Appendix B:

Technical Methodology for the 2022 San Diego Regional Greenhouse Gas Emissions Inventory

Contents

1 Introduction

SANDAG contracted with the Energy Policy Initiatives Center at the University of San Diego (USD EPIC) to estimate the 2022 greenhouse gas (GHG) emissions for the San Diego region. EPIC followed the same methods used in developing the 2022 GHG inventory for SANDAG's Draft 2025 Regional Plan.[1]

1.1 Overview of the Appendix

This appendix includes the following sections:

- **Background** provides common background sources and assumptions used for the inventory.
- **Inventory Results** provides the results of the 2022 GHG inventory.
- **Method to Calculate Emissions Inventory** includes subsections that cover the methods used to develop the inventory by emissions category.

2 Background

2.1 Greenhouse Gases

The primary GHGs included in this document are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), and others are included where data is available. Each GHG has a different capacity to trap heat in the atmosphere, known as its global warming potential (GWP), which is normalized relative to CO_2 and expressed in carbon dioxide equivalents (CO_2e). The 100-year GWPs reported by the Intergovernmental Panel on Climate Change (IPCC) are used by the California Air Resources Board (CARB) to estimate GHG emissions inventories statewide.[2] The GWPs in this document are from the IPCC Fourth Assessment Report (AR4), provided in **Table B.1**.[3] The IPCC AR4 values were used in lieu of updated values from the Sixth Assessment Report (AR6) to be consistent with California's statewide GHG inventory, which uses AR4 values to maintain year over year consistency.

Table B.1: Global Warming Potentials in the Regional Greenhouse Gas Inventory

Greenhouse Gas	Global Warming Potential
Carbon dioxide (CO_2)	1
Methane (CH_4)	25
Nitrous oxide (N_2O)	298
Difluoromethane (HFC-32)	675
1,1,1,2-Tetrafluoroethane (HFC-134a)	1,430
Pentafluoroethane (HFC-125)	3,500
1,1,1-Trifluoroethane (HFC-143a)	4,470
Carbon tetrafluoride (CF_4)	7,390

[1] SANDAG's Regional Plan is the regional transportation plan and sustainable communities strategy for the San Diego region.
[2] CARB: Current California GHG Emission Inventory Data. 2000–2022 GHG Inventory (2024 Edition).
[3] IPCC Fourth Assessment Report: Climate Change 2007: Direct Global Warming Potentials (2013).

Greenhouse Gas	Global Warming Potential
Octafluoropropane (C_3F_8)	8,830
1,1,1,3,3,3-Hexafluoropropane (HFC – 236fa)	9,810
Octafluorocyclobutane (C_4F_8)	10,300
Hexafluoroethane (C_2F_6)	12,200
Fluoroform (HFC-23)	14,800
Nitrogen trifluoride (NF_3)	17,200
Sulfur hexafluoride (SF_6)	22,800

Source: IPCC 2013

2.2 Rounding of Values in Tables and Figures

Rounding is used only for the final GHG values within the tables and figures throughout the document. Values are rounded to the nearest integer. Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values summed in any table or figure.

3 Inventory Results

Table B.2 and **Figure B.1** provide a summary of the 2022 GHG inventory in million metric tons of carbon dioxide equivalent (MMT CO_2e) by sector in the San Diego region.

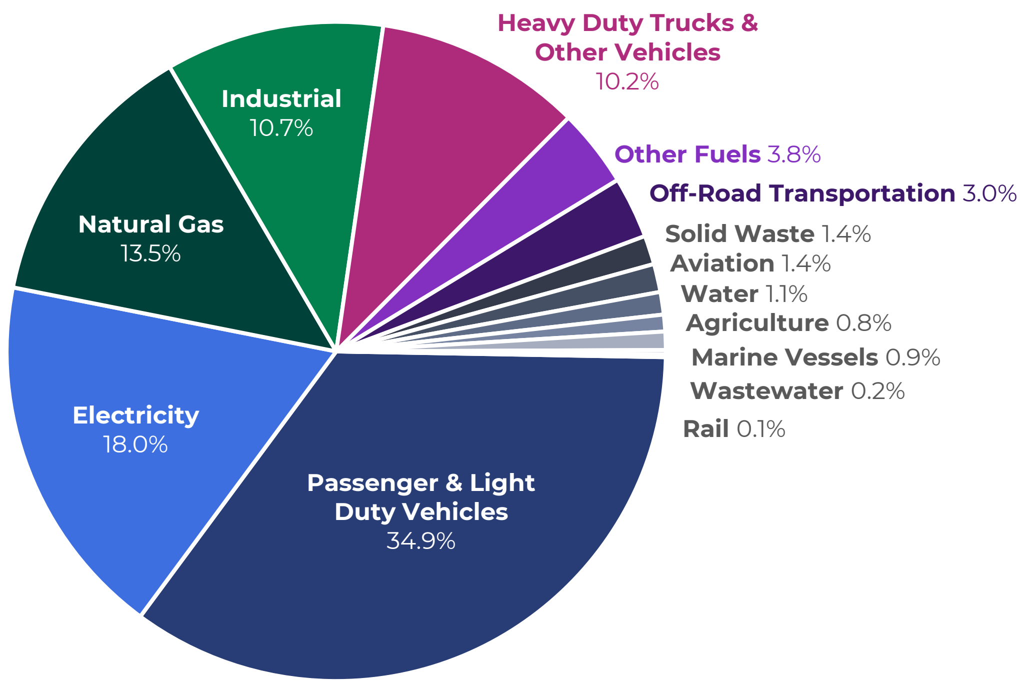
Table B.2: Summary of 2022 Greenhouse Gas Inventory in MMT CO_2e*

Emissions Category	2022
Passenger Cars and Light-Duty Vehicles	7.80
Electricity	4.03
Natural Gas	3.01
Industrial	2.40
Heavy Duty Trucks and Other Vehicles	2.28
Other Fuels	0.86
Off-Road Vehicles	0.68
Solid Waste	0.32
Aviation	0.31
Water	0.25
Marine Vessels	0.20
Agriculture	0.18
Wastewater	0.05
Rail	0.03
Total	**22.39**

*MMT – million metric tons

Source: USD EPIC 2025

Figure B.1: Relative Distribution of 2022 Greenhouse Gas Emissions by Sector



Source: USD EPIC, 2025

This inventory does not include emissions from vegetation nor sequestration to vegetation, which follows CARB's approach to track statewide GHG emissions from anthropogenic activities separately from the GHG flux associated with carbon stocks in California's natural and working lands[4] and wildfire emissions. This is because wildfires are part of Earth's carbon cycle and it is difficult to determine how much of the wildfire emissions are from anthropogenic activities.[5, 6]

The forecast includes the regional effects of existing federal and State polices and regulations to reduce GHG emissions. The projected reductions are based on the current implementation timeline of these regulations.

[4] CARB began a natural and working lands carbon and GHG flux assessment in 2018 based on IPCC principles. See **arb.ca.gov/nwl-inventory**.

[5] CARB: **Frequently Asked Questions: Wildfire Emissions.**

[6] California Senate Bill 901 (Dodd, 2018) (SB 901) requires that the state develops a report assessing GHG emissions from wildfire and forest management activities by December 2020 and every five years thereafter. The SB 901 2020 report provides wildfire estimates for the years 2000–2019. See **California Wildfire Burn Acreages and Preliminary Emissions Estimates.**

4 Method to Calculate Emissions Inventory by Category

4.1 On-Road Transportation – Passenger Cars and Light-Duty Vehicles

The passenger cars and light-duty vehicle emissions category include tailpipe GHG emissions resulting from fossil fuel combustion (i.e., gasoline, diesel, natural gas) in mobile vehicles on freeways, highways, and local roads. This passenger cars and light-duty vehicles emissions category covers the GHG emissions from EMFAC2017 vehicle classes LDA, LDT1, LDT2, and MDV.[7] The GHG emissions from other on-road vehicles are accounted for in the subsection titled **On-Road Transportation – Heavy-Duty Trucks and Vehicles**. Passenger cars and light-duty vehicle emissions are the largest contributor of GHG emissions in the San Diego region, accounting for about 35% of total GHG emissions in the 2022 inventory.

Method Used to Estimate 2022 Emissions

SANDAG developed an updated activity-based model (ABM15.2.1), which estimates the vehicle miles traveled (VMT) on an average weekday by vehicle type. Modeling generated estimates for the year 2022 and forecasted values for years 2026, 2029, 2032, 2040, and 2050. EMFAC2017, CARB's on-road mobile sources emissions model, was used to estimate emissions for passenger cars and light-duty vehicles.[8] The EMFAC model provides CO_2 emissions in tons per weekday for each vehicle category and each fuel type. CARB creates this model using fuel sales, smog testing data, and vehicle registration data to model the current and projected emissions intensity of cars on the road in the San Diego region.

To convert the emissions output from tons of CO_2 per weekday to metric tons of CO_2e per year, EPIC used the weekday-to-year conversion factor and CO_2-to-CO_2e (CO_2, CH_4, and N_2O) conversion factor for each EMFAC vehicle category, based on statewide GHG inventory assumptions and EMFAC2017 default run results, respectively.[9] The weekday-to-annual conversion factors for LDA, LDT1, LDT2 and MDV are all 347 weekdays per year. The CO_2 to CO_2e conversion factors range from 1.01 for gasoline LDA to 1.05 for diesel LDB.[10] The key inputs and results are shown in **Table B.3**.

