Veneco Paredon Crude Oil & Natural Gas Project

Richard Heede
Climate Mitigation Services
Snowmass, Colorado
28-Apr-08

FOLIO #1

Construction phase

Table 1

Emission sources		Quantity	Units	Emission coefficients: Carbon dioxide lb CO2/unit	Methane lb CH4/unit	Nitrous oxide lb N2O /unit	Emissions by gas: CO2, tons CO2 (1)	CH4, tons CO2e (21)	N2O, tons CO2e (310)	CMS Emissions tons CO2e	CMS Emissions tonnes CO2e	FEIR Emissions tons CO2e	data sources
		FEIR											
Direct													
Diesel fuel, trucks	FEIR	18,100	gallons	22.38	0.000661	0.000551	202.6	0.1	1.5	**204**	185	221	CCAR, EIA, FEIR
Diesel fuel, Casitas crane	not appl									not estimated		not estimated	
Natural gas, on-site electricity gen	no data									not estimated		not estimated	
Indirect													
Diesel fuel, trucks, off-site	FEIR	4,600	gallons	22.38	0.000661	0.000551	51.5	0.0	0.4	**52**	47	139	FEIR Appendix G
Gasoline, commuting	FEIR: not est	2,000	gallons	19.56			19.56			**20**	18	not estimated	FEIR, 4.16.1.2
Steel (tanks, pipe), embodied CO2	no data			1.95	lb CO2 per lb steel delivered					not estimated		not estimated	CMS, 2007
Tank removal, decommissioning	no data									not estimated		not estimated	
Cement	no data									not estimated		not estimated	
Engineering, EIR process, etc.	no data									not estimated		not estimated	
Total construction emissions										**276**	**250**	**360**	

Drilling & Operations: Annual

Table 2

Emission sources		Quantity	Units	Emission coefficients: Carbon dioxide lb CO2/unit	Methane lb CH4/unit	Nitrous oxide lb N2O /unit	Emissions by gas: CO2, tons CO2 (1)	CH4, tons CO2e (21)	N2O, tons CO2e (310)	CMS Emissions tons CO2e	CMS Emissions tonnes CO2e	FEIR Emissions tons CO2e	data sources
Direct													
Natural gas, on-site (elec gen, compressors etc)		275.5	million cf/yr	120,376	1,280	5.2	16,582	3,703	222	**20,507**	18,603	19,180	EIA, CMS, FEIR
Diesel, stationary equip., on-site vehicles		4,400	gallons/yr	22.38	0.000661	0.000551	49.2	0.0	0.4	**50**	45	54	CCAR, EIA, FEIR
Fugitive methane (% of ROC, per FEIR)		413.3	tons CH4/yr	-	3,720	-	-	8,679	-	**8,679**	7,873	1,071	FEIR Appendix G
Flaring, CO2 & CH4	no data		no flaring data is reported in FEIR; CMS has not independently estimated flaring emissions given the lack of data in the FEIR										
Natural gas, on-site (vented CO2)	re-injected		unspecified quantities of CO2 separated from produced gas, which contains up to 8 percent CO2, is to be re-injected for gas-lift of crude oil; CMS assumes no direct CO2 venting										
Indirect													
Diesel fuel, trucks, off-site		7,340	gallons/yr	22.38	0.000661	0.000551	82.1	0.1	0.6	**83**	75	222	FEIR Appendix G
Electricity, SCE, incl T&D losses	CMS	43,800	MWh/yr	799.9			17,518			**17,518**	15,892	15,045	EPA eGRID
Electricity, SCE (coal & gas CH4)	not estimated									not estimated		not estimated	
Gasoline, commuting	FEIR: not est	2,000	gallons/yr	19.56			19.56			**20**	18	not estimated	FEIR, 4.16.1.2
Total annual emissions										**46,856**	**42,507**	**35,573**	

