BASIN ELECTRIC POWER COOPERATIVE
LELAND OLDS STATION
COMBINED UNIT 1 AND 2 MODELING ANALYSIS

The U.S. Environmental Protection Agency (EPA) finalized the Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations in July 2005. The final regulations require eligible sources to be analyzed to determine a BART emission limit for nitrogen oxides (NO_X), sulfur dioxide (SO_2), and particulate matter (PM). The North Dakota Department of Health (NDDH) determined that Basin Electric Power Cooperative, Inc.'s (BEPC's) Leland Olds Station (LOS) Units 1 and 2 are subject to a BART evaluation.

The NDDH prepared an air dispersion modeling protocol as a guideline to evaluate potential changes in visibility at nearby Class I Areas[1]. The NDDH modeling protocol requires that pre-control and post-control changes in visibility due to individual emission units be evaluated, and after the individual changes in visibility are determined, the entire facility's change in visibility is evaluated[2]. This document summarizes the facility change in visibility, and should be read in conjunction with the "BART DETERMINATION STUDY for Leland Olds Station Unit 1 and 2 Basin Electric Cooperative" Final Draft dated August 2006[3].

DEFINITION OF VISIBILITY IMPAIRMENT

Visibility impairment is caused by a combination of particles and gases in the atmosphere. Some particles and gases scatter light, others absorb light. The combined effect of scattering and absorption is called "light extinction" which is most commonly seen as haze. This haze is related to a haze index (HI) that is measured in deciview units; this haze index is related to light extinction coefficient by the following equation:

[1] A Class I Area has special national or regional value from a natural, scenic, recreational, or historic perspective. The EPA affords Class I Areas special protection against degradation of these values.
[2] NDDH "Protocol for BART-Related Visibility Impairment Modeling Analyses in North Dakota (Final), November 2005, page 53.
[3] The details of the BART modeling methodology, and changes in visibility from individual sources are summarized in the "BART DETERMINATION STUDY for Leland Olds Station Unit 1 and 2 Basin Electric Cooperative" Final Draft, August 2006.

$$HI = 10 \ln(b_{ext}/10)$$

Where HI is the haze index, and b_{ext} is light extinction coefficient in inverse megameters. An HI of 0.5 or more is considered a noticeable change in haziness, but not necessarily a visibility impairment.

Visibility impairment is a function of light extinction. Light extinction occurs when light energy is either scattered or absorbed by particles in the air. The amount of moisture in the air also plays a role in light extinction. Certain gases combine with moisture in the air to form small light scattering particles. These gases, most notably SO_2 and NO_X, are major components of coal-fired power plant emissions. Particulate matter (PM) also contributes to light extinction. In the final BART Determination Guidelines (70 FR 39160), EPA states that:

> "You may use PM_{10} as an indicator for particulate matter. [Note that we do not recommend the use of Total Suspended Particulates (TSP) as an indicator for particulate matter.]. As emissions of PM10 include the components of $PM_{2.5}$ as a subset, there is no need to have separate 250 ton thresholds for PM_{10} and $PM_{2.5}$. 250 tons of PM_{10} represents at most 250 tons of $PM_{2.5,}$ and at most 250 tons of any individual particulate species such as elemental carbon, crustal material, etc".

MODELING METHODOLOGY

The NDDH recommended using the current guideline version of the CALPUFF modeling system as modified by the NDDH to specifically address terrain, climate, and emission characteristics of the LOS[4]. One of the NDDH modifications is the CALBART post-processing program. CALBART uses the Federal Land Mangers' Air Quality Related Values Workgroup (FLAG) Method 6 for calculating light extinction. Along with the CALPUFF modeling system, the NDDH also provided the RUC2-MM5 gridded wind field data (2000-2002), the surface, upper air, and precipitation files, and the CALMET and CALPUFF input files. These input files contained the specific coordinate grid

[4] CALMET and CALPUFF were recompiled by the NDDH while the CALPOST executable used for this visibility analysis was the EPA guideline executable

points, wind field options, terrain, dispersion options, receptor coordinates, plume characteristics, and other model parameters that the NDDH has determined best represents the region.

