Task 3A Report for the Powder River Basin Coal Review Cumulative Air Quality Effects

Prepared for

Bureau of Land Management
Casper Field Office,
Wyoming State Office, and
Miles City Field Office

Submitted by

ENSR Corporation
Fort Collins, Colorado

February 2006
(with errata)

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ES.1 INTRODUCTION

The Powder River Basin (PRB) of Wyoming and Montana is a major coal-producing region in the United States. It also has produced large quantities of natural gas and oil, and has experienced significant development of coal bed natural gas (CBNG) from its coal seams. The region has a diverse set of environmental values, including proximity to some of the most pristine areas in the United States.

This Task 3A Report for the PRB Coal Review evaluates the air quality-related environmental impacts of ongoing development in the region. Task 1A Report for the PRB Coal Review, Current Air Quality Conditions (ENSR 2005a) documented the air quality impacts of operations during a base year (2002), using actual emissions and operations for that year. The base year analysis evaluated impacts both within the PRB itself and at selected sensitive areas surrounding the region. The analysis specifically looked at impacts of coal mines, power plants, CBNG development, and other activities. Results were provided for both Wyoming and Montana source groups and receptors.

The Task 2 Report for the PRB Coal Review, Past and Present and Reasonably Foreseeable Development Activities (ENSR 2005b) depicted the range of projected coal-related development in the PRB, for a range of source groups. The report identified reasonably foreseeable development (RFD) activities for the years 2010, 2015, and 2020, and was separated into selected source groups, including power plants, coal mine development, conventional oil and gas and CBNG activities, and other coal-related energy development scenarios. The results of that study were used in developing changes in emission rates for the source groups for 2010 and estimating the associated cumulative air quality impacts.

This report evaluates projected changes in impacts on air quality and air quality-related values resulting from the projected RFD activities. Impacts were evaluated for development of different source groups and on the different receptor groups. The development projected for 2010 was modeled using the same model and meteorological data that were used for the base year study in the Task 1A report. Impacts for 2015 and 2020 were projected qualitatively based on expected changes and on modeled impacts for 2010.

ES.2 TECHNICAL APPROACH

The analysis evaluates two levels of coal development for each of the selected years, a lower production (or development) scenario and a higher production scenario. Existing and projected sources in the study area were analyzed using the base year (2002) emissions and an adjustment to those emissions based on the projected development level. Emissions were evaluated for sources in the "study area," which comprises several counties in the PRB in both states:

- Wyoming counties include Campbell County, all of Sheridan and Johnson counties except the Bighorn National Forest lands to the west of the PRB, and the northern portion of Converse County.

- Montana counties include Rosebud, Custer, Powder River, Big Horn, and Treasure counties.

The study evaluates impacts on air quality and air quality-related values resulting from projected development of RFD activities in the study area. A quantitative modeling assessment was used to project ambient air quality impacts for 2010, and qualitative evaluations were made for 2015 and 2020, based largely on the results of the modeling study for 2010.

A state-of-the-art, guideline dispersion model was used to evaluate impacts on several source groups:

- Near-field receptors in Wyoming (within the PRB study area),

- Near-field receptors in Montana (within the PRB study area),

- Receptors in nearby federally designated pristine or "Class I" areas, and

- Receptors at other sensitive areas (Class II sensitive areas)."

The U.S. Environmental Protection Agency (USEPA) guideline CALPUFF model system (Scire et al. 1999a) was used for this study, similar to the approach used in the Task 1A analysis, using the same meteorological data set. Only the impacts for 2010 were directly modeled, including both the lower and upper production scenarios. The modeling domain extends over most of Wyoming, southeastern Montana, southwestern North Dakota, western South Dakota, and western Nebraska. A group of agency stakeholders participated in developing the modeling protocol and related domain that were used for this analysis.

The modeling approach used actual emissions from existing sources representative of 2002 operations and adjusted those emissions for the expected level of development. No specific emissions data were available for the projected levels of development. The base year emissions data were gathered from a variety of sources, but mainly relied on data collected by the Wyoming Department of Environmental Quality (WDEQ) and the Montana Department of Environmental Quality. Only actual emission sources inside the study area were included in the modeling. Key major sources were included, such as the coal-fired power plants, gas-fired power plants, and sources that were included in the Title V (operating permit) program. The Dave Johnston power plant, located in Converse County, is located outside of but adjacent to the study area, and

specifically was included in the base year study and in the projected emissions. Some operational adjustments were made to accommodate small sources that were presumed to be operating at less than full capacity. Emissions from other sources, including estimated fugitive dust construction emissions, were computed based on USEPA emission factors and on input data from WDEQ.

Meteorological data were developed for 1996 for the modeling domain, using the guideline Version V of the CALMET (Scire et al. 1999b) diagnostic model, identical to that used in the PRB Oil and Gas Environmental Impact Statement (Bureau of Land Management 2003) and in the Task 1A report. These data provide a four-dimensional depiction that represents actual meteorological conditions for that year. The data base was enhanced by using data for specific surface station and precipitation data. Terrain and land use data from the USGS also were used. Modeling data settings generally were set to default values, as provided in the technical report. Base year ozone concentrations also were incorporated into the model using measured concentrations representative of the study area, and were not changed for this study.

The objective of this study is to identify the changes in air quality impacts resulting from the projected levels of development. Impacts were assessed for both Wyoming and Montana and at the individual sensitive receptor areas. The impacts were evaluated for the same receptor set that was used in the Task 1A report, using the same dispersion model and the same technical input data. The only difference between the modeling for the base year and for the results presented here is associated with the projected change in emissions as a result of RFD activities.

ES.3 CUMULATIVE IMPACTS

The existing regional air quality conditions generally are very good. The base year (2002) modeling showed that there was a concern about some impacts of particulate matter with an aerodynamic diameter of 10 microns or less (PM_{10}) emissions within the near-field receptors of both Montana and Wyoming. The modeling also showed some substantial base year impacts on visibility at the nearby Class I areas. For regulatory purposes, the Class I evaluations are not directly comparable to the air quality permitting requirements, because the modeling effort does not segregate increment-consuming sources that would need to be evaluated under the Prevention of Significant Deterioration (PSD) program. The cumulative impact analysis focuses on changes in cumulative impacts versus a comparison to PSD-related evaluations, which would apply to specific sources. Changes in impacts for air quality parameters (nitrogen dioxide [NO_2], sulfur dioxide [SO_2], and PM_{10}) were evaluated, along with changes in air quality-related values at Class I areas.

Table ES-1 presents the modeled impacts on ambient air quality at the near-field receptors in Montana and Wyoming. Results indicate the maximum impacts at any point in each receptor group, and data are provided for the base year (2002) analysis and for both development scenarios for 2010.

The results of the modeling depict the anticipated changes under both development scenarios. For the Montana near-field receptors, the impact on the 24-hour PM_{10} levels shows an increase above the National Ambient Air Quality Standard (NAAQS) for the base year as well as for both development scenarios for 2010. The upper development scenario shows an increase in the impact of more than 40 percent above the base year for this parameter. Impacts at all other receptors show compliance with the NAAQS and the Montana Ambient Air Quality Standard (AAQS). There are large percentage increases projected in annual SO_2 impacts, but the impacts themselves are well below the NAAQS.

For the Wyoming near-field receptors, the modeled 24-hour PM_{10} impacts continue to increase above the NAAQS, and, with a noted 32.7 percent increase in annual PM_{10} impacts, the model predicts that the annual PM_{10} standard also would be exceeded under the upper development scenario. Impacts of NO_2 and SO_2 emissions are predicted to be below the NAAQS and Wyoming AAQS at the Wyoming near-field receptors. For both near-field receptor groups (Wyoming and Montana), the maximum modeled impacts above the ambient standard are restricted to one or two receptors over the whole receptor grid.

Table ES-2 provides modeled impacts at the three Class I areas and two Class II areas with the greatest impacts. A comparison to ambient air quality standards and PSD increments is provided; however, it must be noted that the analysis did not separate PSD increment-consuming sources from those that did not consume increment. The PSD-increment comparison is provided for informational purposes only and cannot be directly related to a regulatory interpretation of PSD increment consumption. In the Northern Cheyenne Indian Reservation, modeled impacts are slightly above the PSD Class I increment levels for annual PM_{10}, annual NO_2, 24-hour SO_2, and 3-hour SO_2. Also, at the Northern Cheyenne Indian Reservation, modeled impacts are well above the Class I increments for 24-hour PM_{10}, but are less than the annual SO_2 PSD Class I increment. In the sensitive Class II areas, all modeled impacts are well below the Class II PSD increments, except that the 24-hour PM_{10} impacts are greater than the Class II 24-hour PM_{10} increments at the

Crow Indian Reservation (**Table ES-2**). In the other Class I areas, only the 24-hour PM_{10} impacts are above the comparison to the PSD increment levels.

Table ES-1
Projected Maximum Potential Near-field Impacts
(µg/m^3)

Pollutant	Averaging Time	Base Year (2002) Impacts	2010 Lower Development Scenario Impacts	2010 Upper Development Scenario Impacts	NAAQS	Wyoming AAQS	Montana AAQS	PSD Class II Increments
Wyoming Near-field								
NO_2	Annual	37.3	42.4	49.0	100	100	--	25
SO_2	Annual	3.9	4.8	5.6	80	60	--	20
	24-hour	14.5	33.5	34.8	365	260		91
	3-hour	37.9	148.0	154.2	1,300	1300	--	512
PM_{10}	Annual	42.7	49.0	**56.6**	50	50	--	17
	24-hour	**335.5**	**378.8**	**439.9**	150	150	--	30
Montana Near-field								
NO_2	Annual	8.85	11.3	11.8	100	--	100	25
	1-hour	365.8	415.9	519.5	--	--	564	--
SO_2	Annual	1.3	2.3	2.7	80	--	80	20
	24-hour	18.9	19.5	20.4	365	--	365	91
	3-hour	74.7	76.4	79.8	1,300	--	1,300	512
	1-hour	240.7	246.4	257.3	--	--	1,300	--
PM_{10}	Annual	19.6	22.5	27.7	50	--	50	17
	24-hour	**175.8**	**200.0**	**247.7**	150	--	150	30

Note: -- = No standard or increment.
µg/m^3 = microgram per cubic meter.

Table ES-3 provides a detailed listing of visibility impacts for all analyzed Class I and sensitive Class II areas. Modeled visibility impacts at the identified Class I areas continue to show the same pattern as exhibited for the base year, with a high number of days with impacts above 1 deciview at the most impacted Class I areas. It should be noted, however, that the increase in impacts is relatively small. Visibility impacts show the largest increases at the Badlands, Theodore Roosevelt, and Wind Cave National Parks, but overall the maximum increases (in the number of days exceeding 1 deciview) are all below 26 days per year.

For acid deposition, all predicted impacts are below the deposition threshold values for both nitrogen and sulfur compounds. There are substantial percentage increases in deposition under the lower and upper development scenarios; however, impacts remain well below the threshold values. The acid neutralizing capacity of sensitive lakes also was analyzed, and results are summarized in **Table ES-4**. The base year study indicated that none of the lakes had predicted significant impacts; however, the lower and upper development scenarios for 2010 show an increased impact at one of the lakes, leading to an impact that is above the 10 percent acid neutralizing capacity (ANC) of Florence Lake. Impacts also are predicted to be above the 1 micro-equivalent per liter (µeq/L) for Upper Frozen Lake.

The study also modeled impacts of selected hazardous air pollutant emissions (benzene, ethyl benzene, formaldehyde, n-hexane, toluene, and xylene) on the near-field receptors in Montana and Wyoming. Model results for the 2010 upper development scenario show that impacts were predicted to be above the acute REL for formaldehyde (94 µg/m^3) at only two receptors in Wyoming but continued to be below all Reference Exposure Level and RfC levels in Montana and for other

compounds in Wyoming. Essentially, the modeled impacts for 2010 showed a continuation of the patterns exhibited for the base year analysis.

Table ES-2
Maximum Predicted PSD Class I and Sensitive Class II Area Impacts
($\mu g/m^3$)

Location	Pollutant	Averaging Period	Base Year (2002) Impacts	2010 Lower Development Scenario	2010 Upper Development Scenario	PSD Class I Increments
Class I Areas						
Northern Cheyenne Indian Reservation	NO_2	Annual	**2.0**	**2.3**	**2.7**	2.5
	SO_2	Annual	0.6	0.8	0.9	2
		24-hour	**6.1**	**6.5**	**6.9**	5
		3-hour	**26.8**	**27.9**	**29.3**	25
	PM_{10}	Annual	**5.0**	**5.8**	**7.0**	4
		24-hour	**42.0**	**47.8**	**59.4**	8
Washakie Wilderness Area (WA)	NO_2	Annual	0.1	0.1	0.1	2.5
	SO_2	Annual	0.0	0.1	0.1	2
		24-hour	1.0	3.0	3.3	5
		3-hour	2.0	5.1	5.6	25
	PM_{10}	Annual	0.3	0.4	0.4	4
		24-hour	**14.5**	**16.5**	**16.9**	8
Wind Cave National Park	NO_2	Annual	1.2	1.5	1.7	2.5
	SO_2	Annual	0.2	0.4	0.5	2
		24-hour	1.2	3.5	3.8	5
		3-hour	3.5	9.9	10.3	25
	PM_{10}	Annual	1.3	1.7	1.9	4
		24-hour	**10.7**	**14.0**	**15.7**	8
Sensitive Class II Areas						
Crow Indian Reservation	NO_2	Annual	5.7	6.2	6.7	25
	SO_2	Annual	0.8	0.9	0.9	20
		24-hour	4.7	5.1	5.3	91
		3-hour	14.7	15.1	15.7	512
	PM_{10}	Annual	3.0	3.7	4.0	17
		24-hour	**30.5**	**35.1**	**36.7**	30
Cloud Peak WA	NO_2	Annual	0.5	0.7	0.7	25
	SO_2	Annual	0.1	0.2	0.3	20
		24-hour	1.4	3.3	3.7	91
		3-hour	3.6	6.5	7.9	512
	PM_{10}	Annual	0.8	1.1	1.2	17
		24-hour	13.3	17.1	17.9	30

For 2015 and 2020, the Task 3A report provides a qualitative analysis of potential impacts, based on the changes from 2002 to 2010 for the respective production scenarios. The predicted production from conventional oil and gas and CBNG activities are projected to peak at 2010, with slight declines predicted over the following decade. Therefore, from these sources, expected impacts would decrease slightly from 2010 to 2015 and 2020. The coal mining sources would be the major contributors to PM_{10} impacts in the near-field, and these impacts would result from the proximity of the receptors to the coal mining operations. If coal mines expand or relocate, those impacts likely would follow that development; however, the specific impacts would need to be addressed with a more refined modeling effort, specifically including accurate source parameters. Power plants currently are the major contributors to all SO_2 impacts in the near-field in both states. However, the impacts are well below any ambient standard or PSD increment, and continued

expansion should not jeopardize the attainment of those standards. Impacts on NO_2 concentrations are the result of emissions from all the source groups. No one source group dominates the NO_2 impacts in the near-field.

Table ES-3
Modeled Change in Visibility Impacts at Class I and Sensitive Class II Areas

Location	Base Year (2002) No. of Days >10%	2010 Lower Development Scenario Change in No. of Days > 10%	2010 Upper Development Scenario Change in No. of Days > 10%
Class I Areas			
Badlands National Park	238	19	26
Bob Marshall WA	12	2	4
Bridger WA	47	4	7
Fitzpatrick WA	42	3	5
Fort Peck Indian Reservation	69	8	9
Gates of the Mountain WA	14	6	7
Grand Teton National Park	26	2	5
North Absaorka WA	47	6	6
North Cheyenne Indian Reservation	305	5	10
Red Rock Lakes	16	3	5
Scapegoat WA	14	4	4
Teton WA	40	4	5
Theodore Roosevelt National Park	98	15	22
UL Bend WA	49	4	5
Washakie WA	53	2	3
Wind Cave National Park	261	11	15
Yellowstone National Park	42	7	8
Sensitive Class II Areas			
Absaorka Beartooth WA	53	3	5
Agate Fossil Beds National Monument	199	26	30
Big Horn Canyon National Recreation Area	108	7	8
Black Elk WA	263	16	22
Cloud Peak WA	137	8	8
Crow Indian Reservation	284	10	15
Devils Tower National Monument	279	15	21
Fort Belknap Indian Reservation	46	3	4
Fort Laramie National Historic Site	153	27	30
Jedediah Smith WA	23	1	2
Jewel Cave National Monument	267	14	18
Lee Metcalf WA	25	2	4
Mount Naomi WA	8	6	8
Mount Rushmore National Monument	248	19	25
Popo Agie WA	47	7	8
Soldier Creek WA	223	23	29
Wellsville Mountain WA	6	5	7
Wind River Indian Reservation	66	12	15

A pattern that is similar to the near-field receptors also holds true for the Class I and sensitive Class II receptor groups. Essentially, the mine operations would continue to dominate the PM_{10} impacts, the power plants would continue to dominate the SO_2 impacts (although they would continue to be below the standards), and the overall source groups would continue to contribute to NO_2 impacts, but impacts should remain below the NO_2 standard.

Table ES-4
Predicted Total Cumulative Change in Acid Neutralizing Capacity of Sensitive Lakes

Location	Lake	Background ANC (µeq/L)	Area (hectares)	Base Year (2002) Change (percent)	2010 Lower Development Scenario Change (percent)	2010 Upper Development Scenario Change (percent)	Thresholds (percent)
Bridger WA	Black Joe	67	890	1.3	1.88	1.97	10
	Deep	60	205	1.4	2.08	2.18	10
	Hobbs	70	293	0.9	1.37	1.43	10
	Upper Frozen	5	64.8	0.7[1]	0.99[1]	1.04[1]	1[1]
Cloud Peak WA	Emerald	55.3	293	5.3	6.59	6.89	10
	Florence	32.7	417	8.9	11.52	12.03	10
Fitzpatrick WA	Ross	53.5	4,455	0.9	1.37	1.43	10
Popo Agie WA	Lower Saddlebag	55.5	155	1.9	2.58	2.7	10

[1]Data for Upper Frozen Lake presented in changes in µeq/L. (For lakes with less than 25 µeq/L background ANC.)

Based on modeling results, none of the acid deposition thresholds were exceeded at Class I areas for either the base year or for the lower or upper development scenarios for 2010. In general, the projected increases in coal development (and power plants) are not expected to raise the deposition levels above the threshold, extended into 2020. The only concern relates to the acid deposition into sensitive lakes. The model results showed that the increased deposition, largely from SO_2 emissions from power plants, exceeded the thresholds of significance for the ANC at two sensitive (high alpine) lakes. The results indicate that with increased growth in power plant operations, the reduced ANC of the sensitive lakes would become significant and would need to be addressed carefully for each proposed major development project.

ACRONYMS AND ABBREVIATIONS

µeg/L	micro-equivalents per liter
$\mu g/m^3$	micrograms per cubic meter
AAQS	ambient air quality standards
ANC	acid neutralizing capacity
B_{ext}	extinction coefficient for visibility
BLM	Bureau of Land Management
CALMET	Meteorological Processor System
CALPUFF	model used to generate long range impact
CASTNET	Clean Air Status and Trends Network
CBNG	coal bed natural gas
EIS	Environmental Impact Statement
eq	equivalence
$eq/m^2/yr$	equivalence per cubic meter per year
FLAG	Federal Land Manager's Air Quality Guidance
HAPs	hazardous air pollutants
kg/ha-yr	kilograms per hectare per year
km	kilometer
LAC	limits of acceptable change
LBA	lease by application
LOC	level of concern
MDEQ	Montana Department of Environmental Quality
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
PRB	Powder River Basin
PSD	Prevention of Significant Deterioration
RELs	Reference Exposure Levels
RfCs	Reference Concentrations for Chronic Inhalation
RFD	reasonably foreseeable development
SO_2	sulfur dioxide
SO_4	sulfate
U.S.	United States
USEPA	U.S. Environmental Protection Agency
WA	Wilderness Area
WDEQ	Wyoming Department of Environmental Quality

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1.0 INTRODUCTION

The Powder River Basin (PRB) of Wyoming and Montana is a major energy development area with diverse environmental values. The PRB is the largest coal-producing region in the United States (U.S.); PRB coal is used to generate electricity within and outside of the region. The PRB also has produced large amounts of oil and gas resources. Within the last decade, this region has experienced nationally significant development of natural gas from coal seams.

For the purpose of this study, the Wyoming PRB cumulative effects study area for air quality (**Figure 1-1**) comprises all of Campbell County, all of Sheridan and Johnson counties less the Bighorn National Forest lands to the west of the PRB, and the northern portion of Converse County. It includes all of the area administered by the Bureau of Land Management (BLM) Buffalo Field Office, a portion of the area administered by the BLM Casper Field Office, and a portion of the Thunder Basin National Grasslands, which is administered by the U.S. Department of Agriculture-Forest Service (FS). The Montana portion of the PRB cumulative effects study area for air quality (**Figure 1-1**) comprises the area of relevant coal mines including portions of Rosebud, Custer, Powder River, Big Horn, and Treasure counties. It encompasses the area administered by the BLM Miles City Field Office. State and private lands also are included in the study area.

During the 1970s and early 1980s, the PRB emerged as a major coal production region. Federal coal leasing was a high profile activity as over 90 percent of the PRB's coal is federally owned. The BLM is the lead agency responsible for leasing federal coal lands in the PRB study area. Between 1974 and 1982, the BLM issued three and started a fourth separate regional coal environmental impact statement (EIS), all addressing federal coal leasing and development, as well as other regional development.

In 1982, BLM temporarily halted coal leasing. However, the existing mines continued producing coal, which depleted their leased federal coal reserves. As a result, interest in leasing federal coal to extend mining operations at existing mines in the PRB increased in the late 1980s. There was little to no interest in opening new mines, however, and therefore, there was not enough interest in leasing to justify a regional coal sale. In early 1990, the Powder River Regional Coal Team decertified the Powder River Federal Coal Region, which allowed BLM to begin processing applications by existing mines to lease maintenance tracts of federal coal using the lease by application (LBA) process.

BLM is required to complete a National Environmental Policy Act (NEPA) analysis (EIS or environmental assessment) for each coal lease application as part of the leasing process. In the coal leasing EAs and EISs that have been prepared since decertification, cumulative impacts have been addressed in a separate section of the chapter that describes the expected environmental impacts of the proposed action. This approach was designed to highlight the distinction between site-specific and cumulative impacts.

In the mid-1990s, BLM conducted a study called the PRB Coal Development Status Check (Status Check) (BLM 1996). The purpose of the Status Check was to compare actual cumulative development in the PRB with the levels of cumulative development that were predicted for 1990 and 1995 in the regional EISs discussed above. At the time the Status Check was prepared, the actual levels of cumulative development generally were within the levels that had been predicted.

