San Juan Public Lands Center
Draft Land Management Plan &
Draft Environmental Impact Statement

Air Quality Impact Assessment
Technical Support Document

Prepared for

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December, 2007

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LIST OF ACRONYMS AND ABBREVIATIONS

AAQS	Ambient Air Quality Standards
AEGL	Acute Exposure Guideline Level
ANC	Acid Neutralizing Capacity
AP-42	EPA Compilation of Air Pollution Emission Factors
ARM	Ambient Ratio Method
ATSDR	Agency for Toxic Substances and Disease Registry
AQRV	Air Quality Related Value
BCF	billion cubic feet
bbls	barrels
BETX	benzene, toluene, ethylbenzene, and xylene
BLM	Bureau of Land Management
CFR	Code of Federal Regulations
CDPHE	Colorado Department of Public Health and Environment-Air Pollution Control Division
CO	carbon monoxide
CO_2	carbon dioxide
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FLAG	Federal Land Managers Air Quality Related Values Workgroup
FLM	Federal Land Managers
FS	USDA – Forest Service
f[RH]	Relative humidity aerosol growth function
GRI	Gas Research Institute
HAP	hazardous air pollutant
hp	horsepower
IMPROVE	Interagency Monitoring of PROtected Visual Environments
IWAQM	Interagency Workgroup on Air Quality Modeling
kg/ha-yr	kilograms per hectare per Year
km	kilometer
LAC	Level of Acceptable Change
MEVE	Mesa Verde National Park
MLE	Most Likely Exposure
MMBO	million barrels of oil
MMBtu/hr	million British Thermal Units per hour
MRI	Midwest Research Institute
MRL	Minimal Risk Level
N	nitrogen
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NOC	National Operations Center
NO_2	nitrogen dioxide
NO_X	oxides of nitrogen
NPS	National Park Service
PM_{10}	Particulate matter less than or equal to 10 microns in size
$PM_{2.5}$	Particulate matter less than or equal to 2.5 microns in size
ppb	parts per billion

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

PSD	Prevention of Significant Deterioration
RfC	Reference Concentration
RFD	Reasonable Foreseeable Development
S	sulfur
SJPLC	San Juan Public Lands Center
SJPA	San Juan Project Area
SO_2	sulfur dioxide
SRDT	Solar Radiation/Delta Temperature
TCF	trillion cubic feet
tpy	tons per year
TSD	Technical Support Document
UDEQ	Utah Department of Environmental Quality-Air Quality Division
USGS	United States Geological Survey
VOC	volatile organic compound
WEMI	Weminuche Wilderness Area
yr	year
µeq/l	microequivalents per liter
$\mu g/m^3$	micrograms per cubic meter
°K	degrees Kelvin

1.0 INTRODUCTION

Oil and natural gas development activities may occur within San Juan Public Lands Center (SJPLC) Forest Plan Amendment/Resource Management Plan Project Area (SJPA) over the next 15 years. The lands administered by the SJPLC include approximately two and one half million acres in eleven counties (see Figure 1). Bureau of Land Management (BLM) staff at the SJPLC have provided some site-specific information to air quality staff at BLM's National Operations Center (NOC) to conduct the air quality air impact assessment. All other information needed for the analyses was taken from the Canyon of the Ancients National Monument (CANM) air quality analysis.

Prior to conducting the air quality analyses, BLM staff at the SJPLC and NOC, as well as USDA-Forest Service (FS) staff agreed that the methodologies used in the CANM air quality impact assessment would be applied to the analyses for the SJPA. Therefore, no analysis protocol was prepared for this project.

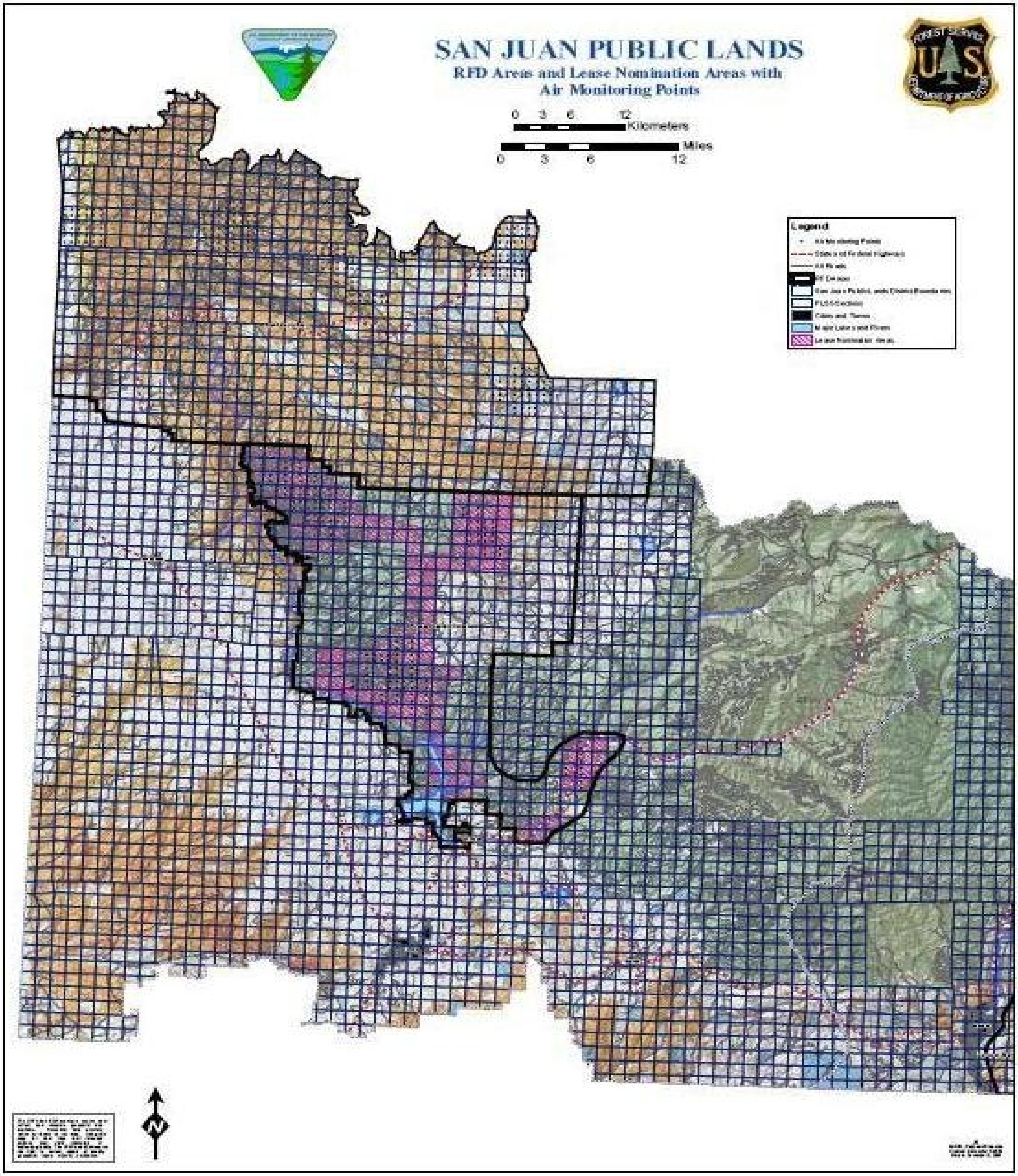
An Environmental Impact Statement (EIS) is being prepared to evaluate alternatives and potential impacts of fluid minerals development (the Project), including impacts to air quality resources. This document is the Draft Air Quality Assessment Technical Support Document (TSD) which presents the air quality impact analyses. The methodologies used were described in the CANM air quality impact analysis protocol (BLM, 2006a). The CANM Protocol was developed with input from the lead agency (BLM), and project advisory stakeholders including the U.S. Environmental Protection Agency (EPA), National Park Service (NPS), and the Colorado Department of Public Health and Environment - Air Pollution Control Division (CDPHE). Unless otherwise noted, the SJPLC air modeling analysis will follow the procedures and methodologies set forth in the CANM Protocol, as agreed to by BLM and FS.

1.1 Site Description

Oil, natural gas, and carbon dioxide are defined as leasable minerals under federal law and regulation. The BLM has jurisdiction over management of federal oil and gas resources underlying both BLM and FS lands, as well as those underlying non-federal surface (split estate) lands within the SJPA. Currently 491,710 acres of public land (21 percent of BLM and FS land in the SJPA) are leased for oil and gas development.

According to the Colorado Oil and Gas Conservation Commission database, 1,339 wells have been drilled in the SJPA, with 40 percent (533) drilled after 1984. At the end of 2004, there were 502 producing wells, 339 (68 percent) of which were located in the Ignacio-Blanco Coal-Bed Methane (CBM) field of Archuleta and La Plata Counties. Of the remainder, 156 wells (31 percent) produced conventional oil and gas in Dolores, Montezuma, and San Miguel counties. Since 1999, an average of 34 new wells have been added annually, equally split between CBM production and conventional oil and gas. In 2004, 331,000 barrels of oil and 89 billion cubic feet (BCF) of gas were produced in the SJPA, excluding carbon dioxide (CO_2) production. CO_2 production from three wells in Montezuma County added another 321 BCF to the total gas produced in the Area.

Figure 1 – Regional Map



1.2 Project Description

For the purposes of this TSD, SJPLC staff estimates that 375 additional wells may be developed within the SJPA over the next 15 years, including 235 natural gas wells on BLM land and 140 wells on Forest Service land. The Reasonably Foreseeable Development (RFD) estimates the potential oil and natural gas reserves that could be developed at production rates equal to the maximum annual production rates that have occurred during the lifetime of the field.

The 375 new wells would require approximately 675 miles of new access roads, and 14 miles of new pipeline right-of-way. Gross surface disturbance would be approximately 1950 acres for well pads, facilities, roads, and pipelines. BLM also estimates that one new production facility will be built within the Project area to treat, compress, and transport the produced natural gas. It is important to note that the actual level of future oil and gas development will depend on the alternative selected and specifics of lease stipulations and other protective measures associated with that alternative.

1.3 Regulatory Framework for Air Quality Analysis

Federal and state governments have established ambient-air-quality standards for criteria air pollutants, including carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter less than or equal to 10 microns in size (PM_{10}), particulate matter less than or equal to 2.5 microns in size ($PM_{2.5}$), ozone, and lead. Ozone is typically not emitted directly from emission sources, but at ground level it is created by a chemical reaction among chemical precursors including oxides of nitrogen (NOx) and volatile organic compounds (VOC). Therefore, the EPA also regulates emissions of VOCs.

EPA classifies all locations in the United States as either "attainment" (including "unclassified"), "non-attainment", or "maintenance" areas with respect to National Ambient Air Quality Standards (NAAQS). These classifications are determined by comparing actual monitored air pollutant concentrations to their applicable federal standards. Most counties in the Four Corners region are classified as attainment for all pollutants; only a small area around the city of Telluride, Colorado, is a PM_{10} Maintenance Area.

Through the Clean Air Act Amendments of 1977, Congress established a system for the Prevention of Significant Deterioration (PSD) to protect areas that are not classified as non-attainment (i.e., cleaner than the NAAQS). A "PSD increment" classification system was implemented based on the amounts of additional NO_2, PM_{10} , and SO_2 degradation that would be allowed above legally defined baseline levels for specifically designated areas. A Class I area would have the greatest limitations, where little additional degradation would be allowed. A Class II area would permit moderate deterioration associated with controlled growth. Mandatory federal Class I areas were defined in the 1977 Amendments as existing National Parks over 6,000 acres and Wilderness Areas and Memorial Parks over 5,000 acres, whereas all other areas not classified as non-attainment were defined as Class II. In addition to more stringent ambient air increments, Class I areas are also protected by the regulation of Air Quality Related Values (AQRVs) by the Federal Land Managers (FLMs) responsible for the areas. Typically, FLMs have focused on two specific AQRVs: visibility, and the deposition of acidic species (e.g., nitrogen and sulfur). The mandatory federal Class I areas closest to the SJPA, and the approximate distances from the locations where development is likely to occur, are:

- Mesa Verde National Park (MEVE), Colorado (25 kilometers [km])
- Weminuche (WEMI) Wilderness Area, Colorado (75 km)

The air quality impact analysis described in this TSD has compared the predicted direct and cumulative air impacts of the Project to state and federal ambient air quality standards, PSD Class I and II increments, and AQRV criteria presented in Table 1.

The air quality analysis consists of several sequential steps:

1) Reviews of the CANM Protocol (BLM, 2006a) and CANM TSD (BLM, 2006b) were conducted so that the analysis would, to the extent practicable, use the same assumptions and methodologies used in the CANM analysis.
2) An emission inventory was compiled that represents a reasonable but conservative estimate of Project emissions.
3) Representative meteorological, background air quality and AQRV monitoring data were taken from the CANM analysis. The background air quality and AQRV monitoring data were used to define the existing air quality impacts from sources in operation as of the date of the monitoring data.
4) A cumulative emission inventory from the CANM analysis was used. This inventory includes emissions from existing oil and gas production sources in the CANM. It also includes emissions from other existing sources and reasonably foreseeable proposed emission sources within the study area, whose impacts are not already represented in the background air quality and AQRV monitoring data (i.e., sources that were not yet in operation as of the date of the monitoring data) within approximately 50 km of the CANM project area.
5) Air quality dispersion models were used to estimate potential direct air quality impacts for each analyzed alternative, as well as the cumulative impacts.
6) The predicted impacts have been compared to relevant significance criteria, standards, PSD increments, and AQRV thresholds.
7) If the predicted impacts warrant consideration of mitigation measures, further modeling analyses may be conducted to evaluate the benefits of mitigation alternatives.

Table 1 – Air Quality Standards, Increments, and AQRV Criteria

Pollutant/AQRV	Averaging Interval	NAAQS (µg/m³)	Class II PSD Increment (µg/m³)	Class I PSD Increment (µg/m³)	AQRV Thresholds
NO_2	Annual	100	25	2.5	--
SO_2	3-Hour	1300 (700)	512	25	--
	24-Hour	365	91	5	--
	Annual	80	20	2	--
PM_{10}	24-Hour	150	30	10	--
	Annual	50	17	5	--
$PM_{2.5}$	24-Hour	65	--	--	--
	Annual	15	--	--	--
CO	1-Hour	40,000	--	--	--
	8-Hour	10,000	--	--	--
Ozone	8-Hour	150	--	--	--
Lead	Quarterly	1.5	--	--	--
Visibility (deciviews)	24-Hour	--	--	--	1.0
Nitrogen Deposition (kg/ha-yr)	Annual	--	--	--	3.0
Sulfur Deposition (kg/ha-yr)	Annual	--	--	--	5.0

Footnotes: The State of Colorado has also established a 3-hour SO_2 ambient air quality standard of 700 µg/m³, as well as a program similar to the federal PSD increments limiting additional amounts of SO_2 above baseline conditions. The FLAG Guideline (FLAG 2000) has established visibility AQRV thresholds. The FLAG "just noticeable change" 1.0 deciview threshold is used to assess the significance of potential visibility impacts. The FS has established cumulative deposition impacts thresholds of concern (Fox et al. 1989).

This National Environmental Policy Act (NEPA) analysis compares potential air quality impacts from the proposed Project to applicable air quality standards, PSD increments and AQRVs, but it does not represent a regulatory air pollutant emissions permit analysis. Comparisons to the PSD Class I and II increments are intended to evaluate a "threshold of concern" for potentially significant impacts, but do not represent a regulatory PSD Increment Consumption Analysis. Such a regulatory PSD increment analysis is the responsibility of the state air quality agency (subject to EPA oversight) and would be conducted during the permitting process.

1.4 Relationship to Other Plans and Documents

The primary law that guides planning on BLM lands is the Federal Land Management Policy Act. The primary laws that guide planning for National Forests include the Multiple Use and Sustained Yield Act, and the Forest and Rangeland Renewable Resources Planning Act as amended by the National Forest Management Act. Both agencies are subject to NEPA which requires an analysis and disclosure processes to identify potential impacts of the development alternatives being considered. This TSD describes the methodologies and data that were used to evaluate direct and cumulative air quality impacts from potential fluid minerals development in the SJPA. The TSD will be referenced in the EIS, and available for review as a stand-alone document.

2.0 EMISSION INVENTORY

Two inventories of air emissions were developed. The Project inventory considered foreseeable oil and gas development activities in the SJPA, and includes air emissions from both construction and production operations. The cumulative inventory considered emissions from other existing sources and reasonably foreseeable future sources within the original CANM study area that were not represented in the background air quality and AQRV data. The air emissions of the following pollutants were inventoried: NO_x (including NO_2), CO, SO_2, VOC, PM_{10}, $PM_{2.5}$, and formaldehyde (a listed the Hazardous Air Pollutant, or HAP.)

