

Appendix F

Detailed Emissions Calculations

Buys & Associates, Inc. Environmental Consultants	Project: Enduring Resources Southam Canyon EA Date: 7/16/2008
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Existing	7 wells 2 producing wells 22 miles road				
Proposed	Total New Wells 249 Total New Pads 152 Number of Wells Per Pad 1.64 Pads with only one vertical well 89 Directional Well Pads 63 38 with vertical wells Vertical Wells 127				
Drilling	New Well pad/road construction Drilling (10 years 25 well average --Assume max year of 35 wells) 21 new well pads per year for 10 years 40-acre spacing 35 new wells per year for 10 years Well Pad Disturbance 684 acres 4.5 acres/pad 196020.00 443 ft/side 134.95 meters ROW Disturbance Roads 109.0 acres 0.717 acres/pad 50' construction ROW 18' running surface, 24' final ROW 36 miles feet/pad model volumes meters/volume 0.237 miles/pad 1250.526 52 7.3152 Pipeline 122.0 acres 0.803 acres/pad Surface 47 miles 0.309 miles/pad Power lines 0 acres 0 acres/pad 0 miles (cross country) 0 miles/pad Compressor Stations 4 acres 174240.00 ft/side meters/side 417 127.2 Pits 0 TOTAL SHORT-TERM ACRES 919.0 SHORT-TERM WELL/ROAD DISTURB PER WELL PAD 6.020 Average Round Trip Distance for Drilling/Construction Traffic = 10 on unpaved off Hwy 45 Average Round Trip Distance for Operations Traffic = 108.2				35
					# of simultaneous operations
	New well pad/road construction 5 days 10 hrs/day 50 Total Hours Pipeline installation 3 days 10 hrs/day 30 Total Hours Avg of days to drill, log and case one gas well 20 days 24 hrs/day 480 Total Hours 2 Time to complete each well 10 days 10 hrs/day 100 Total Hours 2 Time to Frac a well 1 day 8 hrs/day 8 Total Hours 2 Rig Size (hp) 2280 hp (Based on CAZA 82, rig that currently runs in Bonanza) 1000 hp Phase 1				
Completion	assume 2 pads, 2 rigs, 2 completions simultaneously (Prop Action indicates 1-2 drilling rigs at a time). 6-10 hours frac time per well 7 pumps total 9000-10000 hp frac pump engines 10,000 hp avg of 60-70% load 1-60hp gensets 60 hp				
Production	Pumper Vehicle Traffic: 1 new pumers visits 83 wells per day and visits all wells daily (based on ch2) Central Dehydration 1,500 hp engine Section 36 T10S R25E Each reclaimed production well pad will occupy 3.5 acre 3.5 152460 sq ft 390.461266 390.4612657 Each completed well pad will have: a well head, 500Mbtu/hr separator heater, condensate oil tank, water tank, and a dehydrator; per well 119.012594 119.0125938 Pumper Vehicle Traffic: 3 new pumers (Ch2) each pumper logs ~1500 miles/month (B&A Estimate) 3 Compression, 1,500 hp Engines to be LE with ox cat, assume 95% control CO, 76% HCHO and acrolein, 50% VOC 1,500 hp of new compression total 1500 hp Assume CS are 4acre sites (135m x 135m) 18210.85 134.95 20-30 Year LOP (assume average of 25) Assume 5 bbls condensate per day per well as in LCU				

1. Road and Pad Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	5 days per well pad (Estimate) 10 hours/day 50 hours per well pad Dozer 20 hours per well pad Backhoe
Watering Control Efficiency	50 percent (Assumption)
Soil Moisture Content	7.9 percent (AP-42 Table 11.9-3, 10/98)
Soil Silt Content	6.9 percent (AP-42 Table 11.9-3, 10/98)
PM10 Multiplier	0.75 * PM15 (AP-42 Table 11.9-1, 10/98)
PM2.5 Multiplier	0.105 * TSP (AP-42 Table 11.9-1, 10/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
 Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98
 As specified by AP-42 Table 13.2.3-1 Recommended Emission Factors for Construction Operations

Emissions (TSP lbs/hr) = 5.7 * (soil silt content %)^{1.2} * (soil moisture content %)^{-1.3} * Control Efficiency

Emissions (PM15 lbs/hr) = 1.0 * (soil silt content %)^{1.5} * (soil moisture content %)^{-1.4} * Control Efficiency

Emissions = 3.94 lbs TSP/hour/piece of equipment

Emissions = 1.00 lbs PM15/hour/piece of equipment

	Dozer Emissions ^a			Backhoe Emissions ^a			Total
	lbs/hr	tons/well	tons/yr ^b	lbs/hr	tons/well	tons/yr ^b	tons/yr ^b
TSP	3.94	0.0985	2.10	3.94	0.0394	0.00	2.10
PM15	1.00	0.0251	0.54	1.00	0.0100	0.21	0.75
PM10	0.38	0.0094	0.20	0.38	0.0038	0.08	0.28
PM2.5	0.21	0.0052	0.11	0.21	0.0021	0.04	0.15

a Assumes one dozer and one backhoe. Backhoe emissions are conservatively estimated as equivalent to Dozer emissions.

b Assumes maximum development scenario

2. Road Construction Emissions (Grader)

Assumptions:

Grading Length	4.40 0.24 miles/pad x 3 swaths (10' per swath) [road] + pad 3.69 miles on 443 ft x 443 ft pad (10 ft swath for 443 ft * 44 lengths)
Hours of Construction	3 day grading per road-and pad (Estimate) 10 hours/day 30 hours per well pad
Watering Control Efficiency	50 percent (Assumption)
Average Grader Speed	7.1 mph (Typical value AP-42 Table 11.9-3, 10/98)
Distance Graded	4.40 miles
PM10 Multiplier	0.6 * PM15 (AP-42 Table 11.9-1, 10/98)
PM2.5 Multiplier	0.031 * TSP (AP-42 Table 11.9-1, 10/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
 Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98
 As specified by AP-42 Table 13.2.3-1 Recommended Emission Factors for Construction Operations

Emissions (TSP lbs) = 0.040 * (Mean Vehicle Speed)^{2.5} * Distance Graded * Control Efficiency

Emissions (PM15 lbs) = 0.051 * (Mean Vehicle Speed)^{2.0} * Distance Graded * Control Efficiency

Emissions = 11.83 lbs TSP/well

Emissions = 5.66 lbs PM15/well

	Grader Construction Emissions			
	lbs/well	lbs/hr/well	tons/well	tons/yr ^a
TSP	11.83	0.39	5.91E-03	0.13
PM15	5.66	0.19	2.83E-03	0.06
PM10	3.40	0.11	1.70E-03	0.04
PM2.5	0.37	0.01	1.83E-04	0.004

a Assumes maximum development scenario
 a Assumes maximum development scenario

3. Pipeline Construction Emissions (Grader)

Assumptions:

Grading Length	0.31 miles pipeline per pad
Hours of Construction	1 day grading per well pad and road (Estimate) 10 hours/day 10 hours per well pad
Watering Control Efficiency	50 percent (Assumption)
Average Grader Speed	7.1 mph (Typical value AP-42 Table 11.9-3, 10/98)
Distance Graded	0.31 miles
PM10 Multiplier	0.6 * PM15 (AP-42 Table 11.9-1, 10/98)
PM2.5 Multiplier	0.031 * TSP (AP-42 Table 11.9-1, 10/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
 Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98
 As specified by AP-42 Table 13.2.3-1 Recommended Emission Factors for Construction Operations

Emissions (TSP lbs) = $0.040 * (\text{Mean Vehicle Speed})^{2.5} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions (PM15 lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions = 0.83 lbs TSP/well

Emissions = 0.40 lbs PM15/well

	Grader Construction Emissions			
	lbs/well	lbs/hr/well	tons/well	tons/yr ^a
TSP	0.83	0.08	0.0004	0.01
PM15	0.40	0.04	0.0002	4.25E-03
PM10	0.24	0.02	1.19E-04	2.55E-03
PM2.5	0.03	2.58E-03	1.29E-05	2.75E-04

a Assumes maximum development scenario

Buys & Associates, Inc.
Environmental Consultants

Project: Enduring Resources Southam Canyon EA
 Date: 7/16/2008

4. Development Traffic Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
 November 2006

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$
 $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45}$
 Silt Content (S) 8.4 Mean value Table 13.2.2-1 for haul roads
 Round Trip Miles 10 Unpaved from Hwy 45
 Precipitation Days (P) 47 days per year (WRCC data for Bonanza, UT 1938-1993)

	Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM10 (lb/VMT)	PM10/Pad (lbs)	PM10/Pad (lb/day)	PM2.5/Pad (lbs)	PM2.5/Pad (lb/day)
Construction (days pad, road, pipeline)	6							
	Semi: Hvy Equip Hauler	60,000	3					
	Haul Trucks: Equipment/Fuel/Water	40,000	5					
	Pickup Truck: Crew	7,000	10					
	Mean Vehicle Weight	25,000	18	1.8018502	324.3	54.1	32.4	5.4
				PM10/Annual Pads (tons)		PM2.5/Annual Pads (tons)		
				3.5		0.35		
Drilling (days/well)	20.0							
	Semi: Hvy Equip Hauler	60,000	35					
	Haul Trucks: Equipment/Fuel/Water	40,000	45					
	Pickup Truck: Rig Crew	7,000	100					
	Mean Vehicle Weight	30,556	180	1.9721333	3549.8	177.5	355.0	17.7
				PM10/Annual Wells (tons)		PM2.5/Annual Wells (tons)		
				62		6		
Completion (days/well)	10							
	Pickup: Completion Rig Crew	7,000	55					
	Haul Trucks: Equipment/Fuel/Water	40,000	80					
	Mean Vehicle Weight	26,556	135	1.8514655	2499.5	249.9	249.9	25.0
					PM10/Annual Wells (tons)		PM2.5/Annual Wells (tons)	
				43.7		4.4		
Interim Reclamation (days/well)	2							
	Pickup: Crew	7,000	1					
	Haul Trucks: Equipment	40,000	5					
	Mean Vehicle Weight	34,500	6	2.0828801	125.0	62.5	12.5	6.2
					PM10/Annual Wells (tons)		PM2.5/Annual Wells (tons)	
				2.2		0.2		
Annual Traffic Fugitive Dust Emissions (tons/year)					112		11.2	

5. Wind Erosion Fugitive Dust Emissions

Assumptions

Threshold Friction Velocity U_t^*	1.02 m/s (2.28 mph) for well pads (AP-42 Table 13.2.5-2 Overburden - Western Surface Coal Mine 1.33 m/s (2.97 mph) for roads (AP-42 Table 13.2.5-2 Roadbed material)
Initial Disturbance Area	231.0 acres total initial disturbance for roads/pipelines (Proposed Action) 934,822 square meters total initial disturbance for roads/pipelines 684 acres total initial disturbance for well pads (Proposed Action) 2,768,045 square meters total initial disturbance for well pads 915 acres total disturbance
Exposed Surface Type	Flat
Meteorological Data	2002 Grand Junction (obtained from NCDC website)
Fastest Mile Wind Speed U_{10}^+	20.1 meters/sec (45 mph) reported as fastest 2-minute wind speed for Grand Junction (2002)
Number soil of disturbances	2 for well pads (Assumption, disturbance at construction and reclamation) Constant for dirt roads
Development Period	10 years (Proposed Action)

Equations

Friction Velocity $U^* = 0.053 U_{10}^+$

Erosion Potential $P (g/m^2/period) = 58*(U^*-U_t^*)^2 + 25*(U^*-U_t^*)$ for $U^*>U_t^*$, $P = 0$ for $U^*<U_t^*$

Emissions (tons/year) = Erosion Potential($g/m^2/period$)*Disturbed Area(m^2)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 um	<10 um	<2.5 um
1.0	0.5	0.2

Maxium U_{10}^+ Wind Speed (m/s)	Maximum U^* Friction Velocity (m/s)	Well U_t^* Threshold Velocity ^a (m/s)	Well Pad Erosion Potential g/m^2	Road U_t^* Threshold Velocity ^a (m/s)	Road Erosion Potential g/m^2
20.12	1.07	1.02	1.28	1.33	0.00

Wind Erosion Emissions

Particulate Species	Wells (tons/year)	Roads/Pipelines (tons/year)
TSP	0.78	0.00
PM10	0.39	0.00
PM2.5	0.16	0.00

6. Construction Tailpipe Emissions

Assumptions:

Average Round Trip Distance	10.0 miles (Estimated from project area and existing road system)
Hours of Construction	80 hours per site (Proponent)
Number of Heavy Diesel Truck Trips	8 (Proponent)
Number of Pickup Trips	10 (Proponent)
Diesel Fuel sulfur content	0.05 % (Typical value)
Diesel Fuel density	7.08 lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10 miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15 miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \# \text{ Trips} * \text{Trip Distance (miles)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO2 emissions are calculated on a mass balance basis utilizing the following equation:

$$\text{SO}_2 \text{ E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6 \text{ (g/lb)} * \text{Fuel Sulfur Content} * 2 \text{ (S / SO}_2\text{)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total ^d	
	E. Factor ^a (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor ^b (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.018	7.17E-04	3.03	0.008	3.34E-04	0.026	0.022
CO	17.09	0.038	1.51E-03	33.64	0.093	3.71E-03	0.130	0.111
VOC^c	4.83	0.011	4.26E-04	1.84	0.005	2.03E-04	0.016	0.013
SO2	0.32	0.001	2.83E-05	0.21	0.001	2.36E-05	0.001	0.001

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)

b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 50,000 miles (6/95)

c Emission factor is for total Hydrocarbons.

d Assumes maximum development scenario

7. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	10.0 miles (Estimated from project area and existing road system)
Hours of Operation	480.0 hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	80 (Proponent)
Number of Pickup Trips	100 (Proponent)
Diesel Fuel sulfur content	0.05 % (Typical value)
Diesel Fuel density	7.08 lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10 miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15 miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \# \text{ Trips} * \text{Trip Distance (miles)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO2 emissions are calculated on a mass balance basis utilizing the following equation:

$$\text{SO}_2 \text{ E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6 \text{ (g/lb)} * \text{Fuel Sulfur Content} * 2 \text{ (S / SO}_2\text{)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total ^d	
	E. Factor ^a (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor ^b (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.030	0.007	3.03	0.014	0.003	0.044	0.368
CO	17.09	0.063	0.015	33.64	0.155	0.037	0.217	1.825
VOC^c	4.83	0.018	0.004	1.84	0.008	0.002	0.026	0.220
SO2	0.32	0.001	0.000	0.21	0.001	0.000	0.002	0.018

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)

b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 50,000 miles (6/95)

c Emission factor is for total Hydrocarbons.

d Assumes maximum development scenario

8. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	10.0 miles (Estimated from project area and existing road system)
Hours of Operation	100 hours per site (Proponent)
Number of Heavy Diesel Truck Trips	80 (Proponent)
Number of Pickup Trips	55 (Proponent)
Diesel Fuel sulfur content	0.05 % (Typical value)
Diesel Fuel density	7.08 lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10 miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15 miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \# \text{ Trips} * \text{Trip Distance (miles)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO2 emissions are calculated on a mass balance basis utilizing the following equation:

$$\text{SO}_2 \text{ E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6 \text{ (g/lb)} * \text{Fuel Sulfur Content} * 2 \text{ (S / SO}_2\text{)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total ^d	
	E. Factor ^a (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor ^b (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.143	0.007	3.03	0.037	0.002	0.180	0.192
CO	17.09	0.301	0.015	33.64	0.408	0.020	0.709	0.758
VOC^c	4.83	0.085	0.004	1.84	0.022	1.12E-03	0.107	0.115
SO2	0.32	0.006	0.000	0.21	0.003	1.30E-04	0.008	0.009

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)

b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 50,000 miles (6/95)

c Emission factor is for total Hydrocarbons.

d Assumes maximum development scenario

9. Development Tailpipe Emissions

Assumptions:

Average Round Trip Distance	10.0 miles (Estimated from project area and existing road system)
Hours of Operation	20 hours per site (Assumption)
Number of Heavy Diesel Truck Trips	5 (Assumption)
Number of Pickup Trips	1 (Assumption)
Diesel Fuel sulfur content	0.05 % (Typical value)
Diesel Fuel density	7.08 lbs/gallon (Typical value)
Heavy Haul Diesel Fuel Efficiency	10 miles/gallon (Typical value)
Heavy Duty Pickup Fuel Efficiency	15 miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \# \text{ Trips} * \text{Trip Distance (miles)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO2 emissions are calculated on a mass balance basis utilizing the following equation:

$$\text{SO}_2 \text{ E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6 \text{ (g/lb)} * \text{Fuel Sulfur Content} * 2 \text{ (S / SO}_2\text{)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total ^d	
	E. Factor ^a (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor ^b (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.045	0.000	3.03	0.003	0.000	0.048	0.010
CO	17.09	0.094	0.001	33.64	0.037	0.000	0.131	0.028
VOC^c	4.83	0.027	0.000	1.84	0.002	0.000	0.029	0.006
SO2	0.32	0.002	0.000	0.21	0.000	0.000	0.002	0.000

