City of Richmond
2005 Greenhouse Gas Emissions Inventory

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1. Introduction

The City of Richmond recognizes that greenhouse gas (GHG) emissions from human activity are contributing to global warming and that the City must act quickly to reduce these emissions, both through its municipal operations and by inspiring change throughout the community. In January 2007, the City of Richmond signed onto the U.S. Mayor's Climate Protection Agreement committing to reducing GHG emissions to meet or surpass the Kyoto Protocol targets of a seven percent reduction from 1990 levels by 2012. Additionally, on September 17, 2007, Richmond's City Council directed staff to develop a comprehensive policy to lead by example in the fight against global warming. On September 16, 2008, the Richmond City Council passed a resolution committing to the GHG emissions targets established by California's Global Warming Solutions Act, or Assembly Bill 32 (AB 32).

The City is defining and achieving greenhouse gas emissions reduction goals by being one of the first cities in the U.S. to include an Energy and Climate Change Element in its current General Plan update. As part of this General Plan update, the City began its efforts to identify and quantify greenhouse gas emissions with the assistance of ICLEI – Local Governments for Sustainability.

Presented here are estimates of greenhouse gas emissions resulting from activities in Richmond as a whole and from the City's municipal operations. Due to data availability and the desire to conduct a baseline inventory for the same year as other Bay Area cities, data are presented for the year 2005. These data will provide a baseline against which the City will be able to compare future performance and demonstrate progress in reducing emissions.

1.1. Climate Change Background

Naturally occurring gases dispersed in the atmosphere determine the Earth's climate by trapping solar radiation. This phenomenon is known as the greenhouse effect. Overwhelming evidence suggests that human activities are increasing the concentration of greenhouse gases, most notably the burning of fossil fuels for transportation and electricity generation which introduces large amounts of carbon dioxide and other gases into the atmosphere. Collectively, these gases intensify the natural greenhouse effect, causing global average surface temperature to rise, which is in turn expected to affect global climate patterns and cause climate change.

Many communities in the United States have taken responsibility for addressing climate change at the local level, due to historic Federal inaction on the issue.[1] Richmond could be impacted by rising sea levels and resultant changes in the height, salinity and behavior of the San Francisco Bay, as well as other changes to local and regional weather patterns. Richmond is exploring how to adapt to these changes. Beyond Richmond, scientists also expect changing temperatures to result in more frequent and damaging storms accompanied by flooding and land slides, summer water shortages as a result of reduced snow pack, and disruption of ecosystems, habitats and agricultural activities.

1.2. California Legislation

Also in response to Federal inaction to address global warming, California passed the Global Warming Solutions Act (AB 32) in 2006, which charged the California Air Resources Board (CARB) with implementing a comprehensive statewide program to reduce greenhouse gas emissions. AB 32 established the following greenhouse gas emissions reduction targets for the state of California:

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[1] In response to the threat of climate change, communities worldwide are voluntarily reducing greenhouse gas emissions. The Kyoto Protocol, an international effort to coordinate mandated reductions, went into effect in February 2005 with 161 countries participating. The United States is one of three industrialized countries that chose not to sign the Protocol.

- 2000 levels by 2010
- 1990 levels by 2020
- 80% below 1990 levels by 2050

Richmond's GHG emissions inventory is intended to enable the City to develop effective GHG reduction policies and programs to meet these targets and track emissions reduction progress.

1.3. The Cities for Climate Protection Campaign

Richmond, along with more than 1,000 local governments, including over 500 in the United States, have joined ICLEI's Cities for Climate Protection (CCP) campaign.[2] In addition to Richmond, there are approximately 90 jurisdictions (municipal and county) throughout the Bay Area that are CCP participants at the time of this publishing.

The CCP campaign provides a framework for local governments to identify and reduce greenhouse gas emissions, organized along five milestones:

1. Conduct an inventory of local greenhouse gas emissions;
2. Establish a greenhouse gas emissions reduction target;
3. Develop an action plan for achieving the emissions reduction target;
4. Implement the action plan; and,
5. Monitor and report on progress.

This report represents the completion of the first CCP milestone, and provides a foundation for future work to reduce greenhouse gas emissions in Richmond.

1.4. Sustainability & Climate Change Mitigation Activities in Richmond

Richmond initiated its environmental sustainability activities in the 1980s with City policies designed to reduce solid and hazardous waste generation, conserve water and reduce toxins discharged into the city sewer system. More recently, the City of Richmond has taken major steps to increase sustainability efforts and programs throughout the city in addition to the actions listed previously to address and reduce greenhouse gas emissions.

For example, in 2003 the City of Richmond completed an energy audit and retrofit of 58 City-owned buildings to improve energy efficiency and reduce Richmond's energy consumption. In 2007, the City adopted a municipal green building ordinance requiring all City building projects to achieve a LEED "Silver" rating under the appropriate LEED rating system for the project type or a GreenPoint Checklist score of 70 points for residential projects. In addition, the City has been working to attract green collar jobs and provide green job training opportunities to local residents, incorporating solar installation training as an integral part of its ongoing job training program. In late 2007, Richmond joined the cities of Berkeley, Emeryville, and Oakland; the University of California at Berkeley; and the Lawrence Berkeley National Laboratory to create the East Bay Green Corridor Partnership. The Partnership's objective is to strengthen the regional economy through support for emerging green and sustainable industries, alternative energy research, and a healthy built environment. Most recently in September 2008, the City of Richmond joined other progressive Bay Area cities when it voted to become a signatory of the Urban Environmental Accords, a declaration of more than 100 municipalities worldwide to build ecologically sustainable, economically dynamic, and socially equitable urban futures.

[2] ICLEI was formerly known as the International Council for Local Environmental Initiatives, but the name has been changed to ICLEI – Local Governments for Sustainability.

Overall, Richmond has demonstrated policy entrepreneurship in several areas and has achieved national recognition for accomplishments such as adding both health and climate change elements to its current General Plan update, being an early adopter of green building requirements for municipal buildings, and creating a green-collar job training program that other cities are looking to as a new model for green economic development that won the 2008 FBI Director's Community Leadership Award.

2. Methodology

2.1. Greenhouse Gas Emissions Inventory Protocols

The first step towards achieving tangible greenhouse gas emissions reductions requires identifying baseline levels and sources of emissions. As local governments continue to join the climate protection movement, the need for a standardized approach to quantify these emissions is essential. Given this, Richmond staff used the International Local Government GHG Emissions Analysis Protocol (IEAP) to inventory the City's community emissions and the Local Government Operations Protocol (LGOP) to inventory GHG emissions from municipal buildings and operations (which is evaluated as a subsector of the community inventory).

2.1.1. Community Emissions Protocol

The IEAP, developed by ICLEI, provides an easily implementable set of guidelines to assist local governments in quantifying greenhouse gas emissions from both their internal operations and from the whole community within their geopolitical boundaries. Staff used this protocol to inventory Richmond's community emissions. ICLEI began development of the IEAP with the inception of its Cities for Climate Protection Campaign in 1993, and recently formalized an official version to establish a common GHG emissions inventory protocol for all local governments worldwide.[3]

2.1.2. Municipal Emissions Protocol

In 2008, ICLEI, the California Air Resources Board (CARB), and the California Climate Action Registry (CCAR) released the LGOP to serve as a national appendix to the IEAP.[4] The LGOP serves as the national standard for quantifying and reporting greenhouse emissions from local government operations. The purpose of the LGOP is to provide the principles, approach, methodology, and procedures needed to develop a local government operations greenhouse gas emissions inventory. City staff used this protocol to conduct the municipal emissions inventory specifically. While the State of California does not currently require local governments to inventory and report their emissions, an emissions inventory is a critical first step for the City to develop internal emissions reduction strategies and track future progress.

2.2. Quantifying Greenhouse Gases Emissions

2.2.1. Establishing a Base Year

A primary aspect of the emissions inventory process is the requirement to select a base year with which to compare current emissions. While the State's AB 32 emissions reduction goals establish a 1990 base year for the State, most local governments lack comprehensive data from that time period and would be unsuccessful in conducting an accurate inventory for that year. Due to this, the majority of municipalities currently in the emissions inventory process opt to use 2005 as the base year due to the availability of accurate and complete data. Similar to these jurisdictions, Richmond's greenhouse gas emissions inventory utilizes 2005 as its base year.

2.2.2. Establishing Boundaries

Community: Geopolitical Boundary

Setting an organizational boundary for greenhouse gas emissions accounting and reporting is an important step in the inventory process. Richmond's community inventory assesses emissions resulting from activities taking place within the City's geopolitical boundary. The IEAP defines geopolitical boundary as that "consisting of the physical area or region over which the local government has jurisdictional authority." Activities that occur within this boundary can be, for the most part, controlled or influenced by Richmond's policies and educational programs. Although the City may have limited influence over the level of emissions

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[3] ICLEI is currently working with the California Air Resources Board (CARB) and the California Climate Action Registry (CCAR) to leverage the IEAP to establish a community GHG protocol specific to California local governments.

[4] CARB adopted the LGOP in 2008.

from some activities, it is important that every effort be made to compile a complete analysis of all activities that result in greenhouse gas emissions.

Government: Organizational Boundaries

According to the LGOP, a government can use two approaches to define its organizational boundary for reporting greenhouse gas emissions: activities and operations that the jurisdiction controls operationally and activities and operations that the jurisdiction controls financially. Staff estimated Richmond's municipal emissions based on activities and facilities that the City maintains operational control.

2.2.3. Emission Types

The IEAP and LGOP recommend assessing emissions from the six internationally recognized greenhouse gases regulated under the Kyoto Protocol as listed in Table 1. However, quantifying emissions beyond the three primary GHGs (CO_2, CH_4, and N_2O) can be difficult. Therefore, ICLEI has developed a means for local governments to produce a simplified inventory that includes the three primary GHGs yet is still in accordance with the IEAP and LGOP methodology. This inventory uses the ICLEI three GHG methodology.

Table 1: Greenhouse Gases

Greenhouse Gas	Chemical Formula	Global Warming Potential (CO_2e)
Carbon Dioxide	CO_2	1
Methane	CH_4	21
Nitrous Oxide	N_2O	310
Hydrofluorocarbons	Various	43-11,700
Perfluorocarbons	Various	6,500-9,000
Sulfur Hexafluoride	SF_6	23,900

2.2.4. Quantification Methods

Greenhouse gas emissions can be quantified in two ways and both methods were used to generate this inventory:

Measurement-based methodologies refer to the direct measurement of greenhouse gas emissions (from a monitoring system) emitted from a flue of a power plant, wastewater treatment plant, landfill, or industrial facility.[5]

Calculation-based methodologies calculate emissions using activity data and emission factors. To calculate emissions accordingly, the basic equation below is used:

$$\text{Activity Data} \times \text{Emission Factor} = \text{Emissions}$$

Activity data refer to the relevant measurement of energy use or other greenhouse gas-generating processes such as fuel consumption by fuel type, metered annual electricity consumption, and annual vehicle miles traveled. Please see appendices for a detailed listing of the activity data used in composing this inventory.

Known emission factors are used to convert energy usage or other activity data into associated emissions quantities. They are usually expressed in terms of emissions per unit of activity data (e.g. lbs CO_2/kWh of electricity). Table 2 demonstrates an example of common emission calculations that use this formula. Please see appendices for details on the emissions factors used in this inventory.

[5] Richmond's community inventory includes emissions data provided by the Bay Area Air Quality Management District that was gathered through direct measurement of emissions from various commercial and industrial entities in the City.

Table 2: Basic Emissions Calculations

Activity Data	Emissions Factor	Emissions
Electricty Consumption (kWh)	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
Vehicle Miles Traveled	CH_4, N_2O emitted/mile	CH_4, N_20 emitted

2.2.5. CACP Software

To facilitate community efforts to reduce greenhouse gas emissions, ICLEI developed the Clean Air and Climate Protection (CACP) software package in partnership with the State and Territorial Air Pollution Program Administrators (STAPPA), the Association of Local Air Pollution Control Officials (ALAPCO)[6], and Torrie Smith Associates. The CACP software determines emissions by combining activity data (energy consumption, waste generation, etc.) with verified emission factors.[7]

Greenhouse gas emissions are aggregated and reported in terms of equivalent carbon dioxide units, or CO_2e. This standard is based on the Global Warming Potential (GWP) of each gas, which is a measure of the amount of warming a greenhouse gas may cause, measured against the amount of warming caused by carbon dioxide. Converting all emissions to equivalent carbon dioxide units allows for the consideration of different greenhouse gases in comparable terms. For example, methane is twenty-one times more powerful than carbon dioxide on a per weight basis in its capacity to trap heat, so the CACP software converts one metric ton of methane emissions to 21 metric tons of carbon dioxide equivalents. See Table 1 for the GWPs of the commonly occurring greenhouse gases.

The CACP software has been and continues to be used by over 500 U.S. cities and towns to reduce their greenhouse gas emissions. However, it is worth noting that, although the software provides governments with a sophisticated and useful tool, calculating emissions from energy use with precision is difficult. The model depends upon numerous assumptions, and it is limited by the quantity and quality of available data. With this in mind, it is useful to think of any specific number generated by the model as an approximation of reality, rather than an exact value.

2.3. Evaluating Emissions

2.3.1. Emissions by Scope

For both community and government operations, emissions sources are categorized according to where they fall relative to the geopolitical boundary of the community, or the operational boundaries of the government. Emissions sources are categorized as direct or indirect emissions--Scope 1, Scope 2, or Scope 3. One of the most important reasons for using the scopes framework for reporting greenhouse gas emissions at the local level is to prevent double counting for major categories such as electricity use and waste disposal.

Community Scope Definitions

The Scopes framework identifies three emissions scopes for community emissions:

- ***Scope 1:*** All direct emissions from sources located within the geopolitical boundary of the local government.

[6] Now the National Association of Clean Air Agencies (NACAA).

[7] The emission factors and quantification methods employed by the CACP software are consistent with national and international inventory standards established by the Intergovernmental Panel on Climate Change (1996 Revised IPCC Guidelines for the Preparation of National Inventories) the U.S. Voluntary Greenhouse Gas Reporting Guidelines (EIA form 1605), and the Local Government Operations Protocol (LGOP).

- ***Scope 2:*** Indirect emissions associated with the consumption of purchased or acquired electricity, steam, heating, and cooling. Scope 2 emissions occur as a result of activities that take place within the geopolitical boundary of the local government, but that occur at sources located outside of the government's jurisdiction.

- ***Scope 3:*** All other indirect or embodied emissions not covered in Scope 2, that occur as a result of activity within the geopolitical boundary.

Scope 1 and Scope 2 sources are the most essential components of a community greenhouse gas analysis as these sources are typically the most significant in scale, and are most easily impacted by local policy making.

Municipal Scope Definitions
Similar to the community framework, the municipal scopes are divided into three main categories:

- ***Scope 1:*** Direct emissions from sources within a local government's organizational boundaries that the local government owns or controls.

- ***Scope 2:*** Indirect emissions associated with the consumption of purchased or acquired electricity, steam, heating, and cooling. Scope 2 emissions occur as a result of activities that take place within the organizational boundaries of the reporting entity, but that occur at sources owned or controlled by another entity.

- ***Scope 3:*** All other indirect emissions not covered in Scope 2, such as emissions from up-stream and downstream activities that occur as a result of activities within the operational boundaries of the local government, emissions resulting from the extraction of and production of purchased materials and fuels, contracted services, and waste disposal.

As with the community inventory, Scope 1 and Scope 2 sources are the most essential components of a local greenhouse gas analysis because these sources are usually significant in scale and are directly under the control of local governments. Local governments typically have indirect control over Scope 3 emissions. For example, solid waste generated from municipal operations is included as Scope 3 because of the unique circumstances in which emissions are generated – emissions from waste are generated over time as the waste decomposes and not directly in the base year.

2.3.2. Emissions by Sector

In addition to categorizing emissions by scope, this inventory examines emissions by sector. Many local governments find a sector-based analysis more relevant to policy making and project management, as it assists in formulating sector-specific reduction measures and climate action plan components. This inventory evaluates community and municipal emissions by sectors listed in Table 3.

Table 3: Community and Municipal Sectors

Community	Municipal
Residential	Buildings
Commercial / Industrial	Streetlights
Transportation	Vehicle Fleet
Waste	Employee Commute
	Water / Sewage
	Waste

3. Community Emissions Inventory Results

3.1. Emissions by Scope

There are numerous items that can be included in a community scale emissions inventory, as demonstrated above. This inventory includes Scope 1, Scope 2, and Scope 3 sources from the following sectors:

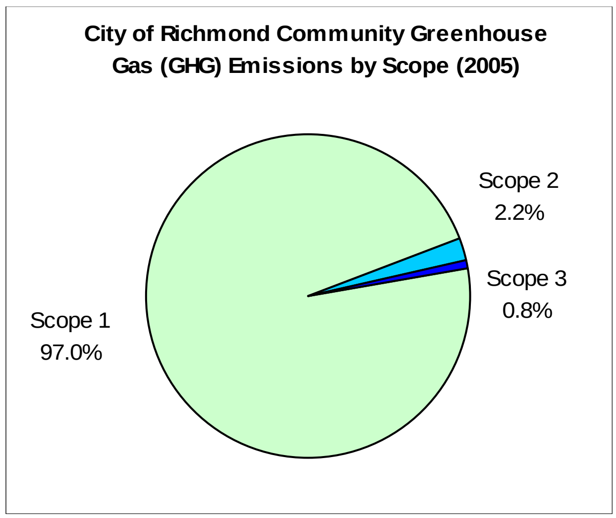
- Residential
- Commercial / Industrial
- Transportation
- Waste

Table 4: Scopes and Sectors Included in City of Richmond 2005 Community Inventory

Sector	Scope 1	Scope 2	Scope 3
Residential	*Natural Gas*	*Electricity*	
Commercial / Industrial	*Natural Gas & Point Source Emissions*	*Electricity*	
Transportation	*Gasoline & Diesel*		
Waste	*Emissions from WCCS Landfill*		*Future Emissions from 2005 Waste*

Including all scopes, the community of Richmond emitted approximately *5,853,020 metric tons*[8] *of $CO_{2}e$* in the year 2005. As shown in Table 5 and illustrated in Figure 1, Scope 1 emissions are by far the largest (97.0 percent) with Scope 2 (2.2 percent) and Scope 3 (0.8 percent) constituting the remainder.

