Appendix A.

Modeling and Emission Inventory Development; Review and Analysis for Louisiana's Regional Haze State Implementation Plan Submittal

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Chapter 1: Background and Introduction

1.1 BACKGROUND

Regional haze is visibility impairment that is caused overwhelmingly by fine particulates (PM2.5). Visibility impairment occurs when PM2.5 in the atmosphere scatters and absorbs light, thereby creating haze. PM2.5 can be emitted into the atmosphere directly as primary particulates, or it can be produced in the atmosphere from photochemical reactions of gas-phase precursors and subsequent condensation to form secondary particulates. Examples of primary PM2.5 include crustal materials and elemental carbon; examples of secondary PM include ammonium nitrate, ammonium sulfates, and secondary organic aerosols (SOA). Secondary PM2.5 is generally smaller than primary PM2.5, and because the ability of PM2.5 to scatter light depends on particle size, with light scattering for fine particles being greater than for coarse particles, secondary PM2.5 plays an especially important role in visibility impairment. Moreover, the smaller secondary PM2.5 can remain suspended in the atmosphere for longer periods and is transported long distances, thereby contributing to regional-scale impacts of pollutant emissions on visibility.

The sources of PM2.5 are difficult to quantify because of the complex nature of their formation, transport, and removal from the atmosphere. This makes it difficult to simply use emissions data to determine which pollutants should be controlled to most effectively improve visibility. Photochemical air quality models offer opportunity to better understand the sources of PM2.5 by simulating the emissions of pollutants and the formation, transport, and deposition of PM2.5. If an air quality model performs well for a historical episode, the model may then be useful for identifying the sources of PM2.5 and helping to select the most effective emissions reduction strategies for attaining visibility goals. Although several types of air quality modeling systems are available, the gridded, three-dimensional, Eulerian models provide the most complete spatial representation and the most comprehensive representation of processes affecting PM2.5, especially for situations in which multiple pollutant sources interact to form PM2.5.

In Section 169A of the 1977 Amendments to CAA, Congress set forth a program for protecting visibility in the nation's national parks and wilderness areas. This section of the CAA establishes 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 manmade air pollution." EPA promulgated a rule to address regional haze on July 1, 1999 (64 FR 35713), the Regional Haze Rule (RHR). The RHR established the goal of achieving "natural" visibility conditions in all 156 Federal Class I areas by 2064.

Because the pollutants that lead to regional haze can originate from sources located across broad geographic areas, EPA has encouraged the States and Tribes across the United States to address visibility impairment from a regional perspective. Five Regional Planning Organizations (RPOs) were developed to address regional haze and related issues (Figure 1-1). One of the main objectives of the RPOs is to analyze available data and conduct pollutant transport modeling to assist the States in developing their regional haze plans.

Figure 1-1. Map of Regional Planning Organizations

The Central Regional Air Planning Association (CENRAP) RPO is a collaborative effort of State governments, tribal governments, and various federal agencies established to conduct data analyses, conduct pollutant transport modeling, and coordinate planning activities among the central States. CENRAP members include the State governments of Nebraska, Kansas, Oklahoma, Texas, Minnesota, Iowa, Missouri, Arkansas, and Louisiana and Tribal governments included in these states.

1.2 TECHNICAL REQUIREMENTS FOR REGIONAL HAZE SIPS

The RHR does not mandate specific milestones or rates of progress, but instead calls for States to establish goals that provide for "reasonable progress" toward achieving natural visibility conditions. In setting Reasonable Progress Goals (RPGs), States must provide for an improvement in visibility for the most impaired days over the ten-year period of the SIP, and ensure no degradation in visibility for the least impaired days over the same period. In setting the RPGs for each 10-year period covered by a SIP, States must also compare the RPGs to the uniform rate of progress needed to reach natural visibility conditions by 2064, referred to as the "glide path", which is the linear rate of reduction in visibility impairment (in deciviews) needed to achieve natural conditions by 2064.

According to the RHR, Regional Haze SIPs must specifically identify and address the following elements:

i. Baseline Visibility Conditions
ii. Natural Visibility Conditions
iii. Uniform Rate of Progress
iv. Best Available Retrofit Technology (BART)
v. Current and Future (2018) Emission Inventories
vi. Source Contribution to Haze
vii. Reasonable Progress Goals

The purpose of this document is to supplement the main TSD and provide review of issues not covered in the main TSD dealing with the technical products developed by the Louisiana Department of Environmental Quality (LDEQ) and CENRAP for the central regional states, in support of their RH SIP. This document evaluated the methods and procedures used by LDEQ and CENRAP to develop the modeling and emission inventory products that assisted Louisiana and the central regional States in addressing the required elements of a RH SIP. Specifically, this document reviewed emission inventory, meteorological, photochemical, and BART modeling conducted by CENRAP and other screening modeling, evaluated the results and determined if these models met applicable guidelines or protocols, and met modeling standards at the time they were conducted.

Chapter 2: Development of Baseline and Natural Visibility Conditions and Glidepath

2.1 INTRODUCTION

Under the Regional Haze Rule (RHR), each State is required to demonstrate reasonable progress in visibility conditions for each of its Class I areas. The State is to determine a uniform rate of progress ("glide path", "glide slope") toward the goal of natural visibility conditions in 2064. Considering various statutory factors, the State is also to define a reasonable rate of progress, and compare this to the benchmark uniform rate; if projected progress is less than the uniform rate, then the State is to explain why. Procedures for assessing progress are described in the Regional Haze Rule and EPA guidance documents.

In brief, the guidance defines a metric to quantify visibility conditions, together with procedures for determining a starting point and an ending point, between which progress is to be made. The metric used is the Haze Index, measured in deciviews, and is designed to correspond to human perception of visibility changes. It is defined as:

$$10*\ln(b_{ext}/10) \qquad (1)$$

where b_{ext} is extinction, the fraction of light scattered out of a sight path due to pollutants over a given distance (with units of Mm^{-1} or "inverse megameters"); it is inversely related to visual range. A 24-hour average is used, so there is a deciview value for each day of the year; the average of the 20% most-impaired days, and the average of the 20% least-impaired days during a year are to be assessed. The Regional Haze Rule goal is to improve visibility on the worst 20% of days, while having no degradation on the best 20%.

The starting point for progress is current or baseline visibility conditions, as monitored by the Interagency Monitoring of PROtected Visual Environments (IMPROVE) monitoring network (webpage and data access: http://vista.cira.colostate.edu/improve/Default.htm). 24-hour samples are collected every three days and are sent to a laboratory facility for analysis to obtain dry concentrations of a wide variety of species that impact visibility. Monitored pollutant concentrations are converted to visibility extinction using the IMPROVE equation, which adds up the contribution of each pollutant to extinction, while accounting for the effect of relative humidity. This total extinction is then converted to deciviews in the Haze Index through equation 1. For each of the years of the baseline period (2000-2004), the average of the deciviews on the worst 20% of days is calculated; the five-year average of these defines the baseline. This procedure is described in detail in EPA's "Guidance for Tracking Progress Under the Regional Haze Rule".[1] The guidance also makes provisions for dealing with missing data, since monitoring instrument maintenance and malfunctions mean that data is not available for every scheduled measurement.

The end point for progress is the goal of natural visibility conditions in 2064. The default approach for determining these is described in EPA's "Guidance for Estimating Natural Visibility

[1] Hereafter "GTR": EPA, 2003, *Guidance for Tracking Progress Under the Regional Haze Rule*, EPA-454/B-03-004, September 2003, EPA OAQPS ; web page: http://www.epa.gov/ttn/oarpg/t1pgm.html
direct link: http://www.epa.gov/ttn/oarpg/t1/memoranda/rh_tpurhr_gd.pdf

Conditions Under the Regional Haze Program".[2] Annual average natural background pollutant concentrations are estimated by Trijonis et al.[3] under NAPAP for the East and West parts of the country. Deciviews are calculated based on these natural background estimates with the IMPROVE equation, using the monthly relative humidity for each specific Class I area. These annual averages are then translated into estimates for the best 20% and worst 20% days needed for the progress assessment. Extinction was assumed to have a lognormal frequency distribution; deciviews would then have a normal distribution, and its 10th and 90th percentiles were used as estimates of the average of the best 20% and worst 20% of days, respectively. The result is a table of best and worst 20% deciview values for each Class I area, which appears in Appendix B of the guidance. The guidance also allows States to use a refined alternative to this default approach for estimating natural conditions.

Finally, the uniform rate of progress is calculated as the difference between the baseline and natural conditions, spread over the 60 years between 2004 and 2064: uniform deciviews per year improvement = (current 2004 deciviews - natural 2064 deciviews) / 60. This rate is the benchmark against which visibility improvement is to be compared by the State; the first planning period envisaged by the Regional Haze Rule is through 2018, so this uniform rate is multiplied by 14 to determine the first benchmark.

2.2 CALCULATION OF VISIBILITY FROM IMPROVE MEASUREMENTS

The CENRAP procedure used for developing a uniform rate of progress (URP, also known as "glide path" or "glide slope") for the State of Louisiana followed EPA guidance contained in the GTR and GENVC with the exception that the revised IMPROVE algorithm was utilized rather than the original IMPROVE equation . The procedure used is described in the Technical Support Document for CENRAP Emissions and Air Quality Modeling to Support Regional Haze State Implementation Plans.[4]

CENRAP used the approach of Pitchford et al.[5]. The equation utilized is referred to as the "revised" IMPROVE algorithm or equation and was used for estimates of both baseline and natural conditions. The revised IMPROVE equation is used to convert measured concentrations into extinction for each pollutant chemical species, and then total them up, accounting for the effect of relative humidity, and including the Rayleigh scattering that occurs in pure air. The extinction total is then used to calculate deciviews for use in visibility progress assessments through equation 1. EPA's 2007 "Guidance on the Use of Models and Other Analyses for

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[2] Hereafter "GENVC": EPA, 2003, *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Program*, EPA-454/B-03-005, September 2003, EPA OAQPS; web page: http://www.epa.gov/ttn/oarpg/t1pgm.html direct link: http://www.epa.gov/ttn/oarpg/t1/memoranda/rh_envcurhr_gd.pdf

[3] Trijonis, J.C., et al., 1990, "Visibility: Existing and Historical Conditions-Causes and Effects", chapter 24 in NAPAP State of Science & Technology, Vol. III web page: http://vista.cira.colostate.edu/improve/Publications/Principle_pubs.htm

[4] Hereafter "CENRAP TSD": Environ International Corp. and University of California at Riverside, September 2007.

[5] (2007) Pitchford, Marc; William Malm, Bret Schichtel, Naresh Kumar, Douglas Lowenthal, and Jenny Hand, 2007: Revised algorithm for estimating light extinction from IMPROVE particle speciation data. J. Air & Waste Manage. Assoc., 57, 1326-1336.

Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze"[6] states that the use of either the IMPROVE or the revised IMPROVE equation is acceptable provided that the States supply documentation concerning the choice of equation and that the same algorithm is utilized for both the base and future extinction calculations.

The IMPROVE program revised the IMPROVE equation after a scientific assessment of its implications for regional haze planning to reduce biases in light extinction estimates compared to the old algorithm.[7] In particular, when compared to nephelometer direct measurements of visibility extinction, the original IMPROVE equation over-predicts for low extinction conditions and under-predicts for high extinction. These biases have direct relevance for estimates for the best 20% and worst 20% visibility days that are used to assess progress.

The revised equation used by CENRAP has four changes: 1) greater completeness though the inclusion of sea salt, which can be important for coastal sites; 2) increased organic carbon mass estimate, based on more recent data for remote areas; 3) Rayleigh scattering using site-specific elevation and temperature, a refinement over the older network-wide constant; and 4) separate estimates for small and large particles of visibility impacts and humidity-dependent particle size growth rates, which could affect estimates at the low and high ends.[8] The revised equation has an additional term for inclusion of NO2; however, none of the CENRAP Class I areas have monitors that provide observations of NO2 so this term was not used.

The new equation shows broader scatter overall, but less bias in matching visibility measurements under high and low visibility conditions. That is, though it has a somewhat worse fit considering all the data, it has a better fit under visibility conditions most relevant to regional haze planning, the best and worst 20% of days. The looser overall fit can cause a slightly different set of days to be the ones chosen as the 20% worst, but the chemical species composition for such days is little changed (IMPROVE technical subcommittee for algorithm review, 2001, pp. 11-12), and so this makes little difference for assessing the contribution of emission sources to current conditions, and for projecting the effect of emission controls. The split between small and large particles was the main factor in reducing the biases.

The organic carbon (OC) measured by the IMPROVE network does not include all organic matter (OM); based on 1970's urban data, a scaling factor of 1.4 is embedded in the old equation to account for the full mass. Based on recent data more relevant to relatively remote Class I

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[6] Hereafter "GOPMRH": EPA, 2007, *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze*, EPA-454/B-07-002, April 2007, EPA OAQPS; web page: http://www.epa.gov/scram001/guidance_sip.htm direct link: http://www.epa.gov/ttn/scram/guidance/guide/final-03-pm-rh-guidance.pdf

[7] IMPROVE, 2006, *Revised IMPROVE algorithm for Esimating Light Extinction from Particle Speciation Data*, January 2006; http://vista.cira.colostate.edu/improve/Publications/GrayLit/gray_literature.htm; Hand, J.L.; Douglas, S.G., 2006, Review of the IMPROVE Equation for Estimating Ambient Light Extinction Coefficients – Final Report, http://vista.cira.colostate.edu/improve/Publications/GrayLit/016_IMPROVEeqReview/IMPROVEeqReview.htm

[8] Pitchford, Marc, 2006, "New IMPROVE algorithm for estimating light extinction approved for use", *The IMPROVE Newsletter*, Volume 14, Number 4, Air Resource Specialists, Inc.; web page: http://vista.cira.colostate.edu/improve/Publications/news_letters.htm direct link: http://vista.cira.colostate.edu/improve/Publications/NewsLetters/IMPNews4thQtr2005.pdf

areas, the revised IMPROVE equation embeds an OM/OC factor of 1.8. At the Caney Creek Wilderness Area and Upper Buffalo Wilderness Area sites, fine sulfurous aerosol contributes the most to visibility impairment on the worst days during the baseline years, although a few of the worst days are dominated by nitrates. . The largest difference in results between the two algorithms is related to the separation of total concentrations of sulfate, nitrate, and organic carbon into small and large size distributions in the revised equation.

The revised IMPROVE equation has less bias, is more refined, accounts for more pollutants, incorporates more recent data, and is based on considerations of relevance for the calculations needed for assessing progress under the RHR. EPA believes it is appropriate for the CENRAP states to use the revised IMPROVE equation. As the state of the science evolves, it is recommended that this procedure is reevaluated to apply more current and site specific data as it becomes available. CENRAP provides alternative calculations using the original IMPROVE equation for comparison with these visibility calculation results.

2.3 BASELINE VISIBILITY CONDITIONS

Section 2 of the EPA's "Guidance for Tracking Progress Under the Regional Haze Rule" ("GTP") describes a step-by-step process for calculating the visibility metric for the baseline period 2000-2004. The steps involve (1) assembly of daily species concentration data from the IMPROVE network, (2) inclusion of substitutions for missing data; (3) assessment of site data completeness (4) calculation of extinction via the IMPROVE equation; (5) calculation of the deciview Haze Index; (6) calculation of average deciviews for the 20% best and 20% worst days for each year; and (7) averaging these over the 5 year period. These steps are mostly straightforward and are briefly discussed here with a more detailed discussion on the differences between EPA guidance and CENRAP procedures.

We discuss the data filling for the Breton monitor and the acceptability of the data that was generated with assistance from the IMPROVE committee and utilized in the CENRAP and LDEQ RH SIP in the main TSD for this action.

The RHR defines the baseline period as the five year span from 2000-2004. As discussed in the main TSD. LDEQ has calculated a baseline visibility based on the average of the worst (best) 20% of days for each of these three years. With the data substitution, this meets the minimum overall data completeness requirements for calculation of the baseline visibility conditions detailed in the GTP.

Every Class I area within the CENRAP states has an associated IMPROVE monitor. Results from analysis of samples collected at each monitor site are used to calculate extinction and haze index using the procedure described above. For those CENRAP sites (Breton (BRET), Louisiana; Boundary Waters (BOWA), Minnesota and Mingo (MING), Missouri) that did not have three valid years that met the completeness requirements for inclusion in the baseline visibility calculations, data filling was used to create at least three years of valid data. These data filled IMPROVE databases were prepared and made available on the VIEWS website. More information on the data filling procedures can be found at the VIEWS website: (http://vista.cira.colostate.edu/views/).

The CENRAP followed EPA guidance for estimating baseline visibility conditions.

2.4 NATURAL VISIBILITY CONDITIONS

EPA guidance set out a default procedure for estimating natural conditions, but also describes circumstances when States might want to use a more refined approach, such as to reduce uncertainty when baseline visibility is already near natural conditions, or when there is marked seasonality; these might be accomplished via alternative estimates of natural concentrations, or use of temporally varying estimates (GENV sec. 3.1 and 3.2).

LDEQ opted to use the revised IMPROVE equation to calculate the “refined” natural visibility conditions. This is an acceptable approach under our 2003 Natural Visibility Guidance. This approach uses the revised IMPROVE equation so that progress between baseline conditions and natural conditions can be calculated on a consistent basis.
The procedure used has several acknowledged limitations. 1) each chemical species can have one of only two possible background concentrations, one for the East and one for the West. Future efforts may provide for a larger number of geographic zones with differing concentrations A second potential limitation is that the same approach is used for both natural- and anthropogenic-dominated species components; EPA guidance mentions the possibility of treating these separately (GENV sec. 3.4).

The majority of visibility impairment at the Breton National Wildlife Refuge site is currently from anthropogenic sources. As measures are taken to improve visibility and decrease emissions, the ability to identify natural sources and background concentrations of PM will improve. The current approach used by LDEQ follows EPA methods and is acceptable. As additional information and more site-specific data become available, LDEQ is encouraged to pursue refinements in this approach to better quantify natural visibility conditions.

2.5 UNIFORM RATE OF PROGRESS (GLIDEPATH) CALCULATION

The uniform rate of progress is calculated as the linear rate of progress (decrease in deciviews per year) required to reach natural visibility conditions in 2064, starting from the baseline conditions in 2004. The first benchmark year is 2018 and the calculated improvement required to attain the desired rate of progress is 3.45 deciviews for Breton Island. Table 2.5 summarize the calculations performed by LDEQ.

Table 2.1. Uniform Rate of Progress for Breton National Wildlife Refuge and (worst quintile, western natural visibility conditions)

Conditions	**Total extinction (Mm^{-1})**	**Haze Index (deciviews)**
Baseline (2002-2004) conditions	131.05	25.73
Natural (for 2064) conditions	32.97	11.93
Observed impairment above natural conditions	98.08	13.8
Progress (2004-2018) at uniform rate		0.23 per year
Improvement needed by 2018 assuming uniform rate of progress	22.885	3.22

Chapter 3: Emission Inventory Development

3.1 Introduction

In support of the CENRAP Regional Haze air quality modeling efforts, air quality modeling inputs including annual meteorology and emissions inventories for a 2002 actual emissions base case, a planning case to represent the 2000-04 regional haze baseline period using averages for key emissions categories, and a 2018 base case of projected emissions are needed. All emission inventories were developed using the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system (See section 3.6). Each of these inventories has undergone a number of revisions throughout the development process to arrive at the final versions used in CMAQ and CAMx air quality modeling. In general, updated 2002 emissions data for the U.S. developed by the Regional Planning Organizations (RPOs), updated emissions data for Mexico from the BRAVO 1999 emissions inventory, and version 2 of the 2000 emissions data for Canada were used to generate a 2002 annual emissions database. The 2002 and 2018 emissions inventories and ancillary modeling data were provided by CENRAP emissions inventory contractors,[9] other RPOs and EPA. Emission modeling and quality assurance (QA) work was based on the *Quality Assurance Project Plan (QAPP) CENRAP Emissions and Air Quality Modeling*[10] and *Protocol for the CENRAP 2002 Annual Emissions and Air Quality Modeling*[11] (hereafter referred to as the "Modeling Protocol"). These protocols were reviewed by the EPA Regions at the time they were developed.

The development of each of these emission scenarios are as follows:

- The 2002 base case emissions scenario was developed to represent the actual conditions in calendar year 2002 with respect to ambient air quality and the associated sources of criteria and particulate matter air pollutants. This emission inventory is used to validate the air quality model and associated databases and to demonstrate acceptable model performance with respect to replicating observed particulate matter air quality. The base case includes actual day-specific emissions of SO_2 and NOx emissions for large stationary point sources based on measured continuous emissions monitoring (CEM) data along with actual 2002 fire emissions.

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9 Pechan and CEP. 2005. Consolidation of Emissions Inventories (Schedule 9; Work Item 3). E.H. Pechan and Associates, Inc. and Carolina Environmental Program (CEP), University of North Carolina(UNC), (http://www.cenrap.org/html/projects.php?mode=subcatdownload&id=50); Pechan and CEP. 2005. Refinements of CENRAP's 2002 Emissions Inventories (Schedule 9; Work Item 3). E.H. Pechan and Associates, Inc. and CEP, UNC. (http://www.dnr.mo.gov/env/apcp/docs/appendixh-3.pdf); Reid, S.B. et al. 2004. Emission Inventory Development for Mobile Sources and Agricultural Dust Sources for the Central States. Sonoma Technology, Inc. (http://cenrap.sonomatech.com/CENRAP_Mobile/FinalReport.pdf).; Reid, S.B et al. 2004. Research and Development of Planned Burning Emission Inventories for the Central States Regional Air Planning Association. Sonoma Technology, Inc. (http://cenrap.sonomatech.com/CENRAP_PlannedBurnData/FinalReport.pdf).; Coe, D.L. and S.B. Reid. 2003. Research and Development of Ammonia Emission Inventories for the Central States Regional Air Planning Association. Sonoma Technology, Inc. (http://cenrap.sonomatech.com/CENRAP_Ammonia_NIF/FinalReport.pdf).

10 Morris, R.E. and G. Tonnesen. 2006. Quality Assurance Project Plan (Draft) for Central Regional Air Planning Association (CENRAP) Emissions and Air Quality Modeling. (http://pah.cert.ucr.edu/aqm/cenrap/docs/CENRAP_QAPP_Rev3_Mar_29_2006.pdf)

11 Morris, R.E. et al. Modeling Protocol for the CENRAP 2002 Annual Emissions and Air Quality Modeling, Draft 2.0. Web:http://pah.cert.ucr.edu/aqm/cenrap/docs/CENRAP_Draft2.0_Modeling_Protocol_120804.pdf).

- The 2000-04 baseline period planning case emissions scenario is referred to as "Typ02G". The purpose of the Typ02G inventory is to represent baseline emission patterns based on average, or "typical", conditions. This inventory provides a basis for comparison with the future year 2018 projected emissions, as well as to gauge reasonable progress with respect to future year visibility. 5-years of CEM data were analyzed and typical seasonal and diurnally varying emissions were defined.

- The 2018 future-year base case emissions scenario is referred to as "2018 Base Case" or "Base18G". These emissions are used to represent conditions in future year 2018 with respect to sources of criteria and particulate matter air pollutants, taking into consideration growth and controls. Modeling results based on this emission inventory are used to define the future year ambient air quality and visibility metrics.

Emission inventory data from five general categories are needed to support air quality modeling: stationary point-source emissions, stationary area-source emissions (also called nonpoint), mobile emissions for on-road sources, mobile emissions for nonroad sources (including aircraft, railroad, and marine vessels), and biogenic emissions. The emission inventory development and emissions modeling steps can be different for each of these categories. The *Technical Support Document for CENRAP Emissions and Air Quality Modeling to Support Regional Haze State Implementation Plans*[12] (hereafter referred to as the "CENRAP TSD") describes the development of each source category inventory is detail. Appendix B of the CENRAP TSD lists the file names, data source, type and a description of emissions used in the 2002 typical (Typ02G) emissions inventory. Emissions inventories for each source category are described briefly in the following section. The CENRAP TSD is included as Appendix B of the LDEQ Regional Haze Implementation Plan Revision.

