CITY OF SAN RAFAEL

COMMUNITY GREENHOUSE GAS EMISSIONS INVENTORY FOR THE YEAR 2023

September 2025

Prepared by the
Marin Climate & Energy Partnership

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EXECUTIVE SUMMARY

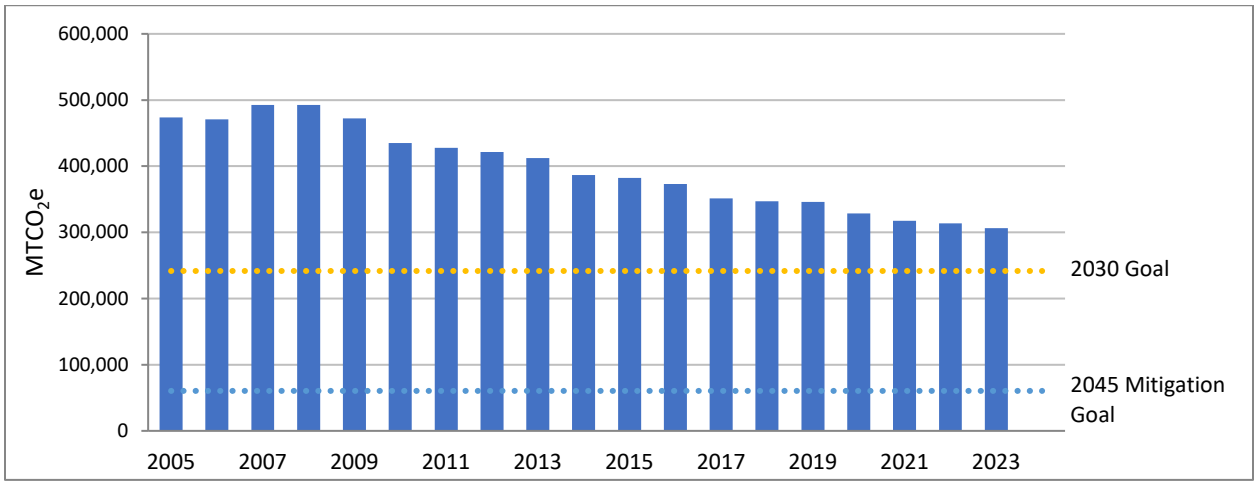
THE TAKEAWAY:

COMMUNITY EMISSIONS ARE DOWN 35% SINCE 2005 AND 24% SINCE 1990

San Rafael publishes annual community greenhouse gas (GHG) emissions estimates through the Marin Climate & Energy Partnership (MCEP). Annual inventories help the City to more closely monitor its progress in meeting its goal to reduce community emissions at least 40% below 1990 emissions by 2030. The City also publishes GHG emissions inventories for municipal operations approximately every five years. Municipal emissions accounted for less than 1% of community emissions when the municipal inventory was last conducted for the year 2022.

This report reviews emissions generated from the community from 2005 through 2023, the most recent year for which data are available. The inventory shows that emissions dropped from about 473,830 metric tons carbon dioxide equivalents ($MTCO_2e$) in 2005 to 306,408 $MTCO_2e$ in 2023, which is equivalent to 35% below the 2005 baseline and 24% below 1990 levels. The community emissions trend and targets are shown below. San Rafael needs to reduce emissions by another 64,755 $MTCO_2e$ to meet the local and State target for 2030. San Rafael adopted a Climate Emergency Resolution in 2021 that establishes a goal to achieve net-zero emissions by 2045 or earlier, which aligns with the State of California's long-term goal. This is expected to be accomplished by reducing GHG emissions approximately 85% below 1990 levels and employing sequestration and/or carbon capture strategies to offset the remaining emissions. San Rafael needs to reduce GHG emissions by another 245,995 $MTCO_2e$ to meet the GHG mitigation target for 2045, as shown in Figure 1.

FIGURE 1: SAN RAFAEL GHG EMISSIONS AND REDUCTION TARGETS



Recognizing the need for a collaborative approach to greenhouse gas reductions, City and county leaders launched the Marin Climate and Energy Partnership (MCEP) in 2007. The City of San Rafael is a member of MCEP and works with representatives from the County of Marin and the other Marin cities and towns to address and streamline the implementation of a variety of greenhouse gas reduction measures. Funding for this inventory was provided by the Marin County Energy Watch Partnership, which administers public goods charges collected by PG&E. Community inventories are available on the MCEP website at marinclimate.org and are used to update the Marin Sustainability Tracker.

INTRODUCTION

PURPOSE OF INVENTORY

The objective of this greenhouse gas emissions inventory is to identify the sources and quantify the amounts of greenhouse gas emissions generated by the activities of the San Rafael community in 2023. This inventory provides a comparison to 2005 and estimated 1990 emissions and identifies the sectors where significant reductions in greenhouse gas emissions have occurred. In some instances, previous year emissions were updated with new data and/or recalculated to ensure the same methodology was employed for all inventory years. In particular, off-road emissions were revised due to an update in the California Air Resources Board OFFROAD model.

GENERAL METHODOLOGY

This inventory uses the national standard for the accounting and reporting of community-wide greenhouse gas emissions, the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, version 1.2 (July 2019). Quantification methodologies, emission factors, and activity and source data are detailed in the appendix.

Community emissions are categorized according to seven sectors:

- Built Environment - Electricity
- Built Environment – Natural Gas
- Transportation
- Off-Road Vehicles and Equipment
- Waste
- Water
- Wastewater

CALCULATING EMISSIONS

Emissions are quantified by multiplying the measurable activity data – e.g., kilowatt hours of electricity, therms of natural gas, gallons of diesel or gasoline, etc. – by emission factors specific to the greenhouse gas-generating source. Most emission factors are the same from year to year. Emission factors for electricity, however, change from year to year due to the specific sources that are used to produce electricity. For example, electricity that is produced from coal generates more greenhouse gases than electricity that is generated from natural gas and therefore has a higher emission factor. Electricity that is produced solely from renewable energy sources, such as solar and wind, has an emission factor of zero.

This inventory calculates individual greenhouse gases – i.e., carbon dioxide, methane, and nitrous oxide – and converts each greenhouse gas emission to a standard metric, known as "carbon dioxide equivalents" or CO_2e, to provide an apples-to-apples comparison among the various emissions. Table 1 shows the greenhouse gases identified in this inventory and their global warming potential (GWP), a measure of the amount of warming each gas causes when compared to a similar amount of carbon dioxide over 100 years. Methane, for example, is approximately 28 times as potent as carbon dioxide over 100 years; therefore, one metric ton of methane is

equivalent to 28 metric tons of carbon dioxide. Greenhouse gas emissions are reported in this inventory as metric tons of carbon dioxide equivalents, or $MTCO_2e$.

