4.0 MODELED BASE YEAR IMPACTS

4.1 Emission Inventories

To use the model for evaluating impacts from presumed growth, the study conducted an evaluation of predicted impacts from base year (2002) emissions. The base year (2002) emissions were estimated by using available databases from the regulatory agencies (WDEQ and MDEQ), along with appropriate USEPA emission factors and equations. Emissions from sources within the study area were based on input from the WDEQ and MDEQ.

The emissions scenarios represent a key component of conducting the air quality analyses. The following emissions scenarios were developed for sources in the Wyoming and Montana PRB study area. A base year emissions database representative of 2002 operations was prepared. The analysis was provided for separate source groupings, including:

- All sources
- CBNG sources (all CBNG producing sources)
- Coal-related sources (from both states, including mines, power plants, and conversion facilities)
- Coal mines (in both states)
- Montana sources (all sources located in Montana including coal mines, CBNG, and power plants)
- Non-coal sources (roads, railroads, 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)
- Wyoming sources (all sources located in Wyoming)

Some sources (such as coal-fired power plants) may be included in more than one group (e.g., coal-related sources and power plants).

Specific data was collected from WDEQ and MDEQ files from air permits and approved air permit applications from active sources. A full scenario of actual emissions from all source groups to be modeled for the base year was prepared.

4.2 Receptors

Within the modeling domain, the analytical work focused on a series of receptors. Specifically, identifying the Class I areas, sensitive Class II areas, and near field receptors within the PRB, both in Montana and Wyoming. **Figure 4-1** depicts those receptors, both as groups and as individual areas. Impacts at each of these receptor groups is evaluated below. Each of the receptor groups consists of multiple receptor points that were evaluated under the CALPUFF model. For example, a large Class I area could have 100 receptors. The comparative evaluation was carried out for the one receptor in each Class I area that had the highest impact.

4.3 Summary of Impacts

This section provides a summary of the maximum modeled impacts for the key components of the analysis (air quality, acid deposition, visibility). **Table 4-1** provides a summary of the results for this study. In general, the modeled impact of the cumulative sources shows some exceedances of the 24-hour and annual PM_{10} standards at near-field receptors, both in Wyoming and Montana.

Modeled impacts of other criteria air pollutants are well below the NAAQS as well as the individual state AAQS.

Table 4-1
Summary of Modeled Air Quality Impacts

Air Quality Component		Year 2002
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 to the east have greater than 200 days with greater than 1 dv
Atmospheric Deposition: Sulfur	LOC	Below 5 kilograms per hectare per year (kg/ha-yr) for sulfur
Atmospheric Deposition: Nitrogen	LOC	Below 3 kg/ha-yr
Atmospheric Deposition: Lake Chemistry	ANC	All below LAC except Upper Frozen Lake

Note: LOC = level of concern

Impacts on visibility in Class I areas and in sensitive Class II areas also were analyzed. As the subsequent analysis shows, all areas have base year (2002) impacts with several days above a 1-dv impact. (1 dv is a 10 percent increase in the extinction coefficient, or a 10 percent reduction in visibility averaged over a 24-hour period.)

Impacts on acid deposition are well below established guidelines of sensitivity.

4.4 Impacts on Ambient Air Quality

A series of receptor groups was established for this analysis, to include a set of near-field receptors in Wyoming, near field receptors in Montana, a listing of Class I areas, and a series of Class II sensitive areas. The analysis does not include an adjustment for background concentrations, which normally would be used in permit applications analyses. In addition, the analysis does not separate PSD increment consuming sources or emissions from non-PSD increment consuming sources. Therefore, the results cannot be used to develop a pattern of increment consumption for a particular site. The PSD comparisons are for informational purposes only and do not constitute a regulatory PSD increment consumption analysis, which may be required for specific projects by air permitting authorities.

The modeled impacts are provided for major resource receptor groups in **Table 4-2**. Results are provided for:

- Annual average NO_2 concentration
- 24-hour and annual PM_{10} concentration
- 3-hour, 24-hour, and annual SO_2 concentrations

Table 4-2 also shows the applicable NAAQS and PSD increments for each pollutant. Data for annual impacts are provided for the highest receptor during the modeled year. Data for short-term impacts (24-hours or 3-hours) were analyzed at each receptor, based on the second-highest reading at that receptor, in accordance with the ambient standard for the applicable pollutant. The receptor with the second-highest impact also is included in the summary.

In the near-field receptor grid, those receptors that were within 1 km of a modeling source location were removed from that grid. The results provide a broad depiction of impacts and do not address impacts at or near fence lines (or within 1 km of a source). These results are not directly applicable to analyzing impacts very close to any one source, as would commonly be evaluated in an air permit application. The model results show that at some near-field receptors in Montana and Wyoming, the 24-hour PM_{10} impacts are potentially above the NAAQS.