2.1 Potential Oil and Natural Gas Development

In 2004, 331,000 barrels of oil and 89 BCF of natural gas were produced in the SJPA. According to the U.S. Geological Survey (USGS) 2000 National Assessment, the most likely estimates of undiscovered oil and gas resources in the San Juan Basin Province are 19 million barrels of oil (MMBO) and 50 trillion cubic feet (TCF) of gas. Undiscovered oil resources in the Paradox Basin are larger, estimated at 500 MMBO; gas is estimated at 1.5 BCF. It is estimated that eventually a maximum of nearly 1,200 new wells could be drilled and produce at least 19 MMBO and 3.25 TCF of gas, which is well below the total discovered and undiscovered resource predicted by the USGS

The BLM estimates that approximately 375 new gas wells and one new gas processing facility could be developed over the next 15 years. The gas processing facility would include separation and dehydration units, and gas compressors. Assuming the new wells and processing facility are built throughout the 15 year project period, a reasonable estimate of the construction schedule is 4 new oil and gas wells and one new processing facility in a year. Future increased natural gas compression requirements were estimated to be 350 hp. Assuming the new wells and processing facility are built throughout the 15 year project period, a reasonable estimate of the construction schedule is 4 new oil and gas wells and one new processing facility in a year.

2.2 Project Emissions

Project activities that potentially result in air emissions include both construction activities and production activities. The Project emission inventory was developed using reasonable but conservative scenarios for each activity. Based on the potential development schedule, Project construction emissions were calculated for the peak year in which the maximum level of construction activity will occur. Project production emissions were calculated based on full production activity. The annual Project emission inventory will sum the construction and production emissions, thereby reasonably and conservatively estimating the overall Project emissions. In addition to the annual emission calculations, short-term (hourly and/or 24-hour) emissions will be calculated for the air modeling analyses based on estimated equipment capacities and reasonable and conservative operating assumptions.

2.2.1 Construction Emissions

Potential construction emission sources include:

- Fugitive $PM_{10}/PM_{2.5}$ emissions, wind erosion emissions, and large equipment tailpipe emissions from general construction activities (grading, scraping, etc.) for construction of well pads, processing facility pads, access roads, and pipelines
- Well drilling and completion, including drill rig emissions and flaring emissions during completion activities
- Fugitive $PM_{10}/PM_{2.5}$ emissions and truck tailpipe emissions from vehicle travel during construction, drilling, and completion operations.

Fugitive $PM_{10}/PM_{2.5}$ emissions from general construction activities were calculated using AP-42 Section 13.2.3, "Heavy Construction Operations" factors and the estimated total gross disturbance area for well pads, facility pads, roadways, and pipelines listed in Table 2 (this is derived from information provided by SJPLC staff). Fugitive $PM_{10}/PM_{2.5}$ emissions from wind erosion at construction areas were calculated using equations in EPA's "Control of Open Fugitive Dust Sources", Section 4.1.3 (EPA, 1988). Fugitive $PM_{10}/PM_{2.5}$ emissions from vehicle travel during construction, drilling, and completion operations were calculated using AP-42 Section 13.2.2 "Unpaved Roads" (EPA, 1995a) equations. The round-trip travel distance for new "resource roads" (i.e., roads constructed to access the new wells and facilities) was estimated at 1.1 miles, and for the primary access roads it was conservatively estimated at 25 miles. It was assumed that adequate dust suppression (watering or dust suppressants) will be applied to resource roads and construction areas to achieve a fugitive PM emission control efficiency of 50%. It was also assumed that dust suppressants are applied to primary access roads to achieve a fugitive PM emission control efficiency of 85%. For all fugitive PM emission sources, $PM_{2.5}$ emissions were estimated as 10% of the calculated PM_{10} emissions, based on data in "Analysis of the Fine Fraction of PM in Fugitive Dust", (MRI 2005). Tailpipe emissions from construction and vehicle equipment for the pollutants CO, NOx, SO_2, VOC, and PM_{10} were calculated using emission factors for large diesel equipment listed in AP-42 Volume II Mobile Sources.

Drilling rig emissions were calculated using AP-42 Section 3.3 emission factors (EPA, 1995a; Table 3.3-1, "Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines"). These AP-42 factors are very conservative and overstate the actual expected emissions. For example, the AP-42 NOx emission factor is equivalent to 14 g/hp-hr, whereas NOx emissions from Tier 2 diesel engines likely to be found on new drill rigs are on the order of 4.8 g/hp-hr. Per the CANM analysis, it was conservatively assumed that all wells were drilled with 2100 hp rigs. Also, it was assumed that all wells were conventional, "straight drilled" wells. Flaring emissions for gas wells were calculated based on AP-42 Section 13.5 factors for NOx and CO, assumed gas constituent analysis for VOC with a 50% flare destruction efficiency, and operator data on flaring volumes.

Appendix A presents detailed emission calculation tables for each of the construction emission sources, and Table 3 presents a summary of construction emissions for natural gas development.

Table 2 – Summary of Gross Surface Disturbance

Resource and Type of Activity	**Number sites**	**Acres/site**	**Total acres**
OIL AND GAS DEVELOPMENT			
Pads	375	2.1	787.5
Pipelines	11.5	2.0	23.1
Roads	375	3.0	1116
Oil and Gas Pads, Pipelines, Roads Subtotal			1926
Oil and Gas Pads, Pipelines, Roads : Per well average			*5.1 per well*
Facility Sites	1	3.0	3.0
Facility Pipelines	1	18.2	18.2
Oil and Gas Facility Subtotal			21.2
Oil and Gas Facility Subtotal / 1 facilities			*21.2 per facility*
TOTAL O&G GROSS DISTURBANCE			**1947**

Table 3 – Summary of Construction Emissions

Oil and Gas Well Construction Emissions - Peak Construction Year											
# of New Wells/yr = 25			**# of New Processing Facilities/yr = 1**								
	Pad, Road, Pipeline Construction		Rig Move and Drilling		Completion and Flaring		Subtotals per well pad		Facility Construction		**TOTAL**
	(lb/hr)	(tons/well)	(lb/hr)	(tons/well)	(lb/hr)	(tons/well)	(lb/hr)	(tons/well)	(lb/hr)	(tons/plant)	**(tons/yr)**
NOx	12.27	0.250	27.53	9.908	3.11	0.04	42.92	10.20	12.50	0.644	**255.65**
CO	3.82	0.082	5.96	2.142	16.87	0.21	26.65	2.43	4.12	0.231	**61.05**
SO_2	1.46	0.029	1.82	0.655	0.0005	0.0001	3.28	0.68	1.47	0.074	**17.19**
PM_{10}	8.21	0.378	2.47	0.871	0.35	0.094	11.04	1.34	24.08	3.681	**37.26**
$PM_{2.5}$	1.83	0.064	2.03	0.728	0.05	0.014	3.91	0.81	3.58	0.443	**20.61**
VOC	0.92	0.021	2.23	0.658	0.008	1.18	3.16	1.86	1.03	0.061	**46.44**
Formaldehyde	NA	NA	1.05	0.377	NA	NA	1.05	0.38	NA	NA	**9.42**

2.2.2 Production Emissions

Potential production emission sources include:

- combustion source emissions at well heads and processing facilities (central gas compressor engines, small well head engines, and heaters for separators and dehydrators)
- Fugitive $PM_{10}/PM_{2.5}$ emissions and truck tailpipe emissions from vehicle travel related to well servicing and truck transport of oil and water
- VOC flashing emissions from separators, dehydrators and tank batteries.

Well head engine emissions were calculated using AP-42 Section 3.2 (EPA, 1995a; Natural Gas-fired Reciprocating Engines) emission factors. These emission factors are very conservative and overstate the actual expected emissions. For example, the AP-42 NOx emission factor for a 350 hp engine is equivalent to 12 g/hp-hr, whereas NOx emissions from 350 hp lean-burn 4-stroke natural gas fired compressor engines are typically on the order of 3 g/hp-hr. In addition to the gas compressor engines, some of the new oil and gas wells may use small (50 hp) well head engines. Current operators in the CANM have indicated that only a fraction of the existing wells are equipped with small well head engines; therefore, a reasonable and conservative assumption was made that 25% of the new oil and gas wells would include a 50 hp gas-fired well head engine.

The exact configuration of separator and dehydration heaters is not known. Some of these units may be at well head locations, while others may be centralized at the processing facilities. As in the CANM analysis, a reasonable and conservative assumption was made that one 0.25 million British Thermal Units per hour (MMBtu/hr) gas-fired heater will be located at each of the 375 new oil and gas wells. The annual operating level of well head heaters was adjusted so that the annual fuel consumption matched the existing typical well head fuel consumption of approximately 15 mcf/month per well, based on discussions with BLM staff.

Fugitive $PM_{10}/PM_{2.5}$ emissions from vehicle travel related to well servicing and truck transport of oil and water were calculated using AP-42 Section 13.2.2 "Unpaved Roads" equations (EPA, 1995a). It was assumed that adequate dust suppression (watering or dust suppressants) will be applied to “resource roads” to achieve a control efficiency of 50%, and that dust suppressants is applied to primary access roads to achieve a fugitive PM emission control efficiency of 85%. The round-trip travel distance for resource roads was estimated at 1.1 miles, and for the primary access roads it was conservatively estimated to be 25 miles. The number of truck trips per oil and gas well was based on (from the CANM analysis):

- maximum projected oil production rates of 1,150,000 bbls/yr for the 375 new wells,
- the capacity of a haul truck at 180 bbls,
- assuming that water production rates are equal to oil production rates, and that all water is trucked offsite for disposal (some water will likely be disposed of via water disposal wells).

The calculated number of oil and water haul truck trips per well is 158 per year. The general well servicing (pickup truck) traffic assumed that each well was visited once per week (52 times per year); however, it was also assumed that each service trip included visits to multiple wells. Therefore, the vehicle travel emissions were calculated assuming 52 roundtrips per year per well on each access road, but 10 roundtrips per year per well on each primary road.

Tailpipe emissions from oil and water haul trucks were calculated using emission factors for large diesel equipment listed in AP-42 Volume II Mobile Sources.

The "per well" fugitive VOC emissions for separator to storage tank flashing were estimated at 20 tpy per well. This estimate is based on the emission level that would require the storage tank battery to comply with upcoming CDPHE requirements (Regulation 7) to control VOC emission by 95%, and therefore is a reasonable and conservative upper estimate on the future VOC emissions from condensate storage tanks. The fugitive VOC emissions from wellhead dehydrator still vents were estimated using emission test results and Gas Research Institute (GRI) GLYCalc estimates presented in "Glycol Dehydrator BTEX and VOC Emission Testing Results at Two Units in Texas and Louisiana", (EPA, 1995b; these reported VOC emission rates were ratioed down for the lower gas production rates per well at CANM and were unchanged for the SJPA analysis).

Appendix A presents detailed emission calculation tables for each of the production emission sources, and Table 4 presents a summary of production emissions for oil and natural gas development.

Table 4 - Summary of Production Emissions

Oil and Gas Production Emissions Summary									
# of O&G wells = 375									
	O&G Production Truck		Wellhead Heaters and Flashing		Wellhead Small Engines		O&G Compression		**TOTAL**
	(lb/hr)	(tons/well)	(lb/hr)	(tons/well)	(lb/hr)	(tons/well)	(lb/hr)	(tons/yr)	**(tons/yr)**
NOx	0.04	0.05	0.03	0.01	1.11	4.84	9.43	41.29	**520.1**
CO	0.05	0.07	0.29	0.13	1.86	8.15	0.73	3.21	**839.9**
SO_2	0.001	0.001	0	0	0.0003	0.001	0.001	0.006	**0.67**
PM_{10}	0.57	0.65	0.003	0.001	0.01	0.04	0.02	0.10	**248.7**
$PM_{2.5}$	0.09	0.10	0.003	0.001	0.01	0.04	0.02	0.10	**42.0**
VOC	0.02	0.03	4.70	20.58	0.01	0.06	0.27	1.19	**7736.0**
Formal-dehyde	NA	NA	NA	NA	0.01	0.04	0.12	0.53	**4.7**

Table 5 presents the overall summary of Project emissions.

Table 5 - Summary of Project Emissions

Project Maximum Annual Emissions			
	Construction emissions (tpy)	Production emissions (tpy)	Total emissions (tpy)
NOx	255.7	520.1	775.8
CO	61.0	839.9	900.9
SO_2	17.2	0.7	17.9
PM_{10}	37.3	248.7	286.0
$PM_{2.5}$	20.6	42.0	62.6
VOC	46.4	7736.0	7782.5
Formaldehyde	9.4	4.7	14.2

2.3 Cumulative Emission Inventory

The cumulative inventory includes emissions from other existing sources and reasonably foreseeable proposed emission sources within the study area (Table 6) whose impacts are not already represented in the background air quality and AQRV monitoring data (i.e., sources that were not in operation as of the end date of the monitoring data, December 2004).

The cumulative inventory area has been defined as the region within 50 km from the center of the CANM Project Area (approximate Universal Transverse Mercator coordinates 685 km E and 4145 km N, Zone 12, NAD83). Per BLM's agreement with the FS and SJPLC staff, the cumulative emissions inventory, as described below for the CANM analysis, was used in this SJPA analysis. The inventory for other existing sources was developed using data obtained from the CDPHE and Utah Department of Environmental Quality-Air Quality Division (UDEQ). Only emission sources that were not operational as of the end of 2004 were included in the cumulative inventory. UDEQ data indicated that the only new source or modification in the area since 2004 was at a uranium processing mill in Blanding located approximately 50 km from CANM. The increase in emissions was 7.4 tpy of NOx, and less than 2 tpy for all other criteria pollutants. Given the large distance and small emissions, this source was not included in the cumulative analysis. CDPHE provided inventory data on 7 new or modified emission units since the end of 2004. These sources included three new emission sources in CANM (permitted by one of the oil and gas operators), a 261 hp compressor, a 142 hp engine, and a 170 kW generator, all well head engines. Other CDPHE cumulative sources included a Saturn T-1300 gas-fired turbine located 45 km distant (NOx emissions of 16 tpy), a 3.6 MMBtu boiler located 21 km distant (emissions less than 10 tpy of all pollutants), a concrete batch plant located 29 km distant (PM10 emissions less than 6 tpy), and a sand and gravel operation located 47 km distant (PM10 emissions less than 7 tpy). Based on the CDPHE cumulative inventory criteria, only the three emission sources located within CANM were included in the cumulative emission inventory.

Proposed BLM development projects within the cumulative inventory area that were not in operation as of the end of 2004 (these projects are classified as reasonable foreseeable development) were also considered in the cumulative inventory. Based upon discussions with Colorado and Utah State BLM offices, there is one reasonable foreseeable development project in the cumulative inventory area; the Monticello NEPA project in Utah located approximately 50 km west of the CANM project area. The projected level of well development described in the Monticello RFD is 5 to 21 wells per year for 20 years over a 3.6 million acre management area. The Monticello EIS document does not include a compilation of air emissions or an air quality impact analysis, because air quality was not identified as a concern during the EIS scoping process. Therefore, a simplified approach was used to include the Monticello NEPA project in the cumulative analysis. Since the well development rate and total number of wells are similar between the Monticello and CANM projects, the total emissions for construction and production were assigned to a 10 km square volume source located 50 km west of CANM to represent emissions from the Monticello NEPA project. Note that the San Juan Basin NEPA project in New Mexico and Moab NEPA project in Utah are outside of the cumulative inventory area and therefore were not included in the cumulative analysis (the Moab project is approximately 80 km distant, and the San Juan project is approximately 100 km distant).

Table 6 – Emission Sources Permitted Since December 31, 2004

Facility Name	Type	Emissions (TPY)		
		CO	NOx	PM_{10}
Questar Exploration & Prod - Cutthroat	261hp Mainline Compressor	3.5	41.0	
	Natural Gas Fired 142hp Engine	1.9	27.4	
	Natural Gas Waukesha 170 Kw Genset	0.7	1.4	
Muscanell Millworks, Inc.	Decton Boiler Rated at 3.6 Mmbtu/Hr	8.6	7.1	5.2
Mid-America Pipeline Co Dove Cr Station	Nat Gas Fired Solar Saturn T-1300 Turbine	31.2	16.4	
Sky Ute Sand & Gravel	McNeilus Concrete Batch Plant			5.5
Mountain Stone Inc. - Koenig Pit	Fugitive Emissions			6.8

3.0 AIR QUALITY ANALYSIS METHODOLOGY

3.1 Model Selection

The pollutants PM_{10}, $PM_{2.5}$, NO_X, SO_2, CO, and formaldehyde were modeled using the EPA Preferred/Recommended air pollutant dispersion model AERMOD (EPA, 2004). Generally, the AERMOD model is recommended by EPA for assessing impacts within 50 km of a source of pollution. As can be seen in Figures 3 and 4, some of the source areas are > 50km from some of the mid-field receptors, as well as most of the Class I receptors. Based on the model's design, potential impacts estimated at these longer distances would be conservatively higher that actually expected. Due to the complexity of the ozone formation at ground-level, ozone impacts can not be predicted with a Gaussian dispersion model such as AERMOD. Therefore, ozone impacts were not estimated for the SJPLC modeling analysis.