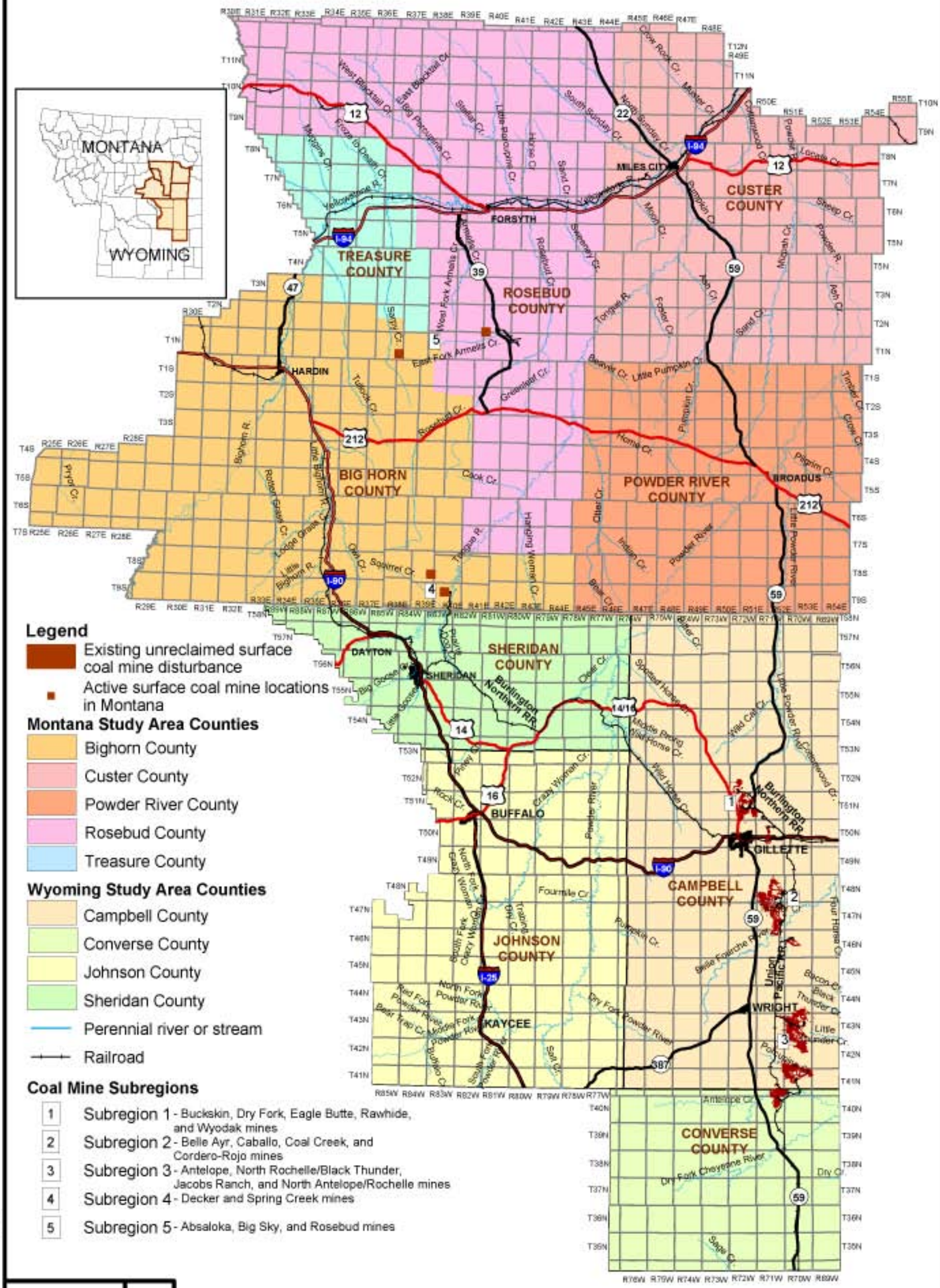
BLM continued updating key portions of the Status Check and used the results in the cumulative impact section of the coal-leasing EAs and EISs. The Status Check updates indicated that the actual levels of coal development and associated impacts began to approach the predicted levels in the late 1990s. Around that same time, impacts related to oil and gas development began increasing due to the development of coal bed natural gas (CBNG) in the PRB.

BLM prepared the Wyodak EIS (BLM 1999) and PRB Oil and Gas EIS (BLM 2003) to address the impacts of projected CBNG development in the Wyoming PRB. Modeling was used to quantify potential cumulative impacts to air and water resources in these two EISs. Surface coal mining operations in Montana and Wyoming were included in the modeling analyses as reasonably foreseeable, non-project sources of impacts. For these analyses, future levels of coal development were estimated using market demand projections. BLM used these cumulative impact analyses in the coal leasing EISs as well as in the CBNG EISs.

In early 2003, BLM completed a study of PRB coal demand through 2020 (Montgomery Watson Harza 2003). The study projected production to increase at a steady pace with current mines able to meet the demand as long as the existing mines continue to have access to additional coal reserves; therefore, the need for leasing using the LBA will continue into the foreseeable future. As part of processing these LBAs, BLM will include a current cumulative impact analysis as part of the NEPA analysis. An initial step in that direction is this PRB Coal Review, which includes the identification of current conditions (Task 1 reports), identification of reasonably foreseeable development (RFD) actions and future coal production scenarios (Task 2 report), and predicted future cumulative impacts (Task 3 reports) in the PRB.

The Task 2 component of the PRB Coal Review defines the past and present development actions in the study area that have contributed to the current environmental and socioeconomic conditions in the PRB study area. This report also defines the projected RFD scenarios in the Wyoming and Montana PRB for years 2010, 2015, and 2020. For the Wyoming PRB, the past and present development and RFD scenarios include coal mine development as well as coal-related activities (i.e., railroads, coal-fired power plants, major transmission lines, and coal technology projects) and non-coal-related activities (i.e., other mines, CBNG, conventional oil and gas, major transportation pipelines, and key water storage reservoirs). Coal mine development and coal-related activities in the Montana PRB study area are included in this study to provide the basis for the analysis of cumulative air quality impacts and to facilitate the concurrent development of the Miles City Resource Management Plan. The past and present activities identified in this report are based on the most recent data available at the end of 2003 and provide the basis for the resource-specific descriptions of current conditions presented in the PRB Coal Review Task 1 reports.

The RFD scenarios presented in the Task 2 report provide the basis for the analysis of potential cumulative impacts in the Task 3 component of the study. The accuracy of any projected cumulative impact analysis is dependent on the adequacy and accuracy of information regarding potential future development activities in the affected area. While it is impossible to identify all potential future activities over the next 15 years, it is possible and desirable to identify reasonably foreseeable future actions based on current industry announcements, agency plans, economic trends, and technological advances affecting major industry sectors. Information regarding potential new development is constantly changing; however, to facilitate development of the information in this study, the RFDs identified in the Task 2 report reflect information available through the end of 2004.



Source: BLM 2003, 2004; Thunder Basin Coal Company 2003

Powder River Basin Coal Review

Figure 1-1

Montana and Wyoming Study Area

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The past and present actions in the Task 2 report were identified based on information in existing NEPA documents on file with federal and state agencies, and the Coal Development Status Check (BLM 1996). The RFD scenarios in the Task 2 report were developed based on recent information that identifies proposed and anticipated development in the PRB, including NEPA documents; various other technical reports and studies; federal, state, and local (county) agency management plans; and permit applications. The specific development scenarios and development activities identified in these sources were assessed as to their current status prior to inclusion in the RFD scenarios for the PRB Coal Review. In addition, potential additional projects were identified through interviews with agency and industry representatives, review of published news articles and trade publications, and discussions with community leaders.

The identified RFD activities subsequently were evaluated as to their probability for occurrence. Due to the lack of detailed information for many developments beyond the next few years, the degree of uncertainty associated with the predicted developments and trends increases as the timeframe extends further into the future.

For each of the past and present and RFD projects and activities, project-specific impact-causing parameters (e.g., disturbance acreage, emission levels, employment levels, etc.) have been compiled from the sources identified above. Where specific information was unavailable, assumptions were developed and included based on typical industry-specific standards, permit criteria for similar existing industries, and professional judgment. This information is summarized in the Task 2 report.

In order to account for the variables associated with future coal production, two detailed coal production scenarios (reflecting upper and lower production estimates) were projected for this study to bracket the most likely foreseeable regional coal production level and to provide a basis for quantification of related impact-causing parameters. These future production levels were derived from the analysis of historic production levels and current PRB coal market forecasts, public and private information sources, and input from individual PRB coal operators and are summarized in the Task 2 report.

1.1 Objectives

This PRB Coal Review is a regional technical study to assess cumulative impacts associated with past, present, and RFD in the PRB. The PRB Coal Review:

- Describes past and present development activities in the PRB that have affected the environmental conditions in the study area;
- Describes the current environmental conditions in the study area and compares these conditions to the conditions described in the BLM's Coal Development Status Check (BLM 1996), as applicable;
- Estimates RFD in the study area through the year 2020, based on available information; and
- Estimates the environmental impacts associated with RFD through the year 2020.

The PRB Coal Review will provide data, models, and projections to facilitate cumulative analyses for future agency land use planning efforts and for future project-specific impact assessments for project development in compliance with NEPA. The PRB Coal Review is not a NEPA document or a policy study, or an analysis of regulatory actions, or an analysis of the impacts associated with the development of a specific project or projects in the PRB.

This report summarizes Task 3A of the PRB Coal Review, a description of predicted future cumulative air quality impacts associated with RFD activities in the Wyoming and Montana PRB cumulative effects study area. Air quality impacts were assessed in both Wyoming and Montana and at individual sensitive receptor areas. The impacts were evaluated for the same receptor set that was used in the Task 1A Report for the PRB Coal Review, Current Air Quality Conditions (ENSR 2005b), using the same dispersion model and the same technical input data. The only difference between the modeling for the base year (2002), and for the results presented here, would be due to the projected change in emissions from the identified RFD activities.

The PRB Coal Review Task 3 descriptions of predicted cumulative impacts for water resources, social and economic conditions, and environmental resources are presented in separate stand-alone reports.

1.2 Agency Outreach, Coordination, and Review

The BLM directed the preparation of this PRB Coal Review. In order to ensure the technical credibility of the data, projections, interpretations, and conclusions of the study and ensure the study's usefulness for other agencies' needs, the BLM initiated contact with other federal and state agencies early in the study. This contact included meetings, periodic briefings, and written communications.

The BLM conducted an agency outreach program to solicit input from other agencies relative to their:

- Interested role and level of involvement in the study;
- Available data for use in the study;
- Input to the technical approach for resource evaluations; and
- Review of project deliverables.

As part of this agency outreach and technical oversight, the BLM organized technical advisory groups. These groups were composed of agency representatives and stakeholders with technical expertise in the applicable resources. Participating agencies relative to air quality included the BLM; Wyoming Department of Environmental Quality (WDEQ); Montana Department of Environmental Quality (MDEQ); U.S. Environmental Protection Agency (USEPA); National Park Service; and FS.

1.3 Methodology

The study included evaluation of impacts at all receptor groups on ambient air levels of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter with an aerodynamic diameter of 10 microns or less (PM_{10}), and selected hazardous air pollutants (HAPs). The HAPs were evaluated at the near-field receptors in Montana and Wyoming, but not at the sensitive receptor areas. At the

sensitive receptor areas, impacts on visibility and acid deposition also were evaluated. The study evaluates the changes in impacts for each of these fields for the projected levels of development.

Impacts of HAPs were evaluated only for near-field receptors, because the areas nearest to the sources would have the maximum impact. Impacts at the more distant sensitive receptor areas were deemed to be well below those at the near-field and well below any applicable threshold concentration. There are no special thresholds for HAPs that apply to Class I or sensitive Class II areas. Impacts on visibility and acid deposition were provided for all the sensitive areas identified by the stakeholder group. The near-field analysis was aimed at evaluating impacts at non-sensitive receptors near the sources in the study area.

The study first included development of emission rates and emission factors, or increases in emissions, for each of the source groups. Emission rates were developed with available technical information, as no specific permit application or other site-specific document was available to determine the expected emissions. The Task 2 Report included the projected increases in production or operation for a series of source groups. For the Task 3A analysis, emissions for most groups were increased by a ratio that was calculated using production data for the proposed development level divided by the production data for the base year.

The study modeled air quality impacts only for 2010, but it included analysis of two separate levels of development for that year (lower and upper production scenarios). Impacts for 2015 and 2020 were based on a qualitative evaluation of the anticipated change in emissions, using the modeled impacts related to the 2010 development scenarios. During development of the approach for the air quality analysis for this study, it was determined that the production estimates for 2015 and 2020 were very qualitative, and, as a result, that a detailed quantitative modeling analysis of these years would not provide sufficient value to the project results.

2.0 TECHNICAL APPROACH

2.1 Overview of Assessment Approach

The objective of the study is to evaluate impacts over a wide range of receptors centered over the PRB cumulative effects study area. The evaluation covers receptors within the PRB in both Montana and Wyoming, and it includes individual sensitive receptor groups in the region surrounding the PRB cumulative effects study area. Key aspects of the study include the selection of air emissions within the study area, the selection of a modeling system to conduct that evaluation, the selection of a receptor set (within the model system) to be used for evaluating cumulative impacts, and the selection of criteria for evaluation of impacts.

The air quality cumulative effects study for the PRB Coal Review, as presented in this Task 3A report, addressed the impact of changes in emissions from the previous base year (2002) study, as presented in the Task 1A report (ENSR 2005b), for a range of development scenarios through 2020. The assessment evaluated changes in air quality levels for NO_2, SO_2, and PM_{10} at the identified receptors. The impacts for both a lower production scenario and upper production scenario were assessed at all receptor groups. Since the various source groups were analyzed separately for expected emissions changes, this study reports the modeled effect of emissions from each source group in 2010. Impacts for 2015 and 2020 were evaluated qualitatively based on changes in emissions and associated impacts from the 2010 scenarios. The change in production and related emissions for individual source groups were used to project the impacts for 2015 and 2020.

This section provides a detailed review of the modeling system, the emissions characterization, the receptor grids, and the assessment criteria that were used for evaluation of impacts. The interpretation of the results is limited by the key assumptions discussed below and project objectives that were used for this study. All results need to be interpreted with the understanding that:

- Actual source characteristics were not included for each source;
- No specific facility boundaries (for ambient air) were developed; and
- Emissions were broadly characterized and do not represent actual short-term emission rates.

2.2 Air Quality Modeling

To conduct a formal modeling of impacts, the USEPA guideline model CALPUFF (Scire et al. 1999a) was used to estimate impacts in both the PRB receptors and the sensitive surrounding areas. The CALPUFF modeling system was recommended for a refined modeling analysis of the region in order to assess impacts over near-field and distant receptor areas. The CALPUFF modeling system has three main components:

- CALMET (a diagnostic three-dimensional meteorological model, which develops the meteorological data for modeling input);

- CALPUFF (the transport and dispersion model that carries out calculations of dispersion); and
- CALPOST (a post-processing package that is used to depict overall concentrations and impacts).

The CALPUFF modeling system is designed to treat the time-varying point and area source emissions; model domains at distances from tens of meters to hundreds of kilometers from the sources; predict averaging times from 1 hour to 1 year; predict impacts for inert pollutants that are not chemically changed in the atmosphere; predict impacts of pollutants that may be subject to removal and chemical conversion mechanisms; and be applied to rough terrain situations. Given these strengths and the objectives of the study, the CALPUFF model is aptly suited to carrying out the required atmospheric dispersion modeling.

The CALPUFF modeling domain for the Task 1A report was established to be identical to that used in the PRB Oil and Gas Final EIS (BLM 2003) and the base year study that is part of the overall PRB Coal Review (Task 1 Report for the PRB Coal Review, Current Air Quality Conditions [ENSR 2005b]). A depiction of the CALPUFF modeling domain, along with the depiction of the study area and sensitive receptors, is provided in **Figure 2-1**.

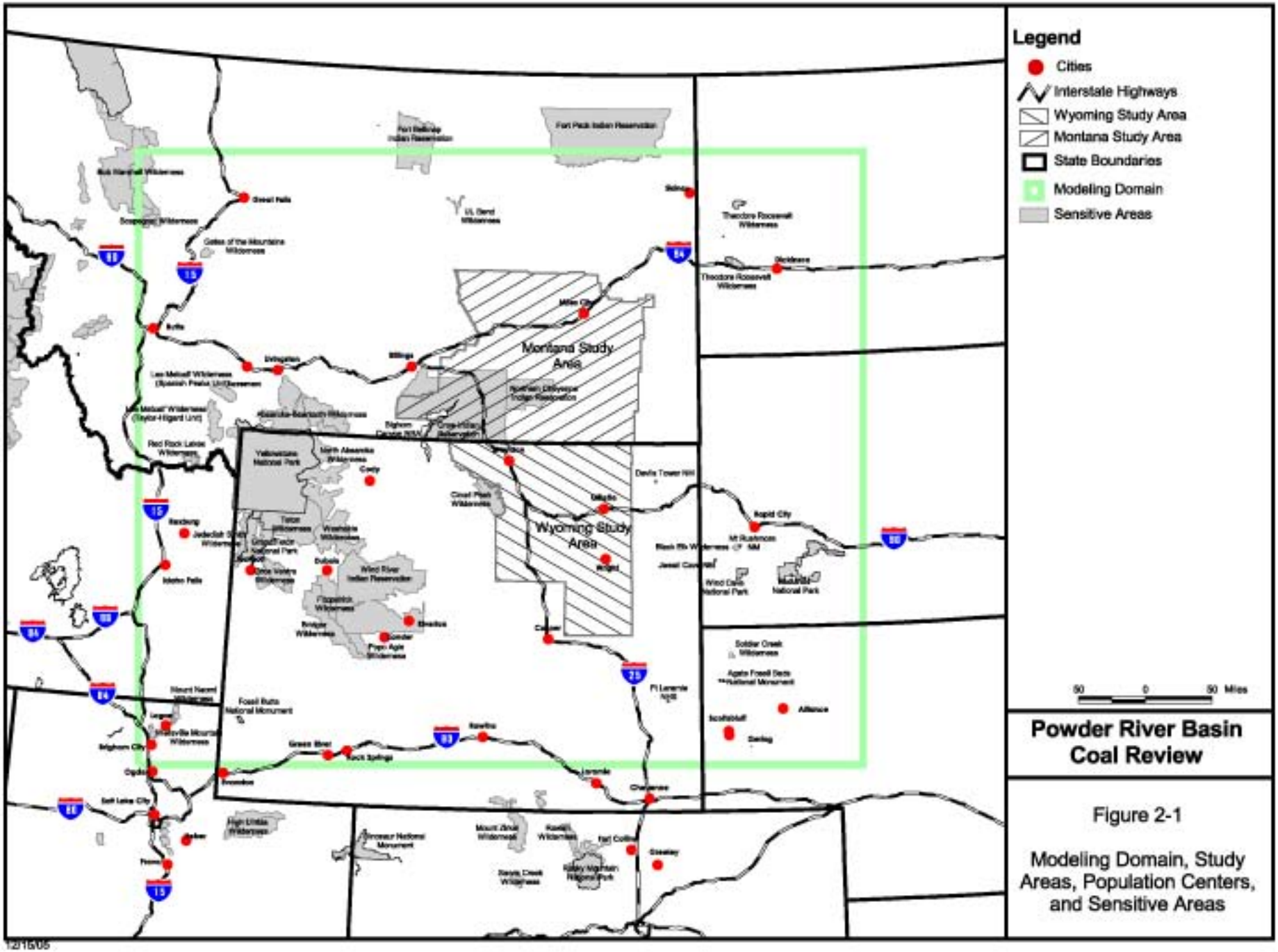
The meteorological data set for 1996 was used in evaluating impacts for all of these referenced studies. As discussed in the Task 1A report (ENSR 2005b), a modeling protocol was submitted to an agency stakeholder group prior to conducting the Task 1A modeling effort. The approach and technical options within that modeling effort were identical to those used for the Task 3A study.

2.3 Receptor Grids and Analyses

Receptor grids were established for various source groups. These included the near-field receptors in both states, which cover the study area in each state. The near-field grid receptors cover grid points within the boundaries of the PRB study area. Near-field receptors were arranged to obtain the maximum estimated concentrations that result from development within the PRB. The purpose of establishing these receptors was to characterize the overall air quality conditions in the PRB as a result of development-related activities, but not to focus on impacts from any individual source. This approach does not address the modeling that would be needed for assessing impacts at any facility fence line, which generally is required for obtaining an air permit from a regulatory agency. The scope of this study did not include a detailed depiction of actual source characteristics; therefore, the modeled impacts very close to each source would not be accurately portrayed. Consequently, all near-field receptors that were located within 1 kilometer (km) of a modeled source were removed from the near-field grid. Overall the near-field receptor grid points were spaced at 1-km intervals over the study area. The elevation of each receptor was obtained from the Digital Elevation Model data for the 1:250,000 quads with 90-meter horizontal resolution (U.S. Geological Survey 2000).

