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 $\mu g/m^3$	19.25 $\mu g/m^3$
	$PM_{2.5}$	Annual [1]	12 $\mu g/m^3$	3.13 $\mu g/m^3$
		24-Hour [1]	35 $\mu g/m^3$	3.77 $\mu g/m^3$
Warm Creek Road	PM_{10}	24-Hour [2]	150 $\mu g/m^3$	41.25 $\mu g/m^3$
	$PM_{2.5}$	Annual [1]	12 $\mu g/m^3$	4.20 $\mu g/m^3$
		24-Hour [1]	35 $\mu g/m^3$	5.64 $\mu g/m^3$

[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 2.87$\mu g/m^3$ for $PM_{2.5}$ and 6.62 $\mu g/m^3$ 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
		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. 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
		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. 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.

ATTACHMENT 1

Emissions Calculations

Table 1-1
GLCA ORV Management Plan Roads for AQ Analysis (Provided by NPS)

COUNTY	ROAD	TRAFFIC COUNTER LOCATION	DATA SOURCE	PROPOSED SPEED LIMIT	ROAD SURFACE	ROAD WIDTH	MODEL LOCATION ONE	MODEL LOCATION TWO	MODEL LOCATION THREE	COMMENTS
Garfield	NPS Route 756 (road to Land of Standing Rocks)	1 1/2 miles south of Teapot Rock campsite on NPS Route 756; situated to count traffic to Land of Standing Rocks in CANY; unpaved road.	CANY traffic counter	25 MPH	Dirt	Single lane	Anywhere along the road; pick "dustiest" soil formation			Vehicle entry into Orange Cliffs (GLCA) and then through to the Maze District (CANY) is predominately from the west at Hans Flat or from the south at Hwy 95 near Hite. This is in interior road system counter and may not be unique vehicles from the other Orange Cliffs location.
Garfield	NPS Route 332 (Moody Canyon Road)			25 MPH	Dirt	Single lane	Anywhere along the road; pick "dustiest" soil formation			
Kane	Warm Creek Road (NPS Route 230)	"Smoky Mountain South" on Warm Creek Road (NPS Route 230) just SE of the fork for Smoky Mountain Road (BLM Route 300); unpaved road.	GSENM traffic counter	Variable - max of 35 MPH	Dirt (clay)	Two lane	Along road as it crosses Tropic Shale formation at max speed limit	At traffic counter location	At intersection with Alstrum Point Road (NPS Route 264)	This counter captures traffic that has entered Warm Creek Road at Big Water and driven to this intersection and either proceeded north into GSENM on Smoky Mountain Road (BLM Route 300) or continued east in GLCA to Alstrum Point (NPS Route 264) or further east and then north into GSENM on Croton Road (BLM Route 340). Traffic beyond this point is extremely sparse as the road up onto Grand Bench and onto NPS Route 262 is extremely rugged).
Kane	Hole in the Rock Road (NPS Route 330)	"Hole in the Rock Road South" at boundary between GSENM and GLCA; unpaved road.	GSENM traffic counter	25 MPH	Dirt - graded	Two lane	At traffic counter location at boundary with GSENM	At road terminus at Hole-in-the-Rock		Number of vehicles entering/leaving GLCA at the end of the Hole in the Rock Road.
Kane	Lone Rock Road (to Lone Rock Beach ORV Area)	An inductive loop traffic counter is located past the entrance station at the turn around on the incoming lane of Lone Rock Road (NPS Route ???); paved road.	GLCA traffic counter	15 MPH on Lone Rock Beach	Paved road to dirt-sand routes on Lone Rock Beach	Two lane road; no lanes on beach	At traffic counter at Entrance Station	On Lone Rock Beach shoreline		Single lane inductive loop counts only incoming traffic. Vehicles typically enter on Lone Rock Road and proceed to beach shoreline and park for camping.

Table 1-2

Data for roads selected for AQ Analysis for ORV Management Plan EIS (Provided by NPS)

County	Year	Road	January	February	March	April	May	June	July	August	September	October	November	December	Notes for Mike 8/29/14
Garfield	2012	NPS Route 756 (Land of Standing Rocks Road)	13	5	50	77	121	68	14	22	74	113	19	13	This is the actual vehicle count. This road has no other exit so the traffic counter reflects entering and exiting traffic.
Garfield	2013	NPS Route 332 (Moody Canyon Road)	25	24	193	513	501	118	117	89	Information not available for this year. June 2011 number was 183; June 2012 was 222.	403	114	45	This is the raw traffic counter data for all vehicles passing this point in either direction. Divide by 2 for number of vehicles. Traffic counter is located on BLM Route 110 which is the access to the Wolverine Loop Road from the Burr Trail. Moody Canyon Road is spur road off of the Wolverine Loop Road. This vehicle count will be higher that what actually travels through to the Moody Canyon Road but will serve as a proxy.
Kane	2013	NPS Route 230 (Warm Creek Road - Smokey Mountain [BLM])	136	150	229	577	762	Information not available for this year. June 2011 number was 281; June 2012 was 291.	149	78	234	516	242	179	This is the raw traffic counter data for all vehicles passing this point in either direction. Divide by 2 for number of vehicles. Traffic enters NPS Route 230 at Big Water and proceeds to this intersection and then heads either north into GSENM on Smoky Mountain Road (BLM Route 300) or continues east in GLCA to Alstrum Point (NPS Route 264) or further east and then north into GSENM on Croton Road (BLM Route 340). Traffic beyond NS Route 264 is extremely sparse as the road up onto Grand Bench and onto NPS Route 262 is extremely rugged.
Kane	2013	NPS Route 330 (Hole in the Rock Road)	80	214	376	690	887	498	234	183	194	374	115	45	This is the raw traffic counter data for all vehicles passing this point in either direction. Divide by 2 for number of vehicles. Traffic enters the road from Hwy 12 in GSENM 50+ miles NW of the location of the traffic counter at the boundary of GSENM and GLCA.
Kane	2011	Lone Rock Beach ORV Area	1185	742	2700	2778	5435	15882	15071	15071	5980	3632	1211	1008	Traffic counter is across the incoming lane so this is the total number of vehicles entering the area, the vast majority of which park at Lone Rock Beach. Traffic counter data has already been adjusted to produce this vehicle county, so do not divide by 2. Exit is out via the same road, but there is no count of exiting traffic.

Glen Canyon National Recreation Area - Off-Highway Vehicle Air Quality Analysis
Emissions Inventory - Summary Table (Tons per Year)

Table A-1a

Annual PM Fugitive Emissions (tons per year)

Road	Base Scenario		Alternative Scenario	
	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}
Land of Standing Rocks Road	0.11	1.13	0.17	1.68
Moody Canyon Road	0.56	5.66	0.84	8.43
Warm Creek Road	0.85	8.58	1.50	15.14
Hole in the Rock Road	0.75	7.54	1.11	11.24
Lone Rock Road & Beach	2.01	19.96	3.97	39.69
Total:	**4.29**	**42.87**	**7.59**	**76.18**

Table A-1b

Annual PM Exhaust Emissions (tons per year)

Road	Base Scenario		Alternative Scenario	
	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}
Land of Standing Rocks Road	1.35E-04	1.96E-04	9.12E-04	1.04E-03
Moody Canyon Road	6.78E-04	9.85E-04	3.77E-03	4.35E-03
Warm Creek Road	1.03E-03	1.49E-03	5.70E-03	6.57E-03
Hole in the Rock Road	9.03E-04	1.31E-03	6.04E-03	6.90E-03
Lone Rock Road & Beach	7.50E-03	1.09E-02	1.94E-01	2.14E-01
Total:	**0.01**	**0.01**	**0.21**	**0.23**

Table A-1c

Total PM Exhaust Emissions (tons per year)

Road	Base Scenario		Alternative Scenario	
	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}
Land of Standing Rocks Road	0.11	1.13	0.17	1.68
Moody Canyon Road	0.56	5.66	0.84	8.44
Warm Creek Road	0.85	8.58	1.51	15.15
Hole in the Rock Road	0.75	7.54	1.12	11.24
Lone Rock Road & Beach	2.02	19.97	4.16	39.90
Total:	**4.30**	**42.88**	**7.80**	**76.41**

Table A-1d

Annual VOC Exhaust Emissions (tons per year)

Road	Base Scenario	Alternative Scenario
Land of Standing Rocks Road	1.17E-03	0.02
Moody Canyon Road	5.86E-03	0.09
Warm Creek Road	8.89E-03	0.14
Hole in the Rock Road	7.81E-03	0.15
Lone Rock Road & Beach	6.49E-02	5.37
Total:	**0.09**	**5.78**

Table A-1e

Annual CO Exhaust Emissions (tons per year)

Road	Base Scenario	Alternative Scenario
Land of Standing Rocks Road	0.03	0.11
Moody Canyon Road	0.15	0.48
Warm Creek Road	0.23	0.72
Hole in the Rock Road	0.20	0.75
Lone Rock Road & Beach	1.66	21.46
Total:	**2.27**	**23.52**

Table A-1f

Annual NO_X Exhaust Emissions (tons per year)

Road	Base Scenario	Alternative Scenario
Land of Standing Rocks Road	0.01	0.01
Moody Canyon Road	0.03	0.03
Warm Creek Road	0.04	0.04
Hole in the Rock Road	0.03	0.04
Lone Rock Road & Beach	0.28	0.46
Total:	**0.38**	**0.57**

Glen Canyon National Recreation Area - Off-Highway Vehicle Air Quality Analysis
Vehicle Exhaust Emissions Summary
MOVES2010b and NONROAD Output Summary

Table A-5a					
Conventional Vehicle Exhaust Emissions - MOVES2010b (lb/VMT)					
	VOC	CO	NO_X	PM_{10}*	$PM_{2.5}$*
On-highway	4.17E-04	1.07E-02	1.81E-03	7.01E-05	4.82E-05

Table A-5b					
Warm Creek Road					
Vehicle Exhaust Emissions (lb/hr)					
Scenario	VOC	CO	NO_X	PM_{10}	$PM_{2.5}$
Base	5.15E-03	1.32E-01	2.23E-02	8.65E-04	5.95E-04

Table A-5c					
Lone Rock Beach					
Vehicle Exhaust Emissions (lb/hr)					
Scenario	VOC	CO	NO_X	PM_{10}	$PM_{2.5}$
Base	2.21E-02	0.57	0.10	3.71E-03	2.55E-03

Table A-5d					
OHV Exhaust Emissions - NONROAD (lb/day per vehicle)					
	VOC	CO	NO_X	PM_{10}	$PM_{2.5}$
OHV	0.15	0.56	4.98E-03	5.74E-03	5.28E-03

Table A-5e					
Warm Creek Road					
Vehicle Exhaust Emissions (lb/hr)					
Scenario	VOC	CO	NO_X	PM_{10}	$PM_{2.5}$
Alternative	8.20E-02	4.19E-01	2.49E-02	3.80E-03	3.30E-03

Table A-5f					
Lone Rock Beach					
Vehicle Exhaust Emissions (lb/hr)					
Scenario	VOC	CO	NO_X	PM_{10}	$PM_{2.5}$
Alternative	3.33	12.92	0.21	0.13	0.12

Note: MOVES2010b PM factors include brake and tire wear.

