APPENDIX F-1

Emissions Inventories for Alternative A

Kleinfelder/Buys	Project: XTO RBU, Alternative A Date: 5/3/2011

1. Road Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Estimate)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98 & 7/98

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

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content }\%)^{1.5} * (\text{soil moisture content }\%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			**Backhoe Emissions** [a]			**Total**
	lbs/hr	**tons/well pad**	**tons/yr** [b]	**lbs/hr**	**tons/well pad**	**tons/yr** [b]	**tons/yr** [b]
TSP	1.97	0.0296	0.61	1.97	0.0099	0.20	0.82
PM_{15}	0.50	0.0075	0.16	0.50	0.0025	0.05	0.21
PM_{10}	0.38	0.0056	0.12	0.19	0.0009	0.02	0.14
$PM_{2.5}$	0.21	0.0031	0.06	0.10	0.0005	0.01	0.07

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

b Assumes maximum development scenario

2. Road Construction Emissions (Grader)

Assumptions:

Grading Length	0.64	miles (0.212 miles/pad x 3 swaths (10' per swath))
Hours of Construction	1	day grading per well pad and road (Estimate)
	10	hours/day
	10	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	0.64	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

Emissions = 1.71 lbs TSP/well pad

Emissions = 0.82 lbs PM_{15}/well pad

	Grader Construction Emissions			
	lbs/well pad	lbs/hr/well pad	tons/well pad	tons/yr [a]
TSP	1.71	0.17	8.55E-04	1.77E-02
PM_{15}	0.82	0.08	4.09E-04	8.47E-03
PM_{10}	0.49	0.05	2.45E-04	5.08E-03
$PM_{2.5}$	0.05	0.01	2.65E-05	5.49E-04

a Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative A Date: 5/3/2011

3. Well Pad Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Proposed Action)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

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 (PM_{15} 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 PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			**Backhoe Emissions** [a]			**Total**
	lbs/hr	**tons/well pad**	**tons/yr** [b]	**lbs/hr**	**tons/well pad**	**tons/yr** [b]	**tons/yr** [b]
TSP	1.97	0.0296	0.61	1.97	0.0099	0.20	0.82
PM_{15}	0.50	0.0075	0.16	0.50	0.0025	0.05	0.21
PM_{10}	0.38	0.0056	0.12	0.38	0.0019	0.04	0.16
$PM_{2.5}$	0.21	0.0031	0.06	0.21	0.0010	0.02	0.09

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

b Assumes maximum development scenario

4. Well Pad Construction Emissions (Grader)

Assumptions:

Grading Length	2.06	miles on 330 ft x 330 ft pad (10 ft swath for 330 ft * 33 lengths)
Hours of Construction	2	day grading per well pad and road (Estimate)
	10	hours/day
	20	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	2.06	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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 (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions = 5.54 lbs TSP/well pad

Emissions = 2.65 lbs PM_{15}/well pad

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/yr [a]**
TSP	5.54	0.28	0.0028	0.06
PM_{15}	2.65	0.13	0.0013	0.03
PM_{10}	1.59	0.08	0.0008	0.02
$PM_{2.5}$	0.17	0.01	0.0001	0.002

a Assumes maximum development scenario

5. New Compressor Station Construction Emissions

Assumptions and Calculations:

All assumptions emission factors, and calculations are the same as those specified in Road Construction Equipment, Road Construction Grader, Well Pad Construction Equipment and Well Pad Grader emissions inventory pages.

Assumes the development of a single additional compressor station with attached roadway

Compressor Station Road Construction Equipment

Pollutant	Dozer Emissions [a]		Backhoe Emissions [a]		Total
	lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr [b]
TSP	1.97	0.030	1.97	0.010	0.039
PM_{15}	0.50	0.008	0.50	0.003	0.010
PM_{10}	0.38	0.006	0.19	0.001	0.007
$PM_{2.5}$	0.21	0.003	0.10	0.001	0.004

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

Compressor Station Road Construction Grader

Pollutant	Grader Construction Emissions		
	lbs/well pad	lbs/hr	tons/yr
TSP	1.71	0.171	8.55E-05
PM_{15}	0.82	0.082	4.09E-05
PM_{10}	0.49	0.049	2.45E-05
$PM_{2.5}$	0.05	0.005	2.65E-06

Compressor Station Construction Equipment

Pollutant	Dozer Emissions [a]		Backhoe Emissions [a]		Total
	lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr [b]
TSP	1.97	0.030	1.97	0.010	0.039
PM_{15}	0.50	0.008	0.50	0.003	0.010
PM_{10}	0.38	0.006	0.38	0.002	0.008
$PM_{2.5}$	0.21	0.003	0.21	0.001	0.004

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

Compressor Station Grader

Pollutant	Grader Construction Emissions		
	lbs/well	lbs/hr	tons/yr
TSP	5.54	0.277	1.39E-04
PM_{15}	2.65	0.133	6.63E-05
PM_{10}	1.59	0.080	3.98E-05
$PM_{2.5}$	0.17	0.009	4.29E-06

Total Compressor Station Construction Emissions

Pollutant	tons/yr
TSP	**0.0790**
PM_{15}	**0.0202**
PM_{10}	**0.0142**
$PM_{2.5}$	**0.0078**

6. Pipeline Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Proposed Action)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

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

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			**Backhoe Emissions [a]**			**Total**
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.0296	0.61	1.97	0.0099	0.20	0.82
PM_{15}	0.50	0.0075	0.16	0.50	0.0025	0.05	0.21
PM_{10}	0.38	0.0056	0.12	0.19	0.0009	0.02	0.14
$PM_{2.5}$	0.21	0.0031	0.06	0.10	0.0005	0.01	0.07

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

b Assumes maximum development scenario

7. Pipeline Construction Emissions (Grader)

Assumptions:

Grading Length	5.50	miles pipeline per pad x 3 (3 10' swaths)
Hours of Construction	3	day grading per well pad and road (Estimate)
	10	hours/day
	30	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	5.50	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

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

Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

Emissions = 14.78 lbs TSP/well

Emissions = 7.07 lbs PM_{15}/well

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/yr [a]**
TSP	14.78	0.49	0.0074	0.15
PM_{15}	7.07	0.24	0.0035	0.07
PM_{10}	4.24	0.14	0.0021	0.04
$PM_{2.5}$	0.46	0.02	0.0002	0.005

a Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative A Date: 5/3/2011

8. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365\text{-}p)/365)$

$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365\text{-}p)/365)$

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Calculation AP-42, Chapter 13.2.1
November 2006

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	82	From Vernal
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Construction (days/pad and road)

	Vehicle Type	Average Weight (lbs)	Round Trips per Well Pad	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
Hours per day 10								
Days per pad 9								
	Semi: Hvy Equip Hauler	60,000	3					
	Haul Trucks: Equipment/Fuel/Water	48,000	5					
	Pickup Truck: Crew	7,000	10					
	Mean Vehicle Weight	27,040	18	1.90	745.3	82.8	74.5	8.3
					Unpaved Roads $PM_{10/15}$ Pads (tons)		**Unpaved Roads $PM_{2.5/15}$ Pads (tons)**	
					7.7		0.8	
			Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
				0.067	98.6	11.0	9.9	1.1
					Paved Roads $PM_{10/15}$ Pads (tons)		**Paved Roads $PM_{2.5/15}$ Pads (tons)**	
					1.02		0.10	

Vertical Drilling (days/well)

	Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Hours per day 10								
Days per well 14								
	Semi: Hvy Equip Hauler	60,000	60					
	Haul Trucks: Equipment/Fuel/Water	48,000	65					
	Pickup Truck: Rig Crew	7,000	88					
	Mean Vehicle Weight	38,103	213	2.22	10,381	741	1,038	74.1
					Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
					73.8		7.4	
			Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
				0.113	165.4	11.8	16.5	1.2
					Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
					1.18		0.12	

Directional Drilling (days/well)

	Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Hours per day 10								
Days per well 21								
	Semi: Hvy Equip Hauler	60,000	60					
	Haul Trucks: Equipment/Fuel/Water	48,000	65					
	Pickup Truck: Rig Crew	7,000	88					
	Mean Vehicle Weight	38,103	213	2.22	10,381	494.3	1,038	49.4
					Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
					408.9		40.9	
			Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
				0.113	165.4	7.9	16.5	0.8
					Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
					6.51		0.65	

Kleinfelder/Buys	Project: XTO RBU, Alternative A Date: 5/3/2011

8. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Calculation AP-42, Chapter 13.2.1
November 2006

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	82	From Vernal
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Completion (days/well)

Hours per day 10
Days per pad 10

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Pickup: Completion Rig Crew	7,000	11					
Haul Trucks: Equipment/Fuel/Water	48,000	73					
Mean Vehicle Weight	42,631	84	2.33	4,306	430.6	430.6	43.1
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				200.2		20.0	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.134	195.8	19.6	19.6	2.0
				Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
				9.11		0.91	

Interim Reclamation (days/well)

Hours per day 10
Days per pad 2

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Day (lbs)	PM_{10}/Day (lb/day)	$PM_{2.5}$/Day (lbs)	$PM_{2.5}$/Day (lb/day)
Pickup: Crew	7,000	4					
Haul Trucks: Equipment	60,000	1					
Mean Vehicle Weight	17,600	5	1.56	172.1	86.1	17.2	8.6
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				1.2		0.1	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.035	51.5	25.7	5.1	2.6
				Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
				0.37		0.04	

Annual Traffic Fugitive Dust Emissions (tons/year)

Unpaved Roads PM_{10} (tons)	**Unpaved Roads $PM_{2.5}$ (tons)**
692	**69.2**
Paved Roads PM_{10} (tons)	**Paved Roads $PM_{2.5}$ (tons)**
18.18	**1.82**

Kleinfelder/Buys	Project: XTO RBU, Alternative A Date: 5/3/2011

9. 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	672	acres total initial disturbance for roads and pipelines (Proposed Action)
	2,719,483	square meters total initial disturbance for roads and pipelines
	395	acres total initial disturbance for well pads (Proposed Action)
	1,598,506	square meters total initial disturbance for well pads
	1,067	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	0.18	for well pads (Assumption, disturbance at construction and reclamation) constant for dirt roads
Development Period	8	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 µm	**<10 µm**	**<2.5 µm**
1.0	0.5	0.075

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	5.12E-02	0.00E+00
PM_{10}	2.56E-02	0.00E+00
$PM_{2.5}$	3.84E-03	0.00E+00

Kleinfelder/Buys	Project: XTO RBU, Alternative A Date: 5/3/2011

10. Construction Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Construction	90	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	8	(Proponent)
Number of Pickup Trips	10	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.162	0.007	3.23	0.082	0.004	0.245	0.228
CO	17.49	0.349	0.016	36.84	0.939	0.042	1.288	1.201
VOC [c]	4.83	0.097	0.004	2.29	0.058	0.003	0.155	0.144
SO_2	0.32	6.42E-03	2.89E-04	0.21	5.45E-03	2.45E-04	1.19E-02	1.11E-02
CH_4 [e, f]	0.23	4.60E-03	2.07E-04	0.18	4.69E-03	2.11E-04	9.28E-03	8.65E-03

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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11. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Hours of Operation	90	hours/site (Proposed Action)
Development Rate	21	new pads per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Backhoe miles per pad	0.515	miles (Value assumed to be 1/4 of dozer and grader mileage)
Backhoe Hours	30	hours per pad
Dozer miles per pad	2.06	miles (Based on 330 ft x 330 ft pad and 10 ft swath for 330 ft * 33 lengths)
Dozer Hours	90	hours per pad
Grader miles per pad	2.06	miles (Based on 330 ft x 330 ft pad and 10 ft swath for 330 ft * 33 lengths)
Motor Grader Hours	60	hours per pad

Equations:

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

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)
NOx	8.13	1.23E-04	1.85E-06	8.13	1.64E-04	7.38E-06	8.13	2.46E-04	7.38E-06
CO	17.49	2.65E-04	3.97E-06	17.49	3.53E-04	1.59E-05	17.49	5.30E-04	1.59E-05
VOC [b]	4.83	7.31E-05	1.10E-06	4.83	9.75E-05	4.39E-06	4.83	1.46E-04	4.39E-06
CH_4	0.23	3.48E-06	5.22E-08	0.23	4.64E-06	2.09E-07	0.23	6.96E-06	2.09E-07

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [c] (tons/yr)
NOx	5.33E-04	3.44E-04
CO	1.15E-03	7.40E-04
VOC [d]	3.17E-04	2.04E-04
CH_4	1.51E-05	1.88E-07

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario
d AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle

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12. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	453	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	125	(Proponent)
Number of Pickup Trips	88	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.515	0.117	3.23	0.144	0.033	0.658	13.9
CO	17.5	1.107	0.251	36.8	1.64	0.372	2.75	57.9
VOC [c]	4.83	0.306	0.069	2.29	0.102	0.023	0.408	8.59
SO_2	0.321	2.03E-02	4.60E-03	0.214	9.54E-03	2.16E-03	2.99E-02	0.629
CH_4 [e, f]	0.230	1.46E-02	3.30E-03	0.180	8.02E-03	1.82E-03	2.26E-02	0.475

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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13. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	100	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	73	(Proponent)
Number of Pickup Trips	11	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	1.361	0.068	3.23	0.081	0.004	1.442	6.706
CO	17.49	2.927	0.146	36.84	0.929	0.046	3.856	17.933
VOC [c]	4.83	0.808	0.040	2.29	0.058	0.003	0.866	4.028
SO_2	0.32	5.38E-02	2.69E-03	0.21	5.40E-03	2.70E-04	5.92E-02	0.275
CH_4 [e, f]	0.23	3.85E-02	1.92E-03	0.18	4.54E-03	2.27E-04	4.30E-02	0.200

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

Kleinfelder/Buys

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Date: 5/3/2011

14. Reclamation Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	20	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	1	(Assumption)
Number of Pickup Trips	4	(Assumption)
Diesel Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.093	0.001	3.23	0.148	0.001	0.241	0.034
CO	17.49	0.201	0.002	36.84	1.689	0.017	1.890	0.269
VOC [c]	4.83	0.055	0.001	2.29	0.105	0.001	0.160	0.023
SO_2	0.32	3.68E-03	3.68E-05	0.21	9.82E-03	9.82E-05	1.35E-02	1.92E-03
CH_4 [e, f]	0.23	2.64E-03	2.64E-05	0.18	8.25E-03	8.25E-05	1.09E-02	1.55E-03

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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15. Drill Rig Engine Emissions

Assumptions:

Hours of Operation	453	hours/well (Proposed Action)
Development Rate	93	wells per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Phase I engine	2,000	hp (used 14% of drilling duration)
Phase II engine	2,000	hp (used 86% of drilling duration)
Diesel Fuel Sulfur Content	0.0005	percent (EPA standard value)

Equations:

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7500 Average BTU/hp-hr / 1,000,000

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

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

Species	Drill Rig Emissions (Tier 0 Engines) E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [g] (tons/yr)
Criteria Pollutants & VOC			
NOx [b]	0.024	19.20	404
CO [b]	5.50E-03	4.40	93
VOC [b]	7.05E-04	0.56	11.9
PM_{10} [b]	4.30E-04	0.34	7.24
$PM_{2.5}$ [b]	3.59E-04	0.29	6.05
SO_2 [b]	4.05E-06	3.24E-03	6.81E-02
Hazardous Air Pollutants			
Benzene [d]	5.82E-06	4.66E-03	9.80E-02
Toluene [d]	2.11E-06	1.69E-03	3.55E-02
Xylenes [d]	1.45E-06	1.16E-03	2.44E-02
Formaldehyde [d]	5.92E-07	4.73E-04	9.97E-03
Acetaldehyde [d]	1.89E-07	1.51E-04	3.18E-03
Acrolein [d]	5.91E-08	4.73E-05	9.96E-04
Naphthalene [e]	9.75E-07	7.80E-04	1.64E-02
Total PAH [e, f]	1.59E-06	1.27E-03	2.68E-02
Greenhouse Gases			
CO_2 [b]	1.16	928	19,541
CH_4 [b, c]	7.05E-04	0.56	11.9

Species	Drill Rig Emissions (Tier II Engines) E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [g] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.01058	8.46	178
CO [a]	5.70E-03	4.56	96
VOC [a]	2.20E-03	1.76	37.1
PM_{10} [a]	3.30E-04	0.26	5.56
$PM_{2.5}$ [b]	3.30E-04	0.26	5.56
SO_2 [b]	4.05E-06	3.24E-03	6.81E-02
Hazardous Air Pollutants			
Benzene [d]	5.82E-06	4.66E-03	9.80E-02
Toluene [d]	2.11E-06	1.69E-03	3.55E-02
Xylenes [d]	1.45E-06	1.16E-03	2.44E-02
Formaldehyde [d]	5.92E-07	4.73E-04	9.97E-03
Acetaldehyde [d]	1.89E-07	1.51E-04	3.18E-03
Acrolein [d]	5.91E-08	4.73E-05	9.96E-04
Naphthalene [e]	9.75E-07	7.80E-04	1.64E-02
Total PAH [e, f]	1.59E-06	1.27E-03	2.68E-02
Greenhouse Gases			
CO_2 [b]	1.16	928	19,541
CH_4 [b, e]	7.05E-04	0.56	11.9

Note: The change from Tier 0 to Tier II engines results in emission changes of:

NOx	**-226**	ton/yr
CO	**3**	ton/yr
VOC	**25.2**	ton/yr
PM_{10}	**-1.68**	ton/yr
$PM_{2.5}$	**-0.49**	ton/yr

[a] Emission factors for Tier II nonroad diesel engine emission standards (engines => 750 hp) from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier II emission standards are not set for VOC (listed as Hydrocarbons), so the Tier I Standard is used
note - Tier II or Tier I emission standards are not set for $PM_{2.5}$, so the Tier 0 (AP-42) emission factor is used

[b] AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96
note - VOC emission factor represents total Hydrocarbon Emissions

[c] CH_4 Emission Factor listed in notes of AP-42 Table 3.4-1 as 9% of Total Organic Compounds

[d] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

[e] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

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

[g] Assumes maximum development scenario

16. Well Fracturing Pump and Generator Engines

Assumptions:

Average Hours of Operation	4	Hours/Well (Proponents)
Development Rate	93	wells per year (Proposed Action)
Load Factor	0.85	(Proponents)
Frac Pump Engine Horsepower	5,000	Horsepower (1@5000 hp)
Temporary Generator Horsepower	75	Horsepower (Proponents)
Diesel Fuel Sulfur Content	0.0005	percent (typical value)

Equations:

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7500 Average BTU/hp-hr / 1,000,000

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

SO_2 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	102.000	18.97
CO [a]	5.50E-03	23.375	4.35
VOC [a,b]	7.05E-04	2.996	0.56
PM_{10} [a,c]	4.30E-04	1.8264	0.3397
$PM_{2.5}$ [a,d]	3.59E-04	1.5268	0.2840
SO_2 [a]	4.05E-06	0.017	0.003
Hazardous Air Pollutants			
Benzene [e]	5.82E-06	2.47E-02	4.60E-03
Toluene [e]	2.11E-06	8.96E-03	1.67E-03
Xylenes [e]	1.45E-06	6.15E-03	1.14E-03
Formaldehyde [e]	5.92E-07	2.51E-03	4.68E-04
Acetaldehyde [e]	1.89E-07	8.03E-04	1.49E-04
Acrolein [e]	5.91E-08	2.51E-04	4.67E-05
Naphthalene [f]	9.75E-07	4.14E-03	7.71E-04
Total PAH [f]	1.59E-06	6.76E-03	1.26E-03
Greenhouse Gases			
CO_2 [a]	1.16	4,930	917
CH_4 [a]	7.05E-04	2.996	0.557

Species	Generator Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants & VOC			
NOx [g]	0.031	1.976	0.37
CO [g]	6.68E-03	0.43	0.08
VOC [b,g]	2.47E-03	0.16	0.03
PM_{10} [g]	2.20E-03	0.14	0.03
$PM_{2.5}$ [g]	2.20E-03	0.14	0.03
SO_2 [g]	2.05E-03	0.13	0.02
Hazardous Air Pollutants			
Benzene [h]	7.00E-06	4.46E-04	8.30E-05
Toluene [h]	3.07E-06	1.96E-04	3.64E-05
Xylenes [h]	2.14E-06	1.36E-04	2.53E-05
Formaldehyde [h]	8.85E-06	5.64E-04	1.05E-04
Acetaldehyde [h]	5.75E-06	3.67E-04	6.82E-05
Acrolein [h]	6.94E-07	4.42E-05	8.23E-06
1,3-Butadiene [h]	2.93E-07	1.87E-05	3.48E-06
Naphthalene [h]	6.36E-07	4.05E-05	7.54E-06
Total PAH [h]	1.26E-06	8.03E-05	1.49E-05
Greenhouse Gases			
CO_2 [g]	1.15	73.3	13.6
CH_4 [b,g]	2.47E-03	0.157	0.03

[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, Total PM_{10} fraction determined from Table 3.4-2
[d] Total particulate emission factor is 0.0007, $PM_{2.5}$ fraction determined from Table 3.4-2
[e] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, 10/96
[f] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, 10/96
[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, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, 10/96
[i] Assumes maximum development scenario

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17. Average Produced Gas Characteristics
RBU Compressor Station
Average of 9-17E, West Willow Creek, Tap 1, Tap 4 and Tap 5 facility inlet gases

Gas Heat Value (wet): 1103.4 Btu/scf

C1-C2 Wt. Fraction:	0.8739
VOC Wt. Fraction:	0.1118
Non-HC Wt. Fraction:	0.0143
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	89.8	16.0	14.4	0.78	1,010	907	910	817
Ethane	5.70	30.1	1.71	0.09	1,770	101	1,618	92.3
Propane	2.17	44.1	0.96	0.05	2,516	54.6	2,316	50.3
i-Butane	0.40	58.1	0.23	0.01	3,252	13.1	3,005	12.1
n-Butane	0.53	58.1	0.31	0.02	3,262	17.2	3,013	15.9
i-Pentane	0.20	72.2	0.14	0.01	4,001	7.86	3,698	7.27
n-Pentane	0.16	72.2	0.11	0.01	4,009	6.30	3,708	5.83
Hexanes+	0.12	86.2	0.10	0.01	4,756	5.75	4,404	5.32
Heptanes	0.10	100	0.10	0.01	5,503	5.46	5,100	5.06
Octanes	0.03	114	0.03	0.00	6,249	1.68	0.00	0.00
Nonanes	0.00	128	0.00	0.00	6,996	0.00	0.00	0.00
Decanes	0.00	142	0.00	0.00	7,743	0.00	0.00	0.00
Benzene	0.01	78.1	0.01	0.00	3,716	0.47	0.00	0.00
Toluene	0.01	92.1	0.01	0.00	4,445	0.01	0.00	0.00
Ethylbenzene	0.00	106	0.00	0.00	5,192	0.02	0.00	0.00
Xylenes	0.00	106	0.00	0.00	5,184	0.14	0.00	0.00
n-Hexane	0.06	86.2	0.05	0.00	4,756	2.80	0.00	0.00
Helium	0.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.42	28.0	0.12	0.01	0.00	0.00	0.00	0.00
Carbon Dioxide	0.33	44.0	0.15	0.01	0.00	0.00	0.00	0.00
Oxygen	0.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00
Hydrogen Sulfide	0.00	34.1	0.00	0.00	637	0.00	588	0.00
Total	**100**	-	**18.4**	**1.00**	-	**1,123**	-	**1,011**

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

Weight Fraction = Net Mole Weight / Total Mole Weight

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18. Well Development Venting

Assumptions: Following completion, wells are vented prior to connection to the gathering pipeline

Venting Period 48 hours (Project Proponents)

Amount of Vented Gas: 1.0 MMscf day (Average volume estimated by proponents)

Development Rate: 93 Wells per year (Project Proponents)

Control Rate 95 Percent from flaring

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf/day)	Component Emission Rate (lb/hr)	Component Emission Rate (tons/yr)
Methane	16.0	89.8	14.4	0.781	898	791	88
Ethane	30.1	5.70	1.71	0.093	57.0	94.1	10.51
Propane	44.1	2.17	0.957	0.052	21.7	52.5	5.86
i-Butane	58.1	0.403	0.234	0.013	4.029	12.9	1.43
n-Butane	58.1	0.529	0.307	0.017	5.285	16.9	1.88
i-Pentane	72.2	0.197	0.142	0.008	1.97	7.78	0.87
n-Pentane	72.2	0.157	0.113	0.006	1.57	6.23	0.69
Hexanes	86.2	0.121	0.104	0.006	1.21	5.72	0.64
Heptanes	100	0.099	0.099	0.005	0.99	5.46	0.61
Octanes	114	0.027	0.031	0.002	0.27	1.69	0.19
Nonanes	128	0.000	0.000	0.000	0.00	0.00	0.00
Decanes +	142	0.000	0.000	0.000	0.00	0.00	0.00
Benzene	78.1	0.013	0.010	0.001	0.13	0.55	0.06
Toluene	92.1	0.011	0.010	0.001	0.11	0.56	0.06
Ethylbenzene	106	0.000	0.000	0.000	0.00	0.02	0.00
Xylenes	106	0.003	0.003	0.000	0.03	0.16	0.02
n-Hexane	86.2	0.059	0.051	0.003	0.59	2.79	0.31
Helium	4.0	0.000	0.000	0.000	0.00	0.00	0.00
Nitrogen	28.0	0.419	0.117	0.006	4.19	6.44	0.72
Carbon Dioxide	44.0	0.331	0.146	0.008	3.31	8.00	0.89
Oxygen	32.0	0.000	0.000	0.000	0.00	0.00	0.00
Hydrogen Sulfide	34.1	0.000	0.000	0.000	0.00	0.00	0.00
VOC Subtotal		**3.79**	**2.06**	**0.11**	**37.9**	**113**	**12.63**
HAP Subtotal		**0.09**	**0.07**	**0.00**	**0.86**	**4.07**	**0.45**
Total		**100**	**18.4**	**1.00**	**1,000**	**1,012**	**113**

Kleinfelder/Buys

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19. Operations Tailpipe Emissions

Assumptions:

Number of New Pumpers:	17	(Proponent)
Pumper Mileage:	1,500	miles/pumper/month (Proponent)
Total Annual New Pumper Mileage:	306,000	miles/year
Number of Condensate Haul Truck Round Trips:	12	trips per day (Based on Peak Production Proposed Action)
Number of Produced Water Truck Round Trips:	31	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for Condensate Transport:	104	miles (Estimate from Vernal)
Total Annual Condensate Truck Mileage:	1,632,590	miles/year
Hours of Pumper Operation:	10	hours per day (Assumption)
Hours of Pumper Operation:	3,640	hours per year
Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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								
NOx	3.23	0.60	1.09	8.13	8.04	14.7	8.64	15.8
CO	36.8	6.83	12.4	17.5	17.3	31.5	24.1	44.0
VOC [c]	2.11	0.39	0.71	4.60	4.55	8.30	4.94	9.01
SO_2	0.21	0.04	0.07	0.32	0.32	0.58	0.36	0.65
Greenhouse Gases								
CH_4 [d]	0.18	0.03	0.06	0.23	0.23	0.41	0.26	0.48

[a] AP-42 Append H Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)

[b] AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 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

Kleinfelder/Buys

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20. Operations Pneumatic Emissions

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

Analysis Gas flow 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	89.7593	14.400	78.092	0.898	1.581	6.925
Ethane	30.07	5.7022	1.715	9.299	0.057	0.188	0.825
Propane	44.097	2.1706	0.957	5.191	0.022	0.105	0.460
i-Butane	58.123	0.4029	0.234	1.270	0.004	0.026	0.113
n-Butane	58.123	0.5285	0.307	1.666	0.005	0.034	0.148
i-Pentane	72.15	0.1965	0.142	0.769	0.002	0.016	0.068
n-Pentane	72.15	0.1572	0.113	0.615	0.002	0.012	0.055
Hexanes	86.177	0.1208	0.104	0.565	0.001	0.011	0.050
Heptanes	100.204	0.0993	0.099	0.539	0.001	0.011	0.048
Octanes	114.231	0.0269	0.031	0.167	0.000	0.003	0.015
Nonanes	128.258	0.0000	0.000	0.000	0.000	0.000	0.000
Decanes +	142.285	0.0000	0.000	0.000	0.000	0.000	0.000
Benzene	78.12	0.0128	0.010	0.054	0.000	0.001	0.005
Toluene	92.13	0.0110	0.010	0.055	0.000	0.001	0.005
Ethylbenzene	106.16	0.0003	0.000	0.002	0.000	0.000	0.000
Xylenes	106.16	0.0028	0.003	0.016	0.000	0.000	0.001
n-Hexane	86.177	0.0589	0.051	0.275	0.001	0.006	0.024
Helium	4.003	0.0000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.4190	0.117	0.636	0.004	0.013	0.056
Carbon Dioxide	44.01	0.3310	0.146	0.790	0.003	0.016	0.070
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	**3.788**	**2.062**	**11.183**	**0.038**	**0.226**	**0.992**
	HAP Subtotal	**0.086**	**0.074**	**0.402**	**0.001**	**0.008**	**0.036**
	Total	**100.000**	**18.440**	**100.000**	**1.000**	**2.025**	**8.868**

	Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)
Proposed Action	484	2196	8634.1

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:	1.0	Mscf/day
Days of Operation:	182	days/year

Methanol Pump Specifications

Gas Consumption Rate:	1.0	Mscf/day
Days of Operation:	182	days/year

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
4	Liquid level controllers	0.13	0.57
2	Trace pump	0.45	1.98
2	Chemical injection pump	0.45	1.98
	Totals (per well) =	1.04	4.54

Pneumatic sources / well		Methane lb/hr	Methane ton/yr
4	Liquid level controllers	0.91	3.99
2	Trace pump	3.16	6.93
2	Chemical injection pump	3.16	6.93
	Totals (per well) =	7.24	17.84

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21. Operations Traffic Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006
365 operating days per year (Estimate)

Unpaved Roads

$E (PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$

$E (PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	miles on unpaved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Roads

$E (PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4)))$

$E (PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4)))$

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-3 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	82	miles from Vernal on paved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Vehicle Type	Ave. Weight (lbs)	Round Trips per Day		PM_{10} (lb/VMT)	Total PM_{10} (lbs/yr)	PM_{10} (lb/day)	Total $PM_{2.5}$ (lbs/yr)	$PM_{2.5}$ (lb/day)
Pickup Truck: Crew	7,000	17.0						
Haul Truck: Oil	48,000	7.0						
Haul Truck: Water	48,000	31.0	Paved	2.14	2,591	7.10	259	0.71
Mean Weight	35,327	55.0	Unpaved	0.101	122	0.33	12.2	0.03
					PM_{10}		**$PM_{2.5}$**	
Annual Traffic Fugitive Dust Emissions (tons/year)			**Paved**		**1.30**		**0.130**	
			Unpaved		**0.061**		**0.006**	
			Total		**1.36**		**0.136**	

Assume 3 barrels per day condensate per well (484 wells = 60,984 gallons/day for transport)
Assume 10,000 gallon condensate truck

22. Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate : 1.0 bbls condensate per day per well (average estimated from surrounding wells)

Size of Development: 484 Producing Wells

Separator Conditions: 337 psi and 78 F (9-17E sample)
API Gravity: 55
Ambient Conditions: 12.64 psi and 52 F

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0

Emissions:

Component		Well Flash/Work/Breathing (tons/yr/well)	Project Emissions [a] (tons/yr)
Total VOC		1.99	961
Hazardous Air Pollutants			
Benzene		0.015	7.3
Toluene		0.012	5.8
Ethylbenzene		0.000	0.000
Xylenes		0.002	0.97
n-Hexane		0.045	21.8
Total HAPS		0.080	38.7
Greenhouse Gases			
CO_2		0.017	8.23
CH_4		0.77	374

a Assumes maximum development scenario

23. Wellsite Dehydrator Emissions

Assumptions

Average Production Rate: 0.20 MMscf/day/well (Average for life of the well, Proposed Action)
Number of Active Wells Requiring Separators: 484 wells at Peak Production
Wells Requiring Dehydrators: 484 (100% of wells, Proposed Action)

Gas Composition: RBU 6-18F 2010 sample analysis

Inlet Gas Conditions: 80 psia, 82 degrees F
Pump: 0.030 acfm gas/gpm glycol

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

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Tons per year per well are calculated with the conservative estimate that the wellsite dehys could theoretically run 8,760 hours out of the year

Emissions

Species		Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions (tons/year)
Total VOC		0.70	3.08	1,489
Hazardous Air Pollutants				
Benzene		0.074	0.32	156
Toluene		0.165	0.72	351
Ethylbenzene		0.010	0.04	20.8
Xylenes		0.146	0.64	309
n-Hexane		0.006	0.03	12.7
Greenhouse Gases				
CH_4		0.069	0.30	147

Kleinfelder/Buys

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25. Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	750	Mbtu/hr (Proponent)
Wellsite Dehydrator Reboiler Size	250	Mbtu/hr
Total Wellsite Heater Size	1,000	Mbtu/hr (1@500, 1@750)
Firing Rate	60	minutes/hour on average for entire year (Typical value)
	8,760	hours/year
Fuel Gas Heat Value	1,103	Btu/scf (Gas Analyses from Existing Wells)
Fuel Gas VOC Content	0.112	by weight (Gas Analyses from Existing Wells)
Development size	484	new wells

Equations

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

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

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

	Wellpad Separator Emissions			Wellpad Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions [l] (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Total Emissions (lb/hr)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.075	159	100	0.025	53	0.100	212
CO [a]	84.0	0.063	134	84.0	0.021	44.5	0.084	178
TOC [c]	11.0	0.008	17.5	11.0	0.003	5.8	0.011	23.3
VOC	-	0.001	1.96	-	0.000	0.65	0.001	2.61
SO_2 [b]	-	0.0	0.0	-	0.0	0.0	0.0	0.0
TSP [c]	7.60	0.006	12.1	7.60	0.002	0.008	0.008	12.1
PM_{10} [c]	7.60	0.006	12.1	7.60	0.002	4.028	0.008	16.1
$PM_{2.5}$ [c]	7.60	0.006	12.1	7.60	0.002	4.028	0.008	16.1
Hazardous Air Pollutants								
Benzene [d]	2.10E-03	1.58E-06	3.34E-03	2.10E-03	5.25E-07	1.11E-03	2.10E-06	4.45E-03
Toluene [d]	3.40E-03	2.55E-06	5.41E-03	3.40E-03	8.50E-07	1.80E-03	3.40E-06	7.21E-03
Hexane [d]	1.80E+00	1.35E-03	2.86E+00	1.80E+00	4.50E-04	9.54E-01	1.80E-03	3.82E+00
Formaldehyde [d]	7.50E-02	5.63E-05	1.19E-01	7.50E-02	1.88E-05	3.97E-02	7.50E-05	1.59E-01
Dichlorobenzene [d]	1.20E-03	9.00E-07	1.91E-03	1.20E-03	3.00E-07	6.36E-04	1.20E-06	2.54E-03
Naphthalene [d]	6.10E-04	4.58E-07	9.70E-04	6.10E-04	1.53E-07	3.23E-04	6.10E-07	1.29E-03
POM 2 [d,e,f]	5.90E-05	4.43E-08	9.38E-05	5.90E-05	1.48E-08	3.13E-05	5.90E-08	1.25E-04
POM 3 [d,g]	1.60E-05	1.20E-08	2.54E-05	1.60E-05	4.00E-09	8.48E-06	1.60E-08	3.39E-05
POM 4 [d,h]	1.80E-06	1.35E-09	2.86E-06	1.80E-06	4.50E-10	9.54E-07	1.80E-09	3.82E-06
POM 5 [d,i]	2.40E-06	1.80E-09	3.82E-06	2.40E-06	6.00E-10	1.27E-06	2.40E-09	5.09E-06
POM 6 [d,j]	7.20E-06	5.40E-09	1.14E-05	7.20E-06	1.80E-09	3.82E-06	7.20E-09	1.53E-05
POM 7 [d,k]	1.8E-06	1.35E-09	2.86E-06	1.8E-06	4.50E-10	9.54E-07	1.80E-09	3.82E-06
Greenhouse Gases								
CO_2 [c]	120,000	90.0	190,793	120,000	30.0	63,598	120	254,390
CH_4 [c]	2.30	1.73E-03	3.66	2.30	5.75E-04	1.22	2.30E-03	4.88
N_2O [c]	2.20	1.65E-03	3.50	2.20	5.50E-04	1.17	2.20E-03	4.66

[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 $PM_{1.0}$)

[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,

[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 maximum development scenario

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24. Wellsite Pumping Unit Engines

Assumptions:

Pumpjack Engine Size: 21.2 Horsepower (Estimate)
Number of Wells Requiring Pumping Unit Engines: 73 wells at Peak Production

Equations:

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

Wellsite Pumping Unit Engines Emissions (old engines)

Pollutant	Emission Factor [1] (lb/MMBtu)	Emission Factor [3] (g/hp-hr)	Emissions (lb/hr/well)	Total Emissions [7] Proposed Action (tons/yr)
Criteria Pollutants & VOC				
NOx	2.21	11.1	0.52	165.8
CO	3.72	18.7	0.87	279.1
VOC	0.03	0.15	0.01	2.2
PM_{10} [4]	1.94E-02	9.75E-02	4.56E-03	1.5
$PM_{2.5}$ [4]	1.94E-02	9.75E-02	4.56E-03	1.5
SO_2 [2]	0.0	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	1.58E-03	7.93E-03	3.7E-04	0.12
Toluene	5.58E-04	2.80E-03	1.3E-04	0.04
Ethylbenzene	2.48E-05	1.25E-04	5.8E-06	0.00
Xylenes	1.95E-04	9.79E-04	4.6E-05	0.01
Formaldehyde	2.05E-02	1.03E-01	4.8E-03	1.5
Acetaldehyde	2.79E-03	1.40E-02	6.5E-04	0.21
Acrolein	2.63E-03	1.32E-02	6.2E-04	0.20
Methanol	3.06E-03	1.54E-02	7.2E-04	0.23
1,1,2,2-Tetrachloroethane	2.53E-05	1.27E-04	5.9E-06	1.90E-03
1,1,2-Trichloroethane	1.53E-05	7.68E-05	3.6E-06	1.15E-03
1,3-Dichloropropene	1.27E-05	6.38E-05	3.0E-06	9.53E-04
1,3-Butadiene	6.63E-04	3.33E-03	1.6E-04	4.98E-02
Carbon Tetrachloride	1.77E-05	8.89E-05	4.2E-06	1.33E-03
Chlorobenzene	1.29E-05	6.48E-05	3.0E-06	9.68E-04
Chloroform	1.37E-05	6.88E-05	3.2E-06	1.03E-03
Ethylene Dibromide	2.13E-05	1.07E-04	5.0E-06	1.60E-03
Methylene Chloride	4.12E-05	2.07E-04	9.7E-06	3.09E-03
Naphthalene	9.71E-05	4.88E-04	2.3E-05	7.29E-03
Styrene	1.19E-05	5.98E-05	2.8E-06	8.93E-04
Vinyl Chloride	7.18E-06	3.61E-05	1.7E-06	5.39E-04
PAH -POM 1 [6]	1.41E-04	7.08E-04	3.3E-05	1.06E-02
Greenhouse Gases				
CO_2 [5]	110	2,557	120	38,217
CH_4	0.23	1.15	0.05	17

Wellsite Pumping Unit Engines Emissions (JJJJ compliant new engines)

Pollutant	Emission Factor [1] (lb/MMBtu)	Emission Factor [3] (g/hp-hr)	Emissions (lb/hr/well)	Total Emissions [7] Proposed Action (tons/yr)
Criteria Pollutants & VOC				
NOx	-	2.0	0.09	30
CO	-	4.0	0.19	60
VOC	-	1.0	0.05	15
PM_{10} [4]	1.94E-02	9.75E-02	4.56E-03	1.5
$PM_{2.5}$ [4]	1.94E-02	9.75E-02	4.56E-03	1.5
SO_2 [2]	0.0	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	1.58E-03	7.93E-03	3.7E-04	0.12
Toluene	5.58E-04	2.80E-03	1.3E-04	0.04
Ethylbenzene	2.48E-05	1.25E-04	5.8E-06	0.00
Xylenes	1.95E-04	9.79E-04	4.6E-05	0.01
Formaldehyde	2.05E-02	1.03E-01	4.8E-03	1.5
Acetaldehyde	2.79E-03	1.40E-02	6.5E-04	0.21
Acrolein	2.63E-03	1.32E-02	6.2E-04	0.20
Methanol	3.06E-03	1.54E-02	7.2E-04	0.23
1,1,2,2-Tetrachloroethane	2.53E-05	1.27E-04	5.9E-06	1.90E-03
1,1,2-Trichloroethane	1.53E-05	7.68E-05	3.6E-06	1.15E-03
1,3-Dichloropropene	1.27E-05	6.38E-05	3.0E-06	9.53E-04
1,3-Butadiene	6.63E-04	3.33E-03	1.6E-04	4.98E-02
Carbon Tetrachloride	1.77E-05	8.89E-05	4.2E-06	1.33E-03
Chlorobenzene	1.29E-05	6.48E-05	3.0E-06	9.68E-04
Chloroform	1.37E-05	6.88E-05	3.2E-06	1.03E-03
Ethylene Dibromide	2.13E-05	1.07E-04	5.0E-06	1.60E-03
Methylene Chloride	4.12E-05	2.07E-04	9.7E-06	3.09E-03
Naphthalene	9.71E-05	4.88E-04	2.3E-05	7.29E-03
Styrene	1.19E-05	5.98E-05	2.8E-06	8.93E-04
Vinyl Chloride	7.18E-06	3.61E-05	1.7E-06	5.39E-04
PAH -POM 1 [6]	1.41E-04	7.08E-04	3.3E-05	1.06E-02
Greenhouse Gases				
CO_2 [5]	110	2,557	120	38,217
CH_4	0.23	1.15	0.05	17

Note: The change from existing engines to JJJJ compliant engines results in emission changes of:

NOx -135.95 **tons/yr**
CO -219.37 **tons/yr**
VOC 12.72 **tons/yr**

[1] AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00

[2] Fuel gas is assumed to be free from sulfur compounds (see gas analysis)

[3] Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 11,070 Btu/hp-hr (11,070/1,000,000 *453.6 = 5.02135 multiplier)

[4] PM = sum of PM filterable and PM condensable

[5] Based on 99.5% conversion of the fuel carbon to CO_2 (AP-42 Table 3.2-3 footnote d)

[6] Polycyclic Aromatic Hydrocarbons (PAH), 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

[7] Estimated at full project production.

Kleinfelder/Buys

Project: XTO RBU, Alternative A
Date: 5/3/2011

26. Well Production Summary

Species	Production Heaters (tons/yr)	Storage Tanks (tons/yr)	Well Dehydrators (tons/yr)	Well Pumping Unit Engines [a] (tons/yr)	Operations Vehicle (tons/yr)	Well Blowdown (tons/yr)	Total Well Production [b] (tons/yr)
Criteria Pollutants & VOC							
NO_x	212	0.0	0.0	30	15.8	0.0	258
CO	178	0.0	0.0	60	44.0	0.0	282
VOC	2.61	961	1,489	15	9.01	13	2,489
SO_2	0.0	0.0	0.0	0.0	0.65	0.0	0.65
PM_{10}	16.1	0.0	0.0	1.5	1.36	0.0	19
$PM_{2.5}$	16.1	0.0	0.0	1.5	0.14	0.0	17.7
Hazardous Air Pollutants							
Benzene	4.5E-03	7.3	156	0.12	0.0	0.06	163
Toluene	7.2E-03	5.8	351	0.04	0.0	0.06	357
Ethylbenzene	0.0	0.00	20.8	0.00	0.0	0.00	20.8
Xylene	0.0	0.97	309	0.01	0.0	0.02	310
n-Hexane	3.82	21.8	12.7	0.0	0.0	0.31	39
Formaldehyde	0.16	0.0	0.0	1.5	0.0	0.0	1.7
Total HAPs	3.99	36	849	1.7	0.0	0.45	891
Greenhouse Gases							
CO_2	254,390	0.0	0.0	38,217	0.0	0.9	292,608
CH_4	4.88	0.0	147	17	0.48	88	258
N_2O	4.66	0.0	0.0	0.0	0.0	0.0	4.66

[a] Well pumping unit engine emissions are for JJJJ compliant engines

[b] Emissions for Peak Field Development

1.986 3.075636

Kleinfelder/Buys	Project: XTO RBU, Alternative A Date: 5/3/2011

27. Production Heater Emissions

Assumptions

Central Separator Heater Size	750	Mbtu/hr (Proponent)
Central Dehydrator Reboiler Heater Size	750	Mbtu/hr
Total Central Facility Heater Requirement:	1500	Mbtu/hr (1@500, 1@750)
Firing Rate	60	minutes/hour on average for entire year (Typical value)
	8760	hours/year
Fuel Gas Heat Value	1103	Btu/scf (Gas Analyses from Existing Wells)
Fuel Gas VOC Content	0.112	by weight (Gas Analyses from Existing Wells)
Development size	9	Facilities

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

	Central Facility Separator Emissions			Central Facility Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/facility)	Total Emissions [l] (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions [l] (tons/yr)	Total Emissions (lb/hr)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.075	2.96	100	0.075	2.957	0.750	5.91
CO [a]	84.0	0.063	2.48	84.0	0.063	2.483	0.630	4.97
TOC [c]	11.0	0.008	0.325	11.0	0.008	0.325	0.083	0.65
VOC	N.A.	0.001	0.036	N.A.	0.001	0.036	0.009	0.07
SO_x [b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TSP [c]	7.60	5.70E-03	0.225	7.60	5.70E-03	0.225	0.057	0.449
PM_{10} [c]	7.60	5.70E-03	0.225	7.60	5.70E-03	0.225	0.057	0.449
$PM_{2.5}$ [c]	7.60	5.70E-03	0.225	7.60	5.70E-03	0.225	0.057	0.449
Hazardous Air Pollutants								
Benzene [d]	2.10E-03	1.58E-06	6.21E-05	2.10E-03	1.58E-06	6.21E-05	1.58E-05	1.24E-04
Toluene [d]	3.40E-03	2.55E-06	1.01E-04	3.40E-03	2.55E-06	1.01E-04	2.55E-05	2.01E-04
Hexane [d]	1.80	1.35E-03	5.32E-02	1.80	1.35E-03	5.32E-02	0.014	0.106
Formaldehyde [d]	7.50E-02	5.63E-05	2.22E-03	7.50E-02	5.63E-05	2.22E-03	5.63E-04	4.43E-03
Dichlorobenzene [d]	1.2E-03	9.00E-07	3.55E-05	1.2E-03	9.00E-07	3.55E-05	1.80E-06	7.10E-05
Naphthalene [d]	6.1E-04	4.58E-07	1.80E-05	6.1E-04	4.58E-07	1.80E-05	9.15E-07	3.61E-05
POM 2 [d,e,f]	5.9E-05	4.43E-08	1.74E-06	5.9E-05	4.43E-08	1.74E-06	8.85E-08	3.49E-06
POM 3 [d,g]	1.6E-05	1.20E-08	4.73E-07	1.6E-05	1.20E-08	4.73E-07	2.40E-08	9.46E-07
POM 4 [d,h]	1.8E-06	1.35E-09	5.32E-08	1.8E-06	1.35E-09	5.32E-08	2.70E-09	1.06E-07
POM 5 [d,i]	2.4E-06	1.80E-09	7.10E-08	2.4E-06	1.80E-09	7.10E-08	3.60E-09	1.42E-07
POM 6 [d,j]	7.2E-06	5.40E-09	2.13E-07	7.2E-06	5.40E-09	2.13E-07	1.08E-08	4.26E-07
POM 7 [d,k]	1.8E-06	1.35E-09	5.32E-08	1.8E-06	1.35E-09	5.32E-08	2.70E-09	1.06E-07
Greenhouse Gases								
CO_2 [c]	120,000	90.0	3,548	120,000	90.0	3,548	180.0	7,096
CH_4 [c]	2.30	1.73E-03	6.80E-02	2.30	1.73E-03	0.068	3.45E-03	0.136
N_2O [c]	2.20	1.65E-03	6.50E-02	2.20	1.65E-03	0.065	3.30E-03	0.130

[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 $PM_{1.0}$)

[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

[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 maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative A Date: 5/3/2011

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

Assumptions:

Average Condensate Production Rate :

Facility 1	10.85	bbls condensate per day (Estimate based on similar facility data)
Facility 2	10.85	bbls condensate per day (Estimate based on similar facility data)
Facility 3	10.85	bbls condensate per day (Estimate based on similar facility data)
Facility 4	10.85	bbls condensate per day (Estimate based on similar facility data)
Facility 5	10.85	bbls condensate per day (Estimate based on similar facility data)
Facility 6	10.85	bbls condensate per day (Estimate based on similar facility data)
Facility 7	10.85	bbls condensate per day (Estimate based on similar facility data)
Facility 8	10.85	bbls condensate per day (Estimate based on similar facility data)
Facility 9	10.85	bbls condensate per day (Estimate based on similar facility data)
Total Facilities	9	

Separator Conditions : 400 psi and 95 F (Sample Conditions)
Ambient Conditions: 12.64 psi and 52 F

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0
Kings Canyon Compressor Station Liquid Sample

Emissions:

Component	Facility Flash/Work/ Breathing (tons/yr)	Total Emissions * (tons/yr)
Total VOC	40.50	365
Hazardous Air Pollutants		
Benzene	0.140	1.26
Toluene	0.140	1.26
Ethylbenzene	0.010	0.09
Xylenes	0.040	0.36
n-Hexane	0.520	4.68
Total HAP's	0.690	6.21
Greenhouse Gases		
CO_2	0.310	2.79
CH_4	8.00	72.0

* Includes 9 Facilities

29. Central TEG Dehydrator Emissions

Assumptions

Production Rate: 100 MMscf/day total

Gas Composition: Kings Canyon 2008 sample analysis

Inlet Gas Conditions: Inlet gas saturated at 814 psia and 98 F
Pump: 0.032 acfm gas/gpm glycol

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

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95% Control Efficiency in order to meet Federal MACT Standards

Emissions

Species	Central Dehydrator Emissions (lb/hr)	Total* Project Emissions (tons/year)
VOC	10.60	46.4
Benzene	1.12	4.9
Toluene	2.85	12.5
Ethylbenzene	0.20	0.9
Xylenes	2.78	12.2
n-Hexane	0.09	0.4
Total HAPs	7.05	30.9
Greenhouse Gases		
CH_4	3.61	15.8

* Includes 9 Facilities and year around operation

Kleinfelder/Buys

Project: XTO RBU, Alternative A
Date: 5/3/2011

30. Central Compression

Assumptions:

Engine Type: TBD
Maximum Engine Capacity Increase: 8,520 horsepower (Proponent)

Equations:

Emissions (g/hp-hr) = average heat rate of 8,000 btu/hp-hr (8,000/1,000,000 *453.6 = 3.6288 multiplier)

Emissions (lbs/hr) = Emission Factor (g/hp-hr) * Power (hp) / 453.6 g/lb

Pollutant	Emission Factor [a, b] (lb/MMBtu)	Emission Factor [d] (g/hp-hr)	Emissions (lb/hr)	Emissions [c] (tons/yr)
Criteria Pollutants & VOC				
NOx [j]	-	1.00	18.8	82.3
CO [d]	-	0.190	3.6	15.6
VOC [d]	-	0.460	9	37.8
PM_{10} [e]	9.95E-03	0.036	0.68	2.97
$PM_{2.5}$ [e]	9.95E-03	0.036	0.68	2.97
SO_2 [f]	5.88E-04	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	4.40E-04	3.83E-04	7.20E-03	3.15E-02
Toluene	4.08E-04	3.55E-04	6.67E-03	2.92E-02
Ethylbenzene	3.97E-05	3.46E-05	6.49E-04	2.84E-03
Xylenes	1.84E-04	1.60E-04	3.01E-03	1.32E-02
n-Hexane	1.11E-03	9.67E-04	1.82E-02	7.95E-02
Formaldehyde	-	6.00E-02	1.13E+00	4.94E+00
Acetaldehyde	8.36E-03	7.28E-03	1.37E-01	5.99E-01
Acrolein	5.14E-03	4.48E-03	8.41E-02	3.68E-01
Methanol	2.50E-03	2.18E-03	4.09E-02	1.79E-01
1,1,2,2-Tetrachloroethane	4.00E-05	3.48E-05	6.54E-04	2.87E-03
1,1,2-Trichloroethane	3.18E-05	2.77E-05	5.20E-04	2.28E-03
1,3-Dichloropropene	2.64E-05	2.30E-05	4.32E-04	1.89E-03
1,3-Butadiene	2.67E-04	2.33E-04	4.37E-03	1.91E-02
2,2,4-Trimethylpentane	2.50E-04	2.18E-04	4.09E-03	1.79E-02
Biphenyl	2.12E-04	1.85E-04	3.47E-03	1.52E-02
Carbon Tetrachloride	3.67E-05	3.20E-05	6.00E-04	2.63E-03
Chlorobenzene	3.04E-05	2.65E-05	4.97E-04	2.18E-03
Chloroform	2.85E-05	2.48E-05	4.66E-04	2.04E-03
Ethylene Dibromide	4.43E-05	3.86E-05	7.25E-04	3.17E-03
Methylene Chloride	2.00E-05	1.74E-05	3.27E-04	1.43E-03
Naphthalene	7.44E-05	6.48E-05	1.22E-03	5.33E-03
Phenol	2.40E-05	2.09E-05	3.93E-04	1.72E-03
Styrene	2.36E-05	2.06E-05	3.86E-04	1.69E-03
Tetrachloroethane	2.48E-06	2.16E-06	4.06E-05	1.78E-04
Vinyl Chloride	1.49E-05	1.30E-05	2.44E-04	1.07E-03
PAH -POM 1 [g, h]	2.69E-05	2.34E-05	4.40E-04	1.93E-03
POM 2 [h, i]	5.93E-05	5.17E-05	9.71E-04	4.25E-03
Benzo(b)fluoranthene/POM6 [h]	1.66E-07	1.45E-07	2.72E-06	1.19E-05
Chrysene/POM7 [h]	6.93E-07	6.04E-07	1.13E-05	4.97E-05
Greenhouse Gases				
CO_2	110	399	7,498	32,839
CH_4	1.25	4.54	85	373

[a] AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/00

[b] Compressor engines compliant with RICE MACT standards, Table 2.a (93% reduction of CO or 14 ppmvd Formaldehyde)

[c] Assumes maximum development scenario

[d] Emission rates based on information from catalyst emissions reduction manufacturer (including 90% CO reduction, 76% formaldehyde and 76% VOC reductions)

[e] PM = sum of PM filterable and PM condensable

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

[g] Polycyclic Aromatic Hydrocarbons (PAH) defined as a HAP by Section 112(b) of the Clean Air Act because it is Polycyclic Organic Matter (POM) AP-42 Table 1.4-3 footnotes.

[h] 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

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

[j] NO_X emission rate reflects 1.0 g/s requirement mandated by the BLM Vernal Field Office

31. Development Emissions Sumary

Pollutant	Development Emissions (tons/year) [a]					Total
	Construction	Drilling[b]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
NO_X	0.23	192	26.0	0.03	0.00	218
CO	1.20	154	22.4	0.27	0.00	178
VOC	0.14	45.6	17	0.02	0.00	63
SO_2	0.01	0.70	0.30	0.002	0.00	1.0
PM_{10}	8.88	496	210	1.59	0.03	716
$PM_{2.5}$	0.95	54.6	21.2	0.16	3.84E-03	77
Benzene	0.00	0.10	0.07	0.00	0.00	0.2
Toluene	0.00	0.04	0.06	0.00	0.00	0.1
Ethylbenzene	0.00	0.00	0.00	0.00	0.00	0.002
Xylene	0.00	0.02	0.02	0.00	0.00	0.0
n-Hexane	0.00	0.00	0.31	0.00	0.00	0.3
Formaldehyde	0.00	9.97E-03	5.73E-04	0.00	0.00	0.011
Acrolein	0.00	9.96E-04	5.49E-05	0.00	0.00	1.1E-03
1,3-Butadiene	0.00	0.00	3.48E-06	0.00	0.00	3.5E-06
Greenhouses Gases						
CO_2	0.00	19,541	932	0.00	0.00	20,472
CH_4	8.65E-03	12.4	89	1.55E-03	0.00	101
N_2O	0.00	0.00	0.00	0.00	0.00	0

[a] Assumes maximum development scenario

[b] Total drilling emissions includes Tier II drill rig engines

32. Total Project Production Related Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a]							Total [a]
	Pump Unit Engines	Production Heaters	Oil Tanks	TEG Dehydrators	Operations Vehicle	Pneumatics	Compressor Engines	(tons/year)
Criteria Pollutants & VOC								
NO_X	30	218	0.00	0.00	15.8	0.0	82	346
CO	60	183	0.00	0.00	44.0	0.0	16	302
VOC	15	2.68	1,326	1,535	9.01	2196.5	38	5,122
SO_2	0.00	0.00	0.00	0.00	0.65	0.0	0.00	0.65
PM_{10}	1.5	16.6	0.00	0.00	1.36	0.0	3.0	22
$PM_{2.5}$	1.5	16.6	0.00	0.00	0.14	0.0	3.0	21
Hazardous Air Pollutants								
Benzene	0.12	0.00	8.5	161	0.00	0.0	0.03	170
Toluene	0.04	0.01	7.1	363	0.00	0.0	0.03	370
Ethylbenzene	0.00	0.00	0.1	21.7	0.00	0.0	0.00	21.8
Xylene	0.01	0.00	1.3	321	0.00	0.0	0.01	323
n-Hexane	0.00	3.92	26.5	13.1	0.00	0.0	0.08	44
Formaldehyde	1.5	0.16	0.00	0.00	0.00	0.0	4.9	6.6
Acetaldehyde	0.21	0.00	0.00	0.00	0.00	0.0	0.6	0.8
Acrolein	0.20	0.00	0.00	0.00	0.00	0.0	0.37	0.57
Methanol	0.23	0.00	0.00	0.00	0.00	0.0	0.18	0.41
1,1,2,2-Tetrachloroethane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,1,2-Trichloroethane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,3-Dichloropropene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,3-Butadiene	0.05	0.00	0.00	0.00	0.00	0.0	0.02	0.07
2,2,4-Trimethylpentane	0.00	0.00	0.00	0.00	0.00	0.0	0.02	0.02
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.0	0.02	0.02
Carbon Tetrachloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Chlorobenzene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Chloroform	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Ethylene Dibromide	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Methylene Chloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Naphthalene	0.01	0.00	0.00	0.00	0.00	0.0	0.01	0.01
Phenol	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Styrene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Vinyl Chloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
PAH -POM 1	0.01	0.00	0.00	0.00	0.00	0.0	0.00	0.01
POM 2	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Benzo(b)fluoranthene/POM6	0.00	0.00	0.00	0.00	0.00	0.0	1.19E-05	1.19E-05
Chrysene/POM7	0.00	0.00	0.00	0.00	0.00	0.0	4.97E-05	4.97E-05
Greenhouse Gases								
CO_2	38,217	261,486	11.0	0.00	0.00	0.0	32,839	332,553
CH_4	17	5.01	446	163	0.48	8634.1	373	9,639
N_2O	0.00	4.79	0.00	0.00	0.00	0.0	0.00	4.79

a Assumes maximum development scenario

APPENDIX F-2

Emissions Inventories for Alternative D

1. Road Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Estimate)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98 & 7/98

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

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content \%})^{1.5} * (\text{soil moisture content \%})^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.0296	0.75	1.97	0.0099	0.25	1.00
PM_{15}	0.50	0.0075	0.19	0.50	0.0025	0.06	0.26
PM_{10}	0.38	0.0056	0.14	0.19	0.0009	0.02	0.17
$PM_{2.5}$	0.21	0.0031	0.08	0.10	0.0005	0.01	0.09

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

b Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative D Date: 11/15/2011

2. Road Construction Emissions (Grader)

Assumptions:

Grading Length	1.12	miles (0.212 miles/pad x 3 swaths (10' per swath))
Hours of Construction	1	day grading per well pad and road (Estimate)
	10	hours/day
	10	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	1.12	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

Emissions = 3.01 lbs TSP/well pad

Emissions = 1.44 lbs PM_{15}/well pad

	Grader Construction Emissions			
	lbs/well pad	**lbs/hr/well pad**	**tons/well pad**	**tons/yr [a]**
TSP	3.01	0.30	1.51E-03	3.83E-02
PM_{15}	1.44	0.14	7.21E-04	1.83E-02
PM_{10}	0.86	0.09	4.32E-04	1.10E-02
$PM_{2.5}$	0.09	0.01	4.67E-05	1.19E-03

a Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative D Date: 11/15/2011

3. Well Pad Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Proposed Action)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

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) = $5.7 * (\text{soil silt content }\%)^{1.2} * (\text{soil moisture content }\%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content }\%)^{1.5} * (\text{soil moisture content }\%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			**Backhoe Emissions [a]**			**Total**
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.0296	0.75	1.97	0.0099	0.25	1.00
PM_{15}	0.50	0.0075	0.19	0.50	0.0025	0.06	0.26
PM_{10}	0.38	0.0056	0.14	0.38	0.0019	0.05	0.19
$PM_{2.5}$	0.21	0.0031	0.08	0.21	0.0010	0.03	0.11

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

b Assumes maximum development scenario

4. Well Pad Construction Emissions (Grader)

Assumptions:

Grading Length	2.06	miles on 330 ft x 330 ft pad (10 ft swath for 330 ft * 33 lengths)
Hours of Construction	2 10 20	day grading per well pad and road (Estimate) hours/day hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	2.06	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

Emissions = 5.54 lbs TSP/well pad

Emissions = 2.65 lbs PM_{15}/well pad

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/yr [a]**
TSP	5.54	0.28	0.0028	0.07
PM_{15}	2.65	0.13	0.0013	0.03
PM_{10}	1.59	0.08	0.0008	0.02
$PM_{2.5}$	0.17	0.01	0.0001	0.002

a Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU EA Date: 11/15/2011

5. New Compressor Station Construction Emissions

Assumptions and Calculations:

All assumptions emission factors, and calculations are the same as those specified in Road Construction Equipment, Road Construction Grader, Well Pad Construction Equipment and Well Pad Grader emissions inventory pages.