3.2 2002 EMISSIONS INVENTORY

LDEQ developed the 2002 point source emissions inventory in-house with Emission Inventory Questionnaires and used the biogenic source inventory developed by EPA.LDEQ contracted with ENVIRON to develop an emission inventory for three inventory source classifications: on-road and non-road mobile sources and nonpoint sources for the baseline year of 2002.[13]

The nonpoint, or area source, inventory includes emitters of ozone pollutants (i.e., NOx and VOCs) such as devices that combust fuel (e.g., dry cleaners, degreasing, and industrial surface coating), gasoline distribution, asphalt paving, and fires and open burning (e.g., agricultural burning, structural fires, wildfires, prescribed burning). In addition, area source categories contributing to visibility pollutants (i.e., PM10, PM2.5, and NH3) are also included in the area source emissions inventory (e.g., fugitive dust, agricultural operations, livestock ammonia, etc.).

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[12] Environ International Corp. and University of California at Riverside, 2007. Technical Support Document for CENRAP Emissions and Air Quality Modeling to Support Regional Haze State Implementation Plans. (http://www.cenrap.org/html/projects.php?mode=download&id=87)

[13] Final Report: Arkansas 2002 Emission Inventory, prepared by ENVIRON and Eastern Research Group, May 13, 2004 (Appendix 7.1A of the RH SIP)

The contractor reviewed all emission factors used in the inventory to ensure they were the most appropriate and up-to-date emission factors available and checked all calculations for accuracy. LDEQ.

The 2002 national emissions inventory (2002 NEI), compiled from submitted inventories from states, tribal and local agencies was the original basis for the CENRAP emission inventory. Sonoma Technology supplemented the 2002 NEI data with non-point source inventories to address agricultural and prescribed burning, on-road and non-road mobile sources, agricultural tilling and livestock dust, and agricultural ammonia for the CENRAP inventory.[14]

Table 3-1. Emissions from Louisiana Sources (tons/yr)

	SO_2	NH_3	NO_X	VOCs	PM_{10}	$PM_{2.5}$
Point	286,050	9,237	312,634	89,025	73,333	60,899
Area	81,153	75,381	99,060	124,311	245,162	84,068
Non-road mobile	14,324	563	117,250	109,598	10,663	9,791
On-road mobile	4,653	3,748	15,137	64,643	3,563	2,689
Total	**386,180**	**88,929**	**544,081**	**387,577**	**332,721**	**157,447**

3.2.1 Stationary Point-Source Emissions

Point sources are typically regulated and information on emissions and locations are available in regulatory reports. Larger permitted point sources in Louisiana are required to submit annual emissions inventories via Emission Inventory Questionnaires (EIQ), and all other point sources have a reporting frequency of every 3 years, beginning with the 2002 base inventory. This data, along with similar data available from other states make the basis of the point source inventory. The CENRAP stationary-point inventory consisted of annual county-level and tribal data provided in August of 2005.[15] Point source inventories were developed by the other RPOs and shared with CENRAP. These inventories are typically further divided into EGU and non-EGU sources. For EGU sources, continuous emissions monitoring (CEM) data is available to create day and hour-specific emission inventories for input into the Base02F inventory. The Typ02G

[14] Reid, S.B. et al. 2004. Emission Inventory Development for Mobile Sources and Agricultural Dust Sources for the Central States. Sonoma Technology, Inc. (http://cenrap.sonomatech.com/CENRAP_Mobile/FinalReport.pdf).; Reid, S.B et al. 2004. Research and Development of Planned Burning Emission Inventories for the Central States Regional Air Planning Association. Sonoma Technology, Inc. (http://cenrap.sonomatech.com/CENRAP_PlannedBurnData/FinalReport.pdf).; Coe, D.L. and S.B. Reid. 2003. Research and Development of Ammonia Emission Inventories for the Central States Regional Air Planning Association. Sonoma Technology, Inc.

[15] Pechan and CEP. 2005. Consolidation of Emissions Inventories (Schedule 9; Work Item 3). E.H. Pechan and Associates, Inc. and CEP, UNC, (http://www.cenrap.org/html/projects.php?mode=subcatdownload&id=50); Pechan and CEP. 2005. Refinements of CENRAP's 2002 Emissions Inventories (Schedule 9; Work Item 3). E.H. Pechan and Associates, Inc. and CEP, UNC. (http://www.dnr.mo.gov/env/apcp/docs/appendixh-3.pdf)

inventory includes further processing of EGU emissions to develop a typical emission levels and temporal profiles.

Coal-fired point sources within the CENRAP states use a PM2.5 speciation profile recently developed for MRPO by Carnegie Mellon that is representative of combustion of eastern bituminous coal. Texas and North Dakota sources that burn lignite coal used a modified NCOAL speciation.[16] More specific speciation profiles should be utilized as they become available to accurately describe the speciation of PM2.5 from combustion of different types of coal utilized in Louisiana.

3.2.2 On-Road Mobile Emissions

Emissions from mobile, on-road sources are prepared for CENRAP modeling in one of two ways: 1) pre-computed emissions supplied by an RPO or other group or 2) supplied vehicle miles traveled (VMT), meteorological data and other MOBILE6[17] inputs for calculation in SMOKE/MOBILE6. Annual mobile emissions were pre-computed as part of the 1999 Mexico inventory and 2000 Canada inventory. Seasonal mobile emissions calculated in MOBILE6 were provided for all 13 WRAP states. For all other RPOs, including CENRAP, county-level VMT were prepared and input into SMOKE/MOBILE6. For all Louisiana parishes, parish-level Highway Performance Monitoring System annual average VMT data were used. Annual average data was adjusted using seasonal factors to arrive at month-specific estimates. Weekday VMT for summer and winter were estimated from monthly values using Texas statewide average weekday/annual average daily factors.[18] For the other CENRAP states, Sonoma Technology provided monthly VMT data and MOBILE6 input files for the months of January and July for all counties in the CENRAP region.[19] MOBILE6 input files for the remaining months of 2002 had to be generated. The EPA MOBILE6 was state-of-the-science at the time the modeling was conducted and deemed acceptable at that time. EPA Office of Transportation and Air Quality has developed a new model, Motor Vehicle Emission Simulator (MOVES), which will replace the MOBILE6 model for estimating emissions from on-road mobile sources.

3.2.3 Biogenic Emissions

The BEIS3 system is utilized to estimate emissions from biogenic sources. BEIS3 is integrated into SMOKE for deriving biogenic emissions estimates given land use information, emissions factors for different plant species, and hourly, gridded meteorology data. Land use data is from the BELD3 land use database and emission factors used are version 0.98 of the BELD emissions factors. These land use data and emission factors were developed by the WRAP during their preliminary modeling efforts. BEIS modeling produces gridded, hourly emissions for input into CMAQ and CAMx.[20] The EPA approves of the use of BEIS3 by CENRAP in this SIP.

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[16] Chow, J et al. 2004. Source Profiles for Industrial, Mobile, and Area Sources in the Big Bend Regional Aerosol Visibility and Observational Study. Chemosphere 54, 185-208.

[17] EPA's MOBILE6 model is available at http://www.epa.gov/OMSWWW/m6.htm

[18] Final Report: Arkansas 2002 Emission Inventory, prepared by ENVIRON and Eastern Research Group, May 13, 2004 (Appendix 7.1A of the RH SIP)

[19] Reid, S.B. et al. 2004. Emission Inventory Development for Mobile Sources and Agricultural Dust Sources for the Central States. Sonoma Technology, Inc. (http://cenrap.sonomatech.com/CENRAP_Mobile/FinalReport.pdf)

[20] Tonnesen, G., et al. 2005. Final Report for the Western Regional Air Partnership (WRAP) Regional Modeling Center (RMC) for the Project Period March 1, 2004 through February 28, 2005. UCR. (http://pah.cert.ucr.edu/aqm/308/reports/final/2004_RMC_final_report_main_body.pdf).

3.2.4 Non-Road Mobile Emissions

Emissions from airport/aircraft operations, commercial and recreational marine vessels, and railroad locomotives, farm equipment, lawn equipment, and other sources were developed by the EPA for the 2002 NEI. The EPA NONROAD[21] (NONROAD 2004 at the time) model was utilized by Sonoma Technology to develop a non-road emissions inventory for the CENRAP states.**Error! Bookmark not defined.** EPA and CENRAP emissions were consolidated by Pechan and CEP.[22]

3.2.5 Area Source Emissions

The area source inventory includes data from the EPA 2002 NEI and inventories prepared by LDEQ, CENRAP and other CENRAP states. Area sources include small sources that combust fuel (small heaters, water heaters, etc.) and other sources such as dry cleaning, degreasing and industrial surface coating. Sonoma Technology prepared additional inventories of prescribed burning, agricultural dust, and soil agricultural ammonia for the CENRAP region.[23] The Western Regional Air Partnership (WRAP) provided an oil and gas production inventory for states within the WRAP that included a number of states in the CENRAP modeling domain. These emissions were consolidated by Pechan and CEP.[24] UCR processed this inventory further to separate the inventory into subcategories (general area, fire, ammonia, road dust, fugitive dust, uncategorized) to assist in particulate source apportionment modeling with CAMx.

3.3 2018 Emissions Inventory

An emission inventory for 2018 including anticipated changes due to population growth, emission controls and development of industry, energy, and natural resources is required to project the net effect on visibility conditions by 2018. CENRAP developed an emission inventory for 2018 (Base18G) using a combination of EPA Economic Growth Analysis System (EGAS 5/6), MOBILE 6, NONROAD, and the Integrated Planning Model (IPM) of ICF International for EGUs to project emissions from 2002 to 2018. Emission projections for most source categories are based on growth and control factors compiled by Pechan and detailed in

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21 NONROAD is available at http://www.epa.gov/otaq/nonrdmdl.htm

22 Pechan and CEP. 2005. Consolidation of Emissions Inventories (Schedule 9; Work Item 3). E.H. Pechan and Associates, Inc. and CEP, UNC, (http://www.cenrap.org/html/projects.php?mode=subcatdownload&id=50)

23 Reid, S.B. et al. 2004. Emission Inventory Development for Mobile Sources and Agricultural Dust Sources for the Central States. Sonoma Technology, Inc. (http://cenrap.sonomatech.com/CENRAP_Mobile/FinalReport.pdf).; Reid, S.B et al. 2004. Research and Development of Planned Burning Emission Inventories for the Central States Regional Air Planning Association. Sonoma Technology, Inc. (http://cenrap.sonomatech.com/CENRAP_PlannedBurnData/FinalReport.pdf).; Coe, D.L. and S.B. Reid. 2003. Research and Development of Ammonia Emission Inventories for the Central States Regional Air Planning Association. Sonoma Technology, Inc.

24 Pechan and CEP. 2005. Consolidation of Emissions Inventories (Schedule 9; Work Item 3). E.H. Pechan and Associates, Inc. and Carolina Environmental Program (CEP), University of North Carolina(UNC), (http://www.cenrap.org/html/projects.php?mode=subcatdownload&id=50); Pechan and CEP. 2005. Refinements of CENRAP's 2002 Emissions Inventories (Schedule 9; Work Item 3). E.H. Pechan and Associates, Inc. and CEP, UNC. (http://www.dnr.mo.gov/env/apcp/docs/appendixh-3.pdf)

Chapter 7 of the Louisiana RH SIP and in Pechan's *Development of Growth and Control Inputs for CENRAP 2018 Emissions* draft technical support document.[25]

Table 3-2. Emission estimates for Louisiana sources in 2018 (tons/yr)

	SO_2	NH_3	NO_X	VOCs	PM_{10}	$PM_{2.5}$
Point	354,087	14,435	269,215	187,741	73,136	60,899
Area	87,538	36,896	114,374	117,600	16,936	14,536
Non-road mobile	11,584	72	106,685	64,294	8,670	7,955
On-road mobile	561	5,436	44,806	30,340	1,191	1,191
Total	**453,770**	**56,839**	**535,080**	**399,975**	**99,933**	**84,581**

Pechan used the following alternative data sources to replace EGAS default projections:

- County-level population projections for CENRAP states;
- Annual Energy Outlook (AEO) projections for oil and gas production emissions;
- average historical values rather than 2002 data for prescribed burning;
- Extrapolation of historical trends for unpaved roads;
- United States Department of Agriculture (USDA) projections of planted acreage; for major crops for crop tilling emissions;
- Onroad vehicle miles traveled projections for paved road fugitive dust emissions;
- USDA livestock projections

All control strategies expected to take effect prior to 2018 are included in the projected emission inventory. Maximum Achievable Control Technology (MACT) regulations were applied to those engines subject to MACT rules. Emissions for Canada are based on a shared 2020 emission inventory. 2018 EGU emissions were based on the run 2.1.9 of the Integrated Planning Model (IPM) updated by the CENRAP states. Reductions anticipated from BART controls for EGUs in Oklahoma, Arkansas, Kansas, and Nebraska were included in projections of 2018 emissions. These anticipated reductions were based on actual operating conditions and estimated control efficiencies from utilities. Newly permitted coal-fired utilities were included in 2018 projections. Conservatively, no IPM projected new units were removed from the simulation with the addition of the permitted facilities. Appendix B of the CENRAP TSD lists the file names, data source, type and a description of emissions used in the 2018 (Base18G) emissions inventory. The Access Database that includes facility specific and day specific emission rates is available upon request due to the size of the file.

[25] Pechan 2005. Development of Growth and Control Inputs for CENRAP 2018 Emissions, Draft Technical Support Document. E.H. Pechan and Associates, Inc. (http://www.dnr.mo.gov/env/apcp/docs/appendixh-4.pdf)

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

- Biogenic VOC and NOx emissions from the BEIS3 biogenic emissions 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 BCs from the 2002 GEOS-CHEM global chemistry model.

The last future runs (2018G) utilized an inventory that had assumptions about BART controls in the CENRAP states.

Chapter 4: Modeling Protocol, Episode Selection and Modeling Set-up Overview

4.1 INTRODUCTION

Meteorological, emission and photochemical models are essential tools in examining factors that impact visibility and for development of effective control strategies to meet the goals and requirements of the RHR. CENRAP selected the team of ENVIRON and UCR to perform the needed emissions and air quality modeling. The team performed regional haze analyses by operating regional scale, three-dimensional air quality models to simulate the transport and fate of key species that affect visibility in Class I Areas in the central U.S. This work included the development of meteorological data for input into the model as well as creation and processing of emission estimates for use in the model. The Modeling Protocol[26] describes the model selection, configuration, episode selection, and model evaluation used in support of the Louisiana RHR SIP.

4.2 QUALITY ASSURANCE PROGRAM PLAN

The modeling team developed a quality assurance program plan (QAPP)[27] to develop clearly defined data quality objectives, documentation, and procedures. This QAPP was developed incorporating the following elements as described in the EPA guidance document for modeling:

- 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 that is detailed enough so others can understand the model output;
- Input data and parameters that are accurate and appropriate for the problem; and
- Output data that can be used to help inform decision makers.

The plan describes the data management and quality assurance/quality control measures taken to assure high quality emission inventories and air quality modeling results for use in the RH analysis.

4.3 EPISODE SELECTION

EPA guidance[28] describes the criteria that should be used to select a modeling episode. The modeling episode should: 1) reflect a variety of meteorological conditions that are representative of the 20% worst and 20% best days in the Class I areas being modeled, 2) be representative of

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[26] Morris, R.E. et al. Modeling Protocol for the CENRAP 2002 Annual Emissions and Air Quality Modeling, Draft 2.0. Web:http://pah.cert.ucr.edu/aqm/cenrap/docs/CENRAP_Draft2.0_Modeling_Protocol_120804.pdf).

[27] Morris, R.E. and G. Tonnesen. 2004. Quality Assurance Project Plan (Draft) for Central Regional Air Planning Association (CENRAP) Emissions and Air Quality Modeling. (http://pah.cert.ucr.edu/aqm/cenrap/docs/CENRAP_QAPP_Nov_24_2004.pdf). December 23.

[28] EPA, 2007. *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze*, EPA-454/B-07-002, April 2007, EPA OAQPS; (http://www.epa.gov/ttn/scram/guidance/guide/final-03-pm-rh-guidance.pdf)

the baseline period of 2000-2004, 3) cover a period where extensive air quality/meteorological data are available, 4) cover a long enough period so that relative response factors (RRF) can be averaged over a period several days (> 10 days). For regional haze modeling, the preferred approach is to simulate an entire representative year. This allows the states to base RRF values on the 20% best and 20% worst days of the year.

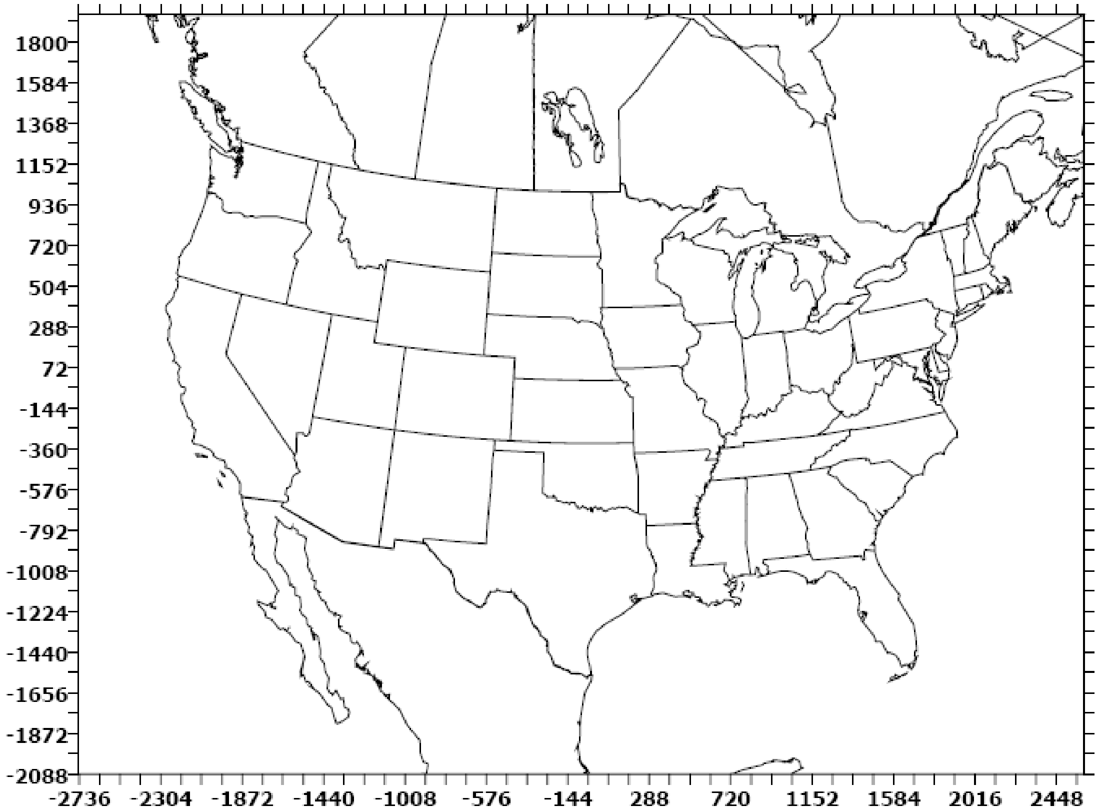
CENRAP selected the entire calendar year of 2002 for regional haze modeling. This is consistent with the EPA guidance and has the added benefit of the base case and baseline inventories covering the same year. Other RPOs selected the same modeling year, allowing for more direct comparison of modeling results and sharing of modeling inputs. The availability of 2002 NEI also provides an additional resource in the development of emission inventories for the modeling episode. 2002 appears to be a more representative year when compared to 2003 and 2004. The EPA approves of the selection of 2002 for the regional haze modeling episode.

4.4 PHOTOCHEMICAL AND EMISSIONS MODELING DOMAIN

CENRAP conducted emissions and air quality modeling on the 36-km national regional planning organization (RPO) domain. This domain consists of a 148 × 112 array of 36-km × 36-km grid cells and covers the continental United States. Additional photochemical modeling runs were performed on a 12-km domain covering the central states to examine the sensitivity of model results to domain resolution. These results were similar to the 36 km results so CENRAP determined that the 36-km modeling domain was sufficient for the 2002 annual modeling.[29] CENRAP's choice of 36 km horizontal resolution was appropriate given the lack of improved performance at 12 km resolution and the additional computational resources required to run the model at the higher resolution. The use of higher spatial resolution modeling should be revisited in future modeling efforts as computational efficiency improves.

[29] Morris, R.E. et al. 2006. CENRAP Modeling: Need for 36 km versus 12 km Grid Resolution. Presented at CENRAP Modeling Work Group Meeting, Baton Rouge, Louisiana. (http://pah.cert.ucr.edu/aqm/cenrap/ppt_files/ Morris_36vs12km_Feb6-8_2006.ppt).

Figure 4-1. National RPO 36-km modeling domain for CMAQ, CAMx, and SMOKE modeling.



4.5 MM5 Meteorological Model

4.5.1 Model Selection

Photochemical grid models, such as CMAQ and CAMx, require inputs of three-dimensional gridded meteorological data, including wind, temperature, humidity, cloud/precipitation, and boundary layer parameters. The Fifth-Generation Penn State/NCAR Mesoscale Model (MM5) was used to develop these input fields for the CENRAP visibility modeling as well as inputs for the SMOKE emissions processing tool. MM5 is a state-of-the-science atmosphere model that has proven useful for air quality applications and has been used extensively in past local, state, regional, and national modeling efforts. MM5 has undergone extensive peer-review, with all of its components continually undergoing development and scrutiny by the modeling community. In-depth descriptions of MM5[30] can be found in Dudhia (1993)[31] and Grell et al. (1994).[32] All meteorological data used for the CENRAP air quality modeling efforts are derived from MM5 model simulations.

[30] http://www.mmm.ucar.edu/mm5

[31] Dudhia, J., 1993. "A non-hydrostatic version of the Penn State/NCAR Mesoscale Model: validation tests and simulation of an Atlantic cyclone and cold front." *Mon. Wea. Rev*. 121, pp.1493-1513.

[32] Grell, G.A., J. Dudhia, and D.R. Stauffer, 1994. "A description of the Fifth Generation Penn State/NCAR Mesoscale Model (MM5)." NCAR Technical Note, NCAR TN-398-STR, 138 pp.

In addition to development of meteorological inputs for CMAQ and CAMx, MM5 was also used to develop meteorological inputs for the CALMET/CALPUFF modeling system. As discussed further in Section 6 of this review, CALMET/CALPUFF was used to determine whether a BART eligible source contributes to visibility impairment at a Class I area. Refer to Section 6 of this review for further information on the use of MM5 for BART modeling.

The CENRAP meteorological modeling used for input to photochemical modeling and emission processing was performed by the Iowa Department of Natural Resources (IDNR) and is described fully in the report entitled Meteorological Model Performance Evaluation of an Annual 2002 MM5 (version 3.6.3) Simulation (hereafter referred to as the Meteorological Model Performance Evaluation report) .[33]

4.5.2 Meteorological Modeling Domain and Vertical Layer Structure

In the IDNR 36-km meteorological modeling, MM5 was configured to run on the standard continental-scale Regional Planning Organization (RPO) National Grid with 36-km grid point spacing. The RPO National Grid is defined on a Lambert conformal projection, with true latitudes at 33°N and 45°N, and the central latitude and longitude at 40°N and 97°W, respectively. The grid point spacing is 36-km. The continental expanse of this domain results in a grid of 165 (east-west) by 129 (north-south) dot points, and 164 (east-west) by 128 (north-south) cross points. Overall, the domain covers 5904 km by 4608 km. The MM5 domain provides overlap of the CMAQ and CAMx air quality modeling grid (described in section 3.3) to alleviate any numerical boundary artifacts that may be present in the MM5 output fields. Meteorology modeling was also completed on a regional-scale domain with 12 km grid spacing covering the central states by EPA Region VII and the Texas Commission on Environmental Quality to examine model prediction sensitivity to grid resolution. The vertical layer structure of the CENRAP meteorological modeling domain consists of 34 layers, a top level at 100 millibars, and increasing layer thickness with altitude. The vertical layer structure is further detailed in the Modeling Protocol.

