O	CHEMICAL MANUFACTUR	BLR0009A01	ICI Boilers - Coal/Wall	SNCR	1,277	511	40	$923,371	$1,807	1.15
GH0004O	CHEMICAL MANUFACTUR	BLR0009A01	ICI Boilers - Coal/Wall	SCR	1,277	1,150	90	$2,646,447	$2,302	1.15

Account	Plant Name	FIN	Source Type for Control	Control Measure	2018 Base Case NOx (Tons)	Control -- Tons Reduced	Controls -- CE (%)	Controls -- Annualized Cost ($2005)	Control -- Cost Per Ton Reduced	Qbase/ 5d
LB0047N	TOLK STATION	UNIT 1	Utility Boiler - Coal/Tangential	LNC3	2,698	823	58.3	$1,426,484	$1,733	3.03
LB0047N	TOLK STATION	UNIT 2	Utility Boiler - Coal/Tangential - POD10	LNC3	2,510	766	58.3	$1,426,484	$1,863	2.82
LI0027L	RELIANT ENERGY LIMESTONE	1	Utility Boiler - Coal/Tangential - POD10	LNC3	5,703	1,739	58.3	$2,208,408	$1,270	2.97
LI0027L	RELIANT ENERGY LIMESTONE	2	Utility Boiler - Coal/Tangential - POD10	LNC3	5,117	1,561	58.3	$2,023,493	$1,297	2.67
MM0023J	SANDOW STEAM ELECTRIC	S4MB	Utility Boiler - Coal/Tangential - POD10	LNC3	5,509	914	58.3	$1,439,691	$1,574	2.27
NB0014R	GUARDIAN INDUSTRIES	01002	Flat Glass Manufacturing	LNB	2,796	1,118	40	$1,684,527	$1,506	1.67
NB0014R	GUARDIAN INDUSTRIES	01002	Flat Glass Manufacturing	SCR	2,796	2,097	75	$3,203,608	$1,528	1.67
PG0041R	HARRINGTON STATION	UNIT 1	Utility Boiler - Coal/Tangential	LNC3	1,779	543	58.3	$876,960	$1,616	1.28
PG0041R	HARRINGTON STATION	UNIT 2	Utility Boiler - Coal/Tangential	LNC3	1,912	583	58.3	$902,072	$1,547	1.38
PG0041R	HARRINGTON STATION	UNIT 3	Utility Boiler - Coal/Tangential	LNC3	1,845	563	58.3	$902,072	$1,603	1.33
RL0020K	MARTIN LAKE	U1-B1	Utility Boiler - Coal/Tangential	LNC3	8,516	1,414	58.3	$1,981,227	$1,401	7.12
RL0020K	MARTIN LAKE	U2-B2	Utility Boiler - Coal/Tangential	LNC3	5,251	872	58.3	$1,981,227	$2,273	4.39
RL0020K	MARTIN LAKE	U3-B3	Utility Boiler - Coal/Tangential	LNC3	5,105	847	58.3	$1,981,227	$2,338	4.26

Account	Plant Name	FIN	Source Type for Control	Control Measure	2018 Base Case NOx (Tons)	Control -- Tons Reduced	Controls -- CE (%)	Controls -- Annualized Cost ($2005)	Control -- Cost Per Ton Reduced	Qbase/ 5d
TF0013B	MONTICELLO	B2	Utility Boiler - Coal/Tangential	LNC3	4,553	756	58.3	$1,492,524	$1,975	5.48
WH0040R	WORKS NO 4	STA-22	Flat Glass Manufacturing	LNB	4,733	1,893	40	$2,851,572	$1,506	11.84
WH0040R	WORKS NO 4	STA-22	Flat Glass Manufacturing	SCR	4,733	3,550	75	$5,423,079	$1,528	11.84
WH0040R	WORKS NO 4	STA-23	Flat Glass Manufacturing	LNB	4,192	1,677	40	$2,525,375	$1,506	10.49
WH0040R	WORKS NO 4	STA-23	Flat Glass Manufacturing	SCR	4,192	3,144	75	$4,802,723	$1,528	10.49
				Totals				$ 54,267,839		

Table 10: Location and Program Status Details For Emission Units With Proposed NO_X Controls

