Appendix I
MODELING EMISSION INVENTORY

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Appendix I: Modeling Emission Inventory

[This Appendix provided by the California Air Resources Board]

Modeling Emission Inventory for the PM2.5 State Implementation Plan April 2024

CALIFORNIA
AIR RESOURCES BOARD

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I. Acronyms

AMSS – Atmospheric Modeling and Support Section

APCD – Air Pollution Control District

AQMD – Air Quality Management District

Caltrans – California Department of Transportation

CalVAD – California Vehicle Activity Database

CARB – California Air Resources Board

CCAQS – Central California Air Quality Studies

CCOS – Central California Ozone Study

CEIDARS – California Emission Inventory Development and Reporting System

CEMS – Continuous emissions monitoring system

CEPAM – California Emission Projection Analysis Model

CMAQ – Community Multi-Scale Air Quality (Model)

COG – Council of Government

CRPAQS – California Regional Particulate Air Quality Study

EIC – Emission Inventory Code

EICSUM – EIC Summary category, the first three digits of EIC

ERG – Eastern Research Group

HD – Heavy Duty

I&M – Inspection and Maintenance

MPO – Metropolitan Planning Organization

NetCDF – Network Common Data Form

NLCD – National Land Cover Database

NOx – Oxides of Nitrogen

OGV – Ocean Going Vessel

PM – Particulate Matter

PM10 – Particulate Matter 10 micrometers in diameter and smaller

PM2.5 – Particulate Matter 2.5 micrometers in diameter and smaller

ROG – Reactive Organic Gases

RRF – Relative Response Factor

RTPA – Regional Transportation Planning Agencies

RWC – Residential Wood Combustion

SAPRC – Statewide Air Pollution Research Center

SCC – Source Classification Code

SIP – State Implementation Plan

SIPIWG – State Implementation Plan Inventory Working Group

SJV – San Joaquin Valley

SMOKE – Sparse Matrix Operator Kernel Emissions

SSS – State SIP Strategy

TOG – Total Organic Gases

II. Development of PM2.5 Emissions Inventories

Emission inputs for air quality modeling (commonly and interchangeably referred to as “modeling inventories” or “gridded inventories”) have been developed by the California Air Resources Board (CARB) and staff from multiple air districts. These inventories support multiple State Implementation Plans (SIPs) across California to address nonattainment of the federal criteria pollutant standards. CARB maintains an electronic database of emissions and other useful information to generate aggregate emission estimates at the county, air basin, and district level, *Criteria Pollutant Emission Inventory Data*. This database is called the California Emission Inventory Development and Reporting System (CEIDARS). CEIDARS provides a foundation for the development of a more refined (hourly, grid cell-specific) set of emission inputs that are required by air quality models. The CEIDARS base year inventory is a primary input to the state’s emission forecasting system, known as the California Emission Projection Analysis Model (CEPAM). CEPAM produces the projected emissions that are then processed to serve as the emission inputs for air quality models. The following sections of this document describe the methods used to prepare the base and future year emissions inventory estimates.

A. Inventory Coordination

Most of this inventory was developed in direct coordination with staff at the regional Air Pollution Control Districts across the state. In July of 2019 CARB convened the SIP Inventory Working Group (SIPIWG) to provide an opportunity and means for interested parties (CARB, districts, etc.) to discuss issues pertaining to the development and review of base year, future year, planning and gridded inventories to be used in SIP modeling. The group met every four to six weeks through early 2020. Group participants included staff from Bay Area, Butte, Eastern Kern, El Dorado, Feather River, Imperial, Northern Sierra, Placer, Sacramento, San Diego, San Joaquin Valley, San Luis Obispo, South Coast, Ventura, and Yolo-Solano air districts.

Additionally, CARB established the SIPIWG Spatial Surrogate Sub-committee, which focuses on improving input data to spatially disaggregate emissions at a more refined level needed for air quality modeling. Local air districts that participate include San Joaquin Valley, San Diego, Bay Area, Imperial, South Coast, Ventura, and Sacramento.

A great deal of work preceded this modeling effort through the Central California Air Quality Studies (CCAQS). CCAQS consisted of two studies: 1) the Central California Ozone Study (CCOS); and 2) the California Regional PM10 (particulate matter 10µm in diameter and smaller) /PM2.5 (particulate matter 2.5µm in diameter and smaller) Air Quality Study (CRPAQS) (Reynolds, et al., 2012).

B. Background

California’s emission inventory is an estimate of the amounts and types of pollutants emitted from thousands of industrial facilities, millions of motor vehicles, and myriad emission sources such as consumer products and fireplaces. The development and maintenance of the emission inventory involves several agencies. This multi-agency effort includes: CARB, 35 local air pollution control and air quality management districts (Districts), regional transportation planning agencies (RTPAs), and the California Department of Transportation (Caltrans). CARB is responsible for the compilation of the final statewide emission inventory, and for maintaining this information in CEIDARS. In addition to the statewide emission inventory, emissions from parts of northern Mexico and the western United States (Nevada, Arizona, Oregon, Idaho, and Utah) are also incorporated in the final emission inventory used for modeling. The final emission inventory reflects the best information available at the time.

The basic principle for estimating county-wide regulatory emissions is to multiply an estimated, per-unit emission factor by an estimate of typical usage or activity. For example, on-road motor vehicle emission factors are estimated for a specific vehicle type and applied to all applicable vehicles. The estimates are based on dynamometer tests of a small sample for a vehicle type. The activity for any given vehicle type is based on an estimate of typical driving patterns, number of vehicle starts, and typical miles driven. Assumptions are also made regarding typical usage: it is assumed that all vehicles of a certain vehicle type are driven under similar conditions in each region of the state.

Developing emission estimates for stationary sources involves the use of per unit emission factors and activity levels. Under ideal conditions, facility-specific emission factors are determined from emission tests for a particular process at a facility. A continuous emission monitoring system (CEMS) can also be used to determine a gas or particulate matter concentration or emission rate (USEPA, 2016). More commonly, a generic emission factor is developed by averaging the results of emission tests from similar processes at several different facilities. This generic factor is then used to estimate emissions from similar types of processes when a facility-specific emission factor is not available. Activity levels from stationary sources can be derived from the amount of product produced, solvent used, or fuel used.

The district-reported and CARB-estimated emissions totals are stored in the CEIDARS database for any given pollutant. Both criteria pollutants and their precursors are stored in this complex database. These are typically annual average emissions for each county, air basin, and district. Modeling inventories for reactive organic gases (ROG) are estimated from total organic gases (TOG). Similarly, the modeling inventories for PM10 and PM2.5 are estimated from total particulate matter (PM). Details about chemical and size resolved speciation of emissions for modeling can be found in Section III.E. Additional information on CARB emission inventories can be found on CARB’s website (CARB, Emission Inventory Activities, n.d.).

C. Inventory Years

The emission inventory scenarios used for air quality modeling must be consistent with U.S. EPA’s Modeling Guidance (USEPA, 2014). Since changes in the emissions inventory can affect the calculation of the relative response factors (RRFs) used to project air quality to future years, the terms used in the preparation of the emission inventory scenarios must be clearly defined. In this document, the following inventory definitions will be used.

1. Base Case Modeling Inventory (2017)

Base case modeling is intended to evaluate model performance and demonstrate confidence in the modeling system used for the modeled attainment test. The base case modeling inventory is not used as part of the modeled attainment test itself. Model performance is assessed relative to how well model-simulated concentrations match actual measured concentrations. The modeling inputs are developed to represent (as best as possible) actual, day-specific conditions. Emissions for certain sectors are based on day-specific activities, meteorology, and emission adjustments. Actual district-reported point source emissions were gathered for the year 2017. The year 2017 was selected to coincide with the year selected for baseline design values (described below). The U.S. EPA modeling guidance states that once the model has been shown to perform adequately, the use of day-specific emissions is no longer needed. In preparation for SIP development, both CARB and the local air districts began a comprehensive review and update of the emission inventory resulting in a comprehensive emissions inventory for 2017.

2. Reference Year Modeling Inventory (2017)

The reference year inventory is intended to be a representation of emission patterns occurring through the baseline design value period and the emission patterns expected in the future year. U.S. EPA modeling guidance describes the reference year modeling inventory as “a common starting point” that represents average or “typical” conditions that are consistent with the baseline design value period. U.S. EPA guidance also states, “using a ‘typical’ or average reference year inventory provides an appropriate platform for comparisons between baseline and future years.” The 2017 reference year inventory represents typical average conditions and emission patterns through the 2017 design value period. This reference emissions inventory is not developed to capture all day-specific emission characteristics; however, this reference inventory does include meteorological effects for 2017 (e.g., temperature, relative humidity, and solar insolation), as well as certain day-specific emission activities, such as agricultural and prescribed burning.

3. Future Year Modeling Inventory (2030)

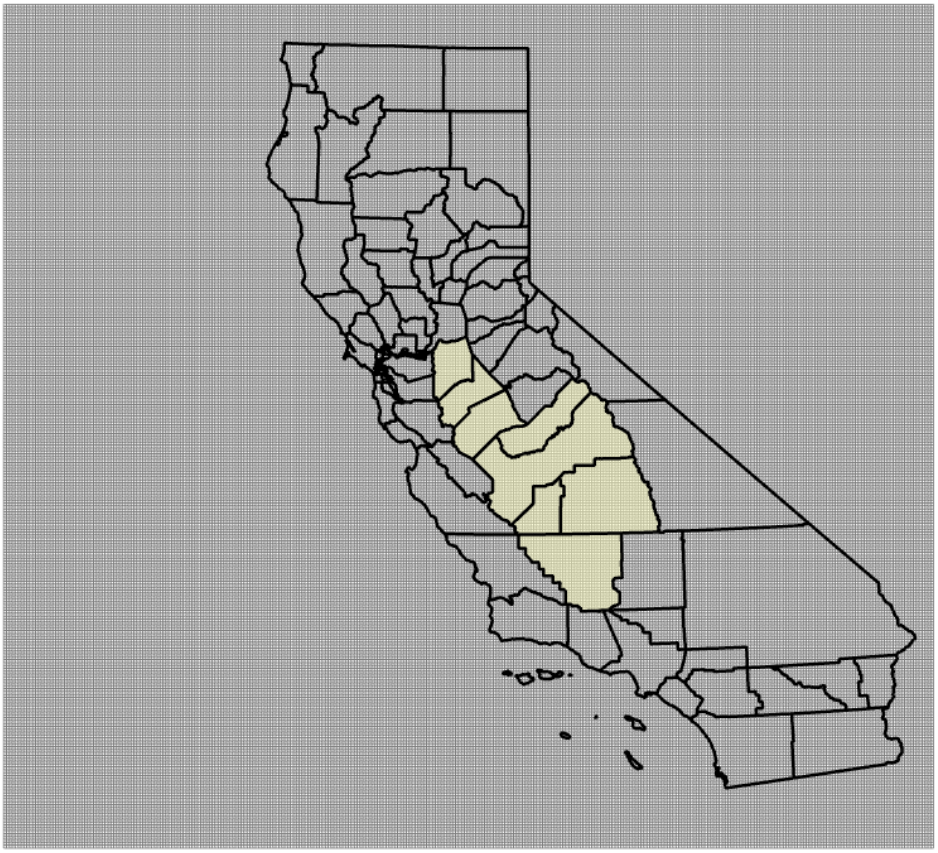
Future year modeling inventories, along with the reference year modeling inventory, are used in the model-derived RRF calculation. Projected inventory year 2030 was chosen to address the modeled attainment year for the annual PM2.5 2012 standard of 12ug/m^3.

These inventories maintain the “typical” average patterns of the 2017 reference year modeling inventory. Some sectors of the 2030 inventory include temporal variations that were driven by temperature, relative humidity, and solar insolation effects from reference year (2017) meteorology. Future year point and area source emissions are projected from the 2017 baseline emissions. Future year on-road emission inventories are projected by EMFAC.

D. Spatial Extent of Emission Inventories

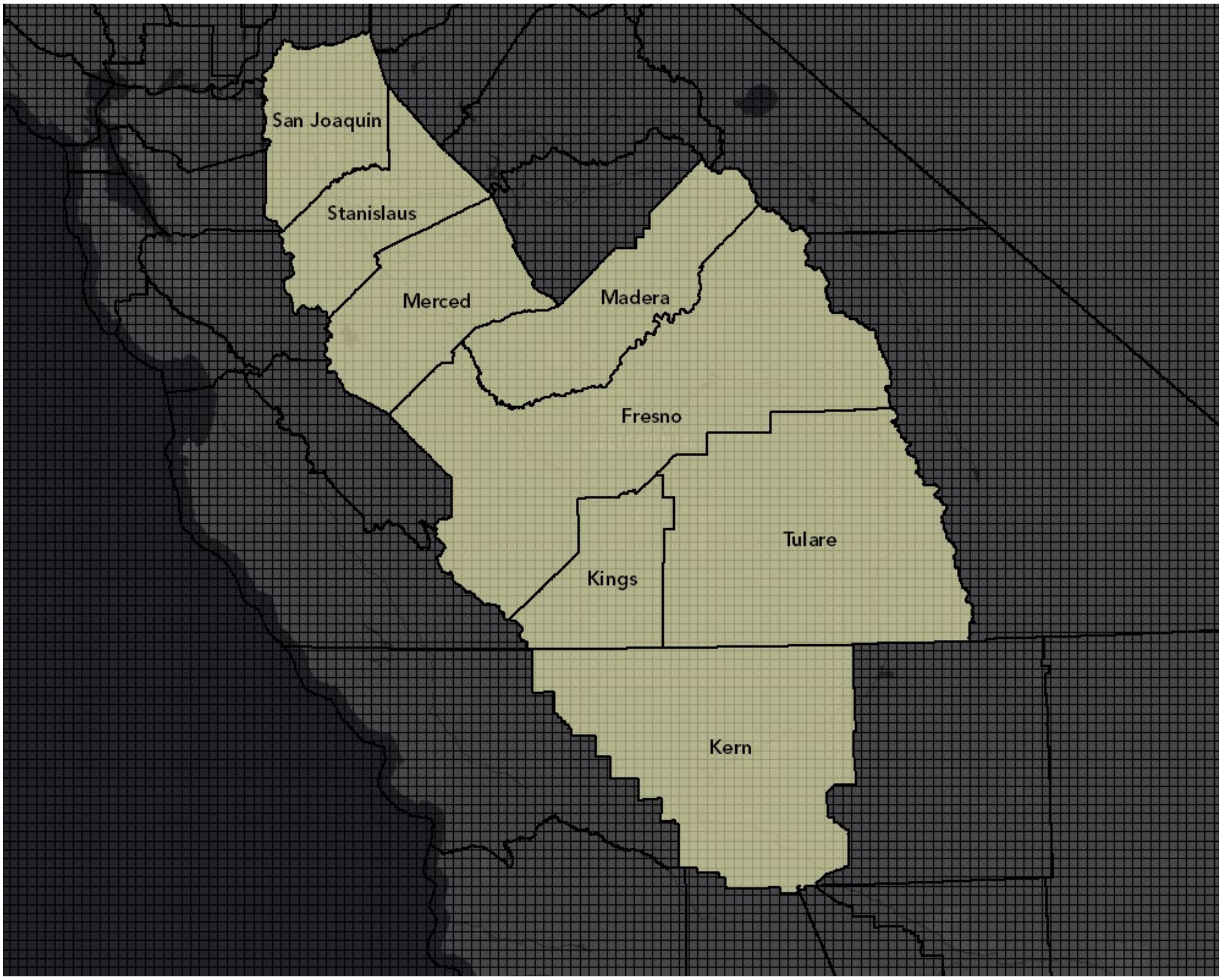
The model-ready emissions files that are prepared for use as an input for the air quality model conform to the definition and extent of the grids shown in Figure 1.

Figure 1. Spatial coverage of emissions grid with nonattainment area highlighted in yellow



An enlarged image of the San Joaquin Valley PM2.5 Nonattainment area in California is highlighted in yellow in Figure 2. This figure illustrates the portion of the statewide 4 km modeling grid around that surrounds the San Joaquin Valley PM2.5 Nonattainment area.

Figure 2: San Joaquin Valley PM2.5 Nonattainment area highlighted in California with statewide 4 km grid overlayed



The domain uses a Lambert projection and assumes a spherical Earth. The emissions inventory grid uses a Lambert Conical Projection with two parallels. The parallels are at 30° and 60° N latitude, with a central meridian at 120.5° W longitude. The coordinate system origin is offset to 37° N latitude. The emissions inventory is developed for the gridded statewide domain at spatial resolution of 4 km x 4 km. The state modeling domain extends entirely over California and 100 nautical miles west over the Pacific Ocean. The specifications for the statewide modeling domain are summarized in Table 1.

Table 1: Modeling domain parameters

Parameter	Statewide Domain
Map Projection	Lambert Conformal Conic
Datum	None (Clarke 1866 spheroid)
1st Standard Parallel	30.0° N
2nd Standard Parallel	60.0° N
Central Meridian	-120.5° W
Latitude of projection origin	37.0° N
Coordinate system Units	Meters
Semi-major axis	6370 km
Semi-minor axis	6370 km
Grid size	4 km x 4 km
Number of cells	I=321, J=291 or 321 x 291
Lambert origin	(-684,000 m, -564,000 m)
Geographic center	-120.5° Lat and 37.0° Lon

III. Estimation of Base Year Modeling Inventory

As mentioned in Section II.C.1, base-case modeling is intended to demonstrate confidence in the modeling system used for the modeled attainment test. The following sections describe the temporal and spatial distribution of emissions and how each of the sectors within the modeling inventories are prepared.

A. Terminology

Table 2 summarizes the terminology and examples used in this document for the different emission source types such as point sources, area sources, on-road motor vehicle sources and biogenic sources. The table shows differences in the terms from modeling and planning perspectives as both these sets of terms are used in this document. The terms “point sources” and “area sources” are often confused. Traditionally, these terms have had different meanings to the developers of planning emissions inventories and the developers of modeling emissions inventories. In modeling terminology, “point sources” traditionally refers to elevated emission sources that exit from a stack and have an associated plume rise. The current inventory includes emissions sources reported by the Air Pollution Control District (APCD). Those sources associated with a facility are treated as either elevated sources or non-elevated. The emissions processor calculates plume rise for elevated sources; non-elevated sources are treated as ground-level sources. Examples of non-elevated emissions sources include landfills and composting facilities. “Area sources” refers collectively to area-wide sources, stationary-aggregated sources, and other mobile sources (including aircraft, trains, ships, and all off-road vehicles and equipment). That is, “area sources” are low-level sources from a modeling perspective. On-road motor vehicle sources are emissions from cars and trucks while biogenic sources are natural sources such as vegetation and soils.

Table 2: Inventory terms for emission source types

Modeling Term	Emission Inventory Term	Examples
Point	Stationary – Point Facilities	Stacks at Individual Facilities
Area	Off-road Mobile	Construction Equipment, Farm Equipment, Trains, Recreational Boats
Area	Area-wide	Residential Fuel Combustion, Livestock Waste, Consumer Products, Architectural Coatings
Area	Stationary - Aggregated	Industrial Fuel Use
On-road Motor Vehicles	On-road Mobile	Cars and Trucks
Biogenic	Biogenic	Vegetation and Soils

The following sections describe in more detail the temporal, spatial, and chemical disaggregation of the emissions inventory for point sources and area sources.

B. Emissions Inventory

Modeling emissions are based on the CEPAM 2019 v1.04 inventories for the base year and future year. Updates to CEPAM were made for pesticide emissions to incorporate the use of the California Department of Pesticide Regulation’s (DPR) latest Pesticide Use Reporting (PUR). Final baseline inventory included a revision from San Joaquin Valley APCD on January 22, 2024 to correct the charbroiling area portion of the cooking inventory. Additionally, the San Joaquin Valley modeling inventory incorporated Emission Reduction Credit (ERC) adjustments to the projected future year (FY) 2030 inventory. The ERC adjustments were applied for the entire San Joaquin Valley air basin to stationary area and point sources. The final ERC adjustment for the annual inventory across the district was 2.43 tons per day of NOx and 0.4 tons per day of SOx.

C. Temporal Distribution of Emissions

The emissions are temporally resolved by month, week, day, and hour to more accurately gauge model performance and, ultimately, better assess the influence of control measures on attainment. This section covers the temporal distributions of the point, area, and off-road mobile sources. The temporal distribution of the emissions from on-road, biogenic, and ocean-going vessel (OGV) sources are discussed in Sections IV.B, IV.C, and IV.E. The temporal distribution of residential wood combustion (RWC) and agricultural ammonia sectors are described in Section IV.F.4 and Section IV.F.5, respectively.

Temporal data are stored in CARB's emission inventory database. Each local air district assigns temporal data for all processes at each facility in their district to represent when emissions at each process occur. For example, emissions from degreasing may have a different temporal distribution than a boiler due to differences in their respective operating hours. CARB or district staff also assign temporal data for each area source category by county/air basin/district.

1. Monthly Variation

Emissions are adjusted temporally to represent variations by month. Some emission sources operate the same throughout a year. For example, a process heater at a refinery or a line-haul locomotive likely operates the same month-to-month. Other emission categories, such as a tomato processing plant or use of recreational boats, vary significantly by season. CARB's emission inventory database stores the relative monthly fractional activity for each process, the sum of which is 100. Using an example of emission sources that typically operate the same over each season, emissions from refinery heaters and line-haul locomotives would have a monthly fraction (throughput) of 8.33 for each month (calculated as 100/12 = 8.33). This is considered a flat monthly profile. To apply monthly variations to create a gridded inventory, the annual average day's emissions (yearly emissions divided by 365) is multiplied by the typical monthly throughput. For example, a typical monthly throughput of 15 in July for recreational boats results in emissions about 1.8 times higher (15 / 8.33 = 1.8) than a day in a month with a flat monthly profile.

2. Weekly Variation

Emissions are adjusted temporally to represent variations by day of the week. Some operations are the same over a week, such as a utility boiler or a landfill. Many businesses operate only 5 days per week. Other emissions sources are similar on weekdays, but may operate differently on weekend days, such as architectural coatings or off-road motorcycles. To accommodate variations in days of the week, each process or emission category is assigned a days-per-week code or DPWK. Table 3 shows the current DPWK codes.

Table 3: Day of week variation factors

Code	Weekly Cycle Code Description	M	T	W	TH	F	S	S
1	One day per week	1	1	1	1	1	0	0

Code	Weekly Cycle Code Description	M	T	W	TH	F	S	S
2	Two days per week	1	1	1	1	1	0	0
3	Three days per week	1	1	1	1	1	0	0
4	Four days per week	1	1	1	1	1	0	0
5	Five days per week - Uniform activity on weekdays, none on Saturday and Sunday	1	1	1	1	1	0	0
6	Six days per week - Uniform activity on weekdays, none on Saturday and Sunday	1	1	1	1	1	1	0
7	Seven days per week – Uniform activity every day of the week	1	1	1	1	1	1	1
20	Uniform activity on Saturday and Sunday, no activity the remainder of the week	0	0	0	0	0	1	1
21	Uniform activity on Saturday and Sunday, half as much activity on weekdays	5	5	5	5	5	10	10
22	Uniform activity on weekdays, reduced activity on weekends	10	10	10	10	10	7	4
23	Uniform activity on weekdays, reduced activity on weekends	10	10	10	10	10	8	8
24	Uniform activity on weekdays; half as much activity on Saturday. Little activity on Sunday	10	10	10	10	10	5	1
25	Uniform activity on weekdays, one third as much on Saturday, little on Sunday	10	10	10	10	10	3	1
26	Uniform activity on weekdays, little activity on Saturday, no activity on Sunday	10	10	10	10	10	3	0
27	Uniform activity on weekdays, half as much activity on weekends	10	10	10	10	10	5	5
28	Uniform activity on weekdays, five times as much activity on weekends	2	2	2	2	2	10	10
29	Uniform activity on Monday through Thursday, increased activity on Friday, Saturday, and Sunday	8	8	8	8	10	10	10

3. Daily Variation

Emissions are adjusted temporally to represent variations by hour of day. Many emission sources occur 24 hours per day, such as livestock waste or a sewage treatment plant whereas many businesses operate 8 hours per day. Other emissions sources vary significantly over a day, such as residential space heating or pesticide application. Each process or emission category is assigned an hours-per-day (HPDY) code. Table 4 displays the daily variation factors or current HPDY codes. Code 33 is no longer used for residential fuel combustion in favor of day specific adjustments see Section IV.F.4. Additional temporal profiles are shown in Appendix C: Additional Temporal Profiles.

