Sacramento Regional
2008 NAAQS
8-Hour Ozone Attainment And
Reasonable Further Progress Plan

July 24, 2017

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SACRAMENTO REGIONAL

2008 NAAQS

8-HOUR OZONE ATTAINMENT AND

REASONABLE FURTHER PROGRESS PLAN

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

List of Abbreviations and Acronyms

AB -	Assembly Bill
ACC -	Advanced Clean Cars
APCD -	Air Pollution Control District
AQIP -	Air Quality Improvement Plan
AQMD -	Air Quality Management District
ARW -	Advanced Research WRF
ASM -	Acceleration Simulation Mode
AVG -	Average
BAR -	Bureau of Automotive Repair
BVOC -	Biogenic Volatile Organic Compound
BY -	Baseline Year
CAA -	Clean Air Act
CARB -	California Air Resources Board
CEPAM -	California Emissions Projection Analysis Model
CFR -	Code of Federal Regulations
CMAQ -	Community Multiscale Air Quality Model (Chapter 6)
CMAQ -	Congestion Mitigation and Air Quality Improvement (Chapter 7)
CO -	Carbon Monoxide
CO_2 -	Carbon Dioxide
CTG -	Control Techniques Guidelines
CVRP -	Clean Vehicle Rebate Project
DTIM -	Direct Travel Impact Model
DV -	Design Value
EDCAQMD -	El Dorado County Air Quality Management District
EPMP -	Enhanced Fleet Modernization Program
EIS -	Emissions Inspection System
EMFAC -	Emissions Factor California’s on-road motor vehicle emission factor model
EMS -	Emissions Modeling System
ERC -	Emission Reduction Credit

FHWA - Federal Highway Administration

FR - Federal Register

FRAQMD - Feather River Air Quality Management District

FY - Future Year

g/bhp-hr grams per brake horsepower-hour

GVWR - Gross Vehicle Weight Rating

HC - Hydrocarbon

HVIP - Hybrid and Zero Emission Truck and Bus Voucher Incentive Project

HWRF - Hurricane WRF

IC - Internal Combustion

I/M - Vehicle Inspection And Maintenance

LEV - Low Emission Vehicle

LSI - Large Spark Ignition

MCAB - Mountain County Air Basin

MEGAN - Model of Emissions of Gases and Aerosols from Nature

MMM - Mesoscale and Microscale Meteorology

MOZART - Model for OZone And Related chemical Tracers

MPO - Metropolitan Planning Organization

MTC - Metropolitan Transportation Commission (Bay Area)

MTIP - Metropolitan Transportation Improvement Program

MTP - Metropolitan Transportation Plan

MVEB - Motor Vehicle Emissions Budgets

NAAQS - National Ambient Air Quality Standard

NCAR - National Center for Atmospheric Research

NMM - Nonhydrostatic Mesoscale Model

NSR - New Source Review

NO_X - Nitrogen Oxides

OAQPS - Office of Air Quality Planning and Standards

OBD - On Board Diagnostics

OGV - Ocean Going Vehicle

PCAPCD - Placer County Air Pollution Control District

PM - Particulate Matter

ppb - parts per billion

ppm - parts per million

RACM - Reasonably Available Control Measure

RACT - Reasonably Available Control Technology

RFG - Reformulated Gasoline

RFP - Reasonable Further Progress

ROG - Reactive Organic Gases

ROP - rate-of-progress

RPP - Regional Planning Partnership

RRF - Relative Response Factor

RS - Redesignation Substitute

SACOG - Sacramento Area Council of Governments

SAPRC - Statewide Air Pollution Research Center

SCS - Sustainable Communities Strategy

SECAT - Sacramento Emergency Clean Air and Transportation

SFNA - Sacramento Federal Nonattainment Area

SIP - State Implementation Plan

SMAQMD - Sacramento Metropolitan Air Quality Management District

SMOKE – Sparse Matrix Operator Kernel Emissions modeling system

SORE - Small Off-Road Engine

SVAB - Sacramento Valley air Basin

TCM - Transportation Control Measure

TSI - Two Speed Idle

tpd - tons per day

USEPA - United States Environmental Protection Agency

VMT - Vehicle Miles Traveled

VOC - Volatile Organic Compounds

WRF - Weather and Research Forecasting

YSAQMD - Yolo-Solano Air Quality Management District

ZEV - Zero-Emission Vehicle

1 EXECUTIVE SUMMARY

1.1 Background Information on Ozone

Ground-level ozone or “smog” is one of the air pollutants regulated by both federal and state laws. It is a colorless gas formed in the presence of sunlight when precursor pollutants (nitrogen oxides and volatile organic compounds) mix. The high ozone season is during May through October for the Sacramento region.

Ground-level ozone is a strong irritant that adversely affects human health. Breathing ozone can reduce lung function and worsen respiratory problems. Ozone exposure has been associated with increased susceptibility to respiratory infections, cardiac-related effects, medical visits, school absenteeism, and can contribute to premature death, especially in people with heart and lung disease. Ozone can also cause damage to crops and natural vegetation by acting as a chemical oxidizing agent.

Ground level ozone is formed as a result of photochemical reactions involving two types of precursor pollutants: volatile organic compounds (VOCs) and nitrogen oxides (NO_X). VOCs and NO_X are emitted by many types of sources, including on-road and off-road combustion engine vehicles, power plants, industrial facilities, gasoline stations, organic solvents, and consumer products.

1.2 Overview of the 2008 Federal 8-Hour Ozone Standard

The 2008 federal 8-hour ozone National Ambient Air Quality Standard (NAAQS) lowered the health-based limit for ambient ozone from a concentration of 84 parts per billion (ppb) to 75 ppb averaged over eight hours[1]. An area’s nonattainment designation is based on whether the 8-hour ozone design value for any of the monitoring sites in the area exceeds the NAAQS. The Sacramento region is designated a nonattainment area, and includes all of Sacramento and Yolo counties and portions of Placer, El Dorado, Solano, and Sutter counties. This area is referred to as the Sacramento Federal Nonattainment Area (SFNA).

Nonattainment areas are classified as marginal, moderate, serious, severe, or extreme depending on the magnitude of the highest 8-hour ozone design value for the monitoring sites in the nonattainment area. The time period allowed to reach attainment increases with the severity of the classification. Under the United States Environmental Protection Agency’s (USEPA) classification rule for the 2008 8-hour ozone NAAQS -- as well as the prior 1997 standard – the SFNA would have been classified as serious based on its design value of 102 ppb (69 FR 23886) at the Folsom Monitoring Site. But the region previously requested reclassification to severe-15 under the 1997 ozone

[1] Under the 2008 eight-hour ozone standard, an area is designated non-attainment if the annual 4th-highest daily maximum 8-hour ozone concentration averaged over 3 years (i.e., ozone design value) exceeds 75 ppb at a monitoring site.

standard, because it could not attain by the deadline for a serious area. USEPA proposed to extend the voluntary reclassification determination for the 1997 ozone NAAQS to the more stringent 2008 ozone NAAQS. It was unknown at the time whether the SFNA would need the additional years afforded to a severe-15 classification area to meet the 2008 standard; therefore none of the air districts within the SFNA opposed the reclassification. Accordingly, California Air Resources Board (CARB) confirmed that it wanted USEPA to interpret previous voluntary reclassification requests as requests for reclassification under the 2008 ozone NAAQS (Goldstene, 2012). As a result, the SFNA was classified as a severe-15 area (77 FR 30088) with a demonstrated attainment deadline of July 20, 2027. To demonstrate compliance, USEPA reviews the last three complete years of ambient data preceding the attainment date. Therefore, the SFNA actually needs to attain the standard by the end of 2026. When referencing statutory attainment deadlines throughout this document the year 2026 will be used rather than the July 20, 2027 date. As discussed later in this plan, achieving the standard at an even earlier date will follow the same year convention referenced for the Severe-15 deadline.

1.3 Purpose of the Plan

This Plan demonstrates how the SFNA will meet Clean Air Act (CAA) reasonable further progress requirements and demonstrate attainment of the 2008 ozone NAAQS. This Plan also includes an updated emissions inventory, sets motor vehicle emissions budgets, demonstrates how it complies with vehicle miles traveled (VMT) emissions offset and reasonably available control measure (RACM) requirements, and documents the photochemical modeling used to support the attainment demonstration.

1.4 8-Hour Ozone Trends in the SFNA

Air quality trends from 1990 – 2016 at monitoring stations in the SFNA were compared to the 75 ppb 2008 ozone NAAQS to determine progress in reaching attainment. Within the SFNA[2] there are currently 17 active ozone monitoring stations that are operated by either local air districts or CARB. Identifying the number of days exceeding the 2008 NAAQS helps determine control strategy effectiveness.

The annual number of 8-hour ozone exceedance days recorded at the peak monitoring sites fluctuates from year to year due to meteorological variability and changes in precursor emission patterns. Most exceedances of the 2008 NAAQS occurred at the region's eastern monitoring sites: Cool, Folsom, Placerville, and Auburn.

[2] More information about the monitoring sites in Sacramento County can be found at http://www.airquality.org/Air-Quality-Health/Air-Monitoring, and the monitoring sites in the other districts at http://www.arb.ca.gov/aqd/amnr/amnr.htm.

Figure 1-1 illustrates the trend in the number of exceedance days at the SFNA's monitoring sites with the highest number of exceedance days for each year. The graph bars show the monitoring station with the highest number of exceedances in any given year. For 2016, Placerville recorded the most exceedance days. The overall trend line shows a decline in the number of exceedance days per year over the past 27 years, from 70 days in 1990 down to 28 days in 2016, representing a declining rate of about 1.5 days per year.

Figure 1-1 8-Hour Ozone Exceedance Days Trend SFNA – Peak Monitoring Site

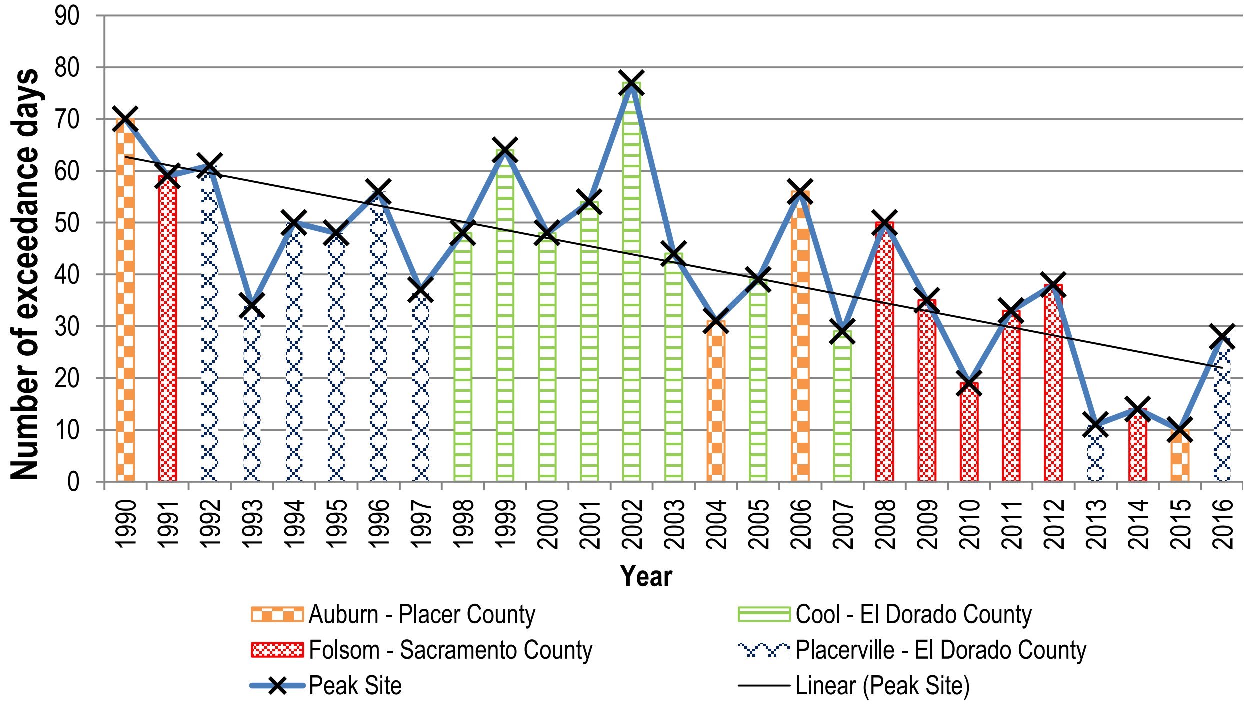
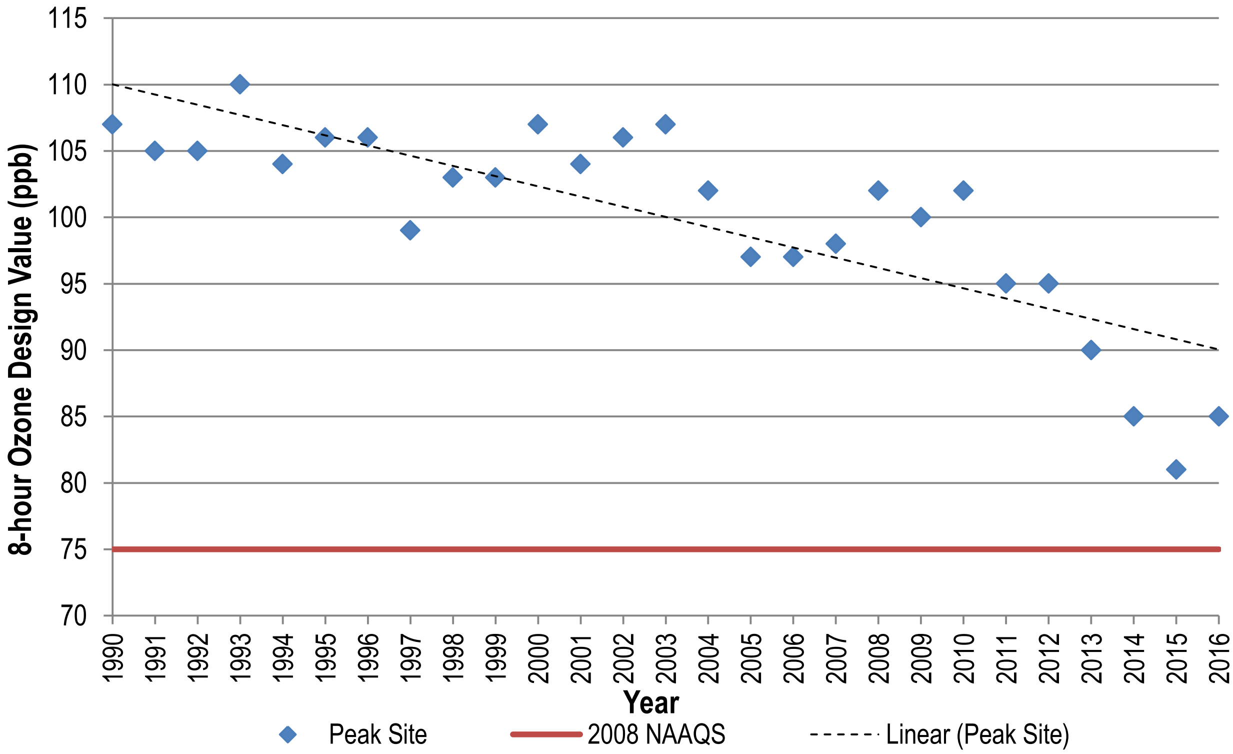


Figure 1-2 shows the ozone design value for the peak monitoring site in each year and a trend line from 1990 to 2016. The overall 27-year trend line indicates a steady decline, from the highest peak of 110 ppb in 1993 down to 85 ppb in 2016. The ozone design value has improved from being 35 ppb (or 46%) over the standard down to about 10 ppb (or 13%) over the standard. The linear trend line in Figure 1-2 shows a declining trend rate of about 0.7 ppb per year.

Figure 1-2 8-Hour Regional Ozone Design Values Trend SFNA



Note: This trend line is the highest 8-hour ozone design values in the region. The current federal 8-hour ozone standard is 75 ppb.

1.5 VOC and NO_X Emissions Inventory

Ozone is not directly emitted into the atmosphere; therefore, planning efforts to evaluate and reduce ozone air pollution include identifying and quantifying the various man-made (anthropogenic) processes and sources of precursor emissions (such as solvents, surface coatings, and motor vehicles, combustion equipment).

The emissions inventory is divided into four broad source categories: stationary sources, area-wide sources, on-road motor vehicles, and other mobile sources. Each of these major categories is further defined into more descriptive equipment types and specific emission processes. The biogenic VOC emissions from vegetation for natural areas, crops, and urban landscapes are estimated separately from the anthropogenic inventory.

The emissions inventory years documented in this plan are 2012 (baseline), 2018 (milestone), 2021 (milestone), and 2024 (attainment year). USEPA emission inventory guidance (USEPA, 2016, p.20) also requires that the State Implementation Plan (SIP) planning emissions inventory be based on estimates of actual emissions for an average summer weekday, typical of the ozone season (May – October). The 2012 base year anthropogenic planning inventory is estimated to be 110 tons per day of VOC emissions and 101 tons per day of NO_X emissions for the SFNA. The base year emissions were used to forecast future year inventories by using socio-economic growth indicators and applying the emission reduction benefits from previously adopted federal, State and local control strategies.

Tables 1-1 and 1-2 show the VOC and NO_X emission inventory forecasts for stationary sources, area-wide sources, on-road motor vehicles, and other mobile sources for the SFNA. The VOC and NO_X emission forecasts show significant declines in mobile source emissions, despite increasing population, vehicle activity, and economic development.

Table 1-1 Emissions Inventory of VOC - SFNA

Emission Category	2012	2018	2021	2024
Stationary Sources	22	22	23	23
Area-Wide Sources	29	29	30	31
On-Road Motor Vehicles	34	20	16	14
Other Mobile Sources	26	20	18	17
Total (tpd)	**110**	**91**	**87**	**84**

Notes: Source (CARB, 2016), does not include 5 tpd of VOC ERCs identified in Appendix A5, Tables A5-1 and A5-2.
Totals may not add exactly due to rounding.

Table 1-2 Emissions Inventory of NO_X - SFNA

Emission Category	2012	2018	2021	2024
Stationary Sources	8	7	7	7
Area-Wide Sources	3	2	2	2
On-Road Motor Vehicles	61	35	26	19
Other Mobile Sources	30	26	23	21
Total (tpd)	**101**	**69**	**58**	**49**

Notes: Source (CARB, 2016), does not include 4 tpd of NO_X ERCs identified in Appendix A5, Tables A5-1 and A5-2.
Totals may not add exactly due to rounding.

1.6 Air Quality Modeling Analysis

To evaluate the attainment of the 2008 8-hour NAAQS, future ozone concentrations were forecasted under changing emission scenarios. Extensive air monitoring and emissions data were collected or estimated for high ozone episodes to provide information for developing base case model simulations.

The photochemical modeling simulations cover May 1, 2012 through Oct 5, 2012 in the SFNA. The simulations were based on 2012 base case year emissions and future year emissions. The future emissions were used to determine if the ozone standard would be attained with existing control strategies. Two future years, 2026 and 2022 were evaluated in determining attainment. Photochemical modeling was done for 2026 since it is the attainment deadline for the SFNA. Based on the air quality data and emissions inventory trends, CARB and the SFNA air districts decided to investigate 2022 as another future modeling year for attainment demonstration.

The modeling results at the Folsom station indicate that both VOC and NO_X reductions provide ozone benefits in the SFNA, but NO_X reductions provide greater ozone benefits than VOC reductions. To lower 1 ppb of ozone, the SFNA can reduce 35 tpd of VOC emissions or 1.7 tpd of NO_X emissions. The modeling results project that the SFNA would attain the 2008 NAAQS between 2022 and 2026.

1.6.1 2024 Attainment Demonstration

Although the CAA sets deadlines for attainment, CAA Sections 172(a)(2)(A) and 181(a) also require nonattainment areas to meet the clean air standards "as expeditiously as practicable." The modeling results predicted that the future design value at the Folsom monitor[3] for 2022 would be 75.2 ppb and for 2026 would be 70.7 ppb. The SFNA would attain the 2008 NAAQS by 2022 based on USEPA guidance[4] without additional future regional and local VOC or NO_X control strategies. The Districts are proposing in this plan an attainment year of 2024, which is between the two modeled years of 2022 and 2026. This is two years earlier than the December 31, 2026 attainment demonstration date for a severe-15 classification[5]. An attainment year of 2024 provides a safeguard against inherent uncertainties in predicting ambient ozone concentrations, particularly in light of the uncertainties in emission reductions, meteorology, or natural events (see discussion of modeling uncertainties in Section 6.11). Base year and future emission forecasts were used to estimate the percent reduction in NO_X and VOC emissions needed from the 2012 base year to the 2024 attainment year. Based on the NO_X emissions projection provided by CARB, the design value at the Folsom monitor is estimated to be 72.1 ppb in 2024.

3 Folsom monitoring station was identified as the peak ozone monitoring site for the modeling. The 2012 weighted design value was 90 ppb.

4 USEPA draft modeling guidance truncates the future design value after decimal point (USEPA, 2014, p.106).

5 The regulatory attainment date of July 20, 2027 means that the region must demonstrate attainment by the end of 2026.

1.7 Control Measure Evaluation

The photochemical modeling results demonstrate that the SFNA does not need additional future regional and local control measures, but this SIP still relies on the reductions from existing local and regional control measures and adopted rules and reductions from existing state and federal regulations.

The SFNA air districts are implementing existing regional and local control measures (including stationary source measures), and are assisting the Sacramento Area Council of Governments (SACOG) in implementing existing transportation control measures. The agencies track the implementation of the control measures and monitor the success of the measures and TCMs committed to in the 1994 SIP (SMAQMD et al, 1994) and 2013 SIP (SMAQMD et al, 2013). CARB also tracks the implementation and success of mobile sources emissions control programs.

The Implementation of the 2008 NAAQS for Ozone: State Implementation Plan Requirements Rule (40 CFR 51.1112) requires that the state adopt all reasonably availably control measures necessary to demonstrate attainment as expeditiously as practicable (which the USEPA has defined as measures that, cumulatively, will advance attainment by at least one year) and to meet any reasonable further progress (RFP) requirements. The RACM analysis (Appendix E) considered all measures that are potentially reasonably available, and concluded that the measures would not advance attainment by an additional year (from 2024 to 2023), and as shown on Table 12-1, the measures were not necessary to meet the 3% per year RFP requirements. Therefore, no new local or regional control measures were needed in this SIP to meet CAA requirements.

1.8 Transport Analysis

The air quality in the SFNA can be impacted by pollutant transport from the San Francisco Bay Area and the San Joaquin Valley. Delta breezes carry air pollutants from coastal Bay Area and San Joaquin Valley emission sources downwind to the inland areas of the Sacramento region, and these pollutants may contribute to ozone formation during the same day or the following days. The CARB has determined that the relative impact on air quality in the Sacramento region, from the Bay Area and San Joaquin Valley pollutant transport can be considered overwhelming, significant, or inconsequential depending on meteorological conditions (CARB, 2001, p.25 and p.37). Various studies (Appendix B-2, p.27 and p.28) over the past two decades also reaffirmed that a strong sea breeze with a deep marine boundary layer from the San Francisco Bay Area enhanced pollutant transport into the Sacramento Delta Region. The air flow pattern in the Sacramento Valley (Schultz eddy) also causes pollutants to recirculate and become trapped in the Sacramento region.

1.9 Transportation Conformity and Motor Vehicle Emissions Budgets (MVEB)

Under the CAA, federal agencies may not approve or fund transportation plans and projects unless they are consistent with the SIP. Transportation conformity with the SIP requires that transportation activities not cause new air quality violations, worsen existing violations, or delay timely attainment of the NAAQS. Conformity regulations state that emissions from transportation plans and projects must be less than or equal to the MVEB established by reasonable further progress, attainment or maintenance plans (SIPs)(40 CFR 93.118).

Table 1-3 shows the transportation conformity MVEB for VOC and NO_X in the SFNA for the milestone (RFP) years of 2018 and 2021 as well as the attainment year of 2024. The budgets are consistent with the emissions inventory used to demonstrate reasonable further progress and attainment.

The MVEB use EMFAC2014 with SACOG modeled VMT and speed distributions. The CARB staff released a revised emission rate program, EMFAC2014, which updates the emission rates and planning assumptions used in calculating conformity budgets. The proposed MVEB will become effective after USEPA finds them adequate or approves the plan, whichever occurs first.

Table 1-3 MVEB for the 2008 8-hour Ozone NAAQS in the SFNA

SFNA	2018		2021		2024	
Unit: tons per day	VOC	NO_X	VOC	NO_X	VOC	NO_X
Baseline Emissions	19.85	35.38	16.24	26.96	14.03	19.55
Margin of Safety				0.5		
Total	19.85	35.38	16.24	27.46	14.03	19.55
Conformity (Emissions) Budget	20	36	17	28	15	20

Note: The budgets are calculated with EMFAC2014 using SACOG 2016 MTP activity and Bay Area Metropolitan Transportation Commission (MTC) data for Eastern Solano County. They reflect the latest regional and state strategies described in Chapter 7. Budgets are rounded up to the nearest ton.

The MVEB incorporated a “safety margin” (40 CFR 93.101; 40 CFR 93.124) of 0.5 tpd of NO_X in 2021. Table 1-3 shows the budgets decline significantly from 2018 through 2024, for both NO_X and VOCs, which will ensure continued progress towards attainment of the 8-hour ozone standard.

1.9.1 Vehicle Miles Traveled Offset (VMT Offset)

Section 182(d)(1)(A) in the CAA requires severe and extreme nonattainment areas to submit VMT offset demonstrations showing that has adopted sufficient transportation measures to offset the any growth in vehicle emissions over the attainment plan period (USEPA, 2012). USEPA Guidance states that these demonstrations must show that

VMT emissions in the attainment year (assuming predicted VMT growth and imposition of new transportation control measures) are equal to or less than the modeled emissions in the attainment year assuming no growth in VMT and no new transportation measures added. The VMT offset demonstration in Appendix C meets this requirement by showing that the full motor vehicle control program emissions in the attainment year are lower than the emissions from the motor vehicle control program frozen at 2012 levels. Consequently, the identified transportation control strategies and TCMs are sufficient to offset the growth in emissions due to growth in VMT and satisfy the VMT Offset requirements. The VMT offset demonstration prepared by CARB is available in Appendix C.

1.10 General Conformity

General conformity is the federal regulatory process for preventing major federal actions or projects from interfering with air quality planning goals. Conformity provisions ensure that federal funding and approval are given only to those activities and projects that are consistent with SIPs. Conformity with the SIP means that major federal actions will not cause new air quality violations, worsen existing violations, or delay timely attainment of the NAAQS. A federal agency may demonstrate conformity by showing that the total of direct and indirect emissions from the action is accounted for in the applicable SIP's attainment or maintenance demonstration.

There were no changes to the general conformity regulations made as part of the 2008 NAAQS implementation guidance (80 FR 12284). The existing de minimis emissions levels contained in 40 CFR 93.153(b)(1) will continue to apply to the 2008 ozone NAAQS. There are no additional set aside emissions included in the general conformity analysis as part of this SIP.

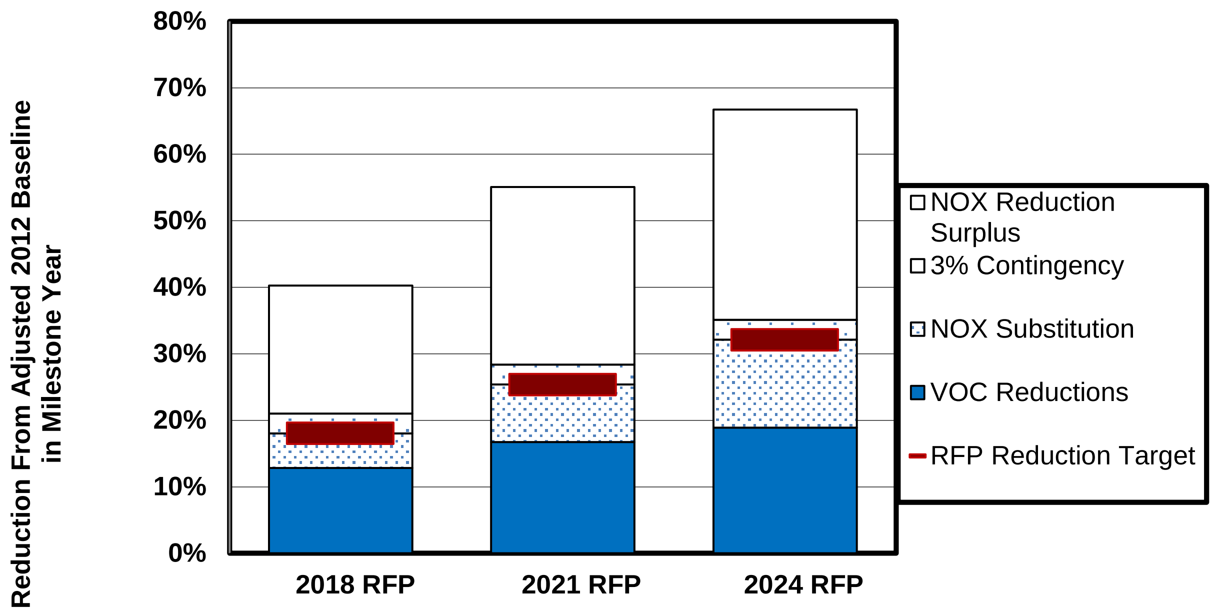
1.11 Reasonable Further Progress Demonstration

The federal 2008 8-hour ozone regulations (70 FR 71634) require that areas classified as "serious or above" submit a RFP demonstration plan that provides for at least 3% average annual reductions of VOC (and/or NO_X) emissions every 3-year period after 2008 out to the attainment year. The RFP demonstration fully accounts for emissions growth when calculating the net emission reductions.

The RFP evaluation shown on Figure 1-3 is based on the emission inventory forecasts, which assume expected growth rates and existing control measures. The 3 year RFP demonstrations are achieved through VOC and NO_X emission reductions for 2018 and 2021 (milestone years), and 2024 (attainment year). Figure 1-3 also shows the percentages of VOC and NO_X emission reductions used to meet the RFP reduction goals.

The RFP demonstrations are determined by forecasted emission reductions from existing control regulations and already adopted control measures. Additional emission reductions from new measures are not required to achieve the RFP and contingency demonstrations. Both VOC and NO_X emission reductions are needed to meet the RFP reduction targets. The NO_X substitution is used on a percentage basis to cover any VOC percentage shortfalls. The amount of NO_X emission reductions (13%) required to offset the VOC shortfalls in the attainment year is less than the total predicted NO_X reductions (48%) in 2024.

Figure 1-3 Summary of Reasonable Further Progress Demonstrations - SFNA



1.12 Conclusions

1. Since 1990, the SFNA shows a declining trend in exceedances of the 2008 8-hour ozone NAAQS and ozone design value concentrations, with the most frequent and highest violations occurring at SFNA's eastern monitoring sites: Cool, Folsom, Placerville, and Auburn.
2. The VOC and NO_X emissions inventory forecasts through 2024 show significant declines in mobile source emissions, despite increasing population, vehicle activity, and economic development in the Sacramento region.
3. Photochemical modeling results indicate that the combined reductions from existing local strategies, regional, state, and federal control measures are sufficient to demonstrate attainment by 2024.
4. No new regulatory VOC or NO_X control measures at the regional and local level are proposed for adoption in this plan.
5. New transportation conformity emission budgets are being proposed for the SFNA. The budgets incorporate the recent EMFAC2014 motor vehicle emission

factors, updated travel activity data, and latest transportation control strategies and TCMs.

6. Reasonable further progress demonstrations will be achieved through a combination of VOC and NO_X reductions for the milestone years of 2018, 2021, and the 2024 attainment analysis year.

7. Future ozone planning efforts will include the preparation of progress (milestone) reports to assess reasonable further progress.

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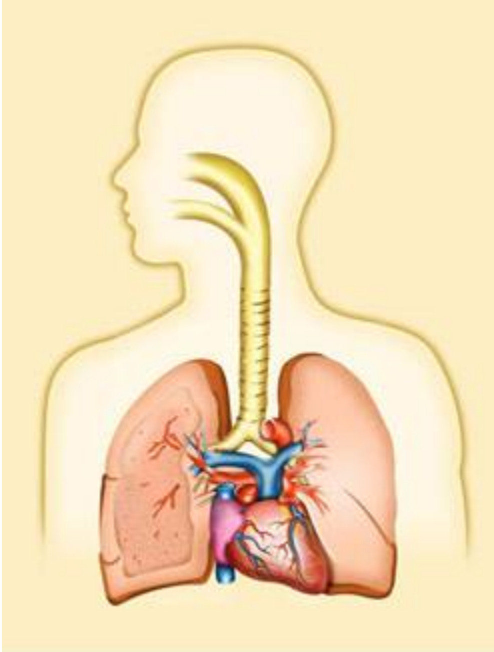
2 BACKGROUND INFORMATION AND PLAN DEVELOPMENT OVERVIEW

2.1 Background Information

2.1.1 Ozone Health Effects

Ground-level ozone is one of the air pollutants regulated by both federal and state laws. It is a colorless gas formed in the presence of sunlight when precursor pollutants (nitrogen oxides and volatile organic compounds) mix together.



Effects on the Airways. Ozone is a powerful oxidant that can irritate the air ways causing coughing, a burning sensation, wheezing and shortness of breath and it can aggravate asthma and other lung diseases.

Ozone is a strong irritant that adversely affects human health. Ozone exposure can cause health issues, especially in sensitive groups: children, the elderly, people suffering from chronic diseases, and outdoor workers. Children are at a greater risk from exposure to ozone, especially at higher concentrations because their respiratory system is still developing and they are likely to be outdoors and more active.

Breathing ozone can trigger a variety of health problems which may:

- Create difficulty breathing deeply and vigorously
- Create a shortness of breath and pain when taking a deep breath
- Cause coughing and create a sore or scratchy throat
- Inflame and damage the airways and lung tissue
- Exacerbate lung diseases such as asthma, emphysema, and chronic bronchitis
- Increase risk of cardiovascular problems, such as heart attacks and strokes
- Make the lungs more susceptible to infection
- Continue to damage the lungs even when the symptoms have disappeared

These effects may lead to an increase in: school absences, medication use, visits to doctors, emergency rooms, and number of hospital admissions. Recent research also indicates that ozone exposure may increase the risk of premature death from heart or lung diseases (USEPA, 2014).

Reducing ground level ozone to concentrations below federal and state standards is one of the primary goals of the air districts in the Sacramento Federal Nonattainment Area (SFNA).

2.1.2 Ecosystem Effects

In addition to health effects, ozone also affects vegetation and ecosystems, e.g. forests, parks, wildlife refuges, and wilderness areas. Ozone harms sensitive vegetation and can reduce tree and plant growth during the growing season.

Plant species that are sensitive to ozone are potentially at an increased risk from exposure, disease, damage from insects, and harm from severe weather. This includes trees such as black cherry, quaking aspen, ponderosa pine, and cottonwood which are found in many areas of the country, including the SFNA.

When sufficient ozone enters the leaves of a plant, it can:

- Interfere with the ability to produce and store food
- Visibly damage the leaves of trees and other plants, harming the appearance of vegetation in urban areas, national parks, and recreation areas.

These effects can also have adverse impacts on ecosystems, including loss of species diversity and changes to habitat quality, water, and nutrient cycles (USEPA, 2012).

Ground level ozone is absorbed by the leaves of plants, where it can reduce photosynthesis, damage leaves and slow growth. It can also make sensitive plants more susceptible to certain diseases, insects, harsh weather and other pollutants.

2.1.3 Ozone Formation and Precursor Pollutants

Ozone is a gas composed of three oxygen atoms. It is not emitted directly into the air from pollution sources. At ground level, it is generated through chemical reactions between volatile organic compounds (VOCs) and nitrogen oxides (NO_X) in the presence of sunlight. VOCs and NO_X are known as ozone “precursors.”

These precursors are emitted by many types of anthropogenic and biogenic sources. Anthropogenic (man-made) sources include on-road and off-road combustion engine vehicles, power plants, industrial facilities, gasoline stations, organic solvents, and consumer products; and biogenic sources include natural areas, crops, and urban vegetation. VOC pollutants are also known as reactive organic gases (ROG).

2.2 National Ambient Air Quality Standards (NAAQS) for Ozone

2.2.1 1979 1-Hour Ozone Standard (124 ppb)

The first comprehensive national air pollution legislation was the federal Clean Air Act (CAA) of 1970. The CAA was amended in 1977 and required states to prepare air quality plans to meet national ambient air quality standards (NAAQS). To further protect the public from unhealthy ozone levels, the United States Environmental Protection Agency (USEPA) revised[6] the NAAQS for ozone in 1979 to a concentration of 124 parts per billion (ppb) averaged over one hour[7].

Congress amended the CAA in 1990, revising the original attainment deadlines and establishing new planning requirements. In 1991, the Sacramento region was designated as a “serious” nonattainment area for the 1-hour ozone standard. The region was required to submit an attainment demonstration plan for the 1-hour ozone standard to USEPA by November 15, 1994 and was required to meet the new standard by 1999. CARB submitted the Sacramento Area Regional Ozone Attainment Plan to USEPA on November 15, 1994 (SMAQMD et al, 1994) and USEPA approved the plan on January 8, 1997 (62 FR 1150).

Attainment and Reasonable Further Progress Plan

Air quality modeling was conducted to simulate future ozone formation and evaluate the effectiveness of emission control scenarios. This modeling projected that the region would not attain the standard by 1999.

Because the emissions reductions from the proposed control strategies would not be adequate to meet the standard, the five air district’s that comprise the SFNA proposed to the California Air Resource Board (CARB) that the region be reclassified from “serious” to “severe-15.” USEPA approved the voluntary reclassification request (bump up) from a “serious” classification to a “severe-15” classification. The reclassification extended the deadline to November 2005. The change became effective June 1, 1995 (60 FR 20237).

Air quality data collected between 2007 and 2009 established that the Sacramento region met the 1-hour standard. Several high ozone days (June 23, June 27, and July 10, 2008) at the Folsom monitoring station were excluded from the attainment demonstration analysis calculations because they were attributable to wildfires.[8] USEPA

6 A one hour ozone standard was developed and approved in April 30, 1971 for total photochemical oxidants (36 FR 8186).

7 A one-hour ozone standard violation is defined as no more than 3 daily exceedances (>124 ppb) over 3 years at a monitoring site.

8 The analysis demonstrating why this data was excluded is contained in the “Exceptional Events Demonstration for High Ozone in the Sacramento Regional Nonattainment Area Due to Wildfires” (SMAQMD, 2009).

issued a determination (77 FR 64036) on October 18, 2012 finding that the Sacramento Region attained the federal 1-hour ozone standard.

2.2.2 1997 8-Hour Ozone Standard (84 ppb)

In July 1997, USEPA promulgated a new ozone standard, which considered prolonged exposure (62 FR 38856). This change lowered the health-based standard and increased the exposure time for ambient ozone from 124 ppb averaged over one hour to 84 ppb averaged over eight hours. The 8-hour standard considers the effect of greater exposure and is more protective of public health and more stringent than the previous 1-hour standard. An area is designated nonattainment if the annual 4th highest daily maximum 8-hour ozone concentration averaged over 3 years (i.e., ozone design value) is over the NAAQS of 84 ppb.

Classification and Voluntary Reclassification

In 2004, the Sacramento region was classified as a serious nonattainment area for the 1997 8-hour standard (69 FR 23858) with an attainment deadline of June 15, 2013. The region determined that it could not meet the 2013 attainment date because it needed to rely on longer term emission reduction strategies from state and federal mobile source control programs. Consequently, on February 14, 2008, CARB, on behalf of the air districts in the Sacramento region, requested that USEPA reclassify (bump-up) the SFNA from “serious” to “severe-15.” USEPA granted the voluntary reclassification request on May 5, 2010 (75 FR 24409), pushing the attainment deadline to June 15, 2019[9] (Goldstene, 2008).

Attainment and Reasonable Further Progress Plan

Air Districts within the SFNA and CARB prepared an attainment demonstration and reasonable further progress plan that included the updated emissions inventory, commitments to adopt and implement new reasonably available control measures, and new emission budgets for transportation and general conformity. On January 29, 2015, USEPA approved (80 FR 4795) the Sacramento Regional 8-hour Ozone Attainment and Reasonable Further Progress Plan (SMAQMD et al., 2013).

2.2.3 2008 8-hour Ozone Standard (75 ppb)

On March 27, 2008, USEPA promulgated a more stringent 8-hour ozone NAAQS of 75 ppb, based on findings from new health studies (73 FR 16436). The new standard provides additional protection for children and other at risk populations against ozone related adverse health effects. USEPA retained the region’s severe-15 classification for the 2008 NAAQS (40 CFR 51.1103(d)).

[9] In order to attain by June 15, the prior year’s ozone season would need to be in attainment, making 2018 the attainment demonstration analysis year.

As a result, the SFNA was classified as a severe-15 area (77 FR 30088) with an attainment deadline of July 20, 2027 (42 U.S. Code § 7511). As a practical matter, this translates to an attainment demonstration deadline of December 31, 2026, because the attainment demonstration must be based on the full calendar years of monitoring data. Consequently, this SIP will refer to 2026 for the attainment demonstration date rather than the 2027 statutory deadline.

2.2.4 2015 Ozone Standard (70 ppb)

On October 26, 2015 USEPA issued a revised, more stringent 8-hour standard of 70 ppb (80 FR 65292).The revised NAAQS strengthens the nation's air quality standards for ground-level ozone to improve public health and environmental protection, especially for at-risk groups including children and older adults. Future planning efforts will address this standard. At this time, the 2008 NAAQS standard has not been revoked.

2.3 Revoked National Ambient Air Quality Standards

The NAAQS for ozone has become more health protective since the CAA was first adopted. USEPA revoked both the 1979 1-hour standard and 1997 8-hour standard. CAA Sections 108 and 109 require periodic review of the standards themselves, and the science upon which these and all standards are based.

2.3.1 1979 1-Hour Standard

On April 30, 2004, USEPA published the Final Phase 1 Rule (69 FR 23951) to implement the 1997 8-hour ozone NAAQS, which revoked the 1-hour ozone NAAQS. This revised the standard from a 1-hour value of 124 ppb to an 8-hour value of 84 ppb.[10] The 1-hour standard was revoked in California effective June 1, 2005 (70 FR 44470), but the region remains subject to anti-backsliding requirements intended to insure the area is able to maintain compliance with the standard (40 CFR 51.1105). These measures are summarized in section 2.3.4

2.3.2 1997 8-Hour Standard

On March 6, 2015, USEPA published the Final Rule (80 FR 12264) to implement the 2008 8-hour ozone NAAQS, which revoked the 1997 8-hour standard. The 8-hour standard was lowered to 75 ppb for both the primary and secondary standards to further protect public health and welfare. (80 FR 65292). The anti-backsliding requirements discussed under 2.3.4 also remain in place for the revoked 1997 8-Hour standard.

[10] USEPA implemented the Phase 2 Final Rule (70 FR 7612) for the 2008 8-hour NAAQS in 2005, which established control and planning obligations: reasonably available control technology and measures (RACT and RACM), reasonable further progress (RFP), modeling, and attainment demonstrations, and new source review (NSR).

2.3.3 Redesignation Substitution Request

The anti-backsliding requirements must remain in place for the 1979 and 1997 standards until USEPA redesignates the areas as attainment. The Air Districts are developing a Redesignation Substitution (RS) Request for the former 1979 1-hour standard. The RS Request demonstrates that the SFNA has attained, and will continue to attain this standard.

Upon approval by the USEPA of the RS Request, the state may request that New Source Review (NSR) requirements be removed from the State Implementation Plan (SIP) and that other anti-backsliding measures be shifted to contingency measures (40 CFR 51.1105(b)(2)). Anti-backsliding control requirements include the possible collection of CAA Section 185 major stationary source penalty fees. Future fees could also be required for the 2008 NAAQS if the region does not attain the standard by the attainment date.

2.3.4 Anti-Backsliding Requirements

The CAA allows for nonattainment NSR to be removed from the SIP, and allows anti-backsliding measures to be shifted to contingency measures in the SIP provided that the action is consistent with CAA Sections 110(l) and 193 (40 CFR 51.1105(b)(2)). Since the SFNA was severe under both the 1979 and 1997 standards, it must adopt all the measures required for marginal, moderate and serious nonattainment areas, in addition to measures required for severe areas.

The region is also classified as a severe-15 nonattainment area for the 2008 NAAQS. Because the classification is the same, all of the requirements that were applicable under the prior NAAQS are applicable under the 2008 NAAQS. Consequently, these anti-backsliding measures are still requirements to be included in the 2008 SIP.

The anti-backsliding requirements that are applicable for the SFNA under a severe standard are:

1. Vehicle Miles Traveled (VMT) - Transportation Control Measures (TCMs) analysis of measures to offset any growth. [CAA section182(d)(1)]
2. Nonattainment New Source Review (NSR) – permitting program under CAA section 172(c)(5) with major source thresholds under CAA section 182(d) and offset ratios under CAA section 182(d)(2). The area will remain subject to the obligation to adopt and implement the major source threshold and offset requirements for NSR that apply to severe nonattainment areas. [CAA section 182(d) and 182(d)(2)].
3. CAA section 185 Fee Requirements - Major stationary sources within the SFNA could be subject to the collection of CAA section 185 fees if the region fails to attain the standard by the attainment date. Fees could be assessed for each year

after the attainment date, until the area is re-designated to attainment. [CAA section 182(d)(3)].

4. Reasonably available control technology (RACT) under CAA sections 172(c)(1) and 182(b)(2).
5. Vehicle Inspection and maintenance programs (I/M) under CAA sections 182(b)(4) and 182(c)(3).
6. Reductions to achieve Reasonable Further Progress (RFP) under CAA sections 172(c)(2), 181(b)(1)(A), 182(c)(2)(B).
7. Clean fuels fleet program under CAA section183(c)(4).
8. Enhanced (ambient) monitoring under CAA section182(c)(1).
9. Transportation controls under CAA section182(c)(5).
10. NO_X requirements under CAA section 182(f).
11. Attainment demonstration requirements under CAA sections 172(c)(4), 181(b)(1)(A), 182(c)(2).
12. Nonattainment contingency measures required under CAA sections 172 (c)(9) and 182(c)(9) for failure to attain by the applicable deadline or to meet RFP milestones.
13. Contingency Measures - CAA section172(c)(9) and 182(c)(9) – An area is required to meet this requirement in their SIPs. (77 FR 28424)
14. Reasonably available control measures (RACM) requirements under CAA Section 172 (c)(1).

2.4 Development of the Sacramento Regional 8-Hour Ozone Attainment and Reasonable Further Progress Plan

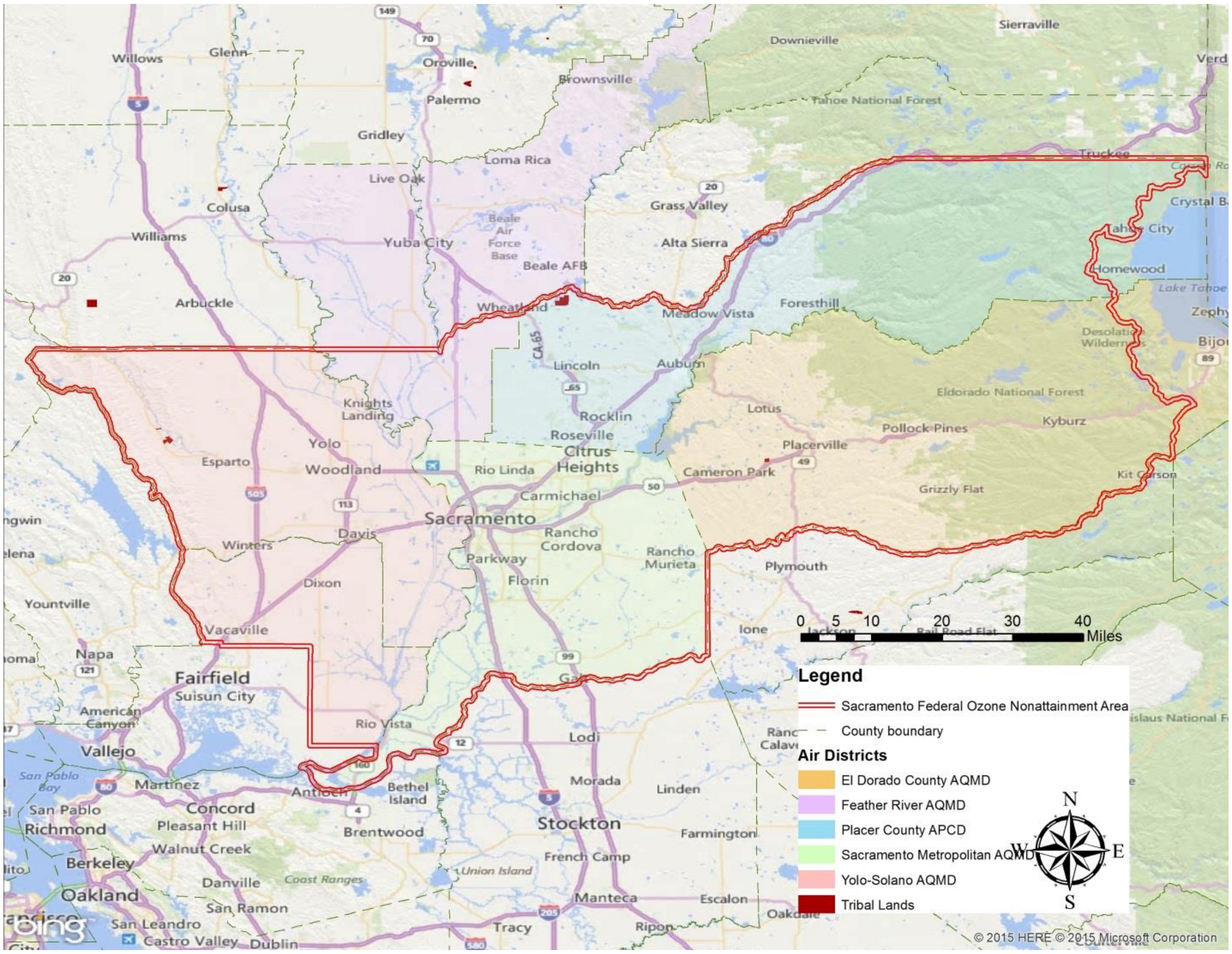
This ozone Attainment Demonstration and Reasonable Further Progress Plan was developed for the Sacramento region by the five air districts in the nonattainment area with participation from the CARB, the Sacramento Area Council of Governments (SACOG), and the Bay Area Metropolitan Transportation Commission (MTC)[11]. The five local air districts include: El Dorado County Air Quality Management District (EDCAQMD), Feather River Air Quality Management District (FRAQMD), Placer County Air Pollution Control District (PCAPCD), SMAQMD, and Yolo-Solano Air Quality Management District (YSAQMD). SACOG and MTC are the metropolitan planning organizations (MPO) for transportation planning in the SFNA.

Figure 2-1 shows the boundaries of the Sacramento Federal Ozone Nonattainment Area (SFNA) which includes all of Sacramento and Yolo counties and portions of Placer, El Dorado, Solano, and Sutter counties. The non-attainment area boundaries

[11] MTC is the MPO for the east Solano County portion of the Sacramento nonattainment area.

are the same boundaries for the 1997 8-hour ozone standard (69 FR 23858) and 2008 8-hour (77 FR 30088) ozone standard.

Figure 2-1 Sacramento Federal Ozone Nonattainment Area



This air quality plan utilizes the latest planning assumptions from the 2016 Metropolitan Transportation Plan/Sustainable Communities Strategy (2016 MTP/SCS). The 2016 MTP/SCS is a long-range transportation plan that is built on the Blueprint[12] concept. The SACOG Board adopted this plan on February 18, 2016. SACOG is the transportation planning agency responsible for conformity determinations[13] in the SFNA and was a key contributor in the development of the motor vehicle emissions inventory and review of transportation control measures. Updated activity data based on the

[12] This program was initiated by SACOG with the goal of reducing traffic congestion in the future metropolitan transportation plans. Blueprint is discussed further in Chapter 10.

[13] Conformity determination ensures that transportation plans and projects are consistent with the applicable SIP. A conformity determination is discussed further in Chapter 10.

2017/2020 Metropolitan Transportation Improvement Program (MTIP)[14] was used in setting the baseline projections for the motor vehicle inventory. The 2017/2020 MTIP/SCS will be included as Amendment #1 to the 2016 MTP/SCS.

2.4.1 Purpose of Plan

This plan demonstrates how the region will reduce emissions to meet CAA reasonable further progress requirements and demonstrate attainment of the 2008 ozone NAAQS of 75 ppb. The Federal CAA General Nonattainment Plan Requirements for a severe area are discussed in Appendix F. This plan includes an updated emissions inventory, sets motor vehicle and general conformity emissions budgets, describes the photochemical modeling used to support the attainment demonstration, and demonstrates how it complies with vehicle miles traveled (VMT), emissions offset and reasonably available control measure (RACM) requirements. It will be part of California's State Implementation Plan (SIP). The California SIP includes plans for each of the state's nonattainment areas, along with rules, regulations, and other control strategies adopted by air districts and the California Air Resource Board (CARB). After this Plan is reviewed and approved by CARB, it will be submitted to USEPA for federal review and approval.

2.4.2 Photochemical Modeling

CARB conducted photochemical modeling for 2022 and 2026 to determine when the region would attain the 2008 NAAQS. This modeling is used to simulate the formation of ozone through mathematical descriptions of atmospheric processes and photochemical reactions of pollutants over large regional air basins. A detailed discussion of the photochemical modeling and results is presented in Chapter 6 and Appendix B.

2.4.3 Interagency Collaboration

Several committees and working groups provided input on technical and policy issues during the development of this Plan.

- The Regional Planning Partnership (RPP) consisted of participants from the various agencies mentioned above and from the California Department of Transportation, USEPA, and Federal Highways Administration. The RPP is assembled to coordinate the efforts of the local, state, and federal governmental agencies directly involved in the preparation or review of the MTP and is responsible for inter-agency consultation on motor vehicle emissions budgets, conformity determinations and transportation control measures.

[14] Conformity analysis adopted by the SACOG Board for the 2016 MTP/SCS Amendment #1 and 2017/2020 MTIP.

- The Regional Air Pollution Control Officers Committee for the Sacramento region helped to discuss and coordinate SIP topics and concerns.
- The State Implementation Plan Inventory Working Group (SIPIWG) provided a platform for sharing information and updating status regarding the emissions inventory development among air districts, USEPA, and CARB.

2.4.4 Public Input and Review Process

This Plan meets the requirements of CAA Section 110(a)(2) which requires reasonable notice and public hearing for plan adoptions. The Board of Directors for each of the air districts in the SFNA provided notice and held a public hearing prior to adopting the plan.

Stakeholder groups helped to disseminate information and seek input during the development of the plan. These included the Sacramento Cleaner Air Partnership, SACOG's Climate and Air Quality Committee and Regional Planning Partnership, and the Chamber of Commerce's Air Quality and Transportation Committee. These stakeholders represent business interests, environmental groups, transportation agencies, local government, and other community organizations. In addition, representatives for the various Native American tribes in the Sacramento region were contacted and invited to participate in the process.

2.5 Contents of 8-Hour Ozone Plan

This document includes information and analyses that fulfills the 2008 8-hour ozone NAAQS attainment demonstration and reasonable further progress planning requirements for the SFNA.

Table 2-1 SIP Plan Chapter Description

Chapter	Title	Descriptions
1	Executive Summary	Executive summary of the 8-hour ozone plan
2	Background Information and Plan Development Overview	An introduction that contains background information on ozone health effects, ozone formation, the federal ozone standards, and an overview of the plan's development process
3	Federal Clean Air Act Requirements	Explains the purpose of the attainment plan and defines federal Clean Air Act 8-hour ozone requirements for the region
4	Air Quality Trends	Analyzes and illustrates 8-hour ozone air quality trends in the Sacramento region
5	Emissions Inventory	Presents the 2012 base year emissions inventory and the emission forecasts that are based on existing control strategies and growth assumptions
6	Air Quality Modeling Analysis	Characterizes the air quality modeling simulations and predictions, and analysis of results for determining attainment emission targets
7	Control Measures	Describes the Reasonable Available Control Measure (RACM) analysis that was conducted and provides an overview of the control measures that were evaluated as part of the process
8	Attainment Demonstration	Shows the 8-hour ozone attainment demonstration for the SFNA using the emission forecasts, photochemical modeling results, and the proposed control strategy scenario
9	Transport Analysis	Discusses inter-basin pollutant transport issues and addresses transport assumptions included in the photochemical modeling
10	Transportation Conformity and Emissions Budget	Documents the motor vehicle emissions budgets for transportation conformity purposes. This chapter also provides an analysis demonstrating that the SFNA meets the vehicle miles traveled (VMT) Offset requirements under CAA section 182(d)(1)(A)
11	General Conformity	Explains general conformity requirements and provides estimates for forecasted airport emissions
12	Reasonable Further Progress Demonstrations	Demonstrates how the Reasonable Further Progress emission reduction requirements will be achieved
13	Summary and Conclusions	Summarizes the key points and major conclusions of this report, and mentions expected future air quality planning efforts by the air districts

Additional documentation for the more technical sections of the 8-hour ozone attainment plan is contained in the following Appendices:

A – Emissions Inventory
B – Photochemical Modeling
C – Motor Vehicle Emissions Budgets and VMT Offset Analysis
D – Reasonable Further Progress Demonstrations
E – Reasonably Available Control Measures (RACM) Analysis

F – Federal Clean Air Act Requirements

2.6 References

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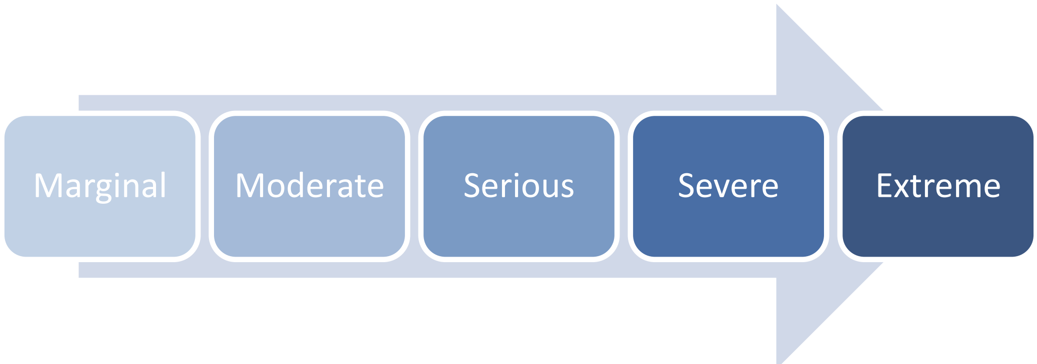
3 FEDERAL CLEAN AIR ACT REQUIREMENTS

3.1 Introduction

The Clean Air Act (CAA) requires that the United States Environmental Protection Agency (USEPA) designate areas as attainment or nonattainment based on how measured pollutant levels compare to standards. Nonattainment areas are classified as marginal, moderate, serious, severe, or extreme (Figure 3-1) based on "such factors as the severity of nonattainment in such area and the availability and feasibility of the pollution control measures that the Administrator believes may be necessary to provide for attainment of such standard in such area (CAA Section 172)."

Figure 3-1 Air Quality Classifications



3.2 Nonattainment Classification and Sacramento Federal Ozone Nonattainment Area

Under USEPA's classification approach for the 2008 8-hour ozone National Ambient Air Quality Standard (NAAQS) the Sacramento Federal Nonattainment Area (SFNA) would have been classified as serious based on its design value of 102 ppb (69 FR 23886) at the Folsom Monitoring Site. USEPA proposed to extend the voluntary reclassification determination for the 1997 ozone NAAQS to the more stringent 2008 ozone NAAQS unless a state explicitly requested otherwise. It was unknown at the time whether the SFNA would need the additional attainment time afforded under the severe-15 classification, so no air district within the SFNA opposed the reclassification. Accordingly, CARB confirmed that it wanted USEPA to interpret previous voluntary reclassification requests as requests for reclassification under the 2008 ozone NAAQS (Goldstene, 2012). As a result, the SFNA was classified as a severe-15 area (77 FR 30088).

3.3 Attainment Deadline and Attainment Date Extension

The statutory attainment date for a severe-15 nonattainment area is 15 years after the effective date of designation and for a serious area it is 9 years (80 FR 12264)[15]. Notwithstanding this requirement, CAA Sections 172(a)(2)(A) and 181(a) require nonattainment areas to meet the clean air standards “as expeditiously as practicable.” To comply with this requirement, and based on the results of the photochemical modeling conducted by CARB for 2022 and 2026, the reasonably available control measure (RACM) analysis, and other factors discussed in Chapter 8, an attainment year of 2024 was selected for this plan which would correspond to an attainment deadline of July 20, 2025 based on the initial nonattainment designation of July 20, 2012. An attainment year of 2024 does not change the severe-15 classification for the SFNA.

USEPA established rule 40 CFR 50.1107 to determine eligibility for attainment date extensions for the 2008 Ozone NAAQS under CAA Section 181(a)(5). If an area fails to attain the standard by its attainment date, it would be eligible for a 1-year extension providing that the attainment year’s fourth highest daily maximum 8-hour average is at or below the 75 ppb standard. The area would be eligible for a second 1-year extension if the fourth highest daily maximum 8-hour value, averaged over both the original attainment year and the first extension year, is at or below the standard (80 FR 12292).

3.4 Transportation Conformity Requirements

Transportation conformity requires the linking and coordinating of transportation and air quality plans and projects. Under the CAA, federal agencies may not approve or fund transportation plans and projects unless they are consistent with state air quality implementation plans (SIPs). Transportation conformity refers to the process used to determine whether transportation projects that require federal approvals or use federal funds are consistent with SIPs.

USEPA restructured the transportation conformity regulations (USEPA, 2012) so that existing conformity requirements will apply for any new or revised NAAQS (77 FR 30160). This was done to provide consistency and avoid the need to revise the rule if the NAAQS changes in the future. Transportation conformity and emissions budgets are discussed in Chapter 10.

[15] The attainment deadline for the SFNA for a severe-15 area is July 20, 2027 and for a serious area is July 20, 2021.

3.5 Major New Source Review Requirements

New Source Review (NSR) requirements apply to new construction of major sources[16] of air pollution, or major modifications of existing sources for all ozone classification categories (marginal through extreme). The major source thresholds change based on the attainment classification, and under CAA Sections 182(d) and 182(f) the severe area emissions threshold is 25 tons per year of Volatile Organic Compound (VOC) or Nitrogen Oxides (NO_X) emissions. In addition, CAA Section 182(d)(2) requires that major sources in severe areas offset any increases in VOC and NO_X emissions by a ratio of 1.3 to 1.

3.6 Reasonably Available Control Technology (RACT) Requirements

RACT (44 FR 53762) is "the lowest emission limitation that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility." CAA Sections 182(b)(2) and 182(f) require the District to implement RACT for:

- Each category of VOC sources covered by a Control Techniques Guidelines (CTG) document issued by USEPA[17]; and
- All major stationary sources of VOC or NO_X.

The 2008 NAAQS implementation rule (80 FR 12264) requires each District to submit a SIP revision that meets the RACT requirements for VOC and NO_X in CAA Sections 182(b)(2) and 182(f). RACT SIP demonstrations are not included in this document and are prepared separately by each air district for submittal.

3.7 Reasonably Available Control Measures (RACM) Requirements

CAA Section 172(c)(1) states that SIP plan provisions "shall provide for the implementation of all reasonably available control measures as expeditiously as practicable (including such reductions in emissions from existing sources in the area as may be obtained through the adoption, at a minimum, of reasonably available control technology) and shall provide for attainment of the national primary ambient air quality standards." The 2008 NAAQS Implementation Rule (80 FR 12264) requires that the "SIP revision demonstrate that it has adopted all RACM necessary to demonstrate attainment as expeditiously as practicable and to meet any Reasonable Further Progress (RFP) requirements."

[16] For severe ozone nonattainment areas, a major source is defined by CAA §182(d) as a source that has the potential to emit 25 tons or more per year of NO_X or VOC.

[17] CTG provide USEPA's recommendations on how to control emissions of VOCs from a specific type of product or process (source category) in an ozone nonattainment area. Each CTG includes emissions limitations based on RACT to address ozone nonattainment. This list can be found at https://www3.epa.gov/ttn/atw/ctg_act.html

USEPA continues to apply the existing guidance to implement RACM provisions under the CAA. USEPA's RACM guidance (Seitz, 1999) indicates that areas should consider all potentially reasonably available measures. Sources of potentially reasonable measures include measures adopted in other nonattainment areas, measures that the USEPA has identified in guidelines or other documents. In addition, any measure that a commenter indicates during a public comment period is reasonably available for a given area should be closely reviewed by the planning agency to determine if it is in fact reasonably available for implementation in the light of local circumstances.

Areas should consider all reasonably available measures for implementation in light of local circumstances. However, areas need only adopt measures if: (i) they are both economically and technologically feasible and cumulatively will advance the attainment date by one year, or (ii) are necessary to meet RFP requirements (80 FR 12278). The RACM analysis is discussed in more detail in Chapter 7 and Appendix E (RACM Analysis).

3.8 Vehicle Miles Travelled (VMT) Offset Requirement

CAA Section 182(d)(1)(A) applies to nonattainment areas classified as severe or extreme. A VMT offset demonstration was prepared in accordance with USEPA's guidance (USEPA, 2012) and is included in Appendix C.

3.9 Reasonable Further Progress Plan Requirements

CAA Sections 172(c)(2), 182(b)(1), and 182(c)(2)(B) include reasonable further progress (RFP) requirements for reducing emissions in ozone nonattainment areas. These requirements are further described in the 2008 NAAQS Implementation Rule (80 FR 12264). The baseline year for this plan is 2012, the two milestone years are 2018 and 2021, and the proposed attainment year is 2024. For moderate and above areas, a 15 percent ozone precursor emissions reduction is required in the 6 year period following the baseline year[18] (2012). After that, an additional 3 percent per year reduction in NO_X or VOC emissions is required, averaged over the 3-year period from 2019 to 2021) (40 CFR 51.1110(a)(2)(ii)).

The implementation rule modified three elements of the RFP calculations:

1. Emissions reductions from SIP-approved or federally promulgated measures that occur after the baseline emissions inventory may be used to meet rate RFP goals (40 CFR 51.1110(a)(5))

[18] USEPA proposed 2011 as the baseline year for nonattainment areas. The implementation rule allows the state to select an alternate year as baseline year between 2008 and 2012 (80 FR 12272; 40 CFR 51.1110(b)). The CARB and air districts selected 2012 as the baseline year, which is the most recent year that best captured current economic conditions, and reflects recovery from the recession.

2. Emission reductions must be obtained within the nonattainment area (40 CFR 51.1110(a)(6))
3. Elimination of the obligation to perform emissions reduction calculations for pre-1990 measures related to motor vehicle exhaust or evaporative emissions, correction of previous RACT requirements, and correction of previous inspection/maintenance programs (40 CFR 51.1110(a)(7)).

The RFP demonstration was prepared for each milestone year in accordance with USEPA's rules and is included as part of this plan in Chapter 12 and Appendix D.

3.10 Milestone Reports

CAA Section 182(g) requires that progress (milestone) reports be prepared to evaluate whether actual emission reductions meet the minimum reasonable further progress targets. This is required to be done every three years out to the attainment year. CARB determines whether each nonattainment area has achieved a reduction in the necessary emissions during the applicable milestone.

3.11 References

Goldstene, James. *Letter from CARB to Air and Radiation Docket and Information Center*, 13 March 2012.

Seitz, John. *Guidance on the Reasonable Available Control Measures (RACM) Requirement and Attainment Demonstration Submissions for Ozone Nonattainment Areas.* Research Triangle, NC: United States Environmental Protection Agency - Office of Air Quality Planning and Standards, [1999.]

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USEPA. (44 FR 53761 - 53763) *State Implementation Plans; General Preamble for Proposed Rulemaking on Approval of Plan Revisions for Nonattainment Areas-Supplement (on Control Techniques Guidelines).* Federal Register, Volume 44, 16 September, 1979, p. 53761-53763.

USEPA (69 FR 23858 - 23951) *Air Quality Designations and Classifications for the 8-Hour Ozone National Ambient Air Quality Standards*. Federal Register, Volume 69, 30 April 2004, p 23858 -23951.

USEPA. (77 FR 30088-30160) *Air Quality Designations for the 2008 Ozone National Ambient Air Quality Standards; Implementation of the 2008 National Ambient Air Quality Standards: Final Rule*. Federal Register, Volume 77, 21 May, 2012, p. 30088-30160.

USEPA. (77 FR 30160-30171) *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: Nonattainment Area Classifications Approach, Attainment Deadlines and Revocation of the 1997 Ozone Standards for Transportation*

Conformity Purposes, Final Rule. Federal Register, Volume 77, 21 May, 2012, p. 30160 – 30171.

USEPA. (80 FR 12264-12319) *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule*. Federal Register, Volume 80, 6 March, 2015, p. 12264-12319.

USEPA. *Implementing Clean Air Act Section 182(d)(1)(A): Transportation Control Measures and Transportation Control Strategies to Offset Growth in Emissions Due to Growth in Vehicle Miles Travelled.* Research Triangle, NC: United States Environmental Protection Agency - Office of Air Quality Planning and Standards. [2012.]

4 8-HOUR OZONE AIR QUALITY TRENDS

4.1 Introduction

This chapter shows air quality trends from 1990 – 2016, and compares the trends to the 2008 ozone National Ambient Air Quality Standard (NAAQS) of 0.075 parts per million (ppm). Identifying the number of days exceeding the federal standard helps determine control strategy effectiveness. A violation is determined by averaging the fourth highest 8-hour average concentration for each of the three most recent years at a monitoring site. The result is referred to as the *design value*[19] for the site. The overall design value is the highest design value of all the sites in the Sacramento Federal Nonattainment Area (SFNA).

4.2 Ozone Monitoring Sites

There are currently 16[20] active ozone monitoring stations located throughout the SFNA[21]. They are operated by either local air districts or CARB. Figure 4-1 shows the map of ozone monitoring stations operating in the SFNA during the summer of 2015. Most ozone monitoring sites also have meteorological instruments, and some sites also sample for ambient concentrations of ozone precursor pollutants. The map shows the 2015 design value contour lines[22]. It also overlays the United States Environmental Protection Agency's (USEPA's) EJSCREEN disadvantaged communities that are impacted by ozone. The area with highest measured ozone concentrations is located in the eastern portion of the nonattainment area. The peak 2015 ozone design value of 0.081 parts per million (ppm) or 81 parts per billion (ppb) was measured at the Placerville monitor.

Clean Air Act (CAA) Section 182(c)(1) requires areas classified as serious, severe, or extreme to establish Photochemical Assessment Monitoring Stations (PAMS) sites, which provide enhanced monitoring of ozone, nitrogen oxides (NO_X), volatile organic compounds (VOCs), and meteorological parameters. New PAMS requirements were promulgated with the 2015 revision of the NAAQS for Ozone (80 FR 65292).The Sacramento Metropolitan Air Quality Management District (SMAQMD) 2016 Monitoring Plan (SMAQMD, 2016) addresses future year changes and requirements under these

[19] For example, the 2015 ozone design value concentration for a monitoring site would be calculated by taking the average of fourth highest daily 8-hour average ozone concentrations of 2013, 2014, and 2015.

[20] The Sacramento Goldenland Court monitoring site was terminated on May 31, 2017. As a result, the number of monitors is reduced from 17 to 16.

[21] More information about the monitoring sites in Sacramento County can be found at http://www.airquality.org/Air-Quality-Health/Air-Monitoring, and the monitoring sites in the other districts at http://www.arb.ca.gov/aqd/amnr/amnr.htm.

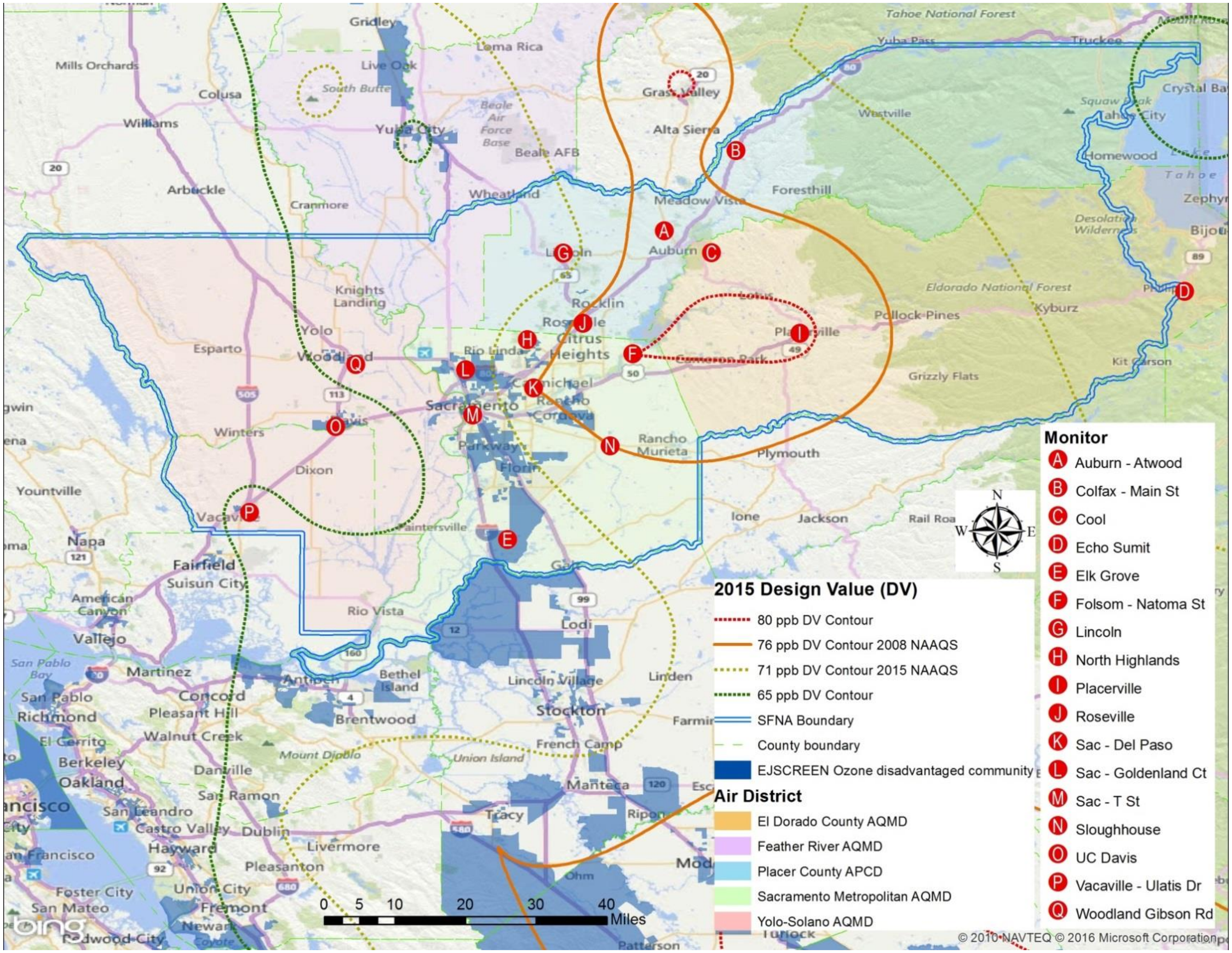
[22] Contour lines were created by Golden Software Surfer 9.0 using Kriging gridding method with resolution of 0.01 degree.

new regulations. CARB also prepared a 2016 monitoring network plan (CARB, 2017) for other SFNA air districts to address future year changes and requirements. USEPA approved the SMAQMD 2016 Monitoring Network Plan on January 20, 2017 (USEPA, 2017a) and CARB's air monitoring network plan on February 24, 2017 (USEPA, 2017b).

4.3 Annual Number of Exceedance Days and Trend

Table 4-1 shows the annual number of days exceeding the 8-hour ozone standard for each of the ozone monitoring sites in the SFNA since 1990. Most exceedances of the 2008 federal 8-hour ozone standard occur at the region's eastern monitoring sites Cool, Folsom, Placerville, and Auburn. Cool recorded the highest number of exceedance days between 1996 and 2007. In the most recent years, 2008 – 2016, the Folsom monitor has recorded the highest number of exceedance days.

Figure 4-1 SFNA Ozone Monitoring Stations and 2015 Design Value Contours



Note: The area inside a contour line is estimated to be higher than the specified design value.

Table 4-1 8-Hour Ozone Exceedance Days above the 2008 NAAQS of 0.075 ppm for the SFNA Monitoring Sites

The site with the highest number of exceedance days for the year is highlighted in yellow.

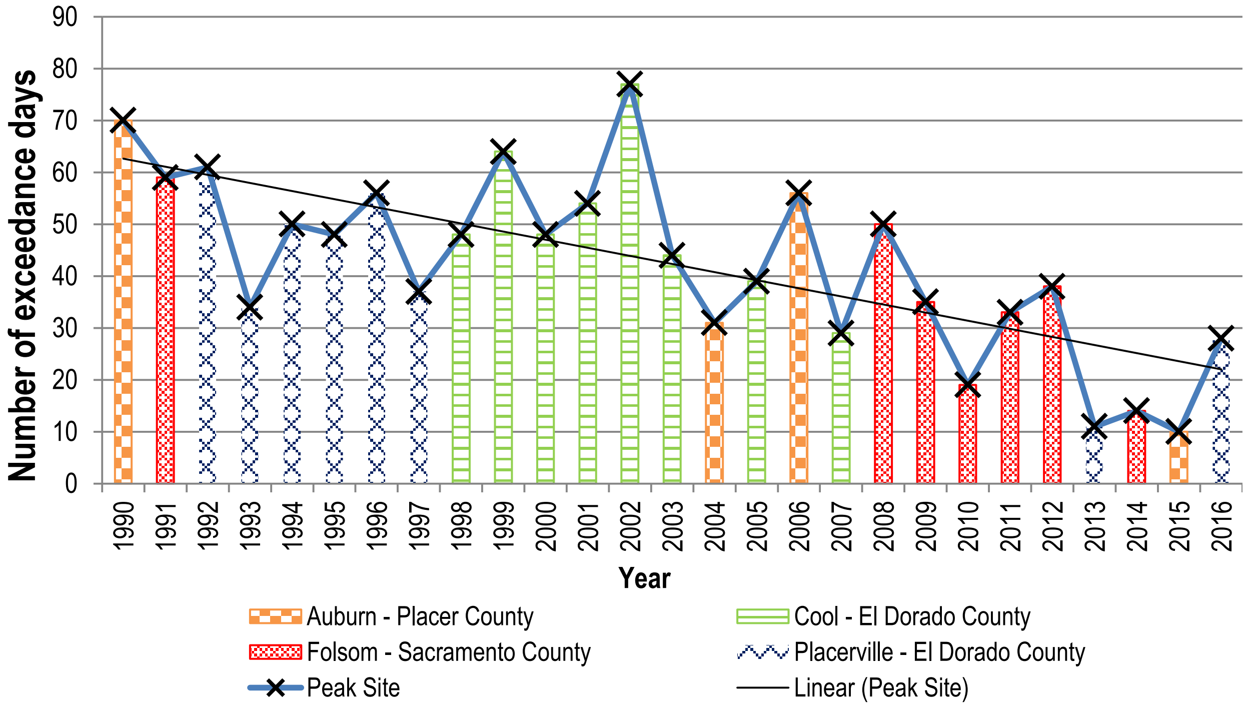
County	Monitoring Site	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
El Dorado	Cool							53	27	48	64	48	54	77	44	27	39	55	29	29	21	6	24	8	4	10	6	15
El Dorado	Echo Summit											2	4	8	3	1		3	3	5	0	0	0	1	0	0		0
El Dorado	Placerville			61	34	50	48	56	37	34	50	38	46	41	40	24	31	45	9	36	20	8	5	20	11	12	7	28
Placer	Auburn[1]	70	48	56	32	50	34	50	9	35	43	39	36	36	27	31	29	56	9	21	14	10	18	13	1	6	10	15
Placer	Colfax[2]	36		36	17	32	23	15	5	23	31	0	3	37	32	26	31	39	10	16	3	3	2	7	1	2	3	9
Placer	Rocklin[3]	23	26	48	18	34	28	40	17	22	25	22	25	29	Site Closed.													
Placer	Roseville				17	23	20	29	8	27	19	15	17	25	16	8	18	25	8	22	19	15	15	13	2	10	3	8
Placer	Lincoln																							5	0	1	2	8
Sacramento	Citrus Heights	18	20	17	Ozone monitoring ended in 1993 and site closed in 1996.																							
Sacramento	Elk Grove[4]	30	18	6	3	10	18	30	5	13	16	2	16	2	14	6	12	17	5	7	5	2	1	5	0	0	1	0
Sacramento	Folsom[5]	3	59	43	32	38	34	45	29	38	34	27	44	40	42	23	30	42	21	50	35	19	33	38	6	14	5	13
Sacramento	North Highlands	11	17	12	6	19	24	33	10	23	18	22	15	24	11	5	6	24	2	2	7	3	9	11	0	3	3	7
Sacramento	Sacramento-Del Paso	25	25	28	17	23	32	36	11	25	17	15	12	46	31	14	19	24	10	18	15	5	3	12	3	1	5	4
Sacramento	Sacramento-Goldenland Ct[6]	12	24	19	4	2	20	21	5	17	10	9	6	6	3	0	3	5	4	9	5	1	1	4	0	1	1	3
Sacramento	Sacramento-T Street	5	7	10	4	5	7	11	1	10	9	3	4	7	5	0	4	6	2	9	4	0	1	4	0	0	1	0
Sacramento	Sloughhouse								7	36	39	30	27	30	34	21	19	32	10	19	24	8	19	18	2	5	6	6
Sutter	Pleasant Grove	2	11	18	6	2	11	16	2	15	20	12	9	12	Site Closed.													
Solano	Vacaville[7]	2					4	12	3	14	14	3	1	2	2	1	2	6	2	4	2	1	0	1	0	0	0	0
Yolo	UC Davis	11	1	13	4	4	6	12	1	17	14	7	3	4	5	0	3	4	3	5	1	0	1	1	0	0	0	0
Yolo	Woodland[8]	7	6	15	1	5	9	15	2	12	18	7	5	13	10	0	6	14	2	4	3	0	0	2	0	0	0	0
	Peak Site	**70**	**59**	**61**	**34**	**50**	**48**	**56**	**37**	**48**	**64**	**48**	**54**	**77**	**44**	**31**	**39**	**56**	**29**	**50**	**35**	**19**	**33**	**38**	**11**	**14**	**10**	**28**

Data source: USEPA AQS database (https://aqs.epa.gov/aqs/) Downloaded on 07/19/2017.

1 Auburn monitor was moved from 108 C Ave, Auburn to 11645 Atwood St, Auburn in 2011.
2 Colfax monitor was moved from 10 West Church St. to 33 South Main St in 1992.
3 Rocklin monitor was moved from Sierra College to 5000 Rocklin Road in 1992. The Rocklin Road monitor ceased operations in 2003.
4 Elk Grove monitor was moved from 2800 Meadowview Road to Bruceville Blvd in 1992.
5 Folsom monitor was moved from City Corp Yard to 50 Natoma Street in 1996.
6 Sacramento-Goldenland Ct monitor was moved from Airport Road in 2009 and subsequently moved to 7926 Earhart Drive in 1998. This monitor was closed in 2017.
7 Vacaville monitor was moved from 1001 Allison Drive to 2012 Ulatis Drive in 2003.
8 Woodland monitor was moved from 177 West Main Street to 40 Sutter Street in 1992 and subsequently moved to 41929 East Gibson Road in 1998.

Figure 4-2 illustrates the trend in number of exceedance days at the region's monitoring sites with the highest number of exceedance days for each year. Year to year differences are caused by meteorological variability and changes in precursor emissions. The trend line in the figure indicates a decline in the number of exceedance days per year over the past 27 years, from 70 days in 1990 down to 28 days in 2016 representing a declining rate of about 1.5 days per year.

Figure 4-2 8-Hour Ozone Exceedance Days Trend SFNA – Peak Monitoring Site



4.4 Ozone Design Values and Trend

Table 4-2 lists the 8-hour ozone design value concentrations for each of the ozone monitoring sites in the SFNA from 1990 to 2016. To demonstrate attainment, the ozone design value must be at or below the 8-hour ozone standard (75 ppb).

Table 4-2 8-Hour Ozone Design Values (ppb) Sacramento Nonattainment Area – Ozone Monitoring Sites

The peak site for the year is highlight in yellow.

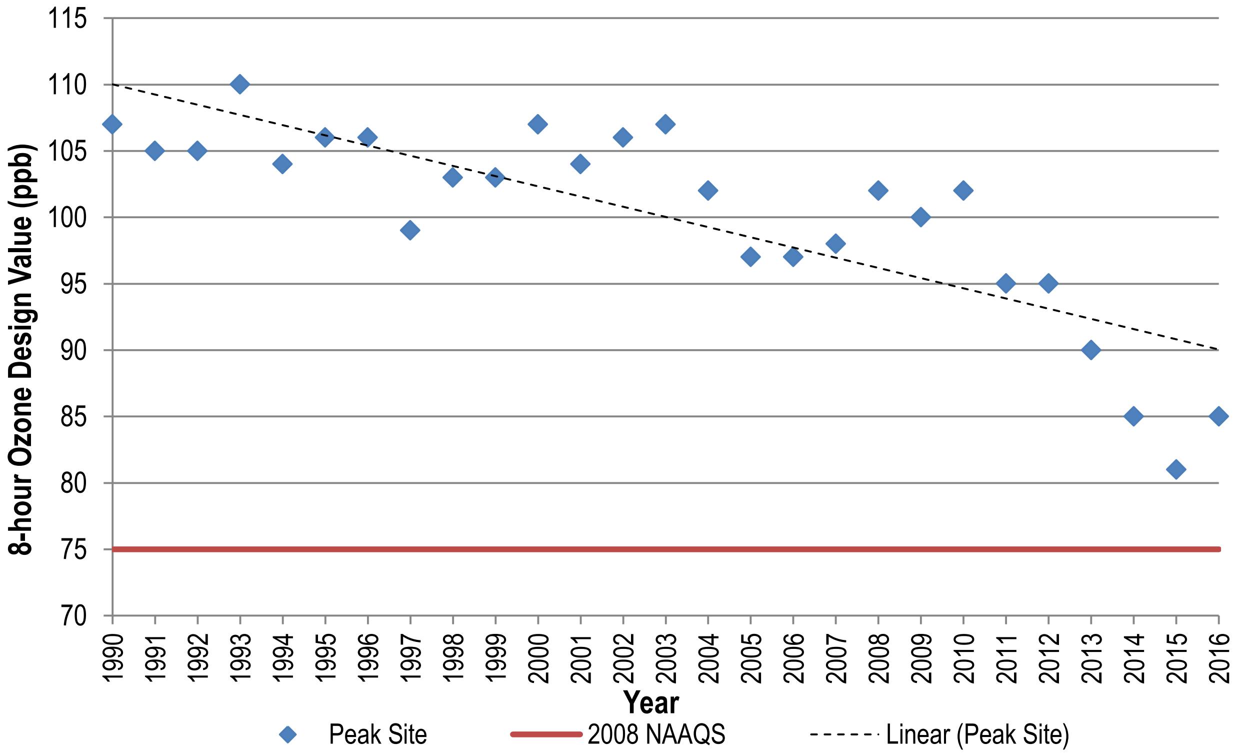
County	Monitoring Site	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
El Dorado	Cool							na	na	103	103	107	104	106	107	102	97	95	96	98	93	89	84	83	81	80	79	82
El Dorado	Echo Summit											na	na	75	76	75	na	na	na	76	na	71	67	69	69	69	na	na
El Dorado	Placerville			na	na	97	99	103	99	98	98	99	96	94	95	94	94	94	93	96	92	90	80	81	82	84	81	85
Placer	Auburn[1]	107	105	105	101	102	105	103	95	95	97	102	101	101	99	95	92	93	89	90	86	87	80	na	79	78	79	83
Placer	Colfax[2]	na	76	na	na	92	92	91	86	86	86	79	na	77	88	92	91	97	94	89	79	78	74	75	73	73	73	76
Placer	Rocklin[3]	na	76	na	101	103	100	100	95	94	92	93	91	92	Site Closed.													
Placer	Roseville				na	na	97	96	93	93	89	93	90	92	90	87	86	89	89	90	89	90	86	85	81	81	77	80
Placer	Lincoln																							na	na	na	69	74
Sacramento	Citrus Heights	98	94	97	80	na	na	Ozone monitoring ended in 1993 and site closed in 1996.																				
Sacramento	Elk Grove[4]	95	97	91	83	na	81	87	87	87	88	85	84	75	80	77	82	82	83	82	79	77	74	na	71	70	66	68
Sacramento	Folsom[5]	101	100	101	110	104	106	106	na	91	101	104	99	100	100	97	97	97	98	102	100	102	95	95	90	85	80	83
Sacramento	North Highlands	87	82	88	87	87	88	91	88	89	87	89	89	92	91	85	80	82	80	76	na	na	77	77	76	75	73	77
Sacramento	Sacramento-Del Paso	96	94	100	99	92	96	100	97	95	91	95	92	95	97	95	92	90	90	87	86	85	81	78	77	77	76	77
Sacramento	Sacramento-Goldenland Ct[6]	na	87	88	84	79	80	83	84	na	na	82	79	78	77	na	na	na	76	78	na	na	69	69	70	71	69	71
Sacramento	Sacramento-T Street	na	76	79	79	78	78	80	77	79	80	82	80	79	79	75	73	76	78	79	77	75	71	71	69	69	67	69
Sacramento	Sloughhouse								na	na	100	105	98	95	95	94	94	96	93	95	91	92	87	88	84	80	76	79
Sutter	Pleasant Grove	82	76	79	82	81	82	83	82	81	81	84	83	82	na	na	Site Closed.											
Solano	Vacaville[7]						na	na	76	82	85	85	77	72	na	na	na	73	74	75	72	71	68	69	67	66	66	67
Yolo	UC Davis	na	na	80	78	79	78	82	79	80	81	85	81	77	76	74	73	74	75	76	74	72	70	70	66	64	62	64
Yolo	Woodland[8]	80	77	na	na	79	78	81	79	na	na	84	82	83	83	79	77	79	80	79	74	72	69	69	69	68	67	69
	Peak Site	**107**	**105**	**105**	**110**	**104**	**106**	**106**	**99**	**103**	**103**	**107**	**104**	**106**	**107**	**102**	**97**	**97**	**98**	**102**	**100**	**102**	**95**	**95**	**90**	**85**	**81**	**85**

Data source: USEPA AQS database (https://aqs.epa.gov/aqs/) Downloaded on 07/19/2017.

1 Auburn monitor was moved from 108 C Ave, Auburn to 11645 Atwood St, Auburn in 2011.
2 Colfax monitor was moved from 10 West Church St. to 33 South Main St in 1992.
3 Rocklin monitor was moved from Sierra College to 5000 Rocklin Road in 1992. The Rocklin Road monitor ceased operations in 2003.
4 Elk Grove monitor was moved from 2800 Meadowview Road to Bruceville Blvd in 1992.
5 Folsom monitor was moved from City Corp Yard to 50 Natoma Street in 1996.
6 Sacramento-Goldenland Ct monitor was moved from Airport Road in 2009 and subsequently moved to 7926 Earhart Drive in 1998. This monitor was closed in 2017.
7 Vacaville monitor was moved from 1001 Allison Drive to 2012 Ulatis Drive in 2003.
8 Woodland monitor was moved from 177 West Main Street to 40 Sutter Street in 1992 and subsequently moved to 41929 East Gibson Road in 1998.
na Insufficient data to determine the design value.

Figure 4-3 shows the ozone design value for the peak monitoring site in each year and a trend line from 1990 to 2016. The overall 27-year trend line indicates a decline, from the peak 110 ppb in 1993 down to 85 ppb in 2016. The ozone design value has improved from being 35 ppb (or 46%) over the standard down to about 10 ppb (or 13%) over the standard. The linear trend line in Figure 4-3 shows a declining trend rate of about 0.7 ppb per year.

Figure 4-3 8-Hour Regional Ozone Design Values Trend SFNA



Note: This trend line is the highest 8-hour ozone design values in the region. The current federal 8-hour ozone standard is 75 ppb.

Figures 4-4 through 4-8 show the ozone design value declining trends of five peak monitors (Folsom, Cool, Sloughhouse, Auburn, and Placerville) in the SFNA. The historical trend lines indicate that the design values for the region are declining.

Figure 4-4 Design Values at the Folsom monitor

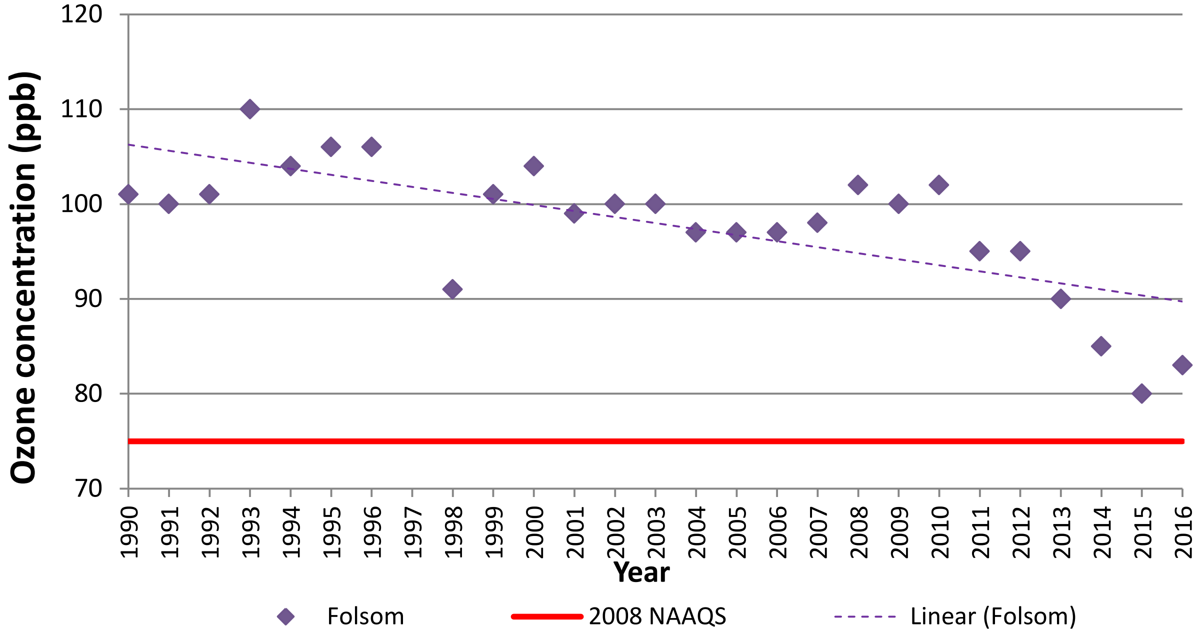


Figure 4-5 Design Values at the Cool monitor

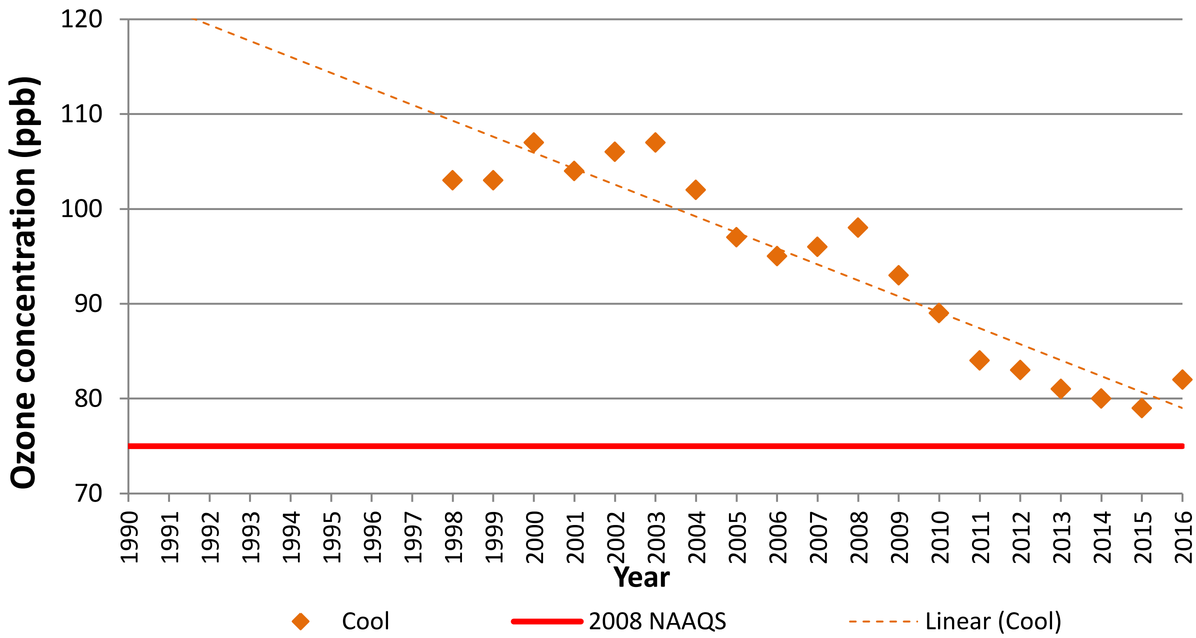


Figure 4-6 Design Values at the Sloughhouse monitor

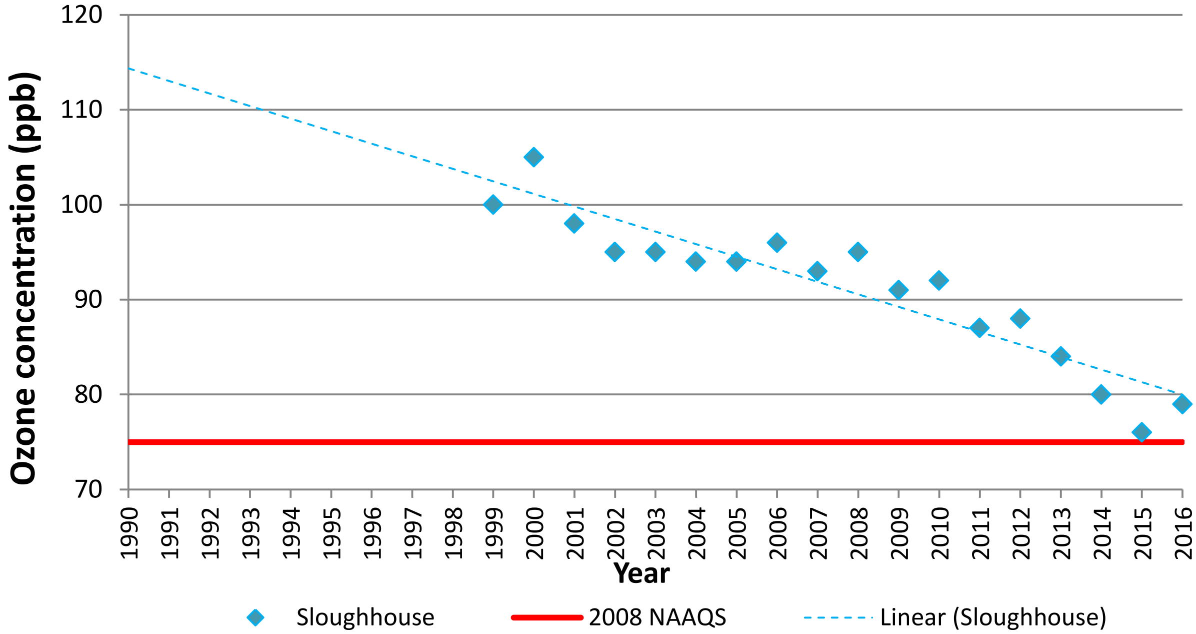


Figure 4-7 Design Values at the Auburn monitor

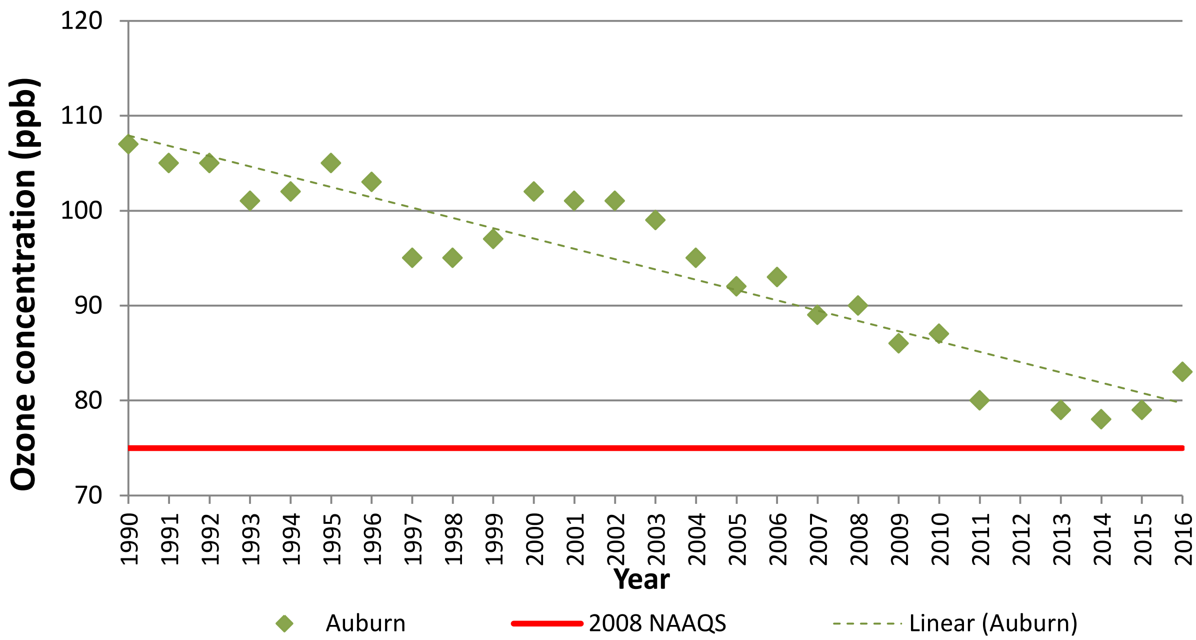
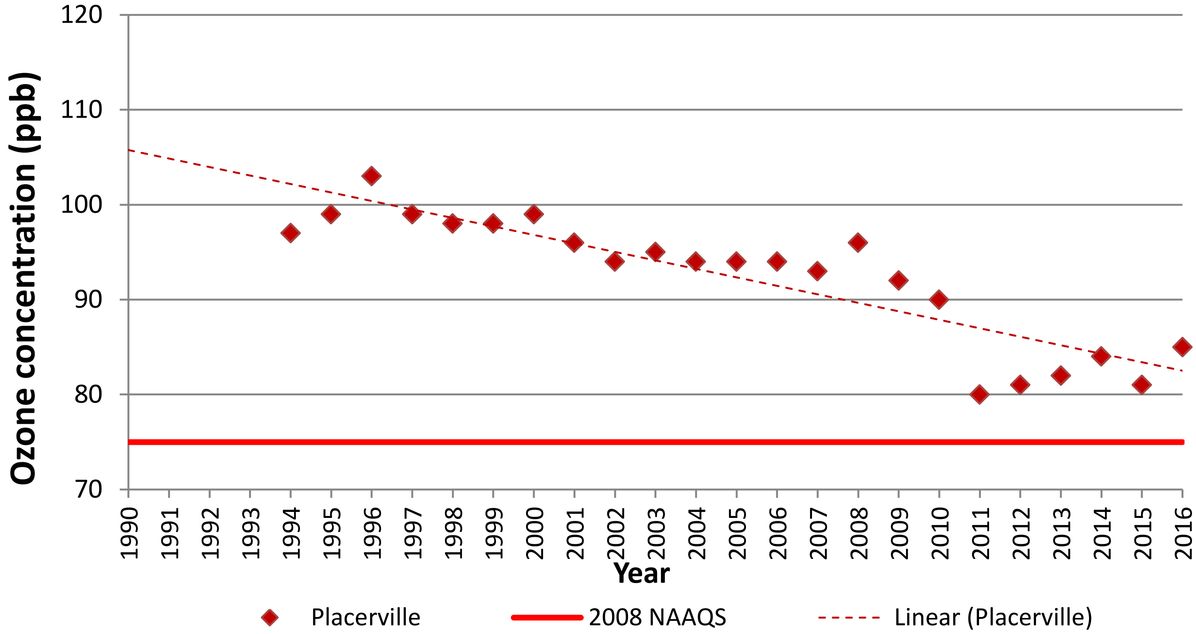


Figure 4-8 Design Values at the Placerville monitor



4.5 References

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USEPA. *Message from Gwen Yoshimura (USEPA, Region IX) to Larry Greene (SMAQMD)* 20 January [2017a]. Letter.

USEPA. *Message from Gwen Yoshimura (USEPA, Region IX) to Ravi Ramalingam (CARB)* 24 February [2017b.] Letter.

5 EMISSIONS INVENTORY

5.1 Introduction to Emissions Inventory

Planning efforts to evaluate and reduce ozone air pollution include identifying and quantifying the various processes and sources of Volatile Organic Compound (VOC) emissions (such as solvents, surface coatings, and motor vehicles) and Nitrogen Oxide (NO_X) emissions (such as motor vehicles and other fuel combustion equipment). VOC pollutants are also known as reactive organic gases (ROG), and the two are considered to be synonymous for this report.

A summary of VOC and NO_X emissions estimates by different air pollutant source categories are provided for the State Implementation Plan (SIP) planning years in tabular and graphical formats. The 2012 base year, 2018, 2021, and 2024 emission inventories use the latest planning assumptions and emissions data in California Air Resources Board's (CARB's) California Emission Projection Analysis Model (CEPAM). These inventories, presented in tons per day for an average summer day, are forecasted using the latest socio-economic growth indicators and applying the emission reduction benefits from adopted control strategies. Emission reduction credits are then added to the emissions inventory forecasts. More detailed information and emissions inventory tables are provided in Appendix A – Emissions Inventory.

5.2 Emission Inventory Requirements

Emissions are updated as part of the overall requirement that plan revisions include "a comprehensive, accurate, current inventory of actual emissions from all sources of the relevant pollutant or pollutants" under Clean Air Act sections 172(c)(3) and 182(a)(1). The baseline year for the SIP planning emissions inventory is identified as 2012.

The United States Environmental Protection Agency (USEPA) draft emission inventory guidance (USEPA, 2016) and federal 8-hour ozone implementation rules (70 FR 71612-71705) set specific planning requirements pertaining to future milestone years for reporting reasonable further progress (RFP) and to attainment demonstration years. Key RFP analysis years in this report include 2018 and every subsequent 3 years out to and including the attainment date.

Attainment demonstration for a severe-15 nonattainment area classification is 2026. However, the regional air districts, in consultation with CARB and USEPA Region IX, are proposing 2024[23] be established as the region's attainment demonstration year for the 2008 ozone National Ambient Air Quality Standard (NAAQS) for the Sacramento Federal Nonattainment Area (SFNA). An attainment year of 2024 is appropriate

[23] The attainment demonstration would be based on ambient air quality data from the 2022-2024 ozone seasons.

because it is bounded by two modeled attainment demonstrations, supports early attainment (it is before the statutory deadline for a severe-15 area), and provides a safeguard against inherent uncertainties in predicting future ambient ozone concentrations beyond 2022 (e.g. emission reductions, meteorology, natural events.). CARB is preparing a weight-of-evidence analysis, which will be submitted to USEPA in conjunction with this SIP.

The emissions inventory years included in this plan are 2012 (baseline), 2018, 2021, and 2024. USEPA draft emission inventory guidance (USEPA, 2016, p.20) also requires the SIP planning emissions inventory to be based on estimates of actual emissions for an average summer weekday, typical of the ozone season (May – October).

5.3 Emission Inventory Source Categories

Due to the large number and wide variety of emission processes and sources, a hierarchical system of emission inventory categories was developed for more efficient use of the data. The anthropogenic (man-made) emissions inventory is divided into four broad categories: stationary, area-wide, on-road motor vehicles, and other mobile sources. Each of these major categories is subdivided into more descriptive subcategory sources, which are further defined into more specific emission processes.

5.3.1 Stationary Sources

The stationary sources category of the emissions inventory includes non-mobile, fixed sources of air pollution. They are mainly comprised of individual industrial, manufacturing, and commercial facilities called “point sources.” The more descriptive subcategories include fuel combustion (e.g., electric utilities and agricultural irrigation engines), waste disposal (e.g., landfills and composting), cleaning and surface coatings (e.g., printing and dry cleaning), petroleum production and marketing, and industrial processes (e.g., breweries and asphaltic concrete production). The facility operators report the process and emissions data to their local air district, which uses the information to calculate emissions from point sources.

5.3.2 Area-Wide Sources

The area-wide sources category includes aggregated emissions data from processes that are individually small and widespread or not well-defined point sources. The area-wide subcategories include solvent evaporation (e.g., consumer products and architectural coatings) and miscellaneous processes (e.g., residential fuel combustion and farming operations). Emissions from these sources are calculated from product sales, population, employment data, and other parameters for a wide range of activities that generate air pollution across the Sacramento nonattainment region. More detailed information on the area-wide source category emissions can be found on the CARB website: http://www.arb.ca.gov/ei/areasrc/areameth.htm

5.3.3 On-Road Motor Vehicles

The on-road motor vehicles inventory category consists of trucks, automobiles, buses, and motorcycles. On-road motor vehicle emission estimates were developed using the latest available transportation data and California's EMFAC2014 model. EMFAC (EMission FACtor) is California's model for estimating emissions from on-road motor vehicles operating in California. Pollutant emissions for hydrocarbons (HC), carbon monoxide (CO), nitrous oxides (NO_X), course particulate matter (PM_{10}), fine particulate matter ($PM_{2.5}$), lead, carbon dioxide (CO_2), and sulfur oxides (SO_x) are output from the model. Emissions are calculated for fifty-one different vehicle classes composed of passenger cars, various types of trucks and buses, motorcycles, and motor homes. EMFAC has undergone many revisions over the years and the current on-road motor vehicles emission model, EMFAC2014, is used in this Plan.

5.3.3.1 Motor Vehicle Emissions Model, EMFAC2014

The CARB has continued to update and improve its EMFAC on-road motor vehicle emissions model. Effective December 14, 2015, the USEPA has approved the EMFAC2014 emissions model for SIP and conformity purposes (80 FR 77337). EMFAC2014 replaces EMFAC2011 and the model's major improvements include:

- Re-design of EMFAC with new programming architecture
- Fuel-based default vs. user-specified custom activities
- Incorporation of fuel-based statewide activity with new vehicle miles traveled (VMT) spatial allocations
- Socio-econometric modeling of population and VMT
- Revision of heavy-duty diesel (HD Diesel) truck emission rates
- Incorporation of natural gas vehicles for select vehicle classes
- Accounting for Federal and California regulations and standards adopted post-2010.

EMFAC2014 software and detailed information on the vehicle emission model can be found on the CARB website: https://www.arb.ca.gov/msei/categories.htm.

5.3.3.2 Vehicle Activity Data

The on-road motor vehicle emissions are from CARB's CEPAM 2016 v1.04 and are generated using EMFAC2014 with vehicle activity data from the 2016 Metropolitan Transportation Plan (2016 MTP) from SACOG and the 2015 Federal Statewide Transportation Improvement Program FSTIP from MTC (CARB, 2017). Although there are small differences between the on-road inventory and the motor vehicle emissions budgets due to the 2017 MTC FSTIP for eastern Solano, these differences do not impact the RFP or attainment demonstration.

5.3.4 Other Mobile Sources

The emission inventory category for other mobile sources includes aircraft, trains, ships, and off-road vehicles and equipment used for construction, farming, commercial, industrial, and recreational activities. Like EMFAC, the off-road emissions model underwent a significant update. The OFFROAD2007 model is being replaced by category-specific methods and inventory models that are being developed for specific regulatory support projects. The diesel equipment categories using the category-specific method include: In-Use Off-Road Equipment (Construction, Industrial, Ground Support and Oil Drilling); Cargo Handling Equipment; In-Use Mobile Agricultural Equipment; Locomotives; Transport Refrigeration Units; Commercial Harbor Craft; Ocean Going Vessels; and Stationary Commercial Engines. The Gasoline-Fueled equipment categories using the category-specific method include: Pleasure Craft, Recreational Vehicles, Outboard Marine Tanks, Portable Fuel Tanks, and Lawn and Garden. If a category is not listed above (e.g., farm equipment), OFFROAD2007 remains the current tool for estimating emissions. In general, emissions are calculated by using estimated equipment population, engine size and load, usage activity, and emissions factors.

More detailed information on the latest off-road motor vehicle emissions inventory, including can be found on the CARB website:
https://www.arb.ca.gov/msei/categories.htm.

5.3.5 Biogenic Sources

Biogenic emissions are emissions from natural sources, such as plants and trees. Using the MEGAN (Model of Emissions of Gases and Aerosols from Nature) model, CARB estimates emission of biogenic volatile organic compounds (BVOC) from vegetation for natural areas, agricultural crops, and urban landscapes. BVOC emissions vary with temperature. CARB does not estimate biogenic nitric oxide emissions from soils, therefore the biogenic emissions estimate is strictly BVOC. The average summer day biogenic emissions for the SFNA, in base year 2012, is 693.4 tons (CARB, 2016a).

5.4 Base Year Emissions Inventory

Anthropogenic Emissions Table by Source Category

The following tables (Tables 5-1 and 5-2) show the anthropogenic emissions inventory of VOC and NO_X by source categories for the SFNA. The SFNA includes emissions from Sacramento and Yolo Counties, the eastern portion of Solano County, Placer and El Dorado Counties excluding the Lake Tahoe Basin, and the southern portion of Sutter County[24]. The emissions inventory for ozone planning purposes represents emissions

[24] Southern Sutter County emissions include:
1) all point sources located in the area,

for a summer seasonal average day in units of tons per day. Inventories were generated using CEPAM: 2016 SIP Baseline Emission Projections (CARB, 2016) and do not include Emission Reduction Credits (ERCs). The VOC and NO_X emissions totals are 110 tons and 101 tons per day in 2012, respectively.

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2) 4% of the county total of area and aggregated point sources that are projected by population where, which is the percent of Sutter County population in the Sutter portion of the SFNA based on the 2010 Census,
3) 41% of the county total for emissions from agriculture, where, 41% is the ag land ratio in the Sutter portion of the SFNA,
4) 34% of the county total for emissions from off-road equipment, where, 34% is the percent of Sutter County land area in the Sutter portion of the SFNA,
5) 56% of the total railroad emissions, where 56% of the train tracks are located in the South Sutter Split,
6) 0% of the county total for emissions from oil and gas operations categories.

Table 5-1 Emissions of VOC (tons per day) SFNA

	2012	2018	2021	2024
TOTAL EMISSIONS[a]	110	91	87	84
STATIONARY	22	22	23	23
AREA-WIDE	29	29	30	31
ON-ROAD MOTOR VEHICLES	34	20	16	14
OTHER MOBILE SOURCES	26	20	18	17
STATIONARY				
Solvent/Coatings	7.2	8.2	8.6	9.0
Petroleum Production/Marketing	5.9	5.3	4.9	4.6
Industrial Process	2.4	2.9	3.1	3.3
Waste Composting	6.1	5.3	5.5	5.7
Other	0.8	0.6	0.6	0.6
AREA-WIDE				
Consumer Products	12.4	12.3	12.6	13.0
Architectural Coatings	8.0	8.3	8.6	8.8
Pesticides/Fertilizers	1.2	1.2	1.2	1.2
Livestock Waste	2.9	2.9	2.9	2.9
Ag Burn/Other Managed Burn	0.9	0.8	0.8	0.8
Other	3.2	3.6	3.8	3.9
ON-ROAD				
Automobiles	12.1	6.0	4.7	4.0
Lt/Med Duty Trucks	13.3	8.5	7.0	6.0
Heavy Duty Gas Trucks	2.5	1.3	1.1	0.9
Heavy Duty Diesel Trucks	2.5	1.0	0.7	0.5
Motorcycles	2.8	2.5	2.5	2.4
Buses/Motor Homes	0.4	0.2	0.1	0.1
OTHER MOBILE				
Recreational Boats	11.7	8.6	7.3	6.2
Equipment (Construction/Industrial/Farm)	4.0	2.8	2.4	2.2
Lawn & Garden Equipment	5.6	4.8	4.7	4.8
Gas Can	1.7	1.4	1.3	1.2
Off-Road Recreational Vehicles	1.7	1.5	1.5	1.4
Trains	0.4	0.3	0.3	0.3
Aircraft	0.5	0.5	0.5	0.5
Ocean Vessels & Harbor Craft	0.1	0.1	0.1	0.1

Source: (CARB, 2016), does not include 5 tpd of VOC ERCs identified in Appendix A, Tables A3-1 and A3-2.
[a] TOTAL EMISSIONS are the rounded sum of reported emissions, as shown in Appendix A1.

Table 5-2 Emissions of NO_X (tons per day) SFNA

	2012	2018	2021	2024
TOTAL EMISSIONS[a]	101	69	58	49
STATIONARY	8	7	7	7
AREA-WIDE	3	2	2	2
ON-ROAD MOTOR VEHICLES	61	35	26	19
OTHER MOBILE SOURCES	30	26	23	21
STATIONARY				
Fuel Combustion	5.3	5.0	5.0	5.1
Ag Irrigation Pumps	2.2	1.0	0.8	0.8
Industrial Process	0.6	0.7	0.7	0.8
Other	0.1	0.1	0.1	0.0
AREA-WIDE				
Residential Fuel Combustion	2.4	2.0	1.9	1.8
Ag Burn/Other Managed Burn	0.3	0.3	0.3	0.3
ON-ROAD				
Heavy Duty Diesel Trucks	36.6	21.8	16.9	12.0
Lt/Med Duty Trucks	10.5	5.5	3.9	2.8
Automobiles	6.5	3.3	2.4	1.9
Heavy Duty Gas Trucks	2.8	1.7	1.3	1.0
Buses/Motor Homes	3.5	2.0	1.5	1.1
Motorcycles	0.5	0.5	0.5	0.5
OTHER MOBILE				
Construction & Mining Equip	5.5	4.6	3.9	3.1
Trains	6.2	6.7	6.3	5.9
Farm Equipment	8.3	6.6	5.6	4.7
Boats (Rec/Ships/Harbor Craft)	3.8	3.0	2.8	2.7
Commercial/Industrial Equipment	0.5	0.3	0.2	0.2
Aircraft	1.4	1.4	1.5	1.6
Oil Drilling/Workover	0.0	0.0	0.0	0.0
Other	2.8	2.1	1.8	1.7
Trans Refrig Units	1.3	0.9	0.9	0.9

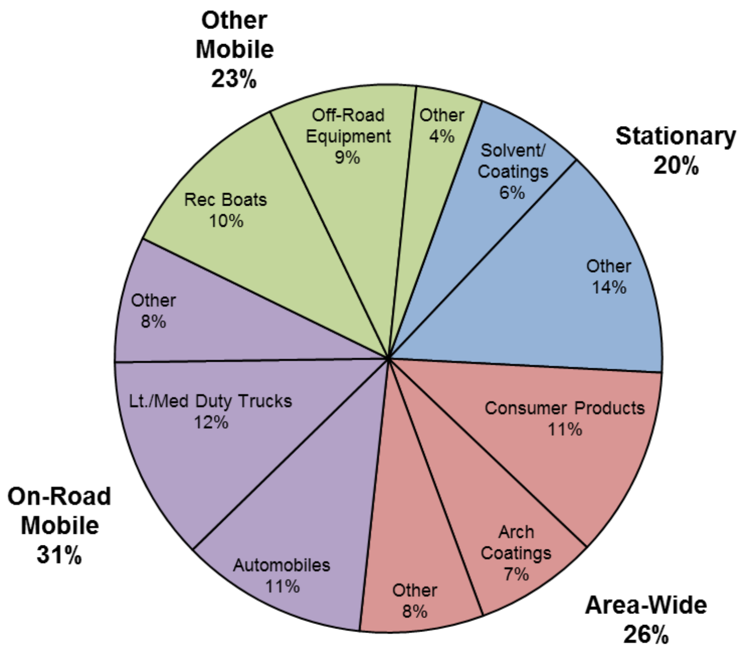
Source: (CARB, 2016), does not include 4 tpd of NO_X ERCs identified in Appendix A, Tables A3-1 and A3-2.
[a] TOTAL EMISSIONS are the rounded sum of reported emissions, as shown in Appendix A1.

2012 Emissions Pie Charts

The following pie charts (Figures 5-1 to 5-2) show the 2012 VOC and NO_X emission inventory categories as a percentage of the total inventory for the SFNA. In 2012, the VOC inventory includes 31% on-road mobile sources, 23% other mobile sources 26% area-wide sources, and 20% stationary sources.

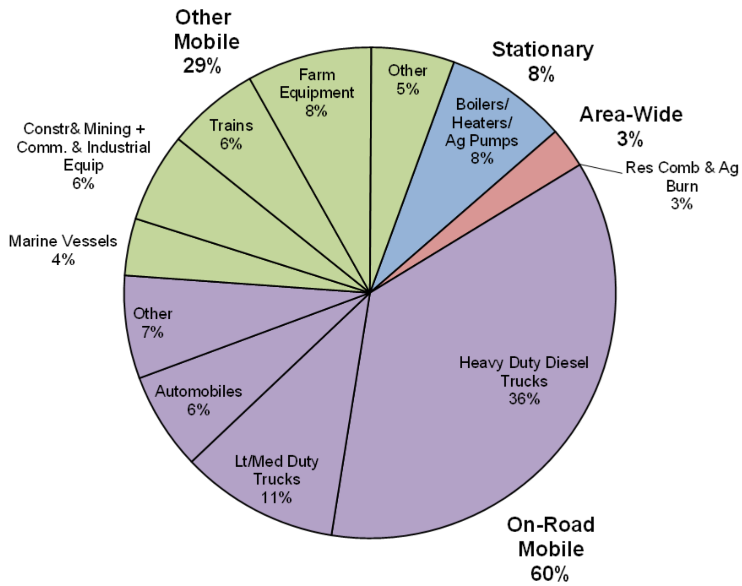
The NO_X inventory is predominately mobile source combustion emissions. In 2012, the NO_X inventory includes 60% on-road mobile sources, 29% other mobile sources, 8% stationary sources, and 3% area-wide sources.

Figure 5-1 2012 VOC Inventory SFNA 110 tpd



Source: (CARB, 2016) does not include 5 tpd of VOC ERCs identified in Appendix A, Tables A3-1and A3-2.

Figure 5-2 2012 NO_X Inventory SFNA 101 tpd



Source: (CARB, 2016) does not include 4 tpd of NO_X ERCs identified in Appendix A, Tables A3-1 and A3-2.

2012 Top 10 Emission Categories

Figures 5-3 and 5-4 contain bar charts that display the 2012 top 10 emission inventory categories for VOC and NO_X, respectively. The largest source categories for VOC are consumer products, automobiles, recreational boats, light-duty trucks, and architectural coatings. The largest source categories for NO_X are heavy-duty diesel trucks, off-road equipment, farm equipment, automobiles, trains, and light-duty trucks.

State and federal laws limit local air district authority to regulate certain emissions sources, notably motor vehicles, off-road engines, and consumer products. USEPA retains almost exclusive regulatory authority for emissions from trains, aircraft, and ships. The largest source categories that air districts have regulatory authority over include architectural coatings, solvents and coatings, waste composting, petroleum marketing, stationary fuel combustion, and agricultural irrigation pumps.

Figure 5-3 Top 10 Categories for VOC Planning Emissions – SFNA 2012

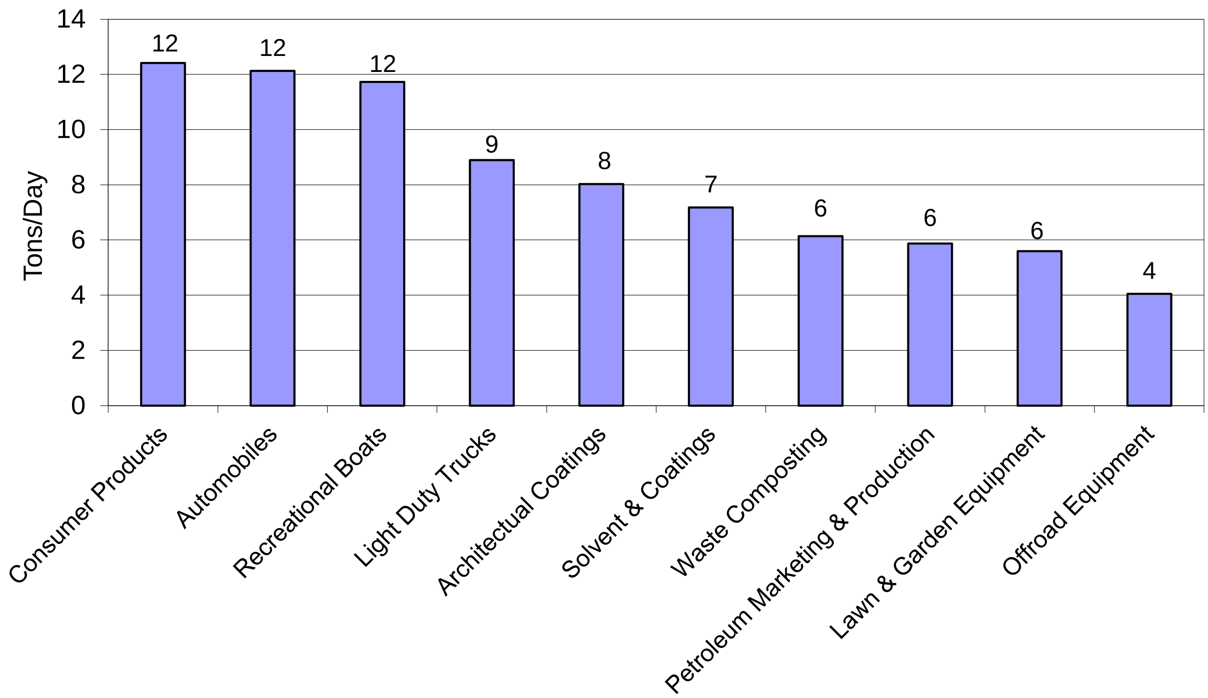
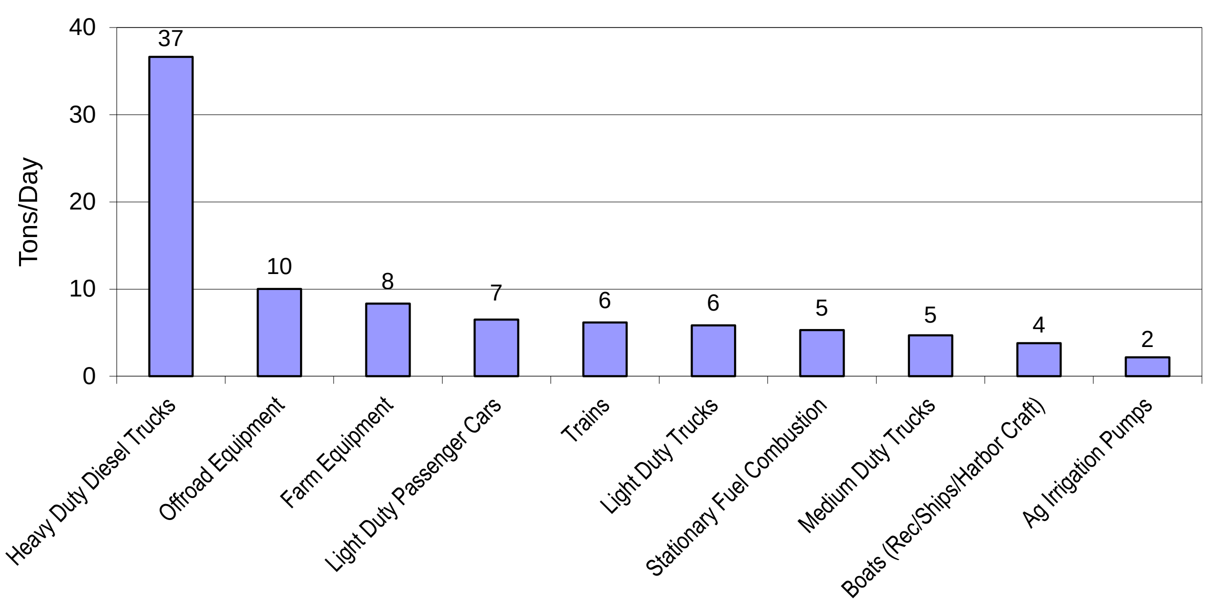


Figure 5-4 Top 10 Categories for NO_X Planning Emissions – SFNA 2012



Emissions Contribution by Agency Responsibility

Figures 5-5 and 5-6 show pie charts that identify the VOC and NO_X emissions contributions by primary agency responsibility (District, CARB, or USEPA). In terms of emissions, local air districts have direct regulatory authority for only 34% of VOC emissions and 11% of NO_X emissions in the SFNA. CARB has the most regulatory responsibility over emissions, 65% of VOC and 82% of NO_X, due to their authority over mobile source emissions.

Figure 5-5 VOC Emissions Contribution by Primary Agency Responsibility - SFNA

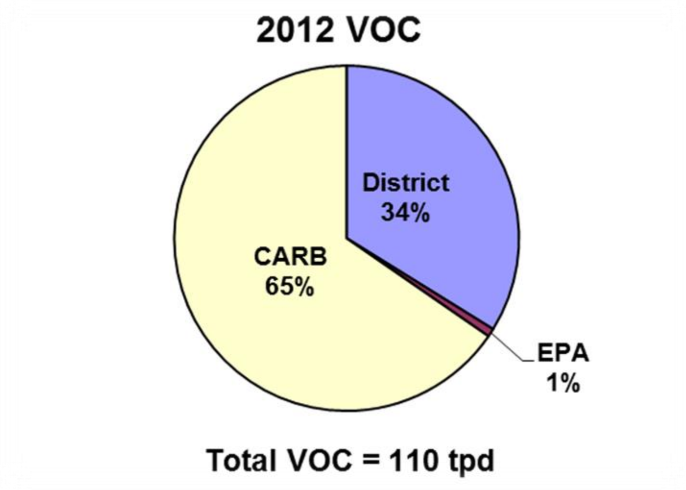
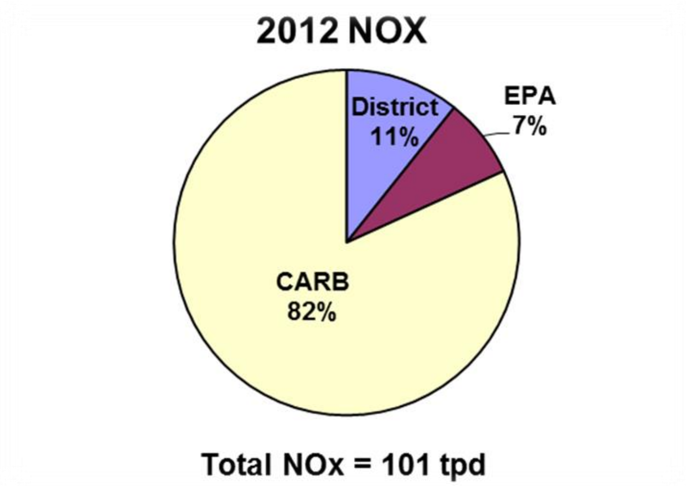


Figure 5-6 NO_X Emissions Contribution by Primary Agency Responsibility - SFNA



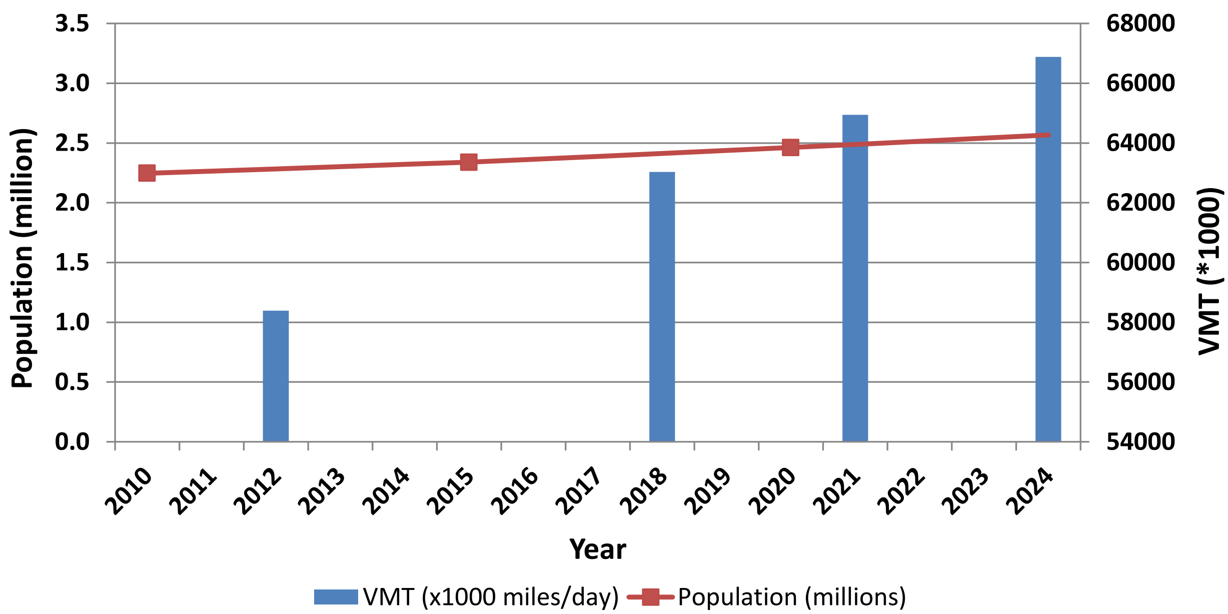
5.5 Emission Inventory Forecasts

The emission inventory forecasts take into account anticipated population and economic growth along with emission benefits from the federal, state, and local control measures. In order to forecast emissions for various future milestone and attainment analysis years, growth parameters and the post-2012 emission reduction effects of control measures[25] received by CARB as of late 2015 are applied to the 2012 emissions inventory at the emission process level for stationary and area-wide sources. The

[25] The growth and control data used for emission forecasting stationary and area-wide sources in CARB's SIP planning projection model, CEPAM, are found in Appendix A2.

various growth parameters include forecasts for population, housing, employment, energy demand, motor vehicle travel, and other industrial and commercial outputs. Off-road motor vehicle emissions are forecasted separately by off-road category specific models using growth rates that were based on category-specific economic indicators such as employment, expenditures and fuel use. Future on-road emissions are determined by using VMT forecasts in SACOG's 2016 MTP (SACOG, 2016) and MTC's 2015 FSTIP (MTC, 2016). Figure 5-7 contains a graph showing population and VMT growth[26] for the Sacramento region. Existing control strategies continue to reduce future VOC and NO_X emissions from stationary and area sources, on-road motor vehicles, and some other mobile source categories (such as off-road equipment).

Figure 5-7 Population Growth and VMT Forecast – SFNA



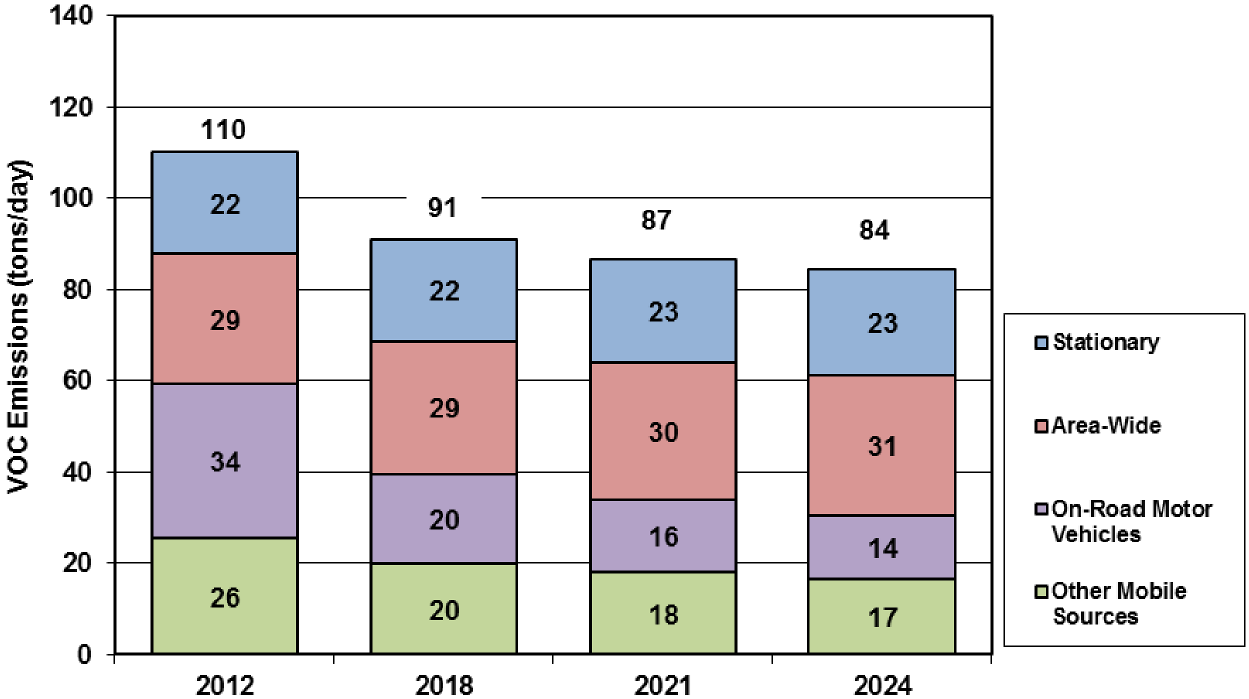
The following bar charts (Figures 5-8 and 5-9) show the VOC and NO_X emission inventory forecasts for stationary sources, area-wide sources, on-road motor vehicles, and other mobile sources for the Sacramento nonattainment region. Bar charts are given for the 2012 base year and compared to the milestone RFP years of 2018, and 2021, and to the attainment demonstration analysis year of 2024. The VOC and NO_X

[26] Population:
1. Data source: CARB Almanac.
2. El Dorado County and Placer County population data exclude the Tahoe Basin.
3. Sacramento Nonattainment Area fraction for South Sutter is estimated at 4% of Sutter County.

VMT:
1. 2012 VMT activities are from EMFAC2014.
2. 2018, 2021, and 2024 VMT activities are from SACOG's 2016 MTP and MTC's Plan Bay Area Preferred Land Use Scenario/Transportation Investment Strategy (MTC, 2016) for Solano County portion of SFNA.

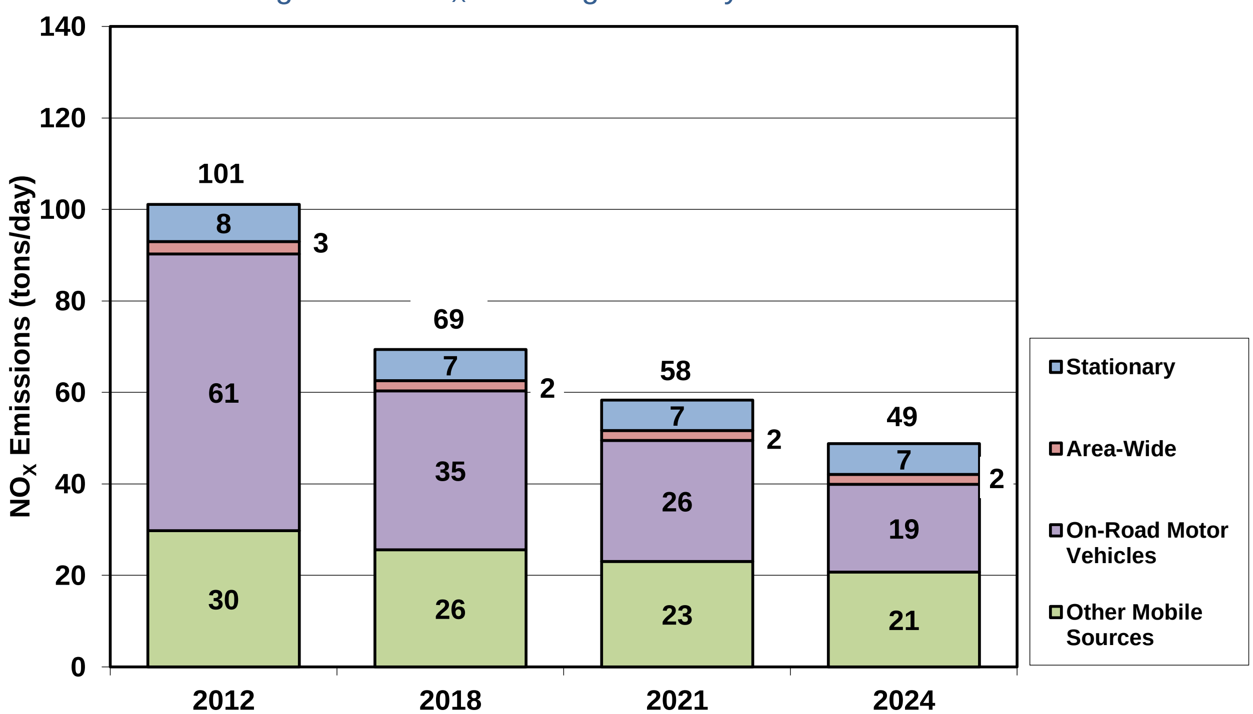
emission forecasts show significant declines in mobile source emissions, despite increasing population, vehicle activity, and economic development.

Figure 5-8 VOC Planning Inventory Forecasts – SFNA



Source: (CARB, 2016), does not include 5 tpd of VOC ERCs identified in Appendix A, Tables A3-1 and A3-2.

Figure 5-9 NO_X Planning Inventory Forecasts – SFNA



Source: (CARB, 2016), does not include 5 tpd of VOC ERCs identified in Appendix A, Tables A3-1 and A3-2.

5.6 Emission Reduction Credits Added to Emission Inventory Forecasts

Certain pollutant emission reductions due to equipment shutdown or voluntary control may be converted to ERCs and registered with the air districts. These ERCs may then be used as “offsets” to compensate for an increase in emissions from a new or modified major emission source regulated by the air districts. ERCs may also be used as an alternative to strict compliance with specified rules. Thus, if a permitted source cannot meet the applicable emission standard requirements, usually because it is technically infeasible or not cost effective, the source may lease or purchase ERCs to achieve the required reductions.

Since ERCs represent potential emissions, they need to be taken into account in the emission inventories. One method is to assume that the use of ERCs will already be included within the projected rate of stationary source growth in the emissions inventory. However, if the use of available ERCs exceeds anticipated emissions growth, future emissions could be underestimated. Therefore, to ensure that the use of ERCs will not be inconsistent with the future reasonable further progress and attainment goals, the amount of ERCs issued for reductions that occurred prior to the 2012 base year are added to the forecasts for VOC and NO_X planning emissions inventories that are used in attainment demonstration modeling and the RFP demonstration.

5.6.1 Emission Reduction Credits

For this attainment plan, the amounts of unused banked ERCs of emissions reductions that occurred prior to the 2012 baseline year for the Sacramento nonattainment area are 4.2 tons per day of VOC and 3.1 tons per day of NO_X. The quantity of these ERCs is listed for each air district in Appendix A. The ERCs consist of emissions reduced from stationary sources. Including these ERCs here simply maintains the validity of previously banked ERCs and other reductions.

5.6.2 Future Bankable Rice Burning Emission Reduction Credits

California legislation[27] in 1991 (known as the Connelly bill) required rice farmers to phase down rice field burning on an annual basis, beginning in 1992. A burn cap of 125,000 acres in the Sacramento Valley Air Basin was established, and growers with 400 acres or less were granted the option to burn their entire acreage once every four years. Since the rice burning reductions were mandated by state law, they would ordinarily not be “surplus” and eligible for banking. However, the Connelly bill included a special provision declaring that the reductions qualified for banking if they met the State and local banking rules.

[27] Connelly-Areias-Chandler Rice Straw Burning Reduction Act of 1991 (California Health and Safety Code Section 41865).

Some rice burning reductions have been banked as ERCs. Other pre-2012 reductions in rice burning may be banked in the future under an ERC rule[28] currently in development. The total amounts of potential bankable rice burning ERCs for the SFNA are estimated at 0.12 ton per day of VOC and 0.13 ton per day of NO_X. The only district with unbanked rice ERCs is SMAQMD. Other districts have already banked their rice emissions so that no more rice ERC will be banked in the future.

5.6.3 Summary of Emission Reduction Credits

ERCs issued for reductions that occurred prior to the 2012 base year and potential future bankable rice burning ERCs are summarized for the Sacramento nonattainment area, rounded up to 5 tpd VOC and 4 tpd NO_X ERCs, and added to the VOC and NO_X emission inventory forecasts for VOC and NO_X planning inventories used in attainment demonstration modeling and RFP demonstration. The summary of the VOC and NO_X planning inventories are shown in Tables 5-3 and 5-4, respectively.

Table 5-3 VOC Emission Reduction Credits - SFNA

Emissions in tons/day	2012	2018	2021	2024
Emission Reduction Credits	---	4.2	4.2	4.2
Future Bankable Rice Burning Emission Reduction Credits	---	0.1	0.1	0.1
Total ERCs (rounded up)	**---**	**5**	**5**	**5**
Emission Forecasts	**110**	**91**	**87**	**84**
Total Planning Inventory	**110**	**96**	**92**	**89**

Table 5-4 NO_X Emission Reduction Credits - SFNA

Emissions in tons/day	2012	2018	2021	2024
Emission Reduction Credits	---	3.1	3.1	3.1
Future Bankable Rice Burning Emission Reduction Credits	---	0.1	0.1	0.1
Total ERCs (rounded up)	**---**	**4**	**4**	**4**
Emission Forecasts	**101**	**69**	**58**	**49**
Total Planning Inventory	**101**	**73**	**62**	**53**

[28] This rice burning ERC rule must be approved by USEPA into the SIP for the rice ERCs to be used for compliance with federal air quality requirements.

5.7 Emissions Inventory Documentation

More detailed documentation of the VOC and NO_X emissions inventory is provided in Appendix A. This appendix contains the estimated 2012, 2018, 2021, and 2024 emission inventories for each county and air basin combination in the SFNA. A listing of the VOC and NO_X emission reduction credits by individual air district is also included.

Emission inventories are constantly being updated to incorporate new and better information and methodologies. Many improvements, especially in the mobile source categories, and the addition of previously un-inventoried emission sources, have been made to the inventory. Detailed information on emission methodologies, changes, and forecasts can be found on CARB websites: http://www.arb.ca.gov/ei/ei.htm and http:/www.arb.ca.gov/msei/msei.htm.

5.8 References

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USEPA. *Draft Emission Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations*. United States Environmental Protection Agency, 16 December [2016.] Web. 19 April 2017

<https://www.epa.gov/sites/production/files/2016-12/documents/2016_ei_guidance_for_naaqs.pdf >

6 AIR QUALITY MODELING ANALYSIS

6.1 Introduction to Air Quality Modeling

Ozone is a secondary pollutant produced by complex chemical reactions in the air involving ozone precursor pollutants of volatile organic compounds (VOC) and nitrogen oxides (NO_X) in the presence of sunlight. Ozone formation is also affected by meteorological characteristics (e.g. temperature, wind, vertical mixing, pressure, cloud cover, and humidity) and land surface features (e.g., land use, surface roughness, albedo[29], and terrain).

Due to the large number of atmospheric interactions, varying physical factors, and vast spatial boundaries pertaining to ozone formation, the evaluation of air quality problems to develop adequate emission reduction strategies is inherently difficult and resource intensive. Therefore, state-of-the-science computer modeling is used to simulate the formation of ozone through mathematical descriptions of atmospheric processes and photochemical reactions of pollutants over large regional air basins.

This chapter describes the air quality modeling and analysis performed by the California Air Resources Board (CARB). The modeling results determine how soon the Sacramento Federal Nonattainment Area (SFNA) will attain the 2008 Ozone National Ambient Air Quality Standard (NAAQS). CARB prepared separate technical documents to address the conceptual modeling, modeling protocol, attainment demonstration, and modeling emissions inventory. These technical documents are included in Appendix B – Photochemical Modeling.

[29] Albedo is a measure of how much light that hits a surface is reflected without being absorbed.

Appendix	Technical Document Title	Key elements in the supporting document
B-1	*Modeling 8-Hour Ozone for the Sacramento Federal Nonattainment Area's 2016 State Implementation Plan for the 75ppb 8-Hour Ozone Standard*	Summary of the photochemical modeling results.
B-2	*Sacramento Federal Non-attainment Area (SFNA) 75 ppb 8-hour Ozone*	Conceptual modeling
B-3	*Photochemical Modeling Protocol – Photochemical Modeling for the 8-Hour Ozone and Annual/24-hour $PM_{2.5}$ State Implementation Plans*	Modeling Protocol
B-4	*Modeling Attainment Demonstration – Photochemical Modeling for the 8-Hour Ozone State Implementation Plan in the Sacramento Federal Non-attainment Area (SFNA)*	Attainment Demonstration Model Performance Evaluation Unmonitored Area Analysis
B-5	*Modeling Emission Inventory for the 8-Hour Ozone State Implementation Plan in the Sacramento Non-Attainment Area*	Photochemical modeling emissions inventory

6.2 Air Quality Modeling Methodology and Applications

To evaluate when the SFNA will attain the 2008 8-hour ozone NAAQS, it is necessary to understand what causes concentrations to be higher during the ozone season and then predict future ozone concentrations under changing emission scenarios. Extensive air monitoring and emissions data were first collected for the ozone season of 2012 (May 1 to October 5) to provide information for developing base case model simulations. Air quality modeling simulations were run for different future year emissions scenarios to study how reducing VOC and NO_X emissions would decrease ambient ozone concentrations. Emission reduction levels for meeting the ambient ozone standard were then quantified for a specified attainment year.

Ozone air quality modeling has other uses besides estimating attainment of the ambient standard. For example, it can also be used to determine potential unmonitored high ozone areas where future monitoring sites may be installed.

6.3 Air Quality Modeling Analysis Requirements

Clean Air Act §182(c)(2)(A) requires the attainment demonstration for a nonattainment area classified as “serious or higher” be based on photochemical grid modeling or any other United States Environmental Protection Agency (USEPA)-approved method. This analysis uses the grid modeling approach. In addition, USEPA published a draft modeling guidance (USEPA, 2014) on how to apply air quality models to generate results for preparing 8-hour ozone attainment demonstrations. The draft guidance document lists the following elements that USEPA expects when building a model platform:

1) A conceptual model which describes the air quality problems of the modeling region;
2) A modeling protocol which describes the proposed model setup procedures;
3) An attainment demonstration documentation package (listed deviation from the modeling protocol, actual modeling procedures; and the attainment demonstration results);
4) Episode selection which discusses the rationale for choosing the base year;
5) Future year selection which discusses the rationale for choosing the future year;
6) Modeling domain selection which considers the size of modeling domain buffer and resolution;
7) Discussion of the photochemical model selection;
8) Discussion of the meteorological model selection, input parameters, and modeling domain;
9) Discussion of the steps taken to develop the gridded emissions inventory; and
10) Discussion of boundary and initial conditions setup.

