

## La Plata Oil & Gas production data

**Colorado Oil & Gas Conservation Commission**  
www.oil-gas.state.co.us/ COGIS - Production Data Inquiry  
copied into Excel 16Nov07

**Richard Heede**  
Climate Mitigation Services  
Snowmass, Colorado  
File Started 16 November 2007  
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Table 1		Oil Production	Oil Sales	Gas Production	Gas Sales	Water Production
		(barrels)	(barrels)	(MCF)	(MCF)	(barrels)
LA PLATA	1999	34,893	34,697	415,917,310	409,860,745	23,732,528
LA PLATA	2000	34,863	34,176	427,624,750	420,256,117	24,215,578
LA PLATA	2001	40,730	40,009	429,608,887	424,051,119	24,107,310
LA PLATA	2002	41,683	39,730	455,786,235	449,727,270	24,810,628
LA PLATA	2003	39,300	41,714	473,838,077	467,015,920	24,830,794
LA PLATA	2004	38,641	36,315	469,883,177	462,897,837	24,611,938
LA PLATA	2005	34,877	33,299	458,363,049	451,289,521	23,176,450
LA PLATA	2006	30,048	29,349	437,170,081	430,302,742	24,084,167
LA PLATA	2007	19,960	19,808	259,532,994	255,313,537	14,282,760
<b>Total 1999-2006</b>		<b>295,035</b>	<b>289,289</b>	<b>3,568,191,566</b>	<b>3,515,401,271</b>	<b>193,569,393</b>
1999-2006 average (8 yrs)		36,879	36,161	446,023,946	439,425,159	24,196,174

Table 2		2006 production data for La Plata County								
Month	Prod. Wells # of	Prod. Days # of	Oil Produced (barrels)	Oil Sold (barrels)	Gas Produced (MCF)	Gas Sold (MCF)	Gas Flared (MCF)	Gas Used (MCF)	Gas Shrinkage (MCF)	Water Prod (barrels)
Jan	2,940	81,370	2,873	2,889	38,125,594	37,502,166	2,716	620,672	40	2,105,567
Feb	2,955	73,494	2,778	1,048	34,683,287	34,115,862	2,810	564,579	36	1,948,825
Mar	2,962	81,814	2,796	2,763	38,259,287	37,615,482	4,007	639,798		2,068,895
Apr	2,967	79,096	2,911	3,479	36,284,091	35,692,985	2,939	588,167		2,072,244
May	2,918	80,849	1,490	1,648	37,561,026	37,024,003	2,640	534,383		2,111,531
Jun	2,984	79,651	2,745	2,550	36,176,922	35,647,682	2,611	526,629		1,826,507
Jul	2,988	82,556	2,825	3,269	37,110,982	36,572,737	2,138	536,107		2,062,232
Aug	2,735	76,141	1,408	1,792	37,042,504	36,515,501	1,194	525,776	33	2,239,775
Sep	2,638	71,050	2,600	2,175	33,693,363	33,192,371	1,159	499,833		1,730,496
Oct	2,788	77,051	2,452	2,393	36,439,919	35,888,080	1,160	550,639	40	1,964,377
Nov	2,781	74,418	2,502	2,907	35,251,666	34,634,827	1,721	615,118		1,944,435
Dec	2,981	82,219	2,668	2,436	36,541,440	35,901,046	2,964	637,390	40	2,009,283
<b>Total 2006</b>	<b>34,637</b>	<b>939,709</b>	<b>30,048</b>	<b>29,349</b>	<b>437,170,081</b>	<b>430,302,742</b>	<b>28,059</b>	<b>6,839,091</b>	<b>189</b>	<b>24,084,167</b>
<b>Average per month</b>	<b>2,886</b>	<b>78,309</b>	<b>2,504</b>	<b>2,446</b>						<b>2,007,014</b>
Average/day (Mcf)					1,197,726	1,178,912	77	18,737	0.5	
Average/day (Bcf)					1.20	1.18	0.00	0.02		
Annual (Bcf)					437.17	430.30	0.03	6.84	0.0002	

Table 3	Natural gas production and sales, La Plata & Colorado total								
	CBM gas prodn		CBM gas sales		Percent CBM of total	CBM + Conv prodn		CBM + Conv sales	
	La Plata	Total Colorado	La Plata	Total Colorado		La Plata	Total Colorado	La Plata	Total Colorado
	Bcf/yr	Bcf/yr	Bcf/yr	Bcf/yr	Bcf/yr	Bcf/yr	Bcf/yr	Bcf/yr	
2006	389	478	383	462	89.0%	437	1,233	430	1,196
	Percent La Plata	81.32%	Percent La Plata	82.93%		Percent La Plata	35.45%	Percent La Plata	35.98%

Table 4	Crude oil production and sales, La Plata & Colorado total					
	Oil prodn La Plata (barrels)	Oil prodn Colorado (barrels)	Percent La Plata	Oil sales La Plata (barrels)	Oil sales Colorado (barrels)	Percent La Plata
	2006	30,048	23,650,945	0.13%	29,349	23,341,717

Gas Emission RATES

**Worksheet on oil & gas industry GHG emission rates**

Richard Heede  
Climate Mitigation Services  
Snowmass, Colorado  
19-Feb-08

**US Oil & Gas Industry Emissions & Rates**

Table 1 Natural Gas emissions from flaring, gas production CO2, and gas production methane						
Flaring CO2	Gas Prod'n CO2	Total Gas Prod CO2	Methane	Methane	Tot Gas CO2+CH4	Percent CH4
Million tonnes CO2	Million tonnes CO2	Million tonnes CO2	Million tonnes CH4	Mt CO2e	Mt CO2e	of total
US, 2005	5.9	17.3	23.2	6.70	140.70	163.90 85.8%

