APPENDIX K. GREENHOUSE GAS EMISSIONS INVENTORY

Buys & Associates, Inc. Environmental Consultants	Project: GASCO Proposed Action Inventory - w/ Voluntary ACEPMS Date: 6/9/2011

1. Well Pad/Access Road/Pipeline Construction Fugitive Dust Emissions

Assumptions:

Pieces of Equipment	Hours of Construction	
- 1 Backhoe	20	hours per well pad
- 1 Dozer/Crawler Tractor	100	hours per well pad

Watering Control Efficiency 50 percent (Chapter 2)

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

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 = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM15/hour/piece of equipment

	Fugitive Dust Emissions [a]		
	lbs/hr/ machine	tons/well	tons/yr [b]
TSP	1.97	0.1182	14.19
PM15	0.50	0.0301	3.61
PM10	0.38	0.0226	2.71
PM2.5	0.21	0.0124	1.49

a Backhoe emissions are conservatively estimated as equivalent to Bulldozing emissions.

b Assumes construction rate specified by Proponent

2. Well Pad/Road/Pipeline Construction Emissions (Grader)

Assumptions:

Grading Length	2.94	0.26 miles/road x 3 plus 0.34 miles pipeline plus 1.74 miles on 225' x400' pad (10 ft swath for 400 ft * 23 lengths) = 9,200 ft = 1.74 miles
Hours of Construction	5	day grading per well pad and road (Estimate)
	10	hours/day
	50	hours per well pad
Watering Control Efficiency	50	percent (Chapter 2)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 10/98)
Distance Graded	2.94	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 Grading Emissions, Western Surface Coal Mining, 10/98

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 = 7.91 lbs TSP/well

Emissions = 3.78 lbs PM15/well

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well**	**tons/well**	**tons/yr [a]**
TSP	7.91	0.16	0.0040	0.47
PM15	3.78	0.08	0.0019	0.23
PM10	2.27	0.05	0.0011	0.14
PM2.5	0.25	0.005	0.0001	0.01

a Assumes maximum development scenario

3. Interim Reclamation Fugitive Dust Emissions

Assumptions:

Hours of Reclamation	2	days per well pad (Estimate)
	12	hours/day
	24	hours per well pad
Pieces of Equipment	1	- Dozer
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

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 = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM15/hour/piece of equipment

	Fugitive Dust Emissions		
	lbs/hr	tons/well	tons/yr [a]
TSP	1.97	0.0236	2.84
PM15	0.50	0.0060	0.72
PM10	0.38	0.0045	0.54
PM2.5	0.21	0.0025	0.30

a Assumes maximum construction rate specified by Proponent

Note: The majority of new pipeline will be installed adjacent to proposed access roads and will not result in significant additional surface disturbance.

Buys & Associates, Inc.

Environmental Consultants

Project: GASCO Proposed Action Inventory - w/ Voluntary ACEPMS
6/9/2011

4. Unpaved Road Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006

E (PM10) / VMT = 1.5 * (S/12)^0.9 * (W/3)^0.45 * (365-p)/365)
E (PM2.5) / 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 58
Precipitation Days (P) 73 days per year (NCDC data, Nutters Ranch, UT 1963-1986)

		Average	Round					
	Vehicle Type	Weight	Trips per	PM10	PM10/Pad	PM10/Pad	PM2.5/Pad	PM2.5/Pad
		(lbs)	Well a	(lb/VMT)	(lbs)	(lb/day)	(lbs)	(lb/day)
Construction (days/pad and road)	10							
	Haul Trucks	80,000	5					
	Water Trucks	60,000	1					
	Light Trucks	8,000	10					
	Mean Vehicle Weight	33,750	16	1.8937586	1757.4	175.7	175.7	17.6
					PM10/Annual Pads		PM2.5/Annual Pads	
					(tons)		(tons)	
					105.4		10.5	
		Average	Round					
	Vehicle Type	Weight	Trips per	PM10	PM10/Well	PM10/Well	PM2.5/Well	PM2.5/Well
		(lbs)	Well a	(lb/VMT)	(lbs)	(lb/day)	(lbs)	(lb/day)
Drilling, Downhole (days/well)	35							
	Haul Trucks	80,000	70					
	Logging/Mud Trucks	70,000	10					
	Water Trucks b	60,000	75					
	Light Trucks	8,000	80					
	Mean Vehicle Weight	48,681	235	2.2331227	30437.5	869.6	3043.7	87.0
					PM10/Annual Wells		PM2.5/Annual Wells	
					(tons)		(tons)	
					1826.2		182.6	
		Average	Round					
	Vehicle Type	Weight	Trips per	PM10	PM10/Well	PM10/Well	PM2.5/Well	PM2.5/Well
		(lbs)	Well a	(lb/VMT)	(lbs)	(lb/day)	(lbs)	(lb/day)
Completion (days/well)	14							
	Semi/Transport/Water/Sand	80,000	46					
	Water Trucks b	60,000	157					
	Light Trucks	8,000	56					
	Mean Vehicle Weight	52,309	259	2.3065367	34648.8	2474.9	3464.9	247.5
					PM10/Annual Wells		PM2.5/Annual Wells	
					(tons)		(tons)	
					2078.9		207.9	
		Average	Round					
	Vehicle Type	Weight	Trips per	PM10	PM10/Day	PM10/Day	PM2.5/Day	PM2.5/Day
		(lbs)	Well a	(lb/VMT)	(lbs)	(lb/day)	(lbs)	(lb/day)
Interim Reclamation (days/well)	2							
	Haul Trucks	80,000	1					
	Light Trucks	8,000	5					
	Mean Vehicle Weight	20,000	6	1.4964593	520.8	260.4	52.1	26.0
					PM10/Annual Wells		PM2.5/Annual Wells	
					(tons)		(tons)	
					31.2		3.1	
Annual Traffic Fugitive Dust Emissions (tons/year)					4042		404	

[a] Traffic Estimates are based upon an approximately 14-days construction, 13-days drilling at downhole locations (shallow wells), 26-days drilling at direction wells (shallow wells), 29-days completion, and 6-days infrastructure development per well or well pad as appropriate.

[b] 25,000 barrels/well for completion; 12,000 barrels/well for drilling; assume 160-barrel water truck

Buys & Associates, Inc. Environmental Consultants	GASCO Proposed Action Inventory - w/ Voluntary Project: ACEPMS Date: 6/9/2011

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	2072.0 acres total initial disturbance for roads/pipelines (Proposed Action) 8,385,073 square meters total initial disturbance for roads/pipelines 5,998 acres total initial disturbance for well pads and other facilities (Proposed Action) 24,273,006 square meters total initial disturbance for well pads and other facilities 8,070 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 and facilities (Assumption, disturbance at construction and reclamation) Constant for dirt roads
Development Period	13 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[n] m/s	Well Pad Erosion Potential g/m^2	Road U_t* Threshold Velocity[n] 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	5.26	0.00
PM10	2.63	0.00
PM2.5	1.05	0.00

6. Construction Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Construction	100	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	6	(Proposed Action)
Number of Pickup Trips	10	(Proposed Action)
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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ \text{(S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.130	0.095	0.005	3.030	0.059	0.003	0.153	0.921
CO	17.090	0.199	0.010	33.640	0.653	0.033	0.852	5.109
VOC [c]	4.600	0.054	0.003	4.646	0.090	0.005	0.144	0.862
SO_2	0.321	0.004	0.000	0.214	0.004	0.000	0.008	0.047
Greenhouse Gases								
CH_4 [e]	0.230	0.003	0.000	0.184	0.004	0.000	0.006	0.037

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

7. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Operation	840	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	155	(Proposed Action)
Number of Pickup Trips	80	(Proposed Action)
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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ \text{(S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.13	0.291	0.122	3.03	0.056	0.024	0.347	17.490
CO	17.09	0.612	0.257	33.64	0.622	0.261	1.233	62.160
VOC [c]	4.600	0.165	0.069	1.656	0.031	0.013	0.195	9.842
SO_2	0.32	0.011	0.005	0.21	0.004	0.002	0.015	0.779
Greenhouse Gases								
CH_4 [c]	0.230	0.008	0.003	0.184	0.003	0.001	0.012	0.586

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

[b] AP-42 Append. H 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 - Methane Offset

[d] Assumes construction rate specified by Proponent

[e] AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

8. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Operation	140.00	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	203	(Proponent)
Number of Pickup Trips	56	(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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\text{ (g/lb)} * \text{Fuel Sulfur Content} * 2\text{ (S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.13	2.287	0.160	3.03	0.235	0.016	2.522	21.186
CO	17.09	4.808	0.337	33.64	2.611	0.183	7.418	62.311
VOC [c]	4.600	1.294	0.091	1.656	0.129	0.009	1.423	11.949
SO_2	0.32	0.090	0.006	0.21	0.017	0.001	0.107	0.898
Greenhouse Gases								
CH_4 [e]	0.230	0.065	0.005	0.184	0.014	0.001	0.079	0.663

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

9. Interim Reclamation Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Operation	60	hours per site (Assumption)
Number of Heavy Diesel Truck Trips	1	(Assumption)
Number of Pickup Trips	5	(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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\text{ (g/lb)} * \text{Fuel Sulfur Content} * 2\text{ (S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.13	0.026	0.001	3.03	0.049	0.001	0.075	0.271
CO	17.09	0.055	0.002	33.64	0.544	0.016	0.599	2.157
VOC [c]	4.600	0.015	0.000	1.656	0.027	0.001	0.042	0.150
SO_2	0.32	0.001	0.000	0.21	0.003	0.000	0.004	0.016
Greenhouse Gases								
CH_4 [e]	0.230	0.001	0.000	0.184	0.003	0.000	0.004	0.013

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Hours of Operation	100 hours/site (Proposed Action)
Development Rate	120 new pads per year (Proposed Action)
Load Factor	0.4 (Assumed typical value)
Backhoe Size	85 hp (Proponent Contractor Typical value)
Dozer/Crawler Tractor	290 hp (Proponent Contractor Typical value)
Motor Grader Size	185 hp (Proponent Contractor Typical value)

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/Crawler Tractor			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)
NO_x	8.15	0.611	3.665	8.15	2.084	12.505	7.14	1.165	6.989
CO	2.28	0.171	1.025	2.28	0.583	3.498	1.54	0.251	1.507
VOC[c]	0.37	0.028	0.166	0.37	0.095	0.568	0.36	0.059	0.352
PM_{10}[d]	0.5	0.037	0.225	0.5	0.128	0.767	0.63	0.103	0.617
$PM_{2.5}$[d]	0.5	0.037	0.225	0.5	0.128	0.767	0.63	0.103	0.617
SO_2	0.22	0.016	0.099	0.22	0.056	0.338	0.22	0.036	0.215
Formaldehyde	0.22	0.016	0.099	0.22	0.056	0.338	0.12	0.020	0.117

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions[e] (tons/yr)
NO_x	3.860	23.160
CO	1.005	6.031
VOC[c]	0.181	1.087
PM_{10}[d]	0.268	1.609
$PM_{2.5}$[d]	0.268	1.609
SO_2	0.109	0.652
Formaldehyde	0.092	0.554

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 construction rate specified by Proponent

11. Drill Rig Engine Emissions

Assumptions:

Hours of Operation	840	hours/ well (Proposed Action)
Development Rate	120	total wells in max year (Proposed Action)
	7%	average time small rig will run per well (Section 2.2.2.3)
Load Factor	0.4	(Assumed typical value)
Rig Size	1000	hp (Estimate - phase 1 drilling)
	2500	hp (Estimate - phase 2 drilling)
	2393	hp (weighted average based on ratio of time in use to drill one well)
Diesel Fuel Sulfur Content	0.05	% (typical value)

Equations:

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

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Drill Rig Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [h] (tons/yr)
Criteria Pollutants & VOC			
NOx [a, II]	0.01058	10.127	510
CO [II]	5.73E-03	5.484	276
VOC [a,b]	7.05E-04	0.675	34.0
PM_{10} [II,c]	3.31E-04	0.317	16.0
$PM_{2.5}$ [a,d]	3.59E-04	0.344	17.3
SO_2 [a]	4.05E-04	0.387	19.5
Hazardous Air Pollutants			
Benzene [e]	1.97E-06	0.002	0.10
Toluene [e]	7.15E-07	0.001	0.03
Xylenes [e]	4.91E-07	4.70E-04	0.02
Formaldehyde [e]	2.01E-07	1.92E-04	0.01
Acetaldehyde [e]	6.41E-08	6.14E-05	3.09E-03
Acrolein [e]	2.01E-08	1.92E-05	9.67E-04
Naphthalene [f]	3.31E-07	3.17E-04	0.02
Total PAH [f,g]	5.40E-07	5.16E-04	0.03
Greenhouse Gases			
CO_2 [a]	1.16	1110	55,958
CH_4 [a,b]	7.05E-04	0.675	34.0

[II] Tier II Emission Factors, hp>750

[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	6	Hours/Well (Proponents)
Development Rate	120	wells per year (Proposed Action)
Load Factor	0.5	(typical value)
Frac Pump Engine Horsepower	19,000	Horsepower (typical)
Temporary Generator Horsepower	75	Horsepower (typical)
Diesel Fuel Sulfur Content	0.05	% (typical value)

Equations:

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

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Frac Pump Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.024	228.000	82.080
CO [a]	5.50E-03	52.250	18.810
VOC [a,b]	7.05E-04	6.698	2.411
PM_{10} [a,c]	5.73E-04	5.444	1.960
$PM_{2.5}$ [a,d]	4.79E-04	4.551	1.638
SO_2 [a]	4.05E-04	3.843	1.383
Hazardous Air Pollutants			
Benzene [e]	1.97E-06	1.88E-02	0.007
Toluene [e]	7.15E-07	6.79E-03	0.002
Xylenes [e]	4.91E-07	4.67E-03	1.68E-03
Formaldehyde [e]	2.01E-07	1.91E-03	6.87E-04
Acetaldehyde [e]	6.41E-08	6.09E-04	2.19E-04
Acrolein [e]	2.01E-08	1.91E-04	6.86E-05
Naphthalene [f]	3.31E-07	3.14E-03	1.13E-03
Total PAH [f]	5.40E-07	5.13E-03	1.85E-03
Greenhouse Gases			
CO_2 [a]	1.16	11,020	3,967.2
CH_4 [a]	7.05E-04	6.698	2.411

Species	Generator Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants			
NOx [g]	0.031	1.163	0.42
CO [g]	6.68E-03	0.25	0.09
VOC [b,g]	2.47E-03	0.09	0.03
PM_{10} [g]	2.20E-03	0.08	0.03
$PM_{2.5}$ [g]	2.20E-03	0.08	0.03
SO_2 [g]	2.05E-03	0.08	0.03
Hazardous Air Pollutants			
Benzene [h]	2.37E-06	8.90E-05	3.21E-05
Toluene [h]	1.04E-06	3.90E-05	1.41E-05
Xylenes [h]	7.25E-07	2.72E-05	9.79E-06
Formaldehyde [h]	3.00E-06	1.13E-04	4.05E-05
Acetaldehyde [h]	1.95E-06	7.32E-05	2.64E-05
Acrolein [h]	2.35E-07	8.83E-06	3.18E-06
1,3-Butadiene [h]	9.95E-08	3.73E-06	1.34E-06
Naphthalene [h]	2.16E-07	8.09E-06	2.91E-06
Total PAH [h]	4.28E-07	1.60E-05	5.77E-06
Greenhouse Gases			
CO_2 [g]	1.15	10,925	3,933
CH_4 [b,g]	2.47E-03	23.465	8.45

[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 conversion factor from Appendix A

[i] Assumes maximum development scenario

14. Well Development Venting

Assumptions: Following Completion, Wells are Vented prior to connnection to the gathering pipeline

Venting Period 48 hours (Project Proponents)

Amount of Vented Gas: 0.2 MMscf (Average Volume Estimated by Proponents)

Development Rate: 120 Wells per year (Project Proponents)

COMPONENT	MOLECULAR WEIGHT (lb/lb-mole)	MOLE PERCENT	RELATIVE MOLE WEIGHT (lb/lb-mole)	WEIGHT Fraction	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (lb/hr)	COMPONENT FLOW RATE (tons/yr)
Methane	16.043	92.713	14.874	0.833	185.426	163.311	470.335
Ethane	30.07	4.078	1.226	0.069	8.156	13.464	38.777
Propane	44.097	1.145	0.505	0.028	2.289	5.542	15.960
i-Butane	58.123	0.248	0.144	0.008	0.496	1.582	4.556
n-Butane	58.123	0.265	0.154	0.009	0.530	1.691	4.869
i-Pentane	72.15	0.118	0.085	0.005	0.236	0.935	2.692
n-Pentane	72.15	0.087	0.063	0.004	0.174	0.689	1.985
Hexanes	86.177	0.000	0.000	0.000	0.000	0.000	0.000
Heptanes	100.204	0.216	0.216	0.012	0.431	2.372	6.831
Octanes	114.231	0.035	0.040	0.002	0.069	0.435	1.253
Nonanes	128.258	0.031	0.039	0.002	0.061	0.430	1.237
Decanes +	142.285	0.007	0.010	0.001	0.014	0.106	0.306
Benzene	78.12	0.021	0.016	0.001	0.042	0.181	0.521
Toluene	92.13	0.035	0.032	0.002	0.070	0.356	1.025
Ethylbenzene	106.16	0.001	0.001	0.000	0.002	0.014	0.040
Xylenes	106.16	0.016	0.017	0.001	0.031	0.183	0.527
n-Hexane	86.177	0.044	0.038	0.002	0.089	0.420	1.210
Helium	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.125	0.035	0.002	0.249	0.384	1.105
Carbon Dioxide	44.01	0.817	0.359	0.020	1.633	3.945	11.363
Oxygen	32	0.000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulfide	34.08	0.000	0.000	0.000	0.000	0.000	0.000
VOC SUBTOTAL		**2.2676**	**1.360**	**0.076**	**4.535**	**14.935**	**43.014**
HAP SUBTOTAL		**0.1176**	**0.105**	**0.006**	**0.235**	**1.154**	**3.324**
TOTAL		**100.000**	**17.855**	**1.000**	**200**	**196.039**	**564.593**

14. Well Development Emissions Summary

Species	Well Development Emissions (tons/year) [a]				Wind Erosion	Total [a] (tons/yr)
	Construction	Drilling	Completion	Interim Reclamation		
Criteria Pollutants & VOC						
NO_x	24.1	528	103.7	0.27		656
CO	11.14	339	81	2.16		433
VOC	1.95	43.9	57.4	0.15		103.4
SO_2	0.70	20.3	2.3	0.02		23.3
PM_{10}	109.9	1,842	2,081	31.8	2.6	4,067
$PM_{2.5}$	13.7	200	210	3.42	1.1	428
Hazardous Air Pollutants						
Benzene		0.10	0.53			0.62
Toluene		0.03	1.03			1.06
Ethylbenzene			0.04			0.04
Xylenes		0.02	5.29E-01			0.55
n-Hexane			1.210			1.21
Formaldehyde	0.55	0.01	0.001			0.56
Acetaldehyde		3.09E-03	2.46E-04			3.3.E-03
Acrolein		9.67E-04	7.18E-05			1.0.E-03
1,3-Butadiene			1.34E-06			1.3.E-06
Naphthalene		0.02	1.13E-03			0.02
Total PAH, POM 1 [b]		0.03	1.85E-03			0.03
Total HAPs	0.55	0.21	3.34	0.0	0.0	4.1
Greenhouse Gases						
CO_2		55,958	7,912			63,870
CH_4	0.04	34.6	481.9	0.01		516.5

a Emissions for Peak Field Development
b Polycyclic Aromatic Hydrocarbons (PAH), Polycyclic Organic Matter (POM)

Buys & Associates, Inc. Environmental Consultants	GASCO Proposed Action Inventory - w/ Voluntary Project: ACEPMS Date: 6/9/2011

15. Average Produced Gas Characteristics
Inlet Wet Gas Sample from Riverbend Compressor Station, dated 3/22/07

Gas Heat Value (wet): 1064.3 Btu/scf

C1-C2 Wt. Fraction:	0.9020
VOC Wt. Fraction:	0.0760
Non-HC Wt. Fraction:	0.0221
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	92.7130	16.043	14.874	0.833	1010.0	936.401	910.0	843.688
Ethane	4.0781	30.070	1.226	0.069	1769.8	72.174	1618.0	65.984
Propane	1.1446	44.097	0.505	0.028	2516.2	28.800	2316.0	26.509
i-Butane	0.2479	58.123	0.144	0.008	3252.1	8.062	3005.0	7.449
n-Butane	0.2649	58.123	0.154	0.009	3262.4	8.642	3013.0	7.981
i-Pentane	0.1180	72.150	0.085	0.005	4000.9	4.721	3698.0	4.364
n-Pentane	0.0870	72.150	0.063	0.004	4008.8	3.488	3708.0	3.226
Hexanes	0.0687	86.177	0.059	0.003	4756.2	3.268	4404.0	3.026
Heptanes	0.0737	100.204	0.074	0.004	5502.5	4.055	5100.0	3.759
Methylcyclohexane	0.0509	98.186	0.050	0.003	1865.5	0.950	1729.0	0.880
Octanes	0.0550	114.231	0.063	0.004	6249.1	3.437	1696.0	0.933
2,2,4-TMP	0.0047	114.220	0.005	0.000	6368.6	0.299	1728.4	0.081
Nonanes	0.0305	128.258	0.039	0.002	6996.4	2.134		0.000
Decanes	0.0068	142.285	0.010	0.001	7743.2	0.527		0.000
Benzene	0.0211	78.120	0.016	0.001	3715.5	0.784		0.000
Toluene	0.0352	92.130	0.032	0.002	4444.6	1.564		0.000
Ethylbenzene	0.0012	106.160	0.001	0.000	5191.5	0.062		0.000
Xylenes	0.0157	106.160	0.017	0.001	5183.5	0.814		0.000
n-Hexane	0.0444	86.177	0.038	0.002	4756.2	2.112		0.000
Helium	0.0000	4.003	0.000	0.000	0.0	0.000	0.0	0.000
Nitrogen	0.1247	28.013	0.035	0.002	0.0	0.000	0.0	0.000
Carbon Dioxide	0.8165	44.010	0.359	0.020	0.0	0.000	0.0	0.000
Oxygen	0.0000	32.000	0.000	0.000	0.0	0.000	0.0	0.000
Hydrogen Sulfide	0.0000	34.080	0.000	0.000	637.1	0.000	588.0	0.000
VOC Subtotal	**2.270**		**1.3558**	**0.0760**		**36.8563**		
HAP Subtotal	**0.1176**		**0.1051**	**0.0059**		**5.3363**		
TOTAL	**100.00**		**17.85**	**1.00**		**1082.29**		**967.88**

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

Weight Fraction = Net Mole Weight / Total Mole Weight

HAP Fractions estimated from GRI Published Factors

16. Wellsite Separator Heater Emissions

Assumptions

Separator Heater Size	500	Mbtu/hr (Typical size Proposed Action)
Wells Requiring Separators:	1422	wells at Peak Production
Firing Rate	8,760	hours/year (Typical Uinta Basin operation)
Fuel Gas Heat Value	968	Btu/scf (Gas Analyses from Riverbend well)
Fuel Gas VOC Content	0.076	by weight (Gas Analyses from Riverbend Facility)

Equations

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

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

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

Species	Wellsite Heater Emissions - Separators		
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)
Criteria Pollutants & VOC			
NO_x [a]	100	0.052	322
CO [a]	84	0.043	270
TOC [c]	11	0.006	35.4
VOC	N.A.	0.000	2.69
SO_x [b]	0.00	0.000	0
TSP [c]	7.6	0.004	24.5
PM_{10} [c]	7.6	0.004	24.5
$PM_{2.5}$ [c]	7.6	0.004	24.5
Hazardous Air Pollutants			
Benzene [d]	0.0021	1.1E-06	6.76E-03
Toluene [d]	0.0034	1.8E-06	0.01
Hexane [d]	1.8	9.3E-04	5.79
Formaldehyde [d]	0.075	3.9E-05	0.24
Dichlorobenzene [d]	1.2E-03	6.2E-07	3.86E-03
Naphthalene [d]	6.1E-04	3.2E-07	1.96E-03
POM 2 [d,e,f]	5.9E-05	3.0E-08	1.90E-04
POM 3 [d,g]	1.6E-05	8.3E-09	5.15E-05
POM 4 [d,h]	1.8E-06	9.3E-10	5.79E-06
POM 5 [d,i]	2.4E-06	1.2E-09	7.72E-06
POM 6 [d,j]	7.2E-06	3.7E-09	2.32E-05
POM 7 [d,k]	1.8E-06	9.3E-10	5.79E-06
Greenhouse Gases			
CO_2 [c]	120,000	61.99	386,103
CH_4 [c]	2.3	0.001	7.40

[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

[e] - 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

[f] - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and 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.

17. Wellsite Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate: 2.01 bbls condensate per day (Estimate based on proponent data)
Number of Active Wells: 1422 wells at Peak Production

Separator Conditions : 130 psi and 60 F (Riverbend sample)
API Gravity: 58.28

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0
Riverbend Compressor Station Liquid Sample Dated 6/4/07

Emissions:

Component	Wellsite Flash/Work/Breathing (lb/hr/well)	Wellsite Flash/Work/Breathing (tons/year/well)	Total Emissions (tons/yr)
Total VOC	0.163	0.713	1014
Hazardous Air Pollutants			
Benzene	1.643E-03	0.007	10.24
Toluene	2.655E-03	0.012	16.53
Ethylbenzene	1.264E-04	0.001	0.787
Xylenes	8.849E-04	0.004	5.512
n-Hexane	4.172E-03	0.018	25.98
Greenhouse Gases			
CO_2	0.033	0.144	204.7
CH_4	0.156	0.683	971

Buys & Associates, Inc.	GASCO Proposed Action Inventory - w/
	Project: Voluntary ACEPMS
Environmental Consultants	Date: 6/9/2011

18. VOC Emissions from NGL Truck Loading Operations

NGL Truck Loading/Unloading Emissions: NGL will normally be transported by pipeline, however truck transport may be utilized as a contingency. A pressurized vapor recovery system will be utilized for truck loading. Potential emissions result from the equalization of the loading rack connection to atmospheric pressure after the loading operation is completed.

Assumed Additional Maximum Number of Truck loads/year 5,840

Truck Loading Connection Configuration

	Load Line		
Load Line Connection Diameter =	0.25	ft	(Assumed typical value)
Load Line Length between Valves =	3.0	ft	(Assumed typical value)
Connection Volume =	0.147	ft^3	
Annual Connection Volume Vented =	860	ft^3	
NGL Density =	5.6	lbs/gal	(Assumed typical value)
NGL Density =	41.9	lbs/ft^3	
Annual Wt. NGL Vented =	36,024.1	lbs/year	
NGL VOC Content =	100.0%	by weight (See NGL Composition for Fugitive Emissions)	
VOC Emissions =	18.0	tons/year VOC	

Example Calculations

Connection volume = Pi * $(Diameter)^2/4$ * Length

Annual Volume Vented (ft^3/year) = Connection Volume (ft^3) * Number Truck Loads per year (1/year)

Density ($lbs/ft^{3)}$ = Density (lbs/gal) * 7.48 gal/ft^3

Vented NGL Weight (lbs) = Volume Vented (ft^3) * NGL Density (lbs/ft^3)

VOC Emissions (tons/year) = Annual NGL Vented (lbs/year) * NGL VOC wt. % / 100 / 2000 (lbs/ton)

19. Operations Vehicle Tailpipe Emissions

Assumptions:

Number of New Pumpers:	44	(Proposed Action Number of Pumpers at Peak Production)
Pumper Mileage:	2,800	miles/pumper/month (Assumption 0.5 miles between wells and roundtrip from Roosevelt))
Total Annual New Pumper Mileage:	1,478,400	miles/year
Number of Condensate Haul Truck Round Trips:	20	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for Condensate Transport:	88	miles (from Roosevelt)
Total Annual Condensate Truck Mileage:	642,400	miles/year
Number of Water Haul Truck Round Trips:	121	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for Water Transport:	17	miles (Average distance to evaporation facility)
Total Annual Water Truck Mileage:	750,805	miles/year
Number of NGL Haul Truck Round Trips:	16	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for NGL Transport:	88	miles (Average distance to evaporation facility)
Total Annual NGL Truck Mileage:	513,920	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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	3.03	2.261	4.938	8.13	7.826	17.091	10.086	22.029
CO	33.64	25.101	54.821	17.09	16.450	35.927	41.551	90.748
VOC [c]	1.656	1.236	2.699	4.600	4.428	9.670	5.663	12.369
SO_2	0.21	0.160	0.349	0.32	0.309	0.675	0.469	1.024
Greenhouse Gases								
CH_4 [d]	0.184	0.137	0.300	0.230	0.221	0.484	0.359	0.783

9.9026862

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: GASCO Proposed Action Inventory - w/ Voluntary ACEPMS
Date: 6/9/2011

20. Pneumatic Device Emissions 0.144 Mscf/day or less = low bleed device

Analysis Gas Consumption Rate:	1.00	Mscf/day
Days of Operation:	365	days/year

GAS COMPONENT	MOLECULAR WEIGHT (lb/lb-mole)	MOLE PERCENT	RELATIVE MOLE WEIGHT (lb/lb-mole)	WEIGHT PERCENT	VOLUME LOW RAT (Mscf/day	MASS FLOW RATE (lb/hr)	MASS FLOW RATE (tons/yr)
Methane	16.043	92.7130	14.874	83.334	0.927	1.633	7.153
Ethane	30.07	4.0781	1.226	6.870	0.041	0.135	0.590
Propane	44.097	1.1446	0.505	2.828	0.011	0.055	0.243
I-Butane	58.123	0.2479	0.144	0.807	0.002	0.016	0.069
n-Butane	58.123	0.2649	0.154	0.863	0.003	0.017	0.074
I-Pentane	72.15	0.1180	0.085	0.477	0.001	0.009	0.041
n-Pentane	72.15	0.0870	0.063	0.352	0.001	0.007	0.030
Hexanes	86.177	0.0687	0.059	0.332	0.001	0.007	0.028
Heptanes	100.204	0.1233	0.124	0.692	0.001	0.014	0.059
Octanes	114.231	0.0584	0.067	0.374	0.001	0.007	0.032
Nonanes	128.258	0.0305	0.039	0.219	0.000	0.004	0.019
Decanes +	142.285	0.0068	0.010	0.054	0.000	0.001	0.005
Benzene	78.12	0.0211	0.016	0.092	0.000	0.002	0.008
Toluene	92.13	0.0352	0.032	0.182	0.000	0.004	0.016
Ethylbenzene	106.16	0.0012	0.001	0.007	0.000	0.000	0.001
Xylenes	106.16	0.0157	0.017	0.093	0.000	0.002	0.008
n-Hexane	86.177	0.0444	0.038	0.214	0.000	0.004	0.018
Hellum	4.003	0.0000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.1247	0.035	0.196	0.001	0.004	0.017
Carbon Dioxide	44.01	0.8165	0.359	2.013	0.008	0.039	0.173
Oxygen	32	0.0000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulfide	34.08	0.0000	0.000	0.000	0.000	0.000	0.000
VOC SUBTOTAL		**2.268**	**1.354**	**7.586**	**0.023**	**0.149**	**0.651**
HAP SUBTOTAL		**0.118**	**0.105**	**0.589**	**0.001**	**0.012**	**0.051**
TOTAL		**100.000**	**17.849**	**100.000**	**1.000**	**1.960**	**8.584**

	Number of Wells	VOC emissions (tons/year)	Methane emissions (tons/yr)
Alternative F	1,422	333	3661.8

LIQUID LEVEL CONTROLLER SPECIFICATIONS

Gas Consumption Rate:	0.144	Mscf/day
Days of Operation:	365	days/year

(low-bleed)

TRACE PUMP SPECIFICATIONS

Gas Consumption Rate:	0.144	Mscf/day
Days of Operation:	182	days/year

Assumed recycle of gas equals low-bleed specification

METHANOL PUMP SPECIFICATIONS

-Solar powered methanol pumps will be installed for the Proposed Action

Pneumatic sources / well			VOC lb/hr	VOC ton/yr
2	Liquid level controllers		0.04	0.19
1	Trace pump		0.01	0.05
2	Chemical injection pump		0	0
		Totals (per well) =	0.05	0.23

Pneumatic sources / well			Methane lb/hr	Methane ton/yr
2	Liquid level controllers		0.47	2.06
1	Trace pump		0.24	0.52
2	Chemical injection pump		0	0
		Totals (per well) =	0.71	2.58

21. Operations Traffic Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006

365 days (Estimate)

Vehicle Type	Ave. Weight (lbs)	Round Trips per Day*
Pickup Truck: Crew	7,000	44
Haul Truck: Oil	48,000	20
Haul Truck: Water	48,000	121
Haul Truck: NGL	48,000	16
Mean Weight	39,025	201

Unpaved Roads

E (PM10) / VMT = 1.5 * (S/12)^0.9 * (W/3)^0.45 * (365-p)/365)
E (PM2.5) / 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)	73	days per year **
Avg. Round Trip Miles	37	miles on unpaved roads ***

Paved Roads

E (PM10) / VMT = 0.016 * (sL/2)^0.65 * (W/3)^1.5 - 0.00047 * (1-(p/(365*4))
E (PM10) / 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	30	From Roosevelt
Precipitation Days (P)	73	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	2.02	5,546,800	15,197	0.20	554,680	1,520
Paved	0.08	170,731	468	0.01	25,004	69
Total		5,717,531	15,664		579,684	1,588

Annual Traffic Fugitive Dust Emissions (tons/year)	**2,859**			**290**	

*Round trips per day at peak production (Proposed Action)
** NCDC data for Nutters Ranch, UT 1963-1986
*** Weighted average of Pumper,Condensate, NGL, and Water Hauling Distance = (58*(44+20+16+15)+17*(90-15))/253. One round trip to evaporative facility is assumed to take about 2-hours, so 6 trips per day are completed in one 12-hr shift, which requires 20 trucks to do 121 trips.

22. Well Production Summary

Species	Storage Tanks (tons/yr)	Well Site Heaters (tons/yr)	Operations Vehicle (tons/yr)	Pneumatic Devices (tons/yr)	Total Well Production [g] (tons/yr)
Criteria Pollutants & VOC					
NO_x		322	22.0		344
CO		270	90.7		361
VOC	1,014	2.69	12.37	333	1,362
SO_2		0	1.02		1.02
PM_{10}		24.5	2,859		2,883
$PM_{2.5}$		24.5	290		314
Hazardous Air Pollutants					
Benzene	10.2	0.01			10.2
Toluene	17	0.01			16.5
Ethylbenzene	0.79				0.79
Xylene	5.5				5.51
n-Hexane	26	5.79			31.8
Formaldehyde		0.24			0.24
Dichlorobenzene		3.86E-03			3.86E-03
Naphthalene		1.96E-03			1.96E-03
POM 2[a]		1.90E-04			1.90E-04
POM 3[b]		5.15E-05			5.15E-05
POM 4[c]		5.79E-06			5.79E-06
POM 5[d]		7.72E-06			7.72E-06
POM 6[e]		2.32E-05			2.32E-05
POM 7[f]		5.79E-06			5.79E-06
Total HAPs	59	6.06	0		65.1
Greenhouse Gases					
CO_2	205	386,103			386,308
CH_4	971	7.40	0.78	3662	4,641

[a] - POM (Particulate Organic Matter) 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

[b] - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[c] - POM 4 includes: 3-Methylchloranthrene.

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

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

[f] - POM 7 includes: Chrysene.

[g] Emissions for Peak Field Development

Buys & Associates, Inc. Environmental Consultants	GASCO Proposed Action Inventory - w/ Voluntary Project: ACEPMS Date: 6/9/2011

23. Average Produced Gas Characteristics
Inlet Wet Gas Sample from Riverbend Compressor Station, dated 3/22/07

Gas Heat Value (wet): 1064.1 Btu/scf

Sample Temperature: 77 F
Sample Pressure: 132 psi

C1-C2 Wt. Fraction:	0.9020
VOC Wt. Fraction:	0.0760
Non-HC Wt. Fraction:	0.0221
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	92.7130	16.043	14.874	0.833	1010.000	936.401	910.000	843.688
Ethane	4.0781	30.070	1.226	0.069	1769.800	72.174	1618.000	65.984
Propane	1.1446	44.097	0.505	0.028	2516.200	28.800	2316.000	26.509
i-Butane	0.2479	58.123	0.144	0.008	3252.100	8.062	3005.000	7.449
n-Butane	0.2649	58.123	0.154	0.009	3262.400	8.642	3013.000	7.981
i-Pentane	0.1180	72.150	0.085	0.005	4000.900	4.721	3698.000	4.364
n-Pentane	0.0870	72.150	0.063	0.004	4008.800	3.488	3708.000	3.226
Hexanes	0.0687	86.177	0.059	0.003	4756.200	3.268	4404.000	3.026
Heptanes	0.0737	100.204	0.074	0.004	5502.500	4.055	5100.000	3.759
Methylcyclohexane	0.0509	98.186	0.050	0.003	1865.455	0.880	1729.000	0.880
Octanes+	0.0550	114.231	0.063	0.004	6249.100	3.437	1695.970	0.933
2,2,4-TMP	0.0047	114.220	0.005	0.000	6368.594	0.081	1728.400	0.081
Nonanes	0.0305	128.258	0.039	0.002	6996.400	2.134		0.000
Decanes	0.0068	142.285	0.010	0.001	7743.200	0.527		0.000
Benzene	0.0211	78.120	0.016	0.001	3715.500	0.784		0.000
Toluene	0.0352	92.130	0.032	0.002	4444.600	1.564		0.000
Ethylbenzene	0.0012	106.160	0.001	0.000	5191.500	0.062		0.000
Xylenes	0.0157	106.160	0.017	0.001	5183.500	0.814		0.000
n-Hexane	0.0444	86.177	0.038	0.002	4756.200	2.112		0.000
Helium	0.0000	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	0.1247	28.013	0.035	0.002	0.000	0.000	0.000	0.000
Carbon Dioxide	0.8165	44.010	0.359	0.020	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		17.85	1.00		1082.01		967.88

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

Weight Fraction = Net Mole Weight / Total Mole Weight

24. Central Compression

Assumptions:

Total Existing Compression:	6,615	Horsepower (Riverbend Facility)
Total New Compression:	21,325	Horsepower (Proposed Action)
Total New Generation:	2,700	Horsepower (Proposed Action)

Equations:

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

Pollutant	Emission Factor [6] (lb/MMBtu)	Emission Factor (g/hp-hr)	Emissions (lb/hr/engine) [7]	10,662 hp Station Emissions (tons/yr)	10,662 hp Station Emissions (tons/yr)	Total Emissions [8] Proposed Action (tons/yr)
Criteria Pollutants & VOC						
NOx [1]		1.0	2.20	103.0	103.0	206
CO [1,9]		0.1	0.22	10.3	10.3	21
VOC [1,10]		0.5	1.10	51.5	51.5	103
PM10 [2,3]	9.95E-03	0.037	0.08	3.8	3.8	7.7
PM2.5 [2,3]	9.95E-03	0.037	0.08	3.8	3.8	7.7
SO_2 [12]	5.88E-04	0.000	0.00	0.0	0.0	0.0
Hazardous Air Pollutants [10]						
Benzene [2]	4.40E-04	6.579E-04	1.45E-03	6.77E-02	6.77E-02	0.14
Toluene [2]	4.08E-04	6.100E-04	1.34E-03	6.28E-02	6.28E-02	0.13
Ethylbenzene [2]	3.97E-05	5.936E-05	1.31E-04	6.11E-03	6.11E-03	0.01
Xylenes [2]	1.84E-04	2.751E-04	6.07E-04	2.83E-02	2.83E-02	0.06
n-Hexane [2]	1.11E-03	1.660E-03	3.66E-03	1.71E-01	1.71E-01	0.34
Formaldehyde [2,11]	5.28E-02	1.974E-02	4.35E-02	2.03E+00	2.03E+00	4.1
Acetaldehyde [2]	8.36E-03	1.250E-02	2.76E-02	1.29E+00	1.29E+00	2.57
Acrolein [2,11]	5.14E-03	1.921E-03	4.24E-03	1.98E-01	1.98E-01	0.40
Methanol [2]	2.50E-03	3.738E-03	8.24E-03	3.85E-01	3.85E-01	0.77
1,1,2,2-Tetrachloroethane[2]	4.00E-05	5.981E-05	1.32E-04	6.16E-03	6.16E-03	0.01
1,1,2-Trichloroethane[2]	3.18E-05	4.755E-05	1.05E-04	4.90E-03	4.90E-03	0.01
1,3-Dichloropropene[2]	2.64E-05	3.947E-05	8.70E-05	4.06E-03	4.06E-03	0.01
1,3-Butadiene[2]	2.67E-04	3.992E-04	8.80E-04	4.11E-02	4.11E-02	0.08
2,2,4-Trimethylpentane[2]	2.50E-04	3.738E-04	8.24E-04	3.85E-02	3.85E-02	0.08
Biphenyl[2]	2.12E-04	3.170E-04	6.99E-04	3.26E-02	3.26E-02	0.07
Carbon Tetrachloride[2]	3.67E-05	5.487E-05	1.21E-04	5.65E-03	5.65E-03	0.01
Chlorobenzene[2]	3.04E-05	4.545E-05	1.00E-04	4.68E-03	4.68E-03	0.01
Chloroform[2]	2.85E-05	4.261E-05	9.39E-05	4.39E-03	4.39E-03	0.01
Ethylene Dibromide[2]	4.43E-05	6.624E-05	1.46E-04	6.82E-03	6.82E-03	0.01
Methylene Chloride[2]	2.00E-05	2.990E-05	6.59E-05	3.08E-03	3.08E-03	6.16E-03
Naphthalene[2]	7.44E-05	1.112E-04	2.45E-04	1.15E-02	1.15E-02	0.02
Phenol[2]	2.40E-05	3.588E-05	7.91E-05	3.69E-03	3.69E-03	7.39E-03
Styrene[2]	2.36E-05	3.529E-05	7.78E-05	3.63E-03	3.63E-03	7.27E-03
Tetrachloroethane[2]	2.48E-06	3.708E-06	8.17E-06	3.82E-04	3.82E-04	7.64E-04
Vinyl Chloride[2]	1.49E-05	2.228E-05	4.91E-05	2.29E-03	2.29E-03	4.59E-03
PAH -POM 1[2,4]	2.69E-05	4.022E-05	8.87E-05	4.14E-03	4.14E-03	0.01
POM 2[2,4,5]	5.93E-05	8.874E-05	1.96E-04	9.14E-03	9.14E-03	0.02
Benzo(b)fluoranthene/POM6[2,4]	1.66E-07	2.482E-07	5.47E-07	2.56E-05	2.56E-05	5.11E-05
Chrysene/POM7[2,4]	6.93E-07	1.036E-06	2.28E-06	1.07E-04	1.07E-04	2.13E-04
Greenhouse Gases						
CO2 [2]	110	411	906	42,333	42,333	84666
CH4 [2]	1.25	4.67	10.3	481	481	962

[1] - Currently permitted emission rates for internal combustion engine

[2] - AP-42 Table 3.2-2 Uncontrolled Emission Factors for 4-Stroke Lean-Burn Engines, 7/00

[3] - PM = sum of PM filterable and PM condensable

[4] - 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

[5] - POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

[6] - Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 8,240 Btu/hp-hr (*3.738)

[7] - Each individual engine estimated at 1,000 hp (Proposed Action)

[8] - Proposed Action Total Annual Emissions for New Compression (21,325 hp)

[9] - CO emission estimate reduced by 95% to reflect reduction by oxidation catalyst.

[10] - VOCs and HAPs emission estimates reduced by 60% to reflect reduction by oxidation catalyst.

[11] - Formaldehyde and acrolein emissions reduced by 90% to reflect reduction by oxidation catalyst.

[12] - Gas analysis indicates no sulfur compounds, see Central Gas Composition page.

25. Central TEG Dehydrator Emissions

Assumptions

Peak Field Production Rate: 200 MMscf/day
1422 Active Wells at Peak Production

Gas Composition: Inlet Gas Sample from Riverbend Compresor Station, dated 3/30/07

Inlet Gas Conditions: Inlet gas saturated at 820.0 psig and 86 F

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

Flare > 95% Control Efficiency in order to meet Federal MACT Standards
Condenser Operating Conditions: 86 deg. F, 834.7 psia

Emissions

Species	Central Dehydrator Emissions 100MMscfd Station (tons/year)	Central Dehydrator Emissions 100MMscfd Station (tons/year)	Total Project Emissions (tons/year)
Total VOC	20.63	20.63	41.3
Hazardous Air Pollutants			
Benzene	2.33	2.33	4.66
Toluene	6.60	6.60	13.2
Ethylbenzene	0.34	0.34	0.67
Xylenes	6.67	6.67	13.3
n-Hexane	0.14	0.14	0.28
Total HAP Emissions	16.1	16.1	32.2
Greenhouse Gases			
CH_4	9.67	9.67	19.3

Each station throughput estimated according to the ratio of new compression proposed at each station and based on a peak field production rate of 194MMscfd

26. Central Facility Heater Emissions

Assumptions

Dehydrator Reboiler Heater	750	Mbtu/hr (Typical)
Separator Heater	500	Mbtu/hr (Based on current Riverbend equipment)
Total Heater Requirmement Facility 1	5,000	Mbtu/hr (Proposed Action Estimate, 4-Dehydrator Reboiler Heaters, 4 separator heaters)
Total Heater Requirmement Facility 2	5,000	Mbtu/hr (Proposed Action Estimate, 4-Dehydrator Reboiler Heaters, 4 separator heaters)
Firing Rate	45	minutes/hour on average for entire year (Typical value)
	8760	hours/year
Fuel Gas Heat Value	968	Btu/scf (Gas Analyses from Riverbend Facility)
Fuel Gas VOC Content	0.076	by weight (Gas Analyses from Riverbend Facility)

Equations

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

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

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

Species	Central Heater Emissions - Facility 1			Central Heater Emissions - Facility 2			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr)	Total Emissions (tons/yr)	Total Emissions (tons/yr)
Criteria Pollutants & VOC							
NO_x [a]	100	0.500	2.190	100	0.500	2.190	4.380
CO [a]	84	0.420	1.840	84	0.420	1.840	3.679
TOC [c]	11	0.055	0.241	11	0.055	0.241	0.482
VOC	N.A.	0.004	0.018	N.A.	0.004	0.018	0.037
SO_x [b]	0.00	0.000	0.000	0.00	0.000	0.000	0.000
TSP [c]	7.6	0.038	0.166	7.6	0.038	0.166	0.333
PM_{10} [c]	7.6	0.038	0.166	7.6	0.038	0.166	0.333
$PM_{2.5}$ [c]	7.6	0.038	0.166	7.6	0.038	0.166	0.333
Hazardous Air Pollutants							
Benzene [d]	2.1E-03	1.1E-05	4.6E-05	2.1E-03	1.1E-05	4.6E-05	9.198E-05
Toluene [d]	3.4E-03	1.7E-05	7.4E-05	3.4E-03	1.7E-05	7.4E-05	1.489E-04
Hexane [d]	1.8E+00	9.0E-03	3.9E-02	1.8E+00	9.0E-03	3.9E-02	0.079
Formaldehyde [d]	7.5E-02	3.8E-04	1.6E-03	7.5E-02	3.8E-04	1.6E-03	0.003
Dichlorobenzene [d]	1.2E-03	6.0E-06	2.6E-05	1.2E-03	6.0E-06	2.6E-05	5.3E-05
Naphthalene [d]	6.1E-04	3.1E-06	1.3E-05	6.1E-04	3.1E-06	1.3E-05	2.7E-05
POM 2 [d,e,f]	5.9E-05	3.0E-07	1.3E-06	5.9E-05	3.0E-07	1.3E-06	2.6E-06
POM 3 [d,g]	1.6E-05	8.0E-08	3.5E-07	1.6E-05	8.0E-08	3.5E-07	7.0E-07
POM 4 [d,h]	1.8E-06	9.0E-09	3.9E-08	1.8E-06	9.0E-09	3.9E-08	7.9E-08
POM 5 [d,i]	2.4E-06	1.2E-08	5.3E-08	2.4E-06	1.2E-08	5.3E-08	1.1E-07
POM 6 [d,j]	7.2E-06	3.6E-08	1.6E-07	7.2E-06	3.6E-08	1.6E-07	3.2E-07
POM 7 [d,k]	1.8E-06	9.0E-09	3.9E-08	1.8E-06	9.0E-09	3.9E-08	7.9E-08
Greenhouse Gases							
CO_2 [c]	120,000	600.00	2,628.00	120,000	600.00	2,628.00	5256.000
CH_4 [c]	2.3	0.012	0.050	2.3	0.012	0.050	0.101

[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

[e] - 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

[f] - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and 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.

