Rio Vista 83 Well Development Project - SMAQMD
CRITERIA POLLUTANTS & GREENHOUSE GAS EMISSIONS
TABLE 1: OPERATION EMISSIONS SUMMARY

Source	Peak Day Emissions (lbs/day)									Annual Emissions (tons/year)									$MTCO_2E$
	NO_x	ROG	PM_{10}	$PM_{2.5}$	CO	SO_2	N_2O	CH_4	CO_2	NO_x	ROG	PM_{10}	$PM_{2.5}$	CO	SO_2	N_2O	CH_4	CO_2	
Operations	38.2	12.6	6.36	4.79	32.1	0.230	0.096	134	45,664	6.97	2.30	0.695	0.555	5.86	0.042	0.016	24.5	8322	8111
Maximum Daily Emissions	**38.2**	**12.6**	**6.36**	**4.79**	**32.1**	**0.230**	**0.096**	**134**	**45,664**	--	--	--	--	--	--	--	--	--	--
Total Annual Emissions	--	--	--	--	--	--	--	--	--	***6.97***	***2.30***	***0.695***	***0.555***	***5.86***	***0.042***	***0.016***	***24.5***	***8322***	***8111***
SMAQMD Significance Thresholds	**65.0**	**65.0**	**80.0**	**81.0**	--	--	--	--	--	--	--	***14.6***	***15.0***	--	--	--	--	--	--
Threshold exceeded?	***No***	***No***	***No***	***No***	--	--	--	--	--	--	--	***No***	***No***	--	--	--	--	--	--
																GHG - $MTCO_2E$ conversions			***298***	***25***	***1***	--
																Total $MTCO_2E$ per year			***8,111***			

Notes:

- EPA Emission Factors for Greenhouse Gas Inventories (298 for N_2O, 25 for CH_4, and 1 for CO_2, Table 10a - https://www.epa.gov/sites/production/files/2018-03/documents/emission-factors_mar_2018_0.pdf
- Estimated total organic compound emissions are included with ROGs to be conservative. Total organic carbon emissions may include non-VOC's such as methane, ethane and other compounds (EPA, 1995).

SMAQMD - Sacramento Metropolitan Air Quality Management District
NO_x - Oxides of Nitrogen
ROG - Reactive Organic Gases
$PM_{2.5}$ - Particulate Matter 2.5 Microns or Less
PM_{10} - Particulate Matter 10 Microns or Less
DPM - Diesel Particulate Matter
CO - Carbon Monoxide
SO_2 - Sulfur Dioxide
N_2O - Nitrous Oxide
CH_4 - Methane
CO_2 - Carbon Dioxide
$MTCO_2E$ - Metric Tons of Carbon Dioxide Equivalent