County	Account	Company	Plant Name	FIN	BART	CAIR	Industrial Code Description	Nearest Area	Distance (km)
Bexar	BG0057U	CPS	SOMMERS DEELY SPRUCE PWR	P-5	No	Yes	Electric Services	Big Bend	440
Cass	CG0010G	IP	TEXARKANA MILL	PB02	Yes	No	Paper Mills	Caney Creek	124
Cass	CG0010G	IP	TEXARKANA MILL	RB02	Yes	No	Paper Mills	Caney Creek	124
Culberson	C20005I	EL PASO NATRL GAS	GUADALUPE COMPRESSOR STATION	C-1	No	No	Natural Gas Transmission	Guadalupe Mtns	6
Fayette	FC0018G	LCRA - Seymour	FAYETTE POWER PROJECT	3-1B	No	Yes	Electric Services	Caney Creek	554
Freestone	FI0020W	TXU	BIG BROWN	B1	No	Yes	Electric Services	Caney Creek	336
Freestone	FI0020W	TXU	BIG BROWN	B2	No	Yes	Electric Services	Caney Creek	336
Gray	GH0003Q	Cabot	PAMPA PLANT	P-1KATUINC	Yes	No	Carbon Black	Wichita Mtns	221
Gray	GH0004O	CELANESE	CHEMICAL MANUFACTURING	BLR0009A01	No	No	Industrial Organic Chemicals, NEC	Wichita Mtns	222
Lamb	LB0047N	XCEL	TOLK STATION	UNIT 1	No	Yes	Electric Services	Salt Creek	178
Lamb	LB0047N	XCEL	TOLK STATION	UNIT 2	No	Yes	Electric Services	Salt Creek	178
Limestone	LI0027L	Limestone	RELIANT ENERGY LIMESTONE	1	No	Yes	Electric Services	Caney Creek	384
Limestone	LI0027L	Limestone	RELIANT ENERGY LIMESTONE	2	No	Yes	Electric Services	Caney Creek	384

County	Account	Company	Plant Name	FIN	BART	CAIR	Industrial Code Description	Nearest Area	Distance (km)
Milam	MM0023J	TXU	SANDOW STEAM ELECTRIC	S4MB	No	Yes	Electric Services	Wichita Mtns	485
Navarro	NB0014R	GUARDIAN	GUARDIAN INDUSTRIES	01002	No	No	Flat Glass	Caney Creek	334
Potter	PG0041R	XCEL	HARRINGTON STATION	UNIT 1	No	Yes	Electric Services	Wichita Mtns	278
Potter	PG0041R	XCEL	HARRINGTON STATION	UNIT 2	No	Yes	Electric Services	Wichita Mountains	278
Potter	PG0041R	XCEL	HARRINGTON STATION	UNIT 3	No	Yes	Electric Services	Wichita Mountains	277
Rusk	RL0020K	TXU	MARTIN LAKE ELECTRICAL STATION	U1-B1	No	Yes	Electric Services	Caney Creek Wilderness	239
Rusk	RL0020K	TXU	MARTIN LAKE ELECTRICAL STATION	U2-B2	No	Yes	Electric Services	Caney Creek	239
Rusk	RL0020K	TXU	MARTIN LAKE ELECTRICAL STATION	U3-B3	No	Yes	Electric Services	Caney Creek	240
Titus	TF0013B	TXU	MONTICELLO STM ELE STN	B2	No	Yes	Electric Services	Caney Creek	166
Wichita	WH0040R	PPG	WORKS NO 4	STA-22	No	No	Flat Glass	Wichita Mtns	80
Wichita	WH0040R	PPG	WORKS NO 4	STA-23	No	No	Flat Glass	Wichita Mtns	80

Acronyms

FGD – flue gas desulfurization
LNB – low NO_X burner
LNC1 - LNB with close-coupled over-fired air (OFA)
LNC2 – LNB with separated OFA
LNC3 – LNB with both close-coupled and separated OFA.
SDA – spray dryer absorber
SCR – selective catalytic reduction
SNCR – selective non-catalytic reduction
OT + WI – oxygen trim plus water injection

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Appendix 10-2: Estimating Visibility Impacts From Additional Point Source Controls

In order to determine reasonable progress goals for the state of Texas, the TCEQ needed to quantify the visibility benefit of the potentially reasonable set of point source controls that are described in Appendix 10-1. The TCEQ used CENRAP's modeling of additional point source controls as the basis of this estimate.