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

Assumptions:

Average Condensate Production Rate :

Facility 1	1.90	bbls condensate per day (Estimate based on Riverbend condensate production)
Facility 2	1.90	bbls condensate per day (Estimate based on Riverbend condensate production)

Separator Conditions : 130 psi and 60 F (Sample Conditions)
API Gravity: 58.28

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0
Riverbend Compressor Station Liquid Sample Dated 6/4/07
Controlled 95% efficiency

Emissions:

Component	Facility 1 Flash/Work/Breathing (tons/yr)	Facility 2 Flash/Work/Breathing (tons/yr)	Total Emissions (tons/yr)
Total VOC	0.034	0.034	0.07
Hazardous Air Pollutants			
Benzene	3.286E-04	3.286E-04	0.00
Toluene	5.437E-04	5.437E-04	0.00
Ethylbenzene	2.39E-05	2.39E-05	4.78E-05
Xylenes	1.912E-04	1.912E-04	3.82E-04
n-Hexane	8.664E-04	8.664E-04	0.00
Greenhouse Gases			
CO_2	0.007	0.007	0.01
CH_4	0.032	0.032	0.06

Buys & Associates, Inc. Environmental Consultants	Project: GASCO Proposed Action Inventory - w/ Voluntary ACEPMS Date: 8/9/2011

28. Central Facility Emission Summary

Central Facility 1

Pollutant	Central Compression Emissions 10,662 hp (tons/year)	Central Dehydrator Emissions 100 MMscfd (tons/year)	Central Heater Emissions 4.000 MBtu/hr (tons/year)	Central Condensate Tank Emissions 1.9 bbl/d (tons/year)	Central Dewpoint Skid Emissions (tons/year)	Total Facility Emissions (tons/year)
Criteria Pollutants & VOC						
NO_x	103.0		2.19			105
CO	10.3		1.84			12.1
VOC	51.5	20.6	0.02	0.03	9.0	81
SO_2	0.00		0.00			0.00
PM_{10}	3.83		0.17			3.99
$PM_{2.5}$	3.83		0.17			3.99
Hazardous Air Pollutants						
Benzene	0.07	2.33	4.60E-05	3.29E-04		2.40
Toluene	0.06	6.60	7.45E-05	5.44E-04		6.7
Ethylbenzene	0.01	0.34		2.39E-05		0.34
Xylene	0.03	6.67		1.91E-04		6.70
n-Hexane	0.17	0.14	0.04	8.66E-04		0.4
Formaldehyde	2.0		1.64E-03			2.0
Acetaldehyde	1.29					1.29
Acrolein	0.20					0.20
Methanol	0.38					0.38
1,1,2,2-Tetrachloroethane	0.01					0.01
1,1,2-Trichloroethane	0.00					0.00
1,3-Dichloropropene	0.00					0.00
1,3-Butadiene	0.04					0.04
2,2,4-Trimethylpentane	0.04					0.04
Biphenyl	0.03					0.03
Carbon Tetrachloride	0.01					0.01
Chlorobenzene	0.00					0.00
Chloroform	0.00					0.00
Dichlorobenzene			2.63E-05			2.63E-05
Ethylene Dibromide	0.01					0.01
Methylene Chloride	3.08E-03					3.08E-03
Naphthalene	0.01		1.34E-05			0.01
Phenol	3.69E-03					3.69E-03
Styrene	3.63E-03					3.63E-03
Tetrachloroethane	3.82E-04					3.82E-04
Vinyl Chloride	2.29E-03					2.29E-03
PAH -POM 1*	0.00					0.00
POM 2*	0.01		1.29E-06			0.01
POM 3*			3.50E-07			3.50E-07
POM 4*			3.94E-08			3.94E-08
POM 5*			5.26E-08			5.26E-08
Benzo(b)fluoranthene/POM6*	2.56E-05		1.58E-07			2.57E-05
Chrysene/POM7*	1.07E-04		3.94E-08			1.07E-04
Total HAPs	4.42	16.1	0.04	1.95E-03		18.5
Greenhouse Gases						
CO_2	42,333		2,628	0.01		44,961
CH_4	481	9.67	0.05	0.03		491

Central Facility 2

Pollutant	Central Compression Emissions 10,662 hp (tons/year)	Central Dehydrator Emissions 100 MMscfd (tons/year)	Central Heater Emissions 4.000 MBtu/hr (tons/year)	Central Condensate Tank Emissions 1.9 bbl/d (tons/year)	Central Dewpoint Skid Emissions (tons/year)	Total Facility Emissions (tons/year)
Criteria Pollutants & VOC						
NO_x	103.0		2.19			105
CO	10.3		1.84			12
VOC	51.5	20.6	0.02	0.03	9.0	81
SO_2	0.00		0.00			0.00
PM_{10}	3.83		0.17			3.99
$PM_{2.5}$	3.83		0.17			3.99
Hazardous Air Pollutants						
Benzene	0.07	2.3	4.60E-05	3.29E-04		2.40
Toluene	0.06	6.6	7.45E-05	5.44E-04		6.7
Ethylbenzene	0.01	0.3		2.39E-05		0.34
Xylene	0.03	6.7		1.91E-04		6.70
n-Hexane		0.1	0.04	8.66E-04		0.2
Formaldehyde	2.0		1.64E-03			2.0
Acetaldehyde	1.29					1.29
Acrolein	0.20					0.20
Methanol	0.38					0.38
1,1,2,2-Tetrachloroethane	0.01					0.01
1,1,2-Trichloroethane	0.00					0.00
1,3-Dichloropropene	0.00					0.00
1,3-Butadiene	0.04					0.04
2,2,4-Trimethylpentane	0.04					0.04
Biphenyl	0.03					0.03
Carbon Tetrachloride	0.01					0.01
Chlorobenzene	0.00					0.00
Chloroform	0.00					0.00
Dichlorobenzene			2.63E-05			2.63E-05
Ethylene Dibromide	0.01					0.01
Methylene Chloride	3.08E-03					3.08E-03
Naphthalene	0.01		1.34E-05			0.01
Phenol	3.69E-03					3.69E-03
Styrene	3.63E-03					3.63E-03
Tetrachloroethane	3.82E-04					3.82E-04
Vinyl Chloride	2.29E-03					2.29E-03
PAH -POM 1*	0.00					0.00
POM 2*	0.01		1.29E-06			0.01
POM 3*			3.50E-07			3.50E-07
POM 4*			3.94E-08			3.94E-08
POM 5*			5.26E-08			5.26E-08
Benzo(b)fluoranthene/POM6*	2.56E-05		1.58E-07			2.57E-05
Chrysene/POM7*	1.07E-04		3.94E-08			1.07E-04
Total HAPs	4.3	16.1	0.04	1.95E-03		18.3
Greenhouse Gases						
CO_2	42333		2,628	0.01		44,961
CH_4	481	9.67	0.05	0.03		491

Buys & Associates, Inc.	Project:	GASCO Proposed Action Inventory - w/ Voluntary ACEPMS
Environmental Consultants	Date:	6/9/2011

29. Evaporation Facility

Assumptions:

Total New Generation: 2,700 Horsepower (Proposed Action)

Evaporation Emissions conservatively estimated using mass balance
-methanol designated as a VOC

Equations:

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

Pollutant	Engine Emission Factor [6] (lb/MMBtu)	Engine Emission Factor (g/hp-hr) [1]	Engine Emissions (lb/hr) [1]	Engine Emissions (tons/yr)	Evaporation Emissions (tons/yr)[7]	Total Evaporation Facility Emissions (tons/yr)
Criteria Pollutants & VOC						
NOx		1.0	5.95	26.1		26.1
CO		2.0	11.90	52.1		52.1
VOC		1.0	5.95	26.07	869.8	895.9
PM10 [2,3]	9.95E-03	0.036	0.22	0.94		0.9
PM2.5 [2,3]	9.95E-03	0.036	0.22	0.94		0.9
SO_2	5.88E-04	0.002	0.01	0.06		0.1
Hazardous Air Pollutants						
Benzene [2]	4.40E-04	1.598E-03	0.01	0.04	5.4	5.44
Toluene [2]	4.08E-04	1.482E-03	0.01	0.04	13.0	13.04
Ethylbenzene [2]	3.97E-05	1.442E-04	8.6E-04	0.00	0.7	0.70
Xylenes [2]	1.84E-04	6.683E-04	4.0E-03	0.02	10.8	10.82
n-Hexane [2]	1.11E-03	4.032E-03	0.02	0.11		0.11
Formaldehyde [2]	5.28E-02	1.918E-01	1.14	5.00		5.00
Acetaldehyde [2]	8.36E-03	0.03	0.18	0.79		0.79
Acrolein [2]	5.14E-03	0.02	0.11	0.49		0.49
Methanol [2]	2.50E-03	9.080E-03	0.05	0.24	785.4	785.64
1,1,2,2-Tetrachloroethane [2]	4.00E-05	1.453E-04	8.65E-04	0.00		0.00
1,1,2-Trichloroethane [2]	3.18E-05	1.155E-04	6.87E-04	0.00		0.00
1,3-Dichloropropene [2]	2.64E-05	9.588E-05	5.71E-04	2.50E-03		0.00
1,3-Butadiene [2]	2.67E-04	9.697E-04	0.01	0.03		0.03
2,2,4-Trimethylpentane [2]	2.50E-04	9.080E-04	0.01	0.02		0.02
Biphenyl [2]	2.12E-04	7.700E-04	4.58E-03	0.02		0.02
Carbon Tetrachloride [2]	3.67E-05	1.333E-04	7.93E-04	3.48E-03		0.00
Chlorobenzene [2]	3.04E-05	1.104E-04	6.57E-04	2.88E-03		0.00
Chloroform [2]	2.85E-05	1.035E-04	6.16E-04	2.70E-03		0.00
Ethylene Dibromide [2]	4.43E-05	1.609E-04	9.58E-04	4.19E-03		0.00
Methylene Chloride [2]	2.00E-05	7.264E-05	4.32E-04	1.89E-03		0.00
Naphthalene [2]	7.44E-05	2.702E-04	1.61E-03	0.01		0.01
Phenol [2]	2.40E-05	8.717E-05	5.19E-04	2.27E-03		0.00
Styrene [2]	2.36E-05	8.572E-05	5.10E-04	2.23E-03		0.00
Tetrachloroethane [2]	2.48E-06	9.007E-06	5.36E-05	2.35E-04		0.00
Vinyl Chloride [2]	1.49E-05	5.412E-05	3.22E-04	1.41E-03		0.00
PAH -POM 1 [2,4]	2.69E-05	9.770E-05	5.82E-04	2.55E-03		0.00
POM 2 [2,4,5]	5.93E-05	2.156E-04	1.28E-03	5.62E-03		0.01
Benzo(b)fluoranthene/POM6 [2,4]	1.66E-07	6.029E-07	3.59E-06	1.57E-05		0.00
Chrysene/POM7 [2,4]	6.93E-07	2.517E-06	1.50E-05	6.56E-05		0.00
Greenhouse Gases						
CO2 [2]	110	399.52	2,378.10	10416		10416.3
CH4 [2]	1.25	4.54000	27.02	118.4		118.4

[1] - Currently permitted emission rates for internal combustion engine

[2] - AP-42 Table 3.2-2 Uncontrolled Emission Factors for 4-Stroke Lean-Burn Engines, 7/00

[3] - PM = sum of PM filterable and PM condensable

[4] - 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

[5] - POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, henzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

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

[7] - BTEX emissions controlled by a minimum of 60 %

30. Total Project Production Related Emissions Summary

Pollutant	Well Production Emissions (tons/year)	Central Facility 1 Emissions (tons/year)	Central Facility 2 Emissions (tons/year)	Evaporation Facility Emissions (tons/year)	Total Production Emissions [h] (tons/year)
Criteria Pollutants & VOC					
NO_x	344	105	105	26.1	580
CO	361	12	12	52.1	437
VOC	1,362	81	81	895.9	2,421
SO_2	1.02	0.00	0.00	0.06	1.08
PM_{10}	2,883	3.99	3.99	0.94	2,892
$PM_{2.5}$	314	3.99	3.99	0.94	323
Hazardous Air Pollutants					
Benzene	10.2	2.40	2.40	5.44	20
Toluene	16.5	6.7	6.7	13.04	43
Ethylbenzene	0.79	0.34	0.34	7.04E-01	2.18
Xylene	5.5	6.70	6.70	10.82	29.7
n-Hexane	31.8	0.4	0.2	0.11	32
Formaldehyde	0.24	2.0	2.0	5.00	9.3
Acetaldehyde	0	1.29	1.29	0.79	3.37
Acrolein	0	0.20	0.20	0.49	0.88
Methanol	0	0.38	0.38	785.64	786.41
1,1,2,2-Tetrachloroethane	0	6.16E-03	6.16E-03	3.79E-03	0.02
1,1,2-Trichloroethane	0	4.90E-03	4.90E-03	3.01E-03	0.01
1,3-Dichloropropene	0	4.06E-03	4.06E-03	2.50E-03	0.01
1,3-Butadiene	0	0.04	0.04	0.03	0.11
2,2,4-Trimethylpentane	0	0.04	0.04	0.02	0.10
Biphenyl	0	0.03	0.03	0.02	0.09
Carbon Tetrachloride	0	5.65E-03	5.65E-03	3.48E-03	0.01
Chlorobenzene	0	4.68E-03	4.68E-03	2.88E-03	0.01
Chloroform	0	4.39E-03	4.39E-03	2.70E-03	0.01
Dichlorobenzene	3.86E-03	2.63E-05	2.63E-05	0	0
Ethylene Dibromide	0	6.82E-03	6.82E-03	4.19E-03	0.02
Methylene Chloride	0	3.08E-03	3.08E-03	1.89E-03	0.01
Naphthalene	1.96E-03	0.01	0.01	7.05E-03	0.03
Phenol	0	3.69E-03	3.69E-03	2.27E-03	0.01
Styrene	0	3.63E-03	3.63E-03	2.23E-03	0.01
Tetrachloroethane	0	3.82E-04	3.82E-04	2.35E-04	0
Vinyl Chloride	0	2.29E-03	2.29E-03	1.41E-03	0.01
PAH -POM 1[a]	0	4.14E-03	4.14E-03	2.55E-03	0.01
POM 2[b]	1.90E-04	0.01	0.01	5.62E-03	0.02
POM 3[c]	5.15E-05	3.50E-07	3.50E-07	0	5.E-05
POM 4[d]	5.79E-06	3.94E-08	3.94E-08	0	6.E-06
POM 5[e]	7.72E-06	5.26E-08	5.26E-08	0	8.E-06
Benzo(b)fluoranthene/POM6[f]	2.32E-05	2.57E-05	2.57E-05	1.57E-05	9.E-05
Chrysene/POM7[g]	5.79E-06	1.07E-04	1.07E-04	6.56E-05	3.E-04
Total HAPs	65	20.5	20.4	822.14	928
Greenhouse Gases					
CO_2	386,308	44,961	44,961	10,416	486,647
CH_4	4,641	491	491	118.4	5,741

a Polycyclic Aromatic Hydrocarbons (PAH), Polycyclic Organic Matter (POM)

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

[c] - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[d] - POM 4 includes: 3-Methylchloranthrene.

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

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

[g] - POM 7 includes: Chrysene.

h Emissions for Peak Field Development

31. Total Project Emissions Summary

Pollutant	Project Emissions (tons/year)						Total Emissions [i] (tons/year)
	Construction	Drilling	Completion	Interim Reclamation	Wind Erosion	Project Production	
Criteria Pollutants & VOC							
NO_x	24.1	528	104	0.27	0	580	1,236
CO	11.1	339	81	2.16	0	437	871
VOC	1.95	43.9	57.4	0.15	0	2,421	2,524
SO_2	0.70	20.3	2.31	0.02	0	1.08	24
PM_{10}	109.9	1,842	2,081	31.8	2.63	2,892	6,960
$PM_{2.5}$	13.7	200	210	3.42	1.05	323	751
Hazardous Air Pollutants							
Benzene	0	0.10	0.53	0	0	20.5	21
Toluene	0	0.03	1.03	0	0	42.9	44
Ethylbenzene	0	0	0.04	0	0	2.2	2.2
Xylene	0	0.02	0.53	0	0	29.7	30
n-Hexane	0	0	1.21	0	0	32	34
Formaldehyde	0.55	0.01	7.27E-04	0	0	9.3	10
Acetaldehyde	0	3.09E-03	2.46E-04	0	0	3.37	3.4
Acrolein	0	9.67E-04	7.18E-05	0	0	0.88	0.9
Methanol	0	0	0	0	0	786.41	786.4
1,1,2,2-Tetrachloroethane	0	0	0	0	0	0.02	2.E-02
1,1,2-Trichloroethane	0	0	0	0	0	0.01	1.E-02
1,3-Dichloropropene	0	0	0	0	0	0.01	1.E-02
1,3-Butadiene	0	0	1.34E-06	0	0	0.11	0.1
2,2,4-Trimethylpentane	0	0	0	0	0	0.10	0.1
Biphenyl	0	0	0	0	0	0.09	0.1
Carbon Tetrachloride	0	0	0	0	0	0.01	1.E-02
Chlorobenzene	0	0	0	0	0	0.01	1.E-02
Chloroform	0	0	0	0	0	0.01	1.E-02
Dichlorobenzene	0	0	0	0	0	3.91E-03	4.E-03
Ethylene Dibromide	0	0	0	0	0	0.02	2.E-02
Methylene Chloride	0	0	0	0	0	0.01	8.E-03
Naphthalene	0	0.02	1.13E-03	0	0	0.03	5.E-02
Phenol	0	0	0	0	0	0.01	1.E-02
Styrene	0	0	0	0	0	0.01	1.E-02
Tetrachloroethane	0	0	0	0	0	9.98E-04	1.E-03
Vinyl Chloride	0	0	0	0	0	6.00E-03	6.E-03
PAH -POM 1[a]	0	0.03	1.85E-03	0	0	0.01	4.E-02
POM 2[b]	0	0	0	0	0	0.02	2.E-02
POM 3[c]	0	0	0	0	0	5.22E-05	5.E-05
POM 4[d]	0	0	0	0	0	5.87E-06	6.E-06
POM 5[e]	0	0	0	0	0	7.83E-06	4.E-02
Benzo(b)fluoranthene/POM6[f]	0	0	0	0	0	9.03E-05	9.E-05
Chrysene/POM7[g]	0	0	0	0	0	2.85E-04	3.E-04
Total HAPs	0.59	0.21	3.34	0	0	928	932
Greenhouse Gases							
CO_2	0	55,958	7,912	0	0	486,647	550,517
CH_4	0.04	34.6	481.9	0.0	0.0	5,741	6,257

[a] 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.

[b] - POM 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

[c] - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

[d] - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[e] - POM 4 includes: 3-Methylchloranthrene.

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

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

[h] - POM 7 includes: Chrysene.

[i] Emissions for Peak Field Development

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1. Well Pad/Access Road/Pipeline Construction Fugitive Dust Emissions

Assumptions:

Pieces of Equipment	Hours of Construction	
- 1 Backhoe	20	hours per well pad
- 1 Dozer/Crawler Tractor	100	hours per well pad

Watering Control Efficiency	50	percent
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

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 = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM15/hour/piece of equipment

	Fugitive Dust Emissions [a]		
	lbs/hr/ machine	tons/well	tons/yr [b]
TSP	1.97	0.1182	11.20
PM15	0.50	0.0301	2.85
PM10	0.38	0.0226	2.14
PM2.5	0.21	0.0124	1.18

a Backhoe/Grader/Loader emissions are conservatively estimated as equivalent to Bulldozing emissions.

b Assumes construction rate specified by Proponent

Note: The majority of new pipeline will be installed adjacent to proposed access roads and will not result significant additional surface disturbance.

2. Well Pad/Road/Pipeline Construction Emissions (Grader)

Assumptions:

Grading Length	2.83	0.25 miles/road*3 plus 0.35 miles pipeline plus 1.74 miles on 225' x400' pad (10 ft swath for 400 ft * 23 lengths) = 9,200 ft = 1.74 miles
Hours of Construction	6	day grading per well pad and road (Estimate)
	10	hours/day
	60	hours per well pad
Watering Control Efficiency	50	percent
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 10/98)
Distance Graded	2.83	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

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 = 7.61 lbs TSP/well

Emissions = 3.64 lbs PM15/well

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well**	**tons/well**	**tons/yr [a]**
TSP	7.61	0.13	0.0038	0.36
PM15	3.64	0.06	0.0018	0.17
PM10	2.19	0.04	0.0011	0.10
PM2.5	0.24	0.00	0.0001	0.01

a Assumes maximum development scenario

3. Interim Reclamation Fugitive Dust Emissions

Assumptions:

Hours of Construction	5	days per well pad (Estimate)
	12	hours/day
	60	hours per well pad
Pieces of Equipment	1	- Dozer
Watering Control Efficiency	50	percent
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

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 = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM15/hour/piece of equipment

	Fugitive Dust Emissions [a]		
	lbs/hr	tons/well	tons/yr [b]
TSP	1.97	0.0591	5.60
PM15	0.50	0.0151	1.43
PM10	0.38	0.0113	1.07
PM2.5	0.21	0.0062	0.59

a Backhoe/Grader/Loader emissions are conservatively estimated as equivalent to Bulldozing emissions.

b Assumes construction rate specified by Proponent

Note: The majority of new pipeline will be installed adjacent to proposed access roads and will not result significant additional surface disturbance.

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4. Unpaved Road Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006

E (PM10) / VMT = 1.5 * (S/12)^0.9 * (W/3)^0.45 * (365-p)/365)
E (PM2.5) / 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 58
Precipitation Days (P) 73 days per year (NCDC data, Nutters Ranch, UT 1963-1986)

		Average	Round					
	Vehicle Type	Weight	Trips per	PM10	PM10/Pad	PM10/Pad	PM2.5/Pad	PM2.5/Pad
		(lbs)	Well a	(lb/VMT)	(lbs)	(lb/day)	(lbs)	(lb/day)
Construction (days/pad and road)	10							
	Haul Trucks	80,000	5					
	Water Trucks	60,000	1					
	Light Trucks	20,000	8					
	Mean Vehicle Weight	44,286	14	2.140	1738	173.8	173.8	17.4
					PM10/Annual Pads		PM2.5/Annual Pads	
					(tons)		(tons)	
					82.3		8.2	

		Average	Round					
	Vehicle Type	Weight	Trips per	PM10	PM10/Well	PM10/Well	PM2.5/Well	PM2.5/Well
		(lbs)	Well a	(lb/VMT)	(lbs)	(lb/day)	(lbs)	(lb/day)
Drilling, Downhole (days/well)	35							
	Haul Trucks	80,000	70					
	Logging/Mud Trucks	70,000	10					
	Water Trucks b	60,000	75					
	Light Trucks	8,000	80					
	Mean Vehicle Weight	48,681	235	2.233	30437	869.6	3043.7	87.0
					PM10/Annual Wells		PM2.5/Annual Wells	
					(tons)		(tons)	
					1446		144.6	

		Average	Round					
	Vehicle Type	Weight	Trips per	PM10	PM10/Well	PM10/Well	PM2.5/Well	PM2.5/Well
		(lbs)	Well a	(lb/VMT)	(lbs)	(lb/day)	(lbs)	(lb/day)
Completion (days/well)	14							
	Semi/Transport/Water/Sand	80,000	46					
	Water Trucks b	60,000	157					
	Light Trucks	8,000	56					
	Mean Vehicle Weight	52,309	259	2.307	34649	2474.9	3464.9	247.5
					PM10/Annual Wells		PM2.5/Annual Wells	
					(tons)		(tons)	
					1646		164.6	

		Average	Round					
	Vehicle Type	Weight	Trips per	PM10	PM10/Day	PM10/Day	PM2.5/Day	PM2.5/Day
		(lbs)	Well a	(lb/VMT)	(lbs)	(lb/day)	(lbs)	(lb/day)
Interim Reclamation (days/well)	5							
	Haul Trucks	80,000	1					
	Light Trucks	8,000	5					
	Mean Vehicle Weight	20,000	6	1.496	521	104.2	52.1	10.4
					PM10/Annual Wells		PM2.5/Annual Wells	
					(tons)		(tons)	
					24.7		2.5	

Annual Traffic Fugitive Dust Emissions (tons/year)					3199		320	

[a] Traffic Estimates are based upon an approximately 14-days construction, 13-days drilling at downhole locations (shallow wells), 26-days drilling at direction wells (shallow wells), 29-days completion, and 6-days infrastructure development per well or well pad as appropriate.
[b] 25,000 barrels/well for completion; 12,000 barrels/well for drilling; assume 160-barrel water truck

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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	1472.0	acres total initial disturbance for roads/pipelines (Proposed Action)
	5,956,963	square meters total initial disturbance for roads/pipelines
	4,390	acres total initial disturbance for well pads and other facilities (Proposed Action)
	17,765,672	square meters total initial disturbance for well pads and other facilities
	5,862	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 and facilities (Assumption, disturbance at construction and reclamation)
	Constant	for dirt roads
Development Period	15 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	3.34	0.00
PM10	1.67	0.00
PM2.5	0.67	0.00

6. Construction Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Construction	100	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	6	(Proposed Action)
Number of Pickup Trips	8	(Proposed Action)
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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\text{ (g/lb)} * \text{Fuel Sulfur Content} * 2\text{ (S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.130	0.095	0.005	3.030	0.047	0.002	0.142	0.671
CO	17.090	0.199	0.010	33.640	0.522	0.026	0.721	3.414
VOC [c]	4.600	0.054	0.003	4.646	0.072	0.004	0.126	0.595
SO_2	0.321	0.004	0.000	0.214	0.003	0.000	0.007	0.033
Greenhouse Gases								
CH_4 [e]	0.230	0.003	0.000	0.184	0.003	0.000	0.006	0.026

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

7. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Operation	840	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	155	(Proposed Action)
Number of Pickup Trips	80	(Proposed Action)
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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ \text{(S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.13	0.291	0.122	3.03	0.056	0.024	0.347	13.846
CO	17.09	0.612	0.257	33.64	0.622	0.261	1.233	49.210
VOC [c]	4.600	0.165	0.069	1.656	0.031	0.013	0.195	7.791
SO_2	0.32	0.011	0.005	0.21	0.004	0.002	0.015	0.617
Greenhouse Gases								
CH_4 [e]	0.230	0.008	0.003	0.184	0.003	0.001	0.012	0.463

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

8. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Operation	140.00	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	203	(Proponent)
Number of Pickup Trips	56	(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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ (\text{g/lb}) * \text{Fuel Sulfur Content} * 2\ (\text{S / SO2})}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.13	2.287	0.160	3.03	0.235	0.016	2.522	16.772
CO	17.09	4.808	0.337	33.64	2.611	0.183	7.418	49.330
VOC [c]	4.600	1.294	0.091	1.656	0.129	0.009	1.423	9.460
SO_2	0.32	0.090	0.006	0.21	0.017	0.001	0.107	0.711
Greenhouse Gases								
CH_4 [e]	0.230	0.065	0.005	0.184	0.014	0.001	0.079	0.524

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

9. Interim Reclamation Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Operation	60	hours per site (Assumption)
Number of Heavy Diesel Truck Trips	1	(Assumption)
Number of Pickup Trips	5	(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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\text{ (g/lb)} * \text{Fuel Sulfur Content} * 2\text{ (S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.13	0.026	0.001	3.03	0.049	0.001	0.075	0.214
CO	17.09	0.055	0.002	33.64	0.544	0.016	0.599	1.702
VOC [c]	4.600	0.015	0.000	1.656	0.027	0.001	0.042	0.118
SO_2	0.32	0.001	0.000	0.21	0.003	0.000	0.004	0.013
Greenhouse Gases								
CH_4 [e]	0.230	0.001	0.000	0.184	0.003	0.000	0.004	0.011

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Hours of Operation	100	hours/site (Proposed Action)
Development Rate	95	new pads per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Backhoe Size	85	hp (Proponent Contractor Typical value)
Crawler Tractor/Loader Size	290	hp (Proponent Contractor Typical value)
Motor Grader Size	185	hp (Proponent Contractor Typical value)

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			Crawler Tractor			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)
NO_x	8.15	0.611	0.579	8.15	2.084	9.869	7.14	1.165	3.309
CO	2.28	0.171	0.162	2.28	0.583	2.761	1.54	0.251	0.714
VOC[c]	0.37	0.028	0.026	0.37	0.095	0.448	0.36	0.059	0.167
PM_{10} [d]	0.5	0.037	0.035	0.5	0.128	0.605	0.63	0.103	0.292
$PM_{2.5}$ [d]	0.5	0.037	0.035	0.5	0.128	0.605	0.63	0.103	0.292
SO_2	0.22	0.016	0.016	0.22	0.056	0.266	0.22	0.036	0.102
Formaldehyde	0.22	0.016	0.016	0.22	0.056	0.266	0.12	0.020	0.056

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions[e] (tons/yr)
NO_x	3.860	13.757
CO	1.005	3.637
VOC[c]	0.181	0.641
PM_{10} [d]	0.268	0.933
$PM_{2.5}$ [d]	0.268	0.933
SO_2	0.109	0.384
Formaldehyde	0.092	0.338

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 construction rate specified by Proponent

11. Drill Rig Engine Emissions

Assumptions:

Hours of Operation	840	hours/ well (Proposed Action)
Development Rate	95	total wells in max year (Proposed Action)
	7%	average time small rig will run per well
Load Factor	0.4	(Assumed typical value)
Rig Size	1000	hp (Estimate - phase 1 drilling)
	2500	hp (Estimate - phase 2 drilling)
	2393	hp (weighted average based on ratio of time in use to drill one well)
Diesel Fuel Sulfur Content	0.05	% (typical value)

Equations:

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

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Drill Rig Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [h] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.024	22.971	917
CO [a]	5.50E-03	5.264	210
VOC [a,b]	7.05E-04	0.675	26.9
PM_{10} [a,c]	5.75E-04	0.550	22.0
$PM_{2.5}$ [a,d]	4.81E-04	0.460	18.4
SO_2 [a]	4.05E-04	0.387	15.4
Hazardous Air Pollutants			
Benzene [e]	1.97E-06	0.002	0.08
Toluene [e]	7.15E-07	0.001	0.03
Xylenes [e]	4.91E-07	4.70E-04	0.02
Formaldehyde [e]	2.01E-07	1.92E-04	0.01
Acetaldehyde [e]	6.41E-08	6.14E-05	2.45E-03
Acrolein [e]	2.01E-08	1.92E-05	7.66E-04
Naphthalene [f]	3.31E-07	3.17E-04	0.01
Total PAH [f,g]	5.40E-07	5.16E-04	0.02
Greenhouse Gases			
CO_2 [a]	1.16	1110.286	44,300
CH_4 [a,b]	7.05E-04	0.675	26.9

[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] 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	6	Hours/Well (Proponents)
Development Rate	95	wells per year (Proposed Action)
Load Factor	0.5	(typical value)
Frac Pump Engine Horsepower	19,000	Horsepower (typical)
Temporary Generator Horsepower	75	Horsepower (typical)
Diesel Fuel Sulfur Content	0.05	% (typical value)

Equations:

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

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Frac Pump Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.024	228.000	65.0
CO [a]	5.50E-03	52.250	14.89
VOC [a,b]	7.05E-04	6.698	1.91
PM_{10} [a,c]	5.73E-04	5.444	1.55
$PM_{2.5}$ [a,d]	4.79E-04	4.551	1.30
SO_2 [a]	4.05E-04	3.843	1.10
Hazardous Air Pollutants			
Benzene [c]	1.97E-06	1.88E-02	5.35E-03
Toluene [c]	7.15E-07	6.79E-03	1.94E-03
Xylenes [c]	4.91E-07	4.67E-03	1.33E-03
Formaldehyde [c]	2.01E-07	1.91E-03	5.44E-04
Acetaldehyde [c]	6.41E-08	6.09E-04	1.74E-04
Acrolein [c]	2.01E-08	1.91E-04	5.43E-05
Naphthalene [f]	3.31E-07	3.14E-03	8.96E-04
Total PAH [f]	5.40E-07	5.13E-03	1.46E-03
Greenhouse Gases			
CO_2 [a]	1.16	11,020	3,141
CH_4 [a]	7.05E-04	6.698	1.91

Species	Generator Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants			
NOx [g]	0.031	1.163	0.33
CO [g]	6.68E-03	0.25	0.07
VOC [b,g]	2.47E-03	0.09	0.03
PM_{10} [g]	2.20E-03	0.08	0.02
$PM_{2.5}$ [g]	2.20E-03	0.08	0.02
SO_2 [g]	2.05E-03	0.08	0.02
Hazardous Air Pollutants			
Benzene [h]	2.37E-06	8.90E-05	2.54E-05
Toluene [h]	1.04E-06	3.90E-05	1.11E-05
Xylenes [h]	7.25E-07	2.72E-05	7.75E-06
Formaldehyde [h]	3.00E-06	1.13E-04	3.21E-05
Acetaldehyde [h]	1.95E-06	7.32E-05	2.09E-05
Acrolein [h]	2.35E-07	8.83E-06	2.52E-06
1,3-Butadiene [h]	9.95E-08	3.73E-06	1.06E-06
Naphthalene [h]	2.16E-07	8.09E-06	2.31E-06
Total PAH [h]	4.28E-07	1.60E-05	4.57E-06
Greenhouse Gases			
CO_2 [g]	1.15	10,925	3,114
CH_4 [b,g]	2.47E-03	23.465	6.69

[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 conversion factor from Appendix A

[i] Assumes maximum development scenario

Buys & Associates, Inc. Environmental Consultants	Project: GASCO Uinta Basin Alternative B Inventory Date: 6/9/2011

13. Well Development Venting

Assumptions: Following Completion, Wells are Vented prior to connnection to the gathering pipeline

Venting Period 48 hours (Project Proponents)

Amount of Vented Gas: 0.2 MMscf (Average Volume Estimated by Proponents)

Development Rate: 95 Wells per year (Project Proponents)

COMPONENT	MOLECULAR WEIGHT (lb/lb-mole)	MOLE PERCENT	RELATIVE MOLE WEIGHT (lb/lb-mole)	WEIGHT Fraction	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (lb/hr)	COMPONENT FLOW RATE (tons/yr)
Methane	16.043	92.713	14.874	0.833	185.426	163.311	372.348
Ethane	30.07	4.078	1.226	0.069	8.156	13.464	30.698
Propane	44.097	1.145	0.505	0.028	2.289	5.542	12.635
i-Butane	58.123	0.248	0.144	0.008	0.496	1.582	3.607
n-Butane	58.123	0.265	0.154	0.009	0.530	1.691	3.854
i-Pentane	72.15	0.118	0.085	0.005	0.236	0.935	2.131
n-Pentane	72.15	0.087	0.063	0.004	0.174	0.689	1.571
Hexanes	86.177	0.000	0.000	0.000	0.000	0.000	0.000
Heptanes	100.204	0.216	0.216	0.012	0.431	2.372	5.408
Octanes	114.231	0.035	0.040	0.002	0.069	0.435	0.992
Nonanes	128.258	0.031	0.039	0.002	0.061	0.430	0.979
Decanes +	142.285	0.007	0.010	0.001	0.014	0.106	0.242
Benzene	78.12	0.021	0.016	0.001	0.042	0.181	0.413
Toluene	92.13	0.035	0.032	0.002	0.070	0.356	0.812
Ethylbenzene	106.16	0.001	0.001	0.000	0.002	0.014	0.032
Xylenes	106.16	0.016	0.017	0.001	0.031	0.183	0.417
n-Hexane	86.177	0.044	0.038	0.002	0.089	0.420	0.958
Helium	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.125	0.035	0.002	0.249	0.384	0.874
Carbon Dioxide	44.01	0.817	0.359	0.020	1.633	3.945	8.996
Oxygen	32	0.000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulfide	34.08	0.000	0.000	0.000	0.000	0.000	0.000
VOC SUBTOTAL		**2.2676**	**1.360**	**0.076**	**4.535**	**14.935**	**34.053**
HAP SUBTOTAL		**0.1176**	**0.105**	**0.006**	**0.235**	**1.154**	**2.631**
TOTAL		**100.000**	**17.855**	**1.000**	**200**	**196.039**	**446.970**

14. Well Development Emissions Summary

Species	Well Development Emissions (tons/year) [a]					Total [a]
	Construction	Drilling	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
Criteria Pollutants & VOC						
NO_x	14.43	930	82.1	0.21		1,027
CO	7.05	259	64	1.70		332
VOC	1.24	34.7	45.4	0.12		81.5
SO_2	0.42	16.1	1.8	0.0		18.3
PM_{10}	85.5	1,468	1,647	25.8	1.7	3,228
$PM_{2.5}$	10.3	163	166	3.1	0.7	343
Hazardous Air Pollutants						
Benzene		0.08	4.18E-01			0.49
Toluene		0.03	8.14E-01			0.84
Ethylbenzene		0	0.03			0.03
Xylenes		0.02	4.19E-01			0.44
n-Hexane			0.958			0.96
Formaldehyde	0.34	0.01	0.001			0.35
Acetaldehyde		2.45E-03	1.95E-04			3.E-03
Acrolein		7.66E-04	5.68E-05			8.E-04
1,3-Butadiene			1.06E-06			1.E-06
Naphthalene		0.01	8.98E-04			0.01
Total PAH, POM 1 [b]		0.02	1.47E-03			0.02
Total HAPs	0.34	0.17	2.64	0.0	0.0	3.15
Greenhouse Gases						
CO_2		44,300	6,263			50,564
CH_4	0.03	27.4	381	0.01		408.9

a Emissions for Peak Field Development
b Polycyclic Aromatic Hydrocarbons (PAH), Polycyclic Organic Matter (POM)

Buys & Associates, Inc. Environmental Consultants	Project: GASCO Uinta Basin Alternative B Inventory Date: 6/9/2011

15. Average Produced Gas Characteristics
Inlet Wet Gas Sample from Riverbend Compressor Station, dated 3/22/07

Gas Heat Value (wet): 1064.1 Btu/scf

C1-C2 Wt. Fraction: 0.9020
VOC Wt. Fraction: 0.0760
Non-HC Wt. Fraction: 0.0221
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	92.7130	16.043	14.874	0.833	1010.000	936.401	910.000	843.688
Ethane	4.0781	30.070	1.226	0.069	1769.800	72.174	1618.000	65.984
Propane	1.1446	44.097	0.505	0.028	2516.200	28.800	2316.000	26.509
i-Butane	0.2479	58.123	0.144	0.008	3252.100	8.062	3005.000	7.449
n-Butane	0.2649	58.123	0.154	0.009	3262.400	8.642	3013.000	7.981
i-Pentane	0.1180	72.150	0.085	0.005	4000.900	4.721	3698.000	4.364
n-Pentane	0.0870	72.150	0.063	0.004	4008.800	3.488	3708.000	3.226
Hexanes	0.0687	86.177	0.059	0.003	4756.200	3.268	4404.000	3.026
Heptanes	0.0737	100.204	0.074	0.004	5502.500	4.055	5100.000	3.759
Methylcyclohexane	0.0509	98.186	0.050	0.003	1865.455	0.880	1729.000	0.880
Octanes	0.0550	114.231	0.063	0.004	6249.100	3.437	1695.970	0.933
2,2,4-TMP	0.0047	114.220	0.005	0.000	6368.594	0.081	1728.400	0.081
Nonanes	0.0305	128.258	0.039	0.002	6996.400	2.134		0.000
Decanes	0.0068	142.285	0.010	0.001	7743.200	0.527		0.000
Benzene	0.0211	78.120	0.016	0.001	3715.500	0.784		0.000
Toluene	0.0352	92.130	0.032	0.002	4444.600	1.564		0.000
Ethylbenzene	0.0012	106.160	0.001	0.000	5191.500	0.062		0.000
Xylenes	0.0157	106.160	0.017	0.001	5183.500	0.814		0.000
n-Hexane	0.0444	86.177	0.038	0.002	4756.200	2.112		0.000
Helium	0.0000	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	0.1247	28.013	0.035	0.002	0.000	0.000	0.000	0.000
Carbon Dioxide	0.8165	44.010	0.359	0.020	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		17.85	1.00		1082.01		967.88

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

Weight Fraction = Net Mole Weight / Total Mole Weight

HAP Fractions estimated from GRI Published Factors

16. Wellsite Heater Emissions

Assumptions

Separator Heater Size	500	Mbtu/hr (Typical size Proposed Action)
Wells Requiring Separators:	1114	wells at Peak Production
Firing Rate	6,480	hours/year (Typical Uinta Basin operation)
Fuel Gas Heat Value	968	Btu/scf (Gas Analyses from Riverbend well)
Fuel Gas VOC Content	0.076	by weight (Gas Analyses from Riverbend Facility)

Equations

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

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

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

Species	Wellsite Heater Emissions - Separators		
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC			
NO_x [a]	100	0.052	186
CO [a]	84	0.043	157
TOC [c]	11	0.006	20.5
VOC	N.A.	0.000	1.56
SO_x [b]	0.00	0.000	0
TSP [c]	7.6	0.004	14.2
PM_{10} [c]	7.6	0.004	14.2
$PM_{2.5}$ [c]	7.6	0.004	14.2
Hazardous Air Pollutants			
Benzene [d]	0.0021	1.1E-06	3.92E-03
Toluene [d]	0.0034	1.8E-06	0.01
Hexane [d]	1.8	9.3E-04	3.36
Formaldehyde [d]	0.075	3.9E-05	0.14
Dichlorobenzene [d]	1.2E-03	6.2E-07	2.24E-03
Naphthalene [d]	6.1E-04	3.2E-07	1.14E-03
POM 2 [d,e,f]	5.9E-05	3.0E-08	1.10E-04
POM 3 [d,g]	1.6E-05	8.3E-09	2.98E-05
POM 4 [d,h]	1.8E-06	9.3E-10	3.36E-06
POM 5 [d,i]	2.4E-06	1.2E-09	4.47E-06
POM 6 [d,j]	7.2E-06	3.7E-09	1.34E-05
POM 7 [d,k]	1.8E-06	9.3E-10	3.36E-06
Greenhouse Gases			
CO_2 [c]	120,000	61.99	223,748
CH_4 [c]	2.3	0.001	4.29

[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

[e] - 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

[f] - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and 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.

[l] - Assumes full development.

17. Wellsite Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate:	2.01	bbls condensate per day (Estimate based on proponent data)
Number of Active Wells:	1114	wells at Peak Production

Separator Conditions 130 psi and 60 F (Riverbend sample)
API Gravity: 58.28

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0
Riverbend Compressor Station Liquid Sample Dated 6/4/07
Scaled from 15.9 bbls per day

Emissions:

Component	Wellsite Flash/Work/Breathing (lb/hr/well)	Wellsite Flash/Work/Breathing (tons/year/well)	Total Emissions (tons/yr)
Total VOC	0.163	0.713	794.5
Hazardous Air Pollutants			
Benzene	1.643E-03	0.007	8.019
Toluene	2.655E-03	0.014	12.95
Ethylbenzene	1.264E-04	0.001	0.617
Xylenes	8.849E-04	0.005	4.318
n-Hexane	4.172E-03	0.018	20.36
Greenhouse Gases			
CO_2	0.033	0.144	160.4
CH_4	0.156	0.683	760.5

Buys & Associates, Inc. Environmental Consultants	Project: GASCO Uinta Basin Alternative B Inventory Date: 6/9/2011

18. VOC Emissions from NGL Truck Loading Operations

NGL Truck Loading/Unloading Emissions: NGL will normally be transported by pipeline, however truck transport may be utilized as a contingency. A pressurized vapor recovery system will be utilized for truck loading. Potential emissions result from the equalization of the loading rack connection to atmospheric pressure after the loading operation is completed.

Assumed Maximum Number of Truck loads/year 4,380

Truck Loading Connection Configuration

	Load Line		
Load Line Connection Diameter =	0.25	ft	(Assumed typical value)
Load Line Length between Valves =	3.0	ft	(Assumed typical value)
Connection Volume =	0.147	ft^3	
Annual Connection Volume Vented =	645	ft^3	
NGL Density =	5.6	lbs/gal	(Assumed typical value)
NGL Density =	41.9	lbs/ft^3	
Annual Wt. NGL Vented =	27,018.1	lbs/year	
NGL VOC Content =	100.0%	by weight (See NGL Composition for Fugitive Emissions)	
VOC Emissions =	13.5	tons/year VOC	

Example Calculations

Connection volume = Pi * $(Diameter)^2/4$ * Length

Annual Volume Vented (ft^3/year) = Connection Volume (ft^3) * Number Truck Loads per year (1/year)

Density ($lbs/ft^{3)}$ = Density (lbs/gal) * 7.48 gal/ft^3

Vented NGL Weight (lbs) = Volume Vented (ft^3) * NGL Density (lbs/ft^3)

VOC Emissions (tons/year) = Annual NGL Vented (lbs/year) * NGL VOC wt. % / 100 / 2000 (lbs/ton)

19. Operations Vehicle Tailpipe Emissions

Assumptions:

Number of New Pumpers:	32	(Proposed Action Number of Pumpers at Peak Production)
Pumper Mileage:	**2,800**	miles/pumper/month (Assumption)
Total Annual New Pumper Mileage:	1,075,200	miles/year
Number of Condensate Haul Truck Round Trips:	14	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for Condensate Transport:	**58**	miles (Estimate from Vernal)
Total Annual Condensate Truck Mileage:	296,380	miles/year
Number of Water Haul Truck Round Trips:	91	trips per day (Based on Peak Production Alternative C)
Average Round Trip Mileage for Water Transport:	17	miles (Average distance to evaporation facility)
Total Annual Water Truck Mileage:	564,655	miles/year
Number of NGL Haul Truck Round Trips:	12	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for NGL Transport:	58	miles (Average distance to evaporation facility)
Total Annual NGL Truck Mileage:	254,040	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:

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

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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * \text{453.6 (g/lb)} * \text{Fuel Sulfur Content} * \text{2 (S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Operations 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)
Criteria Pollutants & VOC								
NO_x	3.03	1.644	3.591	8.13	4.576	7.716	6.220	11.307
CO	33.64	18.255	39.870	17.09	9.618	16.220	27.873	56.090
VOC [c]	1.656	0.899	1.963	4.600	2.589	4.366	3.488	6.329
SO_2	0.21	0.116	0.254	0.32	0.181	0.305	0.297	0.559
Greenhouse Gases								
CH_4 [d]	0.184	0.100	0.218	0.230	0.129	0.218	0.229	0.436

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

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20. Operations Traffic Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006

365 days (Estimate)

Vehicle Type	Ave. Weight (lbs)	Round Trips per Day*
Pickup Truck: Crew	7,000	32
Haul Truck: Oil	48,000	14
Haul Truck: Water	48,000	91
Haul Truck: NGL	48,000	12
Mean Weight	39,195	149

Unpaved Roads

E (PM10) / VMT = 1.5 * (S/12)^0.9 * (W/3)^0.45 * (365-p)/365)
E (PM2.5) / 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) 73 days per year **
Avg. Round Trip Miles 37 miles on unpaved roads ***

Paved Roads

E (PM10) / VMT = 0.016 * (sL/2)^0.65 * (W/3)^1.5 - 0.00047 * (1-(p/(365*4))
E (PM10) / 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 30 From Roosevelt
Precipitation Days (P) 73 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	4,115,925	11,277	0.20	411,593	1128
Paved	0.08	127,393	349	0.01	18,660	51
Total		4,243,318	11,626		430,253	1,179
Annual Traffic Fugitive Dust Emissions (tons/year)		**2,122**			**215**	

*Round trips per day at peak production (Proposed Action)
** NCDC data for Nutters Ranch, UT 1963-1986
*** Weighted average of Pumper,Condensate, NGL, and Water Hauling Distance = (58*(32+14+12+16)+17*(91-16))/149. One round trip to evaporative facility is assumed to take about 2-hours, so 6 trips per day are completed in one 12-hr shift, which requires 16 trucks to do 91 trips.

Buys & Associates, Inc. Environmental Consultants	Project: GASCO Uinta Basin Alternative B Inventory Date: 6/9/2011

21. Pneumatic Device Emissions 0.144 Mscf/day or less = low bleed device

Analysis Gas Consumption Rate:	1.00	Mscf/day
Days of Operation:	365	days/year

GAS COMPONENT	MOLECULAR WEIGHT (lb/lb-mole)	MOLE PERCENT	RELATIVE MOLE WEIGHT (lb/lb-mole)	WEIGHT PERCENT	VOLUME FLOW RATE (Mscf/day)	MASS FLOW RATE (lb/hr)	MASS FLOW RATE (tons/yr)
Methane	16.043	92.7130	14.874	83.334	0.927	1.633	7.153
Ethane	30.07	4.0781	1.226	6.870	0.041	0.135	0.590
Propane	44.097	1.1446	0.505	2.828	0.011	0.055	0.243
i-Butane	58.123	0.2479	0.144	0.807	0.002	0.016	0.069
n-Butane	58.123	0.2649	0.154	0.863	0.003	0.017	0.074
i-Pentane	72.15	0.1180	0.085	0.477	0.001	0.009	0.041
n-Pentane	72.15	0.0870	0.063	0.352	0.001	0.007	0.030
Hexanes	86.177	0.0687	0.059	0.332	0.001	0.007	0.028
Heptanes	100.204	0.1233	0.124	0.692	0.001	0.014	0.059
Octanes	114.231	0.0584	0.067	0.374	0.001	0.007	0.032
Nonanes	128.258	0.0305	0.039	0.219	0.000	0.004	0.019
Decanes +	142.285	0.0068	0.010	0.054	0.000	0.001	0.005
Benzene	78.12	0.0211	0.016	0.092	0.000	0.002	0.008
Toluene	92.13	0.0352	0.032	0.182	0.000	0.004	0.016
Ethylbenzene	106.16	0.0012	0.001	0.007	0.000	0.000	0.001
Xylenes	106.16	0.0157	0.017	0.093	0.000	0.002	0.008
n-Hexane	86.177	0.0444	0.038	0.214	0.000	0.004	0.018
Helium	4.003	0.0000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.1247	0.035	0.196	0.001	0.004	0.017
Carbon Dioxide	44.01	0.8165	0.359	2.013	0.008	0.039	0.173
Oxygen	32	0.0000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulfide	34.08	0.0000	0.000	0.000	0.000	0.000	0.000
VOC SUBTOTAL		**2.268**	**1.354**	**7.586**	**0.023**	**0.149**	**0.651**
HAP SUBTOTAL		**0.118**	**0.105**	**0.589**	**0.001**	**0.012**	**0.051**
TOTAL		**100.000**	**17.849**	**100.000**	**1.000**	**1.960**	**8.584**

	Number of Wells	VOC emissions (tons/year)	Methane emissions (tons/yr)
Alternative B	1,114	261	2868.6

LIQUID LEVEL CONTROLLER SPECIFICATIONS

Gas Consumption Rate:	0.144	Mscf/day	(low-bleed)
Days of Operation:	365	days/year	

TRACE PUMP SPECIFICATIONS

Gas Consumption Rate:	0.144	Mscf/day	Assumed recycle of gas equals low-bleed specification
Days of Operation:	182	days/year	

METHANOL PUMP SPECIFICATIONS

-Solar powered methanol pumps will be installed for the Proposed Action

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.04	0.19
1	Trace pump	0.01	0.05
2	Chemical injection pump	0	0
	Totals (per well) =	0.05	0.23

Pneumatic sources / well		Methane lb/hr	Methane ton/yr
2	Liquid level controllers	0.47	2.06
1	Trace pump	0.24	0.52
2	Chemical injection pump	0	0
	Totals (per well) =	0.71	2.58

22. Well Production Summary

Species	Storage Tanks (tons/yr)	Well Site Heaters (tons/yr)	Operations Vehicle (tons/yr)	Pneumatic Devices (tons/yr)	Total Well Production [a] (tons/yr)
Criteria Pollutants & VOC					
NO_x		186	11.3		198
CO		157	56.1		213
VOC	794	1.56	6.33	261	1,063
SO_2		0	0.56		0.6
PM_{10}		14.2	2,122		2,136
$PM_{2.5}$		14.2	215		229
Hazardous Air Pollutants					
Benzene	8.0	0.00			8.0
Toluene	13	0.01			13
Ethylbenzene	0.62				0.62
Xylene	4.3				4.3
n-Hexane	20	3.36			24
Formaldehyde		0.14			0.14
Dichlorobenzene		2.24E-03			2.24E-03
Naphthalene		1.14E-03			1.14E-03
POM 2[a]		1.10E-04			1.10E-04
POM 3[b]		2.98E-05			2.98E-05
POM 4[c]		3.36E-06			3.36E-06
POM 5[d]		4.47E-06			4.47E-06
POM 6[e]		1.34E-05			1.34E-05
POM 7[f]		3.36E-06			3.36E-06
Total HAPs	46	3.51	0.0		49.8
Greenhouse Gases					
CO_2	160	223,748			223,909
CH_4	761	4.29	0.44	2,869	3,634

[a] - POM (Particulate Organic Matter) 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

[b] - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[c] - POM 4 includes: 3-Methylchloranthrene.