Table 2 US natural gas industry methane emissions, & applied to La Plata County					
US gas industry methane emissions		Upstream focus, reduced downstream			
Million tonnes CH4	Percent of total	Million tonnes CH4	Percent of total	Industry segment	
1.87	27.95%	1.87	51.64%	production	
0.63	9.42%	0.63	17.40%	gas processing	
2.34	34.98%	0.94	25.85%	transmiss. & storage	
1.85	27.65%	0.19	5.11%	distribution	
6.69	100.00%	3.62	100.00%	Total	

Table 3 Natural Gas emission rates of CO2 and methane							
US "marketed gas production"	US Gas prod'n	Gas CO2 Rate	Gas Methane Rate	Gas Methane Rate	Tot Gas CO2+CH4	Percent CH4	
Bcf	Million tonnes	t CO2/Bcf	t CH4/Bcf	t CO2-e/Bcf	t CO2-e/Bcf	of total	
US, 2005	19,115	368.1	1,214	350.5	7,361	8,574	85.8%

**Computation of US methane rate if reduced downstream**

Table 4		Methane Rate	Methane Rate
Million tonnes CH4	t CH4/Bcf	t CO2-e/Bcf	21xCO2
US methane rate if reduced downstream emissions (from Table 2)	3.62	189.4	3,978

**US Oil & Gas Industry Emissions & Rates, 1998-2005**

Table 5	U.S. Energy Information Administration													
	US methane emissions rates, Oil & Gas Industry					Methane emissions			Methane emissions rate			Methane emissions rate		
	Oil production	Oil production	Gas production	Gas production	Oil+Gas prod'n	Oil sector	Gas sector	Oil+Gas	Oil sector	Gas sector	Oil+Gas	Oil sector	Gas sector	Oil+Gas
million bbl	million tonnes	Bcf	million tonnes	million tonnes	MtCH4	MtCH4	MtCH4	kg CH4/tonne	kg CH4/tonne	kg CH4/tonne	Percent	Percent	Percent	Percent
1998	2,924	398.9	19,024	362.6	761.5	1.11	6.26	7.37	2.78	17.27	9.68	0.278%	1.727%	
1999	2,822	385.0	18,832	358.9	743.9	1.04	6.27	7.31	2.70	17.47	9.83	0.270%	1.747%	
2000	2,823	385.1	19,182	365.6	750.7	1.03	6.57	7.60	2.67	17.97	10.12	0.267%	1.797%	
2001	2,800	381.9	19,616	373.9	755.8	1.03	6.39	7.42	2.70	17.09	9.82	0.270%	1.709%	
2002	2,783	379.7	18,928	360.7	740.4	1.02	6.70	7.72	2.69	18.57	10.43	0.269%	1.857%	
2003	2,701	368.5	19,099	364.0	732.5	1.01	6.66	7.67	2.74	18.30	10.47	0.274%	1.830%	
2004	2,638	359.9	18,757	357.5	717.4	0.97	6.73	7.70	2.70	18.83	10.73	0.270%	1.883%	
2005	2,493	340.1	18,215	347.2	687.3	0.92	6.70	7.62	2.71	19.30	11.09	0.271%	1.930%	
average	2,748	374.9	18,957	361.3	736.2	1.02	6.54	7.55	2.71	18.099	10.27	0.271%	1.8088%	

Source: CMS CJP project 2004-2007 "AncillaryCO2&CH4.xls"

Note: CMS lists CH4 emissions from the entire U.S. Natural Gas System, which totaled 6.73 million tonnes in 2004. However, gas production emits 1.89 MtCH4, Processing 0.65 MtCH4, Transmission & Storage 2.34 MtCH4, and Distribution 1.85 MtCH4. EIA (2006) *Emissions of Greenhouse Gases in the U.S., 2005*, now uses methane GWP of 23xCO2.

