City of San Rafael

2010 Greenhouse Gas Emissions Inventory

July 2013

Prepared by the

Marin Climate & Energy Partnership

MARIN CLIMATE & ENERGY PARTNERSHIP

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EXECUTIVE SUMMARY

Climate change, caused by an increase in the concentration of atmospheric greenhouse gases, has been called one of the greatest challenges facing society today. Potential climate change impacts include declining water supplies, spread of disease, diminished agricultural productivity, sea level rise, and increased incidence of wildfire, flooding, and landslides. In addition, the volatility of energy markets has roused concern, and is forcing communities to think differently about their resources. Here, in the State of California – with Assembly Bill 32, the Attorney General's efforts to mandate GHG reductions via the California Environmental Quality Act (CEQA), and other legislation—policies, programs and state laws designed to reduce greenhouse gases to 1990 levels by the year 2020 have been created and are being implemented.

In 2006 San Rafael was one of the early signatories to the U.S. Conference of Mayors Climate Protection Agreement, committing the City to working towards meeting the goals of the Kyoto Protocol. To provide a roadmap on how the City can reduce greenhouse gas emissions from its own municipal operations as well as influence residents and businesses in San Rafael to reduce their emissions, the City Council called for the preparation of a Climate Change Action Plan.

In March 2008 the City Council appointed a 14-member Green Ribbon Committee composed of volunteers with diverse expertise but a common interest in sustainability to prepare a draft plan with extensive community input. The Council also appointed volunteer subject experts to four "Green Teams" which tackled issues such as transportation, waste reduction, land use, green building, energy conservation and adaptation.

The result of this community planning effort is the San Rafael Climate Change Action Plan (CCAP) which was adopted by the City Council on April 20, 2009. This document lays out the goals and implementation plan for achieving a 25% reduction of greenhouse gas (GHG) by 2020, and an ambitious 80% reduction by 2050 to meet state targets. The Implementation Plan is broken down into several distinct areas of action: Lifestyles, Buildings, Environment, Economy, Community Outreach, and City Operations.

This report measures the progress the City has made on reducing greenhouse gas emissions between 2005 and 2010. In some cases, changes have been made to the baseline year calculations in order to ensure an apples-to-apples comparison of emissions between 2005 and 2010. The inventory quantifies greenhouse gas emissions from a wide variety of sources, from the energy used to power, heat and cool buildings, to the fuel used to move vehicles and power off-road equipment, to the decomposition of solid waste and the treatment of wastewater. Emissions are arranged by sector to facilitate detailed analysis of emissions sources and comparison of increases and decreases between 2005 and 2010. It is important to note that the inventory provides a snapshot of two years and does not intend to imply there is necessarily a trend line between those years. Total emissions may have gone up or down during the years between 2005 and 2010.

The encouraging news is that San Rafael reduced community greenhouse gas emissions approximately 8.1% between 2005 and 2010, from 375,845 metric tons in 2005 to 345,516 metric tons in 2010 – a reduction of 30,329 metric tons CO2e. Reductions were measured in all sectors except the wastewater sector. On a percentage basis, the greatest declines occurred in the waste (-34%), water (-31%), and commercial (-15%) sectors. In absolute terms, the greatest reductions were made in the commercial (13,403 metric tons), transportation (9,479 metric tons), and waste (4,376 metric tons) sectors.

TABLE A: COMMUNITY EMISSIONS BY SECTOR, 2005 AND 2010

Sector	2005 Greenhouse Gas Emissions		2010 Greenhouse Gas Emissions		Change in Metric Tons CO_{2e}	% Change in Metric Tons
	Metric Tons CO_2e	% of Total	Metric Tons CO_2e	% of Total		
Residential*	89,715	24%	87,694	25%	-2,021	-2.3%
Commercial*	88,116	23%	74,713	22%	-13,403	-15.2%
Transportation	177,338	49%	167,859	49%	-9,479	-5.3%
Off-Road	4,721	1%	4,095	1%	-626	-13.3%
Water	1,501	<1%	1,040	<1%	-461	-30.7%
Wastewater	1,479	<1%	1,517	<1%	38	2.6%
Waste	12,974	3%	8,598	2%	-4,376	-33.7%
Total	**375,845**	**100%**	**345,516**	**100%**	**-30,329**	**-8.1%**

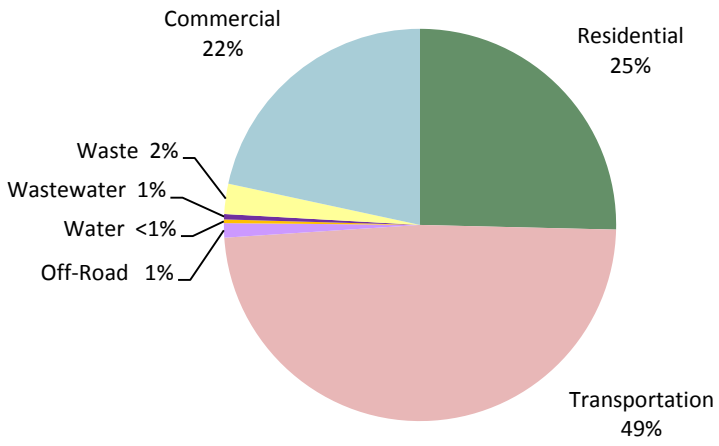
*Energy use only

In the commercial and residential energy sectors, an increase in natural gas usage was offset by reductions in electricity consumption. Emissions dropped because of an improvement in the carbon intensity of PG&E electricity and a mid-year switch to Marin Energy Authority Electricity. Approximately 6% of electricity consumed in San Rafael in 2010 was purchased through the Marin Energy Authority.

In the transportation sector, a decline in vehicle miles traveled on local roads and Highway 101, as well as improvements in fuel efficiency and the carbon intensity of transportation fuels, led to a decline in in transportation emissions. The great strides that were made in the waste sector were due to a 31% reduction in waste going to the landfill. A 31% decrease in fuel used in construction vehicles and equipment was the primary driver behind the reduction in off-road emissions, while a decrease in water usage and an improvement in the carbon intensity of electricity led to a decline in water emissions. More detailed analysis of the factors related to decreases and increases in emissions appears in the Community Inventory Detail by Sector section beginning on page 14.

As shown in Figure A, emissions from the transportation sector were responsible for the greatest percentage of greenhouse gas emissions (49%) in 2010, followed by emissions from the residential sector (25%) and the commercial sector (22%). The waste sector represented 2% of total emissions, while the wastewater, off-road and water sectors were each responsible for 1% or less of community emissions.

FIGURE A: COMMUNITY EMISSIONS BY SECTOR, 2010

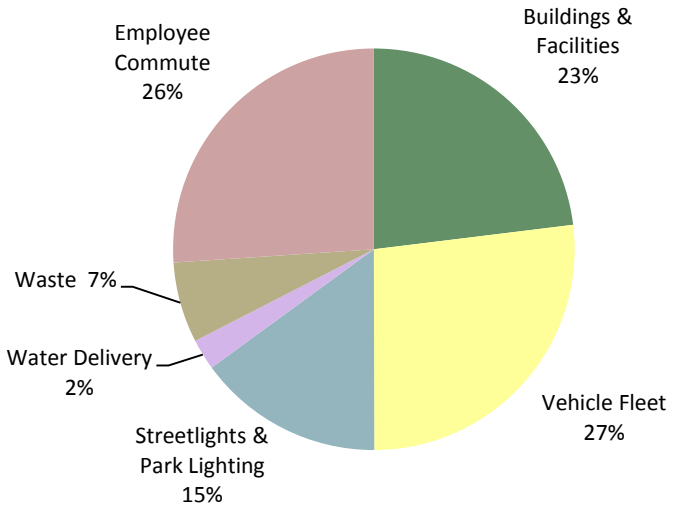


Government operations represent a small fraction of total community emissions, at approximately 1%. Within government operations, emissions decreased by 768 metric tons CO_2e, or by 19.2%. Emissions decreased in all sectors except the waste sector, with the majority of reductions occurring in the employee commute sector (-37%), water delivery sector (-29%) and public lighting sector (-21%). More than three-quarters of the reductions occurred in the employee commute sector, which was due, in part, to a 15% reduction in the number of City employees between 2005 and 2010. Excluding employee commute emissions, total emissions from government operations decreased by 10.2%. Most of the decrease in the other sectors was due to a decrease in the carbon intensity of electricity supplied by Pacific Gas and Electric and the Marin Energy Authority.

TABLE B: GOVERNMENT OPERATIONS EMISSIONS BY SECTOR, 2005 AND 2010

Sector	2005 Greenhouse Gas Emissions		2010 Greenhouse Gas Emissions		Change in Metric Tons CO_{2e}	% Change in Metric Tons CO_2e
	Metric tons CO_2e	% of Total	Metric Tons CO_2e	% of Total		
Buildings & Facilities	802	20%	745	23%	-56	-7%
Vehicle Fleet	934	23%	862	27%	-72	-8%
Public Lighting	615	15%	485	15%	-130	-21%
Water Delivery	114	3%	80	2%	-33	-29%
Waste	187	5%	210	7%	23	12%
Employee Commute	1,341	34%	843	26%	-499	-37%
Total	**3,993**	**100%**	**3,225**	**100%**	**-768**	**-19.2%**

FIGURE B: GOVERNMENT OPERATIONS EMISSIONS BY SECTOR, 2010



In conclusion, these results demonstrate that San Rafael is on its way to accomplishing its greenhouse gas reduction goals for community-wide and government operations emissions. If emissions continue to decrease at the current rate, San Rafael would achieve a reduction in community emissions of 22% by 2020, 7% more than the State goals, and 3% shy of the City's goal of 25%.

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 and local government operations in 2010. This inventory provides a comparison to baseline 2005 emissions, and identifies the sectors where significant reductions in greenhouse gas emissions have occurred and where more work needs to be done. In some instances, baseline emissions were recalculated in order to ensure the same methodology was employed for 2005 and 2010. In addition, some new emission sources were added to the inventory; this report includes emissions from residential use of propane and fugitive emissions from refrigerants used in government operations.

GENERAL METHODOLOGY

This inventory utilizes methodologies developed by the Bay Area Air Quality Management District (BAAQMD) and ICLEI for quantifying community-scale emissions. In general, the inventory follows the standards outlined in the International Local Government GHG Emissions Analysis Protocol and, where appropriate, the Local Government Operations Protocol (discussed below), with additional guidance from the Air District with respect to quantifying emissions from the transportation, off-road, water and wastewater sectors.

Community emissions have been categorized according to seven primary sectors:

- Residential
- Commercial
- Transportation
- Off-Road Vehicles and Equipment
- Water
- Wastewater
- Waste

For quantifying emissions from government operations, this inventory utilizes a national standard called the Local Government Operations Protocol (LGO Protocol) that has been developed and adopted by the California Air Resources Board (ARB) in conjunction with ICLEI-Local Governments for Sustainability, the California Climate Action Registry and The Climate Registry. This standard provides accounting principles, boundaries, quantification methods and procedures for reporting greenhouse gas emissions from local government operations. The LGO Protocol forms the basis of ICLEI's Clean Air & Climate Protection Software (CACP 2009), which allows local governments to compile data and perform the emissions calculations using standardized methods.

Local government operations emissions have been categorized according to the following sectors:

- Buildings and Other Facilities
- Streetlights, Traffic Signals, and Other Public Lighting
- Water Delivery Facilities
- Vehicle Fleet
- Solid Waste
- Employee Commute

Calculating Emissions

In general, emissions can be quantified in two ways:

1. **Measurement-based methodologies** refer to the direct measurement of greenhouse gas emissions from a monitoring system. Emissions measured in this way may include those from a flue of a power plant, wastewater treatment plant, landfill, or industrial facility. This method is the most accurate way of inventorying emissions from a given source, but is generally available for only a few sources of emissions.
2. **Calculation-based methodologies** refer to an estimate of emissions calculated based upon measurable activity data and emission factors. Table 1 provides examples of common emissions calculations. For example, in order to calculate the carbon dioxide (CO_2) emissions from community electricity consumption, the total amount of kilowatt hours (kWh) of electricity consumed by the community over a one-year period is multiplied by an emission factor specific to that source. This results in the amount of carbon dioxide gas emitted by electricity consumption in that year. All emissions inventoried in this report are calculated in this manner.

Table 1: Factors for Calculating Emissions

Emission Source	Activity Data	Emission Factor	Emissions
Electricity Consumption	Kilowatt hours	CO_2 emitted/kWh	CO_2 emitted
Natural Gas Consumption	Therms	CO_2 emitted/therm	CO_2 emitted
Gasoline/Diesel Consumption	Gallons	CO_2 emitted/gallon	CO_2 emitted
Waste Generation	Tons	CH_4 emitted/ton	CH_4 emitted

This inventory calculates individual greenhouse gases – e.g., carbon dioxide, methane and nitrous oxide – and converts each gas emission to a standard metric, known as "carbon dioxide equivalents" or CO_2e, in order to allow an apple-to-apples comparison among the three emissions. Table 2 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. Methane, for example, is 21 times as potent as carbon dioxide; therefore, one metric ton of methane is equivalent to 21 metric tons of carbon dioxide. Greenhouse gas emissions are reported in this inventory as metric tons of carbon dioxide equivalents, or $MTCO_2e$.

