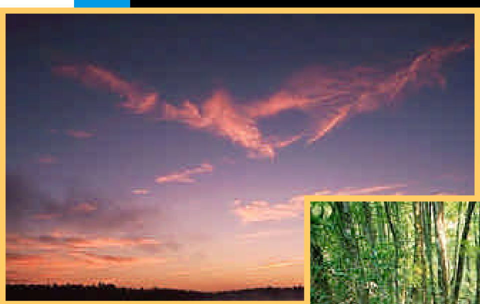
July 21, 2005



# Dispersion Modeling Protocol for the Cliffside Steam Station

## Class I Area Impacts

For:

Cliffside Unit 6 & 7 Project
Rutherford County, North Carolina

Submitted to:

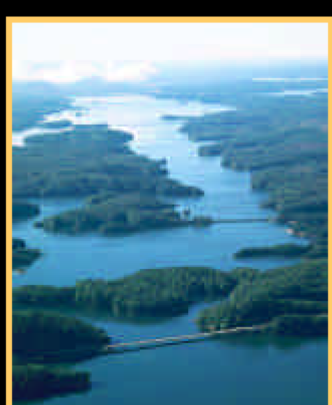
North Carolina Division of Air Quality
Raleigh, North Carolina

Submitted by:

Duke Power (a Duke Energy Company)
Charlotte, North Carolina

Prepared by:

ENSR Consulting and Engineering (NC), Inc.
Raleigh, North Carolina



# Dispersion Modeling Protocol – Class I Area Impacts

# Cliffside Unit 6 & 7 Project
# Rutherford County, North Carolina

ENSR Document No. 02355-134-2225
July 2005

Submitted by
**Duke Power**
Charlotte, North Carolina

Submitted to
**North Carolina Division of Air Quality**
Raleigh, North Carolina

**ENSR Consulting and Engineering (NC), Inc.**
**7041 Old Wake Forest Road, Suite 103**
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# 1.0 INTRODUCTION

## 1.1 Introduction and Project Description

Duke Power (a Duke Energy Company) plans to build and operate two new nominal 800 MW pulverized coal (PC) boilers, which will provide a nominal 1600 MW of power, at Duke Power's existing Cliffside Steam Station located in Rutherford and Cleveland Counties, North Carolina.

The new units, in combination with net reductions in $SO_2$ below the PSD threshold, will result in emission increases of all criteria pollutants, except for $SO_2$, above the Prevention of Significant Deterioration (PSD) threshold limits. The final PSD netting analysis will be presented in the PSD permit application. Therefore all criteria pollutants will be subject to PSD review, except for $SO_2$, and thus a subsequent Class I modeling analysis will be required for $NO_X$ and $PM_{10}$ only.

## 1.2 Modeling at Class I Areas

PSD regulations require that facilities within 100 km of a PSD Class I area perform a modeling evaluation of the ambient air quality in terms of Class I PSD Increments and Air Quality Related Values (AQRVs). In addition, large projects beyond 100 km (but less than 300 km) from the nearest Class I area may be requested to conduct an evaluation of air quality impacts by the Federal Land Managers (FLMs). Figure 1-1 shows the location of the Cliffside Steam Station relative to the nearest PSD Class I areas. The following Class I areas will be assessed for this analysis:

1. Shining Rock Wilderness,
2. Linville Gorge Wilderness,
3. Joyce Kilmer-Slickrock Wilderness,
4. Cohutta Wilderness, and
5. Great Smoky Mountains NP.

There are no other Class I areas within 300 km of the Cliffside Steam Station. Project impacts for $NO_X$ and $PM_{10}$, pollutants subject to PSD review, will be assessed for the Class I areas (and portions thereof) within 300 km of the Cliffside Steam Station.

Since the Class I areas are located more than 50 km from the proposed facility, the CALPUFF model, Version 5.724 (level 041013), along with CALMET, Version 5.547 (level 041016), the meteorological pre-processor, will be applied in a refined mode (Scire et al., 2000a,b).

### 1.3 Protocol Organization

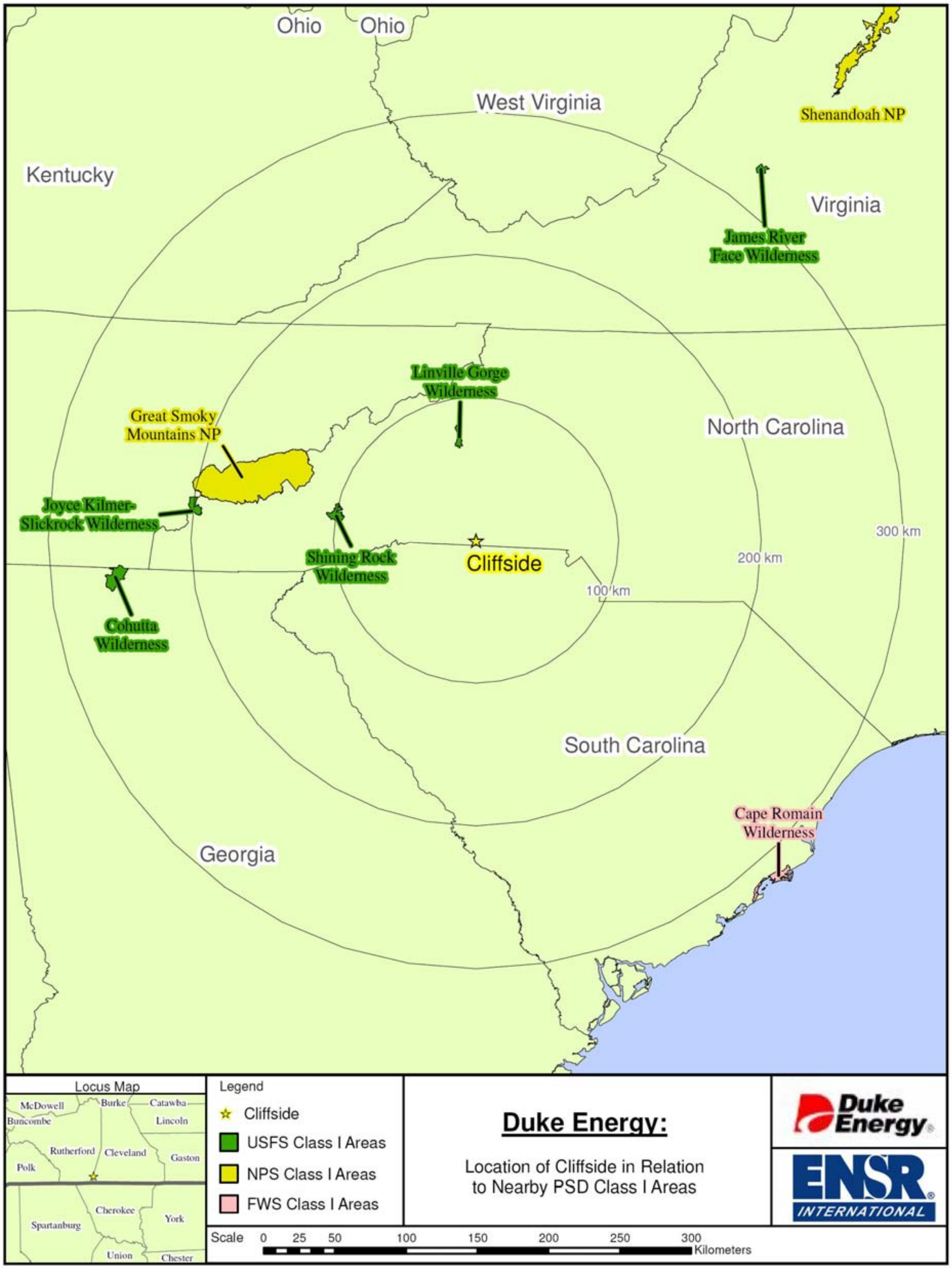
This proposed modeling protocol is based on requirements outlined in the IWAQM Phase II report (USEPA Report EPA-454/R-98-019, 1998; found at http://www.epa.gov/scram001) as well as the Federal Land Managers' Air Quality Related Values Workgroup Phase I Report that was published in December 2000 (found at http://www2.nature.nps.gov/ard/flagfree/index.htm). These are guidance documents provided for suggested modeling approaches by EPA and the Federal Land Managers (FLMs). The modeling will also consider guidance/direction for PSD Class I modeling from the North Carolina Department of Environment and Natural Resources (NCDENR), which is the permitting authority that will review the PSD application. In some cases, there are differences between the guidance provided by the NCDENR and FLAG; these will be noted below in the proposed modeling procedures discussion.

