ENERGY ANALYSIS REPORT

State Route 1 Auxiliary Lanes and Bus-on-Shoulder Improvements – Freedom Boulevard to State Park Drive – and Coastal Rail Trail Segment 12 Project

SANTA CRUZ COUNTY

District 5-SCR-1-PM 8.1/10.7
[E.A. 05-0C734]

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SANTA CRUZ COUNTY, CALIFORNIA

CALIFORNIA DEPARTMENT OF TRANSPORTATION DISTRICT 5

E.A. 05-0C734

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Acronyms and Abbreviations

Term	Definition
AMBAG	Association of Monterey Bay Area Governments
BOS	Bus on Shoulder
CAFE	Corporate Average Fuel Economy
Caltrans	California Department of Transportation
CARB	California Air Resources Board
CEQA	California Environmental Quality Act
CO_2	Carbon Dioxide
EA	Environmental Assessment
EIR	Environmental Impact Report
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GHG	Greenhouse Gas
HOV	High-Occupancy Vehicle
LED	Light-Emitting Diode
LOS	Level of Service
mph	Miles per Hour
MSEI	Mobile Source Émissions Inventory
MTP	Metropolitan Transportation Plan
NEPA	National Environmental Policy Act
PM	Post Mile
SCCRTC	Santa Cruz County Regional Transportation Commission
SCS	Sustainable Communities Strategy
SR	State Route
U.S. EPA	United States Environmental Protection Agency
VHT	Vehicle Hours Traveled
VMT	Vehicle Miles Traveled
CCR	California Code of Regulations
CEC	California Energy Commission

1. Introduction

The California Department of Transportation (Caltrans) in cooperation with the Santa Cruz County Regional Transportation Commission (SCCRTC), the County of Santa Cruz, proposes to widen Highway 1 (State Route 1 [SR1]) to include auxiliary lanes, accommodate bus-on-shoulder (BOS) operations between the Freedom Boulevard and State Park Drive interchanges, and construct Coastal Rail Trail Segment 12. The project is subject to federal and State environmental review requirements. The project limits extend from the State Park Drive interchange on SR 1, at post mile (PM) 8.1, to the Freedom Boulevard interchange (PM 10.7) within an unincorporated area of the County. Caltrans is the lead agency under the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA).

The purpose of the Energy Analysis Report is to identify energy requirements for construction and operation of the Build Alternative. Every activity results in some kind of energy consumption. Energy is either used for work (kinetic energy) or stored (potential energy). Kinetic energy is the amount of work necessary to move an object. In transportation, thermal energy from fuel combustion is converted into kinetic energy to propel vehicles. Electrical energy is used to power facilities such as highway lighting and converted to heat and power for buildings.

Transportation energy is generally described in terms of direct and indirect energy. In the context of transportation, direct energy involves all energy consumed by vehicle propulsion (e.g., automobiles, trains, airplanes). The one-time energy expenditure involved in constructing a project is also considered direct energy. Fuel consumed by equipment required for periodic maintenance of the physical system associated with a project is considered indirect energy. The use of highway maintenance equipment and landscaping involve indirect consumption of energy after a facility is built. The Energy Analysis Report also discusses consistency with federal, state, and local energy conservation plans.

The Energy Analysis Report is organized as follows:

- Chapter 1 Introduction
- Chapter 2 Project Description
- Chapter 3 Affected Environment
- Chapter 4 Study Methods
- Chapter 5 Environmental Consequences
- Chapter 6 References

Figure 1.1. Map of the Project Location

2. Project Description

2.1 Location and Background

SR 1 is a primary route connecting in the southern and central areas of Santa Cruz County and is the only continuous commuter route linking Watsonville, Capitola, Aptos, Cabrillo College, Santa Cruz, and the University of California Santa Cruz. SR 1 is also a southern terminus for SR 9 and SR 17, which bring heavy tourist traffic to coastal destinations in Santa Cruz and Monterey counties.

Improvements in the project area were addressed previously in a combined Tier I/Tier II Environmental Impact Report/Environmental Assessment (EIR/EA), which was adopted in December 2018. The Tier I component, referred to as the corridor improvement project, proposed approximately 8.9 miles of new high-occupancy vehicle (HOV) lanes, HOV on-ramp bypass lanes, auxiliary lanes, pedestrian and bicycle overcrossings, and reconstructed interchanges. It was recognized that the Tier I project would likely be implemented in phases. The Tier II component therefore analyzed the first phase of the corridor improvement project, which included auxiliary lanes between 41st Avenue and Soquel Avenue/Drive among other improvements within the Tier II project limits.

The project is the second phase of the improvements described in the Tier I EIR/EA. The SCCRTC developed an implementation plan for building out the Tier I corridor improvement project based on traffic operation criteria to ensure that each phase identified as a future construction-level project would have independent utility because it would individually provide a benefit to traffic operations on SR 1. The project has independent utility and logical termini because it would resolve a congestion problem on SR 1 between Freedom Boulevard and State Park Drive.

2.2 Purpose and Need

The purpose of the project is to do the following.

- Reduce congestion along SR 1 through the project limits.
- Enhance bicycle and pedestrian connectivity along Segment 12 of the Coastal Rail Trail.
- Promote the use of alternative transportation modes to increase transportation system capacity and reliability.
- Provide Coastal Rail Trail access across SR 1 at the two railroad bridges.

This project is needed for the following reasons.

- Several bottlenecks along SR 1 in the southbound and northbound directions cause congestion during peak hours, significantly delaying drivers.

- Cut-through traffic, or traffic on local streets, is increasing because drivers are seeking to avoid congestion on SR 1.
- There are limited opportunities for pedestrians and bicyclists to safely cross SR 1 and navigate the project corridor, even though portions of the project area are designated as regional bicycle routes.

2.3 No Build Alternative

The No Build (No Action) Alternative consists of those transportation projects that are already planned for construction by or before the horizon year 2045. Consequently, the No Build Alternative represents future travel conditions in the study area without the project and is the baseline against which the other Build Alternatives will be assessed to meet NEPA requirements.

Under the No-Build Alternative, there would be no construction of auxiliary lanes or BOS features on SR 1 within the project area, and Coastal Rail Trail Segment 12 would not be constructed. The existing transportation facilities within the project area would remain unchanged. The No-Build Alternative assumes the construction of other planned and programmed projects in the region, including other auxiliary lanes projects on SR 1 and other segments of the Coastal Rail Trail.

Average weekday daily mainline traffic in the SR 1 northbound and southbound directions under the No Build conditions and within the project limits is expected to grow between the existing year (2019) and the opening year (2025) by 4.2 percent and 5.7 percent, respectively. Average weekday daily mainline traffic in the SR 1 northbound and southbound directions under the No Build conditions and within the project limits is expected to grow between the existing year (2019) and the horizon year (2045) by 17.4 percent and 20.9 percent, respectively.

The peak spreading in the future years (2025 and 2045) would become more common (that is, over a greater number of hours in a day) than in the existing year (2019). As a result, traffic volume growth in the AM and PM peak periods are lower compared to the daily total traffic volume growth. Table 2-1 shows the No Build Alternative vehicle northbound operational performance summary in terms of total model volumes (in vehicles/hour) and truck model volumes, VMT, VHT, average speed (mph), delay (minutes/vehicle) and LOS. Table 2-2 shows the No Build Alternative vehicle southbound operational performance summary for the same scenarios and performance measure as Table 2-1. Due to lack of detailed vehicle classification counts, an average truck percentage of 4 percent was assumed on all roadway segments and under all scenarios.

Table 2.1. Summary of Project Operational Performance for Northbound No Build Alternative Traffic Conditions by Time Period

Direction of Movement & Time Period	Performance Measure	Analysis Duration	Existing (2019) No Build Alternative	Opening Year (2025) No Build Alternative	Horizon Year (2045) No Build Alternative
SR 1 NB AM Peak Period = (6AM–12PM, Peak Hour = 7AM–8AM)	Avg. Hourly Volume (vehicles/hr.)	Peak Hour	3,270	3,428	3,288
		Peak Period	3,142	3,251	3,071
	Hourly Truck Volume (trucks/hr.)	Peak Hour	131	137	132
		Peak Period	126	130	123
	Daily VMT (vehicle miles traveled)	Peak Hour	16,840	17,653	17,201
		Peak Period	97,070	100,445	94,311
	Daily VHT (vehicle hours traveled)	Peak Hour	590	555	744
		Peak Period	2,747	3,332	6,017
	Segment LOS	Peak Hour	F	F	F
		Peak Period	E	F	F
	Avg. Segment Speed (mph)	Peak Hour	29	32	23
		Peak Period	35	30	16
	Avg. Delay (min/veh)	Peak Hour	5.8	4.7	8.4
		Peak Period	3.8	5.3	14.7
SR 1 NB PM (Peak Period = 2PM–8PM, Peak Hour = 4PM–5PM)	Avg. Hourly Volume (vehicles/hr.)	Peak Hour	2,822	2,979	3,400
		Peak Period	2,400	2,537	2,905
	Hourly Truck Volume (trucks/hr.)	Peak Hour	113	119	136
		Peak Period	96	101	116
	Daily VMT (vehicle miles traveled)	Peak Hour	14,535	15,341	17,508
		Peak Period	74,149	78,396	89,753
	Daily VHT (vehicle hours traveled)	Peak Hour	235	249	290
		Peak Period	1,200	1,270	1,487
	Segment LOS	Peak Hour	C	C	C
		Peak Period	C	C	C
	Avg. Segment Speed (mph)	Peak Hour	62	62	60
		Peak Period	62	62	60
	Avg. Delay (min/veh)	Peak Hour	0.0	0.0	0.1
		Peak Period	0.0	0.0	0.1

Source: CDM Smith, 2020.

Table 2.2. Summary of Project Operational Performance for Southbound No Build Alternative Traffic Conditions by Time Period

Direction of Movement & Time Period	Perf. Measure	Analysis Duration	Existing (2019) No Build Alternative	Opening Year (2025) No Build Alternative	Horizon Year (2045) No Build Alternative
SR 1 SB AM Peak Period = (6AM–12PM, Peak Hour = 7AM–8AM)	Avg. Hourly Volume (vehicles/hr.)	Peak Hour	3,042	3,154	3,614
		Peak Period	2,873	3,024	3,458
	Hourly Truck Volume (trucks/hr.)	Peak Hour	122	126	145
		Peak Period	115	121	138
	Daily VMT (vehicle miles traveled)	Peak Hour	28,896	29,965	34,330
		Peak Period	163,737	172,394	197,101
	Daily VHT (vehicle hours traveled)	Peak Hour	486	497	625
		Peak Period	2,738	2,839	3,378
	Segment LOS	Peak Hour	C	C	D
		Peak Period	C	C	C
	Avg. Segment Speed (mph)	Peak Hour	59	60	55
		Peak Period	60	61	58
	Avg. Delay (min/veh)	Peak Hour	0.2	0.1	1.0
		Peak Period	0.2	0.0	0.4
SR 1 SB PM (Peak Period = 2PM–8PM, Peak Hour = 4PM–5PM)	Avg. Hourly Volume (vehicles/hr.)	Peak Hour	3,470	3,526	3,269
		Peak Period	3,391	3,533	3,635
	Hourly Truck Volume (trucks/hr.)	Peak Hour	139	141	131
		Peak Period	136	141	145
	Daily VMT (vehicle miles traveled)	Peak Hour	32,962	33,498	31,056
		Peak Period	193,281	201,373	207,207
	Daily VHT (vehicle hours traveled)	Peak Hour	1,419	1,520	2,274
		Peak Period	6,045	6,953	10,789
	Segment LOS	Peak Hour	F	F	F
		Peak Period	F	F	F
	Avg. Segment Speed (mph)	Peak Hour	23	22	14
		Peak Period	32	29	19
	Avg. Delay (min/veh)	Peak Hour	15.2	16.5	32.4
		Peak Period	8.5	10.3	20.3

Source: CDM Smith, 2020.

2.3.1 Build Alternative

There is one Build Alternative and a No Build Alternative being considered for this project. The assessment of alternatives considers the opening year (2025) and the 20-year design/horizon year (2045).

2.3.1.1 Build Alternative

The Build Alternative proposes to improve operations on SR 1 from State Park Drive to Freedom Boulevard by adding auxiliary lanes and bus on shoulder (BOS) features in the northbound and southbound directions, replacing the SR 1 bridge over Aptos Creek and Spreckels Drive, replacing the two railroad bridges over SR 1, and constructing a bicycle and pedestrian trail along a segment of the Santa Cruz Branch Line railroad right of way. The proposed auxiliary lanes and BOS improvements would extend approximately 2.6 miles along SR 1 in unincorporated Santa Cruz County between the Freedom Boulevard interchange and the State Park Drive interchange, from PM 8.1 to PM 10.7. The proposed Coastal Rail Trail Segment 12 would extend approximately 1.14 miles along the Santa Cruz Branch Line railroad, between Rio Del Mar Boulevard and State Park Drive. The Santa Cruz Branch Line railroad corridor is an active freight line and is owned by the SCCRTC.

The auxiliary lanes would connect the interchange entrance and exit ramps. This would improve merging and weaving movements between the ramps and improve traffic flow by allowing greater separation between vehicles entering and exiting the freeway from mainline traffic. The proposed BOS improvements would support future bus operations on the shoulders of SR 1 through the interchanges at Freedom Boulevard, Rio Del Mar Boulevard, and State Park Drive during peak congestion periods to achieve transit travel time and reliability improvements. Buses would use the auxiliary lanes between the interchanges.

The limits of Coastal Rail Trail Segment 12 extend from the southern terminus of the trail segment at Sumner Avenue, just of the south of the Rio Del Mar Boulevard underpass, to the northern terminus at State Park Drive. The proposed Coastal Rail Trail Segment 12 includes the construction of a paved bicycle and pedestrian shared use trail within the SCBRL right-of-way on the inland side of the tracks. The trail segment would include a new at-grade trail connection to Sumner Avenue just south of the Rio Del Mar Boulevard underpass where the existing railroad tracks pass under Rio Del Mar Boulevard and a new sidewalk on the north side of Sumner Avenue between the terminus of the trail and the existing sidewalk on Rio Del Mar Boulevard.

The Build Alternative is anticipated to require right of way acquisitions and utility relocations to accommodate highway widening, trail pavement, and bridge work. Temporary construction easements are anticipated to be needed to construct retaining walls, soundwalls, and the bridges. Table 2.3 shows the Build Alternative vehicle northbound operational performance summary in terms of total model volumes (in vehicles/hour) and truck model volumes, VMT, VHT, average speed (mph), delay (minutes/vehicle) and LOS. Table 2-4 shows the Build Alternative vehicle southbound operational performance summary for the same scenarios and performance measure as Table 2-3. Due to lack of detailed vehicle classification counts, an average truck percentage of 4 percent was assumed on all roadway segments and under all scenarios.

Table 2.3. Summary of Project Operational Performance for Northbound Build Alternative Traffic Conditions by Time Period

Direction of Movement & Time Period	Perf. Measure	Analysis Duration	Existing (2019) Build Alternative	Opening Year (2025) Build Alternative	Horizon Year (2045) Build Alternative
SR 1 NB AM Peak Period = (6AM–12PM, Peak Hour = 7AM–8AM)	Avg. Hourly Volume (vehicles/hr.)	Peak Hour	3,270	3,492	3,288
		Peak Period	3,142	3,255	3,071
	Hourly Truck Volume (trucks/hr.)	Peak Hour	131	140	132
		Peak Period	126	130	123
	Daily VMT (vehicle miles traveled)	Peak Hour	16,843	17,981	16,931
		Peak Period	97,205	100,559	94,880
	Daily VHT (vehicle hours traveled)	Peak Hour	590	575	863
		Peak Period	2,747	3,893	7,121
	Segment LOS	Peak Hour	F	E	F
		Peak Period	E	F	F
	Avg. Segment Speed (mph)	Peak Hour	29	31	20
		Peak Period	35	26	13
	Avg. Delay (min/veh)	Peak Hour	5.8	4.9	10.8
		Peak Period	3.8	7.0	18.2
SR 1 NB PM (Peak Period = 2PM–8PM, Peak Hour = 4PM–5PM)	Avg. Hourly Volume (vehicles/hr.)	Peak Hour	2,822	3,000	3,397
		Peak Period	2,400	2,555	2,902
	Hourly Truck Volume (trucks/hr.)	Peak Hour	113	120	136
		Peak Period	96	102	116
	Daily VMT (vehicle miles traveled)	Peak Hour	14,535	15,447	17,492
		Peak Period	74,149	78,937	89,654
	Daily VHT (vehicle hours traveled)	Peak Hour	235	249	283
		Peak Period	1,200	1,270	1,449
	Segment LOS	Peak Hour	C	C	C
		Peak Period	C	C	C
	Avg. Segment Speed (mph)	Peak Hour	62	62	62
		Peak Period	62	62	62
	Avg. Delay (min/veh)	Peak Hour	0.0	0.0	0.0
		Peak Period	0.0	0.0	0.0

Source: CDM Smith, 2020.

Table 2.4. Summary of Project Operational Performance for Southbound Build Alternative Traffic Conditions by Time Period

Direction of Movement & Time Period	Perf. Measure	Analysis Duration	Existing (2019) Build Alternative	Opening Year (2025) Build Alternative	Horizon Year (2045) Build Alternative
SR 1 SB AM Peak Period = (6AM–12PM, Peak Hour = 7AM–8AM)	Avg. Hourly Volume (vehicles/hr.)	Peak Hour	3,042	3,241	3,648
		Peak Period	2,873	3,027	3,464
	Hourly Truck Volume (trucks/hr.)	Peak Hour	122	130	146
		Peak Period	115	121	139
	Daily VMT (vehicle miles traveled)	Peak Hour	28,996	30,793	34,660
		Peak Period	164,715	172,559	197,458
	Daily VHT (vehicle hours traveled)	Peak Hour	486	507	592
		Peak Period	2,738	2,835	3,304
	Segment LOS	Peak Hour	C	C	C
		Peak Period	C	C	C
	Avg. Segment Speed (mph)	Peak Hour	59	61	59
		Peak Period	60	61	60
	Avg. Delay (min/veh)	Peak Hour	0.2	0.0	0.4
		Peak Period	0.2	0.0	0.2
SR 1 SB PM (Peak Period = 2PM–8PM, Peak Hour = 4PM–5PM)	Avg. Hourly Volume (vehicles/hr.)	Peak Hour	3,470	3,894	3,927
		Peak Period	3,391	3,581	3,968
	Hourly Truck Volume (trucks/hr.)	Peak Hour	139	156	157
		Peak Period	136	143	159
	Daily VMT (vehicle miles traveled)	Peak Hour	33,554	36,992	37,307
		Peak Period	194,344	204,116	226180
	Daily VHT (vehicle hours traveled)	Peak Hour	1,419	1,520	1,515
		Peak Period	6,045	6,953	7,796
	Segment LOS	Peak Hour	F	F	F
		Peak Period	F	F	F
	Avg. Segment Speed (mph)	Peak Hour	23	22	25
		Peak Period	32	29	29
	Avg. Delay (min/veh)	Peak Hour	15.2	16.5	13.8
		Peak Period	8.5	10.3	10.3

Source: CDM Smith, 2020.