Gas Emission RATES

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
63															
64	<b>Table 6</b>	<b>Miscellaneous estimates of methane emissions from oil and gas production</b>													
65															
66					<b>Natural Gas production</b>				<b>Conversion</b>						
67		Year	Source		Percent loss	kg CH4/tonne	kg CH4/t CO2			t CH4/Bcf					
68		1990	Canadian Gas Ass	Canada	0.28%	2.75	0.90			53.0					
69		1989	Alphatania Group	international	0.16%	1.63	0.53			31.3					
70		1989	Arthur D. Little	global	0.53%	5.30	1.74			102.1					
71		1990	Okken	Germany	0.50%	5.00	1.64			96.3					
72		1993	US EPA	USA 1990	0.46%	4.60	1.51			88.6					
73		1993	US EPA	USA 2000	0.42%	4.20	1.38			80.9					
74		1995	Gas Research Inst	USA	0.75%	7.50	2.46			144.4					
75		1996	Radian Internatio	USA 1992	0.82%	8.20	2.68			157.9					
76		1999	US EPA	USA	0.79%	7.90	2.59			152.2					
77		<b>Average of estimates cited in Delucchi</b>			<b>0.52%</b>	<b>5.23</b>	<b>1.71</b>			<b>100.7</b>					
78															
79		1982	Shepard	global 1975	1.60%	16.00	5.24			308.2					
80		1984	Darmstadter	global	0.64%	6.40	2.10			123.3					
81		1987	Crutzen	global	2.56%	25.60	8.38			493.0					
82		1988	Cicerone & Oreml	global	2.46%	24.60	8.05			473.8					
83		1986	Barns & Edmonds	global	1.28%	12.80	4.19			246.5					
84		<b>Average of estimates cited in Kirchgessner</b>			<b>1.71%</b>	<b>17.08</b>	<b>5.59</b>			<b>329.0</b>					
85		Source: CMS CJP project 2004-2007 "AncillaryCO2&CH4.xls"													
86															
87															
88															
89	<b>Table 7</b>	<b>Ancillary emissions of Methane and Carbon Dioxide in Oil &amp; Gas Operations</b>													
90					<b>Methane</b>			<b>Carbon Dioxide</b>							
91		Oil & Gas sector	emissions per		Oil sector	Gas sector	Oil&Gas Combined	Oil sector	Gas sector	Oil&Gas Combined					
92			tonne of prod'n		specific data	specific data		specific data	CH4 from flaring	general or combined					
93		kg CH4/t CO2	kg CH4/tonne		kg CH4/t CO2	kg CH4/t CO2	kg CH4/t CO2	kg CO2/t CO2	kg CO2/t CO2	kg CO2-eq/t CO2		<b>Conversion</b>		<b>Conversion</b>	
94												t CH4/Bcf		t CO2/Bcf	
95		BP emissions data, 1998	0.9507	2.9037				0.9507		161.53		55.9			
96		BP emissions data, 2004	0.4033	1.2318				0.4033		149.89		23.7			
97		Shell emissions rates, 1998	0.9936	3.0347				0.9936		154.25		58.4			
98		Shell emissions rates, 2004	0.4494	1.3727				0.4494		194.15		26.4			
99		US oil industry, 1998	0.9110	2.7826	0.9110							53.6			
100		US oil industry, 2005	0.8857	2.7051	0.8857							52.1			
101		US gas industry, 1998	5.6529	17.2655		5.6529						332.5			
102		US gas industry, 2005	6.3189	19.2998		6.3189						371.7			
103		ICF Consulting, U.S. Oil Industry			0.9216										
104		Kirchgessner et al, U.S. Gas industry				5.5131									
105		CDIAC, CH4 from flaring, 1880	4.7886	<i>CDIAC attrib to c</i>	4.7886										
106		CDIAC, CH4 from flaring, 1920	4.1494	<i>CDIAC attrib to c</i>	4.1494										
107		CDIAC, CH4 from flaring, 1960	3.3473	<i>CDIAC attrib to c</i>	3.3473										
108		CDIAC, CH4 from flaring, 1980	2.5810	<i>CDIAC attrib to c</i>	2.5810										
109		CDIAC, CH4 from flaring, 2000	0.7752	<i>CDIAC attrib to c</i>	0.7752										
110		CDIAC, CH4 from oil & gas 1860-1	4.5576	<i>CDIAC attrib to oil</i>		4.5576									
111		API example: onshore oil & gas field			2.7608					43.98					
112		API example: offshore oil & gas platform			2.0648										
113		API example: natural gas processin		<i>(not included)</i>		1.1190									
114		API example: oil refinery		<i>(not included)</i>	0.0132					127.09					
115		Delucchi, average of 9 estimates		5.2306		1.7125						100.7			
116		Kirchgessner, average of 5 estimates		17.0800		5.5922						329.0			
117															
118		<b>Average</b>	<b>2.6260</b>	<b>7.2906</b>	<b>2.3198</b>	<b>5.0777</b>	<b>0.6993</b>	<b>-</b>	<b>138.48</b>			<b>140.4</b>			
119															

Gas Emission RATES

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
120																
121		<b>Table 8a</b>	<b>New Mexico GHG Emissions Inventory: Baseline for La Plata Oil &amp; Gas Industry Emissions</b>													
122																
123			<b>All sources</b>			<b>Methane</b>			<b>Carbon dioxide</b>							
124			MtCO2e/yr	Percent of total	Percent of total	MtCO2e/yr	% total	MtCO2/yr	% total				(million tonnes CO2e/yr )			
125																
126		<b>Production</b>														
127			Methane	3.672	22.3%		3.672	22.3%								
128			Combustion (CA)	0.057	0.3%						0.057	0.3%				
129			Combustion	1.827	11.1%						1.827	11.1%				
130			<b>Prodn subtotal</b>	<b>5.555</b>	<b>33.7%</b>	<b>33.7%</b>	<b>3.672</b>	<b>22.3%</b>			<b>1.884</b>	<b>11.4%</b>				
131																
132		<b>Gas Processing</b>														
133			Methane	0.917	5.6%		0.917	5.6%								
134			Combustion (CA)	1.780	10.8%						1.780	10.8%				
135			Combustion	0.243	1.5%						0.243	1.5%				
136			Entrained	4.513	27.4%						4.513	27.4%				
137			<b>Proc subtotal</b>	<b>7.453</b>	<b>45.2%</b>	<b>45.2%</b>	<b>0.917</b>	<b>5.6%</b>			<b>6.536</b>	<b>39.6%</b>				
138																
139		<b>Transmission</b>														
140			Methane	0.851	5.2%		0.851	5.2%								
141			Combustion (CA)	2.339	14.2%						2.339	14.2%				
142			<b>Transm subtotal</b>	<b>3.190</b>	<b>19.3%</b>	<b>19.3%</b>	<b>0.851</b>	<b>5.2%</b>			<b>2.339</b>	<b>14.2%</b>				
143																
144		<b>Distribution</b>														
145			Methane	0.299	1.8%		0.299	1.8%								
146			<b>Distr subtotal</b>	<b>0.299</b>	<b>1.8%</b>	<b>1.8%</b>	<b>0.299</b>	<b>1.8%</b>								
147																
148		<b>Total</b>	<b>16.497645</b>	<b>100.0%</b>	<b>100.0%</b>	<b>5.739</b>	<b>34.8%</b>	<b>10.759</b>	<b>65.2%</b>							
149																
150																
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153																
154																
155		<b>Table 8b</b>	<b>New Mexico Gas Production 2000-2005</b>													
156				2000	2001	2002	2003	2004	2005							
157				Bcf/yr	Bcf/yr	Bcf/yr	Bcf/yr	Bcf/yr	Bcf/yr							
158			Gross Withdrawals	1,714	1,712	1,656	1,616	1,645								
159			From Gas Wells	1,484	1,485	1,433	1,392	1,398								
160			From Oil Wells	229	228	223	224	247								
161			Marketed Production	1,695	1,689	1,632	1,604	1,633	1,609							
162			Dry Production	1,585	1,580	1,522	1,493	1,527								
163																
164																
165																
166		<b>Table 8c</b>	<b>New Mexico emissions from gas industry as percent of combustion of marketed gas production</b>													
167				<b>Emissions if Prodn is combusted</b>		<b>Estimated NM GHG emissions</b>		<b>Production + GHG emissions</b>								
168			2004	MtCO2	Percent	MtCO2e	Percent	MtCO2e	Percent							
169																
170			Marketed Production	95.0	85.2%	16.4976	14.8%	111.5	100.0%							
171			Dry Production	88.9												
172																
173																
174		<b>Table 8d</b>	<b>New Mexico methane emission RATES, tonnes CH4 and CO2 per Bcf (2005)</b>													
175				<b>Methane</b>			<b>Carbon dioxide</b>		<b>Methane + Carbon Dioxide</b>							
176			NM Gas Prodn	MtCO2e	Mt CH4	t CH4/Bcf	t CO2e/Bcf	MtCO2	t CO2/Bcf	MtCO2e	t CO2e/Bcf					
177			Bcf		21xCO2		21xCO2									
178																
179																
180			<b>New Mexico</b>	<b>1,633</b>	<b>5.739</b>	<b>0.273</b>	<b>167.4</b>	<b>3,515</b>	<b>10.759</b>	<b>6,590</b>	<b>16.498</b>	<b>10,106</b>				
181																
182																
183																
				Percent of total:				34.8%		65.2%		100%				

