Near-Field Air Quality Technical Report
for the
Wind River Natural Field Gas Development Project
Proposed By Tom Brown, Inc.

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Prepared for:

Bureau of Indian Affairs
Wind River Agency
Fort Washakie, Wyoming

Prepared by:

Buys & Associates, Inc.
Environmental Consultants
300 East Mineral Ave., Suite 10
Littleton, CO 80122
www.buysandassociates.com

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1.0 INTRODUCTION

The Wind River Project Area (WRPA) near-field air quality assessment was performed in accordance with a written protocol defining methodologies designed to quantify potential air quality impacts from the proposed Project and surrounding development. This protocol was prepared by Buys and Associates with refinements resulting from review and input from the Bureau of Land Management, the Wyoming Department of Environmental Quality, the U.S. Forest Service, the National Park Service, Environmental Protection Agency (EPA) Region VIII, the Bureau of Indian Affairs, the Wind River Environmental Quality Council, and Project proponents. This procedure ensured that the air quality assessment methodology is technically acceptable to all parties providing input.

This technical report presents the near-field WRPA modeling assessment consisting of a sub-grid analysis of project impacts only and a mid-range analysis of Project and background source impacts within 50 kilometers of the WRPA. The sub-grid analysis involved short-term activities such as well pad and road construction, well drilling, and well completion activities that would not only be geographically separated, but would not generally occur simultaneously. A reasonable scenario was developed for each short-term activity that would represent the maximum air quality impacts with the assumption that other activities would have a lesser air quality impact for any given area. The sub-grid modeling also assessed impacts from hazardous air pollutants (HAP) from the larger permanent facilities such as compressor stations that would be widely separated from each other within the WRPA. The mid-range analysis involved the impacts that would occur from permanent facilities installed for the 20-40 year life of the project. A separate technical report (Buys and Associates 2004) presents the far-field modeling assessment beyond 50 kilometers.

Modeled impacts from the sub-grid and mid-range analyses were compared to the most stringent of the State of Wyoming and National Ambient Air Quality Standards and PSD Class II increments. Table 1-1 presents the ambient air quality standards, PSD increments and assumed background concentrations based on referenced monitoring data.

Table 1-1. Ambient Air Quality Standards and PSD Increments (μg/m³).

Pollutant And Averaging Time	Measured Background Concentration (μg/m³)	National and Wyoming Ambient Air Quality Standard (μg/m³)	PSD Class I Increment (μg/m³)	PSD Class II Increment (μg/m³)
Carbon Monoxide (CO)				
1-hour	3,336 a	40,000	n/a	n/a
8-hour	1,381 a	10,000	n/a	n/a
Nitrogen Dioxide (NO_2)				
Annual	3.4 b	100	2.5	25
Ozone (O_3)				
1-hour	169 c	235	n/a	n/a
8-hour	147 c	157	n/a	n/a
Particulate Matter (PM_{10})				
24-hour	61 d	150	8	30
Annual	22 d	50	4	17
Particulate Matter ($PM_{2.5}$)				
24-hour	35 d	65	n/a	n/a
Annual	10 d	15	n/a	n/a
Sulfur Dioxide (SO_2)				
3-hour	132 e	1,300	25	512
24-hour (National)	n/a	365	5	91
24-hour (Wyoming)	43 e	260	5	91
Annual (National)	n/a	80	2	20
Annual (Wyoming)	9 e	60	2	20

Note: The U. S. Supreme Court upheld the proposed 8-hour ozone and PM2.5 standards on February 27, 2001. The State of Wyoming will not enforce compliance with these standards until an implementation rule is issued by the EPA (Cara Casten, WDEQ, personal communication, February 2004).

Measured background ozone concentration value represents the top tenth percentile maximum 1-hour value. Other short-term background concentrations are second-maximum values.

n/a: Not Applicable.

Wyoming Ambient Air Quality Standards from: Wyoming Air Quality Standards and Regulations, Chapter 2 - Ambient Standards.

National Ambient Air Quality Standards from: 40 CFR part 50 National Primary and Secondary Air Quality Standards.

PSD Increments from: 40 CFR part 51.166 Prevention of Significant Deterioration of Air Quality.

Sources of Measured Background Concentrations

a Data collected by Amoco at Ryckman Creek for an 8 month period during 1978-1979, summarized in the Riley Ridge EIS (BLM 1983).

b Data collected at Green River Basin Visibility Study site, Green River, Wyoming during the period January-December 2001. (ARS 2002)

c Data collected at Green River Basin Visibility Study site, Green River, Wyoming during the period June 10, 1998 through December 31, 2001 (ARS 2001).

d Data collected from the Lander, Wyoming monitors for the year 2002 (WDEQ).

e Data collected at LaBarge Study Area at the Northwest Pipeline Craven Creek site, 1982-1983 (WDEQ).

2.0 PROJECT DESCRIPTION

The Wind River Project Area (WRPA) is located in Fremont County, Wyoming (Figure 2-1). The WRPA currently contains 178 active producing wells, with accompanying production-related facilities, roads, and pipelines. Total gas compression and treatment capacity within the WRPA is currently 14,600 horsepower (hp). With the Proposed Action the Wind River Operators propose to drill 325 wells at 325 well locations within the WRPA in addition to the 178 existing active producing wells. Additional natural gas compression and treatment capacity required for the Proposed Action is estimated at 32,800 hp at 8 locations. Some of the additional compression capacity would be located outside of the WRPA.

Drilling density would occur at 1 to 32 wells per section depending on the target formation. Development would be phased in time and would not be uniformly spaced throughout the WRPA. The Operators anticipates that future development in the WRPA would be concentrated primarily within the existing Pavillion, Muddy Ridge, and Sand Mesa fields. However, some exploration and development is planned for the Coastal Extension and Sand Mesa South areas, which currently have no producing wells. The five development areas and the overall WRPA boundary are shown on Figure 2-2.

Three other levels of development are alternatives to the Proposed Action. Under Alternative A, the Wind River Operators propose to drill 485 wells at 485 well locations but only 369 of these wells are projected to be successful. The additional horsepower of all the compressor engines is projected to be 46,000 at the same locations as the Proposed Action. Under Alternative B, the Wind River Operators propose to drill 233 wells at 233 well locations but only 182 of these wells are projected to be successful. The additional horsepower of all the compressor engines is projected to be 22,700 at the same locations as the Proposed Action. Under Alternative C, the No Action Alternative, the Wind River Operators propose to drill 100 wells at 100 well locations on private lands and tribal lands for drainage offset and all are projected to be successful. The additional horsepower of the compressor engines is projected to be 3,200 hp at only one location. Table 2-1 presents the summary of number of wells, annual well development, and total compression for each alternative.

Table 2-1. Summary of WRPA Alternatives.

Alternative	Number Wells	Proposed Annual Development Rate	Total New Compression (hp)
Proposed Action	325	38	32,800
Alternative A	485	39	46,050
Alternative B	233	38	22,700
Alternative C	100	14	3,200

After construction of well pads and roads, drilling and completion of a well, and interconnection to the gathering pipelines, each well pad would consist of a wellhead, a three-phase separator (to separate gas, produced water, and hydrocarbon condensate), and a condensate tank. The gas would be moved under well head pressure to central production facilities (CPF) that would include a single or multiple compressor engines, a central separator, and a central glycol dehydration unit. After processing, the gas would then be transported to a sales pipeline for further distribution.

Derivation of the emissions inventory used for the near-field modeling analysis is described in detail in a separate Emissions Inventory Technical Report (Buys and Associates, 2004a). Project emissions from the WRPA project would consist of the criteria pollutants (nitrogen oxides [NO_X], carbon monoxide [CO], particulates [PM_{10} and $PM_{2.5}$], sulfur dioxide [SO_2], and volatile organic compounds [VOC]), and hazardous air pollutants (HAP). These pollutants would be emitted from the following activities and sources:

- Well pad and road construction: equipment producing fugitive dust while moving and leveling earth;
- Drilling: Vehicles generating fugitive dust on access roads, and drill rig engine exhaust;
- Completion: Vehicles generating fugitive dust on access roads;
- Vehicle tailpipe emissions associated with all development phases;
- Well pad operation: Three-phase separator, flashing and breathing emissions from a condensate tank; and
- Central production facility: Compressor engines and central glycol dehydration units.

Figure 2-1. Project Location

Figure 2-2.WRPA Project Boundary and gas Fields

3.0 DISPERSION MODEL AND METEOROLOGY

The U.S. Environmental Protection Agency (EPA) Industrial Source Complex, Version 3, (ISC3) model (EPA 1995) was used to assess the potential near-field air quality impacts of the proposed Project and background sources. The most recent available version of ISC3 (02035) was used and input was configured in accordance with the Guideline on Air Quality Models, Revised (EPA 1996).

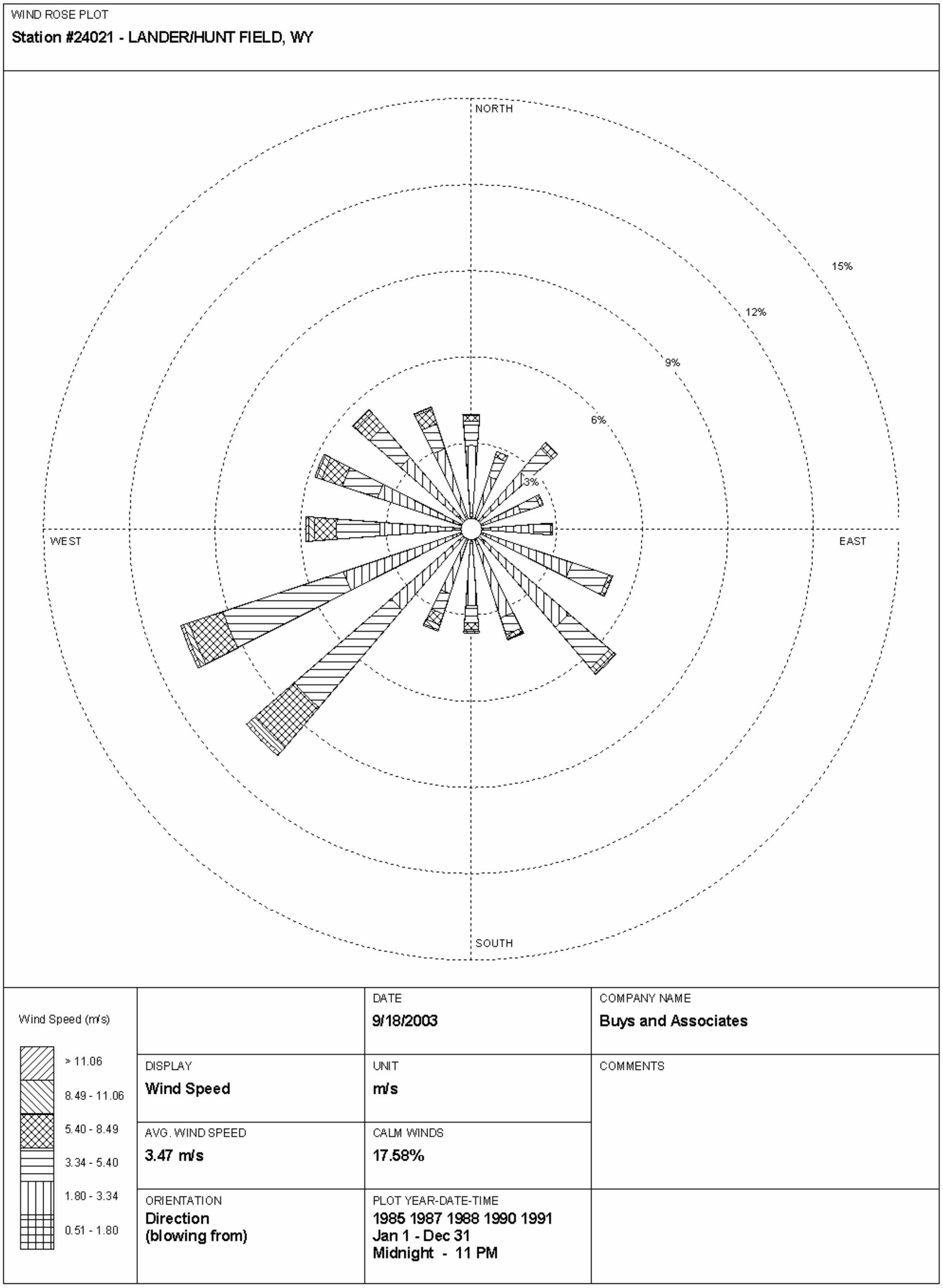
The ISC3 model is a steady-state Gaussian plume model designed to predict ground-level pollutant concentrations from multiple and various sources associated with an industrial source complex. The major features and capabilities of the ISC3 are:

- Regulatory default option;
- Plume rise due to momentum and buoyancy;
- Building downwash procedures;
- Stack tip downwash;
- Default options on wind speed profiles;
- Consideration of gravitational effects settling and dry deposition on ambient concentrations;
- Simulation of point, line, volume, area, and open pit sources;
- Calculation of dry, wet or total deposition;
- Air concentration estimates for averaging periods varying from one hour to one year;
- Variation of source emission rates for month, season, or hour of the day;
- Source groups options;
- All terrain types (simple, intermediate, and complex); and
- Several receptor grid networks and discrete receptors.

To simulate the movement and dispersion of pollutants, the ISC3 model uses hourly sequential meteorological data. Meteorological data was obtained from the EPA's SCRAM website (www.epa.gov/scram001/tt24.htm). A five-year data set of surface data from the Lander, Wyoming Airport was merged with corresponding years of upper air data from Lander to form the meteorological data for the WRPA ISC3 modeling analysis. The Lander Airport is located approximately 25 miles south-southwest of the WRPA and is considered the most representative long-term characterization of meteorological patterns within the WRPA.