Figure 1: Community GHG Emissions by Scope



As shown in Table 6 and Figure 2 below, the largest percentage of Scope 1 emissions came from the Commercial / Industrial Sector (89.0 percent). The Commercial / Industrial Sector emissions are the result of natural gas combustion and various industrial point source emissions from within the City of Richmond's jurisdictional boundaries. Diesel and gasoline use on local roads and on the State highways located within Richmond city limits constituted 8.9 percent of Scope 1 emissions. The remainder of Scope 1 emissions was caused by natural gas consumption in Richmond homes (Residential Sector) (1.5 percent) and fugitive methane emissions from the West Contra Costa Sanitary Landfill (0.8 percent).

Table 5: Community GHG Emissions per Sector per Scope (metric tons of CO_2e)

Sector	Scope 1	Scope 2	Scope 3	TOTAL
Residential	86,671	39,447	-	126,118
Commercial / Industrial	5,048,998	92,574	-	5,141,572
Transportation	506,842	-	-	506,842
Waste	32,309	-	46,179	78,488
TOTAL	5,674,820	132,021	46,179	**5,853,020**
Percentage of Total CO_2e	97.0%	2.2%	0.8%	**100%**

[8] All emissions estimated using STAPPA/ALAPCO and ICLEI's Clean Air and Climate Protection Software developed by Torrie Smith Associates Inc.

The largest percentage of 2005 Scope 2 emissions was generated by the Commercial / Industrial Sector (Table 7 and Figure 3). One hundred percent of Richmond Scope 2 emissions came from electricity consumption by both the Residential and Commercial / Industrial sectors within city boundaries. As noted above in the general description of Scope 2 parameters, the actual emissions from these activities were generated outside of Richmond city boundaries—in this case, at the source of electricity generation.

Table 6: Community Scope 1 GHG Emissions (metric tons CO_2e)

Scope 1 Emissions By Sector	Residential	Commercial / Industrial	Transportation	Waste	TOTAL
CO_2e (metric tons)	86,671	5,048,998	506,842	32,309	5,674,820
% of Total CO_2e	1.5%	89.0%	8.9%	0.6%	100%
MMBtu	1,620,510	28,532,184*	6,911,536	-	37,064,230

** Data does not include Commercial / Industrial MMbtu estimates for BAAQMD point source emissions data*

Table 7: Community Scope 2 GHG Emissions (metric tons CO_2e)

Scope 2 Emissions By Sector	Residential	Commercial / Industrial	TOTAL
CO_2e (metric tons)	39,447	92,574	132,021
% of Total CO_2e	29.9%	70.1%	100%
MMBtu	575,356	1,297,730	1,873,086

Figure 2: Community Scope 1 GHG Emissions

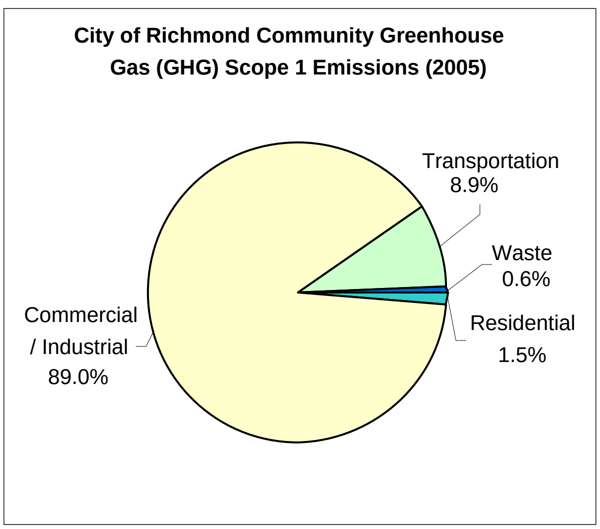
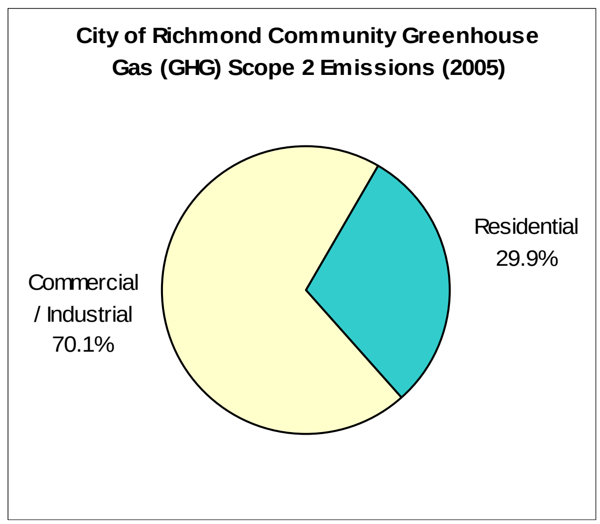


Figure 3: Community Scope 2 GHG Emissions



The remaining portion of emissions included in the City of Richmond 2005 community inventory fall under the category of Scope 3. All emissions in this category are an estimate of future emissions over the lifecycle decomposition of waste and alternative daily cover (ADC) sent to landfill in the base year (2005).[9]

[9] Later in the report there is more detail on emissions from the waste sector.

3.2. Emissions by Sector

As noted above, the community of Richmond, across all scopes, emitted approximately *5,853,020 metric tons of CO_2e in the year 2005*. In addition to viewing these data through the lens of the various scopes, we can also focus specifically on each sector, with scopes aggregated by sector. As visible in Figure 4 and Table 8 below, electricity and natural gas usage within the Commercial/Industrial Sector were by far the largest sources of community emissions (87.8 percent). Emissions from the Transportation Sector (same gasoline and diesel sources as that listed under Scope 1 above) accounted for 8.7 percent of total community emissions, and electricity and natural gas consumption within the Residential Sector caused 2.2 percent of the City's overall emissions. The remaining 1.3 percent of emissions came from a combination of landfilled waste in the WCCS Landfill (Scope 1) and waste generated by Richmond's residents and businesses in 2005 (Scope 3 Sector). See below for further detail on each sector.

Figure 4: Community GHG Emissions by Sector

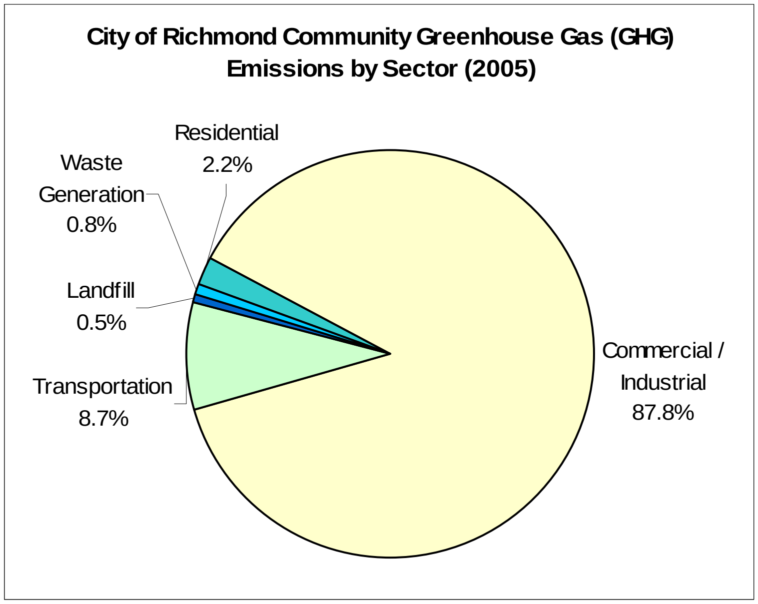


Table 8: Community GHG Emissions by Sector (metric tons CO_2e)

2005 Community Emissions by Sector	Residential	Commercial / Industrial	Transportation	Landfill	Waste Generation	TOTAL
CO_2e (metric tons)	126,118	5,141,572	506,842	32,309	46,179	5,853,020
% of Total CO_2e	2.2%	87.8%	8.7%	0.5%	0.8%	100%
MMBtu	2,195,866	29,663,378	6,818,813	-	-	38,678,057

3.2.1. Residential

As shown in Table 8, Richmond's Residential Sector generated an estimated 126,118 metric tons of CO_2e in 2005. This estimate was calculated using 2005 electricity and natural gas consumption data provided by PG&E, and only includes consumption through residential buildings. Data on residential equipment usage, such as lawnmowers or on-site electricity generation, is not included in this inventory. GHG emissions associated with residential transportation and residential waste generation are included separately in the Transportation and Waste Sector emissions totals.

Table 9 provides information on residential emissions on a per household basis. Richmond households generated 3.6 metric tons of GHG emissions in 2005. Per household emissions can be a useful metric for measuring progress in reducing greenhouse gases and for comparing one's emissions with neighboring cities and against regional and national averages.

Table 9: Richmond 2005 Greenhouse Gas Emissions per Household

Number of Occupied Housing Units	35,200
Total Residential GHG Emissions *(metric tons CO_2e)*	126,118
Residential GHG Emissions/Household *(metric tons CO_2e)*	**3.6**

Figure 5 illustrates the breakdown of residential GHG emissions by fuel type. Nearly 70 percent of residential GHG emissions were generated from the use of natural gas. Natural gas is typically used in residences as a fuel for home heating, water heating and cooking. Approximately 30 percent of residential GHG emissions were generated through electricity provided by PG&E.

Figure 5: Residential Emissions by Source

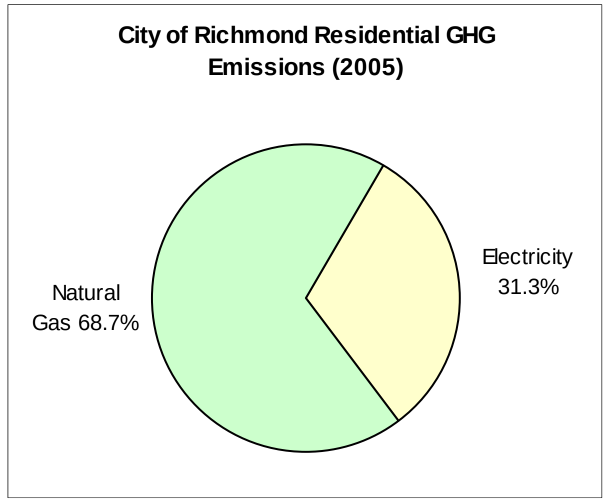


Table 10: Residential Emissions by Source

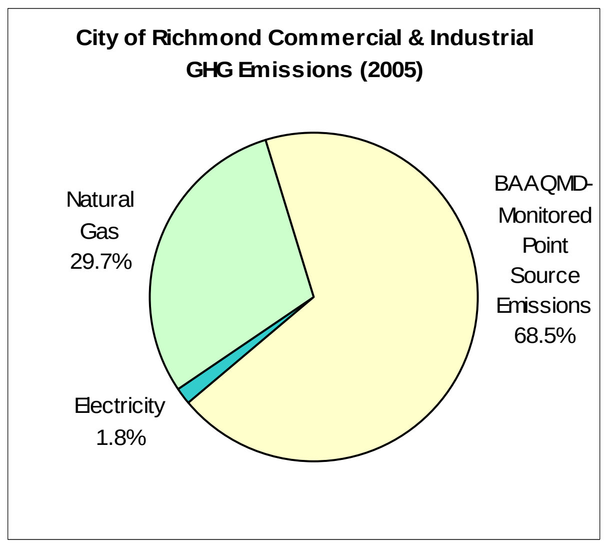
Residential Emission Sources 2005	Electricity	Natural Gas	TOTAL
$MTCO_2e$	39,447	86,671	126,118
% of Total CO_2e	31.3%	68.7%	100%
MMBtu	575,356	1,620,510	2,195,866

3.2.2. Commercial / Industrial

As mentioned previously, Richmond's businesses and industries generated nearly 90 percent of community-wide GHG emissions in 2005, or 5,141,572 metric tons of CO_2e. This figure is not particularly surprising given Richmond's substantial industrial base. PG&E was not able to provide a breakdown between commercial and industrial electricity and natural gas consumption due to the California Public Utilities Commission (CPUC) 15/15 rule.[10]

These calculations take into account electricity and natural gas provided by PG&E, estimates for direct access (DA) natural gas and electricity provided directly to industries by other utilities, and commercial and industrial point source emissions monitored by the Bay Area Air Quality Management District (BAAQMD).[11] The DA data included in this inventory were derived from three sources: PG&E, the California Energy Commission (CEC), and data provided to the City directly by a couple of Richmond industries.[12]

Figure 6: Commercial / Industrial Emissions by Source



In addition to emissions from natural gas and electricity consumption, there are major Commercial / Industrial Sector point source emissions that are included in this inventory.[13] These data were provided by the BAAQMD and includes CO_2, CH_4, and N_20 emissions from the following sources: coke, diesel fuel, liquefied petroleum gas, pathological waste, process gas, digester gas, unleaded gasoline, refinery fuel gas, and hydrogen. Point

[10] The 15/15 Rule was adopted by the CPUC in the Direct Access Proceeding (CPUC Decision 97-10-031) to protect customer confidentiality. If the number of customers in the complied data is below 15, or if a single customer's load is more than 15 percent of the total data, categories must be combined before the information is released.
[11] Direct Access electricity refers to electricity purchased directly by industries from power generation facilities, which is then delivered through the transmission lines of public or private utility.
[12] PG&E provided a small record of DA electricity consumption (86,106 kWh), the CEC provided an estimate on 2005 DA electricity consumption within Contra Costa County at large, and some Richmond industries provided 2005 DA natural gas consumption to the City upon request. The countywide DA consumption figures provided by the CEC were used to estimate the proportion of DA electricity consumed within the City of Richmond. It is important to note that the direct access data included in the inventory may not be comprehensive given that it is primarily based on regional estimates.
[13] Point source emissions are those generated from on-site stationary commercial and industrial equipment or processes.

source emissions associated with Commercial / Industrial natural gas use were intentionally excluded from the BAAQMD data, assuming that the majority of natural gas-associated emissions were accounted for using PG&E and CEC data.[14]

As illustrated in Figure 6 and Table 11, 68.5 percent (or 3,522,986 metric tons of CO_2e) of the Commercial / Industrial greenhouse gas emissions identified in this study were point source emissions generated by the various processes monitored by the BAAQMD (excluding on site natural gas use). 29.7 percent of emissions were generated from the combustion of natural gas, most likely used in large industrial processes, including on-site generation of electricity and the operation of boilers. Commercial / Industrial electricity consumption accounts for less than 2 percent of the Commercial / Industrial greenhouse gas emissions sources.

Table 11: Commercial / Industrial Emissions by Source

Commercial / Industrial Emission Sources 2005	Electricity	Natural Gas	BAAQMD-Monitored Point Source Emissions	TOTAL
CO_2e (metric tons)	92,574	1,526,012	3,522,986	5,141,572
Percentage of Total CO_2e	1.8%	29.7%	68.5%	100%
MMBtu	1,297,730	28,532,184		29,829,914

Table 12 details the 2005 BAAQMD Commercial / Industrial point source greenhouse gas emissions by facility in 2005. Chevron generated nearly 100 percent of these point source emissions. Refer to Appendix C for a detailed list of emissions fuel sources for each facility.

Table 12: BAAQMD- Monitored Commercial / Industrial Point Source Emissions (2005)

Facility	Address	GHG Emissions CO_2e (metric tons)
Chevron Products Company	*841 Chevron Way*	3,516,517
West County Wastewater District	*2377 Garden Tract Rd*	3,464
Dutra Materials/San Rafael Rock Quarry Inc	*961 Western Drive*	2,472
Point Richmond Quarry Inc	*1135 Canal Avenue*	191
Levin Richmond Terminal Corporation	*402 Wright Avenue*	191
Pacific Bell	*2105 MacDonald Ave*	38
Chevron Research and Technology Co	*100 Chevron Way*	24
State of California	*850 Marina Bay Pkwy*	16
Bayer HealthCare Pharmaceuticals, Inc	*2600 Hilltop Drive*	14
City of Richmond	*Castro St, Pumping Station*	11
East Bay Municipal Utility District	*2755 Isabel Street*	9
Kaiser Permanente	*901 Nevin Avenue*	8
AC Transit	*2016 MacDonald Ave*	7
State of California Department of Trans	*Richmond, San Rafael Bridge Pl*	3
City of Richmond Waste Water Treatment Plant	*601 Canal Boulevard*	3
ConocoPhillips	*1300 Canal Boulevard*	3
West Contra Costa County Detention Center	*5555 Giant Highway*	2
Kaiser Permanente - Regional Lab Annex	*914 Marina Way South*	2
East Bay Municipal Utility District	*105 Brookside Drive*	2
U S Postal Service	*2501 Rydin Road*	2
New NGC, Inc	*1040 Canal Boulevard*	2

[14] This is an assumption that was supported by BAAQMD staff; however BAAQMD staff is not authorized to release specific activity data and sources, due to privacy laws.

DiCon Fiberoptics Inc	*1689 Regatta Blvd*	1
General Services Department	*100 38th Street*	1
Verizon Wireless	*3135 Hilltop*	1
West County Wastewater District	*W End Atlas Road*	1
West County Wastewater District	*1600 Atlas Road*	1
BP West Coast Products, LLC	*1306 Canal Street*	1
Sangamo BioSciences	*501 Canal Blvd, Suite A100*	0
West County Wastewater District	*Lake Hlltop Center*	0
General Chemical West LLC	*525 Castro Street*	0
MCI dba Verizon Business	*3201 Cutting Blvd*	0
TOTAL		**3,522,986**

In addition, the BAAQMD recently published a list of the top 200 greenhouse gas emitting facilities in the Bay Area, which includes emissions from all sources (electricity, natural gas, and point source emissions). Five Richmond facilities made this list as shown in Table 13.

Table 13: BAAQMD Identified Top GHG Emitting Facilities in Richmond in 2005

Number on List	Facility	Address	GHG Emissions (metric tons CO_2e)
2	Chevron Products Company	841 Chevron Way	3,845,315
41	West Contra Costa County Landfill	Foot of Parr Blvd	65,794
59	New NGC, Inc	1040 Canal Boulevard	36,603
133	California Oils Corporation	1145 Harbour Way, South	7,833
154	Steelscape	2995 Atlas Road	5,511
TOTAL			***3,961,056***

3.2.3. Transportation

As shown in Figure 4 and Table 8, Richmond's Transportation Sector accounted for 506,842 metric tons CO_2e, or 8.7 percent, of the City's 2005 GHG emissions. The Transportation Sector analysis includes emissions from all vehicle use within Richmond's city boundaries (whether on local roads or State highways passing through Richmond's jurisdiction), as well as railroad emissions from the transportation of goods within the City.[15] Transportation emissions from the movement of goods through Richmond's Port were not available at the time of this report and are not included in the Transportation Sector analysis.[16] Compared to other Bay Area cities, Richmond's transportation emissions make up a significantly smaller proportion of the total community GHG emissions, dwarfed by Richmond's large percentage of industrial emissions.

