Update - Greenhouse Gas Inventory for Central Marin Sanitation Agency (Year 2012)

PREPARED FOR: Central Marin Sanitation Agency

PREPARED BY: Jim Sandoval/CH2M HILL

REVIEWED BY: Priya Sathyanarayan/CH2M HILL

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In 2013, CH2M HILL estimated the greenhouse gas (GHG) emissions for the Central Marin Sanitation Agency (CMSA) Regional Wastewater Treatment Facilities (RWTF). Since the cogeneration unit was offline for nearly three months in 2012, CMSA staff provided adjusted natural gas, digester gas, and purchased electricity consumption totals that would represent a "normal" or "typical" operational year for the purposes of study. In early 2014, CH2M HILL researched voluntary GHG reporting options for CMSA and discovered that adjusted data would not be permissible in a certified GHG inventory with The Climate Registry. Actual data would have to be reported, even during unusual years with extended equipment failures.

In response to this information, CMSA staff asked CH2M HILL to update the 2012 GHG emissions inventory using the actual data for natural gas, digester gas, and purchased electricity consumption. Should CMSA decide to voluntarily report its emissions to TCR, the results of this updated inventory will more accurately align with the emissions yielded by TCR's *Climate Registry Information System* (CRIS) tool.

The updated 2012 GHG emissions estimated for the CMSA RWTF are summarized in Table 1. The highest source of direct emissions from the RWTF in 2012 was biogenic CO_2 emissions from the combustion of digester biogas, followed by anthropogenic emissions from the combustion of digester natural gas. In voluntary and regulatory GHG reporting programs, the CO_2 emissions associated with combustion of biogas are typically tracked and reported separately from Scope 1 emissions because the gas is from a biogenic source, rather than an anthropogenic source such as natural gas or diesel fuel.

Table 2 provides further details that support the data in Table 1. All of the backup calculations supporting the data in these tables are in Attachment 1. The updated data provided by CMSA staff is in Attachment 2.

Table 1. Summary of CMSA Carbon Dioxide Equivalent (CO_{2e}) Emissions for 2012

Source Type	Primary Source Description	CO_{2e} (Metric Tons)
Stationary Combustion (Anthropogenic)	Cogeneration Engine; Boilers; Flares; Diesel Pumps and Generator	**1,513**
Stationary Combustion (Biogenic)	Cogeneration Engine; Boilers; Flares; Diesel Pumps and Generator	**1,937**
Mobile Anthropogenic	CMSA Vehicles & Biosolids Transfer Trucks	**53**
Wastewater Fugitive and Process Emissions	- Incomplete Methane Combustion; - Effluent Discharge; - Centralized Treatment without Nitrification/Denitrification	**1,128**
Indirect Emissions	Purchased Electricity	**281**
Total Scope 1, 2, and 3 CMSA CO_{2e} Emissions		**4,912**

Table 2 breaks out the emissions by scope. The RWTF's highest emissions are in the Scope 1 (direct emissions) category. The CO_2 emissions associated with combustion of digester gas are tracked and reported separately from Scope 1 emissions because the gas is from a biogenic source, rather than an anthropogenic source such as natural gas or diesel fuel.

TABLE 2. SUMMARY OF YEAR 2012 GHG EMISSIONS FOR THE CMSA RWTF

Scope	GHG Emissions (metric tons/ year)				
	Anthropogenic CO_2	CH_4	N_2O	CO_2e [a]	Biogenic CO_2
1	1,521	7.23	3.18	**2,661**	
2	279	0.020	0.004	**281**	
3	23	0.00006	0.00006	**23**	
Biogenic CO_2		0.1190	0.0234	**10** [b]	1,937

a CO2e emissions were estimated using a GWP of 21 for CH_4 and 310 for N_2O.

b The biogenic CO_2e accounts for CH_4 and N_2O emissions, which are Scope 1.

The only Scope 3 emissions estimated were for the transfer of biosolids using trucks owned by contractor Total Waste Systems from the RWTF to the end-use destination at Synagro in southern Sonoma County (land-applied soil amendment) in May through October and to the Redwood Landfill in Novato (alternative daily cover) in November through April. For the purposes of this study, CH2M HILL did not estimate Scope 3 emissions from any other source.

The formulas supporting the calculations in Attachment 1 are in CH2M HILL's GHG inventory spreadsheet tool *CMSA_2012_GHG_Inventory-Update-2014May23.xlsx*, submitted to CMSA staff along with this updated technical memorandum.

Updating the 2012 GHG inventory from "normalized" data to actual data resulted in decreasing the Scope 1 CO_2e emissions from 2,982 metric tons CO_2e to 2,671 metric tons

CO_2e (a 10% decrease) and increasing the Scope 2 CO_2e emissions from 124 metric tons CO_2e to 281 metric tons CO_2e (a 127% increase). The Scope 1 emissions decreased because the actual amount of natural gas consumed for fueling the cogeneration unit was less than a typical year's consumption because the system was down for extended servicing. And since the cogeneration unit was not producing electricity to power the plant, additional grid power had to be purchased to fill the power void. Purchasing additional grid power yielded the Scope 2 emissions increase.

Since biogas production in the digesters is a constant, the utilization of actual data did not change the amount biogas produced and combusted. However, in the updated GHG inventory the volume of biogas produced was updated from 50.272 million standard cubic feet (MMscf) to 54.707 MMscf, which yielded a change in the biogenic GHG emissions produced from 1,780 to 1,937 metric tons CO_2e.