Figure 3-1 shows the distribution of wind velocity for the Lander Airport for the five-year period. The predominant wind blows from the southwest to the northeast. The mean average wind speed is 3.5 meters per second, or 7.8 miles per hour.

Figure 3-1. Lander Airport Windrose



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4.0 SUB-GRID IMPACT ASSESMENT

4.1 CONSTRUCTION AND DEVELOPMENT

4.1.1 Model Setup

The major pollutant associated with construction and development would be PM_{10} generated by earth-moving and traffic activities. As shown in Table 2-1, the annual level of development would be nearly identical for all alternatives. Therefore, the short-term impacts associated with development activities would be identical for all alternatives.

Each phase in the development of a single well (construction, drilling and completion) was modeled separately. A well pad and adjoining unpaved access road were included in this analysis. The Operators have proposed to drill a maximum of 14 wells per year within a development area. Therefore, the construction-, drilling-, and completion-related ambient air impacts were analyzed for one well pad and the associated access road with the assumption that one well pad and access road would be developed at any one time within each of the five development areas. Therefore, each construction activity would be separated by a sufficient distance and time such that the impacts from one construction site would not overlap with another site.

A well pad and access road complex was characterized by an individual well pad (1.2 acres) and an unpaved access road with an average length of 0.15 miles (240 meters) and a width of 30 feet or approximately 9 meters. Each access road was modeled as a series of 3 rectangular area sources with a length of 80 meters and a width of 9 meters to maintain the 10:1 aspect ratio limitation of the ISCST3 model. Although a road could be oriented in any direction, the use of 5 years of meteorological data comprising 1,825 24-hour periods of data should adequately characterize the maximum short-term impacts regardless of orientation.

Receptors were spaced at 100-meter intervals with a buffer zone of 200 meters from the access road and 400 meters from the well pad. The buffer zone criteria were based on minimum distances that heavy equipment operators would allow public access to road construction (200 meters) and the typical spacing between wells and occupied residences. Receptor elevations were assumed to be at the base elevation of well site sources. The modeled sources (well pad and access road) and receptor locations are shown on Figure 4-1.

Modeling for construction activities involved fugitive dust (PM_{10}) emissions from the operation of a grader and dozer. Modeling for the drilling and completion activities involved the traffic-generated fugitive dust and small PM_{10} emissions from a drill rig. Modeling for completion activities only involved the vehicle-generated fugitive dust.

Emissions of PM_{10} were modeled for comparison to applicable ambient air quality standards. Well drilling was assumed to occur 24 hours per day, while construction and completion activities were assumed to occur eight hours per day. Maximum hourly emissions were estimated and used for comparison to short-term 24-hour and long-term annual PM_{10} standards.

4.1.2 Emissions

4.1.2.1 Well Pad and Road Construction

The Operators estimate that each well pad and access road would be completed in 2 days working 8 hours per day. Based upon the emissions inventory, this level of development would produce an average emission rate of 12.54 lbs/hr or 100.3 lbs/day. These emissions were apportioned to the well pad and access road based on the ratio of the 1.15 acre well pad and the 0.54 acre access road, or 68 percent for the well pad and 32 percent for the short access road. The resultant modeling emission rates for the 24-hour period were:

- Well pad: 0.3586 gm/sec;
- Each segment of the access road: 0.0559 gm/sec.

4.1.2.2 Drilling

The Operators estimate that drilling would take from a minimum of 9 days in the Pavillion field to a maximum of 70 days in the other development areas. Because the resultant average daily traffic volume would be the highest in the Pavillion field, drilling activities in the Pavillion field were modeled as representative of the maximum drilling impact. Based on the emissions inventory, traffic-related PM_{10} emissions would be 12.12 lbs/day, or 0.0636 gm/sec on each access road segment. Additional PM_{10} would be generated from the exhaust of a drill rig engine at the rate of 0.24 lbs/hr, or 0.0303 gm/sec. The stack and exhaust parameters for drill rig engines are:

- stack height: 7.6 m
- stack diameter: 0.1 m
- exhaust temperature: 800 K
- exhaust velocity: 50 m/sec

Additionally, the maximum SO_2 emissions would occur during drilling activities from the diesel-fueled drill rig engines and vehicle traffic. Based on the emissions inventory, drill rig SO_2 emissions would be 0.24 lb/hr, and vehicle emissions would be 0.011 lb/hr.

4.1.2.3 Completion

The Proponent estimates that completion activities would take from a minimum of 5-6 days in the Pavillion field to a maximum of 30 days in the other development areas. Because the average daily traffic volume would be the highest in the Pavillion field, completion activities in the Pavillion field were modeled as representative of the maximum completion impact. Based on the emissions inventory, traffic-related PM_{10} emissions would be 80.97 lbs/day, or 0.1417 gm/sec on each access road segment.

4.1.3 Modeling Results

The results of the construction and development phase modeling are shown in Table 4-1. The locations of the maximum 24-hour impacts are shown on Figure 4-1. In all cases of construction and well development activities, the maximum impacts were 200 meters from the access road. The results show that the highest fugitive dust levels would be during the construction of well pads and roads. However, these impacts would be very short-term at any one location because construction would typically last about 2 days. Drilling and completion activities could last from 5 to 70 days at any one location. The modeling demonstrates that PM_{10} ambient air concentrations would be below standards for the lengths of these development activities. Even though these would be short-term impacts, the annual PM_{10} results are also shown to demonstrate that even if these activities lasted for an entire year at one location, the effects would still be less than all applicable standards.

Table 4-1. Modeled PM_{10} Impacts from WRPA Construction and Development

Activity	Ambient Air Concentration (μg/m³)[1]					
	24-Hour Maximum			Annual Average		
	Modeled Impact	With Background[2]	Percent of 24-Hour Standard[3]	Modeled Impact	With Background[4]	Percent of Annual Standard[5]
Pad and Road Construction	81.0	142.0	94.7%	11.0	33.0	66.0%
Drilling	7.3	68.3	45.5%	1.0	23.0	46.0%
Completion	48.2	109.2	72.8%	6.0	28.0	56.0%

1 μg/m³ is micrograms of pollutant per cubic meter of air
2 24-hour PM_{10} background is 61 μg/m³
3 24-hour PM_{10} standard is 150 μg/m³
4 Annual PM_{10} background is 22 μg/m³
5 Annual PM_{10} standard is 50 μg/m³

WRPA Construction-Related Impacts
Maximum 24-hour PM10
(micrograms per cubic meter)

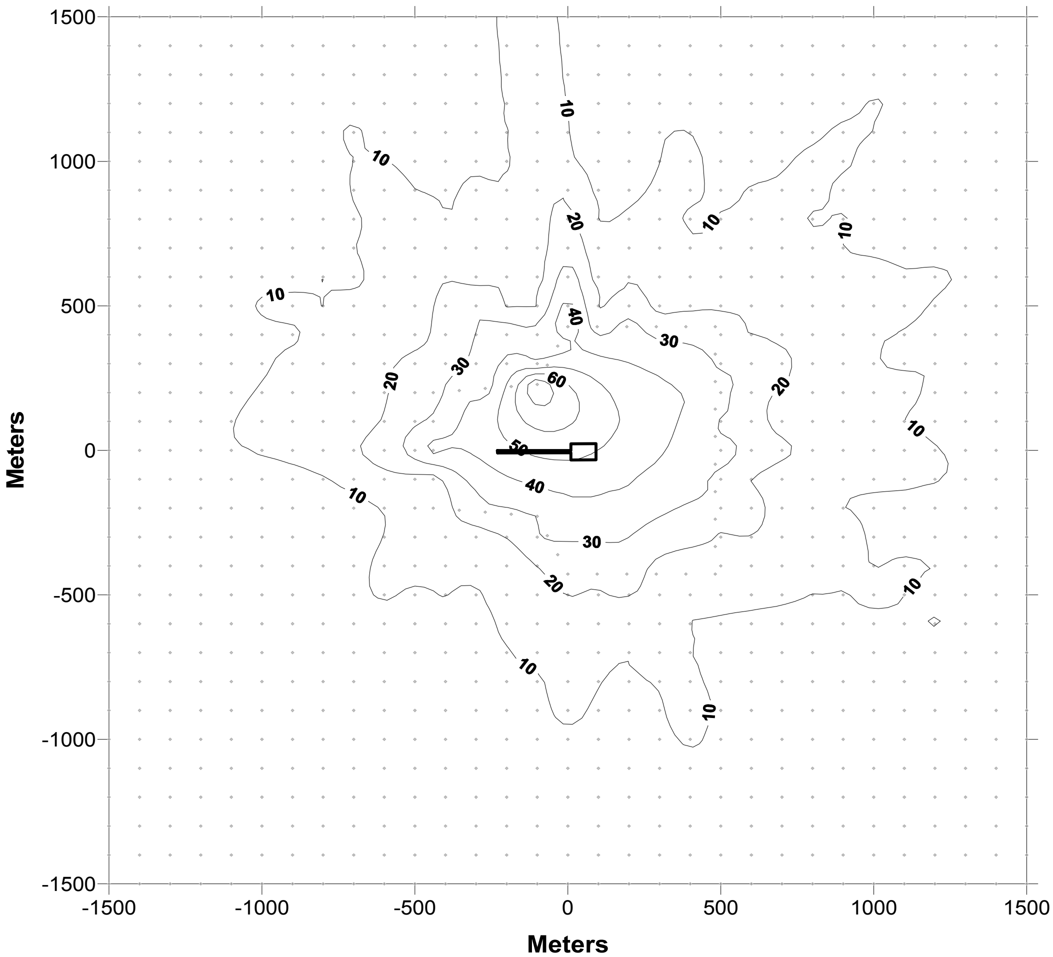

Figure 4-1

Well Pad and Access Road

Drilling activities would result in maximum SO_2 ambient air concentrations well below applicable standards as shown on Table 4-2 below.

Table 4-2. Modeled SO_2 Impacts from WRPA Drilling.

Averaging Period	Modeled Concentration (μg/m^3)	Background (μg/m^3)	Total (μg/m^3)	WAAQS (μg/m^3)	% of WAAQS
3-hour	4.4	132	136.4	1300	10.5
24-hour	1.8	43	44.8	260	17.2
Annual	0.2	9	9.2	60	15.3

4.2 PRODUCTION HAP

4.2.1 Model Setup

After development of well sites, NO_X, CO and HAP emissions would occur during production activities. NO_X and CO impacts considering the full development scenario are addressed later in the mid-range modeling section. This section addresses the impacts from HAP emissions.

A "most-likely scenario" was developed to assess the HAP impacts. A modeling grid was developed with the largest proposed compressor station, the Sand Mesa Station with proposed capacity of 14,400 horsepower (hp) under Alternative A, in the middle of a 5-acre site and 8 well pads at 20-acre spacing on 1.2-acre sites surrounding the compressor station to evaluate formaldehyde impacts. This 20-acre spacing was used because it would be typical of the smallest spacing on which wells would be operated in the WRPA. This scenario therefore illustrates the maximum ambient air HAP concentrations that would occur in the WRPA from multiple facilities under any alternative. The modeled compressor station contained a compressor engine building, a central separator and a dehydration unit. The compressor engine was modeled with building downwash effects using the Building Profile Input Program (BPIP) by placing the stack near a hypothetical compressor building. The dimensions of the building were assumed as 11 x 8 meters with a height of 6 meters. The compressor engine stack was located one meter away from the short side of the building. Each well pad contained a separator and condensate tank depending upon the HAP modeled.

Receptors were placed at 25-meter spacing along the boundaries of the compressor stations and well pads. Receptors were then placed at 100-meter spacing throughout the 2-kilometer by 2-kilometer modeling domain.

The location of sources and the receptors are shown on Figures 4-2 and 4-3 later in this section.

4.2.2 Emissions

Tables 4-3, through 4-6 present the estimated HAP emissions from each facility for the Proposed Action and Alternatives A, B and C, respectively. The emissions for the compressor engines, dehydration unit and central separator are representative of the largest proposed compressor station within the WRPA under each alternative. Emissions from condensate tanks and pad separators are representative of the highest product flow rates within the WRPA.

Table 4-3. WRPA HAP Emission Rates (Proposed Action).

	Annual Pollutant Emissions (tons/year)					
Facility	**Formaldehyde**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**n-Hexane**
Compressor engines	6.96	0.57	0.20	0.009	0.07	0
Dehydration unit	None	.557	None	None	None	.027
Central separator	0.00048	.000014	.000022	None	None	.012
Pad condensate tank	None	.0054	.0081	.0003	.003	.03
Pad separator	.00006	0.0002	0.0003	None	None	.0015
	Modeling Emission Rate (grams/second) [1]					
Facility	**Formaldehyde**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**n-Hexane**
Compressor engines	0.200	0.0164	0.00580	0.000258	0.00203	None
Dehydration unit	None	0.0160	None	None	None	0.000774
Central separator	0.0000139	0.000000390	0.000000632	None	None	0.000335
Pad condensate tank	None	0.000155	0.000234	0.00000921	0.0000881	0.000930
Pad separator	0.00000236	0.0000000662	0.000000107	None	None	0.0000567

[1] **Emission rates are based on assumption that facilities would operate continuously for a year**

Table 4-4. WRPA HAP Emission Rates (Alternative A).

	Annual Pollutant Emissions (tons/year)					
Facility	**Formaldehyde**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**n-Hexane**
Compressor engines	9.73	0.79	0.28	0.02	0.09	0
Dehydration unit	None	0.75	None	None	None	0.05
Central separator	0.0007	0.0002	0.0003	None	None	0.017
Pad condensate tank	None	.0054	.0081	.0003	.003	.03
Pad separator	.00006	0.0002	0.0003	None	None	.0015
	Modeling Emission Rate (grams/second) [1]					
Facility	**Formaldehyde**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**n-Hexane**
Compressor engines	0.280	0.0230	0.00811	0.000360	0.00283	None
Dehydration unit	None	0.0303	None	None	None	0.00146
Central separator	0.00001394	0.000000390	0.000000632	None	None	0.000334
Pad condensate tank	None	0.000155	0.000234	0.00000921	0.0000881	0.000930
Pad separator	0.00000236	0.000000662	0.000000107	None	None	0.0000567

[1] **Emission rates are based on assumption that facilities would operate continuously for a year**

Table 4-5. WRPA HAP Emission Rates (Alternative B).