TABLE 2: 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	21
Nitrous Oxide	N_2O	Combustion, wastewater treatment	310
Hydroflourocarbons	Various	Leaked refrigerants, fire suppressants	12 to 11,700

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 city limits.
- **Fugitive emissions** resulting from the unintentional release of greenhouse gases into the atmosphere, such as leaked refrigerants and methane from waste decomposition.
- **Process emissions** from physical or chemical processing of a material, such as wastewater treatment.

THE SCOPES FRAMEWORK

This inventory reports greenhouse gas emission by sector, as described earlier in this report, and by "scope." The scope framework is used to prevent double counting of emissions across communities for major categories such as electricity use and waste disposal. Scopes are defined as follows:

- **Scope 1:** Direct emissions from the combustion of fuels to produce heat, steam, electricity or to power equipment; mobile combustion of fuels; process emissions from physical or chemical processing; fugitive emissions that result from production, processing, transmission, storage and use of fuels; leaked refrigerants; and other sources.
- **Scope 2:** Indirect emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling. Scope 2 emissions occur as a result of activities that take place within the city limits but are generated outside of the town. For example, electricity from Pacific Gas & Electric Company is consumed within San Rafael but the greenhouse gasses associated with this consumption are emitted outside of the city where the electricity is generated.
- **Scope 3:** All other emissions sources that hold policy relevance to the local government that can be measured and reported. Typically, these are emissions not covered in Scope 2 that occur as a result of activities within the city. Scope 3 emissions include (but are not limited to) emissions resulting from the decomposition of solid waste, the treatment and distribution of water, and the treatment of wastewater at facilities located outside of the city boundaries. Within the government operations inventory, Scope 3 emissions also include emissions resulting from employee commutes.

Organizational Boundaries

The organizational boundary for the inventory determines which aspects of operations are included in the emissions inventory, and which are not. Under the LGO Protocol, two control approaches are used for reporting emissions: operational control or financial control. A local government has operational control if it has full authority to introduce and implement policies that impact the operation. A local government has financial control if the operation is fully consolidated in financial accounts. If a local government has joint control over an operation, the contractual agreement will have to be examined to see who has authority over operating policies and implementation, and thus the responsibility to report emissions under operational control.

The LGO Protocol strongly encourages local governments to utilize operational control as the organizational boundary for a local government operations emission inventory. Operational control is believed to most accurately represent the emissions sources that local governments can most directly influence, and this boundary is consistent with other environmental and air quality reporting program requirements. For this reason, this inventory for local government operations emissions was conducted according to the operational control framework.

Understanding Totals

It is important to realize that the totals listed in the tables and discussed in the report are intended to represent all-inclusive, complete totals for San Rafael's community emissions. However, these totals are only a summation of inventoried emissions using available estimation methods. Each inventoried sector may have additional emissions sources associated with them that were unaccounted for, due to a lack of data or robust quantification methods. 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.

Information Items

Information items are emissions sources that are not included as Scope 1, 2, or 3 emissions in the inventory, but are reported here separately in order to provide a more complete picture of emissions from San Rafael's government operations. Information items for this inventory include one parks department vehicle using the refrigerant R-12, refrigerators and freezers using the refrigerants R-12 and R-22, and air conditioning systems and units using the refrigerant R-22. These refrigerants are not included in the inventory because they are ozone-depleting substances and are being phased out by 2020 under the terms of the Montreal Protocol.

Table 3: Information Items, 2010

Source	Refrigerant	Metric Tons CO_2e
Vehicle	R-12	0.76
Refrigerators and freezers	R-12, R-22	0.54
Air Conditioning	R-22	13.86
Total		**15.16**

Regional and Local Context

Climate Change Mitigation Activities in California

Since 2005, the State of California has responded to growing concerns over the effects of climate change by adopting a comprehensive approach to addressing emissions in the public and private sectors. This approach was officially initiated with the passage of the Global Warming Solutions Act of 2006 (AB 32), which requires the state to reduce its greenhouse gas emissions to 1990 levels by 2020. The AB 32 Scoping Plan was developed to identify strategies for meeting the AB 32 goal, and was adopted by the California Air Resources Board (ARB) in December 2008. Among many other strategies, it encourages local governments to reduce emissions in their jurisdictions by 15 percent below current levels by 2020. In addition, it identifies the following strategies that will impact local governance:

- Develop a California cap-and-trade program
- Expand energy efficiency programs
- Establish and seek to achieve reduction targets for transportation-related GHG emissions
- Expand the use of green building practices
- Increase waste diversion, composting, and commercial recycling toward zero-waste
- Continue water efficiency programs and use cleaner energy sources to move and treat water
- Reduce methane emissions at landfills
- Preserve forests that sequester carbon dioxide

Other measures taken by the state include mandating stronger vehicle emissions standards (AB 1493, 2002), establishing a low-carbon fuel standard (EO # S-01-07, 2007), mandating a climate adaptation plan for the state (S-EO # 13-08, 2008), establishing a Green Collar Job Council, and establishing a renewable energy portfolio standard for power generation or purchase in the state. The state also has made a number of legislative and regulatory changes that have significant implications for local governments:

- SB 97 (2007) required the Office of Planning and Research to create greenhouse gas planning guidelines for the California Environmental Quality Act (CEQA). In addition, ARB is tasked with creating energy-use and transportation thresholds in CEQA reviews, which require local governments to account for greenhouse gas emissions when reviewing project applications.
- AB 811 (2007) authorizes all local governments in California to establish special districts that can be used to finance solar or other renewable energy improvements to homes and businesses in their jurisdiction.
- SB 375 (2008) revises the process of regional transportation planning by metropolitan planning organizations (MPOs), which are governed by elected officials from local jurisdictions. The statute calls on ARB to establish regional transportation-related greenhouse gas targets and requires the large MPOs to develop regional "Sustainable Communities Strategies" of land use, housing and transportation policies that will move the region towards its GHG target. The statute stipulates that transportation investments must be consistent with the Sustainable Communities Strategy and provides CEQA streamlining for local development projects that are consistent with the Strategy.

The Marin Climate & Energy Partnership

Created in 2007, the mission of the Marin Climate & Energy Partnership (MCEP) is to reduce greenhouse gas emission levels to the targets set by Marin County and local municipalities, consistent with the AB32 standards. Ten Marin cities and towns, the County of Marin, the Transportation Authority of Marin, and the Marin Municipal Water District are members. The Marin Climate and Energy Partnership provided staff support and technical

expertise for the development of this inventory. Funding for this project was provided in part by the Marin County Energy Watch (MCEW), a joint project of Pacific Gas and Electric Company (PG&E) and the County of Marin.[1]

Climate Change Mitigation Activities in San Rafael

Since approval of the San Rafael Climate Change Action Plan in April 2009, the City has continued to implement greenhouse gas reduction programs in San Rafael. These include the following:

- Adopted a Green Building Ordinance with building efficiency standards above the State green building and energy codes.
- Adopted a construction and demolition (C&D) debris recycling and reuse ordinance that requires a minimum of 70% of C&D waste to be recycled rather than deposited into the landfill. The ordinance incrementally increases diversion requirements until targets meet 95% by the end of 2025.
- Adopted a Zero Waste resolution that commits the City to reaching a 94% diversion rate by 2025.
- In partnership with Marin Sanitary Service, implemented residential curbside food waste collection. The program reduces methane emissions by composting food waste instead of depositing it into the landfill.
- Adopted a resolution supporting a joint project by the Central Marin Sanitation Agency and the Marin Sanitary Service to collect commercial food waste and convert it to energy at the wastewater treatment plant.
- Participated in the Energy Upgrade California program, which provided substantial rebates to homeowners to perform energy audits and "whole house" energy upgrade retrofits.
- Joined the Marin Energy Authority and provided San Rafael ratepayers with the ability to purchase electricity with a higher renewable energy content.
- In mid-2010, switched all City electricity accounts to Marin Clean Energy light green electricity. Approximately 53% of the City's electricity was purchased through the Marin Energy Authority in 2010.
- Implemented Marin Municipal Water District's Ordinance 421 which added, amended, and repealed certain sections of MMWD's Title 13 Water Code. The revisions were necessary to further meet conservation measures within the District's service area, as well as meet 2010 California Green Building Standards, improve the effectiveness of the District's water waste prevention program, and increase efficiency standards.
- Installed charging stations for plug-in electric vehicles in City garages.
- Led a county-wide Single Use Plastics Advisory Committee to investigate options for reduction of single use plastic bags and takeout containers. Continuing to pursue a plastic bag reduction ordinance county-wide.
- Adopted a polystyrene takeout food container ordinance.
- Adopted an Integrated Pest Management Policy.
- Amended San Rafael's General Plan to incorporate the Climate Change Action Plan as a Sustainability Element.
- Has implemented bicycle and pedestrian infrastructure improvements such as the Lincoln Avenue/Highway 101 Bike and Pedestrian Path, city-wide sidewalk and curb cut improvements, participation in the FHA's Non-Motorized Transportation Pilot Program, support of Safe Routes to Schools, and re-opening the CalPark Tunnel.
- Joined the CaliforniaFIRST commercial property-assessed clean energy financing program (PACE).

[1] MCEW is funded by California utility ratepayers under the auspices of the California Public Utilities Commission.

- Helped pilot a Resilient Neighborhoods residential carbon reduction program. 46 San Rafael households participated in the program, reducing their carbon emissions by approximately 493,000 pounds.
- Hosted a business resiliency learning circles series in conjunction with Dominican University, the Chamber of Commerce, and Natural Capitalism Solutions, with funding by the Marin Community Foundation. 23 local businesses participated and were provided tools and resources to reduce their emissions while reducing their costs of doing business.
- Supported the Sonoma Marin Area Rail Transit (SMART) efforts to bring commuter rail to the 101 corridor through a public planning process for the station areas.
- Implemented traffic signal coordination to limit vehicle idling in San Rafael.
- Implemented recycling at City sponsored events and farmers markets.
- Supports community gardens such as the new Canal Community Garden project in the Canal Neighborhood.
- Has replaced the City Hall HVAC system to a more energy efficient system.
- Has replaced City pool vehicles with fuel efficient vehicles.
- Has been replacing hundreds of street lights to high-efficiency lamps, as well as lighting in City buildings and parking garages, and has replaced all outdoor holiday lighting with LED lights, reducing electricity use and costs.
- Instituted an Employee Green Team in 2010, which works regularly across departments to implement green practices, and piloted an Employee Commute Program in 2013 in an effort to reduce single occupant vehicle employee commutes.
- Adopted energy efficiency ordinances to make it easier for residents and businesses to install solar panels, and developed a Qualified Greenhouse Gas Reduction Strategy to allow CEQA streamlining of new development and building projects.
- Supported EcoFair Marin and Earth Day Marin festivals.
- Signed a Memorandum of Understanding with the Solar SEED Project to be the lead agency in a solar procurement program in the North Bay with the intention of installing solar panels on city facilities in the coming year.
- Eliminated plastic water bottles from City facilities and operations, and instituted an environmentally sensitive cleaning products policy for City departments.

COMMUNITY INVENTORY RESULTS

SAN RAFAEL PROFILE

San Rafael is a city with a land area of 16.5 square miles, located in the heart of Marin County. According to the U.S. Census, the population of San Rafael in 2010 was 57,713 and there were 24,011housing units. The California Department of Finance estimates the population of San Rafael in 2005 was 56,296.[2] San Rafael enjoys a temperate climate, with cool, wet, and almost frostless winters and dry summers. The city is located in climate zone 2, and experienced an estimated 3,649 heating degree days and 292 cooling degree days in 2005. The year 2010 was relatively cooler, with 4,027 heating degree days and 168 cooling degree days. [3]

COMMUNITY INVENTORY SUMMARY

In 2005, the activities taking place by the San Rafael community resulted in approximately 375,845 metric tons of CO_2e. In 2010, those activities resulted in approximately 345,516 metric tons of CO_2e, a reduction of 30,329 metric tons, or 8.1%. These numbers represent a roll-up of emissions. While the roll-up is a valuable figure, the breakdown of emissions information by sectors, sources, and scope allows the comparative analysis and insight needed for effective decision-making for target setting, developing GHG reduction measures, and monitoring. The following summaries break down these totals by sector, sources, and scope.

