FINAL
AIR QUALITY MODELING REPORT
SNOWMOBILE AND SNOWCOACH EMISSIONS

WINTER USE PLAN
Environmental Impact Statement

YELLOWSTONE and GRAND TETON NATIONAL PARKS and the JOHN D. ROCKEFELLER, JR., MEMORIAL PARKWAY

Prepared for

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1.0 Introduction and Background

In support of the Winter Use Plan Preliminary Draft Environmental Impact Statement (PDEIS) for Yellowstone National Park (Yellowstone), Grand Teton National Park (Grand Teton), and the John D. Rockefeller, Jr. Memorial Parkway (Parkway), Air Resource Specialists, Inc. (ARS) completed an analysis of potential air quality impacts from snowmobile and snowcoach operations. This report analyzes potential air quality impacts for several preliminary alternatives utilizing air dispersion modeling and other accepted methods and models. Oversnow motorized vehicle entry limits and other details for each of the preliminary alternatives were provided by NPS to ARS and are discussed in section 3.0 and Appendix A.

This air quality study is part of the National Park Service's (NPS) efforts to complete a long-term analysis of the environmental impacts of winter use in the parks. Currently, the NPS is operating under the *Temporary Winter Use Plans Environmental Assessment* for Yellowstone and Grand Teton National Parks and the John D. Rockefeller, Jr., Memorial Parkway (hereinafter, the temporary plan). Based on this EA, the National Park Service published the temporary plan in the *Federal Register* implementing winter use rules on November 10, 2004. These rules are in effect through the winter of 2006-07.

The temporary plan currently allows 720 snowmobiles per day in Yellowstone, all commercially guided. In Grand Teton and the Parkway, 140 snowmobiles are allowed per day. Within Yellowstone, all snowmobiles must also meet Best Available Technology (BAT) requirements. Guides are not necessary in Grand Teton, but most machines there must also meet BAT requirements. The temporary plan is in effect for an interim period of three winters, allowing snowmobile and snowcoach use through the winter of 2006-2007. The assessment of preliminary alternatives analyzed in this study is based on implementation of the associated entry limits and BAT requirements under consideration in the PDEIS, and beginning during the winter season of 2007-2008, which determines emissions factors.

For this air quality study of oversnow motorized vehicle emissions in Yellowstone, Grand Teton, and the Parkway, maximum predicted ambient concentrations of carbon monoxide (CO) and particulate matter (PM_{10} and $PM_{2.5}$) were calculated using U.S. Environmental Protection Agency (EPA) approved air quality models. Impacts for each preliminary alternative were assessed with respect to the National Ambient Air Quality Standards (NAAQS) and relative to current and historical conditions. Modeling results were also compared to Prevention of Significant Deterioration (PSD) increments for particulate matter, and potential visibility impacts for each preliminary alternative were assessed. Winter-season emission estimates for criteria pollutants (CO, $PM_{,}$ and nitrogen oxides (NO_x)), hydrocarbons (HC), and hazardous air pollutants (HAPs) (benzene, 1,3 butadiene, formaldehyde, and acetaldehyde) were calculated. The methodology employed for this study is discussed in the following sections and is also detailed in the Modeling Study Plan, which is included as Appendix K.

2.0 Regulatory Overview

Yellowstone and Grand Teton are classified as Class I areas under the Federal Clean Air Act. This air quality classification is to provide protection against air quality degradation in national parks and wilderness areas. The Clean Air Act defines mandatory Class I areas as national parks over 6,000 acres, wilderness areas over 5,000 acres, and national memorial parks over 5,000 acres designated as of the date of the Act. The Parkway is a Class II area but is managed as a Class I area according to NPS policy.

For this study, dispersion modeling was utilized to predict concentrations of CO and particulates (PM_{10} and $PM_{2.5}$) for a short-term localized basis at specific locations in the parks. These predicted concentrations were assessed with respect to the NAAQS, which are discussed below, to determine the potential for air quality impacts. In addition, an emission inventory was completed for the four (4) pollutants discussed below to assess regional motorized oversnow vehicle emissions during the winter season. Also, as a Class I area, an analysis of potential visibility impacts resulting from oversnow vehicle emissions was conducted for four (4) areas. The methodology and results of this visibility analysis are presented in Section 8.0.

In 2002, EPA adopted new standards for new non-road engines, including snowmobiles, which were previously unregulated. As a significant source of air pollution, newly manufactured non-road engines will need to meet exhaust emission standards. For snowmobiles, the new HC and CO standards began to take effect for the 2006 model year, with a 50 percent phase-in requirement. Further details on these standards are provided below in Section 4.0.

2.1 Pollutants

Carbon monoxide (CO), a colorless, odorless, and poisonous gas, is produced in locations with motor vehicles, primarily by the incomplete combustion of gasoline and other fossil fuels. Health effects include impairment of the central nervous system, particularly on people with heart disease. CO also interferes with the transport of oxygen in the blood. In the vicinity of roadways, the majority, if not all, CO emissions are from motor vehicles. CO concentrations can vary greatly over relatively short distances. Elevated concentrations are usually limited to locations near crowded intersections, typically along heavily traveled and congested roadways.

Consequently, CO concentrations must be predicted on a localized or microscale basis. Elevated traffic volumes of snowmobiles and snowcoaches on certain park roadways could result in localized increases in CO levels. Therefore, the mobile source analysis evaluated CO concentrations from snowmobiles and snowcoaches at several modeling locations within the parks.

Particulate matter (PM_{10} and $PM_{2.5}$) is emitted into the atmosphere from a variety of sources: industrial facilities, power plants, construction activity, etc. Gasoline powered vehicles typically do not produce any significant quantities of particulate emissions; however, 2-stroke snowmobiles emit substantially more particulates than either 4-stroke snowmobiles or snowcoaches. Although less relevant to this study, diesel-powered vehicles, especially heavy trucks and buses, also emit particulates, and particulate concentrations may be locally elevated near roadways with high volumes of heavy diesel-powered vehicles. The mobile source analysis evaluated particulate (PM_{10} and $PM_{2.5}$) concentrations from snowmobiles, snowcoaches, and diesel buses (for one alternative) at several modeling locations within the parks.

Hydrocarbon (HC) emissions from motor vehicles can result from partially-burned fuel emitted through the tailpipe and from fuel evaporations from the crankcase, carburetor and gas tank. Hydrocarbons are also released from gasoline fuel vapor when vehicles are re-fueled at gas stations and when bulk storage tanks are refilled. When exposed to sunlight, hydrocarbons or volatile organic compounds (VOCs) contribute to formation of harmful ground level ozone, also known as smog. For the purposes of this study, hydrocarbons may also be expressed as VOCs, which include air toxins or hazardous air pollutants (HAPs). Within the parks, these pollutants are of primary concern due to their potential serious health effects on NPS workers and visitors.

Air toxins or HAPs associated with motor vehicles also result from fuel evaporation and the fuel-burning process. These pollutants include a variety of chemicals known to cause cancer, poisoning and other ailments. The emission inventory completed for this study included hydrocarbon emissions as well as the following HAPs: benzene; 1,3 butadiene; formaldehyde; and acetaldehyde.

Nitrogen oxides (NO_x), are typically of principal concern because of their role as precursors in the formation of photochemical oxidants, such as ozone. Ozone is formed through a series of reactions that take place in the atmosphere in the presence of sunlight. However, ozone is not an issue in the parks in the winter, although NO_x also contributes to atmospheric particles, and can cause respiratory problems and visibility impairment. NO_x emissions from mobile sources and the pollutants formed from NO_x can be transported over long distances, so they are generally examined on a regional basis and are assessed in the emission inventory component of this study. With respect to NO_x on a localized basis, since the sources of concern are only present during the winter season, an applicable annual average cannot be predicted using modeling, for comparison to the NAAQS.

2.2 Air Quality Standards

As required by the Clean Air Act and its amendments, the Environmental Protection Agency has established primary and secondary National Ambient Air Quality

Standards (NAAQS) for six major air pollutants: CO, NO_2, ozone, particulate matter (PM_{10} and $PM_{2.5}$), SO_2, and lead. The NAAQS of primary concern for this analysis (CO, PM_{10} and $PM_{2.5}$) are shown in Table 2-1.

Table 2-1
National Ambient Air Quality Standards

Pollutant	**Primary**		**Secondary**	
	PPM	**Micrograms Per Cubic Meter**	**PPM**	**Micrograms Per Cubic Meter**
Carbon Monoxide (CO)				
Maximum 8-Hour Concentration[1]	9		None	
Maximum 1-Hour Concentration[1]	35			
Respirable Particulates (PM_{10})				
Annual Arithmetic Mean[2]		50	Same as Primary	
Maximum 24-Hour Concentration[1]		150		
Respirable Particulates ($PM_{2.5}$)				
Annual Arithmetic Mean[3]		15	Same as Primary	
Maximum 24-Hour Concentration[4]		65		

Notes:
[1] Not to be exceeded more than once per year.
[2] To attain this standard, the 3-year average of the weighted annual mean PM_{10} concentration at each monitor within an area must not exceed 50 ug/m^3.
[3] To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 ug/m^3.
[4] To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 65 ug/m^3.
PPM = parts per million

Source: 40 CFR Part 50—National Primary and Secondary Ambient Air Quality Standards

The primary standards protect public health, and represent levels at which there are no known significant effects on human health. The secondary standards are intended to protect the nation's welfare, and account for air pollutant effects on soil, water, visibility, materials, vegetation, and other aspects of the environment. For CO, PM_{10} and $PM_{2.5}$, the primary and secondary standards are the same.

Impacts for each preliminary alternative were assessed with respect to the NAAQS and relative to current and historical conditions. For Wyoming, Montana, and Idaho, the applicable state standards for CO and particulates are the same as the federal standards, with the exception of the 1-hour CO standard in Montana, which is 23 ppm.

Since Yellowstone and Grand Teton are classified as Federal Class I areas, PM_{10} increment comparison under PSD were also assessed. PSD increments are the maximum permitted increases in pollutant concentrations over baseline levels. For Class I areas, the PM_{10} PSD increments are 4 and 8 micrograms per cubic meter, for the annual and 24-

hour averaging periods, respectively. Winter oversnow vehicle emissions were considered increment consuming or contributing sources for this analysis. This study only assessed PSD increments for the 24-hour averaging period, since the sources of concern are only present during the winter season and an applicable annual average cannot be prepared. This assessment is a screening level approach and may indicate that a detailed analysis is required if concentrations are near the PM_{10} PSD increments. Furthermore, as the methodology employed in this study is a screening-level analysis, it is not intended for regulatory purposes and does not constitute a regulatory PSD increment consumption analysis.

2.3 Air Quality Monitoring

In recent years, ARS has been contracted by NPS to conduct winter air quality monitoring in Yellowstone near the Old Faithful geyser. Meteorological, gaseous, and particulate variables were monitored continuously. The Montana Department of Environmental Quality (DEQ) also collects meteorological, gaseous, and particulate data at a monitoring station at the West Entrance to Yellowstone.

The most recent monitored CO and $PM_{2.5}$ concentrations at these locations can be found in the *Data Transmittal Report for the Yellowstone National Park Winter Use Air Quality Study December 1, 2004 - March 15, 2005*, Air Resource Specialists, August 2005. At the West Entrance monitor, the highest CO 1- and 8-hour averages in 2004-2005 were 2.8 and 1.0 ppm, respectively. The highest CO 1- and 8-hour averages were 1.7 and 0.8 ppm, respectively, at the Old Faithful monitor for 2004-2005. These were well below the respective 1- and 8-hour CO NAAQS (35 and 9 ppm), Montana and Wyoming air quality standards. Similarly, the highest $PM_{2.5}$ 24-hour average in 2004-2005 was 6.0 micrograms per cubic meter at the Old Faithful monitor and 9.5 micrograms per cubic meter at the West Entrance monitor, which were well below the $PM_{2.5}$ NAAQS of 65 micrograms per cubic meter for the 24-hour averaging period.