TABLE 1: GREENHOUSE GASES

Gas	Chemical Formula	Emission Source	Global Warming Potential
Carbon Dioxide	CO_2	Combustion of natural gas, gasoline, diesel, and other fuels	1
Methane	CH_4	Combustion, anaerobic decomposition of organic waste in landfills and wastewater	28
Nitrous Oxide	N_2O	Combustion, wastewater treatment	265

Source: IPCC Fifth Assessment Report (2014), 100-year values

TYPES OF EMISSIONS

Emissions from each of the greenhouse gases can come in a number of forms:

- **Stationary or mobile combustion** resulting from the on-site combustion of fuels (natural gas, diesel, gasoline, etc.) to generate heat or electricity, or to power vehicles and equipment.
- **Purchased electricity** resulting from the generation of power from utilities outside the jurisdictional boundary.
- **Fugitive emissions** resulting from the unintentional release of greenhouse gases into the atmosphere, such as methane from waste decomposition.
- **Process emissions** from physical or chemical processing of a material, such as wastewater treatment.

UNDERSTANDING TOTALS

The totals listed in the tables and discussed in the report are a summation of emissions using available estimation methods. Each inventoried sector may have additional emissions sources associated with it that were unaccounted for due to a lack of data or robust quantification methods. For example, greenhouse gas emissions associated with air travel and the production of goods outside the community's boundary are not included in the inventory. Additionally, the community inventory does not include refrigerants released into the atmosphere from the use of air conditioning in cars and buildings.

COMMUNITY INVENTORY

COMMUNITY INVENTORY SUMMARY

In 2005, the activities taking place by the San Rafael community resulted in approximately 473,830 metric tons of CO_2e.[1] In 2023, those activities resulted in approximately 306,408 metric tons of CO_2e, a reduction of 35% from 2005 levels, which is equivalent to 24% below 1990 levels.

The community inventory tracks emissions in seven sectors:

- The **Built Environment – Electricity** sector represents emissions generated from the use of electricity in San Rafael homes and commercial, industrial, and governmental buildings and facilities.
- The **Built Environment – Natural Gas** sector represents emissions generated from the use of natural gas in San Rafael homes and commercial, industrial, and governmental buildings and facilities. Propane used as a primary heating source is also included, although it represents less than 1% of emissions in this sector.
- The **Transportation** sector includes tailpipe emissions from passenger vehicle trips originating and ending in San Rafael, as well as a share of tailpipe emissions generated by medium and heavy-duty vehicles traveling on Marin County roads. The sector also includes emissions from Marin Transit and Golden Gate Transit buses and the SMART train as these vehicles travel within San Rafael's boundaries. Electricity used to power electric vehicles is embedded in electricity consumption reported in the Built Environment - Electricity sector.
- The **Waste** sector represents fugitive methane emissions that are generated over time as organic material decomposes in the landfill. Although most methane is captured or flared off at the landfill, approximately 25% escapes into the atmosphere.
- The **Off-Road** sector represents emissions from the combustion of gasoline and diesel fuel from the operation of off-road vehicles and equipment used for construction and landscape maintenance.
- The **Water** sector represents emissions from energy used to pump, treat, and convey potable water from the water source to the San Rafael water users.
- The **Wastewater** sector represents stationary, process, and fugitive greenhouse gases that are created during the treatment of wastewater generated by the community. Emissions created from energy used to convey and treat wastewater are included in the Built Environment sectors.

Table 2 shows how emissions in each sector have changed since 2005. The greatest reductions have occurred in the Built Environment – Electricity sector (82,561 $MTCO_2e$), followed by the Transportation sector (63,211 $MTCO_2e$) and the Built Environment – Natural Gas sector (8,940 $MTCO_2e$). The likely reasons for the largest emissions decreases are described in the remainder of this report.

[1] Baseline and historical emissions are recalculated in the annual inventory to integrate new data and improved calculation methodologies and to ensure consistent comparison across each year. For this reason, emission levels may differ from levels reported in previous inventories.

TABLE 2: EMISSIONS SUMMARY BY SECTOR ($MTCO_2E$), 2005 THROUGH 2023

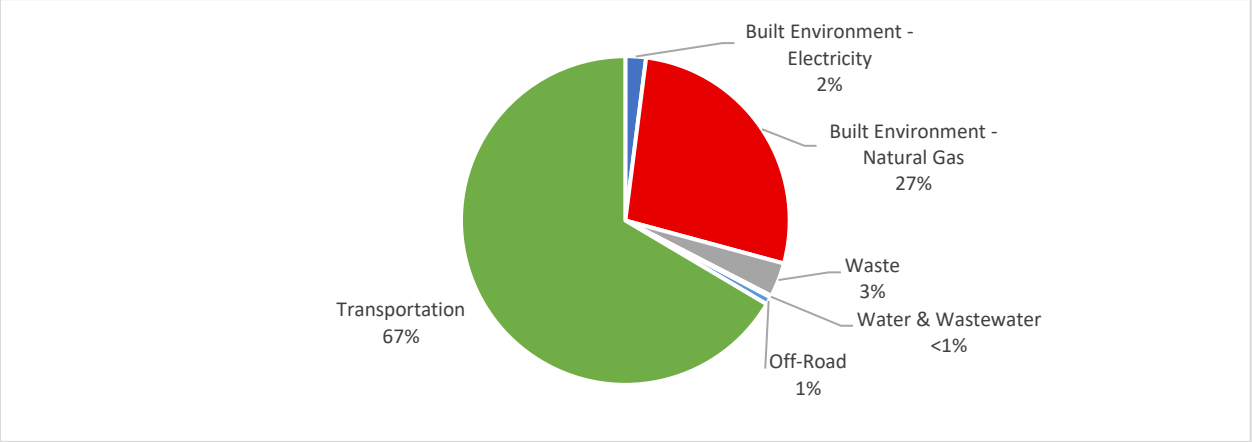
Year	Built Environment - Electricity	Built Environment – Natural Gas	Transportation	Waste	Water	Wastewater	Off-Road	Total	% Change from 2005	% Change from 1990[2]
1990 (est.)[1]								403,713		
2005	88,767	92,247	266,928	19,075	2,371	484	3,958	473,830	0%	
2006	83,610	95,425	266,209	18,913	2,074	485	3,862	470,577	-1%	
2007	111,739	92,455	264,388	17,101	2,804	488	3,741	492,715	4%	
2008	112,024	93,985	265,598	14,205	2,579	490	3,505	492,386	4%	
2009	101,128	92,767	259,960	12,223	2,593	492	3,208	472,371	0%	
2010	76,081	93,296	248,651	12,006	1,486	496	2,935	434,951	-8%	
2011	71,056	96,073	244,487	11,718	1,053	498	2,845	427,730	-10%	
2012	72,706	90,344	241,741	12,149	1,136	503	2,771	421,349	-11%	
2013	68,716	89,797	236,978	12,303	1,323	506	2,717	412,340	-13%	
2014	61,976	76,304	231,401	12,437	1,189	517	2,673	386,496	-18%	
2015	61,260	77,920	226,110	12,887	933	491	2,615	382,215	-19%	
2016	49,936	81,715	222,389	15,147	692	551	2,541	372,971	-21%	
2017	26,412	85,650	220,291	15,852	202	541	2,458	351,407	-26%	
2018	25,961	85,625	218,402	14,054	0	539	2,350	346,932	-27%	
2019	25,813	86,037	217,805	13,397	0	538	2,235	345,824	-27%	-14%
2020	18,412	79,679	214,924	12,732	0	553	2,236	328,535	-31%	-18%
2021	14,955	80,158	209,252	10,513	0	551	2,262	317,691	-33%	-21%
2022	12,913	79,615	208,320	10,091	0	542	2,287	313,768	-34%	-22%
2023	6,206	83,307	203,717	10,332	0	539	2,308	306,408	-35%	-24%
Change from 2005	-82,561	-8,940	-63,211	-8,743	-2,371	55	-1,650	-167,421		
% Change from 2005	-93%	-10%	-24%	-46%	-100%	11%	-42%	-35%		