	FEIR actual
FEIR sum:	35,933	35,743

Table 3a

Paredon average gas production/year	**2.87**	**Bcf/yr**
FEIR estimated fugitive methane	51.0	tons CH4
FEIR estimated fugitive methane	46.3	tonnes CH4
FEIR methane emission rate	**16.1**	**t CH4/Bcf**

see table 3 below

Table 3b

California marketed gas production	320	Bcf
Methane emissions, Cal oil & gas supply	90,476	tonnes CH4
California methane rate	283	t CH4/Bcf

Table 3c

	Methane Rate t CH4/Bcf	Methane Rate t CO2e/Bcf	Paredon CH4 tonnes CH4	Paredon CH4 tonnes CO2e 21xCO2	Paredon CH4 tons CO2e 1 t = 1.1023 tons	Multiple of FEIR
US methane rate (production to end use)	350.5	7,361	1,005	21,100	23,259	21.7
California methane rate	282.8	5,939	811	17,026	18,768	17.5
Colorado methane rate	193.1	4,054	553	11,622	12,811	12.0
US methane rate (upstream, minor downstream)	189.4	3,978	543	11,404	12,570	11.7
New Mexico methane rate	167.4	3,515	480	10,077	11,108	10.4
US methane rate (production & processing only)	130.8	2,747	375	7,873	8,679	8.1
Low methane rate (Delucchi 9-study average)	100.7	2,116	289	6,064	6,685	6.2
MRS methane rate for Paredon	**16.1**	**339**	**46**	**972**	**1,071**	1.0

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
73																
74		*intentionally left blank*														

Veneco Paredon Crude Oil & Natural Gas Project

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FOLIO #2

Table 4 FEIR & CMS total project emissions compared

	Drilling & Ops	End use	Total
	cum tons CO2e	cum tons CO2e	cum tons CO2e
	Note: CMS assumes a 15-yr project duration per FEIR Fig 2-9		
CMS	702,834	14,791,276	**15,494,110**
FEIR	533,590	52,890,000	**53,423,590**

Table 5 Estimated refinery or fuel cycle energy inputs and emission factors

UCS/Wang	22.8	5.4	23.7%
Heede (2003)			15.5%
ANL GREET mode	5,156	1,245	24.1%
FEIR cites GM	averages FEIR citation: 13 to 17%		15.0%
Delucchi (2003)			25.0%
Simple average of above upstream estimates			**20.7%**

Emissions from end use combustion of marketed crude oil and natural gas produced at Paredon

Note: CMS has estimated annual marketed production of crude oil and natural gas from FEIR Figure 2-9; the FEIR does not provide clear data for annual marketed production

Table 6 Natural gas sales, end use combustion, and fugitive methane

	Sales gas prodn	Sales gas prodn	Combustion	Combustion	Fugitive CH4
Fig. 2-9	million cf/day	Bcf/yr	tonnes CO2/yr	tons CO2/yr	tons CO2e/yr
	(estim Fig.2-9)	*adjustmetn factor	54,602 tCO2/Bcf	1 t = 1.1023 tons	
Year 1	-	-	-	-	-
Year 2	2.20	0.75	40,897	45,081	2,268
Year 3	3.80	1.29	70,640	77,867	3,917
Year 4	11.10	3.78	206,344	227,453	11,441
Year 5	18.00	6.13	334,612	368,843	18,553
Year 6	17.30	5.89	321,599	354,499	17,832
Year 7	14.90	5.07	276,984	305,320	15,358
Year 8	12.80	4.36	237,946	262,288	13,193
Year 9	11.00	3.75	204,485	225,404	11,338
Year 10	9.60	3.27	178,460	196,716	9,895
Year 11	8.20	2.79	152,434	168,028	8,452
Year 12	7.00	2.38	130,127	143,439	7,215
Year 13	5.50	1.87	102,243	112,702	5,669
Year 14	3.50	1.19	65,063	71,719	3,608
Year 15	1.40	0.48	26,025	28,688	1,443
15-yr total	**126.30**	**43.00**	**2,347,861**	**2,588,047**	**130,181**
Average/yr	8.42	2.87	156,524	**172,536**	**8,679**

Compare FEIR estimated combustion emissions	Combustion
	tons CO2/yr
FEIR, page 4.2-52	**526,000**

Note: CMS has not discerned the reason for the much higher product emission estimate in the FEIR.