Since monitoring began in 1998 for CO and in 2002 for $PM_{2.5}$ at Yellowstone, measured pollutant concentrations have steadily decreased, consistent with the decrease in number of snowmobile visits and the recent snowmobile technology emission requirements under the temporary plan. As documented in the *Winter Air Quality Study 2004-2005*, John D. Ray, Ph.D., NPS Air Resources Division, December 2005, at the West Entrance, the highest measured 8-hour average CO concentrations have gone from a near NAAQS exceedance of 8.9 ppm in the 1998-1999 winter season to 1.0 ppm in 2004-2005. At Old Faithful, the highest measured 8-hour average CO concentrations have declined from 1.2 ppm in the 2002-2003 winter season to 0.6 ppm in 2004-2005.

Similarly, the highest measured 24-hour average $PM_{2.5}$ concentrations at the West Entrance have declined from 18.6 micrograms per cubic meter in the 2002-2003 winter season to 6.0 micrograms per cubic meter in 2004-2005. At Old Faithful the highest measured 24-hour average $PM_{2.5}$ concentrations have declined from 32.1 micrograms per cubic meter in the 2002-2003 winter season to 4.0 micrograms per cubic meter in 2004-2005. These monitored maximum values demonstrate a distinct trend of improvement in winter pollutant concentrations in Yellowstone. A summary of all monitored data discussed above can be found in the above referenced NPS report.

Modeling results from this study will also be compared with the monitoring data collected at the West Entrance and Old Faithful sites for historical conditions (1999, with 1983 Regulations) and current conditions scenarios.

3.0 Preliminary Alternatives

Oversnow motorized vehicle entry limits and other details of the preliminary alternatives required as inputs for the air quality modeling and emission inventory were provided by the National Park Service (NPS). Descriptions of the six (6) preliminary alternatives are provided in Table 3-1, and the four (4) options for Preliminary Alterative 1 are shown in Table 3-2. (It should be noted that although snowmobile entry limits for Cave Falls Road are provided for the preliminary alternatives, this short roadway segment, approximately only a mile in length within Yellowstone, is used by only a small number of snowmobiles and would be an insignificant contributor to overall park-wide emissions. Therefore, it was not included in the emissions inventory.) In addition, *The Motorized Oversnow Vehicle Scenarios* document and distribution factors spreadsheets are included as Appendix A of this report, and NPS's Alternatives Discussion document is included as Appendix J. Although the methods used to develop the new scenarios and general assumptions are discussed in detail in the appendix, a summary of the development of modeling scenarios analyzed in this study follows.

The development of a model to distribute use within the parks, based on the entrance limits specified under each preliminary alternative, is necessary in order to understand the impacts of the alternatives on park resources and values. These models, called travel factors, were developed in the past for the Temporary Winter Use EA, the SEIS, and the EIS. The scenarios attempt to predict the total amount of daily winter recreational (motorized) traffic on each road segment within Yellowstone and Grand Teton National Parks, by vehicle type.

The scenarios provide both a sense of how much snowmobile or snowcoach traffic one can expect in a day on each road segment within the parks and a comparison of the relative differences among the preliminary alternatives. This approach facilitates an understanding of the magnitude of differences of the environmental consequences of each preliminary alternative. The preliminary alternatives also provide fundamental air quality inputs to the modeling analyses.

For the development of the new long-term EIS, the travel scenarios were updated from those used for the Temporary EA for two major reasons. First, park managers and partners recognized that commercially guided trips may have different visitation patterns than unguided groups. Thus, there could be differences in the travel and visitation patterns for guided vs. unguided (or non-commercially guided) groups. The updated modeling data and travel factor spreadsheets account for differences in the travel characteristics of snowmobiles based on whether commercial guides are required for each particular alternative.

Table 3-1
Summary of Preliminary Alternatives

	Alternative 1: Current Plan	Alternative 2: Snowcoaches Only	Alternative 3: Eliminate Most Road Grooming	Alternative 4: Enhanced Recreational Use	Alternative 5: Provide for Unguided Access	Alternative 6: Mixed Use
Highlights	Allows for nearly historic levels of snowmobile use but requires commercial guides. This Alternative mimics the temporary winter use plan currently in place, with three primary changes: 1) Snowcoaches must meet BAT standards; 2) Daily limit on snowcoaches; and 3) Sylvan Pass is closed to through travel under 3 of 4 options for this Alternative (see Table 3-2).	Emphasizes snowcoach access; prohibits recreational snowmobiling. Road grooming would continue.	Prohibits road grooming or packing on most road segments in Yellowstone National Park. The road from the South Entrance to Old Faithful would be the only oversnow motorized access route Yellowstone.	Allows for increased snowmobile use, relative to historic numbers. Commercial guides would be required for most snowmobilers; some could also visit the park after completing a non-commercial or unguided guide training course.	Balances snowmobile and snowcoach access and accommodates some visitors who wish to have an unguided snowmobile experience. Features a seasonal limit as well as a flexible daily limit	Emphasizes plowing Yellowstone's lower elevation, west-side roads to allowed wheeled commercial vehicle access. Continue to allow oversnow vehicle access through the South Entrance and on the east side of the park.
Daily Snowmobile Limits in YNP	720 snowmobiles per day West: 400 South: 220 North: 30 East: 40 Old Faithful: 30 Cave Falls Road: 50 snowmobiles (no BAT or guiding)	Snowmobiles prohibited. Cave Falls Road closed to snowmobiles	South: 250 snowmobiles per day. Cave Falls Road closed to snowmobiles	1,025 snowmobiles per day West: 600 South: 250 North: 25 East: 100 Old Faithful: 50 Cave Falls Road: 75 snowmobiles (no BAT or guiding)	540 snowmobiles per day West: 290 South: 145 East: 40 North: 40 Old Faithful: 25 Cave Falls Road: 50 snowmobiles (no BAT or guiding) Seasonal entry limit would be put in place: no more than 27,540 snowmobiles and 5,291 snowcoaches per season in YNP. Daily commercial snowmobile and snowcoach entries could exceed above limits by 20% on busy days (up to 518 commercial snowmobiles and 100 snowcoaches) per day, but such entries would count against seasonal limit above.	350 snowmobiles per day South: 250 Old Faithful/Norris: 100 100 wheeled vehicles Cave Falls Road: 50 snowmobiles (no BAT or guiding)

Notes:
BAT = Best Available Technology; CDST = Continental Divide Snowmobile Trail; YNP = Yellowstone National Park;
GTNP = Grand Teton National Park; Targhee NF = Targhee National Forest
Refer to Appendix J, Alternatives Discussion for details on snowmobile and snowcoach limits and technology, guiding requirements, side roads, etc.

Table 3-1
Summary of Preliminary Alternatives

	Alternative 1: Current Plan	Alternative 2: Snowcoaches Only	Alternative 3: Eliminate Most Road Grooming	Alternative 4: Enhanced Recreational Use	Alternative 5: Provide for Unguided Access	Alternative 6: Mixed Use
Daily Snowmobile Limits in GTNP and Parkway	140 snowmobiles per day Grassy Lake Rd: 50 CDST: 50 Jackson Lake: 40	Snowmobiles prohibited	Grassy Lake Rd: 50 CDST: Closed Jackson Lake: Closed	250 snowmobiles per day. Grassy Lake Rd: 75 CDST: 75 Jackson Lake: 100	140 snowmobiles per day Grassy Lake Rd: 50 CDST: 50 Jackson Lake: 40 All would be improved BAT.	90 snowmobiles per day. Grassy Lake Road: 50 Jackson Lake: 40 CDST: Closed.
Snowmobile Guide Requirements	YNP: 100% Commercially guided. GTNP and Parkway: Guides not required.	N/A	YNP: 100% Commercially guided. GTNP and Parkway: Guides not required.	YNP: 75% commercially guided; 25% either unguided or non-commercially guided. GTNP and Parkway: CDST: 50 commercially guided; 25 unguided. Jackson Lake and Grassy Lake Road: unguided	YNP: 80% commercially guided 20% unguided, with brief training. Unguided snowmobiles would be required to enter YNP prior to 10:30AM. GTNP and Parkway: Commercial guides may be allowed, but not required.	YNP: 100% commercially guided, both oversnow and wheeled vehicles. GTNP and Parkway: Commercial guides may be allowed, but not required.
Best Available Technology Requirements for Snowmobiles	YNP: All BAT. GTNP and Parkway: All BAT, except snowmobiles originating on Targhee NF using Grassy Lake Road.	N/A	YNP: All BAT. GTNP and Parkway: All BAT, except snowmobiles originating on Targhee NF using Grassy Lake Road.	YNP: all BAT. GTNP and Parkway: Jackson Lake: All BAT. Grassy Lake Road: All Non-BAT. CDST: 50 commercially guided BAT; 25 unguided 2006 model year or newer.	Improved BAT for snowmobiles (95% reduction in HC and 75% reduction in CO; NTE 72dBA), except snowmobiles originating on Targhee NF using Grassy Lake Road.	YNP: All BAT. GTNP and Parkway: All BAT, except snowmobiles originating on Targhee NF using Grassy Lake Road.
Maximum Snowmobile Group Size	8 with one guide; 17 with 2 guides	N/A	11 with one guide.	11 with one guide	11 with one guide	8 with one guide; 17 with 2 guides

Notes:
BAT = Best Available Technology; CDST = Continental Divide Snowmobile Trail; YNP = Yellowstone National Park;
GTNP = Grand Teton National Park; Targhee NF = Targhee National Forest
Refer to Appendix J, Alternatives Discussion for details on snowmobile and snowcoach limits and technology, guiding requirements, side roads, etc.

Table 3-1
Summary of Preliminary Alternatives

	Alternative 1: Current Plan	Alternative 2: Snowcoaches Only	Alternative 3: Eliminate Most Road Grooming	Alternative 4: Enhanced Recreational Use	Alternative 5: Provide for Unguided Access	Alternative 6: Mixed Use
Use of YNP Side Roads by Snowmobiles	Washburn Overlook and Freight Road: snowcoach only. Firehole Canyon Drive, Canyon North Rim Drive and Riverside Drive: open in afternoon to snowmobiles. Lake Butte and Canyon South Rim: open to snowmobiles. Virginia Cascades: ski only.	Virginia Cascades: ski only. All other side roads: snowcoach only	All closed (there are none on the road from South Entrance to Old Faithful).	All side roads open to snowmobiles. Virginia Cascades: ski only.	Washburn Overlook and Freight Road: snowcoach only. Firehole Canyon Drive, Canyon North Rim Drive and Riverside Drive open in afternoon to snowmobiles. Lake Butte and Canyon South Rim open to snowmobiles. Virginia Cascades ski only.	Canyon North and South Rim Drives, Lake Butte: Open to snowmobiles. Firehole Canyon, Riverside Drive, Fountain Freight Road, Washburn Hot Springs: Snowcoach only. Virginia Cascades: ski only.
Daily Snowcoach Limits in YNP and Snowcoach BAT	78 snowcoaches per day West: 34 South: 13 North: 13 East: 0 Old Faithful /Parkwide: 18 All meet snowcoach BAT	120 snowcoaches per day West: 55 South: 25 North: 17 East: 0 Old Faithful /Parkwide: 23 All meet snowcoach BAT	South: 20 All meet snowcoach BAT	115 snowcoaches per day West: 46 South: 15 North: 5 East: 4 Old Faithful /Parkwide: 35 Private: 10 All meet snowcoach BAT	83 snowcoaches per day West: 34 South: 10 North: 3 East: 2 Old Faithful /Parkwide: 34 All meet snowcoach BAT. Seasonal entry limit would be put in place.	40 snowcoaches per day South: 10 Old Faithful/Norris: 30 All meet snowcoach BAT.
Road Grooming	Continue road grooming, except Sylvan Pass would be closed.	Continue road grooming, except Sylvan Pass would be closed.	Only groom South to Old Faithful. All other segments ungroomed and closed to oversnow travel.	Continue road grooming	Continue road grooming	Plow Mammoth to West to Old Faithful. Groom Old Faithful to South to Lake to Canyon to Norris. Sylvan Pass would be closed.