4.5.3 Model Configuration

The final CENRAP MM5 modeling system configuration for the 2002 annual simulation is provided in the Modeling Protocol and the Meteorological Model Performance Evaluation report. Early MM5 simulations by the State of Iowa and the Lake Michigan Air Directors Consortium (LADCO) and further sensitivity tests were performed to identify an MM5 configuration for annual runs.

The initial 2002 36-km IDNR simulation results showed that MM5 results showed an extreme cold bias over the central U.S and unnatural diurnal profiles near shorelines. A number of sensitivity tests were performed by IDNR to resolve performance issues identified in the initial simulation. At the same time, sensitivity tests were performed in support of the development of

[33] Johnson, M. 2007. Meteorological Model Performance Evaluation of an Annual 2002\ MM5 (version 3.6.3) Simulation. Iowa Department of Natural Resources, Air Quality Bureau. (http://www.iowadnr.gov/air/prof/progdev/files/IDNR.2002mm5v363.evaluation.v204.p f)

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meteorological modeling for VISTAS.[34] The combination of all of these studies led to the configuration used by CENRAP for MM5 modeling detailed in the CENRAP TSD and the Modeling Protocol.

4.5.4 MM5 Processing and Application

Several preprocessing steps are necessary to prepare input data for an MM5 simulation. The MM5 modeling system provides all of the tools necessary to prepare topographic, vegetative, initial condition, boundary condition, and FDDA nudging input files.

Global topographic data at 2-minute (latitude/longitude) resolution were used to define terrain elevations on the 36-km grid. Land use distribution on the MM5 domains was defined from the 24-category USGS vegetation data with a resolution of 2 minutes.

The 3-hour Eta analysis and surface fields available from the National Center for Atmospheric Research (NCAR) were taken from the Eta Data Assimilation System (EDAS) and used to supply initial and boundary conditions to MM5, and for analysis nudging in the FDDA package. The EDAS analyses are developed from a wide variety of observational sources, including standard surface and upper air measurements, profiler networks, radar- and satellite-derived measurements, and ship and aircraft reports. The wide array of data sources, coupled with the high time- and spatial resolution provided by EDAS, result in an analysis product that far exceeds the level of detail found in traditional global-scale analyses.

Sea surface temperatures (SSTs) were approximated by ETA skin temperatures
The annual simulation was generated from 95 independent simulations initialized at 12Z and integrated through five days. To allow for approximately a two week photochemical model spin-up period, the simulation started at 12/16/2001 12Z.

4.5.5 Model Performance

Model performance evaluation was performed by IDNR through comparison with observations of surface and upper-air meteorological conditions and precipitation.[35] Additional performance evaluation was done by CENRAP by comparing the 2002 CENRAP MM5 simulation with the 2002 VISTAS MM5 and the interim 2002 WRAP simulations.[36] Details on this comparison can be found in the CENRAP TSD, Appendix A.

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[34] Olerud, D., Sims, A., 2004. MM5 2002 Modeling in Support of VISTAS (Visibility Improvement—State and Tribal Association). Baron Advanced Meteorological Systems, LLC, Research Triangle Park, NC. http://www.baronams.com/projects/VISTAS/reports/VISTAS_TASK3f_final.pdf

[35] Johnson, M. 2007. Meteorological Model Performance Evaluation of an Annual 2002\ MM5 (version 3.6.3) Simulation. Iowa Department of Natural Resources, Air Quality Bureau. (http://www.iowadnr.gov/air/prof/progdev/files/IDNR.2002mm5v363.evaluation.v204.pdf)

[36] Kemball-Cook, S., Y. Jia, C. Emery, R. Morris, Z. Wang and G. Tonnesen, 2005. *Comparison of CENRAP, VISTAS and WRAP 36 km MM5 Model Runs for 2002, Task 3: Met Gatekeeper Report.* http://pah.cert.ucr.edu/aqm/cenrap/ppt_files/CENRAP_VISTAS_WRAP_2002_36km_MM5_eval.ppt

The goal of the evaluation was to determine whether the meteorological fields are sufficiently accurate to properly characterize the transport, chemistry, and removal processes in CMAQ/CAMx. If errors in the meteorological fields are too large, the ability of the air quality model to replicate regional pollutant levels over the entire base year will be severely hampered and the predicted impacts from future year growth and controls will be highly questionable. To provide a reasonable meteorological characterization to the photochemical/visibility model, MM5 must represent with some fidelity the:

- Large-scale weather patterns (i.e., synoptic patterns depicted in the 850-300 mb height fields), as these are key forcings for mesoscale circulations;
- Mesoscale and regional wind, temperature, PBL height, humidity, and cloud/precipitation patterns;
- Mesoscale circulations such as sea breezes and mountain/drainage circulations;
- Diurnal cycles in PBL depth, temperature, and humidity.

For visibility applications, the moisture and condensate fields are particularly important as they significantly impact PM chemical formation, removal, and light scattering efficiency. In addition, cloud and precipitation fields are a good measure of the integrated performance of the model since these are model-derived quantities and not nudged to observations. Because of the model's coarse resolution of 36-km, the model cannot be expected to faithfully simulate the pattern or variability of the convective precipitation, but should reproduce the synoptic precipitation and cloud patterns.

The IDNR evaluation of the MM5 model performance was limited to operational testing of the model, and not to a scientific evaluation. Previous peer-reviewed documentation of MM5 formulation, testing, and evaluation provide the basis for its scientific validity. An operational evaluation entails an assessment of the model's ability to correctly estimate surface and boundary layer wind, temperature, and moisture largely independent of whether the actual process descriptions in the model are accurate. The operational evaluation essentially tests whether the predicted meteorological fields are reasonable, consistent, and agree adequately with available observations in time and space. The process provides only limited information about whether the results are correct from a scientific perspective or whether they are the fortuitous product of compensating errors; thus a "successful" operational evaluation is a necessary but insufficient condition for achieving a sound, reliable performance testing exercise.

The basis for the IDNR operational performance assessment entailed a comparison of the predicted meteorological fields to available surface and aloft data that are collected, analyzed, and disseminated by the National Weather Service. It was carried out both graphically and statistically to evaluate model performance for winds, temperatures, humidity, and the placement, intensity, and evolution of key weather phenomena. The MM5 results were compared to a specific set of statistics that have been identified for use in establishing benchmarks for acceptable MM5 model performance.[37] The IDNR concluded, based on the

[37] Emery, C.A., E. Tai, and G. Yarwood. 2001. "Enhanced meteorological modeling and performance evaluation for two Texas ozone episodes." Prepared for the Texas Natural Resource Conservation Commission, by ENVIRON International Corporation.

results of the performance evaluation, that the final 36 km CENRAP MM5 simulations exhibit reasonably good performance for the central U.S.

Comparison of CENRAP MM5 performance with similar modeling efforts by WRAP and VISTAS revealed comparable performance across all three simulations. The three simulations showed similar performance for prediction of surface wind speed, wind direction and humidity. The use of surface data assimilation of temperature in the interim WRAP simulation resulted in the best performance in prediction of surface temperatures but the poorest performance for vertical temperature profiles. Surface data assimilation has since been dropped from the WRAP modeling protocol. The 2002 VISTAS MM5 simulations showed the best performance and the CENRAP performance more closely resembled that of the VISTAS than the WRAP.

The 2002 CENRAP MM5 model results are within the bounds of other meteorological databases used for prior air quality modeling efforts. It is therefore deemed reasonable to proceed with its use as inputs for visibility modeling. The EPA accepts the use of MM5 in this configuration and selected modeling domain and recognizes that the MM5 meteorological model used by CENRAP was state-of-the-science at the time the modeling was conducted. The performance of the model was adequate for the purposes for which it was used and on par with other studies at the time. A new meteorological model, the Weather Research Forecast model (WRF), has been developed to address the some of the limitations of the MM5 model and should be considered as a possible alternative for future meteorological modeling efforts.

4.6 SMOKE EMISSIONS MODEL

CENRAP selected the Sparse Matrix Operator Kernel Emissions model[38] to generate gridded hourly speciated emission estimates for mobile, non-road, area, point, fire and biogenic emission sources for use as inputs for photochemical grid models. The purpose of SMOKE is to convert the spatial and temporal resolution of the available emission inventory data to the resolution needed by the air quality model. SMOKE also has the ability to compute emissions for mobile on-road and biogenic sources. Biogenic emission modeling is performed through SMOKE with the Biogenic Emission Inventory System, version 3 (BEIS3)[39] using the Biogenic Emissions Landcover Database (BELD3) vegetative database. Mobile emissions can be calculated by SMOKE from mobile-source activity data, using emission factors from the MOBILE6 model. SMOKE supports the emission input formats required by the CAMX and CMAQ air quality models.

4.7 AIR QUALITY MODEL

Photochemical air quality models offer opportunity to better understand the sources of particulate matter that impair visibility by simulating the emissions, formation, transport, and deposition of these pollutants. If an air quality model performs well for a historical episode, the model may then be useful for identifying the sources of particulate matter and helping to select the most effective emissions reduction strategies for attaining visibility goals. Although several types of air quality modeling systems are available, the gridded, three-dimensional, Eulerian models provide the most complete spatial representation and the most comprehensive representation of

[38] Available at http://www.smoke-model.org/index.cfm
[39] Available at http://www.epa.gov/ttn/chief/software.html#pcbeis

processes affecting particulate matter, especially for situations in which multiple pollutant sources interact to form particulate matter.

4.7.1 Model Selection

Guidance from the EPA requires that the air quality model should be selected based on intended application and must be freely downloadable to all stakeholders. Furthermore, the user must be able to revise the code to perform diagnostic analyses and/or to improve the model's ability to describe observations in a credible manner. Several additional prerequisites should be met for a model to be used to support an attainment demonstration or uniform rate of progress assessment.

- It should have received and been revised in response to a scientific peer review.
- It should be appropriate for the specific application on a theoretical basis.
- It should be used with a data base which is adequate to support its application.
- It should be shown to have performed well in past modeling applications. (If the application is the first for a particular model, then the State should note why it believes the new model is expected to perform sufficiently.)
- It should be applied consistently with a protocol on methods and procedures.

The Guideline on Air Quality Models (GAQM - 40 CFR Part 51 Appendix W) does not indicate a preferred photochemical grid model for Regional Haze applications. The CMAQ and CAMx models have been accepted by EPA for numerous regulatory air quality modeling applications and were considered by CENRAP for use in regional haze modeling. CENRAP selected CMAQ Version 4.5 with "SOAmod enhancements" as the primary air quality model for regional haze modeling and the CAMx Version 4.40 model, applied using similar options as used by CMAQ, as a secondary corroborative model. CAMx was also utilized with its Particulate Source Apportionment Technology (PSAT) tool to provide source apportionment with both the baseline and future case emissions inventories (See Section 5). EPA concurred with the selection of CAMx for the CENRAP regional haze modeling as it has been extensively used within the region and has been proven to be an acceptable model. The selection of CMAQ was based on review of previous and concurrent studies within CENRAP and other RPOs, as well as comparisons with CAMx model results.[40] Major differences between the two models that still exist are in the basic model code, in the treatment of horizontal diffusion SOA formation mechanisms, and in grid nesting. EPA accepts the choice of CMAQ as it satisfies the requirements and guidelines detailed above. The versions of CMAQ and CAMx used by CENRAP in its visibility modeling were the state-of-the-science at the time they were implemented and are acceptable to EPA for this Regional Haze selection.

Both air quality models were set up and run on the RPO national 36–km modeling domain described in section 3.3. This modeling domain is also used by WRAP and VISTAS. Sensitivity runs performed by CENRAP for CMAQ run on a 12km modeling domain revealed limited improvement over the 36-km runs and a large increase in computer resources and time. CAMx runs at 12-km resolution reduced the sulfate under-prediction bias in the summertime when

[40] Morris, R.E., et al. 2006. CENRAP Modeling Update: CMAQ versus CAMx Model Performance Evaluation. Presented at CENRAP Modeling Work Group Meeting, Baton Rouge, Louisiana. (http://pah.cert.ucr.edu/aqm/cenrap/ppt_files/ Morris_MPE_Feb6-8_2006.ppt)

compared to 36-km runs. With this possible exception, CENRAP noted little benefit in overall model performance with use of the 12-km grid. Therefore, the 36km domain was selected for all CENRAP CMAQ and CAMx runs.[41]

These air quality models are discussed in more detail below.

4.7.1.1 CMAQ Air Quality Model

EPA initially developed the Community Multi-Scale Air Quality (CMAQ) modeling system in the late 1990s. The model source code and supporting data can be downloaded from the Community Modeling and Analysis System (CMAS) Center (http://www.cmascenter.org/), which is funded by EPA to distribute and provide limited support for CMAQ users. CMAQ was designed as a "one atmosphere" modeling system to encompass modeling of multiple pollutants and issues, including ozone, PM, visibility, and air toxics. This is in contrast to many earlier air quality models that focused on single-pollutant issues (e.g., ozone modeling by the Urban Airshed Model). CMAQ is an Eulerian model—that is, it is a grid-based model in which the frame of reference is a fixed, three-dimensional (3-D) grid with uniformly sized horizontal grid cells and variable vertical layer thicknesses. The number and size of grid cells and the number and thicknesses of layers are defined by the user, based in part on the size of the modeling domain to be used for each modeling project. The key science processes included in CMAQ are emissions, advection and dispersion, photochemical transformation, aerosol thermodynamics and phase transfer, aqueous chemistry, and wet and dry deposition of trace species. CMAQ offers a variety of choices in the numerical algorithms for treating many of these processes, and it is designed so that new algorithms can be included in the model. CMAQ offers a choice of three photochemical mechanisms for solving gas-phase chemistry: the Regional Acid Deposition Mechanism version 2 (RADM2), a fixed coefficient version of the SAPRC90 mechanism, and the Carbon Bond IV mechanism (CB-IV).

CENRAP used CMAQ Version 4.5 with a "SOAmods enhancement" for 2002 base case (actual emissions), 2002 baseline (typical emissions) and 2018 future case (projected emissions) modeling. The "SOAmods enhancement" was the result of work by VISTAS investigating the model's underestimate of organic mass carbon (OMC) concentrations. The updated CMAQ secondary organic aerosol (SOA) module led to improved estimation of OMC in VISTA modeling. CENRAP examined the use of the enhanced SOA module and found similar improvements in model performance over the original CMAQ Version 4.5 model. CENRAP decided to use the CMAQ Version 4.5 with the "SOAmods enhancement"[42] for CENRAP modeling. Details of the CMAQ model configuration used by CENRAP can be found in the CENRAP TSD and the Modeling Protocol.

4.7.1.2 CAMx Air Quality Model

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[41] Morris, R.E., et al. 2006. CENRAP Modeling: Need for 36 km versus 12 km Grid Resolution. Presented at CENRAP Modeling Work Group Meeting, Baton Rouge, Louisiana. (http://pah.cert.ucr.edu/aqm/cenrap/ppt_files/ Morris_36vs12km_Feb6-8_2006.ppt)

[42] Morris, R.E., B. Koo, A. Guenther, G. Yarwood, D. McNally, T.W. Tesche, G. Tonnesen, J. Boylan and P. Brewer. 2006. Model Sensitivity Evaluation for Organic Carbon using Two MultiPollutant Air Quality Models that Simulate Regional Haze in the Southeastern United States. Atmos. Env. 40 (2006) 4960-4972.

The Comprehensive Air Quality Model with extensions (CAMx) model[43] was initially developed by ENVIRON in the late 1990s as a nested-grid, gas-phase, Eulerian photochemical grid model. ENVIRON later revised CAMx to treat PM, visibility, and air toxics. While there are many similarities between the CMAQ and CAMx systems, there are also some significant differences in their treatment of advection, dispersion, aerosol formation, and dry and wet deposition. CAMx has seen extensive use within many of the CENRAP states. The CAMx model is based on well-established treatments of advection, diffusion, deposition, and chemistry. CENRAP used CAMx Version 4.40, applied using similar options as used by CMAQ, as a secondary corroborative model and utilized CAMx with its Particulate Source Apportionment Technology (PSAT) tool to provide source apportionment of nitrate and sulfate aerosol with both the 2002 baseline and 2018 future case emission inventories (See section 5). Details of the CAMx model configuration used by CENRAP can be found in the CENRAP TSD and the Modeling Protocol.

4.7.2 Vertical Modeling Domain

CMAQ and CAMx have the ability to collapse the 34 layer vertical structure used in MM5 modeling to a smaller set of vertical layers. Sensitivity studies by WRAP and VISTAS examined model performance looking at a variety of vertical modeling domains ranging from modeling all 34 vertical layers to collapsing the structure down to 12 vertical layers. Results of this study showed that collapsing the vertical structure down to 19 layers while matching the 8 bottom most vertical layers produced results nearly identical to the full 34 layer runs. The more aggressive layer collapsing scheme of 12 layers produced substantially different results. Based on these results, CENRAP selected the 19 layer vertical structure described in the CENRAP TSD. This selection improves computational efficiency and produces results almost identical to the full vertical structure runs.

4.7.3 Initial and Boundary Conditions

Initial conditions (ICs) are specified by the user for the first day of a model simulation. For continental-scale modeling using the RPO 36-km domain, the ICs can affect model results for as many as 15 days, although the effect typically becomes very small after about 7 days. A model spin-up period is included in each simulation to eliminate any effects from the ICs. For the CENRAP modeling, the annual simulation is divided into four quarters, and included a 15-day spin-up period for the quarters beginning in April, July, and October. For the quarter beginning in January 2002, a spin-up period covering December 16-31, 2001, using meteorology and emissions data developed for CENRAP were used. We agree that the 15 day spin-up period employed by CENRAP was sufficient to minimize the effects of the IC on model results given the size of the modeling domain.

Boundary conditions (BCs) specify the concentrations of gas and PM species at the four lateral boundaries of the model domain. BCs determine the amounts of gas and PM species that are transported into the model domain when winds flow into the domain. Boundary conditions have a much larger effect on model simulations than do ICs. For some areas in the CENRAP region and for clean conditions, the BCs can be a substantial contributor to visibility impairment. For this study BC data generated in an annual simulation of the global-scale GEOS-Chem model for

[43] ENVIRON, 2006. "User's Guide – Comprehensive Air-quality Model with extensions, Version 4.30." ENVIRON International Corporation, Novato, California. (available at http://www.camx.com).

calendar year 2002 were applied.[44] The BCs employed by CENRAP were state-of-the-science at the time they were implemented.

4.7.4 Base Case/ Baseline Model Performance

The 2002 Base Case modeling efforts were used to evaluate air quality/visibility modeling systems for a historical episode—in this case, for calendar year 2002—to demonstrate the suitability of the modeling systems for subsequent planning, sensitivity, and emissions control strategy modeling. Comparisons between the 2002 Base F actual emissions model performance with the 2002 typical emissions (Typ02F) revealed little difference in model performance. The 2002 F model predictions are nearly identical to 2002 G results so model performance evaluation performed with 2002 Base F emissions is representative of the final model performance. Therefore, model performance was evaluated using the Typ02F emission inventory.

Model performance evaluation is performed by comparing output from model simulations with ambient air quality data for the same time period to determine whether the model's performance is sufficiently accurate to justify using the model for simulating future conditions. There are a number of challenges in completing an annual MPE for regional haze. The model must be compared to ambient data from several different monitoring networks for both PM and gaseous species, for an annual time period, and for a large number of sites. The focus of the performance evaluation is on the six components of particulate matter that are used to characterize visibility at Class I areas: Sulfate (SO4); Particulate Nitrate (NO3); Elemental Carbon (EC); Organic Mass Carbon (OMC); Other inorganic fine particulate (IP or Soil); and Coarse Matter (CM). The model must be evaluated for both the worst visibility conditions and for very clean conditions. Finally, final guidance on how to perform an MPE for fine-particulate models is not available from EPA. Therefore, the CENRAP experimented with many different approaches for showing model performance results.

The plot types that were found to be the most useful are the following:

- Time-series plots comparing the measured and model-predicted species concentrations
- Scatter plots showing model predictions on the y-axis and ambient data on the x-axis
- Spatial analysis plots with ambient data overlaid on model predictions
- Bar plots comparing the mean fractional bias (MFB) or mean fractional error (MFE) performance metrics
- "Bugle plots" showing how model performance varies as a function of the PM species concentration
- Stacked-bar plots of contributions to light extinction for the average of the best-20% visibility days or the worst-20% visibility days at each site; the higher the light extinction, the lower the visibility

The following plots depict summary model performance for CENRAP CMAQ modeling using the Typ02F emissions inventory. Below are six sets of model fractional bias and model fractional error plots. Each set of plots compares the measured chemically speciated aerosol data

[44] Jacob, D.J., R. Park and J.A. Logan. 2005. Documentation and Evaluation of the GEOS-CHEM Simulation for 2002 Provided to the VISTAS Group. Harvard University (http://www.vistas-sesarm.org/documents/Harvard_GEOS-CHEM_FinalReport_20050624.doc)

from a monitoring network with the corresponding model output. The monitoring networks used for comparison are IMPROVE, CASTNET, and STN, and are treated separately because each monitoring network has different goals, siting criteria, and data collection protocols. The model performance plots depicted here are "bugle plots", and depict model performance (symbols) and model performance standards (curves) on the y axis relative to measured concentration on the x axis. Model performance standards are of greater latitude at lower concentrations because of the higher relative uncertainties in the data at lower concentrations. Performance goals or criteria approach 200% error and ≤200% bias as observed concentrations approach zero and asymptotically approach the proposed performance goals or criteria (i.e., the ≤30%/50% and ≤60%/75% bias/error levels) as concentrations become greater than 2.5 $\mu g/m^3$.

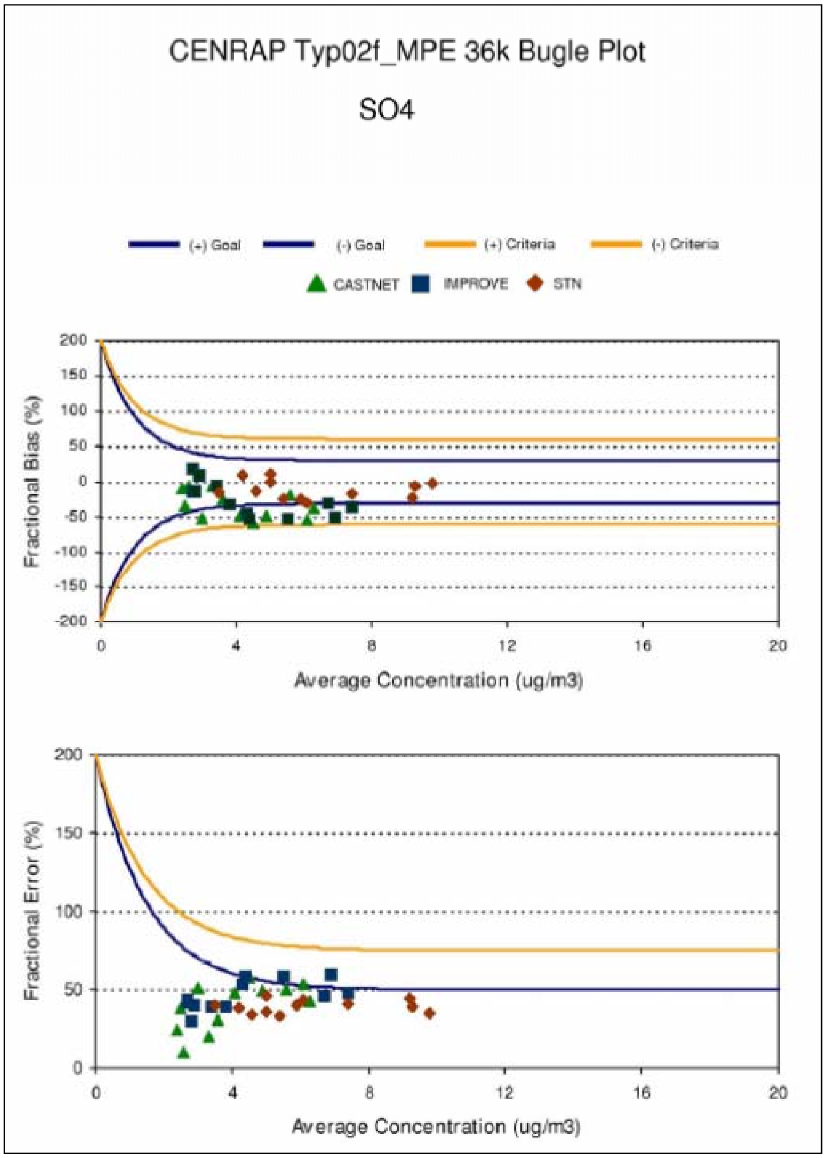
Model performance at IMPROVE monitors is of highest importance, because these monitors are sited to be representative of the visibility conditions impacting each Class 1 Area. The CASTNET monitoring network is more sparse than the IMPROVE network, but is also mostly sited at Class 1 Areas and as such, model performance at CASTNET sites should also be considered important. The STN monitoring network is an urban network, and model performance relative to this network should be given less importance.