3.2 Class I Impact Analysis Procedures

The nearest Class I area is Mesa Verde National Park (MEVE), located approximately 25 km to the south of the assumed development area. The next closest Class I area is the Weminuche Wilderness Area (WEMI), located about 75 km to the east of the Project area. Given the proximity of MEVE and WEMI versus other Class I areas in the region, it is highly likely that the Class I impacts of the Project will be the greatest at either MEVE or WEMI.

Visibility is affected by plume impairment (heterogeneous) or regional haze (homogeneous). Since potential air pollutant emission sources include many small sources spread over a very large area, discrete visible plumes are not likely to impact distant sensitive areas. At this preliminary resource planning stage, the emission sources in this analysis consisted of sources that do not have a defined location. In addition, the U.S. Congress has delegated implementation of the Clean Air Act (including the determination of "visual impacts of plumes from present and future coal-fired power plants in the Coal Bed Methane emphasis area") to applicable local, state and tribal air quality regulatory agencies (subject to EPA oversight). These agencies are able to determine the visual impact of the plume from individual emission sources during the new source review process. In addition, given the nature of air pollutant emissions from oil and gas activities, plume impairment is not likely to occur. Therefore, this analysis did not evaluate the near-field visibility impact of the sources at the resource planning stage.

Regional haze degradation is caused by fine particles and gases scattering and absorbing light. Potential changes to regional haze were calculated in terms of a perceptible "just noticeable change" (1.0 deciview [dv]) in visibility when compared to background conditions. A 1.0 dv change is considered potentially significant in mandatory Federal PSD Class I areas as described in the EPA Regional Haze Regulations, and was originally presented in Pitchford and Malm (1994). A 1.0 dv change is defined as about a 10 percent change in the extinction coefficient (corresponding to a 2 to 5 percent change in contrast, for a black target against a clear sky, at the most optically sensitive distance from an observer), which is a small but noticeable change in haziness under most circumstances when viewing scenes within mandatory Federal Class I areas.

The first level screening analysis for visibility follows the recommendations in the FLAG (2000) Guideline document. Specifically, this analysis compared daily modeled primary (PM_{10} and $PM_{2.5}$) and secondary (sulfate and nitrate) particulate matter concentrations to “natural” background conditions and seasonal relative humidity (f[RH]) values. From this comparison, a potential change in deciview was calculated. FLAG identified a 0.5 dv (5 percent change in extinction) threshold as the “Limit of Acceptable Change” (LAC) for a single emission source’s impact, and a 1.0 deciview (10 percent change in extinction) threshold for the cumulative impacts from multiple emission sources. This screening methodology is implemented by BLM in spreadsheet form (Archer, 2003)

Because the seasonal screening analysis indicated that predicted changes in visibility due to BLM sources exceeded the 1.0 deciview LAC, a daily refined analysis was conducted based on hourly Interagency Monitoring of PROtected Visual Environments (IMPROVE) optical monitoring data measured at MEVE and WEMI for 1988 through 2005 (the most recent available data.) The results are presented in Chapter 5. As with the screening methodology, this refined analysis methodology is implemented by BLM in spreadsheet form for WEMI (Archer, 2007a) and MEVE (Archer, 2007b).

3.3 Background Air Quality and AQRV Data

The background air quality and AQRV monitoring data are used to define the current air quality impacts from sources in operation as of the date of the monitoring data. Modeled direct and cumulative impacts are added to these background concentration values to evaluate total impacts with respect to state Ambient Air Quality Standards (AAQS) and NAAQS. The background air quality and AQRV data are also used to define which sources will be included in the cumulative emission inventory (i.e., sources that were not yet in operation as of the date of the monitoring data, and therefore whose impacts are not already represented in the background data).

There are no air quality monitors operating in the Project area, but background air quality conditions in the SJPA can be determined from monitoring data collected at other representative locations throughout the region. All criteria air pollutants are monitored in the region by state and local air quality regulatory agencies, and AQRV monitoring in MEVE is conducted by the IMPROVE program. Table 7 summarizes the background air quality and AQRV data that were used for the air quality analyses. The background data has been conservatively selected from the monitoring station with the highest concentrations during the reporting period.

Table 7 – Background Air Quality & AQRV Data

Pollutant/AQRV Parameter	Background Data	Monitoring Station
NO_2 – Annual Concentration (ppb)	9	La Plata CO
SO_2 – Annual Concentration (ppb)	2	Farmington NM
SO_2 – 24-hr High-2nd High Concentration (ppb)	8	Farmington NM
SO_2 – 3-hr High-2nd High Concentration (ppb)	26	Farmington NM
CO – 8-hr High-2nd High Concentration (ppm)	1.6	Ignacio CO
CO – 1-hr High-2nd High Concentration (ppm)	2.0	Ignacio CO
PM_{10} – Annual Concentration (μg/m^3)	21	La Plata CO
PM_{10} – 24-hr High-2nd High Concentration (μg/m^3)	64	La Plata CO
$PM_{2.5}$ – Annual Concentration (μg/m^3)	6.9	Farmington NM
$PM_{2.5}$ – 24-hr High-2nd High Concentration (μg/m^3)	22.5	MEVE
Ozone – 8-hr High-2nd Concentration (ppb)	71	MEVE
Ozone – 1-hr High-2nd Concentration (ppb)	77	MEVE
Nitrogen Deposition (kg/ha-yr)	2.3	MEVE
Sulfur Deposition (kg/ha-yr)	1.2	MEVE
MEVE Visibility (annual average deciview)	23.6	MEVE

3.4 AERMOD Source and Receptor Configurations

Three source-receptor configurations were modeled: a near-field configuration (3 km by 3 km sized receptor grid), a mid-field configuration (100 km by 110 km sized receptor grid), and a Class I configuration (using the NPS receptor grid in MEVE and 2 receptors to represent the WEMI).

3.4.1 Near-field Configuration

The following section describes the methodology used for near-field modeling for the SJPA analysis. Following discussions with BLM and FS staff, and the contractor for the CANM analysis, it was decided to use the CANM near-field results unchanged for this analysis. This is appropriate because of the generic layout used for the analysis and the similarity of the two Projects.

Given the nature of the emission sources associated with oil and gas development, it is known that the combustion source stack heights would be approximately 10 meters or less above ground level, and that the majority of PM emissions will occur as ground-level fugitive releases. Therefore, maximum air quality impacts are typically localized near the emission sources. Also, the exact location and layout of the new emission sources is not know with any certainty. Therefore, a near-field source-receptor configuration was developed using a generic layout of well pad, roadway, and processing facility sources which represents a reasonable and conservative configuration. Since this configuration focuses on near-field impacts and the exact locations of the sources are not known, source and receptor elevations were not considered in the near-field analysis.

Based on the discussion of potential future development levels in Section 2 and given that the typical well spacing density in the project area is no greater than 160 acres per well (4 wells per section), a conservative assumption for the maximum density of construction is 2 new wells, 2 existing wells, and one new production within one section. The construction emission sources for 2 new wells and a central processing facility were combined with production emissions from 2 existing wells to fully define an upper bound construction scenario. A separate production scenario was analyzed that considered emissions from four producing wells and one central processing facility.

Point sources were used to model combustion source emissions from construction (drill rigs, flares, and heavy equipment tailpipe emissions) and production sources (well head engines and heaters, and central compressor emissions at the production facility). The well head engine and heater emissions were combined and modeled through an engine stack (this is a reasonable assumption because the majority of the emissions would be from the well head engine). Stack parameters used for these various point sources are presented in Table 8.

Table 8 – Point Source Stack Parameters

Source Type	Stack Height (m)	Temperature (°K)	Exit Velocity (m/s)	Stack Diameter (m)
Drill Rig	6	750	20.0	0.2
Flare	5	1273	20.0	1.0
Dozer Tailpipe	2	750	20.0	0.2
350 hp Compressor	6	750	20.0	0.2
Well Head engine	2	500	4.0	0.2

Volume sources were used to model fugitive PM construction emissions, including general construction emissions at well pad, processing facility, pipeline, and roadway areas, and wind erosion emissions at these construction areas. Multiple volume sources were also used to represent “line sources” of fugitive PM and tailpipe emissions from construction and production vehicle traffic. Hourly emission factors were applied to construction fugitive sources for the hours of 08:00 through 17:00 to represent the typical construction period (although drill rig engines were assumed to operate 24-hrs per day).

The generic source-receptor configuration was laid out as illustrated in Figure 2. The two new well pads were arranged in the northwest and southeast corners of a 640-acre section, the existing wells in the northeast and southwest corners, and the processing facility pad was located in the center. Each new pad was modeled as a 100m by 100m volume source for fugitive PM construction emissions. Access roads were modeled as a series of equally spaced volume sources. The separation of the volume sources that represent these two roads was ½ of the lateral dimension of 12.2 m (equivalent to a 40-foot-wide road), based on guidance in Table 3-1 of the AERMOD User’s Guide (EPA, 2004). The combustion point sources representing drill rig engines, flares, the heater and well head engines at the existing wells, the central compressor, and construction equipment tailpipe emissions were located at the center of the well pads and the processing facility.

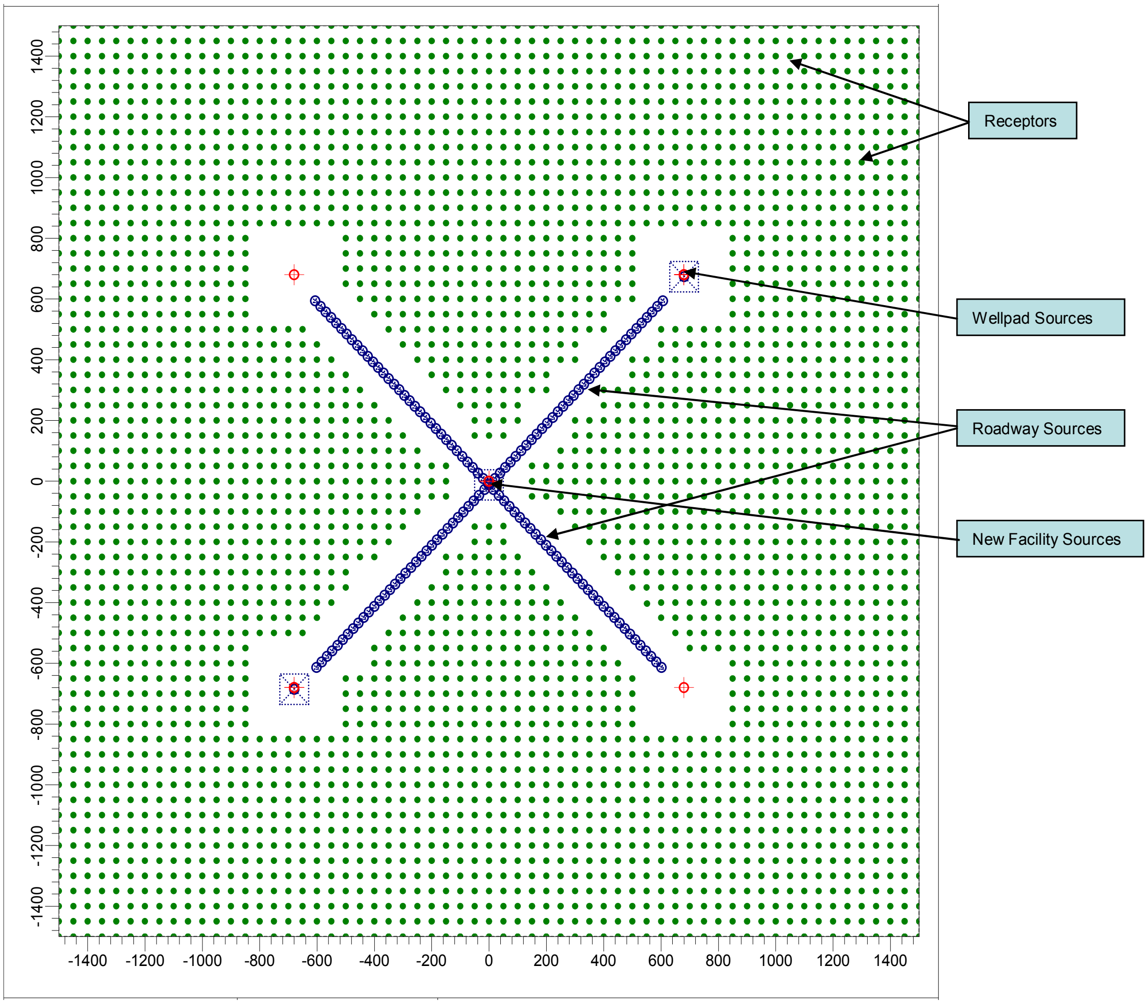
The total "per well" fugitive PM construction and wind erosion emissions from pad, access road, and pipeline ground disturbance (corresponding to a conservative 7 acres of total disturbance per well, although SJPLC analysis assumes only 5.4 acres per well), and from "per well" construction vehicle traffic, were allocated to the construction pad and roadway volume sources as follows. First, the 100m by 100m well pad volume source is 2.5 acres in size; therefore the portion of the total fugitive PM emissions assigned to each well pad was 2.5/7. The remainder of the fugitive PM emissions were allocated to the roadway volume sources (along with construction tailpipe emissions). The second line source, representing the service road for the 2 existing production wells, was modeled using production vehicle fugitive PM and tailpipe emissions. Since the facility pad is the same size as the well pads in this generic layout, the same fugitive PM emission rates were used for the new facility pad.

For PM_{10} and $PM_{2.5}$ analyses, the layout was modeled (for a single meteorological year) once at each of 8 orientations (at 22.5 degree intervals), to ensure that impacts from all directional layouts and meteorological conditions are assessed. Since the layout is symmetrical, modeling through 180 degrees to assessed all possible wind direction effects.

Model receptors were located a minimum of 100 m from all emission sources, and a 100 m grid spacing was used throughout the section (3 km by 3 km total grid size).

Two source groups were defined to properly group the emission sources, CONSTRUC for the Project construction scenario and PRODUCE for the Project and existing source production scenario.

Figure 2 - Near-field AERMOD Layout of Emission Sources and Receptors



NOTE: Distance units are meters relative to center of layout

3.4.2 Mid-field Configuration

The mid-field configuration for the SJPA is significantly different from that used for the CANM modeling, primarily because of the wide-spread nature of potential development areas, but also because both BLM and FS administer the potential development areas. As such, the Project area was divided by Agency as follows:

Table 9 – Areas of Potential Development by Agency

Area Number	Responsible Agency
1	BLM
2	BLM
3	BLM
4	BLM
5	BLM
6	FS
7	FS
8	FS
9	FS

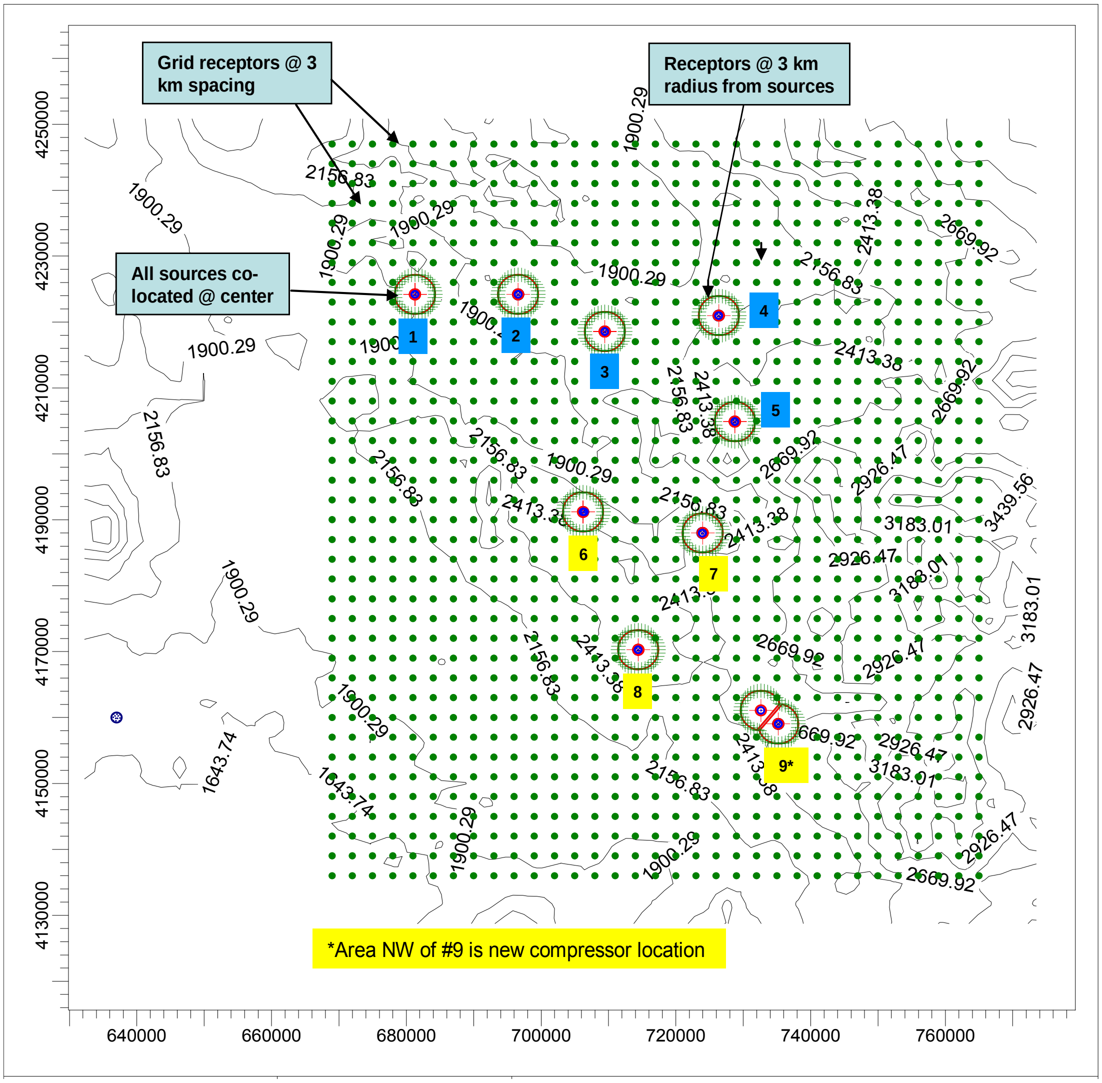
Please see Figure 3 for a graphical representation of the above areas.