Biogas production was measured by two meters in 2012: Meter Nos. FIT 12101A and FIT 1391. During the original 2012 GHG inventory in 2013, the data from FIT 12101A was utilized and yielded a biogas volume of 50.272 MMscf. However, during the exercise of updating the GHG emissions inventory to actual data, CMSA operations staff decided to utilize the meter readings of Meter No. FIT 1391, which yielded a biogas production volume of 54.707 MMscf that was approximately 9 percent higher than Meter No. FIT 12101A's result. The higher volume was used in the inventory so that the estimated GHG emissions would yield a more conservative (i.e., higher) value resulting from biogas combustion. In order to minimize future discrepancies in biogas production data, CMSA recently installed two additional meters (i.e., Meter Nos. FI_13_101 and FI_13_102) that measure the biogas produced in each digester respectively, and also replaced FIT 1391 with a new meter. The addition of these redundant meters in the biogas system will increase the assurance of more accurate gas production measurements.

For further details about this GHG inventory, including background information, definitions, and assumptions, please refer to the November 6, 2013, *Greenhouse Gas Inventory for Central Marin Sanitation Agency (Year 2012) Technical Memorandum* by CH2M HILL.

Attachment 1

Central Marin Regional Wastewater Treatment Facilities
2012 Greenhouse Gas Emissions Calculations

May 23, 2014 Update

Attachment 1.A

Summary

Central Marin Regional Wastewater Treatment Facilities 2012 GHG Emissions

Source	Scope	Emissions (metric tons/year)			
		Anthropogenic CO2	CH4	N2O	CO2e
Stationary Combustion	1	1,492	0.147	0.026	1,503
Mobile Combustion	1 and 3	53	0.013	0.001	53
Fugitive CH4 and Process N2O Emissions	1	-	7.160	3.153	1,128
Indirect Emissions (Purchased Electricity)	2	279	0.020	0.004	281
Biogenic CO2 (metric tons/yr)	1,937	-	0.1190	0.0234	10

1.Emissions estimated following the Local Government Operations Protocol (LGOP), Version 1.1, May 2010 (LGOP, 2010); The Climate Registry General Reporting Protocol, Version 2.0, March 2013; and California Air Resources Board (ARB) Regulation for the Mandatory Reporting of Greenhouse Gases (GHG), Title 17, Div. 3, Chapter 1, Subchapter 10, starting with Section 95100. The ARB GHG regulation references 40 Code of Federal Regulations Part 98 Subpart C.

2.Mobile combustion includes scope 1 emissions from CMSA owned vehicles and scope 3 emissions from biosolid hauling.

3.Biogenic emissions from combustion are reported separately from the scopes (LGOP, 2010).

2012 Summary of Emissions by Scope

Scope	Emissions (metric tons/year)				
	Anthropogenic CO2	CH4	N2O	CO2e	*Biogenic CO2*
1	1,521	7.32	3.18	**2,661**	
2	279	0.020	0.004	**281**	
3	23	0.00006	0.00006	**23**	
Biogenic		0.1190	0.0234	**10**	*1,937*

Definition of Scope Numbers (LGOP, 2010):

Scope 1: All direct GHG emissions (with the exception of direct CO2 emissions from biogenic sources).
Scope 2: Indirect GHG emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling.
Scope 3: All other indirect emissions not covered in Scope 2, such as emissions resulting from the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity (e.g., employee commuting and business travel), outsourced activities, waste disposal, etc.

Attachment 1.B

Stationary Combustion and Fugitive Methane

Methodologies:
*Basic methodology: Emissions = Activity Data * Emission Factor * Mass Conversion Factor*

General Stationary Combustion Emissions:
Calculation methodology from California Air Resources Board (ARB) Regulation for the Mandatory Reporting of Greenhouse Gases (GHG), Title 17, Div. 3, Chapter 1, Subchapter 10, starting with Section 95100.
Emission factors from Table C-1 of Subpart C, Part 98.

CH4 Emissions from Incomplete Combustion:
Calculation methodology from LGOP, Version 1.1, Chapter 10: Wastewater Treatment Facilities, May 2010 (LGOP, 2010).

Assumptions:
None identified.

Color coding:

User entry cells
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Source	Emissions (metric tons/year)				
	Anthropogenic CO2	*Biogenic CO2*	CH4	N2O	CO2e
General Stationary Combustion Emissions from natural gas and biogas, estimated on the *ARB Mandatory Reporting Check* tab, including one cogen engine, two biogas fuel boilers, and two waste biogas flares.	1,484.05	*1,937.05*	1.47E-01	2.62E-02	1,495.27
General Stationary Combustion Emissions from five diesel engine-driven pumps and a diesel generator, estimated on thee *ARB Mandatory Reporting Check* tab.	7.85	*0*	3.18E-04	6.37E-05	7.88
TOTALS	**1,491.90**	***1,937.05***	**0.147**	**0.026**	**1,503.15**

NOTES:
1. The emission factor used to calculate the biogas emissions did not include pass-through CO2 emissions (which doubles the factor).
2. CO2e is the sum of anthropogenic CO2, CH4, and N2O.