Glen Canyon National Recreation Area - Off-Highway Vehicle Air Quality Analysis
Annual Vehicle Exhaust Calculations

Road Data

Table A-6a

Road	Paved Round Trip Distance (mi)	Unpaved Round Trip Distance (mi)	Annual Base No. Vehicles (On-highway)	Annual Future No. Vehicles (OHV Increment)
Land of Standing Rocks Road	---	19.0	295	295
Moody Canyon Road	---	24.0	1,172	1,172
Warm Creek Road	---	24.1	1,769	1,769
Hole in the Rock Road	---	19.3	1,945	1,945
Lone Rock Road	2.0	---	70,695	70,695
Lone Rock Beach	---	2.4	70,695	70,695

Base Scenario Calculations

Table A-6b

Road	Vehicle Exhaust Emissions (tons/year)				
	VOC	CO	NO_X	PM_{10}	$PM_{2.5}$
Land of Standing Rocks Road	0.00	0.03	0.01	0.00	0.00
Moody Canyon Road	0.01	0.15	0.03	0.00	0.00
Warm Creek Road	0.01	0.23	0.04	0.00	0.00
Hole in the Rock Road	0.01	0.20	0.03	0.00	0.00
Lone Rock Road	0.03	0.76	0.13	0.00	0.00
Lone Rock Beach	0.04	0.91	0.15	0.01	0.00

Future Alternative Scenario Calculations

Table A-6c

Road	Vehicle Exhaust Emissions (tons/year)				
	VOC	CO	NO_X	PM_{10}	$PM_{2.5}$
Land of Standing Rocks Road	0.02	0.11	0.01	0.00	0.00
Moody Canyon Road	0.09	0.48	0.03	0.00	0.00
Warm Creek Road	0.14	0.72	0.04	0.01	0.01
Hole in the Rock Road	0.15	0.75	0.04	0.01	0.01
Lone Rock Road	0.03	0.76	0.13	0.00	0.00
Lone Rock Beach	5.34	20.70	0.33	0.21	0.19

Glen Canyon National Recreation Area - Off-Highway Vehicle Air Quality Analysis
Fugitive Dust Emissions - Base Scenario Calculations

Road Data

Table A-7a

Road	Paved Round Trip Distance (mi)	Unpaved Round Trip Distance (mi)	No. of Vehicles											
			Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Land of Standing Rocks Road	---	19.0	7	3	25	39	61	34	7	11	37	57	10	7
Moody Canyon Road	---	24.0	13	12	97	257	251	59	59	45	101	202	57	23
Warm Creek Road	---	24.1	68	75	115	289	381	143	75	39	117	258	121	90
Hole in the Rock Road	---	19.3	40	107	188	345	444	249	117	92	97	187	58	23
Lone Rock Road	2.0	---	1,185	742	2,700	2,778	5,435	15,882	15,071	15,071	5,980	3,632	1,211	1,008
Lone Rock Beach	---	2.4	1,185	742	2,700	2,778	5,435	15,882	15,071	15,071	5,980	3,632	1,211	1,008

Total Emissions $PM_{2.5}$

Table A-7b

Road	Paved EF (lb/VMT)	Unpaved EF (lb/VMT)	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
			tons												
Land of Standing Rocks Road	---	0.04	0.00	0.00	0.01	0.01	0.02	0.01	0.00	0.00	0.01	0.02	0.00	0.00	0.11
Moody Canyon Road			0.01	0.01	0.05	0.12	0.12	0.03	0.03	0.02	0.05	0.10	0.03	0.01	0.56
Warm Creek Road			0.03	0.04	0.06	0.14	0.18	0.07	0.04	0.02	0.06	0.12	0.06	0.04	0.85
Hole in the Rock Road			0.02	0.04	0.07	0.13	0.17	0.10	0.05	0.04	0.04	0.07	0.02	0.01	0.75
Lone Rock Road	8.98E-04	---	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.06
Lone Rock Beach	---	0.02	0.03	0.02	0.07	0.08	0.15	0.44	0.42	0.42	0.16	0.10	0.03	0.03	1.95
		Total:	**0.09**	**0.11**	**0.26**	**0.49**	**0.65**	**0.66**	**0.54**	**0.51**	**0.33**	**0.42**	**0.15**	**0.09**	**4.29**

Total Emissions PM_{10}

Table A-7c

Road	Paved EF (lb/VMT)	Unpaved EF (lb/VMT)	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
			tons												
Land of Standing Rocks Road	---	0.40	0.02	0.01	0.10	0.15	0.23	0.13	0.03	0.04	0.14	0.22	0.04	0.02	1.13
Moody Canyon Road			0.06	0.06	0.47	1.24	1.21	0.28	0.28	0.21	0.49	0.97	0.28	0.11	5.66
Warm Creek Road			0.33	0.36	0.56	1.40	1.85	0.69	0.36	0.19	0.57	1.25	0.59	0.43	8.58
Hole in the Rock Road			0.16	0.41	0.73	1.34	1.72	0.97	0.45	0.35	0.38	0.72	0.22	0.09	7.54
Lone Rock Road	3.66E-03	---	0.00	0.00	0.01	0.01	0.02	0.06	0.06	0.06	0.02	0.01	0.00	0.00	0.26
Lone Rock Beach	---	0.23	0.33	0.21	0.75	0.77	1.51	4.43	4.20	4.20	1.67	1.01	0.34	0.28	19.70
		Total:	**0.90**	**1.06**	**2.61**	**4.91**	**6.54**	**6.56**	**5.38**	**5.06**	**3.26**	**4.19**	**1.46**	**0.94**	**42.87**

Glen Canyon National Recreation Area - Off-Highway Vehicle Air Quality Analysis
Fugitive Dust Emissions - Future Alternative Calculations

Road Data

Table A-8a

Road	Paved Round Trip Distance (mi)	Unpaved Round Trip Distance (mi)	No. of Vehicles											
			Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Land of Standing Rocks Road	---	19.0	13	5	50	77	121	68	14	22	74	113	19	13
Moody Canyon Road	---	24.0	25	24	193	513	501	118	117	89	203	403	114	45
Warm Creek Road	---	24.1	136	150	229	577	762	286	149	78	234	516	242	179
Hole in the Rock Road	---	19.3	80	214	376	690	887	498	234	183	194	374	115	45
Lone Rock Road	2.0	---	2,370	1,484	5,400	5,556	10,870	31,764	30,142	30,142	11,960	7,264	2,422	2,016
Lone Rock Beach	---	2.4	2,370	1,484	5,400	5,556	10,870	31,764	30,142	30,142	11,960	7,264	2,422	2,016

Total Emissions $PM_{2.5}$

Table A-8b

Road	Paved EF (lb/VMT)	Unpaved EF (lb/VMT)	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
			tons												
Land of Standing Rocks Road	---	0.03	0.00	0.00	0.01	0.02	0.03	0.02	0.00	0.01	0.02	0.03	0.01	0.00	0.17
Moody Canyon Road	---	0.03	0.01	0.01	0.07	0.18	0.18	0.04	0.04	0.03	0.07	0.14	0.04	0.02	0.84
Warm Creek Road	---	0.04	0.06	0.06	0.10	0.25	0.32	0.12	0.06	0.03	0.10	0.22	0.10	0.08	1.50
Hole in the Rock Road	---	0.03	0.02	0.06	0.11	0.20	0.25	0.14	0.07	0.05	0.06	0.11	0.03	0.01	1.11
Lone Rock Road	4.93E-04	---	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.07
Lone Rock Beach	---	0.02	0.07	0.04	0.15	0.15	0.30	0.88	0.83	0.83	0.33	0.20	0.07	0.06	3.90
		Total:	**0.16**	**0.18**	**0.44**	**0.80**	**1.10**	**1.22**	**1.02**	**0.97**	**0.58**	**0.71**	**0.25**	**0.17**	**7.59**

Total Emissions PM_{10}

Table A-8c

Road	Paved EF (lb/VMT)	Unpaved EF (lb/VMT)	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual Total
			tons												
Land of Standing Rocks Road	---	0.30	0.04	0.01	0.14	0.22	0.35	0.19	0.04	0.06	0.21	0.32	0.05	0.04	1.68
Moody Canyon Road	---	0.30	0.09	0.09	0.69	1.85	1.80	0.42	0.42	0.32	0.73	1.45	0.41	0.16	8.43
Warm Creek Road	---	0.35	0.58	0.64	0.98	2.47	3.26	1.22	0.64	0.33	1.00	2.21	1.04	0.77	15.14
Hole in the Rock Road	---	0.30	0.23	0.62	1.09	1.99	2.56	1.44	0.68	0.53	0.56	1.08	0.33	0.13	11.24
Lone Rock Road	2.01E-03	---	0.00	0.00	0.01	0.01	0.02	0.06	0.06	0.06	0.02	0.01	0.00	0.00	0.28
Lone Rock Beach	---	0.23	0.66	0.41	1.51	1.55	3.03	8.85	8.40	8.40	3.33	2.02	0.68	0.56	39.41
		Total:	**1.61**	**1.78**	**4.42**	**8.09**	**11.02**	**12.20**	**10.24**	**9.71**	**5.86**	**7.10**	**2.51**	**1.66**	**76.18**

Glen Canyon National Recreation Area - Off-Highway Vehicle Air Quality Analysis
Fugitive Dust Emissions

Base Scenario - Unpaved Roads
Source: Publically Accessible Unpaved Roads

Basis: AP-42 Section 13.2.2 Unpaved Roads (Rev. 11/06)
Assumptions: Road moisture content (M) from USDA Spooky, UT station from April 15, 2010 - September 16, 2014 (dates reflect all available data).
http://www.epa.gov/ttn/chief/ap42/ch13/related/c13s02-2.html
Silt Content (s) from EPA National Emission Inventory
http://www.epa.gov/ttn/chief/ap42/ch13/related/c13s02-2.html

Equation:
$$E = \frac{k\left(\frac{s}{12}\right)^{a}\left(\frac{S}{30}\right)^{d}}{\left(\frac{M}{0.5}\right)^{c}} - C$$

where:

k = particle size multiplier (lb/VMT)
s = silt content of road surface material (%)
S = mean vehicle speed (mph)

M = road material moisture content when dry (%)
C = emission factor for 1980's vehicle fleet exhaust
a = constant
c = constant
d = constant