	Annual Pollutant Emissions (tons/year)					
Facility	**Formaldehyde**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**n-Hexane**
Compressor engines	4.82	0.395	0.140	0.00620	0.0488	None
Dehydration unit	None	0.446	None	None	None	0.0214
Central separator	0.000337	0.00000943	0.0000153	None	None	0.00808
Pad condensate tank	None	0.00540	0.00810	0.000300	0.00300	0.00300
Pad separator	0.0000600	0.000200	0.000300	None	None	0.00150
	Modeling Emission Rate (grams/second) [1]					
Facility	**Formaldehyde**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**n-Hexane**
Compressor engines	0.139	0.0114	0.00402	0.000179	0.00140	None
Dehydration unit	None	0.0128	None	None	None	0.000615
Central separator	0.00000970	0.000000272	0.000000440	None	None	0.000233
Pad condensate tank	None	0.000156	0.000233	0.00000864	0.0000864	0.000864
Pad separator	0.00000173	0.00000576	0.00000864	None	None	0.0000432

[1] **Emission rates are based on assumption that facilities would operate continuously for a year**

Table 4-6. WRPA HAP Emission Rates (Alternative C).

	Annual Pollutant Emissions (tons/year)					
Facility	**Formaldehyde**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**n-Hexane**
Compressor engines	1.42	0.116	0.0411	0.00183	0.0144	None
Dehydration unit	None	None	None	None	None	None
Central separator	None	None	None	None	None	None
Pad condensate tank	None	0.0054	0.0081	0.0003	0.003	0.03
Pad separator	0.00006	0.0002	0.0003	None	None	0.0015
	Modeling Emission Rate (grams/second) [1]					
Facility	**Formaldehyde**	**Benzene**	**Toluene**	**Ethylbenzene**	**Xylenes**	**n-Hexane**
Compressor engines	0.0409	0.00335	0.00118	0.0000526	0.000414	None
Dehydration unit	None	None	None	None	None	None
Central separator	None	None	None	None	None	None
Pad condensate tank	None	0.000155	0.00234	0.00000921	0.000088 03	0.000864
Pad separator	0.00000236	0.0000000662	0.000000107	None	None	0.000043

[1] **Emission rates are based on assumption that facilities would operate continuously for a year**

4.2.3 Results

HAP impacts were modeled to assess short-term effects by comparing one-hour average impacts to the HAP-specific acute REL (reference exposure level) and annual average impacts to the HAP-specific RfC (reference concentration for continuous inhalation exposure). The REL is the acute concentration at or below which no adverse health effects are expected. The RfC is the average concentration, i.e., an annual average, at or below which no long-term adverse health effects are expected. Both of these guideline values are for non-cancer effects.

Tables 4-7, through 4-10 present the acute RELs and RfCs for non-cancer effects for the Proposed Action and Alternatives A, B and C, respectively. The modeled maximum concentrations of all HAPS are compared against the REL and RfC for each pollutant. The results indicate that ambient air concentrations would be below all applicable HAP reference concentrations.

Figures 4-2 and 4-3 show the locations of the highest 1-hour and annual impacts for formaldehyde, and Figures 4-4 and 4-5 show the same information for benzene. For both HAP for the 1-hour and annual averaging period, the maximum impacts occur at the fence line of the compressor station. These impacts are analyzed for the largest emissions from the largest single proposed source, the Sand Mesa compressor station under Alternative A. Therefore, HAP levels near the smaller compressor stations would obviously be less. The distribution of the other HAP ambient air concentration would be in a similar location for the applicable averaging period, but would be a lower percentage of the standards.

Formaldehyde 1-Hour Impacts
(micrograms per cubic meter)

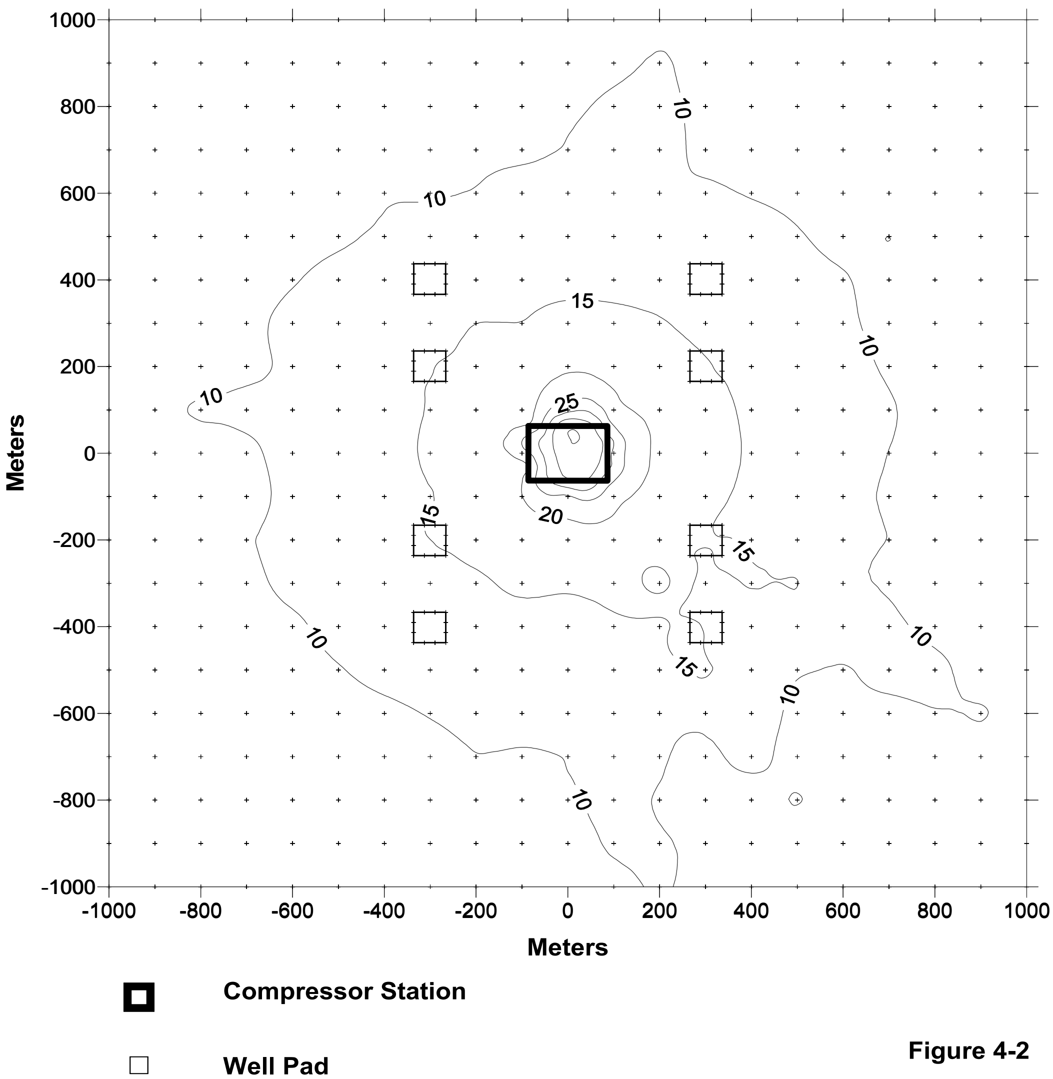

Figure 4-2

Formaldehyde Annual Impacts (micrograms per cubic meter)

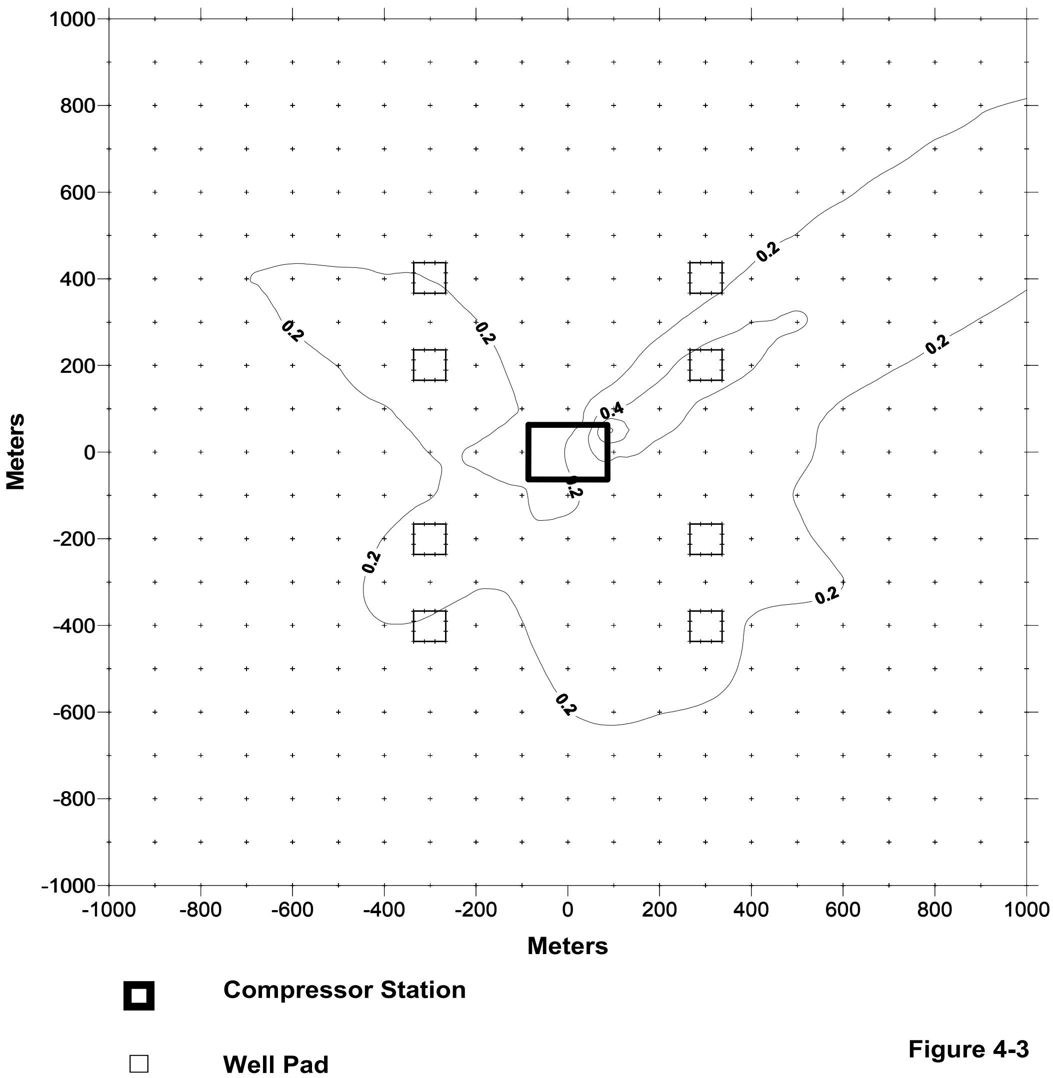

Figure 4-3

Benzene 1-Hour Impacts
(micrograms per cubic meter)

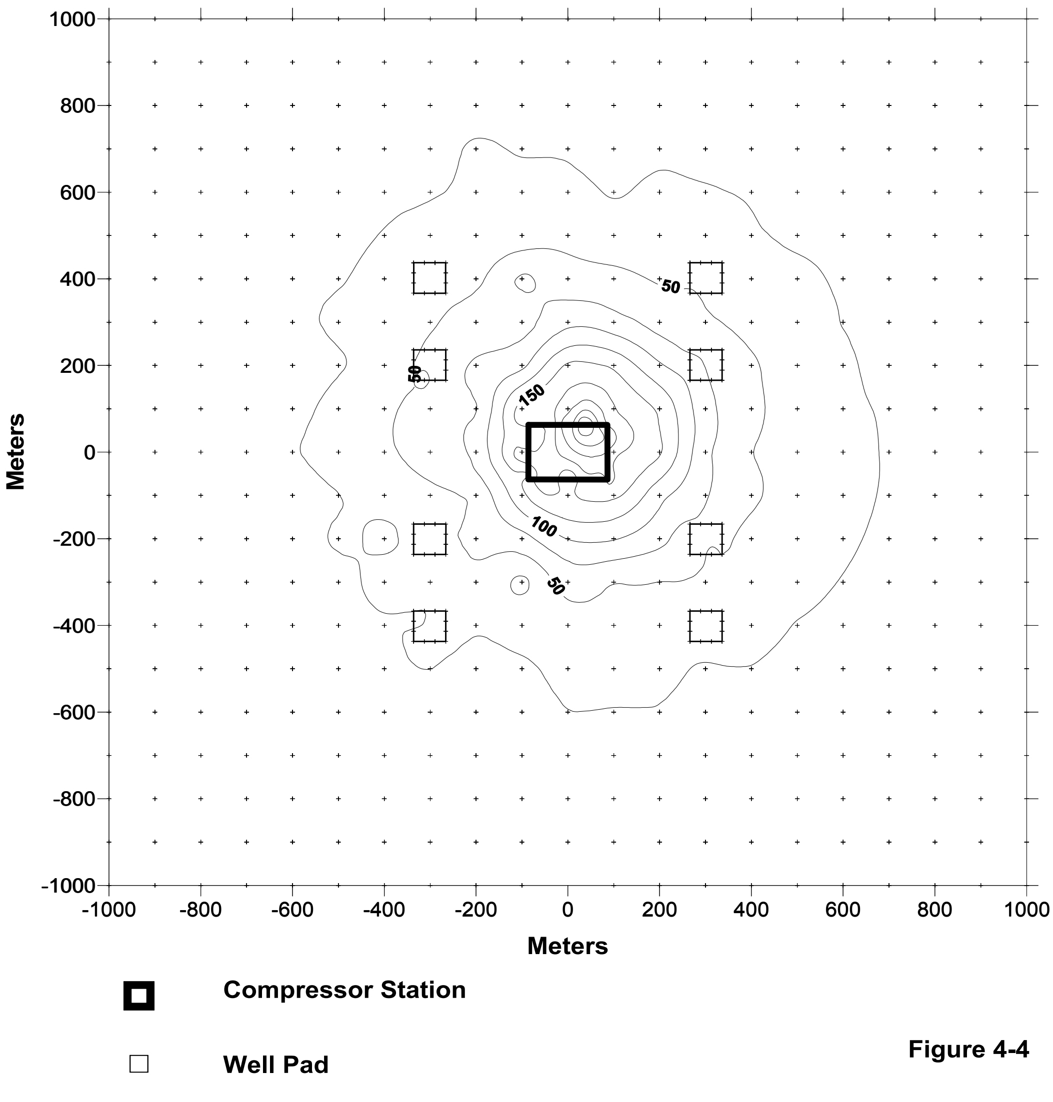

Figure 4-4

Benzene Annual Impacts (micrograms per cubic meter)

