TECHNICAL SUPPORT DOCUMENT
GLEN CANYON NATIONAL RECREATION AREA
AIR QUALITY ANALYSIS FOR PARK PLANNING

Prepared for:

National Park Service – US Department of Interior
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EXECUTIVE SUMMARY

This technical support document presents air pollution emissions and air quality analyses of the proposed changes in off-road use of motor vehicles and on-road use of nonconventional motor vehicles, or off-highway vehicles (OHVs), in Glen Canyon National Recreation Area (GCNRA). GCNRA has proposed to allow OHV use on several roads and off-road vehicle routes within Glen Canyon, as well as allow off-road use of unpaved areas such as Lone Rock Beach. This report evaluates both a base case (current condition) and a worst-case future alternative scenario that accounts for additional access to these roads/areas, by doubling the current number of vehicle trips, which doubles the vehicle miles traveled (VMT).

Emissions from vehicle use on five selected roads in the park were estimated, including conventional on-highway vehicles in the base case, and then adding OHV vehicle emissions in the future alternative. The emissions estimates for the key pollutants of interest, particulate matter (PM_{10} and $PM_{2.5}$), carbon monoxide (CO), nitrogen oxides (NOx), and volatile organic compounds (VOCs), are presented on Tables ES-1 and ES-2. The results show that the proposed changes cause relatively minor emissions increases throughout the park. Detailed calculations for the emission inventory are included in Attachment 1.

Table ES-1
Annual Vehicle Emissions - Base Case
(Tons per Year)

Description	PM_{10}	$PM_{2.5}$	CO	NOx	VOC
Land of Standing Rocks Road	1.13	0.11	0.03	0.01	0.00
Moody Canyon Road	5.66	0.56	0.15	0.03	0.01
Warm Creek Road	8.58	0.85	0.23	0.04	0.01
Hole in the Rock Road	7.54	0.75	0.20	0.03	0.01
Lone Rock Road & Beach	19.97	2.02	1.66	0.28	0.06
TOTALS	42.88	4.30	2.27	0.38	0.09

Table ES-2
Annual Vehicle Emissions – Alternative Scenario
(Tons per Year)

Description	**PM_{10}**	**$PM_{2.5}$**	**CO**	**NOx**	**VOC**
Land of Standing Rocks Road	1.68	0.17	0.11	0.01	0.02
Moody Canyon Road	8.44	0.84	0.48	0.03	0.09
Warm Creek Road	15.15	1.51	0.72	0.04	0.14
Hole in the Rock Road	11.24	1.12	0.75	0.04	0.15
Lone Rock Road & Beach	39.90	4.16	21.46	0.46	5.37
TOTALS	76.41	7.80	23.52	0.57	5.78

In addition, computer modeling was conducted at two park locations, in order to simulate air quality pollution levels, using the most recent version of the appropriate EPA Regulatory Model (AERMOD). An attached modeling report provides further technical details. The modeling results are summarized in Tables ES-3 and ES-4 and show that GCNRA's proposed changes will not cause or contribute to any exceedances of National Ambient Air Quality Standards (NAAQS). This indicates that the proposed additional vehicle activity (conventional and OHV) in the park would not result in any emissions levels that would be harmful to public health or the environment.

Table ES-3
DISPERSON MODELING RESULTS
Base Case Scenario

Location	**Pollutant**	**Averaging Time**	**NAAQS**	**Maximum Air Quality Impact[(3)]**
Lone Rock Beach	PM_{10}	24-Hour [(2)]	150 µg/m^3	19.25 µg/m^3
	$PM_{2.5}$	Annual [(1)]	12 µg/m^3	3.13 µg/m^3
		24-Hour [(1)]	35 µg/m^3	3.77 µg/m^3
Warm Creek Road	PM_{10}	24-Hour [(2)]	150 µg/m^3	41.25 µg/m^3
	$PM_{2.5}$	Annual [(1)]	12 µg/m^3	4.20 µg/m^3
		24-Hour [(1)]	35 µg/m^3	5.64 µg/m^3

[(1)] To attain the $PM_{2.5}$ standard, the 3-year average of the weighted annual mean must not exceed the annual standard, and the 5-year average of the 98th percentile 24-hour average must not exceed the 24-hour standard.
[(2)] To attain the PM_{10} standard, the average cannot exceed the standard more than once/year on average over 5 years.
[(3)] Hourly background concentration of 2.87µg/m^3 for $PM_{2.5}$ and 6.62 µg/m^3 for PM_{10} included.