The CENRAP developed its set of potentially reasonable point source controls and used CMAQ to estimate the visibility benefit of those controls. The TCEQ and CENRAP used the same AirControlNet to develop their control sets. The CENRAP controls extended across all the CENRAP states, not just Texas. CENRAP also assumed a higher cost per ton as potentially reasonable. Table 1 compares the CENRAP control set to the Texas control set. Table 1 shows the annual cost per ton in constant 2005 dollars which define "potentially reasonable point source controls."
The costs are annualized and standardized on 2005 dollars. (Note that under the Texas control scenario only additional controls in Texas are assumed.)

Table 1: Comparison of CENRAP and Texas Control Sets

	CENRAP	Texas
NO_x (tpy) reduction	181,107	27,132
SO_2 (tpy) reduction	725,025	155,873
Total Cost	$2,236,000,000	$324,300,000

Table 2: Projected Visibility Benefit from CENRAP Control Set

Class I Area	2018 (dv)	2018c (dv)	Improvement (dv)
Big Bend	16.63	16.38	0.26
Breton Isle	22.67	17.80	0.46
Caney Creek	22.47	21.46	1.01
Carlsbad Caverns	16.30	16.04	0.26
Guadalupe Mtns	16.30	16.04	0.26
Salt Creek	17.04	16.88	0.15
Upper Buffalo	22.52	21.60	0.91
Wheeler Peak	10.23	10.18	0.05
White Mtn	12.96	12.70	0.26
Wichita Mtns	21.51	20.76	0.75

The projections in Table 2 (and subsequent tables) assume that there will be no change in the coarse mass and soil components of visibility between the base year and 2018.

Table 2 shows visibility impacts under two scenarios. One scenario assumed only "on-the-books" control strategies would be in place by 2018. These results are labeled simply 2018. The other scenario included on-the-books controls plus the CENRAP potentially reasonable control strategy. These results are labeled 2018c.

The Class I areas in Table 2 are of significant interest to Texas. The TCEQ staff used these model results as a framework for estimating the visibility benefits of the potentially reasonable control set developed by the TCEQ.

The CENRAP modeling derived relative response factors (RRF) specific to particular pollutants and Class I areas as per step 3 of section 6.4 of the EPA's "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5 and Regional Haze" (EPA 2007a). These RRF's were multiplied by the measured 2000 through 2004 concentrations at these Class I areas over the 20 percent worst visibility days to estimate concentrations projected for 2018 over said days, as per step 4 of EPA 2007a.

The TCEQ interpolated the RRFs for sulfate and nitrate calculated from the 2018 and 2018c scenarios for each Class I area to generate the expected RRF's that would be obtained if the Texas potentially reasonable control strategy (2018TXc) were selected. Since the emissions differences between the 2018 and 2018c scenarios involve differences over all of CENRAP while the changes in emissions between the 2018 and 2018TXc scenarios involve only changes within Texas, the TCEQ used the results of the PSAT modeling to obtain Class I area specific interpolation coefficients in order to better apportion the expected impacts. An outline of the procedure used is presented in Appendix 10-4, followed by a more general and rigorous mathematical derivation for those interested. A spreadsheet with all the computations is provided as Appendix 10-5. The resulting projected RRFs (shown in Table 3), and corresponding concentrations, of sulfate and nitrate are between those of the 2018 and 2018c scenarios, as would be expected.[1]

Table 3: RRFs Using the Projected 2018 Impacts with the Texas Control Set on Select Class I Areas

Class I Area	Base g RRF for Sulfate	TXc RRF for Sulfate	Base gc RRF for Sulfate	Base g RRF for Nitrate	TXc RRF for Nitrate	Base gc RRF for Nitrate
Big Bend (BIBE)	0.875	0.847	0.832	1.126	1.111	1.088
Guadalupe Mtnts (GUMO)	0.764	0.706	0.699	1.003	0.997	0.987
Wichita Mts (WIMO)	0.709	0.658	0.616	0.814	0.798	0.758
Salt Creek (SACR)	0.800	0.741	0.744	0.917	0.923	0.931
White Mtn (WHIT)	0.809	0.732	0.729	0.987	0.983	0.975

These daily future year species concentrations are then used in steps 5 through 6 of section 6.4 of EPA 2007a to yield the projected visibility metrics, like mean concentrations, extinction, and haze index (in deciviews) for the most impaired days. A comparison of projected mean sulfate and nitrate concentrations over the most impaired days corresponding to the different RRF's at select Class I areas is presented in Table 4, including the projected impacts if the Texas control scenario (2018TXc) had been modeled.

