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DRAFT GREENHOUSE GAS EMISSIONS INVENTORY REPORT

Monterey County

Community Climate Action and Adaptation Plan

Prepared for:

Draft Greenhouse Gas Emissions Inventory Report for the Monterey County Community Climate Action and Adaptation Plan

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LIST OF ABBREVIATIONS

2030 MCAP	2030 Municipal Climate Action Plan
3CE	Central Coast Community Energy
ACO	Agricultural Commissioner's Office
ADC	alternative daily cover
AMBAG	Association of Monterey Bay Area Governments
CalRecycle	California Department of Resources Recycling and Recovery
CAP	climate action plan
Cap-and-Trade	California Greenhouse Gas Cap-and-Trade Program
CARB	California Air Resources Board
CCAAP	Community Climate Action and Adaptation Plan
CDFA	California Department of Food and Agriculture
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CH_4	methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
Community Protocol	*U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions*
County	County of Monterey
county	unincorporated Monterey County
CPUC	California Public Utilities Commissions
eGRID	Emissions & Generation Resource Integrated Database
EMFAC2021	EMissions FACtor model
EPA	U.S. Environmental Protection Agency
GHG	greenhouse gas
GWP	global warming potential
HPMS	Highway Performance Monitoring System
HVAC	heating, ventilation, air conditioning, and cooling
ICLEI	ICLEI - Local Governments for Sustainability
IPCC	Intergovernmental Panel on Climate Change
kBTU	kilo British thermal unit
kWh/AF	kilowatt-hours per acre-foot
lb/kBTU	pounds per kilo British thermal unit
lb/MWh	pounds per megawatt-hour
lb/therm	pounds per therm

LFG	landfill gas
LPG	liquid propane gas
M1W	Monterey One Water
MBARD	Monterey Bay Air Resources District
MCWRA	Monterey County Water Resources Agency
Methane Regulation	Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities
MPO	Metropolitan Planning Organization
MSW	municipal solid waste
$MTCO_2e$	metric tons of carbon dioxide equivalent
MWh	megawatt-hour
N_2O	nitrous oxide
NWCG	National Wildfire Coordinating Group
OPR	Governor's Office of Planning and Research
PG&E	Pacific Gas and Electric Company
RTAC	Regional Targets Advisory Committee
RTDM	Regional Transportation Demand Model
SB	Senate Bill
TCR	The Climate Registry
USDA	U.S. Department of Agriculture
VMT	vehicle miles traveled
WWTP	wastewater treatment plant

1 INTRODUCTION

1.1 PROJECT OVERVIEW

The County of Monterey (County) is developing its Community Climate Action and Adaptation Plan (CCAAP) to reduce greenhouse gas (GHG) emissions within the unincorporated county (county). The County is also updating its Municipal Climate Action Plan for 2030 (2030 MCAP) to reduce GHG emissions associated with local government operations. These efforts are driven by Mitigation Measure CC-1a included in the County's 2010 General Plan Final Environmental Impact Report, which requires the County to develop a GHG Reduction Plan (or climate action plan [CAP]). Measure CC-1a also requires the establishment of an updated baseline GHG emissions inventory for community and municipal operations emissions, a business-as-usual forecast of GHG emissions, and a 2030 reduction goal, along with the identification and quantification of GHG reduction measures and an implementation plan. The CCAAP and 2030 MCAP are intended to align with the requirements of the County's 2010 General Plan, as well as State mandates, and will serve to reduce GHG emissions for target years 2030 and 2045. The long-term target year of 2045 was chosen to align with the statewide carbon neutrality goal expressed in Executive Order B-55-18.

1.2 INVENTORY PURPOSE AND DESCRIPTION

The first step in the climate action planning process is to develop a GHG emissions inventory, which is a snapshot of the GHG emissions associated with a jurisdiction in a given year. The purpose of an inventory is to:

- establish a baseline against which future emissions levels and future reduction targets can be measured,
- understand the sectors and sources generating GHG emissions and their relative contribution to total emissions, and
- monitor progress towards achievement of GHG reduction targets.

Preparing a GHG emissions inventory is a critical step in climate action planning. To develop and implement a CAP that will effectively reduce GHG emissions, local governments must first have a comprehensive understanding of the emissions that are generated by activities within their jurisdictions. GHG emissions inventories not only serve to provide this knowledge, but they also act as the basis for measuring progress and provide agencies with a framework to track emissions over time and assess the effectiveness of CAP implementation. Additionally, local governments often prepare inventories to exhibit accountability and leadership, motivate community action, and demonstrate compliance with regulations.

A GHG emissions inventory estimates emissions generated within a defined geographic boundary during a single year. It identifies the sectors, sources, and activities that are producing these emissions and the relative contribution of each, while also providing a baseline used to forecast emissions trends into the future. This information is used to set reduction targets that are consistent with State objectives and then to create solutions for reducing GHG emissions locally through the creation of a CAP.

1.3 COUNTY INVENTORY BACKGROUND

The County's Metropolitan Planning Organization (MPO), the Association of Monterey Bay Area Governments (AMBAG), regularly provides GHG emissions inventories to the jurisdictions within its service territory. Most recently, AMBAG completed an emissions inventory for the unincorporated county for 2019, the year for which the most recent data were available. While AMBAG's inventory generally follows industry standards and best practices for GHG inventorying, an evaluation of AMBAG's 2019 inventory revealed methodologies and assumptions that needed to be refined to use the 2019 inventory as the basis for the County's CCAAP. These refinements include the following:

- updated global warming potential (GWP) values;
- revised emissions factors for electricity supplied by Pacific Gas & Electric Company (PG&E); and

- the inclusion of off-road vehicles and equipment emissions, additional wastewater treatment-related emissions, and additional agriculture-related emissions.

This first phase in preparation of the CCAAP involved evaluating AMBAG's 2019 community GHG emissions inventory for the unincorporated county and revising the 2019 community inventory to be consistent with recommended protocols. This report describes protocols, methods, and other considerations for preparing a GHG emissions inventory; discusses associated methods, assumptions, emissions factors, and data sources; provides an evaluation of the 2019 community GHG emissions inventory prepared by AMBAG; and presents the results of the revised 2019 community inventory. This GHG emissions inventory provides a foundation for the forthcoming phases of the CCAAP development processes, including forecasting future emissions, setting GHG emissions reduction targets, developing GHG emissions reduction measures, and creating an implementation plan that will help the County achieve identified targets.

1.4 ORGANIZATION OF THIS REPORT

This report consists of three main parts:

- Section 2: Inventory Overview outlines considerations for preparing a community GHG emissions inventory, summarizes industry-leading protocols and methods for inventories, discusses inventory boundaries, and describes the emissions sectors and sources that are included and excluded in the County's 2019 community GHG emissions inventory.
- Section 3: Data, Methods, and Assumptions describes the data, methods, and assumptions used in the County's 2019 community inventory and presents GHG emissions estimates by sector, including new methods and emissions sources recommended by GHG inventory protocols but not previously included in prior inventories.
- Section 4: Summary of Inventory Results presents the results of the 2019 community GHG emissions inventory for each sector and source.

2 INVENTORY OVERVIEW

2.1 CONSIDERATIONS FOR DEVELOPING AN INVENTORY

Nations, states, local jurisdictions, public agencies, and corporations estimate GHG emissions for different purposes. Several general approaches exist to quantify GHG emissions, and the method chosen by governments or private entities is driven by the purpose for developing an inventory. State, federal, and international agencies have developed industry protocols and recommendations for local governments preparing GHG emissions inventories at the community level.

The traditional GHG emissions inventory used by local governments in the climate action planning process, known as a "production-based" inventory, estimates GHG emissions generated by activities occurring within a defined boundary during a single year. This has become the standard approach recommended by industry protocols and includes emissions that are generated from community activities that occur within the jurisdictional boundary of the inventory, such as those emitted from natural gas furnaces used for heating buildings throughout a community. It also includes certain "trans-boundary" emissions that are associated with activities occurring within the inventory's boundary but are released into the atmosphere outside of the boundary. For example, electricity emissions in a production-based inventory are attributed to a community based on electricity consumption within the inventory boundary, even if the electricity was generated and produced GHG emissions outside of the inventory boundary. More information regarding considerations for preparing production-based inventories is included in Sections 2.3.2 through 2.4.1.

In addition to traditional production-based emissions inventories, corporations, local governments, and other entities may prepare a "consumption-based" emissions inventory. A consumption-based emissions inventory includes the total lifecycle GHG emissions generated by the production, shipping, use, and disposal of goods and services consumed by residents of a community within a given year. For example, for transportation GHG emissions, this approach includes the emissions embedded in motor vehicle production, emissions from shipping the vehicle to the consumer, emissions from producing and refining fuel used in the vehicle, emissions from the combustion of the fuel used in the vehicle, and the emissions resulting from the ultimate disposal of the vehicle.

The production-based approach was chosen for the County's community GHG emissions inventory, which is the focus of this report. This is consistent with recommendations and guidance from industry protocols (described further below), as well as State agencies, including the California Air Resources Board (CARB) and the Governor's Office of Planning and Research (OPR). Production-based inventories provide local governments with the information needed to develop effective climate action policy within their communities; because of this, the production-based inventory method is the most common approach taken by local governments across California and nation.

2.1.1 CEQA Considerations

Local agencies preparing climate action plans in California can develop them consistent with the California Environmental Quality Act (CEQA). A plan that meets the requirements set forth in Section 15183.5 of the State CEQA Guidelines provides the ability to streamline GHG analyses of new development projects subject to environmental review. The criteria specified in Section 15183.5 to develop a "CEQA-qualified" GHG reduction plan include the following:

(A) Quantify greenhouse gas emissions, both existing and projected over a specified time period, resulting from activities within a defined geographic area;

(B) Establish a level, based on substantial evidence, below which the contribution to greenhouse gas emissions from activities covered by the plan would not be cumulatively considerable;

(C) Identify and analyze the greenhouse gas emissions resulting from specific actions or categories of actions anticipated within the geographic area;

(D) Specify measures or a group of measures, including performance standards, that substantial evidence demonstrates, if implemented on a project-by-project basis, would collectively achieve the specified levels;

(E) Be adopted in a public process following environmental review.

While the CCAAP will be developed to meet all criteria listed above, only item A relates to GHG emissions inventories. Regarding emissions sources or "activities" within a "defined geographic area," an inventory should focus on production-based emissions within the local jurisdictional boundaries of the community or within the context over which the local agency may have substantial jurisdictional influence, as outlined in the *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions* and recommended by OPR. Section 2.4 in this report provides additional context for the defined geographic area of the County's inventory.

2.1.2 General Plan Consistency

In the 2010 Monterey County General Plan Final Environmental Impact Report, preparation of a GHG Reduction Plan was identified as a mitigation measure that would reduce climate change impacts associated with development contemplated in the General Plan. Policy OS-10.11 was added to provide the desired mitigation and updated in 2020 to reflect the latest State targets and advancements in climate action planning.

Included in Policy OS-10.11 are minimum requirements for the CCAAP, which state that the CCAAP shall: "Establish a current inventory of GHG emissions in the County of Monterey including but not limited to residential, commercial, industrial, and agricultural emissions" (County of Monterey 2020).

The inventory presented in the report includes all of the required sectors that meets the objectives of Policy OS-10.11.

2.2 PROTOCOLS AND METHODOLOGIES

2.2.1 U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions

Several inventory protocols have been developed to provide guidance for communities and local governments to account for emissions accurately and consistently. ICLEI – Local Governments for Sustainability (ICLEI) develops protocols for local-scale accounting of emissions that have become the industry standard for local governments developing GHG emissions inventories. The most recent guidance for community-scale emissions inventories is ICLEI's July 2019 publication *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions* (Community Protocol), Version 1.2 (ICLEI 2019). State agencies, including CARB and OPR, recommend that jurisdictions prepare community GHG emissions inventories using the guidelines included in the Community Protocol (CARB 2017:100; OPR 2017:226).

The Community Protocol identifies six principles for GHG accounting and reporting. These principles were adapted from internationally recognized sources and were used to guide the development of the Community Protocol. ICLEI recommends that local governments consider the principles when preparing an inventory. The GHG accounting and reporting principles are summarized below.

