BEFORE THE ENVIRONMENTAL QUALITY COUNCIL
STATE OF WYOMING

In the Matter of:	)	
Basin Electric Power Cooperative	)	Docket No. 10-2802
Air Quality Permit No. MD-6047	)	
BART Permit: Laramie River Station	)	

RESPONSE TO BASIN ELECTRIC'S MOTION FOR SUMMARY JUDGMENT

Basin Electric's Revised Modeling Submittal, received 2/15/08

EXHIBIT 22

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Basin Electric Power Cooperative
Laramie River Station

B&V Project 145423.0033
B&V File 30.0000
February 14, 2008

Mr. Josh Nall
State of Wyoming
Department of Environmental Quality
Air Quality Division
122 West 25th Street
Herschler Building, 2-E
Cheyenne, WY 82002

Subject: Revised Best Available Retrofit Technology Modeling

Mr. Nall,

On January 15, 2008 WDEQ requested a revision to Basin Electric Power Cooperative's (BEPC) September 25, 2007 BART modeling. The revision was to include updated locations of upper air meteorological stations and a ZFACE height change from 2,980 m to 3,400 m. On behalf of BEPC please find enclosed three copies of the revised sections of Laramie River Station's BART report and one external hard drive containing the revised electronic modeling files.

If you have any questions regarding the contents of this submittal please call me at 913-458-9062. For specific questions regarding the Laramie River BART analysis please contact Bob Eriksen of Basin Electric at (701) 355-5654.

Very truly yours,

BLACK & VEATCH

Kyle Lucas

Kyle Lucas
Air Project Manager

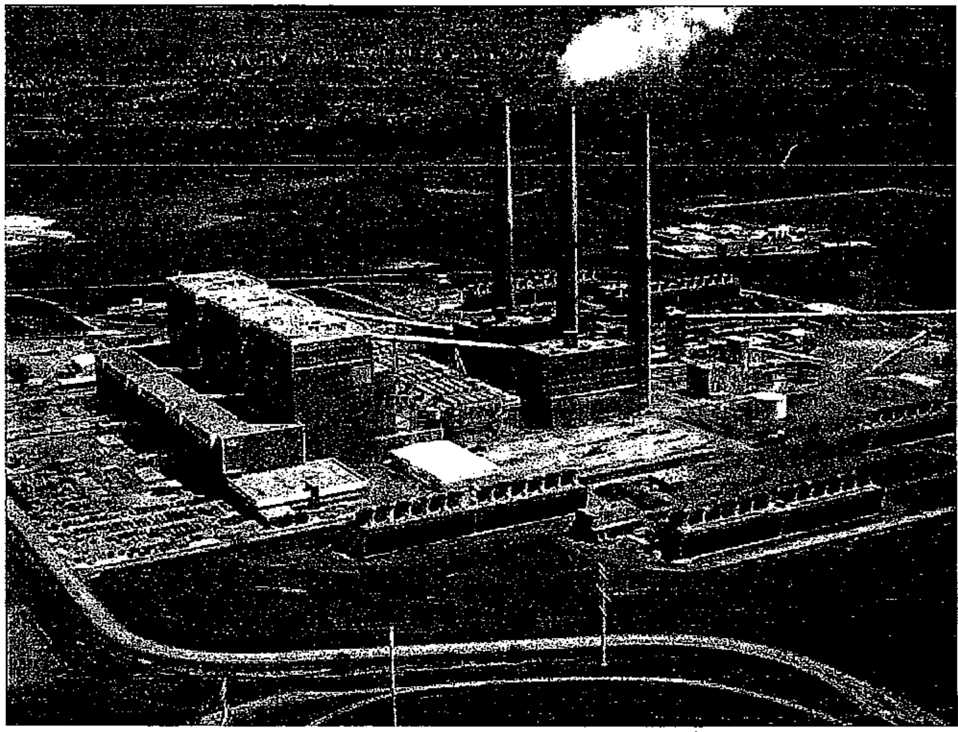
Enclosures

cc: B. Eriksen – Basin (w/o enclosure)
R. Huggins – B&V (w/o enclosure)
D. Chang – B&V (w/o enclosure)
File

Basin Electric Power Cooperative

Laramie River Station

Best Available Retrofit Technology Analysis



Black & Veatch Project: 145423
Black & Veatch File No.: 40.0000

Issue Date and Revision
September 25, 2007, Final Draft
February 14, 2008, Revision

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Executive Summary

The Wyoming Department of Environmental Quality (DEQ) identified Basin Electric Power Cooperative's (BEPC's) Laramie River Station (LRS) as a Best Available Retrofit Technology (BART) eligible source that required a BART engineering and modeling analysis for reducing visibility impacts in accordance with the Environmental Protection Agency's (EPA's) *Guidelines for BART Determinations* under the Regional Haze Rules (40 CFR Part 51, Appendix Y). A BART review was required to identify the best control technology for the reduction of nitrogen oxides (NO_x), sulfur dioxide (SO_2), and particulate matter (PM) emissions. LRS consists of three units: Units 1, 2, and 3.

Prior to performing the BART engineering analysis, a detailed set of design criteria was established for LRS. The design basis was established from information collected during the site visit, supplied plant operating data, performed combustion calculations, and industry standard engineering assumptions made for this analysis (refer to Appendix A for specific details). A summary of the operational characteristics is shown in Table 1-1. The economic design criteria established for the BART engineering analysis were used when estimating the cost of control of the identified technically feasible control technologies and when performing the impact analysis to determine the cost-effectiveness of these technologies. Data for the economic design criteria were developed with BEPC to best represent the actual operational costs for LRS. A summary of the economic design criteria is shown in Table 2-2.

The design basis was then used to establish the anticipated emissions reduction for each applicable technology, which is also called the control effectiveness. The control effectiveness for each applicable technology is shown in Tables 5-1 through 5-3.

Under the BART rule, presumptive levels of emissions are prescribed as emissions targets for BART-eligible units. For LRS, the presumptive NO_x limit is 0.23 lb/MBtu and for SO_2, it is 0.15 lb/MBtu. The NO_x presumptive limit was established based on the type of coal burned and the boiler design. In addition to these presumptive limits, the BART analysis evaluates control technologies that are required as Best Available Control Technology (BACT). PM does not have a prescribed presumptive limit.

The BART review utilizes a five-step process to determine the BART selected technologies. In Step 1 of the BART methodology, available retrofit emissions control technologies that may be practically implemented at the LRS site are identified for NO_x, SO_2, and PM. From this list of available technologies, technically feasible control technologies are identified in Step 2. A control technology is technically feasible if it is determined to have been successfully implemented at a similar facility and/or is commercially available. The technologies that were considered technically feasible in accordance with Step 2 included the following:

- NO_x:
  - Overfire Air (OFA) System.
  - New Low NO_x Burner (LNB).
  - Selective Noncatalytic Reduction/Selective Catalytic Reduction (SNCR/SCR) Hybrid (Cascade).
  - New LNB with OFA.
  - New LNB with OFA and SNCR.
  - SCR.
- SO_2 (for Units 1 and 2):
  - Sorbent Injection.
  - Flue Gas Desulfurization (FGD) Chemical Additives.
  - Elimination of Stack Reheat System.
- SO_2 (for Unit 3):
  - Fabric Filter Retrofit into Unit 3 Electrostatic Precipitator (ESP) Casing.
  - New Wet (W) FGD for Unit 3.
- PM:
  - Existing ESP.

In Step 3, the characteristics and features of the technically feasible control technologies are determined, and the estimated control effectiveness of the technology as applied to LRS was determined. Also evaluated in this step are the retrofit requirements for the control technology at the existing plant site; these are determined by considering the current configuration of the equipment and the situation at the plant site. Control effectiveness is a measure of the emissions reduction expected after the implementation of the control technology. The design parameters and control effectiveness for each control technology are summarized into the design concept definition sheets contained in Appendix B.

For Step 4 of the BART review process, cost-effectiveness is evaluated. An impact analysis for each technically feasible control technology was performed for this purpose. The impact analysis considers such issues as the cost of compliance, energy impacts, non-air quality impact, and the remaining useful life. Upon completion of the impact analysis for each control technology, the cost-effectiveness can be calculated. Cost-effectiveness is categorized as average cost-effectiveness and incremental cost-effectiveness. Summary tables of the technically feasible control technology and its impact analysis (for the three units) can be seen in Tables ES-1 through ES-3.

Table ES-1
Impact Analysis and Cost-Effectiveness Results (LRS 1)

All Feasible Technologies	Emission Performance Level (lb/mmBtu)	Expected Emission Rate (lb/yr)	Expected Emission Rate (ton/yr)	Expected Emission Reductions (tons/year)	Capital Costs (1,000$)	Total Annualized Cost (1,000$)	Cost Effectiveness ($/ton)	Incremental Cost Effectiveness ($/ton)	Energy Impacts (1,000$)	Non-Air Impacts (1,000$)
NO_x Control Technologies										
Overfire Air (OFA) System	**0.23**	**10,767,320**	**5,384**	**936**	**4,983**	**596**	**837**	--	**140**	--
New LNB	0.23	10,767,320	5,384	936	14,595	1,270	1,356	—	—	—
SNCR/SCR Hybrid (Cascade)	0.20	9,362,887	4,681	1,639	42,004	7,110	4,339	—	77	—
New LNB with OFA	**0.15**	**7,022,165**	**3,511**	**2,809**	**20,654**	**1,819**	**648**	**653**	—	--
New LNB with OFA and SNCR	0.12	5,617,732	2,809	3,511	40,596	7,060	2,011	—	77	—
Selective Catalytic Reduction (SCR)	**0.07**	**3,277,010**	**1,639**	**4,681**	**99,229**	**13,241**	**2,828**	**6,100**	414	**1**
SO_2 Control Technologies										
Sorbent Injection	0.15	7,022,165	3,511	234	7,453	906	3,871	—	62	—
FGD Chemical Additives	**0.15**	**7,022,165**	**3,511**	**234**	**2,363**	**366**	**1,564**	--	**6**	—
Eliminate Stack Reheat System	**0.13**	**6,085,876**	**3,043**	**702**	**63,845**	**6,664**	**9,490**	**13,453**	**459**	—