Gas Emission RATES

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
184																
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**Table 9**

**Conversion tables**

Natural Gas & Oil / Production Emissions		
1 million tonnes of natural gas =	52.47	Bcf
1 Bcf =	0.01906	Mt of production
1 Bcf =	0.0582	MtCO2 (Step 8)
1 Mt of gas production =	3.0543	MtCO2 emitted
1 MtCO2 =	0.3274	Mt gas prod
1 tonne oil =	3.1467	t CO2 emitted
t CO2 emitted =	0.3178	tonne oil
t CO2 emitted =	0.0435	bbl oil

Methane	
1 Bcf CH4 =	23,5516 cf CH4 = 1 lb
1 Bcf CH4 =	19,260 tonnes
1 Mt CH4 =	51.921 Bcf CH4

1 t = 7.33 bbl | 1 Mt Oil equiv = 39.2 Bcf of natural gas

EPA Methane Converter	
1 cf CH4 =	0.04246 lb CH4
1 lb =	23.552 cf
1 ton =	47,103 cf
1 tonne =	51,922 cf
1 tonne =	1,470 m <sup>3</sup>
1 Bcf CH4 =	19,260 tonnes CH4

Natural gas, EPA AP42 (1985)	
1 lb =	23.80 cf
1 ton =	47,600 cf
1 tonne =	52,469 cf
1 Bcf =	19,059 t
1 Bcf =	0.019 Mt

1 m<sup>3</sup> = 35.315 cubic feet

673 kg per m<sup>3</sup>  
1 kg per m<sup>3</sup> = 0.0624 lb/cf

CO2 factors		
1 tonne CO2 =	556.2	m <sup>3</sup> CO2
1 Bcf CO2 =	50,918.0	tonne CO2
1 m <sup>3</sup> CO2 =	0.0018	tonne CO2
1 m <sup>3</sup> CO2 =	1.7979	kg CO2
1 ft <sup>3</sup> CO2 =	0.0509	kg CO2
1 ft <sup>3</sup> CO2 =	0.1123	lb CO2

verify conversion value, mole percent, etc.

1.7979 kg m<sup>3</sup> / 35.31 m<sup>3</sup> ft<sup>3</sup>

1 Bcf CO2 = 51,175.0 tonne CO2 | NM conversion

## Gas Emission RATES

**Cell:** D15

**Comment:** Rick Heede:  
“Carbon dioxide in natural gas.” This presumably includes only vented CO<sub>2</sub> from entrained gas.

**Cell:** O15

**Comment:** Rick Heede:  
In order to allocate US national emissions of methane to the upstream industry segments that dominate gas industry emissions in La Plata, CMS attributes 100 percent of production, 100 percent of processing, 40 percent of transmission and storage, and 10 percent of distribution.

**Cell:** G16

**Comment:** Rick Heede:  
Although EIA uses the IPCC FAR GWP factor of methane 23xCO<sub>2</sub>, CMS uses IPCC’s SAR value of 21xCO<sub>2</sub>.

**Cell:** B18

**Comment:** Rick Heede:  
EIA (2006) Emissions of Greenhouse Gases in the United States 2005, Table 5.

**Cell:** F18

**Comment:** Rick Heede:  
EIA (2006) Emissions in the US, Table 17. “U.S. Methane Emissions from Natural Gas Systems” totals 6.7 million tonnes CH<sub>4</sub> in 2005(P), of which 1.87 from production, 0.63 from gas processing, 2.34 from transmission and storage, and 1.85 from distribution.

**Cell:** D25

**Comment:** Rick Heede:  
Using EPA methane Converter (Table below): 19,260 tonnes CH<sub>4</sub> per Bcf.

**Cell:** B28

**Comment:** Rick Heede:  
EIA (2006) Annual Energy Review 2005, Table 6.1, US Dry Gas Production; Consumption totaled 21,981 Bcf (incl imports of 4,285 Bcf, balancing items, withdrawals, etc.)

**Cell:** C28

**Comment:** Rick Heede:  
This is “Dry Gas Production,” including from crude oil wells (see EIA’s Diagram 3 at right). Inasmuch as methane emissions are attributed to gas produced from oil and gas wells (including, presumably, coal bed methane), CMS computes the methane emission RATE on the basis of “Gross Withdrawals” less “repressuring” and “nonhydrocarbon gases removed,” that is on total “Marketed Production” of 19.11 Tcf in 2005.

**Cell:** H37

**Comment:** Rick Heede:  
While most of the world uses the IPCC Second Annual Report’s GWP factors, EIA adopts the IPCC revised data in IPCC’s Third Annual Report. In the case of methane, EIA uses a Global Warming Potential of 23 x CO<sub>2</sub>, whereas most other inventories use the older but formally adopted value of 21 x CO<sub>2</sub> (both 100-year time horizon). EIA (2006), page 6.  
CMS uses IPCC’s SAR value of 21xCO<sub>2</sub>.