Assumes the development of a single additional compressor station with attached roadway

Compressor Station Road Construction Equipment

Pollutant	Dozer Emissions [a]		Backhoe Emissions [a]		Total
	lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr [b]
TSP	1.97	0.030	1.97	0.010	0.039
PM_{15}	0.50	0.008	0.50	0.003	0.010
PM_{10}	0.38	0.006	0.19	0.001	0.007
$PM_{2.5}$	0.21	0.003	0.10	0.001	0.004

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

Compressor Station Road Construction Grader

Pollutant	Grader Construction Emissions		
	lbs/well pad	lbs/hr	tons/yr
TSP	3.01	0.301	1.51E-04
PM_{15}	1.44	0.144	7.21E-05
PM_{10}	0.86	0.086	4.32E-05
$PM_{2.5}$	0.09	0.009	4.67E-06

Compressor Station Construction Equipment

Pollutant	Dozer Emissions [a]		Backhoe Emissions [a]		Total
	lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr [b]
TSP	1.97	0.030	1.97	0.010	0.039
PM_{15}	0.50	0.008	0.50	0.003	0.010
PM_{10}	0.38	0.006	0.38	0.002	0.008
$PM_{2.5}$	0.21	0.003	0.21	0.001	0.004

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

Compressor Station Grader

Pollutant	Grader Construction Emissions		
	lbs/well	lbs/hr	tons/yr
TSP	5.54	0.277	1.39E-04
PM_{15}	2.65	0.133	6.63E-05
PM_{10}	1.59	0.080	3.98E-05
$PM_{2.5}$	0.17	0.009	4.29E-06

Total Compressor Station Construction Emissions

Pollutant	tons/yr
TSP	0.0791
PM_{15}	0.0202
PM_{10}	0.0142
$PM_{2.5}$	0.0078

6. Pipeline Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Proposed Action)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	$0.75 * PM_{15}$	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

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

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content \%})^{1.5} * (\text{soil moisture content \%})^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			**Backhoe Emissions** [a]			**Total**
	lbs/hr	**tons/well pad**	**tons/yr** [b]	**lbs/hr**	**tons/well pad**	**tons/yr** [b]	**tons/yr** [b]
TSP	1.97	0.0296	0.75	1.97	0.0099	0.25	1.00
PM_{15}	0.50	0.0075	0.19	0.50	0.0025	0.06	0.26
PM_{10}	0.38	0.0056	0.14	0.19	0.0009	0.02	0.17
$PM_{2.5}$	0.21	0.0031	0.08	0.10	0.0005	0.01	0.09

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

b Assumes maximum development scenario

7. Pipeline Construction Emissions (Grader)

Assumptions:

Grading Length	9.69	miles pipeline per pad x 3 (3 10' swaths)
Hours of Construction	3	day grading per well pad and road (Estimate)
	10	hours/day
	30	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	9.69	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

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

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions = 26.04 lbs TSP/well

Emissions = 12.46 lbs PM_{15}/well

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/yr [a]**
TSP	26.04	0.87	0.0130	0.33
PM_{15}	12.46	0.42	0.0062	0.16
PM_{10}	7.48	0.25	0.0037	0.10
$PM_{2.5}$	0.81	0.03	0.0004	0.010

a Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative D Date: 11/15/2011

8. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Calculation AP-42, Chapter 13.2.1
November 2006

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	82	From Vernal
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Construction (days/pad and road)

	Vehicle Type	Average Weight (lbs)	Round Trips per Well Pad	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
Hours per day 10								
Days per pad 9								
	Semi: Hvy Equip Hauler	60,000	3					
	Haul Trucks: Equipment/Fuel/Water	48,000	5					
	Pickup Truck: Crew	7,000	10					
	Mean Vehicle Weight	27,040	18	1.90	745.3	82.8	74.5	8.3
					Unpaved Roads $PM_{10/15}$ Pads (tons)		**Unpaved Roads $PM_{2.5/15}$ Pads (tons)**	
					9.5		0.9	
			Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
				0.067	98.6	11.0	9.9	1.1
					Paved Roads $PM_{10/15}$ Pads (tons)		**Paved Roads $PM_{2.5/15}$ Pads (tons)**	
					1.25		0.13	

Vertical Drilling (days/well)

	Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Hours per day 10								
Days per well 14								
	Semi: Hvy Equip Hauler	60,000	60					
	Haul Trucks: Equipment/Fuel/Water	48,000	65					
	Pickup Truck: Rig Crew	7,000	88					
	Mean Vehicle Weight	38,103	213	2.22	10,381	741	1,038	74.1
					Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
					87.2		8.7	
			Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
				0.113	165.4	11.8	16.5	1.2
					Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
					1.39		0.14	

Directional Drilling (days/well)

	Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Hours per day 10								
Days per well 21								
	Semi: Hvy Equip Hauler	60,000	60					
	Haul Trucks: Equipment/Fuel/Water	48,000	65					
	Pickup Truck: Rig Crew	7,000	88					
	Mean Vehicle Weight	38,103	213	2.22	10,381	494.3	1,038	49.4
					Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
					224.2		22.4	
			Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
				0.113	165.4	7.9	16.5	0.8
					Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
					3.57		0.36	

Kleinfelder/Buys	Project: XTO RBU, Alternative D Date: 11/15/2011

8. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Calculation AP-42, Chapter 13.2.1
November 2006

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	82	From Vernal
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Completion (days/well)

	Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Hours per day 10								
Days per pad 10								
	Pickup: Completion Rig Crew	7,000	11					
	Haul Trucks: Equipment/Fuel/Water	48,000	73					
	Mean Vehicle Weight	42,631	84	2.33	4,306	430.6	430.6	43.1
					Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
					129.2		12.9	
			Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
				0.134	195.8	19.6	19.6	2.0
					Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
					5.87		0.59	

Interim Reclamation (days/well)

	Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Day (lbs)	PM_{10}/Day (lb/day)	$PM_{2.5}$/Day (lbs)	$PM_{2.5}$/Day (lb/day)
Hours per day 10								
Days per pad 2								
	Pickup: Crew	7,000	4					
	Haul Trucks: Equipment	60,000	1					
	Mean Vehicle Weight	17,600	5	1.56	172.1	86.1	17.2	8.6
					Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
					1.4		0.1	
			Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
				0.035	51.5	25.7	5.1	2.6
					Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
					0.43		0.04	

Annual Traffic Fugitive Dust Emissions (tons/year)

	PM_{10} (tons)	$PM_{2.5}$ (tons)
Unpaved Roads	**452**	**45.2**
Paved Roads	**12.52**	**1.25**

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9. 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	672	acres total initial disturbance for roads and pipelines (Proposed Action)
	2,719,483	square meters total initial disturbance for roads and pipelines
	395	acres total initial disturbance for well pads (Proposed Action)
	1,598,506	square meters total initial disturbance for well pads
	1,067	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	0.18	for well pads (Assumption, disturbance at construction and reclamation) constant for dirt roads
Development Period	8	years (Proposed Action)

Equations

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

Erosion Potential P (g/m²/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/m²/period)*Disturbed Area(m²)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 µm	**<10 µm**	**<2.5 µm**
1.0	0.5	0.075

Maxium U_{10}^{+} Wind Speed (m/s)	Maximum U* Friction Velocity m/s	Well U_t* Threshold Velocity* m/s	Well Pad Erosion Potential g/m²	Road U_t* Threshold Velocity* m/s	Road Erosion Potential g/m²
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	5.12E-02	0.00E+00
PM_{10}	2.56E-02	0.00E+00
$PM_{2.5}$	3.84E-03	0.00E+00

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10. Construction Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Construction	90	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	8	(Proponent)
Number of Pickup Trips	10	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2 \text{ E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6 \text{ (g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.162	0.007	3.23	0.082	0.004	0.245	0.280
CO	17.49	0.349	0.016	36.84	0.939	0.042	1.288	1.474
VOC [c]	4.83	0.097	0.004	2.29	0.058	0.003	0.155	0.177
SO_2	0.32	6.42E-03	2.89E-04	0.21	5.45E-03	2.45E-04	1.19E-02	1.36E-02
CH_4 [e, f]	0.23	4.60E-03	2.07E-04	0.18	4.69E-03	2.11E-04	9.28E-03	1.06E-02

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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11. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Hours of Operation	90	hours/site (Proposed Action)
Development Rate	25	new pads per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Backhoe miles per pad	0.515	miles (Value assumed to be 1/4 of dozer and grader mileage)
Backhoe Hours	30	hours per pad
Dozer miles per pad	2.06	miles (Based on 330 ft x 330 ft pad and 10 ft swath for 330 ft * 33 lengths)
Dozer Hours	90	hours per pad
Grader miles per pad	2.06	miles (Based on 330 ft x 330 ft pad and 10 ft swath for 330 ft * 33 lengths)
Motor Grader Hours	60	hours per pad

Equations:

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

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)
NOx	8.13	1.23E-04	1.85E-06	8.13	1.64E-04	7.38E-06	8.13	2.46E-04	7.38E-06
CO	17.49	2.65E-04	3.97E-06	17.49	3.53E-04	1.59E-05	17.49	5.30E-04	1.59E-05
VOC [b]	4.83	7.31E-05	1.10E-06	4.83	9.75E-05	4.39E-06	4.83	1.46E-04	4.39E-06
CH_4	0.23	3.48E-06	5.22E-08	0.23	4.64E-06	2.09E-07	0.23	6.96E-06	2.09E-07

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [c] (tons/yr)
NOx	5.33E-04	4.23E-04
CO	1.15E-03	9.09E-04
VOC [d]	3.17E-04	2.51E-04
CH_4	1.51E-05	1.88E-07

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario
d AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle

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12. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	457	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	125	(Proponent)
Number of Pickup Trips	88	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.510	0.117	3.23	0.143	0.033	0.653	8.9
CO	17.5	1.097	0.251	36.8	1.63	0.372	2.72	37.3
VOC [c]	4.83	0.303	0.069	2.29	0.101	0.023	0.404	5.54
SO_2	0.321	2.01E-02	4.60E-03	0.214	9.45E-03	2.16E-03	2.96E-02	0.406
CH_4 [e, f]	0.230	1.44E-02	3.30E-03	0.180	7.95E-03	1.82E-03	2.24E-02	0.307

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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13. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	100	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	73	(Proponent)
Number of Pickup Trips	11	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	1.361	0.068	3.23	0.081	0.004	1.442	4.327
CO	17.49	2.927	0.146	36.84	0.929	0.046	3.856	11.569
VOC [c]	4.83	0.808	0.040	2.29	0.058	0.003	0.866	2.598
SO_2	0.32	5.38E-02	2.69E-03	0.21	5.40E-03	2.70E-04	5.92E-02	0.177
CH_4 [e, f]	0.23	3.85E-02	1.92E-03	0.18	4.54E-03	2.27E-04	4.30E-02	0.129

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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14. Reclamation Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	20	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	1	(Assumption)
Number of Pickup Trips	4	(Assumption)
Diesel Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.093	0.001	3.23	0.148	0.001	0.241	0.041
CO	17.49	0.201	0.002	36.84	1.689	0.017	1.890	0.317
VOC [c]	4.83	0.055	0.001	2.29	0.105	0.001	0.160	0.027
SO_2	0.32	3.68E-03	3.68E-05	0.21	9.82E-03	9.82E-05	1.35E-02	2.27E-03
CH_4 [e, f]	0.23	2.64E-03	2.64E-05	0.18	8.25E-03	8.25E-05	1.09E-02	1.83E-03

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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15. Drill Rig Engine Emissions

Assumptions:

Hours of Operation	457	hours/well (Proposed Action)
Development Rate	60	wells per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Phase I engine	2,000	hp (used 14% of drilling duration)
Phase II engine	2,000	hp (used 86% of drilling duration)
Diesel Fuel Sulfur Content	0.0005	percent (EPA standard value)

Equations:

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7500 Average BTU/hp-hr / 1,000,000

Emissions (tons/year) = Emission Factor (lb/hp-hr) * Rated Horsepower (hp)* Operating Hours (hrs) * Load Factor (Dimensionless) / 2000 (lb/tons)

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

Species	Drill Rig Emissions (Tier 0 Engines)		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [g] (tons/yr)
Criteria Pollutants & VOC			
NOx [b]	0.024	19.20	263
CO [b]	5.50E-03	4.40	60
VOC [b]	7.05E-04	0.56	7.7
PM_{10} [b]	4.30E-04	0.34	4.71
$PM_{2.5}$ [b]	3.59E-04	0.29	3.94
SO_2 [b]	4.05E-06	3.24E-03	4.44E-02
Hazardous Air Pollutants			
Benzene [d]	5.82E-06	4.66E-03	6.38E-02
Toluene [d]	2.11E-06	1.69E-03	2.31E-02
Xylenes [d]	1.45E-06	1.16E-03	1.59E-02
Formaldehyde [d]	5.92E-07	4.73E-04	6.49E-03
Acetaldehyde [d]	1.89E-07	1.51E-04	2.07E-03
Acrolein [d]	5.91E-08	4.73E-05	6.48E-04
Naphthalene [e]	9.75E-07	7.80E-04	1.07E-02
Total PAH [e, f]	1.59E-06	1.27E-03	1.74E-02
Greenhouse Gases			
CO_2 [b]	1.16	928	12,722
CH_4 [b, c]	7.05E-04	0.56	7.7

Species	Drill Rig Emissions (Tier II Engines)		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [g] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.01058	8.46	116
CO [a]	5.70E-03	4.56	63
VOC [a]	2.20E-03	1.76	24.1
PM_{10} [a]	3.30E-04	0.26	3.62
$PM_{2.5}$ [b]	3.30E-04	0.26	3.62
SO_2 [b]	4.05E-06	3.24E-03	4.44E-02
Hazardous Air Pollutants			
Benzene [d]	5.82E-06	4.66E-03	6.38E-02
Toluene [d]	2.11E-06	1.69E-03	2.31E-02
Xylenes [d]	1.45E-06	1.16E-03	1.59E-02
Formaldehyde [d]	5.92E-07	4.73E-04	6.49E-03
Acetaldehyde [d]	1.89E-07	1.51E-04	2.07E-03
Acrolein [d]	5.91E-08	4.73E-05	6.48E-04
Naphthalene [e]	9.75E-07	7.80E-04	1.07E-02
Total PAH [e, f]	1.59E-06	1.27E-03	1.74E-02
Greenhouse Gases			
CO_2 [b]	1.16	928	12,722
CH_4 [b, c]	7.05E-04	0.56	7.7

Note: The change from Tier 0 to Tier II engines results in emission changes of:

NOx	**-147**	ton/yr
CO	**2**	ton/yr
VOC	**16.4**	ton/yr
PM_{10}	**-1.09**	ton/yr
$PM_{2.5}$	**-0.32**	ton/yr

[a] Emission factors for Tier II nonroad diesel engine emission standards (engines => 750 hp) from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier II emission standards are not set for VOC (listed as Hydrocarbons), so the Tier I Standard is used
note - Tier II or Tier I emission standards are not set for $PM_{2.5}$, so the Tier 0 (AP-42) emission factor is used

[b] AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96
note - VOC emission factor represents total Hydrocarbon Emissions

[c] CH_4 Emission Factor listed in notes of AP-42 Table 3.4-1 as 9% of Total Organic Compounds

[d] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

[e] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

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

[g] Assumes maximum development scenario

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16. Well Fracturing Pump and Generator Engines

Assumptions:

Average Hours of Operation	4	Hours/Well (Proponents)
Development Rate	60	wells per year (Proposed Action)
Load Factor	0.85	(Proponents)
Frac Pump Engine Horsepower	5,000	Horsepower (1@5000 hp)
Temporary Generator Horsepower	75	Horsepower (Proponents)
Diesel Fuel Sulfur Content	0.0005	percent (typical value)

Equations:

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7500 Average BTU/hp-hr / 1,000,000

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

SO_2 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	102.000	12.24
CO [a]	5.50E-03	23.375	2.81
VOC [a,b]	7.05E-04	2.996	0.36
PM_{10} [a,c]	4.30E-04	1.8264	0.2192
$PM_{2.5}$ [a,d]	3.59E-04	1.5268	0.1832
SO_2 [a]	4.05E-06	0.017	0.002
Hazardous Air Pollutants			
Benzene [e]	5.82E-06	2.47E-02	2.97E-03
Toluene [e]	2.11E-06	8.96E-03	1.07E-03
Xylenes [e]	1.45E-06	6.15E-03	7.38E-04
Formaldehyde [e]	5.92E-07	2.51E-03	3.02E-04
Acetaldehyde [e]	1.89E-07	8.03E-04	9.64E-05
Acrolein [e]	5.91E-08	2.51E-04	3.01E-05
Naphthalene [f]	9.75E-07	4.14E-03	4.97E-04
Total PAH [f]	1.59E-06	6.76E-03	8.11E-04
Greenhouse Gases			
CO_2 [a]	1.16	4,930	592
CH_4 [a]	7.05E-04	2.996	0.360

Species	Generator Engine Emissions		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [i] (tons/yr)
Criteria Pollutants & VOC			
NOx [g]	0.031	1.976	0.24
CO [g]	6.68E-03	0.43	0.05
VOC [b,g]	2.47E-03	0.16	0.02
PM_{10} [g]	2.20E-03	0.14	0.02
$PM_{2.5}$ [g]	2.20E-03	0.14	0.02
SO_2 [g]	2.05E-03	0.13	0.02
Hazardous Air Pollutants			
Benzene [h]	7.00E-06	4.46E-04	5.35E-05
Toluene [h]	3.07E-06	1.96E-04	2.35E-05
Xylenes [h]	2.14E-06	1.36E-04	1.64E-05
Formaldehyde [h]	8.85E-06	5.64E-04	6.77E-05
Acetaldehyde [h]	5.75E-06	3.67E-04	4.40E-05
Acrolein [h]	6.94E-07	4.42E-05	5.31E-06
1,3-Butadiene [h]	2.93E-07	1.87E-05	2.24E-06
Naphthalene [h]	6.36E-07	4.05E-05	4.87E-06
Total PAH [h]	1.26E-06	8.03E-05	9.64E-06
Greenhouse Gases			
CO_2 [g]	1.15	73.3	8.8
CH_4 [b,g]	2.47E-03	0.157	0.02

[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, Total PM_{10} fraction determined from Table 3.4-2
[d] Total particulate emission factor is 0.0007, $PM_{2.5}$ fraction determined from Table 3.4-2
[e] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, 10/96
[f] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, 10/96
[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, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, 10/96
[i] Assumes maximum development scenario

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17. Average Produced Gas Characteristics
RBU Compressor Station
Average of 9-17E, West Willow Creek, Tap 1, Tap 4 and Tap 5 facility inlet gases

Gas Heat Value (wet): 1103.4 Btu/scf

C1-C2 Wt. Fraction:	0.8739
VOC Wt. Fraction:	0.1118
Non-HC Wt. Fraction:	0.0143
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	89.8	16.0	14.4	0.78	1,010	907	910	817
Ethane	5.70	30.1	1.71	0.09	1,770	101	1,618	92.3
Propane	2.17	44.1	0.96	0.05	2,516	54.6	2,316	50.3
i-Butane	0.40	58.1	0.23	0.01	3,252	13.1	3,005	12.1
n-Butane	0.53	58.1	0.31	0.02	3,262	17.2	3,013	15.9
i-Pentane	0.20	72.2	0.14	0.01	4,001	7.86	3,698	7.27
n-Pentane	0.16	72.2	0.11	0.01	4,009	6.30	3,708	5.83
Hexanes+	0.12	86.2	0.10	0.01	4,756	5.75	4,404	5.32
Heptanes	0.10	100	0.10	0.01	5,503	5.46	5,100	5.06
Octanes	0.03	114	0.03	0.00	6,249	1.68	0.00	0.00
Nonanes	0.00	128	0.00	0.00	6,996	0.00	0.00	0.00
Decanes	0.00	142	0.00	0.00	7,743	0.00	0.00	0.00
Benzene	0.01	78.1	0.01	0.00	3,716	0.47	0.00	0.00
Toluene	0.01	92.1	0.01	0.00	4,445	0.01	0.00	0.00
Ethylbenzene	0.00	106	0.00	0.00	5,192	0.02	0.00	0.00
Xylenes	0.00	106	0.00	0.00	5,184	0.14	0.00	0.00
n-Hexane	0.06	86.2	0.05	0.00	4,756	2.80	0.00	0.00
Helium	0.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.42	28.0	0.12	0.01	0.00	0.00	0.00	0.00
Carbon Dioxide	0.33	44.0	0.15	0.01	0.00	0.00	0.00	0.00
Oxygen	0.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00
Hydrogen Sulfide	0.00	34.1	0.00	0.00	637	0.00	588	0.00
Total	**100**	-	**18.4**	**1.00**	-	**1,123**	-	**1,011**

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

Weight Fraction = Net Mole Weight / Total Mole Weight

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18. 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:	1.0	MMscf day (Average volume estimated by proponents)
Development Rate:	60	Wells per year (Project Proponents)
Control Rate	95	Percent from flaring

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf/day)	Component Emission Rate (lb/hr)	Component Emission Rate (tons/yr)
Methane	16.0	89.8	14.4	0.781	898	791	57
Ethane	30.1	5.70	1.71	0.093	57.0	94.1	6.78
Propane	44.1	2.17	0.957	0.052	21.7	52.5	3.78
i-Butane	58.1	0.403	0.234	0.013	4.029	12.9	0.93
n-Butane	58.1	0.529	0.307	0.017	5.285	16.9	1.21
i-Pentane	72.2	0.197	0.142	0.008	1.97	7.78	0.56
n-Pentane	72.2	0.157	0.113	0.006	1.57	6.23	0.45
Hexanes	86.2	0.121	0.104	0.006	1.21	5.72	0.41
Heptanes	100	0.099	0.099	0.005	0.99	5.46	0.39
Octanes	114	0.027	0.031	0.002	0.27	1.69	0.12
Nonanes	128	0.000	0.000	0.000	0.00	0.00	0.00
Decanes +	142	0.000	0.000	0.000	0.00	0.00	0.00
Benzene	78.1	0.013	0.010	0.001	0.13	0.55	0.04
Toluene	92.1	0.011	0.010	0.001	0.11	0.56	0.04
Ethylbenzene	106	0.000	0.000	0.000	0.00	0.02	0.00
Xylenes	106	0.003	0.003	0.000	0.03	0.16	0.01
n-Hexane	86.2	0.059	0.051	0.003	0.59	2.79	0.20
Helium	4.0	0.000	0.000	0.000	0.00	0.00	0.00
Nitrogen	28.0	0.419	0.117	0.006	4.19	6.44	0.46
Carbon Dioxide	44.0	0.331	0.146	0.008	3.31	8.00	0.58
Oxygen	32.0	0.000	0.000	0.000	0.00	0.00	0.00
Hydrogen Sulfide	34.1	0.000	0.000	0.000	0.00	0.00	0.00
VOC Subtotal		**3.79**	**2.06**	**0.11**	**37.9**	**113**	**8.15**
HAP Subtotal		**0.09**	**0.07**	**0.00**	**0.86**	**4.07**	**0.29**
Total		**100**	**18.4**	**1.00**	**1,000**	**1,012**	**73**

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19. Operations Tailpipe Emissions

Assumptions:

Number of New Pumpers:	5	(Proponent)
Pumper Mileage:	1,500	miles/pumper/month (Proponent)
Total Annual New Pumper Mileage:	90,000	miles/year
Number of Condensate Haul Truck Round Trips:	4	trips per day (Based on Peak Production Proposed Action)
Number of Produced Water Truck Round Trips:	10	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for Condensate Transport:	104	miles (Estimate from Vernal)
Total Annual Condensate Truck Mileage:	531,750	miles/year
Hours of Pumper Operation:	10	hours per day (Assumption)
Hours of Pumper Operation:	3,640	hours per year
Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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								
NOx	3.23	0.18	0.32	8.13	2.62	4.8	2.79	5.1
CO	36.8	2.01	3.7	17.5	5.6	10.3	7.6	14.0
VOC [c]	2.11	0.11	0.21	4.60	1.48	2.71	1.60	2.92
SO_2	0.21	0.01	0.02	0.32	0.10	0.19	0.12	0.21
Greenhouse Gases								
CH_4 [d]	0.18	0.01	0.02	0.23	0.07	0.14	0.08	0.15

[a] AP-42 Append H Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)

[b] AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 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 Pneumatic Emissions

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

Analysis Gas flow 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	89.7593	14.400	78.092	0.898	1.581	6.925
Ethane	30.07	5.7022	1.715	9.299	0.057	0.188	0.825
Propane	44.097	2.1706	0.957	5.191	0.022	0.105	0.460
i-Butane	58.123	0.4029	0.234	1.270	0.004	0.026	0.113
n-Butane	58.123	0.5285	0.307	1.666	0.005	0.034	0.148
i-Pentane	72.15	0.1965	0.142	0.769	0.002	0.016	0.068
n-Pentane	72.15	0.1572	0.113	0.615	0.002	0.012	0.055
Hexanes	86.177	0.1208	0.104	0.565	0.001	0.011	0.050
Heptanes	100.204	0.0993	0.099	0.539	0.001	0.011	0.048
Octanes	114.231	0.0269	0.031	0.167	0.000	0.003	0.015
Nonanes	128.258	0.0000	0.000	0.000	0.000	0.000	0.000
Decanes +	142.285	0.0000	0.000	0.000	0.000	0.000	0.000
Benzene	78.12	0.0128	0.010	0.054	0.000	0.001	0.005
Toluene	92.13	0.0110	0.010	0.055	0.000	0.001	0.005
Ethylbenzene	106.16	0.0003	0.000	0.002	0.000	0.000	0.000
Xylenes	106.16	0.0028	0.003	0.016	0.000	0.000	0.001
n-Hexane	86.177	0.0589	0.051	0.275	0.001	0.006	0.024
Helium	4.003	0.0000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.4190	0.117	0.636	0.004	0.013	0.056
Carbon Dioxide	44.01	0.3310	0.146	0.790	0.003	0.016	0.070
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	**3.788**	**2.062**	**11.183**	**0.038**	**0.226**	**0.992**
	HAP Subtotal	**0.086**	**0.074**	**0.402**	**0.001**	**0.008**	**0.036**
	Total	**100.000**	**18.440**	**100.000**	**1.000**	**2.025**	**8.868**

	Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)
Proposed Action	150	234	1117.7

Liquid Level Controller Specifications

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

Pneumatic Pump Specifications

Gas Consumption Rate:	1.0	Mscf/day
Days of Operation:	182	days/year

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
4	Liquid level controllers	0.13	0.57
1	Pneumatic pump	0.23	0.99
	Totals (per well) =	0.36	1.56

Pneumatic sources / well		Methane lb/hr	Methane ton/yr
4	Liquid level controllers	0.91	3.99
1	Pneumatic pump	1.58	3.46
	Totals (per well) =	2.49	7.45

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21. Operations Traffic Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006
365 operating days per year (Estimate)

Unpaved Roads

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	miles on unpaved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Roads

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
W = average weight in tons of vehicles traveling the road		
Round Trip Miles	82	miles from Vernal on paved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Vehicle Type	Ave. Weight (lbs)	Round Trips per Day		PM_{10} (lb/VMT)	Total PM_{10} (lbs/yr)	PM_{10} (lb/day)	Total $PM_{2.5}$ (lbs/yr)	$PM_{2.5}$ (lb/day)
Pickup Truck: Crew	7,000	5.3						
Haul Truck: Oil	48,000	2.2						
Haul Truck: Water	48,000	9.6	Paved	2.14	803	2.20	80	0.22
Mean Weight	35,327	17.0	Unpaved	0.101	38	0.10	3.8	0.01
					PM_{10}		**$PM_{2.5}$**	
Annual Traffic Fugitive Dust Emissions (tons/year)			**Paved**		**0.40**		**0.040**	
			Unpaved		**0.019**		**0.002**	
			Total		**0.42**		**0.042**	

Assume 3 barrels per day condensate per well
Assume 10,000 gallon condensate truck

22. Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate : 1.0 bbls condensate per day per well (average estimated from surrounding wells)

Size of Development: 150 Producing Wells

Separator Conditions: 337 psi and 78 F (9-17E sample)
API Gravity: 55
Ambient Conditions: 12.64 psi and 52 F

Calculations:
Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0

Emissions:

Component		Well Flash/Work/Breathing (tons/yr/well)	Project Emissions [a] (tons/yr)
Total VOC		1.99	298
Hazardous Air Pollutants			
Benzene		0.015	2.3
Toluene		0.012	1.8
Ethylbenzene		0.000	0.000
Xylenes		0.002	0.30
n-Hexane		0.045	6.8
Total HAPS		0.080	12.0
Greenhouse Gases			
CO_2		0.017	2.55
CH_4		0.77	116

a Assumes maximum development scenario

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23. Wellsite Dehydrator Emissions

Assumptions

Average Production Rate: 0.20 MMscf/day/well (Average for life of the well, Proposed Action)
Number of Active Wells Requiring Separators: 150 wells at Peak Production
Wells Requiring Dehydrators: 150 (100% of wells, Proposed Action)

Gas Composition: RBU 6-18F 2010 sample analysis

Inlet Gas Conditions: 80 psia, 82 degrees F
Pump: 0.030 acfm gas/gpm glycol

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

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Emissions

Species		Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions (tons/year)
Total VOC		0.70	3.08	461
Hazardous Air Pollutants				
Benzene		0.074	0.32	48
Toluene		0.165	0.72	109
Ethylbenzene		0.010	0.04	6.4
Xylenes		0.146	0.64	96
n-Hexane		0.006	0.03	3.9
Greenhouse Gases				
CH_4		0.069	0.30	46

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25. Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	750	Mbtu/hr (Proponent)
Wellsite Dehydrator Reboiler Size	250	Mbtu/hr
Total Wellsite Heater Size	1,000	Mbtu/hr (1@250, 1@750)
Firing Rate	60	minutes/hour on average for entire year (Typical value)
	8,760	hours/year
Fuel Gas Heat Value	1,103	Btu/scf (Gas Analyses from Existing Wells)
Fuel Gas VOC Content	0.112	by weight (Gas Analyses from Existing Wells)
Development size	150	new wells

Equations

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

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

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

	Wellpad Separator Emissions			Wellpad Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions [l] (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Total Emissions (lb/hr)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.075	49	100	0.025	16	0.100	66
CO [a]	84.0	0.063	41	84.0	0.021	13.8	0.084	55
TOC [c]	11.0	0.008	5.4	11.0	0.003	1.8	0.011	7.2
VOC	-	0.001	0.61	-	0.000	0.20	0.001	0.81
SO_2 [b]	-	0.0	0.0	-	0.0	0.0	0.0	0.0
TSP [c]	7.60	0.006	3.7	7.60	0.002	0.008	0.008	3.8
PM_{10} [c]	7.60	0.006	3.7	7.60	0.002	1.248	0.008	5.0
$PM_{2.5}$ [c]	7.60	0.006	3.7	7.60	0.002	1.248	0.008	5.0
Hazardous Air Pollutants								
Benzene [d]	2.10E-03	1.58E-06	1.03E-03	2.10E-03	5.25E-07	3.45E-04	2.10E-06	1.38E-03
Toluene [d]	3.40E-03	2.55E-06	1.68E-03	3.40E-03	8.50E-07	5.58E-04	3.40E-06	2.23E-03
Hexane [d]	1.80E+00	1.35E-03	8.87E-01	1.80E+00	4.50E-04	2.96E-01	1.80E-03	1.18E+00
Formaldehyde [d]	7.50E-02	5.63E-05	3.70E-02	7.50E-02	1.88E-05	1.23E-02	7.50E-05	4.93E-02
Dichlorobenzene [d]	1.20E-03	9.00E-07	5.91E-04	1.20E-03	3.00E-07	1.97E-04	1.20E-06	7.88E-04
Naphthalene [d]	6.10E-04	4.58E-07	3.01E-04	6.10E-04	1.53E-07	1.00E-04	6.10E-07	4.01E-04
POM 2 [d,e,f]	5.90E-05	4.43E-08	2.91E-05	5.90E-05	1.48E-08	9.69E-06	5.90E-08	3.88E-05
POM 3 [d,g]	1.60E-05	1.20E-08	7.88E-06	1.60E-05	4.00E-09	2.63E-06	1.60E-08	1.05E-05
POM 4 [d,h]	1.80E-06	1.35E-09	8.87E-07	1.80E-06	4.50E-10	2.96E-07	1.80E-09	1.18E-06
POM 5 [d,i]	2.40E-06	1.80E-09	1.18E-06	2.40E-06	6.00E-10	3.94E-07	2.40E-09	1.58E-06
POM 6 [d,j]	7.20E-06	5.40E-09	3.55E-06	7.20E-06	1.80E-09	1.18E-06	7.20E-09	4.73E-06
POM 7 [d,k]	1.8E-06	1.35E-09	8.87E-07	1.8E-06	4.50E-10	2.96E-07	1.80E-09	1.18E-06
Greenhouse Gases								
CO_2 [c]	120,000	90.0	59,130	120,000	30.0	19,710	120	78,840
CH_4 [c]	2.30	1.73E-03	1.13	2.30	5.75E-04	0.38	2.30E-03	1.51
N_2O [c]	2.20	1.65E-03	1.08	2.20	5.50E-04	0.36	2.20E-03	1.45

[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 $PM_{1.0}$)

[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,

[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 maximum development scenario

Kleinfelder/Buys

Project: XTO RBU, Alternative D
Date: 11/15/2011

24. Wellsite Pumping Unit Engines

Assumptions:

Pumpjack Engine Size:	21.2	Horsepower (Estimate)
Number of Wells Requiring Pumping Unit Engines:	23	wells at Peak Production

Equations:

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

Wellsite Pumping Unit Engines Emissions (old engines)

Pollutant	Emission Factor [1] (lb/MMBtu)	Emission Factor [3] (g/hp-hr)	Emissions (lb/hr/well)	Total Emissions [7] Proposed Action (tons/yr)
Criteria Pollutants & VOC				
NOx	2.21	11.1	0.52	52.2
CO	3.72	18.7	0.87	87.9
VOC	0.03	0.15	0.01	0.7
PM_{10} [4]	1.94E-02	9.75E-02	4.56E-03	0.5
$PM_{2.5}$ [4]	1.94E-02	9.75E-02	4.56E-03	0.5
SO_2 [2]	0.0	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	1.58E-03	7.93E-03	3.7E-04	0.04
Toluene	5.58E-04	2.80E-03	1.3E-04	0.01
Ethylbenzene	2.48E-05	1.25E-04	5.8E-06	0.00
Xylenes	1.95E-04	9.79E-04	4.6E-05	0.00
Formaldehyde	2.05E-02	1.03E-01	4.8E-03	0.5
Acetaldehyde	2.79E-03	1.40E-02	6.5E-04	0.07
Acrolein	2.63E-03	1.32E-02	6.2E-04	0.06
Methanol	3.06E-03	1.54E-02	7.2E-04	0.07
1,1,2,2-Tetrachloroethane	2.53E-05	1.27E-04	5.9E-06	5.98E-04
1,1,2-Trichloroethane	1.53E-05	7.68E-05	3.6E-06	3.62E-04
1,3-Dichloropropene	1.27E-05	6.38E-05	3.0E-06	3.00E-04
1,3-Butadiene	6.63E-04	3.33E-03	1.6E-04	1.57E-02
Carbon Tetrachloride	1.77E-05	8.89E-05	4.2E-06	4.18E-04
Chlorobenzene	1.29E-05	6.48E-05	3.0E-06	3.05E-04
Chloroform	1.37E-05	6.88E-05	3.2E-06	3.24E-04
Ethylene Dibromide	2.13E-05	1.07E-04	5.0E-06	5.04E-04
Methylene Chloride	4.12E-05	2.07E-04	9.7E-06	9.74E-04
Naphthalene	9.71E-05	4.88E-04	2.3E-05	2.30E-03
Styrene	1.19E-05	5.98E-05	2.8E-06	2.81E-04
Vinyl Chloride	7.18E-06	3.61E-05	1.7E-06	1.70E-04
PAH -POM 1 [6]	1.41E-04	7.08E-04	3.3E-05	3.33E-03
Greenhouse Gases				
CO_2 [5]	110	2,557	120	12,041
CH_4	0.23	1.15	0.05	5

Wellsite Pumping Unit Engines Emissions (JJJJ compliant new engines)

Pollutant	Emission Factor [1] (lb/MMBtu)	Emission Factor [3] (g/hp-hr)	Emissions (lb/hr/well)	Total Emissions [7] Proposed Action (tons/yr)
Criteria Pollutants & VOC				
NOx	-	2.0	0.09	9
CO	-	4.0	0.19	19
VOC	-	1.0	0.05	5
PM_{10} [4]	1.94E-02	9.75E-02	4.56E-03	0.5
$PM_{2.5}$ [4]	1.94E-02	9.75E-02	4.56E-03	0.5
SO_2 [2]	0.0	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	1.58E-03	7.93E-03	3.7E-04	0.04
Toluene	5.58E-04	2.80E-03	1.3E-04	0.01
Ethylbenzene	2.48E-05	1.25E-04	5.8E-06	0.00
Xylenes	1.95E-04	9.79E-04	4.6E-05	0.00
Formaldehyde	2.05E-02	1.03E-01	4.8E-03	0.5
Acetaldehyde	2.79E-03	1.40E-02	6.5E-04	0.07
Acrolein	2.63E-03	1.32E-02	6.2E-04	0.06
Methanol	3.06E-03	1.54E-02	7.2E-04	0.07
1,1,2,2-Tetrachloroethane	2.53E-05	1.27E-04	5.9E-06	5.98E-04
1,1,2-Trichloroethane	1.53E-05	7.68E-05	3.6E-06	3.62E-04
1,3-Dichloropropene	1.27E-05	6.38E-05	3.0E-06	3.00E-04
1,3-Butadiene	6.63E-04	3.33E-03	1.6E-04	1.57E-02
Carbon Tetrachloride	1.77E-05	8.89E-05	4.2E-06	4.18E-04
Chlorobenzene	1.29E-05	6.48E-05	3.0E-06	3.05E-04
Chloroform	1.37E-05	6.88E-05	3.2E-06	3.24E-04
Ethylene Dibromide	2.13E-05	1.07E-04	5.0E-06	5.04E-04
Methylene Chloride	4.12E-05	2.07E-04	9.7E-06	9.74E-04
Naphthalene	9.71E-05	4.88E-04	2.3E-05	2.30E-03
Styrene	1.19E-05	5.98E-05	2.8E-06	2.81E-04
Vinyl Chloride	7.18E-06	3.61E-05	1.7E-06	1.70E-04
PAH -POM 1 [6]	1.41E-04	7.08E-04	3.3E-05	3.33E-03
Greenhouse Gases				
CO_2 [5]	110	2,557	120	12,041
CH_4	0.23	1.15	0.05	5

[1] AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00

[2] Fuel gas is assumed to be free from sulfur compounds (see gas analysis)

[3] Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 11,070 Btu/hp-hr (11,070/1,000,000 *453.6 = 5.02135 multiplier)

[4] PM = sum of PM filterable and PM condensable

[5] Based on 99.5% conversion of the fuel carbon to CO_2 (AP-42 Table 3.2-3 footnote d)

[6] Polycyclic Aromatic Hydrocarbons (PAH), 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

[7] Estimated at full project production.

26. Well Production Summary

Species	Production Heaters (tons/yr)	Storage Tanks (tons/yr)	Well Dehydrators (tons/yr)	Well Pumping Unit Engines [a] (tons/yr)	Operations Vehicle (tons/yr)	Well Blowdown (tons/yr)	Total Well Production [b] (tons/yr)
Criteria Pollutants & VOC							
NO_x	66	0.0	0.0	9	5.1	0.0	80
CO	55	0.0	0.0	19	14.0	0.0	88
VOC	0.81	298	461	5	2.92	8	776
SO_2	0.0	0.0	0.0	0.0	0.21	0.0	0.21
PM_{10}	5.0	0.0	0.0	0.5	0.42	0.0	6
$PM_{2.5}$	5.0	0.0	0.0	0.5	0.04	0.0	5.5
Hazardous Air Pollutants							
Benzene	1.4E-03	2.3	48	0.04	0.0	0.04	51
Toluene	2.2E-03	1.8	109	0.01	0.0	0.04	111
Ethylbenzene	0.0	0.00	6.4	0.00	0.0	0.00	6.4
Xylene	0.0	0.30	96	0.00	0.0	0.01	96
n-Hexane	1.18	6.8	3.9	0.0	0.0	0.20	12
Formaldehyde	0.05	0.0	0.0	0.5	0.0	0.0	0.5
Total HAPs	1.24	11	263	0.5	0.0	0.29	276
Greenhouse Gases							
CO_2	78,840	0.0	0.0	12,041	0.0	0.6	90,881
CH_4	1.51	0.0	46	5	0.15	57	110
N_2O	1.45	0.0	0.0	0.0	0.0	0.0	1.45

[a] Well pumping unit engine emissions are for JJJJ compliant engines

[b] Emissions for Peak Field Development

Kleinfelder/Buys	Project: XTO RBU, Alternative D Date: 11/15/2011

27. Production Heater Emissions

Assumptions

Central Separator Heater Size	750	Mbtu/hr (Proponent)
Central Dehydrator Reboiler Heater Size	750	Mbtu/hr
Total Central Facility Heater Requirement:	1500	Mbtu/hr
Firing Rate	60	minutes/hour on average for entire year (Typical value)
	8760	hours/year
Fuel Gas Heat Value	1103	Btu/scf (Gas Analyses from Existing Wells)
Fuel Gas VOC Content	0.112	by weight (Gas Analyses from Existing Wells)
Development size	3	Facilities

Equations

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

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

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

	Central Facility Separator Emissions			Central Facility Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/facility)	Total Emissions [l] (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions [l] (tons/yr)	Total Emissions (lb/hr)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.075	0.99	100	0.075	0.986	0.750	1.97
CO [a]	84.0	0.063	0.83	84.0	0.063	0.828	0.630	1.66
TOC [a]	11.0	0.008	0.108	11.0	0.008	0.108	0.083	0.22
VOC	N.A.	0.001	0.012	N.A.	0.001	0.012	0.009	0.02
SO_X [b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TSP [c]	7.60	5.70E-03	0.075	7.60	5.70E-03	0.075	0.057	0.150
PM_{10} [c]	7.60	5.70E-03	0.075	7.60	5.70E-03	0.075	0.057	0.150
$PM_{2.5}$ [c]	7.60	5.70E-03	0.075	7.60	5.70E-03	0.075	0.057	0.150
Hazardous Air Pollutants								
Benzene [d]	2.10E-03	1.58E-06	2.07E-05	2.10E-03	1.58E-06	2.07E-05	1.58E-05	4.14E-05
Toluene [d]	3.40E-03	2.55E-06	3.35E-05	3.40E-03	2.55E-06	3.35E-05	2.55E-05	6.70E-05
Hexane [d]	1.80	1.35E-03	1.77E-02	1.80	1.35E-03	1.77E-02	0.014	0.035
Formaldehyde [d]	7.50E-02	5.63E-05	7.39E-04	7.50E-02	5.63E-05	7.39E-04	5.63E-04	1.48E-03
Dichlorobenzene [e]	1.2E-03	9.00E-07	1.18E-05	1.2E-03	9.00E-07	1.18E-05	1.80E-06	2.37E-05
Naphthalene [d]	6.1E-04	4.58E-07	6.01E-06	6.1E-04	4.58E-07	6.01E-06	9.15E-07	1.20E-05
POM 2 [d,e,f]	5.9E-05	4.43E-08	5.81E-07	5.9E-05	4.43E-08	5.81E-07	8.85E-08	1.16E-06
POM 3 [d,g]	1.6E-05	1.20E-08	1.58E-07	1.6E-05	1.20E-08	1.58E-07	2.40E-08	3.15E-07
POM 4 [d,h]	1.8E-06	1.35E-09	1.77E-08	1.8E-06	1.35E-09	1.77E-08	2.70E-09	3.55E-08
POM 5 [d,i]	2.4E-06	1.80E-09	2.37E-08	2.4E-06	1.80E-09	2.37E-08	3.60E-09	4.73E-08
POM 6 [d,j]	7.2E-06	5.40E-09	7.10E-08	7.2E-06	5.40E-09	7.10E-08	1.08E-08	1.42E-07
POM 7 [d,k]	1.8E-06	1.35E-09	1.77E-08	1.8E-06	1.35E-09	1.77E-08	2.70E-09	3.55E-08
Greenhouse Gases								
CO_2 [a]	120,000	90.0	1,183	120,000	90.0	1,183	180.0	2,365
CH_4 [a]	2.30	1.73E-03	2.27E-02	2.30	1.73E-03	0.023	3.45E-03	0.045
N_2O [c]	2.20	1.65E-03	2.17E-02	2.20	1.65E-03	0.022	3.30E-03	0.043

[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 $PM_{1.0}$)

[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

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

[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 maximum development scenario

0.309917 0.340909

9 5.13

Kleinfelder/Buys	Project: XTO RBU, Alternative D Date: 11/15/2011

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

Assumptions:

Average Condensate Production Rate :

Per Facility 10.85 bbls condensate per day (Estimate based on similar facility data)

Total new/modified Facilities 3

Calculations:

Separator Conditions : 400 psi and 95 F (Sample Conditions)
Ambient Conditions: 12.64 psi and 52 F

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0
Kings Canyon Compressor Station Liquid Sample
Assumes 95% emission control

Emissions:

Component	Facility Flash/Work/ Breathing (tons/yr)	Total Emissions * (tons/yr)
Total VOC	2.03	6
Hazardous Air Pollutants		
Benzene	0.01	0.02
Toluene	0.01	0.02
Ethylbenzene	0.00	0.00
Xylenes	0.00	0.01
n-Hexane	0.03	0.08
Total HAP's	0.03	0.10
Greenhouse Gases		
CO_2	0.31	0.93
CH_4	0.40	1.2

*Based on total facilities

Kleinfelder/Buys	Project: XTO RBU, Alternative D Date: 11/15/2011

29. Central TEG Dehydrator Emissions

Assumptions

Production Rate: 34 MMscf/day total (all new production)

Gas Composition: Kings Canyon 2008 sample analysis

Inlet Gas Conditions: Inlet gas saturated at 814 psia and 98 F
Pump: 0.032 acfm gas/gpm glycol

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

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95% Control Efficiency in order to meet Federal MACT Standards

Emissions

Species	Central Dehydrator Emissions (lb/hr)	Total Project Emissions (tons/year)
VOC	3.61	15.8
Benzene	0.38	1.7
Toluene	0.97	4.2
Ethylbenzene	0.07	0.3
Xylenes	0.95	4.2
n-Hexane	0.03	0.1
Total HAPs	2.40	10.5
Greenhouse Gases		
CH_4	1.23	5.4

Kleinfelder/Buys

Project: XTO RBU, Alternative D
Date: 11/15/2011

30. Central Compression

Assumptions:

Engine Type: TBD
Proposed Engine Capacity Increase: 2,905 horsepower (Proponent)

Equations:

Emissions (g/hp-hr) = average heat rate of 8,000 btu/hp-hr (8,000/1,000,000 *453.6 = 3.6288 multiplier)

Emissions (lbs/hr) = Emission Factor (g/hp-hr) * Power (hp) / 453.6 g/lb

Pollutant	Emission Factor [a, b] (lb/MMBtu)	Emission Factor [d] (g/hp-hr)	Emissions (lb/hr)	Emissions [c] (tons/yr)
Criteria Pollutants & VOC				
NOx [j]	-	1.00	6.4	28.1
CO [d]	-	0.190	1.2	5.3
VOC [d]	-	0.460	3	12.9
PM_{10} [e]	9.95E-03	0.036	0.23	1.01
$PM_{2.5}$ [e]	9.95E-03	0.036	0.23	1.01
SO_2 [f]	5.88E-04	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	4.40E-04	3.83E-04	2.45E-03	1.07E-02
Toluene	4.08E-04	3.55E-04	2.28E-03	9.97E-03
Ethylbenzene	3.97E-05	3.46E-05	2.21E-04	9.70E-04
Xylenes	1.84E-04	1.60E-04	1.03E-03	4.50E-03
n-Hexane	1.11E-03	9.67E-04	6.19E-03	2.71E-02
Formaldehyde	-	6.00E-02	3.84E-01	1.68E+00
Acetaldehyde	8.36E-03	7.28E-03	4.66E-02	2.04E-01
Acrolein	5.14E-03	4.48E-03	2.87E-02	1.26E-01
Methanol	2.50E-03	2.18E-03	1.39E-02	6.11E-02
1,1,2,2-Tetrachloroethane	4.00E-05	3.48E-05	2.23E-04	9.77E-04
1,1,2-Trichloroethane	3.18E-05	2.77E-05	1.77E-04	7.77E-04
1,3-Dichloropropene	2.64E-05	2.30E-05	1.47E-04	6.45E-04
1,3-Butadiene	2.67E-04	2.33E-04	1.49E-03	6.52E-03
2,2,4-Trimethylpentane	2.50E-04	2.18E-04	1.39E-03	6.11E-03
Biphenyl	2.12E-04	1.85E-04	1.18E-03	5.18E-03
Carbon Tetrachloride	3.67E-05	3.20E-05	2.05E-04	8.97E-04
Chlorobenzene	3.04E-05	2.65E-05	1.70E-04	7.43E-04
Chloroform	2.85E-05	2.48E-05	1.59E-04	6.96E-04
Ethylene Dibromide	4.43E-05	3.86E-05	2.47E-04	1.08E-03
Methylene Chloride	2.00E-05	1.74E-05	1.12E-04	4.89E-04
Naphthalene	7.44E-05	6.48E-05	4.15E-04	1.82E-03
Phenol	2.40E-05	2.09E-05	1.34E-04	5.86E-04
Styrene	2.36E-05	2.06E-05	1.32E-04	5.77E-04
Tetrachloroethane	2.48E-06	2.16E-06	1.38E-05	6.06E-05
Vinyl Chloride	1.49E-05	1.30E-05	8.31E-05	3.64E-04
PAH -POM 1 [g, h]	2.69E-05	2.34E-05	1.50E-04	6.57E-04
POM 2 [h, i]	5.93E-05	5.17E-05	3.31E-04	1.45E-03
Benzo(b)fluoranthene/POM6 [h]	1.66E-07	1.45E-07	9.26E-07	4.06E-06
Chrysene/POM7 [h]	6.93E-07	6.04E-07	3.87E-06	1.69E-05
Greenhouse Gases				
CO_2	110	399	2,556	11,197
CH_4	1.25	4.54	29	127

[a] AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/00

[b] Compressor engines compliant with RICE MACT standards, Table 2.a (93% reduction of CO or 14 ppmvd Formaldehyde)

[c] Assumes maximum development scenario

[d] Emission rates based on information from catalyst emissions reduction manufacturer (including 90% CO reduction, 76% formaldehyde and 76% VOC reductions)

[e] PM = sum of PM filterable and PM condensable

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

[g] Polycyclic Aromatic Hydrocarbons (PAH) defined as a HAP by Section 112(b) of the Clean Air Act because it is Polycyclic Organic Matter (POM) AP-42 Table 1.4-3 footnotes.

[h] 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

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

[j] NO_X emission rate reflects 1.0 g/s requirement mandated by the BLM Vernal Field Office

31. Development Emissions Sumary

Pollutant	Development Emissions (tons/year) [a]					Total
	Construction	Drilling[b]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
NO_X	0.28	125	16.8	0.04	0.00	142
CO	1.48	100	14.4	0.32	0.00	116
VOC	0.18	29.7	11	0.03	0.00	41
SO_2	0.01	0.45	0.20	0.002	0.00	0.7
PM_{10}	10.90	320	135	1.88	0.03	468
$PM_{2.5}$	1.16	35.3	13.7	0.19	3.84E-03	50
Benzene	0.00	0.06	0.04	0.00	0.00	0.1
Toluene	0.00	0.02	0.04	0.00	0.00	0.1
Ethylbenzene	0.00	0.00	0.00	0.00	0.00	0.001
Xylene	0.00	0.02	0.01	0.00	0.00	0.0
n-Hexane	0.00	0.00	0.20	0.00	0.00	0.2
Formaldehyde	0.00	6.49E-03	3.69E-04	0.00	0.00	0.007
Acrolein	0.00	6.48E-04	3.54E-05	0.00	0.00	6.8E-04
1,3-Butadiene	0.00	0.00	2.24E-06	0.00	0.00	2.2E-06
Greenhouses Gases						
CO_2	0.00	12,722	601	0.00	0.00	13,323
CH_4	1.06E-02	8.0	57	1.83E-03	0.00	65
N_2O	0.00	0.00	0.00	0.00	0.00	0

[a] Assumes 60 wells/yr development scenario

[b] Drilling emissions assumes Tier II drill rig engines

Kleinfelder/Buys	Project: XTO RBU, Alternative D Date: 11/15/2011

32. Total Project Production Related Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a]							Total
	Pump Unit Engines	Production Heaters	Stock Tanks	TEG Dehys	Operations Vehicle	Pneumatics	Compressor Engines	(tons/year)
Criteria Pollutants & VOC								
NO_X	9	68	0.00	0.00	5.1	0.0	28	110
CO	19	57	0.00	0.00	14.0	0.0	5	95
VOC	5	0.83	304	477	2.92	234.4	13	1,037
SO_2	0.00	0.00	0.00	0.00	0.21	0.0	0.00	0.21
PM_{10}	0.5	5.1	0.00	0.00	0.42	0.0	1.0	7
$PM_{2.5}$	0.5	5.1	0.00	0.00	0.04	0.0	1.0	7
Hazardous Air Pollutants								
Benzene	0.04	0.00	2.3	50	0.00	0.0	0.01	52
Toluene	0.01	0.00	1.8	113	0.00	0.0	0.01	115
Ethylbenzene	0.00	0.00	0.0	6.7	0.00	0.0	0.00	6.7
Xylene	0.00	0.00	0.3	100	0.00	0.0	0.00	100
n-Hexane	0.00	1.22	6.8	4.1	0.00	0.0	0.03	12
Formaldehyde	0.5	0.05	0.00	0.00	0.00	0.0	1.7	2.2
Acetaldehyde	0.07	0.00	0.00	0.00	0.00	0.0	0.2	0.3
Acrolein	0.06	0.00	0.00	0.00	0.00	0.0	0.13	0.19
Methanol	0.07	0.00	0.00	0.00	0.00	0.0	0.06	0.13
1,1,2,2-Tetrachloroethane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,1,2-Trichloroethane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,3-Dichloropropene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,3-Butadiene	0.02	0.00	0.00	0.00	0.00	0.0	0.01	0.02
2,2,4-Trimethylpentane	0.00	0.00	0.00	0.00	0.00	0.0	0.01	0.01
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.0	0.01	0.01
Carbon Tetrachloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Chlorobenzene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Chloroform	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Ethylene Dibromide	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Methylene Chloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Naphthalene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Phenol	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Styrene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Vinyl Chloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
PAH -POM 1	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
POM 2	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Benzo(b)fluoranthene/POM6	0.00	0.00	0.00	0.00	0.00	0.0	4.06E-06	4.06E-06
Chrysene/POM7	0.00	0.00	0.00	0.00	0.00	0.0	1.69E-05	1.69E-05
Greenhouse Gases								
CO_2	12,041	81,205	3.5	0.00	0.00	0.0	11,197	104,447
CH_4	5	1.56	117	51	0.15	1117.7	127	1,420
N_2O	0.00	1.49	0.00	0.00	0.00	0.0	0.00	1.49

a Assumes maximum development scenario

APPENDIX F-3

Emissions Inventories for Alternative C

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

1. Road Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Estimate)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98 & 7/98

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

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content }\%)^{1.5} * (\text{soil moisture content }\%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.0296	0.75	1.97	0.0099	0.25	1.00
PM_{15}	0.50	0.0075	0.19	0.50	0.0025	0.06	0.26
PM_{10}	0.38	0.0056	0.14	0.19	0.0009	0.02	0.17
$PM_{2.5}$	0.21	0.0031	0.08	0.10	0.0005	0.01	0.09

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

b Assumes maximum development scenario

2. Road Construction Emissions (Grader)

Assumptions:

Grading Length	0.67	miles (0.212 miles/pad x 3 swaths (10' per swath))
Hours of Construction	1	day grading per well pad and road (Estimate)
	10	hours/day
	10	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	0.67	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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 (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions = 1.81 lbs TSP/well pad

Emissions = 0.86 lbs PM_{15}/well pad

	Grader Construction Emissions			
	lbs/well pad	lbs/hr/well pad	tons/well pad	tons/yr [a]
TSP	1.81	0.18	9.04E-04	2.30E-02
PM_{15}	0.86	0.09	4.32E-04	1.10E-02
PM_{10}	0.52	0.05	2.59E-04	6.60E-03
$PM_{2.5}$	0.06	0.01	2.80E-05	7.13E-04

a Assumes maximum development scenario

3. Well Pad Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Proposed Action)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

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) = $5.7 * (\text{soil silt content }\%)^{1.2} * (\text{soil moisture content }\%)^{-1.3} *$ Control Efficiency

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content }\%)^{1.5} * (\text{soil moisture content }\%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.0296	0.75	1.97	0.0099	0.25	1.00
PM_{15}	0.50	0.0075	0.19	0.50	0.0025	0.06	0.26
PM_{10}	0.38	0.0056	0.14	0.38	0.0019	0.05	0.19
$PM_{2.5}$	0.21	0.0031	0.08	0.21	0.0010	0.03	0.11

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

b Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

4. Well Pad Construction Emissions (Grader)

Assumptions:

Grading Length	2.06	miles on 330 ft x 330 ft pad (10 ft swath for 330 ft * 33 lengths)
Hours of Construction	2 10 20	day grading per well pad and road (Estimate) hours/day hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	2.06	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

Emissions = 5.54 lbs TSP/well pad

Emissions = 2.65 lbs PM_{15}/well pad

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/yr [a]**
TSP	5.54	0.28	0.0028	0.07
PM_{15}	2.65	0.13	0.0013	0.03
PM_{10}	1.59	0.08	0.0008	0.02
$PM_{2.5}$	0.17	0.01	0.0001	0.002

a Assumes maximum development scenario

5. New Compressor Station Construction Emissions

Assumptions and Calculations:

All assumptions emission factors, and calculations are the same as those specified in Road Construction Equipment, Road Construction Grader, Well Pad Construction Equipment and Well Pad Grader emissions inventory pages.

