Chemical Lime
A Lhoist Group Company

September 21, 2007

Ms. Nancy Wrona
Director, Air Quality Division
Arizona Department of Environmental Quality
1110 W. Washington St.
Phoenix, Arizona 85007

RE: ***Chemical Lime Company***
Nelson, Arizona Facility
BART Applicability Modeling Analysis

Dear Ms. Wrona:

Chemical Lime Company (CLC) is submitting the enclosed Best Available Retrofit Technology (BART) Applicability Modeling Analysis in response to your letter dated July 13, 2007, requesting a response to the initial determination that the kilns at the CLC Nelson Facility are potentially subject to BART. In accordance with "Option C" described in the letter, CLC is providing the enclosed modeling report to demonstrate that the BART-eligible emission units at the CLC Nelson Facility are not subject to BART.

Your letter requested that CLC submit a response to the Arizona Department of Environmental Quality (ADEQ) by September 14, 2007. In a telephone conversation on September 13, 2007, Mr. Eric Massey from ADEQ granted CLC an extension of one week to complete the analysis and respond to the ADEQ's request.

As described in the enclosed report, CLC performed a BART applicability modeling analysis of emissions of visibility-affecting constituents from BART-eligible emission units at the Nelson Facility. The results of the analysis indicate that the 3-year average of the 8^{th} highest visibility change is less than 0.5 dv in all Class I areas. The analysis demonstrates that the BART-eligible sources at the CLC Nelson Facility do not cause or contribute to visibility impairment in any Class I area. Therefore, the emission units at the CLC Nelson Facility are not subject to BART.

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CLC would greatly appreciate concurrence from the ADEQ on this determination. If you have any questions or require any clarification, please feel free to contact me at (480) 368-4239.

Sincerely,

CHEMICAL LIME COMPANY

Ed Barry

Ed Barry
Western Regional Environmental Manager

Enclosures

cc: Mr. Eric Massey, ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
Mr. Leonard Montenegro, ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY
Mr. Grant Smedley, TRINITY CONSULTANTS

167024

BART APPLICABILITY MODELING ANALYSIS

CHEMICAL LIME COMPANY ▪ NELSON, ARIZONA

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September 2007

PROJECT 070301.0037

Chemical Lime

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1. INTRODUCTION

Chemical Lime Company (CLC) owns and operates a lime manufacturing facility in Nelson, Arizona (Nelson Facility). The Nelson Facility is considered eligible to be regulated under the U.S. Environmental Protection Agency's (U.S. EPA) Best Available Retrofit Technology (BART) provisions of the Regional Haze Rule. This report describes the methodology utilized and results obtained in a CALPUFF modeling analysis performed to demonstrate that the CLC Nelson Facility does not cause or contribute to visibility impairment in any federal protected Class I area.

1.1 BEST AVAILABLE RETROFIT TECHNOLOGY RULE BACKGROUND

On July 1, 1999, the U.S. EPA published a final rule regarding Regional Haze Regulations and BART Determinations, known as the Regional Haze Rule (RHR). The objective of the RHR is to improve visibility in 156 specific areas across the United States, known as Class I areas. The Clean Air Act defines Class I areas as certain national parks (over 6000 acres), wilderness areas (over 5000 acres), national memorial parks (over 5000 acres), and international parks that were in existence prior to August 7, 1977.

1.1.1 DETERMINATION OF BART ELIGIBILITY

On July 6, 2005, the EPA published amendments to its 1999 RHR to include guidance for making source-specific Best Available Retrofit Technology (BART) determinations. The BART rule defines BART-eligible sources as sources that meet the following criteria:

(1) Have potential emissions of at least 250 tons per year of a visibility-impairing pollutant,
(2) Began operation between August 7, 1962 and August 7, 1977, and
(3) Are listed in one of the 26 source categories in the guidance.

Lime manufacturing plants are one of the listed source categories, and include operations that are considered to be part of major SIC code "32" – Stone, Clay, Glass, and Concrete Products. Kiln #1 and Kiln #2 at the CLC Nelson Facility have been determined to comprise the BART-eligible source because the units operate at a lime manufacturing plant, were in existence on August 7, 1977, and began operation after August 7, 1962, and have potential emissions of greater than 250 tpy of NO_X and SO_2. Specific information about the emission units that comprise the BART-eligible source is provided in Section 2 of this report.

1.1.2 SCREENING ASSESSMENT OF BART APPLICABILITY

A BART-eligible source is determined to be subject to BART if the source causes or contributes to visibility impairment at a federally protected Class I area. Per guidance from the Arizona Department of Environmental Quality (ADEQ):

> *"Arizona has chosen to consider a source that is responsible for a 1.0 or more deciview (dv) change relative to natural background conditions in a Class I area to "cause" visibility*

impairment. Arizona has also chosen to consider a source that is responsible for a 0.5 or greater dv change relative to natural background conditions in a Class I area to "contribute to" visibility impairment in a Class I area. Finally, Arizona has also chosen to compare the 3-year average of the 98th percentile of CALPUFF modeling results to the "contribution" threshold in order to determine which sources would be potentially subject to BART." [1]

This approach for evaluating visibility impairment is consistent with U.S. EPA BART guidelines.[2]

Visibility impairment is quantified using the light extinction coefficient (b_{ext}), which is expressed in terms of the haze index expressed in dv. The haze index (*HI*) is calculated as follows:

$$HI(\text{dv}) = 10 \ln\left(\frac{b_{ext}}{10}\right)$$

The impact of a BART-eligible source is determined by comparing the *HI* attributable to a source relative to estimated natural background conditions. The background extinction coefficient $b_{\text{ext,background}}$ is affected by various chemical species and the Rayleigh scattering phenomenon and can be calculated as shown in the following equation.

$$b_{ext,background}\left(\text{Mm}^{-1}\right) = b_{SO_4} + b_{NO_3} + b_{OC} + b_{Soil} + b_{Coarse} + b_{ap} + b_{Ray}$$

where,

$b_{SO_4} = 3[(\text{NH}_4)_2\text{SO}_4]f(RH)$ — $[(\text{NH}_4)_2\text{SO}_4]$ denotes the ammonium sulfate concentration

$b_{NO_3} = 3[\text{NH}_4\text{NO}_3]f(RH)$ — $[\text{NH}_4\text{NO}_3]$ denotes the ammonium nitrate concentration

$b_{OC} = 4[\text{OC}]$ — $[\text{OC}]$ denotes the concentration of organic carbon

$b_{Soil} = 1[\text{Soil}]$ — $[\text{Soil}]$ denotes the concentration of fine soils

$b_{Coarse} = 0.6[\text{Coarse Mass}]$ — $[\text{Coarse Mass}]$ denotes the concentration of coarse dusts

$b_{ap} = 10[\text{EC}]$ — $[\text{EC}]$ denotes the concentration of elemental carbon

$b_{Ray} = \text{Rayleigh Scattering}\left(10\ \text{Mm}^{-1}\ \text{by default}\right)$ — Rayleigh Scattering is scattering due to air molecules

$f(RH) = \text{Relative Humidity Function}$

$[\ ] = \text{Concentration in}\ \mu\text{g/m}^3$

Particulate species that affect visibility are emitted from anthropogenic sources and include coarse particulate matter (PMC), fine particulate matter (PMF), and elemental carbon (EC), as well as precursors to secondary organic aerosols (SOA) and fine particulate matter such as SO_2 and NO_X. The extinction coefficient due to emissions of visibility-affecting pollutants from a single BART-eligible source $b_{\text{ext,source}}$ is calculated using an air quality model. The extinction due to the BART-eligible source will be calculated as shown in the following equation.

$$b_{ext,source}\left(\text{Mm}^{-1}\right) = b_{SO_4} + b_{NO_3} + b_{PMC} + b_{PMF} + b_{SOA} + b_{EC} + b_{NO_2}$$

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1 Letter from Nancy Wrona, ADEQ, to Michael Stags, CLC Nelson, dated July 13, 2007.

2 40 CFR Part 51, Appendix Y, *Guidelines for BART Determinations Under the Regional Haze Rule*, July 6, 2005.

where,

$b_{SO_4} = 3[(NH_4)_2SO_4]f(RH)$ — $[(NH_4)_2SO_4]$ denotes the ammonium sulfate concentration

$b_{NO_3} = 3[NH_4NO_3]f(RH)$ — $[NH_4NO_3]$ denotes the ammonium nitrate concentration

$b_{SOA} = 4[SOA]$ — $[SOA]$ denotes the concentration of secondary organic aerosols

$b_{PMF} = 1[PMF]$ — $[PMF]$ denotes the concentration of fine PM

$b_{PMC} = 0.6[PMC]$ — $[PMC]$ denotes the concentration of coarse PM

$b_{EC} = 10[EC]$ — $[EC]$ denotes the concentration of elemental carbon

$b_{NO_2} = 0.33[NO_2]$ — $[NO_2]$ denotes the concentration of nitrogen dioxide

$f(RH)$ = Relative Humidity Function

$[\ ]$ = Concentration in $\mu g/m^3$

The change in the haze index, in deciviews, also referred to as "delta dv," based on the source and background light extinction is based on the following equation:

$$\Delta dv = 10 * \ln\left[\frac{b_{ext,\ background} + b_{ext,\ source}}{b_{ext,\ background}}\right]$$

1.1.3 Refined Assessment of BART Applicability

More recently, the Interagency Monitoring of Protected Visual Environments (IMPROVE) workgroup has proposed a more robust equation for calculating light extinction, as described in detail in a report entitled "Revised IMPROVE Algorithm for Estimating Light Extinction from Particle Speciation Data."[3] The updated algorithm, which has been approved by the IMPROVE Steering Committee and is currently undergoing peer review, provides a more refined calculation by including visibility impairment due to the following processes:

- Visibility impairment due to different sizes of sulfates, nitrates, and organic carbon
- Visibility impairment due to sea salt particles
- Distinct water growth curves (i.e., *f*(RH)) for small sulfates and nitrates, large sulfates and nitrates, and sea salt
- Elevation-dependent (hence Class I area dependent) Rayleigh scattering coefficient
- Visibility impairment due to gaseous nitrogen dioxide (NO_2)

[3] http://vista.cira.colostate.edu/IMPROVE/Publications/GrayLit/gray_literature.htm.