**Cell:** J47

**Comment:** Rick Heede:  
EIA (2006) Emissions of GHG 2005, Tables 17 and 18 of Methane chapter. Reported in million tonnes of CH<sub>4</sub> gas per year. EIA is using a GWP factor of 23xCO<sub>2</sub> (change since 2004 edition, and contrary to IPCC SAR and industry practice of using 21xCO<sub>2</sub> per SAR).

**Cell:** D48

**Comment:** Rick Heede:  
7.33 bbl of crude oil = 1 tonne.

## Gas Emission RATES

**Cell:** F48

**Comment:** Rick Heede:

Converted by CMS: gas production in Bcf times 0.0191 Mt per Bcf (see conversion tables below).

**Cell:** L121

**Comment:** Rick Heede:

These emission estimates are taken from Bailie (Pembina) and/or Bruce Gantner (ConocoPhillips). CMS has derived percentage contributions from the file NMOilGasEmissionsFeb06.xls sent by Erik Schlenker-Goodrich of WELC, Aug07.

The emissions estimates for New Mexico in the table below are in substantial agreement with Table D-13 in the CCS (2006) New Mexico Greenhouse Gas Inventory, Appendix D. CMS surmises that NMOGa and other sources were used to compile and estimate NM gas and oil industry emissions (more so than their referenced EPA sources, for example). Thus CMS can cite CCS (2006) as the source.

**Cell:** F167

**Comment:** Rick Heede:

Conversion from BP Statistical Yearbook, glossary.

**Cell:** I167

**Comment:** Rick Heede:

This conversion is specific to CMS accounts of non-fuel uses of natural gas, incomplete combustion, etc, although the CMS factor is very close to the carbon coefficient of natural gas used elsewhere.



La Plata Gas EMISSIONS

**La Plata county natural gas industry GHG emissions inventory**

Richard Heede  
Climate Mitigation Services  
Snowmass, Colorado  
21-Dec-07

**2006 production data for La Plata County**

Table 1	Prod. Wells # of	Oil Produced (barrels)	Oil Sold (barrels)	Gas Produced (Bcf)	Gas Sold (Bcf)	Gas Flared (Bcf)	Gas Used (Bcf)	Water Produced (million barrels)
<b>Total (or average)</b>	<b>2,886</b>	<b>30,048</b>	<b>29,349</b>	<b>437.2</b>	<b>430.3</b>	<b>0.03</b>	<b>6.8</b>	<b>24.1</b>

Table 2

	Gas Produced (Bcf)	Gas Produced million tonnes	Vented CO2 million tonnes
La Plata County, 2006	437.2	8.33	1.46
New Mexico (Marketed Prodn)	1,632.5	31.11	4.51
New Mexico (Dry Prodn, 2004)	1,527.1	29.11	
Colorado Gas Production (2006)	1,233.2	23.50	

(San Juan NM emissions inventory, verify relevant for La Plata)  
(benchmark only, not used for computation)

**in NM inventory, percent CO2**

Mesa Verde	1.39%
Dakota	1.03%
Pictured Cliffs	1.40%
Fruitland Coal	17.47%

**Several methane emission rates as applied to La Plata**

Table 3	Methane Rate t CH4/Bcf	Methane Rate t CO2e/Bcf	La Plata CH4 tonnes CH4	La Plata CH4 tonnes CO2e	La Plata CH4 Mt CO2e
				21 xCO2	
La Plata total methane IF US rate (US marketed prodn)	350.5	7,361	153,233	3,217,883	3.22
<b>La Plata total methane IF NM rate (marketed prodn)</b>	<b>167.4</b>	<b>3,515</b>	<b>73,181</b>	<b>1,536,804</b>	<b>1.54</b>
La Plata total methane IF adjusted US rate	189.4	3,978	82,814	1,739,098	1.74
High methane emission rate (US gas industry 2005)	371.7	7,806	162,500	3,412,497	3.41
Mid methane emission rate (CS Colorado inventory, 2004)	193.1	4,054	84,402	1,772,444	1.77
Low methane emission rate (Delucchi 9-study average)	100.7	2,116	44,040	924,842	0.92

Table 3b Colorado CH4 emissions rate calculation

Methane Mt CO2e	Methane Mt CH4	Gas prodn Bcf	Methane Rate t CH4/Bcf
5.00	0.24	1,233.2	193.1

**Several CO2 emission rates as applied to La Plata**

Table 4	La Plata gas prod Bcf	CO2 Rate t CO2/Bcf	La Plata CO2 tonnes CO2	La Plata CO2 Mt CO2e
	437.2			
La Plata total CO2 IF NM rate (NM marketed prodn)		6,590	2,881,024	2.88
US CO2 from flaring and vented CO2, gas industry		1,214	530,596	0.53
La Plata entrained CO2 only (based on NM, no flaring est)		2,765	1,208,583	1.21
La Plata combustion CO2 (based on NM combustion)		3,826	1,672,441	1.67
La Plata flared gas (COGCC data)			1,633	0.00
<b>CO2 emissions rate applied to La Plata "High estimate"</b>		<b>6,590</b>	<b>2,881,024</b>	<b>2.88</b>

Table 4b Total Colorado CO2 if US flaring + venting rate

t CO2/Bcf	t CO2	Mt CO2
1,214	1,496,793	1.50

Table 4c Total Colorado CO2 if NM CO2 rate

t CO2/Bcf	t CO2	Mt CO2
6,590	8,127,264	8.13

Table 5

	La Plata CO2 tonnes CO2	La Plata CH4 tonnes CO2e	CO2 + CH4 tonnes CO2e	Percent of High Estimate	CO2 of total Percent	CH4 of total Percent	CO2 Rate t CO2/Bcf	CH4 Rate t CO2e/Bcf	CO2 + CH4 Rate t CO2e/Bcf
High estimate	2,881,024	1,536,804	4,417,828	100.0%	65.2%	34.8%	6,590	3,515	10,106
Mid estimate	2,180,586	1,163,175	3,343,761	75.7%	65.2%	34.8%	4,988	2,661	7,649
Low estimate	1,480,148	789,545	2,269,694	51.4%	65.2%	34.8%	3,386	1,806	5,192