Assumes the development of a single additional compressor station with attached roadway

Compressor Station Road Construction Equipment

Pollutant	Dozer Emissions [a]		Backhoe Emissions [a]		Total
	lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr [b]
TSP	1.97	0.030	1.97	0.010	0.039
PM_{15}	0.50	0.008	0.50	0.003	0.010
PM_{10}	0.38	0.006	0.19	0.001	0.007
$PM_{2.5}$	0.21	0.003	0.10	0.001	0.004

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

Compressor Station Road Construction Grader

Pollutant	Grader Construction Emissions		
	lbs/well pad	lbs/hr	tons/yr
TSP	1.81	0.181	9.04E-05
PM_{15}	0.86	0.086	4.32E-05
PM_{10}	0.52	0.052	2.59E-05
$PM_{2.5}$	0.06	0.006	2.80E-06

Compressor Station Construction Equipment

Pollutant	Dozer Emissions [a]		Backhoe Emissions [a]		Total
	lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr [b]
TSP	1.97	0.030	1.97	0.010	0.039
PM_{15}	0.50	0.008	0.50	0.003	0.010
PM_{10}	0.38	0.006	0.38	0.002	0.008
$PM_{2.5}$	0.21	0.003	0.21	0.001	0.004

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

Compressor Station Grader

Pollutant	Grader Construction Emissions		
	lbs/well	lbs/hr	tons/yr
TSP	5.54	0.277	1.39E-04
PM_{15}	2.65	0.133	6.63E-05
PM_{10}	1.59	0.080	3.98E-05
$PM_{2.5}$	0.17	0.009	4.29E-06

Total Compressor Station Construction Emissions

Pollutant	tons/yr
TSP	**0.0790**
PM_{15}	**0.0202**
PM_{10}	**0.0142**
$PM_{2.5}$	**0.0078**

6. Pipeline Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Proposed Action)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	$0.75 * PM_{15}$	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

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

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content }\%)^{1.5} * (\text{soil moisture content }\%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.0296	0.75	1.97	0.0099	0.25	1.00
PM_{15}	0.50	0.0075	0.19	0.50	0.0025	0.06	0.26
PM_{10}	0.38	0.0056	0.14	0.19	0.0009	0.02	0.17
$PM_{2.5}$	0.21	0.0031	0.08	0.10	0.0005	0.01	0.09

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

b Assumes maximum development scenario

7. Pipeline Construction Emissions (Grader)

Assumptions:

Grading Length	5.82	miles pipeline per pad x 3 (3 10' swaths)
Hours of Construction	3	day grading per well pad and road (Estimate)
	10	hours/day
	30	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	5.82	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

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

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions = 15.62 lbs TSP/well

Emissions = 7.48 lbs PM_{15}/well

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/yr [a]**
TSP	15.62	0.52	0.0078	0.20
PM_{15}	7.48	0.25	0.0037	0.10
PM_{10}	4.49	0.15	0.0022	0.06
$PM_{2.5}$	0.48	0.02	0.0002	0.006

a Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

8. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$

$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Calculation AP-42, Chapter 13.2.1
November 2006

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4)))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4)))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	82	From Vernal
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Construction (days/pad and road)

Hours per day 10
Days per pad 9

Vehicle Type	Average Weight (lbs)	Round Trips per Well Pad	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
Semi: Hvy Equip Hauler	60,000	3					
Haul Trucks: Equipment/Fuel/Water	48,000	5					
Pickup Truck: Crew	7,000	10					
Mean Vehicle Weight	27,040	18	1.90	745.3	82.8	74.5	8.3
				Unpaved Roads $PM_{10/15}$ Pads (tons)		**Unpaved Roads $PM_{2.5/15}$ Pads (tons)**	
				9.5		0.9	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.067	98.6	11.0	9.9	1.1
				Paved Roads $PM_{10/15}$ Pads (tons)		**Paved Roads $PM_{2.5/15}$ Pads (tons)**	
				1.25		0.13	

Vertical Drilling (days/well)

Hours per day 10
Days per well 14

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Semi: Hvy Equip Hauler	60,000	60					
Haul Trucks: Equipment/Fuel/Water	48,000	65					
Pickup Truck: Rig Crew	7,000	88					
Mean Vehicle Weight	38,103	213	2.22	10,381	741	1,038	74.1
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				87.2		8.7	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.113	165.4	11.8	16.5	1.2
				Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
				1.39		0.14	

Directional Drilling (days/well)

Hours per day 10
Days per well 21

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Semi: Hvy Equip Hauler	60,000	60					
Haul Trucks: Equipment/Fuel/Water	48,000	65					
Pickup Truck: Rig Crew	7,000	88					
Mean Vehicle Weight	38,103	213	2.22	10,381	494.3	1,038	49.4
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				224.2		22.4	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.113	165.4	7.9	16.5	0.8
				Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
				3.57		0.36	

Completion (days/well)

Hours per day 10
Days per pad 10

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Pickup: Completion Rig Crew	7,000	11					
Haul Trucks: Equipment/Fuel/Water	48,000	73					
Mean Vehicle Weight	42,631	84	2.33	4,306	430.6	430.6	43.1
				Unpaved Roads		**Unpaved Roads**	

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

8. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365\text{-}p)/365)$

$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365\text{-}p)/365)$

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Calculation AP-42, Chapter 13.2.1
November 2006

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1\text{-}(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1\text{-}(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	82	From Vernal
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

		PM_{10}/Annual Wells (tons)		$PM_{2.5}$/Annual Wells (tons)	
		129.2		12.9	
Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
	0.134	195.8	19.6	19.6	2.0
		Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
		5.87		0.59	

Interim Reclamation (days/well)

Hours per day 10
Days per pad 2

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Day (lbs)	PM_{10}/Day (lb/day)	$PM_{2.5}$/Day (lbs)	$PM_{2.5}$/Day (lb/day)
Pickup: Crew	7,000	4					
Haul Trucks: Equipment	60,000	1					
Mean Vehicle Weight	17,600	5	1.56	172.1	86.1	17.2	8.6
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				1.4		0.1	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.035	51.5	25.7	5.1	2.6
				Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
				0.43		0.04	

Annual Traffic Fugitive Dust Emissions (tons/year)

	Unpaved Roads PM_{10} (tons)	Unpaved Roads $PM_{2.5}$ (tons)
	452	**45.2**

	Paved Roads PM_{10} (tons)	Paved Roads $PM_{2.5}$ (tons)
	12.52	**1.25**

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

9. 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	672	acres total initial disturbance for roads and pipelines (Proposed Action)
	2,719,483	square meters total initial disturbance for roads and pipelines
	395	acres total initial disturbance for well pads (Proposed Action)
	1,598,506	square meters total initial disturbance for well pads
	1,067	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	0.18	for well pads (Assumption, disturbance at construction and reclamation) constant for dirt roads
Development Period	8	years (Proposed Action)

Equations

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

Erosion Potential P (g/m²/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/m²/period)*Disturbed Area(m²)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 µm	**<10 µm**	**<2.5 µm**
1.0	0.5	0.075

Maximum 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/m²	Road U_t^* Threshold Velocity[a] m/s	Road Erosion Potential g/m²
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	5.12E-02	0.00E+00
PM_{10}	2.56E-02	0.00E+00
$PM_{2.5}$	3.84E-03	0.00E+00

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10. Construction Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Construction	90	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	8	(Proponent)
Number of Pickup Trips	10	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2 \text{ E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6 \text{ (g/lb)} * \text{Fuel Sulfur Content} * 2 \ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.162	0.007	3.23	0.082	0.004	0.245	0.280
CO	17.49	0.349	0.016	36.84	0.939	0.042	1.288	1.474
VOC [c]	4.83	0.097	0.004	2.29	0.058	0.003	0.155	0.177
SO_2	0.32	6.42E-03	2.89E-04	0.21	5.45E-03	2.45E-04	1.19E-02	1.36E-02
CH_4 [e, f]	0.23	4.60E-03	2.07E-04	0.18	4.69E-03	2.11E-04	9.28E-03	1.06E-02

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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11. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Hours of Operation	90	hours/site (Proposed Action)
Development Rate	25	new pads per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Backhoe miles per pad	0.515	miles (Value assumed to be 1/4 of dozer and grader mileage)
Backhoe Hours	30	hours per pad
Dozer miles per pad	2.06	miles (Based on 330 ft x 330 ft pad and 10 ft swath for 330 ft * 33 lengths)
Dozer Hours	90	hours per pad
Grader miles per pad	2.06	miles (Based on 330 ft x 330 ft pad and 10 ft swath for 330 ft * 33 lengths)
Motor Grader Hours	60	hours per pad

Equations:

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

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)
NOx	8.13	1.23E-04	1.85E-06	8.13	1.64E-04	7.38E-06	8.13	2.46E-04	7.38E-06
CO	17.49	2.65E-04	3.97E-06	17.49	3.53E-04	1.59E-05	17.49	5.30E-04	1.59E-05
VOC [b]	4.83	7.31E-05	1.10E-06	4.83	9.75E-05	4.39E-06	4.83	1.46E-04	4.39E-06
CH_4	0.23	3.48E-06	5.22E-08	0.23	4.64E-06	2.09E-07	0.23	6.96E-06	2.09E-07

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [c] (tons/yr)
NOx	5.33E-04	4.23E-04
CO	1.15E-03	9.09E-04
VOC [d]	3.17E-04	2.51E-04
CH_4	1.51E-05	1.88E-07

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario
d AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle

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12. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	457	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	125	(Proponent)
Number of Pickup Trips	88	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2 \text{ E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6 \text{ (g/lb)} * \text{Fuel Sulfur Content} * 2 \text{ (S / } SO_2\text{)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.510	0.117	3.23	0.143	0.033	0.653	8.9
CO	17.5	1.097	0.251	36.8	1.63	0.372	2.72	37.3
VOC [c]	4.83	0.303	0.069	2.29	0.101	0.023	0.404	5.54
SO_2	0.321	2.01E-02	4.60E-03	0.214	9.45E-03	2.16E-03	2.96E-02	0.406
CH_4 [e, f]	0.230	1.44E-02	3.30E-03	0.180	7.95E-03	1.82E-03	2.24E-02	0.307

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

13. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	100	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	73	(Proponent)
Number of Pickup Trips	11	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2 \text{ E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6 \text{ (g/lb)} * \text{Fuel Sulfur Content} * 2 \text{ } (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	1.361	0.068	3.23	0.081	0.004	1.442	4.327
CO	17.49	2.927	0.146	36.84	0.929	0.046	3.856	11.569
VOC [c]	4.83	0.808	0.040	2.29	0.058	0.003	0.866	2.598
SO_2	0.32	5.38E-02	2.69E-03	0.21	5.40E-03	2.70E-04	5.92E-02	0.177
CH_4 [e, f]	0.23	3.85E-02	1.92E-03	0.18	4.54E-03	2.27E-04	4.30E-02	0.129

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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14. Reclamation Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	20	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	1	(Assumption)
Number of Pickup Trips	4	(Assumption)
Diesel Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2 \text{ E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6 \text{ (g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Development Vehicles	**Heavy Haul Trucks**			**Heavy Duty Pickups**			**Total** [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.093	0.001	3.23	0.148	0.001	0.241	0.041
CO	17.49	0.201	0.002	36.84	1.689	0.017	1.890	0.317
VOC [c]	4.83	0.055	0.001	2.29	0.105	0.001	0.160	0.027
SO_2	0.32	3.68E-03	3.68E-05	0.21	9.82E-03	9.82E-05	1.35E-02	2.27E-03
CH_4 [e, f]	0.23	2.64E-03	2.64E-05	0.18	8.25E-03	8.25E-05	1.09E-02	1.83E-03

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

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15. Drill Rig Engine Emissions

Assumptions:

Hours of Operation	457	hours/well (Proposed Action)
Development Rate	60	wells per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Phase I engine	2,000	hp (used 14% of drilling duration)
Phase II engine	2,000	hp (used 86% of drilling duration)
Diesel Fuel Sulfur Content	0.0005	percent (EPA standard value)

Equations:

Emission factor conversion: lb/hp-hr = AP-42 emission factor (lb/MMbtu) * 7500 Average BTU/hp-hr / 1,000,000

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

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

Species	Drill Rig Emissions (Tier 0 Engines)		
	E. Factor (lb/hp-hr)	**Emissions (lb/hr)**	**Emissions [g] (tons/yr)**
Criteria Pollutants & VOC			
NOx [b]	0.024	19.20	263
CO [b]	5.50E-03	4.40	60
VOC [b]	7.05E-04	0.56	7.7
PM_{10} [b]	4.30E-04	0.34	4.71
$PM_{2.5}$ [b]	3.59E-04	0.29	3.94
SO_2 [b]	4.05E-06	3.24E-03	4.44E-02
Hazardous Air Pollutants			
Benzene [d]	5.82E-06	4.66E-03	6.38E-02
Toluene [d]	2.11E-06	1.69E-03	2.31E-02
Xylenes [d]	1.45E-06	1.16E-03	1.59E-02
Formaldehyde [d]	5.92E-07	4.73E-04	6.49E-03
Acetaldehyde [d]	1.89E-07	1.51E-04	2.07E-03
Acrolein [d]	5.91E-08	4.73E-05	6.48E-04
Naphthalene [e]	9.75E-07	7.80E-04	1.07E-02
Total PAH [e, f]	1.59E-06	1.27E-03	1.74E-02
Greenhouse Gases			
CO_2 [b]	1.16	928	12,722
CH_4 [b, c]	7.05E-04	0.56	7.7

Species	Drill Rig Emissions (Tier II Engines)		
	E. Factor (lb/hp-hr)	**Emissions (lb/hr)**	**Emissions [g] (tons/yr)**
Criteria Pollutants & VOC			
NOx [a]	0.01058	8.46	116
CO [a]	5.70E-03	4.56	63
VOC [a]	2.20E-03	1.76	24.1
PM_{10} [a]	3.30E-04	0.26	3.62
$PM_{2.5}$ [b]	3.30E-04	0.26	3.62
SO_2 [b]	4.05E-06	3.24E-03	4.44E-02
Hazardous Air Pollutants			
Benzene [d]	5.82E-06	4.66E-03	6.38E-02
Toluene [d]	2.11E-06	1.69E-03	2.31E-02
Xylenes [d]	1.45E-06	1.16E-03	1.59E-02
Formaldehyde [d]	5.92E-07	4.73E-04	6.49E-03
Acetaldehyde [d]	1.89E-07	1.51E-04	2.07E-03
Acrolein [d]	5.91E-08	4.73E-05	6.48E-04
Naphthalene [e]	9.75E-07	7.80E-04	1.07E-02
Total PAH [e, f]	1.59E-06	1.27E-03	1.74E-02
Greenhouse Gases			
CO_2 [b]	1.16	928	12,722
CH_4 [b, c]	7.05E-04	0.56	7.7

Note: The change from Tier 0 to Tier II engines results in emission changes of:

NOx	**-147**	ton/yr
CO	**2**	ton/yr
VOC	**16.4**	ton/yr
PM_{10}	**-1.09**	ton/yr
$PM_{2.5}$	**-0.32**	ton/yr

[a] Emission factors for Tier II nonroad diesel engine emission standards (engines => 750 hp) from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier II emission standards are not set for VOC (listed as Hydrocarbons), so the Tier I Standard is used
note - Tier II or Tier I emission standards are not set for $PM_{2.5}$, so the Tier 0 (AP-42) emission factor is used

[b] AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96
note - VOC emission factor represents total Hydrocarbon Emissions

[c] CH_4 Emission Factor listed in notes of AP-42 Table 3.4-1 as 9% of Total Organic Compounds

[d] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

[e] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

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

[g] Assumes maximum development scenario

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16. Well Fracturing Pump and Generator Engines

Assumptions:

Average Hours of Operation	4	Hours/Well (Proponents)
Development Rate	60	wells per year (Proposed Action)
Load Factor	0.85	(Proponents)
Frac Pump Engine Horsepower	5,000	Horsepower (1@5000 hp)
Temporary Generator Horsepower	75	Horsepower (Proponents)
Diesel Fuel Sulfur Content	0.0005	percent (typical value)

Equations:

Emission factor conversion: lb/hp-hr = AP-42 emission factor (lb/MMbtu) * 7500 Average BTU/hp-hr / 1,000,000

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

SO_2 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	102.000	12.24
CO [a]	5.50E-03	23.375	2.81
VOC [a,b]	7.05E-04	2.996	0.36
PM_{10} [a,c]	4.30E-04	1.8264	0.2192
$PM_{2.5}$ [a,d]	3.59E-04	1.5268	0.1832
SO_2 [a]	4.05E-06	0.017	0.002
Hazardous Air Pollutants			
Benzene [e]	5.82E-06	2.47E-02	2.97E-03
Toluene [e]	2.11E-06	8.96E-03	1.07E-03
Xylenes [e]	1.45E-06	6.15E-03	7.38E-04
Formaldehyde [e]	5.92E-07	2.51E-03	3.02E-04
Acetaldehyde [e]	1.89E-07	8.03E-04	9.64E-05
Acrolein [e]	5.91E-08	2.51E-04	3.01E-05
Naphthalene [f]	9.75E-07	4.14E-03	4.97E-04
Total PAH [f]	1.59E-06	6.76E-03	8.11E-04
Greenhouse Gases			
CO_2 [a]	1.16	4,930	592
CH_4 [a]	7.05E-04	2.996	0.360

Species	Generator Engine Emissions		
	E. Factor (lb/hp-hr)	**Emissions (lb/hr)**	**Emissions [i] (tons/yr)**
Criteria Pollutants & VOC			
NOx [g]	0.031	1.976	0.24
CO [g]	6.68E-03	0.43	0.05
VOC [b,g]	2.47E-03	0.16	0.02
PM_{10} [g]	2.20E-03	0.14	0.02
$PM_{2.5}$ [g]	2.20E-03	0.14	0.02
SO_2 [g]	2.05E-03	0.13	0.02
Hazardous Air Pollutants			
Benzene [h]	7.00E-06	4.46E-04	5.35E-05
Toluene [h]	3.07E-06	1.96E-04	2.35E-05
Xylenes [h]	2.14E-06	1.36E-04	1.64E-05
Formaldehyde [h]	8.85E-06	5.64E-04	6.77E-05
Acetaldehyde [h]	5.75E-06	3.67E-04	4.40E-05
Acrolein [h]	6.94E-07	4.42E-05	5.31E-06
1,3-Butadiene [h]	2.93E-07	1.87E-05	2.24E-06
Naphthalene [h]	6.36E-07	4.05E-05	4.87E-06
Total PAH [h]	1.26E-06	8.03E-05	9.64E-06
Greenhouse Gases			
CO_2 [g]	1.15	73.3	8.8
CH_4 [b,g]	2.47E-03	0.157	0.02

[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, Total PM_{10} fraction determined from Table 3.4-2

[d] Total particulate emission factor is 0.0007, $PM_{2.5}$ fraction determined from Table 3.4-2

[e] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, 10/96

[f] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, 10/96

[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, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, 10/96

[i] Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

17. Average Produced Gas Characteristics
RBU Compressor Station
Average of 9-17E, West Willow Creek, Tap 1, Tap 4 and Tap 5 facility inlet gases

Gas Heat Value (wet): 1103.4 Btu/scf

C1-C2 Wt. Fraction:	0.8739
VOC Wt. Fraction:	0.1118
Non-HC Wt. Fraction:	0.0143
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	89.8	16.0	14.4	0.78	1,010	907	910	817
Ethane	5.70	30.1	1.71	0.09	1,770	101	1,618	92.3
Propane	2.17	44.1	0.96	0.05	2,516	54.6	2,316	50.3
i-Butane	0.40	58.1	0.23	0.01	3,252	13.1	3,005	12.1
n-Butane	0.53	58.1	0.31	0.02	3,262	17.2	3,013	15.9
i-Pentane	0.20	72.2	0.14	0.01	4,001	7.86	3,698	7.27
n-Pentane	0.16	72.2	0.11	0.01	4,009	6.30	3,708	5.83
Hexanes+	0.12	86.2	0.10	0.01	4,756	5.75	4,404	5.32
Heptanes	0.10	100	0.10	0.01	5,503	5.46	5,100	5.06
Octanes	0.03	114	0.03	0.00	6,249	1.68	0.00	0.00
Nonanes	0.00	128	0.00	0.00	6,996	0.00	0.00	0.00
Decanes	0.00	142	0.00	0.00	7,743	0.00	0.00	0.00
Benzene	0.01	78.1	0.01	0.00	3,716	0.47	0.00	0.00
Toluene	0.01	92.1	0.01	0.00	4,445	0.01	0.00	0.00
Ethylbenzene	0.00	106	0.00	0.00	5,192	0.02	0.00	0.00
Xylenes	0.00	106	0.00	0.00	5,184	0.14	0.00	0.00
n-Hexane	0.06	86.2	0.05	0.00	4,756	2.80	0.00	0.00
Helium	0.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.42	28.0	0.12	0.01	0.00	0.00	0.00	0.00
Carbon Dioxide	0.33	44.0	0.15	0.01	0.00	0.00	0.00	0.00
Oxygen	0.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00
Hydrogen Sulfide	0.00	34.1	0.00	0.00	637	0.00	588	0.00
Total	**100**	-	**18.4**	**1.00**	-	**1,123**	-	**1,011**

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

Weight Fraction = Net Mole Weight / Total Mole Weight

18. Well Development Venting

Assumptions: Following completion, wells are vented prior to connection to the gathering pipeline

Venting Period 48 hours (Project Proponents)

Amount of Vented Gas: 1.0 MMscf day (Average volume estimated by proponents)

Development Rate: 60 Wells per year (Project Proponents)

Control Rate 95 Percent from flaring

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf/day)	Component Emission Rate (lb/hr)	Component Emission Rate (tons/yr)
Methane	16.0	89.8	14.4	0.781	898	791	57
Ethane	30.1	5.70	1.71	0.093	57.0	94.1	6.78
Propane	44.1	2.17	0.957	0.052	21.7	52.5	3.78
i-Butane	58.1	0.403	0.234	0.013	4.029	12.9	0.93
n-Butane	58.1	0.529	0.307	0.017	5.285	16.9	1.21
i-Pentane	72.2	0.197	0.142	0.008	1.97	7.78	0.56
n-Pentane	72.2	0.157	0.113	0.006	1.57	6.23	0.45
Hexanes	86.2	0.121	0.104	0.006	1.21	5.72	0.41
Heptanes	100	0.099	0.099	0.005	0.99	5.46	0.39
Octanes	114	0.027	0.031	0.002	0.27	1.69	0.12
Nonanes	128	0.000	0.000	0.000	0.00	0.00	0.00
Decanes +	142	0.000	0.000	0.000	0.00	0.00	0.00
Benzene	78.1	0.013	0.010	0.001	0.13	0.55	0.04
Toluene	92.1	0.011	0.010	0.001	0.11	0.56	0.04
Ethylbenzene	106	0.000	0.000	0.000	0.00	0.02	0.00
Xylenes	106	0.003	0.003	0.000	0.03	0.16	0.01
n-Hexane	86.2	0.059	0.051	0.003	0.59	2.79	0.20
Helium	4.0	0.000	0.000	0.000	0.00	0.00	0.00
Nitrogen	28.0	0.419	0.117	0.006	4.19	6.44	0.46
Carbon Dioxide	44.0	0.331	0.146	0.008	3.31	8.00	0.58
Oxygen	32.0	0.000	0.000	0.000	0.00	0.00	0.00
Hydrogen Sulfide	34.1	0.000	0.000	0.000	0.00	0.00	0.00
VOC Subtotal		**3.79**	**2.06**	**0.11**	**37.9**	**113**	**8.15**
HAP Subtotal		**0.09**	**0.07**	**0.00**	**0.86**	**4.07**	**0.29**
Total		**100**	**18.4**	**1.00**	**1,000**	**1,012**	**73**

19. Operations Tailpipe Emissions

Assumptions:

Number of New Pumpers:	9	(Proponent)
Pumper Mileage:	1,500	miles/pumper/month (Proponent)
Total Annual New Pumper Mileage:	162,000	miles/year
Number of Condensate Haul Truck Round Trips:	6	trips per day (Based on Peak Production Proposed Action)
Number of Produced Water Truck Round Trips:	16	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for Condensate Transport:	104	miles (Estimate from Vernal)
Total Annual Condensate Truck Mileage:	835,430	miles/year
Hours of Pumper Operation:	10	hours per day (Assumption)
Hours of Pumper Operation:	3,640	hours per year
Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2 \text{ E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6 \text{ (g/lb)} * \text{Fuel Sulfur Content} * 2 \text{ (S / } SO_2\text{)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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								
NOx	3.23	0.32	0.58	8.13	4.11	7.5	4.43	8.1
CO	36.8	3.61	6.6	17.5	8.8	16.2	12.5	22.8
VOC [c]	2.11	0.21	0.38	4.60	2.33	4.25	2.53	4.63
SO_2	0.21	0.02	0.04	0.32	0.16	0.30	0.18	0.34
Greenhouse Gases								
CH_4 [d]	0.18	0.02	0.03	0.23	0.12	0.21	0.13	0.25

[a] AP-42 Append H Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)

[b] AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 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

Kleinfelder/Buys

Project: XTO RBU, Alternative C
Date: 11/15/2011

20. Operations Pneumatic Emissions

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

Analysis Gas flow 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	89.7593	14.400	78.092	0.898	1.581	6.925
Ethane	30.07	5.7022	1.715	9.299	0.057	0.188	0.825
Propane	44.097	2.1706	0.957	5.191	0.022	0.105	0.460
i-Butane	58.123	0.4029	0.234	1.270	0.004	0.026	0.113
n-Butane	58.123	0.5285	0.307	1.666	0.005	0.034	0.148
i-Pentane	72.15	0.1965	0.142	0.769	0.002	0.016	0.068
n-Pentane	72.15	0.1572	0.113	0.615	0.002	0.012	0.055
Hexanes	86.177	0.1208	0.104	0.565	0.001	0.011	0.050
Heptanes	100.204	0.0993	0.099	0.539	0.001	0.011	0.048
Octanes	114.231	0.0269	0.031	0.167	0.000	0.003	0.015
Nonanes	128.258	0.0000	0.000	0.000	0.000	0.000	0.000
Decanes +	142.285	0.0000	0.000	0.000	0.000	0.000	0.000
Benzene	78.12	0.0128	0.010	0.054	0.000	0.001	0.005
Toluene	92.13	0.0110	0.010	0.055	0.000	0.001	0.005
Ethylbenzene	106.16	0.0003	0.000	0.002	0.000	0.000	0.000
Xylenes	106.16	0.0028	0.003	0.016	0.000	0.000	0.001
n-Hexane	86.177	0.0589	0.051	0.275	0.001	0.006	0.024
Helium	4.003	0.0000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.4190	0.117	0.636	0.004	0.013	0.056
Carbon Dioxide	44.01	0.3310	0.146	0.790	0.003	0.016	0.070
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	**3.788**	**2.062**	**11.183**	**0.038**	**0.226**	**0.992**
	HAP Subtotal	**0.086**	**0.074**	**0.402**	**0.001**	**0.008**	**0.036**
	Total	**100.000**	**18.440**	**100.000**	**1.000**	**2.025**	**8.868**

	Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)
Proposed Action	250	391	1862.9

Liquid Level Controller Specifications

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

Pneumatic Pump Specifications

Gas Consumption Rate:	1.0	Mscf/day
Days of Operation:	182	days/year

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
4	Liquid level controllers	0.13	0.57
1	Pneumatic pump	0.23	0.99
	Totals (per well) =	0.36	1.56

Pneumatic sources / well		Methane lb/hr	Methane ton/yr
4	Liquid level controllers	0.91	3.99
1	Pneumatic pump	1.58	3.46
	Totals (per well) =	2.49	7.45

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

21. Operations Traffic Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006
365 operating days per year (Estimate)

Unpaved Roads

$E\ (PM_{10})\ /\ VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365\text{-}p)/365)$

$E\ (PM_{2.5})\ /\ VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365\text{-}p)/365)$

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	miles on unpaved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Roads

$E\ (PM_{10})\ /\ VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E\ (PM_{2.5})\ /\ VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
W = average weight in tons of vehicles traveling the road		
Round Trip Miles	82	miles from Vernal on paved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Vehicle Type	Ave. Weight (lbs)	Round Trips per Day		PM_{10} (lb/VMT)	Total PM_{10} (lbs/yr)	PM_{10} (lb/day)	Total $PM_{2.5}$ (lbs/yr)	$PM_{2.5}$ (lb/day)
Pickup Truck: Crew	7,000	8.8						
Haul Truck: Oil	48,000	3.6						
Haul Truck: Water	48,000	16.0	Paved	2.14	1,338	3.67	134	0.37
Mean Weight	35,327	28.4	Unpaved	0.101	63	0.17	6.3	0.02
					PM_{10}		**$PM_{2.5}$**	
Annual Traffic Fugitive Dust Emissions (tons/year)			**Paved**		**0.67**		**0.067**	
			Unpaved		**0.032**		**0.003**	
			Total		**0.70**		**0.070**	

Assume 3 barrels per day condensate per well
Assume 10,000 gallon condensate truck

22. Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate : 1.0 bbls condensate per day per well (average estimated from surrounding wells)

Size of Development: 250 Producing Wells

Separator Conditions: 337 psi and 78 F (9-17E sample)
API Gravity: 55
Ambient Conditions: 12.64 psi and 52 F

Calculations:
Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0

Emissions:

Component		Well Flash/Work/Breathing (tons/yr/well)	Project Emissions [a] (tons/yr)
Total VOC		1.99	497
Hazardous Air Pollutants			
Benzene		0.015	3.8
Toluene		0.012	3.0
Ethylbenzene		0.000	0.000
Xylenes		0.002	0.50
n-Hexane		0.045	11.3
Total HAPS		0.080	20.0
Greenhouse Gases			
CO_2		0.017	4.25
CH_4		0.77	193

a Assumes maximum development scenario

23. Wellsite Dehydrator Emissions

Assumptions

Average Production Rate: 0.20 MMscf/day/well (Average for life of the well, Proposed Action)
Number of Active Wells Requiring Separators: 250 wells at Peak Production
Wells Requiring Dehydrators: 250 (100% of wells, Proposed Action)

Gas Composition: RBU 6-18F 2010 sample analysis

Inlet Gas Conditions: 80 psia, 82 degrees F
Pump: 0.030 acfm gas/gpm glycol

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

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Tons per year per well are calculated with the conservative estimate that the wellsite dehys could theoretically run 8,760 hours out of the year

Emissions

Species		Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions (tons/year)
Total VOC		0.70	3.08	769
Hazardous Air Pollutants				
Benzene		0.074	0.32	81
Toluene		0.165	0.72	181
Ethylbenzene		0.010	0.04	10.7
Xylenes		0.146	0.64	160
n-Hexane		0.006	0.03	6.6
Greenhouse Gases				
CH_4		0.069	0.30	76

Kleinfelder/Buys	Project: XTO RBU, Alternative C Date: 11/15/2011

25. Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	750	Mbtu/hr (Proponent)
Wellsite Dehydrator Reboiler Size	250	Mbtu/hr
Total Wellsite Heater Size	1,000	Mbtu/hr (1@500, 1@750)
Firing Rate	60	minutes/hour on average for entire year (Typical value)
	8,760	hours/year
Fuel Gas Heat Value	1,103	Btu/scf (Gas Analyses from Existing Wells)
Fuel Gas VOC Content	0.112	by weight (Gas Analyses from Existing Wells)
Development size	250	new wells

Equations

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

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

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

	Wellpad Separator Emissions			Wellpad Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions [l] (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Total Emissions (lb/hr)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.075	82	100	0.025	27	0.100	110
CO [a]	84.0	0.063	69	84.0	0.021	23.0	0.084	92
TOC [c]	11.0	0.008	9.0	11.0	0.003	3.0	0.011	12.0
VOC	-	0.001	1.01	-	0.000	0.34	0.001	1.35
SO_2 [b]	-	0.0	0.0	-	0.0	0.0	0.0	0.0
TSP [c]	7.60	0.006	6.2	7.60	0.002	0.008	0.008	6.2
PM_{10} [c]	7.60	0.006	6.2	7.60	0.002	2.081	0.008	8.3
$PM_{2.5}$ [c]	7.60	0.006	6.2	7.60	0.002	2.081	0.008	8.3
Hazardous Air Pollutants								
Benzene [d]	2.10E-03	1.58E-06	1.72E-03	2.10E-03	5.25E-07	5.75E-04	2.10E-06	2.30E-03
Toluene [d]	3.40E-03	2.55E-06	2.79E-03	3.40E-03	8.50E-07	9.31E-04	3.40E-06	3.72E-03
Hexane [d]	1.80E+00	1.35E-03	1.48E+00	1.80E+00	4.50E-04	4.93E-01	1.80E-03	1.97E+00
Formaldehyde [d]	7.50E-02	5.63E-05	6.16E-02	7.50E-02	1.88E-05	2.05E-02	7.50E-05	8.21E-02
Dichlorobenzene [d]	1.20E-03	9.00E-07	9.86E-04	1.20E-03	3.00E-07	3.29E-04	1.20E-06	1.31E-03
Naphthalene [d]	6.10E-04	4.58E-07	5.01E-04	6.10E-04	1.53E-07	1.67E-04	6.10E-07	6.68E-04
POM 2 [d,e,f]	5.90E-05	4.43E-08	4.85E-05	5.90E-05	1.48E-08	1.62E-05	5.90E-08	6.46E-05
POM 3 [d,g]	1.60E-05	1.20E-08	1.31E-05	1.60E-05	4.00E-09	4.38E-06	1.60E-08	1.75E-05
POM 4 [d,h]	1.80E-06	1.35E-09	1.48E-06	1.80E-06	4.50E-10	4.93E-07	1.80E-09	1.97E-06
POM 5 [d,i]	2.40E-06	1.80E-09	1.97E-06	2.40E-06	6.00E-10	6.57E-07	2.40E-09	2.63E-06
POM 6 [d,j]	7.20E-06	5.40E-09	5.91E-06	7.20E-06	1.80E-09	1.97E-06	7.20E-09	7.88E-06
POM 7 [d,k]	1.8E-06	1.35E-09	1.48E-06	1.8E-06	4.50E-10	4.93E-07	1.80E-09	1.97E-06
Greenhouse Gases								
CO_2 [c]	120,000	90.0	98,550	120,000	30.0	32,850	120	131,400
CH_4 [c]	2.30	1.73E-03	1.89	2.30	5.75E-04	0.63	2.30E-03	2.52
N_2O [c]	2.20	1.65E-03	1.81	2.20	5.50E-04	0.60	2.20E-03	2.41

[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 $PM_{1.0}$)

[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,

[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 maximum development scenario

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24. Wellsite Pumping Unit Engines

Assumptions:

Pumpjack Engine Size:	21.2	Horsepower (Estimate)
Number of Wells Requiring Pumping Unit Engines:	38	wells at Peak Production

Equations:

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

Wellsite Pumping Unit Engines Emissions (old engines)

Pollutant	Emission Factor [1] (lb/MMBtu)	Emission Factor [3] (g/hp-hr)	Emissions (lb/hr/well)	Total Emissions [7] Proposed Action (tons/yr)
Criteria Pollutants & VOC				
NOx	2.21	11.1	0.52	86.3
CO	3.72	18.7	0.87	145.3
VOC	0.03	0.15	0.01	1.2
PM_{10} [4]	1.94E-02	9.75E-02	4.56E-03	0.8
$PM_{2.5}$ [4]	1.94E-02	9.75E-02	4.56E-03	0.8
SO_2 [2]	0.0	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	1.58E-03	7.93E-03	3.7E-04	0.06
Toluene	5.58E-04	2.80E-03	1.3E-04	0.02
Ethylbenzene	2.48E-05	1.25E-04	5.8E-06	0.00
Xylenes	1.95E-04	9.79E-04	4.6E-05	0.01
Formaldehyde	2.05E-02	1.03E-01	4.8E-03	0.8
Acetaldehyde	2.79E-03	1.40E-02	6.5E-04	0.11
Acrolein	2.63E-03	1.32E-02	6.2E-04	0.10
Methanol	3.06E-03	1.54E-02	7.2E-04	0.12
1,1,2,2-Tetrachloroethane	2.53E-05	1.27E-04	5.9E-06	9.88E-04
1,1,2-Trichloroethane	1.53E-05	7.68E-05	3.6E-06	5.98E-04
1,3-Dichloropropene	1.27E-05	6.38E-05	3.0E-06	4.96E-04
1,3-Butadiene	6.63E-04	3.33E-03	1.6E-04	2.59E-02
Carbon Tetrachloride	1.77E-05	8.89E-05	4.2E-06	6.91E-04
Chlorobenzene	1.29E-05	6.48E-05	3.0E-06	5.04E-04
Chloroform	1.37E-05	6.88E-05	3.2E-06	5.35E-04
Ethylene Dibromide	2.13E-05	1.07E-04	5.0E-06	8.32E-04
Methylene Chloride	4.12E-05	2.07E-04	9.7E-06	1.61E-03
Naphthalene	9.71E-05	4.88E-04	2.3E-05	3.79E-03
Styrene	1.19E-05	5.98E-05	2.8E-06	4.65E-04
Vinyl Chloride	7.18E-06	3.61E-05	1.7E-06	2.80E-04
PAH -POM 1 [6]	1.41E-04	7.08E-04	3.3E-05	5.51E-03
Greenhouse Gases				
CO_2 [5]	110	2,557	120	19,894
CH_4	0.23	1.15	0.05	9

Wellsite Pumping Unit Engines Emissions (JJJJ compliant new engines)

Pollutant	Emission Factor [1] (lb/MMBtu)	Emission Factor [3] (g/hp-hr)	Emissions (lb/hr/well)	Total Emissions [7] Proposed Action (tons/yr)
Criteria Pollutants & VOC				
NOx	-	2.0	0.09	16
CO	-	4.0	0.19	31
VOC	-	1.0	0.05	8
PM_{10} [4]	1.94E-02	9.75E-02	4.56E-03	0.8
$PM_{2.5}$ [4]	1.94E-02	9.75E-02	4.56E-03	0.8
SO_2 [2]	0.0	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	1.58E-03	7.93E-03	3.7E-04	0.06
Toluene	5.58E-04	2.80E-03	1.3E-04	0.02
Ethylbenzene	2.48E-05	1.25E-04	5.8E-06	0.00
Xylenes	1.95E-04	9.79E-04	4.6E-05	0.01
Formaldehyde	2.05E-02	1.03E-01	4.8E-03	0.8
Acetaldehyde	2.79E-03	1.40E-02	6.5E-04	0.11
Acrolein	2.63E-03	1.32E-02	6.2E-04	0.10
Methanol	3.06E-03	1.54E-02	7.2E-04	0.12
1,1,2,2-Tetrachloroethane	2.53E-05	1.27E-04	5.9E-06	9.88E-04
1,1,2-Trichloroethane	1.53E-05	7.68E-05	3.6E-06	5.98E-04
1,3-Dichloropropene	1.27E-05	6.38E-05	3.0E-06	4.96E-04
1,3-Butadiene	6.63E-04	3.33E-03	1.6E-04	2.59E-02
Carbon Tetrachloride	1.77E-05	8.89E-05	4.2E-06	6.91E-04
Chlorobenzene	1.29E-05	6.48E-05	3.0E-06	5.04E-04
Chloroform	1.37E-05	6.88E-05	3.2E-06	5.35E-04
Ethylene Dibromide	2.13E-05	1.07E-04	5.0E-06	8.32E-04
Methylene Chloride	4.12E-05	2.07E-04	9.7E-06	1.61E-03
Naphthalene	9.71E-05	4.88E-04	2.3E-05	3.79E-03
Styrene	1.19E-05	5.98E-05	2.8E-06	4.65E-04
Vinyl Chloride	7.18E-06	3.61E-05	1.7E-06	2.80E-04
PAH -POM 1 [6]	1.41E-04	7.08E-04	3.3E-05	5.51E-03
Greenhouse Gases				
CO_2 [5]	110	2,557	120	19,894
CH_4	0.23	1.15	0.05	9

[1] AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00

[2] Fuel gas is assumed to be free from sulfur compounds (see gas analysis)

[3] Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 11,070 Btu/hp-hr (11,070/1,000,000 *453.6 = 5.02135 multiplier)

[4] PM = sum of PM filterable and PM condensable

[5] Based on 99.5% conversion of the fuel carbon to CO_2 (AP-42 Table 3.2-3 footnote d)

[6] Polycyclic Aromatic Hydrocarbons (PAH), 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

[7] Estimated at full project production.

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26. Well Production Summary

Species	Production Heaters (tons/yr)	Storage Tanks (tons/yr)	Well Dehydrators (tons/yr)	Well Pumping Unit Engines [a] (tons/yr)	Operations Vehicle (tons/yr)	Well Blowdown (tons/yr)	Total Well Production [b] (tons/yr)
Criteria Pollutants & VOC							
NO_x	110	0.0	0.0	16	8.1	0.0	133
CO	92	0.0	0.0	31	22.8	0.0	146
VOC	1.35	497	769	8	4.63	8	1,287
SO_2	0.0	0.0	0.0	0.0	0.34	0.0	0.34
PM_{10}	8.3	0.0	0.0	0.8	0.70	0.0	10
$PM_{2.5}$	8.3	0.0	0.0	0.8	0.07	0.0	9.2
Hazardous Air Pollutants							
Benzene	2.3E-03	3.8	81	0.06	0.0	0.04	84
Toluene	3.7E-03	3.0	181	0.02	0.0	0.04	184
Ethylbenzene	0.0	0.00	10.7	0.00	0.0	0.00	10.7
Xylene	0.0	0.50	160	0.01	0.0	0.01	160
n-Hexane	1.97	11.3	6.6	0.0	0.0	0.20	20
Formaldehyde	0.08	0.0	0.0	0.8	0.0	0.0	0.9
Total HAPs	2.06	19	439	0.9	0.0	0.29	461
Greenhouse Gases							
CO_2	131,400	0.0	0.0	19,894	0.0	0.6	151,294
CH_4	2.52	0.0	76	9	0.25	57	145
N_2O	2.41	0.0	0.0	0.0	0.0	0.0	2.41

[a] Well pumping unit engine emissions are for JJJJ compliant engines

[b] Emissions for Peak Field Development

Kleinfelder/Buys

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Date: 11/15/2011

27. Production Heater Emissions

Assumptions

Central Separator Heater Size	750	Mbtu/hr (Proponent)
Central Dehydrator Reboiler Heater Size	750	Mbtu/hr
Total Central Facility Heater Requirement:	1500	Mbtu/hr (1@500, 1@750)
Firing Rate	60	minutes/hour on average for entire year (Typical value)
	8760	hours/year
Fuel Gas Heat Value	1103	Btu/scf (Gas Analyses from Existing Wells)
Fuel Gas VOC Content	0.112	by weight (Gas Analyses from Existing Wells)
Development size	5	Facilities

Equations

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

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

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

	Central Facility Separator Emissions			Central Facility Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/facility)	Total Emissions [l] (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions [l] (tons/yr)	Total Emissions (lb/hr)	Total Emissions [l] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.075	1.64	100	0.075	1.643	0.750	3.29
CO [a]	84.0	0.063	1.38	84.0	0.063	1.380	0.630	2.76
TOC [c]	11.0	0.008	0.181	11.0	0.008	0.181	0.083	0.36
VOC	N.A.	0.001	0.020	N.A.	0.001	0.020	0.009	0.04
SO_X [b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TSP [c]	7.60	5.70E-03	0.125	7.60	5.70E-03	0.125	0.057	0.250
PM_{10} [c]	7.60	5.70E-03	0.125	7.60	5.70E-03	0.125	0.057	0.250
$PM_{2.5}$ [c]	7.60	5.70E-03	0.125	7.60	5.70E-03	0.125	0.057	0.250
Hazardous Air Pollutants								
Benzene [d]	2.10E-03	1.58E-06	3.45E-05	2.10E-03	1.58E-06	3.45E-05	1.58E-05	6.90E-05
Toluene [d]	3.40E-03	2.55E-06	5.58E-05	3.40E-03	2.55E-06	5.58E-05	2.55E-05	1.12E-04
Hexane [d]	1.80	1.35E-03	2.96E-02	1.80	1.35E-03	2.96E-02	0.014	0.059
Formaldehyde [d]	7.50E-02	5.63E-05	1.23E-03	7.50E-02	5.63E-05	1.23E-03	5.63E-04	2.46E-03
Dichlorobenzene [d]	1.2E-03	9.00E-07	1.97E-05	1.2E-03	9.00E-07	1.97E-05	1.80E-06	3.94E-05
Naphthalene [d]	6.1E-04	4.58E-07	1.00E-05	6.1E-04	4.58E-07	1.00E-05	9.15E-07	2.00E-05
POM 2 [d,e,f]	5.9E-05	4.43E-08	9.69E-07	5.9E-05	4.43E-08	9.69E-07	8.85E-08	1.94E-06
POM 3 [d,g]	1.6E-05	1.20E-08	2.63E-07	1.6E-05	1.20E-08	2.63E-07	2.40E-08	5.26E-07
POM 4 [d,h]	1.8E-06	1.35E-09	2.96E-08	1.8E-06	1.35E-09	2.96E-08	2.70E-09	5.91E-08
POM 5 [d,i]	2.4E-06	1.80E-09	3.94E-08	2.4E-06	1.80E-09	3.94E-08	3.60E-09	7.88E-08
POM 6 [d,j]	7.2E-06	5.40E-09	1.18E-07	7.2E-06	5.40E-09	1.18E-07	1.08E-08	2.37E-07
POM 7 [d,k]	1.8E-06	1.35E-09	2.96E-08	1.8E-06	1.35E-09	2.96E-08	2.70E-09	5.91E-08
Greenhouse Gases								
CO_2 [c]	120,000	90.0	1,971	120,000	90.0	1,971	180.0	3,942
CH_4 [c]	2.30	1.73E-03	3.78E-02	2.30	1.73E-03	0.038	3.45E-03	0.076
N_2O [c]	2.20	1.65E-03	3.61E-02	2.20	1.65E-03	0.036	3.30E-03	0.072

[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 $PM_{1.0}$)

[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

[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 maximum development scenario

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

Assumptions:

Average Condensate Production Rate :
Per Facility 10.85 bbls condensate per day (Estimate based on similar facility data)

Total new/modified Facilities 5

Calculations:

Separator Conditions : 400 psi and 95 F (Sample Conditions)
Ambient Conditions: 12.64 psi and 52 F

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0
Kings Canyon Compressor Station Liquid Sample
Assumes 95% emission control

Emissions:

Component	Facility Flash/Work/ Breathing (tons/yr)	Total Emissions * (tons/yr)
Total VOC	2.03	10
Hazardous Air Pollutants		
Benzene	0.01	0.04
Toluene	0.01	0.04
Ethylbenzene	0.00	0.00
Xylenes	0.00	0.01
n-Hexane	0.02	0.10
Total HAP's	0.39	1.96
Greenhouse Gases		
CO_2	0.31	1.55
CH_4	0.40	2.0

*Based on total facilities

29. Central TEG Dehydrator Emissions

Assumptions

Production Rate: 57 MMscf/day total (all new production)

Gas Composition: Kings Canyon 2008 sample analysis

Inlet Gas Conditions: Inlet gas saturated at 814 psia and 98 F
Pump: 0.032 acfm gas/gpm glycol

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

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95% Control Efficiency in order to meet Federal MACT Standards

Emissions

Species	Central Dehydrator Emissions (lb/hr)	Total Project Emissions (tons/year)
VOC	6.02	26.4
Benzene	0.64	2.8
Toluene	1.62	7.1
Ethylbenzene	0.12	0.5
Xylenes	1.58	6.9
n-Hexane	0.05	0.2
Total HAPs	4.00	17.5
Greenhouse Gases		
CH_4	2.05	9.0

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30. Central Compression

Assumptions:

Engine Type: TBD

Proposed Engine Capacity Increase: 4,841 horsepower (Proponent)

Equations:

Emissions (g/hp-hr) = average heat rate of 8,000 btu/hp-hr (8,000/1,000,000 *453.6 = 3.6288 multiplier)

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

Pollutant	Emission Factor [a, b] (lb/MMBtu)	Emission Factor [d] (g/hp-hr)	Emissions (lb/hr)	Emissions [c] (tons/yr)
Criteria Pollutants & VOC				
NOx [j]	-	1.00	10.7	46.7
CO [d]	-	0.190	2.0	8.9
VOC [d]	-	0.460	5	21.5
PM_{10} [e]	9.95E-03	0.036	0.39	1.69
$PM_{2.5}$ [e]	9.95E-03	0.036	0.39	1.69
SO_2 [f]	5.88E-04	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	4.40E-04	3.83E-04	4.09E-03	1.79E-02
Toluene	4.08E-04	3.55E-04	3.79E-03	1.66E-02
Ethylbenzene	3.97E-05	3.46E-05	3.69E-04	1.62E-03
Xylenes	1.84E-04	1.60E-04	1.71E-03	7.49E-03
n-Hexane	1.11E-03	9.67E-04	1.03E-02	4.52E-02
Formaldehyde	-	6.00E-02	6.40E-01	2.80E+00
Acetaldehyde	8.36E-03	7.28E-03	7.77E-02	3.40E-01
Acrolein	5.14E-03	4.48E-03	4.78E-02	2.09E-01
Methanol	2.50E-03	2.18E-03	2.32E-02	1.02E-01
1,1,2,2-Tetrachloroethane	4.00E-05	3.48E-05	3.72E-04	1.63E-03
1,1,2-Trichloroethane	3.18E-05	2.77E-05	2.96E-04	1.29E-03
1,3-Dichloropropene	2.64E-05	2.30E-05	2.45E-04	1.07E-03
1,3-Butadiene	2.67E-04	2.33E-04	2.48E-03	1.09E-02
2,2,4-Trimethylpentane	2.50E-04	2.18E-04	2.32E-03	1.02E-02
Biphenyl	2.12E-04	1.85E-04	1.97E-03	8.63E-03
Carbon Tetrachloride	3.67E-05	3.20E-05	3.41E-04	1.49E-03
Chlorobenzene	3.04E-05	2.65E-05	2.83E-04	1.24E-03
Chloroform	2.85E-05	2.48E-05	2.65E-04	1.16E-03
Ethylene Dibromide	4.43E-05	3.86E-05	4.12E-04	1.80E-03
Methylene Chloride	2.00E-05	1.74E-05	1.86E-04	8.14E-04
Naphthalene	7.44E-05	6.48E-05	6.92E-04	3.03E-03
Phenol	2.40E-05	2.09E-05	2.23E-04	9.77E-04
Styrene	2.36E-05	2.06E-05	2.19E-04	9.61E-04
Tetrachloroethane	2.48E-06	2.16E-06	2.31E-05	1.01E-04
Vinyl Chloride	1.49E-05	1.30E-05	1.38E-04	6.07E-04
PAH -POM 1 [g, h]	2.69E-05	2.34E-05	2.50E-04	1.10E-03
POM 2 [h, i]	5.93E-05	5.17E-05	5.52E-04	2.42E-03
Benzo(b)fluoranthene/POM6 [h]	1.66E-07	1.45E-07	1.54E-06	6.76E-06
Chrysene/POM7 [h]	6.93E-07	6.04E-07	6.44E-06	2.82E-05
Greenhouse Gases				
CO_2	110	399	4,260	18,659
CH_4	1.25	4.54	48	212

[a] AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/00

[b] Compressor engines compliant with RICE MACT standards, Table 2.a (93% reduction of CO or 14 ppmvd Formaldehyde)

[c] Assumes maximum development scenario

[d] Emission rates based on information from catalyst emissions reduction manufacturer (including 90% CO reduction, 76% formaldehyde and 76% VOC reductions)

[e] PM = sum of PM filterable and PM condensable

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

[g] Polycyclic Aromatic Hydrocarbons (PAH) defined as a HAP by Section 112(b) of the Clean Air Act because it is Polycyclic Organic Matter (POM) AP-42 Table 1.4-3 footnotes.

[h] 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

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

[j] NO_X emission rate reflects 1.0 g/s requirement mandated by the BLM Vernal Field Office

31. Development Emissions Sumary

Pollutant	Development Emissions (tons/year) [a]					Total
	Construction	Drilling[b]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
NO_X	0.28	125	16.8	0.04	0.00	142
CO	1.48	100	14.4	0.32	0.00	116
VOC	0.18	29.7	11	0.03	0.00	41
SO_2	0.01	0.45	0.20	0.002	0.00	0.7
PM_{10}	10.90	320	135	1.88	0.03	468
$PM_{2.5}$	1.16	35.3	13.7	0.19	3.84E-03	50
Benzene	0.00	0.06	0.04	0.00	0.00	0.1
Toluene	0.00	0.02	0.04	0.00	0.00	0.1
Ethylbenzene	0.00	0.00	0.00	0.00	0.00	0.001
Xylene	0.00	0.02	0.01	0.00	0.00	0.0
n-Hexane	0.00	0.00	0.20	0.00	0.00	0.2
Formaldehyde	0.00	6.49E-03	3.69E-04	0.00	0.00	0.007
Acrolein	0.00	6.48E-04	3.54E-05	0.00	0.00	6.8E-04
1,3-Butadiene	0.00	0.00	2.24E-06	0.00	0.00	2.2E-06
Greenhouses Gases						
CO_2	0.00	12,722	601	0.00	0.00	13,323
CH_4	1.06E-02	8.0	57	1.83E-03	0.00	65
N_2O	0.00	0.00	0.00	0.00	0.00	0

[a] Assumes 60 wells/yr development scenario

[b] Drilling emissions assumes Tier II drill rig engines

32. Total Project Production Related Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a]							Total [a]
	Pump Unit Engines	Production Heaters	Stock Tanks	TEG Dehys	Operations Vehicle	Pneumatics	Compressor Engines	(tons/year)
Criteria Pollutants & VOC								
NO_X	16	113	0.00	0.00	8.1	0.0	47	183
CO	31	95	0.00	0.00	22.8	0.0	9	157
VOC	8	1.39	507	795	4.63	390.7	22	1,728
SO_2	0.00	0.00	0.00	0.00	0.34	0.0	0.00	0.34
PM_{10}	0.8	8.6	0.00	0.00	0.70	0.0	1.7	12
$PM_{2.5}$	0.8	8.6	0.00	0.00	0.07	0.0	1.7	11
Hazardous Air Pollutants								
Benzene	0.06	0.00	3.8	83	0.00	0.0	0.02	87
Toluene	0.02	0.00	3.0	188	0.00	0.0	0.02	191
Ethylbenzene	0.00	0.00	0.0	11.3	0.00	0.0	0.00	11.3
Xylene	0.01	0.00	0.5	167	0.00	0.0	0.01	167
n-Hexane	0.00	2.03	11.4	6.8	0.00	0.0	0.05	20
Formaldehyde	0.8	0.08	0.00	0.00	0.00	0.0	2.8	3.7
Acetaldehyde	0.11	0.00	0.00	0.00	0.00	0.0	0.3	0.4
Acrolein	0.10	0.00	0.00	0.00	0.00	0.0	0.21	0.31
Methanol	0.12	0.00	0.00	0.00	0.00	0.0	0.10	0.22
1,1,2,2-Tetrachloroethane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,1,2-Trichloroethane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,3-Dichloropropene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,3-Butadiene	0.03	0.00	0.00	0.00	0.00	0.0	0.01	0.04
2,2,4-Trimethylpentane	0.00	0.00	0.00	0.00	0.00	0.0	0.01	0.01
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.0	0.01	0.01
Carbon Tetrachloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Chlorobenzene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Chloroform	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Ethylene Dibromide	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Methylene Chloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Naphthalene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.01
Phenol	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Styrene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Vinyl Chloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
PAH -POM 1	0.01	0.00	0.00	0.00	0.00	0.0	0.00	0.01
POM 2	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Benzo(b)fluoranthene/POM6	0.00	0.00	0.00	0.00	0.00	0.0	6.76E-06	6.76E-06
Chrysene/POM7	0.00	0.00	0.00	0.00	0.00	0.0	2.82E-05	2.82E-05
Greenhouse Gases								
CO_2	19,894	135,342	5.8	0.00	0.00	0.0	18,659	173,901
CH_4	9	2.59	195	85	0.25	1862.9	212	2,367
N_2O	0.00	2.48	0.00	0.00	0.00	0.0	0.00	2.48

a Assumes maximum development scenario

APPENDIX F-4

Emissions Inventories for Alternative B

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

1. Road Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Estimate)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 10/98 & 7/98

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

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content \%})^{1.5} * (\text{soil moisture content \%})^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	tons/well pad	tons/yr [b]	lbs/hr	tons/well pad	tons/yr [b]	tons/yr [b]
TSP	1.97	0.0296	0.12	1.97	0.0099	0.04	0.16
PM_{15}	0.50	0.0075	0.03	0.50	0.0025	0.01	0.04
PM_{10}	0.38	0.0056	0.02	0.19	0.0009	0.00	0.03
$PM_{2.5}$	0.21	0.0031	0.01	0.10	0.0005	0.00	0.01

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

b Assumes maximum development scenario

2. Road Construction Emissions (Grader)

Assumptions:

Grading Length	47.10	miles (0.212 miles/pad x 3 swaths (10' per swath))
Hours of Construction	1	day grading per well pad and road (Estimate)
	10	hours/day
	10	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	47.10	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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 * (Mean Vehicle Speed)$^{2.5}$ * Distance Graded * Control Efficiency

Emissions (PM_{15} lbs) = 0.051 * (Mean Vehicle Speed)$^{2.0}$ * Distance Graded * Control Efficiency

Emissions = 126.53 lbs TSP/well pad

Emissions = 60.54 lbs PM_{15}/well pad

	Grader Construction Emissions			
	lbs/well pad	**lbs/hr/well pad**	**tons/well pad**	**tons/yr [a]**
TSP	126.53	12.65	6.33E-02	2.53E-01
PM_{15}	60.54	6.05	3.03E-02	1.21E-01
PM_{10}	36.33	3.63	1.82E-02	7.27E-02
$PM_{2.5}$	3.92	0.39	1.96E-03	7.84E-03

a Assumes maximum development scenario

3. Well Pad Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Proposed Action)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

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 (PM_{15} 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 PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			**Backhoe Emissions [a]**			**Total**
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.0296	0.12	1.97	0.0099	0.04	0.16
PM_{15}	0.50	0.0075	0.03	0.50	0.0025	0.01	0.04
PM_{10}	0.38	0.0056	0.02	0.38	0.0019	0.01	0.03
$PM_{2.5}$	0.21	0.0031	0.01	0.21	0.0010	0.00	0.02

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

b Assumes maximum development scenario

4. Well Pad Construction Emissions (Grader)

Assumptions:

Grading Length	2.06	miles on 330 ft x 330 ft pad (10 ft swath for 330 ft * 33 lengths)
Hours of Construction	2 10 20	day grading per well pad and road (Estimate) hours/day hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	2.06	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

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 (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions = 5.54 lbs TSP/well pad

Emissions = 2.65 lbs PM_{15}/well pad

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/yr [a]**
TSP	5.54	0.28	0.0028	0.01
PM_{15}	2.65	0.13	0.0013	0.01
PM_{10}	1.59	0.08	0.0008	0.00
$PM_{2.5}$	0.17	0.01	0.0001	0.000

a Assumes maximum development scenario

5. New Compressor Station Construction Emissions

Assumptions and Calculations:

All assumptions emission factors, and calculations are the same as those specified in Road Construction Equipment, Road Construction Grader, Well Pad Construction Equipment and Well Pad Grader emissions inventory pages.