The revised IMPROVE light extinction algorithm takes the following form:

$$b_{ext} = \begin{array}{l} 2.2 f_S(RH)[\mathrm{NH_4(SO_4)_2}]_{\mathrm{Small}} + 4.8 f_L(RH)[\mathrm{NH_4(SO_4)_2}]_{\mathrm{Large}} + \\ 2.4 f_S(RH)[\mathrm{NH_4NO_3}]_{\mathrm{Small}} + 5.1 f_L(RH)[\mathrm{NH_4NO_3}]_{\mathrm{Large}} + \\ 2.8[\mathrm{OC}]_{\mathrm{Small}} + 6.1[\mathrm{OC}]_{\mathrm{Large}} + 10[\mathrm{EC}] + 1[\mathrm{PMF}] + 0.6[\mathrm{PMC}] + \\ 1.4 f_{SS}(RH)[\mathrm{Sea\ Salt}] + b_{\mathrm{Site-specific\ Rayleigh\ Scattering}} + 0.33[\mathrm{NO_2}] \end{array}$$

In this analysis, if the light extinction calculation performed using the screening approach in Section 1.1.2 indicates an exceedance of the contribution threshold in any Class I area, CLC implemented the revised IMPROVE algorithm as a refined approach for calculating light extinction.

1.1.4 WRAP PRELIMINARY DETERMINATION OF BART APPLICABILITY

In order to perform a preliminary assessment of BART applicability, ADEQ provided information on all potentially BART eligible emissions units to the Western Regional Air Partnership (WRAP) Regional Modeling Center. WRAP performed a screening CALPUFF modeling analysis as a preliminary evaluation of BART applicability for each BART eligible source. Based on the results of this analysis, sources that were determined to be potentially subject to BART were requested to pursue one of the following options in response to the potentially-subject-to-BART determination:[4]

1. Conduct a BART analysis
2. Demonstrate that the emissions units are not BART-eligible
3. Demonstrate that the emission units are not potentially-subject-to-BART

CLC is submitting this modeling analysis in response the request from the ADEQ as a demonstration that the BART-eligible emission units at the CLC Nelson Facility are not subject to BART, in accordance with Option #3 above. The approach presented in this report is consistent with guidance from the U.S. EPA BART guidelines, ADEQ guidance, and the WRAP screening modeling protocol.[5]

1.2 LOCATION OF SOURCES AND RELEVANT CLASS I AREAS

Class I areas are defined by the U.S. EPA as those areas of the nation that are of special natural, scenic, recreational, or historic interest to the public. Class I areas are designated by the Clean Air Act and have a separate set of standards from Class II/unclassified areas. Class I areas are managed by Federal Land Managers (FLMs).

There are nine Class I areas within 300 km of the CLC Nelson Facility. The distance and FLM for each Class I area is listed in Table 1-1. The Nelson Facility is shown in Figure 1-1.

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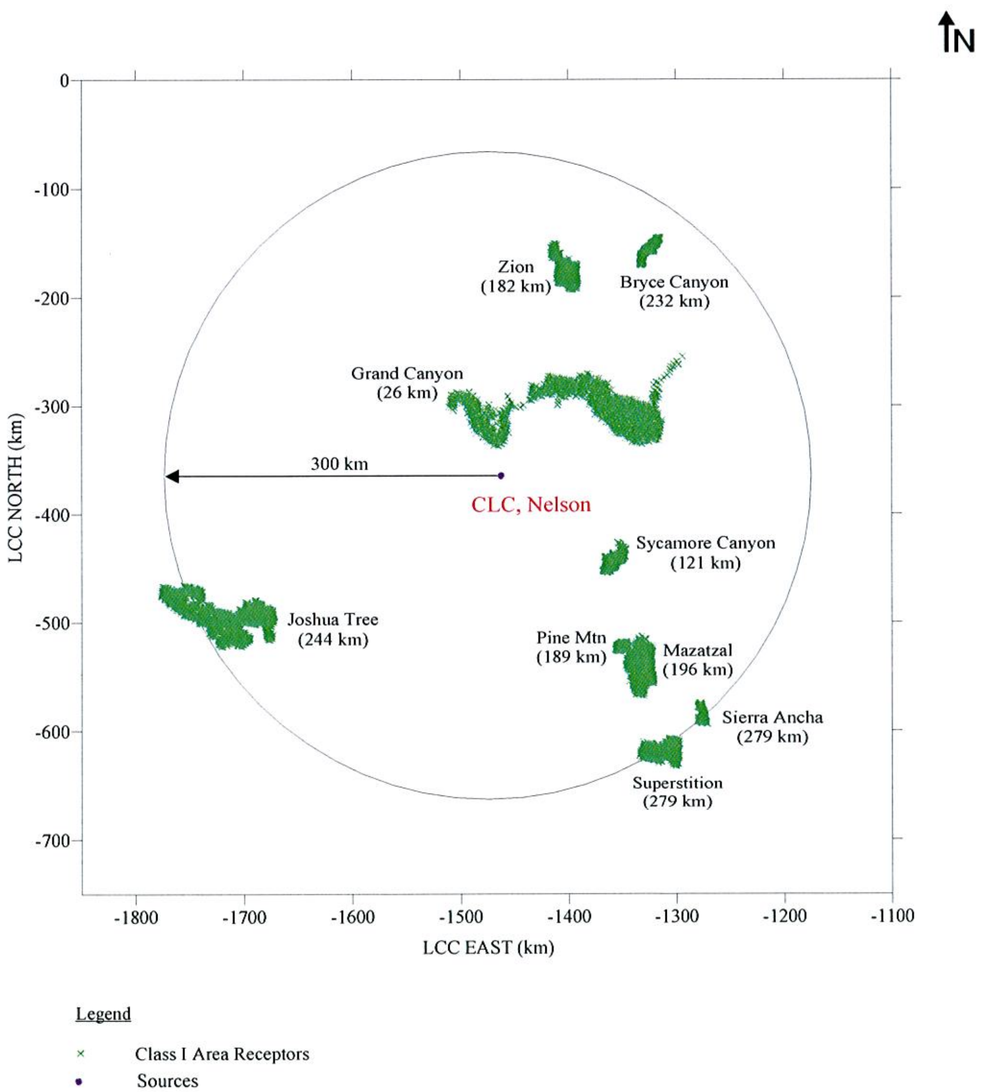
[4] Letter from Nancy Wrona, ADEQ, to Michael Stags, CLC Nelson, dated July 13, 2007.

[5] WRAP, *CALMET/CALPUFF Protocol for BART Exemption Screening Analysis for Class I Areas in the Western United States*, August 2006.

TABLE 1-1. CLASS I AREAS WITHIN 300 KM OF CLC NELSON FACILITY

Name	Minimum Distance to CLC (km)	Federal Land Manager
Grand Canyon National Park	26	NPS
Sycamore Canyon Wilderness	121	USFS
Zion National Park	182	NPS
Pine Mountain Wilderness	189	USFS
Mazatzal Wilderness	196	USFS
Bryce Canyon National Park	232	NPS
Joshua Tree National Monument	244	NPS
Sierra Ancha Wilderness	279	USFS
Superstition Wilderness	279	USFS

FIGURE 1-1. LOCATION OF CLC NELSON FACILITY RELATIVE TO CLASS I AREAS WITHIN 300 KM



1.3 CALPUFF MODELING ANALYSIS

As recommended by the U.S. EPA BART guidelines, ADEQ guidance, and the WRAP screening modeling protocol, the CALPUFF modeling system was used to compute the 24-hour average visibility impairment attributable to the CLC Nelson Facility for comparison with the 0.5 dv contribution threshold. CALPUFF is a refined air quality modeling system that is capable of simulating the dispersion, chemical transformation, and long-range transport of multiple visibility-affecting pollutant emissions from a single source and is therefore preferred for BART applicability and determination analyses. The CALPUFF modeling system is described in technical detail in the screening modeling protocol. [6]

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[6] WRAP, *CALMET/CALPUFF Protocol for BART Exemption Screening Analysis for Class I Areas in the Western United States*, August 2006.

2. EMISSION SOURCE DESCRIPTION

Whereas the BART eligibility determination relies on potential emissions of visibility-affecting pollutants including particulate matter (PM), sulfur dioxide (SO_2), and oxides of nitrogen (NO_X), the U.S. EPA BART guidelines specify that the emissions utilized in the BART applicability modeling analysis should be based on the following:

> "*the 24 hour average actual emission rate from the highest emitting day of the meteorological period modeled that is representative of steady-state operating conditions during periods of high capacity utilization.*" [7]

The ADEQ also specifically requested that *"this demonstration must include documentation of each unit's potential to emit."* [8] The WRAP screening modeling analysis utilized the potential to emit from the BART-eligible emission units at the CLC Nelson Facility, in the absence of more accurate emissions data determined in accordance with the U.S. EPA BART guidelines, as described above. In this report, for the purpose of determining appropriate emissions for use in the BART applicability modeling analysis, CLC has reviewed representative emissions and production data to determine the maximum actual emissions in accordance with the U.S. EPA BART guidelines.

The following sections provide a description of the methodology used to determine the maximum actual emission rates, as well as the stack parameters used in the CALPUFF modeling analysis.

2.1 BART ELIGIBLE EMISSION SOURCE

There are two kilns in operation at the CLC Nelson Facility:

- Kiln #1
- Kiln #2

Kiln #1 and Kiln #2 at the CLC Nelson Facility have been determined to comprise the BART-eligible source because the units operate at a lime manufacturing plant, were in existence on August 7, 1977, and began operation after August 7, 1962, and have potential emissions of greater than 250 tpy of NO_X and SO_2.

2.2 EMISSION CALCULATION METHODOLOGY

2.2.1 NO_x, SO_2, AND PM EMISSION CALCULATIONS

Emission rates of NO_x, SO_2, and PM for the BART applicability modeling analysis were calculated based on the maximum production rates achieved by each kiln during the meteorological period

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[7] 40 CFR Part 51, Appendix Y, *Guidelines for BART Determinations Under the Regional Haze Rule*, July 6, 2005.

[8] Letter from Nancy Wrona, ADEQ, to Michael Stags, CLC Nelson, dated July 13, 2007.

modeled, and representative emission factors from source testing performed at the Nelson Facility. The following equation was used to calculate emissions for each constituent, from each kiln:

$$\text{Emissions}\left(\frac{\text{lb}}{\text{hr}}\right) = \text{Emission Factor}\left(\frac{\text{lb constituent}}{\text{ton lime}}\right) \text{x Max Daily Production Rate}\left(\frac{\text{ton lime}}{\text{day}}\right) \text{ x } \frac{1\text{ day}}{24\text{ hours}}$$

The production rates, emission factors, calculated emissions, and detailed sample calculations, are provided in Appendix A.