SUMMARY BY SECTOR

As shown in Table 4 and Figure 1, the transportation sector was the largest emitter of greenhouse gas emissions in both 2005 and 2010 (47% of total emissions in 2005 and 49% in 2010). Emissions from the residential energy sector produced the second highest quantity (24% in 2005 and 25% in 2010), followed by the commercial energy sector (23% in 2005 and 22% in 2010). Emissions were reduced in all sectors except the wastewater sector, with the greatest reductions occurring in the commercial sector (13,403 metric tons CO_2e), transportation sector (9,479 metric tons), and waste sector (4,376 metric tons CO_2e).

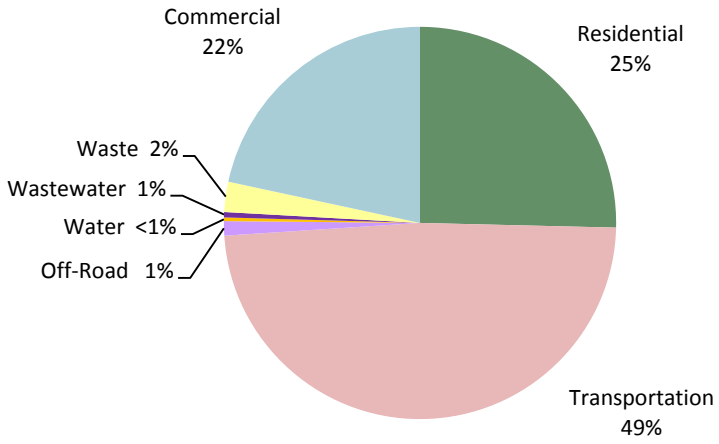
[2] California Department of Finance, "E-4 Population Estimates for Cities, Counties, and the State 2001-2010, with 2000 & 2001 Census Counts," August 2011. To make comparisons to U.S. Census data, this is the average between California Department of Finance estimates for January 1, 2005, and January 1, 2006.

[3] Climate Zone information is supplied by the California Energy Commission, http://www.energy.ca.gov/maps/renewable/Climate_Zones_by_City.pdf, accessed 11/5/12. Heating and cooling degree days data for the North Coast Drainage Division is supplied by NOAA Satellite and Information Service, National Climatic Data Center, U.S. Department of Commerce, http://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp, accessed 5/22/12. A heating degree day (HDD) is a measurement designed to reflect demand for energy needed to heat a facility, while a cooling degree day (CDD) is used to reflect the demand on energy needed to cool a building. Degree days are calculated using daily temperature readings and a base temperature (typically 60 or 65 degrees). For example, a typical January day has an average temperature of 47 degrees. For such a day we can approximate the HDD as (65 - 47) = 18.

TABLE 4: COMMUNITY EMISSIONS SUMMARY BY SECTOR, 2005 AND 2010

Sector	2005 Metric Tons CO_{2e}	2010 Metric Tons CO_2e	Change Metric Tons CO_2e	% Change
Residential	89,715	87,694	-2,021	-2.3%
Commercial/Industrial	88,116	74,713	-13,403	-15.2%
Transportation	177,338	167,859	-9,479	-5.3%
Off-Road	4,721	4,095	-626	-13.3%
Water	1,501	1,040	-461	-30.7%
Wastewater	1,479	1,517	38	2.6%
Waste	12,974	8,598	-4,376	-33.7%
Total	**375,845**	**345,516**	**-30,329**	**-8.1%**

FIGURE 1: COMMUNITY EMISSIONS BY SECTOR, 2010



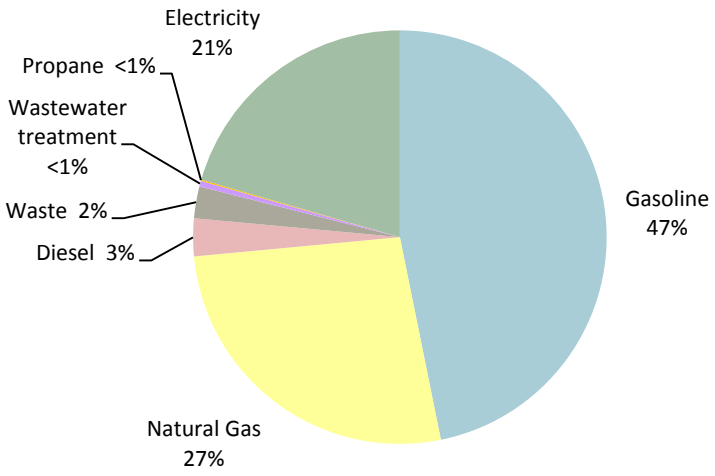
SUMMARY BY SOURCE

When considering how to reduce emissions, it is helpful to look not only at which sectors are generating emissions, but also at the specific raw resources and materials (gasoline, diesel, electricity, natural gas, solid waste, etc.) whose use and generation directly result in the release of greenhouse gases. Table 5 and Figure 2 provide summaries of San Rafael's 2005 and 2010 greenhouse gas emissions by source. Between 2005 and 2010, emissions increased from the combustion of natural gas (2,459 metric tons CO_2e) and the treatment of wastewater (38 metric tons $CO_2e_)$. Emissions from all other sources declined, with the largest decreases occurring from electricity and gasoline sources. In 2010, the largest source of emissions was gasoline (47%), followed by natural gas (27%) and electricity (21%).

TABLE 5: COMMUNITY EMISSIONS SUMMARY BY SOURCE, 2005 AND 2010

Source	2005 Metric Tons CO_{2e}	2010 Metric Tons CO_2e	Change Metric Tons CO_2e	% Change
Gasoline	171,034	161,763	-9,271	-5.4%
Natural Gas	89,759	92,218	2,459	2.7%
Electricity	89,224	70,896	-18,328	-20.5%
Diesel	11,026	10,191	-835	-7.6%
Waste	12,974	8,598	-4,376	-33.7%
Wastewater Treatment	1,479	1,517	38	2.5%
Propane/LPG	349	333	-16	-4.7%
Total	**375,845**	**345,516**	**-30,329**	**-8.1%**

FIGURE 2: COMMUNITY EMISSIONS BY SOURCE, 2010



SUMMARY BY SCOPE

As shown in Table 6, Scope 1 sources produced the largest amount of community greenhouse gas emissions in both 2005 and 2010, with emissions totaling 266,022 metric tons CO_2e in 2010. Scope 2 emissions comprised the second largest amount (69,856 metric tons CO_2e), and Scope 3 emissions totaled 9,638 metric tons CO_2e. The greatest reduction occurred in Scope 3 emissions, which represents emissions from the waste and water sectors.

TABLE 6: COMMUNITY EMISSIONS SUMMARY BY SCOPE, 2005 AND 2010

Activity	2005 Metric Tons CO_{2e}	2010 Metric Tons CO_{2e}	% Change
Scope 1	273,647	266,022	-2.8%
Scope 2	89,224	69,856	-21.7%
Scope 3	12,974	9,638	-25.7%
Total	**375,845**	**345,516**	**-8.1%**

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, and one must be cognizant that there will be some margin of error when comparing figures.

As detailed in Table 7, dividing the total community-wide GHG emissions by service population (residents and employees) yields a result of 3.7 metric tons of CO_2e per capita in 2005. Per capita emissions decreased 2.2% between 2005 and 2010, falling to 3.6 metric tons per person. It is important to understand that this number is not the same as the carbon footprint of the average individual living or working in San Rafael (which would include lifecycle emissions, emissions resulting from air travel, etc.).

Table 7: Per Capita Emissions, 2005 and 2010

	2005	2010	% Change
Service Population (Residents and Employees)	101,436	95,333	-6.0%
Community GHG Emissions (metric tons CO_2e)	375,845	345,516	-8.1%
Service Population Per Capita Emissions (metric tons CO_2e)	3.7	3.6	-2.2%

Community Inventory Detail by Sector

This section explores community activities and emissions by taking a detailed look at each primary sector. As listed above, the sectors included in the community emissions analysis are:

- Residential
- Commercial
- Transportation
- Off-Road Vehicles and Equipment
- Waste
- Water
- Wastewater

Residential Sector

Energy consumption associated with San Rafael homes produced 89,715 metric tons of greenhouse gas emissions in 2005 and 87,694 metric tons in 2010, a decrease of 2.3%. All residential sector emissions are the result of electricity consumption and the on-site combustion of natural gas and propane. Natural gas is typically used in residences as a fuel for home heating, water heating and cooking, and electricity is generally used for lighting, heating, and to power appliances. In 2005, San Rafael's entire residential sector consumed 132,638,035 kWh of electricity and 11,229,829 therms of natural gas.

As shown in Table 8, electricity usage in San Rafael's residential sector decreased by 0.9% between 2005 and 2010, while emissions decreased by 11.3%. This greater decline in GHG emissions occurred for two reasons. First, the carbon intensity of PG&E electricity declined 9% between 2005 and 2010. Second, some San Rafael residents

began to purchase their electricity from the Marin Energy Authority (MEA) approximately mid-way through the year, resulting in about 6% of all residential kWh purchased through MEA in 2010. The carbon intensity of MEA electricity was about 27% lower than that supplied by PG&E in 2010 due to the higher percentage of renewable and non-greenhouse gas emitting energy sources in MEA's energy mix.

The decline in PG&E's emissions from delivered electricity from 2005 to 2010 owed, in large part, to an increase in the amount of zero- and low-emitting electricity in their power portfolio and the expanded use of cleaner fossil-fueled electricity, including two new, state-of-the-art natural gas-fired plants that PG&E brought into service in 2010. More than half of PG&E's power came from a combination of non-greenhouse gas emitting and renewable sources in 2010. Several factors affect PG&E's power mix and emissions from year to year, including demand growth, the weather and the availability of hydro power.

TABLE 8: RESIDENTIAL EMISSIONS SOURCES, 2005 AND 2010

Source	2005 Energy Consumption	2005 GHG Emissions ($MTCO_2e$)	2010 Energy Consumption	2010 GHG Emissions ($MTCO_2e$)	% Change in Energy Consumption	% Change in GHG Emissions ($MTCO_2e$)
Electricity	132,638,035 kWh	29,673	131,421,113 kWh	26,316	-0.9%	-11.3%
Natural Gas	11,229,829 therms	59,693	11,484,281 therms	61,046	2.3%	2.3%
Propane/LPG	5,625 MMBtu	349	5,363 MMBtu	333	-4.7%	-4.7%
Total	-	**89,715**	**-**	**87,694**	**-**	**-2.3%**

Natural gas usage increased 2.3% between 2005 and 2010. This may be due, in part, to the fact that 2010 was a cooler year than 2005.[4] Since the natural gas emissions factor does not fluctuate, the amount of greenhouse gases emitted by the combustion of natural gas also increased 2.3%.

As shown in Table 9 below, San Rafael residents generated approximately 3.9 metric tons of energy-related greenhouse gas emissions per household in 2010. This is a decrease of 1.5% per household since 2005.[5]

TABLE 9: RESIDENTIAL EMISSIONS PER HOUSEHOLD

	2005	2010
Number of Households	22,930	22,764
Residential GHG Emissions (metric tons CO_2e)	89,715	87,694
Residential GHG Emissions per Household (metric tons CO_2e)	3.91	3.85

COMMERCIAL/INDUSTRIAL SECTOR

The commercial and Industrial energy sector includes emissions from the operations of businesses as well as public agencies. Between 2005 and 2010, emissions in the commercial sector decreased by 15.2%. In 2010, buildings and

[4] See discussion on page 12.

[5] Number of San Rafael households is from ABAG Projections 2009 and 2010 U.S. Census SF1:H.

facilities within the commercial sector produced 74,713 metric tons of greenhouse gas emissions. All commercial sector emissions included in this inventory are the result of electricity consumption and the on-site combustion of natural gas. Natural gas is typically used in the commercial sector to heat buildings, fire boilers, and generate electricity; electricity is generally used for lighting, heating, and to power appliances and equipment.

As shown in Table 10, electricity usage decreased by 10.3% in the commercial sector between 2005 and 2010, and emissions from electricity consumption decreased even more – by 25% – due to the same emission factor reasons explained in the section on residential emissions above. Natural gas usage increased 3.7%. The net effect was to decrease total emissions from the commercial sector by 15.2%.

TABLE 10: COMMERCIAL/INDUSTRIAL EMISSIONS, 2005 AND 2010

Source	2005 Energy Consumption	2005 GHG Emissions ($MTCO_2e$)	2010 Energy Consumption	2010 GHG Emissions ($MTCO_2e$)	% Change in Energy Consumption	% Change in GHG Emissions ($MTCO_2e$)
Electricity	231,482,333 kWh	58,050	207,750,003 kWh	43,540	-10.3%	-25.0%
Natural Gas	5,656,158 therms	30,066	5,864,336 therms	31,172	3.7%	3.7%
Total	--	**88,116**	**--**	**74,713**	**--**	**-15.2%**

TRANSPORTATION SECTOR

Emissions in the transportation sector are calculated by estimating all vehicle miles traveled on local roads within the city limits and a proportionate share of vehicle miles traveled on state highways that pass through San Rafael. Air travel and vehicle miles traveled outside of Marin County are not included in the analysis. In 2005, the transportation sector generated 177,338 metric tons of CO_2e. By 2010, emissions from the transportation sector decreased by approximately 5.3% to 167,859 metric tons CO_2e. As shown in Table 11, vehicle miles traveled on local roads decreased 3% between 2005 and 2010, while vehicle miles traveled on state highways are estimated to have decreased by 1%.