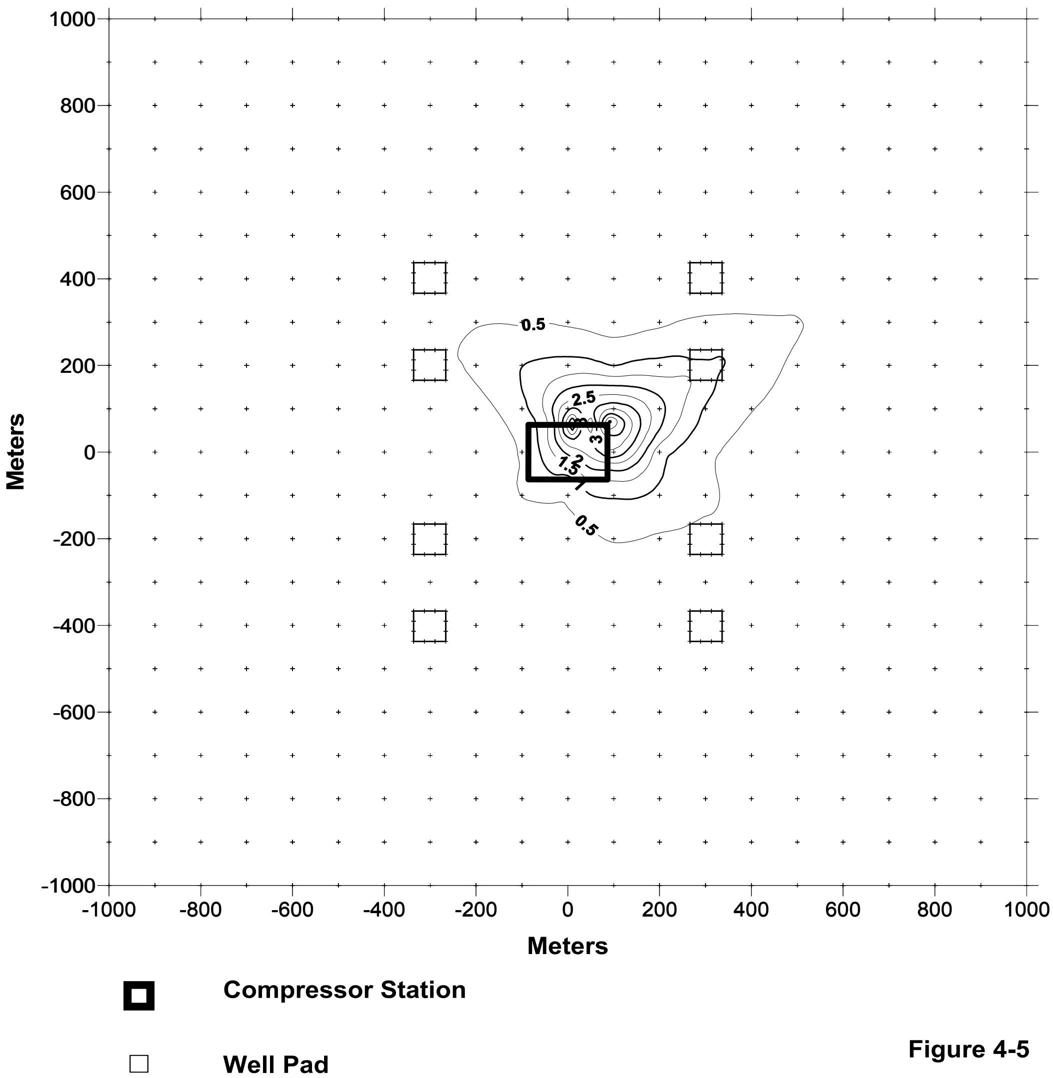

Figure 4-5

Table 4-7. Non-Carcinogenic Acute RELs and RfCs (Proposed Action).

HAP	REL ($\mu g/m^3$)	Modeled Maximum 1-Hour Impact ($\mu g/m^3$)	% of REL	RfC[3] ($\mu g/m^3$)	Modeled Maximum Annual Impact ($\mu g/m^3$)	% of RfC
Benzene	1,300[1]	159.2	12	30	3.1	10
Toluene	37,000[1]	0.96	<1	400	0.03	<1
Ethylbenzene	350,000[2]	0.03	<1	1,000	0.001	<1
Xylenes	22,000[1]	0.34	<1	100	0.01	<1
n-Hexane	390,000[2]	7.60	<1	200	0.20	<1
Formaldehyde	94[1]	31.9	34	9.8	0.71	7

1 EPA Air Toxics Database, Table 2 (EPA, 2002)
2 Immediately Dangerous to Life or Health (IDLH)/10, EPA Air Toxics Database, Table 2 (EPA, 2002) since no available REL
3 EPA Air Toxics Database, Table 1 (EPA, 2003)

Table 4-8. Non-Carcinogenic Acute RELs and RfCs (Alternative A).

HAP	REL ($\mu g/m^3$)	Modeled Maximum 1-Hour Impact ($\mu g/m^3$)	% of REL	RfC[3] ($\mu g/m^3$)	Modeled Maximum Annual Impact ($\mu g/m^3$)	% of RfC
Benzene	1,300[1]	300.1	23	30	5.8	19.3
Toluene	37,000[1]	0.97	<1	400	0.03	<1
Ethylbenzene	350,000[2]	0.04	<1	1,000	0.002	<1
Xylenes	22,000[1]	0.36	<1	100	0.02	<1
n-Hexane	390,000[2]	7.67	<1	200	0.22	<1
Formaldehyde	94[1]	44.7	34	9.8	0.99	10.1

1 EPA Air Toxics Database, Table 2 (EPA, 2002)
2 Immediately Dangerous to Life or Health (IDLH)/10, EPA Air Toxics Database, Table 2 (EPA, 2002) since no available REL
3 EPA Air Toxics Database, Table 1 (EPA, 2003)

Table 4-9. Non-Carcinogenic Acute RELs and RfCs (Alternative B).

HAP	REL ($\mu g/m^3$)	Modeled Maximum 1-Hour Impact ($\mu g/m^3$)	% of REL	RfC[3] ($\mu g/m^3$)	Modeled Maximum Annual Impact ($\mu g/m^3$)	% of RfC
Benzene	1,300[1]	127	9.7	30	2.45	8.2
Toluene	37,000[1]	0.96	<1	400	0.03	<1
Ethylbenzene	350,000[2]	0.04	<1	1,000	0.001	<1
Xylenes	22,000[1]	0.36	<1	100	0.01	<1
n-Hexane	390,000[2]	6.1	<1	200	0.18	<1
Formaldehyde	94[1]	22.2	23.6	9.8	0.49	5.0

1 EPA Air Toxics Database, Table 2 (EPA, 2002)
2 Immediately Dangerous to Life or Health (IDLH)/10, EPA Air Toxics Database, Table 2 (EPA, 2002) since no available REL
3 EPA Air Toxics Database, Table 1 (EPA, 2003)

Table 4-10. Non-Carcinogenic Acute RELs and RfCs (Alternative C).

HAP	REL ($\mu g/m^3$)	Modeled Maximum 1-Hour Impact ($\mu g/m^3$)	% of REL	RfC[3] ($\mu g/m^3$)	Modeled Maximum Annual Impact ($\mu g/m^3$)	% of RfC
Benzene	1,300[1]	0.64	<1	30	0.22	<1
Toluene	37,000[1]	0.96	<1	400	0.02	<1
Ethylbenzene	350,000[2]	0.03	<1	1,000	0.0009	<1
Xylenes	22,000[1]	0.36	<1	100	0.01	<1
n-Hexane	390,000[2]	3.6	<1	200	0.08	<1
Formaldehyde	94[1]	6.5	6.9	9.8	0.15	1.5

[1] **EPA Air Toxics Database, Table 2 (EPA, 2002)**
[2] **Immediately Dangerous to Life or Health (IDLH)/10, EPA Air Toxics Database, Table 2 (EPA, 2002) since no available REL**
[3] **EPA Air Toxics Database, Table 1 (EPA, 2003)**

Since benzene and formaldehyde are carcinogenic, annual average concentrations of these two HAPs were modeled and expressed as a long-term cancer risk (based on 70-year exposure). Cancer risk was estimated for exposure scenarios: most likely exposure (MLE) corresponding to a resident that lives an average of 20 years at a particular location in the WRPA, and a maximally exposed individual (MEI) corresponding to an individual that may be exposed for the entire life of the project (assumed as 40 years). Resultant exposure adjustment factors for the MLE and MEI scenarios of 0.286 (20/70) and 0.571 (40/70) were applied to the estimated cancer risk to account for the actual time that an individual would be exposed during a 70-year lifetime.

Table 4-11 presents the unit risk factor and the exposure adjustment factor for the MLE and MEI exposure scenarios for benzene and formaldehyde. The unit risk factor is a slope factor that when multiplied by the ambient air concentration provides an estimate of the probability of one additional person contracting cancer based on continuous exposure over a 70-year lifetime.

The risks for cancer are based on the maximum annual concentrations 400 meters from a compressor station and 100 meters from a well. These distances represent expected typical spacing between WRPA facilities and occupied residences.

Tables 4-11, through 4-14 summarize modeled HAP cancer risk for the Proposed Action and Alternatives A, B, and C, respectively. All impacts are below applicable health-based guidelines for the non-cancer compounds and below an incremental cancer risk of 3 in a million). These impacts are analyzed for the largest single proposed source, the Sand Mesa compressor station. Therefore, HAP levels near the smaller compressor stations would obviously be less. The significant cancer risk criterion of 1×10^{-6} is at the low end of the range of cancer risks typically considered as acceptable when evaluating the health effects of a particular action. The range of acceptable cancer risks when evaluating the health effects of an action varies from 1 in a million to 1 in 10,000.

Table 4-11. Carcinogenic HAP Risk (Proposed Action).

HAP	Exposure Scenario	Unit Risk Factor (1/µg/m³)	Exposure Adjustment Factor	Modeled Annual Impact (µg/m³)	Predicted Incremental Cancer Risk
Benzene	MLE	7.8×10^{-6}	0.286	0.3	0.7 in a million or 7 in ten million
Formaldehyde	MLE	5.5×10^{-9}	0.286	0.2	0.0003 in a million or 3 in 10 billion
Benzene	MEI	7.8×10^{-6}	0.571	0.3	1 in a million
Formaldehyde	MEI	5.5×10^{-9}	0.571	0.2	0.0006 in a million or 6 in ten billion

Table 4-12. Carcinogenic HAP Risk (Alternative A).

HAP	Exposure Scenario	Unit Risk Factor (1/µg/m³)	Exposure Adjustment Factor	Modeled Annual Impact (µg/m³)	Predicted Incremental Cancer Risk
Benzene	MLE	7.8×10^{-6}	0.286	0.5	1 in a million
Formaldehyde	MLE	5.5×10^{-9}	0.286	0.4	0.0006 in a million or 6 in 10 billion
Benzene	MEI	7.8×10^{-6}	0.571	0.5	2 in a million
Formaldehyde	MEI	5.5×10^{-9}	0.571	0.4	0.001 in a million or 1 in a billion

Table 4-13. Carcinogenic HAP Risk (Alternative B).

HAP	Exposure Scenario	Unit Risk Factor (1/µg/m³)	Exposure Adjustment Factor	Modeled Annual Impact (µg/m³)	Predicted Incremental Cancer Risk
Benzene	MLE	7.8×10^{-6}	0.286	0.2	0.4 in a million or 4 in ten million
Formaldehyde	MLE	5.5×10^{-9}	0.286	0.2	0.0003 in a million or 3 in 10 billion
Benzene	MEI	7.8×10^{-6}	0.571	0.2	0.9 in a million or 9 in ten million
Formaldehyde	MEI	5.5×10^{-9}	0.571	0.2	0.0006 in a million or 6 in ten billion

Table 4-14. Carcinogenic HAP Risk (Alternative C).

HAP	Exposure Scenario	Unit Risk Factor (1/µg/m^3)	Exposure Adjustment Factor	Modeled Annual Impact (µg/m^3)	Predicted Incremental Cancer Risk
Benzene	MLE	7.8×10^{-6}	0.286	0.02	0.04 in a million or 4 in a hundred million
Formaldehyde	MLE	5.5×10^{-9}	0.286	0.05	0.00008 in a million or 8 in a hundred billion
Benzene	MEI	7.8×10^{-6}	0.571	0.02	0.09 in a million or 9 in a hundred million
Formaldehyde	MEI	5.5×10^{-9}	0.571	0.05	0.0002 in a million or 2 in ten billion

4.3 TRAFFIC IMPACTS

Traffic levels would vary throughout the WRPA and according to the level of activity at any one time. The highest short-term emissions from WRPA-related activities would occur during completion activities because the greatest amount of vehicle traffic would be concentrated in a short time period. Traffic volumes associated with operations would be considerably less than those during completion activities. Traffic volumes for development activities would be similar under all alternatives. The maximum hourly traffic during completion activities would consist of 25 heavy-duty trucks and 22 heavy-duty pickup trucks per hour. These emissions were modeled along a typical mile-long road segment. The resultant maximum impacts along this typical roadway are shown in Table 4-15. These maximum impacts would occur at a distance of 50 meters from an access road.