This document has been prepared in order to summarize the applicant's understanding of the permitting requirements for Class I area impact assessment and to briefly describe the air quality dispersion modeling study to be conducted. Review and approval of the proposed modeling protocol by the NCDENR’s Division of Air Quality (DAQ) is requested in order to ensure that potential issues are addressed and to expedite agency review of the PSD permit application.

The guidance in IWAQM Phase II suggests that CALPUFF could be first used in a screening mode and then a refined mode if needed. ENSR is proceeding directly to the use of CALPUFF in a refined mode for three years (2001, 2002, and 2003).

Section 2 of this protocol document discusses the emission parameters used for the modeling. Section 3 outlines an approach for a refined CALPUFF analysis of the proposed expansion.

**Figure 1-1 Location of Nearby Class I Areas in Relation to the Cliffside Steam Station**



# 2.0 EMISSIONS AND SOURCE PARAMETERS

## 2.1 Proposed Project Emissions

Class I Area modeling will be conducted to evaluate PSD increment consumption of $NO_2$ and $PM_{10}$, regional haze (not including $SO_2$ or $SO_4$), and nitrogen deposition at Shining Rock Wilderness, Linville Gorge Wilderness, Joyce Kilmer-Slickrock Wilderness, Cohutta Wilderness, and Great Smoky Mountains NP. The proposed operation of the new PC boilers at 100% load represents the worst case to be assessed for short-term and annual PSD Increments, for regional haze, and for annual nitrogen deposition. The worst-case emissions to be modeled are listed in Table 2-1. No other ancillary equipment will be modeled for the Class I area impact analysis because they are either emergency in nature, have very infrequent usage, or have very localized impacts within a few kilometers of the facility.

The primary $PM_{10}$ emissions will also be speciated according to procedures in recently submitted PSD permit applications for purposes of regional haze impact predictions. The National Park Service (NPS) has requested that the $PM_{10}$ be broken down into separate components of soils, elemental carbon, and organic aerosols. These components are modeled separately because their light scattering/absorption effectiveness differs. For example, elemental carbon is 10 times greater in terms of visibility degradation potential than that of the "soils" (e.g., ash or "soils") portion of $PM_{10}$ emissions. Table 2-2 lists the emissions and stack parameters to be modeled for the regional haze analysis.

The "modeled" soils component of the primary $PM_{10}$ emissions will consist of soils plus inorganic aerosols because they are assumed to have similar light scattering properties. Soils are assumed to be 96 percent of the filterable $PM_{10}$ (USEPA, 2002), whereas the inorganic aerosols are assumed to be 80 percent of the non-sulfate condensable $PM_{10}$ (USEPA, 1998). Non-sulfate condensable $PM_{10}$ is defined as the condensable portion of $PM_{10}$ that has had the primary sulfate emissions subtracted. The organic aerosols "modeled" component of the primary $PM_{10}$ emissions is assumed to be the remaining 20 percent of the non-sulfate condensable $PM_{10}$ (USEPA, 1998). The elemental carbon "modeled" component of the primary $PM_{10}$ emissions is assumed to be 4 percent of the filterable $PM_{10}$ (USEPA, 2002).

CALPUFF regional haze modeling typically considers primary $SO_4$ emissions (derived from $H_2SO_4$). Primary emissions of $SO_4$ are modeled because calculations of regional haze are sensitive to $SO_4$, which combine with free atmospheric ammonia to form light-scattering ammonia sulfate fine particles. However, since the project is netting out of PSD review for $SO_2$, $SO_4$ will not be included in the regional haze analysis and the $PM_{10}$ will be speciated based on the non-sulfate $PM_{10}$ emissions.

**Table 2-1 Short Term and Annual Emissions Data and Stack Parameters (per boiler)**

| Fuel | Boiler Type | Boiler Load % | Stack Height (ft) | Stack Diameter (ft) | Stack Velocity (ft/s) | Exhaust Temp (°F) | $NO_X$ (lb/hr)(1) | $PM_{10}$ (lb/hr)(2) | $SO_2$ (lb/hr) |
|---|---|---|---|---|---|---|---|---|---|
| Coal | Pulverized Coal | Peak | 575.0 | 30.0 | 60.2 | 120.0 | 628.0 | 188.4 | N/A |

(1) $NO_X$ lb/hr emission rate is equivalent to a 0.08 lbs/MMBtu (30-day rolling average).

(2) $PM_{10}$ lb/hr emission rate is equivalent to a 0.024 lbs/MMBtu (0.012 filt. And 0.012 cond.), including the back-half and primary sulfates (30-day rolling average).