Table A-9a			
Total PM	PM_{10}	$PM_{2.5}$	Notes
6	1.8	0.18	Table 13.2.2-2
3.9	3.9	3.9	EPA National Emission Inventory
45	45	45	All other roads
15	15	15	Lone Rock Beach only
3.62	3.62	3.62	From NRCS USDA data
0.00047	0.00047	0.00036	Table 13.2.2-4
1	1	1	Table 13.2.2-2
0.3	0.2	0.2	Table 13.2.2-2
0.3	0.5	0.5	Table 13.2.2-2

Emission Factor:

Table A-9b				
Uncontrolled Emissions (lb/VMT)				
Road	Total PM	PM_{10}	$PM_{2.5}$	Notes
45 mph roads	1.22	0.48	0.05	Uncontrolled
Lone Rock Beach	0.87	0.28	0.03	Uncontrolled

Natural mitigation control efficiency calculated based on Equation 2 in *AP-42 Unpaved Roads*

Equation:
$$E_{ext} = E\frac{(365-P)}{365}$$

where: E_{ext} = annual size-specific emission factor extrapolated for natural mitigation (lb/VMT)
P = number of days in a year with at least 0.254 mm (0.01 in) of precipitation — 60 — From Figure 13.2.2-1 in *AP-42*

Emission Factor:

Table A-9c				
Controlled* Emissions (lb/VMT)				
Road	**Total PM**	**PM_{10}**	**$PM_{2.5}$**	**Notes**
45 mph roads	1.02	0.40	0.04	Natural Mitigation
Lone Rock Beach	0.73	0.23	0.02	Natural Mitigation

*via natural mitigation

Total emissions are based on this factor, the distance travelled, and the number of vehicles

Glen Canyon National Recreation Area - Off-Highway Vehicle Air Quality Analysis
Fugitive Dust Emissions

Base Scenario - Paved Roads
Source: Publically Accessible Paved Roads

Basis: AP-42 Section 13.2.1 Paved Roads (Rev. 1/11)
Assumptions: Vehicle weight from average large truck/SUV MY 2007; Per EPA, weights have not varied significantly from 2004-2014.
http://cars.lovetoknow.com/List_of_Car_Weights; http://www.epa.gov/otaq/fetrends.htm

Equation: $E = k(sL)^{0.91} x\ (W)1.02$

where: k = particle size multiplier (lb/VMT)
sL = silt surface silt loading (g/m^3)
W = average weight (tons) of vehicles

Table A-10a			
Total PM	PM_{10}	$PM_{2.5}$	Notes
0.011	0.0022	0.00054	Table 13.2.1-1
0.6	0.6	0.6	Table 13.2.1-2 for average daily traffic of <500
2.71	2.71	2.71	

Emission Factor:

Table A-10b			
Uncontrolled Emissions (lb/VMT)			
Total PM	PM_{10}	$PM_{2.5}$	Notes
0.02	3.81E-03	9.36E-04	Uncontrolled

Natural mitigation control efficiency calculated based on Equation 2 in *AP-42 Paved Roads*

Equation: $E_{ext} = E\ (1\ - \frac{P}{4(365)})$

where: E_{ext} = annual size-specific emission factor extrapolated for natural mitigation (lb/VMT)
P = number of days in a year with at least 0.254 mm (0.01 in) of precipitation 60 From Figure 13.2.1-2 in *AP-42*

Emission Factor:

Table A-10c			
Controlled* Emissions (lb/VMT)			
Total PM	PM_{10}	$PM_{2.5}$	Notes
0.02	3.66E-03	8.98E-04	Natural Mitigation

* via natural mitigation

Total emissions are based on this factor, the distance travelled, and the number of vehicles

Glen Canyon National Recreation Area - Off-Highway Vehicle Air Quality Analysis
Fugitive Dust Emissions

Future Alternative Scenario - Unpaved Roads
Source: Publically Accessible Unpaved Roads

Basis: AP-42 Section 13.2.2 Unpaved Roads (Rev. 11/06)
Assumptions: Road moisture content (M) from USDA Spooky, UT station from April 15, 2010 - September 16, 2014 (dates reflect all available data).
http://www.epa.gov/ttn/chief/ap42/ch13/related/c13s02-2.html
Silt Content (s) from EPA National Emission Inventory
http://www.epa.gov/ttn/chief/ap42/ch13/related/c13s02-2.html

Equation: $$E = \frac{k\left(\frac{s}{12}\right)^{a}\left(\frac{S}{30}\right)^{d}}{\left(\frac{M}{0.5}\right)^{c}} - C$$

where:

k = particle size multiplier (lb/VMT)
s = silt content of road surface material (%)
S = mean vehicle speed (mph)
M = road material moisture content when dry (%)
C = emission factor for 1980's vehicle fleet exhaust
a = constant
c = constant
d = constant

Table A-11a			
Total PM	PM_{10}	$PM_{2.5}$	Notes
6	1.8	0.18	Table 13.2.2-2
3.9	3.9	3.9	EPA National Emission Inventory
variable			See chart below
3.62	3.62	3.62	From NRCS USDA data
0.00047	0.00047	0.00036	Table 13.2.2-4
1	1	1	Table 13.2.2-2
0.3	0.2	0.2	Table 13.2.2-2
0.3	0.5	0.5	Table 13.2.2-2

Table A-11b					
Uncontrolled Emissions (lb/VMT)					
Site	MPH	Total PM	PM_{10}	$PM_{2.5}$	Notes
Land of Standing Rocks Road	25	1.02	0.36	0.04	
Moody Canyon Road	25	1.02	0.36	0.04	
Warm Creek Road	35	1.13	0.42	0.04	
Hole in the Rock Road	25	1.02	0.36	0.04	
Lone Rock Beach	15	0.87	0.28	0.03	

Natural mitigation control efficiency calculated based on Equation 2 in *AP-42 Unpaved Roads*

Equation: $$E_{ext} = E\,\frac{(365-P)}{365}$$

where: E_{ext} = annual size-specific emission factor extrapolated for natural mitigation (lb/VMT)
P = number of days in a year with at least 0.254 mm (0.01 in) of precipitation 60 From Figure 13.2.2-1 in AP-42

Table A-11c				
Controlled* Emissions (lb/VMT)				
Site	Total PM	PM_{10}	$PM_{2.5}$	Notes
Land of Standing Rocks Road	0.85	0.30	0.03	
Moody Canyon Road	0.85	0.30	0.03	
Warm Creek Road	0.94	0.35	0.04	
Hole in the Rock Road	0.85	0.30	0.03	
Lone Rock Beach	0.73	0.23	0.02	

*via natural mitigation

Total emissions are based on this factor, the distance travelled, and the number of vehicles

Glen Canyon National Recreation Area - Off-Highway Vehicle Air Quality Analysis
Fugitive Dust Emissions

Future Alternative Scenario - Paved Roads
Source: Publically Accessible Paved Roads

Basis: AP-42 Section 13.2.1 Paved Roads (Rev. 1/11)

Assumptions: Vehicle weight from average large truck/SUV MY 2007; Per EPA, weights have not varied significantly from 2004-2014.
http://cars.lovetoknow.com/List_of_Car_Weights; http://www.epa.gov/otaq/fetrends.htm
Average OHV weight most conservative number
http://www.ask.com/question/how-much-does-an-atv-weigh

Equation: $$E = k(sL)^{0.91} x\ (W)1.02$$

where: k = particle size multiplier (lb/VMT)
sL = silt surface silt loading (g/m^3)
W = average weight (tons) of vehicles

Table A-12a			
Total PM	PM_{10}	$PM_{2.5}$	Notes
0.011	0.0022	0.00054	Table 13.2.1-1
0.6	0.6	0.6	Table 13.2.1-2 for average daily traffic of <500
1.50	1.50	1.50	Vehicle wt. 2.71 tons; OHV wt. 0.3 tons

Emission Factor:

Table A-12b			
Uncontrolled Emissions (lb/VMT)			
Total PM	PM_{10}	$PM_{2.5}$	Notes
0.01	2.09E-03	5.14E-04	Uncontrolled

Natural mitigation control efficiency calculated based on Equation 2 in *AP-42 Paved Roads*

Equation: $$E_{ext} = E\ (1\ - \frac{P}{4(365)})$$

where: E_{ext} = annual size-specific emission factor extrapolated for natural mitigation (lb/VMT)
P = number of days in a year with at least 0.254 mm (0.01 in) of precipitation 60 From Figure 13.2.1-2 in *AP-42*

Emission Factor:

Table A-12c			
Controlled* Emissions (lb/VMT)			
Total PM	PM_{10}	$PM_{2.5}$	Notes
0.01	2.01E-03	4.93E-04	Natural Mitigation

*via Natural Mitigation

Total emissions are based on this factor, the distance travelled, and the number of vehicles

ATTACHMENT 2

MOVES2010b Input/Output Files

Table 2-1
MOVES2010b Emissions Summary

Header Item	Header Item Value
Report Description	GCNRA OHV Summary Report
Report Date/Time	10/22/2014 14:06
MOVES Output Database	moves2010CO
Emission Process	All
Run Date/Time	10/22/2014 14:00
Run Specification	MOVES2010b CO
Run Spec File Date/Time	10/22/2014 14:00
Run Spec Description	Example Run Specification for MOVES2010b. VO, CO, NOx, NO2, VMT. passenger trucks only, rural unrestricted, processes. Gasoline diesel fuel Run at preaggregated national level. Time fully preaggregated. UT Kane Cnty
Mass Units	g
Energy Units	J
Distance Units	mi
Time Units	year

Year	State	County	Source	Fuel	Road	Run	Total_PM10	Total_PM25	Brake_PM10	Tire_PM10	Brake_PM25	Tire_PM25	Distance
2014	49	49025	31	1	3	1	442,070	407,064	431,914	193,904	113,066	46,500	35,784,800
2014	49	49025	31	2	3	1	79,993	77,596	8,394	4,903	2,197	1,176	725,728
					Gas+Diesel Totals		522,063	484,660	440,308	198,807	115,263	47,676	36,510,528

	PM-10	**PM2.5**
Total Exhaust + Brake + Tire	**(lb/VMT)**	
(for Gas/Diesel Mix)	**7.01E-05**	**4.82E-05**

Year	State	County	Source	Fuel	Road	Run	CO	NO2	NOx	VOC	Distance
2014	49	49025	31	1	3	1	177,059,248	3,536,251	28,620,072	6,721,610	35,784,800
2014	49	49025	31	2	3	1	876,924	155,935	1,395,984	177,656	725,728
					Gas+Diesel Totals		177,936,172	3,692,186	30,016,056	6,899,266	36,510,528

	CO	**NO2**	**NOx**	**VOC**
		(lb/VMT)		
(for Gas/Diesel Mix)	**1.07E-02**	**2.23E-04**	**1.81E-03**	**4.17E-04**

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for MOVES2010b.