Calculation of CH4 Fugitive Emissions from Incomplete Combustion of Digester Gas
Equation 10.1 from LGOP, Version 1.1, May 2010 (LGOP, 2010):

$$CH_4 \text{ incomplete combustion of digester gas [metric tons } CH_4\text{/year]} = \text{Digester Gas [ft}^3\text{/day]} \times F_{CH4} \times \rho(CH_4)[g/m^3] \times (1 - DE) \times 0.0283[m^3/ft^3] \times 365.25[\text{day/year}] \times 10^{-6} [\text{metric ton/g}]$$

where

Term	Description	Value	CO_2e (metric tons/yr)	
CH_4 incomplete combustion of digester gas	= CH_4 emissions from incomplete combustion of digester gas [metric ton CH_4/year]	**7.16**	**150.35**	
Digester Gas	= measured standard cubic feet of digester gas produced per day [ft^3/day]	149,473		Data source: Annual digas consumption provided in CMSA 2012 GHG Study Compiled Data document divided by 366 days in 2012.
F_{CH4}	= measured fraction of CH_4 in biogas	0.70		Data source: CMSA IR meter (average of mole% CH4 in *Kg C per Kgmoles Gas)*
$\rho(CH_4)$	= density of methane at standard conditions [g/m^3]	662.00		
DE	= CH_4 destruction efficiency from flaring or burning in engine	0.99		
0.0283	= conversion from ft^3 to m^3 [m^3/ft^3]	0.0283		
365.25	= conversion factor [day/year]	365.25		
10^-6	= conversion from g to metric ton [metric ton/g]	1.E-06		

Attachment 1.C

Reporting Applicability Check for Revised Regulation
Central Marin Regional Wastewater Treatment Facilities

Emission Factor Sources:
40 CFR Part 98 Subpart C, General Stationary Fuel Combustion Sources, December 2010 (see http://www.epa.gov/ghgreporting/reporters/subpart/index.html).
Emission factors and High Heat Values for Diesel, Natural Gas, and Biogas from 40 CFR Part 98 Subpart C, Tables C-1 and C-2.

Methodology:
Basic methodology: Emissions = Fuel Use x High Heat Value (HHV) x Emission Factor

Diesel Fuel Emissions Methodology
40 CFR Part 98 Subpart C, Section 98.33(a)(1)(i), Equation C-1, and Section 98.33(c)(1) Equation C-8

Equation C-1 or C-8: CO_2, CH_4, or $N_2O = 1 \times 10^{-3} \times Fuel \times HHV \times EF$

Where:
CO_2, CH_4, N_2O = Annual CO_2, CH_4, or N_2O mass emissions for a specific fuel type (metric tons).
Fuel = Volume of the fuel combusted during the year, from company records as defined in § 98.6 (standard cubic feet for gaseous fuel and gallons for liquid fuel).
HHV = Default high heat value of the fuel from Table C-1 of 40 CFR 98.
EF = Fuel-specific default CO_2 emission factor, from Table C–1 of this subpart (kg CO_2/MMBtu), or CH_4 and N_2O emission factors, from Table C-2 of this subpart (kg CH_4 or N_2O/MMBtu).
1×10^{-3} = Conversion factor from kilograms to metric tons.

Natural Gas and Biogas Emissions Methodology
40 CFR Part 98 Subpart C, 98.33 (a)(2), Equations C-2a and C-2b, and 98.33 (c)(2), Equation C-9a

Equation C-2a or C-9a:

Where:
CO_2, CH_4, N_2O = Annual CO_2, CH_4, or N_2O mass emissions for a specific fuel type (metric tons).
Fuel = Volume of the fuel combusted during the year, from company records as defined in § 98.6 (standard cubic feet for gaseous fuel and gallons for liquid fuel).
HHV = Annual average HHV of the fuel from all valid samples for the year (MMBtu per mass or volume). The average HHV shall be calculated according to the requirements of paragraph (a)(2)(ii) of this section.
EF = Fuel-specific default CO_2 emission factor, from Table C–1 of this subpart (kg CO_2/MMBtu), or CH_4 and N_2O emission factors, from Table C-2 of this subpart (kg CH_4 or N_2O/MMBtu).
1×10^{-3} = Conversion factor from kilograms to metric tons.

Equation C-2b: $HHV_{annual} = \Sigma (HHV_i \times Fuel_i) / \Sigma Fuel_i$

Where:
HHV_{annual} = Weighted annual average HHV of the fuel (MMBtu per volume).
HHV_i = HHV of the fuel for month "i"
$Fuel_i$ = Volume of the fuel combusted during month "i"

Emission Calculations for 2012

Emission Source(s)	Type of Fuel	Annual Fuel Consumption	Fuel Consumption Units	High Heat Value (HHV)	HHV Units	CO_2 Emission Factor (kg/MMBtu)	CO_2 Emissions (metric tons/year)	CH_4 Emission Factor (kg/MMBtu)	CH_4 Emissions (metric tons/year)	N_2O Emission Factor (kg/MMBtu)	N_2O Emissions (metric tons/year)	CO_2e Emissions (metric tons/year)
Facility Diesel Fuel	Diesel	769	Gallons	0.138	MMBtu/gal	73.96	7.85	3.00E-03	3.18E-04	6.00E-04	6.37E-05	8
Facility Natural Gas	Natural Gas	27.228	MMscf	1,028	MMBtu/MMscf	53.02	1,484	1.00E-03	2.80E-02	1.00E-04	2.80E-03	1,486
Facility Digester Gas - Cogen	Biogas	39.512	MMscf	680	MMBtu/MMscf	52.07	1,399	3.20E-03	8.60E-02	6.30E-04	1.69E-02	1,406
Facility Digester Gas - Boilers (2)	Biogas	7.597	MMscf	680	MMBtu/MMscf	52.07	269	3.20E-03	1.65E-02	6.30E-04	3.25E-03	270
Facility Digester Gas - Flares (2)	Biogas	7.597	MMscf	680	MMBtu/MMscf	52.07	269	3.20E-03	1.65E-02	6.30E-04	3.25E-03	270
											Total (metric tons/year)	**3,440**

Notes:

1. For completeness, the diesel fuel use has been included. However, the "relatively stand-by" diesel engine-driven pumps may be exempt from reporting per 40 CFR Part 98 Subpart C, Section 98.30(b)(2). The diesel values are from the 8/13/13 "CMSA 2012 GHG Study Compiled Data" spreadsheet.