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TABLE 2: Operations

On-Road Sources

						Emission Factors (g/mile)									Peak Day Emissions (lb/day)									Total Emissions (tons)								
Source	Peak Round Trips/Day	Average Round Trips/Day	Number of Vehicles	Length of Round Trip (miles)	Duration (days)	NO_x	ROG	PM_{10}	$PM_{2.5}$	CO	SO_2	N_2O	CH_4	CO_2	NO_x	ROG	PM_{10}	$PM_{2.5}$	CO	SO_2	N_2O	CH_4	CO_2	NO_x	ROG	PM_{10}	$PM_{2.5}$	CO	SO_2	N_2O	CH_4	CO_2
Passenger Vehicle - LDA (offsite)	1	1	1	10	52	0.0334	0.0058	0.0009	0.0009	0.6017	0.0026	0.0040	0.0016	262	0.001	0.000	0.000	0.000	0.013	0.000	0.000	0.0000	5.8	0.0000191	0.0000034	0.0000005	0.0000005	0.0003449	0.0000015	0.0000023	0.0000009	0.150
Light-Duty Truck - LDT2 (offsite)	1	1	1	10	52	0.0396	0.0083	0.0042	0.0040	0.0844	0.0025	0.0418	0.0004	265	0.001	0.000	0.000	0.000	0.002	0.000	0.001	0.0000	5.9	0.0000227	0.0000048	0.0000024	0.0000023	0.0000484	0.0000014	0.0000240	0.0000002	0.152
Passenger Vehicle - LDA (onsite)	1	1	1	2	52	0.0493	0.0220	0.0036	0.0033	1.0828	0.0042	0.0059	0.0059	427	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.0000	1.88	0.0000056	0.0000025	0.0000004	0.0000004	0.0001241	0.0000005	0.0000007	0.0000007	0.049
Light-Duty Truck - LDT2 (onsite)	1	1	1	2	52	0.0950	0.0980	0.0093	0.0089	0.9846	0.0049	0.0822	0.0045	522	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.0000	2.30	0.0000109	0.0000112	0.0000011	0.0000010	0.0001129	0.0000006	0.0000094	0.0000005	0.060
Med-Heavy Duty - T6 Utility (offsite)	1	1	2	10	52	0.2218	0.0037	0.0041	0.0039	0.0216	0.0092	0.1525	0.0002	968	0.010	0.000	0.000	0.000	0.001	0.000	0.007	0.0000	42.7	0.0002543	0.0000042	0.0000047	0.0000045	0.0000247	0.0000105	0.0001748	0.0000002	1.110
Med-Heavy Duty - T6 Utility (onsite)	1	1	2	2	52	0.9379	0.0122	0.0020	0.0019	0.0985	0.0141	0.2348	0.0006	1490	0.008	0.000	0.000	0.000	0.001	0.000	0.002	0.0000	13.14	0.0002150	0.0000028	0.0000005	0.0000004	0.0000226	0.0000032	0.0000538	0.0000001	0.342
														Total	**0.02**	**0.001**	**0.000**	**0.000**	**0.026**	**0.001**	**0.010**	**0.000**	**71.64**	**0.0005277**	**0.0000288**	**0.0000096**	**0.0000091**	**0.0006776**	**0.0000177**	**0.0002650**	**0.0000027**	**1.86**

Onroad Dust

						Emission Factors (g/mile)		Peak Day Emissions (lb/day)		Total Emissions (tons)	
Source	Peak Round Trips/Day	Average Round Trips/Day	Number of Vehicles	Length of Round Trip (miles)	Duration (days)	PM_{10}Dust	$PM_{2.5}$Dust	PM_{10}Dust	$PM_{2.5}$Dust	PM_{10}Dust	$PM_{2.5}$Dust
Passenger Vehicle - LDA (offsite)	1	1	1	10	52	0.5412	0.1357	0.012	0.003	0.0003102	0.0000778
Light-Duty Truck - LDT2 (offsite)	1	1	1	10	52	0.5421	0.1360	0.012	0.003	0.0003108	0.0000780
Passenger Vehicle - LDA (onsite)	1	1	1	2	52	0.0088	0.0031	0.00004	0.00001	0.0000010	0.0000004
Light-Duty Truck - LDT2 (onsite)	1	1	1	2	52	0.0121	0.0042	0.00005	0.00002	0.0000014	0.0000005
Med-Heavy Duty - T6 Utility (offsite)	1	1	2	10	52	0.5791	0.1489	0.026	0.007	0.0006639	0.0001707
Med-Heavy Duty - T6 Utility (onsite)	1	1	2	2	52	0.0615	0.0215	0.0005	0.0002	0.0000141	0.0000049
							Total	**0.0500525**	**0.0127781**	**0.0013014**	**0.0003322**

Natural Gas Use (Land Use)

				Emission Factors, g/MMBtu									Peak Day Emissions (lb/day)									Total Emissions (tons)								
Source	Number	Natural Gas Use MMBTU/day	Duration (days)	NO_x	ROG	PM_{10}	$PM_{2.5}$	CO	SO_2	N_2O	CH_4	CO_2	NO_x	ROG	PM_{10}	$PM_{2.5}$	CO	SO_2	N_2O	CH_4	CO_2	NO_x	ROG	PM_{10}	$PM_{2.5}$	CO	SO_2	N_2O	CH_4	CO_2
Compressor Engine	3	130	365	44.5	2.45	3.38	3.38	37.4	0.267	0.100	4.70	53,060	38.2	2.10	2.90	2.90	32.1	0.229	0.086	4.03	45,577	6.97	0.383	0.530	0.530	5.86	0.042	0.016	0.736	8,318
												Total	**38.2**	**2.10**	**2.90**	**2.90**	**32.1**	**0.229**	**0.086**	**4.03**	**45,577**	**6.97**	**0.383**	**0.530**	**0.530**	**5.86**	**0.042**	**0.016**	**0.736**	**8,318**

Notes:
- Equipment, number of personnel, hours and days of operation provided by the client.
- Natural gas fuel usage per compressor of one thousand cubic feet (MCF) provided by the client.
- 125 MCF of natural gas was converted to one million British thermal units MMBTU by using a 1MCF to 1.039 MMBTU conversion.