Notes:

1. Dominant controls are shown in bold
2. All costs are in 2006$
3. Incremental costs are based on:
   a) New LNB with OFA incremental cost relative to OFA
   b) SCR incremental cost relative to New LNB with OFA
   c) Eliminate Stack Reheat System incremental cost relative to FGD Chemical Additives

Table ES-2
Impact Analysis and Cost-Effectiveness Results (LRS 2)

All Feasible Technologies	Emission Performance Level (lb/mmBtu)	Expected Emission Rate (lb/yr)	Expected Emission Rate (ton/yr)	Expected Emission Reductions (tons/year)	Capital Costs (1,000$)	Total Annualized Cost (1,000$)	Cost Effectiveness ($/ton)	Incremental Cost Effectiveness ($/ton)	Energy Impacts (1,000$)	Non-Air Impacts (1,000$)
NO_x Control Technologies										
Overfire Air (OFA) System	**0.23**	**10,708,280**	**5,354**	**931**	**4,983**	**596**	**640**	--	**140**	--
New LNB	0.23	10,708,280	5,354	931	14,595	1,270	1,364	--	--	--
SNCR/SCR Hybrid (Cascade)	0.20	9,311,548	4,656	1,630	42,004	7,110	4,363	--	77	--
New LNB with OFA	**0.15**	**6,983,661**	**3,492**	**2,793**	**20,664**	**1,819**	**651**	**657**	--	--
New LNB with OFA and SNCR	0.12	5,586,929	2,793	3,492	40,596	7,060	2,022	--	77	--
Selective Catalytic Reduction (SCR)	**0.07**	**3,259,042**	**1,630**	**4,656**	**59,229**	**13,241**	**2,844**	**6,133**	**414**	**1**
SO_2 Control Technologies										
Sorbent Injection	0.15	6,983,661	3,492	233	7,453	906	3,892	--	62	--
FGD Chemical Additives	**0.15**	**6,983,661**	**3,492**	**233**	**2,363**	**366**	**1,572**	--	**6**	--
Eliminate Stack Reheat System	**0.13**	**6,052,506**	**3,026**	**698**	**63,846**	**6,664**	**9,542**	**13,527**	**459**	--

Notes:

1. Dominant controls are shown in bold
2. All costs are in 2006$
3. Incremental costs are based on:
   a) New LNB with OFA incremental cost relative to OFA
   b) SCR incremental cost relative to New LNB with OFA
   c) Eliminate Stack Reheat System incremental cost relative to FGD Chemical Additives

Table ES-3
Impact Analysis and Cost-Effectiveness Results (LRS 3)

All Feasible Technologies	Emission Performance Level (lb/mmBtu)	Expected Emission Rate (lb/yr)	Expected Emission Rate (ton/yr)	Expected Emission Reductions (tons/year)	Capital Costs (1,000$)	Total Annualized Cost (1,000$)	Cost Effectiveness ($/ton)	Incremental Cost Effectiveness ($/ton)	Energy Impacts (1,000$)	Non-Air Impacts (1,000$)
NO_x Control Technologies										
Overfire Air (OFA) System	**0.23**	**10,986,072**	**5,493**	**955**	**4,983**	**596**	**624**	--	**140**	--
New LNB	0.23	10,986,072	5,493	955	14,595	1,270	1,329	--	--	--
SNCR/SCR Hybrid (Cascade)	0.20	9,553,106	4,777	1,672	42,004	7,110	4,253	--	77	--
New LNB with OFA	**0.15**	**7,164,829**	**3,582**	**2,866**	**20,654**	**1,819**	**636**	**640**	--	--
New LNB with OFA and SNCR	0.12	5,731,863	2,866	3,582	40,596	7,060	1,971	--	77	--
Selective Catalytic Reduction (SCR)	**0.07**	**3,343,587**	**1,672**	**4,777**	**99,229**	**13,241**	**2,772**	**5,978**	**414**	**1**
SO_2 Control Technologies										
FF Retrofit into Unit 3 ESP Casing: peak rate for loss gen. costs	0.13	6,209,519	3,105	955	194,809	19,585	20,501	--	242	--
FF Retrofit into Unit 3 ESP Casing: non-peak rate for loss gen. costs	**0.13**	**6,209,519**	**3,105**	**955**	**134,934**	**14,376**	**16,049**	--	**243**	--
New WFGD for Unit 3	**0.06**	**2,865,932**	**1,433**	**2,627**	**240,777**	**31,243**	**11,893**	**10,089**	**3,858**	**715**

Notes:

1. Dominant controls are shown in bold
2. All costs are in 2006$
3. Incremental costs are based on:
   a) New LNB with OFA incremental cost relative to OFA
   b) SCR incremental cost relative to New LNB with OFA
   c) New WFGD for Unit 3 incremental cost relative to FF Retrofit into Unit 3 ESP Casing

Also performed in this step is the identification of the most cost-effective control technologies; these are determined by plotting the total annual cost versus the expected emissions reduction. The "least-cost envelope," as shown on Figures 6-1 to 6-3, identifies the most cost-effective control technologies for each pollutant. In summary, the most cost-effective control technologies, also recognized as the dominant control technologies under the guidelines of 40 CFR Part 51, are as follows:

- NO_x:
  - OFA System.
  - New LNB with OFA.
  - SCR.
- SO_2 (Units 1 and 2):
  - FGD Chemical Additives.
  - Elimination of Stack Reheat System.
- SO_2 (Unit 3 only):
  - Fabric Filter Retrofit into Unit 3 ESP Casing.
  - New WFGD for Unit 3.
- PM:
  - Existing ESP.

The control effectiveness information was then used as one of the factors for consideration (along with the cost-effectiveness, existing plant condition, retrofit difficulty of the control technology, and operational impacts of the new control technologies) to determine the control technology for visibility modeling so that the recommended BART control scenario could be identified. Therefore, to meet the presumptive level of emissions, the most cost-effective control technologies were selected as the recommended BART control scenario. The following is a list of the selected control technologies:

- NO_x:
  - OFA System.
- SO_2 (Units 1 and 2):
  - FGD Chemical Additives.
- PM:
  - Existing ESP.

Step 5 of the BART review process, visibility modeling, was performed next (refer to Appendix C for data on the stack outlet conditions). Visibility models were built for the existing emissions case (exemption modeling) and for the recommended control scenario selected, based on the results of the impact analyses. The visibility modeling was performed on a basis of a modeling protocol that was approved by the Wyoming

DEQ (Appendix E). The model was completed using meteorological data from the years 2001 to 2003. For each control technology modeled, the visibility data was analyzed for the 98th percentile modeled visibility and the number of days per year that the 0.5 deciview (dv) extinction criteria in each federal Class I area is exceeded. Two federal Class I areas were modeled: Badlands National Park and Wind Cave National Park.

The improvement in visibility for the recommended BART control scenario is 0.2 dv for all 3 years modeled. This corresponds to the number of days exceeding the 0.5 dv extinction criteria, ranging from 30 to 45 days. A summary of these analyses are presented in Tables ES-4 and ES-5.

Table ES-4
Recommended BART Control Visibility Modeling Results

	2001		2002		2003	
Class I Area	98th Percentile Value (dv)	No. of Days Exceeding 0.5 dv	98th Percentile Value (dv)	No. of Days Exceeding 0.5 dv	98th Percentile Value (dv)	No. of Days Exceeding 0.5 dv
Badlands	1.810	45	1.756	30	1.380	33
Wind Cave	1.613	41	2.137	33	1.525	34

Table ES-5
Visibility Improvement

	2001		2002		2003	
Class I Area	Badlands (dv)	Wind Cave (dv)	Badlands (dv)	Wind Cave (dv)	Badlands (dv)	Wind Cave (dv)
Baseline	2.008	1.812	1.981	2.376	1.539	1.722
Recommended Bart Control	1.810	1.613	1.756	2.137	1.380	1.525
Visibility Improvement	0.198	0.199	0.225	0.239	0.159	0.197

Based on the total annualized cost (TAC) for the recommended BART control scenario and the average visibility improvement at all federal Class I areas for the years modeled, the cost-effectiveness for visibility improvement equates to 11.2 million $/dv.

7.0 Visibility Impacts (Step 5)

Visibility impact was the fifth step considered in the engineering analysis required under the US EPA BART guidelines. This step addressed the degree of improvement in visibility which may reasonably be anticipated to result from the use of the "best control technology" for sources subject to BART. This was achieved by a two-step process. A model run consisting of pre-BART controls was run to establish a baseline. Then model runs were conducted based on the control technologies established during the engineering analysis. The model results were then tabulated for the pre- and post-control scenarios over the time period of meteorology modeled. The difference in the maximums for each receptor, or area, is the expected degree of improvement in visibility. The following sections discuss in greater detail the modeling methodology.

7.1 Introduction

The objective of this modeling analysis was to evaluate visibility impacts for the control technologies selected using the first four steps of the BART analysis as discussed in the previous sections for BEPC's LRS Units 1, 2, and 3. These units were identified as BART-eligible sources by the Wyoming DEQ in June 2006 under the Regional Haze and BART Rule guidelines.

The air dispersion modeling analyses presented in this report were conducted in accordance with the Wyoming DEQ *BART Air Modeling Protocol Individual Source Visibility Assessments for BART Control Analyses* (Wyoming DEQ BART Modeling Protocol), dated September 2006.