Other model impacts are well below the ambient standards. Among the Class I areas, the modeled impacts are highest at the North Cheyenne Indian Reservation. Modeled impacts are approximately 28 percent of the 24-hour PM_{10} standard and approximately 10 percent of the annual PM_{10} standard. Among the sensitive Class II areas, modeled impacts are highest at the Crow Indian Reservation, which are approximately 25 percent of the 24-hour PM_{10} standard and 8 percent of the annual standard. Results show that base year (2002) impacts from the modeled sources are well below the applicable AAQS for both Class I and Class II sensitive receptors.

In addition to implementing the NAAQS, the State of Montana has established a 1-hour standard for NO_2 and SO_2. This ambient standard would apply at all receptors, including both the Class I areas and the near-field receptors in Montana. The Montana NO_2 standard is 0.30 ppm (564 $\mu g/m^3$), not to be exceeded more than once in a 12-month period, and the SO_2 standard is 0.50 ppm (1,300 $\mu g/m^3$), not to be exceeded more than 18 times in any 12-month period. Based on the base year (2002) modeling results for this study and using NO_x emissions from all sources, the maximum impacts for any of the Montana receptors for NO_x was 650 $\mu g/m^3$. However, with the standard adjustment for conversion of NO_x to NO_2 (0.75), the maximum hourly impact for all Montana receptors was determined to be 488 $\mu g/m^3$, which is notably less than the State standard. Modeled 1-hour impacts of SO_2 in Montana were all well below the state 1-hour standard.

4.5 Impacts on Visibility

Under the CAA, visibility has been established as a critical resource for identified Class I areas. The base year (2002) modeled impacts for both the established Class I areas (within the modeling domain) and the identified sensitive Class II areas are provided in **Table 4-3**. Under guidance of the FLAG, the impacts were evaluated using the CALPUFF modeling system and the Method 6 approach, which uses monthly relative humidity values for representative receptors. (For more detail refer to the technical support document [ENSR 2005b]).

Visibility impacts are based on the highest 24-hour reduction in calculated extinction at the indicated source. Impacts are based on a presumed pristine background, and calculated as a percent increase in extinction (reduced visibility) from that background value. A significance threshold of a 10 percent impact has been used to determine significance to evaluate the combined impact of all modeled sources.

The data in **Table 4-3** show that the maximum modeled impact on visibility occurs at the Northern Cheyenne Indian Reservation, which, although a Class I area, is not a mandatory Class I area for visibility. The Northern Cheyenne Indian Reservation is evaluated for visibility impacts under the PSD rules. It is not, however, explicitly protected by the Regional Haze Rule that refers specifically to mandatory federal Class I areas. Otherwise, the maximum modeled impacts are at the Badlands National Park (238 days above 10 percent impact) and the Wind Cave National Park (261 days above 10 percent impact), both in South Dakota. The third-highest modeled impact is at the Theodore Roosevelt National Park in North Dakota, with 98 days' impact above 10 percent. All maximum modeled impacts are to the east, or downwind in the prevailing westerly wind pattern over the PRB.

Modeled impacts on visibility in Class II identified areas also show many locations with total impacts above 10 percent. The major impacts generally are near the PRB study area or located downwind in the prevailing wind direction. For example, Mount Rushmore National Memorial has 248 days above 10 percent impact, Jewel Cave National Monument has 267 days above 10 percent impact, etc. There are no established thresholds for visibility impairment at these locations; however, impacts are provided for comparison to other locations.

4.6 Impacts on Acid Deposition

Emissions of SO_2 and NO_x can lead to increasing acidification of sensitive soils and lakes. Those impacts are evaluated against presumed levels of sensitivity. For western area sources, a comparative deposition value for these compounds is 3 kg/ha-yr for nitrogen compounds and 5 kg/ha-yr for sulfur compounds (Fox et al, 1989). Acid deposition of these compounds was evaluated according to the FLAG guidance, under the CALPUFF model and compared to the significance thresholds identified above.

4.6.1 Acid Deposition

Results of the acid deposition modeling are provided in **Table 4-4** for the indicated Class I areas and identified Class II areas. For each of the listed areas, the impact at the one receptor in each area with the modeled maximum deposition is shown. The model results demonstrate that maximum acid deposition rates are well below any threshold of concern. 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 is higher than sulfur deposition, given the nature of emissions in the PRB study area. Relatively high deposition rates are again noted for the downwind receptors, including the Badlands National Park (0.32 kg/ha-yr) and Wind Cave National Park (0.53 kg/ha-yr). Otherwise, the modeled acid deposition rates are less than 10 percent of the established comparative value.