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TABLE 3: Operational Fugitive Total Organic Compounds

Oilfield Component Emission Sources

Source	Service	Emission Factors (lbs/hr/source)	Hours/day	Number of Sources	Duration (days)	TOC (lbs/day)	TOC (lbs/yr)	TOC (tons/yr)
Per Well Head								
Valves	Unprocessed Natural Gas	0.0099208	24	192	365	45.7	16,686	8.34
Connectors	Unprocessed Natural Gas	0.0004409	24	0	365	0.000	0.000	0.000
Flanges	Unprocessed Natural Gas	0.0008598	24	384	365	7.92	2,892	1.45
Open-Ended Lines	Unprocessed Natural Gas	0.0044092	24	0	365	0.000	0.000	0.000
Other	Unprocessed Natural Gas	0.0194007	24	0	365	0.000	0.000	0.000
					Total	**53.6**	**19,578**	**9.789**
					Total ROGs	**3.58**	**1,308**	**0.654**
					Total CH_4	**44.5**	**16,250**	**8.12**
					Total CO_2	**5.36**	**1,958**	**0.979**
Source	**Service**	**Emission Factors (lbs/hr/source)**	**Hours/day**	**Number of Sources**	**Duration (days)**	**TOC (lbs/day)**	**TOC (lbs/yr)**	**TOC (tons/yr)**
Pipelines								
Valves	Unprocessed Natural Gas	0.0099208	24	192	365	45.7	16,686	8.34
Pump Seals	Unprocessed Natural Gas	0.0052911	24	0	365	0.0000	0.000	0.000
Connectors	Unprocessed Natural Gas	0.0004409	24	384	365	4.06	1,483	0.742
Flanges	Unprocessed Natural Gas	0.0008598	24	0	365	0.0000	0.000	0.000
Open-Ended Lines	Unprocessed Natural Gas	0.0044092	24	0	365	0.0000	0.000	0.000
					Total	**103**	**37,747**	**18.9**
					Total ROGs	**6.91**	**2,522**	**1.26**
					Total CH_4	**85.8**	**31,330**	**15.7**
					Total CO_2	**10.3**	**3,775**	**1.89**
					Project Total ROGs	**10.5**	**3,829**	**1.91**
					Project Total CH_4	**130**	**47,580**	**23.8**
					Project Total CO_2	**15.7**	**5,733**	**2.87**

Notes:

ROG - Reactive Organic Gases

TOC - Total Organic Compounds

- ROG calculated as 6.68.% of TOC value. Composition of ROGs in unproccessed natural gas sourced from Journal of Natural Gas Science and Engineering · September 2014 (Roussanaly, 2014)
- CH_4 calculated as 83.0% of TOC value. Composition of CH_4 in unproccessed natural gas sourced from Journal of Natural Gas Science and Engineering · September 2014 (Roussanaly, 2014)
- CO_2 calculated as 10.0% of TOC value. Composition of CO_2 in unproccessed natural gas sourced from Journal of Natural Gas Science and Engineering · September 2014 (Roussanaly, 2014)
- Component source number provided by the client.