The model performance goals and criteria used by CENRAP were appropriate at the time the modeling was conducted and consistent with the methods adopted by VISTAS and WRAP. The EPA agrees with the CENRAP model performance procedures and analysis. Detailed results of the model performance evaluation can be found in Appendix C of the CENRAP TSD and on the University of California, Riverside CENRAP visibility modeling website (http://pah.cert.ucr.edu/aqm/cenrap/cmaq.shtml#cmaq_typ02f_mpe).

4.7.4.1 Model Performance for Sulfate (SO_4)

Figure 4-2 shows the monthly SO_4 fractional error and bias for the STN, IMPROVE and CASTNET monitoring networks as well as the proposed performance goals and criteria. In general, there is an under-prediction bias that is more pronounced during the spring and summer months. For the STN network, model performance for all months is within the goals for both fractional bias and error. Model performance for CASTNET sites is within goals for fractional error and within the criteria for fractional bias as is model performance for the IMPROVE sites with the exception of two months that lie within the criteria but beyond the goal for fractional error.

Figure 4-2. CENRAP model performance (factional bias and error) of the Typ02f modeling scenario for sulfate (SO_4). The 12 symbols for each monitor represent monthly average model performance for the year 2002, averaging all monitors in the CENRAP region. Solid lines represent CENRAP modeling goals and criteria.

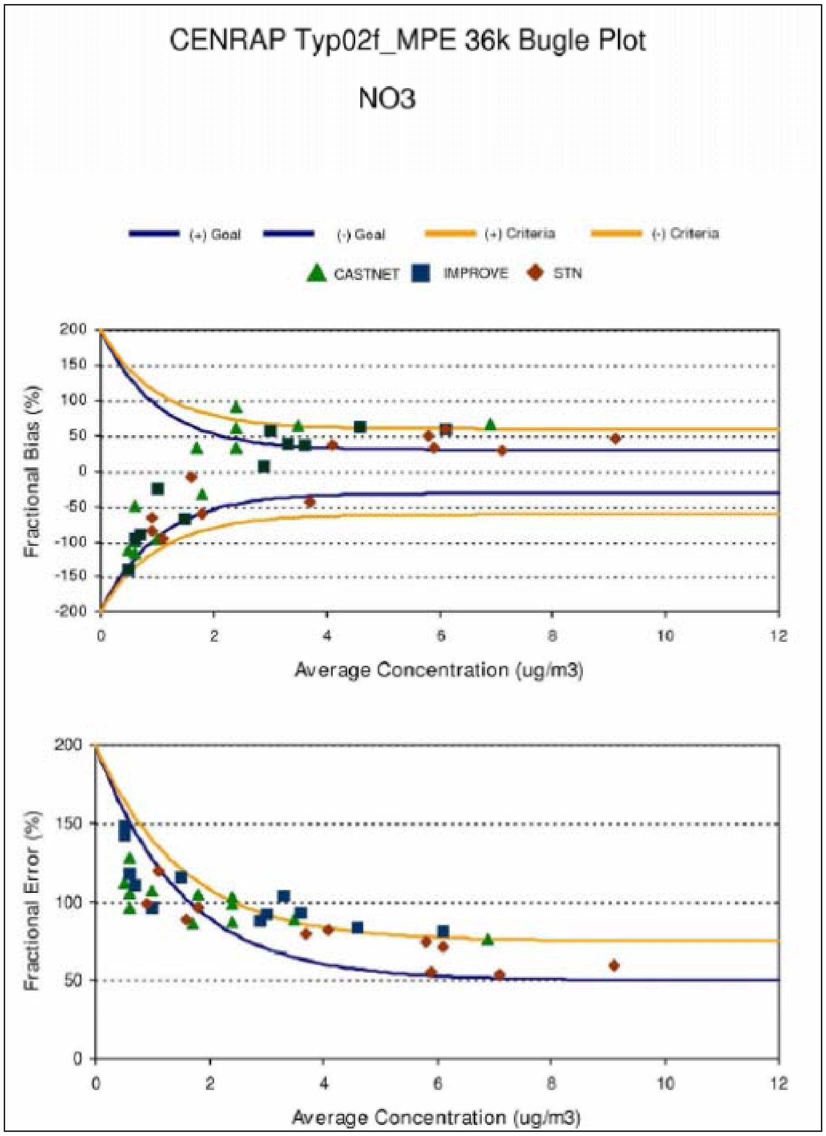


4.7.4.2 Model Performance for Nitrate (NO_3)

Figure 4-3 shows the monthly NO_3 fractional error and bias for the STN, IMPROVE and CASTNET monitoring networks as well as the proposed performance goals and criteria. NO3 model performance is variable. There is an underprediction during the summer months, approaching a fractional bias of -140% in June and July and an overprediction with bias of approximately 50% in the winter. The winter bias is more significant because NO_3 concentrations tend to be a large component of visibility impairment during the winter months.

In general, winter model performance does not meet the performance goals and in some cases does not meet the criteria, predicting concentrations of NO_3 much higher than observed.

Figure 4-3. CENRAP model performance (factional bias and error) of the Typ02f modeling scenario for nitrate (NO_3). The 12 symbols for each monitor represent monthly average model performance for the year 2002, averaging all monitors in the CENRAP region. Solid lines represent CENRAP modeling goals and criteria.

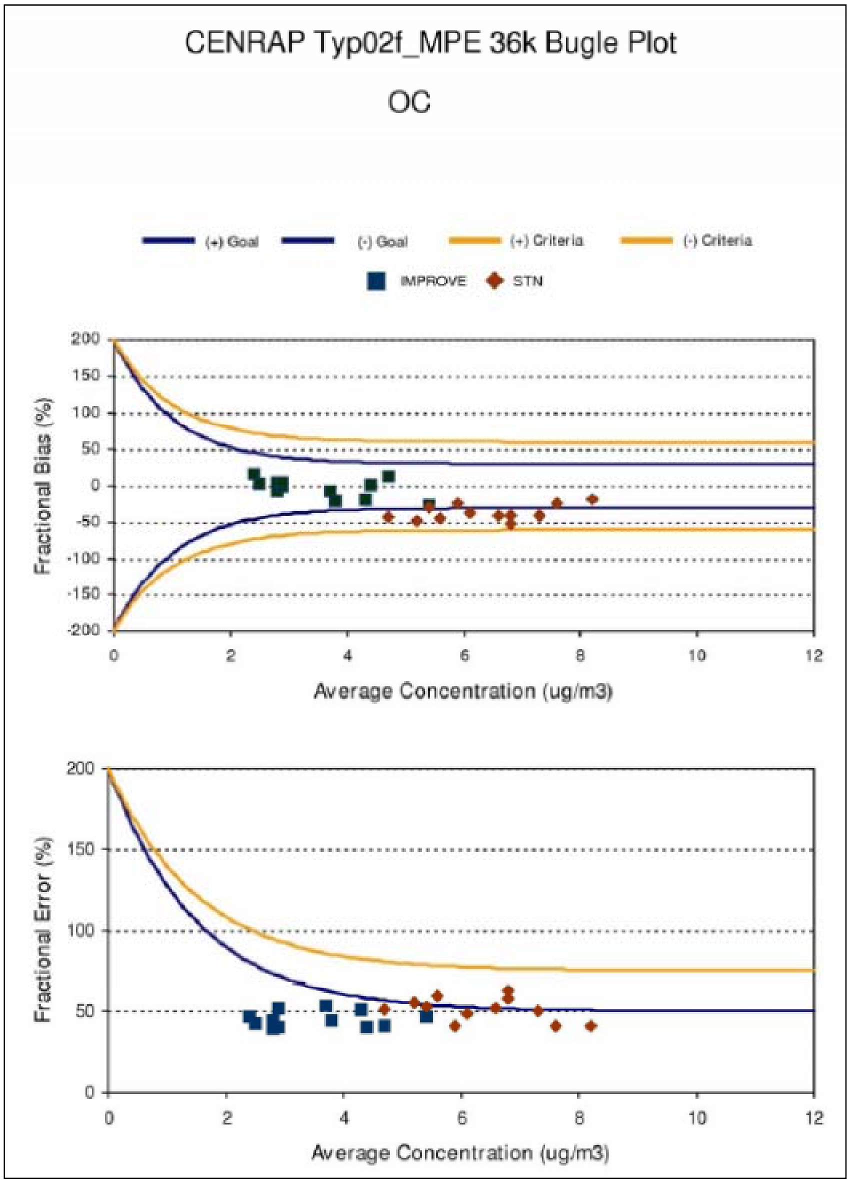


4.7.4.3 Model Performance for Organic Carbon (OC)

Figure 4-4 shows the monthly OC fractional error and bias for the STN and IMPROVE monitoring networks as well as the proposed performance goals and criteria. For the IMPROVE network, model performance for all months is within the goals for both fractional bias and error. The STN monitors in urban areas measured higher concentrations of OC then the rural

IMPROVE monitors. Model performance for STN sites shows a negative bias throughout the year that fall within the model criteria for both bias and error.

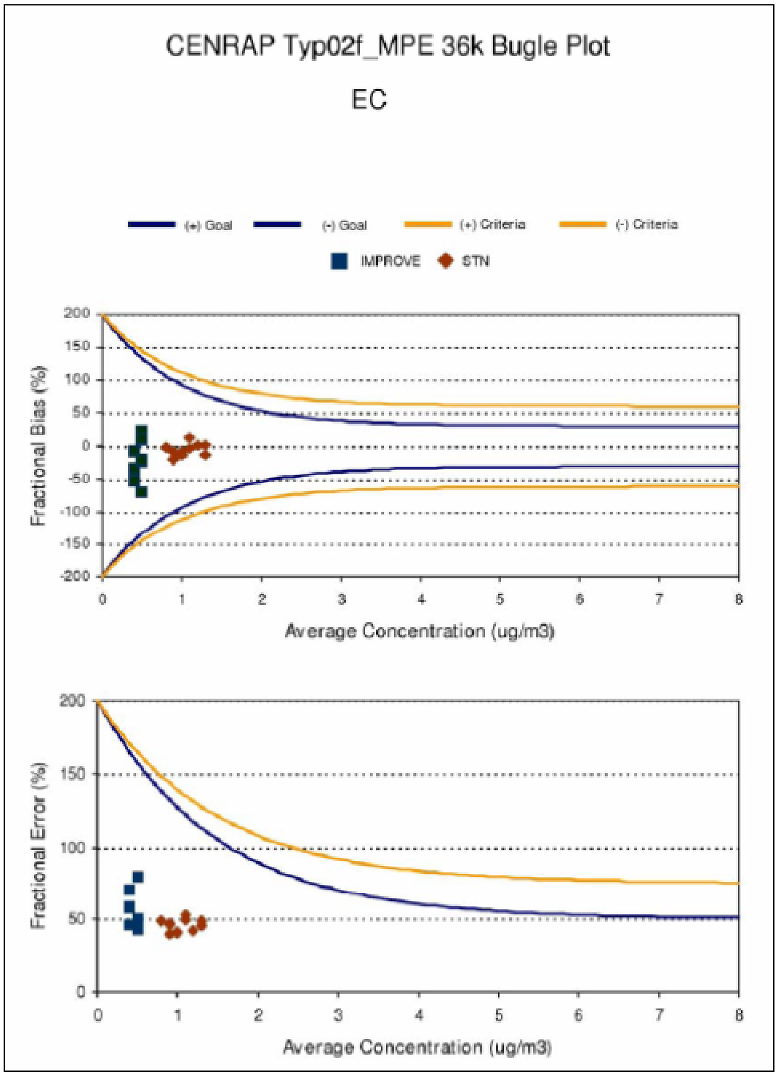
Figure 4-4. CENRAP model performance (factional bias and error) of the Typ02f modeling scenario for organic carbon (OC). The 12 symbols for each monitor represent monthly average model performance for the year 2002, averaging all monitors in the CENRAP region. Solid lines represent CENRAP modeling goals and criteria.



4.7.4.4 Model Performance for Elemental Carbon (EC)

Figure 4-5 shows the monthly EC fractional error and bias for the STN and IMPROVE monitoring networks as well as the proposed performance goals and criteria. Model performance for EC falls within the proposed performance goals. Fractional bias for the STN sites is small with a fractional error around 50%. There is a large model underprediction during the summer at the IMPROVE sites. However, EC concentrations at these sites are low putting the model performance within the goals for low concentrations.

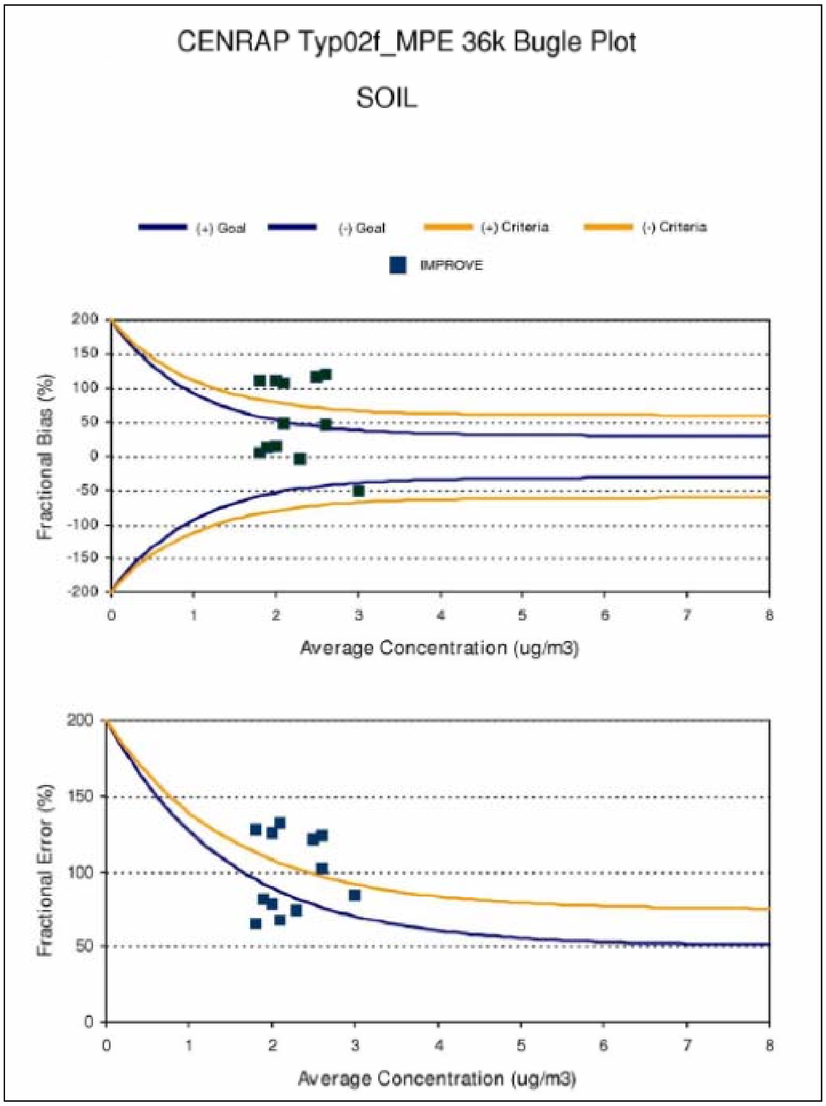
Figure 4-5. CENRAP model performance (factional bias and error) of the Typ02f modeling scenario for elemental carbon (EC). The 12 symbols for each monitor represent monthly average model performance for the year 2002, averaging all monitors in the CENRAP region. Solid lines represent CENRAP modeling goals and criteria.



4.7.4.5 Model Performance for Soil

Figure 4-6 shows the monthly soil fractional error and bias for the monitoring network as well as the proposed performance goals and criteria. Model performance for the winter months is poor with large overpredictions of soil concentrations. The summer months are within the goals for both fractional bias and error with performance getting worse in the fall and spring. This may be due to local effects near the monitor and difficulties in capturing emissions accurately in the inventory. This is an area of concern, especially in areas where soil contributes significantly to visibility impairment.

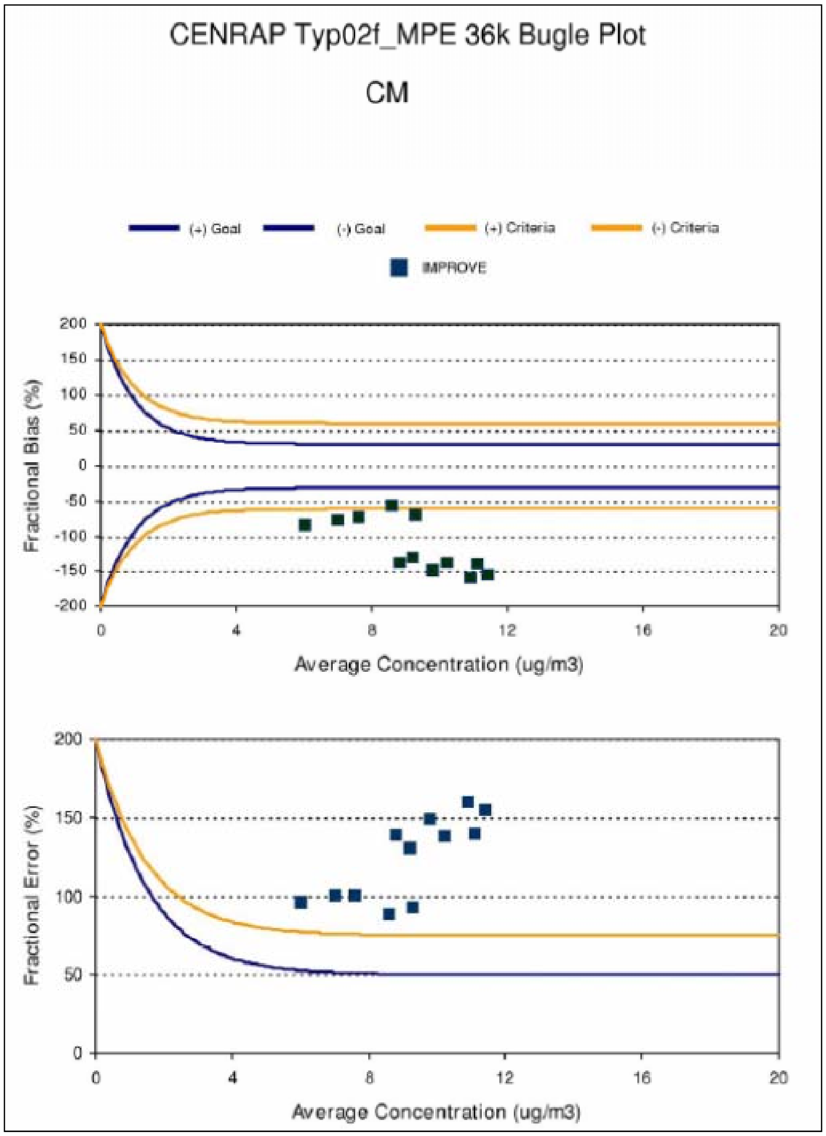
Figure 4-6. CENRAP model performance (factional bias and error) of the Typ02f modeling scenario for soil. The 12 symbols for each monitor represent monthly average model performance for the year 2002, averaging all monitors in the CENRAP region. Solid lines represent CENRAP modeling goals and criteria.



4.7.4.6 Model Performance for Course Particulate Material (CM)

Figure 4-7 shows the monthly CM fractional error and bias for IMPROVE and monitoring network as well as the proposed performance goals and criteria. Model performance is poor with large underpredictions of CM concentrations throughout the year. This may be due to localized emissions near the monitor and difficulties in capturing these emissions accurately in the inventory. This is an area of concern, especially in areas where CM contributes significantly to visibility impairment.

Figure 4-7. CENRAP model performance (factional bias and error) of the Typ02f modeling scenario for course particulate material (CM). The 12 symbols for each monitor represent monthly average model performance for the year 2002, averaging all monitors in the CENRAP region. Solid lines represent CENRAP modeling goals and criteria.



4.7.4.7 Model Performance for Prediction of Total Extinction

The above model performance summary includes all sites within the CENRAP. However, a model performance summary over such a diverse geographic area may mask model performance issues occurring in smaller geographic sub-regions. CENRAP also evaluated model performance in predicting total extinction on the 20% best and 20% worst days at each Class I site. Performance for the worst 20% days at the CENRAP Class I areas is generally characterized by an underestimation bias. Performance at the Breton (BRET), LA, Big Bend (BIBE), TX and Guadalupe Mountains (GUMO), TX Class I areas for the worst 20 percent days is particularly poor. At GUMO, visibility impairment is primarily due to high soil and CM which are not well predicted by the model across the CENRAP area. At the BRET and BIBE sites, all components are under-predicted, leading to an under-prediction in total extinction. Model predictions at these sites are less reliable than at other CENRAP sites for planning purposes. In general, model performance is acceptable for SO_4, NO_3, OMC and EC at the Class I areas. The model was not able to accurately predict CM and soil concentrations in the CENRAP region.

In order to address this model performance issue, CENRAP investigated the assumption that all CM and soil are natural and their concentrations remain constant for future projections as well as assuming that only a portion of the soil was from natural sources. Results of this sensitivity analysis showed that these various projections of CM and soil had little effect on visibility predictions at the CENRAP class I areas. See section 5.5.1 of the CENRAP TSD for results of this sensitivity analysis.

Within the state of Louisiana, Breton National Wildlife Refuge is the only Class I area. Model performance at predicting total extinction at Breton and Caney Creek Wilderness Area during the worst 20% and best 20% days are shown in Figures 4-8 and 4-9.

For Breton Island, the worst 20% days are heavily dominated by sulfate extinction. Nitrates do have a sizeable component on a few days but the sulfate extinction components are still higher on these few days. Sulfate, OMC and Soil under-prediction results in an under-prediction (-50 to -70%) and EC and CM are on the order of -100%. Worst observed extinction is 90-170 Mm-1 but modeled values drop to as low as 15 Mm-1. This underestimation results in more uncertainty for the Breton projections, but the monitoring and modeled data both conclude a high impact from sulfates on total extinction. Overall observed vs. model performance is relatively good on a bias level but there is a lot of scatter on individual days. On average, the low bias looks reasonable, but day specific performance is more questionable.

On most of the worst 20 % days at Caney Creek, total extinction is dominated by sulfate extinction with some extinction due to OMC. On four of the worst 20% days extinction is dominated by nitrate. Sulfate is underestimated and results in an under-prediction (-33% bias) on total extinction. There is an overestimate of extinction (+44% bias) on the 20% best days due to an over-prediction of NO_3.

Figure 4-8. Daily extinction model performance at Breton National Wildlife Refuge, LA for the worst (top) and best (bottom) 20% days during 2002.