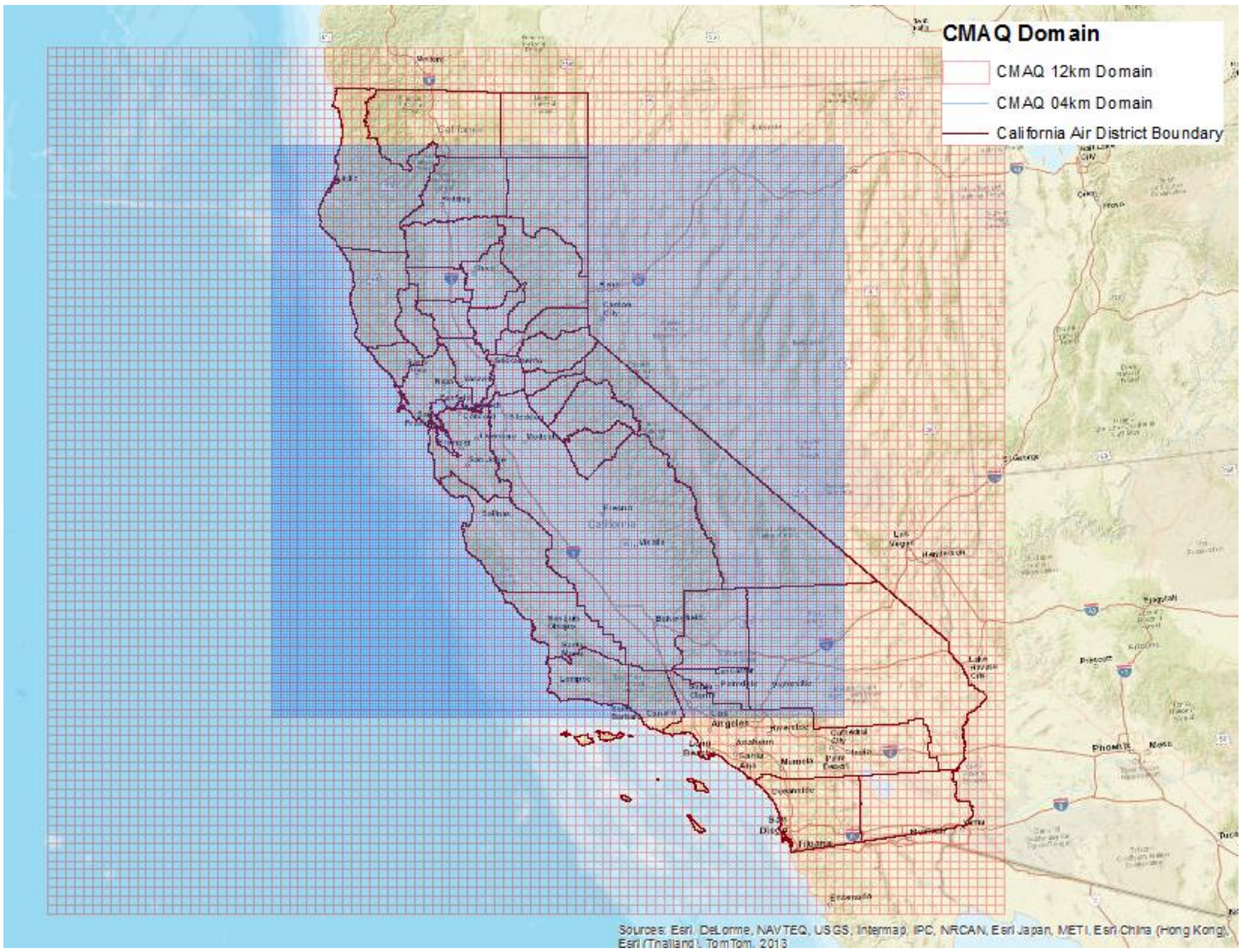
USEPA's draft modeling guidance document (USEPA, 2014, p.95) describes a modeled attainment test as a technical procedure in which an air quality model is used to simulate base year and future air pollutant concentrations for the purpose of demonstrating attainment of the relevant NAAQS. The test uses model estimates in a *relative* rather than *absolute* sense to estimate future design values. The fractional changes in air pollutant concentrations between the model future year and model base year are calculated for all valid monitors. These ratios are called relative response factors (RRF). Future ozone design values are estimated by multiplying the modeled RRF for each monitor by the monitor-specific base year design value. If the calculated future ozone design values are ≤ 75 ppb, then the attainment test is satisfied for the monitors.

The CARB is responsible for analyzing downwind and upwind influences from or on areas outside the nonattainment area. These influences are considered in the recommended modeled attainment test, which predicts whether all estimated future design values will achieve the ozone NAAQS under modeled meteorological conditions.

6.4 Description of Air Quality Model and Modeling Inputs

The photochemical grid modeling used for the 8-hour ozone attainment analysis is developed with the Community Multiscale Air Quality Model (CMAQ). (Version 5.0.2) The CMAQ model, a state-of-the-science "one-atmosphere" modeling system developed by the USEPA, was designed for applications ranging from regulatory and policy analysis to investigating the atmospheric chemistry and physics that contribute to air pollution. The CMAQ model simulates a three-dimensional atmosphere over the course of an ozone season (May 1 – October 5[30]), and is used to investigate air pollution at the spatial resolution of 4 km grid squares for the Central California Domain (see modeling domain in Figure 6-1). The CMAQ model uses the Statewide Air Pollution Research Center (SAPRC) chemical mechanism[31] 2007 version. The model calculates air quality concentrations averaged for each hour at each 4 km grid square location at the surface and for each vertical layer above.

Figure 6-1 CMAQ Modeling Domain



192x192 Grid Cells at 4x4-km Horizontal Resolution

30 The ozone season for the Sacramento Region is usually May through September. However, the region experienced high ozone on October 2 for the base model year. As a result, the model simulation was extended to October 5.

31 Chemical mechanism originally developed by the Statewide Air Pollution Research Center (SAPRC) of the University of California at Riverside.

Air quality models require time-varying meteorological fields including winds, temperature, and water vapor content to calculate the transport and transformations of air pollutants. For this State Implementation Plan (SIP) attainment demonstration, the Weather and Research Forecasting (WRF) model was used to develop the meteorological fields that drive the photochemical modeling. The USEPA draft modeling guidance (USEPA, 2014, p.25) recommends the use of a well-supported grid-based mesoscale meteorological model for generating meteorological inputs. The WRF model is a community-based mesoscale prediction model, which represents the state-of-the-science and has a large community of model users and developers who frequently update the model as new science becomes available (Appendix B-3, p15). The WRF model features two dynamical cores[32], a data assimilation system, and a software architecture facilitating parallel computation and system extensibility. The model serves a wide range of meteorological applications across scales from tens of meters to thousands of kilometers.

In this SIP model, WRF was run using multiple sub-domains with resolutions of 36 km, 12km, and 4 km grid squares. Figure 6-2 shows the WRF Modeling domain. In addition, the vertical structure of the meteorological modeling incorporated a 30 layer configuration and match to the CMAQ vertical modeling layers. Table 6-1 shows the vertical layer structures and the CMAQ layers matching.

[32] The two cores are referred to as the ARW (Advanced Research WRF) core and the NMM (Nonhydrostatic Mesoscale Model) core. The ARW has been largely developed and maintained by the NCAR (National Center for Atmospheric Research) MMM (Mesoscale and Microscale Meteorology) Laboratory. Details of ARW core can be found in the WRF manual < http://www2.mmm.ucar.edu/wrf/users/docs/user_guide_V3.8/users_guide_chap1.htm>. The NMM core was developed by the National Centers for Environmental Prediction. It is currently used in the HWRF (Hurricane WRF) system, for which user support is provided by the Developmental Testbed Center

Figure 6-2 WRF Modeling Domain

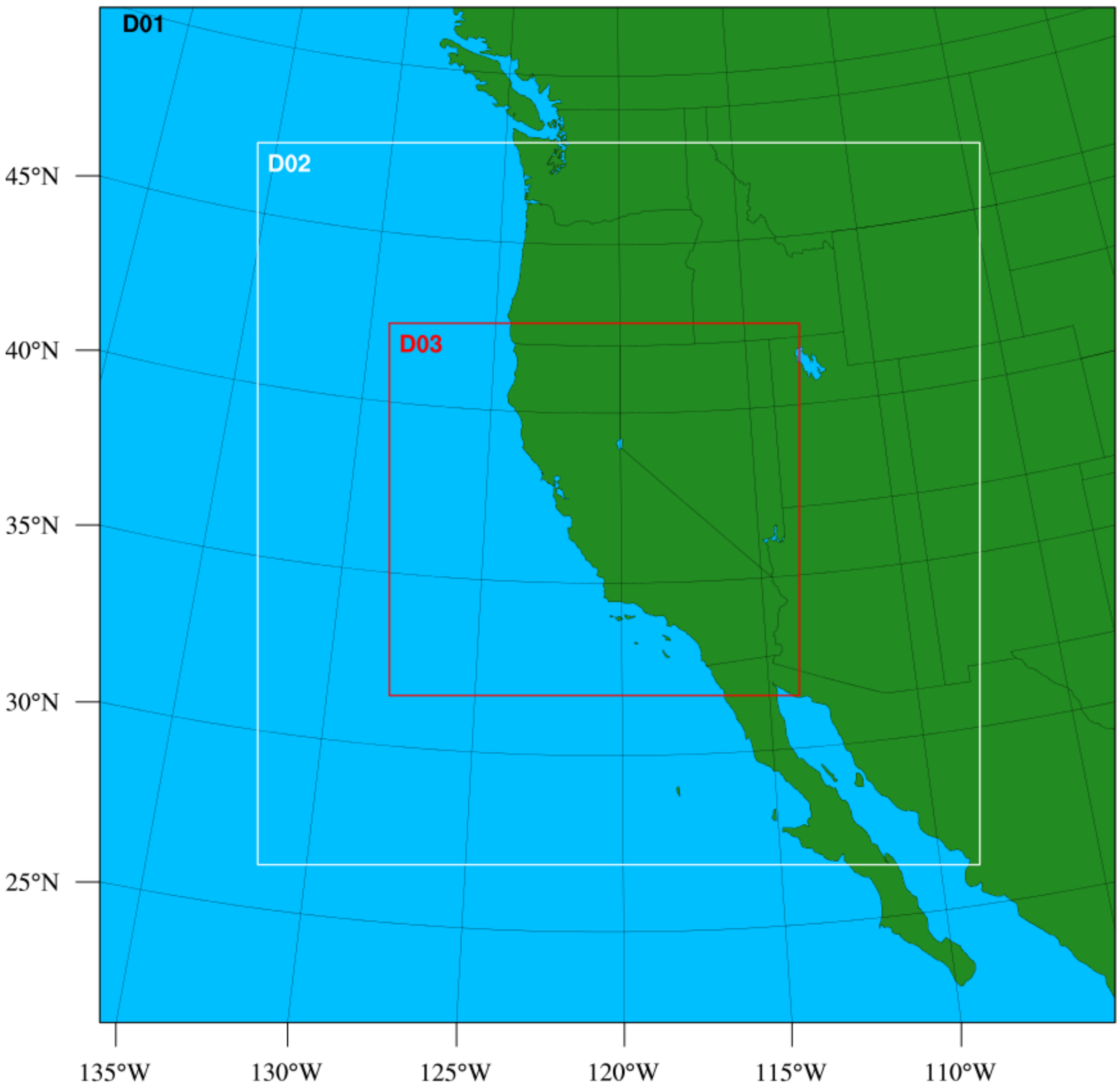


Table 6-1 WRF vertical layer structure and CMAQ layer matching

Layer Number	Height (m)	Layer Thickness (m)	Layer Number	Height (m)	Layer Thickness (m)
30	16082	1192	14	1859	334
29	14890	1134	13	1525	279
28	13756	1081	12	1246	233
27	12675	1032	11	1013	194
26	11643	996	10	819	162
25	10647	970	9	657	135
24	9677	959	8	522	113
23	8719	961	7	409	94
22	7757	978	6	315	79
21	6779	993	5	236	66
20	5786	967	4	170	55
19	4819	815	3	115	46
18	4004	685	2	69	38
17	3319	575	1	31	31
16	2744	482	0	0	0
15	2262	403			

Note: Shaded layers denote the subset of vertical layers to be used in the CMAQ photochemical model simulations.

Air quality models also require inputs for time-varying and spatially gridded emissions estimates. The modeling emissions files consist of hourly speciated emissions for point, area, motor vehicle, wildfires, ocean going vessels, and biogenic sources for each grid cell, which are provided by various methods. Point, area, and off-road mobile source emissions are processed into modeling inputs using SMOKE[33]. On-road motor vehicle emissions are prepared by EMFAC[34] and gridded using Caltrans' DTIM[35]. Ocean Going Vessels emissions (OGV) are prepared by CARB's OGV model. Emissions from biogenic sources are generated by MEGAN[36].

Other air quality model inputs include estimates of speciated concentrations for initial and boundary conditions. Initial pollutant concentrations represent ambient air quality

[33] SMOKE is Sparse Matrix Operator Kernel Emissions modeling system (https://www.cmascenter.org/smoke). It is a processor converting point and area sources into gridded emissions inventory for photochemical modeling.

[34] EMFAC is EMission FACtor model which is designed to generate county-level, average-day emissions estimates. The version for the SFNA SIP simulation is 2014. The EMFAC model is developed by the California Air Resources Board.

[35] DTIM is Direct Travel Impact Model (DTIM). The version for the SFNA SIP simulation is 4. The DTIM model is maintained by California Department of Transportation (Caltrans) Division of Transportation Planning Office of Travel Forecasting and Analysis.

[36] MEGAN is Model of Emissions of Gases and Aerosols from Nature. The model utilizes gridded emission factor and plant functional type data to estimate hourly biogenic emissions within each grid cell of the modeling domain. The model is maintained by Washington State University. (http://lar.wsu.edu/megan/)

inside the modeling domain at the time the modeling episode begins. In this SIP modeling, the default initial conditions included with the CMAQ model were used. Boundary conditions represent pollutant concentrations entering the modeling domain from the vertical top and horizontal side borders. MOZART[37] was used to define the boundary conditions for the outmost modeling domain.

6.5 Base Case Model Performance Evaluation

After preparing the air quality modeling input files (e.g., meteorological fields, gridded emissions inventories, initial and boundary conditions), the CMAQ air quality modeling was conducted and results evaluated for the SFNA which covered the period of May 1, 2012 to October 5, 2012. Since a continuous simulation is time consuming and takes months to complete, the modeling period has been split up into five monthly simulations and each simulation has a seven day spin-up[38] period. Since there are modeling uncertainties and limitations in running air quality models, the model performance was evaluated for each base case scenario.

For model performance, USEPA recommends at a minimum evaluating the following statistical parameters: mean observed value, mean model value, mean bias, mean error, root mean square error, normalized mean bias, normalized mean error, and correlation coefficient. The summary statistics were calculated for individual days averaged over all sites and for individual sites averaged over all days, and then aggregated into meaningful subregions or subperiods. In addition, statistical plots were included in evaluating the modeling: time-series comparing predictions and observations, scatter plots for comparing the magnitude of simulated and observed mixing ratios, box plots to summarize the time series data across different regions and averaging times, as well as frequency distributions. These plots are available in Appendix B-4.

USEPA draft modeling guidance (USEPA, 2014, p63) states it is not appropriate to assign any acceptance criteria levels that distinguish between adequate and inadequate model performance. Instead, USEPA recommends that a qualitative weight-of-evidence approach consisting of a variety of performance tests be used to determine whether a particular modeling application is valid for assessing the future attainment status of an area.

Based on the statistical comparisons between observed and predicted ozone data, the base case modeling scenarios were determined to be performing adequately overall in

37 MOZART is Model for OZone And Related chemical Tracers. It is one of the global chemical transport model (CTM). It was developed by National Center for Atmospheric Research (NCAR) (https://www2.acom.ucar.edu/gcm/mozart).

38 Spin up time is the time taken for a computer model to approach its own climatology after being started from the initial conditions.

the SFNA. Model performance statistics are consistent with previous studies in the SFNA, San Joaquin Valley, and other Central California ozone studies. Base case model performance statistics tables, base case model performance evaluations, and modeling documentation are available in Appendix B-4.

6.6 Baseline and Future Year Model Runs

After the photochemical modeling base case episodes were shown to perform adequately, the modeling was run with the summer planning inventory for a 2012 baseline year and 2022 and 2026 future years with existing control strategies for assessing attainment of the ozone NAAQS and excluded wildfires and 2012 Chevron refinery fire emissions. The USEPA's 2008 Ozone NAAQS implementation rule (40 CFR 51.1108(d)) states that the nonattainment area "must provide for implementation of all control measures needed for attainment no later than the beginning of the attainment year ozone season." As previously discussed, 2026 was the modeling year selected to demonstrate compliance with the "severe-15" nonattainment classification. The preliminary modeling results of 2026 show the SFNA could attain the standard by a margin of 5 ppb lower than the standard at the peak monitoring site. Based on the air quality data and emissions inventory trends, CARB and the SFNA air districts decided to investigate 2022 as another future attainment year. The 2022 modeling results shows that the SFNA future design value at the Folsom monitor is 75.2 ppb which is just 0.3 ppb below the standard when USEPA's rounding conventions are applied.

6.7 Emission Reduction Credits Added to Future Year Model Runs

Emission reduction credits (ERCs) for the Sacramento region are discussed and quantified in Section 5.6. Since ERCs are potential future emissions, it is not currently known what emission sources they will be applied to and where the emission sources will be located. Existing inventories for stationary emissions are gridded for modeling by using the point source facility locations. Estimated area-wide emissions are gridded for modeling using related spatial surrogate parameters, such as population and land use types.

Due to the uncertainty of the type and location of future sources using ERCs, the baseline VOC and NO_X ERCs for the Sacramento nonattainment area were added to the future year gridded modeling inventory as stationary and area-wide emissions. The ERCs from each district were distributed to its stationary and area-wide emission categories using the across the board percentage increase from adding ERCs to total stationary and area-wide emissions.

6.8 Forecasted Ozone Design Values

The results from baseline and future year modeling runs are evaluated at each ozone nonattainment monitor to determine the predicted future ozone design value with the estimated future emissions scenario. The method for calculating the predicted future ozone design values is described by the following equation (USEPA, 2014, p69):

DV_{future} = RRF x (DV_{base}) where,

DV_{future} = the estimated future design value concentration at the monitor used to predict attainment of the 8-hour ozone NAAQS. [Truncated to whole ppb]

RRF = the relative response factor which is the ratio of the future year (FY) modeled average 8-hour daily maximum ozone (rounded to tenths of a ppb) to the baseline year (BY) modeled average 8-hour daily maximum ozone (rounded to tenths of a ppb) for the monitor. Only the top 10 days with baseline year modeled maximum daily average 8-hr ozone greater than or equal to 60 ppb are selected to calculate the RRF. [Rounded to three significant figures to right of decimal]

$$RRF = \frac{FY_{AVG}}{BY_{AVG}}$$

DV_{base} = the three-year average of the actual observed average base year design values (2012, 2013, and 2014) at the monitor for 8-hour ozone. [Rounded to tenths of a ppb]

The results for the forecasted ozone design values for the future year 2022 and 2026 are shown in Table 6-1. The future year 2026 corresponds to the attainment demonstration analysis year for a severe nonattainment classification and the future year 2022 corresponds to the earliest year that the Sacramento region could attain.

Based on the photochemical modeling results, attainment was predicted at all ozone monitors in 2022 in the SFNA. The SFNA air districts, in consultation with CARB and USEPA Region IX, are proposing 2024 be established as the SFNA attainment demonstration analysis year for the 2008 ozone NAAQS. Selection of 2024 is appropriate because it is bounded by two modeled attainment demonstrations, still supports early attainment (it is before the regulatory attainment deadline for a severe-15 area of July 20, 2027), and provides a safeguard against inherent uncertainties in predicting future ambient ozone concentrations beyond 2022 (e.g. emission reductions, meteorology, natural events and other uncertainties discussed in section 6.11, below.).

Table 6-2 Forecasted 8-Hour Ozone Design Values

Site	Base year 2012	Future Year 2022	Future Year 2026
Placerville-Gold Nugget Way (El Dorado, MCAB)	82.3	68.0	64.0
Cool-Hwy193 (El Dorado, MCAB)	81.3	67.8	64.1
Auburn - Atwood Rd (Placer, SVAB)	79.0	64.6	60.6
Colfax-City Hall (Placer, MCAB)	73.7	60.9	57.5
Echo Summit (El Dorado, MCAB)	69.0	64.9	63.9
Folsom-Natoma Street (Sacramento, SVAB)	90.0	75.2	70.7
Sloughhouse (Sacramento, SVAB)	84.0	71.1	67.2
Roseville-N Sunrise Ave (Placer, SVAB)	82.3	69.8	66.3
Sacramento-Del Paso Manor (Sacramento, SVAB)	77.3	66.4	63.1
North Highlands-Blackfoot Way (Sacramento, SVAB)	76.0	65.2	61.9
Sacramento - 1309 T Street (Sacramento, SVAB)	70.0	60.5	57.7
Sacramento-Goldenland Court (Sacramento, SVAB)	70.0	61.7	58.9
Elk Grove - Bruceville Road (Sacramento, SVAB)	71.7	61.4	58.3
Woodland-Gibson Road (Yolo, SVAB)	68.7	58.1	54.9
Vacaville-Ulatis Drive (Solano, SVAB)	67.3	56.9	53.9
Davis-UCD Campus (Yolo, SVAB)	66.7	56.7	53.7

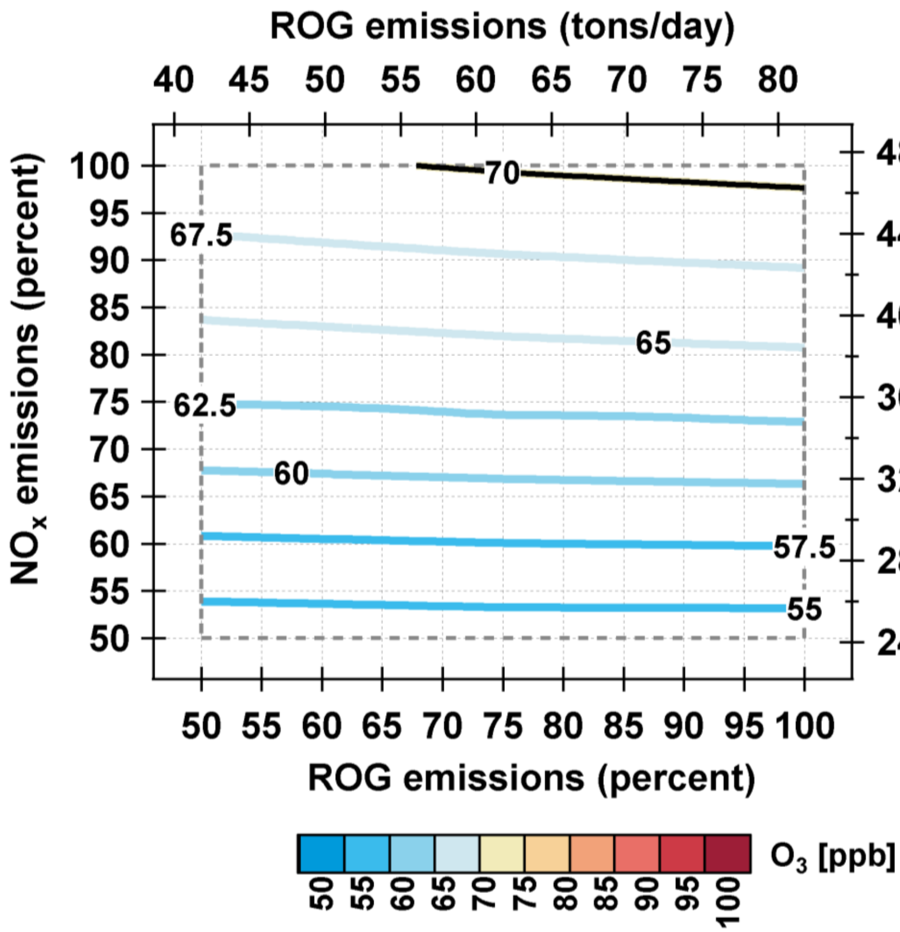
The forecasted 8-hour ozone design values indicate that all of the monitoring sites in the Sacramento nonattainment area are predicted to attain the federal 8-hour ozone standard (75ppb) by 2022.

6.9 Sensitivity to Ozone Precursors

To understand the future ozone sensitivity within the SFNA for different levels of NO_X and VOC emissions in the region, modeling sensitivity simulations were conducted to generate 8-hr ozone isopleths. These sensitivity simulations are identical to the future year 2026 simulation discussed in Section 6.6, except that domain-wide fractional reductions were applied to future year 2026 anthropogenic NO_X and VOC emission levels. Each sensitivity simulation was run for the entire ozone season. The RRF methodology described in Section 6.8 was then applied to the output of each fractional VOC and NO_X sensitivity simulation to calculate the future year DV at each monitoring site in the SFNA.

Figure 6-3 shows the 2026 ozone isopleth emissions at the Folsom Monitor. The bottom and top axes represent the domain-wide fractional ROG emissions and the corresponding SFNA emission totals (tons per day) in 2026, respectively. The left and right axes represent the domain-wide fractional NO_X emissions and emission total in 2026. The ozone isopleth plot shows that the SFNA requires 35 tpd of VOC emissions reductions or 1.7 tpd of NO_X emissions reduction to lower 1ppb of ozone if the other pollutant level remains constant. The future ozone mixing ratios throughout the SFNA are predicted to be in the NO_X-limited regime and the sensitivity to VOC emissions controls will be much lower when compared to NO_X controls.

Figure 6-3 The 2026 8-hr ozone isopleth at the Folsom monitor.



6.10 Unmonitored Area Analysis

The unmonitored area analysis is used to ensure that there are no regions outside of the existing monitoring network that would exceed the NAAQS if a monitor was present (USEPA, 2014, p144). USEPA recommends combining spatially interpolated design value fields with modeled ozone gradients and grid-specific RRFs in order to generate gridded future year gradient adjusted design values. The results and discussion of the unmonitored area analysis are available in Appendix B-4, Section 5.4. No exceedances were identified.

6.11 Air Quality Modeling Uncertainties

USEPA's draft modeling guidance document (USEPA, 2014, p179) states that, "models are simplistic approximations of complex phenomena. The modeling analyses used to assess whether emission reduction measures will bring an individual area into attainment for the NAAQS contain many elements that are uncertain. These uncertain aspects of the analyses can sometimes prevent definitive assessments of future attainment status." Uncertainty arises for a variety of reasons; for example, incomplete representation in the atmospheric physical and chemical processes may cause limitations in the model's scientific formulation. Modeling uncertainties can also result from meteorological, emissions projections, and other input data base limitations, such as land use, microclimate, background ozone concentrations, etc.

Other factors adding to air quality modeling uncertainties include:

1) How well the meteorological simulation represents the severity of future meteorological conditions conducive to high ozone formation,
2) How well the methodology for forecasting ozone design values corresponds to actual future monitored ozone design values, and
3) How well domain-wide emission reductions in the SFNA attainment analysis are achieved, especially during the time when pollutant transport is significant.

The impact of future climate change is not included in the photochemical modeling assumptions. Any effects from climate changes during the timeframe of this SIP (12 years, from 2012 to 2024) will unlikely be significant enough to have an impact on the model results. USEPA draft modeling guidance (USEPA, 2014, p28) states that "there are significant uncertainties regarding the precise location and timing of climate change impacts on air quality. Climate projections are more robust for periods at least several decades in the future because the forcing mechanisms that drive near-term natural variability in climate patterns. (e.g., El Nino, North American Oscillation) have substantially larger signals over short time spans than the driving forces related to long-term climate change. In contrast, attainment demonstration projections are generally for time spans of less than 20 years." USEPA does not recommend that air agencies explicitly account for long-term climate change in attainment demonstrations.

In order to mitigate potential air quality modeling uncertainties, the modeling guidance suggests using corroborative methods and analyses to support the air quality modeling results and attainment demonstration. A separate weight-of-evidence report will be submitted by CARB along with this Plan.

6.12 Air Quality Modeling Analysis Conclusions

The modeling results show that attainment of the 2008 NAAQS can be achieved as early as 2022 with a future design value of 75.2 ppb at the peak monitoring site. The modeling results also indicate that both VOC and NO_X reductions provide ozone benefits in SFNA, but the SFNA exhibits a NO_X-limited regime and therefore NO_X reductions are much more effective than VOC reductions on a tonnage basis. A detailed discussion of attainment demonstration is available in Chapter 8.

6.13 References

USEPA. *Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze.* Washington, D.C.: United States Environmental Protection Agency, [2014.]

USEPA. *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze.* Washington, D.C. United States Environmental Protection Agency, April [2007.]

USEPA (80 FR 65291-65468). *Final Rule: National Ambient Air Quality Standards for Ozone.* Federal Register, Volume 80, 26 October 2015, p. 65291-65468. Print.

7 CONTROL MEASURES

7.1 Introduction to Control Measures

Results of the photochemical modeling analysis performed by the California Air Resources Board (CARB) indicate that the Sacramento Federal Nonattainment Area (SFNA) will attain the 2008 Ozone National Ambient Air Quality Standard (NAAQS) by the end of 2024. To get there, the region will rely on the many existing federal, state, and local control programs to achieve reductions of ozone precursors, and CARB, SFNA air districts, and Sacramento Area Council of Governments (SACOG) will continue to enforce existing strategies and implement transportation control measures (TCMs). This chapter summarizes the reductions from CARB's existing mobile source measures, SACOG TCMs, contingency control measure strategies, local control measures contained in the 2013 8-Hour Ozone Attainment and Reasonable Further Progress Plan (2013 Plan) (SMAQMD, 2013), and results of the reasonably available control measure (RACM) analysis (also contained in Appendix E). This SIP document shows how the region will reach attainment through emissions reductions from existing control measures and adopted rules.

7.2 State and Federal Control Measures

Given the severity of California's air quality challenges and the need for ongoing emission reductions, the CARB has implemented the most stringent mobile source emissions control program in the nation. CARB's comprehensive program relies on four fundamental approaches:

- stringent emissions standards that minimize emissions from new vehicles and equipment;
- in-use programs that target the existing fleet and require the use of the cleanest vehicles and emissions control technologies;
- cleaner fuels that minimize emissions during combustion; and,
- incentive programs that remove older, dirtier vehicles and equipment, and pay for early adoption of the cleanest available technologies.

This multi-faceted approach has spurred the development of increasingly cleaner technologies and fuels and achieved significant emission reductions across all mobile source sectors that go far beyond national programs or programs in other states. These efforts extend back to the first mobile source regulations adopted in the 1960s, and pre-date the federal Clean Air Act (CAA) Amendments of 1970, which established the basic national framework for controlling air pollution. In recognition of the pioneering nature of CARB's efforts, the Act provides California unique authority to regulate mobile sources more stringently than the federal government by providing a waiver of preemption for its new vehicle emission standards under CAA Section 209(b)[39]. These authorization and waiver provisions preserve a pivotal role for California in the control of emissions from new motor vehicles, recognizing that California serves as a laboratory for setting motor vehicle emission standards. Since then, the CARB has consistently sought and obtained authorizations and waivers for its new motor vehicle regulations. CARB's history of progressively strengthening standards as technology advances, coupled with the authorization and waiver process requirements, ensures that California's regulations remain the most stringent in the nation. A list of regulatory actions CARB has taken since 1985 is provided at the end of this analysis to highlight the scope of CARB's actions to reduce mobile source emissions.

Recently, CARB adopted numerous regulations aimed at reducing exposure to diesel particulate matter and oxides of nitrogen, from freight transport sources like heavy duty diesel trucks, transportation sources like passenger cars and buses, and off-road sources like large construction equipment. Phased implementation of these regulations will produce increasing emission reduction benefits from now until 2024 and beyond, as the regulated fleets are retrofitted, and as older and dirtier portions of the fleets are replaced with newer and cleaner models at an accelerated pace.

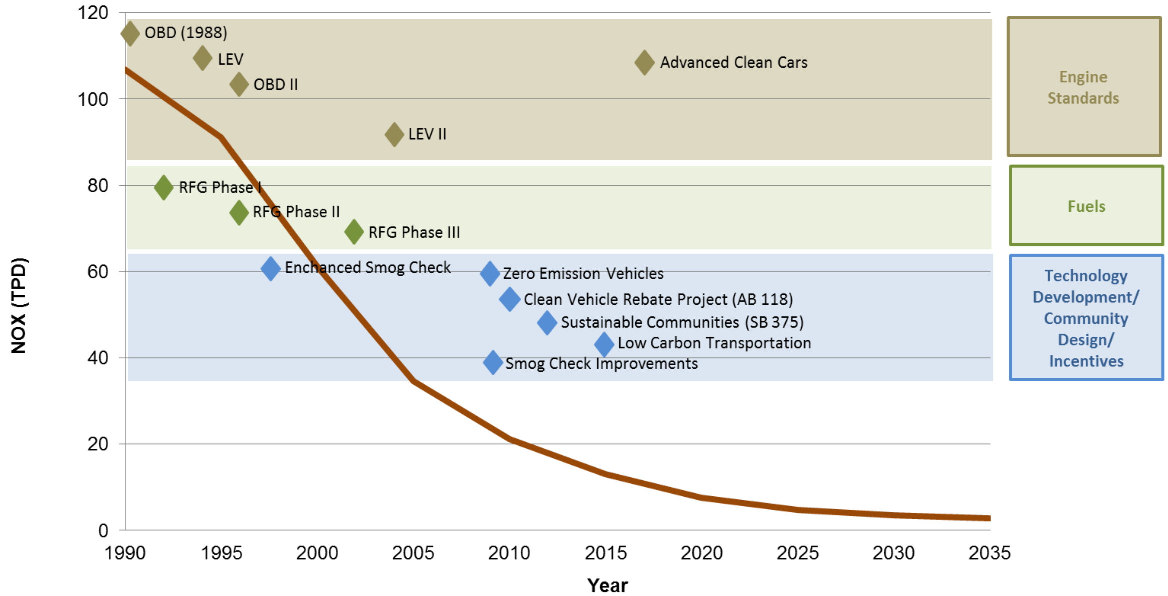
Further, CARB and the SFNA air district staff work closely on identifying and distributing incentive funds to accelerate cleanup of engines. Key incentive programs include: the Carl Moyer Program; the Goods Movement Program; the Lower-Emission School Bus Program; and the Air Quality Improvement Program (AQIP). These incentive-based programs work in tandem with regulations to accelerate deployment of cleaner technology.

7.2.1 Light-Duty Vehicles

Figure 7-1 illustrates the trend in Nitrogen Oxides (NO_X) emissions from light-duty vehicles and key programs contributing to those reductions in the SFNA. As a result of these efforts, light-duty vehicle emissions in the SFNA have been reduced significantly since 1990 and will continue to go down through 2024 due to the benefits of CARB's longstanding light-duty mobile source program. CARB estimates that light-duty vehicle NO_X emissions will be reduced by about 60 percent in 2024 when compared to the current year. Key light-duty programs include Advanced Clean Cars, On-Board Diagnostics, Reformulated Gasoline, Incentive Programs, and the Enhanced Smog Check Program.

[39] CAA Section 209(b) is limited to any state that had a program in 1966 but only California had such a program prior to 1966.

Figure 7-1: Key Programs to Reduce Light-Duty NO_X Emissions (SFNA)



Since setting the nation's first motor vehicle exhaust emission standards in 1966, which led to the first pollution controls, California has dramatically tightened emission standards for light-duty vehicles. Through CARB regulations, today's new cars pollute 99 percent less than their predecessors did thirty years ago. In 1970, CARB required auto manufacturers to meet the first standards to control NO_X emissions along with hydrocarbon emissions. The simultaneous control of emissions from motor vehicles and fuels led to the use of cleaner-burning reformulated gasoline (RFG), which has removed the emissions equivalent of 3.5 million vehicles from California's roads. Since CARB first adopted it in 1990, the Low Emission Vehicle (LEV and LEV II) Program and Zero-Emission Vehicle (ZEV) Program have resulted in the production and sales of hundreds of thousands of ZEVs in California.

7.2.1.1 Advanced Clean Cars

CARB's groundbreaking Advanced Clean Cars (ACC) program is now providing the next generation of emission reductions in California, and ushering in a new zero emission passenger transportation system. The success of these programs is evident: California is the world's largest market for ZEVs, with over 21 models available today, and a wide variety are now available at lower price points, attracting new consumers. As of January 2015, Californians drive 40 percent of all ZEVs on the road in the United States, while the U.S. makes up about half of the world market. This movement towards commercialization of advanced clean cars has occurred due to CARB's ZEV regulation, part of ACC, which affects passenger cars and light-duty trucks.

CARB's ACC Program, approved in January 2012, is a pioneering approach creating a 'package' of regulations that are separate in construction but related in terms of the synergy developed to address both ambient air quality needs and climate change. The

ACC program combines the control of smog, soot and greenhouse gas emissions into a single coordinated package of requirements for model years 2015 through 2025. The program assures the development of environmentally superior cars that will continue to deliver the performance**,** utility, and safety vehicle owners have come to expect.

The ACC program also included amendments affecting the current ZEV regulation through the 2017 model year to enable manufacturers to successfully meet 2018 and subsequent model year requirements. These ZEV amendments are intended to achieve commercialization through simplifying the regulation and pushing technology to higher volume production to achieve cost reductions. The ACC Program benefits will increase over time as new cleaner cars enter the fleet and displace older and dirtier vehicles.

7.2.1.2 On Board Diagnostics (OBD)

California's first OBD regulation required manufacturers to monitor some of the emission control components on vehicles starting with the 1988 model year. In 1989, CARB adopted OBD II, which required 1996 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles and engines to be equipped with second-generation OBD systems. OBD systems are designed to identify when a vehicle's emission control systems or other emission-related computer-controlled components are malfunctioning, causing emissions to be elevated above the vehicle manufacturer's specifications. CARB subsequently strengthened OBD II requirements and added OBD II specific enforcement requirements for 2004 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles and engines.

7.2.1.3 Reformulated Gasoline

Since 1996, CARB has been regulating the formulation of gasoline resulting in California gasoline being the cleanest in the world. California's cleaner-burning gasoline regulation is one of the cornerstones of the State's efforts to reduce air pollution and cancer risk. Reformulated gasoline is fuel that meets specifications and requirements established by CARB. The specifications reduced motor vehicle toxics by about 40 percent and reactive organic gases by about 15 percent. The results from cleaning up fuel can have an immediate impact as soon as it is sold in the State. Vehicle manufacturers design low-emission emission vehicles to take full advantage of cleaner-burning gasoline properties.

7.2.1.4 Incentive Programs

There are a number of different incentive programs focusing on light-duty vehicles that produce extra emission reductions beyond traditional regulations. The incentive programs work in two ways, encouraging the retirement of dirty older cars and encouraging the purchase of cleaner vehicles.

Voluntary accelerated vehicle retirement or “car scrap” programs provide monetary incentives to vehicle owners to retire older, more polluting vehicles. The purpose of these programs is to reduce fleet emissions by accelerating the turnover of the existing fleet and replacement with newer, cleaner vehicles. Both State and local vehicle retirement programs are available.

California’s voluntary vehicle retirement program is administered by the Bureau of Automotive Repair (BAR) and provides $1,000 per vehicle and $1,500 for low-income consumers for unwanted vehicles that meet certain eligibility guidelines. This program is referred to as the Consumer Assistance Program.

The Enhanced Fleet Modernization Program (EFMP) was approved by the AB 118 legislation to augment the State’s existing vehicle retirement program. AB118 and its associated programs have been extended through 2023. CARB developed the program in consultation with BAR. The program is jointly administered by both BAR for vehicle retirement, and local air districts for vehicle replacement.

Other programs, in addition to vehicle retirement programs, help to clean up the light-duty fleet. The AQIP, established by AB 118, is a CARB voluntary incentive program to fund clean vehicle and equipment projects. The Clean Vehicle Rebate Project (CVRP) is one of the current projects under AQIP. CVRP, started in 2009, is designed to accelerate widespread commercialization of zero-emission vehicles and plug-in hybrid electric vehicles by providing consumer rebates up to $2,500 to partially offset the higher cost of these advanced technologies. The CVRP is administered statewide by the California Center for Sustainable Energy. In Fiscal Years 2009-2012, $26.1 million, including $2 million provided by the California Energy Commission, funded approximately 8,000 rebates. In June 2012, the CARB allocated $15-21 million to the CVRP as outlined in the AQIP FY2012-2013 Funding Plan.

7.2.1.5 California Enhanced Smog Check Program

BAR is the state agency charged with administration and implementation of the Smog Check Program. The Smog Check Program is designed to reduce air pollution from California registered vehicles by requiring periodic inspections for emission-control system problems, and by requiring repairs for any problems found. In 1998, the Enhanced Smog Check program began in which Smog Check stations relied on the BAR-97 Emissions Inspection System (EIS) to test tailpipe emissions with either a Two-Speed Idle (TSI) or Acceleration Simulation Mode (ASM) test depending on where the vehicle was registered. For instance, vehicles registered in urbanized areas received an ASM test, while vehicles in rural areas received a TSI test.

In 2009, the following requirements were added in to improve and enhance the Smog Check Program, making it more inclusive of motor vehicles and effective on smog reductions:

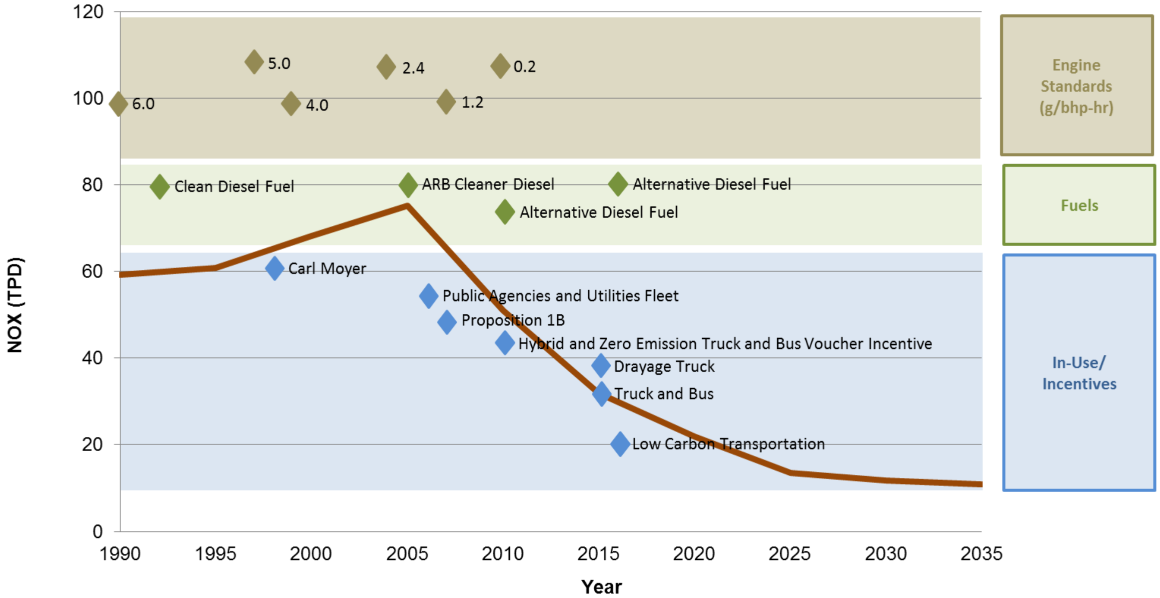
- Low pressure evaporative test;
- More stringent pass/fail cutpoints;
- Visible smoke test; and
- Inspection of light- and medium-duty diesel vehicles.

The next major change was due to AB 2289, which was adopted in October 2010. This new law restructured California's Smog Check Program, streamlined and strengthened inspections, increased penalties for misconduct, and reduced costs to motorists. The law was sponsored by CARB and BAR, and promised faster and less expensive Smog Check inspections by taking advantage of OBD software installed on all vehicles since 2000. The new law also directs vehicles without this equipment to high-performing stations, helping to ensure that these cars comply with current emission standards. This program will reduce consumer costs by having stations take advantage of diagnostic software that monitors pollution-reduction components and tailpipe emissions. Beginning mid-2013, testing of passenger vehicles using OBD was required on all vehicles model years 2000 or newer.

7.2.2 Heavy-Duty Trucks

Figure 7-2 illustrates the trend in NO_X emissions from heavy-duty vehicles and key programs contributing to those reductions in the SFNA. As a result of these efforts, heavy-duty vehicle emissions in the SFNA have been reduced significantly since 1990 and will continue to go down through 2024 due to the benefits of CARB's longstanding heavy-duty mobile source program. Heavy-duty NO_X emissions will be reduced by about 50 percent in 2024 when compared to this year. Key programs include Heavy-Duty Engine Standards, Clean Diesel Fuel, Truck and Bus Regulation and Incentive Programs.

Figure 7-2 : Key Programs to Reduce Heavy-Duty Emissions (SFNA)



7.2.2.1 Heavy-Duty Engine Standards

Since 1990, heavy-duty engine NO_X emission standards have become dramatically more stringent, dropping from 6 grams per brake horsepower-hour (g/bhp-hr) in 1990 down to the current 0.2 g/bhp-hr standard, which took effect in 2010. In addition to mandatory NO_X standards, there have been several generations of optional lower NO_X standards put in place over the past 15 years. Most recently in 2015, engine manufacturers can certify to three optional NO_X emission standards of 0.1 g/bhp-hr, 0.05 g/bhp-hr, and 0.02 g/bhp-hr (i.e., 50 percent, 75 percent, and 90 percent lower than the current mandatory standard of 0.2 g/bhp-hr). The optional standards allow local air districts and CARB to preferentially provide incentive funding to buyers of cleaner trucks to encourage the development of cleaner engines.

7.2.2.2 Clean Diesel Fuel

Since 1993 and amended since then, CARB has required that diesel fuel have a limit on the fuel's aromatic hydrocarbon and sulfur content to lower diesel combustion emissions. The diesel fuel regulation allows alternative diesel formulations as long as emission reductions are equivalent to the CARB formulation.

7.2.2.3 Cleaner In-Use Heavy-Duty Trucks (Truck and Bus Regulation)

The Truck and Bus Regulation was first adopted in December 2008. This rule represents a multi-year effort to turn over the legacy fleet of engines and replace them with the cleanest technology available. In December 2010, CARB revised specific provisions of the in-use heavy-duty truck rule, in recognition of the deep economic effects of the recession on businesses and the corresponding decline in emissions.

Starting in 2012, the Truck and Bus Regulation phases in requirements applicable to an increasing percentage of the truck and bus fleet over time, so that by 2023 nearly all older vehicles would need to be upgraded to have exhaust emissions meeting 2010 model year engine emissions levels. The regulation applies to nearly all diesel-fueled trucks and buses with a gross vehicle weight rating (GVWR) greater than 14,000 pounds, including on-road and off-road agricultural yard goats, and privately and publicly owned school buses. Moreover, the regulation applies to any person (person includes local and state agencies), business, school district, or federal government agency that owns, operates, leases, or rents affected vehicles. The regulation also establishes requirements for any in-state or out-of-state motor carrier, California-based broker, or any California resident who directs or dispatches vehicles subject to the regulation. Finally, California vehicle sellers subject to the regulation would have to disclose the regulation's potential applicability to buyers of the vehicles. The rule affects approximately 170,000 businesses in nearly all industry sectors in California, and almost a million vehicles that operate on California roads each year. Some common industry sectors that operate vehicles subject to the regulation include: for-hire transportation, construction, manufacturing, retail and wholesale trade, vehicle leasing and rental, bus lines, and agriculture.

CARB compliance assistance and outreach activities that are keys in support of the Truck and Bus Regulation include:

- The Truck Regulations Upload and Compliance Reporting System, an online reporting tool developed and maintained by CARB staff;
- The Truck and Bus regulation's fleet calculator, a tool designed to assist fleet owners in evaluating various compliance strategies;
- Targeted training sessions all over the State; and
- Out-of-state training sessions conducted by a contractor.

CARB staff also develops regulatory assistance tools, conducts and coordinates compliance assistance and outreach activities, administers incentive programs, and actively enforces the entire suite of regulations. Accordingly, CARB's approach to ensuring compliance is based on a comprehensive effort.

7.2.2.4 Incentive Programs

There are a number of different incentive programs focusing on heavy-duty vehicles that produce extra emission reductions beyond traditional regulations. The incentive programs encourage the purchase of a cleaner truck.

Several State and local incentive funding pools have been used historically -- and remain available -- to fund the accelerated turnover of on-road heavy-duty vehicles. Since 1998, the Carl Moyer Program (Moyer Program) has provided funding for replacement, new purchase, repower, and retrofit of trucks. Beginning in 2008, the

Goods Movement Emission Reduction Program funded by Proposition 1B has funded cleaner trucks for the region's transportation corridors; the final increment of funds will implement projects through 2018.

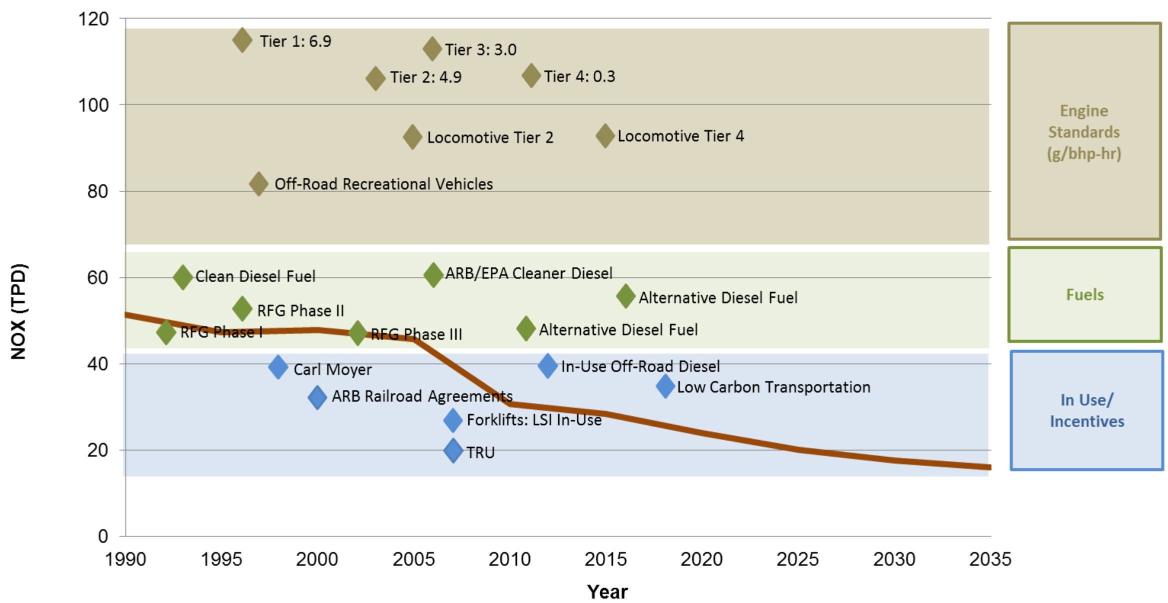
The Air Quality Improvement Program has funded the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) since 2010, and continued Sacramento Valley participation is expected. CARB has also administered a Truck Loan Assistance Program since 2009.

7.2.3 Off-Road Vehicle and Equipment Sources

"Off-road" sources refers to equipment powered by an engine that does not operate on the road. Sources vary from ships to lawn and garden equipment and include sources like locomotives, aircraft, tractors, harbor craft, off-road recreational vehicles, construction equipment, forklifts, and cargo handling equipment.

Figure 7-3 illustrates the trend in NO_X emissions from off-road sources and key programs contributing to those reductions in the SFNA. As a result of these efforts, off-road emissions in the SFNA have been reduced significantly since 1990 and will continue to go down through 2024 due to CARB's and United States Environmental Protection Agency (USEPA) longstanding programs. Off-road NO_X emissions will be reduced by about 25 percent by 2024 when compared to this year. Key programs include Off-Road Engine Standards, Locomotive Engine Standards, Clean Diesel Fuel, Cleaner In-Use Off-Road Regulation, and In-Use Large Spark Ignition (LSI) Fleet Regulation.

Figure 7-3: Key Programs to Reduce Off-Road Emissions (SFNA)



7.2.3.1 Off-Road Engine Standards

The CAA preempts states, including California, from adopting requirements for new off-road engines less than 175 hp used in farm or construction equipment. California may adopt emission standards for in-use off-road engines pursuant to CAA Section 209(e)(2), but must receive authorization from USEPA before it may enforce the adopted standards.

The Board first approved regulations to control exhaust emissions from small off-road engines (SORE) such as lawn and garden equipment in December 1990 with amendments in 1998 and 2003. These regulations were implemented through three tiers of progressively more stringent exhaust emission standards that were phased in between 1995 and 2008.

Manufacturers of forklift engines are subject to new engine standards for both diesel and LSI engines. Off-road diesel engines were first subject to engine standards and durability requirements in 1996 while the most recent Tier 4 final emission standards were phased in starting in 2013. Tier 4 emission standards are based on the use of advanced after-treatment technologies such as diesel particulate filters and selective catalytic reduction. LSI engines have been subject to new engine standards that include both criteria pollutant and durability requirements since 2001 with the cleanest requirements phased-in starting in 2010.

7.2.3.2 Locomotive Engine Standards

The CAA and USEPA national locomotive regulations expressly preempt states and local governments from adopting or enforcing “any standard or other requirement relating to the control of emissions from new locomotives and new engines used in locomotives” (USEPA interpreted new engines in locomotives to mean remanufactured engines, as well). USEPA has approved two sets of national locomotive emission regulations (1998 and 2008). In 1998, USEPA approved the initial set of national locomotive emission regulations. These regulations primarily emphasized NO_X reductions through Tier 0, 1, and 2 emission standards. Tier 2 NO_X emission standards reduced older uncontrolled locomotive NO_X emissions by up to 60 percent, from 13.2 to 5.5 g/bhphr.

In 2008, USEPA approved a second set of national locomotive regulations. Older locomotives upon remanufacture are required to meet more stringent particulate matter (PM) emission standards, which are about 50 percent cleaner than Tier 0-2 PM emission standards. USEPA refers to the PM locomotive remanufacture emission standards as Tier 0+, Tier 1+, and Tier 2+. The new Tier 3 PM emission standard (0.1 g/bhphr), for model years 2012-2014, is the same as the Tier 2+ remanufacture PM emission standard. The 2008 regulations also included new Tier 4 (2015 and later model years) locomotive NO_X and PM emission standards. The USEPA Tier 4 NO_X and

PM emission standards further reduced emissions by approximately 95 percent from uncontrolled levels.

7.2.3.3 Clean Diesel Fuel

Since 1993, CARB has required that diesel fuel used to operate on-road vehicles have a limit on the aromatic hydrocarbon and sulfur content. Diesel powered vehicles account for a disproportionate amount of the diesel particulate matter, which is classified as a toxic air contaminant. In 2006, CARB also adopted a low-sulfur diesel fuel requirement for off-road engines. The diesel fuel regulation allows alternative diesel formulations as long as emission reductions are equivalent to the CARB formulation.

7.2.3.4 Cleaner In-Use Off-Road Equipment (Off-Road Regulation)

The Off-Road Regulation was first approved in 2007 and subsequently amended in 2010 in light of the impacts of the economic recession. The regulation covered off-road vehicles used in construction, manufacturing, rental industry, road maintenance, airport ground support, and landscaping. In December 2011, the Off-Road Regulation was modified to include on-road trucks with two diesel engines.

The Off-Road Regulation will significantly reduce emissions of diesel PM and NO_X from the over 150,000 in-use off-road diesel vehicles that operate in California. The regulation affects dozens of vehicle types used in thousands of fleets by requiring owners to modernize their fleets by replacing older engines or vehicles with newer, cleaner models, retiring older vehicles or using them less often, or applying retrofit exhaust controls.

The Off-Road Regulation imposes idling limits on off-road diesel vehicles, requires a written idling policy, and requires a disclosure when selling vehicles. The regulation also requires that all vehicles be reported to CARB and labeled, restricts the addition of older vehicles into fleets, and requires fleets to reduce their emissions by retiring, replacing, or repowering older engines, or installing verified exhaust retrofits. The requirements and compliance dates of the Off-Road Regulation vary by fleet size.

Fleets will be subject to increasingly stringent restrictions on adding older vehicles. The regulation also sets performance requirements. While the regulation has many specific provisions, in general by each compliance deadline, a fleet must demonstrate that it has either met the fleet average target for that year, or has completed the Best Available Control Technology requirements. The performance requirements of the Off-Road Regulation are phased in from January 1, 2014 through January 1, 2019.

Compliance assistance and outreach activities in support of the Off-Road Regulation include:

- The Diesel Off-road On-line Reporting System, an online reporting tool developed and maintained by CARB staff.

- The Diesel Hotline (866-6DIESEL), which provides the regulated public with answers to questions about the regulations and access to CARB staff. Staff is able to respond to questions in English, Spanish, and Punjabi.
- The Off-road Listserv, providing equipment owners and dealerships with timely announcement of regulatory changes, regulatory assistance documents, and deadline reminders.

7.2.3.5 LSI In-Use Fleet Regulation

Forklift fleets can be subject to either the LSI fleet regulation, if fueled by gasoline or propane, or the off-road diesel fleet regulation. Both regulations require fleets to retire, repower, or replace higher-emitting equipment to maintain fleet average standards. The LSI fleet regulation was originally adopted in 2007 with requirements beginning in 2009. While the LSI fleet regulation applies to forklifts, tow tractors, sweeper/scrubbers, and airport ground support equipment, it maintains a separate fleet average requirement specifically for forklifts. The LSI fleet regulation requires fleets with four or more LSI forklifts to meet fleet average emission standards.

7.3 Stationary and Area-wide Source Control Measures

The California Health and Safety Code §40000 delegates authority to local air districts for control of air pollution from all sources except motor vehicle emissions. This means that local air districts are given regulatory authority to adopt and implement rules for controlling stationary and area-wide emissions sources. Stationary sources include sources such as power plants, cement plants, and manufacturing facilities. Area-wide sources are those where the emissions are spread over a wide area, such as gas stations, residential fuel combustion, and house paints.

7.4 Reductions from Existing Local Stationary and Area-wide Controls

The SFNA air districts have been regulating air pollution sources since the 1970's. Existing rules and their emission benefits are helping to make progress toward achieving clean air goals. The benefits from existing rules are reflected in the 2024 emissions inventory forecast (Chapter 5) and will continue to contribute toward cleaner air.

An analysis was prepared to illustrate benefits from existing SFNA air district rules. Figures 7-4 and 7-5 illustrate the emission reduction benefits in 2016 that were attributable to district stationary and area source Volatile Organic compounds (VOC) and NO_X rules implemented since 1975. Without the air districts' control measures, the emissions from regulated stationary source categories could have emitted 84 tons per day (tpd) of VOC and 18 tpd of NO_X. With the air district rules, the emissions from these sources were reduced to 20 tpd of VOC and 6 tpd of NO_X. The most beneficial VOC rules are those affecting: 1) gasoline dispensing facilities and bulk terminals, and 2) solvent cleaning, degreasing, and painting operations. The majority of NO_X emission reductions are due to controls on stationary and area-wide sources including: 1) gas turbines, 2) internal combustion (IC) engines, 3) boilers, and 4) water heaters.

Figure 7-4 2016 VOC Reduction Benefits (tpd) from SFNA District rules implemented since 1975

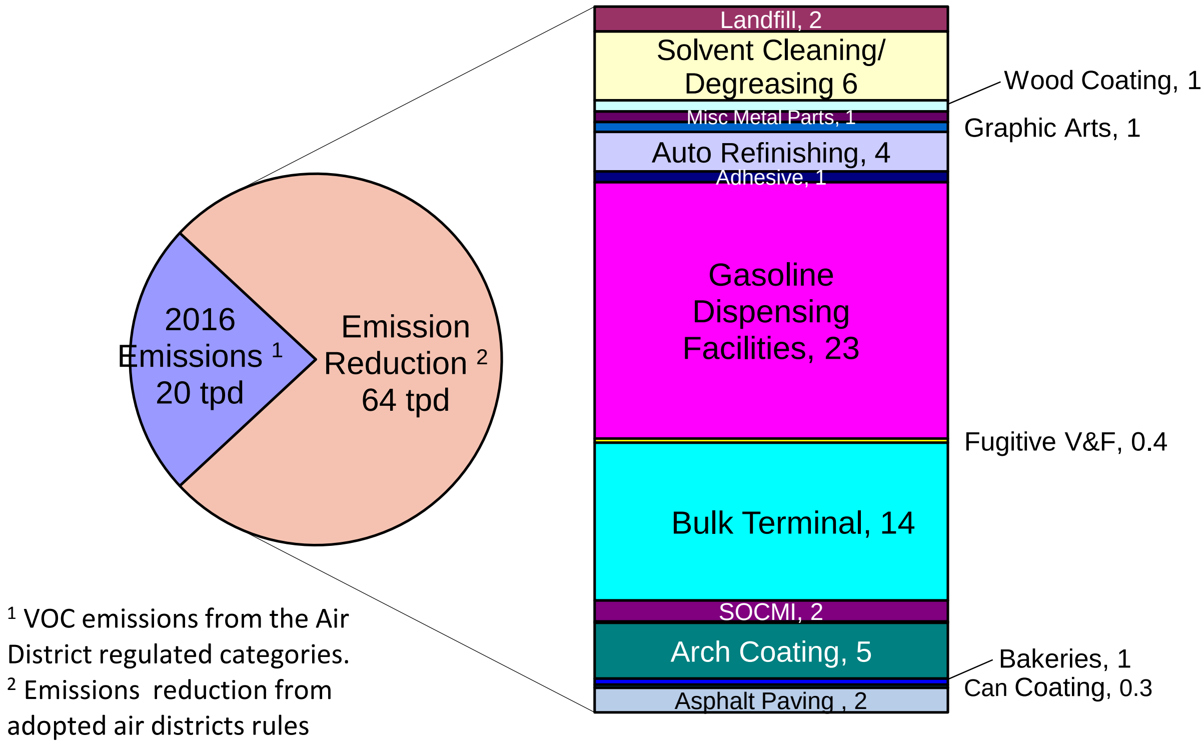
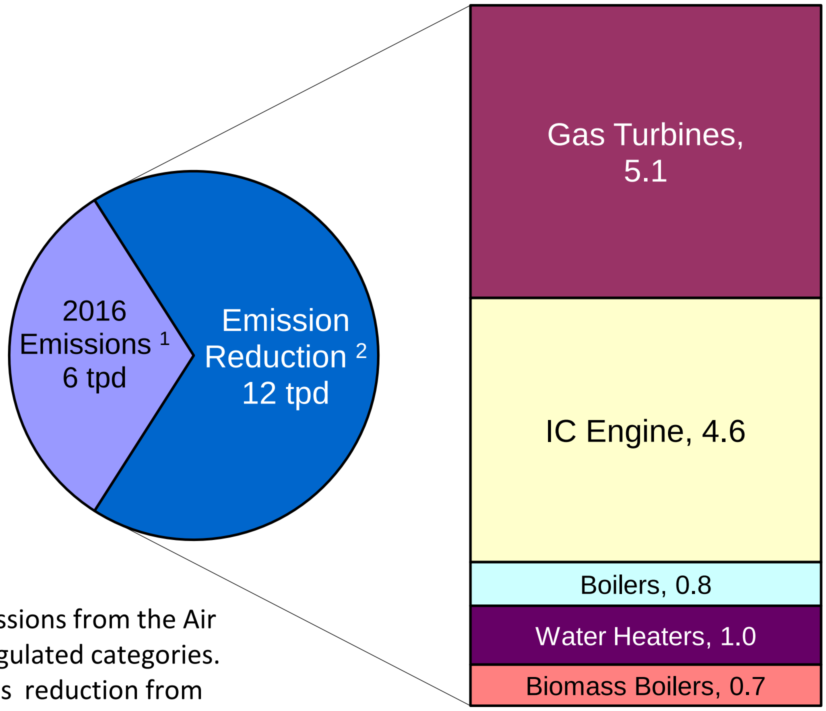


Figure 7-5 2016 NO_X Reduction Benefits (tpd) from SFNA District rules since 1975



[1] NO_X emissions from the Air District regulated categories.
[2] Emissions reduction from adopted air districts rules

7.5 Consideration and Selection of New Regional and Local Control Measures

Photochemical modeling results (Chapter 6) demonstrate that the SFNA will attain the 2008 ozone NAAQS by the end of 2024, which is two years earlier than the attainment demonstration analysis year of 2026 for a severe-15 nonattainment area. Therefore, no new local, regional, or transportation control measure commitments are being proposed in this plan. The SFNA air districts will continue to implement existing local control measures.

USEPA's final 2008 NAAQS ozone implementation rule (40 CFR 51.1112(c)) requires that the attainment demonstration include a demonstration that it has adopted all reasonably available control measures (RACM) necessary to demonstrate attainment "as expeditiously as practicable" and to meet any RFP requirements. In the preamble to the final implementation rule, USEPA interprets "as expeditiously as practicable" to mean measures that, considered cumulatively, could advance attainment by a year (80 FR 12264-12319). The RACM Analysis in Appendix E shows no additional measures were identified that, when considered cumulatively, would advance attainment by one year and no additional measures are needed for demonstrating reasonable further progress requirements (Chapter 12).

7.6 Transportation Control Measures (TCMs)

7.6.1 Background

TCMs are strategies used to reduce motor vehicle emissions. TCMs may reduce vehicle trips, vehicle use, vehicle miles traveled, vehicle idling, or traffic congestion. SACOG is the Metropolitan Planning Organization (MPO) for the greater Sacramento region (includes Sacramento, Yolo, Placer, El Dorado, Sutter, and Yuba counties). SACOG provides transportation planning and funding for the region and has worked with local governments and the SFNA air districts to develop and implement TCMs. For example, one of the TCMs developed for the previous Attainment Plan for the SFNA is the Spare The Air program, a program that has achieved a high level of public awareness.

Implemented TCMs are included in the measured baseline activity in the SACOG transportation model. This baseline activity data was used to forecast future projections for the motor vehicle inventory.

There are transportation planning implications associated with including TCMs in a SIP. Each time the MPO makes a conformity determination to accompany a new Metropolitan Transportation Plan (MTP), a new Metropolitan Transportation Improvement Program (MTIP), or an amendment to either document, it must demonstrate that all TCMs are still on track to be implemented in a timely fashion.

If a TCM does not stay on schedule, the MPO must show that all State and local agencies with influence over approvals or funding for TCMs are giving maximum priority to approve or fund TCMs over other projects within their control. The MPO and other responsible agencies would have to either ensure that the TCM is able to get back on schedule, or substitute another TCM. The MPO may not be able to demonstrate conformity on a new or amended MTP or MTIP if a TCM is failing.

In addition, the Transportation Conformity Rule (40 CFR 93.103) states that “When assisting or approving any action with air quality-related consequences, Federal Highway Authority (FHWA) and Federal Transit Administration shall give priority to the implementation of those transportation portions of an applicable implementation plan prepared to attain and maintain the NAAQS.”

7.6.2 Roles and Responsibilities in TCM Coordination

Based on suggestions received from interagency consultation and discussions with transportation and air quality stakeholders via the Regional Planning Partnership (RPP), SACOG formally refines the types of projects to be included as TCMs during the SIP and/or MTIP and MTIP Guidelines development process. During the regular update cycle for the MTP and MTIP, SACOG, in coordination with the RPP, will refine and revise TCM descriptions and definitions to clarify the general TCM process as well as resolve specific implementation issues. SACOG works with the project implementing agencies, air quality stakeholders, and any other interested parties, primarily through the RPP, to facilitate the TCM process and implement TCMs appropriately.

It is SACOG's responsibility to ensure that TCM strategies are funded in a manner consistent with the implementation schedule established in the MTIP at the time a project is identified as a TCM commitment. The transportation conformity process is designed to ensure timely implementation of TCM strategies. If the implementation of a TCM strategy is delayed, or if a TCM strategy is only partially implemented, the emission reduction shortfall must be made up by either substituting a new TCM strategy or by enhancing other control measures. The criteria for this process is discussed in the Guidance for implementing the CAA Section 176 (c)(8) Transportation Control Measure Substitution and Addition Provision (USEPA, 2009).

7.6.3 TCM RACM Evaluation

An evaluation (Sierra Research, 2015) of TCMs was conducted as part of the RACM Analysis (Appendix E) to identify any TCMs that met the selection criteria. The initial TCM RACM list consisted of: 1) strategies identified through a comprehensive review of implemented TCMs in California, as well as other states; 2) measures and strategies commitments in the Region's 2009 Ozone SIP (SMAQMD et al, 2009); and 3) statewide and mobile source emission reduction strategies.

Out of the almost 100 measures identified in the review, only those that were not already implemented in Sacramento (about 20) were selected for further analysis. The criteria for identifying TCM projects and requirements for timely implementation are defined in USEPA's transportation conformity rule, 40 CFR Part 93. None of the other strategies were included as commitments either because they were economically infeasible, no agency had authority to implement the measures (Seitz, 1999), or failed to advance attainment by a year when considered cumulatively.

7.7 Completed and Continuing TCM Projects

The CAA Section 108(f)(1)(A) lists sixteen potential TCM categories. TCM projects focus on reducing vehicle use or traffic congestion. There were 24 TCM projects and funding programs contained in the 2013 SIP[40] (SMAQMD et al, 2013). Appendix D (Transportation Control Measures) of the 2013 SIP describes the emissions reduction, timeframe, cost, and needed resources and authority for each TCM. All 24 of these TCMs were chosen to provide air quality benefits, while leaving as much flexibility as possible for implementation. They have the following characteristics: early completion dates (all but one will be completed by 2019), reasonable costs, fully committed funding, and projects of small or moderate-sized scope. These 24 TCM projects, measures and funding programs were grouped into seven categories, which include:

[40] 2013 SIP is the latest update for the 2009 SIP.

1. Intelligent Transportation Systems – 3 projects
2. Park and Ride Lots/Transit Centers - 3 projects
3. Transit Service Funding Programs – 2 programs
4. Other Specific Funding Programs- 3 programs
5. MTP Regional Funding Programs – 4 programs
6. Miscellaneous Projects – 2 projects
7. Research and Policy Development Further Study Measures – 7 measures

SAOCG reported the status of the TCMs in the latest conformity analysis (SACOG, 2016). Most of the projects (19 out of 24) were completed before 2014. The remaining five projects are programs, which SMAQMD, SACOG, Sacramento Transportation Authority (STA) and other air districts in the region have commitments to implement. Four of these projects will be implemented through 2018.

1. Freeway Service Patrol (AQ-1)
2. Sacramento Emergency Clean Air and Transportation (SECAT)(AQ-2)
3. Air Quality Funding Program (FP-1)
4. SACOG Regional Rideshare Program (FP-3)

The remaining project, Spare the Air Program (AQ-3), which is described more in Section 7.8 will continue through 2024. None of these five measures were relied on to demonstrate attainment in this SIP.

7.8 TCM Commitments

For severe nonattainment areas, CAA section 182(d)(1) requires that the state “consider measures specified in section 108(f) [see discussion in Section 7.7], and choose from among them and implement such measures as necessary to demonstrate attainment with the NAAQS.” None of the continuing TCM measures were relied on to demonstrate attainment. Therefore, with the exception of the Spare the Air program, they are not included in the SIP. “Spare The Air” was included in the SIP as a TCM because funding was extended from the prior 2019 expiration date to 2024.

Spare the Air is a year-round public education program with an episodic ozone reduction element during the summer ozone season, plus general awareness throughout the rest of the year. This program was created in 1995 to engage the general public in voluntarily helping to solve the problem of ozone air pollution. The program is designed to protect public health by informing people when air quality is unhealthy and achieving voluntary emission reductions. This is done by encouraging residents to reduce vehicle trips, reduce their commute time, take public transportation, and spend less time in their cars.

This program is implemented by the SMAQMD staff and benefits all the air districts within the SFNA, which cover Sacramento County, Yolo County, and parts of Placer, Solano, El Dorado, and Sutter Counties. Information conveyed through Spare The Air, such as alerts, further encourages people to use alternative modes by promoting public transportation and alternative modes of transportation. The Spare the Air program is included in the 2016 Metropolitan Transportation Plan/Sustainable Communities Strategy (MTP/SCS) as an air quality improvement program to reduce vehicle miles traveled on bad air quality days and as a strategy contained under Policy 8[41] (SACOG, 2016a). This 2016 MTP/SCS was adopted by the SACOG Board on February 18, 2016.

The Spare The Air program is a non-regulatory transportation control measure. The air districts receive approximately $600,000 per year from a Congestion Mitigation & Air Quality Improvement (CMAQ) grant. The funding is provided by the FHWA, but appropriated through SACOG. SACOG secured funding for Spare The Air through 2019, and on December 15, 2016, the SACOG Board approved continuing funding for Spare The Air as a TCM from 2019 – 2024.

7.9 Contingency Measures

Contingency measures are control measures that go into effect if a nonattainment area fails to reach desired goals or targets. Contingency provisions are required under CAA §172(c)(9) and 182(c)(9) in the event the nonattainment area fails to meet a reasonable further progress milestone or attainment date. Contingency measures are specific additional controls to be implemented automatically without further significant rulemaking activities, such as public hearings or legislative review, and without further action by the State or the USEPA Administrator.

To meet the contingency measure requirement, federal guidance (57 FR 13511; 80 FR 12285) requires that the plan provide 3% in emission reductions beyond the level needed to meet the reasonable further progress and attainment demonstration requirements. The existing local and state measures meet this requirement because they exceed emission reductions needed for reasonable further progress targets and for attainment requirements by more than 3%. The calculations that demonstrate the anticipated contingency reductions are documented in conjunction with the attainment demonstration in Chapter 8 and the reasonable further progress demonstration in Chapter 12.

7.10 References

USEPA. (57 FR 13511) *General Preamble for the Implementation of Title I of the Clean Air Act Amendments of 1990*. Federal Register, Volume 57, April 16, 1992, p. 13511.

[41] This policy state that it is necessary to support and invest in strategies to reduce vehicle emissions that can be shown as cost effective to help achieve and maintain clean air and better public health.

USEPA, Guidance for implementing the Clean Air Act Section 176 (c)(8) Transportation Control Measure Substitution and Addition Provision, EPA-420-B-09-002, January [2009.] Web. 13 April 2017. < http://www.scag.ca.gov/Documents/Section176-Guide-Jan08.pdf >

USEPA. (80 FR 4795 - 4799) *Approval and Promulgation of Implementation Plans; State of California; Sacramento Metro Area; Attainment Plan for 1997 8-Hour Ozone Standard, Final Rule.* Federal Register, Volume 80, No. 19, January 29, 2015, p. 4795-4799.

USEPA. (80 FR 12264 - 12319) *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule*. Federal Register, Volume 80, March 6, 2015, p. 12264-12319.

USEPA. *Requirements for reasonably available control technology (RACT) and reasonably available control measures (RACM)*, 40 CFR §51.1112

USEPA. *Priority*, 40 CFR §93.103

SACOG. *Conformity Analysis - Developed as part of the Sacramento Area Council of Governments': 2016 Metropolitan Transportation Plan and Sustainable Communities Strategy Amendment #1 and Adoption of the 2017/20 Metropolitan Transportation Improvement Program.* Sacramento, CA: Sacramento Area Council of Governments, 15 September [2016.] Web. 3 March 2017. < http://www.sacog.org/sites/main/files/file-attachments/conformity_analysis_2017_20_mtip_ts.pdf >

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Sierra Research. *Reasonably Available Control Measure Analysis for the Sacramento Area Council of Governments,* Sacramento, CA: Sierra Research, November 12 [2015.] Print.

SMAQMD. et al. *Sacramento Regional 8-Hour Ozone Attainment and Reasonable Further Progress Plan.* Sacramento, CA: Sacramento Metropolitan Air Quality Management District, [2009.]

SMAQMD. et al. *2013 Revisions to the Sacramento Regional 8-Hour Ozone Attainment and Reasonable Further Progress Plan.* Sacramento, CA: Sacramento Metropolitan Air Quality Management District, [2013.]

8 ATTAINMENT DEMONSTRATION

8.1 Attainment Demonstration Requirements

Clean Air Act Section 182(c)(2)(A) requires that attainment demonstrations for "serious and higher" nonattainment areas be based on photochemical grid modeling or any other analytical method determined by the United States Environmental Protection Agency (USEPA) to be at least as effective. The USEPA provides guidance (USEPA, 2014) on how to apply air quality models to generate results for preparing 8-hour ozone attainment demonstrations. The California Air Resource Board (CARB) conducted photochemical modeling to demonstrate attainment of the 2008 ozone National Ambient Air Quality Standard (NAAQS) for the Sacramento Federal Nonattainment Area (SFNA), using the single relative response factor (RRF) method from the guidelines.

8.2 Attainment Demonstration Evaluation using Photochemical Modeling

The photochemical modeling results discussed in Chapter 6 and Appendix B were used to predict the regional peak ozone design value for 2026, which is the attainment demonstration analysis year for a severe-15 nonattainment area. The analysis calculates the weighted design value[42] and projects forward to test for future attainment at each site. Design values were calculated for 2012, 2013, and 2014 and then averaged to determine the weighted design value used for modeling. The highest calculated 8-hour weighted design value was 90 parts per billion (ppb) and was measured at the Folsom-Natoma monitoring site.

The modeled Volatile Organic Compound (VOC) and Nitrogen Oxides (NO_X) emission forecasts incorporate growth assumptions and estimated reductions associated with existing control measures (the combined reductions from existing local, regional, state, and federal control measures). The measures include those adopted as part of the Sacramento Regional 8-Hour Ozone Attainment and Reasonable Further Progress Plan (2013 Plan)(SMAQMD et al, 2013) for the 1997 8-hour standard. The current and forecasted emissions inventory reflects emission reductions from the implementation of federal regulations, ongoing benefits from the CARB programs, and the existing air district control programs. These existing regulations and control programs have demonstrated attainment - no new control measures are necessary to attain the 2008 NAAQS by the 2024 attainment demonstration year.

42 The discussion here and in the following sections uses three related terms: design value, peak design value, and weighted design value. The design value is the average of the 4th highest emission concentration measured at a monitoring station for each year in any consecutive 3-year period. The peak design value is the highest design value in a given year at all stations in the region. The weighted design value is calculated by averaging the design value each year for a three year period. The weighted design value is only used in photo grid modeling and is intended to account for year-to-year meteorological variability (Appendix B, p. B-3).

Modeling results indicated that all monitors located within the SFNA will be below the 2008 8-hour NAAQS of 75 ppb by 2026. The modeling showed that the highest future year (2026) design value for the region was 70.7 ppb at the Folsom-Natoma monitoring site (Table 8-1). It also found that the region could possibly attain the 2008 standard as early as 2022 with a design value of 75.2 ppb at the Folsom-Natoma monitoring site (Table 8-1). This would result in a design value of 75 ppb at the Folsom-Natoma monitoring site because the 3-year average design values are rounded.[43]

8.3 Attainment Year Analysis based on Ambient Air Quality Data

The regional air districts, in consultation with CARB and USEPA Region IX, are proposing 2024 be established as the SFNA attainment deadline for the 2008 ozone NAAQS. Selection of 2024 is two years before the 2008 NAAQS 8-hour ozone attainment demonstration year for a severe-15 area of 2026, and provides a safeguard against inherent uncertainties in predicting future ambient ozone concentrations beyond 2022 (e.g. emission reductions, meteorology, or natural events).

One key additional factor is the steep rate of emission reductions that will be required at the Placerville site. Based on regional ambient air quality data for 2016, the Placerville monitoring site had the highest peak[44] design value of 85 ppb. To demonstrate attainment at this site by the earliest attainment date of 2022, ambient ozone concentrations in the region would need to decrease at a rate of about 1.7 ppb/year from 2016. That would be an extremely ambitious rate of reduction – during the previous 6 years the ambient concentration reduction rate at that site was much slower, decreasing only 0.8 ppb/year from 2010 to 2016. In contrast, a 2024 attainment year would require a 1.3 ppb/year reduction at the Placerville monitoring site over eight years (from 2016 to 2024) which – although still ambitious – is closer to the historic rate of reduction.

Further, the regional air districts and the Sacramento Area Council of Governments (SACOG), the region's metropolitan planning organization (MPO), conducted an exhaustive evaluation of reasonably available control measures (RACM) analysis. It was determined that the measures considered individually or collectively would not advance the attainment by one year from 2024 to 2023 and were not necessary to meet the reasonable further progress (RFP) requirements for the SFNA. The emissions reductions that any control strategies may potentially generate were found to be

[43] The measured 3-year average design values use the rounding/truncation rules established in 40 CRF Part 50 Appendix P (8-hour ozone). Hourly average concentrations are reported in parts per million (ppm) to the third decimal place, with additional digits to the right of the third decimal place truncated.The 2008 NAAQS standard is met when the 3-year average of the annual fourth-highest daily maximum ozone concentration is less than or equal to 0.075 ppm (75 ppb).

[44] See footnote 42 in section 8.2.

insignificant or non-quantifiable. A detailed analysis of the measures considered and evaluated is in Appendix E – Reasonably Available Control Measure (RACM) Analysis.

Finally, CARB is preparing a weight-of-evidence analysis, which will be submitted to USEPA in conjunction with this SIP. Based on the air district's analysis above, we anticipate that the weight-of-evidence test will support the 2024 attainment deadline designation.

8.4 Methodology for Estimating 2024 Design Values

An estimated design value for 2024 was calculated based on photochemical modeling for 2022 and 2026. This was done by assuming that the ozone response to NO_X emissions is linear between those two years, and that small changes in VOC emissions have a negligible effect on ozone. Both assumptions are reasonable based on the results of the photochemical modeling (Appendix B), which shows that small changes in VOC emissions (<5 tons/day) have very little impact on ozone design values at the Folsom-Natoma monitor, and that the response to NO_X emission reductions is approximately linear over reductions less than ~10 tons/day.

Figure 8-1 shows future design values for 2022 and 2026 as a function of NO_X emissions. Emissions of NO_X and VOC for 2022, 2024, and 2026 are shown in Table 8-1, along with the corresponding design value. Assuming a linear relationship between the ozone design value and NO_X emissions from 2022 to 2026, a 2024 ozone design value can be estimated based on the 2024 NO_X emissions. The 2024 NO_X emissions were based on emissions inventories provided by CARB and plotted on the line to determine the 2024 design value. These emission inventories are presented in Chapter 5 and Appendix A. Utilizing this approach, the ozone design value at Folsom-Natoma in 2024 is estimated to be 72.1 ppb.

Figure 8-1 Ozone design value as a function of NO_X emissions at the Folsom-Natoma monitor

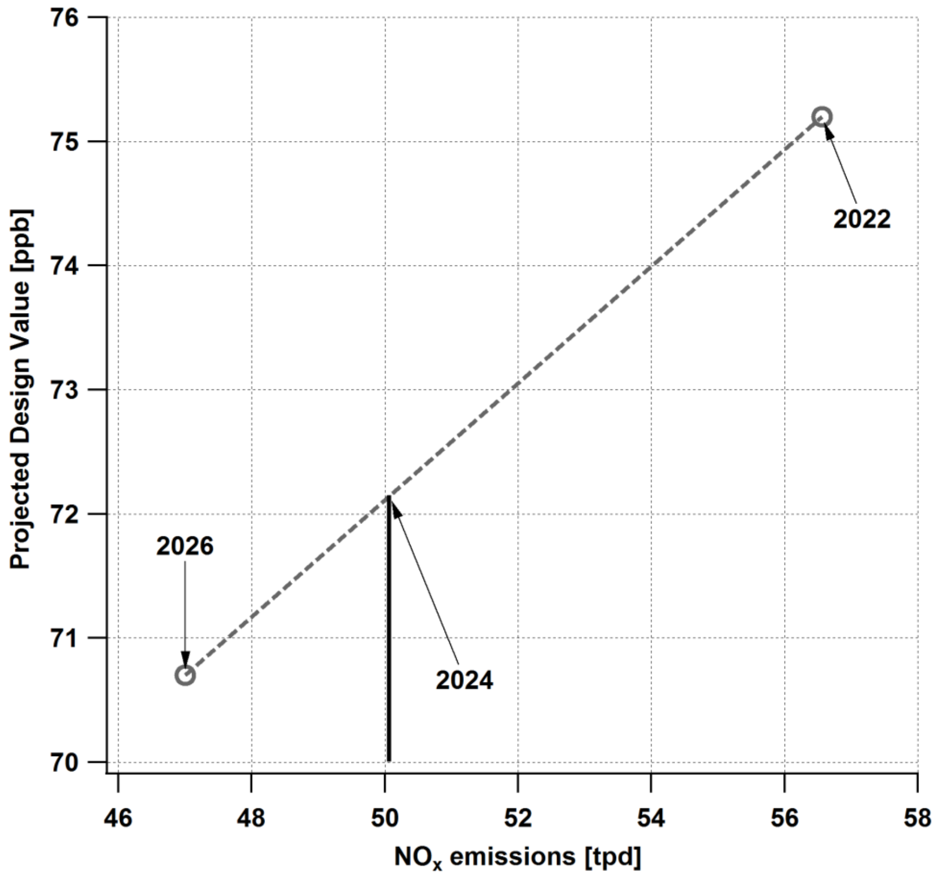

Table 8-1 Emissions of NO_X and VOC in 2022, 2024, 2026, and the corresponding ozone design value.

Year	NO_X Emissions (tpd)	VOC Emissions (tpd)	Linear fit DV
2022	56.6	84.5	75.2
2024	50.1	82.7	**72.1**
2026	47.0	81.5	70.7

Note:

- The 2024 design value is estimated from Figure 8-1
- CEPAM: 2016 SIP Baseline Emission Projections, Version 1.03. Sacramento Regional Nonattainment Area, Summer, Growth and Controlled with External Adjustments, used to calculate 2022 and 2026 emissions. The modeling emissions inventory discussed in Chapter 5 and Appendix B varies slightly.

8.5 VOC and NO_X Reduction Goals

Appendix B - Photochemical Modeling contains the ozone and pollutant emission reduction graphs, based on modeling results, for the peak ozone design value site at

Folsom in the SFNA. Figure 16 in Appendix B-4 shows the pattern of ozone responses to varying combinations in domain-wide VOC and NO_X emission reductions. Since the ozone design values are truncated to the nearest whole ppb, values below 75 ppb represent attainment of the federal 8-hour ozone standard. Additional modeling details and assumptions for assessing the VOC and NO_X reduction attainment goals are also provided in Appendix B – Photochemical Modeling.

8.6 Attainment Demonstration Contingency Measure Requirement

Clean Air Act, sections 172 (c)(9) and 182 (c)(9) require the implementation of contingency measures if the SFNA fails to meet the reasonable further progress requirements (Chapter 12), or attain the standard by the applicable attainment date. Federal guidance requires that there should be sufficient contingency measures in the plan to provide a 3% emission reduction beyond what is needed for the attainment demonstration. Table 8-2 shows that the expected additional emission reduction benefits achieved from existing control programs will meet the 3% attainment demonstration contingency requirement. Projected emissions from after the 2024 attainment (2025 NO_X emissions plus NO_X emissions reduction credits), minus the attainment emissions, show that there will be sufficient emissions reductions to meet the contingency measure requirement, 3% of the 2012 baseline emissions inventory (80 FR 12285), shown in Line B. Line C reflects that, based on the photochemical modeling (Appendix B-1, Table B-1), a 45% reduction in NO_X from the 2012 baseline is needed for attainment.

The SFNA will be able to meet the 3% contingency requirement based entirely on NO_X emissions reductions. These reductions will be from the continued implementation of the mobile source program beyond what is needed for attainment. Reductions of NO_X have been demonstrated to be the most effective in bringing the area into attainment (Appendix B-4).

Table 8-2 Attainment Contingency Measure Reduction

Line		NO_X
A	2012 Baseline Emissions Inventory	101.1
B	3% of 2012 baseline	3.03
C	% NO_X Reduction Required for Attainment	45%
D = A * (100% - C)	Attainment Inventory	55.61
E	2025 Inventory	47.03
F	Emissions Reduction Credits (ERC)	4
G = E + F	2025 Inventory + ERC	51.03
H = D - G	Available Reduction for Attainment Demonstration Contingency	4.58
	Is 3% contingency met (Is H greater than B)	Yes

NOTES:
Line A - NO_X emissions for 2012 Baseline Emissions Inventory (Table 12-1).
Line C – the % NO_X reduction is based on Photochemical modeling (Appendix B-1, Table B-1).
Line E - emissions in 2025, the year after the attainment date (2024).
Line F - ERCs are discussed in Appendix A-3.

8.7 Attainment Demonstration Conclusions

Attainment of the 2008 8-hour ozone NAAQS is demonstrated by 2024, two years before the severe-15 classification attainment demonstration year of 2026.. The total emission reductions from existing measures are sufficient to provide for attainment by 2024.

8.8 References

SMAQMD et al. *Sacramento Regional 8-Hour Ozone Attainment and Reasonable Further Progress Plan (2013 SIP Revisions).* Sacramento, CA: Sacramento Metropolitan Air Quality Management District, 26 September [2013.]

USEPA. *Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$ and Regional Haze*. December 2014. Web < https://www.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf >

9 TRANSPORT ANALYSIS

9.1 Introduction to Pollutant Transport

The air quality in the Sacramento Federal Nonattainment area (SFNA) can be impacted by pollutant transport from the San Francisco Bay Area and the San Joaquin Valley. Delta breezes carry air pollutants from coastal Bay Area and San Joaquin Valley emission sources downwind to the inland areas of the Sacramento region, and these pollutants may contribute to ozone formation during the same day or the following days. The California Air Resources Board (CARB) has determined that the relative impact on air quality in the SFNA, from the Bay Area and San Joaquin Valley pollutant transport can be considered overwhelming, significant or inconsequential on various days (CARB, 2001, p.25, 37) depending on meteorological conditions. Various studies in the past two decades also reaffirmed that a strong sea breeze within the deep marine boundary layer from the San Francisco Bay Area enhanced pollutant transport into the Sacramento Delta Region (Appendix B-2, p.27) and that the air flow pattern in the Sacramento Valley (Schultz eddy) causes pollutants to recirculate and become trapped within the Sacramento region (Appendix B-2, p.28).

This chapter discusses various interbasin transport issues and modeling assumptions regarding transported air pollutants.

9.2 Interbasin Transport Issues

To better manage air pollution, California is divided into 15 air basins based on their geography and meteorological features. County boundaries are also considered in determining an air basin. The SFNA is located at the southern part of the Sacramento Valley Air Basin and the middle of Mountain County Air Basin. Interbasin transport is the transport of air pollutants (ozone precursors) from upwind air basins to downwind air basins.

There are many different issues involving interbasin transport of air pollutants. First, air pollutant transport is evaluated to get a more complete picture of how ozone is formed in the SFNA. Depending on meteorological conditions, the amount of transport from outside the nonattainment area can vary from day to day. Understanding the impacts of transport can be an important factor in predicting future attainment of the ozone standard in the SFNA. For example, if an area’s ozone problem is significantly impacted by outside pollutant transport, then a local emission control strategy may not be effective.

In addition, the influence of air pollutant transport on ozone concentrations is difficult to assess and can involve many different, complex methodologies with varying limitations and uncertainties. For example, surface wind flow data from ambient monitors and wind flow patterns can reveal where pollutants are coming from, but the amount of ozone formation will depend on other factors, like temperature and vertical convection. Thus, impacts cannot be quantified on just the transport data alone. Photochemical grid modeling can quantify a more precise transport contribution to downwind ozone areas and account for pre-existing conditions, but they may only be representative of a specific ozone season and subject to various modeling performance uncertainties.

In addition, other issues pertaining to transport assessment include:

1) uncertainties in transport occurring from aloft layers[45],
2) differences in future emission reduction strategies in upwind air basins,
3) transport from the Sacramento region to other downwind areas, and
4) emissions transport due to motor vehicles traveling between air basins.

9.3 USEPA Rules and Regulations on Intrastate Transport

The 2008 National Ambient Air Quality Standards (NAAQS) ozone implementation rule (80 FR 12270) states that intrastate transport should be considered by the United States Environmental Protection Agency (USEPA) and the CARB in determining the attainment date. In determining the attainment date that is as expeditious as practicable, the CARB considered impacts on the nonattainment area of intrastate transport of pollution from sources within its jurisdiction, and potential reasonable measures to reduce emissions from those sources.

9.4 Attainment Assumptions of Domain-wide Reductions

Transported pollutants from upwind areas can contribute to the ozone problem further downwind across geographic air basins. Consequently, emission reductions from statewide and upwind regions' control measures reduce ozone precursors from transport and help reduce ambient ozone concentrations in the SFNA. The CARB's photochemical modeling simulations include the northern and central regions of California in the modeling domain (see Chapter 6 – Air Quality Modeling Analysis). This air quality modeling was used to address and account for air pollutant transport impacts among the San Francisco Bay Area, San Joaquin Valley, Sacramento Valley, and Mountain Counties air basins.

CARB, as a statewide agency, is responsible for submitting State Implementation Plans (SIPs) for California in which it must address intrastate transport for California's nonattainment areas. CARB modeling for the attainment demonstration for the SFNA used domain-wide emission reductions to characterize future ozone reductions at peak ozone monitoring stations.

[45] Aloft layers are the layers above the surface inversion layer.

9.5 Conclusions

The CARB continues to adopt, enforce, and implement the state control measures as described in Chapter 7. These statewide control measures will continue to bring emission reduction benefits to the SFNA. Other upwind air districts will also continue their efforts to enforce and implement control measures. The total emission reductions from existing federal, state, regional, and local measures will contribute to attainment and ensure the region meets the 2024 attainment deadline.

9.6 References

CARB. *Ozone Transport: 2001 Review.* Sacramento, CA: California Air Resources Board, April [2001.]

CARB. Air Resources Board's Proposed State Strategy for California's 2007 State Implementation Plan. Sacramento, CA: California Air Resources Board, [2007.] Web 18 April 2013,
< http://www.arb.ca.gov/planning/sip/2007sip/2007sip.htm#April26 >

CARB. *Proposed 2016 State Strategy for the State Implementation Plan.* Sacramento, CA: California Air Resources Board, May [2016.]

USEPA (70 FR 71623) *Final Rule to Implement the 8-Hour Ozone National Ambient Air Quality Standard – Phase 2.* Federal Register, Volume 70, 29 November 2005, p. 71623-71624. Print.

USEPA (80 FR 12270) *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements.* Federal Register, Volume 80, 6 March 2015, p. 12264-12319. Print.

10 TRANSPORTATION CONFORMITY AND EMISSION BUDGETS

10.1 Introduction to Transportation Conformity

Transportation conformity analysis and findings are required under federal Clean Air Act (CAA) Section 176 to ensure that transportation activities do not impede an area's ability to attain air quality standards. The CAA requires that transportation plans, programs, and projects that obtain federal funds or require approval be consistent with, or conform to, applicable state implementation plans (SIPs) before they can be approved by a Metropolitan Planning Organization (MPO). Conformity to the SIP means that proposed transportation activities must not:

(1) cause or contribute to any new violation of any standard,
(2) increase the frequency or severity of any existing violation of any standard in any area, or
(3) delay timely attainment of any standard or any required interim emission reductions or other milestones in any area.

This SIP analyzes the region's total emissions inventory from all sources necessary to demonstrate reasonable further progress (RFP) and attainment of the 2008 National Ambient Air Quality Standards (NAAQS) for 8-hour ozone. The on-road highway and transit vehicle portion of the total emissions inventory used to demonstrate RFP and attainment of the NAAQS, is the "motor vehicle emissions budgets" (MVEB)[46]. The MVEB are used to ensure that transportation planning activities conform to the SIP and are set for each RFP milestone year and the attainment year. Transportation projects cannot be approved if they will cause emissions in the transportation plan to exceed the MVEB.

10.2 Transportation Conformity Requirements

To implement the CAA Section 176 requirement, United States Environmental Protection Agency (USEPA) established the Transportation Conformity Rule (40 CFR, Subpart A, 93.100 – 93.129). This rule:

- Establishes criteria and procedures for determining whether the long range metropolitan transportation plan (MTP) and a short range funding program, or metropolitan transportation improvement program (MTIP) conform to the SIP[47].
- Ensures that transportation plans and projects are consistent with the applicable SIP. This means that transportation emissions are less than or equal to the MVEB.

[46] Federal transportation conformity regulations are found in 40 CFR Part 51, subpart T – Conformity to State or Federal Implementation Plans of Transportation Plans, Programs, and Projects Developed, Funded or Approved under Title 23 U.S.C. of the Federal Transit Laws. Part 93, subpart A of this chapter was revised by the USEPA in the August 15, 1997 Federal Register.

[47] The MTP is updated every 4 years and the MTIP is 2 years after MTP.

- Ensures that transportation plans, programs, and other individual projects do not cause new air quality violations, exacerbate existing ones, or delay attainment of air quality standards.

USEPA restructured the transportation conformity rule (USEPA, 2012), so that existing conformity requirements will apply for any new or revised NAAQS. This was done to provide consistency and avoid the need to revise the rule in the future when NAAQS are added or revised..

Before adopting the MTP/MTIP, the Sacramento Area Council of Governments (SACOG), the MPO for the greater Sacramento area must prepare a regional emission analysis based on the projects in the proposed MTP/MTIP and programs as specified in the federal conformity regulation.[48] Those emissions are compared to the emission budgets in the SIP. The MPO may determine that the MTP/MTIP conforms if the emissions from the proposed actions are less than the emissions budgets in the SIP. The conformity determination also signifies that the MPO has met other transportation conformity requirements such as interagency consultation and financial constraint.

10.3 Purpose of the Motor Vehicle Emissions Budget

In this SIP, a motor vehicle emission budget is established for both Volatile Organic Compounds (VOC) and Nitrogen Oxide (NO_X) for two reasons:

1. Both VOC and NO_X are ozone precursors, and reductions of both pollutants are needed to demonstrate attainment of the ozone standards, and
2. The RFP demonstration relies on NO_X substitutions to meet the required goals.

Once ozone SIP budgets in this Plan are approved, areas must use those budgets to determine ozone conformity (40 CFR 93.109(c)(1)). SACOG must demonstrate that projected regional motor vehicle emissions from transportation projects contained in the MTP and MTIP will conform to the levels established in the SIP.

10.4 Latest Planning Assumptions

The latest planning and land use assumptions used to develop the MVEB are included in Amendment #1 to the 2016 Metropolitan Transportation Plan/Sustainable Communities Strategy (2016 MTP/SCS),[49] which was approved by the SACOG Board of Directors in February 2016 (SACOG, 2016a). This included population, housing, households, and employment projections for 2012, 2020, and 2036 for the SACOG planning region (El Dorado, Placer, Sacramento, Sutter, Yolo, and Yuba Counties). These initial projections were updated in the 2017/2020 MTIP, which was adopted by

[48] For purposes of conformity, SACOG is also responsible for the analysis of transportation activities in eastern Solano County.

[49] Projections are updated every 4 years.

the SACOG Board in September 2016 (SACOG, 2016b). The updated activity data based on the 2017/2020 MTIP was used in setting the baseline projections for the motor vehicle inventory.

SACOG's Transportation Model

The transportation analysis for the 2017/2020 MTIP relied on the latest planning assumptions and SACOG's regional travel demand forecasting model, Sacramento Regional Activity-Based Simulation Model (SACSIM). The SACSIM model was used to estimate future traffic volumes and public transit ridership for the SACOG planning region. These boundaries are different than the boundaries of the Sacramento Federal Ozone Nonattainment Area (SFNA). SACSIM includes an "activity-based" travel module that allocates households to parcels and simulates each schedule, mode, and purpose for each person on a typical weekday.

The traffic assignment module loads the vehicle trips onto the road network, resulting in vehicle miles traveled at four time intervals (morning peak, midday, afternoon peak, and evening/early morning) and speed within each time period. To develop the travel forecasting model, information on the characteristics, constraints of the transportation system and residents' travel survey data were collected. The SACSIM travel outputs were compared to actual base year data to demonstrate adequate model performance results.

SACOG used the SACSIM travel demand model to forecast average weekday travel patterns for several future years based on given assumptions about expected future population and employment projections, land use allocations, and transportation system improvements. For the 2016 MTP/SCS[50], SACOG made minor refinements in the growth projections used in the 2012 MTP/SCS (SACOG, 2012). The refinements were based on an assessment of long term economic trends in the region (SACOG, 2016a, Chapter 9).

10.5 Proposed New Motor Vehicle Emissions Budgets

Table 10-1 shows the transportation conformity emissions budgets for VOC and NO_X in the SFNA for the RFP years of 2018 and 2021 as well as the attainment year of 2024. The federal conformity rule allows a SIP to create a safety margin in an emissions budget (40 CFR 93.101, 93.118(e)(4)(vi), and 93.124(a)), so long as the SIP explicitly quantifies the amount by which the MVEB could be higher while still allowing a demonstration of compliance with the milestone and attainment requirements, and explicitly states an intent that some or all of that amount should be available to the MPO and Department of Transportation (DOT) in the emission budget for conformity purposes. A safety margin is defined as the difference between projected emissions and

[50] SACOG typically updates their growth forecast on the four year MTP/SCS cycle.

the emissions necessary to demonstrate RFP and attainment. This plan establishes a safety margin of 0.5 tons/day of NO_X in 2021 only. The budgets, including the safety margin in 2021 for NO_X, are consistent with the emissions inventory used to demonstrate RFP and attainment. Consequently, the emissions budgets may be used by SACOG to establish conformity with their transportation projects and plans.

The emissions budgets presented below use EMFAC2014 with SACOG modeled VMT and speed distributions. For 2018 and 2021 (milestone years) and 2024 (demonstration year), VMT and speed distribution data was generated by SACOG using SACSIM15. Emissions for Eastern Solano County were estimated in EMFAC2014 separately based on data provided by the Metropolitan Transportation Commission (MTC). Because these data represent the most recent data available, there are small differences between the budgets and planning inventory. These differences do not impact the RFP or attainment demonstrations.

The California Air Resources Board (CARB) staff released EMFAC2014, which updates the emission rates and planning assumptions used in calculating conformity budgets. EMFAC2014 was approved for use in SIPs and transportation conformity by USEPA on December 14, 2015 (80 FR 77337).

Calculation Methodology

All the budgets in this plan have been developed in consultation with SACOG. Emissions are based on an average summer day consistent with the ozone attainment and progress demonstrations, using the following method:

1) Calculate the on road motor vehicle emissions totals for the appropriate pollutants (VOC and NO_X) from EMFAC2014.
2) Sum each pollutant (VOC and NO_X) and round each total up to the nearest ton.

Table 10-1 Transportation Conformity Budgets for the 2008 8-hour Ozone standard in the SFNA, tons per average summer day

Sacramento Federal Ozone	2018		2021		2024	
Nonattainment Area	VOC	NO_X	VOC	NO_X	VOC	NO_X
Baseline Emissions	19.85	35.38	16.24	26.96	14.03	19.55
Safety Margin				0.50		
Total	19.85	35.38	16.24	27.46	14.03	19.55
Conformity (Emissions) Budget	20	36	17	28	15	20

Note: The budgets are calculated with EMFAC2014 using SACOG 2016 MTP activity and MTC data for Eastern Solano County. They reflect the latest regional and state strategies described in Chapter 7. Budgets are rounded up to the nearest ton.

10.6 Motor Vehicle Emissions Budgets Approval Process

Before the USEPA approves the MVEB, it conducts an adequacy review process to determine if the MVEB are adequate for conformity purposes. The USEPA can make an adequacy finding on the new MVEB prior to approving the remainder of the Plan. This adequacy review process is subject to public participation and review requirements (40 CFR 93.118(f)).

The USEPA will not find the MVEB to be adequate unless the criteria are satisfied under 40 CFR 93.118(e)(4). This includes endorsement by the governor of the attainment or maintenance plan (40 CFR 93.118(e)(4)(i)). Even if the adequacy finding is effective, the budgets cannot supersede the MVEB already in an approved implementation plan for the years addressed by the previously approved implementation plan.

Interagency Consultation

The SACOG Regional Planning Partnership (RPP) serves as the platform for inter-agency consultation. This inter-agency consultation procedure is required by 40 CFR 93.105(b). The regional air districts consulted with the MPO, cities and counties, Caltrans, USEPA Region IX, U.S. Department of Transportation - Federal Highway Administration, and the USEPA during development of the MVEB proposed in this Plan.

The emissions budgets were presented at the SACOG RPP meeting on April 19, 2017. The RPP recommended, as the designated interagency consultation body, to the SACOG Board that the proposed emissions budgets be included in this regional 8-Hour Ozone SIP. The SACOG Board of Directors took action on this recommendation at their May 18, 2017 meeting.

10.7 Vehicle Miles Traveled Offset (VMT Offset)

Clean Air Act Section 182(d)(1)(A) applies to areas classified as severe or extreme. The SFNA is currently designated severe-15 for the 2008 NAAQS (40 CFR 51.1103(d)) and is therefore subject to the requirement to offset any growth in emissions resulting from an increase in vehicle miles travelled. The VMT offset demonstration was prepared by CARB and is included in Appendix C. The analysis shows that the existing transportation control strategies and TCMs are sufficient to offset the emissions increase due to growth in VMT and demonstrates compliance with the requirements of CAA Section 182(d)(1)(A).

10.8 References

Bradley, M.A., et al. *Development and application of the SACSIM activity-based model system*. Submitted for presentation at the 11th World Conference on Transport Research, Berkeley, California. June [2007.]

Metropolitan Transportation Commission (MTC) Planning /Association of Bay Area Governments Administrative Committees, *Bay Area Plan – Preferred Land Use and Transportation and Investment Strategy*. Oakland, CA: Bay Area Metropolitan Transportation Commission, [2012.]

SMAQMD et al, *Sacramento Regional 8-Hour Ozone Attainment and reasonable Further Progress Plan*. Sacramento, CA: Sacramento Metropolitan Air Quality Management District, [2013.] Print.

SACOG, *Blueprint Preferred Scenario for 2050 Map and Growth Principles, 2004.* Sacramento, CA: Sacramento Area Council of Governments, Web < http://www.sacregionblueprint.org/adopted/ >

SACOG, *Metropolitan Transportation Plan/Sustainable Communities Strategy 2035*. Sacramento, CA: Sacramento Area Council of Governments, [2012.]

SACOG, *2016 Metropolitan Transportation Plan/Sustainable Communities Strategy Building a Sustainable System*. Sacramento, CA: Sacramento Area Council of Governments, 18 February [2016a.]

SACOG, *2017-20 Metropolitan Transportation Improvement Program, Amendment #1 to the 2016 Metropolitan Transportation Plan/Sustainable Communities Strategy, and Air Quality Conformity Analysis*. Sacramento, CA: Sacramento Area Council of Governments, 15 September [2016b.]

USEPA (74 FR 37210), *Adequacy Status of Motor Vehicle Emissions Budgets in Submitted Attainment and Reasonable Further Progress Plan for Sacramento 8-Hour Ozone for Transportation Conformity Purposes; California*. Federal Register, Volume 74, 28 July 2009.

USEPA, *Transportation Conformity Guidance for 2008 Ozone Nonattainment Areas*, July 2012, U.S. Environmental Protection Agency, U.S. EPA 420-B-12-0.

USEPA (80 FR 77337), *Official Release of EMFAC 2014 Motor Vehicle Emission Factor Model for use in the State of California*, Federal Register, Volume 80, 14 December 2015, p. 77337 – 77340.

11 GENERAL CONFORMITY

11.1 Introduction to General Conformity

General conformity is the federal regulatory process that ensures major federal actions[51] or projects will not interfere with air quality planning goals. Conformity provisions state that activities and projects that involve federal funding or approvals must be consistent with state air quality implementation plans (SIPs). Conformity with the SIP means that major federal actions will not cause new air quality violations, worsen existing violations, or delay timely attainment of the national ambient air quality standards (NAAQS).

The current federal rule (80 FR 12284) requires that federal agencies use the emissions inventory from an approved SIP's attainment or maintenance demonstration to support a conformity determination. Therefore, conformity determinations will continue to be based on the Sacramento Regional 8-Hour Ozone Attainment and Reasonable Further Progress Plan (SMAQMD, 2013) until this Plan is approved by the USEPA (40 CFR 93.151).

The general conformity regulations did not change as part of the 2008 NAAQS implementation guidance (80 FR 12284). The existing de minimis emissions levels for a severe nonattainment area of 25 tons per year of VOC or NO_X, contained in 40 CFR 93.153(b)(1) will continue to apply for this Plan.

This chapter summarizes general conformity requirements and emissions criteria for demonstrating general conformity.

11.2 General Conformity Requirements

Clean Air Act (CAA) Section 176 states that no federal department may engage in, support, provide financial assistance, license, or approve any activity that does not conform to an approved SIP.

The USEPA promulgated the conformity regulations for general federal actions (40 CFR 51.851 and 40 CFR 93 subpart B) under CAA section 176(c). The "General Conformity" Rule sets the requirements a federal agency must meet to make a conformity determination. General conformity does not allow federal agencies and departments to support or approve an action that does any of the following (40 CFR 93.153(g)(1)):

- Causes or contributes to new violations of any NAAQS in an area;
- Interfere with provisions in the applicable SIP for maintenance of any standard;

51 Federal actions are defined as any activity engaged in by a department, agency, or instrumentality of the Federal government, or any activity that they support, fund, license, permit, or approve, other than activities related to transportation plans, programs, and projects that are applicable to transportation conformity requirements. (40 CFR 93.152)

- Increases the frequency or severity of an existing violation of any NAAQS; or
- Delays timely attainment of any NAAQS or any required interim emission reductions or other milestone.

11.3 Types of Federal Actions Subject to General Conformity Requirements

Examples of general federal actions that may require a conformity determination include, but are not limited to, the following: leasing of federal land, private construction on federal land, reuse of military bases, airport construction and expansions, construction of federal office buildings, and construction or modifications of dams or levees. These actions are further discussed in 40 CFR 93.153.

General conformity requirements (40 CFR 93.153) apply if direct or indirect emissions from a federal action has the potential to exceed the *de minimis* threshold levels established for each criteria or precursor pollutant in a nonattainment area or maintenance area. The thresholds are shown in 40 CFR 93.153(b)(1)(2). For a severe nonattainment area, the threshold level is 25 tons per year of Volatile Organic Compounds (VOC) or Nitrogen Oxides (NO_X).

Direct emissions of a criteria pollutant or its precursors (40 CFR 93.152) are emissions that are caused or created by the federal action, and occur at the same time and place as the action. Indirect emissions are reasonably foreseeable emissions that occur within the same nonattainment area as the project but are further removed from the federal action in time and/or distance, and can be practicably controlled by the federal agency due to a continuing program responsibility (40 CFR 93.152). A federal agency can indirectly control emissions by placing conditions on federal approval or federal funding. An example would be controlling emissions by limiting the size of a parking facility or by making employee trip reduction requirements (USEPA, 1994, p.13).

There are certain federal actions listed in 40 CFR 93.153 (c)(2)(i-xxii) that would result in no emissions increase, or an increase in emissions that is clearly *de minimis*. These include, but are not limited to continuing and recurring activities such as permit renewals where activities conducted will be similar in scope and operation to the activities currently being conducted, and rulemaking and policy development and issuance.

11.4 Emissions Criteria for Demonstrating General Conformity

To meet the conformity determination emissions criteria, the total of direct and indirect emissions from a federal action must meet all relevant requirements and milestones contained in the applicable SIP (40 CFR 93.158(c)), and must meet other specified requirements, such as:

- For any criteria pollutant or precursor, the total of direct and indirect emissions from the action must be specifically identified and accounted for in the applicable SIP's attainment or maintenance demonstration (40 CFR 93.158(a)(1)); or
- For precursors of ozone, nitrogen dioxide, or particulate matter, the total of direct and indirect emissions from the action must be fully offset within the same nonattainment (or maintenance) area through a revision to the applicable SIP or a similarly enforceable emissions control measure in the SIP (40 CFR 93.158(a)(2)); or
- For ozone, the California Air Resources Board must make a finding that either:
  - the total of direct and indirect emissions from the action will result in a level of emissions that, together with all other emissions in the nonattainment (or maintenance) area, will not exceed the emissions budget specified in the applicable SIP (40 CFR 93.158(a)(5)(i)(A)); or
  - the total of direct and indirect emissions from the action will result in a level of emissions that, together with all other emissions in the nonattainment (or maintenance) area, will exceed the emissions budget specified in the applicable SIP but the State Governor or designee for SIP actions makes a written commitment to the USEPA to take specific future actions (40 CFR 93.158(a)(5)(i)(B)).

11.5 References

SMAQMD et al. *Sacramento Regional 8-Hour Ozone Attainment and Reasonable Further Progress Plan (2013 SIP Revisions).* Sacramento, CA: Sacramento Metropolitan Air Quality Management District. 26 September [2013.]

USEPA. *Subpart B – Determining Conformity of General Federal Actions to State or Federal Implementation Plans*, 40 CFR §93.150 – §93.165, Web 24 April 2017 < https://www.gpo.gov/fdsys/pkg/CFR-2013-title40-vol21/xml/CFR-2013-title40-vol21-part93.xml >

USEPA. *State implementation plan (SIP) or Tribal implementation plan (TIP) revision*, 40 CFR § 51.851

USEPA. *Definitions*, 40 CFR §93.152

USEPA. *Applicability*. 40 CFR §93.153

USEPA. *Criteria for determining conformity of general Federal actions*. 40 CFR §93.158

USEPA. *General Conformity Guidance: Questions and Answers* United States Environmental Protection Agency Office of Air Quality Planning and Standard. 13 July [1994.] Print.

USEPA. (80 FR 12264 – 123190 *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements: Final Rule.* Federal Register, Volume 80, 6 March 2015, p. 12264-12319.

12 REASONABLE FURTHER PROGRESS DEMONSTRATIONS

12.1 Introduction to Reasonable Further Progress

The Clean Air Act (CAA) specifies reasonable further progress (RFP) requirements for ozone nonattainment areas. RFP refers to the general need to obtain a certain level of annual incremental reductions in emissions of relevant air pollutants for the purpose of ensuring attainment of the standard by the applicable attainment deadline.

This chapter begins with a discussion of RFP requirements for the 2008 8-hour ozone National Ambient Air Quality Standards (NAAQS). It also describes the methodology for deriving the base year emissions inventory, calculating RFP emission targets, assessing creditable reductions, and using Nitrogen Oxides (NO_X) substitution for Volatile Organic Compounds (VOC) reduction shortfalls. Finally, this chapter includes the emission reduction summary that demonstrates the RFP targets are met for each of the future milestone years (2018, 2021) and attainment year (2024).

12.2 Reasonable Further Progress Requirements

CAA Sections 172(c)(2), 182(b)(1), and 182(c)(2)(B) include RFP provisions for reducing emissions in ozone nonattainment areas. The federal 2008 8-hour ozone NAAQS regulation (80 FR 12264, 40 CFR 51.1110) requires areas classified under subpart 2 as “serious and above” submit a reasonable further progress plan that shows a VOC (and/or NO_X) emission reduction of at least 18% over the first 6 years from the 2012 baseline year (i.e., 2012-2018) and 3% per year, averaged over each consecutive 3-year period. The total emission reductions required from the base year of 2012 to the attainment year of 2024 is 36%.

12.3 Contingency Measures Requirement

In general, contingency measures are control measures that go into effect if planned emission controls fail to reach desired goals and targets. Contingency measures and provisions are required under CAA Sections 172(c)(9) and 182(c)(9) in the event the nonattainment area fails to meet a RFP milestone or attainment deadline. Contingency measures are specific additional controls to be implemented automatically without further significant rulemaking activities, such as public hearings or legislative review, or without further action by the State or the USEPA Administrator.

Federal guidance (57 FR 13498) requires that sufficient contingency measures in the plan be adopted to provide a 3% emission reduction beyond what is needed for the RFP requirement. The existing control measure strategy in this plan is expected to surpass the amount of emission reductions needed for RFP targets by a margin that meets the contingency measures requirement.

12.4 Methodology for Reasonable Further Progress Demonstrations

The methodology for demonstrating RFP includes preparing the base year and milestone year emissions inventories, calculating RFP emission reduction targets, assessing creditable reductions, and using NO_X substitution for VOC reduction shortfalls if required.

12.4.1 Base Year and Forecast Milestone Year Emissions Inventories

The first step is preparing the 2012 base year VOC and NO_X inventories that are used as the basis for calculating the required percent reduction targets.[52] CAA Section 182(b)(1)(B) defines these baseline emissions as the total amount of actual VOC or NO_X emissions from all anthropogenic sources in the nonattainment area.

The VOC and NO_X emission inventory forecasts are needed for each future milestone year to quantify the emission reductions that are expected to be achieved since the 2012 base year. The emission forecasts are derived by projecting base year emissions using expected growth assumptions and the effects of adopted control measures. In addition, the emission reduction credits (ERCs)[53] and transportation conformity emissions budgets “safety margin”[54] are added to the emission forecasts to ensure they will not interfere with RFP if they are used in the future. ERCs may be used as “offsets” to compensate for an increase in emissions from a new source or modified major source regulated by the air districts.

12.4.2 Reasonable Further Progress Emission Reduction Targets

Federal Regulation (40 CFR 51.1110(a)(2)(i)(A)) requires an 18% emission reduction between the 2012 base year and the first milestone year of 2018 and 40 CFR 51.1110(a)(2)(ii)(A) requires an average emission reduction of 3% per year for all remaining 3-year periods (subsequent milestone years) until the attainment year. For the 2018 RFP target VOC level, the required 18% RFP emission reduction is applied to the 2012 baseline for 2018 milestone year. For the subsequent milestone RFP target VOC level, the required 9% (3% per year averaged over three consecutive years) is applied to the previous milestone RFP target VOC. The attainment RFP target VOC level is the same as the 2024 milestone RFP target.

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52 The USEPA initially determined the base year was 2011, but allowed states to select and justify an alternate year. On July 17, 2014, the California Air Resources Board (CARB) submitted a staff report, titled “8-Hour Ozone State Implementation Plan Emission Inventory Submittal, release date: May 23, 2014” (“submittal”) to the USEPA. This submittal addresses base year inventory requirements for the nonattainment areas in California.

53 Chapter 5, Section 5.6.

54 Chapter 10, Table 10.1.

12.4.3 Creditable Control Measure Reductions

Under 40 CFR 51.1110(a)(5), all emission reductions from State Implementation Plan (SIP) approved or federally promulgated measures that occur after the baseline emissions inventory year are creditable for purposes of the RFP requirements in this section, provided the reductions meet the requirements for creditability, i.e., that they are enforceable, permanent, quantifiable, and surplus. The VOC reductions from existing control regulations are applied to the required RFP target levels. If there are any RFP reduction shortfalls for VOC, the NO_X reductions are used in the RFP demonstration assessment to fulfill the VOC shortfall. The emission reductions used for the RFP demonstration are from local and state control measures that have been adopted, implemented and submitted to USEPA for approval. Some of the control measures have pending USEPA approval and are expected to be approved before USEPA promulgates the SIP. USEPA will determine if the reductions meet the requirements for creditability.

12.4.4 NO_X Substitution for VOC Reduction Shortfalls

Any remaining VOC reduction shortfalls are met by using NO_X emission reductions. CAA Section 182(c)(2)(C) allows for the substitution of NO_X emission reductions in place of VOC reductions to meet the RFP requirements. According to USEPA's NO_X Substitution Guidance (USEPA, 1993), the substitution of NO_X reductions for VOC reductions must be done on a percentage basis, rather than a straight ton-for-ton exchange.

Thus, if there is a certain percent VOC reduction shortfall, an equal percentage reduction in NO_X emissions can be substituted to provide the equivalent reductions necessary for meeting the RFP goals toward attainment. For example, the 8.7% apparent shortfall in VOC in the 2021 milestone year can be met by substituting8.7% NO_X reductions.

12.4.5 NO_X Substitution Attainment Consistency Requirement

CAA Section 182(c)(2)(C) states that NO_X may be substituted for VOC if the substitution will achieve ozone reductions equivalent to those that would be achieved using VOCs. The NO_X Substitution Guidance states that any combination of VOC and NO_X reductions is "equivalent" under the Act so long as the overall VOC and NO_X reduction totals applied to the RFP demonstration are consistent with those required to SIP attainment and reasonable further progress requirements. Therefore, the cumulative amount of NO_X substitution reductions used toward the RFP requirement cannot be greater than the total NO_X reductions dictated by the modeled attainment demonstration. This attainment consistency requirement is meant to prevent the substitution of NO_X reductions that would not lead to progress toward attaining the ozone standard.

The current air quality modeling analysis performed by the California Air Resources Board shows attainment in 2024 with reductions from existing and already adopted VOC and NO_X controls. Photochemical modeling results indicate that both VOC and NO_X reductions provide ozone benefits in the Sacramento region, but on a ton for ton basis NO_X reductions provide greater ozone benefits than VOC reductions. Therefore, a substantial use of NO_X substitution would be consistent with current analyses of ozone attainment strategies in the Sacramento Federal Nonattainment Area.

12.5 Calculations of Reasonable Further Progress Demonstrations

Table 12-1 contains a summary of the calculations for determining whether RFP is achieved for the required milestone targets for 2018, 2021, and the 2024 attainment demonstration year. Projected future VOC and NO_X emission reductions will provide the required RFP reductions, as well as a 3% contingency margin. Appendix D – Reasonable Further Progress Demonstrations contains Table 12-1 with calculation equations.

The RFP demonstrations are achieved by forecasted emission reductions from existing control regulations. Additional emission reductions from new measures are not required in achieving the RFP and contingency demonstrations. Both VOC and NO_X emission reductions are needed to meet the RFP reduction targets as shown in Figure 12-1. The NO_X substitution is used on a percentage basis to cover any VOC percentage shortfalls. The total amount of NO_X emission reductions (13%) used to cover the VOC shortfalls at 2024 attainment demonstration year is less than the total 2024 forecasted NO_X reductions (48%). As the modeling demonstrates, the additional NO_X reductions are more beneficial for the attainment of 2008 8-Hour ozone standard.

Table 12-1 Calculation of RFP Demonstrations [A] SFNA

VOC Emission Calculations - Tons/Day	**2012**	**2018**	**2021**	**2024**
VOC (with existing measures)[B]	110.2	91.0	86.8	84.4
VOC ERCs[C]		5	5	5
VOC plus ERCs	110.2	96.0	91.8	89.4
Required % change since previous milestone year (VOC or Nox)		18%	9%	9%
Required % change since 2012 (VOC or Nox)		18%	27%	36%
Target VOC levels		90.3	82.2	74.8
Shortfall (-)/Surplus (+) in VOC reductions needed to meet target		-5.7	-9.6	-14.6
Shortfall (-)/Surplus (+) in VOC reductions needed to meet target, %		-5.2%	-8.7%	-13.2%
VOC reductions since 2012 used for contingency in this milestone year, %		0%	0%	0%
VOC reductions shortfall previously provided by Nox substitution, %		0%	5.2%	8.7%
Actual VOC reduction Shortfall (-)/Surplus (+), %		-5.2%	-3.5%	-4.5%

NOx Emission Calculations - Tons/Day	**2012**	**2018**	**2021**	**2024**
NOx (with existing measures)[B]	101.1	69.4	58.4	48.8
NOx ERCs[C]		4	4	4
NOx Safety Margin - Transportation Conformity Emissions Budgets[D]		0	0.5	0
NOx plus ERCs and Safety Margin	101.1	73.4	62.9	52.8
Change in Nox since 2012		27.7	38.3	48.4
Change in Nox since 2012, %		27.4%	37.9%	47.8%
NOx reductions since 2012 already used for VOC substitution and contingency through last milestone year, %		0%	8.2%	11.7%
NOx reductions since 2012 available for VOC substitution and contingency in this milestone year, %		27.4%	29.7%	36.2%
NOx reductions since 2012 used for VOC substitution in this milestone year, %		5.2%	3.5%	4.5%
NOx reductions since 2012 used for contingency in this milestone year, %		3%	0%	0%
NOx reductions since 2012 surplus after meeting VOC substitution and contingency needs in this miles year, %		19.2%	26.2%	31.6%
RFP shortfall (-) in reductions needed to meeet target, if any, %		0%	0%	0%
Total shortfall (-) for RFP and Contingency, if any, %		0%	0%	0%
RFP Met?		YES	YES	YES
Contingency Met?		YES	YES	YES

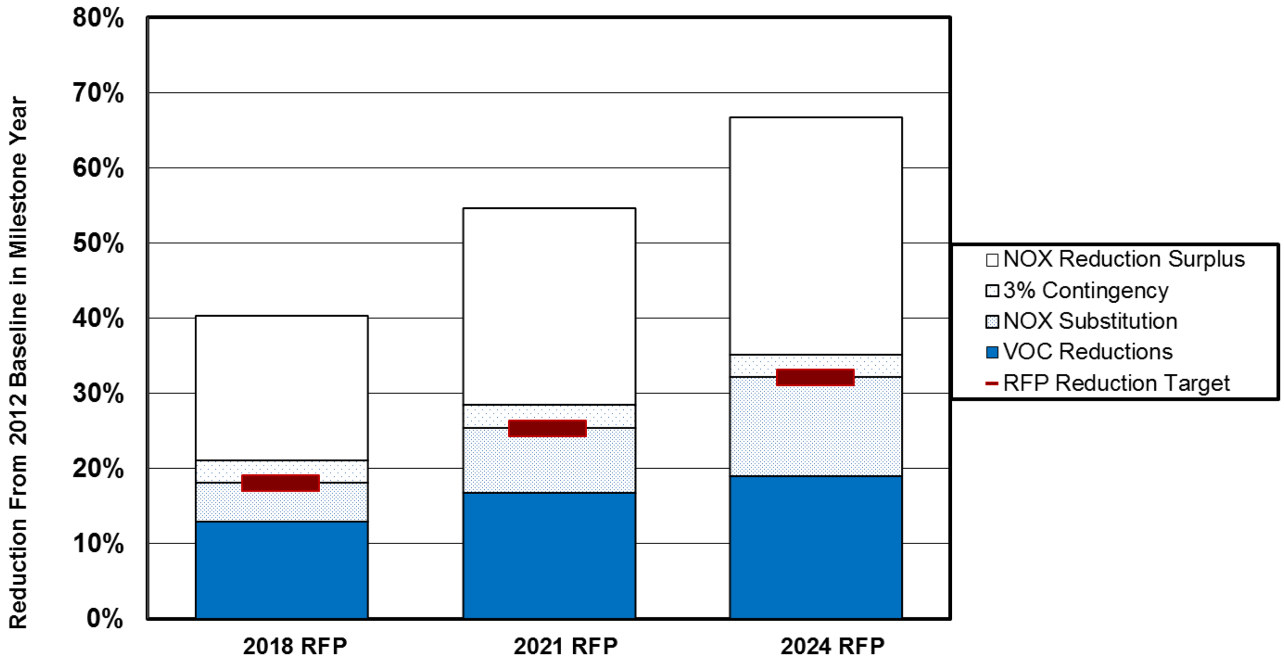
[A]CARB RFP write-up September 8, 2016, email transmittal to SMAQMD with safety margin of 0.5 tpd NOx in 2021 for Transportation Conformity.

[B]VOC and NOx are from CEPAM 2016 Ozone SIP forecast for SFNA, Version 1.04 with approved external adjustments.

[C]ERCs from Chapter 5,Section 5.6: VOC= 5 tpd, NOx = 4 tpd.

[D]Safety Margin of 0.5 tpd NOx in 2021 for Transportation Conformity Emissions Budgets is from Table 10-1.

Figure 12-1 Summary of Reasonable Further Progress Demonstrations - SFNA



12.6 References

USEPA. (57 FR 13498) *General Preamble for the Implementation of Title I of the Clean Air Act Amendments of 1990* Federal Register, Volume 57, 16 April, 1992, p. 13498.

USEPA. *NO_X Substitution Guidance*. United States Environmental Protection Agency Office of Air Quality Planning and Standards, December [1993.]

13 SUMMARY AND CONCLUSIONS

13.1 2008 8-hour Ozone Designation and Classification

The 2008 8-hour ozone National Ambient Air Quality Standard (NAAQS) lowered the health-based limit for ambient ozone from 84 parts per billion (ppb) to 75 ppb. The Sacramento Federal Nonattainment Area (SFNA) is designated as nonattainment for the 2008 NAAQS, because the area's ozone design value[55] exceeds the NAAQS. The SFNA includes all of Sacramento and Yolo counties and portions of Placer, El Dorado, Solano, and Sutter counties.

Under the United States Environmental Protection Agency's (USEPA) classification approach for the 2008 8-hour NAAQS (80 FR 12264), the SFNA would have been classified as serious based on its design value of 102 ppb at the Folsom-Natoma Monitoring Station. USEPA proposed to extend the voluntary reclassification determination for the 1997 ozone NAAQS of severe-15 to the more stringent 2008 NAAQS. No district within the SFNA opposed the reclassification and the California Air Resource Board (CARB) confirmed it wanted USEPA to interpret previous voluntary reclassification requests as requests for reclassification under the 2008 ozone NAAQS (Goldstene, 2012). As a result, the SFNA was voluntarily classified as a severe-15 area (77 FR 30165) for the 2008 NAAQS.

13.2 Ozone Trends

The progress toward attainment was measured by analyzing ambient ozone data collected at monitoring sites in the SFNA over twenty-seven years (1990-2016). There are currently 16 active ozone monitoring stations located throughout the SFNA that are operated by either local air districts or the CARB.

The number of 8-hour ozone exceedance days recorded at the peak monitoring sites fluctuates from year to year due to meteorological variability and changes in precursor emission patterns. Most exceedances of the 2008 federal 8-hour ozone standard occur at the region's eastern monitoring sites - Cool, Folsom-Natoma, Placerville, and Auburn. The ozone design values declined from 1990 to 2016 at all monitoring stations. The highest number of exceedance days was recorded in Placerville between 1990 and 1995, Cool between 1996 and 2007, and Folsom-Natoma between 2008 and 2016.

The overall 27-year (from 1990 to 2016) trend line indicates a decline, from the peak ozone design value of 110 ppb in 1993 down to 85 ppb in 2016. This shows that peak ozone concentrations have improved from being 35 ppb (or 46%) above the 2008 8-hour standard of 75 ppb to about 10 ppb (or 13%) above the standard.

[55] The 8-hour ozone design value is calculated by averaging the annual 4th-highest daily maximum 8-hour ozone concentration over 3 years.

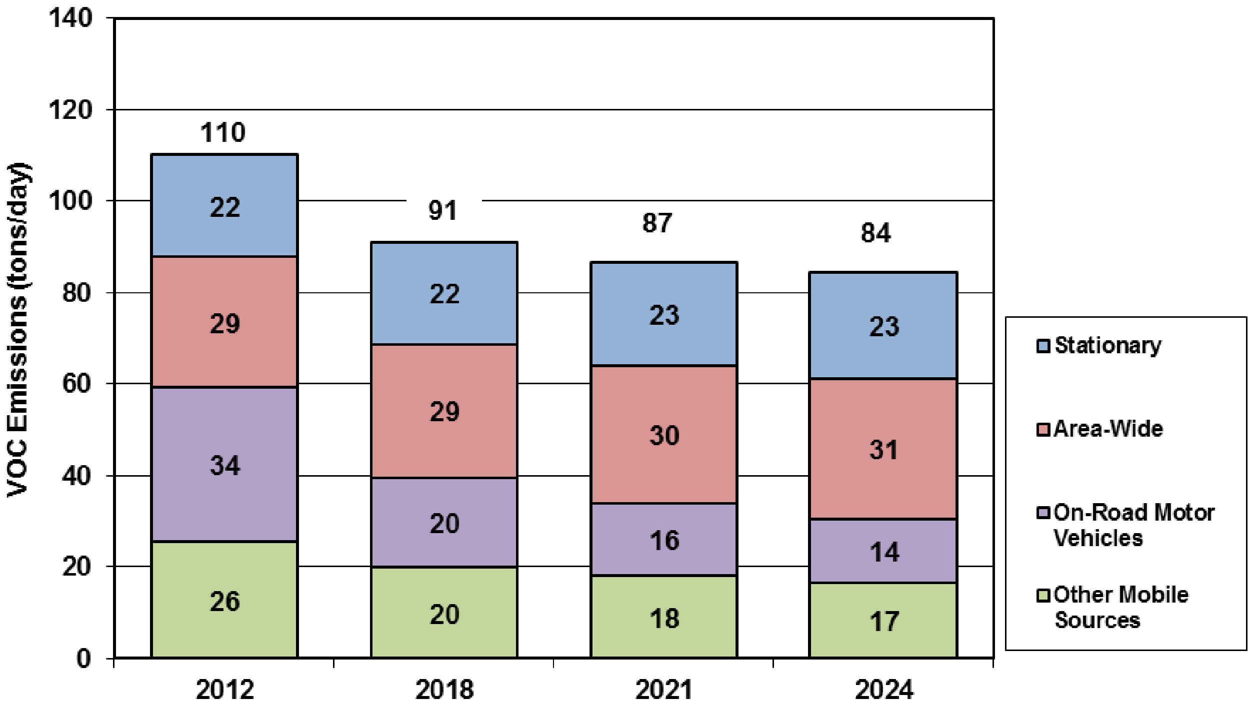
13.3 VOC and NO_X Emissions Inventory

Planning efforts to evaluate and reduce ozone air pollution included identifying and quantifying the various processes and sources of volatile organic compounds (VOC) emissions (such as solvents, surface coatings, and motor vehicles) and nitrogen oxides (NO_X) emissions (such as motor vehicles and other fuel combustion equipment).

The 2012 base year anthropogenic planning inventory for the SFNA is estimated to be 110 tons per day (tpd) of VOC emissions and 101 tpd of NO_X emissions (see Chapter 5, Tables 5-1 and 5-2). The base year emissions are used to forecast future year inventories by using forecasts for control strategies, population, housing, employment, energy demand, motor vehicle travel, and other industrial and commercial outputs. To ensure that the use of emissions reduction credits (ERCs) will not be inconsistent with the reasonable further progress and attainment goals, the amount of ERCs issued for reductions that occurred prior to the 2012 base year are added to the CARB emissions forecasts for VOC and NO_X (see Figures 13-1 and 13-2). These emissions inventories are used in attainment demonstration modeling (Chapter 8) and the Reasonable Further Progress (RFP) demonstration (Chapter 12). ERCs are discussed further in Chapter 5.

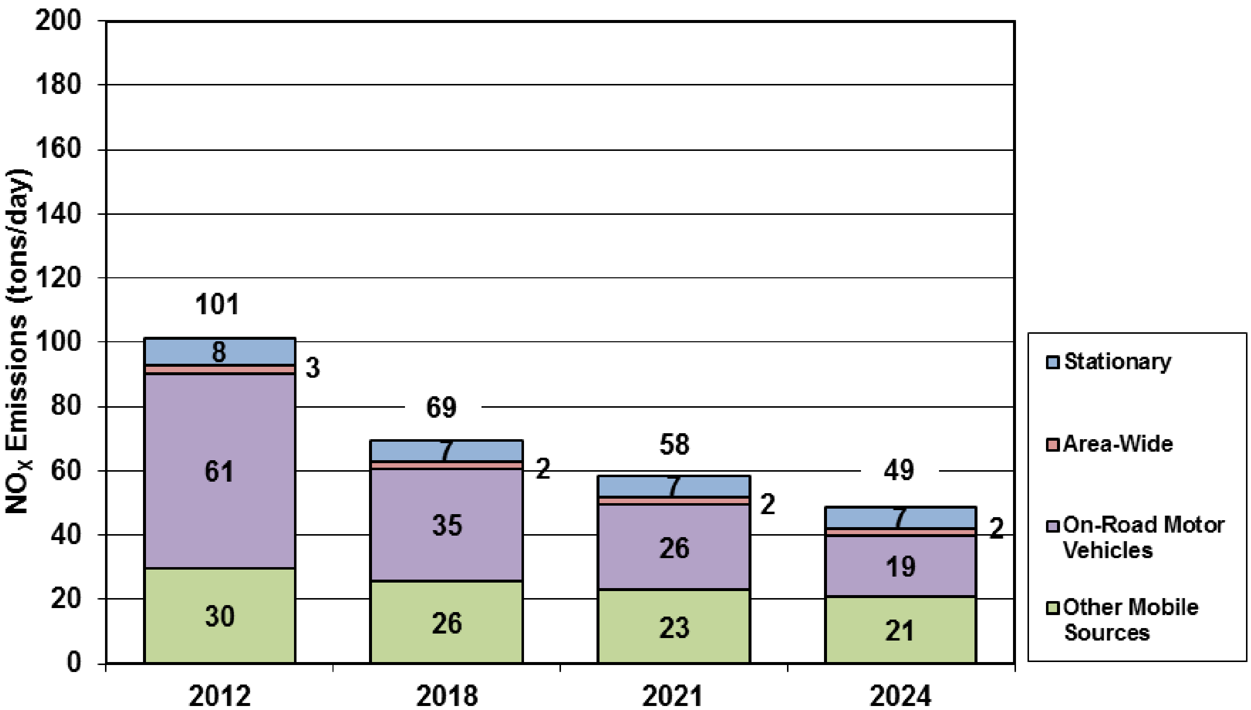
Figure 13-1 shows VOC emissions and Figure 13-2 shows NO_X emissions for 2012 (base year), 2018 and 2021 (milestone years), and 2024 (attainment year) for stationary, area-wide, on-road motor vehicles, and other mobile sources within the SFNA. Figure 13-3 shows population and vehicle miles traveled (VMT) growth for the SFNA. The VOC and NO_X emission forecasts show significant declines in mobile source emissions, despite increasing population, vehicle activity, and economic development in the SFNA. Future year on-road emissions are determined by using VMT forecasts in Sacramento Area Council of Government's (SACOG's) 2016 Metropolitan Transportation Plan/Sustainable Community Strategy (MTP/SCS) (SACOG, 2016) and Metropolitan Transportation Commission's (MTC's) 2015 FSTIP (MTC, 2016).

Figure 13-1 VOC Planning Inventory Forecasts – SFNA



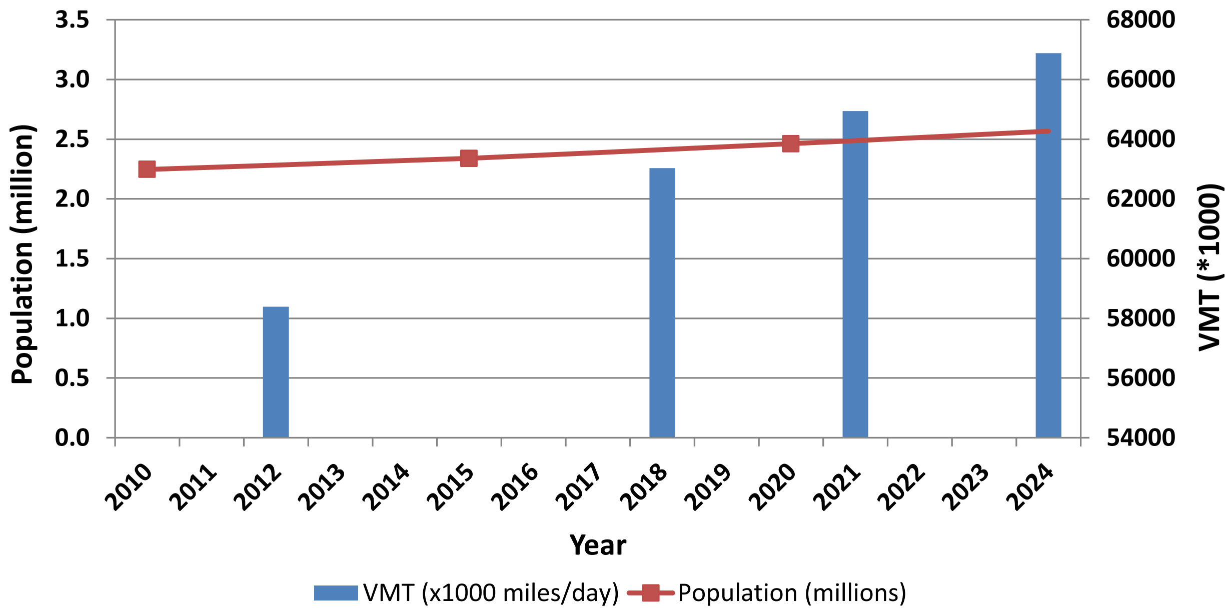
Source: (CARB, 2016), does not include 5 tpd of VOC ERCs in 2018, 2021 and 2024, as shown in Chapter 5 and Appendix A5.

Figure 13-2 NO_X Planning Inventory Forecasts - SFNA



Source: (CARB, 2016), does not include 4 tpd of NO_X ERCs in 2018, 2021 and 2024, as shown in Chapter 5 and Appendix A5.

Figure 13-3 Population Growth and VMT Forecast SFNA



13.4 Attainment Modeling and Analysis

Photochemical modeling (Appendix B) was conducted to simulate base case episodes of high ozone formation. The photochemical model was analyzed based on 2012 baseline year emissions and future year emissions forecasts to determine if the ozone standard would be attained with existing control strategies. The VOC and NO_X emission forecasts included existing control strategies and incorporates the growth assumptions used in the 2016 MTP/SCS (SACOG, 2016).

Modeling results showed a relative decline in future ozone concentrations and predicted attainment at all ozone monitors by 2026[56] without additional VOC or NO_X control strategies. The modeling results indicated that both VOC and NO_X reductions provide ozone benefits in the SFNA, but on a ton for ton basis, NO_X reductions provide greater ozone benefits than VOC reductions.

13.5 2024 Attainment Demonstration

CAA Sections 172(a)(2)(A) and 181(a) require nonattainment areas to meet the clean air standards "as expeditiously as practicable." The regional air districts, in consultation with CARB and USEPA Region IX, are proposing 2024 be established as the SFNA attainment deadline for the 2008 NAAQS, even though the modeling results indicated the SFNA could potentially meet the standard in 2022.

56 The statutory attainment date for a "severe-15" nonattainment area is July 20, 2027 (80 FR 12268). To demonstrate attainment by this date, data is used from 2024, 2025 and 2026 to determine the design value.

Selection of 2024 as an attainment demonstration year is appropriate because it is bounded by two modeled attainment demonstrations, supports attainment before the 2008 NAAQS 8-hour ozone regulatory attainment demonstration year for a severe-15 area of 2026,[57] and provides a safeguard against inherent uncertainties in predicting future ambient ozone concentrations beyond 2022 (e.g. emission reductions, meteorology, or natural events). In addition, it is more realistic than 2022, in light of the very steep rate of emission reductions that would be required at the Placerville site to reach the standard by 2022.

Photochemical modeling shows that the design value at the Folsom-Natoma Monitoring Station[58] for 2022 is 75.2 ppb and for 2026 is 70.7 ppb. Base year and future forecasted emissions were used to estimate the percent reduction in NO_X and VOC emissions needed, from the 2012 base year to the 2024 attainment year, to attain the 2008 NAAQS (75 ppb). The forecasted 2024 NO_X emissions provided by CARB are plotted on a line[59] (Figure 13-4) to determine the 2024 design value. Utilizing this approach, the ozone design value at Folsom-Natoma in 2024 is estimated to be 72.1 ppb.

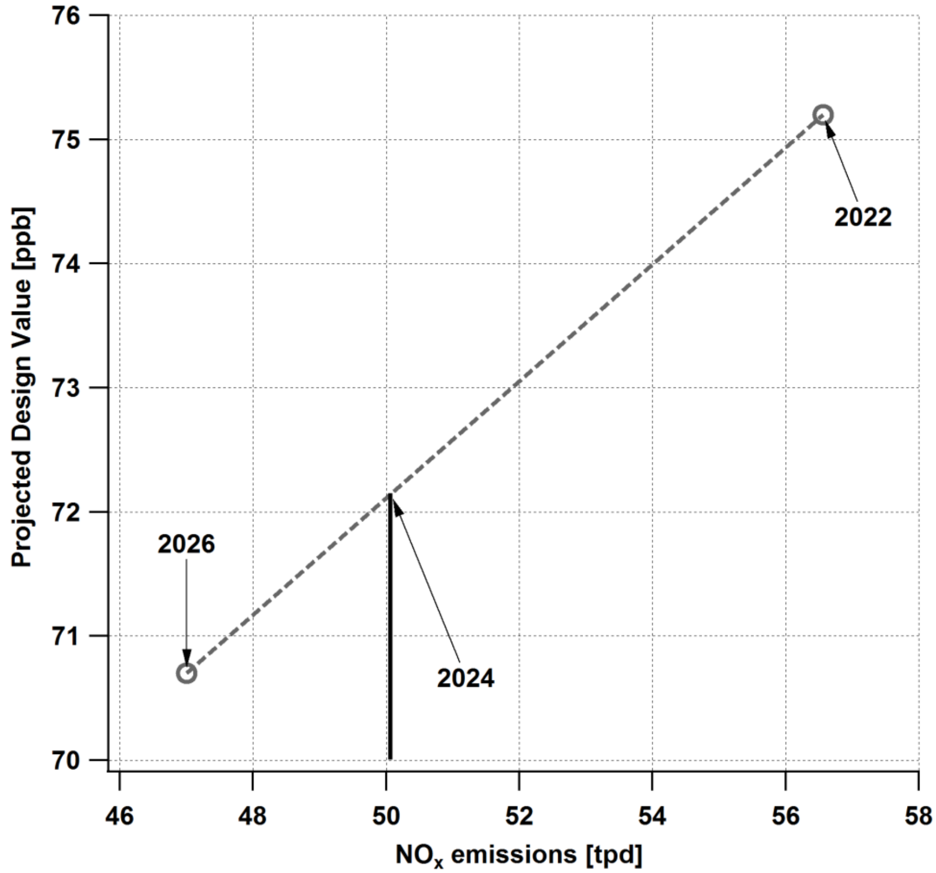
Finally, CARB is preparing a weight-of-evidence analysis, which will be submitted to USEPA in conjunction with this SIP. Based on the air districts' analysis in this SIP, we anticipate that the weight-of-evidence test will support the 2024 attainment deadline designation.

57 The attainment date is July 20, 2027, but attainment must be demonstrated by using air quality data based on 2026.

58 Folsom monitoring station was identified as the peak ozone monitoring site for the modeling. The 2012 weighted design value was 90 ppb.

59 This line assumed a linear relationship between the ozone design value and NO_X emissions from 2022 to 2026. The emission inventories are presented in Chapter 5 and Appendix A.

Figure 13-4 Ozone design value as a function of NO_X emissions at the Folsom-Natoma monitor



Control Measure Evaluation

This SIP relies on the following components:

1. Reductions from existing local and regional control measures and adopted rules, and
2. Reductions from existing state and federal regulations.

Results from the RACM analysis (Appendix E) showed that attainment could not be advanced by an additional year (from 2024 to 2023). In addition, the Reasonable Further Progress and contingency measure requirements discussed in Chapters 8 and 12 demonstrate that additional measures are not needed to satisfy those requirements. Consequently, no additional local or regional control measures were included in this SIP. Reductions in emissions from existing control measures in the 2013 Plan (SMAQMD, 2013) are included in this plan.

13.6 Pollutant Transport

The air quality in the SFNA can be impacted by pollutant transport from the San Francisco Bay Area and the San Joaquin Valley. Delta breezes carry air pollutants from coastal Bay Area and San Joaquin Valley emission sources downwind to the inland areas of the SFNA, and these pollutants may contribute to ozone formation during the same day or the following days. The CARB has determined that the relative impact on air quality in the SFNA, from the Bay Area and San Joaquin Valley pollutant transport can be considered overwhelming, significant, or inconsequential depending on meteorological conditions (CARB, 2001, p.25, 37). The air flow pattern in the Sacramento Valley (Schultz eddy) also causes pollutants to recirculate and can trap them within the SFNA. Various studies (Appendix B-2, p.27 and p.28) over the past two decades also reaffirmed that a strong sea breeze with a deep marine boundary layer from the San Francisco Bay Area enhanced pollutant transport into the Sacramento Delta Region. CARB's photochemical modeling take into account both transported emissions and emission reductions from statewide and upwind regions' control measures.

13.7 Transportation Conformity and Vehicle Miles Traveled Offset

Under the CAA Section 176, federal agencies may not approve or fund transportation plans and projects unless they are consistent with state air quality implementation plans (SIP). Conformity with the SIP requires that transportation activities not cause new air quality violations, worsen existing violations, or delay timely attainment of the NAAQS. The emissions from transportation plans and projects must be less than or equal to the motor vehicle emissions budgets (MVEB) established by the RFP, or attainment plan (40 CFR 93.118). Table 13-1 lists the proposed MVEB for the 2018 and 2021 RFP milestone years, and the 2024 attainment year.

Table 13-1 Proposed New Motor Vehicle Emission Budgets – SFNA

Sacramento Federal Ozone Nonattainment Area	2018		2021		2024	
	VOC	NO_X	VOC	NO_X	VOC	NO_X
Baseline Emissions	19.85	35.38	16.24	26.96	14.03	19.55
Margin of Safety				0.5		
Total	19.85	35.38	16.24	27.46	14.03	19.55
Conformity (Emissions) Budget	20	36	17	28	15	20

Note: The budgets are calculated with EMFAC2014 using SACOG 2016 MTP activity and MTC data for Eastern Solano County. They reflect the latest regional and state strategies described in Chapter 7. Budgets are rounded up to the nearest ton. The Methodology used to calculate the emissions budget is discussed in Chapter 10.

The MVEB reflect a 0.5 ton per day margin of safety for NO_X emissions for 2021. The latest planning and land use assumptions used to develop the MVEB are provided by the 2016 Metropolitan Transportation Plan/Sustainable Communities Strategy (2016 MTP/SCS)[60] which was approved by the SACOG Board of Directors in February 2016

[60] Projections are updated every 4 years.

(SACOG, 2016a). The emissions budgets presented use EMFAC2014 with SACOG modeled VMT and speed distributions. For 2018 and 2021 (milestone years) and 2024 (demonstration year), VMT and speed distribution data was generated by SACOG using SACSIM15. Emissions for Eastern Solano County were estimated in EMFAC2014 separately based on data provided by the Metropolitan Transportation Commission (MTC).

These new MVEB will replace the budgets established as part of the 2013 Plan (SMAQMD, 2013). The Metropolitan Planning Organizations (MPO), SACOG and MTC, must ensure that the aggregate transportation emissions in the SFNA stay below these levels when approving new metropolitan transportation plans and transportation improvement programs, even if the mix of projects changes or growth increases. Before USEPA approves the new MVEB, it will conduct an adequacy review process to determine if the MVEB are adequate for conformity purposes. USEPA can make an adequacy finding on the new MVEB prior to their approval of the SIP. This adequacy review process is subject to public participation and review requirements (40 CFR 93.118(f)).

The MVEB were presented at the SACOG Regional Planning Partnership (RPP) meeting on April 19, 2017. The RPP, as the designated interagency consultation body, recommended to the SACOG Board of Directors that the proposed transportation conformity budgets be included in the regional 8-hour ozone SIP. On April 27, 2017, the SACOG Transportation Committee also unanimously recommended that the SACOG Board of Directors approve the proposed transportation conformity budgets be included in the regional 8-hour ozone SIP. The SACOG Board of Directors took action and unanimously approved the MVEB at their May 18, 2017 meeting.

The SFNA is required by CAA Section 182(d)(1)(A) to offset any growth in emissions resulting from an increase in vehicle miles travelled (VMT). A detailed VMT offset demonstration was prepared by CARB and is included in Appendix C. – The analysis shows there are sufficient transportation control strategies and TCMs to offset the emissions increase due to growth in VMT.

13.8 General Conformity

There were no changes to the general conformity regulations made as part of the 2008 NAAQS implementation rule. The existing de minimis emissions levels contained in 40 CFR 93.153(b)(1) will continue to apply to the 2008 NAAQS.

13.9 Reasonable Further Progress (RFP) Demonstration

The RFP evaluation shown on Table 13-2 and Figure 13-5 is based on the emission inventory forecasts, which assume expected growth rates and existing control measures. The 3-year RFP demonstrations are achieved through VOC and NO_X emission reductions for 2018 and 2021 (milestone years), and 2024 (attainment year).

Table 13-2 shows the percentages of VOC and NO_X emission reductions used to meet the RFP reduction goals.

The RFP demonstration is met through forecasted emission reductions from existing control regulations and previously adopted control measures. Additional emission reductions from new measures are not required in achieving the RFP and contingency demonstrations. Both VOC and NO_X emission reductions are needed to meet the RFP reduction targets. NO_X substitution is used on a percentage basis to cover any VOC percentage shortfalls. Out of the 47.8% total emissions reduction in NO_X achieved from the baseline year (2012) to the attainment year (2024) 13.2% was used to meet the VOC shortfall, and 3% was used to meet the contingency requirement. The remaining 31.6% NO_X reductions exceeds the level needed to meet RFP.