Receptors also were located along boundaries and within each of the following Class I and specified Class II sensitive areas of concern within the modeling domain:

- Badlands National Park
- Wind Cave National Park


Legend
Cities
Interstate Highways
Wyoming Study Area
Montana Study Area
State Boundaries
Modeling Domain
Sensitive Areas
Montana Study Area
Wyoming Study Area
Great Falls
Billings
Miles City
Sidney
Bozeman
Butte
Helena
Missoula
Kalispell
Cody
Sheridan
Gillette
Douglas
Casper
Rawlins
Rock Springs
Green River
Evanston
Laramie
Cheyenne
Rapid City
Alliance
Scottsbluff
Salt Lake City
Ogden
Provo
Pocatello
Idaho Falls
Rexburg
Lander
Riverton
Thermopolis
Worland
Powder River Basin Coal Review
Figure 2-1
Modeling Domain, Study Areas, Population Centers, and Sensitive Areas
50 0 50 Miles

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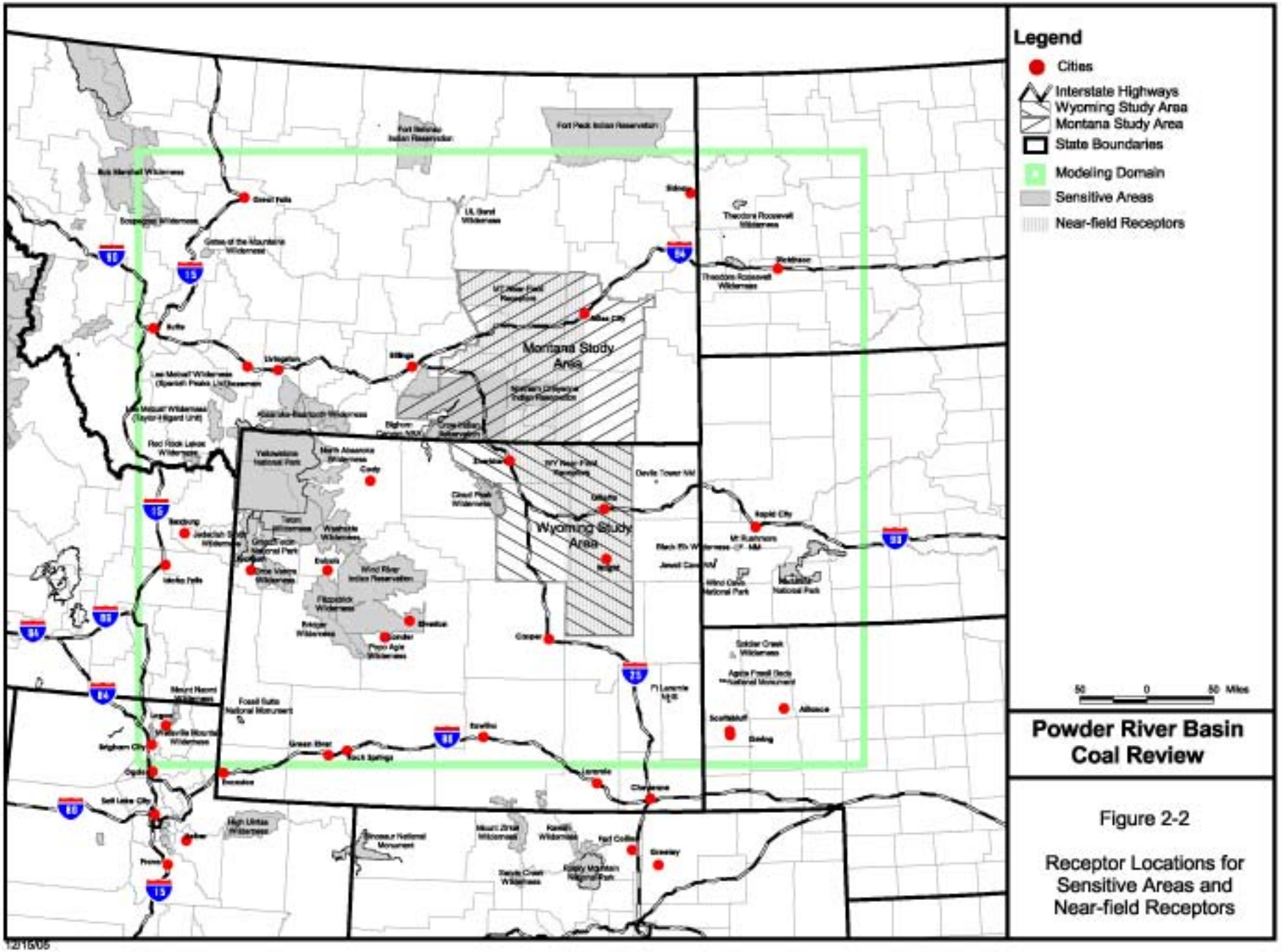
- Bridger Wilderness Area (WA)
- Fitzpatrick WA
- Washakie WA
- North Absoroka WA
- Northern Cheyenne Indian Reservation (Class 1, Northern Cheyenne Tribal Council)
- Devils Tower National Monument
- Mount Rushmore National Memorial
- Jewel Cave National Monument
- Agate Fossil Beds National Monument
- Fort Laramie National Historic Site
- Black Elk WA
- Soldier Creek WA
- Cloud Peak WA
- Yellowstone National Park
- Grand Teton National Park
- Teton WA
- Absaroka Beartooth WA
- Bighorn Canyon National Recreation Area
- Popo Agie WA
- Crow Indian Reservation (Class II Crow Tribal Council)
- Theodore Roosevelt National Park

The following areas are near the edge of the modeling domain. Modeled impacts at receptors within these areas near the edge of the modeling domain might be associated with model inaccuracies and uncertainties due to edge effects of the modeling. Therefore, estimates of potential impacts to these areas near the edge of the modeling domain were made by placing representative receptors no nearer than 25 km from the edge of the modeling domain:

- Bob Marshall WA
- Gates of the Mountains WA
- Lee Metcalf WA, Spanish Peaks Unit
- Lee Metcalf WA, Taylor Hillgard Unit
- Red Rock Lakes WA
- Jedediah Smith WA
- Mount Naomi WA
- Wellsville Mountain WA
- U.L. Bend WA
- Fort Peck Indian Reservation
- Scapegoat WA
- Fort Belknap Indian Reservation

These locations as well as other sensitive receptors, such as lakes, are shown in **Figure 2-2**. The near-field receptor area also is shown in this figure. The receptors were determined with sufficient accuracy to assure that the maximum potential air quality impacts were evaluated. All sensitive receptors were identified and reviewed in the modeling protocol by the stakeholder group, prior to initiating the modeling.


Legend
Cities
Interstate Highways
Wyoming Study Area
Montana Study Area
State Boundaries
Modeling Domain
Sensitive Areas
Near-field Receptors
50 0 50 Miles
Montana Study Area
Wyoming Study Area
Powder River Basin Coal Review
Figure 2-2
Receptor Locations for Sensitive Areas and Near-field Receptors
12/15/05

2.4 Emissions Input Data

Source characterization and emissions data are key inputs to conducting a successful modeling analysis. For this study, sources that were modeled were limited to those in the study areas, with the exception of the Dave Johnston Power Plant in Converse County, which is near the edge of the study area. For the Task 1A study, emissions were determined for 2002 based on data provided by the regulatory agencies (WDEQ and MDEQ). Similar to the Task 1A study, the emission sources for the Task 3A study were separated into various emission source groups, which were analyzed separately. The emission source groups that were analyzed focused on certain air pollutant emissions including SO_2, sulfate (SO_4), oxides of nitrogen (NO_x), and PM_{10}. The emission source groups that were analyzed also focused on certain HAP emissions including benzene, n-hexane, toluene, ethyl-benzene, xylene, and formaldehyde. It should be noted that HAP emissions were not analyzed for the CBNG source category since information for that source category was not provided. The following emission source groups were analyzed as part of the Task 3A study:

- All sources combined
- CBNG sources (all CBNG producing sources)
- Coal production-related sources (from both states, including mines, power plants, railroads, and conversion facilities)
- Coal mines (in both states)
- Montana sources (all sources located in Montana)
- Wyoming sources (all sources located in Wyoming)
- Non-coal sources (roads, urban areas, miscellaneous sources, conventional oil and gas, non-coal power plants [excludes CBNG sources])
- Power plants (includes coal- and gas-fired power plants in Wyoming and Montana)

Emission rates for 2010 were calculated in a different manner for each emission source group. The methodology used to calculate emission rates for each emission source group is presented below.

<u>Coal Production-related Sources</u>

For coal production-related sources, which included mines, mine roads, railroads, and coal conversion sources, the base year data (2002) was used to establish the baseline emissions. For Montana, coal transportation data were not available at the time, and, as a result, no specific coal transportation emissions on impacts were evaluated. Two scenarios were analyzed to estimate emissions rates in 2010, a lower production scenario and an upper production scenario. The lower production scenario emissions were based on the lower range of development projected to occur. The upper production scenario emissions were based on the upper range of development projected to occur. The projected increase in production under the lower and upper production scenarios were used to scale the base year (2002) emissions to the emissions in 2010, as a ratio of the base year production in 2002 to the projected production in 2010.

Different lower production and upper production values used in the ratio of emissions were applied for sources in Wyoming and Montana. The lower and upper coal production values for Wyoming are presented in Tables A-1 and A-2 of the Task 2 report (ENSR 2005a), and the lower and upper coal production values for Montana are presented in Tables A-3 and A-4 of the Task 2 report. These values also are presented in **Table 2-1** of this report.

CBNG Sources

CBNG activity was separated from conventional oil and gas production for this study. CBNG impacts were evaluated separately. Conventional oil and gas impacts were included in non-coal sources (see below). For CBNG, the base year (2002) data were used to establish the baseline emissions. The projected increase in CBNG production was used to scale the baseline (2002) emissions to the emissions in 2010, as a ratio of the baseline year gas production in 2002 to the projected gas production in 2010. The projections of CBNG production activity for 2010 (as used for the air quality model) are presented in **Table 2-1** of this report. The CBNG production projections for this study were being refined concurrently with the air quality modeling conducted for this report. As a result, the initial production numbers used in the air quality model and shown in **Table 2-1** differ somewhat from the final production projections presented in the Task 2 report (ENSR 2005a). The final Task 2 projections for CBNG production in 2010 under both scenarios is 640 BCF. This production level would result in incrementally greater CBNG-related air quality impacts than presented in this report.

Table 2-1
Emissions Calculations for 2010 by Source Group

Source Group	Production Data			Adjustment Ratio		
	Base (2002)	Lower Scenario (2010)	Upper Scenario	Base (2002)	Lower Scenario (2010)	Upper Scenario (2010)
Conventional Oil and Gas Sources	39.9 BCF	42.7 BCF	42.7 BCF	1.0	1.065	1.065
CBNG Sources	338 BCF	554 BCF	554 BCF	1.0	1.639	1.639
Coal Production (Wyoming)	363 mmtpy	411 mmtpy	479 mmtpy	1.0	1.129	1.316
Coal Hauling (Wyoming)	363 mmtpy	411 mmtpy	479 mmtpy	1.0	1.129	1.316
Coal Production (Montana)	36.1 mmtpy	41 mmtpy	51 mmtpy	1.0	1.136	1.413
Power Plants	Individual Plant Adjustments					
Urban Areas	No Adjustment					
Miscellaneous	No Adjustment					

Power Plant Sources

For coal-fired power plants, the projected 2010 emission rates for power plants that were not operational in 2002 but are expected to be operational in 2010 were derived from the actual power plant permit application or the power plant permit from the specified facility. This information should allow for a conservative estimate since the permitted emission rates will be the allowable emission rates, and actual emission rates from these new power plants could be less than the allowable emissions but cannot be higher. Where stack parameters were available, those data were used for input into the model. Emissions of NO_x, SO_2, and PM_{10} from the power plant permits were determined from expected levels with best available control technology that would be applied to those sources. If a coal-fired power plant permit application or permit was not obtainable, emissions

from a coal-fired power plant of the equivalent size was used to estimate 2010 emissions. The coal-fired power plants for which emissions were estimated for 2010 include the following:

- WYGEN 2
- Two Elk Unit 1
- Basin Electric/Gillette
- Hardin Generating Station

These coal-fired power plants were included as individual sources, in addition to the existing coal-fired facilities which also were analyzed. For existing coal-fired power plant sources that were operational in 2002, a scaling factor was used to increase the capacity of these sources from an 88 percent capacity factor in 2002 to a 90 percent capacity factor in 2010 to account for a possible increase in capacity between the baseline year (2002) and 2010. There were no projected increase in emissions for gas-fired power plants.

Other Non-coal Sources

Other non-coal sources include conventional oil and gas production, for which projected emissions increases were based on data developed from **Table 2-1**. For other sources (urban areas, non-coal highways, and miscellaneous sources), there was no adjustment to the emission rates from the base year (2002). For all non-coal sources, the same emission rates were used for both the lower and upper production scenarios.

The modeled location for the projections for cumulative impacts did not change from the base year (2002) modeling for any sources except for the new power plants.

The emissions from the Tongue River Railroad were not included in the base year (2002) or in the 2010 modeling. As reported in the final Task 2 report, it is projected that this railroad would not be constructed under the lower production scenario. Construction of this railroad under the upper production scenario would be dependent on development of the Otter Creek Mine. The modeling for the upper production scenario was not revised to accommodate this source. However, the modeling results did show that impacts in the area of the Tongue River Railroad line are well below the standards and increments for all criteria pollutants (see **Figure 3-2**). The analysis in the Draft Supplemental EIS for the Tongue River Railroad (Surface Transportation Board 2004) concluded that air quality-related impacts from railroad operations would not adversely affect the Northern Cheyenne Indian Reservation. The projected maximum emissions rates for the Miles City to Decker line via the Four Mile Creek Alternative is 1.8 tons per mile per year for PM_{10}, 5.6 tons per mile per year for SO_2 and 6.9 tons per mile per year for NO_X. Over this 29.4-mile line route, the total emissions would amount to 53 tons per year of PM_{10}, 165 tons per year of SO_2, and 203 tons per year for NO_X. Compared to other stationary sources, the impacts are expected to be negligible. For comparison, total stationary source coal mine emissions in Montana for 2002 are 1,099 tons per year of PM_{10}, 109 tons per year for SO_2, and 924 ton/year of NO_X emissions. Since the sources for the railroad would be spread out over a long line, it was concluded that the impact in 2010 from the Tongue River Railroad would be negligible and would not affect the findings of this analysis.

3.0 PREDICTED FUTURE CUMULATIVE IMPACTS

3.1 Modeled Cumulative Impacts for 2010

Using the model and source groups discussed in Chapter 2.0, the modeling effort determined impacts of each of the source groups on each of the receptor groups for both the lower and upper production scenarios for 2010. The modeling effort used the same grid system, meteorological data, and model settings that had been applied to the base year study as presented in the Task 1A report (ENSR 2005b).

A summary of the key findings for each of the air quality components is provided in **Table 3-1**. The detailed analyses for each of the components is provided in this chapter. In general the results of this modeling study confirm the findings presented in the Task 1A report, and extend the impacts that had been identified in that study.

Table 3-1
Summary of Modeled Air Quality Impacts

Air Quality Component		Year 2010 Impacts
Concentrations	Criteria	Below NAAQS and state AAQS, except near-field PM_{10}
	HAPs	Less than RELs and RfCs, except for benzene
Visibility	Far-field	Class I areas have greater than 200 days with greater than 1 deciview, increasing with development
Atmospheric Deposition-Sulfur	LOC	Below 5 kilograms per hectare per year (Fox et al. 1989)
Atmospheric Deposition-Nitrogen	LOC	Below 3 kilograms per hectare per year (Fox et al. 1989)
Atmospheric Deposition-Lake Chemistry	ANC	Development raises impacts above LAC for two lakes[1]

Note: AAQS = Ambient Air Quality Standards
ANC = acid neutralizing capacity
LAC = limits of acceptable change
LOC = level of concern
NAAQS = National Ambient Air Quality Standards
RELs = Reference Exposure Levels
RfCs = Reference Concentration for Chronic Inhalation

[1]LAC refers to a 10 percent change in ANC for lakes with an ANC of 25 micro equivalents per liter (µeq/L) or more, or a threshold of 1 µeq/L for lakes with less than 25 µeq/L ANC.

3.1.1 Impacts on Ambient Air Quality

Using the receptor grids identified in Chapter 2.0 along with the source groupings, the model was used to predict the impacts at each receptor point in the receptor grid. For this analysis, the results are provided for the maximum receptor in each group, which may not be the same receptor in each of the modeling scenarios. Impacts may occur at different receptors for each of the modeling

scenarios, but those changes in location of the maximum receptors are not identified in these results.

The analysis does not separate the sources into Prevention of Significant Deterioration (PSD) increment-consuming and non-PSD increment-consuming sources. Therefore, the results cannot be used to develop a pattern of increment consumption for a particular site. The PSD increment level comparisons are for informational purposes only and do not constitute a regulatory PSD increment level consumption analysis, which would be required for evaluating larger projects by air permitting authorities.

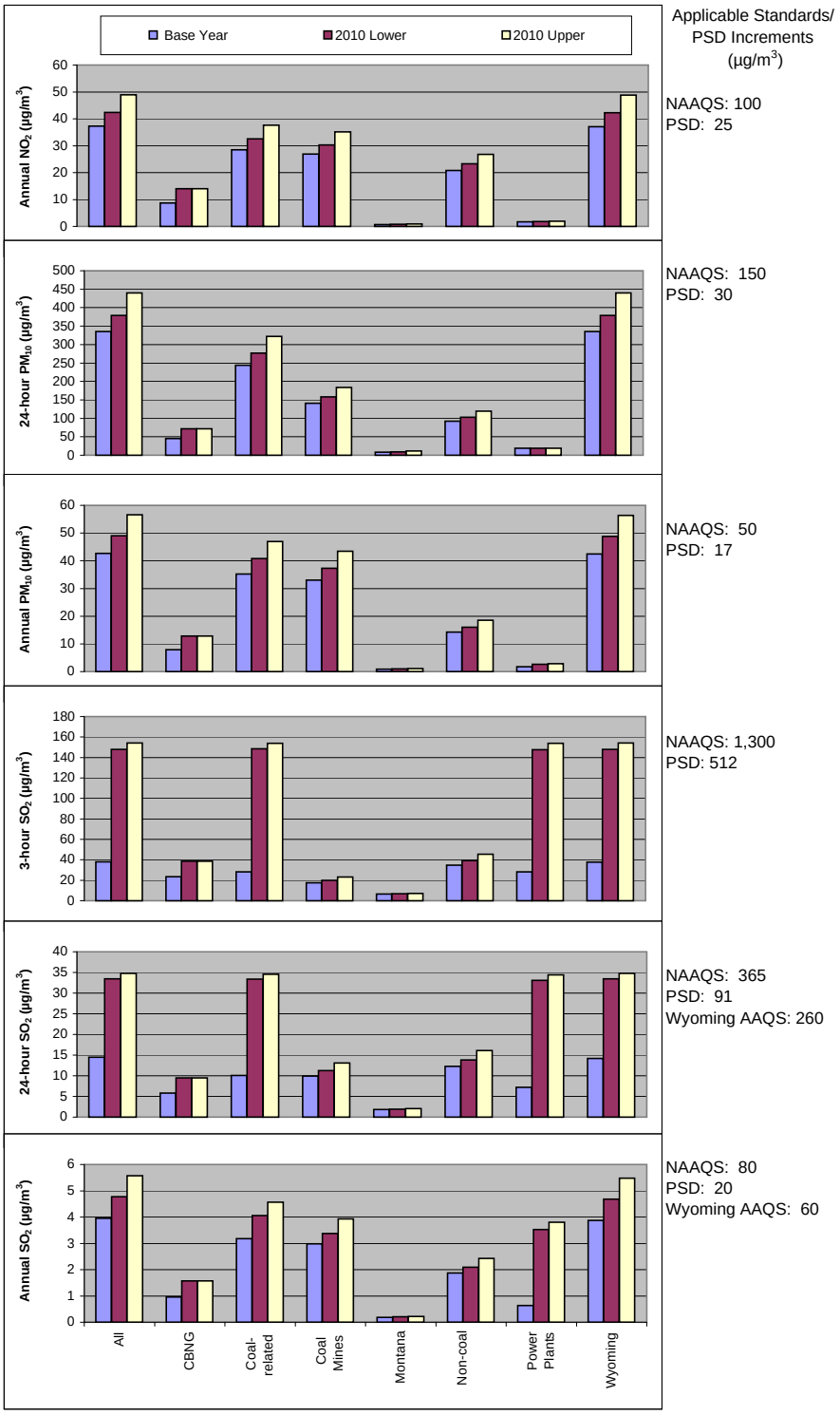
The model results also are limited by certain assumptions regarding sources and receptors. The source characterizations are based on available data, and do not represent specific stacks or sources of fugitive emissions. The modeling sources generally are provided by area or volume, to represent multiple sources within each specified facility. The specific fence lines or exclusion areas around a modeled source also are not identified in this study. The results cannot, therefore, be interpreted as evaluating maximum impacts that might occur at the boundary or fence line of a specific source. The receptors in the near-field grid in both states were removed from modeling if their location was within 1 km of any source. This ensured that the results were representative of the broad area in the PRB study area, rather than unduly affected by a specific source.

3.1.1.1 Impacts at Near-field Receptors in Wyoming

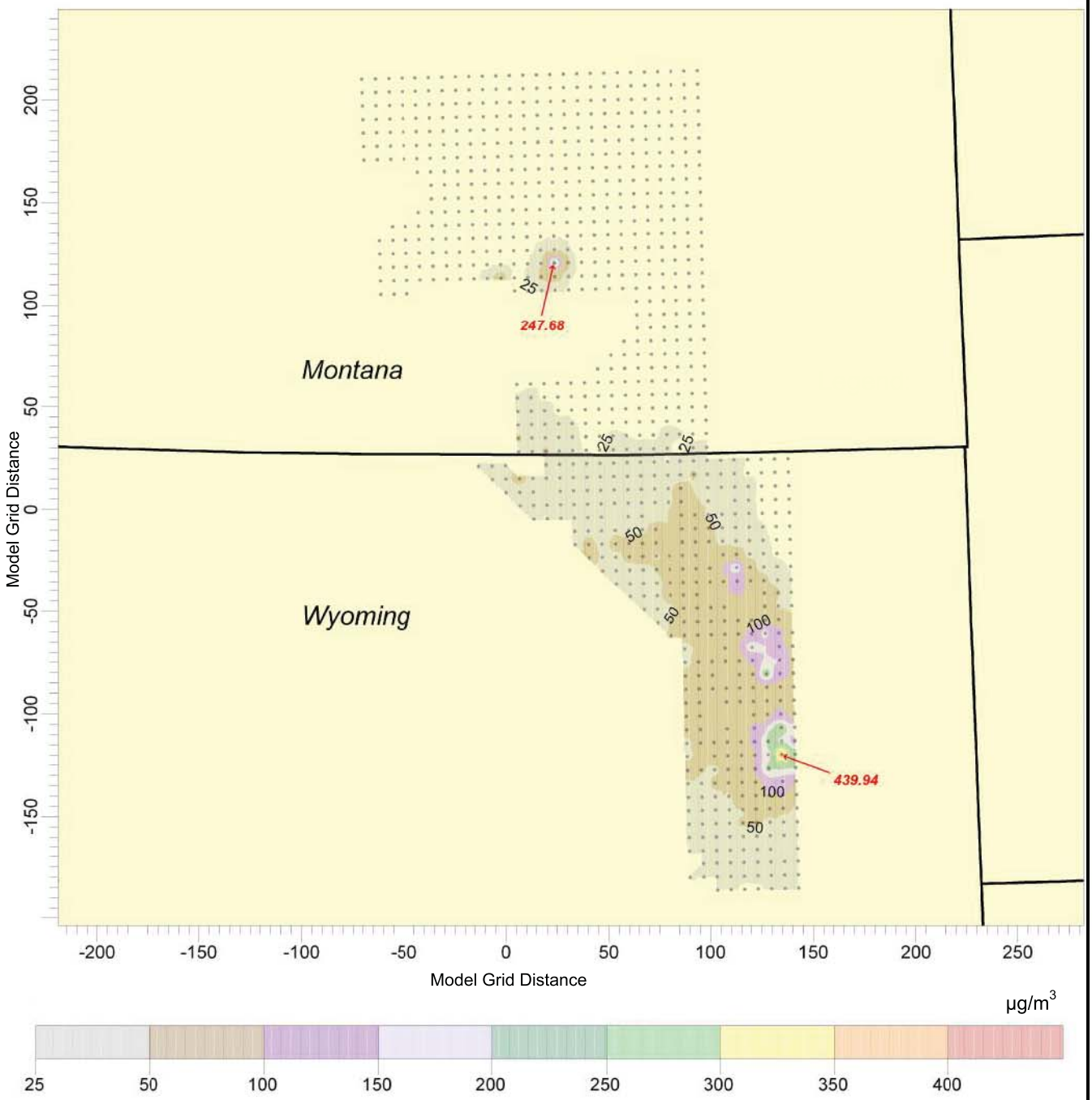
Results for the near-field receptor grid for Wyoming are presented in **Figure 3-1**. The figure shows the impacts at the maximum receptor for each modeling scenario: the base year (2002), 2010 lower production scenario, and 2010 upper production scenario. The impacts on that receptor group are provided for all sources, and the impacts that result from the individual source groups are identified in the figure. Data are provided for each ambient standard and PSD increment levels for NO_2, SO_2, and PM_{10}. The graphs in **Figure 3-1** provide a comparative change for impacts at the maximum receptor for each group. In this presentation, the impact from one source group would not likely be at the same receptor as that of the other source group; therefore, the results for each group are not specifically additive.