Figure 7 and Table 14 detail Richmond's transportation emissions by fuel type. Gasoline use in 2005 generated 87 percent of the total transportation related GHG emissions while diesel use generated the remaining 13 percent. Figure 8 and Table 15, show that nearly 59 percent of Richmond's 2005 transportation-related greenhouse gas emissions were generated from vehicle miles traveled (VMT) on state highways

[15] In addition to Amtrak, three freight railroads operate within the City of Richmond: Union Pacific Railroad, Burlington Northern Santa Fe (BNSF) and Richmond Pacific. To date, City staff has gathered fuel consumption data from only two of the three freight railroads. These data exclude emissions from Amtrak.

[16] Staff attempted to include Richmond's Port GHG emissions data in this report, however, upon investigation, discovered that detailed data would need to be gathered individually from each of the Port's 19 tenants, requiring a substantial amount of staff time to investigate. Staff also attempted to include data from the Honda EIR into this report; however, staff did not receive adequate detail from the EIR consultant to include this data. Given that the constraints for gathering Port data would have delayed this report significantly, staff recommends pursuing a detailed Port GHG inventory separately from this report.

located within city boundaries, while 40 percent was generated from vehicles on local roads. Railroads generated the remaining one and a half percent of transportation-related greenhouse gas emissions.[17]

Figure 7: Transportation Emissions by Fuel Type

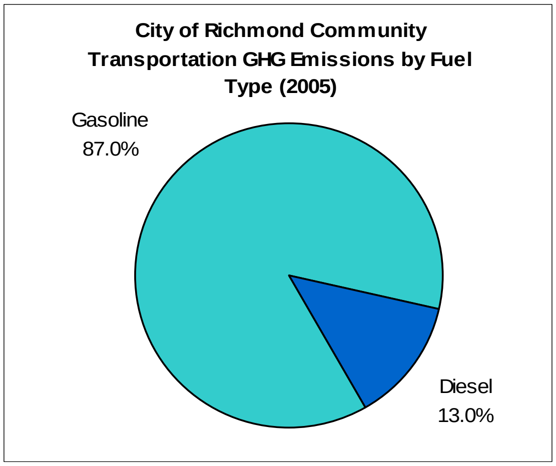


Figure 8: Transportation Emissions by Road Type

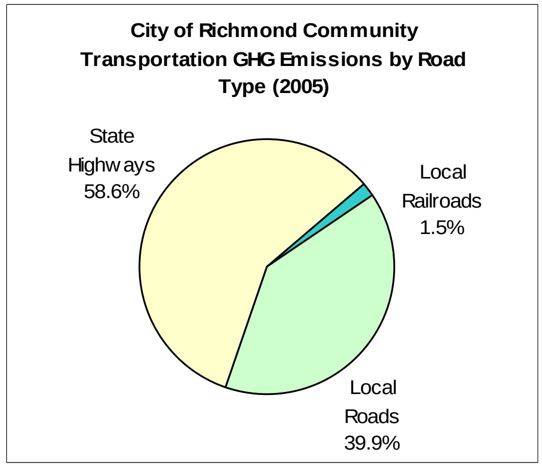


Table 14: Transportation Emissions by Fuel Type

Transportation Fuel Emissions Sources 2005	Gasoline	Diesel	TOTAL
CO_2e (metric tons)	441,142	65,700	506,842
Percentage of Total CO_2e	87.0%	13.0%	100%
MMBtu	6,120,582	790,954	6,911,536

Table 15: Transportation Emissions by Road Type

Transportation Road Type Emissions Sources 2005	Local Railroads	Local Roads	State Highways	TOTAL
CO_2e (metric tons)	7,788	202,208	296,846	506,842
Percentage of Total CO_2e	1.5%	39.9%	58.6%	100%
MMBtu	92,723	2,762,863	4,055,950	6,911,536

Emissions from the air travel of Richmond residents were not included in the Transportation Sector analysis. With more time and the availability of additional data the greenhouse gas emissions from air travel could be estimated. Because there are no airports located within the geographic boundaries of Richmond it is reasonable to exclude air travel from this inventory. Please see Appendix D for more detail on methods and emissions factors used in calculating emissions from the Transportation Sector.

3.2.4. Waste

As noted above in Figure 4 and Table 8, the Waste Sector constituted 1.3 percent of total 2005 emissions for the community of Richmond. Emissions from the Waste Sector are an estimate of methane generation from the anaerobic decomposition of organic wastes (such as paper, food scraps, plant debris, wood, etc.) that are deposited in a landfill. Because Richmond is home to the West Contra Costa Sanitary Landfill (WCCSL), the waste emissions included in this report stem from two separate sources (and analytical models):

[17] The EMFAC emissions factors used in this report aggregate a number of criteria on the county level, including usage by fuel type and fuel efficiency variance from city street traffic to highway traffic. Therefore, while the same emissions factors are used for local road VMT and highway VMT, it is fair to assume that, overall, the variation in mode efficiencies is being captured. See Appendix D for further information on Transportation Sector methods, emissions factors, etc.

1) ***Landfill Emissions (Scope 1 above):*** Total emissions from the West Contra Costa Sanitary Landfill (WCCSL), and
2) ***Waste Generation (Scope 3 above):*** Emissions from Richmond-generated 2005 waste and alternative daily cover (ADC) sent to landfill (WCCSL and other landfills).

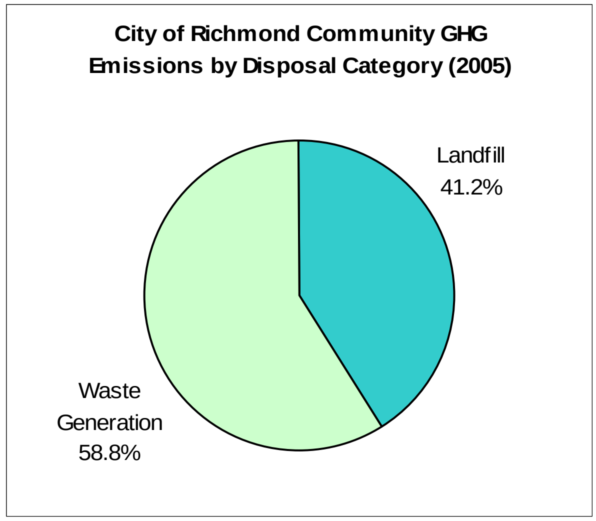
Table 16: Waste Emissions by Scope

Waste Emissions Categories 2005	Landfill Emissions	Waste Generation	TOTAL
CO_2e (metric tons)	32,309	46,179	78,488
Percentage of Total CO_2e	41.2%	58.8%	100.0%
MMBtu	-	-	-

Table 16 and Figure 9 detail Waste Sector emissions by scope. WCCSL emissions are the result of all decomposing organic waste-in-place since the landfill's opening.[18] Specifically, the emissions that are included in the inventory report are an estimate of fugitive emissions (emissions not captured by methane recovery facilities) coming off the landfill in the year 2005.

The waste generation emissions included in this report are the estimated *future* emissions of waste or ADC that was sent to any landfill by Richmond residents or businesses in the base year 2005. These emissions are considered Scope 3 because they are not generated in the base year, but will result from the decomposition of the 2005 waste over the full 100+ year cycle of its decomposition.

Figure 9: Waste Emissions by Scope



Landfill waste emission estimates were made using BAAQMD annual landfill gas recovery rate data. A default 75 percent methane recover factor[19] was used to determine the percentage of all generated emissions that was likely escaping into the atmosphere (fugitive emissions).[20]

Waste generation emissions figures are the product of a modeling exercise that estimates the *future* emissions that will result over the full decomposition of the organic waste and ADC sent to any landfill in the base year 2005. The model used to run this estimation is based on the U.S. EPA Waste Reduction Model (WARM). In order to estimate the relative quantities of various types of waste included in the general disposal figures obtained from Contra Costa County, waste characterization figures were utilized from the 2004 *California Waste Characterization Study*.[21]

There is a possibility of double-counting between these two types of waste emissions. However, because it is assumed that waste will not begin to generate methane until 6 months after it is deposited in a landfill, and because only a small portion of the waste will decompose in the first year, the margin of error is acceptable. It is also important to note that while the majority of Richmond waste was indeed sent to the WCCSL in 2005, there was a significant portion that was sent to other landfills outside of Richmond.

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[18] It can take over 100 years for a given quantity of waste to fully decompose in a landfill, releasing methane and other gases as it breaks down. As such, base year landfill emissions are the result of many years of waste disposal.
[19] Methane recovery factor specified by the U.S. EPA AP 42 guidelines on emissions factors.
[20] See Appendix E for more information on methods and emissions factors used in the Waste Sector analysis.
[21] http://www.ciwmb.ca.gov/Publications/default.asp?pubid=1097

Both waste greenhouse gas emission sources are included because they enable policy development addressing both landfill gas management and waste diversion. Transportation emissions generated from the collection, transfer and disposal of solid waste are included in Transportation Sector GHG emissions.

3.3. Community Emissions by Raw Fuel and Waste Source

In addition to viewing emissions by sector and by scope, it can be useful for developing policy and programs to analyze emissions according to their raw fuel or waste source. Figure 10 and Table 17 show that *more than 60 percent* of all 2005 community emissions came from BAAQMD monitored Commercial / Industrial point source emissions (excluding those derived from natural gas combustion). Residential and commercial natural gas consumption generated 27.6 percent of total community emissions. Gasoline, used to operate vehicles, was the third largest source of GHG emissions in the community (7.5 percent) followed by electricity consumption (2.3 percent), methane generated from landfilled organic materials (1.3 percent), and diesel fuel (1.1 percent).

Figure 10: Community GHGs by Raw Fuel and Waste Source

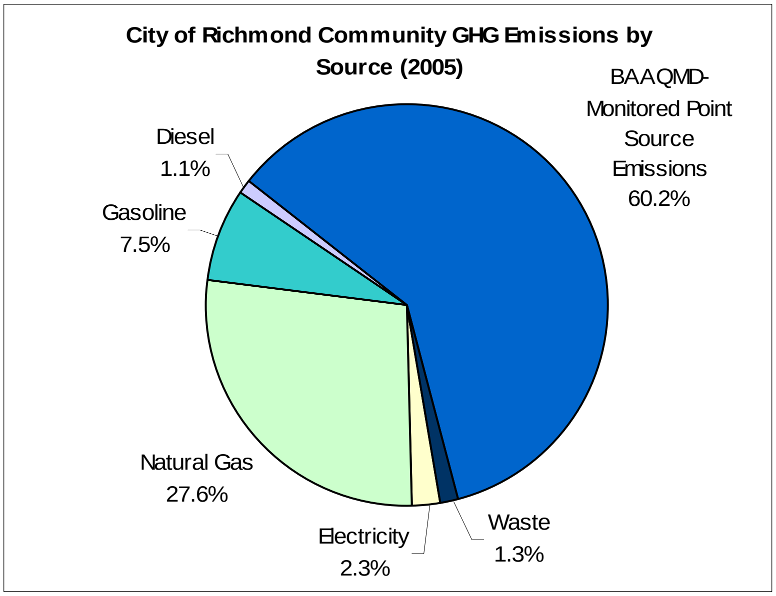


Table 17: Community GHG Emissions by Raw Fuel and Waste Source

Community Emissions 2005 by Source	$CO_{2}e$ (metric tons)	$CO_{2}e$ (%)	MMBtu
Electricity	132,021	2.3%	1,873,086
Natural Gas	1,612,683	27.6%	30,152,694
Gasoline	441,142	7.5%	6,120,582
Diesel	65,700	1.1%	790,954
BAAQMD-Monitored Point Source Emissions	3,522,986	60.2%	-
Waste	78,488	1.3%	-
TOTAL	**5,853,020**	**100%**	**38,937,316**

3.4. 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 get a directly comparable per capita emissions number, and one must be cognizant of this margin of error when comparing figures.

As detailed in Table 18, dividing total community GHG emissions by population yields a result of *58.2 metric tons of $CO_{2}e$ per capita*. It is important to understand that this number is not the same as the carbon footprint of the average individual living in Richmond (which would include lifecycle emissions, emissions resulting from air travel, etc.).

Table 18: Richmond 2005 Greenhouse Gas Emissions per Capita

Estimated 2005 Population*	100,500
Community GHG Emissions (metric tons CO_2e)	5,853,020
GHG Emissions/Resident (metric tons CO_2e)	58.2

** Data Source: ABAG*

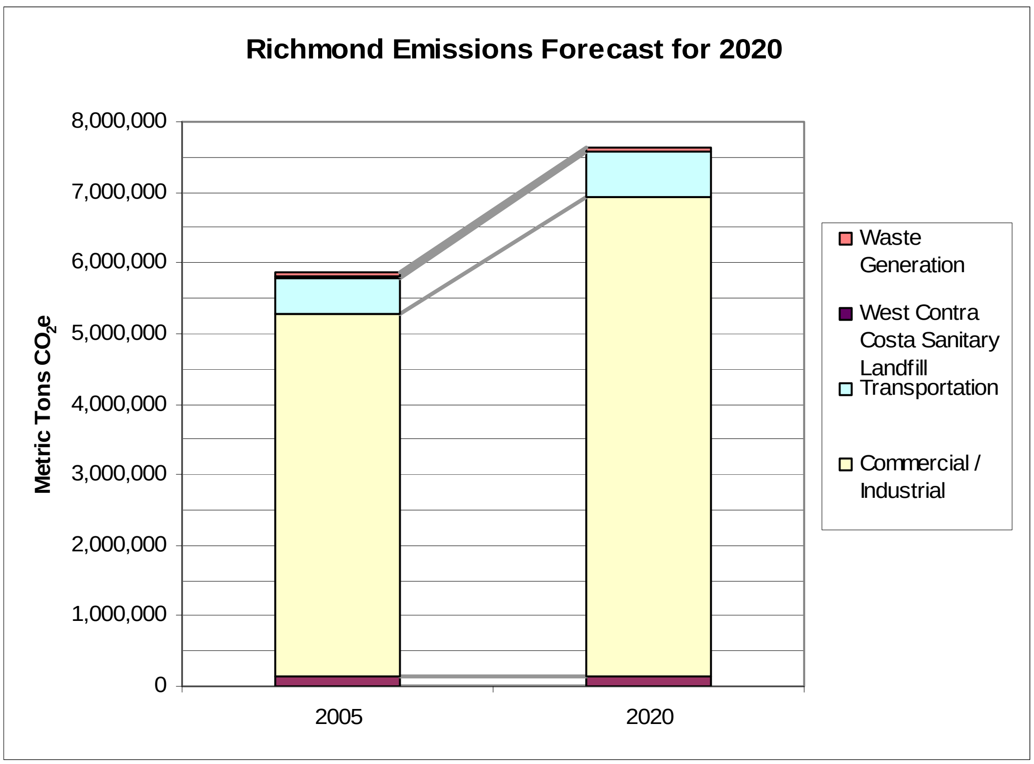
3.5. Community Emissions Forecast

To illustrate the potential emissions growth based on projected trends in energy use, driving habits, job growth, and population growth from the baseline year going forward, ICLEI conducted an emissions forecast for the year 2020. *Under a business-as-usual scenario, the City of Richmond's emissions will grow by approximately 30.4 percent by the year 2020, from 5,853,020 to 7,632,423 metric tons $CO_{2}e$.* Figure 11 and Table 19 show the results of the forecast. A variety of different reports and projections were used to create the emissions forecast, as profiled below.

3.5.1. Residential

For the Residential Sector, a population projection for the City of Richmond conducted by the Association of Bay Area Governments (ABAG) estimated that Richmond's population was 100,500 in 2005, and will be 109,600 in 2020. Based on these population projections, staff estimated average annual compound growth in energy demand to be 0.58 percent annually.

Figure 11: Community Emissions Forecast to 2020



3.5.2. Commercial / Industrial

Analysis contained within *California Energy Demand 2008-2018: Staff Revised Forecast*[22], a report by the California Energy Commission (CEC), shows that commercial floor space and the number of jobs have closely tracked the growth in energy use in the Commercial Sector. Using job growth projections for the City of Richmond from ABAG, it was calculated that the average annual growth in energy use in the Commercial Sector between 2005 and 2020 will be 1.86 percent.[23]

[22] http://www.energy.ca.gov/2007publications/CEC-200-2007-015/CEC-200-2007-015-SF2.PDF
[23] See Appendix F for more detail.

3.5.3. Transportation

For the Transportation Sector, projected growth in energy demand was obtained from the CEC 2008 energy demand forecast referenced above.[24] In their report, *Forecast of the Transportation Energy Demand, 2003-2023*,[25] the CEC projects that on-road VMT will increase at an annual rate of 1.65 percent per year through 2023. This number was used to estimate emissions growth in the Transportation Sector for the Richmond forecast.

3.5.4. Waste Generation

As with the Residential Sector, population is the primary determinate for growth in emissions pertaining to waste generation (Scope 3). Therefore, the average annual population growth rate for 2005 to 2020 (0.58 percent, as calculated from ABAG population projections) was used to estimate future emissions from waste disposal.

Table 19: Community Emissions Growth Projections by Sector

2005 Community Emissions Growth Forecast by Sector	2005	2020	Annual Growth Rate	Percent Change from 2005 to 2020
Residential	126,118	137,538	0.58%	9.1%
Commercial / Industrial	5,141,572	6,781,274	1.86%	31.9%
Transportation	506,842	647,863	1.65%	27.8%
West Contra Costa Sanitary Landfill	32,309	15,387		-52.4%
Waste Generation	46,179	50,360	0.58%	9.1%
TOTAL	**5,853,020**	**7,632,423**	**--**	**30.4%**

3.5.5. West Contra Cost Sanitary Landfill

In 2006 the West Contra Costa Sanitary Landfill closed to public disposal. As methane, carbon dioxide, and other gasses are released from the West Contra Costa Sanitary Landfill, the amount of solid decomposable "waste-in-place" is decreasing. As the feedstock diminishes, so will the amount of landfill gasses that will be released. Using the EPA's Landfill Gas Emissions Model (LandGEM) version 3.02, emissions were estimated for the West Contra Costa Sanitary Landfill for the year 2020. Using 12,123,749 short tons of decomposable waste-in-place for the year 2020, a methane recovery factor of 75 percent, a time constant of decay of 0.05, and a methane generation potential of 0.17 cubic meters of methane per kilogram of waste, it was calculated that in 2020 the West Contra Costa Sanitary Landfill will generate 52 percent less methane emissions in 2020 than in the 2005 baseline year.