Table 13-2 Calculation of RFP Demonstrations [A] SFNA

VOC Emission Calculations - Tons/Day	2012	2018	2021	2024
VOC (with existing measures)[B]	110.2	91.0	86.8	84.4
VOC ERCs[C]		5	5	5
VOC plus ERCs	110.2	96.0	91.8	89.4
Required % change since previous milestone year (VOC or Nox)		18%	9%	9%
Required % change since 2012 (VOC or Nox)		18%	27%	36%
Target VOC levels		90.3	82.2	74.8
Shortfall (-)/Surplus (+) in VOC reductions needed to meet target		-5.7	-9.6	-14.6
Shortfall (-)/Surplus (+) in VOC reductions needed to meet target, %		-5.2%	-8.7%	-13.2%
VOC reductions since 2012 used for contingency in this milestone year, %		0%	0%	0%
VOC reductions shortfall previously provided by Nox substitution, %		0%	5.2%	8.7%
Actual VOC reduction Shortfall (-)/Surplus (+), %		-5.2%	-3.5%	-4.5%
NOx Emission Calculations - Tons/Day	**2012**	**2018**	**2021**	**2024**
NOx (with existing measures)[B]	101.1	69.4	58.4	48.8
NOx ERCs[C]		4	4	4
NOx Safety Margin - Transportation Conformity Emissions Budgets[D]		0	0.5	0
NOx plus ERCs and Safety Margin	101.1	73.4	62.9	52.8
Change in Nox since 2012		27.7	38.3	48.4
Change in Nox since 2012, %		27.4%	37.9%	47.8%
NOx reductions since 2012 already used for VOC substitution and contingency through last milestone year, %		0%	8.2%	11.7%
NOx reductions since 2012 available for VOC substitution and contingency in this milestone year, %		27.4%	29.7%	36.2%
NOx reductions since 2012 used for VOC substitution in this milestone year, %		5.2%	3.5%	4.5%
NOx reductions since 2012 used for contingency in this milestone year, %		3%	0%	0%
NOx reductions since 2012 surplus after meeting VOC substitution and contingency needs in this miles year, %		19.2%	26.2%	31.6%
RFP shortfall (-) in reductions needed to meeet target, if any, %		0%	0%	0%
Total shortfall (-) for RFP and Contingency, if any, %		0%	0%	0%
RFP Met?		YES	YES	YES
Contingency Met?		YES	YES	YES

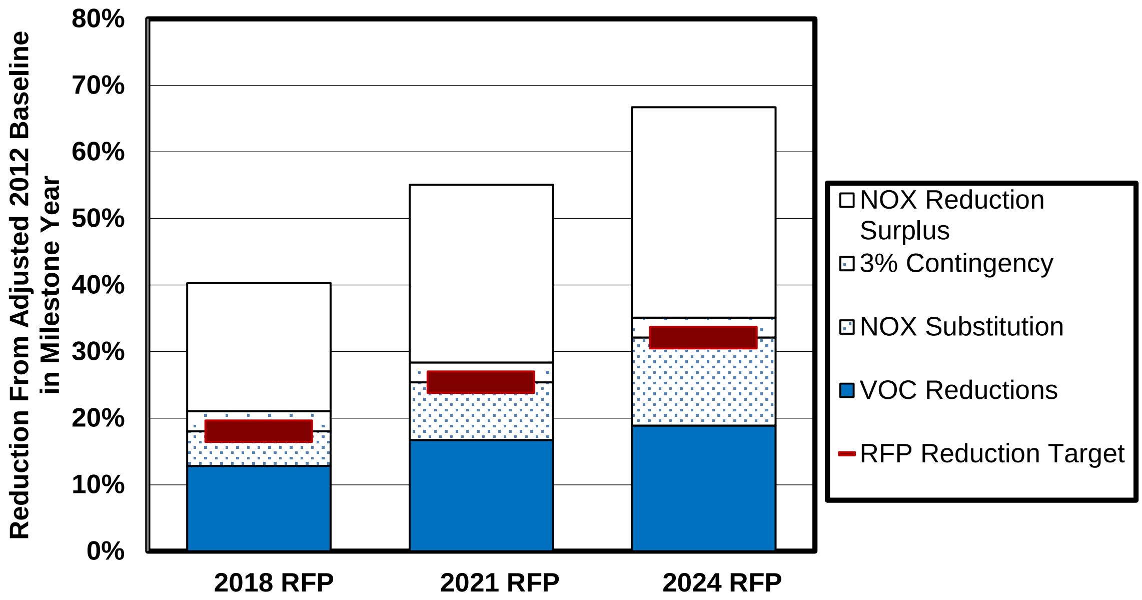
[A]CARB RFP write-up September 8, 2016, email transmittal to SMAQMD with safety margin of 0.5 tpd NOx in 2021 for Transportation Conformity.

[B]VOC and NOx are from CEPAM 2016 Ozone SIP forecast for SFNA, Version 1.04 with approved external adjustments.

[C]ERCs from Chapter 5,Section 5.6: VOC= 5 tpd, NOx = 4 tpd.

[D]Safety Margin of 0.5 tpd NOx in 2021 for Transportation Conformity Emissions Budgets is from Table 10-1.

Figure 13-5 Summary of RFP Demonstrations



13.10 Future Ozone Planning Efforts

This Plan reflects the best available information at this time. Emission inventories, modeling analyses, and control strategies will continue to be updated and re-evaluated. Revisions to this Plan can be made at any time if new information indicates a change is needed.

13.11 Milestone Reports

CAA Section 182(g) requires that progress (milestone) reports be prepared to evaluate whether actual emission reductions meet the minimum RFP targets. Milestone reports will be required to be submitted no later than 90 days after the date of the milestone years (2018 and 2021).

13.12 References

CARB, 2001. *Ozone Transport: 2001 Review.* Sacramento, CA: California Air Resources Board, April [2001.] Print.

Goldstene, James. *Letter: CARB to Air and Radiation Docket and Information Center,* 13 March [2012.] Print.

MTC et al. *Plan Bay Area 2040.* Oakland, CA: Bay Area Metropolitan Transportation Commission, [2017.] Print.

SMAQMD et al. *2013 Revisions to the Sacramento Regional 8-Hour Ozone Attainment and Reasonable Further Progress Plan.* Sacramento, CA: Sacramento Metropolitan Air Quality Management District, [2013.] Print.

SACOG. *2016 Metropolitan Transportation Plan/Sustainable Communities Strategy Building a Sustainable System*. Sacramento, CA: Sacramento Area Council of Governments. 18 February [2016.] Print.

USEPA. (77 FR 30160) *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: Nonattainment Area Classifications Approach, Attainment Deadlines and Revocation of the 1997 Ozone Standards for Transportation Conformity Purposes, Final Rule.* Federal Register, Volume 77, 21 May 2012, p. 30160 – 30171.

USEPA. (80 FR 12264) *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements: Final Rule.* Federal Register, Volume 80, 6 March 2015, p. 12264-12319.

APPENDIX A

Emissions Inventory

Appendix A Emissions Inventory

The 2012, 2018, 2021, and 2024 emission inventories are presented in various formats and details in this appendix.

Appendix A-1 Estimated Forecast Summary by EIC

The Appendix A-1 (available separately in electronic file format) contains the estimated VOC and NO_X forecast summaries by EIC emission categories for the Sacramento Federal Nonattainment Area (SFNA) in CEPAM: External Adjustment Reporting Tool, Section 1.a – Sacramento NAA 2016 Ozone SIP Ver. 1.04.

Workbook Name: Appendix_A1_Emissions_By_EIC

Worksheet Name	Worksheet Description
NOX Emissions by EIC	Estimated NO_X forecast summary by EIC for SFNA in CEPAM Ver. 1.04.
ROG Emissions by EIC	Estimated ROG forecast summary by EIC for SFNA in CEPAM Ver. 1.04.

Appendix A-2 Growth and Control Data for Emission Forecasting

This Appendix A2 (available separately in electronic file format) contains the growth and control data used for emission forecasting stationary and area-wide sources in CARB's SIP planning projection model, CEPAM.

Workbook Name: #DT0199_SacNA_Control_Profiles_OZ16SIP_V100_6FEB2015

Worksheet Name	Worksheet Description
ReadME	Description of each spreadsheet
Rule_List	List of the control profiles applies to SNA
Rule_Desc	Control rule description table
Control_Data	Control data table
Rule_Desc_Field_Description	Description of the fields in the Rule_Desc table
Control_Data_Field_Description	Description of the fields in the Control_Data table

Workbook Name: gap_sacozone

Worksheet Name	Worksheet Description
gap_sacozone	Growth Activity Profiles for SFNA

Workbook Name: pad_sacozone

Worksheet Name	Worksheet Description
pad_sacozone	Parameter Assignment Data for SFNA

Workbook Name: growthparam_update

Worksheet Name	Worksheet Description
Sheet1	Updated name assignments for growth parameters

Appendix A-3 Emission Reduction Credits (ERCs)

This Appendix A3 contains a summary description and inventory of VOC and NO_X emission reduction credits (ERCs) listed by the individual air districts. In addition, the appendix includes: 1) unused ERCs issued for reductions that occurred prior to the 2012 base year, and 2) future bankable rice burning ERCs. The VOC and NO_X ERC totals were added to the emission inventory forecast years in chapter 5, Table 5-3 and Table 5-4, respectively.

Unused ERCs Issued for Reductions That Occurred Prior to 2012 Base Year

Certain pollutant emission reductions due to equipment shutdown or voluntary control may be converted to emission reduction credits (ERCs) and registered with the air districts. These ERCs may then be used as “offsets” to compensate for an increase in emissions from a new or modified major emission source regulated by the air districts. Unused ERCs are considered as potential future emissions supplemental to the forecasted emissions inventory.

The amount of unused ERCs from stationary sources that occurred prior to the 2012 base year are estimated at 4.2 tons per day of VOC and 3.1 tons per day of NO_X and are summarized by air district in Table A3-1. They are included in the emissions forecasts to ensure the potential future use of these credits does not interfere with reasonable further progress and attainment goals.

Future Bankable Rice Burning Emission Reduction Credits

Emission credits from reduction in burning may not be used to comply with offset requirements at a new major stationary source or a major modification, unless they are included in an approved attainment demonstration plan. (USEPA Region IX, 2003) To meet this requirement, the impact of accounting for ERCs from reduction in rice straw burning and other agricultural burning credits are being included in this 8-hour ozone attainment and RFP demonstration plan.

California legislation in 1991 (known as the Connelly bill) required rice farmers to phase down rice field burning on an annual basis, beginning in 1992. A burn cap of 125,000 acres in the Sacramento Valley Air Basin was established, and growers with 400 acres or less were granted the option to burn their entire acreage once every four years. Since the rice burning reductions were mandated by state law, they would ordinarily not be “surplus” and eligible for banking. However, the Connelly bill included a special provision declaring that the reductions qualified for banking if they met the State and local banking rules.

The amount of future bankable rice burning ERCs for the Sacramento nonattainment area are estimated at about 0.12 tons per day of VOC and 0.13 tons per day of NO_X and are listed by air district in Table A3-2. They are included in the emissions forecasts to ensure the potential future use of these credits does not interfere with reasonable further progress and attainment goals.

Table A-1 Summary of Unused Banked ERCs in the SFNA for 2012 Baseline

Air District [a]	**Avg. Summer Day**	
	VOC (tpd)	**NO_X (tpd)**
Sacramento Metropolitan AQMD	2.24	1.41
Yolo-Solano AQMD	0.41	0.40
Placer County APCD	0.58	0.50
Feather River AQMD (South Sutter)	0.92	0.76
Total Unused Banked ERCs	**4.16**	**3.08**

[a] There are no ERCs for El Dorado County AQMD.

Table A-2 Summary of Future Bankable Rice Burning ERCs in the SFNA

Air District [a]	**Avg. Summer Day**	
	VOC (tpd)	**NO_X (tpd)**
Sacramento Metropolitan AQMD	0.12	0.13
Yolo-Solano AQMD	-	-
Placer County APCD	-	-
Feather River AQMD (South Sutter)	-	-
Total Future Rice Burning ERCs	**0.12**	**0.13**

[a] The only district with bankable rice ERCs is Sacramento. All other districts have already banked their rice emissions.

The VOC and NO_X ERC totals from Table A3-1 and A3-2 were rounded up to 5 tons per day VOC and 4 tons per day NO_X and added to the emission inventory forecast years in Chapter 5, Table 5-3 and Table 5-4, respectively.

Reference

USEPA Region IX (Broadbent, Jack P.) Message to Larry Greene (YSAQMD) *"Re: Generating Emissions Offsets from Reductions in Rice Straw Burning in Accordance with Health and Safety Code Section 41865."*, 30 October 2003. Print.

Appendix A-4 Emissions Inventory Summary from CEPAM

This Appendix A4 contains 2012, 2018, 2021, 2024, and 2025 VOC and NO_X emissions inventory summary from CEPAM: External Adjustment Reporting Tool, Section 1.a – Sacramento NAA 2016 Ozone SIP Ver. 1.04.

Table A-3 2012, 2018, 2021, 2024, and 2025 VOC Inventory from CEPAM v1.04

CEPAM: External Adjustment Reporting Tool
Emission Projections by Summary Category

(Includes approved external emission adjustments)

Season: Summer
Reactive Organic Gas
Base Year: 2012

Preliminary Draft: Subject to Change

Download this data as a comma delimited file.
Download more detail data as a comma delimited file.

Sacramento NAA 2016 Ozone SIP Ver. 1.04

STATIONARY SOURCES					
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
FUEL COMBUSTION					
ELECTRIC UTILITIES	0.208	0.208	0.206	0.212	0.216
COGENERATION	0.001	0.001	0.001	0.001	0.001
OIL AND GAS PRODUCTION (COMBUSTION)	0.041	0.036	0.033	0.031	0.031
MANUFACTURING AND INDUSTRIAL	0.125	0.122	0.123	0.122	0.122
FOOD AND AGRICULTURAL PROCESSING	0.220	0.110	0.097	0.085	0.082
SERVICE AND COMMERCIAL	0.069	0.070	0.071	0.071	0.071
OTHER (FUEL COMBUSTION)	0.097	0.091	0.085	0.086	0.087
* TOTAL FUEL COMBUSTION	0.761	0.637	0.617	0.609	0.609
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
WASTE DISPOSAL					
SEWAGE TREATMENT	0.034	0.036	0.037	0.038	0.039
LANDFILLS	0.803	0.846	0.873	0.901	0.911
INCINERATORS	0.007	0.007	0.008	0.008	0.008
SOIL REMEDIATION	0.008	0.008	0.009	0.009	0.009
OTHER (WASTE DISPOSAL)	5.286	4.372	4.540	4.750	4.820
* TOTAL WASTE DISPOSAL	6.138	5.269	5.466	5.706	5.787
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
CLEANING AND SURFACE COATINGS					
LAUNDERING	0.080	0.085	0.087	0.090	0.091

DEGREASING	1.953	2.303	2.406	2.564	2.623
COATINGS AND RELATED PROCESS SOLVENTS	2.889	3.207	3.385	3.617	3.702
PRINTING	1.292	1.436	1.466	1.495	1.505
ADHESIVES AND SEALANTS	0.732	0.919	0.975	1.003	1.013
OTHER (CLEANING AND SURFACE COATINGS)	0.231	0.252	0.261	0.274	0.279
* TOTAL CLEANING AND SURFACE COATINGS	7.177	8.200	8.579	9.042	9.213
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
PETROLEUM PRODUCTION AND MARKETING					
OIL AND GAS PRODUCTION	1.289	1.127	1.055	0.987	0.965
PETROLEUM REFINING	0.000	0.000	0.000	0.000	0.000
PETROLEUM MARKETING	4.579	4.119	3.864	3.630	3.556
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.005	0.005	0.005	0.004	0.004
* TOTAL PETROLEUM PRODUCTION AND MARKETING	5.873	5.251	4.923	4.621	4.525
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
INDUSTRIAL PROCESSES					
CHEMICAL	0.620	0.782	0.862	0.951	0.982
FOOD AND AGRICULTURE	0.577	0.655	0.688	0.717	0.726
MINERAL PROCESSES	0.246	0.303	0.318	0.335	0.341
METAL PROCESSES	0.003	0.003	0.003	0.004	0.004
WOOD AND PAPER	0.713	0.773	0.773	0.776	0.780
ELECTRONICS	0.002	0.002	0.002	0.002	0.002
OTHER (INDUSTRIAL PROCESSES)	0.215	0.415	0.462	0.507	0.523
* TOTAL INDUSTRIAL PROCESSES	2.374	2.931	3.108	3.291	3.357
** TOTAL STATIONARY	22.322	22.289	22.693	23.270	23.490
AREAWIDE SOURCES					
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
SOLVENT EVAPORATION					
CONSUMER PRODUCTS	12.410	12.273	12.632	13.008	13.137
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	8.030	8.343	8.583	8.834	8.920
PESTICIDES/FERTILIZERS	1.157	1.223	1.214	1.205	1.203
ASPHALT PAVING / ROOFING	1.001	1.367	1.482	1.538	1.559
* TOTAL SOLVENT EVAPORATION	22.597	23.205	23.911	24.586	24.819
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
MISCELLANEOUS PROCESSES					
RESIDENTIAL FUEL COMBUSTION	2.029	2.088	2.135	2.183	2.199
FARMING OPERATIONS	2.875	2.875	2.875	2.875	2.875
CONSTRUCTION AND DEMOLITION	0.000	0.000	0.000	0.000	0.000
PAVED ROAD DUST	0.000	0.000	0.000	0.000	0.000
UNPAVED ROAD DUST	0.000	0.000	0.000	0.000	0.000
FUGITIVE WINDBLOWN DUST	0.000	0.000	0.000	0.000	0.000

FIRES	0.037	0.039	0.040	0.042	0.042
MANAGED BURNING AND DISPOSAL	0.818	0.807	0.803	0.801	0.801
COOKING	0.149	0.158	0.163	0.168	0.170
OTHER (MISCELLANEOUS PROCESSES)	0.000	0.000	0.000	0.000	0.000
* TOTAL MISCELLANEOUS PROCESSES	5.908	5.967	6.017	6.070	6.087
** TOTAL AREAWIDE	28.505	29.172	29.928	30.656	30.905
MOBILE SOURCES					
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
ON-ROAD MOTOR VEHICLES					
LIGHT DUTY PASSENGER (LDA)	12.128	6.044	4.676	3.960	3.809
LIGHT DUTY TRUCKS - 1 (LDT1)	3.844	1.820	1.327	1.032	0.959
LIGHT DUTY TRUCKS - 2 (LDT2)	5.054	3.249	2.745	2.474	2.406
MEDIUM DUTY TRUCKS (MDV)	4.399	3.446	2.911	2.469	2.362
LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDV1)	1.557	1.066	0.879	0.719	0.671
LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDV2)	0.151	0.090	0.064	0.045	0.041
MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)	0.589	0.160	0.111	0.083	0.077
HEAVY HEAVY DUTY GAS TRUCKS (HHDV)	0.205	0.033	0.015	0.011	0.010
LIGHT HEAVY DUTY DIESEL TRUCKS - 1 (LHDV1)	0.317	0.242	0.196	0.156	0.145
LIGHT HEAVY DUTY DIESEL TRUCKS - 2 (LHDV2)	0.076	0.059	0.049	0.042	0.040
MEDIUM HEAVY DUTY DIESEL TRUCKS (MHDV)	0.657	0.306	0.103	0.076	0.077
HEAVY HEAVY DUTY DIESEL TRUCKS (HHDV)	1.455	0.343	0.306	0.225	0.225
MOTORCYCLES (MCY)	2.790	2.530	2.488	2.439	2.422
HEAVY DUTY DIESEL URBAN BUSES (UB)	0.139	0.078	0.056	0.040	0.036
HEAVY DUTY GAS URBAN BUSES (UB)	0.054	0.036	0.028	0.023	0.020
SCHOOL BUSES - GAS (SBG)	0.043	0.007	0.006	0.005	0.005
SCHOOL BUSES - DIESEL (SBD)	0.026	0.005	0.004	0.004	0.004
OTHER BUSES - GAS (OBG)	0.046	0.029	0.024	0.019	0.019
OTHER BUSES - MOTOR COACH - DIESEL (OBC)	0.017	0.004	0.004	0.002	0.003
ALL OTHER BUSES - DIESEL (OBD)	0.026	0.004	0.003	0.002	0.002
MOTOR HOMES (MH)	0.058	0.026	0.016	0.011	0.009
* TOTAL ON-ROAD MOTOR VEHICLES	33.633	19.578	16.008	13.835	13.340
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
OTHER MOBILE SOURCES					
AIRCRAFT	0.483	0.500	0.514	0.526	0.531
TRAINS	0.378	0.330	0.302	0.276	0.266
OCEAN GOING VESSELS	0.003	0.004	0.004	0.004	0.004
COMMERCIAL HARBOR CRAFT	0.106	0.095	0.095	0.095	0.094
RECREATIONAL BOATS	11.722	8.619	7.330	6.181	5.833
OFF-ROAD RECREATIONAL VEHICLES	1.651	1.529	1.462	1.390	1.370
OFF-ROAD EQUIPMENT	7.955	6.305	6.095	6.012	5.991
FARM EQUIPMENT	1.686	1.223	1.047	0.916	0.880

FUEL STORAGE AND HANDLING	1.710	1.371	1.275	1.204	1.185
* TOTAL OTHER MOBILE SOURCES	25.692	19.976	18.123	16.604	16.153
** TOTAL MOBILE	59.325	39.554	34.132	30.439	29.493
GRAND TOTAL FOR SACRAMENTO NAA 2016 OZONE SIP VER. 1.04	**2012**	**2018**	**2021**	**2024**	**2025**
	110.152	91.015	86.753	84.364	83.888

Notes:

- Migration ID: 2016_SIP_V104_SAC
- AF Migration Table: AF_MASTERSP16SACOZ104

Report Run time: Started: 05/08/2017 15:22:11 ; Finished: 05/08/2017 15:22:19

Table A-4 2012, 2018, 2021, 2024, and 2025 NOX Inventory from CEPAM v1.04

CEPAM: External Adjustment Reporting Tool
Emission Projections by Summary Category

(Includes approved external emission adjustments)

Season: Summer
Oxides of Nitrogen
Base Year: 2012

PRELIMINARY DRAFT: SUBJECT TO CHANGE

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Sacramento NAA 2016 Ozone SIP Ver. 1.04

STATIONARY SOURCES					
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
FUEL COMBUSTION					
ELECTRIC UTILITIES	1.237	1.318	1.347	1.401	1.431
COGENERATION	0.008	0.010	0.010	0.011	0.011
OIL AND GAS PRODUCTION (COMBUSTION)	0.069	0.060	0.056	0.053	0.052
MANUFACTURING AND INDUSTRIAL	1.629	1.370	1.426	1.455	1.471
FOOD AND AGRICULTURAL PROCESSING	2.362	1.126	0.997	0.871	0.836
SERVICE AND COMMERCIAL	1.516	1.538	1.551	1.532	1.522
OTHER (FUEL COMBUSTION)	0.682	0.576	0.496	0.498	0.499
* TOTAL FUEL COMBUSTION	7.502	5.998	5.884	5.822	5.823
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
WASTE DISPOSAL					
SEWAGE TREATMENT	0.002	0.002	0.002	0.002	0.002
LANDFILLS	0.038	0.039	0.040	0.040	0.041
INCINERATORS	0.019	0.021	0.022	0.023	0.024
SOIL REMEDIATION	0.000	0.000	0.000	0.000	0.000
OTHER (WASTE DISPOSAL)	0.000	0.000	0.000	0.000	0.000
* TOTAL WASTE DISPOSAL	0.058	0.062	0.064	0.066	0.067
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
CLEANING AND SURFACE COATINGS					
LAUNDERING	0.000	0.000	0.000	0.000	0.000
DEGREASING	0.000	0.000	0.000	0.000	0.000
COATINGS AND RELATED PROCESS SOLVENTS	0.008	0.011	0.011	0.012	0.013
PRINTING	0.004	0.005	0.005	0.005	0.005
ADHESIVES AND SEALANTS	0.000	0.000	0.000	0.000	0.000

OTHER (CLEANING AND SURFACE COATINGS)	0.000	0.000	0.000	0.000	0.000
* TOTAL CLEANING AND SURFACE COATINGS	0.012	0.015	0.016	0.017	0.018
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
PETROLEUM PRODUCTION AND MARKETING					
OIL AND GAS PRODUCTION	0.001	0.001	0.001	0.001	0.001
PETROLEUM REFINING	0.000	0.000	0.000	0.000	0.000
PETROLEUM MARKETING	0.010	0.011	0.010	0.010	0.010
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.000	0.000	0.000	0.000	0.000
* TOTAL PETROLEUM PRODUCTION AND MARKETING	0.012	0.012	0.011	0.011	0.010
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
INDUSTRIAL PROCESSES					
CHEMICAL	0.115	0.144	0.158	0.175	0.180
FOOD AND AGRICULTURE	0.015	0.017	0.018	0.018	0.019
MINERAL PROCESSES	0.359	0.443	0.465	0.490	0.499
METAL PROCESSES	0.008	0.009	0.009	0.010	0.010
WOOD AND PAPER	0.041	0.045	0.045	0.045	0.045
ELECTRONICS	0.000	0.000	0.000	0.000	0.000
OTHER (INDUSTRIAL PROCESSES)	0.014	0.027	0.030	0.033	0.034
* TOTAL INDUSTRIAL PROCESSES	0.553	0.684	0.725	0.771	0.787
** TOTAL STATIONARY	8.137	6.771	6.700	6.686	6.705
AREAWIDE SOURCES					
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
SOLVENT EVAPORATION					
CONSUMER PRODUCTS	0.000	0.000	0.000	0.000	0.000
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	0.000	0.000	0.000	0.000	0.000
PESTICIDES/FERTILIZERS	0.000	0.000	0.000	0.000	0.000
ASPHALT PAVING / ROOFING	0.000	0.000	0.000	0.000	0.000
* TOTAL SOLVENT EVAPORATION	0.000	0.000	0.000	0.000	0.000
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
MISCELLANEOUS PROCESSES					
RESIDENTIAL FUEL COMBUSTION	2.389	1.974	1.851	1.847	1.844
FARMING OPERATIONS	0.000	0.000	0.000	0.000	0.000
CONSTRUCTION AND DEMOLITION	0.000	0.000	0.000	0.000	0.000
PAVED ROAD DUST	0.000	0.000	0.000	0.000	0.000
UNPAVED ROAD DUST	0.000	0.000	0.000	0.000	0.000
FUGITIVE WINDBLOWN DUST	0.000	0.000	0.000	0.000	0.000
FIRES	0.013	0.014	0.014	0.015	0.015
MANAGED BURNING AND DISPOSAL	0.300	0.291	0.288	0.286	0.286
COOKING	0.000	0.000	0.000	0.000	0.000
OTHER (MISCELLANEOUS PROCESSES)	0.000	0.000	0.000	0.000	0.000

* TOTAL MISCELLANEOUS PROCESSES	2.702	2.279	2.153	2.148	2.144
** TOTAL AREAWIDE	2.702	2.279	2.153	2.148	2.144
MOBILE SOURCES					
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
ON-ROAD MOTOR VEHICLES					
LIGHT DUTY PASSENGER (LDA)	6.505	3.311	2.438	1.897	1.764
LIGHT DUTY TRUCKS - 1 (LDT1)	1.653	0.687	0.449	0.311	0.278
LIGHT DUTY TRUCKS - 2 (LDT2)	4.184	2.169	1.577	1.213	1.120
MEDIUM DUTY TRUCKS (MDV)	4.695	2.671	1.861	1.292	1.158
LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDV1)	1.885	1.174	0.920	0.703	0.642
LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDV2)	0.203	0.127	0.097	0.072	0.065
MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)	0.564	0.281	0.194	0.134	0.120
HEAVY HEAVY DUTY GAS TRUCKS (HHDV)	0.192	0.077	0.060	0.054	0.053
LIGHT HEAVY DUTY DIESEL TRUCKS - 1 (LHDV1)	7.328	4.547	3.292	2.306	2.036
LIGHT HEAVY DUTY DIESEL TRUCKS - 2 (LHDV2)	1.654	0.918	0.610	0.381	0.320
MEDIUM HEAVY DUTY DIESEL TRUCKS (MHDV)	7.922	5.133	3.359	2.972	3.029
HEAVY HEAVY DUTY DIESEL TRUCKS (HHDV)	19.743	11.176	9.606	6.329	6.221
MOTORCYCLES (MCY)	0.535	0.480	0.465	0.455	0.453
HEAVY DUTY DIESEL URBAN BUSES (UB)	2.035	1.088	0.778	0.571	0.516
HEAVY DUTY GAS URBAN BUSES (UB)	0.110	0.082	0.067	0.056	0.052
SCHOOL BUSES - GAS (SBG)	0.042	0.012	0.009	0.007	0.006
SCHOOL BUSES - DIESEL (SBD)	0.357	0.306	0.257	0.209	0.194
OTHER BUSES - GAS (OBG)	0.122	0.071	0.053	0.040	0.038
OTHER BUSES - MOTOR COACH - DIESEL (OBC)	0.234	0.144	0.119	0.062	0.064
ALL OTHER BUSES - DIESEL (OBD)	0.311	0.141	0.108	0.061	0.062
MOTOR HOMES (MH)	0.273	0.170	0.124	0.089	0.081
* TOTAL ON-ROAD MOTOR VEHICLES	60.545	34.763	26.442	19.213	18.271
SUMMARY CATEGORY NAME	**2012**	**2018**	**2021**	**2024**	**2025**
OTHER MOBILE SOURCES					
AIRCRAFT	1.409	1.430	1.507	1.579	1.605
TRAINS	6.158	6.652	6.317	5.859	5.698
OCEAN GOING VESSELS	0.086	0.074	0.067	0.062	0.061
COMMERCIAL HARBOR CRAFT	1.453	0.979	0.921	0.876	0.866
RECREATIONAL BOATS	2.260	1.937	1.818	1.722	1.691
OFF-ROAD RECREATIONAL VEHICLES	0.046	0.057	0.063	0.068	0.069
OFF-ROAD EQUIPMENT	10.027	7.856	6.747	5.878	5.524
FARM EQUIPMENT	8.322	6.599	5.618	4.674	4.402
FUEL STORAGE AND HANDLING	0.000	0.000	0.000	0.000	0.000
* TOTAL OTHER MOBILE SOURCES	29.760	25.584	23.058	20.718	19.915
** TOTAL MOBILE	90.305	60.346	49.500	39.931	38.186

	2012	2018	2021	2024	2025
GRAND TOTAL FOR SACRAMENTO NAA 2016 OZONE SIP VER. 1.04	101.145	69.396	58.354	48.766	47.035

Notes:

- Migration ID: 2016_SIP_V104_SAC
- AF Migration Table: AF_MASTERSP16SACOZ104

Report Run time: Started: 05/08/2017 16:20:17 ; Finished: 05/08/2017 16:20:25

Appendix A-5 EMFAC2014 Output Data

Appendix A5 contains the on-road motor vehicle emissions, vehicle population, and activity data generated using EMFAC2014, and includes updated activity data for Solano County from MTC.

Workbook Name: Sacramento Non Attainment Area CEPAM V1.04 Emissions - May 10 2017

Worksheet Name	Worksheet Description
ReadME	Description of each spreadsheet
El Dorado (MC)	EMFAC output files for Mountain Counties Air Basin of El Dorado County, consistent with CEPAM V1.04
Placer (MC)	EMFAC output files for Mountain Counties Air Basin of Placer County, consistent with CEPAM V1.04
Placer (SV)	EMFAC output files for Sacramento Valley Air Basin of Placer County, consistent with CEPAM V1.04
Sacramento (SV)	EMFAC output files for Sacramento Valley Air Basin of Sacramento County, consistent with CEPAM V1.04
South Sutter	EMFAC output files for the South Sutter portion of Sacramento Valley Air Basin of Sutter County, consistent with CEPAM V1.04
Yolo (SV)	EMFAC output files Sacramento Valley Air Basin of Yolo County, consistent with CEPAM V1.04
Solano (SV)	EMFAC output files for Sacramento Valley Air Basin of Solano County, consistent with CEPAM V1.04

APPENDIX B

Photochemical Modeling

Appendix B Photochemical Modeling

The 2008 Ozone National Ambient Air Quality Standard (NAAQS) implementation rule (80 FR 12264) requires that an area classified as serious or higher to demonstrate attainment by means of a photochemical grid model or any other analytical method (40 CFR 51.1108).

Appendix B contains a summary and documentation regarding the photochemical grid modeling performed by the California Air Resources Board (CARB) in evaluating and supporting the attainment demonstration for the 2008 ozone NAAQS in the Sacramento Federal Nonattainment Area (SFNA). CARB prepared this appendix includes five sections:

1. summary of the modeling results,
2. conceptual modeling,
3. modeling protocol,
4. modeling attainment demonstration, and
5. modeling emissions inventory.

References

EPA. *Modeling and attainment demonstration requirements.* 40 CFR §51.1108.

EPA. (80 FR 12264 - 12319) *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule*. Federal Register, Volume 80, 6 March 2015, p. 12264 – 12319. Print.

This appendix included the following subsections:

Appendix	Supporting Document Title	Description
B-1	*Modeling 8-Hour Ozone for the Sacramento Federal Nonattainment Area's 2016 State Implementation Plan for the 75ppb 8-Hour Ozone Standard*	This provides a summary of the photochemical modeling results.
B-2	*Sacramento Federal Non-attainment Area (SFNA) 0.075 ppm 8-hour Ozone (2016)*	This appendix provides a description of the conceptual model for the SFNA
B-3	*Photochemical Modeling Protocol – Photochemical Modeling for the 8-Hour Ozone and Annual/24-hour $PM_{2.5}$ State Implementation Plans*	The modeling protocol includes the details and procedures for conducting the photochemical modeling that forms the basis of the attainment demonstration for the State Implementation Plans (SIPs) for California.
B-4	*Modeling Attainment Demonstration – Photochemical Modeling for the 8-Hour Ozone State Implementation Plan in the Sacramento Federal Non-attainment Area (SFNA)*	The modeling attainment demonstration document provides the details of the modeling results for the 2008 Ozone NAAQS in the SFNA, which forms the scientific basis for the attainment demonstration.
B-5	*Modeling Emission Inventory for the 8-Hour Ozone State Implementation Plan in the Sacramento Non-Attainment Area*	This document describes how the base and future year gridded photochemical modeling emissions inventory are prepared.

Appendix B-1 Modeling 8-Hour Ozone for the Sacramento Federal Nonattainment Area's 2016 SIP for the 75ppb 8-Hour Ozone Standard

Photochemical modeling plays a crucial role in the SIP process to demonstrate attainment of air quality standards based on estimated future emissions and for the development of emissions targets necessary for attainment. Currently, the SFNA is designated as a severe ozone non-attainment area for the 2008 0.075 ppm (or 75 ppb) 8-hour ozone standard and is required to demonstrate attainment of this standard by 2026. Consistent with U.S. EPA guidelines for model attainment demonstrations[1], photochemical modeling was used to estimate the future year 2026 ozone (O_3) design values (DVs) at each monitoring site in the SFNA in order to show attainment of the standard by 2026. An additional future year 2022 was also modeled to assess progress toward the 2026 attainment deadline.

The findings of the SFNA's model attainment demonstration are summarized below. Additional information and a detailed description of the procedures employed in this modeling are available in the Modeling Attainment Demonstration Appendix (Appendix B-4) and Modeling Protocol Appendix (Appendix B-3).

The current modeling platform draws on the products of large-scale, scientific studies in the region, collaboration among technical staff of state, local, and federal regulatory agencies, as well as from participation in technical and policy groups within the region (see Modeling Protocol (Appendix B-3) for further details). In this modeling work, the Weather Research and Forecasting (WRF) numerical model version 3.6 was utilized to generate meteorological fields, while the Community Multiscale Air Quality (CMAQ) Model version 5.0.2 was used for modeling ozone in the SFNA. Other relevant information, including the modeling domain definition, chemical mechanism, initial and boundary conditions, and emissions preparation can be found in the Modeling Protocol and Modeling Emissions Inventory Appendices (Appendix B-5).

Based on U.S. EPA modeling guidance[1], modeling was used in a relative sense to project observed DVs to the future. The year 2012 was chosen as the starting point for the modeling and reference (or baseline) DV calculation based on analysis regarding the conduciveness of recent years' meteorological conditions to enhanced ozone formation and the availability of the most detailed emissions inventory. These reference DVs serve as the anchor point for estimating future year projected design values. The year 2026 was the future year modeled in this attainment demonstration since that is the year for which attainment must be demonstrated. An additional future year (2022)

[1] U.S. EPA, 2014, Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$ and Regional Haze, available at https://www.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf

was also modeled to assess progress toward the attainment of the 75 ppb standard by the stipulated deadline (2026).

DVs are the three-year average of the annual 4th highest 8-hour O_3 mixing ratio observed at each monitor, and are used to determine compliance with the standard. In the attainment demonstration, the U.S. EPA recommends using an average of three DVs to account for the year-to-year variability in meteorology, so DVs were calculated for the three year period ending in 2012, 2013, and 2014 and then the three DVs were averaged. This average DV is called a baseline DV (see the 2nd column of Table 2 for the baseline DVs utilized in the attainment demonstration modeling).

In order to use the modeling in a relative sense, three simulations were conducted: 1) base year simulation for 2012, which was used to verify that the model reasonably reproduced the observed air quality; 2) reference year simulation for 2012, which was the same as the base year simulation, but excluded exceptional event emissions such as wildfires; 3) future year simulations for 2022 and 2026, which were the same as the reference year simulation, except that projected anthropogenic emissions for 2022 and 2026 were used in lieu of the 2012 emissions.

Table B-1 summarizes the 2012, 2022, and 2026 SFNA anthropogenic emissions used in the attainment demonstration modeling. Overall, anthropogenic NO_X was projected to decrease ~45% by 2022 (from 104 tpd to 56.8 tpd) and ~55% by 2026 (from 104 tpd to 47.3 tpd) when compared to the 2012 emissions levels. In contrast, anthropogenic ROG was projected to decrease ~23 % by 2022 (from 109.7 tpd to 84.7 tpd) and ~26 % by 2026 (from 109.8 tpd to 81.7 tpd). Biogenic ROG emissions were held constant between all simulations with summer average (May – September, 2012) emissions estimated at ~693 tpd for the SFNA.

Table B-1 Summer emission inventory totals (CEPAM v1.03) for 2012, 2022 and 2026. Biogenic emission totals were averaged over May – September, 2012.

Source Category	NO_X					ROG				
	2012	2022		2026		2012	2022		2026	
	[tpd]	[tpd]	% diff#	[tpd]	% diff#	[tpd]	[tpd]	% diff#	[tpd]	% diff#
Stationary	9.2	7.6	-17	7.6	-17	20.6	21.9	6	22.1	7
Area	2.7	2.1	-22	2.1	-22	28.5	29.5	4	30.4	7
On-Road Mobile	62	24.5	-60	17.7	-71	35	15.6	-55	13.3	-62
Other Mobile	30.1	22.6	-25	19.9	-34	25.7	17.7	-31	15.9	-38
Total	104	56.8	-45	47.3	-55	109.8	84.7	-23	81.7	-26
Biogenic			--			693		--	693	--

% diff denotes percent difference with respect to 2012 emission levels.

As part of the model attainment demonstration, the fractional changes in ozone mixing ratios between the model reference year (2012) and the two model future years (2022 and 2026) were calculated separately at each of the monitors following the U.S. EPA modeling guidance[2] and procedures outlined in the Modeling Protocol Appendix. These ratios, called "relative response factors" or RRFs, were calculated based on the ratio of future year modeled maximum daily average 8-hour (MDA8) ozone to modeled reference year MDA8 ozone (Equation 1).

$$RRF = \frac{\text{average MDA8 ozone}_{\text{future}}}{\text{average MDA8 ozone}_{\text{reference}}} \qquad (1)$$

The site-specific RRF for each of the future years 2022 and 2026 was then multiplied by the weighted DV for the corresponding monitor to predict the future year 2022 and 2026 DVs (Table 2). The RRF approach was previously applied in the 2009 Sacramento 8-Hour Ozone SIP[3] where the emission targets in SFNA were appropriately characterized for attaining the 1997 federal 8-hour ozone standard of 0.08 ppm (or 84 ppb) by 2018. The RRF approach has been applied in other regions of California's Central valley including the SJV for the 2007 8-hour Ozone SIP[4] and later in the 2013 1-hour Ozone SIP[5]. In addition, two peer-reviewed scientific publications focused primarily on areas outside of California (one from researchers at Rice University[6] and one from U.S. EPA scientists[7]), both found that the RRF approach is highly robust in its ability to predict future DVs.

Table B-2 shows that all monitoring sites in the SFNA are projected to have a future DV less than 75 ppb, so that the entire region is projected to attain the 75 ppb 8-hour O_3 standard by 2026 based on the substantial emission reductions from implementation of the current control program. The projected 2022 and 2026 DVs for sites in SFNA show a large decrease when compared to 2012 levels (e.g., at the Folsom monitor, the

2 U.S. EPA, 2014, Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$ and Regional Haze, available at https://www.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf

3 2009 Sacramento Regional 8-Hour Ozone Attainment and Reasonable Further Progress Plan, available at http://www.airquality.org/ProgramCoordination/Documents/4)%202013%20SIP%20Revision%20Report%201997%20Std.pdf

4 2007 Plan for the 1997 8-Hour Ozone Standard available at http://www.valleyair.org/Air_Quality_Plans/AQ_Final_Adopted_Ozone2007.htm

5 2013 Plan for the Revoked 1-Hour Ozone Standard available at http://www.valleyair.org/Air_Quality_Plans/Ozone-OneHourPlan-2013.htm

6 Pegues, A.H., D.S. Cohan, A. Digar, C. Douglass, and R.S. Wilson (2012). Efficacy of recent state implementation plans for 8-hour ozone. *Journal of the Air & Waste Management Association*, 62, 252-261, doi: 10.1080/10473289.2011.646049.

7 Foley. K., P. Dolwick, C. Hogrefe, H. Simon, B. Timin, and N. Possiel, (2015), Dynamic evaluation of CMAQ part II: Evaluation of relative response factor metrics for ozone attainment demonstrations, Atmospheric Environment, 103: 188–195, doi:10.1016/j.atmosenv.2014.12.039

SFNA's site with the highest baseline DV, the baseline DV declines by ~15 ppb in 2022 and ~20 ppb in 2026 compared to 2012), which is consistent with the peer-reviewed, published study conducted by the UC Berkeley researchers on the observed response of ozone to NO_X reductions in the Sacramento area[8]. This study concluded that the region's 1-hour ozone exceedance days have been decreasing linearly with decreases in NO_X suggesting that cumulative NO_X controls over time have successfully transitioned the SFNA into a NO_X-limited chemistry regime where NO_X emission reductions have been becoming increasingly effective at reducing ozone. This is also supported by the analysis on the changes in weekday vs. weekend ozone in the SFNA presented in the Modeling Protocol and Model Attainment Demonstration Appendices, where ozone on weekends is now generally lower than ozone on weekdays (in contrast to higher weekend ozone in the past), which indicates the prevalence of a NO_X-limited chemical regime in this region.

As part of the attainment demonstration, the U.S. EPA[9] also requires analysis of ozone levels outside of the routine monitoring network (i.e., at areas between the monitors) to ensure that all regions within the SFNA (even those without a monitor) are in attainment of the standard. This "unmonitored area" analysis combines measurement based DVs with model based RRFs and ozone spatial gradients to estimate future 2026 DVs in unmonitored areas. Details of how the unmonitored area analysis is performed can be found in the Modeling Protocol and Model Attainment Demonstration Appendices. The unmonitored area analysis in the SFNA showed that the areas with the highest future DVs were captured within the existing monitoring network and that all areas are projected to achieve the 75 ppb ozone standard.

8 LaFranchi, B. W., Goldstein, A. H., and Cohen, R. C.: Observations of the temperature dependent response of ozone to NO_X reductions in the Sacramento, CA urban plume, Atmos. Chem. Phys., 11, 6945-6960, doi:10.5194/acp-11-6945-2011, 2011

9 U.S. EPA, 2014, Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$ and Regional Haze, available at https://www.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf

Table B-2 Baseline Design Value, modeled RRF, and projected future year (2022 and 2026) Design Value for sites in the SFNA.

Site	Baseline 2012	Future year 2022		Future year 2026	
	Average DV (ppb)	RRF	Average DV (ppb)	RRF	Average DV (ppb)
Folsom-Natoma Street	90.0	0.8358	75	0.7857	70
Sloughhouse	84.0	0.8459	71	0.7998	67
Placerville-Gold Nugget Way	82.3	0.8259	68	0.7778	64
Roseville-N Sunrise Ave	82.3	0.8487	69	0.8055	66
Cool-Hwy193	81.3	0.8336	67	0.7882	64
Auburn - Atwood Rd	79.0	0.8180	64	0.7669	60
Sacramento-Del Paso Manor	77.3	0.8595	66	0.8162	63
North Highlands-Blackfoot Way	76.0	0.8578	65	0.8149	61
Colfax-City Hall	73.7	0.8270	60	0.7804	57
Elk Grove - Bruceville Road	71.7	0.8558	61	0.8129	58
Sacramento - 1309 T Street	70.0	0.8644	60	0.8242	57
Sacramento-Goldenland Court	70.0	0.8820	61	0.8415	58
Echo Summit	69.0	0.9411	64	0.9260	63
Woodland-Gibson Road	68.7	0.8459	58	0.7996	54
Vacaville-Ulatis Drive	67.3	0.8459	56	0.8009	53
Davis-UCD Campus	66.7	0.8495	56	0.8052	53

Appendix B-2 Modeling Conceptual Model

Document Title:

Sacramento Federal Non-attainment Area (SFNA) 0.075 ppm 8-hour Ozone (2016)

Document Description:

This document provides conceptual modeling for the SFNA. It includes the description of the history of ambient ozone field studies, ambient air monitoring network, ozone trends, and meteorological conditions that leading to SFNA ozone exceedances.

APPENDIX: Sacramento Federal Non-attainment Area (SFNA) 0.075 ppm 8-hour Ozone (2016)

Table of Contents

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

ACHEX - Aerosol Characterization Experiment

ARCTAS-CARB – California portion of the Arctic Research of the Composition of the Troposphere from Aircraft and Satellites conducted in 2008

BEARPEX – Biosphere Effects on Aerosols and Photochemistry Experiment in 2007 and 2009

CABERNET – California Airborne BVOC Emission Research in Natural Ecosystem Transects in 2011

CalNex – Research at the Nexus of Air Quality and Climate Change conducted in 2010

CARB – California Air Resources Board

CARES – Carbonaceous Aerosols and Radiative Effects Study in 2010

CCOS - Central California Ozone Study

CIRPAS - Center for Interdisciplinary Remotely-Piloted Aircraft Studies

CRPAQS - California Regional $PM_{10}/PM_{2.5}$ Air Quality Study

DISCOVER-AQ - Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality

DV – Design Value

IMS-95 – Integrated Monitoring Study of 1995

IONS – Intercontinental transport experiment Ozonesonde Network Study)

LIDAR – Light Detection And Ranging

MCAB – Mountain Counties Air Basin

MDA – Maximum Daily Average

NASA – National Aeronautics and Space Administration

NOAA - National Oceanic and Atmospheric Administration

NO_x – Oxides of nitrogen

PAMS – Photochemical Assessment Monitoring Stations

PAN – Peroxy Acetyl Nitrate

$PM_{2.5}$ – Particulate Matter with aerodynamic diameter less than 2.5 micrometers

PM_{10} – Particulate Matter with aerodynamic diameter less than 10 micrometers

ROG – Reactive Organic Gases

SAOS – Sacramento Area Ozone Study

SARMAP – SJVAQS/AUSPEX Regional Modeling Adaptation Project

SFNA – Sacramento Federal Non-attainment Area

SIP – State Implementation Plan

SJV – San Joaquin Valley

SJVAB – San Joaquin Valley Air Basin (SJVAB)

SJVAQS/AUSPEX – San Joaquin Valley Air Quality Study/Atmospheric Utilities Signatures Predictions and Experiments

SVAB – Sacramento Valley Air Basin (SJVAB)

SOA – Secondary Organic Aerosol

SoCAB – Southern California Air Basin

U.S. EPA – United States Environmental Protection Agency

VOC – Volatile Organic Compounds

WRF Model – Weather and Research Forecast Model

1. TIMELINE OF THE PLAN

Table 1-1 Timeline for Completion of the Plan

Timeline	Action
Spring 2016	Emission Inventory Completed
Summer 2016	Modeling Completed
March/April 2017	Sacramento Federal Non-attainment Area (SFNA) Governing Board Hearing to consider the Draft Plan
May 2017	ARB Board Hearing to consider the Sacramento Federal Non-attainment Area Adopted Plan
June 2017	Plan submitted to U.S. EPA

2. DESCRIPTION OF THE CONCEPTUAL MODEL FOR THE NONATTAINMENT AREA

2.1 History of Field Studies in the Region

The Sacramento Federal 8–hour ozone Non-attainment Area (SFNA) is located in the northern part of California's Central Valley (Figure 2–1), which is a 500-mile long northwest-southeast oriented valley encompassing two of the worst polluted air basins in the nation, the San Joaquin Valley and Sacramento Valley air basins. As a result, California's Central Valley is one of the most studied regions in the world, in terms of the number of publications in peer-reviewed international scientific/technical journals and other major reports. The Major Field studies that have taken place in California's Central Valley and surrounding areas are listed in Table 2-1.

The first major air quality study in the Central Valley, dubbed Project Lo-Jet, took place in 1970 and resulted in the identification of the San Joaquin Valley "Fresno" Eddy and the Sacramento "Schultz" Eddy (Lin and Jao, 1995 and references therein). The first study in the Sacramento region that formed the foundation for a State Implementation Plan (SIP) was the Sacramento Area Ozone Study (SAOS) conducted in July–August, 1990 (Roberts et al., 1990). The timing of the SAOS coincided with the San Joaquin Valley Air Quality Study/Atmospheric Utilities Signatures Predictions and Experiments (SJVAQS/AUSPEX) study, also known as SARMAP (SJVAQS/AUSPEX Regional Modeling Adaptation Project). The 1990 SAOS study was part of the technical basis for the 1-hour Extreme Ozone Attainment Demonstration Plan that was submitted to the U.S. EPA in 1994 (https://www.arb.ca.gov/planning/sip/94sip/94sip.htm) and was approved in 1997 (62 FR 1150). The next major study was the Integrated Monitoring Study in 1995 (IMS-95), which was the pilot study for the subsequent California Regional PM_{10}/$PM_{2.5}$ Air Quality Study (CRPAQS) in 2000 (Solomon and Magliano, 1998). CRPAQS was the first annual field campaign in the Central Valley, and embedded in it was the Central California Ozone Study (CCOS) that took place during the summer of 2000 (Fujita et al., 2001). The CCOS was part of the technical basis for the 2009 Sacramento Regional 8-Hour Ozone Attainment and Reasonable Further Progress Plan for attaining the 1997 federal 8-hour ozone standard of 0.08 ppm, which was approved by EPA in 2014 (79 FR 61799). While CCOS is still very relevant to the current 8-hour O_3 SIP, there are five subsequent studies which are highly relevant to ozone formation in the Central Valley and surrounding regions: 1) ARCTAS-CARB 2008, 2) CalNex 2010, 3) CARES 2010, 4) BEARPEX 2007 & 2009, and 5) CABERNET 2011. Each of these studies has contributed significantly to our understanding of various atmospheric processes in the Central Valley including the SFNA region.

The ARCTAS-CARB aircraft field campaign, a joint research effort by NASA and CARB, took place from June 18 to 24, 2008 with specific objectives to improve the emission inventories of greenhouse gases/aerosols and characterize upwind boundary conditions for modeling surface ozone and $PM_{2.5}$. During the ARCTAS campaign, large wildfires occurred in California, particularly in northern California. The DC-8 aircraft encountered many of the fire plumes, which helped improve the characterization of California wildfires and their chemical composition. The ARCTAS-CARB campaign provided a unique dataset for evaluating the impacts of wildfires on ozone levels through photochemical modeling studies and for evaluating the distribution of reactive nitrogen species in California (Huang et al., 2011; Cai et al., 2016).

The improved understanding of California wildfires is valuable not only from a regulatory modeling standpoint, but it can also provide helpful information relevant to the U.S. EPA's Exceptional Events Rule (72 FR 13560). For instance, the U.S. EPA approved the SFNA's request to classify 1-hour ozone exceedances for June 23, June 27 and July 10 in 2008 as Exceptional Events that were caused by wildfires prevalent in the region from June 21, 2008 through August 11, 2008 (https://www.arb.ca.gov/desig/excevents/2008wildfires.htm). The exclusion of these 1-hour ozone exceedance days subsequently lead to a "clean data determination" in SFNA for the revoked 1-hour ozone NAAQS based on 2007-2009 ozone monitoring data (77 FR 64036).

The CalNex May-July 2010 field campaign was organized by NOAA (NOAA, 2014) and CARB. The focus of this field study included airborne measurements using the NOAA WP-3D aircraft and the Twin Otter Remote Sensing aircraft, and surface measurements using the R/V *Atlantis* mobile platform as well as two stationary ground supersites. Overall, the CalNex study provided a comprehensive snapshot of air quality in California and indicated remarkable improvement in air quality over the past few decades. The CalNex data analysis helped in improving emissions estimates from various sources in California, including emissions from rice cultivation in the Sacramento Valley. In addition, analysis of the data collected during CalNex has shown that photochemical ozone production in the southern and central portions of the SJV have transitioned to a NO_x-limited chemistry regime, where further NO_x reductions are expected to lead to a more rapid reduction in ozone than was observed over the past decade or more, while the northern portion of the SJV (to the south of the SFNA) is transitioning to a NO_x-limited regime (Pusede and Cohen, 2012). Studies have also shown that there is evidence for an unidentified temperature-dependent VOC emissions source on the hottest days (Pusede and Cohen, 2012; Pusede et al., 2014) and large sources of hydrocarbon compounds from petroleum extraction/processing, dairy (and other cattle) operations, and agricultural crops in the SJV (Gentner et al., 2014a,b).

The CARES field campaign coincided with CalNex, and took place to the northeast of Sacramento in June 2010. Comprehensive data sets of trace gases and aerosols were taken from the daily evolving Sacramento urban plume under relatively well-defined and regular meteorological conditions using multiple suites of ground-based and airborne instruments onboard the Gulfstream (G-1) research aircraft. The ground-based measurements were conducted at two sites: one within the Sacramento urban source area and the other in a downwind area about 70 km to the northeast in Cool, CA. A combination of measurements and model data during CARES (Fast et al., 2012) shows that emissions from the San Francisco Bay area transported by intrusions of marine air contributed a large fraction of the carbon monoxide in the vicinity of Sacramento. The study also showed that mountain venting processes contributed to aged pollutants aloft in the valley atmosphere, which can then be entrained into the growing boundary layer the following day. Overall, the CARES campaign helped in improving the current scientific understanding of the interaction between urban emissions and downwind biogenic sources in the Sacramento region.

BEARPEX was conducted at the University of California's Blodgett Forest Research Station during June-July 2007 and September-October 2009. Blodgett Forest is located 65 miles northeast of Sacramento. The project was designed to study chemistry downwind of urban areas where there is high VOC reactivity (due to biogenic emissions sources) and low NO_x, to understand the full oxidation sequence and subsequent fate of biogenic VOC and the processes leading to formation and removal of biogenic secondary organic aerosol (SOA) and the associated chemical and optical properties of SOA. A study by Bouvier-Brown et al., (2009) suggests that reactive and semi-volatile compounds, especially sesquiterpenes, significantly impact the gas- and particle-phase chemistry of the atmosphere at Blodgett Forest. An analysis of absolute PANs mixing ratios by Lafranchi et al. (2009) reveals a missing PANs sink that can be resolved by increasing the peroxy acetyl radicals + RO2 rate constant by a factor of 3. At the BEARPEX field site, the sum of the individual biogenically derived nitrates account for two-thirds of the organic nitrate, confirming the importance of biogenic nitrates to the NO_y budget (Beaver et al., 2012).

The CABERNET field campaign was conducted during June 2011 in California. The objectives were to develop and evaluate new approaches for regional scale measurements of biogenic VOC emissions, quantify the response of biogenic VOC emissions to land cover change, investigate the vertical transport of isoprene and oxidation products, and evaluate biogenic emission models. Isoprene fluxes were measured on board the Center for Interdisciplinary Remotely-Piloted Aircraft Studies (CIRPAS) Twin Otter (http://www.cirpas.org/twinOtter.html) using the virtual disjunct eddy covariance method (Karl et al. 2012). Isoprene flux measurements from

CABERNET have formed the basis for evaluating the biogenic emissions inventory used in California's SIP modeling (Misztal et al., 2016).

Table 2-1. Major Field Studies in Central California and surrounding areas.

Year	Study	Significance
1970	Project Lo-Jet	Identified summertime low-level jet and Fresno eddy
1972	Aerosol Characterization Experiment (ACHEX)	First TSP chemical composition and size distributions
1979-1980	Inhalable Particulate Network	First long-term PM2.5 and PM10 mass and elemental measurements in Bay Area, Five Points
1978	Central California Aerosol and Meteorological Study	Seasonal TSP elemental composition, seasonal transport patterns
1979-1982	Westside Operators	First TSP sulfate and nitrate compositions in western Kern County
1984	Southern SJV Ozone Study	First major characterization of O3 and meteorology in Kern County
1986-1988	California Source Characterization Study	Quantified chemical composition of source emissions
1988-1989	Valley Air Quality Study	First spatially diverse, chemical characterized, annual and 24-hour PM2.5 and PM10
July and August 1990	Sacramento Area Ozone Study	Intensive ozone measurements in the Sacramento Area
Summer 1990	San Joaquin Valley Air Quality Study/Atmospheric Utilities Signatures Predictions and Experiments (SJVAQS/AUSPEX) –	First central California regional study of O3 and PM2.5

11

	Also known as SARMAP (SJVAQS/AUSPEX Regional Modeling Adaptation Project)	
July – September 1990	Upper Sacramento Valley Transport Study	Measurements to study the transport of pollutants from the lower to upper Sacramento Valley
July and August 1991	California Ozone Deposition Experiment	Measurements of dry deposition velocities of O3 using the eddy correlation technique made over a cotton field and senescent grass near Fresno
Winter 1995	Integrated Monitoring Study (IMS-95, the CRPAQS Pilot Study)	First sub-regional winter study
December 1999–February 2001	California Regional PM10/PM2.5 Air Quality Study (CRPAQS) and Central California Ozone Study	First year-long, regional-scale effort to measure both O_3 and $PM_{2.5}$
December 1999 to present	Fresno Supersite	First multi-year experiment with advanced monitoring technology
July 2003	NASA high-resolution lidar flights	First high-resolution airborne lidar application in SJV in the summer
February 2007	U.S. EPA Advanced Monitoring Initiative	First high-resolution airborne lidar application in SJV in the winter
August-October 2007; June-July 2009	BEARPEX (Biosphere Effects on Aerosols and Photochemistry Experiment)	Research-grade measurements to study the interaction of the Sacramento urban plume with downwind biogenic emissions
June 2008	ARCTAS - CARB	First measurement of high-time resolution (1-10s) measurements of organics and free radicals in SJV
May-July 2010	CalNex 2010 (Research at the Nexus of Air Quality and Climate Change)	Expansion of ARCTAS-CARB type research-grade measurements to multi-platform and expanded geographical area including the ocean.

June 2010	CARES (Carbonaceous Aerosols and Radiative Effects Study)	Research-grade measurements of trace gases and aerosols within the Sacramento urban plume to investigate SOA formation
May – June 2010	IONS (Intercontinental transport experiment Ozonesonde Network Study)	Daily Ozonesonde measurements from four coastal and two inland sites in California to improve the characterization of western U.S. baseline ozone
June 2011	CABERNET (California Airborne BVOC Emission Research in Natural Ecosystem Transects)	Provided the first ever airborne flux measurements of isoprene in California
January-February 2013	DISCOVER-AQ (Deriving Information of Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality)	Research-grade measurements of trace gases and aerosols during two $PM_{2.5}$ pollution episodes in the SJV

2.2 Description of the Ambient Monitoring Network

The SFNA is located in the northern half of the California's Central Valley, which is a 500-mile long northwest-southeast oriented valley comprising the Sacramento Valley (SV) and the San Joaquin Valley (SJV) air basins (left panel of Figure 2–1). The SFNA is home to more than 2 million residents encompassing an area of 5600 square miles and is geographically located in two different air basins including the southern portion of the Sacramento Valley Air Basin (SVAB) and the northern central portion of the Mountain Counties Air Basin (MCAB) (right panel of Figure 2–1). The SFNA area occupies the southern portion of the Sacramento Valley, extending to the inland side of the California Coastal Range on the westernmost edge, and continues to the border of the Lake Tahoe air basin to the east, encompassing portions of the Sierra Nevada Mountain Range. It extends southward to the Sacramento Delta Region and northward to include the southern portion of Sutter County. In total, the SFNA comprises all of Sacramento and Yolo counties, the eastern portion of Solano County, the southern portion of Sutter County, and the portions of El Dorado and Placer counties that are not part of the Lake Tahoe Air Basin.

Due to its inland location, the climate of the Sacramento region is more extreme than that of most coastal regions, such as the San Francisco Bay Area. The winters are generally cool and wet, while the summers are hot and dry and both seasons can experience periods of high pressure and stagnation which are conducive to pollutant buildup. These climate conditions result in seasonal patterns where ozone levels are highest during the summer, while $PM_{2.5}$ concentrations are highest during the winter. The lack of summertime precipitation, coupled with the large extent of forested land surrounding the Central Valley, also creates conditions highly conducive to wildfires during the summer months.

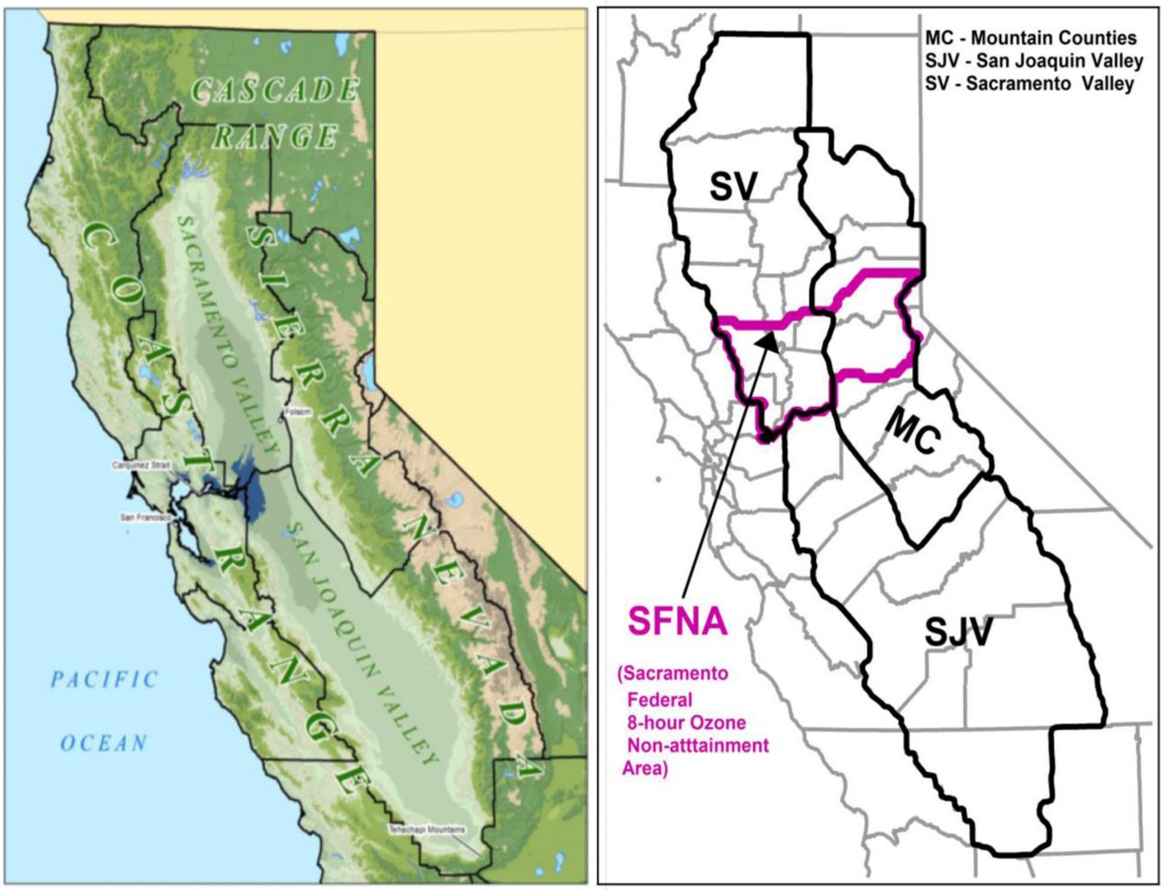

Figure 2-1 Map of California's Central Valley and the geographical location of Sacramento Federal 8-hr Ozone Non-attainment Area (SFNA).

The worst ozone air quality in the SFNA typically occurs during summer months, where the interaction between geography, climate, and a mix of natural (biogenic) and anthropogenic emissions pose significant challenges to air quality progress. A combination of stable wind fields and recirculation patterns generated by daytime upslope and nighttime downslope flows from the mountains located to the west (Coast Range) and east (Sierra Nevada), tend to confine and trap emissions and the pollutants near the surface (See section 2.4 for details on meteorological conditions conducive to ozone production in SFNA). The anthropogenic NO_x and ROG emissions from the urban Sacramento area and biogenic ROG emissions from the Sierra foothills coupled with the hot and dry summertime weather conditions facilitate rapid ozone production in the region. During ozone episodes within the Sacramento Metro area, the most important transport pattern is toward the northeast and the foothills within the Sacramento area itself. Due to the general daytime flow pattern from west to east, as well as the time needed for photochemical processes to occur, the highest ozone mixing ratios in the Sacramento region generally occur in the afternoon in the downwind, eastern portion of the region, near Folsom.

LaFranchi et al. (2011), and the references therein, characterized the production and evolution of ozone in the Sacramento region as a Lagrangian air parcel that produces peak ozone levels downwind of the urban city center in the eastern portion of the region (e.g., Folsom). Due to a prevailing northeast wind flow in the region (U.S. EPA, 2012), the ozone plume is diluted as it migrates farther away from the urban core and downwind into the Sierra foothills (located to the east/northeast). The transport of ozone precursor emissions from the urban Sacramento area dominates the ozone production in the downwind Sierra foothill area, where ozone levels are heavily dependent upon the proximity to the upwind urban source. When compared to the location of peak ozone production shortly downwind from the urban Sacramento area, the ozone levels are relatively lower in the downwind foothills area due to its farther proximity from the upwind anthropogenic NO_x sources.

The air quality planning in the SFNA is led by the Sacramento Metro Air Quality Management District (www.AirQuality.org). Four other air districts also participate in air planning and management in the area. The Yolo-Solano Air Quality Management District (AQMD) (www.ysaqmd.org) has jurisdiction over Yolo County and the SFNA portion of Solano County. Feather River AQMD (www.fraqmd.org) has jurisdiction over Sutter and Yuba counties, including the south Sutter County portion of the SFNA. Placer County Air Pollution Control District (APCD) (www.placer.ca.gov/apcd) has jurisdiction over Placer County, as El Dorado County AQMD (www.edcgov.us/AirQualityManagement) does over its county. These five air districts along with the California Air Resources Board (CARB) operate an extensive network of air quality monitors throughout the region to help improve and protect public health. The data collected from the SFNA regional air monitoring network is used to generate daily air quality forecasts, issue health advisories as needed, support compliance with various ambient air quality standards and serves as the basis for developing long-term attainment strategies and tracking progress toward attainment of health-based air quality standards.

Figure 2-2 shows the spatial distribution of the ozone, NO_x, and PAMS (Photochemical Assessment Monitoring Stations) monitors in the SFNA (see Table 2-2 for longitude/latitude information for each monitor). There are a total of 17 monitoring sites in the region, which are strategically located to capture pollutants within the densely populated urban Sacramento metropolitan area, as well as downwind regions to measure the transport of the Sacramento urban plume to downwind sites in the foothills of eastern Sacramento, Placer, and El Dorado Counties. Finally, the network is able to provide important information on the spatial variability of pollutants, population exposure, and pollutant transport into the Sacramento area from the west/southwest and thus has been shown to sufficiently capture the highest ozone mixing ratios and the corresponding precursors under various weather conditions. A detailed discussion about the monitoring network and its adequacy can be found in the 2015 Air Monitoring Network and Assessment Plans for Sacramento (http://www.airquality.org/air-quality-health/air-monitoring) and other air districts that are part of the SFNA (https://www.arb.ca.gov/aqd/amnr/amnr.htm).

For purposes of model evaluation and analysis, the SFNA is divided into three sub regions that are characterized by distinct geography, meteorology, emissions characteristics, transport patterns, and air quality: 1) Western SFNA comprising Yolo, Solano and the southwest portion of Sacramento counties, which lies upwind of the Sacramento urban emission source and is impacted by pollutant transport from the surrounding Bay Area and SJV located on the west/southwest, 2) Central SFNA including the inland urban core, and the metropolitan areas of Sacramento county and the westernmost portion of Placer county, and 3) Eastern SFNA comprising Placer and El Dorado counties in the Sierra Nevada foothills area that is located downwind of urban Sacramento. The geographical extent of the sub-regions in SFNA and their approximate regional boundaries are shown in the bottom panel of Figure 2-2.

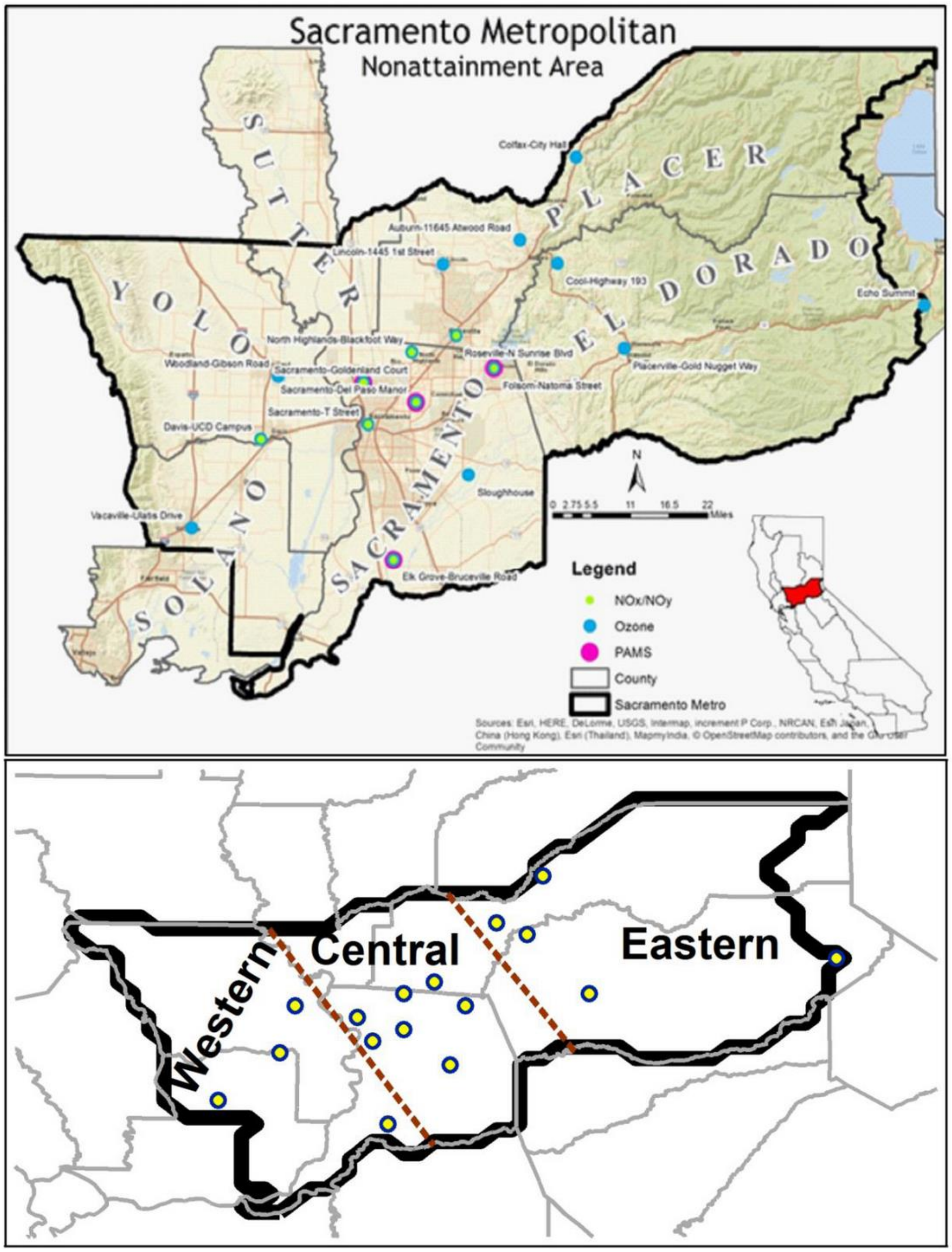

Figure 2-2. Map of the Monitoring Sites in the Sacramento Federal 8-hour Ozone Non-attainment Area. The green, blue and magenta circle markers denote the location of NO_x/NO_y, ozone and PAMS monitors (top panel). The solid black line denotes the regional boundary of the SFNA, while the grey line denotes the county boundaries. The dashed brown lines (bottom panel) show the approximate regional boundaries of the Western, Central and Eastern sub-regions of SFNA.

17

Table 2-2. Ozone, NO_x, and PAMS monitoring sites between 2012 and 2015 in the Sacramento Federal 8-hour ozone Non-attainment Area

Site ID (AQS/ARB)	Sub Region	Site (County, Air Basin)	NO_x	Ozone	PAMS	Latitude	Longitude
060170020 3196	Eastern SFNA	Cool-Hwy193 (El Dorado, MCAB)		X		38.892	-121.002
060170010 3017	Eastern SFNA	Placerville-Gold Nugget Way (El Dorado, MCAB)		X		38.725	-120.822
060170012 3487	Eastern SFNA	Echo Summit (El Dorado,MCAB)		X		38.812	-120.033
060610003 3789	Eastern SFNA	Auburn - Atwood Rd (Placer, SVAB)		X		38.936	-121.1
060610004 3002	Eastern SFNA	Colfax-City Hall (Placer, MCAB)		X		39.1	-120.954
060612002 3796*	Central SFNA	Lincoln - 1445 1st St[1] (Placer, SVAB)		X		38.886	-121.302
060610006 2956	Central SFNA	Roseville- N Sunrise Ave (Placer, SVAB)	X	X		38.746	-121.265
060670012 3187	Central SFNA	Folsom-Natoma Street (Sacramento, SVAB)	X	X	X	38.683	-121.164
060670002 2123	Central SFNA	North Highlands- Blackfoot Way (Sacramento, SVAB)	X	X		38.712	-121.381
060670006 2731	Central SFNA	Sacramento- Del Paso Manor (Sacramento, SVAB)	X	X		38.614	-121.368
060670014 3738	Central SFNA	Sacramento-Goldenland Court (Sacramento, SVAB)	X	X	X	38.651	-121.507
060670010 3011	Central SFNA	Sacramento – 1309 T Street (Sacramento, SVAB)	X	X	X	38.568	-121.493
060675003 3209	Central SFNA	Sloughhouse (Sacramento, SVAB)		X		38.495	-121.211
060670011 2977	Western SFNA	Elk Grove - Bruceville Road (Sacramento, SVAB)	X	X	X	38.303	-121.421
060953003 3678	Western SFNA	Vacaville-Ulatis Drive (Solano, SVAB)		X		38.357	-121.95
061130004 2143	Western SFNA	Davis-UCD Campus (Yolo, SVAB)	X	X		38.535	-121.774
061131003 3249	Western SFNA	Woodland-Gibson Road (Yolo, SVAB)		X		38.661	-121.731

[1] As the Lincoln site in Placer County became operational in October 2012, the measurements were not available for calculating 8-hr ozone design values in 2012 and 2013. Hence this site was excluded from the current SIP attainment demonstration.

2.3 Ozone Trends and Sensitivity to Emissions Reductions

The Sacramento Federal Non-attainment Area (SFNA) is one of the most severely polluted air basins in the U.S., and is designated as a severe ozone nonattainment area for the U.S. EPA 2008 0.075 ppm 8-hour ozone standard. Anthropogenic sources of oxides of nitrogen (NO_x) and reactive organic gases (ROG), along with natural biogenic ROG emissions, are the major precursors that lead to ozone formation in the region. The SFNA's anthropogenic emissions inventory is dominated by emissions from the urbanized areas in Sacramento, Yolo, Solano and Placer counties, while the biogenic ROG emissions in the Sierra foothills and Coast Range are the primary contributors to natural emissions in the region. Since the 1980's, the region's emission control program has substantially reduced emissions of both anthropogenic NO_x and ROG throughout the region (https://www.arb.ca.gov/aqd/almanac/almanac.htm). As the control program has led to changes in the relative levels of NO_x and ROG over time, it has also adapted so as to reduce ozone levels as expeditiously as possible. This adaptation within the control program is necessary because ozone formation responds differently to NO_x and ROG controls as the relative level of each pollutant in the atmosphere changes (see Figure 2-3).

Specifically, ozone formation exhibits a nonlinear dependence on NO_x and ROG precursors in the atmosphere. In general terms, under ambient conditions of high-NO_x and low-ROG (NO_x-disbenefit region in Figure 2-3), ozone formation tends to exhibit a disbenefit to reductions in NO_x emissions (i.e., ozone increases with decreases in NO_x) and a benefit to reductions in ROG emissions (i.e., ozone decreases with decreases in ROG). In contrast, under ambient conditions of low-NO_x and high-ROG (NO_x-limited region in Figure 2-3), ozone formation shows a benefit to reductions in NOx emissions, while changes in ROG emissions result in only minor decreases in ozone. These two distinct "ozone chemical regimes" are illustrated in Figure 2-3 along with a transitional regime that can exhibit characteristics of both the NO_x-disbenefit and NO_x-limited regimes. Note that Figure 2-3 is shown for illustrative purposes only, and does not represent the actual ozone sensitivity within the SFNA for a given combination of NO_x and VOC (ROG) emissions.

During the 1980's in the SFNA, ROG emission controls outpaced NO_x controls as the ROG emissions were high relative to NO_x. During the 1990's, emission controls slowly shifted to a more balanced approach between ROG and NO_x, and by the 2000's NO_x reductions began to outpace ROG reductions. For much of the 1980's through the mid-2000's, the SFNA was in a NO_x-disbenefit or transitional chemical regime and it's only been within the past decade (mid- to late-2000's) where this region began transitioning to a NO_x-limited chemical regime. This transition from a NO_x -disbenefit to a NO_x -limited chemical regime can be analyzed through the year-to-year variability in biogenic

ROG emissions, which during the summer ozone season can be many times greater than anthropogenic ROG emissions in the SFNA, as well as through the so called "weekend effect" which shows an increase in ozone on the weekend under NO_x-disbenefit conditions (and a decrease under NO_x-limited conditions).

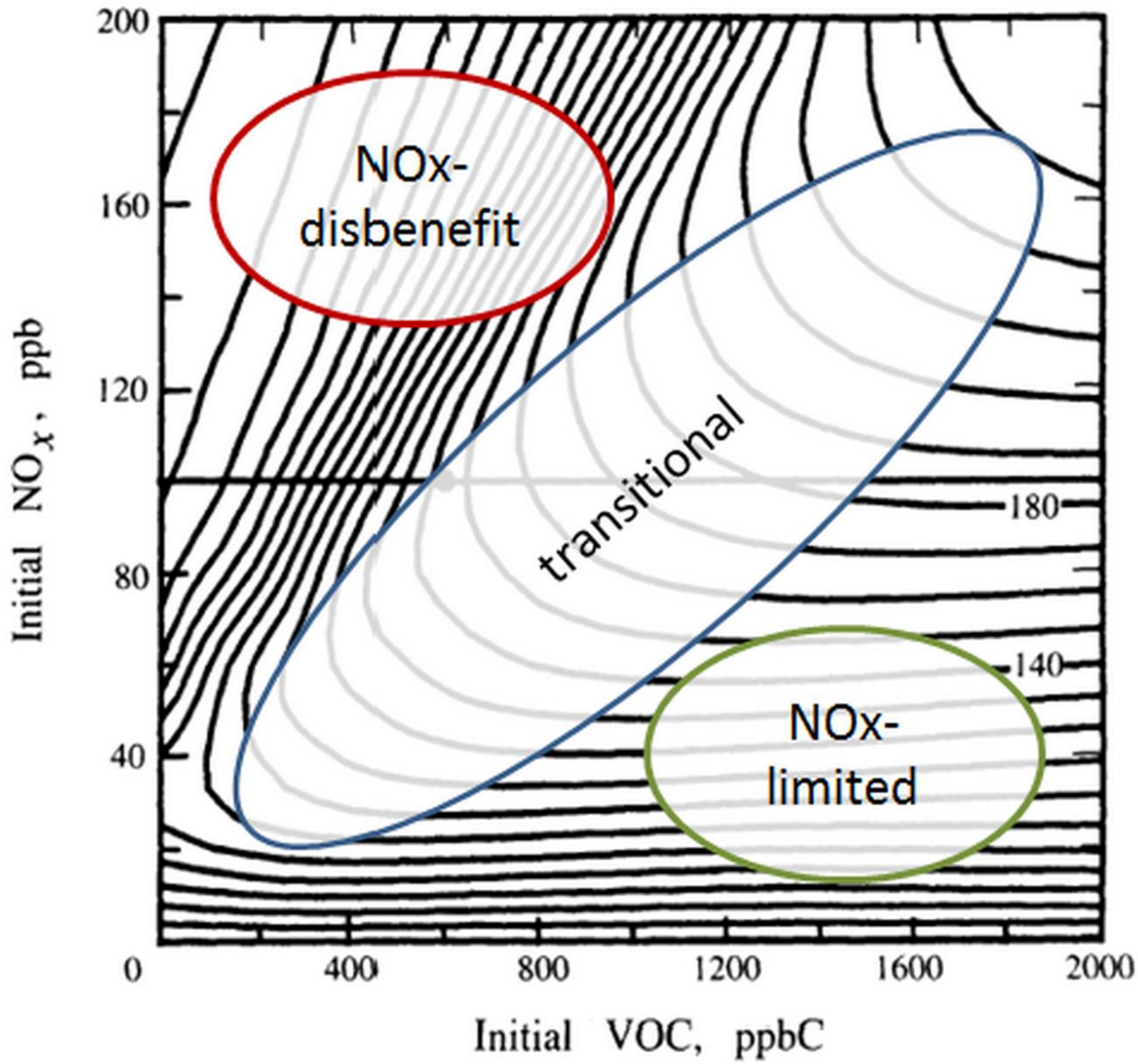

Figure 2-3. Illustrates a typical ozone isopleth plot, where each line represents ozone mixing ratio, in 10 ppb increments, as a function of initial NO_x and VOC (or ROG) mixing ratio (adapted from Seinfeld and Pandis, 1998, Figure 5.15). General chemical regimes for ozone formation are shown as NO_x-disbenefit (red circle), transitional (blue circle), and NO_x-limited (green circle).

Area-wide summer emission trends from 2000 to 2014 for the SFNA are shown in Figure 2-4 (top) for anthropogenic NO_x and ROG, as well as biogenic ROG (biogenic

20

trends are for 2001 to 2014). Figure 2-4 clearly shows large decreases in both anthropogenic NO_x (from 184 tpd to 91 tpd) and ROG (from 173 tpd to 101 tpd) emissions from 2000 to 2012. Over the same time period, biogenic ROG emissions exhibited large year-to-year variability, ranging from ~666 tpd in 2005 to ~1027 tpd and ~ 950 tpd in 2006 and 2010, respectively. Even at its lowest levels, biogenic ROG is estimated to be five times as high as the anthropogenic ROG inventory (in 2005) and upwards of eight times as high during peak biogenic years.

Over the same 2000 to 2014 time period, the ozone design value and days above the ozone standard (exceedance days) within the SFNA declined steadily (Figure 2-4 middle and bottom, respectively), but also exhibited a fair amount of variability due to year-to-year variability in meteorology and the associated changes in biogenic emissions. Overall, the area-wide design values declined by ~ 20 ppb from 107 ppb in 2000 to 85 ppb in 2014. However, these DVs are still substantially higher than the 2008 8-hour ozone standard of 75 ppb.

Since the area-wide DV is focused on the highest ozone values and the location of these peaks can change from year-to-year, the exceedance days, a measure of overall air quality and the frequency of ozone exposure, may be a better metric for evaluating changes in ozone chemistry when viewed in the context of changing biogenic ROG emissions. Exceedance days in the SFNA have substantially decreased over time from 61 in 2000 to 29 in 2014 (~52% lower with respect to 2000) indicating significant improvements in ozone air quality across the entire region. The decline in weekend exceedance days was slightly higher (56% decrease from 16 to 7) than the corresponding decline in weekday exceedance days (~51% decrease from 45 to 22) between the years 2000 and 2014.

Comparing the year-to-year variability in exceedance days to similar variability in the biogenic ROG emissions, shows that from 2001-2007 the two were strongly correlated (i.e., when biogenic ROG emissions increased, so did the number of exceedance days). This is consistent with the SFNA region being primarily in a NO_x-disbenefit regime, where increases in ROG emissions result in enhanced ozone formation. From 2008 onwards, this correlation no longer exists and the two are actually anti-correlated for all years except 2009. Although other factors beyond chemistry, such as meteorology, play a large role in the year-to-year variability in ozone, this is suggestive of a shift from a NO_x-disbenefit regime to a transitional or NO_x-limited regime around the 2008 timeframe.

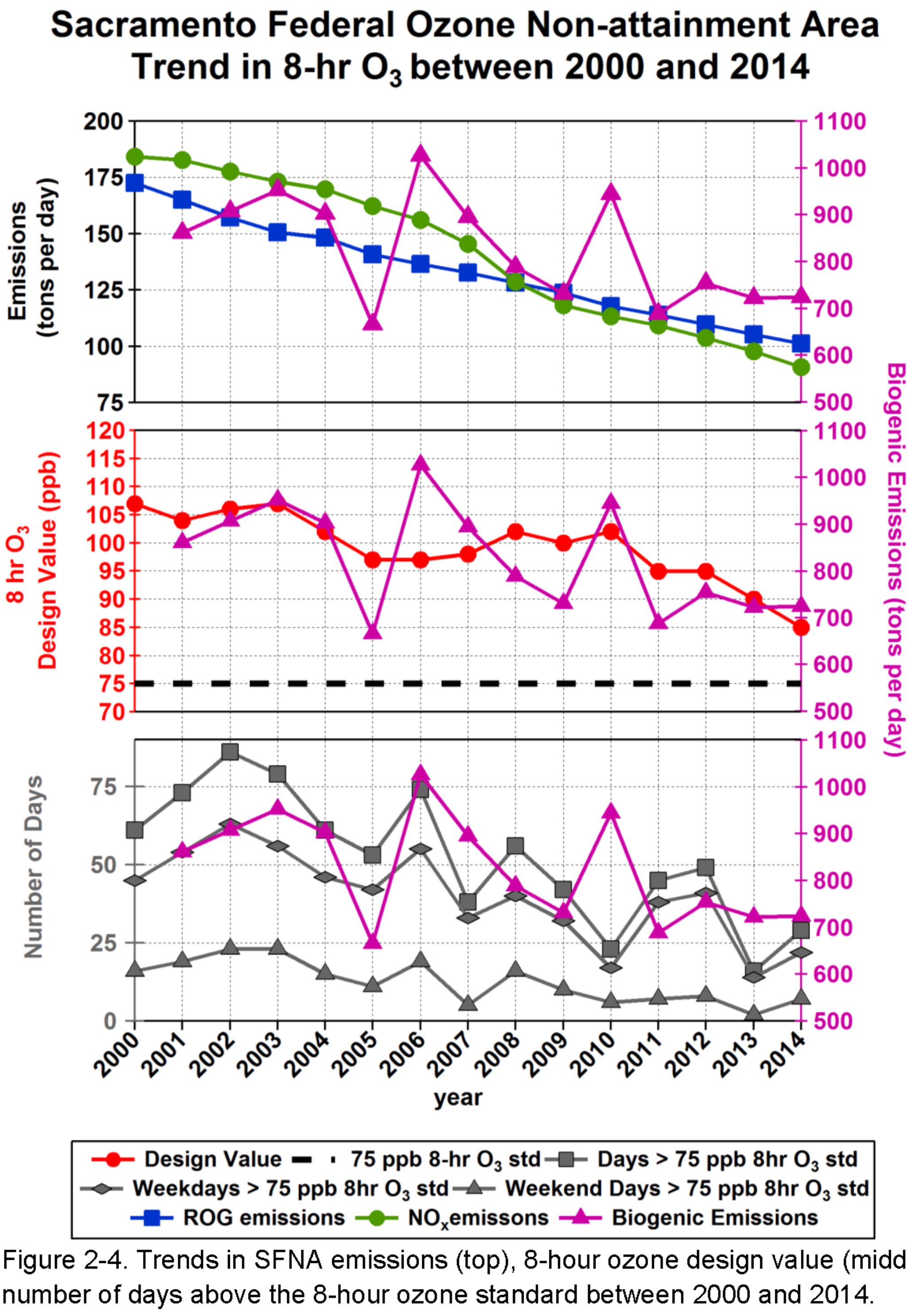

Figure 2-4. Trends in SFNA emissions (top), 8-hour ozone design value (middle), and number of days above the 8-hour ozone standard between 2000 and 2014.

Investigating the "weekend effect" and how it has changed over time is also a useful metric for evaluating the ozone chemistry regime in the SFNA. The weekend effect is a well-known phenomenon in some major urbanized areas where ozone is observed to be lower on weekends than on weekdays. Although there are contributing factors, such as meteorology and activity patterns for various emissions sources, the general consensus is that reduced vehicle traffic (primarily diesel trucks) on the weekend results in lower NO_x emissions, while ROG emissions remain relatively unchanged. The corresponding change in ozone is an indication of the chemical regime (e.g., an increase in ozone suggests a NO_x disbenefit regime; Heuss et al., 2003). The excess NO_x in this regime not only titrates the O_3 but also mutes the VOC reactivity by using peroxy radicals to terminate NO_2 as NO_3 radicals and subsequently HNO_3. The reduction of NO_x during the weekend would lessen the titration and increase the VOC reactivity, which in turn would lead to increased ozone levels. A lack of a weekend effect (i.e., no pronounced high O_3 occurrences during weekends) suggests that the region is in a transition regime, while a reverse weekend effect (i.e., lower ozone during weekends) would suggest that the region is in a NO_x-limited chemical regime.

Murphy et al., (2007) showed that the weekend effect for ozone in the Sacramento area is strongly influenced by the region's proximity to the NO_x emission sources. Hence the trend in day-of-week dependence in the SFNA was analyzed on a sub-regional basis separately for the western (i.e. region upwind of Sacramento), central (i.e. urban Sacramento area) and eastern (i.e. Sierra foothills area downwind to the east of Sacramento) sub-regions (Figure 2–2) using observations between 2000 and 2014 (Figure 2-5). The three-panel scatter plot shown in Figure 2-5 compares the average site-specific weekday (Wednesday and Thursday) and weekend (Sunday) observed summertime (June through September) maximum daily average (MDA) 8-hr ozone value by year (2000 to 2014), separated into three sub-regions: Western SFNA (top), Central SFNA (middle), and Eastern SFNA (bottom). Different definitions of weekday and weekend days were also investigated and did not show appreciable differences from the Wednesday/Thursday and Sunday definitions.

From Figure 2-5 it can be seen that ozone levels are highest in the eastern and central regions of the SFNA, consistent with their location downwind of and within the urban Sacramento emissions source. The lowest ozone levels are seen in the western SFNA region, which is located upwind of the urban Sacramento emissions source. A key observation in Figure 2-5 is that the summertime average weekday and weekend ozone levels have steadily declined between 2000 and 2014, consistent with the decline in the area-wide DV and exceedance days shown in Figure 2-4.

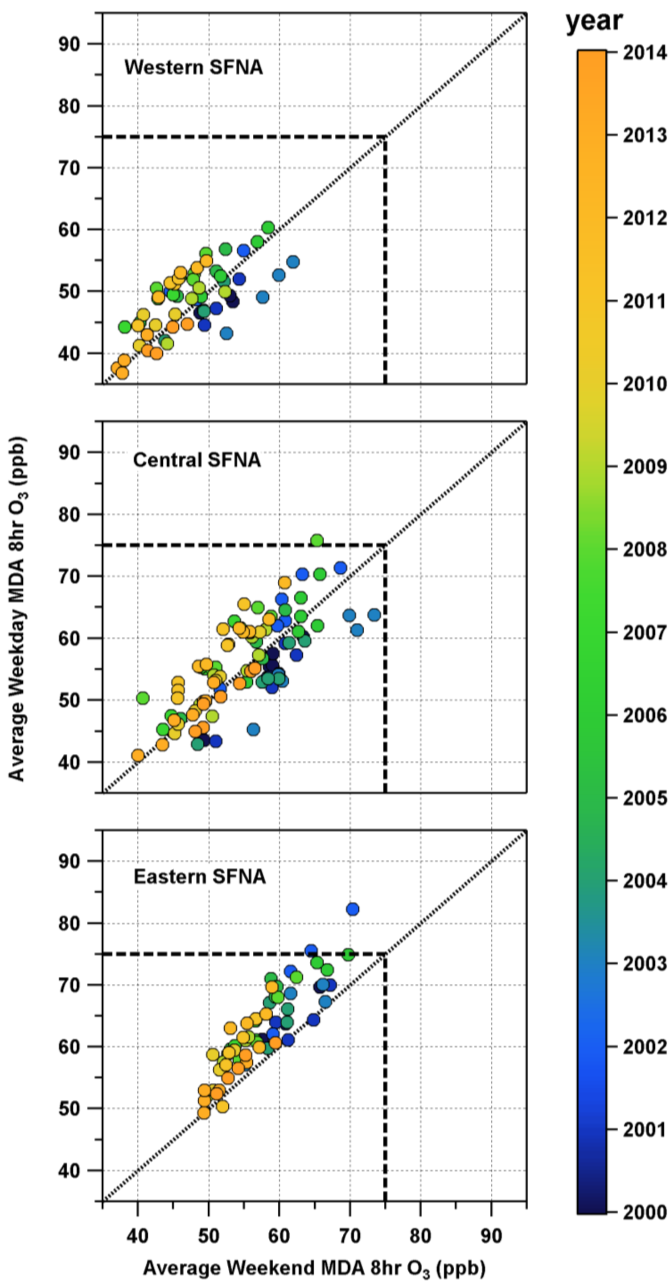

Figure 2-5. Site-specific average weekday and weekend maximum daily average 8-hour ozone for each year from 2000 to 2014 for the Western (top), Central (middle), and Eastern (bottom) sub-regions of SFNA. Points falling below the 1:1 dashed line represent a NO_x-disbenefit regime, those on the 1:1 dashed line represent a transitional regime, and those above the 1:1 dashed line represent a NO_x-limited regime. MDA denotes maximum daily average.

Along with the declining ozone, there is a shift in the weekday and weekend ozone trends between 2000 and 2014. In the early 2000's, the central region of the SFNA exhibited roughly the same number of sites with weekend ozone greater than weekday ozone as sites with weekday ozone greater than weekend ozone, which suggests that the regions may have been in the transitional chemical regime for ozone formation. By the mid-2000's, the majority of the sites were showing weekday ozone greater than weekend ozone, which is consistent with a shift into complete NO_x-limited chemistry. By 2014, however, some of the sites had shifted back towards a more equal distribution between weekday and weekend ozone. This shift though, may be explained by the relatively low level of biogenic emissions in 2014, which could cause a shift from a NO_x-limited environment to a more transitional chemistry environment (e.g., Figure 2-3).

The Western SFNA region clearly experienced a greater NO_x-disbenefit in the early 2000's and then moved into a transitional chemical regime in the mid-2000's and transitioned into the NO_x-limited regime around the 2010/2011 timeframe. There is a shift back towards a more equal distribution between weekday and weekend ozone in 2014, similar to the Central sub-region. However, this shift occurs at low ozone levels (below 60 ppb) that are well below the 75 ppb ozone standard.

In contrast to the central and western portions (described above), the eastern portion of SFNA has been in a NO_x limited regime all along, as seen from the greater weekday ozone when compared to weekend ozone. This region is in close proximity to biogenic ROG emissions sources and farther away from the anthropogenic NO_x sources, such that ROG mixing ratios are relatively high compared to NO_x, resulting in a NO_x-limited regime. The shift towards more equal weekday/weekend ozone levels during the 2011-2014 timeframe, presumably due to the low level of biogenic emissions (Figure 2-4), highlights the important contribution of biogenic ROG emissions to ozone formation in this region.

These findings are consistent with an independent analysis by UC Berkeley researchers on the observed response of ozone between 2001 and 2007 in the Sacramento region to NO_x emission reductions (LaFranchi et al. 2011). This study concluded that NO_x emission reductions had been effective at reducing ozone levels at all points in the Sacramento urban plume, and by 2007 had successfully transitioned the region to a NO_x-limited chemistry regime, except within the Sacramento Metropolitan Area urban core. The UC Berkeley study further predicted that the future cumulative NO_x controls over time will likely transition the entire SFNA (including the urban core) to a NO_x limited regime, which will make NO_x emission controls extremely effective in reducing the Sacramento region's ozone levels.

2.4 Meteorological Conditions Leading to Ozone Exceedances

The SFNA is located in the highly complex terrain region of California's Central Valley (See Figure 2-1). Elevations in the Central Valley extend from a few feet to almost 500 feet above sea level. This long valley is surrounded by the Coastal Mountain Range on the west, the Cascade Range to the northeast, the Sierra Nevada Mountains on the east, and the Tehachapi Mountains to the south. The Coastal Range is actually a series of north/south mountain ranges that extend 800 miles from the northwest corner of Del Norte County south to the Mexican border. The San Francisco Bay Area divides the Coastal Mountain Range into northern and southern ranges. The Coastal Mountains generally form a barrier between the Pacific Ocean and the Central Valley, with occasional breaks created by low elevation passes and the small gap between the northern and southern ranges in the San Francisco Bay area known as the Carquinez Strait. Elevations in the Coastal Range generally vary between 2,000 and 4,000 feet, but can reach heights above 7,000 feet. In contrast, elevations in the Cascade Range and Sierra Mountains in northern California are typically above 5,000 feet and can exceed 10,000 feet.

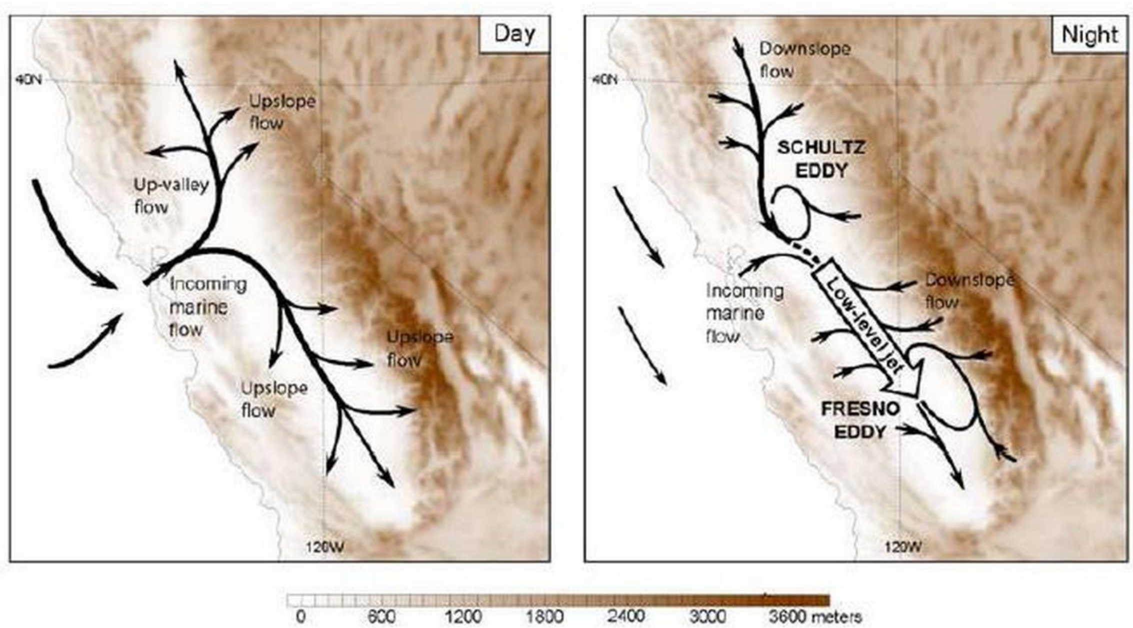

Figure 2-6 Conceptual low-level wind patterns in Central California during the day (left panel) and night (right panel) for typical ozone episode conditions (adapted from Bao et al., 2008).

Weather conditions during much of the summer ozone season are dominated by an area of high pressure, known as the East Pacific Ridge, which creates a broad region of warm, descending air over Central California. Studies have shown that the strength and positioning of this ridge has a strong influence on the prevailing weather conditions and summertime ozone levels in Central California (Lehrman et al., 2004; Pun et al., 2008). Synoptic forcing under the East Pacific Ridge is typically weak, with wind flows above the planetary boundary layer from the northwest, resulting in wind flows in Central California that are primarily thermally driven and strongly influenced by orographic effects (Zhong et al., 2004). Thermal gradients between the eastern Pacific Ocean and inland in the Valley result in a strong daytime sea breeze which follows the terrain and can extend well inland through the Carquinez Strait and to a lesser extent the Altamont, Pacheco, and Cholame Passes. When meteorological conditions are favorable, polluted air masses from the Bay Area travel through the Carquinez Strait and bifurcate over the Delta region, with one branch flowing to the northeast into the southern Sacramento Valley and the other branch flowing southeast into the northern San Joaquin Valley (Figure 2-6).

At night, the sea breeze gradually weakens and can even reverse in some cases, but up-valley flow off of the Delta usually persists. Nighttime surface wind flow in the Central Valley is dominated by downslope flows, known as nocturnal drainage, off of the mountain ranges on all sides (Figure 2-6) and when combined with the continued up-valley flows from the Delta, result in low-level eddies such as the Schultz eddy in the southern Sacramento Valley and the Fresno eddy in the SJV (Lehrman et al., 2004). The dynamical conditions favorable for the formation of both the Fresno and Shultz eddies are investigated and discussed by Lin and Jao (1995).

Clustering and classification techniques have been utilized on both observed meteorology (Lehrman et al., 2001; Blanchard et al., 2008; Beaver and Palazoglu, 2009) and observed and modeled ozone (Fujita et al., 1999; Jin et al., 2011) in the Valley and the surrounding region to better understand the relationship between meteorology and elevated ozone. These various studies reveal that the position and strength of the Pacific High has a dominant influence on ozone levels throughout the Central Valley, along with the height of the marine inversion and strength of the low-level on-shore flow. Synoptic flows that weaken or break down the Pacific High result in lower ozone throughout the Central Valley, while a strong sea breeze with a deep marine boundary layer results in lower ozone levels within the Bay Area, but also an enhanced transport of polluted air masses into the Delta region. Under such conditions, elevated ozone can occur in the Sacramento and San Joaquin Valleys if the synoptic forcing is sufficiently weak so that vertical mixing is reduced and recirculation is enhanced. The highest ozone levels in the Valley occur as the thermal gradient between off-shore and inland weakens and the high pressure system strengthens, resulting in reduced transport of polluted air masses from the Bay Area inland to the Delta, which is accompanied by a rise in temperatures inland. As the sea breeze weakens even further, conditions stagnate within the Valley and ozone levels peak and continue to remain elevated until a synoptic system moves through the area and breaks down the Pacific High.

From an air quality perspective, the Schultz eddy plays a critical role in determining the ozone levels in the Sacramento Valley. The Schultz eddy is the local counterclockwise eddy often formed to the north or northwest of Sacramento due to interaction between the northward marine up-valley inflow and the nocturnal down-valley flow. The typical air flow in the Sacramento Metro area counties is most frequently from the south-southwest, consistent with the incoming marine flow through the Carquinez Strait into the region and orientation of the river valleys extending northeast of Sacramento into the foothills and ranges of the Sierra Nevada mountain range. Instead of allowing the prevailing wind patterns to move north carrying the pollutants out of the region, the Schultz eddy causes the wind pattern and pollutants to circle back in a southeasterly flow, which serves as a mechanism to recirculate and trap air within the region thereby exacerbating the pollution levels in the area and increasing the likelihood of violating the federal and state air quality standards. The Schultz eddy also contributes to the formation of a low-level southerly jet between 500 and 1,000 ft above the surface that is capable of speeds in excess of 35 miles per hour. This jet serves as an important nighttime pollutant transport mechanism transporting air pollutants over large distances thereby impacting the air quality in the Sacramento Valley. The conditions that promote the formation of this jet within the Sacramento Valley may also limit ventilation of the region, resulting in a buildup of pollution over multiple days. The Schultz eddy normally dissipates around noon when the delta sea breeze arrives.

In summary, typical synoptic (large) and local scale weather features associated with 8-hour ozone exceedances in the SFNA generally consist of:

- Broad, upper-level high pressure over the eastern Pacific and western U.S.
- Clear skies
- Sinking motion over the region, which limits vertical mixing through the creation of a subsidence inversion
- Weak winds in most levels of the atmosphere
- Very warm to hot temperatures at the surface and aloft
- Peak warming across the western side or central portion of the Sacramento Valley, which limits the strength of the delta breeze

Synoptic and local scale weather features typically not conducive to 8-hour ozone exceedances include:

- Upper-level low pressure off the Northern California coast (onshore winds) or centered over the four-corner states of Utah, Colorado, Arizona, and New Mexico (northerly winds)
- Rising motion and moderate temperatures aloft, which allow for vertical mixing during peak afternoon heating and pollutant dispersion
- Temperatures rapidly increasing from one day to the next or extremely hot temperatures, both of which lead to a breaking of the temperature inversion
- Moderate to strong northerly winds, even if associated with hot temperatures and clear skies
- Persistent delta breeze on consecutive days with periods of strong onshore winds, which limit exceedances to the eastern-side of the region, namely the foothills, or prevent them entirely

It should be noted that nearly every summer sees both patterns occur, but the key difference is the persistence of one of the patterns, in general, over several weeks and having the pattern align with the peak ozone forming months of July, August, and early September.

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Appendix B-3 Modeling Protocol

Document Title:

Photochemical Modeling Protocol – Photochemical Modeling for the 8-Hour Ozone and Annual/24-hour $PM_{2.5}$ State Implementation Plans

Document Description:

This document provides details and formalizes the procedures for conducting the photochemical modeling that forms the basis of the attainment demonstration. The protocol is intended to communicate up front how the model attainment test will be performed. In addition, the protocol discusses analyses that help corroborate the findings of the model attainment test.

PHOTOCHEMICAL MODELING PROTOCOL

Photochemical Modeling for the 8-Hour Ozone and Annual/24-hour $PM_{2.5}$ State Implementation Plans

Prepared by
California Air Resources Board

Prepared for
United States Environmental Protection Agency Region IX

January 27, 2017

1

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

ARB – Air Resources Board

ARCTAS-CARB – California portion of the Arctic Research of the Composition of the Troposphere from Aircraft and Satellites conducted in 2008

BCs – Boundary Conditions

CalNex – Research at the Nexus of Air Quality and Climate Change conducted in 2010

CCOS - Central California Ozone Study

CMAQ Model – Community Multi-scale Air Quality Model

CIT – California Institute of Technology

CRPAQS – California Regional PM_{10}/$PM_{2.5}$ Air Quality Study

DISCOVER-AQ - Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality

DV – Design Value

FDDA – Four-Dimensional Data Assimilation

FEM – Federal Equivalence Monitors

FRM – Federal Reference Monitors

HNO_3 – Nitric Acid

ICs – Initial Conditions

IMPROVE – Interagency Monitoring of Protected Visual Environments

IMS-95 – Integrated Monitoring Study of 1995

LIDAR – Light Detection And Ranging

MDA – Maximum Daily Average

MM5 – Mesoscale Meteorological Model Version 5

MOZART – Model for Ozone and Related chemical Tracers

NARR - North American Regional Reanalysis

NCAR – National Center for Atmospheric Research

NCEP – National Centers for Environmental Prediction

NH_3 – Ammonia

NOAA - National Oceanic and Atmospheric Administration

NO_x – Oxides of nitrogen

OC – Organic Carbon

OFP - Ozone Forming Potential

PAMS – Photochemical Assessment Monitoring Stations

PAN – Peroxy Acetyl Nitrate

$PM_{2.5}$ – Particulate Matter with aerodynamic diameter less than 2.5 micrometers

PM_{10} – Particulate Matter with aerodynamic diameter less than 10 micrometers

RH – Relative Humidity

ROG – Reactive Organic Gases

RRF – Relative Response Factor

RSAC – Reactivity Scientific Advisory Committee

SANDWICH – Application of the Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbonaceous Material Balance Approach

SAPRC – Statewide Air Pollution Research Center

SARMAP – SJVAQS/AUSPEX Regional Modeling Adaptation Project

SCAQMD – South Coast Air Quality Management District

SIP – State Implementation Plan

SJV – San Joaquin Valley

SJVAB – San Joaquin Valley Air Basin (SJVAB)

SJVUAPCD – San Joaquin Valley Unified Air Pollution Control District

SJVAQS/AUSPEX – San Joaquin Valley Air Quality Study/Atmospheric Utilities Signatures Predictions and Experiments

SLAMS – State and Local Air Monitoring Stations

SMAQMD – Sacramento Metropolitan Air Quality Management District

SMAT – Application of the Speciated Modeled Attainment Test

SOA – Secondary Organic Aerosol

SO_x – Oxides of Sulfur

STN – Speciated Trend Network

UCD – University of California at Davis

U.S. EPA – United States Environmental Protection Agency

VOC – Volatile Organic Compounds

WRF Model – Weather and Research Forecast Model

1. INTRODUCTION

The purpose of this modeling protocol is to detail and formalize the procedures for conducting the photochemical modeling that forms the basis of the attainment demonstration for the 8-hour ozone and annual/24-hour $PM_{2.5}$ State Implementation Plans (SIPs) for California. The protocol is intended to communicate up front how the model attainment test will be performed. In addition, this protocol discusses analyses that are intended to help corroborate the findings of the model attainment test.

1.1 Modeling roles for the current SIP

The Clean Air Act (Act) establishes the planning requirements for all those areas that routinely exceed the health-based air quality standards. These nonattainment areas must adopt and implement a SIP that demonstrates how they will attain the standards by specified dates. Air quality modeling is an important technical component of the SIP, as it is used in combination with other technical information to project the attainment status of an area and to develop appropriate emission control strategies to achieve attainment.

ARB and local Air Districts will jointly develop the emission inventories, which are an integral part of the modeling. Working closely with the Districts, the ARB will perform the meteorological and air quality modeling. Districts will then develop and adopt their local air quality plan. Upon approval by the ARB, the SIP will be submitted to U.S.EPA for approval.

1.2 Stakeholder participation

Public participation constitutes an integral part of the SIP development. It is equally important in all technical aspects of SIP development, including the modeling. As the SIP is developed, the Air Districts and ARB will hold public workshops on the modeling and other SIP elements. Representatives from the private sector, environmental interest groups, academia, and the federal, state, and local public sectors are invited to attend and provide comments. In addition, Draft Plan documents will be available for public review and comment at various stages of plan development and at least 30 days before Plan consideration by the Districts' Governing Boards and subsequently by the ARB Board. These documents will include descriptions of the technical aspects of the SIP. Stakeholders have the choice to provide written and in-person comments at any of the Plan workshops and public Board hearings. The agencies take the comments into consideration when finalizing the Plan.

1.3 Involvement of external scientific/technical experts and their input on the photochemical modeling

During the development of the modeling protocol for the 2012 SJV 24-hour $PM_{2.5}$ SIP (SJVUAPCD, 2012), ARB and the San Joaquin Valley Air Pollution Control District (SJVAPCD) engaged a group of experts on prognostic meteorological modeling and photochemical/aerosol modeling to help prepare the modeling protocol document.

The structure of the technical expert group was as follows:

Conveners: John DaMassa – ARB
Samir Sheikh – SJVAPCD
Members: Scott Bohning – U.S. EPA Region 9
Ajith Kaduwela – ARB
James Kelly – U.S. EPA Office of Air Quality Planning and Standards
Michael Kleeman – University of California at Davis
Jonathan Pleim – U.S. EPA Office of Research and Development
Anthony Wexler – University of California at Davis

The technical consultant group provided technical consultations/guidance to the staff at ARB and SJVAPCD during the development of the protocol. Specifically, the group provided technical expertise on the following components of the protocol:

- Selection of the physics and chemistry options for the prognostic meteorological and photochemical air quality models
- Selection of methods to prepare initial and boundary conditions for the air quality model
- Performance evaluations of both prognostic meteorological and photochemical air quality models. This includes statistical, diagnostic, and phenomenological evaluations of simulated results.
- Selection of emissions profiles (size and speciation) for particulate-matter emissions.
- Methods to determine the limiting precursors for $PM_{2.5}$ formation.
- Application of the Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbonaceous Material Balance Approach (SANDWICH) with potential modifications.
- Application of the Speciated Modeled Attainment Test (SMAT).
- Selection of methodologies for the determination of $PM_{2.5}$ precursor equivalency ratios.
- Preparation of Technical Support Documents.

The current approach to regional air quality modeling has not changed significantly since the 2012 SJV 24-hour $PM_{2.5}$ SIP (SJVUAPCD, 2012), so the expertise provided on the above components to the protocol remain highly relevant. In addition, since regional air quality modeling simulates ozone chemistry and PM chemistry/formation simultaneously, there is generally no difference in how the models are configured and simulations conducted for ozone vs. PM. Therefore, development of this modeling protocol will rely heavily on the recommendations made by this group of technical experts, as well as recently published work in peer-review journals related to regional air quality modeling.

1.4 Schedule for completion of the Plan

Final area designations kick-off the three year SIP development process. For the first two years, efforts center on updates and improvements to the Plan's technical and scientific underpinnings. These include the development of emission inventories, selection of modeling periods, model selection, model input preparation, model performance evaluation and supplemental analyses. During the last year, modeling, further supplemental analyses and control strategy development proceed in an iterative manner and the public participation process gets under way. After thorough review the District Board and subsequently the ARB Board consider the Plan. The Plan is then submitted to U.S. EPA. Table 1-1 in the Appendix corresponding to the appropriate region/standard (e.g., SJV 0.075 ppm 8-hour ozone) summarizes the overall anticipated schedule for Plan completion.

2. DESCRIPTION OF THE CONCEPTUAL MODEL FOR THE NONATTAINMENT AREA

See Section 2 in the Appendix corresponding to the appropriate region/standard (e.g., SJV 0.075 ppm 8-hour ozone).

3. SELECTION OF MODELING PERIODS

3.1 Reference Year Selection and Justification

From an air quality and emissions perspective, ARB and the Districts have selected 2012 as the base year for design value calculation and for the modeled attainment test.

For the SJV, the $PM_{2.5}$ model attainment test will utilize 2013 instead of 2012. These baseline values will serve as the anchor point for estimating future year projected design values.

The selection of 2012/13 is based on the following four considerations:

- Most complete and up to date emissions inventory, which reduces the uncertainty associated with future emissions projections.
- Analysis of meteorological adjusted air quality trends to determine recent years with meteorology most conducive to ozone and $PM_{2.5}$ formation and buildup.
- Availability of research-grade wintertime field measurements in the Valley, which captured two significant pollution episodes during the DISCOVER-AQ field study (January-February 2013).
- The SJV $PM_{2.5}$ design values for year 2013 were some of the highest in recent years, making 2013 a conservative choice for attainment demonstration modeling.

Details and discussion on these analyses can be found in the Weight of Evidence Appendix.

3.2 Future Year Selection and Justification

The future year modeled is determined by the year for which attainment must be demonstrated. Table 3-1 lists the year in which attainment must be demonstrated for the various ozone and $PM_{2.5}$ standards and non-attainment regions in California.

Table 3-1. Future attainment year by non-attainment region and NAAQS. 0.08 ppm and 0.075 ppm refer to the 1997 and 2008 8-hour ozone standards, respectively. 15 ug/m^3 and 12 ug/m^3 refer to the 1997 and 2012 annual $PM_{2.5}$ standards, respectively. 35 ug/m^3 refers to the 2006 24-hour $PM_{2.5}$ standard, and 1-hr ozone refers to the revoked 1979 0.12 ppm 1-hour ozone standard.

Area	Year								
	2031	2026	2025	2024	2023	2021	2020	2019	2017
Southern California Modeling Domain									
South Coast	0.075 ppm	--	--	--	0.08 ppm	12 µg/m^3	--	--	--
Mojave/Coachella	--	0.075 ppm	--	--	--	--	--	--	0.08 ppm
Imperial County	--	--	--	--	--	12 µg/m^3	--	--	0.075 ppm
Ventura County	--	--	--	--	--	--	0.075 ppm	--	--
San Diego	--	--	--	--	--	--	--	--	0.075 ppm
Northern California Modeling Domain									
San Joaquin Valley	0.075 ppm	--	[1]12 µg/m^3	35 µg/m^3	--	[2]12 µg/m^3	15 µg/m^3	35 µg/m^3	1-hr ozone
Sacramento Metropolitan	--	0.075 ppm	--	--	--	--	--	--	--
Portola-Plumas County	--	--	--	--	--	12 µg/m^3	--	--	--
East Kern	--	--	--	--	--	--	--	--	0.075 ppm
W. Nevada County	--	--	--	--	--	--	--	--	0.075 ppm

[1] Serious classification attainment date
[2] Moderate classification attainment date

3.3 Justification for Seasonal/Annual Modeling Rather than Episodic Modeling

In the past, computational constraints restricted the time period modeled for a SIP attainment demonstration to a few episodes (e.g., 2007 SJV 8-hr ozone SIP (SJVUAPCD, 2007), 2007 SC 8-hr ozone SIP (SCAQMD, 2012) and 2009 Sacramento 8-hr ozone SIP (SMAQMD, 2012)). However, as computers have become faster and large amounts of data storage have become readily accessible, there is no longer a need to restrict modeling periods to only a few episodes. In more recent years, SIP modeling in California has covered the entire ozone or peak $PM_{2.5}$ seasons (2012 SC 8-hour ozone and 24-hour $PM_{2.5}$ SIP (SCAQMD, 2012), 2012 SJV 24-hour $PM_{2.5}$ SIP (SJVUAPCD, 2012) and 2013 SJV 1-hr ozone SIP (SJVUAPCD,2013)), or an entire year in the case of annual $PM_{2.5}$ (2008 SJV annual $PM_{2.5}$ SIP (SJVUAPCD, 2008)) The same is true for other regulatory modeling platforms outside of California (Boylan and Russell, 2006; Morris et al., 2006; Rodriguez et al., 2009; Simon et al., 2012; Tesche et al., 2006; U.S. EPA, 2011a, b).

Recent ozone based studies, which focused on model performance evaluation for regulatory assessment, have recommended the use of modeling results covering the full synoptic cycles and full ozone seasons (Hogrefe et al., 2000; Vizuete et al., 2011). This enables a more complete assessment of ozone response to emission controls under a wide range of meteorological conditions. The same is true for modeling conducted for peak 24-hour $PM_{2.5}$. Consistent with the shift to seasonal or annual modeling in most regulatory modeling applications, modeling for the 8-hour ozone standard will cover the entire ozone season (May – September), modeling for the annual 24-hour $PM_{2.5}$ standard will be conducted for the entire year, and modeling for the 24-hour $PM_{2.5}$ standard will, at a minimum, cover the months in which peak 24-hour $PM_{2.5}$ occurs (e.g., October – March in the SJV) and will be conducted annually whenever possible.

4. DEVELOPMENT OF EMISSION INVENTORIES

For a detailed description of the emissions inventory, updates to the inventory, and how it was processed from the planning totals to a gridded inventory for modeling, see the Emissions Inventory Appendix.

5. MODELS AND INPUTS

5.1 Meteorological Model

Meteorological model selection is based on a need to accurately simulate the synoptic and mesoscale meteorological features observed during the selected modeling period. The main difficulties in accomplishing this are California's extremely complex terrain and its diverse climate. It is desirable that atmospheric modeling adequately represent essential meteorological fields such as wind flows, ambient temperature variation, evolution of the boundary layer, and atmospheric moisture content to properly characterize the meteorological component of photochemical modeling.

In the past, the ARB has applied prognostic, diagnostic, and hybrid models to prepare meteorological fields for photochemical modeling. There are various numerical models that are used by the scientific community to study the meteorological characteristics of an air pollution episode. For this SIP modeling platform, the Weather and Research Forecasting (WRF) model (Skaramock et al, 2005) will be used to develop the meteorological fields that drive the photochemical modeling. The U.S. EPA (2014) recommends the use of a well-supported grid-based mesoscale meteorological model for generating meteorological inputs. The WRF model is a community-based mesoscale prediction model, which represents the state-of-the-science and has a large community of model users and developers who frequently update the model as new science becomes available. In recent years, WRF has been applied in California to generate meteorological fields for numerous air quality studies (e.g., Angevine, et al., 2012; Baker et al., 2015; Ensberg et al., 2013; Fast et al., 2014; Hu et al., 2014a, 2014b; Huang et al., 2010; Kelly et al., 2014; Lu et al., 2012; Mahmud et al., 2010), and has been shown to reasonably reproduce the observed meteorology in California.

5.1.1 Meteorological Modeling Domain

The WRF meteorological modeling domain consists of three nested grids of 36 km, 12 km and 4 km uniform horizontal grid spacing (illustrated in Figure 5-1). The purpose of the coarse, 36 km grid (D01) is to provide synoptic-scale conditions to all three grids, while the 12 km grid (D02) is used to provide finer resolution data that feeds into the 4 km grid (D03). The D01 grid is centered at 37 ˚N and 120.5 ˚W and was chosen so that the inner two grids, D02 and D03, would nest inside of D03 and be sufficiently far away from the boundaries to minimize boundary influences. The D01 grid consists of 90 x 90 grid cells, while the D02 and D03 grids encompass 192 x 192 and 327 x 297 grid cells, respectively, with an origin at -696 km x -576 km (Lambert Conformal projection). WRF will be run for the three nested domains simultaneously with two-way feedback between the parent and the nest grids. The D01 and D02 grids are meant to resolve the larger scale synoptic weather systems, while the D03 grid is intended to resolve the finer details of the atmospheric conditions and will be used to drive the air quality model simulations. All three domains will utilize 30 vertical sigma layers (defined in Table 5-1), as well as the various physics options listed in Table 5-2 for each domain.
The initial and boundary conditions (IC/BCs) for WRF will be prepared based on 3-D North American Regional Reanalysis (NARR) data that are archived at the National Center for Atmospheric Research (NCAR). These data have a 32 km horizontal resolution. Boundary conditions to WRF are updated at 6-hour intervals for the 36 km grid (D01). In addition, surface and upper air observations obtained from NCAR will be used to further refine the analysis data that are used to generate the IC/BCs. Analysis

nudging will be employed in the outer 36km grid (D01) to ensure that the simulated meteorological fields are constrained and do not deviate from the observed meteorology.

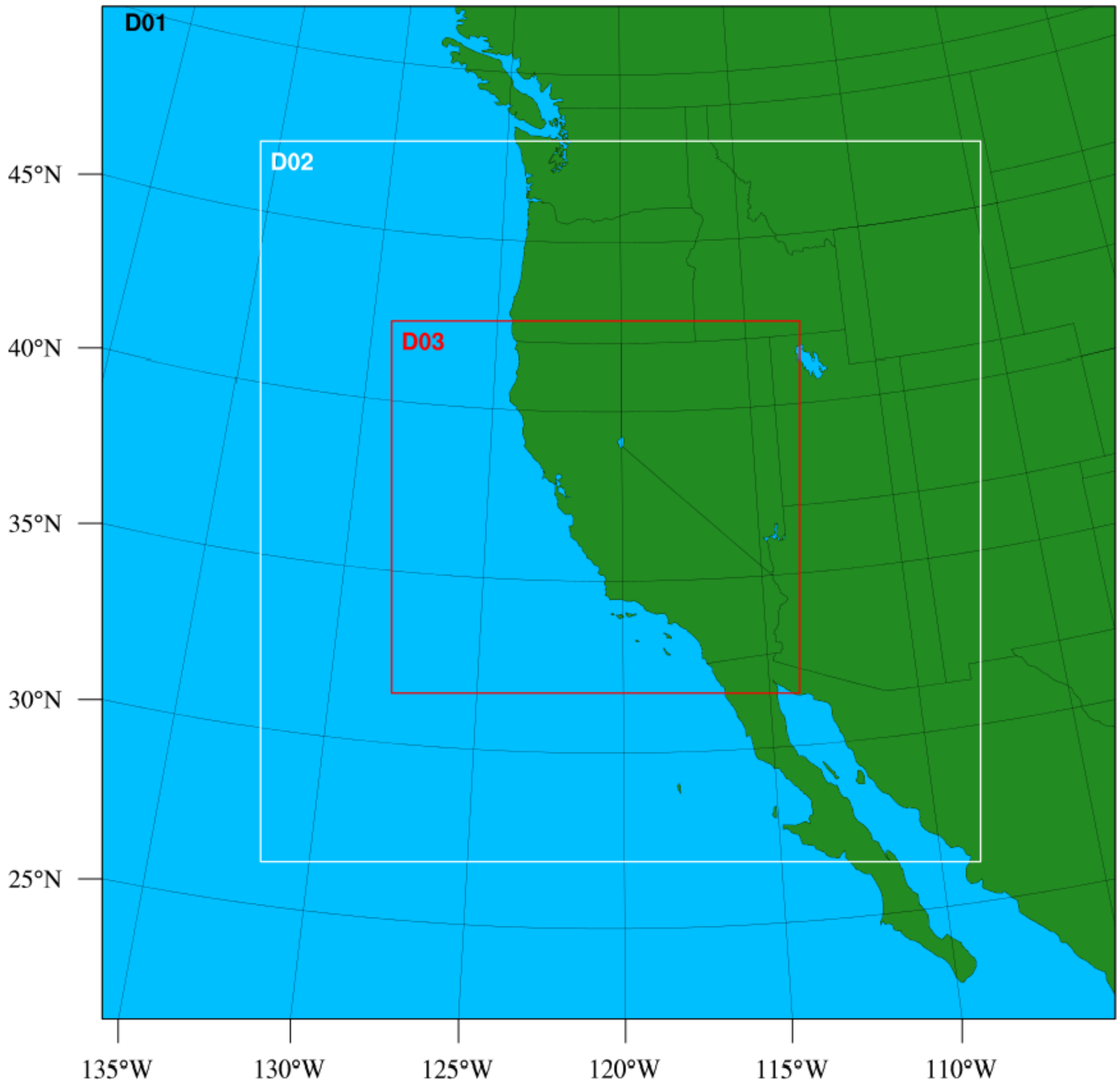

Figure 5-1. The three nested grids for the WRF model (D01 36km; D02 12km; and D03 4km).

Table 5-1. WRF vertical layer structure.

Layer Number	Height (m)	Layer Thickness (m)	Layer Number	Height (m)	Layer Thickness (m)
30	16082	1192	14	1859	334
29	14890	1134	13	1525	279
28	13756	1081	12	1246	233
27	12675	1032	11	1013	194
26	11643	996	10	819	162
25	10647	970	9	657	135
24	9677	959	8	522	113
23	8719	961	7	409	94
22	7757	978	6	315	79
21	6779	993	5	236	66
20	5786	967	4	170	55
19	4819	815	3	115	46
18	4004	685	2	69	38
17	3319	575	1	31	31
16	2744	482	0	0	0
15	2262	403			

Note: Shaded layers denote the subset of vertical layers to be used in the CMAQ photochemical model simulations. Further details on the CMAQ model configuration and settings can be found in subsequent sections.

Table 5-2. WRF Physics Options.

Physics Option	Domain		
	D01 (36 km)	D02 (12 km)	D03 (4 km)
Microphysics	WSM 6-class graupel scheme	WSM 6-class graupel scheme	WSM 6-class graupel scheme
Longwave radiation	RRTM	RRTM	RRTM
Shortwave radiation	Dudhia scheme	Dudhia scheme	Dudhia scheme
Surface layer	Revised MM5 Monin-Obukhov	Revised MM5 Monin-Obukhov	Revised MM5 Monin-Obukhov
Land surface	Pleim-Xiu LSM	Pleim-Xiu LSM	Pleim-Xiu LSM
Planetary Boundary Layer	YSU	YSU	YSU
Cumulus Parameterization	Kain-Fritsch scheme	Kain-Fritsch scheme	None

5.2 Photochemical Model

The U.S. EPA modeling guidance (U.S. EPA, 2014) requires several factors to be considered as criteria for choosing a qualifying air quality model to support the attainment demonstration. These criteria include: (1) It should have received a scientific peer review; (2) It should be appropriate for the specific application on a theoretical basis; (3) It should be used with databases which are available and adequate to support its application; (4) It should be shown to have performed well in past modeling applications; and (5). It should be applied consistently with an established protocol on methods and procedures (U.S. EPA, 2014). In addition, it should be well documented with a user's guide as well as technical descriptions. For the ozone modeled attainment test, a grid-based photochemical model is necessary to offer the best available representation of important atmospheric processes and the ability to analyze the impacts of proposed emission controls on ozone mixing ratios. In ARB's SIP modeling platform, the Community Multiscale Air Quality (CMAQ) Modeling System has been selected as the air quality model for use in attainment demonstrations of NAAQS for ozone and $PM_{2.5}$.

The CMAQ model, a state-of-the-science "one-atmosphere" modeling system developed by U.S. EPA, was designed for applications ranging from regulatory and policy analysis to investigating the atmospheric chemistry and physics that contribute to air pollution. CMAQ is a three-dimensional Eulerian modeling system that simulates ozone, particulate matter, toxic air pollutants, visibility, and acidic pollutant species throughout the troposphere (UNC, 2010). The model has undergone peer review every few years and represents the state-of-the-science (Brown et al., 2011). The CMAQ model is regularly updated to incorporate new chemical and aerosol mechanisms, algorithms, and data as they become available in the scientific literature (e.g., Appel et al., 2013; Foley, et al., 2010; Pye and Pouliot, 2012;). In addition, the CMAQ model is well documented in terms of its underlying scientific algorithms as well as guidance on operational uses (e.g., Appel et al., 2013; Binkowski and Roselle, 2003; Byun and Ching, 1999; Byun and Schere, 2006; Carlton et al., 2010; Foley et al., 2010; Kelly, et al., 2010a; Pye and Pouliot, 2012; UNC, 2010).

The CMAQ model was the regional air quality model used for the 2008 SJV annual $PM_{2.5}$ SIP (SJVUAPCD, 2008), the 2012 SJV 24-hour $PM_{2.5}$ SIP (SJVUAPCD, 2012) and the 2013 SJV 1-hr ozone SIP (SJVUAPCD, 2013). A number of previous studies have also used the CMAQ model to study ozone and $PM_{2.5}$ formation in the SJV (e.g., Jin et al., 2008, 2010b; Kelly et al., 2010b; Liang and Kaduwela, 2005; Livingstone, et al., 2009; Pun et al, 2009; Tonse et al., 2008; Vijayaraghavan et al., 2006; Zhang et al., 2010). The CMAQ model has also been used for regulatory analysis for many of U.S. EPA's rules, such as the Clean Air Interstate Rule (U.S. EPA, 2005) and Light-duty and Heavy-duty Greenhouse Gas Emissions Standards (U.S. EPA, 2010, 2011a). There have been numerous applications of the CMAQ model within the U.S. and abroad (e.g., Appel, et al., 2007, 2008; Civerolo et al., 2010; Eder and Yu, 2006; Hogrefe et al., 2004; Lin et al., 2008, 2009; Marmur et al., 2006; O'Neill, et al., 2006; Philips and Finkelstein, 2006; Smyth et al., 2006; Sokhi et al., 2006; Tong et al., 2006; Wilczak et al., 2009; Zhang et al., 2004, 2006), which have shown it to be suitable as a regulatory and scientific tool for investigating air quality. Staff at the CARB has developed expertise in applying the CMAQ model, since it has been used at CARB for over a decade. In addition, technical support for the CMAQ model is readily available from the Community Modeling and Analysis System (CMAS) Center (http://www.cmascenter.org/) established by the U.S. EPA.

The version 5.0.2 of the CMAQ model released in May 2014, (http://www.airqualitymodeling.org/cmaqwiki/index.php?title=CMAQ_version_5.0.2_%28April_2014_release%29_Technical_Documentation), will be used in this SIP modeling platform. Compared to the previous version, CMAQv4.7.1, which was used for the 2012 SJV 24-hour $PM_{2.5}$ SIP (SJVUAPCD, 2012) and the 2013 SJV 1-hour ozone SIP (SJVUAPCD, 2013), CMAQ version 5 and above incorporated substantial new features and enhancements to topics such as gas-phase chemistry, aerosol algorithms, and structure of the numerical code (http://www.airqualitymodeling.org/cmaqwiki/index.php?title=CMAQ_version_5.0_%28February_2012_release%29_Technical_Documentation#RELEASE_NOTES_for_CMAQv5.0_-.C2.A0February_2012).

5.2.1 Photochemical Modeling Domain

Figure 5-2 shows the photochemical modeling domains used by ARB in this modeling platform. The larger domain (dashed black colored box), covering all of California, has a horizontal grid resolution of 12 km and extends from the Pacific Ocean in the west to Eastern Nevada in the east and runs from south of the U.S.-Mexico border in the south to north of the California-Oregon border in the north. The smaller 4 km Northern (green box) and Southern (red box) modeling domains are nested within the outer 12 km domain and utilized to better reflect the finer scale details of meteorology, topography, and emissions. Consistent with the WRF modeling, the 12 km and 4 km CMAQ domains are based on a Lambert Conformal Conic projection with reference longitude at -120.5°W, reference latitude at 37°N, and two standard parallels at 30°N and 60°N. The 30 vertical layers from WRF were mapped onto 18 vertical layers for CMAQ, extending from the surface to 100 mb such that the majority of the vertical layers fall within the planetary boundary layer. This vertical layer structure is based on the WRF sigma-pressure coordinates and the exact layer structure used can be found in Table 5-1. A third 4 km resolution modeling domain (blue box) is nested within the Northern California domain and covers the SJV air basin. This smaller SJV domain may be utilized for $PM_{2.5}$ modeling in the SJV if computational constraints (particularly for annual modeling) require the use of a smaller modeling domain. In prior work, modeling results from the smaller SJV domain were compared to results from the larger Northern California domain and no appreciable differences were noted, provided that both simulations utilized chemical boundary conditions derived from the same statewide 12 km simulation.

For the coarse portions of nested regional grids, the U.S. EPA guidance (U.S. EPA, 2014) suggests a grid cell size of 12 km if feasible but not larger than 36 km. For the fine scale portions of nested regional grids, it is desirable to use a grid cell size of ~4 km (U.S. EPA, 2014). Our selection of modeling domains and grid resolution is consistent with this recommendation. The U.S. EPA guidance (U.S. EPA, 2014) does not require a minimum number of vertical layers for an attainment demonstration, although typical applications of “one- atmosphere” models (with the model top at 50-100 mb) are anywhere from 14 to 35 vertical layers. In the ARB’s current SIP modeling platform, 18 vertical layers will be used in the CMAQ model. The vertical structure is based on the sigma-pressure coordinate, with the layers separated at 1.0, 0.9958, 0.9907, 0.9846, 0.9774, 0.9688, 0.9585, 0.9463, 0.9319, 0.9148, 0.8946, 0.8709, 0.8431, 0.8107, 0.7733, 0.6254, 0.293, 0.0788, and 0.0. As previously noted, this also ensures that the majority of the layers are in the planetary boundary layer.

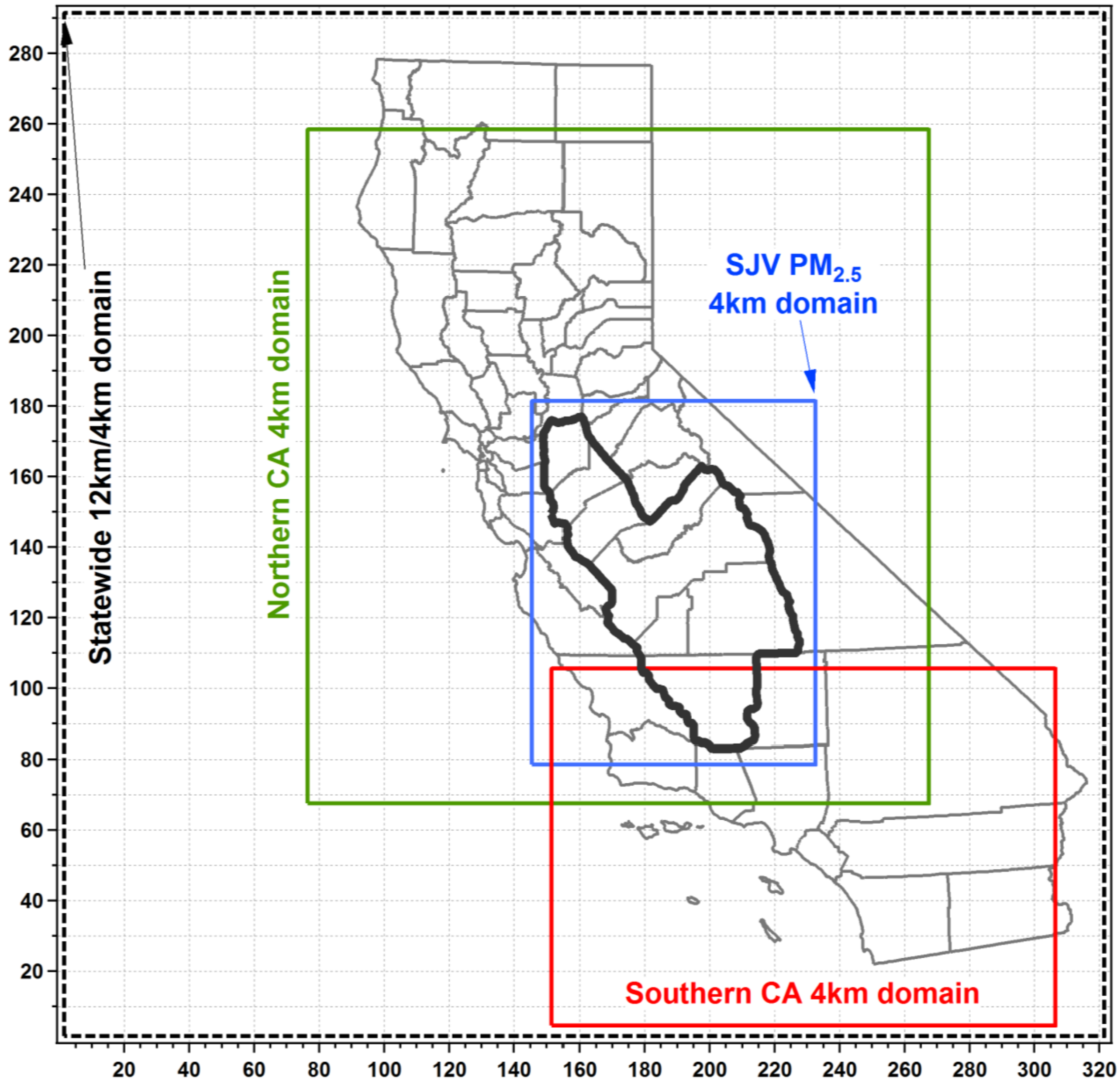

Figure 5-2. CMAQ modeling domains used in this SIP modeling platform. The outer domain (dashed black line) represents the extent of the California statewide domain (shown here with a 4 km horizontal resolution, but utilized in this modeling platform with a 12 km horizontal resolution). Nested higher resolution 4 km modeling domains are highlighted in green and red for Northern/Central California and Southern California, respectively. The smaller SJV $PM_{2.5}$ 4 km domain (colored in blue) is nested within the Northern California 4 km domain.

21

5.2.2 CMAQ Model Options

Table 5-3 shows the CMAQv5.0.2 configuration utilized in this modeling platform. The same configuration will be used in all simulations for both ozone and $PM_{2.5}$, and for all modeled years. The Intel FORTRAN compiler version 12 will be used to compile all source codes.

Table 5-3. CMAQ v5.0.2 configuration and settings.

Process	Scheme
Horizontal advection	Yamo (Yamartino scheme for mass-conserving advection)
Vertical advection	WRF-based scheme for mass-conserving advection
Horizontal diffusion	Multi-scale
Vertical diffusion	ACM2 (Asymmetric Convective Model version 2)
Gas-phase chemical mechanism	SAPRC07 gas-phase mechanism with version "C" toluene updates
Chemical solver	EBI (Euler Backward Iterative solver)
Aerosol module	Aero6 (the sixth-generation CMAQ aerosol mechanism with extensions for sea salt emissions and thermodynamics; includes a new formulation for secondary organic aerosol yields)
Cloud module	ACM_AE6 (ACM cloud processor that uses the ACM methodology to compute convective mixing with heterogeneous chemistry for AERO6)
Photolysis rate	phot_inline (calculate photolysis rates in-line using simulated aerosols and ozone)

5.2.3 Photochemical Mechanism

The SAPRC07 chemical mechanism will be utilized for all CMAQ simulations. SAPRC07, developed by Dr. William Carter at the University of California, Riverside, is a detailed mechanism describing the gas-phase reactions of volatile organic compounds (VOCs) and oxides of nitrogen (NO_X) (Carter, 2010a, 2010b). It represents a complete update to the SAPRC99 mechanism, which has been used for previous ozone SIP plans in the SJV. The well-known SAPRC family of mechanisms have been used widely in California and the U.S. (e.g., Baker, et al., 2015; Cai et al., 2011; Chen et al., 2014; Dennis et al., 2008; Ensberg, et al., 2013; Hakami, et al., 2004a, 2004b; Hu et al., 2012, 2014a, 2014b; Jackson, et al., 2006; Jin et al., 2008, 2010b; Kelly, et al., 2010b; Lane et al., 2008; Liang and Kaduwela, 2005; Livingstone et al., 2009; Lin et al., 2005; Napelenok, 2006; Pun et al., 2009; Tonse et al., 2008; Ying et al., 2008a, 2008b; Zhang et al., 2010; Zhang and Ying, 2011).

The SAPRC07 mechanism has been fully reviewed by four experts in the field through an ARB funded contract. These reviews can be found at http://www.arb.ca.gov/research/reactivity/rsac.htm. Dr. Derwent's (2010) review compared ozone impacts of 121 organic compounds calculated using SAPRC07 and the Master Chemical Mechanism (MCM) v 3.1 and concluded that the ozone impacts using the two mechanisms were consistent for most compounds. Dr. Azzi (2010) used SAPRC07 to simulate ozone formation from isoprene, toluene, m-xylene, and evaporated fuel in environmental chambers performed in Australia and found that SAPRC07 performed reasonably well for these data. Dr. Harley discussed implementing the SAPRC07 mechanism into 3-D air quality models and brought up the importance of the rate constant of NO_2 + OH. This rate constant in the SAPRC07 mechanism in CMAQv5.0.2 has been updated based on new research (Mollner et al., 2010). Dr. Stockwell (2009) compared individual reactions and rate constants in SAPRC07 to two other mechanisms (CB05 and RADM2) and concluded that SAPRC07 represented a state-of-the-science treatment of atmospheric chemistry.

5.2.4 Aerosol Module

The aerosol mechanism with extensions version 6 with aqueous-phase chemistry (AE6-AQ) will be utilized for all SIP modeling. When coupled with the SAPRC07 chemical mechanism, AE6-AQ simulates the formation and evaporation of aerosol and the evolution of the aerosol size distribution (Foley et al., 2010). AE6-AQ includes a comprehensive, yet computationally efficient, inorganic thermodynamic model ISORROPIA to simulate the physical state and chemical composition of inorganic atmospheric aerosols (Fountoukis and Nenes, 2007). AE6-AQ also features the addition of new $PM_{2.5}$ species, an improved secondary organic aerosol (SOA) formation module, as well as new treatment of atmospheric processing of primary organic aerosol (Appel et al., 2013; Carlton et al., 2010; Simon and Bhave, 2011). These updates to AE6-AQ in CMAQv5.0.2 continue to represent state-of-the-art treatment of aerosol processes in the atmosphere (Brown et al., 2011).

5.2.5 CMAQ Initial and Boundary Conditions (IC/BC) and Spin-Up period

Air quality model initial conditions define the mixing ratio (or concentration) of chemical and aerosol species within the modeling domain at the beginning of the model simulation. Boundary conditions define the chemical species mixing ratio (or concentration) within the air entering or leaving the modeling domain. This section discusses the initial and boundary conditions utilized in the ARB modeling system.

U.S. EPA guidance recommends using a model “spin-up” period by beginning a simulation 3-10 days prior to the period of interest (U.S. EPA, 2014). This “spin-up” period allows the initial conditions to be “washed out” of the system, so that the actual initial conditions have little to no impact on the modeling over the time period of interest, as well as giving sufficient time for the modeled species to come to chemical equilibrium. When conducting annual or seasonal modeling, it is computationally more efficient to simulate each month in parallel rather than the entire year or season sequentially. For each month, the CMAQ simulations will include a seven day spin-up period (i.e., the last seven days of the previous month) for the outer 12 km domain to ensure that the initial conditions are “washed out” of the system. Initial conditions at the beginning of the seven day spin-up period will be based on the default initial conditions that are included with the CMAQ release. The 4 km inner domain simulations will utilize a three day spin-up period, where the initial conditions will be based on output from the corresponding day of the 12 km domain simulation.

In recent years, the use of global chemical transport model (CTM) outputs as boundary conditions (BCs) in regional CTM applications has become increasingly common (Chen et al., 2008; Hogrefe et al., 2011; Lam and Fu, 2009; Lee et al., 2011; Lin et al., 2010), and has been shown to improve model performance in many cases (Appel et al., 2007; Borge et al., 2010; Tang et al., 2007, 2009; Tong and Mauzerall, 2006). The advantage of using global CTM model outputs as opposed to fixed climatological-average BCs is that the global CTM derived BCs capture spatial, diurnal, and seasonal variability, as well as provide a set of chemically consistent pollutant mixing ratios. In the ARB’s SIP modeling system, the Model for Ozone And Related chemical Tracers (MOZART; Emmons et al., 2010) will be used to define the boundary conditions for the outer 12 km CMAQ domain, while boundary conditions for the 4 km domain will be derived from the 12 km output. MOZART is a comprehensive global model for simulating atmospheric composition including both gases and bulk aerosols (Emmons et al., 2010). It was developed by the National Center for Atmospheric Research (NCAR), the Max-Planck-Institute for Meteorology (in Germany), and the Geophysical Fluid Dynamics Laboratory (GFDL) of the National Oceanic and Atmospheric Administration (NOAA), and is widely used in the scientific community. In addition to inorganic gases and VOCs, BCs were extracted for aerosol species including elemental carbon, organic matter, sulfate, soil and nitrate. MOZART has been extensively peer-reviewed and applied in a range of studies that utilize its output in defining BCs for regional modeling studies within California and other regions of the U.S. (e.g., Avise et al., 2008; Chen et al., 2008, 2009a, 2009b; Fast et al., 2014; Jathar et al., 2015).

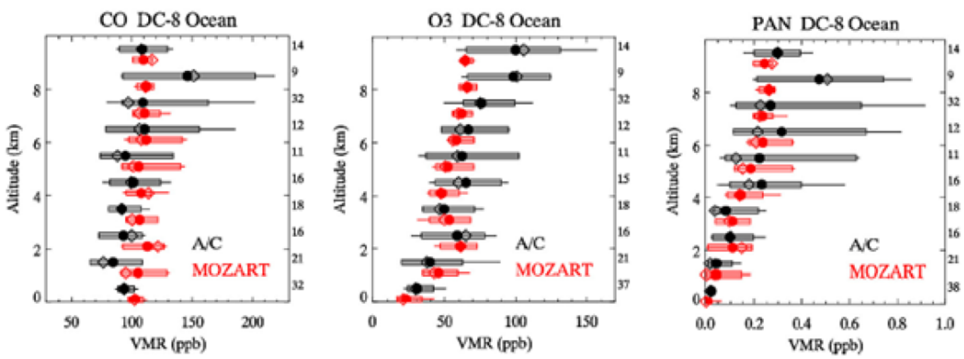

Figure 5-3. Comparison of MOZART (red) simulated CO (left), ozone (center), and PAN (right) to observations (black) along the DC-8 flight track. Shown are mean (filled symbol), median (open symbols), 10th and 90th percentiles (bars) and extremes (lines). The number of data points per 1-km wide altitude bin is shown next to the graphs. Adapted from Figure 2 in Pfister et al. (2011).

In particular, MOZART version 4 (MOZART-4) was recently used in a study characterizing summertime air masses entering California from the Pacific Ocean (Pfister et al., 2011). In their work, Pfister et al. (2011) compared MOZART-4 simulation results to measurements of CO, ozone, and PAN made off the California coast during the ARCTAS-CARB airborne field campaign (Jacob et al., 2010) and showed good agreement between the observations and model results (see Figure 5-3).
The specific MOZART simulations to be utilized in this modeling platform are the MOZART4-GEOS5 simulations by Louisa Emmons (NCAR) for the years 2012 and 2013, which are available for download at http://www.acom.ucar.edu/wrf-chem/mozart.shtml. These simulations are similar to those of Emmons et al. (2010), but with updated meteorological fields. Boundary condition data will be extracted from the MOZART-4 output and processed to CMAQ model ready format using the "mozart2camx" code developed by the Rambol-Environ Corporation (available at http://www.camx.com/download/support-software.aspx). The final BCs represent day-specific mixing ratios, which vary in both space (horizontal and vertical) and time (every six hours).

Per U.S. EPA guidance, the same MOZART derived BCs for the 12 km outer domain will be used for all simulations (e.g., Base Case, Reference, Future, and any sensitivity simulation).

5.3 Quality Assurance of Model Inputs

In developing the IC/BCs and Four Dimensional Data Assimilation (FDDA) datasets for WRF, quality control is performed on all associated meteorological data. Generally, all surface and upper air meteorological data are plotted in space and time to identify extreme values that are suspected to be "outliers". Data points are also compared to other, similar surrounding data points to determine whether there are any large relative discrepancies. If a scientifically plausible reason for the occurrence of suspected outliers is not known, the outlier data points are flagged as invalid and may not be used in the modeling analyses.

In addition, the model-ready emissions files used in CMAQ will be evaluated and compared against the planning inventory totals. Although deviations between the model-ready and planning inventories are expected due to temporal adjustments (e.g., month-of-year and day-of-week) and adjustments based on meteorology (e.g., evaporative emissions from motor vehicles and biogenic sources), any excessive deviation will be investigated to ensure the accuracy of the temporal and meteorology based adjustments. If determined to be scientifically implausible, then the adjustments which led to the deviation will be investigated and updated based on the best available science.

Similar to the quality control of the modeling emissions inventory, the chemical boundary conditions derived from the global CTM model will be evaluated to ensure that no errors were introduced during the processing of the data (e.g., during vertical interpolation of the global model data to the regional model vertical structure or mapping of the chemical species). Any possible errors will be evaluated and addressed if they are determined to be actual errors and not an artifact of the spatial and temporal dynamics inherent in the boundary conditions themselves.

6. METEOROLOGICAL MODEL PERFORMANCE

The complex interactions between the ocean-land interface, orographic induced flows from the mountain-valley topography, and the extreme temperature gradients between the ocean, delta region, valley floor, and mountain ranges surrounding the valley, make the SJV one of the most challenging areas in the country to simulate using prognostic meteorological models. Although there is a long history of prognostic meteorological model applications in California (e.g., Bao et al., 2008; Hu at al., 2010; Jackson et al., 2006; Jin et al., 2010a, 2010b; Livingstone et al., 2009; Michelson et al., 2010; Seaman, Stauffer, and Lario-Gibbs, 1995; Stauffer et al., 2000; Tanrikulu et al., 2000), there is no single model configuration that works equally well for all years and/or seasons, which makes evaluation of the simulated meteorological fields critical for ensuring that the fields reasonably reproduce the observed meteorology for any given time period.

6.1 Ambient Data Base and Quality of Data

Observed meteorological data used to evaluate the WRF model simulations will be obtained from the Air Quality and Meteorological Information System (AQMIS) database, which is a web-based source for real-time and official air quality and meteorological data (www.arb.ca.gov/airqualitytoday/). This database contains surface meteorological observations from 1969-2016, with the data through 2013 having been fully quality assured and deemed official. In addition ARB also has quality-assured upper-air meteorological data obtained using balloons, aircraft, and profilers.

6.2 Statistical Evaluation

Statistical analyses will be performed to evaluate how well the WRF model captured the overall structure of the observed atmosphere during the simulation period, using wind speed, wind direction, temperature, and humidity. The performance of the WRF model against observations will be evaluated using the METSTAT analysis tool (Emery et al, 2001) and supplemented using statistical software tools developed at ARB. The model output and observations will be processed, and data points at each observational site for wind speed, wind direction, temperature, and moisture data will be extracted. The following values will be calculated: Mean Obs, Mean Model, Mean Bias (MB), Mean (Gross) Error (ME/MGE), Normalized Mean Bias (NMB), Root Mean Squared error (RMSE), and the Index Of Agreement (IOA) when applicable. Additional statistical analysis may also be performed.