[1] *Per California Air Resources Board guidance, 1990 levels are estimated at 15% below 2005 levels.*

[2] *In 2019, San Rafael adopted a Climate Action Plan that established a goal to reduce emissions 40% below 1990 levels by 2030. This column will track that progress over time.*

Figure 2 shows the relative contribution of emissions from these sectors in 2023. Transportation emissions represent the largest share of communitywide emissions (66%), while the use of natural gas and propane in the Built Environment accounts for 27% of emissions.

FIGURE 2: EMISSIONS BY SECTOR, 2023

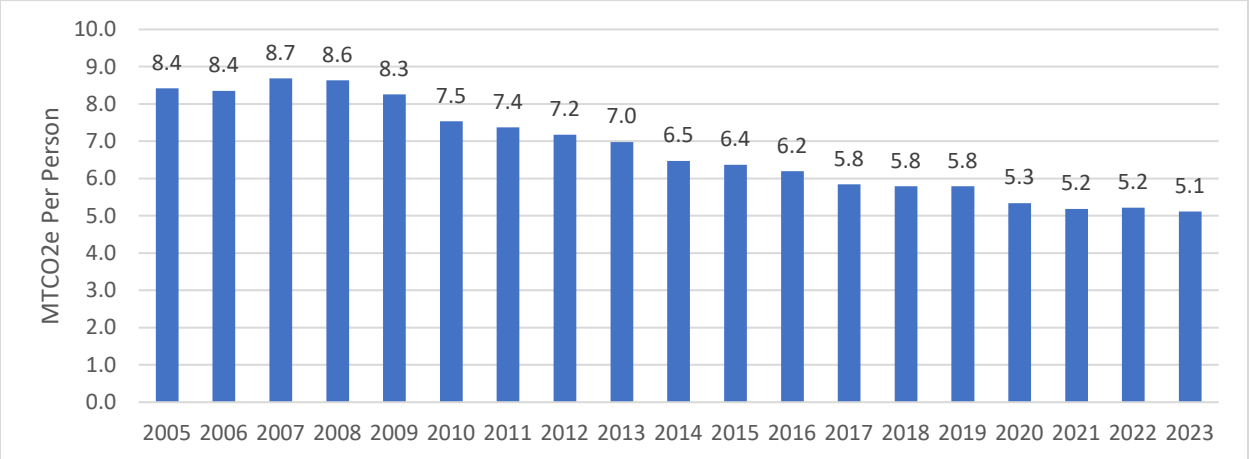


PER CAPITA EMISSIONS

Per capita emissions can be a useful metric for measuring progress in reducing greenhouse gases and for comparing one community's emissions with neighboring cities and against regional and national averages. That said, due to differences in emission inventory methods, it can be difficult to produce directly comparable per capita emissions numbers. Per capita emission rates may be compared among Marin jurisdictions, although some jurisdictions may have higher rates due to the presence of commercial and industrial uses.

Dividing the total communitywide GHG emissions by residents yields a result of 8.4 metric tons CO_2e per capita in 2005. Per capita emissions decreased 39% between 2005 and 2023, falling to 5.1 metric tons per person. Figure 3 shows the trend in per capita emissions over time. It is important to understand that this number is not the same as the carbon footprint of the average individual living in San Rafael, which would include lifecycle emissions, emissions resulting from air travel, etc.

FIGURE 3: EMISSIONS PER CAPITA



SIGNIFICANT SOURCES OF EMISSIONS

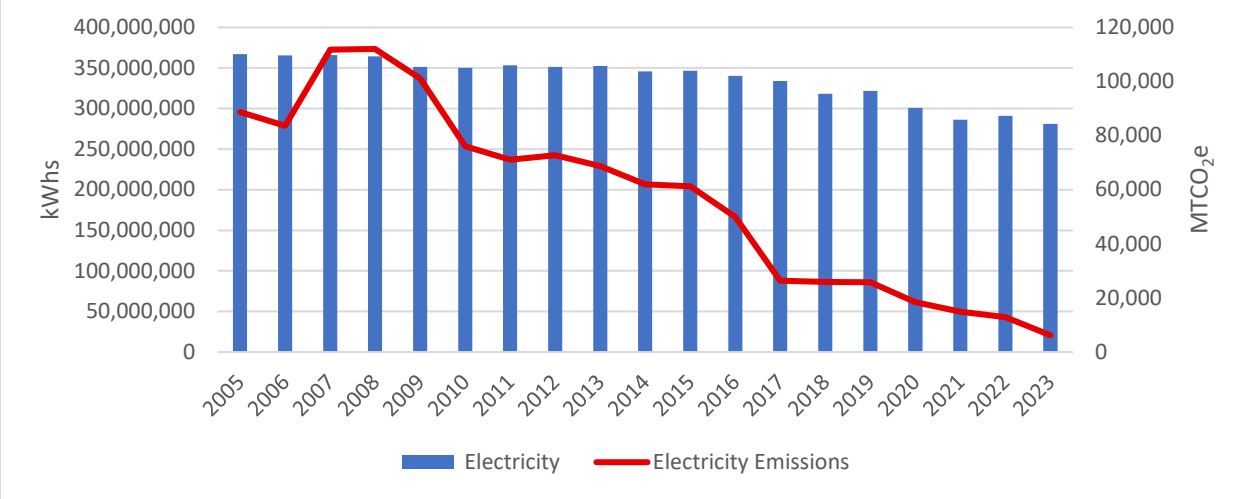
The following sections provide a year-by-year analysis of the changes in source GHG emissions in the Built Environment, Transportation, Waste, and Water sectors. Whenever possible, each section discusses the change in

emissions from previous years and the likely influence of state and local programs or policies and external factors on reducing emissions.