Notes:
BAT = Best Available Technology; CDST = Continental Divide Snowmobile Trail; YNP = Yellowstone National Park;
GTNP = Grand Teton National Park; Targhee NF = Targhee National Forest
Refer to Appendix J, Alternatives Discussion for details on snowmobile and snowcoach limits and technology, guiding requirements, side roads, etc.

Table 3-2
Preliminary Alternative 1 Options

Option	Option A		Option B		Option D		Option E	
Description	**With East Entrance Open**		**With East Entrance Closed**		**With East Entrance Closed and Overall Snowmobile Numbers Reduced by 40 Entries**		**With Gibbon Canyon and East Entrance Closed and Overall Snowmobile Numbers Reduced by 40 Entries**	
Entrance	**Commercially Guided Snowmobiles**	**Commercially Guided Snowcoaches**	**Commercially Guided Snowmobiles**	**Commercially Guided Snowcoaches**	**Commercially Guided Snowmobiles**	**Commercially Guided Snowcoaches**	**Commercially Guided Snowmobiles**	**Commercially Guided Snowcoaches**
West Entrance	400	34	424	34	400	34	400	34
South Entrance	220	10	256	13	220	13	220	13
East Entrance	40	3	0	0	0	0	0	0
North Entrance	30	13	20	13	30	13	30	13
Old Faithful	30	18 (Parkwide)	20	18 (Parkwide)	30	18 (Parkwide)	30	18 (Parkwide)
Total	720	78	720	78	680	78	680	78

Second, the earlier modeling scenarios only included in-bound traffic within Yellowstone and did not include traffic exiting the park (i.e., return trips were not "counted" by the previous modeling as traveling on road segments a second time). Since this potentially excluded a substantial amount of traffic, this was corrected in the update and the latest travel factor spreadsheets include both in-bound and out-bound trips for all alternatives.

In addition to the six (6) preliminary alternatives analyzed in this report, two (2) additional modeling scenarios were also analyzed for comparison. These are the Current Conditions and the 1999 Historical Unregulated Conditions Scenarios. Details on these modeling scenarios are provided in Appendix A.

4.0 Mobile Source Modeling

Estimates of maximum concentrations for pollutant averaging periods were prepared to compare with the national ambient air quality standards (which are based on 1- and 8-hour averages for CO concentrations and 24-hour averages for particulate concentrations). The prediction of CO, PM_{10} and $PM_{2.5}$ concentrations generated by over-snow vehicles takes into account emissions data, meteorological phenomena, vehicle traffic/travel conditions, and physical configurations (of roadways and staging areas). The mathematical formulations that comprise the dispersion and emission models attempt to simulate the extremely complex physical phenomenon as closely as possible. Although most dispersion models are typically conservative, especially under adverse meteorological conditions, the results of the modeling below compared with monitored concentrations show predicted concentrations within the reasonable in range of possibility, considering that all models must employ approximations of actual conditions.

The analysis employs a modeling approach widely used for evaluating air quality impacts throughout the country. This approach was coupled with a series of conservative assumptions for meteorology, traffic conditions, background concentration levels, etc. This combination results in conservative, yet realistic, estimates of expected pollutant concentrations and resulting potential impacts to air quality from the winter use vehicle emissions.

4.1 Dispersion Modeling

Air dispersion modeling analyses were conducted for emissions of CO, PM_{10}, and $PM_{2.5}$ employing EPA's CAL3QHC and Industrial Source Complex Short Term (ISCST3) models. The models and modeling inputs, parameters, and assumptions, along with emission factors are discussed in detail below.

4.1.1 CAL3QHC

At the entrance stations and roadways selected for study, analysis was performed using EPA's CAL3QHC model (*User's Guide to CAL3QHC, A Modeling Methodology for Predicting Pollutant Concentrations Near Roadway Intersections,* Office of Air Quality, Planning Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina). The CAL3QHC model is based on the CALINE-3 line source dispersion model, with an additional algorithm for estimating vehicle queue lengths at signalized intersections. It is a Gaussian model utilized for predicting CO and PM concentrations along roadway segments and assumes the dispersion of pollutants downwind of a pollution source along a Gaussian (or normal) distribution. The pollution source is the emissions from motorized vehicles operating under free flow conditions.

CAL3QHC provides the refinement of including the contribution of emissions from idling vehicles in the overall concentration. The model's queuing algorithm requires additional input for local traffic parameters, such as signal timing, and performs delay calculations to estimate the number of idling vehicles. In this study, locations with snowmobiles and snowcoaches stopping and idling were simulated with the characteristics of a signalized intersection for CAL3QHC modeling.

4.1.2 ISCST3

Air pollutant concentrations from emissions at the snowmobile staging areas were evaluated with the Industrial Source Complex, Short Term dispersion model, Version 3 (ISCST3), developed by EPA and described in the *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models* (EPA-454/B-95-003a). Since vehicles in staging areas are clustered (in the parking lots), the ISC3 model was selected, utilizing its area source dispersion modeling capabilities. All ISCST3 technical options selected followed the *regulatory default option*, and included:

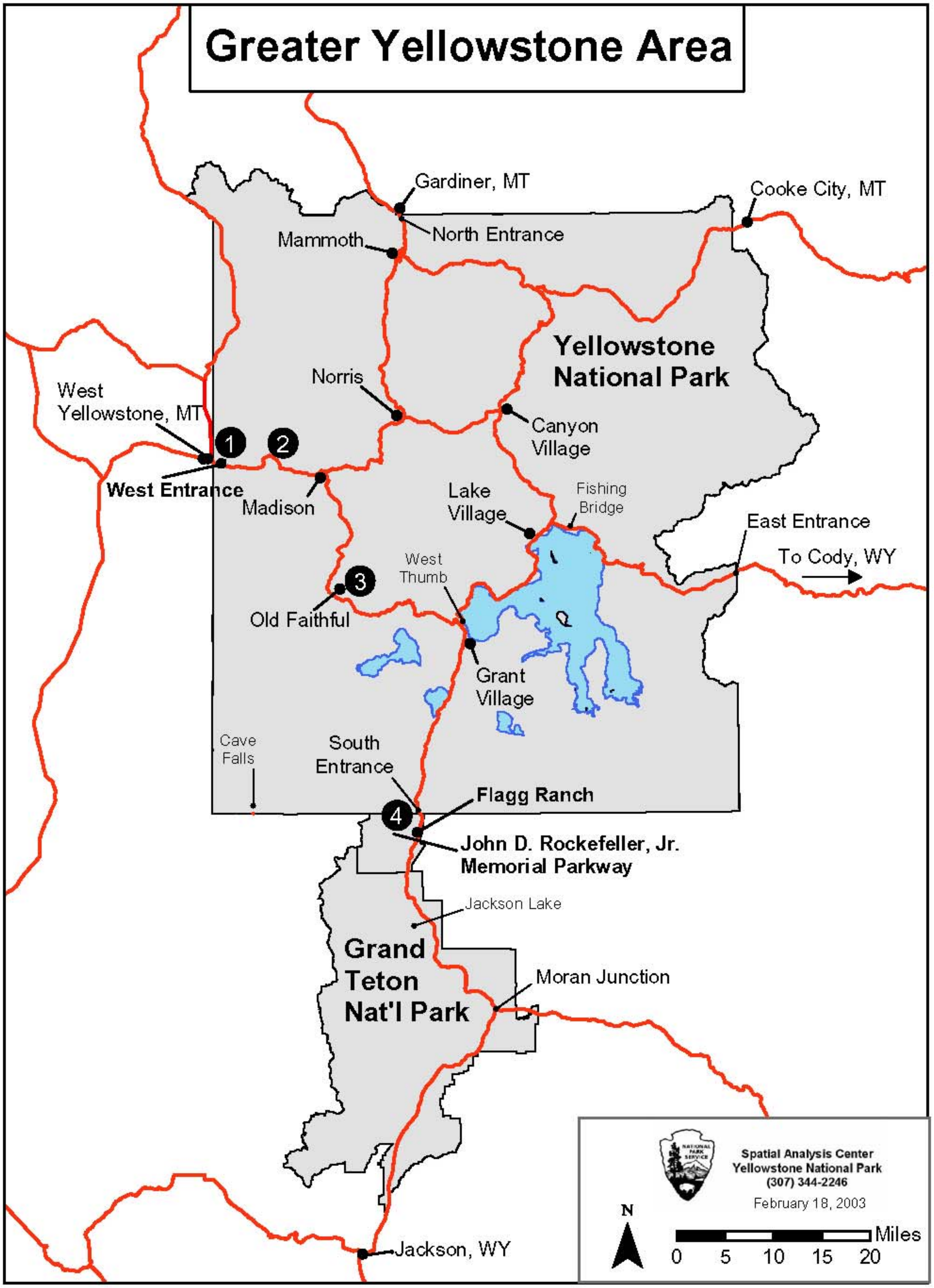
- Buoyancy-induced dispersion
- Final plume rise
- Calms processing
- Default wind speed profile exponents and vertical temperature gradient

Model inputs also specified rural conditions for dispersion coefficients and other variables. Due to the geography of the area, as with prior modeling analyses performed in Yellowstone, terrain data were not used. It was assumed that elevation differences at the staging areas and surrounding areas would not result in any significant impact. As such, the terrain option was omitted.

4.2 Modeling Locations

Four (4) locations in the parks were selected for air quality modeling because they were expected to generate the most elevated ambient air quality impacts associated with snowmobile and snowcoach operations, due to expected vehicle traffic levels. These locations (shown on Figure 4-1) are: Site 1, The West Entrance; Site 2, West Entrance to Madison Junction; Site 3, Old Faithful Staging Area; and Site 4, Flagg Ranch Staging Area (in the Parkway). At the roadway modeling locations, multiple receptors (computer simulations of roadside locations) were modeled for CAL3QHC along the approach and departure links at spaced intervals, outside of the mixing zone, the area of uniform emissions and turbulence. Ground-level receptors were set at a default height of 6 feet. The receptor with the highest predicted concentration was used to represent each modeling site for each preliminary alternative or scenario.

Figure 4-1



Greater Yellowstone Area
Gardiner, MT
Cooke City, MT
Mammoth
North Entrance
Yellowstone National Park
West Yellowstone, MT
Norris
Canyon Village
1
2
West Entrance
Madison
Lake Village
Fishing Bridge
East Entrance
To Cody, WY
West Thumb
3
Old Faithful
Grant Village
Cave Falls
South Entrance
Flagg Ranch
4
John D. Rockefeller, Jr. Memorial Parkway
Jackson Lake
Grand Teton Nat'l Park
Moran Junction
Spatial Analysis Center
Yellowstone National Park
(307) 344-2246
February 18, 2003
N
Miles
0 5 10 15 20
Jackson, WY

Site 1: West Entrance

The West Entrance is a unique location for modeling as snowmobiles and snowcoaches approach the entrance station and then stop for a short time while entrance permits are checked. Vehicles experience delay and queuing traffic conditions. In addition, this location is in close proximity to West Yellowstone, MT. Modeling was performed based on an average approach and departure speed of 15 miles per hour (mph) and an average engine idle time of 30 seconds at each kiosk. The approach and departure paths of the vehicles were simulated by line sources or "links", up to 1,000 feet in each direction from the West Entrance. CAL3QHC modeling was performed for this intersection-type location.