Table 4: Daily variation factors

Code	Code Description	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	1 HOUR PER DAY	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	3 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
4	4 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
5	5 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
6	6 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
7	7 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
8	8 HOURS PER DAY - UNIFORM ACTIVITY FROM 8 A.M. TO 4 P.M. (NORMAL WORKING SHIFT)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
9	9 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
10	10 HOURS PER DAY	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
11	11 HOURS PER DAY	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
12	12 HOURS PER DAY	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
13	13 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
14	14 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
15	15 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0

Code	Code Description	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
16	16 HOURS PER DAY - UNIFORM ACTIVITY FROM 8 A.M. TO MIDNIGHT (2 WORKING SHIFTS)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	17 HOURS PER DAY	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18	18 HOURS PER DAY	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19	19 HOURS PER DAY	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
20	20 HOURS PER DAY	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
21	21 HOURS PER DAY	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
22	22 HOURS PER DAY	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
23	23 HOURS PER DAY	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
24	UNIFORM ACTIVITY DURING THE DAY	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
31	MAJOR ACTIVITY 5-9 P.M., AVERAGE DURING DAY, MINIMAL IN EARLY A.M.(GAS STATIONS)	3	1	1	1	1	1	1	5	5	5	5	5	5	5	5	5	5	10	10	10	10	7	7	3
33	MAX ACTIVITY 7-9 A.M. & 7-11 P.M.,AVERAGE DURING DAY, LOW AT NIGHT (RESIDENTIAL FUEL COMBUSTION)	2	2	2	2	2	2	2	10	10	6	6	5	5	5	5	5	5	5	5	10	10	10	10	2
34	ACTIVITY 1 TO 9 A.M.; NO ACTIVITY REMAINDER OF DAY (i.e. ORCHARD HEATERS)	0	8	8	8	8	10	10	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	MAX ACTIVITY 7 A.M. TO 1 A.M., REMAINDER IS LOW	10	1	1	1	1	1	1	8	8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

Code	Code Description	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	(i.e. COMMERCIAL AIRCRAFT)																								
37	ACTIVITY DURING DAYLIGHT HOURS; LESS CHANCE IN EARLY MORNING AND LATE EVENING	0	0	0	0	0	1	3	6	9	10	10	10	10	10	10	10	10	9	6	3	1	0	0	0
38	ACTIVITY DURING MEAL TIME HOURS (i.e. RESIDENTIAL COOKING)	0	0	0	0	0	2	6	6	2	2	1	2	4	4	2	1	1	3	10	8	7	6	1	0
50	PEAK ACTIVITY AT 7 A.M. & 4 P.M.; AVERAGE DURING DAY (ON-ROAD MOTOR VEHICLES)	1	1	1	1	1	1	6	10	6	5	5	5	5	5	5	6	10	8	6	4	1	1	1	1
51	ACTIVITY FROM 6 A.M. TO 12 P.M. (PETROLEUM DRY CLEANING)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
52	MAJOR ACTIVITY FROM 6 A.M.-12 P.M., LESS FROM 12-7 P.M. (PESTICIDES)	0	0	0	0	0	1	6	10	10	10	10	10	6	3	3	3	3	4	4	0	0	0	0	0
53	ACTIVITY FROM 7 A.M. TO 12 P.M. (AGRICULTURAL AIRCRAFT)	0	0	0	0	0	0	0	2	2	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0
54	UNIFORM ACTIVITY FROM 7 A.M. TO 9 P.M. (DAYTIME BIOGENICS)	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
55	UNIFORM ACTIVITY FROM 9 P.M. TO 7 A.M. (NIGHTIME BIOGENICS)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
56	MAX ACTIVITY 8 A.M. TO 5 P.M, MINIMAL AT NIGHT & EARLY MORNING	0	0	0	0	1	1	2	3	10	10	10	10	10	10	10	10	9	1	1	1	1	1	1	1
57	MAX ACTIVITY 7 A.M. TO 2 P.M., MINIMAL AT EVENING	0	0	0	0	0	1	6	10	10	10	10	10	10	9	8	4	2	1	1	0	0	0	0	0

Code	Code Description	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	AND MORNING HOURS (CONSTRUCTION EQUIPMENT ON HOT DAYS)																								
58	MAX ACTIVITY 7 A.M. TO NOON.;REDUCED ACTIVITY NOON TO 6 P.M. (AUTO REFINISHING)	0	0	0	0	0	0	0	10	10	10	10	10	8	8	8	8	8	8	0	0	0	0	0	0
59	MAXIMUM ACTIVITY FROM 7:00 AM TO 3:00 PM; REDUCED ACTIVITY FROM 3:00 TO 6:00 PM.(CONSTRUCTION EQUIPMENT ON NORMAL DAYS)	0	0	0	0	0	0	2	10	10	10	10	10	10	10	10	7	3	1	1	0	0	0	0	0
60	MAXIMUM ACTIVITY FROM NOON TO 7:00 PM; REDUCED ACTIVITY EVENING AND MORNING HOURS (RECREATIONAL BOAT EXHAUST)	0	0	0	0	0	0	0	2	4	6	7	9	10	10	10	10	10	10	10	7	5	3	1	0
81	MAX ACTIVITY 9 AM TO 3 PM; HALF THE ACTIVITY REMAINING HOURS (WASTE FROM DAIRY CATTLE)	7	6	6	5	4	4	4	5	7	8	9	10	10	10	7	3	3	3	4	4	5	6	7	7
82	ACTIVITY FROM 10 AM TO 9 PM RISING TO PEAK AT 3; NO ACTIVITY REMAINDER OF DAY (WASTE FROM POULTRY)	0	0	0	0	0	0	0	0	0	3	3	7	7	7	10	10	7	3	3	3	3	0	0	0
83	ACTIVITY FROM 9 AM TO 12 AM RISING TO PEAK AT 3; MINIMUM ACTIVITY REMAINDER OF DAY (WASTE FROM SWINE)	0	0	0	0	0	0	0	1	1	2	4	6	8	8	9	10	8	4	3	3	2	1	1	1
84	MAJOR ACTIVITY FROM 11AM TO 6PM; REDUCED	7	7	6	6	6	6	6	7	8	8	9	9	10	10	10	10	9	9	8	8	7	7	7	7

Code	Code Description	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	OTHER HOURS (EVAP-COASTAL COUNTIES)																								
85	MAJOR ACTIVITY FROM 11AM TO 6PM; REDUCED OTHER HOURS (EVAP-NON-COASTAL COUNTIES)	5	5	5	5	4	4	5	5	6	7	8	9	9	10	10	10	9	9	8	7	6	6	6	5

D. Spatial Allocation

Once the base case, reference, or future year inventories are developed, the next step of modeling inventory development is to spatially allocate the emissions. Air quality models attempt to replicate the physical (e.g., transport) and chemical processes that occur in the atmosphere within a modeling domain. Therefore, it is important that the physical location of emissions be specified as accurately as possible. Ideally, the actual location of all emissions would be known exactly. However, some categories of emissions would be virtually impossible to determine—for example, the actual amount and location of consumer products (e.g., deodorant) used every day. To the extent possible, the spatial allocation of emissions in a modeling inventory approximates as closely as possible the actual location of emissions.

Spatial allocation is typically accomplished by using spatial surrogates. These spatial surrogates are processed into spatial allocation factors to geographically distribute county-wide area source emissions to individual grid cells. Spatial surrogates are developed based on demographic, land cover, and other data that exhibit patterns geographically. Sonoma Technology, Inc. (STI) (Funk, Stiefer, & Chinkin, 2001) under CCOS contract, originally developed many of the spatial surrogates by creating a base year (2000) and various future year surrogate inventories. STI updated the underlying spatial data and developed new surrogates (Reid, Penfold, & Pollard, 2008), completing the project in 2008. CARB and districts have since continued to update and improve many of the spatial surrogates, adding new ones as more data become available.

Four basic types of data are used to develop the spatial allocation factors: land use and land cover, satellite imagery, facility location, and demographic and socioeconomic data. Land use and land cover data are associated with specific land uses, such as agricultural harvesting or recreational boats. Facility locations are used for sources such as gas stations and dry cleaners. Demographic and socioeconomic data, such as population and housing, are associated with residential, industrial, and commercial activities (e.g., residential fuel combustion). To develop spatial allocation factors of high quality and resolution, local socioeconomic and demographic data were used when available for developing base case, baseline, and future year inventories. For any given region, data can be available from a local Metropolitan Planning Organization (MPO), a Council of Government (COG) or a Regional Transportation Planning Agency (RTPA). These are used as inputs for travel demand models. In rural regions for which local data is not available, data from California Statewide Travel Demand Model (CSTDM) was used.

The current snapshot used for the San Joaquin Valley PM2.5 SIP emission inventory for BY2017 and FY2030 is defined as snapshot October 1st, 2022 (SNP20221001) patch 1. Detailed methodology for each surrogate can be found in the spatial surrogate methodology document (CARB, Spatial Surrogate Methodology Document SNP20221001, 2022). This snapshot includes all previous updates noted in surrogate snapshot 2021-10-01 (CARB, Spatial Surrogate Methodology Document SNP2021-10-01, 2021) as well as recent improvements outlined below. A summary of the primary spatial surrogates by EICSUM is provided in Appendix D: Spatial Surrogate Assignments.

- Improvements to Construction surrogates
- Improvements to Landfills and Compositing surrogates

- Updates to Distribution Centers
- Creation of new surrogate for Forest Roads
- Updates to Pasture Agriculture Land
- Improvements to the Switch Railyards Surrogate
- Improvements to ocean-going vessel surrogates based on 2018 Automatic Identification System (AIS)

1. Spatial Allocation of Area Sources

Area-wide emissions are modeled using a top-down approach where emission totals are estimated for a large geographic area of interest (GAI). Each area source category is assigned a primary spatial surrogate that is used to allocate emissions to a grid cell in CARB's 4 km statewide modeling domain. Examples of surrogates include population, land use, and other data with known geographic distributions for allocating emissions to grid cells, as described above.

2. Spatial Allocation of Point Sources

Each point source is allocated to grid cells using the latitude and longitude reported for each stack. If there are no stack latitude and longitude, the facility coordinates are used. There are two types of point sources: elevated and non-elevated sources. Stationary point sources with stacks are regarded as elevated sources. Those without physical stacks that provide only latitude/longitude, such as airports or landfills, are considered non-elevated. Emissions are allocated vertically for elevated sources using the SMOKE (Sparse Matrix Operator Kernel Emissions) modeling system's in-line plume rise calculation for the CMAQ (Community Multi-scale Air Quality) photochemical model. SMOKE will select the sources that will receive the CMAQ in-line plume rise treatment, and group together sources with nearly identical stack parameters to reduce the number of calculations performed by the CMAQ in-line plume rise module. SMOKE will then output the emissions by grouped sources and the accompanying stack/facility coordinates and stack parameters for CMAQ's in-line plume rise module to handle the vertical allocation of the elevated sources.

3. Spatial Allocation of Wildfires, Prescribed Burns, and Wildland Fire Use

Emissions from wildfires, prescribed burns, and wildland fires are event- and location-based. A fire event can last a few hours or span multiple days. Where available, data from the Visible Infrared Imaging Radiometer Suite (VIIRS) 375 m thermal anomalies product are used to capture daily growth of the fire. Grid cells from the fire extent are only used for spatial allocation on the days where the VIIRS satellite detect thermal anomalies in these areas. For fires where the VIIRS data is unavailable, the fire is spatially allocated to grid cells using the final extent of each fire event while the temporal distribution also reflects the actual duration of the fire. The spatial information to allocate the fire emissions comes from a statewide interagency fire perimeters geodatabase maintained by the Fire and Resource Assessment Program (FRAP) of the California Department of Forestry and Fire Protection (CALFIRE). More details on the methodology and estimation of the wildfire emissions can be found in Section IV.F.1.

4. Spatial Allocation of Ocean-going Vessels (OGV)

CARB OGV emissions consist of four activity types: hoteling, maneuvering, anchorage and transit. Since hoteling is stationary in port areas, it was treated as a point source. The remaining activity types are regarded as area sources. Individual berths were identified from a combination of AIS telemetry data, satellite and aerial photography, and detailed port maps where available. The centroids of grid cells on the Statewide domain containing berth locations were then associated with hoteling emissions for each GAI. Transit, spatial surrogates were constructed based on the National Waterway Network and AIS data from 2017. Maneuvering spatial surrogates were drawn to connect the transit lanes with the berth locations for each port. Anchorage locations were determined based on raster data from the National Oceanic and Atmospheric Administration (NOAA) which reflects anchorage locations codified in the Federal Register.

5. Spatial Allocation of On-road Motor Vehicles

The spatial allocation of on-road motor vehicles is based on data from the latest travel demand models provided by local MPOs. These model outputs are combined into a statewide transportation network using the Integrated Transportation Network (ITN). For areas without a regional travel demand model, data from CSTDM is used. For more details, see Section IV.B.3.

E. Speciation Profiles

CARB's emission inventory lists the amounts of pollutants discharged into the atmosphere by sources in a certain geographical area during a given time period. It currently contains estimates for CO, NH3, NOx, SOx, total organic gases (TOG) and particulate matter (PM). CO and NH3 each are single species; NOx emissions are composed of NO, NO2 and HONO; and SOx emissions are composed of SO2 and SO3. TOG and PM potentially contain over hundreds of different chemical species, and speciation is the process of disaggregating these inventory pollutants into individual chemical species components or groups of species. CARB maintains and updates such speciation profiles for organic gases (OG) and PM for a variety of source categories.

Photochemical models simulate the physical and chemical processes in the lower atmosphere and include all emissions of the important classes of chemicals involved in photochemistry as well as less reactive compounds that are of concern from a health or visibility standpoint. TOG includes all organic compounds that can become airborne (through evaporation, sublimation, as aerosols, etc.), excluding CO, CO2, carbonic acid, metallic carbides or carbonates, and ammonium carbonate. TOG emissions reported in the CARB's emission inventory are the basis for deriving the reactive organic gas (ROG) emission components, which are also reported in the inventory. ROG is defined as TOG minus CARB's exempt compounds (e.g., methane, ethane, various chlorinated fluorocarbons, acetone, perchloroethylene, volatile methyl siloxanes, etc.). ROG is nearly identical to U.S. EPA's Volatile Organic Compounds (VOC), which is based on EPA's exempt list. For all practical purposes, use of the terms ROG and VOC are interchangeable.

The OG speciation profiles are applied to estimate the amounts of various organic compounds that make up TOG emissions. A speciation profile contains a list of organic compounds and the weight fraction that each compound comprises of the TOG emissions from a particular source type. In addition to the chemical name for each chemical constituent, the file also shows the 5-digit CARB internal identification chemical code. The speciation profiles are applied to TOG to develop both the photochemical model inputs and the emission inventory for ROG. District-reported fractions are not used in developing modeling inventories because the information needed to calculate the amount of each organic compound is not available.

The PM emissions are size-fractionated by using PM size distribution profiles, which contain the total weight fraction for PM2.5 and PM10 out of total PM. The fine and coarse PM chemical compositions are characterized by applying the PM chemical speciation profiles for each source type, which contain the weight fractions of each chemical species for PM2.5, PM10, and total PM. PM chemical speciation profiles may also vary for different PM size fractions even for the same emission source. PM size profiles and speciation profiles are typically generated based on source testing data. In most previous source testing studies aimed at determining PM chemical composition, filter-based sampling techniques were used to collect PM samples for chemical analyses.

The most current OG profiles and PM profiles are available for download from *CARB's speciation profile web page*. Based on these original profiles, a model-ready speciation file, gspro, was generated for a specific chemical mechanism (for example, SAPRC07T) to separate aggregated inventory pollutant emission totals into emissions of model species required by the air quality model.

Each process or product category is keyed to one of the OG profiles and one of the PM profiles. Also available for download from CARB's web site (see link in previous paragraph) is a cross-reference file that indicates which OG profile and PM profile are assigned to each category in the inventory. The inventory source categories are represented by an 8-digit source classification code (SCC) for point sources, or a 14-digit emission inventory code (EIC) for area and mobile sources. Some of the OG profiles and PM profiles related to motor vehicles, ocean going vessels, and fuel evaporative sources vary by the inventory year of interest, due to changes in fuel composition, vehicle fleet composition, and emissions control devices such as diesel particulate filters (DPFs). Details can be found in CARB's references of speciation profile development available on the *Consolidated List for Speciation Profiles site*. Mapping of each category to OG and PM profiles is summarized in rogpm and gsref files.

Research studies are conducted regularly to improve CARB's speciation profiles. These profiles support ozone and PM modeling studies and can also be used for regional toxics modeling. Speciation profiles need to be as complete and accurate as possible. CARB has an ongoing effort to update speciation profiles as data become available through testing of emission sources or surveys of product formulations. New speciation data generally undergo technical and peer review; updates to the profiles are coordinated with end users of the data. The recent additions to CARB's speciation profiles include:

- OG profiles
    - Off-road recreational vehicle exhaust and evaporation
    - Biomass burning
    - Consumer products

    - Architectural coating
    - Gasoline fuel and headspace vapor
    - Gasoline vehicle hot soak and diurnal evaporation
    - Gasoline vehicle start and running exhaust
    - Silage
    - Aircraft exhaust
    - Compressed Natural Gas (CNG) bus running exhaust
- PM profiles
    - Piston-Engine aircraft (aviation gasoline)
    - Tire burning
    - Gasoline vehicle exhaust (start and running)
    - On-road diesel exhaust
    - Off-road diesel exhaust
    - Ocean going vessel exhaust
    - Aircraft exhaust
    - Concrete batching
    - Commercial cooking
    - Residential fuel combustion-natural gas
    - Coating/painting
    - Cotton ginning
    - Stationary combustion
    - OGV auxiliary boiler combustion
    - Compressed Natural Gas (CNG) vehicle running exhaust
    - Off-road diesel military generator exhaust

IV. Methodology for Developing Base Case, Baseline, and Future Projected Emissions Inventories

As mentioned in Section II.C, the base case and reference inventories include temperature, humidity, and solar insolation effects for some emission categories; development of these data is described in Sections IV.F. Sections IV.A through IV.H detail how the base case and reference inventories were created for different sectors of the inventory such as point, area, on-road motor vehicles, biogenic, OGV, other day-specific sources, Northern Mexico, and Western States. Section IV.I briefly describes the control measure reduction factors applied to the future year.

A. Estimation of Gridded Area and Point sources

Emissions inventories that are temporally, chemically, and spatially resolved are needed as inputs for the photochemical air quality model. Point sources and area sources (area-wide, off-road mobile, and aggregated stationary) are processed into emissions inventories for photochemical modeling using the SMOKE modeling system (https://www.cmascenter.org/smoke/). The current SIP modeling uses SMOKE v4.9 (referred as Official SMOKE hereafter) following in-house testing of this version of the software.

1. General Methodology

Inputs for SMOKE are annual emissions totals from CEPAM and information for allocating to temporal, chemical, and spatial resolutions. Temporal inputs for SMOKE are screened for missing or invalid temporal codes as discussed in Section V.A. Temporal allocation of emissions using SMOKE involves the disaggregation of annual emissions totals into monthly, day-of-week, and hour-of-day emissions totals. The temporal codes from Table 3 and Table 4 are reformatted into an input-ready format as explained in the SMOKE user's manual. Chemical speciation profiles, as described in Section III.E, and emissions source cross-reference files used as inputs for SMOKE are developed by CARB staff. SMOKE uses the files for the chemical speciation of NOx, SOx, TOG, and PM to produce the species needed by photochemical air quality models.

Emissions for area sources are allocated to grid cells defined by the modeling grid domain in Section II.D. Emissions are spatially disaggregated using spatial surrogates as described in Section III.D. These spatial surrogates are converted to a SMOKE-ready format as described in the SMOKE user's manual. Emissions for point sources are allocated to grid cells by SMOKE using the latitude and longitude coordinates reported for each stack.

2. Temporal Allocation of Electric Generating Units using U.S. EPA Continuous Emissions Monitoring data

Continuous Emission Monitoring (CEM) data is collected through EPA's clean air markets division in which they monitor continuous CO_2, NOx, SO_2, and mercury emissions from specific electric generating units to check compliance with a variety of federal air quality programs. Electric Generating Units (EGUs) are required to submit operations data such as facility information, monitoring plans, quality assurance (QA) test information as well as hourly heat input and hourly gross electricity generation. This information is helpful when developing a formal emissions inventory that can be used in air quality modeling applications. The emissions from the combustion of fuel by EGU are divided into two classifications: the first is from steam EGUs also known as boilers and non-steam EGUs such as gas turbines and internal combustion engines. The primary fuel type varies across the nation between coal, oil, gas and other waste. But here in California, our primary plant fuel type is natural gas.

Hourly CEM data (USEPA, Clean Air Markets Program Data, 2017) was assessed for each California facility ID (ORIS) and boiler ID that matched to a specific CEIDARS facility ID, stack, segment and process ID. For base year 2017 emissions, facilities in CEIDARS that had matching CEM data used the CEM hourly heat input as the temporal profile to allocate annual reported estimates to each hour for all pollutants. For future year 2030 emissions, facilities in CEIDARS that had matching CEM data used the 2017 hourly heat input as the temporal profile to allocate annual reported estimates of all pollutants. Work is currently being done to generate an average hourly profile using multi-year CEM heat input data that may be more reflective of an average, future year scenario. For a complete review of San Joaquin Valley matching facilities, please review Appendix E: San Joaquin Valley Facilities with CEM data.

B. Estimation of On-road Motor Vehicle Emissions

1. General Methodology

The EMFAC2021 with Metropolitan Planning Organizations specific activity version 11 (MPOv11) emissions are processed into on-road emissions inventories using ESTA developed by CARB. The ESTA model applies spatial and temporal surrogates to emissions to create top-down emission inventory files.

More information on ESTA is available at the following *GitHub repository for Emissions Spatial and Temporal Allocator*.

2. Activity Data Updates

Link-based and Traffic Analysis Zone (TAZ)-based travel activity from travel demand models provided by different MPOs, Caltrans and other California RTPAs. Parameters such as vehicle mix and VMT are compared between the default EMFAC and Caltrans databases prior to spatial allocation to ensure values lie within reasonable limits.

3. Spatial Adjustment

CARB works with local MPOs to obtain the latest available output from regional travel demand models. The output link networks from these models are combined into a statewide link network using the Integrated Transportation Network (ITN) framework (CARB, 2021). For regions where no local travel demand model data are available, data from CSTDM are used (Caltrans, 2020). Data are quality assured by checking network/link volume, vehicle miles traveled (VMT), and spatial rendering. Overlapping networks are checked for duplicate links to avoid overallocation in these regions. Model output years vary between all regional data sources for ITN. The networks are normalized into modeling years used for air quality modeling using county level growth factors from EMFAC. Table 5 contains the data vintages used in the current working version of the statewide ITN.

Spatial allocation of on-road activity surrogates is split into two vehicle groups, light-duty and heavy-duty. Some major MPOs and Caltrans provide vehicle classification splits in their model link outputs. When possible, this information is incorporated into the ITN. However, when no vehicle splits are provided by the regional models the total network volumes must be used for both light-duty and heavy-duty spatial distribution. Travel demand model output provides network volume information organized by peak and off-peak time periods. This peak period volume information is disaggregated to create 24 hourly surrogates for an average modeling day.

The link networks are processed through the spatial allocator tool to create gridded surrogates weighted by VMT.