2.4 Construction Activities and Schedule

The construction period is planned to last approximately three years (36 months) beginning in 2025. Because no construction activities are anticipated to last more than five years at any individual site, emissions from construction-related activities are thus considered temporary as defined in 40 Code of Federal Regulations (CFR) 93.123(c)(5); and are not required to be included in PM hot-spot analyses to meet conformity requirements.

Table 2.5 shows the length of the project construction period is approximately three years (36 months) and milestone completion dates. These dates are estimates for planning purposes and for use in the Energy Report. Temporary construction easements are anticipated to be needed to construct retaining walls, soundwalls, and the bridges.

Table 2.5. Construction Activities and Schedule

Construction Phase	Description/List of Activities	Begin Date	Completion Date
Advertisement and Award of Contract	Procurement	Spring 2024	Winter 2024
Grubbing/Land Clearing	Grubbing/Land Clearing would require soil export volume of 1,500 cubic yards per day. Construction equipment to be utilized during this construction phase includes 4 crawler tractors and 4 excavators.	January 2025	March 2025
Grading/Excavation	Grading/Excavation would require soil export volume of 1,500 cubic yards per day. Construction equipment to be utilized during this construction phase includes 2 cranes, 4 crawler tractors, 6 excavators, 4 graders, 4 rollers, 4 scrapers, and 4 tractors/loaders/backhoes.	April 2025	June 2026
Drainage/Utilities/Sub-Grade	Drainage/Utilities/Sub-Grade would require soil export volume of 150 cubic yards per day. Construction equipment to be utilized during this construction phase includes 2 excavators, 2 forklifts, 2 generator sets, 2 graders, 2 scrapers, and 2 tractors/loaders/backhoes.	July 2026	June 2027
Paving	Paving would require asphalt import volume of 1,500 cubic yards per day. Construction equipment to be utilized during this construction phase includes 4 paving equipment, 4 rollers, and 4 surfacing equipment.	July 2027	January 2028
End of Construction		-	2028

3. Affected Environment

This section provides background information on state and local energy resources and usage, as well as current federal, state, and local energy regulations, policies, and legislation.

3.1 Regulations

3.1.1 Federal

NEPA (42 U.S. Code Part 4332) requires the identification of all potentially significant impacts on the environment, including impacts on energy resources. Guidance for evaluating energy impacts of transportation projects subject to NEPA is outlined in Federal Highway Administration (FHWA) Technical Advisory 6640.8A (Technical Advisory). The Technical Advisory energy analysis requirement applies to projects for which an Environmental Impact Statement is prepared, although it may also be applied to EAs. The Technical Advisory indicates that documentation should discuss energy requirements for construction and operation, and the overall conservation potential for project alternatives. The relationship of the project alternatives to applicable state or regional energy plan should also be documented. Additional conservation measures, such use of high-occupancy vehicle incentives and other measures to improve traffic flow should also be identified.

Other measures to improve energy efficiency in the transportation sector have been implemented at the federal level. In recent years, the U.S. Environmental Protection Agency (U.S. EPA) and the National Highway Traffic Safety Administration issued Final Rules governing Corporate Average Fuel Economy (CAFE) standards and other improvements to fuel economy to new vehicles. The Energy Independence and Security Act consists of provisions designed to increase energy efficiency and the availability of renewable energy. Key provisions of this Act include:

- The CAFE, which sets a target of 54.5 miles per gallon for the combined fleet of cars and light trucks by model year 2025.
- The Renewable Fuels Standard, which sets a modified standard that starts at 9.0 billion gallons in 2008 and rises to 36 billion gallons by 2022.
- The Energy Efficiency Equipment Standards, which includes a variety of new standards for lighting and for residential and commercial appliance equipment.
- The Repeal of Oil and Gas Tax Incentives, which includes repeal of two tax subsidies in order to offset the estimated cost to implement the CAFE provision.

On September 27, 2019, the U.S. EPA and the National Highway Traffic Safety Administration published the “Safer Affordable Fuel-Efficient Vehicles Rule Part One: One National Program” (84 Code of Federal Regulations Vol. 84, No. 188 p. 51310). The Part One Rule revokes California’s authority to set its own greenhouse gas emissions standards and set zero-emission vehicle mandates in California.

3.1.2 State

On December 28, 2018, the Governor's Office of Planning and Research and the California Natural Resources Agency updated the CEQA Guidelines to require that an Environmental Impact Report include an analysis of a project's potential for significant environmental effects resulting from wasteful, inefficient, or unnecessary use of energy; or wasteful use of energy resources (Guidelines § 15126.2(b)). Appendix F, Energy Conservation, of the CEQA Guidelines outlines requirements for the evaluating energy impacts of projects subject to CEQA. The appendix outlines criteria to consider in reviewing potential impacts, and places particular emphasis on avoiding the "inefficient, wasteful, and unnecessary consumption of energy."

The State has passed several bills directing state agencies and entities such as the California Energy Commission (CEC) and the California Public Utilities Commission to implement renewable energy portfolio targets and energy efficiency measures to reduce energy consumption and greenhouse gas emissions. The CEC is the state's primary energy policy and planning agency. Created by legislature in 1974, the CEC has five major responsibilities: (1) forecasting future energy needs and keeping historical energy data, (2) licensing thermal power plants 50 megawatts or larger, (3) promoting energy efficiency through appliance and building standards, (4) developing energy technologies and supporting renewable energy, and (5) planning for and directing the state’s response to energy emergencies. Senate Bill 1389 (Chapter 568, Statutes of 2002) requires the CEC to prepare a biennial integrated energy policy report assessing major energy trends and issues facing the state’s electricity, natural gas, and transportation fuel sectors. The report also provides policy recommendations to conserve resources, protect the environment, and ensure reliable, secure and diverse energy supplies.

The California Transportation Plan is a statewide, long-range transportation plan to meet future mobility needs. It defines performance-based goals, policies, and strategies to achieve an integrated, multimodal transportation system. The California Transportation Plan addresses how the state will achieve maximum feasible emissions reductions, taking into consideration the use of alternative fuels, new vehicle technology and tailpipe emissions reductions. Caltrans must consult and coordinate with related state agencies, air quality management districts, public transit operators and regional transportation planning agencies.

The California Code of Regulations (CCR) includes vehicle requirements for public transit agencies. Sections 1956.1, 2020, 2023, 2023.1, and 2023.4 of Title 13 of the CCR. The Fleet Rule for Transit Agencies includes stringent exhaust emission standards for new Urban Bus engines and vehicles. The regulation also promotes advanced technologies by providing for zero-emission bus demonstration projects and requiring zero emission bus acquisitions applicable to larger transit agencies.

3.1.3 Regional

The Association of Monterey Bay Area Governments (AMBAG) is the designated Metropolitan Planning Organization for Monterey, Santa Cruz, and San Benito Counties and their respective cities. The 2040 Metropolitan Transportation Plan/Sustainable Communities Strategy (MTP/SCS) includes a comprehensive discussion of regional energy policies and use. AMBAG has taken steps to assess what regional infrastructure is needed to accommodate more alternative fuel choices across the region. In 2012, AMBAG adopted the Electric Vehicle Infrastructure for the Monterey Bay Area Plan. This plan presents a siting prioritization method to help identify potential charging locations and presents a framework for establishing a robust electric vehicle charging network in the region. The siting analysis in the plan provides guidance to local and regional stakeholders based on potential demand for electric vehicle charging stations.

In 2013, AMBAG and other regional organizations completed the Monterey Bay Plug-In Electric Vehicle Readiness Plan. The goal of this plan is to encourage the mass adoption of plug-in electric vehicles in the region and reduce greenhouse gas emissions by providing a toolbox of recommended approaches for public, private, and non-profit organizations. These tools range from innovative approaches to plug-in electric vehicle marketing and streamlining electric vehicle supply equipment permitting, to guidelines on establishing an electric vehicle fleet. The Readiness Plan identifies specific regional targets for significantly expanding plug-in electric vehicle adoption in the Monterey Bay Area by 2015, 2020 and 2025. AMBAG and our transportation partners continue to work with local jurisdictions and other organizations to implement charging stations and to increase adoption of electric vehicles around the region.

Within the Monterey Bay Area, the 21 local governments are committed to energy efficiency and climate planning and are working in collaboration with other local governments and their communities. It was through this shared vision of maximizing energy as a resource that the AMBAG Energy Watch program was developed in 2006. The AMBAG Energy Watch programs are designed in two major categories. The first category is implementation programs. These programs achieve direct and measurable energy efficient targets through the installation of energy efficiency equipment. These programs have been developed to serve the diverse stakeholders in the region including residents, municipalities, special districts, non-profit organizations, agriculture, school districts and hospitality businesses. The second category of programs is in the area of climate planning support for jurisdictions. The AMBAG Energy Watch program worked collaboratively with staff from each of the 21 AMBAG jurisdictions to complete each jurisdiction's 2005 municipal and community-wide greenhouse gas inventory, as well as their 2009 and 2010 communitywide greenhouse gas inventory updates. This data was used in the creation of a draft community-wide Energy Action Strategy developed for each of the jurisdictions, which in some cases were incorporated into their Climate Action Plans.

3.2 Existing Setting

3.2.1 Federal

Transportation infrastructure in the United States developed during a period of easy access to relatively inexpensive fossil fuels. The shock of an oil shortage in 1973 contributed to an awareness of petroleum as a finite resource that is ever diminishing as petroleum-based fuels are consumed around the world. Combustion of fossil fuels has also been linked to climate change. The dual concerns of potential energy shortages and environmental impacts of climate change have spurred legislative action at the federal and state levels as well as innovation geared toward conservation of existing fuel supplies, development of renewable fuels, and energy efficiency measures. A notable legislative act was the introduction of federal CAFE standards in 1975 to mandate fuel efficiency improvements in motor vehicles. Energy use in the transportation sector accounted for 29 percent of total U.S. energy use in the year 2017, second only to the industrial sector.

3.2.2 State

In California, the transportation sector accounts for 39 percent of total energy use. California has the highest number of registered motor vehicles among the U.S. states, but in 2013 ranked 41st in vehicle miles traveled per capita and ranked 39th in 2014. California is the second-highest energy consumer in the U.S., which correlates with its status as the country's largest economy and most populous state, estimated at 39.8 million as of 2018. However, California ranks 48th in total energy consumed per capita.

Energy efficiency efforts in California have dramatically reduced statewide per capita energy consumption relative to historical averages. California's per capita energy use is the third lowest in the nation. This statistic is partially attributable to the State's continuous pursuit of policies to reduce energy consumption, promote renewable energy, and reduce reliance on fossil fuels. California's net taxable gasoline sales in 2016 were below 2002 levels, despite a population growth of at least 15 percent during the same time period. Furthermore, gasoline consumption in the State decreased by approximately 2.2 percent between 2005 and 2017, even as VMT increased by 7.5 percent, from 329 billion in 2005 to 354 billion in 2017. These improvements are due in large part to a more fuel-efficient vehicle fleet. Annual trend lines of statewide gasoline consumption and VMT are shown in Figure 3.1.

California's transportation energy consumption has become increasingly efficient due to technological growth, environmental policies, and innovation. Gasoline and diesel represent the largest fraction of fuel consumed by the transportation sector in California. However, it is anticipated that CAFE regulations, renewable fuel uptake, and zero-emission vehicle regulations will gradually displace gasoline-propulsion systems in favor of more energy-efficient systems with lower GHG emissions. As of 2014, renewable fuels represented a growing fraction of transportation energy consumption at 6.2 percent, with ethanol representing 4.5 percent and other renewables representing 1.7 percent of total transportation energy consumption.

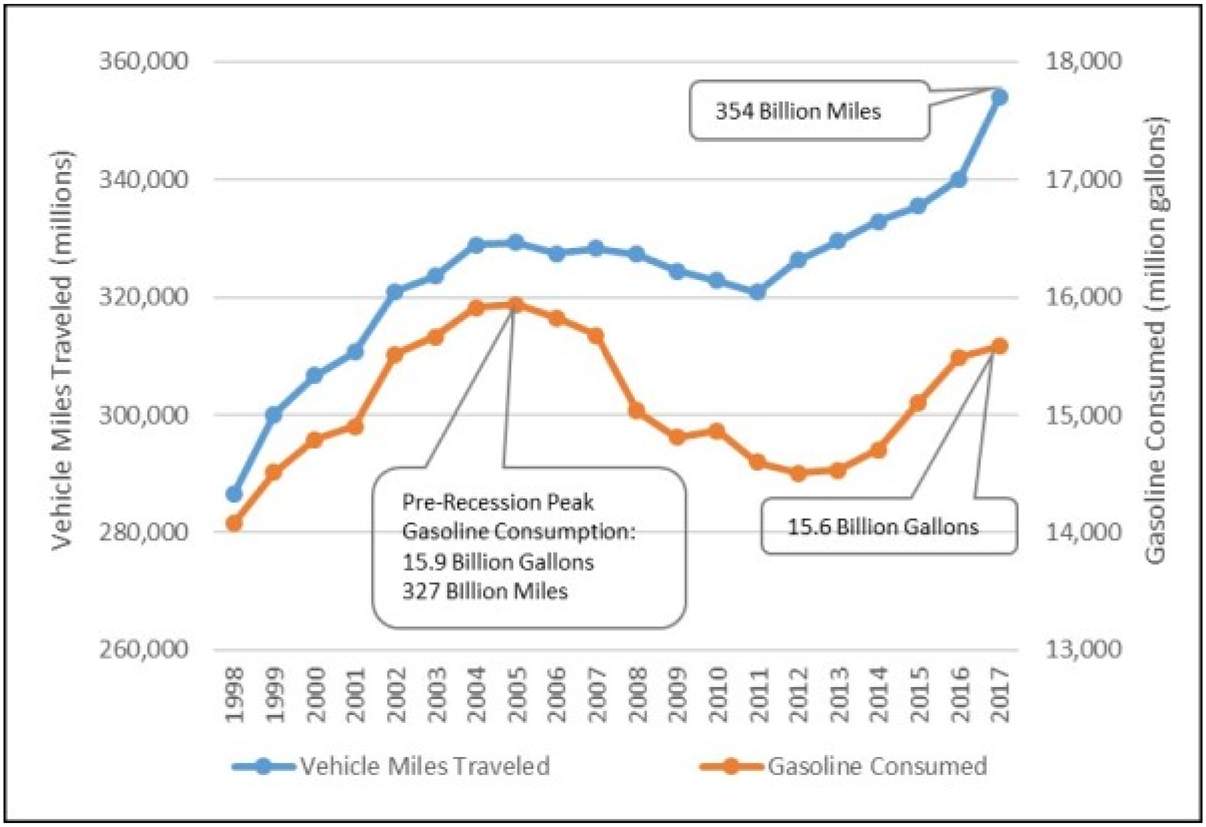

Figure 3.1. California Annual Gasoline Consumption and Vehicle Miles Traveled, 1998-2017

3.2.3 Regional

The region's need for gasoline and diesel is projected to decline from about 129 million gallons per day in 2010 to about 112 million gallons per day by 2035. The projected reduction in fuel consumption is due in large part to state fuel efficiency standards for vehicles and state mandated increases in the supply and use of alternative transportation fuels. Electric vehicles in particular are an important alternative to conventional vehicles as they have the potential to reduce greenhouse gas emissions resulting from the consumption of fossil fuels, particularly in a state with a cleaner energy mix.

The U.S. Census Bureau estimates that the Santa Cruz County population was approximately 274,255 in 2019. The existing population is heavily dependent on automobile travel due to the suburban development throughout most of the County. The majority of energy consumed is from transportation fuels. The California Air Resources Board (CARB) Mobile Source Emissions Inventory (MSEI) EMFAC2017 web database estimates that the 2019 annual VMT in Santa Cruz County is approximately 1,977,948,655 miles.

3.2.4 Project Site

Under CEQA, the baseline for environmental impact analysis consists of the existing conditions (referred to in this document as Baseline) at the time of the Notice of Preparation. The Baseline year has been established as 2019. Emission estimations based on information contained in the Traffic Operations Analysis Report (CDM Smith, 2020). Within the limits of the project, SR 1 currently has two lanes in each direction with multiple on ramps and off ramps.

The existing/baseline project corridor annual VMT is 250,908,760 with 96 percent non-trucks and 4 percent trucks. This results in an annual fuel consumption of approximately 9,440,052 gallons per year of gasoline and 776,551 gallons per year of diesel fuel. Existing traffic management systems include metered ramps and changeable message boards. Standard Caltrans lighting is provided at on and off-ramps, but there is no existing lighting in between the interchanges. The Build Alternative does not include substantial light replacement or upgrades that would significantly change existing energy use. The existing pavement surface is considered to be in good condition, which contributes to energy efficiencies.

Table 3.1 shows the existing vehicle corridor-wide operational performance conditions (including the freeway mainline segments within the project limits and upstream of the project limits). The data describe traffic conditions corresponding to peak periods and peak hours within those peak periods. The AM peak period is 6:00 AM–12:00 PM and the AM peak hour is 7:00 AM–8:00 AM. The PM peak period is 2:00 PM–8:00 PM and the PM peak hour is 4:00 PM–5:00 PM. Table 3.1 presents the average hourly volumes of total vehicles and trucks during the peak hour and remaining five hours of the peak period, the total daily VMT and VHT during those times, and the corresponding LOS, average speed (mph), and delay (minutes/vehicle). Due to lack of detailed vehicle classification counts, an average truck percentage of 4 percent was assumed on all roadway segments and under all scenarios.

Table 3.1. Summary of Existing Traffic Conditions

Direction of Movement & Time Period	Analysis Duration	Average Hourly Volume (veh/hr.)	Average Hourly Truck Volume (veh/hr.)	Daily VMT	Daily VHT	LOS	Average Vehicle Speed (mph)	Average Vehicle Delay (min/veh)
SR-1 NB AM Peak Period	Peak Hour	3,270	131	16,840	590	F	29	5.8
	Peak Period	3,142	126	97,070	2,747	E	35	3.8
SR-1 NB PM Peak Period	Peak Hour	2,822	113	14,535	235	C	62	0.0
	Peak Period	2,400	96	74,149	1,200	C	62	0.0
SR-1 SB AM Peak Period	Peak Hour	3,042	122	28,896	486	C	59	0.2
	Peak Period	2,873	115	163,737	2,738	C	60	0.2
SR-1 SB PM Peak Period	Peak Hour	3,470	139	32,962	1,419	F	23	15.2
	Peak Period	3,391	136	193,281	6,045	F	32	8.5

Source: CDM Smith, 2020

4. Study Methods

Congestion relief and capacity-increasing projects affect the ability of a transportation facility to accommodate existing and future traffic demand. This results in changes to direct energy consumption (i.e., fuel usage) by vehicles using the facilities. Congestion relief and capacity-increasing projects require construction, which is a one-time direct energy source that ceases to consume energy once work is complete. Maintenance and landscaping activities would result in long-term indirect energy consumption through the use of equipment required to maintain the facility and associated facilities.