PM10/2.5, VMT.

passenger trucks only, rural unrestricted, processes.

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Run at preaggregated national level.
Time fully preaggregated.
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sourcetypename="Passenger Truck"/>
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	</offroadvehicleselections>
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	</offroadvehiclesccs>
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		<roadtype roadtypeid="3" roadtypename="Rural Unrestricted Access"/>
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Total" processkey="2" processname="Start Exhaust"/>
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Total" processkey="15" processname="Crankcase Running Exhaust"/>
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Total" processkey="90" processname="Extended Idle Exhaust"/>
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Brakewear Particulate" processkey="9" processname="Brakewear"/>
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Elemental Carbon" processkey="1" processname="Running Exhaust"/>
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Carbon" processkey="16" processname="Crankcase Start Exhaust"/>
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Particulate" processkey="1" processname="Running Exhaust"/>
            <pollutantprocessassociation pollutantkey="105" pollutantname="Primary PM10 - Sulfate
Particulate" processkey="2" processname="Start Exhaust"/>
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Particulate" processkey="15" processname="Crankcase Running Exhaust"/>
            <pollutantprocessassociation pollutantkey="105" pollutantname="Primary PM10 - Sulfate
Particulate" processkey="16" processname="Crankcase Start Exhaust"/>
            <pollutantprocessassociation pollutantkey="105" pollutantname="Primary PM10 - Sulfate
Particulate" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
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Particulate" processkey="90" processname="Extended Idle Exhaust"/>
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Particulate" processkey="10" processname="Tirewear"/>
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Brakewear Particulate" processkey="9" processname="Brakewear"/>
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```

```
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Elemental Carbon" processkey="15" processname="Crankcase Running Exhaust"/>
            <pollutantprocessassociation pollutantkey="112" pollutantname="Primary PM2.5 -
Elemental Carbon" processkey="16" processname="Crankcase Start Exhaust"/>
            <pollutantprocessassociation pollutantkey="112" pollutantname="Primary PM2.5 -
Elemental Carbon" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
            <pollutantprocessassociation pollutantkey="112" pollutantname="Primary PM2.5 -
Elemental Carbon" processkey="90" processname="Extended Idle Exhaust"/>
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            <pollutantprocessassociation pollutantkey="111" pollutantname="Primary PM2.5 - Organic
Carbon" processkey="2" processname="Start Exhaust"/>
            <pollutantprocessassociation pollutantkey="111" pollutantname="Primary PM2.5 - Organic
Carbon" processkey="15" processname="Crankcase Running Exhaust"/>
            <pollutantprocessassociation pollutantkey="111" pollutantname="Primary PM2.5 - Organic
Carbon" processkey="16" processname="Crankcase Start Exhaust"/>
            <pollutantprocessassociation pollutantkey="111" pollutantname="Primary PM2.5 - Organic
Carbon" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
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Carbon" processkey="90" processname="Extended Idle Exhaust"/>
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Particulate" processkey="1" processname="Running Exhaust"/>
            <pollutantprocessassociation pollutantkey="115" pollutantname="Primary PM2.5 - Sulfate
Particulate" processkey="2" processname="Start Exhaust"/>
            <pollutantprocessassociation pollutantkey="115" pollutantname="Primary PM2.5 - Sulfate
Particulate" processkey="15" processname="Crankcase Running Exhaust"/>
            <pollutantprocessassociation pollutantkey="115" pollutantname="Primary PM2.5 - Sulfate
Particulate" processkey="16" processname="Crankcase Start Exhaust"/>
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Particulate" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
            <pollutantprocessassociation pollutantkey="115" pollutantname="Primary PM2.5 - Sulfate
Particulate" processkey="90" processname="Extended Idle Exhaust"/>
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Tirewear Particulate" processkey="10" processname="Tirewear"/>
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Consumption" processkey="1" processname="Running Exhaust"/>
            <pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy
Consumption" processkey="2" processname="Start Exhaust"/>
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Consumption" processkey="90" processname="Extended Idle Exhaust"/>
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            <sourceusetype selected="true"/>
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      <outputstarts value="false"/>
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```
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for MOVES2010b.

VO, CO, NOx, NO2, VMT.

passenger trucks only, rural unrestricted, processes.

Gasoline diesel fuel
Run at preaggregated national level.
Time fully preaggregated.
UT Kane Cnty]]></description>
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		<month id="2"/>
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		<month id="4"/>
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		<month id="12"/>
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		<day id="5"/>
		<beginhour id="1"/>
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	</timespan>
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sourcetypename="Passenger Truck"/>
	</onroadvehicleselections>
	<offroadvehicleselections>
	</offroadvehicleselections>
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processkey="2" processname="Start Exhaust"/>
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processkey="17" processname="Crankcase Extended Idle Exhaust"/>
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processkey="1" processname="Running Exhaust"/>
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processkey="16" processname="Crankcase Start Exhaust"/>
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Hydrocarbons" processkey="15" processname="Crankcase Running Exhaust"/>
            <pollutantprocessassociation pollutantkey="79" pollutantname="Non-Methane
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Hydrocarbons" processkey="19" processname="Refueling Spillage Loss"/>
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processkey="1" processname="Running Exhaust"/>
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processkey="15" processname="Crankcase Running Exhaust"/>
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processkey="17" processname="Crankcase Extended Idle Exhaust"/>
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Hydrocarbons" processkey="16" processname="Crankcase Start Exhaust"/>
            <pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous
Hydrocarbons" processkey="17" processname="Crankcase Extended Idle Exhaust"/>
            <pollutantprocessassociation pollutantkey="1" pollutantname="Total Gaseous
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            <roadtype selected="true"/>
            <sourceusetype selected="true"/>
            <movesvehicletype selected="false"/>
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            <estimateuncertainty selected="false" numberOfIterations="2" keepSampledData="false"
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		<distancefactors selected="false" units="Miles"/>
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		<donotperformfinalaggregation selected="false"/>
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```

Run	Header Item:	Item Value
	Report Description:	Summary Report
	Report Date/Time:	2014-10-29 14:7:49
	MOVES Output Database:	moves2010PM
	Emission Process:	All
1	Run Date/Time:	2014-10-22 13:31:18.0
1	Run Specification:	MOVES2010b PM
1	Run Spec File Date/Time:	2014-10-22 13:31:13.0
1	Run Spec Description:	Example Run Specification for MOVES2010b. PM10/2.5, VMT. passen
1	Mass Units:	g
1	Energy Units:	J
1	Distance Units:	mi
1	Time Units:	year

Year	State	County	Source	Fuel	Road	Run	Total_PM10	Total_PM25	Brake_PM10	Tire_PM10	Brake_PM25	Tire_PM25	Distance
2014	49	49025	31	1	1	1	229083	210942	0	0	0	0	
2014	49	49025	31	1	3	1	442070	407064	431914	193904	113066	46500	35784800
2014	49	49025	31	2	1	1	6689	6489	0	0	0	0	
2014	49	49025	31	2	3	1	79993	77596	8394	4903	2197	1176	725728

Category Field	Value	Description
stateID	49	UTAH
countyID	49025	Kane County
sourceTypeID	31	Passenger Truck
fuelTypeID	1	Gasoline
fuelTypeID	2	Diesel Fuel
roadTypeID	1	Off-Network
roadTypeID	3	Rural Unrestricted Access

Run	Header Item:	Item Value
	Report Description:	Summary Report
	Report Date/Time:	2014-10-29 14:13:34
	MOVES Output Database:	moves2010CO
	Emission Process:	All
1	Run Date/Time:	2014-10-22 14:00:35.0
1	Run Specification:	MOVES2010b CO
1	Run Spec File Date/Time:	2014-10-22 14:00:29.0
1	Run Spec Description:	Example Run Specification for MOVES2010b. VO, CO, NOx, NO2, VMT.
1	Mass Units:	g
1	Energy Units:	J
1	Distance Units:	mi
1	Time Units:	year

Year	State	County	Source	Fuel	Road	Run	CO	NO2	NOx	VOC	Distance
2014	49	49025	31	1	1	1	236281344	468480	13799076	18359934	
2014	49	49025	31	1	2	1	0	0	0	0	0
2014	49	49025	31	1	3	1	177059248	3536251	28620072	6721610	35784800
2014	49	49025	31	1	4	1	0	0	0	0	0
2014	49	49025	31	1	5	1	0	0			

		0			0		0				
2014	49	49025	31	2	1	1		191677		68827	
	352035			62182							
2014	49	49025	31	2	2	1		0		0	
		0			0		0				
2014	49	49025	31	2	3	1		876924		155935	
	1395984			177656		725728					
2014	49	49025	31	2	4	1		0		0	
		0			0		0				
2014	49	49025	31	2	5	1		0		0	
		0			0		0				

Category Field	Value	Description
stateID	49	UTAH
countyID	49025	Kane County
sourceTypeID	31	Passenger Truck
fuelTypeID	1	Gasoline
fuelTypeID	2	Diesel Fuel
roadTypeID	1	Off-Network
roadTypeID	2	Rural Restricted Access
roadTypeID	3	Rural Unrestricted Access
roadTypeID	4	Urban Restricted Access
roadTypeID	5	Urban Unrestricted Access

ATTACHMENT 3

NONROAD Input/Output Files

Table 3-1
NONROAD Emissions Summary

, , , 0, 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
EPA`s NONROAD Emissions Model
Core Model ver 2008a, 07/06/09
Oct 21 13:11:00: 2014
GCNRA OHV
2014
Options file used: C:\NONROAD\GC-OHV-K.opt
Typical weekday for Summer Season, 2014
Region: Kane County, Utah

Tons/Day

Cnty	SubR	SCC	HP	Population	THC-Exhaust	CO-Exhaust	NOx-Exhaust	PM-Exhaust
49025		2260001010	1	2.30E+03	5.98E-01	6.54E-01	4.77E-03	2.35E-02
49025		2260001030	1	3.35E+03	5.79E-01	9.97E-01	6.92E-03	2.29E-02
49025		2265001010	1	1.13E+03	1.62E-02	2.62E-01	3.47E-03	4.94E-04
49025		2265001030	1	1.13E+04	1.39E-01	3.19E+00	2.99E-02	4.95E-03
		Totals		1.81E+04	1.33E+00	5.10E+00	4.50E-02	5.18E-02

grams/Veh-Day

THC-Exhaust	CO-Exhaust	NOx-Exhaust	PM-Exhaust
2.36E+02	2.58E+02	1.88E+00	9.28E+00
1.57E+02	2.70E+02	1.87E+00	6.19E+00
1.29E+01	2.09E+02	2.78E+00	3.95E-01
1.12E+01	2.56E+02	2.40E+00	3.97E-01

lb/Veh-Day

Equipment (Gasoline only)		THC-Exhaust	CO-Exhaust	NOx-Exhaust	PM-10-Exhaust	PM2.5
2-stroke offroad motocycle	34,511	0.52	0.57	0.00	0.02	0.02
2-stroke ATV	50,243	0.35	0.60	0.00	0.01	0.01
4-stroke offroad motocycle	16,998	0.03	0.46	0.01	0.00	0.00
4-stroke ATV	169,434	0.02	0.56	0.01	0.00	0.00
ATV & Offroad Motocycle Average		**0.15**	**0.56**	**4.98E-03**	**5.74E-03**	**5.28E-03**

Written by Nonroad interface at 10/21/2014 1:10:58 PM
This is the options file for the NONROAD program.
The data is sperated into "packets" bases on common
information. Each packet is specified by an
identifier and a terminator. Any notes or descriptions
can be placed between the data packets.

9/2005 epa: Add growth & tech years to PERIOD packet
  and Counties & Retrofit files to RUNFILES packet.

PERIOD PACKET

This is the packet that defines the period for
which emissions are to be estimated. The order of the
records matter. The selection of certain parameters
will cause some of the record that follow to be ignored.
The order of the records is as follows:

1 - Char 10 - Period type for this simulation.
                Valid responses are: ANNUAL, SEASONAL, and MONTHLY
2 - Char 10 - Type of inventory produced.
                Valid responses are: TYPICAL DAY and PERIOD TOTAL
3 - Integer - year of episode (4 digit year)
4 - Char 10 - Month of episode (use complete name of month)
5 - Char 10 - Type of day
                Valid responses are: WEEKDAY and WEEKEND

/PERIOD/
Period type   : Seasonal
Summation type   : Typical day
Year of episode   : 2014
Season of year   : Summer
Month of year   :
Weekday or weekend : Weekday
Year of growth calc:
Year of tech sel   :
/END/

OPTIONS PACKET

This is the packet that defines some of the user
options that drive the model. Most parameters are
used to make episode specific emission factor
adjustments. The order of the records is fixed.
The order is as follows.

1 - Char 80 - First title on reports
2 - Char 80 - Second title on reports
3 - Real 10 - Fuel RVP of gasoline for this simulation
4 - Real 10 - Oxygen weight percent of gasoline for simulation
5 - Real 10 - Percent sulfur for gasoline
6 - Real 10 - Percent sulfur for diesel
7 - Real 10 - Percent sulfur for LPG/CNG
8 - Real 10 - Minimum daily temperature (deg. F)
9 - Real 10 - maximum daily temperature (deg. F)
10 - Real 10 - Representative average daily temperature (deg. F)
11 - Char 10 - Flag to determine if region is high altitude
                     Valid responses are: HIGH and LOW
12 - Char 10 - Flag to determine if RFG adjustments are made
                     Valid responses are: YES and NO

/OPTIONS/
Title 1   : GCNRA OHV
Title 2   : 2014
Fuel RVP for gas   : 8.0
Oxygen Weight %   : 2.44
Gas sulfur %   : 0.0339