Table B.3: Key Inputs and 2022 Greenhouse Gas Emissions from On-Road Transportation – Passenger Cars and Light-Duty Vehicles

Key Inputs and 2022 Greenhouse Gas Emissions from On-Road Transportation – Passenger Cars and Light-Duty Vehicles	
VMT (Miles per weekday)*	71,244,124
CO_2 Emissions (Tons per weekday)**	24,543
Conversion Factor (Tons CO_2 per weekday to MT CO_2e per year)	318
GHG Emissions (MT CO_2e)	**7,804,938**

[7] LDA: passenger cars; LDT1: light-duty trucks with gross vehicle weight rating (GVWR) less than 6,000 lbs. and equivalent test weight (ETW) no larger than 3,750 lbs.; LDT2: light-duty trucks with GVWR less than 6,000 lbs. and ETW between 3,750 and 5,750 lbs.; and MDV: medium-duty trucks with GVWR between 6,000 and 8,500 lbs.

[8] CARB: Mobile Source Emissions Inventory. EMFAC 2017.

[9] This approach is recommended by CARB EMFAC staff. Personal communication, January 27, 2020.

[10] The weekday-to-year conversion factors are based on CARB's California's 2004–2014 Greenhouse Gas Emission Inventory Technical Support Document. 2016 Edition. The CO_2-to-CO_2e conversion factors are based on EMFAC2017 default 2016 emissions run for San Diego region by vehicle category and fuel type, March 2025, model run.

GHG Emissions (MMT CO_2e)	7.80

*SANDAG ABM15.2.1 VMT
**EMFAC2017 model run with custom VMT inputs from ABM15.2.1
Passenger cars and light-duty vehicles are EMFAC2017 vehicle classes LDA, LDT1, LDT2, and MDV.

Source: CARB 2017; SANDAG 2025; USD EPIC 2025

4.2 Electricity

The electricity category accounts for emissions from regional electricity consumption. GHG emissions from electricity use in the San Diego region account for 18% of total emissions in the 2022 inventory.

Method Used to Estimate 2022 Emissions

To estimate GHG emissions from grid-supplied electricity use, EPIC adjusted 2022 electricity sales to reflect transmission and distribution losses and multiplied the adjusted sales by the electricity emission factor for the respective electricity provider, expressed in pounds of CO_2e per megawatt-hour (lbs CO_2e/MWh).

The local utility, San Diego Gas & Electric (SDG&E), provided 2022 San Diego regional electricity sales data separately by bundled customers (i.e., receiving both energy and delivery from SDG&E), Direct Access (DA) customers (i.e., receiving energy from an energy service provider and delivery from SDG&E), and Community Choice Aggregation (CCA)(i.e., receiving energy from a CCA and delivery from SDG&E) for each customer class. The San Diego regional electricity sales data account for electricity sales to all local jurisdictions, including military bases and tribal reservations.[11] The transmission and distribution loss factor, 0.082, is the loss estimate for the entire SDG&E service territory (larger than San Diego region) and accounts for the difference between electricity generated for load and electricity sales.[12]

SDG&E, CCAs, and electric service providers (ESPs) for DA customers have different power mixes in their electricity supplies. The SDG&E 2022 bundled and CCA electricity supply emission factors were retrieved from the California Energy Commission (CEC) Power Source Disclosure Program. **Table B.4** documents each load serving entity's respective 2022 reported emission factors. The DA emission factor, 641 lbs CO_2e/MWh, was calculated using a statewide average of all ESP's emission factors weighted by total energy supplied, also retrieved from the CEC's Power Source Disclosure Program.[13]

[11] Electricity sales data provided by SDG&E to EPIC, February 2025.
[12] Loss factor is from CEC Energy Demand 2023 Forecast. For each forecast cycle, utilities provide the estimates, which remain relatively stable.
[13] CEC. **Power Source Disclosure Program data**.

Table B.4: San Diego Regional 2022 Emission Factors

San Diego Regional 2022 Emission Factors	
Load Serving Entity/Service Option	**lbs CO_2e/MWh**
SDG&E Bundled[14]	508
San Diego Community Power – Power On[15]	375
San Diego Community Power – Power 100	0
Clean Energy Alliance – Clean Impact Power[16]	472
Clean Energy Alliance – Clean Impact Power Plus	143
Clean Energy Alliance – Green Impact Power	0
Direct Access Energy Service Providers	641

Source: CEC 2024; USD EPIC 2025

Three adjustments are made to the emissions estimate for grid-supplied electricity:

- Emissions associated with electricity use at water treatment plants in the San Diego region were allocated to the water category and removed from the electricity category. The method used to identify electricity use at water treatment plants is discussed in the **Water** section of this appendix.
- Emissions associated with electric commuter rail in the San Diego region were allocated to the rail category and removed from the electricity category. The method used to identify electricity use for commuter rail is discussed in the **Rail** section of this appendix.
- Emissions associated with natural gas used for electric generation that is consumed by the customer on-site (i.e., self-serve), mostly at co-generation plants, were removed from the natural gas category and allocated to the electricity category. EPIC used the CEC Quarterly Fuel and Energy Report (QFER) Power Plant Owner Reporting database, U.S. Energy Information Administration (EIA) Form 923 data, and the 2022 SDG&E Power Source Disclosure Program Schedule 1: Procurements and Retail Sales to identify the co-generation plants and the amount of self-serve electric generation.

With these adjustments, the key inputs and results are shown in **Table B.5**.

[14] SDG&E **2022 Power Content Label.**
[15] San Diego Community Power **2022 Power Content Label.**
[16] Clean Energy Alliance **2022 Power Content Label.**

Table B.5: Key Inputs and 2022 Greenhouse Gas Emissions from Electricity

Key Inputs and 2022 Greenhouse Gas Emissions from Electricity	
Electricity Sales – Bundled (MWh)	6,331,771
Electricity Sales – Direct Access (MWh)	3,711,568
Electricity Sales – CCA (MWh)	6,104,050
Transmission and Distribution Loss Factor	1.082
GHG Emissions (MT CO_2e) before adjustments	3,684,429
GHG Emissions associated with Electricity for Water Treatment – Excluded (MT CO_2e)	−79,900
GHG Emissions associated with Electricity for Rail – Excluded (MT CO_2e)	−13,100
GHG Emissions Associated with Natural Gas Used at On-site Self-serve Electric Generation – Added (MT CO_2e)	435,600
GHG Emissions (MT CO_2e)	**4,027,000**
GHG Emissions (MMT CO_2e)	**4.03**

Source: CEC 2024, SDG&E 2025, USD EPIC 2025

4.3 Natural Gas

The natural gas category accounts for emissions from building end-use natural gas for purposes other than electric generation with the exception of co-generation plants, of which the useful thermal output is also captured in this category. The Natural Gas category accounts for 13.5% of total emissions in the 2022.

Method Used to Estimate 2022 Emissions

To estimate GHG emissions from metered natural gas end-use, EPIC multiplied the metered natural gas sales by a constant natural gas emission factor. EPIC used the natural gas emission factor, 0.00545 MT CO_2e per therm, based on CARB's statewide inventory data.[17] Fugitive pipeline emissions associated with the natural gas distribution system was retrieved from the US Environmental Protection Agency (EPA) Facility Level Information on Greenhouse Gases Tool (FLIGHT) Database,[18] to which Sempra Energy reports natural gas distribution leaks within the county annually.

SDG&E provided the 2022 San Diego regional natural gas sales by customer class. The San Diego regional natural gas sales are sales to all local jurisdictions, military bases, and tribal reservations. Utility-level electric generation and on-site self-serve electric generation are accounted for under the electricity category. However, certain co-generation plants generate electricity use for both on-site use and sales to the utility. SDG&E provided data delineating natural gas use for on-site electric generation as well as sales back to the utility so the following categorization adjustments could be made:

[17] CARB: Documentation of California's Greenhouse Gas Inventory (2023 Edition) accessed March 2025. The natural gas emission factor is also used in CARB Mandatory GHG Reporting (MRR) and is the same under each customer class (e.g., residential, commercial).

[18] US EPA Flight Database

- Emissions associated with natural gas used at on-site self-serve electric generation were removed from this category and allocated to the electricity category. EPIC used natural gas consumption data for self-serve electricity generation provided by SDG&E to identify and remove the emissions from the natural gas sector. EPIC then used the CEC QFER Power Plant Owner Reporting database and U.S. EIA Form 923 data to identify the portion of self-serve electricity attributed to the thermal energy from co-generation plants to add to the natural gas sector.
- Emissions associated with heat output from utility-level and co-generation plants were estimated separately and added to this category. This natural gas use is not captured in the SDG&E natural gas sales. EPIC assumed that excess heat output was used for a beneficial purpose (e.g., space heating and cooling) and therefore would necessitate categorization in the natural gas sector instead of waste heat for electrical generation. The method to identify the plants is the same as above.

With these adjustments, the key inputs and results are shown in **Table B.6**.