2. The natural gas and digester gas fuel consumption includes gas to the one dual fuel cogen engine, two digester gas fuel boilers, and two waste digester gas flares. Natural gas use based on the PG&E meter value.
3. Since the WWTF's cogen engine was offline from 10/18/12 - 12/31/12, the natural gas that would typically be used by the engine during this period was estimated by CMSA staff.
4. Since the 2012 HHV for natural gas was not available, CMSA provided PG&E's October 2013 HHV of 1,028 MMBtu/MMscf.

5. The HHV for biogas was measured on 8/29/13 by Centek Laboratories using ASTM Method 3588. If CMSA were obligated to comply with 40 CFR Part 98, HHVs would ideally be measured monthly to produce an accurate annual weighted average HHV. See 40 CFR 98.33(a)(2)(ii).

6. 15.194633 MMscf of digester gas was combusted in the boilers and flares. Since there are no measurements to break down the usage in each combustion source, it is assumed the boilers use 50% of the gas and the flares use 50%.

Comparison of Emissions to Threshold

Sector	Reporting Threshold (metric tons CO_2e/yr)	Reporting Required?
General Stationary Combustion (GSC)	10,000	No

Attachment 1.D

Mobile Sources

Methodology:
Calculation methodology from TCR General Reporting Protocol, Version 2.0, Chapter 13 and LGOP, Version 1.1, Chapter 7: Vehicle Fleet, May 2010 (LGOP, 2010).
*Basic methodology: Emissions = Activity Data * Emission Factor * Mass Conversion Factor*
Emission factors from The Climate Registry's 2013 Default Emission Factors document and Tables G.11, G.12, G.13, and G.14 of the LGOP, Version 1.1, May 2010 (LGOP, 2010).

Calculations:
CO2 Emissions (metric tons/year) = Fuel Usage (gallons/year) x CO2 Emission Factor (kg/gallon) x 0.001 (metric tons/kg)
CH4 Emissions (metric tons CO2e/year) = Mileage (miles/year) x CH4 Emission Factor (g/mile) x 0.000001 (metric tons/g)
N2O Emissions (metric tons CO2e/year) = Mileage (miles/year) x N2O Emission Factor (g/mile) x 0.000001 (metric tons/g)
CO2e Emissions (metric tons/year) = CO2 Emissions (metric tons /year) + CH4 emissions x 21 (metric tons CO2e/metric tons CH4) + N2O emissions x 310 (metric tons CO2e/metric tons N2O)

Assumptions:
Due to the small number of vehicles and climate in San Rafael, it was assumed that air conditioning use was negligible such that fugitive emissions from vehicle air conditioning systems would be minor and did not need to be estimated.
Biosolids hauling truck has an assumed fuel economy (miles/gallon) of 5.5.

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Vehicle Type and Year[1]	Year	VIN	Fuel Type	Fuel Usage (gallons/year)	Fuel Economy (miles/gallon)[7]	Mileage (miles/year)	CO2 Emission Factor (kg/gallon)	CO2 Emissions (metric tons/year)	CH4 Emission Factor (g/mile)	CH4 Emissions (metric tons/year)	N2O Emission Factor (g/mile)	N2O Emissions (metric tons/year)	CO2e (metric tons/year)
Ford F150 (ES/Lab)[2]	2012	1FTFX1CF3CFA45687	Gasoline	457.1	16	7,314	8.78	4.01	0.0163	0.00012	0.0066	0.00005	4.03
Ford F150[3]	2000	1FTPF17MXYKA91404	CNG	312.3	11	3,435	0.007	0.00	0.737	0.00253	0.050	0.00017	0.11
Ford E250 (E/I)	2008	1FNE24W58DA82877	Gasoline	80.8	15	1,212	8.78	0.71	0.0163	0.00002	0.0066	0.00001	0.71
Ford F450	2007	1FDXF46P87EB32036	#2 Diesel	22.7	11	250	10.21	0.23	0.0010	0.00000	0.0015	0.00000	0.23
Ford Ranger 2009	2009	1FTYR14D99PA63193	Gasoline	246.9	16	3,950	8.78	2.17	0.0163	0.00006	0.0066	0.00003	2.18
Ford Ranger 2006	2006	1FTYR14D67PA18368	Gasoline	572.5	15	8,588	8.78	5.03	0.0159	0.00014	0.0089	0.00008	5.05
Ford Crown Victoria[3]	2001	2FAFP7298lXI9I220	CNG	907.7	14	12,708	0.007	0.01	0.737	0.00937	0.050	0.00064	0.40
Ford Explorer	2005	1FMDU62E95UB29612	Gasoline	342.4	14	4,793	8.78	3.01	0.0157	0.00008	0.0101	0.00005	3.02
Honda Civic Eleven	2006	JHMFA36226S011241	Gasoline Hybrid	103.3	40	4,131	8.78	0.91	0.0161	0.00007	0.0057	0.00002	0.92
Honda Civic Twelve	2006	JHMFA36206S030693	Gasoline Hybrid	157.1	40	6,285	8.78	1.38	0.0161	0.00010	0.0057	0.00004	1.39
Toyota Highlander	2007	JTEEW21A670043898	Gasoline Hybrid	473.6	28	13,260	8.78	4.16	0.0170	0.00023	0.0041	0.00005	4.18
Caterpillar 5000 # Forklift (P5000-LP)[4]	2008	AT3511036	Propane	939.3	N/A	149	5.590	5.25	0.0010	0.00000	0.0001	0.00000	5.25
Bobcat Skid Steer Loader S185[5,6]	2006	530313189	#2 Diesel	240.3	2.7	89	10.21	2.45	0.58	0.00014	0.26	0.00006	2.48
Diesel Heavy Duty Trucks - Biosolid Hauling			#2 Diesel	2,293.1	5.5	12,612	10.21	23.41	0.0051	0.00006	0.0048	0.00006	23.43
Total Mobile GHG Emissions						**78,776**		**52.73**		**0.013**		**0.001**	**53.38**

Notes:

1. The diesel and gasoline light duty trucks are CMSA owned and are classified as Scope 1 emissions. The diesel heavy duty trucks represent the biosolid hauling trucks that are contractor owned and are classified as Scope 3 emissions.