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TABLE 4: Construction Activity - Fugitive Dust Emissions

Activity	Source	Source Units	Number of Days	Emission Factor	Emission Factor, Units	Peak Day Emissions (lbs/day)		Total Emissions (tons)	
						PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Operation Activities									
Unpaved Road Travel - Workover Activities	6	vehicle-miles/day	96	0.57	lbs/vehicle-mile	3.41	1.87	0.164	0.025
					Total	**3.41**	**1.87**	**0.164**	**0.025**

Fugitive Dust Emissions: Inputs for the Table

Emission factors based on following inputs		
Mean number of rain days per year	*40*	*San Joaquin Valley per AP-42 13.2.2 Unpaved Roads*
Silt content of soil, fill storage pile, %	*1.5*	*SCAQMD default value*
Roadway inputs (paved and unpaved, as per URBEMIS)		
Roads mean vehicle weight, tons	*20.61*	*Average vehicle weight (average of loaded and unloaded)*
unpaved dirt road silt content, %	*4.3*	*AP-42 13.2.2 Unpaved Roads*
Industrial Roads Constant (a)	*0.9*	*AP-42 13.2.2 Unpaved Roads*
Industrial Roads Constant (b)	*0.45*	*AP-42 13.2.2 Unpaved Roads*
particle size multiplier	*1.5*	*AP-42 13.2.2 Unpaved Roads*
PM2.5/PM10 ratio	*0.15*	
Truck Loading inputs		
k, particle size multiplier, default=0.36 for pm10	*0.35*	
U, mean wind speed, mph range 1.3-15	*8.15*	
M, moisture content, default=12%	*12*	
PM2.5/PM10 ratio truck loading	*0.15*	
Site grading emissions from CalEEMod for grading	*0.091*	*ratio of PM2.5/PM10 CalEEMod*
Demolition materials, tons/yds3	*1.000*	*estimated for concrete debris*
Fill materials, tons/yds3	*1.000*	*estimated for soils*
Mitigation: demolition area watering (fraction reduction,	*0.61*	*0.61 for watering every 3 hours (SCAQMD)*
Mitigation: grading/dist area watering (fraction reduction,	*0.00*	*0.61 for watering every 3 hours (SCAQMD)*
Mitigation: dumping soil moisture (fraction reduction,	*0.69*	*0.69 for minimum 12% soil moisture (SCAQMD)*
Mitigation: storage piles (fraction reduction,	*0.90*	*0.90 for watering by hand and covering (SCAQMD)*
Mitigation: roads (fraction reduction)	*0.55*	*0.55 for watering 2X per day (SCAQMD), 0.80 for soil binders applied monthly (AP-42)*

Notes:

PM2.5/PM10 ratio as per AP-42 k factor for PM10 and PM2.5

Paved and unpaved road dust emissions based on AP-42 2006 (unpaved) Chapt 13. EPA AP-42 2006 is the same as URBEMS and CalEEMod

One month assumes 22 days of activity, as per URBEMIS

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TABLE 5: Emission Factors and Assumptions

Offsite/Onsite			Emission Factors (g/mile)									Emission Factors (lb/mile)								
Source	**Region**	**Speed**	**NO_x**	**ROG**	**PM_{10}**	**$PM_{2.5}$**	**CO**	**SO_2**	**N_2O**	**CH_4**	**CO_2**	**NO_x**	**ROG**	**PM_{10}**	**$PM_{2.5}$**	**CO**	**SO_2**	**N_2O**	**CH_4**	**CO_2**
Passenger Vehicle - LDA (onsite)	Statewide	15	0.049	0.022	0.004	0.003	1.083	0.004	0.006	0.006	427	0.0001	0.00005	0.000008	0.000007	0.0024	0.00001	0.00001	0.000013	0.9410
Passenger Vehicle - LDA (offsite)	Statewide	55	0.033	0.006	0.001	0.001	0.602	0.003	0.004	0.002	262	0.0001	0.00001	0.000002	0.000002	0.0013	0.00001	0.00001	0.000003	0.5785
Light-Duty Truck - LDT2 (onsite)	Statewide	15	0.095	0.098	0.009	0.009	0.985	0.005	0.082	0.005	522	0.0002	0.00022	0.000020	0.000020	0.0022	0.00001	0.00018	0.000010	1.1501
Light-Duty Truck - LDT2 (offsite)	Statewide	55	0.040	0.008	0.004	0.004	0.084	0.003	0.042	0.000	265	0.0001	0.00002	0.000009	0.000009	0.0002	0.00001	0.00009	0.000001	0.5851
Med-Heavy Duty - T6 Utility (onsite)	Statewide	15	0.938	0.012	0.002	0.002	0.098	0.014	0.235	0.001	1490	0.0021	0.00003	0.000004	0.000004	0.0002	0.00003	0.00052	0.000001	3.2859
Med-Heavy Duty - T6 Utility (offsite)	Statewide	55	0.222	0.004	0.004	0.004	0.022	0.009	0.152	0.000	968	0.0005	0.00001	0.000009	0.000009	0.0000	0.00002	0.00034	0.000000	2.1338
Heavy Duty Haul Truck - T78 (onsite)	Statewide	15	4.83	0.04	0.01	0.01	0.39	0.02	0.34	0.00	2168	0.0106	0.00008	0.000015	0.000014	0.0009	0.00005	0.00075	0.000004	4.7791
Heavy Duty Haul Truck - T78 (offsite)	Statewide	55	0.928	0.010	0.020	0.019	0.044	0.013	0.222	0.000	1408	0.0020	0.00002	0.000044	0.000042	0.0001	0.00003	0.00049	0.000001	3.1035