```
Diesel sulfur %    : 0.0351
Marine Dsl sulfur %: 0.0435
CNG/LPG sulfur %   : 0.003
Minimum temper. (F): 60
Maximum temper. (F): 84
Average temper. (F): 75
Altitude of region : LOW
EtOH Blend % Mkt   : 75.1
EtOH Vol %         : 9.3
/END/
```

REGION PACKET

This is the packet that defines the region for which emissions are to be estimated.

The first record tells the type of region and allocation to perform.

Valid responses are:

US TOTAL - emissions are for entire USA without state breakout.

50STATE - emissions are for all 50 states and Washington D.C., by state.

STATE - emissions are for a select group of states and are state-level estimates

COUNTY - emissions are for a select group of counties and are county level estimates. If necessary, allocation from state to county will be performed.

SUBCOUNTY - emissions are for the specified sub counties and are subcounty level estimates. If necessary, county to subcounty allocation will be performed.

The remaining records define the regions to be included. The type of data which must be specified depends on the region level.

US TOTAL - Nothing needs to be specified. The FIPS code 00000 is used automatically.

50STATE - Nothing needs to be specified. The FIPS code 00000 is used automatically.

STATE - state FIPS codes

COUNTY - state or county FIPS codes. State FIPS code means include all counties in the state.

SUBCOUNTY - county FIPS code and subregion code.

```
/REGION/
Region Level       : COUNTY
Kane County UT     : 49025
/END/
```

or use -

```
Region Level       : STATE
Michigan           : 26000
```

SOURCE CATEGORY PACKET

This packet is used to tell the model which source categories are to be processed. It is optional. If used, only those source categories list will

```
appear in the output data file.  If the packet is
not found, the model will process all source
categories in the population files.
-----------------------------------------------------
/SOURCE CATEGORY/
                   :2260001010
                   :2260001030
                   :2265001010
                   :2265001030
/END/


Diesel Only -
                   :2270000000
                   :2282020000
                   :2285002015
Spark Ignition Only -
                   :2260000000
                   :2265000000
                   :2267000000
                   :2268000000
                   :2282005010
                   :2282005015
                   :2282010005
                   :2285004015
                   :2285006015
-----------------------------------------------------
 This is the packet that lists the names of output files
 and some of the input data files read by the model.  If
 a drive:\path\ is not given, the location of the
 NONROAD.EXE file itself is assumed.  You will probably
 want to change the names of the Output and Message files
 to match that of the OPTion file, e.g., MICH-97.OPT,
 MICH-97.OUT, MICH-97.MSG, and if used MICH-97.AMS.
-----------------------------------------------------
/RUNFILES/
ALLOC XREF         : data\allocate\allocate.xrf
ACTIVITY           : data\activity\activity.dat
EXH TECHNOLOGY     : data\tech\tech-exh.dat
EVP TECHNOLOGY     : data\tech\tech-evp.dat
SEASONALITY        : data\season\season.dat
REGIONS            : data\season\season.dat
MESSAGE            : c:\nonroad\outputs\gc-ohv-k.msg
OUTPUT DATA        : c:\nonroad\outputs\gc-ohv-k.out
EPS2 AMS           :
US COUNTIES FIPS   : data\allocate\fips.dat
RETROFIT           :
/END/

-----------------------------------------------------
This is the packet that defines the equipment population
files read by the model.
-----------------------------------------------------
/POP FILES/
Population File    : c:\nonroad\data\pop\ut.pop
/END/

POPULATION FILE    : c:\nonroad\data\POP\MI.POP


-----------------------------------------------------
This is the packet that defines the growth files
files read by the model.
-----------------------------------------------------
/GROWTH FILES/
National defaults  : data\growth\nation.grw
/END/


/ALLOC FILES/
Air trans. empl.   :c:\nonroad\data\allocate\ut_airtr.alo
```

```
Undergrnd coal prod:c:\nonroad\data\allocate\ut_coal.alo
Construction cost  :c:\nonroad\data\allocate\ut_const.alo
Harvested acres    :c:\nonroad\data\allocate\ut_farms.alo
Golf course estab. :c:\nonroad\data\allocate\ut_golf.alo
Wholesale estab.   :c:\nonroad\data\allocate\ut_holsl.alo
Family housing     :c:\nonroad\data\allocate\ut_house.alo
Logging employees  :c:\nonroad\data\allocate\ut_loggn.alo
Landscaping empl.  :c:\nonroad\data\allocate\ut_lscap.alo
Manufacturing empl.:c:\nonroad\data\allocate\ut_mnfg.alo
Oil & gas employees:c:\nonroad\data\allocate\ut_oil.alo
Census population  :c:\nonroad\data\allocate\ut_pop.alo
Allocation File    :c:\nonroad\data\allocate\ut_rail.alo
RV Park establish. :c:\nonroad\data\allocate\ut_rvprk.alo
Snowblowers comm.  :c:\nonroad\data\allocate\ut_sbc.alo
Snowblowers res.   :c:\nonroad\data\allocate\ut_sbr.alo
Snowmobiles        :c:\nonroad\data\allocate\ut_snowm.alo
Rec marine inboard :c:\nonroad\data\allocate\ut_wib.alo
Rec marine outboard:c:\nonroad\data\allocate\ut_wob.alo
/END/
-----------------------------------------------------
This is the packet that defines the emssions factors
files read by the model.
-----------------------------------------------------
/EMFAC FILES/
THC exhaust        : data\emsfac\exhthc.emf
CO exhaust         : data\emsfac\exhco.emf
NOX exhaust        : data\emsfac\exhnox.emf
PM exhaust         : data\emsfac\exhpm.emf
BSFC               : data\emsfac\bsfc.emf
Crankcase          : data\emsfac\crank.emf
Spillage           : data\emsfac\spillage.emf
Diurnal            : data\emsfac\evdiu.emf
Tank Perm          : data\emsfac\evtank.emf
Non-RM Hose Perm   : data\emsfac\evhose.emf
RM Fill Neck Perm  : data\emsfac\evneck.emf
RM Supply/Return   : data\emsfac\evsupret.emf
RM Vent Perm       : data\emsfac\evvent.emf
Hot Soaks          : data\emsfac\evhotsk.emf
RuningLoss         : data\emsfac\evrunls.emf
/END/

-----------------------------------------------------
This is the packet that defines the deterioration factors
files read by the model.
-----------------------------------------------------
/DETERIORATE FILES/
THC exhaust        : data\detfac\exhthc.det
CO exhaust         : data\detfac\exhco.det
NOX exhaust        : data\detfac\exhnox.det
PM exhaust         : data\detfac\exhpm.det
Diurnal            : data\detfac\evdiu.det
Tank Perm          : data\detfac\evtank.det
Non-RM Hose Perm   : data\detfac\evhose.det
RM Fill Neck Perm  : data\detfac\evneck.det
RM Supply/Return   : data\detfac\evsupret.det
RM Vent Perm       : data\detfac\evvent.det
Hot Soaks          : data\detfac\evhotsk.det
RuningLoss         : data\detfac\evrunls.det
/END/

Optional Packets - Add initial slash "/" to activate

/STAGE II/
Control Factor     : 0.0
/END/
Enter percent control: 95 = 95% control = 0.05 x uncontrolled
Default should be zero control.