- Relevance, Including Policy Relevance, and Utility for Users: The ultimate objective and intent of an inventory should be considered during the inventory development process. Inventories should be organized in a way that is understandable and useful for policy makers and the public while appropriately reflecting community GHG emissions and enabling the evaluation of emissions trends over time.
- Accuracy: The use of GHG emissions accounting methods that are expected to systematically under- or over-estimate emissions should be avoided. Decisionmakers should be able to take action with reasonable assurance as to the integrity of emissions estimates.

- Completeness: Community GHG emissions inventories should be as comprehensive as possible and include all emissions associated with the community, as well as community GHG emissions "sinks" (i.e., the opposite of an emissions source; any reservoir, natural or otherwise, that accumulates and stores GHG emissions)[1].
- Measurability: Methods used to quantify GHG emissions should be readily available, adequately substantiated and of known quality, and updated regularly as established methods evolve.
- Consistency and Comparability: Community inventories should consistently use preferred, established methods to enable tracking of emissions over time, evaluation of reduction measures effectiveness, and comparison between communities. Alternative methods should be documented and disclosed.
- Transparency: All relevant data sources, methods, and assumptions should be disclosed and described to allow for future review and replication. Similarly, all relevant issues should be documented and addressed coherently.

Consistent with these recommendations as well as industry standards and best practices, the County's community GHG emissions inventory primarily follows methodologies provided by the Community Protocol. However, additional established methods were used for selected GHG emissions sources where the Community Protocol does not provide guidance, or where updated methods have been established that improve the accuracy of emissions estimates. Table 1 below provides a summary of places in which alternate methods were used. This approach is consistent with guidance from the Community Protocol: "Protocol estimation methods must be used in Protocol-compliant inventories except where the user identifies and documents another method that is likely to better satisfy the Protocol reporting principles" (ICLEI 2019:20-21). The following sections describe additional methods used for estimating GHG emissions in the county.

2.2.2 California Air Resources Board Methods

Each year, CARB develops and publishes the California GHG Emission Inventory for emissions statewide in California. CARB follows Intergovernmental Panel on Climate Change (IPCC) guidelines for national reporting, and its overarching approach and many of its methods align with the Community Protocol. As climate change science and GHG emissions accounting practices have evolved, CARB has implemented additional methodologies for certain emissions sectors and sources that are not included in the Community Protocol.

The County aims to align with the CARB's inventory as much as possible. Consistency with the State's methodologies and approaches will be beneficial for upcoming phases of the CCAAP development process, including estimating projected GHG emissions in the future (i.e., forecasting emissions), setting GHG emissions reduction targets, and measuring progress towards established targets.

The County's inventory utilizes methods provided by CARB and the California GHG Emission Inventory for several emissions sectors and sources. For example, although the Community Protocol recommends using the U.S. Environmental Protection Agency's (EPA's) NONROAD model, emissions from off-road vehicles and equipment in the county were obtained from CARB's OFFROAD models, which provide more geographic-specific emissions estimates for California using the best available data.

2.2.3 Alternative Methods

Although nearly all emissions calculations relied on protocols and methods from the Community Protocol and CARB, some emissions estimates were prepared using alternative methodologies from established sources. This approach was only taken when methods were not provided by the Community Protocol or CARB, which aligns with Community Protocol guidance. For example, GHG emissions from open burning (i.e., the burning of vegetative material), were estimated using methodologies and emissions factors from the National Wildfire Coordinating Group (NWCG)'s *Smoke Management Guide for Prescribed Fire* (NWCG 2018). This sector was included because of the County's ability to have authority or significant influence over this sector. This is discussed in more detail in Section 2.3.2 below.

[1] The County's GHG emissions sinks include carbon sequestration from carbon stored in soil and vegetation in agricultural and open space land uses. An estimate of carbon sequestration within the unincorporated county will be part of the CCAAP development process and will be released at a later date.

2.3 EMISSIONS SECTORS AND SOURCES

There are several approaches for categorizing and grouping GHG emissions in community inventories. Generally, GHG emissions are organized into emissions sectors, which frequently include agriculture, building energy, transportation, solid waste, water, and wastewater. Sometimes these sectors are broken down further, such as residential building energy and nonresidential building energy, and sectors may also be combined, such as water and wastewater. The purpose of categorizing GHG emissions into broad sectors is to provide local governments and the public with a useful organization of community emissions. Importantly, GHG emissions sectors may not align directly with economic sectors (e.g., hospitality), but there may be overlap for some communities.

Within GHG emissions sectors, emissions are generated in a variety of ways. Motor vehicles burn fossil fuels and emit GHGs directly into the atmosphere; the electricity used in homes and businesses produces indirect emissions from power plants; and solid waste that ends up in landfills breaks down and releases GHG emissions over time. The Community Protocol organizes different types of community GHG emissions into two general categories:

- GHG emissions sources are those that release emissions directly into the atmosphere as a result of any physical process that occurs within the jurisdictional boundary of the inventory. Natural gas combustion for heating in homes and diesel fuel combustion in motor vehicles within the community are considered GHG emissions sources.
- GHG emissions activities are those that release emissions into the atmosphere either directly or indirectly as a result of the use of energy, materials, and/or services within the community. For example, GHG emissions from a community's electricity use are accounted for and considered GHG emissions activities, even if the burning of fossil fuels to generate the electricity occurred and produced emissions outside of the inventory boundary.

For the sake of clarity, this report uses "GHG emissions sources" to represent both direct in-boundary emissions *sources* as well as indirect emissions that are produced out-of-boundary as a result of *activities* that occur within the community. The GHG emissions sources in the County's community inventory are organized under seven sectors: building energy (residential and nonresidential), on-road transportation, off-road vehicles and equipment, solid waste, water supply, wastewater treatment, and agriculture.

Figure 1 depicts how sectors, sources, and activities are considered and categorized in the County's inventory.

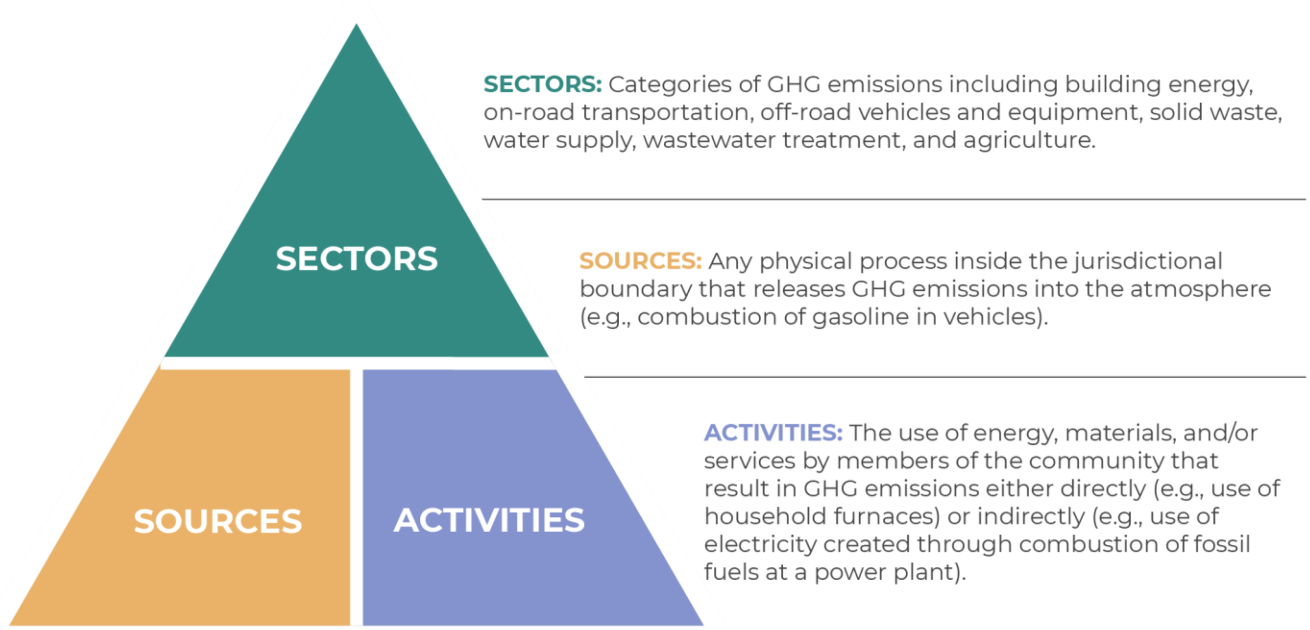

Figure 1 Emissions Sectors, Sources, and Activities Hierarchy

2.3.1 Community Protocol-Compliant Sources

When developing a community inventory, it is important for local governments to determine what will be included in the inventory scope. This may be influenced by factors such as the purpose and intended narrative of the inventory, the reporting framework that will be used, and the GHG emissions sources present in the community. While local governments have some flexibility in determining an inventory's scope, the Community Protocol requires the inclusion of a minimum of five emissions sources in community inventories:

1. Use of electricity by the community.
2. Use of fuel in residential and commercial stationary combustion equipment.
3. On-road passenger and freight motor vehicle travel.
4. Use of energy in potable water and wastewater treatment and distribution.
5. Generation of solid waste by the community.

The Community Protocol strongly encourages local governments to include other emissions-generating sources in accounting and reporting as well. For the County, this includes the four emissions sectors required by Policy OS-10.11 of the General Plan: residential, commercial, industrial, and agricultural emissions. Considerations for including additional sources are outlined in the following section.

2.3.2 Additional Sources

Many local governments go beyond the minimum requirements of the Community Protocol. For example, many community inventories in California account for GHG emissions from off-road vehicles and equipment. Communities that have agricultural land uses also commonly include agriculture-related emissions in inventories.

Beyond the five emissions sources required by the Community Protocol, the additional GHG emissions sources included in a community inventory are determined by the jurisdiction conducting the inventory. The Community Protocol recommends the Local Government Significant Influence reporting framework, where local governments account for all emissions sources over which they have authority or significant influence. This approach benefits the overall climate action planning process because it emphasizes the emissions sources that the local government has the greatest ability to address (ICLEI 2019:29). For example, because California's local air districts regulate permits issued for open burning, the County decided to include emissions from open burning in the CCAAP's inventory. Conversely, because the County has limited control over the waste that is generated by other communities but is disposed at landfills within the unincorporated county, imported waste-related emissions are excluded from the County's inventory.

2.4 BOUNDARIES

The scope and boundary chosen for estimating GHG emissions may vary depending on the focus and/or intent of the inventory. For example, while corporate inventories use the concept of ownership to guide GHG emissions accounting—where emissions generated by all sources and activities owned by the entity are accounted for, regardless of where emissions are produced—community-scale inventories serve to convey information about emissions associated with politically defined communities (ICLEI 2019:12).

As described in the previous sections, production-based community inventories include emissions that are produced within a community's geographic boundary as well as those that are produced outside the boundary but result from activities within the community. Inventories following the Community Protocol are required to include several emissions sources; however, certain emissions sources that are located within the inventory boundary may be excluded from a community inventory. The following section outlines considerations and the decision-making framework for determining what GHG emissions sources are included or excluded from an inventory, consistent with developing an inventory that meets the criteria set forth in State CEQA Guidelines Section 15183.5 and described in Section 2.1.1 above.

2.4.1 County Inventory Boundary

The CCAAP aims to reduce GHG emissions from sources within the unincorporated county for which the County has regulatory authority or significant influence. Importantly, the CCAAP will not apply to incorporated places within the county. Because of this, the County's inventory only includes emissions generated from sources and activities occurring within the boundaries of the unincorporated county; it does not account for GHG emissions generated from activities occurring outside of the County's jurisdiction, as the County does not have operational control of or authority over these emissions sources. Therefore, GHG emissions generated from activities within incorporated places (e.g., City of Salinas) or lands owned and/or managed by State and federal agencies (e.g., Federal Responsibility Areas) are excluded from the inventory.

Additionally, the County's community inventory does not account for embedded or lifecycle GHG emissions. The County's inventory evaluates emissions using the production-based approach; therefore, the County's inventory does not consider the upstream emissions generated by the consumption of goods and services within the community.

