CITY OF SAN JOSÉ

LOCAL GOVERNMENT OPERATIONS CLIMATE ACTION PLAN

APPENDIX B – GHG Inventory Methodology

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This appendix describes the emissions sectors, data sources, and methodology used to prepare the CAP's 2010 baseline emissions inventories and the 2020, 2035, and 2050 emissions forecasts.

It should be noted that the 2010 inventories were prepared separately from the remainder of the CAP (i.e., emissions forecasts, CAP document, supporting appendices), and were not prepared by the same project team that developed the CAP. Per the Santa Clara County regional CAP project scope under which this CAP was prepared, the 2010 inventories were used as the baseline from which the 2020, 2035, and 2050 emissions forecasts were calculated. The 2010 baseline inventories were previously prepared under a separate project contract, and provided to the CAP project team for incorporation and use in preparing the emissions forecasts. However, during the course of preparing the emissions forecasts, several methodological errors were identified in the original 2010 baseline inventory work, and the CAP project team made revisions to the original work to prepare baseline inventories that reflected the best available data and methodologies at their time of completion.

This appendix describes, to the extent feasible, the methodologies used by the original baseline inventory project team based on the supporting data and inventory worksheets that were provided to the CAP project team. In the future, inventory updates should follow the methodologies presented below to provide consistency between inventory versions and allow direct comparisons from one year to another. However, it is likely that inventory methodologies will continue to evolve, and the City may find it more beneficial to follow prevailing industry standards, even if those changes make direct comparisons to prior year inventories more difficult.

Emissions Inventory Overview

The California Air Resources Board, ICLEI – Local Governments for Sustainability (ICLEI), and The Climate Registry (TCR) have co-developed standardized methods for quantifying and reporting GHG emissions from local government sources. These methods are contained within the Local Government Operations Protocol (LGOP).

As mentioned above, the San José municipal operations 2010 baseline inventory was developed by a different team than that which prepared the CAP document and emissions forecasts. However, review of that work (i.e., municipal operations 2010 baseline inventory) indicated that the baseline inventory was developed to be consistent with guidance found in the LGOP. Areas of inconsistency were revised as part of the CAP development process and are described later in the section Baseline Emissions Inventory Revisions.

San José's Organizational Boundary

San José's inventories were prepared using an operational control organization boundary. This includes the GHG emissions resulting from actions governed directly by the local government, such as municipal buildings and facilities, vehicle fleet, and City-owned streetlights. It should be

noted that emissions from City employee commute trips were excluded from the inventory due to the lack of ownership or control over employees' vehicles and employees' commuting choices. This exclusion is compatible with the guidance provided within the LGOP, in which this emissions source can be voluntarily reported but is not required.

EMISSIONS INVENTORY UNITS AND CLASSIFICATION

Emissions inventories are commonly expressed in metric tons (or tonnes) of carbon dioxide equivalent per year (MT CO_2e/yr) to provide a standard measurement that incorporates the varying global warming potentials (GWP) of different greenhouse gases. GWP describes the potential for a greenhouse gas to trap heat in the atmosphere relative to carbon dioxide, which has a GWP of 1. For example, methane has a GWP of 25, which means that 1 metric ton of methane can trap 25 times more heat than 1 metric ton of carbon dioxide, making it a more potent greenhouse gas. Some gases used in industrial applications can have a GWP thousands of times larger than that of CO_2. In order to maintain consistency within each inventory and between the baseline and projected emissions inventories, all GHG emissions have been quantified in units of MT CO_2e/yr.

Emissions can also be described as direct or indirect, depending upon where the emissions generation and consumption activity occurs. Direct emissions are those where the consumption activity directly generates the emissions, such as natural gas combustion for heating or cooling. In this instance, natural gas can be consumed on-site and the resulting emissions are a direct result of that consumption. Indirect emissions are those where the consumption activity takes place within the jurisdiction, but the actual emissions generation occurs outside of that boundary. For example, a City facility can consume electricity as part of its operations, but that electricity may be generated in an area outside of the City's jurisdiction (e.g., power plants throughout the state).

Scope of Emissions Sources in San José

The LGOP further divides emissions into three different Scopes, defined as follows:

- **Scope 1** emissions are those that come from sources that are owned or controlled by the reporting entity, in this case, the City of San José. From the municipal perspective, Scope 1 emissions are direct GHG emissions from sources controlled by the City within San José's boundaries. Such sources include stationary emitters like furnaces and boilers, natural gas combustion for space and water heating, and mobile emitters like vehicles and construction equipment. In addition, the process-related GHG emissions generated from wastewater treatment would also be considered Scope 1 emissions.
- **Scope 2** emissions are indirect GHG emissions related to the consumption of purchased energy (i.e., electricity) that is produced by third-party entities, such as power utilities. From the municipal perspective, the emissions associated with all electricity purchased by the City are considered Scope 2.