The mid-field analysis assessed Project and cumulative impacts at locations within the SJPA and at other nearby PSD Class II areas. It expanded the geographical extent of the near-field analysis by utilizing an approximately 100 km by 110 km sized receptor grid, centered in the Project area. Mid-field model receptors were based on a 3 km grid spacing and were located a minimum of 3 km from all emission sources (impacts within this 3 km zone are assessed by the near-field analysis). USGS elevation data were processed with AERMAP to derive elevation and hill height scale data. The mid-field source-receptor configuration is illustrated in Figure 3.

The mid-field Project construction source configuration is based on the peak year construction scenario of 9 new wells (one per area), a single new processing facility (also in Area 9), fugitive dust and tailpipe emissions (one per area), along with full production emissions. New well construction sources were located at each of the 9 source areas where development is likely to occur. The construction point sources (drill rigs, flares, and heavy construction equipment tailpipe emissions) were modeled at each of the source areas, along with 1 km square volume sources with fugitive PM construction emissions for the new wells and one new processing facility.

The mid-field Project production source configuration is based on full production levels. Production point sources (a central compressor, well head engines and heaters) were modeled at each of the source areas described above. Each of the 9 areas also included four well head heaters/engines, with the total emissions for the 375 new wells equally distributed to the nine source areas (this modeling approach conservatively concentrates the production emissions from

Figure 3 - Mid-field AERMOD Layout of Emission Sources and Receptors



NOTES:

The numbers indicate the source areas as modeled. Blue = BLM; Yellow = FS. An additional source was located to the west of the main receptor grid represented the BLM Monticello NEPA Project.

about 40 wells into one, and results in a modeling analysis with fewer sources). Finally, each of the 9 source areas also included 1 km square volume sources with production fugitive PM emissions (oil and water haul trucks and well servicing traffic) for the full potential gas production rates. For these volume sources, emissions were first calculated on a per well basis for the various source types. Then, the emissions for each volume source were normalized by the number of wells in each source area.

The cumulative sources considered in the mid-field analysis included the three sources identified in the CDPHE cumulative inventory data, and the Monticello NEPA project. A simplified methodology was used to model the Monticello air emission sources, identical to that used in the CANM analysis. Since the well development rate and total number of wells are similar between the Monticello and CANM projects, the Monticello total emissions were set equal to CANM peak construction and full production in emissions, and were assigned to a 10 km square volume source located 50 km west of CANM.

Four source groups were defined to properly group the emission sources: ProjNAQS for the Project construction scenario, ProjPSD for the Project production scenario, NAAQS for the cumulative analysis with Project construction emissions, and PSD for the cumulative analysis with Project production emissions.

3.4.3 Class I Configuration

The configuration and grouping of emission sources for the Class I AERMOD analysis was identical to the mid-field analysis. The receptor grid for MEVE was based on the NPS receptor grid. Two receptor points on the western edge of the WEMI were used to represent all WEMI impacts. The AERMOD Class I source-receptor configurations for each of the areas are shown in Figures 4 and 5 respectively.

3.5 Meteorological Data

The CANM Protocol (BLM, 2006a) and Technical Support Document (BLM, 2006b) describe the data sets and processing procedures used for the meteorological data (see above documents for details of the data selection process). Based on the CANM analysis, the MEVE meteorological data were determined to be representative of conditions in the SJPA. Since the MEVE meteorological data meets the requirements of AERMET (10 m wind speed and direction, and Solar Radiation/Delta T (SRDT) measurements at 2 and 10 meter levels), and meets a data capture rate goal of 90% or greater for the 3 year period from 2001 through 2003, this three year period of meteorological data was used as input to the AERMET meteorological pre-processor.

3.6 NO_2 Conversion Methodology

The majority of NO_X emissions from combustion sources are in the form of nitric oxide (NO), whereas the NAAQS has been established for NO_2. Therefore, a methodology must be used to convert model predictions of ambient NO concentrations into equivalent ambient NO_2 concentrations. EPA provides a three-tiered approach to calculating annual average NO_2 impacts. Tier 1, the most conservative method, assumes that all NO_X emissions are in the form of NO_2. Tier 2, the "Ambient Ratio Method” (ARM), multiplies the Tier 1 impact by either an empirically-derived, annual national default ratio of 0.75, or a site specific ratio determined with a pre-construction monitoring program. Tier 3 allows the use of the most refined method, the “Ozone Limiting Method” on a case-by-case basis.

The Tier 2 ARM method with the default ratio of 0.75 was used for the SJPA NO_2 modeling analyses.

Figure 4 - Far-field AERMOD Layout of Emission Sources and Receptors – Mesa Verde NP

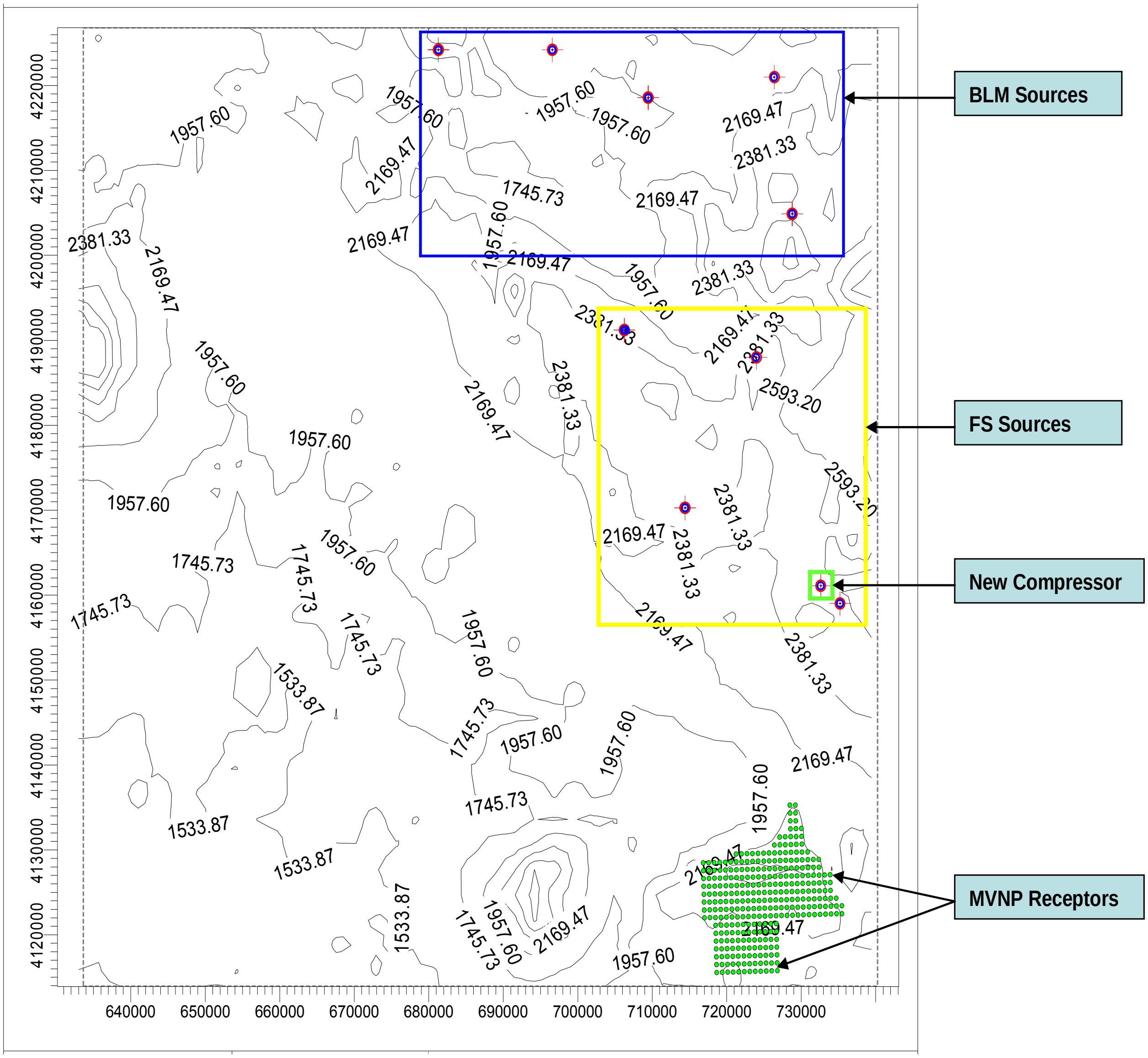
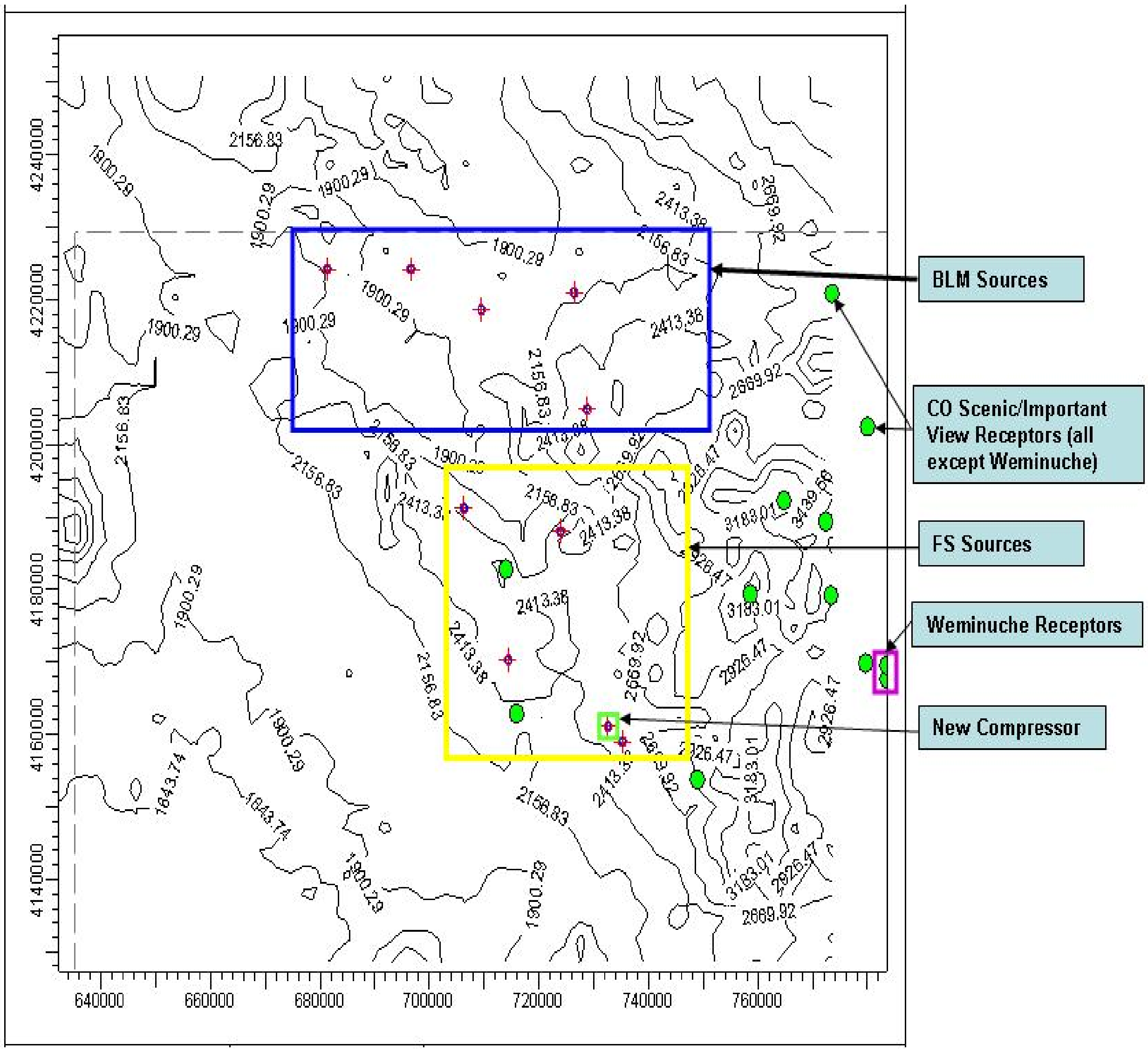


Figure 5 - Far-field AERMOD Layout of Emission Sources and Receptors – Weminuche Wilderness Area



4.0 ASSESSMENT OF STANDARDS AND CLASS II IMPACTS

4.1 AERMOD Impact Analysis

The air quality analyses compare the predicted direct Project and cumulative air impacts to the, the PSD Class II increments, as well as the state AAQS and NAAQS.

The direct Project impacts (excluding temporary construction sources) were also evaluated by comparison to the Class II PSD Increments, and these results are presented in Table 10. This increment analysis is for information purposes only, and does not represent a cumulative regulatory PSD Increment Consumption Analysis. Such a regulatory PSD increment analysis is the responsibility of the state air quality agency (subject to EPA oversight) and would be conducted during the permitting process. All predicted impacts are below the applicable Class II PSD increments.

Finally, the model predicted direct Project and cumulative impacts were added to the background data and then compared to the NAAQS in Table 10. All predicted impacts are below the applicable NAAQS.

Table 10 – Comparison of Project & Cumulative Impacts to PSD Class II Increments

Pollutant/Avg	Project Near- Field Maximum	Project Mid-Field Maximum	Cumulative Mid-Field Maximum	Overall Maximum	Class II PSD Increment
NOx - Annual	20.0	4.74	5.44	20.0	25
PM_{10} - 24-hr	0.47	10.7	10.7	10.7	30
PM_{10} - Annual	0.11	0.4	0.55	0.55	17
SO_2 - 3-hr	0.08	48.8	48.8	48.8	512
SO_2 - 24-hr	0.03	14.1	14.1	14.1	91
SO_2 - Annual	0.004	1.44	1.44	1.44	20

NOTE: Concentrations are in $\mu g/m^3$.

Table 11 – Comparison of Project & Cumulative Impacts to NAAQS

Pollutant/Avg	"NAAQS"	Project Mid-Field Maximum	Cumulative Mid-Field Maximum	Overall Max Impact	Background Concentration	Total Concentration	NAAQS
CO - 1-hr	357	2291	2291	2291	2288	4579	40000
CO - 8-hr	184	452	452	452	1831	2283	10000
NOx - Annual	20.5	4.74	5.44	20.5	16.9	37.4	100
PM_{10} - 24-hr	70.6	10.71	12.61	70.6	64	134.6	150
PM_{10} - Annual	12.6	0.4	0.79	12.6	21	33.6	50
$PM_{2.5}$ -24-hr	29.7	1.49	1.71	29.7	22.5	52.2	65
$PM_{2.5}$ - Annual	4.3	0.24	0.26	4.3	6.9	11.2	15
SO_2 - 3-hr	94.5	48.8	48.8	94.5	68	162.5	700 [a]
SO_2 - 24-hr	26.9	14.1	14.1	26.9	21	47.9	365
SO_2 - Annual	3.6	1.44	1.44	3.6	5	8.6	80

NOTE: Concentrations are in $\mu g/m^3$.
[a] More restrictive Colorado Ambient Air Quality Standard

5.0 ASSESSMENT OF CLASS I IMPACTS

The Class I air quality impact analyses compare the predicted direct and cumulative air impacts of the Project to the PSD Class I increments and the AQRV threshold values.