2. The Climate Registry's 2013 Default Emission Factors document only has data through year 2010. The Ford F150 (ES/Lab) truck is a 2012, but is considered a 2010 for calculation purposes.
3. The CO2 emission factor for CNG vehicles is in units of kg/scf. Accordingly the CO2 emission factor has been converted from 0.054 kg CO2/scf to 0.007 kg CO2/gallon.

4. No fuel economy data for the Caterpillar P5000-LP Forklift could be found in an internet querry. Gallons of propane fuel usage were estimated to be 939 gallons using the following formula for propane gas: annual fuel use (gal/yr) = (hrs use) x hp x (10,000 BTU/hr/hp) x (1 gal/92,000 BTU). 2008 P5000-LP has a HP of 58 at 2675 rpm. Propane BTU properties found at http://www.yamaha-propane-natural-gas-generators.com/fuel_consumption.htm. The Climate Registry's 2013 Default Emission Factors document only has Canadian emission factors for CH4 and N2O in g/liter. Accordingly, the CH4 and N2O emissions factors from Table G.4 of the LGOP have been used.

5. The Bobcat Skid Steer fuel usage is based on a specified fuel economy of 2.7 gallons/hour and 89 hours operated in 2012. Fuel economy reference is October 6, 2007, Bobcat S185 Skid-Steer Loader Sepcifications document: http://webcache.googleusercontent.com/search?q=cache:pLk-mFWABqMJ:lewisrentspdx.com/LinkClick.aspx%3Ffileticket%3DYEwnKm3htpU%253D%26tabid%3D+&cd=4&hl=en&ct=clnk&gl=us.

6. The CH4 and N2O emissions factors for construction equipment have units of g/gallon instead of g/mile. Accordingly the emissions factors for the Bobcat are multiplied by the gallons used, not the miles driven.
7. Since the annual fuel use amount for each individual vehicle was not available, it was back-calculated from vehicle MPG database at the U.S. Department of Energy website http://fueleconomy.gov/. "City" MPG values were used for CMSA-owned vehicles since the majority of miles are likely off-highway.

Attachment 1.E

Process Emissions

Methodology:
Calculation methodology from LGOP, Version 1.1, Chapter 10: Wastewater Treatment Facilities, May 2010 (LGOP, 2010).

Calculations:
See equations below.

Assumptions:
The facility does not include lagoons, nitrification/denitrification, or septic systems.

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Process N_2O Emissions - WWTFs without Nitrification/Denitrificaiton
Equation 10.8 from LGOP, Version 1.1, May 2010 (LGOP, 2010):

$$N_2O_{plant\ w/o\ nit/denit}\left[\frac{metric\ ton\ N_2O}{year}\right] = P\ [person] \times EF_{w/o\ nit/denit}\left[\frac{g\ N_2O}{person \times year}\right] \times 10^{-6}\left[\frac{metric\ ton}{g}\right]$$

where

Term	Description	Value	CO_2e (metric tons)
N_2O plant	= N_2O emissions from a centralized WWTP [metric ton N_2O/year]	**0.35**	**109**
P	= population that is served by the WWTP without nitrification/denitrification [person]	110,000	
EF w/o nit/denit	= emission factor for a WWTP without nitrification/denitrification [g N_2O/person/year]	3.2	
10^-6	= conversion from g to metric ton [metric ton/g]	1.E-06	
CO2e (metric ton)	= N2O Global Warming Potential	310	

Note: if a significant quantity of industrial wastewater (N) is co-discharged with domestic wastewater, then the population should be multiplied by a factor of 1.25. Since only 3% is industrial, the factor is not used.

Process N_2O Emissions - Effluent discharge to receiving aquatic environments
Equation 10.9 from LGOP, Version 1.1, May 2010 (LGOP, 2010):

$$N_2O_{effluent}\ [metric\ tons\ N_2O/year] = TN_{effluent}\ [kg\ N/day] \times EF_{effluent}\ [(kg\ N_2O - N)/(kg\ sewage - N)] \times 44/28\ [(kg\ N_2O)/(kg\ N_2O - N)] \times 365.25\ [days/year] \times 10^{-3}\ [metric\ tons/kg]$$

where

Term	Description	Value	CO_2e (metric tons)
N_2O effluent	= N_2O emissions from effluent discharge to aquatic environments [metric ton N_2O/year]	**2.8**	**868**
TN effluent	= measured average total nitrogen discharged [kg N/day]	976	
EF effluent	= emission factor [kg N_2O-N/kg sewage-N produced]	0.005	
44/28	= conversion of kg N_2O-N into kg N_2O (molecular weight ratio of N_2O to N_2)	1.57	
365.25	= conversion factor [day/year]	365.25	
10^-3	= conversion from kg to metric ton [metric ton/kg]	1.E-03	
CO2e (metric ton)	= N2O Global Warming Potential	310	

TOTAL N2O PROCESS EMISSIONS	**3.15**	**977.41**

Attachment 1.F

Purchased Electricity

Methodology:
Calculation methodology from LGOP, Version 1.1, Chapter 6: Facilities, May 2010 (LGOP, 2010).
Emission factors from Table 14.1 of The Climate Registry's 2013 Default Emission Factors, updated on April 2, 2013 (see http://www.theclimateregistry.org/resources/protocols/general-reporting-protocol/).