[24] The recently passed federal Corporate Average Fuel Economy standards and the state of California's pending tailpipe emission standards could significantly reduce the demand for transportation fuel in Richmond. An analysis of potential fuel savings from these measures at a scale that would be useful for the purpose of this report has not been conducted, nor would such an analysis produce a true business-as-usual estimation. Regardless of future changes in the emissions of vehicles on the road as a result of state or federal rulemaking, emissions from the Transportation Sector will continue to be largely determined by growth in vehicle-miles-traveled (VMT).

[25] http://www.energy.ca.gov/reports/2003-10-01_100-03-016.PDF

4. Municipal Emissions Inventory Results

The City of Richmond's municipal operations generated approximately *10,598 metric tons*[26] *of $CO_{2}e$* in the year 2005. Richmond municipal greenhouse gas emissions were embedded in the community emissions inventory in the following sectors as detailed in Table 20.

Table 20: Municipal Emissions as Included in Community Emissions Inventory

Municipal Sector	Community Sector
Buildings	Commercial / Industrial
Streetlights	Commercial / Industrial
Vehicle Fleet	Transportation
Employee Commute[27]	Transportation
Water / Sewage	Commercial / Industrial
Waste	Waste Generation

Municipal greenhouse gas emissions constituted 0.2 percent of total community emissions. Local government emissions typically account for approximately two percent of community emissions levels, but in Richmond they account for less given its large industrial base. For comparison purposes, when Commercial / Industrial sector data are excluded from the community emissions inventory, municipal emissions constitute 1.5 percent of total community emissions. While reductions in municipal greenhouse gas emissions will have limited impact on the community's overall emissions levels, municipal action has symbolic value that extends beyond the magnitude of emissions reduced.

In 2005, the City of Richmond spent approximately $3,577,509 on electricity, natural gas, and fuel. A breakdown on municipal energy costs is detailed in Appendix G. Beyond reducing greenhouse gas emissions, any future reductions in municipal energy could reduce this expense, enabling the City to reallocate funds toward other municipal services.

4.1. Emissions by Scope

As mentioned previously, including all scopes, the City of Richmond's municipal operations emitted approximately 10,598 metric tons of $CO_{2}e$ in the year 2005. Table 21 lists the breakdown of emissions sources by scope and sector.

Table 21: Scopes and Sectors Included in City of Richmond 2005 Municipal Inventory

Sector	Scope 1	Scope 2	Scope 3
Buildings	*Natural Gas*	*Electricity*	
Streetlights		*Electricity*	
Vehicle Fleet	*Gasoline & Diesel*		
Employee Commute			*Gasoline & Diesel*
Water / Sewage	*Natural Gas*	*Electricity*	
Waste			*Future Emissions from 2005 Waste*

Table 22 and Figure 12 detail Scope 1 (29.7 percent), Scope 2 (39.8 percent), and Scope 3 (30.5 percent) municipal emissions by sector.

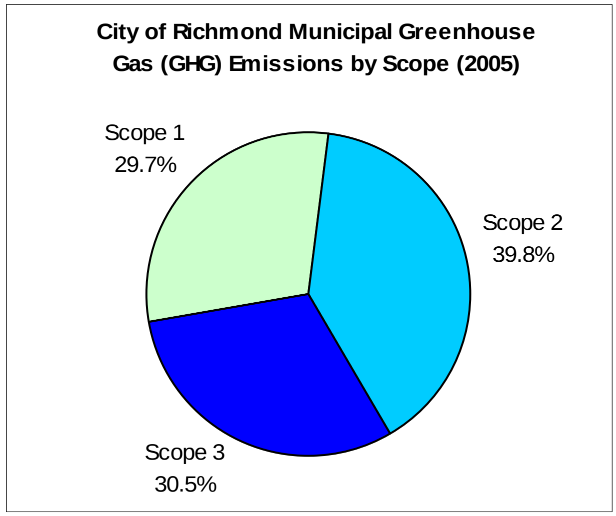
[26] All emissions estimated using STAPPA/ALAPCO and ICLEI's Clean Air and Climate Protection Software developed by Torrie Smith Associates Inc.

[27] Municipal Employee Commute includes emissions from all personal vehicle use in travel to and from work by city employees and therefore includes emissions that occurred outside Richmond's geographical boundaries. Emissions outside the City's boundaries were not included in the community emissions inventory.

Table 22: Municipal GHG Emissions per Sector per Scope (metric tons of CO_2e)

Sector	Scope 1	Scope 2	Scope 3	TOTAL
Buildings	1,746	1,853	-	3,599
Streetlights	-	1,312	-	1,312
Vehicle Fleet	1,386	-	-	1,386
Employee Commute	-	-	2,691	2,691
Water / Sewage	11	1,056	-	1,067
Waste	-	-	543	543
TOTAL	3,143	4,221	3,234	**10,598**
Percentage of Total CO_2e	29.7%	39.8%	30.5%	**100%**

Figure 12: Municipal GHG Emissions by Scope



As shown in Table 23 and Figure 13 below, the largest percentage of Scope 1 emissions came from the Building Sector (55.6 percent). Scope 1 Building Sector emissions are the result of natural gas consumption by municipal buildings, facilities, and on-site equipment[28]. The remainder of Scope 1 emissions resulted from gasoline and diesel consumption by the City's Vehicle Fleet (44.1 percent), and natural gas usage at the Waste Water Treatment Plant (0.3 percent).

As detailed in Table 24 and Figure 14, the largest percentage of 2005 Scope 2 emissions was generated by Buildings (43.9 percent), followed by Streetlights (31.1 percent) and Water / Sewage (25.0 percent). One hundred percent of Richmond's municipal Scope 2 emissions came from electricity consumption from municipally operated sources. As noted previously in the general description of Scope 2 parameters, the actual emissions from these activities were generated outside of Richmond city boundaries—in this case, at the source of electricity generation.

Table 23: Municipal Scope 1 GHG Emissions (metric tons CO_2e)

Scope 1 Emissions By Sector	Buildings	Vehicle Fleet	Water / Sewage	TOTAL
CO_2e (metric tons)	1,746	1,386	11	3,143
Percentage of Total CO_2e	55.6%	44.1%	0.3%	100%
MMBtu	32,648	19,434	211	52,293

Table 24: Municipal Scope 2 GHG Emissions (metric tons CO_2e)

Scope 2 Emissions By Sector	Buildings	Streetlights	Water / Sewage	TOTAL
CO_2e (metric tons)	1,853	1,312	1,056	4,221
Percentage of Total CO_2e	43.9%	31.1%	25.0%	100%
MMBtu	27,026	19,142	15,400	61,568

Table 25: Municipal Scope 3 GHG Emissions (metric tons CO_2e)

Scope 3 Emissions By Sector	Employee Commute	Waste	TOTAL
CO_2e (metric tons)	2,691	543	3,234
Percentage of Total CO_2e	83.2%	16.8%	100%
MMBtu	35,955	-	35,955

[28] Staff did not include on-site generators in the Buildings Sector because generator fuel usage was embedded in the Vehicle Fleet fuel data and could not be separated out based on 2005 data collection methods.

Figure 13: Municipal Scope 1 Emissions

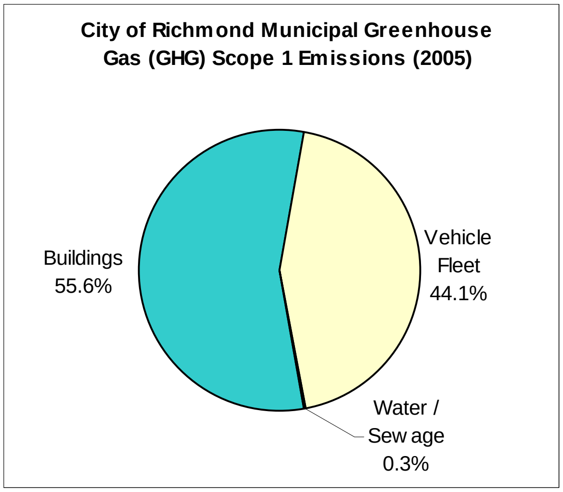
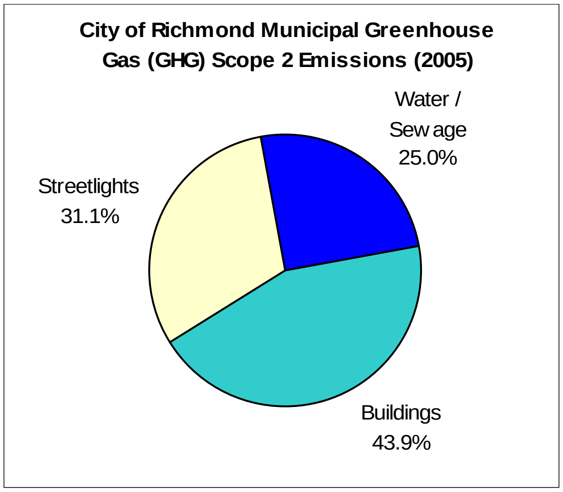
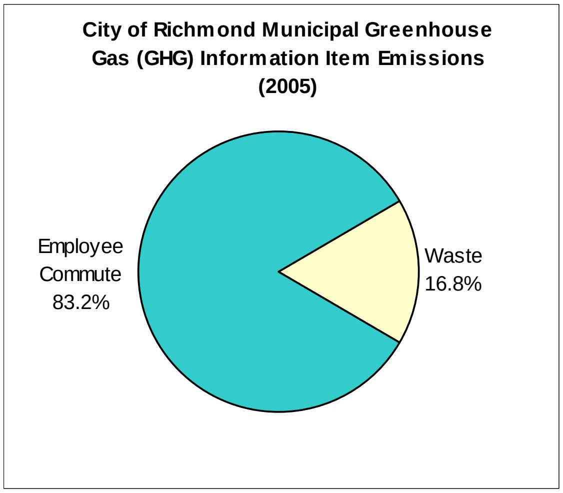


Figure 14: Municipal Scope 2 Emissions



The remaining portion of emissions included in the City of Richmond 2005 community inventory fall under the category of Scope 3. GHG emissions from these sources are related to municipal operations; however they fall outside of Scopes 1 and 2 because they are not financially or operationally controlled by the City of Richmond. As shown in Table 25 and Figure 15, the Employee Commute Sector comprises 83.2 percent of GHG emissions from this category which includes employee gasoline and diesel use in travel to and from work. The Waste Sector comprises 16.8 percent of GHG emissions from this category. Waste Sector emissions are an estimate of future emissions over the lifecycle decomposition of municipal waste sent to the landfill in the base year. Scope 3 items present a more complete picture of a local government's energy use patterns and impact on the climate. The City of Richmond can influence these emissions through various programs despite not having direct control over them.

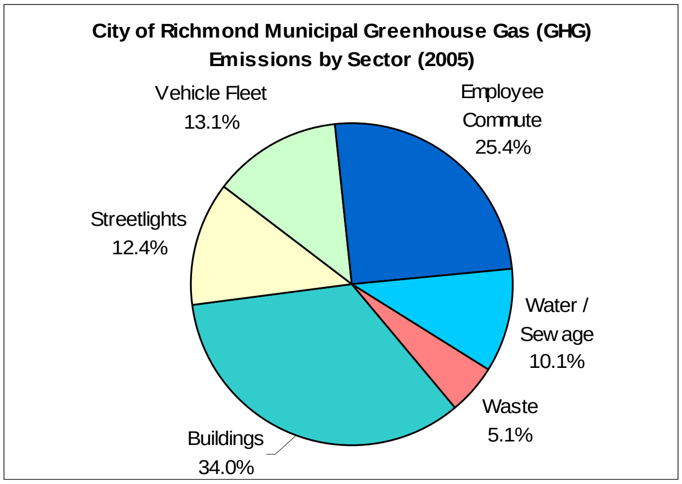
Figure 15: Municipal Scope 3 Emissions



4.2. Emissions by Sector

As noted previously, Richmond's municipal operations emitted approximately 10,598 metric tons of CO2e in the year 2005. In addition to viewing these data through the lens of the various scopes, we can also focus specifically on each sector, with scopes aggregated by sector. As visible in Figure 16 and Table 26 below, electricity and natural gas usage by Buildings was the largest source of municipal emissions (34.0 percent). Emissions from the Employee Commute Sector accounted for 25.4 percent of total municipal emissions, followed by the Vehicle Fleet (13.1 percent), Streetlights (12.4 percent), Water /Sewage (10.1 percent) and

Figure 16: Municipal GHG Emissions by Sector



Waste (5.1 percent). See below for further detail on each sector.

Table 26: Municipal GHG Emissions by Sector (metric tons CO_2e)

2005 Community Emissions by Sector	Buildings	Streetlights	Vehicle Fleet	Employee Commute	Water / Sewage	Waste	TOTAL
CO_2e (metric tons)	3,599	1,312	1,386	2,691	1,067	543	10,598
% of Total CO_2e	34.0%	12.4%	13.1%	25.4%	10.1%	5.1%	100%
MMBtu	59,674	19,142	19,434	35,955	15,611	-	149,816

4.2.1. Buildings

The City of Richmond owns, operates, and occupies a large variety of buildings and facilities. The municipal Buildings Sector generated 34 percent of municipal emissions in 2005, or an estimated 3,599 metric tons of CO_2e. This estimate was calculated using 2005 electricity and natural gas consumption data provided by PG&E, and includes consumption from municipal buildings and facilities, parks and on-site equipment such as transmitters and emergency warning sirens.

Table 27: Building Emissions by Source

Building Emissions Sources 2005	Electricity	Natural Gas	TOTAL
CO_2e (metric tons)	1,853	1,746	3,599
Percentage of Total CO_2e	51.5%	48.5%	100%
MMBtu	27,026	32,648	59,674

Figure 17: Building Emissions by Source

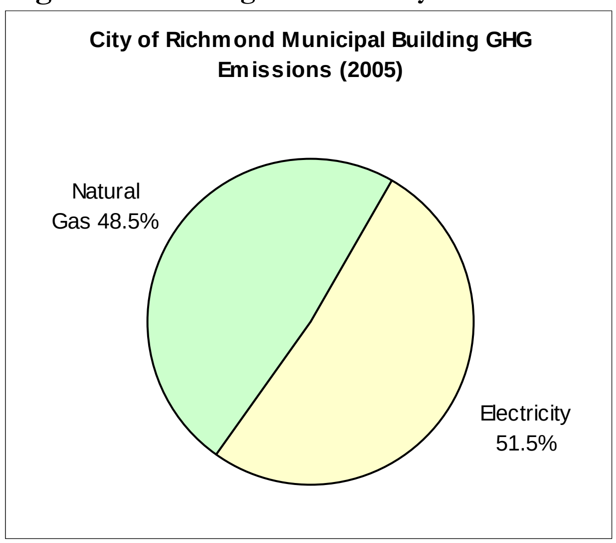


Table 27 and Figure 17 detail Building Sector greenhouse gas emissions by source (electricity and natural gas consumption). 51.5 percent of Building Sector emissions resulted from electricity consumption and the remaining 48.5 percent resulted from natural gas consumption. These data do not include emissions resulting from fuel combustion by stationary equipment located at City facilities. Emissions from equipment that use fuel is in part reflected in the Vehicle Fleet Sector. Additionally, the Buildings Sector does not include fugitive HFC emissions that may result from the use of refrigerants and fire suppression equipment in City facilities. City staff will continue to investigate emissions from these sources.

Table 28 lists the top ten greenhouse gas emitting municipal buildings and facilities in 2005. It is important to note that the City's Waste Water Treatment Plant is accounted for in the Waste / Sewage Sector. The top ten buildings account for 75.7 percent of the municipal Building Sector greenhouse gas emissions, while the top five alone account for 62.7 percent of this Sector's emissions. Greenhouse gas emissions reduction measures in these top emitting buildings would be a worthwhile strategy to achieve notable municipal emissions reductions. Please see Appendix H for a comprehensive listing of greenhouse gas emissions, energy use and utility costs from all municipal buildings and facilities in 2005.

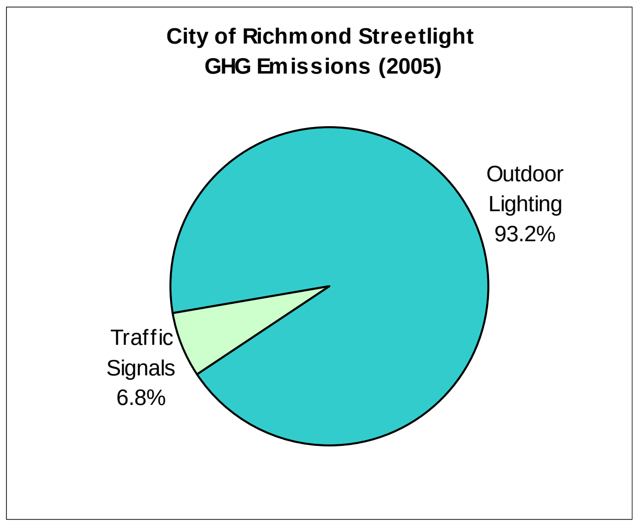
Table 28: Top 10 GHG Emitting Buildings

Building	Location	CO_2e (metric tons)	GHG Emissions (% CO_2e)	Energy (MMBtu)	Utility Costs
Civic Center	*Civic Center Plaza*	580	16.1%	10,038	$129,137
Port Terminal 1	*1500 Dornan*	531	14.7%	7,752	$336,558
City Hall - Marina Way	*1401 Marina Way S, Bldg C*	510	14.2%	8,301	$239,217
Hall of Justice	*401 27th St*	343	9.5%	6,401	$19,912
Kennedy Swim Center	*4300 Cutting Blvd*	294	8.2%	5,221	$52,506
Senior Center	*2525 MacDonald*	144	4.0%	2,435	$54,771
Shipyard	*1312 Canal Blvd*	105	2.9%	1,530	$55,872
Richmond Housing Authority 2	*2400 Nevin*	89	2.5%	1,299	$50,809
Corporation Yard	*6 & 7 13th St*	73	2.0%	1,244	$19,189
Main Library	*325 Civic Center Plaza*	56	1.6%	957	$16,880
TOTAL		**2,725**	**75.7%**	**45,178**	**$974,851**

4.2.2. Streetlights

Richmond's Streetlights Sector generated 12.4 percent of municipal greenhouse gas emissions in 2005, or an estimated 1,312 metric tons of CO_2e. This estimate was calculated using 2005 electricity consumption data for outdoor lighting and traffic signals provided by PG&E. Outdoor lighting includes street lamps, building lamps, park lighting, and other sources of illumination. Traffic signals include traffic lights, crosswalk signals, and amber flashers. As shown in Table 29 and Figure 18 outdoor lighting was responsible for the great majority of the Streetlight Sector greenhouse gas emissions (93.2 percent). The remaining 6.8 percent of emissions was generated by traffic signals.