Table 4-15. WRPA Traffic Impacts.

Pollutant	Averaging Period	Impact (µg/m^3)	Background (µg/m^3)	Total (µg/m^3)	Ambient Air Quality Standard (µg/m^3)	% of Standard
CO	1-hour	15,017	3,336	18,353	40,000	45.9%
CO	8-hour	2,268	1,381	3,649	10,000	36.5%
SO_2	3-hour	73	132	205	1,300	15.8%
SO_2	24-hour	15	43	58	260	22.3%

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5.0 MID-RANGE IMPACT ASSESEMENT

The mid-range cumulative impact modeling considered NO_X and CO emissions for the Proposed Action and Alternative A, the maximum development alternative. PM_{10} and SO_2 emissions were not modeled because these emissions would be insignificant from the permanent operational facilities. The modeling scenario included all emission sources when the WRPA would be completely developed. All facilities were assumed to operate continuously throughout the year. Emissions sources included the following:

- New compressor stations,
- Upgrades at existing compressor stations,
- Existing compressor stations,
- Multiple separators on well pads scaled according to the development rate,
- Multiple drill rigs on well pads scaled according to the development rate, and
- Other identified sources within the modeling domain.

5.1 MODEL SETUP

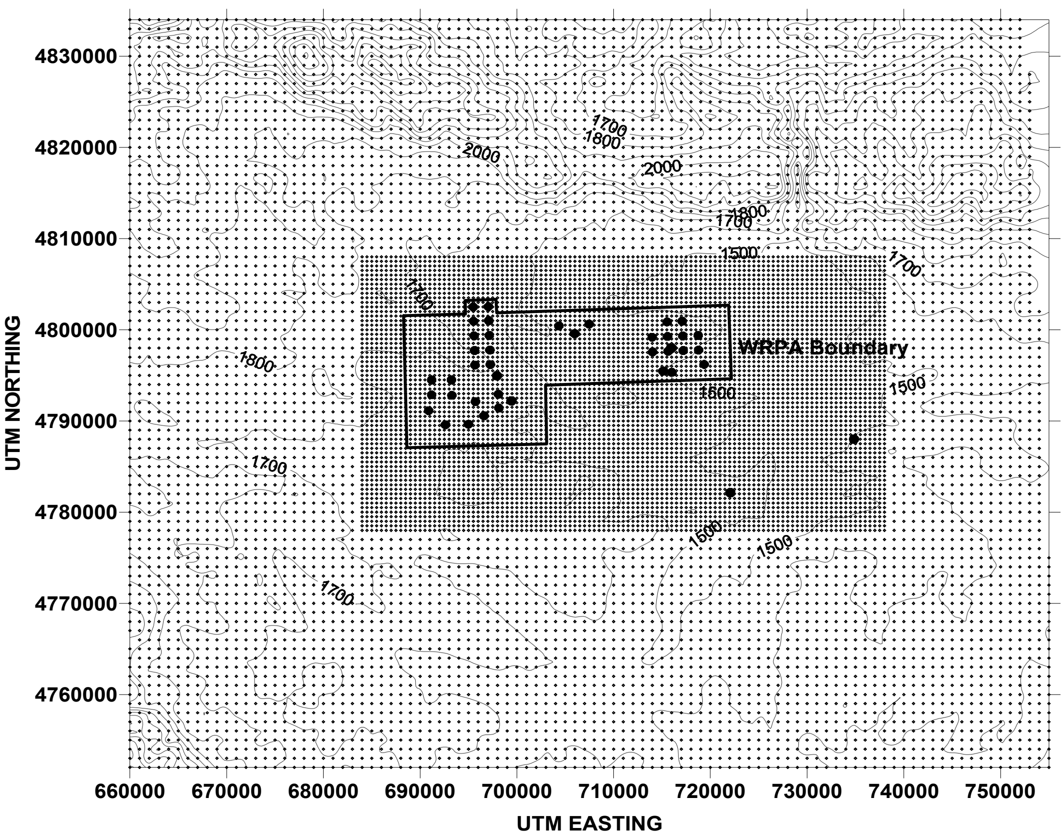
A modeling domain was established that extended approximately 50 kilometers from the mid-point of the WRPA. A course grid of 50-meter spacing was generated around each point source (compressor stations and combined well sites) out to 300 meters from the boundary of these facilities. Next, a finer grid of 500-meter spacing was generated to extend at least 5 kilometers beyond the outermost WRPA facilities. Finally, a grid of 1000-meter spacing was generated to extend to the edges of the modeling domain. The modeling domain and receptor locations are shown on Figure 5-1. Receptor elevations were derived from U.S.G.S Digital Elevation Model (DEM) data.

5.2 WRPA PROPOSED ACTION EMISSION SOURCES

5.2.1 Compressor Stations

The Proposed Action would include five new compressor stations and the upgrade of compression at three existing compressor stations. Two of these compressor stations would be located outside the WRPA. Table 5-1 lists the proposed, upgraded, and existing compressor stations. The stack and exhaust parameters for each source are described in Table 5-2.

WRPA MID-RANGE MODELING GRID



Contour Elevation Interval: 100 meters

Figure 5-1

Table 5-1. WRPA Proposed Action Sources.

Source	Horsepower Rating	UTM Easting (meters)	UTM Northing (meters)	Elevation (meters)
WRPA Proposed Action				
South Pavillion	3,300	696600	4790560	1615
Muddy Ridge	4,500	697950	4794950	1654
Sand Mesa Upgrade	10,300	715975	4798000	1515
Sand Mesa South	4,800	715125	4795469	1510
Coastal	2,700	705976	4799569	1550
Pavillion Plant Upgrade	1,700	699450	4792200	1614
Shoshoni	3,800	734850	4788000	1499
Hidden Valley Upgrade	1,700	722050	4782150	1549
Existing within WRPA				
Pavillion Plant	4,527	699452	4792202	1614
Hidden Valley	2,047	722052	4782152	1549
Sand Mesa	296	715977	4798002	1515
Tribal Pavillion 23-2	167	693980	4792680	1634
Tribal Pavillion 11-14	161	693785	4790390	1634
West Pavillion	3,360	695300	4792530	1640
Cumulative Sources				
Riverton Gas Plant	3,739	716475	4757212	1618
Riverton Compressor Station	1,180	726108	4765574	1580
Peak Sulfur	NA	710660	4763800	1510

Table 5-2. WRPA Proposed Action Modeling Parameters.

Source	Stack Height (m)	Exhaust Temperature (K)	Exhaust Velocity (m/s)	Stack Diameter (m)	NO_X Emission Rate (tons/yr)	NO_X Emission Rate (g/sec)	CO Emission Rate (tons/yr)	CO Emission Rate (g/sec)
WRPA Proposed Action								
South Pavillion	9.144	811	35	0.3048	31.87	0.9167	63.73	1.8333
Muddy Ridge	9.144	811	35	0.3048	43.45	1.2500	86.90	2.5000
Sand Mesa Upgrade	9.144	811	35	0.3048	99.46	2.8611	198.92	5.7222
Sand Mesa South	9.144	811	35	0.3048	46.35	1.3333	92.70	2.6667
Coastal	9.144	811	35	0.3048	26.07	0.7500	52.14	1.5000
Pavillion Plant Upgrade	9.144	811	35	0.3048	16.42	0.4722	32.83	0.9444
Shoshoni	9.144	811	35	0.3048	36.69	1.0556	73.39	2.1111
Hidden Valley Upgrade	9.144	811	35	0.3048	16.42	0.4722	32.83	0.9444
Existing within WRPA								
Pavillion Plant	9.1	811	35	0.305	476.1	13.6961	145.8	4.1942
Hidden Valley	11.4	672	46.6	0.457	13.8	0.3970	51.4	1.4786
Sand Mesa	6.1	514	9.3	0.44	2.8	0.0806	7.0	0.2014
Tribal Pavillion 23-2	7.6	850	12.9	0.15	0.22	0.0063	0.05	0.0014
Tribal Pavillion 11-14	6.5	511	6.8	0.335	8.35	0.2402	1.67	0.0480
West Pavillion	10.6	894	17.4	0.51	32.4	0.9321	81.0	2.3301
Cumulative Sources								
Riverton Gas Plant	9.1	811	35	0.3048	300.4	8.6416	460.2	13.23863
Riverton Compressor Station	9.1	811	35	0.3048	17.1	0.4919	22.8	0.65589
Peak Sulfur	9.1	811	25	0.3048	6.9	0.1984	None	None

5.2.2 Well Pads

Although insignificant emissions would occur from an individual separator on each well pad, the total effect of these emissions from separators at all 325 locations was evaluated. The exact location of well pads is still to be determined. Therefore, a number of well pads were clustered at arbitrary locations within each of the five gas development areas. The locations of these arbitrary well pads are shown on Figure 5-2.

The emissions were summed at each location according to the total number of wells that would be operated at maximum development. The annual drilling rate under the Proposed Action would be similar to Alternative A, B, and C. The only difference would be that drilling would last about four years longer under Alternative A, and about three years less under Alternatives B and C. Table 2-1 shows the proposed number of wells and the proposed drilling rates for each gas field. The stack and exhaust parameters for a separator on a well pad are:

- Stack height: 4.57 m
- Stack diameter: 0.3048 m
- Exhaust temperature: 700 K
- Exhaust velocity: 1.59 m/sec

Table 5-3 lists the arbitrary locations, the number of separators at each location, and the total emissions from each arbitrary well pad based on the full field development.

5.2.3 Drilling Rigs

Drilling rig engines would produce fairly substantial emissions for the short duration (9 to 70 days) proposed for the WRPA. Therefore, the total effect of these emissions was modeled. Similar to the manner described for well pad separators, a drill rig was modeled on each arbitrary well pad and scaled at each location according to the total number of wells that would be drilled in a year. The annual drilling rate under the Proposed Action would be similar to Alternatives A and B. Table 5-4 shows the emissions from each well pad and the scaled number of annual drilling activity within each field. The stack and exhaust parameters for drill rig engines are:

- Stack height: 7.6 m
- Stack diameter: 0.1 m
- Exhaust temperature: 800 K
- Exhaust velocity: 50 m/sec

Table 5-3. WRPA Proposed Action Well Pad Separator Emissions.

Development Area	Number Of Separators	UTM Easting (meters)	UTM Northing (meters)	Total NO_x Emission Rate (g/sec)	Total CO Emission Rate (g/sec)
Pavillion	15	691190	4794488	0.02363	0.01984
Pavillion	15	693227	4794493	0.02363	0.01984
Pavillion	15	691185	4792857	0.02363	0.01984
Pavillion	15	693275	4792812	0.02363	0.01984
Pavillion	15	695716	4792110	0.02363	0.01984
Pavillion	15	698089	4792933	0.02363	0.01984
Pavillion	15	690875	4791131	0.02363	0.01984
Pavillion	15	698133	4791426	0.02363	0.01984
Pavillion	15	692612	4789574	0.02363	0.01984
Pavillion	15	694993	4789635	0.02363	0.01984
Muddy Ridge	5	695478	4802496	0.01813	0.00992
Muddy Ridge	5	697056	4802538	0.01813	0.00992
Muddy Ridge	5	695521	4800938	0.01813	0.00992
Muddy Ridge	5	697102	4800997	0.01813	0.00992
Muddy Ridge	5	695572	4799333	0.01813	0.00992
Muddy Ridge	5	697154	4799383	0.01813	0.00992
Muddy Ridge	5	695618	4797721	0.01813	0.00992
Muddy Ridge	5	697208	4797784	0.01813	0.00992
Muddy Ridge	5	695664	4796123	0.01813	0.00992
Muddy Ridge	5	697256	4796176	0.01813	0.00992
Sand Mesa	6	715530	4800860	0.03150	0.01588
Sand Mesa	6	717090	4800936	0.03150	0.01588
Sand Mesa	6	713978	4799180	0.03150	0.01588
Sand Mesa	6	715574	4799259	0.03150	0.01588
Sand Mesa	6	717146	4799331	0.03150	0.01588
Sand Mesa	6	718742	4799382	0.03150	0.01588
Sand Mesa	6	714024	4797569	0.03150	0.01588
Sand Mesa	6	715630	4797643	0.03150	0.01588
Sand Mesa	6	717188	4797717	0.03150	0.01588
Sand Mesa	6	718795	4797771	0.03150	0.01588
Sand Mesa South	6	716024	4795329	0.01890	0.01588
Sand Mesa South	6	719368	4796197	0.01890	0.01588
Coastal Extension	4	704344	4800430	0.01260	0.01058
Coastal Extension	4	707475	4800613	0.01260	0.01058

Table 5-4. WRPA Proposed Action Drill Rig Emissions.