Offsite/Onsite - Dust			Emission Factors (g/mile)		Emission Factors (lb/mile)	
Source	**Region**	**Speed**	**PM_{10}Dust**	**$PM_{2.5}$Dust**	**PM_{10}Dust**	**$PM_{2.5}$Dust**
Passenger Vehicle - LDA (onsite)	Statewide	15	0.009	0.003	0.001	0.000
Passenger Vehicle - LDA (offsite)	Statewide	55	0.541	0.136	0.0000	0.0000
Light-Duty Truck - LDT2 (onsite)	Statewide	15	0.012	0.004	0.001	0.000
Light-Duty Truck - LDT2 (offsite)	Statewide	55	0.542	0.136	0.0001	0.0000
Med-Heavy Duty - T6 Utility (onsite)	Statewide	15	0.061	0.022	0.001	0.000
Med-Heavy Duty - T6 Utility (offsite)	Statewide	55	0.579	0.149	0.0003	0.0001
Heavy Duty Haul Truck - T78 (onsite)	Statewide	15	0.136	0.048	0.0013	0.0004
Heavy Duty Haul Truck - T78 (offsite)	Statewide	55	0.607	0.159	0.0000	0.0000

Natural Gas Emissions Factors		Emission Factors, g/MMBtu									Emission Factors (lb/MMBtu)								
Source	**Electricity Source**	**NO_x**	**ROG**	**PM_{10}**	**$PM_{2.5}$**	**CO**	**SO_2**	**N_2O**	**CH_4**	**CO_2**	**NO_x**	**ROG**	**PM_{10}**	**$PM_{2.5}$**	**CO**	**SO_2**	**N_2O**	**CH_4**	**CO_2**
Compressor Engine	Unprocessed Natural Gas	44.5	2.45	3.38	3.38	37.4	0.267	0.100	4.70	53,060	0.098	0.005	0.007	0.007	0.082	0.001	0.0002	0.010	117

Onsite		Emission Factors (lb/hr/source)
Emission Source	**Source**	**Total Organic Compounds**
Valves	Unprocessed Natural Gas	0.0099208
Pump Seals	Unprocessed Natural Gas	0.0052911
Connectors	Unprocessed Natural Gas	0.0004409
Flanges	Unprocessed Natural Gas	0.0008598
Open-Ended Lines	Unprocessed Natural Gas	0.0044092
Other	Unprocessed Natural Gas	0.0194007

Notes:

Emission Factors and load factors for equipment obtained from CalEEMod 2020, Appendix D and /or CalEEMod 2022, Appendix G.
Emission factors for on-road vehicles obtained from EMFAC2021 (year 2026, aggregated model year).
N_2O emissions factors from obtained State and Federal Mandatory Reporting Rule, Table 6.
Horsepower for construction equipment and drilling generators obtained from client.
On-road trucks are considered to be diesel powered and passenger cars are considered to be gasoline powered.
Total Organic Compound emissions factors obtained from *USEPA Protocol for Equipment Leak Emission Estimates, Table 2-4*
MMBtu - one million British thermal units
-- Not Available or Applicable.

padre associates, inc.
ENGINEERS, GEOLOGISTS & ENVIRONMENTAL SCIENTISTS