Table 5: Network information for data sources used in current version of ITN

Network	Counties in Network	Data Vintage
Association of Monterey Bay Area Governments (AMBAG)	Monterey, San Benito, Santa Cruz	2018 RTDM
Butte County Association of Governments (BCAG)	Butte	2019 FSTIP
California Statewide Travel Demand Model (CSTDM)	Statewide	Version 3.0
Fresno Council of Governments (FCOG)	Fresno	2022 RTP/SCS
Kings County Association of Governments (KCAG)	Kings	2022 RTP/SCS
Kern Council of Governments (KCOG)	Kern	2022 RTP/SCS
Merced County Association of Governments (MCAG)	Merced	2022 RTP/SCS
Madera County Transportation Commission (MCTC)	Madera	2022 RTP/SCS
Metropolitan Transportation Commission (MTC)	Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, Sonoma	2017 RTP/SCS
Sacramento Area Council of Governments (SACOG)	El Dorado, Placer, Sacramento, Solano, Sutter, Yolo, Yuba	2020 MTP/SCS
San Diego Association of Governments (SANDAG)	San Diego	2021 RTP/SCS
Santa Barbara County Association of Governments (SBCAG)	Santa Barbara	2017 FSTIP
Southern California Association of Governments (SCAG)	Imperial, Los Angeles, Orange, Riverside, San Bernardino, Ventura	2020 RTP/SCS
San Joaquin Council of Governments (SJCOG)	San Joaquin	2022 RTP/SCS

Network	Counties in Network	Data Vintage
San Luis Obispo Council of Governments (SLOCOG)	San Luis Obispo	2019 RTP/SCS
Shasta Regional Transportation Agency (SRTA)	Shasta	2018 RTP/SCS
Stanislaus Council of Governments (StanCOG)	Stanislaus	2022 RTP/SCS
Tulare County Association of Governments (TCAG)	Tulare	2022 RTP/SCS
Tahoe Metropolitan Planning Organization (TMPO)	El Dorado, Placer	2015 FSTIP

Evaporative surrogates were created using registration data from the California Department of Motor Vehicles (DMV). Vehicle registration was provided by census block group for the entire state. Registration data were split into five vehicle types and two fuel types. Table 6 shows the vehicle type categories used for the evaporative emission surrogates. Registration counts were totaled over a three-year period (2015-2018) and assigned to the corresponding census block group polygons. Data from the NASA Nighttime Lights (Mills, Weiss, & Liang, 2013) dataset was used to clip the census block group into areas with active population.

Table 6: Registration data vehicle type classes.

Vehicle Class Group Name	Description
MC	Motorcycles
MH_BUS	Motorhomes and Buses
P	Passenger Vehicles
T1_T4	Light-Heavy Duty Trucks
T5_T7	Heavy-Heavy Duty Trucks

4. Temporal Adjustment (Day-of-week adjustments for EMFAC daily totals)

EMFAC2021 produces a single average day-of-week (DOW) estimate that represents Tuesday, Wednesday, and Thursday for each county in California. To represent daily emissions more accurately, DOW adjustments are made to all emissions estimated on a Friday, Saturday, Sunday, or Monday. The DOW adjustment factors were developed using CalVAD data. The California Vehicle Activity Database (CalVAD), developed by UC Irvine for CARB, is a system that fuses available data sources to produce a “best estimate” of vehicle activity by class. The latest activity from the CalVAD database was released in 2012. There are no expected upcoming updates. The CalVAD data set includes actual daily measurements of VMT on the road network for 43 of the 58 counties in California. However, there are seven counties that can't be used because the total vehicle miles traveled are less than the sum of the heavy heavy-duty truck vehicle miles traveled and trucks excluding heavy heavy-duty vehicle miles traveled. Furthermore, two more counties that have high vehicle miles traveled on Sunday are also excluded. Therefore, only 34 of these counties had useful data. To fill the missing 24 counties' data to cover all of California, a county which is nearby and similar in geography is selected to represent each of the missing counties. The CalVAD fractions were developed for three categories of vehicles: passenger cars (LD), light- and medium-duty trucks (LM), and heavy-heavy duty trucks (HHDT). Heavy-heavy duty vehicle fractions have recently been updated using 2017 Performance Measurement System (PeMS) data. Truck volumes were pulled for each county. Day of year specific fractions were calculated relative to an average weekday for each county. Fractions were manually reviewed by staff to check data integrity. Counties without data or poor data quality were screened out and replaced with an older version of fractions from CalVAD.

Table 7 shows the corresponding assignment to each vehicle type. Furthermore, the CalVAD fractions are scaled so that a typical workday (Tuesday, Wednesday, or Thursday) gets a scaling factor of 1.0. All other days of the week receive a scaling factor where their VMT is related back to the typical workday. This means there are a total of five weekday scaling factors. Lastly, the CalVAD data were used to create a typical holiday, because the traffic patterns for holidays are quite different than a typical weekday. Thus, in the end, there are six daily fractions for each of the three vehicle classes, for all 58 counties. The DOW factors and vehicle type can be found in Appendix A: Day-of-week Redistribution Factors by Vehicle Type and County.

Table 7: Vehicle classification and type of adjustment

Vehicle Class	Vehicle Type	Type of Adjustment
1	LDA	LD
2	LDT1	LD
3	LDT2	LD
4	MDV	LD
5	LHDT1	LM
6	LHDT2	LM
7	T6	LM
8	T7 HHDT	HHDT

Vehicle Class	Vehicle Type	Type of Adjustment
9	Other Bus	LM
10	School Bus	Unadjusted on weekdays, zeroed on weekends
11	Urban Bus	LD
12	Motorhomes	LD
13	Motorcycles	LD

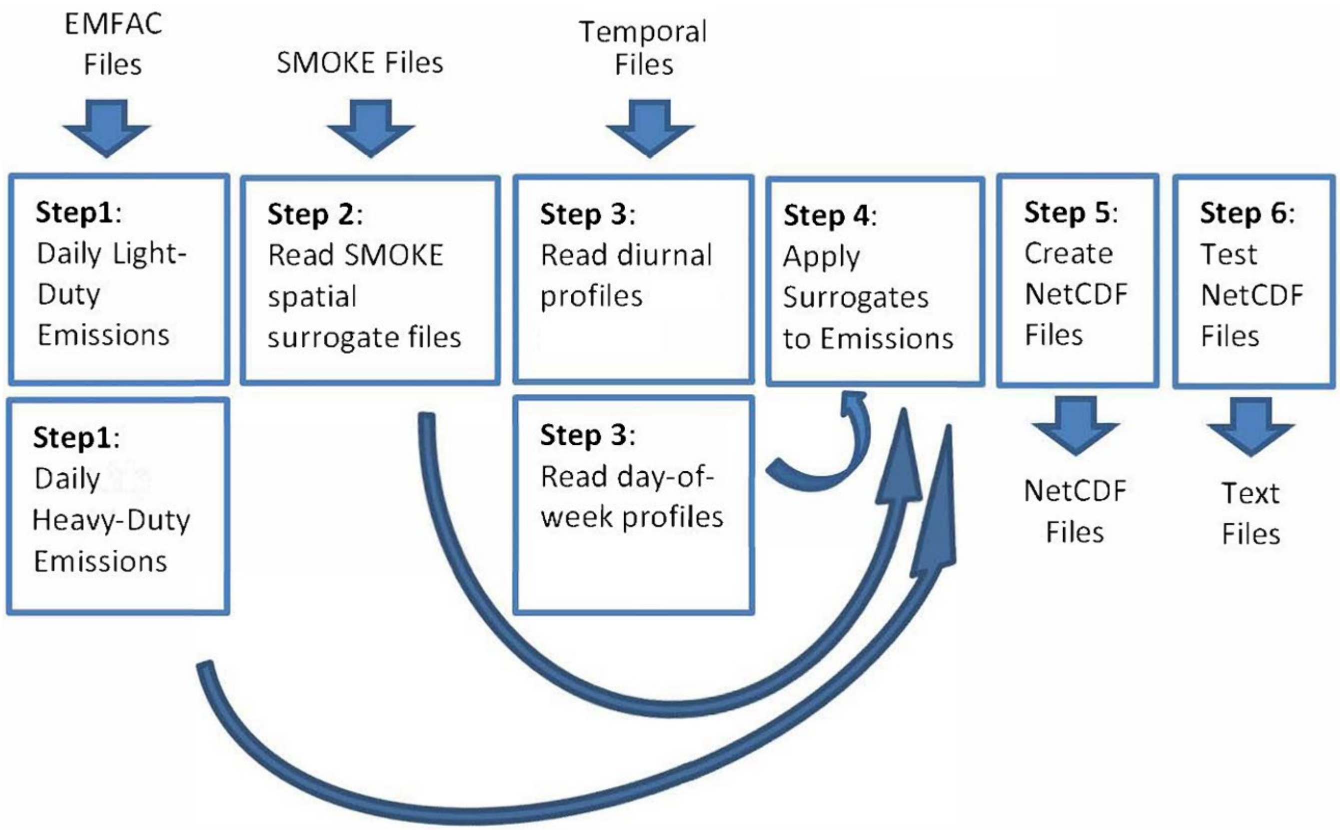
5. Temporal Adjustment (Hour-of-day profiles for EMFAC daily totals)

EMFAC produces emission estimates for an average weekday and lacks the day-of-week hour-of-day temporal variations that are known to occur on specific days of the week. To rectify this, the CalVAD data were used to develop hour-of-day profiles for Friday through Monday, a typical weekday and a typical holiday. Heavy-heavy duty hourly vehicle fractions were updated using 2017 Performance Measurement System (PeMS) data from Caltrans in counties where data were available. The hour-of-day profiles for passenger cars (LD), light- and medium-duty trucks (LM), and heavy heavy-duty trucks (HH) can be found in Appendix B: Hour-of-day Profiles by Vehicle Type and County.

6. Summary of On-road Emissions Processing Steps

The six steps to process on-road emissions for regional air quality modeling with CMAQ are represented below in Figure 3. Step 1 reads daily emissions input data from EMFAC. Step 2 reads SMOKE-ready spatial surrogates files. Step 3 reads day of week and diurnal temporal activity profiles from CalVAD. Step 4 applies both the spatial surrogates and temporal allocations to the daily emissions from EMFAC. Step 5 creates the gridded, hourly Network Common Data Form (NetCDF) files for each day of the year being modeled. Lastly, step 6 produces text files for use in quality assurance and quality checks of the emissions data.

Figure 3: Workflow for spatial and temporal allocation of on-road emissions



7. Adjustment to the Future Year On-road Emissions

The future year on-road mobile source emissions were adjusted to incorporate emission reduction programs for heavy duty vehicles. The reductions applied to the inventory reflect the Low NOx Standard (CARB, Heavy-Duty Low NOx, 2020), Advanced Clean Truck (ACT) (CARB, Advanced Clean Trucks, 2020), Advanced Clean Car II (ACCII), Statewide SIP Strategy (SSS) and Heavy Duty Inspection and Maintenance Regulation (CARB, Heavy-Duty Inspection and Maintenance Regulation, 2021).

C. Estimation of Gridded Biogenic Emissions

Biogenic emissions were generated using the MEGAN3.0 biogenics emissions model (https://bai.ess.uci.edu/megan/versions). MEGAN3.0 incorporates a new pre-processor (MEGAN-EFP) for estimating biogenic emission factors based on available landcover and emissions data. The MEGAN3.0 default datasets for plant growth form, ecotype, and emissions were utilized. Leaf Area Index (LAI) for non-urban grid cells was based on the 8-day 500-m resolution MODIS Terra/Aqua combined product (MCD15A2H) for 2017 (https://earthdata.nasa.gov/). The LAI data was converted to LAIv, which represents the LAI for the vegetated fraction within each grid cell, by dividing the gridded MODIS LAI values by the Maximum Green Vegetation Fraction (MGVF) for each grid cell (DroughtView, 2014). The

MODIS LAI product does not provide information on LAI in urban regions, so urban LAIv was estimated from the US Forest Service's Forest Inventory and Analysis (FIA) urban tree plot data, processed through the i-Tree v6 software (https://www.itreetools.org/tools/i-tree-eco). Hourly meteorology was provided by 4-km WRF simulations for 2017, and all stress factor adjustments were turned off.

D. Aircraft Emissions

Aircraft emissions were generated using the Gridded Aircraft Trajectory Emissions Model (GATE) developed by CARB (CARB, Gridded Aircraft Trajectory Emissions Model Documentation, 2017). The GATE model distributes aircraft emissions in three dimensions. The GATE model takes annual aircraft emissions during landing, taxiing, and take-off, and converts this data into gridded, hourly emissions as follows:

- Read aircraft emissions from an annual inventory
- Split the emissions into hourly components
- Split any county-wide emissions into individual runways and use the point source emissions if they are available
- Geometrically model the 3D flight paths at each runway
- Intersect the above 3D paths with the 3D modeling grid
- Distribute the hourly aircraft emissions into the 3D grid

E. Estimation of Ocean-going Vessel (OGV) Emissions

Annual emissions are provided through CEPAM for commercial and military OGV. The Mobile Source Analysis Branch compiled port activity data for 2016 reported for Long Beach, Port of Los Angeles, Bay Area, and San Diego. The activity data consisted of daily visits by vessel types for the full calendar year. This data was used to derive monthly and weekly temporal profiles for OGV sources. No activity data was available to create temporal profiles for the military sector; default SMOKE temporal profiles were assumed.

Subsequently, emissions were separated by at-berth and everything else. At-berth emissions are processed through SMOKE as inline point sources. Latitude and longitude locations were predetermined as of 22nd October 2021 based on GIS vertices captured by satellites. (Kwok, 2015). The at-berth emissions had been temporally allocated with monthly and weekly profiles derived from the 2016 port activities described in the last paragraph. For transit, maneuvering, and anchorage, emissions are distributed evenly in two vertical layers (2 and 3) (Kwok, 2015).

F. Estimation of Other Day-specific Sources

Day-specific data were used for preparing base case inventories when data were available. CARB and district staff were able to gather hourly/daily emission information for 1) wildfires and prescribed burns, 2) paved and unpaved road dust, and 3) agricultural burns in six districts (more details highlighted below).

For the reference and future year inventories, day-specific emissions for wildfires, prescribed burns, and wildland fires use (WFU) are left out of the inventory. All other day-specific data are included in both reference and future year modeling inventories.

1. Wildfires and Prescribed Burns

Day-specific, base case estimates of emissions from wildfires and prescribed fires were developed in a two-part process. The first part consisted of estimating micro-scale, fire-specific emissions (i.e. at the fire polygon scale, which can be at a smaller spatial scale than the grid cells used in air quality modeling). The second part consisted of several steps of post-processing fire polygon emission estimates into gridded, hourly emission estimates that were formatted for use in air quality modeling.

Fire event-specific emissions were estimated using a combination of geospatial databases and a federal wildland fire emission model (Clinton, Gong, & Scott, 2006). A series of pre-processing steps were performed using GIS to develop fuel loading and fuel moisture inputs to the First Order Fire Effects (FOFEM) fire emission model (Lutes, Keane, & Reinhardt, 2012). Polygons from a statewide interagency fire perimeters geodatabase (Fire17_1.zip, downloaded May 8, 2018) maintained by FRAP, provided georeferenced information on the location, size (area), spatial shape, and timing of wildfires and prescribed burns. Under interagency Memorandums of Understanding, federal, state, and local agencies report California wildfire and prescribed burning activity data to FRAP. Using GIS software, fire polygons were overlaid upon a vegetation fuels raster dataset called the Fuel Characteristic Classification System (FCCS) (Ottmar, Sandberg, & Riccardi, 2007). The FCCS maps vegetation fuels at a 30-meter spatial resolution, and is maintained and distributed by LANDFIRE.GOV, a state and federal consortium of wildland fire and natural resource management agencies. With spatial overlay of fire polygons upon the FCCS raster, fuel model codes were retrieved and component areas within each fire footprint tabulated. For each fuel code, loadings (tons/acre) for fuel categories were retrieved from a FOFEM look-up table. Fuel categories included dead woody fuel size classes, overstory live tree crown, understory trees, shrubs, herbaceous vegetation, litter, and duff. Fuel moisture values for each fire were estimated by overlaying fire polygons on year- and month-specific 1 km spatial resolution fuel moisture raster files generated from the national Wildland Fire Assessment System (WFAS.net) and retrieving moisture values from fire polygon centroids. Fire event-specific fuel loads and fuel moisture values were compiled and formatted to a batch input file and run through FOFEM.

A series of post-processing steps were performed on the FOFEM batch output to include emission estimates (pounds/acre) for three supplemental pollutant species (NH3, TNMHC, and N2O) in addition to the seven species native to FOFEM (CO, CO2, PM2.5, PM10, CH4, NOx, and SO2), and to calculate total emissions (tons) by pollutant species for each fire. Emission estimates for NH3, TNMHC, and N2O were based on mass ratios to emitted CO and CO2 (Gong, Clinton, & Pu, 2003).

Fire polygon emissions were apportioned to CMAQ model grid cells using area fractions, developed using GIS software, by intersecting fire polygons to the grid domain. For fires captured in the VIIRS dataset, a set of automated scripts used the VIIRS data to spatially allocate fire emissions to the gridded modeling domain on days with active thermal anomalies.

Another set of post-processing steps were applied to allocate fire polygon emissions by date and hour of the day. Fire polygon emissions were allocated evenly between fire start and end dates, taken from the fire perimeters geodatabase. For fires captured in the VIIRS dataset, automated scripts determined fire temporal weighting factors based on the total number of satellite detects. Daily emissions were then allocated to hour of day and to the model grid cells by using a script developed by CARB. A stack file and a 2-D hourly emissions file are generated for each day that has fire emissions. The stack file includes the fire locations, stack parameters and the number of acres burned for a fire in one day. The 2-D hourly emissions file includes the emissions for each species and the heat flux (BTU/hr). CMAQ's in-line plume rise module will handle the vertical allocation of the fire emissions.

2. Paved and Unpaved Road Dust

Statewide emissions of total particulate matter from both paved and unpaved road dust are also a part of the CEPAM inventory. However, the sectors that have been embedded in any CEPAM version are already pre-adjusted. The unadjusted emissions are what is required before making any adjustment. Therefore, the unadjusted paved road dust is based upon CEPAM SIP2019v1.02-v1.01, while the unadjusted unpaved road dust uses an older CEPAM version with 20161130 snapshot. To adjust for precipitation, daily precipitation data for 2017 were used, provided by an in-house database maintained by CARB staff that stores meteorological data collected from outside sources. The specific data sources for these data include Remote Automated Weather Stations (RAWS), Atmospheric Infrared Sounder (AIRS), California Irrigation Management Information System (CIMIS) networks, and Federal Aviation Administration (FAA). FAA provides precipitation data collected from airports in California.

When the precipitation reaches or exceeds 0.01 inches (measured anywhere within a county or county/air basin boundary on a particular day), the uncontrolled emissions are reduced on that day only: 25% for paved road dust, and total removal for the unpaved. The reductions are achieved by running SMOKE with control matrices.

3. Agricultural Burning

Agricultural burn 2017 data processed were reported by air districts. The tons burned provided by the air districts were converted to acres using fuel loading data. With date of the burns, the location of the burns (latitude and longitude coordinates), crop type, and burn duration, the agricultural burn data were processed and then projected onto a statewide grid for each hour of a specific day.

4. Residential Wood Combustion Curtailment

Emissions were reduced to reflect residential wood curtailment (RWC) in San Joaquin Valley APCD, Sacramento Metropolitan AQMD and South Coast AQMD.

A pre-SMOKE utility program called GenTpro is used to generate county-specific temporal profiles based on average temperature by grid cell (UNC Chapel Hill - The Institute for the Environment, 2016). Emissions for any given county are only allocated whenever the daily minimum temperature anywhere within a GAI is below 50 °F based on WRF simulated meteorology for year 2017. The subsequent GenTpro county-specific, daily profiles will temporally allocate emissions for both base year 2017 and future year 2030.

San Joaquin Valley APCD provided areas of curtailment where gas utility is accessible. The designated areas are used to mask the spatial surrogates for woodstoves and fireplaces. The masked surrogates were used to apply day-specific curtailment. The corresponding complimentary surrogates were also constructed by subtracting the masked surrogates from the original spatial surrogates. These complimentary surrogates apply to areas without curtailment. For winter months (January, February, November, December) of year 2017; SJVAPCD provided no-burn days by county, from which day-specific CNTLMAT curtailment files were constructed. The no-burn days of the month are determined by thresholds of PM levels for each day and these thresholds are county dependent.

Emissions from residential wood combustion are reduced in curtailment areas by 65% in 2017 and 97% in 2030 on the no burn days to represent compliance with the no burn day status based on ambient aerosol mass spectrometry measurements in Fresno (Ge et al 2012; Young et al, 2016). With these settings, processing of curtailed months using SMOKE is enabled by merging the outputs of two separate runs. The first run is for the portion with masked surrogates with curtailment via CNTLMAT, and the second run is for the portion that includes complimentary surrogates without curtailment.

For non-curtailed months, SMOKE is only run once with the original spatial surrogates without any curtailment of emissions. For the base year, the whole RWC inventory was applied with the assumption of a 65% compliance rate. For the future year, a 97% compliance rate was assumed, and the curtailment days differ depending on two categories of woodstoves: registered and unregistered. The curtailment days also depend on the PM2.5 levels established following the implementation of the hotspots program from the 2018 PM2.5 Plan for the 12 µg/m3 annual PM2.5 standard (SJVAQMD, 2018). Based on surveys conducted by SJVAPCD, portions of registered and unregistered woodstoves are derived to determine the emission shares. Each category is subject to a different set of two-tier PM2.5 thresholds. For Fresno, Kern and Madera that have been deemed as hotspot areas by Valley Air District (SJVAQMD, 2018), no burning is allowed for any devices when PM2.5 is above 35 ug/m3, while registered woodstoves are still allowed to burn when PM2.5 is above 12 ug/m3 but not more than 35 ug/m3. For other SJV counties, no burning is allowed for any devices when PM2.5 is above 65 ug /m3, whereas registered woodstoves are allowed to burn when PM2.5 is above 20 ug/m3 but not more than 65 ug/m3. Fireplaces are subject to the curtailment rules for unregistered woodstoves.

Areas under Sacramento Metropolitan AQMD (SACAQMD) have their RWC emissions reduced by 57% -or 70% depending on the PM level within the county. Curtailment is applied to the entire spatial surrogates without exceptions. Areas under South Coast (SCAQMD) are subject to 75% curtailment whenever no-burn days within the basin are designated. The compliance rates for SACAQMD and SCAQMD apply to both base- and future years.

5. Estimation of Agricultural Ammonia Emissions

Ammonia emissions from fertilizers/pesticides and livestock are separated from the aggregated area source inventory as they are affected by local meteorology. For fertilizers/pesticides, emissions vary by hour based on WRF's two-meter temperature and ten-meter wind speed. For livestock, WRF's ground temperature and aerodynamic resistance drive hourly variations in emissions. Through GenTpro, these meteorological factors are averaged by county before creating year-long hourly profiles for each of the respective sectors. All algorithms are described in the SMOKE Manual 4. (UNC Chapel Hill - The Institute for the Environment, 2016), while the results of CARB in-house tests were summarized in an internal report (Kwok, 2016). In general, higher temperature and/or wind speeds favor ammonia emissions. Monthly surrogates based on the frequency of pesticide applications were also applied to fertilizer NH3. The sector also has emissions reported by a few individual facilities whose latitudes/longitudes are known.

Since the facility-reported livestock sources were represented as point sources, they must be converted to area source format to make use of GenTpro hourly profiles. Another hourly GenTpro file was created for these facility-reported portions of the sector. To preserve the spatial distribution, emissions were apportioned to those individual facilities by GAI. Thus, each area-to-point fraction file was created for each of the pollutants NH3, PM, and TOG. After SMOKE was run for each pollutant, the gridded NetCDF files were merged.

6. Commercial Cooking

Base year 2017 and future year 2030 commercial cooking emissions were updated in accordance with San Joaquin Valley APCD's recent area source methodology (SJVAPCD, 2023). The methodology includes emission estimates for commercial charbroiling, deep fat frying, and other commercial cooking. The methodology uses a study performed for CARB and the number of restaurants listed in each county as surrogates for determining the number of cooking devices and the amount of food (meats and potatoes) cooked in each county. The amount of food cooked on each device type is multiplied by appropriate emission factors to determine the emissions from each food type on each cooking device. These are then summed for county level emissions.