Assumes the development of a single additional compressor station with attached roadway

Compressor Station Road Construction Equipment

Pollutant	Dozer Emissions [a]		Backhoe Emissions [a]		Total
	lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr [b]
TSP	1.97	0.030	1.97	0.010	0.039
PM_{15}	0.50	0.008	0.50	0.003	0.010
PM_{10}	0.38	0.006	0.19	0.001	0.007
$PM_{2.5}$	0.21	0.003	0.10	0.001	0.004

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

Compressor Station Road Construction Grader

Pollutant	Grader Construction Emissions		
	lbs/well pad	lbs/hr	tons/yr
TSP	126.53	12.653	6.33E-03
PM_{15}	60.54	6.054	3.03E-03
PM_{10}	36.33	3.633	1.82E-03
$PM_{2.5}$	3.92	0.392	1.96E-04

Compressor Station Construction Equipment

Pollutant	Dozer Emissions [a]		Backhoe Emissions [a]		Total
	lbs/hr	tons/yr	lbs/hr	tons/yr	tons/yr [b]
TSP	1.97	0.030	1.97	0.010	0.039
PM_{15}	0.50	0.008	0.50	0.003	0.010
PM_{10}	0.38	0.006	0.38	0.002	0.008
$PM_{2.5}$	0.21	0.003	0.21	0.001	0.004

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

Compressor Station Grader

Pollutant	Grader Construction Emissions		
	lbs/well	lbs/hr	tons/yr
TSP	5.54	0.277	1.39E-04
PM_{15}	2.65	0.133	6.63E-05
PM_{10}	1.59	0.080	3.98E-05
$PM_{2.5}$	0.17	0.009	4.29E-06

Total Compressor Station Construction Emissions

Pollutant	tons/yr
TSP	**0.0853**
PM_{15}	**0.0232**
PM_{10}	**0.0160**
$PM_{2.5}$	**0.0080**

6. Pipeline Construction Emissions (Dozer and Backhoe)

Assumptions:

Hours of Construction	3	days per well pad (Proposed Action)
	10	hours/day
	30	hours per well pad Dozer
	10	hours per well pad Backhoe
Watering Control Efficiency	50	percent (Assumption)
Soil Moisture Content	7.9	percent (AP-42 Table 11.9-3, 7/98)
Soil Silt Content	6.9	percent (AP-42 Table 11.9-3, 7/98)
PM_{10} Multiplier	0.75 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.105 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

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

Emissions (PM_{15} lbs/hr) = $1.0 * (\text{soil silt content } \%)^{1.5} * (\text{soil moisture content } \%)^{-1.4} *$ Control Efficiency

Emissions = 1.97 lbs TSP/hour/piece of equipment

Emissions = 0.50 lbs PM_{15}/hour/piece of equipment

	Dozer Emissions [a]			Backhoe Emissions [a]			Total
	lbs/hr	**tons/well pad**	**tons/yr [b]**	**lbs/hr**	**tons/well pad**	**tons/yr [b]**	**tons/yr [b]**
TSP	1.97	0.0296	0.12	1.97	0.0099	0.04	0.16
PM_{15}	0.50	0.0075	0.03	0.50	0.0025	0.01	0.04
PM_{10}	0.38	0.0056	0.02	0.19	0.0009	0.00	0.03
$PM_{2.5}$	0.21	0.0031	0.01	0.10	0.0005	0.00	0.01

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

b Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

7. Pipeline Construction Emissions (Grader)

Assumptions:

Grading Length	407.10	miles pipeline per pad x 3 (3 10' swaths)
Hours of Construction	3	day grading per well pad and road (Estimate)
	10	hours/day
	30	hours per well pad
Watering Control Efficiency	50	percent (Assumption)
Average Grader Speed	7.1	mph (Typical value AP-42 Table 11.9-3, 7/98)
Distance Graded	407.10	miles
PM_{10} Multiplier	0.6 * PM_{15}	(AP-42 Table 11.9-1, 7/98)
$PM_{2.5}$ Multiplier	0.031 * TSP	(AP-42 Table 11.9-1, 7/98)

Equations: From AP-42 tables 11.9-1 and 11.9-3 for
Bulldozing Overburden Emissions, Western Surface Coal Mining, 7/98

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

Emissions (PM_{15} lbs) = $0.051 * (\text{Mean Vehicle Speed})^{2.0} * \text{Distance Graded} * \text{Control Efficiency}$

Emissions = 1093.65 lbs TSP/well

Emissions = 523.31 lbs PM_{15}/well

	Grader Construction Emissions			
	lbs/well	**lbs/hr/well pad**	**tons/well pad**	**tons/yr [a]**
TSP	1093.65	36.45	0.5468	2.19
PM_{15}	523.31	17.44	0.2617	1.05
PM_{10}	313.99	10.47	0.1570	0.63
$PM_{2.5}$	33.90	1.13	0.0170	0.068

a Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

8. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$

$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Calculation AP-42, Chapter 13.2.1
November 2006

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	82	From Vernal
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

Construction (days/pad and road)

Hours per day 10
Days per pad 9

Vehicle Type	Average Weight (lbs)	Round Trips per Well Pad	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
Semi: Hvy Equip Hauler	60,000	3					
Haul Trucks: Equipment/Fuel/Water	48,000	5					
Pickup Truck: Crew	7,000	10					
Mean Vehicle Weight	27,040	18	1.90	745.3	82.8	74.5	8.3
				Unpaved Roads $PM_{10/15}$ Pads (tons)		**Unpaved Roads $PM_{2.5/15}$ Pads (tons)**	
				1.5		0.1	

	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
Paved:	0.067	98.6	11.0	9.9	1.1
		Paved Roads $PM_{10/15}$ Pads (tons)		**Paved Roads $PM_{2.5/15}$ Pads (tons)**	
		0.20		0.02	

Vertical Drilling (days/well)

Hours per day 10
Days per well 14

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Semi: Hvy Equip Hauler	60,000	60					
Haul Trucks: Equipment/Fuel/Water	48,000	65					
Pickup Truck: Rig Crew	7,000	88					
Mean Vehicle Weight	38,103	213	2.22	10,381	741	1,038	74.1
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				5.2		0.5	

	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
Paved:	0.113	165.4	11.8	16.5	1.2
		Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
		0.08		0.01	

Directional Drilling (days/well)

Hours per day 10
Days per well 21

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Semi: Hvy Equip Hauler	60,000	60					
Haul Trucks: Equipment/Fuel/Water	48,000	65					
Pickup Truck: Rig Crew	7,000	88					
Mean Vehicle Weight	38,103	213	2.22	10,381	494.3	1,038	49.4
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				77.9		7.8	

	PM_{10} (lb/VMT)	PM_{10}/Pad (lbs)	PM_{10}/Pad (lb/day)	$PM_{2.5}$/Pad (lbs)	$PM_{2.5}$/Pad (lb/day)
Paved:	0.113	165.4	7.9	16.5	0.8
		Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
		1.24		0.12	

Completion (days/well)

Hours per day 10
Days per pad 10

Vehicle Type	Average Weight (lbs)	Round Trips per Well	PM_{10} (lb/VMT)	PM_{10}/Well (lbs)	PM_{10}/Well (lb/day)	$PM_{2.5}$/Well (lbs)	$PM_{2.5}$/Well (lb/day)
Pickup: Completion Rig Crew	7,000	11					
Haul Trucks: Equipment/Fuel/Water	48,000	73					
Mean Vehicle Weight	42,631	84	2.33	4,306	430.6	430.6	43.1
				Unpaved Roads		**Unpaved Roads**	

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

8. Development Traffic Fugitive Dust Emissions

Unpaved Calculation AP-42, Chapter 13.2.2
November 2006

$E(PM_{10}) / VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365)$

$E(PM_{2.5}) / VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365)$

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Calculation AP-42, Chapter 13.2.1
November 2006

$E(PM_{10}) / VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5}) / VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL)	0.6	AP-42 Table 13.2.1-3 baseline low volume roads
Round Trip Miles	82	From Vernal
Precipitation Days (P)	45	days per year

W = average weight in tons of vehicles traveling the road

		PM_{10}/Annual Wells (tons)		**$PM_{2.5}$/Annual Wells (tons)**	
		34.4		3.4	
Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
	0.134	195.8	19.6	19.6	2.0
		Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
		1.57		0.16	

Interim Reclamation (days/well)

Hours per day 10
Days per pad 2

Vehicle Type	**Average Weight (lbs)**	**Round Trips per Well**	**PM_{10} (lb/VMT)**	**PM_{10}/Day (lbs)**	**PM_{10}/Day (lb/day)**	**$PM_{2.5}$/Day (lbs)**	**$PM_{2.5}$/Day (lb/day)**
Pickup: Crew	7,000	4					
Haul Trucks: Equipment	60,000	1					
Mean Vehicle Weight	17,600	5	1.56	172.1	86.1	17.2	8.6
				Unpaved Roads PM_{10}/Annual Wells (tons)		**Unpaved Roads $PM_{2.5}$/Annual Wells (tons)**	
				0.1		0.0	
		Paved:	**PM_{10} (lb/VMT)**	**PM_{10}/Pad (lbs)**	**PM_{10}/Pad (lb/day)**	**$PM_{2.5}$/Pad (lbs)**	**$PM_{2.5}$/Pad (lb/day)**
			0.035	51.5	25.7	5.1	2.6
				Paved Roads PM_{10}/Annual Wells (tons)		**Paved Roads $PM_{2.5}$/Annual Wells (tons)**	
				0.03		0.00	

Annual Traffic Fugitive Dust Emissions (tons/year)

Unpaved Roads PM_{10} (tons)	**Unpaved Roads $PM_{2.5}$ (tons)**
119	**11.9**
Paved Roads PM_{10} (tons)	**Paved Roads $PM_{2.5}$ (tons)**
3.11	**0.31**

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

9. 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	672	acres total initial disturbance for roads and pipelines (Proposed Action)
	2,719,483	square meters total initial disturbance for roads and pipelines
	395	acres total initial disturbance for well pads (Proposed Action)
	1,598,506	square meters total initial disturbance for well pads
	1,067	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	0.18	for well pads (Assumption, disturbance at construction and reclamation) constant for dirt roads
Development Period	8	years (Proposed Action)

Equations

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

Erosion Potential P (g/m²/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/m²/period)*Disturbed Area(m²)*Disturbances/year*(k)/(453.6 g/lb)/2000 lbs/ton/Develop Period

Particle Size Multiplier (k)		
30 μm	<10 μm	<2.5 μm
1.0	0.5	0.075

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/m²	Road U_t* Threshold Velocity[a] m/s	Road Erosion Potential g/m²
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	5.12E-02	0.00E+00
PM_{10}	2.56E-02	0.00E+00
$PM_{2.5}$	3.84E-03	0.00E+00

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

10. Construction Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Construction	90	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	8	(Proponent)
Number of Pickup Trips	10	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Construction Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.162	0.007	3.23	0.082	0.004	0.245	0.044
CO	17.49	0.349	0.016	36.84	0.939	0.042	1.288	0.232
VOC [c]	4.83	0.097	0.004	2.29	0.058	0.003	0.155	0.028
SO_2	0.32	6.42E-03	2.89E-04	0.21	5.45E-03	2.45E-04	1.19E-02	2.14E-03
CH_4 [e, f]	0.23	4.60E-03	2.07E-04	0.18	4.69E-03	2.11E-04	9.28E-03	1.67E-03

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

11. Construction Heavy Equipment Tailpipe Emissions

Assumptions:

Hours of Operation	90	hours/site (Proposed Action)
Development Rate	4	new pads per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Backhoe miles per pad	0.515	miles (Value assumed to be 1/4 of dozer and grader mileage)
Backhoe Hours	30	hours per pad
Dozer miles per pad	2.06	miles (Based on 330 ft x 330 ft pad and 10 ft swath for 330 ft * 33 lengths)
Dozer Hours	90	hours per pad
Grader miles per pad	2.06	miles (Based on 330 ft x 330 ft pad and 10 ft swath for 330 ft * 33 lengths)
Motor Grader Hours	60	hours per pad

Equations:

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

Heavy Const. Vehicles	Backhoe			Dozer			Grader		
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/pad)
NOx	8.13	1.23E-04	1.85E-06	8.13	1.64E-04	7.38E-06	8.13	2.46E-04	7.38E-06
CO	17.49	2.65E-04	3.97E-06	17.49	3.53E-04	1.59E-05	17.49	5.30E-04	1.59E-05
VOC [b]	4.83	7.31E-05	1.10E-06	4.83	9.75E-05	4.39E-06	4.83	1.46E-04	4.39E-06
CH_4	0.23	3.48E-06	5.22E-08	0.23	4.64E-06	2.09E-07	0.23	6.96E-06	2.09E-07

Heavy Const. Vehicles	Total	
	Emissions (lb/hr)	Emissions [c] (tons/yr)
NOx	5.33E-04	6.65E-05
CO	1.15E-03	1.43E-04
VOC [d]	3.17E-04	3.95E-05
CH_4	1.51E-05	1.88E-07

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b Emission Factor represents total Hydrocarbon Emissions
c Assumes maximum development scenario
d AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

12. Drilling Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	494	hours per site (Proposed Action)
Number of Heavy Diesel Truck Trips	125	(Proponent)
Number of Pickup Trips	88	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2 \text{ E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6 \text{ (g/lb)} * \text{Fuel Sulfur Content} * 2 \text{ (S / } SO_2\text{)}}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Drilling Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.472	0.117	3.23	0.132	0.033	0.604	2.4
CO	17.5	1.016	0.251	36.8	1.51	0.372	2.52	10.0
VOC [c]	4.83	0.280	0.069	2.29	0.094	0.023	0.374	1.48
SO_2	0.321	1.87E-02	4.60E-03	0.214	8.75E-03	2.16E-03	2.74E-02	0.108
CH_4 [e, f]	0.230	1.34E-02	3.30E-03	0.180	7.36E-03	1.82E-03	2.07E-02	0.082

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

13. Completion Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	100	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	73	(Proponent)
Number of Pickup Trips	11	(Proponent)
Diesel Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Completion Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	1.361	0.068	3.23	0.081	0.004	1.442	1.154
CO	17.49	2.927	0.146	36.84	0.929	0.046	3.856	3.085
VOC [c]	4.83	0.808	0.040	2.29	0.058	0.003	0.866	0.693
SO_2	0.32	5.38E-02	2.69E-03	0.21	5.40E-03	2.70E-04	5.92E-02	0.047
CH_4 [e, f]	0.23	3.85E-02	1.92E-03	0.18	4.54E-03	2.27E-04	4.30E-02	0.034

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

14. Reclamation Tailpipe Emissions

Assumptions:

Average Round Trip Distance	104.0	miles (Estimated from project area and existing road system)
Hours of Operation	20	hours per site (Proponent)
Number of Heavy Diesel Truck Trips	1	(Assumption)
Number of Pickup Trips	4	(Assumption)
Diesel Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

Development Vehicles	Heavy Haul Trucks			Heavy Duty Pickups			Total [d]	
	E. Factor [a] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	E. Factor [b] (g/mile)	Emissions (lb/hr)	Emissions (tons/yr/well)	Emissions (lb/hr)	Emissions (tons/yr)
NOx	8.13	0.093	0.001	3.23	0.148	0.001	0.241	0.002
CO	17.49	0.201	0.002	36.84	1.689	0.017	1.890	0.019
VOC [c]	4.83	0.055	0.001	2.29	0.105	0.001	0.160	0.002
SO_2	0.32	3.68E-03	3.68E-05	0.21	9.82E-03	9.82E-05	1.35E-02	1.35E-04
CH_4 [e, f]	0.23	2.64E-03	2.64E-05	0.18	8.25E-03	8.25E-05	1.09E-02	1.09E-04

a AP-42 Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 miles (6/95)
b AP-42 Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)
c Emission factor is for total Hydrocarbons.
d Assumes maximum development scenario
e AP-42 Table 7.10A.2 - Methane offsets for high altitude heavy duty diesel powered vehicle, 1988+
f AP-42 Table 4.10A.2 - Methane offsets for high altitude heavy duty gasoline powered vehicle, 1987+

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

15. Drill Rig Engine Emissions

Assumptions:

Hours of Operation	494	hours/well (Proposed Action)
Development Rate	16	wells per year (Proposed Action)
Load Factor	0.4	(Assumed typical value)
Phase I engine	2,000	hp (used 14% of drilling duration)
Phase II engine	2,000	hp (used 86% of drilling duration)
Diesel Fuel Sulfur Content	0.0005	percent (EPA standard value)

Equations:

Emission factor conversion: lb/hp-hr = AP-42 emission factor (lb/MMbtu) * 7500 Average BTU/hp-hr / 1,000,000

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

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

Species	Drill Rig Emissions (Tier 0 Engines)		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [g] (tons/yr)
Criteria Pollutants & VOC			
NOx [b]	0.024	19.20	76
CO [b]	5.50E-03	4.40	17
VOC [b]	7.05E-04	0.56	2.2
PM_{10} [b]	4.30E-04	0.34	1.36
$PM_{2.5}$ [b]	3.59E-04	0.29	1.13
SO_2 [b]	4.05E-06	3.24E-03	1.28E-02
Hazardous Air Pollutants			
Benzene [d]	5.82E-06	4.66E-03	1.84E-02
Toluene [d]	2.11E-06	1.69E-03	6.66E-03
Xylenes [d]	1.45E-06	1.16E-03	4.57E-03
Formaldehyde [d]	5.92E-07	4.73E-04	1.87E-03
Acetaldehyde [d]	1.89E-07	1.51E-04	5.97E-04
Acrolein [d]	5.91E-08	4.73E-05	1.87E-04
Naphthalene [e]	9.75E-07	7.80E-04	3.08E-03
Total PAH [e, f]	1.59E-06	1.27E-03	5.02E-03
Greenhouse Gases			
CO_2 [b]	1.16	928	3,664
CH_4 [b, c]	7.05E-04	0.56	2.2

Species	Drill Rig Emissions (Tier II Engines)		
	E. Factor (lb/hp-hr)	Emissions (lb/hr)	Emissions [g] (tons/yr)
Criteria Pollutants & VOC			
NOx [a]	0.01058	8.46	33
CO [a]	5.70E-03	4.56	18
VOC [a]	2.20E-03	1.76	6.9
PM_{10} [a]	3.30E-04	0.26	1.04
$PM_{2.5}$ [b]	3.30E-04	0.26	1.04
SO_2 [b]	4.05E-06	3.24E-03	1.28E-02
Hazardous Air Pollutants			
Benzene [d]	5.82E-06	4.66E-03	1.84E-02
Toluene [d]	2.11E-06	1.69E-03	6.66E-03
Xylenes [d]	1.45E-06	1.16E-03	4.57E-03
Formaldehyde [d]	5.92E-07	4.73E-04	1.87E-03
Acetaldehyde [d]	1.89E-07	1.51E-04	5.97E-04
Acrolein [d]	5.91E-08	4.73E-05	1.87E-04
Naphthalene [e]	9.75E-07	7.80E-04	3.08E-03
Total PAH [e, f]	1.59E-06	1.27E-03	5.02E-03
Greenhouse Gases			
CO_2 [b]	1.16	928	3,664
CH_4 [b, c]	7.05E-04	0.56	2.2

Note: The change from Tier 0 to Tier II engines results in emission changes of:

NOx	**-42**	ton/yr
CO	**1**	ton/yr
VOC	**4.7**	ton/yr
PM_{10}	**-0.32**	ton/yr
$PM_{2.5}$	**-0.09**	ton/yr

[a] Emission factors for Tier II nonroad diesel engine emission standards (engines => 750 hp) from dieselnet.com (NO_X, CO, VOC and PM)
note - Tier II emission standards are not set for VOC (listed as Hydrocarbons), so the Tier I Standard is used
note - Tier II or Tier I emission standards are not set for $PM_{2.5}$, so the Tier 0 (AP-42) emission factor is used

[b] AP-42 Volume I, Large Stationary Diesel Engines Tables 3.4-1 and 3.4-2 Diesel Fuel, 10/96
note - VOC emission factor represents total Hydrocarbon Emissions

[c] CH_4 Emission Factor listed in notes of AP-42 Table 3.4-1 as 9% of Total Organic Compounds

[d] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3

[e] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4

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

[g] Assumes maximum development scenario

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

16. Well Fracturing Pump and Generator Engines

Assumptions:

Average Hours of Operation	4	Hours/Well (Proponents)
Development Rate	16	wells per year (Proposed Action)
Load Factor	0.85	(Proponents)
Frac Pump Engine Horsepower	5,000	Horsepower (1@5000 hp)
Temporary Generator Horsepower	75	Horsepower (Proponents)
Diesel Fuel Sulfur Content	0.0005	percent (typical value)

Equations:

Emission factor conversion: 1b/hp-hr = AP-42 emission factor (lb/MMbtu) * 7500 Average BTU/hp-hr / 1,000,000

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

SO_2 E. Factor (lb/hp-hr) = Fuel sulfur content * 0.00809

	Frac Pump Engine Emissions		
Species	**E. Factor (lb/hp-hr)**	**Emissions (lb/hr)**	**Emissions[i] (tons/yr)**
Criteria Pollutants & VOC			
NOx[a]	0.024	102.000	3.26
CO[a]	5.50E-03	23.375	0.75
VOC[a,b]	7.05E-04	2.996	0.10
PM_{10}[a,c]	4.30E-04	1.8264	0.0584
$PM_{2.5}$[a,d]	3.59E-04	1.5268	0.0489
SO_2[a]	4.05E-06	0.017	0.001
Hazardous Air Pollutants			
Benzene[e]	5.82E-06	2.47E-02	7.92E-04
Toluene[e]	2.11E-06	8.96E-03	2.87E-04
Xylenes[e]	1.45E-06	6.15E-03	1.97E-04
Formaldehyde[e]	5.92E-07	2.51E-03	8.05E-05
Acetaldehyde[e]	1.89E-07	8.03E-04	2.57E-05
Acrolein[e]	5.91E-08	2.51E-04	8.04E-06
Naphthalene[f]	9.75E-07	4.14E-03	1.33E-04
Total PAH[f]	1.59E-06	6.76E-03	2.16E-04
Greenhouse Gases			
CO_2[a]	1.16	4,930	158
CH_4[a]	7.05E-04	2.996	0.096

	Generator Engine Emissions		
Species	**E. Factor (lb/hp-hr)**	**Emissions (lb/hr)**	**Emissions[i] (tons/yr)**
Criteria Pollutants & VOC			
NOx[g]	0.031	1.976	0.06
CO[g]	6.68E-03	0.43	0.01
VOC[b,g]	2.47E-03	0.16	0.01
PM_{10}[g]	2.20E-03	0.14	0.00
$PM_{2.5}$[g]	2.20E-03	0.14	0.00
SO_2[g]	2.05E-03	0.13	0.00
Hazardous Air Pollutants			
Benzene[h]	7.00E-06	4.46E-04	1.43E-05
Toluene[h]	3.07E-06	1.96E-04	6.26E-06
Xylenes[h]	2.14E-06	1.36E-04	4.36E-06
Formaldehyde[h]	8.85E-06	5.64E-04	1.81E-05
Acetaldehyde[h]	5.75E-06	3.67E-04	1.17E-05
Acrolein[h]	6.94E-07	4.42E-05	1.42E-06
1,3-Butadiene[h]	2.93E-07	1.87E-05	5.98E-07
Naphthalene[h]	6.36E-07	4.05E-05	1.30E-06
Total PAH[h]	1.26E-06	8.03E-05	2.57E-06
Greenhouse Gases			
CO_2[g]	1.15	73.3	2.3
CH_4[b,g]	2.47E-03	0.157	0.01

[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, Total PM_{10} fraction determined from Table 3.4-2

[d] Total particulate emission factor is 0.0007, $PM_{2.5}$ fraction determined from Table 3.4-2

[e] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-3, 10/96

[f] AP-42 Volume I, Large Stationary Diesel Engines Table 3.4-4, 10/96

[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, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, 10/96

[i] Assumes maximum development scenario

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17. Average Produced Gas Characteristics
RBU Compressor Station
Average of 9-17E, West Willow Creek, Tap 1, Tap 4 and Tap 5 facility inlet gases

Gas Heat Value (wet): 1103.4 Btu/scf

C1-C2 Wt. Fraction:	0.8739
VOC Wt. Fraction:	0.1118
Non-HC Wt. Fraction:	0.0143
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	89.8	16.0	14.4	0.78	1,010	907	910	817
Ethane	5.70	30.1	1.71	0.09	1,770	101	1,618	92.3
Propane	2.17	44.1	0.96	0.05	2,516	54.6	2,316	50.3
i-Butane	0.40	58.1	0.23	0.01	3,252	13.1	3,005	12.1
n-Butane	0.53	58.1	0.31	0.02	3,262	17.2	3,013	15.9
i-Pentane	0.20	72.2	0.14	0.01	4,001	7.86	3,698	7.27
n-Pentane	0.16	72.2	0.11	0.01	4,009	6.30	3,708	5.83
Hexanes+	0.12	86.2	0.10	0.01	4,756	5.75	4,404	5.32
Heptanes	0.10	100	0.10	0.01	5,503	5.46	5,100	5.06
Octanes	0.03	114	0.03	0.00	6,249	1.68	0.00	0.00
Nonanes	0.00	128	0.00	0.00	6,996	0.00	0.00	0.00
Decanes	0.00	142	0.00	0.00	7,743	0.00	0.00	0.00
Benzene	0.01	78.1	0.01	0.00	3,716	0.47	0.00	0.00
Toluene	0.01	92.1	0.01	0.00	4,445	0.01	0.00	0.00
Ethylbenzene	0.00	106	0.00	0.00	5,192	0.02	0.00	0.00
Xylenes	0.00	106	0.00	0.00	5,184	0.14	0.00	0.00
n-Hexane	0.06	86.2	0.05	0.00	4,756	2.80	0.00	0.00
Helium	0.00	4.0	0.00	0.00	0.00	0.00	0.00	0.00
Nitrogen	0.42	28.0	0.12	0.01	0.00	0.00	0.00	0.00
Carbon Dioxide	0.33	44.0	0.15	0.01	0.00	0.00	0.00	0.00
Oxygen	0.00	32.0	0.00	0.00	0.00	0.00	0.00	0.00
Hydrogen Sulfide	0.00	34.1	0.00	0.00	637	0.00	588	0.00
Total	**100**	-	**18.4**	**1.00**	-	**1,123**	-	**1,011**

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

Weight Fraction = Net Mole Weight / Total Mole Weight

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18. 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:	1.0	MMscf day (Average volume estimated by proponents)
Development Rate:	16	Wells per year (Project Proponents)
Control Rate	95	Percent from flaring

Component	Molecular Weight (lb/lb-mole)	Mole Percent	Relative Mole Weight (lb/lb-mole)	Weight Fraction	Component Flow Rate (Mscf/day)	Component Emission Rate (lb/hr)	Component Emission Rate (tons/yr)
Methane	16.0	89.8	14.4	0.781	898	791	15
Ethane	30.1	5.70	1.71	0.093	57.0	94.1	1.81
Propane	44.1	2.17	0.957	0.052	21.7	52.5	1.01
i-Butane	58.1	0.403	0.234	0.013	4.029	12.9	0.25
n-Butane	58.1	0.529	0.307	0.017	5.285	16.9	0.32
i-Pentane	72.2	0.197	0.142	0.008	1.965	7.78	0.15
n-Pentane	72.2	0.157	0.113	0.006	1.57	6.23	0.12
Hexanes	86.2	0.121	0.104	0.006	1.21	5.72	0.11
Heptanes	100	0.099	0.099	0.005	0.99	5.46	0.10
Octanes	114	0.027	0.031	0.002	0.27	1.69	0.03
Nonanes	128	0.000	0.000	0.000	0.00	0.00	0.00
Decanes +	142	0.000	0.000	0.000	0.00	0.00	0.00
Benzene	78.1	0.013	0.010	0.001	0.13	0.55	0.01
Toluene	92.1	0.011	0.010	0.001	0.11	0.56	0.01
Ethylbenzene	106	0.000	0.000	0.000	0.00	0.02	0.00
Xylenes	106	0.003	0.003	0.000	0.03	0.16	0.00
n-Hexane	86.2	0.059	0.051	0.003	0.59	2.79	0.05
Helium	4.0	0.000	0.000	0.000	0.00	0.00	0.00
Nitrogen	28.0	0.419	0.117	0.006	4.19	6.44	0.12
Carbon Dioxide	44.0	0.331	0.146	0.008	3.31	8.00	0.15
Oxygen	32.0	0.000	0.000	0.000	0.00	0.00	0.00
Hydrogen Sulfide	34.1	0.000	0.000	0.000	0.00	0.00	0.00
VOC Subtotal		**3.79**	**2.06**	**0.11**	**37.9**	**113**	**2.17**
HAP Subtotal		**0.09**	**0.07**	**0.00**	**0.86**	**4.07**	**0.08**
Total		**100**	**18.4**	**1.00**	**1,000**	**1,012**	**19**

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19. Operations Tailpipe Emissions

Assumptions:

Number of New Pumpers:	1	(Proponent)
Pumper Mileage:	1,500	miles/pumper/month (Proponent)
Total Annual New Pumper Mileage:	18,000	miles/year
Number of Condensate Haul Truck Round Trips:	0	trips per day (Based on Peak Production Proposed Action)
Number of Produced Water Truck Round Trips:	1	trips per day (Based on Peak Production Proposed Action)
Average Round Trip Mileage for Condensate Transport:	104	miles (Estimate from Vernal)
Total Annual Condensate Truck Mileage:	38,270	miles/year
Hours of Pumper Operation:	10	hours per day (Assumption)
Hours of Pumper Operation:	3,640	hours per year
Fuel sulfur content	0.0005	percent (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 SO_2 emissions are calculated on a mass balance basis utilizing the following equation:

$$SO_2\ \text{E. Factor (g/mi)} = \frac{\text{Fuel Density (lb/gal)} * 453.6\ \text{(g/lb)} * \text{Fuel Sulfur Content} * 2\ (S / SO_2)}{\text{Vehicle Fuel Efficiency (miles/gal)}}$$

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								
NOx	3.23	0.04	0.06	8.13	0.19	0.4	0.22	0.4
CO	36.8	0.40	0.7	17.5	0.4	0.8	0.8	1.5
VOC [c]	2.11	0.02	0.04	4.60	0.11	0.21	0.13	0.25
SO_2	0.21	0.00	0.00	0.32	0.01	0.01	0.01	0.02
Greenhouse Gases								
CH_4 [d]	0.18	0.00	0.00	0.23	0.01	0.01	0.01	0.01

[a] AP-42 Append H Table 4.1A.2 - H.D. Gasoline Vehicles, High Altitude, 1991 - 1997 Vehicle Year, 100,000 miles (6/95)

[b] AP-42 Append. H Table 7.1.2 - H.D. Diesel Powered Vehicles, High Altitude, 1991 - 1997 Model Year, 100,000 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 Pneumatic Emissions

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

Analysis Gas flow 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	89.7593	14.400	78.092	0.898	1.581	6.925
Ethane	30.07	5.7022	1.715	9.299	0.057	0.188	0.825
Propane	44.097	2.1706	0.957	5.191	0.022	0.105	0.460
i-Butane	58.123	0.4029	0.234	1.270	0.004	0.026	0.113
n-Butane	58.123	0.5285	0.307	1.666	0.005	0.034	0.148
i-Pentane	72.15	0.1965	0.142	0.769	0.002	0.016	0.068
n-Pentane	72.15	0.1572	0.113	0.615	0.002	0.012	0.055
Hexanes	86.177	0.1208	0.104	0.565	0.001	0.011	0.050
Heptanes	100.204	0.0993	0.099	0.539	0.001	0.011	0.048
Octanes	114.231	0.0269	0.031	0.167	0.000	0.003	0.015
Nonanes	128.258	0.0000	0.000	0.000	0.000	0.000	0.000
Decanes +	142.285	0.0000	0.000	0.000	0.000	0.000	0.000
Benzene	78.12	0.0128	0.010	0.054	0.000	0.001	0.005
Toluene	92.13	0.0110	0.010	0.055	0.000	0.001	0.005
Ethylbenzene	106.16	0.0003	0.000	0.002	0.000	0.000	0.000
Xylenes	106.16	0.0028	0.003	0.016	0.000	0.000	0.001
n-Hexane	86.177	0.0589	0.051	0.275	0.001	0.006	0.024
Helium	4.003	0.0000	0.000	0.000	0.000	0.000	0.000
Nitrogen	28.013	0.4190	0.117	0.636	0.004	0.013	0.056
Carbon Dioxide	44.01	0.3310	0.146	0.790	0.003	0.016	0.070
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	**3.788**	**2.062**	**11.183**	**0.038**	**0.226**	**0.992**
	HAP Subtotal	**0.086**	**0.074**	**0.402**	**0.001**	**0.008**	**0.036**
	Total	**100.000**	**18.440**	**100.000**	**1.000**	**2.025**	**8.868**

	Number of Wells	VOC emissions (tons/year)	Methane Emissions (tons/yr)
Proposed Action	16	25	119.2

Liquid Level Controller Specifications

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

Pneumatic Pump Specifications

Gas Consumption Rate:	1.0	Mscf/day
Days of Operation:	182	days/year

Pneumatic sources / well		VOC lb/hr	VOC ton/yr
4	Liquid level controllers	0.13	0.57
1	Pneumatic pump	0.23	0.99
	Totals (per well) =	0.36	1.56

Pneumatic sources / well		Methane lb/hr	Methane ton/yr
4	Liquid level controllers	0.91	3.99
1	Pneumatic pump	1.58	3.46
	Totals (per well) =	2.49	7.45

21. Operations Traffic Fugitive Dust Emissions

Calculation AP-42, Chapter 13.2.2
November 2006
365 operating days per year (Estimate)

Unpaved Roads

$E(PM_{10})/VMT = 1.5 * (S/12)^{0.9} * (W/3)^{0.45} * (365-p)/365$

$E(PM_{2.5})/VMT = 0.15 * (S/12)^{0.9} + (W/3)^{0.45} * (365-p)/365$

Silt Content (S)	8.5	AP 42 13.2.2-1 Mean Silt Content Construction Sites
Round Trip Miles	22	miles on unpaved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Paved Roads

$E(PM_{10})/VMT = 0.016 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00047 * (1-(p/(365*4))$

$E(PM_{2.5})/VMT = 0.0024 * (sL/2)^{0.65} * (W/3)^{1.5} - 0.00036 * (1-(p/(365*4))$

Silt Loading (sL) 0.6 AP-42 Table 13.2.1-3 baseline low volume roads

W = average weight in tons of vehicles traveling the road

Round Trip Miles	82	miles from Vernal on paved roads estimated
Precipitation Days (P)	45	days per year (NCDC data for Ouray, UT 1955-2004)

Vehicle Type	Ave. Weight (lbs)	Round Trips per Day		PM_{10} (lb/VMT)	Total PM_{10} (lbs/yr)	PM_{10} (lb/day)	Total $PM_{2.5}$ (lbs/yr)	$PM_{2.5}$ (lb/day)
Pickup Truck: Crew	7,000	0.6						
Haul Truck: Oil	48,000	0.2						
Haul Truck: Water	48,000	1.0	Paved	2.14	86	0.23	9	0.02
Mean Weight	35,327	1.8	Unpaved	0.101	4	0.01	0.4	0.00
					PM_{10}		**$PM_{2.5}$**	
Annual Traffic Fugitive Dust Emissions (tons/year)			**Paved**		**0.04**		**0.004**	
			Unpaved		**0.002**		**0.000**	
			Total		**0.04**		**0.004**	

Assume 3 barrels per day condensate per well
Assume 10,000 gallon condensate truck

22. Condensate Storage Tank Flash/Working/Standing Emissions

Assumptions:

Average Condensate Production Rate : 1.0 bbls condensate per day per well (average estimated from surrounding wells)

Size of Development: 16 Producing Wells

Separator Conditions: 337 psi and 78 F (9-17E sample)
API Gravity: 55
Ambient Conditions: 12.64 psi and 52 F

Calculations:

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0

Emissions:

Component		Well Flash/Work/Breathing (tons/yr/well)	Project Emissions [a] (tons/yr)
Total VOC		1.99	32
Hazardous Air Pollutants			
Benzene		0.015	0.2
Toluene		0.012	0.2
Ethylbenzene		0.000	0.000
Xylenes		0.002	0.03
n-Hexane		0.045	0.7
Total HAPS		0.080	1.3
Greenhouse Gases			
CO_2		0.017	0.27
CH_4		0.77	12

a Assumes maximum development scenario

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23. Wellsite Dehydrator Emissions

Assumptions

Average Production Rate: 0.20 MMscf/day/well (Average for life of the well, Proposed Action)
Number of Active Wells Requiring Separators: 16 wells at Peak Production
Wells Requiring Dehydrators: 16 (100% of wells, Proposed Action)

Gas Composition: RBU 6-18F 2010 sample analysis

Inlet Gas Conditions: 80 psia, 82 degrees F
Pump: 0.030 acfm gas/gpm glycol

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

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Tons per year per well are calculated with the conservative estimate that the wellsite dehys could theoretically run 8,760 hours out of the year

Emissions

Species		Well Dehydrator Emissions (lbs/hr/well)	Well Dehydrator Emissions (tons/year/well)	Total Project Emissions (tons/year)
Total VOC		0.70	3.08	49
Hazardous Air Pollutants				
Benzene		0.074	0.32	5
Toluene		0.165	0.72	12
Ethylbenzene		0.010	0.04	0.7
Xylenes		0.146	0.64	10
n-Hexane		0.006	0.03	0.4
Greenhouse Gases				
CH_4		0.069	0.30	5

Kleinfelder/Buys

Project: XTO RBU, Alternative B
Date: 6/1/2012

24. Wellsite Pumping Unit Engines

Assumptions:

Pumpjack Engine Size: 21.2 Horsepower (Estimate)
Number of Wells Requiring Pumping Unit Engines: 16 wells at Peak Production

Equations:

Emissions (lbs/hr) = Emission Factor (g/hp-hr) * Power (hp) / 453.6 g/lb

Wellsite Pumping Unit Engines Emissions (old engines)

Pollutant	Emission Factor [1] (lb/MMBtu)	Emission Factor [3] (g/hp-hr)	Emissions (lb/hr/well)	Total Emissions [7] Proposed Action (tons/yr)
Criteria Pollutants & VOC				
NOx	2.21	11.1	0.52	36.3
CO	3.72	18.7	0.87	61.2
VOC	0.03	0.15	0.01	0.5
PM_{10} [4]	1.94E-02	9.75E-02	4.56E-03	0.3
$PM_{2.5}$ [4]	1.94E-02	9.75E-02	4.56E-03	0.3
SO_2 [2]	0.0	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	1.58E-03	7.93E-03	3.7E-04	0.03
Toluene	5.58E-04	2.80E-03	1.3E-04	0.01
Ethylbenzene	2.48E-05	1.25E-04	5.8E-06	0.00
Xylenes	1.95E-04	9.79E-04	4.6E-05	0.00
Formaldehyde	2.05E-02	1.03E-01	4.8E-03	0.3
Acetaldehyde	2.79E-03	1.40E-02	6.5E-04	0.05
Acrolein	2.63E-03	1.32E-02	6.2E-04	0.04
Methanol	3.06E-03	1.54E-02	7.2E-04	0.05
1,1,2,2-Tetrachloroethane	2.53E-05	1.27E-04	5.9E-06	4.16E-04
1,1,2-Trichloroethane	1.53E-05	7.68E-05	3.6E-06	2.52E-04
1,3-Dichloropropene	1.27E-05	6.38E-05	3.0E-06	2.09E-04
1,3-Butadiene	6.63E-04	3.33E-03	1.6E-04	1.09E-02
Carbon Tetrachloride	1.77E-05	8.89E-05	4.2E-06	2.91E-04
Chlorobenzene	1.29E-05	6.48E-05	3.0E-06	2.12E-04
Chloroform	1.37E-05	6.88E-05	3.2E-06	2.25E-04
Ethylene Dibromide	2.13E-05	1.07E-04	5.0E-06	3.50E-04
Methylene Chloride	4.12E-05	2.07E-04	9.7E-06	6.78E-04
Naphthalene	9.71E-05	4.88E-04	2.3E-05	1.60E-03
Styrene	1.19E-05	5.98E-05	2.8E-06	1.96E-04
Vinyl Chloride	7.18E-06	3.61E-05	1.7E-06	1.18E-04
PAH -POM 1 [6]	1.41E-04	7.08E-04	3.3E-05	2.32E-03
Greenhouse Gases				
CO_2 [5]	110	2,557	120	8,376
CH_4	0.23	1.15	0.05	4

Wellsite Pumping Unit Engines Emissions (JJJJ compliant new engines)

Pollutant	Emission Factor [1] (lb/MMBtu)	Emission Factor [3] (g/hp-hr)	Emissions (lb/hr/well)	Total Emissions [7] Proposed Action (tons/yr)
Criteria Pollutants & VOC				
NOx	-	2.0	0.09	7
CO	-	4.0	0.19	13
VOC	-	1.0	0.05	3
PM_{10} [4]	1.94E-02	9.75E-02	4.56E-03	0.3
$PM_{2.5}$ [4]	1.94E-02	9.75E-02	4.56E-03	0.3
SO_2 [2]	0.0	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	1.58E-03	7.93E-03	3.7E-04	0.03
Toluene	5.58E-04	2.80E-03	1.3E-04	0.01
Ethylbenzene	2.48E-05	1.25E-04	5.8E-06	0.00
Xylenes	1.95E-04	9.79E-04	4.6E-05	0.00
Formaldehyde	2.05E-02	1.03E-01	4.8E-03	0.3
Acetaldehyde	2.79E-03	1.40E-02	6.5E-04	0.05
Acrolein	2.63E-03	1.32E-02	6.2E-04	0.04
Methanol	3.06E-03	1.54E-02	7.2E-04	0.05
1,1,2,2-Tetrachloroethane	2.53E-05	1.27E-04	5.9E-06	4.16E-04
1,1,2-Trichloroethane	1.53E-05	7.68E-05	3.6E-06	2.52E-04
1,3-Dichloropropene	1.27E-05	6.38E-05	3.0E-06	2.09E-04
1,3-Butadiene	6.63E-04	3.33E-03	1.6E-04	1.09E-02
Carbon Tetrachloride	1.77E-05	8.89E-05	4.2E-06	2.91E-04
Chlorobenzene	1.29E-05	6.48E-05	3.0E-06	2.12E-04
Chloroform	1.37E-05	6.88E-05	3.2E-06	2.25E-04
Ethylene Dibromide	2.13E-05	1.07E-04	5.0E-06	3.50E-04
Methylene Chloride	4.12E-05	2.07E-04	9.7E-06	6.78E-04
Naphthalene	9.71E-05	4.88E-04	2.3E-05	1.60E-03
Styrene	1.19E-05	5.98E-05	2.8E-06	1.96E-04
Vinyl Chloride	7.18E-06	3.61E-05	1.7E-06	1.18E-04
PAH -POM 1 [6]	1.41E-04	7.08E-04	3.3E-05	2.32E-03
Greenhouse Gases				
CO_2 [5]	110	2,557	120	8,376
CH_4	0.23	1.15	0.05	4

[1] AP-42 Table 3.2-3 Uncontrolled Emission Factors for 4-Stroke Rich-Burn Engines, 7/00
[2] Fuel gas is assumed to be free from sulfur compounds (see gas analysis)
[3] Conversion from lb/MMBtu to g/hp-hr assumes an average heat rate of 11,070 Btu/hp-hr (11,070/1,000,000 *453.6 = 5.02135 multiplier)
[4] PM = sum of PM filterable and PM condensable
[5] Based on 99.5% conversion of the fuel carbon to CO_2 (AP-42 Table 3.2-3 footnote d)
[6] Polycyclic Aromatic Hydrocarbons (PAH), 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
[7] Estimated at full project production.

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25. Production Heater Emissions

Assumptions

Wellsite Separator Heater Size	750	Mbtu/hr (Proponent)
Wellsite Dehydrator Reboiler Size	250	Mbtu/hr
Total Wellsite Heater Size	1,000	Mbtu/hr (1@500, 1@750)
Firing Rate	60	minutes/hour on average for entire year (Typical value)
	8,760	hours/year
Fuel Gas Heat Value	1,103	Btu/scf (Gas Analyses from Existing Wells)
Fuel Gas VOC Content	0.112	by weight (Gas Analyses from Existing Wells)
Development size	16	new wells

Equations

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

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

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

	Wellpad Separator Emissions			Wellpad Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/well)	Total Emissions [1] (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions (tons/yr)	Total Emissions (lb/hr)	Total Emissions [1] (tons/yr)
Criteria Pollutants & VOC								
NOx [a]	100	0.075	5	100	0.025	2	0.100	7
CO [a]	84.0	0.063	4	84.0	0.021	1.5	0.084	6
TOC [c]	11.0	0.008	0.6	11.0	0.003	0.2	0.011	0.8
VOC	-	0.001	0.06	-	0.000	0.02	0.001	0.09
SO_2 [b]	-	0.0	0.0	-	0.0	0.0	0.0	0.0
TSP [c]	7.60	0.006	0.4	7.60	0.002	0.008	0.008	0.4
PM_{10} [c]	7.60	0.006	0.4	7.60	0.002	0.133	0.008	0.5
$PM_{2.5}$ [c]	7.60	0.006	0.4	7.60	0.002	0.133	0.008	0.5
Hazardous Air Pollutants								
Benzene [d]	2.10E-03	1.58E-06	1.10E-04	2.10E-03	5.25E-07	3.68E-05	2.10E-06	1.47E-04
Toluene [d]	3.40E-03	2.55E-06	1.79E-04	3.40E-03	8.50E-07	5.96E-05	3.40E-06	2.38E-04
Hexane [d]	1.80E+00	1.35E-03	9.46E-02	1.80E+00	4.50E-04	3.15E-02	1.80E-03	1.26E-01
Formaldehyde [d]	7.50E-02	5.63E-05	3.94E-03	7.50E-02	1.88E-05	1.31E-03	7.50E-05	5.26E-03
Dichlorobenzene [d]	1.20E-03	9.00E-07	6.31E-05	1.20E-03	3.00E-07	2.10E-05	1.20E-06	8.41E-05
Naphthalene [d]	6.10E-04	4.58E-07	3.21E-05	6.10E-04	1.53E-07	1.07E-05	6.10E-07	4.27E-05
POM 2 [d,e,f]	5.90E-05	4.43E-08	3.10E-06	5.90E-05	1.48E-08	1.03E-06	5.90E-08	4.13E-06
POM 3 [d,g]	1.60E-05	1.20E-08	8.41E-07	1.60E-05	4.00E-09	2.80E-07	1.60E-08	1.12E-06
POM 4 [d,h]	1.80E-06	1.35E-09	9.46E-08	1.80E-06	4.50E-10	3.15E-08	1.80E-09	1.26E-07
POM 5 [d,i]	2.40E-06	1.80E-09	1.26E-07	2.40E-06	6.00E-10	4.20E-08	2.40E-09	1.68E-07
POM 6 [d,j]	7.20E-06	5.40E-09	3.78E-07	7.20E-06	1.80E-09	1.26E-07	7.20E-09	5.05E-07
POM 7 [d,k]	1.8E-06	1.35E-09	9.46E-08	1.8E-06	4.50E-10	3.15E-08	1.80E-09	1.26E-07
Greenhouse Gases								
CO_2 [c]	120,000	90.0	6,307	120,000	30.0	2,102	120	8,410
CH_4 [c]	2.30	1.73E-03	0.12	2.30	5.75E-04	0.04	2.30E-03	0.16
N_2O [c]	2.20	1.65E-03	0.12	2.20	5.50E-04	0.04	2.20E-03	0.15

[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 $PM_{1.0}$)

[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,

[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 maximum development scenario

26. Well Production Summary

Species	Production Heaters (tons/yr)	Storage Tanks (tons/yr)	Well Dehydrators (tons/yr)	Well Pumping Unit Engines [a] (tons/yr)	Operations Vehicle (tons/yr)	Well Blowdown (tons/yr)	Total Well Production [b] (tons/yr)
Criteria Pollutants & VOC							
NO_x	7	0.0	0.0	7	0.4	0.0	14
CO	6	0.0	0.0	13	1.5	0.0	21
VOC	0.09	32	49	3	0.25	2	87
SO_2	0.0	0.0	0.0	0.0	0.02	0.0	0.02
PM_{10}	0.5	0.0	0.0	0.3	0.04	0.0	1
$PM_{2.5}$	0.5	0.0	0.0	0.3	0.00	0.0	0.9
Hazardous Air Pollutants							
Benzene	1.5E-04	0.2	5	0.03	0.0	0.01	5
Toluene	2.4E-04	0.2	12	0.01	0.0	0.01	12
Ethylbenzene	0.0	0.00	0.7	0.00	0.0	0.00	0.7
Xylene	0.0	0.03	10	0.00	0.0	0.00	10
n-Hexane	0.13	0.7	0.4	0.0	0.0	0.05	1
Formaldehyde	0.01	0.0	0.0	0.3	0.0	0.0	0.3
Total HAPs	0.13	1	28.1	0.4	0.0	0.08	30
Greenhouse Gases							
CO_2	8,410	0.0	0.0	8,376	0.0	0.2	16,786
CH_4	0.16	0.0	5	4	0.01	15	24
N_2O	0.15	0.0	0.0	0.0	0.0	0.0	0.15

[a] Well pumping unit engine emissions are for JJJJ compliant engines

[b] Emissions for Peak Field Development

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27. Production Heater Emissions

Assumptions

Central Separator Heater Size	750	Mbtu/hr (Proponent)
Central Dehydrator Reboiler Heater Size	750	Mbtu/hr
Total Central Facility Heater Requirement:	1500	Mbtu/hr (1@500, 1@750)
Firing Rate	60	minutes/hour on average for entire year (Typical value)
	8760	hours/year
Fuel Gas Heat Value	1103	Btu/scf (Gas Analyses from Existing Wells)
Fuel Gas VOC Content	0.112	by weight (Gas Analyses from Existing Wells)
Development size	0	Facilities

Equations

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

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

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

	Central Facility Separator Emissions			Central Facility Dehy-Reboiler Emissions			Total Heater	
	Emission Factor (lb/MMscf)	Well Emissions (lb/hr/facility)	Total Emissions[l] (tons/yr)	Emission Factor (lb/MMscf)	Facility Emissions (lb/hr/facility)	Total Emissions[l] (tons/yr)	Total Emissions (lb/hr)	Total Emissions[l] (tons/yr)
Criteria Pollutants & VOC								
NOx[a]	100	0.075	0.00	100	0.075	0.000	0.750	0.00
CO[a]	84.0	0.063	0.00	84.0	0.063	0.000	0.630	0.00
TOC[c]	11.0	0.008	0.000	11.0	0.008	0.000	0.083	0.00
VOC	N.A.	0.001	0.000	N.A.	0.001	0.000	0.009	0.00
SO_X[b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TSP[c]	7.60	5.70E-03	0.000	7.60	5.70E-03	0.000	0.057	0.000
PM_{10}[c]	7.60	5.70E-03	0.000	7.60	5.70E-03	0.000	0.057	0.000
$PM_{2.5}$[c]	7.60	5.70E-03	0.000	7.60	5.70E-03	0.000	0.057	0.000
Hazardous Air Pollutants								
Benzene[d]	2.10E-03	1.58E-06	0.00E+00	2.10E-03	1.58E-06	0.00E+00	1.58E-05	0.00E+00
Toluene[d]	3.40E-03	2.55E-06	0.00E+00	3.40E-03	2.55E-06	0.00E+00	2.55E-05	0.00E+00
Hexane[d]	1.80	1.35E-03	0.00E+00	1.80	1.35E-03	0.00E+00	0.014	0.000
Formaldehyde[d]	7.50E-02	5.63E-05	0.00E+00	7.50E-02	5.63E-05	0.00E+00	5.63E-04	0.00E+00
Dichlorobenzene[d]	1.2E-03	9.00E-07	0.00E+00	1.2E-03	9.00E-07	0.00E+00	1.80E-06	0.00E+00
Naphthalene[d]	6.1E-04	4.58E-07	0.00E+00	6.1E-04	4.58E-07	0.00E+00	9.15E-07	0.00E+00
POM 2[d,e,f]	5.9E-05	4.43E-08	0.00E+00	5.9E-05	4.43E-08	0.00E+00	8.85E-08	0.00E+00
POM 3[d,g]	1.6E-05	1.20E-08	0.00E+00	1.6E-05	1.20E-08	0.00E+00	2.40E-08	0.00E+00
POM 4[d,h]	1.8E-06	1.35E-09	0.00E+00	1.8E-06	1.35E-09	0.00E+00	2.70E-09	0.00E+00
POM 5[d,i]	2.4E-06	1.80E-09	0.00E+00	2.4E-06	1.80E-09	0.00E+00	3.60E-09	0.00E+00
POM 6[d,j]	7.2E-06	5.40E-09	0.00E+00	7.2E-06	5.40E-09	0.00E+00	1.08E-08	0.00E+00
POM 7[d,k]	1.8E-06	1.35E-09	0.00E+00	1.8E-06	1.35E-09	0.00E+00	2.70E-09	0.00E+00
Greenhouse Gases								
CO_2[c]	120,000	90.0	0	120,000	90.0	0	180.0	0
CH_4[c]	2.30	1.73E-03	0.00E+00	2.30	1.73E-03	0.000	3.45E-03	0.000
N_2O[c]	2.20	1.65E-03	0.00E+00	2.20	1.65E-03	0.000	3.30E-03	0.000

[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 $PM_{1.0}$)

[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

[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 maximum development scenario

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

Assumptions:

Average Condensate Production Rate :

Per Facility 10.85 bbls condensate per day (Estimate based on similar facility data)

Total new/modified Facilities 0

Calculations:

Separator Conditions : 400 psi and 95 F (Sample Conditions)
Ambient Conditions: 12.64 psi and 52 F

Condensate tank flashing/working/breathing emissions estimated with E&P Tanks 2.0
Kings Canyon Compressor Station Liquid Sample
Assumes 95% emission control

Emissions:

Component	Facility Flash/Work/ Breathing (tons/yr)	Total Emissions * (tons/yr)
Total VOC	2.03	0
Hazardous Air Pollutants		
Benzene	0.01	0.00
Toluene	0.01	0.00
Ethylbenzene	0.00	0.00
Xylenes	0.00	0.00
n-Hexane	0.02	0.00
Total HAP's	0.03	0.00
Greenhouse Gases		
CO_2	0.31	0.00
CH_4	0.40	0.0

*Based on total facilities

29. Central TEG Dehydrator Emissions

Assumptions

Production Rate: 4 MMscf/day total (all new production)

Gas Composition: Kings Canyon 2008 sample analysis

Inlet Gas Conditions: Inlet gas saturated at 814 psia and 98 F
Pump: 0.032 acfm gas/gpm glycol

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

Calculations

Dehydrator emissions were simulated using GRI GlyCalc version 4.0

Controls

95% Control Efficiency in order to meet Federal MACT Standards

Emissions

Species	Central Dehydrator Emissions (lb/hr)	Total Project Emissions (tons/year)
VOC	0.39	1.7
Benzene	0.04	0.2
Toluene	0.10	0.4
Ethylbenzene	0.01	0.0
Xylenes	0.10	0.4
n-Hexane	0.00	0.0
Total HAPs	0.26	1.1
Greenhouse Gases		
CH_4	0.13	0.6

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30. Central Compression

Assumptions:

Engine Type: TBD
Proposed Engine Capacity Increase: 310 horsepower (Proponent)

Equations:

Emissions (g/hp-hr) = average heat rate of 8,000 btu/hp-hr (8,000/1,000,000 *453.6 = 3.6288 multiplier)

Emissions (lbs/hr) = Emission Factor (g/hp-hr) * Power (hp) / 453.6 g/lb

Pollutant	Emission Factor [a, b] (lb/MMBtu)	Emission Factor [d] (g/hp-hr)	Emissions (lb/hr)	Emissions [c] (tons/yr)
Criteria Pollutants & VOC				
NOx [j]	-	1.00	0.7	3.0
CO [d]	-	0.190	0.1	0.6
VOC [d]	-	0.460	0	1.4
PM_{10} [e]	9.95E-03	0.036	0.02	0.11
$PM_{2.5}$ [e]	9.95E-03	0.036	0.02	0.11
SO_2 [f]	5.88E-04	0.0	0.0	0.0
Hazardous Air Pollutants				
Benzene	4.40E-04	3.83E-04	2.62E-04	1.15E-03
Toluene	4.08E-04	3.55E-04	2.43E-04	1.06E-03
Ethylbenzene	3.97E-05	3.46E-05	2.36E-05	1.03E-04
Xylenes	1.84E-04	1.60E-04	1.10E-04	4.80E-04
n-Hexane	1.11E-03	9.67E-04	6.61E-04	2.89E-03
Formaldehyde	-	6.00E-02	4.10E-02	1.80E-01
Acetaldehyde	8.36E-03	7.28E-03	4.98E-03	2.18E-02
Acrolein	5.14E-03	4.48E-03	3.06E-03	1.34E-02
Methanol	2.50E-03	2.18E-03	1.49E-03	6.52E-03
1,1,2,2-Tetrachloroethane	4.00E-05	3.48E-05	2.38E-05	1.04E-04
1,1,2-Trichloroethane	3.18E-05	2.77E-05	1.89E-05	8.29E-05
1,3-Dichloropropene	2.64E-05	2.30E-05	1.57E-05	6.88E-05
1,3-Butadiene	2.67E-04	2.33E-04	1.59E-04	6.96E-04
2,2,4-Trimethylpentane	2.50E-04	2.18E-04	1.49E-04	6.52E-04
Biphenyl	2.12E-04	1.85E-04	1.26E-04	5.53E-04
Carbon Tetrachloride	3.67E-05	3.20E-05	2.18E-05	9.57E-05
Chlorobenzene	3.04E-05	2.65E-05	1.81E-05	7.93E-05
Chloroform	2.85E-05	2.48E-05	1.70E-05	7.43E-05
Ethylene Dibromide	4.43E-05	3.86E-05	2.64E-05	1.15E-04
Methylene Chloride	2.00E-05	1.74E-05	1.19E-05	5.21E-05
Naphthalene	7.44E-05	6.48E-05	4.43E-05	1.94E-04
Phenol	2.40E-05	2.09E-05	1.43E-05	6.26E-05
Styrene	2.36E-05	2.06E-05	1.40E-05	6.15E-05
Tetrachloroethane	2.48E-06	2.16E-06	1.48E-06	6.47E-06
Vinyl Chloride	1.49E-05	1.30E-05	8.87E-06	3.88E-05
PAH -POM 1 [g, h]	2.69E-05	2.34E-05	1.60E-05	7.01E-05
POM 2 [h, i]	5.93E-05	5.17E-05	3.53E-05	1.55E-04
Benzo(b)fluoranthene/POM6 [h]	1.66E-07	1.45E-07	9.88E-08	4.33E-07
Chrysene/POM7 [h]	6.93E-07	6.04E-07	4.12E-07	1.81E-06
Greenhouse Gases				
CO_2	110	399	273	1,195
CH_4	1.25	4.54	3	14

[a] AP-42 Table 3.2-2 Uncontrolled Emission Factors for a 4 stroke Lean Burn engine, 7/00

[b] Compressor engines compliant with RICE MACT standards, Table 2.a (93% reduction of CO or 14 ppmvd Formaldehyde)

[c] Assumes maximum development scenario

[d] Emission rates based on information from catalyst emissions reduction manufacturer (including 90% CO reduction, 76% formaldehyde and 76% VOC reductions)

[e] PM = sum of PM filterable and PM condensable

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

[g] Polycyclic Aromatic Hydrocarbons (PAH) defined as a HAP by Section 112(b) of the Clean Air Act because it is Polycyclic Organic Matter (POM) AP-42 Table 1.4-3 footnotes.