Figure 18: Streetlight Emissions by Source



PG&E provides electricity consumption information for streetlights grouped into service categories. Unfortunately, these service categories currently do not have clear geographic delineations, rendering the prospect of targeting streetlights at specific locations to achieve greenhouse gas emissions reductions currently unfeasible. However, staff can use alternate methods to determine the best strategy for reducing emissions from the Streetlight Sector.

Table 29: Streetlight Emissions by Source

Streetlight Emissions Sources 2005	Outdoor Lighting	Traffic Signals	TOTAL
CO_2e (metric tons)	1,223	89	1,312
Percentage of Total CO_2e	93.2%	6.8%	100%
MMBtu	17,843	1,299	19,142
Utility Costs	$834,351	$61,679	$896,030

4.2.3. Vehicle Fleet

Richmond's municipal Vehicle Fleet Sector generated 13.1 percent of municipal GHG emissions in 2005, or an estimated 1,386 metric tons of CO_2e. This estimate was calculated using 2008 fleet and fuel consumption data provided by the City's Public Works Department. 2008 was used as a proxy year because complete fleet data and fuel consumption information for 2005 were not available. Table 30 and Figure 19 portray Fleet emissions from gasoline and diesel consumption. Gasoline use constituted 79.1 percent and diesel use constituted 20.9 percent of emissions from the Vehicle Fleet Sector.

The City owned a combined total of approximately 490 fleet vehicles and pieces of equipment in 2008. 377 of these were included in the municipal fleet inventory. The difference in count is attributed partly to the use of vehicles or equipment that did not consume gasoline or diesel fuel. These include arrow boards, rollers, electric vehicles, small tractors, etc. Electricity consumption from some of these vehicles and equipment is reflected in the Building electricity consumption data. Since the fleet management system is not currently able to track fuel consumption by undercover and unregistered vehicles, this inventory does not account for their greenhouse gas emissions. Agricultural and construction equipment were included in the inventory in either the heavy truck or light truck/SUV/pickup categories depending on equipment weight.[29]

Figure 19: Vehicle Fleet Emissions by Fuel Type

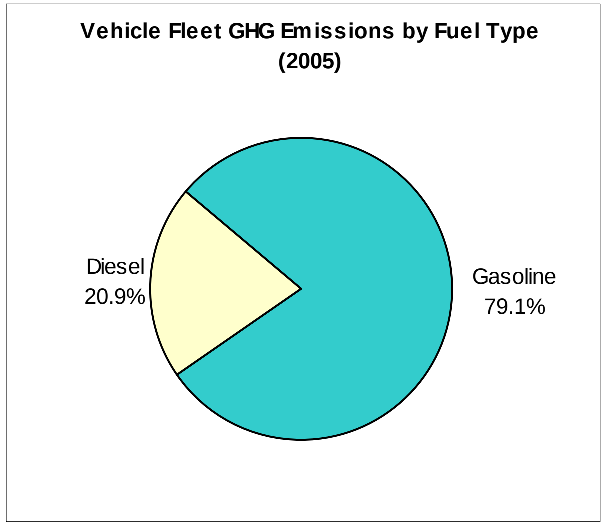


Table 30: Vehicle Fleet Emissions by Fuel Type

Vehicle Fleet Fuel Emissions Sources 2005	Gasoline	Diesel	TOTAL
CO_2e (metric tons)	1,097	289	1,386
Percentage of Total CO_2e	79.1%	20.9%	100%
MMBtu	15,948	3,486	19,434

Table 31 details greenhouse gas emissions from the Vehicle Fleet Sector by department.[30] The Police, Public Works, and Fire Department are the top sources of greenhouse gas emissions in the Vehicle Fleet Sector. This is not surprising given that these departments own and operate 75 percent of municipal fleet vehicles. Appendix J details fuel consumption information by department, vehicle type, and fuel type. While the Police and Public Works Departments own the same number of vehicles, the Police Department contributes significantly more greenhouse gas emissions (nearly 70% more emissions than Public Works). This is most likely due to the nature of police work, which includes twenty four hour regular patrol and call response, requiring greater fuel usage. Many Public Works vehicles may be used less frequently or across shorter distances.

[29] This is in contrast with placing their emissions in the appropriate categories of agricultural and construction equipment as required in the *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventorie*s, adopted by the California Air Resources Board. This was due to limitations in ICLEI's CACP software. Thus, GHG emissions from these sources are accounted for in the Vehicle Fleet Sector, although accuracy of the estimates may be compromised due to use of less than optimal calculation methods.

[30] Double counting may have occurred in the greenhouse gas emissions estimates for the commutes of select employees who have a designated City vehicle for commute to and from work. This should not dramatically alter the final emissions estimate for the sector, as only a small number of employees are provided with designated City vehicles.

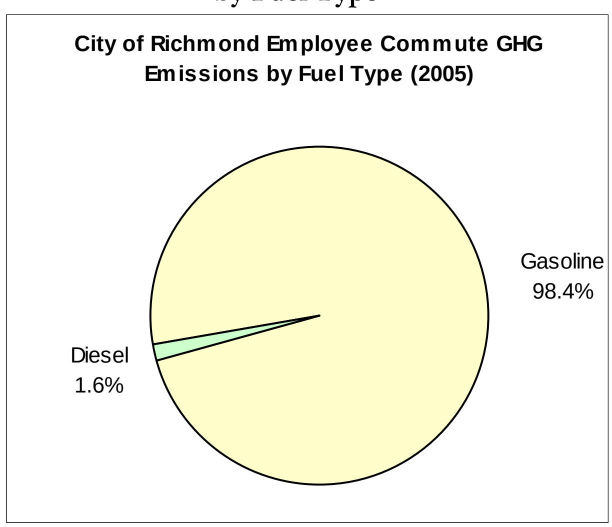
Table 31: Vehicle Fleet Emissions by Department

Department	Number of vehicles	CO_2e (metric tons)	% of Vehicle Fleet Emissions (metric tons CO_2e)
Police	121	628	45.3%
Public Works	121	376	27.1%
Fire	41	163	11.8%
Veolia	11	59	4.3%
Paratransit	9	46	3.3%
Building and Regulations	9	15	1.1%
Recreation	5	14	1.0%
Engineering	8	13	0.9%
Library	5	13	0.9%
Equipment Services	7	10	0.7%
Redevelopment	9	10	0.7%
City Hall (Pool Vehicles)[31]	9	9	0.6%
Employment and Training	5	5	0.4%
Information Technology	4	5	0.4%
Housing and Community Development	3	4	0.3%
Planning	3	4	0.3%
Port	3	4	0.3%
KCRT	1	2	0.1%
Office of Neighborhood Safety	1	2	0.1%
Human Resources	1	1	0.1%
Mayor	1	1	0.1%
TOTAL	**377**	**1,386**	**100%**

4.2.4. Employee Commute

The Employee Commute Sector emissions detailed in this report include greenhouse gas emissions from all personal vehicle use in travel to and from work by employees in 2005. City of Richmond employees generated an estimated 25 percent of municipal emissions in travel to and from work in 2005, or an estimated 2,691 metric tons of CO_2e. Table 32 and Figure 20 provide information on emissions from the Employee Commute Sector by fuel type. Emissions from gasoline use constituted nearly all emissions in the Employee Commute Sector (98.4 percent), while diesel use constituted the remaining 1.6 percent. Although the City of Richmond does not have direct control over these emissions, it may influence emissions through various programs designed to affect employee behavior.

Figure 20: Employee Commute Emissions by Fuel Type



Not included in the Employee Commute Sector are greenhouse gas emissions generated from employees who travel to and from work using alternate modes of transportation, such as by bus, metro, or train. An estimated 3 percent of employees exclusively walk, bike, or take public transit to work, and an estimated 6

[31] City Hall Pool Vehicles are used by various departments.

percent of employees occasionally walk, bike, or take public transit to work. Considering the small number of employees that travel by public transit to and from work, inclusion of emissions from these sources would likely have minimal effect on the current estimate.

Greenhouse gas emissions from the Employee Commute Sector were estimated by conducting a survey of the City of Richmond's current 952 employees to gather information about commute distance, mode and frequency. 71 percent, or 674 employees, responded to the survey.[32]

Table 32: Employee Commute Emissions by Fuel Type

Employee Commute Fuel Emissions Sources 2005	Gasoline	Diesel	TOTAL
CO_2e (metric tons)	2,649	42	2,691
Percentage of Total CO_2e	98.4%	1.6%	100%
MMBtu	35,418	537	35,955

4.2.5. Water / Sewage

The Water/Sewage Sector generated an estimated 10.1 percent of municipal emissions in 2005, or 1,067 metric tons of CO_2e. This estimate was calculated using 2005 natural gas and electricity consumption data provided by PG&E and includes consumption from municipal irrigation systems, stormwater and waste water pumping stations, and the City-owned Waste Water Treatment Plant (WWTP). As detailed in Table 33 and Figure 21, 99 percent of Water / Sewage greenhouse gas emissions were generated from electricity consumption; natural gas consumption accounted for the remaining one percent of emissions.

Table 33: GHG Emissions from Water / Sewage by Source

Water / Sewage Emissions Sources	Electricity	Natural Gas	TOTAL
CO_2e (metric tons)	1,056	11	1,067
Percentage of Total CO_2e	99.0%	1.0%	100%
MMBtu	15,400	211	15,611

Table 34: GHG Emissions from Water/Sewage by Type

Water / Sewage Emissions Sources by Type	Waste Water Treatment Plant	Other Water Pumps	TOTAL
CO_2e (metric tons)	1,005	62	1,067
Percentage of Total CO_2e	94.2%	5.8%	100%
MMBtu	14,703	908	15,611

Table 34 and Figure 22 illustrate Water / Sewage greenhouse gas emissions by type. The WWTP (including waste water pumps at various City locations), generated the vast majority of CO_2e emissions (94.2 percent) while other irrigation and stormwater pumps were responsible for the remaining 5.8 percent.[33]

[32] Estimates for total annual gasoline and diesel consumption were reached using information about VMT per employee per day and vehicle fuel economy. To account for employees who did not complete the survey, fuel consumption information was extrapolated based on fuel consumption and vehicle type information provided by survey respondents. The estimated total fuel consumption figure was estimated for 2005 by adjusting for the difference in the current number of employees with the number of employees in 2005. The adjustment had minimal effect, as the number of employees in 2005 was 941. Please see Appendix K for a comprehensive list of estimated commute distances, fuel consumption, and vehicle types.

[33] At the time of this report, the Waste Water Treatment Plant greenhouse gas emissions data did not include estimates for fugitive emissions from treatment lagoons or from the anaerobic digester flare. City staff is working to gather and include this additional data.

Figure 21: Water / Sewage Emissions by Source

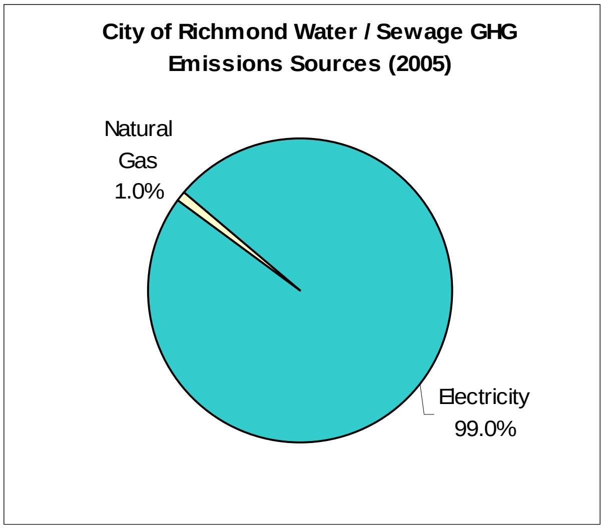
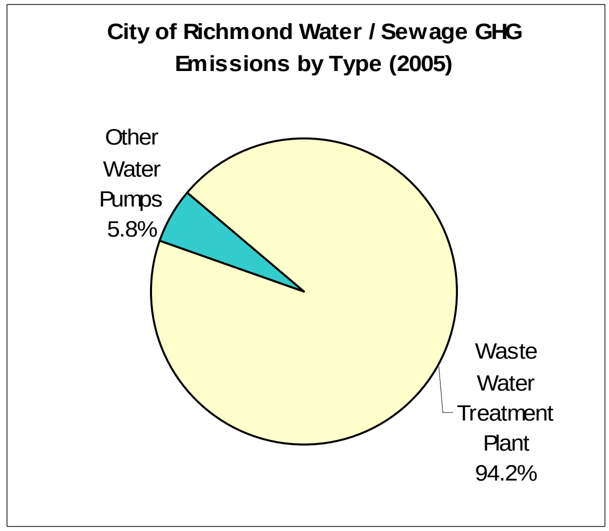


Figure 22: Water / Sewage Emissions by Type



The City's WWTP processes approximately 700 million gallons of waste water per day. For comparison purposes, as a facility, the WWTP generated nearly twice as many greenhouse gas emissions than the next largest municipal building (Civic Center) in 2005 as shown in Table 35. In addition, the City paid nearly $500,000 in utility costs to operate the WWTP that year.

Table 35: Top 5 Emitting GHG Buildings Including the Waste Water Treatment Plant

Building	Location	GHG Emissions (metric tons CO_2e)	Energy (MMBtu)	Utility Costs
Waste Water Treatment Plant	*601 Canal Blvd*	1,005	14,703	$492,058
Civic Center	*Civic Center Plaza*	580	10,038	$129,137
Port Terminal 1	*1500 Dornan*	531	7,752	$336,558
City Hall - Marina Way	*1401 Marina Way S, Bldg C*	510	8,301	$239,217
Hall of Justice	*401 27th St*	343	6,401	$19,912
TOTAL		**2,725**	**47,195**	**$1,216,882**

4.2.6. Waste

The municipal Waste Sector emissions in this report are the estimated *future* emissions of organic waste that was generated and sent to the West Contra Costa Sanitary Landfill by municipal facilities and operations in the base year 2005. These emissions are considered Scope 3 because they are not generated in the base year, but will result from the decomposition of the 2005 waste over the full 100+ year cycle of its decomposition. Based on 2005 disposal estimates, the municipal Solid Waste Sector will generate an estimated 523 metric tons of CO_2e, which is attributed to the base year. Given this, the Waste Sector was responsible for 5.1 percent of total municipal greenhouse gas emissions in 2005.

Table 36: Waste Emissions by Type

Scope 3 Waste Emissions Sources 2005	Paper Products	Food Waste	Plant Debris	Wood / Textiles	TOTAL
CO_2e (metric tons)	303	119	32	89	543
Percentage of Total CO_2e	55.8%	21.9%	5.9%	16.4%	100%
MMBtu	-	-	-	-	0

Staff estimated municipal disposal amounts based on 2008 garbage service level data for each city-operated facility provided by Richmond Sanitary Services. Given that 2005 service data were not available, staff assumed current facility garbage service levels were comparable to service levels in 2005. Staff audited garbage service bins to determine fullness at time of collection to aid in developing a more accurate disposal estimate. Lastly, staff used the results of a 2005 waste characterization study completed by the California Integrated Waste Management Board to determine the makeup of material types disposed. Staff did not include estimates for garbage self-hauled to the West Contra Costa Sanitary Landfill by municipal operations due to the lack of available and accurate data. In addition, a significant proportion of the City's self-hauled garbage is the result of illegal dumping in the community, and, therefore, is not generated by the City's operations.

Figure 23: Waste Emissions by Type

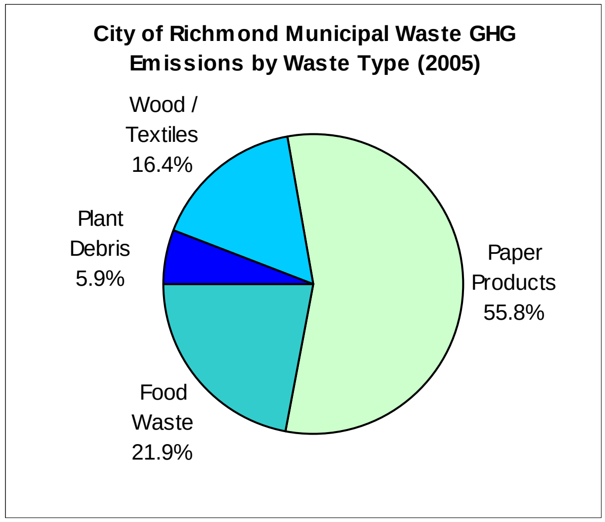


Table 36 and Figure 23 provide information about greenhouse gas emissions from the Waste Sector by waste type. The majority of emissions are a result from the decomposition of paper products (55.8 percent), followed by food waste (21.9 percent), wood and textiles (16.4 percent) and plant debris (5.9 percent).

4.3. Municipal Emissions by Raw Fuel and Waste Source

In addition to viewing emissions by sector and by scope, analyzing emissions according to their raw fuel or waste source can be useful for developing municipal policy and programs. Figure 24 and Table 37 show that nearly 40 percent of all 2005 municipal emissions came from electricity consumption. Gasoline, consumed by the Employee Commute and Vehicle Fleet Sectors, was the second largest source of municipal greenhouse gas emissions (35.3 percent) followed by natural gas consumption (16.6 percent), methane generated from landfilled organic materials (5.1 percent) and diesel fuel consumption (3.1 percent).