Some projects may also include features such as new or replacement roadway lighting or other features requiring electricity which is an ongoing and permanent source of direct energy consumption. The Build Alternative does not include substantial light replacement or upgrades that would significantly change existing energy use.

4.1 Direct Energy (Mobile Sources)

In the context of transportation, direct energy involves all energy consumed by vehicle propulsion (e.g., automobiles, trains, airplanes). This energy consumption is a function of traffic characteristics such as VMT, speed, vehicle mix, and thermal value of the fuel being used. The procedure for analyzing direct energy consumption by mobile sources is to calculate fuel consumption using CT-EMFAC2017. CT-EMFAC2017 is an emissions model developed by Caltrans that calculates project-level emissions and fuel consumption using data from the CARB's MSEI EMFAC model. CT-EMFAC produces speed-based consumption factors for diesel fuel and gasoline fuel based on regional location (Santa Cruz County for the project) and vehicle fleet mix (determined to be 4 percent trucks by transportation engineers).

4.2 Direct Energy (Construction)

The one-time energy expenditure involved in constructing a project is also considered direct energy. The procedure for analyzing direct energy consumption from construction activities is to obtain fuel consumption projections in gallons. The Sacramento Metropolitan Air Quality Management District Road Construction Emissions Model was used to estimate air quality and greenhouse gas emissions for the Build Alternative. For this reason, the Road Construction Emissions Model was also used to estimate fuel use. It is acknowledged that the Caltrans Construction Emission Tool can also be used to estimate fuel use. The Caltrans Construction Emission Tool was not used in this analysis to ensure consistency between project impact analyses. It is preferable to break out construction fuel consumption by diesel and gasoline sources, as the carbon content differs between the two types of fuels. Typical gasoline sources are employee commute vehicles (e.g., light duty automobiles and trucks) and smaller construction equipment pieces (e.g., tampers and mowers). Typical diesel sources are off-road construction equipment (e.g., graders, dozers).

The Air Quality Report prepared for the Draft Environmental Document includes a quantification of construction-related carbon dioxide (CO_2) emissions from off-road equipment and on-road vehicles using the Road Construction Emissions Model. These emissions were used to estimate construction energy from CO_2 emission factors derived for the CARB GHG emissions inventory. For gasoline fuel, approximately 19.4 pounds of CO_2 are generated per gallon combusted, and for diesel fuel approximately 22.5 pounds of CO_2 are generated per gallon combusted. The CO_2 emissions output in units of tons per construction phase from gasoline vehicles and diesel vehicles were converted to pounds and divided by the corresponding CO_2 factor to estimate one-time gasoline and diesel fuel consumption during construction of the project.

Similar to the analysis in the Air Quality Report, the equipment list used to estimate energy use is adequate to construct both the roadway and coastal rail trail components. Less equipment would be needed to individually construct the components thereby generating less energy use than shown below for combined construction activities.

4.3 Indirect Energy (Maintenance)

Maintenance and landscaping activities would result in long-term indirect energy consumption through the use of equipment to maintain the project and associated facilities. Roadway construction projects will require new periodic maintenance, which could result in indirect energy consumption from equipment and vehicles. Generally, these impacts can be discussed qualitatively as attempting to estimate fuel data or greenhouse gas emissions for these activities, the frequency of which is unknown, would be speculative.

5. Environmental Consequences

5.1 Direct Energy

5.1.1 Mobile Sources

Congestion relief and capacity-increasing projects affect the capability of a roadway facility to address existing and future traffic demand. This results in changes to direct energy consumption (i.e., fuel usage) from vehicles using the facility. Another important consideration is that for operation of a project over the long term, newer and more fuel-efficient vehicles will enter the fleet, resulting in an overall lower potential for an increase in energy consumption due to vehicle traffic. Table 5.1 shows that under the Existing/Baseline condition in 2019, annual fuel consumption along the project corridor is approximately 9,440,052 gallons of gasoline and 776,551 gallons of diesel fuel. With substantial improvements in engine fuel efficiency anticipated, fuel consumption per vehicle mile will decrease in the future.

Table 5.1. Annual VMT, Vehicle Percentages, and Operational Fuel Consumption

Analysis Scenario & Year	Annual VMT	Regional Fleet Mix (Truck %)	Annual Fuel Consumption (Gallons)	
			Gasoline	Diesel
Existing Conditions (2019)	250,908,760	4%	9,440,052	776,551
Opening (2025) No Build Alternative	262,474,270	4%	8,567,164	776,800
Opening (2025) Build Alternative	264,150,280	4%	8,679,027	758,503
Design (2045) No Build Alternative	279,217,020	4%	8,129,385	762,194
Design (2045) Build Alternative	288,391,700	4%	8,019,654	760,263

In 2025, the baseline project corridor annual VMT under the No Build Alternative would be 262,474,270, with vehicle travel consuming approximately 776,800 gallons of diesel fuel and 8,567,164 gallons of gasoline per year. Implementation of the project would increase regional gasoline consumption by approximately 111,863 gallons per year and would decrease regional diesel fuel consumption by approximately 18,297 gallons per year through the expanded corridor capacity accommodating 1,676,010 additional annual VMT relative to the No Build Alternative condition, as well as reduced congestion. The change in average vehicle speeds affects gasoline vehicles and diesel vehicles to different degrees and fewer diesel vehicles are expected in future years, which explains the increase for gasoline consumption and the decrease for diesel consumption. The MSEI estimates that Santa Cruz County on-road vehicle travel will consume approximately 68,919,268 gallons of gasoline and 9,693,575 gallons of diesel fuel in 2025. The additional fuel consumption spurred by the Project would represent an increase of approximately 0.2 percent for countywide gasoline consumption and a decrease of 0.2 percent for countywide diesel consumption.

By 2045, implementation of the project would decrease annual gasoline and diesel fuel consumption by approximately 109,732 gallons per year and 1,932 gallons per year, respectively, relative to the No Project condition. The MSEI estimates that Santa Cruz County vehicle travel will consume approximately 54,803,966 gallons of gasoline and 7,678,675 gallons of diesel fuel in 2045. The reduction in annual fuel consumption spurred by the Project would represent decreases of approximately 0.2 percent for countywide gasoline consumption and 0.03 percent for countywide diesel consumption in the design year of 2045.

5.1.2 Construction

Construction energy effects involve the one-time, non-recoverable energy costs associated with construction of roadways and structures. Site preparation and roadway construction typically involves clearing, cut-and-fill activities, grading, removing or improving existing roadways, building bridges, and paving roadway surfaces. Construction-related effects on energy from most highway projects would be greatest during the site preparation and concrete paving phases because the excavation, handling, and transport of materials requires equipment and truck fuels.

The fuel consumption was estimated from the equipment and vehicles that would be employed in construction activities. Diesel engines are installed in heavy-duty off-road construction equipment and on-road haul trucks. Gasoline engines are typically found in passenger vehicles that would be used for construction worker daily commutes. Table 5.2 presents the direct, one-time expenditure of fuel consumption associated with construction activities, including both the roadway and coastal rail trail components. Construction would require approximately 377,602.8 gallons of diesel and 23,320.2 gallons of gasoline over a three-year period. Annual average consumption of petroleum fuels during construction activities would be approximately 125,867.6 gallons of diesel fuel and 7,773.4 gallons of gasoline per year.

Table 5.2. Construction Fuel Consumption

Construction Phase	Duration (Months)	Fuel Consumption (gallons)	
		Diesel	Gasoline
Grubbing/Land Clearing	3.6	47,598	1,295
Grading/Excavation	14.4	214,518	11,487
Drainage/Utilities/Sub-Grade	12.6	54,727	7,174
Paving	5.4	57,987	2,572
Total	**36.0**	**374,829**	**22,528**

5.2 Indirect Energy (Maintenance)

Maintenance comprises energy for the day-to-day upkeep of equipment and systems, as well as the energy embedded in any replacement equipment, materials, and supplies. The energy needed to maintain the Build Alternative improvements would not be measurably greater than the energy used to maintain the existing facility within the project limits. For example, operations would not require Caltrans to purchase additional maintenance vehicles.

5.3 Avoidance, Minimization, and/or Mitigation Measures

The following measures are recommended to reduce energy use.

- Landscaping reduces surface warming and, through photosynthesis, decreases carbon dioxide. The final design plans shall provide landscaping where necessary within the corridor to provide aesthetic treatment, replacement planting, or mitigation planting.
- The final design plans shall incorporate the use of energy-efficient lighting, such as light-emitting diode (LED) traffic signals, to the extent feasible. LED bulbs cost $60 to $70 each but last 5 to 6 years, compared to the 1-year average lifespan of the incandescent bulbs previously used. The LED bulbs themselves consume ten percent of the electricity of traditional lights.
- The construction contractor shall comply with Caltrans Standard Specification Provisions that restrict idling time for lane closure during construction to ten minutes in each direction. In addition, the construction contractor must comply with Title 13, CCR Section 2449(d)(3), which was adopted by the California Air Resources Board on June 15, 2008. That regulation restricts idling of construction vehicles to no longer than five consecutive minutes.
- The Build Alternative shall incorporate the following Best Available Control Technologies related to energy use:
    - Use cement blended with the maximum feasible amount of flash or other materials (i.e., limestone);
    - Recycle construction materials;
    - Use lighter-colored pavement where feasible to increase albedo;
    - Use recycled water or grey water for fugitive dust control;
    - Employ energy- and fuel-efficient vehicles and equipment, zero- and/or near-zero emission technologies; and
    - Encourage ride-sharing and carpooling for construction crews.

6. References

Association of Monterey Bay Area Governments (2018) 2040 Metropolitan Transportation Plan/Sustainable Communities Strategy.

California Air Resources Board (2020) CT-EMFAC2017, Version 1.0.2

Caltrans (2018) 2017 Traffic Volumes: Route I, Available: https://dot.ca.gov/programs/traffic-

CDM Smith (September 2020) Highway 1 Auxiliary Lanes and Bus-on-Shoulder Improvements — Freedom Boulevard to State Park Drive — and Coastal Rail Trail Segment 12 Project Traffic Forecast Report. Report submitted to Santa Cruz County Regional Transportation Commission (RTC) and Caltrans Distrct 5.

Sacramento Metropolitan Air Quality Management District (2020) Road Construction Emissions Model, Version 9.0.

U.S. Census Bureau (2019) American Community Survey (ACS) 5-Year Estimates 2014-2018. February. Available at https://data.census.gov/cedsci/.

Appendix A

Summary of Forecast Traffic Activities

Daily Vehicle Miles Traveled (VMT)

VMT No Build vs. Build Alternative			
	2019	2025	2045
Northbound			
No Project	218,034	227,226	256,571
Build Alternative	219,477	230,768	259,226
Percent Change	0.7%	1.6%	1.0%
Southbound			
No Project	211,031	221,102	233,908
Build Alternative	212,240	224,195	245,529
Percent Change	0.6%	1.4%	5.0%

Peak Period VMT (within Project Limits)

Year	Alternative	NB AM Period	NB PM Period	SB AM Period	SB PM Period
	No Build	86,523	67,637	73,667	79,154
	Interim Build	87,067	68,096	74,182	79,392
2019	Build	87,033	68,096	74,182	79,392
	No Build	87,677	70,493	77,808	82,938
	Interim Build	87,756	71,153	78,272	84,209
2025	Build	87,727	71,669	78,896	84,163
	No Build	86,835	82,121	84,312	86,603
	Interim Build	86,529	82,864	89,076	90,103
2045	Build	86,548	82,980	89,188	90,092

Source: VMT within Project Limits calculated from FREQ output: (Sum of (average hourly volume during the peak period * Distance for each segment)) * Number of hours during the peak period

Peak Period and Daily Total Volume (within Project Limit)

Year	Alternative	Direction	AM Period	PM Period	Daily	Factor
2019	No Build	Northbound	21,760	16,350	53,900	1.4
		Southbound	17,700	19,160	50,900	1.4
	Build Alternative	Northbound	21,910	16,470	54,300	1.4
		Southbound	17,830	19,290	51,300	1.4
2025	No Build	Northbound	22,130	17,060	56,300	1.4
		Southbound	18,650	20,100	53,300	1.4
	Build Alternative	Northbound	22,100	17,340	57,100	1.4
		Southbound	18,940	20,480	54,200	1.4
2045	No Build	Northbound	21,840	19,910	63,400	1.5
		Southbound	21,180	23,100	60,600	1.4
	Build Alternative	Northbound	21,800	20,120	64,100	1.5
		Southbound	21,340	23,420	61,300	1.4

Source: Developed Volumes

Summary of Traffic Data for No Build Alternative (Corridor Summary)

Performance Measure	Units	Time Period	Year 2019 No Build Alternative			
			Northbound AM	Northbound PM	Southbound AM	Southbound PM
Average Travel Time	Minutes per Vehicle	Peak Hour	6.1	4.0	4.2	7.4
		Peak Period	5.2	4.0	4.1	5.3
Average Speed	Miles per Hour	Peak Hour	40	62	59	34
		Peak Period	47	61	60	47
Average Travel Delay	Minutes per Vehicle	Peak Hour	2.2	0.0	0.2	3.4
		Peak Period	1.2	0.0	0.1	1.3
Number of Vehicle Trips (vehicle	Vehicles per Hour	Peak Hour	3,944	3,058	3,104	3,638
		Peak Period	3,693	2,766	2,963	3,322
Number of Person Trips (person	Persons per Hour	Peak Hour	4,457	3,792	3,600	4,293
		Peak Period	4,173	3,430	3,437	3,920
Freeway Travel Time (VHT)	Vehicle-Hours	Peak Hour	404	202	216	448
		Peak Period	1,833	1,103	1,227	1,696
Travel Distance (VMT)	Vehicle-Miles	Peak Hour	16,072	12,461	12,862	15,075
		Peak Period	86,523	67,637	73,667	79,154
Average Vehicle Occupancy	Persons per Vehicle	Peak Hour	1.13	1.24	1.16	1.18
		Peak Period	1.13	1.24	1.16	1.18
Average Density	Passenger Cars per Mile	Peak Hour	48.7	24.5	25.9	51.7
		Peak Period	39.1	22.4	24.5	35.3
Average Level of Service (LOS)	-	Peak Hour	F	C	C	F
		Peak Period	E	C	C	E

Notes:
Peak Hour: 7-8 AM, 4-5 PM
Peak Period: 6 AM-12 PM, 2-8 PM

Performance Measure	Units	Time Period	Year 2025 No Build Alternative			
			Northbound AM	Northbound PM	Southbound AM	Southbound PM
Average Travel Time	Minutes per Vehicle	Peak Hour	6.2	4.0	4.3	8.8
		Peak Period	5.3	4.0	4.4	6.6
Average Speed	Miles per Hour	Peak Hour	39	62	57	28
		Peak Period	46	61	56	38
Average Travel Delay	Minutes per Vehicle	Peak Hour	2.3	0.0	0.3	4.8
		Peak Period	1.3	0.1	0.4	2.6
Number of Vehicle Trips (vehicle	Vehicles per Hour	Peak Hour	3,930	3,197	3,222	3,574
		Peak Period	3,742	2,883	3,129	3,481
Number of Person Trips (person	Persons per Hour	Peak Hour	4,440	3,964	3,737	4,218
		Peak Period	4,229	3,575	3,630	4,107
Freeway Travel Time (VHT)	Vehicle-Hours	Peak Hour	407	212	233	525
		Peak Period	1,887	1,156	1,383	2,191
Travel Distance (VMT)	Vehicle-Miles	Peak Hour	16,012	13,027	13,351	14,812
		Peak Period	87,677	70,493	77,808	82,938
Average Vehicle Occupancy	Persons per Vehicle	Peak Hour	1.13	1.24	1.16	1.18
		Peak Period	1.13	1.24	1.16	1.18
Average Density	Passenger Cars per Mile	Peak Hour	49.0	25.8	27.9	59.1
		Peak Period	40.0	23.5	27.7	44.7
Average Level of Service (LOS)	-	Peak Hour	F	C	D	F
		Peak Period	E	C	D	E

Summary of Traffic Data for No Build Alternative (Corridor Summary)

Notes:
Peak Hour: 7-8 AM, 4-5 PM
Peak Period: 6 AM-12 PM, 2-8 PM

Performance Measure	Units	Time Period	Year 2045 No Build Alternative			
			Northbound AM	Northbound PM	Southbound AM	Southbound PM
Average Travel Time	Minutes per Vehicle	Peak Hour	6.3	4.4	4.9	10.2
		Peak Period	5.4	4.2	5.0	7.6
Average Speed	Miles per Hour	Peak Hour	39	55	51	24
		Peak Period	45	58	50	33
Average Travel Delay	Minutes per Vehicle	Peak Hour	2.3	0.5	0.9	6.1
		Peak Period	1.4	0.3	1.0	3.5
Number of Vehicle Trips (vehicle	Vehicles per Hour	Peak Hour	3,907	3,939	3,502	3,482
		Peak Period	3,706	3,359	3,391	3,635
Number of Person Trips (person	Persons per Hour	Peak Hour	4,415	4,885	4,063	4,109
		Peak Period	4,188	4,165	3,934	4,289
Freeway Travel Time (VHT)	Vehicle-Hours	Peak Hour	409	290	287	589
		Peak Period	1,912	1,418	1,692	2,633
Travel Distance (VMT)	Vehicle-Miles	Peak Hour	15,920	16,052	14,513	14,429
		Peak Period	86,835	82,121	84,312	86,603
Average Vehicle Occupancy	Persons per Vehicle	Peak Hour	1.13	1.24	1.16	1.18
		Peak Period	1.13	1.24	1.16	1.18
Average Density	Passenger Cars per Mile	Peak Hour	49.3	35.4	33.9	65.1
		Peak Period	40.4	29.0	33.6	51.8
Average Level of Service (LOS)	-	Peak Hour	F	E	D	F
		Peak Period	E	D	D	F

Notes:
Peak Hour: 7-8 AM, 4-5 PM
Peak Period: 6 AM-12 PM, 2-8 PM

Summary of Traffic Data for Build Alternative (Corridor Summary)