The mathematical expressions for these quantities are:

$$MB = \frac{1}{N}\sum_{1}^{N}(Model - Obs) \tag{6-1}$$

$$ME = \frac{1}{N}\sum_{1}^{N}\left|Model - Obs\right| \tag{6-2}$$

$$NMB = \frac{\sum_{1}^{N}(Model - Obs)}{\sum_{1}^{N}Obs} \times 100\%, \tag{6-3}$$

$$RSME = \sqrt{\frac{\sum_{1}^{N}(Model - Obs)^2}{N}} \tag{6-4}$$

$$IOA = 1 - \frac{\sum_{1}^{N}(Model - Obs)^2}{\sum_{1}^{N}\left[(Model - Obs) + (Model + Obs)\right]^2}, \tag{6-5}$$

where, "*Model*" is the simulated values, "*Obs*" is the observed value, and *N* is the number of observations. These values will be tabulated and plotted for all monitoring sites within the air basin of interest, and summarized by subregion when there are distinct differences in the meteorology within the basin. Statistics may be compared to other prognostic model applications in California to place the current model performance within the context of previous studies. In addition to the statistics above, model performance may also be evaluated through metrics such as frequency distributions, time-series analysis, and wind-rose plots. Based on previous experience with meteorological simulations in California, it is expected that the analysis will show wind speed to be overestimated at some stations with a smaller difference at others. The diurnal variations of temperature and wind direction at most stations are likely to be captured reasonably well. However, the model will likely underestimate the larger magnitudes of temperature during the day and smaller magnitudes at night.

6.3 Phenomenological Evaluation

In addition to the statistical evaluation described above, a phenomenological based evaluation can provide additional insights as to the accuracy of the meteorological modeling. A phenomenological evaluation may include analysis such as determining the relationship between observed air quality and key meteorological parameters (e.g., conceptual model) and then evaluating whether the simulated meteorology and air quality is able to reproduce those relationships. Another possible approach would be to generate geopotential height charts at 500 and 850 mb using the simulated results and compare those to the standard geopotential height charts. This would reveal if the large-scale weather systems at those pressure levels were adequately simulated by the regional prognostic meteorology model. Another similar approach is to identify the larger-scale meteorological conditions associated with air quality events using the National Centers for Environmental Prediction (NCEP) Reanalysis dataset. These can then be visually compared to the simulated meteorological fields to determine whether those large-scale meteorological conditions were accurately simulated and whether the same relationships observed in the NCEP reanalysis are present in the simulated data.

7. PHOTOCHEMICAL MODEL PERFORMANCE

7.1 Ambient Data

Air quality observations are routinely made at state and local monitoring stations. Gas species and PM species are measured on various time scales (e.g., hourly, daily, weekly). The U.S. EPA guidance recommends model performance evaluations for the following gaseous pollutants: ozone (O_3), nitric acid (HNO_3), nitric oxide (NO), nitrogen dioxide (NO_2), peroxyacetyl nitrate (PAN), volatile organic compounds (VOCs), ammonia (NH_3), NO_y (sum of NO_x and other oxidized compounds), sulfur dioxide (SO_2), carbon monoxide (CO), and hydrogen peroxide (H2O2). The U.S. EPA recognizes that not all of these species are routinely measured (U.S. EPA, 2014) and therefore may not be available for evaluating every model application. Recognizing that $PM_{2.5}$ is a mixture, U.S. EPA recommends model performance evaluation for the following individual $PM_{2.5}$ species: sulfate (SO_4^{2-}), nitrate (NO_3^-), ammonium (NH_4^+), elemental carbon (EC), organic carbon (OC) or organic mass (OM), crustal, and sea salt constituent (U.S. EPA, 2014).

Table 7-1 lists the species for which routine measurements are generally available in 2012 and 2013. When quality assured data are available and appropriate for use, model performance for each species will be evaluated. Observational data will be obtained from the Air Quality and Meteorological Information System (AQMIS), which is a web-based source for real-time and official air quality and meteorological data (www.arb.ca.gov/airqualitytoday/). This database contains surface air quality observations from 1980-2016, with the data through 2014 having been fully quality assured and deemed official.

Table 7-1. Monitored species used in evaluating model performance.

Species	Sampling frequency
O_3	1 hour
NO	1 hour
NO_2	1 hour
NO_x	1 hour
CO	1 hour
SO_2	1 hour
Selected VOCs from the PAMS measurement	3 hours (not every day)
$PM_{2.5}$ measured using FRM[1]	24 hours (daily to one in six days)
$PM_{2.5}$ measured using FEM	Continuously
$PM_{2.5}$ Speciation sites	24 hours (not every day)
Sulfate ion	24 hours (not every day)
Nitrate ion	24 hours (not every day)
Ammonium ion	24 hours (not every day)
Organic carbon	24 hours (not every day)
Elemental carbon	24 hours (not every day)
Sea salt constituents	24 hours (not every day)

[1] Direct comparison between modeled and FRM $PM_{2.5}$ may not be appropriate because of various positive and negative biases associated with FRM measurement procedures.

30

These species cover the majority of pollutants of interest for evaluating model performance as recommended by the U.S. EPA. Other species such as H_2O_2, HNO_3, NH_3, and PAN are not routinely measured. During the DISCOVER-AQ field campaign, which took place in January and February 2013 in the SJV, aircraft sampling provided daytime measurements for a number of species (including HNO_3, NH_3, PAN, alkyl nitrates, and selected VOC species) that are not routinely measured. Modeled concentrations will be compared to aircraft measurements for these species, except for the gaseous HNO_3 measurements, which were contaminated by particulate nitrate (Dr. Chris Cappa, personal communication).

7.2 Statistical Evaluation

As recommended by U.S. EPA, a number of statistical metrics will be used to evaluate model performance for ozone, speciated and total $PM_{2.5}$, as well as other precursor species. These metrics may include mean bias (MB), mean error (ME), mean fractional bias (MFB), mean fractional error (MFE), normalized mean bias (NMB), normalized mean error (NME), root mean square error (RMSE), correlation coefficient (R^2), mean normalized bias (MNB), and mean normalized gross error (MNGE). The formulae for estimating these metrics are given below.

$$MB = \frac{1}{N}\sum_{1}^{N}(Model - Obs) \tag{7-1}$$

$$ME = \frac{1}{N}\sum_{1}^{N}\left|Model - Obs\right| \tag{7-2}$$

$$MFB = \frac{2}{N}\sum_{1}^{N}\left(\frac{Model - Obs}{Model + Obs}\right)\times 100\%, \tag{7-3}$$

$$MFE = \frac{2}{N}\sum_{1}^{N}\left(\frac{\left|Model - Obs\right|}{Model + Obs}\right)\times 100\%, \tag{7-4}$$

$$NMB = \frac{\sum_{1}^{N}(Model - Obs)}{\sum_{1}^{N} Obs} \times 100\%, \qquad (7\text{-}5)$$

$$NME = \frac{\sum_{1}^{N}|Model - Obs|}{\sum_{1}^{N} Obs} \times 100\%, \qquad (7\text{-}6)$$

$$RSME = \sqrt{\frac{\sum_{1}^{N}(Model - Obs)^2}{N}} \qquad (7\text{-}7)$$

$$R^2 = \left(\frac{\sum_{1}^{N}((Model - \overline{Model}) \times (Obs - \overline{Obs}))}{\sqrt{\sum_{1}^{N}(Model - \overline{Model})^2 \sum_{1}^{N}(Obs - \overline{Obs})^2}}\right)^2 \qquad (7\text{-}8)$$

$$MNB = \frac{1}{N}\sum_{1}^{N}\left(\frac{Model - Obs}{Obs}\right) \times 100\%, \qquad (7\text{-}9)$$

$$MNGE = \frac{1}{N}\sum_{1}^{N}\left(\frac{|Model - Obs|}{Obs}\right) \times 100\%. \qquad (7\text{-}10)$$

where, “Model” is the simulated mixing ratio, “$\overline{Model}$” is the simulated mean mixing ratio, “Obs” is the observed value, “$\overline{Obs}$” is the mean observed value, and “N” is the number of observations.

In addition to the above statistics, various forms of graphics will also be created to visually examine and compare the model predictions to observations. These will include time-series plots comparing the predictions and observations, scatter plots for comparing the magnitude of the simulated and observed mixing ratios, box plots to summarize the time series data across different regions and averaging times, as well as frequency distributions. For $PM_{2.5}$ the so called “bugle plots” of MFE and MFB from Boylan and Russell (2006) will also be generated. The plots described above will be created for paired observations and predictions over time scales dictated by the averaging frequencies of observations (i.e., hourly, daily, monthly, seasonally) for the species of interest. Together, they will provide a detailed view of model performance during different time periods, in different sub-regions, and over different concentrations and mixing ratio levels.

7.3 Comparison to Previous Modeling Studies

Previous U.S. EPA modeling guidance (U.S. EPA, 1991) utilized “bright line” criteria for the performance statistics that distinguished between adequate and inadequate model performance. In the latest modeling guidance from U.S. EPA (U.S EPA, 2014) it is now recommended that model performance be evaluated in the context of similar modeling studies to ensure that the model performance approximates the quality of those studies. The work of Simon et al. (2012) summarized photochemical model performance for studies published in the peer-reviewed literature between 2006 and 2012 and this work will form the basis for evaluating the modeling utilized in the attainment demonstration.

7.4 Diagnostic Evaluation

Diagnostic evaluations are useful for investigating whether the physical and chemical processes that control ozone and $PM_{2.5}$ formation are correctly represented in the modeling. These evaluations can take many forms, such as utilizing model probing tools like process analysis, which tracks and apportions ozone mixing ratios in the model to various chemical and physical processes, or source apportionment tools that utilize model tracers to attribute ozone formation to various emissions source sectors and/or geographic regions. Sensitivity studies (either “brute-force” or the numerical Direct Decoupled Method) can also provide useful information as to the response exhibited in the modeling to changes in various input parameters, such as changes to the emissions inventory or boundary conditions. Due to the nature of this type of analysis, diagnostic evaluations can be very resource intensive and the U.S. EPA modeling guidance acknowledges that air agencies may have limited resources and time to perform such analysis under the constraints of a typical SIP modeling application. To the extent possible, some level of diagnostic evaluation will be included in the model attainment demonstration for this SIP.

In addition to the above analysis, the 2013 DISCOVER-AQ field campaign in the SJV offers a unique dataset for additional diagnostic analysis that is not available in other areas, in particular, the use of indicator ratios in determining the sensitivity of secondary $PM_{2.5}$ to its limiting precursors. As an example, the ratio between free ammonia (total ammonia – 2 x sulfate) and total nitrate (gaseous + particulate) was proposed by Ansari and Pandis (1998) as an indicator of whether ammonium nitrate formation is limited by NO_x or ammonia emissions. The DISCOVER-AQ dataset will be utilized to the extent possible to investigate $PM_{2.5}$ precursor sensitivity in the SJV as well as analysis of upper measurements and detailed ground level AMS measurements (Young et al., 2016).

8. ATTAINMENT DEMONSTRATION

The U.S. EPA modeling guidance (U.S. EPA, 2014) outlines the approach for utilizing models to predict future attainment of the 0.075 ppm 8-hour ozone standard. Consistent with the previous modeling guidance (U.S. EPA, 2007) utilized in the most recent 8-hour ozone (2007), annual $PM_{2.5}$ (2008), and 24-hour $PM_{2.5}$ (2012) SIPs, the current guidance recommends utilizing modeling in a relative sense. A detailed description of how models are applied in the attainment demonstration for both ozone and $PM_{2.5}$, as prescribed by U.S. EPA modeling guidance, is provided below.

8.1 Base Year Design Values

The starting point for the attainment demonstration is with the observational based design value (DV), which is used to determine compliance with the standard at any given monitor. The DV for a specific monitor and year represents the three-year average of the annual 4^{th} highest 8-hour ozone mixing ratio, 98^{th} percentile of the 24-hour $PM_{2.5}$ concentration, or annual average $PM_{2.5}$ concentration, depending on the standard, observed at the monitor. For example, the 8-hr O_3 DV for 2012 is the average of the observed 4^{th} highest 8-hour ozone mixing ratio from 2010, 2011, and 2012.

The U.S. EPA recommends using an average of three DVs to better account for the year-to-year variability inherent in meteorology. Since 2012 has been chosen as the base year for projecting DVs to the future, site-specific DVs will be calculated for the three three-year periods ending in 2012, 2013, and 2014 and then these three DVs will be averaged. This average DV is called a weighted DV (in the context of this SIP, the weighted DV will also be referred to as the reference year DV or DV_R). Table 8-1 illustrates how the weighted DV is calculated.

Table 8-1. Illustrates the data from each year that are utilized in the Design Value calculation for that year (DV Year), and the yearly weighting of data for the weighted Design Value calculation (or DV_R). "obs" refers to the observed metric (8-hr O_3, 24-hour $PM_{2.5}$, or annual average $PM_{2.5}$).

DV Year	Years Averaged for the Design Value (4th highest observed 8-hr O_3, 98th percentile 24-hour $PM_{2.5}$, or annual average $PM_{2.5}$)				
2012	2010	2011	2012		
2013		2011	2012	2013	
2014			2012	2013	2014
Yearly Weightings for the Weighted Design Value Calculation					
2012-2014 Average	$DV_R = \frac{obs_{2010} + (2)obs_{2011} + (3)obs_{2012} + (2)obs_{2013} + obs_{2014}}{9}$				

8.2 Base, Reference, and Future Year Simulations

Projecting the weighted DVs to the future requires three photochemical model simulations as described below:

1. ***Base Year Simulation***
   The base year simulation for 2012 or 2013 is used to assess model performance (i.e., to ensure that the model is reasonably able to reproduce the observed ozone mixing ratios). Since this simulation will be used to assess model performance, it is essential to include as much day-specific detail as possible in the emissions inventory, including, but not limited to hourly adjustments to the motor vehicle and biogenic inventories based on observed local meteorological conditions, known wildfire and agricultural burning events, and exceptional events such as the Chevron refinery fire in 2012.

2. ***Reference Year Simulation***
   The reference year simulation is identical to the base year simulation, except that certain emissions events which are either random and/or cannot be projected to the future are removed from the emissions inventory. These include wildfires and events such as the 2012 Chevron refinery fire.

3. ***Future Year Simulation***
   The future year simulation is identical to the reference year simulation, except that the projected future year anthropogenic emission levels are used rather than the reference year emission levels. All other model inputs (e.g., meteorology, chemical boundary conditions, biogenic emissions, and calendar

for day-of-week specifications in the inventory) are the same as those used in the reference year simulation.

The base year simulation is solely used for evaluating model performance, while the reference and future year simulations are used to project the weighted DV to the future as described in subsequent sections of this document.

8.3 Relative Response Factors

As part of the model attainment demonstration, the fractional change in ozone or $PM_{2.5}$ between the model future year and model reference year are calculated for each monitor location. These ratios, called "relative response factors" or RRFs, are calculated based on the ratio of modeled future year ozone or $PM_{2.5}$ to the corresponding modeled reference year ozone or $PM_{2.5}$ (Equation 8-1).

$$\text{RRF} = \frac{\text{average } (\mathrm{O_3} \text{ or } \mathrm{PM_{2.5}})_{\text{future}}}{\text{average } (\mathrm{O_3} \text{ or } \mathrm{PM_{2.5}})_{\text{reference}}} \quad (8\text{-}1)$$

8.3.1 8-hour Ozone RRF

For 8-hour ozone, the modeled maximum daily average 8-hour (MDA8) ozone is used in calculating the RRF. These MDA8 ozone values are based on the maximum simulated ozone within a 3x3 array of cells surrounding the monitor (Figure 8-1). The future and base year ozone values used in RRF calculations are paired in space (i.e., using the future year MDA8 ozone value at the same grid cell where the MDA8 value for the reference? year is located within the 3x3 array of cells). The days used to calculate the average MDA8 for the reference and future years are inherently consistent, since the same meteorology is used to drive both simulations.

Not all modeled days are used to calculate the average MDA8 ozone from the reference and future year simulations. The form of the 8-hour ozone NAAQS is such that it is geared toward the days with the highest mixing ratios in any ozone season (i.e., the 4^{th} highest MDA8 ozone). Therefore, the modeled days used in the RRF calculation should also reflect days with the highest ozone levels. As a result, the current U.S. EPA guidance (U.S. EPA, 2014) suggests using the top 10 modeled days when calculating the RRF. Since the relative sensitivity to emissions changes (in both the model and real world) can vary from day-to-day due to meteorology and emissions (e.g., temperature dependent emissions or day-of-week variability) using the top 10 days ensures that the calculated RRF is robust and stable (i.e., not overly sensitive to any single day used in the calculation).

When choosing the top 10 days, the U.S. EPA recommends beginning with all days in which the simulated reference MDA8 is >= 60 ppb and then calculating RRFs based on the top 10 high ozone days. If there are fewer than 10 days with MDA8 ozone >= 60 ppb then all days >= 60 ppb are used in the RRF calculation, as long as there are at least 5 days used in the calculation. If there are fewer than 5 days >= 60 ppb, an RRF cannot be calculated for that monitor. To ensure that only modeled days which are consistent with the observed ozone levels are used in the RRF calculation, the modeled days are further restricted to days in which the reference MDA8 ozone is within ± 20% of the observed value at the monitor location.

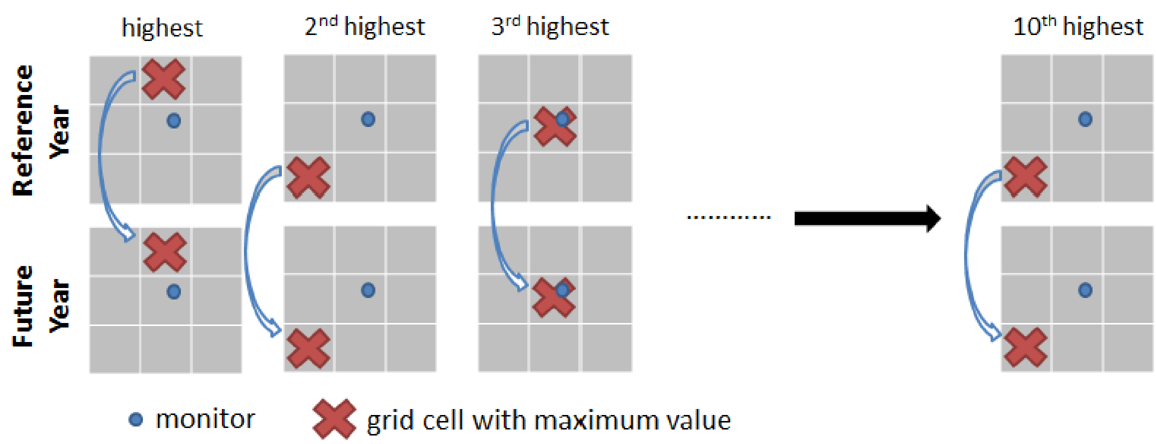

Figure 8-1. Example showing how the location of the MDA8 ozone for the top ten days in the reference and future years are chosen.

8.3.2 Annual and 24-hour $PM_{2.5}$ RRF

The U.S. EPA (2014) guidance requires RRFs for both the annual and 24-hour $PM_{2.5}$ attainment tests be calculated on a quarterly basis (January-March, April-June, July-September, and October-December) and for each $PM_{2.5}$ component (sulfate, nitrate, ammonium, organic carbon, elemental carbon, particle bound water, salt, and other primary inorganic components).

For annual $PM_{2.5}$, the quarterly RRFs are based on modeled quarterly mean concentrations for each component, where the concentrations are averaged over the 9 model grid cells within the 3x3 array of grid cells surrounding each monitor. For the 24-hour $PM_{2.5}$ attainment test, the quarterly RRFs are calculated based on the average for each component over the top 10% of modeled days (or the top nine days per quarter) with the highest total 24-hour average $PM_{2.5}$ concentration. Peak $PM_{2.5}$ values are selected and averaged using the $PM_{2.5}$ concentration simulated at the single grid cell containing the monitoring site for calculating the 24-hour $PM_{2.5}$ RRF (as opposed to the 3x3 array average used in the annual $PM_{2.5}$ RRF calculation).

8.4 Future Year Design Value Calculation

8.4.1 8-hour Ozone

For 8-hour ozone, a future year DV at each monitor is calculated by multiplying the corresponding reference year DV by the site-specific RRF from Equation 8-1 (Equation 8-2).

$$DV_F = DV_R \times RRF \qquad (8\text{-}2)$$

where,
DV_F = future year design value,
DV_R = reference year design value, and
RRF = the site specific RRF from Equation 8-1

The resulting future year DVs are then compared to the 8-hour ozone NAAQS to demonstrate whether attainment will be reached under the future emissions scenario utilized in the future year modeling. A monitor is considered to be in attainment of the 8-hour ozone standard if the estimated future design value does not exceed the level of the standard.

8.4.2 Annual and 24-hour $PM_{2.5}$

8.4.2.1 Sulfate, Adjusted Nitrate, Derived, Water, Inferred Carbonaceous Material Balance Approach (SANDWICH) and Potential Modifications

Federal Reference Method (FRM) $PM_{2.5}$ mass measurements provide the basis for the attainment/nonattainment designations. For this reason it is recommended that the FRM data be used to project future air quality and progress towards attainment. However, given the complex physicochemical nature of $PM_{2.5}$, it is necessary to consider individual $PM_{2.5}$ species as well. While the FRM measurements give the mass of the bulk sample, a method for apportioning this bulk mass to individual $PM_{2.5}$ components is the first step towards determining the best emissions controls strategies to reach NAAQS levels in a timely manner.

The FRM measurement protocol finds its roots in the past epidemiological studies of health effects associated with $PM_{2.5}$ exposure. It is upon these studies that the NAAQS are based. The FRM protocol is sufficiently detailed so that results might be easily reproducible and involves the measurement of filter mass before and after sampling together with equilibrating at narrowly defined conditions. Filters are equilibrated for more than 24 hours at a standard relative humidity between 30 and 40% and temperature between 20 and 23 ºC. Due to the sampler construction and a lengthy filter equilibration period, FRM measurements are subjected to a number of known positive and negative artifacts. FRM measurements do not necessarily capture the $PM_{2.5}$ concentrations in the atmosphere and can differ substantially from what is measured by speciation monitors including the Speciation Trends Network (STN) monitors (see http://www.epa.gov/ttnamti1/specgen.html for more details). Nitrate and semi-volatile organic mass can be lost from the filter during the equilibration process, and particle bound water associated with hygroscopic species like sulfate provides a positive artifact. These differences present an area for careful consideration when one attempts to utilize speciated measurements to apportion the bulk FRM mass to individual species. Given that (1) attainment status is currently dependent upon FRM measurements and (2) concentrations of individual $PM_{2.5}$ species need to be considered in order to understand the nature of and efficient ways to ameliorate the $PM_{2.5}$ problem in a given region, a method has been developed to speciate bulk FRM $PM_{2.5}$ mass with known FRM limitations in mind. This method is referred to as the measured **S**ulfate, **A**djusted **N**itrate, **D**erived **W**ater, **I**nferred **C**arbonaceous material balance approach or “SANDWICH” (Frank, 2006). SANDWICH is based on speciated measurements from other (often co-located) samplers, such as those from STN, and the known sampling artifacts of the FRM. The approach strives to provide mass closure, reconciliation between speciated and bulk mass concentration measurements, and the basis for a connection between observations, modeled $PM_{2.5}$ concentrations, and the air quality standard (U.S. EPA, 2014).

The main steps in estimating the $PM_{2.5}$ composition are as follows:

(1) Calculate the nitrate retained on the FRM filter using hourly relative humidity and temperature together with the STN nitrate measurements,

The FRM does not retain all of the semi-volatile $PM_{2.5}$ mass, and at warmer temperatures, loss of particulate nitrate from filters has been commonly observed (Chow et al., 2005). In order to estimate how much nitrate is retained on the FRM filter, simple thermodynamic equilibrium relations may be used. Necessary inputs include 24-hour average nitrate measurements and hourly temperature and relative humidity data. Frank (2006) suggests the following methodology for estimating retained nitrate. For each hour *i* of the day, calculate the dissociation constant, K_i from ambient temperature and relative humidity (RH).

For RH < 61%:

$$\ln(K_i) = 118.87 - (24084/T_i) - 6.025 \times \ln(T_i),$$

where, T_i is the hourly temperature in Kelvins and K_i is in nanobars.

For RH ≥ 61%, K_i is replaced by:

$$K_i' = [P_1 - P_2(1-a_i) + P_3(1-a_i)^2] \times (1-a_i)^{1.75} \times K_i,$$

where, a_i is "fractional" relative humidity and

$$\ln(P_1) = -135.94 + 8763/T_i + 19.12 \times \ln(T_i),$$
$$\ln(P_2) = -122.65 + 9969/T_i + 16.22 \times \ln(T_i),$$
$$\ln(P_3) = -182.61 + 13875/T_i + 24.46 \times \ln(T_i).$$

Using this information, calculate the nitrate retained on the filter as:

$$\text{Retained Nitrate} = \text{STN nitrate} - 745.7/T_R \times (\kappa - \gamma) \times \frac{1}{24}\sum_{i=1}^{24}\sqrt{K_i},$$

where, T_R is the daily average temperature for the sampled air volume in Kelvin, K_i is the dissociation constant for NH_4NO_3 at ambient temperature for hour i, and $(\kappa - \gamma)$ relates to the temperature rise of the filter and vapor depletion from the inlet surface and is assumed to have a value equal to one (Hering and Cass, 1999).

(2) Calculate quarterly averages for retained nitrate, sulfate, elemental carbon, sea salt, and ammonium,

(3) Calculate particle bound water using the concentrations of ammonium, sulfate, and nitrate, using an equilibrium model like the Aerosol Inorganic Model (AIM) or a polynomial equation derived from model output

Under the FRM filter equilibration conditions, hygroscopic aerosol will retain its particle bound water (PBW) and be included in the observed FRM $PM_{2.5}$ mass. PBW can be calculated using an equilibrium model like the Aerosol Inorganics Model (AIM). AIM requires the concentrations of ammonium, nitrate, sulfate, and estimated H^+ as inputs. In addition to inorganic concentrations, the equilibration conditions are also necessary model inputs. In this case, a temperature of 294.15 K and 35% RH is recommended. Alternatively, for simplification, a polynomial regression equation may be constructed by fitting the calculated water concentration from an equilibrium model and the concentrations of nitrate, ammonium, and sulfate. The AIM model will be used for more accurate calculation of PBW.

(4) Add 0.5 μg/m^3 as blank mass, and

(5) Calculate organic carbon mass (OCMmb) by difference, subtracting all inorganic species (including blank mass) from the $PM_{2.5}$ mass.

Other components that may be represented on the FRM filter include elemental carbon, crustal material, sea salt, and passively collected mass. Depending on location certain species may be neglected (e.g., sea salt for inland areas).

While carbonaceous aerosol may make up a large portion of airborne aerosol, speciated measurements of carbonaceous PM are considered highly uncertain. This is due to the large number of carbon compounds in the atmosphere and the measurement uncertainties associated with samplers of different configurations. In the SANDWICH approach, organic carbonaceous mass is calculated by difference. The sum of all nonorganic carbon components will be subtracted from the FRM $PM_{2.5}$ mass to estimate the mass of organic carbon.

After having calculated the species concentrations as outlined above, we will calculate the percentage contribution of each species to the measured FRM mass (minus the blank concentration of 0.5 μg/m^3) for each quarter of the years represented by the speciated data. Note that blank mass is kept constant at 0.5 μg/m^3 between the base and future years, and future year particle bound water needs to be calculated for the future year values of nitrate, ammonium, and sulfate.

8.4.2.2 Estimation of Species Concentrations at Federal Reference Method (FRM) Monitors that Lack Speciation Data

Speciation data from available STN (speciation) sites will be used to speciate the FRM mass for all FRM sites. For those sites not collocated with STN monitors, surrogate speciation sites will be determined based on proximity and evaluation of local emissions or based on similarity in speciation profiles if such data exists (e.g., such as the speciated data collected in the SJV during CRPAQS (Solomon and Magliano, 1998)).

8.4.2.3 Speciated Modeled Attainment Test (SMAT)

Following U.S. EPA modeling guidance (U.S. EPA, 2014), the model attainment test for the annual $PM_{2.5}$ standard will be performed with the following steps.

Step 1: For each year used in the design value calculation, determine the observed quarterly mean $PM_{2.5}$ and quarterly mean composition for each monitor by multiplying the monitored quarterly mean concentration of FRM derived $PM_{2.5}$ by the fractional composition of $PM_{2.5}$ species for each quarter.

Step 2: Calculate the component specific RRFs at each monitor for each quarter as described in section 8.3.2.

Step 3: Apply the component specific RRFs to the quarterly mean concentrations from Step 1 to obtain projected quarterly species estimates.

Step 4: Calculate future year annual average $PM_{2.5}$ estimates by summing the quarterly species estimates at each monitor and then compare to the annual $PM_{2.5}$ NAAQS. If the projected average annual arithmetic mean $PM_{2.5}$ concentration is ≤ the NAAQS, then the attainment test is passed.

For the 24-hour $PM_{2.5}$ standard, the attainment test is performed with the following steps (U.S. EPA, 2014):

Step 1: Determine the top eight days with the highest observed 24-hour $PM_{2.5}$ concentration (FRM sites) in each quarter and year used in the design value calculation (a total of 32 days per year), and calculate the 98^{th} percentile value for each year.

Step 2: Calculate quarterly ambient species fractions on “high” $PM_{2.5}$ days for each of the major $PM_{2.5}$ component species (i.e., sulfate, nitrate, ammonium, elemental carbon, organic carbon, particle bound water, salt, and blank mass). The “high” days are represented by the top 10% of days in each quarter. Depending on the sampling frequency, the number of days captured in the top 10% would range from three to nine. The species fractions of $PM_{2.5}$ are calculated using the “SANDWICH” approach which was described previously. These quarter-specific fractions along with the FRM $PM_{2.5}$ concentrations are then used to calculate species concentrations for each of the 32 days per year determined in Step 1.

Step 3: Apply the component and quarter specific RRF, described in Section 8.3.2, to observed daily species concentrations from Step 2 to obtain future year concentrations of sulfate, nitrate, elemental carbon, organic carbon, salt, and other primary $PM_{2.5}$.

Step 4: Calculate the future year concentrations for the remaining $PM_{2.5}$ components (i.e., ammonium, particle bound water, and blank mass). The future year ammonium is calculated based on the calculated future year sulfate and nitrate, using a constant value for the degree of neutralization of sulfate from the ambient data. The future year particle bound water is calculated from the AIM model.

Step 5: Sum the concentration of each of the species components to calculate the total $PM_{2.5}$ concentration for each of the 32 days per year and at each site. Sort the 32 days for each site and year, and calculate the 98^{th} percentile value corresponding to each year.

Step 6: Calculate the future design value at each site based on the 98^{th} percentile concentrations calculated in Step 5 and following the standard protocol for calculating design values (see Table 8-1). Compare the future-year 24-hour design values to the NAAQS. If the projected design value is ≤ the NAAQS, then the attainment test is passed.

43

8.4.2.4 Sensitivity Analyses

Model sensitivity analysis may be conducted if the model attainment demonstration does not show attainment of the applicable standard with the baseline future inventory, or for determining precursor sensitivities and inter-pollutant equivalency ratios. For both ozone and $PM_{2.5}$, the sensitivity analysis will involve domain wide fractional reductions of the appropriate anthropogenic precursor emissions using the future year baseline emissions scenario as a starting point. In the event that the model attainment demonstration does not show attainment for the applicable standard, it is important to know the precursor limitation to assess the level of emissions controls needed to attain the standard.

In order to identify what combinations of precursor emissions reductions is predicted to lead to attainment, a series of modeling sensitivity simulations with varying degrees of precursor reductions from anthropogenic sources are typically performed. These sensitivity simulations are identical to the baseline future year simulation discussed earlier except that domain-wide fractional reductions are applied to future year anthropogenic precursor emission levels and a new future year design value is calculated. The results of these sensitivity simulations are plotted on isopleth diagrams, which are also referred to as carrying capacity diagrams. The isopleths provide an estimate of the level of emissions needed to demonstrate attainment and thereby inform the development of a corresponding control strategy.

For ozone, this would likely entail reducing anthropogenic NO_x and VOC emissions in 25% increments including cross sensitivities (e.g., 0.75 x NO_x + 1.00 x VOC; 1.00 x NO_x + 0.75 x VOC; 0.75 x NO_x + 0.75 x VOC; 0.5 x NO_x + 1.00 x VOC; ….). Typically, a full set of sensitivities would include simulations for 25%, 50%, and 75% reduction in NO_x and VOC, along with the cross sensitivities (for a total of 16 simulations including the future base simulation). After design values are calculated for each new sensitivity simulation, an ozone isopleth (or carrying capacity diagram) as a function of NO_x and VOC emissions is generated and used to estimate the additional NO_x and VOC emission reductions needed to attain the standard. The approach for $PM_{2.5}$ is similar, except that additional precursor emissions must be considered. Typically, the precursors considered for $PM_{2.5}$ would include anthropogenic NO_x, SO_x, VOCs, NH_3, as well as direct $PM_{2.5}$ emissions (Chen et al., 2014). Cross sensitivities for generating $PM_{2.5}$ carrying capacity diagrams would be conducted with respect to NO_x, which would include the following precursor pairs: NO_x vs. primary $PM_{2.5}$, NO_x vs. VOC, NO_x vs. NH_3, and NO_x vs. SO_x.

In addition to the $PM_{2.5}$ carrying capacity simulations, precursor sensitivity modeling may be conducted for determining the significant precursors to $PM_{2.5}$ formation and for developing inter-pollutant equivalency ratios. These simulations would follow a similar approach to the carrying capacity simulations described above, but would involve only a single sensitivity simulation for each precursor, where emissions of that precursor are reduced between 30% and 70% from the future base year. The "effectiveness" of reducing a given species can be quantified at each FRM monitor as the change in µg $PM_{2.5}$ (i.e., change in design value) per ton of precursor emissions (corresponding to the 15% change in emissions). Equivalency ratios between $PM_{2.5}$ precursors (i.e., NO_x, SO_x, VOCs, and NH_3) and primary $PM_{2.5}$ will be determined by dividing primary $PM_{2.5}$ effectiveness by the precursors' effectiveness.

8.5 Unmonitored Area Analysis

The unmonitored area analysis is used to ensure that there are no regions outside of the existing monitoring network that could exceed the NAAQS if a monitor was present at that location (U.S. EPA, 2014). The U.S. EPA recommends combining spatially interpolated design value fields with modeled gradients for the pollutant of interest (e.g. Ozone and $PM_{2.5}$) and grid-specific RRFs in order to generate gridded future year gradient adjusted design values. The spatial Interpolation of the observed design values is done only within the geographic region constrained by the monitoring network, since extrapolating to outside of the monitoring network is inherently uncertain. This analysis can be done using the Model Attainment Test Software (MATS) (Abt, 2014); however this software is not open source and comes as a precompiled software package. To maintain transparency and flexibility in the analysis, in-house R codes (https://www.r-project.org/) developed at ARB will be utilized in this analysis. The basic steps followed in the unmonitored area analysis for 8-hour ozone and annual/24-hour $PM_{2.5}$ are described below.

8.5.1 8-hour Ozone

In this section, the specific steps followed in 8-hr ozone unmonitored area analysis are described briefly:

Step 1: At each grid cell, the top-10 modeled maximum daily average 8-hour ozone mixing ratios from the reference year simulation will be averaged, and a gradient in this top-10 day average between each grid cell and grid cells which contain a monitor will be calculated.

Step 2: A single set of spatially interpolated 8-hr ozone DV fields will be generated based on the observed 5-year weighted base year 8-hr ozone DVs from the available monitors. The interpolation is done using normalized inverse distance squared weightings for all monitors within a grid cell's Voronoi Region (calculated with the R tripack library; https://cran.r-project.org/web/packages/tripack/README), and adjusted based on the gradients between the grid cell and the corresponding monitor from Step 1.

Step 3: At each grid cell, the RRFs are calculated based on the reference- and future-year modeling following the same approach outlined in Section 8.3, except that the +/- 20% limitation on the simulated and observed maximum daily average 8-hour ozone is not applicable because observed data do not exist for grid cells in unmonitored areas.

Step 4: The future year gridded 8-hr ozone DVs are calculated by multiplying the gradient-adjusted interpolated 8-hr ozone DVs from Step 2 with the gridded RRFs from Step 3

Step 5: The future-year gridded 8-hr ozone DVs (from Step 4) are examined to determine if there are any peak values higher than those at the monitors, which could potentially cause violations of the applicable 8-hr ozone NAAQS.

8.5.2 Annual $PM_{2.5}$

The unmonitored area analysis for the annual $PM_{2.5}$ standard will include the following steps:

Step 1: At each grid cell, the quarterly average $PM_{2.5}$ (total and by species) will be calculated from the reference year simulation, and a gradient in these quarterly averages between each grid cell and grid cells which contain a monitor will be calculated.

Step 2: Interpolated spatial fields, based on the observed $PM_{2.5}$ (FRM) and each component species of $PM_{2.5}$, will be generated for each quarter using normalized inverse distance squared weightings for all monitors within a grid cell's Voronoi Region. The ambient interpolated spatial fields are then adjusted based on the gradients in predicted quarterly mean concentrations from Step 1.

Step 3: The component specific RRFs are calculated at each grid cell for each quarter as described in section 8.3.2.

Step 4: The quarterly mean concentrations from Step 2 are then multiplied by the corresponding component specific RRF (from Step 3) to obtain the corresponding projected quarterly species estimates.

Step 5: The future year annual average $PM_{2.5}$ estimates are calculated by summing the quarterly species estimates at each grid cell and then compared to the annual $PM_{2.5}$ NAAQS to determine compliance.

8.5.3 24-hour $PM_{2.5}$

The unmonitored area analysis for the 24-hour $PM_{2.5}$ standard will include the following steps:

Step 1: At each grid cell, the quarterly average of the top 10% of the modeled days for 24-hour $PM_{2.5}$ (total and by species for the same top 10% of days) will be calculated from the reference year simulation, and a gradient in these quarterly averages between each grid cell and grid cells which contain a monitor will be calculated.

Step 2: The top 8 days with observed high $PM_{2.5}$ (FRM) are identified for each quarter and for each of the five years (a total of 32 days per year), used in the base year DV calculation. The speciated $PM_{2.5}$ (FRM) values are then interpolated for each of the "high" $PM_{2.5}$ days (identified above) using normalized inverse distance squared weightings for all monitors within a grid cell's Voronoi Region. These ambient interpolated spatial fields are then adjusted based on the appropriate gradients in predicted concentrations from Step 1.

Step 3: The component specific RRFs are calculated at each grid cell for each quarter as described in section 8.3.2.

Step 4: The observed daily species concentrations from Step 2 are multiplied by the component and quarter specific RRF (from Step 3) to estimate the future year concentration of each $PM_{2.5}$ species using the method outlined in section 8.4.2.3

Step 5: The concentration of each of the component $PM_{2.5}$ species is summed to calculate the total $PM_{2.5}$ concentration for each of the 32 days per year (8 days per quarter) and at each grid cell. For each year, the 98^{th} percentile value is calculated by the sorting the 32 days for that particular year at each grid cell.

Step 6: The future design value at each grid cell is calculated based on the 98th percentile concentrations calculated in Step 5 and following the standard protocol for calculating design values (see Table 8-1). The future-year 24-hour design values are then compared to the 24-hour $PM_{2.5}$ NAAQS to determine compliance with that standard.

The R codes used in this analysis will be made available upon request.

8.6 Banded Relative Response Factors for Ozone

The “Band-RRF” approach expands upon the standard “Single-RRF” approach for 8-hour ozone to account for differences in model response to emissions controls at varying ozone levels. The most recent U.S. EPA modeling guidance (U. S. EPA, 2014) accounts for some of these differences by focusing on the top ten modeled days, but even the top ten days may contain a significant range of ozone mixing ratios. The Band-RRF approach accounts for these differences more explicitly by grouping the simulated ozone into bands of lower, medium, and higher ozone mixing ratios. Specifically, daily peak 8-hour ozone mixing ratios for all days meeting model performance criteria (+/- 20% with the observations) can be stratified into 5 ppb increments from 60 ppb upwards (bin size and mixing ratio range may vary under different applications). A separate RRF is calculated for each ozone band following a similar approach as the standard Single-RRF. A linear regression is then fit to the data resulting in an equation relating RRF to ozone band. Similar to the Single-RRF, this equation is unique to each monitor/location.

The top ten days for each monitor, based on observed 8-hour ozone, for each year that is utilized in the design value calculation (see Table 8-1) is then projected to the future using the appropriate RRF for the corresponding ozone band. The top ten future days for each year are then re-sorted, the fourth highest 8-hour ozone is selected, and the future year design value is calculated in a manner consistent with the base/reference year design value calculation. More detailed information on the Band-RRF approach can be found in Kulkarni et al. (2014) and the 2013 SJV 1-hour ozone SIP (SJVUAPCD, 2013).

9. PROCEDURAL REQUIREMENTS

9.1 How Modeling and other Analyses will be Archived, Documented, and Disseminated

The computational burden of modeling the entire state of California and its sub-regions requires a significant amount of computing power and large data storage requirements. For example, there are over half a million grid cells in total for each simulation based on the Northern CA domain (192 x 192 cells in the lateral direction and 18 vertical layers). The meteorological modeling system has roughly double the number of grid cells since it has 30 vertical layers. Archiving of all the inputs and outputs takes several terabytes (TB) of computer disk space (for comparison, one single-layer DVD can hold roughly 5 gigabytes (GB) of data, and it would require ~200 DVDs to hold one TB). Please note that this estimate is for simulated surface-level pollutant output only. If three-dimensional pollutant data are needed, it would add a few more TB to this total. Therefore, transferring the modeling inputs/outputs over the internet using file transfer protocol (FTP) is not practical.

Interested parties may send a request for model inputs/outputs to Mr. John DaMassa, Chief of the Modeling and Meteorology Branch at the following address.

John DaMassa, Chief
Modeling and Meteorology Branch
Air Quality Planning and Science Division
Air Resources Board
California Environmental Protection Agency
P.O. Box 2815
Sacramento, CA 95814, USA

The requesting party will need to send an external disk drive(s) to facilitate the data transfer. The requesting party should also specify what input/output files are requested so that ARB can determine the capacity of the external disk drive(s) that the requester should send.

9.2 Specific Deliverables to U.S. EPA

The following is a list of modeling-related documents that will be provided to the U.S. EPA.

- The modeling protocol

- Emissions preparation and results
- Meteorology
    - Preparation of model inputs
    - Model performance evaluation
- Air Quality
    - Preparation of model inputs
    - Model performance evaluation
- Documentation of corroborative and weight-of-evidence analyses
- Predicted future year Design Values
- Access to input data and simulation results

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53

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Appendix B-4 Modeling Attainment Demonstration

Document Title:

Modeling Attainment Demonstration – Photochemical Modeling for the 8-Hour Ozone State Implementation Plan in the Sacramento Federal Non-attainment Area (SFNA)

Document Description:

This document summarizes the findings of the model attainment demonstration for the 0.075 ppm (or 75 ppb) 8-hour ozone standard in the Sacramento Federal 8-hour ozone Non-attainment Area (SFNA), which forms the scientific basis for the SFNA 2016 8-hour ozone SIP.

MODELING ATTAINMENT DEMONSTRATION

Photochemical Modeling for the 8-Hour Ozone State Implementation Plan in the Sacramento Federal Non-attainment Area (SFNA)

Prepared by

California Air Resources Board

Sacramento Metropolitan Air Quality Management District

Prepared for

United States Environmental Protection Agency Region IX

October 12, 2016

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

ARB – Air Resources Board

BCs – Boundary Conditions

CMAQ Model – Community Multi-scale Air Quality Model

DV – Design Value

GEOS-5 – Goddard Earth Observing System Model, Version 5

GMAO – Global Modeling and Assimilation Office

ICs – Initial Conditions

MCAB Mountain Counties Air Basin

MOZART – Model for Ozone and Related chemical Tracers

MDA8 – Maximum Daily Average 8-hour Ozone

NASA – National Aeronautics and Space Administration

NARR - North American Regional Reanalysis

NCAR – National Center for Atmospheric Research

NOAA - National Oceanic and Atmospheric Administration

NO_x – Oxides of nitrogen

OFP - Ozone Forming Potential

ROG – Reactive Organic Gases

RH – Relative Humidity

RRF – Relative Response Factor

SAPRC – Statewide Air Pollution Research Center

SIP – State Implementation Plan

SJV – San Joaquin Valley

SVAB – Sacramento Valley Air Basin

SFNA – Sacramento Federal Non-attainment Area

U.S. EPA – United States Environmental Protection Agency

VOCs – Volatile Organic Compounds

WRF Model – Weather and Research Forecast Model

1. INTRODUCTION

The purpose of this document is to summarize the findings of the model attainment demonstration for the 0.075 ppm (or 75 ppb) 8-hour ozone standard in the Sacramento Federal 8-hour ozone Non-attainment Area (SFNA), which forms the scientific basis for the SFNA 2016 8-hour ozone SIP. The 75 ppb standard was promulgated by the U.S. EPA in 2008 and became effective in 2010. Currently, the SFNA is designated as a severe ozone non-attainment area for this standard and is mandated to demonstrate attainment of the standard by 2026.

Findings from the model attainment demonstration are summarized in terms of three sub-regions within the SFNA: 1) Western SFNA (Yolo, Solano and southwest portion of Sacramento counties), 2) Central SFNA (Most of Sacramento and western portion of Placer counties), and 3) Eastern SFNA (Placer and El Dorado counties). These three sub-regions are characterized by distinct features in terms of geography, meteorology, and air quality as described in Section 2 of the Photochemical Modeling Protocol Appendix. The general approach utilized in the attainment demonstration is described in Section 2, while the remaining sections discuss the meteorological modeling (Section 3), the emissions inventory (Section 4), and the photochemical modeling and results (Sections 5 and 6). A more detailed description of the modeling and development of the model-ready emissions inventory is presented in the Photochemical Modeling Protocol Appendix.

2. APPROACH

This section describes the Air Resources Board's (ARB's) procedures, based on U.S. EPA guidance[1], for projecting ozone Design Values (DVs) to the future using model output and a Relative Response Factor (RRF) approach in order to show future year attainment of the 0.075 ppm 8-hour ozone standard.

2.1. METHODOLOGY

The U.S. EPA modeling guidance[1] outlines the approach for utilizing models to predict future attainment of the 0.075 ppm 8-hour ozone standard. Consistent with the previous modeling guidance[2], which was utilized in the most recent 8-hour ozone SIPs in

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[1] U.S. EPA, 2014, Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5 and Regional Haze, available at https://www.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf

[2] U.S. EPA, 2007. Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze. EPA-454/B07-002, 2007, available at https://www.epa.gov/ttn/scram/guidance/guide/final-03-pm-rh-guidance.pdf

California's Central Valley, the 2009 Sacramento SIP[1] and the 2007 San Joaquin Valley (SJV) SIP[2] for the 0.08 ppm 8-hour ozone standard, the current guidance recommends utilizing modeling in a relative sense. A brief summary of how models are applied in the attainment demonstration, as prescribed by U.S. EPA modeling guidance (U.S. EPA, 2014[3]), is provided below. A more detailed description of the methodology is provided below and in subsequent sections is provided in the Photochemical Modeling Protocol Appendix.

2.2. MODELING PERIOD

Based on analysis of the conduciveness of recent years' meteorological conditions leading to elevated ozone, as well as the availability of the most detailed emissions inventory, the year 2012 was selected for both baseline modeling and design value calculation in the model attainment test. These baseline design value mixing ratios serve as the anchor point for projecting future year design values.
The severe non-attainment designation for the SFNA requires that attainment of the 2008 8-hour ozone standard be demonstrated by 2026. Therefore, 2026 was the future year modeled in this attainment demonstration. An additional future year 2022 was also modeled to assess progress toward the stipulated attainment deadline (2026).

The revised U.S. EPA modeling guidance[3] requires that the 8-hour ozone model attainment demonstration utilize the top ten modeled days when projecting design values to the future. Recent ozone SIP modeling applications in California's Central Valley[4,5], which encompassed both the SFNA and SJV, have generally simulated the entire ozone season (May – September) as the peak ozone mixing ratios tend to occur between June and September. However, in 2012, the Sacramento region experienced a period of elevated ozone from September 30 through October 4 (see ARB's Air

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[1] 2009 Sacramento Regional 8-Hour Ozone Attainment and Reasonable Further Progress Plan, available at http://www.airquality.org/ProgramCoordination/Documents/4)%202013%20SIP%20Revision%20Report%201997%20Std.pdf
[2] 2007 Plan for the 1997 8-Hour Ozone Standard available at http://www.valleyair.org/Air_Quality_Plans/AQ_Final_Adopted_Ozone2007.htm
[3] U.S. EPA, 2014, Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5 and Regional Haze, available at https://www.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf
[4] 2016 Plan for the 2008 8-Hour Ozone Standard available at http://www.valleyair.org/Air_Quality_Plans/Ozone-Plan-2016.htm
[5] 2013 Plan for the Revoked 1-Hour Ozone Standard available at http://www.valleyair.org/Air_Quality_Plans/Ozone-OneHourPlan-2013.htm

Quality and Meteorological Information System[1] database). Consequently, the modeling period utilized in the SFNA SIP attainment demonstration was extended to include this period, and an ozone season from May – October 5th was modeled for 2012, 2022 and 2026 to ensure that all of the top ozone days were included in the SFNA simulations.

2.3. BASELINE DESIGN VALUES

Specifying the baseline design value is a key consideration in the model attainment test, since this value is projected forward and used to test for future attainment at each site. The starting point for the attainment demonstration is with the observational based design value (DV), which represents the three-year average of the annual 4th highest 8-hour ozone mixing ratio observed at a specific monitor for the year in consideration. For example, a DV for 2012 would represent the average of the 4th highest 8-hour ozone mixing ratio from 2010, 2011, and 2012.

The U.S. EPA recommends using an average of three DVs that straddle the baseline year in order to better account for the year-to-year variability inherent in meteorology. Since 2012 was chosen as the base year for projecting DVs to the future, site-specific DVs were calculated for the three three-year periods ending in 2012, 2013, and 2014 and then these three DVs were averaged. This average DV is called a weighted DV (in the context of this SIP, the weighted DV will also be referred to as the reference year DV or DV_R). Table 1 illustrates the observational data from each year that goes into the calculation of average DV at a particular monitoring site.

Table 1. Illustrates the data from each year that are utilized in the Design Value calculation for a specific year (DV Year), and the yearly weighting of data for the average Design Value calculation (or DV_R).

DV Year	Years Averaged for the Design Value (4th highest observed 8-hr O_3)				
2012	2010	2011	2012		
2013		2011	2012	2013	
2014			2012	2013	2014
Yearly Weightings for the Average Design Value Calculation					
2012-2014 Average	$DV_R = \frac{8hrO3_{2010} + (2)8hrO3_{2011} + (3)8hrO3_{2012} + (2)8hrO3_{2013} + 8hrO3_{2014}}{9}$				

[1]ARB's AQMIS database is available at www.arb.ca.gov/airqualitytoday/

Table 2. Year-specific 8-hour ozone design values for 2012, 2013, and 2014, and the average baseline design value (represented as the average of the three year-specific design values) for the monitoring sites located in the SFNA.

Sub-region	Site (County, Air Basin)	8-hr Ozone Design Value (ppb)			
		2012	2013	2014	2012-2014 Average
Eastern SFNA	Placerville-Gold Nugget Way (El Dorado, MCAB[1])	81	82	84	82.3
	Cool-Hwy193 (El Dorado, MCAB)	83	81	80	81.3
	Auburn - Atwood Rd (Placer, SVAB[1])	80	79	78	79.0
	Colfax-City Hall (Placer, MCAB)	75	73	73	73.7
	Echo Summit (El Dorado, MCAB)	69	69	69	69.0
Central SFNA	**Folsom-Natoma Street (Sacramento, SVAB)**	**95**	**90**	**85**	**90.0**
	Sloughhouse (Sacramento, SVAB)	88	84	80	84.0
	Roseville-N Sunrise Ave (Placer, SVAB)	85	81	81	82.3
	Sacramento-Del Paso Manor (Sacramento, SVAB)	78	77	77	77.3
	North Highlands-Blackfoot Way (Sacramento, SVAB)	77	76	75	76.0
	Sacramento - 1309 T Street (Sacramento, SVAB)	71	70	69	70.0
	Sacramento-Goldenland Court (Sacramento, SVAB)	69	70	71	70.0
Western SFNA	Elk Grove - Bruceville Road (Sacramento, SVAB)	74	71	70	71.7
	Woodland-Gibson Road (Yolo, SVAB)	69	69	68	68.7
	Vacaville-Ulatis Drive (Solano, SVAB)	69	67	66	67.3
	Davis-UCD Campus (Yolo, SVAB)	70	66	64	66.7

[1] SVAB and MCAB denote the Sacramento Valley Air Basin and Mountain Counties Air Basin respectively.

Table 2 lists the design values for the sites within the three major sub-regions of the SFNA that are used in this model attainment demonstration. Note that the DVs are listed in descending order for sites within each sub-region. The Folsom – Natoma Street monitor (highlighted in black bold text), and located in Sacramento county within the Central sub-region, is the SFNA's design site (i.e. site with the highest average DV in the SFNA) with an average DV of 90 ppb. The Placerville monitoring site, located in El Dorado county, is the design site for the eastern SFNA sub-region with an average DV of 82.3 ppb. All the monitoring sites in the western SFNA have average DVs that are below the 75 ppb standard and are already in attainment of the 2008 standard.

Figure 1 shows the spatial distribution of the baseline DVs in the SFNA. The central and eastern portions of the SFNA tend to have higher baseline DVs, and that exceed the 75 ppb standard at many sites. In contrast, baseline DVs are considerably lower, and below the 75 ppb standard, at sites located in the upwind western SFNA and at sites far downwind near the eastern edge of the SFNA. The spatial heterogeneity seen in the baseline DVs is consistent with the general characteristics of Sacramento region's ozone plume production and evolution, which has been described as a Lagrangian air parcel that produces peak ozone levels a few kilometers downwind of the urban city center (LaFranchi et. al., 2011[1] and the references therein). Due to prevailing northeast wind flow patterns in this region (U.S. EPA, 2012[2]), the ozone plume is diluted as it migrates farther away from the urban core and downwind into the Sierra foothills (located to the east/northeast). The transport of ozone precursor emissions from the urban Sacramento area dominates ozone production in the downwind Sierra foothills, where ozone levels are heavily dependent upon the proximity to the upwind urban source. Further details on the regional topography, flow patterns and conceptual model for ozone formation in the SFNA region can be found in the modeling protocol appendix.

[1] LaFranchi, B. W., Goldstein, A. H., and Cohen, R. C.: Observations of the temperature dependent response of ozone to NO_x reductions in the Sacramento, CA urban plume, Atmos. Chem. Phys., 11, 6945-6960, doi:10.5194/acp-11-6945-2011, 2011

[2] U.S. EPA, (2012) 2008 Ground-Level Ozone Standards - Final Designations https://www3.epa.gov/region9/air/ozone/pdf/R9_CA_Sacramento_FINAL.pdf

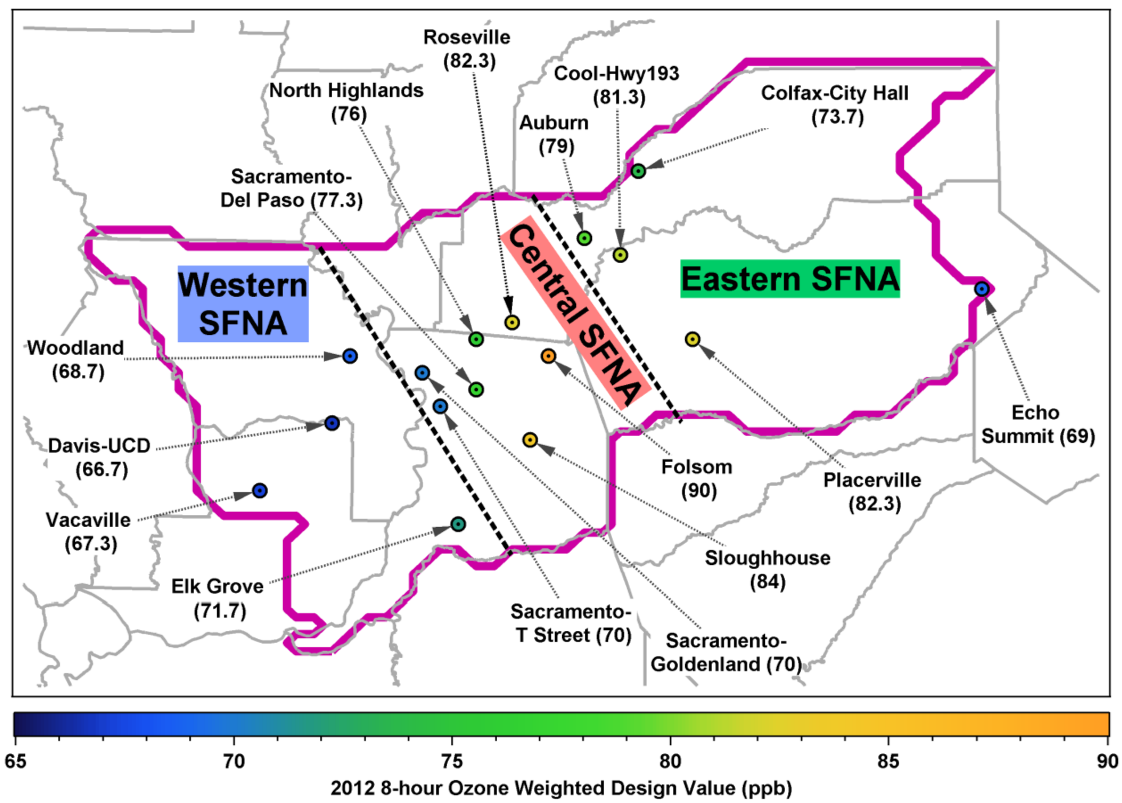

Figure 1. Spatial distribution of the 8-hour ozone baseline DVs in the Sacramento Federal 8-hour Ozone Non-attainment Area (SFNA), where the baseline DV is the average of the 2012, 2013, and 2014 DVs. Circles denote the location of each monitoring site while the baseline DV for each site is shown next to the site name in parenthesis (see Table 2). Solid grey and magenta lines denote the county and regional SFNA boundaries, while dashed black lines show the approximate regional boundaries of the Western, Central and Eastern sub-regions of the SFNA.

2.4. BASE, REFERENCE, AND FUTURE YEARS

The model attainment demonstration consists of the following three primary model simulations, which all utilized the same model inputs, including meteorology, chemical boundary conditions, and biogenic emissions. The only difference between the simulations was in the year represented by the anthropogenic emissions (2012, 2022 or 2026) and certain day-specific emissions.

1. Base Year (or Base Case) Simulation

The base year simulation for 2012 was used to assess model performance and includes as much day-specific detail as possible in the emissions inventory such as hourly adjustments to the motor vehicle and biogenic inventories based on observed local meteorological conditions, known wildfire and agricultural burning events, and exceptional events like the Chevron refinery fire in the Bay Area, which occurred over 6 days from August 19-24, 2012.

2. ***Reference (or Baseline) Year Simulation***
The reference year simulation was identical to the base year simulation, except that certain emissions events which are either random and/or cannot be projected to the future were removed from the emissions inventory. For the 2012 reference year modeling there are two categories/emissions sources that were excluded: 1) wildfires, which are difficult to predict in the future and can influence the model response to anthropogenic emissions reductions in regions with large fires, and 2) the Chevron refinery fire mentioned above.

3. ***Future Year Simulation***
The future year simulation is identical to the reference year simulation, except that projected future year (2022 and 2026) anthropogenic emission levels were used rather than the 2012 emission levels. All other model inputs (e.g., meteorology, chemical boundary conditions, biogenic emissions, and calendar for day-of-week specifications in the inventory) are the same as those used in the reference year simulation.

To summarize (Table 3), the base year 2012 simulation was used for evaluating model performance, while the reference (or baseline) 2012 and future year 2022 and 2026 simulations were used to project the baseline DVs to the future as described in the Photochemical Modeling Protocol Appendix and in subsequent sections of this document.

Table 3. Description of CMAQ model simulations.

Simulation	Anthropogenic Emissions	Biogenic Emissions	Meteorology	Chemical Boundary Conditions
Base year (2012)	2012 w/ wildfires and Chevron refinery fire	2012 MEGAN	2012 WRF	2012 MOZART
Reference year (2012)	2012 w/o wildfires and w/o Chevron refinery fire	2012 MEGAN	2012 WRF	2012 MOZART
Future year (2022)	2022 w/o wildfires and w/o Chevron refinery fire	2012 MEGAN	2012 WRF	2012 MOZART
Future year (2026)	2026 w/o wildfires and w/o Chevron refinery fire	2012 MEGAN	2012 WRF	2012 MOZART

2.5. RELATIVE RESPONSE FACTORS

As part of the model attainment demonstration, the fractional changes in ozone mixing ratios between the model reference year and model future year were calculated at each of the monitors. These ratios, called "relative response factors" (RRFs), were calculated based on the ratio of future year modeled maximum daily average 8-hour (MDA8) ozone to modeled reference year MDA8 ozone (Equation 1).

$$RRF = \frac{\text{average MDA8 ozone}_{\text{future}}}{\text{average MDA8 ozone}_{\text{reference}}} \qquad (1)$$

The MDA8 values, used in calculating the RRF, were based on the maximum simulated ozone within a 3x3 array of cells with the grid cells containing the monitor located at the center of the array[1]. The future and reference year ozone values used in the RRF calculations were paired in space and time (i.e., using the future year MDA8 ozone for the same modeled day and at the same grid cell where the MDA8 ozone for the reference year is located within the 3x3 array of cells). The modeled days utilized in the RRF calculation were selected based on the following U.S. EPA recommended criteria[1].

- Begin with days that have simulated baseline MDA8 > 60 ppb and calculate RRFs based on the top 10 high ozone days.
- If there are fewer than 10 days with MDA8 > 60 ppb then all days > 60 ppb are used in the RRF calculation, as long as there are at least 5 days used in the calculation.
- If there are fewer than 5 days > 60 ppb, an RRF is not calculated at that monitor.

- Restrict the simulated days used in the RRF calculation by only including days with reference MDA8 within +/- 20% of the observed value at the monitor. This ensures that only modeled days which are consistent with the observed ozone levels are used in the RRF calculation.

RRFs were calculated for all monitors within the SFNA following the procedure described above, except for the Folsom monitor. The Folsom monitor is located adjacent to Folsom Lake, such that the northeast corner grid cell of the 3x3 array of grid cells centered at the monitor overlays a portion of Folsom Lake. High ozone mixing ratios are frequently observed over lake surfaces due to a shallow convective boundary layer. Recent studies have shown that simulated ozone over lake surfaces tend to

[1] U.S. EPA, 2014, Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5 and Regional Haze, available at https://www.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf

exhibit a higher positive bias than over the surrounding land[1], which may be due to a simulated boundary layer that is too low over lake surfaces. However, these high biases do not appear to propagate strongly over the inland areas that are located in the vicinity of a lake. Because of this high bias in ozone over lake surfaces, data from the grid cell over Folsom Lake will not be used when calculating the daily maximum 8-hour ozone in the 3x3 array of grid cells centered over the Folsom monitor (i.e., the daily maximum will be calculated from 8 grid cells rather than the standard 9 grid cells).

2.6. FUTURE YEAR DESIGN VALUE CALCULATION

Future year design values for each site were calculated by multiplying the corresponding baseline design value (Table 2) by the site-specific RRF (Equation 2).

$$DV_F = DV_R \times RRF \quad (2)$$

where,

DV_F = the future year design value,
DV_R = the reference year design value (from Table 2), and
RRF = the site specific RRF from Equation 1

Future year design values from the model attainment demonstration are discussed in Section 5.3.

3. METEOROLOGICAL MODELING

California's proximity to the ocean, complex terrain, and diverse climate represent a unique challenge for developing meteorological fields that adequately represent the synoptic and mesoscale features of the regional meteorology. In summertime, the majority of the storm tracks are far away to the north of the state and a semi-permanent Pacific high typically sits off the California coast. Interactions between this eastern Pacific subtropical high pressure system and the thermal low pressure further inland over the Central Valley or South Coast lead to conditions conducive to pollution buildup

[1] Cleary, P. A., Fuhrman, N., Schulz, L., Schafer, J., Fillingham, J., Bootsma, H., McQueen, J., Tang, Y., Langel, T., McKeen, S., Williams, E. J., and Brown, S. S.: Ozone distributions over southern Lake Michigan: comparisons between ferry-based observations, shoreline-based DOAS observations and model forecasts, Atmos. Chem. Phys., 15, 5109-5122, doi:10.5194/acp-15-5109-2015, 2015.

(Fosberg and Schroeder, 1966[1]; Bao et al., 2008[2]). In the past, the ARB has utilized both prognostic and diagnostic meteorological models, as well as hybrid approaches in an effort to develop meteorological fields for use in air quality modeling that most accurately represent the meteorological processes that are important to air quality (e.g., Jackson et al., 2006[3]). In this work, the state-of-the-science Weather and Research Forecasting (WRF) prognostic model (Skamarock et al., 2005[4]) version 3.6 was utilized to develop the meteorological fields used in the subsequent photochemical model simulations.

3.1. WRF MODEL SETUP

The WRF meteorological modeling domain consisted of three nested Lambert projection grids of 36-km (D01), 12-km (D02), and 4-km (D03) horizontal grid spacing (Figure 2). WRF was run simultaneously for the three nested domains with two-way feedback between the parent and the nested grids. The D01 and D02 grids were used to resolve the larger scale synoptic weather systems, while the D03 grid resolved the finer details of the atmospheric conditions and was used to drive the air quality model simulations. All three domains utilized 30 vertical sigma layers (defined in Table 4), with the major physics options for each domain listed in Table 5.

Initial and boundary conditions (IC/BCs) for the WRF modeling were based on the 32-km horizontal resolution North American Regional Reanalysis (NARR) data that are archived at the National Center for Atmospheric Research (NCAR). Boundary conditions to WRF were updated at 6-hour intervals for the 36-km grid (D01). In addition, surface and upper air observations obtained from NCAR were used to further refine the analysis data that were used to generate the IC/BCs. Analysis nudging was employed in the outer 36-km grid (D01) to ensure that the simulated meteorological fields were constrained and did not deviate from the observed meteorology. No

[1] Fosberg, M.A., Schroeder, M.J., Marine air penetration in Central California, Journal of Applied Meteorology, 5, 573-589, 1966.
[2] Bao, J.W., Michelson, S.A., Persson, P.O.G., Djalalova, I.V., Wilczak, J.M., Observed and WRF-simulated low-level winds in a high-ozone episode during the Central California ozone study, Journal of Applied Meteorology and Climatology, 47, 2372-2394, 2008.
[3] Jackson, B.S., Chau, D., Gurer, K., Kaduwela, A.: Comparison of ozone simulations using MM5 and CALMET/MM5 hybrid meteorological fields for the July/August 2000 CCOS episode, *Atmos. Environ.*, 40, 2812-2822, 2006.
[4] Skamarock, W. C., J. B. Klemp, J. Dudhia, D. O. Gill, D. M. Barker, W. Wang, and J. G. Powers, 2005: A description of the Advanced Research WRF Version 2. NCAR Tech Notes-468+STR

nudging was used on the two inner domains to allow model physics to work fully without externally imposed forcing (Rogers et al., 2013[1]).

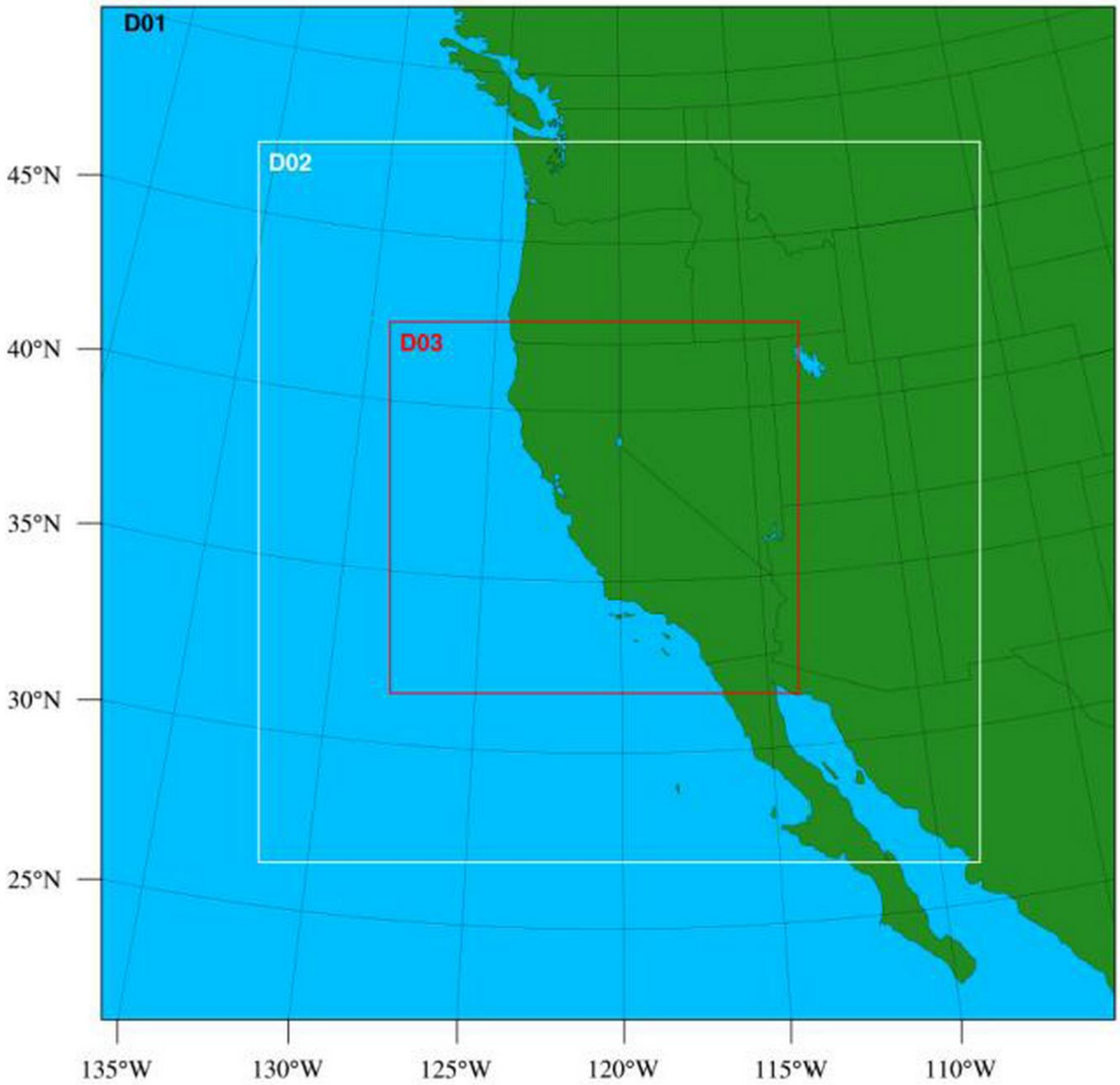

Figure 2. WRF modeling domains (D01 36km; D02 12km; and D03 4km).

[1] Rogers, R.E., Deng, A., Stauffer, D. Gaudet, B.J., Jia, Y., Soong, S.-T., Tanrikulu, S., Application of the Weather Research and Forecasting model for air quality modeling in the San Francisco Bay area, Journal of Applied Meteorology and Climatology, 52, 1953-1973, 2013.

Table 4. WRF vertical layer structure.

Layer Number	Height (m)	Layer Thickness (m)	Layer Number	Height (m)	Layer Thickness (m)
30	16082	1192	14	1859	334
29	14890	1134	13	1525	279
28	13756	1081	12	1246	233
27	12675	1032	11	1013	194
26	11643	996	10	819	162
25	10647	970	9	657	135
24	9677	959	8	522	113
23	8719	961	7	409	94
22	7757	978	6	315	79
21	6779	993	5	236	66
20	5786	967	4	170	55
19	4819	815	3	115	46
18	4004	685	2	69	38
17	3319	575	1	31	31
16	2744	482	0	0	0
15	2262	403			

Note: Shaded layers denote the subset of vertical layers used in the CMAQ photochemical model simulations.

Table 5. WRF Physics Options.

Physics Option	Domain		
	D01 (36 km)	**D02 (12 km)**	**D03 (4 km)**
Microphysics	WSM 6-class graupel scheme	WSM 6-class graupel scheme	WSM 6-class graupel scheme
Longwave radiation	RRTM	RRTM	RRTM
Shortwave radiation	Dudhia scheme	Dudhia scheme	Dudhia scheme
Surface layer	Revised MM5 Monin-Obukhov	Revised MM5 Monin-Obukhov	Revised MM5 Monin-Obukhov
Land surface	Pleim-Xiu LSM	Pleim-Xiu LSM	Pleim-Xiu LSM
Planetary Boundary Layer	YSU	YSU	YSU
Cumulus Parameterization	Kain-Fritsch scheme	Kain-Fritsch scheme	None

3.2. WRF MODEL RESULTS AND EVALUATION

Simulated surface wind speed, temperature, and relative humidity from the 4 km domain were validated against hourly observations at 31 surface stations (Figure 3). Considering the geographical and meteorological differences, the area covered by these sites was divided into two regions: the lower elevation (Valley) and higher elevation mountain (Mountain) areas. Among the 31 surface sites used in this analysis, 17 of them are located in the valley zone with the remaining 14 sites located in the mountain region.

The observational data for the surface stations were obtained from the ARB archived meteorological database available at http://www.arb.ca.gov/aqmis2/aqmis2.php. Table 6 lists the monitoring stations and the meteorological parameters that are measured at each station, including wind speed and direction (wind), temperature (T) and relative humidity (RH). Figure 3 shows the location of each of these sites with the red and green circle markers denoting the sites in the valley and mountain sub-regions while the black lines denote the regional boundary of the (SFNA).

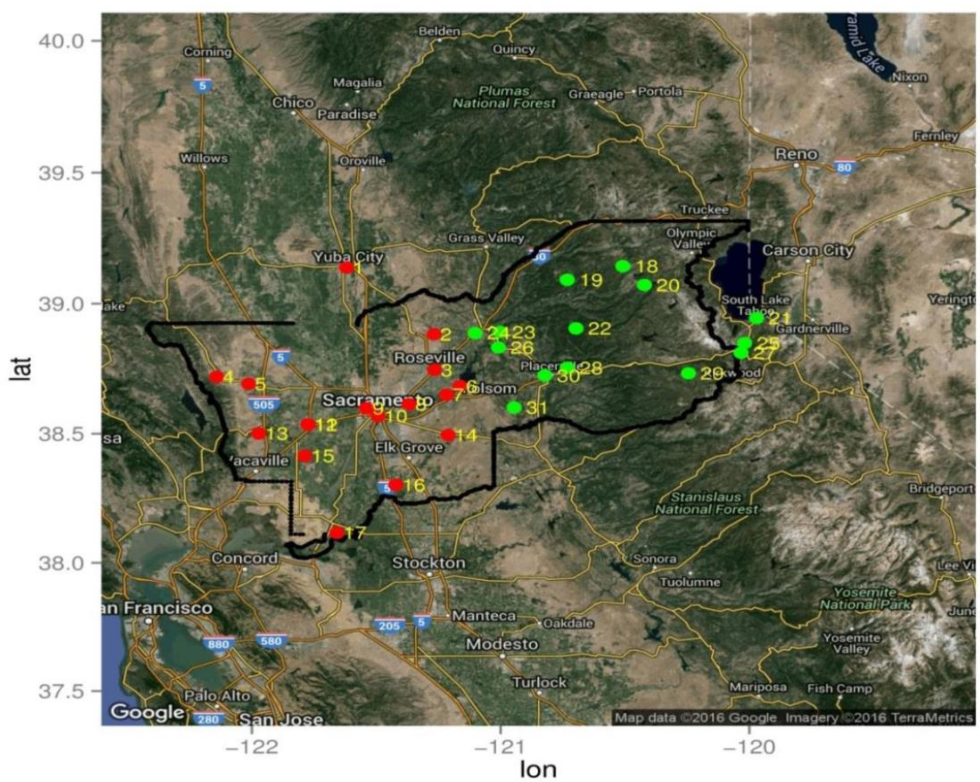

Figure 3. Meteorological monitoring sites in the model results evaluation: red markers represent sites in the valley; green markers represent sites in the mountain region. The thick black line denotes the spatial extent and regional boundary of the Sacramento Federal 8-hour ozone Non-attainment Area (SFNA)

Table 6. Meteorological site location and parameter measured.

Site	Site ID	Site Name	Region	Parameter Measured
1	2958	Yuba City-Almond Street	Valley	Wind, T
2	3290	Lincoln (RAWS)	Valley	Wind, T, RH
3	2956	Roseville-N Sunrise Blvd	Valley	Wind, T, RH
4	3397	Brooks	Valley	Wind, T, RH
5	5833	Esparto	Valley	T, RH
6	3187	Folsom-Natoma Street	Valley	Wind, T, RH
7	5776	Fair Oaks #2	Valley	T, RH
8	2731	Sacramento-Del Paso Manor	Valley	Wind, T, RH
9	5799	Bryte	Valley	R, RH
10	3011	Sacramento-T Street	Valley	Wind, T, RH
11	5710	Davis #2	Valley	T, RH
12	2143	Davis-UCD Campus	Valley	Wind, T
13	5784	Winters	Valley	T, RH
14	3209	Sloughhouse	Valley	Wind
15	5767	Dixon	Valley	T, RH
16	2977	Elk Grove-Bruceville Road	Valley	Wind, T, RH
17	5785	Twitchell Island	Valley	T, RH
18	5880	Duncan #2	Mountain	Wind, T, RH
19	3564	Foresthill #2	Mountain	Wind, T, RH
20	3288	Hell Hole	Mountain	Wind, T, RH
21	2948	South Lake Tahoe-Sandy Way	Mountain	Wind, T
22	3289	Bald Mountain Location	Mountain	Wind
23	3196	Cool-Highway 193	Mountain	Wind, T
24	5832	Auburn #3	Mountain	T, RH
25	3454	Meyers	Mountain	Wind, T, RH
26	3291	Pilot Hill Station	Mountain	Wind, T, RH
27	3487	Echo Summit	Mountain	Wind, T
28	5714	Camino #2	Mountain	T, RH
29	3292	Owens Camp	Mountain	Wind, T, RH
30	3017	Placerville-Gold Nugget Way	Mountain	Wind, T
31	3293	Ben Bolt	Mountain	Wind, T, RH

Several quantitative performance metrics were used to compare hourly surface observations and modeled estimates: mean bias (MB), mean error (ME) and index of agreement (IOA) based on the recommendations from Simon et al. (2012)[1]. A summary of these statistics by performance region is shown in Table 7. The distribution of daily mean bias and mean error are shown in Figure 4. The spatial distributions of the mean bias and mean error of modeled surface wind, temperature and relatively humidity are shown in Figure 5, while observed vs. modeled scatter plots are shown in Figure 6. Wind Speed biases are positive in each of the two regions. The average bias for the valley sites is 0.69 m/s. The model generally over-predicted the wind speed for the mountain sites, with an average positive bias of 1.28 m/s. This is also evident in the wind speed scatter plot (top right panel of Figure 6). Temperature bias is relatively small in the valley with a bias of -0.02 °K, and higher in the mountain areas (-1.22 °K). Temperature generally shows good agreement between the observations and simulation with IOA above 0.90. Relative humidity biases range from 1.03% to 7.96%. These results are comparable to other recent WRF modeling efforts in California investigating ozone formation in Central California (e.g., Hu et al., 2012[2]) and modeling analysis for the CalNex and CARES field studies (e.g., Fast et al., 2014[3]; Baker et al., 2013[4]; Kelly et al., 2014[5]; Angevine et al., 2012[6]). Detailed hourly time-series of surface

[1] Simon, H., Baker, K. R., and Phillips, S.: Compilation and interpretation of photochemical model performance statistics published between 2006 and 2012, *Atmospheric Environment*, 61, 124-139, 2012

[2] Hu, J., Howard, C. J., Mitloehner, F., Green, P. G., and Kleeman, M. J.: Mobile Source and Livestock Feed Contributions to Regional Ozone Formation in Central California, *Environmental Science & Technology*, 46, 2781-2789, 2012.

[3]Fast, J. D., Gustafson Jr, W. I., Berg, L. K., Shaw, W. J., Pekour, M., Shrivastava, M., Barnard, J. C., Ferrare, R. A., Hostetler, C. A., Hair, J. A., Erickson, M., Jobson, B. T., Flowers, B., Dubey, M. K., Springston, S., Pierce, R. B., Dolislager, L., Pederson, J., and Zaveri, R. A.: Transport and mixing patterns over Central California during the carbonaceous aerosol and radiative effects study (CARES), *Atmos. Chem. Phys.,* 12, 1759-1783, 2012, doi:10.5194/acp-12-1759-2012.

[4]Baker, K. R., Misenis, C., Obland, M. D., Ferrare, R. A., Scarino, A. J., and Kelly, J. T.: Evaluation of surface and upper air fine scale WRF meteorological modeling of the May and June 2010 CalNex period in California, *Atmos. Environ.*, 80, 299-309, 2013.

[5] Kelly, J. T., Baker, K. R., Nowak, J. B., Murphy, J. G., Milos, Z. M., VandenBoer, T. C., Ellis, R. A., Neuman, J. A., Weber, R. J., Roberts, J. M., Veres, P. R., de Gouw, J. A., Beaver, M. R., Newman, S., and Misenis, C.: Fine-scale simulation of ammonium and nitrate over the South Coast Air Basin and San Joaquin Valley of California during CalNex-2010, *J. Geophysical Research,* 119, 3600-3614, doi:10.1002/2013JD021290.

[6] Angevine, W. M., Eddington, L., Durkee, K., Fairall, C., Bianco, L., Brioude, J.: Meteorological model evaluation for CalNex 2010, *Monthly Weather Review*, 140, 3885-3906, 2012.

temperature, relative humidity, wind speed, and wind direction for each sub-region can be found in the supplementary material.

Table 7. Hourly surface wind speed, temperature and relative humidity statistics by region for May through October 5, 2012. IOA denotes index of agreement

Region	Observed Mean	Modeled Mean	Mean Bias	Mean Error	IOA
		Wind Speed (m/s)			
Valley	2.11	2.80	0.69	1.21	0.67
Mountain	1.75	3.03	1.28	1.63	0.44
		Temperature (K)			
Valley	295.48	295.46	-0.02	2.42	0.94
Mountain	292.42	291.19	-1.22	2.83	0.94
		Relative Humidity (%)			
Valley	48.63	49.66	1.03	11.32	0.85
Mountain	40.56	48.52	7.96	15.97	0.72

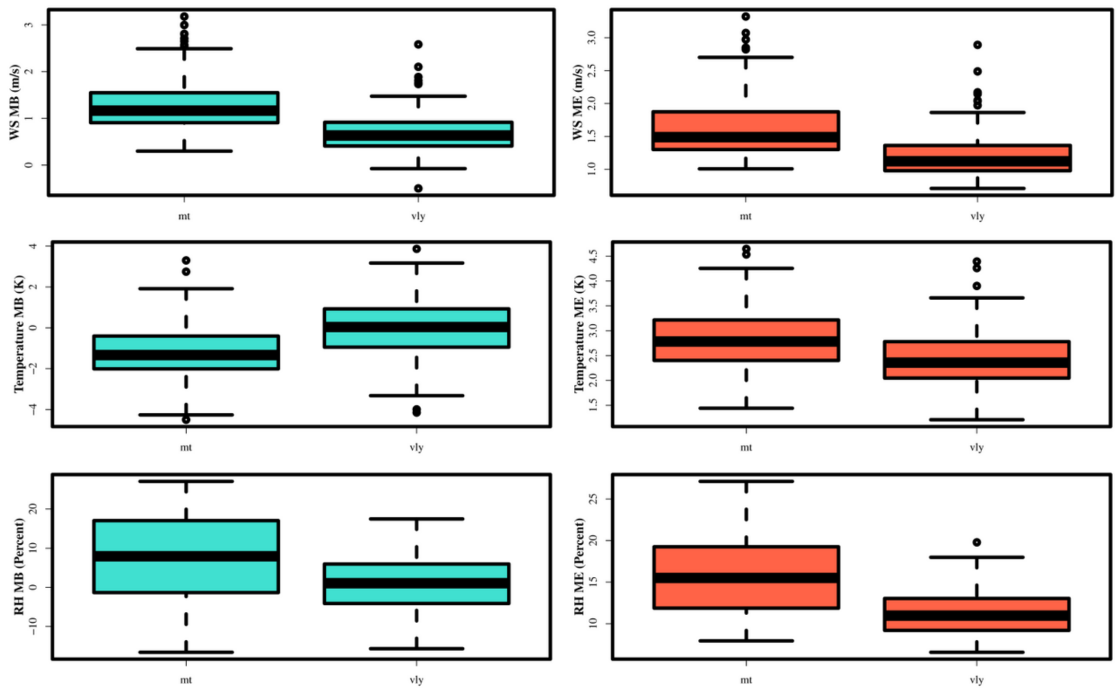

Figure 4. Distribution of daily mean bias (left) and mean error (right) from May-October 5, 2012 for Mountain (mt) and Valley (vly) sites. Results are shown for wind speed (top), temperature (middle), and RH (bottom).

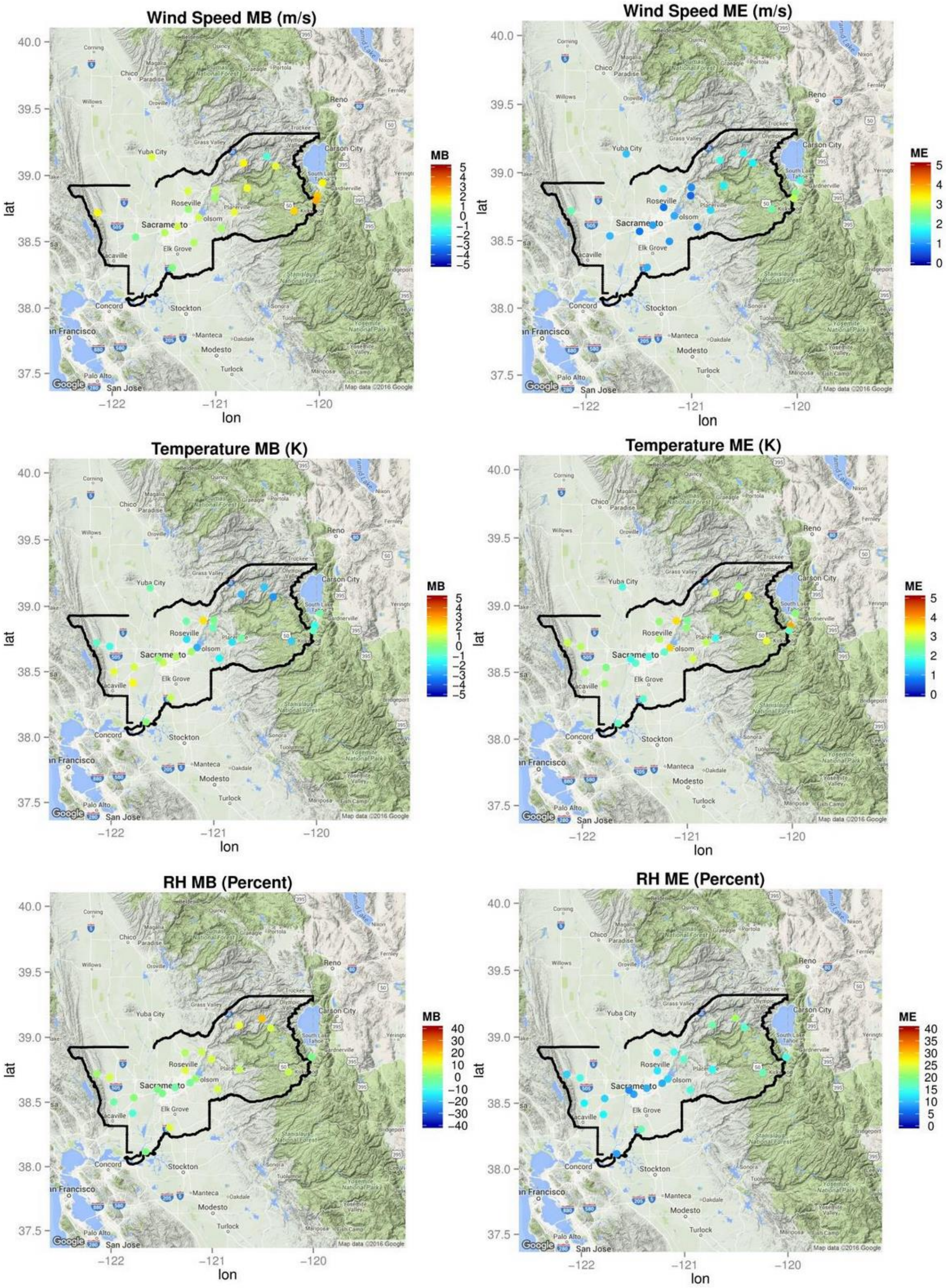

Figure 5. Spatial distribution of mean bias (left) and mean error (right) from May-October 5, 2012 for Mountain (mt) and Valley (vly) sites. Results are shown for wind speed (top), temperature (middle), and RH (bottom).

24

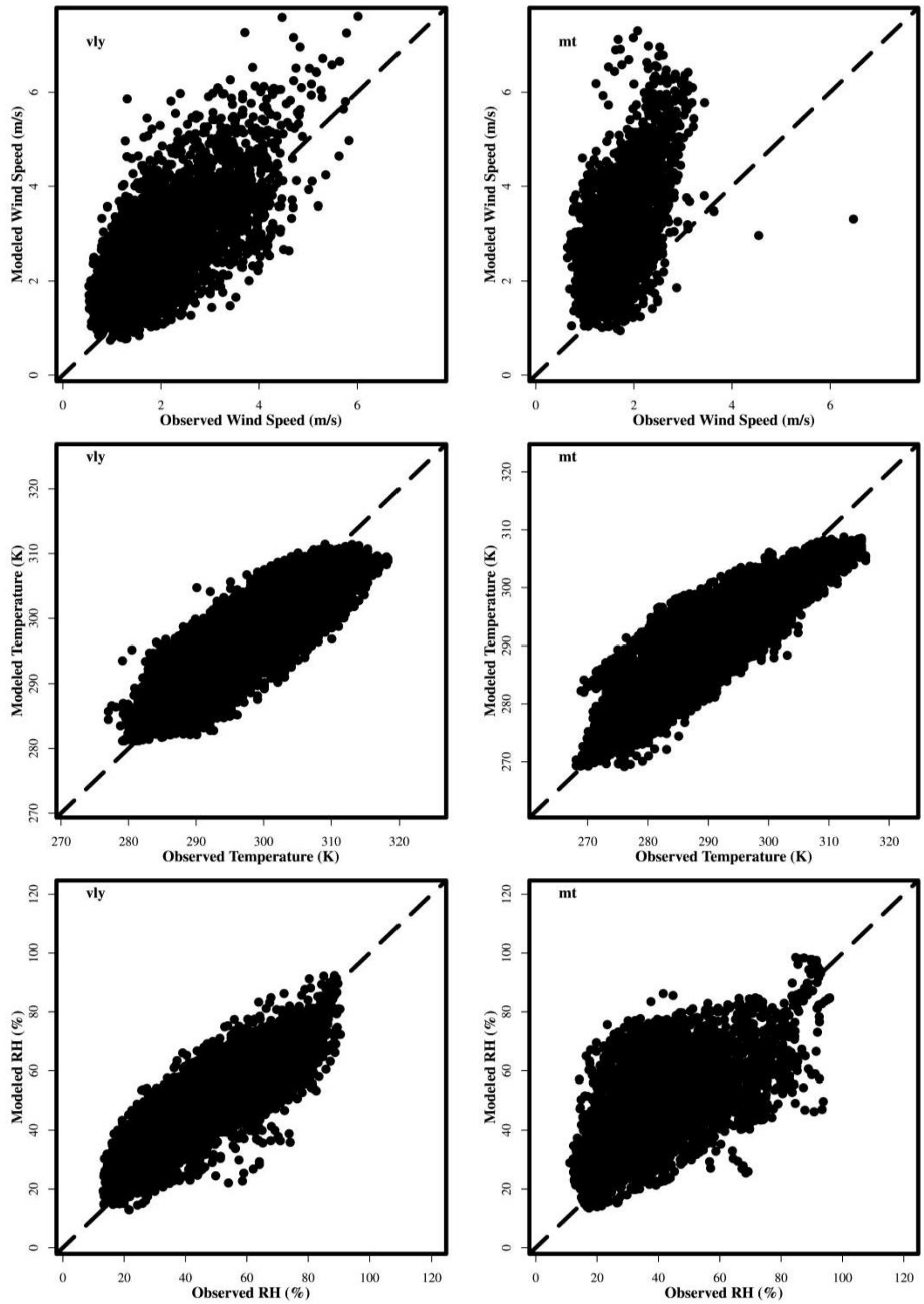

Figure 6. Comparison of modeled and observed hourly wind speed (top row), 2-meter temperature (middle row), and relative humidity (bottom row). Results for Valley (vly) are shown in the left column, and Mountain (mt) in the right column.

3.2.1 PHENOMENOLOGICAL EVALUATION

Conducting a detailed phenomenological evaluation for all modeled days can be resource intensive given that the entire ozone season was modeled. However, some insight and confidence that the model is able to reproduce the meteorological conditions leading to elevated ozone can be gained by investigating the meteorological conditions during a period of peak ozone within the Sacramento non-attainment area in more detail. Meteorological conditions that produced the highest ozone levels in the area occurred on or around July 10, 2012. The July 10th episode represents a typical ozone episode in the Sacramento area consistent with the conceptual model for ozone described in the Modeling Protocol Appendix. Surface weather analysis during the episode showed that the Sacramento area was caught between a high pressure center off the California coast and a large high pressure system over an area spanning from the Rockies to the Midwest. The surface wind distributions (Figures 7, 8, 9) indicate the model was able to capture many of the important features of the meteorological fields in this area. In the early morning of July 9 (Figure 7), the bifurcation of the delta breeze, one branch up to the Sacramento valley and one down to the San Joaquin Valley, is not as strong as during the afternoon of July 11 (Figure 9). The downslope flows on the west slope of the Sierra and east side of the Coastal Ranges created some convergence zones along the foothills. Figure 8 shows a lower valley convergence formed along the Solano-Yolo border in the afternoon of July 10 with upslope flows fully developed in the mountain areas. This is a wind pattern which occurs relatively infrequently in the area (Hayes et al., 1984[1]). The upslope flows are stronger than those in the afternoon of July 11, but less orderly. Overall, the modeled winds are in general agreement with the observations on both the valley floor and mountain areas during this episode. Although a phenomenological evaluation of a single episode does not necessarily mean the model performs equally well on all days, the fact that the model can adequately reproduce wind flows consistent with the ozone conceptual model, combined with reasonable performance statistics over the ozone season (Table 7), provides added confidence in the meteorological fields.

[1] Hayes, T.P., J.J. Kinney, and N.J. Wheeler 1984: California surface wind climatology. California Air Resources Board, Sacramento, CA, 180pp.

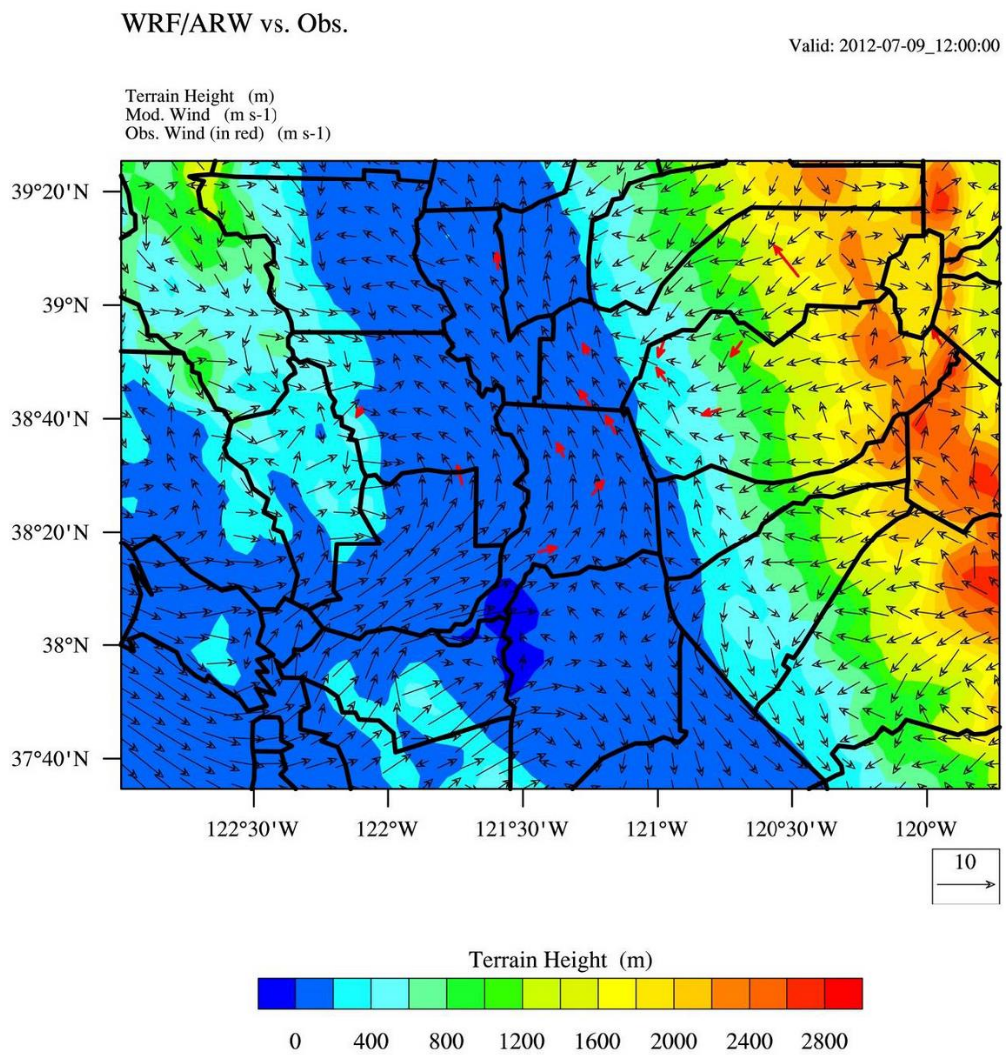

Figure 7. Surface wind field at 04:00 PST July 09, 2012.

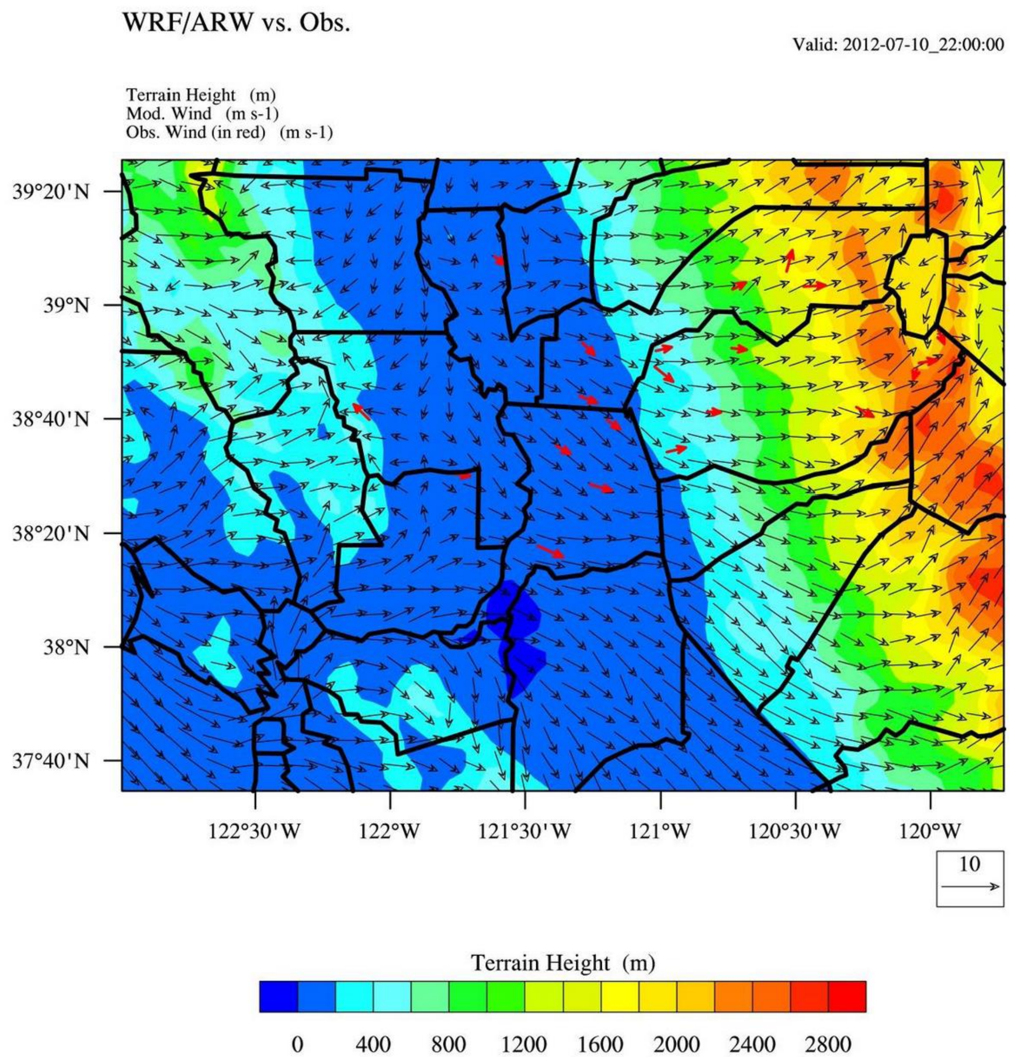

Figure 8. Surface wind field at 14:00 PST July 10, 2012.

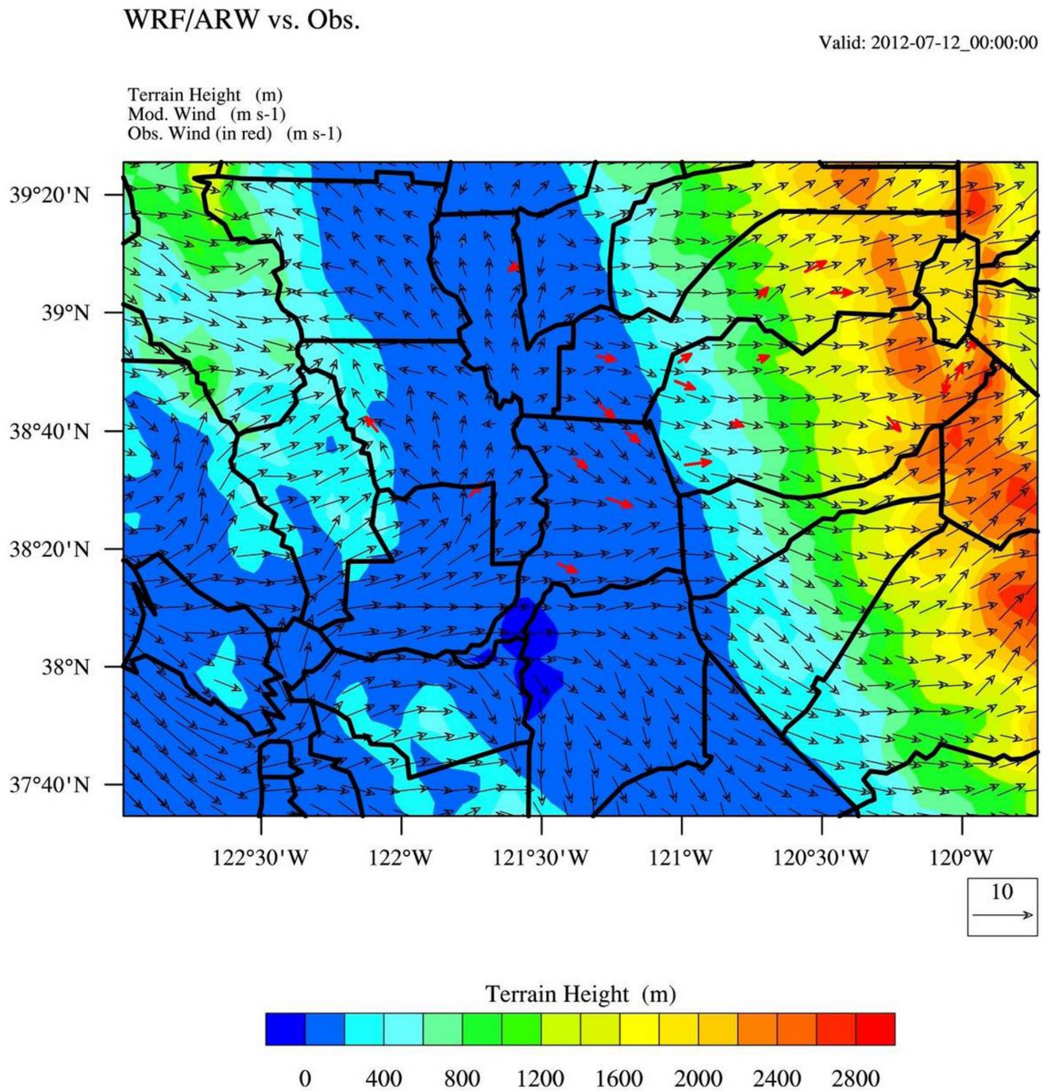

Figure 9. Surface wind field at 16:00 PST July 11, 2012.

4. EMISSIONS

The emissions inventory used in this modeling was based on the most recent inventory submitted to the U.S. EPA, with base year 2012 (http://www.arb.ca.gov/planning/sip/2012iv/2012iv.htm). For a detailed description of the emissions inventory, updates to the inventory, and how it was processed from the planning totals to a gridded inventory for modeling, see the Modeling Emissions Inventory Appendix.

4.1 EMISSIONS SUMMARIES

Table 8 summarizes the 2012, 2022 and 2026 SFNA anthropogenic emissions used in this work. Overall, anthropogenic NO_x was projected to decrease ~45% by 2022 (from 104 tpd to 56.8 tpd) and ~55% by 2026 (from 104 tpd to 47.3 tpd) when compared to 2012 emissions levels. In contrast, anthropogenic ROG was projected to decrease ~23 % by 2022 (from 109.8 tpd to 84.7 tpd) and ~26 % by 2026 (from 109.8 tpd to 81.7 tpd).

Table 8. SFNA Summer Planning Emissions for 2012, 2022 and 2026 (tons/day).

Source Category	NO_x					ROG				
	2012	2022		2026		2012	2022		2026	
	[tpd]	[tpd]	% diff#	[tpd]	% diff#	[tpd]	[tpd]	% diff#	[tpd]	% diff#
Stationary	9.2	7.6	-17	7.6	-17	20.6	21.9	6	22.1	7
Area	2.7	2.1	-22	2.1	-22	28.5	29.5	4	30.4	7
On-Road Mobile	62	24.5	-60	17.7	-71	35	15.6	-55	13.3	-62
Other Mobile	30.1	22.6	-25	19.9	-34	25.7	17.7	-32	15.9	-39
Total	104	56.8	-45	47.3	-55	109.8	84.7	-23	81.7	-26

% diff denotes percent difference with respect to 2012 emission levels.

Monthly biogenic ROG totals for 2012 within the SFNA are shown in Figure 10 (note that the same biogenic emissions were used in 2012, 2022 and 2026 modeling). Throughout the summer, biogenic ROG emissions ranged from ~450 tpd in May to over 900 tpd in July and August, with the difference in emissions primarily due to differences in temperature, solar radiation, and leaf area from month-to-month.

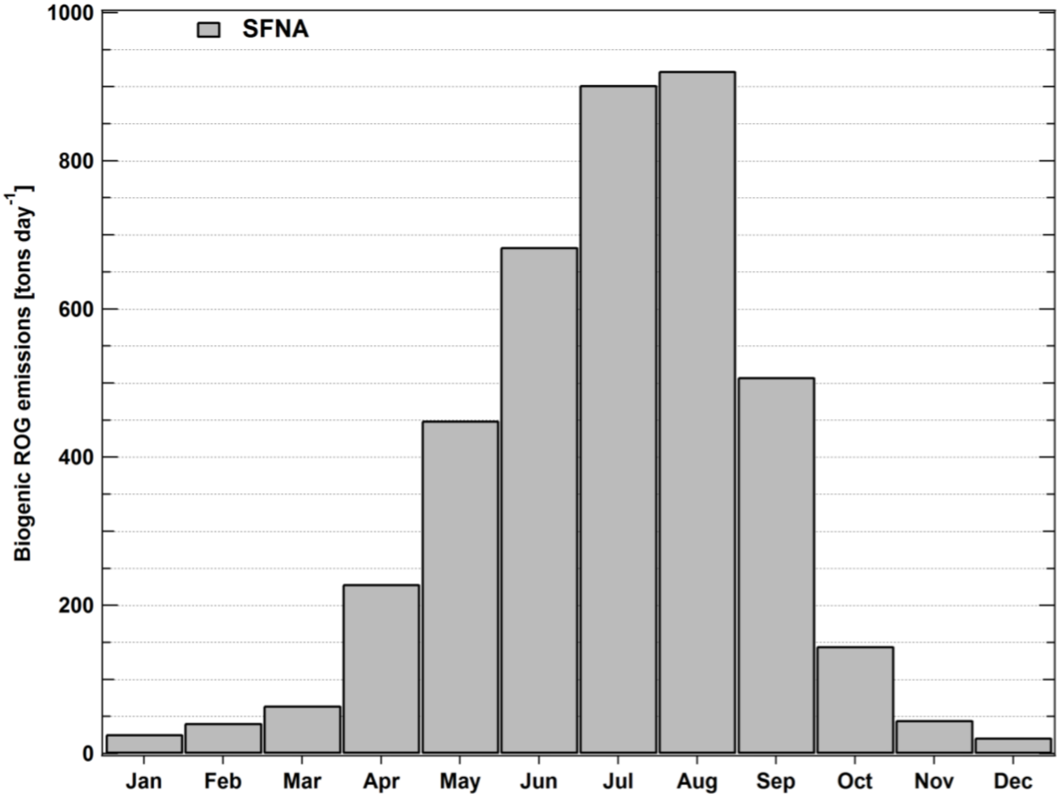

Figure 10. Monthly average biogenic ROG emissions for 2012.

5. OZONE MODELING

5.1. CMAQ MODEL SETUP

Figure 11 shows the CMAQ modeling domains used in this work. The larger domain covering all of California has a horizontal grid resolution of 12 km with 107x97 lateral grid cells for each vertical layer and extends from the Pacific Ocean in the west to Eastern Nevada in the east, and runs from the U.S.-Mexico border in the south to the California-Oregon border in the north. The smaller nested domain (dashed black line) covering the Central valley region including the San Joaquin Valley, Sacramento Valley, and Mountain Counties air basins has a finer scale 4 km grid resolution and includes 192x192 lateral grid cells. The 12 km and 4 km domains are based on a Lambert Conformal Conic projection with reference longitude at -120.5°W, reference latitude at 37°N, and two standard parallels at 30°N and 60°N, which is consistent with WRF domain settings. The 30 vertical layers from WRF were mapped onto 18 vertical layers for CMAQ extending from the surface to 100 mb such that majority of the vertical layers fall within the planetary boundary layer. This vertical layer structure is based on the

WRF sigma-pressure coordinates and the exact layer structure used can be found in Table 4.

The photochemical modeling for this attainment demonstration utilized CMAQ version 5.0.2, released by the U.S. EPA (https://www.cmascenter.org/cmaq/) in May 2014. The SAPRC07 mechanism was selected as the photochemical mechanism for the CMAQ simulations. Further details of the CMAQ configuration used in this work are summarized in Table 9 and in the Photochemical Modeling Protocol Appendix. The same configuration has been used for all simulations including the base, reference, and future years. CMAQ was compiled using the Intel FORTRAN compiler version 12.

The entire ozone season (May – October 5th 2012) was simulated through individual monthly simulations conducted in parallel. For each month, the CMAQ simulations included a seven day spin-up period (i.e., the last seven days of the previous month) for the outer 12 km domain, where initial conditions for the first day were set to the default initial conditions included with the CMAQ release. The 4 km inner domain simulations utilized a three day spin-up period, with initial conditions derived from output from the corresponding day of the 12 km domain simulation.

Chemical boundary conditions (BCs) for the outer 12 km domain were extracted from the global chemical transport Model for Ozone and Related chemical Tracers, version 4 (MOZART-4; Emmons et al., 2010[1]). The MOZART-4 data for 2012 was obtained from the National Center for Atmospheric Research (NCAR; http://www.acom.ucar.edu/wrf-chem/mozart.shtml) for the simulations driven by meteorological fields from the NASA GMAO GEOS-5 model. The same MOZART derived BCs for the 12 km outer domain, were used for all simulations (e.g., Base, Reference, Future, and any sensitivity simulation). The inner 4 km domain simulations utilized BCs that were based on the output from the corresponding day of the 12 km domain simulation.

[1] Emmons, L. K., Walters, S., Hess, P. G., Lamarque, J.-F., Pfister, G. G., Fillmore, D., Granier, C., Guenther, A., Kinnison, D., Laepple, T., Orlando, J., Tie, X., Tyndall, G., Wiedinmyer, C., Baughcum, S. L., and Kloster, S.: Description and evaluation of the Model for Ozone and Related chemical Tracers, version 4 (MOZART-4), Geosci. Model Dev., 3, 43-67, doi:10.5194/gmd-3-43-2010, 2010.

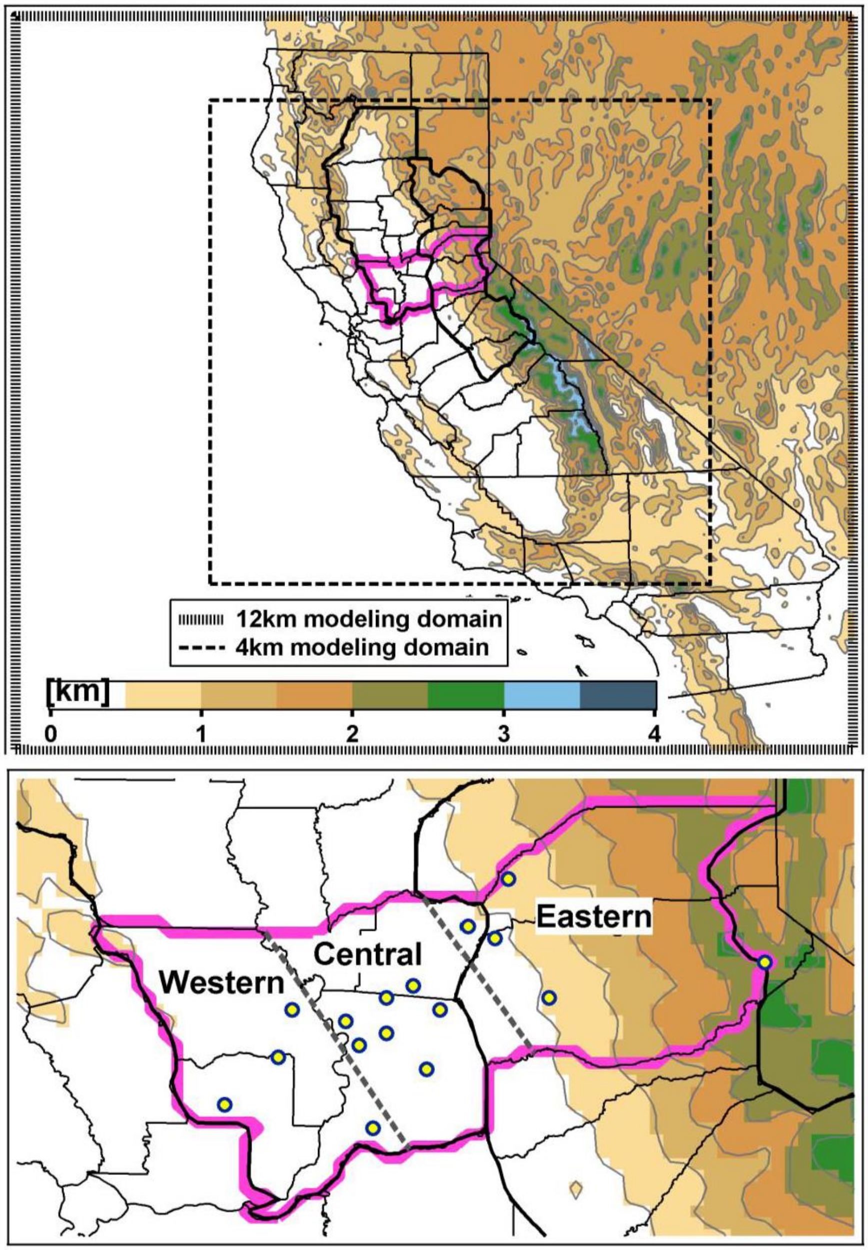

Figure 11. The CMAQ modeling domains used in this SIP modeling. The outer box of the top panel is the California statewide 12 km modeling domain, while the inner box shows the 4 km modeling domain covering Central California. The shaded and gray line contours denote the gradients in topography (km). The insert on the bottom shows the zoomed-in view of the spatial extent (magenta lines), approximate regional boundaries of the Western, Central and Eastern sub-regions (dashed black lines) and the location of ozone monitoring sites (circle markers) in the SFNA.

Table 9. CMAQ configuration and settings.

Process	Scheme
Horizontal advection	Yamo (Yamartino scheme for mass-conserving advection)
Vertical advection	WRF-based scheme for mass-conserving advection
Horizontal diffusion	Multi-scale
Vertical diffusion	ACM2 (Asymmetric Convective Model version 2)
Gas-phase chemical mechanism	SAPRC-07 gas-phase mechanism with version “C” toluene updates
Chemical solver	EBI (Euler Backward Iterative solver)
Aerosol module	Aero6 (the sixth-generation CMAQ aerosol mechanism with extensions for sea salt emissions and thermodynamics; includes a new formulation for secondary organic aerosol yields)
Cloud module	ACM_AE6 (ACM cloud processor that uses the ACM methodology to compute convective mixing with heterogeneous chemistry for AERO6)
Photolysis rate	phot_inline (calculate photolysis rates in-line using simulated aerosols and ozone concentrations)

5.2. CMAQ MODEL EVALUATION

Observed ozone data from the Air Quality and Meteorological Information System (AQMIS) database (www.arb.ca.gov/airqualitytoday/) was used to evaluate the accuracy of the 4 km CMAQ modeling for all ozone monitors listed in Table 2 and Figure 11. The U.S. EPA modeling guidance[1] recommends using model output from the grid cell in which the monitor is located in the operational evaluation of the model predictions. However, the future year design value calculations (discussed in Sections 2.5 and 2.6) are based on simulated values > 60 ppb near the monitor (i.e., the maximum simulated ozone within a 3x3 array of grid cells with the grid cell containing the monitor located at the center of the array). Hence, model performance was evaluated at each monitor by comparing observations against the simulated values using only data above the 60 ppb threshold at the monitored grid cell as well as the peak grid cell within the 3x3 grid array

[1] U.S. EPA, 2014, Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5 and Regional Haze, available at https://www.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf

centered on the monitor (i.e., the 3x3 maximum). Model performance was further summarized separately for the three sub-regions in Figure 11.

As recommended by U.S. EPA[1], a number of statistical metrics have been used to evaluate the model performance for ozone. These metrics include mean bias (MB), mean error (ME), mean fractional bias (MFB), mean fractional error (MFE), normalized mean bias (NMB), normalized mean error (NME), root mean square error (RMSE), and correlation coefficient (R^2). In addition, the following plots were used in evaluating the modeling: time-series comparing predictions and observations, scatter plots for comparing the magnitude of simulated and observed mixing ratios, box plots to summarize the time series data across different regions and averaging times, as well as frequency distributions.

The model performance evaluation is presented for the entire SFNA region and also disaggregated for the three sub-regions. Performance statistics for data above 60 ppb are reported separately for different ozone metrics including 8-hour daily maximum ozone, 1-hour daily maximum ozone, and hourly ozone (all hours of the day) for the monitored grid cell as well as the 3x3 maximum.

Performance statistics for Maximum Daily Average 8-hour ozone (MDA8) are shown in Table 10. Overall, when simulated data extracted at the grid cell is used for comparison with observations, the model shows a slight negative bias in MDA8 ozone greater than 60 ppb in the Central SFNA (-2.4 ppb) and Eastern SFNA (-1.3 ppb), while a very small positive bias (0.4) is seen in the Western SFNA. However, when the 3x3 maximum is used, the model shows a slight positive bias in MDA8 in the Western (1.9 ppb) and Eastern (0.1) SFNA, with a slight negative bias in Central SFNA (-0.1 ppb). Mean error shows a consistent trend with the error increasing slightly by 0.2 ppb (from 7.2 ppb to 7.4 ppb) for the entire SFNA when the 3x3 maximum is considered. Similar statistics for daily maximum 1-hour ozone and hourly ozone can be found in Table 11 and Table 12, respectively.

[1] U.S. EPA, 2014, Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5 and Regional Haze, available at https://www.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf

Table 10. Daily maximum 8-hour ozone performance statistics by modeling sub-regions and entire SFNA for the 2012 ozone season (May-October 5th 2012).

Daily Maximum 8-hour ozone > 60 ppb with simulated data extracted at grid cell where the monitor is located				
Parameter	**Western SFNA**	**Central SFNA**	**Eastern SFNA**	**Entire SFNA**
Number of data points	64	244	227	535
Mean obs (ppb)	67.2	72.1	69.4	70.4
Standard Deviation obs (ppb)	6.6	9.5	6.9	8.3
Mean Bias (ppb)	0.4	-2.4	-1.3	-1.6
Mean Error (ppb)	5.1	7.9	7.1	7.2
RMSE (ppb)	6.6	10	9.1	9.3
Normalized Mean Bias (%)	0.6	-3.3	-1.9	-2.3
Normal Mean Error (%)	7.6	10.9	10.3	10.3
R-squared	0.15	0.14	0.03	0.1
Index of Agreement	0.61	0.62	0.49	0.58

Daily Maximum 8-hour ozone > 60 ppb with simulated data extracted from the 3x3 grid cell array maximum centered at the monitor				
Parameter	**Western SFNA**	**Central SFNA**	**Eastern SFNA**	**Entire SFNA**
Number of data points	69	275	259	603
Mean obs (ppb)	67.3	71.7	69.2	70.1
Standard Deviation obs (ppb)	6.4	9.3	6.9	8.2
Mean Bias (ppb)	1.9	-0.1	0.1	0.2
Mean Error (ppb)	6.1	7.9	7.3	7.4
RMSE (ppb)	7.4	10.2	9.3	9.5
Normalized Mean Bias (%)	2.7	-0.2	0.2	0.3
Normal Mean Error (%)	9	11	10.5	10.6
R-squared	0.11	0.14	0.04	0.11
Index of Agreement	0.58	0.63	0.51	0.6

Table 11. Daily maximum 1-hour ozone performance statistics by modeling sub-regions and entire SFNA for the 2012 ozone season (May-October 5th 2012).

Daily Maximum 1-hour ozone > 60 ppb with simulated data extracted at grid cell where the monitor is located				
Parameter	**Western SFNA**	**Central SFNA**	**Eastern SFNA**	**Entire SFNA**
Number of data points	189	455	361	1005
Mean obs (ppb)	71	77	73.4	74.6
Standard Deviation obs (ppb)	8.3	12.4	9.5	11
Mean Bias (ppb)	0.7	-2.8	-0.8	-1.4
Mean Error (ppb)	6.8	9.5	8.3	8.6
RMSE (ppb)	8.9	12.5	10.8	11.3
Normalized Mean Bias (%)	1	-3.6	-1.1	-1.9
Normal Mean Error (%)	9.6	12.4	11.4	11.5
R-squared	0.16	0.22	0.15	0.2
Index of Agreement	0.64	0.68	0.63	0.67

Daily Maximum 1-hour ozone > 60 ppb with simulated data extracted from the 3x3 grid cell array maximum centered at the monitor				
Parameter	**Western SFNA**	**Central SFNA**	**Eastern SFNA**	**Entire SFNA**
Number of data points	207	505	395	1107
Mean obs (ppb)	70.7	76.6	73	74.2
Standard Deviation obs (ppb)	8.2	12.2	9.5	10.9
Mean Bias (ppb)	3.2	0.6	1.5	1.4
Mean Error (ppb)	7.3	9.8	8.6	8.9
RMSE (ppb)	9.5	13.2	11.1	11.8
Normalized Mean Bias (%)	4.5	0.8	2.1	1.9
Normal Mean Error (%)	10.3	12.8	11.8	12
R-squared	0.2	0.22	0.18	0.21
Index of Agreement	0.67	0.69	0.65	0.68

Table 12. Hourly ozone performance statistics by modeling sub-regions and entire SFNA for the 2012 ozone season (May-October 5th 2012). Note that only statistics for the grid cell in which the monitor is located were calculated for hourly ozone.

Hourly ozone > 60 ppb with simulated data extracted at grid cell where the monitor is located				
Parameter	**Western SFNA**	**Central SFNA**	**Eastern SFNA**	**Entire SFNA**
Number of data points	608	2044	1571	4223
Mean obs (ppb)	69.7	73.9	70.4	72
Standard Deviation obs (ppb)	7.6	10.8	8.2	9.7
Mean Bias (ppb)	0.4	-2.2	-0.6	-1.2
Mean Error (ppb)	6.7	8.7	7.8	8.1
RMSE (ppb)	8.8	11.4	10.4	10.7
Normalized Mean Bias (%)	0.5	-3	-0.8	-1.7
Normal Mean Error (%)	9.6	11.8	11	11.2
R-squared	0.08	0.17	0.06	0.13
Index of Agreement	0.57	0.64	0.55	0.61

Model performance statistics within the range of values shown in Tables 10, 11 and 12 are consistent with previous studies in the SFNA, SJV and studies elsewhere in the U.S. Hu et al. (2012)[1], simulated an ozone episode in central California (July 27 – August 2, 2000) using a different chemical mechanisms and found that modeled bias ranged from -2.7 to -10.8 ppb for daily maximum 8-hour ozone (compared to -1.6 and 0.2 ppb for the entire SFNA in this work) and -3.6 to -12.7 ppb for daily maximum 1-hour ozone in Central California (compared to -1.4 and 1.4 ppb in this work). Similarly, Shearer et al. (2012)[2] compared model performance in Central California during two episodes in 2000 (July 24 – 26 and July 31 – August 2) for two different chemical mechanisms and found that normalized bias for daily maximum 8-hour ozone ranged from -7% to -14% with hourly peak ozone showing a slightly larger range from -7% to -18%. These values are greater than the statistics found in this work, which were calculated as -2.3% (or 0.3% with 3x3 maximum values) for daily maximum 8-hour

[1] Hu, J., Howard, C. J., Mitloehner, F., Green, P. G., and Kleeman, M. J.: Mobile Source and Livestock Feed Contributions to Regional Ozone Formation in Central California, *Environmental Science & Technology*, 46, 2781-2789, 2012.
[2] Shearer, S. M., Harley, R. A., Jin, L., and Brown, N. J.: Comparison of SAPRC99 and SAPRC07 mechanisms in photochemical modeling for central California, *Atmos. Environ.*, 46, 205-216, 2012.

ozone and -3% (or 1.9% with 3x3 maximum values) for daily maximum 1-hour ozone. Jin et al. (2010)[1] conducted a longer term simulation over Central California (summer 2000) and found a RMSE for daily maximum 8-hour ozone of 14 ppb, which is greater than the 9.3 ppb (or 9.5 ppb with 3x3 maximum values) found in this work. Jin et al. (2010) also showed an overall negative bias of -2 ppb, which is consistent with the -1.6 ppb (0.2 ppb with 3x3 maximum values) found in this work.

Simon et al. (2012)[2] conducted a review of photochemical model performance statistics published between 2006 and 2012 for North America (from 69 peer-reviewed articles). In Figure 12, the statistical evaluation of this model attainment demonstration is compared to the model performance summary presented in Simon et al. (2012) by overlaying the various summary statistics from this attainment demonstration onto the Simon et al. (2012) model performance summary. Note that the box-whisker plot (colored in gray) shown in Figure 12 is reproduced using data from Figure 4 of Simon et al. (2012). The blue and red colored horizontal line markers in each of the panels in Figure 12 denote the model performance statistics from the current modeling work, calculated using the simulated monitor grid cell and the 3x3 maximum, respectively. Figure 11 clearly shows that the model performance statistical metrics for hourly, daily maximum 8-hour and daily maximum 1-hour ozone from this work are consistent with previous modeling studies reported in the scientific literature. In particular, the Simon et. al. (2012) study found that mean bias for daily maximum 8-hour ozone ranged from approximately -7 ppb to 13 ppb, while mean error ranged from around 4 ppb to 22 ppb, and RMSE ranged from approximately 8 ppb to 23 ppb; all of which are similar in magnitude to the statistics presented in Table 10. Time series, scatter plots, box plots of mean bias (grouped into 10 ppb bins based on observed values), frequency distribution along with the spatial distribution of mean bias and error plots of the hourly, 1-hourr daily maximum and 8-hour daily maximum ozone data used to generate Tables 10, 11 and 12 can be found in the supplementary material.

[1] Jin, L., Brown, N. J., Harley, R. A., Bao, J.-W., Michelson, S. A., and Wilczak, J. M.: Seasonal versus episodic performance evaluation for an Eulerian photochemical air quality model, *J. Geophys. Res.*, 115, D09302, doi:10.1029/2009JD012680, 2010.
[2] Simon, H., Baker, K. R., and Phillips, S.: Compilation and interpretation of photochemical model performance statistics published between 2006 and 2012, *Atmospheric Environment*, 61, 124-139, 2012.

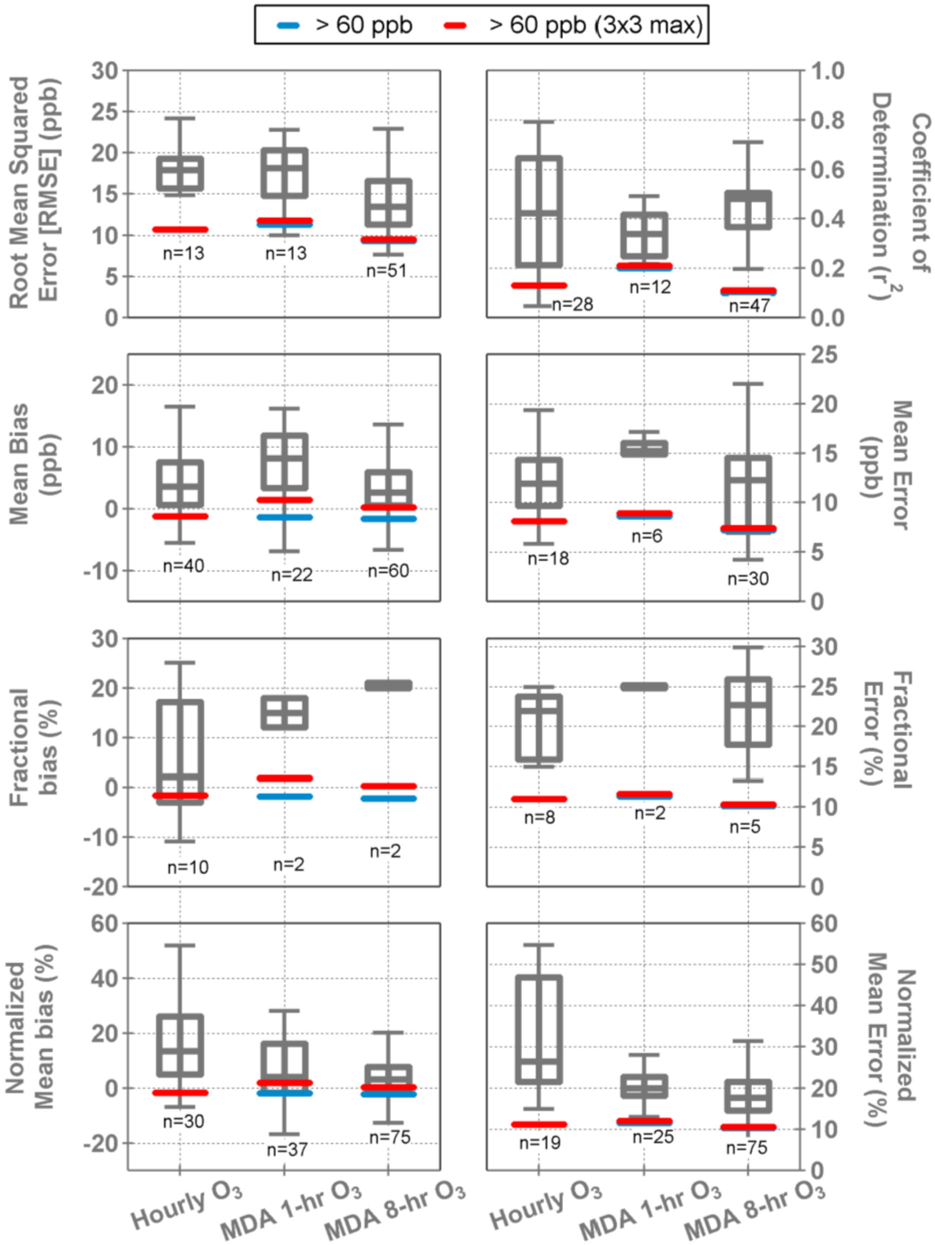

Figure 12. Comparison of various statistical metrics from the model attainment demonstration modeling to the range of statistics from the 69 peer-reviewed studies summarized in Simon et al. (2012)[1]. (MDA denotes Maximum Daily Average).

[1] Simon, H., Baker, K. R., and Phillips, S.: Compilation and interpretation of photochemical model performance statistics published between 2006 and 2012, *Atmospheric Environment*, 61, 124-139, 2012.

5.2.1 DIAGNOSITC EVALUATION

In addition to the statistical evaluation presented above, since the modeling is utilized in a relative sense, it is also useful to consider whether the model is able to reproduce observable relationships between changes in emissions and ozone. One approach to this would be to conduct a retrospective analysis where additional years are modeled (e.g., 2000 or 2005) and the ability of the modeling system to reproduce the observed change in ozone over time is investigated. Since this approach is extremely time consuming and resource intensive, it is generally not feasible to perform such an analysis under the constraints of a typical SIP modeling application. Another approach to investigating the ozone response to changes in emissions is through the so called "weekend effect".

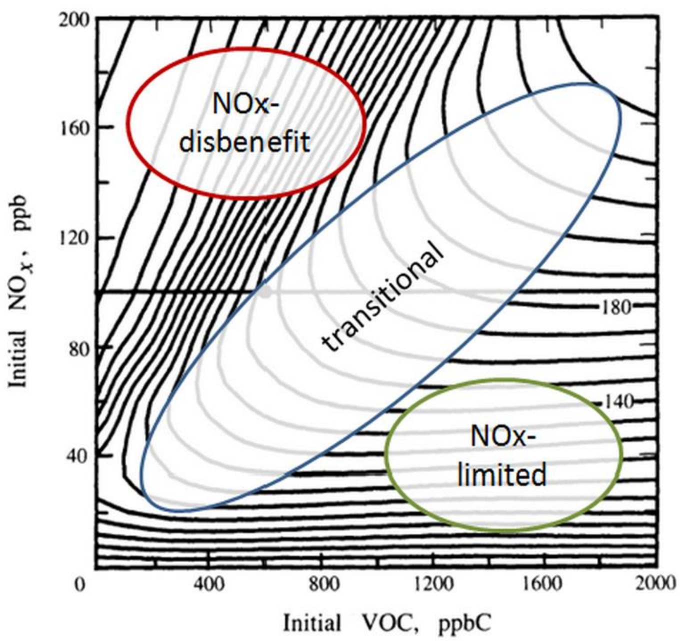

Figure 13. Illustrates a typical ozone isopleth plot, where each line represents ozone mixing ratio, in 10 ppb increments, as a function of initial NO_X and VOC (or ROG) mixing ratio (adapted from Seinfeld and Pandis, 1998[1], Figure 5.15). General chemical regimes for ozone formation are shown as NO_X-disbenefit (red circle), transitional (blue circle), and NO_X-limited (green circle).

The weekend effect is a well-known phenomenon in some major urbanized areas where emissions of NO_X are substantially lower on weekends than on weekdays, but

[1] Seinfeld J. H. and Pandis S. N. (1998) Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, 1st edition, J. Wiley, New York.

measured levels of ozone are higher on weekends than on weekdays. This is due to the complex and non-linear relationship between NO_x and ROG precursors and ozone (e.g., Swamy et al., 2012)[1]. Ozone formation exhibits a nonlinear dependence to NO_x and ROG precursors in the atmosphere. In general terms, under ambient conditions of high-NO_x and low-ROG (NO_x-disbenefit region in Figure 13), ozone formation tends to exhibit a disbenefit to reductions in NO_x emissions (i.e., ozone increases with decreases in NO_x) and a benefit to reductions in ROG emissions (i.e., ozone decreases with decreases in ROG). In contrast, under ambient conditions of low-NO_x and high-ROG (NO_x-limited region in Figure 13), ozone formation shows a benefit to reductions in NO_x emissions, while changes in ROG emissions result in only minor decreases in ozone. These two distinct "ozone chemical regimes" are illustrated in Figure 13 along with a transitional regime that can exhibit characteristics of both the NO_x-disbenefit and NOx-limited regimes. Note that Figure 13 is shown for illustrative purposes only, and does not represent the actual ozone sensitivity within the SFNA for a given combination of NO_x and ROG (VOC) emissions.

In this context, the prevalence of a weekend effect in a region suggests that the region is in a NO_x-disbenefit regime (Heuss et al., 2003)[2]. A lack of a weekend effect (i.e., no pronounced high O_3 occurrences during weekends) would suggest that the region is in a transition regime and moving between exhibiting a NO_x-disbenefit and being NO_x-limited. A reversed weekend effect (i.e., lower O_3 during weekends) would suggest that the region is NO_x-limited.

Investigating the "weekend effect" and how it has changed over time is a useful real world metric for evaluating the ozone chemistry regime in the SFNA and how well it is represented in the modeling. The trend in day-of-week dependence of SFNA's sub-regional observed ozone levels between 2000 and 2014 is shown in Figure 14.
The three-panel scatter plot shown in Figure 14 compares the average site-specific weekday (Wednesday and Thursday) and weekend (Sunday) observed summertime (June through September) maximum daily average (MDA) 8-hour ozone by year (2000 to 2014), separated into three sub-regions: Western SFNA (top), Central SFNA (middle), and Eastern SFNA (bottom). Different definitions of weekday and weekend

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[1] Swamy, Y.V., Venkanna, R.,Nikhil, G.N., Chitanya, D.N.S.K., Sinha, P.R., Ramakrishna, M., and Rao, A.G., 2012. Impact of Nitrogen Oxides, Volatile Organic Compounds and Black Carbon on Atmospheric Ozone Levels at a Semi Arid Urban Site in Hyderabad. Aerosol and Air Quality Research 12, 662–671.
[2] Heuss, J.M., Kahlbaum, D.F., and Wolff, G.T., 2003. Weekday/weekend ozone differences: What can we learn from them? Journal of the Air & Waste Management Association 53(7), 772-788

days were also investigated and did not show appreciable differences from the Wednesday/Thursday and Sunday definitions.

From Figure 14, it can be seen that ozone levels are highest in the eastern and central regions of the SFNA consistent with their location downwind to and within the urban core of the Sacramento Metropolitan Area. The lowest ozone levels are seen in the western SFNA region, which is located upwind of the urban Sacramento emissions source. In addition, in all regions, summertime average weekday and weekend ozone levels have steadily declined between 2000 and 2014.

Along with the declining ozone, there was shift in the relative difference between weekday and weekend ozone from 2000 and 2014. In the early 2000's, the central region of the SFNA exhibited a roughly equal number sites with weekend ozone greater than weekday ozone as sites with weekday ozone greater than weekend ozone, which suggests that the region may have been in a transitional chemistry regime for ozone formation. By the mid-2000's, the majority of sites were showing weekday ozone greater than weekend ozone, which is consistent with a shift into complete NO_x-limited chemistry. By 2014, however, some of the sites had shifted back towards a more equal distribution between weekday and weekend ozone, likely due to variability in the biogenic emissions and meteorology that can shift the ozone chemistry between NO_x-limited and NO_x-disbenefit regimes in the Sacramento area (LaFranchi et al., 2011)[1].

The Western SFNA region clearly experienced a greater NO_x-disbenefit in the early 2000's and then moved into a transitional chemical regime in the mid-2000's and transitioned into the NO_x-limited regime around the 2010/2011 timeframe. There was a shift back towards a more equal distribution between weekday and weekend ozone by 2014, similar to the Central sub-region. However, this shift occurred at very low ozone levels (below 50 ppb) that are well below the 75 ppb 8-hour ozone standard.

In contrast to the central and western regions described above, the eastern portion of SFNA has been in a NO_x-limited regime since before 2000, which can be seen from the greater weekday ozone when compared to the weekend ozone. This region is in close proximity to large biogenic ROG emission sources and farther away from the anthropogenic NO_x sources in the urban Sacramento Metropolitan area, which are conditions (i.e. low NO_x and high ROG) which place the region in a NO_x-limited regime.

[1] LaFranchi, B. W., Goldstein, A. H., and Cohen, R. C.: Observations of the temperature dependent response of ozone to NO_x reductions in the Sacramento, CA urban plume, Atmos. Chem. Phys., 11, 6945-6960, doi:10.5194/acp-11-6945-2011, 2011

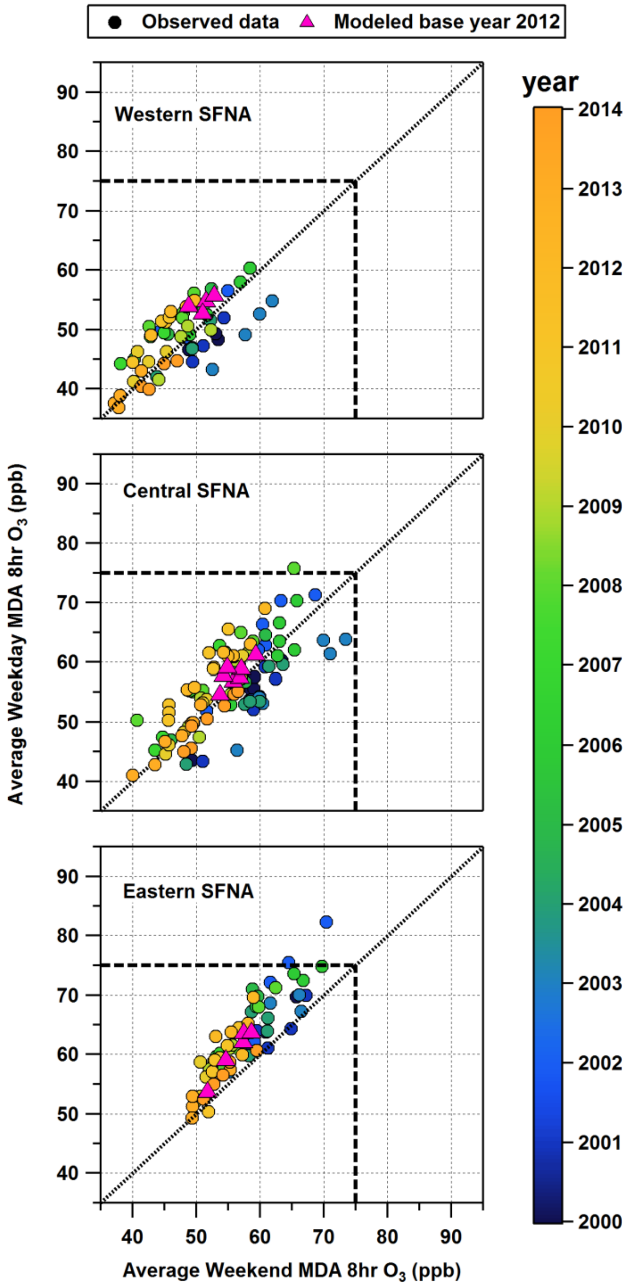


Figure 14. Site-specific average weekday and weekend maximum daily average 8-hour ozone for each year from 2000 to 2014 for the Western (top), Central (middle), and Eastern (bottom) sub-regions of SFNA. The colored circle markers denote observed values while the magenta triangle markers denote the simulated baseline 2012 values. Points falling below the 1:1 dashed line represent a NO_x-disbenefit regime, those on the 1:1 dashed line represent a transitional regime, and those above the 1:1 dashed line represent a NO_x-limited regime.

The simulated baseline 2012 weekday/weekend values (magenta triangle markers in Figure 14) from the attainment demonstration modeling show greater weekday ozone compared to weekend ozone for all three sub-regions, with smaller differences seen in the Central and Western SFNA. These predicted values are consistent with observed findings in 2012 that show a shift into a NO_x-limited chemistry regime for the Central and Western SFNA and prevalence of NO_x-limited conditions in Eastern SFNA.

These findings are consistent with an independent analysis by UC Berkeley researchers that examined the observed ozone response due to the decline in NO_x emissions within the Sacramento area between 2001 and 2007[1]. The study showed a significant decline in 1-hour ozone exceedance days corresponding to a 30% decrease in observed NO_x due to reductions in NO_x emissions, and suggesting that NO_x emission reductions have been effective at reducing ozone levels at all points in Sacramento urban plume. This study concluded that the decline in NO_x emissions levels has successfully transitioned the region to a NO_x-limited chemistry regime except within the urban core of the Sacramento Metropolitan Area and predicted that the future cumulative NO_x controls over time will likely transition the entire SFNA (including the urban core) to a NO_x limited regime.

5.3. RELATIVE RESPONSE FACTORS AND FUTURE YEAR DESIGN VALUES

The RRFs (Section 2.5) and future year design values (Section 2.6) for the representative sites in the western, central and eastern regions of the SFNA were calculated using the procedures outlined in the corresponding sections, respectively, and are summarized in Table 13. Note that the results shown in Table 13 are ordered by each sub-region in descending order of the average reference year 2012 DVs.

The results in Table 13 show that all monitoring sites in the SFNA have a future DV less than 75 ppb based on the 2026 emissions inventory, with the Folsom monitor in Central SFNA having the highest predicted future design of 70 ppb in 2026 (Note that Folsom is also the valley's design site for base year 2012). Therefore, the air quality simulations predict that the entire region will attain the 75 ppb 8-hour O_3 standard by 2026.

[1] LaFranchi, B. W., Goldstein, A. H., and Cohen, R. C.: Observations of the temperature dependent response of ozone to NO_x reductions in the Sacramento, CA urban plume, Atmos. Chem. Phys., 11, 6945-6960, doi:10.5194/acp-11-6945-2011, 2011

Table 13. Summary of key parameters related to the calculation of future year 2022 and 2026 8-hour ozone design values (DV). Note that final future year design values are truncated, and fractional values are shown for reference only.

Sub-region	Site (County, Air Basin)	Base year 2012	Future year 2022		Future year 2026	
		Average DV (ppb)	RRF	Average DV (ppb)	RRF	Average DV (ppb)
Eastern SFNA	Placerville-Gold Nugget Way (El Dorado, MCAB)	82.3	0.8259	68.0	0.7778	64.0
Eastern SFNA	Cool-Hwy193 (El Dorado, MCAB)	81.3	0.8336	67.8	0.7882	64.1
Eastern SFNA	Auburn - Atwood Rd (Placer, SVAB)	79.0	0.8180	64.6	0.7669	60.6
Eastern SFNA	Colfax-City Hall (Placer, MCAB)	73.7	0.8270	60.9	0.7804	57.5
Eastern SFNA	Echo Summit (El Dorado, MCAB)	69.0	0.9411	64.9	0.9260	63.9
Central SFNA	**Folsom-Natoma Street[1] (Sacramento, SVAB)**	**90.0**	**0.8358**	**75.2[1]**	**0.7857**	**70.7[1]**
Central SFNA	Sloughhouse (Sacramento, SVAB)	84.0	0.8459	71.1	0.7998	67.2
Central SFNA	Roseville-N Sunrise Ave (Placer, SVAB)	82.3	0.8487	69.8	0.8055	66.3
Central SFNA	Sacramento-Del Paso Manor (Sacramento, SVAB)	77.3	0.8595	66.4	0.8162	63.1
Central SFNA	North Highlands-Blackfoot Way (Sacramento, SVAB)	76.0	0.8578	65.2	0.8149	61.9
Central SFNA	Sacramento - 1309 T Street (Sacramento, SVAB)	70.0	0.8644	60.5	0.8242	57.7
Central SFNA	Sacramento-Goldenland Court (Sacramento, SVAB)	70.0	0.8820	61.7	0.8415	58.9
Western SFNA	Elk Grove - Bruceville Road (Sacramento, SVAB)	71.7	0.8558	61.4	0.8129	58.3
Western SFNA	Woodland-Gibson Road (Yolo, SVAB)	68.7	0.8459	58.1	0.7996	54.9
Western SFNA	Vacaville-Ulatis Drive (Solano, SVAB)	67.3	0.8459	56.9	0.8009	53.9

[1] The RRF and projected future DVs at the Folsom site do not include the grid cell where the Folsom lake is located (See section 2.5 for details). This does not impact the findings of this attainment demonstration as the future year 2022 and 2026 DVs at Folsom site are estimated to be 73.6 ppb and 68.8 ppb, when the Folsom lake grid cell location is included in RRF and future DV calculations.

	Davis-UCD Campus (Yolo, SVAB)	66.7	0.8495	56.7	0.8052	53.7

The projected 2022 and 2026 DVs in SFNA show a large decrease when compared to 2012 levels (e.g., at the Folsom Natoma Street monitoring site, the SFNA's design site for 2012, the DV declined by ~15 ppb in 2022 and ~20 ppb in 2026 compared to 2012), which is consistent with the peer-reviewed, published study conducted by the UC Berkeley researchers on the observed response of ozone to NO_x reductions in the Sacramento area[1]. This study concluded that the region's ozone exceedance days have been decreasing linearly with decreases in NO_x, which suggests that cumulative NO_x controls over time have successfully transitioned the SFNA into a NO_x-limited chemistry regime, where NO_x emission reductions are becoming increasingly effective at reducing ozone levels in the region.

5.4. UNMONITORED AREA ANALYSIS

The unmonitored area analysis is used to ensure that there are no regions outside of the existing monitoring network that would exceed the NAAQS if a monitor was present (U.S. EPA, 2014[2]). U.S. EPA recommends combining spatially interpolated design value fields with modeled ozone gradients and grid-specific RRFs in order to generate gridded future year gradient adjusted design values.

This analysis can be done using the Model Attainment Test Software (MATS) (Abt, 2014[3]). However, this software is not open source and comes as a precompiled software package. To maintain transparency and flexibility in the analysis, in-house R codes (https://www.r-project.org/) developed at ARB, were utilized in this analysis.

The unmonitored area analysis was conducted using the 8-hr O_3 weighted DVs from all the available sites that fall within the 4 km inner modeling domain along with the reference year 2012 and future year 2026 4 km CMAQ model output. The steps followed in the unmonitored area analysis are as follows:

---

[1] LaFranchi, B. W., Goldstein, A. H., and Cohen, R. C.: Observations of the temperature dependent response of ozone to NO_x reductions in the Sacramento, CA urban plume, Atmos. Chem. Phys., 11, 6945-6960, doi:10.5194/acp-11-6945-2011, 2011

[2] U.S. EPA, 2014, Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5 and Regional Haze, available at https://www.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf

[3] Abt, 2014. Modeled Attainment Test Software: User's Manual. MATS available at: http://www.epa.gov/scram001/modelingapps_mats.htm

Step 1: At each grid cell, the top-10 modeled maximum daily average 8-hour ozone mixing ratios from the reference year simulation were averaged, and a gradient in this top-10 day average between each grid cell and grid cells which contain a monitor was calculated.

Step 2: A single set of spatially interpolated 8-hr ozone DV fields was generated based on the observed 5-year weighted base year 8-hr ozone DVs from the available monitors. The interpolation is done using normalized inverse distance squared weightings for all monitors within a grid cell's Voronoi Region (calculated with the R tripack library; https://cran.r-project.org/web/packages/tripack/README), and adjusted based on the gradients between the grid cell and the corresponding monitor from Step 1.

Step 3: At each grid cell, the RRFs are calculated based on the reference- and future-year modeling following the same approach outlined in Section 8.3, except that the +/- 20% limitation on the simulated and observed maximum daily average 8-hour ozone was not applied because observed data do not exist for grid cells in unmonitored areas.

Step 4: The future year gridded 8-hr ozone DVs were calculated by multiplying the gradient-adjusted interpolated 8-hr ozone DVs from Step 2 with the gridded RRFs from Step 3

Step 5: The future-year gridded 8-hr ozone DVs (from Step 4) were examined to determine if there are any peak values higher than those at the monitors, which could potentially cause violations of the applicable 8-hr ozone NAAQS.

Figure 15 shows the spatial distribution of gridded DVs in 2026 for the SFNA based on the unmonitored area analysis (described above). The black colored triangle markers denote the monitoring sites, which had valid reference year 2012 DVs and were used in the analysis. The entire region shows gridded DVs that are below 70 ppb, except for a small region near the center of the spatial map in Figure 15, which shows DVs between 71 and 75 ppb. Those grid cells are located over Folsom Lake and the higher DVs are likely an artifact of the lower mixing heights predicted by the model. Therefore, the unmonitored area analysis predicts that all unmonitored regions within the SFNA will attain the 75 ppb 8-hour O_3 standard by 2026.