[1] SACR saw a slight increase in modeled nitrate impact with the additional CENRAP potentially reasonable point source controls. This increase is likely due to the decrease of sulfate competing with the nitrate for the available ammonia.

Table 4: Projected Mean Sulfate and Nitrate Concentrations on Select Class I Areas, for Most Impaired Days, Including Projected Concentrations if Texas Controls Had Been Modeled

Class I Area	2018 Sulfate (μg/m^3)	2018TXc Sulfate (μg/m^3)	2018c Sulfate (μg/m^3)	2018 Nitrate (μg/m^3)	2018TXc Nitrate (μg/m^3)	2018c Nitrate (μg/m^3)
Big Bend (BIBE)	4.55	4.40	4.32	0.525	0.518	0.507
Guadalupe Mtnts (GUMO)	2.28	2.11	2.09	0.657	0.653	0.646
Wichita Mts (WIMO)	4.32	4.01	3.75	2.212	2.170	2.060
Salt Creek (SACR)	2.59	2.39	2.40	1.686	1.698	1.713
White Mtn (WHIT)	1.79	1.62	1.62	0.588	0.586	0.581

The daily future year species concentrations are then used in steps 5 through 6 of section 6.4 of EPA 2007a, using the new IMPROVE Equation, to calculate the projected visibility impact. The use of the new IMPROVE Equation is described in Chapter 4 of the Modeling Technical Support Document contained in Appendix 8-1 of this Regional Haze SIP. A spreadsheet is presented in Appendix 10-6 that shows the calculations of the RRF interpolations all the way through application of the RRFs to obtain the visibility metrics (mean concentrations, extinctions, and haze indices over the most impaired days).

Table 5 shows the estimated impact of the Texas control strategy on the Class I areas of significant interest to Texas.

Table 5: Modeled Visibility Benefit from the Texas Control Set

Class I Area	2018 (dv)	2018 TXc (dv)	Improvement (dv)
Big Bend	16.63	16.47	0.16
Breton Isle	22.67	22.62	0.05
Caney Creek	22.47	22.14	0.33
Carlsbad Caverns	16.30	16.08	0.22
Guadalupe Mtns	16.30	16.08	0.22
Salt Creek	17.04	16.86	0.18
Upper Buffalo	22.52	22.35	0.16
Wheeler Peak	10.23	10.18	0.04
White Mtn	12.96	12.72	0.24
Wichita Mtns	21.51	21.15	0.36

Texas 2018 projections assume that there would be no change in the coarse mass and soil components of visibility between the base year and 2018. The TCEQ finds that this is a reasonable assumption for Big Bend and Guadalupe Mountains. The agency has not determined if it is a reasonable assumption for the other Class I areas shown. However, for consistency, TCEQ is presenting the Texas 2018 projections for those areas.

Appendix 10-3: Uniform Rate of Progress Curves Using Default Natural Condition Estimates

Chapter 10 presents the uniform rate of progress (URP) for the best 20 percent and the worst 20 percent days for the two Class I areas in Texas using the best site-specific natural conditions estimates available to the TCEQ. Appendix 10-3 shows the two different URPs for Big Bend National Park and the two for Guadalupe Mountains National Park based on the site-specific estimates and on the default natural conditions estimates the EPA recommends. These are the Natural Conditions II (NCII) estimates.

Table 1: Uniform Rate of Progress for Class I Areas in Texas (Worst 20 Percent Days)

Class I Area	**Using Texas Site-specific Natural Condition Estimates**			**Using EPA-recommended NCII Default Natural Condition Estimates**		
	Improvement Needed by 2018 assuming URP (dv)	Progress Annually to 2018 assuming URP (dv)	Improvement Needed by 2064 (dv)	Improvement Needed by 2018 assuming URP (dv)	Progress Annually to 2018 assuming URP (dv)	Improvement Needed by 2064 (dv)
Big Bend	1.7	0.12	7.2	2.3	0.17	10.1
Guadalupe Mountains	1.2	0.08	4.9	2.4	0.17	10.4