Built Environment - Electricity

Purchased electricity consumption in homes and businesses in San Rafael decreased about 23% between 2005 and 2023. Greenhouse gas emissions from this electricity use decreased 93% since 2005, as shown in Figure 4. This is primarily due to the lower carbon intensity of electricity. PG&E has been steadily increasing the amount of renewable energy in its electricity mix. In 2023, PG&E electricity came from a mix of renewable (33%), large hydroelectric (14%), and nuclear (53%) energy sources.[2] MCE Light Green electricity came primarily from renewable (60%) and hydroelectric (40%) sources.[3] In 2023, about 19.4% of MCE electricity purchased by San Rafael customers was 100% renewable Deep Green electricity, including electricity purchased by the City for facilities and operations. San Rafael's Climate Action Plan target is to reduce electricity emissions 93% below the 2005 level by 2030.

FIGURE 4: ELECTRICITY USE AND EMISSIONS



Built Environment - Natural Gas

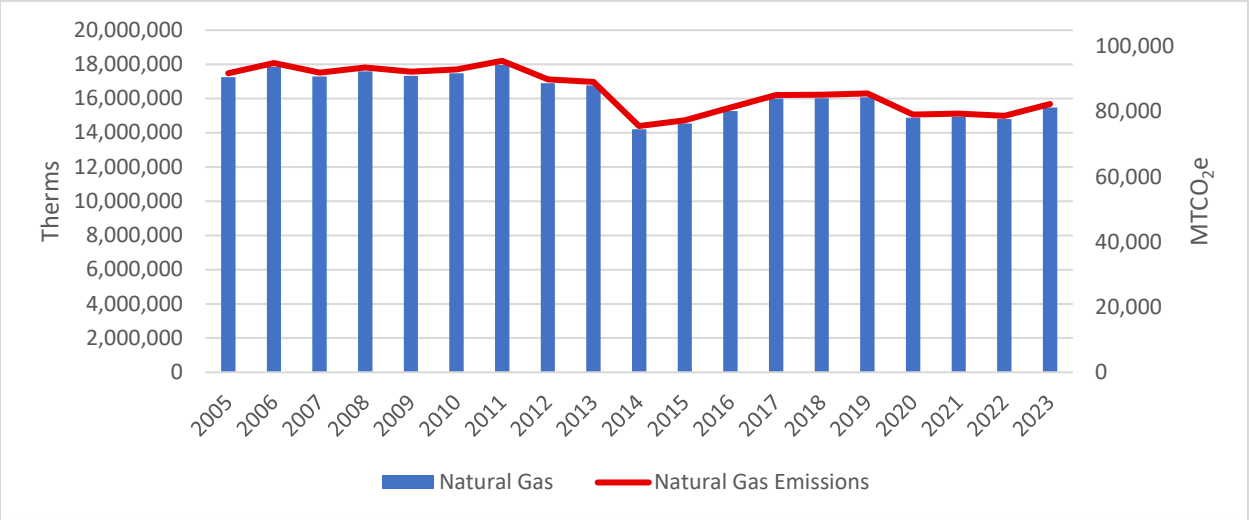
Natural gas is used in residential, commercial, and industrial buildings to provide space and water heating and to power appliances. Use of natural gas is highly variable depending on the weather conditions. This variability has led natural gas consumption in San Rafael to fluctuate from year to year, from a high of 18 million therms in 2011 to a low of 14.2 million therms in 2014. Reduction in energy use may also be attributed to energy efficiency programs and rebates, local green building ordinances, and State building codes.

Natural gas consumption increased 5% between 2022 and 2023 and was 10% below the 2005 level. Unlike electricity emissions, which vary according to the power content mix, natural gas emissions track the amount of natural gas consumed (Figure 5). The Climate Action Plan target is to reduce natural gas consumption and emissions 28% below the 2005 level by 2030.

[2] PG&E 2023 Power Content Label, https://www.energy.ca.gov/filebrowser/download/7281. Nuclear and large hydro sources are considered GHG-free.

[3] MCE 2023 Power Content Label, https://www.energy.ca.gov/filebrowser/download/7276.

FIGURE 5: NATURAL GAS USE AND EMISSIONS



TRANSPORTATION

Transportation activities accounted for approximately 66% of San Rafael's emissions in 2023. According to the transportation model and annual data the City uses to calculate passenger and commercial vehicle miles, vehicle miles traveled (VMT) have essentially remained the same since 2005.

On-road transportation emissions have decreased 24% since 2005 due to more fuel-efficient and alternatively fueled cars (Figure 6). As shown in Figure 7, most transportation emissions come from passenger vehicles, which accounted for 72% of transportation emissions in 2023. Marin County continues to be a leader in zero-emission vehicles (ZEVs) – second only to Santa Clara County – with 19,221 ZEVs in Marin at the end of 2023, or about 9.3% of registered automobiles. ZEVs include battery electric cars, plug-in hybrid electric cars, hydrogen fuel cell cars, and zero-emission motorcycles. San Rafael had 4,326 ZEVs by the end of 2023, or 7.3% of registered light-duty vehicles. San Rafael's Climate Action Plan targets 25% of passenger vehicles registered in Marin and traveling in San Rafael to be ZEVs by 2030 and a 46% reduction in transportation emissions.

While it is difficult to pinpoint exactly how each land use and transportation policy affects emissions, the City has undertaken many efforts to reduce transportation emissions. The City encourages workforce housing and has made improvements to the transportation network to make it easier for residents to bicycle, walk, and take public transportation. The City has also promoted electric vehicle adoption by installing chargers and providing free electricity at select municipal EV charging stations.