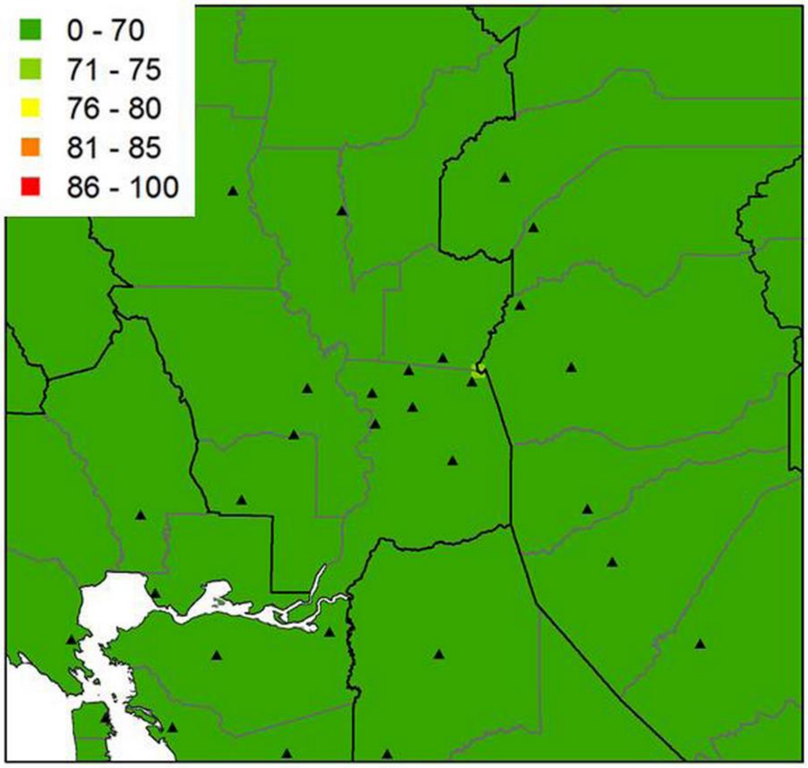


Figure 15. Spatial distribution of the future 2026 DVs based on the unmonitored area analysis in the SFNA. Color scale is in ppb of ozone.

5.5. "BANDED" RELATIVE RESPONSE FACTORS AND FUTURE YEAR DESIGN VALUES

The "Banded-RRF" approach expands upon the standard "Single-RRF" (Section 5.3) approach to account for differences in model response to emissions controls at varying ozone levels. The most recent U.S. EPA modeling guidance (U. S. EPA, 2014[1]) accounts for some of these differences by focusing on the top ten modeled days, but even the top ten days may contain a significant range of ozone mixing ratios. The Banded-RRF approach accounts for these differences more explicitly by grouping the simulated ozone into bands of lower, medium, and higher ozone mixing ratios.

[1] U.S. EPA, 2014, Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5 and Regional Haze, available at https://www.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf

In this work, the banded RRFs were calculated to project the future year 2022 and 2026 DVs. The data used for this analysis is inherently consistent with the data used in the single RRF calculations (Sections 2.5 and 5.3). The various steps involved in the calculation of banded RRFs are as follows:

1. MDA 8-hour ozone mixing ratios for all days that are above 60 ppb and that fall within +/- 20% of observations are stratified into 5 ppb increments in the 60 -100 ppb range. (All days above 100 ppb are grouped into a single bin)

2. A separate RRF is calculated for each ozone band following a similar approach as for the standard Single-RRF. A linear regression is then fit to the data resulting in an equation relating RRF to ozone band as long as there are at least 3 bands (without missing data). The band RRF calculations were not available for sites that had fewer than 3 bands of valid RRFs. Similar to the Single-RRF; this equation is unique to each monitor/location.

3. The top ten days for each monitor, based on observed 8-hour ozone for each year of the 5 years that is utilized in the design value calculation (see Table 1), are then projected to the future using the appropriate RRF for the corresponding ozone band.

4. The top ten future days for each individual year are then re-sorted, the fourth highest 8-hour ozone is selected, and the future year design value is calculated in a manner consistent with the base/reference year design value calculation.

5. The future Design Values were then compared with the 75 ppb 8-hour O_3 standard to determine the attainment status for each monitor.

More detailed information on the Banded-RRF approach can be found in Kulkarni et al. (2014)[1] and the SJV 2013 1-Hour Ozone SIP[2].

The banded RRFs and the corresponding future year 2022 and 2026 design values for the representative sites in the eastern, central, and western regions of the SFNA were calculated using the procedure outlined above, and are summarized in Table 14. Note

[1] Kulkarni, S., Kaduwela, A. P., Avise, J. C., DaMassa, J. A., and Chau, D.: An extended approach to calculate the ozone relative response factors used in the attainment demonstration for the National Ambient Air Quality Standards, *J. Air & Waste Management Association*, 64(10), 1204-1213, 2014, doi:10.1080/10962247.2014.936984.
[2] http://www.valleyair.org/Air_Quality_Plans/Ozone-OneHourPlan-2013.htm

that the results shown in Table 14 are ordered by each sub-region in the descending order of average reference year 2012 DVs.

Table 14. Summary of future year (2022 and 2026) design values projected using a banded RRF approach. Note that final future year design values are truncated, and fractional values are shown for reference only.

Sub-region	**Site (County, Air Basin)**	**Base year 2012**	**Future Year 2022**	**Future Year 2026**
		Average DV (ppb)	**Average DV (ppb)**	**Average DV (ppb)**
Eastern SFNA	Placerville-Gold Nugget Way (El Dorado, MCAB)	82.3	67.0	62.3
	Cool-Hwy193 (El Dorado, MCAB)	81.3	66.0	62.0
	Auburn - Atwood Rd (Placer, SVAB)	79.0	65.3	61.3
	Colfax-City Hall (Placer, MCAB)	73.7	60.3	57.3
	Echo Summit (El Dorado, MCAB)	69.0	65.7	65.0
Central SFNA	**Folsom-Natoma Street (Sacramento, SVAB)**	**90.0**	**74.0**	**69.0**
	Sloughhouse (Sacramento, SVAB)	84.0	70.7	67.0
	Roseville-N Sunrise Ave (Placer, SVAB)	82.3	68.7	64.7
	Sacramento-Del Paso Manor (Sacramento, SVAB)	77.3	66.0	63.0
	North Highlands-Blackfoot Way (Sacramento, SVAB)	76.0	65.0	62.0
	Sacramento - 1309 T Street (Sacramento, SVAB)	70.0	61.0	58.0
	Sacramento-Goldenland Court (Sacramento, SVAB)	70.0	61.3	59.3
Western SFNA	Elk Grove - Bruceville Road (Sacramento, SVAB)	71.7	61.7	58.7
	Woodland-Gibson Road (Yolo, SVAB)	68.7	58.3	55.7
	Vacaville-Ulatis Drive (Solano, SVAB)	67.3	57.0	54.0
	Davis-UCD Campus (Yolo, SVAB)	66.7	-	-

The results in Table 14 show that all the monitoring sites in the SFNA have a future DV less than 75 ppb, with the Folsom Natoma Street monitoring site in Central SFNA having the highest predicted future design value with an estimated future design value of 74 and 69 ppb in 2022 and 2026, respectively. These future DV's are ~1 ppb lower than the corresponding single-RRF values (Table 13).

6. OZONE ISOPLETHS

Since the entire SFNA is projected to be in attainment for the 2008 75 ppb 8-hour O_3 standard, no additional emission reductions beyond what is being implemented through the current control program will be necessary. However, the U.S. EPA revised the 8-hr O_3 standard to a level of 0.070 ppm (70 ppb) in October 2015[1], for which the final designations are due in late 2017. Hence, it is important to know the emission targets in the future to assess the level of emissions controls needed to attain the 2015 8-hour O_3 standard of 0.070 ppm (70 ppb). Although 2026 DVs at all monitoring sites are predicted to be in attainment of the 70 ppb ozone standard, it is still useful to examine the future DV sensitivity to precursor emissions to evaluate how this sensitivity may change in the future.

To examine the future ozone sensitivity within the SFNA for different combinations of NO_x and VOC (ROG) emissions in the region, modeling sensitivity simulations were conducted to generate 8-hr ozone isopleths. These sensitivity simulations are identical to the future year 2026 simulation discussed earlier in Section 2.4 and Table 3, except that domain-wide fractional reductions were applied to future year 2026 anthropogenic NO_x and ROG emission levels. Each sensitivity simulation was run for the entire ozone season (May – October 5th 2012) and included statewide 12 km simulations nested down to 4 km. The inner 4 km domain sensitivity simulations utilized BCs based on output from the corresponding 12 km sensitivity simulation, while the 12 km simulations all utilized the same MOZART derived BCs. The RRF methodology described in Section 2.5 was then applied to the inner 4 km domain output of each fractional ROG and NO_x sensitivity simulation to calculate the future year DV (for that specific NO_x-ROG combination) at each monitoring site in the SFNA.

Figure 16 shows the 2026 8-hour ozone isopleths for the Folsom monitoring site (isopleths for other sites are not shown since their projected DVs are below 70 ppb). In Figure 16, the bottom and top axes represent the domain-wide fractional ROG emissions and the corresponding SFNA emission totals (tons per day) in 2026,

[1] Federal Register, Vol. 80 , No. 206, October 26, 2015, National Ambient Air Quality Standards for Ozone, Final Rule, Pages 65291-65468

respectively. Similarly, the left and right axes represent the domain-wide fractional NO_x emissions and the corresponding SFNA emission totals (tons per day) in 2026, respectively. The upper right point on each diagram represents the projected DV for the attainment demonstration modeling (listed in Table 13).

The shape of the ozone isopleth shown in Figure 16 indicates that it falls in the bottom right corner of the Figure 13, where the NO_x-limited regime is prevalent. It is evident from this diagram that the future O_3 mixing ratios throughout the SFNA are predicted to be in the NO_x-limited regime and that the sensitivity to ROG emissions controls will be much lower when compared to NO_x controls.

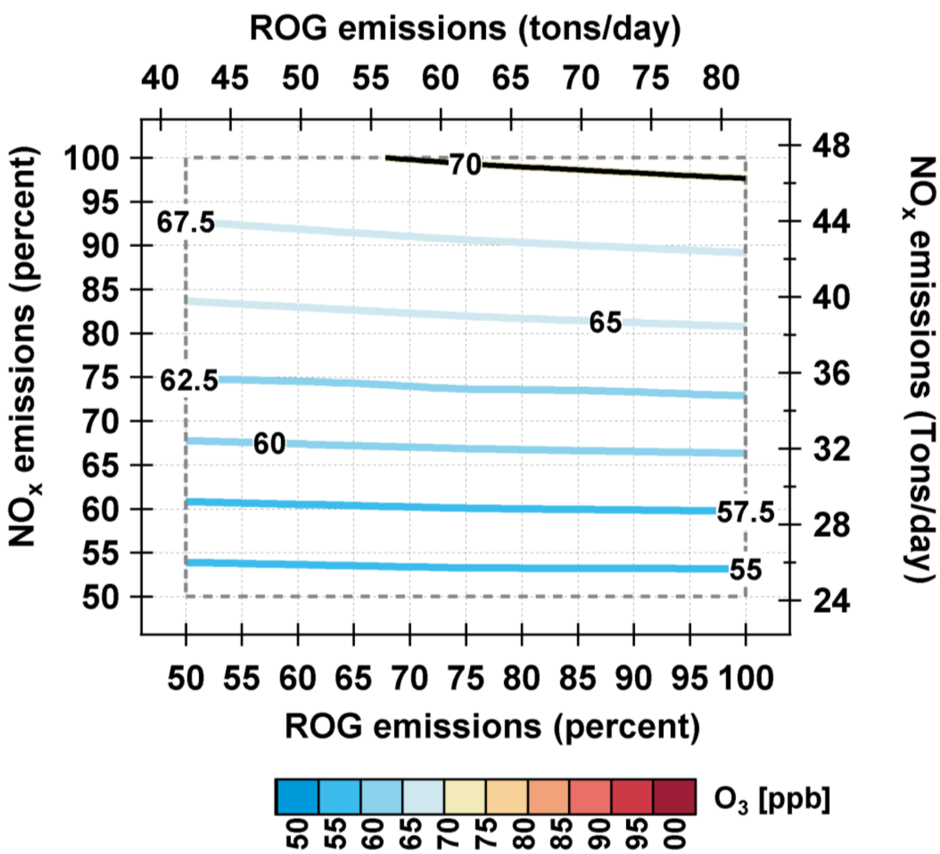


Figure 16. The 8-hr ozone isopleth based on 2026 emission levels at the Folsom Natoma Street monitoring site located in Central SFNA.

SUPPLEMENTAL MATERIALS

SUPPLEMENTAL MATERIALS TABLE OF CONTENTS

SUPPLEMENTAL MATERIALS LIST OF FIGURES

MONTHLY METEROLOGICAL TIME SERIES PLOTS

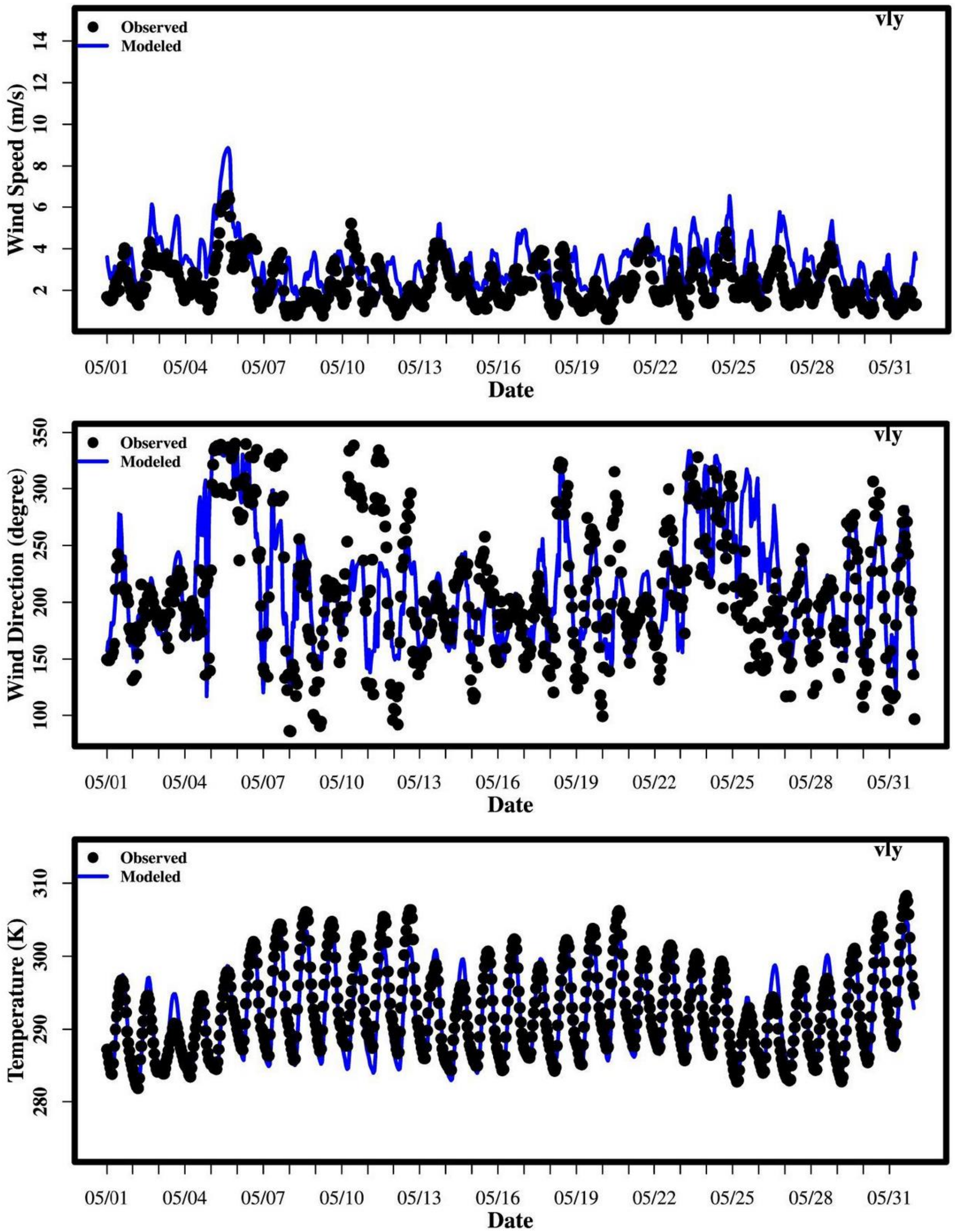


Figure S. 1 Time series of wind speed, direction, and temperature for Valley in May 2012.

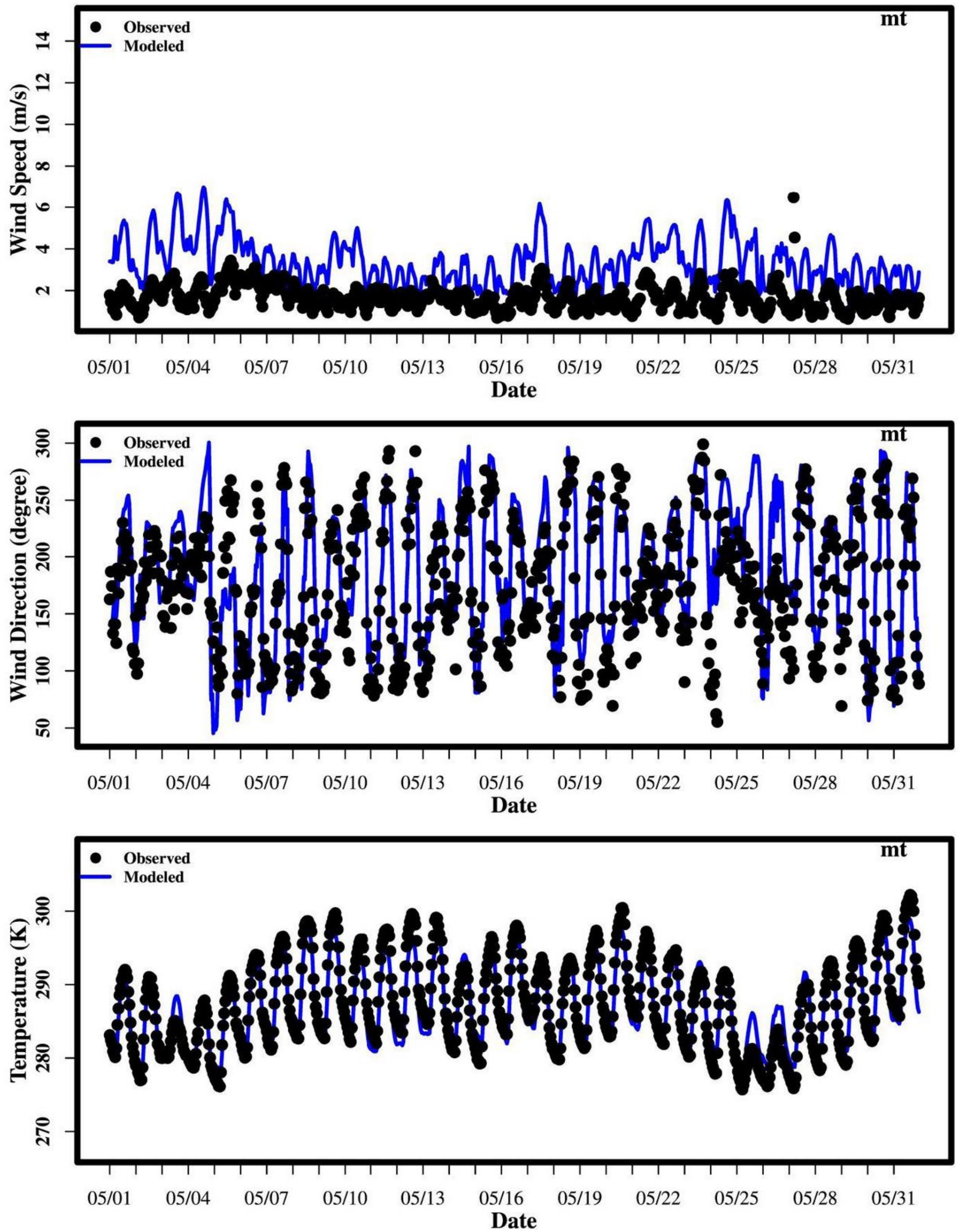


Figure S. 2 Time series of wind speed, direction, and temperature for Mountain in May 2012.

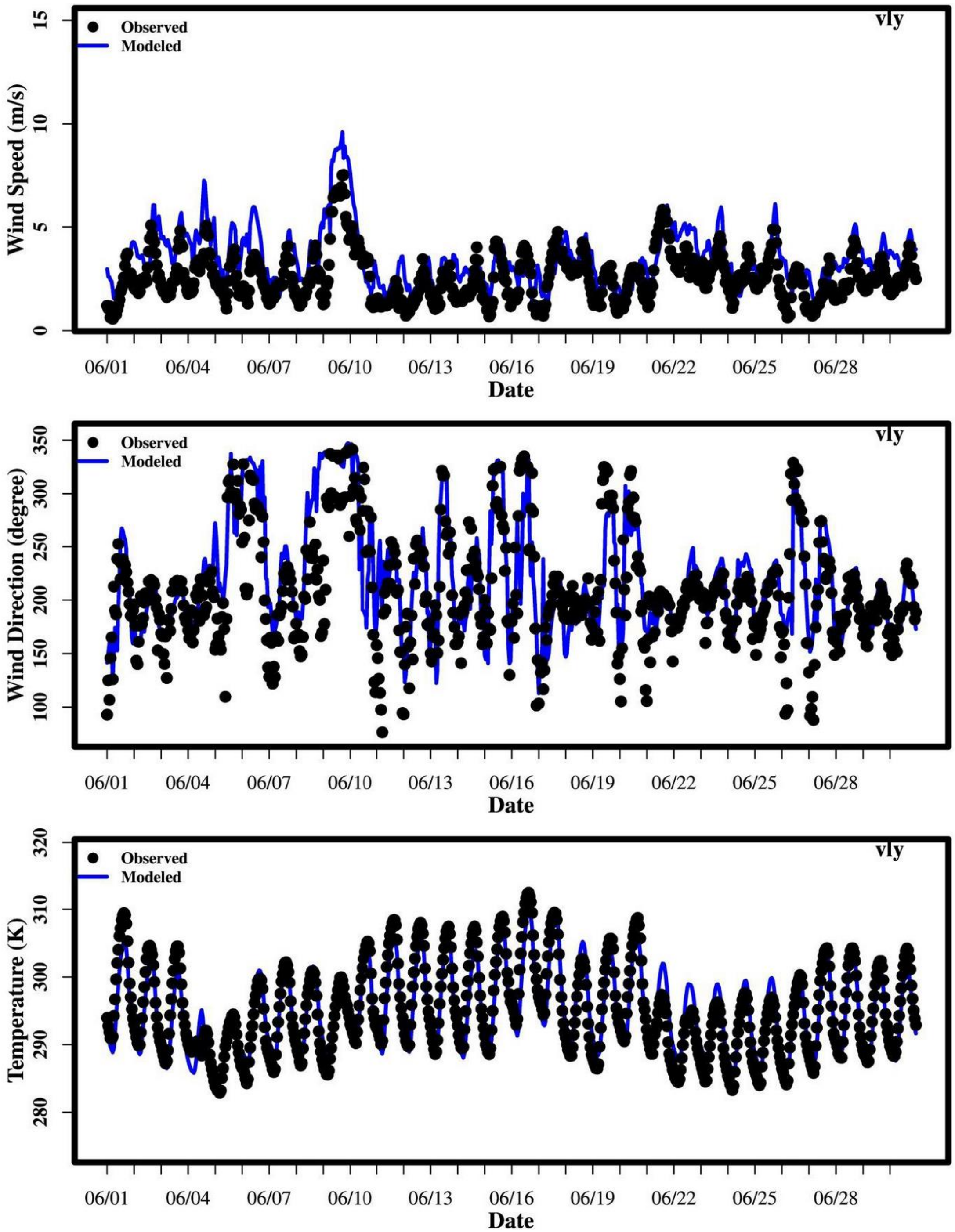


Figure S. 3 Time series of wind speed, direction, and temperature for Valley in June 2012.

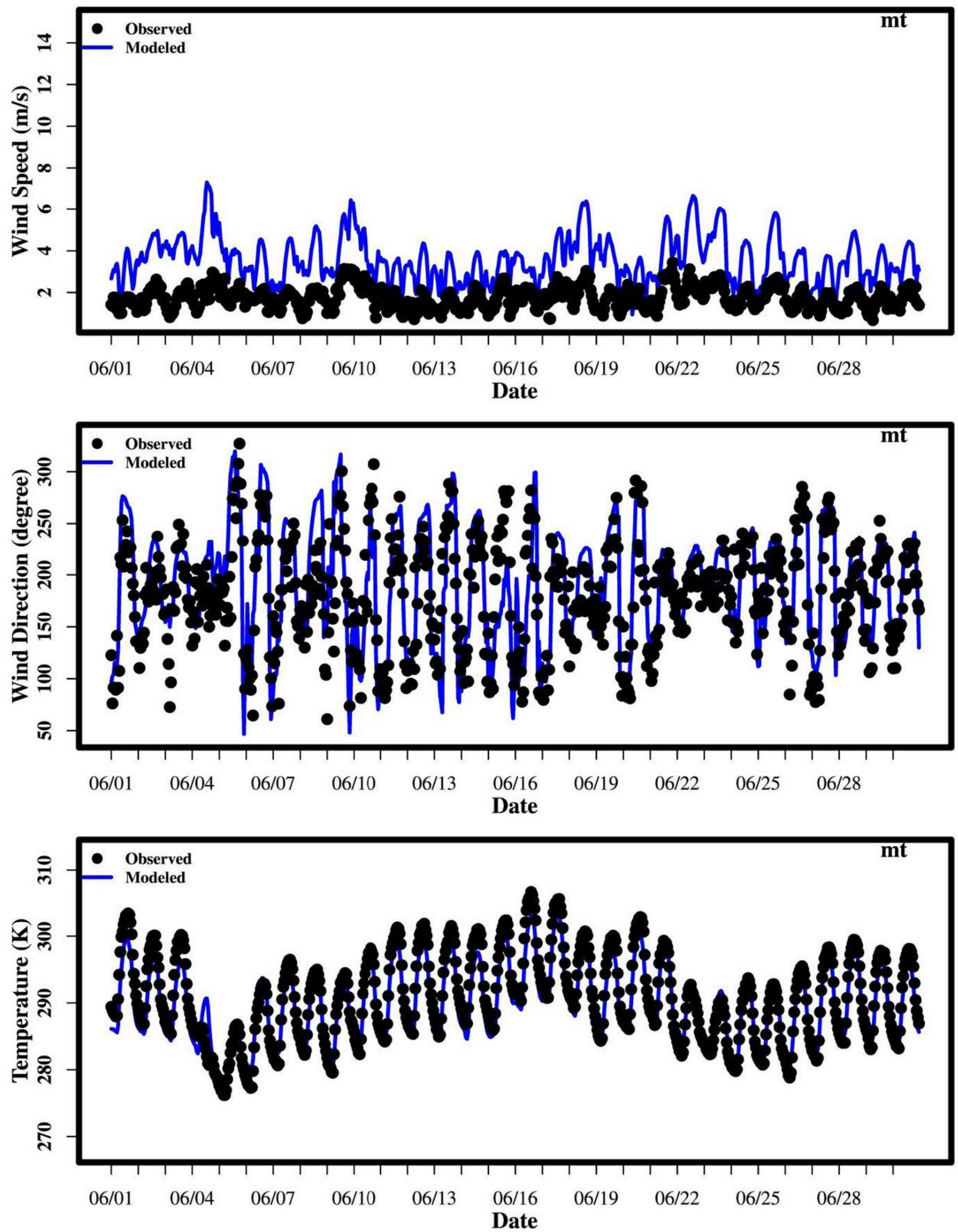


Figure S. 4 Time series of wind speed, direction, and temperature for Mountain in June 2012.

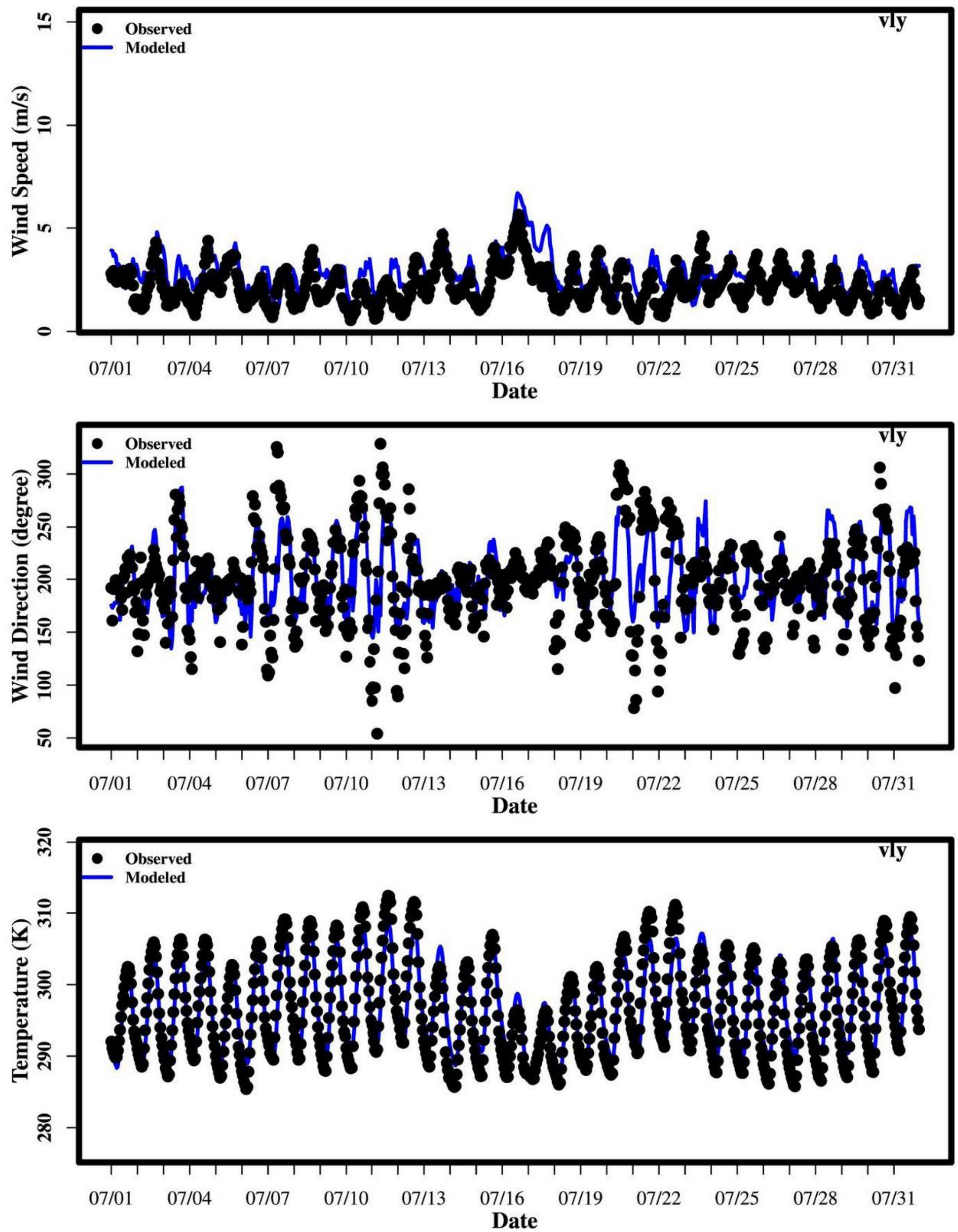


Figure S. 5 Time series of wind speed, direction, and temperature for Valley in July 2012.

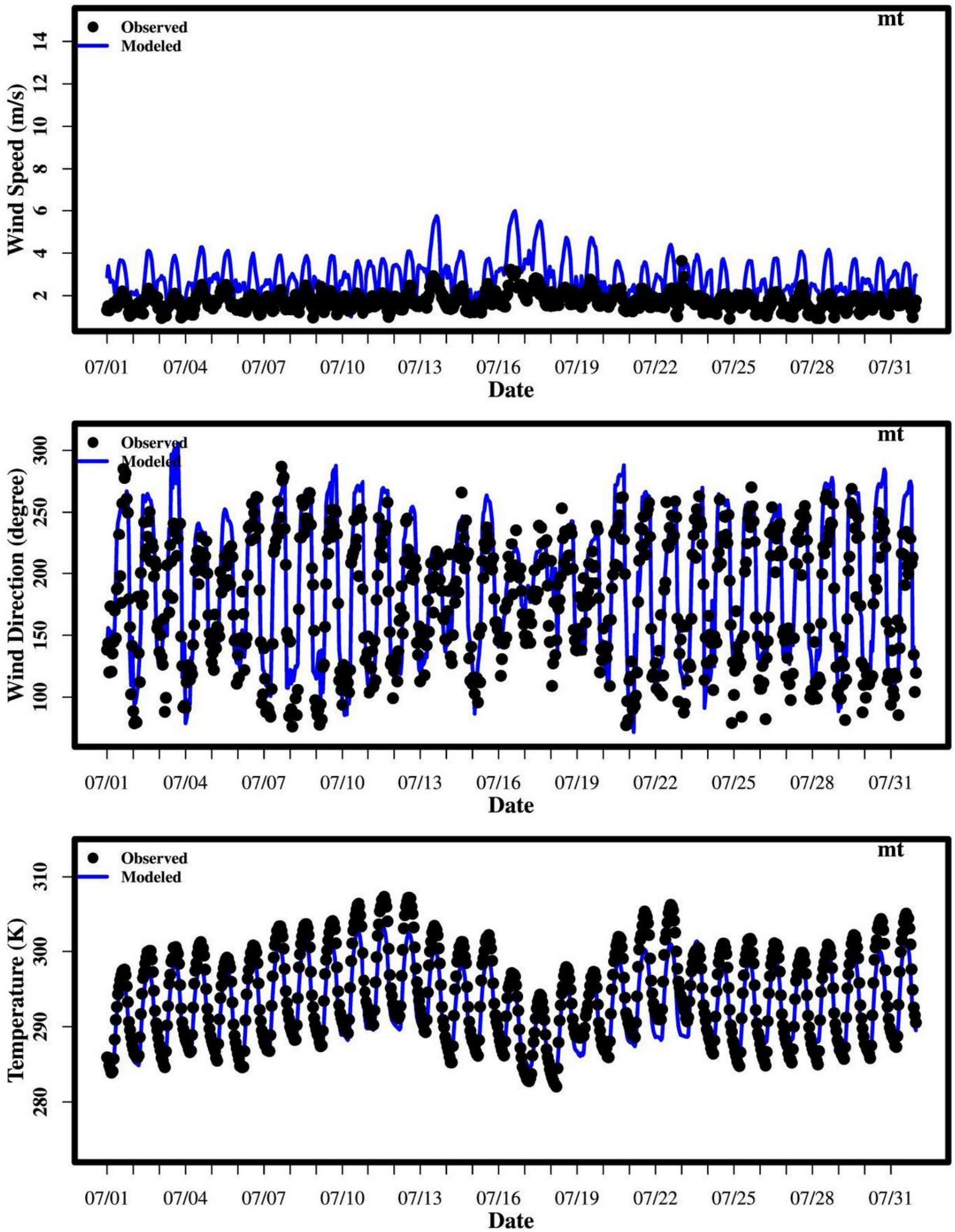


Figure S. 6 Time series of wind speed, direction, and temperature for Mountain in July 2012.

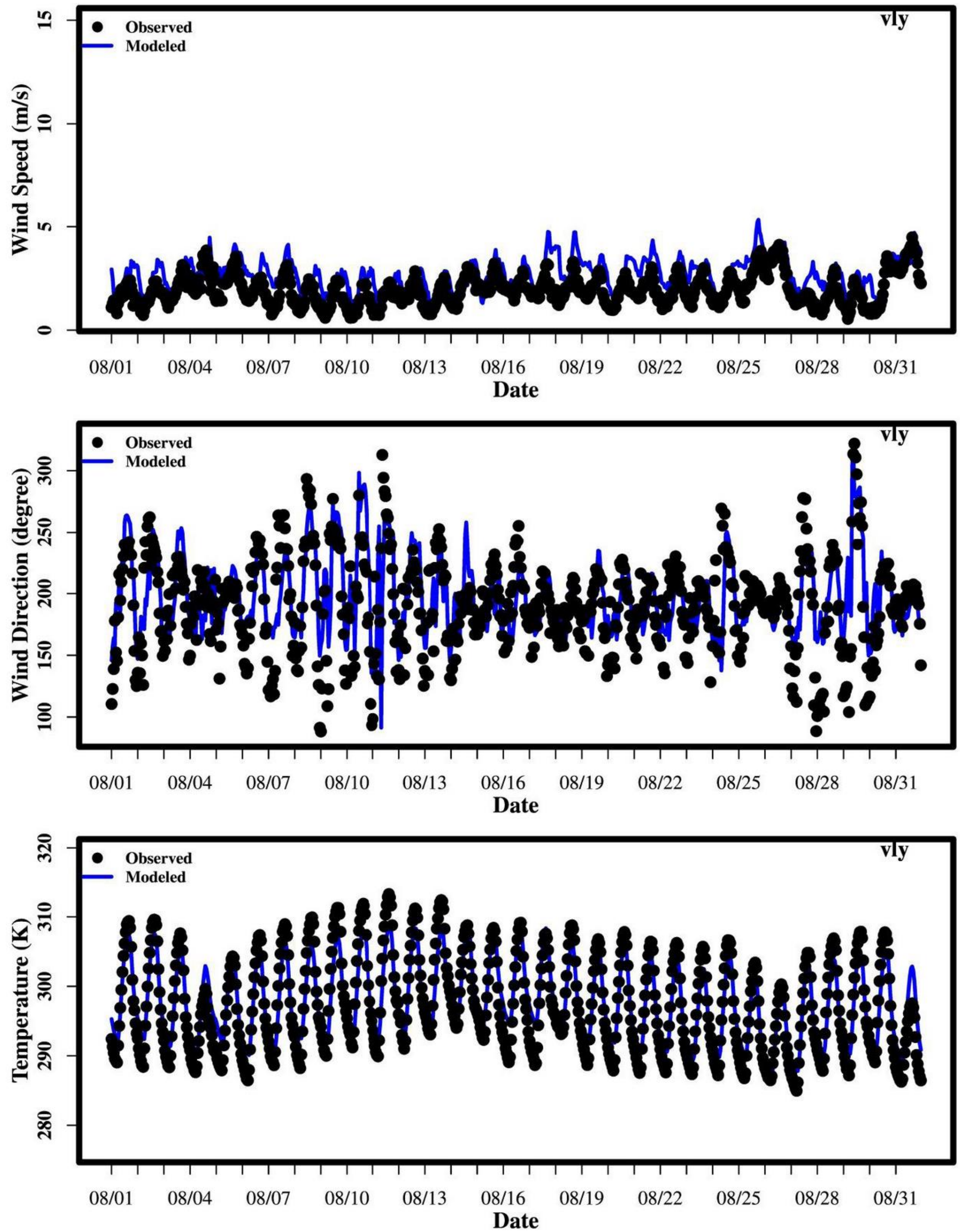


Figure S. 7 Time series of wind speed, direction, and temperature for Valley in August 2012.

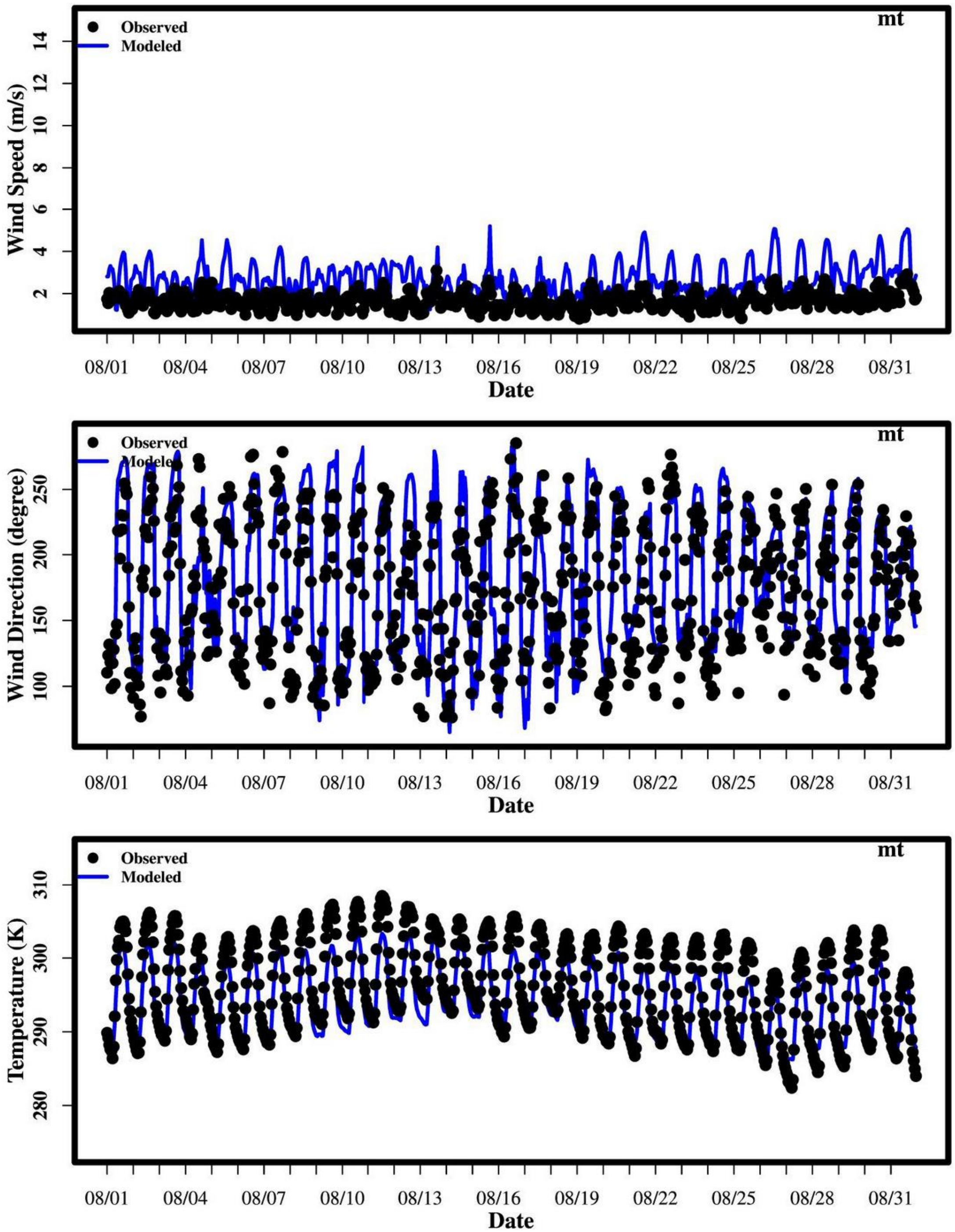


Figure S. 8 Time series of wind speed, direction, and temperature for Mountain in August 2012.

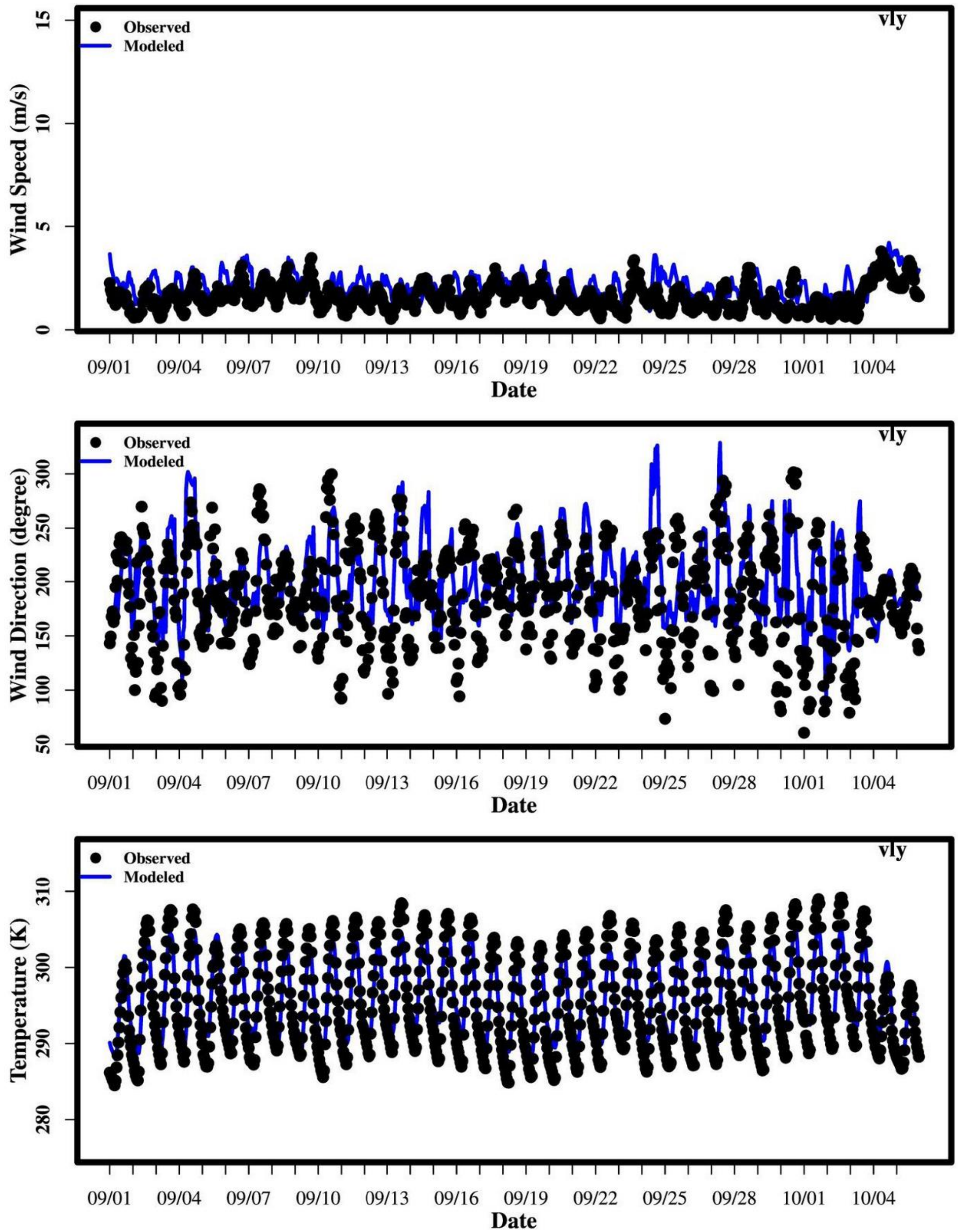


Figure S. 9 Time series of wind speed, direction, and temperature for Valley in September through October 5 2012.

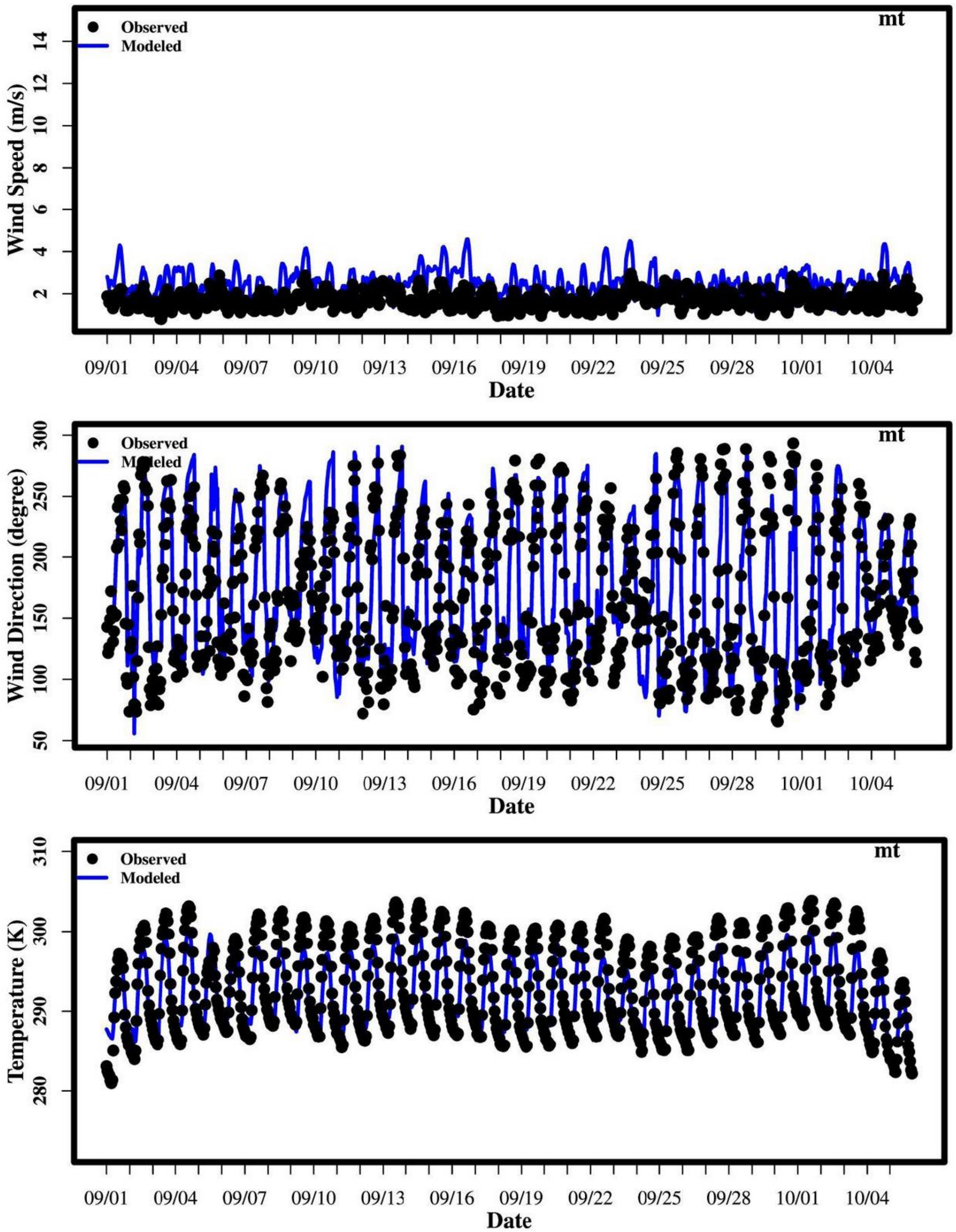
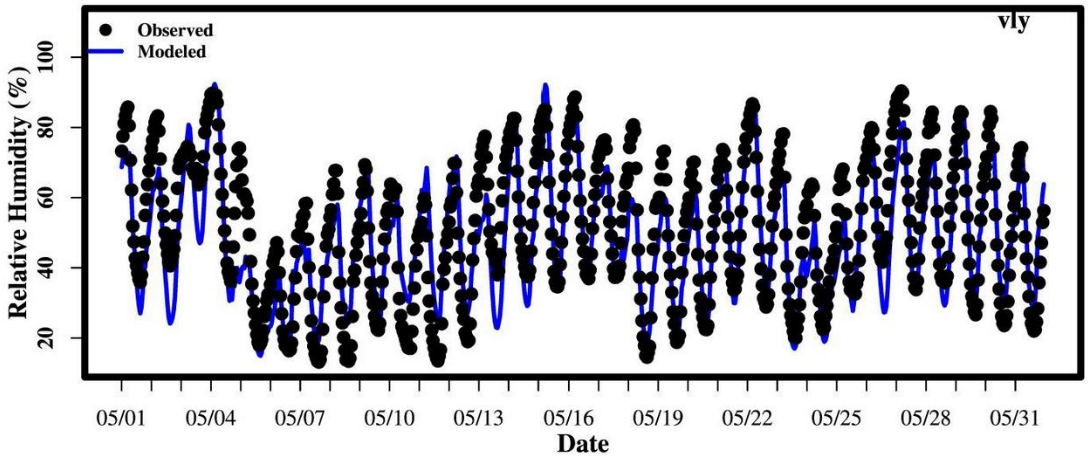


Figure S. 10 Time series of wind speed, direction, and temperature for Mountain in September through October 5 2012.



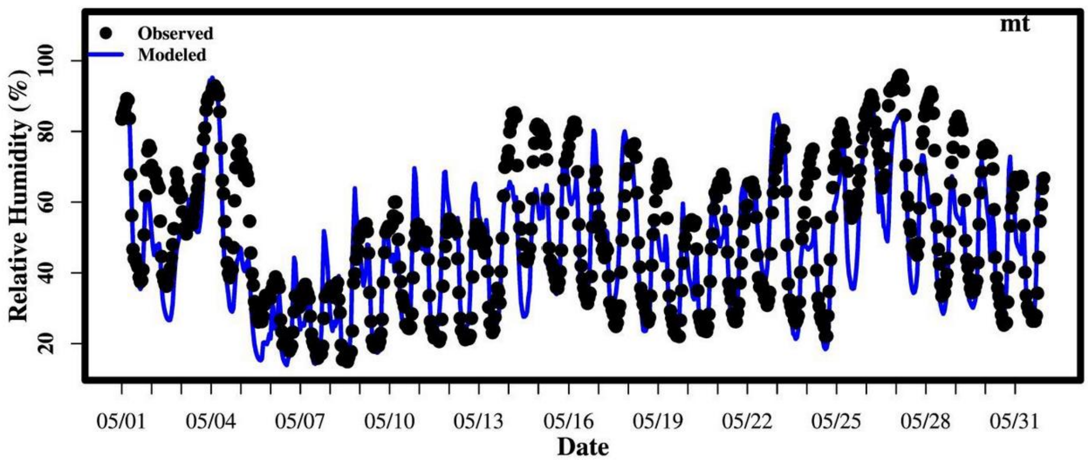
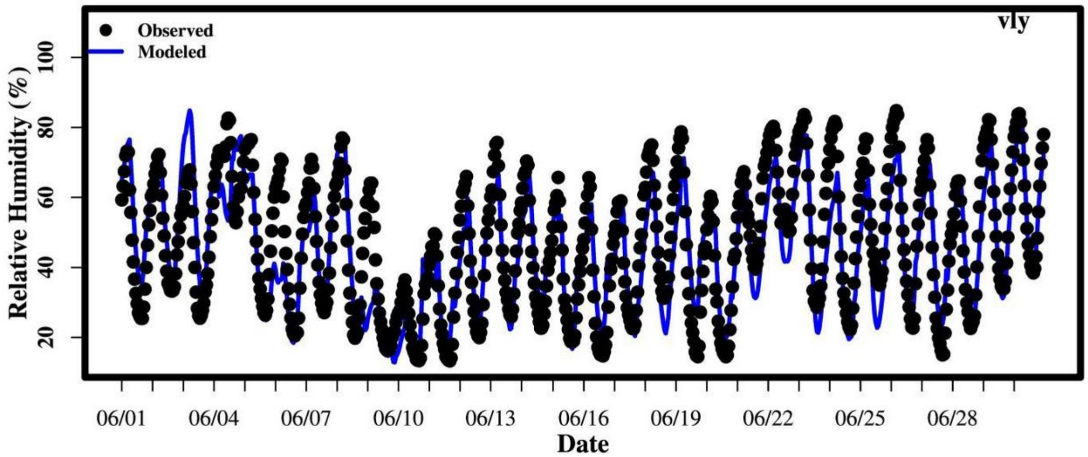


Figure S. 11 Time series of relative humidity for Valley and Mountain in May 2012.



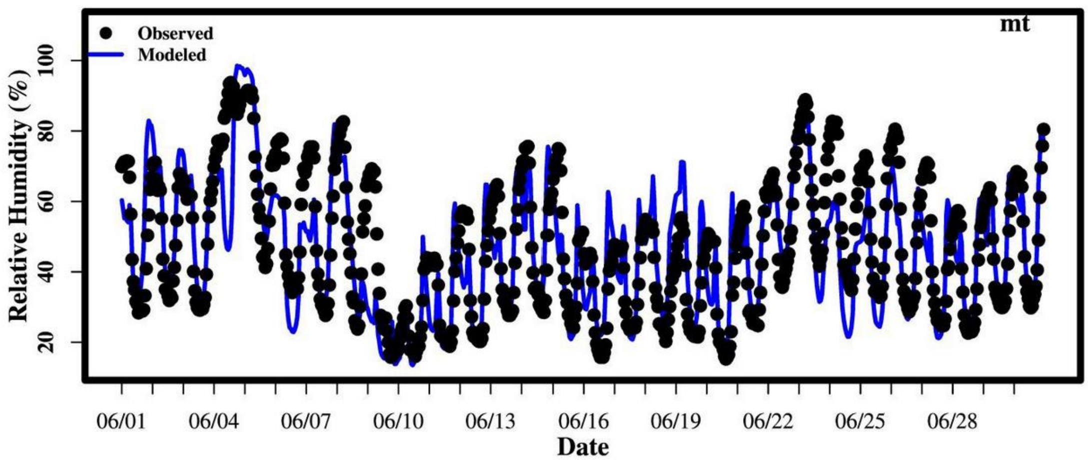


Figure S. 12 Time series of relative humidity for Valley and Mountain in June 2012.

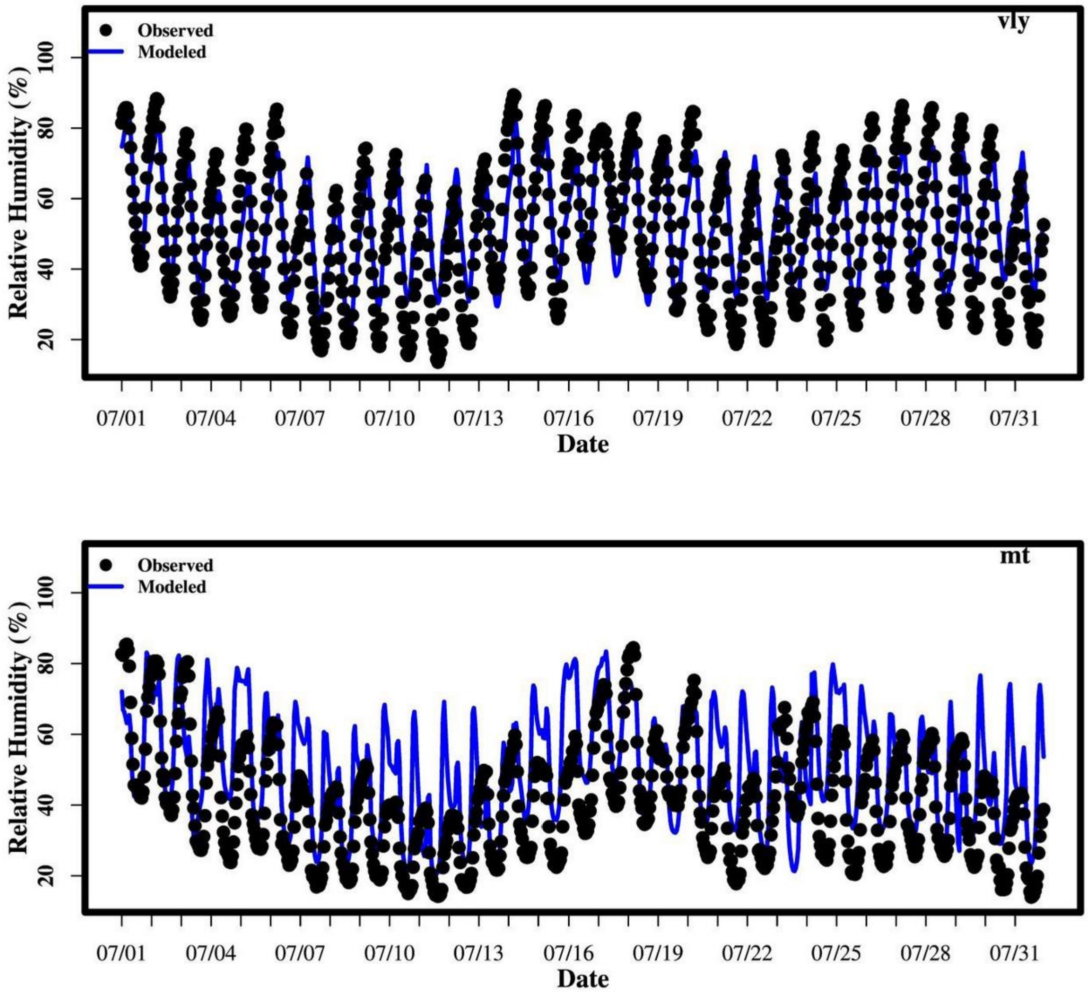
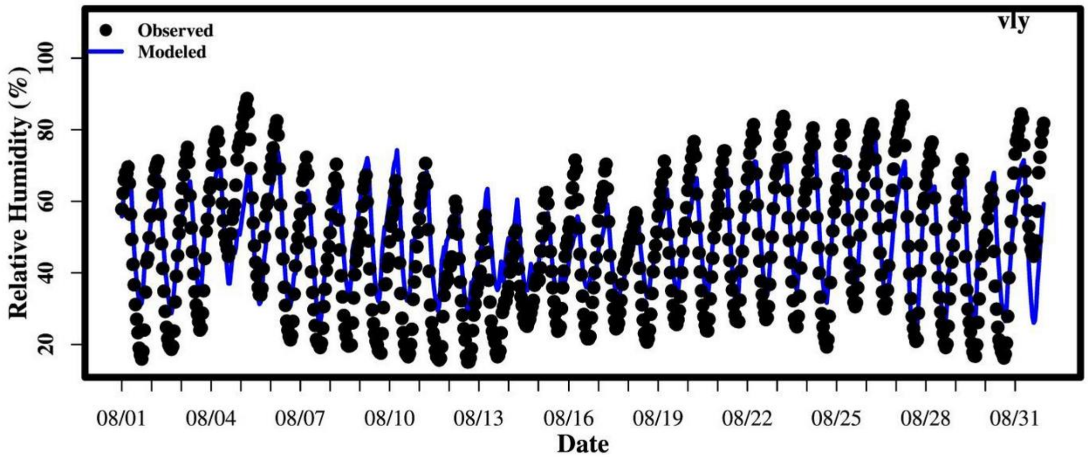


Figure S. 13 Time series of relative humidity for Valley and Mountain in July 2012.



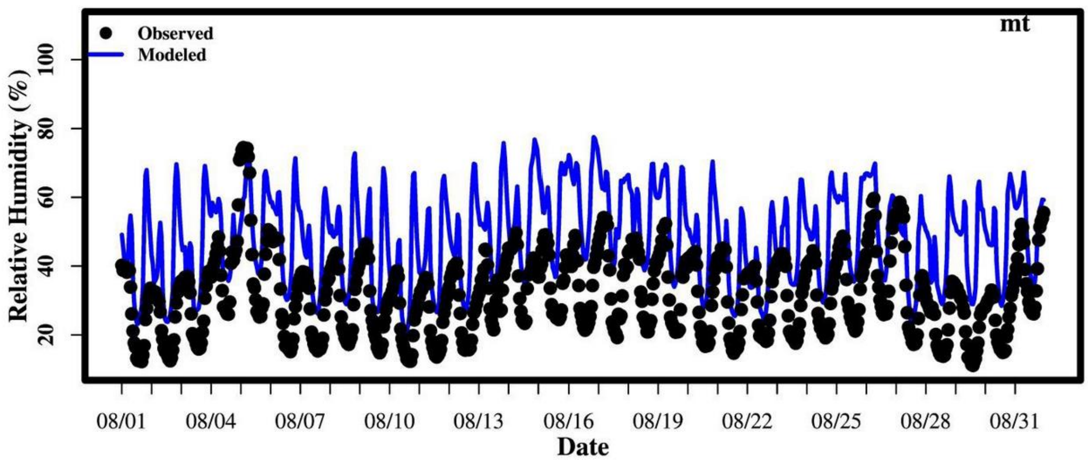
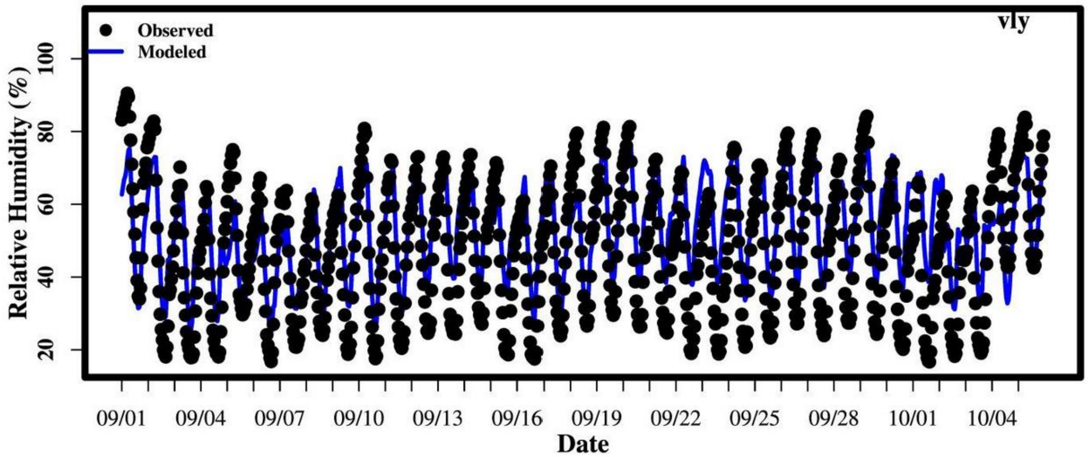


Figure S. 14 Time series of relative humidity for Valley and Mountain in August 2012.



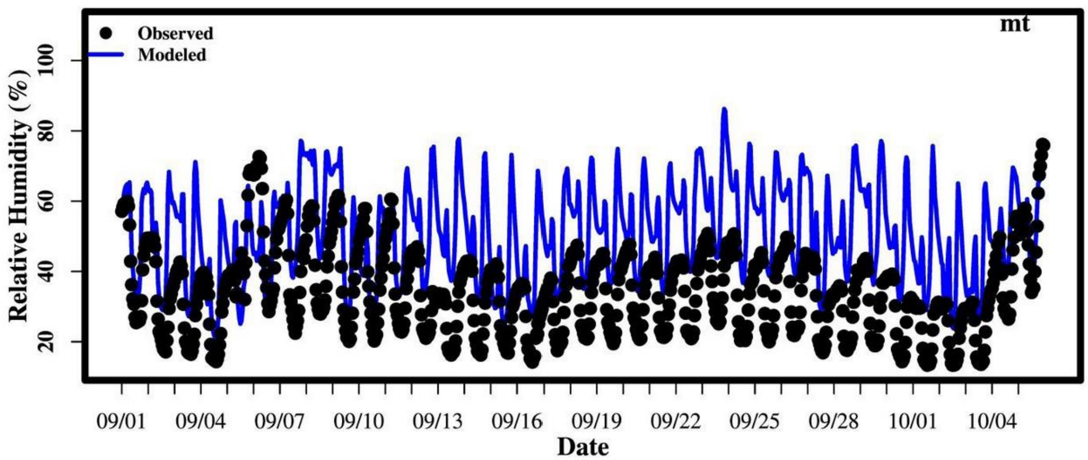


Figure S. 15 Time series of relative humidity for Valley and Mountain in September through October 5 2012.

OZONE PLOTS

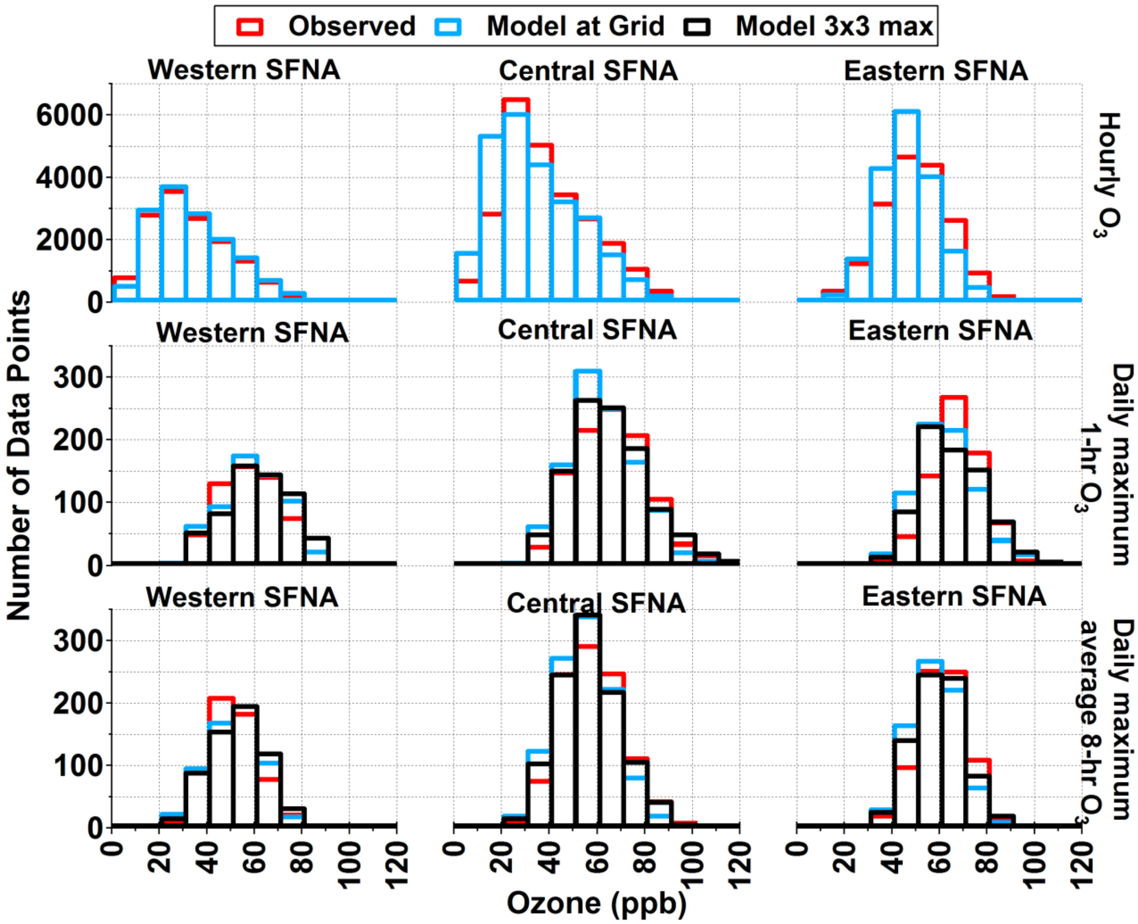


Figure S. 16 Observed and modeled ozone frequency distribution for the ozone season (May – October 5th 2012)

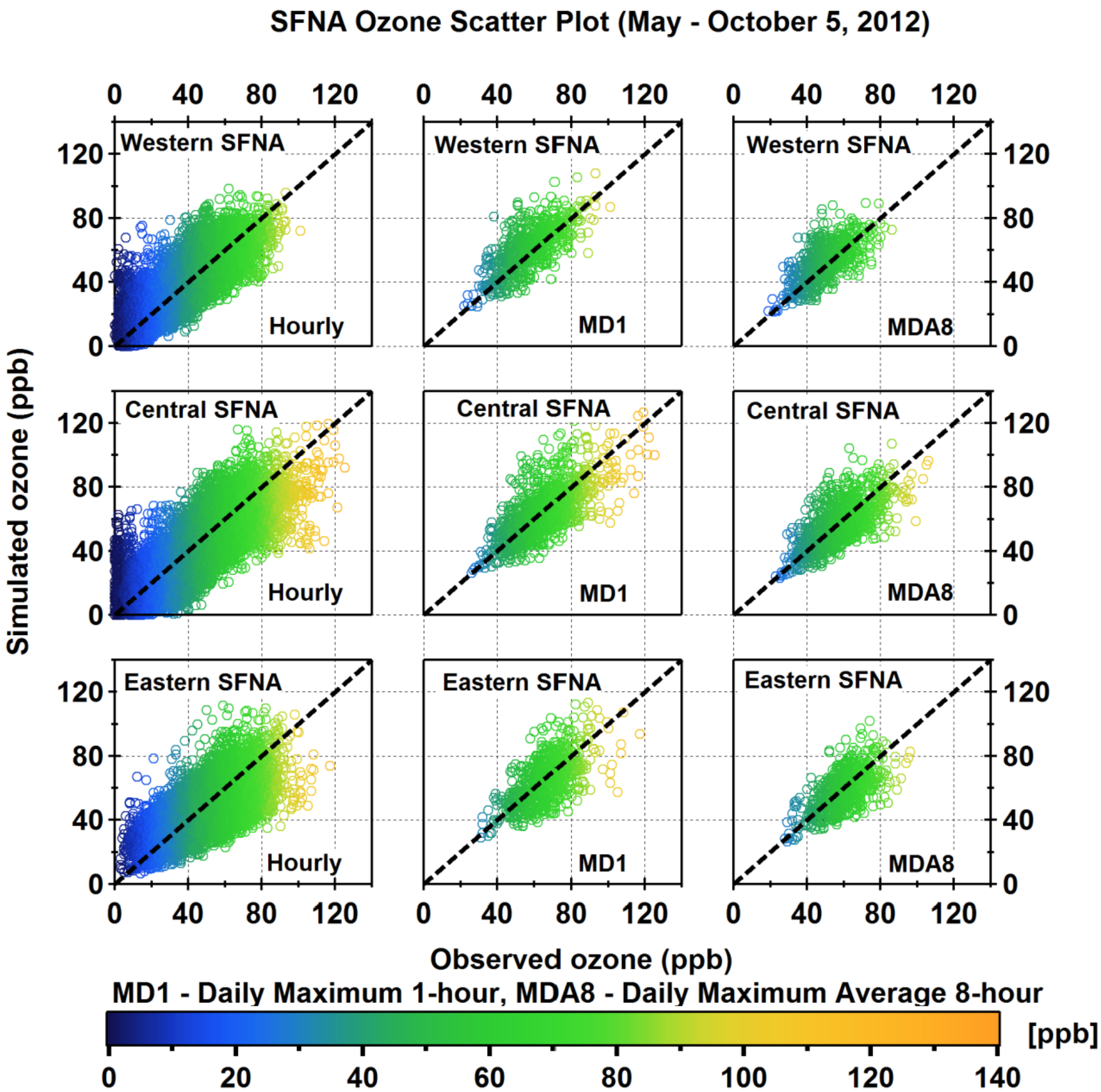


Figure S. 17 Comparison of modeled ozone with observations for the ozone season (May – October 5th 2012)

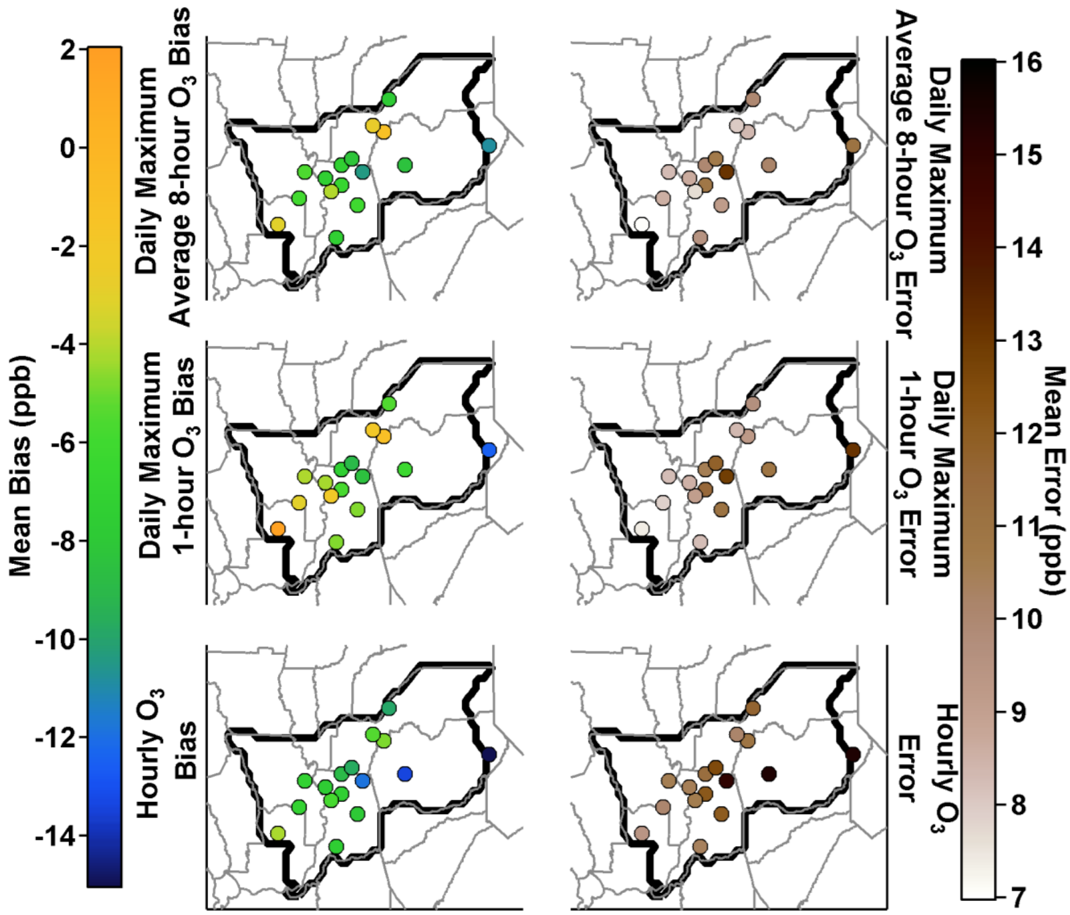


Figure S. 18 Spatial distribution of ozone mean bias (left) and mean error (right) for the ozone season (May-October 5th 2012).

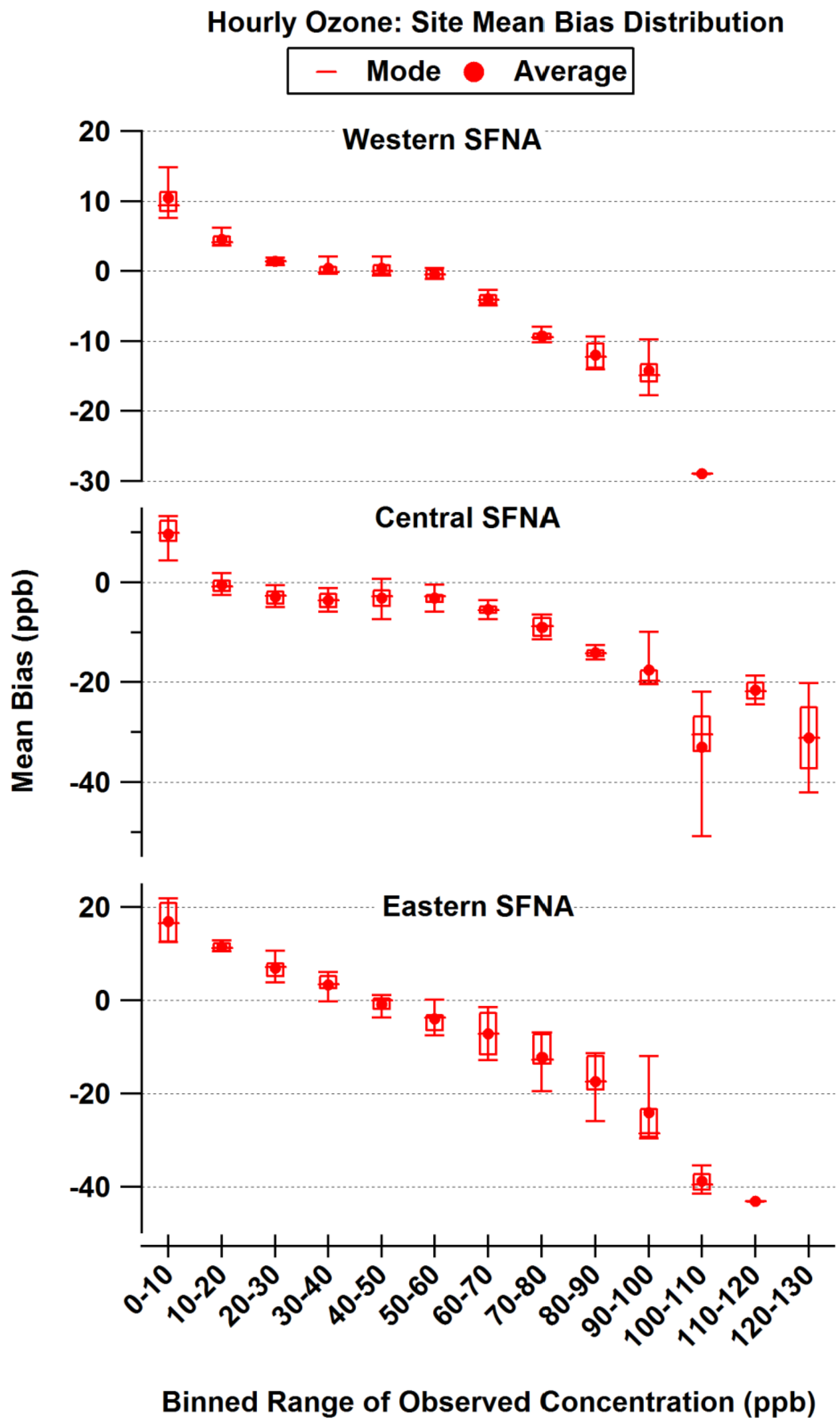


Figure S. 19 Hourly Ozone Site Mean Bias Distribution for the ozone season (May-October 5th 2012)

80

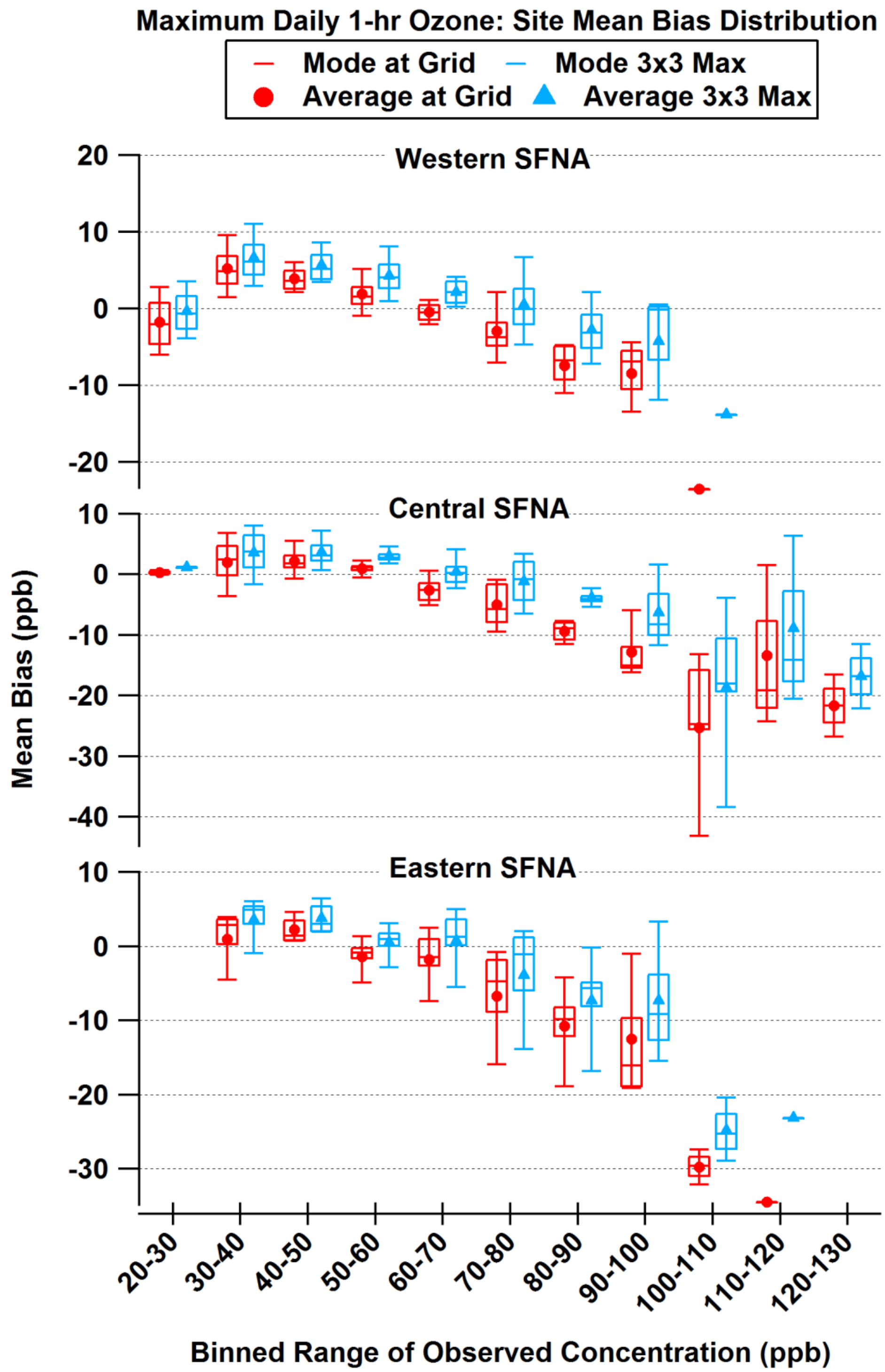


Figure S. 20 Daily Maximum 1-hour Ozone Site Mean Bias Distribution for the ozone season (May-October 5th 2012)

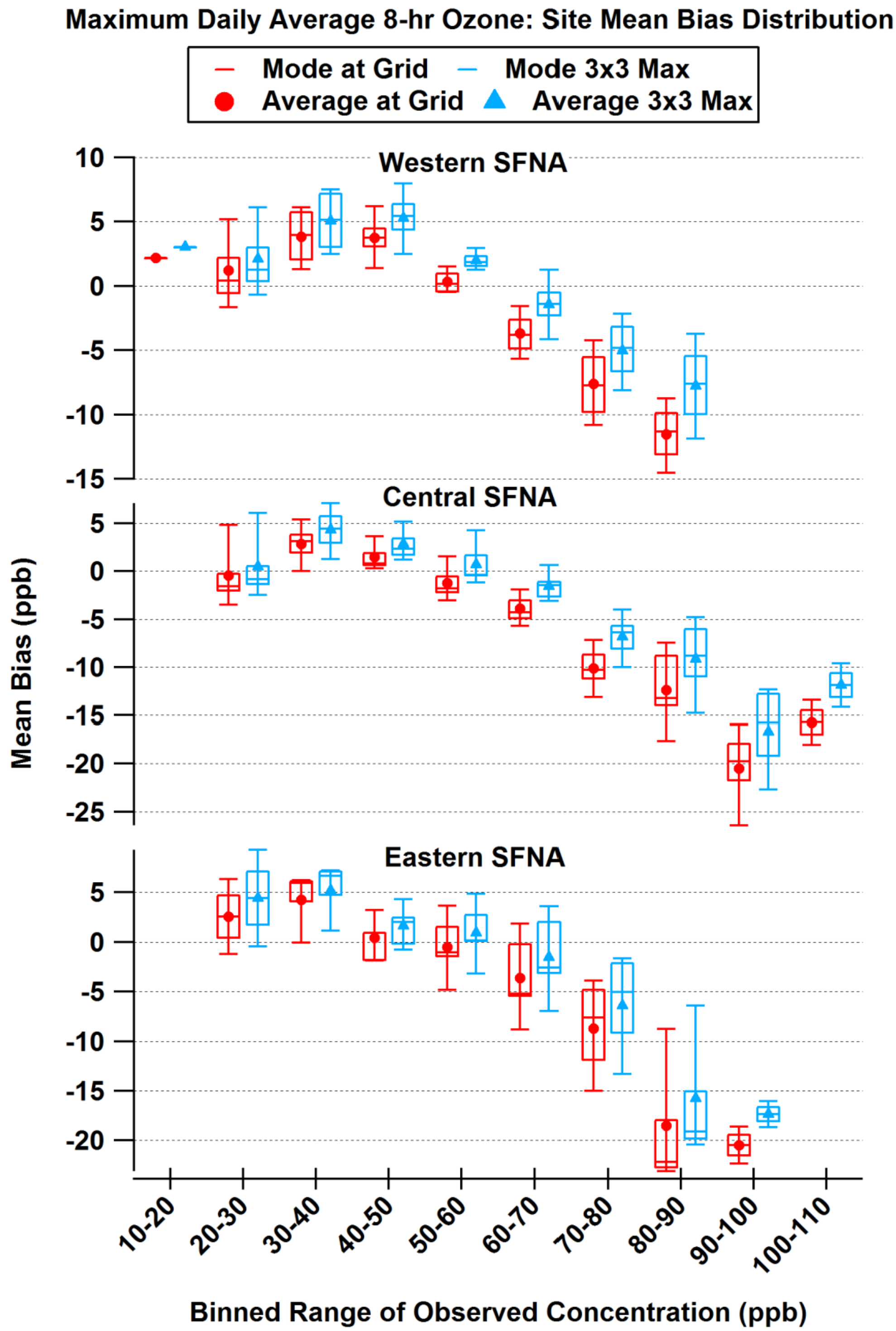


Figure S. 21 Daily Maximum Average 8-hour Ozone Site Mean Bias Distribution for the ozone season (May-October 5th 2012)

HOURLY OZONE TIMESERIES PLOTS

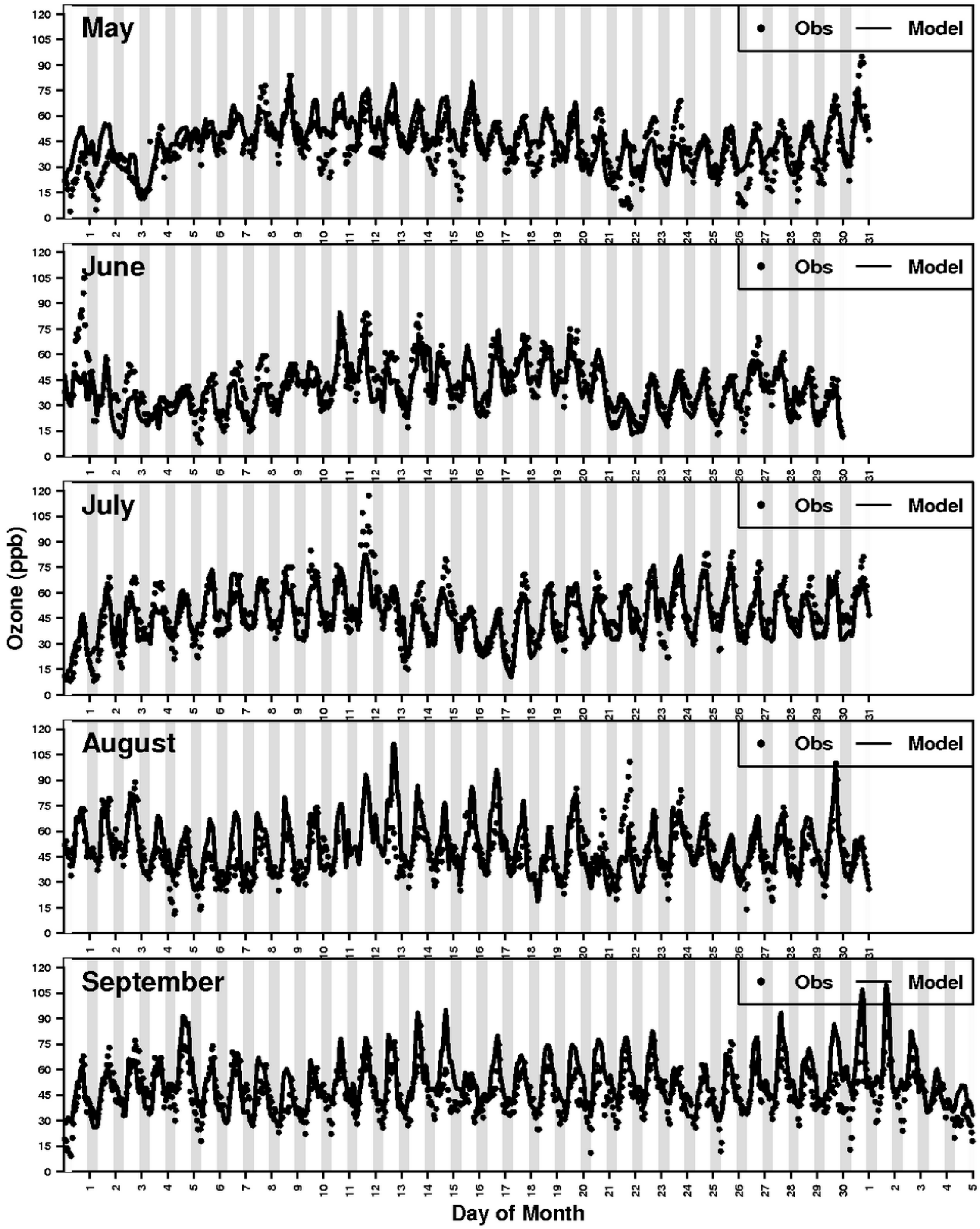


Figure S. 22 Time-series of hourly ozone at Cool Hwy 193 monitor

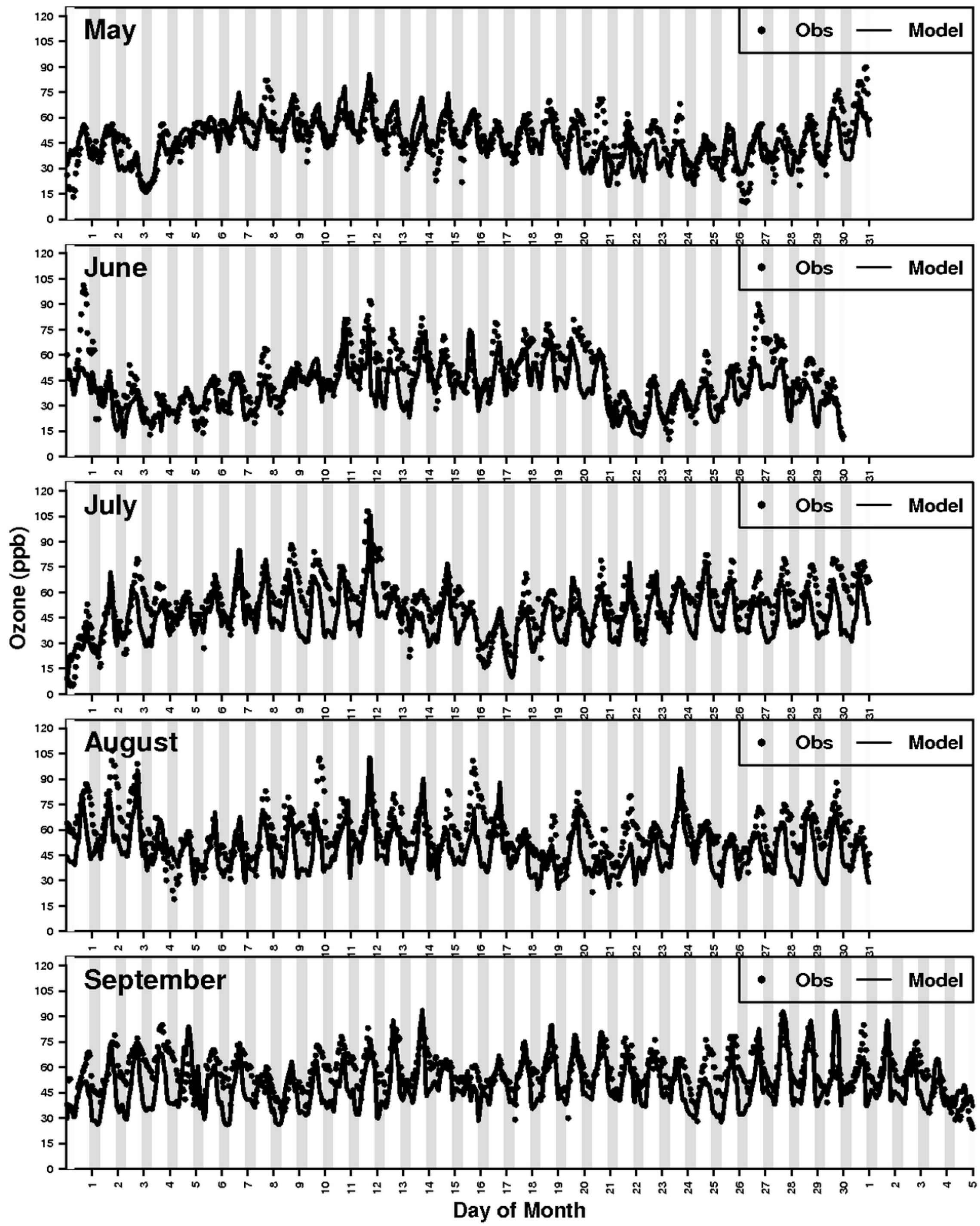


Figure S. 23 Time-series of hourly ozone at Placerville Gold Nugget Way

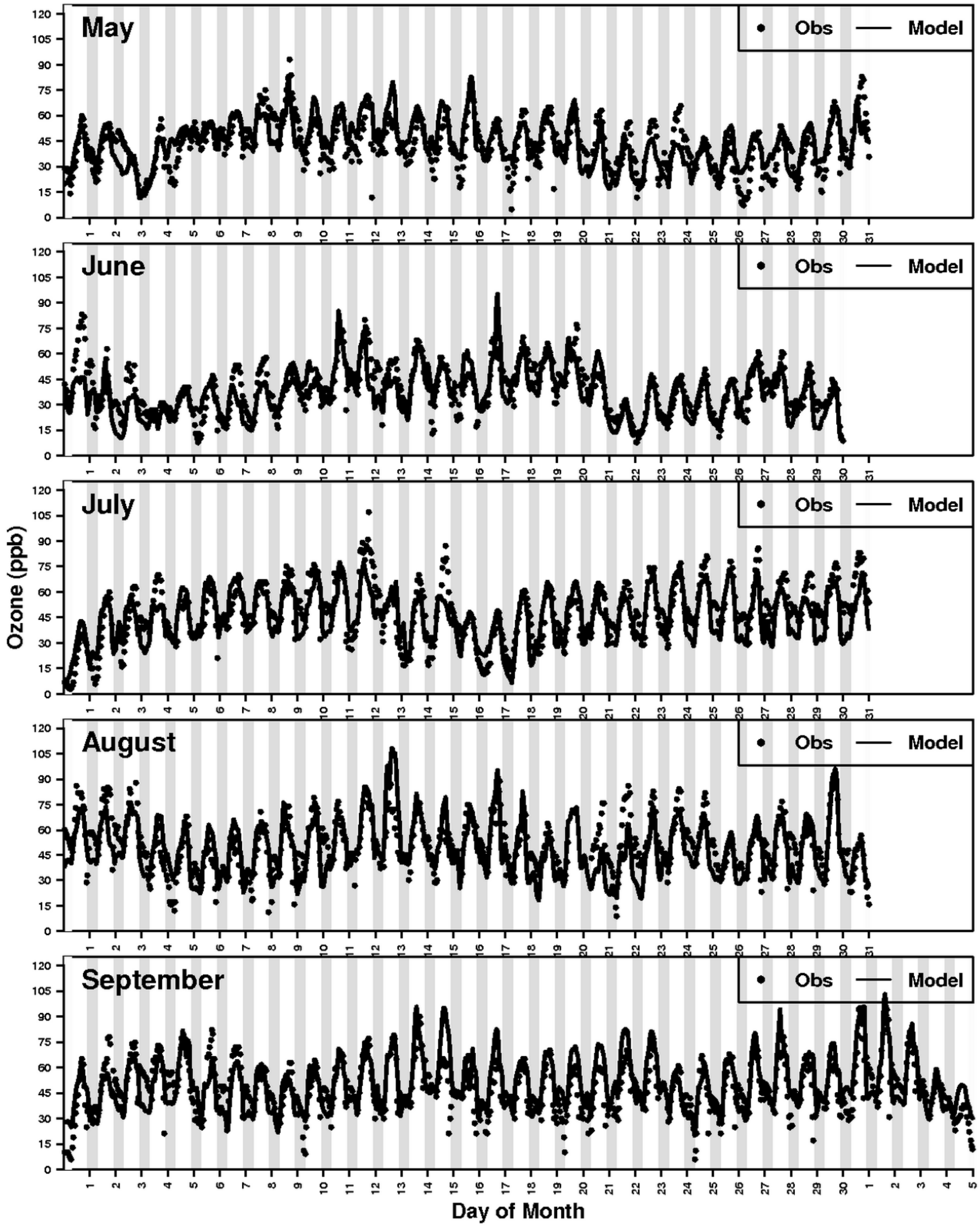


Figure S. 24 Time-series of hourly ozone at Auburn Atwood road

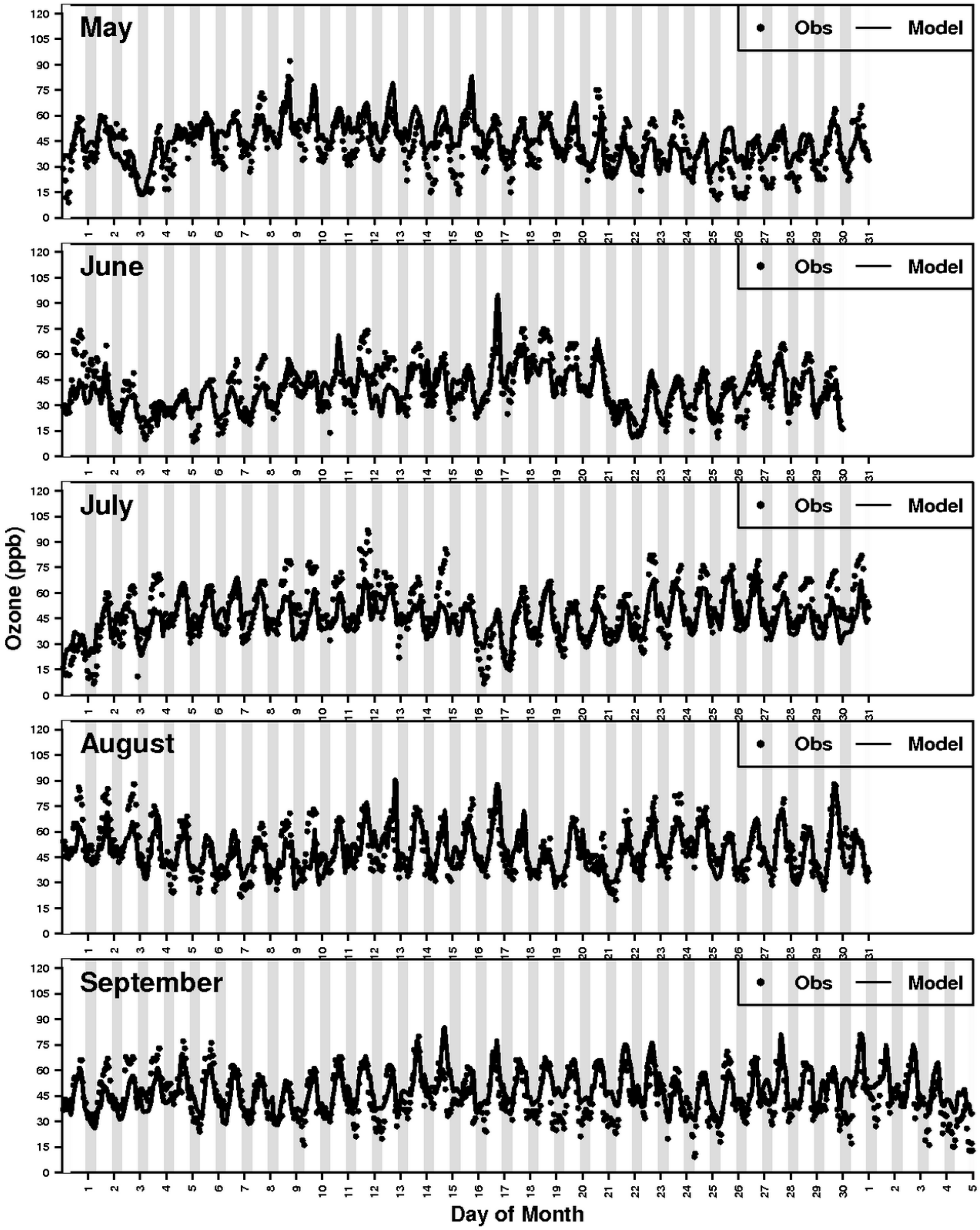


Figure S. 25 Time-series of hourly ozone at Colfax City Hall

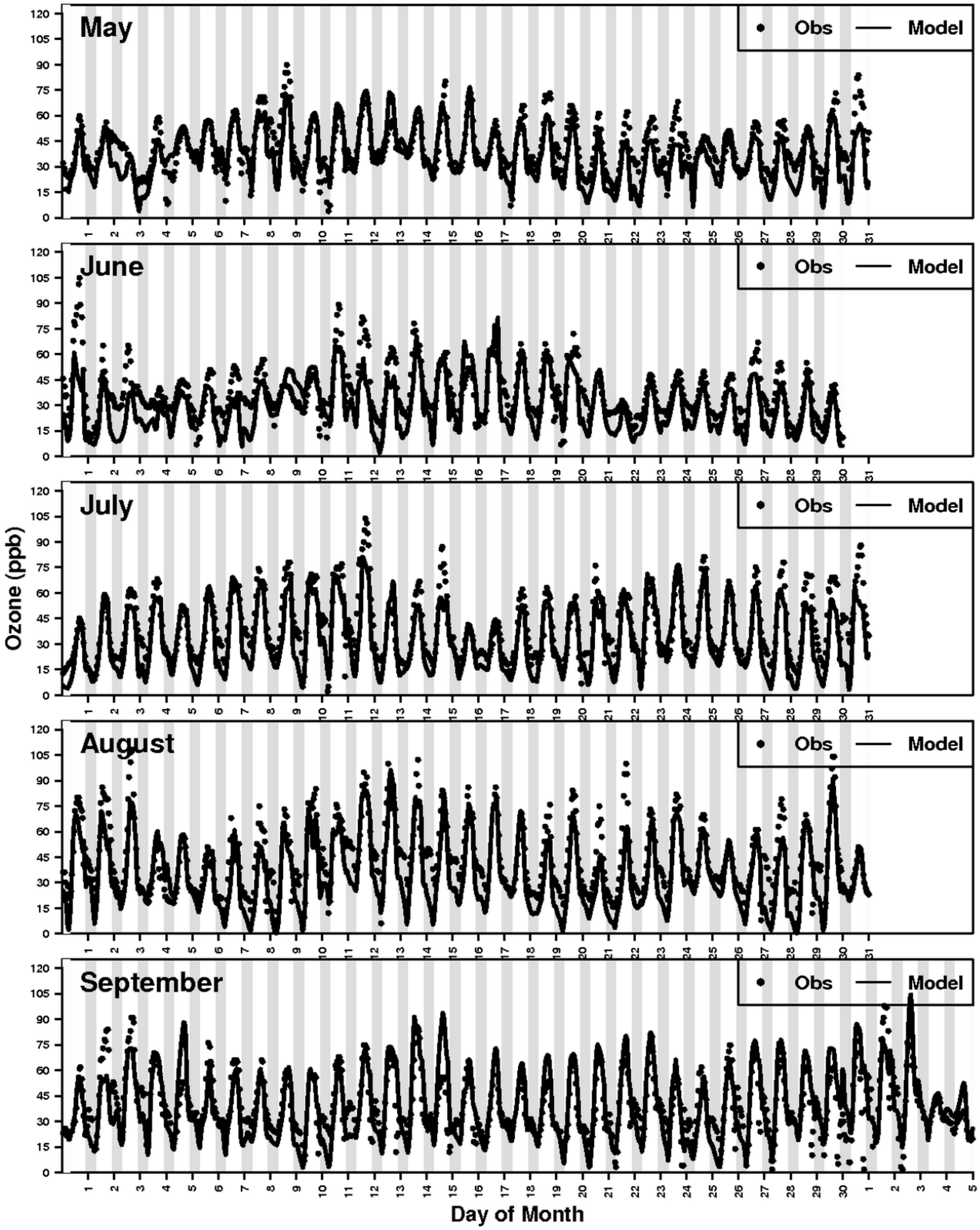


Figure S. 26 Time-series of hourly ozone at Roseville – N. Sunrise Ave

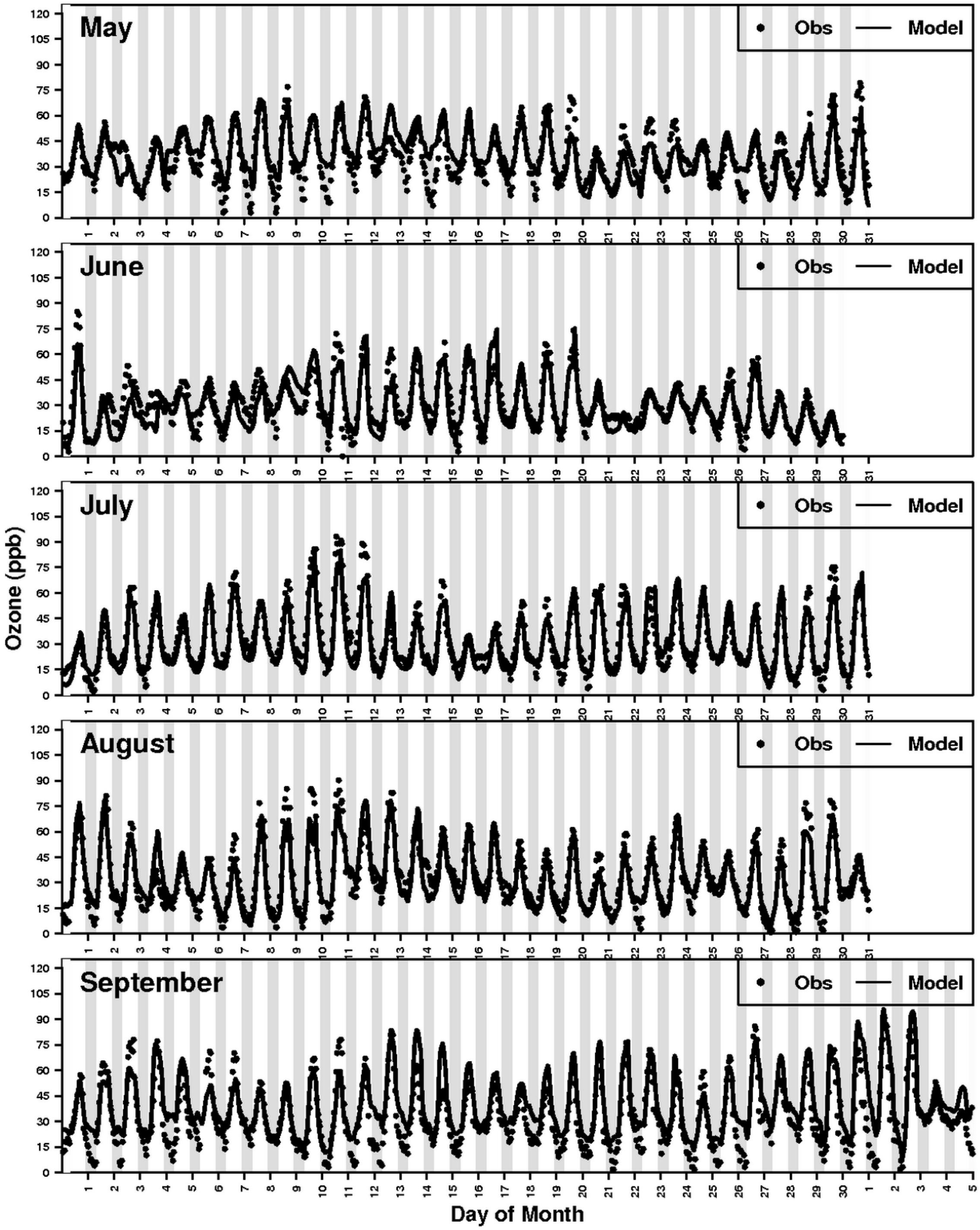


Figure S. 27 Time-series of hourly ozone at Elk Grove – Bruceville Road

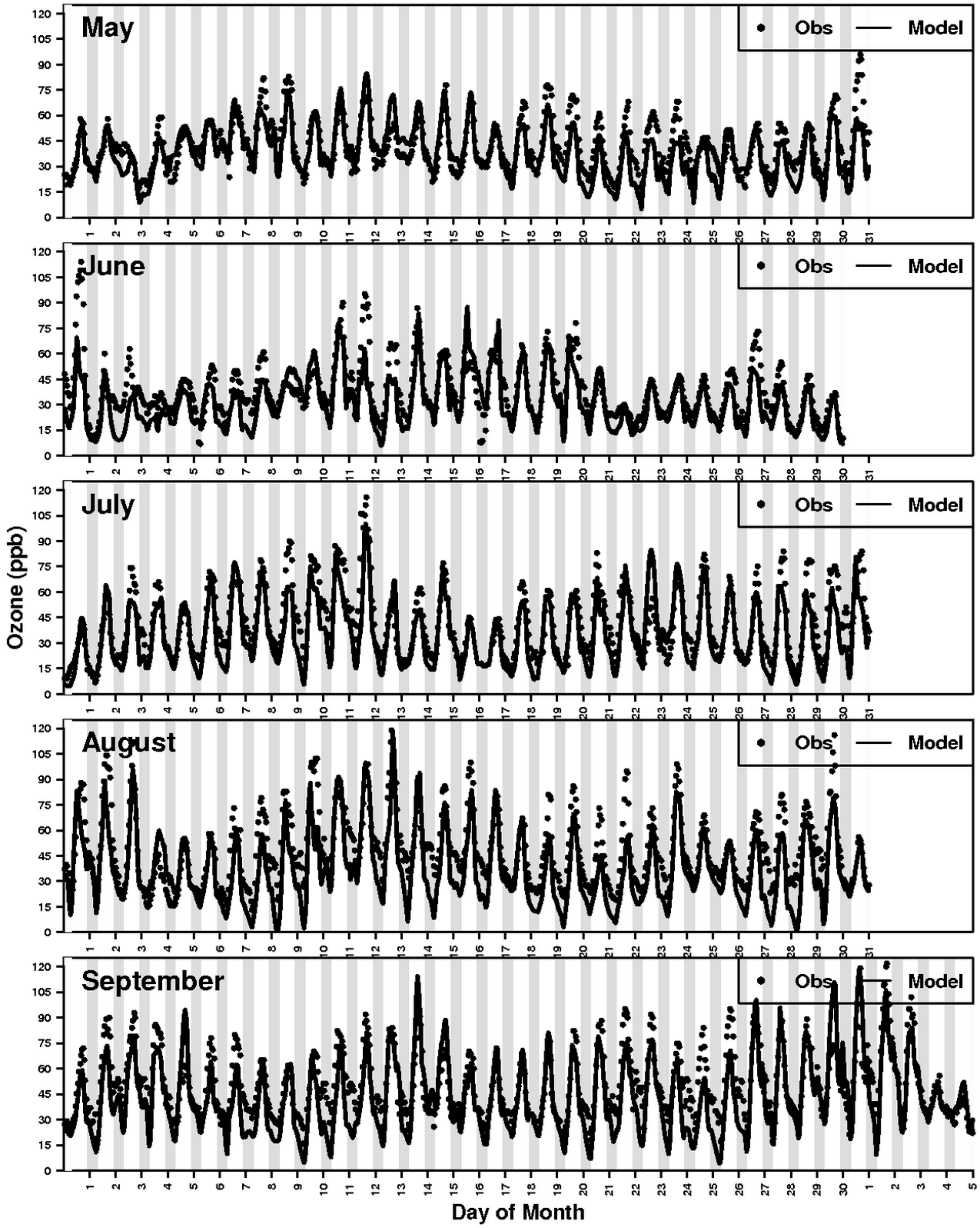


Figure S. 28 Time-series of hourly ozone at Folsom Natoma Street

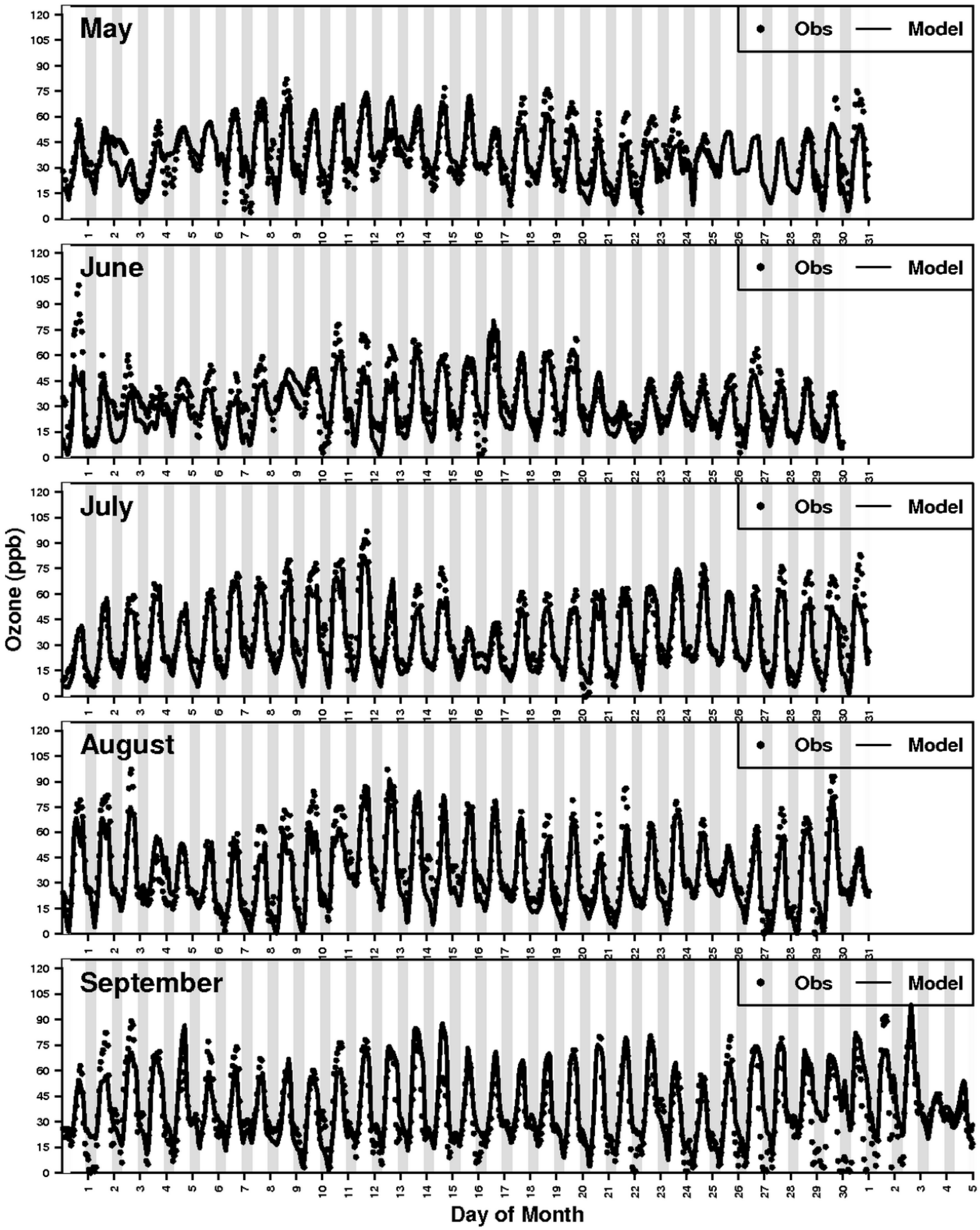


Figure S. 29 Time-series of hourly ozone at North Highlands – Blackfoot way

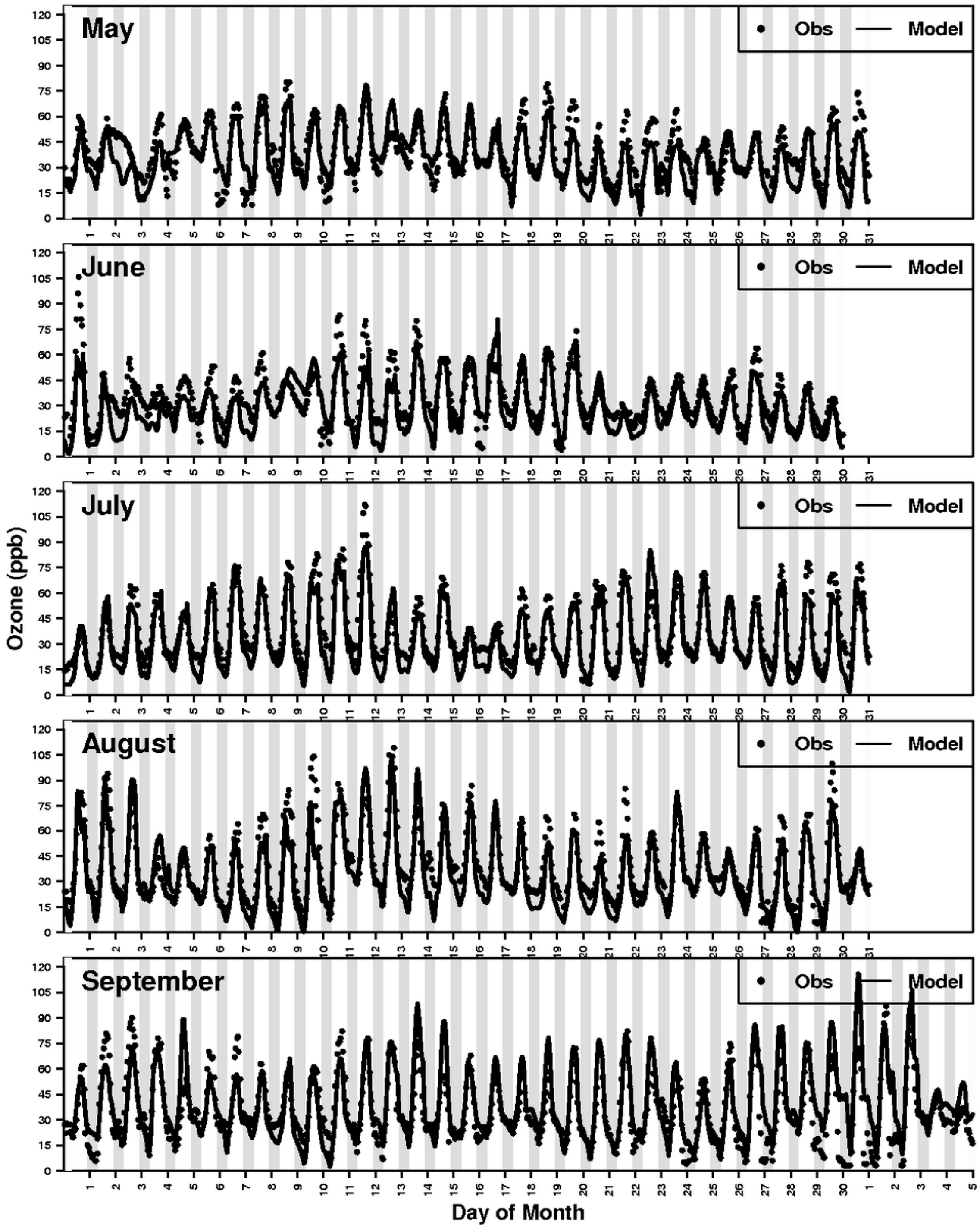


Figure S. 30 Time-series of hourly ozone at Sacramento – Del Paso Manor

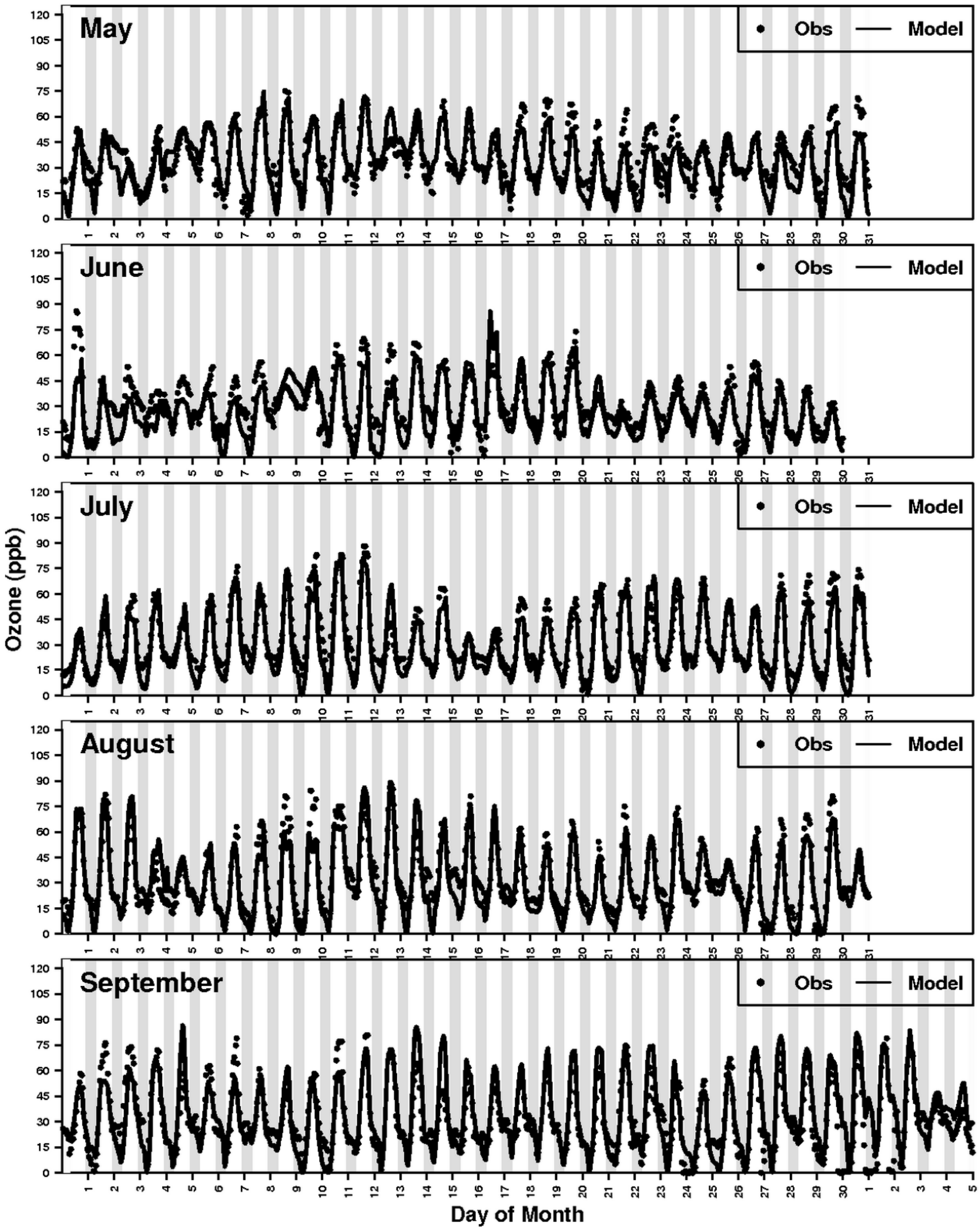


Figure S. 31 Time-series of hourly ozone at Sacramento – Goldenland Court

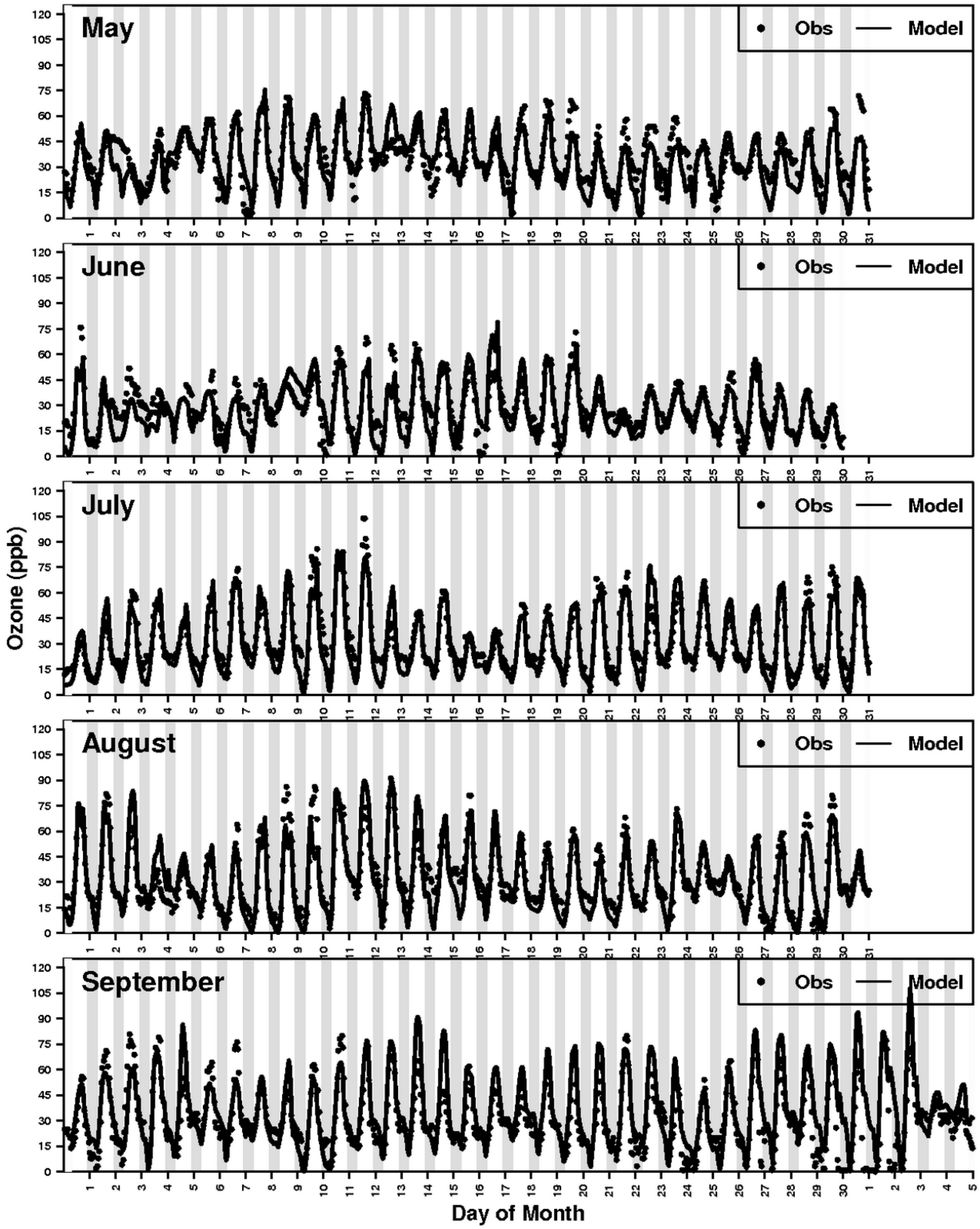


Figure S. 32 Time-series of hourly ozone at Sacramento – T Street

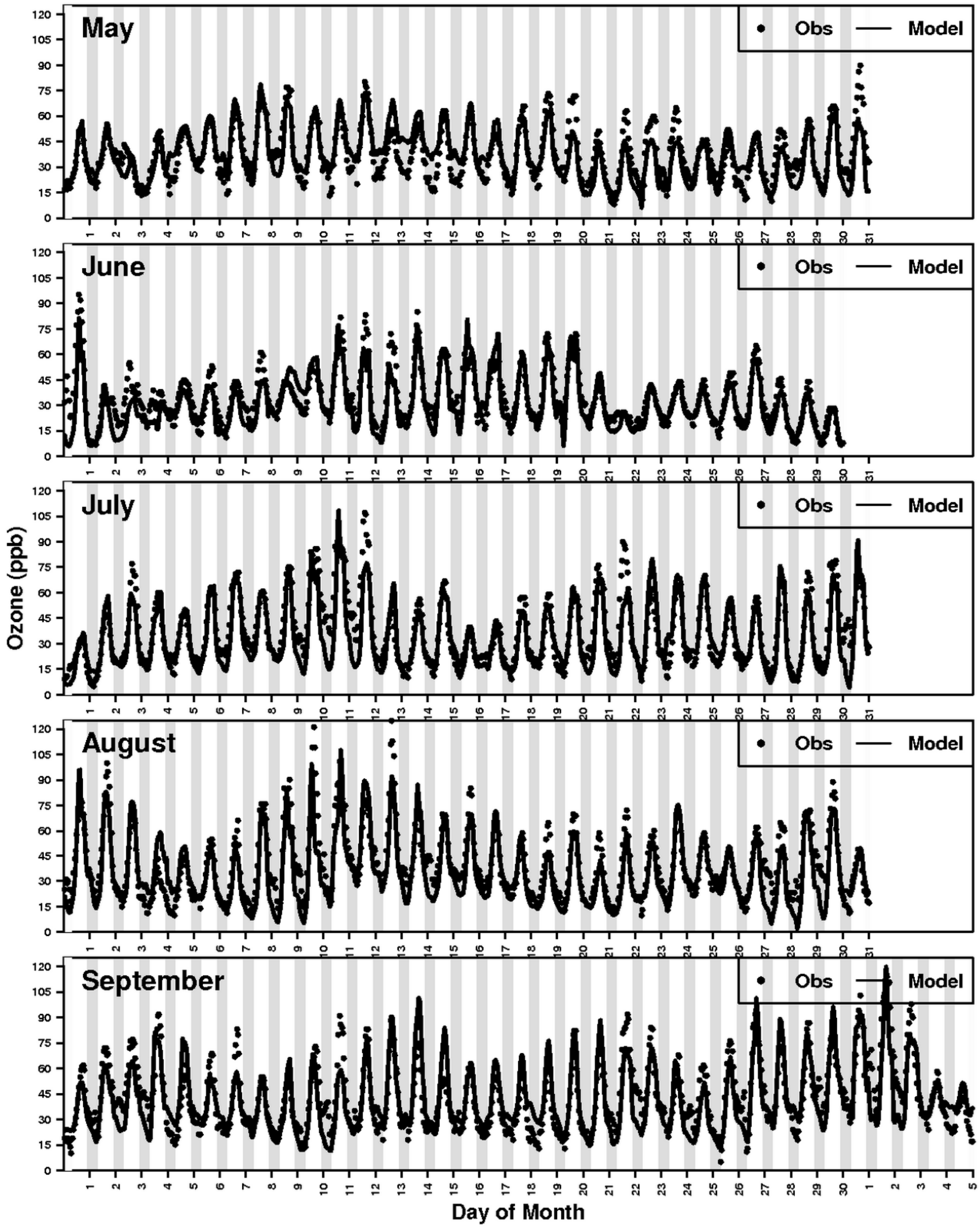


Figure S. 33 Time-series of hourly ozone at Sloughhouse

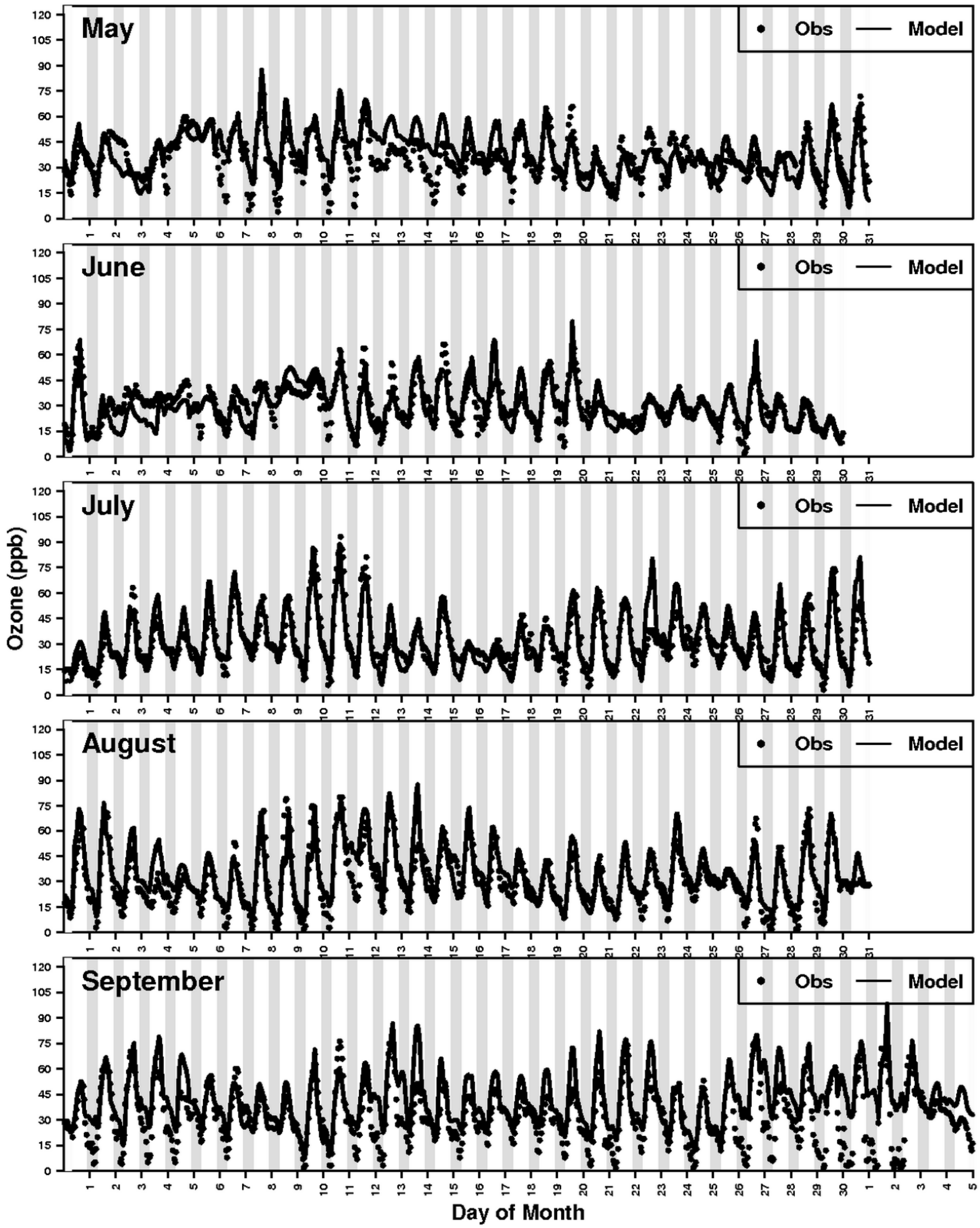


Figure S. 34 Time-series of hourly ozone at Vacaville Ulatis Drive

96

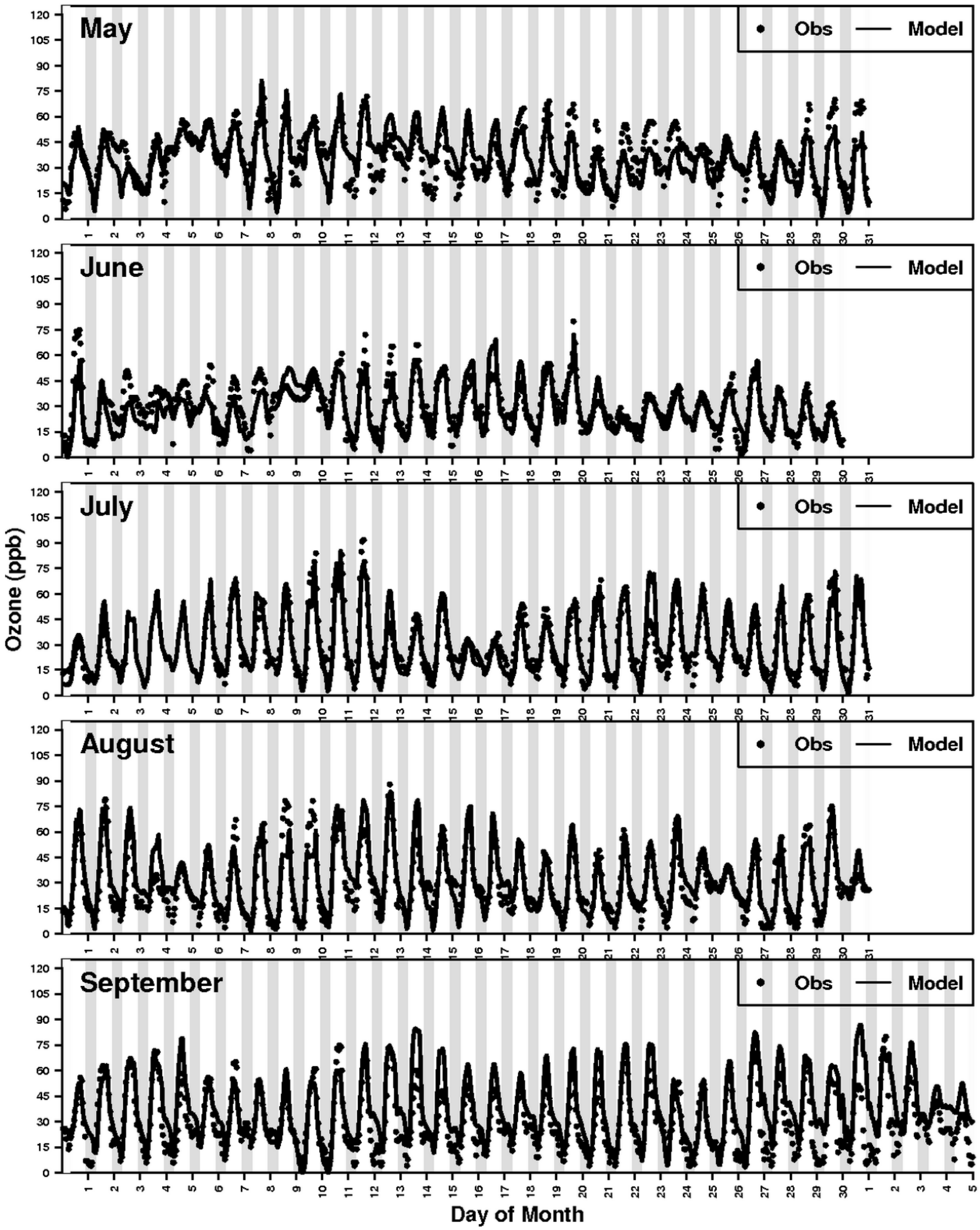


Figure S. 35 Time-series of hourly ozone at Davis – UCD Campus

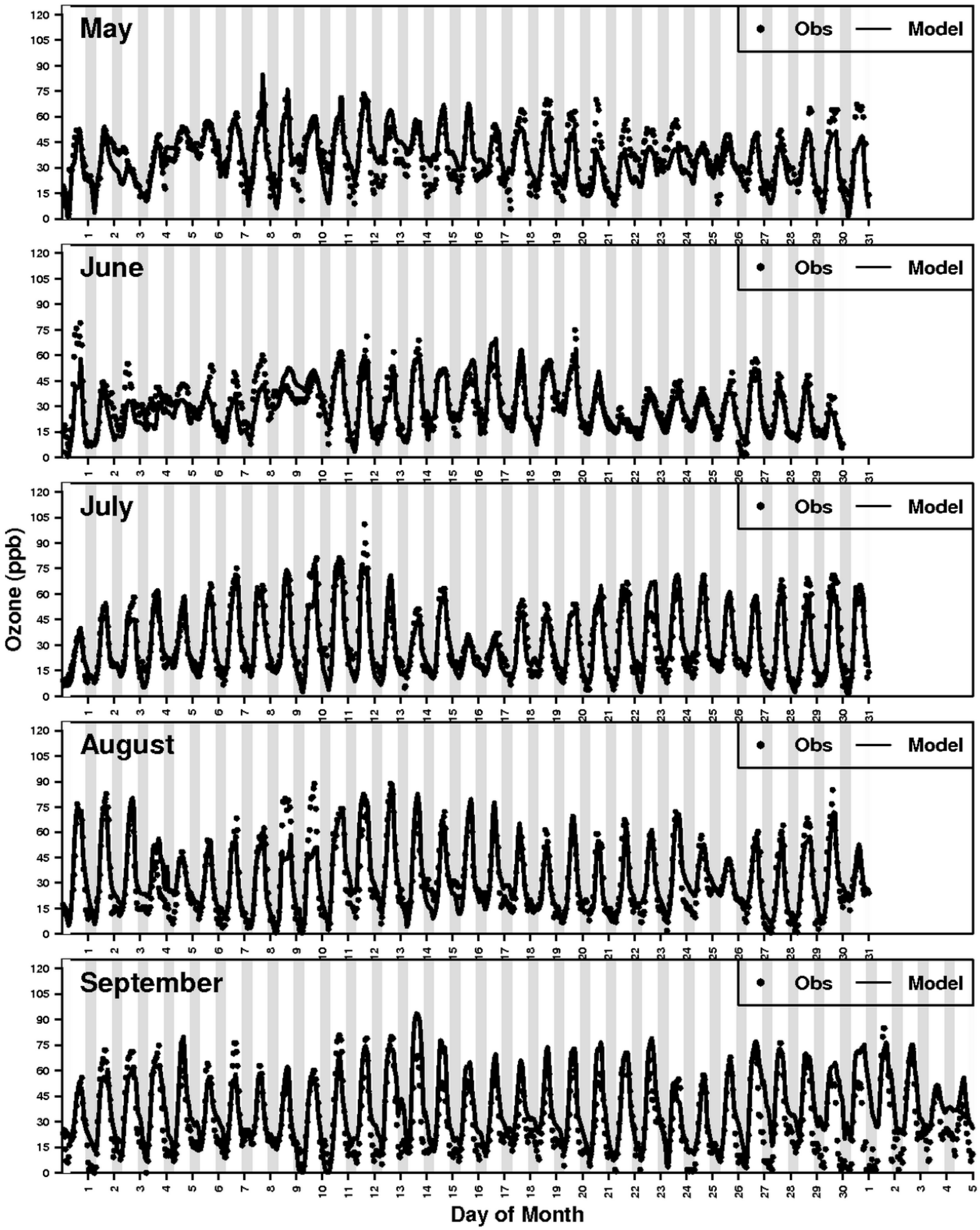


Figure S. 36 Time-series of hourly ozone at Woodland – Gibson road

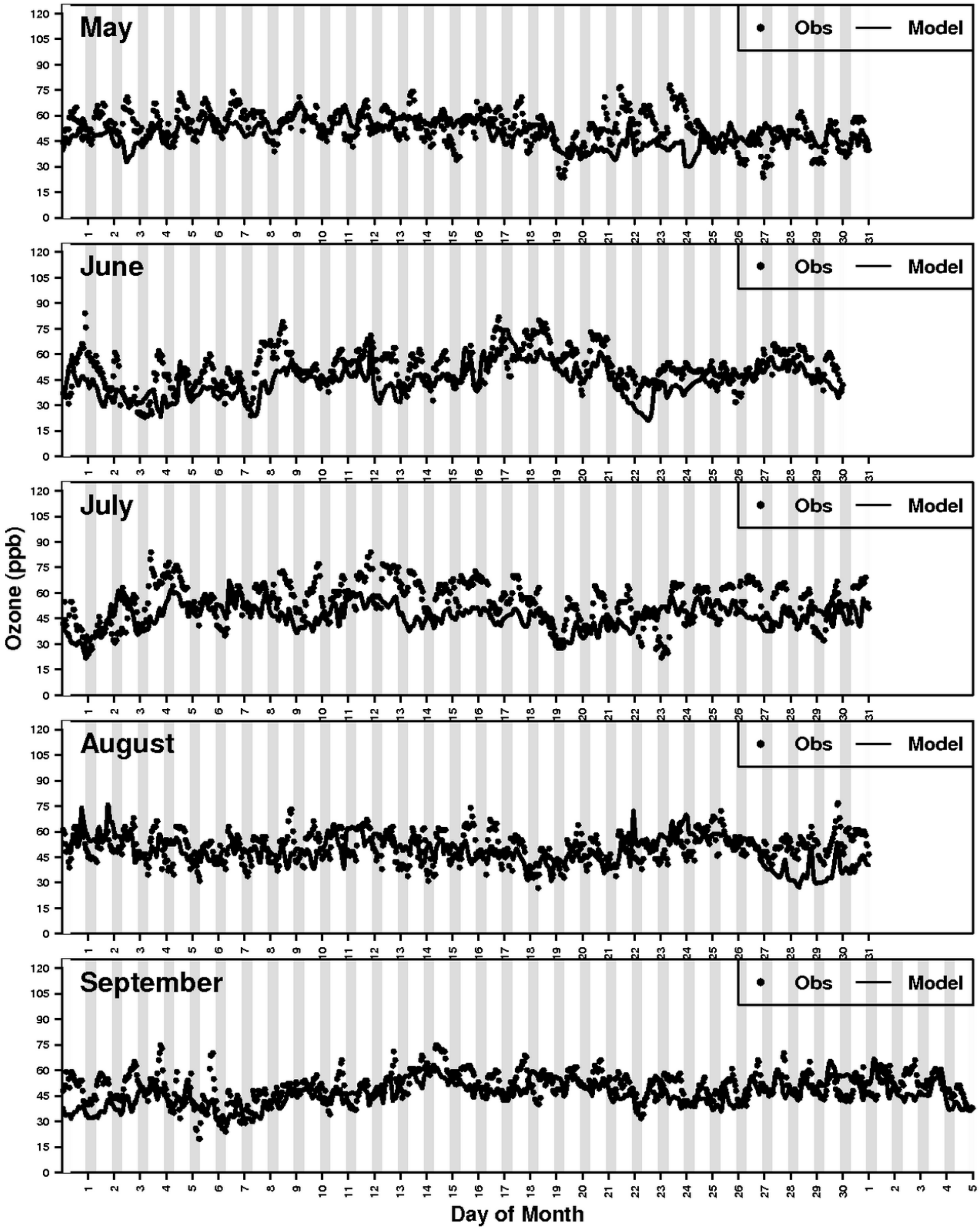


Figure S. 37 Time-series of hourly ozone at Echo Summit

DAILY MAXIMUM 1 – HOUR OZONE TIME SERIES PLOTS

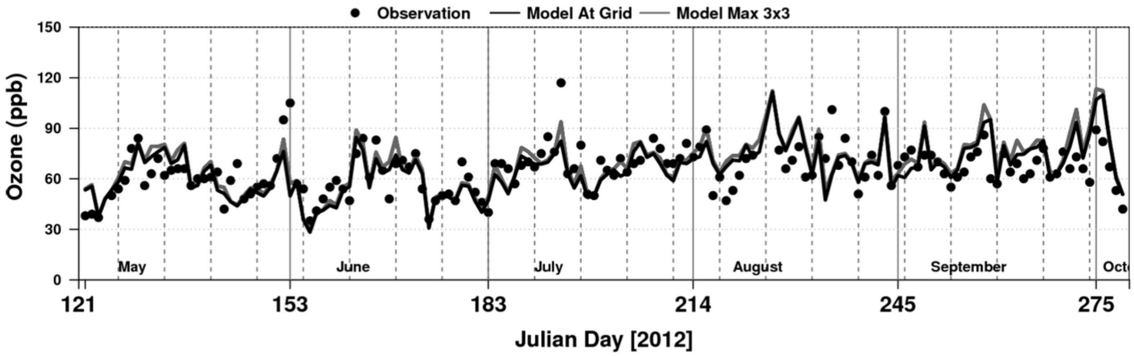


Figure S. 38 Time-series of daily maximum 1-hour ozone at Cool – Highway 193

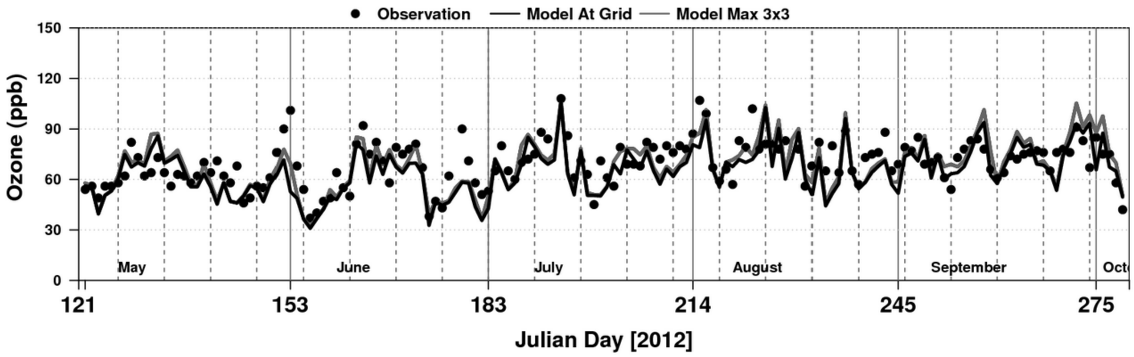


Figure S. 39 Time-series of daily maximum 1-hour ozone at Placerville – Gold Nugget way