The direct Project impacts (excluding temporary construction sources) were evaluated by comparison to the Class I PSD Increments, and these results are presented in Tables 12 and 13. This increment analysis is for information purposes only, and does not represent a cumulative regulatory PSD Increment Consumption Analysis. All predicted impacts are below the applicable Class I PSD increments.

The model predicted direct Project and cumulative impacts were added to the background data and then compared to the NAAQS in Tables 11 and 12. All predicted impacts are below the applicable NAAQS.

Table 12 – Comparison of Direct Project Impacts to NAAQS & Class I Increments – Mesa Verde NP

Pollutant/Avg	Project Maximum	Class I PSD Increment	Background Concentration	Total Concentration	NAAQS
NOx - Annual	0.31	2.5	16.9	17.2	100
PM_{10} - 24-hr	0.48	8	64	64.5	150
PM_{10} - Annual	0.03	4	21	21.0	50
SO_2 - 3-hr	0.77	25	68	68.8	700 [a]
SO_2 - 24-hr	0.14	5	21	21.1	365
SO_2 - Annual	0.01	2	5	5.0	80

NOTE: Concentrations are in $\mu g/m^3$.
[a] More restrictive Colorado Ambient Air Quality Standard

Table 13 – Comparison of Direct Project Impacts to NAAQS & Class I Increments – Weminuche WA

Pollutant/Avg	Project Maximum	Class I PSD Increment	Background Concentration	Total Concentration	NAAQS
NOx - Annual	0.09	2.5	16.9	17.0	100
PM_{10} - 24-hr	0.09	8	64	64.1	150
PM_{10} - Annual	0.01	4	21	21.0	50
SO_2 - 3-hr	0.13	25	68	68.1	700 [a]
SO_2 - 24-hr	0.02	5	21	21.0	365
SO_2 - Annual	0.003	2	5	5.0	80

NOTE: Concentrations are in $\mu g/m^3$.
[a] More restrictive Colorado Ambient Air Quality Standard

Potential cumulative visibility impacts to the Mesa Verde National Park and Weminuche Wilderness PSD Class I areas (Table 14) were calculated using the BLM Daily Refined Visibility Analyses spreadsheets (Archer, 2007a and 2007b) based on the FLAG published method to evaluate potential visibility impacts at mandatory federal PSD Class I areas (FR 66:2, pp 382-383; Wednesday, January 3, 2001), observed hourly relative humidity, as well as speciated aerosol concentrations measured between 1988 through 2005 (the most recent available data.) If the predicted air quality impacts had occurred during the observed visibility measurement period, a 1.0 deciview “just noticeable change” would have been exceeded between 2 and 7 days per year at the Weminuche Wilderness Area, but given the conservative assumptions incorporated into the analyses, these direct impacts are not likely to occur. However, significant adverse visibility impacts were predicted to occur within the mandatory federal Mesa Verde PSD Class I area – ranging from 56 to 146 days per year. Again, based on the conservative nature of this analysis, the actual extent (numbers of days) of these perceptible visibility impacts is likely to be less, but a more refined modeling method, including specific potential mitigation methods should be applied to better predict potential visibility impacts at MEVE.

Direct and cumulative Class I deposition impacts were determined using the Level 1 method described in section 5.1.3 of the “Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 1 Recommendations” (1993). This method uses the maximum modeled Project and cumulative PSD increment concentrations at MEVE with the conservative assumption that all SO_2 and NOx are converted and deposited as elemental sulfur (S) and nitrogen (N.) Table 15 compares deposition impacts to FS levels of concern (Fox et al. 1989) defined as 5 kilograms per hectare per year (kg/ha-yr) for S and 3 kg/ha-yr for N. All direct Project deposition impacts, as well as the cumulative S deposition impacts are below the levels of concern. Although the cumulative N deposition impact is higher than the level of concern, this is likely the result of the extremely conservative methodology used in this deposition analysis.

The FS (2000) screening methodology was used to calculate the potential acid neutralizing capacity (ANC) changes at four sensitive lakes, all located within the Weminuche Wilderness Area (Archer, 2007c). No sensitive lakes were identified within Mesa Verde National Park. Potential changes in ANC at all four lakes (Table 16) were predicted to exceed significance thresholds. Again, based on the conservative nature of this analysis, the actual magnitude (ANC change) of these predicted lake chemistry impacts are likely to be less, but a more refined modeling method, including specific potential mitigation methods should be applied to better predict potential lake chemistry changes within WEMI.

Table 14 – Visibility Impacts – Class I Areas

Meteorology Year	Number of days > 0.5 dv change		Number of days > 1.0 dv change	
	Minimum	Maximum	Minimum	Maximum
Mesa Verde National Park				
2001	180	233	**104**	**146**
2002	134	182	**63**	**110**
2003	104	156	**56**	**99**
Weminuche Wilderness Area				
2001	13	25	**3**	**7**
2002	3	15	**2**	**4**
2003	4	18	**2**	**4**

Table 6 – Sulfur & Nitrogen Deposition Impacts – Class I Areas

Pollutant	Mesa Verde Maximum	Weminuche Maximum	Background Concentration	Mesa Verde Total Concentration	Weminuche Total Concentration	Significance Threshold
	(kg/ha-yr)	(kg/ha-yr)	(kg/ha-yr)	(kg/ha-yr)	(kg/ha-yr)	(kg/ha-yr)
Nitrogen	**10.18**	2.24	2.3	**12.5**	**4.5**	3
Sulfur	0.06	0.02	1.2	1.3	1.2	5

Table 7 – Maximum Predicted Lake Chemistry Impacts – Weminuche Wilderness Area

Lake	Total Nitrogen Deposition	Total Sulfur Deposition	Background ANC	ANC Change	Significance Threshold [a]	ANC Change	Significance Threshold [b]
	(kg/ha-yr)	(kg/ha-yr)	(µeq/l)	(percent)	(percent)	(µeq/l)	(µeq/l)
Big Eldorado Lake	2.24	0.02	18.2	NA	NA	**24**	1.0
Lower Sunlight Lake	2.24	0.02	86.9	**28**	10	NA	NA
Upper Grizzly Lake	2.24	0.02	36.9	**65**	10	NA	NA
Upper Sunlight Lake	2.24	0.02	32.8	**73**	10	NA	NA

[a] Significant impact threshold is a 10 percent change in ANC for lakes with background values above 25 µeq/l.
[b] Significant impact threshold is a 1.0 µeq/l change in ANC for lakes with background values at or less than 25 µeq/l.

6.0 HAP ANALYSIS RESULTS

The HAP analysis evaluated the direct Project formaldehyde impacts for both short-term (acute) and long-term (chronic) exposure assessment, as well as an evaluation of formaldehyde cancer risks.

Formaldehyde emissions for both the construction and production phases were modeled. The modeling methodology used the same near field source layout and receptor configuration previously described in Section 3.4. The maximum modeled hourly formaldehyde concentration was 16.9 μg/m^3, and the maximum annual average concentration was 0.116 μg/m^3.

The short-term analysis evaluated modeled impacts against the EPA Acute Exposure Guideline Level[1] (AEGL) level-1 one-hour concentration threshold for formaldehyde of 0.90 ppm, equivalent to 1,107 μg/m^3. Therefore, the maximum modeled 1 hour concentration is only 1.5% of the AEGL concentration.

The long-term analysis evaluates modeled annual impacts against a chronic threshold of concern. EPA has not established a long-term Reference Concentration (RfC) for formaldehyde. However, the Agency for Toxic Substances and Disease Registry (ATSDR) has established a chronic inhalation minimal risk level (MRL) of 0.003 ppm, equivalent to 3.7 μg/m^3 (ATSDR, 1997). The MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure. The maximum modeled annual concentration is only 3.1% of the MRL concentration.

The incremental risk analysis considered exposure over a 70-year lifetime using EPA's unit risk factor (EPA 1997) for formaldehyde (1.3×10^{-5}). The most likely exposure (MLE) scenario was considered. The duration of exposure for the MLE scenario is assumed to be 50 years to represent the project (well field) lifetime, corresponding to an exposure adjustment factor of 50/70 = 0.71. A second adjustment is made for time spent at home versus time spent elsewhere, but this MLE scenario assumes that the individual is at home 100% of the time, for a final MLE adjustment factor of (0.71 x 1.0) = 0.71. To calculate the excess cancer risk, the maximum annual predicted formaldehyde concentration was multiplied by the adjustment factors, then by the unit risk factor. The resulting estimated cancer risk is 1.07×10^{-6}, which is at the very low end of the generally accepted cancer risk range of 1 to 100×10^{-6} presented in the "Superfund" National Oil and Hazardous Substances Pollution Contingency Plan (EPA, 1990).

[1] The AEGLs are intended to describe the risk to humans resulting from short-term (acute) exposure to airborne chemicals. Three different levels of AEGLs have been developed that represent varying degrees of severity of toxic effects. AEGL level-1 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects.
Available on-line at: <http://www.epa.gov/oppt/aegl/index.htm>

7.0 REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR). 1997. Toxicological Profile for Formaldehyde (Draft). Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA.

Archer, S.F. 2003. DRAFT Microsoft Excel © Seasonal FLAG Screening Analysis Spreadsheet. USDI - Bureau of Land Management, National Science and Technology Center. Denver, CO.

Archer, S.F. 2007a. DRAFT Microsoft Excel © Mesa Verde Daily FLAG Refined Analysis Spreadsheet. USDI - Bureau of Land Management, National Science and Technology Center. Denver, CO.

Archer, S.F. 2007b. DRAFT Microsoft Excel © Weminuche Daily FLAG Refined Analysis Spreadsheet. USDI - Bureau of Land Management, National Science and Technology Center. Denver, CO.

Archer, S.F. 2007c. DRAFT Microsoft Excel © Weminuche Wilderness Area Atmospheric Deposition and Lake Chemistry Analysis Spreadsheet. USDI - Bureau of Land Management, National Science and Technology Center. Denver, CO.

Bureau of Land Management (BLM). 2006a. Canyons of the Ancients National Monument Resource Management Plan and Environmental Impact Statement Air Quality Impact Analysis Protocol - FINAL DRAFT.

Bureau of Land Management (BLM). 2006b. Canyons of the Ancients National Monument Resource Management Plan and Environmental Impact Statement Air Quality Impact Analysis Technical Support Document - FINAL DRAFT.

FLAG. 2000. Federal Land Managers' Air Quality Related Values Workgroup (FLAG) - Phase I Report (dated December 2000). USDI-National Park Service, Air Resources Division. Denver, CO.

USDA – Forest Service (FS). 2000. Screening Methodology for Calculating ANC Change to High Elevation Lakes. Rocky Mountain Region. Lakewood, Colorado.

Fox, Douglas G.; Ann M. Bartuska; James G. Byrne; Ellis Cowling; Richard Fisher; Gene E. Likens; Steven E. Lindberg; Rick A. Linthurst; Jay Messer; and Dale S. Nichols. 1989. "A screening procedure to evaluate air pollution effects on Class I wilderness areas" Gen. Tech. Rep. RM-168. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. , Fort Collins, Colorado.

IWAQM, 1993. Interagency Workshop on Air Quality Modeling Phase 1 Report. EPA-454/R-93-015. U.S. EPA, Research Triangle Park, NC.

Midwest Research Institute (MRI). 2205. Analysis of the Fine Fraction of Particulate Matter in Fugitive Dust - Final Report. Prepared for Western Governors' Association Western Regional Air Partnership (WRAP). MRI Project No. 110397. October 12.

Pitchford, M.L., and W.C. Malm. 1994. Development and Applications of a Standard Visual Index. Atmos. Environ. 28(5):1049-1054.

U.S. Environmental Protection Agency (EPA), 1988. Control of Open Fugitive Dust Sources, EPA 450/3-88-008. U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1988

__________ 1990. "Superfund" National Oil and Hazardous Substances Pollution Contingency Plan. 41 CFR 300

__________ 1995a. Compilation of Air Pollution Emission Factors, Volume I. Stationary Point and Area Sources (AP-42). Fifth Edition (with subsequent U.S. supplements and updates). Office of Air Quality Planning and Standards (OAQPS), Research Triangle Park, North Carolina.

__________ 1995b. Glycol Dehydrator BTEX and VOC Emission Testing Results at Two Units in Texas and Louisiana. EPA/600/SR-95/046, Air and Energy Engineering Research Laboratory. Research Triangle Park, NC. May

__________ 1997. Exposure Factors Handbook. Volume 1. EPA/600/P-95/002Fa. Office of Health and Environmental Assessment. Research Triangle Park, NC.

__________ 2004. User's Guide for the AMS/EPA Regulatory Model - AERMOD. EPA 454/B-03-001. U.S. Environmental Protection Agency, Research Triangle Park, NC, September 12004

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APPENDIX A

Detailed Project Emission Calculation Tables

Table of Contents

TABLE A-1
OIL AND GAS WELL - WELL PAD, RESOURCE ROAD (ACCESS ROAD), AND PIPELINE CONSTRUCTION

Project: San Juan Public Lands Center FPA & EIS
Activity: Well Pad, Resource Road (Access Road), and Pipeline Construction and Wind Erosion
Emissions: Fugitive Particulate Emissions
Date: August, 2007

Ave. Disturbance per well [1]	TSP Emission Factor[2]	Construction Activity Duration	Construction Activity Duration	Emission Control Efficiency	PM_{10} Emissions (controlled)[3]	$PM_{2.5}$ Emissions (controlled)[4]
(acres)	(tons/acre-month)	(days/well)	(hours/day)	(%)	(lb/pad)	(lb/pad)
General Construction Activity 5.4	1.2	10	10	50	536.00	53.60
Wind Erosion 5.4	0.0289	10	10	50	12.91	1.29
				Construction Emissions (lb/pad)	548.91	54.89
				Construction Emissions (lb/hr/pad) for hours of activity	5.49	0.55

[1] Area = Total Pad, Roadway, and Pipeline Disturbance of 434.16 acres divided by 81 total wells; TSP = total suspended particulates.

[2] For construction, AP-42 (EPA 2004), Section 13.2.3, "Heavy Construction Operations".

For Wind Erosion, Control of Open Fugitive Dust Sources, Section 4.1.3, EPA-450/3-98-008, Silt = 5.1, 5% of time WS > 5.4 m/s

[3] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads". The PM10 factor is calculated as 25% of the TSP factor.

[4] Assuming 10% of the PM10 is PM2.5, based on "Analysis of the Fine Fraction of PM in Fugitive Dust, MRI Report 110397, Oct. 12 2005.

TABLE A-2
OIL AND GAS WELL - PAD/ROAD/PIPELINE CONSTRUCTION HEAVY EQUIPMENT TAILPIPE

Project: San Juan Public Lands Center FPA & EIS
Activity: Pad/Road/Pipeline Construction Equipment
Emissions: Diesel Combustion Tailpipe Emissions From Heavy Construction Traffic
Date: August, 2007

Heavy Equipment	Engine Horsepower	Number Required	Operating Load Factor[1]	Pollutant Emission Factor[2] (g/hp-hr)					Operation Duration	Construction Activity Duration	Pollutant Emissions (lb/pad)					Pollutant Emissions[4] (lb/hr/pad)				
	(hp)			CO	NO_x	SO_2	VOC	PM_{10}	(days/equipment type)	(hours/day)	CO	NO_x	SO_2	VOC	PM_{10}[5]	CO	NO_x	SO_2	VOC	PM_{10}[5]
Scraper	700	2	0.4	2.45	7.46	0.901	0.55	0.789	4	10	120.99	368.40	44.49	27.16	38.96	3.02	9.21	1.11	0.68	0.97
Motor Grader	250	1	0.4	1.54	7.14	0.874	0.36	0.625	4	10	13.58	62.96	7.71	3.17	5.51	0.34	1.57	0.19	0.08	0.14
D8 Dozer[3]	210	1	0.4	2.15	7.81	0.851	0.75	0.692	4	10	15.93	57.85	6.30	5.56	5.13	0.40	1.45	0.16	0.14	0.13
										Total Heavy Equipment Tailpipe Emissions	150.49	489.21	58.50	35.89	49.60	3.76	12.23	1.46	0.90	1.24

1 Taken from "Surface Mining" (Pfleider 1972) for average service duty.
2 AP-42 (EPA 1985), Volume II Mobile Sources.
3 Emission factor for track-type tractor.
4 Calculated as lb/well; days/equipment type; 10 hours/day.
5 $PM_{2.5}$ assumed equivalent to PM_{10} for combustion sources.