FIGURE 6: ON-ROAD TRANSPORTATION VEHICLE MILES TRAVELED AND EMISSIONS

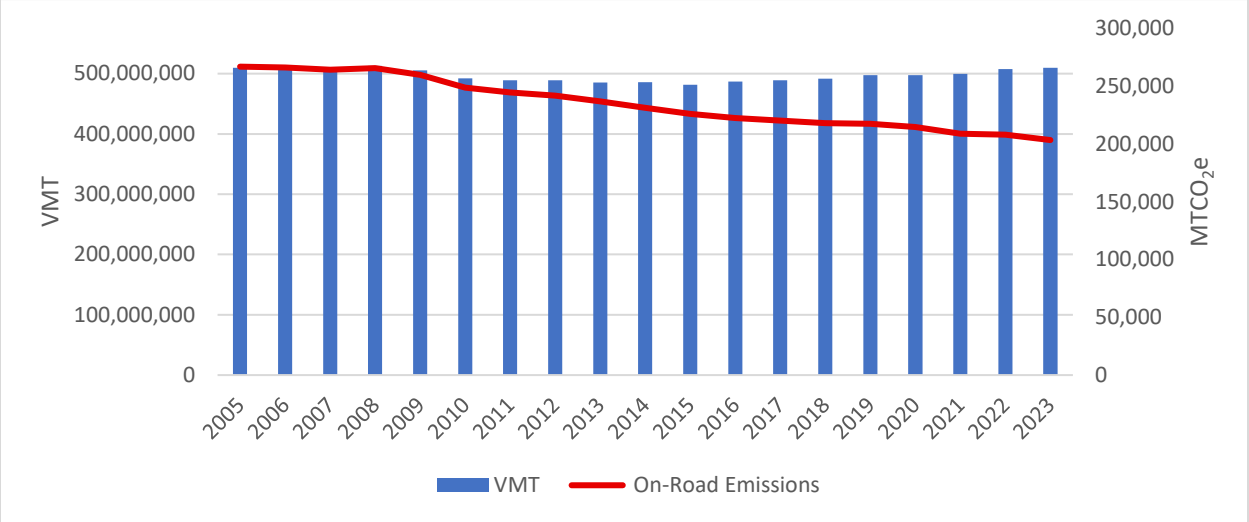
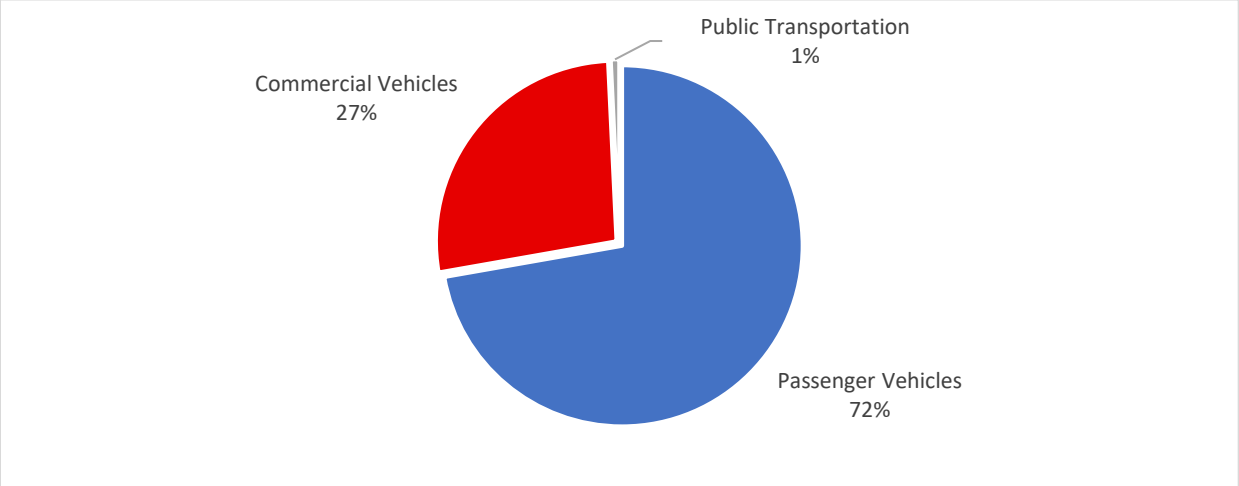


FIGURE 7: TRANSPORTATION EMISSIONS BY VEHICLE CATEGORY, 2023



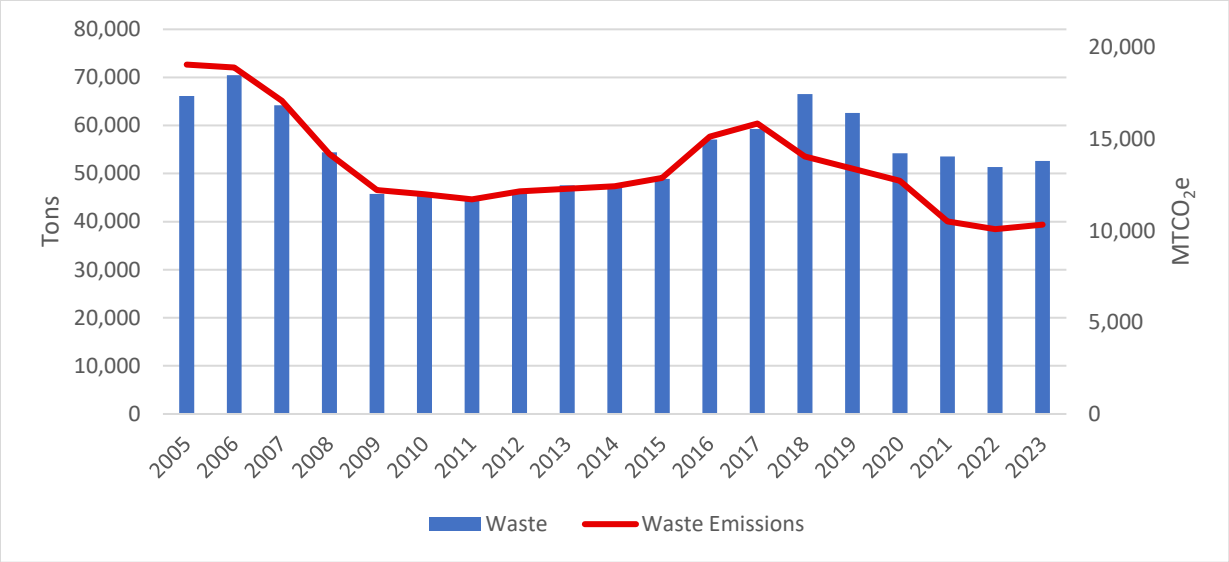
Note: Public transportation includes emissions from Marin Transit and Golden Gate Transit fixed-route buses and the SMART train.