**Table 2-2 Regional Haze Speciation of Particulate Emissions Data (per boiler)**

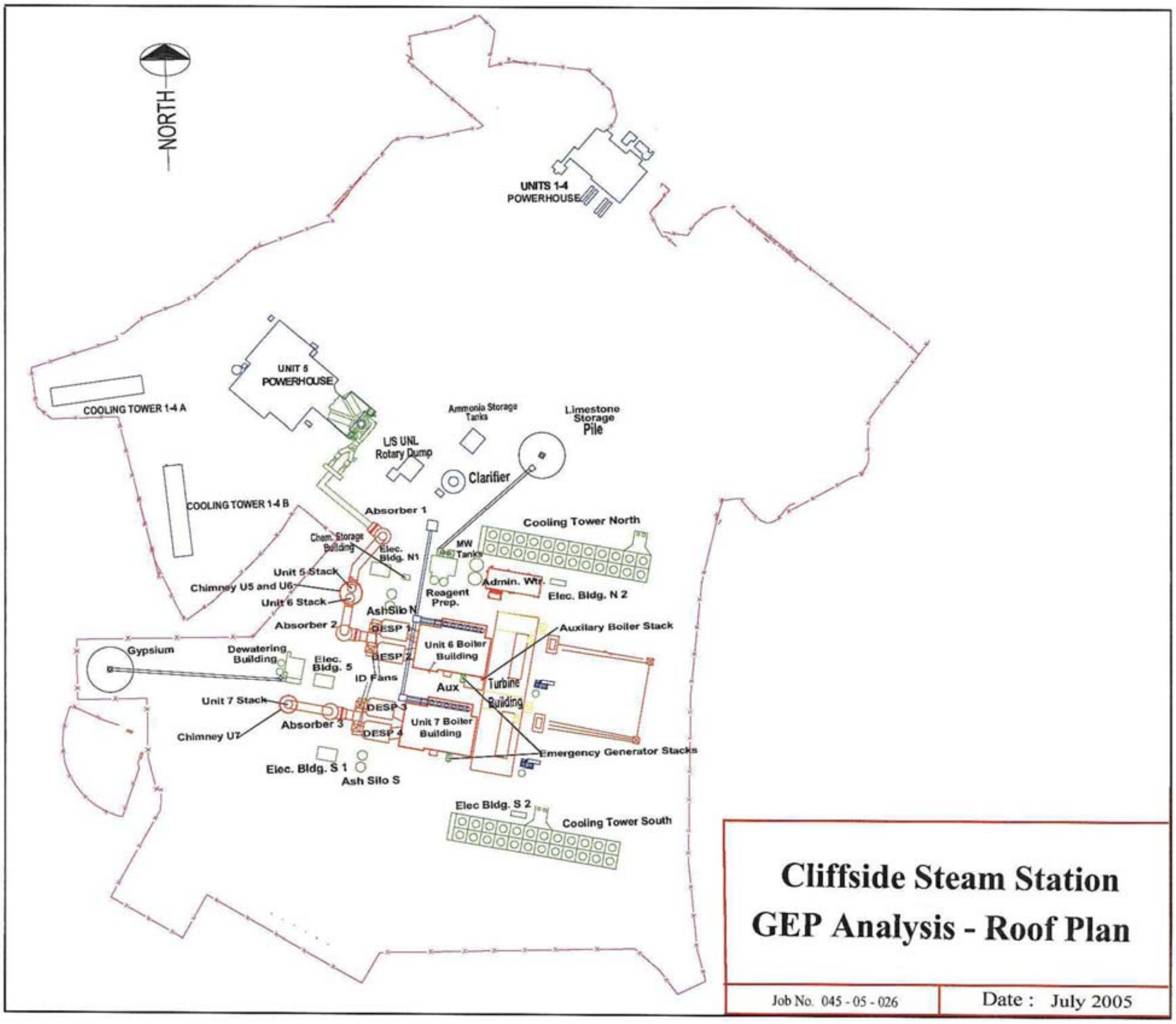
| Fuel | Boiler Type | Boiler Load % | Non-Sulfate $PM_{10}$ (lb/hr) | Filt. $PM_{10}$ (lb/hr) | Non-Sulfate Cond. $PM_{10}$ (lb/hr) | Primary $H_2SO_4$ (lb/hr) | Soils plus Inorganic (lb/hr)(1) | Carbon (lb/hr)(2) | Organics (lb/hr)(3) |
|---|---|---|---|---|---|---|---|---|---|
| Coal | Pulverized Coal | Peak | 121.7 | 94.2 | 27.5 | N/A | 112.4 | 3.8 | 5.5 |

(1) Soils = 96% of Filt. $PM_{10}$. Inorganic = 80% of Non-Sulfate Cond. $PM_{10}$.

(2) Elemental Carbon = 4% of Filt. $PM_{10}$.

(3) Organics = 20% of Non-Sulfate Cond. $PM_{10}$.

**Figure 2-1 Layout of Cliffside Steam Station**



# 3.0 CALPUFF MODELING

CALPUFF was promulgated by the United States Environmental Protection Agency on April 15, 2003 as a preferred dispersion model to assess long-range transport applications (transport distances exceeding 50 kilometers). For the Cliffside Steam Station, the distance to each of the PSD Class I areas is greater than 50 km. At this distance, a non-steady-state modeling approach which considers spatial and time variations in meteorological conditions, such as CALPUFF, is appropriate.

## 3.1 Modeling Procedures

### 3.1.1 Selection of Dispersion Model

ENSR will run CALPUFF 5.724 (level 041013) in a refined mode to determine the effect that the proposed project's emissions will have on $NO_X$ and $PM_{10}$ increment, regional haze (without consideration of $SO_2$ and $SO_4$ emissions, which net out), and nitrogen deposition. CALMET is the meteorological pre-processor for the CALPUFF modeling system which produces three-dimensional wind fields that incorporate a variety of meteorological data observations and terrain effects. Advanced meteorological data in the form of prognostic mesoscale meteorological data (such as the Fifth Generation Mesoscale Model (MM5) will be used to provide a superior estimate of the initial wind fields. This application will consider three years, 2001-2003, of prognostic MM5 meteorological data. The 2001-2003 databases were provided by Alpine Geophysics and are described by Olerud (2003) and McNally (2003, 2005).

### 3.1.2 Computational Grid

The CALMET and CALPUFF grid systems will extend at least 50 kilometers in all directions beyond the Cliffside Steam Station along with any portions of a Class I within 300 km to be assessed. The additional buffer distance of at least 50 km will allow for the consideration of puff trajectory recirculations. This design allows for a 360 km (E/W) x 248 km (N/S) computational grid (modeling domain) extent with 180 (NX) x 124 (NY) number of grid cells and a 2-km grid element size. The southwest corner of the grid is located at approximately 34.07° N latitude and 85.16° W longitude. Figure 3-1 shows the proposed modeling domain. ENSR may determine that finer grid resolution is needed in the vicinity of high terrain in specific cases. If a finer grid resolution is warranted needed, then we will use a grid spacing smaller than 2 km, but we plan to use 2-km spacing initially due to the large file sizes generated by the smaller grid size.

Due to the size of the modeling domain used for this analysis, a Lambert Conformal Conic (LCC) coordinate system is proposed. The LCC projection is proposed because it accounts for the curvature of the Earth's surface. The LCC projection for this analysis is based on the WGS-84 datum and standard parallels of 30° N and 60° N, with an origin of 35.5° N and 81.5° W.

### 3.1.3 CALMET Processing

In accordance with the IWAQM Phase II guidance, CALMET, the CALPUFF meteorological pre-processor, will be used to simulate three years (2001, 2002, and 2003) of meteorological conditions. For the hourly wind field initialization, CALMET will use gridded prognostic mesoscale meteorological (MM5) data for all years. For all years, the MM5 data is available every 36 kilometers within the modeling domain. The years 2001-2003 are being proposed instead of the older 1990, 1992, and 1996 databases because the horizontal resolution for the 1990 and 1992 data is coarse (80 km) as opposed to 36 km for 2001-2003 and the MM4 modeling system is inferior to the more up-to-date version of the MM5 model used to generate the 2001-2003 data sets. These years are also consistent with those proposed as a part of the VISTAS workgroup's BART assessments.

These prognostic meteorological data sets will initially be combined with 2-km grid resolution terrain and land use data to more accurately characterize the wind flow throughout the modeling domain. ENSR may determine that finer grid resolution is needed in the vicinity of high terrain in specific cases. The 2-km gridded terrain data will be derived from United States Geological Survey (USGS) 1:250,000 (3 arc second or 90-meter grid spacing) Digital Elevation Model (DEM) files and the TERREL pre-processor program. The gridded land use data will be derived from USGS 1:250,000 Composite Theme Grid (CTG) land use files. Figures 3-2 and 3-3 show the terrain and land use, respectively, as characterized throughout the modeling domain.