**CO2 emissions if La Plata's marketed gas and oil production is fully combusted by end-users**

**Total CO2 from combustion of marketed oil and gas**

Table 6	La Plata gas sold Bcf	Gas combust. EF Mt CO2/Bcf	Combusted CO2 million tonnes CO2	La Plata oil sold bbl	Oil combust. EF tonnes CO2/bbl	Combusted CO2 million tonnes CO2	Combusted CO2 million tonnes CO2	Prodn emissions million tonnes CO2e	Combust. + Prodn million tonnes CO2e	Prodn / Comb + Prodn percent
<b>Total CO2 from full combustion of marketed gas:</b>	<b>430.30</b>	<b>0.05821</b>	<b>25,048</b>	<b>30,048</b>	<b>0.04353</b>	<b>0.001</b>	<b>25.049</b>	<b>3.344</b>	<b>28.393</b>	<b>11.78%</b>

La Plata Gas EMISSIONS

	A	B	C	D	E	F	G	H	I	J	K	L	M
70													
71		<b>Table 7</b>	<b>La Plata County GHG Emissions from Natural Gas &amp; Oil Industry: High, "Best," &amp; Low estimates</b>										
72			<b>Carbon dioxide sources</b>			<b>Methane sources</b>			<b>CO2 &amp; methane sources</b>			<b>Percent</b>	
73			<b>Low estimate</b>	<b>Best Estimate</b>	<b>High estimate</b>	<b>Low estimate</b>	<b>Best Estimate</b>	<b>High estimate</b>	<b>Low estimate</b>	<b>Best Estimate</b>	<b>High estimate</b>	<b>High Estimate</b>	
74			tonnes CO <sub>2</sub>	tonnes CO <sub>2</sub>	tonnes CO <sub>2</sub>	tonnes CO <sub>2</sub> e	tonnes CO <sub>2</sub> e	tonnes CO <sub>2</sub> e	tonnes CO <sub>2</sub> e	tonnes CO <sub>2</sub> e	tonnes CO <sub>2</sub> e	Percent of total	
75													
76		<b>US CO2 + CH4 rates / NM CO2 + CH4 rates</b>	0.514	75.7% of NM	<b>NM model</b>	51.4% of NM	75.7% of NM	<b>NM model</b>	51.4% of NM	75.7% of NM	<b>NM model</b>		
77			of NM model										
78		<b>La Plata GHG emission, Gas Industry</b>							51.4%	75.7%	100.0%		
79		<b>Production</b>											
80		<b>Methane</b>				505,149	744,196	983,243	505,149	744,196	983,243	22.3%	
81		Flared gas (COGCC)											
82		Combustion	259,151	381,786	504,422				259,151	381,786	504,422	11.4%	
83		Vented (entrained) CO2										na	
84		<b>Subtotal, production</b>	259,151	381,786	504,422	505,149	744,196	983,243	764,299	1,125,982	1,487,664		
85		<b>Gas Processing</b>											
86		<b>Methane</b>				126,132	185,820	245,509	126,132	185,820	245,509	5.6%	
87		Combustion	278,311	410,013	541,715				278,311	410,013	541,715	12.3%	
88		Vented (entrained) CO2	620,919	914,751	1,208,583				620,919	914,751	1,208,583	27.4%	
89		<b>Subtotal, production</b>	899,229	1,324,764	1,750,298	126,132	185,820	245,509	1,025,361	1,510,584	1,995,807		
90		<b>Transmission &amp; storage</b>											
91		<b>Methane</b>				117,095	172,507	227,919	117,095	172,507	227,919	5.2%	
92		Combustion	321,768	474,036	626,304				321,768	474,036	626,304	14.2%	
93		Vented CO2										na	
94		<b>Subtotal, production</b>	321,768	474,036	626,304	117,095	172,507	227,919	438,864	646,543	854,223		
95		<b>Distribution</b>											
96		<b>Methane</b>				41,170	60,652	80,134	41,170	60,652	80,134	1.8%	
97		Combustion										na	
98		Vented (entrained) CO2											
99		<b>Subtotal, production</b>	-	-	-	41,170	60,652	80,134	41,170	60,652	80,134		
100		<b>La Plata GHG emission, Gas Industry</b>											
101		<b>Methane</b>				789,545	1,163,175	1,536,804	789,545	1,163,175	1,536,804	34.79%	
102		Flared gas (COGCC)	-	-	-								
103		Combustion	859,230	1,265,835	1,672,441				859,230	1,265,835	1,672,441	37.86%	
104		Vented (entrained) CO2	620,919	914,751	1,208,583				620,919	914,751	1,208,583	27.36%	
105		<b>Total, La Plata Gas Industry emissions</b>	<b>1,480,148</b>	<b>2,180,586</b>	<b>2,881,024</b>	<b>789,545</b>	<b>1,163,175</b>	<b>1,536,804</b>	<b>2,269,694</b>	<b>3,343,761</b>	<b>4,417,828</b>	100.000000%	
106		<b>La Plata GHG emission, Oil Industry</b>											
107		<b>Methane</b>											
108		Flared gas (COGCC)											
109		Combustion											
110		Vented (entrained) CO2											
111		<b>Total, La Plata Oil Industry emissions</b>											
112		<b>La Plata GHG emission, Gas &amp; Oil Industry total</b>											
113		<b>Methane</b>				789,545	1,163,175	1,536,804	789,545	1,163,175	1,536,804		
114		Flared gas (COGCC)	-	-	-								
115		Combustion	859,230	1,265,835	1,672,441				859,230	1,265,835	1,672,441		
116		Vented (entrained) CO2	620,919	914,751	1,208,583				620,919	914,751	1,208,583		
117		<b>Total, La Plata Gas &amp; Oil Industry emissions</b>	<b>1,480,148</b>	<b>2,180,586</b>	<b>2,881,024</b>	<b>789,545</b>	<b>1,163,175</b>	<b>1,536,804</b>	<b>2,269,694</b>	<b>3,343,761</b>	<b>4,417,828</b>		
118													
119													
120													
121													
122													
123													
124													
125													