/MODELYEAR OUT/
EXHAUST BMY OUT    :
EVAP BMY OUT       :
```

```
/END/

SI REPORT/
SI report file-CSV :OUTPUTS\NRPOLLUT.CSV
/END/

/DAILY FILES/
DAILY TEMPS/RVP    :
/END/

PM Base Sulfur
 cols 1-10: dsl tech type;
 11-20: base sulfur wt%; or '1.0' means no-adjust (cert= in-use)
/PM BASE SULFUR/
T2        0.0350    0.02247
T3        0.2000    0.02247
T3B       0.0500    0.02247
T4A       0.0500    0.02247
T4B       0.0015    0.02247
T4        0.0015    0.30
T4N       0.0015    0.30
T2M       0.0350    0.02247
T3M       1.0       0.02247
T4M       1.0       0.02247
/END/
```

```
 ,  ,  ,    0, 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
" EPA`s NONROAD Emissions Model"
"Core Model ver 2008a, 07/06/09"
"Oct 21 13:11:00: 2014"
"GCNRA OHV"
"2014"
Options file used: C:\NONROAD\GC-OHV-K.opt
"Typical weekday for Summer Season, 2014"
"Tons/Day"
Cnty ,SubR ,SCC       ,HP   ,Population     ,THC-Exhaust    ,CO-Exhaust     ,NOx-Exhaust    ,CO2-
Exhaust    ,SO2-Exhaust    ,PM-Exhaust     ,Crankcase      ,Hot-Soaks      ,Diurnal
,Displacement   ,Spillage       ,RunLoss        ,TankPerm       ,HosePerm       ,FuelCons.
,Activity       ,LF             ,HPAvg          ,
49025,     ,2260001010,    1, 0.23007605E+04, 0.59847283E+00, 0.65367764E+00, 0.47713569E-02,
0.33985956E+01, 0.68831083E-03, 0.23536416E-01, 0.00000000E+00, 0.22647767E-02, 0.49612080E-02,
0.21815002E-02, 0.33868956E-02, 0.86061526E-02, 0.27549968E-02, 0.50053461E-02, 0.54221307E+03,
0.13697144E+05, 0.10000000E+01, 0.10000000E+01,
49025,     ,2260001030,    1, 0.33495222E+04, 0.57914966E+00, 0.99719626E+00, 0.69222264E-02,
0.39242952E+01, 0.79708960E-03, 0.22866139E-01, 0.00000000E+00, 0.69035999E-02, 0.96302507E-02,
0.23708420E-02, 0.27606445E-02, 0.26067158E-01, 0.52941502E-02, 0.52443757E-02, 0.58927411E+03,
0.20040457E+05, 0.10000000E+01, 0.10000000E+01,
49025,     ,2265001010,    1, 0.11332086E+04, 0.16171658E-01, 0.26166761E+00, 0.34668017E-02,
0.16422238E+01, 0.33819632E-03, 0.49402629E-03, 0.39640360E-03, 0.11154854E-02, 0.24435760E-02,
0.69506536E-03, 0.10791261E-02, 0.42388448E-02, 0.13569366E-02, 0.24653161E-02, 0.17275891E+03,
0.67463442E+04, 0.10000000E+01, 0.10000000E+01,
49025,     ,2265001030,    1, 0.11295602E+05, 0.13889444E+00, 0.31863842E+01, 0.29872244E-01,
0.17504179E+02, 0.36055406E-02, 0.49473373E-02, 0.45091175E-02, 0.23281027E-01, 0.32476116E-01,
0.73595373E-02, 0.85695572E-02, 0.87906331E-01, 0.17603997E-01, 0.17404646E-01, 0.18292174E+04,
0.67582469E+05, 0.10000000E+01, 0.10000000E+01,
```

ATTACHMENT 4

Air Quality Impact Assessment

ATTACHMENT 4: AIR QUALITY IMPACT ASSESSMENT
GLEN CANYON NATIONAL RECREATION AREA
AIR QUALITY ANALYSIS FOR PARK PLANNING

Prepared for:

National Park Service – US Department of Interior
Glen Canyon National Recreation Area
PO Box 1507 – 691 Scenic View Road
Page, AZ 86040

Prepared by:

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(970) 484-7941

December 2014

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EXECUTIVE SUMMARY

This report presents air pollution emissions and air quality analyses for particulates from off-road use of motor vehicles and on-road use of off-highway vehicles (OHVs) and street-legal all-terrain vehicles (ATVs) in Glen Canyon National Recreation Area (GCNRA). The dispersion modeling analysis has been prepared on behalf of GCNRA by Air Resource Specialists, Inc. (ARS) of Fort Collins, Colorado.

GCNRA has proposed to allow off-highway vehicle use of 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 describes the air quality analyses for both a base case (current condition) and a worst-case future alternative scenario that accounts for additional access to these roads/areas.

Dispersion modeling was conducted 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.

Modeling results are summarized in Table ES-1 and ES-2. 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 ES-1
SUMMARY OF 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-2
SUMMARY OF 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 AND BACKGROUND

1.1 Overview

GCNRA is proposing to allow off-road vehicles increased access to the park. This report presents air pollution emissions and air quality analyses of additional off-road vehicle use on paved and unpaved roads in the recreation area. Two scenarios were modeled: a base case (current condition) scenario and a worst-case future alternative scenario, at two park locations: Lone Rock Beach (unpaved area) and Warm Creek Road (unpaved road).

For the base scenario, only conventional highway vehicles such as cars and light duty trucks are operated on existing paved/unpaved roads. A second scenario, the future alternative scenario, estimates the air quality impact of adding off-highway vehicles (OHVs), such as ATVs, and by doubling the number of vehicle trips, which also doubles vehicle miles traveled (VMT). For this analysis, conservative or worst-case assumptions were selected for each scenario and location, based on the estimated traffic use or VMT and length of the road. Based on data from the National Park Service (NPS), Lone Rock Beach provided the worst-case scenario for a higher visitation unpaved area, and Warm Creek Road provided the worst-case scenario for a typical unpaved road. The modeling was done in this way to ensure that all roads within the recreational area are well represented by this analysis.

This dispersion modeling assessment is being provided in support of an analysis for an Environmental Impact Statement (EIS) assessing the air pollution impacts of possible changes in off-highway vehicle use. The modeling analysis is provided to assess compliance with the applicable National Ambient Air Quality Standards (NAAQS). The modeling study and report were prepared by Air Resource Specialists, Inc. (ARS) of Fort Collins, Colorado.

The dispersion modeling analysis assessed the predicted air quality impacts of particulate matter less than 10 microns (PM_{10}) as well as the predicted impacts of particulate matter less than 2.5 microns ($PM_{2.5}$). Based on the historical vehicle counts, only the PM_{10} and $PM_{2.5}$ fugitive emissions were of concern for this analysis, and emissions for other regulated pollutants were not modeled.

Dispersion modeling was conducted using the most recent regulatory version of the AMS/EPA Regulatory Model (AERMOD). ARS uses the version of AERMOD supplied by Providence-Oris dba Bee-Line Software. These modeling results are based on five years of meteorological data collected at Page, AZ for 2005-2009. Modeling followed approved U.S. Environmental Protection Agency (USEPA) procedures, as contained in the USEPA *Guideline of Air Quality Models* found in 40 CFR 51, Appendix W.

1.2 Site Description

GCNRA covers over 1.2 million acres stretching from Lees Ferry in northern Arizona northeastward to the Orange Cliffs in southeastern Utah. The primary uses for GCNRA are water–based recreation on Lake Powell and backcountry recreation in the off-shore regions. All lands within GCNRA are managed by the NPS, part of the U.S. Department of Interior.

Lone Rock Beach and the beginning of Warm Creek Road are both located off of Utah Highway 89 near the town of Big Water. Lone Rock Beach lies on the west side of Lake Powell in Kane County. Warm Creek Road also lies in Kane County on the northwest side of Lake Powell. Figure 1-1 shows the location of Lone Rock Beach and Figure 1-2 shows the location of Warm Creek Road. Both images are from Google Earth.