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)

b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 50,000 miles (6/95)

c Emission factor is for total Hydrocarbons.

d Assumes maximum development scenario

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Hours of Operation	50 hours/site (Proposed Action)	
Development Rate	21 new pads per year (Proposed Action)	
Load Factor	0.4 (Assumed typical value)	
Backhoe Size	100 hp (Assumed Typical value)	20 hrs
Dozer Size	150 hp (Assumed Typical value)	50 hrs
Motor Grader Size	135 hp (Assumed Typical value)	40 hrs

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/tons)}}$$

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor ^a (g/hp-hr)	Emissions (lb/hr)	Emissions ^e (tons/yr)	E. Factor ^a (g/hp-hr)	Emissions (lb/hr)	Emissions ^e (tons/yr)	E. Factor ^b (g/hp-hr)	Emissions (lb/hr)	Emissions ^e (tons/yr)
NOx	8.15	0.719	0.154	8.15	1.078	0.576	7.14	0.850	0.363
CO	2.28	0.201	0.043	2.28	0.302	0.161	1.54	0.183	0.078
VOC^c	0.37	0.033	0.007	0.37	0.049	0.026	0.36	0.043	0.018
PM10^d	0.5	0.044	0.009	0.5	0.066	0.035	0.63	0.075	0.032
PM2.5^d	0.5	0.044	0.009	0.5	0.066	0.035	0.63	0.075	0.032
SO2	0.22	0.019	0.004	0.22	0.029	0.016	0.22	0.026	0.011
Formaldehyd^e	0.22	0.019	0.004	0.22	0.029	0.016	0.12	0.014	0.006

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions ^e (tons/yr)
NOx	2.647	1.093
CO	0.686	0.282
VOC^c	0.124	0.051
PM10^d	0.185	0.077
PM2.5^d	0.185	0.077
SO2	0.075	0.031
Formaldehyd^e	0.063	0.026

- a AP-42 Volume II, Mobile Sources, Nonroad Vehicles, Table 11-7.1 Off-highway truck
- b AP-42 Volume II, Mobile Sources, Nonroad Vehicles, Table 11-7.1 Motor Grader
- c Emission Factor represents total Hydrocarbon Emissions
- d All emitted particulate matter assumed to be PM2.5
- e Assumes maximum development scenario

11. Drill Rig Engine Emissions

Assumptions:

Hours of Operation	480.0 hours/well (Proposed Action)
Development Rate	35 wells per year (Proposed Action)
Load Factor	0.4 (Assumed typical value)
Rig Size	1000 hp Phase 1 (vicinity projects estimate) 2280 hp Phase 2 (Proponent previous projects) 2152 average
Diesel Fuel Sulfur Content	0.05 % (typical value)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{2000 \text{ (lb/tons)}}$$

$$\text{SO}_2 \text{ E. Factor (lb/hp-hr)} = \text{Fuel sulfur content} * 0.00809$$

Species	Drill Rig Emissions		
	E. Factor ^a (lb/hp-hr)	Emissions (lb/hr)	Emissions ^c (tons/yr)
<i>Criteria Pollutants & VOC</i>			
NO_x	2.40E-02	20.66	174
CO	5.50E-03	4.734	40
VOC^b	7.05E-04	0.282	2.4
PM10^c	5.73E-04	0.493	4.1
PM2.5^d	4.79E-04	0.412	3.46
SO₂	4.05E-04	0.348	2.92
<i>Hazardous Air Pollutants</i>			
Benzene^e	1.97E-06	0.002	0.01
Toluene^e	7.15E-07	0.001	0.01
Xylenes^e	4.91E-07	4.23E-04	3.55E-03
Formaldehyde^e	2.01E-07	1.73E-04	1.45E-03
Acetaldehyde^e	6.41E-08	5.52E-05	4.64E-04
Acrolein^e	2.01E-08	1.73E-05	1.45E-04
Naphthalene^f	3.31E-07	2.85E-04	2.39E-03
Total PAH^g	5.40E-07	4.64E-04	3.90E-03
<i>Greenhouse Gases</i>			
CO₂^a	1.16	999	8,388
CH₄^{a,b}	7.05E-04	0.607	5.1

^a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1 Diesel Fuel, 10/96

^b Emission Factor represents total Hydrocarbon Emissions

^c Total particulate emission factor is 0.0007, PM10 fraction determined from Table 3.4-2

^d Total particulate emission factor is 0.0007, PM2.5 fraction determined from Table 3.4-2

^e AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, 10/96 converted using boiler conversion factor from Appendix A

^f AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, 10/96 converted using boiler conversion factor from Appendix A

^g PAH (Polycyclic Aromatic Hydrocarbons) includes naphthalene and are a HAP because they are polycyclic organic matter (POM)

^h Assumes maximum development scenario

12. Well Fracturing Pump and Generator Engines

Assumptions:

Average Hours of Operation	8 Hours/Well (Proponents)
Development Rate	35 wells per year (Proposed Action)
Load Factor	0.65 (Proponents)
Frac Pump Engine Horsepower	10,000 Horsepower (Proponents)
Temporary Generator Horsepower	60 Horsepower (Proponents)
Diesel Fuel Sulfur Content	0.05 % (typical value)

Equations:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (lb/hp-hr)} * \text{Rated Horsepower (hp)} * \text{Operating Hours (hrs)} * \text{Load Factor (Dimensionless)}}{2000 \text{ (lb/tons)}}$$

$$\text{SO}_2 \text{ E. Factor (lb/hp-hr)} = \text{Fuel sulfur content} * 0.00809$$

Species	Frac Pump Engine Emissions		
	E. Factor ^a (lb/hp-hr)	Emissions (lb/hr)	Emissions ^e (tons/yr)
NOx	2.40E-02	156.0	21.84
CO	5.50E-03	35.75	5.005
VOC^b	7.05E-04	4.583	0.642
PM10^c	5.73E-04	3.725	0.521
PM2.5^d	4.79E-04	3.114	0.436
SO₂^a	4.05E-04	2.629	0.368
<i>Hazardous Air Pollutants</i>			
Benzene^e	1.97E-06	1.28E-02	1.80E-03
Toluene^e	7.15E-07	4.65E-03	0.001
Xylenes^e	4.91E-07	3.19E-03	4.47E-04
Formaldehyde^e	2.01E-07	1.31E-03	1.83E-04
Acetaldehyde^e	6.41E-08	4.17E-04	5.84E-05
Acrolein^e	2.01E-08	1.30E-04	1.83E-05
Naphthalene^f	3.31E-07	2.15E-03	3.01E-04
Total PAH^f	5.40E-07	3.51E-03	4.91E-04
<i>Greenhouse Gases</i>			
CO₂^a	1.16	7,540	1,055.6
CH₄^a	7.05E-04	4.583	0.642

Species	Generator Engine Emissions		
	E. Factor ^f (lb/hp-hr)	Emissions (lb/hr)	Emissions ^e (tons/yr)
NOx	0.031	1.209	0.169
CO	6.68E-03	0.261	0.036
VOC^b	2.47E-03	0.096	1.35E-02
PM10	2.20E-03	0.086	1.20E-02
PM2.5^g	2.20E-03	0.086	1.20E-02
SO₂^g	2.05E-03	0.08	1.12E-02
<i>Hazardous Air Pollutants</i>			
Benzene^h	2.37E-06	9.26E-05	1.30E-05
Toluene^h	1.04E-06	4.06E-05	5.68E-06
Xylenes^h	7.25E-07	2.83E-05	3.96E-06
Formaldehyde^h	3.00E-06	1.17E-04	1.64E-05
Acetaldehyde^h	1.95E-06	7.61E-05	1.07E-05
Acrolein^h	2.35E-07	9.18E-06	1.29E-06
1,3-Butadiene^h	9.95E-08	3.88E-06	5.43E-07
Naphthalene^h	2.16E-07	8.42E-06	1.18E-06
Total PAH^h	4.28E-07	1.67E-05	2.33E-06
<i>Greenhouse Gases</i>			
CO₂^g	1.15	7,475	1,047
CH₄^{bg}	2.47E-03	16.055	2.25

^a AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-1, 10/96

^b Emission Factor represents total Hydrocarbon Emissions

^c Total particulate emission factor is 0.0007, PM10 fraction determined from Table 3.4-2

^d Total particulate emission factor is 0.0007, PM2.5 fraction determined from Table 3.4-2

^e AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, 10/96 converted using boiler conversion factor from Appendix A

^f AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, 10/96 converted using boiler conversion factor from Appendix A

^g AP-42 Table 3.3-1, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, 10/96