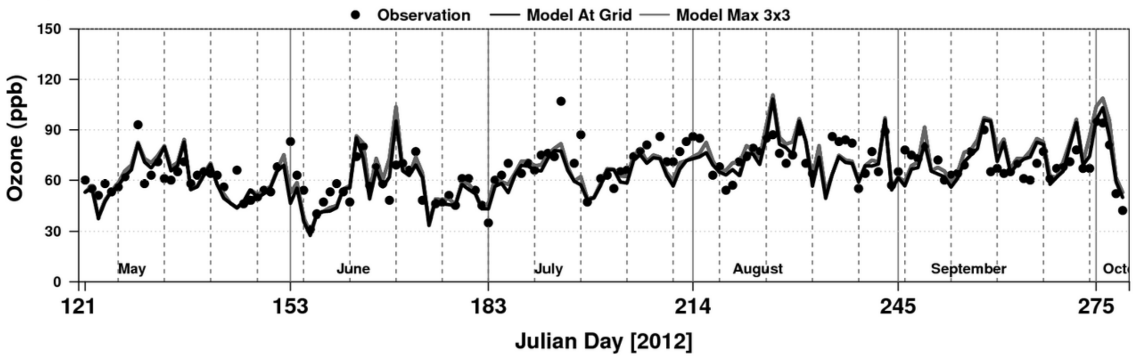


Figure S. 40 Time-series of daily maximum 1-hour ozone at Auburn – Antwoo Road

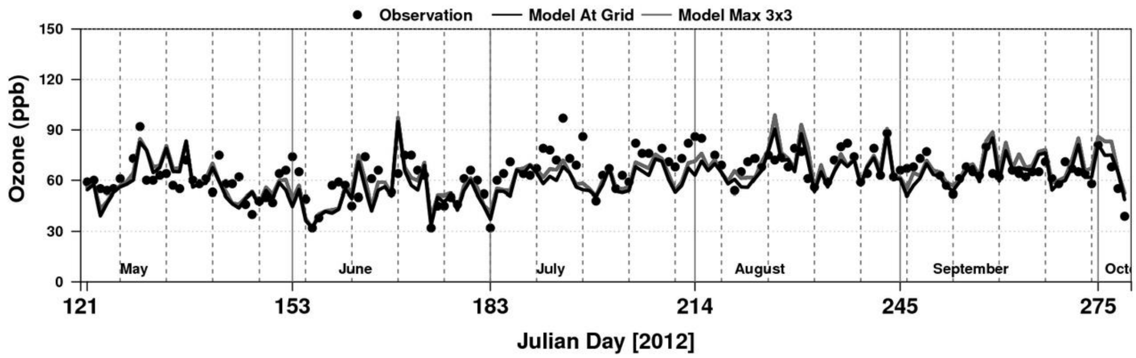


Figure S. 41 Time-series of daily maximum 1-hour ozone at Colfax City Hall

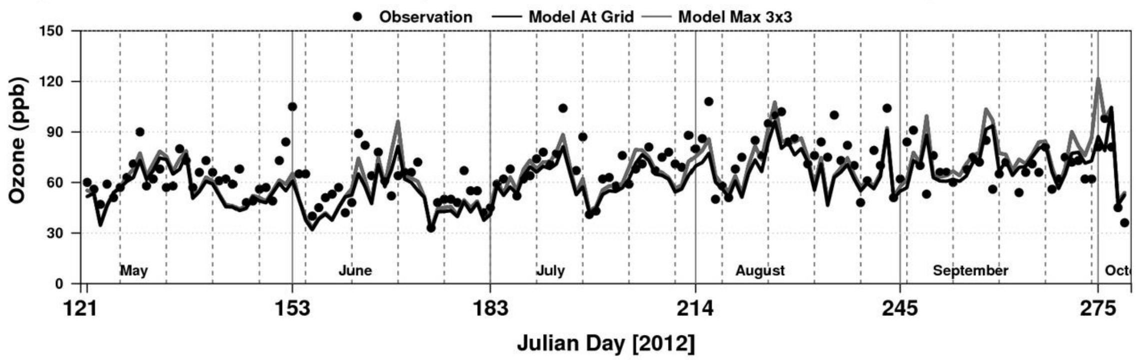


Figure S. 42 Time-series of daily maximum 1-hour ozone at Roseville – N Sunrise Ave

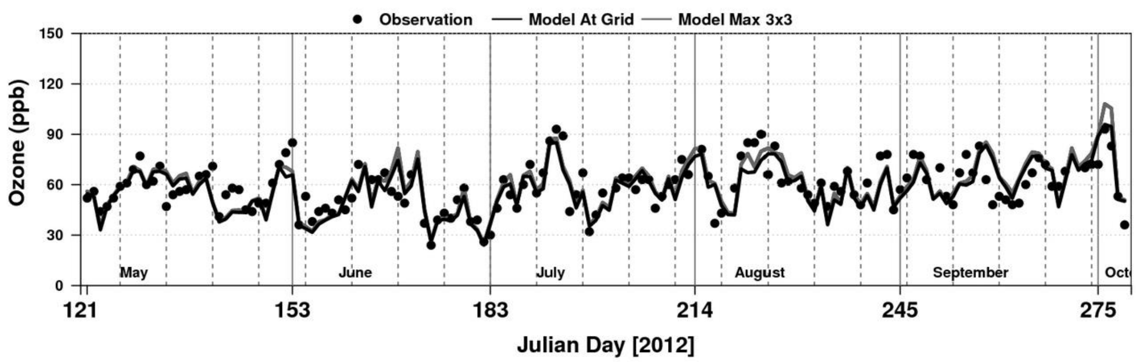


Figure S. 43 Time-series of daily maximum 1-hour ozone at Elk Grove – Bruceville road

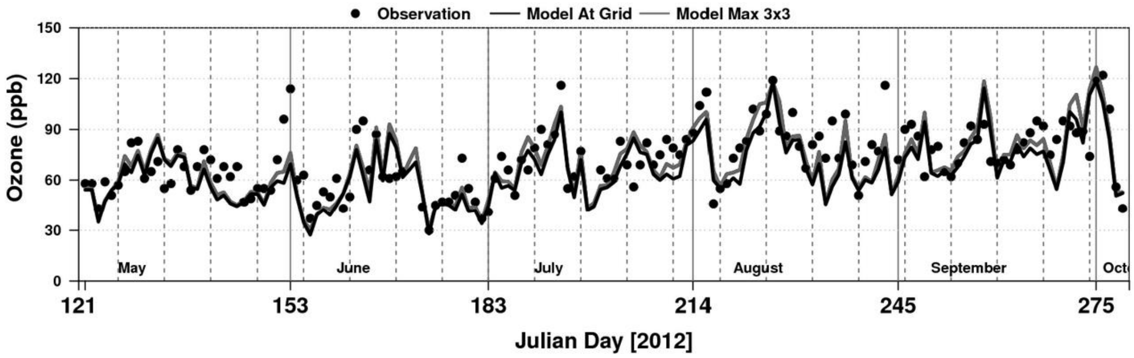


Figure S. 44 Time-series of daily maximum 1-hour ozone at Folsom – Natoma street

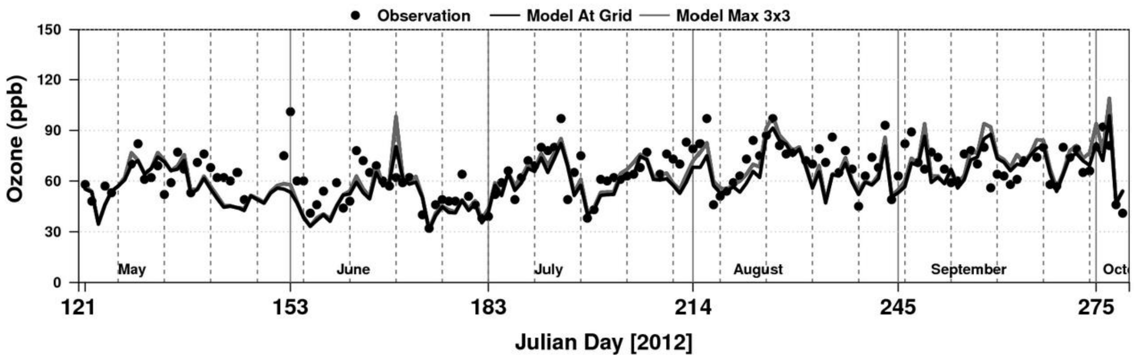


Figure S. 45 Time-series of daily maximum 1-hour ozone at North Highlands – Blackfoot way

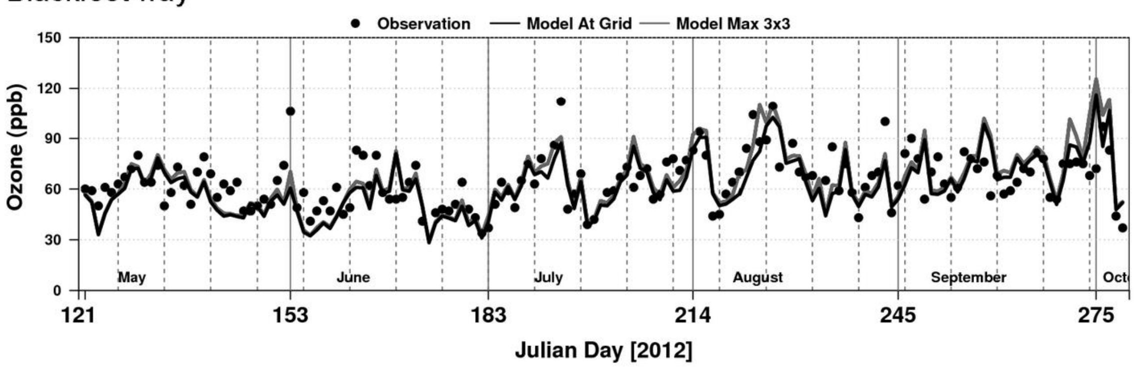


Figure S. 46 Time-series of daily maximum 1-hour ozone at Sacramento – Del Paso Manor

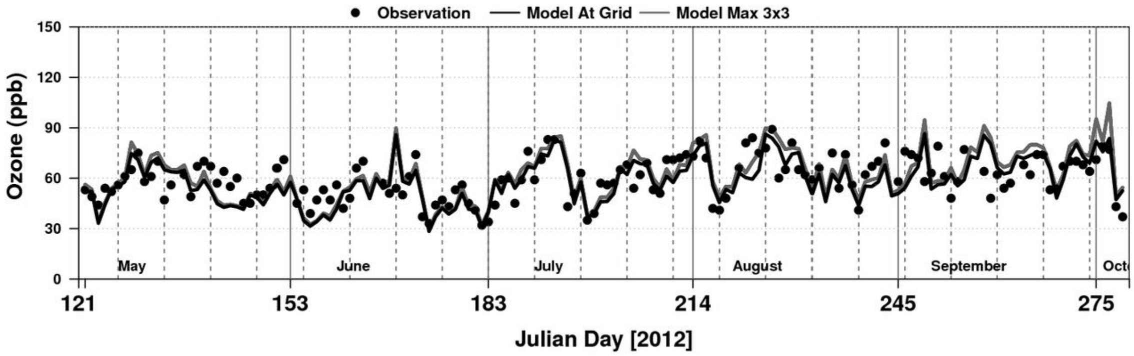


Figure S. 47 Time-series of daily maximum 1-hour ozone at Sacramento – Goldenland Court

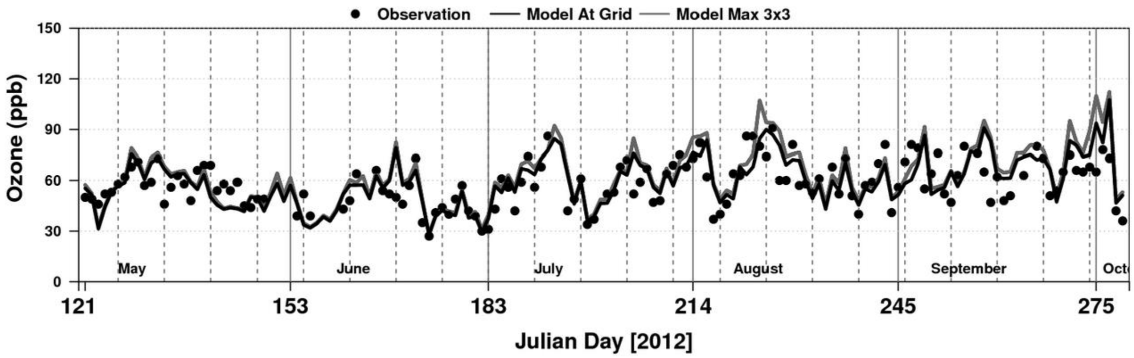


Figure S. 48 Time-series of daily maximum 1-hour ozone at Sacramento – T street

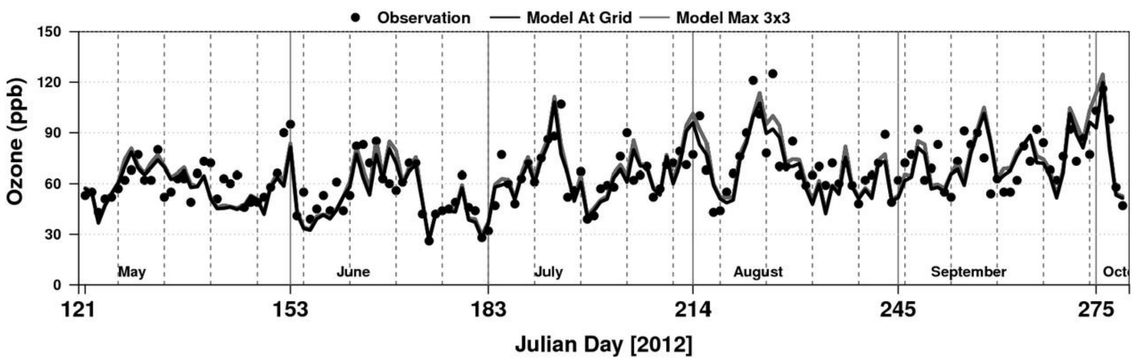


Figure S. 49 Time-series of daily maximum 1-hour ozone at Sloughhouse

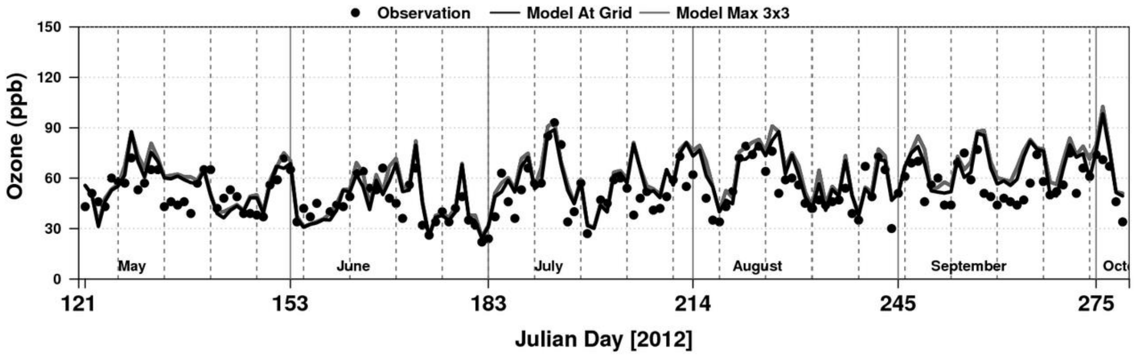


Figure S. 50 Time-series of daily maximum 1-hour ozone at Vacaville-Ulatis Drive

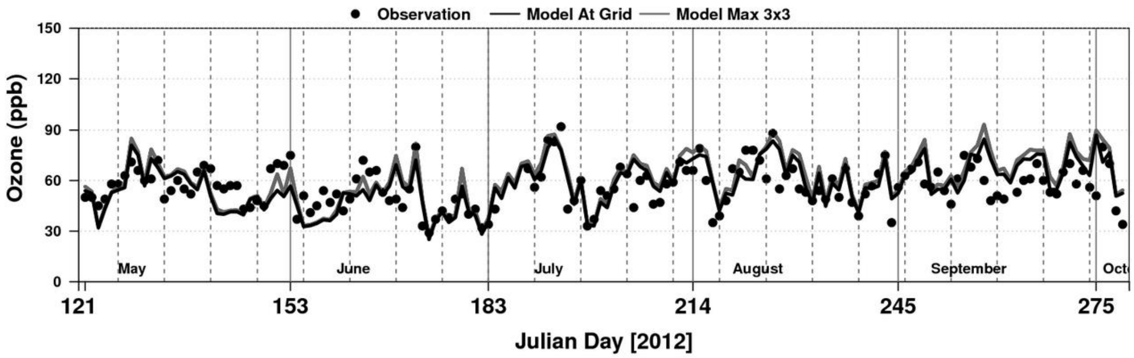


Figure S. 51 Time-series of daily maximum 1-hour ozone at Davis – UCD campus

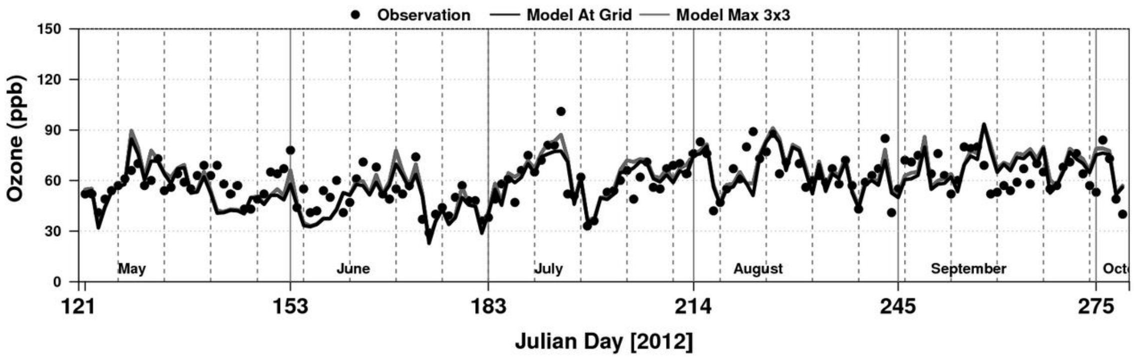


Figure S. 52 Time-series of daily maximum 1-hour ozone at Woodland – Gibson road

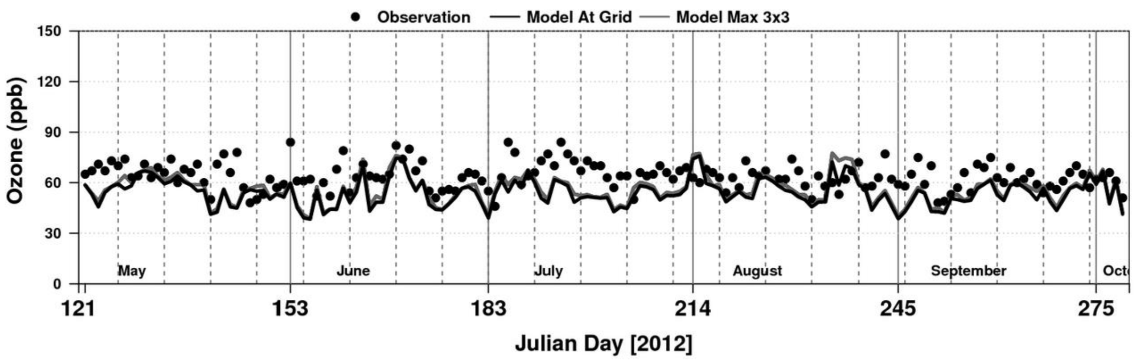


Figure S. 53 Time-series of daily maximum 1-hour ozone at Echo Summit

DAILY MAXIMUM 8 – HOUR OZONE TIME SERIES PLOTS

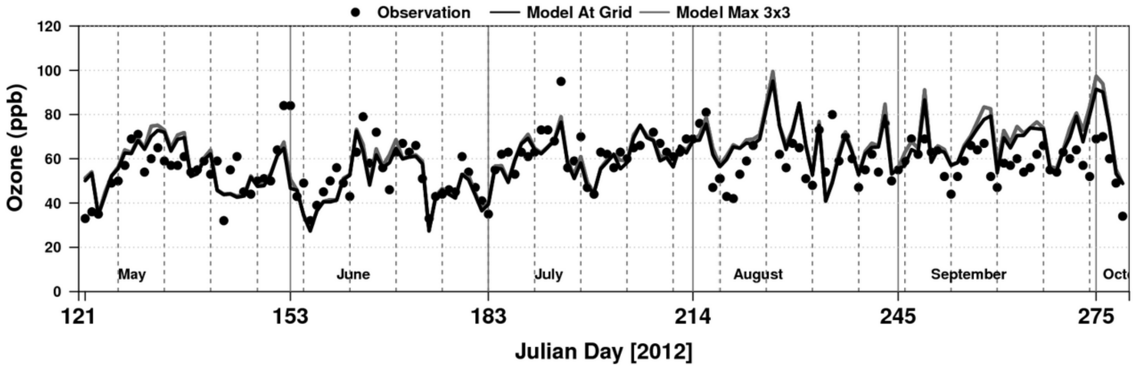


Figure S. 54 Time-series of daily maximum average 8-hour ozone at Cool – Highway 193

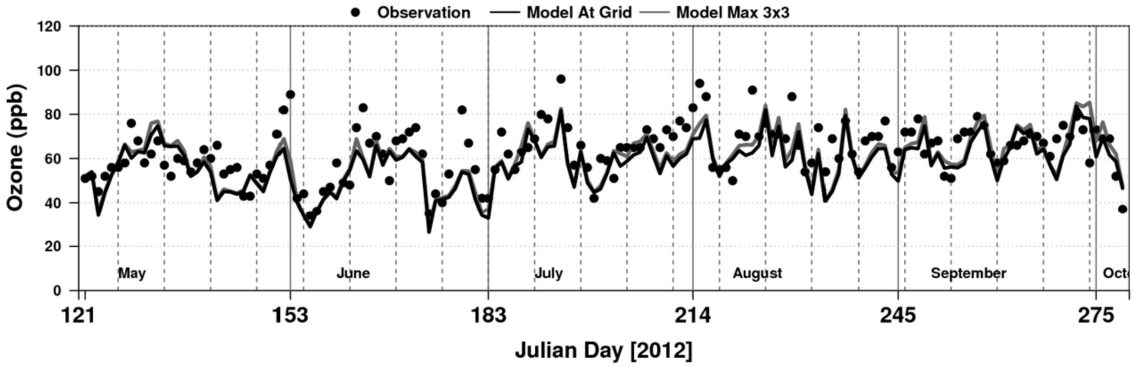


Figure S. 55 Time-series of daily maximum average 8-hour ozone at Placerville – Gold Nugget Way

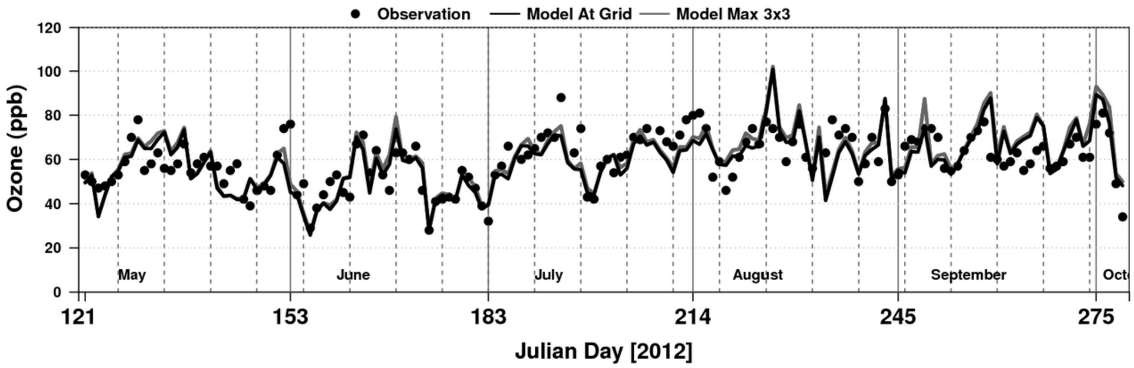


Figure S. 56 Time-series of daily maximum average 8-hour ozone at Auburn Antwoo Road

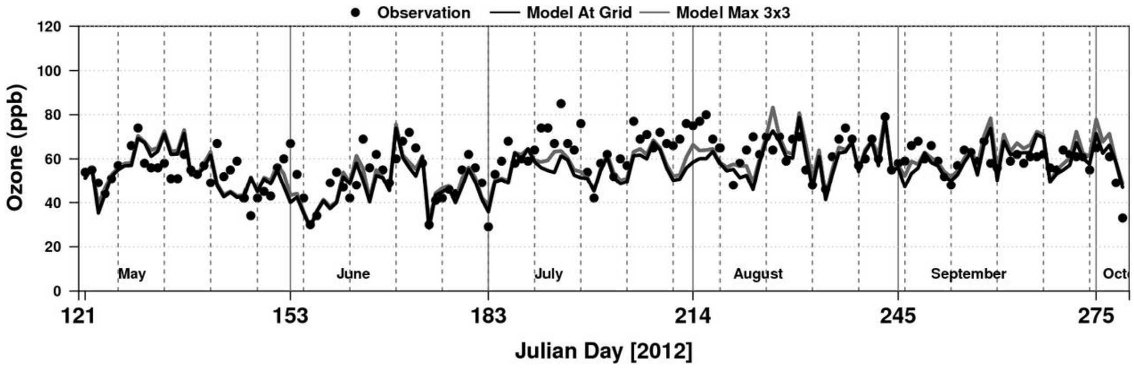


Figure S. 57 Time-series of daily maximum average 8-hour ozone at Colfax – City Hall

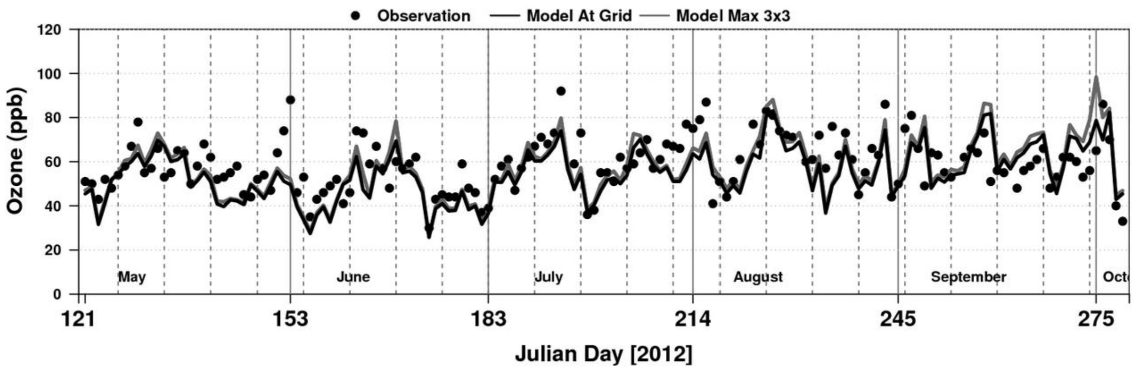


Figure S. 58 Time-series of daily maximum average 8-hour ozone at Roseville N. Sunrise Ave

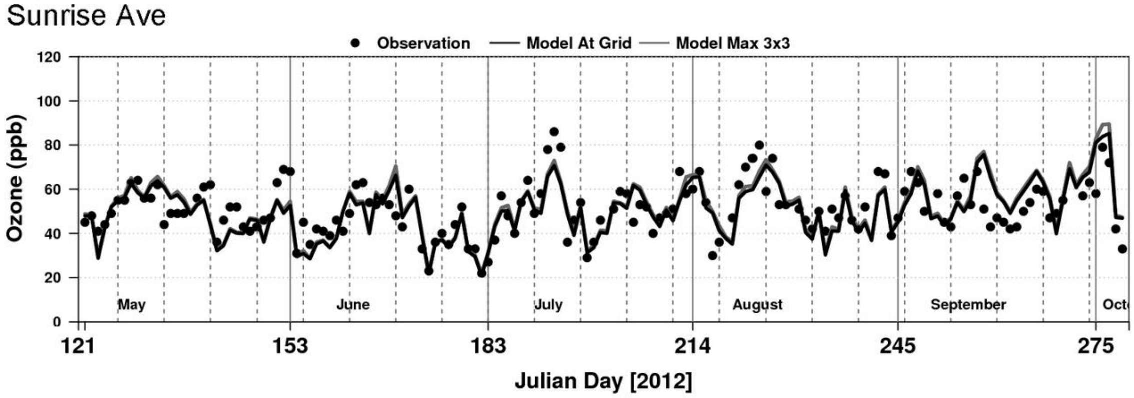


Figure S. 59 Time-series of daily maximum average 8-hour ozone at Elk Grove Bruceville Road

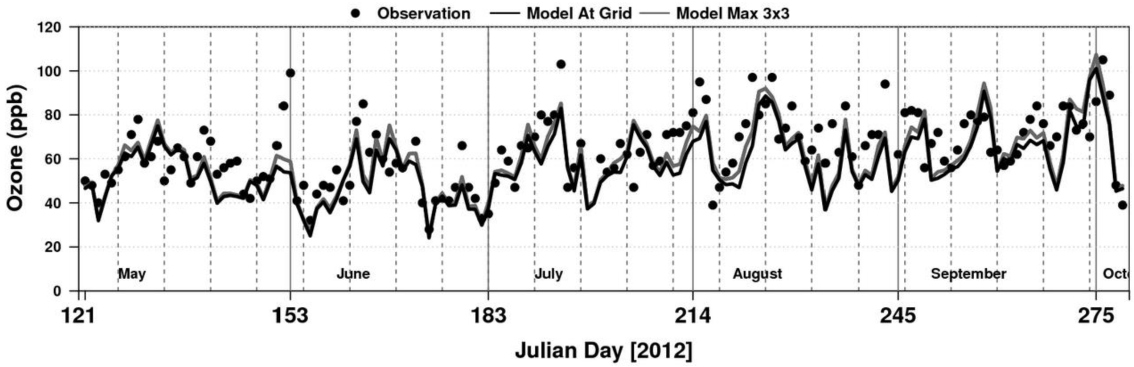


Figure S. 60 Time-series of daily maximum average 8-hour ozone at Folsom Natoma Street

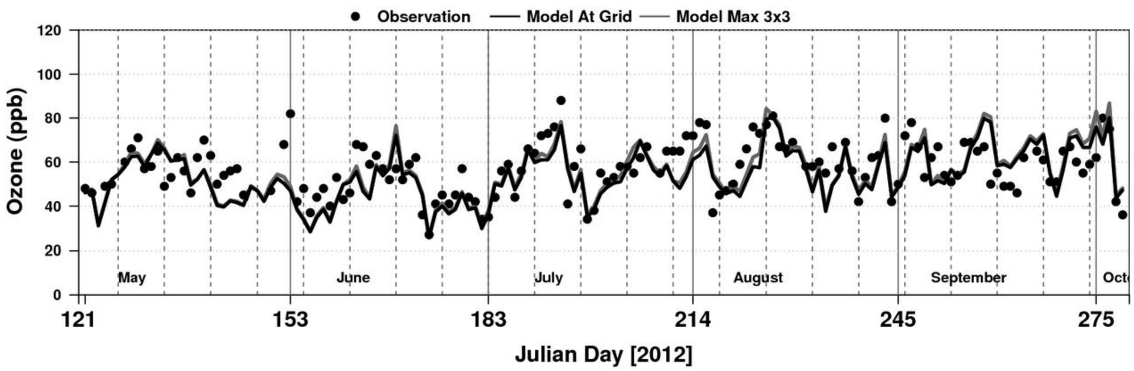


Figure S. 61 Time-series of daily maximum average 8-hour ozone at North Highlands – Blackfoot way

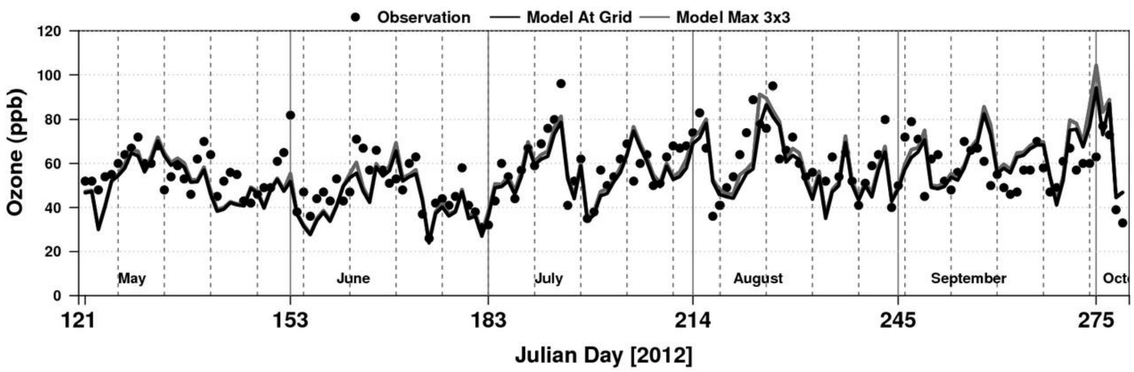


Figure S. 62 Time-series of daily maximum average 8-hour ozone at Sacramento – Del Paso Manor

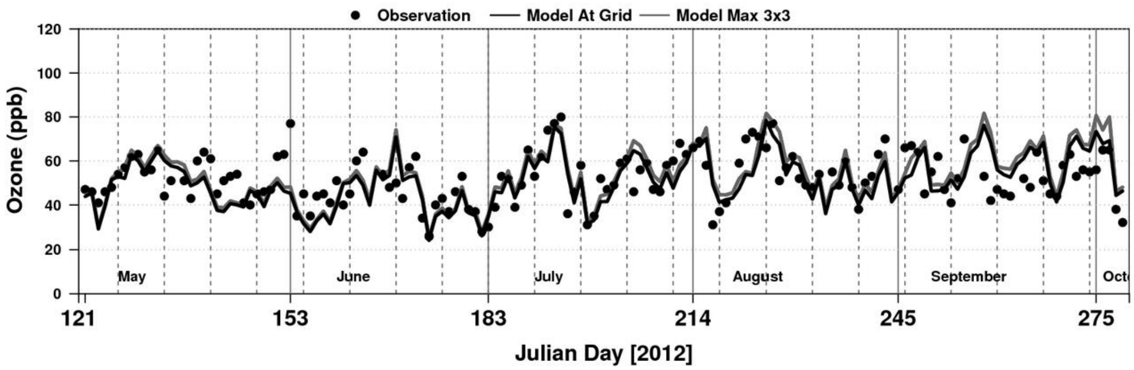


Figure S. 63 Time-series of daily maximum average 8-hour ozone at Sacramento Goldenland Court

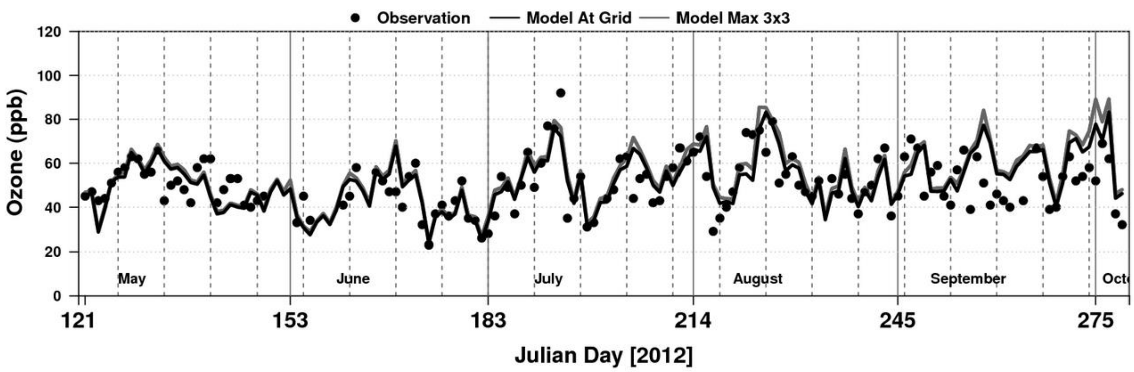


Figure S. 64 Time-series of daily maximum average 8-hour ozone at Sacramento – T street

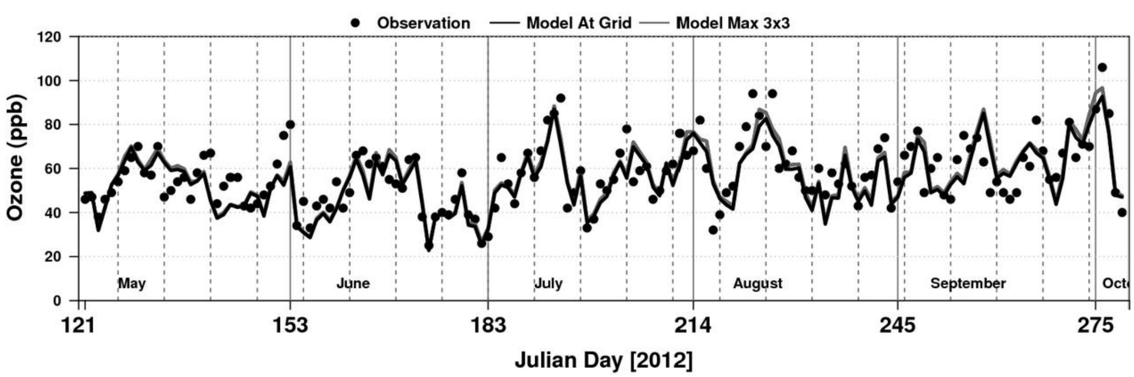


Figure S. 65 Time-series of daily maximum average 8-hour ozone at Sloughhouse

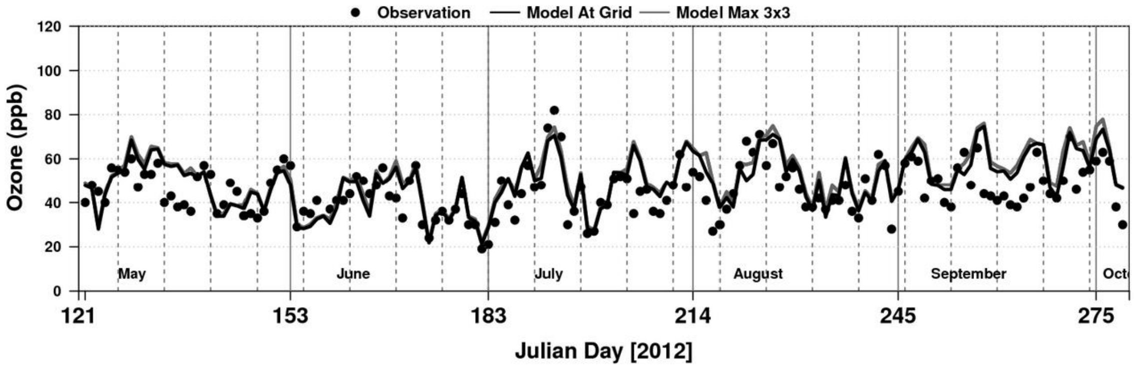


Figure S. 66 Time-series of daily maximum average 8-hour ozone at Vacaville – Ulatis Drive

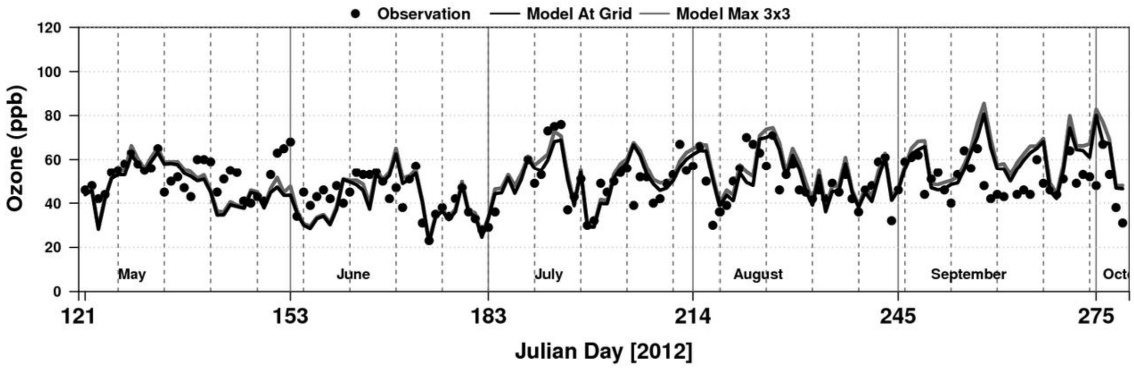


Figure S. 67 Time-series of daily maximum average 8-hour ozone at Davis – UCD campus

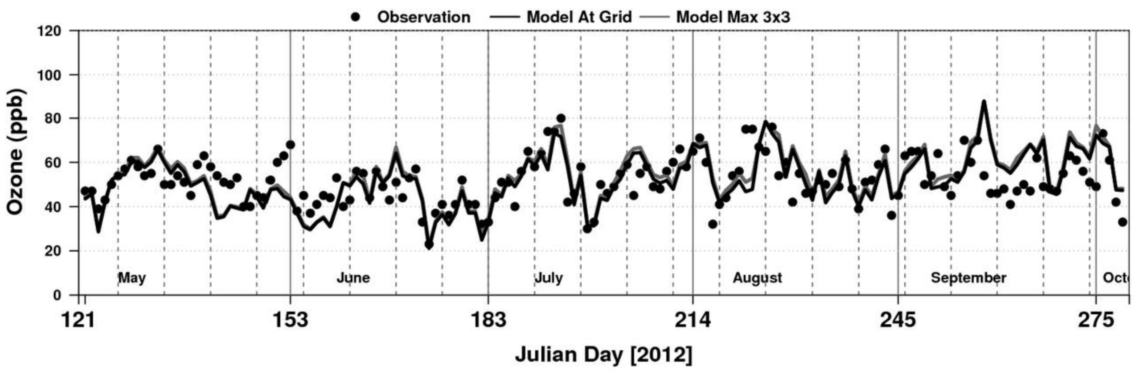


Figure S. 68 Time-series of daily maximum average 8-hour ozone at woodland- Gibson Road

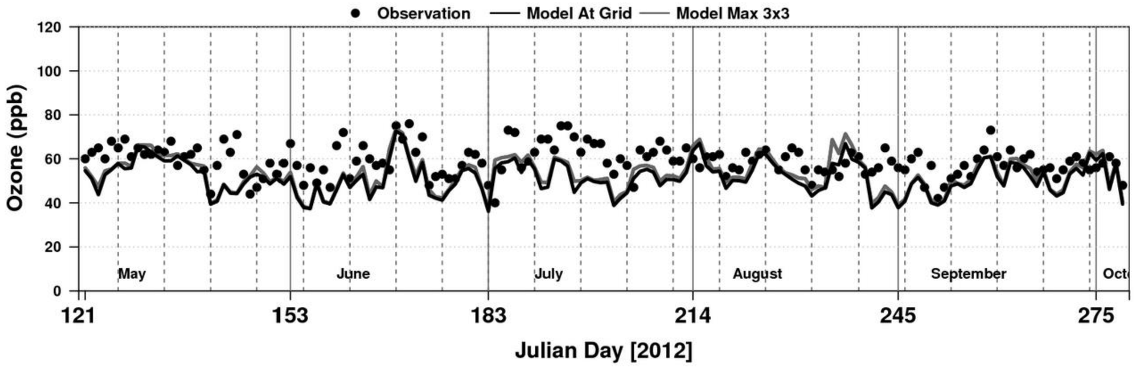


Figure S. 69 Time-series of daily maximum average 8-hour ozone at Echo Summit

Appendix B-5 Modeling Emissions Inventory

Document Title:

Modeling Emission Inventory for the 8-Hour Ozone State Implementation Plan in the Sacramento Non-Attainment Area

Document Description:

This document describes how the base and future year gridded photochemical modeling emissions inventory are prepared.

Modeling Emission Inventory for the 8-Hour Ozone State Implementation Plan in the Sacramento Non-Attainment Area

Prepared by

California Air Resources Board

El Dorado County Air Quality Management District

Feather River Air Quality Management District

Placer County Air Pollution Control District

Sacramento Air Quality Management District

Yolo-Solano Air Quality Management District

Prepared for

United States Environmental Protection Agency Region IX

January 27, 2017

Contents

List of Figures

List of Tables

1. Development of Ozone Emissions Inventories

Emission inputs for air quality modeling (commonly and interchangeably referred to as 'modeling inventories' or 'gridded inventories') have been developed by ARB and district staff. These inventories support the different SIPs across California to meet various federal $PM_{2.5}$ standards. ARB maintains an electronic database of emissions and other useful information to generate aggregate emission estimates at the county, air basin and district level. 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 gridded and serve as the emission input for the particulate matter models.

The following sections of this document describe how base and future year emissions inventory estimates are prepared.

1.1. Inventory Coordination

The Air Resources Board convened the SIP Inventory Working Group (SIPIWG) to provide an opportunity and means for interested parties (ARB, 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 has met every four to six weeks since March 2013. Group participants included district staff from Bay Area, Butte, Eastern Kern, El Dorado, Feather River, Imperial, Northern Sierra, Placer, Sacramento, San Diego, San Joaquin, San Luis Obispo, South Coast, Ventura and Yolo-Solano.

Additionally, ARB established the SIPIWG Spatial Surrogate Sub-committee, which focused on improving input data to spatially disaggregate emissions at a more refined level needed for air quality modeling. Local air districts that participated included San Joaquin Valley APCD, South Coast AQMD, Ventura County APCD and Sacramento Metropolitan AQMD.

In addition to the two coordination groups described above, 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 PM_{10}/$PM_{2.5}$ Air Quality Study (CRPAQS).

1.2. 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 a myriad of emission sources such as consumer products and fireplaces. The development and maintenance of the emission inventory involves several agencies. This multi-agency effort includes: ARB, 35 local air pollution control and air quality management districts (Districts), regional transportation planning agencies (RTPAs), and the California Department of Transportation (Caltrans). The ARB 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 northern Mexico (Jackson, 2012) 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 (U.S. EPA, 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 are measured in terms such as the amount of product produced, solvent used, or fuel used.

The district reported or ARB estimated emissions totals are stored in the CEIDARS database for any given pollutant. Both criteria and toxic air pollutant emission inventories 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 total particulate matter 10μ in diameter and smaller (PM_{10}) and total particulate matter 2.5μ in diameter and smaller ($PM_{2.5}$) are estimated from total particulate matter (PM). Details about chemical and size resolved speciation of emissions for modeling can be found in Section 2.4. Additional information on ARB emission inventories can be found at: http://www.arb.ca.gov/ei/ei.htm.

1.3. Inventory Years

The emission inventory scenarios used for air quality modeling must be consistent with U.S. EPA's Modeling guidance (U.S. EPA, 2014). Since changes in the emissions inventory can affect the calculation of the relative response factors (RRFs), 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:

1.3.1. Base Case Modeling Inventory (2012): 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. Therefore, the base case modeling inventory for 2012 includes day-specific emissions for certain sectors. This includes, for instance, actual district-reported point source emissions information for 2012, as well as available day-specific activities and emission adjustments. The year 2012 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 ARB and the local air districts began a comprehensive review and update of the emission inventory several years ago resulting in a comprehensive emissions inventory for 2012.

1.3.2. Reference Year (or Baseline) Modeling Inventory (2012): The baseline or 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 2012 reference year inventory represents typical average conditions and emission patterns through the 2012 design value period. The baseline inventory includes temperature, relative humidity and solar insolation effects, for 2012.

1.3.3. Future Year Modeling Inventory (2022/2026): Future year modeling inventories, along with the reference year modeling inventory, are used in the model-derived RRF calculation. These inventories maintain the “typical”, average patterns of the 2012 reference year modeling inventory. The 2022 or 2026 inventory will include temperature, relative humidity, and solar insolation effects from reference year (2012) meteorology. Future year point and area source emissions are projected from the 2012 baseline emissions used in the

2012 reference year modeling inventory. Additionally, future year on-road emission inventories are used, as projected by EMFAC.

In summary and based on the definitions above, the following modeling emission inventories were developed:

1.3.4. 2012 Base Case Modeling Inventory: This day-specific inventory is used for the model performance evaluation.

1.3.5. 2012 Reference Year (Baseline) Modeling Inventory: This 2012 reference year inventory is used to determine site-specific RRFs in the modeled attainment test. The 2012 reference year modeling inventory represents typical, average conditions and emission patterns over the baseline design value period, and includes 2012 meteorological effects.

1.3.6. 2022/2026 Future Year Modeling Inventories: These typical, average-day inventories are used to determine site-specific RRFs in the modeled attainment test. Consistent with the 2012 reference year modeling inventory, the 2022 or 2026 inventory is projected from the 2012 baseline inventory and includes 2012 meteorological effects.

1.4. Spatial Extent of Emission Inventories

The emissions model-ready 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.

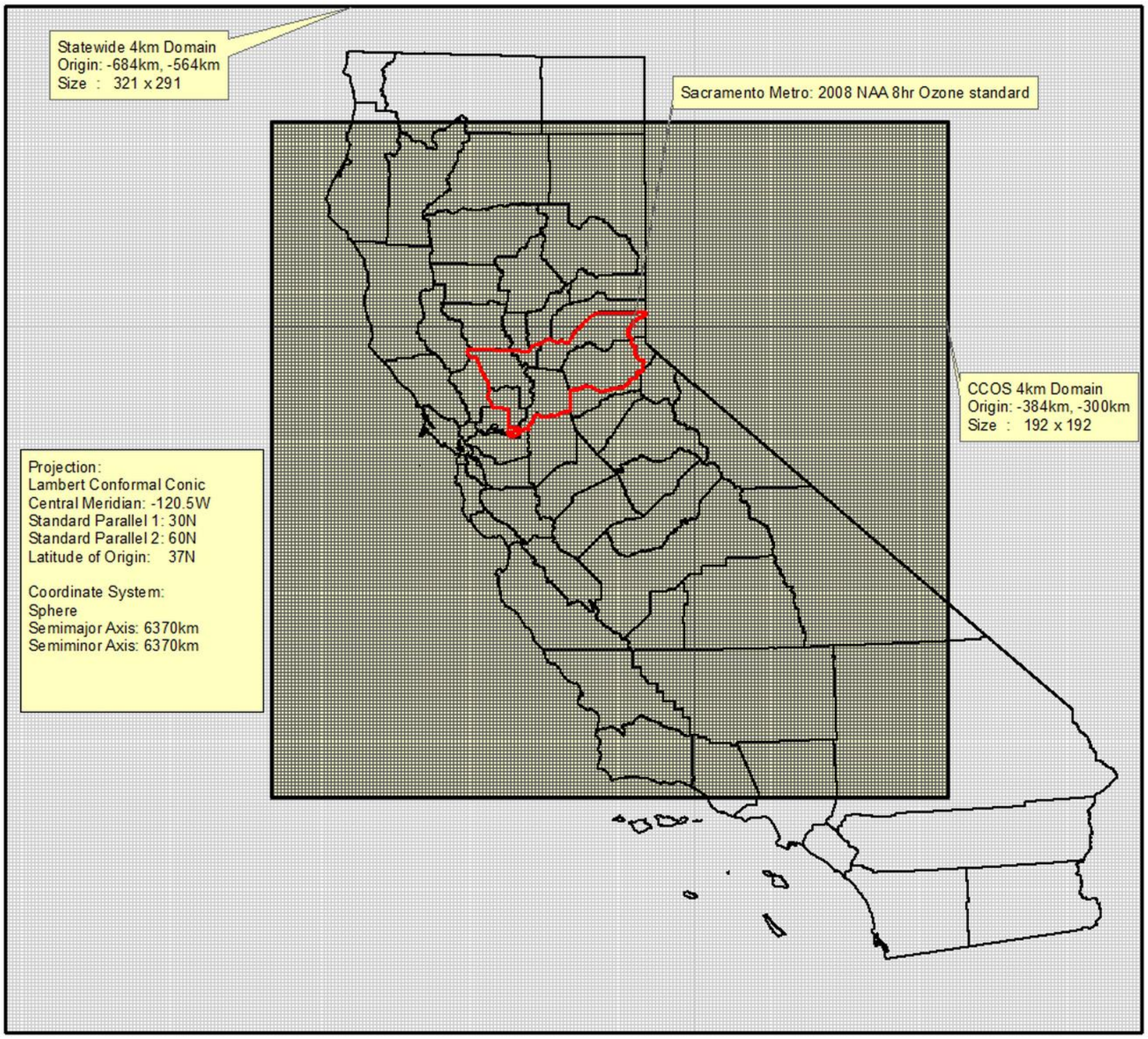


Figure 1 Spatial coverage and parameter summary of modeling domains

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 uses a grid with a spatial resolution of 4 km x 4 km. The state modeling domain (ST4K) extends entirely over California and 100 nautical miles west over the Pacific Ocean. A smaller subdomain (CCOS) is used for Sacramento area. It has the same grid definitions and resolution as the main domain, but has a smaller area offset to cover central and northern California. The specifications of the emissions inventory domain and CCOS subdomain are summarized in Table 1.

Table 1 Modeling domain parameters

Parameter	**Statewide domain (ST4K)**	**Subdomain (CCOS)**
Map Projection	Lambert Conformal Conic	Lambert Conformal Conic
Datum	None (Clarke 1866 spheroid)	None (Clarke 1866 spheroid)
1st Standard Parallel	30.0° N	30.0° N
2nd Standard Parallel	60.0° N	60.0° N
Central Meridian	-120.5° W	-120.5° W
Latitude of projection origin	37.0° N	37.0° N
COORDINATE SYSTEM		
Units	Meters	Meters
Semi-major axis	6370 km	6370 km
Semi-minor axis	6370 km	6370 km
DEFINITION OF GRID		
Grid size	4km x 4km	4km x 4km
Number of cells	321 x 291 cells	192 x 192 cells
Lambert origin	(-684,000 m, -564,000 m)	(-384,000 m, -300,000 m)
Geographic center	-120.5° Lat and 37.0° Lon	-120.5° Lat and 37.0° Lon

2. Estimation of Base Year Modeling Inventory

As mentioned in Section 1.3, 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 the different sectors of the modeling inventories are prepared.

2.1. Terminology

The terms “point sources” and “area sources” are often confused. Traditionally, these terms have had different meanings to the developers of emissions inventories and the developers of modeling inventories. Table 2 summarizes the difference in the terms. Both sets of terms are used in this document. In modeling terminology, “point sources” traditionally refer to elevated emission sources that exit from a stack and have an associated plume rise. While the current inventory includes emissions from stacks, all emission sources reported by the SJVAPCD associated with a facility are treated as potential elevated sources. The emissions processor calculates plume rise if appropriate; non-elevated sources are treated as ground-level sources. Examples of non-elevated emissions sources include gas dispensing facilities and storage piles. "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.

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	Trees

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

2.2. Temporal Distribution of Emissions

Emission inventories that are temporally and spatially resolved are needed for modeling purposes, for the base case and baseline modeling inventories as well as future year inventories. The temporal distribution of on-road emissions and biogenic emissions are discussed in Sections 3.4 and 3.5, respectively. How emissions are temporally distributed for the remaining sources (point, area and off-road mobile sources) is discussed below.

Emissions are adjusted temporally to represent variations by month, day of week and hour of day. Temporal data are stored in ARB'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 operate differently than a boiler. ARB or district staff also assigns temporal data for each area source category by county/air basin/district.

2.2.1. 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. ARB'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 in July for recreational boats of 15 results in about 1.8 times higher (15 / 8.33 = 1.8) emissions than a day with flat monthly profile.

2.2.2. Weekly Variation: Emissions are adjusted temporally to represent variations by day of 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 below shows the current DPWK codes and Table 11 in Appendix D shows additional DPWK codes used for agricultural-related emissions.

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
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 week days; non on Saturday and Sunday	1	1	1	1	1	0	0
6	Six days per week - Uniform activity on week days; non 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; No activity the remainder of the week	5	5	5	5	5	10	10
22	Uniform activity on week days; Reduced activity on weekends	10	10	10	10	10	7	4
23	Uniform activity on week days; Reduced activity on weekends (For onroad motor vehicles)	10	10	10	10	10	8	8
24	Uniform activity on week days; half as much activity on Saturday. Little activity on Sunday	10	10	10	10	10	5	1
25	Uniform activity on week days; one third as much on Saturday; little on Sunday	10	10	10	10	10	3	1
26	Uniform activity on week days; little activity on Saturday; no activity on Sunday	10	10	10	10	10	3	0
27	Uniform activity on week days; half as much activity on weekends	10	10	10	10	10	5	5
28	Uniform activity on week days; 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, Sunday	8	8	8	8	10	10	10

2.2.3. 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. 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 code or HPDY. Table 4 below shows the daily variation factors or current HPDY codes. Table 12 in Appendix D shows additional DPWK codes used for agricultural-related emissions.

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	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
2	2 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
3	3 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	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	1	1	1	1	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	1	1	1	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	1	1	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	1	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
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	24 HOURS PER DAY - 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 (i.e. COMMERCIAL AIRCRAFT)	10	1	1	1	1	1	1	8	8	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
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(CAN&COIL/METAL PARTS COATINGS)	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 AND MORNING HOURS (CONSTRUCTION EQUIPMENT ON HOT	0	0	0	0	0	1	6	10	10	10	10	10	10	9	8	4	2	1	1	0	0	0	0	0
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	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	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 OTHER HOURS (EVAP-COASTAL COUNTIES)	7	7	6	6	6	6	6	7	8	8	9	9	10	10	10	10	9	9	8	8	7	7	7	7
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

17

2.3. Spatial Allocation

Once the base case, baseline or future year inventories are developed, the next step of modeling inventory development is to spatially allocate the emissions. Air quality modeling attempts to replicate the physical and chemical processes that occur in an inventory 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. In reality, 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 in order 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 which vary geographically. The spatial surrogates have been updated over the years mainly by Sonoma Technology, Inc. (STI) (Funk, et al., 2001) who created a 2000 base year and various future years. Later, STI updated the underlying spatial data and developed new surrogates (Reid, et al., 2006) completing the project in 2008. ARB and districts have continued to update and improve many of the spatial surrogates and added new ones.

Three basic types of surrogate data were used to develop the original spatial allocation factors: land use and land cover; 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 activity (e.g. residential fuel combustion). To develop spatial allocation factors of high quality and resolution, local socioeconomic and demographic data were used where available for developing base case, baseline and future year inventories. These data were available from local Metropolitan Planning Organizations (MPO) or Regional Transportation Planning Agencies (RTPA), where they are used as inputs for travel demand models. In rural regions for which local data were not available, data from Caltrans' Statewide Transportation Model were used.

Since 2008, ARB and district staffs have continued to search for more recent or improved sources of data, since the underlying data used by STI were pre-recession. ARB and district staffs have updated many of the spatial surrogates and added many new ones.

- Updates to land use categories were made using the National Land Cover Database 2011 (Homer, et al., 2015).
- Many surrogates were updated using the locations from Dun & Bradstreet's Market Insight Database (Dun and Bradstreet, 2015). The types of sources were defined by SIC (Standard Industrial Classification). Fourteen new surrogates were developed for industrial-related sources using SIC and whether manufacturing occurred at the facility.
- U.S. Census American Community Survey (FactFinder, 2011) data by census block were used to update residential fuel use.
- Sierra Research developed nine new surrogates related to agricultural activities (Anderson, et al., 2012) , some of which incorporated crop-specific factors.
- Seven new surrogates were developed using vessel traffic data, or Automatic Identification System (AIS) data, collected by the U.S. Coast Guard.
- A new surrogate was created to represent the location of construction equipment. The distribution is a combination of two sets of data: 90% change in "imperviousness" between 2006 and 2011 from NLCD 2011 and 10% road network. Impervious surfaces are mainly artificial structures such as pavements (roads, sidewalks, driveways and parking lots) that are covered by materials impenetrable to a satellite such as asphalt, concrete, brick, stone and rooftops.
- A new surrogate was compiled to distribute emissions from transport refrigeration units (TRU) from three sources: 65% distribution centers, 34% road network and 1% grocery stores / food processing facilities. Information on

distribution centers were retrieved from ARBER, the ARB Equipment Registration software for the Transport Refrigeration Unit (TRU) ATCM and the Drayage Truck Regulation.

In all, a total of 99 unique surrogates are available for use. A summary of the spatial surrogates for which spatial allocation factors were developed is shown below in Table 5.

Table 5 Spatial Surrogates

Surrogate Name	**Surrogate Definition**
AEROSPACE	Spatial distribution of businesses involved in aerospace
Airports	Spatial locations of all airports
All_PavedRds	Spatial distribution of road network (all paved roads)
AutobodyShops	Locations of autobody repair and refinishing shops
CAFO	Spatial distribution of concentrated animal feeding operations
CANCOIL	Spatial distribution of businesses involved in can and coil operations
Cemeteries	Spatial locations of cemeteries
Comm_Airports	Spatial locations of commercial airports
COMPOST	Spatial distribution of composting
CONSTRUCTION_EQUIP	Spatial distribution of where construction equipment is used
Devplnd_HiDensity	Spatial distribution of developed land - low density, medium density and high density
Devplnd_LoDensity	Spatial distribution of developed land - open space (lowest density)
DREDGE	Locations of dredging
Drycleaners	Locations of dry cleaning facilities
DryLakeBeds	Locations of dry lake beds
Elev5000ft	Topological contours – areas above 5000 feet
Employ_Roads	Spatial distribution of total employment and road density (all paved roads)
FABRIC	Spatial distribution of businesses involved in fabric manufacturing
FERRIES	Locations of ferry ports and routes
FISHING_COMM	Locations of commercial fishing
Forestland	Spatial distribution of forest land
Fugitive_Dust	Spatial distribution of barren land
GAS_DISTRIBUTION	Location of gas pipelines
GAS_SEEP	Location of natural-occurring gas seeps
GasStations	Locations of gasoline service stations
GASWELL	Locations of gas wells
GolfCourses	Spatial locations of golf courses
HE_Sqft	Computed surrogate based on housing and employment (est. ft2 / person)
Hospitals	Spatial locations of hospitals
Housing	Spatial distribution of total housing
Housing_Autobody	Spatial distribution of housing and autobody refinishing shops
Housing_Com_Emp	Spatial distribution of total housing and commercial employment
Housing_Restaurants	Spatial distribution of total housing and restaurants/bakeries
Surrogate Name	Surrogate Definition
INDUSTRIAL	Spatial distribution of industrial businesses where manufacturing occurs (SIC<4000)
Industrial_Emp	Spatial distribution of industrial employment
InlandShippingLanes	Spatial distribution of major shipping lanes within bays and inland areas
Irr_Cropland	Spatial location of agricultural cropland
Lakes_Coastline	Locations of lakes, reservoirs, and coastline
LAKES_RIVERS_RECBOAT	Locations of lakes, rivers and reservoirs where recreational boats are used
LANDFILLS	Locations of landfills
LANDPREP	Spatial distribution of dust from land preparation operations (e.g. tilling)
LINEHAUL	Spatial distribution of Class I rail network
LiveStock	Spatial distribution of cattle ranches, feedlots, dairies, and poultry farms
MARINE	Spatial distribution of businesses involved in marine

20

Surrogate Name	Surrogate Definition
METALFURN	Spatial distribution of businesses involved in metal furniture
METALPARTS	Spatial distribution of businesses involved in metal parts and products
Metrolink_Lines	Spatial distribution of metrolink network
MILITARY_AIRCRAFT	Locations of landing strips on military bases
MILITARY_SHIPS	Locations of military ship activity
MILITARY_TACTICAL	Military bases where tactical equipment are used
MiltaryBases	Locations of military bases
NON_PASTURE_AG	Spatial distribution of farmland
NonIrr_Pastureland	Spatial location of pasture land
NonRes_Chg	Computed surrogate based on spatial distribution of non-residential areas
OCEAN_RECBOAT	Locations of recreational boat activity that can occur on the ocean and SF Bay
OIL_SEEP	Location of naturally-occurring oil seeps
OILWELL	Locations of oil wells (both onshore and offshore)
OTHERCOAT	Spatial distribution of businesses with SIC<4000 not included in another category
PAPER	Spatial distribution of businesses involved in paper
PASTURE	Spatial distribution of grazing land
PEST_ME_BR	Spatial distribution of methyl bromide pesticides
PEST_NO_ME_BR	Spatial distribution of non-methyl bromide pesticides
PLASTIC	Spatial distribution of businesses involved in plastic
Pop_ComEmp_Hos	Spatial distribution of hospitals, population and commercial employment
Population	Spatial distribution of population
Ports	Locations of shipping ports
POTWs	Coordinate locations of POTWs
PrimaryRoads	Spatial distribution of road network (primary roads)
PRINT	Spatial distribution of print businesses
Raillines	Spatial distribution of railroad network
RailYards	Locations of rail yards
Rds_HE	Calculated surrogate based on road densities and housing/employment (est. ft2 / person)
RefinieriesTankFarms	Coordinate locations of refineries and tank farms
Res_NonRes_Chg	Computed surrogate based on spatial distribution of residential and non-residential areas
ResGasHeating	Spatial distribution of homes using gas supplied by a utility as primary source of heating
Residential_Chg	Computed surrogate based on spatial distribution of residential areas
ResLPGHeat	Spatial distribution of homes using gas (bottled, tank or LP) as primary source of heating
ResNonResChg_IndEmp	Spatial distribution of industrial employment and residential/non-residential change
ResOilHeat	Spatial distribution of homes using fuel oil or kerosene as primary source of heating
Restaurants	Locations of restaurants
ResWoodHeating	Spatial distribution of homes using wood as primary source of heating
Surrogate Name	Surrogate Definition
SandandGravelMines	Locations of sand/gravel excavation and mining
Schools	Spatial locations of schools
SecondaryPavedRds	Spatial distribution of road network (secondary roads)
SEMICONDUCT	Spatial distribution of businesses involved in semiconductors
Ser_ComEmp_Sch_GolfC_Cem	Spatial distribution of service and commercial employment, schools, cemeteries, olf courses
Service_Com_Emp	Spatial distribution of service and commercial employment
Shiplanes	Spatial distribution of major shipping lanes
SILAGE	Spatial distribution of silage operations
SingleHousingUnits	Spatial distribution of single dwelling units
TRU	Spatial distribution of transport refrigeration units
TUG_TOW	Spatial distribution of tug and tow boats
UnpavedRds	Spatial distribution of road network (unpaved roads)
Wineries	Locations of wineries
WOOD	Spatial distribution of businesses using wood
WOODFURN	Spatial distribution of businesses involved in wood furniture

The following sections describe in more detail the type of spatial disaggregation used for each sector of the emissions inventory.

2.3.1. Spatial Allocation of Area Sources: Each area source category is assigned a spatial surrogate that is used to allocate emissions to a grid cell in ARB's 4km 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.

2.3.2. 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. Vertical distribution of elevated sources is allocated using the plume rise algorithm in the emissions processor, SMOKE (see Section 3.3), while non-elevated are allocated to the first layer. Most stationary point sources with existing stacks are regarded as elevated sources. Those without physical stacks that provide only latitude/longitude, such as airports or landfills, are considered non-elevated.

2.3.3. Spatial Allocation of Wildfires, Prescribed Burns and Wildland Fire Use: Emissions from these sources are event and location-based. A fire event can last a few hours or span multiple days. Each fire is spatially allocated to grid cells using the 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 3.6.1.

2.3.4. Spatial Allocation of Ocean going vessels (OGV): Ship emissions are allocated to the grids corresponding to the vessel traffic lanes in ARB's OGV model (ARB-PTSD, 2011) These traffic lanes were estimated from three different sources:

a. National Waterway Network
b. The Ship Traffic, Energy and Environment Model
c. Automated instrumentation system (AIS) telemetry data collected in 2007

2.3.5. Spatial Allocation of On-road Motor Vehicles: The spatial allocation of on-road motor vehicles is based on DTIM as described in Section 3.4.

2.3.6. Spatial Allocation of Biogenic Emissions: As described in Section 3.5, gridded biogenic emissions are derived using the Model of Emissions of Gases and Aerosols from Nature (MEGAN). MEGAN utilizes gridded emission factor and plant functional type data, adjusted by local meteorological conditions and satellite derived leaf area data, to estimate hourly biogenic emissions within each grid cell of the modeling domain. More details about MEGAN can be found at http://lar.wsu.edu/megan/.

2.4. Speciation Profiles

ARB's emission inventory lists the amount of pollutants discharged into the atmosphere by source in a certain geographical area during a given time period. It currently contains estimates for CO, NH_3, NOx, SOx, total organic gases (TOG) and particulate matter (PM). CO and NH3 are single species; NOx emissions are composed of NO, NO_2 and HONO; and SOx emissions are composed of SO_2 and SO_3. Emissions of TOG and PM for many sources can actually 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. ARB maintains and updates such species 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. Organic gases emitted to the atmosphere are referred to as Total Organic Gas or TOG. TOG includes all organic compounds that can become airborne (through evaporation, sublimation, as aerosols, etc.), excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates and ammonium carbonate. TOG emissions reported in the ARB'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 ARB'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 term ROG and VOC are interchangeable. Also, various regulatory uses of the term VOC, such as that for consumer products exclude specific, additional compounds from particular control requirements.

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 chemical code (a 5-digit ARB internal identifier). The speciation profiles are applied to TOG to develop both the photochemical model inputs and the emission inventory for ROG. It should be noted that districts are allowed to report their own reactive fraction of TOG that is used to calculate ROG rather than use the information from the assigned organic gas speciation profiles. These 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 profiles, which contain the total weight fraction for $PM_{2.5}$ and PM_{10} 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 $PM_{2.5}$, PM_{10} 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 organic gas profiles and PM profiles used in the emission inventory are available for download from the ARB's web site at: http://www.arb.ca.gov/ei/speciate/speciate.htm

Each process or product category is keyed to one of the OG profiles and one of the PM profiles. Also available for download from ARB's web site 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 organic gas 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 diesel particulate filter (DPF) requirements over time. Details can be found in ARB's documentation of heavy-duty diesel vehicle exhaust PM speciation profiles (ARB, 2011).

Research studies are conducted regularly to improve ARB's speciation profiles. These profiles support ozone and PM modeling studies but are also designed to be used for aerosol and regional toxics modeling. The profiles are also used to support other health or welfare related modeling studies where the compounds of interest cannot always be anticipated. Therefore, speciation profiles need to be as complete and accurate as possible. ARB has an ongoing effort to update speciation profiles as data become available, such as the testing of emission sources or surveys of product formulations. New speciation data generally undergo technical and peer review, and updating of the profiles is coordinated with users of the data. The recent addition to ARB's speciation profiles include:

(1) Organic gas profile

- 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

(2) PM profile

- Gasoline vehicle exhaust
- 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

3. Methodology for Developing Base Case and Baseline Emissions Inventories

As mentioned in Section 0, the base case and baseline inventories include temperature, humidity and solar insolation effects for some emission categories; development of these data is described in Sections 3.1 and 3.2. The remaining sections of Chapter 3 detail how the base case and baseline inventories were created for different sectors of the inventory, such as for point, area, on-road motor vehicles, biogenic and other day-specific sources.

3.1. Surface Temperature and Relative Humidity Fields

The calculation of gridded emissions for some categories of the emissions inventory is dependent on meteorological variables. More specifically, biogenic emissions are sensitive to air temperatures and solar radiation while emissions from on-road mobile sources are sensitive to air temperature and relative humidity. As a result, estimates of air temperature (T), relative humidity (RH), and solar radiation are needed for each grid cell in the modeling domain in order to take into account the effects of these meteorological variables.

Gridded temperature and humidity fields are readily available from prognostic meteorological models such as the Weather Research and Forecasting (WRF) model (http://www.wrf-model.org/index.php), which is used to prepare meteorological inputs for the air quality model. However, prognostic meteorological models can at times have difficulty capturing diurnal temperature extremes (Valade, 2009; Caldwell, 2009; Fovell, 2008). Since temperature and the corresponding relative humidity extremes can have an appreciable influence on some emissions categories, such as on-road mobile and biogenic sources, measurement based fields for these parameters are used in processing emissions. The CALMET (http://www.src.com/) diagnostic meteorological model is utilized to generate both the gridded temperature and relative humidity fields used in processing emissions. The solar radiation fields needed for biogenic emission inventory calculations were taken from the WRF prognostic model, which is also used to generate meteorology for the air quality model. The principal steps involved in generating a gridded, surface-level temperature field using CALMET include the following:

1. Compute the relative weights of each surface observation station to each grid cell (the weight is inversely proportional to the distance between the surface observation station and grid cell center).
2. Adjust all surface temperatures to sea level. In this step, a lapse rate of -0.0049 ^{o}C/m is used (this lapse rate is based on private communication with Gary Moore of Earth Tech, Inc., Concord, MA). This lapse rate (=2.7 F/1000 feet) is based on observational data.

3. Use the weights to compute a spatially-averaged sea-level temperature for each grid cell.
4. Correct all sea-level temperatures back to 10 m height above ground level (i.e. the standard height of surface temperature measurements) using the lapse rate of -0.0049 ^{o}C/m again.
5. The current version of CALMET does not generate estimates of relative humidity. As a result, a post-processing program was used to produce gridded, hourly relative humidity estimates from observed relative humidity data. The major steps needed to generate gridded, surface-level relative humidity are described as follows:
    a. Calculate actual vapor pressure from observed relative humidity and temperature at all meteorological stations. The (Mc. Rae, 1980) method is used to calculate the saturated vapor pressure from temperature;
    b. Compute the relative weights of each surface observation station to each grid in question, exactly as done by CALMET to compute the temperature field;
    c. Use the weights from step 2 to compute a spatially-averaged estimate of actual vapor pressure in each grid cell;
    d. For each grid cell, calculate relative humidity from values for actual vapor pressure and temperature for the same grid cell.

3.2. Insolation Effects

Insolation data was used in the estimation of the gridded emissions inventory and provided by the WRF meteorological fields as mentioned in Section 3.5.

3.3. 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 (Sparse Matrix Operator

Kernel Emissions) modeling system (https://www.cmascenter.org/smoke/). Improvements to SMOKE were recently implemented under ARB contract for version 4.0 of SMOKE (Baek, 2015).

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 4.1. 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 2.4, and emissions source cross-reference files used as inputs for SMOKE are developed by ARB staff. SMOKE uses the files for the chemical speciation of NOx, SOx, TOG and PM to species needed by photochemical air quality models.

Emissions for area sources are allocated to grid cells as defined by the modeling grid domain defined in Section 1.4. Emissions are spatially disaggregated by the use of spatial surrogates as described in Section 2.3. 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.

3.4. Estimation of On-road Motor Vehicle Emissions

The EMFAC emissions model is used by ARB to assess emissions from on-road vehicles including cars, trucks, and buses in California, and to support air quality planning efforts to meet the Federal Highway Administration's transportation planning requirements. EMFAC is designed to produce county-level, average-day estimates. As a result, these estimates must be disaggregated spatially and temporally into gridded, hourly estimates for air quality modeling.

The general methodology used to disaggregate EMFAC emission estimates is a two-step approach. The first step uses the Direct Travel Impact Model (DTIM4) (Systems Applications Inc., 2001) to produce gridded, hourly emission estimates. The second step distributes EMFAC emissions according to the spatiotemporal output from DTIM. This methodology has been peer reviewed by the Institute of Transportation Studies at the University of California, Irvine, under CCOS contract 11-4CCOS.

The spatiotemporal allocation of emissions from DTIM does not vary dramatically with small changes in meteorological data (T/RH), resulting in a negligible monthly variation of the spatial surrogate. However, differences in DTIM's winter versus summer spatiotemporal allocation are slightly appreciable. Therefore, spatial surrogates are created for a winter and a summer day.

The most recent version of EMFAC, EMFAC2014, has three separate modules that are relevant for the preparation of the on-road emissions gridded inventory: one that estimates emissions, one that estimates emission rates, and one that estimates activity data. The emissions module is run for every county and every day of the modeled year using day-specific temperature and relative humidity. On a less granular level, the emissions rates module is run for every county for a summer day and a winter day. Lastly, the activity module is run once to estimates vehicle miles traveled (VMT), number of vehicle trips, fuel consumption, and the number of vehicles in use.

3.4.1. General Methodology: Mobile source emissions are sensitive to ambient temperature and humidity. Both EMFAC and DTIM account for meteorological effects using day-specific inputs. For EMFAC, hourly gridded temperature and humidity fields are averaged by county using a gridded VMT weighted average (i.e. weighted proportional to the VMT per grid cell in a county). DTIM accepts gridded, hourly data directly (CALMET formatted data). See Section 3.1 for more information.

EMFAC provides vehicle-class-specific emissions estimates for: exhaust, evaporative, tire wear, and brake wear emissions. EMFAC also produces estimates of: VMT, number of vehicle trips, fuel consumption, and the number of vehicles in use. More information on EMFAC can be found at (ARB-MSEI, 2015) . The vehicle activity is the most important input for spatiotemporal distribution of emissions. DTIM uses hourly vehicle miles traveled on each highway link and each of the vehicle trips in the modeling domain. The detailed vehicle activity data is obtained from ARB's Integrated Transportation Network (dtiv3) database.

The overall processing of on-road emissions to create the gridded emissions inventory can be seen in Figure . Activity data from the ITN (see Section3.4.2) is developed for the thirteen EMFAC 2007 vehicle types, but activity is split for gas and diesel, resulting in a total of 26 vehicle types as shown in the block diagram. The forecasted on-road modeling inventories are developed using the same methodology as the baseline year, where future year emissions are based on running EMFAC 2014 in Emissions Mode for the associated future year.

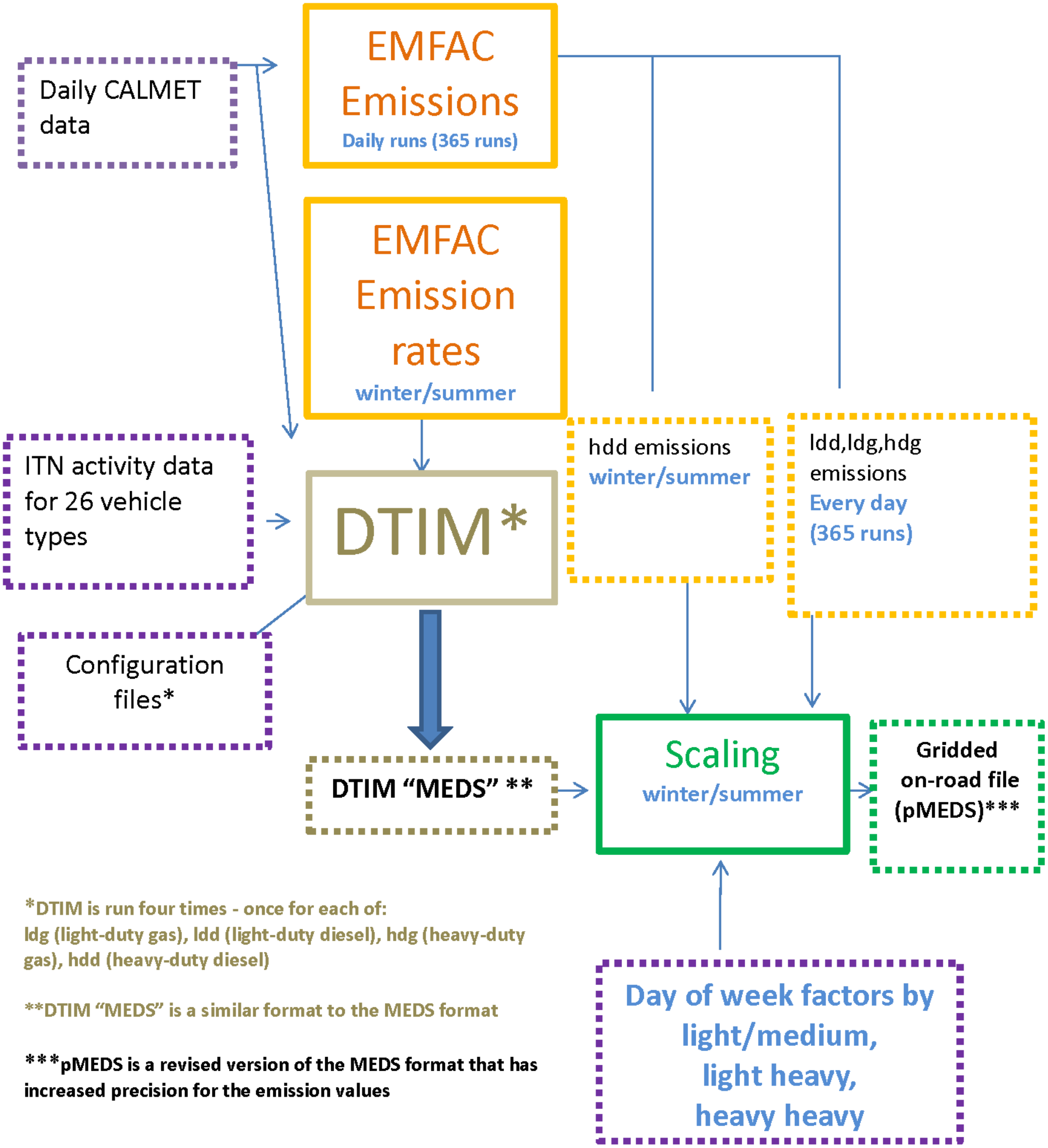


Figure 2 Block diagram for on-road processing

32

3.4.2. ITN Activity Data: The ITN is a database which is populated with link-based and Traffic Analysis Zone (TAZ)-based travel activity from travel demand models provided by different metropolitan planning organizations (MPOs), California Department of Transportation (Caltrans) and other California regional transportation planning agencies. The vintage and types of data used in the current version of the ITN are shown in Table 6. Different types of quality control parameters like vehicle mix, hourly distributions and post-mile coverage are obtained from default EMFAC and Caltrans databases. After these various pieces of data are imported to the database, the data can be examined for quality assurance. These input data sets are later moved into consolidated and geographically referenced master tables of link and TAZ activity data. Finally, these master tables are processed to produce hourly tables and hourly activity data input files for DTIM.

Table 6 Vintage of travel demand models for link based and traffic analysis zone

Metropolitan Planning Organizations	TDM Version Base year	Data types received	Data received on
AMBAG	2010	Links, Trips	06/15/2015
BCAG	2010	Links, Trips	05/13/2015
FCOG	2008	Links†	06/11/2015
CALTRANS	2010	Links, Trips	12/09/2014
KCOG	2010	Links†	06/11/2015
KCAG	2010	Links†	06/11/2015
MTC	2010	Links, Trips	03/23/2015
MCTC	2010	Links†	06/11/2015
MCAG	2010	Links, Trips	06/11/2015
SACOG	2010	Links, Trips	05/08/2014
SANDAG	2008	Links, Trips	12/09/2014
SBCAG	2010	Links, Trips	04/06/2015
SCAG	2008	Links, Trips	01/23/2014
SJCOG	2010	Links, Trips	06/11/2015
SLOCOG	2010	Links, Trips	12/19/2014
StanCOG	2010	Links, Trips	06/11/2015
SCRTPA	2010	Links, Trips	07/13/2015
TCAG	2010	Links†	06/11/2015
TMPO	2010	Links, Trips	04/02/2015

† Trips data from Caltrans Statewide Travel Demand model were used

3.4.3. Spatial Adjustment: The spatial allocation of county-wide EMFAC emissions is accomplished using gridded, hourly emission estimates from DTIM normalized by county. DTIM uses emission rates from EMFAC along with activity data, digitized roadway segments (links) and traffic analysis zone centroids to calculate gridded, hourly emissions for travel and trip ends. DTIM considers fewer vehicle categories than EMFAC outputs; therefore a mapping between EMFAC and DTIM vehicle categories is necessary. Categories of emissions after running DTIM are presented in Table 7. The categories are represented by the listed source classification codes (SCC) developed by ARB and depend on vehicle type, technology, and whether the vehicle is catalyst, non-catalyst, or diesel. Light- and medium-duty vehicles are separated from heavy-duty vehicles to allow for separate reporting and control strategy applications.

Table 7 DTIM Emission Categories

SCC for light and medium duty gas vehicles	SCC for heavy-duty gas vehicles	SCC for light-duty and medium-duty diesel vehicles	SCC for heavy-duty diesel vehicles	Description
202	302			Catalyst Start Exhaust
203	303			Catalyst Running Exhaust
204	304			Non-catalyst Start
205	305			Non-catalyst Running
206	306			Hot Soak
207	307			Diurnal Evaporatives
		808	408, 508	Diesel Exhaust
209	309			Running Evaporatives
210	310			Resting Evaporatives
211	311			Multi-Day Resting
212	312			Multi-Day Diurnal
213	313	813	413, 513, 613,	PM Tire Wear
214	314	814	414, 514, 614,	PM Brake Wear
215	315			Catalyst Buses
216	316			Non-catalyst Buses
		817	617, 717	Diesel Bus
218	318			Catalyst Idle
219	319			Non-catalyst Idle
		820	420, 520, 620,	Diesel Idle
221	321			PM Road Dust

DTIM and EMFAC2014 are both run using the 13 vehicle types shown in Table 8. In order to obtain better resolved spatiotemporal surrogates, the DTIM runs are split by light-duty (LDA, LDT1, LDT2, MDV, LHDT1, LHDT2, Urban Bus, MH, MCY) and heavy-duty (T6/T7 HHDT, SBUS, Other BUS) vehicle classes, and also by fuel type (gas, diesel). Each DTIM run outputs emissions for categories from 1-13; therefore, the mapping from Table 8 is used to preserve the spatial surrogates for each of the four DTIM runs. These codes depend on vehicle type, technology, and whether the vehicle is catalyst, non-catalyst, or diesel.

Table 8 Vehicle classification and type of adjustment

DTIM Category	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
9	Other Bus	LM
10	School Bus	Unadjusted on weekdays, zeroed on weekends
11	Urban Bus	LD
12	Motorhomes	LD
13	Motorcycles	LD

3.4.4. Temporal Adjustment (Day-of-Week adjustments to EMFAC daily totals): EMFAC2014 produces average day-of-week (DOW) estimates that represent Tuesday, Wednesday, and Thursday. In order to more accurately represent daily emissions, 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 ARB, is a system that fuses available data sources to produce a “best estimate” of vehicle activity by class. 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. In order to fill the missing 24 counties' data to cover all of California, a county which is nearby and similar in geography is selected for 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). Table 8 also 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 work day. 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 week day. 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.

3.4.5. Temporal Adjustment (Hour-of-Day re-distribution of hourly travel network volumes): The travel networks provided by local transportation agencies and used with DTIM represent an hourly distribution for an average day. As for EMFAC, it is assumed that these average day-of-week hourly distributions represent hourly mid-week activities (i.e. for Tuesday, Wednesday, and Thursday). As such, they lack the temporal variations that are known to occur on other days of the week. To rectify this, the CalVAD data were used to develop hour-of-day profiles for Friday through Monday and a typical holiday. In a similar manner as the DOW factors, these hour-of-day profiles are used to re-allocate the hourly travel network distributions used in DTIM to Friday through Monday and a typical holiday. The hour-of-day profiles can be found in Appendix B: Hour of Day Profiles by vehicle type and county.

3.4.6. Summary of On-road Emissions Processing Steps: Eight general steps are used to spatially and temporally allocate EMFAC emissions by hour and grid cell:

1. Activity Data
   a. EMFAC is run in default mode for a single day to generate hourly activity data for each vehicle type and county: VMT, vehicle population, and number of vehicle trips. This is a single day's run, as EMFAC2014 yields the same hourly activity data for every day of the year.
   b. The activity data are used to generate various input files for ITN and DTIM, the general goal being to determine how much each activity belongs to each vehicle type through the day.

2. Road Network
   a. Pull a full copy of the California road network from the ITN database, using MPO inputs.
   b. Convert the ITN results to a form readable by DTIM.
   c. Apply travel network volumes by county hourly DOW fractions.

3. Meteorological Input Data
   a. Gridded, hourly temperature (T) and relative humidity (RH) are modeled using CALMET. Section 3.1 describes the development of these meteorological (met) data in more detail.
   b. Daily met files are prepared in formats readable by both EMFAC2014 and DTIM4.

4. EMFAC Emission Rates
    a. EMFAC is run in emissions rates mode (using monthly-average T and RH) to generate a look-up table of on-road mobile source emission rates by speed, temperature, and relative humidity for each county. These results are created on a monthly-average basis to save processing time.
    b. The emissions rates are pulled from the EMFAC database and reformatted in the DTIM-ready IRS file format.

5. EMFAC Emissions
    a. EMFAC is run in emissions mode (using day-specific T and RH) to provide county-wide on-road mobile source emission estimates by day and hour for EMFAC categories.
    b. These results are saved for later use.

6. DTIM
    a. DTIM is run for one week (five representative days since Tuesday, Wednesday and Thursday are treated as a single day) and one holiday in the summer and in the winter.
    b. Convert the DTIM output results into MEDS format for further processing.

More details on the DTIM and scaling processing can be found in the Appendix C.

7. Scale EMFAC Emissions Using DTIM
    a. For each day of EMFAC emissions, the closest day-of-week matching DTIM file is chosen for scaling.
    b. The daily, county-wide EMFAC emissions are distributed spatially and temporally using the DTIM MEDS files as surrogates, as shown by the equation:

$$E_{P,ij,hr,cat} = \frac{EF_{P,cat} \times DTIM_{P,ij,hr,cat}}{DTIM_{P,daily,cat,cnty}}$$

where:

E = grid cell emissions
EF = EMFAC emissions
DTIM = DTIM emissions
p = pollutant
i,j = grid cell
hr = hourly emissions
cat = emission category
daily = daily emissions
cnty = county

c. Finally, the Caltrans day-of-week factors are applied to the gridded, hourly emissions to better match traffic patterns.

8. Final Formatting
   a. The final step of on-road emissions processing is to convert the gridded, hourly emissions data to a NetCDF file usable by the CMAQ photochemical model.

3.5. Estimation of Gridded Biogenic Emissions

Biogenic emissions were estimated using the Model of Emissions of Gases and Aerosols from Nature (MEGAN) version 2.04 (Guenther, et al., 2006). MEGAN estimates biogenic emissions as a function of normalized emission rates (i.e. emission rates at standard conditions), which are adjusted to reflect variations in temperature, light, leaf area index (LAI), and leaf age (estimated from changes in LAI). The default MEGAN input databases for emission factors (EFs), plant functional types (PFTs), and LAI are not used in the application of MEGAN in California. Instead, California-specific emission factor and PFT databases were translated from those used in the Biogenic Emission Inventory GIS (BEIGIS) system (Scott & Benjamin, 2003) to improve emission estimates and to maintain consistency with previous California biogenic emission inventories. LAI data were derived from the MODIS 8-day LAI satellite product. Hourly surface temperatures were from observations gridded with the CALMET meteorological model and insolation data was provided by the WRF meteorological fields, as discussed in Section 3.1. Emissions of isoprene, monoterpenes, and methylbutenol were estimated from California-specific gridded emission factor data, while emissions of sesquiterpenes, methanol, and other volatile organic compounds were estimated from California-specific PFT data and PFT-derived emission rates.

MEGAN emissions estimates for California were evaluated during the California Airborne BVOC Emission Research in Natural Ecosystems Transects (CABERNET) field campaign in 2011 (Karl, et al., 2013), (Misztal, et al., 2014) and were shown to agree to within +/-20% of the measured fluxes (Misztal, et al., 2015), which is well within the stated model uncertainty of 50%.

3.6. Estimation of Other Day-Specific Sources

Day-specific data were used for preparing base case inventories when data were available. ARB and district staffs were able to gather hourly/daily emission information for 1) wildfires and prescribed burns 2) paved and unpaved road dust 3) agricultural burns in six districts and 4) a refinery fire. Additionally, emissions in future years were removed for facilities that have closed after 2012.

For the reference and future year inventories, which are used to calculate Relative Response Factors (RRFs), day-specific emissions for wildfires, prescribed burns, wildland fires use (WFU) and the Chevron fire are left out of the inventory. All other day-specific data are included in both reference and future year modeling inventories.

3.6.1. 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, first described in (Clinton, et al., 2006). A series of pre-processing steps were performed using a Geographic Information System (GIS) to develop fuel loading and fuel moisture inputs to the First Order Fire Effects (FOFEM) fire emission model (Lutes, et al., 2012). Polygons from a statewide interagency fire perimeters geodatabase (fire12_1.gdb, downloaded June 4, 2013) maintained by the Fire and Resource Assessment Program (FRAP) of the California Department of Forestry and Fire Protection (CALFIRE) 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, et al., 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

41

pollutant species (NH_3, TNMHC and N_2O) in addition to the seven species native to FOFEM (CO, CO_2, $PM_{2.5}$, PM_{10}, CH_4, NO_x, SO_2), and to calculate total emissions (tons) by pollutant species for each fire. Emission estimates for NH_3, TNMHC and N_2O were based on mass ratios to emitted CO and CO_2 (Gong, et al., 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.

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. Daily emissions were then allocated to hour of day and to the model grid cells and distributed vertically using a method developed by the Western Regional Air Partnership (WRAP), which specifies a pre-defined diurnal temporal profile, plume bottom and plume top for each fire. (WRAP, 2005)

3.6.2. Paved Road Dust: Statewide emissions from paved road dust were adjusted for each day of the baseline year. The adjustment reduced emissions by 25% from paved road dust on days when precipitation occurred. Paved road dust emissions are calculated using the AP-42 method described in (U.S. EPA, 2011).

This methodology includes equations that adjust emissions based on average precipitation in a month; these precipitation-adjusted emissions were placed in the CEIDARS and CEPAM databases. Since daily precipitation totals are readily available, ARB and district staff agreed that paved road dust emissions should be estimated for each day rather than by month as described in the AP-42 methodology. The emissions from CEIDARS were replaced with day-specific data. A description of the steps used to calculate day-specific emissions is as follows:

Daily uncontrolled emissions for each county/air basin are estimated from the AP-42 methodology [Equation (1) on page 13.2.1-4]. No monthly precipitation adjustments are incorporated into the equation to estimate emissions.

To adjust for precipitation, daily precipitation data for 2013 were provided by an in-house database maintained by ARB staff that stores collected meteorology data 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, SFBMET (a meteorological database maintained by the Bay Area Air Quality Management District), and Federal Aviation Administration (FAA). FAA data provide precipitation data collected from airports in California.

If the precipitation is greater than or equal to 0.01 inches (measured anywhere in a county or county/air basin piece on a particular day), then the uncontrolled emissions are reduced by 25% for that day only. This reduction of emissions follows the recommendation in AP-42 as referenced above.

Replace the annual average emissions with day-specific emissions for every day in the corresponding emission inventory dataset.

3.6.3. Unpaved Road Dust: Statewide emissions from unpaved road dust were adjusted for rainfall suppression for each day of the year. The adjustment reduced county-wide emissions by 100% (total suppression) from unpaved road dust on days when precipitation greater than 0.01” occurred in a county/air basin. Dust emissions from unpaved roads were calculated using an emission factor derived from tests conducted by the University of California, Davis, and the Desert Research Institute (DRI). Unpaved road vehicle miles traveled (VMT) were based on county-specific road mileage estimates.

Emissions were assumed to be suppressed for each day with rainfall of 0.01 inch or greater using equation (2) from the method described in (U.S. EPA, 2011). The equation adjusts emissions based on annual precipitation; these precipitation-adjusted emissions were placed in the CEIDARS database. Similar to paved road dust, ARB and district staff agreed that unpaved road dust emissions should be estimated for each day. The emissions from CEIDARS were replaced with day-specific data for the appropriate years. Following is a description of the steps that were taken to calculate day-specific emissions.

a) Start with the daily uncontrolled emissions for each county/air basin as estimated from ARB's methodology. In other words, no precipitation adjustments have been incorporated in the emission estimates.
b) Use the same daily precipitation data as for paved road dust (see above)
c) If the precipitation is greater than or equal to 0.01 inches measured anywhere in a county or county/air basin portion on a particular day, then the emissions are removed for that day only.
d) Replace the annual average emissions with day-specific emissions for every day.

3.6.4. Agricultural Burning: Agricultural burning day-specific emission estimations were incorporated into the inventory for the following areas:

San Joaquin Valley

The San Joaquin Valley Air Pollution Control District estimated emissions for each day of 2012 when agricultural burning occurred. Emissions were estimated for the burning of prunings, field crops, weed abatement and other solid fuels. Information needed to estimate emissions came from the district's

Smoke Management System, which stores information on burn permits issued by the district. In order to obtain a daily burn authorization, the person requesting the burn provides information to the district, including the acres and type of material to be burned, the specific location of the burn and the date of the burn. Acres are converted to tons of fuel burned using a fuel loading factor based on the specific crop to be burned. Emissions are calculated by multiplying the tons of fuel burned by a crop-specific emission factor. More information can be found in (ARB-Miscellaneous Methodologies, 2013).

To determine the location of the burn, district staff created spatial allocation factors for each 4 kilometer grid cell used in modeling. These factors were developed for “burn zones” in the San Joaquin Valley based on the agricultural land coverage. Daily emissions in each “agricultural burn zone” were then distributed across the zone/grid cell combinations using the spatial allocation factors. Emissions were summarized by grid cell and day.

Burning was assumed to occur over three hours from 10:00 a.m. to 1:00 p.m., except for two categories. Orchard removals were assumed to burn over eight hours from 10:00 a.m. to 6:00 p.m. Vineyard removals were assumed to burn over five hours from 10:00 a.m. to 3:00 p.m.

Sacramento

Sacramento Metropolitan Air Quality Management District provided information needed to calculate emissions in Sacramento County from agricultural burning for each day of 2012 when agricultural burning occurred. Using the same methodology as San Joaquin Valley, emissions were estimated for the burning of prunings, field crops, weed abatement and other solid fuels. Information needed to estimate emissions came from burn permits issued by the district. In order to obtain a burn permit, the person requesting the burn provides information to the district, including the acres to be burned, the specific location of the burn and the date of the burn. Acres are converted to tons of fuel burned using a fuel loading factor based on the specific crop to be burned. Emissions are calculated by multiplying the tons of fuel burned by a crop-specific emission factor. The location of the burn was converted to latitude/longitude based on the address or description of location provided by the burn permit holder, then ultimately to grid cell. Burning was assumed to occur over eight hours from 10:00 a.m. to 6:00 p.m.

Yolo-Solano

Yolo-Solano Air Quality Management District provided information needed to calculate emissions from agricultural burning for each day of 2012 when agricultural burning occurred. Data were provided for their region: all of Yolo County and the Sacramento Valley portion of Solano County. Using the same methodology as San Joaquin Valley, emissions were estimated for the burning of prunings, field crops, weed abatement and range improvement. The location of the burn was converted to latitude/longitude based on the address or description of location provided by the burn permit holder, then ultimately to grid cell. Burning was assumed to occur over five hours from 11:00 a.m. to 4:00 p.m.

Feather River

Feather River Air Quality Management District provided information needed to calculate emissions from agricultural and prescribed burning for each day of 2012 when agricultural burning occurred. Data were provided for Sutter and Yuba Counties. Using the same methodology as San Joaquin Valley, emissions were estimated for the burning of prunings, field crops, weed abatement and other solid waste. The location of each burn was converted to latitude/longitude based on the address or description of location provided by the burn permit holder, then ultimately to grid cell. Orchard prunings were assumed to occur from 9:00 a.m. to 4:00 p.m. The burning of field crops, rice, weeds and ditch banks were assumed to occur from 10:00 a.m. to 5:00 p.m. from March 1 through August 31 and from 10:00 a.m. to 4:00 p.m. from September 1 through February 29. Prescribed burns over 10 acres were assumed to occur from 9:00 a.m. to 12:00 a.m. while prescribed burns less than 10 acres were assumed to occur from 9:00 a.m. to 6:00 p.m.

Ventura

Ventura County Air Pollution Control District provided emissions in Ventura County from agricultural burning for each day of 2012 when agricultural burning occurred. Using the same methodology as San Joaquin Valley, emissions were estimated for the burning of prunings, field crops, weed abatement, range improvement and prescribed burns not included in the wildfires / prescribed burns discussed in the San Joaquin Valley portion of Section 3.6.4. Information needed to estimate emissions came from burn permits issued by the district. In order to obtain a burn permit, the person requesting the burn provides information to the district, including the acres to be burned, the specific location of the burn and the date of the burn. Acres are converted to tons of fuel burned using a fuel loading factor based on the specific crop to be burned. Emissions are calculated by multiplying the tons of fuel burned by a crop-specific emission factor. The location of the burn was converted to latitude/longitude based on the address or description of location provided by the burn permit holder, then ultimately to grid cell. Burning was assumed to occur over three hours from 9:00 a.m. to 12:00 p.m.

Imperial

Imperial County Air Pollution Control District provided information needed to calculate emissions from agricultural and prescribed burning for each day of 2012 when agricultural burning occurred. Using the same methodology as

San Joaquin Valley, emissions were estimated for the burning of field crops and weed abatement. The location of each burn was converted to latitude/longitude based on the nearest crossroads provided by the burn permit holder, then ultimately to grid cell. Burning was assumed to occur over four hours from 11:00 a.m. to 3:00 p.m.

3.6.5. Refinery Fire: On August 6, 2012, the Chevron U.S.A Inc. refinery in Richmond experienced a catastrophic pipe rupture. The flammable, high temperature gas oil flowing through the pipe ignited shortly after the release and burned for approximately 5 hours. Flaring also occurred for four days from August 6 through August 10. Bay Area Air Quality Management District (BAAQMD) staff estimated NOx and SOx emissions from both the fire and flaring; TOG emissions from flaring were also estimated. The emissions were spread evenly across the hours they occurred.

Additionally, stack data were estimated by the BAAQMD. Based on physical observation of the plume height, the first two hours of the fire were estimated to have the highest gas flow rate used in the calculation of plume rise. The gas flow rate was reduced for the latter three hours of the fire.

3.6.6. Closed Facilities: Emissions in future years were removed for facilities that have closed beyond the baseline year. In other words, the emissions were removed from future year inventories for a facility that was included in the 2012 inventory but stopped operating after 2012. Local air district staffs provided the lists of facilities.

4. Quality Assurance of Modeling Inventories

As mentioned in Section 1.3, base case modeling is intended to demonstrate confidence in the modeling system. Quality assurance of the data is fundamental in order to detect any possible outliers and potential problems with emission estimates. The most important quality assurance checks of the modeling emissions inventory are summarized in the following sections.

4.1. Area and Point Sources

Before utilizing SMOKE to process the annual emissions totals into temporally, chemically, and spatially-resolved emissions inventories for photochemical modeling, all SMOKE inputs are subject to extensive quality assurance procedures performed by ARB staff. Annual and forecasted emissions are carefully reviewed before input into SMOKE. ARB and district staff review data used to calculate emissions along with other associated data, such as the location of facilities and assignment of SCC to each process. Growth and control information are reviewed and updated as needed.

The next check is to 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 is developed by month. Both inventory types use the same temporal data described in Section 2.2. 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 a weekday, Saturday and Sunday for each month.

Annual emissions totals are plotted using the same gridding inputs as used in SMOKE in order to visually inspect and analyze the spatial allocation of emissions independent of temporal allocation and chemical speciation. Spatial plots by source category like the one shown in Figure 3 are carefully screened for proper spatial distribution of emissions.

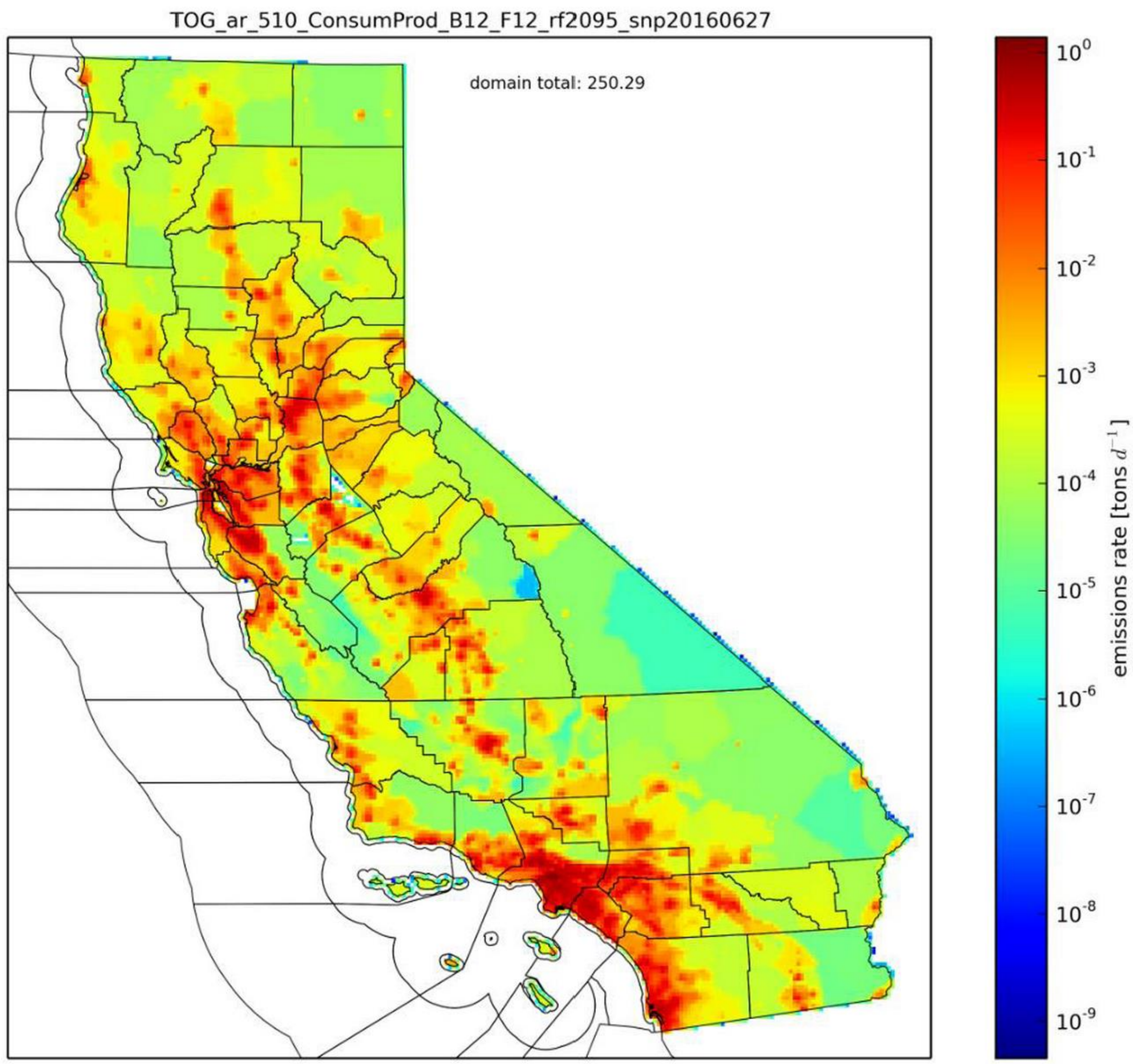


Figure 3 Example of a spatial plot by source category

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. ARB staff utilize the SMOKE reports by checking emissions totals by source category and region, creating and analyzing time series plots, and comparing aggregate emissions totals with the pre-SMOKE emissions totals obtained from CEPAM. A screenshot capture of a portion of such report can be seen in Figure 4.

```
# Processed as Area sources
# Base inventory year      2012
# No gridding matrix applied
# No speciation matrix applied
# Temporal factors applied for episode from
#      Wednesday Aug. 8, 2012   at 080000 to
#      Thursday Aug. 9, 2012   at 080000
# Annual total data basis in report
#          ,              ,                      , [tons/day]    , [tons/day]    , [tons/day]    , [tons/day]    , [tons/day]    , [tons/day]
#Date      , Region       , SCC                  , CO            , NOX           , TOG           , NH3           , SOX           , PM
 08/09/2012, 0LC006017LAK, 00000005204212000010,   0.19098E-01,   0.46288E-01,   0.44956E-02,   0.00000E+00,   0.16055E-03,   0.16051E-02
 08/09/2012, 0LC006017LAK, 00000005204212000011,   0.94908E-02,   0.21052E-01,   0.30532E-02,   0.00000E+00,   0.00000E+00,   0.11252E-02
 08/09/2012, 0LC006017LAK, 00000011011003000000,   0.00000E+00,   0.00000E+00,   0.00000E+00,   0.63987E-03,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000012012202420000,   0.00000E+00,   0.00000E+00,   0.00000E+00,   0.29915E-01,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000019917002400000,   0.00000E+00,   0.00000E+00,   0.00000E+00,   0.13904E-01,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000021020033000000,   0.00000E+00,   0.00000E+00,   0.13736E-01,   0.00000E+00,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000021020081500000,   0.00000E+00,   0.00000E+00,   0.31439E-02,   0.00000E+00,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000022020405000000,   0.00000E+00,   0.00000E+00,   0.31245E-01,   0.00000E+00,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000022020430220000,   0.00000E+00,   0.00000E+00,   0.72951E-03,   0.00000E+00,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000022020430830000,   0.00000E+00,   0.00000E+00,   0.36475E-03,   0.00000E+00,   0.00000E+00,   0.00000E+00
 08/09/2012, 0LC006017LAK, 00000022020432040000,   0.00000E+00,   0.00000E+00,   0.36475E-03,   0.00000E+00,   0.00000E+00,   0.00000E+00
```

Figure 4 Screen capture of a SMOKE-generated QA report

4.1.1. Area and Point Sources Temporal Profiles: 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. For the agricultural source sector (e.g. agricultural pesticides/fertilizers, farming operations, fugitive windblown dust, managed burning and disposal, and farm equipment), replacement temporal assignments are extracted from the Agricultural Emissions Temporal and Spatial Allocation Tool (AgTool). (Anderson, et al., 2012). The AgTool is a database management system capable of temporally and spatially allocating emissions from the agricultural source sector. It was developed by Sierra Research, Inc. and its subcontractor Alpine Geophysics, LLC along with collaboration from ARB and the San Joaquin Valley Air Pollution Control District (SJVAPCD). Temporal allocation data outputs from the AgTool, were compiled using input data provided by the UC Cooperative Extension, U.S. Department of Agriculture (USDA), and the CA Department of Pesticide Regulation (DPR).

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

4.2. 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:

1. Generate an ITN spatial plot to check if there were any missing network activities.
2. Generate a time series plot for each county to check the diurnal pattern of network activities.
3. Generate time series plots for the DTIM output files by county and by SCC to check the diurnal pattern.
4. Generate time series plots for the on-road mobile source files after scaling to EMFAC 2014 emissions (MEDS files) by county and SCC to check the diurnal pattern.
5. Compare the statewide daily total emissions for the MEDS files and the EMFAC 2014 emissions files to ensure that the emissions are the same.
6. Generate the spatial plot for the MEDS file to check if there were any missing emissions.
7. Generate time series and spatial plots again to check the final MEDS files.

4.3. Day-specific Sources

4.3.1. Wildfires and Prescribed Burns: To check for potential wildfire activity data gaps in the CALFIRE interagency fire perimeters geodatabase, staff examined geospatial fire activity data reported in the national Geospatial Multi-Agency Coordination (www.geomac.gov) wildland fire geodatabase. California wildfires reported to GeoMAC were accounted for in the CALFIRE geodatabase.

Prescribed burns are performed by land and fire management agencies primarily to reduce wildfire risk to local communities associated with high loads of vegetation fuels in adjacent wildlands. Vegetation is burned during winter, in-situ or in piles following mechanical treatment. Public land management agencies also perform prescribed burning to restore the natural role of fire in selected ecosystems. To check for potential prescribed burn activity data gaps in the CALFIRE interagency fire perimeters geodatabase, staff queried data for calendar year 2012 reported to ARB's Prescribed Fire Information Reporting System (PFIRS) (https://ssl.arb.ca.gov/pfirs/index.php). Staff discovered that CALFIRE data accounted for 38 prescribed burn projects, while PFIRS reported 453 projects. Only one burn project was accounted for in both datasets. Burn project area for CALFIRE data totaled approximately 3,780 acres, while burned acres reported to PFIRS totaled 9,097 acres. Burn projects reported to PFIRS were located in the Sierra Nevada Mountains and northern Coast Range.

Records for 651 prescribed wildland burn events reported for 2012 were downloaded from PFIRS and imported to a geodatabase. Data fields included event ("Unit") name, burned area, latitude/longitude, start and end dates. A series of geoprocessing steps were used to map and overlay prescribed burns as points on the statewide vegetation fuels (FCCS) and moisture raster datasets, to retrieve associated fuel loadings and moisture values for use as input to FOFEM. Prescribed burn points were also overlayed on the statewide 4-km modeling grid to assign grid cell IDs to each burn. Emission estimates for each prescribed burn event were generated by FOFEM and summarized in an Access database.

4.3.2. Paved Road Dust: The average daily emissions inventory was adjusted with day-specific precipitation data to produce a day-specific emissions inventory. Total emissions by county before the adjustment were compared to CEPAM for a reasonable match. After the adjustment, the day-specific total emissions by county were compared to CEPAM using time series plots. These plots were verified to confirm that there were only two values for every county/air basin/district: high values and low values. The high values are emissions that were not affected by rain adjustment, while the low values are emissions that were affected by the 25% rain adjustment reduction. Additionally the day-specific total was also compared to other inventory years to verify the expected growth trend.

4.3.3. Unpaved Road Dust: Unpaved road dust followed the same quality assurance process as paved road dust, except that total removal rather than 25% reduction is applied whenever precipitation is greater than 0.01”.

4.3.4. 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 reasonableness. Time series plots were reviewed for each county to see 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 MEDS files to make sure the calculations were done correctly. Spatial plots were made to double check the locations of each burn.

4.3.5. Refinery Fire: The calculations in the MEDS files were verified by hand to make sure the emissions and stack data matched what was provided by the BAAQMD.

4.4. Additional QA

In addition to the QA 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 3.4; since weekend travel is generally less than weekday travel, modeling inventory emissions are usually lower when compared to annual average inventories from CEPAM. Figure 5 provides a screen capture of a report that summarizes different emission categories for San Luis Obispo County. Please note that this table is only an example since emissions have been updated from what is displayed here.

County:***40*** Spec:***NOx***

EIC	Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	CEPAM	Difference
10	electric utilities	0.12	0.11	0.1	0.06	0.09	0.13	0.13	0.16	0.14	0.16	0.14	0.13	0.12	0.12	0.00
20	cogeneration	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.00
30	oil and gas production (combustion)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.00
40	petroleum refining (combustion)	0.3	0.3	0.26	0.3	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.26	0.31	0.31	0.00
50	manufacturing and industrial	0.06	0.06	0.06	0.06	0.07	0.06	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.00
52	food and agricultural processing	0.19	0.19	0.19	0.34	0.34	0.34	0.38	0.38	0.38	0.18	0.18	0.18	0.27	0.27	0.00
60	service and commercial	0.91	0.92	0.92	0.92	0.92	0.9	0.9	0.91	0.91	0.91	0.92	0.91	0.91	0.91	0.00
99	other (fuel combustion)	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	0.00
110	sewage treatment	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
120	landfills	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
130	incinerators	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
140	soil remediation	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
199	other (waste disposal)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
210	laundering	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
220	degreasing	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
230	coatings and related process solvents	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
240	printing	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
250	adhesives and sealants	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
299	other (cleaning and surface coatings)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
310	oil and gas production	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
320	petroleum refining	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	0.00
330	petroleum marketing	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
399	other (petroleum production and marketing)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
410	chemical	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
420	food and agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
430	mineral processes	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.04	0.00
440	metal processes	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
450	wood and paper	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
460	glass and related products	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
470	electronics	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
499	other (industrial processes)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
510	consumer products	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
520	architectural coatings and related process sol	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
530	pesticides/fertilizers	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
540	asphalt paving / roofing	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
610	residential fuel combustion	0.73	0.73	0.68	0.65	0.57	0.57	0.57	0.57	0.57	0.65	0.7	0.73	0.64	0.64	0.00
620	farming operations	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
630	construction and demolition	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
640	paved road dust	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
645	unpaved road dust	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
650	fugitive windblown dust	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
660	fires	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
670	managed burning and disposal	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	0.00
690	cooking	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
699	other (miscellaneous processes)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
700	on-road vehicles	9.34	9.32	9.36	9.17	9.06	8.81	8.69	8.77	8.63	8.79	9.3	9.23	9.04	9.60	0.56
810	aircraft	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	0.00
820	trains	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.93	0.74
830	ships and commercial boats	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
833	ocean going vessels	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.23	11.52	0.29
835	commercial harbor craft	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	0.83	-0.29
840	recreational boats	0.05	0.05	0.17	0.18	0.16	0.47	0.46	0.43	0.12	0.11	0.11	0.06	0.2	0.20	0.00
850	off-road recreational vehicles	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.04	0.00
860	off-road equipment	1.08	1.24	1.21	1.24	1.25	1.28	1.25	1.25	1.28	1.21	1.19	1.12	1.21	1.21	0.00
870	farm equipment	1.08	1.22	1.72	1.77	2.21	2.21	2.16	2.21	2.17	1.52	1.14	1.06	1.71	1.71	0.00
890	fuel storage and handling	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
920	geogenic sources	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
***	Total	26.78	27.05	27.59	27.61	27.93	28.05	27.88	28.01	27.55	26.87	27.01	26.67	27.42	28.73	1.31

Notes:
CEPAM refers to annual average emissions from 2016 SIP Baseline Emission Inventory Tool with external adjustments: http://outapp.arb.ca.gov/cefs/2016oz
Monthly gridded emissions comes from GeoVAST mo-yr/avg tabular summary - gid 319

On-road vehicles: The modeling inventory adjusts on-road by day of week as well as day-specific temperatures and relative humidity - Fridays are higher wit
time series plots shows weekdays are ~9-10 tpd
Trains: The modeling inventory reflects the revised locomotive emissions; the planning inventory reflects the previous emission estimates
OGV model produces gridded OGV emissions, which can vary from planning inventory (these emissions include OC1 and OC2 offshore air basins)
CHC The modeling inventory reflects the revised commercial harbor craft emissions; the planning inventory reflects the previous emission estimates

Figure 5 Screenshot of comparison of inventories report

Staff also review how modeling emissions vary over a year. Figure 6 provides an example of a modeling inventory time series plot for San Luis Obispo County for area-wide sources, on-road sources and off-road sources. Again, this figure is <u>only an example</u>.

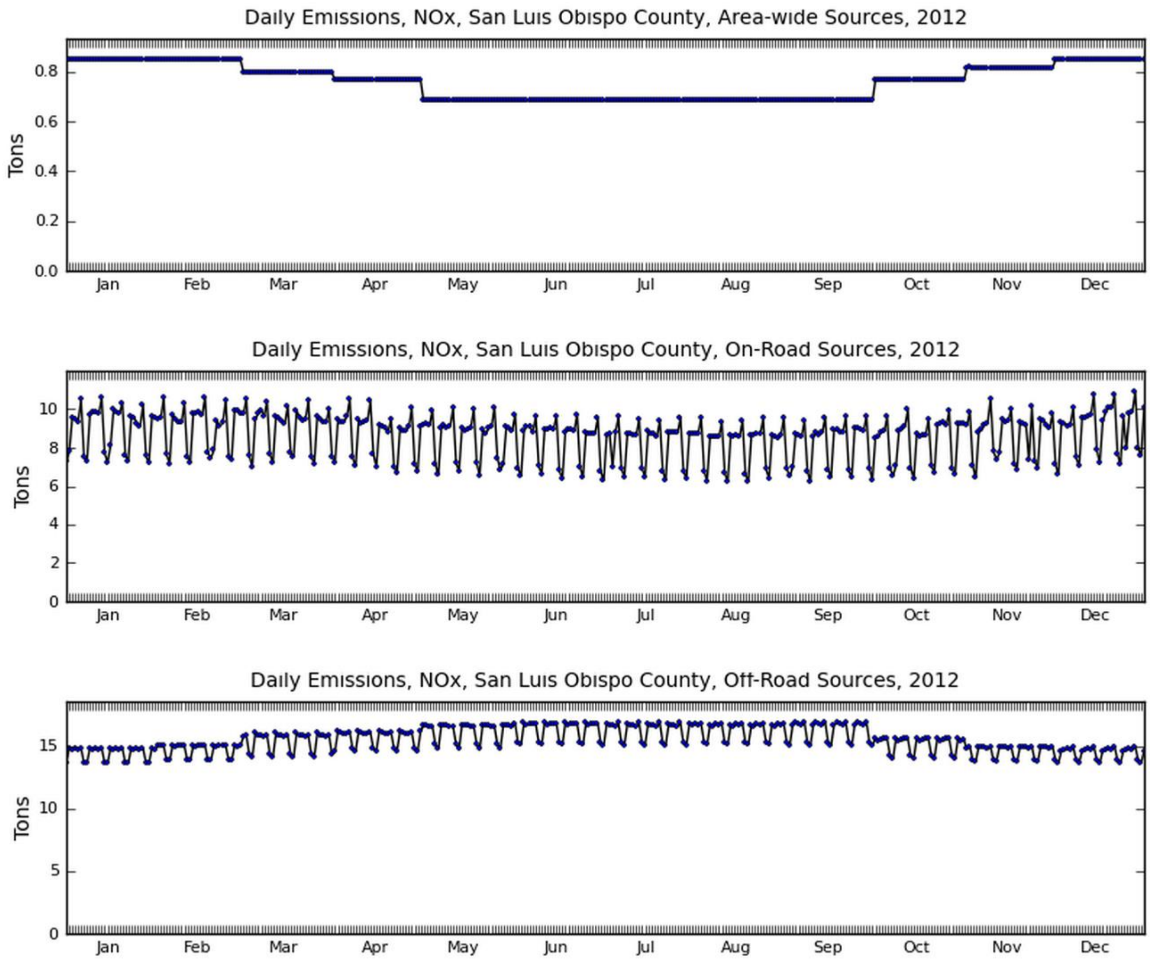


Figure 6 Daily variation of NOx emissions for mobile sources for San Luis Obispo

4.5. Model ready files QA

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 ARB staff on the intermediate emissions files (e.g. MEDS, 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.

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. Day-specific source inventories (when necessary) should have emissions for every day in the modeling period. Likewise, source inventories with emissions files that use averaged temporal allocation (e.g. day-of-week, weekday/weekend, monthly) should have model-ready emissions files to represent every day in the modeling period. In particular, 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 what each daily model-ready emissions file is comprised of as an additional means of verifying that each daily model-ready inventory is complete.

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Appendix A: Day of week redistribution factors by vehicle type and county

The factors shown in Table 9 represent the "day of week" factors 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.

Table 9 Day of week adjustment by vehicle class and county

County	Day of Week	LD	LM	HH
Alameda	Sunday	0.797	0.496	0.324
Alameda	Monday	0.948	0.919	0.893
Alameda	Tues/Wed/Thurs	1	1	1
Alameda	Friday	1.051	1.014	0.959
Alameda	Saturday	0.929	0.618	0.369
Alameda	Holiday	0.797	0.866	0.829
Alpine	Sunday	1.201	0.821	0.415
Alpine	Monday	1.007	0.945	0.908
Alpine	Tues/Wed/Thurs	1	1	1
Alpine	Friday	1.247	1.082	1.007
Alpine	Saturday	1.219	0.803	0.442
Alpine	Holiday	1.118	0.935	0.832
Amador	Sunday	1.201	0.821	0.415
Amador	Monday	1.007	0.945	0.908
Amador	Tues/Wed/Thurs	1	1	1
Amador	Friday	1.247	1.082	1.007
Amador	Saturday	1.219	0.803	0.442
Amador	Holiday	1.118	0.935	0.832
Butte	Sunday	0.651	0.442	0.41
Butte	Monday	0.964	0.96	0.871
Butte	Tues/Wed/Thurs	1	1	1
Butte	Friday	1.008	1.015	0.962
Butte	Saturday	0.771	0.604	0.503
Butte	Holiday	0.73	0.657	0.606
Calaveras	Sunday	1.201	0.821	0.415
Calaveras	Monday	1.007	0.945	0.908
Calaveras	Tues/Wed/Thurs	1	1	1
Calaveras	Friday	1.247	1.082	1.007
Calaveras	Saturday	1.219	0.803	0.442
Calaveras	Holiday	1.118	0.935	0.832
Colusa	Sunday	0.651	0.442	0.41
Colusa	Monday	0.964	0.96	0.871
Colusa	Tues/Wed/Thurs	1	1	1
Colusa	Friday	1.008	1.015	0.962
Colusa	Saturday	0.771	0.604	0.503
Colusa	Holiday	0.73	0.657	0.606
Contra Costa	Sunday	0.779	0.519	0.376
Contra Costa	Monday	0.943	0.927	0.873
Contra Costa	Tues/Wed/Thurs	1	1	1
Contra Costa	Friday	1.048	1.023	0.982
Contra Costa	Saturday	0.924	0.665	0.471
Contra Costa	Holiday	0.788	0.827	0.799
Del Norte	Sunday	0.85	0.493	0.326
Del Norte	Monday	0.961	0.95	0.915
Del Norte	Tues/Wed/Thurs	1	1	1
Del Norte	Friday	1.031	1.004	0.932
Del Norte	Saturday	0.924	0.619	0.376
Del Norte	Holiday	0.77	0.619	0.527
El Dorado	Sunday	0.972	0.668	0.602
El Dorado	Monday	0.988	0.977	0.943
El Dorado	Tues/Wed/Thurs	1	1	1
El Dorado	Friday	1.178	1.101	0.963
El Dorado	Saturday	1.037	0.786	0.575
El Dorado	Holiday	0.971	0.933	0.921
Fresno	Sunday	0.851	0.443	0.396
Fresno	Monday	1.016	0.934	0.878
Fresno	Tues/Wed/Thurs	1	1	1
Fresno	Friday	1.155	1.026	0.927
Fresno	Saturday	0.946	0.563	0.478
Fresno	Holiday	0.799	0.774	0.784
Glenn	Sunday	0.651	0.442	0.41

63

County	Day of Week	LD	LM	HH
Glenn	Monday	0.964	0.96	0.871
Glenn	Tues/Wed/Thurs	1	1	1
Glenn	Friday	1.008	1.015	0.962
Glenn	Saturday	0.771	0.604	0.503
Glenn	Holiday	0.73	0.657	0.606
Humboldt	Sunday	0.85	0.493	0.326
Humboldt	Monday	0.961	0.95	0.915
Humboldt	Tues/Wed/Thurs	1	1	1
Humboldt	Friday	1.031	1.004	0.932
Humboldt	Saturday	0.924	0.619	0.376
Humboldt	Holiday	0.77	0.619	0.527
Imperial	Sunday	1.082	0.608	0.396
Imperial	Monday	1.004	0.931	0.948
Imperial	Tues/Wed/Thurs	1	1	1
Imperial	Friday	1.109	1.161	0.983
Imperial	Saturday	1.065	0.687	0.522
Imperial	Holiday	1.024	0.814	0.673
Inyo	Sunday	1.201	0.821	0.415
Inyo	Monday	1.007	0.945	0.908
Inyo	Tues/Wed/Thurs	1	1	1
Inyo	Friday	1.247	1.082	1.007
Inyo	Saturday	1.219	0.803	0.442
Inyo	Holiday	1.118	0.935	0.832
Kern	Sunday	1.114	0.63	0.416
Kern	Monday	1.061	0.942	0.849
Kern	Tues/Wed/Thurs	1	1	1
Kern	Friday	1.253	1.044	0.9
Kern	Saturday	1.1	0.734	0.535
Kern	Holiday	0.986	0.911	0.837
Kings	Sunday	0.663	0.358	0.355
Kings	Monday	0.961	0.909	0.89
Kings	Tues/Wed/Thurs	1	1	1
Kings	Friday	1.045	0.982	0.947
Kings	Saturday	0.807	0.52	0.454
Kings	Holiday	0.669	0.665	0.758
Lake	Sunday	0.85	0.493	0.326
Lake	Monday	0.961	0.95	0.915
Lake	Tues/Wed/Thurs	1	1	1
Lake	Friday	1.031	1.004	0.932
Lake	Saturday	0.924	0.619	0.376
Lake	Holiday	0.77	0.619	0.527
Lassen	Sunday	0.941	0.703	0.587
Lassen	Monday	0.993	0.942	0.798
Lassen	Tues/Wed/Thurs	1	1	1
Lassen	Friday	1.094	1.07	0.882
Lassen	Saturday	0.962	0.766	0.658
Lassen	Holiday	0.968	0.744	0.608
Los Angeles	Sunday	0.858	0.489	0.398
Los Angeles	Monday	0.973	0.936	0.878
Los Angeles	Tues/Wed/Thurs	1	1	1
Los Angeles	Friday	1.047	1.005	0.918
Los Angeles	Saturday	0.979	0.641	0.509
Los Angeles	Holiday	0.863	0.808	0.801
Madera	Sunday	1.017	0.478	0.4
Madera	Monday	1.024	0.942	0.902
Madera	Tues/Wed/Thurs	1	1	1
Madera	Friday	1.176	1.022	0.96
Madera	Saturday	1.105	0.602	0.476
Madera	Holiday	0.866	0.833	0.832
Marin	Sunday	0.779	0.519	0.376
Marin	Monday	0.943	0.927	0.873
Marin	Tues/Wed/Thurs	1	1	1
Marin	Friday	1.048	1.023	0.982
Marin	Saturday	0.924	0.665	0.471
Marin	Holiday	0.788	0.827	0.799
Mariposa	Sunday	1.201	0.821	0.415
Mariposa	Monday	1.007	0.945	0.908
Mariposa	Tues/Wed/Thurs	1	1	1
Mariposa	Friday	1.247	1.082	1.007
Mariposa	Saturday	1.219	0.803	0.442
Mariposa	Holiday	1.118	0.935	0.832
Mendocino	Sunday	0.85	0.493	0.326
Mendocino	Monday	0.961	0.95	0.915
Mendocino	Tues/Wed/Thurs	1	1	1

County	Day of Week	LD	LM	HH
Mendocino	Friday	1.031	1.004	0.932
Mendocino	Saturday	0.924	0.619	0.376
Mendocino	Holiday	0.77	0.619	0.527
Merced	Sunday	1.002	0.593	0.421
Merced	Monday	1.009	0.958	0.904
Merced	Tues/Wed/Thurs	1	1	1
Merced	Friday	1.185	1.103	0.97
Merced	Saturday	1.055	0.713	0.477
Merced	Holiday	0.977	0.897	0.797
Modoc	Sunday	1.133	0.801	0.638
Modoc	Monday	1.159	0.961	0.634
Modoc	Tues/Wed/Thurs	1	1	1
Modoc	Friday	1.202	1.109	0.767
Modoc	Saturday	1.041	0.819	0.745
Modoc	Holiday	1.087	0.992	0.704
Mono	Sunday	1.201	0.821	0.415
Mono	Monday	1.007	0.945	0.908
Mono	Tues/Wed/Thurs	1	1	1
Mono	Friday	1.247	1.082	1.007
Mono	Saturday	1.219	0.803	0.442
Mono	Holiday	1.118	0.935	0.832
Monterey	Sunday	1.2	0.603	0.342
Monterey	Monday	1.106	0.988	0.876
Monterey	Tues/Wed/Thurs	1	1	1
Monterey	Friday	1.116	1.093	0.995
Monterey	Saturday	1.023	0.724	0.7
Monterey	Holiday	1.083	0.755	0.607
Napa	Sunday	1.028	0.624	0.392
Napa	Monday	0.989	0.95	0.895
Napa	Tues/Wed/Thurs	1	1	1
Napa	Friday	1.126	1.041	0.988
Napa	Saturday	1.118	0.743	0.44
Napa	Holiday	0.952	0.905	0.847
Nevada	Sunday	0.972	0.668	0.602
Nevada	Monday	0.988	0.977	0.943
Nevada	Tues/Wed/Thurs	1	1	1
Nevada	Friday	1.178	1.101	0.963
Nevada	Saturday	1.037	0.786	0.575
Nevada	Holiday	0.971	0.933	0.921
Orange	Sunday	0.808	0.415	0.327
Orange	Monday	0.962	0.92	0.891
Orange	Tues/Wed/Thurs	1	1	1
Orange	Friday	1.038	1.025	0.988
Orange	Saturday	0.94	0.587	0.433
Orange	Holiday	0.831	0.774	0.796
Placer	Sunday	0.972	0.668	0.602
Placer	Monday	0.988	0.977	0.943
Placer	Tues/Wed/Thurs	1	1	1
Placer	Friday	1.178	1.101	0.963
Placer	Saturday	1.037	0.786	0.575
Placer	Holiday	0.971	0.933	0.921
Plumas	Sunday	0.651	0.442	0.41
Plumas	Monday	0.964	0.96	0.871
Plumas	Tues/Wed/Thurs	1	1	1
Plumas	Friday	1.008	1.015	0.962
Plumas	Saturday	0.771	0.604	0.503
Plumas	Holiday	0.73	0.657	0.606
Riverside	Sunday	0.894	0.489	0.383
Riverside	Monday	0.974	0.941	0.887
Riverside	Tues/Wed/Thurs	1	1	1
Riverside	Friday	1.085	1.028	0.977
Riverside	Saturday	1.011	0.629	0.491
Riverside	Holiday	0.933	0.848	0.844
Sacramento	Sunday	0.774	0.49	0.431
Sacramento	Monday	0.963	0.954	0.913
Sacramento	Tues/Wed/Thurs	1	1	1
Sacramento	Friday	1.065	1.039	0.973
Sacramento	Saturday	0.884	0.622	0.502
Sacramento	Holiday	0.809	0.832	0.852
San Benito	Sunday	1.2	0.603	0.342
San Benito	Monday	1.106	0.988	0.876
San Benito	Tues/Wed/Thurs	1	1	1
San Benito	Friday	1.116	1.093	0.995
San Benito	Saturday	1.023	0.724	0.7

County	Day of Week	LD	LM	HH
San Benito	Holiday	1.083	0.755	0.607
San Bernardino	Sunday	0.89	0.56	0.532
San Bernardino	Monday	0.988	0.931	0.913
San Bernardino	Tues/Wed/Thurs	1	1	1
San Bernardino	Friday	1.094	1.069	1.012
San Bernardino	Saturday	0.97	0.743	0.634
San Bernardino	Holiday	0.942	0.818	0.831
San Diego	Sunday	0.796	0.532	0.341
San Diego	Monday	0.963	0.928	0.882
San Diego	Tues/Wed/Thurs	1	1	1
San Diego	Friday	1.067	1.022	0.982
San Diego	Saturday	0.928	0.665	0.446
San Diego	Holiday	0.808	0.785	0.785
San Francisco	Sunday	0.852	0.522	0.39
San Francisco	Monday	0.928	0.897	0.888
San Francisco	Tues/Wed/Thurs	1	1	1
San Francisco	Friday	1.05	1.002	0.98
San Francisco	Saturday	0.957	0.639	0.452
San Francisco	Holiday	0.783	0.811	0.84
San Joaquin	Sunday	0.933	0.5	0.393
San Joaquin	Monday	0.984	0.918	0.908
San Joaquin	Tues/Wed/Thurs	1	1	1
San Joaquin	Friday	1.128	1.086	0.976
San Joaquin	Saturday	1.035	0.657	0.466
San Joaquin	Holiday	0.907	0.77	0.757
San Luis Obispo	Sunday	1.038	0.629	0.413
San Luis Obispo	Monday	1.064	0.97	0.935
San Luis Obispo	Tues/Wed/Thurs	1	1	1
San Luis Obispo	Friday	1.113	1.094	1.047
San Luis Obispo	Saturday	0.99	0.725	0.563
San Luis Obispo	Holiday	0.967	0.714	0.669
San Mateo	Sunday	0.714	0.439	0.324
San Mateo	Monday	0.926	0.89	0.887
San Mateo	Tues/Wed/Thurs	1	1	1
San Mateo	Friday	1.02	0.983	0.978
San Mateo	Saturday	0.835	0.55	0.402
San Mateo	Holiday	0.78	0.742	0.767
Santa Barbara	Sunday	0.81	0.388	0.301
Santa Barbara	Monday	1.044	0.952	0.912
Santa Barbara	Tues/Wed/Thurs	1	1	1
Santa Barbara	Friday	1.08	1.011	0.996
Santa Barbara	Saturday	0.829	0.542	0.562
Santa Barbara	Holiday	0.811	0.535	0.545
Santa Clara	Sunday	0.734	0.489	0.343
Santa Clara	Monday	0.954	0.909	0.906
Santa Clara	Tues/Wed/Thurs	1	1	1
Santa Clara	Friday	1.042	1.004	0.953
Santa Clara	Saturday	0.853	0.614	0.4
Santa Clara	Holiday	0.765	0.834	0.807
Santa Cruz	Sunday	0.846	0.526	0.468
Santa Cruz	Monday	0.935	0.923	0.947
Santa Cruz	Tues/Wed/Thurs	1	1	1
Santa Cruz	Friday	1.027	1.012	1.036
Santa Cruz	Saturday	0.935	0.652	0.541
Santa Cruz	Holiday	0.9	0.896	0.875
Shasta	Sunday	1.076	0.823	0.627
Shasta	Monday	0.939	1.007	0.66
Shasta	Tues/Wed/Thurs	1	1	1
Shasta	Friday	1.078	1.156	0.774
Shasta	Saturday	1.117	0.863	0.719
Shasta	Holiday	0.902	0.837	0.602
Sierra	Sunday	0.972	0.668	0.602
Sierra	Monday	0.988	0.977	0.943
Sierra	Tues/Wed/Thurs	1	1	1
Sierra	Friday	1.178	1.101	0.963
Sierra	Saturday	1.037	0.786	0.575
Sierra	Holiday	0.971	0.933	0.921
Siskiyou	Sunday	1.133	0.801	0.638
Siskiyou	Monday	1.159	0.961	0.634
Siskiyou	Tues/Wed/Thurs	1	1	1
Siskiyou	Friday	1.202	1.109	0.767
Siskiyou	Saturday	1.041	0.819	0.745
Siskiyou	Holiday	1.087	0.992	0.704
Solano	Sunday	1.008	0.589	0.36

County	Day of Week	LD	LM	HH
Solano	Monday	0.979	0.948	0.887
Solano	Tues/Wed/Thurs	1	1	1
Solano	Friday	1.13	1.033	0.969
Solano	Saturday	1.091	0.719	0.416
Solano	Holiday	0.909	0.896	0.844
Sonoma	Sunday	0.779	0.519	0.376
Sonoma	Monday	0.943	0.927	0.873
Sonoma	Tues/Wed/Thurs	1	1	1
Sonoma	Friday	1.048	1.023	0.982
Sonoma	Saturday	0.924	0.665	0.471
Sonoma	Holiday	0.788	0.827	0.799
Stanislaus	Sunday	1.002	0.593	0.421
Stanislaus	Monday	1.009	0.958	0.904
Stanislaus	Tues/Wed/Thurs	1	1	1
Stanislaus	Friday	1.185	1.103	0.97
Stanislaus	Saturday	1.055	0.713	0.477
Stanislaus	Holiday	0.977	0.897	0.797
Sutter	Sunday	0.972	0.668	0.602
Sutter	Monday	0.988	0.977	0.943
Sutter	Tues/Wed/Thurs	1	1	1
Sutter	Friday	1.178	1.101	0.963
Sutter	Saturday	1.037	0.786	0.575
Sutter	Holiday	0.971	0.933	0.921
Tehama	Sunday	1.076	0.823	0.627
Tehama	Monday	0.939	1.007	0.66
Tehama	Tues/Wed/Thurs	1	1	1
Tehama	Friday	1.078	1.156	0.774
Tehama	Saturday	1.117	0.863	0.719
Tehama	Holiday	0.902	0.837	0.602
Trinity	Sunday	1.133	0.801	0.638
Trinity	Monday	1.159	0.961	0.634
Trinity	Tues/Wed/Thurs	1	1	1
Trinity	Friday	1.202	1.109	0.767
Trinity	Saturday	1.041	0.819	0.745
Trinity	Holiday	1.087	0.992	0.704
Tulare	Sunday	1.029	0.429	0.185
Tulare	Monday	1.052	0.936	0.912
Tulare	Tues/Wed/Thurs	1	1	1
Tulare	Friday	1.099	1.02	0.97
Tulare	Saturday	0.993	0.67	0.503
Tulare	Holiday	0.942	0.585	0.567
Tuolumne	Sunday	1.201	0.821	0.415
Tuolumne	Monday	1.007	0.945	0.908
Tuolumne	Tues/Wed/Thurs	1	1	1
Tuolumne	Friday	1.247	1.082	1.007
Tuolumne	Saturday	1.219	0.803	0.442
Tuolumne	Holiday	1.118	0.935	0.832
Ventura	Sunday	0.772	0.406	0.491
Ventura	Monday	0.956	0.924	0.932
Ventura	Tues/Wed/Thurs	1	1	1
Ventura	Friday	1.036	0.992	1.004
Ventura	Saturday	0.888	0.554	0.637
Ventura	Holiday	0.817	0.785	0.863
Yolo	Sunday	0.902	0.563	0.357
Yolo	Monday	0.972	0.954	0.932
Yolo	Tues/Wed/Thurs	1	1	1
Yolo	Friday	1.099	1.045	0.973
Yolo	Saturday	0.992	0.669	0.426
Yolo	Holiday	0.895	0.883	0.861
Yuba	Sunday	0.972	0.668	0.602
Yuba	Monday	0.988	0.977	0.943
Yuba	Tues/Wed/Thurs	1	1	1
Yuba	Friday	1.178	1.101	0.963
Yuba	Saturday	1.037	0.786	0.575
Yuba	Holiday	0.971	0.933	0.921

Appendix B: Hour of Day Profiles by vehicle type and county

The factors shown in Table 10 represent the “day of week” factors 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.