Table ES-4
DISPERSON MODELING RESULTS
Future Alternative Scenario

Location	Pollutant	Averaging Time	NAAQS	Maximum Air Quality Impact(3)
Lone Rock Beach	PM_{10}	24-Hour (2)	150 μg/m^3	32.35 μg/m^3
	$PM_{2.5}$	Annual (1)	12 μg/m^3	3.49 μg/m^3
		24-Hour (1)	35 μg/m^3	4.99 μg/m^3
Warm Creek Road	PM_{10}	24-Hour (2)	150 μg/m^3	68.41 μg/m^3
	$PM_{2.5}$	Annual (1)	12 μg/m^3	5.26 μg/m^3
		24-Hour (1)	35 μg/m^3	7.86 μg/m^3

(1) To attain the $PM_{2.5}$ standard, the 3-year average of the weighted annual mean must not exceed the annual standard, and the 5-year average of the 98th percentile 24-hour average must not exceed the 24-hour standard.
(2) To attain the PM_{10} standard, the average cannot exceed the standard more than once/year on average over 5 years.
(3) Hourly background concentration of 2.87μg/m^3 for $PM_{2.5}$ and 6.62 μg/m^3 for PM_{10} included.

For the base case, the Lone Rock Beach PM_{10} and $PM_{2.5}$ 24-hour modeling results were 13 and 11 percent of the NAAQS, respectively. The annual $PM_{2.5}$ modeling result for this location was 26 percent of the NAAQS. The Warm Creek Road PM_{10} and $PM_{2.5}$ 24-hour modeling results were 27 and 16 percent of the NAAQS, respectively. The annual $PM_{2.5}$ modeling result was 35 percent of the NAAQS.

For the future alternative scenario, the Lone Rock Beach PM_{10} and $PM_{2.5}$ 24-hour modeling results were 22 and 14 percent of the NAAQS, respectively. The annual $PM_{2.5}$ modeling result for this location was 29 percent of the NAAQS. The Warm Creek Road PM_{10} and $PM_{2.5}$ 24-hour modeling results were 46 and 22 percent of the NAAQS, respectively. The annual $PM_{2.5}$ modeling result was 44 percent of the NAAQS.

1.0 Introduction

In support of the Glen Canyon National Recreation Area (GCNRA) Off-road Vehicle Management Plan Environmental Impact Statement (EIS), Air Resource Specialists, Inc. (ARS) completed air pollution emissions and air quality analyses to quantify road emissions and evaluate potential impacts from changes in nonconventional motor vehicle, or off-highway vehicle (OHV), use in the park. GCNRA has proposed changes, including allowing additional use by OHV on roads within the park. This analysis describes air quality emissions and potential impacts for two alternatives:

- Base case (current condition) scenario, and
- Worst-case future alternative scenario (highest potential increase in OHVs).

The park identified five roads/areas for inclusion in this study. Vehicle visitation data, road characteristics, and other information were provided by National Park Service (NPS) to ARS and are included in the Appendices.

As fugitive dust from unpaved road travel has been raised as a concern, particulate matter (PM_{10} and $PM_{2.5}$) emissions were calculated. In addition, vehicle exhaust emissions for particulates, carbon monoxide (CO), and nitrogen oxides (NO_x), and hydrocarbons (HC) were also determined.

Dispersion modeling was also conducted for two of highest vehicular use roads/areas, using the most recent regulatory version of the AMS/EPA Regulatory Model (AERMOD). The modeling results are based on five years of meteorological data collected at Page, AZ for 2005-2009.

The methodology employed for this study is discussed in the following sections.

2.0 Pollutants

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. 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. This analysis estimated particulate (PM_{10} and $PM_{2.5}$) emissions from conventional light duty cars and trucks and OHV use within the park.

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. This analysis estimated CO emissions from vehicle use within the park.

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). This analysis estimated VOC emissions from conventional light duty cars and trucks and OHV use within the park.

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. 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. This analysis estimated localized NO_x emissions from vehicle use within the park.