TABLE 11: TRANSPORTATION EMISSIONS, 2005 AND 2010

Source	2005 Vehicle Miles Traveled	2005 GHG Emissions ($MTCO_2e$)	2010 Vehicle Miles Traveled	2010 GHG Emissions ($MTCO_2e$)	% Change in Vehicle Miles Traveled	% Change in GHG Emissions ($MTCO_2e$)
Local Roads	228,887,565	112,057	222,020,865	105,027	-3.0%	-6.3%
State Highways	134,200,048	65,281	132,823,054	62,832	-1.0%	-3.8%
Total	**363,087,613**	**177,338**	**354,843,919**	**167,859**	**-2.3%**	**-5.3%**

Decreases in transportation sector emissions are largely due to changes in fuel efficiency and the carbon intensity of transportation fuels. The Pavley I vehicle standards are over the long-term increasing fuel efficiency and decreasing emissions per vehicle mile. Fuel efficiency data available for this inventory show an increase in fuel efficiency from an average of 18.1 miles per gallon to an average of 18.5 miles per gallon for vehicles using gasoline

between 2005 and 2010. California's Low Carbon Fuel Standard is reducing the carbon intensity of fuel over the long term, and some decreases in carbon intensity were measured between 2005 and 2010.[6]

Off-Road Sector

Emissions in the off-road sector are from the combustion of fuels used to power vehicles and equipment in the construction and lawn and garden categories, and include everything from hedge trimmers to cranes. As shown in Table 12, off-road emissions decreased by approximately 13.3% between 2005 and 2010. This decrease was due to a reduction in gasoline and diesel use in off-road vehicles and equipment, and an improvement in the carbon-intensity of fuels. Emissions from construction equipment and off-road vehicles, in particular, decreased by about 31%, a result of the decline in the construction industry since the peak of the real estate boom in 2006-2007.

Table 12: Off-Road Emissions, 2005 and 2010

Source	2005 Energy Consumption (gallons)	2005 GHG Emissions ($MTCO_2e$)	2010 Energy Consumption (gallons)	2010 GHG Emissions ($MTCO_2e$)	% Change in Energy Consumption	% Change in GHG Emissions
Construction Equipment	231,440	2,069	159,394	1,437	-31.1%	-30.5%
Lawn and Garden Equipment	267,210	2,651	268,210	2,658	0.4%	0.3%
Total	**498,650**	**4,721**	**427,604**	**4,095**	**-14.2%**	**-13.3%**

Water Sector

Emissions in the water sector are a result of Marin Municipal Water District's use of electricity to pump, treat, convey and distribute water from the water source to the water users in San Rafael. Emissions from the water sector decreased about 30.7% between 2005 and 2010 (see Table 13). This reduction is based on two factors: a decline in the amount of electricity needed to treat and distribute water, and a decline in the carbon intensity of the electricity provided by PG&E and the Marin Energy Authority (MEA). MMWD began purchasing electricity procured by the Marin Energy Authority about mid-way through 2010, and MEA electricity represented about 54% of the District's total electricity usage in that year. MEA's electricity was about 27% less carbon intensive than PG&E electricity in 2010.

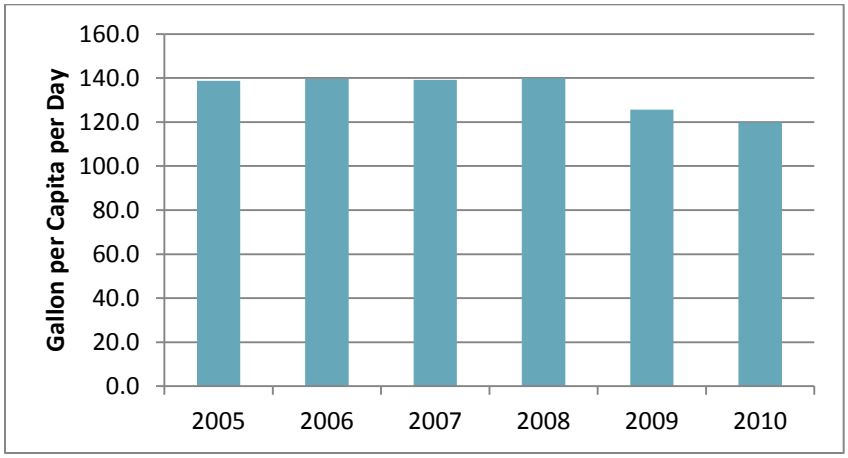
Table 13: Water Emissions, 2005 and 2010

Source	2005 Energy Consumption (kWh)	2005 GHG Emissions ($MTCO_2e$)	2010 Energy Consumption (kWh)	2010 GHG Emissions ($MTCO_2e$)	% Change in Energy Consumption	% Change in GHG Emissions
Water	6,711,604	1,501	5,988,426	1,040	-10.8%	-30.7%

[6] See the Appendix for further information.

As shown in Figure 3, water use has declined from 138.7 gallons per person in 2005 to 119.8 gallons per person in 2010, a reduction of almost 14%. Water demand responds to a variety of factors, including economic conditions, precipitation patterns and weather conditions, water conservation fixture and behavioral changes, and water rate structure changes. MMWD has increased water rates significantly in recent years (9.7% in 2008, 7.3% in 2009, and 9.8% in 2010), and demand has most likely declined in response to these rate increases. The recession of December 2007 to June 2009, and the poor economic conditions that followed the official end of the recession, have also likely contributed to a reduction in water demand.

FIGURE 3: MMWD PER CAPITA WATER USE, 2005 TO 2010



WASTEWATER SECTOR

Wastewater coming from homes and businesses is rich in organic matter and has a high concentration of nitrogen and carbon, along with other organic elements. As wastewater is collected, treated and discharged by the Central Marin Sanitation Agency, chemical processes in anaerobic conditions lead to the creation and emission of two greenhouse gases: methane and nitrous oxide. Emissions from the wastewater sector are estimated to have increased 2.6% between 2005 and 2010, due to an increase in the San Rafael population.

TABLE 14: WASTEWATER EMISSIONS, 2005 AND 2010

Source	2005 Population	2005 GHG Emissions ($MTCO_2e$)	2010 Population	2010 GHG Emissions ($MTCO_2e$)	% Change in Population	% Change in GHG Emissions
Treatment	56,296	1,479	57,713	1,517	2.5%	2.6%

WASTE SECTOR

Emissions from the waste sector are an estimate of methane generation from the decomposition of municipal solid waste and alternative daily cover sent to the landfill in the 2005 and 2010. These emissions are considered Scope 3 because they are not generated in the base year, but will result from the decomposition of 2005 and 2010 waste

over the full 100+ year cycle of its decomposition. About 75 percent[7] of landfill methane emissions are captured through landfill gas collection systems, but the remaining 25 percent escape into the atmosphere as a significant contributor to global warming.

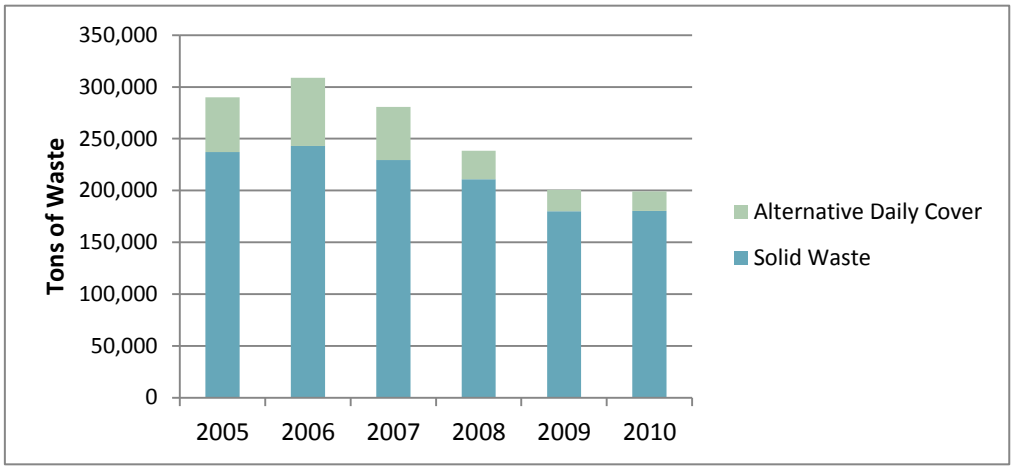
Emissions from waste generated by the San Rafael community in 2010 were 31% lower than 2005 due to a reduction in landfilled waste.

TABLE 15: WASTE EMISSIONS, 2005 AND 2010

Source	2005 Quantity (tons)	2005 GHG Emissions ($MTCO_2e$)	2010 Quantity (tons)	2010 GHG Emissions ($MTCO_2e$)	% Change in Waste Generation	% Change in GHG Emissions
Total	66,134	12,974	45,525	8,598	-31.2%	-33.7%

Figure 4 shows the trend in county-wide waste generation between 2005 and 2010. Waste disposal decreased approximately 31% over that time period. County-wide waste disposal hit a high of nearly 309,000 tons in 2006, steadily declined over the next three years, and leveled off at just over 199,000 tons in 2010.

FIGURE 4: COUNTYWIDE WASTE GENERATION, 2005 TO 2010



[7] U.S. Environmental Protection Agency, "Compilation of Air Pollutant Emissions Factors," AP-42, Fifth Edition, January 1995.

GOVERNMENT OPERATIONS INVENTORY

GOVERNMENT PROFILE

The City of San Rafael is a charter city and is governed by a four-member City Council and an elected mayor. The local government operates administrative, planning, building, public works, and recreations and childcare departments, as well as library, police and fire departments. In 2010, there were 362 total FT employees. Expenses for governmental activities for fiscal year 2010-2011 were $91,327,624. [8]

GOVERNMENT OPERATIONS INVENTORY SUMMARY

In 2005, San Rafael's government operations produced approximately 3,993 metric tons of CO_2e. In 2010, those activities resulted in approximately 3,225 metric tons of CO_2e, a reduction of 768 metric tons, or 19.2%. These numbers include all Scope 1 emissions from the on-site combustion of fuels in facilities and vehicles, Scope 2 emissions from the purchase of electricity generated outside San Rafael's borders, and Scope 3 emissions from waste generated by local government operations and transportation emissions from employee commutes. The following summaries break down these totals by sector, sources and scope.

SUMMARY BY SECTOR

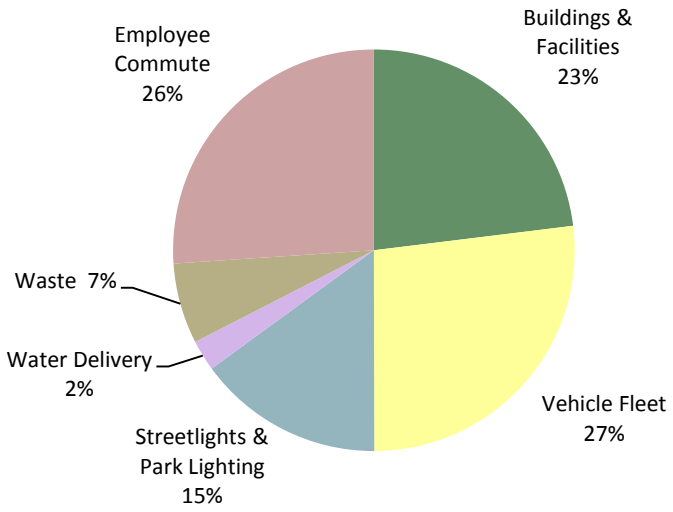
As shown in Table 16, emissions from government operations increased in the waste sector and decreased in all other sectors. The greatest reduction occurred in the employee commute sector, which experienced a reduction in emissions of 499 metric tons CO2e, or nearly 37%. Other significant reductions occurred in the public lighting (130 metric tons), vehicle fleet (72 metric tons) and buildings and facilities sector (56 metric tons). Figure 4 shows that the vehicle fleet sector was the largest emitter of greenhouse gas emissions in 2010 (27%), followed by employee commute sector (26%) and the buildings and facilities sector (23%).

TABLE 16: GOVERNMENT OPERATIONS EMISSIONS SUMMARY BY SECTOR, 2005 AND 2010

Sector	2005 Metric Tons CO_{2e}	2010 Metric Tons CO_2e	Change Metric Tons CO_2e	% Change
Buildings & Facilities	802	745	-56	-7%
Vehicle Fleet	934	862	-72	-8%
Public Lighting	615	485	-130	-21%
Water Delivery	114	80	-33	-29%
Waste	187	210	23	12%
Employee Commute	1,341	843	-499	-37%
Total	**3,993**	**3,225**	**-768**	**-19.2%**

[8] City of San Rafael 2011 Comprehensive Financial Audit Report, page 10.