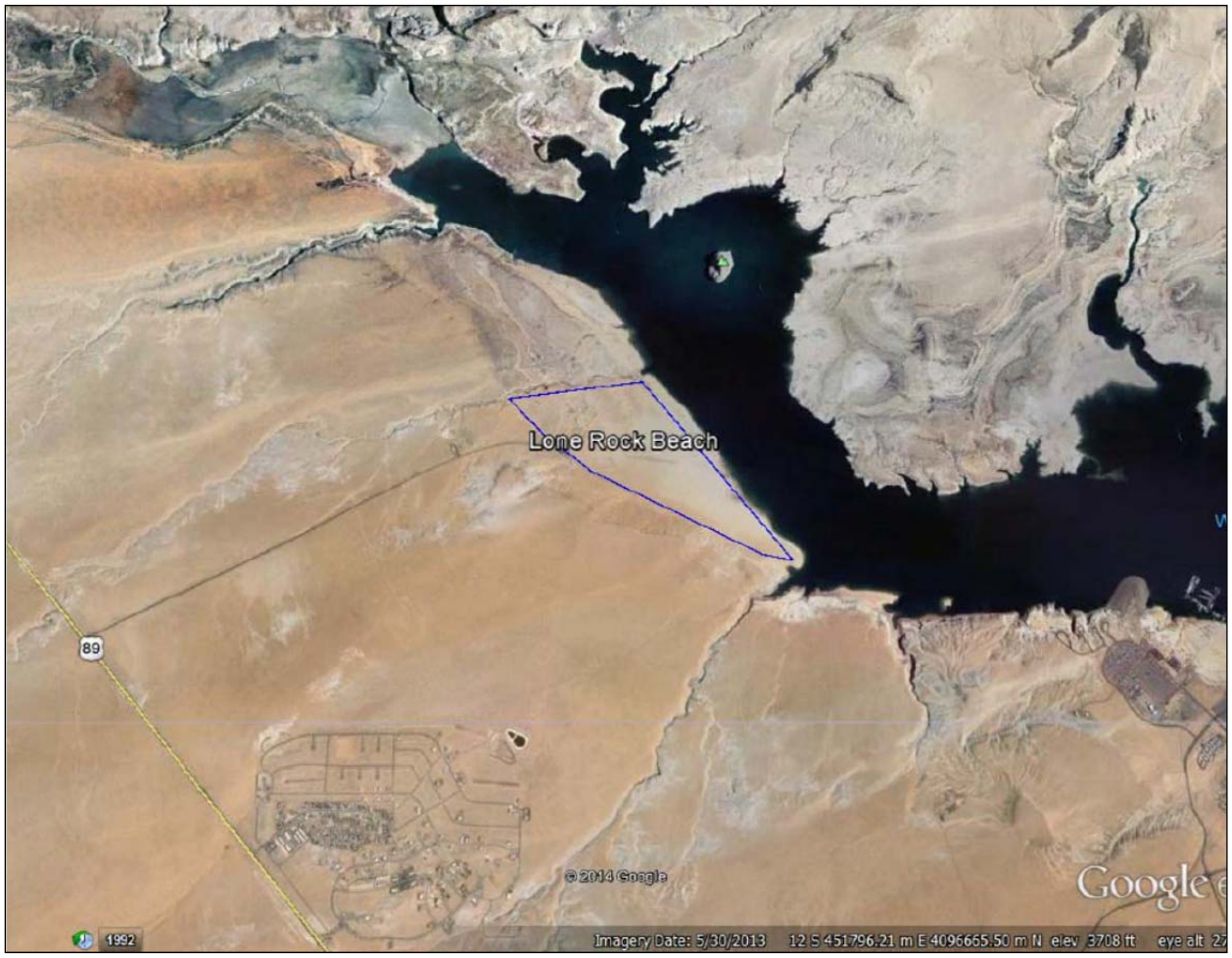


Figure 1-1: Lone Rock Beach Location Map – From Google Earth

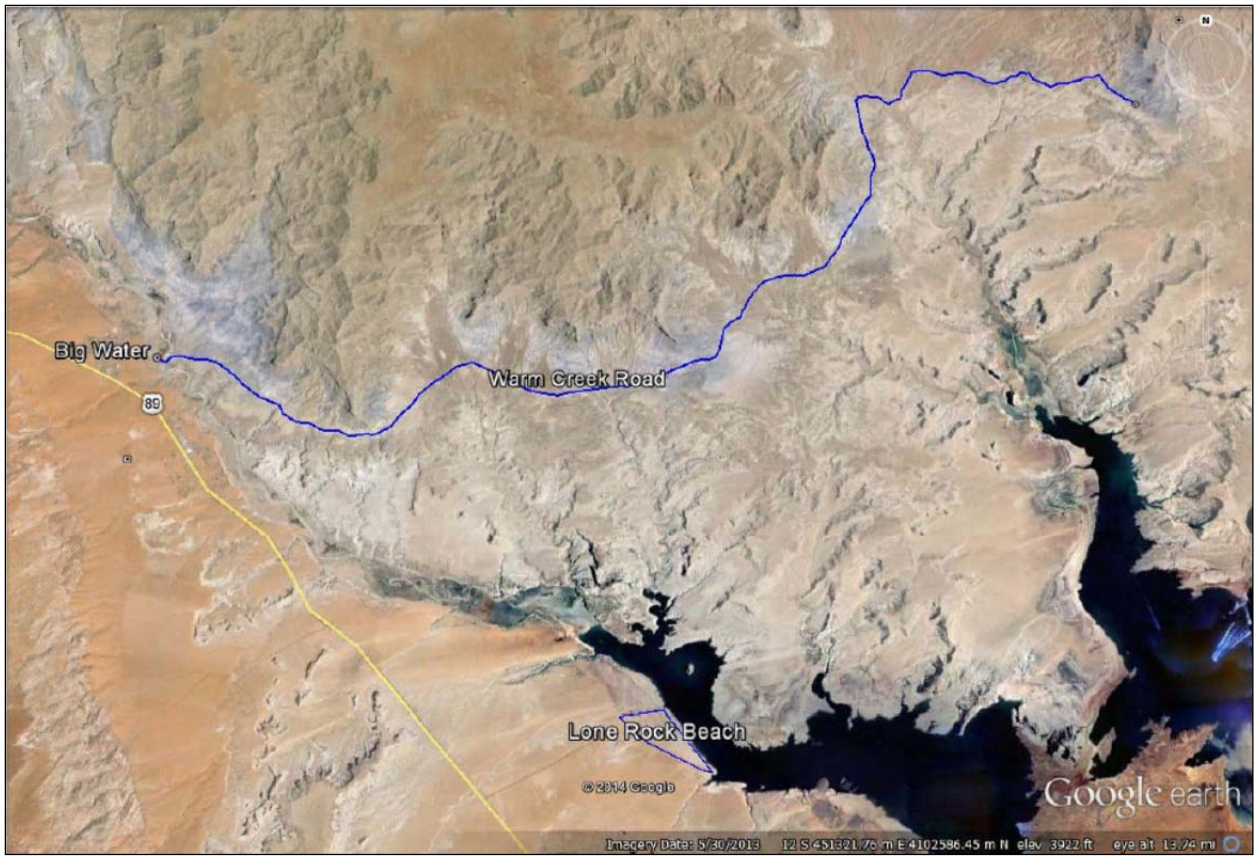


Figure 1-2: Warm Creek Road Map – From Google Earth

2.0 EMISSIONS & SOURCE INFORMATION

Emissions for the Lone Rock Beach and the Warm Creek Road locations are based on road use data provided as part of the proposed Off-road Vehicle Management Plan for GCNRA. This includes vehicle counts as well as posted (or proposed) speed limits for the areas of study. Fugitive particulate emissions were obtained using Table 13.2.2-2 in *AP-42, Section 13.2.2 Unpaved Roads*. EPA's NONROAD Emissions Model (version 2008a) and Motor Vehicle Emission Simulator (MOVES2010b) provided particulate exhaust emissions for OHVs and conventional on-highway vehicles, respectively. Further technical information for these emissions is included in Attachments 1 through 3 of the Technical Support Document.

2.1 Lone Rock Beach Area Source

There are no defined roads in the Lone Rock Beach area. Therefore, it was modeled as a series of four area sources. It was estimated that the area around the point of entry (Lone Rock Beach Road) would have a greater emission rate than that of the rest of the beach due to increased vehicle activity at the area entrance. Therefore, the representative emission rate per square foot for each area decreases as distance from the point of entry increases.

Figure 2-1 shows a map with the approximate breakdown of these four area sources. Tables 2-3 and 2-4 list the area size as well as a breakdown of emission factors associated with each area source.

Figure 2-1: Lone Rock Beach Area Source Breakdown

Road use data from the peak visitation month of June of 2011 was used, as it represented the most conservative estimate for the air quality analysis.

Table 2-1
Lone Rock Beach Base Scenario Emissions

Area ID	Area in ft^2	PM_{10} Emissions ($lb/hr*ft^2$)	$PM_{2.5}$ Emissions ($lb/hr*ft^2$)
A	702,604	4.38E-06	4.39E-07
B	1,509,955	2.04E-06	2.04E-07
C	2,466,457	1.25E-06	1.25E-07
D	3,031,229	1.02E-06	1.02E-07

Table 2-2
Lone Rock Beach Alternative Scenario Emissions

Area ID	Area in ft^2	PM_{10} Emissions ($lb/hr*ft^2$)	$PM_{2.5}$ Emissions ($lb/hr*ft^2$)
A	702,604	8.93E-06	1.04E-06
B	1,509,955	4.16E-06	4.84E-07
C	2,466,457	2.54E-06	2.96E-07
D	3,031,229	2.07E-06	2.41E-07

2.2 Warm Creek Road Volume Source

Warm Creek Road is a 24.1 mile unpaved road. The modeling analysis utilized ten (10) volume sources along a 4000 foot segment of road to represent this source. Each volume source was 24 feet wide and 6 feet tall. Initial lateral and vertical dimensions were estimated per Table 3-1 in EPA's *User Guide for the AMS/EPA Regulatory Model – AERMOD (*EPA-454/B-03-001, September 2004). Other modeling factors, such as the top of plume height, were determined following guidance from EPA's *Haul Road Workgroup Recommendations* memorandum (November 2011). Road use data from the peak visitation month of May of 2013 was used, as it represented the most conservative estimate for the air quality analysis.

Since each of the volume sources is identical, Table 2-3 shows the modeled emission factors, for one of these sources, for the base and alternative scenarios.

Table 2-3
Warm Creek Road Emissions (per modeled volume source)

Scenario	PM_{10} Emissions (lb/hr)	$PM_{2.5}$ Emissions (lb/hr)
Base	0.51	0.05
Alternative	0.91	0.09

3.0 DISPERSION MODELING INPUT DATA

3.1 Model Selection and Technical Inputs

Dispersion modeling was conducted using AERMOD. Selected technical options followed the regulatory default option. Model inputs also specified rural conditions for dispersion coefficients and other variables. AERMOD version 14134 was utilized for this analysis.

The application of AERMOD follows guidance from the *EPA Guideline for Air Quality Models* (40 CFR 51, Appendix W). All modeling used the Universal Transverse Mercator (UTM) grid coordinates. Modeling input/output files are included on the enclosed CD-ROM, as Appendix B.

For modeling at both locations, the emission rates from Section 2.0 were weighted by hour of day to account for normal fluctuations in vehicle traffic or VMT in the recreation area. For more details, please refer to data provided in the Appendices.

Since no road source is perfectly straight, a representative segment of Warm Creek Road was analyzed several times at a variety of angles to represent different orientations. Only the worst-case output results from these varying analyses is presented in this report. By modeling in this manner, the results not only represent Warm Creek Road emissions, but would be a worst-case representation of all roads within the park.

3.2 Receptor Inputs

As explained previously, GCNRA is comprised of over 1.2 million acres of public lands and covers portions of Kane, Garfield, and San Juan Counties in southeastern Utah. Generally, access to public lands is unrestricted within GCNRA.

Lone Rock Beach is a highly visited area and the only location in Glen Canyon where OHV and street-legal ATVs (in addition to conventional motor vehicles) are currently allowed to be operated off-road. The area also includes recreational activities such as swimming, fishing, boating, and camping. For Lone Rock Beach, beginning at five meters out from the source, receptors were spaced every 100 meters out to a distance of approximately 200 meters (also 100 meters spacing between receptors for each interval). Additional receptors at a higher density were not utilized based on the initial modeling results. As modeled concentrations were well below the NAAQS and dropped off sharply from the initial (five meter) receptor interval closest to the source, there is a high confidence that the maximum pollutant concentrations were identified with the current receptor density.

Warm Creek Road stretches from Big Water, Utah, below the southern edge of the Kaiparowits Plateau, and connects to roads within Grand Staircase-Escalante National Monument to the north. The area of interest in this modeling study is limited to the beginning of Warm Creek Road near Big Water until it meets up with National Park Route 264. Around the

Warm Creek Road segment, receptors were placed at 20 meter intervals out to a distance of approximately 100 meters (also 100 meters spacing between receptors for each interval).

Terrain elevations for receptors were determined from USGS National Elevation Dataset (NED) input data for the surrounding area. The USGS downloaded elevation data uses the NAD83 coordinate system. Terrain heights for receptors and point sources were calculated using the most recent version of AERMap supplied by Beeline Software.

3.3 Meteorological Data Inputs

The AERMOD inputs of meteorological data for both locations in the park are a five-year data set from the National Weather Service (NWS) observation site at Page, AZ. The five-year period covers 2005-09. Utah Division of Air Quality (UDAQ) performed the AERMET data processing using the most recent regulatory version of AERMET (Version 14134) and provided these data electronically to ARS. The meteorological data are included with the modeling files on the CD-ROM.