7.2 Source Description

The LRS is located in southeast Wyoming near Wheatland, Wyoming, within Platte County, along the Laramie River. It has three sources that are BART eligible, Units 1, 2, and 3. All three units at LRS are B&W subcritical, opposed-wall boilers that operate on balanced draft. The units are designed for operation on low-sulfur subbituminous coal and are equipped with LNB and a cold-side ESP for NO_x and particulate control, respectively. LRS Units 1 and 2 are also equipped with WFGD systems while LRS Unit 3 is equipped with a dry scrubber for SO_2 removal. The plant currently burns PRB coal from Wyoming.

7.3 Location of Sources Versus Relevant Class I Areas

As noted in the BART Rule, BART determinations are based on the totality of circumstance in a given situation such as the distance of a source from a Class I area, the type and amount of pollutants, etc. There are many Class I areas within and surrounding Wyoming, but Wyoming DEQ has determined that only five federal Class I areas potentially need to be addressed for BART individual source analysis. Furthermore, in a letter dated June 14, 2006, Wyoming DEQ identified only two Class I areas that LRS was to assess in its BART analysis. These two mandatory federal Class I areas are Wind Cave National Park and Badlands National Park, located 193 km and 271 km from LRS, respectively. Figure 7-1 provides the locations of these Class I areas with respect to the LRS facility.

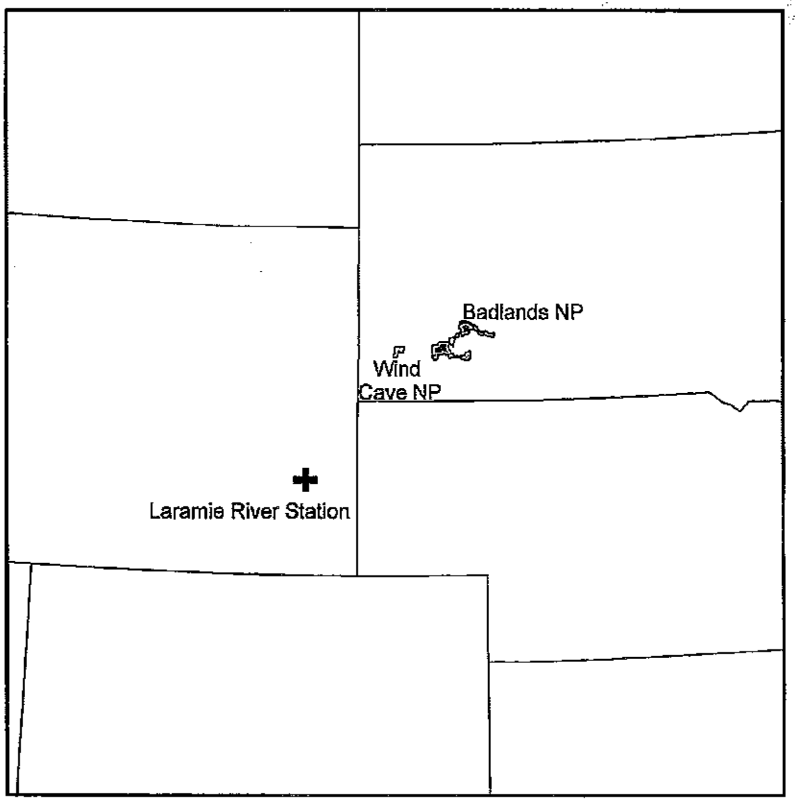

Figure 7-1
LRS with Respect to Class I Areas

7.4 Model Processing

The CALPUFF Modeling System is the recommended model to conduct BART visibility impact analyses. The CALPUFF Modeling System includes three main components: CALMET, CALPUFF, CALPOST and a large set of preprocessing programs designed to interface with the model to process standard, routinely available meteorological and geophysical data sets. In the simplest terms, CALMET is a meteorological model that develops hourly wind and temperature fields on a three-dimensional gridded modeling domain. Associated fields such as mixing height, surface characteristics, and dispersion properties are also included in the file produced by CALMET. CALPUFF is a transport and dispersion model that advects "puffs" or material emitted from modeled sources, simulating the dispersion and chemical transformation process along the way. In doing so, it typically uses the fields generated by CALMET, or as an option, it may use simpler non-gridded meteorological data much like existing plume models. Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period. The primary output files from CALPUFF contain either hourly concentrations or hourly deposition fluxes evaluated at selected receptor locations. CALPOST is used to process these files and produce tabulations that summarize the results of the simulation. When performing visibility-related modeling, CALPOST uses concentrations from CALPUFF to compute extinction coefficients and related measures of visibility, reporting these for a 24 hour averaging period at selected locations.

All files necessary to conduct the modeling were provided by Wyoming DEQ via an external hard drive on December 14, 2006. The files provided were to include all the necessary meteorological and geophysical data to run the CALPUFF Modeling System, along with sample input files.

The versions of the CALPUFF Modeling System (CALMET/CALPUFF/CALPOST) programs and the preprocessors (TERREL/CTGPROC/MAKEGEO) that were used for the modeling are listed in Table 7-1. In most cases, the regulatory versions of the programs and preprocessors were used. The regulatory versions are provided by TRC's Atmospheric Studies Group on its Web site http://www.src.com. However, in a few instances, due to known computing code issues or limitations in the regulatory version, edits were made to an executable or an alternative version was used. Those instances are discussed, as appropriate, throughout the following sections.

Table 7-1
Model Versions

Program	Suggested Version	Suggested Level	LRS Analyses Version	LRS Analyses Level
TERREL[a]	3.3	030402	3.3	030402
CTGPROC[b]	2.4	030402	2.66	060202
MAKEGEO	2.2	030402	2.2	030402
CALMET[c]	5.53a	040716	5.53a	040716
CALPUFF	5.711a	051130	5.711a	051130
APPEND	2.2	030402	2.2	030402
CALPOST	5.51	030709	5.51	030709

(a)Code was edited as discussed in Subsection 7.5.5.
(b)Alternative version was used as discussed in Subsection 7.5.5.
(c)Code was edited as discussed in Subsection 7.5.7.

7.4.1 Modeling Domain

It was discovered while evaluating the data provided by the Wyoming DEQ that the modeling domain did not contain adequate coverage for the LRS BART modeling analyses. The modeling domain expected in the provided data was the NE Wyoming Domain, Figure 1 of the Wyoming DEQ BART Modeling Protocol provided in Appendix E, Section 1, and illustrated on Figure 7-2. Figure 7-3 shows an enhanced view of the NE Wyoming domain. However, as shown on Figure 7-4, the Wyoming DEQ modeling domain was not large enough to incorporate the LRS sources. Additionally, the receptors at the applicable Class I areas, Wind Cave and Badlands, were not in the correct location. As a result, Black & Veatch created a new modeling domain of sufficient size to incorporate the LRS sources and the Class I area receptors. The modeling domain was created sufficiently large to include the LRS sources, as well as the receptors at the relevant Class I areas with at least a 150 km buffer in each direction as shown on Figure 7-5. The map projection used the Lambert Conformal Conic (LCC), and the coordinate system was NWS-84 6,370 km radius global sphere. A grid resolution of 4 km was used in the refined modeling.