Calculations:
Emissions (metric tons) = Electricity Use (MWh) × Emission Factor (lbs/MWh) / 2,204.62 (lbs/metric ton)
CO2e Emissions (metric tons/year) = CO2 Emissions (metric tons/year) + CH4 emissions x 21 (metric tons CO2e/metric tons CH4) + N2O emissions x 310 (metric tons CO2e/metric tons N2O)

Assumptions:
None identified.

Color coding:
User entry cells
Pre-defined cells

Electricity Use

Facility	Purchased Electricity (kWh/year)
RWTF (January-June 2012)	746,460
RWTF (July-December 2012)	746,460
Total	1,492,920

Emissions

Grid Power Utility[1]	Electricity Use (MWh/year)[2]	CO2 Emission Factor (lbs/MWh)[3, 4]	CO2 Emissions (metric tons/year)	CH4 Emission Factor (lbs/MWh)	CH4 Emissions (metric tons/year)[5]	N2O Emission Factor (lbs/MWh)	N2O Emissions (metric tons/year)[5]	CO2e (metric tons/year)
PG&E (January-June 2012)	746	444.62	151	0.02894	0.0098	0.00617	0.00209	151
Marin Clean Energy (July-December 2012)	746	380	129	0.02894	0.0098	0.00617	0.00209	130

Notes:
1. CMSA changed its power utility provider from PG&E to Marin Clean Energy on July 1, 2012.
2. It is assumed that each utility provided 50% of CMSA's power consumption in 2012.
3. The most current CO2 emission factor published for PG&E is for 2012. It is published at http://www.theclimateregistry.org/resources/protocols/general-reporting-protocol/#jump3. In the November 5, 2013 inventory, the latest published value was for year 2011 at 392.87 lbs/MWh.

4. The most current CO2 emission factor published for Marin Clean Energy is for 2012. It is published at http://www.marinenergyauthority.com/sites/default/files/key-documents/Att.%20A%20-%20Understanding%20MCE%20GHG%27s%20Emission%20Factor_2012_3%2021%202014.pdf. In the November 5, 2013 inventory, the latest published value was for year 2011 at 389 lbs/MWh.

5. CH4 and N2O emission factors were not published for PG&E or Marin Clean Energy. Accordingly, California values published by the Western Electricity Coordinating Council were used. They are published in Table 14.1 of The Climate Registry's 2014 Default Emission Factors document. The latest values published are from 2009.

Attachment 2

Data Request Form

Summary of Collected Data (May 1, 2014 Update)

REQUEST FOR 2012 DATA
2012 Greenhouse Gas Emissions Inventory
Central Marin Sanitation Agency Wastewater Treatment Facility

Please provide the following data for calendar year 2012. The data will support the estimation of Scope 1, Scope 2 and limited Scope 3 Greenhouse gas (GHG) emissions.[1]

SCOPE 1 GHG Data

1. Mobile Combustion
    a. Provide the following information for <u>each</u> vehicle owned by CMSA that is dedicated to the wastewater treatment facility (WWTF). For CMSA vehicles that partially support the WWTF, provide a percentage.
        i. Vehicle Owner[2]
        ii. Make
        iii. Model
        iv. Model Year
        v. Fleet ID#
        vi. 2012 miles traveled
        vii. Fuel type (gasoline, diesel, biodiesel 20, etc.)
        viii. Fuel use amount (gallons or liters) in 2012
            1. Measured carbon content of fuels and measure fuel density or heat content. If you cannot obtain these, then we need the measured heat content. If you cannot obtain the measured heat content, then we'll use the less accurate Tier B calculations which allow for default values for carbon and heat content.
        ix. Vehicle type and associated control technology in Table 13.4 of the attached "2013-TCR-Default-Emissions-Factors.pdf" file
            1. If gathering the control technology is not possible or too cumbersome, The Climate Registry (TCR) General Reporting Protocol (GRP) allows reporting agencies to utilize Table 13.5, in which case you need to provide the vehicle type on Table 13.5

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[1] Scope 1 GHG emissions are from sources *owned or controlled* by the CMSA WWTF. Scope 2 emissions result from the generation of electricity, heat or steam *purchased* by the WWTF. Scope 3 emissions are from *sources not owned or directly controlled* by the WWTF, *but related* to the facility activities.

[2] The GHG emissions of vehicles that are not owned by CMSA (e.g., biosolids transfer trucks) will be moved to the Scope 3 emissions category.

2. Stationary Combustion

    a. A list of stationary emission sources such as natural gas and dual fuel boilers, generators, flares, fuel powered pumps, or cogeneration engines and the fuel type for each source. An inventory of emergency or standby equipment.

    b. The total facility natural gas and digester gas throughput in 2012 (units of standard cubic feet [scf] for natural gas and scf or MMBtu for digester gas) in all stationary emissions sources including:[3]

        i. Cogeneration engines

        ii. Flares

        iii. Boilers

    c. The monthly and annual average natural gas heat content (units of Btu/scf). The monthly value should be provided on the utility bill/invoice.

    d. The measured monthly and annual average digester gas heat content (units of Btu/scf)

    e. The total facility diesel throughput in 2012 (units of gallons) in all stationary emissions sources.[4]

    f. The total facility gasoline throughput in 2012 (units of gallons) in all stationary emissions sources. [4]

    g. Additional information to consider: How is fuel use metered? Is there one meter for each fuel type (e.g. PG&E natural gas meter)? Does each unit have a separate meter? The regulation requires that emissions are calculated based on a meter with calibrated accuracy of $\pm$ 5 percent. For example, if the individual natural gas meters do not have this accuracy, you can report the fuel use by the individual meters and use the PG&E meter to estimate emissions. ARB assumes PG&E (or other supplier) meters meet the $\pm$ 5 percent accuracy.

    h. If the total General Stationary Combustion GHG emissions are found to exceed 10,000 metric tons CO2e, then CH2M HILL may request additional data that may include the following information. <u>However, it is not necessary to collect this data at this time.</u>

        i. The cogeneration operation in 2012. This information will be used to calculate the CO_2 emissions from electricity generation.

            a. The nameplate generating capacity (MW) of each cogeneration engine.