The GHG emissions sectors and sources included and excluded in the County's 2019 community inventory are presented in Table 1 below. Additionally, Table 1 identifies the protocol that provided the methodology for estimating GHG emissions from each emissions source. Emissions sources that identify multiple protocols used a combination of data and methods from multiple protocols. Fertilizer application and off-road vehicles and equipment calculations used methods consistent with IPCC and the Community Protocol but substituted California-specific data obtained from CARB for less geographic-specific data provided by the protocols. More information can be found in Appendix A.

Table 1 2019 Monterey County Summary of Sectors and Sources

Sector/Source	Included	Excluded	Protocol(s)
Agriculture			
Livestock Management – Enteric Fermentation	Emissions from enteric fermentation from livestock within the county		ICLEI
Livestock Management – Manure Management	Emissions associated with manure management practices within the county		ICLEI
Fertilizer Application	Emissions associated with fertilizer use within the county		CARB/IPCC
Agricultural Equipment - Off-Road Vehicles and Equipment	Emissions from agricultural off-road vehicles and equipment within the county		ICLEI/CARB
Agricultural Equipment – Irrigation Pumps	Emissions from diesel fuel use for irrigation pumps within the county		CARB
Open Burning	Emissions from open burning of vegetative matter within the county		NWCG
On-Road Transportation			
On-Road Transportation[1] (current methodology)	Emissions from all vehicle miles traveled (VMT) on roads within the county, including pass-through trips that start and end outside of the unincorporated county	Emissions from VMT on roads outside the unincorporated county, even if the trips start or end within the unincorporated county	ICLEI

Sector/Source	Included	Excluded	Protocol(s)
On-Road Transportation (updated methodology)[2]	Emissions from 100 percent of trips within the unincorporated county (internal-internal) and 50 percent of trips starting or ending outside the unincorporated county (internal-external and external-internal)	Emissions from 100 percent of pass-through trips starting and ending outside the unincorporated county (external-external)	ICLEI
Building Energy			
Electricity	Emissions associated with all electricity consumed within the unincorporated county		ICLEI
Natural Gas	Emissions from natural gas consumed within the unincorporated county		ICLEI
Backup Generators	Emissions from diesel, liquid propane gas, and natural gas consumed in backup generators within the unincorporated county		ICLEI
Solid Waste			
Community-Generated Solid Waste	Emissions from all waste generated within the unincorporated county	Emissions from waste generated outside of the county but disposed of within the county	ICLEI
Off-Road Vehicles and Equipment			
Off-Road Vehicles and Equipment	Emissions from off-road vehicles and equipment within the unincorporated county		ICLEI/CARB
Wastewater Treatment			
Wastewater Treatment	Emissions associated with wastewater generated within the unincorporated county	Emissions from wastewater generated outside of the county but treated within the county	ICLEI
Water Supply			
Water Supply	Emissions associated with water use within the unincorporated county		ICLEI

Notes: CARB = California Air Resources Board; ICLEI = ICLEI – Local Governments for Sustainability; NWCG = National Wildfire Coordinating Group; VMT = vehicle miles traveled.

1 The current methodology used to estimate on-road transportation emissions will be updated in 2022 upon AMBAG's release of its new travel demand model.

2 The updated methodology will include emissions from 100 percent of trips within the unincorporated county (internal-internal) and 50 percent of trips starting or ending outside the unincorporated county (internal-external and external-internal); it will exclude emissions from 100 percent of pass-through trips starting and ending outside the unincorporated county (external-external).

Source: Ascent Environmental 2021.

3 DATA, METHODS, AND ASSUMPTIONS

3.1 OVERVIEW OF ACTIVITY DATA AND EMISSIONS FACTORS

The basic calculation for estimating GHG emissions involves two primary inputs: activity data and emissions factors. Activity data refers to the relevant measurement of a community's activity resulting in emissions, and emissions factors represent the amount of a GHG emitted on a per unit of activity basis. Emissions factors are applied to activity data (i.e., the two values are multiplied together) to estimate GHG emissions. For example, in the residential energy sector, activity data of annual community electricity consumption in megawatt-hours (MWh) is multiplied by an emissions factor in pounds of GHG per MWh, which results in a pounds of GHG emissions value. This calculation-based methodology is used for estimating emissions from most sources in the County's inventory. An overview of activity data and emissions factors for each emissions source, along with data sources, is shown in Table 2. Detailed methods are described in the following sections.

Table 2 2019 Monterey County Summary of Activity Data and Emissions Factors

Sector/Source	Input Type	Description and Data Sources
Agriculture		
Livestock Management	Activity data	Livestock population data from the County of Monterey Agricultural Commissioner's Office's 2019 Crop Report and U.S. Department of Agriculture's 2017 Census of Agriculture
	Emissions factor	Livestock-specific emissions factors from CARB, IPCC, and EPA
Fertilizer Application	Activity data	Fertilizer application data from AMBAG
	Emissions factor	Organic and synthetic fertilizer emissions factors from CARB
Agricultural Equipment - Off-Road Vehicles and Equipment	Activity data	Off-road vehicles and equipment activity data and emissions factors from CARB
	Emissions factor	
Agricultural Equipment – Irrigation Pumps	Activity data	Diesel-powered irrigation pumps data from the County
	Emissions factor	Monterey County region-specific average emissions factor from CARB
Open Burning	Activity data	Open burning data from Monterey Bay Air Resources District (MBARD)
	Emissions factor	Average emissions factors from NWCG
On-Road Transportation		
On-Road Transportation (current methodology)	Activity data	Vehicle miles traveled (VMT) on local roads data from the California Department of Transportation
	Emissions factor	Monterey County-specific emissions factors from CARB
On-Road Transportation (updated methodology)[1]	Activity data	VMT data from AMBAG's Regional Travel Demand Model
	Emissions factor	Monterey County-specific emissions factors from CARB
Building Energy		
Electricity	Activity data	Electricity consumption data from Pacific Gas and Electric Company (PG&E) and Central Coast Community Energy (3CE)
	Emissions factor	Utility-specific emissions factors from 3CE, The Climate Registry (TCR), and EPA
Natural Gas	Activity data	Natural gas consumption data from PG&E and California Energy Commission
	Emissions factor	Average emissions factors from TCR
Backup Generators	Activity data	Fuel consumption data from MBARD
	Emissions factor	Average emissions factors from TCR

Sector/Source	Input Type	Description and Data Sources
Solid Waste		
Community-Generated Solid Waste	Activity data	Waste disposal data from the California Department of Resources Recycling and Recovery
	Emissions factor	Mixed municipal solid waste emissions factor from EPA
Off-Road Vehicles and Equipment		
Off-Road Vehicles and Equipment	Activity data	Off-road vehicles and equipment activity and emissions factors data from CARB
	Emissions factor	
Wastewater Treatment		
Wastewater Treatment	Activity data	Wastewater generation and process-related data from Monterey One Water (M1W) and the County
	Emissions factor	Emissions factors based on treatment processes from M1W and ICLEI
Water Supply		
Water Supply	Activity data	Water consumption data from Monterey County Water Resources Agency
	Emissions factor	Energy intensity factors from California Public Utilities Commission

Notes: 3CE = Central Coast Community Energy; AMBAG = Association of Monterey Bay Area Governments; CARB = California Air Resources Board; EPA = U.S. Environmental Protection Agency; ICLEI = ICLEI – Local Governments for Sustainability; IPCC = Intergovernmental Panel on Climate Change; M1W = Monterey One Water; MBARD = Monterey Bay Air Resources District; PG&E = Pacific Gas and Electric Company; TCR = The Climate Registry; VMT = vehicle miles traveled.

[1] The methodology used to estimate on-road transportation emissions will be updated in 2022 upon AMBAG's release of its new travel demand model. See Section 3.3.3, "On-Road Transportation" for more information.

Source: Ascent Environmental 2021.

3.2 GLOBAL WARMING POTENTIALS AND EMISSIONS UNITS

GHG emissions other than carbon dioxide (CO_2) generally have a stronger insulating effect and thus, a greater ability to warm the Earth's atmosphere through the greenhouse effect. This effect is measured in terms of a pollutant's Global Warming Potential (GWP). CO_2 has a GWP factor of one while all other GHGs have GWP factors measured in multiples of one relative to the GWP of CO_2. This conversion of non-CO_2 gases to one unit enables the reporting of all emissions in terms of carbon dioxide equivalent (CO_2e), which allows for the consideration of all gases in comparable terms and makes it easier to communicate how various sources and types of GHG emissions contribute to climate change. The standard unit for reporting emissions is metric tons of carbon dioxide equivalent ($MTCO_2e$).

Consistent with the best available science, these inventories use GWP factors published in the Sixth Assessment Report from IPCC, where methane (CH_4) and nitrous oxide (N_2O) have GWP factors of 27.9 and 273, respectively (IPCC 2021). These values represent the GWP of GHG on a 100-year time horizon. This means that CH_4 is approximately 28 times stronger than CO_2 and N_2O is 273 times stronger than CO_2 in their potential to warm Earth's atmosphere over the course of 100 years. The use of 100-year GWP values is consistent with CARB methods and reflects the long-term planning horizon of the CCAAP.

3.3 DATA QUALITY AND ACCURACY

When preparing a GHG emissions inventory, the goal is to use the best available data and methodologies to develop the most accurate picture of a community's emissions. However, some degree of inaccuracy is inherent to all inventories. As described by the Community Protocol, "While no community inventory is fully comprehensive (some emissions cannot be estimated due to a lack of valid methods, a lack of emissions data, or for other reasons), community inventories often aim to provide as complete a picture of GHG emissions associated with a community as is feasible" (ICLEI 2019:12). The accuracy of a GHG emissions inventory is primarily dependent on activity data (e.g., tons of solid waste generated by a community), emissions factors (e.g., grams of CO_2 per vehicle mile traveled [VMT] in a county), and scaling factors (e.g., percentage of county-level off-road vehicles and equipment emissions attributed to a local jurisdiction).

Development of the County's GHG emissions inventory was a robust and comprehensive process rooted in industry standards and best practices, and it included extensive research and consultation with County staff and departments, regional and State agencies and organizations, and community stakeholders to ensure data was as accurate as feasible. The County recognizes that even though its inventory is consistent with all protocols previously discussed and the data used are as accurate as feasible, perfect precision in emissions estimates will never be possible. The following are some assumptions that were made due to the unavailability of data:

- Electricity consumption by electricity utility. Assumptions regarding electricity consumption by provider were made based on the availability of data from utilities. It was assumed that all nonresidential and Direct Access electricity was supplied by Central Coast Community Energy (3CE).
- Nonresidential natural gas consumption. A complete dataset for nonresidential natural gas usage in 2019 was not available from PG&E. Average annual change in countywide nonresidential natural gas consumption, including incorporated places, was used to estimate nonresidential natural gas usage in the unincorporated county.
- Open burning activity data. Open burning data for the county was obtained from Monterey Bay Air District (MBARD). However, MBARD was not able to provide a complete dataset of all tons of vegetative matter burned within the county; some burn operations were excluded and not accounted for in emissions estimates.
- Water and wastewater activity data. Data for water consumption within the unincorporated county were limited. Approximate total water supply was obtained from the Monterey County Water Resources Agency (MCWRA) and verified through County sources, and it was assumed that all water used within the unincorporated county was extracted, conveyed, treated, and distributed within the unincorporated county. Additionally, water consumption electricity usage could not be broken down by use type; therefore, water supply emissions were assumed to be captured entirely within the building energy sector, which accounts for all electricity consumption. Similarly, wastewater-related data was limited. It was assumed that Monterey One Water (M1W) was the only centralized wastewater treatment plant (WWTP) serving the unincorporated county and that onsite septic systems served the rest of the community.
- Agriculture data granularity. Much of the data used to calculate agriculture-related GHG emissions are specific to the unincorporated county and were obtained from local sources. For example, cattle population data for the unincorporated county were obtained from the County of Monterey Agricultural Commissioner's Office (ACO). However, some of the agricultural data used for emissions calculations were aggregated at the regional level. For example, agricultural off-road vehicles and equipment data were obtained from CARB, and these data were provided for the entire level (i.e., including incorporated places). For data that were provided for the entire county, it was assumed that all agricultural operations countywide occurred in the unincorporated county. Refer to Section 3.2.8, "Agriculture," for additional information.
- Scaling factors used to attribute emissions to the unincorporated county level. Certain emissions sectors use data that are not specific to the unincorporated county but the county as a whole (including incorporated places), and scaling factors were used to apportion data to the unincorporated county. For example, emissions data for off-road vehicles and equipment, obtained from CARB's OFFROAD models, are provided for the entire county (including incorporated cities). Population, employment, and service population factors (i.e., the proportion of the unincorporated county compared to the entire county) were used to scale county-level data to the unincorporated area. Additionally, agricultural data were obtained for the entire county, and it was assumed that all agricultural land in the county is located in the unincorporated county.