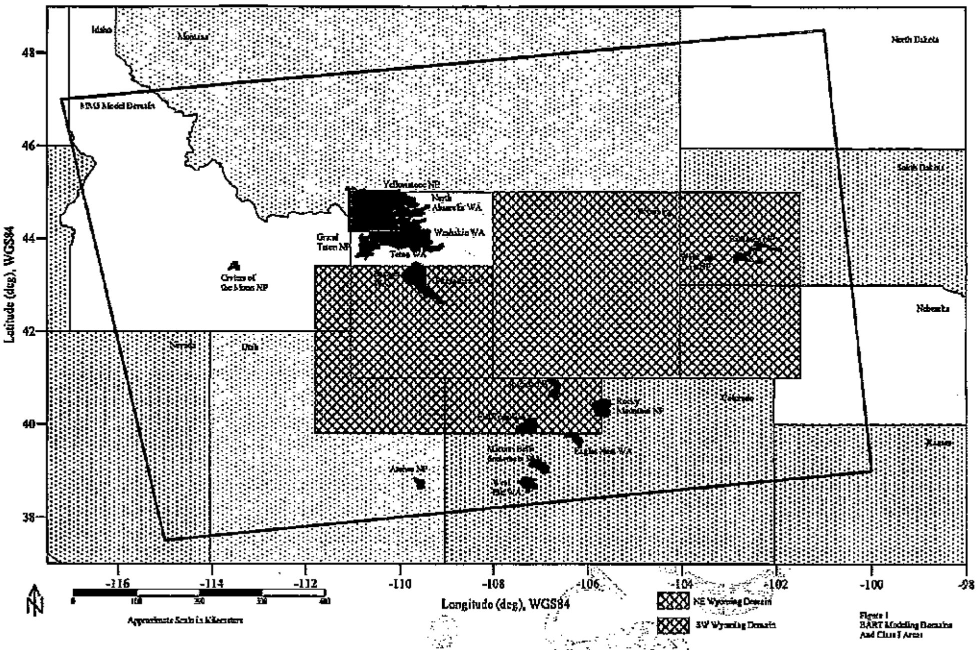

Figure 7-2
Wyoming DEQ BART Modeling Protocol Figure 1

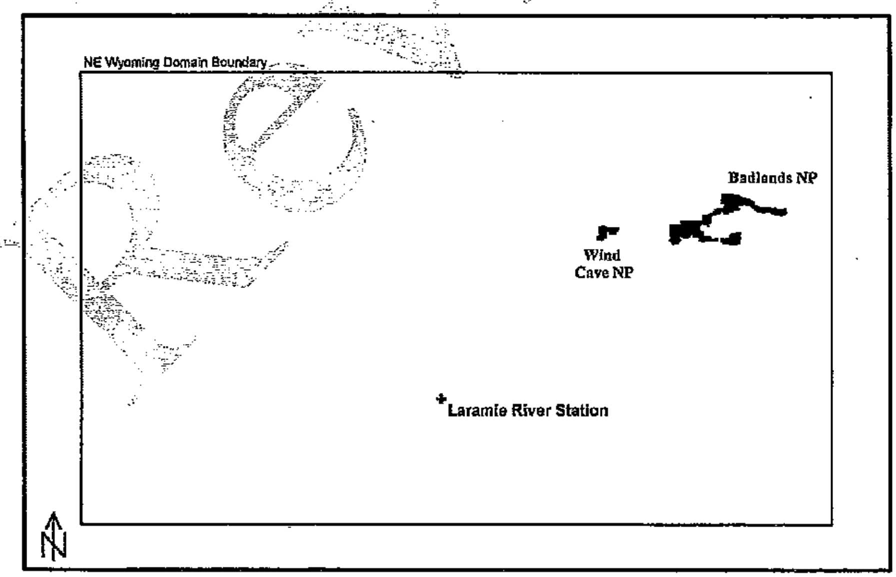

Figure 7-3
NE Wyoming Domain

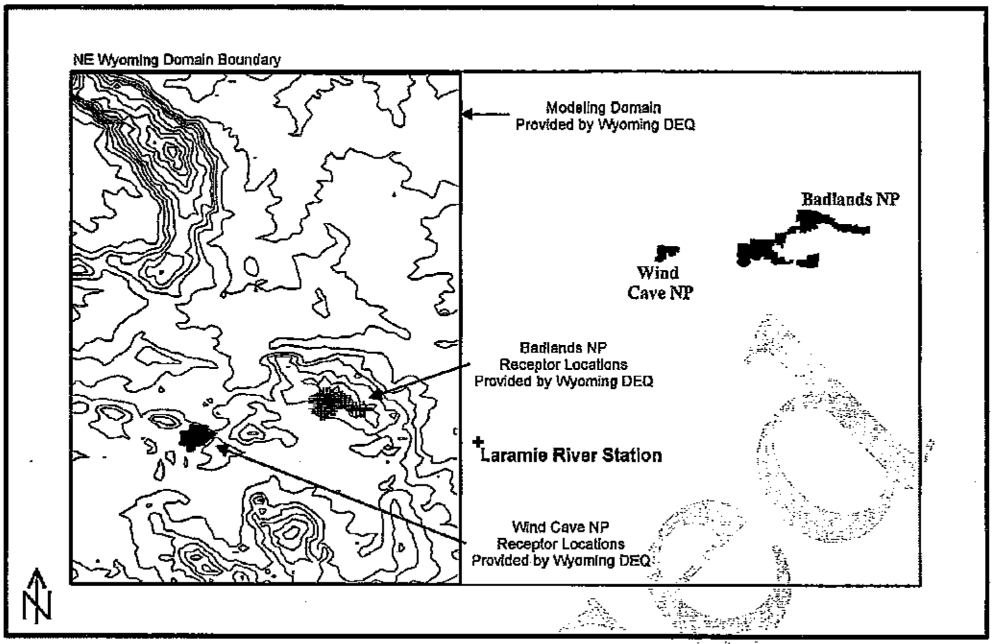

Figure 7-4
Wyoming DEQ Modeling Domain

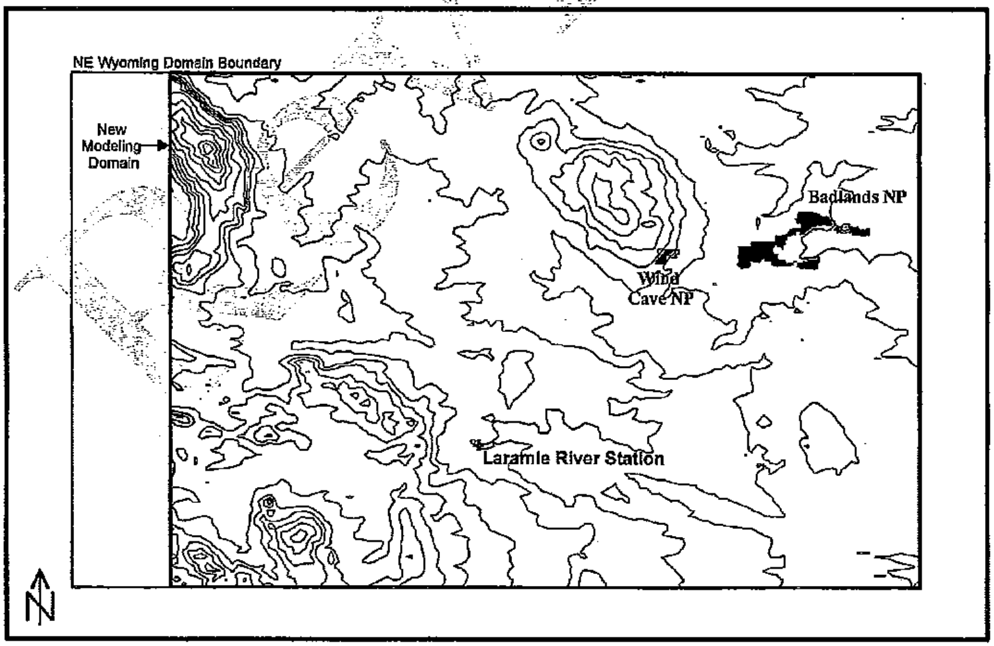

Figure 7-5
New Modeling Domain

AQD LRS BART
000179

The origin coordinate of the new domain is Latitude 43.0 N, Longitude 103.5 W and was assigned as the 0, 0 reference point of the domain. The southwest corner of the modeling domain is Latitude 40.28 N, Longitude 107.24 W, which translates to -318.00 km (X) and -296.00 (Y) in LCC coordinates. The domain measured 636 km in the east-west (X) direction by 592 km in the north-south (Y) direction. At a refined grid spacing of 4 km, the number of X grid cells is 159 and the number of the Y grid cells is 148.

7.5 Geophysical and Meteorological Data

Using the new domain characteristics and the raw files provided by the Wyoming DEQ, the necessary geophysical preprocessors: TERREL, CTGPROC, and MAKEGEO, as well as the CALMET meteorological processor were run. The following subsections describe the geophysical and meteorological data that was used for the modeling.

7.5.1 Mesoscale Model Data

Pennsylvania State University in conjunction with the National Center for Atmospheric Research (NCAR) Assessment Laboratory have developed mesoscale meteorological data sets of prognostic wind fields, or "guess" fields, for the United States. The hourly meteorological variables used to create these data sets are extensive and are used to initialize the modeling domain with meteorological data. The Wyoming DEQ provided MM5 meteorological data fields for the years 2001, 2002, and 2003 that were utilized as input into CALMET. The MM5 output was at 12 km resolution and covered the full domain shown on Figure 7-2 (Figure 1 of the Wyoming DEQ BART Modeling Protocol in Appendix E, Section 1).

The MM5 data sets, used to simulate atmospheric variables within the modeling domain in CALMET, although advanced, lack the fine detail of specific temporal and spatial meteorological variables and geophysical data. These variables were processed into the appropriate format and introduced into the CALMET model through the utilization of additional data files obtained from numerous sources. These ancillary data files are described in more detail in the following subsections.

7.5.2 Surface Data Station and Processing

The surface station data for the CALPUFF analysis consisted of data from the National Weather Service (NWS) stations or Federal Aviation Administration (FAA) Flight Service stations within the CALMET domain. Figure 7-6 provides an illustration of the location of the surface stations used. The surface station parameters included wind speed, wind direction, cloud ceiling height, opaque cloud cover, dry-bulb temperature, relative humidity, station pressure, and a precipitation code that was based on current weather conditions.

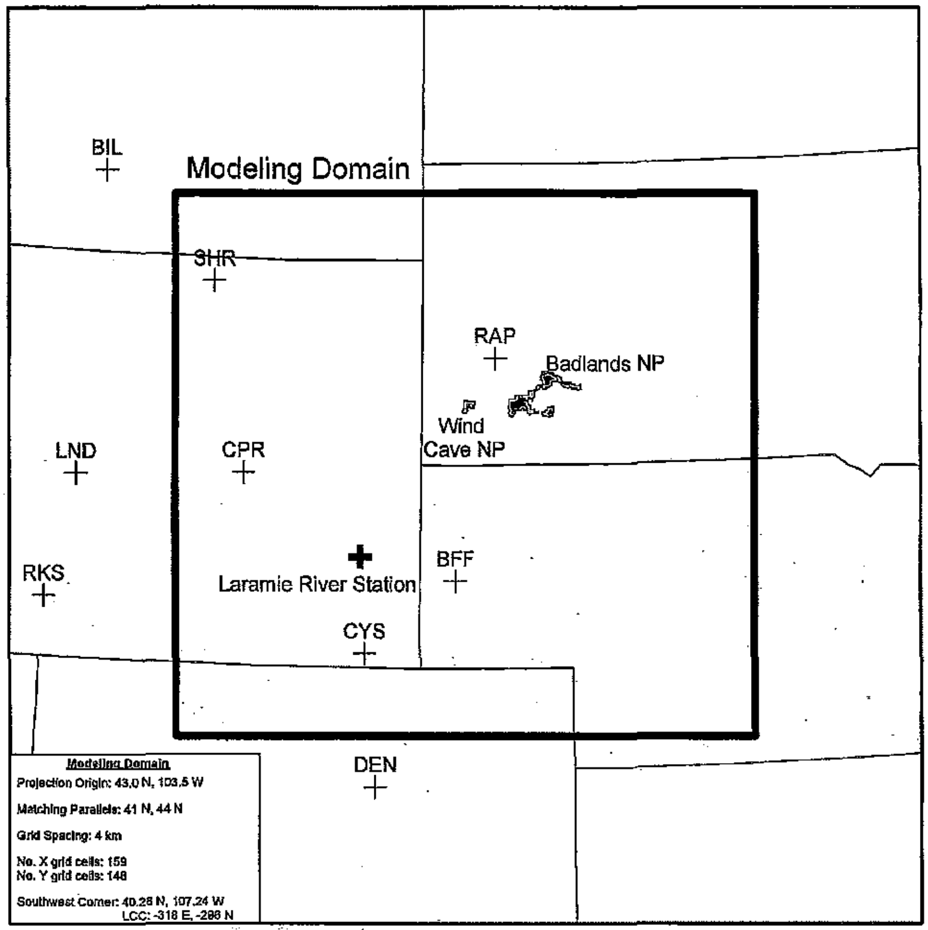

Figure 7-6
Surface Stations

The surface station data was provided by the Wyoming DEQ for use in the modeling analyses. The data was processed with the CALMET preprocessor utility program, SMERGE, to create one surface file (SURF.DAT) for each year modeled. The SURF.DAT files provided were acceptable for use with the new modeling domain; therefore, no reprocessing of the surface data was required.