- **Scope 3** emissions are other indirect GHG emissions not covered by Scope 2 that are associated with municipal activities. In a municipal inventory this generally includes emissions occurring upstream or downstream of a municipal activity, such as the methane emissions resulting from degradation of the City's solid waste deposited at a landfill outside of city limits (and outside of the City's operational control), or the electricity used to pump water to the City from upstream reservoirs. Quantification and reporting of Scope 3 emissions is generally considered optional, but including them in a municipal inventory is appropriate where there is local control over an activity that has an indirect emissions reduction impact, such as diverting waste from landfills.

The City's 2010 municipal operations inventory includes emissions from the following sectors, as well as their correlation to the aforementioned Scopes:

- **Energy:** This sector comprises direct emissions (Scope 1) from natural gas combustion at City buildings and facilities as well from stationary sources (e.g., emergency generators, boilers), and indirect emissions (Scope 2) from purchased electricity for City buildings and facilities (including the Norman Y. Mineta San José International Airport and Regional Wastewater Facility) and City streetlights and traffic signals;
- **Vehicle Fleet:** This sector includes direct emissions (Scope 1) from fuel combustion in municipal fleet vehicles and off-road equipment identified in the City's vehicle fleet inventory;
- **Water Services:** This sector includes indirect emissions (Scope 2) from electricity used to convey and fluoridate water consumed by municipal operations;
- **Wastewater Services:** This sector includes process emissions that occur as a result of operations at the Regional Wastewater Facility (RWF). Influent received at the RWF contains organic material that would generate methane emissions during wastewater treatment processes (Scope 1). Effluent discharged from the RWF contains nitrogen that could generate nitrous oxide emissions offsite (Scope 3). While the RWF also uses electricity (Scope 2) to power plant operations and natural gas (Scope 1) for water heating, emissions associated with these activities are included in the Energy sector.
- **Solid Waste:** This sector consists of the indirect emissions (Scope 3) resulting from the decomposition of solid waste within a landfill that is generated by City-operated facilities, such as City Hall, community parks, and the airport.

Baseline Emissions Inventory Revisions

The CAP project team reviewed the original San José municipal inventory that was previously prepared by the baseline inventory project team. During this review, methodological revisions were made to the original inventory to provide a more accurate and useful inventory for the purposes of local government climate action planning. Adjustments within the City of San José's baseline inventory were focused on methodological revisions to the Wastewater Services sector.

In general, revisions were made to allocate emissions previously assigned to the RWF to their respective sectors pursuant to the LGOP guidance and to confirm the accuracy of previously allocated emissions. The main changes included removing chemical handling, chemical production (i.e., lifecycle emissions), and solids handling from the wastewater category because these types of emissions would be included in the regional transportation (i.e., chemical and solids haul truck trips) and stationary source data (i.e., chemical production). Therefore, if these emissions were left in the wastewater sector, it would result in double counting emissions. In addition, the landfilling and composting of wastewater treatment post-process materials were also removed because those emissions would be included in the solid waste sector. The RWF also combusts biogas generated at the treatment plant, which would be considered biogenic emissions and thus were removed from the wastewater sector. Lastly, the CAP project team compared the original electricity consumption attributed to the RWF with empirical PG&E data, which resulted in an updated electricity consumption attributed to the wastewater sector.

Baseline Inventory Methodology by Sector

To the extent feasible, this section describes the methodological approach used by the baseline inventory project team to calculate the City's 2010 emissions inventory. The following descriptions are based on a review of the data files and sources provided to the CAP project team, and an understanding of the prevailing emissions accounting guidance provided by various organizations and agencies.

ENERGY

Energy emissions are generated through the combustion of fossil fuels to generate electricity or directly provide power (e.g., natural gas combustion for water heating). The Energy sector includes the use of electricity and natural gas in municipal buildings and facilities within the City's operational boundary.

The Energy sector comprises five subsectors, including Buildings, Airport, Regional Wastewater Facility, Public Lighting, and Stationary Sources. Energy sector emissions were calculated using metered electricity and natural gas activity data from the buildings and facilities operated by the City along with the associated 2010 energy emissions factors (e.g., MT CO_2e/kWh). The activity data and emission factors were provided by PG&E, with the exception of stationary source activity data, which was provided by the City.