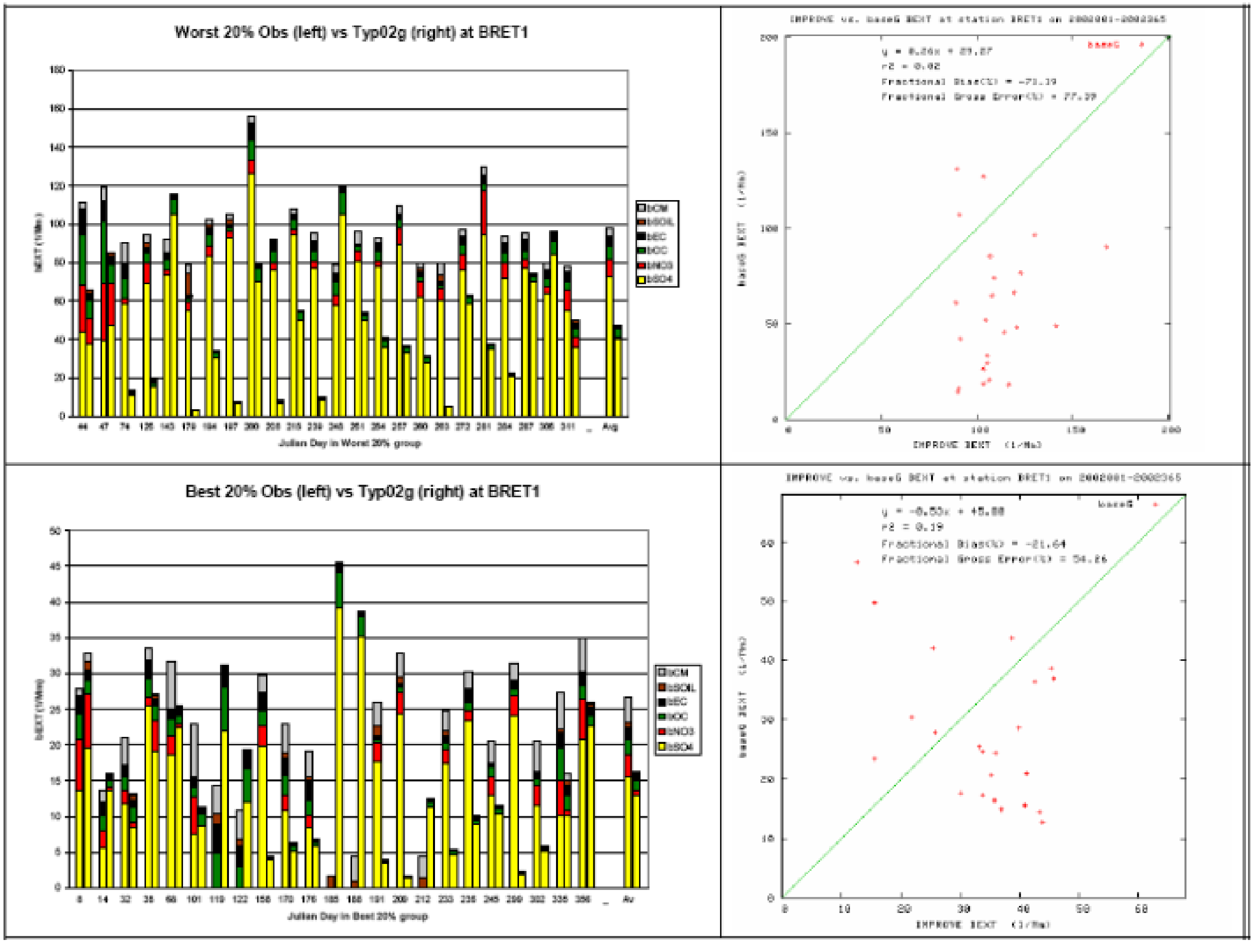
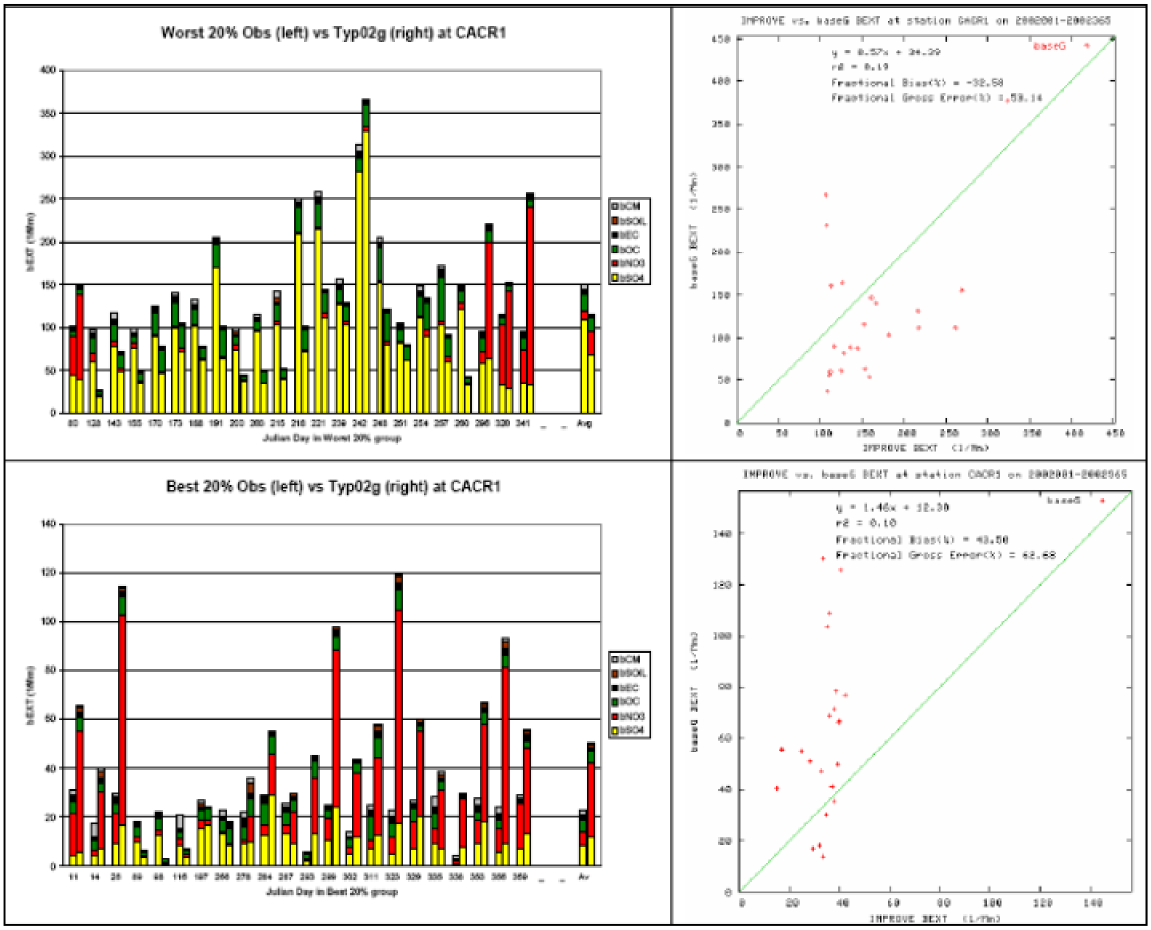


Figure 4-9. Daily extinction model performance at Caney Creek Wilderness Area, AR for the worst (top) and best (bottom) 20% days during 2002.



Chapter 5: 2018 Future Year Modeling

5.1 2018 Model Simulations

The 2018 future-year base case scenario is referred to as "2018 Base Case" or "Base18G". The purpose of the Base18G scenario is to simulate the air quality representative of conditions in future year 2018 with respect to sources of criteria and particulate matter air pollutants, taking into consideration growth and controls. Modeling results based on this emission inventory are used to define the future year ambient air quality and visibility metrics.

Input data used for the 2018 Base Case model simulations consisted of the same meteorology as for the 2002 Base Case and the Base18 emission inventories described under the Emissions Modeling section (Section 3). The setup of the CMAQ model (including science options, run scripts, simulation periods, and ancillary data) for the Base18 cases was identical to that used in the Typ02G modeling.

The purpose of modeling 2018 visibility is to compare the 2018 visibility predictions to the 2002 typical-year visibility modeling results and compare 2018 visibility predictions to the URP goal for 2018, as discussed below. Some improvements in visibility by 2018 are expected because of reductions in emissions due to currently planned regulations and technology improvements. The methodology used by CENRAP in developing visibility projections for 2018 and described below is consistent with EPA guidance.

5.2 Visibility Projections

The Regional Haze Rule (RHR) goals include achieving natural visibility conditions at 156 federally mandated Class I areas by 2064. In more specific terms, that RHR goal is defined as (1) visibility improvement toward natural conditions for the 20% of days that have the worst visibility (termed "20% worst" visibility days) and (2) no worsening in visibility for the 20% of days that have the best visibility ("20% best" visibility days). One component of the states' demonstration to EPA that they are making reasonable progress toward this 2064 goal is the comparison of modeled visibility projections for the first milestone year of 2018 with what is termed a uniform rate of progress (URP) goal. As explained in detail in Section 2, the 2018 URP goal is obtained by constructing a "linear glide path" (in deciviews) that has at one end the observed visibility conditions during the mandated five-year (2000-2004) baseline period and at the other end natural visibility conditions in 2064; the visibility value that occurs on the glide path at year 2018 is the URP goal.

CENRAP has made 2018 visibility projections using Typ02G and Base18G CMAQ 36-km modeling results following EPA guidance[45] that recommends applying the modeling results in a relative sense to project future-year visibility conditions. Projections are made using relative

[45] US EPA, 2006. Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze, US EPA, Office of Air Quality and Planning Standards, EPA-454/B-07-002, EPA, April 2007, (http://www.epa.gov/ttn/scram/guidance/guide/final-03-pm-rh-guidance.pdf)

response factors (RRFs), which are defined as the ratio of the future-year modeling results for each component that affects visibility to the current-year modeling results. The calculated RRFs are applied to the baseline observed visibility conditions to project future-year observed visibility. These projections can then be used to assess the effectiveness of the simulated emission control strategies that were included in the future-year modeling. The major features of our recommended visibility projections and guidance are as follows:

- Monitoring data should be used to define current air quality.
- Monitored concentrations of PM10 are divided into six major components; the first five are assumed to be PM2.5 and the sixth is PM2.5-10.
    - SO4 (sulfate)
    - NO3 (particulate nitrate)
    - OC (organic carbon)
    - EC (elemental carbon)
    - Soil (other fine particulate or soil)
    - CM (coarse matter).
- Models are used in a relative sense to develop RRFs between future and current predicted concentrations of each component.
- Component-specific RRFs are multiplied by current monitored values to estimate future component concentrations.
- Estimates of future component concentrations are consolidated to provide an estimate of future air quality.
- Future estimated air quality is compared with the goal for regional haze to see whether the simulated control strategy would result in the goal being met.

5.2.1 Mapping Model Results to IMPROVE Measurements

Each of the six PM components of light extinction in the revised IMPROVE mass extinction equation[46] is scaled separately. Because the modeled species do not exactly match up with the IMPROVE measured PM species, assumptions must be made to map the modeled PM species to the IMPROVE measured species for the purpose of projecting visibility improvements. Table 4-2 of the CENRAP TSD shows the assumptions used to relate modeled species in CMAQ Version 4.5 to the species used in the equation to estimate visibility. Some additional species (described in section 4.3.1 of the CENRAP TSD) resulting from the modified SOA module used by CENRAP are also included in the OC term.

5.2.2 Projecting Visibility Changes Using Modeling Results

RRFs are calculated as the ratio of the 2018 modeling results to the 2002 modeling results, and are specific to each Class I area and each PM species. These RRFs are applied to the baseline period visibility conditions calculated from observed PM species levels to project future-year PM levels. The projected PM levels are used to estimate visibility conditions in 2018 through the

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[46] IMPROVE technical subcommittee for algorithm review, 2006. Revised IMPROVE Algorithm for Estimating Light Extinction from Particle Speciation Data. (http://vista.cira.colostate.edu/improve/Publications/GrayLit/019_RevisedIMPROVEeq/RevisedIMPROVEAlgorithm3.doc)

revised IMPROVE equation. The following six steps found in the modeling guidance[47] summarize the general procedure used to project future-year visibility for the 20% best and 20% worst visibility days:

1) For each Class I area, rank visibility (in deciviews) on each day with observed speciated PM data for each of the 5 years of the base period.
2) For each of the 5 years comprising the base period, calculate the mean deciviews for the 20% worst and 20% best visibility days. For each Class I area, calculate the 5 year mean deciviews for the worst and best days from the 5 year-specific values.
3) Use an air quality model to simulate base period emissions and future emissions. Use the resulting information to develop relative response factors for each component of particulate matter identified in the IMPROVE equation.
4) Multiply the relative response factors times the measured species concentration data during the base period (for the 20% best and worst days). This results in daily future year species concentrations data.
5) Using the results in Step 4 and the IMPROVE algorithm calculate the future daily extinction coefficients for the 20% best and worst visibility days in each of the five base years.
6) Calculate daily deciview values (from total daily extinction) and then compute the future average mean deciviews for the best and worst days of each year. Then average the 5 years together to get the final future mean deciview value for the best and worst days.

The six steps listed above from national EPA modeling guidance for regional haze were followed by CENRAP to estimate projected future visibility conditions. These methods were appropriate at the time the modeling was performed.

5.3 REASONABLE PROGRESS GOAL AND PATH TO NATURAL CONDITIONS

A linear URP from the Baseline Conditions in 2004 to Natural Conditions in 2064 is assumed, and the value on the glide path at 2018 is the presumptive URP visibility target that the modeled 2018 projections are compared against to judge progress. The estimated visibility impairment in 2018 is slightly less than the calculated URP for 2018 (Section 2). The URP acts as a benchmark for evaluating the reasonable progress towards reaching natural conditions by 2064.

In determining reasonable progress, section 169A(g) of the Clean Air Act requires that four factors be considered:

- Cost of compliance
- Time necessary for compliance
- Energy and non-air quality environmental impacts of compliance
- Remaining useful life of existing sources that contribute to visibility impairment.

Table 5-1 and figures 5-1 and 5-2 compares the URP using the natural conditions described in section 2 to the modeled visibility conditions in 2018 for each Class I area. For Breton Island,

[47] US EPA, 2006. Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze, US EPA, Office of Air Quality and Planning Standards, EPA-454/B-07-002, EPA, April 2007, (http://www.epa.gov/ttn/scram/guidance/guide/final-03-pm-rh-guidance.pdf)

the baseline visibility (2002-2004) is 25.73 dv, and the estimated 2018 URP is 22.51dv. The modeling predicts a visibility improvement of 3.01 dv by 2018, compared to the URP improvement of 3.22 dv by 2018. The modeling predicts a visibility improvement of 3.01 dv, compared to the URP improvement of 3.22 dv by 2018, less than 10% gap is left. Achieving the 2018 URP point is not a requirement of the RHR SIPs, but it serves as a benchmark to compare progress toward natural visibility conditions in 2064 and is designed to help states in selecting their 2018 RPGs. As stated in EPA Guidance for Setting Reasonable Progress Goals Under the Regional Haze Program[48], "The glidepath is not a presumptive target, and States may establish a RPG that provides for greater, lesser, or equivalent improvement as that described by the glidepath."

The modeling also shows visibility impairment in 2018 for the 20% best days show an improvement in visibility of 0.90 dv at Breton by 2018. This is consistent with the requirement of no degradation of visibility on the best days at Class I sites.

LDEQ adopted the modeled 2018 visibility conditions as the Reasonable Progress Goal for Breton Class I area. We are proposing to partially approve and partially disapprove Louisiana's Reasonable Progress Goals because of the linkage to EPA's CAIR and the Transport Rule. See the Notice and the main TSD for more details. CENRAP and LDEQ's projections indicate that Sulfate emissions in Louisiana are projected to increase from 2002 to 2018. Louisiana sources are projected to remain significant contributors to visibility impairment in 2018, thus providing further support that additional analysis should have be performed according to the statutory factors as additional analyses are conducted for BART on sources as discussed in the BART sections of the main TSD and in the FRN proposal.

Table 5-1. Comparison of reasonable progress goal to uniform rate of progress for 2018 (total extinction and deciviews)

	Breton Island
Avg. for 20% Worst Days (Baseline 2000-04)	25.73 dv
2018 URP Goal	22.51 dv
RPG	22.72 dv
Change by 2018 (reasonable progress goal)	-3.22 dv
Change by 2018 at uniform rate of progress	-3.45 dv
Projected rate of change (2004-2018)	-0.32 dv/yr
Change needed to reach natural conditions	-14.78 dv
Avg. for r20% Best Days (Baseline 2000-04)	13.12 dv
RPG	12.22 dv

[48] US EPA, 2007, Guidance for Setting Reasonable Progress Goals Under the Regional Haze Program, EPA, June 2007. http://www.epa.gov/ttncaaa1/t1/memoranda/reasonable_progress_guid071307.pdf

Figure 5-1. Projections of visibility impairment for 20% worst days at Breton Island

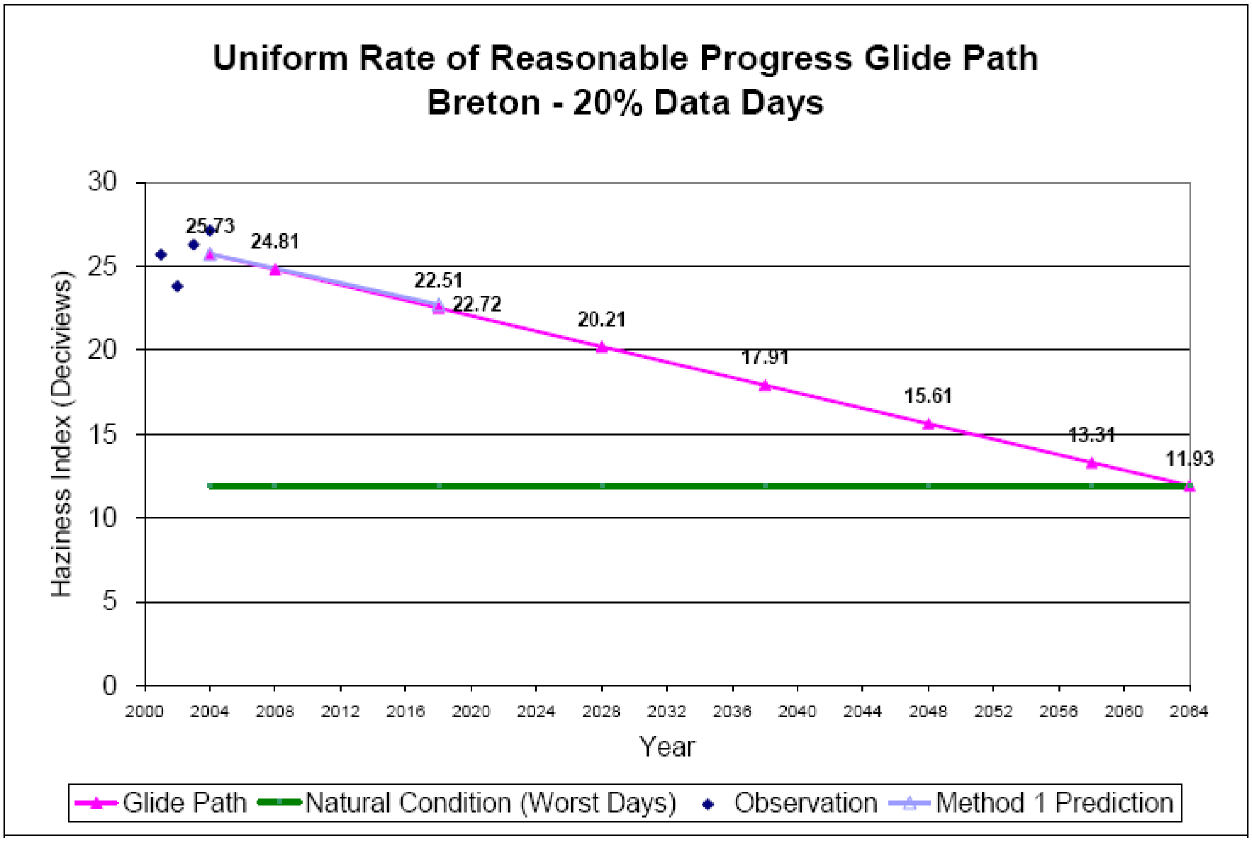

Figure 5-2. shows the differences in model results of total extinction between the Base18g and Typ02g model predictions, including the contributions from each component specie of the IMPROVE algorithm. On most days, visibility improvements are due to reductions in sulfate. A few days exhibit differences in nitrate concentrations being the most significant contribution to improved visibility.

Figure 5-2. Differences in modeled total extinction (Bext) between Base18G and Typ02g for 20% worst days at Breton National Wildlife Refuge.

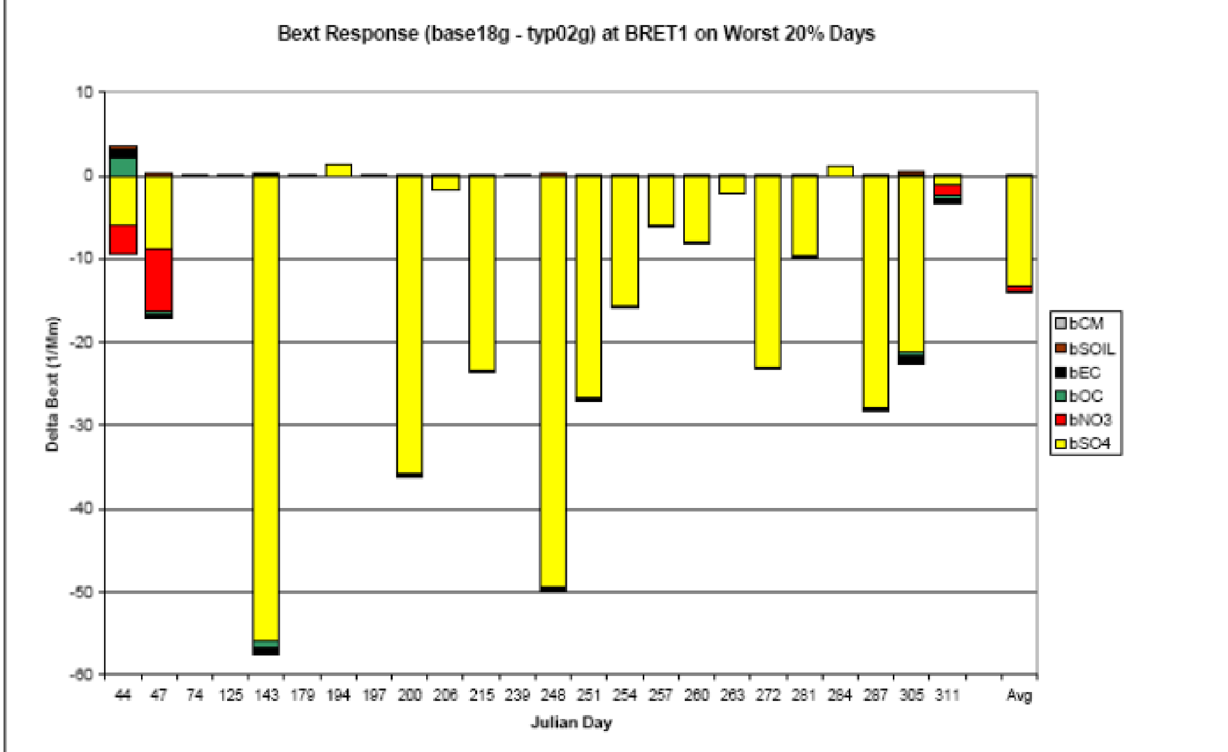

Figure D-3d. Differences in modeled 2002 and 2018 Base G CMAQ results (2018-2002) daily extinction for Breton Island (BRET), Louisiana and Worst 20% (W20%) days in 2002.

As discussed in the following chapter on source apportionment, visibility impairment at Breton National Wildlife Refuge is due to emissions and transport from outside of Louisiana as well as in state sources.