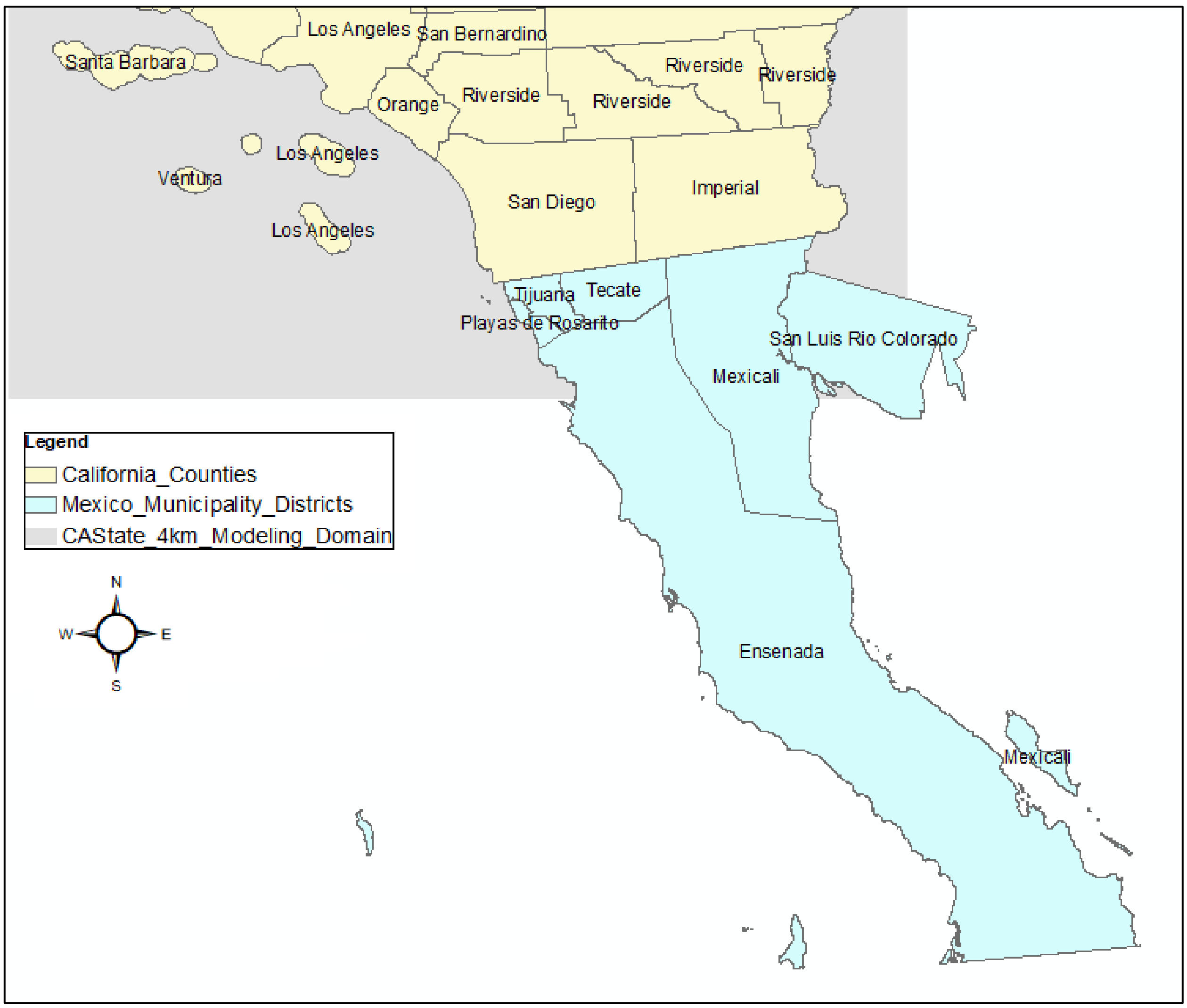
G. Northern Mexico Emissions

Transboundary flow of pollutants between California and Mexico must be considered and accounted for in air quality simulations of Southern California. Affected areas in California include the border regions of San Diego and Imperial counties. Given the right meteorological conditions, more northern counties such as Riverside, Orange, and Los Angeles may also be impacted. As a result, emissions within the five municipalities of Mexico's State of Baja California and one municipality from Sonora must be included when running regional air quality models on the California Statewide Domain. The boundaries of our California 4km modeling domain is shown in grey color in Figure 4.

CARB's Mexico emissions inventory for area, point and non-road emission sources have been processed using an updated inventory developed by Eastern Research Group Inc. (ERG). This inventory is based on the 2014 Mexico National Emissions Inventory (MNEI) with additional improvements made by ground-truthing agricultural burning and brick kilns, and improving methods to calculate idling mobile emissions at the border entries (ERG, 2019). Base year 2017 emission estimates were developed by projecting the 2014 emissions to 2017. Future year 2030 emissions estimates were developed by interpolating 2014, 2020 and 2025 emission estimates to 2030.

For mobile sources, the U.S. EPA on-road emissions model SMOKE-MOVES (Sparse Matrix Operator Kernel Emissions – Motor Vehicle Emission Simulator) Mexico was used to produce an on-road emissions inventory. The on-road sector is reflective of true 2017 emissions. Future year 2030 emission estimates used the U.S. EPA on-road emissions model SMOKE-MOVES Mexico for future year 2028. SMOKE-MOVES is more comprehensive than the data provided for the on-road sector in the 2014 MNEI, and after discussions with U.S. EPA it was suggested to use SMOKE-MOVES over the 2014 MNEI estimates.

Figure 4: Outline of Mexico municipalities included in California air quality simulations



Under contract to CARB, ERG completed an update to the spatial distribution of Mexico's area, non-road and on-road emissions (ERG, 2019). These updates include additional spatial surrogates such as the location of brick kilns, bakeries, ports, airports etc. for the state of Baja California. In addition, the project supports large improvements on emission estimates at two major border crossings (ERG, 2019). These updates have been included in the base and future year inventories and the surrogates used are listed in Table 8.

EPA's National Emission Inventory (NEI) has been used by CARB as a foundation for identifying spatial surrogates that will aid in allocating emissions in the northern part of Mexico. While searching for improved surrogates, different online databases were investigated to find shapefiles relevant to established source sectors. The updated population surrogate was pulled from Instituto Nacional de Estadística y Geografía (INEGI) using information from Mexico's 2010 Population and Housing Census. INEGI provides spatial information about Mexico such as resources, population, and land use. The population surrogate was also used to update the following residential heating sources: wood, distillate oil, coal, and LP gas. The total road miles surrogate that is used to spatially allocate on-road emissions was also updated using data provided by INEGI's dataset containing information on urban and rural roads and highways. Agriculture and forests spatial surrogates were updated using the same dataset from Comisión Nacional Forestal (CONAFOR). Using satellite images taken by the MODIS sensor (Moderate Resolution Imaging Spectroradiometer), the resulting vector data set from CONAFOR was produced to characterize Mexico's land. The border crossings surrogate was updated using statistics from the U.S. Bureau of Transportation, which provided points of entry along California and Mexico's border. Once the shapefiles were collected, they were converted to the standard projection used in CARB's modelling. These EPA-based surrogates are used within the state of Sonora, which was not covered in the ERG contract, and as secondary spatial allocation for the state of Baja CA. Table 9 lists the EPA-based Mexico surrogates with vintage May 2018.

Table 8: List indicating ERG developed spatial surrogates for the state of Baja California

Spatial Surrogate ID	Description	Year
100	Mexicali Agriculture	2014
110	Mexicali Agburn	2014
111	Mexicali Agburn Asparagus	2014
112	Mexicali Agburn Bermuda	2014
113	Mexicali Agburn Wheat	2014
120	Airports	2014
130	Autoshop	2014
140	Bakeries	2014
150	Border Crossing	2014

Spatial Surrogate ID	Description	Year
160	Brick Kilns	2014
170	Charbroiling	2014
180	Feedlots	2014
190	Gas Stations	2014
200	Graphic Arts	2014
210	Hospitals	2014
220	Landfills	2014
230	Total Population	2014
231	Rural Population	2014
232	Urban Population	2014
240	Ports	2014
250	Railroads	2014
260	Wastewater	2014
270	Windblown Dust	2014

Table 9: List of EPA's Mexico surrogates with vintage of May 2018

ID	Surrogate	Year	Shapefile	Weight Field
10	Population	2010	north_mexico_population.shp	population
12	Housing	2010	north_mexico_population.shp	population
14	Residential Heating Wood	2010	north_mexico_population.shp	population
16	Residential Heating Distillate Oil	2010	north_mexico_population.shp	population
18	Residential Heating Coal	2010	north_mexico_population.shp	population

ID	Surrogate	Year	Shapefile	Weight Field
20	Residential Heating LP Gas	2010	north_mexico_population.shp	population
22	Total Road Miles	2011	MEX_roads.shp	WEIGHT
24	Total Railroad Miles	2000	mexico_rr_MM5.shp	LENGTH
26	Total Agriculture	2015	MEX_agriculture.shp	WEIGHT
28	Forest Land	2015	MEX_Forests.shp	WEIGHT
30	Land Area	2000	REPMEX_ES_HEAT1_MM5.shp	P001
32	Commercial Land	1999	com_ind_viv_MM5.shp	A500_2000
34	Industrial Land	1999	com_ind_viv_MM5.shp	A505_2000
36	Commercial Plus Industrial	1999	com_ind_viv_MM5.shp	A510_2000
38	Commercial plus Industrial Land	1999	com_ind_viv_MM5.shp	A515_2000
40	Residential Commercial Industrial Institutional	1999	com_ind_viv_MM5.shp	a535_2000
42	Personal Repair	1999	REP_CRUCES_MM5.shp	a545_1999
44	Airports Area	1999	mexico_air_MM5.shp	WEIGHT
46	Marine Ports	1999	mexico_ports_MM5.shp	VALUE
48	Brick Kilns	1999	BOSQUE_LAD_MM5.shp	LAD_2000
50	Mobile Sources Border Crossing	2014	Border_Crossing_Years_MM5.shp	Y20**

H. Western States Emissions

In addition to transboundary flow from Mexico into California cities, pollutants can travel between various bordering states such as Nevada, Arizona, Oregon, Idaho, and Utah. The current statewide modeling domain includes grid cells that cover these regions and therefore emission estimates from the four major source sectors (area, point, non-road and on-road) need to be included for a complete California State modeling domain inventory. As CARB or California air districts are not responsible for the development of emission estimates in those geographic regions, the national emission inventory developed by the U.S. EPA was used for states outside of California.

CARB's Western US emissions inventory has been developed using the U.S. Environmental Protection Agency (EPA) 2016v2 Modeling Platform for the years 2016, 2023, 2026 and 2032.This platform drew on data from the 2017 National Emissions Inventory with incorporation of 2016-specific state data and adjustments / projections for each sector (USEPA, 2021).

Base year 2017 emissions were developed with the "2016fj_16j" case for year 2016 while future year 2030 emissions were developed with "2032_16j" for year 2032. The "f" represents the base year emissions modeling platform iteration and "j" represents the 10th configuration of emissions modeled for the modeling platform (USEPA, 2021). Spatial and temporal allocations were applied using the U.S. EPA ancillary files, however, all spatial surrogates were processed through the spatial allocator tool with the California statewide map projection applied.

I. Application of Control Measure Reduction Factors

Future year Residential wood combustion was adjusted by extending the curtailment program into March in addition to the winter months (January, February, November and December). This additional month of the curtailment program results in additional PM2.5 reduction benefits. Details on the application of the curtailment program can be found in Section IV.F.4.

Future year onroad vehicle emissions were adjusted to reflect statewide reduction commitments for CARB's Low NOx, ACT, ACCII, SSS, and HD I&M. The onroad adjustments are summarized in Section IV.B.7.

Offroad emissions in the future year were adjusted to account for the SSS reductions in year 2030. Off-road mobile source categories that were adjusted for the SSS were:

- Trains
- Commercial harbor craft
- Recreational boats
- Off-road recreational vehicles
- Off-road equipment
- Portable equipment (PERP)
- Farm equipment.

Farm equipment NOx and PM2.5 emissions in the future year were adjusted to reflect additional reductions resulting from the Funding Agricultural Replacement Measures for Emission Reductions (FARMER) Program.

V. Quality Assurance of Modeling Inventories

As mentioned in Section II.C.1., base case modeling is intended to demonstrate confidence in the modeling system. Quality assurance of the data is necessary to detect outliers and potential problems with emission estimates. The most important quality assurance checks of the modeling emissions inventory are summarized in the following sections.

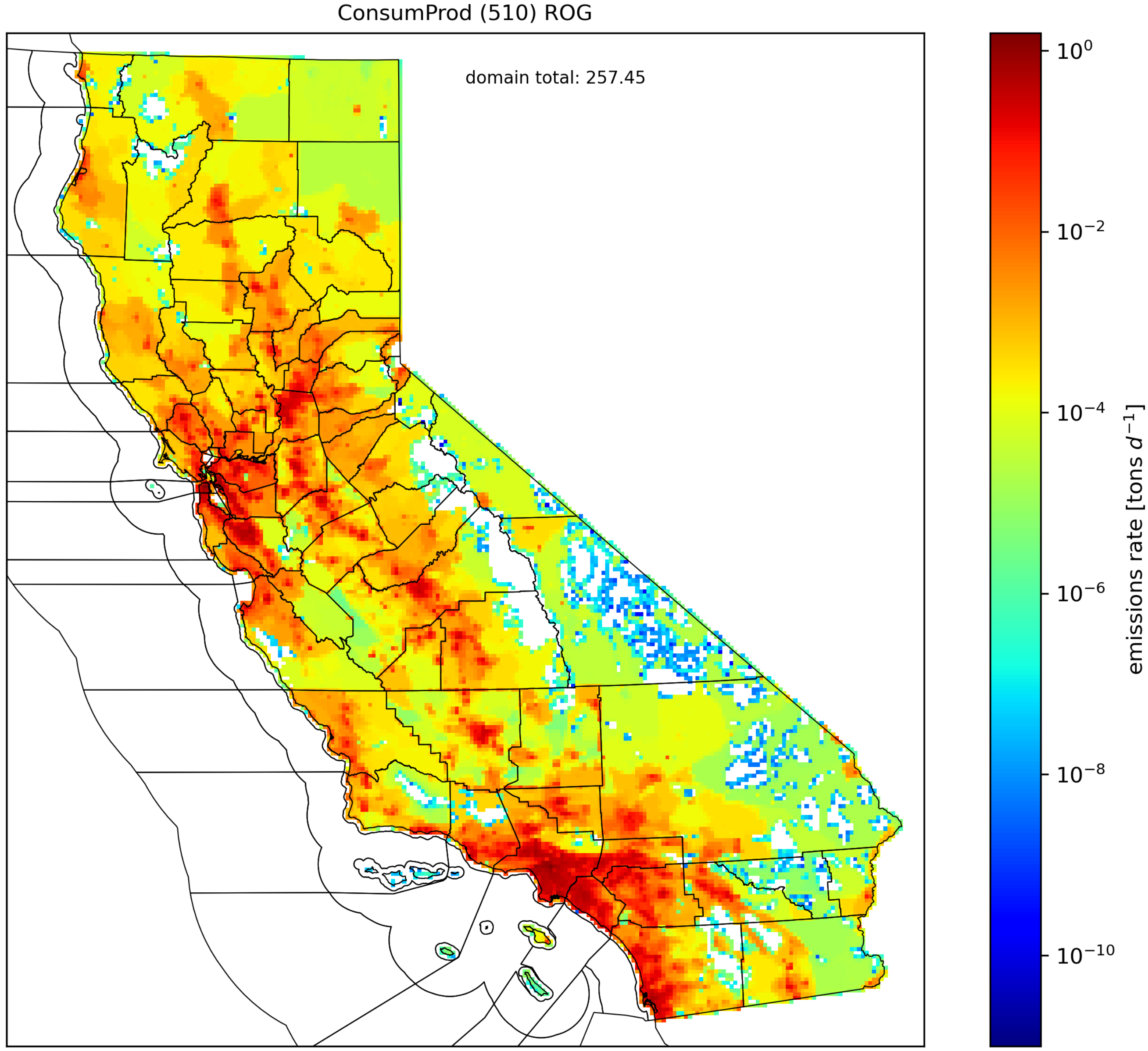
A. Area and Point Sources

All SMOKE inputs are subject to extensive quality assurance procedures performed by CARB staff. Annual and forecasted emissions are carefully reviewed prior to running SMOKE. CARB and district staff review data used to calculate emissions along with other ancillary data, such as temporal profiles and the location of facilities and assignment of SCC to each process. Growth and control information are reviewed and updated as needed.

We also compare annual average emissions from CEPAM with planning inventory totals to ensure data integrity. The planning and modeling inventories start with the same annual average emissions. The planning inventory is developed for an average summer day and an average winter day, whereas the modeling inventory processes daily emissions. Both inventory types use the same temporal data described in Section III.C. The summer planning inventory uses the monthly throughputs from May through October. Similarly, the winter planning inventory uses the monthly throughputs from November through April. The modeling inventory produces emissions for every day of the year.

Annual, gridded emissions totals are plotted on the statewide modeling domain and visually inspected to check the spatial allocation of emissions. Spatial plots by source category like the one shown in Figure 5 are carefully screened for proper spatial distribution of emissions.

Figure 5: Example of an ROG spatial plot by source category (Consumer Products)



Before air quality model-ready emissions files are generated by SMOKE, the run configurations and parameters set within the SMOKE environment are checked for consistency for both the reference and future years.

To aid in the quality assurance process, SMOKE is configured to generate inventory reports of temporally, chemically, and spatially-resolved emissions inventories. CARB staff utilize the SMOKE reports by checking emissions totals by source category and region. Staff also create and analyze time series plots, and compare aggregate emissions totals with the pre-SMOKE emissions totals obtained from CEPAM.

Checks for missing or invalid temporal assignments are conducted to ensure accurate temporal allocation of emissions. Special attention is paid to checking monthly throughputs and appropriate monthly temporal distribution of emissions for each source category. In addition, checks for time-invariant temporal assignments are done for certain source categories and suitable alternate temporal assignments are determined and applied.

Further improvements to temporal profiles used in the allocation of area source emissions are performed using suitable alternate temporal assignments determined by CARB staff. Select sources from manufacturing and industrial, degreasing, petroleum marketing, mineral processes, consumer products, residential fuel combustion, farming operations, aircraft, off-road equipment, and commercial harbor craft sectors are among the source categories included in the application of adjustments to temporal allocation.

B. On-road Emissions

There are several processes to conduct quality assurance of the on-road mobile source modeling inventory at various stages of the inventory processing. The specific steps taken are described below.

- Plot MPO provided data spatially to find any missing or incomplete links.
- Compare spatial distribution of VMT between on and off-peak periods for each MPO.
- Generate time series plots for the on-road emissions files to check the diurnal pattern.
- Compare the daily total emissions for the on-road emissions files and the EMFAC2021 emissions files for each county to ensure that the emissions are the same.
- Generate the spatial plot for the on-road emissions files to check if there were any missing emissions.

C. Aircraft Emissions

There are two steps to conduct quality assurance of the aircraft emissions.

- Compare the daily total emissions for the aircraft emissions files and the raw emissions files for each county to ensure that the emissions are the same.
- Generate the spatial plot for the aircraft emissions files to check if there were any missing emissions.

D. Day-specific Sources

1. Wildfires

GIS records for 607 wildfires, 219 prescribed wildland burn events, and 17 wildland fires use reported for 2017 were downloaded from FRAP and imported to a geodatabase. Data fields included wildfire or burn project name, burned area, and start and end dates. A series of geoprocessing steps were used to map and overlay wildfire and prescribed burn footprint polygons on the statewide vegetation fuels (FCCS) and moisture raster datasets, to retrieve associated fuel loadings and moisture values for use as input to FOFEM. Wildfire and prescribed burn footprint polygons were also overlaid on the statewide 4-km modeling grid to assign grid cell IDs to each wildfire and prescribed burn. Emission estimates for each wildfire and prescribed burn event were generated by FOFEM and summarized in an Access database. To check the location of the fires and the daily total emissions, a script is used to make a NetCDF file from the stack file and the 2-D hourly emissions file for each day. The spatial plot and the daily total emissions from processing the NetCDF file are then compared to the raw fire emissions data to check for accuracy.

2. Agricultural Burning

Checks were done to verify the quality of the agricultural burn data. The day-specific emissions from agricultural burning were compared to the emissions from CEPAM for each county to check for agreement between the planning and modeling inventories. Time series plots were reviewed for each county to confirm that days when burning occurred matched the days provided by the local air district. For each county, a few individual fires were calculated by hand starting from the raw data through all the steps to the final model-ready emissions files to make sure the calculations were done correctly. Spatial plots were made to verify the location of each burn.

E. Additional Quality Assurance

In addition to the quality assurance described above, comparisons are made between annual average inventories from CEPAM and modeling inventories. The modeling inventory shows emissions by month and subsequently calculates the annual average for comparison with CEPAM emissions. Annual average inventories and modeling inventories can be different, but differences should be well understood. For example, modeling inventories are adjusted to reflect different days of the week for on-road motor vehicles as detailed in Section IV.B since weekend travel is generally less than weekday travel, modeling inventory emissions are usually lower when compared to annual average inventories from CEPAM. Figure 6 is an example of a QA report that summarizes PM2.5 emissions by category for EIC3 10 through 499 for the San Joaquin Valley PM2.5 Nonattainment Area. The report compares the monthly and annual processed emissions totals against CEPAM. Please note that this report is only an example since emissions have been updated from what is displayed here.