2.2.2 PARTICULATE MATTER SPECIATION

Modeling of visibility impairment requires that the PM components of the exhaust stream be speciated because different types of PM affect visibility to varying extents. The amount by which a mass of a certain species scatters or absorbs light is termed the *extinction efficiency* or *extinction coefficient*, and dry values range from 0.6 m^2/g for coarse PM to 10 m^2/g for elemental carbon. Fine PM (1 m^2/g) and organic aerosols (4 m^2/g) scatter light with intermediate efficiencies, and ammonium sulfate and ammonium nitrate (that form from precursor SO_2 and NO_X emissions in the presence of ambient ammonia) are hygroscopic species that are particularly efficient light scatters in the presence of ambient water vapor [$3f(RH)$ m^2/g, where $f(RH)$ is a function of the relative humidity]. The size distribution of particle species is also important, since smaller particles may be transported longer distances than larger particles and dispersed differently under prevailing ambient conditions. Table 2-1 provides definitions for the nomenclature used herein for speciated PM data.

TABLE 2-1. NOMENCLATURE FOR PM SPECIATION ANALYSIS

Nomenclature	Description
PM_{10}	Filterable particulate matter with an aerodynamic diameter < 10 μm
$PM_{6\text{-}10}$	Filterable particulate matter with an aerodynamic diameter > 6 and < 10 μm
$PM_{2.5\text{-}6}$	Filterable particulate matter with an aerodynamic diameter > 2.5 and < 6 μm
$PM_{2.5}$	Filterable particulate matter with an aerodynamic diameter < 2.5 μm
EC	Elemental carbon
CPM	Condensable particulate matter (organic and inorganic)
SO4	Primary sulfate
POC	Primary organic condensable emissions
TPM_{10}	Filterable PM_{10} + CPM

The emission rates of each of these particulate phases and size categories are modeled in CALPUFF and grouped according to visibility affecting characteristics. Elemental carbon (EC), if emitted, typically results from unburned carbonaceous fuel and is distinguished from other PM types because of its light extinction characteristics. Coarse PM (PMC) comprises $PM_{2.5\text{-}6}$ and $PM_{6\text{-}10}$. Fine PM (PMF) includes $PM_{2.5}$. Condensable particulate matter (CPM) is comprised of both organic and inorganic species. The organic fraction of CPM is represented in CALPUFF as primary organic condensable (POC) emissions, which are direct emissions but are sometimes referred to as secondary organic aerosols (SOA) by convention and due to the representation of their visibility-affecting characteristics in the light extinction equation. Primary emissions of inorganic CPM may contain hygroscopic sulfates (SO_4) and nitrates (NO_3), as well as other salts (e.g., carbonates) that may be hygroscopic to a lesser degree, and hence are considered in a manner similar to PMF (i.e., as soil) in terms of light extinction.[9] Therefore, it can be important to distinguish inorganic CPM since certain hygroscopic species (i.e., sulfate and nitrate species) will have a greater extinction coefficient than non-hygroscopic (i.e., non-sulfate and non-nitrate) species. However, in this analysis, as a screening approach, it is conservatively assumed that all inorganic CPM is sulfates.

Table 2-2 summarizes the grouping of PM species and extinction coefficient of each component.

TABLE 2-2. ASSIGNMENT OF EMITTED PM SPECIES TO MODELED PM CATEGORIES

Modeled PM Category[1]	Components	Output Category[2]	Extinction Coefficient (m^2/g)
PMC	Filterable coarse particles (PM_{6-10}, $PM_{2.5-6}$)	PMC	0.6
PMF	Filterable fine particles ($PM_{2.5}$)	SOIL	1
SO_4	Primary inorganic condensable emissions of sulfates	SO_4	$3f(RH)$
POC	Primary organic condensable emissions	SOA	4
EC	Uncombusted carbonaceous fuel	EC	10

1 Modeled PM Category denotes the input of emissions data into CALPUFF.
2 Output Category denotes the assignment of modeled emissions in POSTUTIL for the visibility calculations in CALPOST.

Since few facilities have the necessary data to accurately quantify speciated PM emissions from lime kilns, the National Park Service (NPS) and the National Lime Association (NLA) prepared a PM emissions speciation template that uses filterable or total PM emissions from kilns to estimate CPM, SO_4, and EC, and to speciate filterable PM into three size bins (10-6 μm, 6-2.5 μm, and less than 2.5 μm) for different types of kilns and control devices.[10] These speciation templates are based on AP-42 Section 11.17 and additional data developed by Air Control Technologies under contract to NLA.

CLC used the NPS/NLA speciation profiles to quantify speciated PM emissions for the CALPUFF modeling analysis. Since both kilns at the Nelson Facility are equipped with fabric filters, the following PM speciation schemes were used for the kilns at the CLC Nelson Facilty:

- Nelson Kiln #1: Coal-fired rotary lime kilns with fabric filter
- Nelson Kiln #2: Coal-fired rotary lime kilns with fabric filter

Using the PM speciation profiles and the calculated maximum actual 24-hour average PM_{10} emission rates, the complete speciated emission profiles were determined. The speciated PM emissions are presented in Appendix A.

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9 The U.S. EPA's *Guidance for Tracking Progress under the Regional Haze Rule* identifies carbonates, magnesium oxides, and sodium oxides as components of the soil mass concentration when analyzed to assess natural background visibility (Malm 1994).

10 http://www2.nature.nps.gov/air/Permits/ect/ectLimeKiln.cfm.

2.3 MODELED STACK PARAMETERS

Actual stack parameters for Kiln #1 and Kiln #2 were input to the CALPUFF model to represent the point of visibility-affecting pollutant emissions. The stack parameters used in this analysis are the same as those that were modeled by WRAP in the BART CALPUFF screening modeling analysis. The stack parameters are listed in Table 2-3.

TABLE 2-3. STACK PARAMETERS FOR KILNS 1 AND 2 AT CLC NELSON FACILITY

	Stack Location			Stack	Stack	Exit	
Source ID	LCC East (km)	LCC North (km)	Elevation (m)	Height (m)	Diameter (m)	Velocity (m/s)	Exit Temperature (K)
Kiln #1	-1462.800	-364.127	1570.3	42.7	3.05	11.55	510.4
Kiln #2	-1462.800	-364.127	1570.3	43.0	3.05	14.69	488.7

This section presents a brief overview of the approach used in the BART applicability modeling analysis. In general, unless stated otherwise, CLC utilized an approach that is consistent with the WRAP screening modeling protocol for the BART applicability modeling analysis presented in this report.

3.1 MODEL SELECTION

As recommended by the U.S. EPA BART guidelines, ADEQ guidance, and the WRAP screening modeling protocol, the CALPUFF modeling system was used to compute the 24-hour average visibility impairment attributable to the CLC Nelson Facility for comparison with the 0.5 dv contribution threshold. CALPUFF is a sophisticated air quality modeling system that is capable of simulating the dispersion, chemical transformation, and long-range transport of multiple visibility-affecting pollutants and is therefore preferred for the BART applicability and determination analyses.

It should be noted that the CALPUFF model is generally intended for use on scales from 50 km to several hundred kilometers away from a source. In this analysis, the Grand Canyon Class I area is less than 50 km from the source. Per ADEQ guidance:

> *"In specific situations where the distance from the emission point to a Class I area was less than 50 kilometers, Arizona has exercised its discretion, and has determined that it will accept the CALPUFF modeling results for any Class I area that is greater than 10 kilometers from the emission point. Arizona also recognizes that CALPUFF's results have limited value at distances greater than 300 km, and has only considered modeling results that occur within the 10 to 300 kilometer distance from the emission point."* [11]

Therefore, in accordance with the above guidance, the modeling in this report was performed using CALPUFF for all Class I areas within 300 km of the Nelson Facility BART-eligible emission units.

In accordance with the modeling analysis performed by WRAP, modeling for the CLC Nelson Facility was performed using the versions of the modeling programs listed in Table 3-1.

TABLE 3-1. MODEL VERSIONS

Processor	Description	Version	Level
CALMET	Meteorological data processor used by WRAP	6.211	060414
CALPUFF	Plume dispersion model	6.112	060412
POSTUTIL	Post-processing utility	1.52	060412
CALPOST	Post-processing utility for visibility impact	6.131	060410

[11] Letter from Nancy Wrona, ADEQ, to Michael Stags, CLC Nelson, dated July 13, 2007.

3.2 RECOMPILATION OF CALPUFF MODELING PROGRAMS

Due to the large number of grid cells, the number of mesoscale model files, and other parameters selected by WRAP for the CALMET meteorological domain, it was necessary to recompile the CALMET, CALPUFF, and CALPOST programs for use in the BART modeling.

The following steps were performed to recompile the programs:

1. Downloaded the source code files for the related program from the TRC website: http://www.src.com/calpuff/download/epa_codes.htm.

2. Modified certain parameter values in the params file (typically based on the "Large" version provided in the downloaded file). The names of these files are "params.met" for CALMET, "params.puf" for CALPUFF, and "params.pst" for CALPOST. All the parameters listed in the params files are typically used to define the maximum dimensions to be allowed for the parameter arrays used in the source code. For example, in the BART analysis, the maximum number of gridded receptors along "x" and "y" directions in the params files were adjusted to 500. This was necessary because the WRAP modeling domain for Arizona is 288 grid cells in the "x" direction and 225 grid cells in the "y" direction, which exceeds the values used in the executables posted on the website.

3. Recompiled the program using the Lahey 95 Fortran compiler. The compiling options are also identical to those prescribed in the downloaded compiling batch file.

The change in the parameter values described in Step #2 above will not affect any scientific algorithms in the source code, and therefore the modeling results will not be affected by any changes in the params files. The parameters are used for initiating the array size and the required computer memory for the program. If a parameter value is not sufficiently large, a run will be stopped and no results would be generated.

3.3 MODELING DOMAIN

The domain utilized in this modeling analysis is the same as the domain used in the WRAP BART CALPUFF modeling. The map projection for the modeling domain is in Lambert Conformal Conic (LCC) and the datum is NWS-84. The reference point for the modeling domain is Latitude 40°N, Longitude 97°W (LCC point 0, 0). The meteorological grid spacing is 4 km, resulting in 288 grid cells in the X direction and 225 grid cells in the Y direction. There are 11 vertical layers.

3.4 CALMET

The CALMET input files located on the WRAP RMC website were used in this modeling analysis. [12] The CALMET input files available from WRAP include geophysical data (including terrain and land use) and Mesoscale Model Meteorological data. WRAP developed three 4-km CALMET

[12] http://pah.cert.ucr.edu/aqm/308/bart.shtml.

meteorological datasets for three years (2001-2003) to span across all potential BART eligible sources within the southern WRAP states.