The Step 2 wind field will be produced with the input of all available National Weather Service (NWS) hourly surface and twice daily upper air balloon sounding data within and just outside the modeling domain. Hourly surface data from both first-order and second-order stations will also be considered in this analysis. Other sources of meteorological data such as CASTNET data may be used to supplement areas lacking NWS or second-order data. Hourly precipitation data from stations within and just outside of the modeling domain will be taken from a National Climatic Data Center (NCDC) data set for purposes of wet scavenging of the plume and wet deposition calculations. Figure 3-1 shows the locations of all meteorological stations whose data will be used as input to CALMET.

### 3.1.4 Receptors

Receptors from the National Park Service (NPS) database of Class I receptors will be used for this modeling analysis (found at: http://www2.nature.nps.gov/air/maps/Receptors/index.htm).

## 3.2 Assessing Air Quality Impacts at Class I Areas

The CALPUFF refined modeling will be conducted with hourly background ozone data from the closest monitors and monthly average ammonia background values. In the absence of hourly ozone data for a particular hour, the monthly average of all hourly data from all stations will be used. The background ammonia concentration will initially be taken from the IWAQM Phase 2 guidance that suggests values based on the predominant land use throughout the modeling domain. However, if needed, refinements to the IWAQM ammonia background concentration will be considered due to observed seasonal variations in the background ammonia levels. IWAQM guidance provides the following values for background ammonia concentrations:

- Grasslands – 10 ppb
- Forest – 0.5 ppb
- Arid Lands @ 20° C – 1 ppb.

Figure 3-3 in the next subsection indicates a predominance of forest cover within the modeling domain which would warrant the use of 0.5 ppb as the ammonia background value. However, 1.0 ppb will be used as a conservative initial estimate.

### 3.2.1 Class I Increment Values

CALPUFF and CALPOST will be used with CALMET meteorological data to assess maximum concentrations of $NO_X$ and $PM_{10}$ due to emissions from the new main boiler stacks at Shining Rock Wilderness, Linville Gorge Wilderness, Joyce Kilmer-Slickrock Wilderness, Cohutta Wilderness, and Great Smoky Mountains NP. Initially, it will be conservatively assumed that 100 percent of the $NO_X$ emissions are converted to $NO_2$, but a national default conversion rate of 75 percent will be used to more accurately assess modeled $NO_2$ impacts, if a refined analysis is necessary. The modeled concentrations at all receptors within the Class I areas will be documented and compared to their proposed significant impact level (SILs) shown in Table 3-1.

**Table 3-1 Class I Area Significant Impact Levels**

| Pollutant | 3-hour* ($\mu g/m^3$) | 24–hour* ($\mu g/m^3$) | Annual** ($\mu g/m^3$) |
|---|---|---|---|
| $PM_{10}$ | NA | 0.32 | 0.16 |
| $NO_2$ | NA | NA | 0.1 |
| * Highest of the second-highest modeled concentrations at any receptors.<br>**Highest arithmetic mean concentration at any receptor.<br>NA = not applicable. | | | |

### 3.2.2 Acidic Deposition

CALPUFF and CALPOST will be applied to obtain upper limit estimates of annual wet and dry deposition of nitrogen compounds (kg/ha/yr) associated with emissions from the new main boiler stacks at Shining Rock Wilderness, Linville Gorge Wilderness, Joyce Kilmer-Slickrock Wilderness, Cohutta Wilderness, and Great Smoky Mountains NP. Specifically, CALPUFF will be used to model both wet and dry deposition of $NO_3$ and $HNO_3$ as well as dry deposition of $NO_X$ to estimate the maximum annual wet and dry deposition of nitrogen (N) at the Class I areas.

The deposition results will be documented for evaluation. However, it is noted that the United States Department of Agriculture Forest Service web site (http://www.fs.fed.us/r6/aq/natarm/document.htm) indicates that the minimum detectable level for measuring an increase in wet deposition of sulfates or nitrates is 0.5 kg/ha/yr. For conservatism, the Forest Service recommends a significance level of one tenth of this minimum detectable level, or 0.05 kg/ha/yr. The FLM has also recently developed a Deposition Analysis Threshold (DAT) of 0.01 kg/ha/yr in the east (FLAG, 2002 – Eastern US; DAT = 0.005 kg/ha/yr – Western US) to be used as a threshold for further FLM analysis, rather than as an adverse impact threshold (Porter, 2004). Since all Class I areas to be assessed in this analysis are east of the Mississippi River, the selected DAT for this project is 0.01 kg/ha/yr.

It is important to note that the DAT value was established because the FLMs are concerned that, over time, cumulative deposition from emission sources may produce impacts upon Class 1 areas that are of concern. The FLMs needs to have a reasonable assurance that cumulative deposition from all new sources does not exceed 50% of natural background. Natural background in eastern Class 1 areas is 0.5 kg/ha/yr. This value was multiplied by 0.5 to attain 50% of natural background and by 0.04 which is a safety factor to account for cumulative new source growth consisting of 25 identical facilities in the area of concern (0.5 x 0.5 x 0.04 = 0.01). Therefore the use of a 0.01 kg/ha/yr threshold of concern for a new PSD source is very conservative due to the assumption of cumulative growth and due to not considering a substantial reduction in deposition from reductions in SO2 emissions in the East.

### 3.2.3 Regional Haze

CALPUFF and CALPOST processing will be used for the regional haze analysis to compute the maximum 24-hour average light extinction due to $NO_X$, and $PM_{10}$ emissions from the new main boiler stacks at Shining Rock Wilderness, Linville Gorge Wilderness, Joyce Kilmer-Slickrock Wilderness, Cohutta Wilderness, and Great Smoky Mountains NP.

The computation of incremental background light extinction due to the proposed new main boiler stack's emissions will use the option to calculate extinction from speciated particulate matter measurements, by applying the EPA-recommended hourly relative humidity adjustment factors to background and modeled sulfate and nitrate (MVISBK=2). The EPA-recommended hourly relative humidity adjustment factors were published in September 2003 "Guidance for Tracking Progress Under the Regional Haze Rule" (EPA 2003). FLAG guidance recommends that the hygroscopic particle growth curve be capped when the relative humidity exceeds 98 percent, although the FLMs have allowed a cap of 95% for several projects. This cap is consistent with monitoring guidance in support of the IMPROVE program that flags nephalometer measurements with relative humidities of at least 95% (and transmissometer measurements with relative humidities of at least 90%) as correspond to hours with meteorological interferences. Therefore, for this analysis, ENSR proposes to cap the particle growth curve at 95 percent relative humidity.

In order to determine a percent change in light extinction due to the project-related emission increase, a reference background light extinction must be quantified. The State of North Carolina has a Memorandum of Understanding (MOU) with the FLM that allows the use of existing "clean day" background values. This equates to the mean of the 20 percent cleanest days at each specific park to be representative of the background light extinction for purposes of calculating the project-related percent change in light extinction (Evans 2002) (see Attachment 1). Therefore, based on the guidance provided in the MOU for this project at the Cliffside Steam Station, ENSR proposes to use the mean of the 20 percent cleanest days as the background light extinction in CALPOST. These annual average values are summarized in Figure 3-4 for each affected Class I area within 300 kilometers of the Cliffside Steam Station. The background values are based on a 2000-2002 IMPROVE data summarized in a VISTAS workgroup report (Brewer 2004).