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[3] GHG emissions from any natural gas, digester gas or other gaseous fuels that are combusted in the WWTF in stationary equipment other than digester engines or equipment permitted by the BAAQMD is likely considered to be *de minimis* (i.e., less than 5% of the WWTF's total GHG emissions), and therefore the GRP does not require reporting. However, if this data is easily obtainable, please include it in the data submission so we can verify *de minimis*. If it's tedious to obtain this data, then discuss with CH2M HILL before collecting the data.

[4] GHG emissions from any gasoline or diesel that are combusted in the WWTF in stationary equipment other than equipment permitted by the BAAQMD is likely considered to be *de minimis* (i.e., less than 5% of the WWTF's total GHG emissions), and therefore the GRP does not require reporting. However, if this data is easily obtainable, please include it in the data submission so we can verify *de minimis*. If it's tedious to obtain this data, then discuss with CH2M HILL before collecting the data.

b. Net power generated (MWh) for each engine

c. Efficiency of electricity generation (if known).

i. *If the efficiency values are not known, the regulation provides the following default values: §95112(b)(4)(A) "Operators may use assumed values of 0.35 for electricity generation efficiency and/or 0.80 for thermal energy production efficiency, when parameters are unknown."*

ii. The following information regarding electricity generation, as applicable:

a. Electricity sold wholesale (MWh)

b. Electricity sold or provided directly to end-users (MWh) and end-user's NAICS code

c. Electricity consumed on-site (MWh)

3. Wastewater Treatment Process Emissions

a. Population serviced by the WWTF

b. Population serviced by the WWTF's anaerobic digester (if different than 4.a)

c. Measured fraction of CH4 in the WWTF's biogas (only if measured)

d. Percentage of industrial and commercial discharges into the WWTF (if known)

e. Measured average total nitrogen discharged (kg N/day) from the WWTF to the ocean outfall (only if measured)

f. Amount of known significant industrial contributions of nitrogen (kg N) discharged into the WWTF

Scope 2 GHG Data

1. Purchased Electricity

a. Known electricity use (metered readings or utility bills) in kilowatt-hours (kWh) or megawatt-hours (MWh) at the WWTF in 2012

CMSA 2012 GHG Study Compiled Data
Jeff Boheim E/I Tech
~~8/13/2013~~ May 1, 2014 UPDATE