During the preliminary CALMET simulations, several CALMET meteorological days corresponding to the mesoscale model files provided on WRAP's database ran unsuccessfully. The error information is provided below:

> *"In ALOG(x) or LOG(x) or ALOG10(x) or LOG10(x) or ALOG2(x) or LOG2, X.LE.0.0 (x=0.0000e+00)"*

Internal debugging indicated that the error occurred due to the fact that the surface relative humidity (RH) values at some CALMET cells were zero. These days include:

- Jan 7, 2001
- Jan 19, 2001
- Jan 10, 2002
- Jan 23, 2002
- Mar 2, 2002
- Mar 4, 2002
- Aug 24, 2002
- Nov 14, 2002
- Nov 19, 2002
- Jan 15, 2003
- Oct 25, 2003
- Dec 14, 2003
- Dec 17, 2003
- Dec 18, 2003

To overcome the error, the surface station data recorded in the "surf.dat" file downloaded from the WRAP database was used as the source of the RH values for these 14 days. To enable this option in CALMET, IRHPROG was set to zero in the input files for these 14 days only. For all remaining days, IRHPROG was set to one in accordance with the approach used in the WRAP files, which uses the mesoscale data as the source of the RH values. The use of an IRHPROG value of zero is consistent with the most recently U.S. EPA approved version of CALMET (version 5.8), in which the variable is automatically assigned a value of zero as a default. Following the change in this variable to a value of zero for the 14 days noted above, CALMET ran successfully for all 14 days.

The output files from CALMET were used, along with the other WRAP output files, as input to the CALPUFF modeling analysis. The electronic CALMET input files used in the modeling analysis for the CLC Nelson Facility are included with this report. A list of the files is included in Appendix B.

3.5 CALPUFF

The CALPUFF model uses the meteorological data from CALMET together with the emission source, receptor, and chemical reaction information to predict hourly concentrations of modeled species. Similar to the CALMET simulation, the CALPUFF input files for 2001 were downloaded from the WRAP website and used as the template to populate the CLC Nelson facility BART modeling input files generated in this analysis.

WRAP executed daily CALPUFF runs, with the variable MRESTART set to one so that information for all puffs within the CALPUFF domain are saved to one file to initialize a continuation run. In the modeling analysis presented in this report, CALPUFF was executed for the complete years (2001, 2002, and 2003). To handle this update, all CALMET output files are referenced in CALPUFF sequentially for an entire year. This approach does not affect the CALPUFF simulation or the modeling results obtained.

The electronic CALPUFF input and output files generated in the modeling analysis for the CLC Nelson Facility are included with this report. A list of the files is included in Appendix B.

3.6 POSTPROCESSING

Using the hourly concentrations of visibility-affecting pollutants computed by CALPUFF, two postprocessors, POSTUTIL and CALPOST, were used to compute light extinction attributable to the CLC Nelson Facility. The CALPOST input files for 2001 were downloaded from the WRAP website and used as the template to generate and populate the CALPOST input files for this analysis. [13]

3.6.1 POSTUTIL

The first postprocessing step involves running POSTUTIL to calculate the concentrations of visibility-affecting species, as described in Section 2 of this report. Specifically, POSTUTIL is executed to group modeled species into visibility-affecting pollutant categories, as shown in Table 3-2.

TABLE 3-2. ASSIGNMENT OF MODELED PM SPECIES TO LIGHT EXTINCTION GROUPS IN POSTUTIL

Modeled Components	CALPOST Light Extinction Group	Extinction Coefficient (m^2/g)
PMC800 PMC425	PMC	0.6
PMF	SOIL	1
POC	SOA	4
SO_4	SO_4	$3f(RH)$
EC	EC	10

[13] http://pah.cert.ucr.edu/aqm/308/bart.shtml.

The electronic POSTUTIL input and output files generated in the modeling analysis for the CLC Nelson Facility are included with this report. A list of the files is included in Appendix B.

3.6.2 CALPOST

CALPOST uses the concentration values from POSTUTIL to calculate light extinction attributable to the CLC Nelson Facility and the natural background. The equations presented in Section 1 of this report are used to perform the light extinction calculations.

In accordance with U.S. EPA BART guidance, and the WRAP modeling protocol, the CALPOST Method 6 option was selected in this analysis. Method 6 calculates hourly light extinction impacts from the source and background using monthly average relative humidity adjustment factors. Monthly Class I area-specific relative humidity adjustment factors based on the centroid of the Class I areas from U.S. EPA guidance will be used. [14]

In CALPOST, the light extinction attributable to the source is calculated by first using the hygroscopic components of the source-caused concentrations, due to ammonium sulfate and nitrate, and monthly Class I area-specific relative humidity values. The contribution to the total source-caused extinction from ammonium sulfate and nitrate is then added to the other, non-hygroscopic components of the particulate concentration (from coarse and fine soil, secondary organic aerosols, and from elemental carbon) to yield the total hourly source-caused extinction.

The electronic CALPOST input and output files generated in the modeling analysis for the CLC Nelson Facility are included with this report. A list of the files is included in Appendix B.

3.7 NATURAL BACKGROUND CONDITIONS

The visibility goal of the Clean Air Act is both the remedying of existing visibility impairment and prevention of future visibility impairment. In the BART implementation guidance, U.S. EPA affirms that it interprets the goal to mean return atmospheric conditions to "natural visibility conditions." For the purposes of BART analyses, the U.S. EPA has determined that it

> *"did not intend to limit States to the use of the 20% best visibility days...States may use 20% best visibility days or annual average" to assess BART applicability."* [15]

In accordance with the methodology used by WRAP in generating the screening modeling results, CLC calculated visibility change in this analysis based on the annual average natural background

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[14] U.S. EPA, *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule*, Table A-3, Attachment A, September 2003, EPA-454/B-03-005.

[15] U.S. EPA Memorandum from Mr. Joseph Paisie to Ms. Kay Prince, as Attachment A to a proposed settlement agreement between the Utility Air Regulatory Group and U.S. EPA, published at 71 Federal Register No. 84, pp. 25,838-25,840, May 2, 2006.

conditions.[16] The parameters used to calculate natural background light extinction on an annual average basis were obtained from U.S. EPA guidance.[17]

3.8 Screening Assessment of BART Applicability

The WRAP modeling protocol represents a screening application of the CALPUFF model for the purposes of BART applicability assessments. As the name of this technique implies, a screening analysis is intended to provide a conservative estimate of visibility impacts using computationally efficient techniques. A refined analysis utilizes less conservative and more representative data and modeling methods to compute visibility impacts following appropriate guidelines. Screening analyses may be used to determine that a facility is not subject to BART using a conservative assessment.

As a preliminary screening step in this analysis, CLC utilized input data and modeling assumptions consistent with the WRAP screening modeling, with the revised emissions data presented in Section 2 of this report. Per guidance from the ADEQ:

> *"Arizona has chosen to consider a source that is responsible for a 1.0 or more deciview (dv) change relative to natural background conditions in a Class I area to "cause" visibility impairment. Arizona has also chosen to consider a source that is responsible for a 0.5 or greater dv change relative to natural background conditions in a Class I area to "contribute to" visibility impairment in a Class I area. Finally, Arizona has also chosen to compare the 3-year average of the 98th percentile of CALPUFF modeling results to the "contribution" threshold in order to determine which sources would be potentially subject to BART."* [18]

In accordance with the above approach, and the calculation methodology used by WRAP, the 8th highest visibility impact was calculated for each year of the meteorological period modeled (2001-2003) as a surrogate for the 98th percentile visibility change. The 3-year average of the 8th highest impact was compared to the contribution threshold of 0.5 dv as a preliminary assessment of BART applicability.

For Class I areas in which visibility impairment was predicted to be less than the 0.5 dv threshold, the demonstration was deemed to be complete and no additional analysis was preformed. For any areas in which the screening modeling indicated impacts in excess of the 0.5 dv threshold, a refined approach for calculating light extinction was considered, as described in the following section.

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[16] WRAP, *Summary of WRAP RMC BART Modeling for Arizona*, Draft #5, May 2007.

[17] U.S. EPA, *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule*, Table 2-1, Attachment A, September 2003, EPA-454/B-03-005.

[18] Letter from Nancy Wrona, ADEQ, to Michael Stags, CLC Nelson, dated July 13, 2007.

3.9 Refined Assessment of BART Applicability

If the light extinction calculation performed using the screening approach described in the previous section indicates an exceedance of the contribution threshold in any Class I area, CLC implemented the revised IMPROVE algorithm as a refined approach for calculating light extinction in this analysis.

To facilitate the use of the revised IMPROVE algorithm for assessing BART applicability, a spreadsheet processing tool was developed and distributed by the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) Technical Advisor for BART modeling projects performed in the Southeastern United States. The spreadsheet processing tool implements the revised IMPROVE light extinction algorithm, designated as the CALPOST-IMPROVE Processor Version 2 (September 29, 2006). This processor calculates the reconstructed light extinction using the revised IMPROVE algorithm and output from the current version of the CALPOST postprocessor.

In this analysis, CLC utilized the spreadsheet tool developed by VISTAS as a refined approach to calculating light extinction. To implement the CALPOST-IMPROVE Processor, three additional data points are required: background concentration of gaseous NO_2, Rayleigh scattering parameter corrected for site-specific elevation, and an estimate of the average background sea salt aerosol concentration. The following specific inputs to the tool were used:

- Elevation-dependent Rayleigh scattering coefficient and sea salt background concentration determined from the Visibility Information Exchange Web System (VIEWS) for the Class I area[19]
- 24-hour average NO_2 concentration at each receptor attributable to BART-eligible sources at the CLC Nelson Facility as calculated by an additional CALPOST analysis

The 24-hour average NO_2 concentration for each day and receptor was calculated by separate CALPOST processing analyses, and converted from units of micrograms per cubic meter ($\mu g/m^3$) to parts per billion as required by the tool. The NO_2 concentration entered into the CALPOST-IMPROVE Processor for each 24-hour average visibility impacts corresponds to the specific day and receptor at which the modeled visibility impact occurs. The NO_2/NO_X ratio was conservatively entered as 1.0 in the CALPOST-IMPROVE Processor.

It should also be noted that the natural background concentrations for the Eastern United States were updated for the Western United States before applying the VISTAS spreadsheet tool.

Appendix C of this report contains the calculation tables generated by the CALPOST-IMPROVE calculation tool. The electronic versions of the spreadsheets, as well as the input and output files used to generate the NO_x concentration data, are also included with this report. A list of the files is included in Appendix B.

[19] http://vista.cira.colostate.edu/views.

This section presents the results obtained in the BART applicability modeling analysis. As described in Section 3, a screening analysis was performed as an initial step, and based on the results of the screening analysis, refined modeling was performed as needed. The screening and refined modeling results are summarized in the sections that follow.

4.1 SCREENING MODELING RESULTS

Screening analyses of visibility impacts attributable to the CLC Nelson Facility were conducted to determine whether the facility is subject to BART using a conservative assessment, and to focus the scope of refined analyses by demonstrating that visibility impairment is not likely to occur at more distant Class I areas. The screening analyses were conducted using the emissions data represented in Section 2, the screening CALMET and CALPUFF methods described in Section 3, and the screening postprocessing methods specified in Section 3 of this report.