Chapter 6: Source Apportionment Modeling

6.1 INTRODUCTION

Visibility impairment in Class I areas is the result of local air pollution as well as transport of regional pollution across long distances. The relative contributions to visibility impairment from each source region and category is needed to develop effective control strategies to improve visibility. CENRAP used CAMx Version 4.40 with its Particulate Source Apportionment Technology (PSAT) tool to provide source apportionment by geographic regions and major source category. CAMx was run with similar options and inputs as the CAMQ modeling with both the 2002 baseline and 2018 future case emission inventories (Base F). The CAMX model selection and performance are discussed briefly in section 3.7 of this document and details of the CAMx model configuration used by CENRAP can be found in the CENRAP TSD and the Modeling Protocol. PSAT uses reactive tracers that operate in parallel to the CAMx host model using the same emissions, transport, chemical transformation and deposition rates as the host model to account for the contributions of user specified source regions and categories to PM concentrations throughout the modeling domain. Details on the formulation of the CAMx PSAT source apportionment can be found in the CAMx user's guidance.[49] The CAMx PSAT analysis has been tested and evaluated against other apportionment techniques.[50,51] The goals of the PSAT assessment are to evaluate the contributions of different geographic regions and source categories to visibility impairment at Class I areas in 2002 and the projected 2018 case in order to identify those regions and source categories that, if controlled, would produce the greatest improvements in visibility.

CENRAP defined 30 geographical source regions (Fig 5-1) consisting of CENRAP and nearby states, with Texas divided into 3 regions, the remainder of the western and eastern United States, the Gulf of Mexico, Canada and Mexico. Six source categories (elevated point sources; low-level point sources, on-road mobile, non-road mobile, area and natural or non-anthropogenic sources) were tracked separately. The CENRAP PSAT 2002 and 2018 applications used three of the PSAT families of tracers: 1) sulfate, 2) nitrate and ammonium, and 3) secondary organic aerosols (SOA). SOA was portioned into an anthropogenic (SOAA) and biogenic (SOAB) components. Contributions for the 20% worst and 20% best days at each CENRAP and nearby Class I area were extracted from the PSAT results. The original IMPROVE equation was used to calculate extinction coefficients from modeled concentrations. Modeling performance is poor for soil and coarse material. As discussed in Section 3 of this document, results of various projections of CM and soil had little effect on visibility predictions at the CENRAP class I areas. Extinction due to soil and coarse material changes very little between 2002 and 2018. A PSAT Visualization Tool was developed that can be used by States, Tribes and others to generate displays of the contributions of source regions and categories to visibility impairment for the

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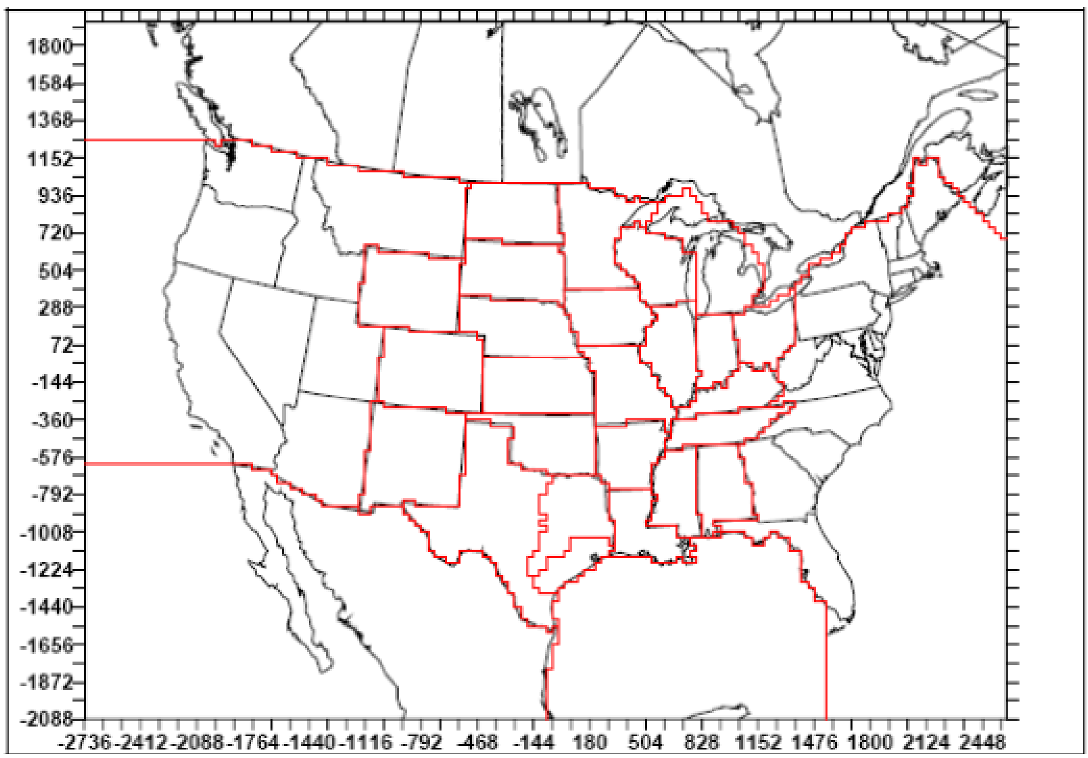
[49] "User's Guide Comprehensive Air Quality Model With Extensions (CAMx) Version 4.30." ENVIRON International Corporation, Novato, California, 2006 (available at www.camx.com).

[50] Morris, R.E., G.Y., C.E., G.W., B.K. 2005. "Recent Advances in One-Atmospheric Modeling Using the Comprehensive Air-quality Model with Extensions." Presented at the 98th Annual Air and Waste Management Conference, Minneapolis, MN. June.

[51] Yarwood, G., R.E. Morris, G. Wilson. 2004. "Particulate Matter Source Apportionment Technology (PSAT) in the CAMx Photochemical Grid Model." Presented at the ITM 27th NATO Conference- Banff Centre, Canada, October. (http://www.camx.com/publ/pdfs/___Yarwood_ITM_paper.pdf)

average of the worst 20 percent and best 20 percent days at each CENRAP and nearby Class I areas.[52] The 2002 projected results apply the 2002 PSAT modeled source apportionment to the observed 2000-2004 Baseline extinction keeping the relative contributions of source groups to each PM species (e.g., SO4, NO3, etc.) the same averaged across the 2002 worst 20 percent days but scaling their magnitudes up or down based on the ratio of the 2000-2004 Baseline to the 2002 modeling results. Similarly, the 2018 projected results use the relative contributions of the 2018 PSAT results from each source group and scales them according to the differences in the 2018 projected PM species to the 2018 modeled PM species for the average of the worst 20 percent days. EPA believes the selection and application of CAMx for source apportionment analysis is appropriate.

Figure 6-1. Source Regions used in CAMx PSAT PM source apportionment modeling



6.2 SOURCE APPORTIONMENT RESULTS AT BRETON NATIONAL WILDLIFE REFUGE

Tables 6-1 and 6-2 show the modeled contributions to total extinction for each source category and species for 2002 and 2018, respectively. Figures 6-2, 6-3, 6-4, and 6-5 show the geographical source apportionment by source category and species for the 20% worst days in 2002 and 2018. Visibility impairment at the Breton National Wildlife Refuge site in 2002 on the worst 20% days is largely due to sulfate from point sources that contributes over half (96.83 Mm^{-1}) of the total extinction of 132.52 Mm^{-1}. The largest contributions of sulfate come from Louisiana (15.48 Mm^{-1} from all source categories) and the eastern United States (22.88 Mm^{-1}). Overall, the largest source region contributions to visibility impairment in 2002 are from the eastern United States, Louisiana, Alabama, and Indiana).

[52] available at http://www.cenrap.org/html/projects.php

In 2018, Louisiana sources contribute the most to visibility impairment at Breton, as large reductions in impairment from point sources in the Indiana, Alabama and the eastern U.S. occur while sulfate emissions increase in Louisiana. The 2018 projection shows the total extinction at Breton for the worst 20 % days is estimated to be 102.5 Mm^{-1}, a reduction of approximately 23%. Reductions of sulfate emissions from point sources in Alabama, the eastern United States, Indiana, and Ohio make up the lionshare of the decrease in total light extinction. Even with such large reductions in SO4 from point sources in 2018, extinction due to point sources is still the highest contributor to visibility impairment on the worst 20% days, accounting for over half of the total extinction. There is an under-prediction bias in the model that must be considered when examining source apportionment results for sulfate. Use of a 12km resolution modeling grid in CAMX reduced the summertime sulfate bias but required large computational expense. The use of higher resolution modeling should be reconsidered in future modeling efforts.

Table 6-1. Projected light extinction for 20% worst days at Breton National Wildlife Refuge in 2002 (Mm^{-1})

	Total[1]	Point	Natural	On-Road	Non-Road	Area
SO4	96.83	78.92	0.08	1.31	2.95	8.74
NO3	8.29	2.53	0.48	1.44	1.29	1.03
POA	4.71	1.03	0.49	0.13	0.46	2.00
EC	5.40	0.35	0.34	0.70	2.08	1.41
SOIL	0.95	0.25	0.03	0.01	0.01	0.60
CM	3.70	0.30	0.18	0.02	0.04	2.14
Sum	132.52	83.38	1.60	3.61	6.82	15.93

[1]Totals include contributions from boundary conditions and secondary organic matter

Table 6-2. Projected light extinction for 20% worst days at Breton National Wildlife Refuge in 2018 (Mm^{-1})

	Total[1]	Point	Natural	On-Road	Non-Road	Area
SO4	68.63	51.59	0.04	0.15	1.57	10.61
NO3	8.20	2.53	0.49	0.53	1.22	1.85
POA	4.37	1.21	0.21	0.05	0.38	1.93
EC	3.92	0.34	0.15	0.14	1.43	1.34
SOIL	1.16	0.43	0.03	0.01	0.01	0.63
CM	3.95	0.31	0.15	0.02	0.04	2.40
Sum	102.50	56.43	1.05	0.90	4.64	18.76

[1]Totals include contributions from boundary conditions and secondary organic matter

Figure 6-2. Source apportionment modeling results by source region and source category for worst 20% days at Breton National Wildlife Refuge in 2002.

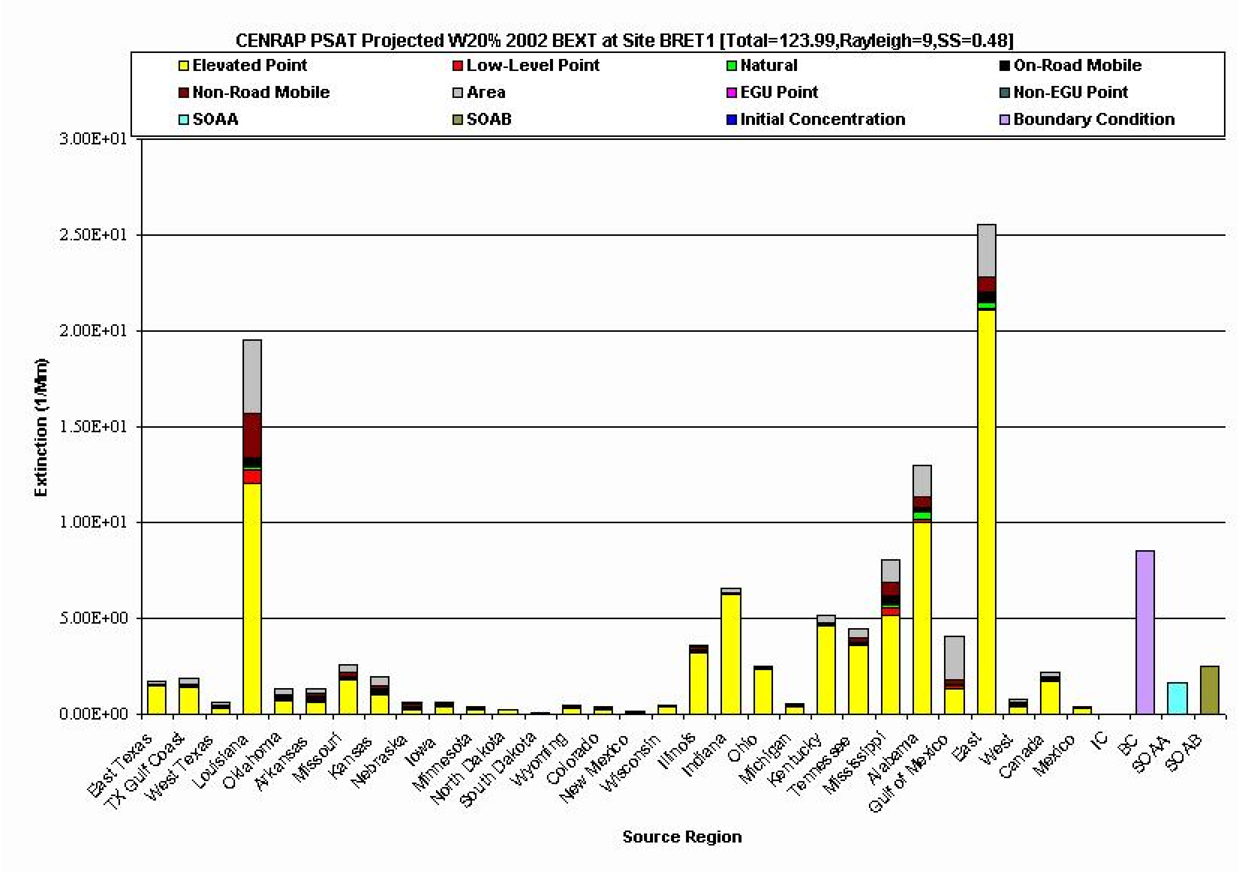


Figure 6-3. Source apportionment modeling results by source region and species for worst 20% days at Caney Creek Wilderness Area in 2002.

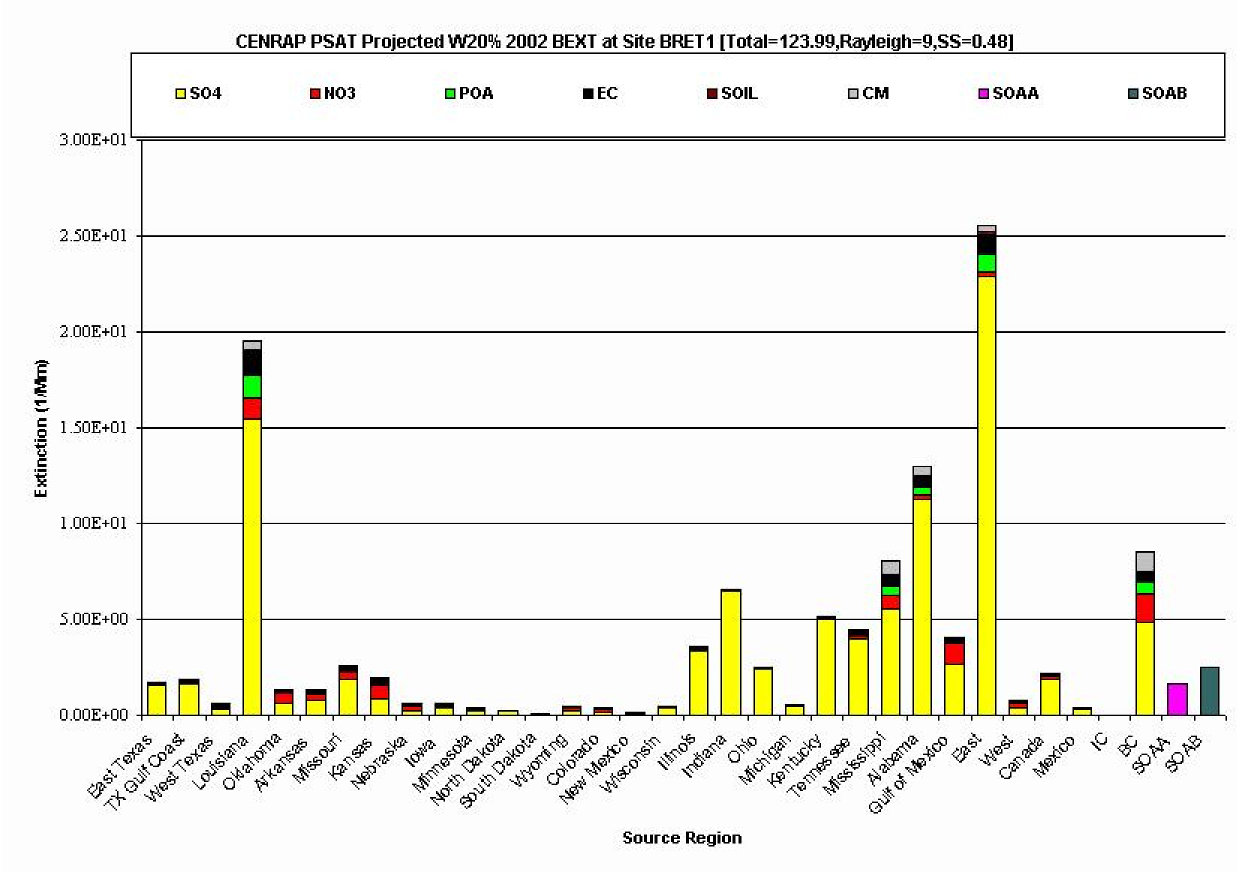
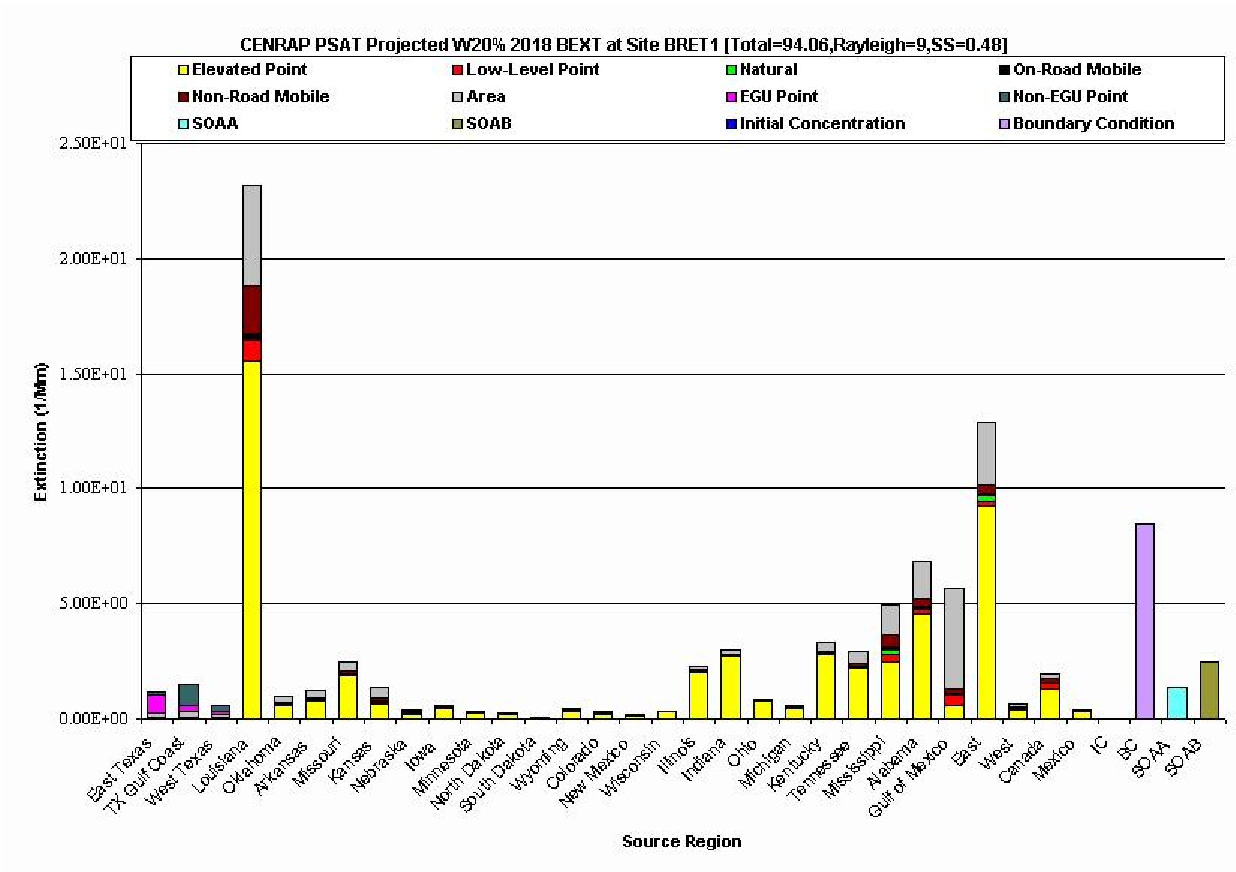
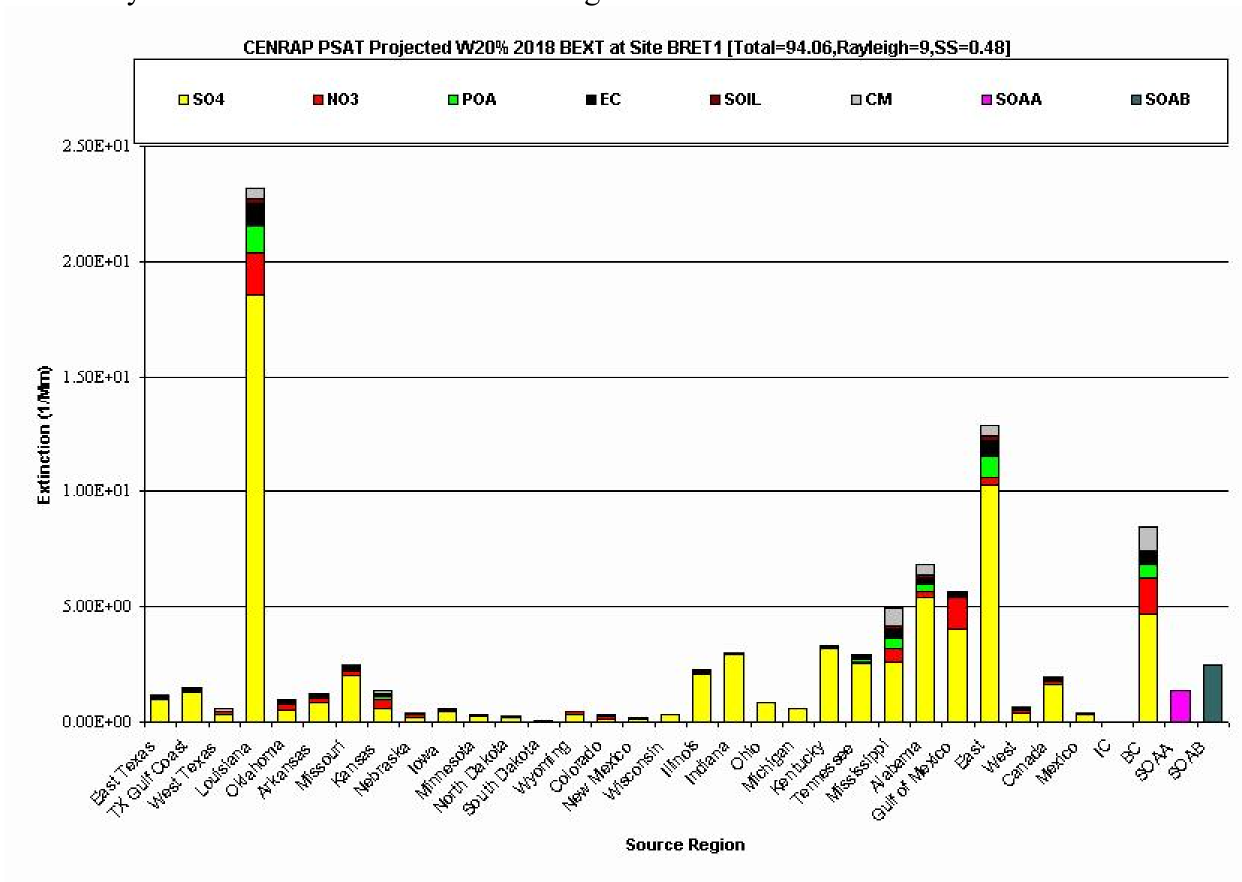


Figure 6-4. Source apportionment modeling results by source region and source category for worst 20% days at Breton National Wildlife Refuge in 2018.