Table B.6: Key Inputs and 2022 Greenhouse Gas Emissions from Natural Gas

Key Inputs and 2022 Greenhouse Gas Emissions from Natural Gas	
Natural Gas Sales (therms)	621,630,424
Natural Gas Emission Factor (MT CO_2e/therm)	0.00545
GHG Emissions (MT CO_2e)	3,390,400
Fugitive Emissions from Natural Gas Pipelines (MT CO_2e)	54,700
GHG Emissions from Natural Gas Used at On-site Self-serve Electric Generation – *Removed and added into Electric sector* (MT CO_2e)	-470,700
GHG Emissions Associated with Useful Thermal Output from Self-Serve Co-generation Plants – *Added back into Natural Gas sector* (MT CO_2e)	35,100
GHG Emissions Associated with Heat Output from Utility-level Co-generation Plants – *Added to Natural Gas sector* (MT CO_2e)	4,100
GHG Emissions (MT CO_2e)	**3,013,600**
GHG Emissions (MMT CO_2e)	**3.01**

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

Source: CARB 2019, SDG&E 2025, EPA 2025, USD EPIC 2025

4.4 Industrial

Emissions of high-GWP gases used in industrial processes and products account for 10.7% of total emissions in the 2022 inventory. High GWP gases are used in air conditioning units and refrigeration, as well as in the manufacturing of electronics, fire protection equipment, insulation, and aerosols. Emissions from activities to process materials for manufacturing (e.g., mineral aggregate products, chemicals, metals, refrigerants, electronics, and other consumer goods) are also included in this category. This category focuses on industrial processes that directly release CO_2 and other GHGs with high GWPs (i.e., SF_6, C_2F_6, C_3F_8, CF_4, C_4F_8, HFC-23, NF_3, HFC-125, HFC-134a, HFC-143a, HFC-236fa, HFC-32) by processes other than fuel combustion.

Method Used to Estimate 2022 Emissions

EPIC scaled down the industrial emissions in the CARB statewide GHG inventory to the San Diego region based on the ratio of San Diego region to state data relevant to each economic sector.[19]

The following are the IPCC category numbers, subcategory numbers, headings, codes, and fuel types used within each type of activity in the statewide inventory. Only those categories, subcategories, activities, and fuel types causing emissions in the San Diego region are shown:

- 2A: Mineral Industry
    - Manufacturing: Stone, Clay, Glass & Cement: Cement > Clinker production
    - Manufacturing: Stone, Clay, Glass & Cement: Lime > Lime production
- 2D1: Industrial Lubricant Use
    - Not Specified Industrial > Fuel consumption – Lubricants > CO_2
    - Not Specified Transportation > Fuel consumption – Lubricants > CO_2
- 2D3: Industrial Solvent Use
    - Solvents & Chemicals: Evaporative losses: Fugitives > Fugitive emissions > CO_2
- 2E: Electronic Industry
    - Manufacturing: Electric & Electronic Equip.: Semiconductors & Related Products > Semiconductor manufacture > C_2F_6
    - Manufacturing: Electric & Electronic Equip.: Semiconductors & Related Products > Semiconductor manufacture > C_3F_8
    - Manufacturing: Electric & Electronic Equip.: Semiconductors & Related Products > Semiconductor manufacture > C_4F_8
    - Manufacturing: Electric & Electronic Equip.: Semiconductors & Related Products > Semiconductor manufacture > CF_4
    - Manufacturing: Electric & Electronic Equip.: Semiconductors & Related Products > Semiconductor manufacture > HFC-23

[19] CARB: **CARB Greenhouse Gas Emission Inventory from 2000 to 2022**, accessed October 2024.

    - Manufacturing: Electric & Electronic Equip.: Semiconductors & Related Products > Semiconductor manufacture > NF_3
    - Manufacturing: Electric & Electronic Equip.: Semiconductors & Related Products > Semiconductor manufacture > SF_6
- 2F: Product Uses as Substitutes for Ozone Depleting Substances
    - Not Specified Commercial
        - Aerosols > HFC-134a, HFC-152a, HFC-43-10mee
    - Fire Protection > CF_4, HFC-125, HFC-227ea, HFC-236fa
        - Foams > HFC-134a, HFC-245fa
        - Refrigeration and Air Conditioning > HFC-125. HFC-134a, HFC-143a, HFC-152a, HFC-236fa, HFC-32
    - Not Specified Industrial
- Aerosols > HFC-134a, HFC-152a, HFC-43-10mee
- Fire Protection > CF_4, HFC-125, HFC-227ea, HFC-236fa
- Foams > HFC-134a, HFC-245fa
- Refrigeration and Air Conditioning > HFC-125. HFC-134a, HFC-143a, HFC-152a, HFC-236fa, HFC-32
    - Not Specified Residential
        - Aerosols > HFC-134a, HFC-152a, HFC-227ea, HFC-43-10mee
        - Foams > HFC-134a, HFC-245fa
        - Refrigeration and Air Conditioning > HFC-125. HFC-134a, HFC-32
    - Not Specified Transportation
        - Aerosols > HFC-134a,
- Refrigeration and Air Conditioning > HFC-125. HFC-134a, HFC-143a, HFC-32
    - 2G1b: Use of Electrical Equipment
        - Imported Electricity: Transmission and Distribution > Electricity transmitted > SF_6
        - In State Generation: Transmission and Distribution > Electricity transmitted > SF_6
    - 2G4: Other Industrial Product – CO_2, Limestone
        - Not Specified Industrial > CO_2 consumption > CO_2
        - Not Specified Industrial > Limestone and dolomite consumption > CO_2

- Not Specified Industrial > Soda ash consumption > CO_2

EPIC used different ratios to scale down the activities above to the San Diego region. **Table B.7** shows the ratios used and their values in 2022.

Table B.7: Key Inputs and 2022 Greenhouse Gas Emissions from Industrial

Key Inputs and 2022 Greenhouse Gas Emissions from Industrial				
Economic Sector/Industry	**Basis for Ratio Value**	**California (MMT CO_2e)**	**Ratio Value**	**San Diego Region (MMT CO_2e)**
2A: Mineral Industry	San Diego cement and product manufacturing employees / California cement and product manufacturing employees (NAICS* code 3273xx)	4.70	7.5%	0.35
2D1: Industrial Lubricant Use > Not Specified Industrial	San Diego manufacturing sector employees/ California manufacturing sector employees	0.72	8.9%	0.06
2D1: Industrial lubricant Use - Not Specified Transportation	San Diego VMT/California statewide VMT	0.74	8.6%	0.07
2D3: Industrial Solvent Use – Solvents and Chemicals	San Diego manufacturing sector employees/ California manufacturing sector employees	0.35	8.6%	0.03
2E: Electronic Industry – Semiconductor Manufacture	San Diego semiconductor manufacturing sector employees/California semiconductor manufacturing sector employees (NAICS code 3344xx)	0.30	7.8%	0.02
2F: Not Specified Residential	San Diego total residential units/California total residential units	4.86	8.4%	0.41
2F: Not Specified Commercial and Industrial	San Diego total employees/California total employees	12.07	8.4%	1.02
2F: Not Specified Transportation	San Diego VMT/California statewide VMT	3.85	8.9%	0.34

Key Inputs and 2022 Greenhouse Gas Emissions from Industrial

Economic Sector/Industry	Basis for Ratio Value	California (MMT CO_2e)	Ratio Value	San Diego Region (MMT CO_2e)
2G1B: Imported Electricity – Transmission and Distribution	San Diego purchased electricity/California purchased electricity	0.07	16.7%	0.012
2G1B: In State Generation – Transmission and Distribution	San Diego in-county electricity generated/ California in-state electricity generated	0.17	2.8%	0.005
2G4: Other Industrial Product > CO_2 and soda ash consumption	San Diego manufacturing sector employees/ California manufacturing sector employees	0.84	8.6%	0.07
2G4: Other Industrial Product > Limestone and dolomite consumption	San Diego construction sector employees/ California construction sector employees	0.15	9.9%	0.01
Total GHG Emissions (MMT CO_2e)		**28.81**	**N/A**	**2.40**

*NAICS code refers to the North American Industry Classification System

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

*Source: 9799 **County Business Patterns**; SANDAG ABM15.2.1 VMT-**EMFAC9784 statewide on?road emission inventory**; SANDAG Demographic data; USD EPIC, 2025*

Emissions from the following categories were included in CARB's statewide inventory but not in the 2022 regional inventory because County Business Pattern data indicated no employment or business establishments existed in the San Diego region. The categories are:

- 2B2: Manufacturing: Chemical and Allied Products: Nitric Acid > Nitric Acid Production > N_2O
- 2C: Metal Industry > Lead Production
- 2H3: Petroleum Refining: Transformation > Fuel Consumption > CO_2

4.5 On-Road Transportation – Heavy-Duty Trucks and Other Vehicles

The heavy-duty trucks and other vehicles emissions category includes tailpipe GHG emissions resulting from fossil fuel combustion (i.e., gasoline, diesel, natural gas) in mobile vehicles on freeways, highways, and local roads. This vehicle emissions category covers the GHG emissions from all other EMFAC2017 vehicle classes not included in the passenger and light-duty vehicles category. [20] The on-road transportation heavy-duty trucks and vehicles category accounts for 10.2% of total GHG emissions in the 2022 inventory.

Method Used to Estimate 2022 Emissions

EPIC used the same method to estimate emissions from this category and the on-road transportation passenger cars and light-duty vehicles category. Emissions derive from an EMFAC2017 model run using VMT from SANDAG ABM15.2.1 and are converted from tons of CO_2 per weekday to MT CO_2e per year. The key inputs and results are shown in **Table B.8**.