7.5.3 Upper Air Data Station and Processing

The upper air data for the CALPUFF analysis consisted of data from NWS stations within and around the CALMET domain. Figure 7-7 provides an illustration of the location of the surface stations used. The upper air station parameters included wind speed, wind direction, temperature, and atmospheric pressure at several sounding levels.

The upper air data was provided by the Wyoming DEQ for use in the modeling analyses. The data was processed with the CALMET preprocessor utility program, READ62, to create one upper air file for each station processed. The upper air files provided were acceptable for use with the new modeling domain; therefore, no reprocessing of the upper air data was required.

7.5.4 Precipitation Data Stations and Processing

Precipitation data was processed from a network of hourly precipitation data files collected from NWS precipitation recording stations within the CALMET domain. Figure 7-8 provides an illustration of the location of the precipitation stations used.

The precipitation data was provided by the Wyoming DEQ for use in the modeling analyses. The data was processed with the CALMET preprocessor utility programs PXTRACT and PMERGE to create one precipitation file (PRECIP.DAT) for each year modeled. The PRECIP.DAT files provided were acceptable for use with the new modeling domain; therefore, no reprocessing of the precipitation data was required.

7.5.5 Geophysical Data Processing (Terrain and Land Use)

TERREL is a preprocessor program that extracts and reformats Digital Elevation Model (DEM) terrain data according to the domain and resolution selected. The regulatory version of TERREL (Version 2.4 Level 030402) is limited to 100 input terrain data files in one run of TERREL. Black & Veatch recompiled the executable with the use of a Lahay FORTRAN compiler to accept 1,000 input terrain data files. This allowed for the use of the TERREL input file provided by the Wyoming DEQ, which included all the 1 degree DEMs for the entire United States, allowing the program to select the DEMs needed for the new domain characteristics. All the Wyoming DEQ provided 1 degree

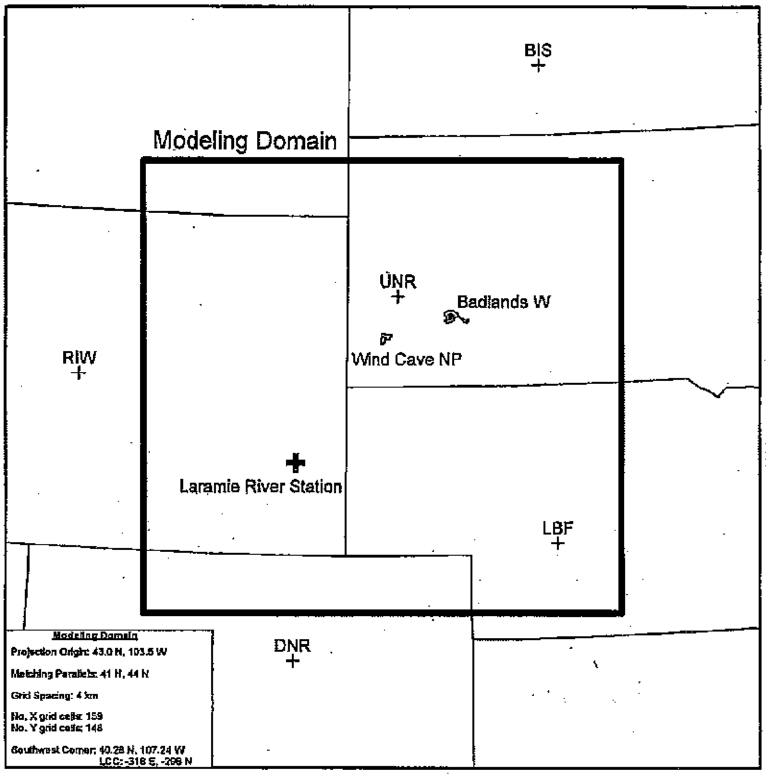

Figure 7-7
Upper Air Stations

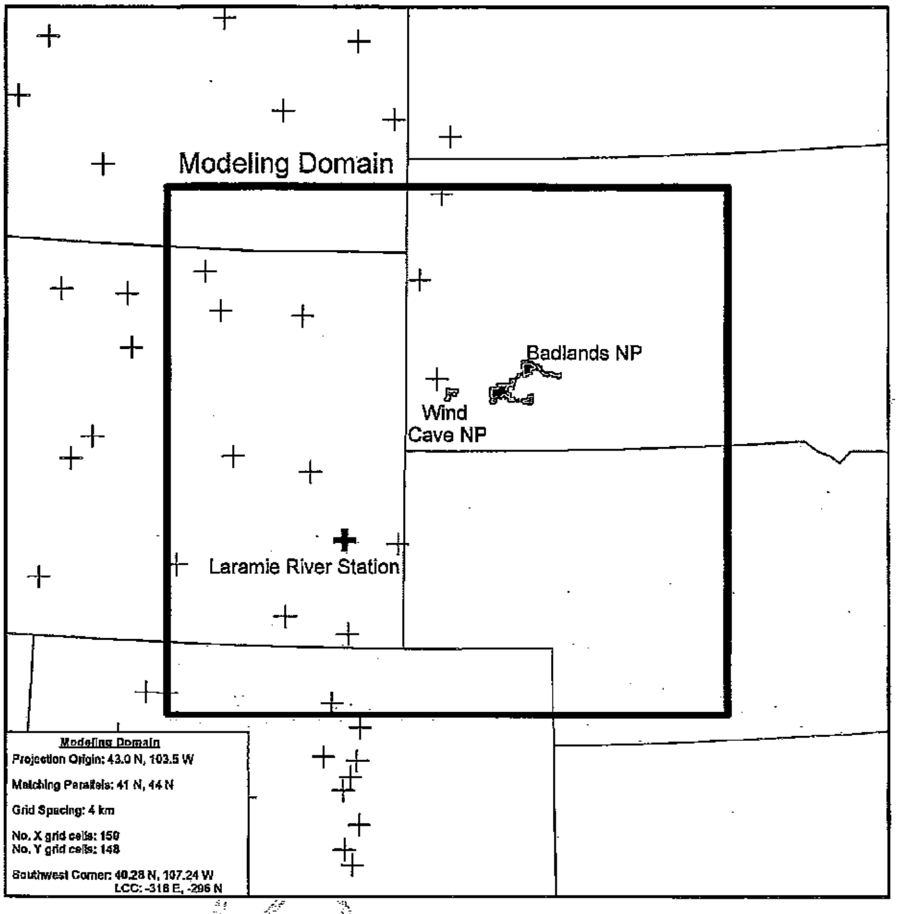

Figure 7-8
Precipitation Stations

DEMs were used except for the Craig-E.DEM. The provided file was corrupt and caused a processing error when run through TERREL. Black & Veatch downloaded the DEM file from the United States Geological Survey (USGS) Web site. This new USGS file was not corrupt and allowed TERREL to run to completion creating a TERREL.DAT file that was used as an input file in the MAKEGEO preprocessor described in Subsection 7.5.6. Figure 7-9 depicts the terrain elevations in the domain. The updated code and program executable are included on the DVD in Appendix E, Section 5.

CTGPROC is a preprocessor program that reads compressed USGS Land Use and Land Cover (LULC) data in Composite Theme Grid (CTG) format. The regulatory version of CTGPROC (Version 2.4 Level 030402) reads a LULC data file and determines fractional land use for each grid cell in a user-specified gridded domain. If the domain requires multiple files, CTGPROC is applied iteratively (continuation option) to build the land use grid incrementally. To more efficiently process the LULC files, Black & Veatch used the VISTAS version of CTGPROC (Version 2.66 Level 060202). This version allows for multiple LULC files to be entered in on the CTGPROC run. Based on the aforementioned new modeling domain characteristics, 35 LULC files were required. The Wyoming DEQ provided all the LULC files necessary to run CTGPROC; however, the Craig LULC was missing requiring the file to be re-downloaded from the USGS Web site. The 35 LULC files were entered into the VISTAS version of CTGPROC and run to completion creating the LU.DAT file that is used as an input file in the MAKEGEO preprocessor described in Subsection 7.5.6. Figure 7-10 shows the land use of the domain. The aforementioned files are included on the DVD in Appendix E, Section 6.

7.5.6 MAKEGEO

MAKEGEO creates the geophysical data file (GEO.DAT) for CALMET. Using the fractional land use data from CTGPROC (LU.DAT), it calculates the dominant land use for each cell and computes weighted surface parameters. It may also remap land use categories if desired. Terrain data can be obtained from TERREL or provided in a file of similar format (TERREL.DAT). The regulatory version of MAKEGEO (Version 2.2 Level 030402) was used for these analyses. No changes were required to the processor. The TERREL.DAT and LU.DAT created from the aforementioned TERREL and CTGPROC preprocessors were used as input for MAKEGEO. MAKEGEO created the GEO.DAT file that was used as an input file in the CALMET model.