Performance Measure	Units	Time Period	2019 Existing Build Alternative			
			Northbound AM	Northbound PM	Southbound AM	Southbound PM
Average Travel Time	Minutes per Vehicle	Peak Hour	5.4	3.9	4.0	7.0
		Peak Period	4.7	4.0	4.0	5.0
Average Speed	Miles per Hour	Peak Hour	46	62	62	36
		Peak Period	53	62	62	50
Average Travel Delay	Minutes per Vehicle	Peak Hour	1.4	0.0	0.0	2.9
		Peak Period	0.7	0.0	0.0	1.0
Number of Vehicle Trips (vehicle	Vehicles per Hour	Peak Hour	4,068	3,082	3,143	3,700
		Peak Period	3,715	2,785	2,984	3,332
Number of Person Trips (person	Persons per Hour	Peak Hour	4,597	3,821	3,645	4,365
		Peak Period	4,197	3,454	3,461	3,932
Freeway Travel Time (VHT)	Vehicle-Hours	Peak Hour	363	203	212	429
		Peak Period	1,657	1,102	1,201	1,588
Travel Distance (VMT)	Vehicle-Miles	Peak Hour	16,577	12,557	13,023	15,331
		Peak Period	87,033	68,096	74,182	79,392
Average Vehicle Occupancy	Persons per Vehicle	Peak Hour	1.13	1.24	1.16	1.18
		Peak Period	1.13	1.24	1.16	1.18
Average Density	Passenger Cars per Mile	Peak Hour	37.1	20.5	21.2	41.3
		Peak Period	29.4	18.5	19.9	27.8
Average Level of Service (LOS)	-	Peak Hour	E	C	C	E
		Peak Period	D	C	C	D

Notes:

Peak Hour: 7-8 AM, 4-5 PM

Peak Period: 6 AM-12 PM, 2-8 PM

Performance Measure	Units	Time Period	Year 2025 Build Alternative			
			Northbound AM	Northbound PM	Southbound AM	Southbound PM
Average Travel Time	Minutes per Vehicle	Peak Hour	5.4	4.0	4.1	9.5
		Peak Period	4.7	4.0	4.1	6.9
Average Speed	Miles per Hour	Peak Hour	45	62	61	26
		Peak Period	52	62	61	36
Average Travel Delay	Minutes per Vehicle	Peak Hour	1.5	0.0	0.1	5.5
		Peak Period	0.7	0.0	0.0	2.9
Number of Vehicle Trips (vehicle	Vehicles per Hour	Peak Hour	4,065	3,377	3,342	3,703
		Peak Period	3,744	2,931	3,173	3,532
Number of Person Trips (person	Persons per Hour	Peak Hour	4,593	4,188	3,877	4,370
		Peak Period	4,231	3,635	3,681	4,168
Freeway Travel Time (VHT)	Vehicle-Hours	Peak Hour	367	223	227	588
		Peak Period	1,673	1,163	1,285	2,328
Travel Distance (VMT)	Vehicle-Miles	Peak Hour	16,563	13,762	13,851	15,345
		Peak Period	87,727	71,669	78,896	84,163
Average Vehicle Occupancy	Persons per Vehicle	Peak Hour	1.13	1.24	1.16	1.18
		Peak Period	1.13	1.24	1.16	1.18
Average Density	Passenger Cars per Mile	Peak Hour	37.5	22.6	22.8	55.2
		Peak Period	29.7	19.6	21.4	39.6
Average Level of Service (LOS)	-	Peak Hour	E	C	C	F
		Peak Period	D	C	C	E

Summary of Traffic Data for Build Alternative (Corridor Summary)

Notes:
Peak Hour: 7-8 AM, 4-5 PM
Peak Period: 6 AM-12 PM, 2-8 PM

Performance Measure	Units	Time Period	Year 2025 Build Alternative			
			Northbound AM	Northbound PM	Southbound AM	Southbound PM
Average Travel Time	Minutes per Vehicle	Peak Hour	5.7	4.1	4.6	17.5
		Peak Period	4.9	4.0	4.3	12.1
Average Speed	Miles per Hour	Peak Hour	43	60	54	14
		Peak Period	50	61	57	21
Average Travel Delay	Minutes per Vehicle	Peak Hour	1.8	0.2	0.6	13.5
		Peak Period	0.9	0.1	0.3	8.1
Number of Vehicle Trips (vehicle	Vehicles per Hour	Peak Hour	3,986	3,938	3,788	3,481
		Peak Period	3,694	3,394	3,587	3,781
Number of Person Trips (person	Persons per Hour	Peak Hour	4,505	4,883	4,394	4,107
		Peak Period	4,174	4,209	4,161	4,462
Freeway Travel Time (VHT)	Vehicle-Hours	Peak Hour	381	269	291	1,017
		Peak Period	1,720	1,371	1,557	4,387
Travel Distance (VMT)	Vehicle-Miles	Peak Hour	16,244	16,046	15,698	14,424
		Peak Period	86,548	82,980	89,188	90,092
Average Vehicle Occupancy	Persons per Vehicle	Peak Hour	1.13	1.24	1.16	1.18
		Peak Period	1.13	1.24	1.16	1.18
Average Density	Passenger Cars per Mile	Peak Hour	38.5	27.4	29.7	91.0
		Peak Period	30.4	23.3	26.2	69.4
Average Level of Service (LOS)	-	Peak Hour	E	D	D	F
		Peak Period	D	C	D	F

Notes:
Peak Hour: 7-8 AM, 4-5 PM
Peak Period: 6 AM-12 PM, 2-8 PM

Appendix B

Operational Fuels Consumption

- Project Corridor Fuels Consumption Calculations
- Gasoline and Diesel Fuel Consumption Rates
- CT EMFAC Output – 2019
- CT EMFAC Output – 2025
- CT EMFAC Output – 2045

PROJECT CORRIDOR OPERATIONAL FUEL CONSUMPTION ANALYSIS

Year	Alt	Direction	Time Period	Time Sum	VMT	Speed	Gas Gal/Day	Diesel Gal/Day	Gas Gal/Year	Diesel Gal/Year
2019	NB	North	AM/PH	PH	16,840	29	626.704	56.828	217,466.277	19,719.408
2019	NB	North	AM/PP	PP	80,230	37	2,751.761	246.033	954,860.939	85,373.561
2019	NB	North	PM/PH	PH	14,535	62	564.057	43.954	195,727.723	15,251.982
2019	NB	North	PM/PP	PP	59,614	62	2,313.429	180.273	802,759.716	62,554.639
2019	NB	North	OP	OP	76,111	62	2,953.624	230.160	1,024,907.651	79,865.403
2019	NB	South	AM/PH	PH	28,896	59	1,096.378	84.787	380,443.100	29,420.965
2019	NB	South	AM/PP	PP	134,841	60	5,155.241	402.635	1,788,868.666	139,714.423
2019	NB	South	PM/PH	PH	32,962	23	1,458.100	127.095	505,960.853	44,101.923
2019	NB	South	PM/PP	PP	160,319	35	5,677.858	507.089	1,970,216.623	175,959.882
2019	NB	South	OP	OP	118,732	62	4,607.609	359.046	1,598,840.315	124,588.812
	NB Total				723,080		27,204.8	2,237.9	9,440,051.9	776,551.0
2019	B	North	AM/PH	PH	16,843	29	626.8	56.8	217,505.0	19,722.9
2019	B	North	AM/PP	PP	80,362	36	2,801.2	250.3	972,014.4	86,858.1
2019	B	North	PM/PH	PH	14,659	62	568.9	44.3	197,397.5	15,382.1
2019	B	North	PM/PP	PP	59,989	62	2,328.0	181.4	807,809.5	62,948.1
2019	B	North	OP	OP	76,397	62	2,964.7	231.0	1,028,758.9	80,165.5
2019	B	South	AM/PH	PH	28,996	60	1,108.6	86.6	384,675.5	30,044.0
2019	B	South	AM/PP	PP	135,719	60	5,188.8	405.3	1,800,516.7	140,624.2
2019	B	South	PM/PH	PH	33,554	24	1,415.8	124.4	491,291.1	43,177.8
2019	B	South	PM/PP	PP	160,790	36	5,604.7	500.8	1,944,827.1	173,787.6
2019	B	South	OP	OP	119,411	62	4,634.0	361.1	1,607,983.7	125,301.3
	B Total				726,720		27,241.4	2,242.1	9,452,779.5	778,011.6
2025	NB	North	AM/PH	PH	17,653	32	541.4	52.8	187,858.6	18,336.3
2025	NB	North	AM/PP	PP	82,792	30	2,674.8	260.9	928,152.9	90,524.5
2025	NB	North	PM/PH	PH	15,341	62	503.7	43.5	174,779.3	15,077.8
2025	NB	North	PM/PP	PP	63,055	62	2,070.3	178.6	718,382.7	61,973.2
2025	NB	North	OP	OP	79,499	62	2,610.2	225.2	905,728.5	78,135.0
2025	NB	South	AM/PH	PH	29,965	60	969.3	83.4	336,334.7	28,926.8
2025	NB	South	AM/PP	PP	142,429	61	4,641.7	399.8	1,610,673.1	138,739.9
2025	NB	South	PM/PH	PH	33,498	22	1,310.8	126.7	454,840.4	43,951.9
2025	NB	South	PM/PP	PP	167,875	31	5,286.0	515.7	1,834,235.6	178,963.7
2025	NB	South	OP	OP	124,303	62	4,081.2	352.1	1,416,178.4	122,170.3
	NB Total				756,410		24,689.2	2,238.6	8,567,164.2	776,799.5
2025	B	North	AM/PH	PH	17,981	31	566.2	55.2	196,464.0	19,168.7
2025	B	North	AM/PP	PP	82,578	25	3,006.4	292.7	1,043,204.8	101,580.4
2025	B	North	PM/PH	PH	15,447	62	507.2	43.8	175,987.0	15,182.0
2025	B	North	PM/PP	PP	63,490	62	2,084.5	179.8	723,338.7	62,400.7
2025	B	North	OP	OP	79,794	62	2,619.9	226.0	909,089.4	78,425.0
2025	B	South	AM/PH	PH	30,793	61	1,003.5	86.4	348,225.8	29,995.4
2025	B	South	AM/PP	PP	141,766	61	4,620.1	398.0	1,603,175.5	138,094.0
2025	B	South	PM/PH	PH	36,992	53	1,125.2	95.4	390,448.9	33,117.5
2025	B	South	PM/PP	PP	167,124	59	5,365.5	453.6	1,861,840.6	157,413.6
2025	B	South	OP	OP	125,275	62	4,113.1	354.8	1,427,252.4	123,125.6
	B Total				761,240		25,011.6	2,185.9	8,679,027.0	758,502.9

PROJECT CORRIDOR OPERATIONAL FUEL CONSUMPTION ANALYSIS

Year	Alt	Direction	Time Period	Time Sum	VMT	Speed	Gas Gal/Day	Diesel Gal/Day	Gas Gal/Year	Diesel Gal/Year
2045	NB	North	AM/PH	PH	17,201	23	506.5	52.2	175,754.9	18,108.0
2045	NB	North	AM/PP	PP	77,110	15	3,109.2	299.6	1,078,899.8	103,951.6
2045	NB	North	PM/PH	PH	17,508	60	446.1	40.0	154,784.4	13,882.0
2045	NB	North	PM/PP	PP	72,245	60	1,840.6	165.1	638,702.4	57,282.7
2045	NB	North	OP	OP	81,826	62	2,116.1	190.8	734,298.1	66,208.2
2045	NB	South	AM/PH	PH	34,330	55	841.7	74.4	292,079.7	25,826.3
2045	NB	South	AM/PP	PP	162,771	59	4,116.1	361.2	1,428,291.3	125,343.8
2045	NB	South	PM/PH	PH	31,056	14	1,308.0	127.8	453,868.1	44,347.2
2045	NB	South	PM/PP	PP	176,151	21	5,665.9	571.9	1,966,058.5	198,446.5
2045	NB	South	OP	OP	134,462	62	3,477.4	313.5	1,206,648.1	108,797.9
	NB Total				804,660		23,427.6	2,196.5	8,129,385.3	762,194.2
2045	B	North	AM/PH	PH	16,931	20	567.6	56.8	196,957.6	19,699.1
2045	B	North	AM/PP	PP	77,949	12	3,562.8	356.7	1,236,280.4	123,762.2
2045	B	North	PM/PH	PH	17,492	62	452.4	40.8	156,971.4	14,153.4
2045	B	North	PM/PP	PP	72,162	62	1,866.2	168.3	647,574.3	58,388.8
2045	B	North	OP	OP	82,036	62	2,121.6	191.3	736,182.6	66,378.2
2045	B	South	AM/PH	PH	34,660	59	876.5	76.9	304,136.3	26,690.4
2045	B	South	AM/PP	PP	162,798	60	4,147.7	372.0	1,439,261.9	129,081.7
2045	B	South	PM/PH	PH	37,307	25	1,069.2	109.4	371,027.3	37,969.2
2045	B	South	PM/PP	PP	188,873	30	4,803.8	490.3	1,666,911.6	170,139.1
2045	B	South	OP	OP	140,892	62	3,643.7	328.5	1,264,350.2	114,000.6
	B Total				831,100		23,111.4	2,191.0	8,019,653.7	760,262.6

CT-EMFAC FUEL CONSUMPTION RATES gallons/fleet-mile

Year	Speed	Gas	Diesel
2019	10	0.074026	0.006468
2019	11	0.071333	0.006181
2019	12	0.068639	0.005895
2019	13	0.065946	0.005608
2019	14	0.063252	0.005322
2019	15	0.060559	0.005035
2019	16	0.057866	0.004748
2019	17	0.055172	0.004462
2019	18	0.052479	0.004175
2019	19	0.049785	0.003889
2019	20	0.050357	0.004298
2019	21	0.048317	0.004151
2019	22	0.046276	0.004003
2019	23	0.044236	0.003856
2019	24	0.042195	0.003708
2019	25	0.043056	0.003785
2019	26	0.041596	0.003682
2019	27	0.040136	0.00358
2019	28	0.038675	0.003477
2019	29	0.037215	0.003375
2019	30	0.03821	0.003404
2019	31	0.037241	0.003328
2019	32	0.036272	0.003252
2019	33	0.035302	0.003175
2019	34	0.034333	0.003099
2019	35	0.035416	0.003163
2019	36	0.034857	0.003115
2019	37	0.034298	0.003067
2019	38	0.03374	0.003018
2019	39	0.033181	0.00297
2019	40	0.03427	0.002975
2019	41	0.034041	0.002937
2019	42	0.033812	0.0029
2019	43	0.033582	0.002862
2019	44	0.033353	0.002825
2019	45	0.034373	0.002853
2019	46	0.034394	0.002829
2019	47	0.034414	0.002804
2019	48	0.034435	0.00278
2019	49	0.034455	0.002755
2019	50	0.035361	0.002837
2019	51	0.035559	0.002834
2019	52	0.035756	0.002831
2019	53	0.035954	0.002827

CT-EMFAC FUEL CONSUMPTION RATES gallons/fleet-mile

Year	Speed	Gas	Diesel
2019	54	0.036151	0.002824
2019	55	0.036795	0.002891
2019	56	0.037082	0.002902
2019	57	0.037369	0.002913
2019	58	0.037655	0.002923
2019	59	0.037942	0.002934
2019	60	0.038232	0.002986
2019	61	0.038519	0.003005
2019	62	0.038807	0.003024
2019	63	0.039094	0.003043
2019	64	0.039382	0.003062
2019	65	0.038251	0.003098
2025	10	0.060734	0.006114
2025	11	0.058523	0.005834
2025	12	0.056312	0.005554
2025	13	0.0541	0.005275
2025	14	0.051889	0.004995
2025	15	0.049678	0.004715
2025	16	0.047467	0.004435
2025	17	0.045256	0.004155
2025	18	0.043044	0.003876
2025	19	0.040833	0.003596
2025	20	0.041306	0.004048
2025	21	0.039632	0.003915
2025	22	0.037957	0.003781
2025	23	0.036283	0.003648
2025	24	0.034608	0.003514
2025	25	0.035315	0.003545
2025	26	0.034117	0.003444
2025	27	0.032919	0.003344
2025	28	0.03172	0.003243
2025	29	0.030522	0.003143
2025	30	0.031339	0.003151
2025	31	0.030544	0.003072
2025	32	0.029749	0.002993
2025	33	0.028953	0.002915
2025	34	0.028158	0.002836
2025	35	0.029048	0.002897
2025	36	0.02859	0.002846
2025	37	0.028132	0.002795
2025	38	0.027673	0.002745
2025	39	0.027215	0.002694
2025	40	0.028113	0.002705
2025	41	0.027926	0.002667

CT-EMFAC FUEL CONSUMPTION RATES		gallons/fleet-mile	
Year	Speed	Gas	Diesel
2025	42	0.027739	0.002628
2025	43	0.027552	0.00259
2025	44	0.027365	0.002551
2025	45	0.028202	0.002588
2025	46	0.02822	0.002565
2025	47	0.028238	0.002541
2025	48	0.028255	0.002518
2025	49	0.028273	0.002494
2025	50	0.029017	0.002583
2025	51	0.02918	0.002582
2025	52	0.029343	0.002581
2025	53	0.029506	0.00258
2025	54	0.029669	0.002579
2025	55	0.030198	0.002656
2025	56	0.030434	0.002671
2025	57	0.03067	0.002685
2025	58	0.030907	0.0027
2025	59	0.031143	0.002714
2025	60	0.031377	0.002782
2025	61	0.031613	0.002807
2025	62	0.031849	0.002832
2025	63	0.032084	0.002858
2025	64	0.03232	0.002883
2025	65	0.031391	0.002942
2045	10	0.043846	0.005036
2045	11	0.04225	0.004806
2045	12	0.040653	0.004576
2045	13	0.039057	0.004345
2045	14	0.03746	0.004115
2045	15	0.035864	0.003885
2045	16	0.034268	0.003655
2045	17	0.032671	0.003425
2045	18	0.031075	0.003194
2045	19	0.029478	0.002964
2045	20	0.029818	0.003353
2045	21	0.028609	0.003247
2045	22	0.0274	0.00314
2045	23	0.02619	0.003034
2045	24	0.024981	0.002927
2045	25	0.025492	0.002933
2045	26	0.024627	0.002849
2045	27	0.023762	0.002765
2045	28	0.022896	0.002681
2045	29	0.022031	0.002597

CT-EMFAC FUEL CONSUMPTION RATES gallons/fleet-mile

Year	Speed	Gas	Diesel
2045	30	0.022622	0.002596
2045	31	0.022048	0.002529
2045	32	0.021474	0.002461
2045	33	0.0209	0.002394
2045	34	0.020326	0.002326
2045	35	0.020968	0.002372
2045	36	0.020637	0.002327
2045	37	0.020306	0.002282
2045	38	0.019976	0.002238
2045	39	0.019645	0.002193
2045	40	0.020295	0.002206
2045	41	0.02016	0.002173
2045	42	0.020026	0.00214
2045	43	0.019891	0.002106
2045	44	0.019757	0.002073
2045	45	0.020362	0.002108
2045	46	0.020375	0.002088
2045	47	0.020389	0.002069
2045	48	0.020402	0.002049
2045	49	0.020416	0.00203
2045	50	0.020953	0.002104
2045	51	0.021071	0.002103
2045	52	0.021189	0.002102
2045	53	0.021308	0.002102
2045	54	0.021426	0.002101
2045	55	0.021808	0.002168
2045	56	0.021979	0.002181
2045	57	0.02215	0.002194
2045	58	0.022321	0.002206
2045	59	0.022492	0.002219
2045	60	0.022661	0.002285
2045	61	0.022832	0.002308
2045	62	0.023002	0.002332
2045	63	0.023173	0.002355
2045	64	0.023343	0.002379
2045	65	0.022671	0.002444