Table B.8: Key Inputs and 2022 Greenhouse Gas Emissions from On-Road Transportation – Heavy-Duty Trucks and Other Vehicles

Key Inputs and 2022 Greenhouse Gas Emissions from On-Road Transportation – Heavy-Duty Trucks and Other Vehicles	
VMT (Miles per weekday)*	6,862,024
CO_2 Emissions (Tons per weekday)**	7,605
Conversion Factor (Tons CO_2 per weekday to MT CO_2e per year)	304
GHG Emissions (MT CO_2e)	**2,276,300**
GHG Emissions (MMT CO_2e)	**2.28**

*SANDAG ABM15.2.1 VMT

**EMFAC2017 model run with custom VMT inputs from SANDAG

Heavy-duty trucks and vehicles are EMFAC2017 vehicle categories except LDA, LDT1, LDT2, and MDV. Conversion factors are different for each vehicle class.

Source: CARB 2017; SANDAG 2025; USD EPIC 2025

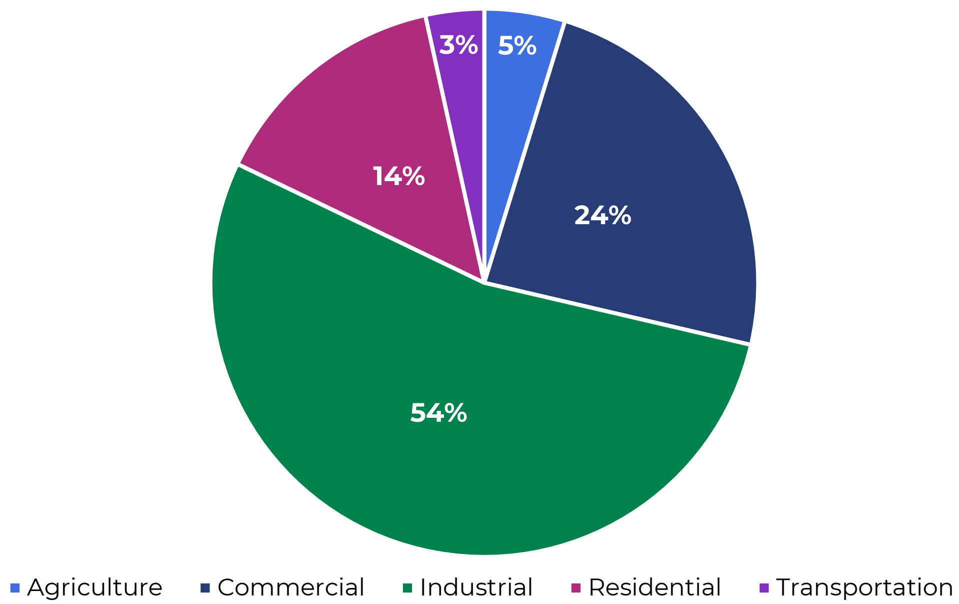
4.6 Other Fuels

The Other Fuels category accounts for 3.8% of the total emissions in the 2022 inventory. This category includes fuels that are not otherwise accounted for in other sectors, such as distillate (other than in power production), coal, kerosene, gasoline (other than in transportation), liquefied petroleum gas (LPG), residual fuel oil (other than in power production), and wood (wet). Cement manufacturing is estimated to contribute 26% of the Other Fuels category, primarily from coal and petroleum coke use.

Emissions from this category are divided into the following economic sectors, according to the CARB statewide GHG inventory: agriculture, commercial, industrial, residential, and transportation. The relative distribution of emissions by economic sector is provided in **Figure B.2** and by fuel type in **Figure B.3.**

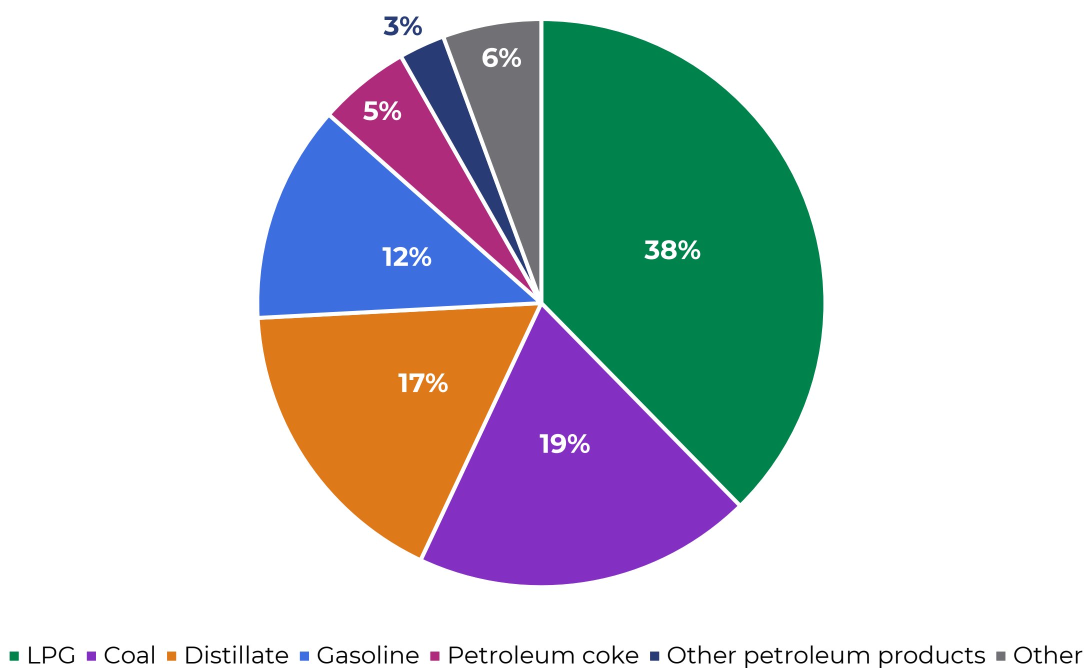
[20] Vehicle classes are all except LDA, LDT1, LDT2, and MDV as shown in EMFAC2017 Technical Documentation, Table 6.1-1.

Figure B.2: Relative Distribution of 2022 Greenhouse Gas Emissions from Other Fuels by Economic Sectors



Source: USD EPIC 2025

Figure B.3: Relative Distribution of 2022 Greenhouse Gas Emissions from Other Fuels by Fuel Type



Source: USD EPIC 2025

Method Used to Estimate 2022 Emissions

The GHG emissions from the CARB statewide inventory were the basis of the regional estimates.[21] EPIC scaled down the statewide emissions by economic sector to the San Diego region based on whether a particular sector had any economic activity in San Diego region using relevant economic, population, employment, or transportation data. Therefore, not all the CARB's statewide emissions from these economic sectors are included in the 2022 regional inventory.

CARB uses the IPCC category and subcategory names and codes, as specified in the IPCC 2006 Guidelines for GHG Inventories, to be consistent with the EPA national inventory. Below are only those IPCC categories, subcategories, activities, and fuel types with GHG emissions in the San Diego region, based on economic activity data in the San Diego region.

CARB Agriculture sector: EPIC scaled down the emissions from the following categories to the San Diego region using the ratio of the revenue generated by agricultural activities in the San Diego region to the statewide agricultural revenue for 2022.[22]

- 1A4c: Agriculture > Ag Energy Use > Not Specified > Fuel Combustion
  - Biodiesel > CH_4, N_2O
  - Distillate > CO_2, N_2O
  - Ethanol > CH_4, N_2O
  - Gasoline > CH_4, CO_2, N_2O
  - Kerosene > CH_4, CO_2, N_2O
  - Renewable Diesel > CH_4, N_2O

CARB Commercial sector: EPIC scaled down the emissions from the following categories to the San Diego region using the ratio of the number of employees in the San Diego region's manufacturing sector to the statewide manufacturing sector for 2022.[23]

- 1A4a: Commercial > Not Specified > Fuel Combustion
  - Biodiesel > CH_4, N_2O
  - Coal > CH_4, CO_2, N_2O
  - Distillate > CH_4, CO_2, N_2O
  - Ethanol > CH_4, N_2O
  - Gasoline > CH_4, CO_2, N_2O
  - Kerosene > CH_4, CO_2, N_2O
  - LPG > CH_4, CO_2, N_2O
  - Renewable Diesel > CH_4, N_2O

[21] CARB Greenhouse Gas Emission Inventory for years 2000 to 2022 (2024 edition). Accessed October 2024

[22] California Department of Food & Agriculture: California Agricultural Statistics Review, 2022-2023. accessed October 2024.

[23] 2022 County Business Patterns, accessed October 2024. The 2022 North American Industry Classification System (NAICS) Code for the manufacturing sector is 31-33.

- Residual Fuel Oil > CH_4, CO_2, N_2O
- Wood (wet) > CH_4, N_2O

CARB Residential sector: EPIC scaled down the emissions from the following categories to the San Diego region using the ratio of the San Diego regional population to the statewide population for 2022.[24]

- 1A4b: Residential > Household Use > Not Specified > Fuel Combustion
  - Biodiesel > CH_4, N_2O
  - Coal > CH_4, CO_2, N_2O
  - Distillate > CH_4, CO_2, N_2O
  - Kerosene > CH_4, CO_2, N_2O
  - LPG > CH_4, CO_2, N_2O
  - Renewable Diesel > CH_4, N_2O
  - Wood (wet) > CH_4, N_2O

CARB Transportation sector: This category includes emissions from fuel sold to on-road transportation agencies but reported by the end users as non-road, therefore not already included in the transportation sector. EPIC scaled down the emissions from the following categories to the San Diego region using the ratio of San Diego regional VMT to statewide VMT for 2022.[25]

- 1A3: Transport > Not Specified Transportation
  - Biodiesel > CH_4, N_2O
  - Distillate > CH_4, CO_2, N_2O
  - LPG > CH_4, CO_2, N_2O
  - Renewable Diesel > CH_4, N_2O

CARB Industrial sector: EPIC scaled down the emissions from the following categories to the San Diego region using the ratio of the number of employees in the San Diego region's manufacturing sector and the statewide manufacturing sector for 2022.[26]

- 1A2f: Manufacturing Industries > Construction > Fugitives & Fuel Combustion
  - Distillate > CH_4, CO_2, N_2O
  - LPG > CH_4, CO_2, N_2O
  - MSW > CH_4, CO_2, N_2O
  - Petroleum Coke > CH_4, CO_2, N_2O

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[24] San Diego demographic data are shown in Table G.2. Statewide population projections are from **California Department of Finance**, accessed October 2024.