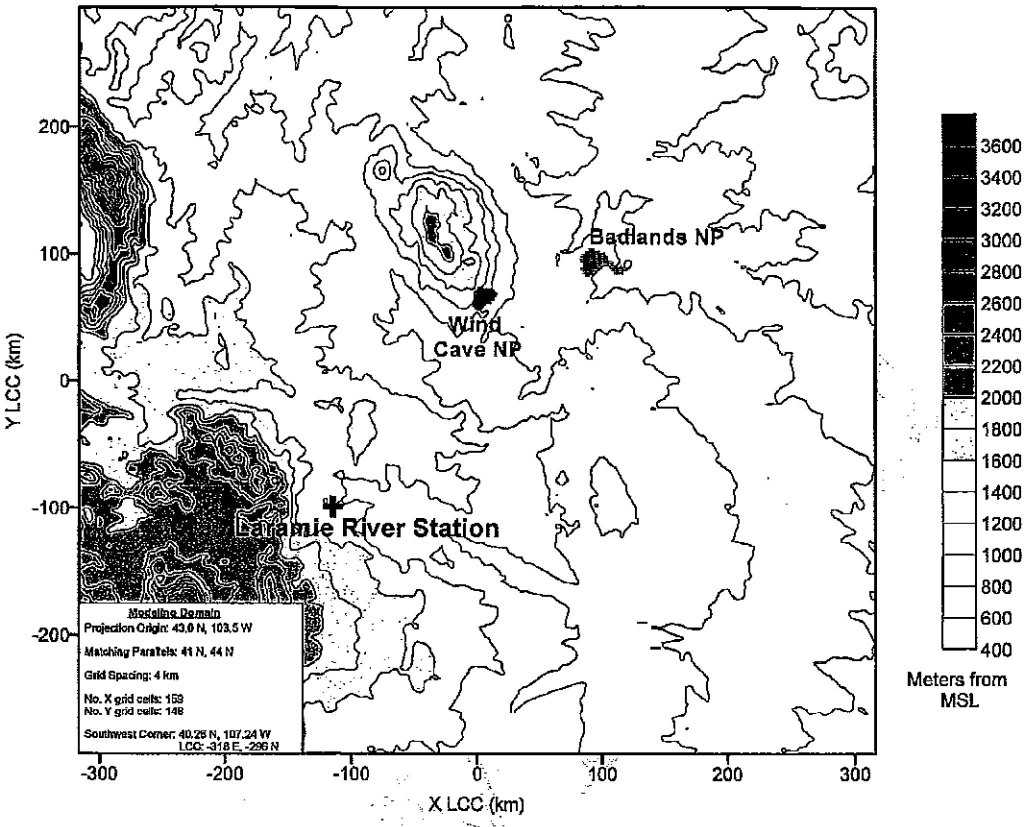

Figure 7-9
Terrain Elevation Plot

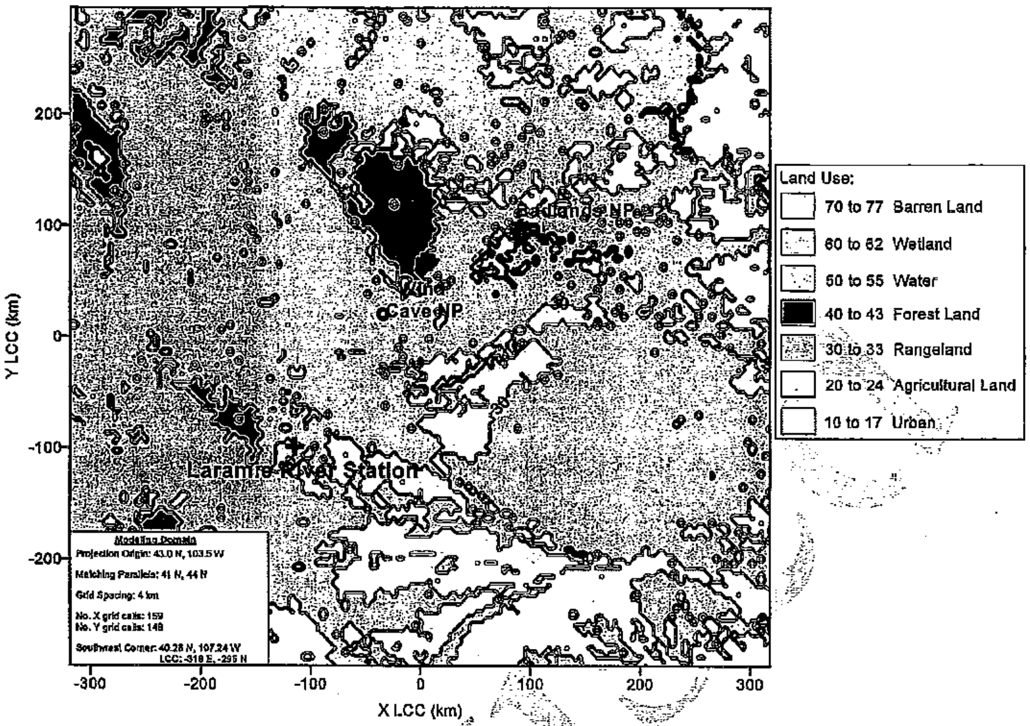

Figure 7-10
Land Use Plot

7.5.7 CALMET

The regulatory version of CALMET (Version 5.53a Level 040716) was used to obtain the necessary control information and meteorological inputs from a number of different input files. The control file (CALMET.INP) contains the data that defines a particular model run, such as starting date and time, horizontal and vertical grid data, and model option flags. Geophysical data, including terrain elevations, land use, and surface characteristics are read from a formatted data file called GEO.DAT. The regulatory version, as provided, limits the prognostic data (MM5) to a modeling domain of 100 X grid cells, 100 Y grid cells, and 32 vertical layers. The MM5 files provided by the Wyoming DEQ for the analyses had a maximum of 125 X grid cells, 101 Y grid cells, and 34 vertical layers. Black & Veatch recompiled the CALMET executable with the use of a Lahay FORTRAN compiler. The acceptable MM5 file limits were changed to 130 X grid cells, 105 Y grid cells, and 35 vertical layers. No other changes were made to the executable. With these changes, CALMET processed the provided MM5 data to completion. CALMET was run on a once daily basis due to its limit of one MM5 file per run; thus, 365 separate CALMET files were run for 2001 and 2002 and 364 for 2003. The updated code and program executable are included in the DVD in Appendix E, Section 6. The selection of the specific variables used in CALMET is provided in Appendix E, Section 1.

7.6 CALPUFF

The CALPUFF Modeling System is recommended as the preferred modeling approach for use in BART analyses. CALPUFF and its meteorological model, CALMET, are designed to handle the complexities posed by complex terrain, large source-receptor distances, chemical transformation and deposition, as well as other issues related to Class I visibility impacts. The CALPUFF Modeling System has been adopted by the EPA as a Guideline Model for source-receptor distances greater than 50 km, and for use on a case-by-case basis in complex flow situations for shorter distances (68 FR 18440-18482). CALPUFF is recommended for Class I impact assessments by the Federal Land Managers Workgroup (FLAG 2000) and the Interagency Workgroup on Air Quality Modeling (IWAQM) (EPA 1998). The final BART guidance recommends CALPUFF as "the best modeling application available for predicting a single source's contribution to visibility impairment" (70 FR 39122).

CALPUFF is a non-steady-state, Lagrangian, puff transport and dispersion model that advects Gaussian puffs of multiple pollutants from modeled sources. CALPUFF's algorithms have been designed to be applicable on spatial scales from a few tens of meters to hundreds of kilometers from a source. It includes algorithms for near-field effects such as building downwash, stack tip downwash, and transitional plume rise as well as processes important in the far-field such as chemical transformation, wet deposition, and dry deposition. CALPUFF contains an option to allow puff splitting in the horizontal and vertical directions, which extends the distance range of the model. The primary outputs from CALPUFF are hourly concentrations and hourly deposition fluxes evaluated at user-specified receptor locations.

The regulatory version of CALPUFF (Version 5.711a Level 051130), which was used to calculate the hourly concentrations at each receptor from LRS Units 1, 2, and 3, is limited to 12 CALMET.DAT files in one CALPUFF run. As a result, 31 CALPUFF input files were created for each year. Each file contained 12 daily CALMET.DAT files, except for the last one which contained the remaining 5 days for 2001 and 2002 and 4 days for 2003. The CALPUFF postprocessor APPEND was then used create a single yearly concentration file for use in CALPOST.

7.6.1 CALPUFF Domain and Variables

The CALPUFF computational domain was the same as that used in CALMET and explained in Subsection 7.4.1. The selection of the specific variables used in CALPUFF is provided in Appendix E, Section 2.

7.6.2 Receptors

The CALPUFF analyses used an array of discrete receptors with receptor elevations for the Class I areas, which were created and distributed by the NPS. Specifically, the array consisted of receptors spaced to cover the extent of each Class I area. Receptor elevations were included in the same NPS-provided receptor files. The Class I receptor files provided by the Wyoming DEQ for Wind Cave and Badlands were not properly located for use with the new modeling domain. New Class I receptor files based on the new modeling domain for Wind Cave and Badlands were obtained from the NPS Class I conversion program in the LCC coordinate system. Appendix E, Section 4 provides illustrations of the receptors to be used in the modeling analysis for each Class I area.

7.6.3 Downwash

Because the modeling conducted for BART is concerned with long-range transport, not localized impacts, data about building heights and widths that are used to calculate building induced downwash were not included in the modeling analyses. Stack tip downwash is a phenomenon different from building induced downwash and is, additionally, a regulatory default option (i.e., in order to turn stack tip downwash off, the user must also change the variable to skip regulatory checks of the model). Therefore, stack tip downwash was used for this analysis.

7.6.4 Ozone Concentrations

Background ozone concentrations are important for the photochemical conversion of SO_2 and NO_x to sulfates (SO_4) and nitrates (NO_3), respectively. CALPUFF allows the use of a single background ozone value, monthly background ozone values, or spatial, hourly ozone data from one or more ozone monitoring stations (the preferred method) to represent the background ozone concentrations within the domain.