Table 7 Crude oil production, non-fuel use adjustment, refinery emissions, and end use combustion

	Production	Production	Combustion	Adjust: non-fuel	Adjust: non-fuel	Refining emissions	Total emissions
	bbl per day	bbl per year	tonnes CO2/yr	tonnes CO2/yr	tons CO2/yr	tons CO2/yr	tons CO2/yr
		* adjustment factor	429.3 kg CO2/bbl	390.43 kg CO2/bbl	1 t = 1.1023 tons	20.7%	
Year 1	-	-	-	-	-	-	-
Year 2	800	284,418	122,100	111,045	122,405	25,289	147,694
Year 3	1,800	639,939	274,726	249,852	275,411	56,900	332,312
Year 4	6,700	2,381,997	1,022,591	930,003	1,025,142	211,796	1,236,939
Year 5	10,100	3,590,772	1,541,518	1,401,945	1,545,364	319,275	1,864,639
Year 6	8,900	3,164,145	1,358,368	1,235,377	1,361,756	281,341	1,643,097
Year 7	7,700	2,737,519	1,175,217	1,068,810	1,178,149	243,407	1,421,556
Year 8	6,700	2,381,997	1,022,591	930,003	1,025,142	211,796	1,236,939
Year 9	5,800	2,062,027	885,228	805,077	887,437	183,346	1,070,783
Year 10	5,000	1,777,610	763,128	694,032	765,032	158,057	923,088
Year 11	4,400	1,564,297	671,552	610,748	673,228	139,090	812,318
Year 12	3,800	1,350,983	579,977	527,464	581,424	120,123	701,547
Year 13	2,900	1,031,014	442,614	402,539	443,718	91,673	535,391
Year 14	1,300	462,179	198,413	180,448	198,908	41,095	240,003
Year 15	200	71,104	30,525	27,761	30,601	6,322	36,924
Total	**66,100**	**23,500,000**	**10,088,550**	**9,175,105**	**10,113,718**	**2,089,511**	**12,203,229**
Average/yr	4,407	1,566,667	672,570	611,674	**674,248**	139,301	**813,549**

Compare FEIR estimated combustion emissions		Combustion
		tons CO2/yr
FEIR, page 4.2-52	approximately	3,000,000

Note: CMS has not discerned the reason for the much higher product emission estimate in the FEIR. FEIR , page 4.2-52
Note: CMS has accounted for ~8.6 percent non-fuel use of crude oil (e.g., for asphalt, waxes, lubricants, chemicals, etc)

Estimated annual direct, indirect, and end use emissions through assumed total project duration of 15 years