[25] San Diego regional 2022 VMT are provided in **Table B.3** and **Table B.8** . California statewide VMT is from EMFAC2017 accessed October 2024.

[26] **2022 County Business Patterns**. The 2012 NAICS Code for manufacturing Sector is 31-33.

- Residual Fuel Oil > CH_4, CO_2, N_2O
- Tires > CH_4, CO_2, N_2O

- 1A2k: Manufacturing Industries > Fugitives
  - Gasoline > CH_4, CO_2, N_2O
- 1A2m: Manufacturing Industries and Construction > Non-Specified Industry
  - Distillate > CH_4, CO_2, N_2O
  - Gasoline > CH_4, CO_2, N_2O
  - Kerosene > CH_4, CO_2, N_2O
  - LPG > CH_4, CO_2, N_2O
  - Petroleum Coke > CH_4, CO_2, N_2O
  - Residual Fuel Oil > CH_4, CO_2, N_2O
- 1B2: Oil and Natural Gas > Manufacturing
  - Chemicals and Allied Products > Fugitives > Fugitive Emissions > CH_4
  - Construction > Fugitives > Fugitive Emissions > CH_4
  - Electric and Electronic Equipment > Fugitives > Fugitive Emissions > CH_4
  - Food Products > Fugitives > Fugitive Emissions > CH_4
  - Fugitives > Fugitive Emissions > CH_4
  - Plastic and Rubber > Fugitives > Fugitive Emissions > CH_4
  - Primary Metals > Fugitives > Fugitive Emissions > CH_4
  - Pulp and Paper > Fugitives > Fugitive Emissions > CH_4
  - Storage Tanks > Fugitives > Fugitive Emissions > CH_4

Several categories were included in CARB's statewide inventory, but not in this 2022 regional inventory, because 2022 census business patterns data for the San Diego region indicated no economic activities under these categories. The categories are:

- 1A1b: Petroleum Refining
  - Associated Gas > CH_4, CO_2, N_2O
  - Catalyst Coke > CH_4, CO_2, N_2O
  - Distillate > CH_4, CO_2, N_2O
  - LPG > CH_4, CO_2, N_2O
  - Petroleum Coke > CH_4, CO_2, N_2O
  - Refinery Gas > CH_4, CO_2, N_2O
  - Residual Fuel Oil > CH_4, CO_2, N_2O

- 1A1c: Manufacture of Solid Fuels and Other Energy Industries
  - Associated Gas > CH_4, CO_2, N_2O
  - Crude Oil > CH_4, CO_2, N_2O
  - Distillate > CH_4, CO_2, N_2O
  - Residual Fuel Oil > CH_4, CO_2, N_2O
- 1B2: Oil and Natural Gas > Manufacturing: Stone, Clay, Glass, and Cement: Fugitives > Fugitive Emissions > CH_4
- 1B2a: Oil > Petroleum Refining: Process Losses: Fugitives > Fugitive Emissions > CH_4
- 1B3: Other Emissions from Energy Production > In State Generation: Merchant Owned > Geothermal Power – Geothermal > CO_2
- 1B3: Other Emissions from Energy Production > In State Generation: Utility Owned > Geothermal power > CO_2

The key inputs and results are shown in **Table B.9.**

Table B.9: Key Inputs and 2022 Greenhouse Gas Emissions from Other Fuels

Key Inputs and 2022 Greenhouse Gas Emissions from Other Fuels	
Economic Sectors Associated with Other Fuels*	**GHG Emissions (MT CO_2e)**
Agriculture	40,900
Commercial	205,100
Industrial	459,700
Residential	123,800
Transportation	29,700
Total GHG Emissions (MT CO_2e)	**859,200**
Total GHG Emissions (MMT CO_2e)	**0.86**

*Economic sectors used in CARB statewide GHG inventory.

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

*Source: **California Ag Stats review 9799?979 0; 9799 County Business Patterns**; SANDAG ABM15.2.1 VMT; **EMFAC978 4 statewide on?road emission inventory**-USD EPIC 2025*

4.7 Off-Road Transportation

The Off-Road Transportation category includes the following subcategories by equipment type: construction and mining equipment, cargo handling equipment, industrial equipment, large spark ignition fleets (forklifts), airport ground support, recreational vehicles, pleasure craft, lawn and garden equipment, transport refrigeration units, military tactical support equipment, and other portable equipment. The GHG emissions from off-road transportation fuel combustion account for 3% of total emissions in the 2022 inventory and 4% of the 2050 projection.

Method Used to Estimate 2022 Emissions

CARB maintains the OFFROAD2021 model to generate off-road vehicle emission data by county, vehicle category, vehicle type, Horsepower, and fuel type. Due to overlap with other emissions sectors, the following OFFROAD2021 categories were excluded from this category: commercial harbor freight and ocean-going vessels (included in Marine category); locomotive (included in Rail category); aircraft (included in Aviation category); and agricultural equipment (included in Agriculture sector). Emissions from military tactical support include diesel engines registered with California's Portable Equipment Registration Program and may not include all sources of military offroad equipment.[27]

The 2022 GHG emissions by off-road vehicle subcategory are shown in **Table B.10**.

Table B.10: 2022 Greenhouse Gas Emissions from Off-Road Transportation

2022 Greenhouse Gas Emissions from Off-Road Transportation	
Subcategories	**GHG Emissions (MT CO_2e)**
Airport Ground Support	18,100
Cargo Handling Equipment	2,200
Construction and Mining	154,900
Industrial	98,200
Large Spark Ignition Fleet	87,600
Lawn and Garden	52,500
Light Commercial	76,100
Military Tactical Support	20,100
Pleasure Craft	59,400
Portable Equipment	69,400
Recreational Vehicles	3,000
Transportation Refrigeration Unit	34,700
Total GHG Emissions (MT CO_2e)	**676,100**
Total GHG Emissions (MMT CO_2e)	**0.68**

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

[27] CARB Offroad Inventory Descriptions

Source: CARB: OFFROAD2021, USD EPIC 2025

4.8 Solid Waste

Emissions from solid waste are a result of biodegradable, carbon-bearing waste decomposing in largely anaerobic environments. The degradation process, which can take 5 to 50 years depending on conditions, produces methane landfill gas. Emissions from solid waste contribute 1.4% of total emissions in the 2022 inventory. For this inventory, EPIC calculated the future emissions due to the waste disposed in 2022. Emissions from waste-in-place at landfills are not calculated to be consistent with the 2016 GHG inventory methods.

Method Used to Estimate 2022 Emissions

EPIC estimated the emissions from solid waste using method SW.4 from the ICLEI U.S. Community Protocol.[28] The emissions are based on the disposed waste in a given year, the characterization of the waste stream, and emission factors for each type of waste. Because a recent waste characterization study for the entire region was not available, EPIC used the statewide waste characterization study compiled by CalRecycle in 2021.[29] The solid waste emission factors, MT CO_2e per short ton of waste by type, are from the EPA Waste Reduction Model (WARM) version 16.[30] **Table B.11** shows the waste composition derived and the corresponding emission factors.

Table B.11: Estimated San Diego Region Solid Waste Composition

2021 Statewide Waste Composition Study Results		
Type of Waste	**Percentage of Total Composition**	**Landfill Methane Emission Factor from WARM v16 (MT CO_2e/short ton)***
Paper	16%	0.87
Plastic	13%	0.00
Glass	2%	0.00
Metal	5%	0.00
Organics	29%	0.52
Electronics	1%	0.00
Inerts and Other	12%	0.00
Household Hazardous Waste	0%	0.00
Special Waste	5%	0.56
Mixed Residue	17%	0.56

*The WARM v16 assumption of 0.02MT CO_2e emissions from transporting materials to landfills and operating landfilling equipment have been removed from these figures to estimate landfill methane emissions.

[28] ICLEI: U.S. Community Protocol Appendix E, accessed in October 2024.
[29] 2021 Disposal-Facility-Based Characterization of Solid Waste in California (DRRR-2024-1737).
[30] U.S. EPA Waste Reduction Model (WARM) Version 16.

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

Source: CalRecycle 2021, EPA WARM v16.

The 2022 emissions from solid waste are provided in **Table B.12.**

Table B.12: Key Inputs and 2022 Greenhouse Gas Emissions from Solid Waste

Key Inputs and 2022 Greenhouse Gas Emissions from Solid Waste	
Total Waste Disposal (Short tons)	3,473,333
Mixed Waste Emission Factor (MT CO_2e/short ton)*	0.41
Landfill Gas Capture Rate**	0.75
Oxidation Rate	0.10
Total GHG Emissions (MT CO_2e)	**317,800**
Total GHG Emissions (MMT CO_2e)	**0.32**

*Weighted average from Table G.22
** The 2022 regional landfill gas capture rate was estimated using a weighted average of landfill gas capture rates and total landfill emissions reported to the EPA FLIGHT database for all regional landfills, including West and North Miramar Sanitary Landfill, Sycamore Landfill, San Marcos Landfill, Otay Landfill, and Las Pulgas Landfill.