As noted in FLAG (2000), if a project-related change in extinction is less than 5 percent of the background extinction (as defined in Table 3-2), then the project's regional haze impact is determined to be insignificant and no further modeling is required to demonstrate no adverse impact. If the project-related change in extinction exceeds 5 percent, then further analysis is warranted. For that purpose, we would consider an alternative analysis for additional information to be considered by the permitting authority and the FLMs, as noted below. The reviewers will then analyze the information being submitted and consider whether a conclusion of no adverse impact is reasonable.

One such component of an alternative analysis could include the investigation of whether days associated with impacts greater than a 5% change in the extinction involve natural obscuration due to meteorological interferences: precipitation, fog, high relative humidity, and/or a cloud ceiling during nighttime hours. In such an event, for that hour a modified background visual range would be applied more representative of the visual range during that meteorological interference. The daily average change would then need to be recalculated based on the daily average of the hourly percent changes rather than using the current averaging scheme that take ratio of the daily average modeled and background extinction. This is done based on feedback from the FLMs that one hour of observed meteorological interferences should not affect any other hours during that day. The most recent version of CALPOST has been designed to incorporate this analysis in a method referred to as 7'. This method is described in more detail in Attachment 2 from documentation provided to ENSR by Earth Tech, the CALPUFF model developer.

Additional refinements to the regional haze procedure may also be considered, such as (1) elevation-based adjustments to the Raleigh scattering extinction coefficient (if appropriate), (2) the use of the ammonia-limiting method to refine the estimate of ammonium nitrate formation that affects visibility impairment, and (3) the use of a finer scale modeling grid. The finer scale modeling grid may be especially appropriate where the interaction between the emitted puffs and the terrain surrounding the source or the Class I area may not well characterized with the initial grid spacing.

The default value for the Rayleigh scattering coefficient recommended by FLAG (2000) is 10 inverse megameters ($Mm^{-1}$). However, the Rayleigh scattering is a function of temperature, elevation, and pressure. The FLAG recommended value of 10 $Mm^{-1}$ is based on an elevation of 5000 ft. Since the maximum elevation at several Class I areas is less than 5000 ft, a refined Rayleigh scattering coefficient can be calculated based on a standard atmosphere (T = 15.2 C, p = 1016 hPa) and the average elevation of each Class I area.