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

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

[f] - POM 7 includes: Chrysene.

[g] Emissions for Peak Field Development

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23. Average Produced Gas Characteristics
Inlet Wet Gas Sample from Riverbend Compressor Station, dated 3/22/07

Gas Heat Value (wet): 1064.1 Btu/scf

Sample Temperature: 77 F
Sample Pressure: 132 psig

C1-C2 Wt. Fraction:	0.9020
VOC Wt. Fraction:	0.0760
Non-HC Wt. Fraction:	0.0221
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	92.7130	16.043	14.874	0.833	1010.000	936.401	910.000	843.688
Ethane	4.0781	30.070	1.226	0.069	1769.800	72.174	1618.000	65.984
Propane	1.1446	44.097	0.505	0.028	2516.200	28.800	2316.000	26.509
i-Butane	0.2479	58.123	0.144	0.008	3252.100	8.062	3005.000	7.449
n-Butane	0.2649	58.123	0.154	0.009	3262.400	8.642	3013.000	7.981
i-Pentane	0.1180	72.150	0.085	0.005	4000.900	4.721	3698.000	4.364
n-Pentane	0.0870	72.150	0.063	0.004	4008.800	3.488	3708.000	3.226
Hexanes	0.0687	86.177	0.059	0.003	4756.200	3.268	4404.000	3.026
Heptanes	0.0737	100.204	0.074	0.004	5502.500	4.055	5100.000	3.759
Methylcyclohexane	0.0509	98.186	0.050	0.003	1865.455	0.880	1729.000	0.880
Octanes+	0.0550	114.231	0.063	0.004	6249.100	3.437	1695.970	0.933
2,2,4-TMP	0.0047	114.220	0.005	0.000	6368.594	0.081	1728.400	0.081
Nonanes	0.0305	128.258	0.039	0.002	6996.400	2.134		0.000
Decanes	0.0068	142.285	0.010	0.001	7743.200	0.527		0.000
Benzene	0.0211	78.120	0.016	0.001	3715.500	0.784		0.000
Toluene	0.0352	92.130	0.032	0.002	4444.600	1.564		0.000
Ethylbenzene	0.0012	106.160	0.001	0.000	5191.500	0.062		0.000
Xylenes	0.0157	106.160	0.017	0.001	5183.500	0.814		0.000
n-Hexane	0.0444	86.177	0.038	0.002	4756.200	2.112		0.000
Helium	0.0000	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	0.1247	28.013	0.035	0.002	0.000	0.000	0.000	0.000
Carbon Dioxide	0.8165	44.010	0.359	0.020	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		17.85	1.00		1082.01		967.88

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

Weight Fraction = Net Mole Weight / Total Mole Weight

24. Central Compression

Assumptions:

Total Existing Compression:	6,615	Horsepower (Riverbend Facility)
Total New Compression:	15,608	Horsepower (Proposed Action)
Total New Generation	1,980	Horsepower (Proposed Action)

Equations:

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

Pollutant	Emission Factor [6] (lb/MMBtu)	Emission Factor (g/hp-hr)	Emissions (lb/hr/engine) [7]	7,804 hp Station Emissions (tons/yr)	7,804 hp Station Emissions (tons/yr)	Total Emissions [8] Proposed Action (tons/yr)
Criteria Pollutants & VOC						
NOx [1]		1.5	3.31	113.0	113.0	226
CO [1,9]		0.1	0.22	7.5	7.5	15.1
VOC [1,10]		0.5	1.10	37.7	37.7	75.4
PM10 [2,3]	9.95E-03	0.037	0.08	2.80	2.80	5.60
PM2.5 [2,3]	9.95E-03	0.037	0.08	2.80	2.80	5.60
SO_2	5.88E-04	0.002	0.00	0.2	0.2	0.33
Hazardous Air Pollutants [10]						
Benzene [2]	4.40E-04	8.224E-04	1.81E-03	0.06	0.06	0.12
Toluene [2]	4.08E-04	7.626E-04	1.68E-03	0.06	0.06	0.11
Ethylbenzene [2]	3.97E-05	7.420E-05	1.64E-04	0.01	0.01	0.01
Xylenes [2]	1.84E-04	3.439E-04	7.58E-04	0.03	0.03	0.05
n-Hexane [2]	1.11E-03	2.075E-03	4.57E-03	0.16	0.16	0.31
Formaldehyde [2,11]	5.28E-02	2.960E-02	6.53E-02	2.23	2.23	4.46
Acetaldehyde [2]	8.36E-03	1.562E-02	3.44E-02	1.18	1.18	2.35
Acrolein [2]	5.14E-03	2.882E-03	6.35E-03	0.22	0.22	0.43
Methanol [2]	2.50E-03	4.673E-03	1.03E-02	0.35	0.35	0.70
1,1,2,2-Tetrachloroethane[2]	4.00E-05	7.476E-05	1.65E-04	0.01	0.01	0.01
1,1,2-Trichloroethane[2]	3.18E-05	5.943E-05	1.31E-04	4.48E-03	4.48E-03	0.01
1,3-Dichloropropene[2]	2.64E-05	4.934E-05	1.09E-04	3.72E-03	3.72E-03	0.01
1,3-Butadiene[2]	2.67E-04	4.990E-04	1.10E-03	0.04	0.04	0.08
2,2,4-Trimethylpentane[2]	2.50E-04	4.673E-04	1.03E-03	0.04	0.04	0.07
Biphenyl[2]	2.12E-04	3.962E-04	8.74E-04	0.03	0.03	0.06
Carbon Tetrachloride[2]	3.67E-05	6.859E-05	1.51E-04	0.01	0.01	0.01
Chlorobenzene[2]	3.04E-05	5.682E-05	1.25E-04	4.28E-03	4.28E-03	8.56E-03
Chloroform[2]	2.85E-05	5.327E-05	1.17E-04	4.01E-03	4.01E-03	8.03E-03
Ethylene Dibromide[2]	4.43E-05	8.280E-05	1.83E-04	0.01	0.01	0.01
Methylene Chloride[2]	2.00E-05	3.738E-05	8.24E-05	2.82E-03	2.82E-03	5.63E-03
Naphthalene[2]	7.44E-05	1.391E-04	3.07E-04	0.01	0.01	0.02
Phenol[2]	2.40E-05	4.486E-05	9.89E-05	3.38E-03	3.38E-03	6.76E-03
Styrene[2]	2.36E-05	4.411E-05	9.72E-05	3.32E-03	3.32E-03	6.65E-03
Tetrachloroethane[2]	2.48E-06	4.635E-06	1.02E-05	3.49E-04	3.49E-04	6.99E-04
Vinyl Chloride[2]	1.49E-05	2.785E-05	6.14E-05	2.10E-03	2.10E-03	4.20E-03
PAH -POM 1[2,4]	2.69E-05	5.028E-05	1.11E-04	3.79E-03	3.79E-03	7.58E-03
POM 2[2,4,5]	5.93E-05	1.109E-04	2.45E-04	0.01	0.01	0.02
Benzo(b)fluoranthene/POM6[2,4]	1.66E-07	3.103E-07	6.84E-07	2.34E-05	2.34E-05	4.68E-05
Chrysene/POM7[2,4]	6.93E-07	1.295E-06	2.86E-06	9.76E-05	9.76E-05	1.95E-04
Greenhouse Gases						
CO2 [2]	110	411	906	30986	30986	61971
CH4 [2]	1.25	4.67	10.3	352	352	704

[1] - Currently permitted emission rates for internal combustion engine

[2] - AP-42 Table 3.2-2 Uncontrolled Emission Factors for 4-Stroke Lean-Burn Engines, 7/00

[3] - PM = sum of PM filterable and PM condensable

[4] - 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

[5] - POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

[6] - Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 8,240 Btu/hp-hr (*3.738)

[7] - Each individual engine estimated at 1,000 hp (Proposed Action)

[8] - Proposed Action Total Annual Emissions for New Compression (21,325 hp)

[9] - CO emission estimate reduced by 95% to reflect reduction by oxidation catalyst.

[10] - VOCs and HAPs emission estimates reduced by 50% to reflect reduction by oxidation catalyst.

[11] - Formaldehyde emission estimates reduced by 85% to reflect reduction by oxidation catalyst.

25. Central TEG Dehydrator Emissions

Assumptions

Peak Field Production Rate: 150 MMscf/day
1114 Active Wells at Peak Production

Gas Composition: Inlet Gas Sample from Riverbend Compresor Station, dated 3/22/07

Inlet Gas Conditions: Inlet gas saturated at 820.0 psig and 86 F

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0
Station emissions = 3*25MMscfd emissions

Controls

Flare > 95% Control Efficiency in order to meet Federal MACT Standards
Condenser Operating Conditions: 86 deg. F, 834.7 psia

Emissions

Species	Central Dehydrator Emissions 75MMscfd Station (tons/year)	Central Dehydrator Emissions 75MMscfd Station (tons/year)	Total Project Emissions (tons/year)
Total VOC	12.02	12.02	24.04
Hazardous Air Pollutants			
Benzene	1.35	1.35	2.70
Toluene	3.82	3.82	7.63
Ethylbenzene	0.19	0.19	0.39
Xylenes	3.90	3.90	7.81
n-Hexane	0.08	0.08	0.17
Greenhouse Gases			
CH_4	6.42	6.42	12.84

26. Central Facility Heater Emissions

Assumptions

Dehydrator Reboiler Heater	750	Mbtu/hr (Typical)
Separator Heater	500	Mbtu/hr (Based on current Riverbend equipment)
Total Heater Requirmement Facility 1	3,750	Mbtu/hr (Proposed Action Estimate, 3-Dehydrator Reboiler Heaters, 3 Separator Heaters)
Total Heater Requirmement Facility 2	3,750	Mbtu/hr (Proposed Action Estimate, 3-Dehydrator Reboiler Heaters, 3 Separator Heaters)
Firing Rate	45	minutes/hour on average for entire year (Typical value)
	6570	hours/year
Fuel Gas Heat Value	968	Btu/scf (Gas Analyses from Riverbend Facility)
Fuel Gas VOC Content	0.076	by weight (Gas Analyses from Riverbend Facility)

Equations

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

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

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

Species	Central Heater Emissions - Facility 1			Central Heater Emissions - Facility 2			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr)	Total Emissions (tons/yr)	Total Emissions (tons/yr)
Criteria Pollutants & VOC							
NO_x [a]	100	0.375	1.232	100	0.375	1.232	2.464
CO [a]	84	0.315	1.035	84	0.315	1.035	2.070
TOC [c]	11	0.041	0.136	11	0.041	0.136	0.271
VOC	N.A.	0.003	0.010	N.A.	0.003	0.010	0.021
SO_x [b]	0.00	0.000	0.000	0.00	0.000	0.000	0.000
TSP [c]	7.6	0.029	0.094	7.6	0.029	0.094	0.187
PM_{10} [c]	7.6	0.029	0.094	7.6	0.029	0.094	0.187
$PM_{2.5}$ [c]	7.6	0.029	0.094	7.6	0.029	0.094	0.187
Hazardous Air Pollutants							
Benzene [d]	2.1E-03	7.88E-06	2.59E-05	2.1E-03	7.88E-06	2.59E-05	5.17E-05
Toluene [d]	3.4E-03	1.28E-05	4.19E-05	3.4E-03	1.28E-05	4.19E-05	8.38E-05
Hexane [d]	1.8E+00	6.75E-03	0.02	1.8E+00	6.75E-03	0.02	0.04
Formaldehyde [d]	7.5E-02	2.81E-04	9.24E-04	7.5E-02	2.81E-04	9.24E-04	1.85E-03
Dichlorobenzene [d]	1.2E-03	4.50E-06	1.48E-05	1.2E-03	4.50E-06	1.48E-05	2.96E-05
Naphthalene [d]	6.1E-04	2.29E-06	7.51E-06	6.1E-04	2.29E-06	7.51E-06	1.50E-05
POM 2 [d,e,f]	5.9E-05	2.21E-07	7.27E-07	5.9E-05	2.21E-07	7.27E-07	1.45E-06
POM 3 [d,g]	1.6E-05	6.00E-08	1.97E-07	1.6E-05	6.00E-08	1.97E-07	3.94E-07
POM 4 [d,h]	1.8E-06	6.75E-09	2.22E-08	1.8E-06	6.75E-09	2.22E-08	4.43E-08
POM 5 [d,i]	2.4E-06	9.00E-09	2.96E-08	2.4E-06	9.00E-09	2.96E-08	5.91E-08
POM 6 [d,j]	7.2E-06	2.70E-08	8.87E-08	7.2E-06	2.70E-08	8.87E-08	1.77E-07
POM 7 [d,k]	1.8E-06	6.75E-09	2.22E-08	1.8E-06	6.75E-09	2.22E-08	4.43E-08
Greenhouse Gases							
CO_2 [c]	120,000	450	1478	120000	450	1478	2957
CH_4 [c]	2.3	0.01	0.03	2.3	0.01	0.03	0.06

[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

[e] - 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

[f] - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and 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.

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

Assumptions:

Average Condensate Production Rate :

Facility 1	1.43	bbls condensate per day (Estimate Based on typical average lifetime condensate well production)
Facility 2	1.43	bbls condensate per day (Estimate Based on typical average lifetime condensate well production)

Separator Conditions : 130 psi and 60 F (Sample Conditions)
API Gravity: 53.4

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0 Run Date 7/30/08
Riverbend Compressor Station Liquid Sample Dated 3/22/07
Scaled from 15.9 bbls per day
Controlled 95% efficiency

Emissions:

Component	Facility 1 Flash/Work/Breathing (tons/yr)	Facility 2 Flash/Work/Breathing (tons/yr)	Total Emissions (tons/yr)
Total VOC	0.039	0.039	0.08
Hazardous Air Pollutants			
Benzene	3.040E-04	3.040E-04	6.080E-04
Toluene	5.083E-04	5.083E-04	1.017E-03
Ethylbenzene	2.38E-05	2.38E-05	4.75E-05
Xylenes	1.805E-04	1.805E-04	3.61E-04
n-Hexane	8.028E-04	8.028E-04	1.606E-03
Greenhouse Gases			
CO_2	5.938E-03	5.938E-03	0.01
CH_4	0.025	0.025	0.05

28. Central Facility Emission Summary

Central Facility 1

Pollutant	Central Compression Emissions 7,804 hp (tons/year)	Central Dehydrator Emissions 75MMscfd (tons/year)	Central Heater Emissions 3,000 MBtu/hr (tons/year)	Central Condensate Tank Emissions 1.43 bbl/d (tons/year)	Central Dewpoint Skid Emissions (tons/year)	Total Facility Emissions (tons/year)
Criteria Pollutants & VOC						
NO_x	113		1.23			114
CO	7.5		1.03			8.6
VOC	37.7	12.0	0.01	0.04	6.75	57
SO_2	0.17		0			0.17
PM_{10}	2.80		0.09			2.90
$PM_{2.5}$	2.80		0.09			2.90
Hazardous Air Pollutants						
Benzene	0.06	1.35	2.59E-05	3.04E-04		1
Toluene	0.06	3.82	4.19E-05	5.08E-04		3.9
Ethylbenzene	5.59E-03	0.19		2.38E-05		0.20
Xylene	0.03	3.90		1.81E-04		3.93
n-Hexane	0.16	0.08	0.02	8.03E-04		0.3
Formaldehyde	2.23		9.24E-04			2.2
Acetaldehyde	1.18					1.18
Acrolein	0.22					0.22
Methanol	0.35					0.35
1,1,2,2-Tetrachloroethane	5.63E-03					0.01
1,1,2-Trichloroethane	4.48E-03					0.00
1,3-Dichloropropene	3.72E-03					0.00
1,3-Butadiene	0.04					0.04
2,2,4-Trimethylpentane	0.04					0.04
Biphenyl	0.03					0.03
Carbon Tetrachloride	5.17E-03					0.01
Chlorobenzene	4.28E-03					0.00
Chloroform	4.01E-03					0.00
Dichlorobenzene			1.48E-05			0.00
Ethylene Dibromide	6.24E-03					0.01
Methylene Chloride	2.82E-03					0.00
Naphthalene	0.01		7.51E-06			0.01
Phenol	3.38E-03					0.00
Styrene	3.32E-03					0.00
Tetrachloroethane	3.49E-04					0.00
Vinyl Chloride	2.10E-03					0.00
PAH -POM 1*	3.79E-03					0.00
POM 2*	8.36E-03		7.27E-07			0.01
POM 3*			1.97E-07			1.97E-07
POM 4*			2.22E-08			2.22E-08
POM 5*			2.96E-08			2.96E-08
Benzo(b)fluoranthene/POM	2.34E-05		8.87E-08			2.35E-05
Chrysene/POM7*	9.76E-05		2.22E-08			9.76E-05
Total HAPs	4.46	9.3	0.02	1.82E-03		11.9
Greenhouse Gases						
CO_2	30,986		1,478	0.01		32,464
CH_4	352	6.4	0.03	0.02		359

Central Facility 2

Pollutant	Central Compression Emissions 7,804 hp (tons/year)	Central Dehydrator Emissions 75MMscfd (tons/year)	Central Heater Emissions 3,000 MBtu/hr (tons/year)	Central Condensate Tank Emissions 1.43 bbl/d (tons/year)	Central Dewpoint Skid Emissions (tons/year)	Total Facility Emissions (tons/year)
Criteria Pollutants & VOC						
NO_x	113		1.23			114
CO	7.5		1.03			9
VOC	37.7	12.0	0.01	0	6.75	57
SO_2	0.17		0.00			0.17
PM_{10}	2.80		0.09			2.90
$PM_{2.5}$	2.80		0.09			2.90
Hazardous Air Pollutants						
Benzene	0.06	1.35	2.59E-05	0.00		1.41
Toluene	0.06	3.82	4.19E-05	0.00		3.9
Ethylbenzene	0.01	0.19		0.00		0.20
Xylene	0.03	3.90		0.00		3.93
n-Hexane	0.16	0.08	0.02	0.00		0.3
Formaldehyde	2.23		9.24E-04			2.2
Acetaldehyde	1.18					1.18
Acrolein	0.22					0.22
Methanol	0.35					0.35
1,1,2,2-Tetrachloroethane	0.01					0.01
1,1,2-Trichloroethane	4.48E-03					4.48E-03
1,3-Dichloropropene	3.72E-03					3.72E-03
1,3-Butadiene	0.04					0.04
2,2,4-Trimethylpentane	0.04					0.04
Biphenyl	0.03					0.03
Carbon Tetrachloride	0.01					0.01
Chlorobenzene	4.28E-03					4.28E-03
Chloroform	4.01E-03					4.01E-03
Dichlorobenzene			1.48E-05			1.48E-05
Ethylene Dibromide	0.01					0.01
Methylene Chloride	2.82E-03					2.82E-03
Naphthalene	0.01		7.51E-06			0.01
Phenol	3.38E-03					3.38E-03
Styrene	3.32E-03					3.32E-03
Tetrachloroethane	3.49E-04					3.49E-04
Vinyl Chloride	2.10E-03					2.10E-03
PAH -POM 1*	3.79E-03					3.79E-03
POM 2*	0.01		7.27E-07			0.01
POM 3*			1.97E-07			1.97E-07
POM 4*			2.22E-08			2.22E-08
POM 5*			2.96E-08			2.96E-08
Benzo(b)fluoranthene/POM	2.34E-05		8.87E-08			2.35E-05
Chrysene/POM7*	9.76E-05		2.22E-08			9.76E-05
Total HAPs	4.46	9.35	0.02	0.0		11.9
Greenhouse Gases						
CO_2	30,986		1,478	0.0		32,464
CH_4	352	6.4	0.03	0		359

Buys & Associates, Inc. Environmental Consultants	Project:	GASCO Uinta Basin Alternative B Inventory
	Date:	6/9/2011

29. Evaporation Facility

Assumptions:

Total New Generation: 1,980 Horsepower (Proposed Action)

Evaporation Emissions conservatively estimated using mass balance
-methanol designated as a VOC

Equations:

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

Pollutant	Engine Emission Factor [6] (lb/MMBtu)	Engine Emission Factor (g/hp-hr) [1]	Engine Emissions (lb/hr) [1]	Engine Emissions (tons/yr)	Evaporation Emissions (tons/yr)[7]	Total Evaporation Facility Emissions (tons/yr)
Criteria Pollutants & VOC						
NOx		1.0	4.37	19.1		19.1
CO		2.0	8.73	38.2		38.2
VOC		1.0	4.37	19.12	837.4	856.5
PM10 [2,3]	9.95E-03	0.036	0.16	0.69		0.7
PM2.5 [2,3]	9.95E-03	0.036	0.16	0.69		0.7
SO_2	5.88E-04	0.002	0.01	0.04		0.0
Hazardous Air Pollutants						
Benzene [2]	4.40E-04	1.598E-03	0.01	0.03	5.2	5.23
Toluene [2]	4.08E-04	1.482E-03	0.01	0.03	12.5	12.53
Ethylbenzene [2]	3.97E-05	1.442E-04	6.3E-04	0.00	0.5	0.47
Xylenes [2]	1.84E-04	6.683E-04	2.9E-03	0.01	10.4	10.41
n-Hexane [2]	1.11E-03	4.032E-03	1.8E-02	0.08		0.08
Formaldehyde [2]	5.28E-02	1.918E-01	0.84	3.67		3.67
Acetaldehyde [2]	8.36E-03	3.036E-02	0.13	0.58		0.58
Acrolein [2]	5.14E-03	1.867E-02	0.08	0.36		0.36
Methanol [2]	2.50E-03	9.080E-03	0.04	0.17	756.1	756.27
1,1,2,2-Tetrachloroethane[2]	4.00E-05	1.453E-04	6.34E-04	0.00		0.00
1,1,2-Trichloroethane[2]	3.18E-05	1.155E-04	5.04E-04	0.00		0.00
1,3-Dichloropropene[2]	2.64E-05	9.588E-05	4.19E-04	1.83E-03		0.00
1,3-Butadiene[2]	2.67E-04	9.697E-04	4.23E-03	0.02		0.02
2,2,4-Trimethylpentane[2]	2.50E-04	9.080E-04	3.96E-03	0.02		0.02
Biphenyl[2]	2.12E-04	7.700E-04	3.36E-03	0.01		0.01
Carbon Tetrachloride[2]	3.67E-05	1.333E-04	5.82E-04	2.55E-03		0.00
Chlorobenzene[2]	3.04E-05	1.104E-04	4.82E-04	2.11E-03		0.00
Chloroform[2]	2.85E-05	1.035E-04	4.52E-04	1.98E-03		0.00
Ethylene Dibromide[2]	4.43E-05	1.609E-04	7.02E-04	3.08E-03		0.00
Methylene Chloride[2]	2.00E-05	7.264E-05	3.17E-04	1.39E-03		0.00
Naphthalene[2]	7.44E-05	2.702E-04	1.18E-03	0.01		0.01
Phenol[2]	2.40E-05	8.717E-05	3.80E-04	1.67E-03		0.00
Styrene[2]	2.36E-05	8.572E-05	3.74E-04	1.64E-03		0.00
Tetrachloroethane[2]	2.48E-06	9.007E-06	3.93E-05	1.72E-04		0.00
Vinyl Chloride[2]	1.49E-05	5.412E-05	2.36E-04	1.03E-03		0.00
PAH -POM 1[2,4]	2.69E-05	9.770E-05	4.26E-04	1.87E-03		0.00
POM 2[2,4,5]	5.93E-05	2.156E-04	9.41E-04	4.12E-03		0.00
Benzo(b)fluoranthene/POM6[2,4]	1.66E-07	6.029E-07	2.63E-06	1.15E-05		0.00
Chrysene/POM7[2,4]	6.93E-07	2.517E-06	1.10E-05	4.81E-05		0.00
Greenhouse Gases						
CO2 [2]	110	400	1,743.94	7639		7638.6
CH4 [2]	1.25	4.54	19.82	86.8		86.8

[1] - Currently permitted emission rates for internal combustion engine

[2] - AP-42 Table 3.2-2 Uncontrolled Emission Factors for 4-Stroke Lean-Burn Engines, 7/00

[3] - PM = sum of PM filterable and PM condensable

[4] - 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

[5] - POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

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

[7] - BTEX emissions controlled by a minimum of 60 %

30. Total Project Production Related Emissions Summary

Pollutant	Well Production Emissions (tons/year)	Central Facility 1 Emissions (tons/year)	Central Facility 2 Emissions (tons/year)	Evaporation Facility Emissions (tons/year)	Total Production Emissions [h] (tons/year)
Criteria Pollutants & VOC					
NO_x	198	114	114	19.1	445
CO	213	8.57	8.57	38.2	268
VOC	1,063	57	57	856.5	2,033
SO_2	0.56	0.17	0.17	0.04	0.93
PM_{10}	2,136	2.90	2.90	0.69	2,142
$PM_{2.5}$	229	2.90	2.90	0.69	236
Hazardous Air Pollutants					
Benzene	8.0	1.41	1.41	5.23	16.1
Toluene	13.0	3.9	3.9	12.53	33
Ethylbenzene	0.62	0.20	0.20	4.73E-01	1.49
Xylene	4.3	3.93	3.93	10.41	22.6
n-Hexane	23.7	0.3	0.3	0.08	24
Formaldehyde	0.14	2.2	2.2	3.67	8.3
Acetaldehyde	0	1.18	1.18	0.58	2.94
Acrolein	0	0.22	0.22	0.36	0.79
Methanol	0	0.35	0.35	756.27	756.98
1,1,2,2-Tetrachloroethane	0	5.63E-03	5.63E-03	2.78E-03	0.01
1,1,2-Trichloroethane	0	4.48E-03	4.48E-03	2.21E-03	0.01
1,3-Dichloropropene	0	3.72E-03	3.72E-03	1.83E-03	0.01
1,3-Butadiene	0	0.04	0.04	0.02	0.09
2,2,4-Trimethylpentane	0	0.04	0.04	0.02	0.09
Biphenyl	0	0.03	0.03	0.01	0.07
Carbon Tetrachloride	0	5.17E-03	5.17E-03	2.55E-03	0.01
Chlorobenzene	0	4.28E-03	4.28E-03	2.11E-03	0.01
Chloroform	0	4.01E-03	4.01E-03	1.98E-03	0.01
Dichlorobenzene	2.24E-03	1.48E-05	1.48E-05	0	0
Ethylene Dibromide	0	6.24E-03	6.24E-03	3.08E-03	0.02
Methylene Chloride	0	2.82E-03	2.82E-03	1.39E-03	0.01
Naphthalene	1.14E-03	0.01	0.01	5.17E-03	0.03
Phenol	0	3.38E-03	3.38E-03	1.67E-03	0.01
Styrene	0	3.32E-03	3.32E-03	1.64E-03	0.01
Tetrachloroethane	0	3.49E-04	3.49E-04	1.72E-04	0
Vinyl Chloride	0	2.10E-03	2.10E-03	1.03E-03	0.01
PAH -POM 1[a]	0	3.79E-03	3.79E-03	1.87E-03	0.01
POM 2[b]	1.10E-04	0.01	0.01	4.12E-03	0.02
POM 3[c]	2.98E-05	1.97E-07	1.97E-07	0	0
POM 4[d]	3.36E-06	2.22E-08	2.22E-08	0	0
POM 5[e]	4.47E-06	2.96E-08	2.96E-08	0	0
Benzo(b)fluoranthene/POM6[f]	1.34E-05	2.35E-05	2.35E-05	1.15E-05	0
Chrysene/POM7[g]	3.36E-06	9.76E-05	9.76E-05	4.81E-05	0
Total HAPs	50	13.8	13.8	789.68	867
Greenhouse Gases					
CO_2	223,909	32,464	32,464	7,639	296,475
CH_4	3,634	359	359	86.8	4,438

a Polycyclic Aromatic Hydrocarbons (PAH), Polycyclic Organic Matter (POM)

b - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene,

[c] - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[d] - POM 4 includes: 3-Methylchloranthrene.

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

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

[g] - POM 7 includes: Chrysene.

h Emissions for Peak Field Development

31. Total Project Emissions Summary

Pollutant	Project Emissions (tons/year)		Total Emissions [h] (tons/year)
	Well Development	Project Production	
Criteria Pollutants & VOC			
NO_x	1,027	445	1,473
CO	332	268	600
VOC	81.5	2,033	2,114
SO_2	18.3	0.93	19
PM_{10}	3,228	2,142	5,370
$PM_{2.5}$	343	236	579
Hazardous Air Pollutants			
Benzene	0.49	16.1	16.6
Toluene	0.84	33.2	34
Ethylbenzene	0.03	1.49	1.5
Xylene	0.44	22.6	23
n-Hexane	0.96	24.3	25
Formaldehyde	0.35	8.27	8.6
Acetaldehyde	2.64E-03	2.94	2.9
Acrolein	8.23E-04	0.79	0.8
Methanol	0	756.98	757.0
1,1,2,2-Tetrachloroethane	0	0.01	1.E-02
1,1,2-Trichloroethane	0	0.01	1.E-02
1,3-Dichloropropene	0	0.01	9.E-03
1,3-Butadiene	1.06E-06	0.09	0.1
2,2,4-Trimethylpentane	0	0.09	0.1
Biphenyl	0	0.07	0.1
Carbon Tetrachloride	0	0.01	1.E-02
Chlorobenzene	0	0.01	1.E-02
Chloroform	0	0.01	1.E-02
Dichlorobenzene	0	2.27E-03	2.E-03
Ethylene Dibromide	0	0.02	2.E-02
Methylene Chloride	0	0.01	7.E-03
Naphthalene	0.01	0.03	4.E-02
Phenol	0	0.01	8.E-03
Styrene	0	0.01	8.E-03
Tetrachloroethane	0	8.71E-04	9.E-04
Vinyl Chloride	0	5.23E-03	5.E-03
PAH -POM 1[a]	0.02	0.01	3.E-02
POM 2[b]	0	0.02	2.E-02
POM 3[c]	0	3.02E-05	3.E-05
POM 4[d]	0	3.40E-06	3.E-06
POM 5[e]	0	4.53E-06	5.E-06
Benzo(b)fluoranthene/POM6	0	7.19E-05	7.E-05
Chrysene/POM7[g]	0	2.47E-04	2.E-04
Total HAPs	3.15	867.1	870
Greenhouse Gases			
CO_2	50,564	296,475	347,039
CH_4	409	4,438	4,847

a Polycyclic Aromatic Hydrocarbons (PAH), Polycyclic Organic Matter (POM)

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

[c] - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[d] - POM 4 includes: 3-Methylchloranthrene.

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

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

[g] - POM 7 includes: Chrysene.

h Emissions for Peak Field Development

1. Well Pad/Access Road/Pipeline Construction Fugitive Dust Emissions

Assumptions:

Pieces of Equipment	Hours of Construction
- 1 Backhoe	20 hours per well pad
- 1 Dozer/Crawler Tractor	100 hours per well pad

Watering Control Efficiency	50	percent
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

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 = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM15/hour/piece of equipment

	Fugitive Dust Emissions [a]		
	lbs/hr	**tons/well**	**tons/yr [b]**
TSP	1.97	0.1182	15.61
PM15	0.50	0.0301	3.97
PM10	0.38	0.0226	2.98
PM2.5	0.21	0.0124	1.64

a Backhoe/Grader/Loader emissions are conservatively estimated as equivalent to Bulldozing emissions.

b Assumes construction rate specified by Proponent

Note: The majority of new pipeline will be installed adjacent to proposed access roads and will not result significant additional surface disturbance.

2. Well Pad/Road/Pipeline Construction Emissions (Grader)

Assumptions:

Grading Length	3.03	0.28 miles/road plus 0.46 miles pipeline plus 1.74 miles on 225' x400' pad (10 ft swath for 400 ft * 23 lengths) = 9,200 ft = 1.74 miles
Hours of Construction	6	day grading per well pad and road (Estimate)
	10	hours/day
	60	hours per well pad
Watering Control Efficiency	50	percent
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 10/98)
Distance Graded	3.03	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

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 = 8.15 lbs TSP/well

Emissions = 3.90 lbs PM15/well

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well**	**tons/well**	**tons/yr [a]**
TSP	8.15	0.14	0.0041	0.54
PM15	3.90	0.07	0.0020	0.26
PM10	2.34	0.04	0.0012	0.15
PM2.5	0.25	4.2E-03	0.0001	0.02

a Assumes maximum development scenario

3. Interim Reclamation Fugitive Dust Emissions

Assumptions:

Hours of Construction	5	days per well pad (Estimate)
	12	hours/day
	60	hours per well pad
Pieces of Equipment	1	- Dozer
Watering Control Efficiency	50	percent
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

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 = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM15/hour/piece of equipment

	Fugitive Dust Emissions [a]		
	lbs/hr	tons/well	tons/yr [b]
TSP	1.97	0.0591	7.80
PM15	0.50	0.0151	1.99
PM10	0.38	0.0113	1.49
PM2.5	0.21	0.0062	0.82

a Backhoe/Grader/Loader emissions are conservatively estimated as equivalent to Bulldozing emissions.

b Assumes construction rate specified by Proponent

Note: The majority of new pipeline will be installed adjacent to proposed access roads and will not result significant additional surface disturbance.

Buys & Associates, Inc.
Environmental Consultants

Project: GASCO Uinta Basin Alternative C Inventory

4. Unpaved Road Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006

E (PM10) / VMT = 1.5 * (S/12)^0.9 * (W/3)^0.45 * (365-p)/365)
E (PM2.5) / 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 **58**
Precipitation Days (P) 73 days per year (NCDC data, Nutters Ranch, UT 1963-1986)

		Average	Round					
	Vehicle Type	**Weight**	**Trips per**	**PM10**	**PM10/Pad**	**PM10/Pad**	**PM2.5/Pad**	**PM2.5/Pad**
		(lbs)	**Well a**	**(lb/VMT)**	**(lbs)**	**(lb/day)**	**(lbs)**	**(lb/day)**
Construction (days/pad and road)	10							
	Haul Trucks	80,000	5					
	Water Trucks	60,000	1					
	Light Trucks	20,000	8					
	Mean Vehicle Weight	44,286	14	2.140031	1737.7	173.8	173.8	17.4
					PM10/Annual Pads		**PM2.5/Annual Pads**	
					(tons)		**(tons)**	
					114.7		11.5	

		Average	Round					
	Vehicle Type	**Weight**	**Trips per**	**PM10**	**PM10/Well**	**PM10/Well**	**PM2.5/Well**	**PM2.5/Well**
		(lbs)	**Well a**	**(lb/VMT)**	**(lbs)**	**(lb/day)**	**(lbs)**	**(lb/day)**
Drilling, Downhole (days/well)	35							
	Haul Trucks	80,000	70					
	Logging/Mud Trucks	70,000	10.0					
	Water Trucks b	60,000	75.0					
	Light Trucks	8,000	80					
	Mean Vehicle Weight	48,681	235	2.2331227	30437	869.6	3043.7	87.0
					PM10/Annual Wells		**PM2.5/Annual Wells**	
					(tons)		**(tons)**	
					2008.9		200.9	

		Average	Round					
	Vehicle Type	**Weight**	**Trips per**	**PM10**	**PM10/Well**	**PM10/Well**	**PM2.5/Well**	**PM2.5/Well**
		(lbs)	**Well a**	**(lb/VMT)**	**(lbs)**	**(lb/day)**	**(lbs)**	**(lb/day)**
Completion (days/well)	14							
	Semi/Transport/Water/Sand	80,000	46					
	Water Trucks b	60,000	157					
	Light Trucks	8,000	56					
	Mean Vehicle Weight	52,309	259	2.3065367	34649	2474.9	3464.9	247.5
					PM10/Annual Wells		**PM2.5/Annual Wells**	
					(tons)		**(tons)**	
					2287		228.7	

		Average	Round					
	Vehicle Type	**Weight**	**Trips per**	**PM10**	**PM10/Day**	**PM10/Day**	**PM2.5/Day**	**PM2.5/Day**
		(lbs)	**Well a**	**(lb/VMT)**	**(lbs)**	**(lb/day)**	**(lbs)**	**(lb/day)**
Interim Reclamation (days/well)	5							
	Haul Trucks	80,000	1					
	Light Trucks	8,000	5					
	Mean Vehicle Weight	20,000	6	1.4964593	521	104.2	52.1	10.4
					PM10/Annual Wells		**PM2.5/Annual Wells**	
					(tons)		**(tons)**	
					34.4		3.4	
Annual Traffic Fugitive Dust Emissions (tons/year)					**4445**		**444.5**	

[a] Traffic Estimates are based upon an approximately 14-days construction, 13-days drilling at downhole locations (shallow wells), 26-days drilling at direction wells (shallow wells), 29-days completion, and 6-days infrastructure development per well or well pad as appropriate.
[b] 25,000 barrels/well for completion; 12,000 barrels/well for drilling; assume 160-barrel water truck

Buys & Associates, Inc. **Environmental Consultants**	Project: GASCO Uinta Basin Alternative C Inventory Date: 6/2/2011

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	2957.0	acres total initial disturbance for roads/pipelines (Proposed Action)
	11,966,535	square meters total initial disturbance for roads/pipelines
	7,442	acres total initial disturbance for well pads and other facilities (Proposed Action)
	30,116,658	square meters total initial disturbance for well pads and other facilities
	10,399	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 and facilities (Assumption, disturbance at construction and reclamation)
	Constant	for dirt roads
Development Period	15	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	5.66	0.00
PM10	2.83	0.00
PM2.5	1.13	0.00

6. Construction Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Construction	100	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	6	(Proposed Action)
Number of Pickup Trips	8	(Proposed Action)
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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.130	0.095	0.005	3.030	0.047	0.002	0.142	0.935
CO	17.090	0.199	0.010	33.640	0.522	0.026	0.721	4.759
VOC [c]	4.600	0.054	0.003	4.646	0.072	0.004	0.126	0.829
SO_2	0.321	0.004	0.000	0.214	0.003	0.000	0.007	0.047
Greenhouse Gases								
CH_4 [e]	0.230	0.003	0.000	0.184	0.003	0.000	0.006	0.037

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

7. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Operation	840	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	155	(Proposed Action)
Number of Pickup Trips	80	(Proposed Action)
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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\text{ (g/lb)} * \text{Fuel Sulfur Content} * 2\text{ (S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.13	0.291	0.122	3.03	0.056	0.024	0.347	19.239
CO	17.09	0.612	0.257	33.64	0.622	0.261	1.233	68.377
VOC [c]	4.600	0.165	0.069	1.656	0.031	0.013	0.195	10.826
SO_2	0.32	0.011	0.005	0.21	0.004	0.002	0.015	0.857
Greenhouse Gases								
CH_4 [e]	0.230	0.008	0.003	0.184	0.003	0.001	0.012	0.645

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

8. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Operation	140.00	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	203	(Proponent)
Number of Pickup Trips	56	(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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\text{ (g/lb)} * \text{Fuel Sulfur Content} * 2\text{ (S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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/br)	Emissions (tons/yr)
Criteria Pollutants & VOC								
NO_x	8.13	2.287	0.160	3.03	0.235	0.016	2.522	23.305
CO	17.09	4.808	0.337	33.64	2.611	0.183	7.418	68.542
VOC [c]	4.600	1.294	0.091	1.656	0.129	0.009	1.423	13.144
SO_2	0.32	0.090	0.006	0.21	0.017	0.001	0.107	0.988
Greenhouse Gases								
CH_4 [e]	0.230	0.065	0.005	0.184	0.014	0.001	0.079	0.730

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

9. Development Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Operation	60	hours per site (Assumption)
Number of Heavy Diesel Truck Trips	1	(Assumption)
Number of Pickup Trips	5	(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:

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

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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * \text{453.6 (g/lb)} * \text{Fuel Sulfur Content} * \text{2 (S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.13	0.026	0.001	3.03	0.049	0.001	0.075	0.298
CO	17.09	0.055	0.002	33.64	0.544	0.016	0.599	2.372
VOC [c]	4.600	0.015	0.000	1.656	0.027	0.001	0.042	0.165
SO_2	0.32	0.001	0.000	0.21	0.003	0.000	0.004	0.018
Greenhouse Gases								
CH_4 [e]	0.230	0.001	0.000	0.184	0.003	0.000	0.004	0.015

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Hours of Operation	100	hours/site (Proposed Action)
Development Rate	132	new pads per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Backhoe Size	85	hp (Proponent Contractor Typical value)
Crawler Tractor/Loader Size	290	hp (Proponent Contractor Typical value)
Motor Grader Size	185	hp (Proponent Contractor Typical value)

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			Crawler Tractor			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)
NO_x	8.15	0.611	0.806	8.15	2.084	13.756	7.14	1.165	4.613
CO	2.28	0.171	0.226	2.28	0.583	3.848	1.54	0.251	0.995
VOC[c]	0.37	0.028	0.037	0.37	0.095	0.624	0.36	0.059	0.233
PM_{10}[d]	0.5	0.037	0.049	0.5	0.128	0.844	0.63	0.103	0.407
$PM_{2.5}$[d]	0.5	0.037	0.049	0.5	0.128	0.844	0.63	0.103	0.407
SO_2	0.22	0.016	0.022	0.22	0.056	0.371	0.22	0.036	0.142
Formaldehyde	0.22	0.016	0.022	0.22	0.056	0.371	0.12	0.020	0.078

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions[e] (tons/yr)
NO_x	3.860	19.175
CO	1.005	5.069
VOC[c]	0.181	0.894
PM_{10}[d]	0.268	1.300
$PM_{2.5}$[d]	0.268	1.300
SO_2	0.109	0.535
Formaldehyde	0.092	0.471

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 construction rate specified by Proponent

11. Drill Rig Engine Emissions

Assumptions:

Hours of Operation	840	hours/ well (Estimate based on Proposed Action)
Development Rate	132	total wells in max year (Proposed Action)
	7%	average time small rig will run per well
Load Factor	0.4	(Assumed typical value)
Rig Size	1000	hp (Estimate - phase 1 drilling)
	2500	hp (Estimate - phase 2 drilling)
	2393	hp (weighted average based on ratio of time in use to drill one well)
Diesel Fuel Sulfur Content	0.05	% (typical value)

Equations:

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

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Drill Rig Emissions		
	E. Factor [a] (lb/hp-hr)	Emissions (lb/hr)	Emissions [e] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.024	22.971	1,274
CO [a]	5.50E-03	5.264	292
VOC [a,b]	7.05E-04	0.675	37.4
PM_{10} [a,c]	5.75E-04	0.550	30.5
$PM_{2.5}$ [a,d]	4.81E-04	0.460	25.5
SO_2 [a]	4.05E-04	0.387	21.5
Hazardous Air Pollutants			
Benzene [e]	1.97E-06	0.002	0.10
Toluene [e]	7.15E-07	0.001	0.04
Xylenes [e]	4.91E-07	4.70E-04	0.03
Formaldehyde [e]	2.01E-07	1.92E-04	0.01
Acetaldehyde [e]	6.41E-08	6.14E-05	3.40E-03
Acrolein [e]	2.01E-08	1.92E-05	1.06E-03
Naphthalene [f]	3.31E-07	3.17E-04	0.02
Total PAH [f,g]	5.40E-07	0.001	0.03
Greenhouse Gases			
CO_2 [a]	1.16	1110.286	61,554
CH_4 [a,b]	7.05E-04	0.675	37.4

[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] 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	6	Hours/Well (Proponents)
Development Rate	132	wells per year (Proposed Action)
Load Factor	0.5	(typical value)
Frac Pump Engine Horsepower	19,000	Horsepower (typical)
Temporary Generator Horsepower	75	Horsepower (typical)
Diesel Fuel Sulfur Content	0.05	% (typical value)

Equations:

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

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Frac Pump Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.024	228.00	90.3
CO [a]	5.50E-03	52.25	20.69
VOC [a,b]	7.05E-04	6.698	2.65
PM_{10} [a,c]	5.73E-04	5.444	2.16
$PM_{2.5}$ [a,d]	4.79E-04	4.551	1.80
SO_2 [a]	4.05E-04	3.843	1.522
Hazardous Air Pollutants			
Benzene [e]	1.97E-06	1.88E-02	7.43E-03
Toluene [e]	7.15E-07	6.79E-03	2.69E-03
Xylenes [e]	4.91E-07	4.67E-03	1.85E-03
Formaldehyde [e]	2.01E-07	1.91E-03	7.55E-04
Acetaldehyde [e]	6.41E-08	6.09E-04	2.41E-04
Acrolein [e]	2.01E-08	1.91E-04	7.54E-05
Naphthalene [f]	3.31E-07	3.14E-03	1.24E-03
Total PAH [f]	5.40E-07	5.13E-03	2.03E-03
Greenhouse Gases			
CO_2 [a]	1.16	11,020	4,364
CH_4 [a]	7.05E-04	6.698	2.65

Species	Generator Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants			
NOx [g]	0.031	1.163	0.46
CO [g]	6.68E-03	0.25	0.10
VOC [b,g]	2.47E-03	0.09	0.04
PM_{10} [g]	2.20E-03	0.08	0.03
$PM_{2.5}$ [g]	2.20E-03	0.08	0.03
SO_2 [g]	2.05E-03	0.08	0.03
Hazardous Air Pollutants			
Benzene [h]	2.37E-06	8.90E-05	3.53E-05
Toluene [h]	1.04E-06	3.90E-05	1.55E-05
Xylenes [h]	7.25E-07	2.72E-05	1.08E-05
Formaldehyde [h]	3.00E-06	1.13E-04	4.46E-05
Acetaldehyde [h]	1.95E-06	7.32E-05	2.90E-05
Acrolein [h]	2.35E-07	8.83E-06	3.50E-06
1,3-Butadiene [h]	9.95E-08	3.73E-06	1.48E-06
Naphthalene [h]	2.16E-07	8.09E-06	3.20E-06
Total PAH [h]	4.28E-07	1.60E-05	6.35E-06
Greenhouse Gases			
CO_2 [g]	1.15	10,925	4,326
CH_4 [b,g]	2.47E-03	23.465	9.29

[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 conversion factor from Appendix A

[i] Assumes maximum development scenario

Buys & Associates, Inc. Environmental Consultants	Project: GASCO Uinta Basin Alternative C Inventory Date: 6/2/2011

13. Well Development Venting

Assumptions: Following Completion, Wells are Vented prior to connnection to the gathering pipeline

Venting Period	48	hours (Project Proponents)
Amount of Vented Gas:	0.2	MMscf (Average Volume Estimated by Proponents)
Development Rate:	132	Wells per year (Project Proponents)