File Name:	Santa Cruz (NCC) - 2019 - Annual.EF
CT-EMFAC2017 Version:	1.0.2.27401
Run Date:	2/19/2020 17:18
Area:	Santa Cruz (NCC)
Analysis Year:	2019
Season:	Annual

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Vehicle Category	VMT Fraction Across Category	Diesel VMT Within Cat	Gas VMT Fraction Within Category
Truck 1	0.023	0.5	0.5
Truck 2	0.017	0.927	0.066
Non-Truck	0.96	0.018	0.97

==

Road Type:	Freeway		
Silt Loading Factor:	CARB	0.015 g/m2	
Precipitation Correction:	None	P = NA	N = NA

==

FleetAverageFuelConsumption(gallons/veh-mile)

FuelType	<= 5 mph	10 mph	15 mph	20 mph	25 mph	30 mph	35 mph	40 mph	45 mph	50 mph	55 mph	60 mph	65 mph	70 mph	75 mph
Gasoline	0.091189	0.074026	0.060559	0.050357	0.043056	0.03821	0.035416	0.03427	0.034373	0.035361	0.036795	0.038232	0.038251	0.038251	0.038251
Diesel	0.007574	0.006468	0.005035	0.004298	0.003785	0.003404	0.003163	0.002975	0.002853	0.002837	0.002891	0.002986	0.003098	0.003098	0.003098

File Name:	Santa Cruz (NCC) - 2025 - Annual.EF
CT-EMFAC2017 Version:	1.0.2.27401
Run Date:	2/19/2020 17:21
Area:	Santa Cruz (NCC)
Analysis Year:	2025
Season:	Annual

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Vehicle Category	VMT Fraction Across Category	Diesel VMT Within Cat	Gas VMT Fraction Within Category
Truck 1	0.022	0.516	0.484
Truck 2	0.018	0.929	0.061
Non-Truck	0.96	0.018	0.955

===

Road Type:	Freeway		
Silt Loading Factor:	CARB	0.015 g/m2	
Precipitation Correction:	None	P = NA	N = NA

===

FleetAverageFuelConsumption(gallons/veh-mile)

FuelType	<= 5 mph	10 mph	15 mph	20 mph	25 mph	30 mph	35 mph	40 mph	45 mph	50 mph	55 mph	60 mph	65 mph	70 mph	75 mph
Gasoline	0.074803	0.060734	0.049678	0.041306	0.035315	0.031339	0.029048	0.028113	0.028202	0.029017	0.030198	0.031377	0.031391	0.031391	0.031391
Diesel	0.007279	0.006114	0.004715	0.004048	0.003545	0.003151	0.002897	0.002705	0.002588	0.002583	0.002656	0.002782	0.002942	0.002942	0.002942

File Name: Santa Cruz (NCC) - 2045 - Annual.EF
CT-EMFAC2017 Version: 1.0.2.27401
Run Date: 2/19/2020 17:22
Area: Santa Cruz (NCC)
Analysis Year: 2045
Season: Annual

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Vehicle Category	VMT Fraction Across Category	Diesel VMT Within Cat	Gas VMT Fraction Within Category
Truck 1	0.019	0.521	0.479
Truck 2	0.021	0.926	0.062
Non-Truck	0.96	0.015	0.931

===

Road Type: Freeway
Silt Loading Factor: CARB 0.015 g/m2
Precipitation Correction: None P = NA N = NA

===

FleetAverageFuelConsumption(gallons/veh-mile)

FuelType	<= 5 mph	10 mph	15 mph	20 mph	25 mph	30 mph	35 mph	40 mph	45 mph	50 mph	55 mph	60 mph	65 mph	70 mph	75 mph
Gasoline	0.054002	0.043846	0.035864	0.029818	0.025492	0.022622	0.020968	0.020295	0.020362	0.020953	0.021808	0.022661	0.022671	0.022671	0.022671
Diesel	0.006039	0.005036	0.003885	0.003353	0.002933	0.002596	0.002372	0.002206	0.002108	0.002104	0.002168	0.002285	0.002444	0.002444	0.002444

Appendix C

Construction Fuels Consumption

- Construction Fuel Consumption Calculations
- Road Construction Emissions Model Output
- Road Construction Emissions Model Input
- Emission Factors for GHG Inventories – USEPA 2020

Worker Commute

Emissions	CO2	
Pounds per day - Grubbing/Land Clearing	316.43	
Tons per const. Period - Grubbing/Land Clearing	12.53	1,294.7
Pounds per day - Grading/Excavation	701.87	
Tons per const. Period - Grading/Excavation	111.18	11,487.2
Pounds per day - Drainage/Utilities/Sub-Grade	500.93	
Tons per const. Period - Drainage/Utilities/Sub-Grad	69.43	7,173.7
Pounds per day - Paving	419.04	
Tons per const. Period - Paving	24.89	2,571.8
Total tons per construction project	218.03	

Source	Fuel	Total CO2 Emissions (tons)	Combustion Factor (poundsCO2/gallon)	Gallons Fuel
Worker Vehicles	Gas	218.03	19.36	22,527.55
Soil Haul Trucks	Diesel	1,765.98	22.51	156,912.42
Asphalt Trucks	Diesel	482.06	22.51	42,832.51
Water Trucks	Diesel	57.96	22.51	5,149.70
Equipment	Diesel	1,912.54	22.51	169,934.44

Total Gasoline (Gallons)	**22,527.6**
Total Diesel Fuel (Gallons)	**374,829.1**

Annual Average	
Gasoline	7,509.2
Diesel	124,943.0

Soil Hauling

Hauling Emissions	CO2	
Pounds per day - Grubbing/Land Clearing	8344.737871	
Tons per const. Period - Grubbing/Land Clearing	330.4516197	47,597.5
Pounds per day - Grading/Excavation	8299.795735	
Tons per const. Period - Grading/Excavation	1314.687644	#######
Pounds per day - Drainage/Utilities/Sub-Grade	871.8972311	
Tons per const. Period - Drainage/Utilities/Sub-Grad	120.8449562	54,727.0
Pounds per day - Paving	0	
Tons per const. Period - Paving	0	57,986.5
Total tons per construction project	1765.98422	

Asphalt Hauling

Emissions	CO2
Pounds per day - Grubbing/Land Clearing	0
Tons per const. Period - Grubbing/Land Clearing	0
Pounds per day - Grading/Excavation	0
Tons per const. Period - Grading/Excavation	0
Pounds per day - Drainage/Utilities/Sub-Grade	0
Tons per const. Period - Drainage/Utilities/Sub-Grad	0
Pounds per day - Paving	8115.524165
Tons per const. Period - Paving	482.0621354
Total tons per construction project	482.0621354

Water Trucks

Emissions	CO2
Pounds per day - Grubbing/Land Clearing	148.3508955
Tons per const. Period - Grubbing/Land Clearing	5.874695461
Pounds per day - Grading/Excavation	147.5519242
Tons per const. Period - Grading/Excavation	23.37222479
Pounds per day - Drainage/Utilities/Sub-Grade	145.3162052
Tons per const. Period - Drainage/Utilities/Sub-Grad	20.14082604
Pounds per day - Paving	144.2759852
Tons per const. Period - Paving	8.569993519
Total tons per construction project	57.95773981

Off-Road Equipment Emissions

		CO2
Grubbing/Land Clearing	pounds per day	5034.42966
Grubbing/Land Clearing	tons per phase	199.363415
Grading/Excavation	pounds per day	6794.524
Grading/Excavation	tons per phase	1076.2526
Drainage/Utilities/Sub-Grade	pounds per day	3426.72449
Drainage/Utilities/Sub-Grade	tons per phase	474.944015
Paving	pounds per day	2726.96367
Paving	tons per phase	161.981642
All Activities	total tons project	1912.54167

Road Construction Emissions Model, Version 9.0.0

Daily Emission Estimates for -> Highway 1 Auxiliary Lane (State Park Drive to Freedom Boulevard) F

Project Phases (Pounds)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	SOx (lbs/day)	CO2 (lbs/day)	CH4 (lbs/day)	N2O (lbs/day)	CO2e (lbs/day)
Grubbing/Land Clearing	2.43	24.57	39.04	31.49	1.49	30.00	7.31	1.07	6.24	0.14	13,843.95	1.64	1.39	14,298.62
Grading/Excavation	3.46	33.97	50.76	31.93	1.93	30.00	7.68	1.44	6.24	0.16	15,943.75	2.22	1.40	16,417.92
Drainage/Utilities/Sub-Grade	1.71	18.94	18.35	30.76	0.76	30.00	6.88	0.64	6.24	0.05	4,944.87	0.76	0.20	5,023.44
Paving	1.24	16.09	27.78	1.08	1.08	0.00	0.69	0.69	0.00	0.11	11,405.81	0.90	1.33	11,825.19
Maximum (pounds/day)	3.46	33.97	50.76	31.93	1.93	30.00	7.68	1.44	6.24	0.16	15,943.75	2.22	1.40	16,417.92
Total (tons/construction project)	0.96	9.93	13.78	10.63	0.53	10.10	2.50	0.40	2.10	0.04	4,436.57	0.58	0.38	4,565.49

Notes:	
Project Start Year ->	2025
Project Length (months) ->	36
Total Project Area (acres) ->	45
Maximum Area Disturbed/Day (acres) ->	3
Water Truck Used? ->	Yes

	Total Material Imported/Exported Volume (yd^3/day)		Daily VMT (miles/day)			
Phase	Soil	Asphalt	Soil Hauling	Asphalt Hauling	Worker Commute	Water Truck
Grubbing/Land Clearing	1500	0	2,250	0	480	40
Grading/Excavation	1,500	0	2,250	0	1,080	40
Drainage/Utilities/Sub-Grade	150	0	240	0	800	40
Paving	0	1500	0	2,250	680	40

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns G and H. Total PM2.5 emissions shown in Column I are the sum of exhaust and fugitive dust emissions shown in columns J and K.

CO2e emissions are estimated by multiplying mass emissions for each GHG by its global warming potential (GWP), 1 , 25 and 298 for CO2, CH4 and N2O, respectively. Total CO2e is then estimated by summing CO2e estimates over all GHGs.

Total Emission Estimates by Phase for -> Highway 1 Auxiliary Lane (State Park Drive to Freedom Boulevard) F

Project Phases (Tons for all except CO2e. Metric tonnes for CO2e)	ROG (tons/phase)	CO (tons/phase)	NOx (tons/phase)	Total PM10 (tons/phase)	Exhaust PM10 (tons/phase)	Fugitive Dust PM10 (tons/phase)	Total PM2.5 (tons/phase)	Exhaust PM2.5 (tons/phase)	Fugitive Dust PM2.5 (tons/phase)	SOx (tons/phase)	CO2 (tons/phase)	CH4 (tons/phase)	N2O (tons/phase)	CO2e (MT/phase)
Grubbing/Land Clearing	0.10	0.97	1.55	1.25	0.06	1.19	0.29	0.04	0.25	0.01	548.22	0.07	0.05	513.68
Grading/Excavation	0.55	5.38	8.04	5.06	0.31	4.75	1.22	0.23	0.99	0.02	2,525.49	0.35	0.22	2,359.25
Drainage/Utilities/Sub-Grade	0.24	2.63	2.54	4.26	0.11	4.16	0.95	0.09	0.86	0.01	685.36	0.11	0.03	631.63
Paving	0.07	0.96	1.65	0.06	0.06	0.00	0.04	0.04	0.00	0.01	677.50	0.05	0.08	637.23
Maximum (tons/phase)	0.55	5.38	8.04	5.06	0.31	4.75	1.22	0.23	0.99	0.02	2525.49	0.35	0.22	2,359.25
Total (tons/construction project)	0.96	9.93	13.78	10.63	0.53	10.10	2.50	0.40	2.10	0.04	4436.57	0.58	0.38	4,141.78

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns G and H. Total PM2.5 emissions shown in Column I are the sum of exhaust and fugitive dust emissions shown in columns J and K.

CO2e emissions are estimated by multiplying mass emissions for each GHG by its global warming potential (GWP), 1 , 25 and 298 for CO2, CH4 and N2O, respectively. Total CO2e is then estimated by summing CO2e estimates over all GHGs.

The CO2e emissions are reported as metric tons per phase.

Road Construction Emissions Model Version 9.0.0
Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells D10 through D24, E28 through G35, and D38 through D41 for all project types.
Please use "Clear Data Input & User Overrides" button first before changing the Project Type or begin a new project.

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

Input Type

Project Name	Highway 1 Auxiliary Lane (State Park Drive to Freedom Boulevard) Project	
Construction Start Year	2025	Enter a Year between 2014 and 2040 (inclusive)
Project Type	2	1) New Road Construction : Project to build a roadway from bare ground, which generally requires more site preparation than widening an existing roadway 2) Road Widening : Project to add a new lane to an existing roadway 3) Bridge/Overpass Construction : Project to build an elevated roadway, which generally requires some different equipment than a new roadway, such as a crane 4) Other Linear Project Type: Non-roadway project such as a pipeline, transmission line, or levee construction
Project Construction Time	36.00	months
Working Days per Month	22.00	days (assume 22 if unknown)
Predominant Soil/Site Type: Enter 1, 2, or 3 (for project within "Sacramento County", follow soil type selection instructions in cells E18 to E20 otherwise see instructions provided in cells J18 to J22)	1	1) Sand Gravel : Use for quaternary deposits (Delta/West County) 2) Weathered Rock-Earth : Use for Laguna formation (Jackson Highway area) or the Ione formation (Scott Road, Rancho Murieta) 3) Blasted Rock : Use for Salt Springs Slate or Copper Hill Volcanics (Folsom South of Highway 50, Rancho Murieta)
Project Length	2.60	miles
Total Project Area	45.00	acres
Maximum Area Disturbed/Day	3.00	acres
Water Trucks Used?	1	1. Yes 2. No

Please note that the soil type instructions provided in cells E18 to E20 are specific to Sacramento County. Maps available from the California Geologic Survey (see weblink below) can be used to determine soil type outside Sacramento County.

http://www.conservation.ca.gov/cgs/information/geologic_mapping/Pages/googlemaps.aspx#regionalseries

Material Hauling Quantity Input

Material Type	Phase	Haul Truck Capacity (yd^3) (assume 20 if unknown)	Import Volume (yd^3/day)	Export Volume (yd^3/day)
Soil	Grubbing/Land Clearing	20.00	0.00	1500.00
	Grading/Excavation	20.00	0.00	1500.00
	Drainage/Utilities/Sub-Grade	20.00	0.00	150.00
	Paving	20.00	0.00	0.00
Asphalt	Grubbing/Land Clearing	20.00	0.00	0.00
	Grading/Excavation	20.00	0.00	0.00
	Drainage/Utilities/Sub-Grade	20.00	0.00	0.00
	Paving	20.00	1500.00	0.00

Mitigation Options

On-road Fleet Emissions Mitigation	No Mitigation	Select "2010 and Newer On-road Vehicles Fleet" option when the on-road heavy-duty truck fleet for the project will be limited to vehicles of model year 2010 or newer
Off-road Equipment Emissions Mitigation	No Mitigation	Select "20% NOx and 45% Exhaust PM reduction" option if the project will be required to use a lower emitting off-road construction fleet. The SMAQMD Construction Mitigation Calculator can be used to confirm compliance with this mitigation measure (http://www.airquality.org/Businesses/CEQA-Land-Use-Planning/Mitigation). Select "Tier 4 Equipment" option if some or all off-road equipment used for the project meets CARB Tier 4 Standard

The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.

Note: The program's estimates of construction period phase length can be overridden in cells D50 through D53, and F50 through F53.

Construction Periods	User Override of Construction Months	Program Calculated Months	User Override of Phase Starting Date	Program Default Phase Starting Date
Grubbing/Land Clearing		3.60		1/1/2025
Grading/Excavation		14.40		4/21/2025
Drainage/Utilities/Sub-Grade		12.60		7/3/2026
Paving		5.40		7/22/2027
Totals (Months)		36		

Note: Soil Hauling emission default values can be overridden in cells D61 through D64, and F61 through F64.

Soil Hauling Emissions **User Input**	User Override of Miles/Round Trip	Program Estimate of Miles/Round Trip	User Override of Truck Round Trips/Day	Default Values Round Trips/Day	Calculated Daily VMT
Miles/round trip: Grubbing/Land Clearing		30.00		75	2250.00
Miles/round trip: Grading/Excavation		30.00		75	2250.00
Miles/round trip: Drainage/Utilities/Sub-Grade		30.00		8	240.00
Miles/round trip: Paving		30.00		0	0.00

Emission Rates	**ROG**	**CO**	**NOx**	**PM10**	**PM2.5**	**SOx**	**CO2**	**CH4**	**N2O**	**CO2e**
Grubbing/Land Clearing (grams/mile)	0.04	0.43	3.46	0.12	0.05	0.02	1,682.27	0.00	0.26	1,761.12
Grading/Excavation (grams/mile)	0.04	0.43	3.45	0.11	0.05	0.02	1,673.21	0.00	0.26	1,751.63
Draining/Utilities/Sub-Grade (grams/mile)	0.04	0.43	3.41	0.11	0.05	0.02	1,647.86	0.00	0.26	1,725.09
Paving (grams/mile)	0.04	0.43	3.40	0.11	0.05	0.02	1,636.06	0.00	0.26	1,712.74
Grubbing/Land Clearing (grams/trip)	0.00	0.00	4.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grading/Excavation (grams/trip)	0.00	0.00	4.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Draining/Utilities/Sub-Grade (grams/trip)	0.00	0.00	4.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paving (grams/trip)	0.00	0.00	4.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hauling Emissions	**ROG**	**CO**	**NOx**	**PM10**	**PM2.5**	**SOx**	**CO2**	**CH4**	**N2O**	**CO2e**
Pounds per day - Grubbing/Land Clearing	0.20	2.12	17.90	0.57	0.26	0.08	8,344.74	0.01	1.31	8,735.85
Tons per const. Period - Grubbing/Land Clearing	0.01	0.08	0.71	0.02	0.01	0.00	330.45	0.00	0.05	345.94
Pounds per day - Grading/Excavation	0.20	2.12	17.84	0.57	0.26	0.08	8,299.80	0.01	1.30	8,688.80
Tons per const. Period - Grading/Excavation	0.03	0.34	2.83	0.09	0.04	0.01	1,314.69	0.00	0.21	1,376.31
Pounds per day - Drainage/Utilities/Sub-Grade	0.02	0.23	1.89	0.06	0.03	0.01	871.90	0.00	0.14	912.76
Tons per const. Period - Drainage/Utilities/Sub-Grade	0.00	0.03	0.26	0.01	0.00	0.00	120.84	0.00	0.02	126.51
Pounds per day - Paving	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Paving	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total tons per construction project	0.04	0.45	3.80	0.12	0.05	0.02	1,765.98	0.00	0.28	1,848.75

Note: Asphalt Hauling emission default values can be overridden in cells D91 through D94, and F91 through F94.