3.4 COMMUNITY INVENTORY DATA AND ASSUMPTIONS

3.4.1 Sector-Specific Assumptions and Methods

The following sections describe in detail the methods, data, and assumptions that were used in estimating the county's community GHG emissions in 2019. Population and employment data were used to scale activity levels for certain emissions sources and sectors. Population and employment data for 2019 were obtained from AMBAG's 2022 Final Regional Growth Forecasts, which were developed for AMBAG's 2045 Metropolitan Transportation Plan/Sustainable Communities Strategy (AMBAG 2020).

The list below summarizes this information at a high level for each sector.

- Building Energy: Annual electricity and natural gas usage data for the county were provided by PG&E and 3CE, and additional natural gas usage data was obtained from the California Energy Commission (CEC). Utility emissions factors were provided by 3CE, The Climate Registry (TCR), and EPA (see Table 3 below). Annual nonresidential backup generator usage was provided by MBARD. Emissions factors for nonresidential backup generator fuels were obtained from TCR.
- On-Road Transportation: For the on-road transportation sector, daily VMT were obtained from the California Department of Transportation's Highway Performance Monitoring System (HPMS). Importantly, this is preliminary data based on what is currently available; VMT data will be updated upon the release of AMBAG's new travel model (explained further in Section 3.3.3, "On-Road Transportation"). Vehicle emissions factors were derived from the 2021 EMissions FACtor (EMFAC2021) model, CARB's statewide mobile source emissions inventory model.
- Off-Road Vehicles and Equipment: Off-road vehicles and equipment emissions were estimated from CARB's OFFROAD2007 and OFFROAD2021 models and scaled by population, employment, or service population (i.e., the sum of population and employment) depending on the equipment type.
- Solid Waste: Emissions associated with waste generated by residents and businesses in the county were estimated using disposal data available from the California Department of Resources Recycling and Recovery (CalRecycle) for landfills receiving waste from the county. Landfill gas (LFG) collection information was available from EPA.
- Water Supply: Using guidance provided by ICLEI, water supply emissions were estimated using approximate water consumption volumes obtained from MCWRA in combination with region-specific energy intensity factors obtained from the California Public Utilities Commissions (CPUC).
- Wastewater Treatment: Emissions from wastewater treatment depend on the types of treatment processes and equipment that centralized WWTPs use. Emissions in this sector are also generated from onsite wastewater treatment systems, or septic systems. Data regarding treatment processes, population served, digester gas combustion, and daily nitrogen load were obtained from M1W to estimate emissions from centralized WWTPs. Population data for calculating emissions from septic systems was estimated using M1W service population data combined with population data from AMBAG.
- Agriculture: Emissions associated with the agriculture sector result from livestock management, fertilizer application, pesticide use, open burning, and operation of agricultural equipment. Agriculture emissions were estimated using data available from the County, CARB, California Department of Food and Agriculture (CDFA), U.S. Department of Agriculture (USDA), and MBARD.

3.4.2 Utility Emissions Factors

Emissions of CO_2, CH_4, and N_2O per MWh of electricity or therm of natural gas can vary by location and from year to year depending on several factors. Utility-specific emissions factors were obtained and used throughout the 2019 inventories to estimate GHG emissions from electricity and natural gas consumption. Sources for electricity and natural gas emissions factors are shown below.

- Electricity: Utility electricity emissions factors for CO_2, CH_4, and N_2O were obtained from 3CE, TCR, and EPA's Emissions & Generation Resource Integrated Database (eGRID). 3CE provided a CO_2 emissions factor for 2019, and the CO_2 emissions factor for PG&E in 2019 was interpolated using PG&E's 2018 CO_2 emissions factor obtained from TCR's 2020 Default Emission Factors and the requirements of the Renewables Portfolio Standard included in Senate Bill (SB) 100 (TCR 2020)[2]. California-specific emissions factors for CH_4 and N_2O obtained from eGRID2019 were used for PG&E (EPA 2021). For 3CE, these emissions factors were adjusted using additional data available from eGRID2019 to account for the specific energy resources used in 3CE's energy generation portfolio.
- Natural Gas: Utility natural gas emissions factors for CO_2, CH_4, and N_2O were obtained from TCR's 2020 Default Emission Factors (TCR 2020).

Specific utility emissions factors used in the inventory calculations are shown below in Tables 3 and 4. Emissions factors are shown in standards units for electricity (pounds of GHG per MWh) and natural gas (pounds per therm). Emissions factors are also presented in pounds of GHG per kilo British thermal unit (kBTU) to enable a comparison between energy types in similar terms.

Table 3 2019 Monterey County Electricity Emissions Factors

Provider	Pollutant	Emissions Factor (lb/MWh)	Emissions Factor (lb/kBTU)
3CE	CO_2	9.99	0.0029
	CH_4	0.028	0.0000081
	N_2O	0.0036	0.0000011
PG&E	CO_2	198.65	0.0528
	CH_4	0.033	0.0000097
	N_2O	0.004	0.0000012

Notes: 3CE = Central Coast Community Energy; CH_4 = methane; CO_2 = carbon dioxide; kBTU = kilo British thermal unit; lb = pounds; MWh = megawatt-hours; N_2O = nitrous oxide; PG&E = Pacific Gas and Electric Company.

Source: Utility emissions factors provided by 3CE, TCR, and EPA. Table compiled by Ascent Environmental in 2021.

Table 4 2019 Monterey County Natural Gas Emissions Factors

Provider	Pollutant	Emissions Factor (lb/therm)	Emissions Factor (lb/kBTU)
PG&E	CO_2	11.7	0.117
	CH_4	0.00104	0.0000104
	N_2O	0.0000220	0.0000002

Notes: CH_4 = methane; CO_2 = carbon dioxide; kBTU = kilo British thermal unit; lb = pounds; MWh = megawatt-hours; N_2O = nitrous oxide; PG&E = Pacific Gas and Electric Company.

Source: Utility emissions factors provided by TCR. Table compiled by Ascent Environmental in 2021.

RESIDENTIAL ENERGY

Residential energy emissions in the county result indirectly from electricity consumption and directly from onsite combustion of natural gas. 3CE and PG&E are the providers of residential energy in the county. 3CE is a community-owned community choice energy agency established to source clean and renewable electricity for Monterey, San Benito, Santa Cruz, San Luis Obispo, and Santa Barbara counties. It began providing clean, near-zero-emissions electricity to the county in 2018 and currently serves approximately 96 percent of residential and nonresidential accounts, while the remaining electricity accounts are served by PG&E. Because 3CE provides almost all of the grid-

[2] A third party-verified CO_2 emissions factor for PG&E in 2019 was not available at the time this analysis was conducted. Therefore, the 2019 emissions factor was interpolated using the third party-verified CO_2 emissions factor for 2018 and the requirements of the Renewables Portfolio Standard under SB 100.

supplied electricity consumed within the county, its near-carbon-free electricity results in a minor amount of electricity-related GHG emissions. Residential natural gas in the county is provided by PG&E.

Annual residential electricity usage data in the county in MWh was obtained from PG&E and 3CE. To calculate the $MTCO_2e$ of residential electricity consumption, emissions factors (shown in Table 3) for CO_2, CH_4, and N_2O were applied to electricity consumption data. Figure 2 below shows a sample calculation for estimating CO_2 emissions from residential electricity supplied by 3CE.

$$3CE\ Residential\ CO_2\ Electricity\ Emissions\ (MTCO_2) = residential\ electricity\ use\ (MWh) * CO_2\ emissions\ factor\ \left(\frac{lb\ CO_2}{MWh}\right) * pounds\ to\ metric\ ton\ conversion\ factor\ \left(\frac{MT}{lb}\right)$$

$$3CE\ Residential\ CO_2\ Electricity\ Emissions\ (MTCO_2) = 183{,}798\ MWh * 9.99\frac{lb\ CO_2}{MWh} * \frac{1\ MT}{2{,}204.62\ lb} = 833\ MTCO_2$$

Source: ICLEI 2019; calculations conducted by Ascent Environmental in 2021.

Figure 2 Sample Calculation for Estimating Carbon Dioxide Emissions from Residential Electricity

Annual residential natural gas consumption in therms was obtained from PG&E. CO_2, CH_4, and N_2O emissions factors for natural gas were applied to consumption data to estimate $MTCO_2e$ from residential natural gas usage. Figure 3 below shows a sample calculation for estimating CO_2e emissions from residential natural gas supplied by PG&E.

$$PG\&E\ Residential\ Natural\ Gas\ Emissions\ (MTCO_2e) = residential\ natural\ gas\ use\ (therms) * \left[\left(CO_2\ emissions\ factor\ \left(\frac{lb\ CO_2}{therm}\right) * CO_2\ GWP\right) + \left(CH_4\ emissions\ factor\ \left(\frac{lb\ CH_4}{therm}\right) * CH_4\ GWP\right) + \left(N_2O\ emissions\ factor\ \left(\frac{lb\ N_2O}{therm}\right) * N_2O\ GWP\right)\right] * pounds\ to\ metric\ ton\ conversion\ factor\ \left(\frac{MT}{lb}\right)$$

$$PG\&E\ Residential\ Natural\ Gas\ Emissions\ (MTCO_2e) = 14{,}959{,}603\ therms * \left[\left(11.7\frac{lb\ CO_2}{therm} * 1\right) + \left(0.00104\frac{lb\ CH_4}{therm} * 27.9\right) + \left(0.000022\frac{lb\ N_2O}{therm} * 273\right)\right] * \frac{1\ MT}{2{,}204.62\ lb} = 79{,}613\ MTCO_2e$$

Source: ICLEI 2019; calculations conducted by Ascent Environmental in 2021.

Figure 3 Sample Calculation for Estimating Carbon Dioxide Equivalent Emissions from Residential Natural Gas

NONRESIDENTIAL ENERGY

Nonresidential energy emissions, which are generated by commercial and industrial uses, result indirectly from electricity consumption and directly from onsite combustion of natural gas. PG&E and 3CE provide nonresidential electricity in the county. Both PG&E and 3CE provided nonresidential electricity in 2019, with over 99 percent of nonresidential electricity being supplied by 3CE. Nonresidential natural gas in the county is provided by PG&E.

Annual nonresidential electricity usage data in MWh was obtained from PG&E and 3CE. Annual commercial natural gas consumption in therms was obtained from PG&E, but PG&E was unable to provide industrial natural gas usage due to the 15/15 Rule[3]. Countywide (including incorporated places) commercial and industrial natural gas consumption data for 2013 through 2019 were obtained from CEC, which were used to calculate the percent change in natural gas consumption for the entire county from 2013 to 2019. This change, calculated to be an increase of approximately 11 percent, was applied to commercial and industrial natural gas consumption data provided by PG&E for 2013, the most recent year for which both commercial and industrial natural gas consumption was reported. Emissions associated with nonresidential energy consumption were quantified using the same methods as described above for residential energy calculations.

[3] The 15/15 Rule originates from a CPUC ruling in 1997 that enacted privacy standards for utilities to help ensure customer anonymity when energy data is released to third parties without customer consent. The 15/15 Rule requires that aggregated data include a minimum of 15 customers with no one customer's load exceeding 15 percent of the group's energy consumption.

Data for annual nonresidential backup generators were obtained from MBARD, expressed as gallons for diesel fuel and standard cubic feet for propane and natural gas. Emissions factors obtained from TCR were applied to fuel consumption data to estimate GHG emissions associated with nonresidential backup generator usage.