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

Source: USD EPIC 2025

4.9 Civil Aviation

The GHG emissions from commercial aviation operations account for 1.4% of total emissions in the 2022 inventory. The San Diego International Airport (SAN) and McClellan-Palomar Airport (CRQ) are the only airports in the San Diego region in 2022 with scheduled commercial flight services. The County of San Diego governs CRQ as well as the remaining municipal and private airports in the region: Gillespie Field, Fallbrook Airpark, Ramona Airport, Borrego Valley Airport, Agua Caliente Airport, and Jacumba Airport. GHG emissions in this category are from the combustion of jet fuel and aviation gasoline used by aircraft operating in the Landing and Takeoff (LTO) Cycle.

Method Used to Estimate 2022 Emissions

EPIC used the aircraft emissions reported by the following entities:

- **SAN:** 2018 GHG Emissions from San Diego International's Final Environmental Impact Report GHG Emissions Inventory for Proposed Airfield Improvements and Terminal 1 Replacement Project (SAN EIR).[31] GHG Emissions were estimated for 2022 using SAN reported enplanement data from 2018 to 2022.[32]

[31] Final Environmental Assessment. San Diego International Airport Airfield Improvements and Terminal 1 Replacement Project. (2021).
[32] SAN Air Traffic Reports.

- **CRQ:** 2016 Emissions Inventory developed for the McClellan-Palomar Airport Master Plan Update (PEIR).[33] GHG emissions were estimated for 2022 using FAA airport operations data.[34]
- **San Diego County Municipal and Private Airfields:** The remaining SD County aviation emissions for municipal and private airfields were taken from the greenhouse gas inventory included in the County of San Diego Draft Airports Sustainability Management Plan.[35] Aviation emissions specified to be for military use were delineated and omitted.

The aircraft emissions in the SAN EIR followed Federal Aviation Administration guidelines[36] and include aircraft emissions from the LTO cycle, which include aircraft start-up, taxi and delay, take-off, climb-out, up to mixing height (3,000 feet), approach, landing, and taxi to gate. These emissions differ from what is published in the SAN 2022 GHG Inventory, as the San Diego International Airport now participates in the Airports Council International's Airport Carbon Accreditation (ACA) program and uses an expanded boundary (full flight emissions) to quantify emissions. [37] To maintain consistency with the boundaries of this inventory (regional), FAA guidelines, and the emissions boundaries of the other airports in the San Diego region that used LTO emissions boundaries, LTO emissions for SAN were estimated using available data described above.

Of the total regional aircraft emissions in 2022, SAN accounted for 93%, CRQ for 5%, and County Municipal airports for 2%. Inventory emissions are shown in **Table B.13.**

Table B.13: 2022 Greenhouse Gas Emissions and Projected Greenhouse Gas Emissions from Civil Aviation

2022 Greenhouse Gas Emissions and Projected Greenhouse Gas Emissions from Civil Aviation	
Airport	**GHG Emissions (MT CO_2e)**
SAN GHG Emissions	289,200
CRQ GHG Emissions	14,200
County Airports GHG Emissions	6,100
Total GHG Emissions (MT CO_2e)	**309,500**
Total GHG Emissions (MMT CO_2e)	**0.31**

SAN: San Diego International Airport; CRQ: McClellan-Palomar Airport; County Airports refer to Gillespie Field, Fallbrook Airpark, Ramona Airport, Borrego Valley Airport, Agua Caliente Airport, and Jacumba Airport.

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

[33] CRQ Master Plan Update PEIR: Appendix H – Climate Change Technical Report. (2017).
[34] FAA Airport Tower Operations.
[35] Baseline Assessment and Inventory Reference: CoSD Airports Baseline Assessment and Inventory Report_03082023. County of San Diego Airports Sustainability Management Plan. (2023).
[36] Aviation Emissions and Air Quality Handbook. Federal Aviation Administration. Office of Environment and Energy.
[37] 2022 Greenhouse Gas Emissions Inventory. San Diego International Airport. (2023)

Source: USD EPIC 2025

4.10 Water

The GHG emissions from energy associated with upstream supply and conveyance, and treatment of water (including surface water and groundwater treatment, desalinization, and potable water reuse) account for 1.1% of total emissions in the 2022 inventory. This category does not include emissions associated with energy used for water distribution and water end-use (e.g., water heating at homes), nor does it account for the energy emissions associated with treating and distributing recycled water. The emissions from energy used for treating and distributing recycled water, and water end-use are captured in the electricity and natural gas categories, discussed in previous sections.

Method Used to Estimate 2022 Emissions

The San Diego County Water Authority (SDCWA) is the water wholesaler for the San Diego region. SDCWA imports raw and treated water on behalf of its 24 member agencies. The raw water sources, from the State Water Project and Colorado River, vary year by year depending on water availability; therefore, the energy needed to supply and convey water differs as well. The latest available upstream energy intensity, in kWh per acre-foot of water, is from the average of fiscal years 2018 and 2019 in the SDCWA 2020 Urban Water Management Plan. EPIC calculated the GHG emissions from upstream water supply by multiplying the water supplies with their respective energy intensities or the California average electricity GHG emission factor in 2022.[38] The upstream emissions are shown in **Table B.14**.[39]

Table B.14: 2022 Upstream Emissions from Water Supply

2022 Upstream Emissions from Water Supply		
Water Source	**Imported Treated Water**	**Imported Raw Water**
Water Demand (Acre-feet)	142,374	270,806
Energy Intensity (kWh/Acre-foot)*	1,873	1,767
California Average Electricity Emission Factor (lbs CO_2e/MWh)**	499	499
Total Upstream GHG Emissions (Treated and Raw) (MT CO_2e)		**167,600**

[38] SDCWA 2021: Urban Water Management Plan 2020, Metropolitan Water District of Southern California, Urban Water Management Plan 2020. The Western Electricity Coordinating Council CAMX (eGRID Subregion) emission rate from eGRID was used as representative of the average California electricity emission rate for upstream electricity. U.S. EPB. eGRID 2022 Edition, released January 30, 2024, accessed October 2024.

[39] 2022 water source and demand for each SDCWA member agency were provided by SDCWA staff to EPIC, September 12, 2024.

*Includes water conveyance from the State Water Project & Colorado River to Metropolitan Water District and SDCWA system. The difference between energy intensity for treated and raw water is the water treatment energy intensity.
**eGRID 2022 CAMX subregion emission factor.

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

Source: USD EPIC 2025

SDCWA has its own water treatment plant (WTP), Twin Oaks WTP, and many SDCWA member agencies have their own WTPs. Member agencies that do not have WTPs may purchase treated water from other member agencies or from SDCWB. For example, the City of San Diego and the City of Del Mar are member agencies of the SDCWA, but the City of San Diego provides water treatment services for the City of Del Mar. Local water treatment energy intensity depends on water sources, treatment level, capacity, and efficiency of the WTP. For example, brackish groundwater requires advanced treatment, such as reverse osmosis, to remove the salinity in the water, so its treatment has a higher energy intensity than surface water treatment with conventional methods. **Table B.15** below shows the WTPs in San Diego region, the quantity of water treated, and the associated electricity use for water treatment in 2022.[40] EPIC calculated the GHG emissions from water treatment by multiplying the electricity used for water treatment with SDG&E bundled 2022 electricity GHG emission factor as a default, unless the specific LSE is known, as indicated in the footnotes of **Table B.15.**

Table B.15: 2022 Emissions from Local Water Treatment

2022 Emissions from Local Water Treatment				
Water Treatment Plant	**Plant Operator**	**Water Treated (Acre-feet)**	**Water Treatment Energy Intensity (kWh/Acre-foot)**	**Water Treatment Electricity Use (kWh)**
R.M Levy WTP	Helix WD	29,117	48	2,322,000
R.E. Badger Filtration Plant	Santa Fe ID	14,736	4.1	60,417
Combined Miramar, Otay and Alvarado WTP*	City of San Diego	162,302	24	3,246,153
Escondido-Vista WTP	Escondido + Vista ID	34,907	297	10,367,498

[40] Data were collected for City of San Diego and Helix facilities through EPIC's continued technical assistance role with the entities. Carlsbad Desalination Plant was calculated using the expected average electricity demand of 32MWh/h when operating at 50mgd as noted in the **Supplement to the Precise Development Plan and Desalination Plant Project Final Environmental Impact Report (EIR 03-05)**. The remaining WTP energy intensities are from the following sources: **Escondido 2020 UWMP**, **Olivenhain 2020 UWMP**, **Sweetwater Authority 2020 UWMP**, **Poway 2020 UWMP**, **Oceanside 2020 UWMP**, **Santa Fe Irrigation District 2020 UWMP**, **San Dieguito Water District 2020 UWMP**.