Figure 6: Comparison of inventories report

2017 SJV PM2.5 SIP, Base Year 2017 -- Based Off Of Gid687 With Updates: Apply District Monthly Temporal Profiles For RWC In SJV (Instead Of Gentpro) BYr:2017 MYr:2017

Spec:*PM25*

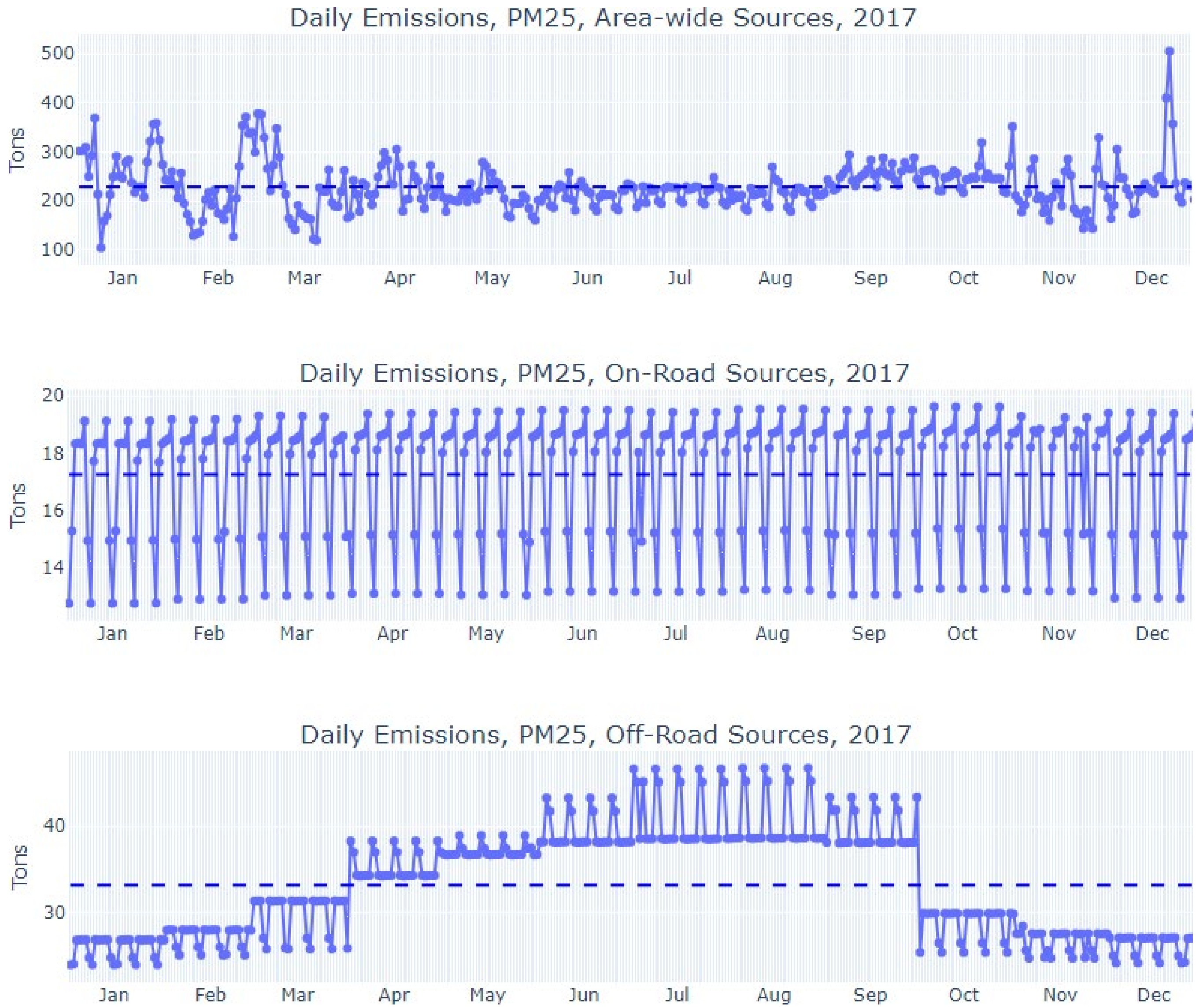
EIC	Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	RF3064_19v1.02	RF3084_19v1.03	RF3108_19v1.04	RF3089_22v1.01
10	Electric Utilities	4.51	4.17	3.68	3.57	3.79	4.89	5.71	6.39	5.55	5.27	4.46	4.40	4.70	4.46	4.46	4.46	4.46
20	Cogeneration	1.45	1.43	1.40	1.43	1.47	1.48	1.49	1.48	1.45	1.47	1.46	1.45	1.45	1.57	1.57	1.57	1.58
30	Oil And Gas Production (Combustion)	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.21	2.22	2.24	2.24	2.24	2.24
40	Petroleum Refining (Combustion)	4.17	4.17	4.27	4.27	4.27	4.24	4.24	4.24	4.19	4.19	4.19	4.17	4.22	4.12	4.14	4.14	4.14
50	Manufacturing And Industrial	3.38	3.49	3.67	3.81	4.01	4.09	4.02	4.13	4.14	4.18	3.86	3.58	3.86	4.01	4.14	4.14	4.35
52	Food And Agricultural Processing	1.42	1.46	0.87	1.16	1.01	1.04	1.26	1.40	1.38	0.84	1.31	1.35	1.21	1.13	1.16	1.16	1.16
60	Service And Commercial	5.10	5.00	4.57	4.09	3.44	3.42	3.35	3.44	3.38	3.62	3.78	4.80	3.99	4.18	4.22	4.01	3.99
99	Other (Fuel Combustion)	2.78	2.79	2.79	2.79	2.82	2.83	2.81	2.84	2.82	2.83	2.79	2.78	2.81	0.23	0.70	0.70	0.71
110	Sewage Treatment	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
120	Landfills	0.99	0.96	0.97	0.97	0.99	1.00	0.97	0.98	0.97	0.97	0.97	0.98	0.98	1.09	1.09	1.09	1.09
130	Incinerators	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
140	Soil Remediation	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.06	0.06	0.06	0.06
199	Other (Waste Disposal)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
210	Laundering	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
220	Degreasing	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
230	Coatings And Related Process Solvents	1.76	1.79	1.82	1.78	1.82	1.84	1.76	1.85	1.78	1.81	1.78	1.76	1.80	1.82	1.82	1.82	1.85
240	Printing	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
250	Adhesives And Sealants	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
299	Other (Cleaning And Surface Coatings)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
310	Oil And Gas Production	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
320	Petroleum Refining	2.55	2.55	2.54	2.54	2.54	2.55	2.55	2.55	2.55	2.55	2.55	2.55	2.55	2.85	2.85	2.85	2.85
330	Petroleum Marketing	0.04	0.04	0.06	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
399	Other (Petroleum Production And Marketing)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
410	Chemical	1.54	1.58	1.63	1.61	1.63	1.65	1.59	1.64	1.58	1.59	1.57	1.54	1.60	1.56	1.56	1.56	1.58
420	Food And Agriculture	1.58	1.55	1.52	1.50	1.51	1.53	2.62	3.67	4.89	5.32	4.11	1.85	2.64	3.21	3.21	3.21	3.24
430	Mineral Processes	10.29	10.48	11.02	10.97	11.11	11.60	10.67	11.26	10.65	10.72	10.32	9.95	10.75	12.67	12.67	12.67	12.79
440	Metal Processes	0.75	0.76	0.79	0.77	0.79	0.79	0.75	0.79	0.77	0.78	0.76	0.75	0.77	0.73	0.73	0.73	0.74
450	Wood And Paper	6.70	6.78	6.86	6.79	6.87	6.94	6.74	6.96	6.80	6.88	6.77	6.71	6.82	6.88	6.88	6.88	6.95
460	Glass And Related Products	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
470	Electronics	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
499	Other (Industrial Processes)	11.12	11.32	11.56	11.37	11.55	11.76	11.30	12.07	11.79	11.98	11.49	11.20	11.54	4.00	3.52	3.52	3.52

Notes:

- CEPAM refers to annual average emissions from 2019 SIP Baseline Emission Inventory Tool with external adjustments: *CEPAM External Adjustment Reporting Tool*
- Monthly gridded emissions come from GeoVAST mo-yr/avg tabular summary - gid 703

Staff also review how modeling emissions vary over a year. Figure 7 provides an example of a modeling inventory time series plot for San Joaquin Valley Air Basin for area-wide sources, on-road sources, and off-road sources. Again, this figure is only an example.

Figure 7: Daily variation of NOx emission sources in San Joaquin Valley Air Basin in 2017



F. Model-ready Files Quality Assurance

Prior to developing the modeling inventory emissions files used in the photochemical models, the same model-ready emissions files developed for the individual source categories (e.g., on-road, area, point, day-specific sources) are checked for quality assurance. Extensive quality assurance procedures are already performed by CARB staff on the intermediate emissions files (e.g., SMOKE-generated reports); however, further checks are needed to ensure data integrity is preserved when the model-ready emissions files are generated from those intermediate emissions files. Figure 8 shows the share of area, on-road, cooking, livestock, residential wood combustion, stationary and agricultural day specific burns contribution to annual PM2.5 emissions for the San Joaquin Valley Air Basin in 2017. These same sources are shown as a daily timeseries for the San Joaquin Valley PM2.5 Nonattainment Area in Figure 9. These figures are only examples and do not reflect the inventory totals used for SIP attainment modeling.

Figure 8: Annual processed emissions example for 2017 San Joaquin Valley Air Basin PM 2.5 for selected sectors

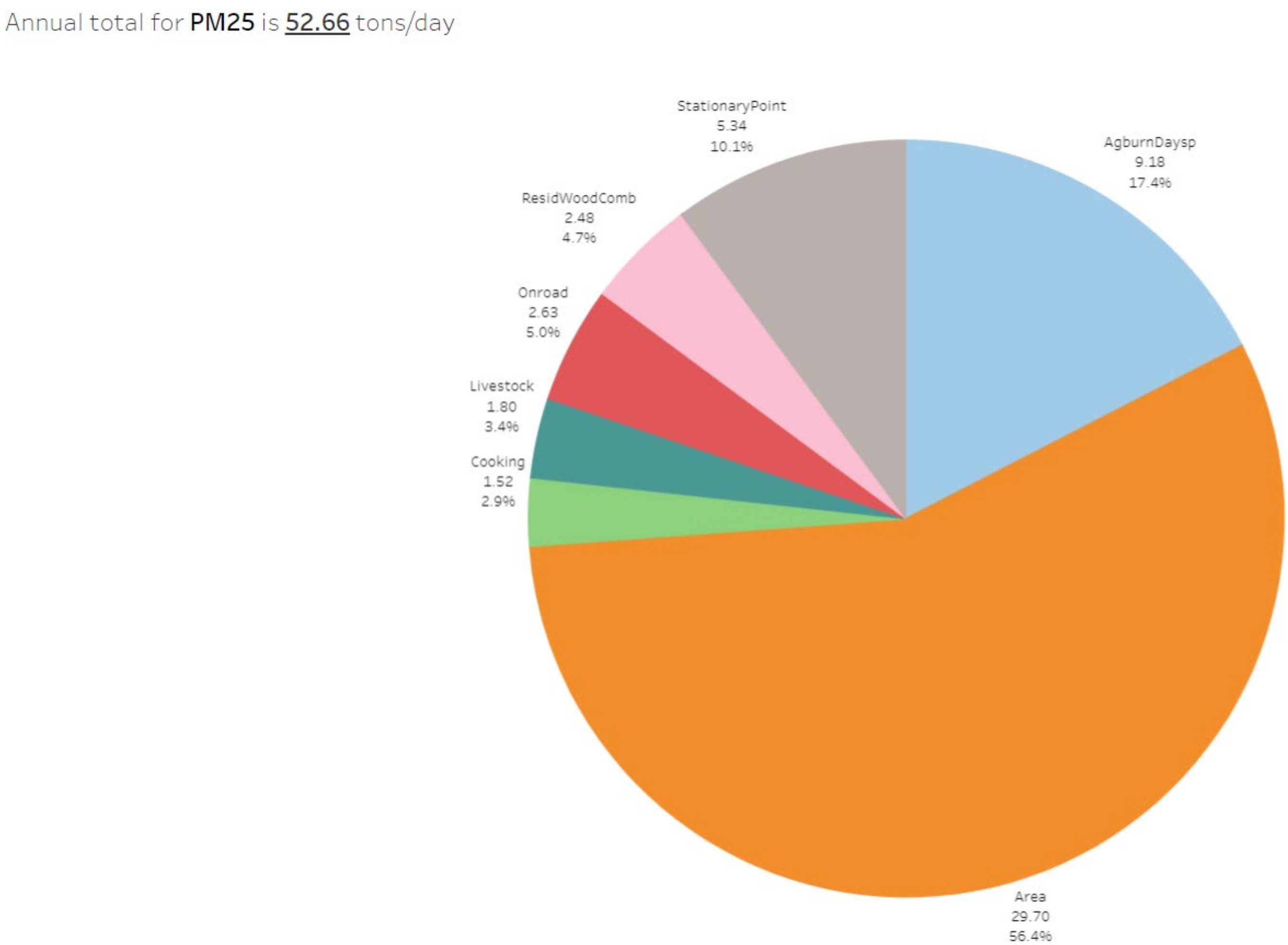
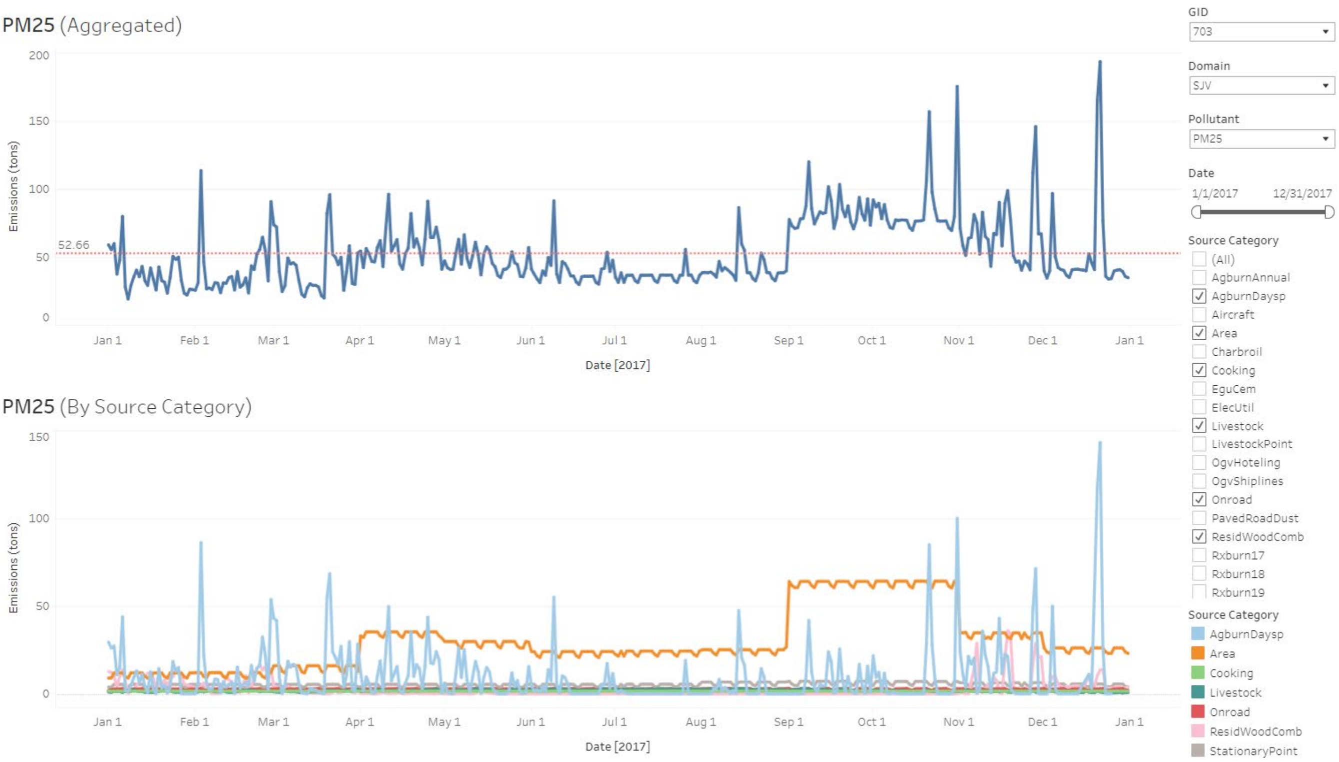


Figure 9: Example timeseries plot for daily 2017 PM 2.5 emissions from selected sectors for San Joaquin Valley Air Basin



Comparisons of the totals for both the intermediate and model-ready emissions files are made. Emissions totals are aggregated spatially, temporally, and chemically to single-layer, statewide, daily values by inventory pollutant. Spatial plots are also generated for both the intermediate and model-ready emissions files using the same graphical utilities and aggregated to the same spatial, temporal, and chemical resolution to allow equal comparison of emissions. Any discrepancies in the emissions totals are reconciled before proceeding with the development of the model-ready inventory emissions files.

Before combining the model-ready emissions files of the individual source category inventories into a single model-ready inventory, they are checked for completeness. Most sources should have emissions for every day in the modeling period. Exceptions to this apply to sources like fires since burning (natural or planned) does not occur every day. It is important that during these checks source inventories with missing files are identified and resolved. Once all constituent source inventories are complete, they are used to develop the model-ready inventory used in photochemical modeling. When the modeling inventory files are generated, log files are also generated documenting the constituents of each daily model-ready emissions file as an additional means of verifying that each daily model-ready inventory is complete.

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VII. Appendix A: Day-of-week Redistribution Factors by Vehicle Type and County

The factors shown in Table 10 shows the "day-of-week" factors for broad vehicle classes: LD is Light-Duty, LM is Light- and Medium-Duty Trucks. The "day-of-week" factors for Heavy Heavy-Duty Trucks or HD are available daily for the entire year. Table 11 shows an excerpt the week of July 1st to 7th.

Table 10: Day-of-week adjustment for LD and LM vehicle class by county

County	Day of Week	LD	LM
Fresno	Sunday	0.85	0.44
Fresno	Monday	1.01	0.93
Fresno	Tues/Wed/Thurs	1.00	1.00
Fresno	Friday	1.15	1.03
Fresno	Saturday	0.95	0.56
Fresno	Holiday	0.80	0.78
Kern	Sunday	1.11	0.63
Kern	Monday	1.06	0.94
Kern	Tues/Wed/Thurs	1.00	1.00
Kern	Friday	1.25	1.04
Kern	Saturday	1.10	0.73
Kern	Holiday	0.99	0.91
Kings	Sunday	0.66	0.36
Kings	Monday	0.96	0.91
Kings	Tues/Wed/Thurs	1.00	1.00
Kings	Friday	1.04	0.98
Kings	Saturday	0.81	0.52

County	Day of Week	LD	LM
Kings	Holiday	0.67	0.67
Madera	Sunday	1.02	0.48
Madera	Monday	1.02	0.94
Madera	Tues/Wed/Thurs	1.00	1.00
Madera	Friday	1.17	1.02
Madera	Saturday	1.10	0.60
Madera	Holiday	0.87	0.83
Merced	Sunday	1.00	0.59
Merced	Monday	1.01	0.96
Merced	Tues/Wed/Thurs	1.00	1.00
Merced	Friday	1.18	1.10
Merced	Saturday	1.06	0.71
Merced	Holiday	0.98	0.90
San Joaquin	Sunday	0.93	0.50
San Joaquin	Monday	0.98	0.92
San Joaquin	Tues/Wed/Thurs	1.00	1.00
San Joaquin	Friday	1.13	1.09
San Joaquin	Saturday	1.04	0.66
San Joaquin	Holiday	0.91	0.77
Stanislaus	Sunday	1.00	0.59
Stanislaus	Monday	1.01	0.96
Stanislaus	Tues/Wed/Thurs	1.00	1.00

County	Day of Week	LD	LM
Stanislaus	Friday	1.18	1.10
Stanislaus	Saturday	1.06	0.71
Stanislaus	Holiday	0.98	0.90
Tulare	Sunday	1.03	0.43
Tulare	Monday	1.05	0.94
Tulare	Tues/Wed/Thurs	1.00	1.00
Tulare	Friday	1.10	1.02
Tulare	Saturday	0.99	0.67
Tulare	Holiday	0.94	0.58

Table 11: Day-of-week adjustment for July 1st to 7th for HH vehicle class by county

Date	Day of Week	Fresno	Kern	Kings	Madera	Merced	San Joaquin	Stanislaus	Tulare
7/1	Saturday	0.77	0.83	0.76	0.63	0.90	0.74	0.90	0.73
7/2	Sunday	0.71	0.75	0.68	0.55	0.78	0.64	0.78	0.60
7/3	Monday	0.99	1.03	0.96	0.97	1.04	1.04	1.04	0.97
7/4	Holiday	0.70	0.77	0.71	0.62	0.73	0.67	0.73	0.64
7/5	Wednesday	0.99	1.03	1.00	0.93	1.08	1.05	1.08	1.00
7/6	Thursday	0.99	1.06	1.02	0.95	1.02	1.04	1.02	1.01
7/7	Friday	1.01	1.07	1.00	0.95	1.14	1.06	1.14	1.03

VIII. Appendix B: Hour-of-day Profiles by Vehicle Type and County

The factors shown in the table below represent the different hourly profiles for days of the week for each county for a broad vehicle class: LD is Light-Duty, LM is Light- and Medium-Duty Trucks, and HH is Heavy Heavy-Duty Trucks. Hourly profiles for LD, LM, and HH by day of week are shown in Table 12, Table 13, and Table 14. The county names are abbreviated as follows: Fresno is C10, Kern is C15, Kings is C16, Madera is C20, Merced is C24, San Joaquin is C39, Stanislaus is C50 and Tulare is C54.

Table 12: Hour-of-day profiles for LD and LM vehicle classes for Counties C10 – C20

Day of Week	Hour	C10 LD	C10 LM	C15 LD	C15 LM	C16 LD	C16 LM	C20 LD	C20 LM
Sunday	0	0.015	0.033	0.014	0.028	0.016	0.031	0.014	0.037
Sunday	1	0.010	0.030	0.010	0.024	0.010	0.025	0.008	0.032
Sunday	2	0.008	0.027	0.007	0.022	0.007	0.026	0.005	0.028
Sunday	3	0.005	0.025	0.006	0.020	0.005	0.022	0.004	0.026
Sunday	4	0.006	0.024	0.007	0.021	0.004	0.020	0.004	0.026
Sunday	5	0.010	0.026	0.012	0.024	0.008	0.023	0.009	0.027
Sunday	6	0.017	0.029	0.016	0.027	0.018	0.029	0.016	0.030
Sunday	7	0.022	0.032	0.024	0.032	0.023	0.030	0.022	0.033
Sunday	8	0.032	0.038	0.032	0.039	0.034	0.040	0.033	0.039
Sunday	9	0.044	0.046	0.042	0.045	0.048	0.049	0.046	0.047
Sunday	10	0.055	0.052	0.051	0.051	0.059	0.057	0.056	0.052
Sunday	11	0.063	0.057	0.059	0.056	0.071	0.064	0.065	0.057
Sunday	12	0.071	0.062	0.066	0.060	0.084	0.077	0.071	0.059
Sunday	13	0.076	0.064	0.071	0.063	0.083	0.077	0.073	0.059
Sunday	14	0.077	0.063	0.075	0.065	0.080	0.072	0.076	0.059
Sunday	15	0.077	0.061	0.078	0.064	0.076	0.065	0.076	0.058

Day of Week	Hour	C10 LD	C10 LM	C15 LD	C15 LM	C16 LD	C16 LM	C20 LD	C20 LM
Sunday	16	0.075	0.059	0.077	0.063	0.074	0.062	0.077	0.058
Sunday	17	0.073	0.056	0.074	0.060	0.068	0.056	0.074	0.055
Sunday	18	0.066	0.050	0.069	0.055	0.059	0.044	0.068	0.048
Sunday	19	0.057	0.044	0.061	0.049	0.050	0.037	0.060	0.043
Sunday	20	0.050	0.038	0.053	0.042	0.043	0.032	0.052	0.039
Sunday	21	0.040	0.033	0.042	0.035	0.036	0.028	0.042	0.034
Sunday	22	0.030	0.028	0.032	0.030	0.028	0.022	0.030	0.028
Sunday	23	0.020	0.023	0.021	0.025	0.015	0.015	0.018	0.023
Monday	0	0.009	0.019	0.013	0.022	0.005	0.013	0.007	0.021
Monday	1	0.005	0.018	0.009	0.019	0.002	0.012	0.003	0.020
Monday	2	0.004	0.018	0.008	0.019	0.001	0.013	0.002	0.020
Monday	3	0.005	0.020	0.011	0.022	0.001	0.012	0.004	0.023
Monday	4	0.011	0.023	0.021	0.029	0.003	0.015	0.012	0.028
Monday	5	0.024	0.034	0.040	0.041	0.012	0.021	0.029	0.039
Monday	6	0.044	0.047	0.047	0.046	0.034	0.040	0.050	0.051
Monday	7	0.069	0.064	0.056	0.054	0.070	0.071	0.072	0.063
Monday	8	0.063	0.062	0.050	0.052	0.073	0.071	0.063	0.059
Monday	9	0.055	0.056	0.049	0.052	0.061	0.063	0.058	0.056
Monday	10	0.055	0.056	0.052	0.053	0.058	0.062	0.057	0.057
Monday	11	0.057	0.059	0.057	0.056	0.059	0.063	0.059	0.059
Monday	12	0.061	0.061	0.061	0.059	0.062	0.064	0.060	0.062
Monday	13	0.063	0.062	0.064	0.060	0.064	0.067	0.061	0.061