In general, the Buildings subsector represents the energy-related emissions generated from operation of the City's buildings and facilities as identified through utility account data. However, due to their unique character and importance within the community, special consideration was given to list Airport and RWF energy emissions as individual subsectors. This also aligns with the City's desire to develop CAP reduction measures specifically related to these facilities. Some municipally-owned facilities were excluded from the baseline inventory because the City

does not have operational control over their energy-consuming activities, such as the Convention Center, HP Pavilion, and the City's cultural centers.

Similar to the Buildings subsector, the Public Lighting subsector includes all utility accounts associated with public lighting fixtures, such as street lights and traffic signals. In most cases, parking lot lights or City park area and pathway lights are associated with a nearby building or facility, and therefore represented within the Buildings subsector.

Because the inventory was prepared using an operational control approach, emissions associated with energy consumption at the airport should only include utility accounts that represent consumption from equipment or fixtures that the City controls, such as parking lot and interior lighting, baggage handling systems, and office equipment. A portion of interior square footage is leased to third-party operators (e.g., food court vendors) who have operational control over their leased spaces and therefore, control over certain emissions sources (e.g., lighting, kitchen equipment). Energy-related emissions from these leased spaces over which the City lacks operational control should not be included within the municipal operations inventory. However, it is unclear from reviewing the baseline inventory data whether or not these non-jurisdictional emissions sources were removed from the City's inventory since they are likely incorporated within and not distinguished from the City's airport utility accounts (unlike the Convention Center, for example, which has its own utility accounts that can easily be removed or omitted from data analysis). Future inventory updates should consider options to clearly identify this non-jurisdictional energy consumption so that it can be removed from the City's inventory calculations. Alternatively, this energy use could be considered a Scope 3 emissions source, which could be voluntarily reported within the City's inventory since it occurs as an indirect result of the City's airport operations.

The Stationary Sources subsector represents emissions associated with the combustion of diesel fuel in stationary (i.e., non-vehicular) equipment. The City provided data on the amount of fuel consumed by such equipment during the baseline year, which was then multiplied by applicable emissions factors from the LGOP Appendix G.

Electricity-related GHG emissions were quantified using the PG&E-specific emissions factor that accounts for PG&E's 2010 electricity production portfolio (e.g., the mix of coal, oil, wind, solar and other sources of electricity production). Natural gas GHG emissions were also quantified using a PG&E-specific natural gas emissions factor. The energy use activity data described above was multiplied by the appropriate emissions factors to calculate total MT CO_2e/yr. The following energy emissions factors were used to calculate the 2010 baseline emissions:

Table B-1
Baseline Energy Emissions Factors

Energy Type	Metric Tons CO_2e/kWh	Metric Tons CO_2e/therm
Electricity	0.000204	-
Natural Gas	-	0.005438

VEHICLE FLEET

This sector includes emissions from on-road and off-road fuel consumption from vehicles operated by the City and identified in the municipal vehicle fleet. Fleet data and fuel usage data were provided by City staff. Relevant emission factors provided in the LGOP were applied to gasoline, diesel, methanol, LPG, and biodiesel fuel quantities to obtain emissions estimates.

WATER SERVICES

This sector comprises electricity consumed by the City's water conveyance and distribution system as identified in utility account data. The energy data describing total electricity use (in kWh) associated with local conveyance and distribution activities were provided by PG&E, as well as the utility's 2010 electricity emissions factors.

WASTEWATER SERVICES

The Wastewater Services sector includes emissions resulting from wastewater treatment processes. Treatment of wastewater influent could generate methane (CH_4) emissions, while discharged effluent could generate nitrous oxide (N_2O) emissions. The influent CH_4 emissions are considered direct process emissions because they would occur on-site during wastewater treatment, while effluent N_2O emissions would occur off-site following discharge of treated wastewater and would be considered indirect process emissions. Natural gas combustion for water heating at the RWF would also be considered direct emissions. Electricity consumption to power the wastewater treatment plant would generate indirect GHG emissions. As described above, electricity and natural gas consumption at the water pollution control plant are included within the Energy sector.

SOLID WASTE

The solid waste sector includes emissions associated with solid waste disposal. During the solid waste decomposition process, organic materials release GHGs. Carbon dioxide emissions are generated under aerobic conditions (i.e., in the presence of oxygen), while CH_4 emissions are generated under anaerobic conditions (i.e., in the absence of oxygen), as in many landfill environments. Solid waste-related CO_2 emissions are considered biogenic emissions that are part of the natural carbon cycle. However, CH_4 emissions have a higher GWP and are generated as a result of controllable landfill waste management techniques, and are therefore included within an emissions inventory.