Table 2: Reasonable Progress Goals for Class I Areas (Worst 20 Percent Days)

Class I Area	Improvement Projected by 2018 using RPG (dv)	**Using Texas Site-specific Natural Condition Estimates**			**Using EPA-recommended NCII Default Natural Condition Estimates**		
		Improvement by 2018 at URP (dv)	Projected Improvement by 2064 at RPG Rate (dv)	Date Natural Visibility Attained at RPG Rate	Improvement by 2018 at URP (dv)	Projected Improvement by 2064 at RPG Rate (dv)	Date Natural Visibility Attained at RPG Rate
Big Bend	0.7	1.7	2.9	2155	2.3	2.9	2215
Guadalupe Mountains	0.9	1.2	3.8	2081	2.4	3.8	2167

These projections of the year in which visibility would improve to natural conditions for the worst 20 percent of days are a requirement of the Regional Haze Rule. The large contribution that international pollution transport makes to Big Bend and to Guadalupe Mountains means that U.S. emission reductions alone could never bring these two Class I areas to natural visibility conditions.

For the best 20 percent of days the requirement is to project the haze index in deciviews for the end of the planning period, which is 2018 for this first Regional Haze SIP submission, and to show that the projection does not show any degradation from the base period average haziness for the best 20 percent days. Table 10-3 in the body of Chapter 10 does show that the modeling using Texas' long-term strategy does provide for 0.2 deciview improvement in haze for the best 20 percent of days at both Big Bend and Guadalupe Mountains. For quick reference a copy of Table 10-3 from the SIP text appears here:

Table 3: Reasonable Progress Goals for Class I Areas (Best 20 Percent Days)

Class I Area	Baseline Visibility (dv)	Projected 2018 Visibility (RPG) (dv)	Improvement by 2018 at RPG (dv)
Big Bend	5.8	5.6	0.2
Guadalupe Mountains	5.9	5.7	0.2

The following two figures show both the site-specific and the EPA default uniform rate of progress lines along with the 2018 projected RPG points for Big Bend and Guadalupe Mountains.

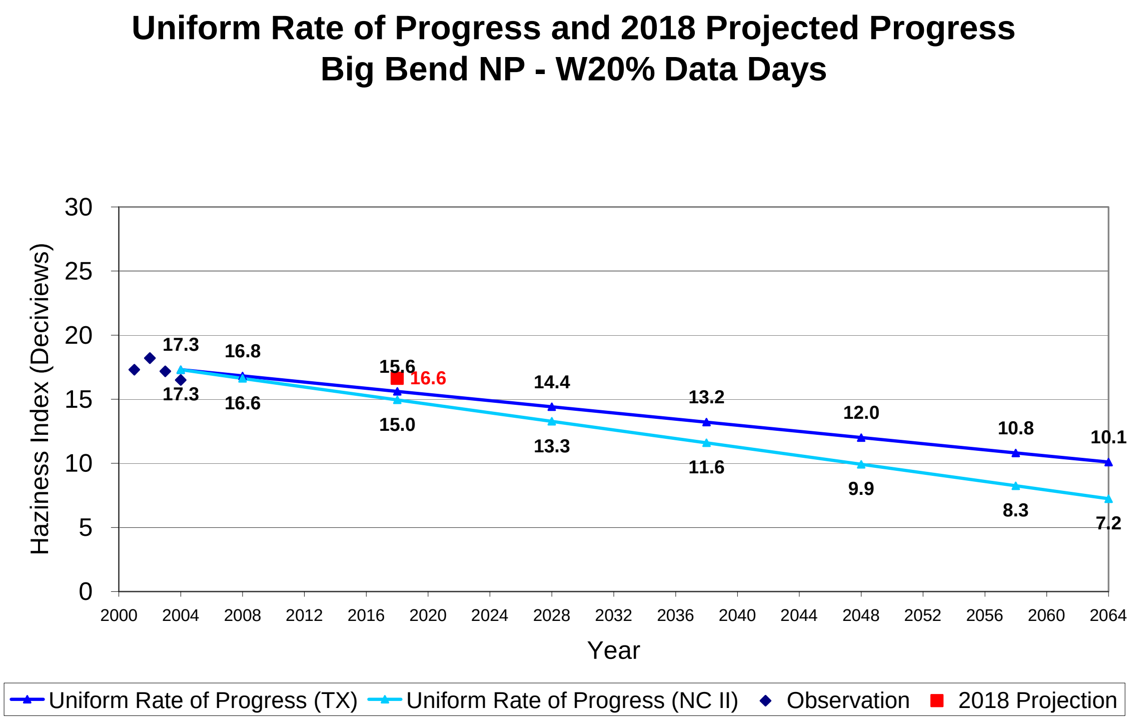

Figure 1: Glide Paths for Big Bend National Park Calculated Using Site-Specific 2064 Natural Conditions Estimates and Natural Conditions II Committee Estimates