3.4.3 Building Energy

Residential and nonresidential building energy use in the county resulted in approximately 252,388 $MTCO_2e$ in 2019. This sector generated approximately 26 percent of the county's emissions in 2019 and represents the third-largest emissions sector in the inventory. Most of these emissions were a result of natural gas combustion for heating and cooking in homes and businesses, while a small proportion of the county's building energy emissions were associated with electricity use, primarily for lighting and heating, ventilation, air conditioning, and cooling (HVAC) and to power appliances, due to nearly-carbon-free electricity supplied by 3CE (see the residential energy section below for additional information). A marginal amount of nonresidential building energy emissions was associated with the consumption of diesel, liquified petroleum gas (i.e., propane), and natural gas in backup generators.

Nonresidential natural gas use accounted for approximately 66 percent of the county's 2019 building energy emissions, and residential natural gas use accounted for approximately 32 percent. Electricity from both residential and nonresidential buildings accounted for approximately 2 percent of emissions from the building energy sector, and nonresidential backup generators accounted for less than 1 percent of emissions from the building sector in 2019. Annual electricity, natural gas, and backup generator usage and GHG emissions are shown in Table 5, and additional information regarding each emissions source and calculations are discussed below.

Table 5 2019 Monterey County Community Building Energy Use and GHG Emissions

Energy Type	Quantity	GHG Emissions
Electricity	MWh	$MTCO_{2e}$
Residential	196,520	2,137
Nonresidential	712,851	3,931
Electricity Total	*909,370*	*6,067*
Natural Gas	therms	$MTCO_2e$
Residential	14,959,603	79,613
Nonresidential	31,290,974	166,526
Natural Gas Total	*46,250,577*	*246,138*
Backup Generators	NA	$MTCO_2e$
Nonresidential	NA	183
Energy Combined	NA	$MTCO_2e$
Residential	NA	81,750
Nonresidential	NA	170,639
Total	NA	252,388

Notes: Totals in columns may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; MWh = megawatt-hours; NA = not applicable.

Source: Ascent Environmental 2021.

3.4.4 On-Road Transportation

Based on modeling conducted, on-road transportation in the county resulted in approximately 291,389 $MTCO_2e$ in 2019, or 30 percent of the county's emissions in 2019. The on-road transportation sector represents the second-largest emissions sector in the county. Annual VMT and GHG emissions from on-road transportation are shown in Table 6. Additional details and calculation methodologies and assumptions are described below.

Table 6 2019 Monterey County Community On-Road Transportation VMT and GHG Emissions

Source	Annual VMT	GHG Emissions ($MTCO_2e$)
On-Road Transportation	639,028,260	291,389

Notes: GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; VMT = vehicle miles traveled.

Source: Ascent Environmental 2021.

On-road transportation emissions are primarily the result of the combustion of gasoline and diesel fuels in passenger vehicles (i.e., cars, light-duty trucks, and motorcycles), medium- and heavy-duty trucks, and other types of vehicles permitted to operate "on road." To a smaller degree, emissions from on-road electric vehicles also result from upstream electricity generation; these emissions are represented in annual electricity emissions in the county. Due to lack of available data, emissions from the combustion of natural gas and other non-electric alternative fuels in on-road vehicles were not included in the community inventory and are assumed to have minimal contribution to total emissions.

AMBAG is the regional MPO responsible for regional transportation planning in Monterey, San Benito, and Santa Cruz counties. AMBAG's Regional Travel Demand Model (RTDM) provides VMT estimates for the entire region and for each county. However, the RTDM does not provide accurate data at smaller geographic scales, including the jurisdiction-specific level. Because VMT estimates specific to the county were not available through the RTDM, estimates for VMT were obtained using HPMS data for local roads within the unincorporated county. While this accounting method is not consistent with the Regional Targets Advisory Committee (RTAC) origin-destination method established through SB 375 and CARB recommendations, it is consistent with the Community Protocol and was chosen as the best currently available methodology. Importantly, AMBAG is in the process of updating its RTDM, which is scheduled to be complete in June 2022. Once the model has been updated and more accurate data is available, the county's VMT data will be revised, and emissions estimates will be updated.

An overall emissions rate for countywide VMT was derived from EMFAC2021. EMFAC2021 was used to generate emission rates for the county for the calendar year 2019 with all vehicle classes, model years, speeds, and fuel types. The countywide $MTCO_2e$ per mile emissions factor was calculated based on the distribution of VMT for each vehicle class and its emissions factor. The equation for estimating on-road transportation emissions is shown in Figure 4.

$$On\text{-}Road\ Transportation\ Emissions\ (MTCO_2e) = countywide\ VMT * \left[\left(CO_2\ emissions\ factor\ \left(\frac{g\ CO_2}{mile}\right) * CO_2\ GWP\right) + \left(CH_4\ emissions\ factor\ \left(\frac{g\ CH_4}{mile}\right) * CH_4\ GWP\right) + \left(N_2O\ emissions\ factor\ \left(\frac{g\ N_2O}{mile}\right) * N_2O\ GWP\right)\right] * grams\ to\ metric\ ton\ conversion\ factor\left(\frac{MT}{g}\right)$$

$$On\text{-}Road\ Transportation\ Emissions\ (MTCO_2e) = 639{,}028{,}260\ miles * \left[\left(446.9\frac{g\ CO_2}{mile} * 1\right) + \left(0.0277\frac{g\ CH_4}{mile} * 27.9\right) + \left(0.0304\frac{g\ N_2O}{mile} * 273\right)\right] * \frac{1\ MT}{1{,}000{,}000\ g} = 291{,}389\ MTCO_2e$$

Source: ICLEI 2019; calculations conducted by Ascent Environmental in 2021.

Figure 4 Sample Calculation for Estimating Carbon Dioxide Equivalent Emissions from On-Road Transportation

3.4.5 Off-Road Vehicles and Equipment

Based on modeling conducted, off-road vehicles and equipment operating in the county emitted approximately 17,616 $MTCO_2e$ in 2019, or 2 percent of the 2019 inventory. The largest emissions-generating off-road categories include construction and mining equipment and commercial harbor craft. The estimated annual emissions and scaling factors used are presented in Table 7 by vehicles and equipment type. Additional details regarding calculation methods and assumptions are discussed below.

Table 7 2019 Monterey County Community Off-Road Vehicles and Equipment GHG Emissions and Scaling Method

Off-Road Vehicles and Equipment Type	GHG Emissions ($MTCO_2e$)	Scaling Method
Airport Ground Support	215	population
Commercial Harbor Craft	4,018	employment
Construction and Mining Equipment	5,136	service population
Entertainment Equipment	58	employment
Industrial Equipment	1,860	employment
Lawn and Garden Equipment	637	population
Light Commercial Equipment	1,466	employment
Pleasure Craft	1,206	population
Portable Equipment	622	employment
Railyard Operations	394	employment
Recreational Equipment	113	population
Transportation Refrigeration Units	1,891	service population
Total	17,616	NA

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; NA = not applicable.

Source: Data provided by Ascent Environmental in 2021, based on modeling from CARB's OFFROAD2007 and OFFROAD2021.

Emissions from the off-road vehicles and equipment sector result from fuel combustion in off-road vehicles and equipment. Data associated with this sector were available from CARB's OFFROAD2007 and OFFROAD2021 models. These models provide emissions details at the state, air basin, or county level. Monterey County emissions data from OFFROAD2007 and OFFROAD2021, which include emissions from incorporated areas of the county, were apportioned to the unincorporated county using custom scaling factors depending on the off-road vehicle and equipment type. For example, due to the likely correlation between commercial activity and employment, the county's portion of emissions from light commercial equipment in the entire county is assumed to be proportional to the number of jobs in the unincorporated county as compared to the county as a whole.

OFFROAD2007 provides emissions details for all off-road vehicle and equipment types, but OFFROAD2021 only provides details for certain types of off-road vehicles and equipment that are relevant to the county (i.e., it does not include emissions estimates for all off-road vehicle and equipment types). CARB recommends using OFFROAD2007 where desired information is unavailable from the OFFROAD2021 model, so data from both models were used (CARB 2020a). Additionally, while OFFROAD2021 provides estimates of CO_2 emissions, it does not provide estimates for CH_4 and N_2O emissions. To estimate CH_4 and N_2O emissions from the vehicle and equipment types included in OFFROAD2021, ratios of CH_4 to CO_2 and N_2O to CO_2 were obtained from OFFROAD2007 and applied to CO_2 data from OFFROAD2021 to calculate CH_4 and N_2O emissions.

3.4.6 Solid Waste

Based on modeling conducted, the solid waste sector was responsible for approximately 69,724 $MTCO_2e$ in 2019, or 7 percent of community GHG emissions. Community-generated solid waste emissions are associated primarily with the decomposition of solid waste generated by the county in landfills, while a smaller proportion of emissions are produced by the decomposition of alternative daily cover (ADC) generated by the county. Table 8 summarizes emissions from the solid waste sector. Additional details regarding calculation methods and assumptions are discussed below.

Table 8 2019 Monterey County Community Solid Waste Quantity and GHG Emissions

Source	Quantity (tons)	GHG Emissions ($MTCO_2e$)
Community-Generated Solid Waste	185,115	69,724

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Ascent Environmental 2021.

COMMUNITY-GENERATED SOLID WASTE

CH_4 emissions generated by community-generated solid waste occur from the decay of landfill disposed waste generated annually by residences and businesses in the county. A total of 172,514 tons of landfilled waste was reported for the county in 2019. In addition to landfilled waste, communities send ADC to landfills. ADC is non-earthen material used to cover an active surface of a landfill at the end of each operating day to control for vectors, fires, odors, blowing litter, and scavenging. This material can include compost, construction and demolition waste, sludge, green material, shredded tires, spray-on cement, and fabric. Given that ADC can also include organic material, CH_4 emissions from landfills result from organic decomposition in both waste disposal and ADC. ADC from the county was reported to be 12,601 tons in 2019. Data for landfilled waste and ADC was obtained from CalRecycle (CalRecycle 2021).

The amount of CH_4 released from community-generated waste depends on the LFG management systems of the landfills at which the waste is disposed. Information regarding the use of an LFG capture system was available from EPA's Landfill Methane Outreach Program. All facilities included an LFG capture system; therefore, the default LFG collection efficiency of 0.75 was applied to adjust emissions estimates, as recommended by the Community Protocol. Default waste characterization emissions factors obtained from EPA were used in calculations. A sample calculation for estimating emissions from solid waste is shown in Figure 5.

$$Solid\ Waste\ Emissions\ (MTCO_2e) = quantity\ of\ community\text{-}generated\ solid\ waste\ and\ ADC\ (tons) * (1 - default\ LFG\ collection\ efficiency) * (1 - default\ oxidation\ rate) * CH_4\ emissions\ factor\ \left(\frac{MT\ CH_4}{ton}\right) * CH_4\ GWP$$

$$Solid\ Waste\ Emissions\ (MTCO_2e) = (172{,}514\ tons + 12{,}601\ tons) * (1 - 0.75) * (1 - 0.1) * 0.06 \frac{MTCH_4}{ton} * 27.9 = 69{,}724\ MTCO_2e$$

Source: ICLEI 2019; calculations conducted by Ascent Environmental in 2021.

Figure 5 Sample Calculation for Estimating Carbon Dioxide Equivalent Emissions from Solid Waste

3.4.7 Water Supply

Because all water is supplied from local sources within the county, it was assumed that all electricity usage associated with extracting, conveying, treating, and distributing water is captured in the building energy sector because these activities occur within the county. As discussed in Section 3.3, data for water consumption was limited and electricity usage associated with water supply could not be broken down by use type. Therefore, based on modeling conducted, water supply emissions are incorporated in the residential and nonresidential electricity-related emissions presented in Table 5 above. GHG emissions associated with water supply occur from the indirect use of energy associated with water extraction, conveyance, treatment, and distribution to the point of use (e.g., residences, businesses). Table 9 presents water supply quantity by use type for the county in 2019.

Table 9 2019 Monterey County Community Water Supply Quantity and GHG Emissions

Source	Quantity (AF)	GHG Emissions ($MTCO_2e$)[1]
Residential and Nonresidential Water Supply	25,000	—
Agricultural Water Supply	475,000	—

Notes: AF = acre-feet; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

[1] Water supply emissions are captured in the building energy sector. Additional information regarding water supply emissions can be found in the section above this table and in Section 3.3, "Data Quality and Accuracy."

Source: Ascent Environmental 2021.