Asphalt Hauling Emissions **User Input**	User Override of Miles/Round Trip	Program Estimate of Miles/Round Trip	User Override of Truck Round Trips/Day	Default Values Round Trips/Day	Calculated Daily VMT
Miles/round trip: Grubbing/Land Clearing		30.00		0	0.00
Miles/round trip: Grading/Excavation		30.00		0	0.00
Miles/round trip: Drainage/Utilities/Sub-Grade		30.00		0	0.00
Miles/round trip: Paving		30.00		75	2250.00

Emission Rates	**ROG**	**CO**	**NOx**	**PM10**	**PM2.5**	**SOx**	**CO2**	**CH4**	**N2O**	**CO2e**
Grubbing/Land Clearing (grams/mile)	0.04	0.43	3.46	0.12	0.05	0.02	1,682.27	0.00	0.26	1,761.12
Grading/Excavation (grams/mile)	0.04	0.43	3.45	0.11	0.05	0.02	1,673.21	0.00	0.26	1,751.63
Draining/Utilities/Sub-Grade (grams/mile)	0.04	0.43	3.41	0.11	0.05	0.02	1,647.86	0.00	0.26	1,725.09
Paving (grams/mile)	0.04	0.43	3.40	0.11	0.05	0.02	1,636.06	0.00	0.26	1,712.74
Grubbing/Land Clearing (grams/trip)	0.00	0.00	4.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grading/Excavation (grams/trip)	0.00	0.00	4.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Draining/Utilities/Sub-Grade (grams/trip)	0.00	0.00	4.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paving (grams/trip)	0.00	0.00	4.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Emissions	**ROG**	**CO**	**NOx**	**PM10**	**PM2.5**	**SOx**	**CO2**	**CH4**	**N2O**	**CO2e**
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Drainage/Utilities/Sub-Grade	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Drainage/Utilities/Sub-Grade	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Paving	0.19	2.12	17.61	0.57	0.26	0.08	8,115.52	0.01	1.28	8,495.88
Tons per const. Period - Paving	0.01	0.13	1.05	0.03	0.02	0.00	482.06	0.00	0.08	504.66
Total tons per construction project	0.01	0.13	1.05	0.03	0.02	0.00	482.06	0.00	0.08	504.66

Note: Worker commute default values can be overridden in cells D121 through D126.

Worker Commute Emissions	User Override of Worker Commute Default Values	Default Values	Calculated Daily Trips	Calculated Daily VMT
User Input				
Miles/ one-way trip		20		
One-way trips/day		2		
No. of employees: Grubbing/Land Clearing		12	24	480.00
No. of employees: Grading/Excavation		27	54	1,080.00
No. of employees: Drainage/Utilities/Sub-Grade		20	40	800.00
No. of employees: Paving		17	34	680.00

Emission Rates	ROG	CO	NOx	PM10	PM2.5	SOx	CO2	CH4	N2O	CO2e
Grubbing/Land Clearing (grams/mile)	0.01	0.78	0.06	0.05	0.02	0.00	295.84	0.00	0.01	297.52
Grading/Excavation (grams/mile)	0.01	0.75	0.05	0.05	0.02	0.00	291.64	0.00	0.01	293.27
Draining/Utilities/Sub-Grade (grams/mile)	0.01	0.70	0.05	0.05	0.02	0.00	281.00	0.00	0.00	282.50
Paving (grams/mile)	0.01	0.68	0.04	0.05	0.02	0.00	276.54	0.00	0.00	277.99
Grubbing/Land Clearing (grams/trip)	0.93	2.56	0.25	0.00	0.00	0.00	63.73	0.06	0.03	73.77
Grading/Excavation (grams/trip)	0.90	2.53	0.24	0.00	0.00	0.00	62.83	0.06	0.03	72.65
Draining/Utilities/Sub-Grade (grams/trip)	0.85	2.43	0.22	0.00	0.00	0.00	60.54	0.05	0.03	69.80
Paving (grams/trip)	0.82	2.39	0.21	0.00	0.00	0.00	59.58	0.05	0.03	68.61
Emissions	**ROG**	**CO**	**NOx**	**PM10**	**PM2.5**	**SOx**	**CO2**	**CH4**	**N2O**	**CO2e**
Pounds per day - Grubbing/Land Clearing	0.06	0.96	0.07	0.05	0.02	0.00	316.43	0.01	0.01	318.75
Tons per const. Period - Grubbing/Land Clearing	0.00	0.04	0.00	0.00	0.00	0.00	12.53	0.00	0.00	12.62
Pounds per day - Grading/Excavation	0.13	2.09	0.15	0.11	0.05	0.01	701.87	0.01	0.02	706.93
Tons per const. Period - Grading/Excavation	0.02	0.33	0.02	0.02	0.01	0.00	111.18	0.00	0.00	111.98
Pounds per day - Drainage/Utilities/Sub-Grade	0.09	1.45	0.10	0.08	0.03	0.00	500.93	0.01	0.01	504.40
Tons per const. Period - Drainage/Utilities/Sub-Grade	0.01	0.20	0.01	0.01	0.00	0.00	69.43	0.00	0.00	69.91
Pounds per day - Paving	0.08	1.19	0.08	0.07	0.03	0.00	419.04	0.01	0.01	421.89
Tons per const. Period - Paving	0.00	0.07	0.00	0.00	0.00	0.00	24.89	0.00	0.00	25.06
Total tons per construction project	0.04	0.64	0.05	0.03	0.01	0.00	218.03	0.00	0.00	219.57

Note: Water Truck default values can be overridden in cells D153 through D156, I153 through I156, and F153 through F156.

Water Truck Emissions	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Round Trips/Vehicle/Day	Default Values Round Trips/Vehicle/Day	Calculated Trips/day	User Override of Miles/Round Trip	Default Values Miles/Round Trip	Calculated Daily VMT
User Input								
Grubbing/Land Clearing - Exhaust		1		5	5		8.00	40.00
Grading/Excavation - Exhaust		1		5	5		8.00	40.00
Drainage/Utilities/Subgrade		1		5	5		8.00	40.00
Paving		1		5	5		8.00	40.00

Emission Rates	ROG	CO	NOx	PM10	PM2.5	SOx	CO2	CH4	N2O	CO2e
Grubbing/Land Clearing (grams/mile)	0.04	0.43	3.46	0.12	0.05	0.02	1,682.27	0.00	0.26	1,761.12
Grading/Excavation (grams/mile)	0.04	0.43	3.45	0.11	0.05	0.02	1,673.21	0.00	0.26	1,751.63
Draining/Utilities/Sub-Grade (grams/mile)	0.04	0.43	3.41	0.11	0.05	0.02	1,647.86	0.00	0.26	1,725.09
Paving (grams/mile)	0.04	0.43	3.40	0.11	0.05	0.02	1,636.06	0.00	0.26	1,712.74
Grubbing/Land Clearing (grams/trip)	0.00	0.00	4.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grading/Excavation (grams/trip)	0.00	0.00	4.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Draining/Utilities/Sub-Grade (grams/trip)	0.00	0.00	4.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paving (grams/trip)	0.00	0.00	4.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Emissions	**ROG**	**CO**	**NOx**	**PM10**	**PM2.5**	**SOx**	**CO2**	**CH4**	**N2O**	**CO2e**
Pounds per day - Grubbing/Land Clearing	0.00	0.04	0.35	0.01	0.00	0.00	148.35	0.00	0.02	155.30
Tons per const. Period - Grubbing/Land Clearing	0.00	0.00	0.01	0.00	0.00	0.00	5.87	0.00	0.00	6.15
Pounds per day - Grading/Excavation	0.00	0.04	0.35	0.01	0.00	0.00	147.55	0.00	0.02	154.47
Tons per const. Period - Grading/Excavation	0.00	0.01	0.06	0.00	0.00	0.00	23.37	0.00	0.00	24.47
Pounds per day - Drainage/Utilities/Sub-Grade	0.00	0.04	0.35	0.01	0.00	0.00	145.32	0.00	0.02	152.13
Tons per const. Period - Drainage/Utilities/Sub-Grade	0.00	0.01	0.05	0.00	0.00	0.00	20.14	0.00	0.00	21.08
Pounds per day - Paving	0.00	0.04	0.35	0.01	0.00	0.00	144.28	0.00	0.02	151.04
Tons per const. Period - Paving	0.00	0.00	0.02	0.00	0.00	0.00	8.57	0.00	0.00	8.97
Total tons per construction project	0.00	0.01	0.14	0.00	0.00	0.00	57.96	0.00	0.01	60.67

Note: Fugitive dust default values can be overridden in cells D183 through D185.

Fugitive Dust	User Override of Max Acreage Disturbed/Day	Default Maximum Acreage/Day	PM10 pounds/day	PM10 tons/per period	PM2.5 pounds/day	PM2.5 tons/per period
Fugitive Dust - Grubbing/Land Clearing		3.00	30.00	1.19	6.24	0.25
Fugitive Dust - Grading/Excavation		3.00	30.00	4.75	6.24	0.99
Fugitive Dust - Drainage/Utilities/Subgrade		3.00	30.00	4.16	6.24	0.86

Off-Road Equipment Emissions

Grubbing/Land Clearing	Default Number of Vehicles	Mitigation Option Override of	Default		ROG	CO	NOx	PM10	PM2.5	SOx	CO2	CH4	N2O	CO2e
Override of Default Number of Vehicles	*Program-estimate*	Default Equipment Tier (applicable only when "Tier 4 Mitigation" Option Selected)	Equipment Tier	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
			Model Default Tier	Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Cranes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	1		Model Default Tier	Crawler Tractors	1.49	8.42	15.83	0.62	0.57	0.03	3,033.08	0.98	0.03	3,065.79
			Model Default Tier	Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	2		Model Default Tier	Excavators	0.67	13.04	4.89	0.24	0.22	0.02	2,001.35	0.65	0.02	2,022.93
			Model Default Tier	Forklifts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Graders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Other General Industrial Equipm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Other Material Handling Equipm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Pavers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Pumps	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Rollers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	6		Model Default Tier	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Welders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

User-Defined Off-road Equipment If non-default vehicles are used, please provide information in 'Non-default Off-road Equipment' tab

Number of Vehicles	Equipment Tier	Type		ROG	CO	NOx	PM10	PM2.5	SOx	CO2	CH4	N2O	CO2e
				pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

			ROG	CO	NOx	PM10	PM2.5	SOx	CO2	CH4	N2O	CO2e
	Grubbing/Land Clearing	pounds per day	2.16	21.45	20.72	0.86	0.79	0.05	5,034.43	1.63	0.05	5,088.71
	Grubbing/Land Clearing	tons per phase	0.09	0.85	0.82	0.03	0.03	0.00	199.36	0.06	0.00	201.51

Grading/Excavation	Default Number of Vehicles	Mitigation Option Override of Default Equipment Tier (applicable only when "Tier 4 Mitigation" Option Selected)	Default Equipment Tier	Type	ROG	CO	NOx	PM10	PM2.5	SOx	CO2	CH4	N2O	CO2e
Override of Default Number of Vehicles	*Program-estimate*				pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
			Model Default Tier	Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0		Model Default Tier	Cranes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	1		Model Default Tier	Crawler Tractors	0.75	4.21	7.92	0.31	0.28	0.02	1,516.54	0.49	0.01	1,532.89
			Model Default Tier	Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	3		Model Default Tier	Excavators	0.33	6.52	2.44	0.12	0.11	0.01	1,000.68	0.32	0.01	1,011.46
			Model Default Tier	Forklifts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	2		Model Default Tier	Graders	1.24	6.38	13.83	0.45	0.41	0.03	2,560.96	0.83	0.02	2,588.55
			Model Default Tier	Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Other General Industrial Equipm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Other Material Handling Equipm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Pavers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Pumps	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2		Model Default Tier	Rollers	0.27	3.69	2.89	0.15	0.13	0.01	508.12	0.16	0.00	513.60
			Model Default Tier	Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1		Model Default Tier	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2		Model Default Tier	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	6		Model Default Tier	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.00	4		Model Default Tier	Tractors/Loaders/Backhoes	0.53	8.92	5.34	0.22	0.20	0.01	1,208.22	0.39	0.01	1,221.22
			Model Default Tier	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Welders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

User-Defined Off-road Equipment If non-default vehicles are used, please provide information in 'Non-default Off-road Equipment' tab

Number of Vehicles	Equipment Tier	Type		ROG	CO	NOx	PM10	PM2.5	SOx	CO2	CH4	N2O	CO2e
				pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

		ROG	CO	NOx	PM10	PM2.5	SOx	CO2	CH4	N2O	CO2e
Grading/Excavation	pounds per day	3.13	29.71	32.41	1.24	1.14	0.07	6,794.52	2.20	0.06	6,867.73
Grading/Excavation	tons per phase	0.50	4.71	5.13	0.20	0.18	0.01	1,076.25	0.35	0.01	1,087.85

Drainage/Utilities/Subgrade Override of Default Number of Vehicles	Default Number of Vehicles *Program-estimate*	Mitigation Option Override of Default Equipment Tier (applicable only when "Tier 4 Mitigation" Option Selected)	Default Equipment Tier		ROG pounds/day	CO pounds/day	NOx pounds/day	PM10 pounds/day	PM2.5 pounds/day	SOx pounds/day	CO2 pounds/day	CH4 pounds/day	N2O pounds/day	CO2e pounds/day
			Model Default Tier	Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1		Model Default Tier	Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Cranes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00			Model Default Tier	Excavators	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00			Model Default Tier	Forklifts	0.17	2.27	1.64	0.09	0.08	0.00	296.06	0.10	0.00	299.26
2.00	1		Model Default Tier	Generator Sets	0.53	7.32	4.79	0.19	0.19	0.01	1,246.07	0.05	0.01	1,250.01
2.00	1		Model Default Tier	Graders	0.62	3.19	6.91	0.22	0.20	0.01	1,280.48	0.41	0.01	1,294.28
			Model Default Tier	Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Other General Industrial Equipm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Other Material Handling Equipm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Pavers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1		Model Default Tier	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1		Model Default Tier	Pumps	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Rollers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1		Model Default Tier	Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1		Model Default Tier	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	6		Model Default Tier	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	3		Model Default Tier	Tractors/Loaders/Backhoes	0.26	4.46	2.67	0.11	0.10	0.01	604.11	0.20	0.01	610.61
			Model Default Tier	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Welders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

User-Defined Off-road Equipment If non-default vehicles are used, please provide information in 'Non-default Off-road Equipment' tab

Number of Vehicles	Equipment Tier	Type	ROG pounds/day	CO pounds/day	NOx pounds/day	PM10 pounds/day	PM2.5 pounds/day	SOx pounds/day	CO2 pounds/day	CH4 pounds/day	N2O pounds/day	CO2e pounds/day
0.00	N/A	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

		ROG	CO	NOx	PM10	PM2.5	SOx	CO2	CH4	N2O	CO2e
Drainage/Utilities/Sub-Grade	pounds per day	1.59	17.23	16.01	0.61	0.58	0.04	3,426.72	0.75	0.03	3,454.15
Drainage/Utilities/Sub-Grade	tons per phase	0.22	2.39	2.22	0.08	0.08	0.00	474.94	0.10	0.00	478.75

Paving	Default Number of Vehicles	Mitigation Option Override of	Default		ROG	CO	NOx	PM10	PM2.5	SOx	CO2	CH4	N2O	CO2e
Override of Default Number of Vehicles	*Program-estimate*	Default Equipment Tier (applicable only when "Tier 4 Mitigation" Option Selected)	Equipment Tier	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
			Model Default Tier	Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Cranes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Excavators	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Forklifts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Graders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Other General Industrial Equipm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Other Material Handling Equipm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	1		Model Default Tier	Pavers	0.35	5.79	3.17	0.15	0.14	0.01	909.99	0.29	0.01	919.80
0.00	1		Model Default Tier	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Pumps	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00	2		Model Default Tier	Rollers	0.27	3.69	2.89	0.15	0.13	0.01	508.12	0.16	0.00	513.60
			Model Default Tier	Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	6		Model Default Tier	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.00			Model Default Tier	Surfacing Equipment	0.36	3.25	3.69	0.14	0.13	0.01	1,308.85	0.42	0.01	1,322.98
			Model Default Tier	Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3		Model Default Tier	Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Model Default Tier	Welders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

User-Defined Off-road Equipment	If non-default vehicles are used, please provide information in 'Non-default Off-road Equipment' tab			ROG	CO	NOx	PM10	PM2.5	SOx	CO2	CH4	N2O	CO2e
Number of Vehicles	Equipment Tier	Type		pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

			ROG	CO	NOx	PM10	PM2.5	SOx	CO2	CH4	N2O	CO2e
	Paving	pounds per day	0.98	12.74	9.74	0.44	0.40	0.03	2,726.96	0.88	0.02	2,756.38
	Paving	tons per phase	0.06	0.76	0.58	0.03	0.02	0.00	161.98	0.05	0.00	163.73
Total Emissions all Phases (tons per construction period) =>			0.86	8.70	8.75	0.34	0.31	0.02	1,912.54	0.57	0.02	1,931.84

Equipment default values for horsepower and hours/day can be overridden in cells D403 through D436 and F403 through F436.

Equipment	User Override of Horsepower	Default Values Horsepower	User Override of Hours/day	Default Values Hours/day
Aerial Lifts		63		8
Air Compressors		78		8
Bore/Drill Rigs		221		8
Cement and Mortar Mixers		9		8
Concrete/Industrial Saws		81		8
Cranes		231		8
Crawler Tractors		212		8
Crushing/Proc. Equipment		85		8
Excavators		158		8
Forklifts		89		8
Generator Sets		84		8
Graders		187		8
Off-Highway Tractors		124		8
Off-Highway Trucks		402		8
Other Construction Equipment		172		8
Other General Industrial Equipment		88		8
Other Material Handling Equipment		168		8
Pavers		130		8
Paving Equipment		132		8
Plate Compactors		8		8
Pressure Washers		13		8
Pumps		84		8
Rollers		80		8
Rough Terrain Forklifts		100		8
Rubber Tired Dozers		247		8
Rubber Tired Loaders		203		8
Scrapers		367		8
Signal Boards		6		8
Skid Steer Loaders		65		8
Surfacing Equipment		263		8
Sweepers/Scrubbers		64		8
Tractors/Loaders/Backhoes		97		8
Trenchers		78		8
Welders		46		8

END OF DATA ENTRY SHEET

Emission Factors for Greenhouse Gas Inventories

Last Modified: 26 March 2020

Red text indicates an update from the 2018 version of this document.

Typically, greenhouse gas emissions are reported in units of carbon dioxide equivalent (CO_2e). Gases are converted to CO_2e by multiplying by their global warming potential (GWP). The emission factors listed in this document have not been converted to CO_2e. To do so, multiply the emissions by the corresponding GWP listed in the table below.

Gas	100-Year GWP
CH_4	25
N_2O	298

Source: Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007. See the source note to Table 11 for further explanation.