[h] 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

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

[j] NO_X emission rate reflects 1.0 g/s requirement mandated by the BLM Vernal Field Office

Kleinfelder/Buys	Project: XTO RBU, Alternative B Date: 6/1/2012

31. Development Emissions Sumary

Pollutant	Development Emissions (tons/year) [a]					Total
	Construction	Drilling[b]	Completion	Interim Reclamation	Wind Erosion	(tons/yr)
NO_X	0.04	36	4.5	0.00	0.00	40
CO	0.23	28	3.8	0.02	0.00	32
VOC	0.03	8.4	3	0.00	0.00	11
SO_2	0.00	0.12	0.05	0.000	0.00	0.2
PM_{10}	1.80	85	36	0.11	0.03	123
$PM_{2.5}$	0.20	9.5	3.7	0.01	3.84E-03	13
Benzene	0.00	0.02	0.01	0.00	0.00	0.0
Toluene	0.00	0.01	0.01	0.00	0.00	0.0
Ethylbenzene	0.00	0.00	0.00	0.00	0.00	0.000
Xylene	0.00	0.00	0.00	0.00	0.00	0.0
n-Hexane	0.00	0.00	0.05	0.00	0.00	0.1
Formaldehyde	0.00	1.87E-03	9.85E-05	0.00	0.00	0.002
Acrolein	0.00	1.87E-04	9.45E-06	0.00	0.00	2.0E-04
1,3-Butadiene	0.00	0.00	5.98E-07	0.00	0.00	6.0E-07
Greenhouses Gases						
CO_2	0.00	3,664	160	0.00	0.00	3,824
CH_4	1.67E-03	2.3	15	1.09E-04	0.00	18
N_2O	0.00	0.00	0.00	0.00	0.00	0

[a] Assumes 60 wells/yr development scenario

[b] Drilling emissions assumes Tier II drill rig engines

Kleinfelder/Buys

Project: XTO RBU, Alternative B
Date: 6/1/2012

32. Total Project Production Related Emissions Summary

Pollutant	Total Project Production Related Emissions (tons/year) [a]							Total [a]
	Pump Unit Engines	Production Heaters	Stock Tanks	TEG Dehys	Operations Vehicle	Pneumatics	Compressor Engines	(tons/year)
Criteria Pollutants & VOC								
NO_X	7	7	0.00	0.00	0.4	0.0	3	17
CO	13	6	0.00	0.00	1.5	0.0	1	21
VOC	3	0.09	32	51	0.25	25.0	1	113
SO_2	0.00	0.00	0.00	0.00	0.02	0.0	0.00	0.02
PM_{10}	0.3	0.5	0.00	0.00	0.04	0.0	0.1	1
$PM_{2.5}$	0.3	0.5	0.00	0.00	0.00	0.0	0.1	1
Hazardous Air Pollutants								
Benzene	0.03	0.00	0.2	5	0.00	0.0	0.00	6
Toluene	0.01	0.00	0.2	12	0.00	0.0	0.00	12
Ethylbenzene	0.00	0.00	0.0	0.7	0.00	0.0	0.00	0.7
Xylene	0.00	0.00	0.0	11	0.00	0.0	0.00	11
n-Hexane	0.00	0.13	0.7	0.4	0.00	0.0	0.00	1
Formaldehyde	0.3	0.01	0.00	0.00	0.00	0.0	0.2	0.5
Acetaldehyde	0.05	0.00	0.00	0.00	0.00	0.0	0.0	0.1
Acrolein	0.04	0.00	0.00	0.00	0.00	0.0	0.01	0.06
Methanol	0.05	0.00	0.00	0.00	0.00	0.0	0.01	0.06
1,1,2,2-Tetrachloroethane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,1,2-Trichloroethane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,3-Dichloropropene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
1,3-Butadiene	0.01	0.00	0.00	0.00	0.00	0.0	0.00	0.01
2,2,4-Trimethylpentane	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Biphenyl	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Carbon Tetrachloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Chlorobenzene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Chloroform	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Ethylene Dibromide	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Methylene Chloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Naphthalene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Phenol	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Styrene	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Vinyl Chloride	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
PAH -POM 1	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
POM 2	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00
Benzo(b)fluoranthene/POM6	0.00	0.00	0.00	0.00	0.00	0.0	4.33E-07	4.33E-07
Chrysene/POM7	0.00	0.00	0.00	0.00	0.00	0.0	1.81E-06	1.81E-06
Greenhouse Gases								
CO_2	8,376	8,410	0.3	0.00	0.00	0.0	1,195	17,981
CH_4	4	0.16	12	5	0.01	119.2	14	155
N_2O	0.00	0.15	0.00	0.00	0.00	0.0	0.00	0.15

a Assumes maximum development scenario

APPENDIX G

Near-Field Air Quality Technical Support Document for the XTO Energy River Bend Unit Infill Development Project Environmental Assessmen

Near-Field

Air Quality Technical Support Document
for the
XTO Energy River Bend Unit Infill Development Project
Environmental Assessment

January 2010
Updated August 2012

Prepared for:
Bureau of Land Management
Vernal Field Office
Vernal, Utah

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APPENDIX B – VISCREEN Inputs and Results File

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1.0 INTRODUCTION

This Near-Field Air Quality Technical Support Document (AQTSD) describes the process used to develop the Near-Field Air Quality impact assessment for the Bureau of Land Management (BLM), Vernal Field Office, Draft Environmental Assessment (EA) for XTO Energy's (XTO) infill development within the River Bend Unit project area. The River Bend project area is located approximately 34 miles south of Vernal. The River Bend project area consists of 16,719 acres including parts of Township 9 South, Range 19 East; Township 10 South, Range 19 East; and Township 10 South, Range 20 East; Salt Lake Meridian, Uintah County, Utah.

A BLM-approved air quality impact analysis was issued with the West Tavaputs Draft Environmental Impact Statement (BLM 2008). The River Bend project area is located in the Uinta Basin of Utah, and is located in near proximity to a similar project in the West Tavaputs area of the Uinta Basin. Due to the geographical proximity this AQTSD incorporates the Protocol adopted for the West Tavaputs Air Quality Assessment Technical Support Document (BLM 2008). This document provides a detailed description of the procedures applied for the EA analysis to quantify potential ambient air quality and air quality related values (AQRV) impacts that may result from the implementation of the River Bend project.

This Near-Field air quality document is one of three documents that support the air quality analysis presented in the EA. This document was initially completed in May 2010, but was updated in June 2012 to account for the availability of more recent background air quality data and updates in the emission inventory for the Proposed Action. The other supporting documents for the EA are the Emissions Inventory for the XTO River Bend Unit infill development project (Buys & Associates 2010, updated in 2011), and the XTO, RBU Ozone Assessment report. (Alpine/Buys 2010 and updated in August 2011).

2.0 PROJECT DESCRIPTION

The River Bend project area currently contains active producing wells, with accompanying production related facilities, roads, and pipelines. Under the Proposed Action, an additional 484 wells are proposed for development.
The spacing of the wells will vary according to the geologic characteristics of the formation being developed; the densest spacing expected is one well pad per 20 acres.

XTO Energy proposes the following primary components for development under the Proposed Action:

- Up to 484 natural gas wells from 243 pads over a 8 year development period and a 40 year life of project (LOP);
- Up to 12 drilling rigs operating year round;
- Up to 7,825 acres short-term surface disturbance (wells, access roads, pipelines, compressor stations); and

An additional 8,520 of new compression horsepower
The near-field analysis is being conducted and analyzed using the specifications of the proposed action, which includes the maximum development scenario throughout the life of the project (i.e.

484 wells). Analysis of the impacts associated with any of the other alternatives would yield equal or lesser impacts.

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

Emissions to the atmosphere from the proposed project would consist of criteria pollutants: nitrogen oxides (NO_X), carbon monoxide (CO), particulates (PM_{10} and $PM_{2.5}$) and sulfur dioxide (SO_2). Additional emissions from the project include volatile organic compounds (VOC) and various hazardous air pollutants (HAPs).

Table 2-1 presents the summary of the emissions inventory analyzed for the Proposed Action when this document was completed in May 2010. Table 2-1 shows total (well development plus project production) NO_x emissions of 905 tons per year (TpY) and VOC emissions of 11,848 tons per year. However, an updated emission inventory was completed in 2011 (as discussed in Chapter 4 of the EA) and the emissions for the Proposed Action are now estimated as 564 TpY NOx and 5,185 TpY VOC, reductions of 38 and 56 percent, respectively (with similar changes in the other pollutant emissions as well). Near-field air quality impacts are not necessarily linearly related to total emissions; however, the impacts presented in this analysis are overstated because of the change in emission estimates for the Proposed Action.

The pollutants shown in Table 2-1 would be emitted from the following activities and sources:

- Well pad, new central facility and road construction: equipment producing fugitive dust while moving and leveling earth and vehicles generating fugitive dust on access roads;
- Drilling: vehicles generating fugitive dust on access roads and drill rig engine exhaust;
- Completion: vehicles generating fugitive dust on access roads, frac pump engine and generator emissions and completion venting emissions;
- Vehicle tailpipe emissions associated with all development phases;
- Well production operations: three-phase separator emissions, well site glycol dehydration unit emissions, flashing and breathing emissions from a condensate tank, fugitive emissions from pneumatic devices, fugitive dust and tailpipe emissions from pumpers and trucks transporting produced condensate and water from storage tanks; and
- Central production facility: compressor engines emissions, central glycol dehydration unit emissions, fugitive emissions from pneumatic devices, flare emissions from central dehydrators and central flashing and breathing emissions from condensate tanks.

Table 2-1 River Bend Emissions for the Proposed Action[a]		
Pollutant	**Project Emissions (tons/year)**	
	Well Development	**Project Production**
Criteria Pollutants & VOC		
NO_x	206	699
CO	171	947
VOC	301	11,510
SO_2	1.01	0.65
PM_{10}	698	41
$PM_{2.5}$	74.8	40
Hazardous Air Pollutants		
Benzene	1.23	445
Toluene	1.25	728
Ethylbenzene	0.04	36.8
Xylene	0.36	447
n-Hexane	6.22	139
Formaldehyde	0.00	22.1
Acetaldehyde	4.62E-06	2.9
Acrolein	9.95E-07	2.55
Methanol	0.00	2.72
1,1,2,2-Tetrachloroethane	0.00	0.02
1,1,2-Trichloroethane	0.00	0.01
1,3-Dichloropropene	0.00	0.01
1,3-Butadiene	1.19E-07	0.57
Carbon Tetrachloride	0.00	0.02
Dichlorobenzene	0.00	0.01
Ethylene Dibromide	0.00	0.02
Methylene Chloride	0.00	0.04
Naphthalene	1.20E-05	0.09
Vinyl Chloride	0.00	0.01
Benzo(b)fluoranthene [b]	0.00	3.10E-05
Chrysene [b]	0.00	5.44E-05
Total HAPs	9.09	1,827
Greenhouse Gases		
CO_2	19,122	780,053
CH_4	1,777	11,183
N_2O	0.00	5.96

[a] Emissions shown are from the initial estimates developed in 2010 for 484 additional producing wells. An updated emission inventory was completed in 2011 (for 484 wells) and emissions are on the order of one-half those shown herein. The updated 2011 emissions data are presented in Chapter 4 of the EA.

[b] Pollutants are HAPs because they are polycyclic organic matter (POM)

3.0 NEAR-FIELD DISPERSION MODEL AND METEOROLOGY

The American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) version 07026, has been promulgated in the EPA Guideline on Air Quality Models to replace ISCST3 as the primary dispersion model for assessing near-field impacts (40 CFR Part 51 in 9 Nov 05,Vol 70 # 216 FR 68218-68261), and was therefore applied in this analysis. The AERMOD system contains three primary components: AERMOD (dispersion model with prime building downwash algorithms), AERMAP (terrain preprocessor), and AERMET (meteorological preprocessor). The USEPA *Guideline on Air Quality Models* (40 CFR Part 51, Appendix W) specifies that impacts calculated with steady-state Gaussian plume models (AERMOD) are applicable and recommended at distances up to 50 km from the origin of the emission source.

Examples of AERMOD input and output files are attached to the document in Appendix A.

The AERMET system utilizes both surface and upper air measurements in order to estimate profiles of wind, turbulence, and temperature in the Planetary Boundary Layer. Minimum meteorological data requirements in the surface and upper air data files for successful execution of AERMET include horizontal wind speed, horizontal wind direction, ambient temperature, cloud cover, and a morning upper air sounding. The recent version of the model, however, has incorporated the Bulk Richardson Number scheme which removes the model dependence on cloud cover if Solar Radiation and Temperature Change with Height (SRDT) data are available. This is especially important in areas where cloud cover data are unavailable or considered to be non-representative. After entering the surface and upper air data into AERMET, the surface characteristics that pertain to the meteorological data are required, including; Albedo, Bowen Ratio and Surface Roughness.

Another requirement for accurate model performance is representative meteorological data of the conditions affecting the transport and dispersion of pollutants within the modeling domain. Generally, this means that the surface characteristics surrounding the meteorological monitoring site should be similar to those within the modeling domain. While a degree of similarity may correlate with proximity of the monitoring site to the project site, meteorological data measured at more distant sites may be considered representative as long as it adequately represents the meteorology and surface characteristics of the modeling domain.

In consideration of these limitations, this analysis utilized five years of recent surface measurements collected at Canyonlands National Park as part of the Clean Air Status and Trends Network (CASTNET) operated by the US Environmental Protection Agency (USEPA) and National Park Service (NPS). Evaluation of the surface characteristics surrounding the data collection site indicate that the data is likely to be representative of the meteorological conditions encountered within the modeling domain. Furthermore, the availability of SRDT data at this site allowed the application of the Bulk Richardson Number scheme providing an alternative to the less reliable ASOS data. The five years of surface data collected at Canyonlands was combined with National Weather Service twice-daily upper air soundings available at Grand Junction Walker Field in order to successfully operate AERMET and create five full years (1995-1999) of AERMOD ready meteorological data. Extracted from the Canyonlands data were wind speed, wind direction, horizontal wind direction deviation (sigma theta), solar radiation, and delta temperature (9m and 2m probes). Missing data or data outside acceptable ranges was reviewed and replaced as necessary using regulatory guidance along with professional judgment.

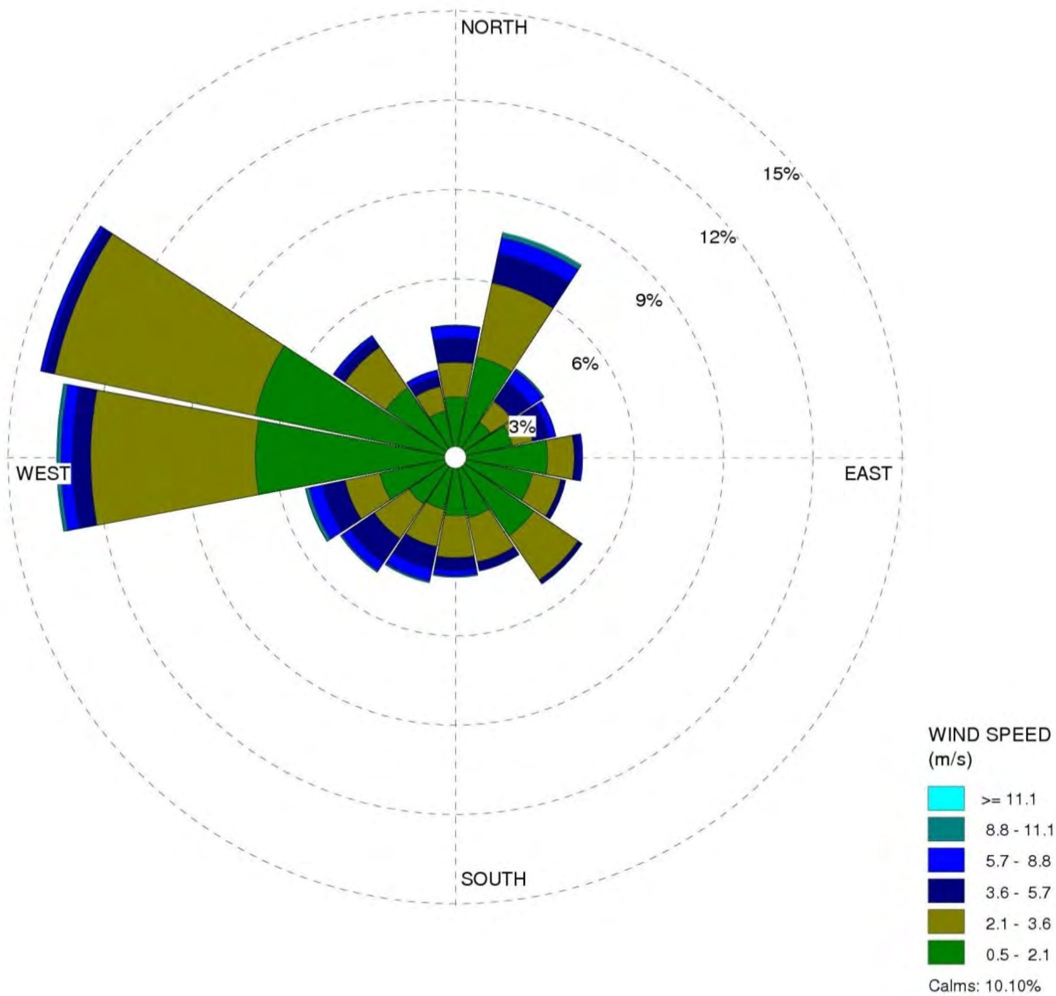
Finally, the AERMET processing program was utilized with all of the input data and produced two types of finished data files for each meteorological year for use by AERMOD; surface scalar parameters (*filename*.sss) and vertical profiles (*filename*.pfc). A profile base elevation of 1,470 m (4,823 ft.) was used with the meteorological data for the execution of AERMOD.

National Elevation Dataset (NED) data files were obtained containing information for the geographical area surrounding the facility. USGS 1/3 arc-second Geotiff files were downloaded in seamless data file format from the seamless.usgs.gov website. The NED data were based on the North American Datum of 1983 (NAD83). USEPA's AERMAP computer program was used to extract data from the DEM files and to calculate source base elevations and receptor elevations using the default algorithm (inverse distance squared of the nearest four terrain nodes). The most recent USEPA AERMAP version (09040) is being used to calculate elevations.

A wind rose for the project area is shown on Figure 3-1.

Figure 3-1

Wind Rose from Vernal Airport Data 2005-2009 (Vernal, UT)



4.0 SIGNIFICANCE CRITERIA

Potential impacts to near-field air quality that would result from the implementation of the River Bend Proposed Action were compared to the significance criteria listed below.

4.1 AIR QUALITY STANDARDS AND BACKGROUND DATA

Utah and National Ambient Air Quality Standards (UAAQS and NAAQS) have been promulgated for the purpose of protecting human health and welfare with an adequate margin of safety. Pollutants for which standards have been determined include sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), particulate matter less than 10 microns in diameter (PM_{10}), and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$).

The applicable ambient air quality standards and the Uinta Basin background concentrations are summarized in Table 4-1.

Under the Prevention of Significant Deterioration (PSD) provisions of the Clean Air Act (CAA), incremental increases of specific pollutant concentrations are limited above a legally defined baseline level. Many national parks and wilderness areas are designated as PSD Class I. The PSD program protects air quality within Class I areas by allowing only slight incremental increases in pollutant concentrations. Areas of Utah not designated as PSD Class I are classified as Class II. For Class II areas, greater incremental increases in ambient pollutant concentrations are allowed.

The PSD increments for Class II areas are also shown in Table 4-1.

Throughout this impact analysis, all comparisons with PSD increments are intended as a point of reference only and do not represent a regulatory PSD increment consumption analysis. PSD increment consumption analyses are applied to large industrial sources during the permitting process, and are the responsibility of the State of Utah with USEPA oversight. The Proposed Action is not subject to the PSD program.

Table 4-1 Ambient Criteria Pollutant National and State Ambient Air Quality Standards, and PSD Increments				
Pollutant	**Averaging Period(s)**	**Uinta Basin Background Concentration [a] (μg/m^3)**	**NAAQS (μg/m^3)**	**PSD Class II Increment (μg/m^3)**
SO_2	Annual	5	-[e]	20
	24-hour	10	-[e]	91
	3-hour	20	1,300	512
	1-hour	21.7[b]	196[e]	-[e]
NO_2	Annual	9.0[b]	100	25
NO_2	1-hour	69.6[b]	188[d]	-[d]
PM_{10}	24-hour	18.0[b]	150	30
$PM_{2.5}$	Annual	12.3[b]	15	4[f]
	24-hour	21.6[b]	35	9[f]
CO	8-hour	3,910[b]	10,000	None
CO	1-hour	6,325[b]	40,000	None
O_3	8-hour	105	147[c]	None

[a] Source: Utah Division of Environmental Quality - Division of Air Quality (UDAQ) unless otherwise noted.

[b] Based on data collected at the Ouray or Redwash Monitoring Stations (see AQIA, Greater Natural Buttes FEIS, AQTSD, March 2012. The 1-hour NO_2 value is the largest value in a range of 98[th] percentile values presented in the Greater Natural Buttes FEIS, AQTSD. [c] The 147 μg/m^3 value in the table is equivalent to the NAAQS of 0.075 ppm.

[d] NO_2 1-hour standard is based on the January 22, 2010 EPA update to the NAAQS standard (final rule effective April 12, 2010). The standard is the 3-year average of the 98[th] percentile. No PSD increment has been established.

[e] The USEPA published a 1-hour SO_2 standard, effective August 23, 2010, and eliminated the annual and 24-hour standard. The standard is the 3-year average of the 99[th] percentile. No PSD increment has been established.

[f] The USEPA published PSD increments for $PM_{2.5}$, effective October 20, 2011.

4.2 ACUTE AND CHRONIC HAP EXPOSURE THRESHOLDS

Hazardous Air Pollutants (HAPs) predicted to be released in significant quantities associated with the River Bend project include benzene, toluene, xylene, formaldehyde, and acrolein. Hydrogen sulfide (H_2S) is not expected to constitute a significant portion of the gas stream and therefore was not modeled. Since there are no applicable federal ambient air quality standards for the above pollutants, Reference Concentrations (RfC) for chronic inhalation exposure, and Reference Exposure Levels (REL) for acute inhalation exposures are applied as significance criteria. The RfCs represent an estimate of the continuous (i.e. annual average) inhalation exposure rate to the human population (including sensitive subgroups such as children and the elderly) without an appreciable risk of harmful effects. The RELs represent the acute (i.e. one-hour average) concentration at or below which no adverse health effects are expected; set by California EPA. Both the RfC and REL guideline values are for non-cancer effects.

Concentrations and exposure levels for the RfCs and RELs are provided in Table 4-2.

Table 4-2 HAP Reference Exposure Levels and Reference Concentrations		
Hazardous Air Pollutant (HAP)	**Reference Exposure Level [REL 1-hr Average] (μg/m^3)**	**Reference Concentration [1] [RfC Annual Average] (μg/m^3)**
Acrolein [2]	0.19	0.02

Table 4-2 HAP Reference Exposure Levels and Reference Concentrations		
Hazardous Air Pollutant (HAP)	**Reference Exposure Level [REL 1-hr Average] (µg/m³)**	**Reference Concentration [1] [RfC Annual Average] (µg/m³)**
Formaldehyde [2]	94	9.8
Benzene [2, 3]	1,300	30
Toluene [2]	37,000	5,000
Xylenes [2]	22,000	100

[1] EPA Air Toxics Database, Table 1 (EPA 2007a) http://www.epa.gov/ttn/atw/toxsource/summary.html
[2] EPA Air Toxics Database, Table 2 (EPA 2007a)
[3] REL for benzene is based on a 6-hr exposure (OEHHA 1999), predicted concentration is a 6-hr average.

The State of Utah has adopted Toxic Screening Levels (TSLs) which are applied during the air permitting process to assist in the evaluation of hazardous air pollutants released into the atmosphere (Utah Department of Environmental Quality- Division of Air Quality 2000). The TSLs are derived from Threshold Limit Values (TLVs) published in the American Conference of Governmental Industrial Hygienists (ACGIH) – "Threshold Limit Values for Chemical Substances and Physical Agents" (American Conference of Governmental Industrial Hygienists 2007). These levels are not standards that must be met, but screening thresholds which if exceeded, would suggest that additional information is needed to evaluate potential health and environmental impacts. The TSLs are compared against modeling concentrations for averaging periods of 1-hour (short-term) and 24-hour (chronic).

Table 4-3 lists the corresponding TSLs for each applicable HAP.

Table 4-3 Utah Toxic Screening Levels (TSLs)	
Pollutant and Averaging Time	**Toxic Screening Levels [b] (µg/m³)**
Formaldehyde (1-hour)	36.8
Acrolein (1-hour)	22.9
Benzene [a] (24-hour)	53.2
Toluene (24-hour)	2,512
Xylenes (24-hour)	14,473

[a] Although there exists an acute TLV for benzene, the State of Utah does not apply a comparison to an acute TSL since the chronic TSL is more stringent.
[b] Source: Prey Utah Department of Environmental Quality - Air Quality Division (2008b).

4.3 INCREMENTAL CANCER RISK

To assess long-term exposure from carcinogenic HAP emissions, traditional risk assessment methods are applied and the risk for the maximally exposed individual (MEI) and most likely exposure (MLE) are compared to the generally acceptable risk range of one additional cancer per one million exposed persons (1×10^{-6}), to one additional cancer per ten thousand exposed persons (1×10^{-4}) (EPA 1993). For the MEI risk, it is assumed that a person is exposed continuously (24 hours per day, 365 days per year) for the life of project. For the MLE risk, an adjustment was made for the amount of time a family stays at a residence (nine years) and for the portion of time spent away from the home (64 percent of the day) (EPA 1997). It is further assumed that households are exposed to one-quarter of the maximum concentration the remaining (36 percent) of the time. Exposure adjustment factors of 0.643 for the MEI (45/70) and 0.095 for the MLE [(9/70)*((0.64*1)+(0.36*0.25))] are applied to the estimated cancer risk to account for the actual time that an individual could be exposed during a 70-year lifetime.

The chronic inhalation cancer risk factors for benzene and formaldehyde and other HAPs are presented in Table 4-4.

Table 4-4 Carcinogenic Unit Risk Factors

Hazardous Air Pollutant	Carcinogenic Unit Risk Factor [Annual Inhalation Exposure] ($1/\mu g/m^3$)
Formaldehyde[1]	1.3×10^{-5}
Benzene[1]	2.2×10^{-6} - 7.8×10^{-6}

Source: [1] EPA Integrated Risk Information System (IRIS) database (EPA 2008). A range of risk factors is available for benzene.

5.0 NEAR-FIELD DEVELOPMENT AND CONSTRUCTION IMPACTS

The major pollutants associated with development activities are particulate matter, characterized as PM_{10} and $PM_{2.5}$, generated by earth-moving and traffic activities. The major pollutants associated with production activities are NO_2, CO, and HAPs as presented in section 6.0 of this report).

1-Hour NO_2 and SO_2 Standards s

Since the new 1-hour NO_2 and SO_2 standards were promulgated after the initial Near-Field scoping and impact analyses were completed, potential project impacts for comparison to the 1-hour NO_2 and SO_2 standard were not explicitly included in this analysis. However, the Greater Natural Buttes FEIS (GNB FEIS, March 2012) modeled and assessed the potential impacts from cumulative development and construction impacts in the region, including the RBU Proposed Action sources. The potential impacts of the Proposed Action as discussed in the GNB FEIS are presented in Chapter 4 of the EA.

5.1 DEVELOPMENT AND CONSTRUCTION MODELING SETUP

For air quality modeling purposes, a scenario of 1 expanded well pad and 1 new well pad based on 20-acre spacing, and an attached segment of new road were used to simulate a likely development scenario in a single section of the well field for purposes of PM_{10} and $PM_{2.5}$ modeling. In order to alleviate some of the extensive AERMOD processing times associated with area source emissions, PM_{10} and $PM_{2.5}$ emissions are not being modeled based on a full field of development (i.e. maximum well pads developed per year), but rather under this scenario that includes a section of development that is estimated to result in the maximum emissions impact. The construction, drilling, and completion related air quality impacts were analyzed with this modeling setup for PM_{10} and $PM_{2.5}$.

A well pad and access road complex was characterized by an individual well pad and an access road right-of-way approximately 1,619-feet long by 22-feet wide. Project access roads were modeled as a line of volume sources. Although a road could be oriented in any direction, the use of five years of meteorological data adequately characterizes the maximum short-term impacts regardless of orientation.

A buffer zone of 100-meters from the access road and the well pad was entered. The buffer zone criteria were based on minimum distances that heavy equipment operators would allow public access to construction. Receptors were spaced at 50-meter intervals along the 100-meter buffer zone (acting as a fenceline), at 100-meter intervals extending out 1.0 km from the center point of the two well pads, and at 250-meter intervals 2.5 km from the center point of the two well pads. Receptor elevations were entered into BEEST through the AERMAP modeling program.

5.2 DEVELOPMENT PARTICULATE MATTER EMISSIONS

Modeling for construction activities involved PM_{10} and $PM_{2.5}$ emissions from the operation of a backhoe, dozer and grader; in addition to fugitive dust generated by vehicles traveling on the existing roadways for transportation and hauling development purposes. Modeling for the drilling activities includes traffic-generated fugitive dust as well as PM_{10} and $PM_{2.5}$ emissions from a drill rig. Modeling for completion activities include vehicle-generated fugitive dust and well fracturing activity PM_{10} and $PM_{2.5}$ emissions. Development, construction and completion equipment and activity emissions are distributed to each well pad and the roadways based on emission factors which are specific to each proposed well pad or roadway segment.

Based on the proposed project schedule, a well pad and associated access road would be constructed in about 9 days. The time to drill a well would range from 14 days for shallower vertical drilling to 21 days for directional wells. A well would then be completed (well fracturing) in about 10 days. Well drilling, construction and completion activities are assumed to occur 10 hours per day.

PM_{10} and $PM_{2.5}$ emissions were predicted for comparison to applicable short-term and annual ambient air quality standards. For annual particulate impacts the 10-hour based particulate matter emission rates are calculated as if they were to be equally spread throughout the full annual period (e.g., a PM_{10} pounds per hour emission rate is multiplied by the total number of hours it would take to complete the activity, then divided by the 8,760-hour time period). Impacts for short-term (24-hour) particulate emissions are evaluated in AERMOD for full 24-hour periods; thus, the 10-hour based particulate matter emission rates are calculated as if they were to be equally spread throughout the full 24-hour period (e.g., a PM_{10} pounds per hour emission rate is multiplied by the total number of hours it would take to complete the activity, then divided by the 24-hour time period). Note, for drill rig emissions the emission rate is not re-calculated for the 24-hour short term impact because drill rig operations can occur throughout a whole 24-hour period.

Fugitive dust emissions from well pads were modeled as area sources with the release parameters listed in Table 5-1. Fugitive dust emissions from roads were modeled as volume sources with the parameters listed in Table 5-2. Drill rig and well fracturing pump and generator emissions were included as emissions releases through the well pad area sources.

Table 5-1 River Bend Development Area Source Release Parameters

Source	Dimensions (meters)		Release Height [a] (meters)
	X-Dimension	Y-Dimension	
New Pad	101	101	6
Expanded Pad	45	45	6

[a] Typical values used in modeling fugitive dust range from 0 to 6 meters. Tailpipe emissions immediately rise and dust plumes from vehicles can rise from one to two times the vehicle height. Truck heights are generally higher than cars, hence 6 meters is being used.

Table 5-2 River Bend Development Volume Source Release Parameters

Source	Dimensions (meters)		Release Height [a] (meters)
	X-Dimension	Y-Dimension	
New Road Segment	7.62	7.62	6

[a] Typical values used in modeling fugitive dust range from 0 to 6 meters. Tailpipe emissions immediately rise and dust plumes from vehicles can rise from one to two times the vehicle height. Truck heights are generally higher than cars, hence 6 meters is being used.

Because road construction usually precedes well pad construction, fugitive dust emissions from construction traffic was also added to the volume sources for the associated road. This is conservative because traffic associated with road construction is included.

Emission rates were derived according to the averaging period being modeled. For instance, NO_x emission rates were annualized for each activity because the NO_x emissions standard is an annual threshold. However, short-term fugitive dust emission rates reflect the maximum 24-hour emissions that could be observed during a single day.

The maximum predicted short-term emissions from well development are shown in Table 5-3.

Table 5-3 River Bend Proposed Action Short-Term Development Emission Rates			
Activity	**Duration**	**Maximum PM_{10} Emission Rate (lbs/hr)**	**Maximum $PM_{2.5}$ Emission Rate (lbs/hr)**
Construction (per pad)	10 days		
Earth Moving		0.698	0.358
Vehicle Traffic (per volume)		0.033	0.003
Drilling (per well)	35 to 54 days		
Drill Rig		0.250	0.200
Vehicle Traffic (per volume)		0.033	0.0033
Completion (per well)			
Well Fracturing	6 hours	0.327	0.278
Vehicle Traffic (per volume)	14 days	0.033	0.0033

5.3 DEVELOPMENT EMISSION IMPACT RESULTS

5.3.1 Proposed Action Emission Impacts

Well development impacts as compared to the NAAQS for the Proposed Action are shown in Table 5-4.

Since well development activities are temporary and short-term in nature, comparisons to PSD increments are not appropriate. The annual results demonstrate that even if these activities lasted for an entire year in the same location, the effects would still be less than all applicable standards.

Table 5-4 Proposed Action Potential Development Impacts

Pollutant	Averaging Period	Ambient Air Concentration (μg/m^3)				
		Year of Maximum Impact	Predicted	Background [a]	Total	NAAQS
PM_{10}	24-Hour	1999	41.9	18.0	59.9	150
$PM_{2.5}$	24-Hour [b]	1995	18.4	21.6	40.0[b]	35
	Annual	1995	0.73	12.3	13.0	15

[a] Based on data collected at the Ouray or Redwash Monitoring Stations (see AQIA, Greater Natural Buttes FEIS, AQTSD, March 2012

[b] Although the modeled total impact appears to exceed the NAAQS, this is not case. The NAAQS is the 3-year average of the 98th percentile. The modeled impact presented herein is the maximum modeled concentration, not the 98th percentile. Accordingly, due to the conservative nature of the model assumptions, use of a background data value based on less than 3-years of data, and use of the maximum impact instead of the 98th percentile, actual impacts are expected to be less than the NAAQS.

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6.0 NEAR-FIELD OPERATIONS IMPACTS

The near-field impact assessment considers NO_X, CO, and HAP emissions during the operational phase of the River Bend project in the final year of full-field development (as the maximum amount of wells would be operational by the final year, and considering the possibility that the final year could be the maximum year of development). Since SO_2 concentrations within the gas are very minimal, these emissions were not included in the near-field modeling. All facilities were assumed to operate continuously throughout the year.

6.1 MODELING SETUP

Maximum impacts predicted to occur in the River Bend project infill area are analyzed by modeling the full project area with complete maximum development in the air quality modeling analysis. Criteria and HAP emissions that are based on development of all 484 wells are modeled through each well, and emissions that are based on the maximum year of well development are spread throughout a representation of 93 wells as a conservative estimate that the maximum year of development would occur during the final development year (i.e. the final year of project development is when maximum emission rates could occur).

Criteria pollutant emissions were modeled as point sources for the following development and operations:

- Gas well pads: drill rigs engines, well fracing engines, pumping unit engines, dehydrators and production heaters;
- Central Gas Plant: compressor engines and separator emissions;

HAP emissions were modeled for the following sources:

- Gas well pads: drill rigs engines, well fracing engines, pumping unit engines, dehydrators, production heaters and well site condensate tank flashing/working/breathing emissions;
- Central Gas Plant: compressor engine, central condensate tank flashing/working/breathing emissions, production heaters, dehydrator and dehydrator reboiler emissions.

Receptor spacing of 125-meters was utilized within all of the RBU facility property boundary. Preliminary modeling results show that maximum impacts occur within a center portion of the property, and not near the edge of the boundary (i.e. maximum impacts occur where development and operations are the densest in emission sources).

The release parameters for all point sources are described in Tables 6-1. Volume sources do not have release parameters. Table 6-2 summarizes the point source modeling emission rates calculated from the estimated annual emissions for the full-field operations.

Table 6-1 Operations Proposed Action Point Source Release Parameters				
Equipment	**Stack height (m)**	**Temperature (K)**	**Exit Velocity (m/sec)**	**Stack Diameter (m)**
Compressor Engine	6.1	730	50	0.3048
Generator Engine	6.1	730	50	0.3048
Separator or Dehydrator Reboiler	4.6	700	2.84	0.2286

[a] For large sources, sigma z = 2*release ht./2.15. (See the ISC Model User's Guide [EPA, 1995], pp 3-28 to 3-35 for further information)

Table 6-2 Operations Proposed Action Point Source Modeling Emission Rates (tons/year)			
Pollutant	**Central Station Compressor Engine**	**Central Station Heaters**	**Well site Heaters**
NOx	82.3	5.91	265
CO	15.6	4.97	223

6.2 OPERATIONS IMPACTS RESULTS

The predicted impacts are compared to applicable Utah and NAAQS standards and applicable PSD Class II increments presented in Section 4.0. All comparisons with PSD Class II increments are intended as a point of reference only and do not represent a regulatory PSD increment consumption analysis. PSD increment consumption analyses are applied to large industrial sources during permitting, and are solely the responsibility of the State of Utah with EPA oversight. The Proposed Action is not subject to the PSD program. The maximum impact for NO_2 reflects an adjustment by a factor of 0.75, in accordance with standard EPA methodology (60:153 FR 40469, Aug 9, 1995) to convert from the modeled Nitrogen Oxides (NO_X) concentration to Nitrogen Dioxide (NO_2).

6.2.1 Proposed Action Results

Results of the near-field modeling are for each pollutant of interest, and based on the highest predicted value from the five years of meteorological data modeled, are presented in Table 6-3.

Table 6-3 Proposed Action Potential Development Impacts							
Pollutant	Averaging Period	Ambient Air Concentration ($\mu g/m^3$)					
		Year of Maximum Impact	Predicted	Background	Total	PSD Class II Increment	NAAQS
NOx	Annual	1999	19.2 [a]	9.0[b]	28.2	25	100
CO	8-hour	1999	338	3,910[b]	4,248	-	10,000
	1-hour	1996	658	6,325[b]	6,983	-	40,000

[a] NO_2 annual impacts are converted from modeled NOx to NO_2 using a 75% conversion rate.
[b] Based on data collected at the Ouray or Redwash Monitoring Stations (see AQIA, Greater Natural Buttes FEIS, AQTSD, March 2012).

6.3 HAP EMISSIONS

The gas plant and well pad sources were modeled as point sources with the release parameters listed in Table 6-4.

Table 6-4 River Bend HAP Point Source Release Parameters [a]				
Source	Stack height (m)	Temperature (K)	Exit Velocity (m/sec)	Stack Diameter (m)
Central Station (CS) Compressor Engine (Natural Gas)	7.0	730	50	0.3048
Drill and Fracing	6.0	800	50	0.1000
Dehydrator Reboiler (CS & Well pad)	4.6	700	2.84	0.2286
Separators (CS & Well pad)	4.6	700	2.84	0.2286
Storage Tanks (CS and Well Pad)	6.7	281	0.001	0.0508

[a] Data is a combination of previous installation and typical manufacturers' specifications.

Table 6-5 shows the estimated HAP emission rates from each emission category of emission sources.

Table 6-5 River Bend HAP Point Source Modeling Emission Rates [a]					
Source	Maximum Emission Rate (lbs/hr per pad or per central station)				
	Benzene	Toluene	Xylene	Formaldehyde	Acrolein
Central Station (CS) Compressor Engine, Heaters and Dehy	0.12501	0.31764	0.30893	0.12533	0.00934
Well Pad Dehy, Pump and Separator	0.19812	0.32782	0.20228	0.00811	0.00103
Well Pad Drilling, Fracing and Venting	0.00300	0.00305	0.00089	2.74E-08	2.28E-09
CS Storage Tanks	0.03265	0.03242	0.00982	-	-
Well Pad Storage Tanks	0.00891	0.00891	0.00274	-	-

[a] Emission rates are based on the maximum years production and operation.

6.4 OPERATIONS HAZARDOUS AIR POLLUTANT RESULTS

Modeled results were compared to the Utah screening levels, and the acute, chronic, and carcinogenic thresholds listed in Section 4.0 for each applicable HAP. Impacts from HAPs with the highest four predicted emissions, plus acrolein due to the dangers in small levels of exposure, were compared to all criteria. Short-term impacts from HAP exposure were assessed by comparing one-hour average impacts to the HAP-specific acute REL (reference exposure level) and annual average impacts to the HAP-specific RfC (reference concentration for continuous inhalation exposure). The REL is the acute concentration at or below which no adverse health effects are expected. The RfC is the average concentration, i.e., an annual average, at or below which no long-term adverse health effects are expected. Both of these guideline values are for non-cancer effects.

Screening level risk assessment involves application of a HAP specific unit risk factor. The unit risk factor is an upper-bound estimate of the probability of one additional person contracting cancer based on continuous exposure to 1 ug/m^3 of the substance over a 70-year lifetime. Annual average concentrations of carcinogenic HAPs were modeled and expressed as a long-term cancer risk (based on 70-year exposure) using the HAP specific unit risk factor. The risk from long-term exposure to carcinogenic HAP emissions is assessed by comparison to the generally acceptable risk range of one additional cancer per one million exposed persons (1 x 10^{-6}) to one additional cancer per ten thousand exposed persons (1 x 10^{-4}) (EPA 1993).

Exposure adjustment factors are calculated to adjust for actual exposure times. Cancer risk is estimated for two exposure scenarios: the most likely exposure (MLE) that individuals will experience, and the maximally exposed individual (MEI).

The MLE was assumed to apply to people living in the general vicinity of the RBU project area. For the MLE exposure adjustment factor, it is assumed a family stays at a residence an average of nine years and spends 64 percent of the day away from the home (EPA 1997). It is further assumed that households are exposed to one-quarter of the maximum concentration the remaining (36 percent) of the time. This results in an adjustment factor of 0.095 [(9/70)*((0.64*1)+(0.36*0.25))].

An example of an MEI could be a person assigned to project area pumping that visits well sites daily and lives near a well pad. For the MEI exposure adjustment factor, exposure is assumed to occur continuously (24 hours per day, 365 days per year) for the life of project (assumed to be 45 years). This results in an adjustment factor of 0.643 [45/70].

EPA's first guidelines on carcinogen risk assessment assumed that risks exist at any dose (EPA 1986). More recent data show that there are some exceptions to this assumption however it is still the default when there is a lack of data (EPA 2007). Therefore carcinogenic risk was assessed for the known, probable, and possible human carcinogens (possible human carcinogen meaning known animal carcinogen) associated with the Proposed Action with existing unit risk factors (EPA 2007).

Table 6-6 presents the predicted results of emission impacts under the proposed action in comparison to the State of Utah TSLs for averaging periods of 1-hour (short-term) and 24-hour (chronic). None of the HAPs exceed Utah TSLs.

Table 6-6 River Bend Proposed Action Utah Toxic Screening Level (TSL) Impacts

Pollutant and Averaging Time	Predicted Maximum Impact (μg/m^3)	Maximum Impact Year	Toxic Screening Levels [b] (μg/m^3)	Percent of TSL
Formaldehyde (1-hour)	12.8	1996	36.8	34.8%
Acrolein (1-hour)	1.63	1996	22.9	7.12%
Benzene [a] (Annual)	26.9	1999	53.2	50.6%
Toluene (24-hour)	10.5	1996	2,512	0.40%
Xylenes (24-hour)	103	1999	14,473	0.70%

[a] Although there exists an acute TLV for benzene, the State of Utah does not apply a comparison to an acute TSL since the chronic TSL is more stringent. Thus, the annual Benzene impact is compared to the Benzene chronic TSL.
[b] Source: Utah Department of Environmental Quality – Division of Air Quality (2008).

Table 6-7 presents the acute RELs and RfCs for non-cancer effects for the Proposed Action. The predicted maximum concentrations of all HAPs are compared against the REL and RfC for each pollutant. Predicted concentrations of acrolein for the Proposed Action exceed both the acute REL and the RfC. The sources of acrolein for the Proposed Action include the compressor engines and pump unit engines. Acrolein is a very reactive compound with a half-life in air of 1 day. Exposure to lower levels of acrolein can cause eye, nose, and throat irritation, and can lower breathing rates. Higher levels of acrolein can damage the lungs and cause death (ATSDR 2007). For perspective, the annual average ambient urban background in California is 0.15 μg/m^3 with a 95th percentile of 0.3 μg/m^3. Acrolein levels measured in smoky bars and restaurants ranged from 2.3 to 275 μg/m^3 (OEHHA 2001). A public draft is available through the OEHHA website (dated November 7, 2007) increasing the acute REL to 2.3 μg/m^3, and increasing the chronic level to 0.1 μg/m^3 (OEHHA 2007). The ACGIH has set a threshold limit ceiling value that should never be exceeded in a work environment at 229 μg/m^3 (ACGIH 2007). EPA's website documentation for the acrolein RfC indicates EPA has medium confidence in the RfC as it is based on medium quality data. (http://www.epa.gov/iris/subst/0364.htm)

Table 6-7 River Bend Proposed Action Non-Carcinogenic Acute REL and RfC Impacts

HAP	REL [a] (µg/m³)	Predicted Maximum 1-Hour Impact (µg/m³)	% of REL	RfC [c] (µg/m³)	Predicted Maximum Annual Impact (µg/m³)	% of RfC
Acrolein	0.19	1.63	858%	0.02	0.13	650%
Acrolein [d]		-	-	0.06	0.13	216%
Formaldehyde	94	12.8	13.6%	9.8	1.04	10.6%
Benzene [b]	1,300	187	13.0%	30	26.9	89.6%
Toluene	37,000	521	1.41%	5,000	43.3	0.87%
Xylenes	22,000	321	1.46%	100	26.2	26.2%

[a] California EPA Reference Exposure Level (REL) for no adverse effects EPA Air Toxics Database, Table 2 (EPA 2007a)
[b] REL for benzene is based on a 6-hr exposure (OEHHA 1999), predicted concentration is a 6-hr average.
[c] EPA Air Toxics Database, Table 1 (EPA 2007a)
[d] California EPA chronic REL

Table 6-8 presents the unit risk factor, exposure adjustment factor, and the estimated cancer risk for the MLE and MEI exposure scenarios for the Proposed Action known, probable, and possible carcinogenic HAPs. The unit risk factor is a slope factor that when multiplied by the ambient air concentration provides an estimate of the probability of one additional person contracting cancer based on continuous exposure over a 70-year lifetime. A range of unit risk factors is available for benzene. All estimated risks are within the acceptable range.

Table 6-8 River Bend Proposed Action Potential Carcinogenic HAP Risk

Exposure Scenario	HAP	Unit Risk Factor (1/µg/m³)	Exposure Adjustment Factor	Modeled Annual Impact (µg/m³)	Cancer Risk
MLE	Benzene	2.2×10^{-06} to 7.8×10^{-06}	0.095	26.9	5.6×10^{-06} to 2.0×10^{-05}
	Formaldehyde	1.3×10^{-05}	0.095	1.04	1.3×10^{-06}
	TOTAL MLE RISK				**1.3×10^{-05}**
MEI	Benzene	2.2×10^{-06} to 7.8×10^{-06}	0.40	26.9	2.4×10^{-05} to 8.4×10^{-05}
	Formaldehyde	1.3×10^{-05}	0.643	1.04	8.7×10^{-06}
	TOTAL MEI RISK				**9.3×10^{-05}**

Example Benzene MLE Calculation: 0.0000022 unit risk factor * 0.095 adjustment factor * 26.9 impact = 0.0000056 cancer risk

MEI = maximally exposed individual
MLE = most likely exposure

There is uncertainty associated with adding cancer risk values together although it is commonly done for carcinogens having similar modes of action or target organs. However formaldehyde, a suspected human carcinogen, is suspected to cause leukemia and therefore it is reasonable to add benzene and formaldehyde risk numbers together.

7.0 VISIBILITY DEGRADATION ANALYSIS

A screening analysis to determine the impacts on visibility caused by the River Bend Unit project area at 50 km distances was performed. The VISCREEN model provided by the USEPA was used to determine the visual effect parameters (color difference parameter and plume contrast against a background) from the RBU project area emissions plumes from a given vantage point (i.e., a scenic vista). VISCREEN is recommended for use up to a maximum distance of 50 km from the source. Due to the distance from RBU to the nearest Class I area (greater than 150 km), analyzing the visibility impact (degradation) that RBU could have on a given location at 50 km is considered to be a conservative estimate.

Potential visibility degradation can be evaluated in terms of the change in deciview (Δdv) or a change in background extinction (B_{ext}). A 1.0 dv "Just Noticeable Change" is equivalent to a 10% change in B_{ext}. There are no applicable federal, state, tribal, or local visibility standards. However, predicted visibility impacts are compared to Levels of Acceptable Change (LAC) developed by Federal Land Managers (FLAG 2000). This threshold is based on the original development of the deciview scale (Pitchford and Malm 1994), and is supported by EPA's Final Regional Haze Regulation (EPA 1999) decision to use 1.0 Δdv as the significance level when preparing periodic reasonable progress reports. Therefore, a "Just Noticeable Change" threshold of a 10% change in the reference background extinction or 1.0 Δdv is being used as a threshold.

The VISCREEN model used for the visibility impact screening analysis calculates the contrast of a potential plume of pollutants emitted by the proposed project. The model uses 5 percent contrast as the significance criterion. Contrast is directly related to visual range, and most visual range calculations use a 2 percent contrast difference as being "barely noticeable". That is, if there is a 2 percent difference in contrast between the object being viewed and the background, the object would be barely noticeable and the distance at which the contrast decreases to 2 percent is the visual range. Accordingly, to be comparable to the deciview "Just Noticeable Change" criterion, a 2 plume percent contrast value was used as the significance criterion instead of the default VISCREEN criterion of 5 percent.

The VISCREEN model was run with an particulate matter ($PM_{2.5}$) emission rate of 77 tpy and a NO_X emission rate of 218 tpy. These emission rates are for maximum development, where maximum $PM_{2.5}$ emissions occur. This set of emissions was used since $PM_{2.5}$ has the greatest effect on visual air quality. The source-observer distance and minimum distance to the scenic vista was set at 50 kilometers and the maximum distance to the scenic vista was set at 50 kilometers. The 50 km distance was used since the VISCREEN model is designed to yield conservative (i.e., over predict) estimates of potential visibility impacts near a source. The model uses hypothetical worst case meteorology (e.g., 1 meter per second wind speed) and assumes straight line transport indefinitely. At a 1 meter per second wind speed, it will take nearly 14 hours to transport emissions 50 km. Therefore, using VISCREEN quantitatively for distances beyond 50 km is not reasonable. However, at distances beyond 50 km, the plume contrast will be much less than at 50 km due to plume dispersion and entrainment of background ambient air.

A background visual range of 170 kilometers was used for the surrounding area, as presented and recommended in Figure 4-3 of the VISCREEN manual. Although more recent visual air quality data indicate that some of the "best" days in the region of the Proposed Action may have visual ranges greater than 170 km, the VISCREEN model was developed with the hypothetical background visual range values incorporated into the model as defaults. Along with the default background visual range, default particle size, particle density and worst-case meteorological conditions (F stability and 1 meter per second wind speed) were selected for the model to provide a worst-case scenario (i.e., Level-1 screening analysis) in accordance with the VISCREEN User's Manual.

Execution of the VISCREEN model with the inputs specified above resulted in visual impacts 50 km from RBU that are not considered objectionable or adverse (i.e., do not exceed screening criteria) at the distance of the theoretical scenic vista.

Appendix B presents the VISCREEN model inputs and results.

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APPENDIX A

AERMOD INPUT EXAMPLE FILE

APPENDIX B

VISCREEN INPUTS AND RESULTS

VISUAL EFFECTS SCREENING ANALYSIS FOR
SOURCE: RBU
CLASS I AREA: RBURECEPTOR

*** LEVEL-1 SCREENING ***
INPUT EMISSIONS FOR

PARTICULATES	77.00	TON/YR
NOX (AS NO2)	218.00	TON/YR
PRIMARY NO2	.00	TON/YR
SOOT	.00	TON/YR
PRIMARY SO4	.00	TON/YR

**** DEFAULT PARTICLE CHARACTERISTICS ASSUMED

TRANSPORT SCENARIO SPECIFICATIONS:

BACKGROUND OZONE:	.04 PPM
BACKGROUND VISUAL RANGE:	170.00 KM
SOURCE-OBSERVER DISTANCE:	50.00 KM
MIN. SOURCE-CLASS I DISTANCE:	50.00 KM
MAX. SOURCE-CLASS I DISTANCE:	50.00 KM
PLUME-SOURCE-OBSERVER ANGLE:	11.25 DEGREES
STABILITY:	6
WIND SPEED:	1.00 M/S

R E S U L T S

ASTERISKS (*) INDICATE PLUME IMPACTS THAT EXCEED SCREENING CRITERIA

MAXIMUM VISUAL IMPACTS INSIDE CLASS I AREA
SCREENING CRITERIA ARE NOT EXCEEDED

					DELTA E		CONTRAST	
BACKGRND	THETA	AZI	DISTANCE	ALPHA	CRIT	PLUME	CRIT	PLUME
SKY	10.	84.	50.0	84.	2.00	.896	.05	.013
SKY	140.	84.	50.0	84.	2.00	.497	.05	-.009
TERRAIN	10.	84.	50.0	84.	2.00	1.937	.05	.017
TERRAIN	140.	84.	50.0	84.	2.00	.176	.05	.003

MAXIMUM VISUAL IMPACTS OUTSIDE CLASS I AREA
SCREENING CRITERIA ARE EXCEEDED

					DELTA E		CONTRAST	
BACKGRND	THETA	AZI	DISTANCE	ALPHA	CRIT	PLUME	CRIT	PLUME
SKY	10.	0.	1.0	169.	2.28	11.415*	.05	.173*
SKY	140.	0.	1.0	169.	2.00	2.459*	.05	-.079*
TERRAIN	10.	0.	1.0	169.	2.00	12.463*	.05	.131*
TERRAIN	140.	0.	1.0	169.	2.00	3.147*	.05	.080*

APPENDIX H-1

Ozone Impact Assessment for XTO Energy's River Bend Unit Natural Gas Development Project Environmental Assessment

Ozone Impact Assessment
for
XTO Energy's
River Bend Unit Natural Gas Development Project
Environmental Assessment

Prepared for: Bureau of Land Management
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May 2010

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1.0 Introduction

XTO Energy (XTO) has proposed to the United States Department of the Interior (USDOI) Bureau of Land Management (BLM) Vernal Field Office (VFO) to develop oil and natural gas resources within XTO's Federal leases located within the River Bend Unit Project Area (RBU Project Area).

The RBU Project Area is located approximately 34 miles south of Vernal. The RBU Project Area consists of 16,719 acres including parts of Township 9 South, Range 19 East; Township 10 South, Range 19 East; and Township 10 South, Range 20 East; Salt Lake Meridian, Uintah County, Utah. Surface ownership in the RBU Project Area consists of BLM land administered by the Vernal FO (12,002 acres), Uintah and Ouray Indian reservation administered by the Bureau of Indian Affairs (BIA) (4,075 acres), and State land administered by the School and Institutional Trust Lands Administration (SITLA).

The XTO River Bend Project Area currently contains active producing wells, with accompanying production related facilities, roads, and pipelines.

1.1 Project Description

XTO proposes to expand and fully develop gas production in the existing RBU Project Area through the use of vertical and directional drilling to attain 20-acre well spacing. Due to the extensive amount of pre-existing development via vertical drilling in the RBU Project Area, XTO has gained an intricate understanding of the sub-surface formations and associated pay zones. Based upon this knowledge, XTO is able to target additional pay zones via directional drilling in a technically and economically feasible manner, with lower risks for missing these targets. As such, full field development in the RBU Project Area would include the drilling of 484 wells.

The Proposed Action includes utilizing directional drilling from existing and proposed well pads in the RBU Project Area. This would include the construction of necessary infrastructure to directionally and vertically drill 484 wells, including the 128 wells previously approved (EA No. 1997-49). Development on State and Tribal leases is also included in the Proposed Action. Specific requirements would include the expansion of the existing, and installation of new, infrastructure including well pads, roads, pipelines, and supporting facilities such as tanks, dehydrators, and compressors.