Based on modeling results, in Wyoming, the coal-related operations would result in impacts on PM_{10} levels that would be above the NAAQS for the 24-hour period (150 micrograms per cubic meter [$\mu g/m^3$]), for the base year as well as for both of the 2010 scenarios. The combined impacts from all sources would be nearly three times the standard for the 2010 upper production scenario. **Figure 3-2** provides a spatial depiction of the 24-hour PM_{10} impacts at the near-field receptors from all sources. For the 2010 upper production scenario, the modeled impacts are above 150 $\mu g/m^3$ for only seven of the receptors in Wyoming. This impact is confined to an area of intensive coal development. Also, for the 2010 upper production scenario, the modeled impacts on the annual PM_{10} levels would be above the standard (50 $\mu g/m^3$) at the maximum receptor in Wyoming. A large portion of the impacts for all scenarios would be associated with the coal-related source, although non-coal sources would contribute a notable portion of the impact. **Figure 3-3** depicts the modeled extent of the annual PM_{10} impacts for the 2010 upper production scenario for all sources. The high impacts (greater than 50 $\mu g/m^3$) are confined to a single receptor in the Wyoming near-field receptor grid.

Figure 3-1
Change in Modeled Concentrations of NO_2, SO_2, and PM_{10} at Wyoming Near-field Receptors



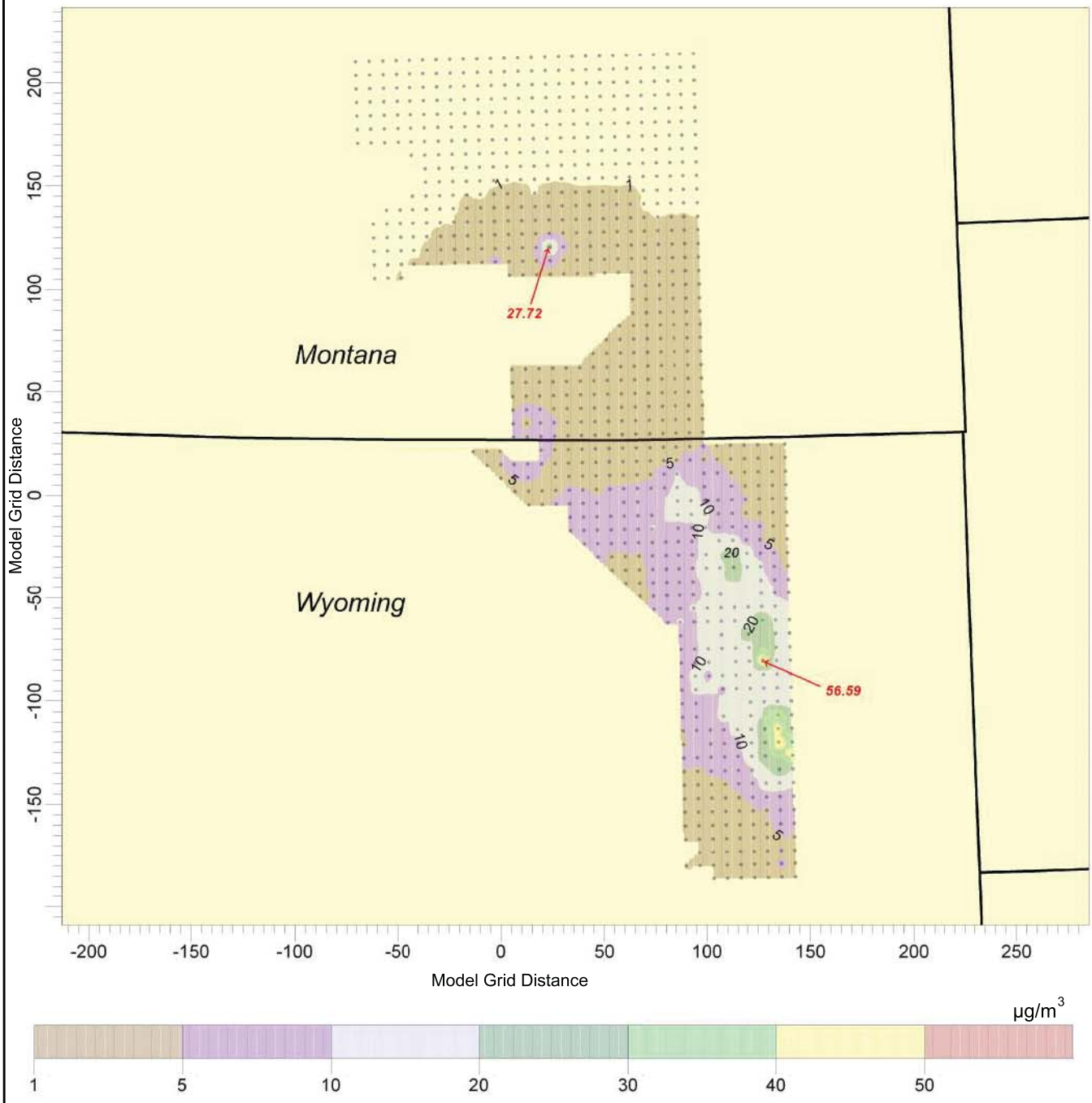
Note: Base year = 2002
2010 Lower = 2010 lower production scenario
2010 Upper = 2010 upper production scenario



Powder River Basin Coal Review

Figure 3-2
24-hour PM_{10} Concentrations for Near-field Receptors - 2010 Upper Production Scenario

Note: Includes all sources.



Note: Includes all sources.

Powder River Basin Coal Review

Figure 3-3
Annual PM_{10} Concentrations for Near-field Receptors - 2010 Upper Production Scenario

The modeled impacts of NO_2 generally were about half the annual standard, increasing to approximately 49 percent of the annual standard under the upper production scenario. The coal sources would be the largest contributor to the maximum NO_2 impacts; however, CBNG and non-coal sources also would contribute. The combined Wyoming sources would be responsible for virtually all of the NO_2 impacts in Wyoming. While potential NO_2 concentrations are above the PSD increment levels at the maximum receptor in Wyoming, the result is not a direct evaluation of PSD increment consumption. The regulatory agency has the authority and responsibility to determine if an exceedance or violation has occurred. **Figure 3-4** provides a depiction of the modeled spatial extent of NO_2 impacts from all sources in the near-field receptor grids. The maximum impact is confined to a single receptor in the Wyoming near-field. Impacts decrease dramatically from this point.

The modeled impacts of SO_2 emissions were well below the ambient standards and PSD increment levels for all scenarios. The modeled impacts from power plants, however, showed substantial increases in impacts at the maximum receptor, with an increase in impacts at the maximum power plant receptor of 400 percent or more. However, those impacts were well below the ambient standards and PSD increment levels.

3.1.1.2 Impacts at Near-field Receptors in Montana

Figure 3-5 provides a similar analysis for near-field receptors in Montana, providing the modeled impact for each receptor group as well as the overall group. The modeled impacts and a comparison to the 1-hour standards for SO_2 and NO_2 are provided in **Figure 3-6**.

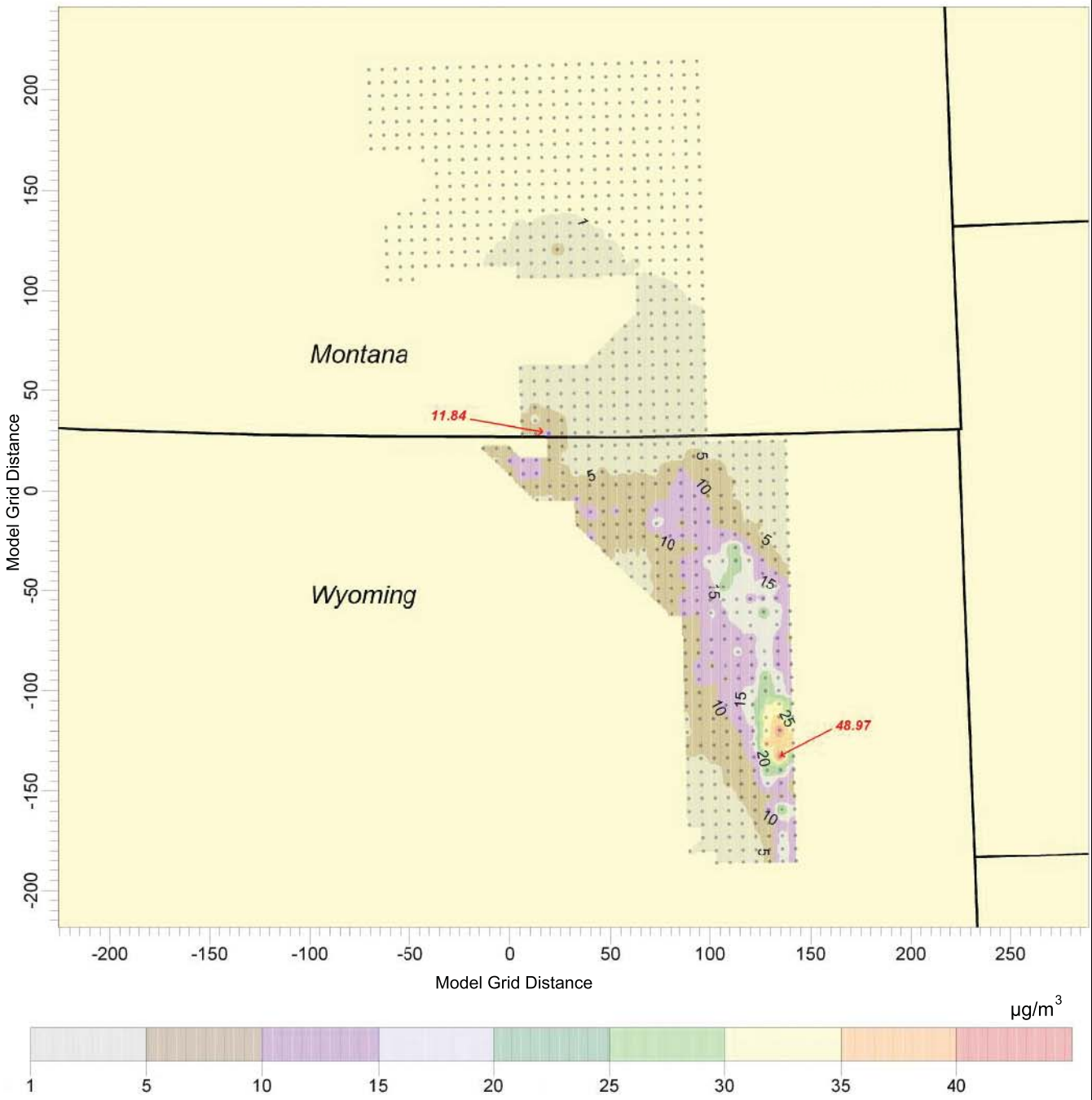
Similar to the Wyoming receptors, the 24-hour PM_{10} impacts were modeled to exceed the NAAQS, with the impact arising largely from the coal mine operations in Montana. The annual impacts of PM_{10} emissions remained below the applicable standard, but total impacts are greater than the PSD increment levels. No formal increment consumption analysis was completed; therefore, this comparison is not a valid PSD increment consumption evaluation.

Based on the modeling results, the NO_2 impacts in Montana would be well below the annual ambient standard, and also would be below the state 1-hour standard. An acceptable adjustment of 0.75 was used to convert the NO_x impacts to the 1-hour NO_2 impacts. The projected levels also were below the annual Class II PSD increment levels for NO_2.

Based on the modeling, the SO_2 impacts in Montana would be well below the applicable standards and PSD increment levels. The projected maximum impacts from SO_2 emissions are attributable to emissions from the coal-fired power plant sources, all located in Montana. The modeled impacts showed relatively high percentage increases of SO_2 impacts, resulting largely from coal mining operations.

3.1.2 Air Quality Impacts at Class I Area Receptors

As discussed in Chapter 2.0, the impacts at Class I areas also were modeled, with separate assessments for each Class I receptor group. The Class I area with the highest impacts was the Northern Cheyenne Indian Reservation in Montana. Those results are provided in **Figure 3-7**. The modeled impacts were all well below the ambient standards, but in general, were greater than the

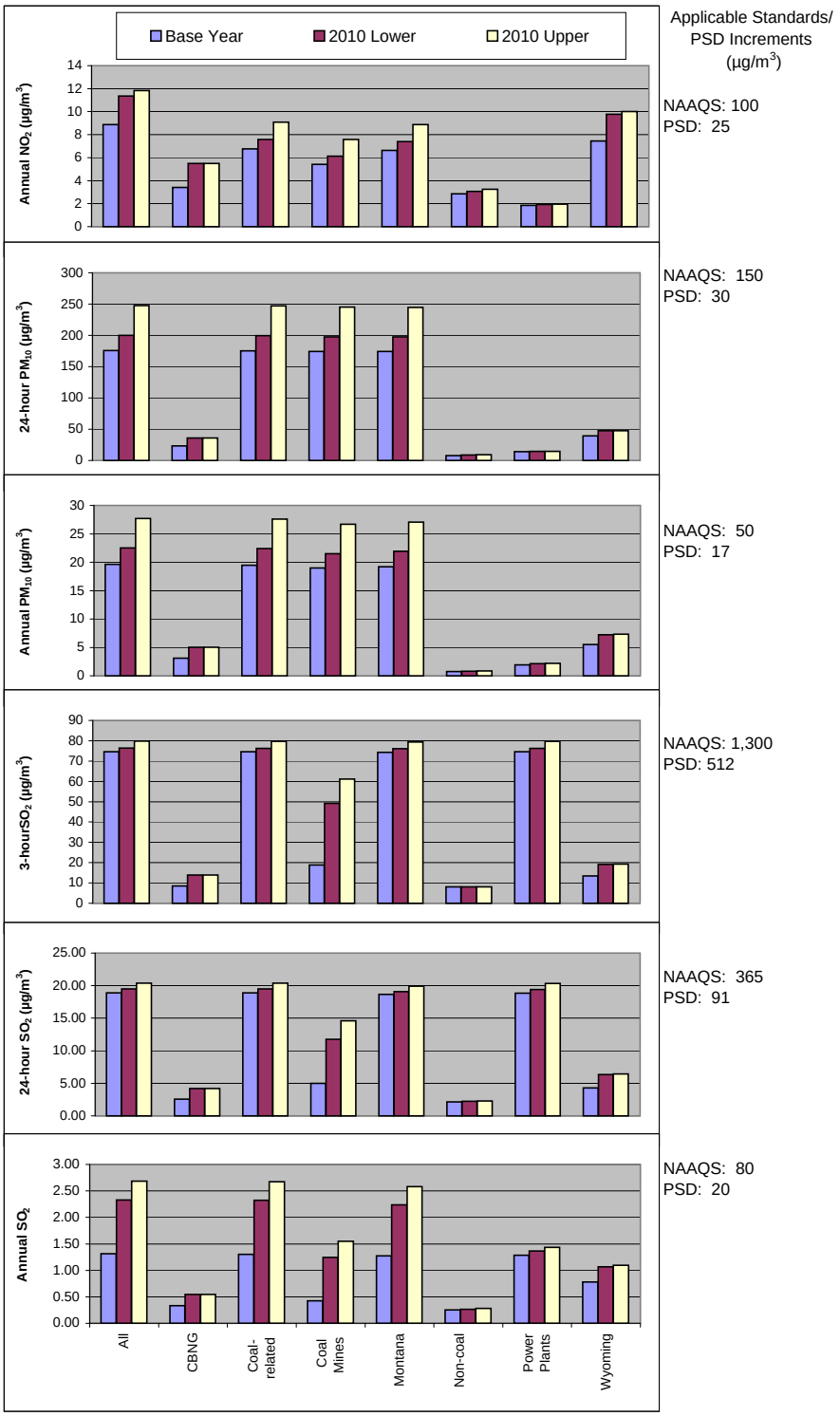


Powder River Basin Coal Review

Figure 3-4
Annual NO_2 Concentrations for Near-field Receptors - 2010 Upper Production Scenario

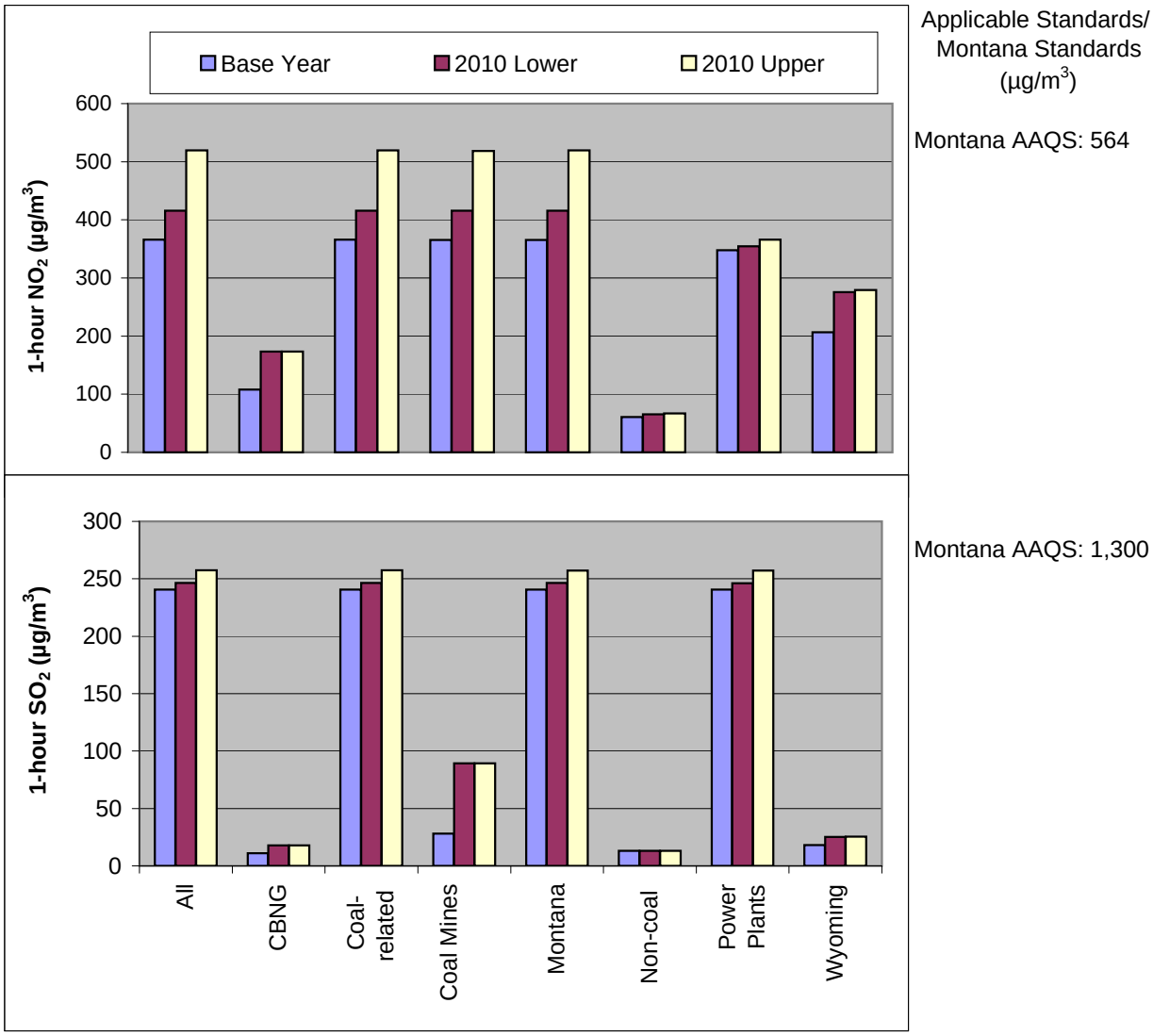
Note: Includes all sources.

Figure 3-5
Change in Modeled Concentrations of NO_2, SO_2, and PM_{10} at Montana Near-field Receptors



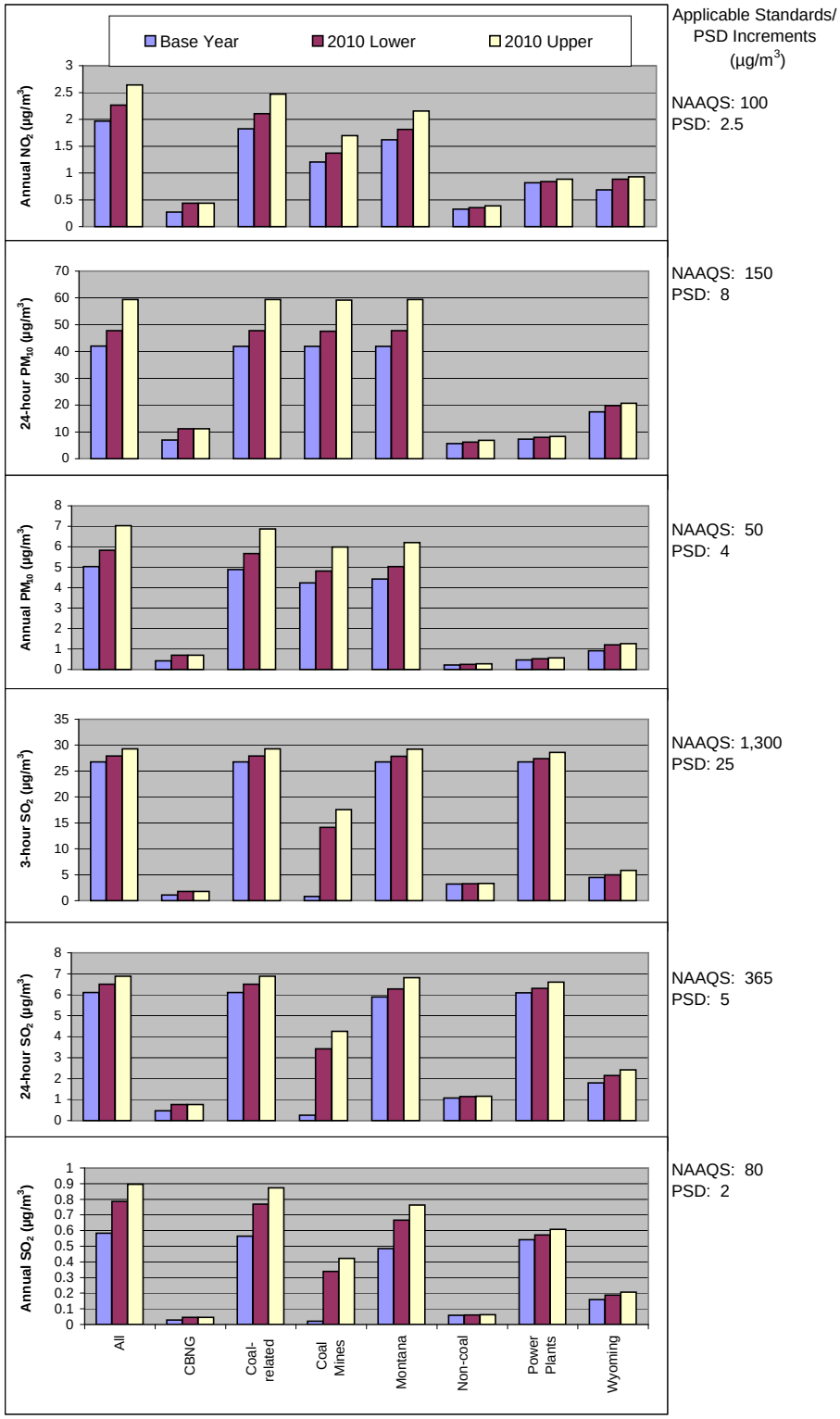
Note: Base year = 2002
2010 Lower = 2010 lower production scenario
2010 Upper = 2010 upper production scenario

Figure 3-6
Change in Modeled 1-Hour Concentrations of NO_2, SO_2, and PM_{10} at Montana Near-field Receptors



Note: Base year = 2002
2010 Lower = 2010 lower production scenario
2010 Upper = 2010 upper production scenario

Figure 3-7
Change in Modeled Concentrations of NO_2, SO_2, and PM_{10} at the Northern Cheyenne Indian Reservation



Note: Base year = 2002
2010 Lower = 2010 lower production scenario
2010 Upper = 2010 upper production scenario

respective Class I PSD increment levels. For comparison only, of the impacts of criteria pollutants at this receptor group, only the annual SO_2 impacts were modeled to be below the Class I increment levels. Although the results show a large percent increase in SO_2 impacts in these areas, those impacts would remain well below the respective standards.