Development Area	Drilling Rate per Well Pad	UTM Easting (meters)	UTM Northing (meters)	Total NO_X Emission Rate (g/sec)	Total CO Emission Rate [1] (g/sec)
Pavillion	1.4	691190	4794488	0.02297	0.15246
Pavillion	1.4	693227	4794493	0.02297	0.15246
Pavillion	1.4	691185	4792857	0.02297	0.15246
Pavillion	1.4	693275	4792812	0.02297	0.15246
Pavillion	1.4	695716	4792110	0.02297	0.15246
Pavillion	1.4	698089	4792933	0.02297	0.15246
Pavillion	1.4	690875	4791131	0.02297	0.15246
Pavillion	1.4	698133	4791426	0.02297	0.15246
Pavillion	1.4	692612	4789574	0.02297	0.15246
Pavillion	1.4	694993	4789635	0.02297	0.15246
Muddy Ridge	1.2	695478	4802496	0.1789	0.4158
Muddy Ridge	1.2	697056	4802538	0.1789	0.4158
Muddy Ridge	1.2	695521	4800938	0.1789	0.4158
Muddy Ridge	1.2	697102	4800997	0.1789	0.4158
Muddy Ridge	1.2	695572	4799333	0.1789	0.4158
Muddy Ridge	1.2	697154	4799383	0.1789	0.4158
Muddy Ridge	1.2	695618	4797721	0.1789	0.4158
Muddy Ridge	1.2	697208	4797784	0.1789	0.4158
Muddy Ridge	1.2	695664	4796123	0.1789	0.4158
Muddy Ridge	1.2	697256	4796176	0.1789	0.4158
Sand Mesa	0.8	715530	4800860	0.1988	0.4158
Sand Mesa	0.8	717090	4800936	0.1988	0.4158
Sand Mesa	0.8	713978	4799180	0.1988	0.4158
Sand Mesa	0.8	715574	4799259	0.1988	0.4158
Sand Mesa	0.8	717146	4799331	0.1988	0.4158
Sand Mesa	0.8	718742	4799382	0.1988	0.4158
Sand Mesa	0.8	714024	4797569	0.1988	0.4158
Sand Mesa	0.8	715630	4797643	0.1988	0.4158
Sand Mesa	0.8	717188	4797717	0.1988	0.4158
Sand Mesa	0.8	718795	4797771	0.1988	0.4158
Sand Mesa South	1.5	716024	4795329	0.3728	0.4158
Sand Mesa South	1.5	719368	4796197	0.3728	0.4158
Coastal	1	704344	4800430	0.2485	0.4158
Coastal	1	707475	4800613	0.2485	0.4158

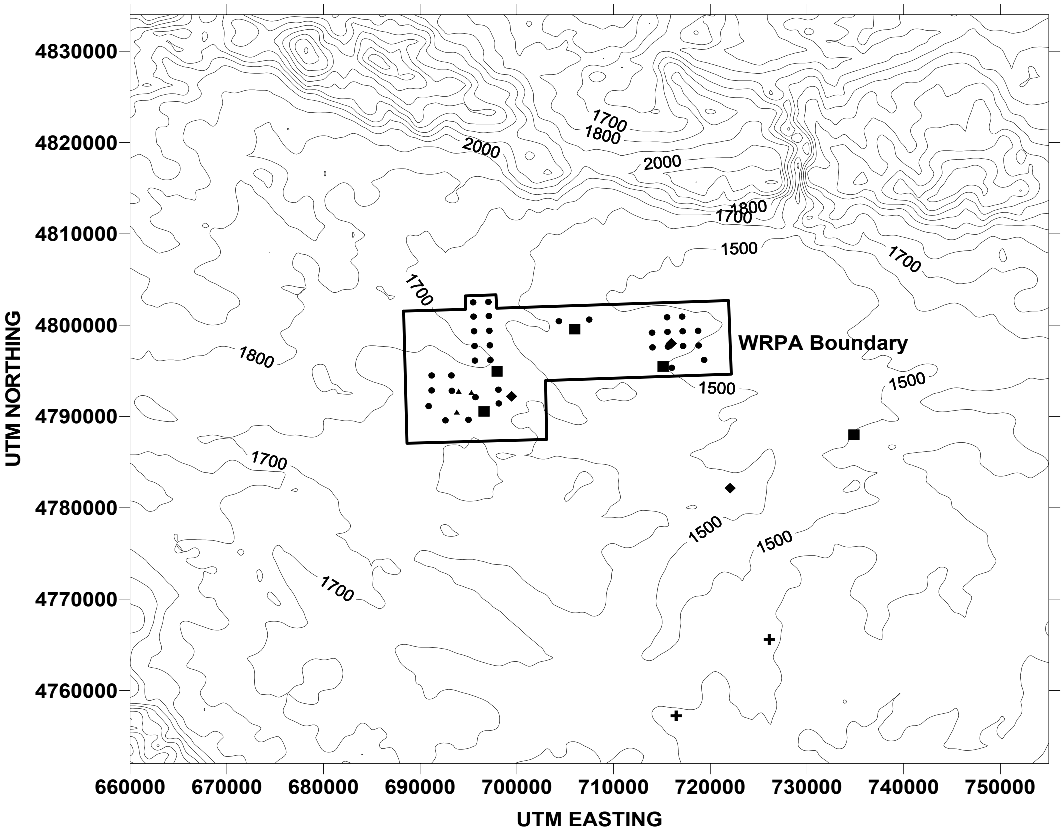
[1] Based on maximum hourly and 8-hourly rate for one rig

The location of all sources considered in the mid-range modeling analysis is shown on Figure 5-2.

5.3 WRPA ALTERNATIVE A EMMISIONS SOURCES

Under Alternative A, the requirement for compression would increase and the total number of wells drilled and operated would increase. Table 5-5 shows the horsepower requirements Alternative A. Table 5-6 shows the increased emissions that would occur under the higher horsepower requirement. Table 2-1 indicates the total field development and the annual drilling rate. Table 5-6 summarizes the random locations, the number of separators at each location, the emissions from each separator, and the total emissions from each centralized well pad based on the full field development. Finally, the annual drilling rate for Alternative A would be identical to the Proposed Action. Therefore, the Alternative A drilling emissions are identical to those shown on Table 5-7.

WRPA MID-RANGE MODELING SOURCES



- ■ New WRPA Compressor Station
- ◆ Upgrade to Existing WRPA Existing Compressor Station
- ● Grouped WRPA Well Pad
- ▲ Existing Compressor Station within WRPA
- + Cumulative Sources

Contour Interval 100 meters

Figure 5-2

Table 5-5. WRPA Alternative A Sources.

Source	Horsepower Rating	UTM Easting (meters)	UTM Northing (meters)	Elevation (meters)
WRPA Proposed Action				
South Pavillion	4,650	696600	4790560	1615
Muddy Ridge	6,300	697950	4794950	1654
Sand Mesa Upgrade	9,100	715975	4798000	1515
Sand Mesa South	4,650	715125	4795469	1510
Coastal	3,100	705976	4799569	1550
Pavillion Plant Upgrade	2,400	699450	4792200	1614

Table 5-6. WRPA Alternative A Modeling Parameters.

Source	Stack Height (meters)	Exhaust Temperature (K)	Exhaust Velocity (m/s)	Stack Diameter (meters)	NO_X Emission Rate (tons/yr)	NO_X Emission Rate (g/sec)	CO Emission Rate (tons/yr)	CO Emission Rate (g/sec)
WRPA Proposed Action								
South Pavillion	9.144	811	35	0.3048	44.90	1.29	89.80	2.58
Muddy Ridge	9.144	811	35	0.3048	60.83	1.75	121.67	3.50
Sand Mesa Upgrade	9.144	811	35	0.3048	139.05	4.00	278.10	8.00
Sand Mesa South	9.144	811	35	0.3048	51.66	1.88	130.36	3.75
Coastal	9.144	811	35	0.3048	36.69	1.06	73.39	2.11
Pavillion Plant Upgrade	9.144	811	35	0.3048	23.17	0.67	46.35	1.33
Shoshoni	9.144	811	35	0.3048	51.66	1.49	103.32	2.97
Hidden Valley Upgrade	9.144	811	35	0.3048	23.17	0.67	46.35	1.33

Table 5-7 WRPA Alternative A Well Pad Separator Emissions

Development Area	Number Of Separators	UTM Easting (meters)	UTM Northing (meters)	Total NO_X Emission Rate (g/sec)	Total CO Emission Rate (g/sec)
Pavillion	20.6	691190	4794488	0.03244	0.03622
Pavillion	20.6	693227	4794493	0.03244	0.03622
Pavillion	20.6	691185	4792857	0.03244	0.03622
Pavillion	20.6	693275	4792812	0.03244	0.03622
Pavillion	20.6	695716	4792110	0.03244	0.03622
Pavillion	20.6	698089	4792933	0.03244	0.03622
Pavillion	20.6	690875	4791131	0.03244	0.03622
Pavillion	20.6	698133	4791426	0.03244	0.03622
Pavillion	20.6	692612	4789574	0.03244	0.03622
Pavillion	20.6	694993	4789635	0.03244	0.03622
Muddy Ridge	6.6	695478	4802496	0.01559	0.01729
Muddy Ridge	6.6	697056	4802538	0.01559	0.01729
Muddy Ridge	6.6	695521	4800938	0.01559	0.01729
Muddy Ridge	6.6	697102	4800997	0.01559	0.01729
Muddy Ridge	6.6	695572	4799333	0.01559	0.01729
Muddy Ridge	6.6	697154	4799383	0.01559	0.01729
Muddy Ridge	6.6	695618	4797721	0.01559	0.01729
Muddy Ridge	6.6	697208	4797784	0.01559	0.01729
Muddy Ridge	6.6	695664	4796123	0.01559	0.01729
Muddy Ridge	6.6	697256	4796176	0.01559	0.01729
Sand Mesa	6.7	715530	4800860	0.02111	0.02375
Sand Mesa	6.7	717090	4800936	0.02111	0.02375
Sand Mesa	6.7	713978	4799180	0.02111	0.02375
Sand Mesa	6.7	715574	4799259	0.02111	0.02375
Sand Mesa	6.7	717146	4799331	0.02111	0.02375
Sand Mesa	6.7	718742	4799382	0.02111	0.02375
Sand Mesa	6.7	714024	4797569	0.02111	0.02375
Sand Mesa	6.7	715630	4797643	0.02111	0.02375
Sand Mesa	6.7	717188	4797717	0.02111	0.02375
Sand Mesa	6.7	718795	4797771	0.02111	0.02375
Sand Mesa South	24	716024	4795329	0.07560	0.25400
Sand Mesa South	24	719368	4796197	0.07560	0.25400
Coastal	6	704344	4800430	0.01890	0.02380
Coastal	6	707475	4800613	0.01890	0.02380

5.4 MODELING RESULTS

Total impacts from the Project only for the Proposed Action and Alternatives within the near-field analysis area were modeled. Cumulative impacts from the Project and modeled background sources were also modeled.

Results of the near-field Project modeling for each of the highest value of the 5 years of meteorological data, with the added background concentrations, are presented in Table 5-8 for NO_X and Tables 5-9 and 5-10 for CO, and compared to applicable State and NAAQS and PSD Class II increments for NO_x. Figure 5-3 shows the concentration contours for the highest impacts for NO_X under Alternative A along with cumulative sources.

The maximum project-related impacts under the Proposed Action and Alternatives A and B would occur in the vicinity of the Sand Mesa compressor station. Under Alternative C, the maximum impact would occur near the South Pavillion compressor station, the only one proposed under Alternative C. When cumulative sources are considered, the maximum impact would occur in the vicinity of the existing Pavilion gas plant.

Figure 5-4 shows the same results for CO impacts under Alternative A. The locations of the 1-hour and 8-hour maximum impacts are at the same locations as the NO_X results. Results of all modeling scenarios demonstrate that the WRPA project would not contribute to any exceedances of applicable ambient air quality standards. The existing Pavillion Plant, the location of the maximum cumulative impact is an existing and "grandfathered" source that was constructed before the PSD NO_X baseline was established in 1988 and therefore would not be considered in a PSD increment analysis.

Table 5-8. WRPA NO_X Annual Predicted Impacts.

Alternative	Project Max ($\mu g/m^3$)	UTM Location (meters)	% of NAAQS [1]	% of PSD Increment	Cumulative Max [1] ($\mu g/m^3$)	UTM Location (meters)	% of NAAQS
Proposed Action	12.1	716023 E 4798063 N	16%	48.4	46.5	699340 E 4792071 N	46.5
Alternative A	16.5	716023 E 4798063 N	20%	66.0	47.5	699340 E 4792071 N	47.5
Alternative B	9.7	695590 E 4802571 N	13%	38.8	45.8	699340 E 4792071 N	45.8
Alternative C	5.3	696646 E 4790590 N	9%	21.2	44.6	699340 E 4792071 N	44.6

[1] with NO_X background 3.4 $\mu g/m^3$

Table 5-9. WRPA CO 1-Hour Predicted Impacts.

Alternative	Project Max ($\mu g/m^3$)	UTM Location (meters)	% of NAAQS [1]	Cumulative Max [1] ($\mu g/m^3$)	UTM Location (meters)	% of NAAQS
Proposed Action	1,553	697929 E 4795013 N	12%	4,902	697929 E 4795013 N	12.3
Alternative A	2,174	697929 E 4795013 N	14%	5,523	697929 E 4795013 N	13.8
Alternative B	1,070	697929 E 4795013 N	11%	4,419	697929 E 4795013 N	11.1
Alternative C	312	696646 E 4790590 N	9%	4,258	699471 E 4792137 N	10.7

[1] with CO 1-hour background 3,336 $\mu g/m^3$

Table 5-10. WRPA CO 8-Hour Predicted Impacts.