The primary components of the Proposed Action were utilized for the development of a project specific emissions inventory for this ozone assessment. The Proposed Action primary components are as follows:

- Directional drilling of up to 378 natural gas wells from 169 existing well pads;
- Vertical drilling of up to 74 natural gas wells from 74 new well pads;
- Directional drilling of up to 32 wells from 19 of the 74 new well pads;
- Construction of 15.7 miles of new co-located road, gas lines, and produced water lines;

- Depending upon well production, installation of up to 120 miles of replacement gas lines that would transport gas produced from both existing and proposed wells to the main gathering lines. These replacement spur gas lines would be buried adjacent to the existing gas line ROWs; and
- Construction of one new compressor station, and expansion of eight existing compressor stations.

Emissions to the atmosphere from the proposed project would include the following criteria pollutants and precursors: nitrogen oxides (NO_x), particulates (PM_{10} and $PM_{2.5}$), Volatile Organic Compounds (VOC), and sulfur dioxide (SO_2). These pollutants would be emitted from the following activities and sources:

- Well pad and road construction: equipment producing fugitive dust while moving and leveling earth, vehicles generating fugitive dust on access roads;
- Drilling: vehicles generating fugitive dust on access roads, and drill rig engine exhaust;
- Completion: vehicles generating fugitive dust on access roads, frac pump engine and generator emissions, and completion venting emissions;
- Vehicle tailpipe emissions associated with all development phases;
- Well production operations: three-phase separator emissions, flashing and breathing emissions from stock tanks, dehydrator emissions, fugitive pneumatic device emissions, fugitive dust and tailpipe emissions from pumpers and trucks transporting produced condensate and water from storage tanks; and
- Central production facilities: compressor engines emissions, central glycol dehydration unit emissions, flare emissions for control of central facility VOC emissions, central flashing and breathing emissions from condensate tanks, fugitive pneumatic device emissions, and emissions associated with loading natural gas liquids (NGL) into trucks;

To reduce the emission of ozone forming precursors (NO_X and VOC) XTO has committed to implement the following Applicant Committed Environmental Protection Measures (ACEPMs):

- The use of Tier II or better diesel drill rig engines to reduce NO_X emissions;
- RMP compliant NO_X emissions limitation of 1.0 g/hp-hr for engines rated greater than 300 hp, and a NO_X emissions limitation of 2.0 g/hp-hr for engines rated less than 300 hp.
- The installation of low-bleed pneumatic controls, where technically feasible, on all new equipment to reduce potential VOC emissions;

This ozone impact analysis considered the emissions from the Proposed Action with applicant committed measures to reduce ozone precursor emissions.

Project emissions modeled in this assessment are shown below in Table1-1. A detailed project emission inventory is also available.

Table 1-1. XTO River Bend Unit Emissions

Alternative	Phase	Pollutant (ton/yr)			
		NO_x	CO	VOC	SO_2
Proposed Action	Development	206	171	301	1.0
	Operations	699	947	11,547	0.65
	Total	***905***	***1,118***	***11,848***	***1.65***

1.2 Modeling Approach

For more than a decade, EPA has been developing the Models-3 Community Multiscale Air Quality (CMAQ) modeling system with the overarching aim of producing a 'One-Atmosphere' air quality modeling system capable of addressing ozone, particulate matter (PM), visibility and acid deposition within a common platform (Byun and Ching, 1999, Pleim et al., 2003, Byun and Schere, 2006). The original justification for the Models-3 development emerged from the challenges posed by the 1990 Clean Air Act Amendments and EPA's desire to develop an advanced modeling framework for 'holistic' environmental modeling utilizing state-of-science representations of atmospheric processes in a high performance computing environment. EPA completed the initial stage of development with Models-3 and released CMAQ in mid-1999 as the initial operating science model under the Models-3 framework. This study used CMAQ version 4.6, publicly released October 2006.

CMAQ consists of a core Chemical Transport Model (CTM) and several pre-processors including the Meteorological-Chemistry Interface Processor (MCIP), initial and boundary conditions processors (ICON and BCON) and a photolysis rates processor (JPROC). EPA continues to improve and develop new modules for the CMAQ model and typically provides a new release each year. In the past, EPA has also provided patches for CMAQ as errors are discovered and corrected. More recently, EPA has funded the Community Modeling and Analysis Systems (CMAS) center to support the coordination, update and distribution of the Models-3 system. Byun and Schere (2006) describe the newest features implemented in the previously released CMAQ version 4.5.

2.0 CMAQ Modeling

The CMAQ modeling system is used for assessing the potential ozone impacts of the XTO RBU project in the surrounding area. The CMAQ analysis consists of the following model simulations:

- Run 1 is the *2006 actual* year simulation using actual emissions and also is used in the model performance evaluation;
- Run 2 is the *2006 typical* year, which uses typical emissions instead of actual emissions, and is used for comparison with the future case design value calculations. The only difference between the *actual* and *typical* runs are that the *actual* run uses Continuous Emission Monitoring (CEM) data for point sources whereas the *typical* run has point sources operating at more typical permitted levels;
- Run 3 is a *future baseline* year, which is 2018 – the year the XTO RBU project is projected to have maximum development activities and emissions;
- Run 4 is the simulation that includes the 2018 future baseline year and the anticipated emissions for XTO RBU project;

The "XTO RBU project-only" impacts are estimated by determining the difference between Runs 4 and 3.

The year 2006 is used for the CMAQ ozone modeling for the XTO RBU study. This selection is appropriate primarily because of data availability for 2006 from the IPAMS Uinta Basin Air Quality Study (UBAQS) and being a current year to take advantage of implementation of federal and local control programs.

The year 2018 was selected as the future baseline year based upon the predicted maximum development rate and associated emissions for the XTO RBU Proposed Action.

2.1 Modeling Domains

This section summarizes the model domain definitions for the XTO RBU ozone modeling, including the domain coverage, resolution, map projection, and nesting schemes for the high resolution sub-domain.

2.1.1 Horizontal Modeling Domain

Figure 2-1 displays the 36/12 km modeling domains that are used in the CMAQ/SMOKE air quality/emissions modeling. The 36-km continental United States (U.S.) horizontal domain for CMAQ air quality and SMOKE emissions modeling are identical to what is used by several Regional Planning Organizations (RPOs) for their regional haze modeling (e.g., WRAP, CENRAP and VISTAS). This 36-km modeling domain covers the continental U.S. as well as large portions of Mexico and Canada. The CMAQ 12-km modeling domain is shown in **Figure 2-2** and covers eastern Utah, western Colorado and portions of Wyoming, Arizona and New Mexico.

The CMAQ air quality and SMOKE emissions modeling 36/12 km modeling domains are aligned within the MM5 domains. The larger MM5 modeling domains provide a buffer around the CMAQ/emissions modeling domains by at least 6 grid cells in each direction. These grids are based on a Lambert Conformal Projection (LCP) using the same projection as adopted by the RPOs. The LCP parameters are listed in **Table 2-1**.

There is a possibility of boundary "noise" effects resulting from boundary conditions coming into dynamic balance with the MM5 algorithms. The WRAP 12-km MM5 domain, with the 12-km CMAQ domain in red, is presented in **Figure 2-3**. The larger MM5 domain is designed to sequester such errors from the air quality simulation. The buffer region used in the current study exceeds the EPA suggestion of at least 5 grid cell buffers at each boundary.

Table 2-2 lists the number of rows and columns (i.e., the number of grid cells in the east-west and north-south direction) and the definition of the X and Y origin (i.e., the southwest corner) for the 36/12 km domains used in the CMAQ and the SMOKE models for the current study.

2.1.2 Vertical Modeling Structure

The CMAQ vertical structure is primarily defined by the vertical grid used in the MM5 modeling. The MM5 model employs a terrain-following coordinate system defined by pressure, using multiple layers that extend from the surface to 100 millibars (mb), which is approximately 15 km above ground level (AGL). A layer-averaging scheme is adopted for CMAQ simulations to reduce the air quality computational time. The effects of layer averaging were evaluated by WRAP and VISTAS and found to have a relatively minor effect on the model performance metrics when both 34 layer and 19 layer CMAQ model simulations were compared to ambient monitoring data (Morris et al., 2004a). For the XTO RBU ozone modeling, 19 vertical layers are used. **Table 2-3** lists the mapping from the MM5 vertical layer structure to the CMAQ vertical layers. This MM5 structure was taken from the WRAP, VISTAS and CENRAP RPO configuration and the same CMAQ structure is also being used in the RPO modeling. Note that the MM5 and CMAQ models both use a terrain following "sigma" coordinate system so over elevated terrain the model heights will be compressed.

2.2 Model Input Preparation Procedures

2.2.1 Meteorological Inputs

This and the following subsections describe the procedures used in developing the meteorological, emissions, and air quality inputs to the CMAQ model for the XTO RBU ozone modeling study on the 36/12 km grids. The development of the CMAQ meteorological and emissions inputs are discussed together with the science options recommended for the CMAQ model. The procedures for developing the initial and boundary conditions and photolysis rates are also discussed along with the model application procedures.

The procedures set forth here are consistent with EPA guidance (e.g., EPA, 1991; 1999; 2005a; 2007), other recent 8-hour ozone modeling studies conducted for various State and local agencies using these or other state-of-science modeling tools (e.g., Tesche et al., 2003; Morris et al., 2004a,b; Tesche et al., 2005a), as well as the methods used by EPA in support of the recent Clean Air Interstate Rule (EPA, 2005b) and the Clean Air Mercury Rule (EPA, 2005c).

Annual 36/12 km MM5 simulations for 2005 (McNally and Schewe 2006) and 2006 (McNally and Schewe, 2008) are used to provide meteorological inputs to the CMAQ and SMOKE models. The MM5 configuration is based on the WRAP 2002 simulation (Kemball-Cook et. al. 2004), which were based on an extensive review of available MM5 physical and dynamical options and have been the basis of many subsequent MM5 applications in the region. The WRAP did a fairly extensive study to determine the optimal configuration for the MM5 modeling system. One of the choices they made was to use the Betts-Miller Cumulus Parameterization. Betts-Miller was developed to parameterize tropical convection. However, using Betts-Miller improved the precipitation skill of the model.

2.2.2 Emission Inputs

In order to simulate atmospheric ozone levels, it is necessary to develop emissions estimates for all other emission sources (i.e., industrial, electric generation, motor vehicle, biogenic) in addition to the emissions from the XTO RBU project. The foundation datasets for the emissions development are based on the emissions data developed by the Western Regional Air Partnership (WRAP). Details on the emissions input preparation are presented in Chapter 3.0. The emissions are processed into CMAQ-ready files using SMOKE 2.4 for both the 36- and 12-km grids. SMOKE 2.4 is used because several of the WRAP-developed emissions files are not directly compatible with the newest version of SMOKE (i.e., Version 2.6). Further, this project would not have benefited from the enhancements in SMOKE Version 2.6.

2.2.3 CMAQ Science and Input Configurations

This section describes the model configuration and science options to be used in the XTO RBU ozone modeling effort. **Table 2-4** summarizes the CMAQ configuration that was used in the study. The latest version of CMAQ (Version 4.6) was used in the XTO RPU ozone modeling.

As indicated in the CMAQ model setup defined in **Table 2-4**, two grids were employed. CMAQ was initially run for the 2006 base case on the 36-km continental U.S. grid for calendar year 2006. CMAQ was then run for the 2006 base case on the 12-km grid utilizing the initial and boundary conditions from the 36-km CMAQ simulation.

CMAQ inputs were as follows:

> <u>Meteorological Inputs:</u> The MM5-derived meteorological fields were prepared for CMAQ using MCIP 3.3.
>
> <u>Initial/Boundary Conditions (IC/BC's)</u>: The IC/BC's for the 36-km continental U.S. simulation were based on the latest available information. Currently, the RPOs use IC/BC's for the same domain based on a 2002 GEOS-CHEM global chemistry model simulation. Boundary and initial conditions for the 12-km nest will be generated from the 36-km CMAQ nest using the CMAQ ICON and BCON processors.

Photolysis Rates: The modeling team prepared the photolysis inputs as well as the albedo/haze/ozone/snow inputs for CMAQ based on Total Ozone Mapping Spectrometer (TOMS) data using the CMAQ JPROC processor.

Spin-Up Initialization: The model was run in quarters using a nominal 15-day spin-up from the previous quarter for the 36-km grid and a nominal 4 day spin-up from the previous quarter for the 12-km grid.

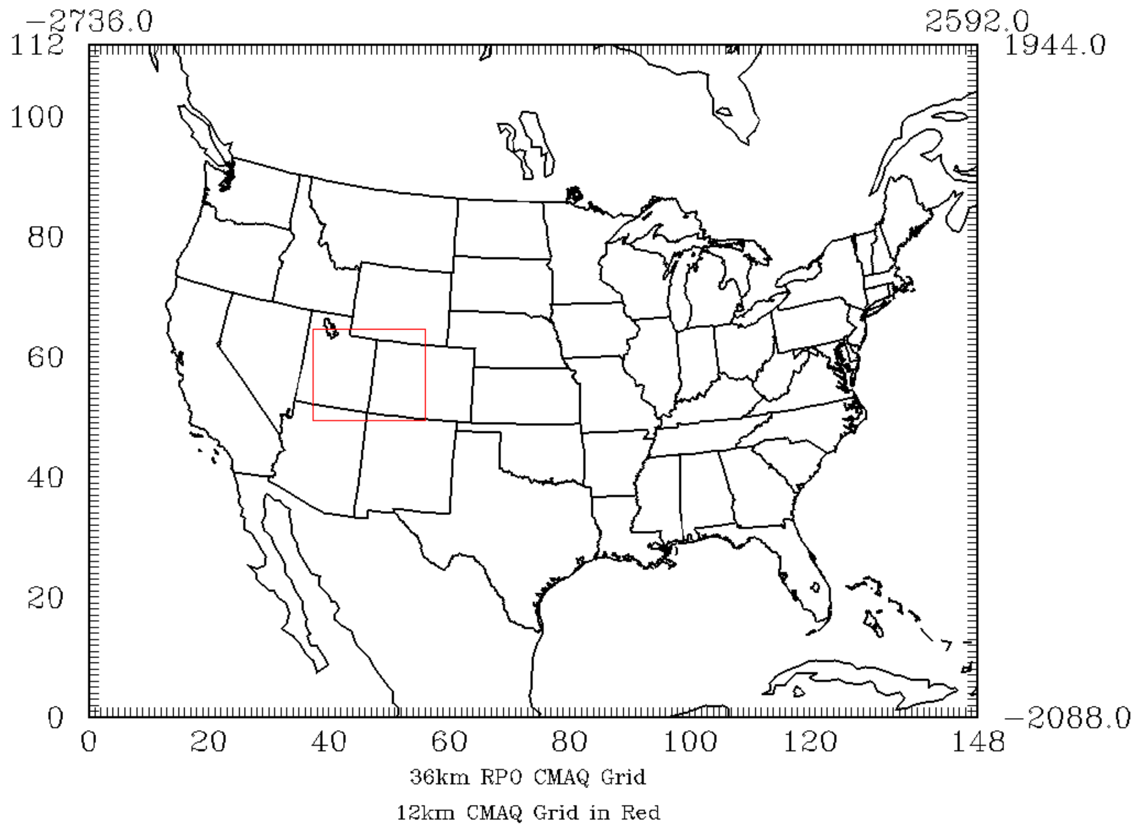


Figure 2-1. 36- and 12-km CMAQ Domains for XTO RBU Study. The 12-km domain is highlighted in red and is expanded in Figure 2-2.

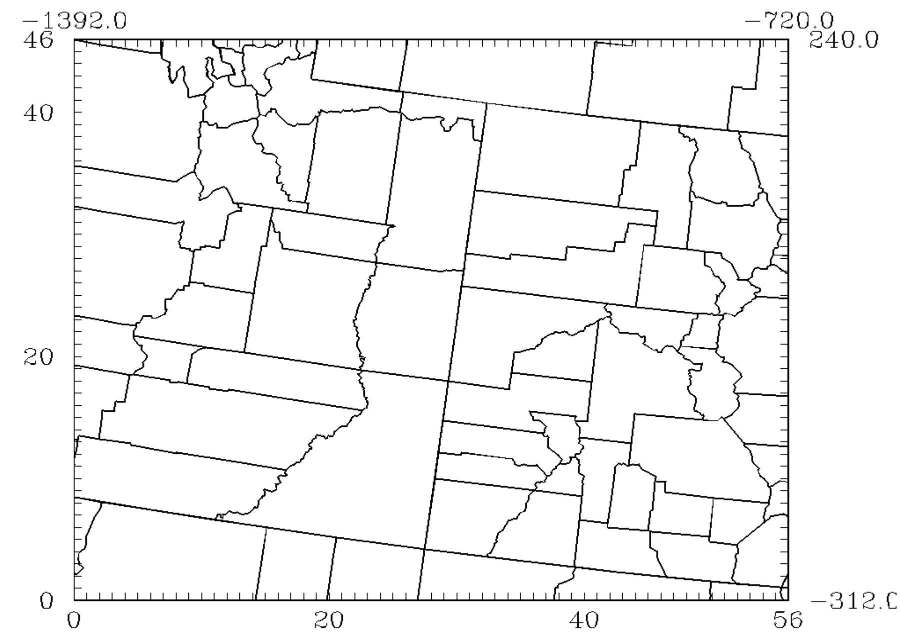


Figure 2-2. 12-km CMAQ Domain for XTO RBU Study.

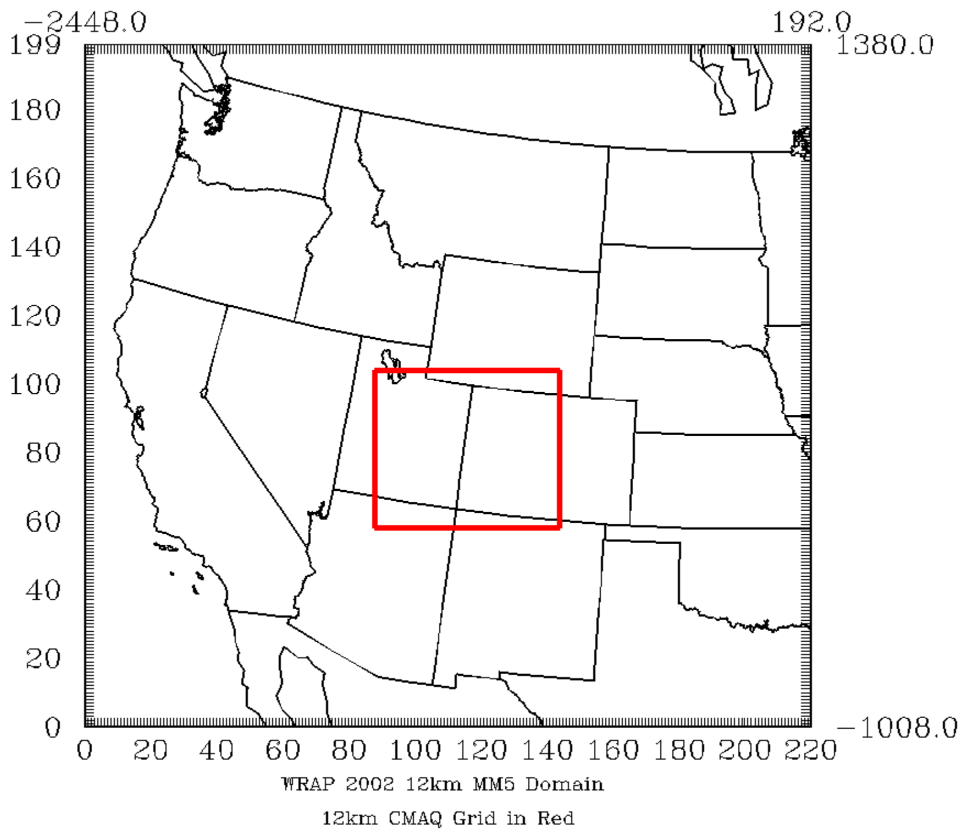


Figure 2-3. 12-km WRAP MM5 Domain with 12-km CMAQ Domain for XTO RBU Study

Table 2-1. Lambert Conformal Projection (LCP) Definition for the XTO RBU Modeling Grid	
Parameter	**Value**
Projection	Lambert-Conformal
1st True Latitude	33 degrees N
2nd True Latitude	45 degrees N
Central Longitude	-97 degrees W
Central Latitude	40 degrees N

Table 2-2. Grid Definitions for SMOKE and CMAQ				
Grid Resolution	**east-west grid cells**	**north-south grid cells**	**X-origin (km)**	**Y-origin (km)**
36-km grid	148	112	-2736.0	-2088.0
12-km grid	53	47	-1368.0	-288.0

Table 2-3. Vertical Layer Definition for MM5 Simulations (left most columns), and Approach for Reducing CMAQ Layers by Collapsing Multiple MM5 Layers (right columns)

MM5					CMAQ			
Layer	**Sigma**	**Pres (mb)**	**Height (m)**	**Depth (m)**	**Layer**	**Pres (mb)**	**Height (m)**	**Depth (m)**
34 (top)	0.000	100	18123	2856	19	100	18123	9160
33	0.050	145	15267	2097				
32	0.100	190	13170	1659				
31	0.150	235	11510	1374				
30	0.200	280	10136	1173				
39	0.250	325	8963	1024	18	325	8963	3492
28	0.300	370	7938	909				
27	0.350	415	7030	817				
26	0.400	460	6213	742				
25	0.450	505	5471	680	17	505	5471	1890
24	0.500	550	4791	627				
23	0.550	595	4163	582				
22	0.600	640	3581	543	16	640	3581	1053
21	0.650	685	3038	509				
20	0.700	730	2528	386	15	730	2528	664
19	0.740	766	2142	278				
18	0.770	793	1864	269	14	793	1864	443
17	0.800	820	1596	174				
16	0.820	838	1421	171	13	838	1421	338
15	0.840	856	1251	167				
14	0.860	874	1083	164	12	874	1083	163
13	0.880	892	920	161	11	892	920	161
12	0.900	910	759	79	10	910	759	158
11	0.910	919	680	78				
10	0.920	928	601	78	9	928	601	155
9	0.930	937	524	77				
8	0.940	946	447	76	8	946	447	76
7	0.950	955	371	75	7	955	371	76
6	0.960	964	295	75	6	964	295	75
5	0.970	973	220	74	5	973	220	74
4	0.980	982	146	37	4	982	146	37
3	0.985	987	109	37	3	987	109	37
2	0.990	991	73	36	2	991	73	36
1	0.995	996	36	36	1	996	36	36
0 (ground)	1.000	1000	0	0	0	0	0	0

Table 2-4. CMAQ (version 4.6) Model Configuration		
Science Options	**Configuration**	**Details/Comments**
Model Code	CMAQ (version 4.6)	Pleim et al., (2003)
Horizontal Grid Mesh	36/12 km	36-km covering continental U.S; 12-km covering Eastern UT and Western CO
36-km grid	148 x 112 cells	RPO National Grid
12-km grid	53 x 47 cells	
Vertical Grid Mesh	19 Layers	First 8 layers synchronized with MM5
Grid Interaction	One-way nesting	
Initial Conditions	15 days full spin-up	Separately run 4 quarters of 2002
Boundary Conditions	GEOS-CHEM annual run	2002 GEOS-CHEM run.
Emissions		
Baseline Emissions Processing	See SMOKE (Ver 2.4) model configuration	MM5 Meteorology input to SMOKE, CMAQ
Dust Transport Fraction	Applied in emissions before SMOKE	
NH3 Inventory Adjustment	Applied in emissions before SMOKE	
Sub-grid-scale Plumes	No Plume-in-Grid (PinG)	
Chemistry		
Gas Phase Chemistry	CBM-IV	with Isoprene updates
Aerosol Chemistry	AE3/ISORROPIA	
Secondary Organic Aerosols	Secondary Organic Aerosol Model (SORGAM)	Schell et al., (2001)
Aerosol Mass Conservation Patch	Yes	
Cloud Chemistry	RADM-type aqueous chemistry	Includes subgrid cloud processes
N2O5 Reaction Probability	0.01 – 0.001	
Horizontal Transport		
Eddy Diffusivity Scheme	K-theory with K_h grid size dependence	Multiscale Smagorinsky (1963) approach
Vertical Transport		
Eddy Diffusivity Scheme	K-theory	
Diffusivity Lower Limit	Kzmin = 0.1	
Planetary Boundary Layer	No Patch [1]	
Deposition Scheme	M3dry	Directly linked to Pleim-Xiu Land Surface Model parameters

Table 2-4. CMAQ (version 4.6) Model Configuration		
Science Options	**Configuration**	**Details/Comments**
Numerics		
Gas Phase Chemistry Solver	Euler Backward Iterative (EBI) solver	Hertel et al (1993) EPI solver ~ 2x faster than MEBI
Horizontal Advection Scheme	Piecewise Parabolic Method (PPM) scheme	
Other		
Meteorological Processor	MCIP ver 3-3	
Simulation Periods	Annual 2005/2006	
Integration Time Step	Internally Computed	15 minute coupling time step
Time zone	GMT	
Platform	Dual Processor/Quad Core Intel Xeon	
Run-Time (expected)	7-10 days	Platform Dependent

[1]PATCH means applying a mosaic scheme based on land-use, which is not normally done for CMAQ. The terminology is not the same as used for a software fix.

3.0 CMAQ Emissions Input Procedures

The emissions inventories utilized for the XTO RBU Study were based on several sources. The ozone modeling required CMAQ-ready emissions estimates for 2006 and an additional future modeling year. 2018 was selected as the future year modeling inventory because it coincided with the projected Proposed Action maximum development activity and emissions rates.

3.1 2006 and 2018 Emissions Inventory Sources

Air emissions inventories are developed from the WRAP emissions inventories. The WRAP inventories are compiled using data provided by state and tribal regulatory agencies, as well as industry partners, and include data for point, area, non-road mobile, and on-road mobile sources. All or portions of five different WRAP inventories are used to develop emissions for the 2006 Baseline and 2018 Projected Baseline scenarios. These WRAP inventories include:

- 2002 Plan2D – Baseline 2002 WRAP inventory for area, point, on-road and non-road mobile source;
- 2018 PRP18a – original WRAP forecasted inventory for non-road mobile and on-road mobile sources;
- 2018 PRP18b – updated WRAP forecasted inventory for point and area sources;
- 2006 Phase III – 2006 base year inventory for oil and gas sources within the Uinta and Piceance basins only; and
- 2012 Phase III – 2012 forecasted inventory for oil and gas sources.

A summary of the emissions datasets used for each emissions source category is included in Table 3-1.

Table 3-1. Summary of 2006 and 2018 Emissions Inventory Data Sources.

Emissions Source Category	Inventory Used for 2005/2006 Baseline	Inventory Used for 2018 Projected Baseline
Oil and Gas – Uinta Basin	WRAP Oil and Gas Phase III 2006	Projected from WRAP Phase III Oil and Gas 2006 based on projected cumulative activity in 2018
Oil and Gas – Piceance Basin	WRAP Oil and Gas Phase III 2006	Projected from WRAP Phase III Oil and Gas 2006 and 2012
Oil and Gas – Southwest WY	Wyoming 5-County (SWWY) 2005/2006 O&G Inventory	Wyoming 5-County (SWWY) 2005/2006 O&G Inventory with projections
Point Sources – Non Oil and Gas	Interpolated from WRAP 2002 Plan 2D and WRAP 2018 PRP 18a +Denver SIP	WRAP 2018 PRP18b
Area Sources – Non Oil and Gas	Interpolated from WRAP 2002 Plan 2D and WRAP 2018 PRP 18a + Denver SIP	WRAP 2018 PRP 18b
Non-Road Motor Vehicle	Interpolated from WRAP 2002 Plan 2D and WRAP 2018 PRP 18a +Denver SIP	WRAP 2018 PRP 18a
On-Road Motor Vehicle	Calculated with 2005 and 2006 meteorology and Interpolated VMT from WRAP 2002 Plan 2D and WRAP 2018 PRP 18a	Calculated with 2005 and 2006 Meteorology and WRAP 2018 PRP 18a VMT
Biogenic	MEGAN with 2005/2006 meteorology	MEGAN with 2005/2006 meteorology (held steady from 2005/2006)
Wildfire	2005/2006 Wildfire Inventory	2005/2006 Wildfire Inventory (held steady from 2005/2006)

3.1.1 2006 Baseline Inventory

The 2006 Baseline CMAQ-ready emissions were developed from the WRAP2002 Plan2d and WRAP 2018 PRP18a inventory using the same methodology as followed for the UBAQS project. (Morris et al., 2009). For the 2006 Baseline, the draft 2006 WRAP Phase III oil and gas emissions for the Piceance and Uinta basins are used. For Wyoming, the 2006 Southwest Wyoming (also referred to as the 5-County) oil and gas inventory was used. (WDEQ, 2008). For the area, non-road, and non-Continuous Emission Monitor (CEM) point source emissions, the emission rates are directly interpolated from the 2002 and 2018 values. The 2006 on-road motor vehicle emissions are calculated using vehicle miles traveled (VMT) values interpolated from the 2002 and 2018 VMT totals combined with mobile source emissions factors and meteorological data specific for the 2006 episode. Day-specific emissions for the 2006 episodes are obtained for the CEM point sources and fire emissions and are calculated for the biogenic emissions. For all source categories in Colorado, the WRAP emissions were replaced by the 2006 emissions inventories developed for the Denver State Implementation Plan. (Morris, 2007)

3.1.2 2018 Future Year Inventory

The 2018 future year emissions estimates were based mainly on the WRAP 2018PRPa and PRPb inventories. (ERG, 2009) For non oil and gas related sources, the predicted emissions for the 2018 forecast year for non-road and on road mobile sources are directly from the WRAP 2018PRP18a inventory. The WRAP 2018PRPb inventory update was incorporated for area sources and point sources. Fire and biogenic source categories were maintained at 2006 levels, which is consistent with the WRAP Phase II 2018PRP18a development approach.

The Oil and Gas (O&G) portions of the 2018 future year emissions projections were done on a regionally specific basis, with the Uinta Basin, Piceance Basin, Wyoming 5-County region, and other Colorado (outside the Piceance Basin) emissions handled separately.

Colorado O&G sources outside the Piceance Basin were calculated using the same inventory growth and controls as used in the future year inventories developed for the Denver SIP. (Morris, 2009).

Emissions projection factors for the Wyoming 5-County O&G emissions have not been developed by the Wyoming DEQ, but large portions of the regions are covered by emissions offset requirements for new development. To accommodate these offset requirements, the 2018 5-County inventory was held to 2006 levels, with the exception of the vehicular traffic emissions required for well maintenance and support. The growth in well counts for this area was assumed to be in proportion to other active drilling areas (Piceance and Uinta basins) and the traffic emissions were grown accordingly.

In the Piceance basin the 2018 oil and gas emissions were estimated by developing a growth rate from the 2006 and 2012 WRAP III estimates for the basin, applying the growth rates by county and SCC code, and then accounting for control measures being adopted in Colorado. (Bar-Ilan, 2009a).

Table 3-2. Projection Parameter Data for Piceance Basin.			
SCC	Description	Projection Parameter	Projection Factor
2310000100	Heaters	total well count	2.391
2310000220	Drill rigs	Spuds	1.686
2310000230	Workover rigs	total well count	2.391
2310000300	Pneumatic devices	Conv. Gas Well Count	2.391
2310000700	Unpermitted Fugitives	total well count	2.391
2310000801	Gas Well Truck Loading	Condensate Production	2.096
2310000802	Oil Well Truck Loading	Oil Well Oil Production	1.000
2310000820	Gas Plant Truck Loading	Condensate Production	2.096
2310001610	Venting - initial completions	Spuds	1.686
2310001620	Venting - recompletions	Spuds	1.686
2310001630	Venting - blowdowns	total gas production	2.476
2310002230	Condensate tank	Condensate Production	2.096
2310002240	Oil Tank	Oil Well Oil Production	1.000
2310003100	Exempt engines	total well count	2.391
2310003200	Pneumatic pumps	total well count	2.391
2310003500	Flaring	total gas production	2.476
20200201	Compressor Engines	total gas production	2.476
20200202	Compressor Engines	total gas production	2.476
20200203	Compressor Engines	total gas production	2.476
20200252	Compressor Engines	total gas production	2.476
20200253	Compressor Engines	total gas production	2.476
20200254	Compressor Engines	total gas production	2.476
31000101	Permitted Fugitives	total oil production	0.810
31000102	Oil Production, Miscellaneous Well: General	total oil production	0.810
31000123	Oil Production, Well Casing Vents	total oil production	0.810
31000130	Oil Production, Fugitives: Compressor Seals	total oil production	0.810
31000132	Oil Production, Atmospheric Wash Tank: Flashing Loss	total oil production	0.810
31000199	Oil Production, Processing Operations: Not Classified	total oil production	0.810
31000201	Natural Gas Production, Gas Sweetening	total gas production	2.476
31000202	Natural Gas Production, Gas Stripping Operations	total gas production	2.476
31000203	Compressor Engines	total gas production	2.476
31000205	Natural Gas Production, Flares	total gas production	2.476
31000207	Permitted Fugitives	total gas production	2.476
31000209	Natural Gas Production, Incinerators	total gas production	2.476
31000215	Natural Gas Production, Flares Combusting Gases >1000 BTU/scf	total gas production	2.476
31000216	Natural Gas Production, Flares Combusting Gases <1000 BTU/scf	total gas production	2.476
31000220	Natural Gas Production, All Equipt Leak Fugitives	total gas production	2.476
31000225	Natural Gas Production, Compressor Seals	total gas production	2.476
31000227	Glycol Dehydrator	total gas production	2.476
31000228	Glycol Dehydrator	total gas production	2.476
31000230	Natural Gas Production, Hydrocarbon Skimmer	total gas production	2.476

Table 3-2. Projection Parameter Data for Piceance Basin.			
SCC	**Description**	**Projection Parameter**	**Projection Factor**
31000299	Natural Gas Production, Other Not Classified	total gas production	2.476
31000301	Glycol Dehydrator	total gas production	2.476
31000302	Glycol Dehydrator	total gas production	2.476
31000303	Glycol Dehydrator	total gas production	2.476
31000304	Glycol Dehydrator	total gas production	2.476
31000305	Natural Gas Processing Facilities, Gas Sweeting: Amine Process	total gas production	2.476
31000306	Natural Gas Processing Facilities, Process Valves	total gas production	2.476
31000309	Natural Gas Processing Facilities, Compressor Seals	total gas production	2.476
31000311	Natural Gas Processing Facilities, Flanges and Connections	total gas production	2.476
31000404	Process Heaters	total well count	2.391
31000405	Process Heaters	total well count	2.391
31000406	Process Heaters	total well count	2.391
31000502	Liquid Separator	total well count	2.391
31088801	Permitted Fugitives	total gas production	2.476
31088803	Permitted Fugitives	total gas production	2.476
31088804	Permitted Fugitives	total gas production	2.476
31088805	Permitted Fugitives	total gas production	2.476
31088811	Permitted Fugitives	total gas production	2.476
40400311	Tank Losses	total oil production	0.810
40400322	Tank Losses	total oil production	0.810

In the Uinta basin, the 2018 oil and gas emissions are projected based on predicted growth in key operating activity parameters by county from 2006 to 2018. (Bar-Ilan, 2009b) These growth rates are applied to specific oil and gas sources by Source Classification Codes (SCC) and control efficiencies are applied for control measures being adopted by operators under federal rule or consent decree.

3.1.3 Projected Activity Parameters and 2018 Scaling Ratios in the Uinta Basin

The 2018 projected baseline is estimated based on the growth of five operating parameters in each of the five counties within the Uinta Basin. The level of each of these parameters is based on the reasonably foreseeable development demonstrated by pending or proposed projects filed with the Bureau of Land Management.

These projects and associated well counts are summarized in Table 3-3. These parameters include:

- Total well count – total number of operating wells for all operators in each county;
- Spud count – number of wells drilled by all operators in each county;
- Total gas production – total gas produced by all operators in each county;
- Total condensate production – total condensate produced by all operators in each county; and
- Total oil production – total oil produced by all operators in each county.

Table 3-3. Summary of New Well Development for Proposed Projects in the Uinta Basin				
	Proposed Natural Gas Wells by 2018	**Uinta County**	**Duchesne County**	**Carbon County**
Anadarko Greater Natural Buttes EIS	3,675	3,675	--	--
BBC West Tavaputs Plateau EIS	807	20	23	764
Berry Petroleum ANF South Unit EIS	140	--	140	--
Enduring Resources Big Pack EA	490	490	--	--
Enduring Resources Southam Canyon EA	225	25	--	--
EOG Greater Chapita Wells EIS	3,725	3,725	--	--
EOG North Alger EA	44	44	--	--
Gasco Uinta Basin EIS	900	301	599	--
Newfield Monument Buttes EIS	700	272	428	--
XTO Hill Creek Unit EA	144	144	--	--
XTO Little Canyon EA	510	510	--	--
XTO River Bend Unit Infill EA	484	484	--	--

In reviewing proposed projects, no reasonably foreseeable future development is anticipated for Grand or Emery counties; therefore, these counties will be maintained at their 2006 uncontrolled emissions levels for the purposes of this analysis. Uncontrolled emissions of criteria pollutants for 2018 are calculated for each source category as the product of the 2006 emissions and the ratio of 2018 predicted activity level to the historic 2006 level for that parameter. The list of the source categories and the relevant activity parameter are summarized in Table 3-3. New development for the XTO RBU is calculated in the project specific alternatives, and therefore the XTO RBU well data is not included in the 2018 projection calculations.

A control efficiency is applied to the predicted uncontrolled emissions for certain source categories based on implementation of more stringent federal emission standards or installation of additional controls required by consent decree. Determination of these control efficiencies is discussed in detail in Section 3.1.4.

Table 3-4. Activity Parameters Used for Emissions Scaling by Source Category Code		
SCC	**Description**	**Scaling Parameter**
2310000100	Heaters	Total well count
2310000220	Drill rigs	Spud count
2310000230	Workover rigs	Total well count
2310000300	Pneumatic devices	Total well count
2310000330	Artificial lift	Total oil production
2310000700	Unpermitted fugitives	Total well count
2310000800	Truck loading of condensate	Total condensate production
2310000801	Truck loading of oil	Total oil production
2310000820	Gas plant truck loading	Total condensate production

2310001610	Venting - initial completions	Spud count
2310001611	Initial completion flaring	Spud count
2310001620	Venting - recompletions	Spud count
2310001630	Venting - blowdowns	Total gas production
2310001640	Venting - compressor startup	Total gas production
2310001650	Venting - compressor shutdown	Total gas production
2310002230	Condensate tank	Total condensate production
2310002231	Condensate tank flaring	Total condensate production
2310002240	Oil tank	Total oil production
2310003100	Miscellaneous engines	Total well count
2310003200	Pneumatic pumps	Total well count
2310020600	Compressor engines	Total gas production
2310021410	Dehydrator	Total gas production
2310021411	Dehydrator Flaring	Total gas production

Additional conventional well counts are taken from the proposed projects listed in Table 3-1 and are spatially allocated to each county on an annual basis based on the fraction of the project area in each county and the estimated start date, drilling rate, and schedule. This information was taken from pending EA or EIS documents for each project and is accumulated with recorded total well counts for each county for 2009 from the IHS, Inc. Exploration and Production Information database

Spud counts are estimated based on the change in total wells (conventional and CBM) from 2017 to 2018 in each county. An additional 5 percent spud to well rate is assumed to account for unsuccessful holes and ancillary drilling activities including monitoring and injection wells.

Gas production in 2018 from each county is predicted using a county-specific estimated well production decline over time. The number of wells at each given age is estimated as the number of new wells in each year based on projected and historical data. Gas production in each year is the product of the number of new wells and the assigned gas production rate for a well of that age; the total 2018 gas production is the sum of these products. For year 2018, only one half of the incremental production is considered due year round drilling and completion schedules.

For Uintah and Duchesne counties, condensate production in 2018 is predicted using a county-specific estimated well condensate production decline over time. The number of wells at each given age is estimated as the number of new wells in each year based on projected and historical data. Condensate production in each year is the product of the number of new wells and the condensate production for a well of that age; the total 2018 gas production is the sum of these products. For year 2018, only one-half of the production is considered due to well completion. For Carbon County, condensate production data was not available. Therefore, condensate production in Carbon County is predicted based on the historical ratio of the change in condensate production to the change in gas production of 0.0012.

The Newfield Monument Butte EIS indicates there will be 3,250 oil wells installed in Uintah and Duchesne counties over the life of the project; however, no data are available to predict oil production based on well schedule. Therefore, oil production in these counties is linearly forecast based on historical data. For each county, the linear increase is based on the growth rate from the last upturn in production (2001 for Uintah County and 2002 for Duchesne County). Projected oil production for the remaining counties in the Uinta Basin is held at their 2006 levels

Table 3-5 summarizes the historical 2006 activity parameter data and the projected 2018 activity levels. The ratio of 2018 to 2006 levels is used to develop a scaling ratio for uncontrolled emissions to predict 2018 emissions by source category for each county.

Table 3-5. Summary of Projection Parameter Data in Uinta Basin.

	Well Count			Spud Count			Total Gas Production		
County	**2006**	**2018**	**Ratio**	**2006**	**2018**	**Ratio**	**2006**	**2018**	**Ratio**
Uinta	4,035	12,207	3.03	685	677	.99	203,391	595,651	2.93
Carbon	730	1,615	2.21	58	0	0	20,497	121,803	5.94
Duchesne	1474	2,981	2.02	277	156	.56	22,526	40,025	1.77
Grand	368	368	1	27	27	1	6855	6,855	1
Emery	56	56	1	23	23	1	951	951	1

Table 3-5 Continued. Summary of Projection Parameter Data in Uinta Basin.

	Total Condensate Production			Total Oil Production		
County	**2006**	**2018**	**Ratio**	**2006**	**2018**	**Ratio**
Uinta	1,554	5,842	3.76	3,399	4,828	1.42
Carbon	43	148	3.43	0.3	0.3	1
Duchesne	163	455	2.79	6,402	15,093	2.36
Grand	9	9	1	116	116	1
Emery	4	4	1	4	4	1

3.1.4 Baseline Emissions Control Efficiency from Federal Rule and Consent Decree

Several existing federal rules will require more stringent emission standards on existing sources. Furthermore, some operators have entered into consent decrees with the U.S. Department of Justice that require them to install additional controls. This analysis reviewed and determined emissions reductions to baseline emissions for selected source categories based on these rules or agreements. For rules that affect only new sources, these controls are applied only to the portion of emissions above 2006 levels. Control efficiencies derived from retroactive rules or requirements are applied to all emissions for the relevant source category.

Federally enforceable emissions reductions occur with the stationary and nonroad engine requirements under 40 CFR Part 60, Subpart JJJJ and 40 CFR 89, respectively. VOC reductions from dehydrators at area sources under 40 CFR Part 63, Subpart HH are not likely to be required since these standards apply to area sources with a gas throughput of 3 MMscf/day. Based on the decline curve, the average production of a new well under the proposed project is 215 MMscf/yr (0.59 MMscf/day). Therefore, there is no expected applicability or enforceability of these reductions at area sources, and thus, reductions from this rule are not considered.

The U.S. District Court recently entered into the following 3 Consent Decrees with 7 operators in the Uinta Basin requiring controls on selected dehydrators, compressor engines, selected condensate tanks, and pneumatic devices:

- U.S. v. Wind River Resources Corporation and Bill Barrett Corporation;
- U.S. v. Dominion Exploration and Production, Inc. and XTO Energy, Inc.; and
- U.S. v. Miller, Dyer, & Co., LLC, Chicago Energy Associates, and Whiting Oil and Gas Corporation.

The only requirement under these consent decrees to have measurable and enforceable impact to baseline emissions is the installation of low-bleed pneumatics. Since low bleed pneumatics reduce the maximum release of actuating gas by 50 percent or more, emissions of VOC are assumed to be reduced by 50 percent for this source category. The total control efficiency for a county for pneumatic controls and devices is then calculated as the product of this 50 percent control and the fraction of operator control of future assets.

3.1.5 Summary of Emissions Inventory Data

The results of the emissions inventory 2006 base year and 2018 future year development are summarized by major source category in Table 3-6. These totals are average day emissions, before temporal adjustments are applied. The totals are over the 12-km modeling domain only.

Table 3-6. 12-km Emissions Modeling Domain Grid Totals. Average Tons/day

	2018 Emissions Totals			2006 Emissions Totals		
	CO	NOx	VOC	CO	NOx	VOC
Area	211.3	31.1	264.3	93.3	17.5	113.5
NonRoad	574.4	31.4	85.2	775.0	102.8	83.5
Motor Vehicle	1787.0	70.0	69.0	2587.9	192.7	143.6
Point	362.8	505.4	120.3	225.2	662.6	50.6
Total Non-O&G	2935.5	637.9	538.8	3681.3	975.6	391.2
Piceance Basin O&G	11.0	10.0	42.0	0.2	17.3	59.7
Uinta Basin O&G	29.0	38.0	531.0	23.9	28.8	192.0
SWWY O&G	8.4	22.5	347.5	8.2	22.4	347.4
Other O&G	68.3	94.2	279.1	21.1	33.0	38.7
Total O&G	116.7	164.7	1199.6	53.4	101.5	637.8
Total	3052.2	802.6	1738.4	3734.7	1077.1	1029.0

3.2 Development of CMAQ Ready Emissions Inventories

Emissions inventory development for CMAQ ozone and haze modeling addressed several source categories including: (a) stationary point sources, (b) area sources, (c) on-road mobile sources, (d) non-road mobile sources, (e) biogenic sources and (f) fire sources. For this analysis, CMAQ ready emissions input files were created using SMOKE 2.4 for the 2006 and 2018 annual periods over the 36- and 12-km grids.

CMAQ requires emission input files containing hourly emission estimates, distributed both vertically and horizontally in the modeling domain. For ozone modeling alone, hourly emissions are required for NO, NO_2, CO, several classes of VOCs and other chemicals as available. The VOC classes used depend upon the chemical mechanism selected, which for the current study was CB-05 with updates to the isoprene chemistry.

CMAQ was also configured to provide particulate matter (PM) estimates, as well as visibility and deposition results. Thus, additional PM precursor species were needed as emissions inputs, which included SO_2, NH_3, SO_4, NO_3, EC, OMC, other primary $PM_{2.5}$ and coarse PM ($PM_{2.5\text{-}10}$).

3.3 Set-up of SMOKE for the XTO RBU Domain

SMOKE was configured to generate point, area, non-road, highway, and biogenic source emissions. In addition, certain subcategories, such as fires and electricity generator units (EGU) were maintained in separate source category files in order to allow maximum flexibility in producing alternate emissions modeling strategies. Domain specific oil and gas-related emissions were also maintained as a separate source category. With the exception of biogenic and highway mobile source emissions, that were generated using the MEGAN and MOBILE6 modules in SMOKE, respectively, pre-computed annual emissions were processed using the month, day, and hour-specific temporal profiles of the SMOKE model.

Producing 365 day-specific input files for all source categories places a burden on available computing facilities, data management systems, and would adversely affect the project schedule. Selecting representative model days for some or all of the source categories reduces the processing and file handling requirements to a more manageable level, and in most cases, does not compromise the accuracy of the emissions files. Other current or recent projects undertaken by EPA, WRAP and LADCO have used representative weekday/Saturday/Sunday emissions estimates for all source categories except biogenics either for each month or each season to model.

In an attempt to better represent the level of temporal and spatial detail available for each source category, a more detailed strategy was adopted. Biogenic emissions were modeled for each episode day, using the daily meteorology. Point sources, including CEM and fire emissions, were modeled for each episode day to take advantage of the available day-specific emissions and meteorology. All sources were treated by SMOKE as potentially elevated. No plume-in-grid sources were modeled. Wildfire emissions were handled as point sources. In the past, wildfire emissions were often handled as area source releases. However, since wildfires do have plume rise, techniques have been developed using plume rise calculations to place emissions into appropriate vertical layers. This technique was used in the WRAP and VISTAS CMAQ modeling.

Area sources, including non-road mobile and dust emissions, which do not utilize meteorological data, were temporally allocated by monthly, daily and hourly profiles that are contained in SMOKE. Review of these temporal profiles indicated that maximum temporal definition was achieved by selecting representative Thursday, Friday, Saturday, Sunday and Monday profiles for each month. Though motor vehicle emissions are influenced by meteorological variability, the processing requirements for daily motor vehicle emissions were prohibitive under the project schedule. Instead, a single week per month was selected to model emissions from on-road mobile sources. This week was selected from mid-month, to best represent the average temperature ranges for the month, and also adjusted to exclude holidays that would have required atypical processing. The area source modeling dates were also selected from these weeks to simplify data handling procedures. The selected weeks for area source and on-road mobile source emissions modeling were as follows:

2006 On-Road Mobile Sources Represented by the Following Weeks:

January 15-21	February 11-17
March 12-18	April 6-22
May 14-20	June 11-17
July 16-22	August 13-19
September 17-23	October 15-21
November 12-18	December 17-23

3.4 Development of Point Source Emissions

Stack parameter data are frequently incorrectly reported, especially in some of the current regional modeling inventories, and careful QA is required to assure that the point source emissions are properly located both horizontally and vertically on the modeling grid. To screen for simple, but potentially serious inventory errors such as these, the study team has modified procedures originally developed by EPA to quality assure, augment, and where necessary, revise the stack parameters to examine the accuracy of the point source emissions, as well as standardize procedures to identify and correct stack data errors. SMOKE has a number of built-in QA procedures designed to catch missing or out-of-range stack parameters. These procedures were invoked in the processing of the point source data.

Point source emissions were separated into Electric Generating Units (EGU) and non-EGU categories. The non-EGU category did not have any day or hour-specific emissions. All non-EGU point source emissions were temporally allocated to month, day, and hours using annual emissions and source category code (SCC) based allocation factors. These factors were based on the cross-reference and profile data supplied with the SMOKE 2.4 and were supplemented with relevant data that were developed during the WRAP and VISTAS modeling projects.

To temporally allocate the EGU point sources, the heat input data were derived from the 2002 Continuous Emissions Monitoring (CEM) datasets, and were used to develop facility-level temporal distributions. The day-specific and facility-specific temporal profiles were used in conjunction with the emissions data to estimate hourly EGU emissions by facility.

All point sources were spatially allocated in the domain based on the stationary source geographic coordinates. If a point source was missing its latitude/longitude coordinates, the source was placed in the center of its respective county.

3.5 Development of Area and Non-Road Source Emissions

All area and non-road source emissions were temporally allocated to month, day, and hour using annual emissions and source category code (SCC) based allocation factors. These factors were based on the cross-reference and profile data supplied with the SMOKE 2.4 and supplemented with relevant data developed during the WRAP and VISTAS studies. Area and non-road sources were spatially allocated in the domain based on SCC-based spatial surrogate allocation factors. If an area or non-road source SCC did not have an existing cross-reference profile assigned to it, the county-level emissions were allocated by population density in the respective county.

A crustal PM transport factor was applied to fugitive dust emission sources that were identified in U.S. EPA modeling to have only a portion of its mass transported from the source of the emissions generation. The EPA's studies indicated that 60 to 90 percent of PM emissions from fugitive dust sources are rapidly deposited to near-source locales; hence, do not participate in the physicochemical processes on the spatial scales that are typically used in air quality modeling simulations. For this reason, the county-specific fugitive dust emissions transport factors were applied to these sources to adjust PM emissions prior to the SMOKE modeling.

3.6 Development of On-Road Mobile Source Emissions

The MOBILE6 module of SMOKE was used to develop the base year on-road mobile source emissions estimates for CO, NOx, PM, and VOC emissions. The MOBILE6 parameters, vehicle fleet descriptions, and VMT estimates were combined with gridded, episode-specific temperature data to calculate the gridded, hourly emission estimates. Of note, whereas the on-network emissions estimates were spatially allocated based on link location and subsequently summed to the grid cell level, the off-network emissions estimates were spatially allocated based on a combination of the FHWA version 2.0 highway networks and population. For the XTO RBU 36/12 km modeling, no link based data were used. The MOBILE6 emissions factors were based on episode-specific temperatures predicted by the meteorological model. Further, the MOBILE6 emissions factors model accounted for the following:

- Hourly and daily minimum/maximum temperatures;
- Facility speeds;
- Locale-specific inspection and maintenance (I/M) control programs, if any;
- Adjustments for running losses;
- Splitting of evaporative and exhaust emissions into separate source categories;
- VMT, fleet turnover, and changes in fuel composition and Reid vapor pressure (RVP).

The primary input to MOBILE6 was the MOBILE shell file. The MOBILE shell contained the various options (e.g., type of inspection and maintenance program in effect, type of oxygenated fuel program in effect, alternative vehicle mix profiles, RVP of in-use fuel, operating mode) that direct the calculation of the MOBILE6 emissions factors.

3.7 Development of Biogenic Source Emissions

Biogenic emissions are generated using MEGAN, which uses high resolution GIS data on plant types and biomass loadings and the Fifth Generation National Center for Atmospheric Research/Penn State Mesoscale Model (MM5) surface temperature fields, and solar radiation (modeled or satellite-derived) to develop hourly emissions for biogenic species on the 36/12 km grids. MEGAN generates gridded, speciated, temporally allocated emission files as well as biogenic VOC precursor emission species for the new secondary organic aerosol (SOA) module in CMAQ. MEGAN was selected over BEIS as the biogenics model of choice in order to maintain consistency with the Uinta Basin Air Quality Study emissions inventory development.

3.8 Wildfires and Prescribed Burns

Wildfire and prescribed burn emissions were handled separately from the standard area source input files. The study team had nation-wide fire emissions for the 2002 year, developed for WRAP and VISTAS. Spatial and temporal distributions of the fire emissions were calculated based on this information rather than relying on standard distribution profiles. Also, the study team calculated the vertical distribution of the fire emissions, based on fire size and biomass involvement. SMOKE 2.4 can model fire plume rise if provided with the following variables:

PTOP **–** Top of the fire plume profile (meters above ground level)
PBOT **–** Bottom of the fire plume profile (meters above ground level)
Lay1 **–** The percent of the emissions entrained in the first modeling layer

The WRAP Fire Emissions Joint Forum Emissions Inventory Report (WRAP/FEJF, 2002) documented an approach to estimate these plume descriptors. In this method, the fires were assigned to one of 5 size categories, based on the total burn acreage, and the biomass fuel loading. These categories were then used to calculate representative hourly plume profiles. These profiles were used by SMOKE 2.4 to distribute the vertical emissions for the fires.

3.9 Products of the Emissions Inventory Development Process

In addition to the CMAQ-ready input files generated for each hour of the days modeled in the annual run, a number of quality assurance (QA) files were prepared and used to check for gross errors in the emissions inputs. Importing the model-ready emissions into the Package for Analysis and Visualization of Environmental Data (PAVE) and looking at both the spatial and temporal distribution of the emissions provided insight into the quality and accuracy of the emissions inputs. PAVE allowed for the following quality assurance checks on the emissions estimated using SMOKE 2.4:

Visualizing the model-ready emissions with the scale of the plots set to a very low value, areas where emissions were omitted from the raw inventory and erroneously located emissions (such as area source industrial emission in water cells) were corrected.

Normalizing the emissions by population for each state illustrated where the inventories may have been deficient and provided a reality check of the inventories vis-à-vis a spatial evaluation of the population weighted emissions estimates.

Spot checked vertical allocation of point source emissions estimates.

State inventory summaries were prepared prior to the emissions processing to compare against SMOKE output report totals generated after each major step of the emissions generation process.

To check the vertical allocation of the emissions estimates, reports were created by source, hour, and layer for randomly selected states in the domain.

Quantitative QA analyses often reveal significant deficiencies in the input data or the model setup. Sometimes it is necessary to tailor these procedures to track down the source of each problem. As such, the basic quantitative QA steps that were performed in an attempt to reveal the underlying problems with the inventories or processing are described. Some of the reports that may be generated to review the processed emissions estimates include the following:

- State and county totals from inventory for each source category
- State and county totals after spatial allocation for each source category
- State and county totals by day after temporal allocation for each source category for representative days
- State and county totals by model species after chemical speciation for each source category
- State and county model-ready totals (after spatial allocation, temporal allocation, and chemical speciation) for each source category and for all source categories combined
- If elevated source selection is chosen by user, the report indicating which sources have been selected as elevated and plume-in-grid will be included.
- Totals by source category code (SCC) from the inventory for area, mobile, and point sources
- Totals by state and SCC from the inventory for area, mobile, and point sources
- Totals by county and SCC from the inventory for area, mobile, and point sources
- Totals by SCC and spatial surrogates code for area and mobile sources
- Totals by speciation profile code for area, mobile, and point sources
- Totals by speciation profile code and SCC for area, mobile, and point sources
- Totals by monthly temporal profile code for area, mobile, and point sources
- Totals by monthly temporal profile code and SCC for area, mobile, and point sources
- Totals by weekly temporal profile code for area, mobile, and point sources
- Totals by weekly temporal profile code and SCC for area, mobile, and point sources
- Totals by diurnal temporal profile code for area, mobile, and point sources
- Totals by diurnal temporal profile code and SCC for area, mobile, and point sources

3.10 Project Emissions

Study-specific emission inventories for the simulation, described in Section 1.1, were developed for the Proposed Action without controls beyond mandates and a simulation with ACEPMs to reduce NO_X and VOC emissions beyond mandates. These inventories included the construction and operations emissions. The emissions were calculated for the predicted year of maximum development activity and emissions; 2018. Because emissions related to the Proposed Action are expected to peak in 2018, use of the WRAP 2018 inventory was possible thus allowing for the application of the best available emissions estimates for the future year.

4.0 2005/2006 Base Case Modeling Results

The CMAQ modeling database used in this study was the Uinta Basin Air Quality Study (UBAQS) developed by the Independent Petroleum Association of Mountain States (IPAMS) (IPAMS, 2009). Presented below is the technical summary of the ozone performance evaluation. The UBAQS report provides more detail on the model performance.

Table 4-1 compares the UBAQS CMAQ 2005 and 2006 base case simulation ozone model performance across CASTNet monitoring sites in the 12-km domain with EPA's hourly ozone model performance goals for bias (≤±15%) and error (≤35%) (EPA, 1991). Presented in Table 4-1 are the fractional bias (FB), normalized mean bias (NMB) and mean normalized bias (MNB) ozone performance metrics (and similar metrics for error) that are calculated using hourly predicted and observed ozone pairs for which the observed value is above a 60 parts per billion (ppb) threshold (EPA, 1991) for each Quarter of 2005 and 2006. Bias and error performance statistics in Table 4-1 are only presented for Quarters when there is a minimum of at least 100 predicted and observed hourly ozone pairs available. For Q1 and Q2 in 2005 and 2006 with at least 100 predicted and observed hourly ozone pairs, the UBAQS CMAQ base case ozone performance consistently achieved EPA's ozone performance goal. During Q3 of both 2005 and 2006, the CMAQ ozone bias performance metrics were just at the -15% ozone performance goal (≤±15%) with some of the bias metrics achieving the goal, whereas others are just outside of the goal. However, the CMAQ error ozone performance metrics achieved the ≤35% ozone performance goal by a wide margin (over a factor of two all the time).