Table 8

	Electricity	Diesel fuel	Gasoline	Fugitive CH4	On-site gas	Flaring	Subtotal	Gas end use	Oil refin. & end use	Total annual	% end use	
	tons CO2/yr	tons CO2e/yr	tons CO2/yr	tons CO2e/yr	tons CO2/yr	(not estimated)	tons CO2e/yr	tons CO2/yr	tons CO2/yr	tons CO2e/yr	percent	
Year 1	17,518	132	20	-	20,507	-	38,177	-	-	**38,177**	0.0%	
Year 2	17,518	132	20	2,268	20,507	-	40,444	45,081	147,694	**233,219**	82.7%	
Year 3	17,518	132	20	3,917	20,507	-	42,094	77,867	332,312	**452,272**	90.7%	
Year 4	17,518	132	20	11,441	20,507	-	49,618	227,453	1,236,939	**1,514,009**	96.7%	
Year 5	17,518	132	20	18,553	20,507	-	56,730	368,843	1,864,639	**2,290,211**	97.5%	
Year 6	17,518	132	20	17,832	20,507	-	56,008	354,499	1,643,097	**2,053,605**	97.3%	
Year 7	17,518	132	20	15,358	20,507	-	53,535	305,320	1,421,556	**1,780,411**	97.0%	
Year 8	17,518	132	20	13,193	20,507	-	51,370	262,288	1,236,939	**1,550,597**	96.7%	
Year 9	17,518	132	20	11,338	20,507	-	49,515	225,404	1,070,783	**1,345,701**	96.3%	
Year 10	17,518	132	20	9,895	20,507	-	48,072	196,716	923,088	**1,167,876**	95.9%	
Year 11	17,518	132	20	8,452	20,507	-	46,629	168,028	812,318	**1,026,975**	95.5%	
Year 12	17,518	132	20	7,215	20,507	-	45,392	143,439	701,547	**890,378**	94.9%	
Year 13	17,518	132	20	5,669	20,507	-	43,846	112,702	535,391	**691,939**	93.7%	
Year 14	17,518	132	20	3,608	20,507	-	41,784	71,719	240,003	**353,507**	88.2%	
Year 15	17,518	132	20	1,443	20,507	-	39,620	28,688	36,924	**105,231**	62.3%	
15-yr total	**262,774**	**1,987**	**293**	**130,181**	**307,598**	**-**	**702,834**	**2,588,047**	**12,203,229**	**15,494,110**	**95.5%**	**CMS estimate**
Average/yr	17,518	132	20	8,679	20,507	-	46,856	172,536	813,549	**1,032,941**	95.5%	CMS estimate
% of15-yr total	1.70%	0.01%	0.00%	0.84%	1.99%	0.00%	4.54%	16.70%	78.76%	100.0%		

Note: The FEIR does not provide estimates of variable electricity, diesel fuel, gas combustion, or fugitives over the project duration.
Note: The FEIR is also unclear about the expected project duration. CMS assumes 15 years, based on FEIR Figure 2-9.

Table 9

Oil: refining etc: "wells to wheels"	2,089,511	tons CO2
Oil: combustion of gasoline & diese	10,113,718	tons CO2
Oil: total refining & end use	12,203,229	tons CO2

Cell: G15
Comment: Rick Heede:
Emissions of methane associated with fuel use and combustion in mobile sources. Factors from California Climate Action Registry (2007) General Reporting Protocol, Table C-4. CCAR estimates CH4 emissions rate: light duty diesel trucks (0.01 grams CH4/mile) and heavy duty diesel trucks (0.06 grams CH4/mile); average equals 0.035 grams CH4/mile. CMS assumes Paredon's diesel trucks at 5 mpg, thus 5x0.06 = 0.30 grams CH4 per gallon of diesel fuel combusted. 0.3 g = 0.00066138679 lb.

CMS has used IPCC's GWP factor for methane of 21xCO2.

Cell: H15
Comment: Rick Heede:
Emissions of nitrous oxides associated with fuel use and combustion in mobile sources. Factors from California Climate Action Registry (2007) General Reporting Protocol, Table C-4. CCAR estimates N2O emissions rate: light duty diesel trucks (0.03 grams N2O /mile) and heavy duty diesel trucks (0.05 grams N2O /mile). CMS assumes 5 mpg diesel trucks, thus 5x0.05 = 0.25 grams N2O per gallon used. CMS uses IPCC's GWP factor for nitrous oxide of 310xCO2.

Cell: N23
Comment: Rick Heede:
The estimated emissions from diesel fuel combustion in off-site trucks in the FEIR Appendix G (p. G-58) uses methane and N2O emissions factors referenced as "EPA AP-42 and EPA 2004, criteria estimates". These factors -- especially the N2O EF -- appear in error and comprise the main reason why the FEIR emission estimates far exceed the CMS estimates.

Cell: B25
Comment: Rick Heede:
Emissions from steel embodied into the project's infrastructure from Heede (2006) Minnesota Steel.