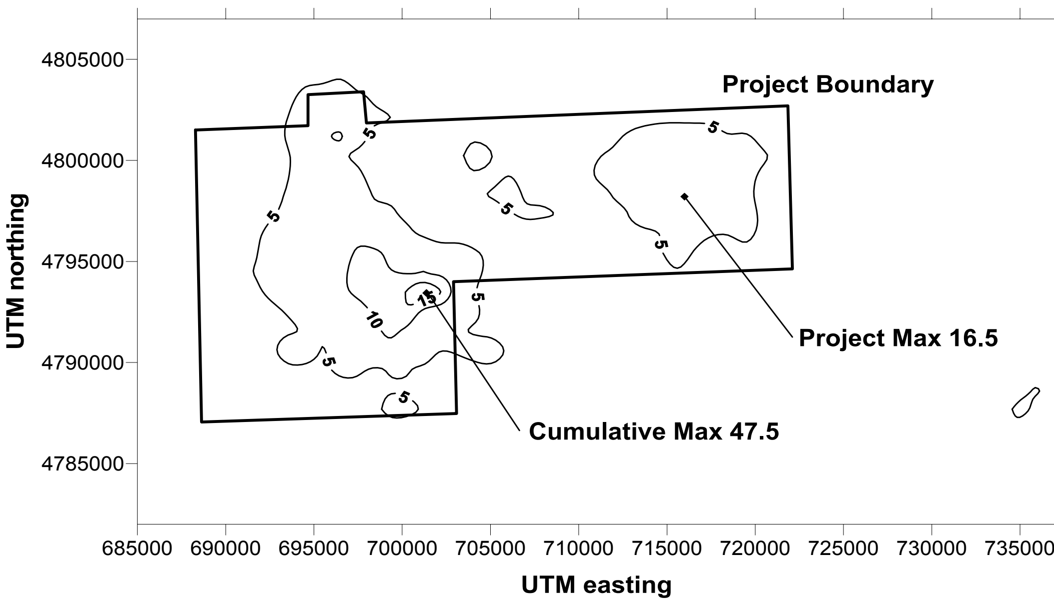
Alternative	Project Max (μg/m³)	UTM Location (meters)	% of NAAQS [1]	Cumulative Max (μg/m³)	UTM Location (meters)	% of NAAQS
Proposed Action	497	716040 E 4798071 N	19%	2,141	699471 E 4792137 N	21.4
Alternative A	695	716040 E 4798071 N	20%	2,187	699471 E 4792137 N	21.9
Alternative B	344	699471 E 4792137 N	17%	2,101	699471 E 4792137 N	21.1
Alternative C	119	696640 E 4790521 N	15%	2,003	699471 E 4792137 N	20.1

[1] **with CO 8-hour background 1,381 μg/m³**

Figure 5-3 depicts the concentration contours for the cumulative annual average NO_2 impacts for Alternative A from Project and background sources. These concentration plots indicate that the maximum ambient air impacts for the Proposed Action only would be near the largest compressor station in the Sand Mesa gas field. The highest cumulative effect would be near the existing Pavillion Plant in the Pavillion gas field.

Figures 5-4 and 5-5 depict concentration contours for the cumulative 1-hour and 8-hour impacts for Alternative A, respectively, from Project and background sources. The maximum CO impacts would occur near the Sand Mesa compressor station for both alternatives.

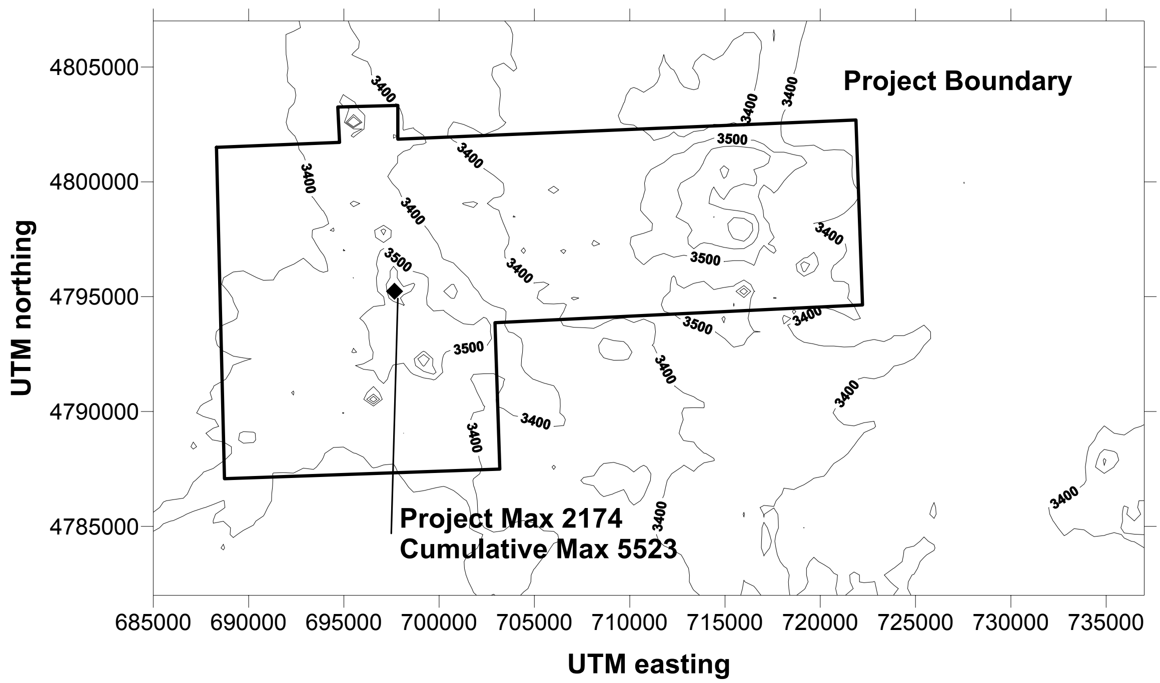
WRPA MAXIMUM NOx IMPACTS
ALTERNATIVE A AND CUMULATIVE
(micrograms per cubic meter)



Contour Interval 5 micrograms per cubic meter

Figure 5-3

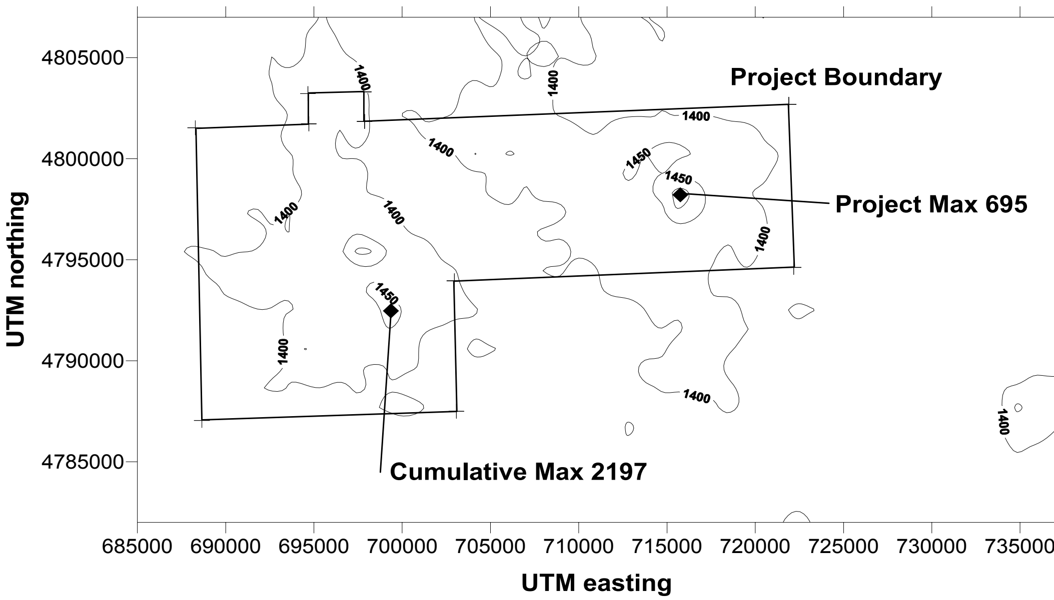
WRPA MAXIMUM CO 1-HOUR IMPACTS ALTERNATIVE A AND CUMULATIVE (micrograms per cubic meter)



Contour Interval 100 micrograms per cubic meter

Figure 5-4

WRPA MAXIMUM CO 8-HOUR IMPACTS ALTERNATIVE A AND CUMULATIVE (micrograms per cubic meter)



Contour Interval 50 micrograms per cubic meter

Figure 5-5

5.5 OZONE IMPACTS

Ozone is formed through the chemical reaction of NO_X and VOCs in the atmosphere in the presence of sunlight. To estimate near-field ozone impacts, a model such as ISCST3 is inappropriate as complex chemistry is involved in the formation of ozone and ISCST3 does not have an algorithm to simulate this chemistry. Thus, ozone modeling was performed with a simplified screening tool, the Reactive Plume Model (RPM II), which was developed by EPA (Scheffe 1988). The Scheffe methodology uses the ratio of total VOC to total NO_X emissions from all production and gas processing/compression sources and the magnitude of the estimated VOC emissions to provide a conservative estimate of ozone impacts. Appendix A contains a copy of this document.

The ratio of VOCs to NO_X and total VOC emissions were referenced to Appendix A, Table 1 of the Scheffe report, applicable to a rural setting, to provide estimated Project ozone impacts. The Scheffe table was used to estimate one-hour average ozone concentrations from the referenced VOC and NO_X emissions.

Total VOC emissions from the development and operation of 325 wells for the Proposed Action were estimated as 906 tons per year (tpy) from the following sources:

- Vehicle tailpipes,
- Construction equipment exhaust
- Drill rigs,
- Gas venting,
- Well blowdowns,
- Well pad condensate tanks,
- Well pad separators,
- Compressor station engines,
- Central separators, and
- Central dehydration units.

Table 5-11 presents the average ozone impacts from the Proposed Action and each of the Alternatives. As shown, predicted impacts are less than the applicable ambient air quality standard. When evaluating the potential ozone impacts, the reader should consider that the Scheffe methodology provides a very conservative estimate of the potential impact. Thus, actual impacts resulting from the project would most likely be less than the predicted values.

Table 5-11. Predicted Ozone Impacts.

Project Alternative	Predicted Ozone 1-hr Average Impact (μg/m^3)	Background Level (μg/m^3)	Cumulative Impact (μg/m^3)	Ambient Air Quality Standard (μg/m^3)	Percent of Standard
Proposed Action	50	169	219	235	93%
Alternative A	58	169	227	235	97%
Alternative B	43	169	212	235	90%
Alternative C	31	169	200	235	85%

6.0 REFERENCES

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APPENDIX A
SCHEFFE OZONE SCREENING METHODOLOGY

DISCLAIMER

This document has been recreated from a copy of an original. Although every attempt has been made to ensure exact duplication of the original document, it is an electronic re-creation of the original and there may be errors. It is recommended that the reader obtain the complete printed document from U.S. EPA. Greg Remer, Nevada Bureau of Air Pollution Control, July 27, 1998.

VOC/NOx POINT SOURCE SCREENING TABLES

By Richard D. Scheffe

September 1988

United States Environmental Protection Agency
Office of Air Quality Planning and Standards
Technical Support Division
Source Receptor Analysis Branch

Table of Contents

1.O INTRODUCTION

This document provides a simple screening procedure presented in tabular form to calculate the ozone increment due to a VOC dominated (i.e, VOC mass emissions greater than NOx emissions) point source. [Throughout this document, ozone increment refers to a calculated increase in ozone above an assumed ambient value due to the effect of a single point source.] The tables are based on a series of applications of the Reactive Plume Model-II (RPM-II), a Lagrangian based photochemical model. Anticipated applications would include evaluation of the impact on ambient ozone due to new or modified point sources emitting more than 25 tons/year NMOC (nonmethane hydrocarbons). The screening technique is presented as two separate tables intended for application in urban and rural areas, respectively.

The user is directed to Section 3 of this report for application procedures needed to conduct an ozone increment screening analysis. Required inputs for determining an ozone increment are limited to estimates of NMOC and NOx mass emissions rates. As a screening technique the procedure has been designed be both robust and simple to use, while maintaining several inherent assumptions which lead to conservative (high ozone)ozone increment predictions. The user is not required to characterize ambient meteorology or source emission and ambient speciation profiles. This technique is not intended to substituted for a realistic photochemical modeling analysis; rather it is to be used only in the context of a firth-step procedure which potentially can preclude further resource intensive analyses. The ozone increment estimates produced from this analysis should be interpreted as conservative predictions which would exceed ozone formation produced by actual episodic events.

A description of the protocol and assumptions used in developing the screening tables is given in Appendix A.

2.0 BACKGROUND

Estimations of impacts of point sources emitting ozone precursors (NOx and/or VOC emissions) on ambient ozone provide regulatory agencies with data to address air quality issues involving proposed new or modified sources. In theory many issues can be resolved by applying a photochemical air quality model. However, two questions regarding model application must be resolved: (1) what is the most appropriate model for a particular application, and (2) how could that model be applied (i.e., how are model inputs developed and output interpreted)?

The Guideline on Air Quality Models (1986) recommends application of two photochemical models for addressing ozone air quality issues, the Urban Airshed Model (UAM) or EKMA. The EKMA model is not designed to handle point sources, as point source emissions are immediately spread into a broadly based urban mix and the individual contribution of a single point source is quenched by such broad spatial dilution. Although the UAM explicitly handles spatial resolution of point sources through spatially gridded cells, the degree of resolution typically offered by such gridding (4-5 km) is still insufficient to account for near-source behavior. Also, the resources and input data required by the UAM are very extensive; consequently, it is an inefficient means for evaluating effects of individual sources.

The Reactive Plue Model-II (RPM-II) is an alternative air quality model which was developed in the late 1970's to address photochemically reactive plumes. The model's inherent flexibility accommodates recently developed chemical mechanisms; this work was based on use of the Carbon Bond Mechanism-Version IV (CBM-IV), which is consistent with other, current EPA photochemical models (ROM, EXMA).

The RPM-II is an appropriate choice for case by case refined (i.e., not an initial screening estimate) modeling applications. However, the prospective model user faces the possibility of conducting an exhaustive compilation of meteorological and emissions source data. Consequently, use of photochemical models to assess individual point sources has been limited. The development of a screening analysis may eliminate, in certain applications, the need for a more intensive refined modeling analysis. Current modeling guidelines do not offer recommendations for screening of individual source impacts on ozone. The tables presented herein are intended to serve as a means for screening effects on ozone from individual point sources so that subsequent, more refined analyses can be focused on sources where it is warranted.