TABLE A-3
OIL AND GAS WELL PAD/RESOURCE ROAD/PIPELINE CONSTRUCTION TRAFFIC

Project: San Juan Public Lands Center FPA & EIS
Activity: Well Pad/Resource Road/Pipeline Construction Traffic
Emissions: Fugitive Particulate Emissions from Traffic on Unpaved Roads
Date: August, 2007

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight [1]	Average Vehicle Speed	Silt Content[2]	Moisture Content[3]	RTs per Well	RT Distance	VMT [4]	Emission Control Efficiency	PM_{10} Emission Factor[5]	$PM_{2.5}$ Emission Factor[5]	PM_{10} Emissions[6] (controlled)	$PM_{2.5}$ Emissions[6] (controlled)
			(lb)	(mph)	(%)	(%)		(miles)	(VMT/pad)	(%)	(lb/VMT)	(lb/VMT)	(lb/well)	(lb/well)
Gravel haul/Semis/transport, boom, equipment, trucks	Primary Access	magnesium chloride	35,000	20	5.1	2.4	16	25	400	85	1.54	0.24	92.14	14.13
	Resource	water	35,000	15	5.1	2.4	16	1.1	18	50	1.54	0.24	13.51	2.07
Light trucks/pickups	Primary Access	magnesium chloride	7,000	25	5.1	2.4	24	25	600	85	0.51	0.076	45.88	6.86
	Resource	water	7,000	15	5.1	2.4	24	1.1	26	50	0.39	0.059	5.21	0.78
												Total Unpaved Road Traffic Emissions (lb/well)	156.75	23.84
												Total Unpaved Road Traffic Emissions (lb/hr/well)[7]	0.22	0.03
												Total Unpaved Access Road Traffic Emissions (lb/hr/well)[7]	0.026	0.0040

[1] Average weight for gravel and semi trucks estimated at 35,000 lbs used for calculations

[2] AP-42 (EPA 2004), Table 13.2.2-1, "Typical Silt Content Values of Surface Material on Industrial and Rural Unpaved Roads."

[3] AP-42 (EPA 2004), Table 11.9-3, "Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations."

[4] Calculated as Round Trips per Vehicle Type x Round Trip Distance.

[5] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", equations 1a and 1b.

[6] Calculated as lb/VMT x VMT/pad x control efficiency.

[7] Calculated as (lb/well); 30 days/well; 24 hours/day.

TABLE A-4
OIL AND GAS WELL PAD/RESOURCE ROAD/PIPELINE CONSTRUCTION TRAFFIC

Project: San Juan Public Lands Center FPA & EIS
Activity: Well Pad/Resource Road/Pipeline Construction Traffic Tailpipe
Emissions: Diesel Combustion Tailpipe Emissions From Heavy Construction Traffic
Date: August, 2007

Pollutant	Pollutant Emission Factor[1]	Total Haul Truck RTs	RT Distance	Total Haul Truck Miles Traveled	Haul Activity Duration	Haul Activity Duration	Emissions	Emissions[3]
	(g/mile)	(RTs/well)	(miles/RT)	(miles/well)	(days/well)	(hours/day)	(lb/well)	(lb/hr/well)
CO	14.74	16	26.1	417.6	10	24	13.57	0.06
NO_x	11.44	16	26.1	417.6	10	24	10.53	0.04
SO_2[2]	0.32	16	26.1	417.6	10	24	0.29	0.0012
VOC	5.69	16	26.1	417.6	10	24	5.24	0.02

[1] AP-42 (EPA 1985), Volume II Mobile Sources. Heavy duty diesel engine powered trucks, high altitude, 20 mph, "aged" with 50,000 miles, 1997+ model.

[2] The SO_2 emission factor is calculated assuming 10 mpg fuel consumption, with 0.05% sulfur content of #2 diesel fuel, and fuel density of 7.001 lb/gal.

[3] Calculated as lb/well divided by haul duration days/well and hours/day.

TABLE A-5
RIG MOVE AND DRILLING TRUCK

Project: San Juan Public Lands Center FPA & EIS
Activity: Rig Move and Drilling Truck Emissions
Emissions: Fugitive Particulate Emissions from Traffic on Unpaved Roads
Date: August, 2007

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight	Average Vehicle Speed	Silt Content[2]	Moisture Content[3]	RTs per Well	RT Distance	VMT [4]	Emission Control Efficiency	PM_{10} Emission Factor[5]	$PM_{2.5}$ Emission Factor[5]	PM_{10} Emissions[6] (controlled)	$PM_{2.5}$ Emissions[6] (controlled)
			(lb)	(mph)	(%)	(%)		(miles)	(VMT/pad)	(%)	(lb/VMT)	(lb/VMT)	(lb/well)	(lb/well)
Semis-tractor/ trailer/mud/water/ fuel/cement trucks[1]	Primary Access	magnesium chloride	44,000	20	5.1	2.4	10	25	250	85	1.70	0.26	63.83	9.79
	Resource	water	44,000	15	5.1	2.4	10	1.1	11	50	1.70	0.26	9.36	1.44
Logging/mud trucks	Primary Access	magnesium chloride	48,000	20	5.1	2.4	10	25	250	85	1.77	0.27	66.38	10.18
	Resource	water	48,000	15	5.1	2.4	10	1.1	11	50	1.77	0.27	9.74	1.49
Vendors/marketers/ various	Primary Access	magnesium chloride	7,000	30	5.1	2.4	80	25	2,000	85	0.56	0.083	167.56	25.05
	Resource	water	7,000	20	5.1	2.4	80	1.1	88	50	0.46	0.068	20.06	3.00
												Total Unpaved Road Traffic Emissions (lb/well)	336.94	50.94
												Total Unpaved Road Traffic Emissions (lb/hr/well)[7]	0.47	0.07
												Total Unpaved Access Road Traffic Emissions (lb/hr/well)[7]	0.054	0.0082

[1] Semi vehicle weight range is 28,000-60,000 lbs; average weight of 44,000 lbs used for calculations.

[2] AP-42 (EPA 2004), Table 13.2.2-1, "Typical Silt Content Values of Surface Material on Industrial and Rural Unpaved Roads."

[3] AP-42 (EPA 2004), Table 11.9-3, "Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations."

[4] Calculated as Round Trips per Vehicle Type x Round Trip Distance.

[5] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", equations 1a and 1b.

[6] Calculated as lb/VMT x VMT/pad x control efficiency.

[7] Calculated as (lb/well); 30 days/well; 24 hours/day.

TABLE A-6
RIG MOVE AND DRILLING TRUCK – TAILPIPE

Project: San Juan Public Lands Center FPA & EIS
Activity: Rig Move and Drilling Trucks - Tailpipe
Emissions: Diesel Combustion Emissions from Heavy Equipment Tailpipes
Date: August, 2007

Pollutant	Pollutant Emission Factor[1]	Total Haul Truck RTs	RT Distance	Total Haul Truck Miles Traveled	Haul Activity Duration	Haul Activity Duration	Emissions	Emissions[3]
	(g/mile)	(RTs/well)	(miles/RT)	(miles/well)	(days/well)	(hours/day)	(lb/well)	(lb/hr/well)
CO	14.74	20	26.1	522	22	24	16.96	0.03
NO_x	11.44	20	26.1	522	22	24	13.17	0.02
SO_2[2]	0.32	20	26.1	522	22	24	0.37	0.0007
VOC	5.69	20	26.1	522	22	24	6.55	0.01

[1] AP-42 (EPA 1985), Volume II Mobile Sources. Heavy duty diesel engine powered trucks, high altitude, 20 mph, "aged" with 50,000 miles, 1997+ model.
[2] The SO_2 emission factor is calculated assuming 10 mpg fuel consumption, with 0.05% sulfur content of #2 diesel fuel, and fuel density of 7.001 lb/gal.
[3] Calculated as lb/well divided by haul duration days/well and hours/day.

TABLE A-7
DRILLING RIG EMISSIONS

Project: San Juan Public Lands Center FPA & EIS
Activity: Drilling Rigs
Emissions: Diesel Combustion Emissions from Drilling Engines - EPA AP-42
Date: August, 2007

Pollutant	Pollutant Emission Factor[1]	Total Horsepower (hp) All Engines[2]	Overall Load Factor[3]	Drilling Activity Duration	Drilling Activity Duration	Emissions	Emissions
	(lb/hp-hr)	(hp)		(days/well)	(hours/day)	(lb/well)	(lb/hr/well)
CO	6.68E-03	2,100	0.42	30	24	4,267.32	5.93
NOx	0.031	2,100	0.42	30	24	19,803.42	27.50
SO_2[4]	2.05E-03	2,100	0.42	30	24	1,309.58	1.82
VOC	2.50E-03	2,100	0.42	30	24	1,597.05	2.22
PM_{10}[5]	2.20E-03	2,100	0.42	30	24	1,405.40	1.95
Formaldehyde	1.18E-03	2,100	0.42	30	24	753.81	1.05

Stack Parameters

Height	5 m
Temperature	700 Kelvin
Diameter	0.2 m
Velocity	25 m/s

5 x 5 x 5 m structure used to determine downwash parameters for the drilling rigs.

[1] AP-42 (EPA 2004), Section 3.3, "Gasoline and Diesel Industrial Engines. Table 3.3-1, "Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines"; lb/hp-hr = pounds per horsepower-hour.

[2] Drilling engine horsepower based on three engines, two at 800 hp and one at 500 hp.

[3] The overall load factor is calculated based on average throttle setting of 65% and a load factor of 65%. Therefore, the overall load factor = 0.65 * 0.65 = 0.42.

[4] The SO_2 emission factor is calculated assuming 26.4 gal/hr fuel consumption, with 0.05% sulfur content of #2 diesel fuel, and fuel density of 7.001 lb/gal. Fuel consumption rate calculated from Caterpillar's specification sheet for G3412, gas petroleum drilling engine.

[5] $PM_{2.5}$ assumed equivalent to PM_{10} for drilling engines.

TABLE A-8
COMPLETION/TESTING TRAFFIC

Project: San Juan Public Lands Center FPA & EIS
Activity: Completion/Testing Traffic
Emissions: Fugitive Particulate Emissions from Traffic on Unpaved Roads
Date: August, 2007

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight	Average Vehicle Speed	Silt Content[2]	Moisture Content[3]	RTs per Well	RT Distance	VMT[4]	Emission Control Efficiency	PM_{10} Emissions[5]	$PM_{2.5}$ Emissions[5]	PM_{10} Emissions[6] (controlled)	$PM_{2.5}$ Emissions[6] (controlled)
			(lb)	(mph)	(%)	(%)		(miles)	(VMT/well)	(%)	(lb/VMT)	(lb/VMT)	(lb/well)	(lb/well)
Semis/transport/ water/sand/frac trucks[1]	Primary Access	magnesium chloride	54,000	20	5.1	2.4	10	25	250	85	1.87	0.29	70.00	10.73
	Resource	water	54,000	15	5.1	2.4	10	1.1	11	50	1.87	0.29	10.27	1.57
Large Haul Trucks	Primary Access	magnesium chloride	48,000	20	5.1	2.4	5	25	125	85	1.77	0.27	33.19	5.09
	Resource	water	48,000	15	5.1	2.4	5	1.1	6	50	1.77	0.27	4.87	0.75
Light trucks/ pick-ups	Primary Access	magnesium chloride	7,000	30	5.1	2.4	30	25	750	85	0.56	0.08	62.83	9.39
	Resource	water	7,000	20	5.1	2.4	30	1.1	33	50	0.46	0.07	7.52	1.12
												Total Unpaved Road Traffic Emissions (lb/well)	188.68	28.66
												Total Unpaved Road Traffic Emissions (lb/hr/well)[7]	0.32	0.05
												Total Unpaved Access Road Traffic Emissions (lb/hr/well)[7]	0.031	0.0048

[1] Semi vehicle weight range is 28,000-80,000 lbs; average weight of 54,000 lbs used for calculations.

[2] AP-42 (EPA 2004), Table 13.2.2-1, "Typical Silt Content Values of Surface Material on Industrial and Rural Unpaved Roads."

[3] AP-42 (EPA 2004), Table 11.9-3, "Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations."

[4] Calculated as Round Trips per Vehicle Type x Round Trip Distance.

[5] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", equations 1a and 1b.

[6] Calculated as lb/VMT x VMT/pad x control efficiency.

[7] Calculated as lb/well; 35 days/well; 17 hours/day; and represents emissions for 9.5-mile segment of road.

TABLE A-9
COMPLETION/TESTING HEAVY EQUIPMENT TAILPIPE

Project: **San Juan Public Lands Center FPA & EIS**
Activity: **Completion/Testing Tailpipe**
Emissions: **Diesel Combustion Emissions from Heavy Equipment Tailpipes**
Date: **August, 2007**

Pollutant	Pollutant Emission Factor[1]	Total Haul Truck RTs	RT Distance	Total Haul Truck Miles Traveled	Haul Activity Duration	Haul Activity Duration	Emissions	Emissions[3]
	(g/mile)	(RTs/well)	(miles/RT)	(miles/well)	(days/well)	(hours/day)	(tons/well)	(lb/hr/well)
CO	14.74	15	26.1	391.5	35	17	6.4E-03	0.021
NO_x	11.44	15	26.1	391.5	35	17	4.9E-03	0.017
SO_2[2]	0.32	15	26.1	391.5	35	17	1.4E-04	0.0005
VOC	5.69	15	26.1	391.5	35	17	2.5E-03	0.008

[1] AP-42 (EPA 1985), Volume II Mobile Sources. Heavy duty diesel engine powered trucks, high altitude, 20 mph, "aged" with 50,000 miles, 1997+ model.

[2] The SO_2 emission factor is calculated assuming 10 mpg fuel consumption, with 0.05% sulfur content of #2 diesel fuel, and fuel density of 7.001 lb/gal.

[3] Calculated as lb/well divided by haul duration days/well and hours/day.

TABLE A-10
COMPLETION FLARING

Project: San Juan Public Lands Center FPA & EIS
Activity: Oil and Gas Well Completion/Testing Flaring
Emissions: NOx, CO, and VOC
Date: August, 2007

Flaring Specifications:			
Total Volume of Gas Emitted	1,000	mcf	
Total Volume of Condensate Emitted (separator)	0	bbls	
Average Heat Content	1,093	BTU/scf	
Flaring/Flowback Activity Duration	0	hrs/well	No Fracturing
Flaring Duration	24	hrs/well	
Pre-ignition Flow-back Duration	0	hrs/well	
Pre-ignition Flow-back Time Involving a Gas Stream	0	%	
Actual Hours Gas is Vented	0	hrs	
Total Hours in which Gas is Vented or Flared[1]	24	hrs	
Average Flowrate of Gas[2]	41.67	mcf/hr	
Total Volume of Gas Vented[3]	166.67	mcf	
Total Volume of Flared Gas[4]	1,000.00	mcf	
Average Flowrate of Condensate	0.00	bbls/hr	
Pre-flare Volume of Condensate	0.00	bbls	
Volume of Condensate Flared	0.00	bbls	

Activity	Volume	Volume Units	Pollutant	Emission Factor	Emission Factor Units	Emission Factor Source	Total Emissions (tons)	Duration (hours)	Hourly Emissions (lb/hr)
Flaring - Natural Gas	1,000.00	mcf	NOx	0.068	lb / 10^6 BTU	AP-42 Section 13.5	0.04	24	3.10
			CO	0.37	lb / 10^6 BTU	AP-42 Section 13.5	0.20	24	16.85
			VOC	2.35	lb / 1000 scf	Estimated Analysis - 50% Destruction	1.17	24	97.84
TOTAL FLARING EMISSIONS			NOx				0.04	24	3.10
			CO				0.20	24	16.85
NOTE: Sweet Gas without sulfur, so no SO2 emissions.			VOC				1.17	24	97.84

TABLE A-11
PROCESSING FACILITY CONSTRUCTION

Project: **San Juan Public Lands Center FPA & EIS**
Activity: **Treatment Facility and Associated Pipelines Construction**
Emissions: **Fugitive Particulate Emissions**
Date: **August, 2007**

Ave. Disturbance per facility [1]	TSP Emission Factor[2]	Construction Activity Duration	Construction Activity Duration	Emission Control Efficiency	PM_{10} Emissions (controlled)[3]	$PM_{2.5}$ Emissions (controlled)[4]
(acres)	(tons/acre-month)	(days/facility)	(hours/day)	(%)	(lb/facility)	(lb/pad)
General Construction Activity						
21.2	1.2	30	10	50	6360.00	636.00
Wind Erosion						
21.2	0.0289	30	10	50	153.17	15.32
		Construction Emissions (lb/pad)			6513.17	651.32
		Construction Emissions (lb/hr/pad) for hours of activity			21.71	2.17

[1] Area = 3 acres facility plus 18.2 acres pipeline; TSP = total suspended particulates.

[2] For construction, AP-42 (EPA 2004), Section 13.2.3, "Heavy Construction Operations".

For Wind Erosion, Control of Open Fugitive Dust Sources, Section 4.1.3, EPA-450/3-98-008, Silt = 5.1, 5% of time WS > 5.4 m/s

[3] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads". The PM10 factor is calculated as 25% of the TSP factor.