3.4.8 Wastewater Treatment

Based on modeling conducted, wastewater treatment resulted in GHG emissions of approximately 15,586 $MTCO_2e$, which represents 1 percent of total emissions. Septic systems accounted for approximately 72 percent of emissions from wastewater treatment, while centralized WWTPs make up the remaining 28 percent of emissions from this sector. Wastewater treatment emissions are summarized in Table 10, and additional details for this sector are included below.

Table 10 2019 Monterey County Wastewater Treatment GHG Emissions

Wastewater Treatment Type	GHG Emissions ($MTCO_2e$)
Centralized WWTPs	3,749
Septic Systems	11,837
Total	15,586

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; WWTP = wastewater treatment plant.

Source: Ascent Environmental 2021.

SEPTIC SYSTEMS

Onsite septic systems are used to collect wastewater in rural areas of the county. These systems collect wastewater onsite in underground tanks, which create anaerobic conditions. Microorganisms biodegrade the soluble organic material found in waste, which results in fugitive CH_4 emissions. Consistent with the Community Protocol, wastewater discharge and treatment energy intensities associated with septic tanks and other onsite systems are assumed to be negligible.

CH_4 emissions from the septic systems in the county were calculated based on population served, using Equation WW.11(alt) of the Community Protocol. Direct data for the population served by septic systems in the county was unavailable. This population was estimated by calculating the difference between the county's total population and the population served by M1W's centralized WWTP, which was obtained from M1W. This method resulted in an estimate of 97,775 individuals in the county served by septic systems. Figure 6 below shows a sample calculation for estimating emissions from septic systems.

$$Septic\ Systems\ Emissions\ (MTCO_2e) = population\ served * daily\ biological\ oxygen\ demand\ load\ \left(\frac{kg\ BOD_5}{person}\right) * maximum\ CH_4\ producing\ capacity\ for\ domestic\ wastewater\ \left(\frac{kg\ CH_4}{kg\ BOD_5}\right) * CH_4\ correction\ factor * days\ to\ year\ conversion\ factor\ \left(\frac{days}{year}\right) * kilograms\ to\ metric\ ton\ conversion\ factor\ \left(\frac{MT}{kg}\right) * CH_4\ GWP$$

$$Septic\ Systems\ Emissions\ (MTCO_2e) = 97{,}775 * 0.09\frac{kg\ BOD_5}{person} * 0.6\frac{kg\ CH_4}{kg\ BOD_5} * 0.22 * \frac{365.25\ days}{1\ year} * \frac{1\ MT}{1{,}000kg} * 27.9 = 11{,}837\ MTCO_2e$$

Source: ICLEI 2019; calculations conducted by Ascent Environmental in 2021.

Figure 6 Sample Calculation for Estimating Carbon Dioxide Equivalent Emissions from Septic Systems

CENTRALIZED WWTPS

Emissions associated with the treatment of sewage are highly dependent on the processes and components used by specific WWTPs such as lagoons, nitrification or denitrification, and digester gas or combustion devices. There are several centralized wastewater treatment providers in the county, most of which are small-scale operations that serve a minimal number of residents and obtaining data for all facilities was not feasible. The largest wastewater provider, M1W, is a centralized WWTP that collects wastewater from customers' homes and businesses. Collected wastewater enters the regional sewer system, which is operated by M1W, and is then conveyed and pumped to the facility where it is treated before being safely reintroduced to the environment. Specific data regarding the type of WWTP and associated processes, population served, digester gas production, and daily nitrogen load were available from M1W. Due to lack of available data for the other providers and the minimal number of individuals served by these providers, it was assumed that all individuals served by centralized WWTPs were served by M1W.

Stationary CH_4 and N_2O emissions from the combustion of digester gas were calculated based on the volume of digester gas provided by M1W, using Community Protocol equation WW.1a and WW.2a, respectively. These equations contain factors for the fraction of CH_4 and N_2O in digester gas. A sample equation for estimating N_2O emissions from digester gas combustion is displayed in Figure 7. Emissions of CH_4 from digester combustion were calculated using the same equation but with a CH_4 emissions factor rather than an N_2O emissions factor.

$$Digester\ Gas\ Combustion\ N_2O\ Emissions\ (MTCO_2e) = daily\ digester\ gas\ combustion\ \left(\frac{scf}{day}\right) * fraction\ of\ CH_4\ in\ biogas * default\ BTU\ content\ of\ CH_4\ \left(\frac{BTU}{scf}\right) * BTU\ to\ MMBTU\ conversion\ factor\ \left(\frac{MMBTU}{BTU}\right) * N_2O\ emissions\ factor\ \left(\frac{kg\ N_2O}{MMBTU}\right) * kilograms\ to\ metric\ ton\ conversion\ factor\ \left(\frac{MT}{kg}\right) * days\ to\ year\ conversion\ factor\ \left(\frac{days}{year}\right) * N_2O\ GWP$$

$$Digester\ Gas\ Combustion\ N_2O\ Emissions\ (MTCO_2e) = 12{,}160\frac{scf}{day} * 0.60 * 1{,}028\frac{BTU}{scf} * \frac{1\ MMBTU}{10^6\ BTU} * \left(6.3 * 10^{-4}\ \frac{kg\ N_2O}{MMBTU}\right) * \frac{1\ MT}{1{,}000kg} * \frac{365.25\ days}{1\ year} * 273 = 0.5\ MTCO_2e$$

Source: ICLEI 2019; calculations conducted by Ascent Environmental in 2021.

Figure 7 Sample Calculation for Estimating Nitrous Oxide Emissions from Wastewater Treatment Digester Gas Combustion

Process CH_4 emissions from lagoons were calculated based on population data, using Community Protocol equation WW.6(alt) for anaerobic or facultative lagoons. Equation WW.6(alt) contains factors for the maximum CH_4 production capacity of domestic wastewater and a CH_4 correction factor for anaerobic systems. Process N_2O emissions were also calculated based on population data, using Community Protocol WW.8 for WWTPs without nitrification or denitrification. These equations contain nitrogen loading factors and WWTP emission factors. Fugitive N_2O emissions from effluent discharge were calculated based on average daily nitrogen load data provided by M1W, using Community Protocol equation WW.12. A sample calculation for wastewater treatment process CH_4 emissions is shown in Figure 8. The equation for calculating both process and fugitive N_2O emissions follow the same principles but with different data inputs.

$$Process\ CH_4\ Emissions\ from\ Lagoons\ (MTCO_2e) = population\ served * commercial\ and\ industrial\ discharge\ factor * daily\ biological\ oxygen\ demand\ load\ \left(\frac{kg\ BOD_5}{person}\right) * (1 - fraction\ of\ BOD_5\ removed\ in\ primary\ treatment) * maximum\ CH_4\ producing\ capacity\ for\ domestic\ wastewater\ \left(\frac{kg\ CH_4}{kg\ BOD_5}\right) * CH_4\ correction\ factor * days\ to\ year\ conversion\ factor\ \left(\frac{days}{year}\right) * kilograms\ to\ metric\ ton\ conversion\ factor\ \left(\frac{MT}{kg}\right) * CH_4\ GWP$$

$$Process\ CH_4\ Emissions\ from\ Lagoons\ (MTCO_2e) = 8{,}422 * 1.25 * 0.09\frac{kg\ BOD_5}{person} * (1 - 0.325) * 0.6\frac{kg\ CH_4}{kg\ BOD_5} * 0.8 * \frac{365.25\ days}{1\ year} * \frac{1\ MT}{1{,}000kg} * 27.9 = 3{,}128\ MTCO_2e$$

Source: ICLEI 2019; calculations conducted by Ascent Environmental in 2021.

Figure 8 Sample Calculation for Estimating Process Methane Emissions from Wastewater Treatment Lagoons

Energy-related emissions result from the energy required for wastewater treatment operations, including the energy used in wastewater conveyance as well as energy used throughout wastewater treatment processes and to provide power to the M1W facility. However, because M1W is located within the county, it was assumed that energy-related emissions from wastewater treatment are captured in the buildings energy sector emissions estimates.

3.4.9 Agriculture

Based on modeling conducted, emissions from the agriculture sector accounted for approximately 319,499 $MTCO_2e$ in 2019, or 33 percent of the county's emissions. Emissions in this sector are generated from livestock management, fertilizer application, the operation of agricultural equipment, and open burning. Emissions from livestock, which include enteric fermentation and manure management, accounted for 50 percent of emissions from the agriculture sector. Emissions from agricultural equipment, which include off-road vehicles and equipment as well as diesel-powered irrigation pumps, and fertilizer application accounted for 28 percent and 22 percent, respectively, and open burning accounted for less than 1 percent. The county's agriculture emissions in 2019 are summarized in Table 11, and additional details and information about this sector are included below.

Table 11 2019 Monterey County Agriculture GHG Emissions

Agricultural Activity	GHG Emissions ($MTCO_2e$)
Livestock Management	159,094
Agricultural Equipment	89,430
Fertilizer Application	70,148
Open Burning	827
Water Supply	0[1]
Total	319,499

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

[1] Because data were unavailable for electricity usage associated with agricultural water supply, water-related emissions in the agriculture sector are included in the building energy sector. See Section 3.3., "Data Quality and Accuracy" and Section 3.4.8, "Water Supply" for additional information.

Source: Ascent Environmental 2021.

LIVESTOCK MANAGEMENT

Livestock produce CH_4 and N_2O emissions through enteric fermentation (a type of digestion process) and decomposition of manure produced by these animals. The Monterey County 2019 Crop Report and USDA's 2017 Census of Agriculture provided total heads of beef calves, stocker cattle, sheep and lambs, goats, hogs, poultry, and horses (County of Monterey 2020; USDA 2019). The County of Monterey ACO confirmed livestock heads data used in this inventory. Emissions factors for livestock were obtained CARB's California GHG Emission Inventory (CARB 2021).

Livestock heads data are shown in Table 12 below, along with associated data sources.

Table 12 2019 Monterey County Livestock Heads Data and Sources

Livestock Type	Livestock Heads	Source
Calves	8,000	Monterey County 2019 Crop Report; County of Monterey ACO
Cattle	17,000	Monterey County 2019 Crop Report; County of Monterey ACO
Stocker Cattle	60,400	Monterey County 2019 Crop Report; County of Monterey ACO
Sheep and Lambs	1,200	Monterey County 2019 Crop Report; County of Monterey ACO
Goats	912	USDA 2017 Census of Agriculture
Hogs	1,600	Monterey County 2019 Crop Report; County of Monterey ACO
Poultry	2,229	USDA 2017 Census of Agriculture
Horses	1,475	USDA 2017 Census of Agriculture

Notes: ACO = Agricultural Commissioner's Office; USDA = U.S. Department of Agriculture.

Source: Ascent Environmental 2021.

Livestock emissions factors for enteric fermentation and manure management are displayed in Table 13. Emissions factors were obtained from CARB's California GHG Emission Inventory.

Table 13 2019 Monterey County Enteric Fermentation and Manure Management Emissions Factors

Livestock Type	Enteric Fermentation Emissions Factor (kg CH_4/head)	Manure Management Emissions Factor (kg CH_4/head)	Manure Management Emissions Factor (kg N_2O/head)
Calves	25	0.56	0
Cattle	96	3.20	0
Stocker Cattle	59	1.95	0
Sheep and Lambs	8	0.70	0.40
Goats	5	0.37	0.37
Hogs	1.5	16.22	0.10
Poultry	0	0.10	0.02
Horses	18	3.29	1.34

Notes: CH_4 = methane; kg = kilogram; N_2O = nitrous oxide.

Source: Ascent Environmental 2021.