COMPONENT	MOLECULAR WEIGHT (lb/lb-mole)	MOLE PERCENT	RELATIVE MOLE WEIGHT (lb/lb-mole)	WEIGHT Fraction	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (lb/hr)	COMPONENT FLOW RATE (tons/yr)
Methane	16.043	92.713	14.874	0.833	185.426	163.311	517.368
Ethane	30.07	4.078	1.226	0.069	8.156	13.464	42.655
Propane	44.097	1.145	0.505	0.028	2.289	5.542	17.556
i-Butane	58.123	0.248	0.144	0.008	0.496	1.582	5.012
n-Butane	58.123	0.265	0.154	0.009	0.530	1.691	5.356
i-Pentane	72.15	0.118	0.085	0.005	0.236	0.935	2.961
n-Pentane	72.15	0.087	0.063	0.004	0.174	0.689	2.183
Hexanes	86.177	0.000	0.000	0.000	0.000	0.000	0.000
Heptanes	100.204	0.216	0.216	0.012	0.431	2.372	7.515
Octanes	114.231	0.035	0.040	0.002	0.069	0.435	1.379
Nonanes	128.258	0.031	0.039	0.002	0.061	0.430	1.361
Decanes +	142.285	0.007	0.010	0.001	0.014	0.106	0.337
Benzene	78.12	0.021	0.016	0.001	0.042	0.181	0.573
Toluene	92.13	0.035	0.032	0.002	0.070	0.356	1.128
Ethylbenzene	106.16	0.001	0.001	0.000	0.002	0.014	0.044
Xylenes	106.16	0.016	0.017	0.001	0.031	0.183	0.580
n-Hexane	86.177	0.044	0.038	0.002	0.089	0.420	1.331
Helium	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.125	0.035	0.002	0.249	0.384	1.215
Carbon Dioxide	44.01	0.817	0.359	0.020	1.633	3.945	12.499
Oxygen	32	0.000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulfide	34.08	0.000	0.000	0.000	0.000	0.000	0.000
VOC SUBTOTAL		**2.2676**	**1.360**	**0.076**	**4.535**	**14.935**	**47.316**
HAP SUBTOTAL		**0.1176**	**0.105**	**0.006**	**0.235**	**1.154**	**3.656**
TOTAL		**100.000**	**17.855**	**1.000**	**200**	**196.039**	**621.053**

14. Well Development Emissions Summary

Species	Well Development Emissions (tons/year) [a]				Wind Erosion	Total [a] (tons/yr)
	Construction	Drilling	Completion	Interim Reclamation		
Criteria Pollutants & VOC						
NO_x	20.1	1,293	44.1	0.3		1,357
CO	9.83	360	71.2	2.37		444
VOC	1.72	48.2	62.6	0.16		113
SO_2	0.58	22.3	1.0	0.0		23.9
PM_{10}	119	2,039	2,289	35.9	2.8	4,486
$PM_{2.5}$	14.4	226	230	4.3	1.1	476
Hazardous Air Pollutants						
Benzene		0.10	5.81E-01			0.69
Toluene		0.04	1.13E+00			1.17
Ethylbenzene		0	0.04			4.4E-02
Xylenes		0.03	5.82E-01			0.61
n-Hexane			1.331			1.33
Formaldehyde	0.47	0.01	0.001			0.48
Acetaldehyde		3.40E-03	2.70E-04			3.7E-03
Acrolein		1.06E-03	7.89E-05			1.1E-03
1,3-Butadiene			1.48E-06			1.5E-06
Naphthalene		0.02	1.25E-03			0.02
Total PAH, POM 1 [b]		0.03	2.04E-03			0.03
Total HAPs	0.47	0.23	3.67	0.0	0.0	4.32
Greenhouse Gases						
CO_2		61,554	8,703			70,257
CH_4	0.04	38.1	530	0.01		568.1

a Emissions for Peak Field Development
b Polycyclic Aromatic Hydrocarbons (PAH), Polycyclic Organic Matter (POM)

Buys & Associates, Inc. **Environmental Consultants**	Project: GASCO Uinta Basin Alternative C Inventory Date: 6/2/2011

15. Average Produced Gas Characteristics
Inlet Wet Gas Sample from Riverbend Compressor Station, dated 3/22/07

Gas Heat Value (wet): 1064.1 Btu/scf

Sample Temperature: 77 F
Sample Pressure: 132 psi

C1-C2 Wt. Fraction:	0.9020
VOC Wt. Fraction:	0.0760
Non-HC Wt. Fraction:	0.0221
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	92.7130	16.043	14.874	0.833	1010.000	936.401	910.000	843.688
Ethane	4.0781	30.070	1.226	0.069	1769.800	72.174	1618.000	65.984
Propane	1.1446	44.097	0.505	0.028	2516.200	28.800	2316.000	26.509
i-Butane	0.2479	58.123	0.144	0.008	3252.100	8.062	3005.000	7.449
n-Butane	0.2649	58.123	0.154	0.009	3262.400	8.642	3013.000	7.981
i-Pentane	0.1180	72.150	0.085	0.005	4000.900	4.721	3698.000	4.364
n-Pentane	0.0870	72.150	0.063	0.004	4008.800	3.488	3708.000	3.226
Hexanes	0.0687	86.177	0.059	0.003	4756.200	3.268	4404.000	3.026
Heptanes	0.0737	100.204	0.074	0.004	5502.500	4.055	5100.000	3.759
Methylcyclohexane	0.0509	98.186	0.050	0.003	1865.455	0.880	1729.000	0.880
Octanes	0.0550	114.231	0.063	0.004	6249.100	3.437	1695.970	0.933
2,2,4-TMP	0.0047	114.220	0.005	0.000	6368.594	0.081	1728.400	0.081
Nonanes	0.0305	128.258	0.039	0.002	6996.400	2.134		0.000
Decanes	0.0068	142.285	0.010	0.001	7743.200	0.527		0.000
Benzene	0.0211	78.120	0.016	0.001	3715.500	0.784		0.000
Toluene	0.0352	92.130	0.032	0.002	4444.600	1.564		0.000
Ethylbenzene	0.0012	106.160	0.001	0.000	5191.500	0.062		0.000
Xylenes	0.0157	106.160	0.017	0.001	5183.500	0.814		0.000
n-Hexane	0.0444	86.177	0.038	0.002	4756.200	2.112		0.000
Helium	0.0000	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	0.1247	28.013	0.035	0.002	0.000	0.000	0.000	0.000
Carbon Dioxide	0.8165	44.010	0.359	0.020	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		17.85	1.00		1082.01		967.88

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

Weight Fraction = Net Mole Weight / Total Mole Weight

HAP Fractions estimated from GRI Published Factors

16. Wellsite Heater Emissions

Assumptions

Separator Heater Size	500	Mbtu/hr (Typical size Proposed Action)
Wells Requiring Separators:	1887	wells at Peak Production
Firing Rate	6,480	hours/year (Proponent)
Fuel Gas Heat Value	968	Btu/scf (Gas Analyses from Riverbend well)
Fuel Gas VOC Content	0.076	by weight (Gas Analyses from Riverbend Facility)

Equations

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

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

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

Species	Wellsite Heater Emissions - Separators		
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC			
NO_x [a]	100	0.052	316
CO [a]	84	0.043	265
TOC [c]	11	0.006	35
VOC	N.A.	0.000	2.64
SO_x [b]	0.00	0.000	0
TSP [c]	7.6	0.004	24
PM_{10} [c]	7.6	0.004	24
$PM_{2.5}$ [c]	7.6	0.004	24
Hazardous Air Pollutants			
Benzene [d]	0.0021	1.08E-06	6.63E-03
Toluene [d]	0.0034	1.76E-06	0.01
Hexane [d]	1.8	9.30E-04	5.69
Formaldehyde [d]	0.075	3.87E-05	0.24
Dichlorobenzene [d]	1.2E-03	6.20E-07	3.79E-03
Naphthalene [d]	6.1E-04	3.15E-07	1.93E-03
POM 2 [d,e,f]	5.9E-05	3.05E-08	1.86E-04
POM 3 [d,g]	1.6E-05	8.27E-09	5.05E-05
POM 4 [d,h]	1.8E-06	9.30E-10	5.69E-06
POM 5 [d,i]	2.4E-06	1.24E-09	7.58E-06
POM 6 [d,j]	7.2E-06	3.72E-09	2.27E-05
POM 7 [d,k]	1.8E-06	9.30E-10	5.69E-06
Greenhouse Gases			
CO_2 [c]	120,000	61.991	379007
CH_4 [c]	2.3	1.19E-03	7.3

[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

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

[f] - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene,

[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] - Assumes full development.

17. Wellsite Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate:	2.01	bbls condensate per day (Estimate based on proponent data)
Number of Active Wells:	1887	wells at Peak Production
Separator Conditions :	130 psi and 60 F (Riverbend sample)	
API Gravity:	58.28	

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0
Riverbend Compressor Station Liquid Sample Dated 6/4/07
Scaled from 15.9 bbls per day

Emissions:

Component	Wellsite Flash/Work/Breathing (lb/hr/well)	Wellsite Flash/Work/Breathing (tons/year/well)	Total Emissions (tons/yr)
Total VOC	0.163	0.713	1346
Hazardous Air Pollutants			
Benzene	1.643E-03	0.007	13.6
Toluene	2.655E-03	0.012	21.9
Ethylbenzene	1.264E-04	0.001	1.045
Xylenes	8.849E-04	0.004	7.31
n-Hexane	4.172E-03	0.018	34.5
Greenhouse Gases			
CO_2	0.033	0.144	272
CH_4	0.156	0.683	1288

Buys & Associates, Inc. Environmental Consultants	Project: GASCO Uinta Basin Alternative C Inventory Date: 6/2/2011

18. VOC Emissions from NGL Truck Loading Operations

NGL Truck Loading/Unloading Emissions: NGL will normally be transported by pipeline, however truck transport may be utilized as a contingency. A pressurized vapor recovery system will be utilized for truck loading. Potential emissions result from the equalization of the loading rack connection to atmospheric pressure after the loading operation is completed.

Assumed Maximum Number of Truck loads/year 7,300

Truck Loading Connection Configuration

	Load Line		
Load Line Connection Diameter =	0.25	ft	(Assumed typical value)
Load Line Length between Valves =	3.0	ft	(Assumed typical value)
Connection Volume =	0.147	ft^3	
Annual Connection Volume Vented =	1075	ft^3	
NGL Density =	5.6	lbs/gal	(Assumed typical value)
NGL Density =	41.9	lbs/ft^3	
Annual Wt. NGL Vented =	45,030.2	lbs/year	
NGL VOC Content =	100.0%	by weight (See NGL Composition for Fugitive Emissions)	
VOC Emissions =	22.5	tons/year VOC	

Example Calculations

Connection volume = Pi * $(Diameter)^2/4$ * Length

Annual Volume Vented (ft^3/year) = Connection Volume (ft^3) * Number Truck Loads per year (1/year)

Density ($lbs/ft^{3)}$ = Density (lbs/gal) * 7.48 gal/ft^3

Vented NGL Weight (lbs) = Volume Vented (ft^3) * NGL Density (lbs/ft^3)

VOC Emissions (tons/year) = Annual NGL Vented (lbs/year) * NGL VOC wt. % / 100 / 2000 (lbs/ton)

19. Operations Vehicle Tailpipe Emissions

Assumptions:

Number of New Pumpers:	54	(Proposed Action Number of Pumpers at Peak Production)
Pumper Mileage:	**2,800**	miles/pumper/month (Assumption)
Total Annual New Pumper Mileage:	1,814,400	miles/year
Number of Condensate Haul Truck Round Trips:	24	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for Condensate Transport:	88	miles (Estimate from Roosevelt)
Total Annual Condensate Truck Mileage:	770,880	miles/year
Number of Water Haul Truck Round Trips:	151	trips per day (Based on Peak Production Alternative C)
Average Round Trip Mileage for Water Transport:	17	miles (Average distance to evaporation facility)
Total Annual Water Truck Mileage:	936,955	miles/year
Number of NGL Haul Truck Round Trips:	20	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for NGL Transport:	88	miles (Average distance to evaporation facility)
Total Annual NGL Truck Mileage:	642,400	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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	3.03	2.775	6.060	8.13	9.644	15.305	12.418	21.365
CO	33.64	30.806	67.280	17.09	20.272	32.173	51.078	99.453
VOC [c]	1.656	1.516	3.312	4.600	5.456	8.660	6.973	11.972
SO_2	0.21	0.196	0.428	0.32	0.381	0.605	0.577	1.033
Greenhouse Gases								
CH_4 [d]	0.184	0.168	0.368	0.230	0.273	0.433	0.441	0.801

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

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20. Pneumatic Device Emissions 0.144 Mscf/day or less = low bleed device

Analysis Gas Consumption Rate:	1.00	Mscf/day
Days of Operation:	365	days/year

GAS COMPONENT	MOLECULAR WEIGHT (lb/lb-mole)	MOLE PERCENT	RELATIVE MOLE WEIGHT (lb/lb-mole)	WEIGHT PERCENT	VOLUME FLOW RATE (Mscf/day)	MASS FLOW RATE (lb/hr)	MASS FLOW RATE (tons/yr)
Methane	16.043	92.7130	14.874	83.334	0.927	1.633	7.153
Ethane	30.07	4.0781	1.226	6.870	0.041	0.135	0.590
Propane	44.097	1.1446	0.505	2.828	0.011	0.055	0.243
I-Butane	58.123	0.2479	0.144	0.807	0.002	0.016	0.069
n-Butane	58.123	0.2649	0.154	0.863	0.003	0.017	0.074
i-Pentane	72.15	0.1180	0.085	0.477	0.001	0.009	0.041
n-Pentane	72.15	0.0870	0.063	0.352	0.001	0.007	0.030
Hexanes	86.177	0.0687	0.059	0.332	0.001	0.007	0.028
Heptanes	100.204	0.1233	0.124	0.692	0.001	0.014	0.059
Octanes	114.231	0.0584	0.067	0.374	0.001	0.007	0.032
Nonanes	128.258	0.0305	0.039	0.219	0.000	0.004	0.019
Decanes +	142.285	0.0068	0.010	0.054	0.000	0.001	0.005
Benzene	78.12	0.0211	0.016	0.092	0.000	0.002	0.008
Toluene	92.13	0.0352	0.032	0.182	0.000	0.004	0.016
Ethylbenzene	106.16	0.0012	0.001	0.007	0.000	0.000	0.001
Xylenes	106.16	0.0157	0.017	0.093	0.000	0.002	0.008
n-Hexane	86.177	0.0444	0.038	0.214	0.000	0.004	0.018
Hellum	4.003	0.0000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.1247	0.035	0.196	0.001	0.004	0.017
Carbon Dioxide	44.01	0.8165	0.359	2.013	0.008	0.039	0.173
Oxygen	32	0.0000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulfide	34.08	0.0000	0.000	0.000	0.000	0.000	0.000
VOC SUBTOTAL		**2.268**	**1.354**	**7.586**	**0.023**	**0.149**	**0.651**
HAP SUBTOTAL		**0.118**	**0.105**	**0.589**	**0.001**	**0.012**	**0.051**
TOTAL		**100.000**	**17.849**	**100.000**	**1.000**	**1.960**	**8.584**

	Number of Wells	VOC emissions (tons/year)	Methane emissions (tons/yr)
Alternative C	1,887	442	4859.2

LIQUID LEVEL CONTROLLER SPECIFICATIONS

Gas Consumption Rate:	0.144	Mscf/day	(low-bleed)
Days of Operation:	365	days/year	

TRACE PUMP SPECIFICATIONS

Gas Consumption Rate:	0.144	Mscf/day	Assumed recycle of gas equals low-bleed specification
Days of Operation:	182	days/year	

METHANOL PUMP SPECIFICATIONS

-Solar powered methanol pumps will be installed for the Proposed Action

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.04	0.19
1	Trace pump	0.01	0.05
2	Chemical injection pump	0	0
	Totals (per well) =	0.05	0.23

Pneumatic sources / well		Methane lb/hr	Methane ton/yr
2	Liquid level controllers	0.47	2.06
1	Trace pump	0.24	0.52
2	Chemical injection pump	0	0
	Totals (per well) =	0.71	2.58

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21. Operations Traffic Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006

365 days (Estimate)

Vehicle Type	Ave. Weight (lbs)	Round Trips per Day*
Pickup Truck: Crew	7,000	54
Haul Truck: Oil	48,000	24
Haul Truck: Water	48,000	151
Haul Truck: NGL	48,000	20
Mean Weight	39,108	249

Unpaved Roads

E (PM10) / VMT = 1.5 * (S/12)^0.9 * (W/3)^0.45 * (365-p)/365)
E (PM2.5) / 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) 73 days per year **
Avg. Round Trip Miles 37 miles on unpaved roads ***

Paved Roads

E (PM10) / VMT = 0.016 * (sL/2)^0.65 * (W/3)^1.5 - 0.00047 * (1-(p/(365*4))
E (PM10) / 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 30 From Fort Roosevelt
Precipitation Days (P) 73 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	2.02	6,881,642	18,854	0.20	688,164	1,885
Paved	0.08	212,186	581	0.01	31,078	85
Total		7,093,828	19,435		719,242	1,971

Annual Traffic Fugitive Dust Emissions (tons/year)	**3,547**			**360**	

*Round trips per day at peak production (Proposed Action)
** (NCDC data for Nutters Ranch, UT 1963-1986)
*** Weighted average of Pumper,Condensate, NGL, and Water Hauling Distance = (58*(54+24+20+26)+17*(235-26))/249.
One round trip to evaporative facility is assumed to take about 2-hours, so 6 trips per day are completed in one 12-hr shift, which requires 26 trucks to do 151 trips.

22. Well Production Summary

Species	Storage Tanks (tons/yr)	Well Site Heaters (tons/yr)	Operations Vehicle (tons/yr)	Pneumatic Devices (tons/yr)	Total Well Production [a] (tons/yr)
Criteria Pollutants & VOC					
NO_x		316	21.4		337
CO		265	99.5		365
VOC	1,346	2.64	11.97	442	1,802
SO_2		0	1.03		1.0
PM_{10}		24.0	3,547		3,571
$PM_{2.5}$		24.0	360		384
Hazardous Air Pollutants					
Benzene	14	0.01			14
Toluene	22	0.01			22
Ethylbenzene	1.04				1.04
Xylene	7.3				7.3
n-Hexane	34	5.69			40
Formaldehyde		0.24			0.24
Dichlorobenzene		3.79E-03			3.79E-03
Naphthalene		1.93E-03			1.93E-03
POM 2[a]		1.86E-04			1.86E-04
POM 3[b]		5.05E-05			5.05E-05
POM 4[c]		5.69E-06			5.69E-06
POM 5[d]		7.58E-06			7.58E-06
POM 6[e]		2.27E-05			2.27E-05
POM 7[f]		5.69E-06			5.69E-06
Total HAPs	78	5.95	0.0		84
Greenhouse Gases					
CO_2	272	379,007			379,278
CH_4	1,288	7.26	0.80	4859	6,156

[a] - POM (Particulate Organic Matter) 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

[b] - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[c] - POM 4 includes: 3-Methylchloranthrene.

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

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

[f] - POM 7 includes: Chrysene.

[g] Emissions for Peak Field Development

Buys & Associates, Inc. **Environmental Consultants**	Project: GASCO Uinta Basin Alternative C Inventory Date: 6/2/2011

23. Average Produced Gas Characteristics
Inlet Wet Gas Sample from Riverbend Compressor Station, dated 3/22/07

Gas Heat Value (wet): 1064.1 Btu/scf

Sample Temperature: 77 F
Sample Pressure: 132 psi

C1-C2 Wt. Fraction:	0.9020
VOC Wt. Fraction:	0.0760
Non-HC Wt. Fraction:	0.0221
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	92.7130	16.043	14.874	0.833	1010.000	936.401	910.000	843.688
Ethane	4.0781	30.070	1.226	0.069	1769.800	72.174	1618.000	65.984
Propane	1.1446	44.097	0.505	0.028	2516.200	28.800	2316.000	26.509
i-Butane	0.2479	58.123	0.144	0.008	3252.100	8.062	3005.000	7.449
n-Butane	0.2649	58.123	0.154	0.009	3262.400	8.642	3013.000	7.981
i-Pentane	0.1180	72.150	0.085	0.005	4000.900	4.721	3698.000	4.364
n-Pentane	0.0870	72.150	0.063	0.004	4008.800	3.488	3708.000	3.226
Hexanes	0.0687	86.177	0.059	0.003	4756.200	3.268	4404.000	3.026
Heptanes	0.0737	100.204	0.074	0.004	5502.500	4.055	5100.000	3.759
Methylcyclohexane	0.0509	98.186	0.050	0.003	1865.455	0.880	1729.000	0.880
Octanes+	0.0550	114.231	0.063	0.004	6249.100	3.437	1695.970	0.933
2,2,4-TMP	0.0047	114.220	0.005	0.000	6368.594	0.081	1728.400	0.081
Nonanes	0.0305	128.258	0.039	0.002	6996.400	2.134		0.000
Decanes	0.0068	142.285	0.010	0.001	7743.200	0.527		0.000
Benzene	0.0211	78.120	0.016	0.001	3715.500	0.784		0.000
Toluene	0.0352	92.130	0.032	0.002	4444.600	1.564		0.000
Ethylbenzene	0.0012	106.160	0.001	0.000	5191.500	0.062		0.000
Xylenes	0.0157	106.160	0.017	0.001	5183.500	0.814		0.000
n-Hexane	0.0444	86.177	0.038	0.002	4756.200	2.112		0.000
Helium	0.0000	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	0.1247	28.013	0.035	0.002	0.000	0.000	0.000	0.000
Carbon Dioxide	0.8165	44.010	0.359	0.020	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		17.85	1.00		1082.01		967.88

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

Weight Fraction = Net Mole Weight / Total Mole Weight

24. Central Compression

Assumptions:

Total Existing Compression:	6,615	Horsepower (Riverbend Facility)
Total New Compression:	26,439	Horsepower (Proposed Action)
Total New Generation	3,420	Horsepower (Proposed Action)

Equations:

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

13219.5

Pollutant	Emission Factor [6] (lb/MMBtu)	Emission Factor (g/hp-hr)	Emissions (lb/hr/engine) [7]	Emissions 13,220 hp Station (tons/yr)	Emissions 13,220 hp Station (tons/yr)	Total Emissions [8] Proposed Action (tons/yr)
Criteria Pollutants & VOC						
NOx [1]		1.5	3.31	191.5	191.5	383.0
CO [1,9]		0.1	0.22	12.8	12.8	25.5
VOC [1,10]		0.5	1.10	63.8	63.8	127.7
PM10 [2,3]	9.95E-03	0.037	0.08	4.75	4.75	9.49
PM2.5 [2,3]	9.95E-03	0.037	0.08	4.75	4.75	9.49
SO_2 [12]	5.88E-04	0.000	0.00	0.0	0.0	0.00
Hazardous Air Pollutants [10]						
Benzene [2]	4.40E-04	8.224E-04	1.81E-03	0.10	0.10	0.21
Toluene [2]	4.08E-04	7.626E-04	1.68E-03	0.10	0.10	0.19
Ethylbenzene [2]	3.97E-05	7.420E-05	1.64E-04	0.01	0.01	0.02
Xylenes [2]	1.84E-04	3.439E-04	7.58E-04	0.04	0.04	0.09
n-Hexane [2]	1.11E-03	2.075E-03	4.57E-03	0.26	0.26	0.53
Formaldehyde [2,11]	5.28E-02	2.960E-02	6.53E-02	3.78	3.78	7.6
Acetaldehyde [2]	8.36E-03	1.562E-02	3.44E-02	1.99	1.99	3.99
Acrolein [2]	5.14E-03	2.882E-03	6.35E-03	0.37	0.37	0.74
Methanol [2]	2.50E-03	4.673E-03	1.03E-02	0.60	0.60	1.19
1,1,2,2-Tetrachloroethane[2]	4.00E-05	7.476E-05	1.65E-04	0.01	0.01	0.02
1,1,2-Trichloroethane[2]	3.18E-05	5.943E-05	1.31E-04	0.01	0.01	0.02
1,3-Dichloropropene[2]	2.64E-05	4.934E-05	1.09E-04	0.01	0.01	0.01
1,3-Butadiene[2]	2.67E-04	4.990E-04	1.10E-03	0.06	0.06	0.13
2,2,4-Trimethylpentane[2]	2.50E-04	4.673E-04	1.03E-03	0.06	0.06	0.12
Biphenyl[2]	2.12E-04	3.962E-04	8.74E-04	0.05	0.05	0.10
Carbon Tetrachloride[2]	3.67E-05	6.859E-05	1.51E-04	0.01	0.01	0.02
Chlorobenzene[2]	3.04E-05	5.682E-05	1.25E-04	0.01	0.01	0.01
Chloroform[2]	2.85E-05	5.327E-05	1.17E-04	0.01	0.01	0.01
Ethylene Dibromide[2]	4.43E-05	8.280E-05	1.83E-04	0.01	0.01	0.02
Methylene Chloride[2]	2.00E-05	3.738E-05	8.24E-05	4.77E-03	4.77E-03	0.01
Naphthalene[2]	7.44E-05	1.391E-04	3.07E-04	0.02	0.02	0.04
Phenol[2]	2.40E-05	4.486E-05	9.89E-05	0.01	0.01	0.01
Styrene[2]	2.36E-05	4.411E-05	9.72E-05	0.01	0.01	0.01
Tetrachloroethane[2]	2.48E-06	4.635E-06	1.02E-05	5.92E-04	5.92E-04	1.18E-03
Vinyl Chloride[2]	1.49E-05	2.785E-05	6.14E-05	3.55E-03	3.55E-03	0.01
PAH -POM 1[2,4]	2.69E-05	5.028E-05	1.11E-04	0.01	0.01	0.01
POM 2[2,4,5]	5.93E-05	1.109E-04	2.45E-04	0.01	0.01	0.03
Benzo(b)fluoranthene/POM6[2,4]	1.66E-07	3.103E-07	6.84E-07	3.96E-05	3.96E-05	7.92E-05
Chrysene/POM7[2,4]	6.93E-07	1.295E-06	2.86E-06	1.65E-04	1.65E-04	3.31E-04
Greenhouse Gases						
CO2 [2]	110	411	906	52490	52490	104975
CH4 [2]	1.25	4.67	10.3	596	596	1193

[1] - Currently permitted emission rates for internal combustion engine

[2] - AP-42 Table 3.2-2 Uncontrolled Emission Factors for 4-Stroke Lean-Burn Engines, 7/00

[3] - PM = sum of PM filterable and PM condensable

[4] - 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

[5] - POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

[6] - Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 8,240 Btu/hp-hr (*3.738)

[7] - Each individual engine estimated at 1,000 hp (Proposed Action)

[8] - Proposed Action Total Annual Emissions for New Compression (21,325 hp)

[9] - CO emission estimate reduced by 95% to reflect reduction by oxidation catalyst.

[10] - VOCs and HAPs emission estimates reduced by 50% to reflect reduction by oxidation catalyst.

[11] - Formaldehyde and acrolein emission estimates reduced by 85% to reflect reduction by oxidation catalyst.

[12] - Gas analysis indicates no sulfur compounds, see Central Gas Composition page.

25. Central TEG Dehydrator Emissions

Assumptions

Peak Field Production Rate: 250 MMscf/day
1887 Active Wells at Peak Production

Gas Composition: Inlet Gas Sample from Riverbend Compresor Station, dated 3/30/07

Inlet Gas Conditions: Inlet gas saturated at 820.0 psig and 86 F

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCale version 4.0
Assuming five 25-MMscf/d units/station

Controls

Flare > 95% Control Efficiency in order to meet Federal MACT Standards
Condenser Operating Conditions: 86 deg. F, 834.7 psia

Emissions

Species	Central Dehydrator Emissions 125MMscfd Station (tons/year)	Central Dehydrator Emissions 125MMscfd Station (tons/year)	Total Project Emissions (tons/year)
Total VOC	20.03	20.03	40.06
Hazardous Air Pollutants			
Benzene	2.25	2.25	4.49
Toluene	6.36	6.36	12.72
Ethylbenzene	0.32	0.32	0.65
Xylenes	6.51	6.51	13.01
n-Hexane	0.14	0.14	0.28
Greenhouse Gases			
CH_4	10.70	10.70	21.40

Each station throughput estimated according to the ratio of new compression proposed at each station and based on a peak field production rate of 250MMscfd scaled from the proposed action

26. Central Facility Heater Emissions

Assumptions

Dehydrator Reboiler Heater	750	Mbtu/hr (Typical)
Separator Heater	500	Mbtu/hr (Based on current Riverbend equipment)
Total Heater Requirmement Facility 1	6,250	Mbtu/hr (Proposed Action Estimate, 5-Dehydrator Reboiler Heaters, 5 Separator Heaters)
Total Heater Requirmement Facility 2	6,250	Mbtu/hr (Proposed Action Estimate, 5-Dehydrator Reboiler Heaters, 5 Separator Heaters)
Firing Rate	45	minutes/hour on average for entire year (Typical value)
	6570	hours/year
Fuel Gas Heat Value	968	Btu/scf (Gas Analyses from Riverbend Facility)
Fuel Gas VOC Content	0.076	by weight (Gas Analyses from Riverbend Facility)

Equations

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

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

VOC Emissions (tons/yr) = TOC Emissions (tons/yr) * VOC wt. fraction

Species	Central Heater Emissions - Facility 1			Central Heater Emissions - Facility 2			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr)	Total Emissions (tons/yr)	Total Emissions (tons/yr)
Criteria Pollutants & VOC							
NO_x [a]	100	0.625	2.053	100	0.625	2.053	4.106
CO [a]	84	0.525	1.725	84	0.525	1.725	3.449
TOC [c]	11	0.069	0.226	11	0.069	0.226	0.452
VOC	N.A.	0.005	0.017	N.A.	0.005	0.017	0.034
SO_x [b]	0.00	0.000	0.000	0.00	0.000	0.000	0.000
TSP [c]	7.6	0.048	0.156	7.6	0.048	0.156	0.312
PM_{10} [c]	7.6	0.048	0.156	7.6	0.048	0.156	0.312
$PM_{2.5}$ [c]	7.6	0.048	0.156	7.6	0.048	0.156	0.312
Hazardous Air Pollutants							
Benzene [d]	2.1E-03	1.31E-05	4.31E-05	2.1E-03	1.31E-05	4.31E-05	8.62E-05
Toluene [d]	3.4E-03	2.13E-05	6.98E-05	3.4E-03	2.13E-05	6.98E-05	1.40E-04
Hexane [d]	1.8E+00	1.13E-02	0.04	1.8E+00	1.13E-02	0.04	0.07
Formaldehyde [d]	7.5E-02	4.69E-04	1.54E-03	7.5E-02	4.69E-04	1.54E-03	3.08E-03
Dichlorobenzene [d]	1.2E-03	7.50E-06	2.46E-05	1.2E-03	7.50E-06	2.46E-05	4.93E-05
Naphthalene [d]	6.1E-04	3.81E-06	1.25E-05	6.1E-04	3.81E-06	1.25E-05	2.50E-05
POM 2 [d,e,f]	5.9E-05	3.69E-07	1.21E-06	5.9E-05	3.69E-07	1.21E-06	2.42E-06
POM 3 [d,g]	1.6E-05	1.00E-07	3.29E-07	1.6E-05	1.00E-07	3.29E-07	6.57E-07
POM 4 [d,h]	1.8E-06	1.13E-08	3.70E-08	1.8E-06	1.13E-08	3.70E-08	7.39E-08
POM 5 [d,i]	2.4E-06	1.50E-08	4.93E-08	2.4E-06	1.50E-08	4.93E-08	9.86E-08
POM 6 [d,j]	7.2E-06	4.50E-08	1.48E-07	7.2E-06	4.50E-08	1.48E-07	2.96E-07
POM 7 [d,k]	1.8E-06	1.13E-08	3.70E-08	1.8E-06	1.13E-08	3.70E-08	7.39E-08
Greenhouse Gases							
CO_2 [c]	120,000	750	2464	120000	750	2464	4928
CH_4 [c]	2.3	0.01	0.05	2.3	0.01	0.05	0.09

[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

[e] - 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

[f] - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and 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.

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

Assumptions:

Average Condensate Production Rate :

Facility 1	2.38	bbls condensate per day (Estimate Based on typical average lifetime condensate well production)
Facility 2	2.38	bbls condensate per day (Estimate Based on typical average lifetime condensate well production)

Separator Conditions : 130 psi and 60 F (Sample Conditions)
API Gravity: 53.4

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0 Run Date 7/30/08
Riverbend Compressor Station Liquid Sample Dated 3/22/07
Scaled from 15.9 bbls per day
Controlled 95% efficiency

Emissions:

Component	Facility 1 Flash/Work/Breathing (tons/yr)	Facility 2 Flash/Work/Breathing (tons/yr)	Total Emissions (tons/yr)
Total VOC	0.065	0.065	0.13
Hazardous Air Pollutants			
Benzene	5.067E-04	5.067E-04	1.01E-03
Toluene	8.471E-04	8.471E-04	1.69E-03
Ethylbenzene	3.96E-05	3.96E-05	7.92E-05
Xylenes	3.008E-04	3.008E-04	6.02E-04
n-Hexane	1.338E-03	1.338E-03	2.68E-03
Greenhouse Gases			
CO_2	9.896E-03	9.896E-03	0.02
CH_4	0.041	0.041	0.08

28. Central Facility Emission Summary

Central Facility 1

Pollutant	Central Compression Emissions 13,220 hp (tons/year)	Central Dehydrator Emissions 125MMscfd (tons/year)	Central Heater Emissions 6,250 Mbtu/hr (tons/year)	Central Condensate Tank Emissions 2.38 bbl/d (tons/year)	Dewpoint Skid Emissions (tons/year)	Total Facility Emissions (tons/year)
Criteria Pollutants & VOC						
NO_x	191.5		2.05			194
CO	12.8		1.72			14.5
VOC	63.8	20.0	0.02	0.07	11.3	95
SO_2	0.00		0.00			0.00
PM_{10}	4.75		0.16			4.90
$PM_{2.5}$	4.75		0.16			4.90
Hazardous Air Pollutants						
Benzene	0.10	2.25	4.31E-05	5.07E-04		2.35
Toluene	0.10	6.36	6.98E-05	8.47E-04		6.5
Ethylbenzene	0.01	0.32		3.96E-05		0.33
Xylene	0.04	6.51		3.01E-04		6.55
n-Hexane	0.26	0.14	0.04	1.34E-03		0.4
Formaldehyde	3.78		1.54E-03			3.78
Acetaldehyde	1.99					1.99
Acrolein	0.37					0.37
Methanol	0.60					0.60
1,1,2,2-Tetrachloroethane	0.01					0.01
1,1,2-Trichloroethane	0.01					0.01
1,3-Dichloropropene	0.01					0.01
1,3-Butadiene	0.06					0.06
2,2,4-Trimethylpentane	0.06					0.06
Biphenyl	0.05					0.05
Carbon Tetrachloride	0.01					0.01
Chlorobenzene	0.01					0.01
Chloroform	0.01					0.01
Dichlorobenzene			2.46E-05			2.46E-05
Ethylene Dibromide	0.01					0.01
Methylene Chloride	4.77E-03					4.77E-03
Naphthalene	0.02		1.25E-05			0.02
Phenol	5.73E-03					0.01
Styrene	5.63E-03					0.01
Tetrachloroethane	5.92E-04					5.92E-04
Vinyl Chloride	3.55E-03					3.55E-03
PAH -POM 1[a]	6.42E-03					0.01
POM 2[a]	0.01		1.21E-06			0.01
POM 3[a]			3.29E-07			3.29E-07
POM 4[a]			3.70E-08			3.70E-08
POM 5[a]			4.93E-08			4.93E-08
Benzo(b)fluoranthene/POM	3.96E-05		1.48E-07			3.98E-05
Chrysene/POM7[a]	1.65E-04		3.70E-08			1.65E-04
Total HAPs	7.55	15.6	0.04	3.03E-03		19.9
Greenhouse Gases						
CO_2	52,490		2,464	0.01		54,953
CH_4	596	10.7	0.05	0.04		607

Central Facility 2

Pollutant	Central Compression Emissions 13,220 hp (tons/year)	Central Dehydrator Emissions 125MMscfd (tons/year)	Central Heater Emissions 6,250 Mbtu/hr (tons/year)	Central Condensate Tank Emissions 2.38 bbl/d (tons/year)	Dewpoint Skid Emissions (tons/year)	Total Facility Emissions (tons/year)
Criteria Pollutants & VOC						
NO_x	191		2.05			194
CO	13		1.72			14
VOC	64	20.0	0.02	0.07	11.3	95
SO_2	0.00		0.00			0.00
PM_{10}	4.75		0.16			4.90
$PM_{2.5}$	4.75		0.16			4.90
Hazardous Air Pollutants						
Benzene	0.10	2.25	4.31E-05	5.07E-04		2.35
Toluene	0.10	6.36	6.98E-05	8.47E-04		6.5
Ethylbenzene	0.01	0.32		3.96E-05		0.33
Xylene	0.04	6.51		3.01E-04		6.55
n-Hexane	0.26	0.14	0.04	1.34E-03		0.4
Formaldehyde	3.78		1.54E-03			3.8
Acetaldehyde	1.99					1.99
Acrolein	0.37					0.37
Methanol	0.60					0.60
1,1,2,2-Tetrachloroethane	0.01					0.01
1,1,2-Trichloroethane	0.01					7.59E-03
1,3-Dichloropropene	0.01					6.30E-03
1,3-Butadiene	0.06					0.06
2,2,4-Trimethylpentane	0.06					0.06
Biphenyl	0.05					0.05
Carbon Tetrachloride	0.01					0.01
Chlorobenzene	0.01					7.25E-03
Chloroform	0.01					6.80E-03
Dichlorobenzene			2.46E-05			2.46E-05
Ethylene Dibromide	0.01					0.01
Methylene Chloride	4.77E-03					4.77E-03
Naphthalene	0.02		1.25E-05			0.02
Phenol	0.01					5.73E-03
Styrene	0.01					5.63E-03
Tetrachloroethane	5.92E-04					5.92E-04
Vinyl Chloride	3.55E-03					3.55E-03
PAH -POM 1[a]	0.01					6.42E-03
POM 2[a]	0.01		1.21E-06			0.01
POM 3[a]			3.29E-07			3.29E-07
POM 4[a]			3.70E-08			3.70E-08
POM 5[a]			4.93E-08			4.93E-08
Benzo(b)fluoranthene/POM	3.96E-05		1.48E-07			3.98E-05
Chrysene/POM7[a]	1.65E-04		3.70E-08			1.65E-04
Total HAPs	7.55	15.58	0.04	3.03E-03		19.9
Greenhouse Gases						
CO_2	52,490		2,464	0.01		54,953
CH_4	596	10.7	0.05	0.04		607

29. Evaporation Facility

Assumptions:

Total New Generation: 3,420 Horsepower (Proposed Action)

Evaporation Emissions conservatively estimated using mass balance
-methanol designated as a VOC

Equations:

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

Pollutant	Engine Emission Factor [6] (lb/MMBtu)	Engine Emission Factor (g/hp-hr) [1]	Engine Emissions (lb/hr) [1]	Engine Emissions (tons/yr)	Evaporation Emissions (tons/yr)[7]	Total Evaporation Facility Emissions (tons/yr)
Criteria Pollutants & VOC						
NOx [1]		1.0	7.54	33.0		33.0
CO [1]		2.0	15.08	66.0		66.0
VOC [1]		1.0	7.54	33.02	1091.6	1124.6
PM10 [2,3]	9.95E-03	0.036	0.27	1.19		1.2
PM2.5 [2,3]	9.95E-03	0.036	0.27	1.19		1.2
SO_2	5.88E-04	0.002	0.02	0.07		0.1
Hazardous Air Pollutants						
Benzene [2]	4.40E-04	1.598E-03	0.01	0.05	6.8	6.85
Toluene [2]	4.08E-04	1.482E-03	0.01	0.05	16.3	16.35
Ethylbenzene [2]	3.97E-05	1.442E-04	1.1E-03	0.00	0.9	0.90
Xylenes [2]	1.84E-04	6.683E-04	5.0E-03	0.02	13.6	13.62
n-Hexane [2]	1.11E-03	4.032E-03	3.0E-02	0.13		0.13
Formaldehyde [2]	5.28E-02	1.918E-01	1.45	6.33		6.33
Acetaldehyde [2]	8.36E-03	3.04E-02	0.23	1.00		1.00
Acrolein [2]	5.14E-03	1.87E-02	0.14	0.62		0.62
Methanol [2]	2.50E-03	9.080E-03	0.07	0.30	985.7	986.00
1,1,2,2-Tetrachloroethane[2]	4.00E-05	1.453E-04	1.10E-03	0.00		0.00
1,1,2-Trichloroethane[2]	3.18E-05	1.155E-04	8.71E-04	0.00		0.00
1,3-Dichloropropene[2]	2.64E-05	9.588E-05	7.23E-04	3.17E-03		0.00
1,3-Butadiene[2]	2.67E-04	9.697E-04	0.01	0.03		0.03
2,2,4-Trimethylpentane[2]	2.50E-04	9.080E-04	0.01	0.03		0.03
Biphenyl[2]	2.12E-04	7.700E-04	5.81E-03	0.03		0.03
Carbon Tetrachloride[2]	3.67E-05	1.333E-04	1.00E-03	4.40E-03		0.00
Chlorobenzene[2]	3.04E-05	1.104E-04	8.32E-04	3.65E-03		0.00
Chloroform[2]	2.85E-05	1.035E-04	7.80E-04	3.42E-03		0.00
Ethylene Dibromide[2]	4.43E-05	1.609E-04	1.21E-03	5.31E-03		0.01
Methylene Chloride[2]	2.00E-05	7.264E-05	5.48E-04	2.40E-03		0.00
Naphthalene[2]	7.44E-05	2.702E-04	2.04E-03	0.01		0.01
Phenol[2]	2.40E-05	8.717E-05	6.57E-04	2.88E-03		0.00
Styrene[2]	2.36E-05	8.572E-05	6.46E-04	2.83E-03		0.00
Tetrachloroethane[2]	2.48E-06	9.007E-06	6.79E-05	2.97E-04		0.00
Vinyl Chloride[2]	1.49E-05	5.412E-05	4.08E-04	1.79E-03		0.00
PAH -POM 1[2,4]	2.69E-05	9.770E-05	7.37E-04	3.23E-03		0.00
POM 2[2,4,5]	5.93E-05	2.156E-04	1.63E-03	7.12E-03		0.01
Benzo(b)fluoranthene/POM6[2,4]	1.66E-07	6.029E-07	4.55E-06	1.99E-05		0.00
Chrysene/POM7[2,4]	6.93E-07	2.517E-06	1.90E-05	8.31E-05		0.00
Greenhouse Gases						
CO2 [2]	110	400	3,012.25	13194		13194.0
CH4 [2]	1.25	4.54	34.23	149.9		149.9

[1] - Currently permitted emission rates for internal combustion engine

[2] - AP-42 Table 3.2-2 Uncontrolled Emission Factors for 4-Stroke Lean-Burn Engines, 7/00

[3] - PM = sum of PM filterable and PM condensable

[4] - 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

[5] - POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

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

[7] - BTEX emissions controlled by a minimum of 60 %

30. Total Project Production Related Emissions Summary

Pollutant	Well Production Emissions (tons/year)	Central Facility 1 Emissions (tons/year)	Central Facility 2 Emissions (tons/year)	Evaporation Facility Emissions (tons/year)	Total Production Emissions [h] (tons/year)
Criteria Pollutants & VOC					
NO_x	337	194	194	33.0	757
CO	365	14.5	14.5	66.0	460
VOC	1,802	95	95	1,124.6	3,117
SO_2	1.03	0.00	0.00	0.07	1.10
PM_{10}	3,571	4.90	4.90	1.19	3,582
$PM_{2.5}$	384	4.90	4.90	1.19	395
Hazardous Air Pollutants					
Benzene	13.6	2.35	2.35	6.85	25
Toluene	22.0	6.5	6.5	16.35	51
Ethylbenzene	1.04	0.33	0.33	9.05E-01	2.62
Xylene	7.3	6.55	6.55	13.62	34.0
n-Hexane	40.2	0.4	0.4	0.13	41
Formaldehyde	0.24	3.8	3.8	6.33	14.1
Acetaldehyde	0	1.99	1.99	1.00	4.99
Acrolein	0	0.37	0.37	0.62	1.35
Methanol	0	0.60	0.60	986.00	987.19
1,1,2,2-Tetrachloroethane	0	9.54E-03	9.54E-03	4.80E-03	0.02
1,1,2-Trichloroethane	0	7.59E-03	7.59E-03	3.81E-03	0.02
1,3-Dichloropropene	0	6.30E-03	6.30E-03	3.17E-03	0.02
1,3-Butadiene	0	0.06	0.06	0.03	0.16
2,2,4-Trimethylpentane	0	0.06	0.06	0.03	0.15
Biphenyl	0	0.05	0.05	0.03	0.13
Carbon Tetrachloride	0	8.76E-03	8.76E-03	4.40E-03	0.02
Chlorobenzene	0	7.25E-03	7.25E-03	3.65E-03	0.02
Chloroform	0	6.80E-03	6.80E-03	3.42E-03	0.02
Dichlorobenzene	3.79E-03	2.46E-05	2.46E-05	0	0
Ethylene Dibromide	0	1.06E-02	1.06E-02	5.31E-03	0.03
Methylene Chloride	0	4.77E-03	4.77E-03	2.40E-03	0.01
Naphthalene	1.93E-03	0.02	0.02	8.92E-03	0.05
Phenol	0	5.73E-03	5.73E-03	2.88E-03	0.01
Styrene	0	5.63E-03	5.63E-03	2.83E-03	0.01
Tetrachloroethane	0	5.92E-04	5.92E-04	2.97E-04	0
Vinyl Chloride	0	3.55E-03	3.55E-03	1.79E-03	0.01
PAH -POM 1[a]	0	6.42E-03	6.42E-03	3.23E-03	0.02
POM 2[b]	1.86E-04	0.01	0.01	7.12E-03	0.04
POM 3[c]	5.05E-05	3.29E-07	3.29E-07	0	0
POM 4[d]	5.69E-06	3.70E-08	3.70E-08	0	0
POM 5[e]	7.58E-06	4.93E-08	4.93E-08	0	0
Benzo(b)fluoranthene/POM6[f]	2.27E-05	3.98E-05	3.98E-05	1.99E-05	0
Chrysene/POM7[g]	5.69E-06	1.65E-04	1.65E-04	8.31E-05	0
Total HAPs	84	23.2	23.2	1,031.96	1,163
Greenhouse Gases					
CO_2	379,278	54,953	54,953	13,194	502,379
CH_4	6,156	607	607	149.9	7,520

a Polycyclic Aromatic Hydrocarbons (PAH), Polycyclic Organic Matter (POM)

b - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene,

[c] - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[d] - POM 4 includes: 3-Methylchloranthrene.

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

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

[g] - POM 7 includes: Chrysene.

h Emissions for Peak Field Development

31. Total Project Emissions Summary

Pollutant	Project Emissions (tons/year)		Total Emissions [h] (tons/year)
	Well Development	Project Production	
Criteria Pollutants & VOC			
NO_x	1,357	757	2,115
CO	444	460	903
VOC	112.8	3,117	3,230
SO_2	23.9	1.10	25
PM_{10}	4,486	3,582	8,068
$PM_{2.5}$	476	395	871
Hazardous Air Pollutants			
Benzene	0.69	25.1	25.8
Toluene	1.17	51.2	52
Ethylbenzene	0.04	2.62	2.7
Xylene	0.61	34.0	35
n-Hexane	1.33	41.2	43
Formaldehyde	0.48	14.1	15
Acetaldehyde	3.67E-03	4.99	5.0
Acrolein	1.14E-03	1.35	1.4
Methanol	0	987.19	987.2
1,1,2,2-Tetrachloroethane	0	0.02	2.4E-02
1,1,2-Trichloroethane	0	0.02	1.9E-02
1,3-Dichloropropene	0	0.02	1.6E-02
1,3-Butadiene	1.48E-06	0.16	0.2
2,2,4-Trimethylpentane	0	0.15	0.1
Biphenyl	0	0.13	0.1
Carbon Tetrachloride	0	0.02	2.2E-02
Chlorobenzene	0	0.02	1.8E-02
Chloroform	0	0.02	1.7E-02
Dichlorobenzene	0	3.84E-03	3.8E-03
Ethylene Dibromide	0	0.03	2.6E-02
Methylene Chloride	0	0.01	1.2E-02
Naphthalene	0.02	0.05	6.5E-02
Phenol	0	0.01	1.4E-02
Styrene	0	0.01	1.4E-02
Tetrachloroethane	0	1.48E-03	1.5E-03
Vinyl Chloride	0	8.90E-03	8.9E-03
PAH -POM 1[a]	0.03	0.02	4.7E-02
POM 2[b]	0	0.04	3.6E-02
POM 3[c]	0	5.12E-05	5.1E-05
POM 4[d]	0	5.76E-06	5.8E-06
POM 5[e]	0	7.68E-06	7.7E-06
Benzo(b)fluoranthene/POM6	0	1.22E-04	1.2E-04
Chrysene/POM7[g]	0	4.20E-04	4.2E-04
Total HAPs	4.37	1,163	1,167
Greenhouse Gases			
CO_2	70,257	502,379	572,636
CH_4	568	7,520	8,088

a Polycyclic Aromatic Hydrocarbons (PAH), Polycyclic Organic Matter (POM)

b - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene,

[c] - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[d] - POM 4 includes: 3-Methylchloranthrene.

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

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

[g] - POM 7 includes: Chrysene.

h Emissions for Peak Field Development

1. Well Pad/Access Road/Pipeline Construction Fugitive Dust Emissions

Assumptions:

Pieces of Equipment	Hours of Construction
- 1 Backhoe	20 hours per well pad
- 1 Dozer/Crawler Tractor	100 hours per well pad

Watering Control Efficiency	50 percent
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

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 = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM15/hour/piece of equipment

	Fugitive Dust Emissions [a]		
	lbs/hr/ machine	tons/well	tons/yr [b]
TSP	1.97	0.1182	5.91
PM15	0.50	0.0301	1.51
PM10	0.38	0.0226	1.13
PM2.5	0.21	0.0124	0.62

a Backhoe/Grader/Loader emissions are conservatively estimated as equivalent to Bulldozing emissions.

b Assumes construction rate specified by Proponent

Note: The majority of new pipeline will be installed adjacent to proposed access roads and will not result significant additional surface disturbance.