3.0 AP-42 Emission Factors

For this analysis, two sections of EPA's AP-42 emission reference document were employed to determine particulate emission factors, for paved and unpaved road types. Particulate emission factors for vehicle travel on paved roads were determined using EPA's *AP-42 Section 13.2.1, Paved Roads*, January 2011. The AP-42 calculation accounts for particle size, surface silt loading, and the average weight of vehicles, along with natural mitigation from precipitation. The average vehicle weight was adjusted between the base case and the alternative scenario, in order to account for adding OHVs. The paved road fugitive dust emission factors were only utilized for one analysis location, Lone Rock Road, since only this selected location included a paved road. The details of the fugitive particulate emission calculations are included as Attachment 1.

A second set of particulate emission factors for vehicle travel on unpaved roads were determined using EPA's *AP-42 Section 13.2.2, Unpaved Roads*, November 2006. The AP-42 calculation accounts for particle size, silt content of road surface, mean vehicle speed, and road material moisture content, along with natural mitigation from precipitation. The vehicle speed was adjusted for different analysis locations/roads and between the base case and the alternative scenario, in order to account for the posted and/or future proposed speed limits. The unpaved roads fugitive dust emission factors were used at all 5 analysis locations. The details of the emission calculations are included as Attachment 1.

4.0 MOVES2010b Emission Factors

To estimate conventional vehicle exhaust emissions (CO, PM, NO_x and VOC), emission factors estimates were computed using the current EPA recommended model for mobile source emissions, the EPA-developed Motor Vehicle Emission Simulator (MOVES2010b).

MOVES2010b emission factors were prepared based on model defaults, for the geographic location of Utah's Kane County (e.g. default vehicle age distributions were used), with a selected modeling year of 2014. All conventional vehicles travelling on GCNRA unpaved roads were conservatively assumed to be passenger trucks, and the MOVES2010b road type employed was rural unrestricted. The model's default settings were used to determine gasoline vs. diesel fractions as well. The modeled PM_{10} and $PM_{2.5}$ emission factors also include brake and tire wear. MOVES2010b emission factors and input and output files are included as Attachment 2.

5.0 NONROAD Emission Factors

To estimate OHV or nonconventional vehicle exhaust emissions (CO, PM, NO_x and VOC), emission factors estimates were computed using the EPA's NONROAD Emissions Model (version 2008a), for Utah's Kane County, for the selected modeling year of 2014. The OHVs modeled included 4 gasoline-fueled source categories (or equipment types), for both ATVs and off-road motorcycles, and 2-stroke and 4-stroke varieties of each. Emission factors were prepared based on model defaults (for fuel type, sulfur level, temperature, etc.), including the default data for determining the mix or fractions between ATV and motorcycle types as well. NONROAD emission factors and input and output files are included as Attachment 3.

6.0 Traffic and Road Data

Traffic data and VMT for the air quality analysis were derived from counts of vehicle use in the park and other vehicle travel assumptions and information provided to ARS by NPS (Attachment 1). In addition, the park provided daily one-way vehicle travel distances for each of the analysis locations. The monthly estimates of vehicle trips for each road were determined from the highest use level of data collected by the park in recent years. This analysis assumed that for the future alternative scenario, the level of increased OHV activity on the roadways/areas of concern would equivalent to the peak collected data; this is effectively a doubling of the total vehicle traffic, which doubles the total VMT, with the additional vehicles all being OHVs.

7.0 Emissions Inventory

An emissions inventory of vehicle use on the five selected roads in GCNRA was completed, including only emissions from conventional on-highway vehicles in the base case, and then adding OHV vehicle emissions in the future alternative. Total emissions estimates including the fugitive and exhaust (tailpipe) components were prepared for the criteria pollutants of interest (PM, CO, NOx, and VOC), and are presented in Tables 7-1 and 7-2. The results show that the proposed changes cause relatively minor emissions increases throughout the park. Detailed calculations for the emission inventory are included in Attachment 1.

Table 7-1
Annual Vehicle Emissions - Base Case
(Tons per Year)

Description	PM_{10}	$PM_{2.5}$	CO	NOx	VOC
Land of Standing Rocks Road	1.13	0.11	0.03	0.01	0.00
Moody Canyon Road	5.66	0.56	0.15	0.03	0.01
Warm Creek Road	8.58	0.85	0.23	0.04	0.01
Hole in the Rock Road	7.54	0.75	0.20	0.03	0.01
Lone Rock Road & Beach	19.97	2.02	1.66	0.28	0.06
TOTALS	42.88	4.30	2.27	0.38	0.09

Table 7-2
Annual Vehicle Emissions – Alternative Scenario
(Tons per Year)