4.6.2 Impact 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 U.S. Forest Service (USFS) (2000). Lake data were obtained from the USFS web site, which provides data for the 10 percent ANC values for the individual lakes that were evaluated. This threshold is intended to account for sensitive conditions that may occur on an episodic or seasonal basis. Calculations were made using the formulations and steps included in the USFS (2000) screening methodology. Input data include the deposition rates for sulfur and nitrogen compounds (from the CALPUFF model results) the 10 percent ANC level, the watershed area, and the annual precipitation data, which was generated from the annual depiction of precipitation for the State of Wyoming, as prepared by the Spatial Climate Analysis Service at Oregon State University (2005).

The input data are provided in **Table 4-5** for each of the analyzed lakes. The calculated change in percent ANC projected for the sulfur and the nitrogen deposition also is included in the table. The threshold for significance analysis is based on a 10 percent change in ANC for lakes with an ANC value of 25 micro-equivalents per liter (μeq/L) and a 1 μeq/l change for lakes with an ANC value of less than 25 μeq/l. All lakes except Upper Frozen Lake in the Bridger WA have 10 percent ANC value of more than 25 μeq/l. For Upper Frozen Lake, its 10 percent ANC value is 5.0 μeq/l, and the calculated percent change in ANC is less than 1 μeq/l. Results show that no significant impacts are expected for the identified lakes.

4.7 Analysis of Hazardous Air Pollutants

The modeling for this study also addressed HAP impacts from existing sources in 2002. Emissions data for HAPs were developed based on emission factors and other available data. Sources included the Vernal and Glenwood Springs resource management plans for the Roan Plateau for emissions from compressor stations, a recent USEPA (1998) report, and HAP emission factors from USEPA (1995). These sources are understood to provide the most comprehensive emissions data. Emissions were applied to each source based on comparison to design data or as a ratio of emissions to other (criteria) pollutants. The analysis only was conducted for the near-field receptor grid and did not target specific receptors. There was no removal of specific receptors that may have been located very close to the nearby sources; therefore, these receptors may have unrealistic impacts.

Modeling results for short-term (1-hour) HAP emissions for the base year (2002) are provided in **Table 4-6** for the near-field receptor grid and for all sources and source groups that were modeled in the study. Results are provided separately for each state, based on the 1-hour impacts (as an option in the CALPUFF model). Since Wyoming and Montana do not have specified ambient standards for these compounds, for comparison purposes, the results were evaluated in terms of the RELs (USEPA 2005a). **Table 4-6** also provides the RELs for each of the compounds analyzed. The results indicate that the maximum modeled impacts for formaldehyde were slightly above the REL for the Wyoming near-field receptors; however, all other formaldehyde impacts were below the REL for the maximum receptor in Montana. Impacts of other modeled pollutants (n-hexane, benzene, ethyl benzene, toluene, and xylene) were well below the RELs for both states.

4.0 Modeled Base Year Impacts

Modeling results for the annual impacts are provided in **Table 4-7** for the base year. The results were compared to the RfCs as provided by USEPA (2005b). The modeled benzene impacts are below the non-carcinogenic RfCs, and the results of modeling the carcinogenic impacts for benzene show an exposure adjustment greater than 1×10^{-6} for Wyoming receptors. The modeled impacts of the other compounds (n-hexane, formaldehyde, ethyl benzene, toluene, and xylene) were well below the RfCs. Over 99 percent of the contribution to the formaldehyde and benzene impacts are from the oil and gas operations in Wyoming.

Table 4-6
Evaluation of Acute Concentrations of HAPs

Receptor Set	Pollutant	Averaging Period	Rank	Modeled Concentration ($\mu g/m^3$)	RELs ($\mu g/m^3$)
Montana Near-field Receptors	Benzene	1-hour	1st high	2.6	1,300
	Ethyl Benzene	1-hour	1st high	0.78	35,000[1]
	Formaldehyde	1-hour	1st high	25.1	94
	n-Hexane	1-hour	1st high	0.6	39,000[1]
	Toluene	1-hour	1st high	3.2	37,000
	Xylene	1-hour	1st high	3.3	22,000
Wyoming Near-field Receptors	Benzene	1-hour	1st high	52.7	1,300
	Ethyl Benzene	1-hour	1st high	31.2	35,000[1]
	Formaldehyde	1-hour	1st high	150.4	94
	n-Hexane	1-hour	1st high	21.9	39,000[1]
	Toluene	1-hour	1st high	126.5	37,000
	Xylene	1-hour	1st high	129.6	22,000

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