Two separate Class I areas also were analyzed, including the Washakie WA (**Figure 3-8**) and Wind Cave National Park (**Figure 3-9**). These areas represent the closest Class I areas east and west of the PRB study area, and should provide a representative depiction of impacts at the Class I areas in western Wyoming and western South Dakota. For both areas, all modeled impacts were well below the ambient standards, and also were comparatively below the PSD increment levels for all impacts except the 24-hour PM_{10} increment level. The base year (2002) 24-hour PM_{10} impact at Washakie was 14.5 µg/m^3, and the impact at Wind Cave was 10.7 µg/m^3, against a Class I PSD increment level of 8 µg/m^3. Again, these data are provided for comparison only, because the PSD increment-consuming sources were not specifically evaluated. It should be noted that the modeled impact at the Wind Cave National Park increased by 5 µg/m^3 for the upper production scenario, consuming a comparatively large part of the 24-hour PM_{10} Class I PSD increment level of 8 µg/m^3.

3.1.3 Air Quality Impacts at Sensitive Class II Area Receptors

Modeled impacts at the Crow Indian Reservation were higher than impacts at the other identified Class II area receptor groups for all scenarios (**Figure 3-10**). For this receptor group, modeled impacts were all well below the ambient standards, and they were below the established Class II PSD increment levels, except for comparing impacts to the 24-hour PM_{10} levels. The impacts reached 36.7 µg/m^3 for the upper production scenario, compared to a Class II PSD increment level of 30 µg/m^3; however, a formal PSD evaluation was not conducted.

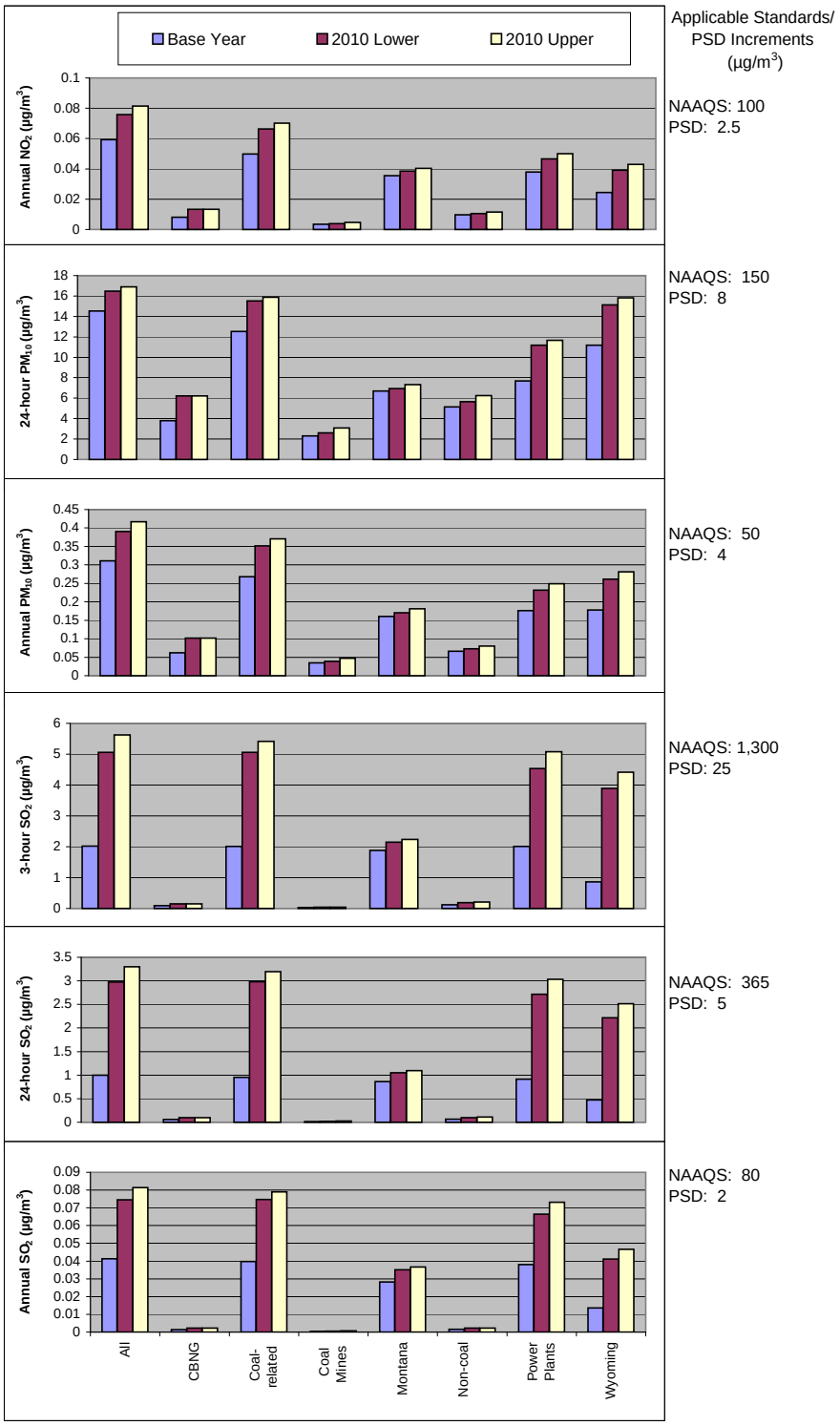
The other nearby Class II receptor group is the Cloud Peak WA in north central Wyoming, just west of the PRB study area. Results for this receptor group are shown in **Figure 3-11**. All modeled impacts were well below applicable standards for all scenarios, and impacts were less than the Class II PSD increment levels for all scenarios. Modeled SO_2 impacts increased substantially on a percent basis, but are still a few percent of the standards. The modeled 24-hour PM_{10} impacts reached 17.9 µg/m^3 for the 2010 upper production scenario, but this was less than the comparable PSD increment level of 30 µg/m^3. The greatest percentage increases arose from coal mine and coal-fired power plant operations, but these increases still did not exceed ambient standards or PSD increment levels.

3.1.4 Impacts on Visibility

Under the Clean Air Act, visibility has been established as a critical resource for identified Class I areas. The Task 1 report provided an analysis of base year (2002) impacts at the Class I areas and at sensitive Class II areas in the region. Under the guidance of the Federal Land Managers Air Quality Workgroup (FLAG) (FLAG 2000), the impacts were provided using the CALPUFF modeling system and the Method 6 approach, which uses monthly relative humidity values for representative receptor groups.

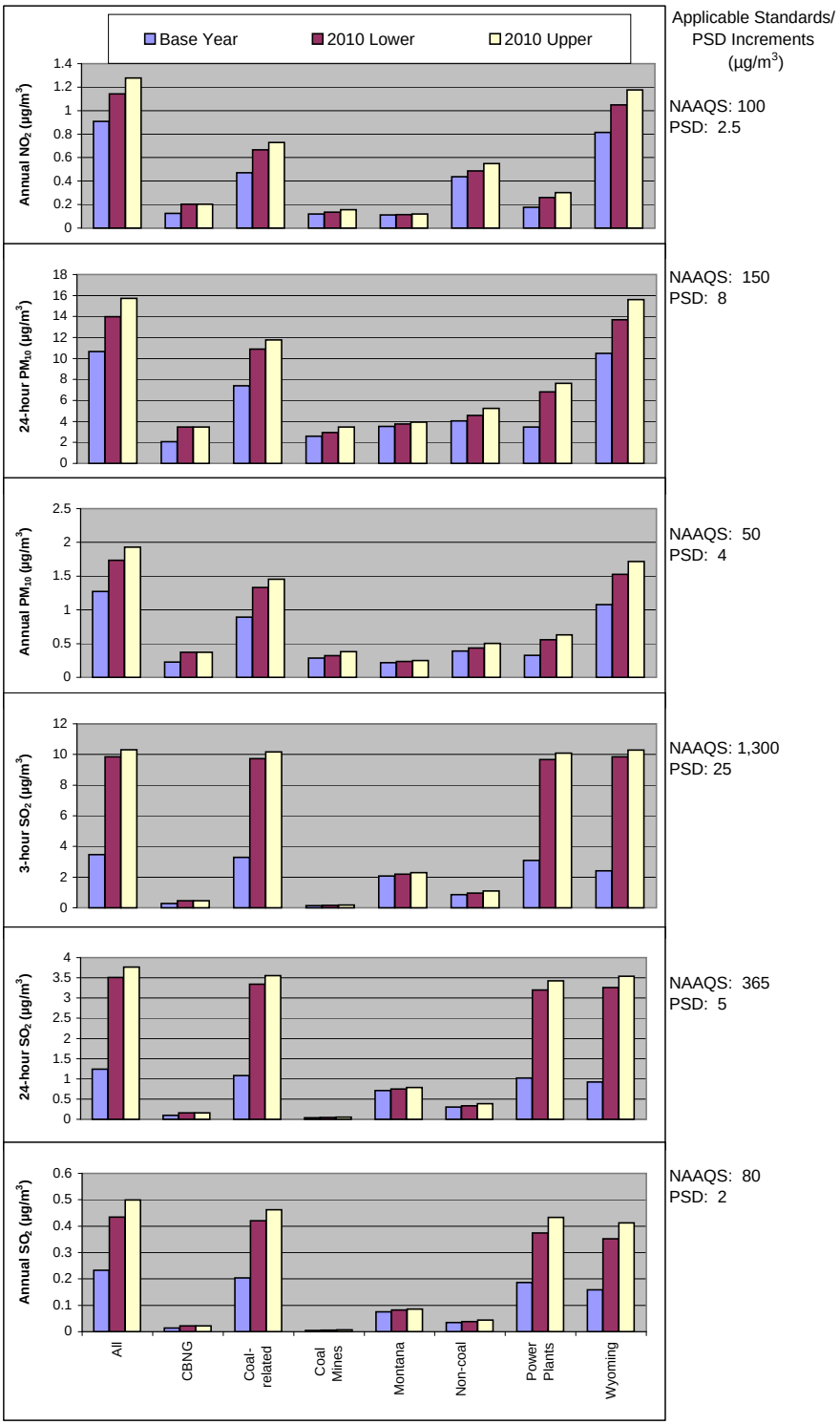
Visibility impacts were based on the highest 24-hour calculated extinction at the indicated source receptors. Impacts were based on a presumed pristine background and calculated as a percent

Figure 3-8
Change in Modeled Concentrations of NO_2, SO_2, and PM_{10} at the Washakie Wilderness Area



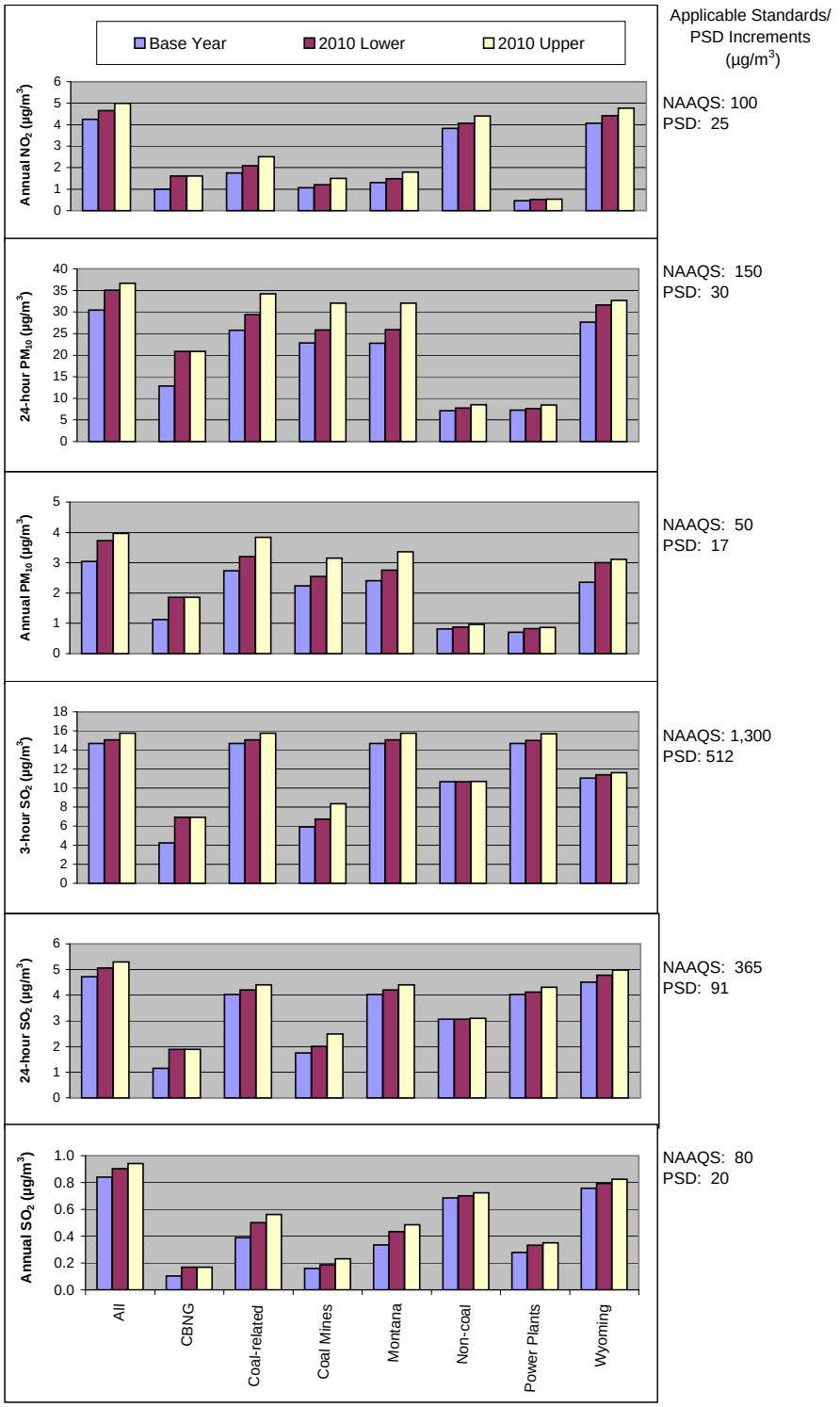
Note: Base year = 2002
2010 Lower = 2010 lower production scenario
2010 Upper = 2010 upper production scenario

Figure 3-9
Change in Modeled Concentrations of NO_2, SO_2, and PM_{10} at the Wind Cave National Park



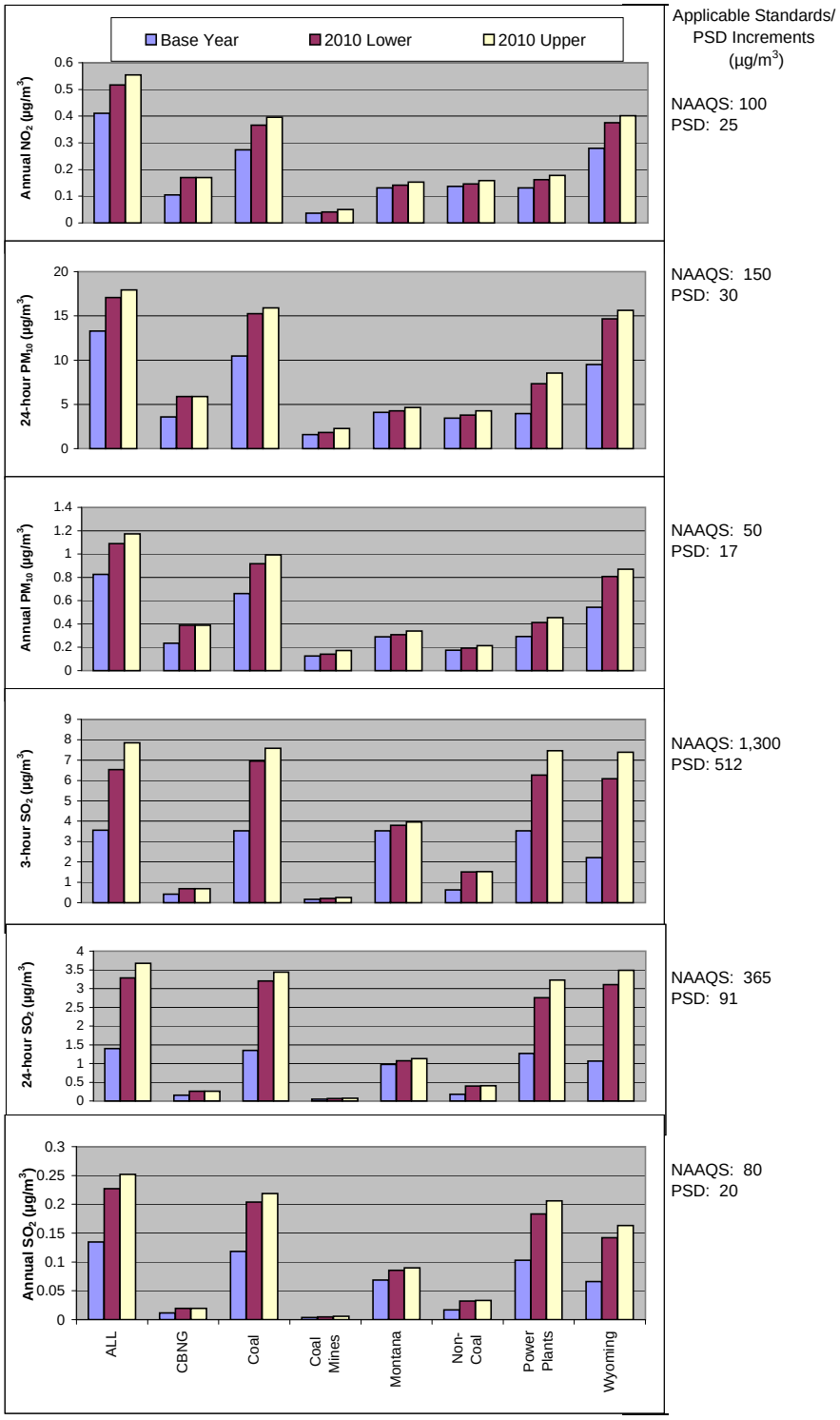
Note: Base year = 2002
2010 Lower = 2010 lower production scenario
2010 Upper = 2010 upper production scenario

Figure 3-10
Change in Modeled Concentrations of NO_2, SO_2, and PM_{10} at the Crow Indian Reservation



Note: Base year = 2002
2010 Lower = 2010 lower production scenario
2010 Upper = 2010 upper production scenario

Figure 3-11
Change in Modeled Concentrations of NO_2, SO_2, and PM_{10} at the Cloud Peak Wilderness Area



Note: Base year = 2002
2010 Lower = 2010 lower production scenario
2010 Upper = 2010 upper production scenario

increase in extinction (reduced visibility) from that background value. The study tabulated the reduced visibility at the maximum impact receptor in each of the Class I and Class II groups in terms of the maximum reduction on any one 24-hour period, the number of days annually that showed visibility reductions of 5 percent and 10 percent. These reductions are indicated as reductions in deciviews (0.5 and 1 deciview, respectively). A significance threshold of 10 percent has been used in this analysis to evaluate the impact from the source groups.

Table 3-2 provides the modeled visibility impacts for the base year (2002) for each of the analyzed areas. For the Class I areas, the maximum impacts were determined at the North Cheyenne Indian Reservation in Montana and at the Wind Cave National Park and the Badlands National Park in South Dakota. Both of the South Dakota areas are downwind of the prevailing wind direction from the PRB. In the base year (2002), modeling showed more than 200 days would be impacted with a change of 10 percent or more in extinction at each of these locations. For the Class II areas, the maximum impacts were at the Crow Indian Reservation in Montana. Five other Class II areas showed impacts of 10 percent or more for 200 days or more per year, and these areas also were east (downwind in the prevailing wind direction) of the PRB study area. The modeling results showed that there would be at least some impact on each of the receptor groups from each of the source groups. Coal mine operations dominated the impacts at the Class II areas, and the impacts on the Class I areas were noted for all the source groups.

Tables 3-3 and **3-4** provide the modeled visibility impact results for the lower and upper production scenarios for 2010, respectively. The contributions show slight increases in impact from the source groups. To provide a basis for discussing the modeled visibility impacts resulting from increased production (emissions) under both the lower and upper production scenarios in 2010, the modeled visibility impacts for the base year (2002) (**Table 3-2**) were subtracted from the model results for 2010. The resulting changes in modeled visibility impacts are presented in **Tables 3-5** and **3-6**. The data in these tables depict the projected changes in the number of days with impacts greater than 5 and 10 percent, as well as the projected incremental increase in the maximum percent change in B_{ext} as a result of the RFD activities. It should be noted that for some receptors, the model results shown no change from the base year in the number of days with impacts greater than 5 percent, although the modeling results indicate that the level of impacts for those days would increase. Concurrently, the model results may show a corresponding increase from the base year in the number of days with impacts above 10 percent. For such data sets, the increase in the number of days with impacts greater than 10 percent does not conflict with the fact that there is no anticipated increase in the number of days with impacts greater than 5 percent, as the data represent the change over base year conditions.

For the combined source groups, the largest impacts (greater than 10 percent for 10 days or more for both production scenarios) would be at the Class I areas well to the east of the PRB study area. These groups include Theodore Roosevelt National Park in North Dakota and Badlands National Park and Wind Cave National Park in South Dakota.