Description	PM_{10}	$PM_{2.5}$	CO	NOx	VOC
Land of Standing Rocks Road	1.68	0.17	0.11	0.01	0.02
Moody Canyon Road	8.44	0.84	0.48	0.03	0.09
Warm Creek Road	15.15	1.51	0.72	0.04	0.14
Hole in the Rock Road	11.24	1.12	0.75	0.04	0.15
Lone Rock Road & Beach	39.90	4.16	21.46	0.46	5.37
TOTALS	76.41	7.80	23.52	0.57	5.78

8.0 Dispersion Modeling

In addition to total emissions calculations at the five analysis locations, dispersion modeling was conducted for two locations, Lone Rock Beach and Warm Creek Road, using the most recent regulatory version of the AMS/EPA Regulatory Model (AERMOD). The modeling results are based on five years of meteorological data collected at Page, AZ for 2005-2009. Full details of the air quality impact analysis are provided as Attachment 4, which includes a dispersion modeling report and supporting technical information.

The modeling results are summarized in Tables 8-1 and 8-2 below. The predicted modeling concentrations show that GCNRA's proposed changes will not cause or contribute to any exceedances of the National Ambient Air Quality Standards (NAAQS), as the maximum predicted concentrations, with additional OHV traffic plus current conventional vehicle traffic and background concentrations, are all below the applicable the NAAQS for PM_{10} and $PM_{2.5}$.

Table 8-1
DISPERSON MODELING RESULTS
Base Case Scenario

Location	Pollutant	Averaging Time	NAAQS	Maximum Air Quality Impact(3)
Lone Rock Beach	PM_{10}	24-Hour (2)	150 µg/m^3	19.25 µg/m^3
	$PM_{2.5}$	Annual (1)	12 µg/m^3	3.13 µg/m^3
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Warm Creek Road	PM_{10}	24-Hour (2)	150 µg/m^3	41.25 µg/m^3
	$PM_{2.5}$	Annual (1)	12 µg/m^3	4.20 µg/m^3
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(1) To attain the $PM_{2.5}$ standard, the 3-year average of the weighted annual mean must not exceed the annual standard, and the 5-year average of the 98th percentile 24-hour average must not exceed the 24-hour standard.
(2) To attain the PM_{10} standard, the average cannot exceed the standard more than once/year on average over 5 years.
(3) Hourly background concentration of 2.87µg/m^3 for $PM_{2.5}$ and 6.62 µg/m^3 for PM_{10} included. Data obtained from Colorado State University's IMPROVE Database Query Wizard; Canyonlands 2005-2009.

Table 8-2
DISPERSON MODELING RESULTS
Future Alternative Scenario

Location	Pollutant	Averaging Time	NAAQS	Maximum Air Quality Impact(3)
Lone Rock Beach	PM_{10}	24-Hour (2)	150 µg/m^3	32.35 µg/m^3
	$PM_{2.5}$	Annual (1)	12 µg/m^3	3.49 µg/m^3
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Warm Creek Road	PM_{10}	24-Hour (2)	150 µg/m^3	68.41 µg/m^3
	$PM_{2.5}$	Annual (1)	12 µg/m^3	5.26 µg/m^3
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(3) Hourly background concentration of 2.87µg/m^3 for $PM_{2.5}$ and 6.62 µg/m^3 for PM_{10} included. Data obtained from Colorado State University's IMPROVE Database Query Wizard; Canyonlands 2005-2009.

For the base case, the Lone Rock Beach PM_{10} and $PM_{2.5}$ 24-hour modeling results were 13 and 11 percent of the NAAQS, respectively. The annual $PM_{2.5}$ modeling result for this location was 26 percent of the NAAQS. The Warm Creek Road PM_{10} and $PM_{2.5}$ 24-hour modeling results were 27 and 16 percent of the NAAQS, respectively. The annual $PM_{2.5}$ modeling result was 35 percent of the NAAQS.

For the future alternative scenario, the Lone Rock Beach PM_{10} and $PM_{2.5}$ 24-hour modeling results were 22 and 14 percent of the NAAQS, respectively. The annual $PM_{2.5}$ modeling result for this location was 29 percent of the NAAQS. The Warm Creek Road PM_{10} and $PM_{2.5}$ 24-hour modeling results were 46 and 22 percent of the NAAQS, respectively. The annual $PM_{2.5}$ modeling result was 44 percent of the NAAQS.