2022 Emissions from Local Water Treatment				
Water Treatment Plant	**Plant Operator**	**Water Treated (Acre-feet)**	**Water Treatment Energy Intensity (kWh/Acre-foot)**	**Water Treatment Electricity Use (kWh)**
David C. McCollum WTP	Olivenhain MWD	16,900	139	2,349,128
Richard B. Reynolds Ground Water Desalination Facility	Sweetwater Authority	4,563	920	4,199,237
Robert B. Perdue WTP	Sweetwater	8,169	920	7,517,931
Lester J. Berglund WTP	City of Poway	9,850	313	3,085,942
Robert B. Weese WFP	City of Oceanside	14,396	279	4,016,345
Mission Basin Groundwater	City of Oceanside	2,373	279	661,928
Twin Oaks Valley WTP	SDCWA	24,296	112	2,723,244
Carlsbad Desalination Plant**	SDCWA	46,778	5,005	280,320,000
Total Water Treatment Electricity Use (kWh)				320,869,821
Transmission and Distribution Loss Factor				1.082
Local Treatment GHG Emissions (MT CO_2e)				**79,900**

ID: irrigation district; WD: water district; WFP: water filtration plant; WTP: water treatment plant

*The electricity use and energy intensity include both water treatment and conveyance from nearby reservoirs for City of San Diego WTPs and both water extraction and treatment for Sweetwater Authority's brackish water desalination plant. The data associated with water treatment cannot be separated out.

**The water treated at the plant includes SDCWA wholesale water and local supply for individual SDCWA member agencies that have separate contracts with the plant. The energy intensity is the high efficiency estimate from the Plant's Environmental Impact Report (2008).

All WTPs are assumed to use SDG&E Bundled electricity aside from the following known sources: City of San Diego WTPs use San Diego Community Power-Power On, R.M. Levy WTP uses SDG&E DB. Electricity emission factors can be found in Table G.9

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

Source: USD EPIC 2025

Combining the upstream and local emissions, the total 2022 emissions from water are shown in **Table B.16.**

Table B.16: 2022 Greenhouse Gas Emissions from Water Supply and Treatment

2022 Greenhouse Gas Emissions from Water Supply and Treatment	
Upstream GHG Emissions (MT CO_2e)	167,600
Local Treatment GHG Emissions (MT CO_2e)	79,900
Total (Upstream + Local) GHG Emissions (MT CO_2e)	**247,600**
Total (Upstream + Local) GHG Emissions (MMT CO_2e)	**0.25**

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

Source: USD EPIC 2025

4.11 Marine Vessels

The GHG emissions from marine vessels in the San Diego region are largely attributed to harbor craft in the Port of San Diego, including activities in San Diego Bay, Mission Bay, and other coastal waters. The GHG emissions from marine vessels account for 0.9% of total emissions in the 2022 inventory.

The emissions are from the following subcategories:

- **Ocean-Going Vessels (OGV):** These include ocean-going vessels greater than 400 feet in length and over 10,000 gross tons.
- **Commercial Harbor Craft (CHC):** These include harbor craft, barges, tugboats, and commercial fishing vessels.

Method Used to Estimate 2022 Emissions

EPIC used CARB's OFFROAD2021 model to estimate emissions from marine vessels. The 2022 emissions are shown in **Table B.17.**

Table B.17: 2022 Greenhouse Gas Emissions from Marine Vessels

2022 Greenhouse Gas Emissions from Marine Vessels	
Vessel Type	**2022 Emissions**
Commercial Habor Craft (MT CO_2e)	64,200
Ocean Going Vessels (MT CO_2e)	136,700
Total GHG Emissions (MT CO_2e)	**201,000**
Total GHG Emissions (MMT CO_2e)	**0.20**

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

Source: OFFROAD2021, USD EPIC 2025

4.12 Agriculture

The GHG emissions from agriculture are broken down into four sub-categories: agricultural equipment, enteric fermentation, manure management, and soil management. Enteric fermentation is a microbial fermentation process that occurs in the stomach of ruminant animals, producing CH_4 that is released through flatulence and eructation. Manure management is the process by which manure is stabilized or stored. CH_4 and N_2O emissions result from livestock manure, and the amount of gas produced depends on the manure management system involved. Emissions from soil management include emissions from fertilizer use and crop residues. Emissions from fertilizers and crop residue management include direct N_2O emissions, indirect N_2O emissions from nitrogen volatilization, leaching, and runoff as well as CO_2 emissions from urea and lime application. Finally, emissions from equipment and fuel use include emissions from mobile and on-site combustion sources. Emissions from electricity use is excluded from this sector but included in the Electricity sector.

The total emissions from the agriculture sector are shown in **Table B.18** and are 0.8% of total regional emissions in 2022.

Table B.18: 2022 Greenhouse Gas Emissions from Agriculture

Greenhouse Gas Emissions from Agriculture	
Agricultural Emissions Category	**GHG Emissions ($MT CO_2e$)**
Agricultural Equipment	73,300
Enteric Fermentation	36,000
Manure Management	41,100
Soil Management	33,800
Total GHG Emissions ($MT CO_2e$)	**184,100**
Total GHG Emissions ($MMT CO_2e$)	**0.18**

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

Method Used to Estimate 2022 Emissions

Agricultural Equipment

Agricultural equipment includes fuel combustion emissions from off-road mobile agriculture equipment. Non-mobile, stationary equipment is not included in this category, but would be included in the Other Fuels category. CARB released the 2021 Agricultural Equipment Emissions Inventory with the latest available data on farm acreage, equipment population, activity, and overall sector fuel consumption.[41] The results were incorporated into OFFROAD2021, an online emissions inventory database for off-road equipment and vehicles, discussed in more detail in the **Off-Road Transportation** section. The total emissions from the agriculture sector are shown in **Table B.19.**

Table B.19: 2022 Greenhouse Gas Emissions from Agricultural Equipment

Greenhouse Gas Emissions from Agricultural Equipment	
Fuel Type	**GHG Emissions ($MTCO_2e$)**
Diesel Equipment	70,800
Gasoline Equipment	2,500
Total GHG Emissions (MT CO_2e)	**73,300**
Total GHG Emissions (MMT CO_2e)	**0.07**

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

Source: CARB 2021; USD EPIC 2025

Enteric Fermentation

The GHG emissions from enteric fermentation, a process that occurs in the stomach of ruminant animals that produces and releases CH_4, were estimated using method A.*1, Enteric Fermentation from Domesticated Animal Production*, from the U.S. Community Protocol.[42] This method multiplies animal-specific CH_4 emission factors with the specific livestock population to estimate the total emissions from enteric fermentation.

The livestock population was obtained from the 2022 Crop Statistics and Annual Report for the San Diego region.[43] Animal-specific CH_4 emission factors in California were obtained from the EPA 2022 U.S. Greenhouse Gas Inventory Report.[44]

[41] CARB: 2021 Agriculture Equipment Emission Inventory (August 2021). The types of agriculture equipment are shown in Table 16 of the CARB 2021 Agriculture Equipment Inventory.

[42] ICLEI – Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.2 (2019). Appendix G: Agricultural Livestock Emission Activities and Sources.

[43] County of San Diego Department of Agriculture, Weights and Measures. 2022 Crop Statistics and Annual Report.

[44] EPA: Annexes to the Inventory of U.S. GHG Emissions and Sinks 1990–2019 (April 2021), accessed June 10, 2021. Table A-159 Emission Factors for Cattle by Animal Type and State, and Table A-162 Emission Factors for Other livestock. CARB's California statewide inventory refers to the EPA U.S. GHG Emissions Inventory for the California emission factors.

Livestock population in the San Diego region, animal-specific CH_4 emission factors, and emissions from enteric fermentation are provided in **Table B.20.**

Table B.20: Key Inputs and 2022 Greenhouse Gas Emissions from Enteric Fermentation

Greenhouse Gas Emissions from Enteric Fermentation			
Animal Type	**Population (Head)**	**Emission Factor (kg CH_4/head/year)**	**GHG Emissions (MT CO_2e)**
Dairy Cow	5,505	146	20,100
Beef Cow	4,046	100	10,100
Other Cattle	3,749	54	5,000
Sheep and Lamb	923	9	200
Goats	1,909	9	400
Hogs and Pigs	1,546	1.5	100
Total GHG Emissions (MT CO_2e)			**36,000**
Total GHG Emissions (MMT CO_2e)			**0.04**

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

Source: EPA Annexes to the US GHG Inventory; USD EPIC 2025

Manure Management

Manure, the natural byproduct of livestock, creates both CH_4 and N_2O emissions as it biodegrades. The emissions from manure management, including from stabilizing and storing manure, were estimated using methods A.2.1 (CH_4), A.2.3 (direct N_2O), and A.2.4 (indirect N_2O) from the U.S. Community Protocol.[45] These methods use a combination of livestock population, animal type, and animal-specific manure management systems to estimate the emissions from manure management.

Livestock population and the type are the same as discussed in the Enteric Fermentation section above. Animal-specific manure management systems in California were obtained from the EPA 2019 U.S. Greenhouse Gas Inventory Report for each animal type.[46] The sub-sections below describe methods to estimate emissions for manure management by emission type CH_4 and N_2O, and the total emissions from manure management, combining CH_4, direct N_2O, and indirect N_2O emissions, are provided in **Table B.21.**

[45] ICLEI – Local Governments for Sustainability USA: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, Version 1.2 (2019). Appendix G: Agricultural Livestock Emission Activities and Sources.

[46] EPA: Annexes to the Inventory of U.S. GHG Emissions and Sinks 1990–2019 (April 2021), accessed June 10, 2021.

Under method A.2.1, CH_4 emissions from manure management, the amount of methane produced depends on the type of animal, the animal's diet and the manure management system. As the manure management systems used throughout the San Diego region are not known, the distribution of various manure management systems is estimated using the statewide distribution.[47] Methane emissions from each management system for each animal population are calculated separately by multiplying the maximum CH_4 producing capacity per pound of manure by the CH_4 conversion factor for each management system. The maximum CH_4 producing capacity depends on the volatile solids in manure managed. For cattle, the amount of volatile solids produced is based on the number of cattle; for other animals, it is based on animal weight.