Day of Week	Hour	C10 LD	C10 LM	C15 LD	C15 LM	C16 LD	C16 LM	C20 LD	C20 LM
Monday	14	0.069	0.065	0.068	0.063	0.073	0.071	0.066	0.062
Monday	15	0.074	0.068	0.074	0.067	0.078	0.072	0.071	0.064
Monday	16	0.079	0.068	0.073	0.065	0.086	0.073	0.075	0.062
Monday	17	0.076	0.062	0.067	0.058	0.087	0.070	0.074	0.058
Monday	18	0.053	0.043	0.050	0.044	0.056	0.046	0.052	0.041
Monday	19	0.037	0.030	0.037	0.034	0.037	0.028	0.037	0.030
Monday	20	0.030	0.023	0.032	0.028	0.029	0.021	0.030	0.022
Monday	21	0.024	0.018	0.026	0.023	0.023	0.015	0.025	0.017
Monday	22	0.018	0.013	0.021	0.018	0.016	0.010	0.019	0.014
Monday	23	0.012	0.010	0.014	0.015	0.009	0.007	0.012	0.011
Tues, Wed, Thurs	0	0.007	0.018	0.010	0.021	0.004	0.013	0.005	0.020
Tues, Wed, Thurs	1	0.004	0.017	0.007	0.019	0.002	0.011	0.002	0.019
Tues, Wed, Thurs	2	0.003	0.017	0.006	0.020	0.001	0.011	0.001	0.019
Tues, Wed, Thurs	3	0.004	0.019	0.009	0.022	0.001	0.011	0.003	0.021
Tues, Wed, Thurs	4	0.010	0.023	0.019	0.029	0.003	0.014	0.010	0.027
Tues, Wed, Thurs	5	0.024	0.032	0.039	0.041	0.012	0.021	0.027	0.037
Tues, Wed, Thurs	6	0.044	0.047	0.048	0.046	0.035	0.040	0.050	0.050
Tues, Wed, Thurs	7	0.070	0.064	0.058	0.053	0.069	0.066	0.074	0.063

Day of Week	Hour	C10 LD	C10 LM	C15 LD	C15 LM	C16 LD	C16 LM	C20 LD	C20 LM
Tues, Wed, Thurs	8	0.065	0.063	0.052	0.052	0.073	0.071	0.065	0.059
Tues, Wed, Thurs	9	0.055	0.057	0.049	0.050	0.060	0.062	0.057	0.057
Tues, Wed, Thurs	10	0.054	0.056	0.050	0.051	0.057	0.061	0.055	0.057
Tues, Wed, Thurs	11	0.055	0.058	0.054	0.054	0.058	0.063	0.056	0.058
Tues, Wed, Thurs	12	0.058	0.060	0.059	0.056	0.060	0.064	0.057	0.059
Tues, Wed, Thurs	13	0.061	0.062	0.062	0.058	0.061	0.065	0.059	0.060
Tues, Wed, Thurs	14	0.068	0.065	0.068	0.062	0.071	0.070	0.065	0.063
Tues, Wed, Thurs	15	0.074	0.067	0.075	0.067	0.077	0.072	0.071	0.064
Tues, Wed, Thurs	16	0.080	0.067	0.075	0.066	0.086	0.073	0.078	0.064
Tues, Wed, Thurs	17	0.078	0.063	0.070	0.060	0.087	0.072	0.078	0.061
Tues, Wed, Thurs	18	0.055	0.045	0.052	0.046	0.059	0.051	0.055	0.043
Tues, Wed, Thurs	19	0.039	0.032	0.039	0.036	0.039	0.032	0.039	0.031
Tues, Wed, Thurs	20	0.032	0.024	0.033	0.030	0.032	0.023	0.033	0.024
Tues, Wed, Thurs	21	0.027	0.019	0.029	0.025	0.026	0.017	0.028	0.019
Tues, Wed, Thurs	22	0.020	0.014	0.023	0.020	0.018	0.011	0.021	0.014

Day of Week	Hour	C10 LD	C10 LM	C15 LD	C15 LM	C16 LD	C16 LM	C20 LD	C20 LM
Tues, Wed, Thurs	23	0.013	0.010	0.015	0.017	0.010	0.007	0.013	0.011
Friday	0	0.007	0.019	0.009	0.021	0.006	0.014	0.006	0.020
Friday	1	0.004	0.018	0.007	0.019	0.002	0.012	0.002	0.019
Friday	2	0.003	0.017	0.006	0.019	0.001	0.011	0.002	0.019
Friday	3	0.004	0.019	0.008	0.021	0.001	0.012	0.003	0.021
Friday	4	0.009	0.023	0.015	0.027	0.002	0.015	0.009	0.027
Friday	5	0.020	0.032	0.031	0.037	0.011	0.021	0.022	0.036
Friday	6	0.037	0.044	0.039	0.043	0.031	0.039	0.039	0.047
Friday	7	0.059	0.060	0.048	0.050	0.063	0.064	0.059	0.058
Friday	8	0.057	0.059	0.045	0.050	0.067	0.069	0.054	0.058
Friday	9	0.052	0.056	0.045	0.049	0.057	0.062	0.051	0.056
Friday	10	0.053	0.057	0.049	0.053	0.057	0.063	0.052	0.057
Friday	11	0.056	0.059	0.054	0.055	0.059	0.065	0.054	0.059
Friday	12	0.059	0.061	0.058	0.057	0.061	0.065	0.056	0.060
Friday	13	0.062	0.063	0.063	0.060	0.062	0.066	0.059	0.062
Friday	14	0.068	0.066	0.068	0.063	0.070	0.069	0.065	0.063
Friday	15	0.073	0.067	0.072	0.067	0.073	0.069	0.071	0.064
Friday	16	0.077	0.067	0.073	0.064	0.079	0.073	0.077	0.062
Friday	17	0.074	0.061	0.070	0.059	0.078	0.065	0.076	0.057
Friday	18	0.060	0.047	0.060	0.048	0.061	0.050	0.063	0.046
Friday	19	0.046	0.034	0.049	0.039	0.045	0.034	0.050	0.035

Day of Week	Hour	C10 LD	C10 LM	C15 LD	C15 LM	C16 LD	C16 LM	C20 LD	C20 LM
Friday	20	0.038	0.026	0.042	0.032	0.036	0.023	0.042	0.026
Friday	21	0.034	0.020	0.037	0.027	0.031	0.017	0.037	0.021
Friday	22	0.028	0.015	0.031	0.023	0.028	0.013	0.030	0.015
Friday	23	0.020	0.011	0.021	0.018	0.017	0.008	0.021	0.012
Saturday	0	0.015	0.028	0.016	0.028	0.013	0.022	0.012	0.031
Saturday	1	0.010	0.025	0.011	0.023	0.008	0.019	0.008	0.027
Saturday	2	0.008	0.024	0.009	0.022	0.005	0.017	0.006	0.025
Saturday	3	0.007	0.023	0.009	0.021	0.003	0.016	0.005	0.024
Saturday	4	0.009	0.024	0.014	0.025	0.004	0.016	0.008	0.027
Saturday	5	0.016	0.029	0.027	0.034	0.010	0.022	0.017	0.032
Saturday	6	0.026	0.036	0.034	0.038	0.023	0.031	0.026	0.039
Saturday	7	0.036	0.043	0.042	0.045	0.036	0.041	0.036	0.045
Saturday	8	0.045	0.050	0.050	0.052	0.045	0.049	0.047	0.052
Saturday	9	0.053	0.055	0.056	0.056	0.053	0.054	0.055	0.057
Saturday	10	0.060	0.061	0.060	0.057	0.061	0.063	0.062	0.062
Saturday	11	0.066	0.064	0.063	0.059	0.067	0.072	0.067	0.063
Saturday	12	0.069	0.065	0.065	0.061	0.071	0.072	0.068	0.062
Saturday	13	0.069	0.063	0.066	0.061	0.071	0.069	0.068	0.059
Saturday	14	0.070	0.063	0.067	0.060	0.071	0.070	0.068	0.059
Saturday	15	0.069	0.060	0.067	0.060	0.070	0.067	0.068	0.056
Saturday	16	0.067	0.057	0.064	0.056	0.070	0.061	0.068	0.054
Saturday	17	0.063	0.051	0.058	0.052	0.066	0.056	0.064	0.050

Day of Week	Hour	C10 LD	C10 LM	C15 LD	C15 LM	C16 LD	C16 LM	C20 LD	C20 LM
Saturday	18	0.056	0.044	0.051	0.046	0.059	0.048	0.057	0.042
Saturday	19	0.047	0.036	0.044	0.037	0.049	0.036	0.049	0.034
Saturday	20	0.041	0.031	0.039	0.033	0.043	0.032	0.043	0.030
Saturday	21	0.038	0.027	0.035	0.029	0.040	0.027	0.039	0.027
Saturday	22	0.034	0.024	0.030	0.024	0.037	0.024	0.035	0.024
Saturday	23	0.024	0.019	0.023	0.020	0.024	0.017	0.025	0.020
Holiday	0	0.013	0.023	0.015	0.023	0.011	0.017	0.011	0.023
Holiday	1	0.007	0.022	0.009	0.021	0.006	0.018	0.005	0.024
Holiday	2	0.006	0.022	0.007	0.020	0.002	0.018	0.004	0.022
Holiday	3	0.005	0.022	0.008	0.021	0.001	0.019	0.004	0.024
Holiday	4	0.008	0.025	0.013	0.024	0.003	0.015	0.007	0.026
Holiday	5	0.016	0.030	0.027	0.032	0.010	0.021	0.016	0.033
Holiday	6	0.028	0.039	0.033	0.037	0.026	0.034	0.027	0.040
Holiday	7	0.040	0.046	0.039	0.043	0.043	0.046	0.037	0.045
Holiday	8	0.045	0.049	0.043	0.047	0.050	0.052	0.043	0.051
Holiday	9	0.049	0.052	0.050	0.050	0.051	0.052	0.051	0.053
Holiday	10	0.057	0.058	0.055	0.055	0.060	0.067	0.059	0.060
Holiday	11	0.065	0.062	0.064	0.060	0.067	0.070	0.067	0.064
Holiday	12	0.070	0.067	0.068	0.061	0.073	0.078	0.071	0.066
Holiday	13	0.071	0.067	0.071	0.066	0.075	0.072	0.071	0.067
Holiday	14	0.074	0.066	0.073	0.064	0.076	0.070	0.072	0.064
Holiday	15	0.076	0.067	0.075	0.067	0.072	0.073	0.075	0.062

Day of Week	Hour	C10 LD	C10 LM	C15 LD	C15 LM	C16 LD	C16 LM	C20 LD	C20 LM
Holiday	16	0.076	0.064	0.072	0.064	0.075	0.066	0.076	0.060
Holiday	17	0.072	0.058	0.066	0.059	0.071	0.059	0.072	0.056
Holiday	18	0.058	0.046	0.056	0.046	0.059	0.046	0.060	0.044
Holiday	19	0.047	0.035	0.047	0.042	0.047	0.032	0.050	0.035
Holiday	20	0.039	0.028	0.039	0.033	0.040	0.029	0.043	0.029
Holiday	21	0.032	0.022	0.031	0.027	0.034	0.024	0.035	0.022
Holiday	22	0.026	0.017	0.025	0.021	0.030	0.015	0.028	0.018
Holiday	23	0.018	0.013	0.016	0.018	0.018	0.009	0.017	0.014

Table 13: Hour-of-day profiles for LD and LM vehicle classes for Counties C24 – C50

Day of Week	Hour	C24 LD	C24 LM	C39 LD	C39 LM	C50 LD	C50 LM	C54 LD	C54 LM
Sunday	0	0.014	0.025	0.016	0.024	0.014	0.025	0.022	0.015
Sunday	1	0.009	0.019	0.010	0.017	0.009	0.019	0.024	0.015
Sunday	2	0.007	0.016	0.007	0.015	0.007	0.016	0.023	0.011
Sunday	3	0.005	0.015	0.006	0.014	0.005	0.015	0.023	0.009
Sunday	4	0.006	0.016	0.008	0.015	0.006	0.016	0.024	0.010
Sunday	5	0.010	0.019	0.011	0.018	0.010	0.019	0.026	0.018
Sunday	6	0.015	0.023	0.017	0.022	0.015	0.023	0.030	0.031
Sunday	7	0.021	0.029	0.023	0.027	0.021	0.029	0.034	0.035
Sunday	8	0.031	0.038	0.032	0.036	0.031	0.038	0.035	0.042
Sunday	9	0.043	0.050	0.045	0.048	0.043	0.050	0.040	0.057
Sunday	10	0.055	0.060	0.056	0.059	0.055	0.060	0.044	0.066

Day of Week	Hour	C24 LD	C24 LM	C39 LD	C39 LM	C50 LD	C50 LM	C54 LD	C54 LM
Sunday	11	0.063	0.065	0.063	0.067	0.063	0.065	0.047	0.070
Sunday	12	0.070	0.070	0.068	0.071	0.070	0.070	0.051	0.076
Sunday	13	0.075	0.071	0.071	0.074	0.075	0.071	0.054	0.073
Sunday	14	0.077	0.069	0.073	0.073	0.077	0.069	0.056	0.071
Sunday	15	0.078	0.070	0.073	0.071	0.078	0.070	0.059	0.071
Sunday	16	0.077	0.067	0.073	0.068	0.077	0.067	0.060	0.066
Sunday	17	0.075	0.062	0.072	0.063	0.075	0.062	0.061	0.063
Sunday	18	0.068	0.055	0.067	0.055	0.068	0.055	0.060	0.052
Sunday	19	0.061	0.047	0.061	0.047	0.061	0.047	0.059	0.050
Sunday	20	0.051	0.039	0.054	0.040	0.051	0.039	0.055	0.037
Sunday	21	0.041	0.031	0.044	0.031	0.041	0.031	0.048	0.029
Sunday	22	0.029	0.024	0.031	0.024	0.029	0.024	0.038	0.018
Sunday	23	0.019	0.019	0.019	0.019	0.019	0.019	0.028	0.014
Monday	0	0.011	0.017	0.010	0.012	0.011	0.017	0.022	0.004
Monday	1	0.007	0.015	0.006	0.010	0.007	0.015	0.023	0.004
Monday	2	0.006	0.015	0.006	0.010	0.006	0.015	0.023	0.004
Monday	3	0.009	0.018	0.011	0.015	0.009	0.018	0.024	0.006
Monday	4	0.018	0.027	0.029	0.028	0.018	0.027	0.027	0.015
Monday	5	0.030	0.039	0.043	0.043	0.030	0.039	0.035	0.035
Monday	6	0.044	0.051	0.053	0.052	0.044	0.051	0.040	0.056
Monday	7	0.058	0.058	0.061	0.059	0.058	0.058	0.044	0.063
Monday	8	0.053	0.058	0.055	0.057	0.053	0.058	0.046	0.071

Day of Week	Hour	C24 LD	C24 LM	C39 LD	C39 LM	C50 LD	C50 LM	C54 LD	C54 LM
Monday	9	0.051	0.059	0.051	0.056	0.051	0.059	0.046	0.066
Monday	10	0.054	0.062	0.051	0.058	0.054	0.062	0.049	0.070
Monday	11	0.057	0.064	0.052	0.060	0.057	0.064	0.051	0.070
Monday	12	0.060	0.064	0.054	0.061	0.060	0.064	0.056	0.072
Monday	13	0.061	0.064	0.056	0.063	0.061	0.064	0.055	0.073
Monday	14	0.067	0.066	0.063	0.068	0.067	0.066	0.058	0.073
Monday	15	0.072	0.065	0.069	0.072	0.072	0.065	0.061	0.077
Monday	16	0.075	0.063	0.072	0.071	0.075	0.063	0.061	0.073
Monday	17	0.074	0.055	0.070	0.065	0.074	0.055	0.059	0.059
Monday	18	0.055	0.042	0.055	0.045	0.055	0.042	0.050	0.037
Monday	19	0.042	0.031	0.041	0.031	0.042	0.031	0.045	0.024
Monday	20	0.034	0.023	0.033	0.023	0.034	0.023	0.040	0.017
Monday	21	0.027	0.018	0.027	0.017	0.027	0.018	0.035	0.013
Monday	22	0.020	0.014	0.021	0.013	0.020	0.014	0.029	0.010
Monday	23	0.014	0.011	0.014	0.010	0.014	0.011	0.022	0.006
Tues/Wed/Thurs	0	0.008	0.016	0.009	0.011	0.008	0.016	0.021	0.004
Tues/Wed/Thurs	1	0.005	0.014	0.006	0.010	0.005	0.014	0.021	0.004
Tues/Wed/Thurs	2	0.005	0.014	0.005	0.010	0.005	0.014	0.022	0.004
Tues/Wed/Thurs	3	0.008	0.018	0.010	0.014	0.008	0.018	0.024	0.005
Tues/Wed/Thurs	4	0.017	0.026	0.027	0.026	0.017	0.026	0.028	0.014
Tues/Wed/Thurs	5	0.030	0.039	0.043	0.041	0.030	0.039	0.035	0.033
Tues/Wed/Thurs	6	0.044	0.050	0.054	0.051	0.044	0.050	0.041	0.056

Day of Week	Hour	C24 LD	C24 LM	C39 LD	C39 LM	C50 LD	C50 LM	C54 LD	C54 LM
Tues/Wed/Thurs	7	0.059	0.059	0.062	0.059	0.059	0.059	0.044	0.067
Tues/Wed/Thurs	8	0.055	0.058	0.056	0.057	0.055	0.058	0.046	0.071
Tues/Wed/Thurs	9	0.051	0.059	0.051	0.055	0.051	0.059	0.047	0.067
Tues/Wed/Thurs	10	0.052	0.060	0.049	0.056	0.052	0.060	0.049	0.069
Tues/Wed/Thurs	11	0.054	0.061	0.050	0.058	0.054	0.061	0.052	0.071
Tues/Wed/Thurs	12	0.057	0.062	0.052	0.059	0.057	0.062	0.054	0.069
Tues/Wed/Thurs	13	0.060	0.063	0.055	0.062	0.060	0.063	0.056	0.072
Tues/Wed/Thurs	14	0.066	0.065	0.062	0.068	0.066	0.065	0.059	0.074
Tues/Wed/Thurs	15	0.073	0.066	0.069	0.074	0.073	0.066	0.061	0.080
Tues/Wed/Thurs	16	0.077	0.064	0.072	0.074	0.077	0.064	0.060	0.072
Tues/Wed/Thurs	17	0.076	0.057	0.070	0.067	0.076	0.057	0.057	0.059
Tues/Wed/Thurs	18	0.058	0.044	0.056	0.048	0.058	0.044	0.051	0.037
Tues/Wed/Thurs	19	0.044	0.032	0.043	0.033	0.044	0.032	0.045	0.025
Tues/Wed/Thurs	20	0.036	0.025	0.034	0.025	0.036	0.025	0.041	0.019
Tues/Wed/Thurs	21	0.028	0.019	0.028	0.019	0.028	0.019	0.035	0.014
Tues/Wed/Thurs	22	0.021	0.014	0.021	0.014	0.021	0.014	0.029	0.010
Tues/Wed/Thurs	23	0.015	0.012	0.015	0.010	0.015	0.012	0.022	0.006
Friday	0	0.008	0.016	0.008	0.012	0.008	0.016	0.020	0.004
Friday	1	0.006	0.014	0.006	0.010	0.006	0.014	0.021	0.003
Friday	2	0.005	0.014	0.005	0.010	0.005	0.014	0.023	0.004
Friday	3	0.008	0.017	0.009	0.013	0.008	0.017	0.022	0.005
Friday	4	0.014	0.024	0.022	0.023	0.014	0.024	0.027	0.013

Day of Week	Hour	C24 LD	C24 LM	C39 LD	C39 LM	C50 LD	C50 LM	C54 LD	C54 LM
Friday	5	0.024	0.035	0.036	0.036	0.024	0.035	0.034	0.032
Friday	6	0.036	0.045	0.046	0.045	0.036	0.045	0.038	0.051
Friday	7	0.049	0.053	0.053	0.052	0.049	0.053	0.042	0.062
Friday	8	0.047	0.054	0.049	0.051	0.047	0.054	0.046	0.070
Friday	9	0.047	0.056	0.046	0.052	0.047	0.056	0.047	0.066
Friday	10	0.051	0.060	0.048	0.055	0.051	0.060	0.050	0.070
Friday	11	0.054	0.062	0.050	0.058	0.054	0.062	0.052	0.071
Friday	12	0.057	0.063	0.054	0.061	0.057	0.063	0.054	0.070
Friday	13	0.061	0.065	0.058	0.065	0.061	0.065	0.056	0.072
Friday	14	0.068	0.067	0.065	0.070	0.068	0.067	0.058	0.074
Friday	15	0.074	0.067	0.069	0.075	0.074	0.067	0.059	0.075
Friday	16	0.076	0.064	0.071	0.073	0.076	0.064	0.059	0.070
Friday	17	0.075	0.058	0.069	0.069	0.075	0.058	0.055	0.057
Friday	18	0.064	0.048	0.061	0.052	0.064	0.048	0.053	0.041
Friday	19	0.052	0.037	0.050	0.038	0.052	0.037	0.045	0.027
Friday	20	0.043	0.029	0.042	0.029	0.043	0.029	0.042	0.020
Friday	21	0.035	0.022	0.035	0.022	0.035	0.022	0.039	0.017
Friday	22	0.027	0.016	0.028	0.017	0.027	0.016	0.032	0.014
Friday	23	0.020	0.012	0.020	0.012	0.020	0.012	0.026	0.011
Saturday	0	0.015	0.026	0.014	0.021	0.015	0.026	0.025	0.010
Saturday	1	0.010	0.020	0.009	0.016	0.010	0.020	0.025	0.007
Saturday	2	0.008	0.018	0.007	0.014	0.008	0.018	0.026	0.007

Day of Week	Hour	C24 LD	C24 LM	C39 LD	C39 LM	C50 LD	C50 LM	C54 LD	C54 LM
Saturday	3	0.008	0.019	0.007	0.015	0.008	0.019	0.027	0.009
Saturday	4	0.011	0.021	0.011	0.018	0.011	0.021	0.029	0.014
Saturday	5	0.017	0.028	0.018	0.025	0.017	0.028	0.036	0.033
Saturday	6	0.025	0.036	0.027	0.033	0.025	0.036	0.042	0.056
Saturday	7	0.034	0.044	0.036	0.042	0.034	0.044	0.041	0.055
Saturday	8	0.044	0.053	0.045	0.050	0.044	0.053	0.043	0.057
Saturday	9	0.054	0.061	0.054	0.059	0.054	0.061	0.045	0.061
Saturday	10	0.062	0.068	0.061	0.067	0.062	0.068	0.048	0.066
Saturday	11	0.067	0.071	0.065	0.071	0.067	0.071	0.050	0.067
Saturday	12	0.069	0.070	0.067	0.072	0.069	0.070	0.052	0.068
Saturday	13	0.070	0.067	0.067	0.070	0.070	0.067	0.053	0.067
Saturday	14	0.070	0.064	0.067	0.068	0.070	0.064	0.055	0.070
Saturday	15	0.069	0.061	0.067	0.065	0.069	0.061	0.058	0.077
Saturday	16	0.068	0.057	0.066	0.061	0.068	0.057	0.057	0.066
Saturday	17	0.064	0.051	0.063	0.055	0.064	0.051	0.054	0.053
Saturday	18	0.056	0.042	0.057	0.045	0.056	0.042	0.052	0.040
Saturday	19	0.048	0.034	0.049	0.036	0.048	0.034	0.046	0.034
Saturday	20	0.041	0.029	0.043	0.030	0.041	0.029	0.042	0.027
Saturday	21	0.037	0.024	0.040	0.026	0.037	0.024	0.038	0.023
Saturday	22	0.031	0.020	0.035	0.023	0.031	0.020	0.032	0.019
Saturday	23	0.023	0.016	0.025	0.017	0.023	0.016	0.025	0.014
Holiday	0	0.013	0.020	0.012	0.015	0.013	0.020	0.024	0.008