[4] Assuming 10% of the PM10 is PM2.5, based on "Analysis of the Fine Fraction of PM in Fugitive Dust, MRI Report 110397, Oct. 12 2005.

TABLE A-12
FACILITY CONSTRUCTION HEAVY EQUIPMENT TAILPIPE

Project: San Juan Public Lands Center FPA & EIS
Processing facility Pad/Road/Pipeline
Activity: Construction Equipment
Emissions: Diesel Combustion Tailpipe Emissions From Heavy Construction Traffic
Date: August, 2007

Heavy Equipment	Engine Horsepower (hp)	Number Required	Operating Load Factor[1]	Pollutant Emission Factor[2] (g/hp-hr)					Operation Duration (days/ equipment type)	Construction Activity Duration (hours/day)	Pollutant Emissions (lb/pad)					Pollutant Emissions[4] (lb/hr/pad)				
				CO	NO_x	SO_2	VOC	PM_{10}			CO	NO_x	SO_2	VOC	PM_{10}[5]	CO	NO_x	SO_2	VOC	PM_{10}[5]
Scraper	700	2	0.4	2.45	7.46	0.901	0.55	0.789	10	10	302.47	920.99	111.23	67.90	97.41	3.02	9.21	1.11	0.68	0.97
Motor Grader	250	1	0.4	1.54	7.14	0.874	0.36	0.625	10	10	33.95	157.41	19.27	7.94	13.78	0.34	1.57	0.19	0.08	0.14
D8 Dozer[3]	210	1	0.4	2.15	7.81	0.851	0.75	0.692	10	10	39.81	144.63	15.76	13.89	12.81	0.40	1.45	0.16	0.14	0.13
							Total Heavy Equipment Tailpipe Emissions				376.23	1223.02	146.26	89.73	124.00	3.76	12.23	1.46	0.90	1.24

[1] Taken from "Surface Mining" (Pfleider 1972) for average service duty.
[2] AP-42 (EPA 1985), Volume II Mobile Sources.
[3] Emission factor for track-type tractor.
[4] Calculated as lb/well; days/equipment type; 10 hours/day.
[5] $PM_{2.5}$ assumed equivalent to PM_{10} for combustion sources.

TABLE A-13
PROCESSING FACILITY CONSTRUCTION TRAFFIC

Project: San Juan Public Lands Center FPA & EIS
Activity: Facility Construction Traffic
Emissions: Fugitive Particulate Emissions from Traffic on Unpaved Roads
Date: August, 2007

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight [1]	Average Vehicle Speed	Silt Content[2]	Moisture Content[3]	RTs per Well Site	RT Distance	VMT [4]	Emission Control Efficiency	PM_{10} Emission Factor[5]	$PM_{2.5}$ Emission Factor[5]	PM_{10} Emissions[6] (controlled)	$PM_{2.5}$ Emissions[6] (controlled)
			(lb)	(mph)	(%)	(%)		(miles)	(VMT/pad)	(%)	(lb/VMT)	(lb/VMT)	(lb/well)	(lb/well)
Gravel haul/Semis/transport, boom, equipment, trucks	Primary Access	magnesium chloride	35,000	20	5.1	2.4	100	25	2,500	85	1.54	0.24	575.88	88.30
	Resource	water	35,000	15	5.1	2.4	100	1.1	110	50	1.54	0.24	84.46	12.95
Light trucks/pickups	Primary Access	magnesium chloride	7,000	25	5.1	2.4	30	25	750	85	0.51	0.076	57.36	8.57
	Resource	water	7,000	15	5.1	2.4	30	1.1	33	50	0.39	0.059	6.51	0.97
												Total Unpaved Road Traffic Emissions (lb/well)	724.22	110.80
												Total Unpaved Road Traffic Emissions (lb/hr/well)[7]	1.01	0.15
												Total Unpaved Access Road Traffic Emissions (lb/hr/well)[7]	0.126	0.0193

[1] Average weight for gravel and semi trucks estimated at 35,000 lbs used for calculations

[2] AP-42 (EPA 2004), Table 13.2.2-1, "Typical Silt Content Values of Surface Material on Industrial and Rural Unpaved Roads."

[3] AP-42 (EPA 2004), Table 11.9-3, "Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations."

[4] Calculated as Round Trips per Vehicle Type x Round Trip Distance.

[5] AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", equations 1a and 1b.

[6] Calculated as lb/VMT x VMT/pad x control efficiency.

[7] Calculated as (lb/well); 30 days/well; 24 hours/day.

TABLE A-14
PROCESSING FACILITY CONSTRUCTION TRUCK TAILPIPE

Project: San Juan Public Lands Center FPA & EIS
Activity: Facility Construction Truck Tailpipe emissions
Emissions: Diesel Combustion Tailpipe Emissions From Heavy Construction Traffic
Date: August, 2007

Pollutant	Pollutant Emission Factor[1]	Total Truck RTs	RT Distance	Total Haul Truck Miles Traveled	Haul Activity Duration	Haul Activity Duration	Emissions	Emissions[3]
	(g/mile)	(RTs/site)	(miles/RT)	(miles/well)	(days/well)	(hours/day)	(lb/well)	(lb/hr/well)
CO	14.74	100	26.1	2610	10	24	84.81	0.35
NO_x	11.44	100	26.1	2610	10	24	65.83	0.27
SO_2[2]	0.32	100	26.1	2610	10	24	1.83	0.0076
VOC	5.69	100	26.1	2610	10	24	32.74	0.14

[1] AP-42 (EPA 1985), Volume II Mobile Sources. Heavy duty diesel engine powered trucks, high altitude, 20 mph, "aged" with 50,000 miles, 1997+ model.

[2] The SO_2 emission factor is calculated assuming 10 mpg fuel consumption, with 0.05% sulfur content of #2 diesel fuel, and fuel density of 7.001 lb/gal.

[3] Calculated as lb/well divided by haul duration days/well and hours/day.

TABLE A-15
OIL &GAS PRODUCTION TRAFFIC

Project: San Juan Public Lands Center FPA & EIS
Activity: O&G Production Traffic
Emissions: Fugitive Particulate Emissions from Traffic on Unpaved Roads
Date: August, 2007

Vehicle Type	Road Type	Dust Control Method	Average Vehicle Weight	Average Vehicle Speed	Silt Content[2]	Moisture Content[3]	RTs per Well	RT Distance	VMT[5]	Emission Control Efficiency	PM_{10} Emission Factor[6]	$PM_{2.5}$ Emission Factor[6]	PM_{10} Emissions[7] (controlled)	$PM_{2.5}$ Emissions[7] (controlled)
			(lb)	(mph)	(%)	(%)	(RTs/yr)	(miles)	(VMT/well/yr)	(%)	(lb/VMT)	(lb/VMT)	(lb/well/yr)	(lb/well/yr)
Haul trucks (Oil/condensate/water)[1]	Primary Access	magnesium chloride	54,000	20	5.1	2.4	158	25	3,950	85	1.87	0.29	1,105.96	169.58
	Resource	water	54,000	15	5.1	2.4	158	1.1	174	50	1.87	0.29	162.21	24.87
Light trucks/ pickups/pumpers[8]	Primary Access	magnesium chloride	7,000	30	5.1	2.4	10	25	250	85	0.56	0.08	20.94	3.13
	Resource	water	7,000	20	5.1	2.4	52	1.1	57	50	0.46	0.07	13.04	1.95
												Total Access and Unimproved Road Emissions (lb/well/yr)	1,302.15	199.53
												Total Access and Unimproved Road Emissions (lb/hr/well)	0.5008	0.0767
												Total Unpaved Access Road Traffic Emissions (lb/hr/well)[7]	0.0674	0.0103

1 Haul trucks weight range is 28,000-80,000 lbs. Average weight of 54,000 lbs used for calculations.
2 AP-42 (EPA 2004), Table 13.2.2-1, "Typical Silt Content Values of Surface Material on Industrial and Rural Unpaved Roads."
3 AP-42 (EPA 2004), Table 11.9-3, "Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations."
4 Removed
5 Calculated as Round Trips per Vehicle Type x Round Trip Distance
6 AP-42 (EPA 2004), Section 13.2.2 "Unpaved Roads", equations 1a and 1b.
7 Calculated as lb/VMT x VMT/well x control efficiency.
8 Emissions based on trip frequency and miles traveled to one well in the field. During production, 20 wells could be visited per day. This assumption will be reflected in full-field modeled emissions.

TABLE A-16
OIL &GAS PRODUCTION HEAVY EQUIPMENT TAILPIPE

Project: San Juan Public Lands Center FPA & EIS
Activity: Oil and Gas Well Production Traffic - tailpipe Emissions
Emissions: Diesel Combustion Tailpipe Emissions From Heavy Truck Traffic
Date: August, 2007

Pollutant	Pollutant Emission Factor[1]	Annual RTs per Well	Single Well Round Trip Distance	Single Well Annual VMT	Hourly Emissions Single Well	Annual Emissions Single Well
	(g/mi)	(RTs/well/yr)	(mi/RT)	(mi/well/yr)	(lb/hr)	(tpy)
CO	14.74	158	26.1	4123.80	0.051541	0.06700
NO_x	11.44	158	26.1	4123.80	0.040002	0.05200
SO_2[2]	0.32	158	26.1	4123.80	0.001123	0.00146
VOC	5.69	158	26.1	4123.80	0.019896	0.02586

[1] AP-42 (EPA 1985), Table 2.7.1 "Volume II Mobile Sources." Heavy duty diesel engine powered trucks, high altitude, 20 mph, "aged" with 50,000 miles, 1997+ model.

[2] The SO_2 emission factor is calculated assuming 10 mpg fuel consumption, with 0.05% sulfur content of #2 diesel fuel, and fuel density of 7.08 lb/gal.

Lb/hr rates based on 10 hours/day times 5 days/wk

TABLE A-17
NATURAL GAS COMPRESSOR FACILITY

Project: San Juan Public Lands Center FPA & EIS
Activity: Natural Gas Compression Facility
Emissions: Compressor Natural Gas IC Engine Combustion Emissions
Date: August, 2007

Fuel Combustion Source:

Unit Description	New Natural Gas Compression Requirements					
Engine design (hp/hr)	350					

Operating Parameters:

Operated	24	hr/day,	7	days/wk,	365	days/yr
Operating hours	8,760					
Capacity (%)	100	(while operating)				
Annual Load (%)	Winter	25	Spring	25		
	Summer	25	Fall	25		

Potential Fuel Combustion for the Year for Unit:

Gas consumption rate	6,601	Btu/hp-hr
Heat Content	1,000	Btu/scf
Hourly Heat Input Rate:	2.31	MMBtu/hr
Volume of Natural Gas Combusted	20.24	MMSCF/yr

Emission Data:	lb/hr	tpy	Method of Determination	Emission Factor[1]	Units
NO_x	9.42623	41.287	AP-42	4.08	lb/MMBtu
CO	0.73238	3.208	AP-42	0.317	lb/MMBtu
SO_2	0.00136	0.006	AP-42	5.88E-04	lb/MMBtu
PM_{10} Including condensibles	0.02290	0.100	AP-42	9.91E-03	lb/MMBtu
$PM_{2.5}$ including condensibles	0.02290	0.100	AP-42	9.91E-03	lb/MMBtu
VOC	0.27262	1.194	AP-42	0.118	lb/MMBtu
Formaldehyde	0.12199	0.534	AP-42	5.28E-02	lb/MMBtu

[1] Based on a 4-stroke lean burn engine, taken from AP-42 Table 3.2-2 (EPA 2004).

TABLE A-18
WELL HEAD SEPARATOR/TANK FLASHING AND DEHYDRATOR STILL VENT VOC EMISSIONS

Project: San Juan Public Lands Center FPA & EIS
Activity: Wellhead Separator to Oil Tank Flashing and Dehydrator Still Vent
Emissions: VOC emissions
Date: August, 2007

Separator to Storage Tank VOC Emissions		
Estimated VOC Emissions per well	20	tpy
Number of New O&G Wells	81	
Total VOC Emissions at maximum production	1,620	total tpy
Dehydrator Still Vent VOC Emissions		
EPA Consensus Testing Results and GRI-GLYCalc VOC Emissions for 3.6 mmscfd dehydrator	21	tpy
Ratioed for Estimated Throughput for 0.1 mmscfd wellhead dehydrator	0.58	tpy/well
Number of New O&G Wells	81	
Total VOC Emissions at maximum production	47	total tpy
Combined VOC Emissions from Both Processes		
VOC Emissions lb/hr per well (assuming 8760 hours per year)	4.70	lb/hr
VOC Emissions per well	20.58	tpy/well
Total VOC Emissions	1,667	tpy

TABLE A-19
WELL HEAD INTERNAL COMBUSTION ENGINES

Project: San Juan Public Lands Center FPA & EIS
Activity: Wellhead Gas Fired IC Engines
Emissions: Compressor Natural Gas IC Engine Combustion Emissions
Date: August, 2007

Fuel Combustion Source:						
Unit Description	Wellhead IC Engine					
Engine design (hp/hr)	50					
Operating Parameters:						
Operated	24	hr/day,	7	days/wk,	365	days/yr
Operating hours	8,760					
Capacity (%)	100	(while operating)				
Potential Fuel Combustion for the Year for Unit:						
Gas consumption rate	10,000	Btu/hp-hr				
Heat Content	1,000	Btu/scf				
Hourly Heat Input Rate:	0.50	MMBtu/hr				
Volume of Natural Gas Combusted	4.38	MMSCF/yr				

Emission Data:	lb/hr	tpy	Method of Determination	Emission Factor[1]	Units
NO_x	1.10500	4.840	AP-42	2.21	lb/MMBtu
CO	1.86000	8.147	AP-42	3.720	lb/MMBtu
SO_2	0.00029	0.001	AP-42	5.88E-04	lb/MMBtu
PM_{10} Including condensibles	0.00970	0.042	AP-42	1.94E-02	lb/MMBtu
$PM_{2.5}$ including condensibles	0.00970	0.042	AP-42	1.94E-02	lb/MMBtu
VOC	0.01480	0.065	AP-42	0.030	lb/MMBtu
Formaldehyde	0.01025	0.045	AP-42	2.05E-02	lb/MMBtu

[1] Based on a 4-stroke rich burn engine, taken from AP-42 Table 3.2-2 (EPA 2004).

TABLE A-20
WELL-HEAD HEATERS

Project: San Juan Public Lands Center FPA & EIS
Activity: Production Well head Heaters
Emissions: Emissions from Wellhead Heaters (Indirect Heaters, Sep Heaters, Dehy Heaters)
Date: August, 2007

Fuel Combustion Source:						
Unit Description	Wellhead Heater					
Design Firing Rate (MMBTU/hr)	0.25					
Operating Parameters:						
Annual Operating Factor	0.10					
Actual Fuel Combustion for the Year per Unit:						
Gas Heat Content	1,000	Btu/scf				
Volume of Natural Gas Combusted	0.22	mmscf/yr	18.25	mscf/mo		
Building Size (approximate):						
Width	8.00	ft				
Length	15.00	ft				
Height	7	ft				
Potential Emission Data:						
	From Stack Testing (lb/hr)	Actual[2] (lb/hr)	Actual (tpy)	Method of Determination	Emission Factors	Units
NO_x	0.034	0.0340	0.015	Stack test		
CO	0.291	0.2910	0.127	Stack test		
SO_2	--	0.0	0.0	Fuel Analysis	0.0	lb/MMscf
Total PM	--	0.00300	0.00131	AP-42	12.0	lb/MMscf
VOC	--	0.00200	0.00088	AP-42	8.0	lb/MMscf
Filterable Particulate	--	0.00113	0.00049	AP-42	4.5	lb/MMscf
Condensable Particulate	--	0.00188	0.00082	AP-42	7.5	lb/MMscf

[1] Stack testing data for this heater was provided by EnCana and included five separate tests of NO_x and CO emissions.
NOx and CO were the only pollutants for which stack testing emission were provided. The maximum of the stack test emissions was used for calculations.
[2] Actual lb/hr stack testing data for NOx and CO

TABLE A-21
WELL-HEAD HEATERS

Project:	**San Juan Public Lands Center FPA & EIS**	
Activity:	**Construction Wind Erosion**	
Emissions:	**Wind Erosion Emissions from Construction Areas**	
Date:	**August, 2007**	
Reference: Control of Open Fugitive Dust Sources, Section 4.1.3, EPA-450/3-98-008 - [Wind Emissions From Continuously Active Piles]		
E (lb TSP per day per acre) =	1.7 (s/1.5) (f/15)	
where:		
		AP-42 Table
s =	5.1	silt content % 13.2.2-1
f =	5.0	percentage of time that wind speed exceeds 5.4 m/s [from MVNP wind data 3 year period]
E =	**1.9**	**lb TSP per day per acre**
E =	**0.0289**	**TSP tons/acre/month**