**Figure 3-1 Computational Grid and MET Stations Used for CALMET and CALPUFF Modeling**

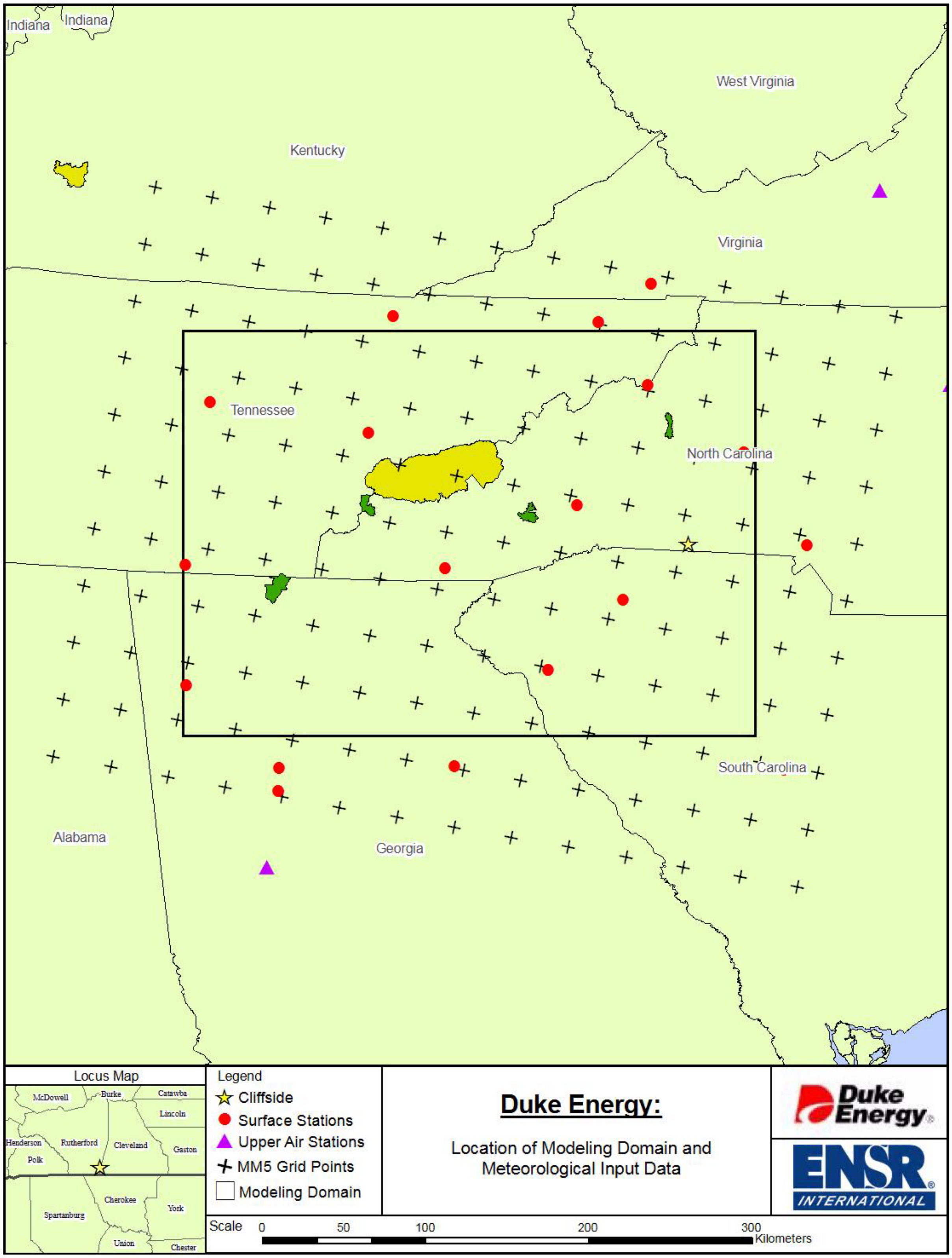


**Figure 3-2 3-D Terrain as Characterized Throughout the Modeling Domain (Looking NW)**

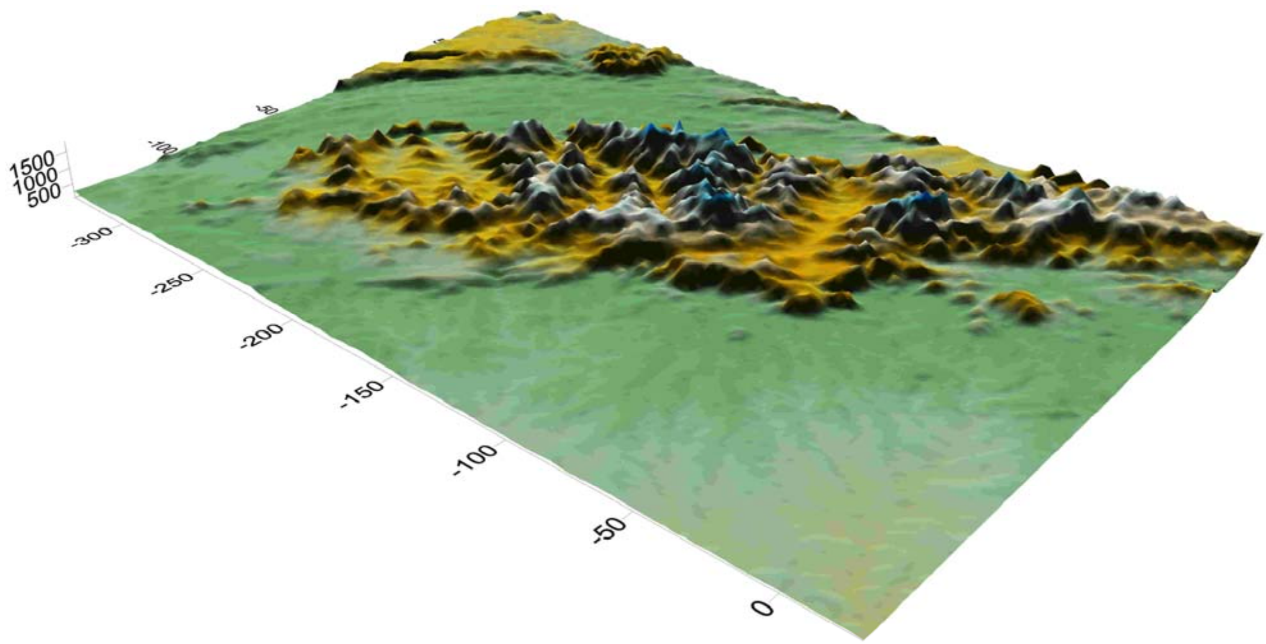


**Figure 3-3 Land Use as Characterized Throughout the Modeling Domain**

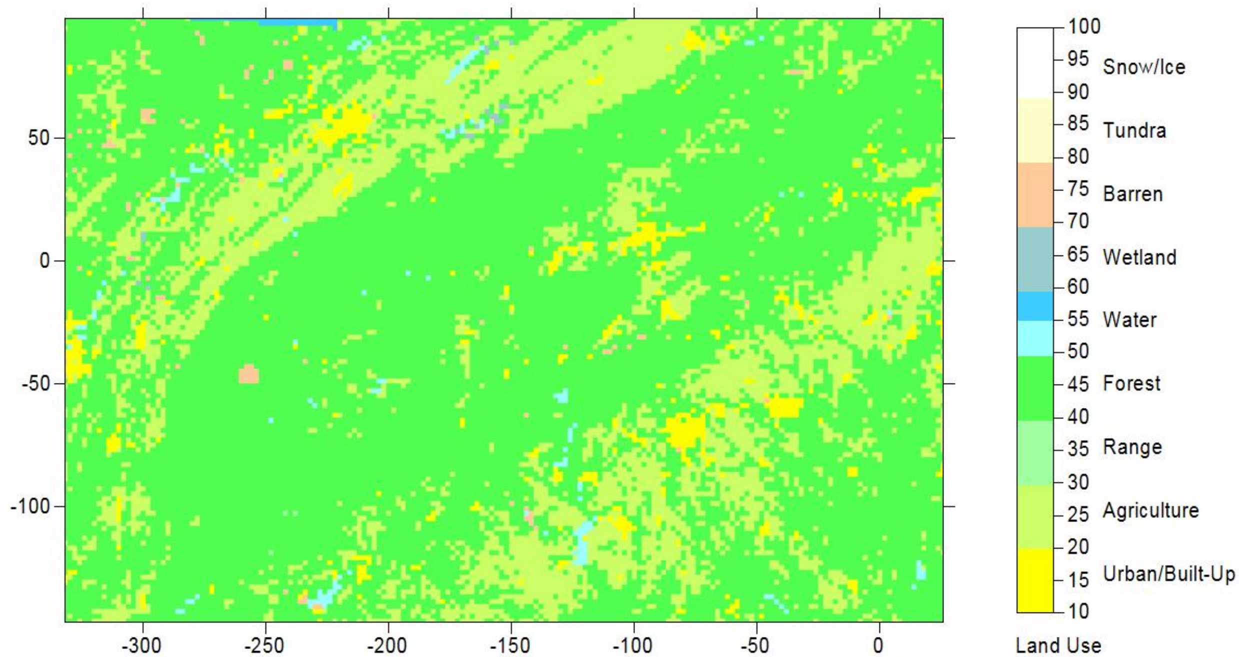
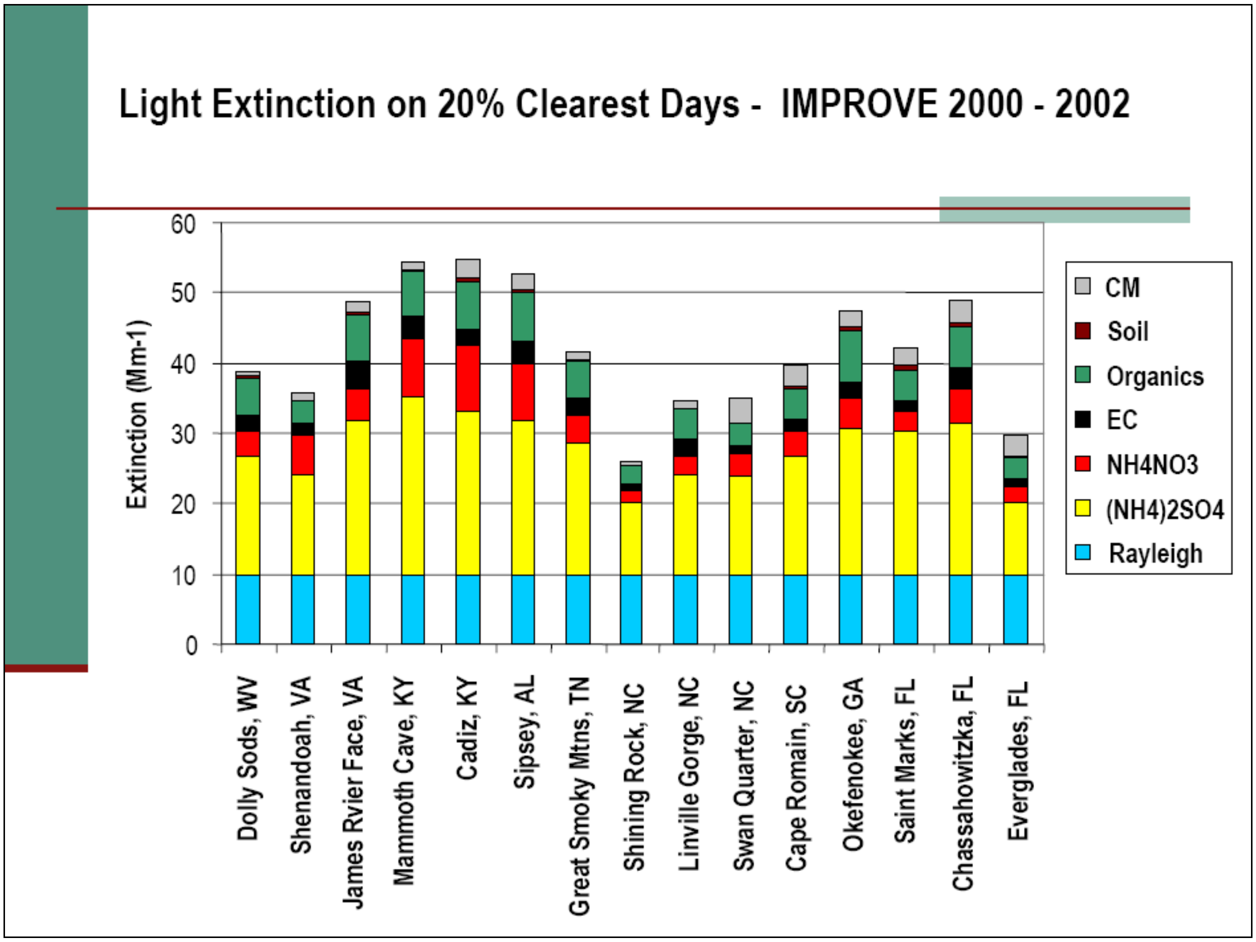