At the West Entrance modeling location, receptors were spaced oppositely in each direction out from a central receptor placed at the origin of the queuing links, with receptors placed in pairs on each side of the links. Receptors were placed 3 feet both east and west (lengthwise) of the central receptor; the next pair of receptors were placed 25 feet from the central receptor. The remaining receptors were placed at intervals of 25 feet out to a distance of 500 feet along the link.

Site 2: West Entrance to Madison

For many of the preliminary alternatives, this modeling location is expected to have the highest traffic volumes compared to other roadway segments in Yellowstone, Grand Teton, and the Parkway. This is expected to result in elevated emissions and associated impacts from snowmobile and snowcoach traffic. CAL3QHC modeling was performed for the free-flow roadway segments of this location, employing emissions data for snowmobiles traveling at 35 to 45 mph (see discussion of modes below). In winter, the speed limit for this road segment is 35 mph, whereas the limit is 45 mph for most of the park. As discussed above, vehicle traffic levels were based on the proposed entry limits in the winter use plan for each preliminary alternative.

For the West Entrance to Madison location, receptors were spaced along 2000 feet of the straight portions of the links. For the middle section of this modeling location, a gradual curve in the roadway geometry could result in potential overlapping emission contributions from roadway link segments at some modeling wind directions. Therefore, along these links, receptors were placed in pairs at intervals of 5, 25, 25, 50, 200, 200, 1500, and 1500 feet in both directions from the central receptors at the apex of the curve. As at the West Entrance, receptors were placed in pairs on each side of the links.

Site 3: Old Faithful Staging Area and Site 4: Flagg Ranch Staging Area

The Old Faithful and Flagg Ranch staging areas were selected for modeling because of the concentration of emissions from snowmobiles and snowcoaches bringing visitors to the Old Faithful Geyser Basin and parking area, and Flagg Ranch (in the Parkway). The primary contributor of emissions is the idling of engines after visitors enter and also prior to leaving these staging areas.

At the staging areas, emissions are clustered in distinct areas (the parking lots). Therefore, the ISC3 model was selected for area source modeling. Emissions at the staging area were calculated only for engine idling, which is assumed to be a total of five minutes on average for each vehicle, including during arrival and before departure. Engine emission calculations for the staging area did not explicitly include ingress and egress emissions from the vehicles, as these were included in the roadway segment emissions. It was conservatively assumed that all vehicles traveling from Madison and West Thumb to Old Faithful would enter the Old Faithful staging area and that all vehicles traveling to Yellowstone's South Entrance would enter the Flagg Ranch staging area, to maximize the number of vehicles included in the modeling for these sites.

The Old Faithful staging area, including the three (3) main parking areas, was modeled as a 630 meter by 1037 meter rectangular area source for ISC3 modeling, aligned north-south. The Flagg Ranch staging area, with two (2) parking areas, was modeled as a 60 meter by 165 meter rectangular area source for ISC3 modeling, also aligned north-south. These dimensions were confirmed by Yellowstone staff.

At the staging areas, a grid network of receptors was modeled for ISC3 along the perimeters of the area sources representing idling vehicles. Receptors were arranged in rectangular grids surrounding the Old Faithful and Flagg Ranch staging areas. At Old Faithful, receptors were placed at 100 meter intervals around the perimeter of the staging area out to approximately 1.5 kilometers in both the east and west directions, and out to approximately 2.0 kilometers in both the north and south directions. At Flagg Ranch, receptors were placed at 25-meter intervals around the perimeter of the staging area out to approximately 250 meters from the perimeter; at 50-meter intervals from the 250 meter boundary out to approximately 1.0 kilometer; at 100 meter intervals from the 1.0 kilometer boundary out to approximately 2.0 kilometers. Receptors were set at a default height of 6 feet.

4.3 Vehicle Emissions Data

To predict ambient concentrations of pollutants generated by vehicular traffic, emissions from vehicle exhaust systems must be estimated accurately. This analysis focuses primarily on emissions associated with visitor use of snowmobiles and snowcoaches and does not address other snowmobile use or other modes of vehicle travel within the park. However, Preliminary Alternative 6 would provide guided visitor access by on-road vehicles, by plowing Yellowstone's west-side roadways. Administrative vehicles are not included in any of the modeling. In general, the alternatives to be analyzed include only visitor snowmobile and snowcoach travel.

Emissions data and vehicle usage data (discussed below) were used for atmospheric dispersion modeling analyses to calculate the ambient levels of CO, PM_{10}, and $PM_{2.5}$ at four (4) locations within the parks, for the preliminary alternatives. Emissions data will also be utilized to predict the total winter-season emissions of CO, PM, NO_x, HC, and HAPs due to the operations of snowmobiles and snowcoaches in the park. The data to be employed for this analysis were obtained from past air quality and emissions testing, research studies, as well as from vehicle manufacturers. Snowmobile laboratory test data utilized below may not reflect actual operating conditions in

Yellowstone, Grand Teton, and the Parkway, as high altitude and low winter temperatures in the parks are likely to decrease overall snowmobile engine performance and increase relative emissions. However, this data is the best available.

For the 1999 Historical Conditions Scenario (1983 Regulations), the air quality analysis assumed that all snowmobiles were 2-stroke engines (see the next paragraph for a discussion of EPA 2-stroke emissions regulations). Therefore, for this modeling scenario, the analysis assumed no snowmobile BAT requirements, replicating historic, unregulated conditions. For most preliminary alternatives, the analysis assumed that all snowmobiles are 4-stroke engines meeting NPS Best Available Technology (BAT) requirements (or better, in some alternatives, as defined below). Current BAT for snowmobiles operating in Yellowstone, Grand Teton, and the Parkway has been established for CO and HC emissions, at less than 120 and 15 grams per kilowatt hour, respectively. NPS is also considering implementing an "improved" snowmobile BAT requirement of less than 79 and 3.2 grams per kilowatt hour for CO and HC, respectively. This "improved" snowmobile BAT requires lower CO and HC emissions than the current BAT and is being considered by NPS to further reduce overall snowmobile emissions in the parks. Additional information on "improved" BAT for snowmobiles is provided below. Current and "improved" BAT requirements are shown in Table 4-1.

Table 4-1
Snowmobile BAT Requirements and EPA Standards

	Emission Requirement or Standard		**Phase-in***
	Hydrocarbons (HC) (g/KW-hr)	**Carbon Monoxide (CO) (g/KW-hr)**	
NPS BAT	15	120	-
Proposed "Improved" BAT	3.2	79	-
EPA Emission Standards			
Model Year			
2006	100	275	50%
2007-2009	100	275	100%
2010	75	275	100%
2012	75	200	100%

Note:
Improved BAT based on testing from SwRI's *Laboratory Testing of Snowmobile Emissions*, Lela and White, July 2002.
* Percent of newly manufactured sleds for the model year that must meet the applicable requirement.

In addition, EPA adopted new standards for new non-road engines in 2002. For snowmobiles, the new standards will begin to take effect for the 2006 model year, with a 50 percent phase-in requirement. These standards and the corresponding implementation years are also provided in Table 4-1. Since they are less stringent than NPS BAT requirements, EPA standards would only be applicable (for modeling purposes) to the analysis of the 1999 Historical Conditions scenario, and to some snowmobiles that enter the Parkway from Targhee National Forest, via Grassy Lake Road. For these situations, the 2-stroke vs. 4-stroke mix was determined based on replacement rates and future mix estimates in the Final Regulatory Support Document (EPA420-R-02-022) for EPA's *Final Rule for Cleaner Large Industrial Spark-Ignition Engines, Recreational Marine Diesel Engines, and Recreational Vehicles* (published November 8, 2002). Details on the mix of snowmobiles under these conditions (Preliminary Alternative 4 and 1999 Historical Conditions scenario) can be found in Appendix H.

All 2-stroke engine emission factors are based on the average emissions data from snowmobiles tested by the equipment manufacturer or by the Southwest Research Institute (SwRI). 4-stroke engine emission factors are based on manufacturers' EPA certification modal emission testing results. These snowmobile emission factors were previously presented in the *Temporary Winter Use Plans Environmental Assessment,* National Park Service, August 2004, although some minor revisions were made for this study. Composite emission factors for each preliminary alternative were calculated by weighting the snowmobile and snowcoach emission factors appropriate for each particular preliminary alternative according to usage levels of each vehicle type. These composite emission factors (weighted averages) were inputted to the CAL3QHC modeling.

4.3.1 2-Stroke Snowmobile Emission Factors

Emission factors for 2-stroke snowmobiles were calculated based on tests performed by SwRI (*Emissions from Snowmobile Engines Using Bio-Based Fuels and Lubricants*, Southwest Research Institute, October 1998). Emission testing and engine performance were measured during modal engine tests following standard EPA test procedures. 2-stroke snowmobile emission factors for CO and HC are calculated from engine horsepower output, in grams per mile for traveling vehicles and in grams per hour for idling vehicles. These calculations were made with information from the SwRI report, which was prepared for the State of Montana Department of Environmental Quality.

The SwRI modal testing obtained data for five (5) varying modes of operation. Mode 5 (a slow engine speed) approximates conditions when an engine is idling. Mode 4 (a moderate engine speed) is representative of a snowmobile traveling at a speed of approximately 15-20 miles per hour. Mode 3 (a moderately high engine speed) is representative of a snowmobile traveling at a speed of approximately 20-35 miles per hour, and Mode 2 (a higher engine speed) represents a snowmobile speed of 35-45 miles per hour. Mode 1 (a high engine speed) is representative of snowmobiles traveling over 45 miles per hour. Modes 4 and 2 were selected as reasonable approximations of slow and higher snowmobile travel speeds within the parks. Four different engines tested by SwRI were used to calculate average 2-stroke snowmobile emissions. For this analysis, emission factors were determined from modal testing data for the following operating conditions: Modes 5, 4, and 2. Emission factors were converted from grams per hour to grams per mile, using an equation provided to ARS by NPS. This allows determination of speed from power. Table 4-2 summarizes the average emissions for 2-stroke snowmobile engines operating under those conditions.

4.3.2 4-Stroke Snowmobile Emission Factors

4-stroke snowmobile emission factors were calculated in a similar manner as 2-stroke engines. 4-stroke emission factors were determined from manufacturers' EPA certification modal emission testing results for the BAT-approved snowmobile engines of three different manufacturers (Arctic Cat T660, Polaris Frontier, and SkiDoo Legend with Yellowstone BAT kit). The average 4-stroke snowmobile emission factors based on these data are shown in Table 4-2.

Table 4-2
Snowmobile Emission Factors

	PM			CO			HC			NO_X		
	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)	Idle (g/hr)	15 mph (g/mi)	35 mph (g/mi)
2-Stroke snowmobiles	3.77	3.86	1.02	266	220.6	242.9	473	179.9	78.7	0.53	0.20	0.23
BAT 4- Stroke snowmobiles	0.49	0.065	0.031	191.5	35.1	22.9	35.3	2.82	2.32	0.93	2.80	5.64
Improved BAT 4- Stroke snowmobiles	0.54	0.068	0.034	137.6	18.4	10.7	35.3	0.56	0.90	1.05	0.91	3.29

Preliminary Alternative 5 assumes implementation of an "improved" BAT emissions requirement. This requirement is based on the cleanest test data available; a pre-production model Polaris 4-stroke Frontier snowmobile tested in the SwRI's *Laboratory Testing of Snowmobile Emissions*, Lela and White, July 2002. The "improved" BAT emission requirements were determined from composite five-mode ISMA/SwRI cycle engine dynamometer test results of the Polaris with reference gasoline (no ethanol) for HC and CO. These proposed requirements are shown in Table 4-1, in grams per kilowatt-hour, and are based on grams per horsepower-hour test results presented in the above-referenced report. "Improved" BAT cruise emission factors for modeling purposes were calculated (from test results with units of grams per hour) and are shown in Table 4-2 (the calculations are included in Appendix B).