Figure 9 below illustrates an example calculation for estimating livestock management CH_4 emissions from stocker cattle. This equation was used to calculate livestock management emissions for all other livestock using data for heads and emissions factors specific to each livestock type.

$$Livestock\ Management\ CH_4\ Emissions\ from\ Stocker\ Cattle\ (MTCO_2e) = \Bigg[\Bigg(stocker\ cattle\ heads * \Bigg(enteric\ fermentation\ CH_4\ emissions\ factor\ \left(\frac{kg\ CH_4}{head}\right) + manure\ management\ CH_4\ emissions\ factor\ \left(\frac{kg\ CH_4}{head}\right)\Bigg) * CH_4\ GWP\Bigg) + \Bigg(stocker\ cattle\ heads * manure\ management\ N_2O\ emissions\ factor\ \left(\frac{kg\ N_2O}{head}\right) * N_2O\ GWP\Bigg)\Bigg] * kilogram\ to\ metric\ ton\ conversion\ factor\left(\frac{MT}{kg}\right)$$

$$Livestock\ Management\ CH_4\ Emissions\ from\ Stocker\ Cattle\ (MTCO_2e) = \left[\left(60{,}400\ heads * \left(59\frac{kg\ CH_4}{head} + 1.95\frac{kg\ CH_4}{head}\right) * 27.9\right) + \left(60{,}400\ heads * 0\frac{kg\ N_2O}{head} * 273\right)\right] * \frac{1\ MT}{1{,}000\ kg} = 103{,}548\ MTCO_2e$$

Source: CARB 2021; calculations conducted by Ascent Environmental in 2021.

Figure 9 Sample Calculation for Estimating Livestock Management Methane Emissions from Stocker Cattle

AGRICULTURAL EQUIPMENT

GHG emissions associated with agricultural equipment were obtained from CARB's OFFROAD2007 and OFFROAD2021 models, as discussed in Section 3.3.4, "Off-Road Vehicles and Equipment." Agricultural equipment emissions obtained from CARB were assumed to occur entirely within the unincorporated county.

Agricultural equipment emissions also include emissions from diesel-powered irrigation pumps. The County provided the number of pumps in the county, and GHG emissions were estimated using MBARD-specific emissions factors obtained from CARB (CARB 2006). Activity data and associated GHG emissions from agricultural equipment are included in Table 14.

Table 14 2019 Monterey County Agricultural Equipment Data and Sources

Equipment Type	Activity Data	GHG Emissions ($MTCO_2e$)	Source
Off-Road Agricultural Equipment	—[1]	61,564	CARB
Diesel-Powered Irrigation Pumps	446 pumps	27,866	County

Notes: CARB = California Air Resources Board; County = County of Monterey.

[1] Emissions from off-road agricultural equipment were obtained directly from CARB's OFFROAD2007 and OFFROAD2021 models; no activity data were used to calculate emissions estimates.

Source: Ascent Environmental 2021.

A sample calculation for estimating emissions from diesel-powered irrigation pumps is displayed in Figure 10.

$$\mathit{Diesel\text{-}Powered\ Irrigation\ Pump\ Emissions}\ (MTCO_2e) = \mathit{number\ of\ pumps} * CO_2\ \mathit{emissions\ factor}\ \left(\frac{tons\ CO_2}{day*pump}\right) * \mathit{days\ to\ year\ conversion\ factor}\ \left(\frac{days}{year}\right) * \mathit{tons\ to\ metric\ tons\ conversion\ factor}\left(\frac{MT}{ton}\right)$$

$$\mathit{Diesel\text{-}Powered\ Irrigation\ Pump\ Emissions}\ (MTCO_2e) = 446\ pumps * 0.189\ \frac{tons\ CO_2}{day*pump} * \frac{365.25\ days}{1\ year} * \frac{0.907\ MT}{1\ ton} = 27{,}866\ MTCO_2e$$

Source: CARB 2006; calculations conducted by Ascent Environmental in 2021.

Figure 10 Sample Calculation for Estimating Carbon Dioxide Equivalent Emissions from Irrigation Pumps

FERTILIZER APPLICATION

The application of fertilizers and other soil amendments produces GHG emissions. Nitrogen fertilizers produce N_2O emissions, and application of lime produces emissions of CO_2. Synthetic and organic nitrogen application was calculated by AMBAG using crop acreages obtained from the Monterey County 2019 Crop Report and crop-specific fertilizer application rates in pounds per acre obtained from a variety of sources such as CDFA's California Crop Fertilization Guidelines and University of California, Davis's Vegetable Research & Information Center. Data regarding tonnage of lime were obtained from CDFA's *2019 Fertilizer Tonnage Report* (CDFA 2019). Emissions factors and quantification methods for GHG emissions associated with application of nitrogen and lime were obtained from CARB and IPCC, respectively (IPCC 2006). Data for fertilizer and lime application is presented in Table 15 below, and additional data can be found in Appendix A.

Table 15 2019 Monterey County Fertilizer and Lime Application Data and Sources

Application Type	Application Amount (tons)	Source
Organic Nitrogen (including urea)	3,980	AMBAG
Synthetic Nitrogen (including urea)	17,536	AMBAG
Lime	20,768	CDFA

Notes: AMBAG = Association of Monterey Bay Area Governments; CDFA = California Department of Food and Agriculture.

Source: Ascent Environmental 2021.

Emissions factors and data sources for fertilizer and lime application are shown in Table 16.

Table 16 2019 Monterey County Fertilizer and Lime Application Emissions Factors and Sources

Application Type	Fertilizer Emissions Factor (g N_2O/ton N)	Source	Lime Application Emissions Factor (g CO_2/ton Lime)	Source
Organic Nitrogen (including urea)	14,253	CARB	NA	NA
Synthetic Nitrogen (including urea)	9,688	CARB	NA	NA
Lime	NA	NA	398,886	IPCC

Notes: CARB = California Air Resources Board; CO_2 = carbon dioxide; g = grams; IPCC = Intergovernmental Panel on Climate Change; N = nitrogen; N_2O = nitrous oxide; NA = not applicable.

Source: Ascent Environmental 2021.

Figure 11 below shows a sample calculation for estimating emissions from synthetic fertilizer application. The same equation was used to estimate emissions from organic nitrogen fertilizer and lime application using application type-specific data and emissions factors.

$$Synthetic\ Nitrogen\ Fertilizer\ Application\ Emissions\ (MTCO_2e) = quantity\ of\ synthetic\ nitrogen\ fertilizer\ applied\ (tons) * N_2O\ emissions\ factor\ \left(\frac{g\ N_2O}{ton\ N_2O}\right) * grams\ to\ metric\ tons\ conversion\ factor\left(\frac{MT}{g}\right) * N_2O\ GWP$$

$$Synthetic\ Nitrogen\ Fertilizer\ Application\ Emissions\ (MTCO_2e) = 17{,}536\ tons * 9{,}688\frac{g\ N_2O}{ton\ N_2O} * \frac{1MT}{1{,}000{,}000g} * 273 = 46{,}379\ MTCO_2e$$

Source: CARB 2021; calculations conducted by Ascent Environmental in 2021.

Figure 11 Sample Calculation for Estimating Carbon Dioxide Equivalent Emissions from Fertilizer Application

OPEN BURNING

Open burning refers to agricultural and non-agricultural burning of vegetative matter, hazard reduction and ditch/road maintenance burning, and other burn activities that are permitted by MBARD. Tons of vegetative matter burned were obtained from MBARD, and CO_2 and CH_4 emissions factors were obtained from NWCG's *2018 Smoke Management Guide for Prescribed Fire* (NWCG 2018). It is important to note that MBARD was unable to provide a full dataset for all open burning operations, so emissions estimates for this source are likely underreported. Table 17 below shows data and emissions factors for open burning, including associated data sources.

Table 17 2019 Monterey County Open Burning Data, Emissions Factors, and Sources

Open Burning	Quantity (tons)	Source	CO_2 Emissions Factor (g CO_2/ton)	CH_4 Emissions Factor (g CH_4/ton)	Source
Vegetative Materials	497	MBARD	1,454,670	7,530	NWCG

Notes: CH_4 = methane; CO_2 = carbon dioxide; g = grams; MBARD = Monterey Bay Air Resources District; N_2O = nitrous oxide; NWCG = National Wildfire Coordinating Group.

Source: Ascent Environmental 2021.

A sample calculation for estimating open burning emissions is displayed in Figure 12.

$$Open\ Burning\ Emissions\ (MTCO_2e) = quantity\ of\ vegetative\ materials\ burned\ (tons) * \left[\left(CO_2\ emissions\ factor\ \left(\frac{g\ CO_2}{ton}\right) * CO_2\ GWP\right) + \left(CH_4\ emissions\ factor\ \left(\frac{g\ CH_4}{ton}\right) * CH_4\ GWP\right)\right] * grams\ to\ metric\ tons\ conversion\ factor\left(\frac{MT}{g}\right)$$

$$Open\ Burning\ Emissions\ (MTCO_2e) = 497\ tons * \left[\left(1{,}454{,}670\frac{g\ CO_2}{ton} * 1\right) + \left(7{,}530\frac{g\ CH_4}{ton} * 27.9\right)\right] * \frac{1MT}{1{,}000{,}000g} = 827\ MTCO_2e$$

Source: NWCG 2018; calculations conducted by Ascent Environmental in 2021.

Figure 12 Sample Calculation for Estimating Carbon Dioxide Equivalent Emissions from Open Burning

3.4.10 Additional Community Inventory Greenhouse Gas Emissions Sources

Additional GHG emissions sources were evaluated for the County's community inventory. Although these sources are not included in the total community GHG emissions for the inventory, they provide additional context for understanding emissions in the county. Details regarding GHG emissions from regulated stationary sources are discussed below.

REGULATED STATIONARY SOURCES

GHG emissions are generated from a variety of regulated stationary sources operating within the county. As shown in Table 18 below, many facilities include two types of GHG emissions estimates: those considered "Covered" and those considered "Non-Covered." "Covered" emissions are those that are regulated by CARB under the California Greenhouse Gas Cap-and-Trade Program (Cap-and-Trade). "Non-Covered" emissions are associated with the facilities regulated under Cap-and-Trade but are separate from the allowance budget. Cap-and-Trade establishes an aggregate GHG allowance budget on covered entities and provides a trading mechanism for compliance instruments (allowance or offset credit). Facilities regulated under Cap-and-Trade may purchase allowances to emit GHG emissions from facilities that reduce GHG emissions (e.g., solar farms) or sell emission offset credits to regulated facilities that need to reduce their emissions to meet CARB's industry-wide emissions cap. Currently, CARB gives such allowances to facilities that emit more than 25,000 $MTCO_2e$ per year. These entities primarily involve heavy industrial activities that consume large amounts of natural gas and are eligible purchasers of Cap-and-Trade emissions allowances because the facility emits more than 25,000 $MTCO_2e$ per year. Due to the involvement of many facilities located in the county in Cap-and-Trade, the State, and not the County, is responsible for reducing emissions from this sector. For the purposes of developing the community inventory, emissions associated with Cap-and-Trade covered facilities, including the non-covered emissions, are excluded.

In addition to Cap-and-Trade covered facilities, other regulated stationary sources of GHG emissions in the county are oil and gas operations, which is explained further below.

Table 18 2019 Monterey County GHG Emissions from Regulated Stationary Sources

Facility Name	Industry Description	Covered GHG Emissions ($MTCO_2e$)	Non-Covered GHG Emissions ($MTCO_2e$)	Total GHG Emissions ($MTCO_2e$)
Aera Energy Coastal Basins	Crude Petroleum and Natural Gas Extraction	405,706	1,501	407,207
Calpine - King City Cogen, LLC, King City Cogen Peaker	Fossil Fuel Electric Power Generation	80,503	0	80,503
Chevron AAPG 740 Coastal Basin	Crude Petroleum and Natural Gas Extraction	229,859	2,128	231,988
Chevron AAPG 745 San Joaquin Basin	Crude Petroleum and Natural Gas Extraction	2,418,316	15,528	2,433,844
Chevron Products Company - Headquarters Fuel Supplier	Petroleum Refineries	32,084,209	2,866,462	34,950,670
Dynegy Moss Landing, LLC	Fossil Fuel Electric Power Generation	1,940,437	0	1,940,437
Eagle Petroleum - Lynch Canyon Field	Crude Petroleum and Natural Gas Extraction	27,871	409	28,280
Lhoist North America - Natividad Plant	Lime Manufacturing	82,662	13	82,675
Matsui Nursery, Inc.	Floriculture Production	0	12,803	12,803
Monterey Bay Community Power	Electric Power Distribution	0	0	0
Monterey Regional Waste Management District	Solid Waste Landfill	0	16,984	16,984
Salinas River Cogeneration Facility	Fossil Fuel Electric Power Generation	221,314	0	221,314
Viasyn, Inc.	Electric Bulk Power Transmission and Control	1	0	1
Total	NA	37,490,879	2,915,827	40,406,705

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gases; $MTCO_2e$ = metric tons of carbon dioxide equivalent; NA = not applicable.