**Figure 3-4 Light Extinction on 20% Clearest Days – IMPROVE 2000-2002 (Brewer 2004)**



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# Attachment #1

October 9, 2002

**To:** Donald van der Vaart

**From:** John C. Evans

**Re:** Background Visual Range
Visibility AQRV Analysis under the PSD Program

**Issue:**
Is the background visual range (BVR) used in an Air Quality Related Value (AQRV) analysis for visibility an input parameter value within the meaning of the Memorandum of Understanding (MOU) between DENR and the Federal Land Managers (FLMs)? If so, how should the BVR be determined?

**Conclusion:**
Yes, the background visual range is "parameter value within the meaning of paragraph C of the MOU. The appropriate BVR to be used under the PSD program is a range based on existing conditions.

**Discussion:**
On April 7, 1999 North Carolina entered into a MOU with the FLMs. The MOU, which was originally set to expire in December of 2000, has been extended until March of 2003 by written agreement of both parties. The MOU was intended to enhance communication between the parties and by its express terms was not intended to modify existing law or regulations. When performing an AQRV analysis, the MOU requires that "All modeling and/or analysis shall be performed in accordance with applicable statutes, regulations, policies and guidance. However, the MOU also provides that the permitting authority, DENR, has the express authority to "define the assumptions, including the parameter values, needed to complete the ... AQRV analysis. When deciding what the BVR for a Class I area should be, the issue was raised as to whether BVR is a "parameter value(s) in the context of an AQRV analysis for visibility.

BVR As a Parameter

Under North Carolina's PSD regulations an applicant is required to perform a visibility analysis if the FLM alleges that the proposed project may have an impact on a Class I designated area (see 15 NCAC 2D .0530(p)). However, the method to be used to carry out a visibility analysis is not defined in any existing statute or regulation. The FLMs for the various Class I areas have, over the years, developed guidance detailing how they believe an AQRV analysis should be performed. These policies have been modified and revised numerous times over the last several years with the latest guidance issued in December 2000 under the name Federal Land Managers Air Quality Related Values Workgroup (FLAG). The FLAG document specifically identifies background visual range as one of several "Visibility Parameters . (FLAG report Appendix 2.A., p. 36; listing "visibility parameters.

BVR Value for PSD Purposes

As noted above the FLMs have issued numerous guidance documents describing how to perform a visibility analysis. The December 2000 FLAG document represents the most recent guidance. One of the most significant changes between earlier guidance and the December 2000 FLAG document is the recommendation to use "natural background when evaluating new sources under the PSD permitting program. Natural background is defined as "the long-term degree of visibility that is estimated to exist in a given mandatory Class I area in the absence of human-caused impairment. [1] The following discussion provides additional background on this issue.

This recommendation is different from prior guidance that recommended using existing background visual range conditions. For example, the November 2000 FLM guidance for the James River Face Wilderness Area in Virginia recommended using a background visual range of between 63 (62 km) and 105 $Mm^{-1}$ (37 km), depending on the season.[2] These values were established using monitored site specific IMPROVE data that represented the existing visual range in the Class I area. Under the FLAG guidance, instead of using the site specific IMPROVE data, the recommended background visual range would be changed to approximately 21 $Mm^{-1}$ (186 km). This is a much more stringent standard for the visibility analysis than the use of existing background visual range as recommended by the FLM in earlier guidance documents.[3,4] The earlier guidance documents include the

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[1] Draft Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule, September 27, 2001, U.S. EPA, Office of Air Quality Planning and Standards, p. 1-2.

[2] Preliminary Air Quality Related Screening Values for the James River Face Wilderness, a Class I Area in Virginia, November 2000. Table 2. Seasonal Clear-day Aerosol Profile for James River Face IMPROVE monitoring site (8/94 – 9/96).

[3] Background visual range (VR) is the greatest distance that a large dark object can be seen and is often expressed as inverse megameters (Mm-1). The light extinction coefficient, the attenuation of light per unit distance due to scattering and absorption by gases and particle in the atmosphere, is expressed as ($B_{ext}$). Under certain conditions, these parameters are inversely related to each other.
VR (km) = $3912/((b_{ext}\ (Mn^{-1}))$. The background VR is used as the denominator in determining the % change in visibility. For example, if the extinction attributable to a new source is determined to be 10.0 $Mm^{-1}$ then the % change for this source against an existing background of 50 $Mn^{-1}$ would be (10/50) or 20%. However, the same source as compared to a natural background of 20 $Mn^{-1}$ would be (10/20) or 50%. Without changing the sources contribution the perceived impact of the source on visibility in the Class I area is dramatically increased.

[4] See Preliminary Air Quality Related Screening Values for Three Class I Areas in North Carolina and Tennessee (undated document issued by the Forest Service); Tables 2 and 3 list IMPROVE visual range data and example calculations showing how to calculate visibility impacts.

December 1998 Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Report. The IWAQM Phase 2 report recommended the use of background conditions based on actual IMPROVE data of existing conditions.[5]

In developing the FLAG guidance the FLM's requested comments from interested parties. Several commentors raised the issue of using natural background in the context of the PSD program. In fact, the Mid-Atlantic Regional Air Management Association (MARAMA) [6] specifically rejected the recommendation to use natural background saying, "It would be more reasonable to compare a new source's visibility impact to the *current visibility measurements*, such as the value representative of the 10 percent of days with the greatest visual range at the Class I area. Use of measured values would help account for each Class I areas unique factors effecting its background visual range. [7] (emphasis added).

It is also important to note that the MOU between the FLM and NC currently in effect states in Paragraph C that the screening level values used in these analyses should be "based on *current* air quality and AQRV conditions. (emphasis added).

One important consideration when deciding what is the appropriate background visual range to be used for the purposes of the Prevention of Significant (PSD) permitting program is to consider the context of the FLAG recommendation. According to the FLAG document "the basis for some of the decisions outlined in this chapter [including the use of natural background] is Section 169A of the Clean Air Act. Section 169A of the CAA is entitled "Visibility Protection for Federal Class I Areas. [8] The stated goal of this section of the Act is the "prevention of any future, and the remedying of any existing, impairment in visibility in mandatory class I areas which impairment results from man-made air pollution. [9] On July 1, 1999 the EPA issued the final Regional Haze rule pursuant to this section requiring states to develop and submit a SIP [State Implementation Plan] that provides for reasonable progress toward achieving "natural visibility conditions in class I areas.[10]

While the rule was challenged, the court upheld the EPA Regional Haze rule with respect to the issue establishing a goal of natural conditions calling the decision "an eminently reasonable elucidation of the statute. [11] However, the decision included a discussion of the relationship between the goal of natural conditions under the Regional Haze (RH) regulations and the visibility concerns of the Prevention of Significant Deterioration program. Industry petitioners had argued

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[5] IWAQM Phase 2 Report, EPA–454/R-98-019, December 1998, p. 27.