Table 4-1 summarizes the 8th highest 24-hour average visibility impacts at each of the Class I areas identified in Table 1-1 attributable to the CLC Nelson Facility.

TABLE 4-1. SCREENING MODELING RESULTS

		98th percentile (8th highest) Visibility Change (dv)			
ID	**Name of Class I area**	**2001**	**2002**	**2003**	**Average**
grca	Grand Canyon NP	0.452	0.419	0.624	0.498
syca	Sycamore Canyon WA	0.096	0.114	0.158	0.123
zion	Zion NP	0.163	0.096	0.149	0.136
pimo	Pine Mountain Wilderness	0.076	0.065	0.076	0.072
maza	Mazatzal Wilderness	0.085	0.061	0.072	0.073
brca	Bryce Canyon NP	0.080	0.053	0.089	0.074
jotr	Joshua Tree NM	0.154	0.097	0.072	0.108
sian	Sierra Ancha Wilderness	0.044	0.048	0.054	0.049
supe	Superstition Wilderness	0.052	0.049	0.060	0.054

As can be seen in the table, the 3-year average of the 8th highest visibility changes attributable to the CLC Nelson Facility is less than 0.5 dv in all Class I areas. Therefore, the modeling anlaysis demonstrates that the CLC Nelson Facility does not contribute to visibility impairment in any Class I area.

Given that the 3-year average of the 8th highest visibility changes in the Grand Canyon National Park is close to the 0.5 dv threshold, a refined analysis was considered for this Class I area to demonstrate that the visibility impacts are less than 0.5 dv.

4.2 Refined Modeling Results

Although the maximum visibility change obtained in the screening modeling analysis is not equal to or greater than the 0.5 dv contribution threshold, a refined analysis was performed in which light extinction in the Grand Canyon National Park was calculated using the CALPOST-IMPROVE implementation of the revised light extinction algorithm described in Section 1 of this report.

A Rayleigh scattering value of 9 M/m and a sea salt background value of 0.01 μg/m^3 was used, as obtained from VIEWS, for the Hance Camp at Grand Canyon National Park monitoring station.[20]

Table 4-2 summarizes the 8th highest 24-hour average visibility impacts at Grand Canyon attributable to the CLC Nelson Facility using refined calculation method, as computed using CALPOST output and the new IMPROVE equation.

Table 4-2. Refined Modeling Results for the Grand Canyon National Park

		98th percentile (8th highest) Visibility Change (dv)			
ID	**Name of Class I area**	**2001**	**2002**	**2003**	**Average**
grca	Grand Canyon NP	0.417	0.379	0.585	0.460

As can be seen in the table, the visibility change attributable to the CLC Nelson Facility in the Grand Canyon National Park is less than 0.5 dv. Therefore, the CLC Nelson Facility does not contribute to visibility impairment in the Grand Canyon National Park.

[20] http://vista.cira.colostate.edu/views.

5. CONCLUSIONS

Using analysis methods prescribed by the U.S. EPA, WRAP, and the ADEQ, CLC performed a BART applicability modeling analysis of emissions of visibility-affecting constituents from BART-eligible emission units at the Nelson Facility. The results of the analysis indicate that the 3-year average of the 8th highest visibility change is less than 0.5 dv in all Class I areas. The analysis demonstrates that the BART-eligible sources at the CLC Nelson Facility do not contribute to visibility impairment in any Class I area. Therefore, the BART-eligible sources (Kiln #1 and Kiln #2) at the CLC Nelson Facility are not subject to BART.

CLC reserves the right to revise the applicability analyses and determinations described in this report if new methods are approved for regulatory use by the U.S. EPA and ADEQ.

APPENDIX A

EMISSION CALCULATIONS

PROPOSED EMISSIONS FOR BART CALPUFF MODELING
Chemical Lime Company - Nelson, Arizona

Table A-1. Maximum Daily Production Rates [1]

	Nelson Kiln 1 (tons/day)	**Nelson Kiln 2 (tons/day)**
Maximum Lime Production Rate	859	1,145

[1] Based on records from the meteorological period modeled (2001-2003).

Table A-2. Emission Factors [1]

Constituent	**Nelson Kiln 1 (lb/ton)**	**Nelson Kiln 2 (lb/ton)**
NO_x	2.66	2.08
SO_2	3.29	7.87
PM_{10}	0.0423	0.0702

[1] Based on recent source test data.

Table A-3. Modeled Emissions [1]

Constituent	**Nelson Kiln 1 (lb/hr)**	**Nelson Kiln 2 (lb/hr)**
NO_x	95	99
SO_2	118	375
PM_{10}	1.51	3.35

[1] PM emisisons are modeled in CALPUFF as speciated components based on speciation profiles developed by the National Lime Association, as shown in Table A-4.

Sample Calculation:

NO_x Emissions from Kiln #1:

$$\frac{859 \text{ tons}}{\text{day}} \left| \frac{2.66 \text{ lb}}{\text{ton}} \right| \frac{24 \text{ hrs}}{\text{day}} = \frac{95 \text{ lb}}{\text{hr}}$$

Table A-4. Speciated PM Emissions

Nomenclature	Modeled Category	Emission Rate Kiln 1 (lb/hr)	Emission Rate Kiln 2 (lb/hr)	Reference
Total Particulate				
TPM_{10}	--	1.89	4.17	NLA - filterable is 80.3% of total particulate
Filterable Emissions				
PM_{10}	--	1.51	3.35	From emissions data obtained from source testing in Table A-3 [1]
PM_{6-10}	PMC	0.385	0.852	NLA - 50.9% of filterable PM_{10} is PMC
$PM_{2.5-6}$	PMC	0.385	0.852	NLA - 50.9% of filterable PM_{10} is PMC
$PM_{2.5}$	--	0.74	1.64	NLA - 49.1% of filterable PM_{10} is filterable $PM_{2.5}$
EC	EC	0.028	0.061	NLA - 3.7% of filterable $PM_{2.5}$
PMF (non-EC)	PMF	0.72	1.58	$PM_{2.5}$ - EC
Condensable Emissions				
CPM	--	0.37	0.82	TPM_{10} - PM_{10}
POC	POC	0.0089	0.0197	NLA - POC is 2.4% of condensable
SO_4	SO_4	0.363	0.802	Conservatively set equal to all non-POC condensable emissions

[1] All PM measured in source test is conservatively assumed to be filterable PM_{10}.

Table A-5. Modeled Emission Rates

Constituent	Nelson Kiln 1 (g/s)	Nelson Kiln 2 (g/s)
SO_2	14.84	47.31
SO_4	0.046	0.102
NO_x	12.00	12.50
HNO_3	0.00	0.00
NO_3	0.00	0.00
Organic Condensable PM (0.5 – 1.0 mm)	0.0011	0.0025
Coarse Filterable PM (6 – 10 mm)	0.049	0.108
Coarse Filterable PM (2.5 – 6 mm)	0.049	0.108
Fine Filterable PM (1.25 – 2.5 mm)	0.09	0.20
Elemental Carbon (0.5 –0.625 mm)	0.0035	0.0077

APPENDIX B

ELECTRONIC FILE LIST

CALMET FILES

calmet_az_yyyymmdd.inp

yyyy denotes the met model year: 2001, 2002 and 2003
mm denotes data analysis month (ex. Jan=*01* , Feb=*02* , etc.)
dd denotes data analysis day

CALPUFF FILES

CLC*yyyy* Calpuff.inp
src09_az_*YY*.lst

yyyy denotes the met model year: 2001, 2002 and 2003
YY denotes the last two digitals of the met model year: 2001, 2002 and 2003
inp denotes CALPUFFinput files
lst denotes CALPUFF output summary files

Ozone Data Files

BART_Ozone_*yyyy*. dat
yyyy denotes data analysis years 2001, 2002, and 2003

POSTUTIL FILES

2001.PU.VIS.PM.*fff*
2002.PU.VIS.PM.*fff*
2003.PU.VIS.PM.*fff*

fff = **inp** denotes POSTUTIL input files
fff = **lst** denotes POSTUTIL output summary files

CALPOST FILES FOR VISIBILITY

Grand Canyon

az_2001_src09_grca.*fff*
az_2002_src09_grca.*fff*
az_2003_src09_grca.*fff*

Sycamore Canyon

az_2001_src09_syca.*fff*
az_2002_src09_syca.*fff*
az_2003_src09_syca.*fff*

zion

az_2001_src09_zion.*fff*
az_2002_src09_zion.*fff*
az_2003_src09_zion.*fff*

Pine Mountain

az_2001_src09_pimo.*fff*
az_2002_src09_pimo.*fff*
az_2003_src09_pimo.*fff*

Mazatzal

az_2001_src09_maza.*fff*
az_2002_src09_maza.*fff*
az_2003_src09_maza.*fff*

Bryce Canyon

az_2001_src09_brca.*fff*
az_2002_src09_brca.*fff*
az_2003_src09_brca.*fff*

Joshua Tree

az_2001_src09_jotr.*fff*
az_2002_src09_jotr.*fff*
az_2003_src09_jotr.*fff*

Sierra Ancha

az_2001_src09_sian.*fff*
az_2002_src09_sian.*fff*
az_2003_src09_sian.*fff*

Superstition

az_2001_src09_supe.*fff*
az_2002_src09_supe.*fff*
az_2003_src09_supe.*fff*

fff = **inp** denotes CALPOST input files
fff = **lst** denotes CALPOST output summary files

CALPOST FILES FOR EXTRACTION OF NOX CONCENTRATIONS IN GRAND CANYON ARE

GRCA.NOx.*YY.dd.fff*

YY = denotes the last two digitals of the met model year: 2001, 2002 and 2003
dd = denotes the day with top 22 highest visibility impact.
fff = **inp** denotes CALPOST input files
fff = **lst** denotes CALPOST output summary files

RECOMPILED EXECUTABLE FILES

calmetl.exe
calpuffl.exe
calpostl.exe
postutill.exe

REVISED IMPROVE ALGORITHM SPREADSHEETS

Revised IMPROVE Calculation *yyyy*.xls

yyyy denotes the met model year: 2001, 2002 and 2003

APPENDIX C

REVISED IMPROVE EQUATION CALCULATIONS

CALPOST Recalculation with New IMPROVE Algorithm

Version 2.
29 Sept. 2006

---------------------------- INPUT from CALPOST (based on old IMPROVE algorithm) -----------

1. At cell A7, import "Ranked Daily Visibility Change" (bext) table, including column headings, from CALPOST (22 days, max)

5. Check calculated values below against CALPOST's "Ranked Daily Visibility

(Optional) Enter 24hr NOx conc.