Figure 24: Municipal GHG Emissions by Source

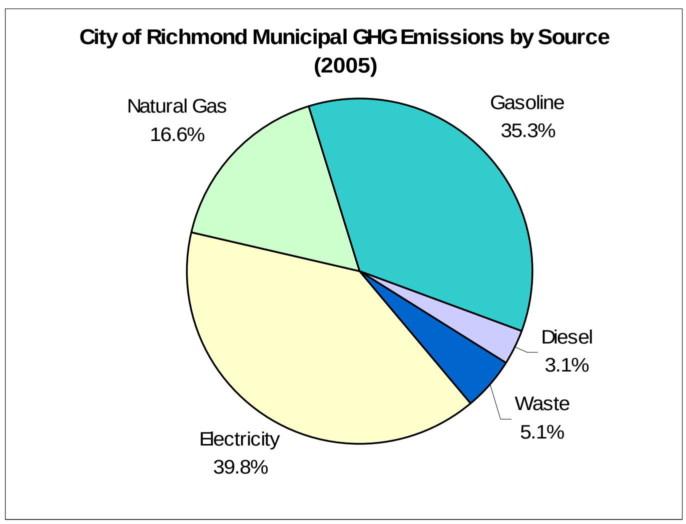


Table 37: Municipal GHG Emissions by Raw Fuel and Waste Source

Community Emissions 2005 by Source	CO_2e (metric tons)	CO_2e (%)	MMBtu
Electricity	4,221	39.8%	61,568
Natural Gas	1,757	16.6%	32,859
Gasoline	3,746	35.3%	51,366
Diesel	331	3.1%	4,023
Waste	543	5.1%	-
TOTAL	**10,598**	**100%**	**149,816**

4.4. Per Employee Emissions

Table 38 provides information on municipal emissions on a per employee basis. Estimated using GHG emissions totals from the Buildings, Vehicle Fleet, Waste, and Employee Commute Sectors, Richmond employees generated 8,219 metric tons of GHG emissions in 2005. This is may be an overestimate for Richmond employees, as the Buildings and Vehicle Fleet Sectors include emissions from public buildings and operations that are used by both Richmond residents and employees. The Streetlights and Water / Sewage Sectors are not included in the estimate for GHG Emissions per employee because these operations primarily serve the community as a whole. Per employee emissions can be a useful metric for comparing one's emissions with those of employees of neighboring cities and against regional and national averages and for measuring progress in reducing greenhouse gases from municipal sources.

Table 38: Municipal GHG Emissions per Employee

Number of Employees	941
Total Employee GHG Emissions (metric tons CO_2e)	8,219
GHG Emissions/Employee (metric tons CO_2e)	**8.7**

5. Conclusion

The City of Richmond has made a formal commitment to reduce its greenhouse gas emissions by passing a resolution in 2007 to endorse the U.S. Conference of Mayors Climate Protection Agreement and in 2008 by committing to the greenhouse gas reduction targets established in AB 32 and becoming a signatory to the Urban Environmental Accords in 2008. Richmond has taken further initiative to reduce greenhouse gas emissions by being one of the first cities in the U.S. to include an Energy and Climate Change Element in its current General Plan update. This emissions inventory provides baseline emission levels against which future progress can be demonstrated.

This analysis found that the Richmond community as a whole was responsible for emitting 5,853,020 metric tons of CO_2e in the base year 2005, with point source emissions from the Commercial / Industrial sector contributing the most to this total. (See summary table in Appendix A for more detail.) The City of Richmond's municipal operations were responsible for emitting 10,598 metric tons of communitywide CO_2e in the base year 2005, with Buildings and Employee Commute Sectors contributing 60 percent of this total. (See summary table in Appendix G for more detail.)

The results from the 2020 emissions forecast demonstrate that under a business-as-usual scenario, emissions will grow significantly in the Commercial / Industrial and Transportation sectors. These results suggest that energy use in vehicular travel and commercial and industrial facilities presents both the greatest challenge and requires the most urgent action in order for Richmond to reduce its emissions in the future. Community climate action planning through the General Plan update efforts should take this into account.

The results of the municipal inventory suggest that there is significant opportunity to reduce greenhouse gas emissions in the Buildings and Employee Commute sectors. Efforts to reduce energy consumption and increase energy efficiency in the top emitting buildings and facilities may have significant effects in reducing municipal greenhouse gas emissions. The City of Richmond also has considerable opportunity to influence employee commute behavior through various programs.

Based on the ICLEI methodology and recommendations, the City of Richmond should begin to document emission reduction measures that have been implemented since 2005 and should quantify the emissions benefits of these measures to demonstrate progress made to date.

As Richmond moves forward with considering emission reduction strategies and works to finalize the Energy and Climate Change Element and create a local climate action plan, the City should identify and quantify the emission reduction benefits of climate and sustainability strategies that could be implemented in the future, including energy efficiency, renewable energy, vehicle fuel efficiency, alternative transportation, vehicle trip reduction, land use and transit planning, waste reduction and other strategies. Through these efforts and others the City of Richmond can achieve additional benefits beyond reducing emissions, including saving money and improving Richmond's economic vitality and its quality of life.

City staff will continue to update this inventory as additional data become available. Specifically, City staff and ICLEI will continue to gather data specific to the Richmond Port.

6. Appendices

6.1. Appendix A

Detailed Community Greenhouse Gas Emissions in 2005

Sector	Emissions Source	Equiv CO_2 (metric tons)	Equiv CO_2 (%)	Energy (MMBtu)	Data Source
Residential					
	Electricity	39,447	0.7%	575,356	PG&E
	Natural Gas	86,671	1.5%	1,620,510	PG&E
Subtotal Residential		**126,118**	**2.2%**	**2,195,866**	
Commercial/Industrial					
"District" Direct Access					
	Electricity	28	0.0%	294	PG&E
Commercial/Industrial PG&E					
	Electricity	79,392	1.4%	1,157,964	PG&E
	Natural Gas	1,517,105	25.9%	28,365,648	PG&E
Other Direct Access					
	Electricity (Estimated)	13,154	0.2%	139,472	CEC
	Natural Gas	8,907	0.2%	166,536	From Industry
BAAQMD Monitored Point Source Emissions		3,522,986	60.2%		BAAQMD
Subtotal Commercial		**5,141,572**	**87.8%**	**29,829,914**	
Transportation					
Local Roads AVMT					
	Gasoline	178,743	3.1%	2,479,952	CalTrans
	Diesel	23,465	0.4%	282,911	CalTrans
State Highways AVMT					
	Gasoline	262,399	4.5%	3,640,630	MTC
	Diesel	34,447	0.6%	415,320	MTC
Rail					
	Diesel	7,788	0.1%	92,723	BNSF/Richmond Pacific
Subtotal Transportation		**506,842**	**8.7%**	**6,911,536**	
Waste					
ADC					
	Plant Debris	804	0.0%		CCC / CIWMB
Total Waste Disposed (w/o ADC)					
	Paper Products	25,313	1.1%		CCC / CIWMB
	Food Waste	9,961	0.4%		CCC / CIWMB
	Plant Debris	2,664	0.1%		CCC / CIWMB
	Wood/Textiles	7,437	0.3%		CCC / CIWMB
West Contra Costa Sanitary Landfill					
	Waste-In-Place	32,309	0.6%		CCC / Republic Services/BAAQMD
Subtotal Waste		**78,488**	**1.3%**		
Grand Total		**5,853,020**	**100.0%**	**38,937,316**	

6.2. Appendix B

Residential Sector Notes

Data Inputs:

Residential	Electricity Consumption	kWh	168,579,363
	Natural Gas Consumption	Therms	16,205,099

Data Sources:

1. PG&E: Jasmin Ansar, JxA2@pge.com, Xantha Bruso, XxB1@pge.com.
   File name: straphael2005.xls

   Data entered by Jenny Oorbeck, Environmental Manager, City of Richmond, Jenny_Oorbeck@ci.richmond.ca.us; and Wesley Look, Program Associate, ICLEI, wesley.look@iclei.org . Coefficient set updated February 25, 2008.

Notes:

1. The "PG&E California" electricity coefficient set is based on the 2005 PG&E CO_2e emission factor of 0.49 lbs/kWh of delivered electricity. This emissions factor is certified by the California Climate Action Registry and was reported to ICLEI in January 2007 by Greg San Martin. Criteria air pollutant emission factors for electricity are derived from the NERC Region 13 - Western Systems Coordinating Council/CNV Average Grid Electricity Set.

2. The "California Coefficients for Natural Gas" coefficient set is based on a PG&E CO_2e emissions factor of 53.05 kg/mmbtu of delivered natural gas, certified by the California Climate Action Registry and the CEC, and was reported to ICLEI in Dec. 2007 by Jasmin Ansar. Criteria air pollutant emissions factors for natural gas are derived from the USEPA's annual report of air pollution emission trends (USEPA, 2001c).

ABAG Housing Projections:

HOUSEHOLDS							
Jurisdictional Boundary	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
RICHMOND	34,625	35,280	35,910	37,150	38,890	41,230	42,800
CONTRA COSTA COUNTY	**34,625**	**35,280**	**35,910**	**37,150**	**38,890**	**41,230**	**42,800**

6.3. Appendix C

Commercial / Industrial Sector Notes

Data Inputs:

Commercial	Electricity Consumption	kWh	339,283,466
	Natural Gas Consumption	Therms	283,656,478
Industrial	Electricity Consumption	kWh	0
	Natural Gas Consumption	Therms	0
	Industrial Electricity (Fails 15/15)[1]		Fail
	Industrial Natural Gas (Fails 15/15)		Fail
Direct Access (see below for DA emission factor)	Electricity Direct Access (from PG&E)	kWh	86,106 (District)
	% DA County Estimate for Residential	%	0.00%
	% DA County Estimate for Commercial and Industrial [4]	%	12.07%
	Estimated Direct Access Electricity Consumption	kWh	40,865,408
	Natural Gas DA from Richmond Industries	Therms	8,907

Data Sources:

1. PG&E: Jasmin Ansar, JxA2@pge.com, Xantha Bruso, XxB1@pge.com.
   File name: straphael2005.xls

2. California Energy Commission (CEC): Andrea Gough, agough@energy.state.ca.us, (916) 654.4928
   File name: California Electricity Consumption.xls

2. Direct Access natural gas data provided to City staff directly by Richmond industries

   Data entered by Jenny Oorbeck, Wesley Look, Program Associate, ICLEI, wesley.look@iclei.org, (510) 844-0699 x 322 Coefficient set updated February 25, 2008.

Notes:

1. The "PG&E California" electricity coefficient set is based on the 2005 PG&E CO_2e emission factor of 0.49 lbs/kWh of delivered electricity. This emissions factor is certified by the California Climate Action Registry and was reported to ICLEI in January 2007 by Greg San Martin. Criteria air pollutant emission factors for electricity are derived from the NERC Region 13 - Western Systems Coordinating Council/CNV Average Grid Electricity Set.

2. The "California Coefficients for Natural Gas" coefficient set is based on a PG&E CO_2e emissions factor of 53.05 kg/mmbtu of delivered natural gas, certified by the California Climate Action Registry and the CEC, and was reported to ICLEI in Dec. 2007 by Jasmin Ansar. Criteria air pollutant emissions factors for natural gas are derived from the USEPA's annual report of air pollution emission trends (USEPA, 2001c).

3. Estimations of electricity purchased through Direct Access (DA) contracts at the county level based on data provided by the California Energy Commission. The amount of DA in a given community varies. 12.07 percent of "non-residential" electricity consumption in Contra Costa County was DA in 2005 according to the CEC.

BAAQMD – Monitored Commercial / Industrial Point Source GHG Emissions

Plant	Address	CO_2e (metric tons)	Coke	Diesel	LPG	Pathological Waste	Process Gas	Digester Gas	Gasoline - (Unleaded)	Refinery Fuel Gas	Hydrogen
Chevron Products Company	*841 Chevron Way*	3,516,517	X	X	X		X		X	X	X
West County Wastewater District	*2377 Garden Tract Rd*	3,464		X			X	X			
Dutra Materials/San Rafael Rock Quarry	*961 Western Drive*	2,472		X							
Point Richmond Quarry Inc	*1135 Canal Avenue*	191		X							
Levin Richmond Terminal Corporation	*402 Wright Avenue*	191		X							
Pacific Bell	*2105 MacDonald Ave*	38		X							
Chevron Research and Technology Co	*100 Chevron Way*	24		X							
State of California	*850 Marina Bay Pkwy*	16		X		X					
Bayer HealthCare Pharmaceuticals, Inc	*2600 Hilltop Drive*	14		X							
City of Richmond	*Castro St, Pumping Station*	11		X							
East Bay Municipal Utility District	*2755 Isabel Street*	9		X							
Kaiser Permanente	*901 Nevin Avenue*	8		X							
AC Transit	*2016 MacDonald Ave*	7		X							
State of California Department of Trans	*Richmond, San Rafael Bridge Pl*	3		X							
Waste Water Treatment Plant	*601 Canal Boulevard*	3		X							
ConocoPhillips	*1300 Canal Boulevard*	3		X							
West Contra Costa County Detention Cntr	*5555 Giant Highway*	2		X							
Kaiser Permanente - Regional Lab Annex	*914 Marina Way South*	2		X							
East Bay Municipal Utility District	*105 Brookside Drive*	2		X							
U S Postal Service	*2501 Rydin Road*	2		X							
New NGC, Inc	*1040 Canal Boulevard*	2		X							
DiCon Fiberoptics Inc	*1689 Regatta Blvd*	1		X							
General Services Department	*100 38th Street*	1		X							
Verizon Wireless	*3135 Hilltop*	1		X							
West County Wastewater District	*W End Atlas Road*	1		X							
West County Wastewater District	*1600 Atlas Road*	1		X							
BP West Coast Products, LLC	*1306 Canal Street*	1		X							
Sangamo BioSciences	*501 Canal Blvd, Suite A100*	0		X							
West County Wastewater District	*Lake Hlltop Center*	0			X						
General Chemical West LLC	*525 Castro Street*	0		X							
MCI dba Verizon Business	*3201 Cutting Blvd*	0			X						
TOTAL		**3,522,986**									

6.4. Appendix D

Transportation Sector Notes

Data Inputs:

Transportation	Local Roads (VMT)[2]	Annual VMT (95.2% Gasoline 4.8% Diesel)	381,614,800
	State Highway VMT [3]	Annual VMT (95.2% Gasoline 4.8% Diesel)	560,219,885
	Railroads	Diesel (gallons)	759,935

Data Sources:

1. Local Roads Vehicle Miles Traveled (VMT) 2005 data provided by Harold Brazil, Air Quality Associate, Metropolitan Transportation Commission (MTC) hbrazil@mtc.ca.gov, (510) 817-5747. Data analyzed by Micah Lang, Program Officer, ICLEI.

2. State Highways Vehicle Miles Traveled (VMT) 2005 data provided by CalTrans, analyzed by Micah Lang, ICLEI Program Officer and Theresa Crebbs, ICLEI. Data source file: 2005 Public Roads Data, HPMS division of CalTrans http://www.dot.ca.gov/hq/tsip/hpms/hpmslibrary/hpmspdf/2005PRD.pdf

3. EMFAC data provided in November, 2007 by Amir Fanai, Principal Air Quality Engineer, Bay Area Air Quality Management District, AFanai@baaqmd.gov

4. Data Source File: Bay Area miles and DVMT_Local roads_Richmond.xls

5. Railroad data provided directly by BNSF and Richmond Pacific.

Notes:

1. Local Road and state highway VMT data provided by MTC is in Daily VMT (DVMT); Annual VMT = DVMT x 365.

2. 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 Richmond roads and state highways. Fleet mix data was provided by the MTC, and local EMFAC emissions factors were provided by BAAQMD. (See above.)

6.5. Appendix E

Waste Sector Notes

Data Inputs:

Waste	Total Landfill Waste (See Waste Table)	Short Tons	155,348
	Total Alternative Daily Cover (See Waste Table)	Short Tons	3,230
	% ADC Green Material	%	100%
	Landfill Waste in Place in 2005	Short Tons	12,025,053
	Landfill Waste in Place in 2020	Short Tons	12,123,749
	Year Opened / closed		1953 / 2006

Data Sources:

1. 2005 Disposal Figures for the City of Richmond: Contra Costa County Community Development Department: Deidra Dingman, Solid Waste Program Manager, dding@cd.cccounty.us, (925) 335-1224.

2. West Contra Costa Sanitary Landfill WIP Data: Republic Services: Deborah Krulevitch, Waste Compliance Assistant, KrulevitchD@repsrv.com, (510) 262-1663.

3. Waste Characterization: CIWMB 2004 Statewide Waste Characterization Study. This state average waste characterization accounts for residential, commercial and self haul waste.
http://www.ciwmb.ca.gov/Publications/default.asp?pubid=1097
Data source file: CA Waste Characterization per CACP.xls

Methods:

1. CO_2e emissions from 2005 waste disposal were calculated using the methane commitment method in the CACP software, which uses a version of the EPA WARM model. This model has the following general formula:

$CO_2e = W_t * (1-R)A$

Where:
W_t is the quantify of waste type 't',
R is the methane recovery factor,
A is the CO_2e emissions of methane per metric ton of waste at the disposal site (the methane factor)

2. To calculate emission that occurred in 2005 from the West Contra Costa Sanitary Landfill, the Waste-In-Place method was used. Methane emissions were estimated using EPA's Landfill Gas Emission Model (LandGEM) version 3.02. This method is often used in national and state inventories of greenhouse gas emissions. This method calculates emissions based on the amount of waste in the landfill less the amount of gas recovered. While not particularly sensitive to "three R" (Reduce, Reuse, Recycle) waste programs, the waste-in-place method is appropriate for approximating the amount of landfill gas available for flaring, heat recovery, or power generation projects.

Methane emissions in LandGEM are computed using a first order kinetics model. For a particular amount of waste-in-place, at a landfill, the simplifying assumption is made that the waste was deposited in the landfill in equal installments for each of the years the landfill was open. It therefore follows that the methane generated in the current year (before recovery) can be estimated as:

$$k * L_o * R_n * WIP * \frac{\exp^{-kA} - \exp^{-kB}}{\exp^{-k} - 1}$$

where

k is the exponential time constant of decay. (0.05 was used for WCCS Landfill).

Lo is the methagenic potential of the waste, expressed in cubic meters of methane per kg of waste. It has a value of 0.17 cubic meters of methane per kg of waste (or 2.72 cubic feet per pound in Standard American units).

WIP is the total waste-in-place in the landfill as of the year you are analyzing, input in metric tons.

Rn is a factor that incorporates the density of methane and any unit conversions required to balance the equation dimensionally.

A is the difference between the current year (plus one) and year the landfill was opened.

B is the difference between the current year (plus one) and the most recent year and the last year waste was deposited in the landfill.