^h AP-42 Table 3.3-2 Speciated Organic Compound Emission Factors for Uncontrolled Diesel Engines, 10/96 converted using boiler

^h conversion factor from Appendix A

ⁱ Assumes maximum development scenario

13. Completion Flare Emissions

Assumptions

Hours of Operation	2 days (Typical)
Amount of Gas Flared	5 MMscf/well (Assumption, based on initial Production Rates)
Average Gas Heat Content	950 Btu/scf (Gas Analyses from Existing Wells)
Average Gas VOC Content	0.007 weight % (Gas Analyses from Existing Wells)
Average Mole Weight	17.6 lb/lb-mole (Gas Analyses from Existing Wells)
Development rate	35 gas wells per year

Equations

NOx/CO Emissions (lb/well) = Emission Factor (lb/MM Btu) * Gas Amount (MMscf/well) * Heat Content (Btu/scf)

PM/HAP Emissions (lb/well) = Emission Factor (lb/MMscf) * Gas Amount (MMscf/well)

Flare Gas Wt. (lb/well) = $\frac{\text{Flare Gas Volume (MMscf/well)} * 10^6 \text{ (scf/MMscf)} * \text{Mole Weight (lb/lb-mole)}}{379.49 \text{ (scf/mole)}}$

VOC Emissions (lb/well) = Flare Gas Wt. (lb/well) * VOC wt. % * 0.02 (Assumes 98% destruction Efficiency)

Species	Emission Factor (lb/MMBtu)	Well Emissions (lb/well)	Well Emissions (lb/hr/well)	Total Emissions ^m (tons/vr)
<i>Criteria Pollutants</i>				
NO _x ^a	0.068	323	6.73	5.7
CO ^a	0.37	1757	36.60	31
VOC	N.A.	0.3	0.01	0.0
SO _x ^b	0.00	0.0	0.00	0.00
TSP ^c	7.6	38	0.792	0.67
PM ₁₀ ^c	7.6	38	0.792	0.67
PM _{2.5} ^c	7.6	38	0.792	0.67
<i>Hazardous Air Pollutants</i>				
Benzene ^d	2.1E-03	1.1E-02	2.2E-04	1.8E-04
Toluene ^d	3.4E-03	1.7E-02	3.5E-04	3.0E-04
Hexane ^d	1.8	9.0	0.2	0.2
Formaldehyde ^d	7.5E-02	3.8E-01	7.8E-03	6.6E-03
Dichlorobenzene ^d	1.2E-03	6.0E-03	1.3E-04	1.1E-04
Naphthalene ^d	6.1E-04	3.1E-03	6.4E-05	5.3E-05
POM 2 ^{d,e,f}	5.9E-05	3.0E-04	6.1E-06	5.2E-06
POM 3 ^{d,g}	1.6E-05	8.0E-05	1.7E-06	1.4E-06
POM 4 ^{d,h}	1.8E-06	9.0E-06	1.9E-07	1.6E-07
POM 5 ^{d,i}	2.4E-06	1.2E-05	2.5E-07	2.1E-07
POM 6 ^{d,j}	7.2E-06	3.6E-05	7.5E-07	6.3E-07
POM 7 ^{d,k}	1.8E-06	9.0E-06	1.9E-07	1.6E-07
Arsenic ^l	2.0E-04	1.0E-03	2.1E-05	1.8E-05
Beryllium ^l	1.2E-05	6.0E-05	1.3E-06	1.1E-06
Cadmium ^l	1.1E-03	5.5E-03	1.1E-04	9.6E-05
Chromium ^l	1.4E-03	7.0E-03	1.5E-04	1.2E-04
Cobalt ^l	8.4E-05	4.2E-04	8.8E-06	7.4E-06
Manganese ^l	3.8E-04	1.9E-03	4.0E-05	3.3E-05
Mercury ^l	2.6E-04	1.3E-03	2.7E-05	2.3E-05
Nickel ^l	2.1E-03	1.1E-02	2.2E-04	1.8E-04
Selenium ^l	2.4E-05	1.2E-04	2.5E-06	2.1E-06
<i>Greenhouse Gases</i>				
CO ₂ ^c	120,000	600,000	12,500	10,500
CH ₄ ^a	0.14	665	13.8	11.6

a AP-42 Table 13.5-1, Emission Factors for Flare Operations, 9/91

b Assumes produced gas contains no sulfur

c AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are PM1.0)

d AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

e POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network

f POM 2 includes: Acenaphthene, acenaphthylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene,

g POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

h POM 4 includes: 3-Methylchloranthrene.

i POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

j POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

k POM 7 includes: Chrysene.

l AP-42 Table 1.4-3, Emission Factors for Metals from Natural Gas Combustion, 7/98

m Assumes proposed development rate

Buy's & Associates, Inc.
Environmental Consultants

Project: Enduring Resources Southam Canyon EA
 Date: 7/16/2008

14. Operations Vehicle Tailpipe Emissions

Assumptions:

Number of New Pumpers: 3 (Proponent Number of Pumpers at Peak Production)
 Pumper Mileage: 4,000 miles/pumper/month (Assumption 0.5 miles between well pads and roundtrip from Vernal)
 Total Annual New Pumper Mileage: 144,000 miles/year
 Number of Condensate Haul Truck Round Trips: 2 trips per day (based on Section 2.2)
 Average Round Trip Mileage for Condensate Transport: 108 miles (from Vernal)
 Total Annual Condensate Truck Mileage: 78,986 miles/year
 Number of Water Haul Truck Round Trips: 3 trips per day (based on Section 2.2)
 Average Round Trip Mileage for Water Transport: 56 miles (Average distance to Myton or Ouray)
 Total Annual Water Truck Mileage: 61,320 miles/year

Daily Hours of Operation: 12 hours per day (Assumption)
 Annual Hours of Operation: 4368 hours per year
 Fuel sulfur content: 0.05 % (Typical value)
 Fuel density: 7.08 lbs/gallon (Typical value)
 Heavy Duty Pickup Fuel Efficiency: 15 miles/gallon (Typical value)
 Heavy Haul Diesel Fuel Efficiency: 10 miles/gallon (Typical value)

Equations:

For NOx, CO and VOC:

$$\text{Emissions (tons/year)} = \frac{\text{Emission Factor (g/mile)} * \text{Vehicle Miles Traveled (miles/yr)}}{453.6 \text{ (g/lb)} * 2000 \text{ (lb/tons)}}$$

The NOx, CO and VOC emission factors for the above equation are from AP-42, while the SO2 emissions are calculated on a mass balance basis utilizing the following equation:

$$\text{SO}_2 \text{ E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6 \text{ (g/lb)} * \text{Fuel Sulfur Content} * 2 \text{ (S / SO}_2\text{)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Pumper Vehicles	Heavy Duty Pickups			Heavy Haul Trucks			Total	
	E. Factor ^a (g/mile)	Emissions (lb/hr)	Emissions (tons/yr)	E. Factor ^b (g/mile)	Emissions (lb/hr)	Emissions (tons/yr)	Emissions (lb/hr)	Emissions (tons/yr)
<i>Criteria Pollutants & VOC</i>								
NO _x	3.03	0.220	0.481	8.13	0.324	0.708	0.544	1.189
CO	33.64	2.445	5.340	17.09	0.681	1.488	3.126	6.828
VOC ^c	1.656	0.120	0.263	4.600	0.183	0.401	0.304	0.663
SO ₂	0.21	0.016	0.034	0.32	0.013	0.028	0.028	0.062
<i>Greenhouse Gases</i>								
CH ₄ ^d	0.184	0.013	0.029	0.230	0.009	0.020	0.023	0.049

0.96454736

- a AP-42 Append H Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 50,000 miles (6/95)
- b AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
- c Emission factor is for total Hydrocarbons - Methane Offset
- d AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

Buys & Associates, Inc.
Environmental Consultants

Project: Enduring Resources Southam Canyon EA

Date: 7/16/2008

15. Operations Traffic Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
 November 2006

365 days (Estimate)

Unpaved Roads

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$
 $E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$
 Silt Content (S) 8.4 Mean value Table 13.2.2-1 for haul roads
 W = average weight in tons of vehicles traveling the road
 Precipitation Days (P) 47 days per year **
 Avg. Round Trip Miles 10 miles on unpaved roads ***

Vehicle Type	Ave. Weight (lbs)	Round Trips per Day*
Pickup Truck: Crew	7,000	3
Haul Truck: Oil	48,000	2
Haul Truck: Water	48,000	3
Mean Weight	32,625	8

Paved Roads

$E (PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4)))$
 $E (PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4)))$
 Silt Loading (sL) 0.33 grains/square foot
 W = average weight in tons of vehicles traveling the road
 Round Trip Miles 68 From Vernal
 Precipitation Days (P) 45 days per year**