Day of Week	Hour	C24 LD	C24 LM	C39 LD	C39 LM	C50 LD	C50 LM	C54 LD	C54 LM
Holiday	1	0.009	0.017	0.008	0.013	0.009	0.017	0.024	0.007
Holiday	2	0.007	0.015	0.006	0.012	0.007	0.015	0.023	0.006
Holiday	3	0.007	0.016	0.008	0.014	0.007	0.016	0.023	0.007
Holiday	4	0.011	0.020	0.015	0.020	0.011	0.020	0.027	0.016
Holiday	5	0.019	0.028	0.023	0.028	0.019	0.028	0.033	0.030
Holiday	6	0.027	0.035	0.031	0.035	0.027	0.035	0.035	0.045
Holiday	7	0.035	0.042	0.036	0.040	0.035	0.042	0.040	0.052
Holiday	8	0.040	0.048	0.041	0.045	0.040	0.048	0.043	0.065
Holiday	9	0.048	0.055	0.047	0.051	0.048	0.055	0.045	0.061
Holiday	10	0.059	0.064	0.055	0.061	0.059	0.064	0.050	0.075
Holiday	11	0.065	0.070	0.063	0.069	0.065	0.070	0.049	0.076
Holiday	12	0.069	0.072	0.066	0.072	0.069	0.072	0.058	0.075
Holiday	13	0.071	0.071	0.068	0.074	0.071	0.071	0.052	0.069
Holiday	14	0.072	0.069	0.070	0.073	0.072	0.069	0.055	0.069
Holiday	15	0.073	0.068	0.071	0.072	0.073	0.068	0.062	0.070
Holiday	16	0.073	0.065	0.071	0.068	0.073	0.065	0.065	0.074
Holiday	17	0.070	0.057	0.068	0.061	0.070	0.057	0.053	0.057
Holiday	18	0.060	0.046	0.060	0.050	0.060	0.046	0.051	0.040
Holiday	19	0.050	0.036	0.051	0.040	0.050	0.036	0.047	0.031
Holiday	20	0.042	0.029	0.044	0.031	0.042	0.029	0.046	0.027
Holiday	21	0.034	0.023	0.037	0.025	0.034	0.023	0.040	0.019
Holiday	22	0.027	0.017	0.029	0.019	0.027	0.017	0.034	0.014

Day of Week	Hour	C24 LD	C24 LM	C39 LD	C39 LM	C50 LD	C50 LM	C54 LD	C54 LM
Holiday	23	0.018	0.014	0.020	0.013	0.018	0.014	0.024	0.011

Table 14: Hour-of-day profiles excerpt from July 1st to 7th for HH vehicle class by county

Date	Hour	C10	C15	C16	C20	C24	C39	C50	C54
7/1/2017	0	0.017	0.022	0.021	0.025	0.023	0.021	0.023	0.019
7/1/2017	1	0.020	0.024	0.024	0.021	0.019	0.018	0.019	0.022
7/1/2017	2	0.023	0.028	0.027	0.021	0.017	0.020	0.017	0.021
7/1/2017	3	0.027	0.031	0.031	0.031	0.028	0.028	0.028	0.030
7/1/2017	4	0.031	0.035	0.035	0.035	0.032	0.033	0.032	0.034
7/1/2017	5	0.036	0.038	0.039	0.039	0.037	0.037	0.037	0.039
7/1/2017	6	0.040	0.042	0.043	0.043	0.041	0.042	0.041	0.043
7/1/2017	7	0.044	0.045	0.046	0.046	0.045	0.047	0.045	0.047
7/1/2017	8	0.048	0.048	0.049	0.050	0.049	0.050	0.049	0.051
7/1/2017	9	0.051	0.051	0.052	0.052	0.053	0.054	0.053	0.054
7/1/2017	10	0.054	0.053	0.054	0.054	0.055	0.056	0.055	0.056
7/1/2017	11	0.056	0.054	0.055	0.056	0.057	0.058	0.057	0.057
7/1/2017	12	0.057	0.055	0.056	0.056	0.058	0.059	0.058	0.058
7/1/2017	13	0.057	0.055	0.055	0.056	0.058	0.059	0.058	0.057
7/1/2017	14	0.057	0.054	0.054	0.055	0.057	0.058	0.057	0.056
7/1/2017	15	0.055	0.053	0.053	0.053	0.056	0.056	0.056	0.054
7/1/2017	16	0.053	0.050	0.050	0.051	0.053	0.053	0.053	0.052
7/1/2017	17	0.051	0.048	0.047	0.048	0.050	0.049	0.050	0.048

Date	Hour	C10	C15	C16	C20	C24	C39	C50	C54
7/1/2017	18	0.047	0.045	0.044	0.044	0.046	0.045	0.046	0.044
7/1/2017	19	0.044	0.041	0.040	0.041	0.042	0.041	0.042	0.040
7/1/2017	20	0.039	0.038	0.037	0.037	0.038	0.036	0.038	0.036
7/1/2017	21	0.035	0.034	0.033	0.033	0.033	0.031	0.033	0.031
7/1/2017	22	0.031	0.030	0.029	0.029	0.028	0.027	0.028	0.027
7/1/2017	23	0.027	0.027	0.025	0.025	0.024	0.022	0.024	0.023
7/2/2017	0	0.019	0.023	0.023	0.028	0.026	0.024	0.026	0.024
7/2/2017	1	0.020	0.024	0.023	0.024	0.022	0.021	0.022	0.027
7/2/2017	2	0.021	0.025	0.024	0.024	0.020	0.023	0.020	0.026
7/2/2017	3	0.024	0.026	0.026	0.026	0.022	0.023	0.022	0.023
7/2/2017	4	0.026	0.028	0.028	0.028	0.025	0.027	0.025	0.026
7/2/2017	5	0.030	0.030	0.030	0.031	0.029	0.031	0.029	0.029
7/2/2017	6	0.033	0.033	0.033	0.035	0.033	0.035	0.033	0.033
7/2/2017	7	0.037	0.036	0.036	0.038	0.037	0.039	0.037	0.037
7/2/2017	8	0.041	0.039	0.039	0.041	0.041	0.043	0.041	0.040
7/2/2017	9	0.044	0.042	0.042	0.044	0.045	0.047	0.045	0.044
7/2/2017	10	0.048	0.045	0.045	0.047	0.048	0.050	0.048	0.047
7/2/2017	11	0.051	0.048	0.048	0.050	0.052	0.053	0.052	0.050
7/2/2017	12	0.053	0.050	0.050	0.052	0.054	0.055	0.054	0.052
7/2/2017	13	0.055	0.052	0.052	0.053	0.056	0.057	0.056	0.054
7/2/2017	14	0.056	0.053	0.053	0.054	0.057	0.057	0.057	0.055
7/2/2017	15	0.056	0.054	0.054	0.054	0.057	0.057	0.057	0.055

Date	Hour	C10	C15	C16	C20	C24	C39	C50	C54
7/2/2017	16	0.056	0.054	0.054	0.054	0.056	0.056	0.056	0.055
7/2/2017	17	0.055	0.054	0.054	0.052	0.055	0.054	0.055	0.054
7/2/2017	18	0.053	0.053	0.053	0.051	0.053	0.051	0.053	0.052
7/2/2017	19	0.051	0.051	0.051	0.049	0.050	0.048	0.050	0.050
7/2/2017	20	0.048	0.049	0.049	0.046	0.047	0.044	0.047	0.047
7/2/2017	21	0.045	0.047	0.047	0.043	0.043	0.040	0.043	0.044
7/2/2017	22	0.041	0.044	0.044	0.040	0.039	0.036	0.039	0.040
7/2/2017	23	0.038	0.041	0.041	0.036	0.035	0.031	0.035	0.036
7/3/2017	0	0.012	0.016	0.015	0.016	0.020	0.015	0.020	0.015
7/3/2017	1	0.015	0.018	0.017	0.014	0.016	0.013	0.016	0.017
7/3/2017	2	0.019	0.021	0.021	0.014	0.015	0.014	0.015	0.016
7/3/2017	3	0.024	0.025	0.025	0.025	0.025	0.026	0.025	0.024
7/3/2017	4	0.029	0.029	0.029	0.031	0.030	0.032	0.030	0.029
7/3/2017	5	0.034	0.033	0.033	0.037	0.035	0.038	0.035	0.034
7/3/2017	6	0.039	0.037	0.038	0.043	0.040	0.044	0.040	0.039
7/3/2017	7	0.044	0.041	0.042	0.048	0.045	0.049	0.045	0.044
7/3/2017	8	0.049	0.045	0.046	0.053	0.050	0.054	0.050	0.049
7/3/2017	9	0.053	0.049	0.050	0.057	0.053	0.058	0.053	0.053
7/3/2017	10	0.056	0.052	0.053	0.060	0.057	0.061	0.057	0.057
7/3/2017	11	0.059	0.054	0.056	0.062	0.059	0.063	0.059	0.059
7/3/2017	12	0.060	0.056	0.057	0.063	0.060	0.064	0.060	0.060
7/3/2017	13	0.061	0.057	0.058	0.063	0.060	0.063	0.060	0.061

Date	Hour	C10	C15	C16	C20	C24	C39	C50	C54
7/3/2017	14	0.060	0.057	0.058	0.061	0.060	0.062	0.060	0.060
7/3/2017	15	0.059	0.057	0.057	0.059	0.058	0.059	0.058	0.059
7/3/2017	16	0.056	0.055	0.056	0.055	0.055	0.055	0.055	0.056
7/3/2017	17	0.053	0.053	0.053	0.051	0.052	0.050	0.052	0.053
7/3/2017	18	0.049	0.050	0.050	0.046	0.048	0.045	0.048	0.049
7/3/2017	19	0.044	0.047	0.046	0.040	0.043	0.039	0.043	0.044
7/3/2017	20	0.039	0.043	0.042	0.034	0.038	0.033	0.038	0.039
7/3/2017	21	0.034	0.039	0.037	0.029	0.033	0.027	0.033	0.033
7/3/2017	22	0.029	0.035	0.033	0.023	0.028	0.021	0.028	0.028
7/3/2017	23	0.024	0.030	0.028	0.018	0.023	0.015	0.023	0.023
7/4/2017	0	0.020	0.025	0.024	0.025	0.028	0.023	0.028	0.022
7/4/2017	1	0.023	0.027	0.027	0.021	0.023	0.020	0.023	0.025
7/4/2017	2	0.026	0.030	0.030	0.021	0.021	0.022	0.021	0.024
7/4/2017	3	0.030	0.033	0.033	0.032	0.027	0.030	0.027	0.032
7/4/2017	4	0.033	0.037	0.037	0.036	0.031	0.034	0.031	0.036
7/4/2017	5	0.037	0.040	0.041	0.040	0.034	0.039	0.034	0.039
7/4/2017	6	0.041	0.043	0.044	0.044	0.038	0.043	0.038	0.043
7/4/2017	7	0.044	0.046	0.047	0.047	0.042	0.047	0.042	0.046
7/4/2017	8	0.048	0.048	0.050	0.050	0.045	0.050	0.045	0.049
7/4/2017	9	0.050	0.050	0.052	0.053	0.048	0.053	0.048	0.052
7/4/2017	10	0.053	0.052	0.053	0.055	0.051	0.055	0.051	0.053
7/4/2017	11	0.054	0.053	0.054	0.056	0.053	0.057	0.053	0.055

Date	Hour	C10	C15	C16	C20	C24	C39	C50	C54
7/4/2017	12	0.055	0.053	0.055	0.056	0.054	0.057	0.054	0.055
7/4/2017	13	0.055	0.053	0.054	0.056	0.055	0.057	0.055	0.055
7/4/2017	14	0.055	0.052	0.053	0.055	0.055	0.056	0.055	0.054
7/4/2017	15	0.054	0.051	0.051	0.053	0.054	0.054	0.054	0.052
7/4/2017	16	0.052	0.049	0.049	0.050	0.053	0.051	0.053	0.050
7/4/2017	17	0.049	0.046	0.046	0.047	0.051	0.048	0.051	0.047
7/4/2017	18	0.046	0.043	0.042	0.043	0.048	0.044	0.048	0.044
7/4/2017	19	0.042	0.040	0.039	0.040	0.045	0.040	0.045	0.040
7/4/2017	20	0.039	0.037	0.035	0.036	0.041	0.036	0.041	0.037
7/4/2017	21	0.035	0.034	0.032	0.032	0.038	0.031	0.038	0.033
7/4/2017	22	0.031	0.031	0.028	0.028	0.034	0.027	0.034	0.029
7/4/2017	23	0.028	0.028	0.025	0.024	0.030	0.023	0.030	0.026
7/5/2017	0	0.012	0.017	0.015	0.017	0.019	0.015	0.019	0.014
7/5/2017	1	0.016	0.019	0.018	0.014	0.016	0.013	0.016	0.016
7/5/2017	2	0.020	0.023	0.021	0.014	0.014	0.014	0.014	0.016
7/5/2017	3	0.025	0.027	0.026	0.026	0.024	0.027	0.024	0.025
7/5/2017	4	0.030	0.031	0.030	0.032	0.029	0.033	0.029	0.030
7/5/2017	5	0.035	0.035	0.035	0.037	0.035	0.039	0.035	0.036
7/5/2017	6	0.040	0.039	0.040	0.043	0.040	0.045	0.040	0.041
7/5/2017	7	0.045	0.044	0.045	0.048	0.045	0.050	0.045	0.046
7/5/2017	8	0.050	0.047	0.049	0.053	0.050	0.055	0.050	0.051
7/5/2017	9	0.054	0.051	0.052	0.057	0.054	0.059	0.054	0.055

Date	Hour	C10	C15	C16	C20	C24	C39	C50	C54
7/5/2017	10	0.057	0.054	0.055	0.060	0.057	0.061	0.057	0.058
7/5/2017	11	0.059	0.056	0.057	0.062	0.059	0.063	0.059	0.060
7/5/2017	12	0.060	0.057	0.059	0.062	0.061	0.064	0.061	0.061
7/5/2017	13	0.061	0.058	0.059	0.062	0.061	0.063	0.061	0.061
7/5/2017	14	0.060	0.057	0.058	0.061	0.060	0.061	0.060	0.060
7/5/2017	15	0.058	0.056	0.057	0.058	0.058	0.058	0.058	0.058
7/5/2017	16	0.056	0.054	0.055	0.055	0.056	0.054	0.056	0.055
7/5/2017	17	0.052	0.051	0.051	0.050	0.052	0.050	0.052	0.052
7/5/2017	18	0.048	0.048	0.048	0.045	0.048	0.044	0.048	0.047
7/5/2017	19	0.043	0.044	0.043	0.040	0.043	0.038	0.043	0.042
7/5/2017	20	0.038	0.040	0.039	0.034	0.038	0.032	0.038	0.037
7/5/2017	21	0.033	0.036	0.034	0.029	0.032	0.026	0.032	0.031
7/5/2017	22	0.028	0.031	0.029	0.023	0.027	0.020	0.027	0.026
7/5/2017	23	0.023	0.027	0.025	0.018	0.022	0.015	0.022	0.021
7/6/2017	0	0.012	0.016	0.014	0.016	0.018	0.015	0.018	0.014
7/6/2017	1	0.016	0.019	0.017	0.014	0.015	0.013	0.015	0.016
7/6/2017	2	0.020	0.022	0.021	0.014	0.014	0.014	0.014	0.016
7/6/2017	3	0.024	0.026	0.026	0.026	0.024	0.027	0.024	0.024
7/6/2017	4	0.030	0.030	0.030	0.032	0.029	0.033	0.029	0.029
7/6/2017	5	0.035	0.034	0.035	0.038	0.035	0.039	0.035	0.035
7/6/2017	6	0.040	0.039	0.040	0.043	0.040	0.045	0.040	0.040
7/6/2017	7	0.045	0.043	0.044	0.048	0.045	0.050	0.045	0.045

Date	Hour	C10	C15	C16	C20	C24	C39	C50	C54
7/6/2017	8	0.050	0.047	0.048	0.053	0.050	0.055	0.050	0.050
7/6/2017	9	0.054	0.050	0.052	0.057	0.054	0.059	0.054	0.054
7/6/2017	10	0.057	0.053	0.055	0.060	0.057	0.061	0.057	0.057
7/6/2017	11	0.059	0.056	0.057	0.062	0.060	0.063	0.060	0.060
7/6/2017	12	0.060	0.057	0.059	0.063	0.061	0.064	0.061	0.061
7/6/2017	13	0.061	0.058	0.059	0.062	0.061	0.063	0.061	0.061
7/6/2017	14	0.060	0.057	0.059	0.061	0.060	0.061	0.060	0.061
7/6/2017	15	0.058	0.056	0.057	0.058	0.059	0.058	0.059	0.059
7/6/2017	16	0.056	0.054	0.055	0.055	0.056	0.054	0.056	0.056
7/6/2017	17	0.052	0.052	0.052	0.050	0.052	0.050	0.052	0.052
7/6/2017	18	0.048	0.049	0.048	0.045	0.048	0.044	0.048	0.048
7/6/2017	19	0.043	0.045	0.044	0.040	0.043	0.038	0.043	0.043
7/6/2017	20	0.038	0.041	0.039	0.034	0.038	0.032	0.038	0.038
7/6/2017	21	0.033	0.036	0.034	0.028	0.032	0.026	0.032	0.032
7/6/2017	22	0.028	0.032	0.030	0.023	0.027	0.020	0.027	0.027
7/6/2017	23	0.023	0.028	0.025	0.017	0.022	0.015	0.022	0.022
7/7/2017	0	0.012	0.016	0.015	0.016	0.018	0.015	0.018	0.014
7/7/2017	1	0.015	0.019	0.018	0.014	0.015	0.013	0.015	0.016
7/7/2017	2	0.019	0.022	0.021	0.014	0.014	0.014	0.014	0.015
7/7/2017	3	0.024	0.026	0.026	0.026	0.024	0.027	0.024	0.025
7/7/2017	4	0.029	0.030	0.030	0.032	0.030	0.033	0.030	0.030
7/7/2017	5	0.034	0.035	0.035	0.038	0.035	0.039	0.035	0.035

Date	Hour	C10	C15	C16	C20	C24	C39	C50	C54
7/7/2017	6	0.039	0.039	0.040	0.043	0.040	0.045	0.040	0.041
7/7/2017	7	0.044	0.043	0.044	0.048	0.045	0.050	0.045	0.046
7/7/2017	8	0.049	0.047	0.049	0.053	0.050	0.055	0.050	0.050
7/7/2017	9	0.053	0.051	0.052	0.057	0.054	0.059	0.054	0.054
7/7/2017	10	0.056	0.054	0.055	0.060	0.057	0.062	0.057	0.058
7/7/2017	11	0.059	0.056	0.057	0.062	0.059	0.063	0.059	0.060
7/7/2017	12	0.060	0.057	0.059	0.063	0.061	0.064	0.061	0.061
7/7/2017	13	0.061	0.058	0.059	0.062	0.061	0.063	0.061	0.061
7/7/2017	14	0.060	0.057	0.058	0.061	0.060	0.061	0.060	0.060
7/7/2017	15	0.059	0.056	0.057	0.058	0.058	0.058	0.058	0.059
7/7/2017	16	0.056	0.054	0.055	0.055	0.056	0.054	0.056	0.056
7/7/2017	17	0.053	0.051	0.052	0.050	0.052	0.049	0.052	0.052
7/7/2017	18	0.049	0.048	0.048	0.045	0.048	0.044	0.048	0.048
7/7/2017	19	0.044	0.044	0.044	0.040	0.043	0.038	0.043	0.043
7/7/2017	20	0.039	0.040	0.039	0.034	0.038	0.032	0.038	0.037
7/7/2017	21	0.034	0.036	0.034	0.028	0.033	0.026	0.033	0.032
7/7/2017	22	0.029	0.031	0.029	0.022	0.027	0.020	0.027	0.027
7/7/2017	23	0.024	0.027	0.025	0.017	0.022	0.015	0.022	0.022

IX. Appendix C: Additional Temporal Profiles

OGV temporal profiles were constructed based on 2016 port activities of all vessels, compiled by an in-house section in CARB. Fractions for the ports of Long Beach, Los Angeles, Oakland and San Diego were updated using aggregated AIS data from 2015 through 2019. All vessel types were grouped by port area boundary and divided into day of week and monthly activity fractions (Table 15 and Table 16). Some profiles are either area- or inline specific, others will be used by both area and inline sources. Activity data was not available for all ports; a flat (emissions are spread evenly across the time period) monthly and daily profile was used for those ports. A flat profile was also used to represent the hourly variation for all OGV vessels at every port area/waters. The temporal profiles do not apply to OGV military, which assumes a flat at monthly, days of week, and hours of day intervals (see the profile labeled Elsewhere in the tables below). The areas labeled with a “+” received area source profile updates and “*” received inline only updates.

Hourly temporal profiles were updated for consumer products (Table 17 and Table 18). The new profiles were developed by the Consumer Products and Air Quality Assessment Branch based on research on identifying volatile chemical product tracer compounds in U.S. cities (Gkatzelis, et al., 2021).

Table 15: OGV monthly profiles

Port Areas/Waters	Profile ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eureka	M_EKA	0.000	0.000	0.000	0.000	0.167	0.167	0.167	0.000	0.167	0.167	0.167	0.000
Hueneme	M_NTD	0.065	0.088	0.090	0.093	0.095	0.083	0.083	0.075	0.078	0.080	0.088	0.085
Carquinez	M_CAR	0.068	0.076	0.080	0.076	0.087	0.093	0.090	0.085	0.085	0.090	0.075	0.095
Oakland	M_OAK	0.084	0.088	0.081	0.078	0.081	0.084	0.084	0.090	0.081	0.090	0.080	0.079
Redwood City	M_RWC	0.055	0.018	0.091	0.091	0.127	0.073	0.055	0.127	0.091	0.091	0.036	0.145
Richmond	M_RCH	0.083	0.092	0.086	0.081	0.086	0.095	0.083	0.097	0.075	0.062	0.084	0.076
Sacramento	M_SAC	0.018	0.036	0.018	0.054	0.054	0.089	0.036	0.036	0.054	0.071	0.482	0.054
San Diego	M_SGQ	0.081	0.078	0.077	0.086	0.088	0.093	0.085	0.075	0.088	0.086	0.082	0.082
San Francisco	M_SFO	0.070	0.071	0.074	0.080	0.095	0.093	0.071	0.087	0.080	0.087	0.091	0.100
Stockton	M_SCK	0.083	0.088	0.083	0.074	0.111	0.101	0.060	0.101	0.055	0.083	0.092	0.069
Elsewhere	1	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083	0.083
Waters of LA County+	M_6059	0.093	0.071	0.084	0.088	0.084	0.075	0.080	0.091	0.074	0.087	0.081	0.092
El Segundo*	M_ELS	0.104	0.055	0.084	0.093	0.086	0.066	0.075	0.104	0.066	0.090	0.075	0.104

Port Areas/Waters	Profile ID	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Port of Los Angeles*	M_LAX	0.087	0.088	0.087	0.087	0.084	0.083	0.081	0.082	0.081	0.079	0.081	0.081
Port of Long Beach*	M_LGB	0.084	0.086	0.082	0.083	0.081	0.087	0.084	0.082	0.086	0.084	0.081	0.080

Table 16: OGV weekly profiles

Port Areas/Waters	Profile ID	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Eureka	W_EKA	0.500	0.000	0.333	0.000	0.000	0.000	0.167
Hueneme	W_NTD	0.113	0.145	0.205	0.160	0.108	0.115	0.155
Carquinez	W_CAR	0.178	0.131	0.146	0.163	0.136	0.126	0.121
Oakland	W_OAK	0.150	0.151	0.161	0.151	0.135	0.121	0.130
Redwood City	W_RWC	0.109	0.127	0.200	0.091	0.218	0.109	0.145
Richmond	W_RCH	0.167	0.153	0.142	0.126	0.161	0.129	0.122
Sacramento	W_SAC	0.179	0.250	0.089	0.143	0.161	0.071	0.107
San Diego	W_SGQ	0.150	0.162	0.169	0.142	0.129	0.117	0.131
San Francisco	W_SFO	0.155	0.138	0.153	0.137	0.127	0.143	0.146
Stockton	W_SCK	0.152	0.147	0.106	0.157	0.161	0.106	0.171
Elsewhere	7	0.143	0.143	0.143	0.143	0.143	0.143	0.143
Waters of LA County+	W_6059	0.143	0.132	0.152	0.150	0.139	0.148	0.135
El Segundo*	W_ELS	0.137	0.137	0.154	0.148	0.137	0.145	0.143
Port of Los Angeles*	W_LAX	0.142	0.145	0.153	0.155	0.150	0.135	0.121
Port of Long Beach*	W_LGB	0.138	0.140	0.148	0.147	0.152	0.144	0.132

Table 17: Consumer products diurnal profile assignment codes and descriptions

Tracer Diurnal Profile Assignment	CEIDARS HPDY	HPDYN
PCBTF	86	INCREASING ACTIVITY FROM 9AM TO 2PM AND DECREASING UNTIL 10PM. PCBTF TRACER (CP)
D-4 Siloxane	87	MINOR PEAK AT 5 AM, PEAK ACTIVITY AT 2PM AND 6PM. D4-SILOXANE TRACER (CP)
Monoterpenes	88	ACTIVITY STARTS AT 6AM, 12PM PEAK, OSCILLATES TO 8PM. MONOTERPENE TRACER (CP)
PDCB	89	PEAK ACTIVITY FROM 6PM TO 9PM. MINOR PEAKS AT 5AM AND 12PM.
D-5 Siloxane	90	PRIMARY PEAK ACTIVITY AT 12PM AND SECONDARY AT 8PM. D5-SILOXANE TRACER (CP)

Table 18: Consumer products hourly temporal profiles

Hour	PCBTF Tracer (CP)	D4-Siloxane Tracer (CP)	Monoterpene Tracer (CP)	PDCB Tracer (CP)	D5-Siloxane Tracer (CP)
0	0.009	0.015	0.015	0.019	0.016
1	0.011	0.017	0.015	0.022	0.018
2	0.012	0.018	0.014	0.023	0.016
3	0.012	0.020	0.012	0.026	0.015
4	0.017	0.032	0.013	0.041	0.022
5	0.020	0.038	0.013	0.046	0.027
6	0.017	0.031	0.016	0.036	0.025
7	0.014	0.024	0.025	0.028	0.026
8	0.016	0.026	0.042	0.027	0.034
9	0.026	0.037	0.061	0.033	0.058

Hour	PCBTF Tracer (CP)	D4-Siloxane Tracer (CP)	Monoterpene Tracer (CP)	PDCB Tracer (CP)	D5-Siloxane Tracer (CP)
10	0.048	0.048	0.074	0.040	0.081
11	0.072	0.055	0.083	0.041	0.088
12	0.097	0.063	0.074	0.038	0.077
13	0.121	0.075	0.069	0.030	0.055
14	0.108	0.070	0.062	0.022	0.039
15	0.079	0.053	0.063	0.024	0.039
16	0.074	0.047	0.064	0.042	0.047
17	0.076	0.073	0.054	0.080	0.050
18	0.061	0.085	0.061	0.097	0.057
19	0.043	0.068	0.063	0.102	0.068
20	0.031	0.049	0.051	0.088	0.063
21	0.016	0.026	0.025	0.049	0.042
22	0.011	0.017	0.014	0.027	0.021
23	0.009	0.015	0.015	0.019	0.016

X. Appendix D: Spatial Surrogate Assignments

The primary spatial surrogate for each EICSUM and the corresponding data source are listed in Table 19 below.