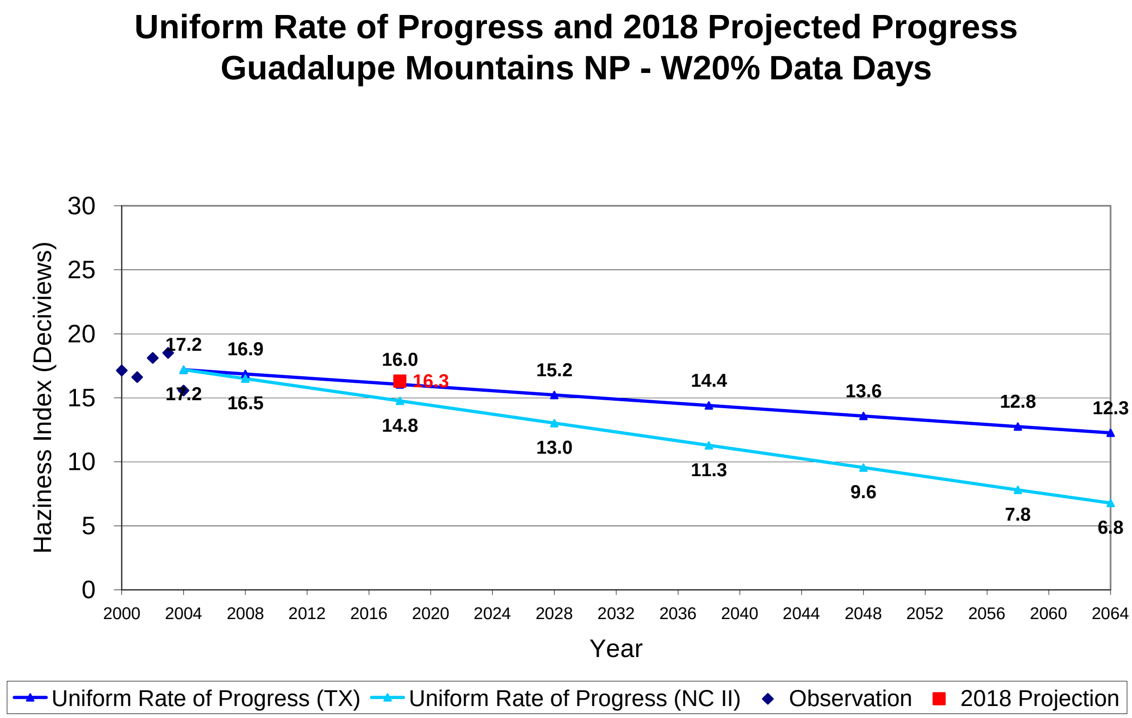

Figure 2: Glide Paths for Guadalupe Mountains National Park Calculated Using Site-Specific 2064 Natural Conditions Estimates and Natural Conditions II Committee Estimates

Appendix 10-4: Detailed Calculations for Estimating Visibility Impacts

Estimating Control Impacts Based on Prior Modeling, Including Particulate Source Apportionment Technology (PSAT) Modeling

By Dr. David Halliday
TCEQ

If results of two or more sets of modeling runs are available, but an estimate of the results of a different set of parameters is needed, such as a different set of controls, and it is not possible to obtain a new set of modeling runs (for instance due to time or budgetary constraints), then some other means of obtaining an estimate of these results is needed. Since Regional Haze modeling (like many other air quality modeling applications) is principally applied via calculation and application of Relative Response Factors (RRFs), it would be natural to interpolate RRFs from prior modeling to estimate RRFs that would be obtained by modeling a given set of controls that are similar to the control sets used in earlier runs.