2. Well Pad/Road/Pipeline Construction Emissions (Grader)

Assumptions:

Grading Length	3.19	0.20 miles/road*3 plus 0.86 miles pipeline plus 1.74 miles on 225' x400' pad (10 ft swath for 400 ft * 23 lengths) = 9,200 ft = 1.74 miles
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
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 10/98)
Distance Graded	3.19	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

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

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

Emissions = 8.56 lbs TSP/well

Emissions = 4.10 lbs PM15/well

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well**	**tons/well**	**tons/yr [a]**
TSP	8.56	0.86	0.0043	0.21
PM15	4.10	0.41	0.0020	0.10
PM10	2.46	0.25	0.0012	0.06
PM2.5	0.27	0.03	0.0001	0.01

a Assumes maximum development scenario

3. Interim Reclamation Fugitive Dust Emissions

Assumptions:

Hours of Construction	5	days per well pad (Estimate)
	12	hours/day
	60	hours per well pad
Pieces of Equipment	1	- Dozer
Watering Control Efficiency	50	percent
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

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 = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM15/hour/piece of equipment

	Fugitive Dust Emissions [a]		
	lbs/hr	tons/well	tons/yr [b]
TSP	1.97	0.0591	2.96
PM15	1.51	0.0452	2.26
PM10	1.13	0.0339	1.69
PM2.5	0.21	0.0062	0.31

a Backhoe/Grader/Loader emissions are conservatively estimated as equivalent to Bulldozing emissions.

b Assumes construction rate specified by Proponent

Note: The majority of new pipeline will be installed adjacent to proposed access roads and will not result significant additional surface disturbance.

Buys & Associates, Inc.
Environmental Consultants

Project: GASCO Uinta Basin Alternative D Inventory

4. Unpaved Road Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006

E (PM10) / VMT = 1.5 * (S/12)^0.9 * (W/3)^0.45 * (365-p)/365)
E (PM2.5) / 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 58
Precipitation Days (P) 73 days per year (NCDC data, Nutters Ranch, UT 1963-1986)

		Average	Round					
	Vehicle Type	Weight	Trips per	PM10	PM10/Pad	PM10/Pad	PM2.5/Pad	PM2.5/Pad
		(lbs)	Well a	(lb/VMT)	(lbs)	(lb/day)	(lbs)	(lb/day)
Construction (days/pad and road)	10							
	Haul Trucks	80,000	5					
	Water Trucks	60,000	1					
	Light Trucks	20,000	8					
	Mean Vehicle Weight	44,286	14	2.140031	1737.7	173.8	173.8	17.4
					PM10/Annual Pads		PM2.5/Annual Pads	
					(tons)		(tons)	
					43.4		4.3	
		Average	Round					
	Vehicle Type	Weight	Trips per	PM10	PM10/Well	PM10/Well	PM2.5/Well	PM2.5/Well
		(lbs)	Well a	(lb/VMT)	(lbs)	(lb/day)	(lbs)	(lb/day)
Drilling, Downhole (days/well)	35							
	Haul Trucks	80,000	70					
	Logging/Mud Trucks	70,000	10					
	Water Trucks b	60,000	75					
	Light Trucks	8,000	80					
	Mean Vehicle Weight	48,681	235	2.2331227	30437.5	869.6	3043.7	87.0
					PM10/Annual Wells		PM2.5/Annual Wells	
					(tons)		(tons)	
					760.9		76.1	
		Average	Round					
	Vehicle Type	Weight	Trips per	PM10	PM10/Well	PM10/Well	PM2.5/Well	PM2.5/Well
		(lbs)	Well a	(lb/VMT)	(lbs)	(lb/day)	(lbs)	(lb/day)
Completion (days/well)	14							
	Semi/Transport/Water/Sand	80,000	46					
	Water Trucks b	60,000	157					
	Light Trucks	8,000	56					
	Mean Vehicle Weight	52,309	259	2.3065367	34648.8	2474.9	3464.9	247.5
					PM10/Annual Wells		PM2.5/Annual Wells	
					(tons)		(tons)	
					866.2		86.6	
		Average	Round					
	Vehicle Type	Weight	Trips per	PM10	PM10/Day	PM10/Day	PM2.5/Day	PM2.5/Day
		(lbs)	Well a	(lb/VMT)	(lbs)	(lb/day)	(lbs)	(lb/day)
Interim Reclamation (days/well)	5							
	Haul Trucks	80,000	1					
	Light Trucks	8,000	5					
	Mean Vehicle Weight	20,000	6	1.4964593	520.8	104.2	52.1	10.4
					PM10/Annual Wells		PM2.5/Annual Wells	
					(tons)		(tons)	
					13.0		1.3	
Annual Traffic Fugitive Dust Emissions (tons/year)					1683.62		168.36	

[a] Traffic Estimates are based upon an approximately 14-days construction, 13-days drilling at downhole locations (shallow wells), 26-days drilling at direction wells (shallow wells), 29-days completion, and 6-days infrastructure development per well or well pad as appropriate.
[b] 25,000 barrels/well for completion; 12,000 barrels/well for drilling; assume 160-barrel water truck

Buys & Associates, Inc. **Environmental Consultants**	Project: GASCO Uinta Basin Alternative D Inventory Date: 6/9/2011

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	645.0 acres total initial disturbance for roads/pipelines (Proposed Action) 2,610,218 square meters total initial disturbance for roads/pipelines
	1,455 acres total initial disturbance for well pads and other facilities (Proposed Action) 5,888,167 square meters total initial disturbance for well pads and other facilities
	2,100 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 and facilities (Assumption, disturbance at construction and reclamation) Constant for dirt roads
Development Period	15 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/pcriod)*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	1.11	0.00
PM10	0.55	0.00
PM2.5	0.22	0.00

6. Construction Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0 miles (Estimated from project area and existing road system)
Hours of Construction	100 hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	6 (Proposed Action)
Number of Pickup Trips	8 (Proposed Action)
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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.130	0.095	0.005	3.030	0.047	0.002	0.142	0.354
CO	17.090	0.199	0.010	33.640	0.522	0.026	0.721	1.803
VOC [c]	4.600	0.054	0.003	4.646	0.072	0.004	0.126	0.314
SO_2	0.321	0.004	0.000	0.214	0.003	0.000	0.007	0.018
Greenhouse Gases								
CH_4 [e]	0.230	0.003	0.000	0.184	0.003	0.000	0.006	0.014

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

7. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Operation	840	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	155	(Proposed Action)
Number of Pickup Trips	80	(Proposed Action)
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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\text{ (g/lb)} * \text{Fuel Sulfur Content} * 2\text{ (S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.13	0.291	0.122	3.03	0.056	0.024	0.347	7.288
CO	17.09	0.612	0.257	33.64	0.622	0.261	1.233	25.900
VOC [c]	4.600	0.165	0.069	1.656	0.031	0.013	0.195	4.101
SO_2	0.32	0.011	0.005	0.21	0.004	0.002	0.015	0.325
Greenhouse Gases								
CH_4 [e]	0.230	0.008	0.003	0.184	0.003	0.001	0.012	0.244

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

8. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Operation	140.00	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	203	(Proponent)
Number of Pickup Trips	56	(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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\text{ (g/lb)} * \text{Fuel Sulfur Content} * 2\text{ (S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.13	2.287	0.160	3.03	0.235	0.016	2.522	8.828
CO	17.09	4.808	0.337	33.64	2.611	0.183	7.418	25.963
VOC [c]	4.600	1.294	0.091	1.656	0.129	0.009	1.423	4.979
SO_2	0.32	0.090	0.006	0.21	0.017	0.001	0.107	0.374
Greenhouse Gases								
CH_4 [e]	0.230	0.065	0.005	0.184	0.014	0.001	0.079	0.276

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

9. Development Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Operation	60	hours per site (Assumption)
Number of Heavy Diesel Truck Trips	1	(Assumption)
Number of Pickup Trips	5	(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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ \text{(S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.13	0.026	0.001	3.03	0.049	0.001	0.075	0.113
CO	17.09	0.055	0.002	33.64	0.544	0.016	0.599	0.899
VOC [c]	4.600	0.015	0.000	1.656	0.027	0.001	0.042	0.062
SO_2	0.32	0.001	0.000	0.21	0.003	0.000	0.004	0.007
Greenhouse Gases								
CH_4 [e]	0.230	0.001	0.000	0.184	0.003	0.000	0.004	0.006

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Hours of Operation	100 hours/site (Proposed Action)
Development Rate	50 new pads per year (Proposed Action)
Load Factor	0.4 (Assumed typical value)
Backhoe Size	85 hp (Proponent Contractor Typical value)
Crawler Tractor/Loader Size	290 hp (Proponent Contractor Typical value)
Motor Grader Size	185 hp (Proponent Contractor Typical value)

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			Crawler Tractor			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)
NO_x	8.15	0.611	0.305	8.15	2.084	5.211	7.14	1.165	1.747
CO	2.28	0.171	0.085	2.28	0.583	1.458	1.54	0.251	0.377
VOC[c]	0.37	0.028	0.014	0.37	0.095	0.237	0.36	0.059	0.088
PM_{10}[d]	0.5	0.037	0.019	0.5	0.128	0.320	0.63	0.103	0.154
$PM_{2.5}$[d]	0.5	0.037	0.019	0.5	0.128	0.320	0.63	0.103	0.154
SO_2	0.22	0.016	0.008	0.22	0.056	0.141	0.22	0.036	0.054
Formaldehyde	0.22	0.016	0.008	0.22	0.056	0.141	0.12	0.020	0.029

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions[e] (tons/yr)
NO_x	3.860	7.263
CO	1.005	1.920
VOC[c]	0.181	0.339
PM_{10}[d]	0.268	0.493
$PM_{2.5}$[d]	0.268	0.493
SO_2	0.109	0.203
Formaldehyde	0.092	0.178

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 construction rate specified by Proponent

11. Drill Rig Engine Emissions

Assumptions:

Hours of Operation	840 hours/ well (Proposed Action)
Development Rate	50 total wells in max year 7% average time small rig will run per well
Load Factor	0.4 (Assumed typical value)
Rig Size	800 hp (Estimate - phase 1 drilling) 2500 hp (Estimate - phase 2 drilling) 2379 hp (weighted average based on ratio of time in use to drill one well)
Diesel Fuel Sulfur Content	0.05 % (typical value)

Equations:

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

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Drill Rig Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [b] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.024	22.834	480
CO [a]	5.50E-03	5.233	110
VOC [a,b]	7.05E-04	0.671	14.1
PM_{10} [a,c]	5.75E-04	0.547	11.5
$PM_{2.5}$ [a,d]	4.81E-04	0.458	9.61
SO_2 [a]	4.05E-04	0.385	8.08
Hazardous Air Pollutants			
Benzene [e]	1.97E-06	0.002	0.04
Toluene [e]	7.15E-07	0.001	0.01
Xylenes [e]	4.91E-07	4.67E-04	0.01
Formaldehyde [e]	2.01E-07	1.91E-04	4.01E-03
Acetaldehyde [e]	6.41E-08	6.10E-05	1.28E-03
Acrolein [e]	2.01E-08	1.91E-05	4.01E-04
Naphthalene [f]	3.31E-07	3.15E-04	0.01
Total PAH [f,g]	5.40E-07	0.001	0.01
Greenhouse Gases			
CO_2 [a]	1.16	1104	23,177
CH_4 [a,b]	7.05E-04	0.671	14.1

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

[h] Assumes maximum development scenario

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12. Well Fracturing Pump and Generator Engines

Assumptions:

Average Hours of Operation	6 Hours/Well (Proponents)
Development Rate	50 wells per year (Proposed Action)
Load Factor	0.5 (typical value)
Frac Pump Engine Horsepower	19,000 Horsepower (typical)
Temporary Generator Horsepower	75 Horsepower (typical)
Diesel Fuel Sulfur Content	0.05 % (typical value)

Equations:

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

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Frac Pump Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.024	228.00	34.2
CO [a]	5.50E-03	52.25	7.84
VOC [a,b]	7.05E-04	6.698	1.00
PM_{10} [a,c]	5.73E-04	5.444	0.82
$PM_{2.5}$ [a,d]	4.79E-04	4.551	0.68
SO_2 [a]	4.05E-04	3.843	0.576
Hazardous Air Pollutants			
Benzene [e]	1.97E-06	1.88E-02	2.81E-03
Toluene [e]	7.15E-07	6.79E-03	1.02E-03
Xylenes [e]	4.91E-07	4.67E-03	7.00E-04
Formaldehyde [e]	2.01E-07	1.91E-03	2.86E-04
Acetaldehyde [e]	6.41E-08	6.09E-04	9.14E-05
Acrolein [e]	2.01E-08	1.91E-04	2.86E-05
Naphthalene [f]	3.31E-07	3.14E-03	4.71E-04
Total PAH [f]	5.40E-07	5.13E-03	7.69E-04
Greenhouse Gases			
CO_2 [a]	1.16	11,020	1,653
CH_4 [a]	7.05E-04	6.698	1.00

Species	Generator Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants			
NOx [g]	0.031	1.163	0.17
CO [g]	6.68E-03	0.25	0.04
VOC [b,g]	2.47E-03	0.09	0.01
PM_{10} [g]	2.20E-03	0.08	0.01
$PM_{2.5}$ [g]	2.20E-03	0.08	0.01
SO_2 [g]	2.05E-03	0.08	0.01
Hazardous Air Pollutants			
Benzene [h]	2.37E-06	8.90E-05	1.34E-05
Toluene [h]	1.04E-06	3.90E-05	5.86E-06
Xylenes [h]	7.25E-07	2.72E-05	4.08E-06
Formaldehyde [h]	3.00E-06	1.13E-04	1.69E-05
Acetaldehyde [h]	1.95E-06	7.32E-05	1.10E-05
Acrolein [h]	2.35E-07	8.83E-06	1.32E-06
1,3-Butadiene [h]	9.95E-08	3.73E-06	5.60E-07
Naphthalene [h]	2.16E-07	8.09E-06	1.21E-06
Total PAH [b]	4.28E-07	1.60E-05	2.41E-06
Greenhouse Gases			
CO_2 [g]	1.15	10,925	1,639
CH_4 [b,g]	2.47E-03	23.465	3.52

[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 conversion factor from Appendix A

[i] Assumes maximum development scenario

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13. Well Development Venting

Assumptions: Following Completion, Wells are Vented prior to connnection to the gathering pipeline

Venting Period 48 hours (Project Proponents)

Amount of Vented Gas: 0.2 MMscf (Average Volume Estimated by Proponents)

Development Rate: 50 Wells per year (Project Proponents)

COMPONENT	MOLECULAR WEIGHT (lb/lb-mole)	MOLE PERCENT	RELATIVE MOLE WEIGHT (lb/lb-mole)	WEIGHT Fraction	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (lb/hr)	COMPONENT FLOW RATE (tons/yr)
Methane	16.043	92.713	14.874	0.833	185.426	163.311	195.973
Ethane	30.07	4.078	1.226	0.069	8.156	13.464	16.157
Propane	44.097	1.145	0.505	0.028	2.289	5.542	6.650
i-Butane	58.123	0.248	0.144	0.008	0.496	1.582	1.898
n-Butane	58.123	0.265	0.154	0.009	0.530	1.691	2.029
i-Pentane	72.15	0.118	0.085	0.005	0.236	0.935	1.122
n-Pentane	72.15	0.087	0.063	0.004	0.174	0.689	0.827
Hexanes	86.177	0.000	0.000	0.000	0.000	0.000	0.000
Heptanes	100.204	0.216	0.216	0.012	0.431	2.372	2.846
Octanes	114.231	0.035	0.040	0.002	0.069	0.435	0.522
Nonanes	128.258	0.031	0.039	0.002	0.061	0.430	0.515
Decanes +	142.285	0.007	0.010	0.001	0.014	0.106	0.127
Benzene	78.12	0.021	0.016	0.001	0.042	0.181	0.217
Toluene	92.13	0.035	0.032	0.002	0.070	0.356	0.427
Ethylbenzene	106.16	0.001	0.001	0.000	0.002	0.014	0.017
Xylenes	106.16	0.016	0.017	0.001	0.031	0.183	0.220
n-Hexane	86.177	0.044	0.038	0.002	0.089	0.420	0.504
Helium	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.125	0.035	0.002	0.249	0.384	0.460
Carbon Dioxide	44.01	0.817	0.359	0.020	1.633	3.945	4.735
Oxygen	32	0.000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulfide	34.08	0.000	0.000	0.000	0.000	0.000	0.000
VOC SUBTOTAL		**2.2676**	**1.360**	**0.076**	**4.535**	**14.935**	**17.923**
HAP SUBTOTAL		**0.1176**	**0.105**	**0.006**	**0.235**	**1.154**	**1.385**
TOTAL		**100.000**	**17.855**	**1.000**	**200**	**196.039**	**235.247**

14. Well Development Emissions Summary

Species	Well Development Emissions (tons/year) [a]				Wind Erosion	Total [a] (tons/yr)
	Construction	Drilling	Completion	Interim Reclamation		
Criteria Pollutants & VOC						
NO_x	7.62	487	16.7	0.11		511
CO	3.72	136	27.0	0.90		167
VOC	0.65	18.2	23.7	0.06		42.6
SO_2	0.22	8.4	0.4	0.0		9.01
PM_{10}	45.1	772	867	14.7	0.55	1,700
$PM_{2.5}$	5.46	85.7	87.2	1.61	0.22	180
Hazardous Air Pollutants						
Benzene		0.04	2.20E-01			0.26
Toluene		0.01	4.28E-01			0.44
Ethylbenzene			0.02			0.02
Xylenes		0.01	2.20E-01			0.23
n-Hexane			0.504			0.50
Formaldehyde	0.18	4.01E-03	3.03E-04			0.18
Acetaldehyde		1.28E-03	1.02E-04			1.38.E-03
Acrolein		4.01E-04	2.99E-05			4.31.E-04
1,3-Butadiene			5.60E-07			5.60.E-07
Naphthalene		0.01	4.73E-04			0.01
Total PAH, POM 1 [b]		0.01	7.71E-04			0.01
Total HAPs	0.18	0.09	1.39	0.0	0.0	1.64
Greenhouse Gases						
CO_2		23,177	3,296			26,473
CH_4	0.01	14.3	201	0.01		215

a Emissions for Peak Field Development

b Polycyclic Aromatic Hydrocarbons (PAH), Polycyclic Organic Matter (POM)

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

[d] POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[e] POM 4 includes: 3-Methylchloranthrene.

[f] POM 5 includes: Benzo(a)pyrene and dibenzo(a,h)anthracene.

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

[h] POM 7 includes: Chrysene.

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15. Average Produced Gas Characteristics
Inlet Wet Gas Sample from Riverbend Compressor Station, dated 3/22/07

Gas Heat Value (wet): 1064.1 Btu/scf

C1-C2 Wt. Fraction:	0.9020
VOC Wt. Fraction:	0.0760
Non-HC Wt. Fraction:	0.0221
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	92.7130	16.043	14.874	0.833	1010.000	936.401	910.000	843.688
Ethane	4.0781	30.070	1.226	0.069	1769.800	72.174	1618.000	65.984
Propane	1.1446	44.097	0.505	0.028	2516.200	28.800	2316.000	26.509
i-Butane	0.2479	58.123	0.144	0.008	3252.100	8.062	3005.000	7.449
n-Butane	0.2649	58.123	0.154	0.009	3262.400	8.642	3013.000	7.981
i-Pentane	0.1180	72.150	0.085	0.005	4000.900	4.721	3698.000	4.364
n-Pentane	0.0870	72.150	0.063	0.004	4008.800	3.488	3708.000	3.226
Hexanes	0.0687	86.177	0.059	0.003	4756.200	3.268	4404.000	3.026
Heptanes	0.0737	100.204	0.074	0.004	5502.500	4.055	5100.000	3.759
Methylcyclohexane	0.0509	98.186	0.050	0.003	1865.455	0.880	1729.000	0.880
Octanes	0.0550	114.231	0.063	0.004	6249.100	3.437	1695.970	0.933
2,2,4-TMP	0.0047	114.220	0.005	0.000	6368.594	0.081	1728.400	0.081
Nonanes	0.0305	128.258	0.039	0.002	6996.400	2.134		0.000
Decanes	0.0068	142.285	0.010	0.001	7743.200	0.527		0.000
Benzene	0.0211	78.120	0.016	0.001	3715.500	0.784		0.000
Toluene	0.0352	92.130	0.032	0.002	4444.600	1.564		0.000
Ethylbenzene	0.0012	106.160	0.001	0.000	5191.500	0.062		0.000
Xylenes	0.0157	106.160	0.017	0.001	5183.500	0.814		0.000
n-Hexane	0.0444	86.177	0.038	0.002	4756.200	2.112		0.000
Helium	0.0000	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	0.1247	28.013	0.035	0.002	0.000	0.000	0.000	0.000
Carbon Dioxide	0.8165	44.010	0.359	0.020	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		17.85	1.00		1082.01		967.88

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

Weight Fraction = Net Mole Weight / Total Mole Weight

HAP Fractions estimated from GRI Published Factors

16. Wellsite Heater Emissions

Assumptions

Separator Heater Size	500	Mbtu/hr (Typical size Proposed Action)
Wells Requiring Separators:	368	wells at Peak Production
Firing Rate	6,480	hours/year (Typical Uinta Basin operation)
Fuel Gas Heat Value	968	Btu/scf (Gas Analyses from Riverbend well)
Fuel Gas VOC Content	0.076	by weight (Gas Analyses from Riverbend Facility)

Equations

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

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

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

Species	Wellsite Heater Emissions - Separators		
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC			
NO_x [a]	100	0.052	61.6
CO [a]	84	0.043	51.7
TOC [c]	11	0.006	6.8
VOC	N.A.	0.000	0.51
SO_x [b]	0.00	0.000	0
TSP [c]	7.6	0.004	4.68
PM_{10} [c]	7.6	0.004	4.68
$PM_{2.5}$ [c]	7.6	0.004	4.68
Hazardous Air Pollutants			
Benzene [d]	0.0021	1.08E-06	1.29E-03
Toluene [d]	0.0034	1.76E-06	2.09E-03
Hexane [d]	1.8	9.30E-04	1.11
Formaldehyde [d]	0.075	3.87E-05	0.05
Dichlorobenzene [d]	1.2E-03	6.20E-07	7.39E-04
Naphthalene [d]	6.1E-04	3.15E-07	3.76E-04
POM 2 [d,e,f]	5.9E-05	3.05E-08	3.63E-05
POM 3 [d,g]	1.6E-05	8.27E-09	9.86E-06
POM 4 [d,h]	1.8E-06	9.30E-10	1.11E-06
POM 5 [d,i]	2.4E-06	1.24E-09	1.48E-06
POM 6 [d,j]	7.2E-06	3.72E-09	4.43E-06
POM 7 [d,k]	1.8E-06	9.30E-10	1.11E-06
Greenhouse Gases			
CO_2 [c]	120,000	61.991	73,913
CH_4 [c]	2.3	0.001	1.42

[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

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

[f] - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene,

[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] - Assumes full development.

17. Wellsite Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate: 2.01 bbls condensate per day (Estimate based on proponent data)
Number of Active Wells: 368 wells at Peak Production

Separator Conditions : 130 psi and 60 F (Riverbend sample)
API Gravity: 53.4

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0 Run Date 7/30/08
Riverbend Compressor Station Liquid Sample Dated 3/22/07
Scaled from 15.9 bbls per day

Emissions:

Component	Wellsite Flash/Work/Breathing (lb/hr/well)	Wellsite Flash/Work/Breathing (tons/year/well)	Total Emissions (tons/yr)
Total VOC	0.252	1.106	406.9
Hazardous Air Pollutants			
Benzene	2.010E-03	0.009	3.240
Toluene	3.216E-03	0.014	5.184
Ethylbenzene	1.340E-04	0.001	0.216
Xylenes	1.206E-03	0.005	1.944
n-Hexane	5.226E-03	0.023	8.423
Greenhouse Gases			
CO_2	0.038	0.167	61.56
CH_4	0.160	0.702	258.3

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18. VOC Emissions from NGL Truck Loading Operations

NGL Truck Loading/Unloading Emissions: NGL will normally be transported by pipeline, however truck transport may be utilized as a contingency. A pressurized vapor recovery system will be utilized for truck loading. Potential emissions result from the equalization of the loading rack connection to atmospheric pressure after the loading operation is completed.

Assumed Maximum Number of Truck loads/year 1,460

Truck Loading Connection Configuration

	Load Line		
Load Line Connection Diameter =	0.25	ft	(Assumed typical value)
Load Line Length between Valves =	3.0	ft	(Assumed typical value)
Connection Volume =	0.147	ft^3	
Annual Connection Volume Vented =	215	ft^3	
NGL Density =	5.6	lbs/gal	(Assumed typical value)
NGL Density =	41.9	lbs/ft^3	
Annual Wt. NGL Vented =	9,006.0	lbs/year	
NGL VOC Content =	100.0%	by weight (See NGL Composition for Fugitive Emissions)	
VOC Emissions =	4.5	tons/year VOC	

Example Calculations

Connection volume = Pi * $(Diameter)^2/4$ * Length

Annual Volume Vented (ft^3/year) = Connection Volume (ft^3) * Number Truck Loads per year (1/year)

Density ($lbs/ft^{3)}$ = Density (lbs/gal) * 7.48 gal/ft^3

Vented NGL Weight (lbs) = Volume Vented (ft^3) * NGL Density (lbs/ft^3)

VOC Emissions (tons/year) = Annual NGL Vented (lbs/year) * NGL VOC wt. % / 100 / 2000 (lbs/ton)

19. Operations Vehicle Tailpipe Emissions

Assumptions:

Number of New Pumpers:	11	(Proposed Action Number of Pumpers at Peak Production)
Pumper Mileage:	2,800	miles/pumper/month (Assumption)
Total Annual New Pumper Mileage:	369,600	miles/year
Number of Condensate Haul Truck Round Trips:	5	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for Condensate Transport:	58	miles (Estimate from Vernal)
Total Annual Condensate Truck Mileage:	105,850	miles/year
Number of Water Haul Truck Round Trips:	30	trips per day (Based on Peak Production Alternative C)
Average Round Trip Mileage for Water Transport:	17	miles (Average distance to evaporation facility)
Total Annual Water Truck Mileage:	186,150	miles/year
Number of NGL Haul Truck Round Trips:	4	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for NGL Transport:	58	miles (Average distance to evaporation facility)
Total Annual NGL Truck Mileage:	84,680	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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ \text{(S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	3.03	0.565	1.234	8.13	1.546	2.617	2.111	3.851
CO	33.64	6.275	13.705	17.09	3.249	5.501	9.524	19.206
VOC [c]	1.656	0.309	0.675	4.600	0.875	1.481	1.183	2.155
SO_2	0.21	0.040	0.087	0.32	0.061	0.103	0.101	0.191
Greenhouse Gases								
CH_4 [d]	0.184	0.034	0.075	0.230	0.044	0.074	0.078	0.149

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

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20. Operations Traffic Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006

365 days (Estimate)

Vehicle Type	Ave. Weight (lbs)	Round Trips per Day*
Pickup Truck: Crew	7,000	11.0
Haul Truck: Oil	48,000	5.0
Haul Truck: Water	48,000	30.0
Haul Truck: NGL	48,000	4.0
Mean Weight	38,980	50.0

Unpaved Roads

E (PM10) / VMT = 1.5 * (S/12)^0.9 * (W/3)^0.45 * (365-p)/365)
E (PM2.5) / 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) 73 days per year **
Avg. Round Trip Miles 38 miles on unpaved roads ***

Paved Roads

E (PM10) / VMT = 0.016 * (sL/2)^0.65 * (W/3)^1.5 - 0.00047 * (1-(p/(365*4))
E (PM10) / 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 30 From Roosevelt
Precipitation Days (P) 73 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	2.02	1,382,848	3789	0.20	138,285	379
Paved	0.08	42,397	116	0.01	6,209	17
Total		1,425,244	3,905		144,494	396
Annual Traffic Fugitive Dust Emissions (tons/year)		**691.4**			**69.14**	

*Round trips per day at peak production (Proposed Action)
** NCDC data for Nutters Ranch, UT 1963-1986
*** Weighted average of Pumper,Condensate, NGL, and Water Hauling Distance = (58*(11+5+4+5)+17*(30-5))/50. One round trip to evaporative facility is assumed to take about 2-hours, so 6 trips per day are completed in one 12-hr shift, which requires 5 trucks to do 30 trips.

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21. Pneumatic Device Emissions — 0.144 Mscf/day or less = low bleed device

Analysis Gas Consumption Rate:	1.00	Mscf/day
Days of Operation:	365	days/year

GAS COMPONENT	MOLECULAR WEIGHT (lb/lb-mole)	MOLE PERCENT	RELATIVE MOLE WEIGHT (lb/lb-mole)	WEIGHT PERCENT	VOLUME LOW RAT (Mscf/day	MASS FLOW RATE (lb/hr)	MASS FLOW RATE (tons/yr)
Methane	16.043	92.7130	14.874	83.334	0.927	1.633	7.153
Ethane	30.07	4.0781	1.226	6.870	0.041	0.135	0.590
Propane	44.097	1.1446	0.505	2.828	0.011	0.055	0.243
i-Butane	58.123	0.2479	0.144	0.807	0.002	0.016	0.069
n-Butane	58.123	0.2649	0.154	0.863	0.003	0.017	0.074
i-Pentane	72.15	0.1180	0.085	0.477	0.001	0.009	0.041
n-Pentane	72.15	0.0870	0.063	0.352	0.001	0.007	0.030
Hexanes	86.177	0.0687	0.059	0.332	0.001	0.007	0.028
Heptanes	100.204	0.1233	0.124	0.692	0.001	0.014	0.059
Octanes	114.231	0.0584	0.067	0.374	0.001	0.007	0.032
Nonanes	128.258	0.0305	0.039	0.219	0.000	0.004	0.019
Decanes +	142.285	0.0068	0.010	0.054	0.000	0.001	0.005
Benzene	78.12	0.0211	0.016	0.092	0.000	0.002	0.008
Toluene	92.13	0.0352	0.032	0.182	0.000	0.004	0.016
Ethylbenzene	106.16	0.0012	0.001	0.007	0.000	0.000	0.001
Xylenes	106.16	0.0157	0.017	0.093	0.000	0.002	0.008
n-Hexane	86.177	0.0444	0.038	0.214	0.000	0.004	0.018
Helium	4.003	0.0000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.1247	0.035	0.196	0.001	0.004	0.017
Carbon Dioxide	44.01	0.8165	0.359	2.013	0.008	0.039	0.173
Oxygen	32	0.0000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulfide	34.08	0.0000	0.000	0.000	0.000	0.000	0.000
VOC SUBTOTAL		**2.268**	**1.354**	**7.586**	**0.023**	**0.149**	**0.651**
HAP SUBTOTAL		**0.118**	**0.105**	**0.589**	**0.001**	**0.012**	**0.051**
TOTAL		**100.000**	**17.849**	**100.000**	**1.000**	**1.960**	**8.584**

	Number of Wells	VOC emissions (tons/year)	Methane emissions (tons/yr)
Alternative D	368	86	947.6

LIQUID LEVEL CONTROLLER SPECIFICATIONS

Gas Consumption Rate:	0.144	Mscf/day
Days of Operation:	365	days/year

(low-bleed)

TRACE PUMP SPECIFICATIONS

Gas Consumption Rate:	0.144	Mscf/day
Days of Operation:	182	days/year

Assumed recycle of gas equals low-bleed specification

METHANOL PUMP SPECIFICATIONS

-Solar powered methanol pumps will be installed for the Proposed Action

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.04	0.19
1	Trace pump	0.01	0.05
2	Chemical injection pump	0	0
	Totals (per well) =	0.05	0.23

Pneumatic sources / well		Methane lb/hr	Methane ton/yr
2	Liquid level controllers	0.47	2.06
1	Trace pump	0.24	0.52
2	Chemical injection pump	0	0
	Totals (per well) =	0.71	2.58

22. Well Production Summary

Species	Storage Tanks (tons/yr)	Well Site Heaters (tons/yr)	Operations Vehicle (tons/yr)	Total Well Production [g] (tons/yr)
Criteria Pollutants & VOC				
NO_x		61.6	3.9	65.4
CO		51.7	19.2	70.9
VOC	407	0.51	2.16	496
SO_2		0	0.19	0.19
PM_{10}		4.68	691	696
$PM_{2.5}$		4.68	69	74
Hazardous Air Pollutants				
Benzene	3.2	1.29E-03		3.2
Toluene	5	2.09E-03		5.2
Ethylbenzene	0.22			0.22
Xylene	1.9			1.9
n-Hexane	8	1.11		9.5
Formaldehyde		0.05		0.05
Dichlorobenzene		7.39E-04		7.39E-04
Naphthalene		3.76E-04		3.76E-04
POM 2[a]		3.63E-05		3.63E-05
POM 3[b]		9.86E-06		9.86E-06
POM 4[c]		1.11E-06		1.11E-06
POM 5[d]		1.48E-06		1.48E-06
POM 6[e]		4.43E-06		4.43E-06
POM 7[f]		1.11E-06		1.11E-06
Total HAPs	19	1.16	0.0	20
Greenhouse Gases				
CO_2	62	73,913		73,975
CH_4	258	1.42	0.15	1,208

[a] - POM (Particulate Organic Matter) 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

[b] - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[c] - POM 4 includes: 3-Methylchloranthrene.

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

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

[f] - POM 7 includes: Chrysene.

[g] Emissions for Peak Field Development, include pneumatics

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23. Average Produced Gas Characteristics
Inlet Wet Gas Sample from Riverbend Compressor Station, dated 3/22/07

Gas Heat Value (wet): 1064.1 Btu/scf

Sample Temperature: 77 F
Sample Pressure: 132 psi

C1-C2 Wt. Fraction:	0.9020
VOC Wt. Fraction:	0.0760
Non-HC Wt. Fraction:	0.0221
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	92.7130	16.043	14.874	0.833	1010.000	936.401	910.000	843.688
Ethane	4.0781	30.070	1.226	0.069	1769.800	72.174	1618.000	65.984
Propane	1.1446	44.097	0.505	0.028	2516.200	28.800	2316.000	26.509
i-Butane	0.2479	58.123	0.144	0.008	3252.100	8.062	3005.000	7.449
n-Butane	0.2649	58.123	0.154	0.009	3262.400	8.642	3013.000	7.981
i-Pentane	0.1180	72.150	0.085	0.005	4000.900	4.721	3698.000	4.364
n-Pentane	0.0870	72.150	0.063	0.004	4008.800	3.488	3708.000	3.226
Hexanes	0.0687	86.177	0.059	0.003	4756.200	3.268	4404.000	3.026
Heptanes	0.0737	100.204	0.074	0.004	5502.500	4.055	5100.000	3.759
Methylcyclohexane	0.0509	98.186	0.050	0.003	1865.455	0.880	1729.000	0.880
Octanes+	0.0550	114.231	0.063	0.004	6249.100	3.437	1695.970	0.933
2,2,4-TMP	0.0047	114.220	0.005	0.000	6368.594	0.081	1728.400	0.081
Nonanes	0.0305	128.258	0.039	0.002	6996.400	2.134		0.000
Decanes	0.0068	142.285	0.010	0.001	7743.200	0.527		0.000
Benzene	0.0211	78.120	0.016	0.001	3715.500	0.784		0.000
Toluene	0.0352	92.130	0.032	0.002	4444.600	1.564		0.000
Ethylbenzene	0.0012	106.160	0.001	0.000	5191.500	0.062		0.000
Xylenes	0.0157	106.160	0.017	0.001	5183.500	0.814		0.000
n-Hexane	0.0444	86.177	0.038	0.002	4756.200	2.112		0.000
Helium	0.0000	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	0.1247	28.013	0.035	0.002	0.000	0.000	0.000	0.000
Carbon Dioxide	0.8165	44.010	0.359	0.020	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		17.85	1.00		1082.01		967.88

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

Weight Fraction = Net Mole Weight / Total Mole Weight

24. Central Compression

Assumptions:

Total Existing Compression: 6,615 Horsepower (Riverbend Facility)
Total New Compression: 5,200 Horsepower (Proposed Action)
Total New Generation 3,420 Horsepower (Proposed Action)

Equations:

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

Pollutant	Emission Factor [6] (lb/MMBtu)	Emission Factor (g/hp-hr)	Emissions (lb/hr/engine) [7]	2,600 hp Station Emissions (tons/yr)	2,600 hp Station Emissions (tons/yr)	Total Emissions [8] Proposed Action (tons/yr)
Criteria Pollutants & VOC						
NOx [1]		1.5	3.31	37.7	37.7	75.3
CO [1,9]		0.1	0.22	2.5	2.5	5.0
VOC [1,10]		0.5	1.10	12.6	12.6	25.1
PM10 [2,3]	9.95E-03	0.037	0.08	0.93	0.93	1.9
PM2.5 [2,3]	9.95E-03	0.037	0.08	0.93	0.93	1.9
SO_2	5.88E-04	0.002	0.00	0.1	0.1	0.1
Hazardous Air Pollutants [10]						
Benzene [2]	4.40E-04	8.224E-04	1.81E-03	0.02	0.02	0.04
Toluene [2]	4.08E-04	7.626E-04	1.68E-03	0.02	0.02	0.04
Ethylbenzene [2]	3.97E-05	7.420E-05	1.64E-04	1.86E-03	1.86E-03	3.73E-03
Xylenes [2]	1.84E-04	3.439E-04	7.58E-04	0.01	0.01	0.02
n-Hexane [2]	1.11E-03	2.075E-03	4.57E-03	0.05	0.05	0.10
Formaldehyde [2,11]	5.28E-02	2.960E-02	6.53E-02	0.74	0.74	1.49
Acetaldehyde [2]	8.36E-03	1.562E-02	3.44E-02	0.39	0.39	0.78
Acrolein [2,11]	5.14E-03	2.882E-03	6.35E-03	0.07	0.07	0.14
Methanol [2]	2.50E-03	4.673E-03	1.03E-02	0.12	0.12	0.23
1,1,2,2-Tetrachloroethane[2]	4.00E-05	7.476E-05	1.65E-04	1.88E-03	1.88E-03	3.75E-03
1,1,2-Trichloroethane[2]	3.18E-05	5.943E-05	1.31E-04	1.49E-03	1.49E-03	2.98E-03
1,3-Dichloropropene[2]	2.64E-05	4.934E-05	1.09E-04	1.24E-03	1.24E-03	2.48E-03
1,3-Butadiene[2]	2.67E-04	4.990E-04	1.10E-03	0.01	0.01	0.03
2,2,4-Trimethylpentane[2]	2.50E-04	4.673E-04	1.03E-03	0.01	0.01	0.02
Biphenyl[2]	2.12E-04	3.962E-04	8.74E-04	0.01	0.01	0.02
Carbon Tetrachloride[2]	3.67E-05	6.859E-05	1.51E-04	1.72E-03	1.72E-03	3.44E-03
Chlorobenzene[2]	3.04E-05	5.682E-05	1.25E-04	1.43E-03	1.43E-03	2.85E-03
Chloroform[2]	2.85E-05	5.327E-05	1.17E-04	1.34E-03	1.34E-03	2.67E-03
Ethylene Dibromide[2]	4.43E-05	8.280E-05	1.83E-04	2.08E-03	2.08E-03	4.16E-03
Methylene Chloride[2]	2.00E-05	3.738E-05	8.24E-05	9.38E-04	9.38E-04	1.88E-03
Naphthalene[2]	7.44E-05	1.391E-04	3.07E-04	3.49E-03	3.49E-03	0.01
Phenol[2]	2.40E-05	4.486E-05	9.89E-05	1.13E-03	1.13E-03	2.25E-03
Styrene[2]	2.36E-05	4.411E-05	9.72E-05	1.11E-03	1.11E-03	2.21E-03
Tetrachloroethane[2]	2.48E-06	4.635E-06	1.02E-05	1.16E-04	1.16E-04	2.33E-04
Vinyl Chloride[2]	1.49E-05	2.785E-05	6.14E-05	6.99E-04	6.99E-04	1.40E-03
PAH -POM 1[2,4]	2.69E-05	5.028E-05	1.11E-04	1.26E-03	1.26E-03	2.52E-03
POM 2[2,4,5]	5.93E-05	1.109E-04	2.45E-04	2.78E-03	2.78E-03	0.01
Benzo(b)fluoranthene/POM6[2,4]	1.66E-07	3.103E-07	6.84E-07	7.79E-06	7.79E-06	1.56E-05
Chrysene/POM7[2,4]	6.93E-07	1.295E-06	2.86E-06	3.25E-05	3.25E-05	6.50E-05
Greenhouse Gases						
CO2 [2]	110	411	906	10323	10323	20646
CH4 [2]	1.25	4.67	10.3	117	117	235

[1] - Currently permitted emission rates for internal combustion engine

[2] - AP-42 Table 3.2-2 Uncontrolled Emission Factors for 4-Stroke Lean-Burn Engines, 7/00

[3] - PM = sum of PM filterable and PM condensable

[4] - 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

[5] - POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

[6] - Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 8,240 Btu/hp-hr (*3.738)

[7] - Each individual engine estimated at 1,000 hp (Proposed Action)

[8] - Proposed Action Total Annual Emissions for New Compression (21,325 hp)

[9] - CO emission estimate reduced by 95% to reflect reduction by oxidation catalyst.

[10] - VOCs and HAPs emission estimates reduced by 50% to reflect reduction by oxidation catalyst.

[11] - Formaldehyde and acrolein emission estimates reduced by 85% to reflect reduction by oxidation catalyst.

25. Central TEG Dehydrator Emissions

Assumptions

Peak Field Production Rate: 50 MMscf/day
368 Active Wells at Peak Production

Gas Composition: Inlet Gas Sample from Riverbend Compresor Station, dated 3/22/07

Inlet Gas Conditions: Inlet gas saturated at 820.0 psig and 86 F

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

Flare > 95% Control Efficiency in order to meet Federal MACT Standards
Condenser Operating Conditions: 86 deg. F, 834.7 psia

Emissions

Species	Central Dehydrator Emissions 25MMscfd Station (tons/year)	Central Dehydrator Emissions 25MMscfd Station (tons/year)	Total Project Emissions (tons/year)
Total VOC	4.0063	4.0063	8.01
Hazardous Air Pollutants			
Benzene	0.4494	0.4494	0.90
Toluene	1.2720	1.2720	2.54
Ethylbenzene	0.0649	0.0649	0.13
Xylenes	1.3012	1.3012	2.60
n-Hexane	0.0277	0.0277	0.06
Greenhouse Gases			
CH_4	2.1402	2.1402	4.28

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26. Central Facility Heater Emissions

Assumptions

Dehydrator Reboiler Heater	750	Mbtu/hr (Estimate based on Riverbend Facility)
Separator Heater	500	Mbtu/hr (Based on current Riverbend equipment)
Total Heater Requirmement Facility 1	1,250	Mbtu/hr (Proposed Action Estimate, 1-Dehydrator Reboiler Heater, 1-Separator Heater)
Total Heater Requirmement Facility 2	1,250	Mbtu/hr (Proposed Action Estimate, 1-Dehydrator Reboiler Heater, 1-Separator Heater)
Firing Rate	45	minutes/hour on average for entire year (Typical value)
	6570	hours/year
Fuel Gas Heat Value	968	Btu/scf (Gas Analyses from Riverbend Facility)
Fuel Gas VOC Content	0.076	by weight (Gas Analyses from Riverbend Facility)

Equations

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

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

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

Species	Central Heater Emissions - Facility 1			Central Heater Emissions - Facility 2			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr)	Total Emissions (tons/yr)	Total Emissions (tons/yr)
Criteria Pollutants & VOC							
NO_x [a]	100	0.125	0.411	100	0.125	0.411	0.821
CO [a]	84	0.105	0.345	84	0.105	0.345	0.690
TOC [c]	11	0.014	0.045	11	0.014	0.045	0.090
VOC	N.A.	0.001	0.003	N.A.	0.001	0.003	0.007
SO_x [b]	0.00	0.000	0.000	0.00	0.000	0.000	0.000
TSP [c]	7.6	0.010	0.031	7.6	0.010	0.031	0.062
PM_{10} [c]	7.6	0.010	0.031	7.6	0.010	0.031	0.062
$PM_{2.5}$ [c]	7.6	0.010	0.031	7.6	0.010	0.031	0.062
Hazardous Air Pollutants							
Benzene [d]	2.1E-03	2.63E-06	8.62E-06	2.1E-03	2.63E-06	8.62E-06	1.72E-05
Toluene [d]	3.4E-03	4.25E-06	1.40E-05	3.4E-03	4.25E-06	1.40E-05	2.79E-05
Hexane [d]	1.8E+00	2.25E-03	0.01	1.8E+00	2.25E-03	0.01	0.01
Formaldehyde [d]	7.5E-02	9.38E-05	3.08E-04	7.5E-02	9.38E-05	3.08E-04	6.16E-04
Dichlorobenzene [d]	1.2E-03	1.50E-06	4.93E-06	1.2E-03	1.50E-06	4.93E-06	9.86E-06
Naphthalene [d]	6.1E-04	7.63E-07	2.50E-06	6.1E-04	7.63E-07	2.50E-06	5.01E-06
POM 2 [d,e,f]	5.9E-05	7.38E-08	2.42E-07	5.9E-05	7.38E-08	2.42E-07	4.85E-07
POM 3 [d,g]	1.6E-05	2.00E-08	6.57E-08	1.6E-05	2.00E-08	6.57E-08	1.31E-07
POM 4 [d,h]	1.8E-06	2.25E-09	7.39E-09	1.8E-06	2.25E-09	7.39E-09	1.48E-08
POM 5 [d,i]	2.4E-06	3.00E-09	9.86E-09	2.4E-06	3.00E-09	9.86E-09	1.97E-08
POM 6 [d,j]	7.2E-06	9.00E-09	2.96E-08	7.2E-06	9.00E-09	2.96E-08	5.91E-08
POM 7 [d,k]	1.8E-06	2.25E-09	7.39E-09	1.8E-06	2.25E-09	7.39E-09	1.48E-08
Greenhouse Gases							
CO_2 [c]	120,000	150	493	120000	150	493	986
CH_4 [c]	2.3	0.00	0.01	2.3	0.00	0.01	0.02

[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

[e] - 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

[f] - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and 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.