Waste Disposal

Waste generated by the community increased 2% between 2022 and 2023 and was 20% below the 2005 level by 2023, as shown in Figure 8 (based on countywide disposal data). Total landfilled waste includes alternative daily cover.[4] Emissions from waste disposal decreased 46% due to the lower organic content of landfilled waste and material used for alternative daily cover (Figure 8). The City's Climate Action Plan targets a 74% reduction in waste emissions by 2030.

FIGURE 8: DISPOSED WASTE

[4] Alternative daily cover is material other than earthen material placed on the surface of the active face of a municipal solid waste landfill at the end of each operating day to control vectors, fires, odors, blowing litter, and scavenging.



Water Use

Per capita water use declined 28% since 2005, as shown in Figure 9, based on Marin Municipal Water District (Marin Water) district-wide data. Emissions, which are based on an estimate of energy used to pump, treat, and convey water from the water source to the City limits, dropped 100% between 2005 and 2023 due to the water agencies' use of carbon-free electricity. Marin Water purchases MCE Deep Green for its electricity needs, and the Sonoma County Water Agency, which supplies approximately 25% of Marin Water's water, uses renewable and carbon-free sources for its electricity. Total water consumption decreased 25% since 2005; the City's Climate Action Plan targets a 26% reduction in water consumption by 2030.

FIGURE 9: PER CAPITA WATER USE

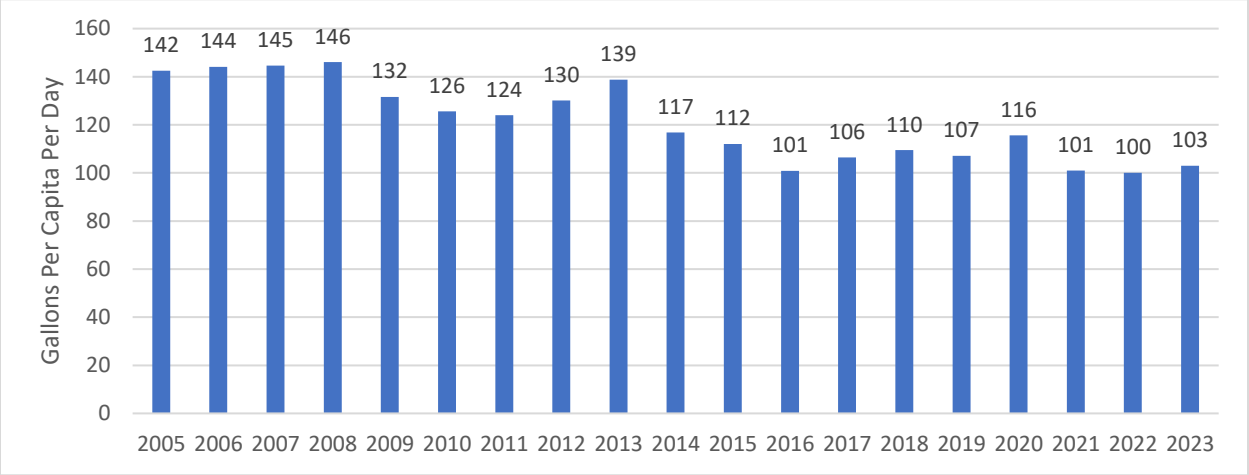
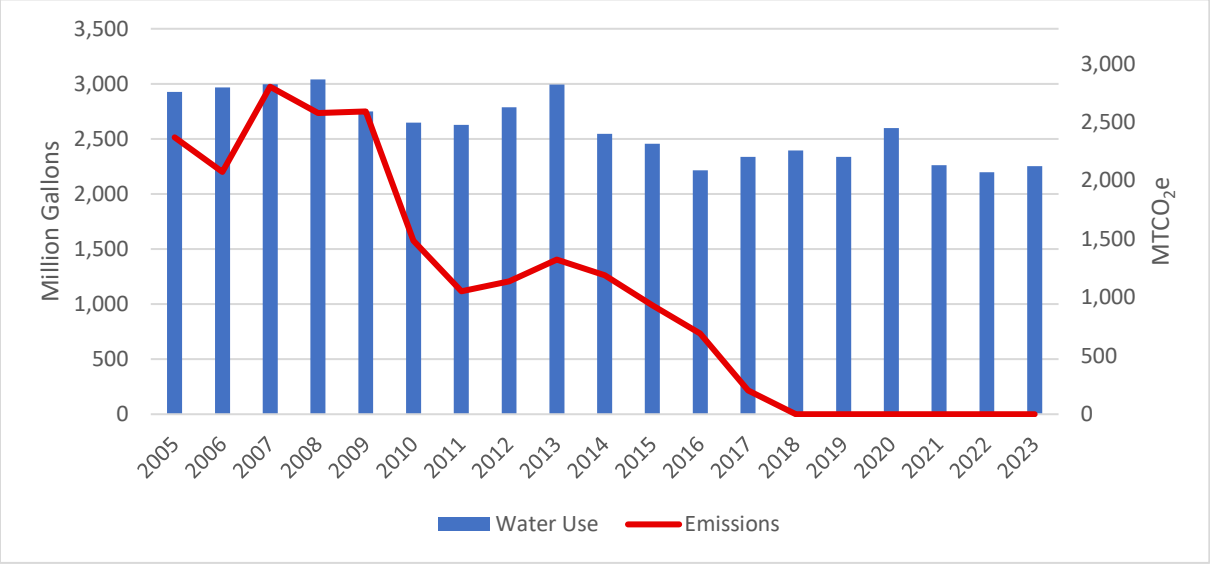


FIGURE 10: WATER USE AND EMISSIONS



Marin Water provides rebates and programs to reduce water use. Rebates are available to replace fixtures with high-efficiency clothes washers and to purchase cisterns and rain barrels. Marin Water provides free home and landscape water-use evaluations as well as free high-efficiency showerheads and faucet aerators. The City of San Rafael actively promotes water conservation and Marin Water rebates and programs to residents and businesses.

WASTEWATER

Greenhouse gas emissions are created during the treatment of wastewater generated by the community. These emissions have increased 11% since 2005 as San Rafael's population has increased.

Emissions created from energy used to convey and treat wastewater are included in the Built Environment sectors. The Central Marin Sanitation Agency (CMSA), located in San Rafael, has two anaerobic digesters that process primary sludge, thickened waste-activated sludge, and organic waste to produce biogas. The biogas is used to generate heat and renewable electricity via the cogeneration system. CMSA normally produces 100% of the facility's power needs, and, at times, exports renewable energy to the grid, which is procured by MCE.