4.0 RESULTS AND DISCUSSION

Tables 4-1 and 4-2 summarize the dispersion modeling results and documents compliance with Federal PM_{10} and $PM_{2.5}$ air quality standards. Dispersion modeling results are presented using the highest predicted 24-hour average for both PM_{10} and $PM_{2.5}$ and highest predicted annual $PM_{2.5}$ average concentration for the meteorological data set employed. As noted above, all modeling input/output files are also included on the enclosed CD-ROM in Appendix B.

The coordinates for the maximum impact point for each scenario are also provided. The maximum impact for both the base scenario and the future alternative scenario for the Lone Rock Beach is concentrated around the point of entry to the beach near Lone Rock Beach Road. The maximum impact for both the base scenario and the future alternative scenario for the Warm Creek Road is concentrated directly along the road. This dispersion modeling analysis concludes that additional OHV use in GCNRA will not cause or contribute to any exceedances of the PM_{10} or $PM_{2.5}$ NAAQS.

Table 4-1
Predicted Concentration Lone Rock Beach (Base vs. Future Alternative)

AVERAGING PERIOD	SCENARIO	TOTAL IMPACT ($\mu g/m^3$)*	PRIMARY NAAQS ($\mu g/m^3$)	RECEPTOR UTM (METERS) E-W	RECEPTOR UTM (METERS) N-S
PM_{10} 24-Hour Ave. (6^{th} Highest)	Base	19.25	150	451,490.9	4,096,815.5
	Alternative	32.35			
$PM_{2.5}$ 24-Hour Ave. (8^{th} Highest)	Base	3.77	35		
	Alternative	4.99			
$PM_{2.5}$ Annual Ave. (1^{st} Highest)	Base	3.13	12		
	Alternative	3.49			

*This includes an hourly background concentration of 2.87$\mu g/m^3$ for $PM_{2.5}$ and 6.62 $\mu g/m^3$ for PM_{10}. Data obtained from Colorado State University's IMPROVE Database Query Wizard; Canyonlands 2005-2009.

Table 4-2
Predicted Concentration Warm Creek Road (Base vs. Future Alternative)

AVERAGING PERIOD	SCENARIO	TOTAL IMPACT ($\mu g/m^3$)*	PRIMARY NAAQS ($\mu g/m^3$)	RECEPTOR UTM (METERS) E-W	RECEPTOR UTM (METERS) N-S
PM_{10} 24-Hour Ave. (6^{th} Highest)	Base	41.25	150	545,946.6	4,550,008.7
	Alternative	68.41			
$PM_{2.5}$ 24-Hour Ave. (8^{th} Highest)	Base	5.64	35	545,272.6	4,550,008.7
	Alternative	7.86			
$PM_{2.5}$ Annual Ave. (1^{st} Highest)	Base	4.20	12		
	Alternative	5.26			

*This includes an hourly background concentration of 2.87$\mu g/m^3$ for $PM_{2.5}$ and 6.62 $\mu g/m^3$ for PM_{10}. 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 was 26 percent of the NAAQS. At this location, the future alternative scenario PM_{10} and $PM_{2.5}$ 24-hour modeling results were 22 and 14 percent of the NAAQS, respectively. The future alternative annual $PM_{2.5}$ modeling result was 29 percent of the NAAQS.

At Warm Creek Road, the base case, the 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. At this location, the future alternative scenario PM_{10} and $PM_{2.5}$ 24-hour modeling results were 46 and 22 percent of the NAAQS, respectively. The future alternative annual $PM_{2.5}$ modeling result was 44 percent of the NAAQS.

APPENDIX A

Modeling Source Input Calculations

Glen Canyon National Recreation Area - Off-Highway Vehicle Air Quality Analysis
Modeled Particulate Emissions - AERMOD Output Results Summary

Table A-2a			
Base Scenario	Annual	24-Hour	
	$PM_{2.5}$	$PM_{2.5}$	PM_{10}
Lone Rock Beach	3.13284	3.76524	19.24665
Warm Creek	4.02782	5.34403	37.23095
Warm Creek 30	4.14077	5.46712	39.03194
Warm Creek 45	4.18571	5.58335	40.2869
Warm Creek 60	4.19789	5.64109	41.12445
Warm Creek 90	4.18459	5.6132	41.24898

Table A-2b			
Alternative Scenario	Annual	24-Hour	
	$PM_{2.5}$	$PM_{2.5}$	PM_{10}
Lone Rock Beach	3.49491	4.99428	32.35002
Warm Creek	4.95535	7.32452	61.23983
Warm Creek 30	5.15866	7.55531	64.45336
Warm Creek 45	5.23955	7.75531	66.69262
Warm Creek 60	5.26148	7.85923	68.18707
Warm Creek 90	5.23754	7.80902	68.40926

Glen Canyon National Recreation Area - Off-Highway Vehicle Air Quality Analysis
Total Emissions Summary - Model Input

Lone Rock Beach Emissions

Table A-3a												
Scenario	Pollutant	Emissions	Emissions (lb/hr)		Area (ft^2)				Emissions (lb/hr*ft^2)			
		tpm	Fug Dust	Vehicle	Area A	Area B	Area C	Area D	Area A	Area B	Area C	Area D
Base	PM_{10}	4.43	3.0764	0.0037	702,604	1,509,955	2,466,457	3,031,229	4.38E-06	2.04E-06	1.25E-06	1.02E-06
	$PM_{2.5}$	0.44	0.3056	0.0026					4.39E-07	2.04E-07	1.25E-07	1.02E-07
	VOC	---	---	0.0221					3.14E-08	1.46E-08	8.95E-09	7.28E-09
	CO	---	---	0.5665					8.06E-07	3.75E-07	2.30E-07	1.87E-07
	NO_X	---	---	0.0958					1.36E-07	6.35E-08	3.88E-08	3.16E-08
Alternative	PM_{10}	8.85	6.1458	0.1303					8.93E-06	4.16E-06	2.54E-06	2.07E-06
	$PM_{2.5}$	0.88	0.6111	0.1190					1.04E-06	4.84E-07	2.96E-07	2.41E-07
	VOC	---	---	3.3308					4.74E-06	2.21E-06	1.35E-06	1.10E-06
	CO	---	---	12.9191					1.84E-05	8.56E-06	5.24E-06	4.26E-06
	NO_X	---	---	0.2057					2.93E-07	1.36E-07	8.34E-08	6.79E-08

Warm Creek Road Emissions (lb/hr)

Table A-3b				
Base Scenario				
Pollutant	Vehicle	Fug Dust	Total	Per source*
PM_{10}	8.65E-04	5.14	5.14	0.51
$PM_{2.5}$	5.95E-04	0.51	0.51	0.05
VOC	5.15E-03	---	5.15E-03	5.15E-04
CO	1.32E-01	---	1.32E-01	0.01
NO_X	2.23E-02	---	2.23E-02	0.00

*10 sources on a 4000 ft section of road

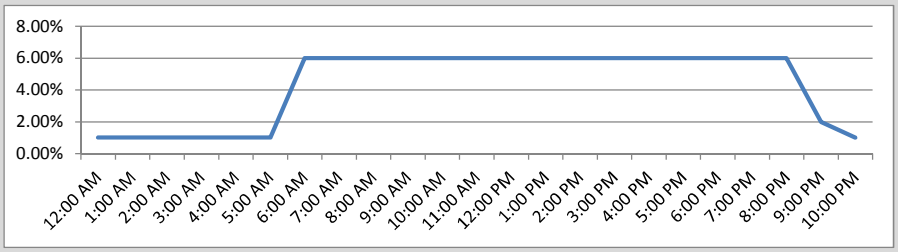
Table A-3c				
Alternative Scenario				
Pollutant	Vehicle	Fug Dust	Total	Per source*
PM_{10}	3.80E-03	9.06	9.06	0.91
$PM_{2.5}$	3.30E-03	0.90	0.90	0.09
VOC	0.08	---	0.08	0.01
CO	0.42	---	0.42	0.04
NO_X	2.49E-02	---	0.02	0.00

*10 sources on a 4000 ft section of road

Glen Canyon National Recreation Area - Off-Highway Vehicle Air Quality Analysis
Hourly Distribution for Traffic & Emissions - Lone Rock Beach and Warm Creek Road

Table A-4	
Hourly Distribution for Vehicle Traffic	**Use Percentage**
12:00 AM	1.00%
1:00 AM	1.00%
2:00 AM	1.00%
3:00 AM	1.00%
4:00 AM	1.00%
5:00 AM	1.00%
6:00 AM	6.00%
7:00 AM	6.00%
8:00 AM	6.00%
9:00 AM	6.00%
10:00 AM	6.00%
11:00 AM	6.00%
12:00 PM	6.00%
1:00 PM	6.00%
2:00 PM	6.00%
3:00 PM	6.00%
4:00 PM	6.00%
5:00 PM	6.00%
6:00 PM	6.00%
7:00 PM	6.00%
8:00 PM	6.00%
9:00 PM	2.00%
10:00 PM	1.00%
11:00 PM	1.00%
Total:	**100.00%**

Figure A-1



Glen Canyon National Recreation Area - Off-Highway Vehicle Air Quality Analysis
Vehicle Exhaust Emissions Summary
MOVES2010b and NONROAD Output Summary

Table A-5a					
Conventional Vehicle Exhaust Emissions - MOVES2010b (lb/VMT)					
	VOC	CO	NO_X	PM_{10}*	$PM_{2.5}$*
On-highway	4.17E-04	1.07E-02	1.81E-03	7.01E-05	4.82E-05

Table A-5b					
Warm Creek Road					
Vehicle Exhaust Emissions (lb/hr)					
Scenario	VOC	CO	NO_X	PM_{10}	$PM_{2.5}$
Base	5.15E-03	1.32E-01	2.23E-02	8.65E-04	5.95E-04

Table A-5c					
Lone Rock Beach					
Vehicle Exhaust Emissions (lb/hr)					
Scenario	VOC	CO	NO_X	PM_{10}	$PM_{2.5}$
Base	2.21E-02	0.57	0.10	3.71E-03	2.55E-03

Table A-5d					
OHV Exhaust Emissions - NONROAD (lb/day per vehicle)					
	VOC	CO	NO_X	PM_{10}	$PM_{2.5}$
OHV	0.15	0.56	4.98E-03	5.74E-03	5.28E-03

Table A-5e					
Warm Creek Road					
Vehicle Exhaust Emissions (lb/hr)					
Scenario	VOC	CO	NO_X	PM_{10}	$PM_{2.5}$
Alternative	8.20E-02	4.19E-01	2.49E-02	3.80E-03	3.30E-03

Table A-5f					
Lone Rock Beach					
Vehicle Exhaust Emissions (lb/hr)					
Scenario	VOC	CO	NO_X	PM_{10}	$PM_{2.5}$
Alternative	3.33	12.92	0.21	0.13	0.12

Note: MOVES2010b PM factors include brake and tire wear.

APPENDIX B

Electronic Copy of AERMOD Modeling Input/Output Files