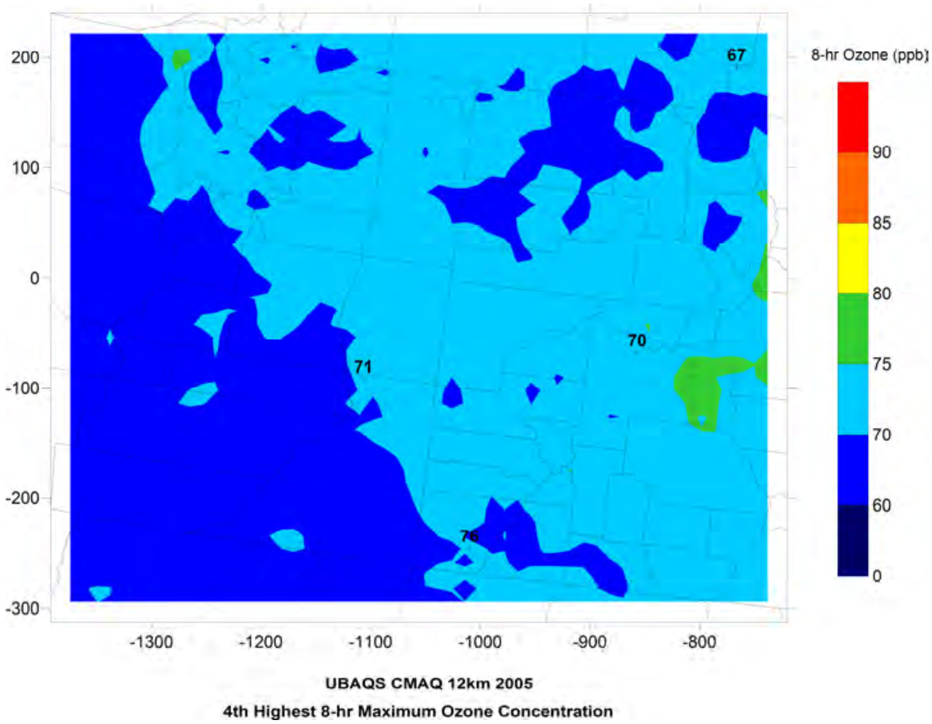
Table 4-1. Ozone model performance bias and error statistical performance measures across the five CASTNet monitoring sites in the UBAQS 12-km modeling domain and 2005 and 2006 by Quarter (statistics based on a minimum of 100 predicted/observed hourly ozone pairs, N≥100).

	Bias Metrics			Error Metrics			
Site	**FB**	**NMB**	**MNB**	**FE**	**NMGE**	**MNGE**	**N**
EPA Goal	*≤±15%*	*≤±15%*	*≤±15%*	*≤35%*	*≤35%*	*≤35%*	
2005 Quarter 2	-5.80	-5.16	-4.82	11.16	10.65	10.51	2015
2005 Quarter 3	-16.75	-15.04	-14.89	17.52	15.82	15.70	1388
2006 Quarter 1	-5.00	-4.52	-4.43	8.56	8.18	8.14	278
2006 Quarter 2	-4.06	-3.66	-3.40	9.14	8.87	8.77	3174
2006 Quarter 3	-16.48	-14.83	-14.71	16.86	15.21	15.11	1179

The UBAQS CMAQ base case simulations also satisfied EPA's daily maximum 8-hour ozone concentration performance goal that requires predicted daily maximum 8-hour ozone concentration "near the monitor" to be within ±20% of the observed value most of the time (EPA, 1999). Even using the most stringent definition of "near the monitor", which is based on the predicted 8-hour ozone concentration at the monitor, the CMAQ base case predicted daily maximum 8-hour ozone concentration were within ±20% of the observed value 90% and 83% of the time for the 2005 and 2006 modeling years, respectively.

The 8-hour ozone NAAQS is expressed as the three-year average of the fourth highest daily maximum 8-hour ozone concentrations. Thus, an important ozone performance issue when analyzing the future year CMAQ absolute modeling results is the fourth highest daily maximum 8-hour ozone concentration. Figure 4-1 compares the CMAQ estimated fourth highest daily maximum 8-hour ozone concentration with the observed values for 2005 and 2006. The modeled fourth highest daily maximum 8-hour ozone concentrations are comparable to the observed values. The modeled fourth highest daily maximum 8-hour ozone concentrations at the locations of the ozone monitors are usually higher than the observed value resulting in an over-prediction bias that is greater in 2006 than 2005. This ozone over-prediction bias must be accounted for when interpreting the future year absolute model ozone predictions.

2005



2006

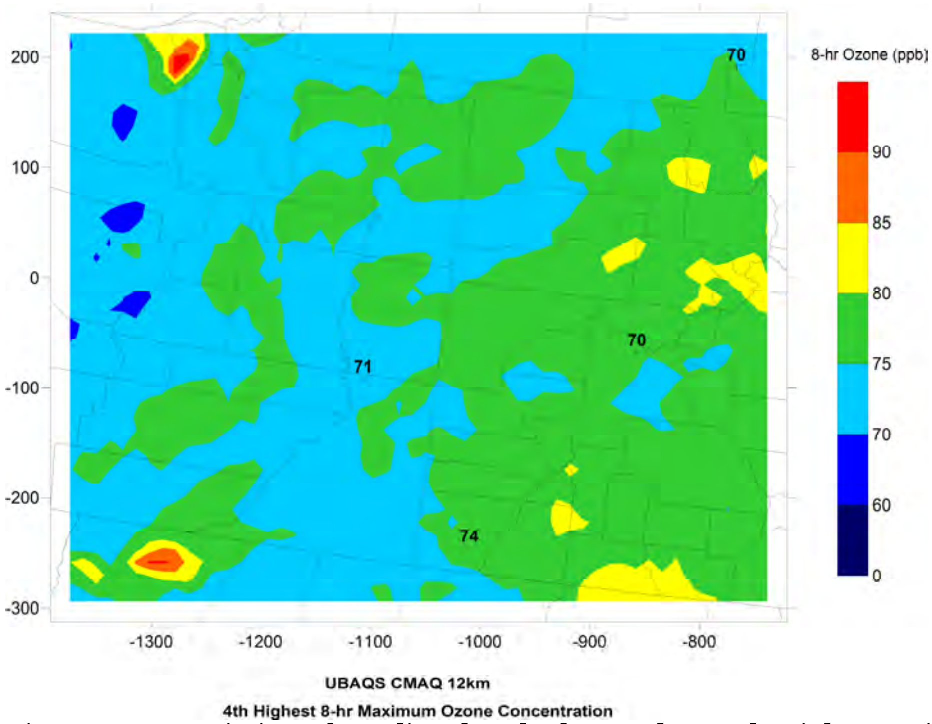


Figure 4-1: Depiction of Predicted and Observed Fourth Highest Daily Maximum 8-hour Ozone Concentrations for 2005 and 2006.

5.0 CMAQ Ozone Impact Assessment

The following subsections present the ozone impacts of the 2018 Future Year Base Case and 2018 Proposed Action cases using both the USEPA guidance relative approach (USEPA 2007) and an absolute impact approach. Considerable caution must be taken in interpreting the project impacts. In traditional CMAQ ozone modeling applications, the model is applied in regions with sufficient ozone and precursor observations (monitoring) to judge the adequacy of the model for use in ozone forecasting. In this application, the closest rural monitor with a sufficiently long data record for attainment designation, Canyonlands, is approximately 150 km from the project area. Ozone observations closer to the project (Vernal and Dinosaur National Park) were operated for shorter time periods that did not correspond to the 2005/2006 period being modeling and were not able to be used for the performance evaluation. Without sufficient local monitored ozone data, the base and future year model estimated ozone levels cannot be validated; however, the comparative modeled ozone levels among the alternatives are considered a reliable evaluation.

5.1 Results Using EPA Guidance Ozone Projection Approach

EPA guidance for projecting future 8-hour ozone concentrations recommends using the photochemical grid model in a relative sense to scale current observed 8-hour ozone design values (EPA, 2007).

The EPA metrics for determining attainment of the ozone standard are based on the modeled ozone concentrations at a monitor location. For this analysis, the study area has very few available ozone measurements, so it is desirable to examine the ozone impacts both at the monitors, and also at areas removed from monitors. This section treats each in-turn.

5.1.1 EPA Guidance 8-Hour Ozone Projection Procedures

USEPA guidance for projecting future 8-hour ozone concentrations recommends using the photochemical grid model in a relative sense to scale current observed 8-hour design values (USEPA 2007). A design value is defined as a 3-year average of the fourth highest daily maximum 8-hour ozone concentrations at a monitor. Model scaling factors, referred to as relative response factors (RRFs), are used to scale the observed design values in order to predict future year design values. RRFs are the ratio of the future year (or the control case) to the current-year modeled 8-hour ozone concentrations near a monitor site. USEPA has defined "near the monitor" to be approximately 15 km from the monitor location. The future-year design value (DVf) is obtained from the current-year design value (DVc) using the relation:

$$DVf = DVc \times RRF$$

The RRFs are calculated for all days in which the current-year modeled 8-hour ozone value is above a threshold. This is done so that the model response to future changes in emissions is considered only on high ozone days of comparable conditions to the days used to produce the DVc. USEPA recommends a threshold between 70 and 85 ppb.

To perform the 8-hour projections, USEPA has developed the Modeled Attainment Test Software (MATS) tool that uses modeling results, 8-hour ozone design values and follows USEPA guidance (USEPA 2007) to project 8-hour ozone concentrations that reflect the change in emissions from the base case to an alternative emissions scenario.

EPA recommends using a DVc based on an average of three year 8-hour ozone Design Values that span 5 consecutive years centered on the modeling year (i.e., a weighted average of 5 years of fourth highest daily maximum 8-hour ozone concentrations). For example, for the 2006 baseline modeling year used in this analysis, this would mean the DVc at a given monitor would be the weighted average of the fourth highest 8-hour daily maximum ozone at that monitor from the years 2004, 2005, 2006, 2007 and 2008 using weights of 1, 2, 3, 2 and 1, respectively. To develop RRFs, EPA guidance recommends using current and future modeling results for all days in which the current year daily maximum 8-hour ozone concentration near the monitor exceeds an ozone threshold value. For a 12-km grid, as in the XTO RBU CMAQ modeling, the maximum modeled daily maximum 8-hour ozone concentration in a 3 x 3 array of grid cells centered on the monitor is used. EPA recommends using an 8-hour ozone threshold concentration of 85 ppb and also recommends that RRFs be based on a minimum of 5 days, although a total of 10 days or more is preferred. EPA allows a reduction of the threshold value to 70 ppb to meet the minimum 5-10 days requirement. These procedures were developed mainly for urban ozone nonattainment areas where there are typically many more days of elevated ozone concentrations than are observed in the rural Uinta Basin study area.

There are several issues with using the MATS tool in its standard configuration for the XTO RBU ozone analysis. The most serious is that the monitoring network is relatively dense in the Salt Lake but sparse throughout the rest of Utah, with no monitors in the Uinta Basin that have a sufficiently long data record to allow inclusion in the MATS tool (Figure 5-1). Therefore, use of the MATS tool as is would result in the DVCs in Uintah County, Utah being based on interpolation of DVCs from monitors hundreds of kilometers away in the Salt Lake City area, San Juan County, Utah (Cayonlands) and the Gothic, Colorado and Centennial, Wyoming CASTNet sites. This results in the interpolation of high Salt Lake City ozone values typical of an urban area across the Wasatch Range into the rural Uinta Basin region. Note that the Uinta Basin is not part of the Salt Lake City airshed. In addition, restricting sites used in MATS to those with a minimum of 5 days of DVc greater than 70 ppb means that MATS cannot project future ozone in the middle of the Uinta Basin and leaves this area blank in plotting future year design values in the Unmonitored Area Analysis. The most effective way to remedy this problem is to include monitors that record ozone data according to EPA standard methods, but are not included in the default MATS tool because they have fewer than five years of data available.

For this analysis a MATS assessment was performed in which all available data were used. While this may not be acceptable to NAAQS attainment designation, this approach leads to a more informative analysis. The 5 year data requirement to construct DVc was relaxed so that sites with a minimum of 1 year of data were included as DVc in the analysis. DVc for sites with multiple years of record were based on the three year 8-hour ozone Design Value that spanned 2004-2008. In the enhanced MATS Unmonitored Area Analysis grid cells are included in the RRF calculation if they had 1 or more days over both a 70 ppb and a 60 ppb threshold.

The most important difference in the Uinta Basin is the addition of DVc associated with the Vernal, Utah ozone monitor and the monitor at Dinosaur National Monument. The Vernal monitor lies within the Uinta Basin and was active in 2007 and the fourth highest daily maximum 8-hour ozone concentration was used for the DVc. The DVc for the Dinosaur National Monument was based on three years of monitoring data (2006-2008) with the three-year average fourth highest daily maximum 8-hour ozone concentrations used as the DVc.

The 8-hour ozone projections are performed twice times for each meteorological year. The first projection is performed using the 2006 typical simulation and the Future Year Base Case. Projections are then run comparing the Proposed Action case to the 2006 typical simulation. The project impacts are the differences in the future design values between the Proposed Action simulations and the Future Year Base case simulation.

5.1.2 Impact Assessment at Monitors

Monitor station 2006 design values (DVc), 2018 future year design values (DVf) and the RRF for the 2018 Future Year Base Case and 2018 Proposed Action for all stations in the domain analyzed over the entire 2018 period run with 2005 and 2006 meteorology with a minimum ozone threshold of 70 ppb are presented in Tables 5-1 and 5-2, respectively. EPA Guidance (EPA, 2007) suggests truncating ozone concentrations to the parts per billion level when performing attainment testing. However, for this analysis the results are presented to the tenth of a ppb to better resolve potential project impacts.

For the 2005 meteorological year (Table 5-1) the Proposed Action scenario increases ozone design values by 0.1 ppb at 2 monitors. The CMAQ model indicated greater impacts from the project using the 2006 meteorology. For the 2006 meteorological year (Table 5-2) the Proposed Action scenario increases ozone by 0.1 ppb at 2 monitors and by 0.2 ppb at the Dinosaur NM monitor. Tables 5-1 and Table 5-2 show that for all three future scenarios all monitors in the modeling domain are predicted to be in attainment of the 75 ppb ozone NAAQS.

Analogous tables with the MATS analysis run with a minimum threshold of 60 ppb are presented in Tables 5-3 and 5-4 for the 2005 and 2006 meteorologies, respectively. The impact results are very similar to, but somewhat lower than, the impacts with the 70 ppb threshold. For the 2005 meteorology (Table 5-3) the maximum impact is 0.1 ppb, which occurs at 3 stations for the Proposed Action case. For the 2006 meteorology (Table 5-4) the Proposed Action case shows an impact of 0.1 ppb at 2 monitors.

5.1.3 Impact Assessment Removed from Monitors

To assess the project impacts in areas removed from monitor locations, EPA guidance calls for an unmonitored area analysis. For this application, the MATS tool is used to prepare spatial fields of the projected future year ozone design values throughout the 12-km domain. EPA does not determine attainment of the 8-hour standard based on the unmonitored area analysis. Rather the unmonitored analysis is used as more of a weight of evidence analysis (EPA, 2007).

Figure 5-1 presents the 2006 MATS estimated ozone design values using the 2005 and 2006 meteorologies. For both meteorological years the highest values are estimated to occur in the Salt Lake City area. For the 2005 meteorology in the XTO RBU project area the estimated design values are sub 70 ppb. For the 2006 meteorology the majority of the values are sub 70 ppb with one grid cell in the range of 70 to 73 ppb. No grid cells in the vicinity of the project area are estimated to have design values in excess of the 75 ppb ozone NAAQS.

Figures 5-2 through 5-4 present the results of the MATS analysis with a minimum threshold of 70 ppb. Figure 5-2 presents the 2018 projected project Future Year Base Case design values. For both years of meteorology the CMAQ model is generally estimating a decrease in the design value across the domain. Figure 5-3 presents the 2018 design values which include the XTO RBU Proposed Action emissions. The results are near indistinguishable from the 2018 project Future Year Base Case figures. The model is not estimating ozone concentrations in excess of the 75 ppb standard in the project area for any simulations.

To focus on the differences in the 2018 design values, difference plots between the various simulations were prepared. Figure 5-4 presents the differences in the design values between the project Future Year Base Case and the project Proposed Action simulations. The project emissions show more impact in the 2006 meteorology than the 2005. The maximum increase with the 2005 meteorology is 0.2 ppb occurring southwest of the project and only three grid cells showing impacts of 0.2 ppb. With the 2006 meteorology the maximum increase is 0.7 ppb in the project area with the project emissions showing a 0.2 ppb or greater impact over portions of Uintah County and into Colorado.

Figures 5-5 through 5-7 present the results of the MATS analysis with a minimum threshold of 60 ppb. Figure 5-5 presents the 2018 projected project Future Year Base Case design values. For both years of meteorology the CMAQ model is generally estimating a decrease in the design value across the domain. Figure 5-6 presents the 2018 design values which include the XTO RBU Proposed Action emissions. The results are near indistinguishable from the 2018 project Future Year Base Case figures. The model is not estimating ozone concentrations in excess of the 75 ppb standard in the project area for any simulations.

To focus on the differences in the 2018 design values, difference plots between the various simulations were prepared. Figure 5-7 presents the differences in the design values between the project Future Year Base Case and the project Proposed Action simulations with the 60 ppb threshold. The project emissions show more impact in the 2006 meteorology than the 2005. The maximum increase with the 2005 meteorology is 0.2 ppb occurring at two grid cells just east of the project area. With the 2006 meteorology the maximum increase is 0.7 ppb in the project area with the project emissions showing a 0.2 ppb or greater impact over portions of Uintah County and into Colorado.

5.2 Ozone Projections Using Absolute Modeling Results

As was stated previously, the USEPA preferred approach for use of photochemical models to assess ozone attainment is to use air quality model results in a relative sense. However, another approach is to use the model in an absolute sense. Again, the lack of observations in the vicinity of the XTO RBU study area make it impossible to assess whether the CMAQ model is able to replicate the ozone levels in the base year and hence reduces the credibility of the model to estimate future ozone concentrations.

The fourth highest ozone concentrations for 2018 project Future Year Base Case with the 2005 and 2006 meteorology are presented in Figure 5-8. With the 2005 meteorology the project area is estimated to have sub 70 ppb ozone concentrations. With the 2006 meteorology the study area is estimated to have sub 76 ppb ozone concentrations. The model is not simulating a fourth high ozone concentration of 76 ppb or greater in the vicinity of the project area with either year of meteorology.

Fourth high ozone concentrations for the Proposed Action case are presented in Figure 5-9. The spatial patterns are very similar to the project baseline, with only a few grid cells near the XTO RBU project area showing difference. No grid cells in the study area exceed 76 ppb.

As was performed for the unmonitored area analysis, differences between the different alternatives were prepared to highlight the differences. Figure 5-10 presents differences between the Proposed Action and the project Future Year Base Case using the 2005 and 2006 meteorologies. For the 2005 meteorology the maximum ozone increase is 0.8 ppb with the impact area being generally oriented southwest to northeast. For the 2006 meteorology the maximum increase is 1.1 ppb.

5.3 Ozone Impact Assessment Summary

The project impacts for the 2018 Future Year Base Case and the Proposed Action scenario were examined using both the USEPA recommended relative approach and an absolute approach. Using the relative approach at the monitors, the criteria used by USEPA to show attainment of the NAAQS, indicates that all monitors are simulated to be below the 75 ppb NAAQS for all scenarios. The maximum predicted impact at a monitor for the Proposed Action case is 0.1 ppb.

Using the USEPA recommended relative non-monitored area analysis, no areas in the vicinity of the XTO RBU project area are simulated to exceed the 75 ppb ozone standard with either the 2005 or 2006 meteorologies with or without the project emissions. The maximum predicted impact from the Proposed Action case is 0.7 ppb. The areas of predicted maximum impact are occurring in areas simulated to be below the 75 ppb ozone standard.

Using the more uncertain absolute impact approach, none of the project alternative cases predict any regions in the XTO RBU project area to be in excess of the 75 ppb standard. On an absolute basis the project emissions are predicted to increase ozone by a maximum of 1.1 ppb.

Table 5-1. Annual monitor station 2005 meteorological year 8-hour ozone design values (DVc) and future year design values (DVf) for 2018 Future Year Base Case case, and 2018 Proposed Action for monitors in the 12-km modeling domain with a 70 ppb minimum threshold.							
			Baseline	Future Year Base Case		Proposed Action	
Monitor ID	State	Name	DVc	DVf	RRF	DVf	RRF
80450012	CO	Rifle - Heath	66.0	60.4	0.9154	60.4	0.9157
80677001	CO	LaPlata7001	56.3	50.0	0.8892	50.0	0.8892
80677003	CO	LaPlata7003	65.3	56.8	0.8700	56.8	0.8700
80679000	CO	Shamrock	71.3	66.4	0.9317	66.4	0.9317
80770020	CO	Palisade-Water	70.0	64.3	0.9187	64.3	0.9190
80771001	CO	Colorado NM	69.0	62.7	0.9094	62.7	0.9095
80830101	CO	Montezuma0101	72.3	64.1	0.8869	64.1	0.8869
350450009	NM	SanJuan0009	67.3	61.8	0.9185	61.8	0.9185
350450018	NM	Navajo Dam	77.0	70.4	0.9150	70.4	0.9150
350451005	NM	SanJuan1005	71.0	66.0	0.9300	66.0	0.9300
490110004	UT	Davis0004	80.0	69.1	0.8642	69.1	0.8642
490350003	UT	SaltLake0003	80.0	72.5	0.9074	72.5	0.9074
490352004	UT	SaltLake2004	80.0	63.0	0.7877	63.0	0.7877
490353006	UT	SaltLake30006	77.0	69.1	0.8986	69.1	0.8986
490353007	UT	SaltLake3007	78.0	64.4	0.8258	64.4	0.8258
490353008	UT	SaltLake3008	78.0	66.5	0.8529	66.5	0.8529
490370101	UT	SanJuan0101	71.0	62.2	0.8763	62.2	0.8764
490471002	UT	Dinosaur NM	65.0	59.2	0.9110	59.2	0.9115
490490002	UT	Utah0002	73.0	64.7	0.8867	64.7	0.8868
490495008	UT	Utah5008	75.0	67.4	0.8990	67.4	0.8991
490495010	UT	Utah5010	76.0	65.9	0.8677	65.9	0.8677
490570007	UT	Weber0007	78.0	66.7	0.8554	66.7	0.8554
490571003	UT	Weber1003	79.0	67.5	0.8554	67.5	0.8554
Black_CnNP	CO	Black_CnNP	74.0	67.2	0.9090	67.2	0.9090
Cent_WY	WY	Cent_WY	68.0	63.0	0.9265	63.0	0.9265
EnCanaCyn	CO	EnCanaCyn	68.0	62.5	0.9195	62.5	0.9200
EnCanaMtn	CO	EnCanaMtn	68.0	63.2	0.9308	63.3	0.9310
Gothic	CO	Gothic	67.7	63.9	0.9439	63.9	0.9443
USFS-Sunlight	CO	USFS-Sunlight	70.0	64.0	0.9157	64.1	0.9160
USFS_Ajax	CO	USFS_Ajax	77.0	71.8	0.9330	71.8	0.9332
USFS_Bell	CO	Garfield	70.5	63.0	0.8947	63.0	0.8950
USFS_Ripp	CO	USFS_Ripp	66.0	61.0	0.9257	61.1	0.9258
Vernal	UT	Vernal	68.9	64.1	0.9304	64.1	0.9304

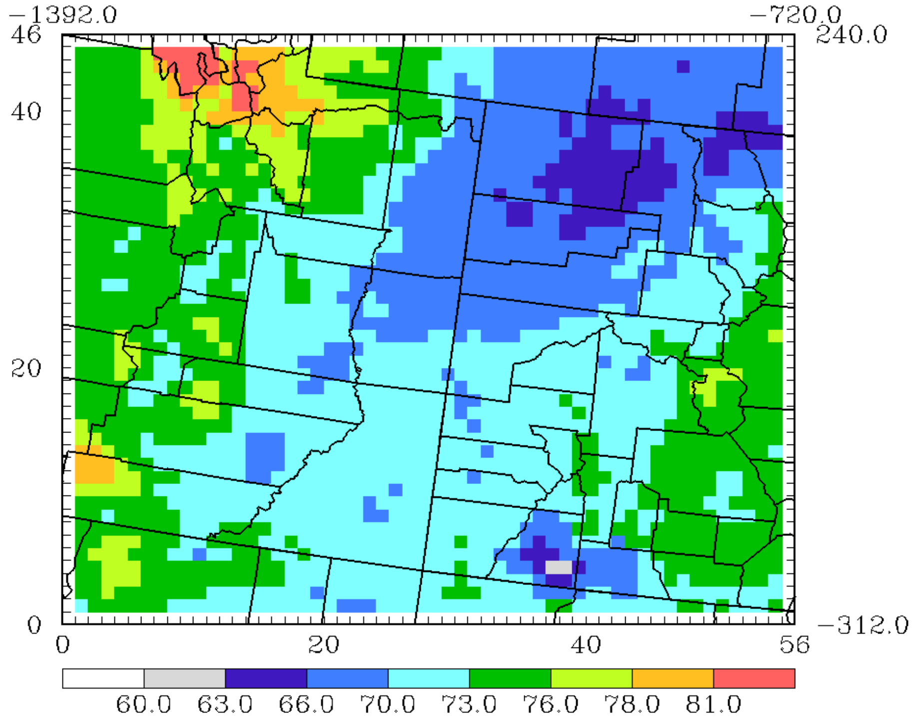
Table 5-2. Annual monitor station 2006 meteorological year 8-hour ozone design values (DVc) and future year design values (DVf) for 2018 Future Year Base Case case, and 2018 Proposed Action for monitors in the 12-km modeling domain with a 70 ppb minimum threshold.

			Baseline	Future Year Base Case		Proposed Action	
Monitor ID	State	Name	DVc	DVf	RRF	DVf	RRF
80450012	CO	Rifle - Heath	66.0	59.8	0.9064	59.8	0.9067
80677001	CO	LaPlata7001	56.3	51.8	0.9210	51.8	0.9211
80677003	CO	LaPlata7003	65.3	59.9	0.9176	59.9	0.9176
80679000	CO	Shamrock	71.3	66.1	0.9282	66.1	0.9282
80770020	CO	Palisade-Water	70.0	63.8	0.9124	63.8	0.9126
80771001	CO	Colorado NM	69.0	62.6	0.9078	62.6	0.9079
80830101	CO	Montezuma0101	72.3	65.5	0.9069	65.5	0.9070
350450009	NM	SanJuan0009	67.3	62.8	0.9332	62.8	0.9332
350450018	NM	Navajo Dam	77.0	71.0	0.9221	71.0	0.9221
350451005	NM	SanJuan1005	71.0	66.3	0.9340	66.3	0.9340
490110004	UT	Davis0004	80.0	73.2	0.9161	73.2	0.9162
490350003	UT	SaltLake0003	80.0	71.2	0.8908	71.2	0.8909
490352004	UT	SaltLake2004	80.0	67.6	0.8460	67.6	0.8461
490353006	UT	SaltLake30006	77.0	68.0	0.8842	68.0	0.8843
490353007	UT	SaltLake3007	78.0	66.5	0.8535	66.5	0.8537
490353008	UT	SaltLake3008	78.0	71.6	0.9187	71.6	0.9188
490370101	UT	SanJuan0101	71.0	64.0	0.9028	64.1	0.9032
490471002	UT	Dinosaur NM	65.0	59.4	0.9152	59.6	0.9173
490490002	UT	Utah0002	73.0	65.1	0.8931	65.1	0.8931
490495008	UT	Utah5008	75.0	66.2	0.8837	66.2	0.8837
490495010	UT	Utah5010	76.0	67.1	0.8838	67.1	0.8839
490570007	UT	Weber0007	78.0	70.7	0.9068	70.7	0.9069
490571003	UT	Weber1003	79.0	71.6	0.9068	71.6	0.9069
Black_CnNP	CO	Black_CnNP	74.0	68.3	0.9240	68.3	0.9240
Cent_WY	WY	Cent_WY	68.0	64.3	0.9461	64.3	0.9464
EnCanaCyn	CO	EnCanaCyn	68.0	62.1	0.9133	62.1	0.9135
EnCanaMtn	CO	EnCanaMtn	68.0	61.8	0.9091	61.8	0.9093
Gothic	CO	Gothic	67.7	63.1	0.9330	63.1	0.9331
USFS-Sunlight	CO	USFS-Sunlight	70.0	64.7	0.9245	64.7	0.9247
USFS_Ajax	CO	USFS_Ajax	77.0	71.8	0.9330	71.8	0.9330
USFS_Bell	CO	Garfield	70.5	64.2	0.9107	64.2	0.9108
USFS_Ripp	CO	USFS_Ripp	66.0	62.8	0.9518	62.8	0.9521
Vernal	UT	Vernal	68.9	63.6	0.9244	63.7	0.9258

Table 5-3. Annual monitor station 2005 meteorological year 8-hour ozone design values (DVc) and future year design values (DVf) for 2018 Future Year Base Case case, and 2018 Proposed Action for monitors in the 12-km modeling domain with a 60 ppb minimum threshold.							
			Baseline	Future Year Base Case		Proposed Action	
Monitor ID	State	Name	DVc	DVf	RRF	DVf	RRF
80450012	CO	Rifle - Heath	66.0	60.4	0.9154	60.4	0.9157
80677001	CO	LaPlata7001	56.3	50.0	0.8892	50.0	0.8892
80677003	CO	LaPlata7003	65.3	56.8	0.8700	56.8	0.8700
80679000	CO	Shamrock	71.3	66.4	0.9317	66.4	0.9317
80770020	CO	Palisade-Water	70.0	64.7	0.9254	64.7	0.9256
80771001	CO	Colorado NM	69.0	62.4	0.9049	62.4	0.9050
80830101	CO	Montezuma0101	72.3	64.1	0.8869	64.1	0.8869
350450009	NM	SanJuan0009	67.3	61.8	0.9185	61.8	0.9185
350450018	NM	Navajo Dam	77.0	70.4	0.9150	70.4	0.9150
350451005	NM	SanJuan1005	71.0	66.0	0.9300	66.0	0.9300
490110004	UT	Davis0004	80.0	69.1	0.8642	69.1	0.8642
490350003	UT	SaltLake0003	80.0	72.5	0.9066	72.5	0.9066
490352004	UT	SaltLake2004	80.0	63.0	0.7877	63.0	0.7877
490353006	UT	SaltLake30006	77.0	69.1	0.8986	69.1	0.8986
490353007	UT	SaltLake3007	78.0	64.4	0.8258	64.4	0.8258
490353008	UT	SaltLake3008	78.0	69.1	0.8862	69.1	0.8862
490370101	UT	SanJuan0101	71.0	64.7	0.9120	64.7	0.9121
490471002	UT	Dinosaur NM	65.0	59.8	0.9201	59.8	0.9212
490490002	UT	Utah0002	73.0	64.7	0.8874	64.7	0.8874
490495008	UT	Utah5008	75.0	67.4	0.8990	67.4	0.8991
490495010	UT	Utah5010	76.0	66.9	0.8811	66.9	0.8811
490570007	UT	Weber0007	78.0	66.7	0.8554	66.7	0.8554
490571003	UT	Weber1003	79.0	67.5	0.8554	67.5	0.8554
Black_CnNP	CO	Black_CnNP	74.0	68.4	0.9253	68.4	0.9253
Cent_WY	WY	Cent_WY	68.0	64.2	0.9443	64.2	0.9443
EnCanaCyn	CO	EnCanaCyn	68.0	62.8	0.9243	62.8	0.9246
EnCanaMtn	CO	EnCanaMtn	68.0	63.2	0.9308	63.3	0.9310
Gothic	CO	Gothic	67.7	63.9	0.9439	63.9	0.9443
USFS-Sunlight	CO	USFS-Sunlight	70.0	64.0	0.9157	64.1	0.9160
USFS_Ajax	CO	USFS_Ajax	77.0	71.8	0.9330	71.8	0.9332
USFS_Bell	CO	Garfield	70.5	65.0	0.9225	65.0	0.9226
USFS_Ripp	CO	USFS_Ripp	66.0	61.0	0.9257	61.1	0.9258
Vernal	UT	Vernal	68.9	63.4	0.9214	63.4	0.9214

Table 5-4. Annual monitor station 2006 meteorological year 8-hour ozone design values (DVc) and future year design values (DVf) for 2018 Future Year Base Case case, and 2018 Proposed Action for monitors in the 12-km modeling domain with a 60 ppb minimum threshold.							
			Baseline	Future Year Base Case		Proposed Action	
Monitor ID	State	Name	DVc	DVf	RRF	DVf	RRF
80450012	CO	Rifle - Heath	66.0	59.8	0.9064	59.8	0.9067
80677001	CO	LaPlata7001	56.3	51.8	0.9210	51.8	0.9211
80677003	CO	LaPlata7003	65.3	59.9	0.9176	59.9	0.9176
80679000	CO	Shamrock	71.3	66.1	0.9282	66.1	0.9282
80770020	CO	Palisade-Water	70.0	63.8	0.9124	63.8	0.9126
80771001	CO	Colorado NM	69.0	62.6	0.9078	62.6	0.9079
80830101	CO	Montezuma0101	72.3	65.5	0.9069	65.5	0.9070
350450009	NM	SanJuan0009	67.3	62.8	0.9332	62.8	0.9332
350450018	NM	Navajo Dam	77.0	71.0	0.9221	71.0	0.9221
350451005	NM	SanJuan1005	71.0	66.3	0.9340	66.3	0.9340
490110004	UT	Davis0004	80.0	73.2	0.9161	73.2	0.9162
490350003	UT	SaltLake0003	80.0	71.2	0.8908	71.2	0.8909
490352004	UT	SaltLake2004	80.0	67.6	0.8460	67.6	0.8461
490353006	UT	SaltLake30006	77.0	68.0	0.8842	68.0	0.8843
490353007	UT	SaltLake3007	78.0	66.5	0.8535	66.5	0.8537
490353008	UT	SaltLake3008	78.0	71.6	0.9187	71.6	0.9188
490370101	UT	SanJuan0101	71.0	64.0	0.9028	64.1	0.9032
490471002	UT	Dinosaur NM	65.0	59.6	0.9173	59.7	0.9194
490490002	UT	Utah0002	73.0	65.1	0.8931	65.1	0.8931
490495008	UT	Utah5008	75.0	66.2	0.8837	66.2	0.8837
490495010	UT	Utah5010	76.0	67.1	0.8838	67.1	0.8839
490570007	UT	Weber0007	78.0	70.7	0.9068	70.7	0.9069
490571003	UT	Weber1003	79.0	71.6	0.9068	71.6	0.9069
Black_CnNP	CO	Black_CnNP	74.0	68.3	0.9240	68.3	0.9240
Cent_WY	WY	Cent_WY	68.0	62.1	0.9133	62.1	0.9135
EnCanaCyn	CO	EnCanaCyn	68.0	62.1	0.9133	62.1	0.9135
EnCanaMtn	CO	EnCanaMtn	68.0	61.8	0.9091	61.8	0.9093
Gothic	CO	Gothic	67.7	63.1	0.9330	63.1	0.9331
USFS-Sunlight	CO	USFS-Sunlight	70.0	64.7	0.9245	64.7	0.9247
USFS_Ajax	CO	USFS_Ajax	77.0	71.8	0.9330	71.8	0.9330
USFS_Bell	CO	Garfield	70.5	64.2	0.9107	64.2	0.9108
USFS_Ripp	CO	USFS_Ripp	66.0	62.8	0.9518	62.8	0.9521
Vernal	UT	Vernal	68.9	63.4	0.9206	63.4	0.9216

2005



2006

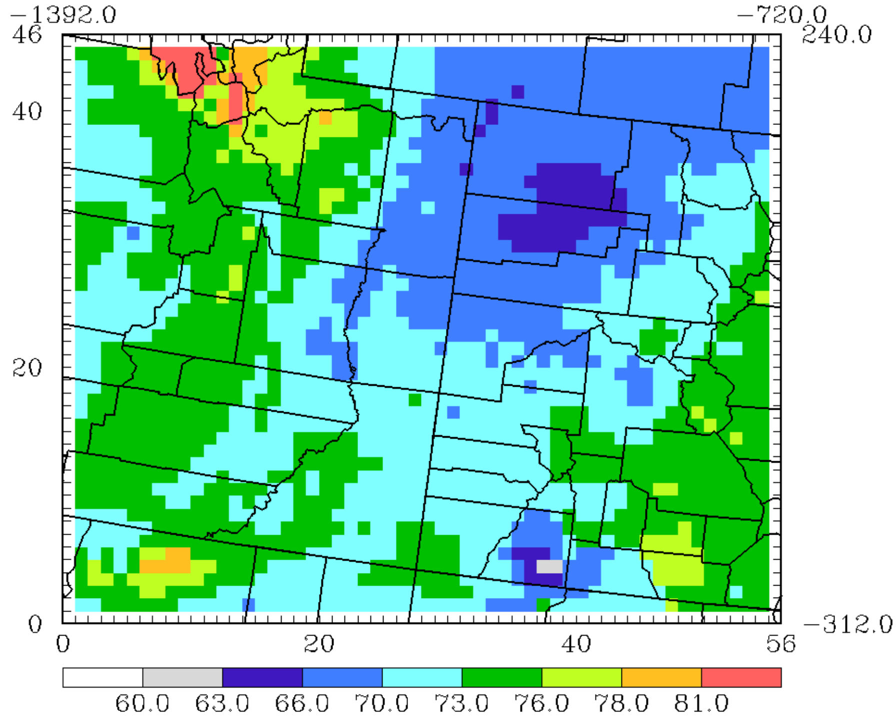
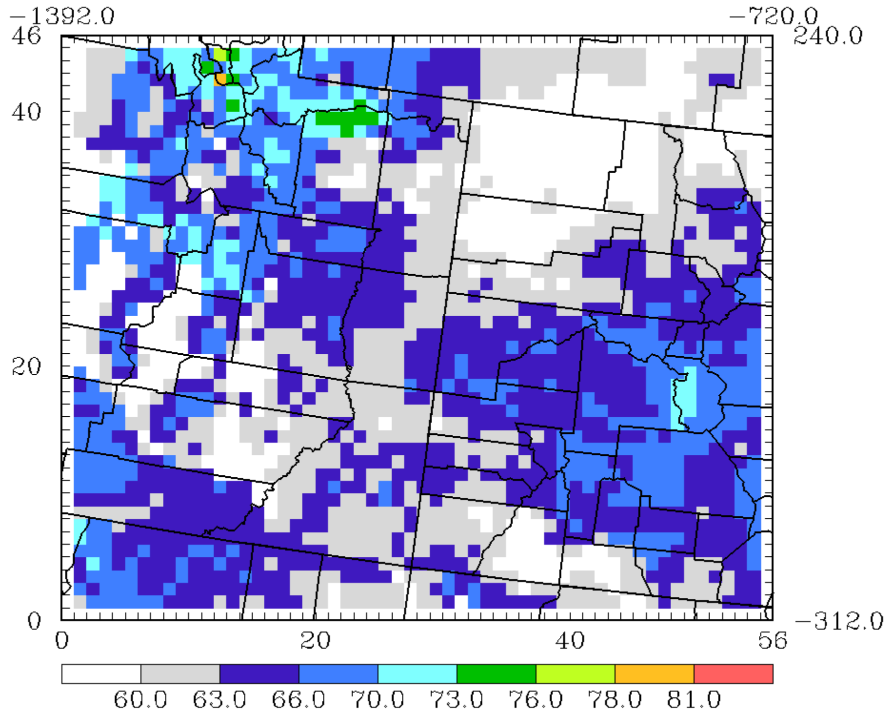


Figure 5-1: Baseline 8-hour Ozone Design Values

2005



2006

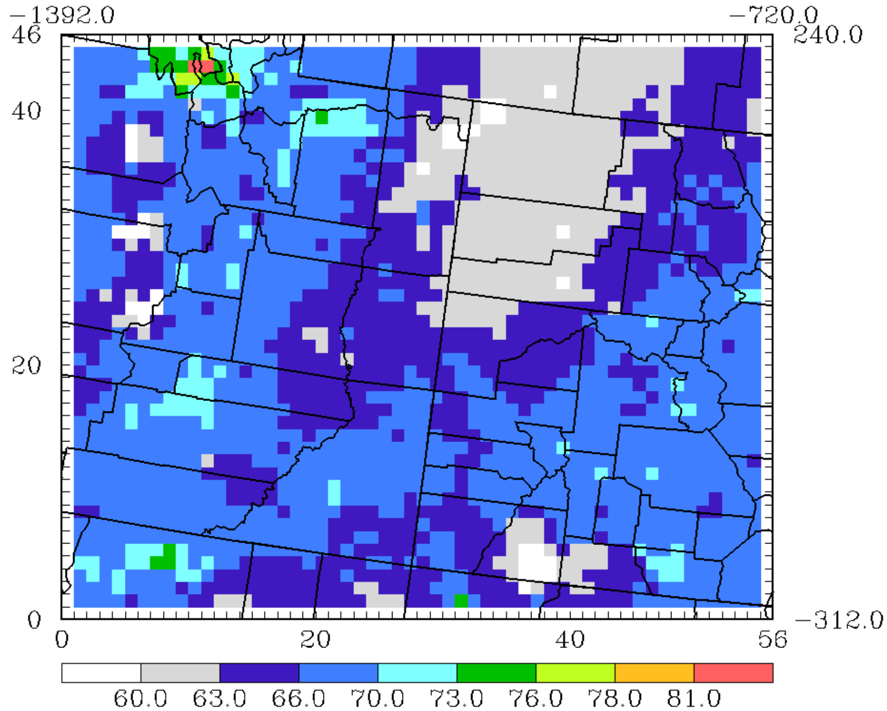
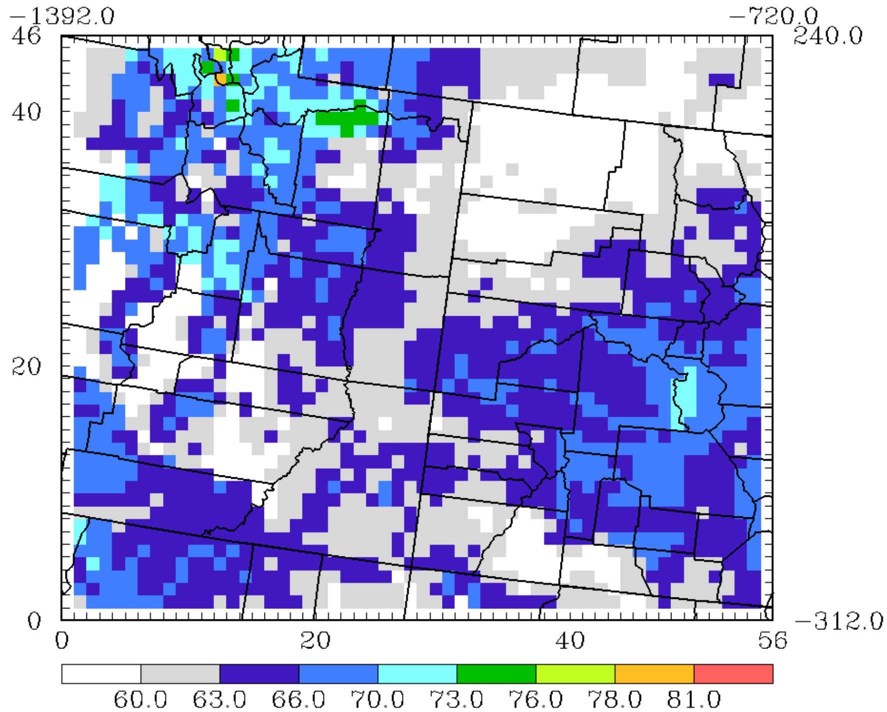


Figure 5-2: Annual 8-hour Ozone Future year Design Values for 2018 Future Year Base Case Projected Baseline with 70 ppb minimum threshold

2005



2006

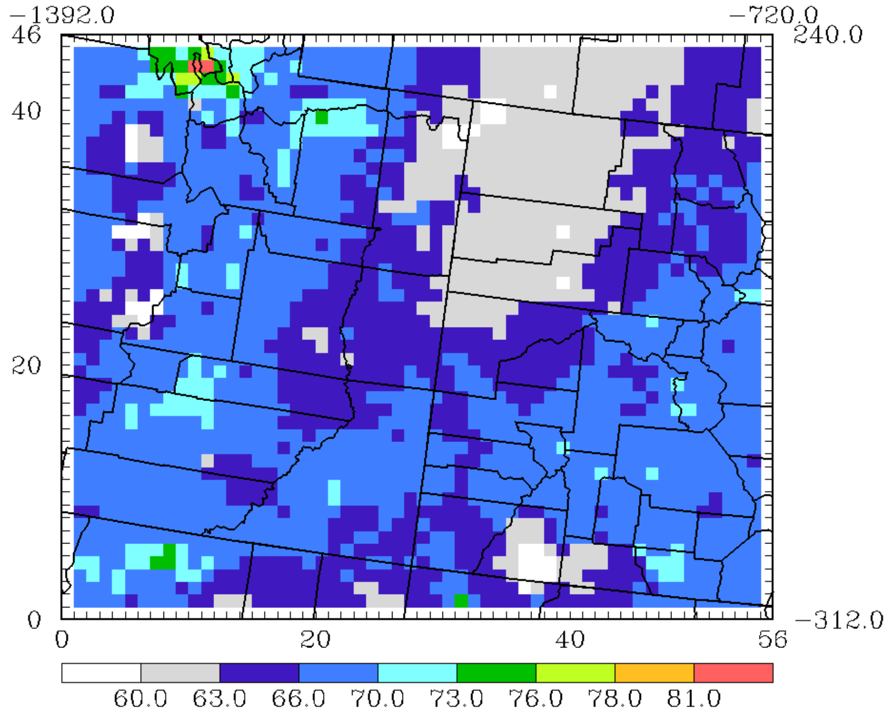
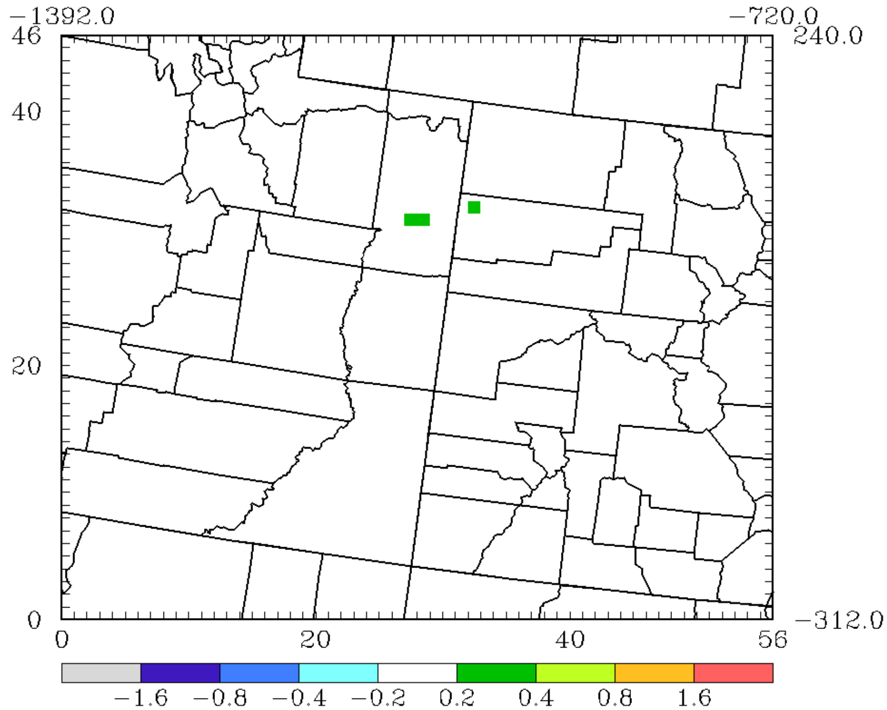


Figure 5-3: Annual 8-hour Ozone Future year Design Values for 2018 Proposed Action with 70 ppb minimum threshold

2005



2006

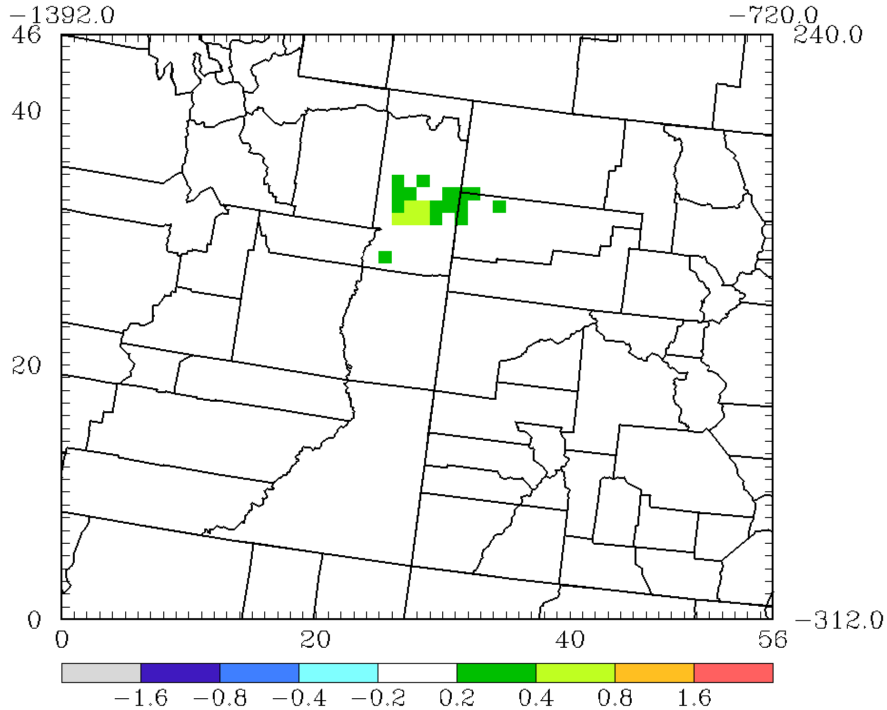


Figure 5-4: Annual 8-hour Ozone Future Design Value Differences for Proposed Action Minus 2018 Future Year Base Case with 70 ppb minimum threshold

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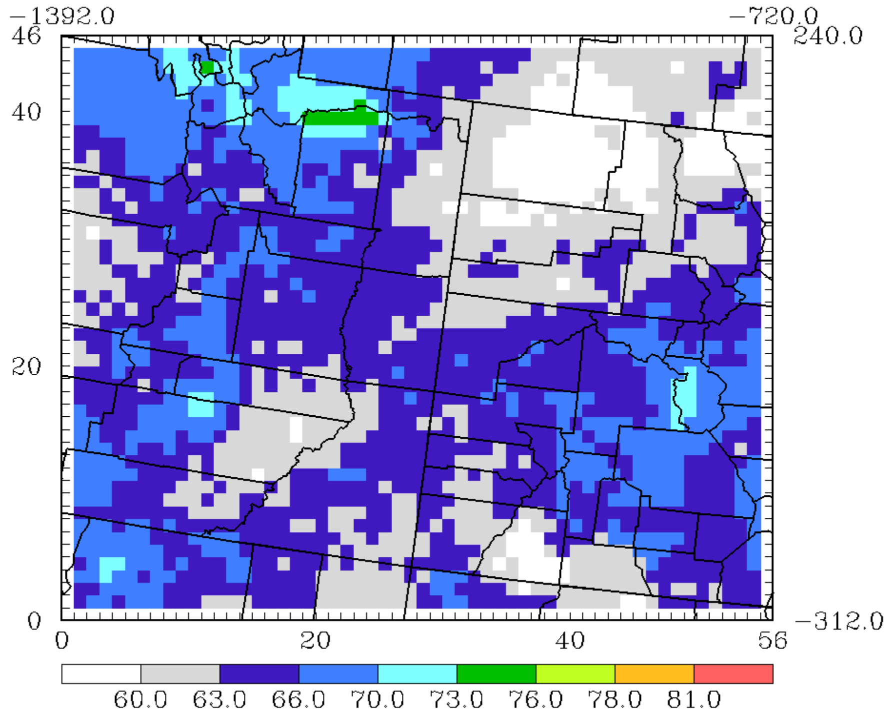


2006

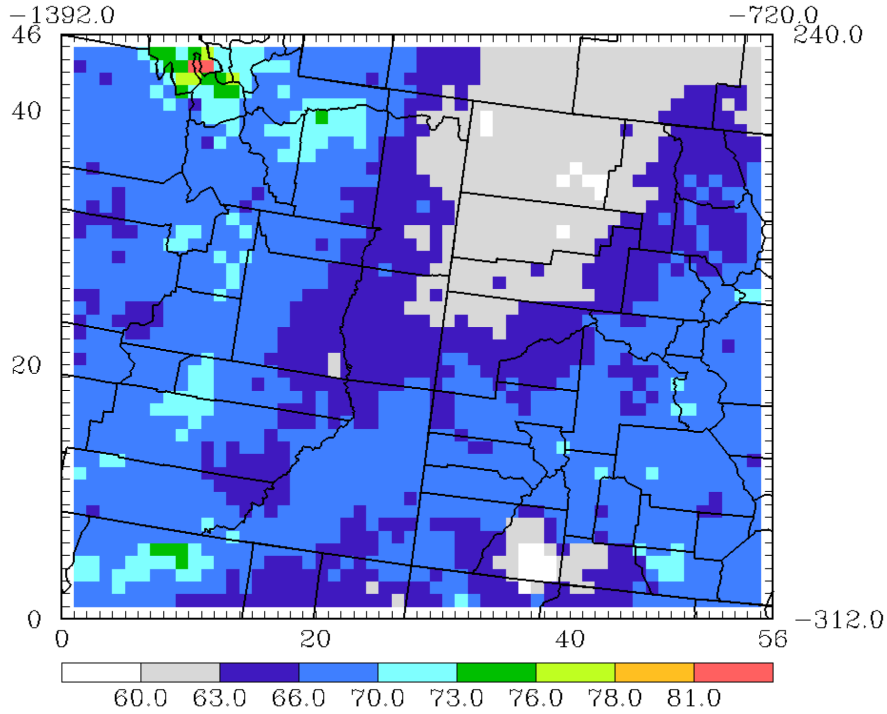
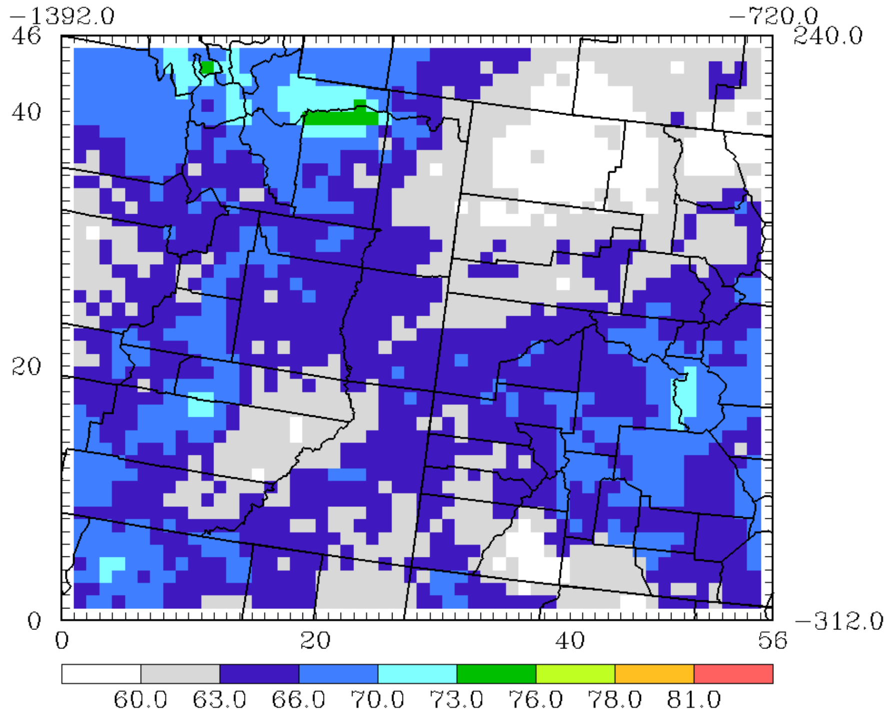


Figure 5-5: Annual 8-hour Ozone Future year Design Values for 2018 Future Year Base Case Projected Baseline with 60 ppb minimum threshold

2005



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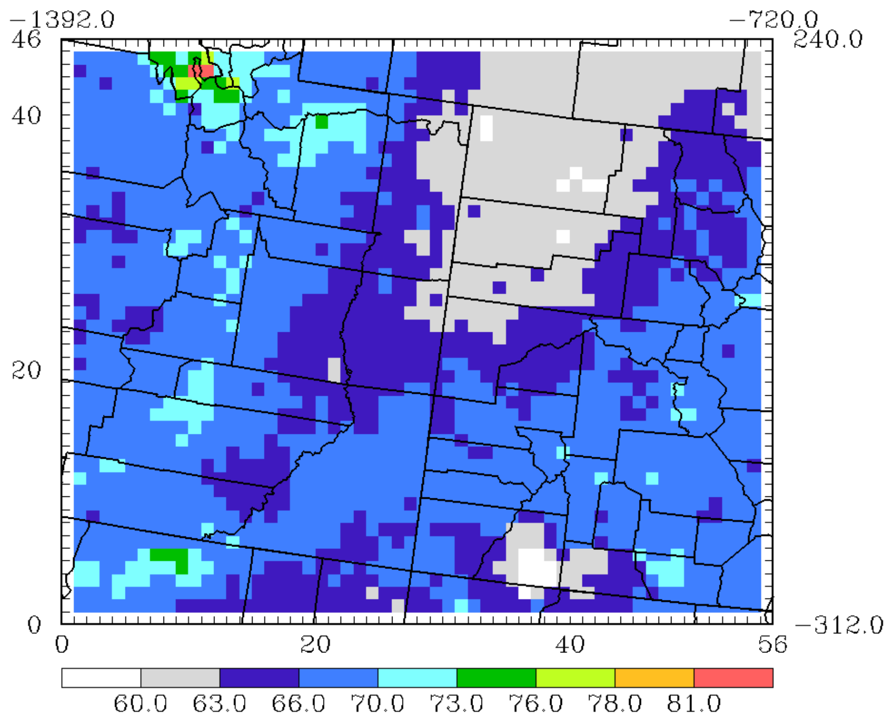
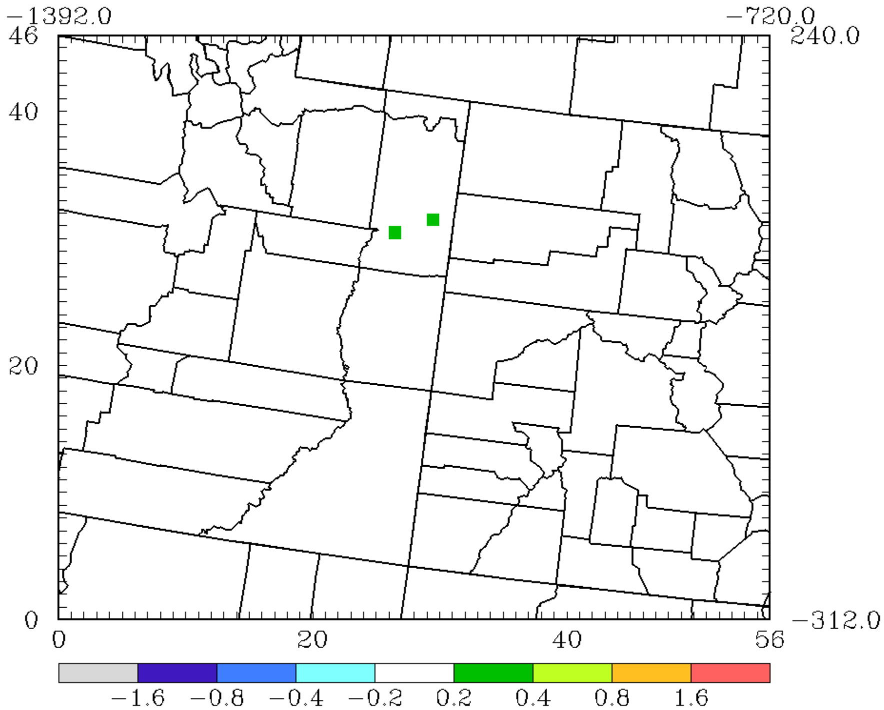