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

Assumptions:

Average Condensate Production Rate :

Facility 1 0.48 bbls condensate per day (Estimate Based on typical average lifetime condensate well production)
Facility 2 0.48 bbls condensate per day (Estimate Based on typical average lifetime condensate well production)

Separator Conditions : 130 psi and 60 F (Sample Conditions)
API Gravity: 53.4

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0 Run Date 7/30/08
Riverbend Compressor Station Liquid Sample Dated 3/22/07
Scaled from 15.9 bbls per day
Controlled 95% efficiency

Emissions:

Component	Facility 1 Flash/Work/Breathing (tons/yr)	Facility 2 Flash/Work/Breathing (tons/yr)	Total Emissions (tons/yr)
Total VOC	0.013	0.013	0.03
Hazardous Air Pollutants			
Benzene	1.013E-04	1.013E-04	2.03E-04
Toluene	1.694E-04	1.694E-04	3.39E-04
Ethylbenzene	7.92E-06	7.92E-06	1.58E-05
Xylenes	6.017E-05	6.017E-05	1.20E-04
n-Hexane	2.676E-04	2.676E-04	5.35E-04
Greenhouse Gases			
CO_2	1.979E-03	1.979E-03	3.96E-03
CH_4	0.008	0.008	0.02

28. Central Facility Emission Summary

Central Facility 1

Pollutant	Central Compression Emissions 2,600 hp (tons/year)	Central Dehydrator Emissions 25MMscfd (tons/year)	Central Heater Emissions 1,000 MBtu/hr (tons/year)	Central Condensate Tank Emissions 0.48 bbl/d (tons/year)	Central Dewpoint Skid Emissions (tons/year)	Total Facility Emissions (tons/year)
Criteria Pollutants & VOC						
NO_x	37.7		0.41			38
CO	2.5		0.34			3
VOC	12.6	4.0	0.00	0.01	2.25	19
SO_2	0.06		0			0.06
PM_{10}	0.93		0.03			0.96
$PM_{2.5}$	0.93		0.03			0.96
Hazardous Air Pollutants						
Benzene	0.02	0.45	8.62E-06	1.01E-04		0.47
Toluene	0.02	1.27	1.40E-05	1.69E-04		1.3
Ethylbenzene	1.86E-03	0.06		7.92E-06		0.07
Xylene	0.01	1.30		6.02E-05		1.31
n-Hexane	0.05	0.03	0.01	2.68E-04		0.1
Formaldehyde	0.74		3.08E-04			0.74
Acetaldehyde	0.39					0.39
Acrolein	0.07					0.07
Methanol	0.12					0.12
1,1,2,2-Tetrachloroethane	1.88E-03					1.88E-03
1,1,2-Trichloroethane	1.49E-03					1.49E-03
1,3-Dichloropropene	1.24E-03					1.24E-03
1,3-Butadiene	0.01					0.01
2,2,4-Trimethylpentane	0.01					0.01
Biphenyl	0.01					9.95E-03
Carbon Tetrachloride	1.72E-03					1.72E-03
Chlorobenzene	1.43E-03					1.43E-03
Chloroform	1.34E-03					1.34E-03
Dichlorobenzene			4.93E-06			4.93E-06
Ethylene Dibromide	2.08E-03					2.08E-03
Methylene Chloride	9.38E-04					9.38E-04
Naphthalene	3.49E-03		2.50E-06			3.49E-03
Phenol	1.13E-03					1.13E-03
Styrene	1.11E-03					1.11E-03
Tetrachloroethane	1.16E-04					1.16E-04
Vinyl Chloride	6.99E-04					6.99E-04
PAH -POM 1*	1.26E-03					1.26E-03
POM 2*	2.78E-03		2.42E-07			2.79E-03
POM 3*			6.57E-08			6.57E-08
POM 4*			7.39E-09			7.39E-09
POM 5*			9.86E-09			9.86E-09
Benzo(b)fluoranthene/POM6	7.79E-06		2.96E-08			7.82E-06
Chrysene/POM7*	3.25E-05		7.39E-09			3.25E-05
Total HAPs	1.48	3.1	0.01	6.06E-04		4.0
Greenhouse Gases						
CO_2	10,323		493	1.98E-03		10,816
CH_4	117	2.1	0.01	8.29E-03		119

Central Facility 2

Pollutant	Central Compression Emissions 2,600 hp (tons/year)	Central Dehydrator Emissions 25MMscfd (tons/year)	Central Heater Emissions 1,000 MBtu/hr (tons/year)	Central Condensate Tank Emissions 0.48 bbl/d (tons/year)	Central Dewpoint Skid Emissions (tons/year)	Total Facility Emissions (tons/year)
Criteria Pollutants & VOC						
NO_x	37.7		0.41			38.1
CO	2.51		0.34			2.86
VOC	12.6	4.0	0.00	0	2.3	19
SO_2	0.06		0.00			0.06
PM_{10}	0.93		0.03			0.96
$PM_{2.5}$	0.93		0.03			0.96
Hazardous Air Pollutants						
Benzene	0.02	0.45	8.62E-06	0.00		0.47
Toluene	0.02	1.27	1.40E-05	0.00		1.29
Ethylbenzene	1.86E-03	0.06		0.00		0.07
Xylene	0.01	1.30		0.00		1.31
n-Hexane	0.05	0.03	0.01	0.00		0.09
Formaldehyde	0.74		3.08E-04			0.74
Acetaldehyde	0.39					0.39
Acrolein	0.07					0.07
Methanol	0.12					0.12
1,1,2,2-Tetrachloroethane	1.88E-03					1.88E-03
1,1,2-Trichloroethane	1.49E-03					1.49E-03
1,3-Dichloropropene	1.24E-03					1.24E-03
1,3-Butadiene	0.01					0.01
2,2,4-Trimethylpentane	0.01					0.01
Biphenyl	0.01					0.01
Carbon Tetrachloride	1.72E-03					1.72E-03
Chlorobenzene	1.43E-03					1.43E-03
Chloroform	1.34E-03					1.34E-03
Dichlorobenzene			4.93E-06			4.93E-06
Ethylene Dibromide	2.08E-03					2.08E-03
Methylene Chloride	9.38E-04					9.38E-04
Naphthalene	3.49E-03		2.50E-06			3.49E-03
Phenol	1.13E-03					1.13E-03
Styrene	1.11E-03					1.11E-03
Tetrachloroethene	1.16E-04					1.16E-04
Vinyl Chloride	6.99E-04					6.99E-04
PAH -POM 1*	1.26E-03					1.26E-03
POM 2*	2.78E-03		2.42E-07			2.79E-03
POM 3*			6.57E-08			6.57E-08
POM 4*			7.39E-09			7.39E-09
POM 5*			9.86E-09			9.86E-09
Benzo(b)fluoranthene/POM6	7.79E-06		2.96E-08			7.82E-06
Chrysene/POM7*	3.25E-05		7.39E-09			3.25E-05
Total HAPs	1.48	3.12	0.01	0.0		4.0
Greenhouse Gases						
CO_2	10,323		493	0.0		10,816
CH_4	117	2.1	0.01	0		119

29. Evaporation Facility

Assumptions:

Total New Generation: 720 Horsepower (Proposed Action)

Evaporation Emissions conservatively estimated using mass balance
-methanol designated as a VOC

Equations:

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

Pollutant	Engine Emission Factor [6] (lb/MMBtu)	Engine Emission Factor (g/hp-hr) [1]	Engine Emissions (lb/hr) [1]	Engine Emissions (tons/yr)	Evaporation Emissions (tons/yr)[7]	Total Evaporation Facility Emissions (tons/yr)
Criteria Pollutants & VOC						
NOx [1]		1.0	1.59	7.0		7.0
CO [1]		2.0	3.17	13.9		13.9
VOC [1]		1.0	1.59	6.95	212.5	219.5
PM10 [2,3]	9.95E-03	0.036	0.06	0.25		0.3
PM2.5 [2,3]	9.95E-03	0.036	0.06	0.25		0.3
SO_2	5.88E-04	0.002	0.00	0.01		0.0
Hazardous Air Pollutants						
Benzene [2]	4.40E-04	1.598E-03	2.54E-03	0.01	1.3	1.31
Toluene [2]	4.08E-04	1.482E-03	2.35E-03	0.01	3.2	3.21
Ethylbenzene [2]	3.97E-05	1.442E-04	2.3E-04	0.00	0.2	0.20
Xylenes [2]	1.84E-04	6.683E-04	1.1E-03	0.00	191.8	191.80
n-Hexane [2]	1.11E-03	4.032E-03	6.4E-03	0.03		0.03
Formaldehyde [2]	5.28E-02	1.918E-01	0.30	1.33		1.33
Acetaldehyde [2]	8.36E-03	0.03	0.05	0.21		0.21
Acrolein [2]	5.14E-03	0.02	0.03	0.13		0.13
Methanol [2]	2.50E-03	9.080E-03	0.01	0.06	191.8	191.86
1,1,2,2-Tetrachloroethane[2]	4.00E-05	1.453E-04	2.31E-04	0.00		0.00
1,1,2-Trichloroethane[2]	3.18E-05	1.155E-04	1.83E-04	0.00		0.00
1,3-Dichloropropene[2]	2.64E-05	9.588E-05	1.52E-04	6.67E-04		0.00
1,3-Butadiene[2]	2.67E-04	9.697E-04	1.54E-03	0.01		0.01
2,2,4-Trimethylpentane[2]	2.50E-04	9.080E-04	1.44E-03	0.01		0.01
Biphenyl[2]	2.12E-04	7.700E-04	1.22E-03	0.01		0.01
Carbon Tetrachloride[2]	3.67E-05	1.333E-04	2.12E-04	9.27E-04		0.00
Chlorobenzene[2]	3.04E-05	1.104E-04	1.75E-04	7.68E-04		0.00
Chloroform[2]	2.85E-05	1.035E-04	1.64E-04	7.20E-04		0.00
Ethylene Dibromide[2]	4.43E-05	1.609E-04	2.55E-04	1.12E-03		0.00
Methylene Chloride[2]	2.00E-05	7.264E-05	1.15E-04	5.05E-04		0.00
Naphthalene[2]	7.44E-05	2.702E-04	4.29E-04	0.00		0.00
Phenol[2]	2.40E-05	8.717E-05	1.38E-04	6.06E-04		0.00
Styrene[2]	2.36E-05	8.572E-05	1.36E-04	5.96E-04		0.00
Tetrachloroethane[2]	2.48E-06	9.007E-06	1.43E-05	6.26E-05		0.00
Vinyl Chloride[2]	1.49E-05	5.412E-05	8.59E-05	3.76E-04		0.00
PAH -POM 1[2,4]	2.69E-05	9.770E-05	1.55E-04	6.79E-04		0.00
POM 2[2,4,5]	5.93E-05	2.156E-04	3.42E-04	1.50E-03		0.00
Benzo(b)fluoranthene/POM6[2,4]	1.66E-07	6.029E-07	9.57E-07	4.19E-06		0.00
Chrysene/POM7[2,4]	6.93E-07	2.517E-06	4.00E-06	1.75E-05		0.00
Greenhouse Gases						
CO2 [2]	110	400	634.16	2778		2777.7
CH4 [2]	1.25	4.54	7.21	31.6		31.6

[1] - Currently permitted emission rates for internal combustion engine

[2] - AP-42 Table 3.2-2 Uncontrolled Emission Factors for 4-Stroke Lean-Burn Engines, 7/00

[3] - PM = sum of PM filterable and PM condensable

[4] - POM (Particulate Organic Matter) grouped according to subgroups described at EPA's Technology Transfer Network website for the 1999 National-

[5] - POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and

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

[7] - BTEX emissions controlled by a minimum of 60 %

30. Total Project Production Related Emissions Summary

Pollutant	Well Production Emissions (tons/year)	Central Facility 1 Emissions (tons/year)	Central Facility 2 Emissions (tons/year)	Evaporation Facility Emissions (tons/year)	Total Production Emissions [h] (tons/year)
Criteria Pollutants & VOC					
NO_x	65.4	38.1	38.1	7.0	149
CO	70.9	2.86	2.86	13.9	91
VOC	496	19	19	219.45	753
SO_2	0.19	0.06	0.06	0.01	0.32
PM_{10}	696	0.96	0.96	0.25	698
$PM_{2.5}$	73.8	0.96	0.96	0.25	76.0
Hazardous Air Pollutants					
Benzene	3.2	0.47	0.47	1.31	5.5
Toluene	5.2	1.3	1.3	3.21	11.0
Ethylbenzene	0.22	0.07	0.07	2.01E-01	0.55
Xylene	1.9	1.31	1.31	191.80	196.4
n-Hexane	9.5	0.1	0.1	0.03	10
Formaldehyde	0.05	0.7	0.7	1.33	2.9
Acetaldehyde	0	0.39	0.39	0.21	1.00
Acrolein	0	0.07	0.07	0.13	0.27
Methanol	0	0.12	0.12	191.86	192.10
1,1,2,2-Tetrachloroethane	0	1.88E-03	1.88E-03	1.01E-03	0.00
1,1,2-Trichloroethane	0	1.49E-03	1.49E-03	8.03E-04	0.00
1,3-Dichloropropene	0	1.24E-03	1.24E-03	6.67E-04	0.00
1,3-Butadiene	0	0.01	0.01	0.01	0.03
2,2,4-Trimethylpentane	0	0.01	0.01	0.01	0.03
Biphenyl	0	0.01	0.01	0.01	0.03
Carbon Tetrachloride	0	1.72E-03	1.72E-03	9.27E-04	0.00
Chlorobenzene	0	1.43E-03	1.43E-03	7.68E-04	0.00
Chloroform	0	1.34E-03	1.34E-03	7.20E-04	0.00
Dichlorobenzene	7.39E-04	4.93E-06	4.93E-06	0	0
Ethylene Dibromide	0	2.08E-03	2.08E-03	1.12E-03	0.01
Methylene Chloride	0	9.38E-04	9.38E-04	5.05E-04	0.00
Naphthalene	3.76E-04	0.00	0.00	1.88E-03	0.01
Phenol	0	1.13E-03	1.13E-03	6.06E-04	0.00
Styrene	0	1.11E-03	1.11E-03	5.96E-04	0.00
Tetrachloroethane	0	1.16E-04	1.16E-04	6.26E-05	0
Vinyl Chloride	0	6.99E-04	6.99E-04	3.76E-04	0.00
PAH -POM 1[a]	0	1.26E-03	1.26E-03	6.79E-04	0.00
POM 2[b]	3.63E-05	0.00	0.00	1.50E-03	0.01
POM 3[c]	9.86E-06	6.57E-08	6.57E-08	0	0
POM 4[d]	1.11E-06	7.39E-09	7.39E-09	0	0
POM 5[e]	1.48E-06	9.86E-09	9.86E-09	0	0
Benzo(b)fluoranthene/POM6[f]	4.43E-06	7.82E-06	7.82E-06	4.19E-06	0
Chrysene/POM7[g]	1.11E-06	3.25E-05	3.25E-05	1.75E-05	0
Total HAPs	20	4.6	4.6	390.12	420
Greenhouse Gases					
CO_2	73,975	10,816	10,816	2,778	98,385
CH_4	1,208	119	119	31.6	1,478

a Polycyclic Aromatic Hydrocarbons (PAH), Polycyclic Organic Matter (POM)

b - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene,

[c] - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[d] - POM 4 includes: 3-Methylchloranthrene.

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

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

[g] - POM 7 includes: Chrysene.

h Emissions for Peak Field Development

31. Total Project Emissions Summary

Pollutant	Project Emissions (tons/year)		Total Emissions [h] (tons/year)
	Well Development	Project Production	
Criteria Pollutants & VOC			
NO_x	511	149	660
CO	167	90.6	258
VOC	42.6	753	796
SO_2	9.0	0.32	9
PM_{10}	1,700	698	2,398
$PM_{2.5}$	180	76.0	256
Hazardous Air Pollutants			
Benzene	0.26	5.49	5.8
Toluene	0.44	10.98	11.4
Ethylbenzene	0.02	0.55	0.6
Xylene	0.23	196.37	196.6
n-Hexane	0.50	9.74	10.2
Formaldehyde	0.18	2.87	3.0
Acetaldehyde	1.38E-03	1.00	1.0
Acrolein	4.31E-04	0.27	0.3
Methanol	0	192.10	192.1
1,1,2,2-Tetrachloroethane	0	4.76E-03	5.E-03
1,1,2-Trichloroethane	0	3.79E-03	4.E-03
1,3-Dichloropropene	0	3.14E-03	3.E-03
1,3-Butadiene	5.60E-07	0.03	3.E-02
2,2,4-Trimethylpentane	0	0.03	3.E-02
Biphenyl	0	0.03	3.E-02
Carbon Tetrachloride	0	4.37E-03	4.E-03
Chlorobenzene	0	3.62E-03	4.E-03
Chloroform	0	3.39E-03	3.E-03
Dichlorobenzene	0	7.49E-04	7.E-04
Ethylene Dibromide	0	0.01	5.E-03
Methylene Chloride	0	2.38E-03	2.E-03
Naphthalene	0.01	0.01	2.E-02
Phenol	0	2.86E-03	3.E-03
Styrene	0	2.81E-03	3.E-03
Tetrachloroethane	0	2.95E-04	3.E-04
Vinyl Chloride	0	1.77E-03	2.E-03
PAH -POM 1[a]	0.01	3.20E-03	1.E-02
POM 2[b]	0	0.01	7.E-03
POM 3[c]	0	9.99E-06	1.E-05
POM 4[d]	0	1.12E-06	1.E-06
POM 5[e]	0	1.50E-06	1.E-06
Benzo(b)fluoranthene/POM6	0	2.43E-05	2.E-05
Chrysene/POM7[g]	0	8.37E-05	8.E-05
Total HAPs	1.66	419.5	421
Greenhouse Gases			
CO_2	26,473	98,385	124,858
CH_4	215	1,478	1,693

a Polycyclic Aromatic Hydrocarbons (PAH), Polycyclic Organic Matter (POM)

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

[c] - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[d] - POM 4 includes: 3-Methylchloranthrene.

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

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

[g] - POM 7 includes: Chrysene.

h Emissions for Peak Field Development

Buys & Associates, Inc. **Environmental Consultants**	Project: Gasco Alternative E Inventory Date: 6/9/2011

1. Well Pad/Access Road/Pipeline Construction Fugitive Dust Emissions

Assumptions:

Pieces of Equipment	Hours of Construction	
- 1 Backhoe	20	hours per well pad
- 1 Dozer/Crawler Tractor	100	hours per well pad

Watering Control Efficiency	50	percent (Assumption - means none for calculations)
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

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 = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM15/hour/piece of equipment

	Fugitive Dust Emissions [a]		
	lbs/hr/ machine	**tons/well**	**tons/yr [b]**
TSP	1.97	0.1182	4.18
PM15	0.50	0.0301	1.06
PM10	0.38	0.0226	0.80
PM2.5	0.21	0.0124	0.44

a Backhoe/Grader/Loader emissions are conservatively estimated as equivalent to Bulldozing emissions.

b Assumes construction rate specified by Proponent

Note: The majority of new pipeline will be installed adjacent to proposed access roads and will not result significant additional surface disturbance.

2. Well Pad/Road/Pipeline Construction Emissions (Grader)

Assumptions:

Grading Length	3.37	0.32 miles/road *3 plus 0.65 miles pipeline plus 1.74 miles on 225' x400' pad (10 ft swath for 400 ft * 23 lengths) = 9,200 ft = 1.74 miles
Hours of Construction	6	day grading per well pad and road (Estimate)
	10	hours/day
	60	hours per well pad
Watering Control Efficiency	50	percent (Assumption - means none for calculations)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 10/98)
Distance Graded	3.37	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
Grading Emissions, Western Surface Coal Mining, 10/98

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 = 9.05 lbs TSP/well

Emissions = 4.33 lbs PM15/well

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well**	**tons/well**	**tons/yr [a]**
TSP	9.05	0.15	0.0045	0.16
PM15	4.33	0.07	0.0022	0.08
PM10	2.60	0.04	0.0013	0.05
PM2.5	0.28	0.00	0.0001	0.00

a Assumes maximum development scenario

3. Interim Reclamation Fugitive Dust Emissions

Assumptions:

Hours of Construction	5	days per well pad (Estimate)
	12	hours/day
	60	hours per well pad
Pieces of Equipment	1	- Dozer
Watering Control Efficiency	50	percent (Assumption - means none for calculations)
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

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 = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM15/hour/piece of equipment

	Fugitive Dust Emissions [a]		
	lbs/hr	tons/well	tons/yr [b]
TSP	1.97	0.0591	2.09
PM15	0.50	0.0151	0.53
PM10	0.38	0.0113	0.40
PM2.5	0.21	0.0062	0.22

a Backhoe/Grader/Loader emissions are conservatively estimated as equivalent to Bulldozing emissions.

b Assumes construction rate specified by Proponent

Note: The majority of new pipeline will be installed adjacent to proposed access roads and will not result significant additional surface disturbance.

Buys & Associates, Inc.
Environmental Consultants

Project: Gasco Alternative E Inventory
Date: 6/9/2011

4. Unpaved Road Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006

E (PM10) / VMT = 1.5 * (S/12)^0.9 * (W/3)^0.45 * (365-p)/365)
E (PM2.5) / 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	58	
Precipitation Days (P)	73	days per year (NCDC data, Nutters Ranch, UT 1963-1986)

	Vehicle Type	Average Weight (lbs)	Round Trips per Well a	PM10 (lb/VMT)	PM10/Pad (lbs)	PM10/Pad (lb/day)	PM2.5/Pad (lbs)	PM2.5/Pad (lb/day)
Construction (days/pad and road)	10							
	Haul Trucks	80,000	5					
	Water Trucks	60,000	1					
	Light Trucks	8,000	10					
	Mean Vehicle Weight	33,750	16	1.8937586	1757.4	175.7	175.7	17.6
					PM10/Annual Pads		PM2.5/Annual Pads	
					(tons)		(tons)	
					31.0		3.1	

	Vehicle Type	Average Weight (lbs)	Round Trips per Well a	PM10 (lb/VMT)	PM10/Well (lbs)	PM10/Well (lb/day)	PM2.5/Well (lbs)	PM2.5/Well (lb/day)
Drilling, Downhole (days/well)	35							
	Haul Trucks	80,000	70					
	Logging/Mud Trucks	70,000	10					
	Water Trucks b	60,000	75					
	Light Trucks	8,000	80					
	Mean Vehicle Weight	48,681	235	2.2331227	30437	869.6	3043.7	87.0
					PM10/Annual Wells		PM2.5/Annual Wells	
					(tons)		(tons)	
					537.7		53.8	

	Vehicle Type	Average Weight (lbs)	Round Trips per Well a	PM10 (lb/VMT)	PM10/Well (lbs)	PM10/Well (lb/day)	PM2.5/Well (lbs)	PM2.5/Well (lb/day)
Drilling, Directional (days/well)	55							
	Haul Trucks	80,000	0					
	Logging/Mud Trucks	70,000	10					
	Water Trucks	60,000	75					
	Light Trucks	8,000	125					
	Mean Vehicle Weight	29,544	210	1.7836711	21704	397.5	2170.4	39.8
					PM10/Annual Wells		PM2.5/Annual Wells	
					(tons)		(tons)	
					919		91.9	

	Vehicle Type	Average Weight (lbs)	Round Trips per Well a	PM10 (lb/VMT)	PM10/Well (lbs)	PM10/Well (lb/day)	PM2.5/Well (lbs)	PM2.5/Well (lb/day)
Completion (days/well)	14							
	Semi/Transport/Water/Sand	80,000	46					
	Water Trucks	60,000	157					
	Light Trucks	8,000	56					
	Mean Vehicle Weight	52,309	259	2.3065367	34649	2474.9	3464.9	247.5
					PM10/Annual Wells		PM2.5/Annual Wells	
					(tons)		(tons)	
					2079		207.9	

	Vehicle Type	Average Weight (lbs)	Round Trips per Well a	PM10 (lb/VMT)	PM10/Day (lbs)	PM10/Day (lb/day)	PM2.5/Day (lbs)	PM2.5/Day (lb/day)
Interim Reclamation (days/well)	5							
	Haul Trucks	80,000	1					
	Light Trucks	8,000	5					
	Mean Vehicle Weight	20,000	6	1.4964593	520.8	104.2	52.1	10.4
					PM10/Annual Wells		PM2.5/Annual Wells	
					(tons)		(tons)	
					31.2		3.1	

Annual Traffic Fugitive Dust Emissions (tons/year)					2679		267.9	

[a] Traffic Estimates are based upon an approximately 14-days construction, 13-days drilling at downhole locations (shallow wells), 26-days drilling at direction wells (shallow wells), 29-days completion, and 6-days infrastructure development per well or well pad as appropriate.
[b] 25,000 barrels/well for completion; 12,000 barrels/well for drilling; directional drilling takes twice as long and twice the water assume 160-barrel water truck

Buys & Associates, Inc. Environmental Consultants	Project: Gasco Alternative E Inventory Date: 6/9/2011

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	648.0	acres total initial disturbance for roads/pipelines (Proposed Action)
	2,622,359	square meters total initial disturbance for roads/pipelines
	1,527	acres total initial disturbance for well pads and other facilities (Proposed Action)
	6,179,540	square meters total initial disturbance for well pads and other facilities
	2,175	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 and facilities (Assumption, disturbance at construction and reclamation)
	Constant	for dirt roads
Development Period	15	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(in^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	1.16	0.00
PM10	0.58	0.00
PM2.5	0.23	0.00

6. Construction Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Construction	100	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	6	(Proposed Action)
Number of Pickup Trips	10	(Proposed Action)
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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ \text{(S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.130	0.095	0.005	3.030	0.059	0.003	0.153	0.271
CO	17.090	0.199	0.010	33.640	0.653	0.033	0.852	1.504
VOC [c]	4.600	0.054	0.003	4.646	0.090	0.005	0.144	0.254
SO_2	0.321	0.004	0.000	0.214	0.004	0.000	0.008	0.014
Greenhouse Gases								
CH_4 [c]	0.230	0.003	0.000	0.184	0.004	0.000	0.006	0.011

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

7. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Operation	1172	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	155	(Proposed Action)
Number of Pickup Trips	80	(Proposed Action)
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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ \text{(S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.13	0.209	0.122	3.03	0.040	0.024	0.249	17.490
CO	17.09	0.439	0.257	33.64	0.446	0.261	0.884	62.160
VOC [c]	4.600	0.118	0.069	1.656	0.022	0.013	0.140	9.842
SO_2	0.32	0.008	0.005	0.21	0.003	0.002	0.011	0.779
Greenhouse Gases								
CH_4 [e]	0.230	0.006	0.003	0.184	0.002	0.001	0.008	0.173

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 Hydroearbons - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

8. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Operation	140.00	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	203	(Proponent)
Number of Pickup Trips	56	(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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\text{ (g/lb)} * \text{Fuel Sulfur Content} * 2\text{ (S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.13	2.287	0.160	3.03	0.235	0.016	2.522	21.186
CO	17.09	4.808	0.337	33.64	2.611	0.183	7.418	62.311
VOC [c]	4.600	1.294	0.091	1.656	0.129	0.009	1.423	11.949
SO_2	0.32	0.090	0.006	0.21	0.017	0.001	0.107	0.898
Greenhouse Gases								
CH_4 [e]	0.230	0.065	0.005	0.184	0.014	0.001	0.079	0.195

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

9. Development Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Operation	60	hours per site (Assumption)
Number of Heavy Diesel Truck Trips	1	(Assumption)
Number of Pickup Trips	5	(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:

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

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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * \text{453.6 (g/lb)} * \text{Fuel Sulfur Content} * \text{2 (S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.13	0.026	0.001	3.03	0.049	0.001	0.075	0.080
CO	17.09	0.055	0.002	33.64	0.544	0.016	0.599	0.635
VOC [c]	4.600	0.015	0.000	1.656	0.027	0.001	0.042	0.044
SO_2	0.32	0.001	0.000	0.21	0.003	0.000	0.004	0.005
Greenhouse Gases								
CH_4 [e]	0.230	0.001	0.000	0.184	0.003	0.000	0.004	0.004

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e 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: Gasco Alternative E Inventory Date: 6/9/2011

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Hours of Operation	100	hours/site (Proposed Action)
Development Rate	35	new pads per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Backhoe Size	85	hp (Proponent Contractor Typical value)
Crawler Tractor/Loader Size	290	hp (Proponent Contractor Typical value)
Motor Grader Size	185	hp (Proponent Contractor Typical value)

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			Crawler Tractor			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)
NO_x	8.15	0.611	1.079	8.15	2.084	3.682	7.14	1.165	2.058
CO	2.28	0.171	0.302	2.28	0.583	1.030	1.54	0.251	0.444
VOC[c]	0.37	0.028	0.049	0.37	0.095	0.167	0.36	0.059	0.104
PM_{10}[d]	0.5	0.037	0.066	0.5	0.128	0.226	0.63	0.103	0.182
$PM_{2.5}$[d]	0.5	0.037	0.066	0.5	0.128	0.226	0.63	0.103	0.182
SO_2	0.22	0.016	0.029	0.22	0.056	0.099	0.22	0.036	0.063
Formaldehyde	0.22	0.016	0.029	0.22	0.056	0.099	0.12	0.020	0.035

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions[e] (tons/yr)
NO_x	3.860	6.819
CO	1.005	1.776
VOC[c]	0.181	0.320
PM_{10}[d]	0.268	0.474
$PM_{2.5}$[d]	0.268	0.474
SO_2	0.109	0.192
Formaldehyde	0.092	0.163

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 construction rate specified by Proponent

11. Drill Rig Engine Emissions

Assumptions:

Hours of Operation	1172	hours/ well (Proposed Action)
Development Rate	120	total wells in max year (Proposed Action)
	5%	average time small rig will run per well
Load Factor	0.4	(Assumed typical value)
Rig Size	1000	hp (Estimate - phase 1 drilling)
	2500	hp (Estimate - phase 2 drilling)
	2423	hp (weighted average based on ratio of time in use to drill one well)
Diesel Fuel Sulfur Content	0.05	% (typical value)

Equations:

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

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Drill Rig Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [h] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.024	23.263	1,636
CO [a]	5.50E-03	5.331	375
VOC [a,b]	7.05E-04	0.683	48.0
PM_{10} [a,c]	5.75E-04	0.557	39.2
$PM_{2.5}$ [a,d]	4.81E-04	0.466	32.8
SO_2 [a]	4.05E-04	0.392	27.6
Hazardous Air Pollutants			
Benzene [e]	1.97E-06	0.002	0.13
Toluene [e]	7.15E-07	0.001	0.05
Xylenes [e]	4.91E-07	4.76E-04	0.03
Formaldehyde [e]	2.01E-07	1.95E-04	0.01
Acetaldehyde [e]	6.41E-08	6.22E-05	4.37E-03
Acrolein [e]	2.01E-08	1.94E-05	1.37E-03
Naphthalene [f]	3.31E-07	3.21E-04	0.02
Total PAH [f,g]	5.40E-07	0.001	0.04
Greenhouse Gases			
CO_2 [a]	1.16	1124	79,059
CH_4 [a,b]	7.05E-04	0.683	48.0

[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] 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	6	Hours/Well (Proponents)
Development Rate	120	wells per year (Proposed Action)
Load Factor	0.5	(typical value)
Frac Pump Engine Horsepower	19,000	Horsepower (typical)
Temporary Generator Horsepower	75	Horsepower (typical)
Diesel Fuel Sulfur Content	0.05	% (typical value)

Equations:

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

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Frac Pump Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.024	228.00	82.1
CO [a]	5.50E-03	52.25	18.81
VOC [a,b]	7.05E-04	6.698	2.41
PM_{10} [a,c]	5.73E-04	5.444	1.96
$PM_{2.5}$ [a,d]	4.79E-04	4.551	1.64
SO_2 [a]	4.05E-04	3.843	1.383
Hazardous Air Pollutants			
Benzene [e]	1.97E-06	1.88E-02	6.75E-03
Toluene [e]	7.15E-07	6.79E-03	2.45E-03
Xylenes [e]	4.91E-07	4.67E-03	1.68E-03
Formaldehyde [e]	2.01E-07	1.91E-03	6.87E-04
Acetaldehyde [e]	6.41E-08	6.09E-04	2.19E-04
Acrolein [e]	2.01E-08	1.91E-04	6.86E-05
Naphthalene [f]	3.31E-07	3.14E-03	1.13E-03
Total PAH [f]	5.40E-07	5.13E-03	1.85E-03
Greenhouse Gases			
CO_2 [a]	1.16	11,020	3,967
CH_4 [a]	7.05E-04	6.698	2.41

Species	Generator Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants			
NOx [g]	0.031	1.163	0.42
CO [g]	6.68E-03	0.25	0.09
VOC [b,g]	2.47E-03	0.09	0.03
PM_{10} [g]	2.20E-03	0.08	0.03
$PM_{2.5}$ [g]	2.20E-03	0.08	0.03
SO_2 [g]	2.05E-03	0.08	0.03
Hazardous Air Pollutants			
Benzene [h]	2.37E-06	8.90E-05	3.21E-05
Toluene [h]	1.04E-06	3.90E-05	1.41E-05
Xylenes [h]	7.25E-07	2.72E-05	9.79E-06
Formaldehyde [h]	3.00E-06	1.13E-04	4.05E-05
Acetaldehyde [h]	1.95E-06	7.32E-05	2.64E-05
Acrolein [h]	2.35E-07	8.83E-06	3.18E-06
1,3-Butadiene [h]	9.95E-08	3.73E-06	1.34E-06
Naphthalene [h]	2.16E-07	8.09E-06	2.91E-06
Total PAH [h]	4.28E-07	1.60E-05	5.77E-06
Greenhouse Gases			
CO_2 [g]	1.15	10,925	3,933
CH_4 [b,g]	2.47E-03	23.465	8.45

[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 conversion factor from Appendix A

[i] Assumes maximum development scenario

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14. Well Development Venting

Assumptions: Following Completion, Wells are Vented prior to connnection to the gathering pipeline

Venting Period 48 hours (Project Proponents)

Amount of Vented Gas: 0.2 MMscf (Average Volume Estimated by Proponents)

Development Rate: 120 Wells per year (Project Proponents)

COMPONENT	MOLECULAR WEIGHT (lb/lb-mole)	MOLE PERCENT	RELATIVE MOLE WEIGHT (lb/lb-mole)	WEIGHT Fraction	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (lb/hr)	COMPONENT FLOW RATE (tons/yr)
Methane	16.043	92.713	14.874	0.833	185.426	163.311	470.335
Ethane	30.07	4.078	1.226	0.069	8.156	13.464	38.777
Propane	44.097	1.145	0.505	0.028	2.289	5.542	15.960
i-Butane	58.123	0.248	0.144	0.008	0.496	1.582	4.556
n-Butane	58.123	0.265	0.154	0.009	0.530	1.691	4.869
i-Pentane	72.15	0.118	0.085	0.005	0.236	0.935	2.692
n-Pentane	72.15	0.087	0.063	0.004	0.174	0.689	1.985
Hexanes	86.177	0.000	0.000	0.000	0.000	0.000	0.000
Heptanes	100.204	0.216	0.216	0.012	0.431	2.372	6.831
Octanes	114.231	0.035	0.040	0.002	0.069	0.435	1.253
Nonanes	128.258	0.031	0.039	0.002	0.061	0.430	1.237
Decanes +	142.285	0.007	0.010	0.001	0.014	0.106	0.306
Benzene	78.12	0.021	0.016	0.001	0.042	0.181	0.521
Toluene	92.13	0.035	0.032	0.002	0.070	0.356	1.025
Ethylbenzene	106.16	0.001	0.001	0.000	0.002	0.014	0.040
Xylenes	106.16	0.016	0.017	0.001	0.031	0.183	0.527
n-Hexane	86.177	0.044	0.038	0.002	0.089	0.420	1.210
Helium	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.125	0.035	0.002	0.249	0.384	1.105
Carbon Dioxide	44.01	0.817	0.359	0.020	1.633	3.945	11.363
Oxygen	32	0.000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulfide	34.08	0.000	0.000	0.000	0.000	0.000	0.000
VOC SUBTOTAL		**2.2676**	**1.360**	**0.076**	**4.535**	**14.935**	**43.014**
HAP SUBTOTAL		**0.1176**	**0.105**	**0.006**	**0.235**	**1.154**	**3.324**
TOTAL		**100.000**	**17.855**	**1.000**	**200**	**196.039**	**564.593**

14. Well Development Emissions Summary

Species	Well Development Emissions (tons/year) [a]				Wind Erosion	Total [a] (tons/yr)
	Construction	Drilling	Completion	Interim Reclamation		
Criteria Pollutants & VOC						
NO_x	7.1	1,653	104	0.08		1,764
CO	3.28	437	81	0.64		522
VOC	0.57	57.9	57.4	0.04		116
SO_2	0.21	28.3	2.31	0.00		30.9
PM_{10}	32.4	1,496	2,081	31.6	0.58	3,641
$PM_{2.5}$	4.02	178	210	3.34	0.23	396
Hazardous Air Pollutants						
Benzene		0.13	5.28E-01			0.66
Toluene		0.05	1.03E+00			1.08
Ethylbenzene		0	0.04			0.04
Xylenes		0.03	5.29E-01			0.56
n-Hexane			1.21			1.21
Formaldehyde	0.16	0.01	7.27E-04			0.18
Acetaldehyde		4.37E-03	2.46E-04			4.62E-03
Acrolein		1.37E-03	7.18E-05			1.44E-03
1,3-Butadiene			1.34E-06			1.34E-06
Naphthalene		0.02	1.13E-03			0.02
Total PAH, POM 1 [b]		0.04	1.85E-03			0.04
Total HAPs	0.16	0.30	3.34	0.0	0.0	3.7
Greenhouse Gases						
CO_2		79,059	7,912			86,970
CH_4	0.01	48.2	481	0.00		530

a Emissions for Peak Field Development
b Polycyclic Aromatic Hydrocarbons (PAH), Polycyclic Organic Matter (POM)

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15. Average Produced Gas Characteristics
Inlet Wet Gas Sample from Riverbend Compressor Station, dated 3/22/07

Gas Heat Value (wet): 1064.1 Btu/scf

C1-C2 Wt. Fraction: 0.9020
VOC Wt. Fraction: 0.0760
Non-HC Wt. Fraction: 0.0221
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	92.7130	16.043	14.874	0.833	1010.000	936.401	910.000	843.688
Ethane	4.0781	30.070	1.226	0.069	1769.800	72.174	1618.000	65.984
Propane	1.1446	44.097	0.505	0.028	2516.200	28.800	2316.000	26.509
i-Butane	0.2479	58.123	0.144	0.008	3252.100	8.062	3005.000	7.449
n-Butane	0.2649	58.123	0.154	0.009	3262.400	8.642	3013.000	7.981
i-Pentane	0.1180	72.150	0.085	0.005	4000.900	4.721	3698.000	4.364
n-Pentane	0.0870	72.150	0.063	0.004	4008.800	3.488	3708.000	3.226
Hexanes	0.0687	86.177	0.059	0.003	4756.200	3.268	4404.000	3.026
Heptanes	0.0737	100.204	0.074	0.004	5502.500	4.055	5100.000	3.759
Methylcyclohexane	0.0509	98.186	0.050	0.003	1865.455	0.880	1729.000	0.880
Octanes	0.0550	114.231	0.063	0.004	6249.100	3.437	1695.970	0.933
2,2,4-TMP	0.0047	114.220	0.005	0.000	6368.594	0.081	1728.400	0.081
Nonanes	0.0305	128.258	0.039	0.002	6996.400	2.134		0.000
Decanes	0.0068	142.285	0.010	0.001	7743.200	0.527		0.000
Benzene	0.0211	78.120	0.016	0.001	3715.500	0.784		0.000
Toluene	0.0352	92.130	0.032	0.002	4444.600	1.564		0.000
Ethylbenzene	0.0012	106.160	0.001	0.000	5191.500	0.062		0.000
Xylenes	0.0157	106.160	0.017	0.001	5183.500	0.814		0.000
n-Hexane	0.0444	86.177	0.038	0.002	4756.200	2.112		0.000
Helium	0.0000	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	0.1247	28.013	0.035	0.002	0.000	0.000	0.000	0.000
Carbon Dioxide	0.8165	44.010	0.359	0.020	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		17.85	1.00		1082.01		967.88

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

Weight Fraction = Net Mole Weight / Total Mole Weight

HAP Fractions estimated from GRI Published Factors

16. Wellsite Heater Emissions

Assumptions

Separator Heater Size	500	Mbtu/hr (Typical size Proposed Action)
Wells Requiring Separators:	1114	wells at Peak Production
Firing Rate	6,480	hours/year (Typical Uinta Basin operation)
Fuel Gas Heat Value	968	Btu/scf (Gas Analyses from Riverbend well)
Fuel Gas VOC Content	0.076	by weight (Gas Analyses from Riverbend Facility)

Equations

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

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

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

Species	Wellsite Heater Emissions - Separators		
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC			
NO_x [a]	100	0.052	186.5
CO [a]	84	0.043	156.6
TOC [c]	11	0.006	20.5
VOC	N.A.	0.000	1.56
SO_x [b]	0.00	0.000	0
TSP [c]	7.6	0.004	14.17
PM_{10} [c]	7.6	0.004	14.17
$PM_{2.5}$ [c]	7.6	0.004	14.17
Hazardous Air Pollutants			
Benzene [d]	0.0021	1.08E-06	3.92E-03
Toluene [d]	0.0034	1.76E-06	6.34E-03
Hexane [d]	1.8	9.30E-04	3.36
Formaldehyde [d]	0.075	3.87E-05	0.14
Dichlorobenzene [d]	1.2E-03	6.20E-07	2.24E-03
Naphthalene [d]	6.1E-04	3.15E-07	1.14E-03
POM 2 [d,e,f]	5.9E-05	3.05E-08	1.10E-04
POM 3 [d,g]	1.6E-05	8.27E-09	2.98E-05
POM 4 [d,h]	1.8E-06	9.30E-10	3.36E-06
POM 5 [d,i]	2.4E-06	1.24E-09	4.47E-06
POM 6 [d,j]	7.2E-06	3.72E-09	1.34E-05
POM 7 [d,k]	1.8E-06	9.30E-10	3.36E-06
Greenhouse Gases			
CO_2 [c]	120,000	61.991	223,748
CH_4 [c]	2.3	0.001	4.29

[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

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

[f] - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene,

[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] - Assumes full development.

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17. Wellsite Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate:	2.01	bbls condensate per day (Estimate based on proponent data)
Number of Active Wells:	1114	wells at Peak Production

Separator Conditions : 130 psi and 60 F (Riverbend sample)
API Gravity: 58.28

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0
Riverbend Compressor Station Liquid Sample Dated 6/4/07
Scaled from 15.9 bbls per day

Emissions:

Component	Wellsite Flash/Work/Breathing (lb/hr/well)	Wellsite Flash/Work/Breathing (tons/year/well)	Total Emissions (tons/yr)
Total VOC	0.163	0.713	794
Hazardous Air Pollutants			
Benzene	1.643E-03	0.007	8.02
Toluene	2.655E-03	0.012	13.0
Ethylbenzene	1.264E-04	0.001	0.62
Xylenes	8.849E-04	0.004	4.3
n-Hexane	4.172E-03	0.018	20.4
Greenhouse Gases			
CO_2	0.033	0.144	160
CH_4	0.156	0.683	761

18. VOC Emissions from NGL Truck Loading Operations

NGL Truck Loading/Unloading Emissions: NGL will normally be transported by pipeline, however truck transport may be utilized as a contingency. A pressurized vapor recovery system will be utilized for truck loading. Potential emissions result from the equalization of the loading rack connection to atmospheric pressure after the loading operation is completed.

Assumed Maximum Number of Additional Truck loads/year 4,380

Truck Loading Connection Configuration

	Load Line		
Load Line Connection Diameter =	0.25	ft	(Assumed typical value)
Load Line Length between Valves =	3.0	ft	(Assumed typical value)
Connection Volume =	0.147	ft^3	
Annual Connection Volume Vented =	645	ft^3	
NGL Density =	5.6	lbs/gal	(Assumed typical value)
NGL Density =	41.9	lbs/ft^3	
Annual Wt. NGL Vented =	27,018.1	lbs/year	
NGL VOC Content =	100.0%	by weight (See NGL Composition for Fugitive Emissions)	
VOC Emissions =	13.5	tons/year VOC	

Example Calculations

Connection volume = Pi * $(Diameter)^2/4$ * Length
Annual Volume Vented (ft^3/year) = Connection Volume (ft^3) * Number Truck Loads per year (1/year)
Density ($lbs/ft^{3)}$ = Density (lbs/gal) * 7.48 gal/ft^3
Vented NGL Weight (lbs) = Volume Vented (ft^3) * NGL Density (lbs/ft^3)
VOC Emissions (tons/year) = Annual NGL Vented (lbs/year) * NGL VOC wt. % / 100 / 2000 (lbs/ton)

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19. Operations Vehicle Tailpipe Emissions

Assumptions:

Number of New Pumpers:	32	(Proposed Action Number of Pumpers at Peak Production)
Pumper Mileage:	2,800	miles/pumper/month (Assumption)
Total Annual New Pumper Mileage:	1,075,200	miles/year
Number of Condensate Haul Truck Round Trips:	14	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for Condensate Transport:	58	miles (Estimate from Vernal)
Total Annual Condensate Truck Mileage:	296,380	miles/year
Number of Water Haul Truck Round Trips:	91	trips per day (Based on Peak Production Alternative C)
Average Round Trip Mileage for Water Transport:	17	miles (Average distance to evaporation facility)
Total Annual Water Truck Milcage:	564,655	miles/year
Number of NGL Haul Truck Round Trips:	12	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for NGL Transport:	58	miles (Average distance to evaporation facility)
Total Annual NGL Truck Mileage:	254,040	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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	3.03	1.644	3.591	8.13	4.576	7.716	6.220	11.307
CO	33.64	18.255	39.870	17.09	9.618	16.220	27.873	56.090
VOC [c]	1.656	0.899	1.963	4.600	2.589	4.366	3.488	6.329
SO_2	0.21	0.116	0.254	0.32	0.181	0.305	0.297	0.559
Greenhouse Gases								
CH_4 [d]	0.184	0.100	0.218	0.230	0.129	0.218	0.229	0.436

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

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20. Pneumatic Device Emissions 0.144 Mscf/day or less = low bleed device

Analysis Gas Consumption Rate:	1.00	Mscf/day
Days of Operation:	365	days/year

GAS COMPONENT	MOLECULAR WEIGHT (lb/lb-mole)	MOLE PERCENT	RELATIVE MOLE WEIGHT (lb/lb-mole)	WEIGHT PERCENT	VOLUME FLOW RATE (Mscf/day)	MASS FLOW RATE (lb/hr)	MASS FLOW RATE (tons/yr)
Methane	16.043	92.7130	14.874	83.334	0.927	1.633	7.153
Ethane	30.07	4.0781	1.226	6.870	0.041	0.135	0.590
Propane	44.097	1.1446	0.505	2.828	0.011	0.055	0.243
I-Butane	58.123	0.2479	0.144	0.807	0.002	0.016	0.069
n-Butane	58.123	0.2649	0.154	0.863	0.003	0.017	0.074
I-Pentane	72.15	0.1180	0.085	0.477	0.001	0.009	0.041
n-Pentane	72.15	0.0870	0.063	0.352	0.001	0.007	0.030
Hexanes	86.177	0.0687	0.059	0.332	0.001	0.007	0.028
Heptanes	100.204	0.1233	0.124	0.692	0.001	0.014	0.059
Octanes	114.231	0.0584	0.067	0.374	0.001	0.007	0.032
Nonanes	128.258	0.0305	0.039	0.219	0.000	0.004	0.019
Decanes +	142.285	0.0068	0.010	0.054	0.000	0.001	0.005
Benzene	78.12	0.0211	0.016	0.092	0.000	0.002	0.008
Toluene	92.13	0.0352	0.032	0.182	0.000	0.004	0.016
Ethylbenzene	106.16	0.0012	0.001	0.007	0.000	0.000	0.001
Xylenes	106.16	0.0157	0.017	0.093	0.000	0.002	0.008
n-Hexane	86.177	0.0444	0.038	0.214	0.000	0.004	0.018
Helium	4.003	0.0000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.1247	0.035	0.196	0.001	0.004	0.017
Carbon Dioxide	44.01	0.8165	0.359	2.013	0.008	0.039	0.173
Oxygen	32	0.0000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulfide	34.08	0.0000	0.000	0.000	0.000	0.000	0.000
VOC SUBTOTAL		**2.268**	**1.354**	**7.586**	**0.023**	**0.149**	**0.651**
HAP SUBTOTAL		**0.118**	**0.105**	**0.589**	**0.001**	**0.012**	**0.051**
TOTAL		**100.000**	**17.849**	**100.000**	**1.000**	**1.960**	**8.584**

	Number of Wells	VOC emissions (tons/year)	Methane emissions (tons/yr)
Alternative E	1,114	261	2868.6

LIQUID LEVEL CONTROLLER SPECIFICATIONS

Gas Consumption Rate:	0.144	Mscf/day	(low-bleed)
Days of Operation:	365	days/year	

TRACE PUMP SPECIFICATIONS

Gas Consumption Rate:	0.144	Mscf/day	Assumed recycle of gas equals low-bleed specification
Days of Operation:	182	days/year	

METHANOL PUMP SPECIFICATIONS

-Solar powered methanol pumps will be installed for the Proposed Action

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
2	Liquid level controllers	0.04	0.19
1	Trace pump	0.01	0.05
2	Chemical injection pump	0	0
	Totals (per well) =	0.05	0.23

Pneumatic sources / well		Methane lb/hr	Methane ton/yr
2	Liquid level controllers	0.47	2.06
1	Trace pump	0.24	0.52
2	Chemical injection pump	0	0
	Totals (per well) =	0.71	2.58

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21. Operations Traffic Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006

365 days (Estimate)

Vehicle Type	Ave. Weight (lbs)	Round Trips per Day*
Pickup Truck: Crew	7,000	32
Haul Truck: Oil	48,000	14
Haul Truck: Water	48,000	91
Haul Truck: NGL	48,000	12
Mean Weight	39,195	149

Unpaved Roads

E (PM10) / VMT = 1.5 * (S/12)^0.9 * (W/3)^0.45 * (365-p)/365)
E (PM2.5) / 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)	73	days per year **
Avg. Round Trip Miles	37	miles on unpaved roads ***

Paved Roads

E (PM10) / VMT = 0.016 * (sL/2)^0.65 * (W/3)^1.5 - 0.00047 * (1-(p/(365*4))
E (PM10) / 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	30	From Roosevelt
Precipitation Days (P)	73	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	4,115,925	11,277	0.20	411,593	1,128
Paved	0.08	127,393	349	0.01	18,660	51
Total		4,243,318	11,626		430,253	1,179

Annual Traffic Fugitive Dust Emissions (tons/year)	**2,122**			**215**	

*Round trips per day at peak production (Proposed Action)
** NCDC data for Nutters Ranch, UT 1963-1986
*** Weighted average of Pumper,Condensate, NGL, and Water Hauling Distance = (58*(32+14+12+16)+17*(91-16))/149. One round trip to evaporative facility is assumed to take about 2-hours, so 6 trips per day are completed in one 12-hr shift, which requires 16 trucks to do 91 trips.

22. Well Production Summary

Species	Storage Tanks (tons/yr)	Well Site Heaters (tons/yr)	Operations Vehicle (tons/yr)	Pneumatic Devices (tons/yr)	Total Well Production [a] (tons/yr)
Criteria Pollutants & VOC					
NO_x		186	11.3		198
CO		157	56.1		213
VOC	794	1.56	6.33	261	1,063
SO_2		0	0.56		0.56
PM_{10}		14.2	2,122		2,136
$PM_{2.5}$		14.2	215		229
Hazardous Air Pollutants					
Benzene	8.0	3.92E-03			8.0
Toluene	13	6.34E-03			13
Ethylbenzene	0.62				0.62
Xylene	4.3				4.3
n-Hexane	20	3.36			23.7
Formaldehyde		0.14			0.14
Dichlorobenzene		2.24E-03			2.24E-03
Naphthalene		1.14E-03			1.14E-03
POM 2[a]		1.10E-04			1.10E-04
POM 3[b]		2.98E-05			2.98E-05
POM 4[c]		3.36E-06			3.36E-06
POM 5[d]		4.47E-06			4.47E-06
POM 6[e]		1.34E-05			1.34E-05
POM 7[f]		3.36E-06			3.36E-06
Total HAPs	46	3.51	0.0		50
Greenhouse Gases					
CO_2	160	223,748			223,909
CH_4	761	4.29	0.44	2869	3,634

[a] - POM (Particulate Organic Matter) 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

[b] - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[c] - POM 4 includes: 3-Methylchloranthrene.