Cell: G39
Comment: Rick Heede:
Emissions of methane associated with fuel use and combustion in mobile sources. Factors from California Climate Action Registry (2007) General Reporting Protocol, Table C-4. CCAR estimates CH4 emissions rate: light duty diesel trucks (0.01 grams CH4/mile) and heavy duty diesel trucks (0.06 grams CH4/mile); average equals 0.035 grams CH4/mile. CMS assumes Paredon's diesel trucks at 5 mpg, thus 5x0.06 = 0.30 grams CH4 per gallon of diesel fuel combusted. 0.3 g = 0.00066138679 lb.

CMS has used IPCC's GWP factor for methane of 21xCO2.

Cell: H39
Comment: Rick Heede:
Emissions of nitrous oxides associated with fuel use and combustion in mobile sources. Factors from California Climate Action Registry (2007) General Reporting Protocol, Table C-4. CCAR estimates N2O emissions rate: light duty diesel trucks (0.03 grams N2O /mile) and heavy duty diesel trucks (0.05 grams N2O /mile). CMS assumes 5 mpg diesel trucks, thus 5x0.05 = 0.25 grams N2O per gallon used. CMS uses IPCC's GWP factor for nitrous oxide of 310xCO2.

Cell: B44
Comment: Rick Heede:
FEIR Appendix G (p. G-58) calculates fugitive methane based on a proportion of ROCs (reactive organic compounds) estimated to be methane: 0.35 lb CH4 per lb ROC. ROC appears to be carefully analyzed and estimated throughout Appendix G from valves and seals and compressors and ICE engines and so on, but no independent estimate of fugitive methane was undertaken, nor is the proportion cited above documented or evaluated for various fugitive methane emission sources.

It is beyond CMS's scope to undertake an independent analysis of total methane emissions using, for example, the IPIECA or API estimation procedures.

Note: The fugitive methane calculation in the FEIR is not clear, but appears to show 51 tons of total fugitive methane, which computes to 1,070 tons CO2e. But is this reasonable, given average natural gas sales production of 3.07 Bcf of natural gas and 1.61 million bbl or crude oil per annum? In short, no. While individual fields differ, the U.S. average upstream methane emission rate is 189.4 tons methane per Bcf produced; see Table 3c above for several methane emission rates.

CMS applies the US methane rate for natural gas production and processing only computed in Table 3c and compared to other national and regional methane rates. Using the US rate of 130.8 tonnes CH4 per Bcf of gas produced yields estimated methane emissions of 402 tonnes (443 tons) methane equal to 9,304 tons CO2e (at CH4 of 21xCO2). This is 8.7 times the fugitive methane estimate shown in Appendix G-58 and Table 4.2-17 in the FEIR text (page 4.2-58).

If CMS instead applied the California methane rate of 282.8 tonnes methane per Bcf, Paredon fugitive methane would total 869 tonnes (20,121 tons CO2e).

CMS does not have access to data necessary to generate methane emissions in detail for each emissions source over the duration of the Paredon project, nor do we have the budget or the scope. The present methane emission estimate is preliminary and is certain to be revised and improved with further review.

Cell: N44
Comment: Rick Heede:

As discussed at left, CMS considers the FEIR fugitive methane emissions estimate unreasonably low at 51 tons CH4 (equal to 1,071 tons CO2e). The FEIR estimates 27.4 tons ROC emissions, times 1.86 methane per unit of ROC, thus 51 tons CH4.

The CMS calculation and rationale is discussed in Tables 3a, 3b, and 3c.

Cell: C45
Comment: Rick Heede:
CMS searched the FEIR for discussion of routine flaring -- typical for gas production and processing facilities -- but only found reference to flaring of sour H2S-rich gas in possible upset conditions. For example, page 4.1-60 and Table 8.1.

CMS cannot determine if no flaring is anticipated, is too minor to report, or has simply been ignored.

Cell: C46
Comment: Rick Heede:
FEIR, Section 2.5.3, page 2-31.