	PM ₁₀ (lb/VMT)	Total PM ₁₀ (lbs/yr)	PM ₁₀ (lb/day)	PM _{2.5} (lb/VMT)	Total PM _{2.5} (lbs/yr)	PM _{2.5} (lb/day)
Unpaved	2.03	355,349	974	0.20	35,535	97
Paved	0.06	6,603	18	0.01	960	3
Total		361,952	992		36,495	100

Annual Traffic Fugitive Dust Emissions (tons/year)	181.0			18.2
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*Maximum round trips per day on an access road.
 ** WRCC data for Bonanza, UT 1938-1993
 *** Estimated average round trip from Vernal

Buy's & Associates, Inc.
Environmental Consultants

Project: Enduring Resources Southam Canyon EA
 Date: 7/16/2008

16. Average Produced Gas Characteristics
 (Average of Uintah Basin from IPAMS)

Gas Heat Value (wet): 949.7 Btu/scf
 C1-C2 Wt. Fraction: 0.8654
 VOC Wt. Fraction: 0.0066
 Non-HC Wt. Fraction: 0.1280
 Total: 1.0000

COMPONENT	MOLE PERCENT	COMPONENT MOLE WEIGHT (lb/lb-mole)	NET MOLE WEIGHT (lb/lb-mole)	WEIGHT FRACTION	GROSS HEATING VALUE (BTU/scf)	NET DRY HEATING VALUE (BTU/scf)	LOWER HEATING VALUE (BTU/scf)	NET LOW HEATING VALUE (BTU/scf)
Methane	93.9570	16.043	15.074	0.856	1010.000	948.966	910.000	855.009
Ethane	0.5700	30.070	0.171	0.010	1769.800	10.088	1618.000	9.223
Propane	0.1820	44.097	0.071	0.004	2516.200	4.076	2316.000	3.752
i-Butane	0.0240	58.123	0.014	0.001	3252.100	0.781	3005.000	0.721
n-Butane	0.0220	58.123	0.013	0.001	3262.400	0.718	3013.000	0.663
i-Pentane	0.0070	72.150	0.005	0.000	4000.900	0.280	3698.000	0.259
n-Pentane	0.0040	72.150	0.003	0.000	4008.800	0.160	3708.000	0.148
Hexanes	0.0070	86.177	0.006	0.000	4756.200	0.334	4404.000	0.309
Heptanes	0.0008	100.204	0.001	0.000	5502.500	0.042	5100.000	0.039
Octanes+	0.0005	114.231	0.001	0.000	6249.100	0.033		0.000
Nonanes	0.0000	128.258	0.000	0.000	6996.400	0.000		0.000
Decanes	0.0000	142.285	0.000	0.000	7743.200	0.000		0.000
Benzene	0.0004	78.120	0.000	0.000	3715.500	0.014		0.000
Toluene	0.0003	92.130	0.000	0.000	4444.600	0.014		0.000
Ethylbenzene	0.0000	106.160	0.000	0.000	5191.500	0.001		0.000
Xylenes	0.0001	106.160	0.000	0.000	5183.500	0.004		0.000
n-Hexane	0.0016	86.177	0.001	0.000	4756.200	0.077		0.000
Helium	0.0000	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	0.3260	28.013	0.091	0.005	0.000	0.000	0.000	0.000
Carbon Dioxide	4.9170	44.010	2.164	0.123	0.000	0.000	0.000	0.000
Oxygen	0.0000	32.000	0.000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulfide	0.0000	34.080	0.000	0.000	637.100	0.000	588.000	0.000
TOTAL	100.00		17.62	1.00		965.59		870.12

Relative Mole Weight (lb/lb-mole) = [Mole Percent * Molecular weight (lb/lb-mole)] / 100

Weight Fraction = Net Mole Weight / Total Mole Weight

	AVG		
Nitrogen	0.326		
Methane	93.957		
Carbon Dioxide	4.917		
Ethane	0.57		
H2S	0		
Propane	0.162		
Isobutane	0.024		
n-Butane	0.022		
Isopentane	0.007		
n-Pentane	0.004		
Hexanes+	0.004		
Heptanes	0.004		
Octanes	0.003		
Nonanes	0		
	100	0	0

	Factor**	
c6+		0.011000
other hexanes	0.6385	0.007024
n-hexane	0.1479	0.001627
heptane	0.0687	0.0007557
224 trimethylper	0.0267	0.0002937
octanes+	0.048	0.000528
benzene	0.0331	0.0003641
toluene	0.0285	0.0003135
ethylbenzene	0.0014	0.0000154
xylenes (mpo)	0.0072	0.0000792
	1	

**from GRI published factors from Glycol Dehydration Handbook

GLYCALC	
Carbon Dioxide	4.917
Hydrogen Sulfic	0
Nitrogen	0.326
Methane	93.957
Ethane	0.57
Propane	0.162
Isobutane	0.024
n-Butane	0.022
Isopentane	0.007
n-Pentane	0.004
Cyclopentane	0
n-Hexane	0.001627
Cyclohexane	0
Other Hexanes	0.007024
Heptanes Plus	0.000756
Methylcyclohex	0
2,2,4 Trimethyl	0.0003
Benzene	0.0004
Toluene	0.0003
Ethylbenzene	0.0000
Xylenes	0.0001
C-8 + Heavies	0.0005
	100
Xylenes	0.0000
C-8 + Heavies	0.0000
	194.75702

17. Central Compression

Assumptions:

Engine Type: TBD
 Total Compression per Station 1,500 Horsepower (Proponent)
 Total New Compression: 1,500 Horsepower (Proponent)

Equations:

$$\text{Emissions (lbs/hr)} = \frac{\text{Emission Factor (g/hp-hr)} * \text{Power (hp)}}{453.6 \text{ g/lb}}$$

Pollutant	Emission Factor ^{1,2} (lb/MMBtu)	Emission Factor (g/hp-hr)	Emissions (lb/hr/station)	CS1 Emissions 1,500 hp (tons/yr)	Total Emissions ³ Proposed Action (tons/yr)
NO _x ⁴		1.5	4.96	21.7	22
CO ⁴		0.1	0.43	1.9	1.9
VOC ⁴		0.3	0.83	3.6	3.6
PM ₁₀ ⁵	9.9871E-03	0.036	0.12	0.53	0.5
PM _{2.5} ⁵	9.9871E-03	0.036	0.12	0.53	0.5
SO ₂ ⁶	5.88E-04	0.00E+00	0.00	0.00	0
Benzene ⁴	4.40E-04	0.00160	0.01	2.31E-02	2.3E-02
Toluene ⁴	4.08E-04	0.00148	4.90E-03	2.15E-02	2.1E-02
Ethylbenzene ⁴	3.97E-05	0.00014	4.77E-04	2.09E-03	2.1E-03
Xylenes ⁴	1.84E-04	0.00067	2.21E-03	9.68E-03	9.7E-03
n-Hexane ⁴	1.11E-03	0.00403	1.33E-02	5.84E-02	0.1
Formaldehyde ⁴	5.28E-02	0.02	6.61E-02	0.29	0.29
Acetaldehyde ⁴	8.36E-03	0.02	5.02E-02	0.22	0.22
Acrolein ⁴	5.14E-03	4.48E-03	1.48E-02	6.49E-02	0.1
Methanol ⁴	2.50E-03	4.54E-03	1.50E-02	6.58E-02	0.1
1,1,2,2-Tetrachloroethane ⁴	4.00E-05	7.26E-05	2.40E-04	1.05E-03	1.1E-03
1,1,2-Trichloroethane ⁴	3.18E-05	5.77E-05	1.91E-04	8.36E-04	8.4E-04
1,3-Dichloropropene ⁴	2.64E-05	4.79E-05	1.59E-04	6.94E-04	6.9E-04
1,3-Butadiene ⁴	2.67E-04	4.85E-04	1.60E-03	7.02E-03	7.0E-03
2,2,4-Trimethylpentane ⁴	2.50E-04	4.54E-04	1.50E-03	6.58E-03	6.6E-03
Biphenyl ⁴	2.12E-04	3.85E-04	1.27E-03	5.58E-03	5.6E-03
Carbon Tetrachloride ⁴	3.67E-05	6.66E-05	2.20E-04	9.65E-04	9.7E-04
Chlorobenzene ⁴	3.04E-05	5.52E-05	1.83E-04	8.00E-04	8.0E-04
Chloroform ⁴	2.85E-05	5.18E-05	1.71E-04	7.50E-04	7.5E-04
Ethylene Dibromide ⁴	4.43E-05	8.04E-05	2.66E-04	1.17E-03	1.2E-03
Methylene Chloride ⁴	2.00E-05	3.63E-05	1.20E-04	5.26E-04	5.3E-04
Naphthalene ⁴	7.44E-05	1.35E-04	4.47E-04	1.96E-03	2.0E-03
Phenol ⁴	2.40E-05	4.36E-05	1.44E-04	6.31E-04	6.3E-04
Styrene ⁴	2.36E-05	4.29E-05	1.42E-04	6.21E-04	6.2E-04
Tetrachloroethane ⁴	2.48E-06	4.50E-06	1.49E-05	6.52E-05	6.5E-05
Vinyl Chloride ⁴	1.49E-05	2.71E-05	8.95E-05	3.92E-04	3.9E-04
PAH -POM 1 ^{4,7,8}	2.69E-05	4.89E-05	1.62E-04	7.08E-04	7.1E-04
POM 2 ^{4,8,9}	5.93E-05	1.08E-04	3.56E-04	1.56E-03	1.6E-03
Benzo(b)fluoranthene/POM6 ^{4,8}	1.66E-07	3.01E-07	9.97E-07	4.37E-06	4.4E-06
Chrysene/POM7 ^{4,8}	6.93E-07	1.26E-06	4.16E-06	1.82E-05	1.8E-05
TOTAL HAPS	7.22E-02	5.43E-02	0.2	0.8	0.8
<i>Greenhouse Gases</i>					
CO ₂	110	400	1,321	5,787	5,787
CH ₄	1.25	4.54	15	66	66