In 2023, the Las Gallinas Valley Sanitary District completed a Secondary Treatment Plant that expanded the treatment plant's capacity and the recycled water facility's capacity from 1.4 million to over 5 million gallons per day.

APPENDIX: COMMUNITY INVENTORY

Community GHG Emissions Summary Table

Jurisdiction: City of San Rafael
Population: 59,855 (CA Department of Finance)
Number of Households: 23,527 (CA Department of Finance)

Inventory Year: 2023
Date Prepared: March 30, 2024
Reporting Framework: Communitywide Activities

ID	Emissions Type	Source or Activity	Included, Required Activities	Included, Optional Activities	Excluded (IE, NA, NO or NE)	Notes	Emissions ($MTCO_2e$)
1.0	Built Environment						
1.1	Use of fuel in residential and commercial stationary combustion equipment	Both	●				83,307
1.2	Industrial stationary sources	Source			NE		
1.3	Power generation in the community	Source			NO		
1.4	Use of electricity in the community	Activity	●			Includes transmission and distribution losses	6,206
1.5	District heating/cooling facilities in the community	Source			NE		
1.6	Use of district heating/cooling facilities in the community	Activity			NE		
1.7	Industrial process emissions in the community	Source			NO		
1.8	Refrigerant leakage in the community	Source			NE		
2.0	Transportation and Other Mobile Sources						
2.1	On-road passenger vehicles operating within the community boundary	Source			IE	Obtained data for the preferred activity-based method instead	
2.2	On-road passenger vehicles associated with community land uses	Activity	●				147,156
2.3	On-road freight and service vehicles operating within the community boundary	Source			IE	Obtained data for the preferred activity-based method instead	
2.4	On-road freight and service vehicles associated with community land uses	Activity	●				55,034
2.5	On-road transit vehicles associated with community land uses	Activity		●		Emissions calculated for transit vehicles operating within the community boundary	1,202
2.6	Transit rail vehicles operating within the community boundary	Source		●			325

2.7	Use of transit rail travel by the community	Activity			NE		
2.8	Inter-city passenger rail vehicles operating within the community boundary	Source			NO		
2.9	Freight rail vehicles operating within the community boundary	Source			NO		
2.10	Marine vessels operating within the community boundary	Source			NE		
2.11	Use of ferries by the community	Activity			NE		
2.12	Off-road surface vehicles and other mobile equipment operating within the community boundary	Source		●			2,308
2.13	Use of air travel by the community	Activity			NE		
3.0	Solid Waste						
3.1	Operation of solid waste disposal facilities in the community	Source			NE		
3.2	Generation and disposal of solid waste by the community	Activity	●			Includes alternative daily cover	10,332
4.0	Water and Wastewater						
4.1	Operation of water delivery facilities in the community	Source			IE	Energy use is included in 1.1 and 1.4	
4.2	Use of energy associated with the use of potable water by the community	Activity	●				0
4.3	Use of energy associated with the generation of wastewater by the community	Activity	●			Energy use is included in 1.1 and 1.4	
4.4	Process emissions from the operation of wastewater treatment facilities located in the community	Source			NE	Wastewater treatment facilities are located in the community, but only process emissions associated with the generation of wastewater by the community are reported in 4.5	
4.5	Process emissions associated with the generation of wastewater by the community	Activity	●				539
4.6	Use of septic systems in the community	Source			NE		
5.0	Agriculture						
5.1	Domesticated animal production	Source			NE		
5.2	Manure decomposition and treatment	Source			NE		
6.0	Upstream Impacts of Communitywide Activities						
6.1	Upstream impacts of fuels used in stationary applications by the community	Activity			NE		
6.2	Upstream and transmission and distribution (T&D) impacts of purchased electricity used by the community	Activity			IE	Transmission and distribution losses are included in 1.4	
6.3	Upstream impacts of fuels used by water and wastewater facilities for water used and wastewater generated within the community boundary	Activity			IE		
6.4	Upstream impacts of select materials (concrete, food, paper, carpets, etc.) used by the whole community.	Activity			NE		

Legend

IE – Included Elsewhere: Emissions for this activity are estimated and presented in another category of the inventory. The category where these emissions are included should be noted in the explanation.

NE – Not Estimated: Emissions occur but have not been estimated or reported (e.g., data unavailable, effort required not justifiable).

NA – Not Applicable: The activity occurs but does not cause emissions; explanation should be provided.

NO – Not Occurring: The source or activity does not occur or exist within the community.

Community Emissions Data Sources and Calculation Methodologies

Sector/ID	Emissions Source	Source and/or Activity Data	Emission Factor and Methodology
1.0 Built Environment			
1.1 Stationary Combustion	Stationary Combustion (CO_2, CH_4 & N_2O)	Known fuel use (meter readings by PG&E) and estimated fuel use (American Community Survey 5-Year Estimates, and U.S. Energy Information Administration Household Site Fuel Consumption data).	Default CO_2, CH_4 & N_2O emission factors by fuel type (U.S. Community Protocol v. 1.1, Appendix C, Tables B.1 and B.3). U.S. Community Protocol v. 1.1, Appendix C, Method BE.1.1 and BE.1.2.
1.4 Electricity Use	Electricity Use (CO_2, CH_4 & N_2O)	Known electricity use (meter readings by PG&E and MCE) and estimated direct access electricity consumption.	Verified utility-specific emission factors (PG&E and MCE) and eGrid subregion default emission factors. U.S. Community Protocol v. 1.1, Appendix C, Method BE.2.1.
	Electric Power Transmission and Distribution Losses (CO_2, CH_4 & N_2O)	Estimated electricity grid loss for the Western region from eGrid.	U.S. Community Protocol v. 1.1, Appendix C, Method BE.4.1.
2.0 Transportation and Other Mobile Sources			
2.2 On-Road Passenger Vehicle Operation	On-Road Mobile Combustion (CO_2)	Estimated passenger vehicle miles traveled associated with origin and destination land uses (Metropolitan Transportation Commission, CAPVMT Data Portal 2.0 (mtcanalytics.org)).	CO_2 for on-road passenger vehicles quantified in the EMFAC2021 v.1.0.2 model. Passenger vehicle emissions calculated according to U.S. Community Protocol v. 1.1, Appendix D, Method TR.1.A.
	On-Road Mobile Combustion (CH_4 & N_2O)	Estimated vehicle miles traveled associated with origin and destination land uses (Metropolitan Transportation Commission, CAPVMT Data Portal 2.0 (mtcanalytics.org).	CH_4 and N_2O for on-road passenger vehicles quantified in the EMFAC2021 v.1.0.2 model. Passenger vehicle emissions calculated according to U.S. Community Protocol v. 1.1, Appendix D, Method TR.1.A.
2.4 On-Road Freight and Service Truck Freight Operation	On-Road Mobile Combustion (CO_2)	Estimated commercial vehicle miles traveled within the boundary (Metropolitan Transportation Commission utilizing Plan Bay Area 2050).	CO_2 for on-road commercial vehicles quantified in the EMFAC2021 v.1.0.2 model. Emissions allocated utilizing LEHD data according to U.S. Community Protocol v. 1.1, Appendix D, Method TR.2.A.
	On-Road Mobile Combustion (CH_4 & N_2O)	Estimated commercial vehicle miles traveled within the boundary (Metropolitan Transportation Commission utilizing Plan Bay Area 2050).	CH_4 and N_2O for on-road commercial vehicles quantified in the EMFAC2021 v.1.0.2 model. Emissions allocated utilizing LEHD data according to U.S. Community Protocol v. 1.1, Appendix D, Method TR.2.A.
2.5 On-Road Transit Operation	On-Road Mobile Combustion (CO_2)	Estimated vehicle miles traveled within the boundary (Marin Transit and Golden Gate Transit) and estimated diesel fuel efficiency for the transit fleet (Golden Gate Transit). Fuel type provided by Marin Transit and Golden Gate Transit.	Renewable diesel emission factor provided by NEXGEN. U.S. Community Protocol v. 1.1, Appendix D, Method TR.4.A.
	On-Road Mobile Combustion (CH_4 & N_2O)	Estimated vehicle miles traveled within the boundary (Marin Transit and Golden Gate Transit) and estimated diesel fuel	Renewable diesel emission factor provided by NEXGEN. U.S. Community Protocol v. 1.1, Appendix D, Method TR.4.B.