3.0 SCREENING TABLES

The interpretation or definition of a “rural” or “urban” area within the framework of this technique is intended to be rather broad and flexible. The rationale for having rural and urban tables stems from the need to account for the coupled effect of point source emissions and background chemistry on ozone formation. Background chemistry in the context of this procedure refers to a characterization of the ambient atmospheric chemistry into which a point source emits. The underlying model runs used to develop the rural table (Table 1) were performed with spatially invariant background chemistry representative of “clean” continental U.S. areas. Model runs used to develop the urban table (Table 2) are based on background chemistry incorporating daily temporal fluctuations of NOx and hydrocarbons associated with a typical urban atmosphere (refer to Appendix A for details regarding background chemistry). Background chemistry is an important factor in estimating ozone formation; however, characterization of background chemistry is perhaps the most difficult aspect of reactive plume modeling because of data scarcity and the level of resources required to measure or model (temporally and spatially) the components necessary to characterize the ambient atmospheric along the trajectory of a point source plume.

Recognizing the conflicting needs of using simple characterizations of background chemistries and applying this screening technique in situations where sources are located in or impact on areas which can not be simply categorized, the following steps should be used to choose an appropriate table:

(1) If the source location and downwind impact area can be described as rural and where ozone exceedances have never been reported, choose the rural area table.

(2) If the source location and downwind impact area are of urban character, choose the urban area table.

(3) If an urban based source potentially can impact a downwind rural area, or a rural based source can potentially impact a downwind urban area, use the highest value obtained from applying both tables.

The VOC point source screening tables (Tables 1 and 2) provided ozone increments as a function of NMOC (nonmethane organic carbon) mass emissions rates and NMOC/NOx emissions ratios. To determine an ozone impact the user is required to apply best estimates of maximum daily NMOC emissions rate, and
estimated annual mass emissions rates of NMOC and NOx which are used to determine NMOC/NOx ratio for ascribing the applicable column in Table 1 or 2. The reasons for basing application on daily maximum NMOC emissions rates are (1) to avoid underestimates resulting from discontinuous operations and (2) the underlying modeling simulations are based on single day episodes. The NMOC emissions rates in Tables 1 and 2 are given on an annual basis; consequently the user must project daily maximum to annual emissions rates illustrated in the example application given below. One purpose of the technique is to provide a simple, non-resource intensive tool; therefore, annual NMOC/NOx emissions ratios are used because consideration of daily fluctuations would require a screening application applied to each day.

Parameters describing background chemistry, episodic meteorology, and source emissions speciation affect actual ozone impact produced by a point source. However, as a screening methodology the application should be simple, robust and yield conservative (high ozone) values. Thus, only NMOC and Nox emissions rates are required as input to Tables 1 and 2.

Rural Example Application

A manufacturing company intends to construct a facility in an isolated rural location where ozone exceedances have never been observed. The pollution control agency requires that the company submit an analysis showing that operation of the proposed facility will not result in an ozone increment greater than X ppm in order to permit operation. The estimated daily maximum NMOC emissions rate is 9000 lbs/day. The annual estimated emissions rates for NMOC and NOx are 1000 tons/yr and 80 tons/yr, respectively. The company's strategy is to provide a screening analysis using the rural area table to prove future compliance. If the screening result exceeds X ppm, the company will initiate a detailed modeling analysis requiring characterization of source emissions speciation, ambient chemistry, and episodic meteorology.

Screening Estimate:

1 - Determine which column of Table (I) is applicable:

The NMOC/NOx ratio is based on annual estimates; thus, 1000/80 = 12.5 and middle column values are applied.

2 - Calculate annual NMOC emissions rates in tons/yr from maximum daily rate:

(9000 lbs/day)(1 ton/2000 1bs)(365 days/yr) = 1643 ton~/yr

3 - Interpolate linearly between 1500 tons/yr and 2000 tons/yr to produce an interpolated column 2 ozone increment:

(1643-l500)(3.84-3.05)/(2000-1500) + 3.04 = 3.27 pphm

3.27pphm(1 ppm/100 pphm) = 0.0327 ppm

If 0.0327 ppm is below the criterion value (X ppm), no further modeling analysis required and operation may be permitted. Otherwise, the company wil1 proceed with an additional case-specific modeling analysis.

Table 1. Rural based ozone increment (pphm) as a function of NMOC emissions and NMOC/NOx ratios.

NMOC/NOx

TONS NMOC/TONS NOx
(PPMC/PPM)

NMOC EMISSIONS (TONS/YR)	> 20.7 (>20)	5.2-20.7 (5-20)	< 5.2 (< 5)
50	0.4	0.4	1.1
75	0.4	0.4	1.2
100	0.4	0.5	1.4
300	0.8	1.0	1.7
500	1.1	1.4	1.9
750	1.6	1.9	2.3
1000	2.0	2.4	2.7
1500	2.7	3.0	3.3
2000	3.4	3.8	3.7
3000	4.8	5.2	4.3
5000	7.0	7.5	4.8
7500	9.8	10.1	5.1
10000	12.2	12.9	5.4

- multiply pphm by 0.01 to obtain ppm

DRAFT

Table 2. Urban based ozone increment (pphm) as a function of NMOC emissions and NMOC/NOx ratios.

NMOC/NOx

TONS NMOC/TONS NOx
(PPMC/PPM)

NMOC EMISSIONS (TONS/YR)	> 20.7 (>20)	5.2-20.7 (5-20)	< 5.2 (< 5)
50	1.1	1.1	1.0
75	1.2	1.1	1.1
100	1.3	1.2	1.1
300	1.8	1.6	1.9
500	2.2	2.0	2.8
750	3.3	2.6	3.9
1000	4.1	3.2	4.7
1500	5.8	4.2	4.9
2000	7.1	5.4	4.9
3000	9.5	7.8	6.5
5000	13.3	12.0	9.3
7500	17.3	16.7	12.5
10000	21.1	20.8	15.5

- multiply pphm by 0.01 to obtain ppm

DRAFT

4.0 REFERENCES

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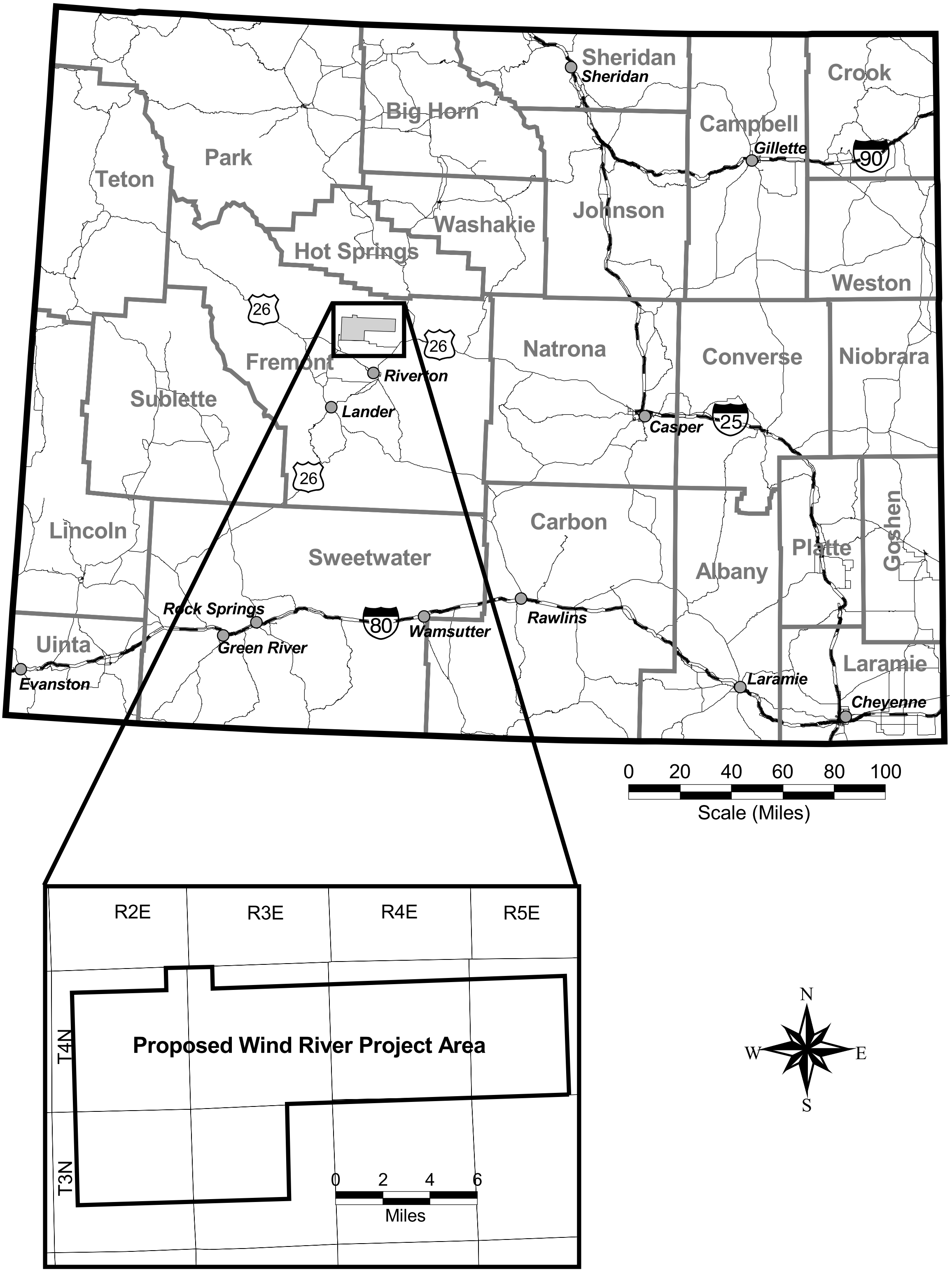

Figure 2-1. Location of Wind River Gas Development Project Area in Central Wyoming.

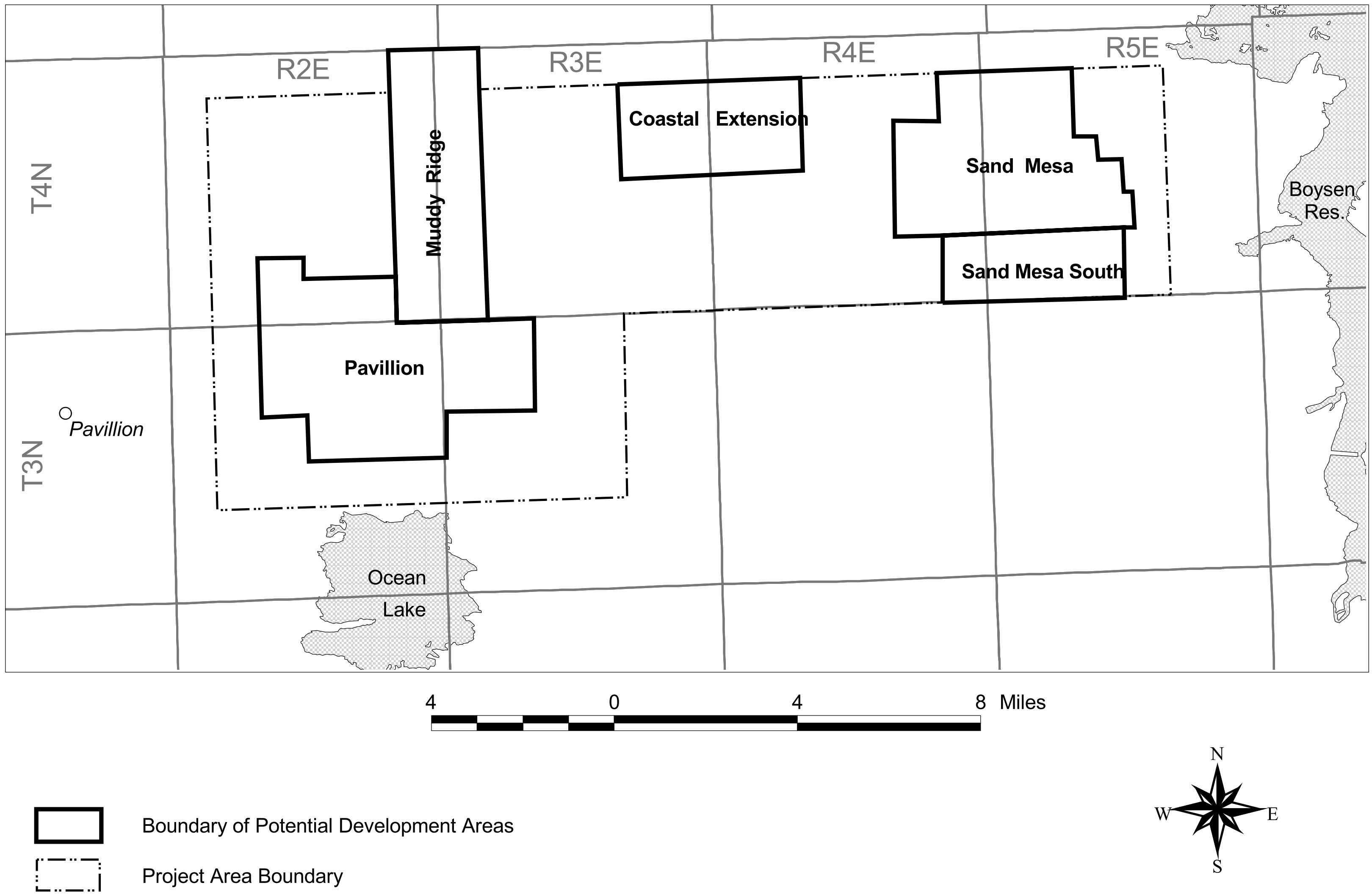

Figure 2-2. WRPA Project Boundary and Gas Fields.