A similar pattern of higher impacts to the east holds for the Class II receptor groups. The number of days with 10 percent impact or more would exceed 20 days per year for three source groups under the lower production scenario, and it would exceed 20 days per year for six groups under the upper production scenario. Based on the modeling results, areas to the west of the PRB study area show a distinctly lower impact than those to the east of the PRB study area for both production scenarios. The results of this analysis show that the visibility impacts from increased production would be

Table 3-2
Modeled Impacts on Visibility at Indicated Receptors for the Base Year (2002)[1]

	All Sources			CBNG			Coal-related			Coal Mines			Montana Sources			Non-coal			Power Plants			Wyoming Sources		
	Number of Days> N% Change in B_{ext}		Maximum % change in B_{ext}	Number of Days> N% Change in B_{ext}		Maximum % change in B_{ext}	Number of Days> N% Change in B_{ext}		Maximum % change in B_{ext}	Number of Days> N% Change in B_{ext}		Maximum % change in B_{ext}	Number of Days> N% Change in B_{ext}		Maximum % change in B_{ext}	Number of Days> N% Change in B_{ext}		Maximum % change in B_{ext}	Number of Days> N% Change in B_{ext}		Maximum % change in B_{ext}	Number of Days> N% Change in B_{ext}		Maximum % change in B_{ext}
Receptor Set	**5%**	**10%**		**5%**	**10%**		**5%**	**10%**		**5%**	**10%**		**5%**	**10%**		**5%**	**10%**		**5%**	**10%**		**5%**	**10%**	
CLASS I AREAS																								
Badlands National Park	284	238	380	90	51	101	271	219	250	60	32	45	138	83	199	156	96	298	221	141	198	251	196	375
Bob Marshall WA	18	12	120	4	3	27	14	12	78	2	2	14	11	9	28	4	3	43	13	9	40	10	5	98
Bridger WA	57	47	489	25	11	99	52	43	354	11	6	47	36	28	156	28	15	162	43	29	192	41	35	360
Fitzpatrick WA	48	42	484	23	10	104	46	40	380	9	5	50	31	25	175	27	13	174	38	30	216	38	32	372
Fort Peck Indian Reservation	87	69	130	23	8	30	81	62	117	9	2	11	63	31	94	30	7	37	65	40	103	60	40	81
Gates of the Mountain WA	25	14	121	5	2	29	21	12	80	2	2	14	11	9	33	5	2	42	15	9	32	15	7	99
Grand Teton National Park	37	26	162	13	7	31	29	24	115	6	2	14	20	14	88	14	8	48	24	15	90	24	17	111
North Absaorka WA	65	47	359	21	13	63	60	44	306	11	6	32	46	33	205	22	14	103	52	36	213	40	25	240
North Cheyenne Indian Reservation	332	305	501	120	84	221	327	302	386	310	273	295	320	296	325	110	68	218	238	190	315	182	142	462
Red Rock Lakes	28	16	44	6	0	9	24	15	43	0	0	4	12	6	40	8	2	13	14	6	40	16	10	30
Scapegoat WA	21	14	117	5	3	27	17	13	76	3	2	13	12	9	29	5	3	41	14	9	42	12	6	96
Teton WA	49	40	363	15	12	68	47	36	284	10	3	34	30	22	143	21	12	115	37	25	174	38	23	256
Theodore Roosevelt National Park	136	98	185	38	25	49	129	84	155	12	4	13	72	32	116	45	19	35	88	43	123	99	68	94
UL Bend WA	63	49	351	12	7	74	62	45	248	8	3	33	48	34	129	12	9	108	50	39	139	39	27	257
Washakie WA	62	53	531	28	17	127	60	50	494	18	8	68	48	35	281	30	21	227	53	43	335	43	36	450
Wind Cave National Park	298	261	425	109	53	87	287	235	321	89	49	52	145	107	186	182	114	209	237	161	223	272	229	338
Yellowstone National Park	53	42	274	20	12	48	52	39	209	9	6	23	40	28	150	21	12	77	44	30	153	33	24	179
SENSITIVE CLASS II AREAS																								
Absaorka Beartooth WA	64	53	306	21	13	75	64	52	264	14	7	33	54	41	192	22	15	98	61	46	197	36	28	221
Agate Fossil Beds National Monument	242	199	587	79	34	92	216	168	460	43	9	45	117	78	267	145	83	166	178	122	307	229	173	361
Big Horn Canyon National Recreation Area	127	108	424	53	32	196	121	101	354	51	29	86	103	90	230	54	33	218	104	86	227	78	62	378
Black Elk WA	304	263	387	114	55	88	293	245	291	70	29	46	159	111	195	168	104	143	261	187	197	271	224	324
Cloud Peak WA	158	137	525	99	65	155	143	132	412	53	27	59	116	91	219	100	60	207	121	103	275	135	112	398
Crow Indian Reservation	318	284	756	177	140	330	299	270	568	282	247	282	287	254	325	250	208	300	191	162	225	260	224	715
Devils Tower National Monument	316	279	432	183	111	124	311	249	303	119	59	43	149	111	147	194	133	136	187	128	170	272	234	293
Fort Belknap Indian Reservation	54	46	366	14	5	74	54	40	262	7	5	36	44	34	126	16	8	109	45	37	156	36	22	270
Fort Laramie National Historic Site	196	153	540	59	35	143	169	123	461	45	15	65	88	51	224	117	75	215	130	84	277	183	137	442
Jedediah Smith WA	30	23	123	12	7	20	27	20	111	3	0	9	18	13	88	13	7	29	22	13	90	21	16	67
Jewel Cave National Mounument	300	267	467	126	61	91	291	241	342	97	53	58	140	98	165	185	117	184	246	171	213	278	236	385
Lee Metcalf WA	33	25	63	12	4	16	32	22	55	2	0	7	21	7	53	12	4	22	26	12	52	22	16	51
Mount Naomi WA	15	8	150	4	2	18	11	5	131	1	0	7	4	3	97	4	2	21	7	3	107	15	7	58
Mount Rushmore	294	248	346	102	46	88	280	234	267	63	24	43	150	111	195	157	95	132	242	163	194	259	203	301

Table 3-2 (Continued)

Receptor Set	All Sources			CBNG			Coal-related			Coal Mines			Montana Sources			Non-coal			Power Plants			Wyoming Sources		
	Number of Days> N% Change in B_{ext}		Maximum % change in B_{ext}	Number of Days> N% Change in B_{ext}		Maximum % change in B_{ext}	Number of Days> N% Change in B_{ext}		Maximum % change in B_{ext}	Number of Days> N% Change in B_{ext}		Maximum % change in B_{ext}	Number of Days> N% Change in B_{ext}		Maximum % change in B_{ext}	Number of Days> N% Change in B_{ext}		Maximum % change in B_{ext}	Number of Days> N% Change in B_{ext}		Maximum % change in B_{ext}	Number of Days> N% Change in B_{ext}		Maximum % change in B_{ext}
	5%	10%		5%	10%		5%	10%		5%	10%		5%	10%		5%	10%		5%	10%		5%	10%	
National Monument																								
Popo Agie WA	62	47	562	24	16	122	57	43	443	12	7	59	35	27	200	29	15	201	41	30	247	46	34	436
Soldier Creek WA	267	223	568	94	39	79	233	187	432	53	15	40	123	83	261	172	96	144	190	139	299	256	194	316
Wellsville Mountain WA	13	6	120	4	1	16	10	5	102	1	0	6	4	3	72	3	1	18	6	3	79	11	5	50
Wind River Indian Reservation	87	66	587	44	31	220	78	65	670	27	15	116	58	45	383	44	36	394	68	53	464	69	50	658

[1]Visibility - Method 6 and Monthly f(RH) values
Note: N = N percent (5 or 10 as indicated)
$_{ext}$ = extinction coefficient for visibility

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Table 3-3
Modeled Visibility Impacts for the 2010 Lower Production Scenario

Receptor Set	All			CBNG			Coal-related			Coal Mines			Montana			Non-coal			Power Plants			Wyoming		
	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}
	5%	10%		5%	10%		5%	10%		5%	10%		5%	10%		5%	10%		5%	10%		5%	10%	
CLASS I AREAS																								
Badlands National Park	296	257	525	149	78	164	288	242	397	72	37	51	146	90	205	165	106	328	255	192	304	265	225	525
Bob Marshall WA	20	14	203	6	4	44	20	13	164	3	2	16	11	9	29	5	3	47	15	11	98	14	9	176
Bridger WA	66	51	604	31	22	162	63	48	555	12	7	54	39	29	183	29	17	179	52	43	398	50	39	547
Fitzpatrick WA	55	45	586	30	20	169	52	45	542	9	6	57	33	25	189	27	15	193	47	39	419	43	37	528
Fort Peck Indian Reservation	95	77	205	40	16	48	93	74	169	11	3	12	66	36	101	34	8	40	78	53	123	70	50	161
Gates of the Mountain WA	26	20	202	7	5	47	26	17	162	3	2	16	13	10	34	6	2	47	20	12	88	16	13	175
Grand Teton National Park	41	28	257	16	13	51	40	26	210	6	2	16	23	16	97	16	10	53	28	23	136	31	20	204
North Absaorka WA	68	53	435	26	19	102	68	50	391	12	6	36	51	37	226	22	14	114	56	42	327	40	31	355
North Cheyenne Indian Reservation	341	310	634	155	112	350	341	307	502	316	283	336	333	300	347	115	73	238	245	198	323	196	150	593
Red Rock Lakes	30	19	63	11	3	15	30	18	50	0	0	4	14	6	43	9	2	15	23	13	42	23	15	56
Scapegoat WA	25	18	196	6	4	44	24	15	157	4	2	15	14	10	30	5	3	46	19	11	92	14	10	170
Teton WA	50	44	456	34	26	207	49	43	417	11	3	38	47	33	300	21	13	127	42	34	328	38	31	398
Theodore Roosevelt National Park	145	113	265	56	35	80	140	108	235	17	6	15	77	37	122	47	22	39	108	67	184	112	84	143
UL Bend WA	66	53	526	24	12	122	65	52	467	10	4	37	49	37	134	14	10	120	54	42	301	42	32	474
Washakie WA	69	55	553	35	27	207	67	55	529	19	8	77	50	37	304	30	23	251	57	50	488	49	40	524
Wind Cave National Park	306	272	584	166	92	148	302	257	518	100	55	60	156	113	198	190	121	228	254	202	389	281	251	478
Yellowstone National Park	56	49	363	24	17	77	54	45	328	11	6	26	41	31	167	22	15	85	49	35	243	35	28	310
SENSITIVE CLASS II AREAS																								
Absaorka Beartooth WA	69	56	377	26	19	121	65	54	340	15	8	37	56	45	214	24	15	109	61	47	237	41	30	318
Agate Fossil Beds National Monument	262	225	677	116	66	150	249	202	655	49	12	51	121	85	284	152	92	183	214	170	602	255	205	650
Big Horn Canyon National Recreation Area	138	115	513	69	47	280	128	111	474	53	31	97	110	93	246	56	37	236	111	97	377	89	71	449
Black Elk WA	310	279	555	166	93	149	305	265	484	80	38	53	169	122	206	178	111	162	269	216	345	283	250	440
Cloud Peak WA	166	145	625	120	85	249	155	138	595	61	28	67	119	98	232	103	62	228	131	113	467	153	124	552
Crow Indian Reservation	329	294	758	195	170	525	318	285	692	287	254	320	315	272	368	251	210	323	197	164	377	262	226	743
Devils Tower National Monument	318	294	599	222	169	210	316	286	526	131	76	50	162	115	159	205	142	151	222	162	345	284	255	514
Fort Belknap Indian Reservation	61	49	557	23	13	121	60	47	508	9	5	41	51	36	144	18	8	122	53	41	320	38	28	501
Fort Laramie National Historic Site	217	180	629	90	51	231	202	162	589	52	20	74	100	55	241	129	76	238	177	141	507	211	168	567
Jedediah Smith WA	38	24	151	14	11	32	34	24	130	5	0	10	20	13	97	13	9	32	26	20	96	28	20	121
Jewel Cave National Monument	311	281	670	177	104	153	302	269	569	118	61	67	147	107	176	193	126	213	263	205	370	286	259	574
Lee Metcalf WA	35	27	107	16	7	26	34	27	84	3	0	8	22	12	59	12	5	24	30	20	54	22	21	93
Mount Naomi WA	17	14	187	6	2	29	17	11	167	2	0	8	5	4	104	5	2	23	12	5	128	16	12	90
Mount Rushmore National Monument	304	267	514	153	88	148	296	247	451	71	31	50	163	115	205	168	105	149	256	202	329	271	233	414
Popo Agie WA	65	54	604	36	21	198	64	49	581	12	8	67	40	27	219	29	17	222	53	41	481	51	40	589
Soldier Creek WA	285	246	663	124	77	128	271	229	637	61	19	45	133	88	277	179	106	160	244	187	543	277	225	603
Wellsville Mountain WA	16	11	155	5	2	26	13	10	137	1	0	7	4	3	77	3	1	20	10	5	99	15	8	79
Wind River Indian Reservation	91	78	690	56	41	355	89	74	675	32	16	131	66	51	404	45	37	429	78	65	643	77	62	696

Note: B_{ext} = extinction coefficient for visibility
N = N percent (5 or 10 as indicated)

Table 3-4
Modeled Visibility Impacts for the 2010 Upper Production Scenario

	All			CBNG			Coal-related			Coal Mines			Montana			Non-coal			Power Plants			Wyoming		
	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}
Receptor Set	5%	10%		5%	10%		5%	10%		5%	10%		5%	10%		5%	10%		5%	10%		5%	10%	
CLASS I AREAS																								
Badlands National Park	301	264	543	149	78	164	294	250	424	91	41	61	150	97	213	174	113	360	265	200	330	274	232	542
Bob Marshall WA	20	16	226	6	4	44	20	13	178	4	2	19	12	9	31	5	3	53	15	12	114	14	10	197
Bridger WA	69	54	617	31	22	162	65	50	571	12	9	64	39	30	194	31	18	199	53	43	436	51	39	570
Fitzpatrick WA	57	47	596	30	20	169	55	45	560	11	7	67	35	26	200	27	18	214	47	40	462	45	39	547
Fort Peck Indian Reservation	97	78	226	40	16	48	93	76	181	15	6	15	66	38	106	34	9	45	79	55	134	71	51	179
Gates of the Mountain WA	26	21	224	7	5	47	26	20	175	3	2	19	14	10	36	6	4	52	21	13	103	16	14	195
Grand Teton National Park	41	31	283	16	13	51	40	26	225	7	2	19	23	16	102	17	10	59	33	23	151	32	21	227
North Absaorka WA	69	53	458	26	19	102	68	51	408	20	8	43	55	37	238	22	17	127	60	46	343	42	34	373
North Cheyenne Indian Reservation	347	315	674	155	112	350	347	314	551	334	296	421	341	307	432	119	79	263	248	200	359	197	157	645
Red Rock Lakes	30	21	70	11	3	15	30	18	54	1	0	5	15	6	46	9	2	16	23	14	44	23	15	63
Scapegoat WA	25	18	218	6	4	44	25	16	170	4	2	18	15	10	31	5	3	51	21	13	107	16	12	190
Teton WA	50	45	472	34	26	207	50	43	431	11	5	46	49	34	316	22	14	141	45	34	348	39	32	420
Theodore Roosevelt National Park	147	120	287	56	35	80	143	114	250	23	6	18	82	40	128	53	26	44	112	75	200	115	90	160
UL Bend WA	68	54	539	24	12	122	67	53	492	10	6	44	51	37	140	17	10	133	57	45	341	43	34	511
Washakie WA	70	56	563	35	27	207	67	56	533	21	9	91	52	40	321	31	23	278	59	50	494	50	40	532
Wind Cave National Park	310	276	611	166	92	148	304	262	543	118	61	72	158	117	208	200	131	250	264	213	434	286	254	504
Yellowstone National Park	59	50	378	24	17	77	56	48	340	15	7	31	44	32	175	22	17	95	50	41	267	37	30	329
SENSITIVE CLASS II AREAS																								
Absaorka Beartooth WA	70	58	399	26	19	121	67	56	356	18	11	44	56	46	225	24	15	122	61	52	256	42	30	339
Agate Fossil Beds National Monument	265	229	684	116	66	150	253	207	663	61	23	61	124	87	299	160	101	203	221	178	619	260	214	664
Big Horn Canyon National Recreation Area	141	116	536	69	47	280	134	112	489	62	38	115	112	95	259	59	43	256	111	101	409	91	74	465
Black Elk WA	314	285	643	166	93	149	309	272	525	97	47	64	176	125	215	184	120	189	283	233	392	285	253	525
Cloud Peak WA	170	145	635	120	85	249	158	139	607	71	35	80	121	104	243	110	67	251	132	116	512	156	125	588
Crow Indian Reservation	332	299	769	195	170	525	325	290	725	300	266	388	321	280	439	261	221	343	199	164	409	269	237	755
Devils Tower National Monument	320	300	616	222	169	210	318	290	554	143	88	60	169	122	167	214	154	169	233	170	384	286	258	557
Fort Belknap Indian Reservation	63	50	574	23	13	121	61	47	535	10	5	49	52	36	153	18	9	136	54	41	365	40	30	533
Fort Laramie National Historic Site	223	183	645	90	51	231	206	166	602	58	32	88	101	60	254	136	84	265	181	145	526	215	172	588
Jedediah Smith WA	38	25	166	14	11	32	35	25	137	6	2	12	21	13	102	15	10	36	27	21	102	31	20	134
Jewel Cave National Monument	312	285	755	177	104	153	305	278	618	132	71	82	154	108	185	206	140	253	279	226	430	296	263	675
Lee Metcalf WA	35	29	117	16	7	26	34	27	91	4	0	10	23	13	62	16	5	27	33	22	56	22	21	104
Mount Naomi WA	20	16	201	6	2	29	17	12	177	2	1	10	5	4	109	5	2	25	13	6	137	18	15	100
Mount Rushmore National Monument	305	273	552	153	88	148	300	258	484	86	41	60	170	118	215	176	114	173	264	218	374	277	241	457
Popo Agie WA	65	55	609	36	21	198	64	51	586	14	8	79	40	27	231	31	18	247	54	44	517	51	41	601
Soldier Creek WA	287	252	673	124	77	128	276	232	646	79	24	54	135	94	291	189	121	178	246	199	586	279	233	628
Wellsville Mountain WA	17	13	167	5	2	26	13	11	145	2	0	9	4	3	81	4	2	22	11	5	107	16	10	87
Wind River Indian Reservation	92	81	691	56	41	355	91	75	675	33	17	155	66	52	425	48	38	467	80	69	641	77	64	697

Note: B_{ext} = extinction coefficient for visibility
N = N percent (5 or 10 as indicated)

Table 3-5
Change in Modeled Visibility Impacts – 2010 Lower Production Scenario Less the Base Year (2002)

	All			CBNG			Coal-related			Coal Mines			Montana			Non-coal			Power Plants			Wyoming		
	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}
Receptor Set	**5%**	**10%**		**5%**	**10%**		**5%**	**10%**		**5%**	**10%**		**5%**	**10%**		**5%**	**10%**		**5%**	**10%**		**5%**	**10%**	
CLASS I AREAS																								
Badlands National Park	12	19	145	59	27	63	17	23	147	12	5	7	8	7	5	9	10	29	34	51	106	14	29	150
Bob Marshall WA	2	2	82	2	1	17	6	1	86	1	0	2	0	0	2	1	0	5	2	2	58	4	4	77
Bridger WA	9	4	115	6	11	62	11	5	201	1	1	6	3	1	27	1	2	17	9	14	205	9	4	186
Fitzpatrick WA	7	3	102	7	10	65	6	5	161	0	1	7	2	0	15	0	2	18	9	9	203	5	5	156
Fort Peck Indian Reservation	8	8	75	17	8	18	12	12	51	2	1	1	3	5	7	4	1	4	13	13	20	10	10	80
Gates of the Mountain WA	1	6	81	2	3	18	5	5	82	1	0	2	2	1	1	1	0	5	5	3	56	1	6	76
Grand Teton National Park	4	2	96	3	6	20	11	2	95	0	0	2	3	2	9	2	2	5	4	8	46	7	3	93
North Absaorka WA	3	6	76	5	6	40	8	6	85	1	0	4	5	4	21	0	0	11	4	6	114	0	6	115
North Cheyenne Indian Reservation	9	5	133	35	28	129	14	5	116	6	10	42	13	4	22	5	5	20	7	8	8	14	8	131
Red Rock Lakes	2	3	19	5	3	6	6	3	7	0	0	1	2	0	3	1	0	1	9	7	2	7	5	26
Scapegoat WA	4	4	79	1	1	17	7	2	81	1	0	2	2	1	1	0	0	5	5	2	50	2	4	74
Teton WA	1	4	93	19	14	139	2	7	133	1	0	5	17	11	157	0	1	12	5	9	154	0	8	142
Theodore Roosevelt National Park	9	15	80	18	10	31	11	24	80	5	2	2	5	5	6	2	3	4	20	24	62	13	16	49
UL Bend WA	3	4	175	12	5	47	3	7	219	2	1	4	1	3	5	2	1	12	4	3	162	3	5	217
Washakie WA	7	2	22	7	10	80	7	5	35	1	0	9	2	2	23	0	2	24	4	7	153	6	4	75
Wind Cave National Park	8	11	159	57	39	61	15	22	197	11	6	8	11	6	12	8	7	19	17	41	167	9	22	140
Yellowstone National Park	3	7	88	4	5	30	2	6	119	2	0	3	1	3	17	1	3	8	5	5	91	2	4	131
SENSITIVE CLASS II AREAS																								
Absaorka Beartooth WA	5	3	71	5	6	46	1	2	76	1	1	4	2	4	22	2	0	11	0	1	40	5	2	97
Agate Fossil Beds National Monument	20	26	90	37	32	58	33	34	194	6	3	6	4	7	18	7	9	17	36	48	295	26	32	289
Big Horn Canyon National Recreation Area	11	7	90	16	15	84	7	10	120	2	2	11	7	3	16	2	4	18	7	11	150	11	9	72
Black Elk WA	6	16	168	52	38	61	12	20	194	10	9	7	10	11	11	10	7	20	8	29	148	12	26	116
Cloud Peak WA	8	8	99	21	20	94	12	6	183	8	1	8	3	7	13	3	2	21	10	10	193	18	12	154
Crow Indian Reservation	11	10	2	18	30	195	19	15	124	5	7	38	28	18	43	1	2	23	6	2	152	2	2	28
Devils Tower National Monument	2	15	167	39	58	86	5	37	223	12	17	7	13	4	12	11	9	15	35	34	176	12	21	221
Fort Belknap Indian Reservation	7	3	192	9	8	47	6	7	247	2	0	5	7	2	18	2	0	13	8	4	164	2	6	232
Fort Laramie National Historic Site	21	27	89	31	16	88	33	39	128	7	5	9	12	4	18	12	1	23	47	57	230	28	31	124
Jedediah Smith WA	8	1	28	2	4	12	7	4	19	2	0	1	2	0	9	0	2	3	4	7	6	7	4	54
Jewel Cave National Monument	11	14	203	51	43	63	11	28	227	21	8	9	7	9	11	8	9	28	17	34	157	8	23	189

Table 3-5 (Continued)