6.6. Appendix F

Forecast Tables

ABAG Population Growth Projections:

TOTAL POPULATION						
JURISDICTION	**2000**	**2005**	**2010**	**2015**	**2020**	**Annual Growth Rate**
ANTIOCH	90,532	102,300	107,400	111,600	116,000	
BRENTWOOD	23,302	44,300	51,700	55,600	59,000	
CLAYTON	10,762	10,900	11,200	11,700	12,000	
CONCORD	121,780	123,900	127,000	132,600	139,400	
DANVILLE	41,715	43,100	43,400	44,100	44,600	
EL CERRITO	23,171	23,200	23,300	24,000	24,600	
HERCULES	19,488	22,400	23,800	25,400	26,900	
LAFAYETTE	23,908	24,100	24,400	24,800	25,400	
MARTINEZ	35,866	36,500	36,900	38,500	40,100	
MORAGA	16,290	16,300	16,500	17,000	17,700	
OAKLEY	25,619	28,300	30,200	32,400	34,900	
ORINDA	17,599	17,700	17,800	18,200	18,600	
PINOLE	19,039	19,300	19,400	19,900	20,500	
PITTSBURG	56,769	61,300	64,600	66,800	70,600	
PLEASANT HILL	32,837	33,200	33,700	34,600	35,300	
RICHMOND	99,216	100,500	101,400	105,100	109,600	0.580%
SAN PABLO	30,215	30,900	31,000	31,800	32,500	
SAN RAMON	44,722	52,200	58,700	64,400	70,500	
WALNUT CREEK	64,296	65,200	66,900	69,400	72,000	
UNINCORP.	151,690	160,700	166,300	174,400	180,700	
CONTRA COSTA COUNTY	**948,816**	**1,016,300**	**1,055,600**	**1,102,300**	**1,150,900**	

ABAG Job Growth Projections:

TOTAL JOBS						
JURISDICTION	**2000**	**2005**	**2010**	**2015**	**2020**	**Annual Growth Rate**
ANTIOCH	19,700	19,830	22,930	25,950	29,170	
BRENTWOOD	6,670	6,750	7,930	9,730	11,780	
CLAYTON	1,390	1,410	1,450	1,700	1,870	
CONCORD	59,860	60,210	63,700	68,840	74,480	
DANVILLE	13,670	13,910	14,920	15,350	15,580	
EL CERRITO	5,580	5,630	5,980	6,610	7,090	
HERCULES	2,780	2,820	3,460	4,030	4,640	
LAFAYETTE	10,790	10,780	11,340	11,700	11,850	
MARTINEZ	18,150	18,230	19,860	21,600	23,450	
MORAGA	4,940	4,970	5,230	5,440	5,520	
OAKLEY	3,170	3,190	4,330	5,410	6,630	
ORINDA	6,230	6,210	6,500	6,680	6,700	
PINOLE	5,570	5,580	5,940	6,490	6,960	
PITTSBURG	15,000	15,070	17,530	20,910	24,710	
PLEASANT HILL	16,870	16,940	17,760	18,530	19,150	
RICHMOND	39,250	39,290	42,620	46,890	51,820	1.863%
SAN PABLO	6,010	6,040	6,510	7,020	7,530	
SAN RAMON	40,030	39,700	46,460	49,100	51,820	
WALNUT CREEK	54,900	55,280	57,820	59,690	61,690	
UNINCORP.	40,750	41,160	43,740	47,350	50,390	
CONTRA COSTA COUNTY	**371,310**	**373,000**	**406,010**	**439,020**	**472,830**	

6.7. Appendix G

Detailed Municipal GHG Emissions Inventory in 2005

Sector	Emissions Source	Equiv CO_2 (metric tons)	Equiv CO_2 (%)	Energy (MMBtu)	Cost	Data Source
Buildings						
	Electricity	1,853	17.5%	27,026	$1,137,997	PG&E
	Natural Gas	1,746	16.5%	32,648	$165,238	PG&E
Subtotal Buildings		**3,599**	**34.0%**	**59,674**	**1,303,235**	
Streetlights						
Outdoor Lighting						
	Electricity	1,223	11.5%	17,843	$1,115,990	PG&E
Traffic Signals						
	Electricity	89	0.8%	1,299	$61,679	PG&E
Subtotal Streetlights		**1,312**	**12.4%**	**19,142**	**1,177,669**	
Vehicle Fleet						
	Gasoline	1,097	10.4%	15,948	$516,000	CalTrans
	Diesel	289	2.7%	3,486	$50,075	CalTrans
Subtotal Vehicle Fleet		**1,386**	**13.1%**	**19,434**	**566,075**[34]	
Employee Commute						
	Gasoline	2,649	25.0%	35,418		City Survey
	Diesel	42	0.4%	537		City Survey
Subtotal Employee Commute		**2,691**	**25.4%**	**35,955**	**0**	
Water/Sewage						
Waste Water Treatment Plant						
	Electricity	994	9.4%	14,492	$489,392	PG&E
	Natural Gas	11	0.1%	211	$2,666	PG&E
Water Pumping						
	Electricity	62	0.6%	908	$38,472	PG&E
Subtotal Water/Sewage		**1,067**	**10.1%**	**15,611**	**530,530**	
Waste						
Total Waste Disposed						
	Paper Products	303	2.9%		N/A	City Survey / RSS / CIWMB
	Food Waste	119	1.1%		N/A	City Survey / RSS / CIWMB
	Plant Debris	32	0.3%		N/A	City Survey / RSS / CIWMB
	Wood/Textiles	89	0.8%		N/A	City Survey / RSS / CIWMB
Subtotal Waste		**543**	**5.1%**		**N/A**	
Grand Total		**10,598**	**100%**	**149,816**	**$3,577,509**	

[34] Vehicle Fleet fuel costs were calculated from 2005 data. Since Vehicle Fleet greenhouse gas emissions were estimated using 2008 as a proxy year, fuel use data and cost data do not directly correlate.

6.8. Appendix H

Municipal Building Sector Notes

Data Inputs:

See "Detailed Municipal GHG Emissions from Buildings Sector in 2005" Table below.

Data Sources:

1. PG&E: Jasmin Ansar, JxA2@pge.com, Xantha Bruso, XxB1@pge.com.
   File name: straphael2005.xls

   Data entered by Jenny Oorbeck, Environmental Manager, City of Richmond, Jenny_Oorbeck@ci.richmond.ca.us. Coefficient set updated February 25, 2008.

Notes:

1. The "PG&E California" electricity coefficient set is based on the 2005 PG&E CO_2e emission factor of 0.49 lbs/kWh of delivered electricity. This emissions factor is certified by the California Climate Action Registry and was reported to ICLEI in January 2007 by Greg San Martin. Criteria air pollutant emission factors for electricity are derived from the NERC Region 13 - Western Systems Coordinating Council/CNV Average Grid Electricity Set.

2. The "California Coefficients for Natural Gas" coefficient set is based on a PG&E CO_2e emissions factor of 53.05 kg/mmbtu of delivered natural gas, certified by the California Climate Action Registry and the CEC, and was reported to ICLEI in Dec. 2007 by Jasmin Ansar. Criteria air pollutant emissions factors for natural gas are derived from the USEPA's annual report of air pollution emission trends (USEPA, 2001c).

Detailed Municipal GHG Emissions from Buildings Sector in 2005

Building	Location	GHG Emissions (metric tons CO_2e)	GHG Emissions (% CO_2e)	Electricity (kWh)	Electricity Cost ($)	Natural Gas Use (therms)	Natural Gas Cost ($)	Total Cost ($)	Total Energy Equivalent (MMBtu)
Civic Center	*Civic Center Plaza*	580	16.1%	834,600	$111,775	71,898	$17,362	$129,137	10,038
Port Terminal 1	*1500 Dornan*	531	14.7%	2,271,200	$336,558	0	$0	$336,558	7,752
City Hall - Marina Way	*1401 Marina Way S, Bldg C*	510	14.2%	1,295,700	$195,008	38,786	$44,209	$239,217	8,301
Hall of Justice	*401 27th St*	343	9.5%	4,640	$689	63,851	$19,223	$19,912	6,401
Kennedy Swim Center	*4300 Cutting Blvd*	294	8.2%	292,360	$39,943	42,228	$12,563	$52,506	5,221
Senior Center	*2525 MacDonald*	144	4.0%	261,360	$35,326	15,431	$19,445	$54,771	2,435
Shipyard	*1312 Canal Blvd*	105	2.9%	448,200	$55,872	0	$0	$55,872	1,530
Richmond Housing Authority 2	*2400 Nevin*	89	2.5%	380,529	$50,809	0	$0	$50,809	1,299
Corporation Yard	*6 & 7 13th St*	73	2.0%	125,640	$16,044	8,149	$3,145	$19,189	1,244
Main Library	*325 Civic Center Plaza*	56	1.6%	94,138	$14,414	6,363	$2,466	$16,880	957
Parks Department	*3230 MacDonald Ave*	52	1.4%	60,600	$9,548	7,073	$2,588	$12,136	914
MLK Center	*360 Harbour Way S*	47	1.3%	93,960	$14,761	4,665	$1,857	$16,618	788
Museum	*400 Nevin Ave*	46	1.3%	22,560	$3,380	7,737	$2,561	$5,941	851
Moving & Storage Facility	*1320 Canal Blvd*	41	1.1%	177,040	$25,749	0	$0	$25,749	604
Richmond Housing Authority 1	*1300 Roosevelt Ave*	41	1.1%	176,664	$25,672	0	$0	$25,672	603
Fire Station 64	*4801 Bayview Ave*	38	1.1%	62,080	$7,241	4,331	$1,634	$8,875	645
Fire Station 62	*1065 7th St*	37	1.0%	45,959	$5,372	4,809	$1,756	$7,128	638
Nicholl Park	*Euclid*	34	0.9%	57,367	$8,205	4,007	$1,650	$9,855	597
Fire Station 63	*5201 Valley View Rd*	32	0.9%	40,600	$6,098	4,048	$1,556	$7,654	544
Fire Station 68	*2904 Hilltop Dr*	29	0.8%	69,280	$10,398	2,405	$1,014	$11,412	477
Office Building 3	*1387 Marina Way S #B*	27	0.7%	115,482	$17,459	0	$0	$17,459	394
Shields Reid Community Center	*1410 Kelsey St*	27	0.7%	56,480	$7,185	2,607	$1,081	$8,266	454
Communications Equipment	*Various locations*	26	0.7%	109,620	$22,090	0	$0	$22,090	374
Nevin Community Center	*598 Nevin Ave*	25	0.7%	79,680	$11,893	1,118	$1,456	$13,349	384
Office Building 5	*1401 Marina Way South*	25	0.7%	0		4,595	$5,733	$5,733	460
Office Building 2	*1387 Marina Way S*	23	0.6%	97,600	$14,724	0	$0	$14,724	333
Booker T. Anderson Community Ctr	*960 S 47th St*	22	0.6%	0	$0	4,054	$5,076	$5,076	405
Untitled 6	*564 Stege*	21	0.6%	3,999	$627	3,789	$4,580	$5,207	393
Auditorium	*24th @ Nevin and Barrett*	20	0.6%	0	$0	3,831	$1,290	$1,290	383

Building	Location	GHG Emissions (metric tons CO_2e)	GHG Emissions (% CO_2e)	Electricity (kWh)	Electricity Cost ($)	Natural Gas Use (therms)	Natural Gas Cost ($)	Total Cost ($)	Total Energy Equivalent (MMBtu)
Residential Building 6	*Bld 121 Cal 4416*	18	0.5%	54,218	$7,953	856	$1,142	$9,095	271
Fire Station 61	*140 W Richmond Ave*	17	0.5%	25,120	$2,987	2,052	$896	$3,883	291
Fire Station 67	*1131 Cutting*	17	0.5%	32,610	$4,111	1,761	$713	$4,824	287
Engineering Service Bldg 2	*2566 MacDonald Ave*	16	0.4%	22,068	$3,016	2,070	$820	$3,836	282
Office Building 1	*1101 MacDonald Ave*	14	0.4%	58,606	$8,741	0	$0	$8,741	200
Fire Station 66	*4100 Clinton Ave*	13	0.4%	12,086	$1,901	1,928	$788	$2,689	234
Parchester Community Center	*900 Williams Dr*	12	0.3%	13,985	$1,834	1,619	$690	$2,524	210
Port Terminal Warehouse	*1500 Dornan*	12	0.3%	49,280	$6,930	0	$0	$6,930	168
Community Center	*960 Triangle Ct*	11	0.3%	17,718	$2,455	1,217	$1,631	$4,086	182
Park - Trailhead Parking		10	0.3%	41,842	$4,206	0	$0	$4,206	143
Bayview Library	*5100 Hartnett*	9	0.2%	9,546	$1,165	1,388	$583	$1,748	172
Westside Branch Library	*135 Washington Ave*	9	0.2%	8,385	$998	1,277	$567	$1,565	157
Winters Building	*333 11th St*	9	0.2%	23,240	$3,244	825	$426	$3,670	162
Annex Senior Center	*5801 Huntington Ave*	7	0.2%	7,692	$1,031	933	$456	$1,487	119
DPRC	*1900 Barrett Ave*	7	0.2%	3,754	$597	1,147	$541	$1,138	128
Fire Training School	*3506 Cutting*	7	0.2%	18,599	$2,128	552	$338	$2,466	118
Potrero Park	*S 39th St and Cutting*	6	0.2%	27,608	$4,135	0	$0	$4,135	94
Residential Building 1	*1025 Ridgeview Dr*	6	0.2%	7,395	$1,179	764	$944	$2,123	101
Vincent Park	*End of Peninsula Dr*	6	0.2%	23,600	$3,532	0	$0	$3,532	81
May Valley Community Center	*3530 Morningside Dr*	5	0.1%	13,778	$1,936	441	$258	$2,194	91
Office Building 4	*1389 Marina Way S*	5	0.1%	20,525	$3,152	0	$0	$3,152	70
Port Terminal Office	*1500 Dornan*	5	0.1%	19,244	$2,999	0	$0	$2,999	66
Engineering Services Bldg 1	*2562 MacDonald Ave*	4	0.1%	320	$183	657	$329	$512	67
Untitled	*1301 Canal*	4	0.1%	19,120	$2,921	0	$0	$2,921	65
Park	*Western Dr & Dornan*	3	0.1%	12,281	$1,865	0	$0	$1,865	42
Untitled 2	*1320 Park Central*	3	0.1%	2,365	$274	328	$466	$740	41
Washington Field House	*110 E Richmond Ave*	3	0.1%	4,747	$722	296	$208	$930	46
ES Park	*S 47th & Cypress*	2	0.1%	7,680	$1,080	0	$0	$1,080	26
Hilltop Park	*Birmingham Drive & Groom*	2	0.1%	9,281	$1,451	0	$0	$1,451	32
Parking Garage Downtown	*333 12th St*	2	0.1%	9,840	$1,158	0	$0	$1,158	34

Building	Location	GHG Emissions (metric tons CO_2e)	GHG Emissions (% CO_2e)	Electricity (kWh)	Electricity Cost ($)	Natural Gas Use (therms)	Natural Gas Cost ($)	Total Cost ($)	Total Energy Equivalent (MMBtu)
Police Substation 1	*1000 MacDonald Ave*	2	0.1%	10,191	$1,496	9	$116	$1,612	36
Police Substation 2	*3051 Hilltop Mall Rd*	2	0.1%	7,577	$1,217	0	$0	$1,217	26
Tiller Park	*Sierra & Ventura*	2	0.1%	10,016	$1,561	0	$0	$1,561	34
Untitled 1	*1303 Canal*	2	0.1%	7,447	$1,247	0	$0	$1,247	25
Vacant Building	*1101 MacDonald Ave #A*	2	0.1%	7,166	$1,283	0	$0	$1,283	24
Community Building	*314 11th St*	1	0.0%	0	$0	182	$361	$361	18
Emergency Center	*326 27th St*	1	0.0%	0	$0	172	$168	$168	17
Office Building 6	*342 11th St*	1	0.0%	2,932	$499	16	$121	$620	12
Oil Storage	*Pt San Pablo*	1	0.0%	2,640	$446	0	$0	$446	9
Police Department	*100 W. Cutting*	1	0.0%	2,281	$390	0	$0	$390	8
Radio Station	*6700 Monte Cresta Ave*	1	0.0%	2,930	$525	0	$0	$525	10
Residential Building 3	*2115 Virginia*	1	0.0%	266	$30	123	$195	$225	13
Restroom Facility	*10th & Lucas*	1	0.0%	3,373	$542	0	$0	$542	12
Untitled 3	*1441 Monterey*	1	0.0%	2,209	$396	0	$0	$396	8
Untitled 4	*1671 Mendocino*	1	0.0%	2,540	$458	0	$0	$458	9
Bookmobile	*NE Cr Vlt VIiew-May Rd*	0	0.0%	0	$36	0	$0	$36	0
Boorman Park	*2701 Maine*	0	0.0%	73	$104	0	$0	$104	0
Hilltop GR	*1207 Parkway Ct*	0	0.0%	0	$89	0	$0	$89	0
MLK Park	*12th St & Virginia*	0	0.0%	603	$268	0	$0	$268	2
Playground	*Duke & Loyola*	0	0.0%	1,000	$239	0	$0	$239	3
Port Terminal 4 Office Building	*2101 Western Drive*	0	0.0%	1,370	$286	0	$0	$286	5
Residential Building 2	*211 Marina Way S*	0	0.0%	39	$10	17	$23	$33	2
Residential Building 4	*315 S. Marina Way*	0	0.0%	54	$6	1	$10	$16	0
Residential Building 5	*928 8th St*	0	0.0%	14	$3	5	$8	$11	1
Richmond Plunge	*1 East Richmond Ave*	0	0.0%	0	$0	0	$115	$115	0
Untitled 5	*4031 Lakeside*	0	0.0%	0	$87	0	$0	$87	0
Untitled 7	*801 Lincoln*	0	0.0%	74	$14	34	$54	$68	3
Untitled 8	*917 Lincoln*	0	0.0%	2	$4	3	$5	$9	0
Untitled 9	*946 8th*	0	0.0%	70	$8	22	$21	$29	2
Virginia Park	*S 5th St & Virginia*	0	0.0%	0	$29	0	$0	$29	0
TOTAL		**3,602**	**100.0%**	**7,918,738**	**1,137,997**	**326,470**	**$165,238**	**$1,303,235**	**59,674**

6.9. Appendix I

Municipal Streetlights Sector

Data Inputs:

Streetlights	Outdoor Lighting (kWh)	5,227,998
	Traffic Signals (kWh)	380,548

Data Sources:

1. PG&E: Jasmin Ansar, JxA2@pge.com, Xantha Bruso, XxB1@pge.com.
   File name: straphael2005.xls

   Data entered by Jenny Oorbeck, Environmental Manager, City of Richmond, Jenny_Oorbeck@ci.richmond.ca.us. Coefficient set updated February 25, 2008.

Notes:

1. The "PG&E California" electricity coefficient set is based on the 2005 PG&E CO_2e emission factor of 0.49 lbs/kWh of delivered electricity. This emissions factor is certified by the California Climate Action Registry and was reported to ICLEI in January 2007 by Greg San Martin. Criteria air pollutant emission factors for electricity are derived from the NERC Region 13 - Western Systems Coordinating Council/CNV Average Grid Electricity Set.