4.3.3 Snowcoach Emission Factors

Snowcoach emission factors for this analysis were obtained from the University of Denver's *In-use Emission Measurements of Snow Coaches and Snowmobiles in Yellowstone National Park*, Gary A. Bishop, Daniel A. Burgard, Thomas R. Dalton, and Donald H. Stedman, January 2006. This study included measuring emissions from nine (9) snowcoaches operating in Yellowstone during February of 2005. Preliminary emissions data collected from ten (10) snowcoaches during the winter season of 2006 (*Portable Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park*, Bishop, Stadtmuller, and Stedman, report in progress) were also used, and together, this data provides the most comprehensive collection of emissions data from in-use snowcoaches to date. These studies, along with others, show that the vehicle operating conditions (altitude, temperature, terrain, vehicle operator, etc.) can greatly affect snowcoach emission factors.

A summary of the idle and traveling (low speeds of less than 15 mph and cruise speeds of 15 to 35 mph) emissions is shown in Table 4-3, representing current fleet emissions for modeling purposes. Since the snowcoaches measured in the study are not fully representative of the mix of vehicles in the overall snowcoach fleet operating in Yellowstone, emission factors were determined by weighting the data from the study based on the current fleet mix of snowcoaches operating in Yellowstone, by engine type and age (see Appendix C).

All preliminary alternatives assume implementation of a snowcoach BAT requirement based on EPA Tier 2 light-duty vehicle emission standards. Separate requirements would also need to be developed for heavy-duty/diesel snowcoaches, possibly based on EPA's Heavy-duty Diesel regulation. Future snowcoach BAT requirements are likely to only require the vehicles employ the related technologies associated with these EPA emission standards, rather than meet the actual standards themselves, as snowcoaches operate in conditions very different from their on-road counterparts.

For modeling purposes, snowcoach BAT emissions factors were determined by averaging emission factors of the cleanest subgroup of snowcoaches tested in the University of Denver studies. These emission factors represented the proposed snowcoach BAT emission values and are included in Table 4-3, and the calculations are provided in Appendix C.

4.3.4 On-road Vehicle Emission Factors

For the analysis of Preliminary Alternative 6, which includes plowing of Yellowstone's west-side roads, on-road (wheeled) vehicular emissions (CO, PM, NO_x and HC) were necessary. Emission factor estimates were computed using the EPA-developed Mobile Source Emissions Model (MOBILE6) for up to five (5) classes of motor vehicles: light-duty, gasoline-powered trucks (LDGT3 and LDGT4); heavy-duty, gasoline-powered trucks (HDGV); heavy-duty, diesel vehicles (HDDV); gasoline buses (HDGB); and diesel buses (HDDBT). The types of on-road vehicles in the fleet for this preliminary alternative would be limited since all vehicle entry would be commercially guided. The vehicle mix for this analysis was estimated to be one third of each of the following vehicle types: suburban/large passenger truck or similar; 12-15 person vans/small buses or similar light-duty trucks; and large, heavy-duty buses (30-40 feet in length).

Table 4-3
Snowcoach Emission Factors for Modeling

	PM*			CO			HC			NO_X		
	Idle (g/hr)	**< 15 mph (g/mi)**	**35 mph (g/mi)**	**Idle (g/hr)**	**< 15 mph (g/mi)**	**35 mph (g/mi)**	**Idle (g/hr)**	**< 15 mph (g/mi)**	**35 mph (g/mi)**	**Idle (g/hr)**	**< 15 mph (g/mi)**	**35 mph (g/mi)**
Snowcoaches – Current Fleet	0.11	0.06	0.05	441.5	164.1	254.2	24.6	5.4	10.9	3.9	15.9	15.6
Snowcoaches – 1999 Fleet	0.11	0.05	0.05	731.7	259.9	349.0	37.8	8.0	17.4	3.1	20.4	19.9
BAT Snowcoaches	0.11	0.06	0.05	43.7	17.4	38.7	12.0	1.6	1.0	4.4	8.6	11.2

Note:
* PM emissions measured only from NPS Van and NPS Bus (diesel engines).
Source: *In-use Emission Measurements of Snow Coaches and Snowmobiles in Yellowstone National Park,* University of Denver, Bishop, Burgard, Dalton, and Stedman, January 2006 and *Potable Emission Measurements of Snowmobiles and Snowcoaches in Yellowstone National Park,* Bishop, Stadtmuller, and Stedman, University of Denver, Report in progress.

MOBILE6 emission factors were prepared to account for high altitude, no Inspection and Maintenance (I&M) programs, conventional gasoline, and current winter inputs such as temperature (0° to 30° Fahrenheit), fuel parameters, etc. (e.g., fuel volatility). NPS provided vehicle classification data, and national default vehicle age distributions were used. Emission factors for on-road vehicles were determined for idle conditions and the same low (15mph) and cruise (35mph) speeds as modeled for oversnow vehicles, representing slower winter conditions traveling speeds.

Emission estimates typically account for three possible vehicle operating conditions: cold vehicle operation, hot start operation, and hot stabilized operation. It is important to distinguish between these three operating categories, because vehicles emit pollutants at different rates depending on whether they are cold or warmed up. Since local data are not available, MOBILE6 defaults were employed for operating conditions. Composite emission factors for modeling on-road vehicles were determined based on the vehicle mix estimated above and are shown in Table 4-4. MOBILE6 input and output files are included as Appendix D. In addition, particulate emission factors for Preliminary Alternative 6 on-road vehicle travel on paved roads (plowed) were determined using EPA's *AP-42 Section 13.2.1, Paved Roads*, December 2003. These calculations are included in Appendix H.

4.4 Traffic Activity Data

Traffic data for the air quality analysis were derived from snowmobile and snowcoach entry limits and other information for each preliminary alternative provided to ARS by NPS (Appendix A). Microscale, or localized, dispersion modeling analysis was conducted for the peak-hour periods that produce the highest levels of vehicle traffic at each of the four modeling locations, and therefore have the greatest potential for significant air quality impacts. For the emission inventory, estimated daily vehicle miles

Table 4-4
MOBILE6 Emission Factors for On-road Vehicles
(Preliminary Alternative 6 only)

	PM_{10}			CO			HC			NO_X		
	Idle (g/hr)	**15 mph (g/mi)**	**35 mph (g/mi)**	**Idle (g/hr)**	**15 mph (g/mi)**	**35 mph (g/mi)**	**Idle (g/hr)**	**15 mph (g/mi)**	**35 mph (g/mi)**	**Idle (g/hr)**	**15 mph (g/mi)**	**35 mph (g/mi)**
On-Road Vehicles (Composite Mix)	0.62	0.15	0.15	188.7	30.3	19.3	14.6	1.93	1.22	28.2	7.33	5.86

Note:
Vehicle mix / VMT fractions: 34% LDT4, 11% CLASS 2b HDV, 11% CLASS 3 HDV, 11% CLASS 4 HDV, 33% BUS
PM_{10} emissions include tire and brake wear.
Source: MOBILE6.2.03 September 2003.

traveled (VMT) for oversnow and on-road vehicles (in Preliminary Alternative 6) are included in Appendix A.

To determine peak-hour vehicle traffic inputs for the West Entrance and West Entrance to Madison line source modeling locations, entrance data collected in February 2006 were used to determine morning peak-hour levels from daily entry limits. This data reflected that, on average, 65.8 percent of all daily snowmobile entries come in between 9:00 and 10:00 a.m., and 39.3 percent of all daily snowcoaches enter between 8:00 and 9:00 a.m. (37.0 percent of snowcoaches enter between 9:00 and 10:00 a.m.). Therefore, a 65.8 percent factor was applied to West Entrance daily entry limits for snowmobiles and the higher 39.3 percent factor was applied to snowcoach daily entry limits. The modeling assumed two lanes open in the morning, with about two thirds of daily entries going to the southernmost booth and third going to the middle (north) booth; the northernmost booth is currently unused in winter.

To determine peak-hour vehicle traffic inputs for the Old Faithful area source modeling location, Yellowstone Old Faithful Visitor Center staff estimated the busiest hour as approximately 11:30 a.m. to 12:30 p.m., when about 75 percent of daily visitors arrive at the Old Faithful staging area. Therefore, peak-hour traffic volumes for the staging area were estimated as 75 percent of all daily inbound traffic between Madison and Old Faithful and West Thumb and Old Faithful (inbound trips assumed to be half of total trips on each roadway segment). Peak-hour vehicle traffic inputs for the Flagg Ranch staging area were determined using a 75 percent factor, based on peak morning entry data for the South Entrance.

4.5 Meteorological Conditions

Following EPA guidelines, conservative meteorological conditions were selected for the modeling, to produce the expected highest ambient concentrations. These conservative conditions selected for CAL3QHC pollutant computations include a low wind speed of 1 meter/second and stability class F (very thermally stable). The

CAL3QHC model was utilized to vary the wind angle, to determine the wind direction which would maximize pollutant concentrations at each of the analysis locations.

Since ISC3 requires actual meteorological data input, a two month (January 1, 2000 through February 28, 2000) winter data set from the West Entrance monitoring site was used for modeling. Even though sequential meteorological data were used, the results were treated in a conservative manner because of the limited meteorological data set. The ISCST3 results were evaluated to determine the maximum predicted 1-hour average impacts (regardless of the time period(s) the impacts occurred), and maximum predicted 8-hour CO and 24-hour PM concentrations were determined using persistence factors. This approach assumes that the worst-case meteorology may occur concurrently with periods of peak emissions.

In addition, the default meteorological data used by the SCREEN3 model, which includes the full range of stability classes and windspeed combinations (Table 2. Wind Speed and Stability Classes Combinations, *SCREEN3 Model User's Guide*, USEPA, September 1995) were input to ISC3 model runs of the staging areas to determine potential impacts under meteorological conditions not measured during the monitored meteorological period. It was found that results using this data were always higher than modeling with the actual meteorological data set.

4.6 Background Concentrations

Background concentrations are those pollutant concentrations not directly accounted for by the modeling analysis. Background concentrations must be added to modeling results to obtain total pollutant concentrations at prediction sites. Background concentrations can typically be attributed to local sources, long-range transport and natural sources. For this analysis, background levels include smoke (from wood-burning stoves and fireplaces) and other emissions from West Yellowstone. Background concentrations for this analysis were estimated considering the guidelines provided in *40 CFR Part 51, Appendix W*.

Recent data collected at West Yellowstone and Old Faithful monitors provided background concentration estimates of a 1-hour average CO background of 0.17 ppm, and an 8-hour average CO background of 0.15 ppm, based on overnight monitoring data (John D. Ray, Atmospheric Chemist, NPS Air Resources Division, Denver, Colorado, July 2006 personal communication), so that emissions from the daytime oversnow vehicles modeled in this analysis would not be "double-counted".

The 24-hour average PM_{10} and $PM_{2.5}$ background concentrations were determined from the IMPROVE network aerosol data and are 4.2 and 2.4 micrograms per cubic meter (gravimetric mass average of 2002-04 annual mean values), respectively. Consistent with EPA guidance, IMPROVE data provide representative background particulate levels that are not directly affected by winter oversnow vehicle emissions, as the monitoring station is located near Lake Village. All background concentrations used in this analysis are shown in Table 4-5.

Table 4-5
Background Concentrations

CO (ppm)	
1-hour	**8-hour**
0.17	0.15
24-hour Particulates (ug/m^3)	
PM_{10}	**$PM_{2.5}$**
4.2	2.4

Note:
CO backgrounds estimated from average overnight values from John D. Ray (Atmospheric Chemist, NPS Air Resources Division, Denver Colorado), July 2006, personal communication.
Particulate backgrounds based on IMPROVE network aerosol data (2002-04 average).