The hourly ozone concentrations files that were used by the Wyoming DEQ in the initial screening analysis were also used for this refined BART evaluation. These hourly ozone data files were provided by the Wyoming DEQ. In addition to the hourly ozone data, the recommended monthly average background ozone value of 44 parts per billion (ppb) was used in this refined modeling for times when hourly ozone data were not available.

7.6.5 Ammonia Concentrations

As recommend by the Wyoming DEQ BART Modeling Protocol, a constant of 2 ppb was used for the background ammonia concentration.

7.6.6 Unit-Specific Source Data

As previously presented in Sections 3.0 through 6.0 of this report, various emissions control strategies and technologies have been evaluated for use at Units 1, 2, and 3. The baseline emissions for NO_x and SO_2 were established based on CEM annual emissions averages for years 2001 to 2003. PM emissions are based on current operational experience. For modeling purposes, all PM emissions were assumed to be $PM_{2.5}$.

As specified in the Wyoming DEQ BART Modeling Protocol, direct emissions of sulfate (SO_4) should be included where possible. The emissions can be from test data, engineering data, or the relative fraction of fine and course particles obtained by using speciation profiles available from the Federal Land Managers on its Web site http://www2.nature.nps.gov/air/permits/ect/index.cfm. Source specific SO_4 emissions were available for the LRS BART sources. SO_4 emissions calculated for the Toxic Release Inventory (TRI) for the period being modeled (2001, 2002, and 2003) were modeled for the analyses. The calculated SO_4 emission rates were entered directly into the CALPUFF model.

The control technologies evaluated as part of this study were analyzed to determine resulting visibility impacts at the nearby Class I areas. The analysis was conducted by beginning with the baseline scenario and modifying the scenario by adjusting only one pollutant while keeping the remainder of the scenario consistent with the baseline scenario. To simplify the process, all three units were assumed to operate simultaneously at a specific emission control level.

As specified in Section 6.0, for the recommended BART control scenario, the least-cost dominant NO_x and SO_2 controls to achieve the presumptive limits on a facility-wide basis versus a unit-by-unit basis were modeled. PM_{10} emissions were also included based on the previously outlined methodology. The aforementioned approach consisted of OFA system operation on all three units for NO_x control, DBA addition on Units 1 and 2, and the use of existing ESPs for PM control.

Due to the use of low-sulfur fuel, it was conservatively assumed that the BART controls would not affect the SO_4 emissions. Therefore, the maximum SO_4 emission rates used in the baseline modeling for each year and unit were modeled for the recommended BART control scenarios. However, it should be noted that in the case of NO_x, the SCR and SNCR/SCR Hybrid control scenarios contain catalyst technology that will increase the oxidation of SO_2 to SO_3 and increase H_2SO_4. While this increase was not assessed, it would be expected that the resulting impacts from these cases could be greater than the results indicated in this report and thus reduce the overall visibility improvement. The baseline and BART control scenario stack parameters and emissions are presented in Appendix C, and the location of the stacks, stack height, and the SO_4 emissions for 2001 to 2003 used in the analysis are presented in Table 7-2. A summary of the modeling scenarios has been included as Tables 7-3 and 7-4.

7.7 CALPOST

CALPOST (Version 5.51 Level 030709) is used to process the CALPUFF outputs by producing tabulations summarizing the results of the simulations, identifying, for example, the highest and second highest hourly average concentrations at each receptor. When performing visibility-related modeling, CALPOST uses concentrations from CALPUFF to compute light extinction and related measures of visibility (haze index in dvs), reporting these for a 24 hour averaging time. The selections of the specific variables used in CALPOST are provided in Appendix E, Section 3.

Table 7-2
CALPUFF Modeling Stack Parameters and SO_4 Emissions

Baseline								
	Stack Location[a]					SO_4 Emission Rate[c] (tpy)		
Unit[d]	LCC East (km)	LCC North (km)	Stack Height[b] (m)	Base Elevation[b] (m)	Stack Diameter[b] (m)	2001	2002	2003
LRS 1	-113.865	-98.200	184.40	1348	8.69	3.06	3.18	2.88
LRS 2	-113.863	-98.112	184.40	1348	8.69	2.80	3.25	3.24
LRS 3	-113.862	-98.025	184.40	1348	8.69	0.22	0.19	0.17

[a]Stack Coordinates in Lambert format included in the CALPUFF modeling.
[b]Stack parameters from engineering analysis.
[c]H_2SO_4 emission rate is the TRI reported values for the specific year. These specific values for each unit were used in the baseline scenario modeling. The modeling for the future control scenarios used the maximum 2001 to 2003 TRI reported value for Units 1, 2, and 3 of 3.18, 3.25, and 0.22 tpy, respectively.
[d]All particulate emissions were assumed to be $PM_{2.5}$, and the emission rate is based on 0.030 lb/MBtu. Additionally, the fraction of PM_{10} and $PM_{2.5}$ were not determined; therefore, as recommended in the Wyoming DEQ BART Modeling Protocol, all PM was assumed to be $PM_{2.5}$.

Table 7-3
Technically Feasible Control Options[a]

Scenario	Unit 1 Pollutant Emissions Rate (lb/MBtu)	Control Option	Unit 2 Pollutant Emissions Rate (lb/MBtu)	Control Option	Unit 3 Pollutant Emissions Rate (lb/MBtu)	Control Option
			NO_x			
1	0.23	1 and 2	0.23	1 and 2	0.23	1 and 2
2	0.20	3	0.20	3	0.20	3
3	0.15	4	0.15	4	0.15	4
4	0.12	5	0.12	5	0.12	5
5	0.07	6	0.07	6	0.07	6
			Particulate			
6	0.030	Baseline	0.030	Baseline	0.030	Baseline
7	0.030	Baseline	0.030	Baseline	0.015[c]	SO_2 Option 1
			SO_2			
8[b]	0.15	2 and 3	0.15	2 and 3	0.17	Baseline
9	0.13	1	0.13	1	0.13[c]	1
10	0.15	2 and 3	0.15	2 and 3	0.06	2
11	0.13	1	0.13	1	0.06	2

[a]Control options are summarized in Appendix C. For control options that yield the same emissions level, it was assumed that the minimal differences in temperature and stack velocity would not affect results. Therefore, to simplify the analysis, the lowest temperature and stack velocity was used for the applicable scenarios.
[b]This scenario represents a station average control option for SO_2.
[c] This scenario evaluates the addition of a fabric filter on Unit 3, which in addition to controlling particulate to 0.015 lb/MBtu, controls SO_2 to 0.13 lb/MBtu as a co-benefit.

Table 7-4
Recommended Control Option[a]

Unit 1 Pollutant Emissions Rate (lb/MBtu)	Control Option	Unit 2 Pollutant Emissions Rate (lb/MBtu)	Control Option	Unit 3 Pollutant Emissions Rate (lb/MBtu)	Control Option
NO_x					
0.23	1	0.23	1	0.23	1
Particulate					
0.030	Baseline	0.030	Baseline	0.030	Baseline
SO_2					
0.15	2	0.15	2	0.17	Baseline

[a]Control options are summarized in Appendix C. For control options that yield the same emissions level, it was assumed that the minimal differences in temperature and stack velocity would not affect results. Therefore, to simplify the analysis, the lowest temperature and stack velocity was used for the applicable scenarios.

7.7.1 *Light Extinction*

Light extinction must be computed in order to calculate visibility. CALPOST has seven methods for computing light extinction. This BART refined analysis used Method 6, which computes extinction from speciated PM with monthly Class I area-specific relative humidity adjustment factors. Relative humidity is an important factor in determining light extinction (and therefore visibility) because sulfate and nitrate aerosols, which absorb moisture from the air, have greater extinction efficiencies with greater relative humidity. This BART analysis applied relative humidity correction factors (f(RH)s), obtained from the Wyoming DEQ BART Modeling Protocol, to sulfate and nitrate concentrations outputs from CALPUFF. The f(RH) values for the Class I areas that were assessed are provided in Table 7-5. The default Rayleigh scatter value (b_{ray}) of 10 Mm^{-1} was also used. The light extinction equation is provided below. As recommended by the Wyoming DEQ BART Modeling Protocol, organic carbon (OC) and elemental carbon (EC) were not included in the analyses.

$$b_{ext} = 3 * f(RH) * [(NH_4)_2SO_4] + 3 * f(RH) * [NH_4NO_3] + 4*[OC] + 1*[PM_f] + 0.6*[PM_c] + 10*[EC] + b_{ray}$$

Table 7-5
Monthly Relative Humidity Factors

Class I Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind Cave	2.65	2.65	2.65	2.55	2.70	2.60	2.30	2.30	2.20	2.25	2.75	2.65
Badlands	2.65	2.65	2.65	2.55	2.70	2.60	2.30	2.30	2.20	2.25	2.75	2.65

7.7.2 *Natural Background*

The natural background concentration of aerosol concentrations was obtained from the Wyoming DEQ BART Modeling Protocol and is included in Table 7-6.

7.8 Modeling Results

Based in the air dispersion modeling methodology outlined in the previous sections, the CALPUFF modeled visibility impacts from Units 1, 2, and 3 were determined. Visibility impairment is based on the 98th percentile modeled value. Over an annual period, this implies the 8th highest 24 hour value. An external hard drive of all electronic modeling files has been provided separately to WDEQ.

Table 7-6
Natural Background Concentrations of Aerosol Components for 20 Percent Best Days (μg/m^3)

Aerosol Component	Wind Cave	Badlands
Ammonium Sulfate	0.047	0.047
Ammonium Nitrate	0.040	0.040
Organic Carbon Mass	0.186	0.186
EC	0.008	0.008
Soil	0.198	0.198
Coarse Mass	1.191	1.191

7.8.1 Baseline

The results of the baseline modeling are presented in Table 7-7. The baseline impacts are used to establish a comparison for the recommended BART control impacts. As Table 7-7 illustrates, the combined visibility impacts for the LRS BART sources exceed the recommended guideline value of 0.5 dv, subjecting the units to the aforementioned BART engineering and refined modeling analysis.