6.10. Appendix J

Municipal Vehicle Fleet Sector Notes

Data Inputs:

See "Detailed Municipal GHG Emissions from Vehicle Fleet Sector in 2005" Table below.

Data Sources:

1. Gasoline vehicle factors from EPA Climate Leaders, Mobile Combustion Guidance, (2007) based on U.S. EPA*, Inventory of U.S. Greenhouse Gas Emissions and Sinks*: 1990-2005 (2007). Diesel vehicle factors based on U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks*: 1990-2005 (2007), Annex 3.2, Table A-98.

2. City of Richmond: Dee Karnes, Equipment Services Superintendent

   Data entered by Jennifer Ly, Sustainability Intern, City of Richmond, Jennifer_Ly@ci.richmond.ca.us.

Methods:

1. CO_2e emissions from the 2005 vehicle fleet were calculated based on detailed fuel consumption information from each vehicle and piece of equipment from April 2008 to December 2008 as a proxy.
   - For each vehicle, an annual fuel consumption estimate was determined by doubling the gallon amount used in the period from April 2008 to December 2008.
   - Aggregate fuel consumption (gallons/year) figures by vehicle size class were calculated. Vehicle size class was determined based on vehicle make, model and year and the EPA's vehicle class categories. Agricultural and construction equipment were included in either the heavy truck or light truck/SUV/pickup categories depending on equipment weight.
2. The number of vehicles and fuel consumption in 2005 was assumed to match the 2008 number of vehicles and fuel consumption estimate.

Detailed Municipal GHG Emissions from Vehicle Fleet Sector in 2005

Department	Fuel and Vehicle Type	Number of Vehicles	Fuel Use (gallons)	CO_2e (metric tons)	% Total CO_2e	Energy (MMBtu)
Building and Regulations	**Gasoline**	9	1,593	15	1.1%	200
	Auto - Mid Size	1	31			
	Light Truck/SUV/Pickup	8	1,562			
Employment and Training	**Gasoline**	5	565	5	0.4%	71
	Auto - Mid Size	1	99			
	Auto - Subcompact/Compact	1	224			
	Light Truck/SUV/Pickup	3	243			
Engineering	**Gasoline**	7	1,443	12	0.9%	181
	Light Truck/SUV/Pickup	7	1,443			
	Diesel	1	55	1	0.1%	7
	Heavy Truck	1	55			
	TOTAL	8	1,498	13	0.9%	188
Equipment Services	**Gasoline**	7	1,159	10	0.7%	146
	Auto - Mid Size	1	412			
	Light Truck/SUV/Pickup	5	717			
	Heavy Truck	1	30			
Finance	**Gasoline**	9	1,095	9	0.6%	138
	Auto - Mid Size	7	880			
	Light Truck/SUV/Pickup	2	216			
Fire	**Gasoline**	24	6,514	56	4.0%	818
	Auto - Full Size	6	3,220			
	Auto - Mid Size	4	782			
	Heavy Truck	6	807			
	Light Truck/SUV/Pickup	7	1,686			
	Unconfirmed	1	20			
	Diesel	17	10,555	107	7.7%	1,288
	Heavy Truck	17	10,555			
	TOTAL	41	17,069	163	11.8%	2,106
Housing and Community Development	**Gasoline**	3	510	4	0.3%	64
	Auto - Mid Size	2	242			
	Auto - Subcompact/Compact	1	268			
Human Resources	**Gasoline**	1	172	1	0.1%	22
	Auto - Mid Size	1	172			
Information Technology	**Gasoline**	4	552	5	0.4%	69
	Auto - Mid Size	1	166			
	Light Truck/SUV/Pickup	3	386			
KCRT	**Gasoline**	1	186	2	0.1%	23
	Auto - Mid Size	1	186			

Department	Fuel and Vehicle Type	Number of Vehicles	Fuel Use (gallons)	CO_2e (metric tons)	% Total CO_2e	Energy (MMBtu)
Library	**Gasoline**	4	1,249	11	0.8%	157
	Auto - Subcompact/Compact	1	164			
	Light Truck/SUV/Pickup	1	130			
	Vanpool Van	2	955			
	Diesel	1	225	2	0.1%	27
	Heavy Truck	1	225			
	TOTAL	5	1,474	13	0.9%	184
Mayor	**Gasoline**	1	100	1	0.1%	13
	Auto - Subcompact/Compact	1	100			
Office of Neighborhood Safety	**Gasoline**	1	273	2	0.1%	34
	Auto - Mid Size	1	273			
Paratransit	**Gasoline**	9	5,370	46	3.3%	674
	Auto - Full Size	1	198			
	Heavy Truck	6	4,944			
	Light Truck/SUV/Pickup	1	109			
	Vanpool Van	1	119			
Planning	**Gasoline**	3	512	4	0.3%	64
	Auto - Mid Size	3	512			
Police	**Gasoline**	118	72,621	627	45.3%	9,121
	Auto - Full Size	96	67,940			
	Auto - Mid Size	2	145			
	Auto - Subcompact/Compact	2	278			
	Light Truck/SUV/Pickup	11	2,146			
	Vanpool Van	5	1,848			
	Unconfirmed	2	264			
	Diesel	3	118	1	0.1%	14
	Heavy Truck	3	118			
	TOTAL	121	72,739	628	45.3%	9,136
Port	**Gasoline**	3	423	4	0.3%	53
	Auto - Mid Size	1	79			
	Light Truck/SUV/Pickup	2	344			
Public Works	**Gasoline**	80	27,827	240	17.3%	3,495
	Auto - Mid Size	1	149			
	Auto - Subcompact/Compact	2	402			
	Heavy Truck	15	8,565			
	Light Truck/SUV/Pickup	48	13,950			
	Vanpool van	1	362			
	Unconfirmed	13	4,399			
	Diesel	41	13,517	136	9.8%	1,649
	Heavy Truck	23	7,779			
	Light Truck/SUV/Pickup	13	2,217			
	Unconfirmed	5	3,521			
	TOTAL	121	41,344	376	27.1%	5,144
Recreation	**Gasoline**	5	1,632	14	1.0%	205
	Auto - Mid Size	1	331			
	Light Truck/SUV/Pickup	4	1,301			

Department	Fuel and Vehicle Type	Number of Vehicles	Fuel Use (gallons)	CO_2e (metric tons)	% Total CO_2e	Energy (MMBtu)
Redevelop-ment	**Gasoline**	9	1,122	10	0.7%	141
	Auto - Mid Size	5	537			
	Auto - Subcompact/Compact	2	320			
	Light Truck/SUV/Pickup	2	265			
Veolia	**Gasoline**	4	2,054	18	1.3%	258
	Light Truck/SUV/Pickup	2	1,213			
	Unconfirmed	2	841			
	Diesel	7	4,102	42	3.0%	500
	Heavy Truck	7	4,102			
	TOTAL	11	6,155	59	4.3%	758
TOTAL GASOLINE		**307**	**126,972**	**1,096**	**79.1%**	**15,947**
TOTAL DIESEL		**70**	**28,571**	**289**	**20.9%**	**3,485**
GRAND TOTAL		**377**	**155,543**	**1,385**	**100.0%**	**19,432**

6.11. Appendix K

Municipal Employee Commute Sector Notes

Data Inputs:

See "Detailed Municipal GHG Emissions from Employee Commute in 2005" Table below.

Data Sources:

1. City of Richmond: Andy Russo, Personnel Analyst

2. Gasoline vehicle factors from EPA Climate Leaders, Mobile Combustion Guidance, (2007) based on U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks*: 1990-2005 (2007). Diesel vehicle factors based on U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks*: 1990-2005 (2007), Annex 3.2, Table A-98.

3. Required employee commute survey for all current employees. (See Employee Commute Survey below.)

Data entered by Jennifer Ly, Sustainability Intern, City of Richmond, Jennifer_Ly@ci.richmond.ca.us.

Methods:

1. Staff tallied the results of 674 Employee Commute Surveys. CO_2e emissions from employee commute in 2005 were calculated based on estimated annual fuel consumption information for current employees in 2008 as a proxy.
   - For each employee, a miles/year figure was calculated based on distance traveled and the number of days per week driven in a personal vehicle.
   - For each employee, a gallons/year figure was calculated based on the miles/year figure and the fuel economy of the vehicle.

     $$\text{Miles/Year} \div \text{Miles/Gallon} = \text{Gallons/Year}$$

   - Aggregate fuel consumption (gallons/year) figures by vehicle class were calculated. Vehicle size class was determined based on vehicle make, model and year and the EPA's vehicle class categories.
2. Fuel consumption estimates for employees who did not submit (278) or submitted incomplete employee commute surveys (175) were made based on the results of complete employee commute surveys (499) based on the employee categories: full-time, part-time, and youth. Average commute distance and percentage of employees that regularly drive personal vehicles to work vary among these categories.
   - The number of employees was adjusted for the estimated number of employees in the category that do not regularly drive personal vehicles in travel to and from work.
   - Unknown vehicle size class categories were assumed to be the same makeup as the vehicle size class of employees who completed the survey.
   - Unknown vehicle fuel economies were assumed to be the average fuel economy of the vehicles of employees who completed the survey.
3. The fuel consumption estimate was adjusted from the 952 employees in 2008 to the 941 employees in 2005.

Employee Commute Survey

Please answer the following questions. Your answers will help us complete a greenhouse gas emissions inventory for the City of Richmond. By evaluating current emission levels, the City of Richmond can develop effective strategies to reduce emissions, save energy and money, and improve the quality of life in our community.

Name ____
Department____

What is the average roundtrip commute distance from home to work each day? ______ miles

What are your current work hours?
☐ 8:30 am -5 pm ☐ other ________________

How many days of the week do you ride **BART** to work?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ I don't ride BART to work.

How many days of the week do you ride the **bus** to work?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ I don't ride the bus to work.

How many days of the week do you **bike** to work?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ I don't bike to work.

How many days of the week do you **walk** to work?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ I don't walk to work.

How many days of the week do you **drive** a vehicle to work?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ I don't drive to work.

If you drive a vehicle to work, please answer the following questions.

What is the Vehicle Make (i.e. Chevrolet, Honda, Ford)? ______________________
Model (i.e. Civic, F550)? __________________
Year? __________________

Based on your regular driving habits, what is your vehicle's average fuel economy? _______ miles/gallon

What is the vehicle fuel type?
☐Gasoline
☐Diesel
☐Biodiesel

How many co-workers do you carpool with?
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ more

Thank you!

City of Richmond Employee Commute Distances 2008

City of Residence	Number Employees	Approximate Distance (miles)[35]
Full-time Employees		
Richmond	189	4
Fairfield	67	34
Hercules	47	11
Vallejo	42	20
San Pablo	41	2
Vacaville	38	20
Oakland	33	16
Pinole	33	9
Suisin City	22	29
Benicia	19	22
El Sobrante	19	8
Antioch	16	38
El Cerrito	14	3
Berkeley	13	8
Rodeo	12	11
Martinez	10	21
Brentwood	9	46
Sacramento	10	73
San Francisco	8	17
San Ramon	8	35
Walnut Creek	8	24
Concord	7	27
Dublin	7	36
Napa	7	34
Oakley	7	43
Pittsburg	7	33
San Leandro	7	22
Alameda	6	14
Pleasant Hill	5	23
American Canyon	4	23
Hayward	4	28
Lafayette	4	21
Santa Rosa	4	49
Newark	3	36
Petaluma	3	33
Bay Point	2	29
Castro Valley	2	27
Clayton	2	33
El Dorado Hills	2	100
Fremont	2	38
Orinda	2	17
San Jose	2	56
Sonoma	2	38
Winters	2	54

[35] Commute distances estimated using average distances between cities generated by Google Maps.

City of Residence	Number Employees	Approximate Distance (miles)[36]
Full-time Employees (continued)		
Albany	1	4
Belmont	1	39
Burlingame	1	31
Cazadero	1	73
Cordelia	1	27
Denair	1	106
Dixon	1	52
Emeryville	1	8
Forestville	1	57
Galt	1	96
Livermore	1	44
Marin City	1	16
Moraga	1	21
Mountain House	1	60
Pacheco	1	22
Pleasanton	1	40
Rocklin	1	95
Rohnert Park	1	43
San Lorenzo	1	25
San Rafael	1	13
Stockton	1	82
Tiburon	1	17
Union City	1	33
Vail, AZ	1	n/a[37]
West Hills	1	n/a[38]
Woodland	1	68
TOTAL	**777**	-
Part-Time Employees		
Richmond	98	4
San Pablo	15	2
Oakland	14	16
El Sobrante	12	8
Berkeley	8	8
Hercules	4	11
Pinole	4	9
Albany	3	4
Vallejo	3	20
Antioch	2	38
El Cerrito	2	3
Martinez	2	21
Rodeo	2	11
San Leandro	2	22
Fairfield	1	34

[36] Commute distances estimated using average distances between cities generated by Google Maps.
[37] Assumed that employee works remotely because it is unlikely that employee commutes this distance daily.
[38] Assumed that employee works remotely because it is unlikely that employee commutes this distance daily.

City of Residence	Number Employees	Approximate Distance (miles)[39]
Part-Time Employees (continued)		
Fremont	1	38
San Francisco	1	17
Suisin City	1	29
TOTAL	**175**	-

[39] Commute distances estimated using average distances between cities generated by Google Maps.

Detailed Municipal GHG Emissions from Employee Commute in 2005

Employee Type	Fuel Type	Fuel Use of Surveyed Employees (gallons)	Fuel Use of Employees Not Surveyed (gallons)	2008 Estimated Total Fuel Use (gallons)	2005 Estimated Total Fuel Use (gallons)
Full-Time	**Gasoline**				
	Vehicle Type				
	Auto - Full Size	25,571.7	5,634.3	31,206.1	30,844.1
	Auto - Mid size	69,558.6	18,480.6	88,039.2	87,018.0
	Auto - Sub-compact/Compact	31,761.3	9,353.0	41,114.3	40,637.4
	Light Truck/SUV/Pickup	84,394.5	22,311.9	106,706.5	105,468.7
	Motorcycle	2,272.9	563.4	2,836.3	2,803.4
	Diesel				
	Vehicle Type				
	Auto - Full Size	130.2	78.5	208.7	206.3
	Auto - Mid size	427.2	257.4	684.6	676.7
	Auto - Sub-compact/Compact	216.2	130.3	346.5	342.5
	Light Truck/SUV/Pickup	2,710.9	310.8	3,021.7	2,986.6
	Motorcycle	13.0	7.8	20.9	20.6
Part-Time	**Gasoline**				
	Vehicle Type				
	Auto - Full Size	158.9	1,011.2	1,170.1	1,156.5
	Auto - Mid size	1,137.1	3,316.8	4,453.9	4,402.2
	Auto - Sub-compact/Compact	541.2	1,678.6	2,219.8	2,194.1
	Light Truck/SUV/Pickup	1,051.5	4,004.4	5,055.9	4,997.3
	Motorcycle	14.9	101.1	116.0	114.7
	Diesel				
	Vehicle Type				
	Auto - Full Size	0.0	14.1	14.1	13.9
	Auto - Mid size	0.0	46.2	46.2	45.7
	Auto - Sub-compact/Compact	0.0	23.4	23.4	23.1
	Light Truck/SUV/Pickup	0.0	55.8	55.8	55.1
	Motorcycle	0.0	1.4	1.4	1.4
Youth	**Gasoline**				
	Vehicle Type				
	Auto - Full Size	14.7	193.5	208.2	205.8
	Auto - Mid size	48.2	634.6	682.8	674.9
	Auto - Sub-compact/Compact	70.1	321.2	391.3	386.7
	Light Truck/SUV/Pickup	303.6	766.2	1,069.7	1,057.3
	Motorcycle	1.5	19.3	20.8	20.6
	Diesel				
	Vehicle Type				
	Auto - Full Size	0.0	2.7	2.7	2.7
	Auto - Mid size	0.0	8.8	8.8	8.7
	Auto - Sub-compact/Compact	0.0	4.5	4.5	4.4
	Light Truck/SUV/Pickup	0.0	10.7	10.7	10.5
	Motorcycle	0.0	0.3	0.3	0.3

6.12. Appendix L

Municipal Water / Sewage Sector Notes

Data Inputs:

Waste Water Treatment Plant	Electricity Consumption	kWh	4,246,195
	Natural Gas Consumption	Therms	2,107
Water Usage	Electricity Consumption	kWh	266,037
	Natural Gas Consumption	Therms	n/a

Data Sources:

1. PG&E: Jasmin Ansar, JxA2@pge.com, Xantha Bruso, XxB1@pge.com.
   File name: straphael2005.xls

   Data entered by Jenny Oorbeck, Environmental Manager, City of Richmond,
   Jenny_Oorbeck@ci.richmond.ca.us.

Notes:

1. The "PG&E California" electricity coefficient set is based on the 2005 PG&E CO_2e emission factor of 0.49 lbs/kWh of delivered electricity. This emissions factor is certified by the California Climate Action Registry and was reported to ICLEI in January 2007 by Greg San Martin. Criteria air pollutant emission factors for electricity are derived from the NERC Region 13 - Western Systems Coordinating Council/CNV Average Grid Electricity Set.

2. The "California Coefficients for Natural Gas" coefficient set is based on a PG&E CO_2e emissions factor of 53.05 kg/mmbtu of delivered natural gas, certified by the California Climate Action Registry and the CEC, and was reported to ICLEI in Dec. 2007 by Jasmin Ansar. Criteria air pollutant emissions factors for natural gas are derived from the USEPA's annual report of air pollution emission trends (USEPA, 2001c).

6.13. Appendix M

Municipal Waste Sector Notes

Data Inputs:

Waste	Total Landfill Waste (See Waste Table)	Short Tons	2,970

Data Sources:

1. Municipal solid waste services data, 2008: Republic Services: Wayne Bonfante, Customer Service Manager, KrulevitchD@repsrv.com, (510) 262-1663.

2. Waste Characterization: CIWMB 2004 Statewide Waste Characterization Study. This state average waste characterization accounts for residential, commercial and self haul waste.
http://www.ciwmb.ca.gov/Publications/default.asp?pubid=1097
Data source file: CA Waste Characterization per CACP.xls

3. Municipal waste audits performed by Jennifer Ly, Sustainability Intern.

Methods:

1. CO_2e emission from 2005 waste disposal was calculated using the methane commitment method in the CACP software, which uses a version of the EPA WARM model. This model has the following general formula:

$CO_2e = W_t * (1\text{-}R)A$

Where:
W_t is the quantify of waste type ‘t’,
R is the methane recovery factor,
A is the CO_2e emissions of methane per metric ton of waste at the disposal site (the methane factor)