		efficiency for the transit fleet (Golden Gate Transit). Fuel type provided by Marin Transit and Golden Gate Transit.	
2.6 Passenger Rail	Mobile Combustion (CO_2, CH_4 & N_2O)	Estimated train-miles by multiplying the number of train cars per day (in both directions, according to the SMART published schedule) by the railway track mileage located within the community boundary (Marin Map). Average Diesel Multiple Unit fuel efficiency provided by SMART.	U.S. Community Protocol v. 1.1, Appendix D, Method TR.5. Emission factors from Equation TR.5.2.
2.12 Off-Road Vehicles and Equipment	Off-Road Mobile Combustion (CO_2)	Estimated fuel use from OFFROAD v.1.0.1 for Lawn and Garden and Construction equipment. All categories are allocated by share of countywide households.	CO_2 emissions calculated according to U.S. Community Protocol v. 1.1, Appendix D, Method TR.8. Emission factors provided in Table TR.1.6.
	Off-Road Mobile Combustion (CH_4 & N_2O)	Estimated fuel use from OFFROAD v.1.0.1 for Lawn and Garden and Construction equipment. All categories are allocated by share of countywide households.	CH_4 and N_2O emissions calculated according to U.S. Community Protocol v. 1.1, Appendix D, Method TR.8. Emission factors provided in the Local Government Operations Protocol Table G.11 and G.14.
3.0 Solid Waste			
3.2 Solid Waste Generation and Disposal	Fugitive Emissions from Landfilled Waste (CH_4)	Estimated landfilled tons based on reporting to CalRecycle by Marin County Solid and Hazardous Waste JPA and allocated to jurisdiction based on the share of the countywide population. Waste characterization based on the Statewide Waste Characterization Study (2008, 2014, 2018, and 2021) and Alternative Daily Cover by Jurisdiction of Origin and Material Type as reported to CalRecycle.	Emission factors calculated utilizing U.S. Community Protocol for Accounting and Report of Greenhouse Gas Emissions, Version 1.1, July 2013, Appendix E, Method SW.4.
4.0 Water and Wastewater			
4.2 Water Supply & Conveyance, Treatment and Distribution	Electricity Use (CO_2)	Water consumption data provided by Marin Water. Sonoma County Water Agency (SCWA) delivery amount provided by SCWA.	Verified utility-specific emission factors (PG&E, MCE, and SCWA). Emissions calculated according to U.S. Community Protocol v. 1.1, Appendix F, Method WW.14.
	Electricity Use (CH_4 & N_2O)	Water consumption data provided by Marin Water. Electricity consumption data provided by MMWD.	eGrid subregion default emission factors. Emissions calculated according to U.S. Community Protocol v. 1.1, Appendix F, Method WW.14.
4.5 Treatment of Wastewater	Stationary Emissions from Combustion of Digester Gas (CH_4)	Known amount of digester gas produced per day and known percent of methane in digester gas provided by the Central Marin Sanitation Agency. Known amount of digester gas produced per day (2016) and known percent of methane in digester gas (2017) provided by Las Gallinas Valley Sanitary District.	Emissions calculated according to U.S. Community Protocol v. 1.1, Appendix F, Method WW.1.a.

	Stationary Emissions from Combustion of Digester Gas (N_2O)	Known amount of digester gas produced per day and known percent of methane in digester gas provided by the Central Marin Sanitation Agency. Known amount of digester gas produced per day (2016) and known percent of methane in digester gas (2017) provided by Las Gallinas Valley Sanitary District.	Emissions calculated according to U.S. Community Protocol v. 1.1, Appendix F, Method WW.2.a.
	Process Emissions from Wastewater Treatment Plant without Nitrification or Denitrification	The estimated population served by the wastewater treatment plant is provided by the Central Marin Sanitation Agency.	Emissions calculated according to U.S. Community Protocol v. 1.1, Appendix F, Method WW.8.
	Process Emissions from Wastewater Treatment Plant with Nitrification or Denitrification	Estimated population served by wastewater treatment plant provided by Las Gallinas Valley Sanitary District (2010 data).	Emissions calculated according to U.S. Community Protocol v. 1.1, Appendix F, Method WW.7.
	Fugitive Emissions from Effluent Discharge (N_2O)	The estimated population served by the wastewater treatment plant is provided by the Central Marin Sanitation Agency. Assumed significant industrial or commercial input.	Emissions calculated according to U.S. Community Protocol v. 1.1, Appendix F, Method WW.12(alt).
	Fugitive Emissions from Effluent Discharge (N_2O)	The estimated population served by the wastewater treatment plant is provided by the Las Gallinas Valley Sanitary District. Assumed no significant industrial or commercial input.	Emissions calculated according to U.S. Community Protocol v. 1.1, Appendix F, Method WW.12.