FIGURE 4: GOVERNMENT OPERATIONS EMISSIONS BY SECTOR, 2010



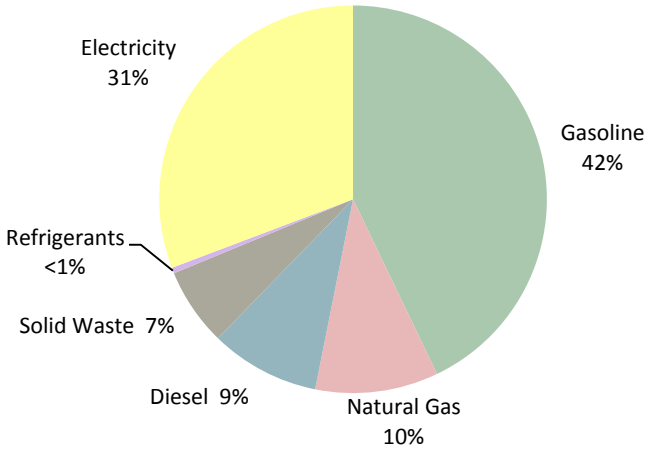
SUMMARY BY SOURCE

Table 17 shows a summary of the City's greenhouse gas emissions by source. Emissions decreased from gasoline and electricity sources and increased from natural gas, diesel and solid waste sources. The greatest decrease occurred in emissions from gasoline (623 metric tons, or -31%). Despite this significant decrease in gasoline emissions, gasoline was the largest source of greenhouse gas emissions in San Rafael's governmental operations in 2010 (see Figure 5), contributing 42% of all emissions. Emissions from refrigerants were not calculated in the 2005 inventory, so 2010 refrigerant data was used as a proxy to estimate refrigerant emissions for 2005.

TABLE 17: SUMMARY BY SOURCE, 2005 AND 2010

Source	2005 Metric Tons CO_{2e}	2010 Metric Tons CO_2e	Change Metric Tons CO_2e	% Change
Electricity	1,226	995	-231	-19%
Natural Gas	303	332	29	10%
Gasoline	1,992	1,368	-623	-31%
Diesel	271	305	34	13%
Solid Waste	187	210	23	12%
Refrigerants	16	16	--	--
Total	**3,993**	**3,225**	**-768**	**-19.2%**

FIGURE 5: GOVERNMENT OPERATIONS EMISSIONS BY SOURCE, 2010



SUMMARY BY SCOPE

As shown in Table 18, Scope 1 sources, which represent emissions generated within the San Rafael city limits, produced the largest amount of greenhouse gas emissions from governmental operations in 2010. Scope 1 emissions declined 3% between 2005 and 2010. The largest decrease occurred in Scope 3 emissions, which include the waste and employee commute sectors. Scope 2 emissions, which represent electricity consumed within San Rafael but generated outside the City's borders, decreased by 20%.

TABLE 18: GOVERNMENT OPERATIONS EMISSIONS SUMMARY BY SCOPE, 2005 AND 2010

Activity	2005 Metric Tons CO_{2e}	2010 Metric Tons CO_{2e}	% Change
Scope 1	1,240	1,196	-3%
Scope 2	1,226	976	-20%
Scope 3	1,528	1,052	-31%
Total	**3,993**	**3,225**	**-19.2%**

GOVERNMENT OPERATIONS INVENTORY DETAIL BY SECTOR

This section explores government operations and emissions by taking a detailed look at each primary sector. As listed above, the sectors included in the government operations emissions analysis are:

- Buildings and Other Facilities
- Streetlights and Traffic Signals
- Water Delivery
- Vehicle Fleet
- Waste
- Employee Commute

Buildings and Other Facilities

Facilities operations contribute to greenhouse gas emissions in two major ways. First, facilities consume electricity and fuels such as natural gas, gasoline and diesel. This consumption is associated with the majority of greenhouse gas emissions from facilities. In addition, air conditioning and refrigeration equipment in buildings can emit hydro fluorocarbons (HFCs) and other greenhouse gases when these systems leak refrigerants. Refrigerants are very potent greenhouse gases, and have Global Warming Potential (GWP) of up to many thousand times that of CO_2. For example, HFC-134a, a very common refrigerant, has a GWP of 1300, or 1300 times that of CO_2. Therefore, even small amounts of leaked refrigerants can have a significant effect on greenhouse gas emissions.

In 2010, San Rafael operated several major facilities, including the City Hall, library and police station, fire stations, public works buildings, community centers, and childcare facilities. Data relating to electricity and natural gas consumption for buildings and facilities was obtained from PG&E and data for refrigerants and fuel used for backup generators were obtained from San Rafael staff.

As shown in Table 19, emissions from the buildings sector decreased by 7% between 2005 and 2010. Electricity consumption increased by 6% but emissions decreased by 17% for two reasons. First, the carbon intensity of PG&E electricity was lower in 2010. Second, the City purchased approximately 53% of its electricity for buildings and other facilities from MEA in 2010; as noted earlier, the carbon intensity of MEA electricity was about 27% lower than that supplied by PG&E in 2010, due to the higher percentage of renewable and non-greenhouse gas emitting energy sources in MEA's energy mix.

Natural gas consumption and emissions increased by 10%. Fugitive emissions from refrigerants used in air conditioners and refrigerators barely registered because most of the older equipment in San Rafael uses refrigerants that are being phased out and are not reported in the Local Government Operating Protocol. These emissions are reported separately and were discussed on page 8.

Table 19: Buildings and Other Facilities Emissions, 2005 and 2010

Source	2005 Energy Consumption	2005 GHG Emissions ($MTCO_2e$)	2010 Energy Consumption	2010 GHG Emissions ($MTCO_2e$)	% Change in Energy Consumption	% Change in GHG Emissions ($MTCO_2e$)
Electricity	2,218,847 kWh	496	2,355,016 kWh	411	6%	-17%
Natural Gas	57,008 therms	303	62,474 therms	332	10%	10%
Diesel/ Gasoline	n/a	n/a	15 gallons	<1	n/a	n/a
Refrigerants	--	2	--	2	0%	0%
Total	--	**802**	**--**	**745**	**--**	**-7%**

Table 20 shows electricity and natural gas usage by facility. While energy consumption went down or remained relatively stable in most facilities, there were a few notable exceptions. In particular, natural gas consumption increased 40% at City Hall and the redevelopment agency offices. One reason for this increase was the installation of a new HVAC system at City Hall in 2006; in 2005, the heating system was not working in the Council Chambers and the City Hall foyer. Electricity and natural gas use increased at community centers by 30% and 13%, respectively. This is due to the fact that the Pickleweed Community Center was under construction in 2005.

TABLE 20: ENERGY USAGE AT SAN RAFAEL BUILDINGS AND FACILITIES

Building/ Facility	Energy Source	2005 Energy Consumption	2010 Energy Consumption	% Change in Energy Consumption
City Hall & RDA	Electricity	664,686 kWh	706,334 kWh	6%
	Natural Gas	6,132 therms	8,558 therms	40%
Community Centers	Electricity	398,528 kWh	518,919 kWh	30%
	Natural Gas	31,502 therms	35,494 therms	13%
Childcare Facilities	Electricity	106,240 kWh	95,091 kWh	-10%
	Natural Gas	4,333 therms	3,827 therms	-12%
Public Works	Electricity	325,440 kWh	307,680 kWh	-5%
	Natural Gas	5,573 therms	5,471 therms	-2%
Fire Department	Electricity	294,175 kWh	299,941 kWh	2%
	Natural Gas	9,334 therms	9,124 therms	-2%
Other Facilities	Electricity	429,778 kWh	427,051 kWh	-1%
	Natural Gas	134 therms	0 therms	-100%

STREETLIGHTS AND TRAFFIC SIGNALS

San Rafael operates streetlights, traffic signals, and other outdoor lighting. Emissions associated with the operation of this public lighting are from electricity consumption. The City replaced all holiday lighting with LED lighting, and electricity consumption for holiday lights decreased by nearly 50%. Overall, electricity consumption in the public lighting sector increased 2% between 2005 and 2010. Despite this increase in electricity use, emissions dropped by 21% due to the lower emission factors for PG&E and MEA electricity. In 2010, approximately 56% of the electricity used in the public lighting sector came from MEA.

TABLE 21: STREETLIGHTS AND TRAFFIC SIGNAL EMISSIONS, 2005 AND 2010

Source	2005 Electricity Consumption	2005 GHG Emissions ($MTCO_2e$)	2010 Electricity Consumption	2010 GHG Emissions ($MTCO_2e$)	% Change in Electricity Consumption	% Change in GHG Emissions ($MTCO_2e$)
Streetlights	2,420,240 kWh	541	2,514,990 kWh	434	4%	-20%
Traffic Signals	253,919 kWh	57	252,719 kWh	44	<-1%	-23%
Holiday Lights	76,293 kWh	17	39,185 kWh	7	-49%	-59%
Total	**2,750,452 kWh**	**615**	**2,806,894 kWh**	**485**	**2%**	**-21%**

WATER DELIVERY

This sector includes any facilities used for the management and distribution of water. Typical systems included in this sector are potable water delivery pumps, sprinkler and irrigation controls, and stormwater management. The systems identified for this report and used by the City were water delivery pumps and sprinkler and irrigation systems. The source of San Rafael's water delivery emissions is from electricity consumption. Overall, electricity usage declined 14% and emissions dropped 30%. The City purchased about 37% of electricity used in the water delivery sector from MEA in 2010.

TABLE 22: WATER DELIVERY EMISSIONS, 2005 AND 2010

Source	2005 Electricity Consumption	2005 GHG Emissions ($MTCO_2e$)	2010 Electricity Consumption	2010 GHG Emissions ($MTCO_2e$)	% Change in Electricity Consumption	% Change in GHG Emissions ($MTCO_2e$)
Irrigation	6,778 kWh	1.5	6,615 kWh	1.1	-2%	-25%
Water Pumps	502,295 kWh	112	432,722 kWh	79	-14%	-29%
Total	**509,073 kWh**	**114**	**439,337 kWh**	**80**	**-14%**	**-30%**

VEHICLE FLEET

The vehicles and mobile equipment used in San Rafael's daily operations include public works trucks and equipment, police cars and motorcycles, fire trucks, and vehicles for use by administration and other department staff. These vehicles and equipment burn gasoline and diesel, which result in greenhouse gas emissions. In addition, vehicles with air conditioning use refrigerants that leak from the vehicle. In 2010, San Rafael operated a fleet of approximately 170 vehicles.

Table 23 shows that total fuel consumption and emissions decreased by 8% between 2005 and 2010. Fuel consumption decreased in all departments except the fire department, which increased 11%.

TABLE 23: VEHICLE FLEET EMISSIONS, 2005 AND 2010

Source	2005 Fuel Consumption	2005 GHG Emissions ($MTCO_2e$)	2010 Fuel Consumption	2010 GHG Emissions ($MTCO_2e$)	% Change in Fuel Consumption	% Change in GHG Emissions ($MTCO_2e$)
Police Dept.	41,245 gallons	369	38,058 gallons	337	-8%	-9%
Fire Dept.	21,662 gallons	218	24,201 gallons	242	12%	11%
Public Works	30,841 gallons	286	24,784 gallons	231	-20%	-19%
All other departments	5,423 gallons	49	4,327 gallons	38	-20%	-22%
Refrigerants, all departments	—	13	—	13	--	0%
Total	**99,171 gallons**	**934**	**91,370 gallons**	**862**	**-8%**	**-8%**

WASTE

Waste generated by government buildings and operations include organic material such as paper, food scraps, plant debris, textiles, and construction waste. This organic material generates methane as it decays in the anaerobic environment of a landfill. An estimated 75 percent of this methane is routinely captured via landfill gas collection systems; however, a portion escapes into the atmosphere, contributing to the greenhouse effect. Emissions from waste are an estimate of methane generation that will result from the decomposition of all organic waste sent to the landfill in the inventoried year, even though those emissions will occur over the 100+ year timeframe that the waste will decompose.

Waste generated by governmental operations increased by 11% between 2005 and 2010, and emissions increased by 12%. In particular, waste hauled by the City increased nearly 50%. This was due to a significant increase in

homeless encampment removals, brush removal in homeless encampment areas, and illegal dumping due to adverse economic conditions.