*2018 projections for Texas Point sources are divided into EGU and Non-EGU point sources

Figure 6-5. Source apportionment modeling results by source region and species for worst 20% days at Breton National Wildlife Refuge in 2018.



6.3 SOURCE APPORTIONMENT RESULTS AT CANEY CREEK WILDERNESS AREA

Tables 6-3 and 6-4 show the modeled contributions to total extinction for each source category and species for 2002 and 2018, respectively. Figures 6-2, 6-3, 6-4, and 6-5 show the geographical source apportionment by source category and species for the 20% worst days in 2002 and 2018. Visibility impairment at the Caney Creek Wilderness Area site in 2002 on the worst 20% days is largely due to sulfate from point sources that contributes over half (75.1 Mm^{-1}) of the total extinction of 133.93 Mm^{-1}. The largest contributions of sulfate come from Texas (11.55 Mm^{-1} from all source categories) and the eastern United States (17.98 Mm^{-1}). Overall, the largest source region contributions to visibility impairment in 2002 are from the eastern United States (19.16 Mm^{-1}), Texas (14.89 Mm^{-1}) and Louisiana (13.57 Mm^{-1}).

In 2018, Louisiana sources contribute the most to visibility impairment at Caney Creek, as large reductions in impairment from point sources in East Texas and the eastern U.S. occur while sulfate emissions increase in Louisiana. The 2018 projection shows the total extinction at Caney Creek Wilderness Area for the worst 20 % days is estimated to be 85.84 Mm^{-1}, a reduction of approximately 36%. Reductions of sulfate emissions from point sources in Texas, the eastern United States, Indiana, and Ohio account for a decrease of 24.41 Mm^{-1} in total light extinction, approximately half of the total reduction between 2002 and 2018. Even with such large reductions in SO4 from point sources in 2018, extinction due to point sources is still the highest contributor to visibility impairment on the worst 20% days, accounting for over half of the total extinction. Visibility impairment from all Louisiana sources decreases 2.32 Mm^{-1}, almost entirely due to reductions from mobile sources. Total reductions in mobile sources of NO3 contribute a decrease in total extinction of approximately 9 Mm^{-1}. There is an under-prediction bias in the model that must be considered when examining source apportionment results for sulfate. Use of a 12km resolution modeling grid in CAMX reduced the summertime sulfate bias but required large computational expense. The use of higher resolution modeling should be reconsidered in future modeling efforts.

Table 6-3. Projected light extinction for 20% worst days at Caney Creek Wilderness Area in 2002 (Mm^{-1})

	Total[1]	**Point**	**Natural**	**On-Road**	**Non-Road**	**Area**
SO4	87.05	75.10	0.09	1.19	1.70	5.66
NO3	13.78	4.06	0.64	4.70	2.45	1.37
POA	10.50	1.29	1.33	0.46	1.34	5.32
EC	4.80	0.19	0.33	0.86	1.79	1.40
SOIL	1.12	0.19	0.01	0.01	0.01	0.87
CM	3.73	0.21	0.04	0.03	0.02	3.19
Sum	*133.93*	*81.04*	*2.45*	*7.26*	*7.31*	*17.81*

[1]Totals include contributions from boundary conditions and secondary organic matter

Table 6-4. Projected light extinction for 20% worst days at Caney Creek Wilderness Area in 2018 (Mm^{-1})

	Total[1]	**Point**	**Natural**	**On-Road**	**Non-Road**	**Area**
SO4	48.95	39.83	0.07	0.12	0.44	5.31
NO3	7.57	2.84	0.53	0.97	1.33	1.37
POA	9.93	1.76	1.18	0.14	1.03	5.09
EC	3.17	0.24	0.30	0.16	0.94	1.31
SOIL	1.29	0.35	0.01	0.01	0.01	0.87
CM	3.58	0.24	0.04	0.03	0.01	3.02
Sum	*85.84*	*45.27*	*2.12*	*1.44*	*3.76*	*16.96*

[1]Totals include contributions from boundary conditions and secondary organic matter

Figure 6-6. Source apportionment modeling results by source region and source category for worst 20% days at Caney Creek Wilderness Area in 2002.

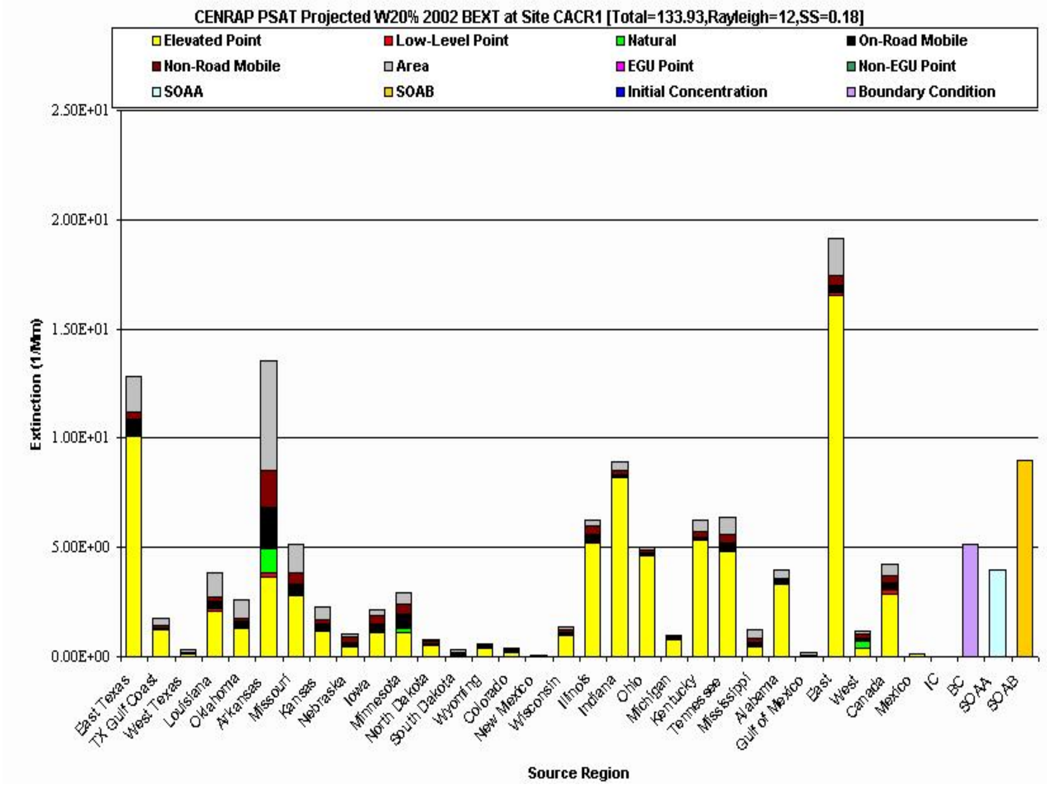


Figure 6-7. Source apportionment modeling results by source region and species for worst 20% days at Caney Creek Wilderness Area in 2002.

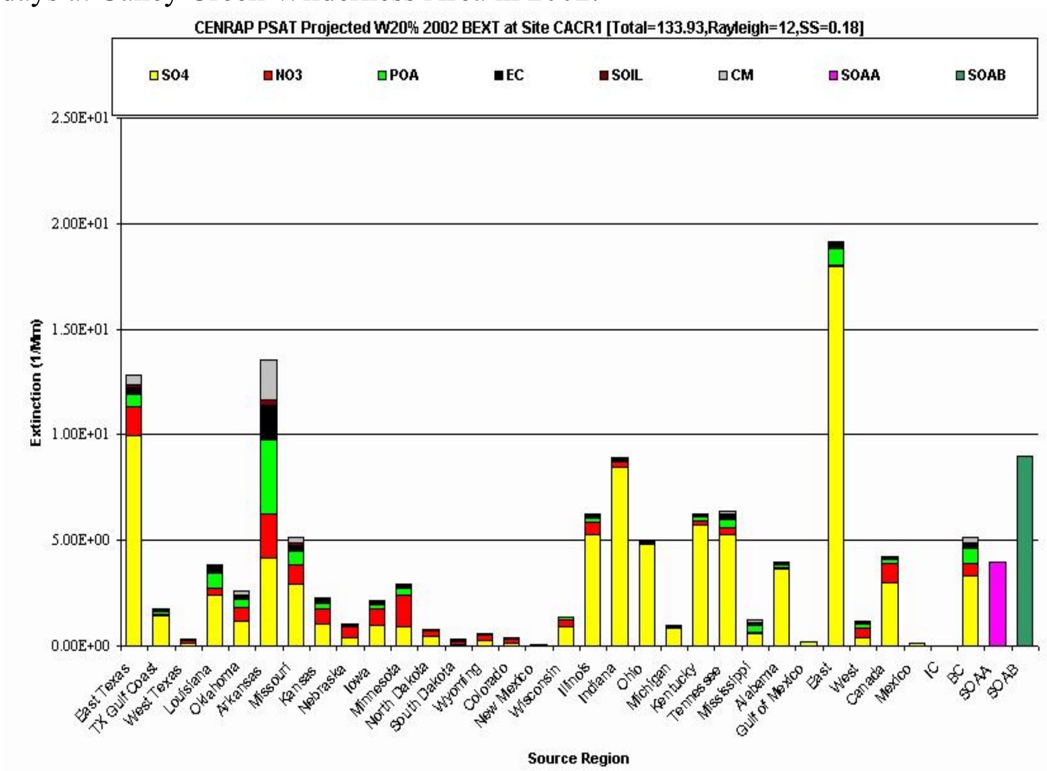
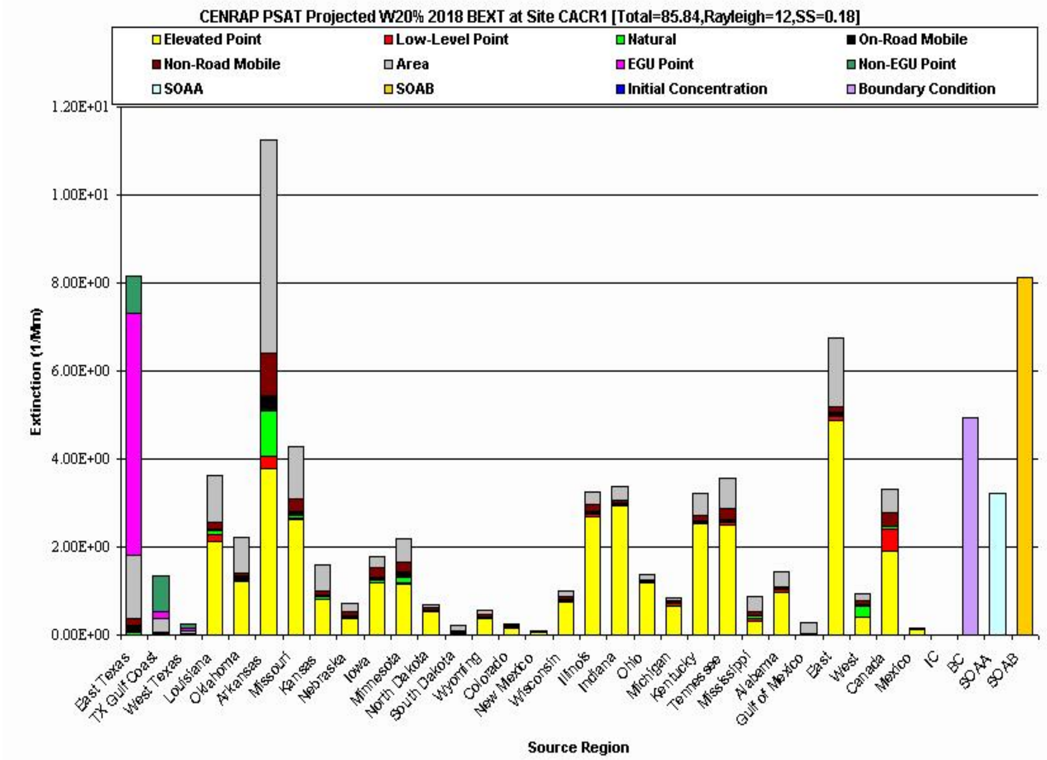
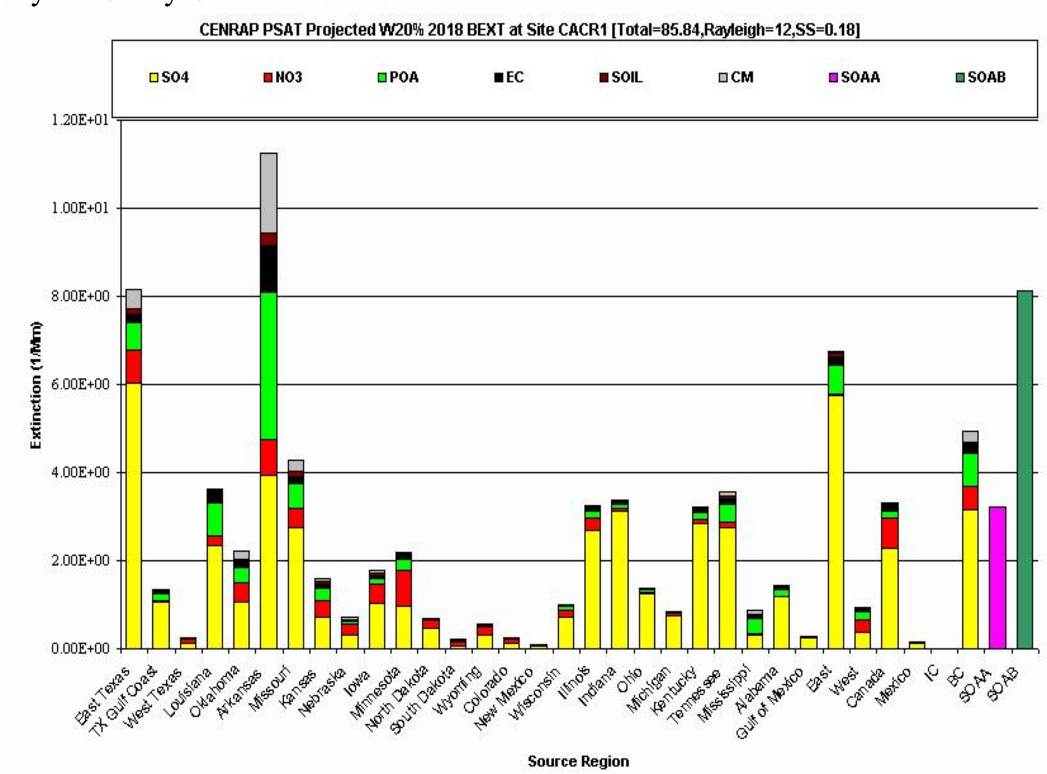


Figure 6-8. Source apportionment modeling results by source region and source category for worst 20% days at Caney Creek Wilderness Area in 2018.



*2018 projections for Texas Point sources are divided into EGU and Non-EGU point sources

Figure 6-9. Source apportionment modeling results by source region and species for worst 20% days at Caney Creek Wilderness Area in 2018.



6.4 CONTRIBUTIONS TO VISIBILITY IMPAIRMENT AT OTHER CLASS I AREAS

CAMx PSAT results are also utilized to evaluate the impact of Louisiana emission sources in 2002 and 2018 on visibility impairment at Class I areas outside of the state. Louisiana sources are modeled to have contributions to the Class I areas in Oklahoma with impairment % increasing from 3.55 to 4.99%. Outside of Oklahoma, the next largest contributions from Louisiana sources are on Class I areas in Arkansas (Upper Buffalo), Texas (Big Bend and Guadalupe Mtns.) and Missouri (Hercules-Glades and Mingo). The growth in % of apportionment is partially due to the increase in emissions projected for 2018 from Louisiana sources, especially the SO2 emissions.

Table 6-5. Percent contribution to total visibility impairment at Class I areas on 20% worst days from Louisiana Sources (contributions less than 1% are excluded)

Class I area	2002	2018
UPBU1	2.42%	2.99%
CACR1	2.87%	4.36%
HEGL1	2.24%	3.05%
MING1	0.22%	0.34%
WIMO1	3.55%	4.99%
GUMO1	2.00%	2.48%
BIBE1	2.42%	2.85%

Chapter 7: BART Determination

7.1 BART SCREENING ANALYSES

The discussion that follows is a description of the process used to determine BART Sources. LDEQ conducted an evaluation to support just evaluating the two closest Class I areas. The two Class I areas closest to Louisiana sources are Breton National Wildlife Refuge and Caney Creek Wilderness Area. We concur with LDEQ's decision to focus on these two Class I areas.

First, LDEQ sorted the BART-eligible facilities in Louisiana with visibility impairing pollutants by distances to the nearest Class I area. Second, LDEQ evaluated the ratios of the total of visibility impairing emissions to the distance to the Class I area was calculated on the spreadsheet. See Tables 7-2 and 7-3 for this information. Third, the facilities with the higher emissions to distance ratios were modeled with the CALPUFF screening model using the following methodology:

● EPA regulatory approved model, CALPUFF version 5.711a;
● CENRAP 6 km spacing resolution domains with no observation
● CALMET met data of 2001, 2002 and 2003; and,
● Ozone data for 2001, 2003 Louisiana state ozone data and 2002 CENRAP southern region ozone data were used in the screening process.
● The 24 hour maximum pollutant emissions of NOx, SO2 and particulate collected in the BART survey were used for the model emissions inputs.
● POSTUTIL was used in calculation of repartitioning of NO3/HNO3 without ammonia data.
● CALPOST version 5.51 was used to determine the visibility impact on the Class I area of interest.

We concur with the use of this version of CALPUFF at the time and the methodology that LDEQ utilized for using specific facilities with a high Q/D of visibility impairing pollutants as model plants for screening of sources.

In accordance with the Guidelines, LDEQ chose to use a contribution threshold of 0.5 deciviews (98^{th} percentile) for determining which sources were subject to BART. To be more conservative, due to some of the uncertainties with this approach, LDEQ used the maximum impact value instead of the 98^{th} Percentile. Therefore, LDEQ used a screening evaluation criterion was a maximum deciview impact of greater than 0.5 deciviews to require a refined analysis. We concur with this approach.

The two (2) existing facilities that had the highest emission divided by distance ratios with respect to the Caney Creek Class I area were Smurfit Stone in Jackson Parish, Louisiana and Chemtrade Refining in Caddo Parish, Louisiana. Results of the facility's screening are shown in table 7-4. Modeled results indicated that there was no visibility impact at Caney Creek, with the exception of Chemtrade in 2002 and the average of the maximums were below 0.5 dv impact.. Model outputs are listed below:

Smurfit Stone, Jackson Parish, Louisiana; distance from Caney Creek equals 263km SSE

- o 2001 inputs indicated 0.188 dv impact
- o 2002 inputs indicated 0.259 dv impact
- o 2003 inputs indicated 0.183 dv impact

Chemtrade Refining, Caddo Parish, Louisiana; distance from Caney Creek equals 226.6km almost due south

- o 2001 inputs indicate 0.043 dv impact
- o 2002 inputs indicate 0.052 dv impact
- o 2003 in puts indicate 0.042 dv impact.

Graphics Packaging International (see Facility 1 in Table 7-4) reported revised BART eligible emissions after the screening modeling had begun, so this facility was requested to perform its own screening. The remaining facilities listed in Table 7-2, were eliminated from BART consideration as their emissions were less than either Smurfit Stone or Chemtrade Refining and they were farther away from the Caney Creek Class I area. As a check, LDEQ modeled a carbon black plant, Cabot Company in Evangeline Parish and a coal-fired EGU, Big Cajun 2 in Pointe Coupee Parish that were over 300 kms from Caney Creek and emitted high amounts of visibility impairing pollutants from tall stacks. The modeling indicated there was no impact to visibility at Caney Creek from these two additional sources.

Table 7-1. BART-eligible facilities closest to Caney Creek

COMPANY NAME	STATIONARY SOURCE NAME	LONGITUDE	LATITUDE	DISTANCE TO CLASS 1 AREA (KM)	SO2 24-hour MAXIMUM (tons/day)	NOx 24-hour MAXIMUM (tons/day)	PM10 24-hour MAXIMUM (tons/day)	total SO2, NOx, and PM	total/distance
Graphic Packaging International	West Monroe Mill	-92.1526003	32.48667262	272.8	2.33	9.66	1.89	13.88	0.05088
Smurfit-Stone Container Enterprise, Inc	Facility Wide	-92.7271006	32.27364037	262.9	0.51	4.94	5.75	11.2	0.042602
International Paper Company	Bastrop - Louisiana Mill	-91.908196	32.78150968	264.7	4.83	2.32	3.75	10.9	0.041179
Boise Cascade	DeRidder Paper Mill	-93.3753244	30.85758291	395.3	4	5.3	2.35	11.65	0.029471
Koch Nitrogen Company	Sterlington Ammonia Plant	-92.0826419	32.68555292	260.5	0.01	4.57	0.13	4.71	0.018081
Weyerhaeuser Company	Red River Mill	-93.1714369	31.9039304	285.8	0.38	1.37	0.79	2.54	0.008887
Cleco Power LLC.	Rodemacher Power Station	-92.7185213	31.3996156	352.4	40.25	15.88	2.94	2.94	0.008343
Entergy Louisiana	Sterlington	-92.0792663	32.70266681	259.4	10.57	19.5	1.46	1.46	0.005628

COMPANY NAME	STATION-ARY SOURCE NAME	LONGITUDE	LATITUDE	DIS-TANCE TO CLASS 1 AREA (KM)	SO2 24-hour MAXIMUM (tons/day)	NOx 24-hour MAXIMUM (tons/day)	PM10 24-hour MAXIMUM (tons/day)	total SO2, NOx, and PM	total/distance
Chemtrade Refinery Services Inc.	Sulfuric Acid Plant	-93.6336163	32.35992291	226.6	1.17	0.03	0.02	1.22	0.005384
City of Ruston	Ruston Electrical Generation Station	-92.6137195	32.52735312	243.7	1.83	1.18	0.13	0.13	0.000533
Procter & Gamble Manufacturing Company	Alexandria Plant	-92.4100859	31.36766549	366.7	0	0.05	0.1	0.15	0.000409
City of Natchitoches Utility Dept.	Springfield Boiler	-93.0945177	31.76913137	302.2	3.59	3.86	0.1	0.1	0.000331

LDEQ altered their methods for determining visibility impairment for the Breton Class I area from the analysis methods they used for Caney Creek. LDEQ chose to model two facilities: ConocoPhillips Alliance Refiner in St. Bernard Parish, Louisiana and the Big Cajun 2 power plant in Pointe Coupee Parish, Louisiana. Because Louisiana was a CAIR state at the time, only the particulate matter (PM10) component was used when performing the modeling for Big Cajun 2.

Model results from both facilities indicated an impact of visibility at Breton. LDEQ used as its criteria an emissions/distance ratio equal to or greater than Big Cajun 2 (0.0898678). If a facility's emissions/distance ration was greater than 0.0898678 then the facility was requested to conduct its own modeling exercise. Facilities 2 through 10 in Table 7-4 were above this ratio (0.0898678).

LDEQ then performed screening models on Murphy Oil USA, Meraux Refinery, St. Bernard Parish, Louisiana and the Entergy Michoud facility in Orleans Parish, Louisiana. Once again, because Louisiana was a CAIR state at the time, the Entergy Michoud facility was screened only for particulates. Both of these facilities were found to have an impact on visibility at Breton, and both were requested to perform the refined modeling. (Facilities 11 and 12 in Table 9.4) Facility 13, Sid Richardson, was requested to perform refined modeling also because its emissions/distance ratio was slightly greater than of Murphy Oil (0.0891079). Looking at BART-eligible facilities further to the west from Breton, LDEQ performed the screening model on the Dupont Ponchartrain Diamines Unit, St. John the Baptist Parish, Louisiana. The results of this run showed no impact on visibility at Breton.

Using established guidelines, LDEQ removed all of the remaining facilities listed in Table 7-3 that were a greater distance from Breton from BART consideration with exceptions listed below. LDEQ then modeled, as a double check on the analysis, Cabot Corporation, which is a carbon-black, facility located 332.3 km west of Breton in Evangeline Parish, Louisiana. This facility was chosen because it emits high amounts of visibility impairing pollutants from a tall stack. The modeling indicated there was no impact from this facility at Breton.