Within this document we present a reasonable method for estimating impacts of controls that have not actually been modeled, based upon a linear interpolation over RRFs of two available modeling runs. This method is reasonable provided the two interpolated model runs have the same baseline conditions as the unmodeled run, and are sufficiently similar to each other and to the unmodeled run, to justify a linear approximation. The interpolation coefficient used in this method takes advantage of a Source Apportionment Technology (in this case, Particulate Source Apportionment Technology or PSAT) future case run to provide a receptor and/or monitor[1]specific interpolation, provided this run is sufficiently similar to the conditions of the future cases of the prior modeled runs.

Consider one of the two modeled runs to be a "base" control run. The difference in emissions between the "second" control run and this "base" control run are the emission reductions of the "second" control set. Further, the difference in emissions between the unmodeled, or, "target" control run and this "base" control run are the emission reductions of the "target" control set. Since this approach is a linear approximation, emission species such as sulfur dioxide and nitrogen oxides, will be associated with measured species that are most closely related, such as ammonium sulfate and ammonium nitrate, respectively.

The **emissions reduction ratio** associated with a given species will be the ratio of the emission reductions of the "target" control set associated with that species over the emissions reductions of the "second" control set associated with the same species. These ratios are computed on an emission apportionment category basis (such as source region and emitter category) using the same emission apportionment categories in the PSAT future case run. The **apportionment fraction**, for each species and receptor, is the fraction of the average PSAT modeled future case concentration apportioned to a given

[1] Henceforth, the term *receptor* shall be used in place of receptor and/or monitor.

emission apportionment category, for that species and receptor, over all emission apportionment categories that differ between the “base” and “second” control runs. This ensures the sum of the apportionment fractions, over all the emission apportionment categories that differ between the “base” and “second” control runs, will yield one.

The interpolation coefficient, for each species and receptor, equals the sum, over all the emission apportionment categories that differ between the “base” and “second” control runs, of the product of the emissions reduction ratio associated with that species, and the apportionment fraction, for the category, species, and receptor.

This interpolation factor, for each species and receptor, is then multiplied by the difference in the RRFs of the “second” control run and the “base” control run (with the “base” being subtracted from the “second”). This product is added to the RRF of the “base” control run to obtain the estimate of the RRF of the “target” control run, for the given species and receptor.

What follows is a mathematical derivation of this method.

Derivation of the Method

Equation 10-4-1 below shows the method of linear interpolation to a new “target” RRF (RRF_T) from RRFs obtained from “base” (RRF_B) and “second” (RRF_S) modeling runs, as above:

$$\begin{aligned} RRF_{T\,rs} &= \left(1 - f_{T\,rs}\right) RRF_{B\,rs} + f_{T\,rs} RRF_{S\,rs} \\ &= RRF_{B\,rs} + f_{T\,rs}\left(RRF_{S\,rs} - RRF_{B\,rs}\right) \end{aligned} \qquad \text{(eq. 10-4-1)}$$

where $f_{T\,rs}$ is the interpolation coefficient, $RRF_{x\,rs}$ is the RRF for modeling run x, (where $x \in \{B,S,T\}$), with B and S representing the two modeled runs and T representing the interpolated “target” estimate desired, for each receptor (r)and species (s).

If the new control set is simply an interpolated set of emissions between those used in the “base” and “second” modeling, and emissions in these modeling runs are not too different (so a linear approximation is reasonable), then the interpolation coefficient is given by

$$f_{T\,rs} = f_{T\,s} = \frac{E_{T\,r} - E_{B\,s}}{E_{S\,s} - E_{B\,s}} = \frac{\Delta E_{T\,s}}{\Delta E_{S\,s}} \qquad \text{(eq. 10-4-2)}$$

where the $E_{x\,s}$ are the emissions for modeling run x ($x \in \{A,B,I\}$) associated with species s.

If emissions are not simply a scaled interpolation between ”base” and “second” model runs, then determination of a proper interpolation coefficient becomes much less straight forward. In this case, the above interpolation is likely to misappropriate the impacts of changes, since it applies the same interpolation for all receptors (r), for a given species (s).

However, if apportioned RRFs from ”base” and ”second” modeling runs were available, then interpolation of apportioned RRFs would be possible and a more representative set of emissions could be obtained. For instance, if the equivalent of RRFs for each run, species, receptor, and apportionment category (such as source region and emitter category, like electric generating units, etc.) were available, it would be possible to obtain RRFs apportioned by such categories.