Receptor Set	All			CBNG			Coal-related			Coal Mines			Montana			Non-coal			Power Plants			Wyoming		
	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}
	5%	10%		5%	10%		5%	10%		5%	10%		5%	10%		5%	10%		5%	10%		5%	10%	
Lee Metcalf WA	2	2	44	4	3	10	2	5	30	1	0	1	1	5	5	0	1	2	4	8	2	0	5	43
Mount Naomi WA	2	6	37	2	0	11	6	6	36	1	0	1	1	1	7	1	0	2	5	2	21	1	5	33
Mount Rushmore National Monument	10	19	168	51	42	61	16	13	184	8	7	7	13	4	11	11	10	18	14	39	136	12	30	113
Popo Agie WA	3	7	42	12	5	76	7	6	139	0	1	8	5	0	19	0	2	21	12	11	234	5	6	153
Soldier Creek WA	18	23	95	30	38	50	38	42	205	8	4	5	10	5	16	7	10	15	54	48	244	21	31	286
Wellsville Mountain WA	3	5	35	1	1	10	3	5	35	0	0	1	0	0	6	0	0	2	4	2	19	4	3	29
Wind River Indian Reservation	4	12	104	12	10	135	11	9	5	5	1	15	8	6	21	1	1	35	10	12	178	8	12	38

Notes: B_{ext} = extinction coefficient for visibility
N = N percent (5 or 10 as 9indicated)

Table 3-6
Change in Modeled Visibility Impacts – 2010 Upper Production Scenario Less the Base Year (2002)

	All			CBNG			Coal-related			Coal Mines			Montana			Non-coal			Power Plants			Wyoming		
	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}
Receptor Set	**5%**	**10%**		**5%**	**10%**		**5%**	**10%**		**5%**	**10%**		**5%**	**10%**		**5%**	**10%**		**5%**	**10%**		**5%**	**10%**	
CLASS I AREAS																								
Badlands National Park	17	26	163	59	27	63	23	31	174	31	9	17	12	14	14	18	17	62	44	59	132	23	36	167
Bob Marshall WA	2	4	106	2	1	17	6	1	99	2	0	5	1	0	3	1	0	10	2	3	74	4	5	99
Bridger WA	12	7	127	6	11	62	13	7	217	1	3	16	3	2	38	3	3	38	10	14	243	10	4	209
Fitzpatrick WA	9	5	112	7	10	65	9	5	179	2	2	17	4	1	25	0	5	40	9	10	246	7	7	176
Fort Peck Indian Reservation	10	9	96	17	8	18	12	14	64	6	4	4	3	7	12	4	2	8	14	15	31	11	11	98
Gates of the Mountain WA	1	7	103	2	3	18	5	8	95	1	0	5	3	1	3	1	2	10	6	4	71	1	7	96
Grand Teton National Park	4	5	122	3	6	20	11	2	110	1	0	5	3	2	14	3	2	11	9	8	61	8	4	117
North Absaorka WA	4	6	99	5	6	40	8	7	102	9	2	11	9	4	33	0	3	24	8	10	129	2	9	133
North Cheyenne Indian Reservation	15	10	173	35	28	129	20	12	165	24	23	126	21	11	107	9	11	45	10	10	44	15	15	183
Red Rock Lakes	2	5	26	5	3	6	6	3	11	1	0	1	3	0	5	1	0	3	9	8	5	7	5	33
Scapegoat WA	4	4	101	1	1	17	8	3	93	1	0	5	3	1	2	0	0	10	7	4	65	4	6	95
Teton WA	1	5	109	19	14	139	3	7	147	1	2	12	19	12	173	1	2	27	8	9	174	1	9	164
Theodore Roosevelt National Park	11	22	102	18	10	31	14	30	95	11	2	6	10	8	12	8	7	9	24	32	77	16	22	66
UL Bend WA	5	5	188	12	5	47	5	8	244	2	3	11	3	3	11	5	1	26	7	6	203	4	7	254
Washakie WA	8	3	32	7	10	80	7	6	39	3	1	23	4	5	39	1	2	51	6	7	159	7	4	83
Wind Cave National Park	12	15	186	57	39	61	17	27	222	29	12	20	13	10	22	18	17	41	27	52	212	14	25	166
Yellowstone National Park	6	8	104	4	5	30	4	9	131	6	1	8	4	4	26	1	5	18	6	11	115	4	6	150
SENSITIVE CLASS II AREAS																								
Absaorka Beartooth WA	6	5	93	5	6	46	3	4	93	4	4	11	2	5	33	2	0	24	0	6	59	6	2	118
Agate Fossil Beds National Monument	23	30	98	37	32	58	37	39	202	18	14	16	7	9	32	15	18	36	43	56	312	31	41	303
Big Horn Canyon National Recreation Area	14	8	112	16	15	84	13	11	135	11	9	30	9	5	29	5	10	38	7	15	182	13	12	87
Black Elk WA	10	22	256	52	38	61	16	27	235	27	18	18	17	14	20	16	16	46	22	46	195	14	29	201
Cloud Peak WA	12	8	109	21	20	94	15	7	195	18	8	20	5	13	25	10	7	44	11	13	237	21	13	190
Crow Indian Reservation	14	15	13	18	30	195	26	20	156	18	19	106	34	26	113	11	13	43	8	2	184	9	13	39
Devils Tower National Monument	4	21	184	39	58	86	7	41	250	24	29	16	20	11	21	20	21	33	46	42	214	14	24	264
Fort Belknap Indian Reservation	9	4	209	9	8	47	7	7	273	3	0	13	8	2	26	2	1	27	9	4	209	4	8	263
Fort Laramie National Historic Site	27	30	105	31	16	88	37	43	141	13	17	22	13	9	30	19	9	50	51	61	250	32	35	145
Jedediah Smith WA	8	2	43	2	4	12	8	5	26	3	2	3	3	0	14	2	3	7	5	8	12	10	4	67
Jewel Cave National Monument	12	18	288	51	43	63	14	37	276	35	18	23	14	10	20	21	23	68	33	55	218	18	27	290

Table 3-6 (Continued)

Receptor Set	All			CBNG			Coal-related			Coal Mines			Montana			Non-coal			Power Plants			Wyoming		
	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}	Number of Days > N% Change in B_{ext}		Maximum % Change in B_{ext}
	5%	10%		5%	10%		5%	10%		5%	10%		5%	10%		5%	10%		5%	10%		5%	10%	
Lee Metcalf WA	2	4	54	4	3	10	2	5	36	2	0	3	2	6	8	4	1	5	7	10	4	0	5	53
Mount Naomi WA	5	8	51	2	0	11	6	7	45	1	1	3	1	1	12	1	0	4	6	3	30	3	8	42
Mount Rushmore National Monument	11	25	207	51	42	61	20	24	217	23	17	17	20	7	20	19	19	42	22	55	180	18	38	156
Popo Agie WA	3	8	47	12	5	76	7	8	144	2	1	20	5	0	31	2	3	46	13	14	271	5	7	165
Soldier Creek WA	20	29	105	30	38	50	43	45	215	26	9	14	12	11	30	17	25	34	56	60	287	23	39	312
Wellsville Mountain WA	4	7	47	1	1	10	3	6	43	1	0	2	0	0	10	1	1	4	5	2	27	5	5	37
Wind River Indian Reservation	5	15	104	12	10	135	13	10	5	6	2	38	8	7	41	4	2	73	12	16	176	8	14	38

Note: B_{ext} = extinction coefficient for visibility
N = N percent (5 or 10 as indicted)

greater to the east of the PRB study area than to the west, although modeling results show that all areas would experience some increase in visibility impacts.

3.1.5 Impacts on Acid Deposition

Emissions of NO_x and SO_2 could lead to increasing impacts of acidic deposition in the region. This study evaluated the potential increase in acid deposition as a result of the projected increase in production activity. The base year (2002) analysis showed that impacts for all listed Class I and Class II areas would be below the established thresholds for sulfur and nitrogen deposition, which are 5 kilograms per hectare per year (kg/ha-yr) for sulfur compounds and 3 kg/ha-yr for nitrogen compounds. **Table 3-7** provides a summary of base year deposition levels at the sensitive receptor areas. The highest modeled impacts are at the Northern Cheyenne Indian Reservation with nitrogen deposition reaching 1.76 kg/ha-yr, or approximately 59 percent of the threshold. Generally, nitrogen deposition was greater than sulfur deposition for the base year analysis. Relatively higher deposition rates were noted to the east of the PRB study area, as a result of the prevailing wind direction in the region.

The modeled changes in acid deposition (kg/ha-yr) under the lower and upper production scenarios are shown in **Tables 3-8** and **3-9**, respectively. For all receptors and for both sulfur and nitrogen compounds, the combined deposition rates would not exceed the thresholds provided above. The maximum impacts would occur at the Northern Cheyenne Indian Reservation. Relatively high increases in impacts would occur at other Class I areas to the east of the PRB study area.

3.1.6 Impacts on Sensitive Lake Acid Neutralizing Capacity

The analysis of impacts of deposition of acidic substances was carried out in accordance with the screening methodology as provided by the FS (FS 2000). Data for lake neutralizing capacity were obtained from the FS web site, which provides data for the 10 percent ANC values for the individual lakes that were evaluated. The threshold is intended to account for sensitive conditions that may occur with an episodic or seasonal basis. Input data to the analysis include the deposition rates that were modeled for the base year (2002), and under the lower and upper production scenarios for 2010.

The input data are provided in **Table 3-10** for the analyzed lakes. Modeling results are provided for the base year (2002) analysis as well as the lower and upper production scenarios for 2010. The threshold for significance was based on a 10 percent change in ANC for lakes with an ANC of 25 µeq/L and a 1 µeq/L threshold change for lakes with an ANC value of less than 25 µeq/L.

At Upper Frozen Lake, the base year (2002) impact was 0.7 µeq/L, which is less than the threshold value of 1 µeq/L for these lakes. The modeled results for the 2010 lower production scenario show an impact of 0.99 µeq/L for Upper Frozen Lake, equivalent to the threshold value, and the results for the 2010 upper production scenario show an impact of 1.04 µeq/L, which is slightly above the threshold value.

Impacts at other lakes all would be below the 10 percent threshold, except for Florence Lake in the Cloud Peak WA, which is just west of the PRB study area. For the base year (2002) analysis, the impacts were 8.9 percent change in ANC; however, for the 2010 lower production scenario, the

Table 3-7
Modeled Deposition for Nitrogen and Sulfur for the Base Year (2002)

Receptor Set	Pollutant	Maximum Deposition (kg/ha-yr)								Comparative Deposition Value (kg/ha-yr)
		All Sources	CBNG	Coal-related	Coal Mines	Montana Sources	Non-coal	Power Plants	Wyoming Sources	
CLASS I AREAS										
Badlands National Park	Nitrogen	0.325	0.039	0.025	0.021	0.069	0.080	0.175	0.258	3
	Sulfur	0.116	0.003	0.112	0.001	0.022	0.006	0.107	0.095	5
Bridger WA	Nitrogen	0.072	0.012	0.059	0.004	0.028	0.013	0.041	0.044	3
	Sulfur	0.015	0.001	0.015	0.000	0.007	0.001	0.014	0.009	5
Bob Marshall WA	Nitrogen	0.017	0.001	0.016	0.001	0.012	0.002	0.014	0.005	3
	Sulfur	0.005	0.000	0.005	0.000	0.004	0.000	0.005	0.001	5
Fitzpatrick WA	Nitrogen	0.048	0.008	0.039	0.003	0.018	0.009	0.027	0.029	3
	Sulfur	0.010	0.000	0.010	0.000	0.005	0.000	0.009	0.006	5
Fort Peck Indian Reservation	Nitrogen	0.080	0.011	0.066	0.005	0.039	0.014	0.051	0.042	3
	Sulfur	0.026	0.001	0.025	0.000	0.013	0.001	0.024	0.014	5
Gates of the Mountain WA	Nitrogen	0.023	0.002	0.021	0.001	0.014	0.003	0.017	0.009	3
	Sulfur	0.006	0.000	0.006	0.000	0.003	0.000	0.005	0.002	5
Grand Teton National Park	Nitrogen	0.026	0.005	0.021	0.002	0.011	0.005	0.014	0.016	3
	Sulfur	0.005	0.000	0.005	0.000	0.003	0.000	0.005	0.003	5
North Absaorka WA	Nitrogen	0.051	0.007	0.044	0.003	0.029	0.009	0.034	0.025	3
	Sulfur	0.014	0.000	0.014	0.000	0.009	0.001	0.013	0.006	5
North Cheyenne Indian Reservation	Nitrogen	1.760	0.106	1.684	1.197	1.557	0.126	0.552	0.288	3
	Sulfur	0.319	0.011	0.314	0.007	0.275	0.009	0.302	0.050	5
Red Rock Lakes WA	Nitrogen	0.019	0.003	0.016	0.001	0.011	0.003	0.012	0.008	3
	Sulfur	0.004	0.000	0.004	0.000	0.003	0.000	0.004	0.001	5
Scapegoat WA	Nitrogen	0.019	0.002	0.017	0.001	0.013	0.002	0.014	0.007	3
	Sulfur	0.005	0.000	0.005	0.000	0.004	0.000	0.005	0.002	5
Teton WA	Nitrogen	0.036	0.006	0.030	0.002	0.016	0.007	0.021	0.020	3
	Sulfur	0.009	0.000	0.008	0.000	0.005	0.000	0.008	0.004	5
Theodore Roosevelt National Park	Nitrogen	0.200	0.028	0.165	0.012	0.093	0.036	0.121	0.109	3
	Sulfur	0.050	0.002	0.049	0.000	0.026	0.002	0.046	0.025	5
UL Bend WA	Nitrogen	0.095	0.008	0.084	0.004	0.057	0.011	0.070	0.037	3
	Sulfur	0.032	0.001	0.032	0.000	0.019	0.001	0.031	0.013	5
Washakie WA	Nitrogen	0.063	0.010	0.052	0.004	0.030	0.011	0.038	0.034	3
	Sulfur	0.017	0.001	0.016	0.000	0.009	0.001	0.015	0.007	5
Wind Cave National Park	Nitrogen	0.534	0.065	0.360	0.050	0.094	0.182	0.215	0.451	3
	Sulfur	0.178	0.006	0.166	0.002	0.038	0.014	0.157	0.141	5
Yellowstone National Park	Nitrogen	0.044	0.006	0.038	0.002	0.024	0.007	0.029	0.020	3

Table 3-7 (Continued)

Receptor Set	Pollutant	Maximum Deposition (kg/ha-yr)								Comparative Deposition Value (kg/ha-yr)
		All Sources	CBNG	Coal-related	Coal Mines	Montana Sources	Non-coal	Power Plants	Wyoming Sources	
	Sulfur	0.012	0.000	0.012	0.000	0.007	0.000	0.011	0.005	5
CLASS I / CLASS II SENSITIVE LAKES										
Black Joe Lake, Bridger WA	Nitrogen	0.067	0.011	0.055	0.004	0.026	0.012	0.038	0.040	3
	Sulfur	0.014	0.001	0.014	0.000	0.006	0.001	0.013	0.008	5
Deep Lake, Bridger WA	Nitrogen	0.066	0.011	0.054	0.004	0.026	0.012	0.038	0.040	3
	Sulfur	0.014	0.001	0.013	0.000	0.006	0.001	0.013	0.008	5
Emerald Lake, Cloud Peak WA	Nitrogen	0.204	0.039	0.163	0.012	0.070	0.043	0.108	0.135	3
	Sulfur	0.069	0.003	0.067	0.001	0.026	0.004	0.061	0.043	5
Florence Lake Cloud Peak WA	Nitrogen	0.208	0.045	0.165	0.012	0.066	0.044	0.104	0.142	3
	Sulfur	0.065	0.003	0.062	0.001	0.024	0.004	0.057	0.041	5
Hobbs Lake, Bridger WA	Nitrogen	0.040	0.007	0.032	0.002	0.015	0.008	0.022	0.025	3
	Sulfur	0.009	0.000	0.008	0.000	0.004	0.000	0.008	0.005	5
Lower Saddlebag Lake, Popo Agie WA	Nitrogen	0.079	0.013	0.064	0.005	0.031	0.015	0.044	0.048	3
	Sulfur	0.017	0.001	0.016	0.000	0.007	0.001	0.015	0.009	5
Ross Lake, Cloud Peak WA	Nitrogen	0.038	0.007	0.031	0.002	0.015	0.007	0.021	0.023	3
	Sulfur	0.009	0.000	0.008	0.000	0.004	0.000	0.008	0.005	5
Upper Frozen Lake, Bridger WA	Nitrogen	0.067	0.011	0.055	0.004	0.026	0.012	0.038	0.041	3
	Sulfur	0.014	0.001	0.014	0.000	0.006	0.001	0.013	0.008	5

Table 3-8
Change in Modeled Deposition of Sulfur and Nitrogen Compounds – 2010 Lower Production Scenario

Receptor Set	Pollutant	Change in Maximum Deposition (kg/ha-yr)							
		All	CBNG	Coal-related	Coal Mines	Montana	Non-coal	Power Plants	Wyoming
CLASS I AREAS									
Badlands National Park	Nitrogen	0.040	0.025	0.027	0.003	0.005	0.008	0.001	0.029
	Sulfur	0.020	0.002	0.014	0.000	0.003	0.001	0.012	0.013
Bridger WA	Nitrogen	-0.052	-0.010	-0.041	-0.004	-0.015	-0.012	-0.025	-0.037
	Sulfur	-0.009	0.000	-0.008	0.000	-0.002	-0.001	-0.008	-0.007
Bob Marshall WA	Nitrogen	0.078	0.018	0.061	0.004	0.018	0.013	0.036	0.056
	Sulfur	0.021	0.001	0.018	0.000	0.004	0.001	0.017	0.015
Fitzpatrick WA	Nitrogen	0.015	0.005	0.012	0.000	0.001	0.001	0.006	0.012
	Sulfur	0.008	0.000	0.007	0.000	0.001	0.000	0.006	0.006
Fort Peck Indian Reservation	Nitrogen	0.020	0.007	0.015	0.001	0.003	0.001	0.008	0.016
	Sulfur	0.010	0.000	0.008	0.000	0.002	0.000	0.007	0.006
Gates of the Mountain WA	Nitrogen	0.005	0.001	0.004	0.000	0.001	0.000	0.002	0.003
	Sulfur	0.002	0.000	0.002	0.000	0.001	0.000	0.002	0.001
Grand Teton National Park	Nitrogen	0.008	0.003	0.007	0.000	0.001	0.000	0.003	0.007
	Sulfur	0.003	0.000	0.002	0.000	0.000	0.000	0.002	0.002
North Absaorka WA	Nitrogen	0.012	0.005	0.008	0.000	0.003	0.001	0.004	0.008
	Sulfur	0.007	0.000	0.006	0.000	0.002	0.000	0.005	0.003
North Cheyenne Indian Reservation	Nitrogen	0.270	0.067	0.254	0.162	0.190	0.005	0.045	0.094
	Sulfur	0.172	0.007	0.160	0.170	0.137	0.012	0.083	0.036
Red Rock Lakes	Nitrogen	0.005	0.002	0.004	0.000	0.001	0.000	0.002	0.003
	Sulfur	0.002	0.000	0.001	0.000	0.000	0.000	0.001	0.001
Scapegoat WA	Nitrogen	0.004	0.001	0.003	0.000	0.001	0.000	0.002	0.002
	Sulfur	0.002	0.000	0.002	0.000	0.001	0.000	0.001	0.001
Teton WA	Nitrogen	0.010	0.004	0.008	0.000	0.001	0.001	0.003	0.007
	Sulfur	0.005	0.000	0.004	0.000	0.001	0.000	0.004	0.003
Theodore Roosevelt National Park	Nitrogen	0.052	0.018	0.040	0.002	0.006	0.003	0.021	0.038
	Sulfur	0.025	0.001	0.019	0.000	0.004	0.000	0.018	0.015
UL Bend WA	Nitrogen	0.016	0.005	0.012	0.001	0.004	0.001	0.006	0.010
	Sulfur	0.009	0.000	0.007	0.000	0.003	0.000	0.006	0.004
Washakie WA	Nitrogen	0.017	0.006	0.014	0.001	0.002	0.001	0.007	0.013
	Sulfur	0.012	0.000	0.010	0.000	0.002	0.000	0.010	0.009
Wind Cave National Park	Nitrogen	0.129	0.041	0.109	0.006	0.005	0.019	0.058	-0.386
	Sulfur	0.089	0.004	0.081	0.000	0.004	0.001	0.078	-0.124
Yellowstone National Park	Nitrogen	0.009	0.004	0.007	0.000	0.002	0.001	0.002	0.006
	Sulfur	0.004	0.000	0.003	0.000	0.001	0.000	0.003	0.002
CLASS I / CLASS II SENSITIVE LAKES									
Black Joe Lake, Bridger WA	Nitrogen	0.022	0.007	0.017	0.001	0.002	0.001	0.010	0.017
	Sulfur	0.011	0.000	0.009	0.000	0.001	0.000	0.009	0.009
Deep Lake, Bridger WA	Nitrogen	0.022	0.007	0.017	0.000	0.002	0.001	0.010	0.016
	Sulfur	0.011	0.000	0.009	0.000	0.001	0.000	0.009	0.008
Emerald Lake, Cloud Peak WA	Nitrogen	0.038	0.025	0.027	0.002	0.006	0.003	0.001	0.025
	Sulfur	0.016	0.002	0.006	0.000	0.005	0.002	0.006	0.005
Florence, Cloud Peak WA	Nitrogen	0.045	0.029	0.033	0.002	0.005	0.003	0.004	0.032
	Sulfur	0.021	0.002	0.012	0.000	0.004	0.001	0.011	0.010
Hobbs Lake, Bridger WA	Nitrogen	0.013	0.004	0.010	0.000	0.001	0.001	0.005	0.010
	Sulfur	0.007	0.000	0.005	0.000	0.001	0.000	0.005	0.005
Lower Saddlebag, Popo Agie WA	Nitrogen	0.023	0.008	0.018	0.001	0.002	0.001	0.009	0.017
	Sulfur	0.011	0.000	0.009	0.000	0.001	0.000	0.008	0.008
Ross Lake, Cloud Peak WA	Nitrogen	0.012	0.004	0.009	0.000	0.001	0.001	0.004	0.009
	Sulfur	0.006	0.000	0.005	0.000	0.001	0.000	0.005	0.004
Upper Frozen Lake, Bridger WA	Nitrogen	0.022	0.007	0.017	0.001	0.002	0.001	0.009	0.016
	Sulfur	0.025	0.001	0.023	0.000	0.007	0.001	0.021	0.016

Table 3-9
Change in Modeled Deposition for Nitrogen and Sulfur – 2010 Upper Production Scenario