Cell: N49
Comment: Rick Heede:
The estimated emissions from diesel fuel combustion in off-site trucks in the FEIR Appendix G (p. G-58) uses methane and N2O emissions factors referenced as “EPA AP-42 and EPA 2004, criteria estimates”. These factors -- especially the N2O EF -- appear in error and comprise the main reason why the FEIR emission estimates far exceed the CMS estimates.

Cell: B50
Comment: Rick Heede:
The EPA eGRID data shows CO2 emissions from plants owned by operators in lb CO2 per MWh of net generation, hence does not estimate T&D losses. Nor does the data include methane or nitrous oxide emission rates.

SCE nameplate capacity in 2004 was 5,240 MW, annual net generation totaled 29,845,917 MWh, emissions totaled 11,229,981 tons CO2, 31,634 tons SO2, and 502 lb of mercury.

WECC California subregion rate is 878.7 lb CO2 per MWh.

NERC WECC subregion rate is 1107.2 lb CO2 per MWh.

CMS computes emissions per MWh of electricity delivered to SCE customers using a conservative transmission and distribution grid loss factor of 6 percent.

Cell: F50
Comment: Rick Heede:
CMS uses emission rates for Southern California Edison (SCE), estimated in EPA eGRID data (2007, data for 2004) as 752 lb CO2/MWh generated, to which CMS adds T&D losses of 6 percent -- I.e., to 780 lb CO2/MWh --in order to account for total emissions per DELIVERED MWh.

Cell: N50
Comment: Rick Heede:
The FEIR uses emission factors cited as eGRID for Cal ISO region at 687 lb CO2 per MWH. CMS instead uses emission rates for Southern California Edison (SCE), listed as 752 lb CO2/MWh generated, to which CMS adds T&D losses of 6 percent so as to account for total emissions per DELIVERED MWh.

Cell: N56
Comment: Rick Heede:
FEIR Appendix G (page G-58) sums to 35,743 tons CO2e. CMS, having corrected the FEIR use of 10.7 rather than the correct value for diesel fuel CO2 rate of 11.2 tons CO2 per 1,000 gallons.

Cell: C61
Comment: Rick Heede:
The FEIR generally discusses maximum anticipated natural gas production, but average production of sales gas, shown in Fig. 2-9, orver years 1 through 15 of the Paredon project, is averaged by CMS in Table 4 below (3.07 Bcf/yr)

Cell: I63
Comment: Rick Heede:
CMS calculates methane emissions from the U.S. natural gas production, processing, transportation, distribution, and end use as a rate: that is, gas system methane emissions divided by total marketed gas production, in tonnes CH4 per Bcf.

US, 2005: 6.69 million tonnes methane from gas production through end-use, divided by 19,115 Bcf of marketed production = 350.5 tonnes CH4 per Bcf.

EIA (2006) Emissions of Greenhouse Gases in the United States 2005, Table 5.

Cell: I64
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: I65
Comment: Rick Heede:
CMS computes emissions of methane and carbon dioxide from an inventory of Colorado oil and gas industry emissions. Center for Climate Strategies (2007).

Cell: I66
Comment: Rick Heede:
Adjusted as follows: Total US emissions of methane from gas industry: 100 percent of emissions from gas production (1.87 million tonnes CH4), 100% from processing (0.63 million tonnes CH4), 40 percent from transmission & storage (2.34 * 0.4 = 0.94 million tonnes CH4), and 10 percent from distribution (1.85 *0.1 = 0.19 million tonnes CH4). Total methane of 3.62 million tonnes / US marketed production of 19,115 Bcf =198.4 tCH4/Bcf.

Cell: C67
Comment: Rick Heede:
US Energy Information Administration, California marketed natural gas production, 2004: 319.919 Bcf.
http://tonto.eia.doe.gov/dnav/ng/hist/n9050ca2A.htm

Cell: I67
Comment: Rick Heede:
CMS computes emissions of methane and carbon dioxide from a New Mexico inventory of its oil and gas industry emissions. Center for Climate Strategies (2006).