For the 8-hour average CO and 24-hour average $PM_{2.5}$ concentrations, the highest 1-hour average concentrations for each pollutant were converted to either an 8-hour or 24-hour averaging period using persistence factors calculated from the *Data Transmittal Report for the Yellowstone National Park Winter Use Air Quality Study December 1, 2004 - March 15, 2005*, Air Resource Specialists, August 2005. As recommended by EPA's *Guideline for Modeling Carbon Monoxide from Roadway Intersections*, November 1992, these unitless factors were determined based on the ratio of actual maximum 8-hour to 1-hour CO measurements collected at the West Entrance or Old Faithful monitoring stations for the latest three seasons of monitoring data and averaged. Persistence factors for calculating 24-hour average $PM_{2.5}$ concentrations were also determined in this manner. Persistence factors are shown in Table 4-6

Table 4-6
Persistence Factors

	CO	**$PM_{2.5}$**
West Entrance	0.31	0.41
Old Faithful	0.43	0.15

Note:
CO persistent factor for converting 1-hour concentrations to 8-hour.
$PM_{2.5}$ persistent factor for converting 1-hour concentrations to 24-hour.
Persistent factors based on *Data Transmittal Report for the Yellowstone National Park Winter Use Air Quality Study December 1, 2004 - March 15, 2005*, Air Resource Specialists, August 2005.

5.0 Dispersion Modeling Results

As noted previously, receptors were placed at multiple locations at each of four modeling locations. The receptor with the highest predicted concentration was used to represent each modeling site for each of the preliminary alternatives. CO and PM concentrations were calculated for each location, for each alternative.

For all modeling results, the values shown are the highest predicted concentrations for each receptor location and include background levels. CO concentrations under each preliminary alternative were determined using the methodology previously described. Tables 5-1 and 5-2 show the maximum predicted 1- and 8-hour average CO concentrations for each of the preliminary alternatives at the analysis sites. The modeling results indicate that winter use vehicle emissions would not result in any exceedances of the CO NAAQS, or the Montana or Wyoming ambient air quality standards, under any of the preliminary alternatives. Table 5-3 shows predicted 8-hour CO levels for the alternatives as a percent of levels predicted under the 1999 Historical Conditions Scenario. Similarly, Table 5-4 shows predicted 8-hour CO as a percent of levels predicted under the Current Conditions Scenario. These percentages are based on total CO concentrations including the modeling and background values.

Table 5-5 shows the maximum predicted 24-hour $PM_{2.5}$ concentrations for each of the preliminary alternatives at the analysis sites. The modeling results indicate that no winter use vehicle emissions from any of the preliminary alternatives would result in exceedances of the 24-hour $PM_{2.5}$ NAAQS, or the Montana or Wyoming ambient air quality standards. The modeling results are consistent with recent (2002-2005) monitoring in the park, documented in the *Data Transmittal Report for the Yellowstone National Park Winter Use Air Quality Study December 1, 2004 - March 15, 2005*, which does not show any measured CO or $PM_{2.5}$ NAAQS exceedances. Further discussion is provided below in Section 9.0

In addition, it should be noted that all predicted $PM_{2.5}$ concentrations for this analysis are conservative, as most available emission factors utilized for vehicles assumed total particulates, or PM_{10} as all $PM_{2.5}$. In addition, 24-hour $PM_{2.5}$ values were determined from maximum predicted 1-hour modeling results using persistence factors, which do not reflect that winter use vehicle activity occurs primarily during daytime hours, or approximately during only one third of the hours in a day (9am to 5pm). However, the modeling results indicate there would not be any exceedances of the 24-hour PM_{10} NAAQS, or the Montana or Wyoming ambient air quality standards, under any of the preliminary alternatives.

Table 5-6 shows predicted 24-hour $PM_{2.5}$ levels for the alternatives as a percent of levels predicted under the 1999 Historical Conditions Scenario. These percentages were determined including the appropriate background level. Similarly, Table 5-7 shows predicted 24-hour $PM_{2.5}$ levels for the alternatives as a percent of levels predicted under the Current Conditions Scenario.

Table 5-1
Maximum Predicted 1-hour CO Concentrations
(parts per million)

Scenario	Description	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
		1-hour (ppm)	1-hour (ppm)	1-hour (ppm)	1-hour (ppm)
Alternative 1a	Current Plan	6.4	1.4	0.7	4.7
Alternative 1b	Current Plan, East Entrance Closed	6.7	1.1	0.7	5.3
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	6.4	1.1	0.7	4.8
Alternative 1e	Experimental Closure Gibbon Canyon	6.4	1.1	0.8	4.7
Alternative 2	Snowcoaches Only	0.3	0.3	0.2	0.2
Alternative 3*	Eliminate Most Road Grooming	0.2	0.2	0.4	4.4
Alternative 4	Enhanced Recreational Use	7.7	1.5	0.9	6.4
Alternative 5	Provide for Unguided Access	4.3	0.6	0.5	2.9
Alternative 6	Mixed Use (West-side Roads Plowing)	2.0	0.4	0.5	4.4
Current Conditions	Current Conditions / Actual Use Scenario	3.7	0.7	0.4	1.8
1999 Historical	Historical Unregulated Scenario	23.7	21.0	1.7	8.7

Note:
* Background levels only for Sites 1 and 2, since no West Entrance and Madison oversnow access for Alternative 3.
NAAQS for CO are 35 and 9 parts per million (ppm), for the 1-hour and 8-hour averaging periods, respectively.

Table 5-2
Maximum Predicted 8-hour CO Concentrations
(parts per million)

Scenario	Description	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
		8-hour (ppm)	8-hour (ppm)	8-hour (ppm)	8-hour (ppm)
Alternative 1a	Current Plan	2.1	0.5	0.4	2.1
Alternative 1b	Current Plan, East Entrance Closed	2.2	0.4	0.4	2.3
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	2.1	0.4	0.4	2.1
Alternative 1e	Experimental Closure Gibbon Canyon	2.1	0.4	0.4	2.1
Alternative 2	Snowcoaches Only	0.2	0.2	0.2	0.2
Alternative 3*	Eliminate Most Road Grooming	0.2	0.2	0.2	2.0
Alternative 4	Enhanced Recreational Use	2.5	0.6	0.5	2.8
Alternative 5	Provide for Unguided Access	1.4	0.3	0.3	1.3
Alternative 6	Mixed Use (West-side Roads Plowing)	0.7	0.2	0.3	2.0
Current Conditions	Current Conditions / Actual Use Scenario	1.2	0.3	0.3	0.9
1999 Historical	Historical Unregulated Scenario	7.4**	6.6	0.8	3.8

Note:
NAAQS for CO are 35 and 9 parts per million (ppm), for the 1-hour and 8-hour averaging periods, respectively.
*Background levels only for Sites 1 and 2, since no West Entrance and Madison oversnow access for Alternative 3.
**For actual historical unregulated conditions, Yellowstone recorded a 8-hour CO measurement of 8.9 ppm at the West Entrance air qualtiy monitor in 1999.

Table 5-3
Percent of Historical Conditions Concentration - 8-hour CO

Scenario	Description	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
		Percent Concentration of 1999 Historical Conditions			
Alternative 1a	Current Plan	28%	8%	47%	56%
Alternative 1b	Current Plan, East Entrance Closed	29%	7%	49%	62%
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	28%	7%	47%	56%
Alternative 1e	Experimental Closure Gibbon Canyon	28%	7%	52%	56%
Alternative 2	Snowcoaches Only	2%	3%	20%	5%
Alternative 3	Eliminate Most Road Grooming	2%	2%	31%	52%
Alternative 4	Enhanced Recreational Use	33%	8%	58%	74%
Alternative 5	Provide for Unguided Access	19%	4%	36%	35%
Alternative 6	Mixed Use (West-side Roads Plowing)	10%	3%	35%	52%
Current Conditions	Current Conditions / Actual Use Scenario	17%	5%	31%	23%
1999 Historical	Historical Unregulated Scenario	100%	100%	100%	100%

Note:
Percentages determined using modeled concentrations, including background levels (0.15 parts per million for 8-hour CO).

Table 5-4
Percent of Current Conditions Concentration - 8-hour CO

Scenario	Description	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
		Percent Concentration of Current Conditions			
Alternative 1a	Current Plan	168%	171%	149%	244%
Alternative 1b	Current Plan, East Entrance Closed	175%	141%	155%	270%
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	168%	141%	149%	244%
Alternative 1e	Experimental Closure Gibbon Canyon	168%	141%	165%	244%
Alternative 2	Snowcoaches Only	15%	59%	63%	21%
Alternative 3	Eliminate Most Road Grooming	12%	49%	97%	229%
Alternative 4	Enhanced Recreational Use	200%	181%	183%	325%
Alternative 5	Provide for Unguided Access	115%	90%	115%	155%
Alternative 6	Mixed Use (West-side Roads Plowing)	57%	70%	111%	228%
Current Conditions	Current Conditions / Actual Use Scenario	100%	100%	100%	100%
1999 Historical	Historical Unregulated Scenario	602%	2163%	317%	438%

Note:
Percentages determined using modeled concentrations, including background levels (0.15 parts per million for 8-hour CO).

Table 5-5
Maximum Predicted 24-hour $PM_{2.5}$ Concentrations (micrograms per cubic meter)

Scenario	Description	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
		24-hour (ug/m^3)	24-hour (ug/m^3)	24-hour (ug/m^3)	24-hour (ug/m^3)
Alternative 1a	Current Plan	9.4	2.8	2.7	4.7
Alternative 1b	Current Plan, East Entrance Closed	9.8	2.8	2.7	5.0
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	9.4	2.8	2.7	4.7
Alternative 1e	Experimental Closure Gibbon Canyon	9.4	2.8	2.7	4.7
Alternative 2	Snowcoaches Only	2.4	2.4	2.4	2.5
Alternative 3*	Eliminate Most Road Grooming	2.4	2.4	2.4	4.6
Alternative 4	Enhanced Recreational Use	10.6	3.2	2.8	4.9
Alternative 5	Provide for Unguided Access	9.8	3.2	2.6	4.5
Alternative 6	Mixed Use (West-side Roads Plowing)	21.3	26.6	10.3	4.5
Current Conditions	Current Conditions / Actual Use Scenario	6.1	2.8	2.5	3.1
1999 Historical	Historical Unregulated Scenario	193.9	42.6	6.2	25.1

Note:
* Background levels only for Sites 1 and 2, since no West Entrance and Madison oversnow access for Alternative 3.
NAAQS for PM_{10} is 150 µg/m3 and for $PM_{2.5}$ is 65 µg/m3, for the 24-hour averaging period.

Table 5-6
Percent of Historical Conditions Concentration - 24-hour $PM_{2.5}$

Scenario	Description	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
		Percent Concentration of 1999 Historical Conditions			
Alternative 1a	Current Plan	5%	7%	43%	19%
Alternative 1b	Current Plan, East Entrance Closed	5%	7%	43%	20%
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	5%	7%	43%	19%
Alternative 1e	Experimental Closure Gibbon Canyon	5%	7%	44%	19%
Alternative 2	Snowcoaches Only	1%	6%	39%	10%
Alternative 3	Eliminate Most Road Grooming	1%	6%	39%	18%
Alternative 4	Enhanced Recreational Use	5%	8%	45%	20%
Alternative 5	Provide for Unguided Access	5%	8%	43%	18%
Alternative 6	Mixed Use (West-side Roads Plowing)	11%	62%	167%	18%
Current Conditions	Current Conditions / Actual Use Scenario	3%	7%	40%	13%
1999 Historical	Historical Unregulated Scenario	100%	100%	100%	100%

Note:
Percentages determined using modeled concentrations, including background levels.