TABLE A-22
SUMMARY OF MAXIMUM ANNUAL AIR EMISSIONS FOR FLUID MINERAL DEVELOPMENT AND PRODUCTION

Oil and Gas Well Construction Emissions - Peak Construction Year

# of New Wells/yr =	25		# of New Processing Facilities/yr =		1					
	Pad, Road, Pipeline Construction		Rig Move and Drilling		Completion and Flaring		Subtotals per well pad		Facility Construction		**TOTAL**
	(lb/hr)	(tons/well)	(lb/hr)	(tons/well)	(lb/hr)	(tons/well)	(lb/hr)	(tons/well)	(lb/hr)	(tons/plant)	**(tons/yr)**
NOx	12.27	0.25	27.53	9.91	3.11	0.04	42.92	10.20	12.50	0.64	**256**
CO	3.82	0.08	5.96	2.14	16.87	0.21	26.65	2.43	4.12	0.23	**61.0**
SO2	1.46	0.03	1.82	0.65	0.0005	0.000137	3.28	0.68	1.47	0.07	**17.2**
PM10	6.95	0.38	2.42	0.87	0.32	0.09	9.68	1.34	22.72	3.68	**37.3**
PM2.5	1.82	0.06	2.02	0.73	0.05	0.01	3.89	0.81	2.32	0.44	**20.6**
VOC	0.92	0.02	2.23	0.80	98	1.18	101	2.00	1.03	0.06	**50.0**
Formaldehyde	NA	NA	1.05	0.38	NA	NA	NA	NA	NA	NA	**9.4**

Oil and Gas Production Emissions Summary

# of O&G wells =	375										
	O&G Production Truck - per well		CO2 Production Truck - per well		Wellhead Heaters and Flashing		Wellhead Small Engines		O&G Compression		**TOTAL**
	(lb/hr)	(tons/well)	(lb/hr)	(tons/well)	(lb/hr)	(tons/well)	(lb/hr)	(tons/well)	(lb/hr)	(tons/yr)	**(tons/yr)**
NOx	0.0400	0.0520	0.0	0.0	0.034	0.015	1.105	4.840	9.4	41.3	**520**
CO	0.0515	0.0670	0.0	0.0	0.291	0.127	1.860	8.147	0.7	3.2	**840**
SO2	0.0011	0.0015	0.0	0.0	0.0000	0.0000	0.0003	0.0013	0.0014	0.0060	**0.7**
PM10	0.5008	0.6511	0.0	0.0	0.0030	0.0013	0.0097	0.0425	0.0229	0.1003	**249**
PM2.5	0.0767	0.0998	0.0	0.0	0.0030	0.0013	0.0097	0.042	0.0229	0.1003	**42.0**
VOC	0.0199	0.0259	0.0	0.0	4.701	20.584	0.015	0.065	0.27	1.19	**7736**
Formaldehyde	NA	NA	NA	NA	NA	NA	0.010	0.045	0.122	0.53	**9.0**

Project Maximum Annual Emissions

	Construction emissions (tpy)	Production emissions (tpy)	**Total emissions (tpy)**
NOx	255.7	520.1	**776**
CO	61.0	839.9	**901**
SO2	17.2	0.7	**17.9**
PM10	37.3	248.7	**286**
PM2.5	20.6	42.0	**62.6**
VOC	50.0	7736.0	**7786**
Formaldehyde	9.4	9.0	**18.4**

LOP 15 **years**

TABLE A-23
POINT SOURCE CONFIGURATION, CHARACTERISTICS & EMISSIONS

		Mid-field		Class 1						Model Input Emission Rates[2, 3]												
Source ID in AERMOD[1]	Source Description	Easting (X) (m)	Northing (Y) (m)	Easting (X) (m)	Northing (Y) (m)	Stack Height m	Temperature K	Exit Velocity mps	Stack Diameter m	PM10 g/sec	SO2 g/sec	NOx g/sec	CO g/sec	PM25 g/sec	Formaldehyde g/sec	PM10 lb/hr	PM2.5 lb/hr	SO2 lb/hr	NOx lb/hr	CO lb/hr	Formaldehyde lb/hr	Notes
DrilR1B	Drill Rig 1 - BLM (area 1)	681307	4224189	682940	4222010	6.0	750.0	20.0	0.2	2.46E-01	2.29E-01	3.47E+00	7.51E-01	2.46E-01	1.32E-01	1.95	1.95	1.82	27.5	5.96	1.05	area 1
DrilR2B	Drill Rig 2 - BLM (area 3)	709471	4218556	713497	4215356	6.0	750.0	20.0	0.2	2.46E-01	2.29E-01	3.47E+00	7.51E-01	2.46E-01	1.32E-01	1.95	1.95	1.82	27.5	5.96	1.05	area 3
DrilR3B	Drill Rig 3 - BLM (area 5)	728783	4204877	730201	4201769	6.0	750.0	20.0	0.2	2.46E-01	2.29E-01	3.47E+00	7.51E-01	2.46E-01	1.32E-01	1.95	1.95	1.82	27.5	5.96	1.05	area 5
DrilR1F	Drill Rig 1 - FS (area 6)	706252	4191197	707861	4187174	6.0	750.0	20.0	0.2	2.46E-01	2.29E-01	3.47E+00	7.51E-01	2.46E-01	1.32E-01	1.95	1.95	1.82	27.5	5.96	1.05	area 6
DrilR2F	Drill Rig 2 - FS (area 8)	714419	4170272	716713	4165448	6.0	750.0	20.0	0.2	2.46E-01	2.29E-01	3.47E+00	7.51E-01	2.46E-01	1.32E-01	1.95	1.95	1.82	27.5	5.96	1.05	area 8
Flare1	Flare - Area 1	681307	4224189	682940	4222010	5.0	1273.0	20.0	1.0	0.00E+00	0.00E+00	3.92E-01	2.13E+00	0.00E+00	0.00E+00	0.00	0.00	0.00	3.11	16.9	0.0	
Flare2	Flare - Area 2	696596	4224189	695045	4221754	5.0	1273.0	20.0	1.0	0.00E+00	0.00E+00	3.92E-01	2.13E+00	0.00E+00	0.00E+00	0.00	0.00	0.00	3.11	16.9	0.0	
Flare3	Flare - Area 3	709471	4218556	713497	4215356	5.0	1273.0	20.0	1.0	0.00E+00	0.00E+00	3.92E-01	2.13E+00	0.00E+00	0.00E+00	0.00	0.00	0.00	3.11	16.9	0.0	
Flare4	Flare - Area 4	726369	4220970	726369	4218556	5.0	1273.0	20.0	1.0	0.00E+00	0.00E+00	3.92E-01	2.13E+00	0.00E+00	0.00E+00	0.00	0.00	0.00	3.11	16.9	0.0	
Flare5	Flare - Area 5	728783	4204877	730201	4201769	5.0	1273.0	20.0	1.0	0.00E+00	0.00E+00	3.92E-01	2.13E+00	0.00E+00	0.00E+00	0.00	0.00	0.00	3.11	16.9	0.0	
Flare6	Flare - Area 6	706252	4191197	707861	4187174	5.0	1273.0	20.0	1.0	0.00E+00	0.00E+00	3.92E-01	2.13E+00	0.00E+00	0.00E+00	0.00	0.00	0.00	3.11	16.9	0.0	
Flare7	Flare - Area 7	723955	4187979	724759	4184760	5.0	1273.0	20.0	1.0	0.00E+00	0.00E+00	3.92E-01	2.13E+00	0.00E+00	0.00E+00	0.00	0.00	0.00	3.11	16.9	0.0	
Flare8	Flare - Area 8	714419	4170272	716713	4165448	5.0	1273.0	20.0	1.0	0.00E+00	0.00E+00	3.92E-01	2.13E+00	0.00E+00	0.00E+00	0.00	0.00	0.00	3.11	16.9	0.0	
Flare9	Flare - Area 9	735220	4159010	735225	4156636	5.0	1273.0	20.0	1.0	0.00E+00	0.00E+00	3.92E-01	2.13E+00	0.00E+00	0.00E+00	0.00	0.00	0.00	3.11	16.9	0.0	
NewComp9	New Compression Area 9	732625	4161081	732625	4161081	6.0	750.0	20.0	0.2	2.88E-03	1.71E-04	1.19E+00	9.23E-02	2.88E-03	0.00E+00	0.0229	0.0229	0.00136	9.4	0.73	0.0	area 9
NewPro1	New Prod Well Area 1	681307	4224189	682940	4222010	2.0	298.0	0.5	0.1	6.75E-03	9.14E-05	3.86E-01	9.40E-01	6.75E-03	3.19E-03	0.054	0.054	0.00073	3.06	7.46	0.0253	
NewPro2	New Prod Well Area 2	696596	4224189	695045	4221754	2.0	298.0	0.5	0.1	4.58E-03	6.20E-05	2.62E-01	6.38E-01	4.58E-03	2.16E-03	0.036	0.036	0.00049	2.08	5.06	0.0172	
NewPro3	New Prod Well Area 3	709471	4218556	713497	4215356	2.0	298.0	0.5	0.1	5.83E-03	7.89E-05	3.33E-01	8.12E-01	5.83E-03	2.75E-03	0.046	0.046	0.00063	2.64	6.44	0.0218	
NewPro4	New Prod Well Area 4	726369	4220970	726369	4218556	2.0	298.0	0.5	0.1	5.45E-03	7.39E-05	3.12E-01	7.60E-01	5.45E-03	2.58E-03	0.043	0.043	0.00059	2.48	6.03	0.0204	
NewPro5	New Prod Well Area 5	728783	4204877	730201	4201769	2.0	298.0	0.5	0.1	5.13E-03	6.95E-05	2.93E-01	7.14E-01	5.13E-03	2.42E-03	0.041	0.041	0.00055	2.33	5.67	0.0192	
NewPro6	New Prod Well Area 6	706252	4191197	707861	4187174	2.0	298.0	0.5	0.1	4.58E-03	6.20E-05	2.62E-01	6.38E-01	4.58E-03	2.16E-03	0.036	0.036	0.00049	2.08	5.06	0.0172	
NewPro7	New Prod Well Area 7	723955	4187979	724759	4184760	2.0	298.0	0.5	0.1	1.07E-02	1.45E-04	6.11E-01	1.49E+00	1.07E-02	5.04E-03	0.085	0.085	0.00115	4.85	11.81	0.0400	
NewPro8	New Prod Well Area 8	714419	4170272	716713	4165448	2.0	298.0	0.5	0.1	5.13E-03	6.95E-05	2.93E-01	7.14E-01	5.13E-03	2.42E-03	0.041	0.041	0.00055	2.33	5.67	0.0192	
NewPro9	New Prod Well Area 9	735220	4159010	735225	4156636	2.0	298.0	0.5	0.1	2.56E-02	3.47E-04	1.47E+00	3.57E+00	2.56E-02	1.21E-02	0.203	0.203	0.00276	11.63	28.35	0.0961	
															Total Project Modeled (lb/hr)	10.4	10.4	9.1	208.6	263.9	5.5	
															Total Project Modeled tpy	45.4	45.4	39.9	913.5	1156.0	24.1	

1 – Source IDs – DrilR1B – Drill rig, area 1 (B-BLM; F-USFS); NewComp9 – New Compressor near area 9; NewPro1 – New Production well, area 1
2 - = lb/hr emissions * Conversion factor
3 – Emission rate for each area determined by per well emissions ratioed by number of wells in each area.

TABLE A-24
PARTICULATE MATTER VOLUME SOURCE EMISSIONS

PM Emissions - Volume Source Configuration Calculations

Process	Total Emissions PM10 lb/hr	Total Emissions PM2.5 lb/hr
Construction	6.9	1.8
Prod Truck Traffic	187.8	28.78

Source Name[1]	PM10 lb/hr	PM2.5 lb/hr	PM10 g/sec	PM2.5 g/sec		
ConV1	0.704	0.18	0.089	0.023	10 hrs/day	
ConV2	1.037	0.27	0.131	0.034	10 hrs/day	
ConV3	0.815	0.21	0.103	0.027	10 hrs/day	
ConV4	0.871	0.23	0.110	0.029	10 hrs/day	
ConV5	0.926	0.24	0.117	0.031	10 hrs/day	
ConV6	1.037	0.27	0.131	0.034	10 hrs/day	
ConV7	0.445	0.12	0.056	0.015	10 hrs/day	
ConV8	0.926	0.24	0.117	0.031	10 hrs/day	
ConV9	0.185	0.05	0.023	0.006	10 hrs/day	
ProV1	19.03	2.92	2.398	0.367	10 hrs/day	
ProV2	28.05	4.30	3.534	0.541	10 hrs/day	
ProV3	22.04	3.38	2.777	0.425	10 hrs/day	
ProV4	23.54	3.61	2.966	0.454	10 hrs/day	
ProV5	25.04	3.84	3.155	0.483	10 hrs/day	
ProV6	28.05	4.30	3.534	0.541	10 hrs/day	
ProV7	12.02	1.84	1.515	0.232	10 hrs/day	
ProV8	25.04	3.84	3.155	0.483	10 hrs/day	
ProV9	5.01	0.77	0.631	0.097	10 hrs/day	
Use 18 1km volume sources			1000	meters square.	Sigma Y_0 =	232.6
Release ht is 7 m, sigma Z is 3.26, based on previous BLM Roan analysis and CDPHE guidance.						

1 – ConV1 = Construction Volume Source, area 1; ProV1 = Production Volume Source, area 1
2 – Emission rate for each area determined by per well emissions ratioed by number of wells in each area.

TABLE A-25
PARTICULATE MATTER VOLUME SOURCE CHARACTERISTICS

Source Name[1]		X (Easting)	Y (Northing)	Elev (m)[2]	Length of Side X (m)	Length of Side Y (m)	sigma Y_0	Release Ht. (m)	Initial Sigma Z_0	PM10 g/sec	SO2	NOx	CO	PM2.5 g/sec
ConV1	Construct Vol Source 1	681307	4224189		1000	1000	232.6	7	3.26	0.089	---	---	---	0.023
ConV2	Construct Vol Source 2	696596	4224189		1000	1000	232.6	7	3.26	0.131	---	---	---	0.034
ConV3	Construct Vol Source 3	709471	4218556		1000	1000	232.6	7	3.26	0.103	---	---	---	0.027
ConV4	Construct Vol Source 4	726369	4220970		1000	1000	232.6	7	3.26	0.110	---	---	---	0.029
ConV5	Construct Vol Source 5	728783	4204877		1000	1000	232.6	7	3.26	0.117	---	---	---	0.031
ConV6	Construct Vol Source 6	706252	4191197		1000	1000	232.6	7	3.26	0.131	---	---	---	0.034
ConV7	Construct Vol Source 7	723955	4187979		1000	1000	232.6	7	3.26	0.056	---	---	---	0.015
ConV8	Construct Vol Source 8	714419	4170272		1000	1000	232.6	7	3.26	0.117	---	---	---	0.031
ConV9	Construct Vol Source 9	735220	4159010		1000	1000	232.6	7	3.26	0.023	---	---	---	0.006
ProV1	Product Vol Source 1	681307	4224189		1000	1000	232.6	7	3.26	2.398	---	---	---	0.367
ProV2	Product Vol Source 2	696596	4224189		1000	1000	232.6	7	3.26	3.534	---	---	---	0.541
ProV3	Product Vol Source 3	709471	4218556		1000	1000	232.6	7	3.26	2.777	---	---	---	0.425
ProV4	Product Vol Source 4	726369	4220970		1000	1000	232.6	7	3.26	2.966	---	---	---	0.454
ProV5	Product Vol Source 5	728783	4204877		1000	1000	232.6	7	3.26	3.155	---	---	---	0.483
ProV6	Product Vol Source 6	706252	4191197		1000	1000	232.6	7	3.26	3.534	---	---	---	0.541
ProV7	Product Vol Source 7	723955	4187979		1000	1000	232.6	7	3.26	1.515	---	---	---	0.232
ProV8	Product Vol Source 8	714419	4170272		1000	1000	232.6	7	3.26	3.155	---	---	---	0.483
ProV9	Product Vol Source 9	735220	4159010		1000	1000	232.6	7	3.26	0.631	---	---	---	0.097
MontNEPA	Monticello NEPA	637000	4160000	1850	1000	1000	232.6	7	3.26	23.074	4.20	103.28	66.46	7.336

1 – ConV1 = Construction Volume Source, area 1; ProV1 = Production Volume Source, area 1
2 – All source elevations calculated by AERMAP, except Monticello which is from CANM analysis

TABLE A-26
DISTRIBUTION OF WELLS BY SOURCE AREA

Source Area	Area Owner	# of Wells	Sub-total
Area 1	BLM	38	
Area 2	BLM	56	
Area 3	BLM	44	
Area 4	BLM	47	
Area 5	BLM	50	**235**
Area 6	USFS	56	
Area 7	USFS	24	
Area 8	USFS	50	
Area 9	USFS	10	**140**
	Total		**375**