The NDDH confirmed that the two Class I areas to be considered for visibility impairment analysis are the Theodore Roosevelt National Park (TRNP) and Lostwood Wilderness Area (LWWA).

BEPC performed an analysis to determine what emission levels would constitute BART. Those emission rates are listed in the attached Table 1[5]. In order to predict the change in light extinction at the TRNP and LWWA areas, SO_2, NO_x, and PM were modeled with CALPUFF using the emission controls determined to be BART. Even though other pollutants are emitted during coal combustion, the BART guidelines focus on SO_2, NO_x, and PM. The NDDH identified 104 receptors allocated over both the TRNP and the LWWA. These receptors are the points for which CALPUFF was used to perform a visibility calculation.

A BART visibility impact analysis measures visibility improvement over the worst 2 percent (98^{th} percentile) and 20 percent (90^{th} percentile) visibility days at each receptor. The 98^{th} percentile is the 8^{th} worst visibility day (2 percent times 365 days equals about eight days). Since visibility is a 24-hour averaged analysis, the 90^{th} percentile is calculated where each receptor was tabulated for each day and the worst 73 days (365 days times 0.2 equals about 73 days) were averaged together to determine the worst 20 percent visibility days.

DEGREE OF VISIBILITY IMPROVEMENT

The NDDH does not have a target threshold for visibility improvement for BART analyses. The BART determination takes into account the following parameters:

1. The cost of compliance.

[5] Details of the controls and emission limits are found in the "BART DETERMINATION STUDY for Leland Olds Station Unit 1 and 2 Basin Electric Cooperative" Final Draft, August 2006.

2. The energy and non-air quality environmental impacts.
3. Any pollution control equipment in use at the source.
4. The remaining useful life of the source.
5. The visibility that may reasonably be anticipated to result from the use of such technology.

Parameter number five does not set a target threshold for visibility. As a result, Units 1 and 2 were combined to fulfill parameter number five, and to show the improvement in visibility from the LOS facility. The pre-control emissions were taken from the NDDH modeling protocol. The post-control emissions are the expected emissions after employing BART.

Table 2a presents the pre-control visibility impacts while Table 2b shows the post-control visibility impacts when employing BART. Both Tables 2a and 2b are the direct output from CALPUFF's CALBART post-processor. The tables show the change in deciview when compared to background values, the total deciview (background and LOS sources), and the year, day, and location of the occurrence (SEQ RECP, and ND RECP columns in Table 2a and 2b). The final four columns in both tables breakdown the contribution of the haziness into its components: sulfates, nitrates, fine particulate, and coarse particulate.[6]

Table 3a shows that the three-year average improvement in visibility ranged from 56 percent to over 77 percent when the largest, 98th percentile, and 90th percentile deciview changes are compared to pre-control levels. Table 3b shows that the average number of hazy days over 0.5 deciview decreased about 65 percent when compared to pre-control levels. The number of hazy days is the total number of hazy days over 0.5 and 1.0 change in deciview.

[6] Details of the CALPUFF modeling methodology are found in the "BART DETERMINATION STUDY for Leland Olds Station Unit 1 and 2 Basin Electric Cooperative" Final Draft, August 2006, pgs. 85, 116, 217, 227.

CONCLUSION

A BART analysis does not need to meet a target threshold for visibility improvement; in other words, the LOS does not need for a BART to achieve a certain HI value. The visibility values listed in Tables 2b, 3a and 3b should be considered the visibility that may reasonably be anticipated to result from the use of the BART controls.

REFERENCES

Burns & McDonnell. August 2006. *BART DETERMINATION STUDY for Leland Olds Station Unit 1 and 2 Basin Electric Cooperative Final Draft*. Kansas City: Burns & McDonnell.

North Dakota Department of Health. November 2005. *Protocol for BART-Related Visibility Impairment Modeling Analyses in North Dakota (Final)*. Bismarck, North Dakota: North Dakota Department of Health.