YEAR	DAY	HR	RECEPTOR	COORDINATES (km)		TYPE	BEXT(Model)	BEXT(BKG	BEXT(Total)	%CHANGE	F(RH)	bxSO4	bxNO3	bxOC	bxEC	bxPMC	bxPMF	Rank				NOx(ppb)	Check
YEAR	DAY	HR	RECEPTOR	COORDIN	ATES (km)	TYPE	BEXT(Model)	BEXT(BKG)	BEXT(Total)	%CHANGE	F(RH)	bxSO4	bxNO3	bxOC	bxEC	bxPMC	bxPMF	Rank	dv(total)	dv(bkg)	Δdv		
2001	363	0	690	-1433.031	-286.729	D	1.69	15.898	17.588	10.63	2.3	0.943	0.734	0	0.003	0.003	0.007	1	5.65	4.64	1.01	1.84E-01	OK
2001	27	0	253	-1469.557	-325.116	D	1.661	15.964	17.625	10.4	2.4	1.15	0.505	0	0.001	0.002	0.003	2	5.67	4.68	0.99	7.67E-02	OK
2001	57	0	333	-1510.597	-300.588	D	1.156	15.898	17.054	7.27	2.3	0.683	0.467	0	0.001	0.002	0.003	3	5.34	4.64	0.70	9.58E-02	OK
2001	23	0	333	-1510.597	-300.588	D	1.09	15.964	17.054	6.83	2.4	0.414	0.664	0	0.002	0.003	0.006	4	5.34	4.68	0.66	1.62E-01	OK
2001	10	0	240	-1467.848	-328.244	D	1.04	15.964	17.004	6.52	2.4	0.485	0.54	0	0.003	0.004	0.007	5	5.31	4.68	0.63	2.82E-01	OK
2001	345	0	415	-1458.963	-304.539	D	0.87	15.898	16.768	5.47	2.3	0.399	0.467	0	0.001	0.001	0.003	6	5.17	4.64	0.53	7.75E-02	OK
2001	56	0	274	-1488.406	-316.009	D	0.745	15.898	16.643	4.69	2.3	0.331	0.406	0	0.002	0.002	0.004	7	5.09	4.64	0.46	9.59E-02	OK
2001	47	0	217	-1475.472	-332.476	D	0.734	15.898	16.632	4.62	2.3	0.35	0.381	0	0.001	0.001	0.002	8	5.09	4.64	0.45	7.42E-03	OK
2001	69	0	240	-1467.848	-328.244	D	0.713	15.634	16.347	4.56	1.9	0.327	0.375	0	0.002	0.003	0.006	9	4.91	4.47	0.45	2.16E-01	OK
2001	28	0	910	-1404.264	-277.788	D	0.702	15.964	16.666	4.39	2.4	0.394	0.304	0	0.001	0.001	0.002	10	5.11	4.68	0.43	5.92E-02	OK
2001	344	0	652	-1435.717	-289.058	D	0.69	15.898	16.588	4.34	2.3	0.301	0.385	0	0.001	0.001	0.002	11	5.06	4.64	0.42	2.52E-02	OK
2001	60	0	588	-1410.303	-299.205	D	0.579	15.634	16.213	3.7	1.9	0.233	0.341	0	0.001	0.001	0.003	12	4.83	4.47	0.36	8.22E-02	OK
2001	59	0	453	-1456.266	-302.217	D	0.554	15.898	16.452	3.48	2.3	0.262	0.284	0	0.002	0.002	0.004	13	4.98	4.64	0.34	1.62E-01	OK
2001	26	0	253	-1469.557	-325.116	D	0.539	15.964	16.503	3.38	2.4	0.291	0.241	0	0.001	0.002	0.004	14	5.01	4.68	0.33	1.21E-01	OK
2001	364	0	1002	-1297.879	-262.149	D	0.532	15.898	16.43	3.35	2.3	0.375	0.155	0	0	0	0.001	15	4.97	4.64	0.33	4.01E-03	OK
2001	53	0	240	-1467.848	-328.244	D	0.5	15.898	16.398	3.14	2.3	0.157	0.334	0	0.002	0.003	0.004	16	4.95	4.64	0.31	1.95E-01	OK
2001	338	0	994	-1313.715	-276.376	D	0.5	15.898	16.398	3.14	2.3	0.266	0.232	0	0	0	0.001	17	4.95	4.64	0.31	1.47E-02	OK
2001	7	0	234	-1485.509	-324.994	D	0.491	15.964	16.455	3.08	2.4	0.337	0.151	0	0.001	0	0.001	18	4.98	4.68	0.30	1.21E-02	OK
2001	11	0	453	-1456.266	-302.217	D	0.492	15.964	16.456	3.08	2.4	0.267	0.219	0	0.001	0.001	0.004	19	4.98	4.68	0.30	1.15E-01	OK
2001	339	0	240	-1467.848	-328.244	D	0.485	15.898	16.383	3.05	2.3	0.162	0.317	0	0.001	0.002	0.003	20	4.94	4.64	0.30	9.03E-02	OK
2001	12	0	836	-1416.201	-281.299	D	0.478	15.964	16.442	3	2.4	0.162	0.313	0	0.001	0.001	0.002	21	4.97	4.68	0.30	4.91E-02	OK
2001	9	0	416	-1456.761	-304.94	D	0.477	15.964	16.441	2.99	2.4	0.333	0.143	0	0	0	0.001	22	4.97	4.68	0.29	7.49E-03	OK

3. Enter value of site-specific Rayleigh scattering coefficient, from "Rayleigh & Sea Salt" worksheet: 9

4. (Optional) Insert annual average sea salt concentration, from "Rayleigh & Sea Salt" worksheet. Leave blank if not used, i.e. default is 0.: 0.01

http://vista.cira.colostate.edu/views/

6. Enter desired NO2/NOx ratio (default is 0): 1

------------------------------------ OUTPUT (based on new IMPROVE algorithm) -----------------------------

YEAR	DAY	HR	RECEPTOR	COORDINATES (km)		TYPE	BEXT(Source	BEXT(BKG	BEXT(Total)	%CHANGE	RH(%)	bsSO4	bsNO3	bsOC	bsEC	bsPMC	bsPMF	baNO2	New Rank	dv(total)	dv(bkg)	Δdv
2001	363	0	690	-1433.031	-286.729	D	1.371	14.48	15.852	9.51	71	0.702	0.595	0	0.003	0.003	0.007	0.061	1	4.61	3.70	0.91
2001	27	0	253	-1469.557	-325.116	D	1.297	14.53	15.830	8.97	73	0.857	0.408	0	0.001	0.002	0.003	0.025	2	4.59	3.73	0.86
2001	57	0	333	-1510.597	-300.588	D	0.923	14.48	15.403	6.41	71	0.508	0.378	0	0.001	0.002	0.003	0.032	3	4.32	3.70	0.62
2001	23	0	333	-1510.597	-300.588	D	0.909	14.53	15.440	6.29	73	0.307	0.538	0	0.002	0.003	0.006	0.054	4	4.34	3.73	0.61
2001	10	0	240	-1467.848	-328.244	D	0.904	14.53	15.435	6.25	73	0.36	0.437	0	0.003	0.004	0.007	0.093	5	4.34	3.73	0.61
2001	345	0	415	-1458.963	-304.539	D	0.705	14.48	15.183	4.89	71	0.296	0.378	0	0.001	0.001	0.003	0.026	6	4.18	3.70	0.48
2001	56	0	274	-1488.406	-316.009	D	0.661	14.32	14.987	4.63	64	0.257	0.321	0	0.002	0.003	0.006	0.071	7	4.05	3.59	0.45
2001	47	0	217	-1475.472	-332.476	D	0.614	14.48	15.091	4.26	71	0.246	0.328	0	0.002	0.002	0.004	0.032	8	4.12	3.70	0.42
2001	69	0	240	-1467.848	-328.244	D	0.574	14.48	15.052	3.98	71	0.26	0.308	0	0.001	0.001	0.002	0.002	9	4.09	3.70	0.39
2001	28	0	910	-1404.264	-277.788	D	0.561	14.53	15.091	3.88	73	0.292	0.246	0	0.001	0.001	0.002	0.02	10	4.12	3.73	0.38
2001	344	0	652	-1435.717	-289.058	D	0.547	14.48	15.025	3.80	71	0.223	0.311	0	0.001	0.001	0.002	0.008	11	4.07	3.70	0.37
2001	60	0	588	-1410.303	-299.205	D	0.507	14.32	14.833	3.56	64	0.183	0.292	0	0.001	0.001	0.003	0.027	12	3.94	3.59	0.35
2001	59	0	453	-1456.266	-302.217	D	0.485	14.48	14.962	3.37	71	0.194	0.23	0	0.002	0.002	0.004	0.054	13	4.03	3.70	0.33
2001	26	0	253	-1469.557	-325.116	D	0.460	14.48	14.937	3.19	71	0.116	0.27	0	0.002	0.003	0.004	0.064	14	4.01	3.70	0.31
2001	364	0	1002	-1297.879	-262.149	D	0.457	14.53	14.986	3.16	73	0.216	0.195	0	0.001	0.002	0.004	0.04	15	4.05	3.73	0.31
2001	53	0	240	-1467.848	-328.244	D	0.419	14.53	14.948	2.89	73	0.198	0.177	0	0.001	0.001	0.004	0.038	16	4.02	3.73	0.29
2001	338	0	994	-1313.715	-276.376	D	0.412	14.48	14.889	2.86	71	0.12	0.256	0	0.001	0.002	0.003	0.03	17	3.98	3.70	0.28
2001	7	0	234	-1485.509	-324.994	D	0.406	14.48	14.883	2.82	71	0.278	0.125	0	0	0	0.001	0.001	18	3.98	3.70	0.28
2001	11	0	453	-1456.266	-302.217	D	0.393	14.53	14.922	2.72	73	0.12	0.253	0	0.001	0.001	0.002	0.016	19	4.00	3.73	0.27
2001	339	0	240	-1467.848	-328.244	D	0.391	14.48	14.867	2.71	71	0.197	0.187	0		0	0.001	0.005	20	3.97	3.70	0.27
2001	12	0	836	-1416.201	-281.299	D	0.378	14.53	14.907	2.61	73	0.25	0.122	0	0.001		0.001	0.004	21	3.99	3.73	0.26
2001	9	0	416	-1456.761	-304.94	D	0.366	14.53	14.895	2.53	73	0.247	0.115	0	0	0	0.001	0.002	22	3.98	3.73	0.25

CALPOST Recalculation with New IMPROVE Algorithm

Version 2.
29 Sept. 2006

---------------------------- INPUT from CALPOST (based on old IMPROVE algorithm) -----------

1. At cell A7, import "Ranked Daily Visibility Change" (bext) table, including column headings, from CALPOST (22 days, max)