Table 19: Primary surrogate assignment at the EICSUM level, description, and data source

EICSUM	EICSUM Name	Primary Surrogate ID	Primary Surrogate Name	Data Source of Primary Surrogate
10	Electric Utilities	302	UCD Industrial	Longitudinal Employer-Household Dynamics (LEHD)
20	Cogeneration	302	UCD Industrial	Longitudinal Employer-Household Dynamics (LEHD)
30	Oil and Gas Production (Combustion)	211	Gas Well	California Department of Conservation, Division of Oil, Gas and Geothermal Resources
30	Oil and Gas Production (Combustion)	431	Oil well	Division of Oil, Gas, And Geothermal Resources
50	Manufacturing and Industrial	302	UCD Industrial	Longitudinal Employer-Household Dynamics (LEHD)
52	Food and Agricultural Processing	720	Farm Road Vehicle Miles Traveled	Department of Pesticide Regulation
60	Service and Commercial	621	UCD Service, Commercial, Employment	MPO/COG/CSTDM Data
99	Other (Fuel Combustion)	302	UCD Industrial	Longitudinal Employer-Household Dynamics (LEHD)
110	Sewage Treatment	470	Publicly Owned Treatment Works	State Water Resources Control Board
120	Landfills	341	Landfills	CalRecycle - Solid Waste Information System (SWIS) Dataset
130	Incinerators	302	UCD Industrial	Longitudinal Employer-Household Dynamics (LEHD)

EICSUM	EICSUM Name	Primary Surrogate ID	Primary Surrogate Name	Data Source of Primary Surrogate
140	Soil Remediation	302	UCD Industrial	Longitudinal Employer-Household Dynamics (LEHD)
199	Other (Waste Disposal)	343	Compost	CalRecycle - Solid Waste Information System (SWIS) Dataset
199	Other (Waste Disposal)	390	Non irrigated Pastureland	National Land Cover Database (NLCD)
199	Other (Waste Disposal)	470	Publicly Owned Treatment Works	State Water Resources Control Board
210	Laundering	150	Drycleaners	Dun & Bradstreet's Market Insight Database
220	Degreasing	120	Autobody Shops	Dun & Bradstreet's Market Insight Database
220	Degreasing	302	UCD Industrial	Longitudinal Employer-Household Dynamics (LEHD)
230	Coatings and Related Process Solvents	120	Autobody Shops	Dun & Bradstreet's Market Insight Database
230	Coatings and Related Process Solvents	743	Wood Furniture	Dun & Bradstreet's Market Insight Database
230	Coatings and Related Process Solvents	302	UCD Industrial	Longitudinal Employer-Household Dynamics (LEHD)
240	Printing	731	Print	Dun & Bradstreet's Market Insight Database
250	Adhesives and Sealants	302	UCD Industrial	Longitudinal Employer-Household Dynamics (LEHD)
299	Other (Cleaning and Surface Coatings)	302	UCD Industrial	Longitudinal Employer-Household Dynamics (LEHD)
310	Oil and Gas Production	211	Gas well	California Department of Conservation, Division of Oil, Gas and Geothermal Resources

EICSUM	EICSUM Name	Primary Surrogate ID	Primary Surrogate Name	Data Source of Primary Surrogate
310	Oil and Gas Production	431	Oilwell	California Department of Conservation, Division of Oil, Gas and Geothermal Resources
330	Petroleum Marketing	460	Ports	National Transportation Atlas Database (NTAD)
330	Petroleum Marketing	200	Gas Stations	Dun & Bradstreet’s Market Insight Database
330	Petroleum Marketing	520	Refineries and Tank Farms	FEMA and the ARB CEIDAR Database
330	Petroleum Marketing	214	Gas Distribution	U.S. Energy Information Administration
399	Other (Petroleum Production and Marketing)	200	Gas Stations	Dun & Bradstreet’s Market Insight Database
410	Chemical	741	Plastic	Dun & Bradstreet’s Market Insight Database
420	Food and Agriculture	680	Wineries	Dun & Bradstreet’s Market Insight Database
420	Food and Agriculture	320	Irrigated Cropland	National Land Cover Database (NLCD)
430	Mineral Processes	590	Sand and Gravel Mines	National Atlas
440	Metal Processes	738	Metal Parts	Dun & Bradstreet’s Market Insight Database
450	Wood And Paper	732	Wood	Dun & Bradstreet’s Market Insight Database
499	Other (Industrial Processes)	302	UCD Industrial	Longitudinal Employer-Household Dynamics (LEHD)
500	Solvent Evaporation Unspecified	441	UCD Population	MPO/COG/CSTDM Data

EICSUM	EICSUM Name	Primary Surrogate ID	Primary Surrogate Name	Data Source of Primary Surrogate
510	Consumer Products	550	Residential and Nonresidential Change Industrial Employment	Council of Government (Cog) Housing and Employment
510	Consumer Products	252	UCD Total Housing	MPO/COG/CSTDM Data
510	Consumer Products	280	Housing and Restaurants	Combo: MPO/COG/CSTDM Data and Dun & Bradstreet Market Insight
510	Consumer Products	260	Housing and Autobody	Combo: MPO/COG/CSTDM Data and Dun & Bradstreet Market Insight
510	Consumer Products	120	Autobody Shops	Dun & Bradstreet's Market Insight Database
510	Consumer Products	739	Other Coatings	Dun & Bradstreet's Market Insight Database
510	Consumer Products	270	Housing and Commercial Employment	MPO/COG/CSTDM Data
510	Consumer Products	651	UCD Single Family Housing	MPO/COG/CSTDM Data
510	Consumer Products	450	Population, Commercial Employment and Hospitals	MPO/COG/CSTDM Data and ESRI
510	Consumer Products	672	Developed Land High Density	National Land Cover Database (NLCD)
520	Architectural Coatings and Related Process Solvents	230	HE Square Feet	Council of Government (COG) Housing and Employment
520	Architectural Coatings and Related Process Solvents	270	Housing and Commercial Employment	MPO/COG/CSTDM Data

EICSUM	EICSUM Name	Primary Surrogate ID	Primary Surrogate Name	Data Source of Primary Surrogate
520	Architectural Coatings and Related Process Solvents	110	All Paved Roads	Tiger Geodatabases from U.S. Census Bureau
530	Pesticides/Fertilizers	230	HE Square Feet	Council of Government (COG) Housing and Employment
530	Pesticides/Fertilizers	512	Pesticides No Methyl Bromide	Department of Pesticide Regulation
530	Pesticides/Fertilizers	514	Pesticides Methyl Bromide	Department of Pesticide Regulation
530	Pesticides/Fertilizers	732	Wood	Dun & Bradstreet’s Market Insight Database
540	Asphalt Paving / Roofing	588	UCD On-road Construction	Caltrans Highway Construction Projects Dataset (Line)
610	Residential Fuel Combustion	573	Fireplaces	Digital Map Products 2017 Parcel Data
610	Residential Fuel Combustion	572	Residential Liquid Petroleum Gas Heating	US Census American Community Survey (ACS)
620	Farming Operations	356	Horse Ranches	CARB Green House Gas Inventory Group
620	Farming Operations	320	Irrigated Cropland	National Land Cover Database (NLCD)
620	Farming Operations	690	Land Prep	Department of Pesticide Regulation
630	Construction and Demolition	588	UCD On-road Construction	Caltrans Highway Construction Projects Dataset (Line)
630	Construction and Demolition	587	UCD Offroad Construction	Storm Notice of Intent (NOI) Dataset
640	Paved Road Dust	590	Sand and Gravel Mines	National Atlas
640	Paved Road Dust	610	Secondary Paved Roads	Tiger Geodatabases from U.S. Census Bureau

EICSUM	EICSUM Name	Primary Surrogate ID	Primary Surrogate Name	Data Source of Primary Surrogate
645	Unpaved Road Dust	384	Military Tactical	Federal Aviation Administration / National Transportation Atlas Database (NTAD) And ESRI
645	Unpaved Road Dust	190	Forestland	National Land Cover Database (NLCD)
645	Unpaved Road Dust	720	Farm Road Vehicle Miles Traveled	Department of Pesticide Regulation
645	Unpaved Road Dust	660	Unpaved Roads	Tiger Geodatabases from U.S. Census Bureau
650	Fugitive Windblown Dust	391	Pasture	National Land Cover Database (NLCD)
650	Fugitive Windblown Dust	660	Unpaved Roads	Tiger Geodatabases from U.S. Census Bureau
650	Fugitive Windblown Dust	160	Dry Lake Beds	U.S. Geological Survey (USGS)
660	Fires	441	UCD Population	MPO/COG/CSTDM Data
660	Fires	480	Primary Roads	Tiger Geodatabases from U.S. Census Bureau
670	Managed Burning and Disposal	674	Developed Land Low Density	National Land Cover Database (NLCD)
670	Managed Burning and Disposal	190	Forestland	National Land Cover Database (NLCD)
670	Managed Burning and Disposal	720	Farm Road Vehicle Miles Traveled	Department of Pesticide Regulation
680	Utility Equipment	651	UCD Single Family Housing	MPO/COG/CSTDM Data
690	Cooking	561	Charbroiling	SJV APCD & Dun and Bradstreet Insight Market

EICSUM	EICSUM Name	Primary Surrogate ID	Primary Surrogate Name	Data Source of Primary Surrogate
699	Other (Miscellaneous Processes)	441	UCD Population	MPO/COG/CSTDM Data
7XX	On-Road	801-824	Light-Duty Vehicle Miles Traveled	MPO/COG/CSTDM Data
7XX	On-Road	825-848	Heavy-Duty Vehicle Miles Traveled	MPO/COG/CSTDM Data
7XX	On-Road	853	30% Idling/70% Distribution	Digital Map Products Parcel Data/California Statewide Travel Demand Model (CSTDM) Data
7XX	On-Road	859	90% Idling/10% Distribution	Digital Map Products Parcel Data/California Statewide Travel Demand Model (CSTDM) Data
7XX	On-Road	860	Diesel Motorcycle Evaporatives	EMFAC California Department of Motor Vehicle (DMV) Registration Data
7XX	On-Road	861	Gas Motorcycle Evaporatives	EMFAC California Department of Motor Vehicle (DMV) Registration Data
7XX	On-Road	862	Diesel Motor Home and Bus Evaporatives	EMFAC California Department of Motor Vehicle (DMV) Registration Data
7XX	On-Road	863	Gas Motor Home and Bus Evaporatives	EMFAC California Department of Motor Vehicle (DMV) Registration Data
7XX	On-Road	864	Diesel Passenger Vehicles	EMFAC California Department of Motor Vehicle (DMV) Registration Data
7XX	On-Road	865	Gas Passenger Vehicles	EMFAC California Department of Motor Vehicle (DMV) Registration Data
7XX	On-Road	866	Diesel Light-Heavy Duty Vehicles	EMFAC California Department of Motor Vehicle (DMV) Registration Data

EICSUM	EICSUM Name	Primary Surrogate ID	Primary Surrogate Name	Data Source of Primary Surrogate
7XX	On-Road	867	Gas Light-Heavy Duty Vehicles	EMFAC California Department of Motor Vehicle (DMV) Registration Data
7XX	On-Road	868	Diesel Heavy-Heavy Duty Vehicles	EMFAC California Department of Motor Vehicle (DMV) Registration Data
7XX	On-Road	869	Gas Heavy-Heavy Duty Vehicles	EMFAC California Department of Motor Vehicle (DMV) Registration Data
810	Aircraft	382	Military Aircraft	Federal Aviation Administration / National Transportation Atlas Database (NTAD) And ESRI
810	Aircraft	100	Airports	Federal Aviation Administration and ESRI
810	Aircraft	140	Commercial Airports	Federal Aviation Administration, National Transportation Atlas Database (NTAD)
810	Aircraft	320	Irrigated Cropland	National Land Cover Database (NLCD)
820	Trains	491	Linehaul	ARB In-House Rail Modeling
820	Trains	360	Metrolink Lines	Federal Railroad Administration / National Transportation Atlas Database (NTAD)
820	Trains	490	Rail Lines	Federal Railroad Administration / National Transportation Atlas Database (NTAD)
820	Trains	361	Passenger Rail	Offroad Diesel Analysis Section, AQPSD
820	Trains	501	Switcher Railyards	Off-Road Diesel Analysis Section, AQPSD: Union Pacific Railroad (Up) And Burlington Northern Santa Fe Railway (BNSF)
830	Ships and Commercial Boats	460	Ports	(US DOT)/Bureau of Transportation Statistics' (BTS's) National

EICSUM	EICSUM Name	Primary Surrogate ID	Primary Surrogate Name	Data Source of Primary Surrogate
				Transportation Atlas Database (NTAD)
830	Ships and Commercial Boats	431	Oilwell	Division of Oil, Gas, And Geothermal Resources
830	Ships and Commercial Boats	640	Ship Lanes	Marine Cadastre Automatic Identification System
833	Ocean Going Vessels	460	Ports	National Transportation Atlas Database (NTAD)
833	Ocean Going Vessels	383	Military Ships	Marine Cadastre - Military Vessel
833	Ocean Going Vessels	640	Ship Lanes	Marine Cadastre Automatic Identification System
833	Ocean Going Vessels	642	Tanker	Marine Cadastre Automatic Identification System
833	Ocean Going Vessels	643	Passenger	Marine Cadastre Automatic Identification System
835	Commercial Harbor Craft	460	Ports	National Transportation Atlas Database (NTAD)
835	Commercial Harbor Craft	332	Ferries	Ferry Company Websites and Google Maps
835	Commercial Harbor Craft	383	Military Ships	Marine Cadastre - Military Vessel
835	Commercial Harbor Craft	641	Crew Supply	Marine Cadastre Automatic Identification System
835	Commercial Harbor Craft	339	Dredge	Marine Cadastre Coastal Maintained Channels
840	Recreational Boats	338	Ocean Recreation Boats	Marine Cadastre Automatic Identification System - Pleasure Craft
840	Recreational Boats	651	UCD Single Family Housing	MPO/COG/CSTDM Data

EICSUM	EICSUM Name	Primary Surrogate ID	Primary Surrogate Name	Data Source of Primary Surrogate
840	Recreational Boats	336	Ocean, Lakes and Recreation Boats	U.S. Geological Survey (USGS)
840	Recreational Boats	335	Lakes, Rivers, Recreation Boats	U.S. Geological Survey (USGS)
850	Off-Road Recreational Vehicles	220	Golf Courses	ESRI
850	Off-Road Recreational Vehicles	651	UCD Single Family Housing	MPO/COG/CSTDM Data
850	Off-Road Recreational Vehicles	660	Unpaved Roads	Tiger Geodatabases from U.S. Census Bureau
850	Off-Road Recreational Vehicles	170	Elevation over 1500 m	U.S. Geological Survey (USGS)
860	Off-Road Equipment	580	Residential Nonresidential Change	Council of Government (COG) Housing and Employment
860	Off-Road Equipment	630	Service and Commercial Employment, Schools, Golf Courses and Cemeteries	Council of Government (COG) Service and Commercial Employment & Esri
860	Off-Road Equipment	460	Ports	National Transportation Atlas Database (NTAD)
860	Off-Road Equipment	431	Oilwell	Division of Oil, Gas, And Geothermal Resources
860	Off-Road Equipment	384	Military Tactical	Federal Aviation Administration / National Transportation Atlas Database (NTAD) and ESRI
860	Off-Road Equipment	100	Airports	Federal Aviation Administration and Esri
860	Off-Road Equipment	500	Railyards	Federal Railroad Administration / National Transportation Atlas Database (NTAD)

EICSUM	EICSUM Name	Primary Surrogate ID	Primary Surrogate Name	Data Source of Primary Surrogate
860	Off-Road Equipment	485	TRU	Integrated Transportation Network and Caltrans Truck Network and Digital Map Products 2017 Parcel Data
860	Off-Road Equipment	302	UCD Industrial	Longitudinal Employer-Household Dynamics (LEHD)
860	Off-Road Equipment	339	Dredge	Marine Cadastre Coastal Maintained Channels
860	Off-Road Equipment	651	UCD Single Family Housing	MPO/COG/CSTDM Data
860	Off-Road Equipment	190	Forestland	National Land Cover Database (NLCD)
860	Off-Road Equipment	191	Forestland Roads	NLCD in conjunction with TIGER road network
860	Off-Road Equipment	587	UCD Offroad Construction	Storm Notice of Intent (NOI) Dataset
870	Farm Equipment	720	Farm Road Vehicle Miles Traveled	Department of Pesticide Regulation
890	Fuel Storage and Handling	651	UCD Single Family Housing	MPO/COG/CSTDM Data
890	Fuel Storage and Handling	335	Lakes, Rivers, Recreation boats	U.S. Geological Survey (USGS)
910	Biogenic Sources	672	Developed Land High Density	National Land Cover Database (NLCD)
910	Biogenic Sources	190	Forestland	National Land Cover Database (NLCD)
920	Geogenic Sources	190	Forestland	National Land Cover Database (NLCD)
920	Geogenic Sources	212	Gas Seep	U.S. Geological Survey (USGS)

EICSUM	EICSUM Name	Primary Surrogate ID	Primary Surrogate Name	Data Source of Primary Surrogate
920	Geogenic Sources	432	Oil Seep	U.S. Geological Survey (USGS) – Pacific Coastal & Marine Science
930	Wildfires	190	Forestland	National Land Cover Database (NLCD)
930	Wildfires	391	Pasture	Sierra Research Agtool Contract
940	Windblown Dust	412	Fugitive Dust	National Land Cover Database (NLCD)

XI. Appendix E: San Joaquin Valley Facilities with CEM data

Table 20 below, summarizes the facilities from San Joaquin Valley that have Continuous Emissions Monitoring hourly data.

Table 20: San Joaquin Valley facilities with Continuous Emissions Monitoring.

State	CEM Facility Name	ORIS ID	Unit ID	AB	FACID	POINT ID	STACK ID	SEGMENT ID
CA	Woodland Generation Station	7266	1	SJV	3233	1	1	1
CA	Woodland Generation Station	7266	2	SJV	3233	4	4	1
CA	Almond Power Plant	7315	1	SJV	3299	1	1	1
CA	NCPA Combustion Turbine Project #2	7449	NA1	SJV	583	1	1	1
CA	Fresno Cogeneration Partners, LP	10156	GEN1	SJV	14	10	10	1
CA	Kingsburg Cogen Facility	10405	1	SJV	722	2	2	1
CA	Bear Mountain Limited	10649	GT1	SJV	2049	1	1	1

CA	Badger Creek Limited	10650	GT1	SJV	1250	1	1	1
CA	DTE Stockton	54238	BIOMS1	SJV	645	36	36	2
CA	Live Oak Limited	54768	GT1	SJV	172	1	1	1
CA	La Paloma Generating Plant	55151	CTG-1	SJV	3412	1	1	1
CA	La Paloma Generating Plant	55151	CTG-2	SJV	3412	2	2	1
CA	La Paloma Generating Plant	55151	CTG-3	SJV	3412	3	3	1
CA	La Paloma Generating Plant	55151	CTG-4	SJV	3412	4	4	1
CA	Sunrise Power Company	55182	CTG1	SJV	3746	1	1	1
CA	Sunrise Power Company	55182	CTG2	SJV	3746	2	2	1
CA	Elk Hills Power	55400	CTG-1	SJV	3523	1	1	1
CA	Elk Hills Power	55400	CTG-2	SJV	3523	2	2	1
CA	CalPeak Power - Panoche	55508	GT-1	SJV	3811	1	1	1
CA	Pastoria Energy Facility	55656	CT001	SJV	3636	1	1	1
CA	Pastoria Energy Facility	55656	CT002	SJV	3636	2	2	1
CA	Pastoria Energy Facility	55656	CT004	SJV	3636	3	3	1
CA	Hanford Energy Park Peaker	55698	HEP1	SJV	4140	1	1	1
CA	Hanford Energy Park Peaker	55698	HEP2	SJV	4140	2	2	1

CA	Henrietta Peaker Plant	55807	HPP1	SJV	3929	1	1	1
CA	Henrietta Peaker Plant	55807	HPP2	SJV	3929	2	2	1
CA	Tracy Combined Cycle Power Plant	55933	TPP1	SJV	4597	1	1	1
CA	Tracy Combined Cycle Power Plant	55933	TPP2	SJV	4597	2	2	1
CA	Walnut Energy Center	56078	1	SJV	7172	1	1	1
CA	Walnut Energy Center	56078	2	SJV	7172	2	2	1
CA	Ripon Generation Station	56135	1	SJV	4940	1	1	1
CA	Ripon Generation Station	56135	2	SJV	4940	2	2	1
CA	Malaga Power	56239	GT-1	SJV	4305	1	1	1
CA	Malaga Power	56239	GT-2	SJV	4305	2	2	1
CA	Midway Peaking	56639	1	SJV	7286	1	1	1
CA	Midway Peaking	56639	2	SJV	7286	2	2	1
CA	Panoche Energy Center	56803	1	SJV	7220	1	1	1
CA	Panoche Energy Center	56803	2	SJV	7220	2	2	1
CA	Panoche Energy Center	56803	3	SJV	7220	3	3	1
CA	Panoche Energy Center	56803	4	SJV	7220	4	4	1
CA	Algonquin Power Sanger	57564	8	SJV	4071	8	8	1

CA	Lodi Energy Center	57978	CT1	SJV	2697	5	5	1
CA	Delano Energy Center, LLC	58122	GEN1	SJV	6662	2	2	1

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