Cell: C68
Comment: Rick Heede:
CEC (2006) shows California methane emissions from petroleum and natural gas supply system, and while chiefly from oil and gas production in California the data also includes methane from natural gas transportation and distribution, crude oil production and storage, gas processing plants, etc. The CEC data is not disaggregated in the 2006 report. Thus the CMS rate calculation includes a wider boundary than that of Paredon oil and gas drilling, production, storage, processing, re-injection, and so forth, yet are generally comparable to the methane emission rate in the FEIR.

CEC (2006), lines 19 and 20 show 0.5 and 1.4 million tonnes CO2e, respectively; 1.9 million tonnes / methane GWP of 21 = 90,476 tonnes CH4.

Cell: I68
Comment: Rick Heede:
Adjusted as follows: Total US emissions of methane from gas industry: 100 percent of emissions from gas production (1.87 million tonnes CH4), 100% from processing (0.63 million tonnes CH4), none from transmission & storage none from distribution. Total methane of 2.50 million tonnes / US marketed production of 19,115 Bcf = 130.8 tCH4/Bcf.

Cell: I69
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.

Cell: I70
Comment: Rick Heede:
CMS computes the methane rate developed for the FEIR by MRS (Appendix G-58) in Table 3a.

Cell: K83
Comment: Rick Heede:
UCS (2007) "Rolling Smokestacks: Cleaning Up America's Trucks and Buses" Ch 1: "Each gallon of diesel fuel burned in a diesel truck engine results in emissions of 22.8 pounds of carbon and other heat-trapping gases. An additional 5.4 pounds of heat-trapping gases result from the production and delivery of each gallon (Wang and Huang 1999). The units are lb CO2 per gallon of diesel at combustion, lb CO2 per gallon from production to fuel delivery (well to tank), and percentage adder.

Cell: K84
Comment: Rick Heede:
Heede (2003) ExxonMobil Corporation Emissions Inventory 1882-2002: Methods and Results, page 23.

Cell: K85
Comment: Rick Heede:
Wang, Michael Q. (2001) Well-to-Tank Energy Use and Greenhouse Gas Emissions of Transportation Fuels: North American Analysis, Vol. 3, results summarized in Heede (2003). Units are Btu per mile for driving typical car, and Btu per mile for "wells to wheels," and full fuel cycle percent adder.

Cell: K86
Comment: Rick Heede:
FEIR, page 4.2-52: "GHG emissions associated with refining would increase these emissions by an estimated 13-17 %."). CMS averages this range to 15 percent, even though the datum cited (may) only include refinery inputs and excludes pipeline transportation to refineries and transportation by tanker trucks and product pielines to distribution centers and gasoline stations.

Cell: K87
Comment: Rick Heede:
Delucchi (2003) Lifecycle emissions model (LEM), table 56 "Upstream fuel cycle emissions as a percentage of end use emissions, by pollutant amd feedstock/fuel combination," shows 27 percent for conventional gasoline and 19 percent for diesel.

Since the gasoline/diesel output ratio is roughly 6.7 million bbl per week (gasoline) and 2.3 million bbl per week (diesel), CMS uses this blended average to estimate average fuel cycle emissions per gallon, i.e., (27 percent * 6.7 + 19 percent * 2.3) / (6.7 + 2.3) = (180.9 + 43.7) / 9.0 = 24.96 percent on average.
Cal gasoline and diesel refining data: www.energy.ca.gov/gasoline/quarterly/index.html

Delucchi (2003), page 95: "In Table H.6 of DeLuchi (1993), refineries consumed 0.145 BTUs of process energy to produce 1.0 BTU of conventional gasoline." Note: gasoline requires much higher refinery energy inputs than does diesel fuel (0.039 to 0.072). Note: refinery inputs only, excluding production, pipeline, and distribution energy and emissions. Since this does not include other refinery emissions sources, CMS uses above emissions calculations instead.