The Solid Waste sector includes landfill methane emissions produced from the decomposition of solid waste generated at City buildings and facilities. Annual municipal solid waste and recycling volume data was provided by City staff. The baseline inventory project team used the EPA's LandGEM software to calculate methane emissions from tons of disposed (i.e., landfilled) solid waste.

Municipal Operations Emissions Forecast Assumptions and Methodology

Forecast Methodology

While standardized methods for quantifying *baseline* local government operations emissions are provided within the LGOP, the LGOP does not provide guidance on developing *future-year* emissions forecasts. For this reason, the CAP project team utilized a growth estimation methodology based on methods frequently used within city fiscal impact analyses. Rather than assuming that each emissions sector will increase at a one-to-one ratio with new population and employment growth, the analysis assumes that a portion of each sector's activity is independent and not influenced by growth. To reflect this assumption, the analysis estimates the degree of independence or dependence (expressed as a variable percentage) for each sector. The higher the percentage the more closely correlated the growth in emissions is to the growth in population and employment (referred to as service population). The factors used to develop the CAP's emissions forecasts are presented below in Table B-2.

Table B-2
Emissions Sector Activity Growth Variable Factors

Sector/Subsector Variable	Variable Factor
Energy	
Buildings	40%
Airport	20%
Regional Wastewater Facility	100%
Public Lighting	60%
Stationary Sources	50%
Vehicle Fleet	70%
Water Services	100%
Wastewater Services	
Process Emissions	100%
Solid Waste	60%

It should be noted that these growth factors represent a best estimate for how municipal operations emissions growth may occur in the future. However, due to the complexity in predicting the interrelationship of service population growth and the resulting demand for various municipal services, it is important that the City continue to monitor actual emissions trends through regular inventory updates as described in Chapter 4 of the CAP.

In the most conservative scenario, emissions would be forecast to grow in lock-step with service population (i.e., 100% variable factors for all sectors). However, it is likely that existing City staff, buildings, and equipment could handle some portion of increased demand for services without

the need hire additional staff, construct new City buildings (or expand existing ones), or purchase new fleet vehicles. Therefore, it was assumed that some activities are highly correlated to service population growth, such as process emissions from the water pollution control plant, in which additional residents and employees will directly generate additional wastewater to be treated. Other activities were assumed to be less directly correlated, such as solid waste generation which is dependent upon the number of municipal employees generating waste in City buildings and facilities, as well as growth in community-generated waste collected from City facilities, such as parks and the airport.

Additionally, the analysis applied service population factors to population and employment to identify the amount of emissions likely generated by an additional resident versus an additional employee. A residential factor of 100% and an employment factor of 50% were utilized. The lower employment factor serves to reduce the overall service population growth factor, and reflects the reality that the average resident demands considerably more services than the average non-resident employee. Table B-3 demonstrates how these factors dampen the service population growth rate to create the weighted service population values that form the basis for the forecast's growth rate estimates.

The application of the sector variable factors and the residential and employment factors provide a more nuanced method for estimating municipal operations growth. Using this method, emissions forecasts were developed for 2020, 2035, and 2050.

Table B-3
Residential and Employment Factors Influence on Service Population Growth Rates

	2010		2020		2035		2050	
	Value	Service Factor	Value	Service Factor	Value	Service Factor	Value	Service Factor
Population	981,000	1.0	1,137,700	1.0	1,313,811	1.0	1,572,466	1.0
Employment	369,500	0.5	493,060	0.5	839,450	0.5	1,004,716	0.5
Service Population	1,350,500		1,630,760		2,153,261		2,577,182	
Weighted Service Population	1,165,750		1,384,230		1,733,536		2,074,824	
Weighted Service Population Annual Growth Rate	-	-	2010-2020	1.87%	2020-2035	1.68%	2035-2050	1.31%

The municipal operations emissions were forecasted using the following formula:

$$Emissions_{PHY} = Emissions_{BASE} + (Emissions_{BASE} \times SP_{WEIGHTED} \times VF \times Years)$$

Where:

$Emissions_{PHY}$ = GHG emissions during the planning horizon year

$Emissions_{BASE}$ = GHG emissions during the baseline year

$SP_{WEIGHTED}$ = weighted service population annual growth rate from Table B-3

VF = variable factor from Table B-2

Years = years of growth between the baseline and planning horizon year

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