Table 7-7
Baseline Visibility Modeling Results

	2001		2002		2003	
Class I Area	98th Percentile Value (dv)	No. of Days Exceeding 0.5 dv	98th Percentile Value (dv)	No. of Days Exceeding 0.5 dv	98th Percentile Value (dv)	No. of Days Exceeding 0.5 dv
Badlands	2.008	49	1.981	34	1.539	37
Wind Cave	1.812	46	2.376	34	1.722	37

7.8.2 BART Technology Controls

The results of the modeling for the analyzed technology control scenarios and recommended BART emissions control options are presented in Tables 7-8 and 7-9 for Badlands and Wind Cave, respectively. The improvement in visibility as a result of the BART controls is summarized in Tables 7-10 and 7-11. As shown in the tables, the BART controls improved the visibility impacts at the two Class I areas, on average, approximately 0.2 dv with a maximum improvement for the recommended control ethnology for either area of 0.24 dv.

Table 7-8
BART Control Visibility Modeling Results
For Badlands

Scenario	2001		2002		2003		Average Impact (dv)	Maximum Impact (dv)
	98th Percentile Value (dv)	No. of Days Exceeding 0.5 dv	98th Percentile Value (dv)	No. of Days Exceeding 0.5 dv	98th Percentile Value (dv)	No. of Days Exceeding 0.5 dv		
NO_x - 1	1.834	46	1.770	30	1.403	34	1.669	1.834
NO_x - 2	1.686	45	1.599	27	1.301	33	1.529	1.686
NO_x - 3	1.423	38	1.309	25	1.139	29	1.290	1.423
NO_x - 4	1.263	34	1.134	24	1.042	28	1.146	1.263
NO_x - 5	1.101	27	0.955	21	0.882	25	0.979	1.101
Particulate - 6	2.009	49	1.981	34	1.539	37	1.843	2.009
Particulate - 7	1.948	47	1.940	33	1.491	34	1.794	1.948
SO_2 - 8	1.987	48	1.960	33	1.519	37	1.822	1.987
SO_2 - 9	1.881	46	1.893	30	1.531	33	1.768	1.893
SO_2 - 10	1.921	45	1.877	29	1.420	32	1.739	1.921
SO_2 - 11	1.839	45	1.851	28	1.499	33	1.730	1.851
Recommended	1.810	45	1.756	30	1.380	33	1.649	1.810

Table 7-9
BART Control Visibility Modeling Results
For Wind Cave

Scenario	2001		2002		2003		Average Impact (dv)	Maximum Impact (dv)
	98th Percentile Value (dv)	No. of Days Exceeding 0.5 dv	98th Percentile Value (dv)	No. of Days Exceeding 0.5 dv	98th Percentile Value (dv)	No. of Days Exceeding 0.5 dv		
NO_x - 1	1.628	41	2.166	33	1.540	34	1.778	2.166
NO_x - 2	1.492	41	2.006	33	1.400	31	1.633	2.006
NO_x - 3	1.285	37	1.735	29	1.165	29	1.395	1.735
NO_x - 4	1.141	32	1.571	25	1.022	26	1.245	1.571
NO_x - 5	0.947	24	1.199	22	0.896	18	1.014	1.199
Particulate - 6	1.813	46	2.376	34	1.723	37	1.971	2.376
Particulate - 7	1.772	42	2.310	34	1.688	34	1.923	2.310
SO_2 - 8	1.800	46	2.348	34	1.705	34	1.951	2.348
SO_2 - 9	1.779	43	2.257	34	1.649	35	1.895	2.257
SO_2 - 10	1.697	41	2.183	33	1.597	34	1.826	2.183
SO_2 - 11	1.736	43	2.160	34	1.731	35	1.876	2.160
Recommended	1.613	41	2.137	33	1.525	34	1.758	2.137

Table 7-10 Visibility Improvement Badlands					
Scenario	2001 Improvements (dv)	2002 Improvements (dv)	2003 Improvements (dv)	Average Improvement (dv)	Maximum Improvement (dv)
NO_x - 1	0.174	0.211	0.136	0.174	0.211
NO_x - 2	0.322	0.382	0.238	0.314	0.382
NO_x - 3	0.585	0.672	0.400	0.552	0.672
NO_x - 4	0.745	0.847	0.497	0.696	0.847
NO_x - 5	0.907	1.026	0.657	0.863	1.026
Particulate - 6	NI	NI	NI	NI	NI
Particulate - 7	0.060	0.041	0.048	0.050	0.060
SO_2 - 8	0.021	0.021	0.20	0.021	0.021
SO_2 - 9	0.127	0.088	0.008	0.074	0.127
SO_2 - 10	0.087	0.104	0.119	0.103	0.119
SO_2 - 11	0.169	0.130	0.040	0.113	0.169
Recommended	0.198	0.225	0.159	0.194	0.225
Notes: NI = No Improvement					

Table 7-11
Visibility Improvement
Wind Cave

Scenario	2001 Improvements (dv)	2002 Improvements (dv)	2003 Improvements (dv)	Average Improvements (dv)	Maximum Improvements (dv)
NO_x - 1	0.184	0.210	0.182	0.192	0.210
NO_x - 2	0.320	0.370	0.322	0.337	0.370
NO_x - 3	0.527	0.641	0.557	0.575	0.641
NO_x - 4	0.671	0.805	0.700	0.725	0.805
NO_x - 5	0.865	1.177	0.826	0.956	1.177
Particulate - 6	NI	NI	NI	NI	NI
Particulate - 7	0.040	0.066	0.034	0.047	0.066
SO_2 - 8	0.012	0.028	0.017	0.019	0.028
SO_2 - 9	0.033	0.119	0.073	0.075	0.119
SO_2 - 10	0.115	0.193	0.125	0.144	0.193
SO_2 - 11	0.076	0.216	NI	0.094	0.216
Recommended	0.199	0.239	0.197	0.212	0.239

Notes:
NI = No Improvement

7.9 Visibility Improvement Cost-Effectiveness

The visibility improvement cost-effectiveness defined in Subsection 1.2.5 was determined according to the TAC for all the evaluated scenarios as indicated in Table 7-12. The maximum modeled visibility impacts at the affected federal Class I areas were used to determine the visibility improvement cost-effectiveness in \$/deciview (\$/dv).

Table 7-12
Visibility Improvement Cost-Effectiveness

Scenario	Control Option Unit 1	Unit 2	Unit 3	TAC (1,000$)	Badlands Maximum Improvements (dv)	Badlands Maximum Improvements (1,000$/dv)	Wind Cave Maximum Improvements (dv)	Wind Cave Maximum Improvements (1,000$/dv)
				NO_x				
1	1	1	1	1,788	0.211	8,474	0.210	8,514
	2	2	2	3,810	0.211	18,057	0.210	18,143
2	3	3	3	21,330	0.382	55,837	0.370	57,649
3	4	4	4	5,457	0.672	8,121	0.641	8,513
4	5	5	5	21,180	0.847	25,006	0.805	26,311
5	6	6	6	39,723	1.026	38,716	1.177	33,749
				Particulate				
6	Base	Base	Base	0	NI	NA	NI	NA
7	Base	Base	1 (SO_2)	19,585	0.060	326,417	0.066	296,742
				SO_2				
8	2	2	Base	732	0.021	34,857	0.028	26,143
	3	3	Base	1,812	0.021	86,286	0.028	64,713
9	1	1	1	32,913	0.127	259,157	0.119	276,580
10	2	2	2	31,975	0.119	268,697	0.193	165,674
	3	3	2	33,055	0.119	277,773	0.193	171,269
11	1	1	2	44,571	0.169	263,734	0.216	206,347
Recommended	1 (NO_x) Base (PM) 5 (SO_2)	1 (NO_x) Base (PM) 5 (SO_2)	1 (NO_x) Base (PM) Base (SO_2)	2,520	0.225	11,200	0.239	10,544

Notes:
NI = No Improvement
NA = Not Applicable

AQD LRS BART 000202

8.0 Conclusion

After completing all five steps of the BART analysis, a BART control scenario for all three units at LRS was selected and evaluated for the visibility improvement at affected federal Class I areas. The visibility improvement modeling is summarized in Section 7.0 of this report.

The recommended BART control scenario was based on the ability of the evaluated control technologies to meet the prescribed presumptive emissions limits; this evaluation was performed as described in Sections 3.0 through 6.0 of this report. The recommended BART control scenario for LRS consists of installing an OFA system for all three units and using FGD chemical additives in the Unit 1 and 2 WFGD system. The control scenario also includes utilizing the existing ESP to control particulate matter emissions. The SO_2 control technology selection was based on averaging SO_2 reductions across all the units at the LRS, as allowed in the BART EPA and Wyoming DEQ guidelines.

This control scenario was determined to be the most cost-effective solution, which would allow LRS to meet the BART presumptive emissions limits for NO_x and SO_2.

The visibility improvements modeled for the BART control scenarios, as described in Section 7.0, indicate an average visibility improvement for all control technologies of 0.3 dv at both affected federal Class I areas through the years 2001 to 2003. The low visibility improvement value is attributed to the low modeled baseline visibility impact, which reflects the near-BART presumptive level emissions currently at LRS. The maximum improvement is attributed to a costly SCR control technology scenario for each unit, which exceeds the targeted NO_x presumptive limit of 0.23 lb/MBtu.

Based on the visibility improvement modeled and the total annual cost evaluated in the impact analysis stage (Step 4), the cost-effectiveness for visibility improvement, which was defined as annual cost per improvement in visibility ($/dv), was determined for LRS. The total annual cost for the implementation of the recommended control technologies to meet the presumptive emissions levels is approximately 2.5 million $/yr. The maximum modeled visibility improvements for the recommended control scenario at each federal Class I area through the 2001 to 2003 time period is 0.2 dv. From this analysis, the cost-effectiveness for visibility improvement at LRS is 11.2 million $/dv.