TABLE 24: WASTE EMISSIONS, 2005 AND 2010

Source	2005 Landfilled Waste	2005 GHG Emissions ($MTCO_2e$)	2010 Landfilled Waste	2010 GHG Emissions ($MTCO_2e$)	% Change in Landfilled Waste	% Change in GHG Emissions ($MTCO_2e$)
Street Cans	402.3 tons	81	400.6 tons	81	<1%	<1%
Waste Hauled by City	184.1 tons	44	273.9 tons	65	49%	49%
Parks	164.3 tons	33	177.8 tons	36	8%	8%
Community Centers[1]	71.6 tons	14	68.3 tons	14	-5%	-5%
Bus Stops	29.1 tons	6	30.0 tons	6	3%	3%
Other Facilities[2]	40.6 tons	8	39.7 tons	8	-2%	-2%
Total	**892.0 tons**	**187**	**990.3 tons**	**210**	**11%**	**12%**

[1] Community Centers include childcare centers, community and recreation centers, Falkirk Museum and the library.

[2] Other Facilities include fire stations, City hall, the police station, the corporation yard, and parking lots.

EMPLOYEE COMMUTE

Emissions in the employee commute sector are due to the combustion of fuels used by City employees commuting to and from work in San Rafael. Emissions dropped by 37%, due, in part, to a 15% reduction in the number of San Rafael employees. Table 25 shows that vehicle miles traveled decreased by 24% between 2005 and 2010, suggesting that the average commute may have decreased. Emissions per employee decreased 26%. This drop in emissions may also be attributed to an improvement in the fuel efficiency of the vehicles that San Rafael employees drive. However, it is difficult to draw definitive conclusions from the data, as emissions are determined from employee commute surveys, and changes from year to year may be due to differences in sampling. In addition, the City endeavored to collect more detailed data on the vehicles City employees drove in 2010, and emissions quantified for that year may be lower due to improved data collection.

TABLE 25: EMPLOYEE COMMUTE EMISSIONS, 2005 AND 2010

	2005	2010	% Change
Number of Employees	425	362	-15%
Vehicle Miles Traveled	2,572,471	1,955,951	-24%
GHG Emissions ($MTCO_2e$)	1,341	843	-37%
Emissions per Employee ($MTCO_2e$)	3.2	2.3	-26%

CONCLUSION

San Rafael has achieved significant early successes in reducing greenhouse gas emissions over the past five years. Community emissions decreased by 8.1% between 2005 and 2010, putting the City on track to reduce emissions by 22% below the 2005 baseline year if the community continues to reduce emissions at the current rate. Emissions decreased in all sectors except the wastewater sector.

More than 60% of total community emissions reductions came from a decline in emissions from electricity use in the commercial and residential sectors. San Rafael can expect to see additional reductions from electricity emissions as PG&E and the Marin Energy Authority add more renewable sources to their energy portfolios. Since the Marin Energy Authority began supplying electricity to some of its customers midway through 2010, emissions reductions attributed to the switch to MEA's greener electricity were not fully realized in that year. Therefore, San Rafael will most likely see additional reductions in electricity emissions in subsequent years. An increase in the number of customers who sign up for 100% renewable electricity from MEA could further reduce San Rafael's community emissions.

Despite the potential for greener electricity, residents and businesses need to do their part to reduce energy demand in homes and commercial buildings. Natural gas consumption increased in 2010, and emissions rose lockstep with consumption. In order to reduce emissions from natural gas consumption, consumers can reduce demand by better insulating and sealing buildings, turning down the thermostat, and installing solar-powered water heaters.

Emissions reductions in the transportation sector had a significant effect on the bottom line. Further reductions in transportation emissions can be expected as state mandates to increase vehicle fuel efficiency and reduce the carbon intensity of transportation fuels take hold. Locally, the City can continue to implement programs and provide infrastructure to increase travel by bicycle, foot, and alternative means of transportation. Electric vehicles also offer much promise to reduce emissions significantly in the community, especially since the electricity provided by local utilities is significantly lower in greenhouse gas emissions than most other electricity producers in the rest of the country.

One of the brightest spots in the inventory came from the waste sector, which saw a reduction in emissions of nearly 34%. Programs to divert food waste from the landfill, recycle more construction and demolition debris, and achieve zero waste goals in Marin County should continue to reduce emissions in this sector.

Within government operations, emissions decreased 19.2%. Emissions declined in most sectors, with the majority occurring in the employee commute, public lighting and buildings and facilities sectors. About two-thirds of the reductions occurred in the employee commute sector, which was due, in part, to a reduction in the number of City employees between 2005 and 2010. Excluding employee commute emissions, total emissions from government operations decreased 10.2%

The City's decision to use Marin Clean Energy electricity for all facilities had a significant, positive effect on emissions in 2010 and can be expected to further reduce emissions in subsequent years. The City can reduce emissions even more by completing measures in its Climate Action Plan, including retrofitting additional streetlights with energy efficient lamps, installing renewable energy systems, completing energy efficiency upgrades, purchasing more fuel-efficient vehicles, and implementing commute incentives for City employees. Staff should always be aware of the impact their decisions have on the environment.

San Rafael has made an excellent start. If the community's emissions are to continue to decline, then residents, businesses, and other organizations must modify their energy consumption and travel patterns and support more clean energy from utility providers. San Rafael can serve as a model to others in curbing greenhouse gas emissions by implementing programs in the Climate Change Action Plan.

APPENDIX A: COMMUNITY INVENTORY

SCOPING AND REPORTING

Emissions Type		Included	Excluded (IE, NA, NO, or NE)	Explanatory Notes
Built Environment				
Use of fuel in residential and commercial stationary combustion equipment		x		
Industrial stationary combustion sources			IE	Included in PG&E data for commercial built environment
Electricity	Power generation in the community		NO	
	Use of electricity by the community	x		
District Heating/ Cooling	District heating/cooling facilities in the community		NO	
	Use of district heating/cooling by the community		NO	
Industrial process emissions in the community			NE	
Refrigerant leakage in the community			NE	
Transportation and Other Mobile Sources				
On-road Passenger Vehicles	On-road passenger vehicles operating within the community boundary	x		
	On-road passenger vehicle travel associated with community land uses	x		
On-road Freight Vehicles	On-road freight and service vehicles operating within the community boundary	x		
	On-road freight and service vehicle travel associated with community land uses	x		
On-road transit vehicles operating within the community boundary		x		
Transit Rail	Transit rail vehicles operating within the community boundary		NO	
	Use of transit rail travel by the community		NE	
Inter-city passenger rail vehicles operating within the community boundary			NO	
Freight rail vehicles operating within the community boundary			NO	
Marine	Marine vessels operating within the community boundary		NE	
	Use of ferries by the community		NE	
Off-road surface vehicles and other mobile equipment operating within the community boundary		x		
Use of air travel by the community			NE	

Solid Waste				
Solid Waste	Operation of solid waste disposal facilities in the community		NO	
	Generation and disposal of solid waste by the community	x		
Water and Wastewater				
Potable Water - Energy Use	Operation of water delivery facilities in the community		IE	Included in PG&E and MEA data for commercial built environment
	Use of energy associated with use of potable water by the community	x		
Use of energy associated with generation of wastewater by the community			IE	Included in PG&E data for commercial built environment
Centralized Wastewater Systems - Process Emissions	Process emissions from operation of wastewater treatment facilities located in the community		IE	Wastewater treatment facility is located in the community but only process emissions associated with generation of wastewater by the community are reported
	Process emissions associated with generation of wastewater by the community	x		
Use of septic systems in the community			NE	
Agriculture				
Domesticated animal production			NE	
Manure decomposition and treatment			NE	
Upstream Impacts of Community-Wide Activities				
Upstream impacts of fuels used in stationary applications by the community			NE	
Upstream and transmission and distribution (T&D) impacts of purchased electricity used by the community			NE	
Upstream impacts of fuels used for transportation in trips associated with the community			NE	
Upstream impacts of fuels used by water and wastewater facilities for water used and wastewater generated within the community boundary			NE	
Upstream impacts of select materials (concrete, food, paper, carpets, etc.) used by the whole community			NE	

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 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.

Residential and Commercial/Industrial Sector Notes

2005 Data Summary

Sector	Scope	Fuel	Quantity	Units	Greenhouse Gas Emissions (metric tons)			
					CO_2	N_2O	CH_4	CO_2e
Residential	2	Electricity	132,638,035	kWh	29,429.63	0.66	1.80	29,672.69
	1	Natural Gas	11,229,829	therms	59,540.55	0.11	5.61	59,693.28
	1	Propane/LPG	5,625	MMBtu	345.71	0.01	0.06	348.93
		TOTAL			89,315.89	0.78	7.48	89,714.89
Commercial / Industrial	2	Electricity	201,399,752	kWh	44,686.42	1.00	2.74	45,055.49
	1	Natural Gas	5,656,158	therms	29,988.95	0.06	2.83	30,065.87
	2	Direct Access Electricity	30,082,581	kWh	12,939.50	0.15	0.41	12,994.62
		TOTAL			87,614.87	1.21	5.98	88,115.99

2010 Data Summary

Sector	Scope	Fuel	Quantity	Units	Greenhouse Gas Emissions (metric tons)			
					CO_2	N_2O	CH_4	CO_2e
Residential	2	PG&E Electricity	123,038,553	kWh	24,835.16	0.56	1.62	25,042.16
	1	Natural Gas	11,484,281	therms	60,889.66	0.11	5.74	61,045.84
	2	MEA Electricity	8,197,532	kWh	1,204.22	0.04	0.11	1,218.01
	2	Direct Access Electricity	185,028	kWh	55.28	0.00	0.00	1,218.01
	1	Propane/LPG	5,363	MMBtu	329.61	0.01	0.06	332.67
		TOTAL			87,313.93	0.72	7.53	87,694.18
Commercial / Industrial	2	PG&E Electricity	177,107,148	kWh	35,748.83	0.80	2.33	36,046.79
	1	Natural Gas	5,864,336	therms	31,092.71	0.06	2.93	31,172.46
	2	MEA Electricity	11,211,674	kWh	1,646.99	0.05	0.15	1,665.86
	2	Direct Access Electricity	19,431,181	kWh	5,805.50	0.05	0.26	5,827.71
		TOTAL			74,294.03	0.97	5.66	74,712.82

2005 Emission Factors

Emission Source	GHG	Emission Factor	Emission Factor Source
PG&E Electricity	CO_2	0.48916 lbs/kwh	Local Government Operations Protocol, Version 1.1, May 2010, Table G.6, Utility Specific Verified Electricity CO2 Emission Factors
	CH_4	0.000030 lbs/kWh	Local Government Operations Protocol, Version 1.1, May 2010, G.7 California Grid Average Electricity Emission Factors
	N_20	0.000011 lbs/kWh	
Default Direct Access Electricity	CO_2	0.94828 lbs/kWh	Local Government Operations Protocol, Version 1.1, May 2010, G.7 California Grid Average Electricity Emission Factors
	CH_4	0.000030 lbs/kWh	
	N_20	0.000011 lbs/kWh	

Natural Gas	CO_2	53.02 kg/MMBtu	Local Government Operations Protocol, Version 1.1, May 2010, Table G.1 U.S. Default Factors for Calculating Carbon Dioxide Emission from Fossil Fuel Combustion.
	CH_4	0.005 kg/MMBtu	Local Government Operations Protocol, Version 1.1, May 2010, Table G.3 Default Methane and Nitrous Oxide Emission Factors by Fuel type and Sector
	N_20	0.001 kg/MMBtu	

2010 Emission Factors

Emission Source	GHG	Emission Factor	Emission Factor Source
PG&E Electricity	CO_2	0.445 lbs/kwh	PG&E, http://www.pgecurrents.com/2012/03/26/pge-reports-lowest-greenhouse-gas-emissions/
	CH_4	0.000029 lbs/kWh	Local Government Operations Protocol, Version 1.1, May 2010, G.7 California Grid Average Electricity Emission Factors (2007 factors used)
	N_20	0.000010 lbs/kWh	
Default Direct Access Electricity	CO_2	0.65868 lbs/kWh	eGrid2012 Version 1.0 Year 2009 Summary Tables http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2012V1_0_year09_SummaryTables.pdf
	CH_4	0.00002894 lbs/kWh	
	N_20	0.00000617 lbs/kWh	
Marin Energy Authority	CO_2	0.323859 lbs/kwh	Marin Energy Authority, Light Green and Deep Green combined. Emission factor is not certified.
	CH_4	0.000029 lbs/kWh	Local Government Operations Protocol, Version 1.1, May 2010, G.7 California Grid Average Electricity Emission Factors (2007 factors used)
	N_20	0.000010 lbs/kWh	
Natural Gas	CO_2	53.02 kg/MMBtu	Local Government Operations Protocol, Version 1.1, May 2010, Table G.1 U.S. Default Factors for Calculating Carbon Dioxide Emission from Fossil Fuel Combustion
	CH_4	0.005 kg/MMBtu	Local Government Operations Protocol, Version 1.1, May 2010, Table G.3 Default Methane and Nitrous Oxide Emission Factors by Fuel type and Sector
	N_20	0.0001 kg/MMBtu	

Data Sources

PG&E Electricity and Natural Gas Data: John Joseph, JGJ3@pge.com, Mathew Sturm, MwSs@pge.com.
Direct Access Electricity: California Energy Commission (CEC): Steven Mac, Smac@energy.state.ca.us
Marin Energy Authority: Justin Kudo, jkudo@marinenergy.com.