Source: Data obtained from CARB; table compiled by Ascent Environmental in 2021.

OIL AND GAS

Based on modeling conducted, emissions from the oil and gas sector accounted for approximately 83,245 $MTCO_2e$ in 2019. Emissions from oil and gas are associated with the onsite combustion of fossil fuels (e.g., diesel, crude oil byproducts) as well as fugitive (i.e., "leaked") emissions resulting from the processing and extraction of oil and gas. Onsite fuel combustion accounted for approximately 20 percent of emissions from this sector, and fugitive emissions contributed approximately 80 percent of emissions. The county's oil and gas emissions in 2019 are summarized in Table 19, and additional details and information about this sector are included below.

Similar to the Cap-and-Trade covered facilities discussed above, the oil and gas sector is highly regulated by the State. The Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities (Methane Regulation) adopted by CARB in 2017 aims to reduce fugitive and vented emissions of methane from new and existing oil and gas facilities. The Methane Regulation established uniform control requirements for methane sources, including those from oil and gas facilities. Additionally, the County's GHG inventory follows the Community Protocol, which recommends that local agencies report on "GHG activities and sources over which [the] local government has significant influence" (ICLEI 2019:20). Because the County has limited authority over existing oil and well facilities, and the fact these facilities are highly regulated by the State, this sector is excluded from the inventory total.

Table 19 2019 Monterey County Oil and Gas GHG Emissions

Source	GHG Emissions ($MTCO_2e$)
Onsite Fuel Combustion	16,402
Fugitive Emissions	66,843
Total	83,245

Notes: Totals may not sum exactly due to independent rounding. $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Ascent Environmental 2021.

Onsite Fuel Combustion

According to CARB, onsite fuel combustion emissions included in CARB's California GHG Emission Inventory consist of GHG emissions generated by equipment burning fuel for energy. To estimate the county's emissions from this sector, statewide oil and gas production data by county obtained from the California Department of Conservation were used to calculate the county's proportion of production for various types of oil and gas operations in the state. These proportions were applied to statewide oil and gas emissions data available from CARB's California GHG Emission Inventory to scale emissions to the county. This inventory does not include emissions related to the combustion of products sold by the oil and gas producers, such as vehicular fuels or other petroleum products, nor does the inventory include supply chain-related emissions, such as the transport of oil via rail or maritime tankers.

Fugitive Emissions

Fugitive emissions, or unintentional releases of vapors to the atmosphere, from oil and gas operations are typically attributed to equipment leaks, process venting, evaporation losses, disposal of waste gas streams (e.g., by flaring), and accidents or equipment failures. Fugitive emissions were estimated using the same methods described above for onsite fuel combustion.

4 SUMMARY OF INVENTORY RESULTS

4.1 2019 COMMUNITY INVENTORY

Based on the modeling conducted, community activities in the county generated approximately 966,203 $MTCO_2e$ in 2019. The largest emissions-generating sectors include agriculture, on-road transportation, and nonresidential building energy. The 2019 inventory will be the County's GHG emissions baseline for the CCAAP and will be used to forecast emissions and set emissions reductions targets. Table 20 and Figure 13 present the results of the County's 2019 community GHG emissions inventory by sector. Descriptions of each emissions sector, including key sources of emissions, are provided in further detail above in Section 3, "Data, Methods, and Assumptions"

Table 20 2019 Monterey County Community GHG Emissions Inventory

Sector	GHG Emissions ($MTCO_2e$)	Percent of Total
Agriculture	319,499	33
On-Road Transportation	291,389	30
Nonresidential Building Energy	170,639	18
Residential Building Energy	81,750	8
Solid Waste	69,724	7
Off-Road Vehicles and Equipment	17,616	2
Wastewater Treatment	15,586	2
Water Supply[1]	0	0
Total	966,203	100

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gases; $MTCO_2e$ = metric tons of carbon dioxide equivalent; NA = not applicable.

1 Water supply emissions are estimated to be 0 $MTCO_2e$ because electricity consumption associated with extraction, conveyance, treatment, and distribution are captured in the building energy sectors (both residential and nonresidential).

Source: Ascent Environmental 2021.

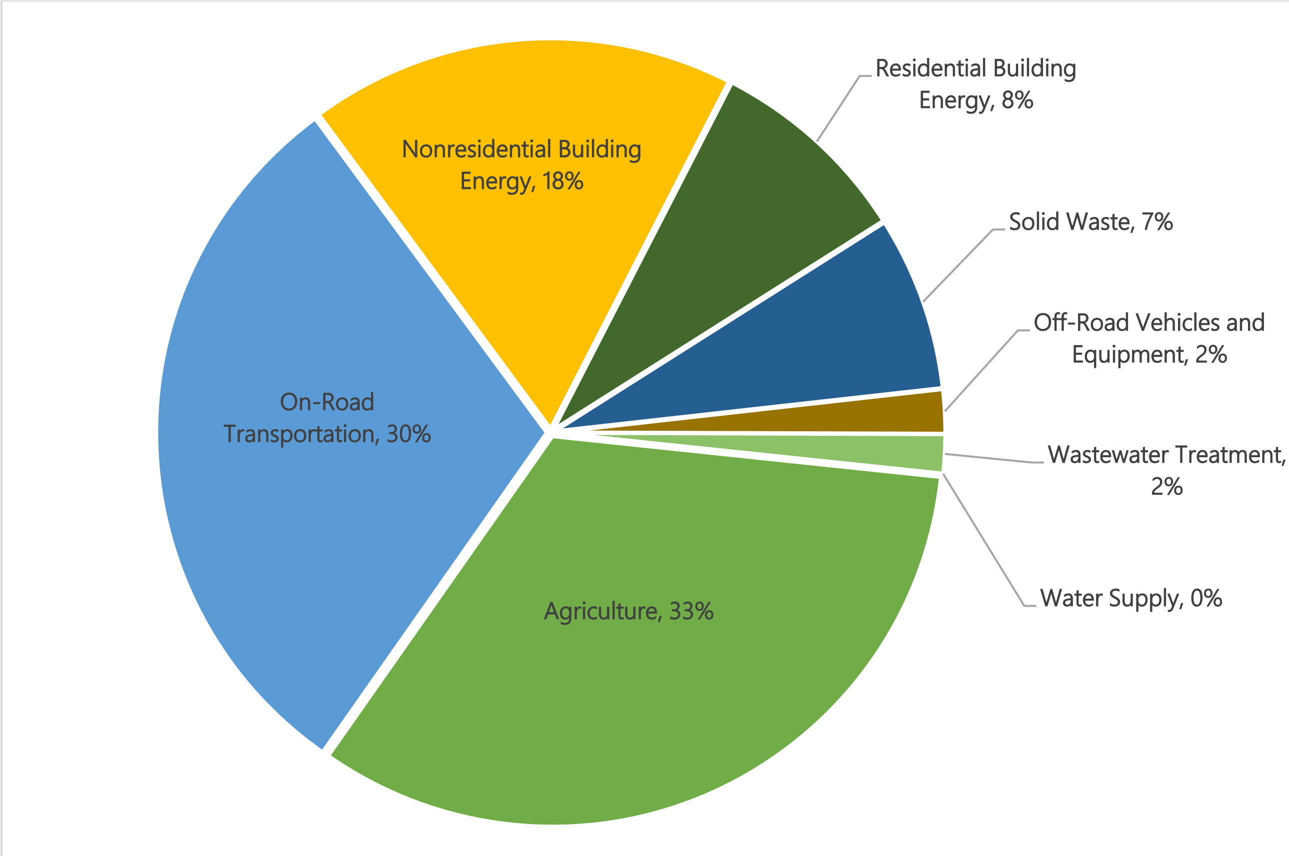

Figure 13 2019 Monterey County Community GHG Emissions Inventory

5 REFERENCES

Association of Monterey Bay Area Governments. 2020 (November). Final 2022 Regional Growth Forecast. Available: https://www.ambag.org/plans/regional-growth-forecast. Accessed August 1, 2021.

California Air Resources Board. 2006. *Rulemaking to Consider Proposed Amendments to the Stationary Diesel Engine Control Measure - Appendix D: Emission Inventory Methodology Agricultural Irrigation Pumps - Diesel*. Available: http://www.arb.ca.gov/regact/agen06/append.pdf. Accessed August 26, 2021.

———. 2017. *California's 2017 Climate Change Scoping Plan*. Available: https://ww2.arb.ca.gov/sites/default/files/classic/cc/scopingplan/scoping_plan_2017.pdf. Accessed August 2, 2021.

———. 2020a. Mobile Source Emissions Inventory – Off-Road Documentation. Available: https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/msei-road-documentation-0. Accessed August 1, 2021.

———. 2021. Greenhouse Gas Emission Inventory - Query Tool for years 2000 to 2019 (14^{th} Edition). Available: https://www.arb.ca.gov/app/ghg/2000_2019/ghg_sector.php. Accessed August 19, 2021.

California Department of Food and Agriculture. 2019. *Fertilizing Materials Tonnage Report*. Available: http://www.cdfa.ca.gov/is/ffldrs/pdfs/2019_Tonnage.pdf. Accessed August 22, 2021.

California Department of Resources Recycling and Recovery. 2021. Jurisdiction Disposal and Alternative Daily Cover (ADC) Tons by Facility. Available: https://www2.calrecycle.ca.gov/LGCentral/DisposalReporting/Destination/DisposalByFacility. Accessed August 11, 2021.

California Governor's Office of Planning and Research. 2017. *General Plan Guidelines, Chapter 8: Climate Change*. Available: https://opr.ca.gov/planning/general-plan/guidelines.html. Accessed August 4, 2021.

CalRecycle. *See* California Department of Resources Recycling and Recovery.

CARB. *See* California Air Resources Board.

County of Monterey. 2020. Monterey County 2019 Crop Report. Available: https://www.co.monterey.ca.us/home/showpublisheddocument/92362/637356978155970000. Accessed August 16, 2021.

———. No date. Monterey County Water Resources Agency – Overview. Available: https://www.co.monterey.ca.us/government/government-links/water-resources-agency-old/programs/groundwater-level-monitoring/overview#wra. Accessed August 13, 2021.

EPA. *See* U.S. Environmental Protection Agency.

ICLEI. *See* ICLEI – Local Governments for Sustainability.

IPCC. *See* Intergovernmental Panel on Climate Change.

ICLEI – Local Governments for Sustainability. 2019. *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions*. Version 1.2.

Intergovernmental Panel on Climate Change. 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Agriculture, Forestry and Other Land Use.* Available: https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_11_Ch11_N2O&CO2.pdf. Accessed August 24, 2021.

———. 2021 (August). *Climate Change 2021: The Physical Science Basis. Chapter 7: The Earth's energy budget, climate feedbacks, and climate sensitivity - Supplementary Material.* Available: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf. Accessed August 18, 2021.

Monterey County Water Resources Agency. 2018 (September). *Integrated Regional Water Management Plan for the Greater Monterey County Region.* Available: http://www.greatermontereyirwmp.org/documents/plan/. Accessed August 14, 2021.

MCWRA. *See* Monterey County Water Resources Agency.

National Wildfire Coordinating Group. 2018. *Smoke Management Guide for Prescribed Fire*. Available: https://www.nwcg.gov/sites/default/files/publications/pms420-2.pdf. Accessed August 24, 2021.

NWCG. *See* National Wildfire Coordinating Group.

OPR. *See* California Governor's Office of Planning and Research.

TCR. *See* The Climate Registry.

The Climate Registry. 2020. *2020 Default Emission Factor Document*. Available: https://www.theclimateregistry.org/wp-content/uploads/2020/04/The-Climate-Registry-2020-Default-Emission-Factor-Document.pdf. Accessed August 5, 2021.

U.S. Department of Agriculture. 2019 (April). 2017 Census of Agriculture: California – State and County Data. Available: https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/California/cav1.pdf. Accessed August 20, 2021.

U.S. Environmental Protection Agency. 2021 (February). *Emissions & Generation Integrated Database (eGRID).* Available: https://www.epa.gov/egrid/download-data. Accessed August 1, 2021.