¹ - AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/0

² - Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 8,000 Btu/hp-hr (*3.632)

³ - Assumes maximum development scenario

⁴ - Average BACT emission rates (95% reduction of CO, 76% reduction of formaldehyde and acrolein, 50% reduction all other VOCs/HAPS)

⁵ - PM = sum of PM filterable and PM condensable

⁶ - Gas analysis indicates no sulfur compounds, see Central Gas Composition page.

⁷ Polycyclic Aromatic Hydrocarbons (PAH) defined as a HAP by Section 112(b) of the Clean Air Act because it is Polycyclic Organic Matter (POM) AP42 Table 1.4-3 footnotes.

⁸ - POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-Scale Air Toxics Assessment at <http://www.epa.gov/ttn/atw/nata1999/nsata99.html>

⁹ - POM 2 includes: Acenaphthene, acenaphthylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

18. Wellsite Dehydrator Emissions

Assumptions

Average Production Rate: 0.3 MMscf/day/well (proponent estimate from Big Pack EA)
 Number of Active Wells Requiring Separators: 249 wells at Peak Production
 75 MMscfd Total Gas Production

Gas Composition: (Average of Uintah Basin from IPAMS)

Inlet Gas Conditions: Inlet gas saturated at 800 psi and 75F

Glycol Circulation Rate: 3 gallons/ lb of water
 (Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

50% Control Efficiency in order to meet Utah BACT

Emissions

Species	Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions (tons/year)
Total VOC	0.0022	9.6E-03	0.7
<i>Hazardous Air Pollutants</i>			
Benzene	0.0003	1.3E-03	0.1
Toluene	0.0004	1.8E-03	0.1
Ethylbenzene	0.0001	4.4E-04	3.3E-02
Xylenes	0.0003	1.3E-03	0.1
n-Hexane	0.0001	4.4E-04	0.0
<i>Greenhouse Gases</i>			
CH₄	0.0456	0.2	15

19. Central TEG Dehydrator Emissions
Southam Canyon Station, Section 36, T10S, R25E

Assumptions

Production Rate: 75 MMscf/day

Gas Composition: (Average of Uintah Basin from IPAMS)

Inlet Gas Conditions: Inlet gas saturated at 800 psi and 75F

Glycol Circulation Rate: 3 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
95% Control Efficiency in order to meet Federal MACT Standards

Emissions

Species	Central Dehydrator Emissions (lb/hr)	Total Project Emissions (tons/year)
VOC	0.0547	0.24
Benzene	0.0076	0.03
Toluene	0.0105	0.05
Ethylbenzene	0.0008	3.5E-03
Xylenes	0.0078	0.03
n-Hexane	0.0008	3.5E-03
Total HAPs	0.0278	0.12
Methane	1.1966	5.24

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Project: Enduring Resources Southam Canyon EA
 Date: 7/16/2008

20. Heater Emissions

Assumptions

Wellsite Heater Size	1,000 MBtu/hr	Assumption (500 Mbtu/hr dehy reboiler + 500 Mbtu/hr separator)
Proposed Central Facility Heaters	6,000 MBtu/hr	Assumption (3,000 Mbtu/hr dehy reboiler + 3,000 Mbtu/hr separator)
Firing Rate	30 minutes/hour on average for entire year (Typical value) 4,380 hours/year	
Fuel Gas Heat Value	950 Btu/scf (Gas Analyses from Existing Wells)	
Fuel Gas VOC Content	0.007 by weight (Gas Analyses from Existing Wells)	
Development size	249 new wells	

Equations

$$\text{Fuel Consumption (MMscf/yr)} = \frac{\text{Heater Size (MBtu/hr)} * 1,000 \text{ (Btu/MBtu)} * \text{Hours of Operation (hrs/yr)}}{\text{Fuel Heat Value (Btu/scf)} * 1,000,000 \text{ (scf/MMscf)}}$$

$$\text{NOx/CO/TOC Emissions (tons/yr)} = \frac{\text{AP-42 E.Factor (lbs/MMscf)} * \text{Fuel Consumption (MMscf/yr)} * \text{Fuel heating Value (Btu/scf)}}{2,000 \text{ (lbs/ton)} * 1,000 \text{ (Btu/scf - Standard Fuel Heating Value)}}$$

$$\text{VOC Emissions (tons/yr)} = \text{TOC Emissions (tons/yr)} * \text{VOC wt. fraction}$$

	Wellpad Heater Emissions			Central Facility Heaters			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions ¹ (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/site)	Total Emissions ¹ (tons/yr)	Well Emissions (lb/hr/pad)	Total Emissions ¹ (tons/yr)
NOx ^a	100	0.050	55	100	0.300	2.6	0.050	62
CO ^a	84	0.042	46	84	0.252	2.2	0.042	52
TOC ^c	11	0.006	6.0	11	0.033	0.3	0.006	6.9
VOC	N.A.	0.000	0.0	N.A.	0.000	1.9E-03	0.000	0.0
SOx ^b	0.00	0.000	0	0.00	0.00	0.0	0.000	0
TSP ^c	7.6	0.004	4.1	7.6	0.023	0.2	0.004	4.7
PM ₁₀ ^c	7.6	0.004	4.1	7.6	0.023	0.2	0.004	4.7
PM _{2.5} ^c	7.6	0.004	4.1	7.6	0.023	0.2	0.004	4.7
Benzene ^d	2.1E-03	1.050E-06	1.1E-03	2.1E-03	6.30E-06	5.52E-05	1.05E-06	1.3E-03
Toluene ^d	3.4E-03	1.700E-06	1.9E-03	3.4E-03	1.02E-05	8.94E-05	1.70E-06	2.1E-03
Hexane ^d	1.8	9.000E-04	1.0	1.8	5.40E-03	4.7E-02	9.00E-04	1.1
Formaldehyde ^d	0.075	3.750E-05	4.1E-02	0.075	2.25E-04	1.97E-03	3.75E-05	4.7E-02
Dichlorobenzene ^d	1.2E-03	6.000E-07	6.5E-04	1.2E-03	3.60E-06	3.15E-05	6.00E-07	7.5E-04
Naphthalene ^d	6.1E-04	3.050E-07	3.3E-04	6.1E-04	1.83E-06	1.60E-05	3.05E-07	3.8E-04
POM 2 ^{d,e,f}	5.9E-05	2.950E-08	3.2E-05	5.9E-05	1.77E-07	1.55E-06	2.95E-08	3.7E-05
POM 3 ^{d,g}	1.6E-05	8.000E-09	8.7E-06	1.6E-05	4.80E-08	4.20E-07	8.00E-09	1.0E-05
POM 4 ^{d,h}	1.8E-06	9.000E-10	9.8E-07	1.8E-06	5.40E-09	4.73E-08	9.00E-10	1.1E-06
POM 5 ^{d,i}	2.4E-06	1.200E-09	1.3E-06	2.4E-06	7.20E-09	6.31E-08	1.20E-09	1.5E-06
POM 6 ^{d,j}	7.2E-06	3.600E-09	3.9E-06	7.2E-06	2.16E-08	1.89E-07	3.60E-09	4.5E-06
POM 7 ^{d,k}	1.8E-06	9.000E-10	9.8E-07	1.8E-06	5.40E-09	4.73E-08	9.00E-10	1.1E-06
CO ₂ ^c	120,000	60	65,437	120,000	360	3,154	60	7.5E+04
Methane ^c	2.3	1.2E-03	1.3	2.3	6.9E-03	0.060	1.2E-03	1.4

a AP-42 Table 1.4-1, Emission Factors for Natural Gas Combustion, 7/98

b Assumes produced gas contains no sulfur

c AP-42 Table 1.4-2, Emission Factors for Natural Gas Combustion, 7/98 (All Particulates are PM1.0)

d AP-42 Table 1.4-3, Emission Factors for Organic Compounds from Natural Gas Combustion, 7/98

Scale Air Toxics Assessment at <http://www.epa.gov/ttn/atw/nata1999/nsata99.html>

pyrene.