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

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

[f] - POM 7 includes: Chrysene.

[g] Emissions for Peak Field Development

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23. Average Produced Gas Characteristics
Inlet Wet Gas Sample from Riverbend Compressor Station, dated 3/22/07

Gas Heat Value (wet): 1064.1 Btu/scf

Sample Temperature: 77 F
Sample Pressure: 132 psig

C1-C2 Wt. Fraction:	0.9020
VOC Wt. Fraction:	0.0760
Non-HC Wt. Fraction:	0.0221
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	92.7130	16.043	14.874	0.833	1010.000	936.401	910.000	843.688
Ethane	4.0781	30.070	1.226	0.069	1769.800	72.174	1618.000	65.984
Propane	1.1446	44.097	0.505	0.028	2516.200	28.800	2316.000	26.509
i-Butane	0.2479	58.123	0.144	0.008	3252.100	8.062	3005.000	7.449
n-Butane	0.2649	58.123	0.154	0.009	3262.400	8.642	3013.000	7.981
i-Pentane	0.1180	72.150	0.085	0.005	4000.900	4.721	3698.000	4.364
n-Pentane	0.0870	72.150	0.063	0.004	4008.800	3.488	3708.000	3.226
Hexanes	0.0687	86.177	0.059	0.003	4756.200	3.268	4404.000	3.026
Heptanes	0.0737	100.204	0.074	0.004	5502.500	4.055	5100.000	3.759
Methylcyclohexane	0.0509	98.186	0.050	0.003	1865.455	0.880	1729.000	0.880
Octanes+	0.0550	114.231	0.063	0.004	6249.100	3.437	1695.970	0.933
2,2,4-TMP	0.0047	114.220	0.005	0.000	6368.594	0.081	1728.400	0.081
Nonanes	0.0305	128.258	0.039	0.002	6996.400	2.134		0.000
Decanes	0.0068	142.285	0.010	0.001	7743.200	0.527		0.000
Benzene	0.0211	78.120	0.016	0.001	3715.500	0.784		0.000
Toluene	0.0352	92.130	0.032	0.002	4444.600	1.564		0.000
Ethylbenzene	0.0012	106.160	0.001	0.000	5191.500	0.062		0.000
Xylenes	0.0157	106.160	0.017	0.001	5183.500	0.814		0.000
n-Hexane	0.0444	86.177	0.038	0.002	4756.200	2.112		0.000
Helium	0.0000	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	0.1247	28.013	0.035	0.002	0.000	0.000	0.000	0.000
Carbon Dioxide	0.8165	44.010	0.359	0.020	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		17.85	1.00		1082.01		967.88

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

Weight Fraction = Net Mole Weight / Total Mole Weight

24. Central Compression

Assumptions:

Total Existing Compression: 6,615 Horsepower (Riverbend Facility)
Total New Compression: 15,608 Horsepower (Proposed Action)
Total New Generation 1,980 Horsepower (Proposed Action)

Equations:

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

Pollutant	Emission Factor [6] (lb/MMBtu)	Emission Factor (g/hp-hr)	Emissions (lb/hr/engine) [7]	7,804 hp Station Emissions (tons/yr)	7,804 hp Station Emissions (tons/yr)	Total Emissions [8] Proposed Action (tons/yr)
Criteria Pollutants & VOC						
NOx [1]		1.5	3.31	113.0	113.0	226.1
CO [1,9]		0.1	0.22	7.5	7.5	15.1
VOC [1,10]		0.5	1.10	37.7	37.7	75.4
PM10 [2,3]	9.95E-03	0.037	0.08	2.80	2.80	5.6
PM2.5 [2,3]	9.95E-03	0.037	0.08	2.80	2.80	5.6
SO_2	5.88E-04	0.002	0.00	0.2	0.2	0.3
Hazardous Air Pollutants [10]						
Benzene [2]	4.40E-04	8.224E-04	1.81E-03	0.06	0.06	0.12
Toluene [2]	4.08E-04	7.626E-04	1.68E-03	0.06	0.06	0.11
Ethylbenzene [2]	3.97E-05	7.420E-05	1.64E-04	0.01	0.01	0.01
Xylenes [2]	1.84E-04	3.439E-04	7.58E-04	0.03	0.03	0.05
n-Hexane [2]	1.11E-03	2.075E-03	4.57E-03	0.16	0.16	0.31
Formaldehyde [2,11]	5.28E-02	2.960E-02	6.53E-02	2.23	2.23	4.46
Acetaldehyde [2]	8.36E-03	1.562E-02	3.44E-02	1.18	1.18	2.35
Acrolein [2]	5.14E-03	2.882E-03	6.35E-03	0.22	0.22	0.43
Methanol [2]	2.50E-03	4.673E-03	1.03E-02	0.35	0.35	0.70
1,1,2,2-Tetrachloroethane[2]	4.00E-05	7.476E-05	1.65E-04	0.01	0.01	0.01
1,1,2-Trichloroethane[2]	3.18E-05	5.943E-05	1.31E-04	4.48E-03	4.48E-03	0.01
1,3-Dichloropropene[2]	2.64E-05	4.934E-05	1.09E-04	3.72E-03	3.72E-03	0.01
1,3-Butadiene[2]	2.67E-04	4.990E-04	1.10E-03	0.04	0.04	0.08
2,2,4-Trimethylpentane[2]	2.50E-04	4.673E-04	1.03E-03	0.04	0.04	0.07
Biphenyl[2]	2.12E-04	3.962E-04	8.74E-04	0.03	0.03	0.06
Carbon Tetrachloride[2]	3.67E-05	6.859E-05	1.51E-04	0.01	0.01	0.01
Chlorobenzene[2]	3.04E-05	5.682E-05	1.25E-04	4.28E-03	4.28E-03	0.01
Chloroform[2]	2.85E-05	5.327E-05	1.17E-04	4.01E-03	4.01E-03	0.01
Ethylene Dibromide[2]	4.43E-05	8.280E-05	1.83E-04	0.01	0.01	0.01
Methylene Chloride[2]	2.00E-05	3.738E-05	8.24E-05	2.82E-03	2.82E-03	0.01
Naphthalene[2]	7.44E-05	1.391E-04	3.07E-04	0.01	0.01	0.02
Phenol[2]	2.40E-05	4.486E-05	9.89E-05	3.38E-03	3.38E-03	0.01
Styrene[2]	2.36E-05	4.411E-05	9.72E-05	3.32E-03	3.32E-03	0.01
Tetrachloroethane[2]	2.48E-06	4.635E-06	1.02E-05	3.49E-04	3.49E-04	6.99E-04
Vinyl Chloride[2]	1.49E-05	2.785E-05	6.14E-05	2.10E-03	2.10E-03	4.20E-03
PAH -POM 1[2,4]	2.69E-05	5.028E-05	1.11E-04	3.79E-03	3.79E-03	0.01
POM 2[2,4,5]	5.93E-05	1.109E-04	2.45E-04	0.01	0.01	0.02
Benzo(b)fluoranthene/POM6[2,4]	1.66E-07	3.103E-07	6.84E-07	2.34E-05	2.34E-05	4.68E-05
Chrysene/POM7[2,4]	6.93E-07	1.295E-06	2.86E-06	9.76E-05	9.76E-05	1.95E-04
Greenhouse Gases						
CO2 [2]	110	411	906	30986	30986	61971
CH4 [2]	1.25	4.67	10.3	352	352	704

[1] - Currently permitted emission rates for internal combustion engine

[2] - AP-42 Table 3.2-2 Uncontrolled Emission Factors for 4-Stroke Lean-Burn Engines, 7/00

[3] - PM = sum of PM filterable and PM condensable

[4] - 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

[5] - POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

[6] - Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 8,240 Btu/hp-hr (*3.738)

[7] - Each individual engine estimated at 1,000 hp (Proposed Action)

[8] - Proposed Action Total Annual Emissions for New Compression (21,325 hp)

[9] - CO emission estimate reduced by 95% to reflect reduction by oxidation catalyst.

[10] - VOCs and HAPs emission estimates reduced by 50% to reflect reduction by oxidation catalyst.

[11] - Formaldehyde and acetaldehyde emission estimates reduced by 85% to reflect reduction by oxidation catalyst.

25. Central TEG Dehydrator Emissions

Assumptions

Peak Field Production Rate: 150 MMscf/day
1114 Active Wells at Peak Production

Gas Composition: Inlet Gas Sample from Riverbend Compresor Station, dated 3/22/07

Inlet Gas Conditions: Inlet gas saturated at 820.0 psig and 86 F

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

Flare > 95% Control Efficiency in order to meet Federal MACT Standards
Condenser Operating Conditions: 86 deg. F, 834.7 psia

Emissions

Species	Central Dehydrator Emissions 75MMscfd Station (tons/year)	Central Dehydrator Emissions 75MMscfd Station (tons/year)	Total Project Emissions (tons/year)
Total VOC	12.02	12.02	24.04
Hazardous Air Pollutants			
Benzene	1.35	1.35	2.70
Toluene	3.82	3.82	7.63
Ethylbenzene	0.19	0.19	0.39
Xylenes	3.90	3.90	7.81
n-Hexane	0.08	0.08	0.17
Greenhouse Gases			
CH_4	6.42	6.42	12.84

Each station throughput estimated according to the ratio of new compression proposed at each station and based on a peak field production rate of 250MMscfd and scaled from the Proposed Action

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26. Central Facility Heater Emissions

Assumptions

Dehydrator Reboiler Heater	750	Mbtu/hr (Typical)
Separator Heater	500	Mbtu/hr (Based on current Riverbend equipment)
Total Heater Requirmement Facility 1	3,750	Mbtu/hr (Proposed Action Estimate, 3-Dehydrator Reboiler Heaters, 3 Separator Heaters)
Total Heater Requirmement Facility 2	3,750	Mbtu/hr (Proposed Action Estimate, 3-Dehydrator Reboiler Heaters, 3 Separator Heaters)
Firing Rate	45	minutes/hour on average for entire year (Typical value)
	6570	hours/year
Fuel Gas Heat Value	968	Btu/scf (Gas Analyses from Riverbend Facility)
Fuel Gas VOC Content	0.076	by weight (Gas Analyses from Riverbend Facility)

Equations

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

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

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

Species	Central Heater Emissions - Facility 1			Central Heater Emissions - Facility 2			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr)	Total Emissions (tons/yr)	Total Emissions (tons/yr)
Criteria Pollutants & VOC							
NO_x [a]	100	0.375	1.232	100	0.375	1.232	2.464
CO [a]	84	0.315	1.035	84	0.315	1.035	2.070
TOC [c]	11	0.041	0.136	11	0.041	0.136	0.271
VOC	N.A.	0.003	0.010	N.A.	0.003	0.010	0.021
SO_x [b]	0.00	0.000	0.000	0.00	0.000	0.000	0.000
TSP [c]	7.6	0.029	0.094	7.6	0.029	0.094	0.187
PM_{10} [c]	7.6	0.029	0.094	7.6	0.029	0.094	0.187
$PM_{2.5}$ [c]	7.6	0.029	0.094	7.6	0.029	0.094	0.187
Hazardous Air Pollutants							
Benzene [d]	2.1E-03	7.88E-06	2.59E-05	2.1E-03	7.88E-06	2.59E-05	5.17E-05
Toluene [d]	3.4E-03	1.28E-05	4.19E-05	3.4E-03	1.28E-05	4.19E-05	8.38E-05
Hexane [d]	1.8E+00	6.75E-03	0.02	1.8E+00	6.75E-03	0.02	0.04
Formaldehyde [d]	7.5E-02	2.81E-04	9.24E-04	7.5E-02	2.81E-04	9.24E-04	1.85E-03
Dichlorobenzene [d]	1.2E-03	4.50E-06	1.48E-05	1.2E-03	4.50E-06	1.48E-05	2.96E-05
Naphthalene [d]	6.1E-04	2.29E-06	7.51E-06	6.1E-04	2.29E-06	7.51E-06	1.50E-05
POM 2 [d,e,f]	5.9E-05	2.21E-07	7.27E-07	5.9E-05	2.21E-07	7.27E-07	1.45E-06
POM 3 [d,g]	1.6E-05	6.00E-08	1.97E-07	1.6E-05	6.00E-08	1.97E-07	3.94E-07
POM 4 [d,h]	1.8E-06	6.75E-09	2.22E-08	1.8E-06	6.75E-09	2.22E-08	4.43E-08
POM 5 [d,i]	2.4E-06	9.00E-09	2.96E-08	2.4E-06	9.00E-09	2.96E-08	5.91E-08
POM 6 [d,j]	7.2E-06	2.70E-08	8.87E-08	7.2E-06	2.70E-08	8.87E-08	1.77E-07
POM 7 [d,k]	1.8E-06	6.75E-09	2.22E-08	1.8E-06	6.75E-09	2.22E-08	4.43E-08
Greenhouse Gases							
CO_2 [c]	120,000	450	1478	120000	450	1478	2957
CH_4 [c]	2.3	0.01	0.03	2.3	0.01	0.03	0.06

[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

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

[f] - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene,

[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.

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

Assumptions:

Average Condensate Production Rate :

Facility 1	1.43	bbls condensate per day (Estimate Based on typical average lifetime condensate well production)
Facility 2	1.43	bbls condensate per day (Estimate Based on typical average lifetime condensate well production)

Separator Conditions : 130 psi and 60 F (Sample Conditions)
API Gravity: 53.4

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0 Run Dated 7/30/08
Riverbend Compressor Station Liquid Sample Dated 3/22/07
Controlled 95% effieiency

Emissions:

Component	Facility 1 Flash/Work/Breathing (tons/yr)	Facility 2 Flash/Work/Breathing (tons/yr)	Total Emissions (tons/yr)
Total VOC	0.039	0.039	0.08
Hazardous Air Pollutants			
Benzene	3.040E-04	3.040E-04	6.08E-04
Toluene	5.083E-04	5.083E-04	1.02E-03
Ethylbenzene	2.38E-05	2.38E-05	4.75E-05
Xylenes	1.805E-04	1.805E-04	3.61E-04
n-Hexane	8.028E-04	8.028E-04	1.61E-03
Greenhouse Gases			
CO_2	5.938E-03	5.938E-03	0.01
CH_4	0.025	0.025	0.05

Buys & Associates, Inc.
Environmental Consultants

Project: Gasco Alternative E Inventory
Date: 6/9/2011

28. Central Facility Emission Summary

Central Facility 1

Pollutant	Central Compression Emissions 7,804 hp (tons/year)	Central Dehydrator Emissions 75MMscfd (tons/year)	Central Heater Emissions 3,000 MBtu/hr (tons/year)	Central Condensate Tank Emissions 1.43 bbl/d (tons/year)	Central Dewpoint Skid Emissions (tons/year)	Total Facility Emissions (tons/year)
Criteria Pollutants & VOC						
NO_x	113		1.23			114
CO	7.54		1.03			8.57
VOC	37.7	12.0	0.01	0.04	6.75	57
SO_2	0.17		0			0.17
PM_{10}	2.80		0.09			2.90
$PM_{2.5}$	2.80		0.09			2.90
Hazardous Air Pollutants						
Benzene	0.06	1.35	2.59E-05	3.04E-04		1.41
Toluene	0.06	3.82	4.19E-05	5.08E-04		3.87
Ethylbenzene	5.59E-03	0.19		2.38E-05		0.20
Xylene	0.03	3.90		1.81E-04		3.93
n-Hexane	0.16	0.08	0.02	8.03E-04		0.26
Formaldehyde	2.23		9.24E-04			2.23
Acetaldehyde	1.18					1.18
Acrolein	0.22					0.22
Methanol	0.35					0.35
1,1,2,2-Tetrachloroethane	5.63E-03					5.63E-03
1,1,2-Trichloroethane	4.48E-03					4.48E-03
1,3-Dichloropropene	3.72E-03					3.72E-03
1,3-Butadiene	0.04					0.04
2,2,4-Trimethylpentane	0.04					0.04
Biphenyl	0.03					0.03
Carbon Tetrachloride	5.17E-03					5.17E-03
Chlorobenzene	4.28E-03					4.28E-03
Chloroform	4.01E-03					4.01E-03
Dichlorobenzene			1.48E-05			1.48E-05
Ethylene Dibromide	6.24E-03					6.24E-03
Methylene Chloride	2.82E-03					2.82E-03
Naphthalene	1.05E-02		7.51E-06			0.01
Phenol	3.38E-03					3.38E-03
Styrene	3.32E-03					3.32E-03
Tetrachloroethane	3.49E-04					3.49E-04
Vinyl Chloride	2.10E-03					2.10E-03
PAH -POM 1*	3.79E-03					3.79E-03
POM 2*	8.36E-03		7.27E-07			8.36E-03
POM 3*			1.97E-07			1.97E-07
POM 4*			2.22E-08			2.22E-08
POM 5*			2.96E-08			2.96E-08
Benzo(b)fluoranthene/POM6	2.34E-05		8.87E-08			2.35E-05
Chrysene/POM7*	9.76E-05		2.22E-08			9.76E-05
Total HAPs	4.46	9.3	0.02	1.82E-03		11.9
Greenhouse Gases						
CO_2	30,986		1,478	5.94E-03		32,464
CH_4	352	6.4	0.03	0.02		359

Central Facility 2

Pollutant	Central Compression Emissions 7,804 hp (tons/year)	Central Dehydrator Emissions 75MMscfd (tons/year)	Central Heater Emissions 3,000 MBtu/hr (tons/year)	Central Condensate Tank Emissions 1.43 bbl/d (tons/year)	Central Dewpoint Skid Emissions (tons/year)	Total Facility Emissions (tons/year)
Criteria Pollutants & VOC						
NO_x	113.0		1.23			114.3
CO	7.54		1.03			8.57
VOC	37.7	12.0	0.01	0	6.75	57
SO_2	0.17		0			0.17
PM_{10}	2.80		0.09			2.90
$PM_{2.5}$	2.80		0.09			2.90
Hazardous Air Pollutants						
Benzene	0.06	1.35	2.59E-05	0.00		1.41
Toluene	0.06	3.82	4.19E-05	0.00		3.87
Ethylbenzene	5.59E-03	0.19		0.00		0.20
Xylene	0.03	3.90		0.00		3.93
n-Hexane	0.16	0.08	0.02	0.00		0.26
Formaldehyde	2.23		9.24E-04			2.23
Acetaldehyde	1.18					1.18
Acrolein	0.22					0.22
Methanol	0.35					0.35
1,1,2,2-Tetrachloroethane	5.63E-03					5.63E-03
1,1,2-Trichloroethane	4.48E-03					4.48E-03
1,3-Dichloropropene	3.72E-03					3.72E-03
1,3-Butadiene	0.04					0.04
2,2,4-Trimethylpentane	0.04					0.04
Biphenyl	0.03					0.03
Carbon Tetrachloride	5.17E-03					5.17E-03
Chlorobenzene	4.28E-03					4.28E-03
Chloroform	4.01E-03					4.01E-03
Dichlorobenzene			1.48E-05			1.48E-05
Ethylene Dibromide	6.24E-03					6.24E-03
Methylene Chloride	2.82E-03					2.82E-03
Naphthalene	1.05E-02		7.51E-06			0.01
Phenol	3.38E-03					3.38E-03
Styrene	3.32E-03					3.32E-03
Tetrachloroethane	3.49E-04					3.49E-04
Vinyl Chloride	2.10E-03					2.10E-03
PAH -POM 1*	3.79E-03					3.79E-03
POM 2*	8.36E-03		7.27E-07			8.36E-03
POM 3*			1.97E-07			1.97E-07
POM 4*			2.22E-08			2.22E-08
POM 5*			2.96E-08			2.96E-08
Benzo(b)fluoranthene/POM6	2.34E-05		8.87E-08			2.35E-05
Chrysene/POM7*	9.76E-05		2.22E-08			9.76E-05
Total HAPs	4.46	9.35	0.02	0.0		11.9
Greenhouse Gases						
CO_2	30,986		1,478	0.0		32,464
CH_4	352	6.4	0.03	0		359

29. Evaporation Facility

Assumptions:

Total New Generation: 1,980 Horsepower (Proposed Action)

Evaporation Emissions conservatively estimated using mass balance
-methanol designated as a VOC

Equations:

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

Pollutant	Engine Emission Factor [6] (lb/MMBtu)	Engine Emission Factor (g/hp-hr) [1]	Engine Emissions (lb/hr) [1]	Engine Emissions (tons/yr)	Evaporation Emissions (tons/yr)[7]	Total Evaporation Facility Emissions (tons/yr)
Criteria Pollutants & VOC						
NOx [1]		1.0	4.37	19.1		19.1
CO [1]		2.0	8.73	38.2		38.2
VOC [1]		1.0	4.37	19.12	837.4	856.5
PM10 [2,3]	9.95E-03	0.036	0.16	0.69		0.7
PM2.5 [2,3]	9.95E-03	0.036	0.16	0.69		0.7
SO_2	5.88E-04	0.002	0.01	0.04		0.0
Hazardous Air Pollutants						
Benzene [2]	4.40E-04	1.598E-03	6.98E-03	0.03	5.2	5.23
Toluene [2]	4.08E-04	1.482E-03	6.47E-03	0.03	12.5	12.53
Ethylbenzene [2]	3.97E-05	1.442E-04	6.3E-04	0.00	0.7	0.70
Xylenes [2]	1.84E-04	6.683E-04	2.9E-03	0.01	10.4	10.41
n-Hexane [2]	1.11E-03	4.032E-03	0.02	0.08		0.08
Formaldehyde [2]	5.28E-02	1.918E-01	0.84	3.67		3.67
Acetaldehyde [2]	8.36E-03	0.03	0.13	0.58		0.58
Acrolein [2]	5.14E-03	0.02	0.08	0.36		0.36
Methanol [2]	2.50E-03	9.080E-03	0.04	0.17	756.1	756.27
1,1,2,2-Tetrachloroethane[2]	4.00E-05	1.453E-04	6.34E-04	0.00		0.00
1,1,2-Trichloroethane[2]	3.18E-05	1.155E-04	5.04E-04	0.00		0.00
1,3-Dichloropropene[2]	2.64E-05	9.588E-05	4.19E-04	1.83E-03		0.00
1,3-Butadiene[2]	2.67E-04	9.697E-04	4.23E-03	0.02		0.02
2,2,4-Trimethylpentane[2]	2.50E-04	9.080E-04	3.96E-03	0.02		0.02
Biphenyl[2]	2.12E-04	7.700E-04	3.36E-03	0.01		0.01
Carbon Tetrachloride[2]	3.67E-05	1.333E-04	5.82E-04	2.55E-03		0.00
Chlorobenzene[2]	3.04E-05	1.104E-04	4.82E-04	2.11E-03		0.00
Chloroform[2]	2.85E-05	1.035E-04	4.52E-04	1.98E-03		0.00
Ethylene Dibromide[2]	4.43E-05	1.609E-04	7.02E-04	3.08E-03		0.00
Methylene Chloride[2]	2.00E-05	7.264E-05	3.17E-04	1.39E-03		0.00
Naphthalene[2]	7.44E-05	2.702E-04	1.18E-03	0.01		0.01
Phenol[2]	2.40E-05	8.717E-05	3.80E-04	1.67E-03		0.00
Styrene[2]	2.36E-05	8.572E-05	3.74E-04	1.64E-03		0.00
Tetrachloroethane[2]	2.48E-06	9.007E-06	3.93E-05	1.72E-04		0.00
Vinyl Chloride[2]	1.49E-05	5.412E-05	2.36E-04	1.03E-03		0.00
PAH -POM 1[2,4]	2.69E-05	9.770E-05	4.26E-04	1.87E-03		0.00
POM 2[2,4,5]	5.93E-05	2.156E-04	9.41E-04	4.12E-03		0.00
Benzo(b)fluoranthene/POM6[2,4]	1.66E-07	6.029E-07	2.63E-06	1.15E-05		0.00
Chrysene/POM7[2,4]	6.93E-07	2.517E-06	1.10E-05	4.81E-05		0.00
Greenhouse Gases						
CO2 [2]	110	400	1,743.94	7639		7638.6
CH4 [2]	1.25	4.54	19.82	86.8		86.8

[1] - Currently permitted emission rates for internal combustion engine

[2] - AP-42 Table 3.2-2 Uncontrolled Emission Factors for 4-Stroke Lean-Burn Engines, 7/00

[3] - PM = sum of PM filterable and PM condensable

[4] - 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

[5] - POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

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

[7] - BTEX emissions controlled by a minimum of 60 %

30. Total Project Production Related Emissions Summary

Pollutant	Well Production Emissions (tons/year)	Central Facility 1 Emissions (tons/year)	Central Facility 2 Emissions (tons/year)	Evaporation Facility Emissions (tons/year)	Total Production Emissions [h] (tons/year)
Criteria Pollutants & VOC					
NO_x	198	114	114	19.1	445
CO	213	8.57	8.57	38.2	268
VOC	1,063	57	57	856.5	2,033
SO_2	0.56	0.17	0.17	0.04	0.93
PM_{10}	2,136	2.90	2.90	0.69	2,142
$PM_{2.5}$	229	2.90	2.90	0.69	236
Hazardous Air Pollutants					
Benzene	8.0	1.41	1.41	5.23	16.1
Toluene	13.0	3.9	3.9	12.53	33
Ethylbenzene	0.62	0.20	0.20	7.03E-01	1.72
Xylene	4.3	3.93	3.93	10.41	22.6
n-Hexane	23.7	0.3	0.3	0.08	24
Formaldehyde	0.14	2.2	2.2	3.67	8.3
Acetaldehyde	0	1.18	1.18	0.58	2.94
Acrolein	0	0.22	0.22	0.36	0.79
Methanol	0	0.35	0.35	756.27	756.98
1,1,2,2-Tetrachloroethane	0	5.63E-03	5.63E-03	2.78E-03	0.01
1,1,2-Trichloroethane	0	4.48E-03	4.48E-03	2.21E-03	0.01
1,3-Dichloropropene	0	3.72E-03	3.72E-03	1.83E-03	0.01
1,3-Butadiene	0	0.04	0.04	0.02	0.09
2,2,4-Trimethylpentane	0	0.04	0.04	0.02	0.09
Biphenyl	0	0.03	0.03	0.01	0.07
Carbon Tetrachloride	0	5.17E-03	5.17E-03	2.55E-03	0.01
Chlorobenzene	0	4.28E-03	4.28E-03	2.11E-03	0.01
Chloroform	0	4.01E-03	4.01E-03	1.98E-03	0.01
Dichlorobenzene	2.24E-03	1.48E-05	1.48E-05	0	0
Ethylene Dibromide	0	6.24E-03	6.24E-03	3.08E-03	0.02
Methylene Chloride	0	2.82E-03	2.82E-03	1.39E-03	0.01
Naphthalene	1.14E-03	0.01	0.01	5.17E-03	0.03
Phenol	0	3.38E-03	3.38E-03	1.67E-03	0.01
Styrene	0	3.32E-03	3.32E-03	1.64E-03	0.01
Tetrachloroethane	0	3.49E-04	3.49E-04	1.72E-04	0
Vinyl Chloride	0	2.10E-03	2.10E-03	1.03E-03	0.01
PAH -POM 1[a]	0	3.79E-03	3.79E-03	1.87E-03	0.01
POM 2[b]	1.10E-04	0.01	0.01	4.12E-03	0.02
POM 3[c]	2.98E-05	1.97E-07	1.97E-07	0	0
POM 4[d]	3.36E-06	2.22E-08	2.22E-08	0	0
POM 5[e]	4.47E-06	2.96E-08	2.96E-08	0	0
Benzo(b)fluoranthene/POM6[f]	1.34E-05	2.35E-05	2.35E-05	1.15E-05	0
Chrysene/POM7[g]	3.36E-06	9.76E-05	9.76E-05	4.81E-05	0
Total HAPs	50	13.8	13.8	789.91	867
Greenhouse Gases					
CO_2	223,909	32,464	32,464	7,639	296,475
CH_4	3,634	359	359	86.8	4,438

a Polycyclic Aromatic Hydrocarbons (PAH), Polycyclic Organic Matter (POM)

b - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene,

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

d - POM 4 includes: 3-Methylchloranthrene.

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

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

g - POM 7 includes: Chrysene.

h Emissions for Peak Field Development

31. Total Project Emissions Summary

Pollutant	Project Emissions (tons/year)		Total Emissions [h] (tons/year)
	Well Development	Project Production	
Criteria Pollutants & VOC			
NO_x	1,764	445	2,209
CO	522	268	790
VOC	116	2,033	2,149
SO_2	30.9	0.93	32
PM_{10}	3,641	2,142	5,784
$PM_{2.5}$	396	236	631
Hazardous Air Pollutants			
Benzene	0.66	16.1	16.7
Toluene	1.08	33	34
Ethylbenzene	0	1.72	1.8
Xylene	0.56	22.6	23
n-Hexane	1.21	24	26
Formaldehyde	0.18	8.3	8
Acetaldehyde	4.62E-03	2.94	2.9
Acrolein	1.44E-03	0.79	0.8
Methanol	0	756.98	757.0
1,1,2,2-Tetrachloroethane	0	0.01	1.E-02
1,1,2-Trichloroethane	0	0.01	1.E-02
1,3-Dichloropropene	0	0.01	9.E-03
1,3-Butadiene	1.34E-06	0.09	0.1
2,2,4-Trimethylpentane	0	0.09	0.1
Biphenyl	0	0.07	0.1
Carbon Tetrachloride	0	0.01	1.E-02
Chlorobenzene	0	0.01	1.E-02
Chloroform	0	0.01	1.E-02
Dichlorobenzene	0	2.27E-03	2.E-03
Ethylene Dibromide	0	0.02	2.E-02
Methylene Chloride	0	0.01	7.E-03
Naphthalene	0.02	0.03	0.1
Phenol	0	0.01	8.E-03
Styrene	0	0.01	8.E-03
Tetrachloroethane	0	8.71E-04	9.E-04
Vinyl Chloride	0	5.23E-03	5.E-03
PAH -POM 1[a]	0.04	0.01	5.E-02
POM 2[b]	0	0.02	2.E-02
POM 3[c]	0	3.02E-05	3.E-05
POM 4[d]	0	3.40E-06	3.E-06
POM 5[e]	0	4.53E-06	5.E-06
Benzo(b)fluoranthene/POM6	0	7.19E-05	7.E-05
Chrysene/POM7[g]	0	2.47E-04	2.E-04
Total HAPs	3.80	867.3	871
Greenhouse Gases			
CO_2	86,970	296,475	383,445
CH_4	530	4,438	4,967

a Polycyclic Aromatic Hydrocarbons (PAH), Polycyclic Organic Matter (POM)

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

[c] - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[d] - POM 4 includes: 3-Methylchloranthrene.

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

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

[g] - POM 7 includes: Chrysene.

[h] Emissions for Peak Field Development

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1. Well Pad/Access Road/Pipeline Construction Fugitive Dust Emissions

Assumptions:

Pieces of Equipment	Hours of Construction	
- 1 Backhoe	20	hours per well pad
- 1 Dozer/Crawler Tractor	100	hours per well pad

Watering Control Efficiency 50 percent (Chapter 2)

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

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 = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM15/hour/piece of equipment

	Fugitive Dust Emissions [a]		
	lbs/hr/ machine	tons/well	tons/yr [b]
TSP	1.97	0.1182	14.19
PM15	0.50	0.0301	3.61
PM10	0.38	0.0226	2.71
PM2.5	0.21	0.0124	1.49

a Backhoe emissions are conservatively estimated as equivalent to Bulldozing emissions.

b Assumes construction rate specified by Proponent

2. Well Pad/Road/Pipeline Construction Emissions (Grader)

Assumptions:

Grading Length	3.33	0.26 miles/road x 3 plus 0.34 miles pipeline plus 1.74 miles on 225' x400' pad (10 ft swath for 400 ft * 23 lengths) = 9,200 ft = 1.74 miles
Hours of Construction	5	day grading per well pad and road (Estimate)
	10	hours/day
	50	hours per well pad
Watering Control Efficiency	50	percent (Chapter 2)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 10/98)
Distance Graded	3.33	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 Grading Emissions, Western Surface Coal Mining, 10/98

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 = 8.93 lbs TSP/well

Emissions = 4.27 lbs PM15/well

	Grader Construction Emissions			
	lbs/well	lbs/hr/well	tons/well	tons/yr [a]
TSP	8.93	0.18	0.0045	0.54
PM15	4.27	0.09	0.0021	0.26
PM10	2.56	0.05	0.0013	0.15
PM2.5	0.28	0.006	0.0001	0.02

a Assumes maximum development scenario

3. Interim Reclamation Fugitive Dust Emissions

Assumptions:

Hours of Reclamation	2	days per well pad (Estimate)
	12	hours/day
	24	hours per well pad
Pieces of Equipment	1	- Dozer
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

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 = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM15/hour/piece of equipment

	Fugitive Dust Emissions		
	lbs/hr	tons/well	tons/yr [a]
TSP	1.97	0.0236	2.84
PM15	0.50	0.0060	0.72
PM10	0.38	0.0045	0.54
PM2.5	0.21	0.0025	0.30

a Assumes maximum construction rate specified by Proponent

Note: The majority of new pipeline will be installed adjacent to proposed access roads and will not result in significant additional surface disturbance.

Buys & Associates, Inc.

Environmental Consultants

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4. Unpaved Road Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006

E (PM10) / VMT = 1.5 * (S/12)^0.9 * (W/3)^0.45 * (365-p)/365)
E (PM2.5) / 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 58
Precipitation Days (P) 73 days per year (NCDC data, Nutters Ranch, UT 1963-1986)

		Average	Round					
	Vehicle Type	Weight	Trips per	PM10	PM10/Pad	PM10/Pad	PM2.5/Pad	PM2.5/Pad
		(lbs)	Well a	(lb/VMT)	(lbs)	(lb/day)	(lbs)	(lb/day)
Construction (days/pad and road)	10							
	Haul Trucks	80,000	5					
	Water Trucks	60,000	1					
	Light Trucks	8,000	10					
	Mean Vehicle Weight	33,750	16	1.8937586	1757.4	175.7	175.7	17.6
					PM10/Annual Pads		PM2.5/Annual Pads	
					(tons)		(tons)	
					105.4		10.5	
		Average	Round					
	Vehicle Type	Weight	Trips per	PM10	PM10/Well	PM10/Well	PM2.5/Well	PM2.5/Well
		(lbs)	Well a	(lb/VMT)	(lbs)	(lb/day)	(lbs)	(lb/day)
Drilling, Downhole (days/well)	35							
	Haul Trucks	80,000	70					
	Logging/Mud Trucks	70,000	10					
	Water Trucks b	60,000	75					
	Light Trucks	8,000	80					
	Mean Vehicle Weight	48,681	235	2.2331227	30437.5	869.6	3043.7	87.0
					PM10/Annual Wells		PM2.5/Annual Wells	
					(tons)		(tons)	
					1826.2		182.6	
		Average	Round					
	Vehicle Type	Weight	Trips per	PM10	PM10/Well	PM10/Well	PM2.5/Well	PM2.5/Well
		(lbs)	Well a	(lb/VMT)	(lbs)	(lb/day)	(lbs)	(lb/day)
Completion (days/well)	14							
	Semi/Transport/Water/Sand	80,000	46					
	Water Trucks b	60,000	157					
	Light Trucks	8,000	56					
	Mean Vehicle Weight	52,309	259	2.3065367	34648.8	2474.9	3464.9	247.5
					PM10/Annual Wells		PM2.5/Annual Wells	
					(tons)		(tons)	
					2078.9		207.9	
		Average	Round					
	Vehicle Type	Weight	Trips per	PM10	PM10/Day	PM10/Day	PM2.5/Day	PM2.5/Day
		(lbs)	Well a	(lb/VMT)	(lbs)	(lb/day)	(lbs)	(lb/day)
Interim Reclamation (days/well)	2							
	Haul Trucks	80,000	1					
	Light Trucks	8,000	5					
	Mean Vehicle Weight	20,000	6	1.4964593	520.8	260.4	52.1	26.0
					PM10/Annual Wells		PM2.5/Annual Wells	
					(tons)		(tons)	
					31.2		3.1	
Annual Traffic Fugitive Dust Emissions (tons/year)					4042		404	

[a] Traffic Estimates are based upon an approximately 14-days construction, 13-days drilling at downhole locations (shallow wells), 26-days drilling at direction wells (shallow wells), 29-days completion, and 6-days infrastructure development per well or well pad as appropriate.
[b] 25,000 barrels/well for completion; 12,000 barrels/well for drilling; assume 160-barrel water truck

Buys & Associates, Inc. Environmental Consultants	Project: GASCO Alternative F - w/ Voluntary ACEPMS Date: 6/11/2011

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	1103.0 acres total initial disturbance for roads/pipelines (Proposed Action) 4,463,676 square meters total initial disturbance for roads/pipelines 2,629 acres total initial disturbance for well pads and other facilities (Proposed Action) 10,639,169 square meters total initial disturbance for well pads and other facilities 3,732 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 and facilities (Assumption, disturbance at construction and reclamation) Constant for dirt roads
Development Period	10.81666667 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	2.77	0.00
PM10	1.39	0.00
PM2.5	0.55	0.00

6. Construction Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Construction	100	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	6	(Proposed Action)
Number of Pickup Trips	10	(Proposed Action)
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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.130	0.095	0.005	3.030	0.059	0.003	0.153	0.921
CO	17.090	0.199	0.010	33.640	0.653	0.033	0.852	5.109
VOC [c]	4.600	0.054	0.003	4.646	0.090	0.005	0.144	0.862
SO_2	0.321	0.004	0.000	0.214	0.004	0.000	0.008	0.047
Greenhouse Gases								
CH_4 [e]	0.230	0.003	0.000	0.184	0.004	0.000	0.006	0.037

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

7. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Operation	840	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	155	(Proposed Action)
Number of Pickup Trips	80	(Proposed Action)
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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ \text{(S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.13	0.291	0.122	3.03	0.056	0.024	0.347	17.490
CO	17.09	0.612	0.257	33.64	0.622	0.261	1.233	62.160
VOC [c]	4.600	0.165	0.069	1.656	0.031	0.013	0.195	9.842
SO_2	0.32	0.011	0.005	0.21	0.004	0.002	0.015	0.779
Greenhouse Gases								
CH_4 [c]	0.230	0.008	0.003	0.184	0.003	0.001	0.012	0.586

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

[b] AP-42 Append. H 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 - Methane Offset

[d] Assumes construction rate specified by Proponent

[e] AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

8. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0	miles (Estimated from project area and existing road system)
Hours of Operation	140.00	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	203	(Proponent)
Number of Pickup Trips	56	(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:

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

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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * \text{453.6 (g/lb)} * \text{Fuel Sulfur Content} * \text{2 (S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.13	2.287	0.160	3.03	0.235	0.016	2.522	21.186
CO	17.09	4.808	0.337	33.64	2.611	0.183	7.418	62.311
VOC [c]	4.600	1.294	0.091	1.656	0.129	0.009	1.423	11.949
SO_2	0.32	0.090	0.006	0.21	0.017	0.001	0.107	0.898
Greenhouse Gases								
CH_4 [e]	0.230	0.065	0.005	0.184	0.014	0.001	0.079	0.663

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

9. Interim Reclamation Tailpipe Emissions

Assumptions:

Average Round Trip Distance	88.0 miles (Estimated from project area and existing road system)
Hours of Operation	60 hours per site (Assumption)
Number of Heavy Diesel Truck Trips	1 (Assumption)
Number of Pickup Trips	5 (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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\text{ (g/lb)} * \text{Fuel Sulfur Content} * 2\text{ (S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	8.13	0.026	0.001	3.03	0.049	0.001	0.075	0.271
CO	17.09	0.055	0.002	33.64	0.544	0.016	0.599	2.157
VOC [c]	4.600	0.015	0.000	1.656	0.027	0.001	0.042	0.150
SO_2	0.32	0.001	0.000	0.21	0.003	0.000	0.004	0.016
Greenhouse Gases								
CH_4 [e]	0.230	0.001	0.000	0.184	0.003	0.000	0.004	0.013

a AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 50,000 miles (6/95)
b AP-42 Append. H 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 - Methane Offset
d Assumes construction rate specified by Proponent
e AP-42 Append. H Tables 7.10A.2 and 4.10A.2 H.D. Methane Offsets, High Altitude, 1986+ and 1988+ Vehicle Year

10. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Hours of Operation	100 hours/site (Proposed Action)
Development Rate	120 new pads per year (Proposed Action)
Load Factor	0.4 (Assumed typical value)
Backhoe Size	85 hp (Proponent Contractor Typical value)
Dozer/Crawler Tractor	290 hp (Proponent Contractor Typical value)
Motor Grader Size	185 hp (Proponent Contractor Typical value)

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/Crawler Tractor			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)
NO_x	8.15	0.611	3.665	8.15	2.084	12.505	7.14	1.165	6.989
CO	2.28	0.171	1.025	2.28	0.583	3.498	1.54	0.251	1.507
VOC [c]	0.37	0.028	0.166	0.37	0.095	0.568	0.36	0.059	0.352
PM_{10} [d]	0.5	0.037	0.225	0.5	0.128	0.767	0.63	0.103	0.617
$PM_{2.5}$ [d]	0.5	0.037	0.225	0.5	0.128	0.767	0.63	0.103	0.617
SO_2	0.22	0.016	0.099	0.22	0.056	0.338	0.22	0.036	0.215
Formaldehyde	0.22	0.016	0.099	0.22	0.056	0.338	0.12	0.020	0.117

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions[e] (tons/yr)
NO_x	3.860	23.160
CO	1.005	6.031
VOC [c]	0.181	1.087
PM_{10} [d]	0.268	1.609
$PM_{2.5}$ [d]	0.268	1.609
SO_2	0.109	0.652
Formaldehyde	0.092	0.554

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 construction rate specified by Proponent

11. Drill Rig Engine Emissions

Assumptions:

Hours of Operation	840	hours/ well (Proposed Action)
Development Rate	120	total wells in max year (Proposed Action)
	7%	average time small rig will run per well (Section 2.2.2.3)
Load Factor	0.4	(Assumed typical value)
Rig Size	1000	hp (Estimate - phase 1 drilling)
	2500	hp (Estimate - phase 2 drilling)
	2393	hp (weighted average based on ratio of time in use to drill one well)
Diesel Fuel Sulfur Content	0.05	% (typical value)

Equations:

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

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Drill Rig Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [h] (tons/yr)
Criteria Pollutants & VOC			
NO_x [a, II]	0.01058	10.127	510
CO [II]	5.73E-03	5.484	276
VOC [a,b]	7.05E-04	0.675	34.0
PM_{10} [II,c]	3.31E-04	0.317	16.0
$PM_{2.5}$ [a,d]	3.59E-04	0.344	17.3
SO_2 [a]	4.05E-04	0.387	19.5
Hazardous Air Pollutants			
Benzene [e]	1.97E-06	0.002	0.10
Toluene [e]	7.15E-07	0.001	0.03
Xylenes [e]	4.91E-07	4.70E-04	0.02
Formaldehyde [e]	2.01E-07	1.92E-04	0.01
Acetaldehyde [e]	6.41E-08	6.14E-05	3.09E-03
Acrolein [e]	2.01E-08	1.92E-05	9.67E-04
Naphthalene [f]	3.31E-07	3.17E-04	0.02
Total PAH [f,g]	5.40E-07	5.16E-04	0.03
Greenhouse Gases			
CO_2 [a]	1.16	1110	55,958
CH_4 [a,b]	7.05E-04	0.675	34.0

[II] Tier II Emission Factors, hp>750

[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	6	Hours/Well (Proponents)
Development Rate	120	wells per year (Proposed Action)
Load Factor	0.5	(typical value)
Frac Pump Engine Horsepower	19,000	Horsepower (typical)
Temporary Generator Horsepower	75	Horsepower (typical)
Diesel Fuel Sulfur Content	0.05	% (typical value)

Equations:

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

SO2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

Species	Frac Pump Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.024	228.000	82.080
CO [a]	5.50E-03	52.250	18.810
VOC [a,b]	7.05E-04	6.698	2.411
PM_{10} [a,c]	5.73E-04	5.444	1.960
$PM_{2.5}$ [a,d]	4.79E-04	4.551	1.638
SO_2 [a]	4.05E-04	3.843	1.383
Hazardous Air Pollutants			
Benzene [e]	1.97E-06	1.88E-02	0.007
Toluene [e]	7.15E-07	6.79E-03	0.002
Xylenes [e]	4.91E-07	4.67E-03	1.68E-03
Formaldehyde [e]	2.01E-07	1.91E-03	6.87E-04
Acetaldehyde [e]	6.41E-08	6.09E-04	2.19E-04
Acrolein [e]	2.01E-08	1.91E-04	6.86E-05
Naphthalene [f]	3.31E-07	3.14E-03	1.13E-03
Total PAH [f]	5.40E-07	5.13E-03	1.85E-03
Greenhouse Gases			
CO_2 [a]	1.16	11,020	3,967.2
CH_4 [a]	7.05E-04	6.698	2.411

Species	Generator Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants			
NOx [g]	0.031	1.163	0.42
CO [g]	6.68E-03	0.25	0.09
VOC [b,g]	2.47E-03	0.09	0.03
PM_{10} [g]	2.20E-03	0.08	0.03
$PM_{2.5}$ [g]	2.20E-03	0.08	0.03
SO_2 [g]	2.05E-03	0.08	0.03
Hazardous Air Pollutants			
Benzene [h]	2.37E-06	8.90E-05	3.21E-05
Toluene [h]	1.04E-06	3.90E-05	1.41E-05
Xylenes [h]	7.25E-07	2.72E-05	9.79E-06
Formaldehyde [h]	3.00E-06	1.13E-04	4.05E-05
Acetaldehyde [h]	1.95E-06	7.32E-05	2.64E-05
Acrolein [h]	2.35E-07	8.83E-06	3.18E-06
1,3-Butadiene [h]	9.95E-08	3.73E-06	1.34E-06
Naphthalene [h]	2.16E-07	8.09E-06	2.91E-06
Total PAH [h]	4.28E-07	1.60E-05	5.77E-06
Greenhouse Gases			
CO_2 [g]	1.15	10,925	3,933
CH_4 [b,g]	2.47E-03	23.465	8.45

[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 conversion factor from Appendix A

[i] Assumes maximum development scenario

Buys & Associates, Inc. Environmental Consultants	Project: GASCO Alternative F - w/ Voluntary ACEPMS Date: 6/11/2011

14. Well Development Venting

Assumptions: Following Completion, Wells are Vented prior to connnection to the gathering pipeline

Venting Period 48 hours (Project Proponents)

Amount of Vented Gas: 0.2 MMscf (Average Volume Estimated by Proponents)

Development Rate: 120 Wells per year (Project Proponents)

COMPONENT	MOLECULAR WEIGHT (lb/lb-mole)	MOLE PERCENT	RELATIVE MOLE WEIGHT (lb/lb-mole)	WEIGHT Fraction	COMPONENT FLOW RATE (Mscf/day)	COMPONENT FLOW RATE (lb/hr)	COMPONENT FLOW RATE (tons/yr)
Methane	16.043	92.713	14.874	0.833	185.426	163.311	470.335
Ethane	30.07	4.078	1.226	0.069	8.156	13.464	38.777
Propane	44.097	1.145	0.505	0.028	2.289	5.542	15.960
i-Butane	58.123	0.248	0.144	0.008	0.496	1.582	4.556
n-Butane	58.123	0.265	0.154	0.009	0.530	1.691	4.869
i-Pentane	72.15	0.118	0.085	0.005	0.236	0.935	2.692
n-Pentane	72.15	0.087	0.063	0.004	0.174	0.689	1.985
Hexanes	86.177	0.000	0.000	0.000	0.000	0.000	0.000
Heptanes	100.204	0.216	0.216	0.012	0.431	2.372	6.831
Octanes	114.231	0.035	0.040	0.002	0.069	0.435	1.253
Nonanes	128.258	0.031	0.039	0.002	0.061	0.430	1.237
Decanes +	142.285	0.007	0.010	0.001	0.014	0.106	0.306
Benzene	78.12	0.021	0.016	0.001	0.042	0.181	0.521
Toluene	92.13	0.035	0.032	0.002	0.070	0.356	1.025
Ethylbenzene	106.16	0.001	0.001	0.000	0.002	0.014	0.040
Xylenes	106.16	0.016	0.017	0.001	0.031	0.183	0.527
n-Hexane	86.177	0.044	0.038	0.002	0.089	0.420	1.210
Helium	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.125	0.035	0.002	0.249	0.384	1.105
Carbon Dioxide	44.01	0.817	0.359	0.020	1.633	3.945	11.363
Oxygen	32	0.000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulfide	34.08	0.000	0.000	0.000	0.000	0.000	0.000
VOC SUBTOTAL		**2.2676**	**1.360**	**0.076**	**4.535**	**14.935**	**43.014**
HAP SUBTOTAL		**0.1176**	**0.105**	**0.006**	**0.235**	**1.154**	**3.324**
TOTAL		**100.000**	**17.855**	**1.000**	**200**	**196.039**	**564.593**

14. Well Development Emissions Summary

Species	Well Development Emissions (tons/year) [a]				Wind Erosion	Total [a] (tons/yr)
	Construction	Drilling	Completion	Interim Reclamation		
Criteria Pollutants & VOC						
NO_x	24.1	528	103.7	0.27		656
CO	11.14	339	81	2.16		433
VOC	1.95	43.9	57.4	0.15		103.4
SO_2	0.70	20.3	2.3	0.02		23.3
PM_{10}	109.9	1,842	2,081	31.8	1.4	4,066
$PM_{2.5}$	13.7	200	210	3.42	0.6	427
Hazardous Air Pollutants						
Benzene		0.10	0.53			0.62
Toluene		0.03	1.03			1.06
Ethylbenzene			0.04			0.04
Xylenes		0.02	5.29E-01			0.55
n-Hexane			1.210			1.21
Formaldehyde	0.55	0.01	0.001			0.56
Acetaldehyde		3.09E-03	2.46E-04			3.3.E-03
Acrolein		9.67E-04	7.18E-05			1.0.E-03
1,3-Butadiene			1.34E-06			1.3.E-06
Naphthalene		0.02	1.13E-03			0.02
Total PAH, POM 1 [b]		0.03	1.85E-03			0.03
Total HAPs	0.55	0.21	3.34	0.0	0.0	4.1
Greenhouse Gases						
CO_2		55,958	7,912			63,870
CH_4	0.04	34.6	481.9	0.01		516.5

a Emissions for Peak Field Development
b Polycyclic Aromatic Hydrocarbons (PAH), Polycyclic Organic Matter (POM)

Buys & Associates, Inc.