Table 5-7
Percent of Current Conditions Concentration - 24-hour $PM_{2.5}$

Scenario	Description	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful Staging Area	Site 4: Flagg Ranch Staging Area
		Percent Concentration of Current Conditions			
Alternative 1a	Current Plan	154%	100%	106%	150%
Alternative 1b	Current Plan, East Entrance Closed	161%	100%	107%	158%
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	154%	100%	106%	150%
Alternative 1e	Experimental Closure Gibbon Canyon	154%	100%	108%	150%
Alternative 2	Snowcoaches Only	39%	85%	96%	79%
Alternative 3	Eliminate Most Road Grooming	39%	85%	96%	145%
Alternative 4	Enhanced Recreational Use	174%	115%	110%	156%
Alternative 5	Provide for Unguided Access	161%	115%	106%	144%
Alternative 6	Mixed Use (West-side Roads Plowing)	349%	946%	412%	144%
Current Conditions	Current Conditions / Actual Use Scenario	100%	100%	100%	100%
1999 Historical	Historical Unregulated Scenario	3183%	1515%	247%	799%

Note:
Percentages determined using modeled concentrations, including background levels.

Since Yellowstone and Grand Teton are Class I areas, PM_{10} increment consumption under PSD was also assessed. For Class I areas, the PM_{10} PSD increment is 8 micrograms per cubic meter, for the 24-hour averaging period, which EPA has determined is the small “allowable” incremental increase for PM_{10} in these areas. This increment is evaluated in reference to the previously established (by Montana and Wyoming) baseline date of 1979 for Yellowstone (*Air Quality Concerns Related to Snowmobile Usage in National Parks*, National Park Service Air Resources Division, February 2000), which was used to determine baseline concentrations. This study employed only a screening level approach in comparing predicted PM_{10} increments (no background contribution) with estimated 1979 baseline concentrations to determine the increment for the preliminary alternatives.

Although snowmobile (and snowcoach) traffic in the parks has increased since 1979, it was expected that the 4-stroke BAT snowmobiles required by the preliminary alternatives would generally result in a net decrease in 24-hour PM_{10} levels compared to the established baseline date. The 1979 baseline levels were estimated from adjusting 1999 Historical Conditions Scenario modeled PM_{10} levels based on the maximum daily snowmobile levels (from Yellowstone entry records) of the two years. As the methodology employed in this study is a screening-level analysis, it is not intended for regulatory purposes and does not constitute a regulatory PSD increment consumption analysis. Typically, detailed analysis would be required if concentrations are near or “consume” allowable Class I PM_{10} PSD increment. Calculations for estimating baseline levels are included as Appendix G.

The predicted 24-hour PM_{10} increment consumption values based on the previously described particulate modeling are shown in Table 5-8 for each of the preliminary alternatives. With the exception of Preliminary Alternative 6, there is no 24-hour PM_{10} increment consumption for Sites 1, 2, and 3 compared to the baseline date, and all Site 4 results are lower than the PSD increment of 8 micrograms per cubic meter. For

Table 5-8
24-hour PM_{10} PSD Increment Consumption

Scenario	Description	Site 1: West Entrance 24-hour (ug/m^3)	Site 2: West Entrance to Madison 24-hour (ug/m^3)	Site 3: Old Faithful Staging Area 24-hour (ug/m^3)	Site 4: Flagg Ranch Staging Area 24-hour (ug/m^3)
Alternative 1a	Current Plan	7.0	0.4	0.3	2.3
Alternative 1b	Current Plan, East Entrance Closed	7.4	0.4	0.3	2.6
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	7.0	0.4	0.3	2.3
Alternative 1e	Experimental Closure Gibbon Canyon	7.0	0.4	0.3	2.3
Alternative 2	Snowcoaches Only	0.0	0.0	0.0	0.1
Alternative 3*	Eliminate Most Road Grooming	0.0	0.0	0.0	2.2
Alternative 4	Enhanced Recreational Use	8.2	0.8	0.4	2.5
Alternative 5	Provide for Unguided Access	7.4	0.8	0.2	2.1
Alternative 6**	Mixed Use (West-side Roads Plowing)	18.9	24.2	7.9	2.1
1999 Historical***	Historical Unregulated Scenario	191.5	40.2	3.8	22.7
PSD Baseline Year	1979 Historical Conditions	42.5	8.9	0.7	2.0

Note:
Baseline Year concentrations are based on the ratio of 1979 to 1999 snowmobile levels at the modeling locations.
Class I PSD Increment for 24-hour average PM_{10} is 8 $\mu g/m^3$
As the methodology employed in this study is a screening-level analysis, it is not intended for regulatory purposes and does not constitute a regulatory PSD increment consumption analysis.
* No modeled increment for Sites 1 and 2, since no West Entrance and Madison oversnow access for Alternative 3.
** For Site 2, Class I PSD Increment is exceeded.
*** For Sites 1 and 2, Class I PSD Increment is exceeded.

Preliminary Alternative 6, the PSD increment is exceeded for Site 2, and a more detailed modeling assessment may be required for this location. In addition, for 1999 Historical Conditions, the modeling results predict that at Sites 1 and 2, the PM_{10} PSD increment would have been exceeded.

6.0 Emissions Inventory

In addition to the dispersion modeling analysis for determining potential short-term CO and particulate concentrations, an emissions inventory of snowmobiles and snowcoaches operating in Yellowstone, Grand Teton and the Parkway in tons per winter season was completed for each preliminary alternative, based on vehicle entry limits and other information provided (Appendix A).

Emissions were calculated using travel estimates of oversnow and on-road vehicles used on Yellowstone and Grand Teton roadways, the roadway lengths, and modes of operation of the vehicles. Emission factor data previously discussed in Section 4.3 were combined with daily vehicle traffic levels for each roadway segment, for each alternative, to determine total park-wide emissions for each pollutant. The winter season was defined as a 90-day period that typically runs from about mid-December to early March.

Estimates were prepared for criteria pollutants (CO, PM, and NO_x) and HC. The total maximum potential winter season emissions due to operations of snowmobiles and snowcoaches in the parks in tons per winter season are shown for each preliminary alternative in Table 6-1. Detailed emission inventory calculations are included as Appendix H. An emissions inventory for HAPs was also completed for each preliminary alternative and is discussed in the next section. Table 6-2 shows the contribution by vehicle type by percentage of the total season emissions for the preliminary alternatives.

The results of the emission inventory show some significant differences in tons per winter season emissions for each preliminary alternative, based on their respective entry limits and BAT requirements. Preliminary Alternative 2, with only BAT snowcoaches, results in among the lowest emissions for most pollutants, and Preliminary Alternative 3, with most road grooming eliminated, also has relatively low emissions. However, Preliminary Alternative 3 with some snowmobiles (compared to none for Preliminary Alternative 2), with emission factors generally higher than BAT snowcoaches (especially at idle), shows increased winter season emissions in comparison to Preliminary Alternative 2.

Also among lower emitting alternatives, Preliminary Alternative 5 provides for unguided snowmobile access, but also requires “improved” BAT for snowmobiles, which significantly reduces CO and HC emissions compared to current BAT snowmobiles. This compares with Preliminary Alternative 6, which has higher total snowmobile and overall emissions, despite having fewer snowmobiles (based on total entry limits) than Preliminary Alternative 5, due to requiring BAT snowmobiles instead of “improved” BAT and additional emissions from wheeled vehicles traveling on plowed roadways. Preliminary Alternative 6 is also the highest of all alternatives for particulate emissions because of the AP-42 calculated wheeled vehicle travel contribution of resuspended particulate emissions on paved roads under winter conditions.

Preliminary Alternative 4, Enhanced Recreational Use, results in the highest winter season emissions of CO, HC, and NO_x for all the preliminary alternatives, due to more higher-emitting 2-stroke snowmobiles allow in Grand Teton, and substantially higher entry limits for Yellowstone. The various options of Preliminary Alternative 1 all result in comparable emissions, which fall between the lowest and highest emissions alternatives. However, all preliminary alternatives’ emissions are substantially lower than for the 1999 Historical Conditions scenario, which represents 2-stroke snowmobile use in the Parks at high traffic levels, under unregulated conditions. An exception that should be noted is the NO_x emissions for the 1999 Historical Conditions scenario. Despite resulting in much higher emissions of the all other pollutants assessed compared to the preliminary alternatives, the 1999 Historical Conditions scenario has the lowest NO_x emissions, due to the emissions tradeoff between 2-stroke and 4-stroke snowmobile engines that occurs for lower CO emissions.

Table 6-1
Park-wide Total Winter Season Mobile Source Emissions (Pounds per Day / Tons per Year)

Scenario	Description	CO		HC		NOx		PM	
		lb/day	tpy	lb/day	tpy	lb/day	tpy	lb/day	tpy
Alternative 1a	Current Plan	3,934	177	372	17	969	44	6	0.3
Alternative 1b	Current Plan, East Entrance Closed	3,967	179	375	17	977	44	6	0.3
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	3,788	170	357	16	933	42	6	0.3
Alternative 1e	Experimental Closure Gibbon Canyon	3,592	162	338	15	884	40	5	0.2
Alternative 2	Snowcoaches Only	827	37	22	1	239	11	1	0.0
Alternative 3	Eliminate Most Road Grooming	1,267	57	126	6	301	14	2	0.1
Alternative 4	Enhanced Recreational Use	5,939	267	640	29	1,379	62	16	0.7
Alternative 5	Provide for Unguided Access	2,115	50	153	3	616	14	6	0.1
Alternative 6	Mixed Use (West-side Roads Plowing)	2,306	104	554	25	600	27	462	20.8
Current Conditions	Current Conditions / Actual Use Scenario	2,523	114	188	8	362	16	2	0.1
1999 Historical*	Historical Unregulated Scenario	67,662	3,045	20,109	905	203	9	277	12.5

Note:
All Alternatives and scenarios assume current snowmobile BAT, except:
- Alternative 5, which assumes Improved BAT and;
- Historical Conditions, which assumes all uncontrolled 2-stroke.

* For comparison purposes, this scenario was also modeled for the year 2010. The winter season emissions would be as follows: CO - 1,124 tpy; HC - 341 typ; NOx - 8 tpy; PM - 12 tpy.
2010 conditions assumes standard snowmobile replacement rates based on EPA's 2006 and 2010 emissions restrictions.

For all Alternatives, Grassy Lake Road emissions from snowmobiles originating in Targhee NF assume 2007 engine mix; 20% uncontrolled 2-stroke, 70% modified & direct injection 2-stroke, and 10% 4-stroke.

Table 6-2
Percent Contribution by Vehicle Type to Total Scenario Emissions

Scenario	Description	CO			HC			NOx			PM		
		Snowmobile	Snowcoach	On-road Vehicle	Snowmobile	Snowcoach	On-road Vehicle	Snowmobile	Snowcoach	On-road Vehicle	Snowmobile	Snowcoach	On-road Vehicle
Alternative 1a	Current Plan	86%	14%	na	96%	4%	na	84%	16%	na	88%	12%	na
Alternative 1b	Current Plan, East Entrance Closed	87%	13%	na	96%	4%	na	84%	16%	na	88%	12%	na
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	86%	14%	na	96%	4%	na	83%	17%	na	88%	12%	na
Alternative 1e	Experimental Closure Gibbon Canyon	86%	14%	na	96%	4%	na	83%	17%	na	88%	12%	na
Alternative 2	Snowcoaches Only	0%	100%	na	0%	100%	na	0%	100%	na	0%	100%	na
Alternative 3	Eliminate Most Road Grooming	89%	11%	na	97%	3%	na	87%	13%	na	92%	8%	na
Alternative 4	Enhanced Recreational Use	87%	13%	na	97%	3%	na	83%	17%	na	94%	6%	na
Alternative 5	Provide for Unguided Access	68%	32%	na	88%	12%	na	68%	32%	na	85%	15%	na
Alternative 6	Mixed Use (West-side Roads Plowing)	78%	10%	12%	96%	1%	3%	70%	15%	14%	1%	0%	99%
Current Conditions	Current Conditions / Actual Use Scenario	47%	53%	na	70%	30%	na	77%	23%	na	86%	14%	na
1999 Historical	Historical Unregulated Scenario	96%	4%	na	99%	1%	na	30%	70%	na	100%	0%	na

7.0 Hazardous Air Pollutant (HAP) Emissions

Emissions of HAPs (benzene, 1,3 butadiene, formaldehyde, and acetaldehyde) occur in snowmobile and snowcoach emissions and are associated with incomplete fuel combustion. An emission inventory for these HAPs was completed based on HC speciation estimates and the total winter season HC emissions previously determined. For snowmobiles, HAPs emissions were estimated as a fraction of measured HC emissions from 2-stroke and 4-stroke snowmobiles based on data reported in SwRI's *Laboratory Testing of Snowmobile Emissions*, Lela and White, July 2002. HAPs classified as air toxics are presented in Table 7-1 as a percentage of the total HC mass, for snowmobiles.