^g - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

^h - POM 4 includes: 3-Methylchloranthrene.

ⁱ - POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

^j - POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene.

^k - POM 7 includes: Chrysene.

¹ Assumes maximum development scenario

21. Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate : 3.0 bbls condensate per day per well (assumption based on proponent avg for West Bonanza EA)
 Size of Development: 249 Producing Wells

Calculations:

Uinta Basin Flash Gas Data from IPAMS

Emissions:

Component	Well Flash/Work/Breathing (tons/yr/well)	Project Emissions ^a (tons/yr)
Total VOC	3.83	954
Benzene	1.6E-03	0.4
Toluene	1.4E-03	0.4
Ethylbenzene	1.1E-04	2.8E-02
Xylenes	4.7E-04	0.1
n-Hexane	1.6E-02	4.0
<i>Greenhouse Gases</i>		
CO₂	0.09	23.3
CH₄	2.64	658

a Assumes maximum development scenario

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Environmental Consultants

Project: Enduring Resources Southam Canyon EA
 Date: 7/16/2008

22. Central Facility Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate :
 Facility 1 125 bbls condensate per day (Estimate)

Calculations:

Uinta Basin Flash Gas Data from IPAMS

Emissions:

Component	Facility 1 Flash/Work/B reathing (lbs/hr)	Facility 1 Flash/Work/B reathing (tons/yr)	Total Emissions (tons/yr)
Total VOC	36.5	160	160
<i>Hazardous Air Pollutants</i>			
Benzene	0.015	0.06	6.5E-02
Toluene	0.013	0.06	5.9E-02
Ethylbenzene	0.001	4.71E-03	4.7E-03
Xylenes	0.004	0.02	2.0E-02
n-Hexane	0.152	0.67	0.7
<i>Greenhouse Gases</i>			
CO₂	0.89	3.91	3.9
CH₄	25.2	110	110

AVG

Nitrogen	0.3
Methane	85.1
Carbon Dic	1.1
Ethane	7.6
H2S	0
Propane	3.3
Isobutane	0.6
n-Butane	0.9
Isopentane	0.4
n-Pentane	0.3
Hexanes+	0.5
Heptanes	0
Octanes	0
Nonanes	0

100.1	0	0
Storage Factor**		
c6+	0.50	
other hexar	0.5319	0.26595
n-hexane	0.1913	0.09565
heptane	0.1002	0.0501
224 trimeth	0.0103	0.00515
octanes+	0.1241	0.062
benzene	0.0205	0.01025
toluene	0.0159	0.00795
ethylbenze	0.0011	0.00055
xylenes (m)	0.0046	0.0023
	0.9999	

**from GRI published factors Glycol Dehydratic Relative Mole Weight (lb [Mole Percent * Molecular weight (lb/lb-mole)] /

Weight Fraction = Net Mole Weight / Total Mole Weight

GLYCALC	1.1
Carbon Dic	0
Hydrogen	0
Nitrogen	0.3
Methane	85.1
Ethane	7.6
Propane	3.3
Isobutane	0.6
n-Butane	0.9
Isopentane	0.4
n-Pentane	0.3
Cyclopenti	0
n-Hexane	0.09565
Cyclohexa	0
Other Hex:	0.26595
Heptanes	0.0501
Methylcycl	0
2,2,4 Trim	0.0052
Benzene	0.0103
Toluene	0.0080
Ethylbenze	0.0006
Xylenes	0.0023
C-8 + Hea	0.0621
	100.1
Xylenes	0.0000
C-8 + Heav	0.0006
	198.80045

COMPONE	MOLE PERCENT	COMPONE MOLE WEIGHT (lb/lb-mole)	NET MOLE WEIGHT (lb/lb-mole)	WEIGHT FRACTION	tons/year
Methane	85.1000	16.043	13.653	0.690	110.168841
Ethane	7.6000	30.070	2.285	0.115	18.4412628
Propane	3.3000	44.097	1.455	0.074	11.7426636
i-Butane	0.6000	58.123	0.349	0.018	2.81412191
n-Butane	0.9000	58.123	0.523	0.026	4.22118287
i-Pentane	0.4000	72.150	0.289	0.015	2.32884166
n-Pentane	0.3000	72.150	0.216	0.011	1.74663125
Hexanes	0.2660	86.177	0.229	0.012	1.84941766
Heptanes	0.0501	100.204	0.050	0.003	0.4051039
Octanes+	0.0620	114.231	0.071	0.004	0.57150404
Nonanes	0.0000	128.258	0.000	0.000	0
Decanes	0.0000	142.285	0.000	0.000	0
Benzene	0.0103	78.120	0.008	0.000	0.06461446
Toluene	0.0080	92.130	0.007	0.000	0.05910331
Ethylbenz	0.0006	106.160	0.001	0.000	0.00471159
Xylenes	0.0023	106.160	0.002	0.000	0.019703
n-Hexane	0.0957	86.177	0.082	0.004	0.66515059
Helium	0.0000	4.003	0.000	0.000	0
Nitrogen	0.3000	28.013	0.084	0.004	0.67814804
Carbon Di	1.1000	44.010	0.484	0.024	3.90649875
Oxygen	0.0000	32.000	0.000	0.000	0
Hydrogen	0.0000	34.080	0.000	0.000	0
TOTAL	100.09		19.79	1.00	159.6875

23. Development Emissions Summary

Pollutant	Well Development Emissions (tons/year) ^a					Total (tons/yr)
	Construction	Drilling	Completion	Infrastructure development	Wind Erosion	
NO _x	1.1	174	27.9	1.0E-02		203
CO	0.4	42	36.5	2.8E-02		79
VOC	0.1	2.6	0.8	6.1E-03		3.4
SO ₂	3.2E-02	2.9	0.39	4.3E-04		3.4
PM ₁₀	3.7	66	45	2.2	0.4	118
PM _{2.5}	0.5	10	5.5	0.2	0.2	16
Benzene		1.4E-02	2.0E-03			1.6E-02
Toluene		5.2E-03	9.5E-04			6.1E-03
Ethylbenzene						0
Xylene		3.6E-03	4.5E-04			4.0E-03
n-Hexane			0.2			0.2
Formaldehyde	2.6E-02	1.5E-03	6.8E-03			3.4E-02

a Assumes maximum development scenario

24. Well Production Summary

Species	Production Heaters (tons/yr)	Storage Tanks (tons/yr)	Well Dehydrators (tons/yr)	Operations Vehicle (tons/yr)	Total Well Production ^a (tons/yr)
<i>Criteria Pollutants & VOC</i>					
NO _x	54.5			1.19	55.7
CO	45.8			6.8	52.6
VOC	0.04	954	0.7	0.66	955
SO ₂	0.00			0.06	0.1
PM ₁₀	4.1			181	185
PM _{2.5}	4.1			18.2	22
<i>Hazardous Air Pollutants</i>					
Benzene	1.1E-03	0.4	0.1		0.5
Toluene	1.9E-03	0.4	0.1		0.5
Ethylbenzene		0.0	3.3E-02		0.1
Xylene		0.1	0.1		0.2
n-Hexane	9.8E-01	4.0	3.3E-02		5.0
Formaldehyde	4.1E-02				4.1E-02
Dichlorobenzene	6.5E-04				6.54E-04
Naphthalene	3.3E-04				3.3E-04
POM 2 ^{d,c,f}	3.2E-05				3.2E-05
POM 3 ^{d,g}	8.7E-06				8.7E-06
POM 4 ^{d,h}	9.8E-07				9.8E-07
POM 5 ^{d,i}	1.3E-06				1.3E-06
Benzo(b)fluoranthene/POM6 ^e	3.9E-06				3.9E-06
Chrysene/POM7 ^h	9.8E-07				9.8E-07
Total HAPs	1.03	4.9	0.4	0.0	6.3
<i>Greenhouse Gases</i>					
CO ₂	65437				65,437
CH ₄	1.25		14.9		16