Scope 1, Section 1.												
Mobile Combustion	Vehicle Decription	ID #	Make	Year - Model	2012 miles	Fuel type	Source of information	Additional information	Brake HP	KW output	efficiency	
1	Ford F150 (ES/Lab)	1FTFX1CF3CFA45687	Ford	2012 - F150	7,314	Gasoline	NEXGEN PM records					
2	Ford F150	1FTPF17MXYKA91404	Ford	2000 - F150	3,435	CNG	NEXGEN PM records					
3	Ford E250 (E/I)	1FNE24W58DA82877	Ford	2008 - E250	1,212	Gasoline	NEXGEN PM records					
4	Ford F450	1FDXF46P87EB32036	Ford	2007 - F450	250	#2 diesel	NEXGEN PM records					
5	Ford Ranger 2009	1FTYR14D99PA63193	Ford	2009 - Ranger	3,950	Gasoline	NEXGEN PM records					
6	Ford Ranger 2006	1FTYR14D67PA18368	Ford	2006 - Ranger	8,588	Gasoline	NEXGEN PM records					
7	Ford Crown Victoria	2FAFP7298IXI9I220	Ford	2001 - Crown Victoria	12,708	CNG	NEXGEN PM records					
8	Ford Explorer	1FMDU62E95UB29612	Ford	2005 - Explorer	4,793	Gasoline	NEXGEN PM records					
9	Honda Civic Eleven	JHMFA36226S011241	Honda	2006 - Civic	4,131	Gasoline hybrid	NEXGEN PM records					
10	Honda Civic Twelve	JHMFA36206S030693	Honda	2006 - Civic	6,285	Gasoline hybrid	NEXGEN PM records					
11	Toyota Highlander	JTEEW21A670043898	Toyota	2007 - Highlander hybrid	13,260	Gasoline hybrid	NEXGEN PM records					
CMSA Total 2012 miles					**65926**							
12	Caterpillar 5000 # Forklift	AT3511036	Cat/Mitsub	2008 - P5000-LP	149 (hours in 2012)	Propane	NEXGEN PM records					
13	Bobcat Skid Steer Loader	530313189	Bobcat	2006 - S185	89 (hours in 2012)	#2 diesel	NEXGEN PM records					
								Total gasoline consumption in 2012 = 911 gallons				
Scope 1, Section 2.,												
Stationary Combustion	Source Description			Natural gas cu. Ft. per year	Digester gas cu. ft. per	#2 Diesel 2012						
1	Gaseous cogen. 1/1/2012 until Oct . Failur	E12.01		**27,228,000**	**39,512,420**		CMSA Op's daily spreadshee	Waukesha P48 GLD, lean burn, digester/natural gas fueled	1182	750		
1	~~**Gaseous cogen. 2011**~~	~~E12.01~~		~~31,448,000~~	~~51,898,127~~		CMSA Op's daily spreadsheet					
1	~~Gaseous cogen. 2012 - corrected for norm~~	~~E12.02~~		~~33,182,000~~	~~48,851,336~~		Constructed from Op's 2011 and 2012 data					
	Boiler and/or flare (digester gas)			not applicable	**15,194,633**		**We will not be able to distinguish between burning digester gas in the boilers and/or flares**					
					2012 Diesel hours							
4	Diesel generator	E12.02			**11**	unknown - see hours	CMSA Op's Round sheet	Cummins , KTA 2300, 38 liter turbo diesel, 1800 RPM	1135	750		
5	E 20.1 (Diesel engine driven pumps)	E20.1			**16**	unknown - see hours	CMSA Op's log book	Caterpillar C9 E-cert common rail diesel injection, variable speed	275			
6	E 20.2 (Diesel engine driven pumps)	E20.2			**14.5**	unknown - see hours	CMSA Op's log book	Caterpillar C9 E-cert common rail diesel injection, variable speed	275			
7	E 20.3 (Diesel engine driven pumps)	E20.3			**13.6**	unknown - see hours	CMSA Op's log book	Caterpillar C9 E-cert common rail diesel injection, variable speed	275			
8	E 20.4 (Diesel engine driven pumps)	E20.4			**17**	unknown - see hours	CMSA Op's log book	Caterpillar C9 E-cert common rail diesel injection, variable speed	275			
9	E 20.5 (Diesel engine driven pumps)	E20.5			**19.1**	unknown - see hours	CMSA Op's log book	Caterpillar C9 E-cert common rail diesel injection, variable speed	275			
*								**Total diesel fuel consumption in 2012 = 769 gallons**				
Scope 1, Section 3.,												
WWTP Emissions	Process Parameter											
1	Popualtion Served by CMSA	**110000**										
2	Pop. Served by CMSA digesters	**110000**										
3	Measured fraction of CH4 in biogas	**70%**						Typical value on IR based aspirator sampler in boiler room.				
4	% Industrial and Commercial disch.	**3% or .25 MGD**										
5	Measured total nitrogen to bay	**976 kg/day**										
6	Amount of sig. Nitrogen into CMSA	**none**										
Scope 2, Section 1.,												
Purchased Electricity												
	Purchased Electricity 2012 (kWh)	**1,492,920**		Source: Utility invoices, Op's spreadsheets								
Supplementary data												
per 10/10/13 discussion												
Item 1.: HHV from utility bill?	Checked PGE & Spurr bills - no HHV listed											
Item 2.: Natural gas metering?	Natural gas: Metered with Utility's meter											
Item 3.: Vehicle typical usage?	Assume all city miles											
Item 4.: Propane consumption?	Not available for 2012 - future action item											
Item 5.: Purchased Electricity?	Marin Clean Energy - "Light Green" for half of 2012, balance = PG&E.											
Item 6.: Biogas CH4 %?	70-72% on CMSA IR meter. No lab data as of 10/10/13.			**Biogas: HHV = 680 BTU/cf, LHV = 610 BTU/cf**								
Item 7.: CMSA Staff Report on MCE	Separately attached.											
Item 8: Footnote:	CO2 from WWTP process tanks?											
Item 9: Footnote:	Generator failure - annualized data for typical year.											
CMSA Action Items												
Track vehicle fuel use as well as mileage												
Track propane usage												
Track biosolids hauling mileage												
Obtain biosolids hauling truck/engine data												

BASELINE MILEAGE WORKSHEET

Description: Baseline mileage is the total annual mileage to haul biosolids to their current disposal/use site. This mileage will be used to calculate avoided mileage, which will be used to determine part of the overall benefit (well to wheels) for a proposed B2E facility. It will demonstrate the reduction in biosolids hauling miles, truck traffic, fuel consumption, and greenhouse gas emissions.

Avoided mileage will be calculated as "Baseline Mileage - Total Annual Hauling Miles to the B2E Facility."

Instructions: Identify the biosolids disposition alteratives used (i.e., land application, alternative daily cover, composting, landfill), the location of the diposition site, one-way mileage number of annual loads, and annual mileage for hauling biosolids to the agency's disposal/use site.

	Biosolids Disposition				Disposition Site Location				One-way mileage to Disposition Site				Annual Truck Loads to Disposition Site				Annual Mileage for Disposition Alternative			
Coalition Member	Land Application	ADC	Composting	Landfill	Land Application	ADC	Composting	Landfill	Land Application	ADC	Composting	Landfill	Land Application	ADC	Composting	Landfill	Land Application	ADC	Composting	Landfill
City of Burlingame																				
Central Marin Sanitation Agency	2466 tons @ 26.8%	4024 tons @ 26.8%			Synagro site in Southern Sonoma County	Redwood Landfill in Novato			17.4 miles	16.9 miles			139	230			2419	3887		
Delta Diablo Sanitation District																				
Dublin San Ramon Services District																				
Fairfield-Suisun Sewer District																				
Ironhouse Sanitary District																				
City of Livermore																				
North San Mateo County Sanitation District																				
City of Palo Alto																				
City of Richmond																				
San Francisco Public Utilities Commission																				
City of San Jose																				
City of Santa Rosa																				
Sausalito Marin City Sanitary District																				
South Bayside System Authority																				
City of Millbrae																				
Union Sanitary District																				
Vallejo Sanitation District																				
West County Wastewater District																				