Table 10 Hour of Day Profiles by vehicle type and county

		Alameda			Alpine			Amador			Butte			Calaveras			Colusa			Contra Costa		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Sunday	0	0.020	0.041	0.061	0.010	0.014	0.032	0.010	0.014	0.032	0.015	0.010	0.015	0.010	0.014	0.032	0.015	0.010	0.015	0.019	0.038	0.053
Sunday	1	0.013	0.039	0.056	0.007	0.011	0.024	0.007	0.011	0.024	0.010	0.006	0.011	0.007	0.011	0.024	0.010	0.006	0.011	0.012	0.034	0.047
Sunday	2	0.010	0.039	0.052	0.005	0.011	0.022	0.005	0.011	0.022	0.007	0.004	0.012	0.005	0.011	0.022	0.007	0.004	0.012	0.008	0.031	0.043
Sunday	3	0.007	0.038	0.049	0.004	0.010	0.021	0.004	0.010	0.021	0.006	0.004	0.012	0.004	0.010	0.021	0.006	0.004	0.012	0.006	0.030	0.040
Sunday	4	0.007	0.037	0.046	0.004	0.010	0.020	0.004	0.010	0.020	0.006	0.005	0.017	0.004	0.010	0.020	0.006	0.005	0.017	0.006	0.029	0.038
Sunday	5	0.010	0.038	0.044	0.007	0.013	0.021	0.007	0.013	0.021	0.010	0.011	0.029	0.007	0.013	0.021	0.010	0.011	0.029	0.010	0.031	0.038
Sunday	6	0.016	0.038	0.043	0.012	0.019	0.026	0.012	0.019	0.026	0.016	0.017	0.037	0.012	0.019	0.026	0.016	0.017	0.037	0.016	0.033	0.039
Sunday	7	0.022	0.039	0.042	0.019	0.023	0.029	0.019	0.023	0.029	0.023	0.029	0.051	0.019	0.023	0.029	0.023	0.029	0.051	0.023	0.036	0.040
Sunday	8	0.032	0.040	0.041	0.032	0.035	0.038	0.032	0.035	0.038	0.033	0.043	0.071	0.032	0.035	0.038	0.033	0.043	0.071	0.033	0.040	0.042
Sunday	9	0.046	0.043	0.041	0.051	0.051	0.053	0.051	0.051	0.053	0.047	0.063	0.091	0.051	0.051	0.053	0.047	0.063	0.091	0.048	0.046	0.044
Sunday	10	0.059	0.046	0.041	0.067	0.067	0.071	0.067	0.067	0.071	0.057	0.075	0.084	0.067	0.067	0.071	0.057	0.075	0.084	0.062	0.051	0.045
Sunday	11	0.065	0.047	0.039	0.080	0.081	0.085	0.080	0.081	0.085	0.067	0.083	0.079	0.080	0.081	0.085	0.067	0.083	0.079	0.067	0.053	0.046
Sunday	12	0.069	0.048	0.038	0.083	0.081	0.076	0.083	0.081	0.076	0.074	0.090	0.070	0.083	0.081	0.076	0.074	0.090	0.070	0.070	0.054	0.046
Sunday	13	0.071	0.049	0.036	0.085	0.082	0.074	0.085	0.082	0.074	0.078	0.089	0.061	0.085	0.082	0.074	0.078	0.089	0.061	0.073	0.055	0.050
Sunday	14	0.072	0.049	0.035	0.085	0.083	0.069	0.085	0.083	0.069	0.079	0.081	0.057	0.085	0.083	0.069	0.079	0.081	0.057	0.073	0.055	0.047
Sunday	15	0.071	0.049	0.034	0.084	0.081	0.066	0.084	0.081	0.066	0.080	0.079	0.053	0.084	0.081	0.066	0.080	0.079	0.053	0.073	0.053	0.041
Sunday	16	0.070	0.048	0.033	0.082	0.079	0.060	0.082	0.079	0.060	0.079	0.075	0.045	0.082	0.079	0.060	0.079	0.075	0.045	0.072	0.052	0.039
Sunday	17	0.069	0.048	0.034	0.076	0.070	0.053	0.076	0.070	0.053	0.075	0.066	0.043	0.076	0.070	0.053	0.075	0.066	0.043	0.070	0.050	0.038
Sunday	18	0.063	0.045	0.033	0.064	0.056	0.043	0.064	0.056	0.043	0.066	0.054	0.039	0.064	0.056	0.043	0.066	0.054	0.039	0.063	0.047	0.036
Sunday	19	0.057	0.043	0.035	0.049	0.043	0.035	0.049	0.043	0.035	0.055	0.042	0.037	0.049	0.043	0.035	0.055	0.042	0.037	0.056	0.044	0.035
Sunday	20	0.052	0.041	0.036	0.038	0.033	0.024	0.038	0.033	0.024	0.045	0.031	0.030	0.038	0.033	0.024	0.045	0.031	0.030	0.051	0.041	0.036
Sunday	21	0.045	0.037	0.039	0.026	0.022	0.020	0.026	0.022	0.020	0.035	0.022	0.024	0.026	0.022	0.020	0.035	0.022	0.024	0.042	0.038	0.037
Sunday	22	0.033	0.032	0.043	0.017	0.014	0.017	0.017	0.014	0.017	0.023	0.013	0.018	0.017	0.014	0.017	0.023	0.013	0.018	0.030	0.032	0.039
Sunday	23	0.021	0.027	0.049	0.010	0.010	0.020	0.010	0.010	0.020	0.014	0.008	0.015	0.010	0.010	0.020	0.014	0.008	0.015	0.019	0.027	0.043
Monday	0	0.009	0.026	0.032	0.006	0.010	0.017	0.006	0.010	0.017	0.006	0.002	0.006	0.006	0.010	0.017	0.006	0.002	0.006	0.007	0.023	0.029
Monday	1	0.004	0.027	0.032	0.004	0.009	0.016	0.004	0.009	0.016	0.004	0.002	0.007	0.004	0.009	0.016	0.004	0.002	0.007	0.003	0.022	0.028
Monday	2	0.003	0.028	0.033	0.003	0.009	0.016	0.003	0.009	0.016	0.003	0.002	0.010	0.003	0.009	0.016	0.003	0.002	0.010	0.002	0.022	0.029
Monday	3	0.005	0.030	0.035	0.005	0.011	0.019	0.005	0.011	0.019	0.003	0.004	0.012	0.005	0.011	0.019	0.003	0.004	0.012	0.003	0.023	0.030
Monday	4	0.014	0.033	0.039	0.008	0.017	0.024	0.008	0.017	0.024	0.007	0.009	0.021	0.008	0.017	0.024	0.007	0.009	0.021	0.012	0.028	0.035
Monday	5	0.034	0.039	0.044	0.019	0.028	0.036	0.019	0.028	0.036	0.018	0.024	0.037	0.019	0.028	0.036	0.018	0.024	0.037	0.033	0.041	0.042
Monday	6	0.051	0.046	0.048	0.036	0.041	0.050	0.036	0.041	0.050	0.041	0.051	0.055	0.036	0.041	0.050	0.041	0.051	0.055	0.054	0.051	0.048
Monday	7	0.064	0.053	0.052	0.051	0.044	0.065	0.051	0.044	0.065	0.078	0.069	0.066	0.051	0.044	0.065	0.078	0.069	0.066	0.066	0.058	0.053
Monday	8	0.064	0.055	0.053	0.053	0.056	0.068	0.053	0.056	0.068	0.067	0.077	0.077	0.053	0.056	0.068	0.067	0.077	0.077	0.062	0.060	0.055
Monday	9	0.058	0.054	0.054	0.059	0.065	0.080	0.059	0.065	0.080	0.057	0.071	0.080	0.059	0.065	0.080	0.057	0.071	0.080	0.055	0.056	0.054
Monday	10	0.053	0.053	0.054	0.067	0.074	0.087	0.067	0.074	0.087	0.057	0.071	0.077	0.067	0.074	0.087	0.057	0.071	0.077	0.052	0.054	0.053
Monday	11	0.051	0.054	0.054	0.071	0.075	0.082	0.071	0.075	0.082	0.060	0.074	0.073	0.071	0.075	0.082	0.060	0.074	0.073	0.053	0.055	0.054
Monday	12	0.052	0.056	0.054	0.074	0.074	0.080	0.074	0.074	0.080	0.063	0.072	0.071	0.074	0.074	0.080	0.063	0.072	0.071	0.054	0.056	0.054

		Alameda			Alpine			Amador			Butte			Calaveras			Colusa			Contra Costa		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Monday	13	0.054	0.057	0.054	0.074	0.075	0.075	0.074	0.075	0.075	0.063	0.072	0.068	0.074	0.075	0.075	0.063	0.072	0.068	0.056	0.056	0.054
Monday	14	0.061	0.059	0.053	0.077	0.076	0.065	0.077	0.076	0.065	0.067	0.077	0.064	0.077	0.076	0.065	0.067	0.077	0.064	0.063	0.059	0.056
Monday	15	0.066	0.059	0.051	0.082	0.076	0.058	0.082	0.076	0.058	0.078	0.080	0.056	0.082	0.076	0.058	0.078	0.080	0.056	0.069	0.063	0.058
Monday	16	0.069	0.057	0.048	0.081	0.073	0.045	0.081	0.073	0.045	0.086	0.077	0.049	0.081	0.073	0.045	0.086	0.077	0.049	0.072	0.060	0.052
Monday	17	0.070	0.053	0.044	0.071	0.059	0.035	0.071	0.059	0.035	0.087	0.062	0.041	0.071	0.059	0.035	0.087	0.062	0.041	0.073	0.056	0.047
Monday	18	0.062	0.045	0.037	0.052	0.042	0.023	0.052	0.042	0.023	0.051	0.038	0.030	0.052	0.042	0.023	0.051	0.038	0.030	0.061	0.045	0.039
Monday	19	0.048	0.035	0.031	0.037	0.030	0.017	0.037	0.030	0.017	0.036	0.024	0.024	0.037	0.030	0.017	0.036	0.024	0.024	0.045	0.033	0.031
Monday	20	0.036	0.028	0.026	0.027	0.022	0.013	0.027	0.022	0.013	0.026	0.018	0.023	0.027	0.022	0.013	0.026	0.018	0.023	0.035	0.026	0.026
Monday	21	0.031	0.022	0.023	0.020	0.016	0.010	0.020	0.016	0.010	0.020	0.012	0.021	0.020	0.016	0.010	0.020	0.012	0.021	0.031	0.022	0.024
Monday	22	0.024	0.018	0.023	0.015	0.012	0.009	0.015	0.012	0.009	0.013	0.007	0.017	0.015	0.012	0.009	0.013	0.007	0.017	0.023	0.017	0.023
Monday	23	0.016	0.015	0.025	0.009	0.007	0.010	0.009	0.007	0.010	0.008	0.004	0.015	0.009	0.007	0.010	0.008	0.004	0.015	0.014	0.014	0.025
Tues/Wed/Thurs	0	0.008	0.026	0.034	0.005	0.009	0.017	0.005	0.009	0.017	0.006	0.003	0.010	0.005	0.009	0.017	0.006	0.003	0.010	0.006	0.022	0.031
Tues/Wed/Thurs	1	0.004	0.027	0.034	0.003	0.008	0.017	0.003	0.008	0.017	0.003	0.002	0.011	0.003	0.008	0.017	0.003	0.002	0.011	0.003	0.021	0.030
Tues/Wed/Thurs	2	0.003	0.028	0.035	0.002	0.009	0.017	0.002	0.009	0.017	0.003	0.002	0.013	0.002	0.009	0.017	0.003	0.002	0.013	0.002	0.021	0.030
Tues/Wed/Thurs	3	0.005	0.030	0.037	0.003	0.010	0.022	0.003	0.010	0.022	0.003	0.003	0.015	0.003	0.010	0.022	0.003	0.003	0.015	0.003	0.023	0.031
Tues/Wed/Thurs	4	0.014	0.034	0.041	0.006	0.014	0.025	0.006	0.014	0.025	0.006	0.008	0.022	0.006	0.014	0.025	0.006	0.008	0.022	0.011	0.028	0.036
Tues/Wed/Thurs	5	0.035	0.040	0.046	0.018	0.027	0.039	0.018	0.027	0.039	0.017	0.024	0.037	0.018	0.027	0.039	0.017	0.024	0.037	0.034	0.040	0.044
Tues/Wed/Thurs	6	0.055	0.047	0.050	0.037	0.042	0.052	0.037	0.042	0.052	0.041	0.053	0.054	0.037	0.042	0.052	0.041	0.053	0.054	0.056	0.052	0.049
Tues/Wed/Thurs	7	0.067	0.054	0.053	0.053	0.047	0.064	0.053	0.047	0.064	0.077	0.069	0.066	0.053	0.047	0.064	0.077	0.069	0.066	0.068	0.059	0.054
Tues/Wed/Thurs	8	0.064	0.056	0.054	0.054	0.056	0.070	0.054	0.056	0.070	0.066	0.077	0.077	0.054	0.056	0.070	0.066	0.077	0.077	0.063	0.060	0.056
Tues/Wed/Thurs	9	0.057	0.054	0.055	0.059	0.068	0.083	0.059	0.068	0.083	0.057	0.071	0.080	0.059	0.068	0.083	0.057	0.071	0.080	0.055	0.055	0.053
Tues/Wed/Thurs	10	0.051	0.053	0.054	0.064	0.069	0.081	0.064	0.069	0.081	0.056	0.071	0.077	0.064	0.069	0.081	0.056	0.071	0.077	0.051	0.053	0.052
Tues/Wed/Thurs	11	0.049	0.054	0.054	0.068	0.069	0.077	0.068	0.069	0.077	0.058	0.071	0.074	0.068	0.069	0.077	0.058	0.071	0.074	0.050	0.054	0.052
Tues/Wed/Thurs	12	0.050	0.055	0.054	0.069	0.071	0.074	0.069	0.071	0.074	0.062	0.070	0.069	0.069	0.071	0.074	0.062	0.070	0.069	0.052	0.055	0.053
Tues/Wed/Thurs	13	0.053	0.056	0.053	0.072	0.073	0.074	0.072	0.073	0.074	0.063	0.073	0.067	0.072	0.073	0.074	0.063	0.073	0.067	0.054	0.056	0.054
Tues/Wed/Thurs	14	0.060	0.058	0.052	0.077	0.076	0.067	0.077	0.076	0.067	0.066	0.076	0.063	0.077	0.076	0.067	0.066	0.076	0.063	0.062	0.059	0.054
Tues/Wed/Thurs	15	0.064	0.058	0.050	0.084	0.078	0.058	0.084	0.078	0.058	0.079	0.080	0.056	0.084	0.078	0.058	0.079	0.080	0.056	0.067	0.063	0.056
Tues/Wed/Thurs	16	0.067	0.056	0.047	0.082	0.074	0.048	0.082	0.074	0.048	0.087	0.076	0.045	0.082	0.074	0.048	0.087	0.076	0.045	0.070	0.060	0.051
Tues/Wed/Thurs	17	0.067	0.052	0.042	0.074	0.061	0.036	0.074	0.061	0.036	0.088	0.062	0.040	0.074	0.061	0.036	0.088	0.062	0.040	0.071	0.057	0.046
Tues/Wed/Thurs	18	0.061	0.044	0.036	0.053	0.044	0.023	0.053	0.044	0.023	0.054	0.039	0.031	0.053	0.044	0.023	0.054	0.039	0.031	0.062	0.047	0.039
Tues/Wed/Thurs	19	0.050	0.035	0.030	0.038	0.031	0.016	0.038	0.031	0.016	0.036	0.026	0.023	0.038	0.031	0.016	0.036	0.026	0.023	0.048	0.035	0.031
Tues/Wed/Thurs	20	0.038	0.027	0.025	0.030	0.025	0.012	0.030	0.025	0.012	0.028	0.019	0.021	0.030	0.025	0.012	0.028	0.019	0.021	0.038	0.027	0.026
Tues/Wed/Thurs	21	0.033	0.022	0.022	0.023	0.018	0.010	0.023	0.018	0.010	0.021	0.013	0.020	0.023	0.018	0.010	0.021	0.013	0.020	0.033	0.022	0.024
Tues/Wed/Thurs	22	0.026	0.017	0.022	0.017	0.013	0.010	0.017	0.013	0.010	0.014	0.007	0.016	0.017	0.013	0.010	0.014	0.007	0.016	0.024	0.017	0.022
Tues/Wed/Thurs	23	0.016	0.014	0.023	0.010	0.008	0.010	0.010	0.008	0.010	0.009	0.004	0.013	0.010	0.008	0.010	0.009	0.004	0.013	0.015	0.013	0.024
Friday	0	0.009	0.027	0.036	0.005	0.009	0.019	0.005	0.009	0.019	0.007	0.003	0.011	0.005	0.009	0.019	0.007	0.003	0.011	0.008	0.022	0.033
Friday	1	0.005	0.028	0.037	0.003	0.008	0.019	0.003	0.008	0.019	0.004	0.003	0.012	0.003	0.008	0.019	0.004	0.003	0.012	0.004	0.021	0.031
Friday	2	0.004	0.029	0.038	0.002	0.008	0.019	0.002	0.008	0.019	0.004	0.003	0.015	0.002	0.008	0.019	0.004	0.003	0.015	0.003	0.022	0.032
Friday	3	0.005	0.031	0.039	0.002	0.008	0.021	0.002	0.008	0.021	0.004	0.004	0.017	0.002	0.008	0.021	0.004	0.004	0.017	0.004	0.023	0.033
Friday	4	0.013	0.034	0.043	0.005	0.013	0.024	0.005	0.013	0.024	0.006	0.007	0.024	0.005	0.013	0.024	0.006	0.007	0.024	0.010	0.028	0.036
Friday	5	0.032	0.040	0.048	0.013	0.023	0.037	0.013	0.023	0.037	0.015	0.022	0.039	0.013	0.023	0.037	0.015	0.022	0.039	0.030	0.039	0.044
Friday	6	0.049	0.046	0.052	0.026	0.035	0.049	0.026	0.035	0.049	0.035	0.045	0.055	0.026	0.035	0.049	0.035	0.045	0.055	0.050	0.049	0.050
Friday	7	0.060	0.052	0.055	0.039	0.040	0.060	0.039	0.040	0.060	0.063	0.063	0.064	0.039	0.040	0.060	0.063	0.063	0.064	0.063	0.057	0.055
Friday	8	0.059	0.054	0.056	0.043	0.049	0.068	0.043	0.049	0.068	0.058	0.072	0.074	0.043	0.049	0.068	0.058	0.072	0.074	0.059	0.057	0.056
Friday	9	0.054	0.053	0.056	0.049	0.057	0.073	0.049	0.057	0.073	0.052	0.068	0.075	0.049	0.057	0.073	0.052	0.068	0.075	0.053	0.054	0.054
Friday	10	0.051	0.053	0.056	0.058	0.063	0.078	0.058	0.063	0.078	0.055	0.071	0.074	0.058	0.063	0.078	0.055	0.071	0.074	0.051	0.053	0.053
Friday	11	0.052	0.055	0.055	0.064	0.069	0.077	0.064	0.069	0.077	0.060	0.074	0.074	0.064	0.069	0.077	0.060	0.074	0.074	0.053	0.055	0.054
Friday	12	0.054	0.056	0.055	0.066	0.071	0.076	0.066	0.071	0.076	0.063	0.072	0.069	0.066	0.071	0.076	0.063	0.072	0.069	0.056	0.057	0.055
Friday	13	0.056	0.057	0.054	0.071	0.074	0.077	0.071	0.074	0.077	0.065	0.076	0.069	0.071	0.074	0.077	0.065	0.076	0.069	0.058	0.058	0.056
Friday	14	0.061	0.058	0.052	0.076	0.077	0.070	0.076	0.077	0.070	0.069	0.078	0.063	0.076	0.077	0.070	0.069	0.078	0.063	0.064	0.059	0.056
Friday	15	0.063	0.058	0.049	0.083	0.079	0.060	0.083	0.079	0.060	0.078	0.080	0.055	0.083	0.079	0.060	0.078	0.080	0.055	0.066	0.062	0.056
Friday	16	0.064	0.055	0.045	0.083	0.077	0.050	0.083	0.077	0.050	0.085	0.075	0.047	0.083	0.077	0.050	0.085	0.075	0.047	0.067	0.059	0.050

69

		Alameda			Alpine			Amador			Butte			Calaveras			Colusa			Contra Costa		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Friday	17	0.064	0.051	0.040	0.075	0.064	0.038	0.075	0.064	0.038	0.082	0.061	0.039	0.075	0.064	0.038	0.082	0.061	0.039	0.067	0.055	0.046
Friday	18	0.059	0.044	0.034	0.062	0.051	0.025	0.062	0.051	0.025	0.059	0.041	0.029	0.062	0.051	0.025	0.059	0.041	0.029	0.060	0.047	0.039
Friday	19	0.052	0.035	0.027	0.050	0.039	0.018	0.050	0.039	0.018	0.042	0.028	0.024	0.050	0.039	0.018	0.042	0.028	0.024	0.049	0.036	0.030
Friday	20	0.042	0.028	0.022	0.041	0.030	0.013	0.041	0.030	0.013	0.032	0.021	0.021	0.041	0.030	0.013	0.032	0.021	0.021	0.040	0.029	0.023
Friday	21	0.036	0.023	0.019	0.036	0.025	0.010	0.036	0.025	0.010	0.027	0.015	0.020	0.036	0.025	0.010	0.027	0.015	0.020	0.035	0.023	0.020
Friday	22	0.032	0.019	0.017	0.030	0.019	0.011	0.030	0.019	0.011	0.021	0.011	0.016	0.030	0.019	0.011	0.021	0.011	0.016	0.030	0.019	0.019
Friday	23	0.023	0.015	0.018	0.018	0.012	0.009	0.018	0.012	0.009	0.014	0.007	0.015	0.018	0.012	0.009	0.014	0.007	0.015	0.022	0.015	0.020
Saturday	0	0.016	0.033	0.052	0.010	0.015	0.027	0.010	0.015	0.027	0.012	0.007	0.021	0.010	0.015	0.027	0.012	0.007	0.021	0.015	0.030	0.044
Saturday	1	0.010	0.033	0.051	0.007	0.012	0.023	0.007	0.012	0.023	0.008	0.005	0.016	0.007	0.012	0.023	0.008	0.005	0.016	0.009	0.027	0.040
Saturday	2	0.008	0.033	0.049	0.005	0.011	0.022	0.005	0.011	0.022	0.006	0.004	0.020	0.005	0.011	0.022	0.006	0.004	0.020	0.006	0.026	0.039
Saturday	3	0.006	0.034	0.048	0.004	0.010	0.025	0.004	0.010	0.025	0.005	0.004	0.022	0.004	0.010	0.025	0.005	0.004	0.022	0.005	0.025	0.037
Saturday	4	0.008	0.035	0.048	0.005	0.013	0.028	0.005	0.013	0.028	0.006	0.008	0.024	0.005	0.013	0.028	0.006	0.008	0.024	0.006	0.027	0.037
Saturday	5	0.014	0.037	0.049	0.010	0.021	0.034	0.010	0.021	0.034	0.012	0.017	0.039	0.010	0.021	0.034	0.012	0.017	0.039	0.013	0.030	0.040
Saturday	6	0.023	0.039	0.050	0.017	0.028	0.039	0.017	0.028	0.039	0.021	0.028	0.049	0.017	0.028	0.039	0.021	0.028	0.049	0.023	0.035	0.042
Saturday	7	0.033	0.041	0.051	0.029	0.036	0.053	0.029	0.036	0.053	0.034	0.041	0.058	0.029	0.036	0.053	0.034	0.041	0.058	0.034	0.041	0.047
Saturday	8	0.045	0.044	0.052	0.044	0.045	0.060	0.044	0.045	0.060	0.045	0.057	0.067	0.044	0.045	0.060	0.045	0.057	0.067	0.046	0.047	0.049
Saturday	9	0.054	0.047	0.052	0.059	0.061	0.071	0.059	0.061	0.071	0.054	0.068	0.074	0.059	0.061	0.071	0.054	0.068	0.074	0.055	0.051	0.050
Saturday	10	0.060	0.050	0.051	0.073	0.074	0.078	0.073	0.074	0.078	0.063	0.080	0.073	0.073	0.074	0.078	0.063	0.080	0.073	0.061	0.054	0.051
Saturday	11	0.064	0.052	0.050	0.081	0.077	0.083	0.081	0.077	0.083	0.068	0.082	0.071	0.081	0.077	0.083	0.068	0.082	0.071	0.065	0.056	0.052
Saturday	12	0.066	0.053	0.048	0.078	0.077	0.075	0.078	0.077	0.075	0.074	0.083	0.068	0.078	0.077	0.075	0.074	0.083	0.068	0.066	0.058	0.055
Saturday	13	0.066	0.053	0.045	0.075	0.072	0.060	0.075	0.072	0.060	0.074	0.079	0.062	0.075	0.072	0.060	0.074	0.079	0.062	0.067	0.059	0.058
Saturday	14	0.066	0.053	0.042	0.075	0.068	0.055	0.075	0.068	0.055	0.074	0.076	0.057	0.075	0.068	0.055	0.074	0.076	0.057	0.067	0.058	0.057
Saturday	15	0.066	0.053	0.040	0.075	0.068	0.052	0.075	0.068	0.052	0.073	0.074	0.052	0.075	0.068	0.052	0.073	0.074	0.052	0.068	0.057	0.051
Saturday	16	0.065	0.051	0.037	0.072	0.070	0.047	0.072	0.070	0.047	0.073	0.067	0.045	0.072	0.070	0.047	0.073	0.067	0.045	0.068	0.056	0.047
Saturday	17	0.065	0.050	0.034	0.066	0.063	0.040	0.066	0.063	0.040	0.069	0.058	0.039	0.066	0.063	0.040	0.069	0.058	0.039	0.067	0.054	0.044
Saturday	18	0.060	0.046	0.031	0.058	0.052	0.031	0.058	0.052	0.031	0.058	0.047	0.034	0.058	0.052	0.031	0.058	0.047	0.034	0.060	0.048	0.036
Saturday	19	0.050	0.041	0.028	0.047	0.041	0.026	0.047	0.041	0.026	0.046	0.036	0.029	0.047	0.041	0.026	0.046	0.036	0.029	0.049	0.041	0.029
Saturday	20	0.043	0.036	0.025	0.038	0.031	0.020	0.038	0.031	0.020	0.040	0.028	0.024	0.038	0.031	0.020	0.040	0.028	0.024	0.043	0.036	0.025
Saturday	21	0.042	0.033	0.024	0.031	0.025	0.016	0.031	0.025	0.016	0.036	0.022	0.023	0.031	0.025	0.016	0.036	0.022	0.023	0.041	0.033	0.024
Saturday	22	0.039	0.029	0.023	0.025	0.020	0.018	0.025	0.020	0.018	0.029	0.016	0.017	0.025	0.020	0.018	0.029	0.016	0.017	0.037	0.029	0.023
Saturday	23	0.029	0.025	0.023	0.016	0.013	0.018	0.016	0.013	0.018	0.020	0.011	0.017	0.016	0.013	0.018	0.020	0.011	0.017	0.028	0.024	0.022
Holiday	0	0.015	0.028	0.035	0.008	0.011	0.020	0.008	0.011	0.020	0.010	0.004	0.012	0.008	0.011	0.020	0.010	0.004	0.012	0.013	0.027	0.034
Holiday	1	0.008	0.029	0.035	0.005	0.009	0.018	0.005	0.009	0.018	0.006	0.004	0.011	0.005	0.009	0.018	0.006	0.004	0.011	0.007	0.026	0.033
Holiday	2	0.006	0.031	0.036	0.003	0.010	0.018	0.003	0.010	0.018	0.004	0.003	0.012	0.003	0.010	0.018	0.004	0.003	0.012	0.004	0.025	0.033
Holiday	3	0.005	0.032	0.037	0.004	0.010	0.021	0.004	0.010	0.021	0.004	0.005	0.015	0.004	0.010	0.021	0.004	0.005	0.015	0.003	0.025	0.033
Holiday	4	0.009	0.035	0.040	0.005	0.012	0.020	0.005	0.012	0.020	0.007	0.009	0.024	0.005	0.012	0.020	0.007	0.009	0.024	0.007	0.029	0.035
Holiday	5	0.019	0.037	0.043	0.009	0.018	0.031	0.009	0.018	0.031	0.014	0.020	0.037	0.009	0.018	0.031	0.014	0.020	0.037	0.017	0.034	0.039
Holiday	6	0.029	0.042	0.045	0.018	0.023	0.038	0.018	0.023	0.038	0.030	0.036	0.047	0.018	0.023	0.038	0.030	0.036	0.047	0.029	0.040	0.044
Holiday	7	0.038	0.046	0.048	0.029	0.031	0.043	0.029	0.031	0.043	0.044	0.052	0.061	0.029	0.031	0.043	0.044	0.052	0.061	0.038	0.045	0.047
Holiday	8	0.046	0.049	0.051	0.041	0.044	0.056	0.041	0.044	0.056	0.052	0.066	0.075	0.041	0.044	0.056	0.052	0.066	0.075	0.045	0.050	0.051
Holiday	9	0.049	0.050	0.052	0.058	0.057	0.075	0.058	0.057	0.075	0.053	0.071	0.081	0.058	0.057	0.075	0.053	0.071	0.081	0.049	0.053	0.052
Holiday	10	0.055	0.053	0.053	0.076	0.083	0.087	0.076	0.083	0.087	0.059	0.076	0.081	0.076	0.083	0.087	0.059	0.076	0.081	0.056	0.056	0.053
Holiday	11	0.060	0.056	0.054	0.084	0.086	0.088	0.084	0.086	0.088	0.066	0.076	0.071	0.084	0.086	0.088	0.066	0.076	0.071	0.062	0.059	0.055
Holiday	12	0.064	0.058	0.055	0.085	0.087	0.089	0.085	0.087	0.089	0.071	0.078	0.074	0.085	0.087	0.089	0.071	0.078	0.074	0.067	0.061	0.056
Holiday	13	0.066	0.059	0.054	0.083	0.081	0.078	0.083	0.081	0.078	0.071	0.076	0.065	0.083	0.081	0.078	0.071	0.076	0.065	0.070	0.062	0.056
Holiday	14	0.069	0.060	0.053	0.080	0.074	0.068	0.080	0.074	0.068	0.070	0.078	0.060	0.080	0.074	0.068	0.070	0.078	0.060	0.073	0.062	0.057
Holiday	15	0.069	0.058	0.051	0.078	0.074	0.060	0.078	0.074	0.060	0.075	0.075	0.053	0.078	0.074	0.060	0.075	0.075	0.053	0.071	0.061	0.054
Holiday	16	0.068	0.056	0.047	0.078	0.072	0.049	0.078	0.072	0.049	0.079	0.070	0.044	0.078	0.072	0.049	0.079	0.070	0.044	0.070	0.057	0.050
Holiday	17	0.066	0.051	0.043	0.071	0.066	0.041	0.071	0.066	0.041	0.074	0.064	0.041	0.071	0.066	0.041	0.074	0.064	0.041	0.067	0.053	0.044
Holiday	18	0.060	0.044	0.037	0.057	0.049	0.033	0.057	0.049	0.033	0.058	0.044	0.034	0.057	0.049	0.033	0.058	0.044	0.034	0.059	0.045	0.038
Holiday	19	0.052	0.036	0.031	0.043	0.040	0.022	0.043	0.040	0.022	0.047	0.033	0.026	0.043	0.040	0.022	0.047	0.033	0.026	0.051	0.036	0.031
Holiday	20	0.046	0.030	0.027	0.033	0.026	0.013	0.033	0.026	0.013	0.038	0.025	0.025	0.033	0.026	0.013	0.038	0.025	0.025	0.046	0.031	0.028

70

		Alameda			Alpine			Amador			Butte			Calaveras			Colusa			Contra Costa		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Holiday	21	0.042	0.025	0.024	0.024	0.018	0.011	0.024	0.018	0.011	0.030	0.018	0.021	0.024	0.018	0.011	0.030	0.018	0.021	0.041	0.026	0.026
Holiday	22	0.035	0.020	0.024	0.017	0.012	0.009	0.017	0.012	0.009	0.024	0.011	0.017	0.017	0.012	0.009	0.024	0.011	0.017	0.033	0.021	0.025
Holiday	23	0.024	0.016	0.026	0.010	0.008	0.010	0.010	0.008	0.010	0.014	0.007	0.014	0.010	0.008	0.010	0.014	0.007	0.014	0.021	0.017	0.026

		Del Norte			El Dorado			Fresno			Glenn			Humboldt			Imperial			Inyo		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Sunday	0	0.013	0.011	0.008	0.013	0.020	0.031	0.015	0.033	0.043	0.015	0.010	0.015	0.013	0.011	0.008	0.026	0.015	0.017	0.010	0.014	0.032
Sunday	1	0.013	0.008	0.010	0.008	0.016	0.028	0.010	0.030	0.040	0.010	0.006	0.011	0.013	0.008	0.010	0.026	0.013	0.016	0.007	0.011	0.024
Sunday	2	0.012	0.006	0.008	0.006	0.013	0.026	0.008	0.027	0.037	0.007	0.004	0.012	0.012	0.006	0.008	0.025	0.009	0.014	0.005	0.011	0.022
Sunday	3	0.014	0.005	0.007	0.005	0.012	0.025	0.005	0.025	0.034	0.006	0.004	0.012	0.014	0.005	0.007	0.025	0.008	0.015	0.004	0.010	0.021
Sunday	4	0.014	0.004	0.011	0.005	0.012	0.025	0.006	0.024	0.034	0.006	0.005	0.017	0.014	0.004	0.011	0.027	0.010	0.015	0.004	0.010	0.020
Sunday	5	0.017	0.009	0.019	0.008	0.015	0.027	0.010	0.026	0.034	0.010	0.011	0.029	0.017	0.009	0.019	0.030	0.015	0.017	0.007	0.013	0.021
Sunday	6	0.021	0.014	0.028	0.013	0.020	0.030	0.017	0.029	0.036	0.016	0.017	0.037	0.021	0.014	0.028	0.032	0.019	0.021	0.012	0.019	0.026
Sunday	7	0.026	0.020	0.036	0.022	0.028	0.034	0.022	0.032	0.037	0.023	0.029	0.051	0.026	0.020	0.036	0.033	0.026	0.029	0.019	0.023	0.029
Sunday	8	0.031	0.032	0.043	0.034	0.041	0.040	0.032	0.038	0.040	0.033	0.043	0.071	0.031	0.032	0.043	0.037	0.039	0.035	0.032	0.035	0.038
Sunday	9	0.040	0.050	0.054	0.048	0.055	0.046	0.044	0.046	0.044	0.047	0.063	0.091	0.040	0.050	0.054	0.040	0.053	0.047	0.051	0.051	0.053
Sunday	10	0.047	0.064	0.067	0.064	0.068	0.052	0.055	0.052	0.046	0.057	0.075	0.084	0.047	0.064	0.067	0.043	0.063	0.057	0.067	0.067	0.071
Sunday	11	0.055	0.079	0.062	0.075	0.075	0.055	0.063	0.057	0.047	0.067	0.083	0.079	0.055	0.079	0.062	0.046	0.071	0.065	0.080	0.081	0.085
Sunday	12	0.061	0.087	0.065	0.082	0.079	0.058	0.071	0.062	0.049	0.074	0.090	0.070	0.061	0.087	0.065	0.048	0.075	0.068	0.083	0.081	0.076
Sunday	13	0.065	0.092	0.064	0.084	0.079	0.058	0.076	0.064	0.049	0.078	0.089	0.061	0.065	0.092	0.064	0.052	0.078	0.068	0.085	0.082	0.074
Sunday	14	0.067	0.087	0.065	0.084	0.077	0.057	0.077	0.063	0.048	0.079	0.081	0.057	0.067	0.087	0.065	0.053	0.074	0.065	0.085	0.083	0.069
Sunday	15	0.072	0.086	0.067	0.082	0.073	0.057	0.077	0.061	0.047	0.080	0.079	0.053	0.072	0.086	0.067	0.056	0.071	0.061	0.084	0.081	0.066
Sunday	16	0.077	0.086	0.072	0.079	0.068	0.055	0.075	0.059	0.046	0.079	0.075	0.045	0.077	0.086	0.072	0.056	0.068	0.058	0.082	0.079	0.060
Sunday	17	0.070	0.075	0.058	0.072	0.062	0.053	0.073	0.056	0.045	0.075	0.066	0.043	0.070	0.075	0.058	0.059	0.067	0.055	0.076	0.070	0.053
Sunday	18	0.067	0.059	0.054	0.060	0.052	0.049	0.066	0.050	0.044	0.066	0.054	0.039	0.067	0.059	0.054	0.059	0.062	0.055	0.064	0.056	0.043
Sunday	19	0.062	0.045	0.050	0.050	0.043	0.045	0.057	0.044	0.042	0.055	0.042	0.037	0.062	0.045	0.050	0.057	0.051	0.051	0.049	0.043	0.035
Sunday	20	0.054	0.035	0.047	0.041	0.035	0.042	0.050	0.038	0.041	0.045	0.031	0.030	0.054	0.035	0.047	0.052	0.041	0.049	0.038	0.033	0.024
Sunday	21	0.045	0.024	0.039	0.031	0.026	0.039	0.040	0.033	0.040	0.035	0.022	0.024	0.045	0.024	0.039	0.047	0.032	0.044	0.026	0.022	0.020
Sunday	22	0.033	0.015	0.033	0.021	0.019	0.036	0.030	0.028	0.040	0.023	0.013	0.018	0.033	0.015	0.033	0.039	0.023	0.042	0.017	0.014	0.017
Sunday	23	0.022	0.009	0.032	0.013	0.015	0.033	0.020	0.023	0.039	0.014	0.008	0.015	0.022	0.009	0.032	0.031	0.018	0.038	0.010	0.010	0.020
Monday	0	0.010	0.003	0.007	0.008	0.014	0.027	0.009	0.019	0.024	0.006	0.002	0.006	0.010	0.003	0.007	0.025	0.010	0.016	0.006	0.010	0.017
Monday	1	0.009	0.002	0.007	0.005	0.012	0.025	0.005	0.018	0.023	0.004	0.002	0.007	0.009	0.002	0.007	0.025	0.008	0.016	0.004	0.009	0.016
Monday	2	0.010	0.003	0.010	0.004	0.012	0.025	0.004	0.018	0.023	0.003	0.002	0.010	0.010	0.003	0.010	0.024	0.008	0.017	0.003	0.009	0.016
Monday	3	0.012	0.006	0.012	0.006	0.014	0.027	0.005	0.020	0.025	0.003	0.004	0.012	0.012	0.006	0.012	0.030	0.014	0.019	0.005	0.011	0.019
Monday	4	0.014	0.009	0.013	0.011	0.019	0.030	0.011	0.023	0.027	0.007	0.009	0.021	0.014	0.009	0.013	0.030	0.022	0.025	0.008	0.017	0.024
Monday	5	0.022	0.022	0.026	0.023	0.030	0.036	0.024	0.034	0.033	0.018	0.024	0.037	0.022	0.022	0.026	0.034	0.036	0.031	0.019	0.028	0.036
Monday	6	0.037	0.047	0.044	0.042	0.047	0.043	0.044	0.047	0.041	0.041	0.051	0.055	0.037	0.047	0.044	0.036	0.043	0.034	0.036	0.041	0.050
Monday	7	0.045	0.058	0.058	0.060	0.061	0.048	0.069	0.064	0.048	0.078	0.069	0.066	0.045	0.058	0.058	0.040	0.056	0.039	0.051	0.044	0.065
Monday	8	0.047	0.062	0.067	0.059	0.062	0.050	0.063	0.062	0.049	0.067	0.077	0.077	0.047	0.062	0.067	0.041	0.065	0.045	0.053	0.056	0.068
Monday	9	0.050	0.065	0.078	0.056	0.061	0.050	0.055	0.056	0.047	0.057	0.071	0.080	0.050	0.065	0.078	0.043	0.064	0.051	0.059	0.065	0.080
Monday	10	0.051	0.065	0.080	0.058	0.064	0.051	0.055	0.056	0.048	0.057	0.071	0.077	0.051	0.065	0.080	0.044	0.069	0.058	0.067	0.074	0.087
Monday	11	0.056	0.067	0.083	0.062	0.066	0.053	0.057	0.059	0.050	0.060	0.074	0.073	0.056	0.067	0.083	0.047	0.071	0.066	0.071	0.075	0.082
Monday	12	0.058	0.069	0.081	0.066	0.068	0.054	0.061	0.061	0.052	0.063	0.072	0.071	0.058	0.069	0.081	0.048	0.068	0.067	0.074	0.074	0.080
Monday	13	0.063	0.074	0.076	0.067	0.067	0.054	0.063	0.062	0.054	0.063	0.072	0.068	0.063	0.074	0.076	0.050	0.070	0.067	0.074	0.075	0.075
Monday	14	0.067	0.076	0.074	0.070	0.069	0.055	0.069	0.065	0.056	0.067	0.077	0.064	0.067	0.076	0.074	0.051	0.069	0.066	0.077	0.076	0.065
Monday	15	0.073	0.087	0.062	0.073	0.069	0.055	0.074	0.068	0.058	0.078	0.080	0.056	0.073	0.087	0.062	0.057	0.072	0.062	0.082	0.076	0.058
Monday	16	0.076	0.084	0.053	0.075	0.067	0.054	0.079	0.068	0.059	0.086	0.077	0.049	0.076	0.084	0.053	0.054	0.063	0.061	0.081	0.073	0.045
Monday	17	0.075	0.075	0.040	0.073	0.061	0.052	0.076	0.062	0.057	0.087	0.062	0.041	0.075	0.075	0.040	0.057	0.054	0.055	0.071	0.059	0.035

		Del Norte			El Dorado			Fresno			Glenn			Humboldt			Imperial			Inyo		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Monday	18	0.057	0.047	0.032	0.056	0.046	0.045	0.053	0.043	0.050	0.051	0.038	0.030	0.057	0.047	0.032	0.054	0.040	0.047	0.052	0.042	0.023
Monday	19	0.050	0.031	0.029	0.040	0.031	0.039	0.037	0.030	0.043	0.036	0.024	0.024	0.050	0.031	0.029	0.052	0.032	0.041	0.037	0.030	0.017
Monday	20	0.043	0.020	0.021	0.031	0.022	0.035	0.030	0.023	0.039	0.026	0.018	0.023	0.043	0.020	0.021	0.047	0.022	0.037	0.027	0.022	0.013
Monday	21	0.035	0.015	0.020	0.025	0.017	0.032	0.024	0.018	0.035	0.020	0.012	0.021	0.035	0.015	0.020	0.045	0.018	0.031	0.020	0.016	0.010
Monday	22	0.025	0.009	0.014	0.017	0.012	0.030	0.018	0.013	0.032	0.013	0.007	0.017	0.025	0.009	0.014	0.038	0.013	0.026	0.015	0.012	0.009
Monday	23	0.016	0.005	0.013	0.012	0.009	0.030	0.012	0.010	0.029	0.008	0.004	0.015	0.016	0.005	0.013	0.030	0.014	0.025	0.009	0.007	0.010
Tues/Wed/Thurs	0	0.010	0.004	0.008	0.008	0.014	0.029	0.007	0.018	0.027	0.006	0.003	0.010	0.010	0.004	0.008	0.024	0.011	0.023	0.005	0.009	0.017
Tues/Wed/Thurs	1	0.009	0.003	0.008	0.004	0.011	0.027	0.004	0.017	0.027	0.003	0.002	0.011	0.009	0.003	0.008	0.025	0.009	0.020	0.003	0.008	0.017
Tues/Wed/Thurs	2	0.010	0.002	0.012	0.004	0.011	0.027	0.003	0.017	0.027	0.003	0.002	0.013	0.010	0.002	0.012	0.026	0.008	0.020	0.002	0.009	0.017
Tues/Wed/Thurs	3	0.011	0.005	0.014	0.005	0.013	0.029	0.004	0.019	0.028	0.003	0.003	0.015	0.011	0.005	0.014	0.027	0.012	0.022	0.003	0.010	0.022
Tues/Wed/Thurs	4	0.015	0.010	0.021	0.010	0.018	0.031	0.009	0.023	0.031	0.006	0.008	0.022	0.015	0.010	0.021	0.029	0.018	0.025	0.006	0.014	0.025
Tues/Wed/Thurs	5	0.024	0.024	0.035	0.022	0.029	0.037	0.024	0.032	0.036	0.017	0.024	0.037	0.024	0.024	0.035	0.034	0.036	0.032	0.018	0.027	0.039
Tues/Wed/Thurs	6	0.037	0.048	0.048	0.042	0.047	0.044	0.044	0.047	0.044	0.041	0.053	0.054	0.037	0.048	0.048	0.036	0.046	0.039	0.037	0.042	0.052
Tues/Wed/Thurs	7	0.045	0.059	0.065	0.060	0.061	0.050	0.070	0.064	0.051	0.077	0.069	0.066	0.045	0.059	0.065	0.040	0.057	0.044	0.053	0.047	0.064
Tues/Wed/Thurs	8	0.047	0.063	0.069	0.060	0.062	0.051	0.065	0.063	0.051	0.066	0.077	0.077	0.047	0.063	0.069	0.041	0.065	0.048	0.054	0.056	0.070
Tues/Wed/Thurs	9	0.050	0.064	0.074	0.055	0.060	0.050	0.055	0.057	0.049	0.057	0.071	0.080	0.050	0.064	0.074	0.041	0.062	0.053	0.059	0.068	0.083
Tues/Wed/Thurs	10	0.051	0.065	0.075	0.056	0.061	0.051	0.054	0.056	0.050	0.056	0.071	0.077	0.051	0.065	0.075	0.044	0.066	0.057	0.064	0.069	0.081
Tues/Wed/Thurs	11	0.055	0.065	0.076	0.059	0.064	0.052	0.055	0.058	0.051	0.058	0.071	0.074	0.055	0.065	0.076	0.046	0.067	0.061	0.068	0.069	0.077
Tues/Wed/Thurs	12	0.057	0.068	0.076	0.061	0.065	0.053	0.058	0.060	0.051	0.062	0.070	0.069	0.057	0.068	0.076	0.048	0.067	0.064	0.069	0.071	0.074
Tues/Wed/Thurs	13	0.061	0.070	0.071	0.064	0.066	0.053	0.061	0.062	0.053	0.063	0.073	0.067	0.061	0.070	0.071	0.049	0.069	0.063	0.072	0.073	0.074
Tues/Wed/Thurs	14	0.066	0.074	0.068	0.068	0.068	0.053	0.068	0.065	0.054	0.066	0.076	0.063	0.066	0.074	0.068	0.052	0.069	0.061	0.077	0.076	0.067
Tues/Wed/Thurs	15	0.073	0.084	0.062	0.073	0.069	0.053	0.074	0.067	0.056	0.079	0.080	0.056	0.073	0.084	0.062	0.055	0.071	0.057	0.084	0.078	0.058
Tues/Wed/Thurs	16	0.078	0.086	0.053	0.075	0.067	0.052	0.080	0.067	0.056	0.087	0.076	0.045	0.078	0.086	0.053	0.057	0.065	0.056	0.082	0.074	0.048
Tues/Wed/Thurs	17	0.077	0.078	0.041	0.074	0.063	0.050	0.078	0.063	0.054	0.088	0.062	0.040	0.077	0.078	0.041	0.056	0.054	0.051	0.074	0.061	0.036
Tues/Wed/Thurs	18	0.059	0.047	0.030	0.059	0.048	0.044	0.055	0.045	0.047	0.054	0.039	0.031	0.059	0.047	0.030	0.053	0.041	0.045	0.053	0.044	0.023
Tues/Wed/Thurs	19	0.048	0.031	0.027	0.043	0.034	0.038	0.039	0.032	0.040	0.036	0.026	0.023	0.048	0.031	0.027	0.052	0.032	0.039	0.038	0.031	0.016
Tues/Wed/Thurs	20	0.041	0.021	0.020	0.035	0.025	0.034	0.032	0.024	0.035	0.028	0.019	0.021	0.041	0.021	0.020	0.050	0.024	0.036	0.030	0.025	0.012
Tues/Wed/Thurs	21	0.036	0.017	0.020	0.029	0.019	0.031	0.027	0.019	0.032	0.021	0.013	0.020	0.036	0.017	0.020	0.045	0.021	0.030	0.023	0.018	0.010
Tues/Wed/Thurs	22	0.025	0.009	0.014	0.020	0.013	0.029	0.020	0.014	0.028	0.014	0.007	0.016	0.025	0.009	0.014	0.039	0.016	0.027	0.017	0.013	0.010
Tues/Wed/Thurs	23	0.017	0.005	0.012	0.013	0.009	0.028	0.013	0.010	0.025	0.009	0.004	0.013	0.017	0.005	0.012	0.031	0.013	0.025	0.010	0.008	0.010
Friday	0	0.009	0.004	0.008	0.007	0.014	0.032	0.007	0.019	0.030	0.007	0.003	0.011	0.009	0.004	0.008	0.023	0.009	0.025	0.005	0.009	0.019
Friday	1	0.009	0.003	0.009	0.005	0.011	0.030	0.004	0.018	0.030	0.004	0.003	0.012	0.009	0.003	0.009	0.024	0.009	0.022	0.003	0.008	0.019
Friday	2	0.009	0.003	0.011	0.004	0.011	0.030	0.003	0.017	0.029	0.004	0.003	0.015	0.009	0.003	0.011	0.024	0.009	0.021	0.002	0.008	0.019
Friday	3	0.011	0.005	0.016	0.005	0.012	0.030	0.004	0.019	0.031	0.004	0.004	0.017	0.011	0.005	0.016	0.026	0.011	0.023	0.002	0.008	0.021
Friday	4	0.013	0.009	0.022	0.008	0.016	0.033	0.009	0.023	0.034	0.006	0.007	0.024	0.013	0.009	0.022	0.028	0.017	0.027	0.005	0.013	0.024
Friday	5	0.021	0.021	0.039	0.017	0.026	0.038	0.020	0.032	0.039	0.015	0.022	0.039	0.021	0.021	0.039	0.032	0.031	0.034	0.013	0.023	0.037
Friday	6	0.033	0.041	0.054	0.033	0.040	0.045	0.037	0.044	0.046	0.035	0.045	0.055	0.033	0.041	0.054	0.034	0.040	0.040	0.026	0.035	0.049
Friday	7	0.039	0.052	0.065	0.049	0.054	0.050	0.059	0.060	0.053	0.063	0.063	0.064	0.039	0.052	0.065	0.036	0.052	0.049	0.039	0.040	0.060
Friday	8	0.044	0.059	0.074	0.051	0.057	0.052	0.057	0.059	0.053	0.058	0.072	0.074	0.044	0.059	0.074	0.039	0.058	0.051	0.043	0.049	0.068
Friday	9	0.047	0.060	0.078	0.050	0.057	0.052	0.052	0.056	0.052	0.052	0.068	0.075	0.047	0.060	0.078	0.040	0.059	0.056	0.049	0.057	0.073
Friday	10	0.048	0.067	0.075	0.054	0.061	0.054	0.053	0.057	0.052	0.055	0.071	0.074	0.048	0.067	0.075	0.043	0.063	0.060	0.058	0.063	0.078
Friday	11	0.054	0.068	0.077	0.060	0.066	0.055	0.056	0.059	0.053	0.060	0.074	0.074	0.054	0.068	0.077	0.045	0.066	0.064	0.064	0.069	0.077
Friday	12	0.060	0.072	0.079	0.063	0.067	0.055	0.059	0.061	0.053	0.063	0.072	0.069	0.060	0.072	0.079	0.046	0.063	0.065	0.066	0.071	0.076
Friday	13	0.063	0.075	0.072	0.066	0.068	0.054	0.062	0.063	0.054	0.065	0.076	0.069	0.063	0.075	0.072	0.049	0.066	0.063	0.071	0.074	0.077
Friday	14	0.068	0.078	0.067	0.070	0.070	0.054	0.068	0.066	0.055	0.069	0.078	0.063	0.068	0.078	0.067	0.051	0.067	0.059	0.076	0.077	0.070
Friday	15	0.073	0.083	0.060	0.073	0.070	0.052	0.073	0.067	0.055	0.078	0.080	0.055	0.073	0.083	0.060	0.054	0.069	0.057	0.083	0.079	0.060
Friday	16	0.076	0.082	0.049	0.074	0.067	0.050	0.077	0.067	0.053	0.085	0.075	0.047	0.076	0.082	0.049	0.056	0.067	0.053	0.083	0.077	0.050
Friday	17	0.074	0.072	0.038	0.072	0.063	0.047	0.074	0.061	0.050	0.082	0.061	0.039	0.074	0.072	0.038	0.058	0.060	0.048	0.075	0.064	0.038
Friday	18	0.060	0.050	0.026	0.063	0.051	0.042	0.060	0.047	0.043	0.059	0.041	0.029	0.060	0.050	0.026	0.057	0.051	0.042	0.062	0.051	0.025
Friday	19	0.052	0.034	0.024	0.050	0.039	0.035	0.046	0.034	0.036	0.042	0.028	0.024	0.052	0.034	0.024	0.057	0.043	0.038	0.050	0.039	0.018
Friday	20	0.043	0.022	0.017	0.041	0.029	0.030	0.038	0.026	0.030	0.032	0.021	0.021	0.043	0.022	0.017	0.053	0.033	0.033	0.041	0.030	0.013
Friday	21	0.040	0.018	0.016	0.037	0.023	0.028	0.034	0.020	0.026	0.027	0.015	0.020	0.040	0.018	0.016	0.049	0.025	0.027	0.036	0.025	0.010

		Del Norte			El Dorado			Fresno			Glenn			Humboldt			Imperial			Inyo		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Friday	22	0.031	0.012	0.011	0.030	0.017	0.026	0.028	0.015	0.023	0.021	0.011	0.016	0.031	0.012	0.011	0.042	0.017	0.023	0.030	0.019	0.011
Friday	23	0.022	0.007	0.012	0.019	0.011	0.024	0.020	0.011	0.020	0.014	0.007	0.015	0.022	0.007	0.012	0.034	0.014	0.020	0.018	0.012	0.009
Saturday	0	0.012	0.008	0.014	0.013	0.019	0.038	0.015	0.028	0.041	0.012	0.007	0.021	0.012	0.008	0.014	0.025	0.018	0.036	0.010	0.015	0.027
Saturday	1	0.013	0.006	0.014	0.008	0.015	0.034	0.010	0.025	0.038	0.008	0.005	0.016	0.013	0.006	0.014	0.027	0.015	0.030	0.007	0.012	0.023
Saturday	2	0.013	0.004	0.011	0.006	0.014	0.032	0.008	0.024	0.037	0.006	0.004	0.020	0.013	0.004	0.011	0.027	0.012	0.024	0.005	0.011	0.022
Saturday	3	0.012	0.004	0.014	0.006	0.013	0.031	0.006	0.023	0.036	0.005	0.004	0.022	0.012	0.004	0.014	0.028	0.015	0.027	0.004	0.010	0.025
Saturday	4	0.014	0.008	0.020	0.007	0.014	0.032	0.009	0.024	0.037	0.006	0.008	0.024	0.014	0.008	0.020	0.031	0.019	0.030	0.005	0.013	0.028
Saturday	5	0.020	0.016	0.034	0.011	0.018	0.034	0.016	0.029	0.040	0.012	0.017	0.039	0.020	0.016	0.034	0.034	0.035	0.037	0.010	0.021	0.034
Saturday	6	0.025	0.025	0.043	0.019	0.026	0.039	0.026	0.036	0.045	0.021	0.028	0.049	0.025	0.025	0.043	0.035	0.038	0.043	0.017	0.028	0.039
Saturday	7	0.030	0.031	0.058	0.032	0.038	0.046	0.036	0.043	0.049	0.034	0.041	0.058	0.030	0.031	0.058	0.038	0.050	0.050	0.029	0.036	0.053
Saturday	8	0.036	0.041	0.070	0.045	0.051	0.052	0.045	0.050	0.052	0.045	0.057	0.067	0.036	0.041	0.070	0.040	0.057	0.055	0.044	0.045	0.060
Saturday	9	0.043	0.053	0.079	0.057	0.062	0.056	0.053	0.055	0.054	0.054	0.068	0.074	0.043	0.053	0.079	0.043	0.064	0.058	0.059	0.061	0.071
Saturday	10	0.052	0.069	0.082	0.067	0.071	0.060	0.060	0.061	0.056	0.063	0.080	0.073	0.052	0.069	0.082	0.044	0.066	0.064	0.073	0.074	0.078
Saturday	11	0.054	0.076	0.075	0.074	0.076	0.061	0.066	0.064	0.056	0.068	0.082	0.071	0.054	0.076	0.075	0.045	0.064	0.069	0.081	0.077	0.083
Saturday	12	0.061	0.080	0.070	0.075	0.075	0.060	0.069	0.065	0.056	0.074	0.083	0.068	0.061	0.080	0.070	0.046	0.063	0.066	0.078	0.077	0.075
Saturday	13	0.063	0.082	0.064	0.075	0.074	0.057	0.069	0.063	0.054	0.074	0.079	0.062	0.063	0.082	0.064	0.049	0.063	0.063	0.075	0.072	0.060
Saturday	14	0.065	0.081	0.062	0.074	0.071	0.055	0.070	0.063	0.053	0.074	0.076	0.057	0.065	0.081	0.062	0.051	0.062	0.059	0.075	0.068	0.055
Saturday	15	0.067	0.080	0.054	0.072	0.068	0.051	0.069	0.060	0.049	0.073	0.074	0.052	0.067	0.080	0.054	0.053	0.062	0.053	0.075	0.068	0.052
Saturday	16	0.071	0.081	0.051	0.070	0.064	0.048	0.067	0.057	0.046	0.073	0.067	0.045	0.071	0.081	0.051	0.053	0.057	0.047	0.072	0.070	0.047
Saturday	17	0.068	0.072	0.037	0.066	0.057	0.044	0.063	0.051	0.042	0.069	0.058	0.039	0.068	0.072	0.037	0.054	0.054	0.039	0.066	0.063	0.040
Saturday	18	0.062	0.053	0.032	0.056	0.047	0.038	0.056	0.044	0.036	0.058	0.047	0.034	0.062	0.053	0.032	0.055	0.048	0.034	0.058	0.052	0.031
Saturday	19	0.059	0.040	0.029	0.046	0.037	0.033	0.047	0.036	0.031	0.046	0.036	0.029	0.059	0.040	0.029	0.052	0.040	0.030	0.047	0.041	0.026
Saturday	20	0.051	0.032	0.021	0.040	0.030	0.028	0.041	0.031	0.027	0.040	0.028	0.024	0.051	0.032	0.021	0.049	0.032	0.026	0.038	0.031	0.020
Saturday	21	0.047	0.026	0.023	0.035	0.025	0.025	0.038	0.027	0.023	0.036	0.022	0.023	0.047	0.026	0.023	0.045	0.025	0.023	0.031	0.025	0.016
Saturday	22	0.037	0.019	0.020	0.028	0.019	0.023	0.034	0.024	0.021	0.029	0.016	0.017	0.037	0.019	0.020	0.040	0.020	0.020	0.025	0.020	0.018
Saturday	23	0.028	0.014	0.021	0.020	0.014	0.021	0.024	0.019	0.019	0.020	0.011	0.017	0.028	0.014	0.021	0.036	0.018	0.016	0.016	0.013	0.018
Holiday	0	0.010	0.004	0.009	0.010	0.016	0.028	0.013	0.023	0.029	0.010	0.004	0.012	0.010	0.004	0.009	0.027	0.013	0.019	0.008	0.011	0.020
Holiday	1	0.014	0.004	0.008	0.006	0.013	0.027	0.007	0.022	0.027	0.006	0.004	0.011	0.014	0.004	0.008	0.028	0.009	0.017	0.005	0.009	0.018
Holiday	2	0.010	0.003	0.014	0.004	0.012	0.026	0.005	0.022	0.027	0.004	0.003	0.012	0.010	0.003	0.014	0.026	0.008	0.018	0.003	0.010	0.018
Holiday	3	0.014	0.005	0.012	0.005	0.013	0.027	0.004	0.021	0.028	0.004	0.005	0.015	0.014	0.005	0.012	0.027	0.010	0.018	0.004	0.010	0.021
Holiday	4	0.014	0.006	0.017	0.008	0.016	0.029	0.008	0.024	0.030	0.007	0.009	0.024	0.014	0.006	0.017	0.030	0.016	0.022	0.005	0.012	0.020
Holiday	5	0.019	0.018	0.028	0.014	0.023	0.032	0.016	0.031	0.034	0.014	0.020	0.037	0.019	0.018	0.028	0.030	0.026	0.029	0.009	0.018	0.031
Holiday	6	0.028	0.034	0.042	0.025	0.033	0.036	0.028	0.039	0.038	0.030	0.036	0.047	0.028	0.034	0.042	0.032	0.032	0.031	0.018	0.023	0.038
Holiday	7	0.039	0.045	0.052	0.036	0.044	0.042	0.040	0.046	0.041	0.044	0.052	0.061	0.039	0.045	0.052	0.036	0.042	0.037	0.029	0.031	0.043
Holiday	8	0.041	0.051	0.059	0.046	0.053	0.048	0.045	0.049	0.043	0.052	0.066	0.075	0.041	0.051	0.059	0.040	0.055	0.044	0.041	0.044	0.056
Holiday	9	0.044	0.057	0.066	0.054	0.059	0.050	0.049	0.052	0.047	0.053	0.071	0.081	0.044	0.057	0.066	0.042	0.061	0.054	0.058	0.057	0.075
Holiday	10	0.050	0.069	0.075	0.065	0.069	0.053	0.057	0.059	0.049	0.059	0.076	0.081	0.050	0.069	0.075	0.045	0.067	0.060	0.076	0.083	0.087
Holiday	11	0.056	0.072	0.077	0.074	0.074	0.057	0.065	0.063	0.051	0.066	0.076	0.071	0.056	0.072	0.077	0.047	0.070	0.068	0.084	0.086	0.088
Holiday	12	0.058	0.080	0.078	0.077	0.074	0.056	0.070	0.067	0.054	0.071	0.078	0.074	0.058	0.080	0.078	0.046	0.069	0.070	0.085	0.087	0.089
Holiday	13	0.063	0.077	0.069	0.076	0.074	0.058	0.072	0.067	0.056	0.071	0.076	0.065	0.063	0.077	0.069	0.053	0.080	0.070	0.083	0.081	0.078
Holiday	14	0.068	0.083	0.067	0.075	0.073	0.056	0.074	0.066	0.055	0.070	0.078	0.060	0.068	0.083	0.067	0.051	0.075	0.068	0.080	0.074	0.068
Holiday	15	0.071	0.082	0.064	0.074	0.070	0.055	0.076	0.067	0.056	0.075	0.075	0.053	0.071	0.082	0.064	0.054	0.067	0.062	0.078	0.074	0.060
Holiday	16	0.075	0.083	0.061	0.072	0.066	0.054	0.076	0.064	0.055	0.079	0.070	0.044	0.075	0.083	0.061	0.056	0.066	0.057	0.078	0.072	0.049
Holiday	17	0.072	0.076	0.044	0.068	0.059	0.051	0.072	0.058	0.052	0.074	0.064	0.041	0.072	0.076	0.044	0.056	0.061	0.054	0.071	0.066	0.041
Holiday	18	0.054	0.048	0.040	0.057	0.049	0.045	0.058	0.046	0.049	0.058	0.044	0.034	0.054	0.048	0.040	0.052	0.047	0.045	0.057	0.049	0.033
Holiday	19	0.056	0.036	0.029	0.047	0.036	0.041	0.047	0.035	0.043	0.047	0.033	0.026	0.056	0.036	0.029	0.053	0.039	0.040	0.043	0.040	0.022
Holiday	20	0.049	0.025	0.029	0.039	0.029	0.037	0.039	0.028	0.040	0.038	0.025	0.025	0.049	0.025	0.029	0.049	0.029	0.035	0.033	0.026	0.013
Holiday	21	0.040	0.019	0.023	0.030	0.020	0.033	0.032	0.022	0.036	0.030	0.018	0.021	0.040	0.019	0.023	0.046	0.022	0.030	0.024	0.018	0.011
Holiday	22	0.029	0.012	0.018	0.023	0.015	0.031	0.026	0.017	0.032	0.024	0.011	0.017	0.029	0.012	0.018	0.042	0.020	0.027	0.017	0.012	0.009
Holiday	23	0.025	0.010	0.019	0.015	0.010	0.029	0.018	0.013	0.029	0.014	0.007	0.014	0.025	0.010	0.019	0.032	0.019	0.025	0.010	0.008	0.010

		Kern			Kings			Lake			Lassen			Los Angeles			Madera			Marin		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Sunday	0	0.014	0.028	0.041	0.016	0.031	0.042	0.013	0.011	0.008	0.020	0.007	0.015	0.025	0.043	0.051	0.014	0.037	0.044	0.019	0.038	0.053
Sunday	1	0.010	0.024	0.038	0.010	0.025	0.038	0.013	0.008	0.010	0.020	0.005	0.014	0.018	0.033	0.044	0.008	0.032	0.040	0.012	0.034	0.047
Sunday	2	0.007	0.022	0.034	0.007	0.026	0.036	0.012	0.006	0.008	0.020	0.003	0.012	0.014	0.028	0.040	0.005	0.028	0.037	0.008	0.031	0.043
Sunday	3	0.006	0.020	0.033	0.005	0.022	0.031	0.014	0.005	0.007	0.021	0.004	0.011	0.009	0.022	0.035	0.004	0.026	0.035	0.006	0.030	0.040
Sunday	4	0.007	0.021	0.033	0.004	0.020	0.031	0.014	0.004	0.011	0.024	0.007	0.011	0.008	0.021	0.034	0.004	0.025	0.034	0.006	0.029	0.038
Sunday	5	0.012	0.024	0.033	0.008	0.023	0.031	0.017	0.009	0.019	0.028	0.012	0.015	0.012	0.024	0.035	0.009	0.027	0.034	0.010	0.031	0.038
Sunday	6	0.016	0.027	0.034	0.018	0.029	0.036	0.021	0.014	0.028	0.030	0.017	0.026	0.018	0.029	0.037	0.016	0.030	0.036	0.016	0.033	0.039
Sunday	7	0.024	0.032	0.035	0.023	0.030	0.035	0.026	0.020	0.036	0.034	0.032	0.037	0.025	0.034	0.039	0.022	0.033	0.036	0.023	0.036	0.040
Sunday	8	0.032	0.039	0.038	0.034	0.040	0.040	0.031	0.032	0.043	0.037	0.045	0.053	0.035	0.040	0.042	0.033	0.039	0.040	0.033	0.040	0.042
Sunday	9	0.042	0.045	0.040	0.048	0.049	0.046	0.040	0.050	0.054	0.044	0.064	0.064	0.047	0.050	0.045	0.046	0.047	0.044	0.048	0.046	0.044
Sunday	10	0.051	0.051	0.042	0.059	0.057	0.049	0.047	0.064	0.067	0.046	0.076	0.072	0.057	0.056	0.047	0.056	0.052	0.046	0.062	0.051	0.045
Sunday	11	0.059	0.056	0.045	0.071	0.064	0.052	0.055	0.079	0.062	0.050	0.083	0.079	0.062	0.059	0.047	0.065	0.057	0.048	0.067	0.053	0.046
Sunday	12	0.066	0.060	0.046	0.084	0.077	0.057	0.061	0.087	0.065	0.053	0.088	0.075	0.065	0.060	0.047	0.071	0.059	0.049	0.070	0.054	0.046
Sunday	13	0.071	0.063	0.047	0.083	0.077	0.056	0.065	0.092	0.064	0.054	0.082	0.069	0.068	0.060	0.046	0.073	0.059	0.049	0.073	0.055	0.050
Sunday	14	0.075	0.065	0.047	0.080	0.072	0.055	0.067	0.087	0.065	0.059	0.075	0.067	0.068	0.058	0.044	0.076	0.059	0.048	0.073	0.055	0.047
Sunday	15	0.078	0.064	0.048	0.076	0.065	0.052	0.072	0.086	0.067	0.060	0.076	0.064	0.067	0.055	0.043	0.076	0.058	0.047	0.073	0.053	0.041
Sunday	16	0.077	0.063	0.048	0.074	0.062	0.050	0.077	0.086	0.072	0.063	0.074	0.058	0.065	0.052	0.042	0.077	0.058	0.047	0.072	0.052	0.039
Sunday	17	0.074	0.060	0.047	0.068	0.056	0.046	0.070	0.075	0.058	0.063	0.063	0.058	0.063	0.049	0.040	0.074	0.055	0.046	0.070	0.050	0.038
Sunday	18	0.069	0.055	0.046	0.059	0.044	0.042	0.067	0.059	0.054	0.061	0.053	0.050	0.059	0.045	0.040	0.068	0.048	0.043	0.063	0.047	0.036
Sunday	19	0.061	0.049	0.046	0.050	0.037	0.037	0.062	0.045	0.050	0.059	0.051	0.041	0.056	0.042	0.039	0.060	0.043	0.041	0.056	0.044	0.035
Sunday	20	0.053	0.042	0.045	0.043	0.032	0.037	0.054	0.035	0.047	0.051	0.034	0.036	0.052	0.040	0.040	0.052	0.039	0.040	0.051	0.041	0.036
Sunday	21	0.042	0.035	0.044	0.036	0.028	0.035	0.045	0.024	0.039	0.044	0.025	0.031	0.047	0.038	0.041	0.042	0.034	0.039	0.042	0.038	0.037
Sunday	22	0.032	0.030	0.045	0.028	0.022	0.034	0.033	0.015	0.033	0.035	0.016	0.024	0.036	0.034	0.042	0.031	0.028	0.038	0.030	0.032	0.039
Sunday	23	0.021	0.025	0.046	0.015	0.015	0.033	0.022	0.009	0.032	0.024	0.009	0.018	0.024	0.029	0.042	0.018	0.023	0.037	0.019	0.027	0.043
Monday	0	0.013	0.022	0.025	0.005	0.013	0.019	0.010	0.003	0.007	0.020	0.005	0.012	0.012	0.018	0.025	0.007	0.021	0.024	0.007	0.023	0.029
Monday	1	0.009	0.019	0.024	0.002	0.012	0.019	0.009	0.002	0.007	0.021	0.003	0.010	0.007	0.015	0.023	0.003	0.020	0.024	0.003	0.022	0.028
Monday	2	0.008	0.019	0.024	0.001	0.014	0.020	0.010	0.003	0.010	0.022	0.003	0.012	0.006	0.015	0.023	0.002	0.020	0.024	0.002	0.022	0.029
Monday	3	0.011	0.022	0.026	0.001	0.012	0.019	0.012	0.006	0.012	0.023	0.004	0.012	0.007	0.017	0.024	0.004	0.023	0.026	0.003	0.023	0.030
Monday	4	0.021	0.029	0.028	0.003	0.015	0.021	0.014	0.009	0.013	0.026	0.011	0.013	0.016	0.024	0.030	0.012	0.028	0.029	0.012	0.028	0.035
Monday	5	0.040	0.041	0.033	0.012	0.021	0.027	0.022	0.022	0.026	0.037	0.047	0.021	0.038	0.042	0.038	0.029	0.039	0.036	0.033	0.041	0.042
Monday	6	0.047	0.046	0.034	0.034	0.040	0.038	0.037	0.047	0.044	0.038	0.049	0.030	0.054	0.056	0.044	0.050	0.051	0.044	0.054	0.051	0.048
Monday	7	0.056	0.054	0.038	0.070	0.071	0.056	0.045	0.058	0.058	0.041	0.051	0.035	0.061	0.062	0.049	0.072	0.063	0.051	0.066	0.058	0.053
Monday	8	0.050	0.052	0.038	0.073	0.071	0.056	0.047	0.062	0.067	0.043	0.058	0.047	0.059	0.061	0.049	0.063	0.059	0.049	0.062	0.060	0.055
Monday	9	0.049	0.052	0.039	0.061	0.062	0.053	0.050	0.065	0.078	0.045	0.073	0.058	0.054	0.058	0.049	0.058	0.056	0.049	0.055	0.056	0.054
Monday	10	0.052	0.053	0.042	0.059	0.062	0.054	0.051	0.065	0.080	0.047	0.076	0.068	0.052	0.057	0.050	0.057	0.057	0.051	0.052	0.054	0.053
Monday	11	0.057	0.056	0.044	0.059	0.063	0.056	0.056	0.067	0.083	0.052	0.073	0.077	0.052	0.058	0.051	0.059	0.059	0.053	0.053	0.055	0.054
Monday	12	0.061	0.059	0.046	0.062	0.064	0.056	0.058	0.069	0.081	0.053	0.068	0.073	0.054	0.058	0.052	0.060	0.062	0.055	0.054	0.056	0.054
Monday	13	0.064	0.060	0.049	0.064	0.067	0.058	0.063	0.074	0.076	0.056	0.065	0.066	0.055	0.058	0.052	0.061	0.061	0.054	0.056	0.056	0.054
Monday	14	0.068	0.063	0.052	0.073	0.071	0.064	0.067	0.076	0.074	0.058	0.072	0.066	0.059	0.060	0.052	0.066	0.062	0.057	0.063	0.059	0.056
Monday	15	0.074	0.067	0.057	0.078	0.072	0.064	0.073	0.087	0.062	0.059	0.079	0.061	0.062	0.060	0.052	0.071	0.064	0.058	0.069	0.063	0.058
Monday	16	0.073	0.065	0.058	0.086	0.073	0.062	0.076	0.084	0.053	0.061	0.069	0.053	0.063	0.058	0.051	0.075	0.062	0.057	0.072	0.060	0.052
Monday	17	0.067	0.058	0.057	0.087	0.070	0.062	0.075	0.075	0.040	0.059	0.067	0.054	0.064	0.055	0.050	0.074	0.058	0.055	0.073	0.056	0.047
Monday	18	0.050	0.044	0.053	0.056	0.046	0.053	0.057	0.047	0.032	0.056	0.043	0.048	0.059	0.047	0.047	0.052	0.041	0.047	0.061	0.045	0.039
Monday	19	0.037	0.034	0.049	0.037	0.028	0.038	0.050	0.031	0.029	0.050	0.030	0.044	0.049	0.036	0.042	0.037	0.030	0.039	0.045	0.033	0.031
Monday	20	0.032	0.028	0.048	0.029	0.021	0.033	0.043	0.020	0.021	0.043	0.021	0.036	0.039	0.028	0.038	0.030	0.022	0.034	0.035	0.026	0.026
Monday	21	0.026	0.023	0.048	0.023	0.015	0.029	0.035	0.015	0.020	0.040	0.016	0.037	0.034	0.023	0.037	0.025	0.017	0.031	0.031	0.022	0.024
Monday	22	0.021	0.018	0.044	0.016	0.010	0.024	0.025	0.009	0.014	0.030	0.009	0.035	0.027	0.020	0.036	0.019	0.014	0.027	0.023	0.017	0.023
Monday	23	0.014	0.015	0.042	0.009	0.007	0.021	0.016	0.005	0.013	0.022	0.006	0.030	0.017	0.016	0.035	0.012	0.011	0.024	0.014	0.014	0.025

74

		Kern			Kings			Lake			Lassen			Los Angeles			Madera			Marin		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Tues/Wed/Thurs	0	0.010	0.021	0.032	0.004	0.013	0.022	0.010	0.004	0.008	0.022	0.004	0.024	0.011	0.019	0.029	0.005	0.020	0.027	0.006	0.022	0.031
Tues/Wed/Thurs	1	0.006	0.019	0.031	0.002	0.012	0.021	0.009	0.003	0.008	0.022	0.004	0.016	0.006	0.016	0.028	0.001	0.019	0.026	0.003	0.021	0.030
Tues/Wed/Thurs	2	0.006	0.019	0.031	0.000	0.011	0.021	0.010	0.002	0.012	0.024	0.003	0.012	0.005	0.016	0.027	0.001	0.019	0.027	0.002	0.021	0.030
Tues/Wed/Thurs	3	0.009	0.022	0.031	0.000	0.012	0.021	0.011	0.005	0.014	0.025	0.005	0.016	0.007	0.017	0.028	0.002	0.022	0.028	0.003	0.023	0.031
Tues/Wed/Thurs	4	0.019	0.029	0.034	0.003	0.014	0.023	0.015	0.010	0.021	0.028	0.011	0.025	0.015	0.025	0.033	0.010	0.027	0.032	0.011	0.028	0.036
Tues/Wed/Thurs	5	0.039	0.041	0.037	0.012	0.021	0.029	0.024	0.024	0.035	0.039	0.045	0.028	0.037	0.042	0.041	0.027	0.037	0.039	0.034	0.040	0.044
Tues/Wed/Thurs	6	0.048	0.046	0.039	0.035	0.040	0.042	0.037	0.048	0.048	0.041	0.045	0.035	0.054	0.056	0.047	0.050	0.050	0.047	0.056	0.052	0.049
Tues/Wed/Thurs	7	0.058	0.053	0.042	0.070	0.066	0.055	0.045	0.059	0.065	0.041	0.054	0.046	0.061	0.062	0.051	0.074	0.063	0.054	0.068	0.059	0.054
Tues/Wed/Thurs	8	0.052	0.052	0.042	0.073	0.071	0.058	0.047	0.063	0.069	0.044	0.061	0.053	0.059	0.062	0.051	0.065	0.059	0.052	0.063	0.060	0.056
Tues/Wed/Thurs	9	0.049	0.050	0.041	0.060	0.062	0.054	0.050	0.064	0.074	0.046	0.067	0.059	0.054	0.058	0.050	0.057	0.057	0.051	0.055	0.055	0.053
Tues/Wed/Thurs	10	0.050	0.051	0.042	0.057	0.060	0.054	0.051	0.065	0.075	0.048	0.069	0.067	0.052	0.057	0.051	0.055	0.057	0.052	0.051	0.053	0.052
Tues/Wed/Thurs	11	0.054	0.054	0.044	0.058	0.063	0.056	0.055	0.065	0.076	0.049	0.069	0.074	0.052	0.057	0.051	0.056	0.058	0.052	0.050	0.054	0.052
Tues/Wed/Thurs	12	0.059	0.056	0.046	0.060	0.064	0.056	0.057	0.068	0.076	0.051	0.069	0.070	0.053	0.057	0.051	0.057	0.059	0.053	0.052	0.055	0.053
Tues/Wed/Thurs	13	0.062	0.058	0.047	0.061	0.064	0.057	0.061	0.070	0.071	0.054	0.071	0.064	0.055	0.058	0.050	0.059	0.060	0.054	0.054	0.056	0.054
Tues/Wed/Thurs	14	0.068	0.062	0.050	0.071	0.070	0.059	0.066	0.074	0.068	0.056	0.072	0.062	0.059	0.059	0.050	0.065	0.063	0.055	0.062	0.059	0.054
Tues/Wed/Thurs	15	0.075	0.067	0.053	0.077	0.072	0.062	0.073	0.084	0.062	0.058	0.073	0.059	0.060	0.058	0.049	0.072	0.064	0.056	0.067	0.063	0.056
Tues/Wed/Thurs	16	0.075	0.066	0.054	0.086	0.073	0.060	0.078	0.086	0.053	0.058	0.070	0.053	0.062	0.056	0.048	0.078	0.064	0.055	0.070	0.060	0.051
Tues/Wed/Thurs	17	0.070	0.060	0.053	0.087	0.072	0.060	0.077	0.078	0.041	0.060	0.071	0.048	0.062	0.053	0.046	0.079	0.061	0.053	0.071	0.057	0.046
Tues/Wed/Thurs	18	0.052	0.046	0.048	0.059	0.051	0.051	0.059	0.047	0.030	0.053	0.043	0.043	0.058	0.046	0.043	0.055	0.043	0.044	0.062	0.047	0.039
Tues/Wed/Thurs	19	0.039	0.036	0.044	0.039	0.032	0.038	0.048	0.031	0.027	0.049	0.034	0.038	0.051	0.036	0.039	0.040	0.031	0.036	0.048	0.035	0.031
Tues/Wed/Thurs	20	0.033	0.030	0.042	0.032	0.023	0.032	0.041	0.021	0.020	0.044	0.025	0.030	0.042	0.028	0.036	0.033	0.024	0.032	0.038	0.027	0.026
Tues/Wed/Thurs	21	0.029	0.025	0.041	0.026	0.017	0.028	0.036	0.017	0.020	0.038	0.018	0.029	0.037	0.024	0.034	0.028	0.019	0.028	0.033	0.022	0.024
Tues/Wed/Thurs	22	0.023	0.020	0.039	0.018	0.011	0.023	0.025	0.009	0.014	0.029	0.011	0.026	0.030	0.020	0.033	0.021	0.014	0.025	0.024	0.017	0.022
Tues/Wed/Thurs	23	0.015	0.017	0.038	0.010	0.007	0.019	0.017	0.005	0.012	0.022	0.006	0.024	0.019	0.016	0.032	0.013	0.011	0.023	0.015	0.013	0.024
Friday	0	0.009	0.021	0.035	0.006	0.014	0.024	0.009	0.004	0.008	0.021	0.005	0.023	0.012	0.021	0.032	0.005	0.020	0.029	0.008	0.022	0.033
Friday	1	0.007	0.019	0.034	0.002	0.012	0.024	0.009	0.003	0.009	0.022	0.004	0.015	0.008	0.017	0.030	0.002	0.019	0.029	0.004	0.021	0.031
Friday	2	0.006	0.019	0.034	0.001	0.011	0.022	0.009	0.003	0.011	0.023	0.003	0.011	0.007	0.017	0.030	0.001	0.019	0.029	0.003	0.022	0.032
Friday	3	0.008	0.021	0.035	0.001	0.013	0.024	0.011	0.005	0.016	0.024	0.004	0.016	0.007	0.018	0.031	0.003	0.021	0.030	0.004	0.023	0.033
Friday	4	0.015	0.027	0.037	0.002	0.015	0.025	0.013	0.009	0.022	0.025	0.007	0.025	0.014	0.025	0.035	0.008	0.026	0.034	0.010	0.028	0.036
Friday	5	0.031	0.037	0.040	0.011	0.021	0.031	0.021	0.021	0.039	0.033	0.027	0.029	0.033	0.040	0.044	0.022	0.036	0.040	0.030	0.039	0.044
Friday	6	0.039	0.043	0.043	0.031	0.039	0.043	0.033	0.041	0.054	0.035	0.034	0.035	0.049	0.054	0.050	0.039	0.047	0.048	0.050	0.049	0.050
Friday	7	0.048	0.050	0.045	0.063	0.064	0.057	0.039	0.052	0.065	0.040	0.046	0.049	0.057	0.060	0.053	0.059	0.058	0.054	0.063	0.057	0.055
Friday	8	0.045	0.050	0.045	0.067	0.069	0.059	0.044	0.059	0.074	0.044	0.061	0.056	0.056	0.060	0.054	0.054	0.058	0.054	0.059	0.057	0.056
Friday	9	0.045	0.049	0.046	0.057	0.062	0.057	0.047	0.060	0.078	0.047	0.068	0.060	0.052	0.058	0.054	0.051	0.056	0.054	0.053	0.054	0.054
Friday	10	0.049	0.053	0.047	0.057	0.063	0.056	0.048	0.067	0.075	0.046	0.068	0.071	0.052	0.058	0.054	0.052	0.057	0.054	0.051	0.053	0.053
Friday	11	0.054	0.055	0.048	0.059	0.065	0.058	0.054	0.068	0.077	0.049	0.075	0.077	0.053	0.059	0.054	0.054	0.059	0.054	0.053	0.055	0.054
Friday	12	0.058	0.057	0.049	0.061	0.064	0.058	0.060	0.072	0.079	0.051	0.071	0.070	0.054	0.059	0.054	0.056	0.060	0.055	0.056	0.057	0.055
Friday	13	0.063	0.060	0.050	0.062	0.066	0.058	0.063	0.075	0.072	0.056	0.074	0.065	0.056	0.059	0.052	0.059	0.062	0.055	0.058	0.058	0.056
Friday	14	0.068	0.063	0.051	0.070	0.069	0.058	0.068	0.078	0.067	0.056	0.074	0.060	0.057	0.059	0.051	0.065	0.063	0.055	0.064	0.059	0.056
Friday	15	0.072	0.067	0.053	0.073	0.069	0.060	0.073	0.083	0.060	0.059	0.074	0.055	0.058	0.057	0.049	0.071	0.064	0.056	0.066	0.062	0.056
Friday	16	0.073	0.064	0.052	0.079	0.073	0.060	0.076	0.082	0.049	0.061	0.072	0.054	0.059	0.055	0.046	0.077	0.062	0.053	0.067	0.059	0.050
Friday	17	0.070	0.059	0.050	0.079	0.065	0.055	0.074	0.072	0.038	0.058	0.066	0.046	0.059	0.051	0.044	0.076	0.057	0.049	0.067	0.055	0.046
Friday	18	0.060	0.048	0.044	0.061	0.050	0.047	0.060	0.050	0.026	0.056	0.051	0.043	0.057	0.045	0.040	0.063	0.046	0.042	0.060	0.047	0.039
Friday	19	0.049	0.039	0.039	0.045	0.034	0.036	0.052	0.034	0.024	0.052	0.043	0.036	0.051	0.037	0.035	0.050	0.035	0.035	0.049	0.036	0.030
Friday	20	0.042	0.032	0.035	0.036	0.023	0.028	0.043	0.022	0.017	0.046	0.032	0.028	0.045	0.029	0.030	0.042	0.026	0.029	0.040	0.029	0.023
Friday	21	0.037	0.027	0.032	0.031	0.017	0.024	0.040	0.018	0.016	0.041	0.021	0.026	0.040	0.024	0.027	0.037	0.021	0.025	0.035	0.023	0.020
Friday	22	0.031	0.023	0.029	0.028	0.013	0.019	0.031	0.012	0.011	0.032	0.013	0.026	0.036	0.021	0.026	0.030	0.015	0.020	0.030	0.019	0.019
Friday	23	0.021	0.018	0.027	0.017	0.008	0.016	0.022	0.007	0.012	0.023	0.008	0.024	0.027	0.017	0.024	0.021	0.012	0.018	0.022	0.015	0.020
Saturday	0	0.016	0.028	0.043	0.013	0.022	0.035	0.012	0.008	0.014	0.024	0.009	0.025	0.020	0.031	0.046	0.012	0.031	0.042	0.015	0.030	0.044
Saturday	1	0.011	0.023	0.041	0.008	0.019	0.032	0.013	0.006	0.014	0.026	0.007	0.015	0.013	0.025	0.041	0.008	0.027	0.039	0.009	0.027	0.040
Saturday	2	0.009	0.022	0.040	0.005	0.017	0.031	0.013	0.004	0.011	0.025	0.004	0.013	0.011	0.023	0.039	0.006	0.025	0.038	0.006	0.026	0.039
Saturday	3	0.009	0.021	0.040	0.003	0.016	0.030	0.012	0.004	0.014	0.026	0.004	0.017	0.008	0.020	0.037	0.005	0.024	0.036	0.005	0.025	0.037

		Kern			Kings			Lake			Lassen			Los Angeles			Madera			Marin		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Saturday	4	0.014	0.025	0.041	0.004	0.016	0.031	0.014	0.008	0.020	0.029	0.007	0.025	0.010	0.022	0.038	0.008	0.027	0.037	0.006	0.027	0.037
Saturday	5	0.027	0.034	0.044	0.010	0.022	0.033	0.020	0.016	0.034	0.035	0.022	0.023	0.017	0.028	0.042	0.017	0.032	0.041	0.013	0.030	0.040
Saturday	6	0.034	0.038	0.045	0.023	0.031	0.041	0.025	0.025	0.043	0.039	0.035	0.033	0.027	0.036	0.046	0.026	0.039	0.046	0.023	0.035	0.042
Saturday	7	0.042	0.045	0.047	0.036	0.041	0.048	0.030	0.031	0.058	0.039	0.041	0.050	0.037	0.046	0.051	0.036	0.045	0.050	0.034	0.041	0.047
Saturday	8	0.050	0.052	0.050	0.045	0.049	0.053	0.036	0.041	0.070	0.044	0.057	0.053	0.046	0.052	0.054	0.047	0.052	0.054	0.046	0.047	0.049
Saturday	9	0.056	0.056	0.052	0.053	0.054	0.057	0.043	0.053	0.079	0.047	0.074	0.065	0.053	0.057	0.056	0.055	0.057	0.056	0.055	0.051	0.050
Saturday	10	0.060	0.057	0.053	0.061	0.063	0.059	0.052	0.069	0.082	0.050	0.080	0.075	0.057	0.060	0.056	0.062	0.062	0.060	0.061	0.054	0.051
Saturday	11	0.063	0.059	0.053	0.067	0.072	0.062	0.054	0.076	0.075	0.050	0.078	0.073	0.060	0.062	0.056	0.067	0.063	0.058	0.065	0.056	0.052
Saturday	12	0.065	0.061	0.052	0.071	0.072	0.064	0.061	0.080	0.070	0.053	0.075	0.066	0.062	0.062	0.054	0.068	0.062	0.056	0.066	0.058	0.055
Saturday	13	0.066	0.061	0.050	0.071	0.069	0.060	0.063	0.082	0.064	0.055	0.070	0.064	0.062	0.060	0.051	0.068	0.059	0.054	0.067	0.059	0.058
Saturday	14	0.067	0.060	0.049	0.071	0.070	0.060	0.065	0.081	0.062	0.053	0.068	0.063	0.062	0.058	0.048	0.068	0.059	0.051	0.067	0.058	0.057
Saturday	15	0.067	0.060	0.048	0.070	0.067	0.055	0.067	0.080	0.054	0.054	0.063	0.059	0.062	0.056	0.045	0.068	0.056	0.049	0.068	0.057	0.051
Saturday	16	0.064	0.056	0.044	0.070	0.061	0.049	0.071	0.081	0.051	0.057	0.064	0.055	0.062	0.053	0.042	0.068	0.054	0.046	0.068	0.056	0.047
Saturday	17	0.058	0.052	0.041	0.066	0.056	0.046	0.068	0.072	0.037	0.055	0.064	0.051	0.060	0.049	0.038	0.064	0.050	0.041	0.067	0.054	0.044
Saturday	18	0.051	0.046	0.036	0.059	0.048	0.038	0.062	0.053	0.032	0.052	0.049	0.044	0.057	0.044	0.034	0.057	0.042	0.035	0.060	0.048	0.036
Saturday	19	0.044	0.037	0.032	0.049	0.036	0.030	0.059	0.040	0.029	0.048	0.039	0.039	0.051	0.037	0.029	0.049	0.034	0.029	0.049	0.041	0.029
Saturday	20	0.039	0.033	0.028	0.043	0.032	0.027	0.051	0.032	0.021	0.046	0.034	0.030	0.046	0.033	0.026	0.043	0.030	0.025	0.043	0.036	0.025
Saturday	21	0.035	0.029	0.026	0.040	0.027	0.022	0.047	0.026	0.023	0.039	0.026	0.026	0.043	0.030	0.024	0.039	0.027	0.022	0.041	0.033	0.024
Saturday	22	0.030	0.024	0.024	0.037	0.024	0.020	0.037	0.019	0.020	0.031	0.020	0.020	0.042	0.029	0.024	0.035	0.024	0.019	0.037	0.029	0.023
Saturday	23	0.023	0.020	0.020	0.024	0.017	0.017	0.028	0.014	0.021	0.023	0.010	0.017	0.033	0.026	0.022	0.025	0.020	0.018	0.028	0.024	0.022
Holiday	0	0.015	0.023	0.028	0.011	0.017	0.026	0.010	0.004	0.009	0.020	0.007	0.015	0.017	0.024	0.031	0.010	0.023	0.027	0.013	0.027	0.034
Holiday	1	0.009	0.021	0.028	0.006	0.018	0.023	0.014	0.004	0.008	0.020	0.003	0.012	0.011	0.020	0.028	0.004	0.024	0.028	0.007	0.026	0.033
Holiday	2	0.007	0.020	0.028	0.002	0.018	0.027	0.010	0.003	0.014	0.025	0.003	0.011	0.009	0.019	0.027	0.002	0.022	0.027	0.004	0.025	0.033
Holiday	3	0.008	0.021	0.028	0.001	0.019	0.027	0.014	0.005	0.012	0.022	0.002	0.016	0.007	0.019	0.028	0.001	0.023	0.028	0.003	0.025	0.033
Holiday	4	0.013	0.024	0.028	0.002	0.015	0.027	0.014	0.006	0.017	0.024	0.004	0.015	0.012	0.023	0.030	0.006	0.026	0.030	0.007	0.029	0.035
Holiday	5	0.027	0.032	0.032	0.010	0.021	0.027	0.019	0.018	0.028	0.031	0.020	0.021	0.024	0.033	0.036	0.016	0.033	0.035	0.017	0.034	0.039
Holiday	6	0.033	0.037	0.033	0.026	0.034	0.037	0.028	0.034	0.042	0.033	0.025	0.028	0.034	0.041	0.040	0.028	0.040	0.039	0.029	0.040	0.044
Holiday	7	0.039	0.043	0.036	0.043	0.046	0.041	0.039	0.045	0.052	0.038	0.036	0.044	0.042	0.047	0.043	0.037	0.045	0.042	0.038	0.045	0.047
Holiday	8	0.043	0.047	0.037	0.050	0.052	0.042	0.041	0.051	0.059	0.044	0.054	0.043	0.045	0.050	0.045	0.044	0.051	0.045	0.045	0.050	0.051
Holiday	9	0.050	0.050	0.040	0.051	0.052	0.050	0.044	0.057	0.066	0.046	0.071	0.064	0.048	0.053	0.047	0.051	0.053	0.048	0.049	0.053	0.052
Holiday	10	0.055	0.055	0.042	0.060	0.067	0.052	0.050	0.069	0.075	0.051	0.088	0.073	0.054	0.058	0.050	0.060	0.060	0.053	0.056	0.056	0.053
Holiday	11	0.064	0.060	0.047	0.067	0.070	0.059	0.056	0.072	0.077	0.053	0.082	0.075	0.058	0.061	0.051	0.068	0.064	0.055	0.062	0.059	0.055
Holiday	12	0.068	0.061	0.050	0.073	0.077	0.064	0.058	0.080	0.078	0.055	0.082	0.072	0.061	0.063	0.053	0.072	0.066	0.056	0.067	0.061	0.056
Holiday	13	0.071	0.066	0.051	0.075	0.072	0.057	0.063	0.077	0.069	0.054	0.078	0.063	0.063	0.064	0.053	0.071	0.067	0.058	0.070	0.062	0.056
Holiday	14	0.073	0.064	0.052	0.076	0.070	0.062	0.068	0.083	0.067	0.060	0.077	0.067	0.064	0.064	0.053	0.073	0.064	0.058	0.073	0.062	0.057
Holiday	15	0.075	0.067	0.055	0.072	0.073	0.063	0.071	0.082	0.064	0.054	0.081	0.062	0.065	0.061	0.051	0.075	0.062	0.054	0.071	0.061	0.054
Holiday	16	0.072	0.064	0.055	0.075	0.066	0.057	0.075	0.083	0.061	0.062	0.077	0.063	0.064	0.057	0.050	0.076	0.060	0.054	0.070	0.057	0.050
Holiday	17	0.066	0.059	0.054	0.071	0.059	0.053	0.072	0.076	0.044	0.061	0.066	0.050	0.063	0.053	0.048	0.073	0.056	0.053	0.067	0.053	0.044
Holiday	18	0.056	0.046	0.049	0.059	0.046	0.048	0.054	0.048	0.040	0.057	0.043	0.042	0.058	0.046	0.045	0.061	0.044	0.046	0.059	0.045	0.038
Holiday	19	0.047	0.042	0.050	0.047	0.032	0.038	0.056	0.036	0.029	0.052	0.035	0.041	0.052	0.038	0.042	0.050	0.035	0.040	0.051	0.036	0.031
Holiday	20	0.039	0.033	0.046	0.040	0.029	0.033	0.049	0.025	0.029	0.043	0.022	0.034	0.047	0.032	0.039	0.043	0.029	0.037	0.046	0.031	0.028
Holiday	21	0.031	0.027	0.046	0.034	0.024	0.033	0.040	0.019	0.023	0.041	0.024	0.036	0.042	0.028	0.038	0.035	0.022	0.032	0.041	0.026	0.026
Holiday	22	0.025	0.021	0.043	0.030	0.015	0.031	0.029	0.012	0.018	0.031	0.011	0.026	0.037	0.025	0.037	0.028	0.018	0.029	0.033	0.021	0.025
Holiday	23	0.016	0.018	0.041	0.018	0.009	0.022	0.025	0.010	0.019	0.022	0.009	0.026	0.025	0.020	0.036	0.018	0.014	0.026	0.021	0.017	0.026

76

		Mariposa			Mendocino			Merced			Modoc			Mono			Monterey			Napa		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Sunday	0	0.010	0.014	0.032	0.013	0.011	0.008	0.014	0.025	0.037	0.019	0.009	0.017	0.010	0.014	0.032	0.019	0.010	0.029	0.017	0.035	0.054
Sunday	1	0.007	0.011	0.024	0.013	0.008	0.010	0.009	0.019	0.032	0.021	0.007	0.014	0.007	0.011	0.024	0.020	0.008	0.023	0.011	0.030	0.047
Sunday	2	0.005	0.011	0.022	0.012	0.006	0.008	0.007	0.016	0.029	0.022	0.006	0.013	0.005	0.011	0.022	0.020	0.007	0.021	0.007	0.028	0.044
Sunday	3	0.004	0.010	0.021	0.014	0.005	0.007	0.005	0.015	0.028	0.022	0.005	0.013	0.004	0.010	0.021	0.020	0.007	0.019	0.006	0.026	0.043
Sunday	4	0.004	0.010	0.020	0.014	0.004	0.011	0.006	0.016	0.028	0.023	0.006	0.013	0.004	0.010	0.020	0.024	0.012	0.019	0.006	0.025	0.038
Sunday	5	0.007	0.013	0.021	0.017	0.009	0.019	0.010	0.019	0.029	0.025	0.008	0.016	0.007	0.013	0.021	0.026	0.017	0.021	0.009	0.027	0.038
Sunday	6	0.012	0.019	0.026	0.021	0.014	0.028	0.015	0.023	0.031	0.028	0.014	0.024	0.012	0.019	0.026	0.029	0.024	0.026	0.014	0.030	0.038
Sunday	7	0.019	0.023	0.029	0.026	0.020	0.036	0.021	0.029	0.035	0.030	0.022	0.034	0.019	0.023	0.029	0.031	0.030	0.034	0.020	0.033	0.039
Sunday	8	0.032	0.035	0.038	0.031	0.032	0.043	0.031	0.038	0.040	0.033	0.036	0.048	0.032	0.035	0.038	0.035	0.038	0.040	0.031	0.038	0.042
Sunday	9	0.051	0.051	0.053	0.040	0.050	0.054	0.043	0.050	0.047	0.036	0.052	0.062	0.051	0.051	0.053	0.038	0.049	0.049	0.047	0.047	0.046
Sunday	10	0.067	0.067	0.071	0.047	0.064	0.067	0.055	0.060	0.051	0.040	0.071	0.075	0.067	0.067	0.071	0.041	0.057	0.057	0.060	0.054	0.046
Sunday	11	0.080	0.081	0.085	0.055	0.079	0.062	0.063	0.065	0.054	0.044	0.082	0.086	0.080	0.081	0.085	0.047	0.068	0.061	0.066	0.056	0.047
Sunday	12	0.083	0.081	0.076	0.061	0.087	0.065	0.070	0.070	0.055	0.049	0.089	0.088	0.083	0.081	0.076	0.051	0.074	0.063	0.067	0.056	0.045
Sunday	13	0.085	0.082	0.074	0.065	0.092	0.064	0.075	0.071	0.056	0.054	0.090	0.080	0.085	0.082	0.074	0.053	0.073	0.065	0.070	0.056	0.042
Sunday	14	0.085	0.083	0.069	0.067	0.087	0.065	0.077	0.069	0.055	0.058	0.089	0.072	0.085	0.083	0.069	0.059	0.078	0.065	0.071	0.057	0.038
Sunday	15	0.084	0.081	0.066	0.072	0.086	0.067	0.078	0.070	0.053	0.063	0.087	0.069	0.084	0.081	0.066	0.061	0.078	0.066	0.071	0.052	0.037
Sunday	16	0.082	0.079	0.060	0.077	0.086	0.072	0.077	0.067	0.052	0.064	0.081	0.059	0.082	0.079	0.060	0.064	0.074	0.060	0.072	0.055	0.036
Sunday	17	0.076	0.070	0.053	0.070	0.075	0.058	0.075	0.062	0.049	0.065	0.066	0.051	0.076	0.070	0.053	0.063	0.068	0.053	0.071	0.052	0.035
Sunday	18	0.064	0.056	0.043	0.067	0.059	0.054	0.068	0.055	0.046	0.065	0.055	0.044	0.064	0.056	0.043	0.064	0.060	0.049	0.068	0.051	0.036
Sunday	19	0.049	0.043	0.035	0.062	0.045	0.050	0.061	0.047	0.042	0.062	0.043	0.036	0.049	0.043	0.035	0.060	0.052	0.046	0.062	0.048	0.037
Sunday	20	0.038	0.033	0.024	0.054	0.035	0.047	0.051	0.039	0.040	0.057	0.032	0.028	0.038	0.033	0.024	0.055	0.043	0.041	0.056	0.046	0.038
Sunday	21	0.026	0.022	0.020	0.045	0.024	0.039	0.041	0.031	0.038	0.049	0.022	0.023	0.026	0.022	0.020	0.050	0.034	0.037	0.046	0.038	0.038
Sunday	22	0.017	0.014	0.017	0.033	0.015	0.033	0.029	0.024	0.036	0.041	0.015	0.019	0.017	0.014	0.017	0.039	0.022	0.031	0.033	0.032	0.043
Sunday	23	0.010	0.010	0.020	0.022	0.009	0.032	0.019	0.019	0.037	0.028	0.012	0.016	0.010	0.010	0.020	0.030	0.016	0.025	0.020	0.027	0.050
Monday	0	0.006	0.010	0.017	0.010	0.003	0.007	0.011	0.017	0.023	0.023	0.007	0.013	0.006	0.010	0.017	0.023	0.006	0.009	0.010	0.024	0.031
Monday	1	0.004	0.009	0.016	0.009	0.002	0.007	0.007	0.015	0.022	0.023	0.006	0.011	0.004	0.009	0.016	0.024	0.007	0.009	0.005	0.023	0.031
Monday	2	0.003	0.009	0.016	0.010	0.003	0.010	0.006	0.015	0.022	0.025	0.007	0.011	0.003	0.009	0.016	0.025	0.009	0.010	0.004	0.022	0.030
Monday	3	0.005	0.011	0.019	0.012	0.006	0.012	0.009	0.018	0.025	0.027	0.010	0.011	0.005	0.011	0.019	0.025	0.011	0.014	0.005	0.023	0.032
Monday	4	0.008	0.017	0.024	0.014	0.009	0.013	0.018	0.027	0.032	0.030	0.015	0.012	0.008	0.017	0.024	0.033	0.023	0.019	0.014	0.030	0.037
Monday	5	0.019	0.028	0.036	0.022	0.022	0.026	0.030	0.039	0.039	0.033	0.022	0.018	0.019	0.028	0.036	0.039	0.042	0.024	0.039	0.041	0.044
Monday	6	0.036	0.041	0.050	0.037	0.047	0.044	0.044	0.051	0.045	0.036	0.034	0.024	0.036	0.041	0.050	0.044	0.060	0.031	0.050	0.049	0.051
Monday	7	0.051	0.044	0.065	0.045	0.058	0.058	0.058	0.058	0.050	0.040	0.043	0.030	0.051	0.044	0.065	0.041	0.056	0.038	0.059	0.058	0.056
Monday	8	0.053	0.056	0.068	0.047	0.062	0.067	0.053	0.058	0.051	0.043	0.054	0.039	0.053	0.056	0.068	0.043	0.058	0.045	0.055	0.056	0.055
Monday	9	0.059	0.065	0.080	0.050	0.065	0.078	0.051	0.059	0.053	0.045	0.067	0.048	0.059	0.065	0.080	0.045	0.063	0.053	0.053	0.057	0.058
Monday	10	0.067	0.074	0.087	0.051	0.065	0.080	0.054	0.062	0.056	0.050	0.074	0.054	0.067	0.074	0.087	0.046	0.065	0.059	0.055	0.060	0.058
Monday	11	0.071	0.075	0.082	0.056	0.067	0.083	0.057	0.064	0.057	0.052	0.075	0.059	0.071	0.075	0.082	0.050	0.066	0.061	0.057	0.058	0.058
Monday	12	0.074	0.074	0.080	0.058	0.069	0.081	0.060	0.064	0.058	0.055	0.078	0.059	0.074	0.074	0.080	0.052	0.068	0.065	0.058	0.060	0.059
Monday	13	0.074	0.075	0.075	0.063	0.074	0.076	0.061	0.064	0.058	0.057	0.081	0.060	0.074	0.075	0.075	0.056	0.069	0.063	0.059	0.059	0.055
Monday	14	0.077	0.076	0.065	0.067	0.076	0.074	0.067	0.066	0.058	0.057	0.081	0.065	0.077	0.076	0.065	0.057	0.070	0.065	0.064	0.058	0.053
Monday	15	0.082	0.076	0.058	0.073	0.087	0.062	0.072	0.065	0.057	0.059	0.080	0.063	0.082	0.076	0.058	0.058	0.070	0.066	0.068	0.058	0.050
Monday	16	0.081	0.073	0.045	0.076	0.084	0.053	0.075	0.063	0.055	0.060	0.072	0.064	0.081	0.073	0.045	0.059	0.067	0.060	0.071	0.058	0.046
Monday	17	0.071	0.059	0.035	0.075	0.075	0.040	0.074	0.055	0.051	0.057	0.059	0.066	0.071	0.059	0.035	0.058	0.062	0.057	0.070	0.054	0.042
Monday	18	0.052	0.042	0.023	0.057	0.047	0.032	0.055	0.042	0.042	0.053	0.045	0.063	0.052	0.042	0.023	0.055	0.043	0.053	0.055	0.041	0.035
Monday	19	0.037	0.030	0.017	0.050	0.031	0.029	0.042	0.031	0.036	0.048	0.032	0.060	0.037	0.030	0.017	0.045	0.029	0.048	0.043	0.032	0.028
Monday	20	0.027	0.022	0.013	0.043	0.020	0.021	0.034	0.023	0.031	0.042	0.022	0.054	0.027	0.022	0.013	0.041	0.022	0.045	0.035	0.026	0.024
Monday	21	0.020	0.016	0.010	0.035	0.015	0.020	0.027	0.018	0.028	0.036	0.016	0.046	0.020	0.016	0.010	0.035	0.017	0.039	0.030	0.022	0.021
Monday	22	0.015	0.012	0.009	0.025	0.009	0.014	0.020	0.014	0.027	0.029	0.012	0.039	0.015	0.012	0.009	0.026	0.011	0.035	0.023	0.018	0.022
Monday	23	0.009	0.007	0.010	0.016	0.005	0.013	0.014	0.011	0.025	0.020	0.008	0.031	0.009	0.007	0.010	0.020	0.007	0.033	0.016	0.015	0.025
Tues/Wed/Thurs	0	0.005	0.009	0.017	0.010	0.004	0.008	0.008	0.016	0.025	0.023	0.007	0.018	0.005	0.009	0.017	0.020	0.006	0.023	0.009	0.023	0.033
Tues/Wed/Thurs	1	0.003	0.008	0.017	0.009	0.003	0.008	0.005	0.014	0.024	0.025	0.006	0.015	0.003	0.008	0.017	0.022	0.007	0.021	0.005	0.021	0.031
Tues/Wed/Thurs	2	0.002	0.009	0.017	0.010	0.002	0.012	0.005	0.014	0.025	0.027	0.006	0.013	0.002	0.009	0.017	0.023	0.007	0.021	0.004	0.021	0.031
Tues/Wed/Thurs	3	0.003	0.010	0.022	0.011	0.005	0.014	0.008	0.018	0.028	0.029	0.009	0.013	0.003	0.010	0.022	0.025	0.010	0.022	0.005	0.022	0.032

77

		Mariposa			Mendocino			Merced			Modoc			Mono			Monterey			Napa		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Tues/Wed/Thurs	4	0.006	0.014	0.025	0.015	0.010	0.021	0.017	0.026	0.034	0.032	0.014	0.016	0.006	0.014	0.025	0.030	0.019	0.024	0.013	0.028	0.039
Tues/Wed/Thurs	5	0.018	0.027	0.039	0.024	0.024	0.035	0.030	0.039	0.042	0.035	0.021	0.020	0.018	0.027	0.039	0.037	0.037	0.029	0.036	0.040	0.046
Tues/Wed/Thurs	6	0.037	0.042	0.052	0.037	0.048	0.048	0.044	0.050	0.047	0.038	0.033	0.027	0.037	0.042	0.052	0.043	0.057	0.038	0.048	0.048	0.051
Tues/Wed/Thurs	7	0.053	0.047	0.064	0.045	0.059	0.065	0.059	0.059	0.052	0.040	0.046	0.036	0.053	0.047	0.064	0.042	0.057	0.046	0.059	0.056	0.056
Tues/Wed/Thurs	8	0.054	0.056	0.070	0.047	0.063	0.069	0.055	0.058	0.052	0.042	0.056	0.046	0.054	0.056	0.070	0.045	0.062	0.050	0.056	0.057	0.057
Tues/Wed/Thurs	9	0.059	0.068	0.083	0.050	0.064	0.074	0.051	0.059	0.054	0.044	0.066	0.057	0.059	0.068	0.083	0.046	0.063	0.055	0.052	0.055	0.056
Tues/Wed/Thurs	10	0.064	0.069	0.081	0.051	0.065	0.075	0.052	0.060	0.056	0.045	0.071	0.065	0.064	0.069	0.081	0.047	0.061	0.058	0.053	0.057	0.057
Tues/Wed/Thurs	11	0.068	0.069	0.077	0.055	0.065	0.076	0.054	0.061	0.057	0.047	0.076	0.070	0.068	0.069	0.077	0.049	0.065	0.060	0.053	0.058	0.057
Tues/Wed/Thurs	12	0.069	0.071	0.074	0.057	0.068	0.076	0.057	0.062	0.057	0.050	0.076	0.070	0.069	0.071	0.074	0.051	0.066	0.060	0.055	0.058	0.056
Tues/Wed/Thurs	13	0.072	0.073	0.074	0.061	0.070	0.071	0.060	0.063	0.056	0.052	0.077	0.069	0.072	0.073	0.074	0.054	0.069	0.059	0.057	0.060	0.055
Tues/Wed/Thurs	14	0.077	0.076	0.067	0.066	0.074	0.068	0.066	0.065	0.056	0.057	0.081	0.067	0.077	0.076	0.067	0.058	0.072	0.059	0.064	0.061	0.053
Tues/Wed/Thurs	15	0.084	0.078	0.058	0.073	0.084	0.062	0.073	0.066	0.055	0.058	0.078	0.064	0.084	0.078	0.058	0.059	0.072	0.057	0.069	0.061	0.050
Tues/Wed/Thurs	16	0.082	0.074	0.048	0.078	0.086	0.053	0.077	0.064	0.053	0.057	0.072	0.061	0.082	0.074	0.048	0.060	0.070	0.053	0.072	0.058	0.046
Tues/Wed/Thurs	17	0.074	0.061	0.036	0.077	0.078	0.041	0.076	0.057	0.049	0.056	0.060	0.057	0.074	0.061	0.036	0.058	0.063	0.051	0.072	0.055	0.041
Tues/Wed/Thurs	18	0.053	0.044	0.023	0.059	0.047	0.030	0.058	0.044	0.041	0.053	0.046	0.053	0.053	0.044	0.023	0.052	0.044	0.046	0.058	0.044	0.035
Tues/Wed/Thurs	19	0.038	0.031	0.016	0.048	0.031	0.027	0.044	0.032	0.034	0.048	0.033	0.044	0.038	0.031	0.016	0.049	0.032	0.041	0.047	0.035	0.028
Tues/Wed/Thurs	20	0.030	0.025	0.012	0.041	0.021	0.020	0.036	0.025	0.030	0.045	0.025	0.038	0.030	0.025	0.012	0.043	0.024	0.037	0.039	0.029	0.024
Tues/Wed/Thurs	21	0.023	0.018	0.010	0.036	0.017	0.020	0.028	0.019	0.026	0.038	0.018	0.032	0.023	0.018	0.010	0.038	0.018	0.034	0.033	0.022	0.021
Tues/Wed/Thurs	22	0.017	0.013	0.010	0.025	0.009	0.014	0.021	0.014	0.025	0.032	0.014	0.026	0.017	0.013	0.010	0.029	0.011	0.030	0.025	0.018	0.022
Tues/Wed/Thurs	23	0.010	0.008	0.010	0.017	0.005	0.012	0.015	0.012	0.023	0.025	0.010	0.021	0.010	0.008	0.010	0.022	0.008	0.026	0.017	0.015	0.025
Friday	0	0.005	0.009	0.019	0.009	0.004	0.008	0.008	0.016	0.027	0.021	0.007	0.019	0.005	0.009	0.019	0.020	0.006	0.022	0.009	0.022	0.034
Friday	1	0.003	0.008	0.019	0.009	0.003	0.009	0.006	0.014	0.025	0.023	0.006	0.017	0.003	0.008	0.019	0.020	0.006	0.021	0.005	0.022	0.032
Friday	2	0.002	0.008	0.019	0.009	0.003	0.011	0.005	0.014	0.026	0.024	0.007	0.016	0.002	0.008	0.019	0.022	0.007	0.021	0.004	0.021	0.034
Friday	3	0.002	0.008	0.021	0.011	0.005	0.016	0.008	0.017	0.029	0.026	0.009	0.016	0.002	0.008	0.021	0.024	0.009	0.022	0.005	0.022	0.034
Friday	4	0.005	0.013	0.024	0.013	0.009	0.022	0.014	0.024	0.035	0.029	0.013	0.019	0.005	0.013	0.024	0.028	0.018	0.024	0.011	0.026	0.039
Friday	5	0.013	0.023	0.037	0.021	0.021	0.039	0.024	0.035	0.042	0.032	0.018	0.023	0.013	0.023	0.037	0.035	0.033	0.029	0.029	0.038	0.046
Friday	6	0.026	0.035	0.049	0.033	0.041	0.054	0.036	0.045	0.047	0.033	0.030	0.032	0.026	0.035	0.049	0.041	0.050	0.038	0.039	0.045	0.052
Friday	7	0.039	0.040	0.060	0.039	0.052	0.065	0.049	0.053	0.052	0.037	0.039	0.039	0.039	0.040	0.060	0.039	0.049	0.046	0.048	0.051	0.057
Friday	8	0.043	0.049	0.068	0.044	0.059	0.074	0.047	0.054	0.053	0.040	0.051	0.049	0.043	0.049	0.068	0.041	0.056	0.050	0.047	0.051	0.057
Friday	9	0.049	0.057	0.073	0.047	0.060	0.078	0.047	0.056	0.055	0.045	0.063	0.054	0.049	0.057	0.073	0.045	0.058	0.055	0.047	0.055	0.058
Friday	10	0.058	0.063	0.078	0.048	0.067	0.075	0.051	0.060	0.058	0.048	0.069	0.060	0.058	0.063	0.078	0.047	0.062	0.059	0.052	0.057	0.059
Friday	11	0.064	0.069	0.077	0.054	0.068	0.077	0.054	0.062	0.060	0.049	0.072	0.063	0.064	0.069	0.077	0.050	0.067	0.060	0.055	0.058	0.059
Friday	12	0.066	0.071	0.076	0.060	0.072	0.079	0.057	0.063	0.060	0.052	0.074	0.063	0.066	0.071	0.076	0.051	0.067	0.060	0.059	0.060	0.058
Friday	13	0.071	0.074	0.077	0.063	0.075	0.072	0.061	0.065	0.059	0.055	0.077	0.062	0.071	0.074	0.077	0.056	0.071	0.062	0.064	0.061	0.052
Friday	14	0.076	0.077	0.070	0.068	0.078	0.067	0.068	0.067	0.058	0.059	0.080	0.063	0.076	0.077	0.070	0.060	0.075	0.059	0.067	0.061	0.051
Friday	15	0.083	0.079	0.060	0.073	0.083	0.060	0.074	0.067	0.056	0.063	0.081	0.061	0.083	0.079	0.060	0.060	0.074	0.060	0.069	0.061	0.048
Friday	16	0.083	0.077	0.050	0.076	0.082	0.049	0.076	0.064	0.053	0.058	0.075	0.059	0.083	0.077	0.050	0.060	0.070	0.055	0.069	0.058	0.045
Friday	17	0.075	0.064	0.038	0.074	0.072	0.038	0.075	0.058	0.048	0.059	0.063	0.055	0.075	0.064	0.038	0.060	0.064	0.049	0.068	0.051	0.040
Friday	18	0.062	0.051	0.025	0.060	0.050	0.026	0.064	0.048	0.040	0.054	0.052	0.051	0.062	0.051	0.025	0.054	0.049	0.044	0.060	0.046	0.034
Friday	19	0.050	0.039	0.018	0.052	0.034	0.024	0.052	0.037	0.032	0.050	0.036	0.046	0.050	0.039	0.018	0.050	0.036	0.040	0.054	0.039	0.027
Friday	20	0.041	0.030	0.013	0.043	0.022	0.017	0.043	0.029	0.026	0.046	0.030	0.041	0.041	0.030	0.013	0.045	0.028	0.037	0.048	0.033	0.023
Friday	21	0.036	0.025	0.010	0.040	0.018	0.016	0.035	0.022	0.022	0.040	0.022	0.036	0.036	0.025	0.010	0.038	0.021	0.032	0.039	0.026	0.019
Friday	22	0.030	0.019	0.011	0.031	0.012	0.011	0.027	0.016	0.020	0.031	0.016	0.031	0.030	0.019	0.011	0.031	0.015	0.029	0.031	0.020	0.020
Friday	23	0.018	0.012	0.009	0.022	0.007	0.012	0.020	0.012	0.018	0.025	0.012	0.025	0.018	0.012	0.009	0.023	0.010	0.026	0.022	0.016	0.021
Saturday	0	0.010	0.015	0.027	0.012	0.008	0.014	0.015	0.026	0.040	0.026	0.013	0.020	0.010	0.015	0.027	0.023	0.011	0.030	0.014	0.029	0.051
Saturday	1	0.007	0.012	0.023	0.013	0.006	0.014	0.010	0.020	0.035	0.026	0.008	0.016	0.007	0.012	0.023	0.025	0.010	0.027	0.009	0.024	0.044
Saturday	2	0.005	0.011	0.022	0.013	0.004	0.011	0.008	0.018	0.032	0.027	0.007	0.015	0.005	0.011	0.022	0.025	0.009	0.026	0.007	0.022	0.041
Saturday	3	0.004	0.010	0.025	0.012	0.004	0.014	0.008	0.019	0.032	0.030	0.007	0.014	0.004	0.010	0.025	0.027	0.011	0.024	0.006	0.023	0.040
Saturday	4	0.005	0.013	0.028	0.014	0.008	0.020	0.011	0.021	0.035	0.029	0.009	0.016	0.005	0.013	0.028	0.031	0.020	0.025	0.007	0.023	0.041
Saturday	5	0.010	0.021	0.034	0.020	0.016	0.034	0.017	0.028	0.039	0.033	0.015	0.019	0.010	0.021	0.034	0.038	0.034	0.030	0.013	0.029	0.045
Saturday	6	0.017	0.028	0.039	0.025	0.025	0.043	0.025	0.036	0.045	0.036	0.023	0.025	0.017	0.028	0.039	0.038	0.047	0.040	0.021	0.033	0.047
Saturday	7	0.029	0.036	0.053	0.030	0.031	0.058	0.034	0.044	0.050	0.038	0.033	0.036	0.029	0.036	0.053	0.042	0.047	0.046	0.030	0.038	0.053

		Mariposa			Mendocino			Merced			Modoc			Mono			Monterey			Napa		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Saturday	8	0.044	0.045	0.060	0.036	0.041	0.070	0.044	0.053	0.055	0.041	0.047	0.047	0.044	0.045	0.060	0.043	0.055	0.050	0.042	0.046	0.052
Saturday	9	0.059	0.061	0.071	0.043	0.053	0.079	0.054	0.061	0.060	0.045	0.063	0.059	0.059	0.061	0.071	0.047	0.062	0.055	0.054	0.054	0.058
Saturday	10	0.073	0.074	0.078	0.052	0.069	0.082	0.062	0.068	0.063	0.049	0.075	0.067	0.073	0.074	0.078	0.047	0.067	0.062	0.063	0.058	0.055
Saturday	11	0.081	0.077	0.083	0.054	0.076	0.075	0.067	0.071	0.064	0.050	0.084	0.073	0.081	0.077	0.083	0.049	0.068	0.063	0.068	0.060	0.052
Saturday	12	0.078	0.077	0.075	0.061	0.080	0.070	0.069	0.070	0.062	0.053	0.083	0.071	0.078	0.077	0.075	0.055	0.071	0.060	0.069	0.060	0.052
Saturday	13	0.075	0.072	0.060	0.063	0.082	0.064	0.070	0.067	0.058	0.055	0.081	0.069	0.075	0.072	0.060	0.054	0.070	0.059	0.067	0.057	0.047
Saturday	14	0.075	0.068	0.055	0.065	0.081	0.062	0.070	0.064	0.054	0.057	0.076	0.065	0.075	0.068	0.055	0.055	0.066	0.058	0.067	0.057	0.045
Saturday	15	0.075	0.068	0.052	0.067	0.080	0.054	0.069	0.061	0.049	0.060	0.074	0.062	0.075	0.068	0.052	0.055	0.065	0.056	0.067	0.057	0.044
Saturday	16	0.072	0.070	0.047	0.071	0.081	0.051	0.068	0.057	0.045	0.056	0.070	0.058	0.072	0.070	0.047	0.057	0.065	0.052	0.068	0.054	0.038
Saturday	17	0.066	0.063	0.040	0.068	0.072	0.037	0.064	0.051	0.040	0.055	0.061	0.057	0.066	0.063	0.040	0.056	0.053	0.047	0.066	0.054	0.035
Saturday	18	0.058	0.052	0.031	0.062	0.053	0.032	0.056	0.042	0.033	0.051	0.049	0.052	0.058	0.052	0.031	0.052	0.044	0.042	0.060	0.049	0.032
Saturday	19	0.047	0.041	0.026	0.059	0.040	0.029	0.048	0.034	0.027	0.049	0.038	0.045	0.047	0.041	0.026	0.049	0.039	0.039	0.052	0.044	0.030
Saturday	20	0.038	0.031	0.020	0.051	0.032	0.021	0.041	0.029	0.024	0.042	0.031	0.038	0.038	0.031	0.020	0.043	0.031	0.035	0.046	0.040	0.028
Saturday	21	0.031	0.025	0.016	0.047	0.026	0.023	0.037	0.024	0.021	0.037	0.023	0.031	0.031	0.025	0.016	0.038	0.025	0.029	0.042	0.035	0.025
Saturday	22	0.025	0.020	0.018	0.037	0.019	0.020	0.031	0.020	0.019	0.031	0.017	0.026	0.025	0.020	0.018	0.030	0.017	0.026	0.036	0.030	0.023
Saturday	23	0.016	0.013	0.018	0.028	0.014	0.021	0.023	0.016	0.017	0.023	0.012	0.019	0.016	0.013	0.018	0.023	0.011	0.020	0.026	0.024	0.024
Holiday	0	0.008	0.011	0.020	0.010	0.004	0.009	0.013	0.020	0.027	0.024	0.008	0.015	0.008	0.011	0.020	0.024	0.008	0.016	0.014	0.028	0.038
Holiday	1	0.005	0.009	0.018	0.014	0.004	0.008	0.009	0.017	0.025	0.027	0.008	0.012	0.005	0.009	0.018	0.022	0.009	0.015	0.008	0.024	0.033
Holiday	2	0.003	0.010	0.018	0.010	0.003	0.014	0.007	0.015	0.024	0.024	0.008	0.012	0.003	0.010	0.018	0.024	0.007	0.015	0.005	0.026	0.033
Holiday	3	0.004	0.010	0.021	0.014	0.005	0.012	0.007	0.016	0.026	0.029	0.010	0.013	0.004	0.010	0.021	0.024	0.009	0.017	0.004	0.025	0.034
Holiday	4	0.005	0.012	0.020	0.014	0.006	0.017	0.011	0.020	0.029	0.029	0.012	0.014	0.005	0.012	0.020	0.031	0.019	0.019	0.008	0.025	0.035
Holiday	5	0.009	0.018	0.031	0.019	0.018	0.028	0.019	0.028	0.033	0.031	0.016	0.017	0.009	0.018	0.031	0.033	0.029	0.024	0.017	0.030	0.040
Holiday	6	0.018	0.023	0.038	0.028	0.034	0.042	0.027	0.035	0.038	0.037	0.025	0.023	0.018	0.023	0.038	0.038	0.042	0.030	0.024	0.036	0.044
Holiday	7	0.029	0.031	0.043	0.039	0.045	0.052	0.035	0.042	0.042	0.038	0.033	0.031	0.029	0.031	0.043	0.040	0.044	0.037	0.030	0.042	0.049
Holiday	8	0.041	0.044	0.056	0.041	0.051	0.059	0.040	0.048	0.046	0.040	0.049	0.040	0.041	0.044	0.056	0.037	0.050	0.041	0.039	0.047	0.049
Holiday	9	0.058	0.057	0.075	0.044	0.057	0.066	0.048	0.055	0.050	0.043	0.062	0.054	0.058	0.057	0.075	0.046	0.057	0.048	0.048	0.055	0.057
Holiday	10	0.076	0.083	0.087	0.050	0.069	0.075	0.059	0.064	0.055	0.050	0.076	0.060	0.076	0.083	0.087	0.048	0.066	0.056	0.060	0.060	0.056
Holiday	11	0.084	0.086	0.088	0.056	0.072	0.077	0.065	0.070	0.060	0.047	0.084	0.068	0.084	0.086	0.088	0.055	0.077	0.063	0.066	0.064	0.055
Holiday	12	0.085	0.087	0.089	0.058	0.080	0.078	0.069	0.072	0.061	0.053	0.083	0.070	0.085	0.087	0.089	0.052	0.074	0.065	0.068	0.063	0.060
Holiday	13	0.083	0.081	0.078	0.063	0.077	0.069	0.071	0.071	0.061	0.062	0.091	0.067	0.083	0.081	0.078	0.055	0.071	0.069	0.069	0.062	0.055
Holiday	14	0.080	0.074	0.068	0.068	0.083	0.067	0.072	0.069	0.059	0.059	0.087	0.069	0.080	0.074	0.068	0.050	0.071	0.067	0.071	0.060	0.055
Holiday	15	0.078	0.074	0.060	0.071	0.082	0.064	0.073	0.068	0.058	0.057	0.079	0.065	0.078	0.074	0.060	0.061	0.068	0.068	0.071	0.064	0.054
Holiday	16	0.078	0.072	0.049	0.075	0.083	0.061	0.073	0.065	0.055	0.056	0.072	0.062	0.078	0.072	0.049	0.062	0.069	0.058	0.068	0.057	0.046
Holiday	17	0.071	0.066	0.041	0.072	0.076	0.044	0.070	0.057	0.050	0.056	0.058	0.060	0.071	0.066	0.041	0.058	0.062	0.058	0.067	0.055	0.041
Holiday	18	0.057	0.049	0.033	0.054	0.048	0.040	0.060	0.046	0.044	0.053	0.044	0.058	0.057	0.049	0.033	0.054	0.050	0.049	0.061	0.042	0.038
Holiday	19	0.043	0.040	0.022	0.056	0.036	0.029	0.050	0.036	0.039	0.048	0.029	0.049	0.043	0.040	0.022	0.049	0.037	0.047	0.053	0.037	0.029
Holiday	20	0.033	0.026	0.013	0.049	0.025	0.029	0.042	0.029	0.034	0.044	0.024	0.045	0.033	0.026	0.013	0.046	0.032	0.043	0.049	0.029	0.024
Holiday	21	0.024	0.018	0.011	0.040	0.019	0.023	0.034	0.023	0.030	0.040	0.019	0.040	0.024	0.018	0.011	0.040	0.025	0.038	0.042	0.028	0.024
Holiday	22	0.017	0.012	0.009	0.029	0.012	0.018	0.027	0.017	0.028	0.031	0.014	0.030	0.017	0.012	0.009	0.031	0.016	0.032	0.035	0.022	0.025
Holiday	23	0.010	0.008	0.010	0.025	0.010	0.019	0.018	0.014	0.026	0.024	0.009	0.024	0.010	0.008	0.010	0.020	0.008	0.028	0.023	0.018	0.026

		Nevada			Orange			Placer			Plumas			Riverside			Sacramento			San Benito		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Sunday	0	0.013	0.020	0.031	0.023	0.045	0.061	0.013	0.020	0.031	0.015	0.010	0.015	0.022	0.036	0.050	0.019	0.031	0.044	0.019	0.010	0.029
Sunday	1	0.008	0.016	0.028	0.015	0.032	0.049	0.008	0.016	0.028	0.010	0.006	0.011	0.015	0.028	0.044	0.013	0.025	0.039	0.020	0.008	0.023
Sunday	2	0.006	0.013	0.026	0.011	0.025	0.041	0.006	0.013	0.026	0.007	0.004	0.012	0.011	0.023	0.040	0.009	0.021	0.036	0.020	0.007	0.021
Sunday	3	0.005	0.012	0.025	0.007	0.019	0.034	0.005	0.012	0.025	0.006	0.004	0.012	0.009	0.020	0.036	0.007	0.019	0.034	0.020	0.007	0.019
Sunday	4	0.005	0.012	0.025	0.007	0.018	0.031	0.005	0.012	0.025	0.006	0.005	0.017	0.009	0.020	0.035	0.008	0.020	0.034	0.024	0.012	0.019
Sunday	5	0.008	0.015	0.027	0.011	0.022	0.034	0.008	0.015	0.027	0.010	0.011	0.029	0.012	0.023	0.036	0.011	0.023	0.034	0.026	0.017	0.021
Sunday	6	0.013	0.020	0.030	0.018	0.029	0.038	0.013	0.020	0.030	0.016	0.017	0.037	0.019	0.029	0.039	0.017	0.027	0.037	0.029	0.024	0.026
Sunday	7	0.022	0.028	0.034	0.026	0.036	0.041	0.022	0.028	0.034	0.023	0.029	0.051	0.026	0.035	0.041	0.025	0.033	0.039	0.031	0.030	0.034
Sunday	8	0.034	0.041	0.040	0.037	0.046	0.046	0.034	0.041	0.040	0.033	0.043	0.071	0.036	0.045	0.044	0.035	0.042	0.043	0.035	0.038	0.040
Sunday	9	0.048	0.055	0.046	0.050	0.058	0.051	0.048	0.055	0.046	0.047	0.063	0.091	0.049	0.054	0.047	0.049	0.052	0.047	0.038	0.049	0.049
Sunday	10	0.064	0.068	0.052	0.059	0.065	0.052	0.064	0.068	0.052	0.057	0.075	0.084	0.057	0.061	0.047	0.060	0.060	0.049	0.041	0.057	0.057
Sunday	11	0.075	0.075	0.055	0.065	0.067	0.052	0.075	0.075	0.055	0.067	0.083	0.079	0.064	0.065	0.048	0.066	0.063	0.049	0.047	0.068	0.061
Sunday	12	0.082	0.079	0.058	0.068	0.066	0.049	0.082	0.079	0.058	0.074	0.090	0.070	0.067	0.066	0.047	0.072	0.066	0.049	0.051	0.074	0.063
Sunday	13	0.084	0.079	0.058	0.069	0.064	0.046	0.084	0.079	0.058	0.078	0.089	0.061	0.069	0.065	0.045	0.074	0.067	0.049	0.053	0.073	0.065
Sunday	14	0.084	0.077	0.057	0.068	0.059	0.043	0.084	0.077	0.057	0.079	0.081	0.057	0.069	0.063	0.044	0.074	0.064	0.047	0.059	0.078	0.065
Sunday	15	0.082	0.073	0.057	0.068	0.055	0.040	0.082	0.073	0.057	0.080	0.079	0.053	0.068	0.060	0.042	0.072	0.061	0.046	0.061	0.078	0.066
Sunday	16	0.079	0.068	0.055	0.067	0.051	0.038	0.079	0.068	0.055	0.079	0.075	0.045	0.067	0.056	0.041	0.071	0.059	0.045	0.064	0.074	0.060
Sunday	17	0.072	0.062	0.053	0.064	0.047	0.036	0.072	0.062	0.053	0.075	0.066	0.043	0.064	0.052	0.040	0.068	0.056	0.043	0.063	0.068	0.053
Sunday	18	0.060	0.052	0.049	0.060	0.041	0.034	0.060	0.052	0.049	0.066	0.054	0.039	0.061	0.047	0.039	0.061	0.049	0.041	0.064	0.060	0.049
Sunday	19	0.050	0.043	0.045	0.055	0.036	0.033	0.050	0.043	0.045	0.055	0.042	0.037	0.057	0.042	0.039	0.053	0.042	0.040	0.060	0.052	0.046
Sunday	20	0.041	0.035	0.042	0.052	0.034	0.034	0.041	0.035	0.042	0.045	0.031	0.030	0.053	0.037	0.039	0.048	0.038	0.039	0.055	0.043	0.041
Sunday	21	0.031	0.026	0.039	0.045	0.032	0.036	0.031	0.026	0.039	0.035	0.022	0.024	0.044	0.031	0.039	0.040	0.032	0.039	0.050	0.034	0.037
Sunday	22	0.021	0.019	0.036	0.034	0.028	0.038	0.021	0.019	0.036	0.023	0.013	0.018	0.032	0.024	0.038	0.029	0.027	0.038	0.039	0.022	0.031
Sunday	23	0.013	0.015	0.033	0.022	0.024	0.042	0.013	0.015	0.033	0.014	0.008	0.015	0.021	0.018	0.038	0.019	0.023	0.039	0.030	0.016	0.025
Monday	0	0.008	0.014	0.027	0.010	0.016	0.024	0.008	0.014	0.027	0.006	0.002	0.006	0.011	0.018	0.027	0.009	0.018	0.028	0.023	0.006	0.009
Monday	1	0.005	0.012	0.025	0.006	0.012	0.021	0.005	0.012	0.025	0.004	0.002	0.007	0.008	0.016	0.026	0.005	0.015	0.026	0.024	0.007	0.009
Monday	2	0.004	0.012	0.025	0.005	0.012	0.021	0.004	0.012	0.025	0.003	0.002	0.010	0.007	0.016	0.027	0.004	0.015	0.026	0.025	0.009	0.010
Monday	3	0.006	0.014	0.027	0.006	0.013	0.022	0.006	0.014	0.027	0.003	0.004	0.012	0.011	0.020	0.030	0.006	0.018	0.028	0.025	0.011	0.014
Monday	4	0.011	0.019	0.030	0.015	0.022	0.029	0.011	0.019	0.030	0.007	0.009	0.021	0.024	0.033	0.038	0.013	0.026	0.033	0.033	0.023	0.019
Monday	5	0.023	0.030	0.036	0.034	0.041	0.043	0.023	0.030	0.036	0.018	0.024	0.037	0.040	0.049	0.045	0.029	0.040	0.040	0.039	0.042	0.024
Monday	6	0.042	0.047	0.043	0.054	0.060	0.054	0.042	0.047	0.043	0.041	0.051	0.055	0.053	0.059	0.049	0.052	0.057	0.048	0.044	0.060	0.031
Monday	7	0.060	0.061	0.048	0.066	0.073	0.060	0.060	0.061	0.048	0.078	0.069	0.066	0.059	0.064	0.051	0.071	0.066	0.051	0.041	0.056	0.038
Monday	8	0.059	0.062	0.050	0.064	0.073	0.061	0.059	0.062	0.050	0.067	0.077	0.077	0.056	0.062	0.052	0.066	0.064	0.052	0.043	0.058	0.045
Monday	9	0.056	0.061	0.050	0.056	0.065	0.058	0.056	0.061	0.050	0.057	0.071	0.080	0.053	0.059	0.051	0.056	0.059	0.052	0.045	0.063	0.053
Monday	10	0.058	0.064	0.051	0.052	0.061	0.055	0.058	0.064	0.051	0.057	0.071	0.077	0.052	0.058	0.051	0.052	0.057	0.052	0.046	0.065	0.059
Monday	11	0.062	0.066	0.053	0.052	0.060	0.055	0.062	0.066	0.053	0.060	0.074	0.073	0.053	0.058	0.052	0.053	0.058	0.053	0.050	0.066	0.061
Monday	12	0.066	0.068	0.054	0.053	0.060	0.054	0.066	0.068	0.054	0.063	0.072	0.071	0.055	0.058	0.051	0.056	0.059	0.053	0.052	0.068	0.065
Monday	13	0.067	0.067	0.054	0.055	0.059	0.053	0.067	0.067	0.054	0.063	0.072	0.068	0.057	0.059	0.051	0.057	0.059	0.053	0.056	0.069	0.063
Monday	14	0.070	0.069	0.055	0.060	0.061	0.054	0.070	0.069	0.055	0.067	0.077	0.064	0.061	0.060	0.051	0.062	0.060	0.053	0.057	0.070	0.065
Monday	15	0.073	0.069	0.055	0.064	0.061	0.053	0.073	0.069	0.055	0.078	0.080	0.056	0.065	0.061	0.050	0.070	0.064	0.052	0.058	0.070	0.066
Monday	16	0.075	0.067	0.054	0.067	0.060	0.052	0.075	0.067	0.054	0.086	0.077	0.049	0.067	0.059	0.049	0.076	0.063	0.051	0.059	0.067	0.060
Monday	17	0.073	0.061	0.052	0.068	0.057	0.050	0.073	0.061	0.052	0.087	0.062	0.041	0.066	0.054	0.047	0.073	0.057	0.048	0.058	0.062	0.057
Monday	18	0.056	0.046	0.045	0.060	0.044	0.042	0.056	0.046	0.045	0.051	0.038	0.030	0.056	0.043	0.042	0.056	0.044	0.043	0.055	0.043	0.053
Monday	19	0.040	0.031	0.039	0.047	0.029	0.034	0.040	0.031	0.039	0.036	0.024	0.024	0.044	0.031	0.037	0.040	0.031	0.037	0.045	0.029	0.048
Monday	20	0.031	0.022	0.035	0.037	0.020	0.028	0.031	0.022	0.035	0.026	0.018	0.023	0.035	0.023	0.033	0.032	0.024	0.033	0.041	0.022	0.045
Monday	21	0.025	0.017	0.032	0.032	0.017	0.026	0.025	0.017	0.032	0.020	0.012	0.021	0.030	0.017	0.031	0.028	0.019	0.030	0.035	0.017	0.039
Monday	22	0.017	0.012	0.030	0.024	0.013	0.025	0.017	0.012	0.030	0.013	0.007	0.017	0.023	0.012	0.029	0.021	0.015	0.028	0.026	0.011	0.035
Monday	23	0.012	0.009	0.030	0.015	0.010	0.026	0.012	0.009	0.030	0.008	0.004	0.015	0.016	0.009	0.028	0.014	0.011	0.027	0.020	0.007	0.033
Tues/Wed/Thurs	0	0.008	0.014	0.029	0.009	0.015	0.026	0.008	0.014	0.029	0.006	0.003	0.010	0.010	0.017	0.030	0.008	0.018	0.031	0.020	0.006	0.023
Tues/Wed/Thurs	1	0.004	0.011	0.027	0.005	0.012	0.024	0.004	0.011	0.027	0.003	0.002	0.011	0.007	0.015	0.029	0.005	0.015	0.030	0.022	0.007	0.021
Tues/Wed/Thurs	2	0.004	0.011	0.027	0.004	0.012	0.023	0.004	0.011	0.027	0.003	0.002	0.013	0.006	0.015	0.029	0.004	0.015	0.029	0.023	0.007	0.021
Tues/Wed/Thurs	3	0.005	0.013	0.029	0.005	0.013	0.025	0.005	0.013	0.029	0.003	0.003	0.015	0.010	0.019	0.032	0.006	0.017	0.031	0.025	0.010	0.022

		Nevada			Orange			Placer			Plumas			Riverside			Sacramento			San Benito		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Tues/Wed/Thurs	4	0.010	0.018	0.031	0.013	0.022	0.031	0.010	0.018	0.031	0.006	0.008	0.022	0.022	0.032	0.040	0.012	0.024	0.036	0.030	0.019	0.024
Tues/Wed/Thurs	5	0.022	0.029	0.037	0.033	0.040	0.045	0.022	0.029	0.037	0.017	0.024	0.037	0.039	0.048	0.047	0.027	0.038	0.043	0.037	0.037	0.029
Tues/Wed/Thurs	6	0.042	0.047	0.044	0.054	0.061	0.057	0.042	0.047	0.044	0.041	0.053	0.054	0.053	0.060	0.051	0.052	0.057	0.050	0.043	0.057	0.038
Tues/Wed/Thurs	7	0.060	0.061	0.050	0.065	0.073	0.062	0.060	0.061	0.050	0.077	0.069	0.066	0.059	0.064	0.053	0.071	0.066	0.053	0.042	0.057	0.046
Tues/Wed/Thurs	8	0.060	0.062	0.051	0.063	0.073	0.062	0.060	0.062	0.051	0.066	0.077	0.077	0.056	0.062	0.053	0.066	0.063	0.053	0.045	0.062	0.050
Tues/Wed/Thurs	9	0.055	0.060	0.050	0.057	0.066	0.059	0.055	0.060	0.050	0.057	0.071	0.080	0.052	0.059	0.052	0.056	0.059	0.053	0.046	0.063	0.055
Tues/Wed/Thurs	10	0.056	0.061	0.051	0.052	0.061	0.056	0.056	0.061	0.051	0.056	0.071	0.077	0.051	0.058	0.052	0.051	0.057	0.053	0.047	0.061	0.058
Tues/Wed/Thurs	11	0.059	0.064	0.052	0.052	0.061	0.054	0.059	0.064	0.052	0.058	0.071	0.074	0.051	0.058	0.051	0.052	0.057	0.053	0.049	0.065	0.060
Tues/Wed/Thurs	12	0.061	0.065	0.053	0.053	0.060	0.053	0.061	0.065	0.053	0.062	0.070	0.069	0.053	0.058	0.051	0.054	0.058	0.053	0.051	0.066	0.060
Tues/Wed/Thurs	13	0.064	0.066	0.053	0.055	0.060	0.052	0.064	0.066	0.053	0.063	0.073	0.067	0.056	0.059	0.051	0.056	0.059	0.052	0.054	0.069	0.059
Tues/Wed/Thurs	14	0.068	0.068	0.053	0.059	0.061	0.052	0.068	0.068	0.053	0.066	0.076	0.063	0.060	0.061	0.050	0.061	0.061	0.051	0.058	0.072	0.059
Tues/Wed/Thurs	15	0.073	0.069	0.053	0.063	0.061	0.051	0.073	0.069	0.053	0.079	0.080	0.056	0.064	0.061	0.048	0.070	0.064	0.050	0.059	0.072	0.057
Tues/Wed/Thurs	16	0.075	0.067	0.052	0.065	0.059	0.049	0.075	0.067	0.052	0.087	0.076	0.045	0.066	0.060	0.047	0.075	0.063	0.048	0.060	0.070	0.053
Tues/Wed/Thurs	17	0.074	0.063	0.050	0.066	0.055	0.046	0.074	0.063	0.050	0.088	0.062	0.040	0.066	0.055	0.044	0.073	0.057	0.044	0.058	0.063	0.051
Tues/Wed/Thurs	18	0.059	0.048	0.044	0.060	0.044	0.040	0.059	0.048	0.044	0.054	0.039	0.031	0.058	0.045	0.040	0.059	0.046	0.041	0.052	0.044	0.046
Tues/Wed/Thurs	19	0.043	0.034	0.038	0.049	0.030	0.032	0.043	0.034	0.038	0.036	0.026	0.023	0.046	0.032	0.035	0.041	0.033	0.035	0.049	0.032	0.041
Tues/Wed/Thurs	20	0.035	0.025	0.034	0.040	0.021	0.027	0.035	0.025	0.034	0.028	0.019	0.021	0.038	0.024	0.032	0.034	0.026	0.031	0.043	0.024	0.037
Tues/Wed/Thurs	21	0.029	0.019	0.031	0.035	0.017	0.025	0.029	0.019	0.031	0.021	0.013	0.020	0.033	0.018	0.029	0.030	0.021	0.029	0.038	0.018	0.034
Tues/Wed/Thurs	22	0.020	0.013	0.029	0.026	0.013	0.024	0.020	0.013	0.029	0.014	0.007	0.016	0.025	0.012	0.027	0.022	0.016	0.027	0.029	0.011	0.030
Tues/Wed/Thurs	23	0.013	0.009	0.028	0.016	0.010	0.025	0.013	0.009	0.028	0.009	0.004	0.013	0.017	0.008	0.026	0.015	0.012	0.027	0.022	0.008	0.026
Friday	0	0.007	0.014	0.032	0.010	0.017	0.029	0.007	0.014	0.032	0.007	0.003	0.011	0.011	0.018	0.031	0.009	0.019	0.034	0.020	0.006	0.022
Friday	1	0.005	0.011	0.030	0.006	0.014	0.026	0.005	0.011	0.030	0.004	0.003	0.012	0.007	0.015	0.030	0.005	0.016	0.032	0.020	0.006	0.021
Friday	2	0.004	0.011	0.030	0.005	0.013	0.025	0.004	0.011	0.030	0.004	0.003	0.015	0.007	0.016	0.030	0.004	0.016	0.031	0.022	0.007	0.021
Friday	3	0.005	0.012	0.030	0.006	0.014	0.026	0.005	0.012	0.030	0.004	0.004	0.017	0.009	0.019	0.033	0.006	0.017	0.033	0.024	0.009	0.022
Friday	4	0.008	0.016	0.033	0.013	0.021	0.032	0.008	0.016	0.033	0.006	0.007	0.024	0.020	0.030	0.041	0.011	0.024	0.037	0.028	0.018	0.024
Friday	5	0.017	0.026	0.038	0.029	0.038	0.045	0.017	0.026	0.038	0.015	0.022	0.039	0.034	0.045	0.048	0.024	0.036	0.044	0.035	0.033	0.029
Friday	6	0.033	0.040	0.045	0.048	0.057	0.057	0.033	0.040	0.045	0.035	0.045	0.055	0.046	0.055	0.052	0.045	0.053	0.051	0.041	0.050	0.038
Friday	7	0.049	0.054	0.050	0.061	0.070	0.063	0.049	0.054	0.050	0.063	0.063	0.064	0.053	0.061	0.054	0.063	0.063	0.054	0.039	0.049	0.046
Friday	8	0.051	0.057	0.052	0.059	0.070	0.063	0.051	0.057	0.052	0.058	0.072	0.074	0.051	0.059	0.054	0.059	0.061	0.055	0.041	0.056	0.050
Friday	9	0.050	0.057	0.052	0.054	0.064	0.060	0.050	0.057	0.052	0.052	0.068	0.075	0.050	0.058	0.053	0.052	0.058	0.054	0.045	0.058	0.055
Friday	10	0.054	0.061	0.054	0.052	0.062	0.058	0.054	0.061	0.054	0.055	0.071	0.074	0.051	0.059	0.053	0.050	0.057	0.054	0.047	0.062	0.059
Friday	11	0.060	0.066	0.055	0.054	0.062	0.057	0.060	0.066	0.055	0.060	0.074	0.074	0.053	0.060	0.053	0.053	0.059	0.054	0.050	0.067	0.060
Friday	12	0.063	0.067	0.055	0.055	0.062	0.056	0.063	0.067	0.055	0.063	0.072	0.069	0.055	0.061	0.053	0.056	0.060	0.053	0.051	0.067	0.060
Friday	13	0.066	0.068	0.054	0.057	0.062	0.055	0.066	0.068	0.054	0.065	0.076	0.069	0.058	0.061	0.052	0.058	0.060	0.052	0.056	0.071	0.062
Friday	14	0.070	0.070	0.054	0.060	0.062	0.053	0.070	0.070	0.054	0.069	0.078	0.063	0.061	0.062	0.050	0.063	0.062	0.051	0.060	0.075	0.059
Friday	15	0.073	0.070	0.052	0.061	0.060	0.051	0.073	0.070	0.052	0.078	0.080	0.055	0.062	0.061	0.048	0.070	0.063	0.049	0.060	0.074	0.060
Friday	16	0.074	0.067	0.050	0.063	0.057	0.048	0.074	0.067	0.050	0.085	0.075	0.047	0.063	0.058	0.046	0.072	0.060	0.046	0.060	0.070	0.055
Friday	17	0.072	0.063	0.047	0.063	0.053	0.044	0.072	0.063	0.047	0.082	0.061	0.039	0.062	0.053	0.043	0.069	0.055	0.043	0.060	0.064	0.049
Friday	18	0.063	0.051	0.042	0.058	0.042	0.036	0.063	0.051	0.042	0.059	0.041	0.029	0.058	0.045	0.039	0.060	0.046	0.039	0.054	0.049	0.044
Friday	19	0.050	0.039	0.035	0.050	0.031	0.030	0.050	0.039	0.035	0.042	0.028	0.024	0.050	0.035	0.034	0.046	0.035	0.033	0.050	0.036	0.040
Friday	20	0.041	0.029	0.030	0.042	0.023	0.024	0.041	0.029	0.030	0.032	0.021	0.021	0.043	0.026	0.030	0.038	0.026	0.028	0.045	0.028	0.037
Friday	21	0.037	0.023	0.028	0.038	0.018	0.022	0.037	0.023	0.028	0.027	0.015	0.020	0.039	0.020	0.027	0.035	0.022	0.026	0.038	0.021	0.032
Friday	22	0.030	0.017	0.026	0.033	0.015	0.021	0.030	0.017	0.026	0.021	0.011	0.016	0.032	0.014	0.024	0.029	0.018	0.024	0.031	0.015	0.029
Friday	23	0.019	0.011	0.024	0.024	0.012	0.021	0.019	0.011	0.024	0.014	0.007	0.015	0.023	0.009	0.021	0.020	0.013	0.023	0.023	0.010	0.026
Saturday	0	0.013	0.019	0.038	0.017	0.030	0.049	0.013	0.019	0.038	0.012	0.007	0.021	0.017	0.027	0.047	0.016	0.027	0.046	0.023	0.011	0.030
Saturday	1	0.008	0.015	0.034	0.011	0.022	0.041	0.008	0.015	0.034	0.008	0.005	0.016	0.012	0.021	0.042	0.011	0.022	0.042	0.025	0.010	0.027
Saturday	2	0.006	0.014	0.032	0.009	0.019	0.037	0.006	0.014	0.032	0.006	0.004	0.020	0.010	0.019	0.040	0.008	0.020	0.039	0.025	0.009	0.026
Saturday	3	0.006	0.013	0.031	0.007	0.016	0.034	0.006	0.013	0.031	0.005	0.004	0.022	0.009	0.019	0.039	0.007	0.019	0.038	0.027	0.011	0.024
Saturday	4	0.007	0.014	0.032	0.009	0.018	0.036	0.007	0.014	0.032	0.006	0.008	0.024	0.012	0.021	0.041	0.009	0.022	0.039	0.031	0.020	0.025
Saturday	5	0.011	0.018	0.034	0.015	0.026	0.042	0.011	0.018	0.034	0.012	0.017	0.039	0.018	0.029	0.045	0.014	0.027	0.042	0.038	0.034	0.030
Saturday	6	0.019	0.026	0.039	0.026	0.037	0.050	0.019	0.026	0.039	0.021	0.028	0.049	0.028	0.039	0.050	0.023	0.035	0.046	0.038	0.047	0.040
Saturday	7	0.032	0.038	0.046	0.037	0.049	0.058	0.032	0.038	0.046	0.034	0.041	0.058	0.039	0.048	0.055	0.034	0.044	0.050	0.042	0.047	0.046

		Nevada			Orange			Placer			Plumas			Riverside			Sacramento			San Benito		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Saturday	8	0.045	0.051	0.052	0.048	0.060	0.064	0.045	0.051	0.052	0.045	0.057	0.067	0.047	0.056	0.056	0.045	0.052	0.053	0.043	0.055	0.050
Saturday	9	0.057	0.062	0.056	0.055	0.065	0.065	0.057	0.062	0.056	0.054	0.068	0.074	0.054	0.062	0.057	0.054	0.059	0.055	0.047	0.062	0.055
Saturday	10	0.067	0.071	0.060	0.059	0.068	0.064	0.067	0.071	0.060	0.063	0.080	0.073	0.058	0.064	0.056	0.061	0.063	0.055	0.047	0.067	0.062
Saturday	11	0.074	0.076	0.061	0.062	0.069	0.062	0.074	0.076	0.061	0.068	0.082	0.071	0.062	0.066	0.054	0.066	0.065	0.055	0.049	0.068	0.063
Saturday	12	0.075	0.075	0.060	0.064	0.068	0.058	0.075	0.075	0.060	0.074	0.083	0.068	0.063	0.065	0.052	0.068	0.065	0.053	0.055	0.071	0.060
Saturday	13	0.075	0.074	0.057	0.064	0.064	0.053	0.075	0.074	0.057	0.074	0.079	0.062	0.064	0.064	0.050	0.068	0.064	0.051	0.054	0.070	0.059
Saturday	14	0.074	0.071	0.055	0.064	0.061	0.048	0.074	0.071	0.055	0.074	0.076	0.057	0.064	0.062	0.047	0.068	0.061	0.048	0.055	0.066	0.058
Saturday	15	0.072	0.068	0.051	0.064	0.057	0.044	0.072	0.068	0.051	0.073	0.074	0.052	0.064	0.059	0.044	0.067	0.059	0.045	0.055	0.065	0.056
Saturday	16	0.070	0.064	0.048	0.064	0.053	0.039	0.070	0.064	0.048	0.073	0.067	0.045	0.063	0.056	0.041	0.067	0.056	0.042	0.057	0.065	0.052
Saturday	17	0.066	0.057	0.044	0.062	0.048	0.034	0.066	0.057	0.044	0.069	0.058	0.039	0.061	0.051	0.037	0.064	0.052	0.039	0.056	0.053	0.047
Saturday	18	0.056	0.047	0.038	0.057	0.041	0.028	0.056	0.047	0.038	0.058	0.047	0.034	0.056	0.043	0.033	0.057	0.045	0.034	0.052	0.044	0.042
Saturday	19	0.046	0.037	0.033	0.050	0.032	0.022	0.046	0.037	0.033	0.046	0.036	0.029	0.049	0.035	0.028	0.048	0.037	0.030	0.049	0.039	0.039
Saturday	20	0.040	0.030	0.028	0.044	0.027	0.018	0.040	0.030	0.028	0.040	0.028	0.024	0.044	0.030	0.024	0.042	0.031	0.027	0.043	0.031	0.035
Saturday	21	0.035	0.025	0.025	0.042	0.026	0.018	0.035	0.025	0.025	0.036	0.022	0.023	0.042	0.026	0.022	0.040	0.029	0.025	0.038	0.025	0.029
Saturday	22	0.028	0.019	0.023	0.040	0.025	0.018	0.028	0.019	0.023	0.029	0.016	0.017	0.037	0.022	0.020	0.036	0.026	0.024	0.030	0.017	0.026
Saturday	23	0.020	0.014	0.021	0.030	0.021	0.019	0.020	0.014	0.021	0.020	0.011	0.017	0.029	0.017	0.018	0.026	0.020	0.022	0.023	0.011	0.020
Holiday	0	0.010	0.016	0.028	0.015	0.023	0.030	0.010	0.016	0.028	0.010	0.004	0.012	0.015	0.023	0.032	0.013	0.023	0.032	0.024	0.008	0.016
Holiday	1	0.006	0.013	0.027	0.009	0.018	0.027	0.006	0.013	0.027	0.006	0.004	0.011	0.010	0.018	0.030	0.008	0.019	0.030	0.022	0.009	0.015
Holiday	2	0.004	0.012	0.026	0.007	0.015	0.025	0.004	0.012	0.026	0.004	0.003	0.012	0.008	0.018	0.029	0.006	0.018	0.030	0.024	0.007	0.015
Holiday	3	0.005	0.013	0.027	0.006	0.015	0.025	0.005	0.013	0.027	0.004	0.005	0.015	0.009	0.020	0.031	0.006	0.019	0.030	0.024	0.009	0.017
Holiday	4	0.008	0.016	0.029	0.010	0.019	0.029	0.008	0.016	0.029	0.007	0.009	0.024	0.016	0.027	0.035	0.010	0.023	0.033	0.031	0.019	0.019
Holiday	5	0.014	0.023	0.032	0.023	0.032	0.038	0.014	0.023	0.032	0.014	0.020	0.037	0.026	0.036	0.041	0.019	0.032	0.037	0.033	0.029	0.024
Holiday	6	0.025	0.033	0.036	0.038	0.047	0.047	0.025	0.033	0.036	0.030	0.036	0.047	0.035	0.044	0.044	0.031	0.041	0.043	0.038	0.042	0.030
Holiday	7	0.036	0.044	0.042	0.047	0.057	0.053	0.036	0.044	0.042	0.044	0.052	0.061	0.041	0.049	0.046	0.042	0.049	0.046	0.040	0.044	0.037
Holiday	8	0.046	0.053	0.048	0.047	0.058	0.053	0.046	0.053	0.048	0.052	0.066	0.075	0.046	0.054	0.049	0.048	0.054	0.049	0.037	0.050	0.041
Holiday	9	0.054	0.059	0.050	0.050	0.060	0.054	0.054	0.059	0.050	0.053	0.071	0.081	0.051	0.057	0.050	0.052	0.057	0.051	0.046	0.057	0.048
Holiday	10	0.065	0.069	0.053	0.055	0.064	0.056	0.065	0.069	0.053	0.059	0.076	0.081	0.056	0.061	0.051	0.057	0.060	0.052	0.048	0.066	0.056
Holiday	11	0.074	0.074	0.057	0.059	0.067	0.058	0.074	0.074	0.057	0.066	0.076	0.071	0.061	0.065	0.053	0.063	0.065	0.054	0.055	0.077	0.063
Holiday	12	0.077	0.074	0.056	0.061	0.068	0.057	0.077	0.074	0.056	0.071	0.078	0.074	0.063	0.066	0.053	0.067	0.065	0.054	0.052	0.074	0.065
Holiday	13	0.076	0.074	0.058	0.062	0.067	0.057	0.076	0.074	0.058	0.071	0.076	0.065	0.064	0.066	0.053	0.068	0.066	0.055	0.055	0.071	0.069
Holiday	14	0.075	0.073	0.056	0.064	0.066	0.055	0.075	0.073	0.056	0.070	0.078	0.060	0.064	0.064	0.052	0.069	0.065	0.053	0.050	0.071	0.067
Holiday	15	0.074	0.070	0.055	0.065	0.062	0.052	0.074	0.070	0.055	0.075	0.075	0.053	0.064	0.061	0.050	0.070	0.063	0.052	0.061	0.068	0.068
Holiday	16	0.072	0.066	0.054	0.064	0.057	0.049	0.072	0.066	0.054	0.079	0.070	0.044	0.064	0.058	0.048	0.069	0.060	0.049	0.062	0.069	0.058
Holiday	17	0.068	0.059	0.051	0.064	0.051	0.045	0.068	0.059	0.051	0.074	0.064	0.041	0.064	0.053	0.045	0.066	0.054	0.046	0.058	0.062	0.058
Holiday	18	0.057	0.049	0.045	0.058	0.042	0.040	0.057	0.049	0.045	0.058	0.044	0.034	0.059	0.046	0.043	0.058	0.046	0.042	0.054	0.050	0.049
Holiday	19	0.047	0.036	0.041	0.052	0.032	0.034	0.047	0.036	0.041	0.047	0.033	0.026	0.052	0.036	0.038	0.049	0.036	0.037	0.049	0.037	0.047
Holiday	20	0.039	0.029	0.037	0.046	0.025	0.030	0.039	0.029	0.037	0.038	0.025	0.025	0.045	0.029	0.036	0.043	0.030	0.034	0.046	0.032	0.043
Holiday	21	0.030	0.020	0.033	0.041	0.021	0.029	0.030	0.020	0.033	0.030	0.018	0.021	0.039	0.022	0.032	0.037	0.024	0.031	0.040	0.025	0.038
Holiday	22	0.023	0.015	0.031	0.035	0.018	0.029	0.023	0.015	0.031	0.024	0.011	0.017	0.029	0.016	0.030	0.029	0.019	0.029	0.031	0.016	0.032
Holiday	23	0.015	0.010	0.029	0.023	0.014	0.030	0.015	0.010	0.029	0.014	0.007	0.014	0.021	0.011	0.028	0.020	0.014	0.029	0.020	0.008	0.028