Cell: C95
Comment: Rick Heede:
CMS has estimated "sales gas production" from FEIR Fig. 2-9 (shown at left). The FEIR does not show detailed data on sales gas by or project duration except in Fig 2-9. Furthermore, the FEIR estimate of emissions from gas sold -- 526,000 tons CO2 per year -- is much higher. This discrepancy is possibly due to the FEIR inclusion of total gas produced, thus not taking account of company use of gas (e.g., for compressors) and/or for gas re-injected for pressurization and crude oil recovery.

Cell: F95
Comment: Rick Heede:
CMS estimates complete combustion of gas presumably sold to The Gas Company based on the data charted in Fig 2-9. CMS has not included ancillary emissions from methane leakage, or deducted for non-fuel uses of gas, gas processing emissions, or gas pipeline energy and emissions.

Cell: I95
Comment: Rick Heede:
From FEIR Fig 2-9 "crude oil annual average BPD". CMS estimated from chart.

Cell: L95
Comment: Rick Heede:
CMS adjusts full combustion by accounting for non-fuel uses of crude oil of 8.6 percent (based on EIA non-fuel uses, US) and incomplete combustion (0.5 percent, half of the 1.0 percent rate used by IPCC and EPA). Energy used in petroleum refining has not been accounted for.

Cell: N95
Comment: Rick Heede:
CMS computes -- from Table 5 above -- an average of five estimates of fuel cycle emissions from petroleum refining. This factor is thus an adder to combustion of the carbon contained in the crude oil produced and shipped from Paredon and delivered to Los Angeles area refineries. Energy and emission inputs to refineries include electricity, steam petroleum coke, natural gas, and propane. The factor applied here to the delivered crude oil (AFTER non-fuel uses of petroleum is deducted, column "L") equates to an emissions adder of 20.7 percent.

Cell: O95
Comment: Rick Heede:
CMS estimate of total end-use CO2e emissions for each yearof the 15-year production cycle, including combustion of carbon contained in produced oil, deduction for non-fuel uses, and addition of emissions from petroleum refining and delivery to end users (i.e., consumers of gasoline and diesel fuel, in particular).

Cell: D97
Comment: Rick Heede:
CMS's original CMS estimate from pencil and straightedge of FEIR Fig 2-9 resulted in total project "sales gas" production of 46.01 Bcf (3.07 Bcf/yr over 15 years). Since this total is higher than the total production cited in the FEIR -- 43 Bcf -- CMS adjusts the original production estimates by 0.933 (46 / 43). Note: The adjustment is made in column "D".

Previous (unadjusted) calculation:

Yr (estim Fig.2-9*adj fctr)	million cf/day	Bcf/yr
Year 1	0	0
Year 2	2.20	0.80
Year 3	3.80	1.39
Year 4	11.10	4.05
Year 5	18.00	6.57
Year 6	17.30	6.31
Year 7	14.90	5.44
Year 8	12.80	4.67
Year 9	11.00	4.02
Year 10	9.60	3.50
Year 11	8.20	2.99
Year 12	7.00	2.56
Year 13	5.50	2.01
Year 14	3.50	1.28
Year 15	1.40	0.51
Total	126.30	46.0995 Bcf total
Ave/yr	8.42	3.07 Bcf/yr

Cell: J97

Comment: Rick Heede:

As with natural gas production, the CMS estimation of crude oil production from FEIR Fig 2-9 resulted in slight over-estimates: 24.13 million bbl, rather than total oil production listed as 23.5 million bbl in the FEIR. This error is ~2.6 percent, and the downward adjusment is made below in annual production (not in daily production).

Unadjusted totals were:

Year 1	-	-
Year 2	800	292,000
Year 3	1,800	657,000
Year 4	6,700	2,445,500
Year 5	10,100	3,686,500
Year 6	8,900	3,248,500
Year 7	7,700	2,810,500
Year 8	6,700	2,445,500
Year 9	5,800	2,117,000
Year 10	5,000	1,825,000
Year 11	4,400	1,606,000
Year 12	3,800	1,387,000
Year 13	2,900	1,058,500
Year 14	1,300	474,500
Year 15	200	73,000
Total	66,100	24,126,500
Ave/yr	4,407	1,608,433