YEAR	DAY	HR	RECEPTOR	COORDINATES (km)		TYPE	BEXT(Model)	BEXT(BKG	BEXT(Total)	%CHANGE	F(RH)	bxSO4	bxNO3	bxOC	bxEC	bxPMC	bxPMF	Rank
YEAR	DAY	HR	RECEPTOR	COORDIN	ATES (km)	TYPE	BEXT(Model)	BEXT(BKG)	BEXT(Total)	%CHANGE	F(RH)	bxSO4	bxNO3	bxOC	bxEC	bxPMC	bxPMF	Rank
2002	335	0	372	-1472.671	-304.843	D	1.468	15.898	17.366	9.24	2.3	0.849	0.614	0	0.001	0.001	0.003	1
2002	334	0	275	-1486.202	-316.419	D	1.119	15.634	16.753	7.16	1.9	0.876	0.238	0	0.001	0.001	0.003	2
2002	29	0	556	-1375.557	-308.063	D	1.055	15.964	17.019	6.61	2.4	0.54	0.51	0	0.001	0.001	0.003	3
2002	321	0	240	-1467.848	-328.244	D	0.98	15.634	16.614	6.27	1.9	0.361	0.594	0.001	0.005	0.007	0.012	4
2002	3	0	333	-1510.597	-300.588	D	0.811	15.964	16.775	5.08	2.4	0.288	0.514	0	0.002	0.002	0.005	5
2002	355	0	524	-1490.451	-290.288	D	0.72	15.898	16.618	4.53	2.3	0.407	0.31	0	0.001	0.001	0.002	6
2002	341	0	415	-1458.963	-304.539	D	0.719	15.898	16.617	4.52	2.3	0.246	0.462	0	0.002	0.003	0.005	7
2002	45	0	588	-1410.303	-299.205	D	0.68	15.898	16.578	4.28	2.3	0.254	0.42	0	0.001	0.001	0.003	8
2002	16	0	584	-1313.846	-318.421	D	0.601	15.964	16.565	3.76	2.4	0.259	0.339	0	0.001	0	0.002	9
2002	340	0	415	-1458.963	-304.539	D	0.572	15.898	16.47	3.6	2.3	0.212	0.351	0	0.002	0.003	0.004	10
2002	327	0	414	-1461.165	-304.138	D	0.54	15.634	16.174	3.46	1.9	0.233	0.294	0	0.003	0.003	0.007	11
2002	25	0	295	-1461.445	-318.156	D	0.508	15.964	16.472	3.19	2.4	0.243	0.259	0	0.001	0.001	0.004	12
2002	64	0	240	-1467.848	-328.244	D	0.465	15.634	16.099	2.97	1.9	0.203	0.257	0	0.001	0.001	0.002	13
2002	83	0	528	-1369.415	-311.924	D	0.461	15.634	16.095	2.95	1.9	0.16	0.295	0	0.001	0.001	0.003	14
2002	356	0	372	-1472.671	-304.843	D	0.47	15.898	16.368	2.95	2.3	0.242	0.226	0	0	0	0.001	15
2002	348	0	415	-1458.963	-304.539	D	0.443	15.898	16.341	2.79	2.3	0.159	0.277	0	0.001	0.002	0.004	16
2002	354	0	936	-1414.75	-273.125	D	0.439	15.898	16.337	2.76	2.3	0.296	0.142	0	0	0	0.001	17
2002	26	0	268	-1464.645	-323.2	D	0.434	15.964	16.398	2.72	2.4	0.142	0.277	0	0.003	0.004	0.008	18
2002	299	0	738	-1423.758	-285.576	D	0.389	15.436	15.825	2.52	1.6	0.182	0.203	0	0.001	0.001	0.002	19
2002	363	0	937	-1412.557	-273.514	D	0.396	15.898	16.294	2.49	2.3	0.184	0.209	0	0.001	0.001	0.001	20
2002	343	0	227	-1472.763	-330.158	D	0.395	15.898	16.293	2.48	2.3	0.137	0.253	0	0.001	0.001	0.002	21
2002	352	0	835	-1418.396	-280.909	D	0.38	15.898	16.278	2.39	2.3	0.108	0.269	0	0.001	0.001	0.002	22

5. Check calculated values below against CALPOST's "Ranked Daily Visibility

(Optional) Enter 24hr NOx conc.

dv(total)	dv(bkg)	Δdv	NOx(ppb)	Check
5.52	4.64	0.88	4.21E-02	OK
5.16	4.47	0.69	6.33E-02	OK
5.32	4.68	0.64	6.96E-02	OK
5.08	4.47	0.61	4.13E-01	OK
5.17	4.68	0.50	1.54E-01	OK
5.08	4.64	0.44	5.37E-02	OK
5.08	4.64	0.44	2.66E-01	OK
5.05	4.64	0.42	7.29E-02	OK
5.05	4.68	0.37	4.51E-02	OK
4.99	4.64	0.35	9.22E-02	OK
4.81	4.47	0.34	2.71E-01	OK
4.99	4.68	0.31	5.88E-02	OK
4.76	4.47	0.29	4.29E-02	OK
4.76	4.47	0.29	8.41E-02	OK
4.93	4.64	0.29	2.09E-02	OK
4.91	4.64	0.27	1.15E-01	OK
4.91	4.64	0.27	6.24E-03	OK
4.95	4.68	0.27	3.27E-01	OK
4.59	4.34	0.25	3.74E-02	OK
4.88	4.64	0.25	2.78E-02	OK
4.88	4.64	0.25	3.08E-02	OK
4.87	4.64	0.24	7.16E-02	OK

3. Enter value of site-specific Rayleigh scattering coefficient, from "Rayleigh & Sea Salt" worksheet: 9

4. (Optional) Insert annual average sea salt concentration, from "Rayleigh & Sea Salt" worksheet. Leave blank if not used, i.e. default is 0.: 0.01

http://vista.cira.colostate.edu/views/

6. Enter desired NO2/NOx ratio (default is 0): 1

---------------------------------- OUTPUT (based on new IMPROVE algorithm) ----------------------------

YEAR	DAY	HR	RECEPTOR	COORDINATES (km)		TYPE	BEXT(Source	BEXT(BKG	BEXT(Total)	%CHANGE	RH(%)	bsSO4	bsNO3	bsOC	bsEC	bsPMC	bsPMF	baNO2	New Rank	dv(total)	dv(bkg)	Δdv
2002	335	0	372	-1472.671	-304.843	D	1.148	14.48	15.628	7.97	71	0.632	0.497	0	0.001	0.001	0.003	0.014	1	4.47	3.70	0.77
2002	334	0	275	-1486.202	-316.419	D	0.955	14.32	15.282	6.69	64	0.284	0.51	7E-04	0.005	0.007	0.012	0.136	2	4.24	3.59	0.65
2002	29	0	556	-1375.557	-308.063	D	0.921	14.32	15.249	6.46	64	0.692	0.204	0	0.001	0.001	0.003	0.021	3	4.22	3.59	0.63
2002	321	0	240	-1467.848	-328.244	D	0.841	14.53	15.372	5.82	73	0.401	0.413	0	0.001	0.001	0.003	0.023	4	4.30	3.73	0.57
2002	3	0	333	-1510.597	-300.588	D	0.689	14.53	15.219	4.76	73	0.214	0.416	0	0.002	0.002	0.005	0.051	5	4.20	3.73	0.47
2002	355	0	524	-1490.451	-290.288	D	0.654	14.48	15.131	4.53	71	0.182	0.374	0	0.002	0.003	0.005	0.088	6	4.14	3.70	0.44
2002	341	0	415	-1458.963	-304.539	D	0.574	14.48	15.052	3.99	71	0.302	0.251	0	0.001	0.001	0.002	0.018	7	4.09	3.70	0.39
2002	45	0	588	-1410.303	-299.205	D	0.557	14.48	15.035	3.86	71	0.188	0.34	0	0.001	0.001	0.003	0.024	8	4.08	3.70	0.38
2002	16	0	584	-1313.846	-318.421	D	0.537	14.32	14.863	3.76	64	0.183	0.252	0	0.003	0.003	0.007	0.089	9	3.96	3.59	0.37
2002	340	0	415	-1458.963	-304.539	D	0.484	14.53	15.013	3.34	73	0.192	0.274	0	0.001	0	0.002	0.015	10	4.06	3.73	0.33
2002	327	0	414	-1461.165	-304.138	D	0.480	14.48	14.957	3.33	71	0.157	0.284	0	0.002	0.003	0.004	0.03	11	4.03	3.70	0.33
2002	25	0	295	-1461.445	-318.156	D	0.452	14.53	14.980	3.12	73	0.105	0.224	0	0.003	0.004	0.008	0.108	12	4.04	3.73	0.31
2002	64	0	240	-1467.848	-328.244	D	0.411	14.32	14.736	2.88	64	0.126	0.253	0	0.001	0.001	0.003	0.028	13	3.88	3.59	0.28
2002	83	0	528	-1369.415	-311.924	D	0.415	14.53	14.944	2.87	73	0.18	0.209	0	0.001	0.001	0.004	0.019	14	4.02	3.73	0.28
2002	356	0	372	-1472.671	-304.843	D	0.398	14.32	14.723	2.79	64	0.159	0.22	0	0.001	0.001	0.002	0.014	15	3.87	3.59	0.27
2002	348	0	415	-1458.963	-304.539	D	0.387	14.48	14.863	2.68	71	0.118	0.224	0	0.001	0.002	0.004	0.038	16	3.96	3.70	0.26
2002	354	0	936	-1414.75	-273.125	D	0.370	14.48	14.847	2.57	71	0.179	0.183	0	0	0	0.001	0.007	17	3.95	3.70	0.25
2002	26	0	268	-1464.645	-323.2	D	0.353	14.21	14.568	2.50	57	0.152	0.185	0	0.001	0.001	0.002	0.012	18	3.76	3.52	0.25
2002	299	0	738	-1423.758	-285.576	D	0.337	14.48	14.814	2.34	71	0.22	0.115	0	0	0	0.001	0.002	19	3.93	3.70	0.23
2002	363	0	937	-1412.557	-273.514	D	0.325	14.48	14.801	2.25	71	0.08	0.217	0	0.001	0.001	0.002	0.024	20	3.92	3.70	0.22
2002	343	0	227	-1472.763	-330.158	D	0.320	14.48	14.797	2.22	71	0.102	0.204	0	0.001	0.001	0.002	0.01	21	3.92	3.70	0.22
2002	352	0	835	-1418.396	-280.909	D	0.317	14.48	14.794	2.20	71	0.136	0.169	0	0.001	0.001	0.001	0.009	22	3.92	3.70	0.22

CALPOST Recalculation with New IMPROVE Algorithm

Version 2.
29 Sept. 2006

---------------------------- INPUT from CALPOST (based on old IMPROVE algorithm) -----------

1. At cell A7, import "Ranked Daily Visibility Change" (bext) table, including column headings, from CALPOST (22 days, max)

5. Check calculated values below against CALPOST's "Ranked Daily Visibility

(Optional) Enter 24hr NOx conc.