Table 1 Stationary Combustion

Fuel Type	Heat Content (HHV)	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 Factor	CH_4 Factor	N_2O Factor
	mmBtu per short ton	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu	kg CO_2 per short ton	g CH_4 per short ton	g N_2O per short ton
Coal and Coke							
Anthracite Coal	25.09	103.69	11	1.6	2,602	276	40
Bituminous Coal	24.93	93.28	11	1.6	2,325	274	40
Sub-bituminous Coal	17.25	97.17	11	1.6	1,676	190	28
Lignite Coal	14.21	97.72	11	1.6	1,389	156	23
Mixed (Commercial Sector)	21.39	94.27	11	1.6	2,016	235	34
Mixed (Electric Power Sector)	19.73	95.52	11	1.6	1,885	217	32
Mixed (Industrial Coking)	26.28	93.90	11	1.6	2,468	289	42
Mixed (Industrial Sector)	22.35	94.67	11	1.6	2,116	246	36
Coal Coke	24.80	113.67	11	1.6	2,819	273	40
Other Fuels - Solid							
Municipal Solid Waste	9.95	90.70	32	4.2	902	318	42
Petroleum Coke (Solid)	30.00	102.41	32	4.2	3,072	960	126
Plastics	38.00	75.00	32	4.2	2,850	1,216	160
Tires	28.00	85.97	32	4.2	2,407	896	118
Biomass Fuels - Solid							
Agricultural Byproducts	8.25	118.17	32	4.2	975	264	35
Peat	8.00	111.84	32	4.2	895	256	34
Solid Byproducts	10.39	105.51	32	4.2	1,096	332	44
Wood and Wood Residuals	17.48	93.80	7.2	3.6	1,640	126	63
	mmBtu per scf	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu	kg CO_2 per scf	g CH_4 per scf	g N_2O per scf
Natural Gas							
Natural Gas	0.001026	53.06	1.0	0.10	0.05444	0.00103	0.00010
Other Fuels - Gaseous							
Blast Furnace Gas	0.000092	274.32	0.022	0.10	0.02524	0.000002	0.000009
Coke Oven Gas	0.000599	46.85	0.48	0.10	0.02806	0.000288	0.000060
Fuel Gas	0.001388	59.00	3.0	0.60	0.08189	0.004164	0.000833
Propane Gas	0.002516	61.46	3.0	0.60	0.15463	0.007548	0.001510
Biomass Fuels - Gaseous							
Landfill Gas	0.000485	52.07	3.2	0.63	0.025254	0.001552	0.000306
Other Biomass Gases	0.000655	52.07	3.2	0.63	0.034106	0.002096	0.000413
	mmBtu per gallon	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu	kg CO_2 per gallon	g CH_4 per gallon	g N_2O per gallon
Petroleum Products							
Asphalt and Road Oil	0.158	75.36	3.0	0.60	11.91	0.47	0.09
Aviation Gasoline	0.120	69.25	3.0	0.60	8.31	0.36	0.07
Butane	0.103	64.77	3.0	0.60	6.67	0.31	0.06
Butylene	0.105	68.72	3.0	0.60	7.22	0.32	0.06
Crude Oil	0.138	74.54	3.0	0.60	10.29	0.41	0.08
Distillate Fuel Oil No. 1	0.139	73.25	3.0	0.60	10.18	0.42	0.08
Distillate Fuel Oil No. 2	0.138	73.96	3.0	0.60	10.21	0.41	0.08
Distillate Fuel Oil No. 4	0.146	75.04	3.0	0.60	10.96	0.44	0.09
Ethane	0.068	59.60	3.0	0.60	4.05	0.20	0.04
Ethylene	0.058	65.96	3.0	0.60	3.83	0.17	0.03
Heavy Gas Oils	0.148	74.92	3.0	0.60	11.09	0.44	0.09
Isobutane	0.099	64.94	3.0	0.60	6.43	0.30	0.06
Isobutylene	0.103	68.86	3.0	0.60	7.09	0.31	0.06
Kerosene	0.135	75.20	3.0	0.60	10.15	0.41	0.08
Kerosene-Type Jet Fuel	0.135	72.22	3.0	0.60	9.75	0.41	0.08
Liquefied Petroleum Gases (LPG)	0.092	61.71	3.0	0.60	5.68	0.28	0.06
Lubricants	0.144	74.27	3.0	0.60	10.69	0.43	0.09
Motor Gasoline	0.125	70.22	3.0	0.60	8.78	0.38	0.08
Naphtha (<401 deg F)	0.125	68.02	3.0	0.60	8.50	0.38	0.08
Natural Gasoline	0.110	66.88	3.0	0.60	7.36	0.33	0.07
Other Oil (>401 deg F)	0.139	76.22	3.0	0.60	10.59	0.42	0.08
Pentanes Plus	0.110	70.02	3.0	0.60	7.70	0.33	0.07
Petrochemical Feedstocks	0.125	71.02	3.0	0.60	8.88	0.38	0.08
Petroleum Coke	0.143	102.41	3.0	0.60	14.64	0.43	0.09
Propane	0.091	62.87	3.0	0.60	5.72	0.27	0.05
Propylene	0.091	67.77	3.0	0.60	6.17	0.27	0.05
Residual Fuel Oil No. 5	0.140	72.93	3.0	0.60	10.21	0.42	0.08
Residual Fuel Oil No. 6	0.150	75.10	3.0	0.60	11.27	0.45	0.09
Special Naphtha	0.125	72.34	3.0	0.60	9.04	0.38	0.08
Unfinished Oils	0.139	74.54	3.0	0.60	10.36	0.42	0.08
Used Oil	0.138	74.00	3.0	0.60	10.21	0.41	0.08
Biomass Fuels - Liquid							
Biodiesel (100%)	0.128	73.84	1.1	0.11	9.45	0.14	0.01
Ethanol (100%)	0.084	68.44	1.1	0.11	5.75	0.09	0.01
Rendered Animal Fat	0.125	71.06	1.1	0.11	8.88	0.14	0.01
Vegetable Oil	0.120	81.55	1.1	0.11	9.79	0.13	0.01
Biomass Fuels - Kraft Pulping Liquor, by Wood Furnish							
North American Softwood		94.4	1.9	0.42			
North American Hardwood		93.7	1.9	0.42			
Bagasse		95.5	1.9	0.42			
Bamboo		93.7	1.9	0.42			
Straw		95.1	1.9	0.42			

Source:
Federal Register EPA; 40 CFR Part 98; e-CFR, June 13, 2017 (see link below). Table C-1, Table C-2, Table AA-1.
https://www.ecfr.gov/cgi-bin/text-idx?SID=ae265d7d6f98ec86fcd8640b9793a3f6&mc=true&node=pt40.23.98&rgn=div5#ap40.23.98_19.1

Note: Emission factors are per unit of heat content using higher heating values (HHV). If heat content is available from the fuel supplier, it is preferable to use that value. If not, default heat contents are provided.

Table 2 Mobile Combustion CO_2

Fuel Type	kg CO_2 per unit	Unit
Aviation Gasoline	8.31	gallon
Biodiesel (100%)	9.45	gallon
Compressed Natural Gas (CNG)	0.05444	scf
Diesel Fuel	10.21	gallon
Ethanol (100%)	5.75	gallon
Kerosene-Type Jet Fuel	9.75	gallon
Liquefied Natural Gas (LNG)	4.50	gallon
Liquefied Petroleum Gases (LPG)	5.68	gallon
Motor Gasoline	8.78	gallon
Residual Fuel Oil	11.27	gallon

Source:
Federal Register EPA; 40 CFR Part 98; e-CFR, June 13, 2017 (see link below). Table C-1.
https://www.ecfr.gov/cgi-bin/text-idx?SID=ae265d7d6f98ec86fcd8640b9793a3f6&mc=true&node=pt40.23.98&rgn=div5#ap40.23.98_19.1
LNG: The factor was developed based on the CO_2 factor for Natural Gas factor and LNG fuel density from GREET1_2017.xlsx Model, Argonne National Laboratory. This represents a methodology change from previous versions.

Table 3 Mobile Combustion CH_4 and N_2O for On-Road Gasoline Vehicles

Vehicle Type	Year	CH_4 Factor (g / mile)	N_2O Factor (g / mile)
Gasoline Passenger Cars	1973-74	0.1696	0.0197
	1975	0.1423	0.0443
	1976-77	0.1406	0.0458
	1978-79	0.1389	0.0473
	1980	0.1326	0.0499
	1981	0.0802	0.0626
	1982	0.0795	0.0627
	1983	0.0782	0.0630
	1984-93	0.0704	0.0647
	1994	0.0617	0.0603
	1995	0.0531	0.0560
	1996	0.0434	0.0503
	1997	0.0337	0.0446
	1998	0.0240	0.0389
	1999	0.0215	0.0355
	2000	0.0175	0.0304
	2001	0.0105	0.0212
	2002	0.0102	0.0207
	2003	0.0095	0.0181
	2004	0.0078	0.0085
	2005	0.0075	0.0067
	2006	0.0076	0.0075
	2007	0.0072	0.0052
	2008	0.0072	0.0049
	2009	0.0071	0.0046
	2010	0.0071	0.0046
	2011	0.0071	0.0046
	2012	0.0071	0.0046
	2013	0.0071	0.0046
	2014	0.0071	0.0046
	2015	0.0068	0.0042
	2016	0.0065	0.0038
	2017	0.0054	0.0018
	2018	0.0052	0.0016
Gasoline Light-Duty Trucks (Vans, Pickup Trucks, SUVs)	1973-74	0.1908	0.0218
	1975	0.1634	0.0513
	1976	0.1594	0.0555
	1977-78	0.1614	0.0534
	1979-80	0.1594	0.0555
	1981	0.1479	0.0660
	1982	0.1442	0.0681
	1983	0.1368	0.0722
	1984	0.1294	0.0764
	1985	0.1220	0.0806
	1986	0.1146	0.0848
	1987-93	0.0813	0.1035
	1994	0.0646	0.0982
	1995	0.0517	0.0908
	1996	0.0452	0.0871
	1997	0.0452	0.0871
	1998	0.0412	0.0787
	1999	0.0333	0.0618
	2000	0.0340	0.0631
	2001	0.0221	0.0379
	2002	0.0242	0.0424
	2003	0.0221	0.0373
	2004	0.0115	0.0088
	2005	0.0105	0.0064
	2006	0.0108	0.0080
	2007	0.0103	0.0061
	2008	0.0095	0.0036
	2009	0.0095	0.0036
	2010	0.0095	0.0035
	2011	0.0096	0.0034
	2012	0.0096	0.0033
	2013	0.0095	0.0035
	2014	0.0095	0.0033
	2015	0.0094	0.0031
	2016	0.0091	0.0029
	2017	0.0084	0.0018
	2018	0.0081	0.0015
Gasoline Heavy-Duty Vehicles	<1981	0.4604	0.0497
	1982-84	0.4492	0.0538
	1985-86	0.4090	0.0515
	1987	0.3675	0.0849
	1988-1989	0.3492	0.0933
	1990-1995	0.3246	0.1142
	1996	0.1278	0.1680
	1997	0.0924	0.1726
	1998	0.0655	0.1750
	1999	0.0648	0.1724
	2000	0.0630	0.1660
	2001	0.0577	0.1468
	2002	0.0634	0.1673
	2003	0.0602	0.1553
	2004	0.0298	0.0164
	2005	0.0297	0.0083
	2006	0.0299	0.0241
	2007	0.0322	0.0015
	2008	0.0340	0.0015
	2009	0.0339	0.0015
	2010	0.0320	0.0015
	2011	0.0304	0.0015
	2012	0.0313	0.0015
	2013	0.0313	0.0015
	2014	0.0315	0.0015
	2015	0.0332	0.0021
	2016	0.0321	0.0061
	2017	0.0329	0.0084
	2018	0.0326	0.0082
Gasoline Motorcycles	1960-1995	0.0899	0.0087
	1996-2018	0.0672	0.0069

Source: EPA (2020) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018. All values are calculated from Tables A-107 through A-111.

Table 4 **Mobile Combustion CH_4 and N_2O for On-Road Diesel and Alternative Fuel Vehicles**

Vehicle Type	Fuel Type	Vehicle Year	CH_4 Factor (g / mile)	N_2O Factor (g / mile)
Passenger Cars	Diesel	1960-1982	0.0006	0.0012
		1983-1995	0.0005	0.0010
		1996-2006	0.0005	0.0010
		2007-2018	0.0302	0.0192
Light-Duty Trucks	Diesel	1960-1982	0.0011	0.0017
		1983-1995	0.0009	0.0014
		1996-2006	0.0010	0.0015
		2007-2018	0.0290	0.0214
Medium- and Heavy-Duty Vehicles	Diesel	1960-2006	0.0051	0.0048
		2007-2018	0.0095	0.0431
Light-Duty Cars	Methanol		0.0080	0.0060
	Ethanol		0.0080	0.0060
	CNG		0.0820	0.0060
	LPG		0.0080	0.0060
	Biodiesel		0.0300	0.0190
Light-Duty Trucks	Ethanol		0.0120	0.0110
	CNG		0.1230	0.0110
	LPG		0.0120	0.0130
	LNG		0.1230	0.0110
	Biodiesel		0.0290	0.0210
Medium-Duty Trucks	CNG		4.2000	0.0010
	LPG		0.0140	0.0340
	LNG		4.2000	0.0430
	Biodiesel		0.0090	0.0010
Heavy-Duty Trucks	Methanol		0.0750	0.0280
	Ethanol		0.0750	0.0280
	CNG		3.7000	0.0010
	LPG		0.0130	0.0260
	LNG		3.7000	0.0010
	Biodiesel		0.0090	0.0430
Buses	Methanol		0.0220	0.0320
	Ethanol		0.0220	0.0320
	CNG		10.0000	0.0010
	LPG		0.0340	0.0170
	LNG		10.0000	0.0010
	Biodiesel		0.0090	0.0430

Source: EPA (2020) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018. All values are calculated from Tables A-110 through A-113.

Table 5 **Mobile Combustion CH_4 and N_2O for Non-Road Vehicles**

Vehicle Type	Fuel Type	CH_4 Factor (g / gallon)	N_2O Factor (g / gallon)
Ships and Boats	Residual Fuel Oil	0.55	0.55
	Gasoline (2 stroke)	9.54	0.06
	Gasoline (4 stroke)	4.88	0.23
	Diesel	0.31	0.50
Locomotives	Diesel	0.80	0.26
Aircraft	Jet Fuel	0	0.30
	Aviation Gasoline	7.06	0.11
Agricultural Equipment[A]	Gasoline (2 stroke)	12.96	0.06
	Gasoline (4 stroke)	7.24	0.21
	Diesel	0.28	0.49
	LPG	2.19	0.39
Agricultural Offroad Trucks	Gasoline	7.24	0.21
	Diesel	0.13	0.49
Construction/Mining Equipment[B]	Gasoline (2 stroke)	12.42	0.07
	Gasoline (4 stroke)	5.58	0.20
	Diesel	0.20	0.47
	LPG	1.05	0.41
Construction/Mining Offroad Trucks	Gasoline	5.58	0.20
	Diesel	0.13	0.49
Lawn and Garden Equipment	Gasoline (2 stroke)	15.57	0.06
	Gasoline (4 stroke)	5.84	0.18
	Diesel	0.33	0.47
	LPG	0.35	0.41
Airport Equipment	Gasoline	2.58	0.25
	Diesel	0.17	0.49
	LPG	0.33	0.41
Industrial/Commercial Equipment	Gasoline (2 stroke)	15.14	0.06
	Gasoline (4 stroke)	5.48	0.20
	Diesel	0.23	0.47
	LPG	0.44	0.41
Logging Equipment	Gasoline (2 stroke)	12.03	0.08
	Gasoline (4 stroke)	6.71	0.18
	Diesel	0.10	0.49
Railroad Equipment	Gasoline	5.78	0.19
	Diesel	0.44	0.42
	LPG	1.20	0.41
Recreational Equipment	Gasoline (2 stroke)	7.81	0.03
	Gasoline (4 stroke)	8.45	0.19
	Diesel	0.41	0.41
	LPG	2.98	0.38

Source: EPA (2020) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018. All values are calculated from Tables A-114 through A-115.

Notes:

[A] Includes equipment, such as tractors and combines, as well as fuel consumption from trucks that are used off-road in agriculture.

[B] Includes equipment, such as cranes, dumpers, and excavators, as well as fuel consumption from trucks that are used off-road in construction.

Table 6 Electricity

eGRID Subregion	Total Output Emission Factors			Non-Baseload Emission Factors		
	CO_2 Factor (lb / MWh)	CH_4 Factor (lb / MWh)	N_2O Factor (lb / MWh)	CO_2 Factor (lb / MWh)	CH_4 Factor (lb / MWh)	N_2O Factor (lb / MWh)
AKGD (ASCC Alaska Grid)	1,039.6	0.082	0.011	1,262.5	0.110	0.015
AKMS (ASCC Miscellaneous)	525.1	0.024	0.004	1,528.3	0.068	0.012
AZNM (WECC Southwest)	1,022.4	0.077	0.011	1,435.3	0.097	0.014
CAMX (WECC California)	496.5	0.034	0.004	929.5	0.047	0.006
ERCT (ERCOT All)	931.7	0.066	0.009	1,261.0	0.083	0.012
FRCC (FRCC All)	931.8	0.066	0.009	1,123.9	0.068	0.009
HIMS (HICC Miscellaneous)	1,110.7	0.118	0.018	1,535.7	0.139	0.022
HIOA (HICC Oahu)	1,669.9	0.180	0.027	1,682.1	0.159	0.025
MROE (MRO East)	1,678.0	0.169	0.025	1,634.3	0.149	0.022
MROW (MRO West)	1,239.8	0.138	0.020	1,764.3	0.192	0.027
NEWE (NPCC New England)	522.3	0.082	0.011	931.0	0.086	0.011
NWPP (WECC Northwest)	639.0	0.064	0.009	1,575.1	0.148	0.021
NYCW (NPCC NYC/Westchester)	596.4	0.022	0.003	1,067.6	0.022	0.002
NYLI (NPCC Long Island)	1,184.2	0.139	0.018	1,320.3	0.040	0.005
NYUP (NPCC Upstate NY)	253.1	0.018	0.002	931.5	0.043	0.005
RFCE (RFC East)	716.0	0.061	0.008	1,242.6	0.091	0.013
RFCM (RFC Michigan)	1,312.6	0.129	0.018	1,748.9	0.171	0.024
RFCW (RFC West)	1,166.1	0.117	0.017	1,828.3	0.179	0.026
RMPA (WECC Rockies)	1,273.6	0.123	0.018	1,542.6	0.120	0.017
SPNO (SPP North)	1,163.2	0.124	0.018	1,945.5	0.201	0.029
SPSO (SPP South)	1,166.6	0.091	0.013	1,603.5	0.118	0.017
SRMV (SERC Mississippi Valley)	854.6	0.055	0.008	1,137.6	0.069	0.010
SRMW (SERC Midwest)	1,664.2	0.185	0.027	1,907.0	0.204	0.030
SRSO (SERC South)	1,027.9	0.081	0.012	1,413.7	0.107	0.015
SRTV (SERC Tennessee Valley)	1,031.5	0.097	0.014	1,644.3	0.149	0.021
SRVC (SERC Virginia/Carolina)	743.3	0.067	0.009	1,422.6	0.128	0.018
US Average	947.2	0.085	0.012	1,432.3	0.117	0.017

Source: EPA eGRID2018, March 2020

Note: Total output emission factors can be used as default factors for estimating GHG emissions from electricity use when developing a carbon footprint or emissions inventory. Annual non-baseload output emission factors should not be used for those purposes, but can be used to estimate GHG emissions reductions from reductions in electricity use.