HAPs emissions from on-road vehicles were determined using MOBILE6. HAPs emissions from snowcoaches were calculated using the percentages of the total HC mass derived from MOBILE6, based on the on-road vehicle types that are converted to snowcoaches and the snowcoach HC emissions data from the University of Denver testing. The snowcoach vehicle mix was approximated by the following MOBILE6 vehicle mix fractions: 50 percent light-duty trucks (LDT4), 17 percent CLASS 2b heavy-duty vehicles (HDV), 17 percent CLASS 3 HDV, and 16 percent CLASS 4 HDV. A diesel fraction of five (5) percent for all vehicle classes was assumed. HAP emissions as a percentage of total HC mass, for snowcoaches and on-road vehicles are presented in Table 7-2. Using the methodology described, total winter season mobile source emissions of HAPs were estimated and are summarized in Table 7-3.

Table 7-1
Snowmobile HC Speciation Data

	2-stroke (percent of HC)	4-stroke (percent of HC)
Benzene	0.64 %	2.60 %
1-3 Butadiene	0.11 %	0.00 %
Formaldehyde	0.67 %	2.81 %
Acetaldehyde	0.47 %	1.08 %

Table 7-2
Snowcoach and On-road Vehicle HC Speciation

	Snowcoach (percent of HC)	On-road Vehicles (percent of HC)
Benzene	3.55 %	3.20 %
1-3 Butadiene	0.55 %	0.65 %
Formaldehyde	1.66 %	3.35 %
Acetaldehyde	0.49 %	1.21 %

Table 7-3
Park-wide Total Winter Season Mobile Sources HAPs Emissions
(Tons per Year)

Scenario	Description	Benzene (tpy)	1-3 Butadiene (tpy)	Formaldehyde (tpy)	Acetaldehyde (tpy)
Alternative 1a	Current Plan	0.44	0.00	0.46	0.18
Alternative 1b	Current Plan, East Entrance Closed	0.44	0.00	0.47	0.18
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	0.42	0.00	0.44	0.17
Alternative 1e	Experimental Closure Gibbon Canyon	0.40	0.00	0.42	0.16
Alternative 2	Snowcoaches Only	0.03	0.01	0.02	0.00
Alternative 3	Eliminate Most Road Grooming	0.15	0.00	0.16	0.06
Alternative 4	Enhanced Recreational Use	0.76	0.01	0.80	0.31
Alternative 5	Provide for Unguided Access	0.19	0.00	0.18	0.07
Alternative 6	Mixed Use (West-side Roads Plowing)	0.66	0.01	0.70	0.27
Current Conditions	Current Conditions / Actual Use Scenario	0.24	0.01	0.21	0.08
1999 Historical	Historical Unregulated Scenario	5.95	1.02	6.12	4.25

Note:
2-stroke and 4-stroke snowmobile HAPs estimated as a fraction of measured HC emissions based on data reported in SwRI's *Laboratory Testing of Snowmobile Emissions*, Lela and White, July 2002.
Snowcoach and on-road vehicle HAPs estimated as a fraction of HC emissions based on MOBILE6 modeling of HC and air toxics emission factors for light- and heavy-duty vehicles.

8.0 Visibility

Yellowstone and Grand Teton are classified as Class I areas under the Federal Clean Air Act. As required by the visibility protection provision of the Clean Air Act, additional procedural requirements apply when a proposed source has the potential to impair visibility in a Class I area (40 CFR 52.27 (d)). Therefore, an analysis of anticipated visibility impacts resulting from on-snow vehicle emissions was conducted following procedures in the *Workbook for Plume Visual Impact Screening and Analysis*, EPA-450/4-88-015, 1992. The EPA model VISCREEN incorporates the methodology and was used to conduct a Level 1 screening analysis of potential visibility impacts. Virtual point source methods were applied to adapt procedures originally designed for assessing plume impacts resulting from industrial stacks to the line and area sources modeled at the four locations in this study.

For the visibility analysis, a winter Yellowstone value of 240 kilometers was assumed for the background visual range. This was converted from the reference level light-extinction coefficient for Yellowstone (winter) provided in Appendix 2.B of the *Federal Land Managers' Air Quality Related Values Workgroup (FLAG), Phase I Report*, U.S Forest Service, NPS, and U.S. Fish and Wildlife Service (December 2000) using conversion equation 1 in Appendix 2.A of the report.

The results of the VISCREEN modeling are shown in Table 8-1. There were no potential localized, perceptible, visibility impairments predicted for Preliminary Alternatives 1 through 5 at the screening locations. For Preliminary Alternative 6, there would be potential localized, perceptible, visibility impairment near the West Entrance

Table 8-1
Visibility Impairment

Scenario	Description	Screening Criteria Exceedance			
		Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Old Faithful	Site 4: Flagg Ranch
Alternative 1a	Current Plan	No	No	No	No
Alternative 1b	Current Plan, East Entrance Closed	No	No	No	No
Alternative 1d	East Ent Closed & Elim. 40 Snowmobiles	No	No	No	No
Alternative 1e	Experimental Closure Gibbon Canyon	No	No	No	No
Alternative 2	Snowcoaches Only	No	No	No	No
Alternative 3	Eliminate Most Road Grooming	No	No	No	No
Alternative 4	Enhanced Recreational Use	No	No	No	No
Alternative 5	Provide for Unguided Access	No	No	No	No
Alternative 6	Mixed Use (West-side Roads Plowing)	Yes	No	Yes	No
Current Conditions	Current Conditions / Actual Use Scenario	No	No	No	No
1999 Historical	Historical Unregulated Scenario	Yes	No	No	Yes

and Old Faithful locations, due to modeled resuspended particulate emissions from wheeled vehicles. For the 1999 Historical Conditions Scenario, higher pollutant emissions from 2-stroke snowmobiles would potentially cause localized, perceptible, visibility impairment near the West Entrance and Flagg Ranch locations. Visibility modeling parameters and modeling input and output files are included as Appendix I.

9.0 Summary and Conclusions

In support of the Winter Use Plan PDEIS for Yellowstone, Grand Teton, and the Parkway, this report analyzed potential air quality impacts from snowmobile and snowcoach operations for several preliminary alternatives, utilizing air dispersion modeling and other accepted methods and models. For all preliminary alternatives, snowmobiles entering Yellowstone must be BAT machines, and in Grand Teton and the Parkway, most must be also be BAT machines. For Preliminary Alternative 5, most snowmobiles must be "improved" BAT. In addition, all preliminary alternatives assume implementation of a snowcoach BAT.

For each preliminary alternative, maximum predicted ambient concentrations of CO and $PM_{2.5}$ were calculated using dispersion modeling and impacts were assessed with respect to the NAAQS and relative to historical conditions and a no-action scenario. Modeling results were also compared to PSD increments for particulate matter. Winter-season emission estimates in tons per year were calculated for CO, PM, NO_x, HC, and HAPs, and potential visibility impacts for each preliminary alternative were also assessed.

The results of the air quality modeling revealed that none of the alternatives would be likely to exceed the CO and $PM_{2.5}$ NAAQS, or the Montana or Wyoming ambient air quality standards. With respect to both predicted pollutant concentrations and total winter-season emissions, compared to the 1999 Historical Conditions scenario, all of the alternatives were projected to greatly improve CO and HC concentrations as a result of BAT requirements and daily entry limits. The largest reductions in pollutant concentrations and emissions are seen under alternatives that allow only snowcoaches, greatly limit oversnow vehicle entry, or implement “improved” BAT for snowmobiles. $PM_{2.5}$ emissions for all the preliminary alternatives are also greatly reduced compared to the 1999 Historical Conditions scenario, with the exception of Preliminary Alternative 6, which results in higher predicted particulate emissions from the modeled wheeled vehicle travel contribution of resuspended particulate emissions under winter conditions. However, NO_x emissions are increased for all preliminary alternatives compared to the 1999 Historical Conditions scenario, due to an inverse relationship with CO emissions, a tradeoff that occurs between 2-stroke and 4-stroke snowmobile engines for lower CO emissions.

In addition, the results of the Class I PSD assessment shows that 24-hour PM_{10} increment consumption for each of the preliminary alternatives at all modeling locations would be lower than the PSD increment of 8 micrograms per cubic meter, with the exception of Site 2 for Preliminary Alternative 6, which experiences higher predicted particulate emissions from modeled wheeled vehicle travel. The 1999 Historical Conditions scenario also exceeds the 24-hour PM_{10} PSD increment for both Sites 1 and 2. As the methodology employed in this study is a screening-level analysis, it is not intended for regulatory purposes and does not constitute a regulatory PSD increment consumption analysis

Modeling results from this study are compared with monitoring data collected at the West Entrance and Old Faithful sites for historical conditions (1999, with 1983 Regulations) and current conditions scenarios in tables below. Table 9-1 shows the comparison of the CO concentrations at the two locations for both historical (1999) and current conditions (2005) and Table 9-2 shows the comparison of $PM_{2.5}$ concentrations for current conditions.

Table 9-1
Comparison of Monitored and Modeled CO Concentrations

		1-hour (ppm)		**8-hour (ppm)**	
	Year	**Monitored**	**Modeled***	**Monitored**	**Modeled***
West Entrance	1999	18.2	23.7	8.9	7.4
	2005	2.8	3.7	1.0	1.2
Old Faithful	2005	1.7	0.4	0.8	0.3

Note:
* Modeled concentrations for 1999 are from 1999 Historical Conditions Scenario results, and modeled concentrations for 2005 are from Current Conditions Scenario results.
Monitored 1999 concentrations from *Carbon Monoxide Monitoring in West Yellowstone, Montana 1998-2001*, John Coefield, Montana DEQ, May 2002. Monitored 2005 concentrations from *Data Transmittal Report for the Yellowstone National Park Winter Use Air Quality Study December 1, 2004 - March 15, 2005,* Air Resource Specialists, August 2005.

Table 9-2
Comparison of Monitored and Modeled $PM_{2.5}$ Concentrations

		24-hour (ug/m³)	
	Year	**Monitored**	**Modeled***
West Entrance	2005	9.5	6.1
Old Faithful	2005	6.0	2.5

Note:
*Modeled concentrations are from Current Conditions Scenario results.
Monitored concentrations from *Data Transmittal Report for the Yellowstone National Park Winter Use Air Quality Study December 1, 2004 - March 15, 2005,* Air Resource Specialists, August 2005.

The comparison of monitored versus modeled concentrations for CO at the West Entrance are generally consistent with the typical conservative predictions of dispersion modeling. Modeled concentrations for CO at Old Faithful and $PM_{2.5}$ concentrations at both locations are lower than monitored values. However, given the modeling approach must employ a series of assumptions and approximations of actual conditions, utilizing the best available emission factors, and other input parameters, etc., compared with monitored concentrations, the modeling results are within a reasonable in range of possibility, and assess the potential for impacts to air quality from the winter use preliminary alternatives. The modeling results presented in this report provide an assessment of the effects on air quality associated with the entry limits, BAT requirements, and other details of the preliminary alternatives under consideration in the PDEIS.