[6] The Mid-Atlantic Regional Air Management Association is a non-profit association of state and local air pollution control agencies. MARAMA was organized on February 26,1990, by Mid- Atlantic Governors, Mayors, and County Commissioners to promote cooperation and coordination among their air quality agencies. The following State and Local governments are MARAMA members: Delaware, the District of Columbia, Maryland, New Jersey, North Carolina, Pennsylvania, Virginia, West Virginia,
Philadelphia, and Allegheny County, Pennsylvania

[7] MARAMA Class I Area Modeling and Inventory Recommendations, May 22, 2001.

[8] FLAG report, p. 24 (December 2000).

[9] 42 U.S.C § 7491(a)(1).

[10] 64 Fed. Reg. At 35,714 (July 1, 1999).

[11] American Corn Growers v. EPA, D.C. Circuit Ct. May 24, 2002, at __.

that the natural visibility goal and the no degradation requirement under the RH rule could not be reconciled with the PSD program. The court agreed with the EPA argument that the PSD program and the RH program were distinct. The EPA characterized the relationship between the two programs by stating "[w]e believe that allowing localized air quality increases in the short-term due to the emissions from major new sources subject to PSD is not inconsistent with the regional haze program. The regional haze program is focused on long-term emission decreases from the entire regional emissions inventory over the 60 year implementation plan allowed under the regulations. The court recognized EPA's position that the PSD program, unlike the RH program, was never intended to reduce existing ambient pollutant concentrations. Instead, the PSD program was specifically designed to allow for expansion of the industrial base but consistent with the RH program designed to address baseline ambient problems over a longer time scale.

Given the EPA's and the court's characterization of these programs, it is a reasonable conclusion that the proper BVR to be used under the PSD program should be different from the BVR used in the RH program.

North Carolina has shown a commitment to clean air and to protecting Class I areas. NC is one of only two states in the nation that has signed the MOU with the FLM's dealing directly with the issue of AQRVs. Several other states in the southeast have been approached but have declined to sign the MOU. In addition, North Carolina is the first state in the nation to pass a "Clean Smokestacks law. This law requires a 78% cut in nitrogen oxide emissions (ozone) by 2009 and a 73% reduction in sulfur dioxide (haze) by 2013. It would also require the state to study issues related to setting standards for mercury and carbon dioxide. Finally, North Carolina is committed to implementing the Regional Haze regulations and was instrumental in developing the VISTAs modeling workgroup.[12] This group is currently working with other southeast states to develop a regional plan to address regional haze.

These actions clearly demonstrate North Carolina's commitment to protecting air quality in and around Class I areas. North Carolina is also committed to environmentally responsible economic growth. The PSD program, when properly implemented, allows such growth. The decision to use existing BVR under the PSD program is consistent with the goals of the PSD program without compromising North Carolina's commitment to improving air quality in Class I areas.

cc: Ed Martin
Charles Buckler
Rahul Thaker
Tom Anderson

[12] VISTAS is The Visibility Improvement State and Tribal Association of the Southeast. VISTAS is a collaborative effort of state governments, tribal governments, and various federal agencies established to
initiate and coordinate activities associated with the management of regional haze, visibility and other air quality issues in the Southeastern United States.

# Attachment 2:

## CALPOST Method 7'

## (Documentation provided by Earth Tech July 2005)

CALPOST Method 7 is one way of assessing the impact of natural weather events on background visual range, which is a key component of the visibility calculation. A variation of this method, called Method 7 Prime (7'), makes use of alternative method to compute 24-hour average change in light extinction. The changes introduced in Method 7' address comments received from the Federal Land Managers regarding the potential large effect of a single weather-affected hour using the Method 7 technique. As explained below, the 24-hour average change in light extinction with Method 7' is much less sensitive to individual hours with natural weather events.

The Method 7' visibility analysis option makes use of liquid water content and precipitation rate data in the CALMET 3D.DAT dataset (i.e., MM5 or RUC three-dimensional fields used as input to CALMET) to augment the procedures used in the FLAG-recommended Method 2 visibility analysis option (FLAG, 2000). Background visibility, expressed as the extinction coefficient (inverse megameters), is computed in Method 2 using the scattering extinction coefficients due to background concentrations of non-hygroscopic particles and hygroscopic particles (sulfates and nitrates) plus the Rayleigh scattering extinction coefficient, and the local relative humidity. Although the background extinction coefficient computed in this way increases with the relative humidity (the hygroscopic particles grow as the humidity increases, thereby increasing the scattering), effects of weather events that include fog or precipitation, which have a significant effect on background extinction, are not included. If the background extinction is meant to represent conditions during pristine conditions, the effects of natural weather events such as fog and precipitation are particularly important to consider. Method 7' allows liquid water content and precipitation rate computed in a 3D.DAT dataset to be used to obtain the background extinction coefficient during hours in which fog or precipitation are predicted, while the procedures of Method 2 are retained for all other hours.

In the FLAG-recommended procedure, visibility analyses are done over 24-hour averaging periods. The change in light extinction from an individual source or facility is calculated as the ratio of the 24-hour average light extinction due to the source contribution divided by the 24-hour average light extinction of the reference level (background aerosols from the pristine conditions). Method 7 uses the same averaging technique as Method 2. However, in Method 7, observed or computed background visual range (converted to light extinction) is substituted for the pristine values during hours with weather events (fog, rain, snow, etc.). In Method 7', a different averaging method is used. The ratio, source light extinction divided by background light extinction, is calculated every hour and then these 24 values are averaged to obtain the percent change in light extinction due to the source. This method of averaging allows the effect of fog and precipitation to have an impact only on the hours when a hydrometeor event occurs and only when the source contributes to the extinction at the receptor.

CALPOST reads fog/precipitation light extinction and visual range computed from 3D.DAT precipitation or liquid water content and extracted at the closest 3D.DAT grid point to the receptor. If the predicted extinction coefficient at the 3D.DAT grid point is null, the background extinction is computed using the Method 2 approach. Otherwise, the background extinction coefficient read at the 3D.DAT grid point is used for that hour.

Light extinction coefficient and visual range are computed using precipitation rate and/or hydrometeor mixing ratios. Both precipitation rate and mixing ratios of cloud water, rain water, cloud ice and snow are available at all 3D.DAT grid points and can be used to compute extinction coefficient. In most 3D.DAT datasets, precipitation rate is the total precipitation average over a one-hour period, while the mixing ratios are instant records of the last step of the hourly MM5 integration period. Cloud water mixing ratio is used to estimate 1-hour average fog light extinction coefficient because no other parameter is available, but light extinction due to rain water and/or snow is preferentially computed from precipitation rate than from their respective hydrometeor mixing ratio. In the CALPOST Method 7' code, the light extinction coefficient is computed using formulae extracted from viscalc.f routine (code provided by T. Allen, Fish and Wildlife Service for our use in testing of 3D.DAT liquid water content data in determining background extinction.).