Given $RRF_{B\,rs} = \sum_t RRF^t_{B\,rs}$ and $RRF_{S\,rs} = \sum_t RRF^t_{S\,rs}$, where the “tag” ($t$) runs over all apportionment categories (such as source region and emitter category) that differ between the runs, an interpolated “target” $RRF_{T\,rs} = \sum_t RRF^t_{T\,rs}$ is obtained:

$$RRF^t_{T\,rs} = RRF^t_{B\,rs} + f^t_{T\,rs}\left(RRF^t_{S\,rs} - RRF^t_{B\,rs}\right) \qquad \text{(eq. 10-4-3)}$$

where

$$f^t_{T\,rs} = f^t_{T\,s} = \frac{E^t_{T\,s} - E^t_{B\,s}}{E^t_{S\,s} - E^t_{B\,s}} = \frac{\Delta E^t_{T\,s}}{\Delta E^t_{S\,s}} \qquad \text{(eq. 10-4-4)}$$

If the baselines for the two “base” and “second” modeling runs and for the “target” modeling run are identical, then interpolation between RRFs is equivalent to interpolation between averaged modeled concentrations. Thus, if a Source Apportionment Technology (like PSAT) run for the future case is available that involves emissions that are not too different from the future “base”, “second”, and “target” cases, then an apportioned RRFs may be estimated as:

$$RRF^t_{x\,rs} \approx RRF_{x\,rs}\left(\frac{\left\langle C^t{}_{rs}\right\rangle}{\sum_t \left\langle C^t{}_{rs}\right\rangle}\right) = RRF_{x\,rs}\,\frac{\left\langle C^t{}_{rs}\right\rangle}{\left\langle C_{rs}\right\rangle} \qquad \text{(eq. 10-4-5)}$$

where $\left\langle C^t{}_{rs}\right\rangle$ is the averaged modeled future case concentration apportioned to tag (t) for receptor (r), and species (s). $\left\langle C_{rs}\right\rangle$ is defined as $\left\langle C_{rs}\right\rangle = \sum_t \left\langle C^t{}_{rs}\right\rangle$.

Therefore, a better interpolation is thus obtained as:

$$\begin{aligned} RRF_{T\,rs} &= \sum_t RRF^t_{T\,rs} \\ &= \sum_t RRF^t_{B\,rs} + \sum_t f^t_{T\,s}\left(RRF^t_{S\,rs} - RRF^t_{B\,rs} \right) \\ &\approx RRF_{B\,rs} + \left(RRF_{S\,rs} - RRF_{B\,rs} \right) \sum_t f^t_{T\,s} \frac{\left\langle C^t{}_{rs} \right\rangle}{\left\langle C_{rs} \right\rangle} \\ &= RRF_{B\,rs} + f_{T\,rs}\left(RRF_{S\,rs} - RRF_{B\,rs} \right) \end{aligned} \qquad \text{(eq. 10-4-6)}$$

The interpolation coefficient, $f_{T\,rs}$, now depends upon the receptor (r), and is given by

$$f_{T\,rs} = \sum_t f^t_{T\,s} \frac{\left\langle C^t{}_{rs} \right\rangle}{\left\langle C_{rs} \right\rangle} = \sum_t \frac{\Delta E^t_{T\,s}}{\Delta E^t_{S\,s}} \frac{\left\langle C^t{}_{rs} \right\rangle}{\left\langle C_{rs} \right\rangle} \qquad \text{(eq. 10-4-7)}$$

The foregoing is a reasonable method for estimating impacts of controls that have not actually been modeled, based upon interpolation over two available modeling runs, provided, of course, the two runs over which we are interpolating have identical baseline conditions as would be used for the "target" run to be estimated, and are sufficiently similar to each other and to the "target" run. The interpolation coefficient, thereof, takes advantage of a Source Apportionment Technology (like PSAT) future case run to provide a receptor-specific interpolation, provided this run is sufficiently similar to the conditions of the future cases of the other available runs.

Appendix 10-4 has a large spreadsheet that is not easily printed and is available on line with all the other appendixes. All appendixes are available on the web site <http://www.tceq.state.tx.us/implementation/air/sip/bart/haze_appendices.html>.

If you have problems accessing any files, please contact me below or another SIP coordinator through the receptionist at 512-239-4900:

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