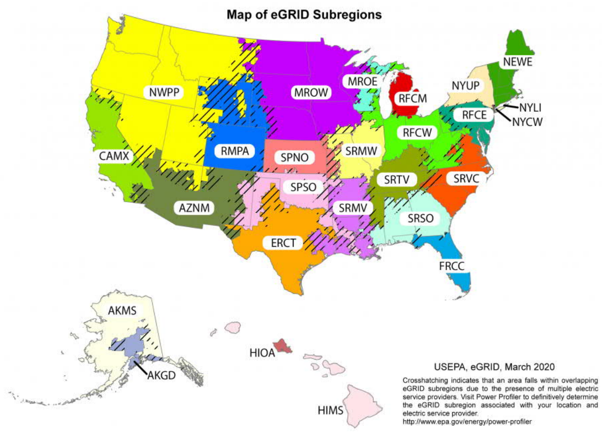

Table 7 Steam and Heat

	CO_2 Factor (kg / mmBtu)	CH_4 Factor (g / mmBtu)	N_2O Factor (g / mmBtu)
Steam and Heat	66.33	1.250	0.125

Note: Emission factors are per mmBtu of steam or heat purchased. These factors assume natural gas fuel is used to generate steam or heat at 80 percent thermal efficiency.

Scope 3 Emission Factors

Scope 3 emission factors provided below are aligned with the Greenhouse Gas Protocol Technical Guidance for Calculating Scope 3 Emissions, version 1.0 (Scope 3 Calculation Guidance). Where applicable, the specific calculation method is referenced. Refer to the Scope 3 Calculation Guidance for more information (http://www.ghgprotocol.org/scope-3-technical-calculation-guidance).

Table 8 Scope 3 Category 4: Upstream Transportation and Distribution and Category 9: Downstream Transportation and Distribution

These factors are intended for use in the distance-based method defined in the Scope 3 Calculation Guidance. If fuel data are available, then the fuel-based method should be used, with factors from Tables 2 through 5.

Vehicle Type	CO_2 Factor (kg / unit)	CH_4 Factor (g / unit)	N_2O Factor (g / unit)	Units
Medium- and Heavy-Duty Truck	1.387	0.013	0.033	vehicle-mile
Passenger Car [A]	0.335	0.009	0.008	vehicle-mile
Light-Duty Truck [B]	0.461	0.012	0.010	vehicle-mile
Medium- and Heavy-Duty Truck	0.207	0.0020	0.0046	ton-mile
Rail	0.021	0.0017	0.0005	ton-mile
Waterborne Craft[C]	0.040	0.0122	0.0017	ton-mile
Aircraft	1.265	0	0.0389	ton-mile

Source:

CO_2, CH_4, and N_2O emissions data for road vehicles are from Table 2-13 of the U.S. Greenhouse Gas Emissions and Sinks: 1990–2018 (Feb. 2020).

Vehicle-miles and passenger-miles data for road vehicles are from Table VM-1 of the Federal Highway Administration Highway Statistics 2018.

CO_2e emissions data for non-road vehicles are based on Table A-124 of the U.S. Greenhouse Gas Emissions and Sinks: 1990–2018, which are distributed into CO_2, CH_4, and N_2O emissions based on fuel/vehicle emission factors.

Freight ton-mile data for non-road vehicles are from Table 1-50 of the Bureau of Transportation Statistics, National Transportation Statistics for 2019 (Data based on 2017).

Notes:

Vehicle-mile factors are appropriate to use when the entire vehicle is dedicated to transporting the reporting company's product. Ton-mile factors are appropriate when the vehicle is shared with products from other companies.

[A] Passenger car: includes passenger cars, minivans, SUVs, and small pickup trucks (vehicles with wheelbase less than 121 inches).

[B] Light-duty truck: includes full-size pickup trucks, full-size vans, and extended-length SUVs (vehicles with wheelbase greater than 121 inches).

[C] Waterborne Craft: updates due to a methodology change.

Table 9 Scope 3 Category 5: Waste Generated in Operations and Category 12: End-of-Life Treatment of Sold Products

New Table

These factors are intended for use in the waste-type-specific method or the average-data method defined in the Scope 3 Calculation Guidance for category 5 and category 12. Choose the appropriate material and disposal method from the table below. For the average-data method, use one of the mixed material types, such as mixed MSW.

	Metric Tons CO_2e / Short Ton Material					
Material	Recycled[A]	Landfilled[B]	Combusted[C]	Composted[D]	Anaerobically Digested (Dry Digestate with Curing)	Anaerobically Digested (Wet Digestate with Curing)
Aluminum Cans	0.06	0.02	0.01	NA	NA	NA
Aluminum Ingot	0.04	0.02	0.01	NA	NA	NA
Steel Cans	0.32	0.02	0.01	NA	NA	NA
Copper Wire	0.18	0.02	0.01	NA	NA	NA
Glass	0.05	0.02	0.01	NA	NA	NA
HDPE	0.21	0.02	2.80	NA	NA	NA
LDPE	NA	0.02	2.80	NA	NA	NA
PET	0.23	0.02	2.05	NA	NA	NA
LLDPE	NA	0.02	2.80	NA	NA	NA
PP	NA	0.02	2.80	NA	NA	NA
PS	NA	0.02	3.02	NA	NA	NA
PVC	NA	0.02	1.26	NA	NA	NA
PLA	NA	0.02	0.01	0.09	NA	NA
Corrugated Containers	0.11	1.07	0.05	NA	NA	NA
Magazines/Third-class mail	0.02	0.50	0.05	NA	NA	NA
Newspaper	0.02	0.42	0.05	NA	NA	NA
Office Paper	0.02	1.52	0.05	NA	NA	NA
Phonebooks	0.04	0.42	0.05	NA	NA	NA
Textbooks	0.04	1.52	0.05	NA	NA	NA
Dimensional Lumber	0.09	0.08	0.05	NA	NA	NA
Medium-density Fiberboard	0.15	0.04	0.05	NA	NA	NA
Food Waste (non-meat)	NA	0.68	0.05	0.07	0.14	0.11
Food Waste (meat only)	NA	0.68	0.05	NA	0.14	0.11
Beef	NA	0.68	0.05	0.07	0.14	0.11
Poultry	NA	0.68	0.05	0.07	0.14	0.11
Grains	NA	0.68	0.05	0.07	0.14	0.11
Bread	NA	0.68	0.05	0.07	0.14	0.11
Fruits and Vegetables	NA	0.68	0.05	0.07	0.14	0.11
Dairy Products	NA	0.68	0.05	0.07	0.14	0.11
Yard Trimmings	NA	0.38	0.05	0.09	0.11	NA
Grass	NA	0.29	0.05	0.09	0.09	NA
Leaves	NA	0.30	0.05	0.09	0.13	NA
Branches	NA	0.62	0.05	0.09	0.16	NA
Mixed Paper (general)	0.07	0.95	0.05	NA	NA	NA
Mixed Paper (primarily residential)	0.07	0.92	0.05	NA	NA	NA
Mixed Paper (primarily from offices)	0.03	0.90	0.05	NA	NA	NA
Mixed Metals	0.23	0.02	0.01	NA	NA	NA
Mixed Plastics	0.22	0.02	2.34	NA	NA	NA
Mixed Recyclables	0.09	0.81	0.11	NA	NA	NA
Food Waste	NA	0.68	0.05	0.07	NA	NA
Mixed Organics	NA	0.55	0.05	0.09	NA	NA
Mixed MSW (municipal solid waste)	NA	0.63	0.43	NA	NA	NA
Carpet	NA	0.02	1.68	NA	NA	NA
Desktop CPUs	NA	0.02	0.40	NA	NA	NA
Portable Electronic Devices	NA	0.02	0.89	NA	NA	NA
Flat-panel Displays	NA	0.02	0.74	NA	NA	NA
CRT Displays	NA	0.02	0.64	NA	NA	NA
Electronic Peripherals	NA	0.02	2.23	NA	NA	NA
Hard-copy Devices	NA	0.02	1.92	NA	NA	NA
Mixed Electronics	NA	0.02	0.87	NA	NA	NA
Clay Bricks	NA	0.02	NA	NA	NA	NA
Concrete	0.01	0.02	NA	NA	NA	NA
Fly Ash	0.01	0.02	NA	NA	NA	NA
Tires	0.10	0.02	2.21	NA	NA	NA
Asphalt Concrete	0.004	0.02	NA	NA	NA	NA
Asphalt Shingles	0.03	0.02	0.70	NA	NA	NA
Drywall	NA	0.02	NA	NA	NA	NA
Fiberglass Insulation	0.05	0.02	NA	NA	NA	NA
Vinyl Flooring	NA	0.02	0.29	NA	NA	NA
Wood Flooring	NA	0.18	0.08	NA	NA	NA

Source: EPA, Office of Resource Conservation and Recovery (February 2016) Documentation for Greenhouse Gas Emission and Energy Factors used in the Waste Reduction Model (WARM). Factors from tables provided in the Management Practices Chapters and Background Chapters. WARM Version 15. Additional data provided by EPA, WARM-15 Background Data.

Notes: These factors do not include any avoided emissions impact from any of the disposal methods. All the factors presented here include transportation emissions, which are optional in the Scope 3 Calculation Guidance, with an assumed average distance traveled to the processing facility. AR4 GWPs are used to convert all waste emission factors into CO_2e.

[A] Recycling emissions include transport to recycling facility and sorting of recycled materials at material recovery facility.

[B] Landfilling emissions include transport to landfill, equipment use at landfill and fugitive landfill CH_4 emissions. Landfill CH_4 is based on typical landfill gas collection practices and average landfill moisture conditions.

[C] Combustion emissions include transport to combustion facility and combustion-related non-biogenic CO_2 and N_2O

[D] Composting emissions include transport to composting facility, equipment use at composting facility and CH_4 and N_2O emissions during composting.

Table 10 Scope 3 Category 6: Business Travel and Category 7: Employee Commuting

These factors are intended for use in the distance-based method defined in the Scope 3 Calculation Guidance. If fuel data are available, then the fuel-based method should be used, with factors from Tables 2 through 5.

Vehicle Type	CO_2 Factor (kg / unit)	CH_4 Factor (g / unit)	N_2O Factor (g / unit)	Units
Passenger Car [A]	0.335	0.009	0.008	vehicle-mile
Light-Duty Truck [B]	0.461	0.012	0.010	vehicle-mile
Motorcycle	0.184	0.070	0.007	vehicle-mile
Intercity Rail - Northeast Corridor [C]	0.058	0.0055	0.0007	passenger-mile
Intercity Rail - Other Routes [C]	0.150	0.0117	0.0038	passenger-mile
Intercity Rail - National Average [C]	0.113	0.0092	0.0026	passenger-mile
Commuter Rail [D]	0.148	0.0123	0.0030	passenger-mile
Transit Rail (i.e. Subway, Tram) [E]	0.099	0.0089	0.0013	passenger-mile
Bus	0.053	0.0206	0.0009	passenger-mile
Air Travel - Short Haul (< 300 miles)	0.215	0.0077	0.0068	passenger-mile
Air Travel - Medium Haul (>= 300 miles, < 2300 miles)	0.133	0.0006	0.0042	passenger-mile
Air Travel - Long Haul (>= 2300 miles)	0.165	0.0006	0.0052	passenger-mile

Source:
CO_2, CH_4, and N_2O emissions data for highway vehicles are from Table 2-13 of the EPA (2020) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2018.
Vehicle-miles and passenger-miles data for highway vehicles are from Table VM-1 of the Federal Highway Administration Highway Statistics 2018.
Fuel consumption data and passenger-miles data for rail are from Tables A.14 to A.16 and C.9 to C.11 of the Transportation Energy Data Book: Edition 38. Fuel consumption was converted to emissions by using fuel and electricity emission factors presented in the tables above.
Intercity Rail factors from personal communication with Amtrak (Laura Fotiou), March 2020
Air Travel factors from 2019 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting. Version 1.0 August 2019.

Notes:
[A] Passenger car: includes passenger cars, minivans, SUVs, and small pickup trucks (vehicles with wheelbase less than 121 inches).
[B] Light-duty truck: includes full-size pickup trucks, full-size vans, and extended-length SUVs (vehicles with wheelbase greater than 121 inches).
[C] Intercity rail: Amtrak long-distance rail between major cities. Northeast Corridor extends from Boston to Washington D.C. Other Routes are all routes outside the Northeast Corridor.
[D] Commuter rail: rail service between a central city and adjacent suburbs (also called regional rail or suburban rail)
[E] Transit rail: rail typically within an urban center, such as subways, elevated railways, metropolitan railways (metro), streetcars, trolley cars, and tramways.

Global Warming Potentials

Table 11 Global Warming Potentials (GWPs)

Gas	100-Year GWP
CO_2	1
CH_4	25
N_2O	298
HFC-23	14,800
HFC-32	675
HFC-41	92
HFC-125	3,500
HFC-134	1,100
HFC-134a	1,430
HFC-143	353
HFC-143a	4,470
HFC-152	53
HFC-152a	124
HFC-161	12
HFC-227ea	3,220
HFC-236cb	1,340
HFC-236ea	1,370
HFC-236fa	9,810
HFC-245ca	693
HFC-245fa	1,030
HFC-365mfc	794
HFC-43-10mee	1,640
SF_6	22,800
NF_3	17,200
CF_4	7,390
C_2F_6	12,200
C_3F_8	8,830
c-C_4F_8	10,300
C_4F_{10}	8,860
C_5F_{12}	9,160
C_6F_{14}	9,300
$C_{10}F_{18}$	>7,500

Source:
100-year GWPs from IPCC Fourth Assessment Report (AR4), 2007. IPCC AR4 was published in 2007 and is among the most current and comprehensive peer-reviewed assessments of climate change. AR4 provides revised GWPs of several GHGs relative to the values provided in previous assessment reports, following advances in scientific knowledge on the radiative efficiencies and atmospheric lifetimes of these GHGs and of CO_2. Because the GWPs provided in AR4 reflect an improved scientific understanding of the radiative effects of these gases in the atmosphere, the values provided are more appropriate for supporting the overall goal of organizational GHG reporting than the Second Assessment Report (SAR) GWP values previously used in the Emission Factors Hub.
While EPA recognizes that Fifth Assessment Report (AR5) GWPs have been published, in an effort to ensure consistency and comparability of GHG data between EPA's voluntary and non-voluntary GHG reporting programs (e.g. GHG Reporting Program and National Inventory), EPA recommends the use of AR4 GWPs. The United States and other developed countries to the UNFCCC have agreed to submit annual inventories in 2015 and future years to the UNFCCC using GWP values from AR4, which will replace the current use of SAR GWP values. Utilizing AR4 GWPs improves EPA's ability to analyze corporate, national, and sub-national GHG data consistently, enhances communication of GHG information between programs, and gives outside stakeholders a consistent, predictable set of GWPs to avoid confusion and additional burden.

Table 12 Global Warming Potentials (GWPs) for Blended Refrigerants

ASHRAE #	100-year GWP	Blend Composition
R-401A	16	53% HCFC-22 , 34% HCFC-124 , 13% HFC-152a
R-401B	14	61% HCFC-22 , 28% HCFC-124 , 11% HFC-152a
R-401C	19	33% HCFC-22 , 52% HCFC-124 , 15% HFC-152a
R-402A	2,100	38% HCFC-22 , 6% HFC-125 , 2% propane
R-402B	1,330	6% HCFC-22 , 38% HFC-125 , 2% propane
R-403B	3,444	56% HCFC-22 , 39% PFC-218 , 5% propane
R-404A	3,922	44% HFC-125 , 4% HFC-134a , 52% HFC 143a
R-406A	0	55% HCFC-22 , 41% HCFC-142b , 4% isobutane
R-407A	2,107	20% HFC-32 , 40% HFC-125 , 40% HFC-134a
R-407B	2,804	10% HFC-32 , 70% HFC-125 , 20% HFC-134a
R-407C	1,774	23% HFC-32 , 25% HFC-125 , 52% HFC-134a
R-407D	1,627	15% HFC-32 , 15% HFC-125 , 70% HFC-134a
R-407E	1,552	25% HFC-32 , 15% HFC-125 , 60% HFC-134a
R-408A	2,301	47% HCFC-22 , 7% HFC-125 , 46% HFC 143a
R-409A	0	60% HCFC-22 , 25% HCFC-124 , 15% HCFC-142b
R-410A	2,088	50% HFC-32 , 50% HFC-125
R-410B	2,229	45% HFC-32 , 55% HFC-125
R-411A	14	87.5% HCFC-22 , 11 HFC-152a , 1.5% propylene
R-411B	4	94% HCFC-22 , 3% HFC-152a , 3% propylene
R-413A	2,053	88% HFC-134a , 9% PFC-218 , 3% isobutane
R-414A	0	51% HCFC-22 , 28.5% HCFC-124 , 16.5% HCFC-142b
R-414B	0	5% HCFC-22 , 39% HCFC-124 , 9.5% HCFC-142b
R-417A	2,346	46.6% HFC-125 , 5% HFC-134a , 3.4% butane
R-422A	3,143	85.1% HFC-125 , 11.5% HFC-134a , 3.4% isobutane
R-422D	2,729	65.1% HFC-125 , 31.5% HFC-134a , 3.4% isobutane
R-423A	2,280	47.5% HFC-227ea , 52.5% HFC-134a ,
R-424A	2,440	50.5% HFC-125, 47% HFC-134a, 2.5% butane/pentane
R-426A	1,508	5.1% HFC-125, 93% HFC-134a, 1.9% butane/pentane
R-428A	3,607	77.5% HFC-125 , 2% HFC-143a , 1.9% isobutane
R-434A	3,245	63.2% HFC-125, 16% HFC-134a, 18% HFC-143a, 2.8% isobutane
R-500	32	73.8% CFC-12 , 26.2% HFC-152a , 48.8% HCFC-22
R-502	0	48.8% HCFC-22 , 51.2% CFC-115
R-504	325	48.2% HFC-32 , 51.8% CFC-115
R-507	3,985	5% HFC-125 , 5% HFC143a
R-508A	13,214	39% HFC-23 , 61% PFC-116
R-508B	13,396	46% HFC-23 , 54% PFC-116

Source:
100-year GWPs from IPCC Fourth Assessment Report (AR4), 2007. See the source note to Table 11 for further explanation. GWPs of blended refrigerants are based on their HFC and PFC constituents, which are based on data from http://www.epa.gov/ozone/snap/refrigerants/refblend.html.