# La Plata County GHG Emissions Summary

## Summary for graphics

Table 8	Low Estimate tonnes CO <sub>2</sub> e	Best Estimate tonnes CO <sub>2</sub> e	Percent of best estimate	High Estimate tonnes CO <sub>2</sub> e
Methane	789,545	1,163,175	34.8%	1,536,804
CO <sub>2</sub> : Combusted Fuel	859,230	1,265,835	37.9%	1,672,441
CO <sub>2</sub> : Vented (entrained)	620,919	914,751	27.4%	1,208,583
<b>Total</b>	2,269,694	3,343,761	100.0%	4,417,828

**Table 9 Comparing gas industry emissions to end use of marketed production**

	million tonnes CO <sub>2</sub> e	% of ancillary plus end use emissions
Methane	1.16	4.1%
CO <sub>2</sub> : Combusted Fuel	1.27	4.5%
CO <sub>2</sub> : Vented (entrained)	0.91	3.2%
<b>Ancillary emissions total</b>	<b>3.34</b>	<b>11.8%</b>

Table 10	Methane Rate t CH <sub>4</sub> /Bcf
US industry average	350.5
US upstream average	189.4
New Mexico average	167.4
Colorado average	193.1
Delucchi average	100.7

Table 11	Three estimates of total La Plata gas industry emissions million tonnes CO <sub>2</sub> e/yr
Low estimate	2.27
Best estimate	3.34
High estimate	4.42

	million tonnes CO <sub>2</sub> e	% of ancillary plus end use emissions
Produced gas fully combusted	25.048	88.2%
Produced oil fully combusted	0.001	0.0%
<b>Total gas &amp; oil fully combusted</b>	<b>25.049</b>	<b>88.2%</b>
<b>Total ancillary plus end use emissions</b>	<b>28.393</b>	<b>100.0%</b>

Comparing methane and carbon dioxide gas industry emission rates to end use combustion					
Table 12	Best estimate tonnes CO <sub>2</sub> e/Bcf	Percent of end use combustion	Table 13	High estimate tonnes CO <sub>2</sub> e/Bcf	Percent of end use combustion
Methane rate	2,661	4.6%	Methane rate	3,515	6.0%
CO <sub>2</sub> vented	2,092	3.6%	CO <sub>2</sub> vented	2,765	4.7%
CO <sub>2</sub> combustion	2,896	5.0%	CO <sub>2</sub> combustion	3,826	6.6%
Subtotal	7,649	13.1%	Subtotal	10,106	17.4%
End Use combustion	58,210	100.0%	End Use combustion	58,210	100.0%

## Table 14 Conversion tables

Natural Gas & Oil / Production Emissions		
1 million tonnes of natural gas =	52.47	Bcf
1 Bcf =	0.01906	Mt of production
1 Bcf =	0.0582	MtCO <sub>2</sub> (Step 8)
1 Mt of gas production =	3.0543	MtCO <sub>2</sub> emitted
1 MtCO <sub>2</sub> =	0.3274	Mt gas prod
1 tonne oil =	3.1467	t CO <sub>2</sub> emitted
t CO <sub>2</sub> emitted =	0.3178	tonne oil

Methane	
23.5516	cf CH <sub>4</sub> = 1 lb
19,260	tonnes
51.921	Bcf CH <sub>4</sub>
1 t = 7.33	bbl
1 Mt Oil equiv = 39.2	Bcf of natural gas
1 m <sup>3</sup> =	35.315 cubic feet

EPA Methane Converter	
1 cf CH <sub>4</sub> =	0.04246 lb CH <sub>4</sub>
1 lb =	23.552 cf
1 ton =	47,103 cf
1 tonne =	51,922 cf
1 tonne =	1,470 m <sup>3</sup>
1 Bcf CH <sub>4</sub> =	19,260 tonnes CH <sub>4</sub>

Natural gas, EPA AP42 (1985)	
1 lb =	23.80 cf
1 ton =	47,600 cf
1 tonne =	52,469 cf
1 Bcf =	19,059 t
1 Bcf =	0.019 Mt

CO <sub>2</sub> factors	
1 tonne CO <sub>2</sub> =	556.2 m <sup>3</sup> CO <sub>2</sub>
1 Bcf CO <sub>2</sub> =	50,918.0 tonne CO <sub>2</sub>
1 m <sup>3</sup> CO <sub>2</sub> =	0.0018 tonne CO <sub>2</sub>
1 m <sup>3</sup> CO <sub>2</sub> =	1.7979 kg CO <sub>2</sub>
1 ft <sup>3</sup> CO <sub>2</sub> =	0.0509 kg CO <sub>2</sub>
1 ft <sup>3</sup> CO <sub>2</sub> =	0.1123 lb CO <sub>2</sub>

verify conversion value, mole percent, etc.

1.7979 kg m<sup>3</sup> / 35.31 m<sup>3</sup> ft<sup>3</sup>

1 Bcf CO <sub>2</sub> =	51,175.0 tonne CO <sub>2</sub>	NM conversion
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## La Plata Gas EMISSIONS

**Cell:** K21

**Comment:** Rick Heede:  
Bruce Gantner, NMoilGasGantnerFeb06.xls, worksheet "Vent Gas".

**Cell:** B23

**Comment:** Rick Heede:  
New Mexico Oil & Gas emissions inventory, confidential to CMS. In this unpublished inventory of the New Mexico oil and gas industry, the single largest source of emissions is "entrained CO2" totaling 4.51 million tonnes CO2e/yr in gas processing; second largest source is methane from natural gas production (3.67 million tonnes CO2e/yr).