YEAR DAY		HR	RECEPTOR	COORDINATES (km)		TYPE	BEXT(Model)	BEXT(BKG	BEXT(Total)	%CHANGE	F(RH)	bxSO4	bxNO3	bxOC	bxEC	bxPMC	bxPMF	Rank				NOx(ppb)	Check
YEAR	DAY	HR	RECEPTOR	COORDIN	ATES (km)	TYPE	BEXT(Model)	BEXT(BKG)	BEXT(Total)	%CHANGE	F(RH)	bxSO4	bxNO3	bxOC	bxEC	bxPMC	bxPMF	Rank	dv(total)	dv(bkg)	Δdv		
2003	59	0	268	-1464.645	-323.2	D	1.78	15.898	17.678	11.2	2.3	0.779	0.981	0	0.004	0.006	0.01	1	5.70	4.64	1.06	3.23E-01	OK
2003	320	0	415	-1458.963	-304.539	D	1.416	15.634	17.05	9.05	1.9	0.877	0.528	0	0.002	0.003	0.005	2	5.34	4.47	0.87	1.35E-01	OK
2003	347	0	246	-1485.005	-322.271	D	1.432	15.898	17.33	9.01	2.3	0.6	0.819	0	0.003	0.003	0.007	3	5.50	4.64	0.86	1.49E-01	OK
2003	60	0	740	-1419.365	-286.358	D	1.284	15.634	16.918	8.21	1.9	0.773	0.506	0	0.001	0.001	0.003	4	5.26	4.47	0.79	1.86E-02	OK
2003	345	0	295	-1461.445	-318.156	D	1.244	15.898	17.142	7.82	2.3	0.444	0.785	0	0.003	0.004	0.008	5	5.39	4.64	0.75	2.33E-01	OK
2003	21	0	240	-1467.848	-328.244	D	1.137	15.964	17.101	7.12	2.4	0.403	0.715	0.001	0.004	0.005	0.01	6	5.37	4.68	0.69	3.91E-01	OK
2003	9	0	415	-1458.963	-304.539	D	1.032	15.964	16.996	6.47	2.4	0.391	0.634	0	0.002	0.002	0.004	7	5.30	4.68	0.63	1.34E-01	OK
2003	348	0	240	-1467.848	-328.244	D	1.023	15.898	16.921	6.44	2.3	0.386	0.607	0.001	0.006	0.007	0.017	8	5.26	4.64	0.62	6.92E-01	OK
2003	321	0	295	-1461.445	-318.156	D	0.982	15.634	16.616	6.28	1.9	0.485	0.488	0	0.002	0.002	0.005	9	5.08	4.47	0.61	1.52E-01	OK
2003	311	0	268	-1464.645	-323.2	D	0.953	15.634	16.587	6.09	1.9	0.349	0.594	0	0.002	0.003	0.005	10	5.06	4.47	0.59	8.65E-02	OK
2003	20	0	240	-1467.848	-328.244	D	0.954	15.964	16.918	5.97	2.4	0.387	0.55	0	0.003	0.005	0.008	11	5.26	4.68	0.58	2.72E-01	OK
2003	56	0	415	-1458.963	-304.539	D	0.901	15.898	16.799	5.67	2.3	0.474	0.419	0	0.001	0.002	0.004	12	5.19	4.64	0.55	1.56E-01	OK
2003	354	0	524	-1490.451	-290.288	D	0.871	15.898	16.769	5.48	2.3	0.395	0.464	0	0.002	0.003	0.006	13	5.17	4.64	0.53	2.17E-01	OK
2003	335	0	480	-1501.949	-290.95	D	0.845	15.898	16.743	5.32	2.3	0.47	0.363	0	0.003	0.003	0.007	14	5.15	4.64	0.52	1.91E-01	OK
2003	10	0	936	-1414.75	-273.125	D	0.848	15.964	16.812	5.31	2.4	0.4	0.444	0	0.001	0.001	0.002	15	5.20	4.68	0.52	4.41E-02	OK
2003	44	0	622	-1376.821	-302.229	D	0.818	15.898	16.716	5.15	2.3	0.624	0.193	0	0	0	0.001	16	5.14	4.64	0.50	1.53E-02	OK
2003	319	0	588	-1410.303	-299.205	D	0.802	15.634	16.436	5.13	1.9	0.295	0.498	0	0.002	0.002	0.005	17	4.97	4.47	0.50	9.68E-02	OK
2003	334	0	333	-1510.597	-300.588	D	0.771	15.634	16.405	4.93	1.9	0.409	0.35	0	0.002	0.002	0.006	18	4.95	4.47	0.48	1.53E-01	OK
2003	75	0	240	-1467.848	-328.244	D	0.74	15.634	16.374	4.74	1.9	0.448	0.283	0	0.002	0.003	0.004	19	4.93	4.47	0.46	1.36E-01	OK
2003	355	0	240	-1467.848	-328.244	D	0.74	15.898	16.638	4.65	2.3	0.272	0.454	0	0.003	0.004	0.007	20	5.09	4.64	0.45	2.56E-01	OK
2003	45	0	415	-1458.963	-304.539	D	0.677	15.898	16.575	4.26	2.3	0.265	0.408	0	0.001	0.001	0.002	21	5.05	4.64	0.42	1.04E-01	OK
2003	68	0	240	-1467.848	-328.244	D	0.65	15.634	16.284	4.16	1.9	0.315	0.328	0	0.001	0.002	0.004	22	4.88	4.47	0.41	1.02E-01	OK

3. Enter value of site-specific Rayleigh scattering coefficient, from "Rayleigh & Sea Salt" worksheet: 9

4. (Optional) Insert annual average sea salt concentration, from "Rayleigh & Sea Salt" worksheet. Leave blank if not used, i.e. default is 0.: 0.01

http://vista.cira.colostate.edu/views/

6. Enter desired NO2/NOx ratio (default is 0): 1

---------------------------------- OUTPUT (based on new IMPROVE algorithm) ----------------------------

YEAR	DAY	HR	RECEPTOR	COORDINATES (km)		TYPE	BEXT(Source	BEXT(BKG	BEXT(Total)	%CHANGE	RH(%)	bsSO4	bsNO3	bsOC	bsEC	bsPMC	bsPMF	baNO2	New Rank	dv(total)	dv(bkg)	Δdv
2003	59	0	268	-1464.645	-323.2	D	1.502	14.48	15.983	10.42	71	0.58	0.796	0	0.004	0.006	0.01	0.106	1	4.69	3.70	0.99
2003	320	0	415	-1458.963	-304.539	D	1.200	14.32	15.529	8.42	64	0.692	0.453	0	0.002	0.003	0.005	0.045	2	4.40	3.59	0.81
2003	347	0	246	-1485.005	-322.271	D	1.172	14.48	15.652	8.13	71	0.446	0.664	0	0.003	0.003	0.007	0.049	3	4.48	3.70	0.78
2003	60	0	740	-1419.365	-286.358	D	1.055	14.32	15.384	7.40	64	0.61	0.434	0	0.001	0.001	0.003	0.006	4	4.31	3.59	0.71
2003	345	0	295	-1461.445	-318.156	D	1.058	14.48	15.537	7.34	71	0.33	0.636	0	0.003	0.004	0.008	0.077	5	4.41	3.70	0.71
2003	21	0	240	-1467.848	-328.244	D	1.037	14.48	15.516	7.19	71	0.286	0.491	7E-04	0.006	0.007	0.017	0.228	6	4.39	3.70	0.69
2003	9	0	415	-1458.963	-304.539	D	1.027	14.53	15.558	7.10	73	0.299	0.579	7E-04	0.004	0.005	0.01	0.129	7	4.42	3.73	0.69
2003	348	0	240	-1467.848	-328.244	D	0.859	14.32	15.187	6.03	64	0.382	0.418	0	0.002	0.002	0.005	0.05	8	4.18	3.59	0.59
2003	321	0	295	-1461.445	-318.156	D	0.856	14.53	15.386	5.91	73	0.29	0.513	0	0.002	0.002	0.004	0.044	9	4.31	3.73	0.57
2003	311	0	268	-1464.645	-323.2	D	0.838	14.53	15.368	5.79	73	0.287	0.445	0	0.003	0.005	0.008	0.09	10	4.30	3.73	0.56
2003	20	0	240	-1467.848	-328.244	D	0.823	14.32	15.150	5.77	64	0.274	0.51	0	0.002	0.003	0.005	0.029	11	4.15	3.59	0.56
2003	56	0	415	-1458.963	-304.539	D	0.751	14.48	15.229	5.21	71	0.293	0.375	0	0.002	0.003	0.006	0.072	12	4.21	3.70	0.51
2003	354	0	524	-1490.451	-290.288	D	0.749	14.48	15.228	5.20	71	0.352	0.339	0	0.001	0.002	0.004	0.051	13	4.21	3.70	0.51
2003	335	0	480	-1501.949	-290.95	D	0.719	14.48	15.197	4.98	71	0.349	0.293	0	0.003	0.003	0.007	0.063	14	4.18	3.70	0.49
2003	10	0	936	-1414.75	-273.125	D	0.700	14.32	15.026	4.91	64	0.232	0.427	0	0.002	0.002	0.005	0.032	15	4.07	3.59	0.48
2003	44	0	622	-1376.821	-302.229	D	0.682	14.32	15.009	4.78	64	0.322	0.3	0	0.002	0.002	0.006	0.05	16	4.06	3.59	0.47
2003	319	0	588	-1410.303	-299.205	D	0.674	14.53	15.204	4.66	73	0.297	0.359	0	0.001	0.001	0.002	0.015	17	4.19	3.73	0.46
2003	334	0	333	-1510.597	-300.588	D	0.667	14.48	15.145	4.63	71	0.202	0.367	0	0.003	0.004	0.007	0.084	18	4.15	3.70	0.45
2003	75	0	240	-1467.848	-328.244	D	0.649	14.32	14.975	4.55	64	0.352	0.242	0	0.002	0.003	0.004	0.045	19	4.04	3.59	0.44
2003	355	0	240	-1467.848	-328.244	D	0.626	14.48	15.104	4.34	71	0.464	0.156	0	0	0	0.001	0.005	20	4.12	3.70	0.43
2003	45	0	415	-1458.963	-304.539	D	0.569	14.32	14.895	3.99	64	0.248	0.281	0	0.001	0.002	0.004	0.034	21	3.98	3.59	0.39
2003	68	0	240	-1467.848	-328.244	D	0.565	14.48	15.042	3.92	71	0.197	0.33	0	0.001	0.001	0.002	0.034	22	4.08	3.70	0.38