^a Emissions for Peak Field Development

25. Central Facility Emission Summary

Central Facility 1

Pollutant	Central Compression Emissions 1,500 hp (tons/year)	Central Dehydrator Emissions 75MMscfd (tons/year)	Central Heater Emissions 3,000 Mbtu/hr (tons/year)	Central Condensate Tank Emissions 125 bbls/day (tons/year)	Total Facility Emissions (tons/year)
<i>Criteria Pollutants & VOC</i>					
NO _x	22		2.63		24
CO	1.9		2.21		4.1
VOC	3.6	0.24	1.90E-03	37	40
SO ₂	0.00		0		0.00
PM ₁₀	0.53		2.00E-01		0.73
PM _{2.5}	0.53		2.00E-01		0.73
<i>Hazardous Air Pollutants</i>					
Benzene	0.02	0.03	5.52E-05	0.01	0.07
Toluene	0.02	0.05	8.94E-05	0.01	0.08
Ethylbenzene	0.00	0.00		0.00	0.01
Xylene	0.01	0.03		0.00	0.05
n-Hexane	0.06	0.00	4.73E-02	0.2	0.26
Formaldehyde	0.29		1.97E-03		0.29
Total HAPs	0.40	0.12	4.94E-02	0.2	0.76
<i>Greenhouse Gases</i>					
CO ₂	0		3154	0.9	3,155
CH ₄	0	5.24	0.06	25	30.5

26. Total Project Production Related Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) ^a					Total (tons/year)
	Production Heaters	Condensate Tanks	TEG Dehydrators	Operations Vehicle	Compressor Engines	
NO _x	62	0.0	0.0	1.2	22	85
CO	52	0.0	0.0	6.8	1.9	61
VOC	4.5E-02	1,114	1.0	0.7	3.6	1,119
SO ₂	0.0E+00	0.0	0.0	0.1	0.0	0.1
PM ₁₀	4.7	0.0	0.0	181	0.5	186
PM _{2.5}	4.7	0.0	0.0	18	0.5	24
<i>HAPs</i>						
Benzene	1.3E-03	0.4	0.1	0.0	2.3E-02	0.5
Toluene	2.1E-03	0.4	0.2	0.0	2.1E-02	0.6
Ethylbenzene	0.0E+00	0.1	3.6E-02	0.0	2.1E-03	0.1
Xylene	0.0E+00	0.1	0.1	0.0	9.7E-03	0.3
n-Hexane	1.12	4.0	3.6E-02	0.0	0.1	5.2
Formaldehyde	0.05	0.0E+00	0.0E+00	0.0	0.3	0.3
Acetaldehyde	0.0	0.0	0.0	0.0	0.2	0.2
Acrolein	0.0	0.0	0.0	0.0	0.1	0.1
Methanol	0.0	0.0	0.0	0.0	0.1	0.1
1,1,2,2-Tetrachloroethane	0.0	0.0	0.0	0.0	1.1E-03	1.E-03
1,1,2-Trichloroethane	0.0	0.0	0.0	0.0	8.4E-04	8.E-04
1,3-Dichloropropene	0.0	0.0	0.0	0.0	6.9E-04	7.E-04
1,3-Butadiene	0.0	0.0	0.0	0.0	7.0E-03	7.E-03
2,2,4-Trimethylpentane	0.0	0.0	0.0	0.0	6.6E-03	7.E-03
Biphenyl	0.0	0.0	0.0	0.0	5.6E-03	6.E-03
Carbon Tetrachloride	0.0	0.0	0.0	0.0	9.7E-04	1.E-03
Chlorobenzene	0.0	0.0	0.0	0.0	8.0E-04	8.E-04
Chloroform	0.0	0.0	0.0	0.0	7.5E-04	7.E-04
Dichlorobenzene	7.5E-04	0.0	0.0	0.0	0	7.E-04
Ethylene Dibromide	0.0	0.0	0.0	0.0	1.2E-03	1.E-03
Methylene Chloride	0.0	0.0	0.0	0.0	5.3E-04	5.E-04
Naphthalene	3.8E-04	0.0	0.0	0.0	2.0E-03	2.E-03
Phenol	0.0	0.0	0.0	0.0	6.3E-04	6.E-04
Styrene	0.0	0.0	0.0	0.0	6.2E-04	6.E-04
Tetrachloroethane	0.0	0.0	0.0	0.0	6.5E-05	7.E-05
Vinyl Chloride	0.0	0.0	0.0	0.0	3.9E-04	4.E-04
PAH -POM 1 ⁶	0.0	0.0	0.0	0.0	7.1E-04	7.E-04
POM 2 ^{d,e,f}	3.7E-05	0.0	0.0	0.0	1.6E-03	2.E-03
POM 3 ^{d,g}	1.0E-05	0.0	0.0	0.0	0	1.E-05
POM 4 ^{d,h}	1.1E-06	0.0	0.0	0.0	0	1.E-06
POM 5 ^{d,i}	1.5E-06	0.0	0.0	0.0	0	1.E-06
Benzo(b)fluoranthene/POM 6 ⁶	4.5E-06	0.0	0.0	0.0	4.4E-06	9.E-06
Chrysene/POM 7 ^h	1.1E-06	0.0	0.0	0.0	1.8E-05	2.E-05
Total HAPs	1.2	5.0	0.5	0.0	0.79	7
<i>Greenhouse Gases</i>						
CO ₂	74,898	4			5,787	80,689
CH ₄	1.4	110	20	4.9E-02	66	198

27. Total Project Emissions Summary

Pollutant	Project Emissions (tons/year)			Total Emissions (tons/year)
	Well Development	Project Production	Compressor Engines	
<i>Criteria Pollutants and VOC</i>				
NO _x	203	64	22	288
CO	79	59	1.9	140
VOC	3.4	1,115	3.6	1,122
SO ₂	3.36	0.1	0.0	3.4
PM ₁₀	118	186	0.5	304
PM _{2.5}	16	23.0	0.5	40
<i>Hazardous Air Pollutants</i>				
Benzene	2.E-02	0.5	0.0	0.6
Toluene	6.E-03	0.6	0.0	0.6
Ethylbenzene	0.0	0.1	2.E-03	0.1
Xylene	4.E-03	0.3	0.0	0.3
n-Hexane	0.2	5	0.1	5.4
Formaldehyde	0.03	0.05	0.3	0.4
Acetaldehyde	6.6E-04	0.0	0.2	0.2
Acrolein	2.1E-04	0.0	0.1	0.1
1,1,2,2-Tetrachloroethane	0.0	0.0	1.1E-03	1.1E-03
1,1,2-Trichloroethane	0.0	0.0	8.4E-04	8.4E-04
1,3-Dichloropropene	0.0	0.0	6.9E-04	6.9E-04
1,3-Butadiene	1.3E-06	0.0	0.01	7.0E-03
Carbon Tetrachloride	0.0	0.0	9.7E-04	9.7E-04
Dichlorobenzene	0.0	7.5E-04	0.0	7.5E-04
Ethylene Dibromide	0.0	0.0	1.2E-03	1.2E-03
Methylene Chloride	0.0	0.0	5.3E-04	5.3E-04
Naphthalene	2.4E-03	3.8E-04	2.0E-03	4.7E-03
Tetrachloroethane	0.0	0.0	6.5E-05	6.5E-05
Vinyl Chloride	0.0	0.0	3.9E-04	3.9E-04
POM 2	0.0	3.7E-05	1.6E-03	1.6E-03
POM 3^d	0.0	1.0E-05	0.0	1.0E-05
POM 4	0.0	1.1E-06	0.0	1.1E-06
POM 5^f	0.0	1.5E-06	0.0	1.5E-06
Benzo(b)fluoranthene/POM6^g	0.0	4.5E-06	4.4E-06	8.9E-06
Chrysene/POM7^h	0.0	1.1E-06	1.8E-05	1.9E-05
Total HAPs	0.2	6.7	0.7	7.6
<i>Greenhouse Gases</i>				
CO ₂	18,888	74,902	5,787	99,576
CH ₄	2,119	132	66	2,316

28. Stack Parameters

Equipment	Height (meters)	Temp (K)	Exit	Diameter (meters)
			Velocity (m/s)	
Compressor	6.1	730	50	0.3048
Drill Rig	8	800	50	0.1
Frac Eng	4	811	50	0.1016
Boiler	4.6	700	2.84	0.2286
TANK	6.7056	282	0.001	0.0508
TEG Dehydrator	3.65	366	0.001	0.05
Flare	6.096	811	20	0.05