Propane/LPG use estimated from number of households using propane/LPG as a home heating source from the 2010 American Community Survey 5 Year Estimate (Table B25040) and average site consumption of propane/LPG from the U.S. Energy Information Administration, Average Consumption by Fuels Used, 2005, Table US9 and Household Site Fuel Consumption in the West Region, Totals and Averages, 2009 (Table CE2.5). Wood and fuel oil use was excluded because average site consumption data was not reported by the U.S. Energy Information Administration for 2009 and no comparison could be made between the two years.

Additional Notes

Data analyzed by Christine O'Rourke, Marin Climate and Energy Partnership Sustainability Coordinator, christine.o@comcast.net.

Estimations of electricity purchased through Direct Access (DA) contracts are derived from county level DA consumption figures, provided by the California Energy Commission.

2005 emissions were recalculated using updated activity data provided by PG&E and 2005 emission factors from the LGO Protocol. Activity data for direct access electricity was revised due to a change in the methodology to allocate direct access among jurisdictions.

Transportation Sector Notes

2005 Data Summary

Sector	Scope	Subsector	Quantity	Units	Greenhouse Gas Emissions (metric tons)			
					CO_2	N_2O	CH_4	CO_2e
Transportation	1	Local Roads	228,887,565	VMT	106,849.55	15.82	14.52	112,057.41
	1	State Highways	134,200,048	VMT	62,227.60	9.27	8.51	65,281.05
		TOTAL	363,087,613	VMT	169,077.16	25.09	23.03	177,338.46

2005 Emission Factors: Provided by the BAAQMD, using EMFAC 2007

County	CO_2 Rates (grams/mile)		CH_4 Rates (grams/mile)		N_2O Rates (grams/mile)		VMT Mix		CO_2 Rates- (grams/gallon)		Fuel Usage		Fuel Efficiency (miles/gallon)	
	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel
Marin County	476	1,426	0.065	0.030	0.070	0.050	95.5%	4.5%	8,628	9,957	89.2%	10.8%	18.1	7.0
BAAQMD Average	463	1,389	0.063	0.030	0.070	0.050	94.9%	5.1%	8,607	10,091	87.8%	12.2%	18.6	7.3

2010 Data Summary:

Sector	Scope	Subsector	Quantity	Units	Greenhouse Gas Emissions (metric tons)			
					CO_2	N_2O	CH_4	CO_2e
Transportation	1	Local Roads	222,020,865	VMT	100,058.78	15.36	9.85	105,027.14
	1	State Highways	132,823,054	VMT	59,859.75	9.19	5.90	62,832.05
		TOTAL	354,843,919	VMT	159,918.53	24.55	15.75	167,859.19

2010 Emission Factors: Provided by the BAAQMD, using EMFAC 2007

County	CO_2 Rates (grams/mile)		CH_4 Rates (grams/mile)		N_2O Rates (grams/mile)		VMT Mix		CO_2 Rates- (grams/gallon)		Fuel Usage		Fuel Efficiency (miles/gallon)	
	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel	Gas	Diesel
Marin County	471	1,500	0.045	0.030	0.070	0.050	95.9%	4.1%	8,732	9,673	89.0%	11.0%	18.5	6.4
BAAQMD Average	461	1,469	0.042	0.027	0.070	0.050	95.3%	4.7%	8,695	10,086	88.1%	11.9%	18.9	6.9

Data Sources

State Highway and Local Roads Vehicle Miles Traveled (VMT) Data: 2005 Public Roads Data, Highway Performance Monitoring System (HPMS) division of the California Department of Transportation (Caltrans), http://www.dot.ca.gov/hq/tsip/hpms/hpmslibrary/hpmspdf/2005PRD.pdf; 2010 Public Roads Data, HPMS division of Caltrans, http://www.dot.ca.gov/hq/tsip/hpms/hpmslibrary/hpmspdf/2010PRD.pdf. State highway VMT determined according to section 1.4.3 of BAAQMD GHG Plan Level Guidance, November 3, 2011.

State highway VMT determined according to section 1.4.3 of Bay Area Air Quality Management District GHG Plan Level Guidance, November 3, 2011.

2005 and 2010 data was calculated using emission factors and fuel usage estimates provided by the Bay Area Air Quality Management District. Data was provided by Amir Fanai, Principal Air Quality Engineer, Bay Area Air Quality Management District, AFanai@baaqmd.gov.

Additional Notes

Data analyzed by Christine O'Rourke, Marin Climate and Energy Partnership Sustainability Coordinator, christine.o@comcast.net.
Local Road and State Highway VMT data provided by MTC is in Daily VMT (DVMT); Annual VMT = DVMT x 365.
Fleet mix data (on-road fleet breakdown by vehicle type, fuel efficiency, and fuel type) was used to extrapolate VMT into actual gallons of gasoline and diesel consumed on Marin roads and state highways.

Off-Road Vehicles and Equipment Sector Notes

2005 Summary

Sector	Scope	Subsector	Quantity	Units	Fuel	Greenhouse Gas Emissions (metric tons)			
						CO_2	N_2O	CH_4	CO_2e
Off-Road	1	Construction and Mining Equipment	205,316	gallons	gasoline	1,802.67	0.00	0.00	1,802.67
	1		26,124	gallons	diesel	266.73	0.00	0.00	266.73
	1	Lawn and Garden Equipment	53,682	gallons	gasoline	471.33	0.00	0.00	471.33
	1		213,528	gallons	diesel	2,180.12	0.00	0.00	2,180.12
		TOTAL	498,650	gallons		4,720.85	0.00	0.00	4,720.85

2010 Data Summary

Sector	Scope	Subsector	Quantity	Units	Fuel	Greenhouse Gas Emissions (metric tons)			
						CO_2	N_2O	CH_4	CO_2e
Off-Road	1	Construction and Mining Equipment	133,267	gallons	gasoline	1,170.08	0.00	0.00	1,170.08
	1		26,127	gallons	diesel	266.76	0.00	0.00	266.76
	1	Lawn and Garden Equipment	55,928	gallons	gasoline	491.05	0.00	0.00	491.05
	1		212,282	gallons	diesel	2,167.40	0.00	0.00	2,167.40
		TOTAL		gallons		4,095.29	0.00	0.00	4,095.29

Fuel usage data provided by Steve Zelinka, Manager, Emission Inventory Development Section, California Air Resources Board, szelinka@arb.ca.gov. Fuel usage was provided at the county level and allocated to individual cities according to population.

Additional Notes

Data analyzed by Christine O'Rourke, Marin Climate and Energy Partnership Sustainability Coordinator, christine.o@comcast.net.

Water Sector Notes

2005 Data Summary

Sector	Scope	Fuel	Quantity	Units	Greenhouse Gas Emissions (metric tons)			
					CO_2	N_2O	CH_4	CO_2e
Water	3	PG&E Electricity	6,711,604	kWh	1,489.17	0.03	0.09	1,501.46
		TOTAL	6,711,604	kWh	1,489.17	0.03	0.09	1,501.46

2010 Data Summary

Sector	Scope	Fuel	Quantity	Units	Greenhouse Gas Emissions (metric tons)			
					CO_2	N_2O	CH_4	CO_2e
Water	3	PG&E Electricity	2,732,278	kWh	551.5	0.01	0.04	556.10
	3	MEA Electricity	3,256,148	kWh	478.33	0.01	0.04	483.81
		TOTAL	5,988,426	kWh	1,029.83	0.03	0.08	1,039.91

Data Sources

Marin Municipal Water District (MMWD) electricity usage provided by Jon LaHaye, MMWD Principal Engineer, jlahaye@marinwater.org and Jamie Tuckey, Marin Energy Authority Communications Director, jtuckey@marinenergyauthority.org. Electricity usage was provided for the service area population and allocated to individual cities on a per capita basis.

Additional Notes

2005 population estimates from CA Dept. of Finance E-4 Population Estimates for Cities, Counties and State 2001-2010 with 2000 and 2010 Census Counts. 2005 population estimate is mid-point between 1/1/2005 and 1/1/2006 estimates. 2010 population from 2010 U.S. Census.

Data analyzed by Christine O'Rourke, Marin Climate and Energy Partnership Sustainability Coordinator, christine.o@comcast.net.

Wastewater Sector Notes

2005 Data Summary

Sector	Scope	Fuel	Quantity	Units	Greenhouse Gas Emissions (metric tons)			
					CO_2	N_2O	CH_4	CO_2e
Wastewater	1	Treatment	56,296	people	0.00	4.56	3.09	1,479.43
		TOTAL	56,296	people	0.00	4.56	3.09	1,479.43

2010 Data Summary

Sector	Scope	Fuel	Quantity	Units	Greenhouse Gas Emissions (metric tons)			
					CO_2	N_2O	CH_4	CO_2e
Wastewater	1	Treatment	57,713	people	0.00	4.68	3.17	1,516.67
		TOTAL	57,713	people	0.00	4.68	3.17	1,516.67

Data Sources

Wastewater treatment data provided by Robert Cole, Environmental Services Manager, Central Marin Sanitation Agency, rcole@cmsa.us, 415-459-1455 ext. 142.
2005 population estimate from CA Dept. of Finance E-4 Population Estimates for Cities, Counties and State 2001-2010 with 2000 and 2010 Census Counts. 2005 population estimate is mid-point between 1/1/2005 and 1/1/2006 estimates. 2010 population from 2010 U.S. Census.

Additional Notes

Data analyzed by Christine O'Rourke, Marin Climate and Energy Partnership Sustainability Coordinator, christine.o@comcast.net
Treatment process emissions calculated according to ICLEI CACP methodology for process N2O emissions from a centralized wastewater treatment plant and stationary CH4 emissions from an anaerobic digester.

Waste Sector Notes

2005 Data Summary

Sector	Scope	Subsector	Quantity	Units	Greenhouse Gas Emissions (metric tons)			
					CO_2	N_2O	CH_4	CO_2e
Waste	3	Landfilled Solid Waste	54,087	tons	0.00	0.00	520.62	10,932.99
	3	Alternative Daily Cover	12,047	tons	0.00	0.00	97.17	2,040.57
		TOTAL	66,134	tons	0.00	0.00	617.79	12,973.56

2010 Data Summary

Sector	Scope	Subsector	Quantity	Units	Greenhouse Gas Emissions (metric tons)			
					CO_2	N_2O	CH_4	CO_2e
Waste	3	Landfilled Solid Waste	41,192	tons	0.00	0.00	396.50	8,326.43
	3	Alternative Daily Cover	4,333	tons	0.00	0.00	12.93	271.50
		TOTAL	45,525	tons	0.00	0.00	409.43	8,597.94

Data Sources

Municipal solid waste and ADC tonnage data: CalRecycle Disposal Reporting System http://www.calrecycle.ca.gov/LGCentral/Reports/DRS/Destination/JurDspFa.aspx and Alex Soulard, Waste Management Specialist, ASoulard@marincounty.org, County of Marin Public Works Department - Waste Management.
Landfilled waste characterization: Final Draft Zero Waste Feasibility Study, Marin County Hazardous and Solid Waste Management JPA, R3 Consulting Group, December 2009, http://www.marinrecycles.org/Docs/Final_Draft_Zero_Waste_Feasibility_Study_121609.pdf.
ADC waste characterization: CalRecycle, "Alternative Daily Cover (ADC) by Jurisdiction of Origin and Material Type," http://www.calrecycle.ca.gov/LGCentral/Reports/Viewer.aspx?P=ReportName%3dEdrsJurisAndMaterials%26CountyID%3d21%26ReportYear%3d2005 and http://www.calrecycle.ca.gov/LGCentral/Reports/Viewer.aspx?P=ReportName%3dEdrsJurisAndMaterials%26CountyID%3d21%26ReportYear%3d2010

Landfilled Waste Characterization, 2005 and 2010

Waste Type	% of Total
Paper Products	23.50
Food Waste	22.85
Plant Debris	7.98
Wood / Textiles	9.57
All Other Waste	36.12

Alternative Daily Cover Waste Characterization, 2005

Waste Type	% of Total
Paper Products	0.00
Food Waste	11.63
Plant Debris	88.37
Wood / Textiles	0.00
All Other Waste	0.00

Alternative Daily Cover Waste Characterization, 2010

Waste Type	% of Total
Paper Products	0.00
Food Waste	16.65
Plant Debris	10.90
Wood / Textiles	0.00
All Other Waste	72.46

Additional Notes

Waste emissions are calculated using ICLEI's Clean Air and Climate protection 2009 Software, Version 3.0. The methane emission factors used in ICLEI's CACP Software were derived from the EPA WARM model. For quantification of emissions, only methane generation (or gross emissions) is taken into account. These emissions are estimated to take place over an extensive (up to 100 year) cycle, as anaerobically degradable organic carbon decomposes in a landfill. More information on the WARM Model is available at: http://epa.gov/climatechange/wycd/waste/calculators/Warm_home.html.