**Cell:** G32

**Comment:** Rick Heede:  
While most of the world uses the IPCC Second Annual Report's GWP factors, EIA adopts the IPCC revised data in IPCC's Third Annual Report. In the case of methane, EIA uses a Global Warming Potential of 23 x CO2, whereas most other inventories use the older but formally adopted value of 21 x CO2 (both 100-year time horizon). EIA (2006), page 6.

CMS uses IPCC's SAR value of 21xCO2.

**Cell:** B33

**Comment:** Rick Heede:  
This factor calculates methane emissions on the basis of marketed production rather than gross withdrawals, hence the CH4 rate is slightly higher than the basis used below ("High methane emission rate").

**Cell:** B34

**Comment:** Rick Heede:  
CMS computes emissions of methane and carbon dioxide from a New Mexico inventory of its oil and gas industry emissions, confidential to CMS (and thus not cited) but which is well-documented, follows CMS protocol, and is essentially based on US average emission rates and filled in with industry emission rates in New Mexico (when known).

That said, the CMS estimated emissions for the oil and gas industry in La Plata county may be revised if and when local industry, emission studies, reports filed with the Colorado Oil and Gas Conservation Commission, or other experts review the CMS estimates. This first quantification of La Plata emissions should be viewed as an initial emissions estimate and will likely be revised.

**Cell:** B35

**Comment:** Rick Heede:  
Adjusted as follows: Total US emissions of methane from gas industry: 100 percent of emissions from gas production, 100% from processing, 40 percent from transmission & storage, and 10 percent from distribution. This is an attempt to attribute to La Plata a methane emission rate that reflects the segments of the natural gas industry that exist in the county. La Plata, CMS has assumed, has all of its production and processing plants within the La Plata county boundary, since most of its gas production is exported CMS attributes 40 percent of transmission and storage emissions, and only 10 percent of distribution emissions.

These percentages may be revised after review by colleagues, industry experts in La Plata county, and local consumption data. Such revision should also be made in Table 2 in the worksheet "Oil & Gas Emissions RATES" in this workbook, to which this emission rate is linked via calculations in Tables 1 and 3 (specifically, at cell F32: 189.4 tonnes CH4/Bcf, as of Nov07).

**Cell:** B36

**Comment:** Rick Heede:  
CMS surveyed several dozen methane emission rates (ranging from multinational oil and gas companies to global, with many estimates specific to US gas industry); details in this workbook's worksheet "Oil and Gas Emission RATES".

CMS uses the US gas industry's methane emission rate in 2005 as the high benchmark. La Plata's methane emission rate may well be lower than the average US rate (which includes methane emissions from production through distribution). In fact, as CMS will show below, the CMS methane emission rate is 55 percent lower than this high benchmark: 167 t CH4/Bcf (NM benchmark) vs 372 t CH4/Bcf (US "high" benchmark).

**Cell:** B38

**Comment:** Rick Heede:  
CMS uses as the low benchmark averaging nine of the studies summarized in Delucchi (2003, Appendix E). See "Oil & Gas Emission RATES" worksheet for details.  
LaPlataGasEmissionsFeb08.xls

## La Plata Gas EMISSIONS

**Cell:** B76

**Comment:** Rick Heede:

As a very conservative preliminary lower bound on La Plata's emissions of CO<sub>2</sub> and CH<sub>4</sub>, CMS calculates the adjusted US methane rate plus the US CO<sub>2</sub> from flaring and venting as a fraction of the New Mexico methane plus CO<sub>2</sub> rate. The US rate is approximately 51.4 percent of the NM rate. This is applied as a conservatism and is used to calculate the "low" estimate (thus 0.514 of the "high" estimate based on NM rates). The "Best" estimate is simply the average of the high and low estimates, thus 0.757 of the "high" estimate based on NM rates). Note: While the US methane rate is directly comparable, the US CO<sub>2</sub> rates greatly underestimates CO<sub>2</sub> emissions from the gas industry: flaring data is uneven and underreported, data on venting of entrained CO<sub>2</sub> uneven and underreported, and CO<sub>2</sub> emissions from industry use of electricity, gas, and steam is not included.

**Cell:** B82

**Comment:** Rick Heede:

Conversion from BP Statistical Yearbook, glossary.

**Cell:** I144

**Comment:** Rick Heede:

Full combustion of marketed products does not account for incomplete combustion, non-fuel uses, etc.

**Cell:** G155

**Comment:** Rick Heede:

Note the difference between these two tables and to Table 9. The latter shows gas industry emissions as percent of gas industry emissions PLUS end use emissions, whereas the present tables compares gas industry emission (rates) to end use combustion (rate). All tables assume full combustion of marketed products, and thus does not deduct for incomplete combustion, non-fuel uses, etc.

**Cell:** E172

**Comment:** Rick Heede:

This conversion is specific to CMS accounts of non-fuel uses of natural gas, incomplete combustion, etc, although the CMS factor is very close to the carbon coefficient of natural gas used elsewhere.

**Cell:** E189

**Comment:** Rick Heede:

Conversions from International Carbon Bank & Exchange: One tonne of CO<sub>2</sub> occupies 556.2 m<sup>3</sup> of volume. 1 m<sup>3</sup> CO<sub>2</sub> = 0.0017979 tonne = 1.7979 kg. 1 ft<sup>3</sup> CO<sub>2</sub> = 1.7979 kg m<sup>-3</sup> / 35.31 m<sup>3</sup> ft<sup>-3</sup> = 0.050918 kg = 0.112253 lbs CO<sub>2</sub>.

**Cell:** F198

**Comment:** Rick Heede:

Bruce Gantner, NMOilGasGantnerFeb06.xls, worksheet "CBM"; derived from Gantner calculations by CMS, Nov07.