Receptor Set	Pollutant	Change for Maximum Deposition (kg/ha-yr)							
		All	CBM	Coal-related	Coal Mine	Montana	Non-coal	Power Plants	Wyoming
CLASS I AREAS									
Badlands National Park	Nitrogen	0.071	0.025	0.053	0.007	0.009	0.018	0.021	0.061
	Sulfur	0.031	0.002	0.029	0.000	0.004	0.001	0.027	0.028
Bridger WA	Nitrogen	-0.051	-0.010	-0.039	-0.004	-0.014	-0.012	-0.024	-0.037
	Sulfur	-0.008	0.000	-0.008	0.000	-0.002	-0.001	-0.007	-0.006
Bob Marshall WA	Nitrogen	0.082	0.018	0.068	0.005	0.020	0.015	0.042	0.063
	Sulfur	0.022	0.001	0.021	0.000	0.004	0.001	0.020	0.018
Fitzpatrick WA	Nitrogen	0.018	0.005	0.016	0.001	0.002	0.002	0.010	0.016
	Sulfur	0.009	0.000	0.008	0.000	0.001	0.000	0.008	0.008
Fort Peck Indian Reservation	Nitrogen	0.025	0.007	0.022	0.002	0.005	0.003	0.014	0.022
	Sulfur	0.012	0.000	0.011	0.000	0.002	0.000	0.011	0.009
Gates of the Mountain WA	Nitrogen	0.006	0.001	0.005	0.001	0.002	0.001	0.004	0.004
	Sulfur	0.003	0.000	0.003	0.000	0.001	0.000	0.002	0.002
Grand Teton National Park	Nitrogen	0.010	0.003	0.009	0.001	0.001	0.001	0.005	0.009
	Sulfur	0.003	0.000	0.003	0.000	0.001	0.000	0.003	0.003
North Absaorka WA	Nitrogen	0.015	0.005	0.012	0.001	0.004	0.002	0.007	0.011
	Sulfur	0.008	0.000	0.007	0.000	0.003	0.000	0.007	0.005
North Cheyenne Indian Reservation	Nitrogen	0.628	0.067	0.612	0.491	0.534	0.019	0.079	0.122
	Sulfur	0.227	0.007	0.222	0.214	0.190	0.013	0.106	0.049
Red Rock Lakes	Nitrogen	0.006	0.002	0.005	0.000	0.001	0.001	0.003	0.005
	Sulfur	0.002	0.000	0.002	0.000	0.001	0.000	0.002	0.001
Scapegoat WA	Nitrogen	0.005	0.001	0.004	0.000	0.002	0.000	0.003	0.003
	Sulfur	0.002	0.000	0.002	0.000	0.001	0.000	0.002	0.001
Teton WA	Nitrogen	0.012	0.004	0.011	0.001	0.002	0.001	0.006	0.010
	Sulfur	0.006	0.000	0.005	0.000	0.001	0.000	0.005	0.004
Theodore Roosevelt National Park	Nitrogen	0.066	0.018	0.057	0.004	0.011	0.008	0.035	0.055
	Sulfur	0.028	0.001	0.027	0.000	0.005	0.001	0.025	0.022
UL Bend WA	Nitrogen	0.022	0.005	0.019	0.001	0.007	0.002	0.012	0.015
	Sulfur	0.011	0.000	0.010	0.000	0.004	0.000	0.010	0.007
Washakie WA	Nitrogen	0.021	0.006	0.019	0.001	0.004	0.002	0.011	0.018
	Sulfur	0.013	0.000	0.012	0.000	0.003	0.000	0.012	0.011
Wind Cave National Park	Nitrogen	0.196	0.041	0.158	0.016	0.010	0.045	0.092	0.186
	Sulfur	0.118	0.004	0.114	0.001	0.006	0.004	0.111	0.111
Yellowstone National Park	Nitrogen	0.012	0.004	0.010	0.001	0.003	0.001	0.005	0.009
	Sulfur	0.005	0.000	0.004	0.000	0.002	0.000	0.004	0.003
CLASS I / CLASS II SENSITIVE LAKES									
Black Joe Lake, Bridger WA	Nitrogen	0.026	0.007	0.024	0.001	0.003	0.003	0.015	0.023
	Sulfur	0.012	0.000	0.012	0.000	0.001	0.000	0.012	0.011
Deep Lake, Bridger WA	Nitrogen	0.026	0.007	0.023	0.001	0.003	0.003	0.015	0.023
	Sulfur	0.012	0.000	0.012	0.000	0.001	0.000	0.011	0.011
Emerald Lake, Cloud Peak WA	Nitrogen	0.051	0.025	0.042	0.004	0.011	0.008	0.012	0.040
	Sulfur	0.019	0.002	0.015	0.000	0.006	0.002	0.014	0.013
Florence, Cloud Peak WA	Nitrogen	0.058	0.029	0.049	0.004	0.010	0.008	0.015	0.048
	Sulfur	0.024	0.002	0.021	0.000	0.006	0.002	0.020	0.019
Hobbs Lake, Bridger WA	Nitrogen	0.015	0.004	0.014	0.001	0.002	0.002	0.008	0.014
	Sulfur	0.007	0.000	0.007	0.000	0.001	0.000	0.007	0.006
Lower Saddlebag, Popo Agie WA	Nitrogen	0.028	0.008	0.025	0.002	0.004	0.003	0.015	0.025
	Sulfur	0.012	0.000	0.012	0.000	0.001	0.000	0.011	0.011
Ross Lake, Cloud Peak WA	Nitrogen	0.014	0.004	0.013	0.001	0.002	0.001	0.007	0.012
	Sulfur	0.007	0.000	0.007	0.000	0.001	0.000	0.006	0.006
Upper Frozen Lake, Bridger WA	Nitrogen	0.026	0.007	0.023	0.001	0.003	0.003	0.015	0.023
	Sulfur	0.012	0.000	0.011	0.000	0.001	0.000	0.011	0.010

Table 3-10
Modeled Impacts on Acid Neutralizing Capacity of Sensitive Lakes – 2010 Production Scenarios

Wilderness Area	Lake	Background ANC (µeq/l)	Number of Samples	Watershed Area (hectare)	Annual Precipitation (meter)	Sulfur Deposition (kg/ha/yr)	Sulfur Deposition ($eq/m^2/yr$)	Nitrogen Deposition (kg/ha/yr)	Nitrogen Deposition (eq/m2/yr)	ANC(o) (eq)	ANC Change (percent)	H_{dep} (µeq/l)
Lower Production Scenario												
Bridger	Black Joe	67	43	890	0.97	0.0270	0.0002	0.0906	0.0006	385,598.9	1.88	1.26
		60	61	205	0.97	0.0266	0.0002	0.0897	0.0006	79,538.3	2.08	1.25
		70	68	293	0.76	0.0166	0.0001	0.0541	0.0004	104,706.6	1.37	0.96
	Upper Frozen	5	(NA)	64.8	1.22	0.0265	0.0002	0.0903	0.0006	2,648.4	19.84	0.99
Cloud Peak	Emerald	55.3	9	293	0.97	0.0927	0.0006	0.2490	0.0018	104,776.4	6.59	3.65
		32.7	10	417	0.97	0.0937	0.0006	0.2592	0.0019	88,176.9	11.52	3.77
Fitzpatrick	Ross	53.5	35	4455	0.97	0.0167	0.0001	0.0518	0.0004	1,541,247.6	1.37	0.73
Popo Agie	Lower Saddlebag	55.5	34	155	0.97	0.0294	0.0002	0.1038	0.0007	55,628.3	2.58	1.43
Upper Production Scenario												
Bridger	Black Joe	67	43	890	0.97	0.0279	0.0002	0.0950	0.0007	385,598.9	1.97	1.32
		60	61	205	0.97	0.0276	0.0002	0.0940	0.0007	79,538.3	2.18	1.31
Florence		70	68	293	0.76	0.0172	0.0001	0.0568	0.0004	104,706.6	1.43	1.00
	Upper Frozen	5	(NA)	64.8	1.22	0.0275	0.0002	0.0948	0.0007	2,648.4	20.76	1.04
Cloud Peak	Emerald	55.3	9	293	0.97	0.0956	0.0006	0.2612	0.0019	104,776.4	6.89	3.81
		32.7	10	417	0.97	0.0967	0.0006	0.2717	0.0019	88,176.9	12.03	3.94
Fitzpatrick	Ross	53.5	35	4455	0.97	0.0172	0.0001	0.0543	0.0004	1,541,247.6	1.43	0.77
Popo Agie	Lower Saddlebag	55.5	34	155	0.97	0.0305	0.0002	0.1090	0.0008	55,628.3	2.70	1.50

Note: eq = equivalence
$eq/m^2/yr$ = equivalence per square meter per year
µeq/l = micro equivalence per liter

modeled impact was approximately 11.5 percent change and for the upper development scenario, the impact showed an approximately 12 percent change in ANC.

The modeling results indicate that the proposed development scenarios may lead to impacts above the acid neutralizing capacity threshold for two lakes in the region, although those impacts would be only slightly above the threshold value.

3.1.7 Analysis of Hazardous Air Pollutant Impacts

The study also modeled HAP impacts from sources in the PRB study area. Since the impacts were greatest in the near-field receptor grids of both states, only those areas were analyzed for HAP impacts. The model was used to develop both 1-hour and annual impacts for these emissions. Results of the 1-hour modeled impacts for these modeling efforts were compared to the RELs (USEPA 2005). **Table 3-11** provides an analysis of the short-term impacts for the six analyzed compounds (benzene, ethyl benzene, formaldehyde, n-hexane, toluene, and xylene) compared to the RELs. Results show that all impacts would be below the RELs, except for formaldehyde in the Wyoming near-field receptor grid. Modeled impacts were approximately 70 percent greater than the established REL for formaldehyde.

The impacts for chronic and carcinogenic risks are provided in **Table 3-12** for the Montana and Wyoming near-field receptor grids. All impacts would be well below the non-carcinogenic RfCs, with the maximum comparative impact for formaldehyde at the Wyoming near-field receptors, where those impacts would be approximately 66 percent of the established RfC. The impacts for carcinogenic risk also are provided in **Table 3-12**. All impacts would be well below the 1 in 1 million risk, except for benzene impacts in Wyoming, where the impacts would be approximately 1.0 to 1.3×10^{-5} for the various scenarios. This impact was evident in the base year (2002) as well as for both of the 2010 production scenarios. These impacts would be within the threshold of acceptable risk range of 1×10^{-4} to 1×10^{-6}, as provided by the USEPA (2005).

3.2 Projected Cumulative Impacts for 2015 and 2020

In addition to projections for 2010, the PRB Coal Review includes a projection of development levels for 2015 and 2020. These development levels were apportioned to coal mining operations, CBNG, conventional oil and gas, and power plants. Projected air quality impacts for 2015 and 2020 were evaluated qualitatively for those periods using comparative development levels for each of the source groups. Air quality impacts that were noted for 2010 and the respective changes from the base year (2002) were used to project the impacts for the later years.

Table 3-13 provides an estimate of production levels for each of those source groups, including both a lower and upper production scenario for coal operations. The data show that production of both conventional oil and gas sources and CBNG sources are projected to decline after 2010. Wyoming coal production is projected to increase steadily across the time period for both the lower and upper production scenarios. The coal production scenarios for Montana show a greater increase than in Wyoming, with the upper production scenario projected to double from the base year to 2015.

Table 3-11
Modeled Acute Concentrations of Hazardous Air Pollutants from All Sources
($\mu g/m^3$)

Receptor Set	Pollutant	Averaging Period	RANK	Base Year (2002)	2010 Lower Production Scenario	2010 Upper Production Scenario	REL
Montana Near-field Receptors	Benzene	1-hour	1st High	2.60	2.64	2.76	1,300
	Ethyl Benzene	1-hour	1st High	0.78	0.88	1.05	35,000[1]
	Formaldehyde	1-hour	1st High	25.1	26.2	26.2	94
	n-Hexane	1-hour	1st High	0.60	0.62	0.75	39,000[1]
	Toluene	1-hour	1st High	3.2	3.6	4.1	37,000
	Xylene	1-hour	1st High	3.3	3.7	4.4	22,000
Wyoming Near-field Receptors	Benzene	1-hour	1st High	52.7	59.5	69.3	1,300
	Ethyl Benzene	1-hour	1st High	31.2	35.2	41.0	35,000[1]
	Formaldehyde	1-hour	1st High	150.4	160.3	160.3	94
	n-Hexane	1-hour	1st High	21.9	24.7	28.8	39,000[1]
	Toluene	1-hour	1st High	126.5	142.9	166.5	37,000
	Xylene	1-hour	1st High	129.6	146.3	170.5	22,000

[1]Data for ethyl benzene and n-Hexane are based on IDLH/100 values.

Table 3-12
Modeled Annual Concentrations of Hazardous Air Pollutants from All Sources

Receptor Set	Pollutant	Averaging Period	RANK	Base Year (2002)	2010 Lower Production Scenario	2010 Upper Production Scenario	Non-carcinogenic RfCs
Near-field Receptors – Non-Carcinogenic Impacts				**µg/m^3**			
Montana Near-field Receptors	Benzene	Annual	1st High	0.06	0.06	0.06	30
	Ethyl Benzene	Annual	1st High	0.02	0.02	0.02	1,000
	Formaldehyde	Annual	1st High	0.82	0.87	0.87	9.8
	n-Hexane	Annual	1st High	0.01	0.01	0.02	200
	Toluene	Annual	1st High	0.07	0.08	0.09	400
	Xylene	Annual	1st High	0.07	0.08	0.09	100
Wyoming Near-field Receptors	Benzene	Annual	1st High	1.90	2.10	2.40	30
	Ethyl Benzene	Annual	1st High	1.20	1.30	1.50	1,000
	Formaldehyde	Annual	1st High	6.50	6.50	6.50	9.8
	n-Hexane	Annual	1st High	0.82	0.92	1.08	200
	Toluene	Annual	1st High	4.70	5.30	6.20	400
	Xylene	Annual	1st High	4.80	5.50	6.40	100
Near-field Receptors – Carcinogenic Risk Evaluation[1]				**Risk Evaluation X 10^{-6}**			
Montana	Benzene	Annual	1st High	0.332	0.332	0.332	--
	Formaldehyde	Annual	1st High	0.003	0.003	0.003	--
Wyoming	Benzene	Annual	1st High	10.522	11.630	13.291	--
	Formaldehyde	Annual	1st High	0.025	0.025	0.025	--

[1]Benzene concentrations multiplied by risk factor: 7.8 X 10^{-6} X 0.71.
Formaldehyde concentrations multiplied by risk factor: 5.5 X 10^{-9} X 0.71.

Table 3-13
Projected Development Levels for 2015 and 2020 by Source Group

Group	Scenario	Base Year (2002)	Projected Development Levels			Development Units	Development Ratios		
			2010	2015	2020		2010	2015	2020
Conventional Oil and Gas Sources	Same for both scenarios	39.9	42.7	39.0	35.1	BCF	1.07	0.97	0.88
CBNG Sources[1]	Same for both scenarios	338	554	530	521	BCF	1.64	1.57	1.54
Coal Production, Wyoming	Lower	363	411	467	495	mmtpy	1.13	1.28	1.36
	Upper	363	479	543	576		1.32	1.49	1.58
Coal Production, Montana	Lower	36.1	41	48	56	mmtpy	1.14	1.33	1.55
	Upper	36.1	51	74	83		1.41	2.05	2.30
Power Plants, Wyoming	Lower	512	1262	1,262	1,262	MW Generating Capacity	2.46	2.46	2.46
	Upper	512	1512	1,512	1,962		2.95	2.95	3.83
Power Plants, Montana	Lower	2,576	2,689	3,439	3,439	MW Generating Capacity	1.04	1.34	1.34
	Upper	2,576	2,689	3,439	4,189		1.04	1.34	1.63

[1]The CBNG production projections for this study were being refined concurrently with the air quality modeling conducted for this report. As a result, the initial production numbers used in the air quality model and shown in this table differ somewhat from the final production projections presented in the Task 2 report (ENSR 2005a). The final Task 2 projections for CBNG production in 2010, 2015, and 2020 are 640, 694, and 631 BCF, respectively. These production levels would result in incrementally greater CBNG-related air quality impacts than presented in this report.

3.2.1 Impacts on Ambient Air Quality

3.2.1.1 Wyoming Near-field Impacts

Coal production in general is anticipated to contribute substantially to impacts on the near-field receptor grid in Wyoming, particularly PM_{10} impacts. The PM_{10} impacts are of most concern in this receptor area, and the projected increase in coal production likely would continue to affect the PM_{10} air quality levels. The 2010 modeled exceedances of the 24-hour PM_{10} standard likely would be adversely affected by increased coal operations in 2015 and 2020. As shown in **Figure 3-1**, impacts at only five receptors were above the NAAQS in Wyoming, confined to an area around intensive coal mining operations.

Power plant projected emissions were major contributors to increased impacts of SO_2 in the near-field receptor grid for the 2010 modeled impacts, and this effect would continue through the projected development in 2015 and 2020. The modeled 3-hour short-term impacts in 2010 nearly tripled as a result of power plant emissions, and the 24-hour impacts increased by 40 percent. However, the modeled levels were below the ambient standards, and it is anticipated that the ratio

of increase for the later years (2015 and 2020) would not lead to an exceedance of the short-term standards.

The NO_2 impacts result more broadly from all of the source groups. It is not clear that the increase in production for either scenario would lead to an exceedance of the NO_2 standard in 2015 or 2020.

3.2.1.2 Montana Near-field Impacts

Coal production in general contributed substantially to impacts on the near-field receptor grid in Montana, particularly the PM_{10} modeled impacts for 2010. The PM_{10} impacts are of most concern in this receptor area, and the increased coal production likely would continue to impact the PM_{10} air quality levels in 2015 and 2020. The 2010 modeled exceedances of the 24-hour PM_{10} standard likely would be adversely affected by the increased coal production in 2015 and 2020.

The SO_2 and NO_2 impacts on the Montana near-field receptors were well below the ambient standards, and would remain below the ambient standards under both the lower and upper production scenarios for 2015 and 2020.

3.2.2 Impacts at Class I Area Receptors

As noted in Section 3.1.2, the projected impacts in Class I areas in 2010 would be below the ambient standards. The impacts at the Northern Cheyenne Indian Reservation were greater than any other Class I area, and those impacts tended to result from coal mine operations in Montana. The PM_{10} impacts are of most concern, and the increased production likely would continue to impact the PM_{10} air quality levels for 2015 and 2020. Impacts for 2010 at other Class I areas also were well below the ambient standards, and the projected level of production for 2015 and 2020 likely would not adversely affect air quality levels at these locations.

3.2.3 Impacts at Sensitive Class II Areas

Based on the 2010 modeling results, the Crow Indian Reservation showed the greatest air quality impacts for the identified sensitive Class II areas. Impacts were well below the ambient standards for all criteria pollutants, and likely would not adversely affect air quality levels at these locations in 2015 or 2020.

3.2.4 Visibility Impacts

Results of visibility impacts at Class I areas and identified Class II areas (Section 3.4) showed that a large number of days had modeled impacts for 2010 above 10 percent reduction in visibility at all identified areas. The modeled impacts for both scenarios for 2010 showed increases of up to 20 days per year with impacts greater than 10 percent, at the most sensitive receptors. Increased development in 2015 and 2020 may lead to further degradation of visibility at the Class I and identified Class II areas.

3.2.5 Impacts on Acid Deposition and Sensitive Lake Acid Neutralizing Capacity

Results of the change in ANC for the identified lakes for 2010 showed that deposition at two separate lakes would result in reductions in ANC greater than the established thresholds. Those lakes (Upper Frozen Lake and Florence Lake) would continue to be impacted by the increased development in the PRB study area in 2015 and 2020. However, impacts to the other lakes were well below the thresholds, and expected increases in development likely would not lead to impacts at the other sensitive lakes.

Impacts on acid deposition in Class I areas for 2010 also were well below the established sensitive thresholds. Increased development would not likely lead to exceedances of those thresholds for any identified sensitive areas in 2015 or 2020.

3.2.6 Impact of Hazardous Air Pollutant Emissions

The base year (2002) study and the analysis of development for 2010 showed that the modeled formaldehyde levels were above the 1-hour REL at the near-field receptor grid in Wyoming. All other impacts were well below the RELs. Increased development in 2015 and 2020 would not likely lead to an exceedance of other RELs.

The base year (2002) study also showed that the impacts of benzene emissions on the Wyoming near-field receptors led to a calculated carcinogenic risk value of greater than 1 per million (10^{-6}). Analyses for 2010 for both scenarios showed a slight increase in that risk, which likely would be maintained through the subsequent development years (2015 and 2020) given the projected levels of development, it is estimated that the carcinogenic risk arising from benzene emissions would be below the 1×10^{-4} risk threshold through 2020. All other impacts were well below the annual non-carcinogenic RfCs and the carcinogenic risk evaluation. The projected levels of increased coal production in 2015 and 2020 would not lead to a change in the impacts of HAP emissions for the near-field receptors in Montana or Wyoming.

4.0 REFERENCES

Bureau of Land Management (BLM). 2004. Coal mine 2003 disturbance area shape files provided to M. Paulson, ENSR.

_____. 2003. Final Environmental Impact Statement and Plan Amendment for the Powder River Basin Oil and Gas Project. Wyoming State Office and Buffalo Field Office. January 2003.

_____. 1999. Wyodak Coalbed Methane Project Draft Environmental Impact Statement. Buffalo Field Office. May 1999.

_____. 1996. Coal Development Status Check Powder River Federal Coal Region Montana & Wyoming Data Tables. Data Compiled by: Wyoming Bureau of Land Management Buffalo Resource Area, Casper District, & State Offices, and Montana Bureau of Land Management Powder River Resource Area, Miles City District & State Offices.

ENSR. 2005a. Task 2 Report for the Powder River Basin Coal Review, Past, Present, and Reasonably Foreseeable Development. Prepared for the Bureau of Land Management Casper Field Office and Wyoming State Office. July 2005.

_____. 2005b. Task 1A Report for the Powder River Basin Coal Review, Current Air Quality Conditions. Prepared for the Bureau of Land Management Casper Field Office, Wyoming State Office, and Montana State Office. September 2005.

Federal Land Managers Air Quality Guide (FLAG). 2000. Federal Land Managers' Air Quality Relative Values Workgroup Phase I Report. December 2000.

Fox et al. 1989. A Screening Procedure to Evaluate Air Pollution Effects on Class I Wilderness Areas. Report RM-168. USDA Rocky Mountain Forest and Range Experiment Station. Fort Collins, Colorado.

Montgomery Watson Harza (MWH). 2003. Coal Planning Estimates Report. Prepared for the Bureau of Land Management Wyoming State Office. March 2003.

Surface Transportation Board, 2004. Draft Supplemental Environmental Impact Statement – Tongue River Railroad Company, Construction and Operation, Western Alignment, Tongue River III Rosebud and Bighorn Counties, Montana. STB ID# 35117. Washington D.C. October 2004.

Thunder Basin Coal Company. 2003. 2002-2003 Coal Creek Mine Annual Report. Permit No. 483-T4. February 2003.

U.S. Environmental Protection Agency (USEPA). 2005. Acute Reference Exposure Levels. Internet web site: http://www.epa.gov/ttn/atw/toxsource/table2.pdf.

U.S. Forest Service (FS). 2000. Rocky Mountain Region. Screening Methodology for Calculating ANC Change to High Elevation Lakes. December 2000.

U.S. Geological Survey. 2000. USGS Digital Elevation Model Data. Internet website: http://edcwww.cr.usgs.gov/glis/hyper/guide/usgs_dem. July 10, 2000.