2005 solid waste tonnage and emissions were recalculated using municipal solid waste and ADC tonnage data (including sludge ADC) provided by County of Marin Public Works Department Waste Management Division, updated waste characterization from the Final Draft Zero Waste Feasibility Study, Marin County Hazardous and Solid Waste Management JPA, R3 Consulting Group, December 2009, and updated ADC waste characterization from CalRecycle 2005 report , "Alternative Daily Cover (ADC) by Jurisdiction of Origin and Material Type" for Marin County.

APPENDIX B: GOVERNMENT OPERATIONS INVENTORY

BUILDINGS AND OTHER FACILITIES SECTOR NOTES

LGO PROTOCOL – EMISSIONS BY SCOPE AND EMISSION TYPE, 2005

Scope	Emission Type	Energy Consumption	Greenhouse Gas Emissions (metric tons)				
			CO_2	N_2O	CH_4	HFCs	CO_2e
Scope 1	Stationary Combustion	57,008 therms	302.26	0.00	0.03	0.00	303.03
	Fugitive Emissions	--	0.00	0.00	0.00	0.00	2.38
	TOTAL		302.26	0.00	0.03	0.00	305.41
Scope 2	Purchased Electricity	2,218,847 kWh	492.32	0.01	0.03	0.00	496.38
	TOTAL	2,218,847 kWh	492.32	0.01	0.03	0.00	496.38

LGO PROTOCOL – EMISSIONS BY SCOPE AND EMISSION TYPE, 2010

Scope	Emission Type	Energy Consumption	Greenhouse Gas Emissions (metric tons)				
			CO_2	N_2O	CH_4	HFCs	CO_2e
Scope 1	Stationary Combustion	62,474 therms	331.24	0.00	0.03	0.00	332.09
	Stationary Combustion	15 gallons	0.13	0.00	0.00	0.00	0.13
	Fugitive Emissions	--	0.00	0.00	0.00	0.00	2.38
	TOTAL		331.37	0.00	0.03	0.00	334.60
Scope 2	PG&E Purchased Electricity	1,108,462 kWh	223.74	0.01	0.01	0.00	225.61
	MEA Purchased Electricity	1,246,554	183.12	0.01	0.02	0.00	185.22
	TOTAL	2,355,016 kWh	406.86	0.01	0.03	0.00	410.82

2005 emissions were recalculated using activity data from the San Rafael 2005 Greenhouse Gas Emissions Inventory and 2005 emission factors from the LGO Protocol. Since refrigerants were not inventoried in 2005, 2010 refrigerant data was used as a proxy.

2010 energy usage was provided by Pacific Gas & Electric Company (PG&E) based on energy usage of PG&E service accounts. MEA electricity usage data provided by Jamie Tuckey, Marin Energy Authority Communications Director, jtuckey@marinenergyauthority.org. Energy usage data included electricity in units of kilowatt hours (kWh) and natural gas in thermal units (therms). Backup generators for buildings and facilities were recorded by amount of fuel consumed, and fuel type. LGO Protocol recommended methods were followed in collection and analysis of this activity data. See Appendix A for emission factors.

Refrigerant type and capacity for air conditioning systems, chillers, refrigerators, and stand-alone commercial applications (water coolers, vending machines, ice makers, etc.) were provided by San Rafael staff. LGO Protocol alternate methods were followed in collection and analysis of refrigerant activity data.

Streetlights and Traffic Signals Sector Notes

LGO Protocol – Emissions by Scope and Emission Type, 2005

Scope	Emission Type	Energy Consumption	Greenhouse Gas Emissions (metric tons)				
			CO_2	N_2O	CH_4	HFCs	CO_2e
Scope 2	Purchased Electricity	2,750,452kWh	610.27	0.01	0.04	0.00	615.31
	TOTAL	2,750,452 kWh	610.27	0.01	0.04	0.00	615.31

LGO Protocol – Emissions by Scope and Emission Type, 2010

Scope	Emission Type	Energy Consumption	Greenhouse Gas Emissions (metric tons)				
			CO_2	N_2O	CH_4	HFCs	CO_2e
Scope 2	PG&E Purchased Electricity	1,236,890	249.66	0.01	0.02	0.00	251.75
	MEA Purchased Electricity	1,570,004	230.63	0.01	0.02	0.00	233.27
	TOTAL	2,806,894	480.30	0.01	0.04	0.00	485.02

2005 emissions were recalculated using activity data from the San Rafael 2005 Greenhouse Gas Emissions Inventory and 2005 emission factors from the LGO Protocol.

2010 energy usage was provided by Pacific Gas & Electric Company (PG&E) based on energy usage of PG&E service accounts. MEA electricity usage data provided by Jamie Tuckey, Marin Energy Authority Communications Director, jtuckey@marinenergyauthority.org. Energy usage data included electricity in units of kilowatt hours (kWh). LGO Protocol recommended methods were followed in collection and analysis of this activity data. See Appendix A for emission factors.

Water Delivery Sector Notes

LGO Protocol – Emissions by Scope and Emission Type, 2005

Scope	Emission Type	Energy Consumption	Greenhouse Gas Emissions (metric tons)				
			CO_2	N_2O	CH_4	HFCs	CO_2e
Scope 2	Purchased Electricity	509,073 kWh	112.95	0.00	0.01	0.00	113.89
	TOTAL	509,073 kWh	112.95	0.00	0.01	0.00	113.89

LGO Protocol – Emissions by Scope and Emission Type, 2010

Scope	Emission Type	Energy Consumption	Greenhouse Gas Emissions (metric tons)				
			CO_2	N_2O	CH_4	HFCs	CO_2e
Scope 2	PG&E Purchased Electricity	276,840	55.88	0.00	0.00	0.00	56.35
	MEA Purchased Electricity	162,497	23.87	0.00	0.00	0.00	24.14
	TOTAL	439,337	79.75	0.00	0.00	0.01	80.49

2005 emissions were recalculated using activity data from the San Rafael 2005 Greenhouse Gas Emissions Inventory and 2005 emission factors from the LGO Protocol.

2010 energy usage was provided by Pacific Gas & Electric Company (PG&E) based on energy usage of PG&E service accounts. MEA electricity usage data provided by Jamie Tuckey, Marin Energy Authority Communications Director, jtuckey@marinenergyauthority.org. Energy usage data included electricity in units of kilowatt hours (kWh). LGO Protocol recommended methods were followed in collection and analysis of this activity data. See Appendix A for emission factors.

Vehicle Fleet Sector Notes

LGO Protocol – Emissions by Scope and Emission Type, 2005

Scope	Emission Type	Energy Consumption	Greenhouse Gas Emissions (metric tons)				
			CO_2	N_2O	CH_4	HFCs	CO_2e
Scope 1	Mobile Combustion	99,171 gallons	908.60	0.04	0.03	0.00	921.02
	Fugitive Emissions	--	0.00	0.00	0.00	0.01	13.15
	TOTAL		908.60	0.04	0.03	0.01	934.17

LGO Protocol – Emissions by Scope and Emission Type, 2010

Scope	Emission Type	Energy Consumption	Greenhouse Gas Emissions (metric tons)				
			CO_2	N_2O	CH_4	HFCs	CO_2e
Scope 1	Mobile Combustion	91,370 gallons	844.68	0.01	0.02	0.00	848.72
	Fugitive Emissions	--	0.00	0.00	0.00	0.01	13.15
	TOTAL		844.68	0.01	0.02	0.01	861.87

2005 emissions were recalculated using activity data from the San Rafael 2005 Greenhouse Gas Inventory, updated activity data for the police department vehicles, and updated default emission factors from the LGOP. VMT was estimated from fuel consumption data. 2005 reporting departments were grouped as follows:

Public Works: Public Works Department, Parks Department, Facility Repair, and San Quentin
Police: Police Department
Fire: Fire Department
All Others: Community Services, Computer Technical Support, Code Enforcement, Print Shop, Planning Department and Building Inspection, Redevelopment Agency, Park Services (Parking Enforcement)

2010 vehicle fleet data was provided by San Rafael staff. LGO Protocol methods were followed in collection and analysis of vehicle fuel consumption and vehicle miles traveled (VMT). In some cases, VMT was estimated according to fuel consumption and estimated vehicle fuel efficiency. Emissions were calculated using default emission factors from the LGOP. 2010 reporting departments were grouped as follows:

Public Works: Public Works Department and Parks Department
Police: Police and Police Administration
Fire: Fire, Fire Non-Emergency and Fire Prevention

All Others: Community Services, Building, Redevelopment, Code Enforcement, IT, Print Shop, and Parking Enforcement.

Refrigerant capacities for vehicles were estimated using sources provided by ICLEI. LGO Protocol alternate methods were followed in collection and analysis of refrigerant activity data. As refrigerant emissions were not included in the 2005 Greenhouse Gas Inventory, 2010 activity data and emissions were used as a proxy for 2005 data.

Waste Sector Notes

LGO Protocol – Emissions by Scope and Emission Type, 2005

Scope	Emission Type	Weight	Greenhouse Gas Emissions (metric tons)				
			CO_2	N_2O	CH_4	HFCs	CO_2e
Scope 3	Landfilled Waste	892.0 tons	0.00	0.00	8.89	0.00	186.72
	TOTAL	892.0 tons	0.00	0.00	8.89	0.00	186.72

LGO Protocol – Emissions by Scope and Emission Type, 2010

Scope	Emission Type	Weight	Greenhouse Gas Emissions (metric tons)				
			CO_2	N_2O	CH_4	HFCs	CO_2e
Scope 3	Landfilled Waste	990.3 tons	0.00	0.00	9.99	0.00	209.69
	TOTAL	990.3 tons	0.00	0.00	9.99	0.00	209.69

Emission Factors

Waste Type	Methane Emissions (metric tons / short ton of waste)	Emission Factor Source
Paper Products	1.940	US EPA
Food Waste	1.098	US EPA
Plant Debris	0.622	US EPA
Wood / Textiles	0.549	US EPA
All Other Waste	0.000	US EPA

2005 solid waste emissions were recalculated using activity data from the San Rafael 2005 Greenhouse Gas Inventory and updated waste characterization from the Final Draft Zero Waste Feasibility Study, Marin County Hazardous and Solid Waste Management JPA, R3 Consulting Group, December 2009, http://www.marinrecycles.org/Docs/Final_Draft_Zero_Waste_Feasibility_Study_121609.pdf

2010 solid waste collection data for quantity of containers, container size, pick-ups per week was provided by Neil Roscoe at Marin Sanitary District. Containers were assumed to be 100% filled at 75 lbs. cubic yard. Landfilled waste characterization: Final Draft Zero Waste Feasibility Study, Marin County Hazardous and Solid Waste Management JPA, R3 Consulting Group, December 2009, http://www.marinrecycles.org/Docs/Final_Draft_Zero_Waste_Feasibility_Study_121609.pdf. Waste characterization adjusted for City self-haul waste.

Landfilled Waste Characterization, 2005 and 2010

Waste Type	% of Total
Paper Products	23.50
Food Waste	22.85
Plant Debris	7.98
Wood / Textiles	9.57
All Other Waste	36.12

Employee Commute Sector Notes

LGO Protocol – Emissions by Scope and Emission Type, 2005

Scope	Emission Type	Number of Employees	Vehicle Miles Traveled	Greenhouse Gas Emissions (metric tons)				
				CO_2	N_2O	CH_4	HFCs	CO_2e
Scope 3	Mobile Combustion	425	2,572,471	1,306.95	0.11	0.08	0.00	1,341.40
		425	2,572,471	1,306.95	0.11	0.08	0.00	1,341.40

LGO Protocol – Emissions by Scope and Emission Type, 2010

Scope	Emission Type	Number of Employees	Vehicle Miles Traveled	Greenhouse Gas Emissions (metric tons)				
				CO_2	N_2O	CH_4	HFCs	CO_2e
Scope 3	Mobile Combustion	362	1,955,951	830.32	0.04	0.04	0.00	842.57
	TOTAL	362	1,955,951	830.32	0.04	0.04	0.00	842.57

2005 emissions were recalculated using activity data from the San Rafael 2005 Greenhouse Gas Inventory and emission factors from the LGOP. The previous inventory did adjust response data for employee holidays, vacation days, and sick days. Employee VMT recorded for heavy trucks were re-categorized as light trucks.

For the 2010 inventory, the City distributed commute surveys to its employees regarding travel mode, vehicle type and model year, fuel type, time of travel to work, and miles traveled to work. Information provided by respondents was used to determine fuel efficiency at www.fueleconomy.gov and estimate gallons of fuel consumed. Weekly data were converted into annual VMT data assuming 10 vacation days, 10 sick days and 10 holidays for most full-time employees. Ninety-seven employees responded to the survey, a response rate of 56%. Estimates for total employee commutes were extrapolated from this data.