Figure 5-6: Annual 8-hour Ozone Future year Design Values for 2018 Proposed Action with 60 ppb minimum threshold

2005



2006

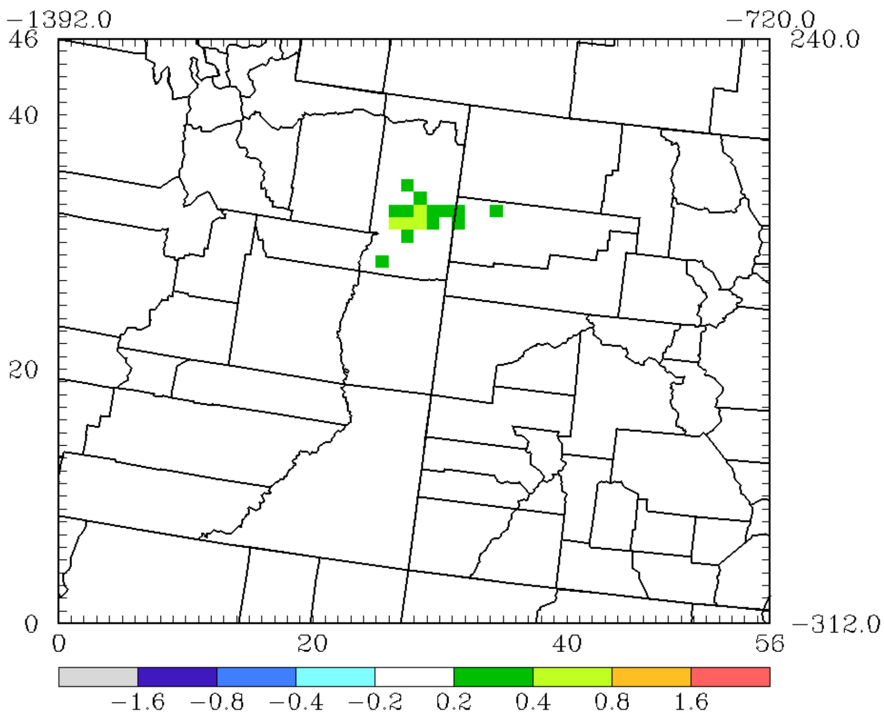
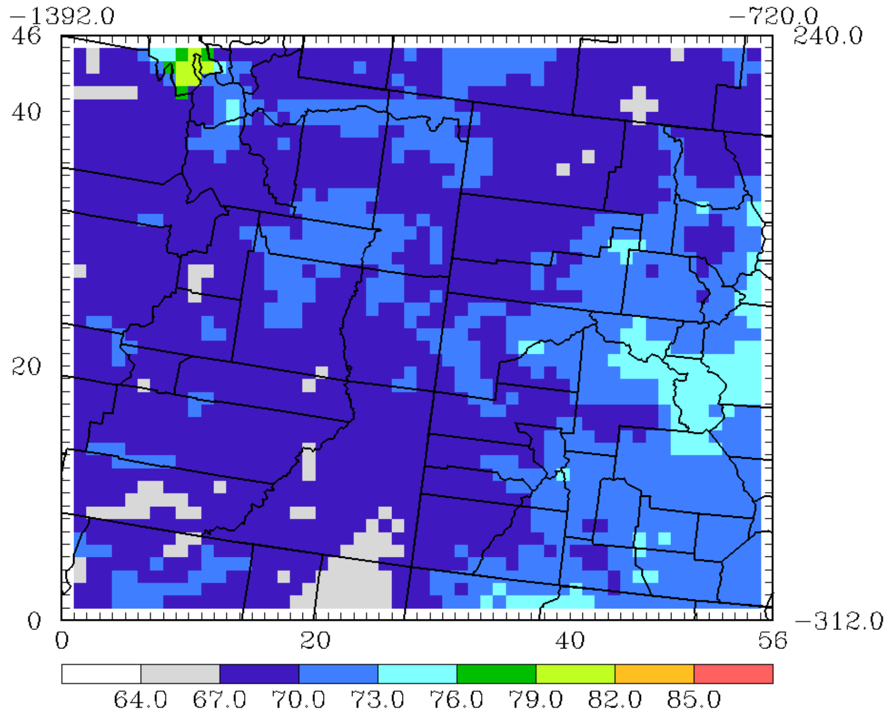


Figure 5-7: Annual 8-hour Ozone Future Design Value Differences for Proposed Action Minus 2018 Future Year Base Case with 60 ppb minimum threshold

2005



2006

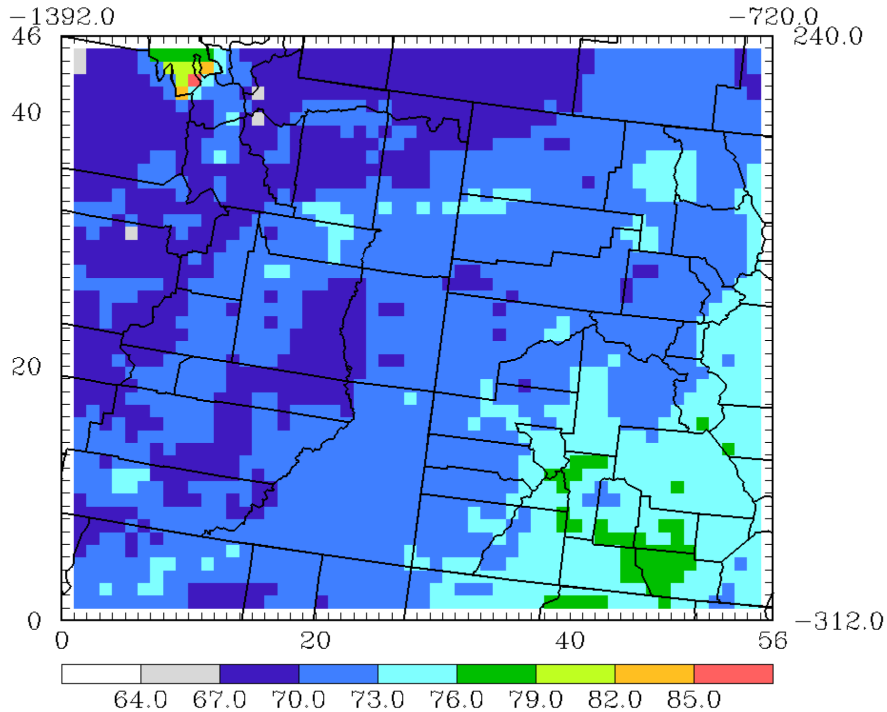
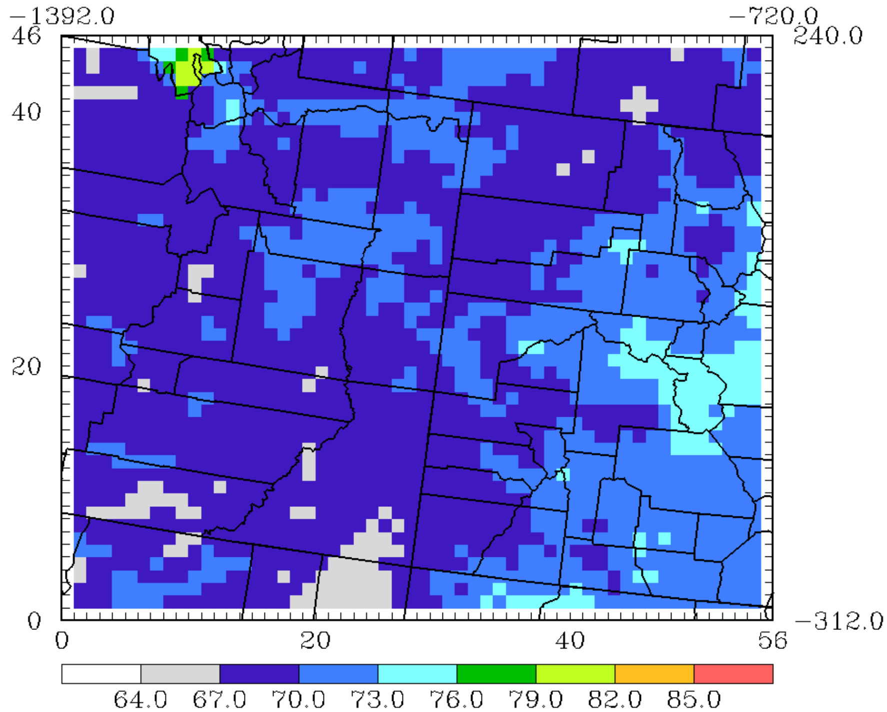


Figure 5-8: Fourth Highest Annual Daily Maximum Predicted 8-hour Ozone Concentration for 2018 Future Year Base Case

2005



2006

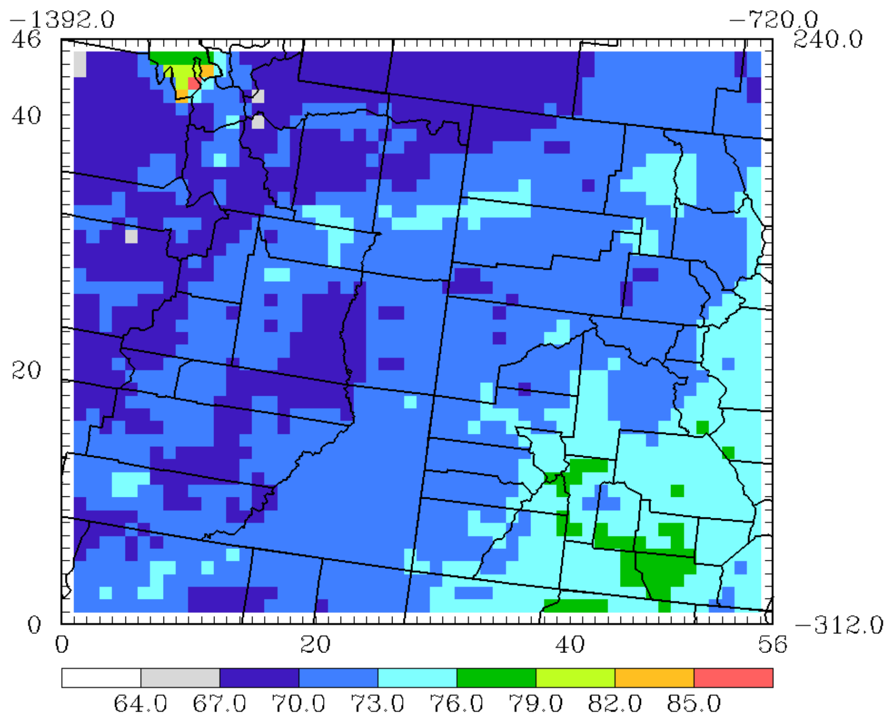
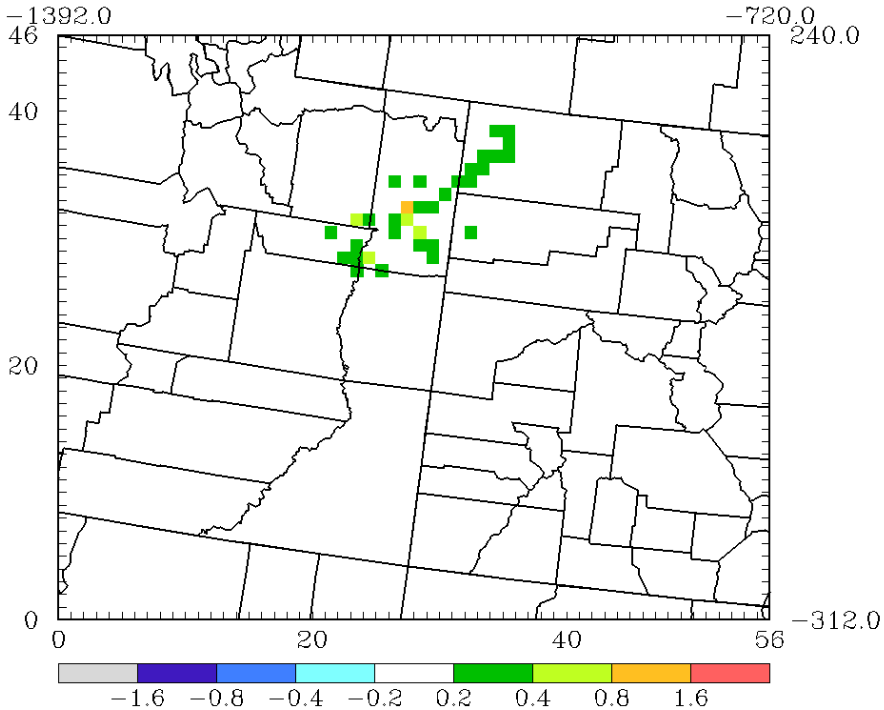


Figure 5-9: Fourth Highest Annual Daily Maximum Predicted 8-hour Ozone Concentration for 2018 Proposed Action

2005



2006

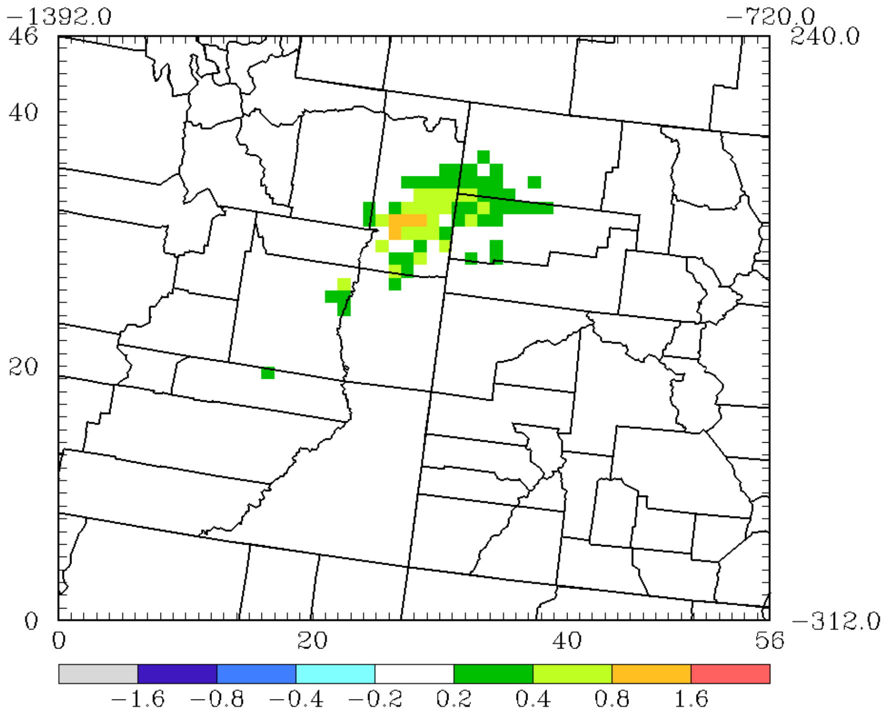


Figure 5-10: Difference in Fourth Highest Annual Daily Maximum Predicted 8-hour Ozone Concentration (ppb) for Future Year Base Case Minus 2018 Proposed Action

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APPENDIX H-2

Memorandum to Update the Ozone Impact Assessment for XTO Energy's River Bend Unit Natural Gas Development Project

Alpine Geophysics, LLC

Memo

To: Daniel Pring, Doug Henderer

From: Dennis McNally

CC: Cyndi Loomis

Date: July 8, 2012

Re: XTO RBU August 2011 Modeling Results

At the request of Kleinfelder, Alpine Geophysics has completed a reanalysis of the XTO River Bend Unit (RBU) project impacts under an alternative emissions scenario. The modeling approach, save the emissions rates, and analyses are contained in the "Ozone Impact Assessment for XTO River Bend Unit Natural Gas Development Project Environmental Impact Statement" report dated May 2010.

For this analysis the emission rates were altered to reflect a higher level of applicant committed measures. The NOx emissions were adjusted from 935.97 tons/year to 585.74 tons/year and the VOC emissions were reduced from 12,173.94 tons/year to 5,174.46 tons/year.

Table **Error! No text of specified style in document.**-1. Annual monitor station 2005 meteorological year 8-hour ozone design values (DVc) and future year design values (DVf) for the 2018 Future Year Base Case case, 2018 Proposed Action, and August 2011 scenarios for monitors in the 12-km modeling domain with a 70 ppb minimum threshold.

			Baseline	No Action		Proposed Action		August 2011	
Monitor ID	State	Name	DVc	DVf	RRF	DVf	RRF	DVf	RRF
80450012	CO	Rifle - Heath	66.0	60.4	0.9154	60.4	0.9157	60.4	0.9155
80677001	CO	LaPlata7001	56.3	50.0	0.8892	50.0	0.8892	50.0	0.8892
80677003	CO	LaPlata7003	65.3	56.8	0.8700	56.8	0.8700	56.8	0.8699
80679000	CO	Shamrock	71.3	66.4	0.9317	66.4	0.9317	66.4	0.9316
80770020	CO	Palisade-Water	70.0	64.3	0.9187	64.3	0.9190	64.3	0.9188
80771001	CO	Colorado NM	69.0	62.7	0.9094	62.7	0.9095	62.7	0.9094
80830101	CO	Montezuma0101	72.3	64.1	0.8869	64.1	0.8869	64.1	0.8869
350450009	NM	SanJuan0009	67.3	61.8	0.9185	61.8	0.9185	61.8	0.9184
350450018	NM	Navajo Dam	77.0	70.4	0.9150	70.4	0.9150	70.4	0.9149
350451005	NM	SanJuan1005	71.0	66.0	0.9300	66.0	0.9300	66.0	0.9299
490110004	UT	Davis0004	80.0	69.1	0.8642	69.1	0.8642	69.1	0.8641
490350003	UT	SaltLake0003	80.0	72.5	0.9074	72.5	0.9074	72.5	0.9074
490352004	UT	SaltLake2004	80.0	63.0	0.7877	63.0	0.7877	63.0	0.7876
490353006	UT	SaltLake30006	77.0	69.1	0.8986	69.1	0.8986	69.1	0.8985
490353007	UT	SaltLake3007	78.0	64.4	0.8258	64.4	0.8258	64.4	0.8257
490353008	UT	SaltLake3008	78.0	66.5	0.8529	66.5	0.8529	66.5	0.8529
490370101	UT	SanJuan0101	71.0	62.2	0.8763	62.2	0.8764	62.2	0.8763
490471002	UT	Dinosaur NM	65.0	59.2	0.9110	59.2	0.9115	59.2	0.9112
490490002	UT	Utah0002	73.0	64.7	0.8867	64.7	0.8868	64.7	0.8867
490495008	UT	Utah5008	75.0	67.4	0.8990	67.4	0.8991	67.4	0.8990
490495010	UT	Utah5010	76.0	65.9	0.8677	65.9	0.8677	65.9	0.8677
490570007	UT	Weber0007	78.0	66.7	0.8554	66.7	0.8554	66.7	0.8553
490571003	UT	Weber1003	79.0	67.5	0.8554	67.5	0.8554	67.5	0.8553
Black_CnNP	CO	Black_CnNP	74.0	67.2	0.9090	67.2	0.9090	67.2	0.9089
Cent_WY	WY	Cent_WY	68.0	63.0	0.9265	63.0	0.9265	63.0	0.9265
EnCanaCyn	CO	EnCanaCyn	68.0	62.5	0.9195	62.5	0.9200	62.5	0.9198
EnCanaMtn	CO	EnCanaMtn	68.0	63.2	0.9308	63.3	0.9310	63.2	0.9308
Gothic	CO	Gothic	67.7	63.9	0.9439	63.9	0.9443	63.9	0.9441
USFS-Sunlight	CO	USFS-Sunlight	70.0	64.0	0.9157	64.1	0.9160	64.1	0.9158
USFS_Ajax	CO	USFS_Ajax	77.0	71.8	0.9330	71.8	0.9332	71.8	0.9331
USFS_Bell	CO	Garfield	70.5	63.0	0.8947	63.0	0.8950	63.0	0.8948
USFS_Ripp	CO	USFS_Ripp	66.0	61.0	0.9257	61.1	0.9258	61.0	0.9257
Vernal	UT	Vernal	68.9	64.1	0.9304	64.1	0.9304	64.0	0.9303

Table5-2. Annual monitor station 2006 meteorological year 8-hour ozone design values (DVc) and future year design values (DVf) for the 2018 Future Year Base Case case, 2018 Proposed Action, and August 2011 scenarios for monitors in the 12-km modeling domain with a 70 ppb minimum threshold.

			Baseline	No Action		Proposed Action		August 2011	
Monitor ID	State	Name	DVc	DVf	RRF	DVf	RRF	DVf	RRF
80450012	CO	Rifle - Heath	66.0	59.8	0.9064	59.8	0.9067	59.8	0.9065
80677001	CO	LaPlata7001	56.3	51.8	0.9210	51.8	0.9211	51.8	0.9210
80677003	CO	LaPlata7003	65.3	59.9	0.9176	59.9	0.9176	59.9	0.9176
80679000	CO	Shamrock	71.3	66.1	0.9282	66.1	0.9282	66.1	0.9282
80770020	CO	Palisade-Water	70.0	63.8	0.9124	63.8	0.9126	63.8	0.9125
80771001	CO	Colorado NM	69.0	62.6	0.9078	62.6	0.9079	62.6	0.9078
80830101	CO	Montezuma0101	72.3	65.5	0.9069	65.5	0.9070	65.5	0.9069
350450009	NM	SanJuan0009	67.3	62.8	0.9332	62.8	0.9332	62.8	0.9332
350450018	NM	Navajo Dam	77.0	71.0	0.9221	71.0	0.9221	71.0	0.9221
350451005	NM	SanJuan1005	71.0	66.3	0.9340	66.3	0.9340	66.3	0.9340
490110004	UT	Davis0004	80.0	73.2	0.9161	73.2	0.9162	73.2	0.9161
490350003	UT	SaltLake0003	80.0	71.2	0.8908	71.2	0.8909	71.2	0.8908
490352004	UT	SaltLake2004	80.0	67.6	0.8460	67.6	0.8461	67.6	0.8461
490353006	UT	SaltLake30006	77.0	68.0	0.8842	68.0	0.8843	68.0	0.8842
490353007	UT	SaltLake3007	78.0	66.5	0.8535	66.5	0.8537	66.5	0.8536
490353008	UT	SaltLake3008	78.0	71.6	0.9187	71.6	0.9188	71.6	0.9187
490370101	UT	SanJuan0101	71.0	64.0	0.9028	64.1	0.9032	64.1	0.9030
490471002	UT	Dinosaur NM	65.0	59.4	0.9152	59.6	0.9173	59.5	0.9164
490490002	UT	Utah0002	73.0	65.1	0.8931	65.1	0.8931	65.1	0.8930
490495008	UT	Utah5008	75.0	66.2	0.8837	66.2	0.8837	66.2	0.8837
490495010	UT	Utah5010	76.0	67.1	0.8838	67.1	0.8839	67.1	0.8838
490570007	UT	Weber0007	78.0	70.7	0.9068	70.7	0.9069	70.7	0.9068
490571003	UT	Weber1003	79.0	71.6	0.9068	71.6	0.9069	71.6	0.9068
Black_CnNP	CO	Black_CnNP	74.0	68.3	0.9240	68.3	0.9240	68.3	0.9239
Cent_WY	WY	Cent_WY	68.0	64.3	0.9461	64.3	0.9464	64.3	0.9463
EnCanaCyn	CO	EnCanaCyn	68.0	62.1	0.9133	62.1	0.9135	62.1	0.9134
EnCanaMtn	CO	EnCanaMtn	68.0	61.8	0.9091	61.8	0.9093	61.8	0.9092
Gothic	CO	Gothic	67.7	63.1	0.9330	63.1	0.9331	63.1	0.9330
USFS-Sunlight	CO	USFS-Sunlight	70.0	64.7	0.9245	64.7	0.9247	64.7	0.9246
USFS_Ajax	CO	USFS_Ajax	77.0	71.8	0.9330	71.8	0.9330	71.8	0.9330
USFS_Bell	CO	Garfield	70.5	64.2	0.9107	64.2	0.9108	64.2	0.9107
USFS_Ripp	CO	USFS_Ripp	66.0	62.8	0.9518	62.8	0.9521	62.8	0.9520
Vernal	UT	Vernal	68.9	63.6	0.9244	63.7	0.9258	63.7	0.9251

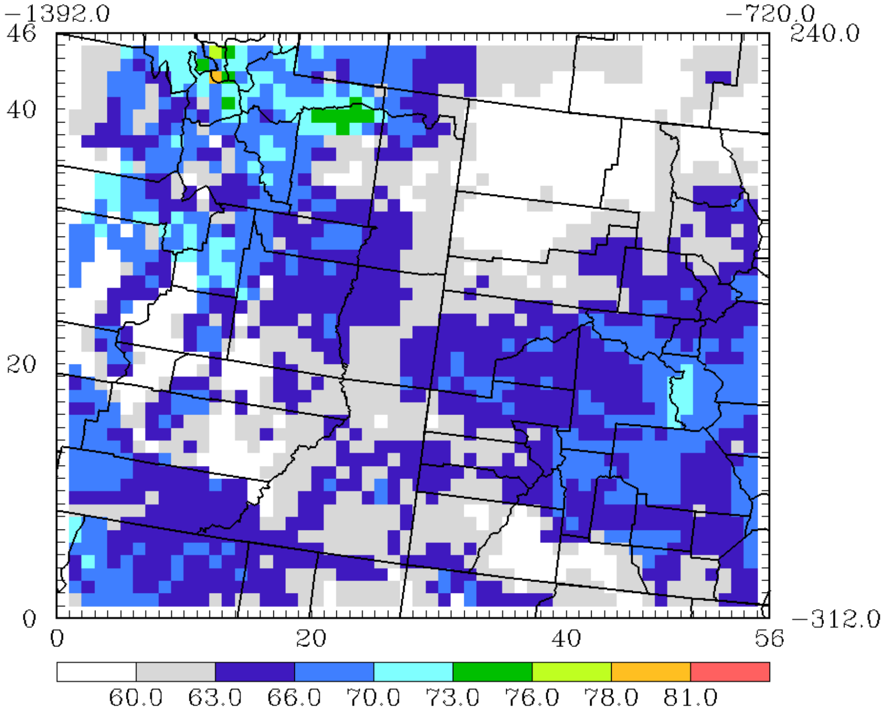
Table 5-3. Annual monitor station 2005 meteorological year 8-hour ozone design values (DVc) and future year design values (DVf) for the 2018 Future Year Base Case case, 2018 Proposed Action, and August 2011 scenarios for monitors in the 12-km modeling domain with a 60 ppb minimum threshold.

			Baseline	No Action		Proposed Action		August 2011	
Monitor ID	State	Name	DVc	DVf	RRF	DVf	RRF	DVf	RRF
80450012	CO	Rifle - Heath	66.0	60.4	0.9154	60.4	0.9157	60.4	0.9155
80677001	CO	LaPlata7001	56.3	50.0	0.8892	50.0	0.8892	50.0	0.8892
80677003	CO	LaPlata7003	65.3	56.8	0.8700	56.8	0.8700	56.8	0.8699
80679000	CO	Shamrock	71.3	66.4	0.9317	66.4	0.9317	66.4	0.9316
80770020	CO	Palisade-Water	70.0	64.7	0.9254	64.7	0.9256	64.7	0.9255
80771001	CO	Colorado NM	69.0	62.4	0.9049	62.4	0.9050	62.4	0.9049
80830101	CO	Montezuma0101	72.3	64.1	0.8869	64.1	0.8869	64.1	0.8869
350450009	NM	SanJuan0009	67.3	61.8	0.9185	61.8	0.9185	61.8	0.9184
350450018	NM	Navajo Dam	77.0	70.4	0.9150	70.4	0.9150	70.4	0.9149
350451005	NM	SanJuan1005	71.0	66.0	0.9300	66.0	0.9300	66.0	0.9299
490110004	UT	Davis0004	80.0	69.1	0.8642	69.1	0.8642	69.1	0.8641
490350003	UT	SaltLake0003	80.0	72.5	0.9066	72.5	0.9066	72.5	0.9066
490352004	UT	SaltLake2004	80.0	63.0	0.7877	63.0	0.7877	63.0	0.7876
490353006	UT	SaltLake30006	77.0	69.1	0.8986	69.1	0.8986	69.1	0.8985
490353007	UT	SaltLake3007	78.0	64.4	0.8258	64.4	0.8258	64.4	0.8257
490353008	UT	SaltLake3008	78.0	69.1	0.8862	69.1	0.8862	69.1	0.8862
490370101	UT	SanJuan0101	71.0	64.7	0.9120	64.7	0.9121	64.7	0.9120
490471002	UT	Dinosaur NM	65.0	59.8	0.9201	59.8	0.9212	59.8	0.9205
490490002	UT	Utah0002	73.0	64.7	0.8874	64.7	0.8874	64.7	0.8874
490495008	UT	Utah5008	75.0	67.4	0.8990	67.4	0.8991	67.4	0.8990
490495010	UT	Utah5010	76.0	66.9	0.8811	66.9	0.8811	66.9	0.8811
490570007	UT	Weber0007	78.0	66.7	0.8554	66.7	0.8554	66.7	0.8553
490571003	UT	Weber1003	79.0	67.5	0.8554	67.5	0.8554	67.5	0.8553
Black_CnNP	CO	Black_CnNP	74.0	68.4	0.9253	68.4	0.9253	68.4	0.9253
Cent_WY	WY	Cent_WY	68.0	64.2	0.9443	64.2	0.9443	64.2	0.9443
EnCanaCyn	CO	EnCanaCyn	68.0	62.8	0.9243	62.8	0.9246	62.8	0.9244
EnCanaMtn	CO	EnCanaMtn	68.0	63.2	0.9308	63.3	0.9310	63.2	0.9308
Gothic	CO	Gothic	67.7	63.9	0.9439	63.9	0.9443	63.9	0.9441
USFS-Sunlight	CO	USFS-Sunlight	70.0	64.0	0.9157	64.1	0.9160	64.1	0.9158
USFS_Ajax	CO	USFS_Ajax	77.0	71.8	0.9330	71.8	0.9332	71.8	0.9331
USFS_Bell	CO	Garfield	70.5	65.0	0.9225	65.0	0.9226	65.0	0.9225
USFS_Ripp	CO	USFS_Ripp	66.0	61.0	0.9257	61.1	0.9258	61.0	0.9257
Vernal	UT	Vernal	68.9	63.4	0.9214	63.4	0.9214	63.4	0.9213

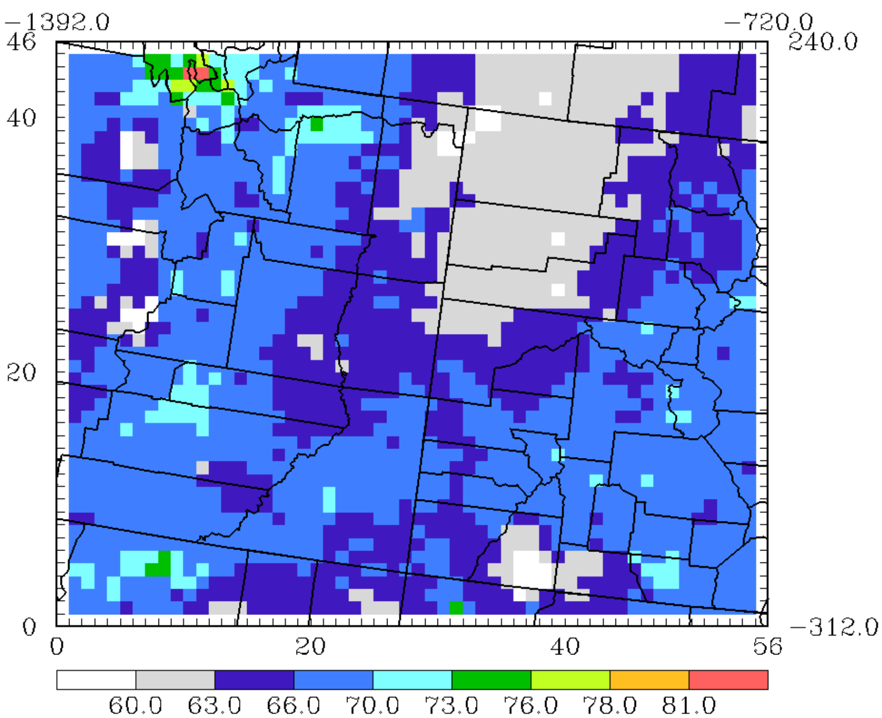
Table 5-4. Annual monitor station 2006 meteorological year 8-hour ozone design values (DVc) and future year design values (DVf) for 2018 Future Year Base Case case, and 2018 Proposed Action for monitors in the 12-km modeling domain with a 60 ppb minimum threshold.

			Baseline	No Action		Proposed Action		August 2011	
Monitor ID	State	Name	DVc	DVf	RRF	DVf	RRF	DVf	RRF
80450012	CO	Rifle - Heath	66.0	59.8	0.9064	59.8	0.9067	59.8	0.9065
80677001	CO	LaPlata7001	56.3	51.8	0.9210	51.8	0.9211	51.8	0.9210
80677003	CO	LaPlata7003	65.3	59.9	0.9176	59.9	0.9176	59.9	0.9176
80679000	CO	Shamrock	71.3	66.1	0.9282	66.1	0.9282	66.1	0.9282
80770020	CO	Palisade-Water	70.0	63.8	0.9124	63.8	0.9126	63.8	0.9125
80771001	CO	Colorado NM	69.0	62.6	0.9078	62.6	0.9079	62.6	0.9078
80830101	CO	Montezuma0101	72.3	65.5	0.9069	65.5	0.9070	65.5	0.9069
350450009	NM	SanJuan0009	67.3	62.8	0.9332	62.8	0.9332	62.8	0.9332
350450018	NM	Navajo Dam	77.0	71.0	0.9221	71.0	0.9221	71.0	0.9221
350451005	NM	SanJuan1005	71.0	66.3	0.9340	66.3	0.9340	66.3	0.9340
490110004	UT	Davis0004	80.0	73.2	0.9161	73.2	0.9162	73.2	0.9161
490350003	UT	SaltLake0003	80.0	71.2	0.8908	71.2	0.8909	71.2	0.8908
490352004	UT	SaltLake2004	80.0	67.6	0.8460	67.6	0.8461	67.6	0.8461
490353006	UT	SaltLake30006	77.0	68.0	0.8842	68.0	0.8843	68.0	0.8842
490353007	UT	SaltLake3007	78.0	66.5	0.8535	66.5	0.8537	66.5	0.8536
490353008	UT	SaltLake3008	78.0	71.6	0.9187	71.6	0.9188	71.6	0.9187
490370101	UT	SanJuan0101	71.0	64.0	0.9028	64.1	0.9032	64.1	0.9030
490471002	UT	Dinosaur NM	65.0	59.6	0.9173	59.7	0.9194	59.6	0.9184
490490002	UT	Utah0002	73.0	65.1	0.8931	65.1	0.8931	65.1	0.8930
490495008	UT	Utah5008	75.0	66.2	0.8837	66.2	0.8837	66.2	0.8837
490495010	UT	Utah5010	76.0	67.1	0.8838	67.1	0.8839	67.1	0.8838
490570007	UT	Weber0007	78.0	70.7	0.9068	70.7	0.9069	70.7	0.9068
490571003	UT	Weber1003	79.0	71.6	0.9068	71.6	0.9069	71.6	0.9068
Black_CnNP	CO	Black_CnNP	74.0	68.3	0.9240	68.3	0.9240	68.3	0.9239
Cent_WY	WY	Cent_WY	68.0	62.1	0.9133	62.1	0.9135	62.1	0.9133
EnCanaCyn	CO	EnCanaCyn	68.0	62.1	0.9133	62.1	0.9135	62.1	0.9134
EnCanaMtn	CO	EnCanaMtn	68.0	61.8	0.9091	61.8	0.9093	61.8	0.9092
Gothic	CO	Gothic	67.7	63.1	0.9330	63.1	0.9331	63.1	0.9330
USFS-Sunlight	CO	USFS-Sunlight	70.0	64.7	0.9245	64.7	0.9247	64.7	0.9246
USFS_Ajax	CO	USFS_Ajax	77.0	71.8	0.9330	71.8	0.9330	71.8	0.9330
USFS_Bell	CO	Garfield	70.5	64.2	0.9107	64.2	0.9108	64.2	0.9107
USFS_Ripp	CO	USFS_Ripp	66.0	62.8	0.9518	62.8	0.9521	62.8	0.9520
Vernal	UT	Vernal	68.9	63.4	0.9206	63.4	0.9216	63.4	0.9211

2005

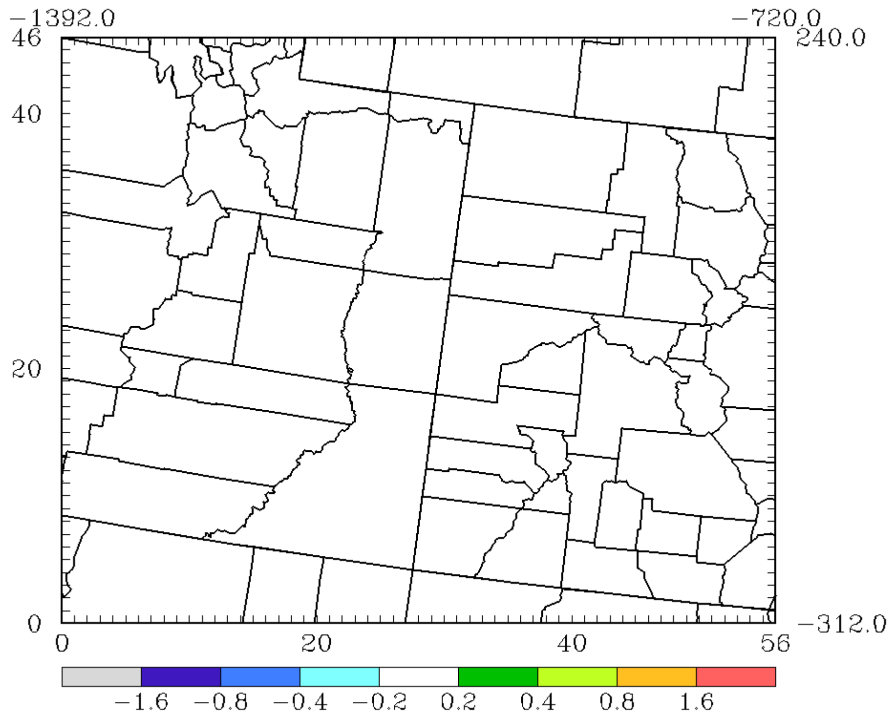


2006

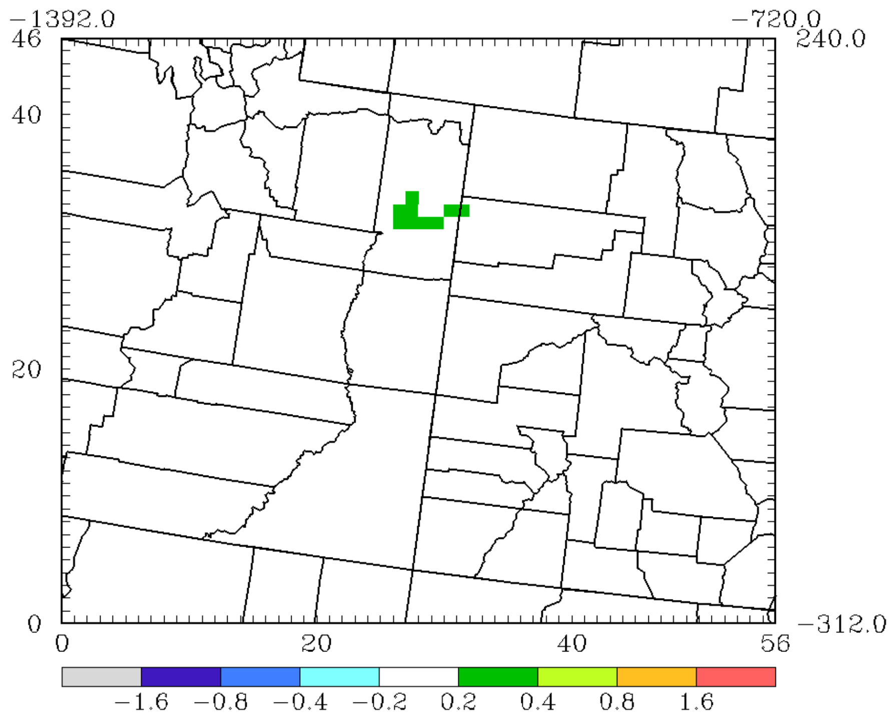


Annual 8-hour Ozone Future year Design Values for 2018 August 2011 scenario with 70 ppb minimum threshold. Analogous to Figure 5-3 in report.

2005

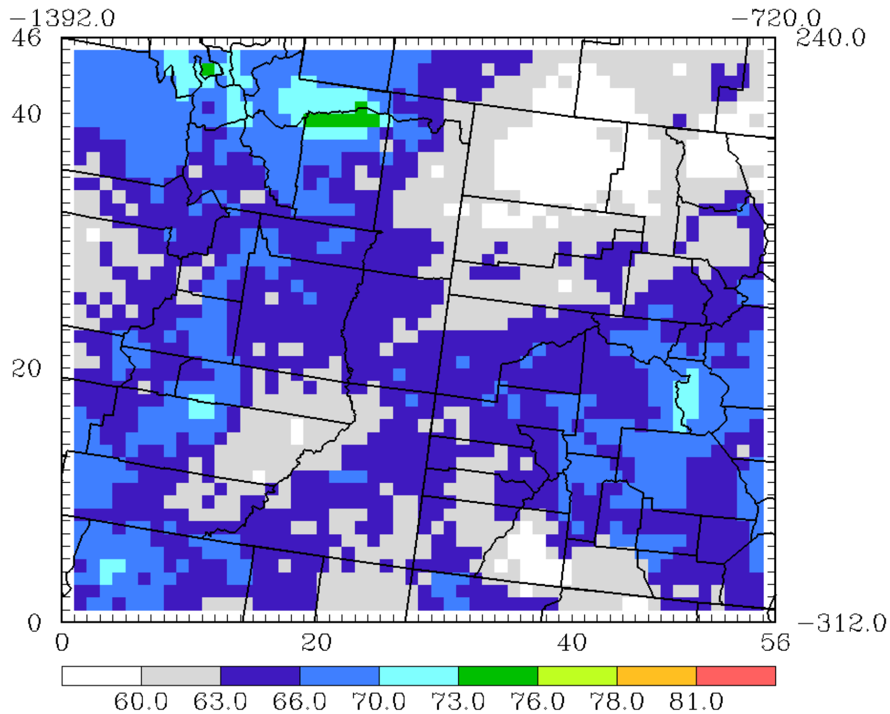


2006

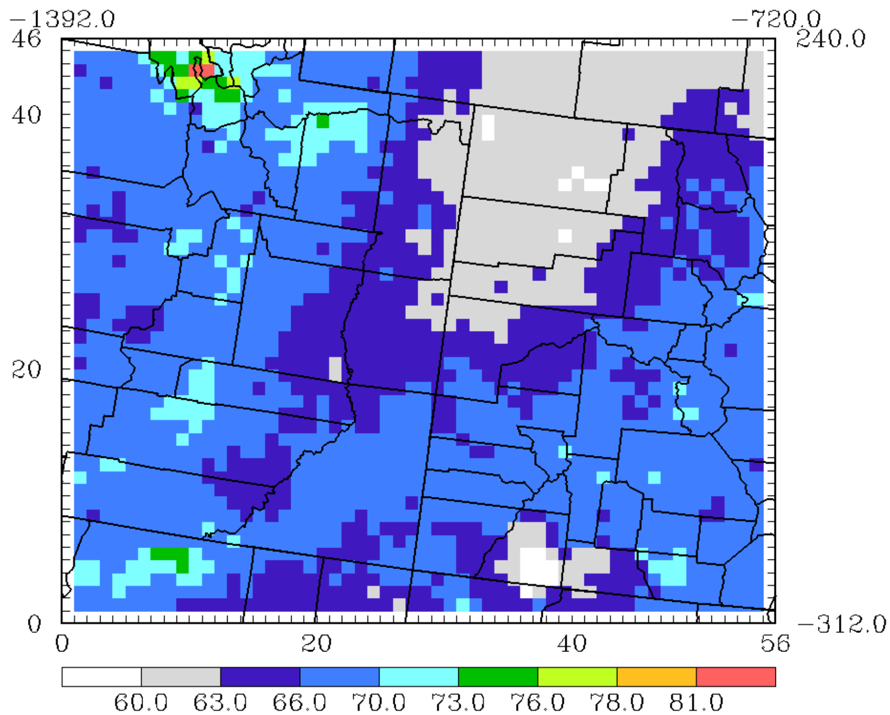


Annual 8-hour Ozone Future Design Value Differences for August 2011 scenario Minus 2018 Future Year Base Case with 70 ppb minimum threshold. Analogous to Figure 5-4 in report.

2005

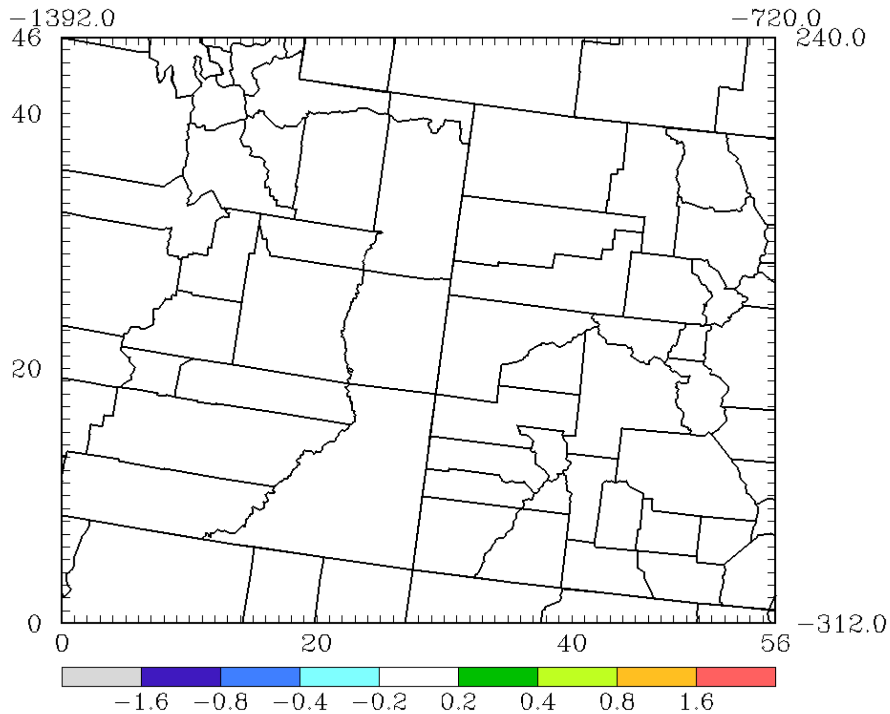


2006

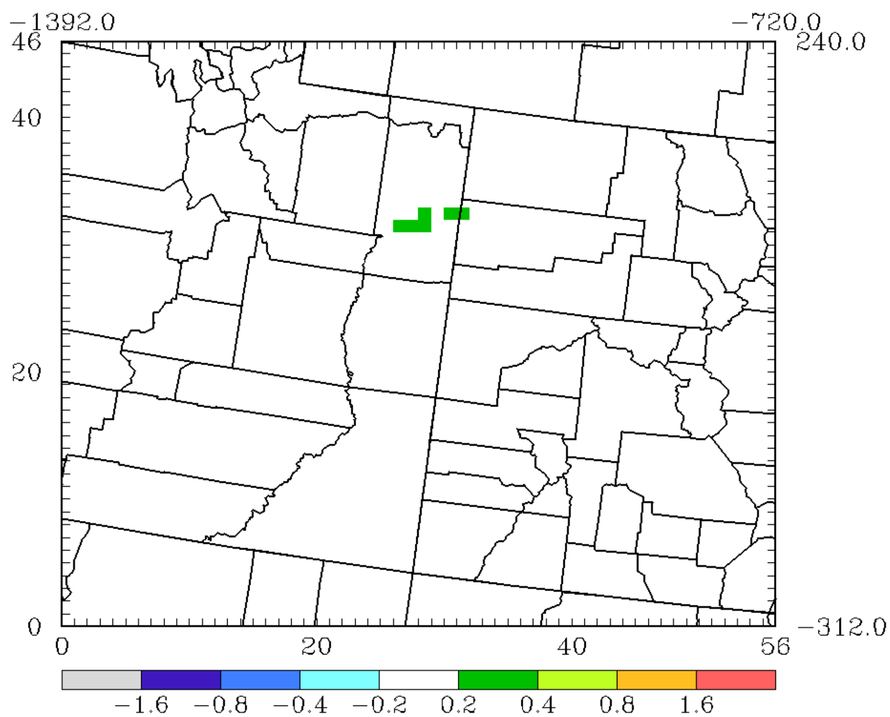


Annual 8-hour Ozone Future year Design Values for 2018 August 2011 Scenario with 60 ppb minimum threshold. Analogous to Figure 5.6 in the report.

2005

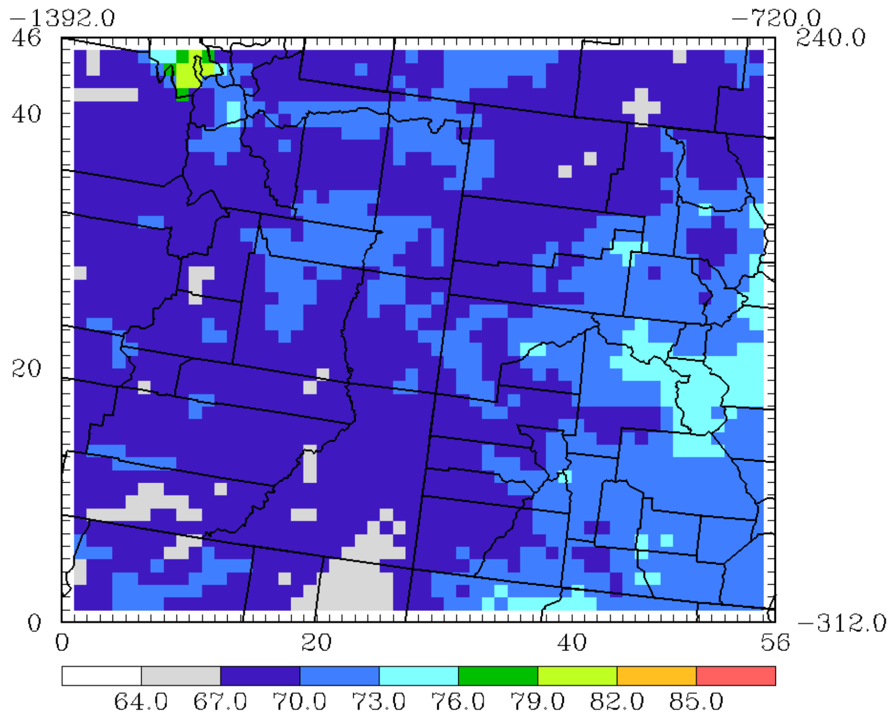


2006

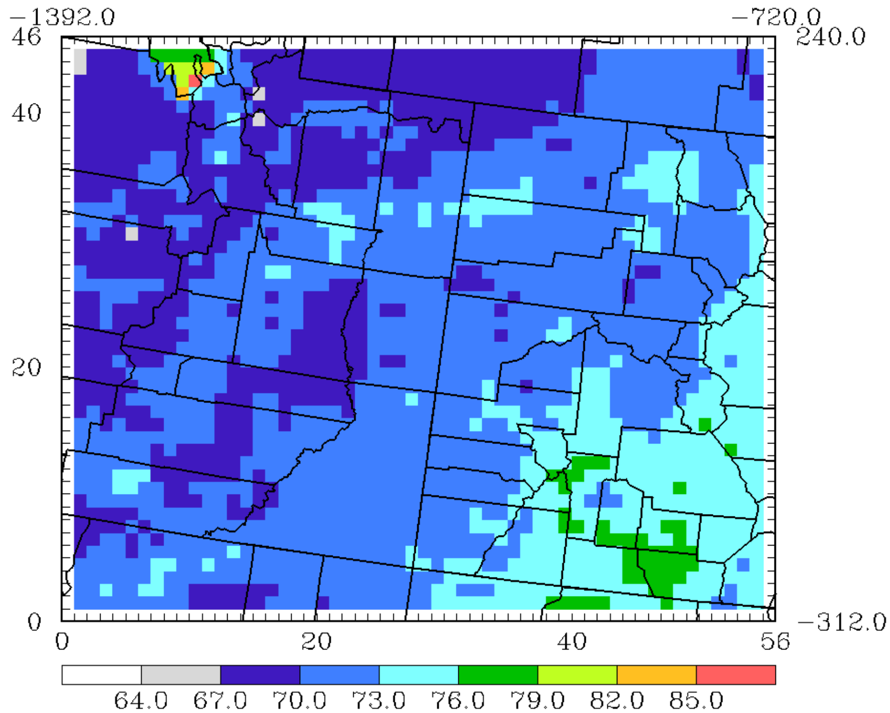


Annual 8-hour Ozone Future Design Value Differences for August 2011 scenario Minus 2018 Future Year Base Case with 60 ppb minimum threshold.

2005

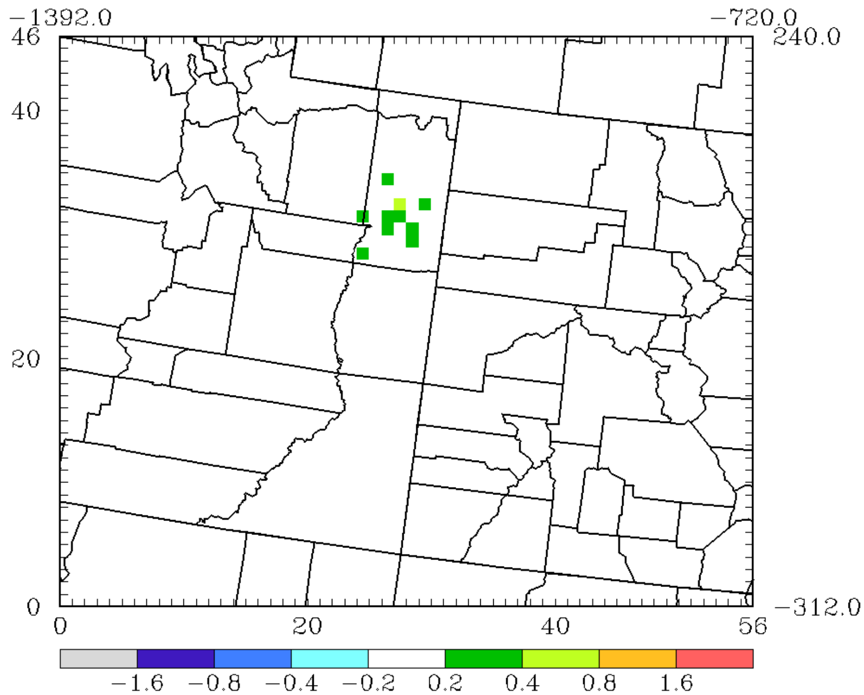


2006

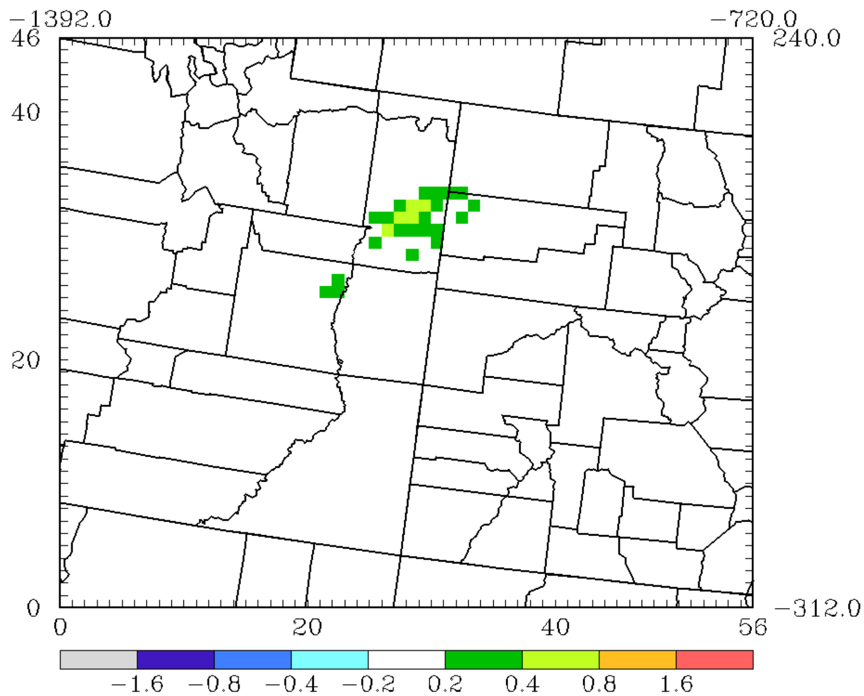


Fourth Highest Annual Daily Maximum Predicted 8-hour Ozone Concentration for 2018 August 2011 scenario. Analogous to Figure 5-9 in the report.

2005



2006



Difference in Fourth Highest Annual Daily Maximum Predicted 8-hour Ozone Concentration (ppb) for Future Year Base Case Minus 2018 August 2011 scenario. Analogous to Figure 5-10 in report.

Comparison of Difference in Fourth Highest Annual Daily Maximum Predicted 8-hour Ozone Concentration (ppb) for Proposed Action and August 2011 Scenario.

Meteorological Year	Proposed Action	August 2011	Difference
2005	0.8	0.6	-0.2
2006	1.1	0.5	-0.6