Environmental Consultants

Project: GASCO Alternative F - w/ Voluntary ACEPMS
Date: 6/11/2011

15. Average Produced Gas Characteristics
Inlet Wet Gas Sample from Riverbend Compressor Station, dated 3/22/07

Gas Heat Value (wet): 1064.3 Btu/scf

C1-C2 Wt. Fraction:	0.9020
VOC Wt. Fraction:	0.0760
Non-HC Wt. Fraction:	0.0221
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	92.7130	16.043	14.874	0.833	1010.0	936.401	910.0	843.688
Ethane	4.0781	30.070	1.226	0.069	1769.8	72.174	1618.0	65.984
Propane	1.1446	44.097	0.505	0.028	2516.2	28.800	2316.0	26.509
i-Butane	0.2479	58.123	0.144	0.008	3252.1	8.062	3005.0	7.449
n-Butane	0.2649	58.123	0.154	0.009	3262.4	8.642	3013.0	7.981
i-Pentane	0.1180	72.150	0.085	0.005	4000.9	4.721	3698.0	4.364
n-Pentane	0.0870	72.150	0.063	0.004	4008.8	3.488	3708.0	3.226
Hexanes	0.0687	86.177	0.059	0.003	4756.2	3.268	4404.0	3.026
Heptanes	0.0737	100.204	0.074	0.004	5502.5	4.055	5100.0	3.759
Methylcyclohexane	0.0509	98.186	0.050	0.003	1865.5	0.950	1729.0	0.880
Octanes	0.0550	114.231	0.063	0.004	6249.1	3.437	1696.0	0.933
2,2,4-TMP	0.0047	114.220	0.005	0.000	6368.6	0.299	1728.4	0.081
Nonanes	0.0305	128.258	0.039	0.002	6996.4	2.134		0.000
Decanes	0.0068	142.285	0.010	0.001	7743.2	0.527		0.000
Benzene	0.0211	78.120	0.016	0.001	3715.5	0.784		0.000
Toluene	0.0352	92.130	0.032	0.002	4444.6	1.564		0.000
Ethylbenzene	0.0012	106.160	0.001	0.000	5191.5	0.062		0.000
Xylenes	0.0157	106.160	0.017	0.001	5183.5	0.814		0.000
n-Hexane	0.0444	86.177	0.038	0.002	4756.2	2.112		0.000
Helium	0.0000	4.003	0.000	0.000	0.0	0.000	0.0	0.000
Nitrogen	0.1247	28.013	0.035	0.002	0.0	0.000	0.0	0.000
Carbon Dioxide	0.8165	44.010	0.359	0.020	0.0	0.000	0.0	0.000
Oxygen	0.0000	32.000	0.000	0.000	0.0	0.000	0.0	0.000
Hydrogen Sulfide	0.0000	34.080	0.000	0.000	637.1	0.000	588.0	0.000
VOC Subtotal	**2.270**		**1.3558**	**0.0760**		**36.8563**		
HAP Subtotal	**0.1176**		**0.1051**	**0.0059**		**5.3363**		
TOTAL	**100.00**		**17.85**	**1.00**		**1082.29**		**967.88**

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

Weight Fraction = Net Mole Weight / Total Mole Weight

HAP Fractions estimated from GRI Published Factors

16. Wellsite Separator Heater Emissions

Assumptions

Separator Heater Size	500	Mbtu/hr (Typical size Proposed Action)
Wells Requiring Separators:	1298	wells at Peak Production
Firing Rate	8,760	hours/year (Typical Uinta Basin operation)
Fuel Gas Heat Value	968	Btu/scf (Gas Analyses from Riverbend well)
Fuel Gas VOC Content	0.076	by weight (Gas Analyses from Riverbend Facility)

Equations

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

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

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

Species	Wellsite Heater Emissions - Separators		
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions (tons/yr)
Criteria Pollutants & VOC			
NO_x [a]	100	0.052	294
CO [a]	84	0.043	247
TOC [c]	11	0.006	32.3
VOC	N.A.	0.000	2.45
SO_x [b]	0.00	0.000	0
TSP [c]	7.6	0.004	22.3
PM_{10} [c]	7.6	0.004	22.3
$PM_{2.5}$ [c]	7.6	0.004	22.3
Hazardous Air Pollutants			
Benzene [d]	0.0021	1.1E-06	6.17E-03
Toluene [d]	0.0034	1.8E-06	0.01
Hexane [d]	1.8	9.3E-04	5.29
Formaldehyde [d]	0.075	3.9E-05	0.22
Dichlorobenzene [d]	1.2E-03	6.2E-07	3.52E-03
Naphthalene [d]	6.1E-04	3.2E-07	1.79E-03
POM 2 [d,e,f]	5.9E-05	3.0E-08	1.73E-04
POM 3 [d,g]	1.6E-05	8.3E-09	4.70E-05
POM 4 [d,h]	1.8E-06	9.3E-10	5.29E-06
POM 5 [d,i]	2.4E-06	1.2E-09	7.05E-06
POM 6 [d,j]	7.2E-06	3.7E-09	2.11E-05
POM 7 [d,k]	1.8E-06	9.3E-10	5.29E-06
Greenhouse Gases			
CO_2 [c]	120,000	61.99	352,435
CH_4 [c]	2.3	0.001	6.75

[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

[e] - 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

[f] - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and 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.

17. Wellsite Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate: 2.01 bbls condensate per day (Estimate based on proponent data)
Number of Active Wells: 1298 wells at Peak Production

Separator Conditions : 130 psi and 60 F (Riverbend sample)
API Gravity: 58.28

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0
Riverbend Compressor Station Liquid Sample Dated 6/4/07

Emissions:

Component	Wellsite Flash/Work/Breathing (lb/hr/well)	Wellsite Flash/Work/Breathing (tons/year/well)	Total Emissions (tons/yr)
Total VOC	0.163	0.713	926
Hazardous Air Pollutants			
Benzene	1.643E-03	0.007	9.34
Toluene	2.655E-03	0.012	15.09
Ethylbenzene	1.264E-04	0.001	0.719
Xylenes	8.849E-04	0.004	5.031
n-Hexane	4.172E-03	0.018	23.72
Greenhouse Gases			
CO_2	0.033	0.144	186.9
CH_4	0.156	0.683	886

Buys & Associates, Inc.	GASCO Alternative F - w/ Voluntary
Environmental Consultants	Project: ACEPMS
	Date: 6/11/2011

18. VOC Emissions from NGL Truck Loading Operations

NGL Truck Loading/Unloading Emissions: NGL will normally be transported by pipeline, however truck transport may be utilized as a contingency. A pressurized vapor recovery system will be utilized for truck loading. Potential emissions result from the equalization of the loading rack connection to atmospheric pressure after the loading operation is completed.

Assumed Additional Maximum Number of Truck loads/year 5,840

Truck Loading Connection Configuration

	Load Line		
Load Line Connection Diameter =	0.25	ft	(Assumed typical value)
Load Line Length between Valves =	3.0	ft	(Assumed typical value)
Connection Volume =	0.147	ft^3	
Annual Connection Volume Vented =	860	ft^3	
NGL Density =	5.6	lbs/gal	(Assumed typical value)
NGL Density =	41.9	lbs/ft^3	
Annual Wt. NGL Vented =	36,024.1	lbs/year	
NGL VOC Content =	100.0%	by weight (See NGL Composition for Fugitive Emissions)	
VOC Emissions =	18.0	tons/year VOC	

Example Calculations

Connection volume = Pi * $(Diameter)^2/4$ * Length

Annual Volume Vented (ft^3/year) = Connection Volume (ft^3) * Number Truck Loads per year (1/year)

Density ($lbs/ft^{3)}$ = Density (lbs/gal) * 7.48 gal/ft^3

Vented NGL Weight (lbs) = Volume Vented (ft^3) * NGL Density (lbs/ft^3)

VOC Emissions (tons/year) = Annual NGL Vented (lbs/year) * NGL VOC wt. % / 100 / 2000 (lbs/ton)

19. Operations Vehicle Tailpipe Emissions

Assumptions:

Number of New Pumpers:	44	(Proposed Action Number of Pumpers at Peak Production)
Pumper Mileage:	2,800	miles/pumper/month (Assumption 0.5 miles between wells and roundtrip from Roosevelt))
Total Annual New Pumper Mileage:	1,478,400	miles/year
Number of Condensate Haul Truck Round Trips:	20	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for Condensate Transport:	88	miles (from Roosevelt)
Total Annual Condensate Truck Mileage:	642,400	miles/year
Number of Water Haul Truck Round Trips:	121	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for Water Transport:	17	miles (Average distance to evaporation facility)
Total Annual Water Truck Mileage:	750,805	miles/year
Number of NGL Haul Truck Round Trips:	16	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for NGL Transport:	88	miles (Average distance to evaporation facility)
Total Annual NGL Truck Mileage:	513,920	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:

$$\text{SO2 E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ \text{(S / SO2)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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)
Criteria Pollutants & VOC								
NO_x	3.03	2.261	4.938	8.13	7.826	17.091	10.086	22.029
CO	33.64	25.101	54.821	17.09	16.450	35.927	41.551	90.748
VOC [c]	1.656	1.236	2.699	4.600	4.428	9.670	5.663	12.369
SO_2	0.21	0.160	0.349	0.32	0.309	0.675	0.469	1.024
Greenhouse Gases								
CH_4 [d]	0.184	0.137	0.300	0.230	0.221	0.484	0.359	0.783

9.9026862

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: GASCO Alternative F - w/ Voluntary ACEPMS Date: 6/11/2011

20. Pneumatic Device Emissions 0.144 Mscf/day or less = low bleed device

Analysis Gas Consumption Rate:	1.00	Mscf/day
Days of Operation:	365	days/year

GAS COMPONENT	MOLECULAR WEIGHT (lb/lb-mole)	MOLE PERCENT	RELATIVE MOLE WEIGHT (lb/lb-mole)	WEIGHT PERCENT	VOLUME LOW RAT (Mscf/day	MASS FLOW RATE (lb/hr)	MASS FLOW RATE (tons/yr)
Methane	16.043	92.7130	14.874	83.334	0.927	1.633	7.153
Ethane	30.07	4.0781	1.226	6.870	0.041	0.135	0.590
Propane	44.097	1.1446	0.505	2.828	0.011	0.055	0.243
i-Butane	58.123	0.2479	0.144	0.807	0.002	0.016	0.069
n-Butane	58.123	0.2649	0.154	0.863	0.003	0.017	0.074
i-Pentane	72.15	0.1180	0.085	0.477	0.001	0.009	0.041
n-Pentane	72.15	0.0870	0.063	0.352	0.001	0.007	0.030
Hexanes	86.177	0.0687	0.059	0.332	0.001	0.007	0.028
Heptanes	100.204	0.1233	0.124	0.692	0.001	0.014	0.059
Octanes	114.231	0.0584	0.067	0.374	0.001	0.007	0.032
Nonanes	128.258	0.0305	0.039	0.219	0.000	0.004	0.019
Decanes +	142.285	0.0068	0.010	0.054	0.000	0.001	0.005
Benzene	78.12	0.0211	0.016	0.092	0.000	0.002	0.008
Toluene	92.13	0.0352	0.032	0.182	0.000	0.004	0.016
Ethylbenzene	106.16	0.0012	0.001	0.007	0.000	0.000	0.001
Xylenes	106.16	0.0157	0.017	0.093	0.000	0.002	0.008
n-Hexane	86.177	0.0444	0.038	0.214	0.000	0.004	0.018
Helium	4.003	0.0000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.1247	0.035	0.196	0.001	0.004	0.017
Carbon Dioxide	44.01	0.8165	0.359	2.013	0.008	0.039	0.173
Oxygen	32	0.0000	0.000	0.000	0.000	0.000	0.000
Hydrogen Sulfide	34.08	0.0000	0.000	0.000	0.000	0.000	0.000
VOC SUBTOTAL		**2.268**	**1.354**	**7.586**	**0.023**	**0.149**	**0.651**
HAP SUBTOTAL		**0.118**	**0.105**	**0.589**	**0.001**	**0.012**	**0.051**
TOTAL		**100.000**	**17.849**	**100.000**	**1.000**	**1.960**	**8.584**

	Number of Wells	VOC emissions (tons/year)	Methane emissions (tons/yr)
Alternative F	1,298	304	3342.5

LIQUID LEVEL CONTROLLER SPECIFICATIONS

Gas Consumption Rate:	0.144	Mscf/day
Days of Operation:	365	days/year

(low-bleed)

TRACE PUMP SPECIFICATIONS

Gas Consumption Rate:	0.144	Mscf/day
Days of Operation:	182	days/year

Assumed recycle of gas equals low-bleed specification

METHANOL PUMP SPECIFICATIONS

-Solar powered methanol pumps will be installed for the Proposed Action

Pneumatic sources / well			VOC lb/hr	VOC ton/yr
2	Liquid level controllers		0.04	0.19
1	Trace pump		0.01	0.05
2	Chemical injection pump		0	0
		Totals (per well) =	0.05	0.23

Buys & Associates, Inc.

Environmental Consultants

Project: GASCO Alternative F - w/ Voluntary ACEPMS
Date: 6/11/2011

21. Operations Traffic Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006

365 days (Estimate)

Unpaved Roads

E (PM10) / VMT = 1.5 * (S/12)^0.9 * (W/3)^0.45 * (365-p)/365)
E (PM2.5) / 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) 73 days per year **
Avg. Round Trip Miles 37 miles on unpaved roads ***

Vehicle Type	Ave. Weight (lbs)	Round Trips per Day*
Pickup Truck: Crew	7,000	44
Haul Truck: Oil	48,000	20
Haul Truck: Water	48,000	121
Haul Truck: NGL	48,000	16
Mean Weight	39,025	201

Paved Roads

E (PM10) / VMT = 0.016 * (sL/2)^0.65 * (W/3)^1.5 - 0.00047 * (1-(p/(365*4))
E (PM10) / 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 30 From Roosevelt
Precipitation Days (P) 73 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	2.02	5,546,800	15,197	0.20	554,680	1,520
Paved	0.08	170,731	468	0.01	25,004	69
Total		5,717,531	15,664		579,684	1,588

Annual Traffic Fugitive Dust Emissions (tons/year)	**2,859**			**290**	

*Round trips per day at peak production (Proposed Action)
** NCDC data for Nutters Ranch, UT 1963-1986
*** Weighted average of Pumper,Condensate, NGL, and Water Hauling Distance = (58*(44+20+16+15)+17*(90-15))/253. One round trip to evaporative facility is assumed to take about 2-hours, so 6 trips per day are completed in one 12-hr shift, which requires 20 trucks to do 121 trips.

22. Well Production Summary

Species	Storage Tanks (tons/yr)	Well Site Heaters (tons/yr)	Operations Vehicle (tons/yr)	Pneumatic Devices (tons/yr)	Total Well Production [g] (tons/yr)
Criteria Pollutants & VOC					
NO_x		294	22.0		316
CO		247	90.7		337
VOC	926	2.45	12.37	304	1,245
SO_2		0	1.02		1.02
PM_{10}		22.3	2,859		2,881
$PM_{2.5}$		22.3	290		312
Hazardous Air Pollutants					
Benzene	9.3	0.01			9.3
Toluene	15	0.01			15.1
Ethylbenzene	0.72				0.72
Xylene	5.0				5.03
n-Hexane	24	5.29			29.0
Formaldehyde		0.22			0.22
Dichlorobenzene		3.52E-03			3.52E-03
Naphthalene		1.79E-03			1.79E-03
POM 2[a]		1.73E-04			1.73E-04
POM 3[b]		4.70E-05			4.70E-05
POM 4[c]		5.29E-06			5.29E-06
POM 5[d]		7.05E-06			7.05E-06
POM 6[e]		2.11E-05			2.11E-05
POM 7[f]		5.29E-06			5.29E-06
Total HAPs	54	5.53	0		59.4
Greenhouse Gases					
CO_2	187	352,435			352,622
CH_4	886	6.75	0.78	3342	4,236

[a] - POM (Particulate Organic Matter) 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

[b] - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[c] - POM 4 includes: 3-Methylchloranthrene.

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

[e] - POM 6 includes: Benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-

[f] - POM 7 includes: Chrysene.

[g] Emissions for Peak Field Development

Buys & Associates, Inc.

Environmental Consultants

Project: GASCO Alternative F - w/ Voluntary ACEPMS
Date: 6/11/2011

23. Average Produced Gas Characteristics
Inlet Wet Gas Sample from Riverbend Compressor Station, dated 3/22/07

Gas Heat Value (wet): 1064.1 Btu/scf

Sample Temperature: 77 F
Sample Pressure: 132 psi

C1-C2 Wt. Fraction:	0.9020
VOC Wt. Fraction:	0.0760
Non-HC Wt. Fraction:	0.0221
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	92.7130	16.043	14.874	0.833	1010.000	936.401	910.000	843.688
Ethane	4.0781	30.070	1.226	0.069	1769.800	72.174	1618.000	65.984
Propane	1.1446	44.097	0.505	0.028	2516.200	28.800	2316.000	26.509
i-Butane	0.2479	58.123	0.144	0.008	3252.100	8.062	3005.000	7.449
n-Butane	0.2649	58.123	0.154	0.009	3262.400	8.642	3013.000	7.981
i-Pentane	0.1180	72.150	0.085	0.005	4000.900	4.721	3698.000	4.364
n-Pentane	0.0870	72.150	0.063	0.004	4008.800	3.488	3708.000	3.226
Hexanes	0.0687	86.177	0.059	0.003	4756.200	3.268	4404.000	3.026
Heptanes	0.0737	100.204	0.074	0.004	5502.500	4.055	5100.000	3.759
Methylcyclohexane	0.0509	98.186	0.050	0.003	1865.455	0.880	1729.000	0.880
Octanes+	0.0550	114.231	0.063	0.004	6249.100	3.437	1695.970	0.933
2,2,4-TMP	0.0047	114.220	0.005	0.000	6368.594	0.081	1728.400	0.081
Nonanes	0.0305	128.258	0.039	0.002	6996.400	2.134		0.000
Decanes	0.0068	142.285	0.010	0.001	7743.200	0.527		0.000
Benzene	0.0211	78.120	0.016	0.001	3715.500	0.784		0.000
Toluene	0.0352	92.130	0.032	0.002	4444.600	1.564		0.000
Ethylbenzene	0.0012	106.160	0.001	0.000	5191.500	0.062		0.000
Xylenes	0.0157	106.160	0.017	0.001	5183.500	0.814		0.000
n-Hexane	0.0444	86.177	0.038	0.002	4756.200	2.112		0.000
Helium	0.0000	4.003	0.000	0.000	0.000	0.000	0.000	0.000
Nitrogen	0.1247	28.013	0.035	0.002	0.000	0.000	0.000	0.000
Carbon Dioxide	0.8165	44.010	0.359	0.020	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		17.85	1.00		1082.01		967.88

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

Weight Fraction = Net Mole Weight / Total Mole Weight

24. Central Compression

Assumptions:

Total Existing Compression: 6,615 Horsepower (Riverbend Facility)
Total New Compression: 18,200 Horsepower (Proposed Action)

Equations:

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

Pollutant	Emission Factor [6] (lb/MMBtu)	Emission Factor (g/hp-hr)	Emissions (lb/hr/engine) [7]	9,100 hp Station Emissions (tons/yr)	9,100 hp Station Emissions (tons/yr)	Total Emissions [8] Proposed Action (tons/yr)
Criteria Pollutants & VOC						
NOx [1]		1.0	2.20	87.9	87.9	176
CO [1,9]		0.1	0.22	8.8	8.8	18
VOC [1,10]		0.5	1.10	43.9	43.9	88
PM10 [2,3]	9.95E-03	0.037	0.08	3.3	3.3	6.5
PM2.5 [2,3]	9.95E-03	0.037	0.08	3.3	3.3	6.5
SO_2 [12]	5.88E-04	0.000	0.00	0.0	0.0	0.0
Hazardous Air Pollutants [10]						
Benzene [2]	4.40E-04	6.579E-04	1.45E-03	5.78E-02	5.78E-02	0.12
Toluene [2]	4.08E-04	6.100E-04	1.34E-03	5.36E-02	5.36E-02	0.11
Ethylbenzene [2]	3.97E-05	5.936E-05	1.31E-04	5.22E-03	5.22E-03	0.01
Xylenes [2]	1.84E-04	2.751E-04	6.07E-04	2.42E-02	2.42E-02	0.05
n-Hexane [2]	1.11E-03	1.660E-03	3.66E-03	1.46E-01	1.46E-01	0.29
Formaldehyde [2,11]	5.28E-02	1.974E-02	4.35E-02	1.73E+00	1.73E+00	3.5
Acetaldehyde [2]	8.36E-03	1.250E-02	2.76E-02	1.10E+00	1.10E+00	2.20
Acrolein [2,11]	5.14E-03	1.921E-03	4.24E-03	1.69E-01	1.69E-01	0.34
Methanol [2]	2.50E-03	3.738E-03	8.24E-03	3.28E-01	3.28E-01	0.66
1,1,2,2-Tetrachloroethane[2]	4.00E-05	5.981E-05	1.32E-04	5.26E-03	5.26E-03	0.01
1,1,2-Trichloroethane[2]	3.18E-05	4.755E-05	1.05E-04	4.18E-03	4.18E-03	0.01
1,3-Dichloropropene[2]	2.64E-05	3.947E-05	8.70E-05	3.47E-03	3.47E-03	0.01
1,3-Butadiene[2]	2.67E-04	3.992E-04	8.80E-04	3.51E-02	3.51E-02	0.07
2,2,4-Trimethylpentane[2]	2.50E-04	3.738E-04	8.24E-04	3.28E-02	3.28E-02	0.07
Biphenyl[2]	2.12E-04	3.170E-04	6.99E-04	2.79E-02	2.79E-02	0.06
Carbon Tetrachloride[2]	3.67E-05	5.487E-05	1.21E-04	4.82E-03	4.82E-03	0.01
Chlorobenzene[2]	3.04E-05	4.545E-05	1.00E-04	3.99E-03	3.99E-03	0.01
Chloroform[2]	2.85E-05	4.261E-05	9.39E-05	3.74E-03	3.74E-03	0.01
Ethylene Dibromide[2]	4.43E-05	6.624E-05	1.46E-04	5.82E-03	5.82E-03	0.01
Methylene Chloride[2]	2.00E-05	2.990E-05	6.59E-05	2.63E-03	2.63E-03	5.26E-03
Naphthalene[2]	7.44E-05	1.112E-04	2.45E-04	9.78E-03	9.78E-03	0.02
Phenol[2]	2.40E-05	3.588E-05	7.91E-05	3.15E-03	3.15E-03	6.31E-03
Styrene[2]	2.36E-05	3.529E-05	7.78E-05	3.10E-03	3.10E-03	6.20E-03
Tetrachloroethane[2]	2.48E-06	3.708E-06	8.17E-06	3.26E-04	3.26E-04	6.52E-04
Vinyl Chloride[2]	1.49E-05	2.228E-05	4.91E-05	1.96E-03	1.96E-03	3.92E-03
PAH -POM 1[2,4]	2.69E-05	4.022E-05	8.87E-05	3.53E-03	3.53E-03	0.01
POM 2[2,4,5]	5.93E-05	8.874E-05	1.96E-04	7.80E-03	7.80E-03	0.02
Benzo(b)fluoranthene/POM6[2,4]	1.66E-07	2.482E-07	5.47E-07	2.18E-05	2.18E-05	4.36E-05
Chrysene/POM7[2,4]	6.93E-07	1.036E-06	2.28E-06	9.11E-05	9.11E-05	1.82E-04
Greenhouse Gases						
CO2 [2]	110	411	906	42,333	42,333	84666
CH4 [2]	1.25	4.67	10.3	481	481	962

[1] - Currently permitted emission rates for internal combustion engine

[2] - AP-42 Table 3.2-2 Uncontrolled Emission Factors for 4-Stroke Lean-Burn Engines, 7/00

[3] - PM = sum of PM filterable and PM condensable

[4] - 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

[5] - POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

[6] - Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 8,240 Btu/hp-hr (*3.738)

[7] - Each individual engine estimated at 1,000 hp (Proposed Action)

[8] - Proposed Action Total Annual Emissions for New Compression (21,325 hp)

[9] - CO emission estimate reduced by 95% to reflect reduction by oxidation catalyst.

[10] - VOCs and HAPs emission estimates reduced by 60% to reflect reduction by oxidation catalyst.

[11] - Formaldehyde and acrolein emissions reduced by 90% to reflect reduction by oxidation catalyst.

[12] - Gas analysis indicates no sulfur compounds, see Central Gas Composition page.

25. Central TEG Dehydrator Emissions

Assumptions

Peak Field Production Rate: 200 MMscf/day
1298 Active Wells at Peak Production

Gas Composition: Inlet Gas Sample from Riverbend Compresor Station, dated 3/30/07

Inlet Gas Conditions: Inlet gas saturated at 820.0 psig and 86 F

Glycol Circulation Rate: 3.0 gallons/ lb of water
(Typical operating rate)

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

Flare > 95% Control Efficiency in order to meet Federal MACT Standards
Condenser Operating Conditions: 86 deg. F, 834.7 psia

Emissions

Species	Central Dehydrator Emissions 100MMscfd Station (tons/year)	Central Dehydrator Emissions 100MMscfd Station (tons/year)	Total Project Emissions (tons/year)
Total VOC	20.63	20.63	41.3
Hazardous Air Pollutants			
Benzene	2.33	2.33	4.66
Toluene	6.60	6.60	13.2
Ethylbenzene	0.34	0.34	0.67
Xylenes	6.67	6.67	13.3
n-Hexane	0.14	0.14	0.28
Total HAP Emissions	16.1	16.1	32.2
Greenhouse Gases			
CH_4	9.67	9.67	19.3

Each station throughput estimated according to the ratio of new compression proposed at each station and based on a peak field production rate of 194MMscfd

26. Central Facility Heater Emissions

Assumptions

Dehydrator Reboiler Heater	750	Mbtu/hr (Typical)
Separator Heater	500	Mbtu/hr (Based on current Riverbend equipment)
Total Heater Requirement Facility 1	5,000	Mbtu/hr (Proposed Action Estimate, 4-Dehydrator Reboiler Heaters, 4 separator heaters)
Total Heater Requirement Facility 2	5,000	Mbtu/hr (Proposed Action Estimate, 4-Dehydrator Reboiler Heaters, 4 separator heaters)
Firing Rate	45	minutes/hour on average for entire year (Typical value)
	8760	hours/year
Fuel Gas Heat Value	968	Btu/scf (Gas Analyses from Riverbend Facility)
Fuel Gas VOC Content	0.076	by weight (Gas Analyses from Riverbend Facility)

Equations

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

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

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

Species	Central Heater Emissions - Facility 1			Central Heater Emissions - Facility 2			
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr)	Total Emissions (tons/yr)	Emission Factor (lb/MMscf)	Well Emissions (lb/hr)	Total Emissions (tons/yr)	Total Emissions (tons/yr)
Criteria Pollutants & VOC							
NO_x [a]	100	0.500	2.190	100	0.500	2.190	4.380
CO [a]	84	0.420	1.840	84	0.420	1.840	3.679
TOC [c]	11	0.055	0.241	11	0.055	0.241	0.482
VOC	N.A.	0.004	0.018	N.A.	0.004	0.018	0.037
SO_x [b]	0.00	0.000	0.000	0.00	0.000	0.000	0.000
TSP [c]	7.6	0.038	0.166	7.6	0.038	0.166	0.333
PM_{10} [c]	7.6	0.038	0.166	7.6	0.038	0.166	0.333
$PM_{2.5}$ [c]	7.6	0.038	0.166	7.6	0.038	0.166	0.333
Hazardous Air Pollutants							
Benzene [d]	2.1E-03	1.1E-05	4.6E-05	2.1E-03	1.1E-05	4.6E-05	9.198E-05
Toluene [d]	3.4E-03	1.7E-05	7.4E-05	3.4E-03	1.7E-05	7.4E-05	1.489E-04
Hexane [d]	1.8E+00	9.0E-03	3.9E-02	1.8E+00	9.0E-03	3.9E-02	0.079
Formaldehyde [d]	7.5E-02	3.8E-04	1.6E-03	7.5E-02	3.8E-04	1.6E-03	0.003
Dichlorobenzene [d]	1.2E-03	6.0E-06	2.6E-05	1.2E-03	6.0E-06	2.6E-05	5.3E-05
Naphthalene [d]	6.1E-04	3.1E-06	1.3E-05	6.1E-04	3.1E-06	1.3E-05	2.7E-05
POM 2 [d,e,f]	5.9E-05	3.0E-07	1.3E-06	5.9E-05	3.0E-07	1.3E-06	2.6E-06
POM 3 [d,g]	1.6E-05	8.0E-08	3.5E-07	1.6E-05	8.0E-08	3.5E-07	7.0E-07
POM 4 [d,h]	1.8E-06	9.0E-09	3.9E-08	1.8E-06	9.0E-09	3.9E-08	7.9E-08
POM 5 [d,i]	2.4E-06	1.2E-08	5.3E-08	2.4E-06	1.2E-08	5.3E-08	1.1E-07
POM 6 [d,j]	7.2E-06	3.6E-08	1.6E-07	7.2E-06	3.6E-08	1.6E-07	3.2E-07
POM 7 [d,k]	1.8E-06	9.0E-09	3.9E-08	1.8E-06	9.0E-09	3.9E-08	7.9E-08
Greenhouse Gases							
CO_2 [c]	120,000	600.00	2,628.00	120,000	600.00	2,628.00	5256.000
CH_4 [c]	2.3	0.012	0.050	2.3	0.012	0.050	0.101

[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

[e] - 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/usata99.html

[f] - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and 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.

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

Assumptions:

Average Condensate Production Rate :

Facility 1	1.90	bbls condensate per day (Estimate based on Riverbend condensate production)
Facility 2	1.90	bbls condensate per day (Estimate based on Riverbend condensate production)

Separator Conditions : 130 psi and 60 F (Sample Conditions)
API Gravity: 58.28

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0
Riverbend Compressor Station Liquid Sample Dated 6/4/07
Controlled 95% efficiency

Emissions:

Component	Facility 1 Flash/Work/Breathing (tons/yr)	Facility 2 Flash/Work/Breathing (tons/yr)	Total Emissions (tons/yr)
Total VOC	0.034	0.034	0.07
Hazardous Air Pollutants			
Benzene	3.286E-04	3.286E-04	0.00
Toluene	5.437E-04	5.437E-04	0.00
Ethylbenzene	2.39E-05	2.39E-05	4.78E-05
Xylenes	1.912E-04	1.912E-04	3.82E-04
n-Hexane	8.664E-04	8.664E-04	0.00
Greenhouse Gases			
CO_2	0.007	0.007	0.01
CH_4	0.032	0.032	0.06

28. Central Facility Emission Summary

Central Facility 1

Pollutant	Central Compression Emissions 9,100 hp (tons/year)	Central Dehydrator Emissions 100 MMscfd (tons/year)	Central Heater Emissions 4,000 MBtu/hr (tons/year)	Central Condensate Tank Emissions 1.9 bbl/d (tons/year)	Central Dewpoint Skid Emissions (tons/year)	Total Facility Emissions (tons/year)
Criteria Pollutants & VOC						
NO_x	87.9		2.19			90
CO	8.8		1.84			10.6
VOC	43.9	20.6	0.02	0.03	9.0	74
SO_2	0.00		0.00			0.00
PM_{10}	3.27		0.17			3.43
$PM_{2.5}$	3.27		0.17			3.43
Hazardous Air Pollutants						
Benzene	0.06	2.33	4.60E-05	3.29E-04		2.39
Toluene	0.05	6.60	7.45E-05	5.44E-04		6.7
Ethylbenzene	0.01	0.34		2.39E-05		0.34
Xylene	0.02	6.67		1.91E-04		6.70
n-Hexane	0.15	0.14	0.04	8.66E-04		0.3
Formaldehyde	1.7		1.64E-03			1.7
Acetaldehyde	1.10					1.10
Acrolein	0.17					0.17
Methanol	0.33					0.33
1,1,2,2-Tetrachloroethane	0.01					0.01
1,1,2-Trichloroethane	0.00					0.00
1,3-Dichloropropene	0.00					0.00
1,3-Butadiene	0.04					0.04
2,2,4-Trimethylpentane	0.03					0.03
Biphenyl	0.03					0.03
Carbon Tetrachloride	0.00					0.00
Chlorobenzene	0.00					0.00
Chloroform	0.00					0.00
Dichlorobenzene			2.63E-05			2.63E-05
Ethylene Dibromide	0.01					0.01
Methylene Chloride	2.63E-03					2.63E-03
Naphthalene	0.01		1.34E-05			0.01
Phenol	3.15E-03					3.15E-03
Styrene	3.10E-03					3.10E-03
Tetrachloroethane	3.26E-04					3.26E-04
Vinyl Chloride	1.96E-03					1.96E-03
PAH -POM 1*	0.00					0.00
POM 2*	0.01		1.29E-06			0.01
POM 3*			3.50E-07			3.50E-07
POM 4*			3.94E-08			3.94E-08
POM 5*			5.26E-08			5.26E-08
Benzo(b)fluoranthene/POM6*	2.18E-05		1.58E-07			2.20E-05
Chrysene/POM7*	9.11E-05		3.94E-08			9.11E-05
Total HAPs	3.78	16.1	0.04	1.95E-03		18.1
Greenhouse Gases						
CO_2	42,333		2,628	0.01		44,961
CH_4	481	9.67	0.05	0.03		491

Central Facility 2

Pollutant	Central Compression Emissions 10,662 hp (tons/year)	Central Dehydrator Emissions 100 MMscfd (tons/year)	Central Heater Emissions 4,000 MBtu/hr (tons/year)	Central Condensate Tank Emissions 1.9 bbl/d (tons/year)	Central Dewpoint Skid Emissions (tons/year)	Total Facility Emissions (tons/year)
Criteria Pollutants & VOC						
NO_x	87.9		2.19			90
CO	8.8		1.84			11
VOC	43.9	20.6	0.02	0.03	9.0	74
SO_2	0.00		0.00			0.00
PM_{10}	3.27		0.17			3.43
$PM_{2.5}$	3.27		0.17			3.43
Hazardous Air Pollutants						
Benzene	0.06	2.3	4.60E-05	3.29E-04		2.39
Toluene	0.05	6.6	7.45E-05	5.44E-04		6.7
Ethylbenzene	0.01	0.3		2.39E-05		0.34
Xylene	0.02	6.7		1.91E-04		6.70
n-Hexane		0.1	0.04	8.66E-04		0.2
Formaldehyde	1.7		1.64E-03			1.7
Acetaldehyde	1.10					1.10
Acrolein	0.17					0.17
Methanol	0.33					0.33
1,1,2,2-Tetrachloroethane	0.01					0.01
1,1,2-Trichloroethane	0.00					0.00
1,3-Dichloropropene	0.00					0.00
1,3-Butadiene	0.04					0.04
2,2,4-Trimethylpentane	0.03					0.03
Biphenyl	0.03					0.03
Carbon Tetrachloride	0.00					0.00
Chlorobenzene	0.00					0.00
Chloroform	0.00					0.00
Dichlorobenzene			2.63E-05			2.63E-05
Ethylene Dibromide	0.01					0.01
Methylene Chloride	2.63E-03					2.63E-03
Naphthalene	0.01		1.34E-05			0.01
Phenol	3.15E-03					3.15E-03
Styrene	3.10E-03					3.10E-03
Tetrachloroethane	3.26E-04					3.26E-04
Vinyl Chloride	1.96E-03					1.96E-03
PAH -POM 1*	0.00					0.00
POM 2*	0.01		1.29E-06			0.01
POM 3*			3.50E-07			3.50E-07
POM 4*			3.94E-08			3.94E-08
POM 5*			5.26E-08			5.26E-08
Benzo(b)fluoranthene/POM6*	2.18E-05		1.58E-07			2.20E-05
Chrysene/POM7*	9.11E-05		3.94E-08			9.11E-05
Total HAPs	3.6	16.1	0.04	1.95E-03		18.0
Greenhouse Gases						
CO_2	42333		2,628	0.01		44,961
CH_4	481	9.67	0.05	0.03		491

Buys & Associates, Inc.

Environmental Consultants

Project: GASCO Alternative F - w/ Voluntary ACEPMS
Date: 6/11/2011

29. Evaporation Facility

Assumptions:

Total New Generation: 1,080 Horsepower (Proposed Action)

Evaporation Emissions conservatively estimated using mass balance -methanol designated as a VOC

Equations:

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

Pollutant	Engine Emission Factor [6] (lb/MMBtu)	Engine Emission Factor (g/hp-hr) [1]	Engine Emissions (lb/hr) [1]	Engine Emissions (tons/yr)	Evaporation Emissions (tons/yr) [7]	Total Evaporation Facility Emissions (tons/yr)
Criteria Pollutants & VOC						
NOx		1.0	2.38	10.4		10.4
CO		2.0	4.76	20.9		20.9
VOC		1.0	2.38	10.4	466.7	477.1
PM10 [2,3]	9.95E-03	0.036	0.09	0.38		0.4
PM2.5 [2,3]	9.95E-03	0.036	0.09	0.38		0.4
SO_2	5.88E-04	0.002	0.01	0.02		0.02
Hazardous Air Pollutants						
Benzene [2]	4.40E-04	1.598E-03	3.80E-03	1.67E-02	2.9	2.9
Toluene [2]	4.08E-04	1.482E-03	3.53E-03	1.55E-02	6.9	6.9
Ethylbenzene [2]	3.97E-05	1.442E-04	3.43E-04	1.50E-03	1.0	1.00
Xylenes [2]	1.84E-04	6.683E-04	1.59E-03	6.97E-03	14.5	14.51
n-Hexane [2]	1.11E-03	4.032E-03	9.60E-03	4.20E-02		4.20E-02
Formaldehyde [2]	5.28E-02	1.918E-01	4.57E-01	2.00E+00		2.00E+00
Acetaldehyde [2]	8.36E-03	0.03	7.23E-02	3.17E-01		3.17E-01
Acrolein [2]	5.14E-03	0.02	4.44E-02	1.95E-01		1.95E-01
Methanol [2]	2.50E-03	9.080E-03	2.16E-02	9.47E-02	421.4	421.5
1,1,2,2-Tetrachloroethane [2]	4.00E-05	1.453E-04	3.46E-04	1.52E-03		1.52E-03
1,1,2-Trichloroethane [2]	3.18E-05	1.155E-04	2.75E-04	1.20E-03		1.20E-03
1,3-Dichloropropene [2]	2.64E-05	9.588E-05	2.28E-04	1.00E-03		1.00E-03
1,3-Butadiene [2]	2.67E-04	9.697E-04	2.31E-03	1.01E-02		1.01E-02
2,2,4-Trimethylpentane [2]	2.50E-04	9.080E-04	2.16E-03	9.47E-03		9.47E-03
Biphenyl [2]	2.12E-04	7.700E-04	1.83E-03	8.03E-03		8.03E-03
Carbon Tetrachloride [2]	3.67E-05	1.333E-04	3.17E-04	1.39E-03		1.39E-03
Chlorobenzene [2]	3.04E-05	1.104E-04	2.63E-04	1.15E-03		1.15E-03
Chloroform [2]	2.85E-05	1.035E-04	2.46E-04	1.08E-03		1.08E-03
Ethylene Dibromide [2]	4.43E-05	1.609E-04	3.83E-04	1.68E-03		1.68E-03
Methylene Chloride [2]	2.00E-05	7.264E-05	1.73E-04	7.58E-04		7.58E-04
Naphthalene [2]	7.44E-05	2.702E-04	6.43E-04	2.82E-03		2.82E-03
Phenol [2]	2.40E-05	8.717E-05	2.08E-04	9.09E-04		9.09E-04
Styrene [2]	2.36E-05	8.572E-05	2.04E-04	8.94E-04		8.94E-04
Tetrachloroethane [2]	2.48E-06	9.007E-06	2.14E-05	9.39E-05		9.39E-05
Vinyl Chloride [2]	1.49E-05	5.412E-05	1.29E-04	5.64E-04		5.64E-04
PAH -POM 1 [2,4]	2.69E-05	9.770E-05	2.33E-04	1.02E-03		1.02E-03
POM 2 [2,4,5]	5.93E-05	2.156E-04	5.13E-04	2.25E-03		2.25E-03
Benzo(b)fluoranthene/POM6 [2,4]	1.66E-07	6.029E-07	1.44E-06	6.29E-06		6.29E-06
Chrysene/POM7 [2,4]	6.93E-07	2.517E-06	5.99E-06	2.62E-05		2.62E-05
Greenhouse Gases						
CO2 [2]	110	399.52	951.24	4166.5		4166.5
CH4 [2]	1.25	4.54000	10.81	47.3		47.3

[1] - Currently permitted emission rates for internal combustion engine

[2] - AP-42 Table 3.2-2 Uncontrolled Emission Factors for 4-Stroke Lean-Burn Engines, 7/00

[3] - PM = sum of PM filterable and PM condensable

[4] - 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

[5] - POM 2 includes: Acenaphthene, acenaphtylene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

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

[7] - BTEX emissions controlled by a minimum of 60 %

29. Total Project Production Related Emissions Summary

Pollutant	Well Production Emissions (tons/year)	Central Facility 1 Emissions (tons/year)	Central Facility 2 Emissions (tons/year)	Evaporation Facility Emissions (tons/year)	Total Production Emissions [h] (tons/year)
Criteria Pollutants & VOC					
NO_x	316	90	90	10.4	506
CO	337	11	11	20.9	380
VOC	1,245	74	74	477.1	1,869
SO_2	1.02	0.00	0.00	0.02	1.05
PM_{10}	2,881	3.43	3.43	0.38	2,888
$PM_{2.5}$	312	3.43	3.43	0.38	319
Hazardous Air Pollutants					
Benzene	9.3	2.39	2.39	2.92	17
Toluene	15.1	6.7	6.7	6.92	35
Ethylbenzene	0.72	0.34	0.34	1.00E+00	2.40
Xylene	5.0	6.70	6.70	14.51	32.9
n-Hexane	29.0	0.3	0.2	0.04	30
Formaldehyde	0.22	1.7	1.7	2.00	5.7
Acetaldehyde	0	1.10	1.10	0.32	2.51
Acrolein	0	0.17	0.17	0.19	0.53
Methanol	0	0.33	0.33	421.49	422.15
1,1,2,2-Tetrachloroethane	0	5.26E-03	5.26E-03	1.52E-03	0.01
1,1,2-Trichloroethane	0	4.18E-03	4.18E-03	1.20E-03	0.01
1,3-Dichloropropene	0	3.47E-03	3.47E-03	1.00E-03	0.01
1,3-Butadiene	0	0.04	0.04	0.01	0.08
2,2,4-Trimethylpentane	0	0.03	0.03	0.01	0.08
Biphenyl	0	0.03	0.03	0.01	0.06
Carbon Tetrachloride	0	4.82E-03	4.82E-03	1.39E-03	0.01
Chlorobenzene	0	3.99E-03	3.99E-03	1.15E-03	0.01
Chloroform	0	3.74E-03	3.74E-03	1.08E-03	0.01
Dichlorobenzene	3.52E-03	2.63E-05	2.63E-05	0	0
Ethylene Dibromide	0	5.82E-03	5.82E-03	1.68E-03	0.01
Methylene Chloride	0	2.63E-03	2.63E-03	7.58E-04	0.01
Naphthalene	1.79E-03	0.01	0.01	2.82E-03	0.02
Phenol	0	3.15E-03	3.15E-03	9.09E-04	0.01
Styrene	0	3.10E-03	3.10E-03	8.94E-04	0.01
Tetrachloroethane	0	3.26E-04	3.26E-04	9.39E-05	0
Vinyl Chloride	0	1.96E-03	1.96E-03	5.64E-04	0.00
PAH -POM 1[a]	0	3.53E-03	3.53E-03	1.02E-03	0.01
POM 2[b]	1.73E-04	0.01	0.01	2.25E-03	0.02
POM 3[c]	4.70E-05	3.50E-07	3.50E-07	0	5.E-05
POM 4[d]	5.29E-06	3.94E-08	3.94E-08	0	5.E-06
POM 5[e]	7.05E-06	5.26E-08	5.26E-08	0	7.E-06
Benzo(b)fluoranthene/POM6[f]	2.11E-05	2.20E-05	2.20E-05	6.29E-06	7.E-05
Chrysene/POM7[g]	5.29E-06	9.11E-05	9.11E-05	2.62E-05	2.E-04
Total HAPs	59	19.9	19.8	449.43	549
Greenhouse Gases					
CO_2	352,622	44,961	44,961	4,167	446,711
CH_4	4,236	491	491	47.3	5,265

a Polycyclic Aromatic Hydrocarbons (PAH), Polycyclic Organic Matter (POM)

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

[c] - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[d] - POM 4 includes: 3-Methylchloranthrene.

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

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

[g] - POM 7 includes: Chrysene.

h Emissions for Peak Field Development

31. Total Project Emissions Summary

Pollutant	Project Emissions (tons/year)						Total Emissions [i] (tons/year)
	Construction	Drilling	Completion	Interim Reclamation	Wind Erosion	Project Production	
Criteria Pollutants & VOC							
NO_x	24.1	528	104	0.27	0	506	1,162
CO	11.1	339	81	2.16	0	380	813
VOC	1.95	43.9	57.4	0.15	0	1,869	1,972
SO_2	0.70	20.3	2.31	0.02	0	1.05	24
PM_{10}	109.9	1,842	2,081	31.8	1.39	2,888	6,955
$PM_{2.5}$	13.7	200	210	3.42	0.55	319	747
Hazardous Air Pollutants							
Benzene	0	0.10	0.53	0	0	17.0	18
Toluene	0	0.03	1.03	0	0	35.3	36
Ethylbenzene	0	0	0.04	0	0	2.4	2.4
Xylene	0	0.02	0.53	0	0	32.9	33
n-Hexane	0	0	1.21	0	0	30	31
Formaldehyde	0.55	0.01	7.27E-04	0	0	5.7	6
Acetaldehyde	0	3.09E-03	2.46E-04	0	0	2.51	2.5
Acrolein	0	9.67E-04	7.18E-05	0	0	0.53	0.5
Methanol	0	0	0	0	0	422.15	422.2
1,1,2,2-Tetrachloroethane	0	0	0	0	0	0.01	1.E-02
1,1,2-Trichloroethane	0	0	0	0	0	0.01	1.E-02
1,3-Dichloropropene	0	0	0	0	0	0.01	8.E-03
1,3-Butadiene	0	0	1.34E-06	0	0	0.08	0.1
2,2,4-Trimethylpentane	0	0	0	0	0	0.08	0.1
Biphenyl	0	0	0	0	0	0.06	0.1
Carbon Tetrachloride	0	0	0	0	0	0.01	1.E-02
Chlorobenzene	0	0	0	0	0	0.01	9.E-03
Chloroform	0	0	0	0	0	0.01	9.E-03
Dichlorobenzene	0	0	0	0	0	3.58E-03	4.E-03
Ethylene Dibromide	0	0	0	0	0	0.01	1.E-02
Methylene Chloride	0	0	0	0	0	0.01	6.E-03
Naphthalene	0	0.02	1.13E-03	0	0	0.02	4.E-02
Phenol	0	0	0	0	0	0.01	7.E-03
Styrene	0	0	0	0	0	0.01	7.E-03
Tetrachloroethane	0	0	0	0	0	7.46E-04	7.E-04
Vinyl Chloride	0	0	0	0	0	4.48E-03	4.E-03
PAH -POM 1[a]	0	0.03	1.85E-03	0	0	0.01	4.E-02
POM 2[b]	0	0	0	0	0	0.02	2.E-02
POM 3[c]	0	0	0	0	0	4.77E-05	5.E-05
POM 4[d]	0	0	0	0	0	5.37E-06	5.E-06
POM 5[e]	0	0	0	0	0	7.15E-06	4.E-02
Benzo(b)fluoranthene/POM6[f]	0	0	0	0	0	7.14E-05	7.E-05
Chrysene/POM7[g]	0	0	0	0	0	2.14E-04	2.E-04
Total HAPs	0.59	0.21	3.34	0	0	549	553
Greenhouse Gases							
CO_2	0	55,958	7,912	0	0	446,711	510,581
CH_4	0.04	34.6	481.9	0.0	0.0	5,265	5,782

[a] 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.

[b] - POM 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

[c] - POM 2 includes: Acenaphthene, acenaphtylene, anthracene, 2-Methylnaphthalene, benzo(e)pyrene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene, and pyrene.

[d] - POM 3 includes: 7,12-Dimethylbenz(a)anthracene.

[e] - POM 4 includes: 3-Methylchloranthrene.

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

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

[b] - POM 7 includes: Chrysene.

[i] Emissions for Peak Field Development