To be conservative due to the uncertainties of LDEQ's BART-eligible screening analysis, LDEQ formally requested other BART-eligible facilities that had emissions greater than 5 tons and within 250 kms to perform a screening analysis. That action added facilities 15, 16, and 17 and 19 through 27 in Table 7-4. LDEQ also added Chalmette Refining, facility 14, and Union Carbide, facility 18, because their emissions approached 5 tons and both facilities are within 150 km of Breton.

Table 7-2. BART-eligible facilities closest to Breton

COMPANY NAME	STATION-ARY SOURCE NAME	LONGITUDE	LATITUDE	DISTANCE TO CLASS 1 AREA (KM)	SO2 24-hour MAXIMUM (tons/day)	NOx 24-hour MAXIMUM (tons/day)	PM10 24-hour MAXIMUM (tons/day)	total SO2, NOx, and PM	total/ distance
Marathon Petroleum Company, LLC-LA Refining Division	Garyville Refinery	-89.40832724	30.059162	50.9	2.74	9.55	0.73	13.02	0.2557957
Conoco-Phillips Co.	Alliance Refinery	-89.98078866	29.678193	93.9	40.48	11.94	1.78	54.2	0.5772098
Murphy Oil USA, Inc.	Meraux Refinery	-89.94436291	29.930831	96.4	4.88	3.23	0.48	8.59	0.0891079
Chevron Oronite Company LLC	Oak Point Plant	-90.01148298	29.809566	98.8	2.74	0.08	0.01	2.83	0.0286437
Chalmette Refining, L.L.C.	Chalmette Refinery	-89.97400146	29.930644	99	0.22	4.2	0.11	4.53	0.0457576
Entergy New Orleans	Michoud	-89.93791281	30.006128	99.1	101.96	22.73	7.39	7.39	0.0745711
Entergy Louisiana	Ninemile Point	-90.14143463	29.949253	114.9	14.09	107.06	1.37	1.37	0.0119234

COMPANY NAME	STATIONARY SOURCE NAME	LONGITUDE	LATITUDE	DISTANCE TO CLASS 1 AREA (KM)	SO2 24-hour MAXIMUM (tons/day)	NOx 24-hour MAXIMUM (tons/day)	PM10 24-hour MAXIMUM (tons/day)	total SO2, NOx, and PM	total/ distance
Temple Inland	Bogalusa Mill	-89.85998757	30.778264	123.7	14.57	5.5	2.2	22.27	0.1800323
Valero Refining-New Orleans, LLC	St. Charles Refinery	-90.39563933	29.985771	139.3	2.99	5.14	1.1	9.23	0.0662599
Shell Chemical LP	Norco Chemical Plant - East Site	-90.40704044	29.999184	140.8	0.06	7.33	0.3	7.69	0.0546165
Motiva Enterprises LLC	Norco Refinery	-90.40704044	29.999184	140.8	1.41	4	0.16	5.57	0.0395597
Union Carbide Corp.	Taft/Star Manufacturing Complex	-90.45488109	29.984369	144.7	1.51	3	0.2	4.71	0.0325501
Entergy Louisiana	Little Gypsy	-90.46080445	30.016234	146.2	28.28	112.16	0.57	0.57	0.0038988
Entergy Louisiana	Waterford	-90.47590204	29.993072	146.9	101.85	31.97	4	4	0.0272294
DuPont	Pontchartrain Diamines Unit	-90.5261004	30.053921	153.4	0.09	10.01	0.15	10.25	0.0668188
DuPont Performance Elastomers	Pontchartrain Chloroprene Unit	-90.52610018	30.05393	153.4	0.07	0.41	0.03	0.51	0.0033246
Terrebonne Parish Consolidated Government	Houma Generating Station	-90.72158049	29.578969	165	0.01	2.52	0.02	0.02	0.0001212
Gramercy Alumina	Gramercy Alumina	-90.66701652	30.058482	166.4	0.13	6.07	0.36	6.56	0.0394231
Mosaic Fertilizer LLC	Uncle Sam Plant	-90.83242332	30.039483	181.1	39.16	3.34	0	42.5	0.234677
Koch Pipeline Company, L.P.	St. James Terminal	-90.84342098	30.030074	181.9	0	0	0	0	0
Motiva Enterprises, LLC	Convent Refinery	-90.89767031	30.033776	187	0	0	0	0	0
Chevron Phillips Chemical Company, LP	St. James Styrene Facility	-90.91386764	30.080657	189.8	0	0	0	0	0
Mosaic Fertilizer LLC	Faustina Plant	-90.91684168	30.0813	190.1	0	4.18	1.67	5.85	0.0307733
E.I. du Pont de Nemours & Co., Inc.	Burnside Plant	-90.91387658	30.123194	191.1	28.4	0.16	0	28.56	0.1494505
CF Industries	CF Industries Donaldsonville	-90.95785687	30.086915	194	0.03	8.88	1.72	10.63	0.0547938

COMPANY NAME	STATION-ARY SOURCE NAME	LONGITUDE	LATITUDE	DISTANCE TO CLASS 1 AREA (KM)	SO2 24-hour MAXIMUM (tons/day)	NOx 24-hour MAXIMUM (tons/day)	PM10 24-hour MAXIMUM (tons/day)	total SO2, NOx, and PM	total/ distance
BASF Corporation	Geismar Site	-90.98059623	30.210231	200	2.65	1.05	0.24	3.94	0.0197
Shell Chemical LP	Geismar Plant	-90.99523584	30.182353	200.4	0	2.82	0.15	2.97	0.0148204
Chemtura USA Corporation	Geismar Plant	-91.00669483	30.205804	202.2	0.05	0.57	0.36	0.98	0.0048467
Monochem, Inc.	Geismar Facility	-91.010967	30.210447	203	0.01	4.79	0.11	4.91	0.02418719
PCS Nitrogen	Geismar Plant - Ammonia Group	-91.05376269	30.226629	207.2	33.4	15.02	1.94	50.36	0.2430502
Williams Olefins LLC	Geismar Ethylene Plant	-91.05301053	30.231057	207.3	0.01	1.29	0.13	1.43	0.0068982
TOTAL Petrochemicals USA, Inc.	Cos-Mar Styrene Monomer Plant	-91.06780502	30.220973	208.3	0.02	1.45	0.99	2.46	0.0118099
Louisiana Energy & Power Authority	Morgan City Steam Plant	-91.18922897	29.689935	209.8	0	4.14	0	4.14	0.0197331
Syngenta Crop Protection	St. Gabriel Plant - HCN Unit	-91.10344169	30.246737	212.4	0	0.11	0.06	0.17	0.0008004
Entergy Gulf States	Willow Glen	-91.11729738	30.272667	214.6	169.77	59.62	5.39	5.39	0.0251165
ExxonMobil Refining & Supply Co.	ExxonMobil Baton Rouge Refinery	-91.16847335	30.482699	224.8	4.68	6.33	1.68	12.69	0.0564502
The Dow Chemical Company	Louisiana Operations	-91.23272546	30.269765	224.9	0.48	0	0.25	0.73	0.0032459
ExxonMobil	Baton Rouge Chemical Plant	-91.16954678	30.494912	225.1	4.18	6.21	3.17	13.56	0.0602399
Lion Copolymer, LLC	Baton Rouge Plant	-91.17323005	30.504635	225.7	0	0	0	0	0
Louisiana Energy and Power Authority	Plaquemine Steam Plant	-91.25555522	30.271876	227.1	0	1.35	0	1.35	0.0059445
Rhodia, Inc.	Baton Rouge Facility	-91.18800147	30.508143	227.2	34.1	1.87	0.01	35.98	0.1583627

COMPANY NAME	STATION-ARY SOURCE NAME	LONGITUDE	LATITUDE	DISTANCE TO CLASS 1 AREA (KM)	SO2 24-hour MAXIMUM (tons/day)	NOx 24-hour MAXIMUM (tons/day)	PM10 24-hour MAXIMUM (tons/day)	total SO2, NOx, and PM	total/ distance
Placid Refining Company, L.L.C.	Port Allen Refinery	-91.21028582	30.474709	228.5	8.15	1.46	0	9.61	0.0420569
Sid Richardson Carbon Company	Addis Plant	-91.27950387	30.329033	231.2	19.49	0.52	0.68	20.69	0.0894896
Exide Technologies	Baton Rouge Smelter	-91.24267772	30.584765	234.2	6.86	0	0	6.86	0.0292912
Columbian Chemicals Company	North Bend	-91.45548632	29.679773	235.3	0	0	0	0	0
Cabot Corporation	Canal Plant	-91.47352568	29.682689	237	0.03	0.29	0.05	0.37	0.0015612
Georgia Pacific	Port Hudson Operations	-91.28110753	30.650659	239.6	3.55	7.37	2.45	13.37	0.0558013
Cleco Power LLC.	Teche Power Station	-91.54348023	29.823214	244.5	7.44	11.27	1.73	1.73	0.0070757
Tembec USA LLC	St. Francisville Mill	-91.31830837	30.709643	244.8	0.57	3.23	1.18	4.98	0.0203431
Louisiana Generating LLC	Big Cajun 1 Power Plant	-91.35383789	30.671025	246.9	23.06	24.23	0.89	0.89	0.0036047
Louisiana Generating LLC	Big Cajun 2 Power Plant	-91.36650704	30.724414	249.7	269.32	51.62	22.44	22.44	0.0898678
Degussa Engineered Carbons, LP	Ivanhoe Carbon Black Plant	-91.7378093	29.778371	262.7	20.14	24.94	3.46	48.54	0.1847735
Lafayette Utilities System	Louis "Doc" Bonin Electric Generation Station	-92.04593816	30.236709	298.9	0.02	8.2	0.3	0.3	0.0010037
Cabot Corporation	Cabot Ville Platte Plant	-92.25346608	30.74712	332.3	4.03	0.46	0.08	4.57	0.0137526
International Paper	Pineville Mill	-92.3481993	31.293607	358.9	6.9	8.37	2.67	17.94	0.0499861
PPG Industries, Inc.	Derivatives	-93.28590531	30.230548	415.1	0	0.56	0.43	0.99	0.002385
Entergy Gulf States	Nelson	-93.29170698	30.284239	416.5	51.84	19.44	3.31	3.31	0.0079472
CITGO Petroleum	Lake Charles Manufacturing Complex	-93.32013703	30.18219	417.6	2.59	2.09	1.48	6.16	0.014751
Sasol North America Inc.	Lake Charles Chemical Plant	-93.32505385	30.186464	418.1	0.16	1.63	0.19	1.98	0.0047357

COMPANY NAME	STATION-ARY SOURCE NAME	LONGITUDE	LATITUDE	DISTANCE TO CLASS 1 AREA (KM)	SO2 24-hour MAXIMUM (tons/day)	NOx 24-hour MAXIMUM (tons/day)	PM10 24-hour MAXIMUM (tons/day)	total SO2, NOx, and PM	total/ distance
Equistar Chemicals	Lake Charles Plant	-93.32577352	30.190505	418.3	0	0.62	0	0.62	0.0014822
CITGO Petroleum Corporation	Clifton Ridge Terminal	-93.32987551	30.165164	418.3	0	0	0	0	0
Firestone Polymers LLC	Lake Charles Facility	-93.33136675	30.185618	418.7	0	0.09	0.09	0.18	0.0004299
CITGO Petroleum Corporation	Pecan Grove Tank	-93.34601014	30.178776	420	0	0	0	0	0

Table 7-3: Facilities Requested to either Screen or Perform Refined Modeling

	Company Name	Source Name	AI Number
1	Graphic Packaging International	West Monroe Mill	1432
2	ConocoPhilips Co.	Alliance Refinery	2418
3	Marathon Petroleum Company, LLC	Garyville Refinery	3165
4	PCS Nitrogen	Geismar Plant	3732
5	Mosaic Fertilizer LLC	Uncle Sam Plant	2532
6	Degussa Engineered Carbons LP	Ivanhoe Carbon Black Plant	2518
7	Temple Inland	Bogalusa Mill	38936
8	Rhodia, Inc	Baton Rouge Facility	1314
9	E.I. du Pont de Nemours & Co., Inc.	Burnside Plant	67572
10	Louisiana Generating LLC	Big Cajun 2 Power Plant	38867
11	Murphy Oil USA, Inc.	Meraux Refinery	1238
12	Entergy New Orleans	Michoud	32494
13	Sid Richardson Carbon Company	Addis Plant	4174
14	Chalmette Refining , L.L.C.	Chalmette Refinery	1376
15	Valero Refining-New Orleans, LLC	St Charles Refinery	26003
16	Motiva Enterprises LLC	Norco Refinery	1406
17	Shell Chemical LP	Norco Chemical Plant – East Site	26336
18	Union Carbide Corp.	Taft/Star Manufacturing Complex	2083

19	Gramercy Alumina	Gramercy Alumina	1388
20	Mosaic Fertilizer LLC	Faustina Plant	2425
21	CF Industries	CF Industries Donaldsonville	2416
22	Entergy Gulf States	Willow Glen	2625
23	ExxonMobil Refining & Supply Co.	ExxonMobil Baton Rouge Refinery	2638
24	ExxonMobil	Baton Rouge Chemical Plant	286
25	Placid Refining Company, L.L.C.	Port Allen Refinery	2366
26	Exide Technologies	Baton Rouge Smelter	1396
27	Georgia Pacific	Port Hudson Operations	2617

The results of the individual screening and refined modeling analyses for each source that could not be eliminated from BART consideration are included in Table 9.5. Each modeling exercise was reviewed and approved by LDEQ, FLM, and EPA.

Table 7-4: CALPUFF/CALPOST Screening Results

Facility	AI Number	Status
Graphic Packaging	1432	Passed Screening Model
Conoco Philips Co.	2418	Failed Refined Model
Marathon Petroleum Company, LLC	3165	Passed Screening Model
PCS Nitrogen	3732	Passed Refined Model
Mosaic Fertilizer, LLC	2532	Passed Refined Model
Degussa Engineered Carbons, LP	2518	Passed Refined Model
Temple Inland	38936	Passed Screening Model
Rhodia, Inc.	1314	Failed Refined Model
E.I. du Pont de Nemours & Co., Inc.	67572	Passed Screening Model
Sid Richardson Carbon Company	4174	Failed Refined Model

Facility	AI Number	Status
Louisiana Generating, LLC	38867	Passed Refined Model
Murphy Oil USA, Inc.	1238	Passed Refined Model
Entergy New Orleans	32494	Passed Refined Model
Chalmette Refining, LLC	1376	Passed Screening Model
Valero Refining-New Orleans,LLC	26003	Passed Screening Model
Motiva Enterprises, LLC	1406	Passed Refined Model
Shell Chemical, LP	26336	Passed Refined Model
Union Carbide Corp.	2083	Passed Screening Model
Gramercy Alumina	1388	Passed Screening Model
Mosaic Fertilizer, LLC	2425	Passed Screening Model
CF Industries	2416	Passed Screening Model
Entergy Gulf States	2625	Passed Refined Model
Exxon Mobil Refining and Supply Co.	2638	Passed Screening Model
Exxon Mobil	286	Passed Screening Model
Placid Refining Company, LLC	2366	Passed Screening Model
Exide Technologies	1396	Passed Screening Model
Georgia Pacific	2617	Passed Screening Model
International Paper	2140	Passed Screening Model

Table 7-5 Facilities that LDEQ determined had units that were subject to BART

Facility Name	AI Number	Emission Units Subject to BART	Pollutants Evaluated in BART	Determination Contribution to Visibility Impair (delta deciview)
Conoco Philips Co.	2418	Various emission points in facility	SO_2, NO_x, and PM	**2.689**
Rhodia, Inc.	1314	Sulfuric acid Units 1 and 2	SO_2	**1.043/0.164**
Sid Richardson Carbon Company	4174	Units 1,2, and 3 flares and dryers 2,3, and 4	SO_2	**0.568**

With the exception of the Mosaic facility, we are in concurrence with LDEQ's assessment of which facilities in Louisiana have units that are subject to BART. For the our detailed review and analysis on these subject to BART sources and the Mosaic facility, see the main TSD.

The modeling files and reports for the BART model plant analysis, modeling files for individual facilities, and modeling reports are available on request. Due to the combined file size of several Gigabytes, we cannot post to the Docket directly. Contact the person identified in the FRN to obtain the materials.

Figures 7-9, 7-10, and 7-11 depict specific BART-eligible sources, their modeled deciview impact, location and distance from the two Class I areas for 2001, 2002, and 2003.

Figure 7-1. BART Source Screening Modeling 2001

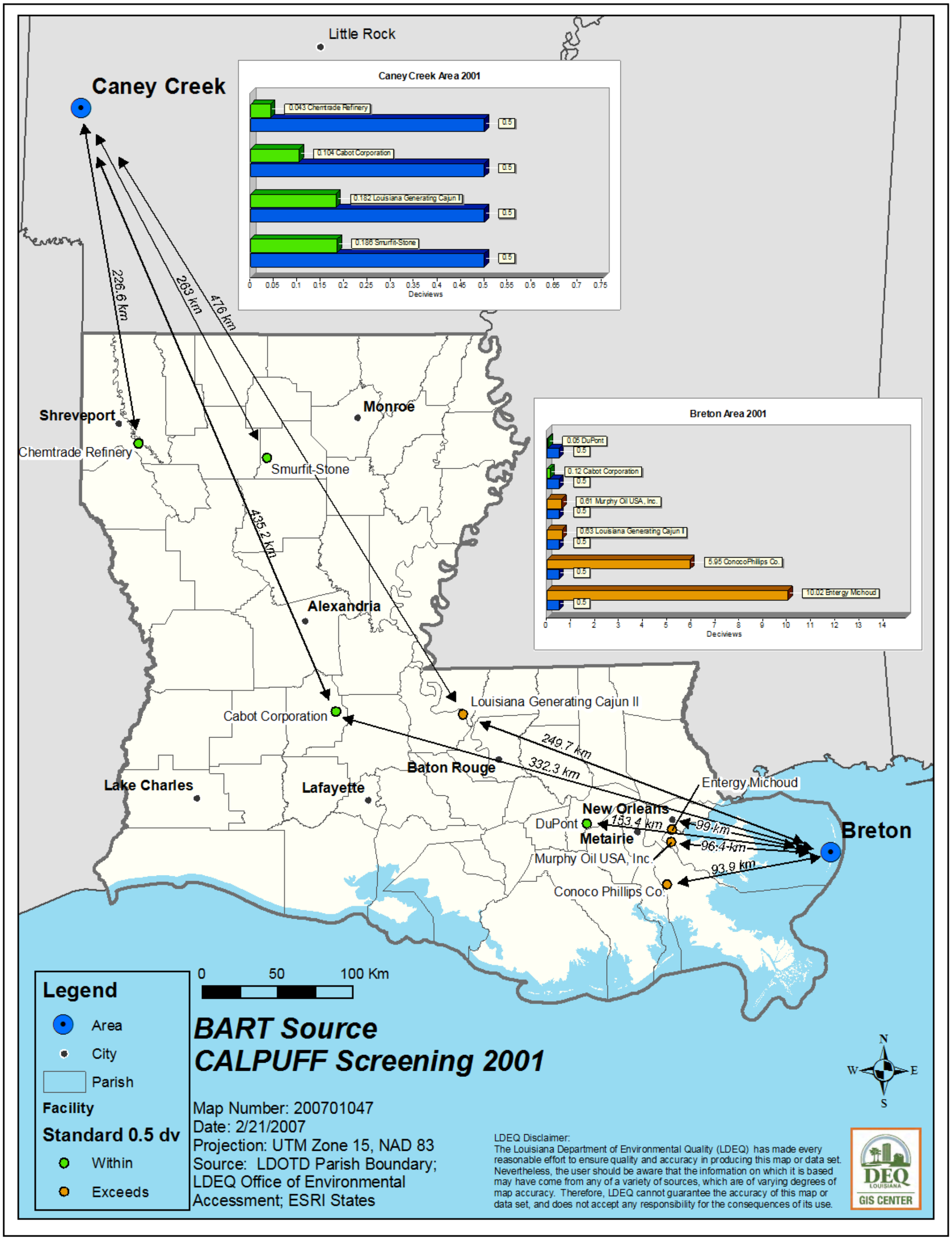


Figure 7-2. BART Source Screening Modeling 2002

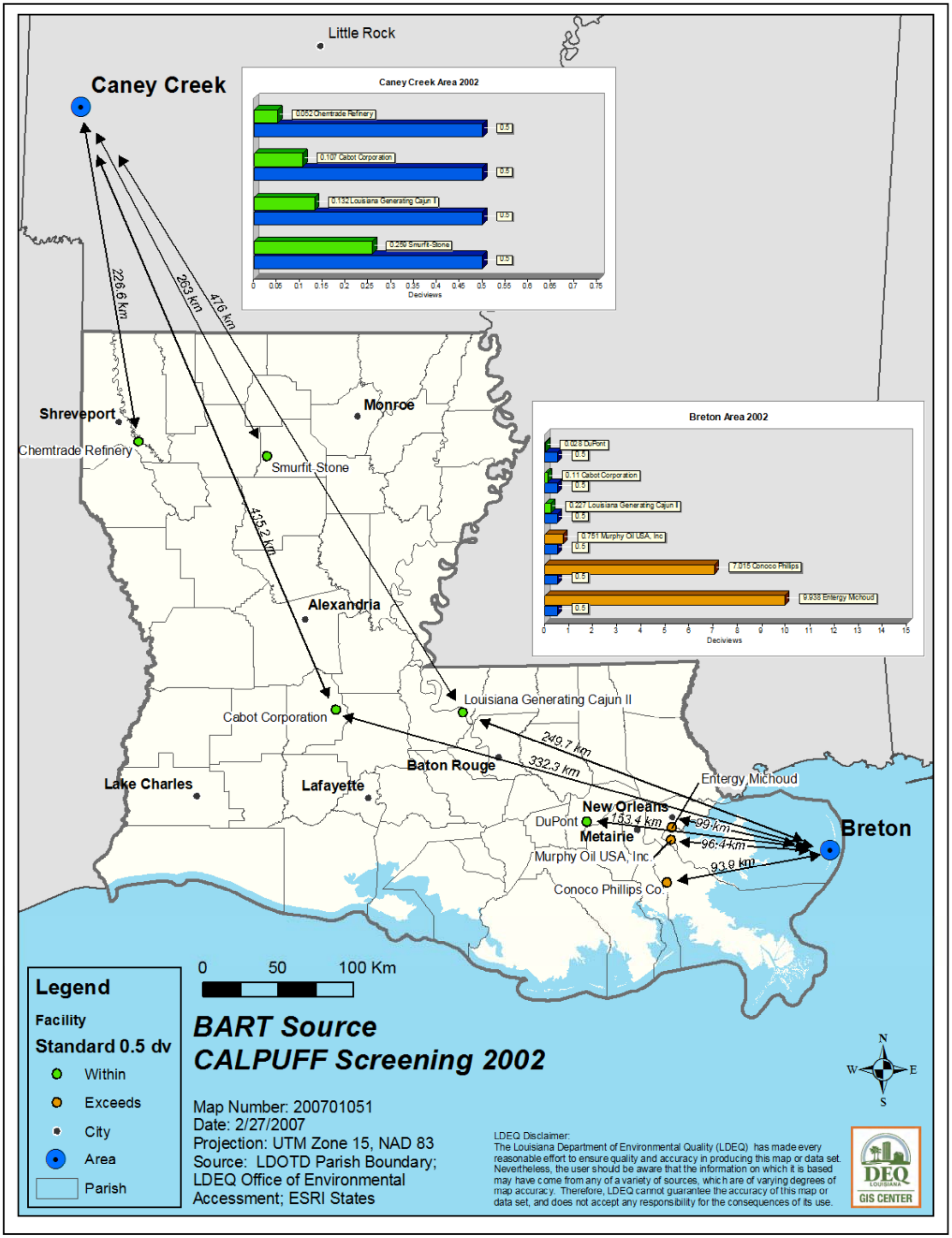


Figure 7-3. BART Source Screening Modeling 2003.