Table B.21: 2022 Greenhouse Gas Emissions from Manure Management

Greenhouse Gas Emissions from Manure Management				
Animal Type	**CH_4 Emissions (MT CO_2e)**	**Direct N_2O Emissions (MT CO_2e)**	**Indirect N_2O Emissions (MT CO_2e)**	**GHG Emissions (MT CO_2e)**
Dairy Cow	27,400	900	2,000	30,200
Beef Cow	800	2,100	1,500	4,300
Other Cattle	200	2,10<100	1,500	3,800
Sheep and Lamb	100	<100	<100	100
Goats	300	<100	<100	300
Hogs and Pigs	2,400	<100	<100	2,400
Total GHG Emissions (MT CO_2e)	**31,000**	**5,100**	**4,900**	**41,100**
Total GHG Emissions (MMT CO_2e)				**0.04**

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

Source: EPA Annexes to the US GHG Inventory; USD EPIC 2025

Soil Management

EPIC followed the IPCC method to calculate the direct and indirect nitrogen (N) resulting N_2O emissions, and CO_2 emissions from managed soils.[48] The IPCC method includes emissions from crop burning activities. Because the San Diego region does not have data on agricultural burning activities, these potential emissions are not considered.

[47] CARB **2024 GHG Inventory Documentation**.
[48] IPCC: **N_2O emissions from managed soils and CO_2 emissions from Urea and Lime application**.

To calculate the direct and indirect N_2O emissions from fertilizer applications for both farm and non-farm activities, EPIC used the tonnage of nitrogen applied as reported to the California Department of Food and Agriculture (CDFA) fertilizer tonnage reports.[49] The CO_2 emissions from urea application and from liming are based on the total quantities of urea and lime applied and their respective emission factors. Among the crops that have nitrogen content in their residue, only oats and hay are grown in the San Diego region. EPIC calculated the emissions from crop residue using the total nitrogen content in the crop residue based on the acres of crop cultivated.[50]

Application of synthetic and organic fertilizer on agricultural land and nitrogen content in crop residue produces N_2O emissions in two ways: (1) direct N_2O emissions from the soils, and (2) indirect N_2O emissions from volatilization and leaching/runoff from land. In addition, urea fertilizer and liming applied to soil to reduce soil acidity and improve plant growth, produce CO_2 emissions. **Table B.22** shows the key inputs and results for soil management emissions.

Table B.22: 2022 Greenhouse Gas Emissions from Nitrogen Inputs to Soil: Fertilizer and Crop Residues

Greenhouse Gas Emissions from Nitrogen Inputs to Soil: Fertilizer and Crop Residues					
Emission Type	**Tons N Directly Applied**	**Indirect N_2O from N Inputs**	**MT CO_2e from Direct N_2O**	**MT CO_2e from N Volatilization**	**MT CO_2e from N Leaching and Runoff**
Synthetic Fertilizer Nitrogen Applied to Soils	7,099	9,802	100	3,000	6,800
Organic Fertilizer Nitrogen Applied to Soils	53	96	<1	100	100
Nitrogen in Crop Residues	1,125	4,322	19,200	0	4,300
Total GHG Emissions (MT CO_2e)			**19,300**	**3,100**	**11,200**
Total GHG Emissions from All Soil N Inputs (MMT CO_2e)					**0.03**

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

Source: USD EPIC 2025

Liming is used to reduce soil acidity and improve plant growth on agricultural land. Adding carbonates to soils in the form of lime leads to CO_2 emissions as the carbonated lime dissolves and releases bicarbonate, which evolves into CO_2 and water. Similarly, adding urea ($CO(NH_2)_2$) to soils during fertilization releases bicarbonate and later evolves into CO_2 and water.

[49] California Department of Food & Agriculture: **2022 Fertilizing Material Tonnage Report**, accessed October 2024.

[50] California Department of Agriculture Weights & Measures: **2022 County of San Diego Crop Statistics and Annual report**, accessed on October 2024.

The CO_2 emissions from urea application and from liming are based on the total quantities of urea and lime applied and their respective emission factors. CO_2 emissions from liming material are calculated by multiplying the tonnage of liming material, emission factor of carbon (C) of liming material, and the resulting CO_2 to C conversion factor. Similarly, CO_2 emissions from urea are calculated by multiplying the tonnage of urea, the emission factor of C to urea, and the CO_2 to C conversion factor. The CO_2 emissions are shown in **Table B.23.**

Table B.23: 2022 Greenhouse Gas Emissions from Carbon Inputs to Soil: Lime and Urea Application

Greenhouse Gas Emissions from Carbon Inputs to Soil: Lime and Urea Application	
Liming Material (tons)	215
Emission Factor (tons of C / tons of liming material)	0.125
CO_2 emissions from liming material (MT CO_2e)	100
Urea (tons)	234
Emission Factor (tons of C / tons of liming material)	0.2
CO_2 emissions from urea material (MT CO_2e)	200
Total GHG Emissions (MT CO_2e)	**300**
Total GHG Emissions (MMT CO_2e)	**0.0003**

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

Source: USD EPIC 2025

4.13 Wastewater

This category presents emissions from community-generated wastewater treated at centralized wastewater treatment plants. Emissions associated with the energy used to collect and treat wastewater are not included in this category but are captured in the electricity and natural gas category. The GHG emissions from domestic wastewater treatment account for 0.2% of total emissions in the 2022 inventory.

Method Used to Estimate 2022 Emissions

California's Regulation for the Mandatory Reporting of Greenhouse Gas Emissions (MRR) requires industrial facilities that emit over 10,000 MT CO_2e per year to report emissions annually to CARB. The three largest wastewater treatment facilities in the San Diego region fall into this reporting requirement. Those facilities, Encina Water Pollution Control Facility, North City Water Reclamation Plant, and Point Loma Wastewater Treatment Plant, treat 70% of the wastewater influent for the region.[51] Emissions reported to the MRR for those facilities were used directly. The remaining emissions were estimated by assuming the same emission factor (CO_2e per unit influent) for all the smaller non-reporting wastewater facilities in the region, and scaling emissions up to account for all influent requiring treatment in the region. Emissions from wastewater are shown in **Table B.24.**

[51] Influent treatment data received from the San Diego Regional Water Quality Control Board October 2024.

Table B.17: Key Inputs and 2022 Greenhouse Gas Emissions from Wastewater

Key Inputs and 2022 Greenhouse Gas Emissions from Wastewater	
Total Influent from San Diego region (Gallons per day)	247,172,267
Encina Water Pollution Control Facility	
Total Influent Treated (Gallons per day)	21,897,812
Annual Emissions (MT CO_2e)	15,300
North City Water Reclamation Plant	
Total Influent Treated (Gallons per day)	11,801,466
Annual Emissions (MT CO_2e)	3,800
Point Loma Wastewater Treatment Plant	
Total Influent Treated (Gallons per day)	138,862,877
Annual Emissions (MT CO_2e)	15,100
Percent of Influent to MRR disclosing Facility	70%
Regional Wastewater Emission Factor (MT CO_2e / Million Gallons)	0.54
Total Annual Regional Emissions (Encina, North City, Point Loma, and an additional 30% for other WWTPs) **(MT CO_2e)**	**49,000**
Total Annual Regional Emissions (Encina, North City, Point Loma, and an additional 30% for other WWTPs) **(MMT CO_2e)**	**0.05**

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

Source: San Diego Regional Water Control Board 2025, CARB 2024, USD EPIC 2025

4.14 Rail

The rail category includes GHG emissions from both passenger and freight rail resulting from the combustion of fuels in internal combustion engines. The rail category includes freight, passenger, and long-haul locomotives operating in the San Diego region as well as light commuter rail and trolley systems operated by San Diego Metropolitan Transit System (MTS) and North County Transit District (NCTD). Emissions from rail contribute to 0.1% of total emissions in the 2022 inventory.

Method Used to Estimate 2022 Emissions

Emissions from freight, line haul, and other inter-regional locomotives were sourced from the CARB OFFROAD2021 model. More information on the OFFROAD model can be found in the **Off-Road Transportation** section. Fuel use from diesel and electric propulsion MTS and NCTD light rail and trolley is used to estimate emissions for in-region light rail systems from the National Transit Database.[52] Key inputs and GHG emissions from rail are listed in **Table B.25.**

[52] National Transit Database (2022). Fuel and Energy Data.

Table B.18: Key Inputs and 2022 Greenhouse Gas Emissions from Rail

Key Inputs and 2022 Greenhouse Gas Emissions from Rail	
Freight and Other Inter-Regional Rail (OFFROAD) (MT CO_2e)	2,200
Intra-Regional Light Rail – Diesel Fuel Consumption (gallons)	1,280,613
Intra-Regional Light Rail – Electric Energy Consumption (kWh)	56,896,708
Diesel Emission Factor (kg CO_2 per gallon)*	10.21
Total Intra-Regional Rail Emissions (MT CO_2e)	26,200
Total Rail Emissions (MT CO_2e)	**28,400**
Total Rail Emissions in San Diego (MMT CO_2e)	**0.03**

*EPA Emission Factor Hub 2024

Values are not rounded in the intermediary steps in the actual calculation. Because of rounding, some totals may not equal the exact values equated from tables or figures.

Source: USD EPIC 2025