		San Bernardino			San Diego			San Francisco			San Joaquin			San Luis Obispo			San Mateo			Santa Barbara		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Sunday	0	0.024	0.030	0.035	0.019	0.033	0.051	0.026	0.032	0.056	0.016	0.024	0.039	0.017	0.009	0.017	0.021	0.029	0.049	0.020	0.017	0.032
Sunday	1	0.017	0.025	0.031	0.012	0.029	0.044	0.019	0.030	0.050	0.010	0.017	0.034	0.017	0.006	0.012	0.013	0.029	0.047	0.021	0.015	0.026
Sunday	2	0.014	0.022	0.028	0.009	0.026	0.040	0.017	0.030	0.048	0.007	0.015	0.031	0.018	0.005	0.009	0.010	0.028	0.045	0.020	0.012	0.022
Sunday	3	0.011	0.020	0.027	0.007	0.023	0.036	0.011	0.028	0.042	0.006	0.014	0.030	0.018	0.004	0.011	0.006	0.029	0.043	0.019	0.010	0.022
Sunday	4	0.012	0.020	0.027	0.007	0.023	0.034	0.009	0.028	0.040	0.008	0.015	0.030	0.019	0.005	0.009	0.007	0.029	0.041	0.023	0.014	0.023
Sunday	5	0.015	0.022	0.028	0.011	0.026	0.035	0.011	0.029	0.039	0.011	0.018	0.031	0.022	0.009	0.012	0.010	0.030	0.040	0.023	0.017	0.029
Sunday	6	0.021	0.026	0.030	0.018	0.030	0.037	0.018	0.032	0.040	0.017	0.022	0.033	0.026	0.015	0.017	0.015	0.031	0.039	0.029	0.024	0.031
Sunday	7	0.027	0.031	0.033	0.026	0.035	0.040	0.024	0.032	0.039	0.023	0.027	0.036	0.030	0.024	0.025	0.022	0.033	0.038	0.031	0.029	0.031
Sunday	8	0.036	0.038	0.037	0.037	0.041	0.043	0.033	0.036	0.040	0.032	0.036	0.040	0.037	0.037	0.039	0.032	0.036	0.038	0.036	0.042	0.037
Sunday	9	0.046	0.046	0.041	0.050	0.048	0.047	0.047	0.042	0.043	0.045	0.048	0.046	0.043	0.056	0.050	0.047	0.040	0.039	0.042	0.054	0.047
Sunday	10	0.055	0.055	0.047	0.062	0.055	0.050	0.060	0.049	0.044	0.056	0.059	0.050	0.051	0.072	0.068	0.062	0.046	0.042	0.046	0.065	0.055
Sunday	11	0.060	0.060	0.050	0.068	0.059	0.050	0.065	0.053	0.045	0.063	0.067	0.054	0.054	0.079	0.080	0.069	0.052	0.042	0.049	0.072	0.059
Sunday	12	0.064	0.066	0.053	0.072	0.061	0.051	0.067	0.056	0.043	0.068	0.071	0.056	0.058	0.089	0.088	0.072	0.056	0.043	0.055	0.078	0.062
Sunday	13	0.067	0.067	0.054	0.072	0.062	0.049	0.067	0.056	0.041	0.071	0.074	0.055	0.059	0.085	0.081	0.073	0.057	0.042	0.057	0.074	0.057
Sunday	14	0.068	0.066	0.054	0.071	0.059	0.046	0.067	0.056	0.040	0.073	0.073	0.054	0.062	0.085	0.075	0.072	0.058	0.041	0.060	0.072	0.051
Sunday	15	0.066	0.063	0.053	0.071	0.057	0.043	0.066	0.056	0.039	0.073	0.071	0.053	0.065	0.081	0.066	0.070	0.059	0.041	0.061	0.070	0.051
Sunday	16	0.065	0.060	0.052	0.070	0.056	0.042	0.065	0.057	0.038	0.073	0.068	0.050	0.067	0.076	0.063	0.070	0.060	0.041	0.063	0.066	0.049
Sunday	17	0.063	0.056	0.051	0.067	0.053	0.040	0.063	0.057	0.038	0.072	0.063	0.049	0.065	0.070	0.064	0.068	0.060	0.043	0.064	0.059	0.049
Sunday	18	0.060	0.051	0.049	0.061	0.048	0.038	0.058	0.054	0.038	0.067	0.055	0.044	0.063	0.058	0.055	0.059	0.055	0.041	0.061	0.054	0.046
Sunday	19	0.056	0.045	0.047	0.054	0.043	0.036	0.053	0.048	0.037	0.061	0.047	0.041	0.057	0.046	0.044	0.052	0.049	0.040	0.059	0.046	0.043
Sunday	20	0.052	0.042	0.047	0.047	0.039	0.036	0.049	0.044	0.038	0.054	0.040	0.039	0.053	0.037	0.035	0.049	0.045	0.041	0.053	0.040	0.043
Sunday	21	0.044	0.036	0.045	0.039	0.035	0.036	0.045	0.038	0.039	0.044	0.031	0.036	0.045	0.026	0.032	0.045	0.039	0.041	0.045	0.031	0.046
Sunday	22	0.034	0.030	0.042	0.029	0.030	0.037	0.037	0.032	0.041	0.031	0.024	0.035	0.034	0.016	0.025	0.034	0.030	0.040	0.035	0.023	0.045
Sunday	23	0.023	0.025	0.041	0.019	0.027	0.040	0.025	0.025	0.044	0.019	0.019	0.036	0.023	0.010	0.024	0.021	0.022	0.040	0.026	0.017	0.042
Monday	0	0.015	0.017	0.023	0.009	0.018	0.023	0.012	0.020	0.031	0.010	0.012	0.022	0.018	0.004	0.008	0.009	0.016	0.025	0.016	0.005	0.012
Monday	1	0.011	0.015	0.022	0.005	0.017	0.022	0.007	0.021	0.030	0.006	0.010	0.021	0.017	0.003	0.008	0.004	0.018	0.026	0.015	0.004	0.014
Monday	2	0.010	0.015	0.022	0.004	0.017	0.023	0.005	0.021	0.031	0.006	0.010	0.022	0.018	0.003	0.010	0.003	0.019	0.028	0.016	0.005	0.016
Monday	3	0.014	0.018	0.024	0.005	0.018	0.024	0.005	0.022	0.031	0.011	0.015	0.025	0.020	0.006	0.014	0.003	0.020	0.029	0.018	0.007	0.019
Monday	4	0.025	0.028	0.029	0.012	0.022	0.028	0.010	0.025	0.035	0.029	0.028	0.033	0.024	0.011	0.019	0.007	0.022	0.031	0.020	0.013	0.028
Monday	5	0.041	0.044	0.038	0.031	0.034	0.037	0.023	0.031	0.040	0.043	0.043	0.042	0.031	0.027	0.029	0.020	0.026	0.034	0.028	0.025	0.038
Monday	6	0.052	0.053	0.044	0.055	0.050	0.047	0.045	0.040	0.046	0.053	0.052	0.048	0.040	0.048	0.041	0.044	0.035	0.041	0.037	0.048	0.045
Monday	7	0.061	0.065	0.052	0.068	0.066	0.057	0.064	0.057	0.055	0.061	0.059	0.053	0.046	0.065	0.053	0.071	0.058	0.057	0.048	0.071	0.046
Monday	8	0.056	0.056	0.047	0.063	0.062	0.058	0.064	0.064	0.057	0.055	0.057	0.053	0.049	0.066	0.057	0.071	0.070	0.064	0.054	0.083	0.052
Monday	9	0.051	0.051	0.045	0.055	0.056	0.054	0.059	0.054	0.054	0.051	0.056	0.055	0.051	0.069	0.064	0.065	0.059	0.058	0.054	0.078	0.055
Monday	10	0.050	0.050	0.045	0.051	0.055	0.054	0.055	0.053	0.054	0.051	0.058	0.056	0.051	0.070	0.073	0.057	0.052	0.053	0.053	0.069	0.060
Monday	11	0.052	0.052	0.046	0.052	0.056	0.055	0.053	0.053	0.055	0.052	0.060	0.058	0.054	0.070	0.074	0.052	0.050	0.051	0.056	0.072	0.066
Monday	12	0.054	0.054	0.049	0.054	0.058	0.057	0.053	0.054	0.053	0.054	0.061	0.058	0.055	0.070	0.070	0.051	0.053	0.051	0.060	0.073	0.069
Monday	13	0.055	0.057	0.051	0.056	0.059	0.057	0.053	0.056	0.053	0.056	0.063	0.057	0.058	0.071	0.070	0.052	0.055	0.051	0.062	0.072	0.064
Monday	14	0.059	0.062	0.055	0.063	0.062	0.057	0.059	0.059	0.052	0.063	0.068	0.058	0.064	0.076	0.067	0.056	0.059	0.052	0.065	0.075	0.062
Monday	15	0.063	0.065	0.058	0.072	0.065	0.057	0.063	0.061	0.051	0.069	0.072	0.059	0.068	0.083	0.061	0.063	0.065	0.055	0.070	0.077	0.060
Monday	16	0.064	0.066	0.060	0.075	0.065	0.057	0.065	0.061	0.049	0.072	0.071	0.056	0.068	0.079	0.053	0.070	0.070	0.057	0.067	0.067	0.052
Monday	17	0.064	0.065	0.060	0.073	0.062	0.055	0.067	0.068	0.049	0.070	0.065	0.052	0.064	0.065	0.047	0.074	0.077	0.059	0.058	0.046	0.041
Monday	18	0.054	0.050	0.052	0.058	0.046	0.044	0.062	0.056	0.042	0.055	0.045	0.041	0.051	0.041	0.040	0.067	0.059	0.048	0.050	0.034	0.037
Monday	19	0.042	0.035	0.043	0.041	0.033	0.034	0.050	0.039	0.033	0.041	0.031	0.033	0.043	0.026	0.036	0.051	0.039	0.035	0.045	0.025	0.035
Monday	20	0.035	0.028	0.038	0.033	0.026	0.029	0.039	0.030	0.027	0.033	0.023	0.028	0.037	0.018	0.030	0.037	0.029	0.028	0.036	0.017	0.033
Monday	21	0.031	0.023	0.036	0.028	0.022	0.025	0.036	0.024	0.024	0.027	0.017	0.026	0.031	0.014	0.027	0.033	0.022	0.024	0.030	0.013	0.034
Monday	22	0.025	0.018	0.033	0.020	0.017	0.023	0.031	0.018	0.023	0.021	0.013	0.023	0.024	0.009	0.026	0.025	0.016	0.022	0.024	0.010	0.032
Monday	23	0.018	0.013	0.030	0.013	0.015	0.022	0.021	0.013	0.025	0.014	0.010	0.022	0.017	0.005	0.021	0.015	0.011	0.020	0.016	0.007	0.030
Tues/Wed/Thurs	0	0.013	0.016	0.024	0.007	0.017	0.025	0.012	0.019	0.032	0.009	0.011	0.024	0.016	0.004	0.017	0.008	0.016	0.026	0.016	0.005	0.022
Tues/Wed/Thurs	1	0.010	0.014	0.023	0.004	0.016	0.024	0.007	0.019	0.031	0.006	0.010	0.023	0.016	0.003	0.014	0.003	0.017	0.027	0.015	0.004	0.022
Tues/Wed/Thurs	2	0.010	0.015	0.024	0.003	0.016	0.024	0.005	0.020	0.032	0.005	0.010	0.023	0.016	0.003	0.014	0.002	0.018	0.028	0.015	0.004	0.021
Tues/Wed/Thurs	3	0.013	0.018	0.025	0.004	0.017	0.026	0.005	0.021	0.032	0.010	0.014	0.026	0.018	0.004	0.017	0.003	0.019	0.029	0.017	0.006	0.024

		San Bernardino			San Diego			San Francisco			San Joaquin			San Luis Obispo			San Mateo			Santa Barbara		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Tues/Wed/Thurs	4	0.024	0.027	0.031	0.010	0.022	0.029	0.009	0.024	0.036	0.027	0.026	0.034	0.021	0.009	0.022	0.007	0.021	0.031	0.019	0.012	0.033
Tues/Wed/Thurs	5	0.041	0.044	0.040	0.029	0.033	0.038	0.024	0.029	0.041	0.043	0.041	0.042	0.030	0.023	0.032	0.020	0.025	0.034	0.026	0.025	0.045
Tues/Wed/Thurs	6	0.053	0.053	0.046	0.055	0.050	0.049	0.047	0.040	0.049	0.054	0.051	0.049	0.041	0.049	0.046	0.046	0.035	0.042	0.039	0.051	0.052
Tues/Wed/Thurs	7	0.062	0.065	0.054	0.068	0.067	0.059	0.065	0.058	0.057	0.062	0.059	0.054	0.048	0.066	0.057	0.073	0.059	0.058	0.051	0.072	0.052
Tues/Wed/Thurs	8	0.056	0.057	0.050	0.063	0.064	0.059	0.064	0.067	0.059	0.056	0.057	0.054	0.049	0.067	0.060	0.071	0.072	0.066	0.056	0.083	0.056
Tues/Wed/Thurs	9	0.050	0.051	0.046	0.055	0.056	0.055	0.058	0.054	0.055	0.051	0.055	0.055	0.050	0.066	0.065	0.064	0.058	0.058	0.056	0.079	0.057
Tues/Wed/Thurs	10	0.049	0.049	0.046	0.050	0.054	0.054	0.053	0.051	0.053	0.049	0.056	0.056	0.052	0.066	0.067	0.054	0.050	0.052	0.054	0.070	0.060
Tues/Wed/Thurs	11	0.050	0.051	0.047	0.051	0.056	0.055	0.051	0.052	0.054	0.050	0.058	0.056	0.053	0.067	0.071	0.050	0.049	0.050	0.057	0.072	0.064
Tues/Wed/Thurs	12	0.052	0.053	0.049	0.053	0.058	0.056	0.051	0.053	0.053	0.052	0.059	0.056	0.056	0.069	0.067	0.049	0.051	0.050	0.060	0.071	0.062
Tues/Wed/Thurs	13	0.054	0.056	0.051	0.055	0.059	0.055	0.052	0.055	0.052	0.055	0.062	0.056	0.060	0.071	0.065	0.050	0.054	0.051	0.063	0.072	0.060
Tues/Wed/Thurs	14	0.058	0.062	0.054	0.063	0.062	0.056	0.058	0.059	0.051	0.062	0.068	0.057	0.063	0.076	0.064	0.056	0.058	0.052	0.064	0.075	0.058
Tues/Wed/Thurs	15	0.062	0.065	0.057	0.072	0.065	0.055	0.060	0.061	0.050	0.069	0.074	0.058	0.069	0.084	0.058	0.062	0.065	0.054	0.067	0.076	0.052
Tues/Wed/Thurs	16	0.064	0.067	0.059	0.074	0.065	0.055	0.064	0.062	0.047	0.072	0.074	0.057	0.070	0.081	0.050	0.070	0.071	0.056	0.064	0.065	0.044
Tues/Wed/Thurs	17	0.064	0.066	0.058	0.073	0.063	0.054	0.065	0.070	0.047	0.070	0.067	0.053	0.063	0.067	0.045	0.072	0.081	0.061	0.056	0.045	0.036
Tues/Wed/Thurs	18	0.055	0.052	0.050	0.061	0.047	0.043	0.062	0.059	0.041	0.056	0.048	0.041	0.053	0.044	0.039	0.067	0.065	0.051	0.050	0.036	0.034
Tues/Wed/Thurs	19	0.044	0.037	0.041	0.044	0.033	0.033	0.052	0.041	0.032	0.043	0.033	0.033	0.044	0.029	0.034	0.053	0.041	0.036	0.044	0.026	0.031
Tues/Wed/Thurs	20	0.038	0.029	0.037	0.036	0.026	0.028	0.042	0.031	0.026	0.034	0.025	0.028	0.038	0.021	0.028	0.039	0.029	0.027	0.037	0.019	0.029
Tues/Wed/Thurs	21	0.033	0.023	0.033	0.031	0.021	0.025	0.039	0.024	0.024	0.028	0.019	0.025	0.032	0.016	0.026	0.035	0.022	0.023	0.031	0.015	0.031
Tues/Wed/Thurs	22	0.027	0.017	0.029	0.022	0.017	0.022	0.034	0.018	0.023	0.021	0.014	0.022	0.025	0.010	0.023	0.027	0.015	0.019	0.025	0.011	0.027
Tues/Wed/Thurs	23	0.020	0.012	0.025	0.014	0.014	0.021	0.023	0.012	0.024	0.015	0.010	0.021	0.018	0.006	0.019	0.017	0.010	0.017	0.018	0.008	0.026
Friday	0	0.014	0.016	0.025	0.008	0.018	0.027	0.014	0.020	0.034	0.008	0.012	0.025	0.016	0.004	0.016	0.009	0.016	0.027	0.016	0.006	0.024
Friday	1	0.011	0.014	0.024	0.005	0.017	0.026	0.008	0.020	0.033	0.006	0.010	0.024	0.016	0.003	0.014	0.005	0.017	0.029	0.016	0.005	0.022
Friday	2	0.010	0.014	0.024	0.004	0.017	0.027	0.007	0.020	0.033	0.005	0.010	0.024	0.016	0.003	0.014	0.003	0.018	0.029	0.016	0.005	0.021
Friday	3	0.013	0.017	0.026	0.005	0.018	0.028	0.006	0.022	0.034	0.009	0.013	0.027	0.017	0.004	0.017	0.003	0.020	0.031	0.016	0.006	0.025
Friday	4	0.021	0.024	0.030	0.009	0.021	0.031	0.009	0.024	0.036	0.022	0.023	0.034	0.020	0.007	0.022	0.007	0.021	0.032	0.020	0.011	0.033
Friday	5	0.035	0.037	0.038	0.026	0.032	0.040	0.022	0.029	0.042	0.036	0.036	0.042	0.027	0.018	0.031	0.019	0.025	0.035	0.025	0.022	0.043
Friday	6	0.046	0.046	0.044	0.048	0.047	0.050	0.043	0.039	0.048	0.046	0.045	0.048	0.038	0.042	0.045	0.042	0.034	0.042	0.038	0.046	0.050
Friday	7	0.055	0.056	0.050	0.061	0.060	0.058	0.060	0.053	0.056	0.053	0.052	0.053	0.044	0.058	0.054	0.067	0.053	0.056	0.046	0.068	0.051
Friday	8	0.052	0.052	0.048	0.057	0.058	0.058	0.060	0.059	0.058	0.049	0.051	0.054	0.048	0.061	0.059	0.068	0.060	0.061	0.053	0.079	0.056
Friday	9	0.049	0.048	0.046	0.052	0.055	0.056	0.055	0.052	0.056	0.046	0.052	0.055	0.049	0.064	0.065	0.061	0.054	0.056	0.054	0.079	0.062
Friday	10	0.050	0.050	0.047	0.051	0.055	0.056	0.052	0.052	0.056	0.048	0.055	0.057	0.052	0.068	0.070	0.054	0.050	0.052	0.053	0.071	0.063
Friday	11	0.052	0.053	0.050	0.054	0.058	0.058	0.052	0.055	0.056	0.050	0.058	0.059	0.054	0.070	0.072	0.053	0.051	0.052	0.058	0.074	0.066
Friday	12	0.054	0.055	0.051	0.056	0.060	0.058	0.053	0.055	0.054	0.054	0.061	0.058	0.056	0.072	0.070	0.052	0.054	0.052	0.059	0.073	0.061
Friday	13	0.056	0.058	0.053	0.059	0.061	0.057	0.054	0.057	0.053	0.058	0.065	0.058	0.060	0.074	0.068	0.053	0.057	0.053	0.064	0.073	0.058
Friday	14	0.059	0.063	0.056	0.066	0.063	0.056	0.058	0.060	0.052	0.065	0.070	0.059	0.064	0.079	0.066	0.059	0.062	0.055	0.066	0.073	0.056
Friday	15	0.060	0.066	0.058	0.071	0.065	0.055	0.060	0.063	0.050	0.069	0.075	0.059	0.067	0.083	0.058	0.064	0.070	0.057	0.067	0.074	0.052
Friday	16	0.061	0.066	0.058	0.070	0.064	0.054	0.062	0.064	0.047	0.071	0.073	0.057	0.068	0.078	0.051	0.069	0.073	0.058	0.064	0.062	0.045
Friday	17	0.060	0.064	0.056	0.068	0.060	0.050	0.062	0.067	0.046	0.069	0.069	0.053	0.062	0.064	0.047	0.069	0.079	0.059	0.057	0.046	0.038
Friday	18	0.055	0.053	0.050	0.060	0.048	0.041	0.059	0.056	0.039	0.061	0.052	0.041	0.056	0.048	0.039	0.064	0.063	0.049	0.050	0.036	0.035
Friday	19	0.048	0.043	0.043	0.048	0.035	0.031	0.052	0.043	0.031	0.050	0.038	0.031	0.047	0.033	0.032	0.052	0.043	0.035	0.046	0.028	0.031
Friday	20	0.043	0.035	0.038	0.039	0.027	0.025	0.042	0.032	0.025	0.042	0.029	0.026	0.042	0.025	0.028	0.039	0.031	0.026	0.038	0.022	0.029
Friday	21	0.039	0.029	0.034	0.035	0.023	0.021	0.039	0.025	0.021	0.035	0.022	0.022	0.036	0.019	0.024	0.034	0.023	0.021	0.032	0.017	0.029
Friday	22	0.033	0.022	0.029	0.029	0.020	0.019	0.039	0.020	0.020	0.028	0.017	0.019	0.028	0.014	0.021	0.031	0.017	0.017	0.027	0.014	0.026
Friday	23	0.025	0.016	0.024	0.020	0.016	0.017	0.031	0.014	0.020	0.020	0.012	0.017	0.021	0.009	0.017	0.023	0.011	0.014	0.019	0.010	0.024
Saturday	0	0.020	0.024	0.034	0.015	0.026	0.043	0.022	0.026	0.048	0.014	0.021	0.037	0.018	0.007	0.027	0.017	0.024	0.042	0.022	0.013	0.039
Saturday	1	0.015	0.020	0.031	0.010	0.023	0.039	0.015	0.025	0.045	0.009	0.016	0.032	0.020	0.006	0.022	0.010	0.024	0.041	0.021	0.010	0.032
Saturday	2	0.013	0.019	0.029	0.007	0.022	0.037	0.013	0.025	0.043	0.007	0.014	0.031	0.020	0.005	0.020	0.008	0.024	0.041	0.022	0.009	0.030
Saturday	3	0.013	0.018	0.029	0.006	0.020	0.035	0.009	0.025	0.041	0.007	0.015	0.031	0.021	0.005	0.021	0.006	0.025	0.041	0.022	0.010	0.032
Saturday	4	0.015	0.020	0.030	0.007	0.022	0.036	0.008	0.026	0.039	0.011	0.018	0.033	0.022	0.007	0.023	0.007	0.026	0.041	0.024	0.014	0.040
Saturday	5	0.021	0.025	0.033	0.014	0.026	0.039	0.013	0.028	0.041	0.018	0.025	0.037	0.025	0.013	0.031	0.011	0.028	0.042	0.028	0.021	0.046
Saturday	6	0.030	0.032	0.038	0.024	0.032	0.045	0.021	0.031	0.044	0.027	0.033	0.042	0.032	0.024	0.039	0.019	0.031	0.043	0.035	0.035	0.053
Saturday	7	0.039	0.040	0.043	0.036	0.040	0.051	0.031	0.036	0.047	0.036	0.042	0.048	0.038	0.041	0.051	0.031	0.035	0.044	0.040	0.048	0.054

		San Bernardino			San Diego			San Francisco			San Joaquin			San Luis Obispo			San Mateo			Santa Barbara		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Saturday	8	0.046	0.047	0.048	0.048	0.048	0.056	0.043	0.041	0.051	0.045	0.050	0.054	0.047	0.053	0.055	0.043	0.039	0.046	0.046	0.059	0.057
Saturday	9	0.052	0.052	0.050	0.056	0.054	0.059	0.052	0.046	0.052	0.054	0.059	0.058	0.050	0.067	0.062	0.054	0.045	0.048	0.050	0.068	0.060
Saturday	10	0.056	0.056	0.053	0.062	0.058	0.060	0.059	0.051	0.053	0.061	0.067	0.062	0.054	0.078	0.069	0.062	0.050	0.051	0.053	0.070	0.059
Saturday	11	0.059	0.060	0.055	0.066	0.061	0.060	0.062	0.055	0.052	0.065	0.071	0.063	0.059	0.084	0.078	0.067	0.056	0.053	0.057	0.073	0.059
Saturday	12	0.061	0.063	0.057	0.068	0.063	0.058	0.063	0.057	0.051	0.067	0.072	0.062	0.060	0.082	0.070	0.068	0.059	0.051	0.059	0.074	0.056
Saturday	13	0.062	0.063	0.055	0.068	0.062	0.055	0.062	0.058	0.048	0.067	0.070	0.059	0.061	0.079	0.064	0.067	0.060	0.050	0.061	0.070	0.051
Saturday	14	0.062	0.063	0.055	0.068	0.061	0.051	0.062	0.059	0.046	0.067	0.068	0.056	0.060	0.074	0.061	0.067	0.061	0.049	0.061	0.068	0.048
Saturday	15	0.062	0.062	0.054	0.068	0.059	0.047	0.063	0.059	0.043	0.067	0.065	0.052	0.062	0.072	0.053	0.067	0.062	0.048	0.061	0.061	0.045
Saturday	16	0.061	0.060	0.052	0.067	0.057	0.043	0.063	0.059	0.042	0.066	0.061	0.048	0.061	0.066	0.050	0.067	0.062	0.046	0.059	0.059	0.041
Saturday	17	0.059	0.057	0.049	0.064	0.054	0.039	0.061	0.059	0.039	0.063	0.055	0.043	0.059	0.059	0.044	0.067	0.061	0.044	0.057	0.053	0.036
Saturday	18	0.055	0.051	0.044	0.057	0.047	0.033	0.058	0.056	0.036	0.057	0.045	0.036	0.053	0.050	0.037	0.061	0.055	0.040	0.052	0.046	0.033
Saturday	19	0.048	0.042	0.039	0.048	0.040	0.027	0.051	0.047	0.031	0.049	0.036	0.030	0.048	0.038	0.031	0.049	0.046	0.034	0.045	0.036	0.029
Saturday	20	0.043	0.037	0.035	0.042	0.035	0.023	0.044	0.040	0.028	0.043	0.030	0.026	0.043	0.032	0.029	0.042	0.039	0.030	0.041	0.031	0.029
Saturday	21	0.041	0.034	0.033	0.039	0.033	0.022	0.044	0.034	0.026	0.040	0.026	0.023	0.037	0.027	0.025	0.042	0.035	0.028	0.035	0.027	0.024
Saturday	22	0.037	0.029	0.030	0.034	0.031	0.021	0.045	0.032	0.027	0.035	0.023	0.021	0.028	0.018	0.021	0.040	0.030	0.025	0.029	0.023	0.023
Saturday	23	0.030	0.023	0.026	0.025	0.027	0.020	0.036	0.025	0.026	0.025	0.017	0.019	0.021	0.013	0.017	0.029	0.022	0.022	0.023	0.019	0.021
Holiday	0	0.018	0.020	0.026	0.013	0.023	0.029	0.021	0.023	0.035	0.012	0.015	0.027	0.018	0.006	0.012	0.014	0.020	0.030	0.020	0.010	0.020
Holiday	1	0.014	0.018	0.024	0.008	0.021	0.027	0.013	0.022	0.033	0.008	0.013	0.025	0.019	0.004	0.009	0.008	0.021	0.031	0.021	0.008	0.020
Holiday	2	0.012	0.017	0.024	0.006	0.020	0.027	0.010	0.024	0.033	0.006	0.012	0.025	0.019	0.003	0.011	0.005	0.022	0.031	0.019	0.006	0.018
Holiday	3	0.013	0.018	0.026	0.005	0.020	0.027	0.007	0.025	0.033	0.008	0.014	0.026	0.022	0.005	0.013	0.004	0.024	0.033	0.021	0.008	0.023
Holiday	4	0.019	0.024	0.029	0.008	0.023	0.030	0.008	0.028	0.035	0.015	0.020	0.030	0.022	0.008	0.015	0.006	0.025	0.034	0.022	0.012	0.028
Holiday	5	0.029	0.032	0.034	0.019	0.029	0.034	0.016	0.031	0.039	0.023	0.028	0.035	0.028	0.017	0.021	0.014	0.029	0.037	0.027	0.023	0.037
Holiday	6	0.036	0.038	0.037	0.035	0.040	0.042	0.028	0.036	0.044	0.031	0.035	0.039	0.034	0.030	0.031	0.027	0.035	0.041	0.031	0.034	0.042
Holiday	7	0.043	0.045	0.041	0.046	0.048	0.049	0.039	0.042	0.047	0.036	0.040	0.043	0.041	0.044	0.040	0.044	0.043	0.046	0.042	0.060	0.045
Holiday	8	0.047	0.048	0.043	0.048	0.050	0.050	0.046	0.049	0.050	0.041	0.045	0.047	0.046	0.055	0.046	0.053	0.048	0.050	0.048	0.073	0.051
Holiday	9	0.049	0.050	0.045	0.052	0.053	0.053	0.051	0.049	0.053	0.047	0.051	0.050	0.050	0.065	0.062	0.055	0.050	0.050	0.051	0.075	0.059
Holiday	10	0.053	0.053	0.047	0.057	0.058	0.056	0.057	0.054	0.054	0.055	0.061	0.056	0.052	0.076	0.072	0.058	0.052	0.052	0.053	0.071	0.058
Holiday	11	0.057	0.059	0.052	0.062	0.063	0.059	0.061	0.057	0.056	0.063	0.069	0.061	0.052	0.082	0.088	0.062	0.056	0.053	0.057	0.076	0.066
Holiday	12	0.060	0.063	0.053	0.065	0.065	0.060	0.063	0.059	0.055	0.066	0.072	0.062	0.058	0.086	0.085	0.062	0.060	0.055	0.059	0.079	0.070
Holiday	13	0.062	0.064	0.055	0.066	0.066	0.059	0.065	0.062	0.057	0.068	0.074	0.062	0.061	0.081	0.082	0.065	0.062	0.055	0.061	0.072	0.056
Holiday	14	0.063	0.066	0.056	0.068	0.065	0.058	0.067	0.063	0.055	0.070	0.073	0.060	0.059	0.076	0.075	0.067	0.066	0.056	0.060	0.073	0.060
Holiday	15	0.062	0.066	0.057	0.070	0.064	0.057	0.065	0.064	0.053	0.071	0.072	0.058	0.064	0.077	0.065	0.068	0.067	0.054	0.064	0.072	0.055
Holiday	16	0.062	0.063	0.057	0.069	0.060	0.053	0.063	0.062	0.048	0.071	0.068	0.054	0.068	0.072	0.057	0.069	0.067	0.055	0.060	0.061	0.050
Holiday	17	0.062	0.061	0.056	0.066	0.055	0.048	0.061	0.058	0.045	0.068	0.061	0.050	0.062	0.063	0.046	0.069	0.063	0.051	0.059	0.047	0.037
Holiday	18	0.056	0.053	0.052	0.058	0.045	0.042	0.057	0.052	0.040	0.060	0.050	0.042	0.053	0.044	0.039	0.060	0.053	0.044	0.053	0.038	0.036
Holiday	19	0.048	0.043	0.046	0.049	0.037	0.035	0.049	0.042	0.032	0.051	0.040	0.037	0.047	0.035	0.037	0.050	0.044	0.037	0.049	0.029	0.036
Holiday	20	0.043	0.034	0.041	0.043	0.030	0.030	0.044	0.034	0.029	0.044	0.031	0.032	0.041	0.027	0.028	0.045	0.033	0.032	0.040	0.024	0.032
Holiday	21	0.037	0.027	0.037	0.037	0.025	0.027	0.042	0.028	0.024	0.037	0.025	0.029	0.035	0.019	0.023	0.042	0.027	0.028	0.036	0.020	0.038
Holiday	22	0.031	0.021	0.033	0.030	0.022	0.025	0.040	0.021	0.025	0.029	0.019	0.026	0.027	0.014	0.022	0.033	0.020	0.025	0.028	0.017	0.034
Holiday	23	0.023	0.015	0.030	0.020	0.018	0.024	0.028	0.016	0.026	0.020	0.013	0.024	0.021	0.010	0.020	0.023	0.014	0.022	0.021	0.013	0.031

		Santa Clara			Santa Cruz			Shasta			Sierra			Siskiyou			Solano			Sonoma		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Sunday	0	0.018	0.036	0.052	0.011	0.032	0.036	0.013	0.008	0.016	0.013	0.020	0.031	0.019	0.009	0.017	0.017	0.037	0.059	0.019	0.038	0.053
Sunday	1	0.011	0.034	0.046	0.006	0.031	0.036	0.013	0.006	0.013	0.008	0.016	0.028	0.021	0.007	0.014	0.011	0.032	0.052	0.012	0.034	0.047
Sunday	2	0.008	0.032	0.042	0.003	0.030	0.037	0.012	0.006	0.011	0.006	0.013	0.026	0.022	0.006	0.013	0.009	0.030	0.048	0.008	0.031	0.043
Sunday	3	0.005	0.032	0.039	0.002	0.034	0.035	0.012	0.005	0.011	0.005	0.012	0.025	0.022	0.005	0.013	0.007	0.027	0.044	0.006	0.030	0.040
Sunday	4	0.005	0.032	0.037	0.003	0.035	0.038	0.015	0.007	0.013	0.005	0.012	0.025	0.023	0.006	0.013	0.007	0.028	0.042	0.006	0.029	0.038
Sunday	5	0.008	0.033	0.036	0.006	0.035	0.035	0.018	0.012	0.018	0.008	0.015	0.027	0.025	0.008	0.016	0.010	0.029	0.042	0.010	0.031	0.038
Sunday	6	0.014	0.035	0.037	0.013	0.036	0.036	0.021	0.019	0.026	0.013	0.020	0.030	0.028	0.014	0.024	0.016	0.032	0.042	0.016	0.033	0.039
Sunday	7	0.021	0.037	0.039	0.022	0.038	0.039	0.029	0.030	0.039	0.022	0.028	0.034	0.030	0.022	0.034	0.021	0.035	0.043	0.023	0.036	0.040
Sunday	8	0.032	0.040	0.040	0.034	0.036	0.040	0.037	0.043	0.053	0.034	0.041	0.040	0.033	0.036	0.048	0.031	0.041	0.045	0.033	0.040	0.042
Sunday	9	0.047	0.046	0.044	0.051	0.043	0.043	0.043	0.055	0.067	0.048	0.055	0.046	0.036	0.052	0.062	0.046	0.048	0.046	0.048	0.046	0.044
Sunday	10	0.061	0.051	0.047	0.064	0.044	0.047	0.053	0.071	0.079	0.064	0.068	0.052	0.040	0.071	0.075	0.059	0.053	0.045	0.062	0.051	0.045
Sunday	11	0.068	0.053	0.047	0.071	0.047	0.046	0.060	0.077	0.080	0.075	0.075	0.055	0.044	0.082	0.086	0.067	0.055	0.044	0.067	0.053	0.046
Sunday	12	0.073	0.054	0.046	0.073	0.046	0.043	0.064	0.084	0.077	0.082	0.079	0.058	0.049	0.089	0.088	0.069	0.055	0.041	0.070	0.054	0.046
Sunday	13	0.075	0.055	0.045	0.076	0.047	0.041	0.066	0.083	0.070	0.084	0.079	0.058	0.054	0.090	0.080	0.070	0.055	0.038	0.073	0.055	0.050
Sunday	14	0.075	0.055	0.044	0.078	0.052	0.047	0.067	0.085	0.065	0.084	0.077	0.057	0.058	0.089	0.072	0.071	0.053	0.036	0.073	0.055	0.047
Sunday	15	0.075	0.054	0.042	0.081	0.054	0.051	0.072	0.083	0.061	0.082	0.073	0.057	0.063	0.087	0.069	0.071	0.052	0.035	0.073	0.053	0.041
Sunday	16	0.073	0.053	0.041	0.082	0.055	0.051	0.073	0.080	0.058	0.079	0.068	0.055	0.064	0.081	0.059	0.071	0.051	0.033	0.072	0.052	0.039
Sunday	17	0.071	0.051	0.040	0.080	0.058	0.052	0.068	0.066	0.056	0.072	0.062	0.053	0.065	0.066	0.051	0.070	0.051	0.033	0.070	0.050	0.038
Sunday	18	0.064	0.047	0.039	0.069	0.051	0.048	0.065	0.056	0.049	0.060	0.052	0.049	0.065	0.055	0.044	0.066	0.048	0.033	0.063	0.047	0.036
Sunday	19	0.057	0.044	0.038	0.058	0.051	0.047	0.058	0.043	0.041	0.050	0.043	0.045	0.062	0.043	0.036	0.060	0.046	0.034	0.056	0.044	0.035
Sunday	20	0.050	0.040	0.037	0.048	0.047	0.044	0.048	0.031	0.032	0.041	0.035	0.042	0.057	0.032	0.028	0.055	0.043	0.035	0.051	0.041	0.036
Sunday	21	0.041	0.034	0.038	0.036	0.039	0.039	0.041	0.023	0.026	0.031	0.026	0.039	0.049	0.022	0.023	0.045	0.039	0.039	0.042	0.038	0.037
Sunday	22	0.029	0.029	0.040	0.022	0.033	0.036	0.031	0.016	0.021	0.021	0.019	0.036	0.041	0.015	0.019	0.032	0.033	0.043	0.030	0.032	0.039
Sunday	23	0.018	0.024	0.044	0.011	0.028	0.032	0.020	0.012	0.017	0.013	0.015	0.033	0.028	0.012	0.016	0.020	0.028	0.049	0.019	0.027	0.043
Monday	0	0.007	0.022	0.028	0.004	0.024	0.033	0.013	0.006	0.012	0.008	0.014	0.027	0.023	0.007	0.013	0.010	0.026	0.035	0.007	0.023	0.029
Monday	1	0.003	0.022	0.027	0.001	0.025	0.031	0.012	0.006	0.011	0.005	0.012	0.025	0.023	0.006	0.011	0.006	0.025	0.034	0.003	0.022	0.028
Monday	2	0.002	0.023	0.028	0.001	0.025	0.034	0.013	0.006	0.011	0.004	0.012	0.025	0.025	0.007	0.011	0.005	0.024	0.034	0.002	0.022	0.029
Monday	3	0.003	0.025	0.030	0.002	0.025	0.034	0.015	0.010	0.012	0.006	0.014	0.027	0.027	0.010	0.011	0.006	0.026	0.035	0.003	0.023	0.030
Monday	4	0.007	0.029	0.033	0.007	0.031	0.038	0.019	0.019	0.015	0.011	0.019	0.030	0.030	0.015	0.012	0.015	0.032	0.040	0.012	0.028	0.035
Monday	5	0.024	0.035	0.040	0.026	0.034	0.038	0.025	0.030	0.021	0.023	0.030	0.036	0.033	0.022	0.018	0.037	0.043	0.046	0.033	0.041	0.042
Monday	6	0.047	0.046	0.049	0.061	0.043	0.049	0.032	0.041	0.024	0.042	0.047	0.043	0.036	0.034	0.024	0.050	0.051	0.050	0.054	0.051	0.048
Monday	7	0.065	0.054	0.057	0.082	0.053	0.056	0.034	0.048	0.032	0.060	0.061	0.048	0.040	0.043	0.030	0.061	0.058	0.053	0.066	0.058	0.053
Monday	8	0.068	0.057	0.060	0.079	0.054	0.059	0.039	0.059	0.039	0.059	0.062	0.050	0.043	0.054	0.039	0.056	0.057	0.055	0.062	0.060	0.055
Monday	9	0.065	0.055	0.055	0.073	0.053	0.053	0.047	0.065	0.046	0.056	0.061	0.050	0.045	0.067	0.048	0.054	0.056	0.055	0.055	0.056	0.054
Monday	10	0.056	0.053	0.054	0.064	0.050	0.052	0.050	0.070	0.053	0.058	0.064	0.051	0.050	0.074	0.054	0.055	0.058	0.056	0.052	0.054	0.053
Monday	11	0.052	0.054	0.054	0.059	0.055	0.054	0.056	0.072	0.055	0.062	0.066	0.053	0.052	0.075	0.059	0.056	0.057	0.055	0.053	0.055	0.054
Monday	12	0.053	0.055	0.054	0.055	0.060	0.059	0.059	0.073	0.055	0.066	0.068	0.054	0.055	0.078	0.059	0.057	0.058	0.054	0.054	0.056	0.054
Monday	13	0.054	0.056	0.053	0.056	0.054	0.052	0.060	0.076	0.058	0.067	0.067	0.054	0.057	0.081	0.060	0.058	0.057	0.052	0.056	0.056	0.054
Monday	14	0.062	0.060	0.054	0.059	0.061	0.057	0.065	0.079	0.059	0.070	0.069	0.055	0.057	0.081	0.065	0.064	0.057	0.051	0.063	0.059	0.056
Monday	15	0.068	0.063	0.055	0.063	0.060	0.051	0.071	0.081	0.062	0.073	0.069	0.055	0.059	0.080	0.063	0.069	0.056	0.048	0.069	0.063	0.058
Monday	16	0.071	0.063	0.054	0.067	0.059	0.051	0.070	0.070	0.063	0.075	0.067	0.054	0.060	0.072	0.064	0.071	0.054	0.044	0.072	0.060	0.052
Monday	17	0.074	0.062	0.052	0.069	0.058	0.047	0.065	0.057	0.066	0.073	0.061	0.052	0.057	0.059	0.066	0.070	0.050	0.040	0.073	0.056	0.047
Monday	18	0.065	0.050	0.042	0.057	0.051	0.040	0.058	0.042	0.064	0.056	0.046	0.045	0.053	0.045	0.063	0.054	0.041	0.035	0.061	0.045	0.039
Monday	19	0.052	0.037	0.031	0.040	0.042	0.034	0.054	0.031	0.059	0.040	0.031	0.039	0.048	0.032	0.060	0.042	0.032	0.028	0.045	0.033	0.031
Monday	20	0.036	0.028	0.025	0.028	0.030	0.025	0.050	0.022	0.054	0.031	0.022	0.035	0.042	0.022	0.054	0.035	0.026	0.025	0.035	0.026	0.026
Monday	21	0.030	0.022	0.022	0.023	0.024	0.020	0.041	0.017	0.051	0.025	0.017	0.032	0.036	0.016	0.046	0.029	0.022	0.023	0.031	0.022	0.024
Monday	22	0.022	0.016	0.020	0.015	0.018	0.017	0.030	0.011	0.043	0.017	0.012	0.030	0.029	0.012	0.039	0.023	0.018	0.024	0.023	0.017	0.023
Monday	23	0.014	0.012	0.022	0.009	0.013	0.017	0.022	0.008	0.034	0.012	0.009	0.030	0.020	0.008	0.031	0.016	0.016	0.028	0.014	0.014	0.025
Tues/Wed/Thurs	0	0.006	0.022	0.029	0.004	0.023	0.029	0.012	0.006	0.017	0.008	0.014	0.029	0.023	0.007	0.018	0.009	0.025	0.037	0.006	0.022	0.031
Tues/Wed/Thurs	1	0.003	0.022	0.029	0.001	0.024	0.032	0.012	0.005	0.015	0.004	0.011	0.027	0.025	0.006	0.015	0.005	0.023	0.036	0.003	0.021	0.030
Tues/Wed/Thurs	2	0.002	0.023	0.029	0.001	0.025	0.032	0.013	0.006	0.014	0.004	0.011	0.027	0.027	0.006	0.013	0.004	0.023	0.036	0.002	0.021	0.030
Tues/Wed/Thurs	3	0.003	0.025	0.031	0.001	0.027	0.034	0.014	0.009	0.015	0.005	0.013	0.029	0.029	0.009	0.013	0.005	0.025	0.037	0.003	0.023	0.031

		Santa Clara			Santa Cruz			Shasta			Sierra			Siskiyou			Solano			Sonoma		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Tues/Wed/Thurs	4	0.007	0.028	0.034	0.006	0.029	0.036	0.018	0.017	0.017	0.010	0.018	0.031	0.032	0.014	0.016	0.013	0.030	0.041	0.011	0.028	0.036
Tues/Wed/Thurs	5	0.025	0.036	0.042	0.026	0.032	0.038	0.023	0.026	0.022	0.022	0.029	0.037	0.035	0.021	0.020	0.035	0.042	0.048	0.034	0.040	0.044
Tues/Wed/Thurs	6	0.050	0.047	0.052	0.065	0.040	0.045	0.030	0.042	0.030	0.042	0.047	0.044	0.038	0.033	0.027	0.050	0.050	0.052	0.056	0.052	0.049
Tues/Wed/Thurs	7	0.067	0.055	0.059	0.084	0.055	0.056	0.038	0.051	0.039	0.060	0.061	0.050	0.040	0.046	0.036	0.061	0.057	0.054	0.068	0.059	0.054
Tues/Wed/Thurs	8	0.069	0.058	0.061	0.080	0.055	0.055	0.042	0.061	0.048	0.060	0.062	0.051	0.042	0.056	0.046	0.056	0.056	0.055	0.063	0.060	0.056
Tues/Wed/Thurs	9	0.065	0.055	0.055	0.074	0.054	0.056	0.047	0.064	0.058	0.055	0.060	0.050	0.044	0.066	0.057	0.053	0.056	0.055	0.055	0.055	0.053
Tues/Wed/Thurs	10	0.055	0.053	0.054	0.062	0.052	0.053	0.051	0.067	0.066	0.056	0.061	0.051	0.045	0.071	0.065	0.052	0.057	0.055	0.051	0.053	0.052
Tues/Wed/Thurs	11	0.051	0.053	0.053	0.057	0.053	0.055	0.054	0.070	0.069	0.059	0.064	0.052	0.047	0.076	0.070	0.052	0.057	0.054	0.050	0.054	0.052
Tues/Wed/Thurs	12	0.051	0.055	0.053	0.054	0.057	0.055	0.058	0.072	0.067	0.061	0.065	0.053	0.050	0.076	0.070	0.054	0.057	0.053	0.052	0.055	0.053
Tues/Wed/Thurs	13	0.054	0.056	0.052	0.054	0.058	0.054	0.061	0.074	0.066	0.064	0.066	0.053	0.052	0.077	0.069	0.057	0.057	0.051	0.054	0.056	0.054
Tues/Wed/Thurs	14	0.061	0.059	0.052	0.058	0.061	0.056	0.065	0.077	0.063	0.068	0.068	0.053	0.057	0.081	0.067	0.064	0.058	0.049	0.062	0.059	0.054
Tues/Wed/Thurs	15	0.067	0.063	0.054	0.062	0.061	0.055	0.070	0.080	0.061	0.073	0.069	0.053	0.058	0.078	0.064	0.070	0.058	0.046	0.067	0.063	0.056
Tues/Wed/Thurs	16	0.070	0.064	0.053	0.065	0.060	0.053	0.072	0.072	0.058	0.075	0.067	0.052	0.057	0.072	0.061	0.073	0.056	0.043	0.070	0.060	0.051
Tues/Wed/Thurs	17	0.072	0.062	0.051	0.067	0.057	0.047	0.065	0.057	0.056	0.074	0.063	0.050	0.056	0.060	0.057	0.072	0.052	0.039	0.071	0.057	0.046
Tues/Wed/Thurs	18	0.065	0.052	0.042	0.058	0.050	0.043	0.060	0.044	0.052	0.059	0.048	0.044	0.053	0.046	0.053	0.058	0.043	0.033	0.062	0.047	0.039
Tues/Wed/Thurs	19	0.053	0.037	0.030	0.041	0.041	0.034	0.053	0.032	0.045	0.043	0.034	0.038	0.048	0.033	0.044	0.046	0.034	0.028	0.048	0.035	0.031
Tues/Wed/Thurs	20	0.038	0.027	0.024	0.029	0.032	0.028	0.047	0.024	0.039	0.035	0.025	0.034	0.045	0.025	0.038	0.038	0.028	0.024	0.038	0.027	0.026
Tues/Wed/Thurs	21	0.032	0.021	0.021	0.024	0.024	0.021	0.042	0.021	0.034	0.029	0.019	0.031	0.038	0.018	0.032	0.032	0.023	0.022	0.033	0.022	0.024
Tues/Wed/Thurs	22	0.023	0.016	0.019	0.017	0.018	0.019	0.031	0.013	0.028	0.020	0.013	0.029	0.032	0.014	0.026	0.025	0.018	0.023	0.024	0.017	0.022
Tues/Wed/Thurs	23	0.014	0.011	0.020	0.009	0.012	0.015	0.022	0.010	0.022	0.013	0.009	0.028	0.025	0.010	0.021	0.016	0.015	0.028	0.015	0.013	0.024
Friday	0	0.007	0.022	0.032	0.005	0.023	0.030	0.013	0.007	0.021	0.007	0.014	0.032	0.021	0.007	0.019	0.009	0.025	0.040	0.008	0.022	0.033
Friday	1	0.004	0.023	0.031	0.002	0.022	0.031	0.012	0.005	0.018	0.005	0.011	0.030	0.023	0.006	0.017	0.006	0.024	0.039	0.004	0.021	0.031
Friday	2	0.003	0.024	0.032	0.001	0.024	0.032	0.012	0.006	0.018	0.004	0.011	0.030	0.024	0.007	0.016	0.005	0.024	0.039	0.003	0.022	0.032
Friday	3	0.003	0.025	0.033	0.002	0.027	0.034	0.014	0.008	0.018	0.005	0.012	0.030	0.026	0.009	0.016	0.005	0.025	0.040	0.004	0.023	0.033
Friday	4	0.007	0.029	0.036	0.005	0.030	0.038	0.016	0.015	0.021	0.008	0.016	0.033	0.029	0.013	0.019	0.011	0.030	0.044	0.010	0.028	0.036
Friday	5	0.022	0.035	0.044	0.022	0.033	0.041	0.023	0.023	0.026	0.017	0.026	0.038	0.032	0.018	0.023	0.027	0.040	0.050	0.030	0.039	0.044
Friday	6	0.044	0.045	0.053	0.054	0.040	0.046	0.029	0.035	0.033	0.033	0.040	0.045	0.033	0.030	0.032	0.039	0.047	0.053	0.050	0.049	0.050
Friday	7	0.060	0.052	0.058	0.075	0.049	0.055	0.034	0.044	0.041	0.049	0.054	0.050	0.037	0.039	0.039	0.050	0.053	0.056	0.063	0.057	0.055
Friday	8	0.063	0.054	0.060	0.071	0.047	0.050	0.039	0.055	0.049	0.051	0.057	0.052	0.040	0.051	0.049	0.048	0.054	0.057	0.059	0.057	0.056
Friday	9	0.060	0.054	0.057	0.068	0.049	0.051	0.042	0.060	0.055	0.050	0.057	0.052	0.045	0.063	0.054	0.048	0.055	0.057	0.053	0.054	0.054
Friday	10	0.054	0.053	0.056	0.061	0.051	0.053	0.049	0.063	0.058	0.054	0.061	0.054	0.048	0.069	0.060	0.052	0.056	0.056	0.051	0.053	0.053
Friday	11	0.053	0.055	0.056	0.061	0.056	0.054	0.052	0.069	0.061	0.060	0.066	0.055	0.049	0.072	0.063	0.056	0.058	0.055	0.053	0.055	0.054
Friday	12	0.055	0.057	0.056	0.058	0.056	0.053	0.057	0.070	0.061	0.063	0.067	0.055	0.052	0.074	0.063	0.059	0.058	0.053	0.056	0.057	0.055
Friday	13	0.058	0.058	0.054	0.060	0.059	0.058	0.057	0.075	0.061	0.066	0.068	0.054	0.055	0.077	0.062	0.063	0.058	0.051	0.058	0.058	0.056
Friday	14	0.064	0.061	0.053	0.064	0.062	0.056	0.065	0.080	0.060	0.070	0.070	0.054	0.059	0.080	0.063	0.067	0.058	0.048	0.064	0.059	0.056
Friday	15	0.067	0.063	0.054	0.065	0.061	0.055	0.070	0.082	0.059	0.073	0.070	0.052	0.063	0.081	0.061	0.069	0.057	0.045	0.066	0.062	0.056
Friday	16	0.069	0.062	0.051	0.065	0.062	0.054	0.072	0.073	0.057	0.074	0.067	0.050	0.058	0.075	0.059	0.070	0.054	0.041	0.067	0.059	0.050
Friday	17	0.069	0.060	0.048	0.064	0.059	0.049	0.065	0.062	0.055	0.072	0.063	0.047	0.059	0.063	0.055	0.067	0.050	0.037	0.067	0.055	0.046
Friday	18	0.063	0.049	0.038	0.056	0.053	0.046	0.061	0.047	0.051	0.063	0.051	0.042	0.054	0.052	0.051	0.061	0.044	0.031	0.060	0.047	0.039
Friday	19	0.053	0.037	0.028	0.044	0.043	0.035	0.059	0.039	0.046	0.050	0.039	0.035	0.050	0.036	0.046	0.054	0.037	0.026	0.049	0.036	0.030
Friday	20	0.039	0.028	0.021	0.032	0.034	0.027	0.051	0.028	0.040	0.041	0.029	0.030	0.046	0.030	0.041	0.047	0.031	0.022	0.040	0.029	0.023
Friday	21	0.033	0.022	0.018	0.027	0.027	0.022	0.045	0.022	0.035	0.037	0.023	0.028	0.040	0.022	0.036	0.039	0.025	0.020	0.035	0.023	0.020
Friday	22	0.028	0.017	0.016	0.023	0.019	0.016	0.037	0.018	0.031	0.030	0.017	0.026	0.031	0.016	0.031	0.030	0.020	0.020	0.030	0.019	0.019
Friday	23	0.021	0.013	0.016	0.015	0.014	0.013	0.026	0.012	0.025	0.019	0.011	0.024	0.025	0.012	0.025	0.021	0.016	0.022	0.022	0.015	0.020
Saturday	0	0.015	0.029	0.046	0.009	0.028	0.038	0.015	0.011	0.021	0.013	0.019	0.038	0.026	0.013	0.020	0.014	0.031	0.057	0.015	0.030	0.044
Saturday	1	0.009	0.028	0.042	0.005	0.028	0.038	0.014	0.008	0.018	0.008	0.015	0.034	0.026	0.008	0.016	0.009	0.028	0.052	0.009	0.027	0.040
Saturday	2	0.007	0.028	0.040	0.003	0.029	0.042	0.014	0.008	0.016	0.006	0.014	0.032	0.027	0.007	0.015	0.007	0.027	0.049	0.006	0.026	0.039
Saturday	3	0.005	0.029	0.038	0.002	0.032	0.042	0.014	0.007	0.016	0.006	0.013	0.031	0.030	0.007	0.014	0.006	0.026	0.046	0.005	0.025	0.037
Saturday	4	0.006	0.030	0.039	0.003	0.032	0.042	0.017	0.014	0.017	0.007	0.014	0.032	0.029	0.009	0.016	0.008	0.028	0.047	0.006	0.027	0.037
Saturday	5	0.011	0.033	0.042	0.009	0.035	0.041	0.021	0.018	0.021	0.011	0.018	0.034	0.033	0.015	0.019	0.014	0.031	0.049	0.013	0.030	0.040
Saturday	6	0.020	0.037	0.046	0.019	0.034	0.043	0.025	0.027	0.028	0.019	0.026	0.039	0.036	0.023	0.025	0.022	0.037	0.052	0.023	0.035	0.042
Saturday	7	0.032	0.041	0.050	0.033	0.038	0.041	0.032	0.038	0.039	0.032	0.038	0.046	0.038	0.033	0.036	0.032	0.042	0.054	0.034	0.041	0.047

87

		Santa Clara			Santa Cruz			Shasta			Sierra			Siskiyou			Solano			Sonoma		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Saturday	8	0.045	0.046	0.053	0.049	0.041	0.046	0.040	0.055	0.051	0.045	0.051	0.052	0.041	0.047	0.047	0.044	0.049	0.056	0.046	0.047	0.049
Saturday	9	0.055	0.051	0.056	0.059	0.046	0.046	0.044	0.064	0.061	0.057	0.062	0.056	0.045	0.063	0.059	0.056	0.054	0.055	0.055	0.051	0.050
Saturday	10	0.062	0.054	0.056	0.066	0.047	0.047	0.051	0.071	0.067	0.067	0.071	0.060	0.049	0.075	0.067	0.065	0.057	0.052	0.061	0.054	0.051
Saturday	11	0.067	0.057	0.056	0.068	0.052	0.052	0.058	0.077	0.068	0.074	0.076	0.061	0.050	0.084	0.073	0.068	0.058	0.050	0.065	0.056	0.052
Saturday	12	0.069	0.057	0.054	0.067	0.053	0.050	0.060	0.076	0.067	0.075	0.075	0.060	0.053	0.083	0.071	0.067	0.057	0.047	0.066	0.058	0.055
Saturday	13	0.069	0.057	0.051	0.067	0.055	0.049	0.059	0.073	0.066	0.075	0.074	0.057	0.055	0.081	0.069	0.066	0.056	0.044	0.067	0.059	0.058
Saturday	14	0.069	0.057	0.049	0.069	0.053	0.049	0.065	0.076	0.066	0.074	0.071	0.055	0.057	0.076	0.065	0.066	0.055	0.041	0.067	0.058	0.057
Saturday	15	0.069	0.057	0.045	0.072	0.056	0.049	0.067	0.073	0.064	0.072	0.068	0.051	0.060	0.074	0.062	0.066	0.054	0.038	0.068	0.057	0.051
Saturday	16	0.068	0.055	0.043	0.074	0.055	0.048	0.065	0.069	0.059	0.070	0.064	0.048	0.056	0.070	0.058	0.066	0.053	0.034	0.068	0.056	0.047
Saturday	17	0.067	0.052	0.038	0.074	0.055	0.046	0.064	0.062	0.055	0.066	0.057	0.044	0.055	0.061	0.057	0.065	0.050	0.031	0.067	0.054	0.044
Saturday	18	0.061	0.047	0.034	0.066	0.052	0.040	0.061	0.048	0.050	0.056	0.047	0.038	0.051	0.049	0.052	0.058	0.046	0.029	0.060	0.048	0.036
Saturday	19	0.050	0.040	0.029	0.054	0.045	0.035	0.059	0.041	0.044	0.046	0.037	0.033	0.049	0.038	0.045	0.050	0.040	0.026	0.049	0.041	0.029
Saturday	20	0.042	0.035	0.025	0.044	0.041	0.033	0.050	0.031	0.036	0.040	0.030	0.028	0.042	0.031	0.038	0.045	0.036	0.023	0.043	0.036	0.025
Saturday	21	0.040	0.031	0.023	0.039	0.037	0.032	0.044	0.023	0.030	0.035	0.025	0.025	0.037	0.023	0.031	0.041	0.033	0.023	0.041	0.033	0.024
Saturday	22	0.036	0.027	0.023	0.032	0.031	0.028	0.034	0.017	0.024	0.028	0.019	0.023	0.031	0.017	0.026	0.035	0.029	0.023	0.037	0.029	0.023
Saturday	23	0.026	0.022	0.022	0.020	0.025	0.025	0.026	0.013	0.019	0.020	0.014	0.021	0.023	0.012	0.019	0.026	0.023	0.023	0.028	0.024	0.022
Holiday	0	0.012	0.025	0.032	0.008	0.024	0.031	0.014	0.008	0.015	0.010	0.016	0.028	0.024	0.008	0.015	0.013	0.029	0.038	0.013	0.027	0.034
Holiday	1	0.007	0.025	0.031	0.003	0.025	0.034	0.013	0.007	0.013	0.006	0.013	0.027	0.027	0.008	0.012	0.008	0.027	0.038	0.007	0.026	0.033
Holiday	2	0.004	0.026	0.032	0.002	0.025	0.034	0.013	0.006	0.012	0.004	0.012	0.026	0.024	0.008	0.012	0.005	0.025	0.037	0.004	0.025	0.033
Holiday	3	0.003	0.027	0.032	0.001	0.024	0.029	0.013	0.006	0.012	0.005	0.013	0.027	0.029	0.010	0.013	0.005	0.026	0.037	0.003	0.025	0.033
Holiday	4	0.005	0.029	0.034	0.004	0.030	0.034	0.016	0.013	0.014	0.008	0.016	0.029	0.029	0.012	0.014	0.008	0.028	0.039	0.007	0.029	0.035
Holiday	5	0.014	0.034	0.038	0.012	0.033	0.041	0.020	0.017	0.020	0.014	0.023	0.032	0.031	0.016	0.017	0.018	0.034	0.043	0.017	0.034	0.039
Holiday	6	0.027	0.039	0.044	0.028	0.037	0.045	0.025	0.028	0.026	0.025	0.033	0.036	0.037	0.025	0.023	0.025	0.040	0.046	0.029	0.040	0.044
Holiday	7	0.039	0.043	0.048	0.043	0.035	0.038	0.030	0.037	0.036	0.036	0.044	0.042	0.038	0.033	0.031	0.032	0.045	0.050	0.038	0.045	0.047
Holiday	8	0.050	0.048	0.052	0.052	0.048	0.053	0.036	0.051	0.046	0.046	0.053	0.048	0.040	0.049	0.040	0.041	0.050	0.053	0.045	0.050	0.051
Holiday	9	0.054	0.052	0.054	0.058	0.051	0.053	0.047	0.068	0.056	0.054	0.059	0.050	0.043	0.062	0.054	0.051	0.055	0.055	0.049	0.053	0.052
Holiday	10	0.058	0.055	0.056	0.064	0.049	0.054	0.051	0.068	0.064	0.065	0.069	0.053	0.050	0.076	0.060	0.062	0.060	0.055	0.056	0.056	0.053
Holiday	11	0.061	0.058	0.057	0.069	0.055	0.050	0.059	0.083	0.069	0.074	0.074	0.057	0.047	0.084	0.068	0.068	0.063	0.056	0.062	0.059	0.055
Holiday	12	0.063	0.060	0.057	0.067	0.057	0.059	0.066	0.081	0.071	0.077	0.074	0.056	0.053	0.083	0.070	0.070	0.061	0.054	0.067	0.061	0.056
Holiday	13	0.066	0.062	0.057	0.068	0.069	0.064	0.062	0.084	0.068	0.076	0.074	0.058	0.062	0.091	0.067	0.071	0.062	0.052	0.070	0.062	0.056
Holiday	14	0.069	0.062	0.056	0.073	0.058	0.060	0.069	0.076	0.064	0.075	0.073	0.056	0.059	0.087	0.069	0.072	0.060	0.051	0.073	0.062	0.057
Holiday	15	0.071	0.062	0.054	0.072	0.070	0.056	0.065	0.081	0.061	0.074	0.070	0.055	0.057	0.079	0.065	0.068	0.056	0.046	0.071	0.061	0.054
Holiday	16	0.072	0.060	0.051	0.071	0.059	0.052	0.070	0.068	0.061	0.072	0.066	0.054	0.056	0.072	0.062	0.066	0.054	0.044	0.070	0.057	0.050
Holiday	17	0.071	0.057	0.047	0.070	0.058	0.048	0.068	0.063	0.060	0.068	0.059	0.051	0.056	0.058	0.060	0.064	0.050	0.040	0.067	0.053	0.044
Holiday	18	0.064	0.048	0.039	0.063	0.054	0.045	0.063	0.047	0.055	0.057	0.049	0.045	0.053	0.044	0.058	0.058	0.042	0.034	0.059	0.045	0.038
Holiday	19	0.054	0.038	0.032	0.052	0.035	0.029	0.056	0.035	0.048	0.047	0.036	0.041	0.048	0.029	0.049	0.051	0.037	0.029	0.051	0.036	0.031
Holiday	20	0.045	0.031	0.026	0.043	0.035	0.027	0.050	0.028	0.041	0.039	0.029	0.037	0.044	0.024	0.045	0.047	0.031	0.025	0.046	0.031	0.028
Holiday	21	0.039	0.025	0.024	0.036	0.029	0.026	0.045	0.021	0.035	0.030	0.020	0.033	0.040	0.019	0.040	0.042	0.026	0.024	0.041	0.026	0.026
Holiday	22	0.031	0.019	0.022	0.024	0.021	0.022	0.027	0.013	0.029	0.023	0.015	0.031	0.031	0.014	0.030	0.033	0.022	0.025	0.033	0.021	0.025
Holiday	23	0.020	0.014	0.024	0.015	0.016	0.015	0.022	0.010	0.023	0.015	0.010	0.029	0.024	0.009	0.024	0.022	0.018	0.029	0.021	0.017	0.026

		Stanislaus			Sutter			Tehama			Trinity			Tulare			Tuolumne			Ventura		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Sunday	0	0.014	0.025	0.037	0.013	0.020	0.031	0.013	0.008	0.016	0.019	0.009	0.017	0.022	0.015	0.017	0.010	0.014	0.032	0.014	0.036	0.048
Sunday	1	0.009	0.019	0.032	0.008	0.016	0.028	0.013	0.006	0.013	0.021	0.007	0.014	0.024	0.015	0.009	0.007	0.011	0.024	0.009	0.026	0.042
Sunday	2	0.007	0.016	0.029	0.006	0.013	0.026	0.012	0.006	0.011	0.022	0.006	0.013	0.023	0.011	0.008	0.005	0.011	0.022	0.006	0.021	0.038
Sunday	3	0.005	0.015	0.028	0.005	0.012	0.025	0.012	0.005	0.011	0.022	0.005	0.013	0.023	0.009	0.010	0.004	0.010	0.021	0.004	0.018	0.036
Sunday	4	0.006	0.016	0.028	0.005	0.012	0.025	0.015	0.007	0.013	0.023	0.006	0.013	0.024	0.010	0.018	0.004	0.010	0.020	0.004	0.018	0.035
Sunday	5	0.010	0.019	0.029	0.008	0.015	0.027	0.018	0.012	0.018	0.025	0.008	0.016	0.026	0.018	0.025	0.007	0.013	0.021	0.008	0.021	0.036
Sunday	6	0.015	0.023	0.031	0.013	0.020	0.030	0.021	0.019	0.026	0.028	0.014	0.024	0.030	0.031	0.042	0.012	0.019	0.026	0.014	0.027	0.038
Sunday	7	0.021	0.029	0.035	0.022	0.028	0.034	0.029	0.030	0.039	0.030	0.022	0.034	0.034	0.035	0.050	0.019	0.023	0.029	0.022	0.034	0.041
Sunday	8	0.031	0.038	0.040	0.034	0.041	0.040	0.037	0.043	0.053	0.033	0.036	0.048	0.035	0.042	0.052	0.032	0.035	0.038	0.034	0.044	0.044
Sunday	9	0.043	0.050	0.047	0.048	0.055	0.046	0.043	0.055	0.067	0.036	0.052	0.062	0.040	0.057	0.047	0.051	0.051	0.053	0.049	0.057	0.047
Sunday	10	0.055	0.060	0.051	0.064	0.068	0.052	0.053	0.071	0.079	0.040	0.071	0.075	0.044	0.066	0.054	0.067	0.067	0.071	0.065	0.070	0.050
Sunday	11	0.063	0.065	0.054	0.075	0.075	0.055	0.060	0.077	0.080	0.044	0.082	0.086	0.047	0.070	0.055	0.080	0.081	0.085	0.074	0.076	0.051
Sunday	12	0.070	0.070	0.055	0.082	0.079	0.058	0.064	0.084	0.077	0.049	0.089	0.088	0.051	0.076	0.058	0.083	0.081	0.076	0.078	0.077	0.051
Sunday	13	0.075	0.071	0.056	0.084	0.079	0.058	0.066	0.083	0.070	0.054	0.090	0.080	0.054	0.073	0.070	0.085	0.082	0.074	0.080	0.074	0.049
Sunday	14	0.077	0.069	0.055	0.084	0.077	0.057	0.067	0.085	0.065	0.058	0.089	0.072	0.056	0.071	0.068	0.085	0.083	0.069	0.079	0.068	0.047
Sunday	15	0.078	0.070	0.053	0.082	0.073	0.057	0.072	0.083	0.061	0.063	0.087	0.069	0.059	0.071	0.067	0.084	0.081	0.066	0.077	0.062	0.045
Sunday	16	0.077	0.067	0.052	0.079	0.068	0.055	0.073	0.080	0.058	0.064	0.081	0.059	0.060	0.066	0.066	0.082	0.079	0.060	0.075	0.057	0.043
Sunday	17	0.075	0.062	0.049	0.072	0.062	0.053	0.068	0.066	0.056	0.065	0.066	0.051	0.061	0.063	0.064	0.076	0.070	0.053	0.070	0.050	0.041
Sunday	18	0.068	0.055	0.046	0.060	0.052	0.049	0.065	0.056	0.049	0.065	0.055	0.044	0.060	0.052	0.056	0.064	0.056	0.043	0.062	0.040	0.038
Sunday	19	0.061	0.047	0.042	0.050	0.043	0.045	0.058	0.043	0.041	0.062	0.043	0.036	0.059	0.050	0.051	0.049	0.043	0.035	0.055	0.034	0.037
Sunday	20	0.051	0.039	0.040	0.041	0.035	0.042	0.048	0.031	0.032	0.057	0.032	0.028	0.055	0.037	0.040	0.038	0.033	0.024	0.046	0.028	0.036
Sunday	21	0.041	0.031	0.038	0.031	0.026	0.039	0.041	0.023	0.026	0.049	0.022	0.023	0.048	0.029	0.028	0.026	0.022	0.020	0.037	0.024	0.036
Sunday	22	0.029	0.024	0.036	0.021	0.019	0.036	0.031	0.016	0.021	0.041	0.015	0.019	0.038	0.018	0.029	0.017	0.014	0.017	0.026	0.020	0.035
Sunday	23	0.019	0.019	0.037	0.013	0.015	0.033	0.020	0.012	0.017	0.028	0.012	0.016	0.028	0.014	0.019	0.010	0.010	0.020	0.015	0.018	0.037
Monday	0	0.011	0.017	0.023	0.008	0.014	0.027	0.013	0.006	0.012	0.023	0.007	0.013	0.022	0.004	0.006	0.006	0.010	0.017	0.006	0.015	0.027
Monday	1	0.007	0.015	0.022	0.005	0.012	0.025	0.012	0.006	0.011	0.023	0.006	0.011	0.023	0.004	0.004	0.004	0.009	0.016	0.003	0.012	0.026
Monday	2	0.006	0.015	0.022	0.004	0.012	0.025	0.013	0.006	0.011	0.025	0.007	0.011	0.023	0.004	0.005	0.003	0.009	0.016	0.002	0.012	0.026
Monday	3	0.009	0.018	0.025	0.006	0.014	0.027	0.015	0.010	0.012	0.027	0.010	0.011	0.024	0.006	0.011	0.005	0.011	0.019	0.003	0.013	0.028
Monday	4	0.018	0.027	0.032	0.011	0.019	0.030	0.019	0.019	0.015	0.030	0.015	0.012	0.027	0.015	0.020	0.008	0.017	0.024	0.008	0.019	0.032
Monday	5	0.030	0.039	0.039	0.023	0.030	0.036	0.025	0.030	0.021	0.033	0.022	0.018	0.035	0.035	0.032	0.019	0.028	0.036	0.024	0.034	0.039
Monday	6	0.044	0.051	0.045	0.042	0.047	0.043	0.032	0.041	0.024	0.036	0.034	0.024	0.040	0.056	0.050	0.036	0.041	0.050	0.049	0.055	0.045
Monday	7	0.058	0.058	0.050	0.060	0.061	0.048	0.034	0.048	0.032	0.040	0.043	0.030	0.044	0.063	0.057	0.051	0.044	0.065	0.075	0.072	0.050
Monday	8	0.053	0.058	0.051	0.059	0.062	0.050	0.039	0.059	0.039	0.043	0.054	0.039	0.046	0.071	0.059	0.053	0.056	0.068	0.071	0.071	0.052
Monday	9	0.051	0.059	0.053	0.056	0.061	0.050	0.047	0.065	0.046	0.045	0.067	0.048	0.046	0.066	0.060	0.059	0.065	0.080	0.057	0.064	0.052
Monday	10	0.054	0.062	0.056	0.058	0.064	0.051	0.050	0.070	0.053	0.050	0.074	0.054	0.049	0.070	0.066	0.067	0.074	0.087	0.053	0.062	0.053
Monday	11	0.057	0.064	0.057	0.062	0.066	0.053	0.056	0.072	0.055	0.052	0.075	0.059	0.051	0.070	0.065	0.071	0.075	0.082	0.056	0.063	0.054
Monday	12	0.060	0.064	0.058	0.066	0.068	0.054	0.059	0.073	0.055	0.055	0.078	0.059	0.056	0.072	0.066	0.074	0.074	0.080	0.058	0.064	0.054
Monday	13	0.061	0.064	0.058	0.067	0.067	0.054	0.060	0.076	0.058	0.057	0.081	0.060	0.055	0.073	0.071	0.074	0.075	0.075	0.058	0.061	0.053
Monday	14	0.067	0.066	0.058	0.070	0.069	0.055	0.065	0.079	0.059	0.057	0.081	0.065	0.058	0.073	0.070	0.077	0.076	0.065	0.063	0.063	0.053
Monday	15	0.072	0.065	0.057	0.073	0.069	0.055	0.071	0.081	0.062	0.059	0.080	0.063	0.061	0.077	0.074	0.082	0.076	0.058	0.072	0.065	0.052
Monday	16	0.075	0.063	0.055	0.075	0.067	0.054	0.070	0.070	0.063	0.060	0.072	0.064	0.061	0.073	0.064	0.081	0.073	0.045	0.078	0.064	0.050
Monday	17	0.074	0.055	0.051	0.073	0.061	0.052	0.065	0.057	0.066	0.057	0.059	0.066	0.059	0.059	0.057	0.071	0.059	0.035	0.080	0.060	0.049
Monday	18	0.055	0.042	0.042	0.056	0.046	0.045	0.058	0.042	0.064	0.053	0.045	0.063	0.050	0.037	0.047	0.052	0.042	0.023	0.063	0.046	0.043
Monday	19	0.042	0.031	0.036	0.040	0.031	0.039	0.054	0.031	0.059	0.048	0.032	0.060	0.045	0.024	0.036	0.037	0.030	0.017	0.042	0.029	0.038
Monday	20	0.034	0.023	0.031	0.031	0.022	0.035	0.050	0.022	0.054	0.042	0.022	0.054	0.040	0.017	0.031	0.027	0.022	0.013	0.031	0.020	0.033
Monday	21	0.027	0.018	0.028	0.025	0.017	0.032	0.041	0.017	0.051	0.036	0.016	0.046	0.035	0.013	0.023	0.020	0.016	0.010	0.025	0.015	0.032
Monday	22	0.020	0.014	0.027	0.017	0.012	0.030	0.030	0.011	0.043	0.029	0.012	0.039	0.029	0.010	0.017	0.015	0.012	0.009	0.016	0.010	0.030
Monday	23	0.014	0.011	0.025	0.012	0.009	0.030	0.022	0.008	0.034	0.020	0.008	0.031	0.022	0.006	0.011	0.009	0.007	0.010	0.009	0.008	0.030
Tues/Wed/Thurs	0	0.008	0.016	0.025	0.008	0.014	0.029	0.012	0.006	0.017	0.023	0.007	0.018	0.021	0.004	0.009	0.005	0.009	0.017	0.005	0.015	0.032
Tues/Wed/Thurs	1	0.005	0.014	0.024	0.004	0.011	0.027	0.012	0.005	0.015	0.025	0.006	0.015	0.021	0.004	0.007	0.003	0.008	0.017	0.002	0.012	0.030
Tues/Wed/Thurs	2	0.005	0.014	0.025	0.004	0.011	0.027	0.013	0.006	0.014	0.027	0.006	0.013	0.022	0.004	0.009	0.002	0.009	0.017	0.001	0.012	0.030
Tues/Wed/Thurs	3	0.008	0.018	0.028	0.005	0.013	0.029	0.014	0.009	0.015	0.029	0.009	0.013	0.024	0.005	0.012	0.003	0.010	0.022	0.002	0.013	0.031

89

		Stanislaus			Sutter			Tehama			Trinity			Tulare			Tuolumne			Ventura		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Tues/Wed/Thurs	4	0.017	0.026	0.034	0.010	0.018	0.031	0.018	0.017	0.017	0.032	0.014	0.016	0.028	0.014	0.018	0.006	0.014	0.025	0.007	0.019	0.035
Tues/Wed/Thurs	5	0.030	0.039	0.042	0.022	0.029	0.037	0.023	0.026	0.022	0.035	0.021	0.020	0.035	0.033	0.032	0.018	0.027	0.039	0.022	0.034	0.043
Tues/Wed/Thurs	6	0.044	0.050	0.047	0.042	0.047	0.044	0.030	0.042	0.030	0.038	0.033	0.027	0.041	0.056	0.052	0.037	0.042	0.052	0.049	0.055	0.049
Tues/Wed/Thurs	7	0.059	0.059	0.052	0.060	0.061	0.050	0.038	0.051	0.039	0.040	0.046	0.036	0.044	0.067	0.060	0.053	0.047	0.064	0.075	0.072	0.052
Tues/Wed/Thurs	8	0.055	0.058	0.052	0.060	0.062	0.051	0.042	0.061	0.048	0.042	0.056	0.046	0.046	0.071	0.063	0.054	0.056	0.070	0.071	0.071	0.054
Tues/Wed/Thurs	9	0.051	0.059	0.054	0.055	0.060	0.050	0.047	0.064	0.058	0.044	0.066	0.057	0.047	0.067	0.065	0.059	0.068	0.083	0.057	0.064	0.053
Tues/Wed/Thurs	10	0.052	0.060	0.056	0.056	0.061	0.051	0.051	0.067	0.066	0.045	0.071	0.065	0.049	0.069	0.065	0.064	0.069	0.081	0.052	0.061	0.053
Tues/Wed/Thurs	11	0.054	0.061	0.057	0.059	0.064	0.052	0.054	0.070	0.069	0.047	0.076	0.070	0.052	0.071	0.062	0.068	0.069	0.077	0.054	0.062	0.053
Tues/Wed/Thurs	12	0.057	0.062	0.057	0.061	0.065	0.053	0.058	0.072	0.067	0.050	0.076	0.070	0.054	0.069	0.065	0.069	0.071	0.074	0.056	0.063	0.053
Tues/Wed/Thurs	13	0.060	0.063	0.056	0.064	0.066	0.053	0.061	0.074	0.066	0.052	0.077	0.069	0.056	0.072	0.067	0.072	0.073	0.074	0.057	0.061	0.051
Tues/Wed/Thurs	14	0.066	0.065	0.056	0.068	0.068	0.053	0.065	0.077	0.063	0.057	0.081	0.067	0.059	0.074	0.070	0.077	0.076	0.067	0.063	0.063	0.050
Tues/Wed/Thurs	15	0.073	0.066	0.055	0.073	0.069	0.053	0.070	0.080	0.061	0.058	0.078	0.064	0.061	0.080	0.071	0.084	0.078	0.058	0.071	0.065	0.049
Tues/Wed/Thurs	16	0.077	0.064	0.053	0.075	0.067	0.052	0.072	0.072	0.058	0.057	0.072	0.061	0.060	0.072	0.063	0.082	0.074	0.048	0.078	0.063	0.046
Tues/Wed/Thurs	17	0.076	0.057	0.049	0.074	0.063	0.050	0.065	0.057	0.056	0.056	0.060	0.057	0.057	0.059	0.054	0.074	0.061	0.036	0.079	0.060	0.044
Tues/Wed/Thurs	18	0.058	0.044	0.041	0.059	0.048	0.044	0.060	0.044	0.052	0.053	0.046	0.053	0.051	0.037	0.043	0.053	0.044	0.023	0.065	0.047	0.040
Tues/Wed/Thurs	19	0.044	0.032	0.034	0.043	0.034	0.038	0.053	0.032	0.045	0.048	0.033	0.044	0.045	0.025	0.036	0.038	0.031	0.016	0.044	0.031	0.034
Tues/Wed/Thurs	20	0.036	0.025	0.030	0.035	0.025	0.034	0.047	0.024	0.039	0.045	0.025	0.038	0.041	0.019	0.027	0.030	0.025	0.012	0.034	0.021	0.030
Tues/Wed/Thurs	21	0.028	0.019	0.026	0.029	0.019	0.031	0.042	0.021	0.034	0.038	0.018	0.032	0.035	0.014	0.021	0.023	0.018	0.010	0.028	0.016	0.029
Tues/Wed/Thurs	22	0.021	0.014	0.025	0.020	0.013	0.029	0.031	0.013	0.028	0.032	0.014	0.026	0.029	0.010	0.015	0.017	0.013	0.010	0.018	0.011	0.028
Tues/Wed/Thurs	23	0.015	0.012	0.023	0.013	0.009	0.028	0.022	0.010	0.022	0.025	0.010	0.021	0.022	0.006	0.011	0.010	0.008	0.010	0.010	0.008	0.030
Friday	0	0.008	0.016	0.027	0.007	0.014	0.032	0.013	0.007	0.021	0.021	0.007	0.019	0.020	0.004	0.010	0.005	0.009	0.019	0.006	0.016	0.033
Friday	1	0.006	0.014	0.025	0.005	0.011	0.030	0.012	0.005	0.018	0.023	0.006	0.017	0.021	0.003	0.007	0.003	0.008	0.019	0.003	0.013	0.031
Friday	2	0.005	0.014	0.026	0.004	0.011	0.030	0.012	0.006	0.018	0.024	0.007	0.016	0.023	0.004	0.008	0.002	0.008	0.019	0.002	0.012	0.031
Friday	3	0.008	0.017	0.029	0.005	0.012	0.030	0.014	0.008	0.018	0.026	0.009	0.016	0.022	0.005	0.013	0.002	0.008	0.021	0.003	0.014	0.032
Friday	4	0.014	0.024	0.035	0.008	0.016	0.033	0.016	0.015	0.021	0.029	0.013	0.019	0.027	0.013	0.020	0.005	0.013	0.024	0.007	0.019	0.036
Friday	5	0.024	0.035	0.042	0.017	0.026	0.038	0.023	0.023	0.026	0.032	0.018	0.023	0.034	0.032	0.033	0.013	0.023	0.037	0.020	0.032	0.042
Friday	6	0.036	0.045	0.047	0.033	0.040	0.045	0.029	0.035	0.033	0.033	0.030	0.032	0.038	0.051	0.057	0.026	0.035	0.049	0.043	0.052	0.049
Friday	7	0.049	0.053	0.052	0.049	0.054	0.050	0.034	0.044	0.041	0.037	0.039	0.039	0.042	0.062	0.063	0.039	0.040	0.060	0.067	0.068	0.052
Friday	8	0.047	0.054	0.053	0.051	0.057	0.052	0.039	0.055	0.049	0.040	0.051	0.049	0.046	0.070	0.063	0.043	0.049	0.068	0.064	0.069	0.054
Friday	9	0.047	0.056	0.055	0.050	0.057	0.052	0.042	0.060	0.055	0.045	0.063	0.054	0.047	0.066	0.063	0.049	0.057	0.073	0.054	0.062	0.053
Friday	10	0.051	0.060	0.058	0.054	0.061	0.054	0.049	0.063	0.058	0.048	0.069	0.060	0.050	0.070	0.066	0.058	0.063	0.078	0.053	0.061	0.054
Friday	11	0.054	0.062	0.060	0.060	0.066	0.055	0.052	0.069	0.061	0.049	0.072	0.063	0.052	0.071	0.063	0.064	0.069	0.077	0.057	0.064	0.054
Friday	12	0.057	0.063	0.060	0.063	0.067	0.055	0.057	0.070	0.061	0.052	0.074	0.063	0.054	0.070	0.067	0.066	0.071	0.076	0.059	0.064	0.053
Friday	13	0.061	0.065	0.059	0.066	0.068	0.054	0.057	0.075	0.061	0.055	0.077	0.062	0.056	0.072	0.067	0.071	0.074	0.077	0.061	0.065	0.052
Friday	14	0.068	0.067	0.058	0.070	0.070	0.054	0.065	0.080	0.060	0.059	0.080	0.063	0.058	0.074	0.070	0.076	0.077	0.070	0.065	0.065	0.050
Friday	15	0.074	0.067	0.056	0.073	0.070	0.052	0.070	0.082	0.059	0.063	0.081	0.061	0.059	0.075	0.068	0.083	0.079	0.060	0.071	0.065	0.049
Friday	16	0.076	0.064	0.053	0.074	0.067	0.050	0.072	0.073	0.057	0.058	0.075	0.059	0.059	0.070	0.059	0.083	0.077	0.050	0.075	0.063	0.046
Friday	17	0.075	0.058	0.048	0.072	0.063	0.047	0.065	0.062	0.055	0.059	0.063	0.055	0.055	0.057	0.055	0.075	0.064	0.038	0.074	0.059	0.043
Friday	18	0.064	0.048	0.040	0.063	0.051	0.042	0.061	0.047	0.051	0.054	0.052	0.051	0.053	0.041	0.043	0.062	0.051	0.025	0.064	0.046	0.040
Friday	19	0.052	0.037	0.032	0.050	0.039	0.035	0.059	0.039	0.046	0.050	0.036	0.046	0.045	0.027	0.036	0.050	0.039	0.018	0.048	0.032	0.034
Friday	20	0.043	0.029	0.026	0.041	0.029	0.030	0.051	0.028	0.040	0.046	0.030	0.041	0.042	0.020	0.026	0.041	0.030	0.013	0.037	0.022	0.029
Friday	21	0.035	0.022	0.022	0.037	0.023	0.028	0.045	0.022	0.035	0.040	0.022	0.036	0.039	0.017	0.019	0.036	0.025	0.010	0.032	0.017	0.027
Friday	22	0.027	0.016	0.020	0.030	0.017	0.026	0.037	0.018	0.031	0.031	0.016	0.031	0.032	0.014	0.015	0.030	0.019	0.011	0.024	0.012	0.027
Friday	23	0.020	0.012	0.018	0.019	0.011	0.024	0.026	0.012	0.025	0.025	0.012	0.025	0.026	0.011	0.010	0.018	0.012	0.009	0.016	0.009	0.027
Saturday	0	0.015	0.026	0.040	0.013	0.019	0.038	0.015	0.011	0.021	0.026	0.013	0.020	0.025	0.010	0.013	0.010	0.015	0.027	0.011	0.024	0.043
Saturday	1	0.010	0.020	0.035	0.008	0.015	0.034	0.014	0.008	0.018	0.026	0.008	0.016	0.025	0.007	0.010	0.007	0.012	0.023	0.006	0.018	0.040
Saturday	2	0.008	0.018	0.032	0.006	0.014	0.032	0.014	0.008	0.016	0.027	0.007	0.015	0.026	0.007	0.011	0.005	0.011	0.022	0.004	0.016	0.038
Saturday	3	0.008	0.019	0.032	0.006	0.013	0.031	0.014	0.007	0.016	0.030	0.007	0.014	0.027	0.009	0.013	0.004	0.010	0.025	0.003	0.015	0.037
Saturday	4	0.011	0.021	0.035	0.007	0.014	0.032	0.017	0.014	0.017	0.029	0.009	0.016	0.029	0.014	0.024	0.005	0.013	0.028	0.005	0.017	0.038
Saturday	5	0.017	0.028	0.039	0.011	0.018	0.034	0.021	0.018	0.021	0.033	0.015	0.019	0.036	0.033	0.032	0.010	0.021	0.034	0.011	0.023	0.041
Saturday	6	0.025	0.036	0.045	0.019	0.026	0.039	0.025	0.027	0.028	0.036	0.023	0.025	0.042	0.056	0.054	0.017	0.028	0.039	0.021	0.033	0.045
Saturday	7	0.034	0.044	0.050	0.032	0.038	0.046	0.032	0.038	0.039	0.038	0.033	0.036	0.041	0.055	0.068	0.029	0.036	0.053	0.034	0.046	0.050

		Stanislaus			Sutter			Tehama			Trinity			Tulare			Tuolumne			Ventura		
Day of Week	Hour	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH	LD	LM	HH
Saturday	8	0.044	0.053	0.055	0.045	0.051	0.052	0.040	0.055	0.051	0.041	0.047	0.047	0.043	0.057	0.069	0.044	0.045	0.060	0.046	0.057	0.053
Saturday	9	0.054	0.061	0.060	0.057	0.062	0.056	0.044	0.064	0.061	0.045	0.063	0.059	0.045	0.061	0.069	0.059	0.061	0.071	0.057	0.065	0.055
Saturday	10	0.062	0.068	0.063	0.067	0.071	0.060	0.051	0.071	0.067	0.049	0.075	0.067	0.048	0.066	0.068	0.073	0.074	0.078	0.065	0.071	0.056
Saturday	11	0.067	0.071	0.064	0.074	0.076	0.061	0.058	0.077	0.068	0.050	0.084	0.073	0.050	0.067	0.068	0.081	0.077	0.083	0.070	0.076	0.056
Saturday	12	0.069	0.070	0.062	0.075	0.075	0.060	0.060	0.076	0.067	0.053	0.083	0.071	0.052	0.068	0.065	0.078	0.077	0.075	0.072	0.074	0.054
Saturday	13	0.070	0.067	0.058	0.075	0.074	0.057	0.059	0.073	0.066	0.055	0.081	0.069	0.053	0.067	0.068	0.075	0.072	0.060	0.072	0.071	0.053
Saturday	14	0.070	0.064	0.054	0.074	0.071	0.055	0.065	0.076	0.066	0.057	0.076	0.065	0.055	0.070	0.070	0.075	0.068	0.055	0.072	0.068	0.050
Saturday	15	0.069	0.061	0.049	0.072	0.068	0.051	0.067	0.073	0.064	0.060	0.074	0.062	0.058	0.077	0.065	0.075	0.068	0.052	0.072	0.063	0.047
Saturday	16	0.068	0.057	0.045	0.070	0.064	0.048	0.065	0.069	0.059	0.056	0.070	0.058	0.057	0.066	0.055	0.072	0.070	0.047	0.072	0.059	0.044
Saturday	17	0.064	0.051	0.040	0.066	0.057	0.044	0.064	0.062	0.055	0.055	0.061	0.057	0.054	0.053	0.050	0.066	0.063	0.040	0.068	0.051	0.040
Saturday	18	0.056	0.042	0.033	0.056	0.047	0.038	0.061	0.048	0.050	0.051	0.049	0.052	0.052	0.040	0.039	0.058	0.052	0.031	0.059	0.041	0.035
Saturday	19	0.048	0.034	0.027	0.046	0.037	0.033	0.059	0.041	0.044	0.049	0.038	0.045	0.046	0.034	0.030	0.047	0.041	0.026	0.048	0.031	0.030
Saturday	20	0.041	0.029	0.024	0.040	0.030	0.028	0.050	0.031	0.036	0.042	0.031	0.038	0.042	0.027	0.021	0.038	0.031	0.020	0.040	0.024	0.027
Saturday	21	0.037	0.024	0.021	0.035	0.025	0.025	0.044	0.023	0.030	0.037	0.023	0.031	0.038	0.023	0.018	0.031	0.025	0.016	0.037	0.022	0.024
Saturday	22	0.031	0.020	0.019	0.028	0.019	0.023	0.034	0.017	0.024	0.031	0.017	0.026	0.032	0.019	0.011	0.025	0.020	0.018	0.031	0.019	0.023
Saturday	23	0.023	0.016	0.017	0.020	0.014	0.021	0.026	0.013	0.019	0.023	0.012	0.019	0.025	0.014	0.008	0.016	0.013	0.018	0.022	0.016	0.022
Holiday	0	0.013	0.020	0.027	0.010	0.016	0.028	0.014	0.008	0.015	0.024	0.008	0.015	0.024	0.008	0.009	0.008	0.011	0.020	0.009	0.019	0.032
Holiday	1	0.009	0.017	0.025	0.006	0.013	0.027	0.013	0.007	0.013	0.027	0.008	0.012	0.024	0.007	0.010	0.005	0.009	0.018	0.005	0.016	0.030
Holiday	2	0.007	0.015	0.024	0.004	0.012	0.026	0.013	0.006	0.012	0.024	0.008	0.012	0.023	0.006	0.007	0.003	0.010	0.018	0.003	0.014	0.029
Holiday	3	0.007	0.016	0.026	0.005	0.013	0.027	0.013	0.006	0.012	0.029	0.010	0.013	0.023	0.007	0.011	0.004	0.010	0.021	0.003	0.015	0.031
Holiday	4	0.011	0.020	0.029	0.008	0.016	0.029	0.016	0.013	0.014	0.029	0.012	0.014	0.027	0.016	0.017	0.005	0.012	0.020	0.007	0.018	0.032
Holiday	5	0.019	0.028	0.033	0.014	0.023	0.032	0.020	0.017	0.020	0.031	0.016	0.017	0.033	0.030	0.032	0.009	0.018	0.031	0.016	0.029	0.038
Holiday	6	0.027	0.035	0.038	0.025	0.033	0.036	0.025	0.028	0.026	0.037	0.025	0.023	0.035	0.045	0.052	0.018	0.023	0.038	0.031	0.042	0.043
Holiday	7	0.035	0.042	0.042	0.036	0.044	0.042	0.030	0.037	0.036	0.038	0.033	0.031	0.040	0.052	0.064	0.029	0.031	0.043	0.047	0.056	0.047
Holiday	8	0.040	0.048	0.046	0.046	0.053	0.048	0.036	0.051	0.046	0.040	0.049	0.040	0.043	0.065	0.066	0.041	0.044	0.056	0.051	0.059	0.049
Holiday	9	0.048	0.055	0.050	0.054	0.059	0.050	0.047	0.068	0.056	0.043	0.062	0.054	0.045	0.061	0.058	0.058	0.057	0.075	0.052	0.061	0.051
Holiday	10	0.059	0.064	0.055	0.065	0.069	0.053	0.051	0.068	0.064	0.050	0.076	0.060	0.050	0.075	0.055	0.076	0.083	0.087	0.059	0.066	0.053
Holiday	11	0.065	0.070	0.060	0.074	0.074	0.057	0.059	0.083	0.069	0.047	0.084	0.068	0.049	0.076	0.055	0.084	0.086	0.088	0.066	0.069	0.054
Holiday	12	0.069	0.072	0.061	0.077	0.074	0.056	0.066	0.081	0.071	0.053	0.083	0.070	0.058	0.075	0.060	0.085	0.087	0.089	0.068	0.072	0.055
Holiday	13	0.071	0.071	0.061	0.076	0.074	0.058	0.062	0.084	0.068	0.062	0.091	0.067	0.052	0.069	0.068	0.083	0.081	0.078	0.070	0.070	0.053
Holiday	14	0.072	0.069	0.059	0.075	0.073	0.056	0.069	0.076	0.064	0.059	0.087	0.069	0.055	0.069	0.070	0.080	0.074	0.068	0.071	0.068	0.053
Holiday	15	0.073	0.068	0.058	0.074	0.070	0.055	0.065	0.081	0.061	0.057	0.079	0.065	0.062	0.070	0.078	0.078	0.074	0.060	0.073	0.064	0.050
Holiday	16	0.073	0.065	0.055	0.072	0.066	0.054	0.070	0.068	0.061	0.056	0.072	0.062	0.065	0.074	0.069	0.078	0.072	0.049	0.073	0.061	0.049
Holiday	17	0.070	0.057	0.050	0.068	0.059	0.051	0.068	0.063	0.060	0.056	0.058	0.060	0.053	0.057	0.062	0.071	0.066	0.041	0.071	0.056	0.046
Holiday	18	0.060	0.046	0.044	0.057	0.049	0.045	0.063	0.047	0.055	0.053	0.044	0.058	0.051	0.040	0.046	0.057	0.049	0.033	0.061	0.045	0.041
Holiday	19	0.050	0.036	0.039	0.047	0.036	0.041	0.056	0.035	0.048	0.048	0.029	0.049	0.047	0.031	0.041	0.043	0.040	0.022	0.049	0.032	0.036
Holiday	20	0.042	0.029	0.034	0.039	0.029	0.037	0.050	0.028	0.041	0.044	0.024	0.045	0.046	0.027	0.026	0.033	0.026	0.013	0.041	0.024	0.033
Holiday	21	0.034	0.023	0.030	0.030	0.020	0.033	0.045	0.021	0.035	0.040	0.019	0.040	0.040	0.019	0.021	0.024	0.018	0.011	0.034	0.019	0.032
Holiday	22	0.027	0.017	0.028	0.023	0.015	0.031	0.027	0.013	0.029	0.031	0.014	0.030	0.034	0.014	0.014	0.017	0.012	0.009	0.025	0.014	0.031
Holiday	23	0.018	0.014	0.026	0.015	0.010	0.029	0.022	0.010	0.023	0.024	0.009	0.024	0.024	0.011	0.011	0.010	0.008	0.010	0.016	0.012	0.032

		Yolo			Yuba		
Day of Week	Hour	LD	LM	HH	LD	LM	HH
Sunday	0	0.016	0.026	0.044	0.013	0.020	0.031
Sunday	1	0.011	0.019	0.036	0.008	0.016	0.028
Sunday	2	0.008	0.017	0.033	0.006	0.013	0.026
Sunday	3	0.006	0.015	0.030	0.005	0.012	0.025
Sunday	4	0.007	0.016	0.029	0.005	0.012	0.025
Sunday	5	0.011	0.020	0.032	0.008	0.015	0.027
Sunday	6	0.016	0.025	0.034	0.013	0.020	0.030
Sunday	7	0.023	0.031	0.040	0.022	0.028	0.034
Sunday	8	0.034	0.041	0.046	0.034	0.041	0.040
Sunday	9	0.048	0.054	0.051	0.048	0.055	0.046
Sunday	10	0.060	0.063	0.054	0.064	0.068	0.052
Sunday	11	0.067	0.067	0.054	0.075	0.075	0.055
Sunday	12	0.071	0.070	0.053	0.082	0.079	0.058
Sunday	13	0.072	0.070	0.052	0.084	0.079	0.058
Sunday	14	0.073	0.069	0.050	0.084	0.077	0.057
Sunday	15	0.073	0.067	0.047	0.082	0.073	0.057
Sunday	16	0.072	0.063	0.045	0.079	0.068	0.055
Sunday	17	0.070	0.059	0.043	0.072	0.062	0.053
Sunday	18	0.063	0.051	0.041	0.060	0.052	0.049
Sunday	19	0.057	0.044	0.038	0.050	0.043	0.045
Sunday	20	0.051	0.038	0.036	0.041	0.035	0.042
Sunday	21	0.042	0.032	0.037	0.031	0.026	0.039
Sunday	22	0.030	0.025	0.037	0.021	0.019	0.036
Sunday	23	0.019	0.020	0.040	0.013	0.015	0.033
Monday	0	0.010	0.018	0.028	0.008	0.014	0.027
Monday	1	0.006	0.015	0.026	0.005	0.012	0.025
Monday	2	0.005	0.014	0.026	0.004	0.012	0.025
Monday	3	0.007	0.016	0.028	0.006	0.014	0.027
Monday	4	0.016	0.025	0.034	0.011	0.019	0.030
Monday	5	0.032	0.040	0.043	0.023	0.030	0.036
Monday	6	0.048	0.052	0.050	0.042	0.047	0.043
Monday	7	0.066	0.065	0.056	0.060	0.061	0.048
Monday	8	0.064	0.064	0.057	0.059	0.062	0.050
Monday	9	0.057	0.062	0.056	0.056	0.061	0.050
Monday	10	0.055	0.061	0.057	0.058	0.064	0.051
Monday	11	0.056	0.062	0.056	0.062	0.066	0.053
Monday	12	0.058	0.062	0.056	0.066	0.068	0.054
Monday	13	0.059	0.061	0.055	0.067	0.067	0.054
Monday	14	0.062	0.062	0.054	0.070	0.069	0.055
Monday	15	0.068	0.063	0.053	0.073	0.069	0.055
Monday	16	0.073	0.062	0.051	0.075	0.067	0.054
Monday	17	0.072	0.057	0.046	0.073	0.061	0.052
Monday	18	0.053	0.043	0.039	0.056	0.046	0.045
Monday	19	0.039	0.030	0.031	0.040	0.031	0.039
Monday	20	0.032	0.023	0.026	0.031	0.022	0.035
Monday	21	0.027	0.018	0.024	0.025	0.017	0.032
Monday	22	0.021	0.014	0.023	0.017	0.012	0.030
Monday	23	0.014	0.011	0.025	0.012	0.009	0.030
Tues/Wed/Thurs	0	0.009	0.017	0.031	0.008	0.014	0.029
Tues/Wed/Thurs	1	0.006	0.014	0.028	0.004	0.011	0.027
Tues/Wed/Thurs	2	0.005	0.014	0.028	0.004	0.011	0.027
Tues/Wed/Thurs	3	0.006	0.016	0.030	0.005	0.013	0.029

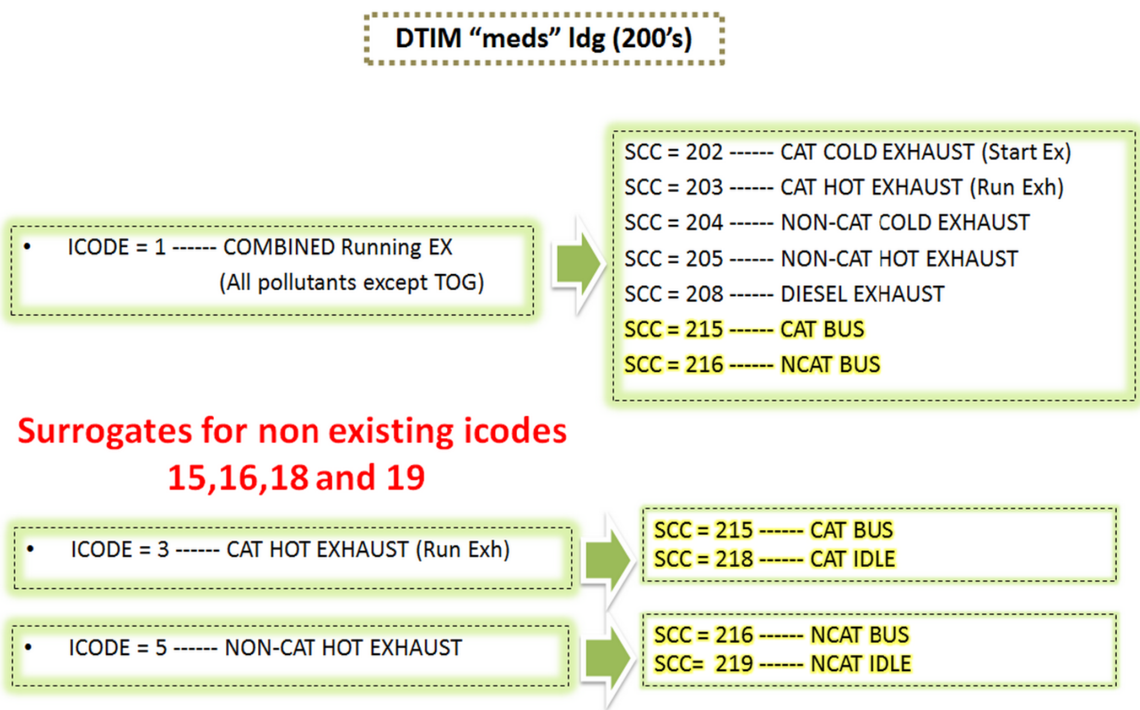
		Yolo			Yuba		
Day of Week	Hour	LD	LM	HH	LD	LM	HH
Tues/Wed/Thurs	4	0.014	0.023	0.036	0.010	0.018	0.031
Tues/Wed/Thurs	5	0.029	0.037	0.044	0.022	0.029	0.037
Tues/Wed/Thurs	6	0.046	0.051	0.052	0.042	0.047	0.044
Tues/Wed/Thurs	7	0.066	0.065	0.057	0.060	0.061	0.050
Tues/Wed/Thurs	8	0.065	0.064	0.057	0.060	0.062	0.051
Tues/Wed/Thurs	9	0.057	0.062	0.057	0.055	0.060	0.050
Tues/Wed/Thurs	10	0.053	0.061	0.057	0.056	0.061	0.051
Tues/Wed/Thurs	11	0.054	0.061	0.057	0.059	0.064	0.052
Tues/Wed/Thurs	12	0.056	0.061	0.056	0.061	0.065	0.053
Tues/Wed/Thurs	13	0.058	0.061	0.055	0.064	0.066	0.053
Tues/Wed/Thurs	14	0.062	0.062	0.053	0.068	0.068	0.053
Tues/Wed/Thurs	15	0.069	0.063	0.051	0.073	0.069	0.053
Tues/Wed/Thurs	16	0.074	0.062	0.048	0.075	0.067	0.052
Tues/Wed/Thurs	17	0.073	0.058	0.044	0.074	0.063	0.050
Tues/Wed/Thurs	18	0.056	0.045	0.037	0.059	0.048	0.044
Tues/Wed/Thurs	19	0.041	0.032	0.030	0.043	0.034	0.038
Tues/Wed/Thurs	20	0.034	0.025	0.025	0.035	0.025	0.034
Tues/Wed/Thurs	21	0.029	0.020	0.023	0.029	0.019	0.031
Tues/Wed/Thurs	22	0.022	0.015	0.022	0.020	0.013	0.029
Tues/Wed/Thurs	23	0.015	0.011	0.023	0.013	0.009	0.028
Friday	0	0.009	0.017	0.032	0.007	0.014	0.032
Friday	1	0.006	0.014	0.030	0.005	0.011	0.030
Friday	2	0.005	0.014	0.030	0.004	0.011	0.030
Friday	3	0.006	0.015	0.032	0.005	0.012	0.030
Friday	4	0.012	0.022	0.037	0.008	0.016	0.033
Friday	5	0.024	0.034	0.044	0.017	0.026	0.038
Friday	6	0.038	0.047	0.052	0.033	0.040	0.045
Friday	7	0.054	0.059	0.058	0.049	0.054	0.050
Friday	8	0.055	0.059	0.059	0.051	0.057	0.052
Friday	9	0.051	0.059	0.058	0.050	0.057	0.052
Friday	10	0.052	0.060	0.058	0.054	0.061	0.054
Friday	11	0.056	0.062	0.058	0.060	0.066	0.055
Friday	12	0.059	0.063	0.056	0.063	0.067	0.055
Friday	13	0.062	0.064	0.055	0.066	0.068	0.054
Friday	14	0.066	0.064	0.053	0.070	0.070	0.054
Friday	15	0.070	0.063	0.050	0.073	0.070	0.052
Friday	16	0.071	0.061	0.046	0.074	0.067	0.050
Friday	17	0.069	0.057	0.041	0.072	0.063	0.047
Friday	18	0.060	0.047	0.037	0.063	0.051	0.042
Friday	19	0.049	0.036	0.029	0.050	0.039	0.035
Friday	20	0.041	0.028	0.024	0.041	0.029	0.030
Friday	21	0.036	0.023	0.021	0.037	0.023	0.028
Friday	22	0.029	0.018	0.019	0.030	0.017	0.026
Friday	23	0.019	0.013	0.019	0.019	0.011	0.024
Saturday	0	0.014	0.024	0.050	0.013	0.019	0.038
Saturday	1	0.009	0.019	0.042	0.008	0.015	0.034
Saturday	2	0.008	0.017	0.039	0.006	0.014	0.032
Saturday	3	0.007	0.016	0.037	0.006	0.013	0.031
Saturday	4	0.009	0.019	0.038	0.007	0.014	0.032
Saturday	5	0.014	0.025	0.043	0.011	0.018	0.034
Saturday	6	0.023	0.033	0.049	0.019	0.026	0.039
Saturday	7	0.034	0.044	0.055	0.032	0.038	0.046

		Yolo			Yuba		
Day of Week	Hour	LD	LM	HH	LD	LM	HH
Saturday	8	0.046	0.055	0.059	0.045	0.051	0.052
Saturday	9	0.057	0.064	0.061	0.057	0.062	0.056
Saturday	10	0.065	0.070	0.063	0.067	0.071	0.060
Saturday	11	0.069	0.071	0.059	0.074	0.076	0.061
Saturday	12	0.069	0.068	0.056	0.075	0.075	0.060
Saturday	13	0.069	0.065	0.052	0.075	0.074	0.057
Saturday	14	0.068	0.063	0.047	0.074	0.071	0.055
Saturday	15	0.067	0.060	0.043	0.072	0.068	0.051
Saturday	16	0.066	0.056	0.039	0.070	0.064	0.048
Saturday	17	0.063	0.052	0.035	0.066	0.057	0.044
Saturday	18	0.057	0.045	0.029	0.056	0.047	0.038
Saturday	19	0.048	0.035	0.025	0.046	0.037	0.033
Saturday	20	0.042	0.030	0.021	0.040	0.030	0.028
Saturday	21	0.039	0.027	0.020	0.035	0.025	0.025
Saturday	22	0.034	0.023	0.020	0.028	0.019	0.023
Saturday	23	0.024	0.018	0.019	0.020	0.014	0.021
Holiday	0	0.012	0.022	0.032	0.010	0.016	0.028
Holiday	1	0.008	0.017	0.029	0.006	0.013	0.027
Holiday	2	0.006	0.015	0.029	0.004	0.012	0.026
Holiday	3	0.006	0.017	0.029	0.005	0.013	0.027
Holiday	4	0.011	0.021	0.032	0.008	0.016	0.029
Holiday	5	0.019	0.030	0.038	0.014	0.023	0.032
Holiday	6	0.027	0.038	0.044	0.025	0.033	0.036
Holiday	7	0.037	0.046	0.050	0.036	0.044	0.042
Holiday	8	0.046	0.054	0.053	0.046	0.053	0.048
Holiday	9	0.053	0.059	0.056	0.054	0.059	0.050
Holiday	10	0.061	0.065	0.058	0.065	0.069	0.053
Holiday	11	0.067	0.069	0.060	0.074	0.074	0.057
Holiday	12	0.069	0.068	0.059	0.077	0.074	0.056
Holiday	13	0.069	0.068	0.057	0.076	0.074	0.058
Holiday	14	0.070	0.066	0.055	0.075	0.073	0.056
Holiday	15	0.069	0.065	0.052	0.074	0.070	0.055
Holiday	16	0.067	0.060	0.049	0.072	0.066	0.054
Holiday	17	0.064	0.055	0.044	0.068	0.059	0.051
Holiday	18	0.057	0.046	0.039	0.057	0.049	0.045
Holiday	19	0.050	0.036	0.033	0.047	0.036	0.041
Holiday	20	0.044	0.029	0.028	0.039	0.029	0.037
Holiday	21	0.039	0.023	0.025	0.030	0.020	0.033
Holiday	22	0.030	0.018	0.024	0.023	0.015	0.031
Holiday	23	0.020	0.014	0.026	0.015	0.010	0.029

Appendix C: Scaling procedures after DTIM processing

C1. Block Diagram of Scaling Process: ldg (gas: heavy- and light-duty; diesel: light-duty)

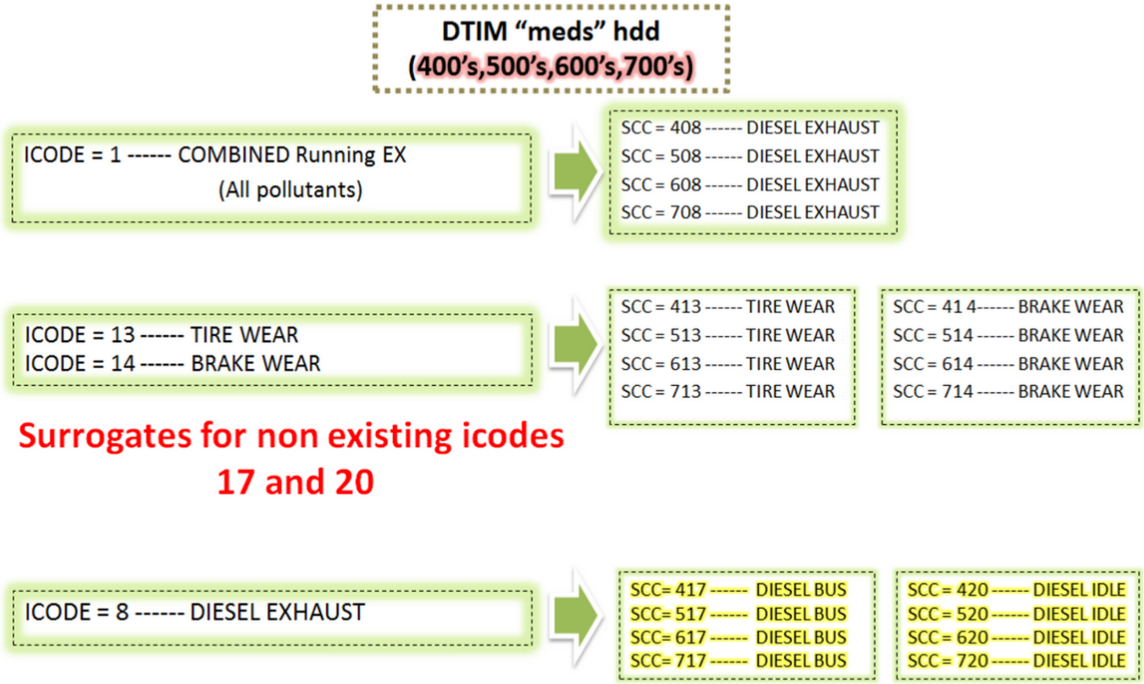
DTIM has 1 to 12 Source Classification Codes (SCC) that vary by species. For CO, NOx, SOx and PM species, DTIM only uses SCC=1 for the running exhaust emissions regardless of the fuel type and process. However, distribution of the running exhaust emissions according to the fuel type and process is needed. The following diagram explains how to distribute the running exhaust emissions for the light-duty gas. The running exhaust emissions are distributed to the catalyst cold exhaust, catalyst hot exhaust, non-catalyst cold exhaust, non-catalyst hot exhaust, catalyst bus and non-catalyst bus by using the corresponding emissions from EMFAC. Since there are no idle emissions in DTIM, surrogates are needed for the catalyst idle and non-catalyst idle. The surrogates for the catalyst idle and non-catalyst idle are catalyst hot exhaust, and non-catalyst hot exhaust, respectively.



95

C2. Block Diagram of Scaling Process: hdd (heavy-duty diesel)

The following diagram explains how to distribute the running exhaust emissions for heavy-duty diesel. The running exhaust emissions are distributed to the diesel exhaust or diesel bus exhaust depending on the vehicle type by using the corresponding emissions from EMFAC. Since there are no idle emissions in DTIM, a surrogate is used. The surrogate for the diesel idle emissions is diesel exhaust or diesel bus exhaust, depending on the vehicle type.



Appendix D: Additional temporal profiles

Temporal profiles developed from the AGTOOL are applied as potential replacements when processing the emissions inventories for modeling using the SMOKE processor. This would apply for agriculturally related emissions with time-invariant temporal distributions, which includes the following emission source categories: food and agricultural processing, pesticides and fertilizers, farming operations, unpaved road dust, fugitive windblown dust, managed burning and disposal, and farming equipment

Table 11 Day of week temporal profiles from the Agricultural Emissions Temporal and Spatial Allocation Tool (AgTool)

Code	M	T	W	TH	F	S	S
201	1	174	248	182	203	97	95
202	1	2	1	0	2	1	993
203	1	117	192	190	229	222	48
204	2	16	13	13	10	928	17
205	3	342	597	25	4	5	24
206	4	100	33	241	105	455	62
207	5	50	284	126	125	315	95
208	6	94	41	40	348	358	112
209	7	203	111	236	340	0	102
210	8	221	225	123	117	80	225
211	9	37	63	667	111	37	77
212	11	2	881	41	40	18	8
213	12	96	105	153	201	425	8
214	13	370	306	90	47	101	73
215	13	368	72	498	2	41	6
216	19	562	125	102	47	39	107
217	22	348	74	115	125	215	102
218	22	292	63	229	65	104	224
219	22	482	41	111	167	93	83
220	25	184	100	136	223	152	182
221	25	192	107	223	278	75	101
222	27	40	51	99	310	58	415
223	29	51	237	127	172	308	77
224	30	219	195	158	222	112	64
225	30	185	151	125	186	120	203
226	35	131	195	172	151	201	114
227	35	146	162	175	157	180	143
228	36	179	200	93	188	186	117
229	37	82	363	208	2	73	235
230	40	211	162	182	160	165	81
231	40	468	0	420	0	72	0
232	41	269	293	118	95	121	62
233	44	56	399	13	268	61	160
234	45	335	72	82	210	180	77
235	46	124	139	148	199	168	177
236	46	207	54	453	54	134	52
237	48	310	346	83	84	91	38
238	52	201	140	196	121	160	132
239	53	134	123	144	206	192	149
240	53	108	150	163	171	207	148
241	57	156	183	117	92	220	175
242	63	105	176	154	148	195	160
243	63	186	136	175	187	134	120

Code	M	T	W	TH	F	S	S
244	64	230	173	136	83	251	63
245	66	249	149	127	105	185	120
246	67	222	278	236	65	129	2
247	70	120	192	168	188	145	116
248	74	95	170	197	157	144	162
249	74	190	108	126	246	116	138
250	77	295	104	187	155	88	93
251	79	135	291	129	86	182	97
252	80	360	9	19	424	79	29
253	81	133	132	125	226	167	135
254	82	136	151	118	160	196	157
255	82	92	125	207	177	153	164
256	85	133	152	145	188	173	124
257	87	295	16	111	47	244	201
258	96	128	104	169	161	224	119
259	104	196	118	155	202	132	94
260	104	111	196	121	181	127	162
261	107	161	70	90	227	243	102
262	107	145	115	203	187	147	95
263	111	171	137	0	297	202	81
264	112	121	144	165	155	172	131
265	113	199	97	132	218	147	94
266	113	167	15	156	399	70	80
267	115	150	128	153	192	139	122
268	115	103	120	138	117	251	156
269	119	125	119	87	144	158	248
270	120	145	130	137	155	166	147
271	125	155	141	108	179	149	142
272	130	140	137	170	93	139	192
273	135	222	191	83	169	110	90
274	136	160	156	162	144	156	86
275	138	109	107	137	227	147	137
276	139	101	117	171	167	171	134
277	143	143	143	143	143	143	143
278	150	230	118	72	144	170	116
279	163	118	106	135	185	112	181
280	199	136	81	163	143	180	99
281	218	8	2	14	6	525	226
282	250	35	290	130	50	109	137
283	255	116	82	103	128	63	252
284	278	182	148	36	105	112	139
285	326	168	189	0	105	0	211
286	0	212	165	131	202	128	161
287	0	289	0	0	356	222	133
288	0	321	93	208	109	81	188
289	0	431	4	160	246	15	144
290	0	515	122	111	48	128	76
291	0	0	0	916	84	0	0
292	0	0	0	0	148	0	852
294	0	0	0	0	1000	0	0

Table 12 Daily temporal profiles from the Agricultural Emissions Temporal and Spatial Allocation Tool (AgTool)

Code	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
201	0	0	0	0	0	10	102	2	26	358	259	134	65	1	26	10	3	2	1	0	0	0	0	0
202	0	0	0	5	3	2	5	59	44	38	28	640	19	21	48	34	21	22	10	1	0	1	0	0
203	1	0	0	0	10	162	64	51	139	270	115	46	61	3	15	16	16	4	12	6	3	1	3	2
204	1	0	0	0	0	1	139	405	79	126	69	54	33	31	13	20	14	14	2	0	0	0	0	0
205	1	3	6	2	3	8	1	2	5	29	73	112	125	115	101	164	46	49	65	68	3	10	5	2
206	2	5	0	4	22	5	6	8	26	31	88	90	66	397	38	28	43	100	34	5	0	0	0	0
207	2	3	0	0	37	177	45	57	167	203	123	102	23	15	8	6	22	6	1	0	0	0	0	1
208	2	0	0	0	0	20	1	498	9	15	28	8	42	6	358	2	2	0	9	0	0	0	0	0
209	2	0	0	12	54	3	41	471	18	105	94	31	7	9	68	33	43	7	0	0	0	0	0	0
210	2	4	2	4	4	3	17	40	60	137	87	178	42	67	82	198	60	6	3	1	1	1	1	1
211	3	2	3	2	0	2	6	12	43	75	220	413	2	199	2	5	4	7	0	0	0	0	0	0
212	4	5	0	0	6	220	16	73	212	321	135	6	0	0	0	0	0	0	3	0	0	0	0	0
213	4	159	11	187	7	0	0	16	71	536	0	1	0	0	0	0	0	0	7	0	0	0	0	0
214	5	5	5	7	6	13	6	91	50	29	237	161	11	37	123	78	76	1	51	1	1	1	1	2
215	8	5	19	15	44	48	35	44	88	109	96	100	58	112	62	44	30	52	13	3	3	3	3	6
216	9	0	0	0	0	10	19	157	83	105	65	92	15	19	73	308	32	6	2	4	1	0	1	0
217	9	9	6	7	10	84	13	35	113	187	138	63	57	58	25	40	44	45	30	4	5	4	3	13
218	10	3	6	5	7	11	17	61	30	44	61	73	88	56	119	265	18	3	108	3	1	3	3	6
219	0	0	0	0	0	393	374	26	0	139	0	4	11	1	2	15	33	2	0	0	0	0	0	0
220	11	11	8	2	25	16	144	131	173	251	106	55	56	4	1	4	1	0	0	0	0	0	0	0
221	13	13	15	25	32	11	8	12	8	123	19	135	6	47	157	65	26	96	154	7	6	6	6	8
222	9	9	2	19	3	19	7	16	76	20	39	156	44	277	29	52	176	37	2	2	2	1	1	2
223	5	5	3	4	13	23	108	64	68	61	92	278	59	38	56	34	38	22	14	5	1	1	2	5
224	1	1	10	4	8	32	50	118	64	72	75	123	130	51	72	63	61	24	8	2	16	2	11	1
225	4	4	8	12	25	22	33	74	62	76	86	114	72	84	86	92	80	33	12	7	3	4	3	4
226	4	4	8	11	12	26	26	46	37	85	114	231	83	67	71	91	57	12	4	4	1	2	3	2
227	7	7	9	10	19	39	25	45	61	92	97	102	73	120	66	66	72	45	19	7	5	5	5	5
228	4	4	8	9	28	20	30	24	34	58	53	180	122	60	128	104	67	29	22	3	2	4	4	3
229	10	10	15	14	18	171	37	47	47	41	38	40	45	22	27	57	13	3	305	4	6	5	5	20
230	19	19	40	29	38	80	48	119	50	39	31	35	75	49	84	80	64	27	22	21	12	10	9	1
231	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
232	0	0	0	0	0	2	20	24	22	21	37	146	32	41	17	219	406	5	4	4	0	1	0	0
233	0	0	0	0	0	0	0	0	512	0	0	0	0	0	488	0	0	0	0	0	0	0	0	0
234	9	9	7	5	9	32	20	58	39	80	110	105	136	66	131	41	89	12	16	9	9	0	7	1
235	2	2	2	5	6	31	48	95	72	51	41	460	48	29	19	20	34	17	9	8	1	0	0	0
236	11	11	23	12	20	28	23	22	28	64	96	55	75	53	105	105	146	58	13	11	8	10	14	9
237	18	18	12	10	15	7	11	24	20	49	77	80	54	38	59	177	120	20	10	35	38	44	39	26
238	1	1	1	4	1	20	52	86	79	118	93	120	71	56	132	73	42	27	8	4	2	3	3	1
239	2	2	1	3	2	42	31	82	79	79	87	78	85	78	76	67	142	38	15	4	1	2	2	1
240	0	0	0	19	27	55	26	23	26	51	112	162	192	112	85	60	22	8	1	12	6	0	0	1
241	3	3	7	34	3	37	32	238	35	45	66	70	64	43	166	68	52	16	4	5	1	1	4	0
242	3	3	2	35	6	40	47	69	76	97	85	95	80	78	105	42	48	56	12	4	1	15	2	0
243	0	0	0	2	18	6	70	47	130	146	115	21	62	64	247	42	22	4	2	0	0	0	1	0
244	22	22	18	16	38	65	86	87	74	83	68	64	61	34	32	51	105	25	17	10	2	2	6	12
245	6	6	5	7	16	30	26	53	78	126	75	74	33	44	63	118	131	12	8	2	68	8	8	4
246	0	0	0	1	7	426	80	147	29	25	23	109	2	29	53	6	45	0	0	0	0	17	0	0
247	0	0	5	175	1	6	0	37	49	13	4	11	250	0	1	0	439	0	0	9	0	0	0	0
248	4	4	12	8	64	229	105	285	61	59	32	42	10	71	3	4	8	0	0	0	0	0	0	0

99

Code	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
249	0	0	0	0	1	6	51	4	11	34	153	492	8	40	7	15	167	8	0	1	0	0	0	0
250	8	8	8	1	1	4	4	4	368	389	188	12	1	1	1	1	1	0	0	0	0	0	0	0
251	17	17	7	68	22	64	11	227	26	299	87	17	4	4	60	15	0	0	0	1	2	25	15	12
252	0	0	0	0	0	3	2	1	2	2	958	9	3	3	2	3	3	8	2	0	0	0	0	0
253	0	2	0	0	0	2	60	212	153	137	76	138	58	47	61	25	13	7	9	1	0	0	0	0
254	0	6	0	0	151	178	73	63	226	62	12	58	9	7	39	21	80	15	0	0	0	0	0	0
255	0	17	356	0	0	149	0	213	0	2	258	0	0	0	0	0	0	0	4	0	0	0	0	0
256	0	0	0	1	0	244	44	98	70	1	0	538	2	0	0	0	0	2	0	0	0	0	0	0
257	0	0	0	0	0	0	11	38	8	77	89	690	18	14	14	10	21	2	8	0	0	0	0	0
258	0	0	0	0	1	217	54	47	60	119	118	231	0	82	0	54	17	0	0	0	0	0	0	0
259	0	0	0	0	8	312	108	95	177	227	73	0	0	0	0	0	0	0	0	0	0	0	0	0
260	0	0	0	0	77	0	1	18	74	134	241	243	121	48	8	11	0	23	0	1	0	0	0	0
261	0	0	0	0	0	1	10	58	48	373	106	114	34	70	38	15	0	0	0	0	0	58	0	76
262	0	0	0	0	0	3	2	20	7	113	26	792	4	5	9	4	10	5	0	0	0	0	0	0
263	0	0	0	0	0	72	919	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
264	0	0	0	0	0	75	0	618	307	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
265	0	0	0	0	0	89	14	0	0	0	0	897	0	0	0	0	0	0	0	0	0	0	0	0
266	0	0	0	0	0	92	0	263	71	187	123	70	50	6	19	4	10	85	19	0	0	0	0	0
267	0	0	0	0	0	377	95	0	0	32	0	495	0	0	0	0	0	0	0	0	0	0	0	0
268	0	0	0	0	0	772	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	206
269	0	0	0	0	0	795	121	7	1	16	9	22	5	3	7	8	4	0	0	0	0	0	0	0
270	0	0	0	0	0	0	67	0	9	371	397	127	26	3	1	0	0	0	0	0	1	0	0	0
271	0	0	0	0	0	0	495	0	31	269	0	0	0	144	0	61	0	0	0	0	0	0	0	0
272	0	0	0	0	0	0	929	34	0	0	0	37	0	0	0	0	0	0	0	0	0	0	0	0
273	0	0	0	0	0	0	0	1	0	0	0	997	0	1	0	0	0	0	0	0	0	0	0	0
274	0	0	0	0	0	0	0	6	24	368	49	198	25	32	42	95	45	58	56	1	0	0	0	0
275	0	0	0	0	0	0	0	46	483	33	11	12	7	17	50	4	336	0	0	0	0	0	0	0
276	0	0	0	0	0	0	0	864	0	0	0	0	136	0	0	0	0	0	0	0	0	0	0	0
277	0	0	0	0	0	0	0	0	42	75	167	483	0	233	0	0	0	0	0	0	0	0	0	0
278	0	0	0	0	0	0	0	0	0	84	93	823	0	0	0	0	0	0	0	0	0	0	0	0
279	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
280	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	0
281	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0
282	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
283	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
284	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX C

VMT Offset Demonstration for the 2008 Ozone Standard As Required by Clean Act Section 182(d)(1)(A)

Appendix C VMT Offset Demonstration

Appendix C.1 Background

In 1979, United States Environmental Protection Agency (USEPA) established a primary health-based national ambient air quality standard (NAAQS) for ozone at 0.12 parts per million (ppm) averaged over a 1-hour period (44 FR 8220). The Clean Air Act (CAA), as amended in 1990, classified areas that had not yet attained that standard, based on the severity of their ozone problem, ranging from Marginal to Extreme. Extreme areas were provided the most time to attain, until November 15, 2010, but were also subject to the most stringent requirements. In particular, Severe and Extreme areas were subject to CAA Section 182(d)(1)(A), which requires state implementation plans to adopt "specific enforceable transportation control strategies and transportation control measures to offset any growth in vehicle miles traveled or numbers of vehicle trips in such area…." USEPA designated the Sacramento Federal Nonattainment Area (SFNA) as Severe on April 25, 1995 (60 FR 20237), and thus the Sacramento Metropolitan area was subject to this requirement. The USEPA has historically interpreted this provision of the CAA (now called "Vehicle Miles Traveled (VMT) emissions offset requirement") to allow areas to meet the requirement by demonstrating that emissions from motor vehicles decline each year through the attainment year (57 FR 13521)

In 1997, USEPA replaced the 1-hour ozone standard with an 8-hour standard of 0.08 ppm (62 FR 38856). The USEPA promulgated rules implementing this standard with the "Phase 1" rule issued on April 30, 2004 (69 FR 23951), and the Phase 2 rule issued on November 29, 2005 (70 FR 71612). These implementation rules required that areas classified as Severe or Extreme under the 1997 8-hour standard would also be subject to the VMT offset requirement.

In 2008, USEPA revised the 8-hour ozone NAAQS to a level of 0.075 parts per million (73 FR16436). The SFNA was designated as non-attainment for the 2008 standard on May 21, 2012 and classified as severe (77 FR 30087), making the SFNA subject to the requirements of CAA Section 182(d)(1)(A) for the 2008 8-hour ozone NAAQS.

Appendix C.2 USEPA Guidance on VMT Offset Requirement

In August 2012, USEPA issued guidance titled "Implementing Clean Air Act Section 182(d)(1)(A): Transportation Control Measures and Transportation Control Strategies to Offset Growth in Emissions Due to Growth in Vehicle Miles Travelled". Among other things, USEPA's guidance states that both "transportation control measures" and "transportation control strategies" (TCS) are eligible to offset growth in emissions due to growth in VMT. The USEPA's guidance indicates that TCSs, which are not defined in the CAA or USEPA regulation, include technology improvements such as vehicle technology improvements, motor vehicle fuels, motor vehicle inspection and maintenance programs, and other control strategies that are transportation-related. USEPA's revised guidance sets forth a method to calculate the actual growth in VOC emissions due to growth in VMT. Essentially, the state would compare projected attainment year emissions assuming no new control measures and no VMT growth with projected actual attainment year emissions (including new control measures and VMT growth). If the first number is higher than the second, the new TCMs and TCS's are sufficient and no additional transportation control measures or strategies would be required. If the first number is lower, additional transportation control measures and transportation control strategies are required. As a practical matter, the state must add the measures and re-calculate emissions until it demonstrates that the TCMs and TCS's are sufficient to offset the growth in VMT. The new measures must be clearly identified and distinguished from the measures included in the initial calculations for the base year.

In addition, the guidance recommends that the base year used in the demonstration should be the base year used in the attainment demonstration for the ozone standard. To address USEPA's guidance, 2012 is used in this demonstration as the base year for the 2008 8-hour standard.

Appendix C.3 Transportation Control Strategies and Transportation Control Measures

By listing them separately, the CAA Section 182(d)(1)(A) differentiates between transportation control strategies (TCS) and transportation control measures (TCM), and thus provides for a wide range of strategies and measures as options to offset growth in emissions from VMT growth. In addition, the example TCMs listed in CAA Section 108(f)(1)(A) include measures that reduce emissions by reducing VMT, reducing tailpipe emissions, and removing dirtier vehicles from the fleet. California's motor vehicle control program includes a variety of strategies and measures, including new engine standards and in-use programs (e.g., smog check, vehicle scrap, fleet rules, and idling restrictions). There were no local TCMs built into the transportation model used to generate emissions. The only TCM moving forward is spare the air. That program was also not built into the transportation model, but since it is implemented by the air district's, they opted to include it in the SIP.

Based on the provisions in CAA Section 182(d)(1)(A) and the clarifications provided in the USEPA guidance, any combination of transportation control strategies and TCMs may be used to meet the requirement to offset growth in emissions resulting from VMT growth. Since 1990 when this requirement was established, California has adopted more than sufficient enforceable transportation strategies and measures to meet the requirement to offset the growth in emissions from VMT growth. A list of the state's mobile source control program adopted since 1990 is provided as part of the Reasonably Available Control Measure Evaluation (Appendix E). Section 7.2, State and

Federal Control Measures, discusses how state and federal regulations will produce increasing emission reduction benefits from now until 2024 and beyond, as the regulated fleets are retrofitted, and as older and dirtier portions of the fleets are replaced with newer and cleaner models at an accelerated pace.

Appendix C.4 Emissions due To VMT Growth

As discussed above, the USEPA guidance provides a recommended calculation methodology to determine if sufficient TCSs and TCMs have been adopted and implemented to offset the growth in emissions due to growth in VMT. Any increase in emissions solely from VMT increases in the future attainment year from the base year would need to be offset. In addition, the USEPA guidance recommends that the analysis include a calculation showing the emissions levels if VMT had remained constant from the base year to the future attainment year. As discussed earlier, the analysis compares the projected attainment year emissions assuming no new control measures and no VMT growth with projected actual attainment year emissions (including new control measures and VMT growth). If the second number is lower than the first, the new measures are adequate and no additional transportation control measures or strategies would be required.

Appendix C.5 Methodology

The following calculations are based on the USEPA guidance recommended calculation methodology. The attainment demonstration for the 8-hour ozone standard uses 2012 as the base year and 2024 is the attainment year.

Analysis Tool

This analysis uses California's approved motor vehicle emissions model, EMFAC.

The EMFAC model estimates the emissions from two combustion processes: running exhaust and start exhaust, and four evaporative processes: hot soak, running losses, diurnal, and resting losses.

Emissions from running exhaust, start exhaust, hot soak, and running losses are a function of how much a vehicle is driven. Emissions from these processes are directly related to VMT, trips, and starts. These processes are included in the calculation of the emissions levels used in the VMT offset demonstration. Emissions from resting loss and diurnal loss processes are not related to VMT, trips or vehicle starts and are not included in the analysis because these emissions occur whether or not the vehicle makes a trip (i.e., a start).

EMFAC combines trip-based VMT from the regional transportation planning agencies, starts data based on household travel surveys, and vehicle population data from the

California Department of Motor Vehicles with corresponding emission rates to calculate emissions[1].

With the EMFAC model, the calculation of emissions growth and whether it is offset is simplified to a comparison of future year emissions with "no growth" in VMT or new control strategies to future emissions with VMT growth and new control strategies. This follows USEPA's 2012 guidance.

Analysis Using 2012 as the Base Year for the 2008 8-hour Ozone Standard with Attainment Year of 2024.

Step 1. Provide the emissions level for the base year.

The following table shows the VOC emissions, VMT, starts, and vehicle population for calendar year 2012 from the EMFAC2014 model.

Summary of 2012 Base Year

	VMT (thousand miles/day)	Starts (thousands/day)	Vehicle Population (thousands)	VOC Emissions* (tons/day)
2012 Base Year	60,570	11,739	1,849	28

* Does not include diurnal or resting loss emissions.

Step 2. Calculate three emissions levels in the attainment year.

For the attainment year,

(1) Calculate emissions level with the motor vehicle control program frozen at 2012 levels and with projected VMT, starts, and vehicle population for the attainment year. This represents what the emissions in the attainment year would have been if transportation control strategies and TCMs had not been implemented after 2012;

(2) Calculate emissions level with the motor vehicle control program frozen at 2012 levels and assuming VMT, starts, and vehicle population do not increase from 2012 levels; and

(3) Calculate an emissions level that represents emissions with full implementation of all transportation control strategies and TCMs pre- and post-2012 and the projected VMT, starts, and vehicle population for the attainment year.

[1] More information on data sources can be found in the EMFAC technical document which is located on the web at: https://www.arb.ca.gov/msei/downloads/emfac2014/emfac2014-vol3-technical-documentation-052015.pdf

Calculation 1*. *Calculate the emissions in the attainment year assuming no new measures since the base year, and including growth in VMT, starts, and vehicle population.

To perform this calculation, California Air Resources Board (CARB) staff identified the on-road motor vehicle control programs adopted since 2012 and adjusted EMFAC2014 to reflect the VOC emissions levels in 2024 without the benefits of the post-2012 control programs. The projected VOC emissions are 16 tons/day.

***Calculation 2. Calculate the emissions with no growth in VMT, starts, or vehicle population*.**

In this calculation, the VOC emission levels in calendar year 2024 without benefit of the post 2012 control program are calculated. EMFAC2014 allows a user to input different VMT, starts, and vehicle population than default. For this calculation, EMFAC2014 was run without the benefit of the post 2012 control program for calendar year 2024 with the 2012 level of VMT of 60,569,748 miles per day, the 2012 level of starts at 11,739,339 per day, and the 2012 level of population at 1,849,178 vehicles. The VOC emissions associated with 2012 VMT, starts, and vehicle population in calendar year 2024 are 15 tons/day.

***Calculation 3. Calculate emission reductions with full Implementation of Transportation Control Strategies & TCMs*.**

The VOC emission levels for 2024 assuming the benefits of the post-2012 motor vehicle control program and the projected VMT, starts, and vehicle population in 2024 are calculated using EMFAC2014. The projected VOC emissions level is 11 tons/day. VOC emissions for the three sets of calculations described above are summarized in the following table.

Summary of 2024 Attainment Year Emissions Levels

	Description	VMT* (miles/day, thousands)	Starts (thousands/day)	Vehicle Population (thousands)	VOC Emissions** (tons/day)
(1)	**Emissions with Motor Vehicle Control Program Frozen at 2012 Levels.** (VMT, starts and vehicle population at 2024 levels.)	69,579	11,965	1,939	16
(2)	**Emissions with Motor Vehicle Control Program Frozen at 2012 Levels.** (VMT, starts, and vehicle population at 2012 levels)	60,570	11,739	1,849	15
(3)	**Emissions with Full Motor Vehicle Control Program in Place.** (VMT, starts and vehicle population at 2024 levels)	69,579	11,965	1,939	11

* CY 2024 VMT based on the SACOG 2016 MTP
** Does not include diurnal or resting loss emissions.

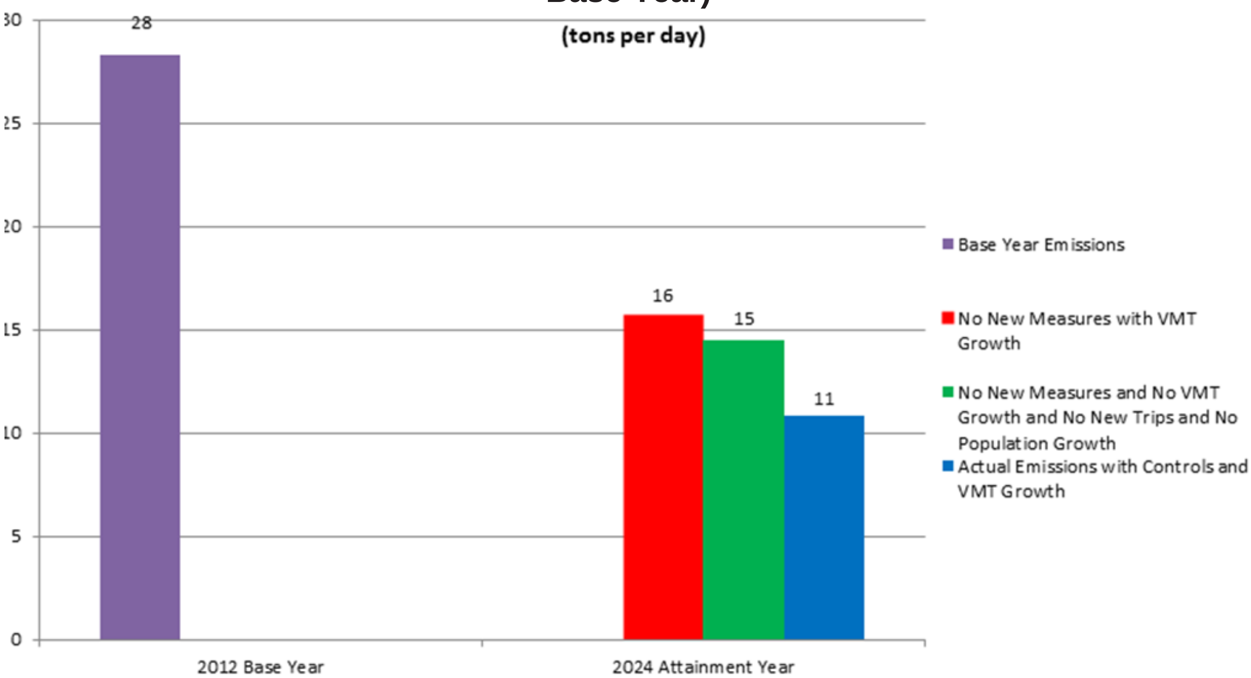
As provided in the USEPA guidance, to determine compliance with the provisions of CAA Section 182(d)(1)(A), the emissions levels calculated in Calculation 3 should be less than the emissions levels in Calculation 2:

VOC: $11 < 15$ tons/day

Appendix C.6 Summary

The previous sections provide an analysis to demonstrate compliance with the provisions of CAA Section 182(d)(1)(A). To further illustrate the demonstration, Figure C-1 below shows graphically the emissions benefits of the motor vehicle control programs in offsetting VOC emissions due to increased VMT, starts, and vehicle population in the SFNA for the 2008 8-hour ozone standard (2012 base year). The left bar (in purple) shows the emissions in the base year with base year controls. The three bars on the right in each figure show the emissions levels in the attainment year for the three calculations identified above: the red bar shows attainment year emissions with base year controls and attainment year VMT, starts, and vehicle population at 2024 levels (calculation 1), the green bar shows attainment year emissions with base year controls, VMT, starts, and vehicle population at 2012 levels (calculation 2), and the blue bar shows attainment year emissions with attainment year controls, VMT, starts, and vehicle population at 2024 levels (calculation 3). Based on the USEPA guidance, if the blue bar (calculation 3) is lower than the green bar (calculation 2), then the identified transportation control strategies and TCMs are sufficient to offset the growth in emissions.

Figure C-1. VOC Emissions* from On-Road Mobile Sources in the SFNA (2012 Base Year)



* Does not include resting or diurnal loss emissions

APPENDIX D

Reasonable Further Progress Calculation

Appendix D Reasonable Further Progress Calculation

Calculation of Reasonable Further Progress Demonstractions[A]
Sacramento Nonattainment Area

Year	2012	2018	2021	2024
1. VOC (with existing measures from CEPAM 1.04)[B]	110.2	91.0	86.8	84.4
2. VOC ERCs[C]		5	5	5
3. VOC plus ERCs (Line 1+Line2)	110.2	96.0	91.8	89.4
4. Required % change since previous milestone year (VOC or Nox)		18%	9%	9%
5. Required % change since 2012 (VOC or Nox)		18%	27%	36%
6. Target VOC levels ((1-Line4)*previous milestone year Line6 (except 110.2 for 2018)		90.3	82.2	74.8
7. Shortfall (-)/Surplus (+) in VOC reductions needed to meet target (Line3 - Line6)		-5.7	-9.6	-14.6
8. Shortfall (-)/Surplus (+) in VOC reductions needed to meet target, % ((Line7)/110.2*100%)		-5.2%	-8.7%	-13.2%
9. VOC reductions since 2012 used for contingency in this milestone year, %		0%	0%	0%
10. VOC reductions shortfall previously provided by Nox substitution, % (sum of previous milestone year Line 20)		0%	5.2%	8.7%
11. Actual VOC reduction Shortfall (-)/Surplus (+), % (Line8 + Line10)		-5.2%	-3.5%	-4.5%
Year	**2012**	**2018**	**2021**	**2024**
12. NOx (with existing measures from CEPAM 1.04)[B]	101.1	69.4	58.4	48.8
13. NOx ERCs[C]		4	4	4
14. NOx Safety Margin - Tranportation Conformity Emissions Budgets[D]		0	0.5	0
15. NOx plus ERCs and Safety Margin (Line 12+Line13+Line14)	101.1	73.4	62.4	52.8
16. Change in Nox since 2012 (101.1 - Line15)		27.7	38.8	48.4
17. Change in Nox since 2012, % (Line16/101.1*100%)		27.4%	38.4%	47.8%
18. NOx reductions since 2012 already used for VOC substitution and contingency through last milestone year, % (previous milestone year(Line18+Line20+Line21))		0%	8.2%	11.7%
19. NOx reductions since 2012 available for VOC substitution and contingency in this milestone year, % (Line17 - Line18)		27.4%	30.2%	36.2%
20. NOx reductions since 2012 used for VOC substitution in this milestone year, % (0-Line11)		5.2%	3.5%	4.5%
21. NOx reductions since 2012 used for contingency in this milestone year, %		3%	0%	0%
22. NOx reductions since 2012 surplus after meeting VOC substitution and contingency needs in this miles year, % (Line19 - Line20 - Line21)		19.2%	26.7%	31.6%
23. RFP shortfall (-) in reductions needed to meeet target, if any, %		0%	0%	0%
24. Total shortfall (-) for RFP and Contingency, if any, %		0%	0%	0%
25. RFP Met?		YES	YES	YES
26. Contingency Met?		YES	YES	YES

[A]CARB RFP write-up September 8, 2016, email transmittal to SMAQMD with safety margin of 0.5 tpd NOx in 2021 for Transportation Conformity.

[B]VOC and NOx are from CEPAM 2016 Ozone SIP forecast for SFNA, Version 1.04 with approved external adjustments.

[C]ERCs from Chapter 5,Section 5.6: VOC= 5 tpd, NOx = 4 tpd.

[D]Safety Margin of 0.5 tpd NOx in 2021 for Transportation Conformity Emissions Budgets is from Table 10-1.

APPENDIX E

Reasonably Available Control Measure Analysis

Appendix E Reasonably Available Control Measure Analysis

Appendix E.1 RACM requirements

This Appendix describes the Reasonably Available Control Measure (RACM) analysis that was conducted for the Sacramento Federal Nonattainment Area (SFNA). This analysis complies with Clean Air Act (CAA) Section 172(c)(1) which requires a nonattainment plan to:

> *"provide for the implementation of all reasonably available control measures as expeditiously as practicable (including such reductions in emissions from existing sources in the area as may be obtained through the adoption, at a minimum, of reasonably available control technology) and shall provide for attainment of the national primary ambient air quality standards."*

United States Environmental Protection Agency's (USEPA) RACM policy (80 FR 12282-12283; USEPA, 1999) indicates that nonattainment areas "should consider all available measures that are potentially reasonably available". Sources of potentially reasonable measures include measures adopted in other nonattainment areas and measures that the USEPA has identified in guidelines or other documents.

Areas should consider all reasonably available measures for implementation in light of local circumstances. However, areas are only required to adopt measures if they are economically and technologically feasible and (alone or cumulatively) will advance the attainment date by one year or more, or are necessary for reasonable further progress (RFP)(80 FR 12282). USEPA "does not believe that Congress intended the RACM requirement to compel the adoption of measures that are absurd, unenforceable, or impracticable." (57 FR 13498)

Appendix E.2 Process of identifying RACM

To identify all RACM, District staff reviewed multiple sources of control measure information, including:

- Control measures included in the attainment plan for the 1997 8-hour National Ambient Air Quality Standard (NAAQS)(SMAQMD, et al, 2013)
- Rules adopted or amended between January 2006 and July 2013 in the Bay Area Air Quality Management District (BAAQMD), South Coast Air Quality Management District (SCAQMD), San Diego Air Pollution Control District (SDAPCD), San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD), and Ventura County Air Pollution Control District (VCAPCD);
- USEPA's Reasonably Available Control Technology (RACT)/ Best Available Control Technology (BACT)/ Lowest achievable Emission Rate (LAER) Clearinghouse;

- California Air Resources Board's (CARB's) BACT Clearinghouse;
- BAAQMD's 2010 Clean Air Plan;
- SCAQMD's 2012 Air Quality Management Plan; and
- Rules from other areas of the nation with similar nonattainment status, including Houston-Galveston-Brazoria, TX; Dallas-Fort Worth, TX; and Baltimore, MD.

Staff from each of the five air districts in the SFNA performed the RACM analysis for the stationary and areawide sources in their jurisdictions. For each potential RACM measure, the emissions inventory, emissions reductions, and cost effectiveness were estimated.

Appendix E.3 Conclusion

The District evaluated and analyzed all reasonable control measures that were currently available for inclusion in the plan. The control measures evaluated for inclusion in this plan also include mobile source measures provided by CARB, and Transportation Control Measures (TCMs) provided by Sacramento Area Council of Governments (SACOG).[1]

The RACMs collectively would not advance the attainment date or contribute to RFP for the Sacramento region because of the insufficient or non-quantifiable amount of emission reductions that they may potentially generate. Tables E1 through E5 contain a list of the measures evaluated by each of the five air districts and a brief discussion of the conclusions. The RACM demonstration for transportation control measures was prepared by the SACOG and is included in Table E6. CARB analyzed mobile measures for RACM purposes and included a written description of that analysis on page E-34.

[1] A RACM analysis for TCM's (Sierra Research, 2015) was completed by SACOG. This analysis summarized the ozone SIP requirements, documents the TCM identification process, and also provided preliminary RACM determination specific to SACOG. This is also discussed in Chapter 7 (Control Measures).

Appendix E.4 Sacramento Metropolitan Air Quality Management District (SMAQMD)

Table E-1 SMAQMD Stationary/Area Source Control Measures Considered

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
460	Adhesives and Sealants	VOC limits on adhesives and sealants	Reduce VOC limits on adhesives and sealants similar to rules adopted by SCAQMD and SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
442	Architectural Coatings	VOC limits on coatings	Reduce the VOC limits on architectural coatings similar to the rule adopted by SCAQMD	Not Recommended – Technical feasibility not demonstrated outside of SCAQMD
	Asphaltic Concrete	None	Establish NO_X emission standards for aggregate dryers similar to the rules adopted by SCAQMD and SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
459	Automotive Refinishing	VOC limits on coatings	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement
411	Boilers	NO_X limits on boiler/steam generators with a rated heat input capacity of 1 mmBtu/hr or greater	Reduce NO_X limits similar to SCAQMD and SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
	Brandy and Wine Aging	None	Establish VOC emissions standards to reduce evaporative VOC emissions from the fermentation process at distilleries and wineries similar to SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
452	Can Coating	VOC limits on coatings	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
	Commercial Cooking	VOC emission standards for large commercial bread bakeries	Establish standards to control VOC emissions from commercial charbroilers similar to SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
	Composting Operations	None	Establish work practice requirements to reduce VOC emissions from green waste composting similar to SCAQMD requirements	Not Recommended - Evaluated for Attainment Advancement
496	Confined Animal Facilities	Implement VOC emission mitigation measures from a menu of options	Reduce animal-count applicability thresholds; increase number of mitigation measures, and control efficiency	Not Recommended - Evaluated for Attainment Advancement
	Flares	None	Establish NO_X emission standards for flares similar to SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
	Furnaces (Residential)	None	Establish point-of-sale NO_X emissions standard for natural gas-fired central furnaces similar to SCAMQD requirements	Not Recommended - Evaluated for Attainment Advancement
	Further Control of High-Emitting Spray Booth Facilities	None	Require additional controls to reduce VOC emissions from spray booths at facilities emitting > 20 tons per year	Not Recommended – No sources
446/447/448	Gasoline Storage, Loading, and Degassing of Tanks and Pipelines	VOC emission standards for organic liquid storage tanks; vapor-recovery requirements for loading at bulk plants and bulk terminals	Reduce VOC emission limits for gasoline loading at bulk plants and bulk terminals to be as stringent as BAAQMD; establish VOC emission standards for degassing storage tanks and pipelines similar to SCAQMD requirements	Not Recommended - Evaluated for Attainment Advancement
	Glass Melting Furnaces	None	Establish NO_X emission limits for glass melting furnaces	Not Recommended – No sources
450	Graphic Arts	VOC limits on inks, coatings, adhesives or use emission control system	Reduce VOC limits for flexographic ink on porous substrates, extreme performance ink, and metallic ink to be as stringent as SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
412	Internal Combustion (IC) Engines	NO_X emission limits on IC engines located at major stationary sources of NO_X	Reduce NO_X limits to be stringent as SCAQMD; expand applicability to include non-major stationary sources of NO_X	Not Recommended - Evaluated for Attainment Advancement
464	Industrial Wastewater	Requirements for covers and emission control systems for wastewater collection and treatment systems at organic chemical plants	Lower applicability thresholds to require controls on more wastewater streams, increase required efficiency of VOC control devices similar to SCAQMD requirements	Not Recommended - Evaluated for Attainment Advancement
	Liquefied Petroleum Gas (LPG) Transfer and Dispensing	None	Establish standards to control VOC emissions from LPG transfer and dispensing similar to the rules adopted by SCAQMD and VCAPCD	Not Recommended - Evaluated for Attainment Advancement
	Metal Melting Furnaces	None	Establish NO_X emission limits for metal melting furnaces	Not Recommended – No sources
451	Metal Parts and Products Coating	VOC limits on coatings, strippers, cleaning solvents	Reduce VOC limits for general one-component, extreme high gloss, and prefabricated architectural coatings, similar to SCAQMD requirements	Not Recommended - Evaluated for Attainment Advancement
	Metal Working Fluids	None	Establish VOC limits on metalworking fluids and direct-contact lubricants similar to the rules adopted by SCAQMD and VCAPCD	Not Recommended - Evaluated for Attainment Advancement
440	Miscellaneous Coatings	None	Establish VOC limits and application method requirements for coating operations not covered by other rules, similar to SCAQMD, SJVUAPCD, VCAPCD, and BAAQMD requirements	Not Recommended - Evaluated for Attainment Advancement
	Miscellaneous Combustion Sources	None	Establish NO_X emission limits on miscellaneous combustion equipment including dryers and ovens similar to rules adopted by SCAQMD and SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
	Mold Release Agents	None	Establish VOC limits on mold release agents similar to the control measure proposed by SCAQMD	Not Recommended – Has not yet been implemented in SCAQMD or any other area
485	Municipal Landfill Gas	Landfill gas collection and control systems	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement
	Oil and Natural Gas Production	None	Establish requirements to inspect and maintain equipment to reduce fugitive VOC emissions	Not Recommended - Evaluated for Attainment Advancement
407/501	Open Burning	Burning of certain materials prohibited; burn procedures to minimize smoke; burning is not allowed on days declared no-burn day	Reduce the types of allowable agricultural burns similar to SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
	Paper, Fabric, and Film Coatings	None	Establish VOC limits on coatings similar to rule adopted by SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
444	Petroleum Solvent Dry Cleaning	Emit no more than 3.5 kg of solvent per 100,000 articles dry cleaned or use a solvent recovery dryer	Expand applicability to include all non-halogenated solvents; require closed-loop machines for new installations	Not Recommended - Evaluated for Attainment Advancement
	Plastic Parts Coating	None	Establish VOC limits on plastic parts coatings similar to rule adopted by SCAMQD	Not Recommended - Evaluated for Attainment Advancement

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
465	Polyester Resin/Plastic Product Manufacturing	Limits on the monomer content of resin, use of vapor suppressants, use of close-mold systems, or emission capture and control system	Remove low-usage exemption, require non-atomizing equipment, and reduce monomer content similar to rules adopted by BAAQMD, SCAQMD, and SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
	Polystyrene /Polymeric Cellular (Foam) Manufacturing	None	Require reduction of VOC emissions from Expanded Polystyrene (EPS) molding using an emission control device	Not Recommended – No sources
	Portland Cement Manufacturing	None	Establish NO_X limits for Portland cement manufacturing	Not Recommended – No sources
	Semiconductor Manufacturing	None	Establish VOC limits for semiconductor manufacturing	Not Recommended – No sources
443	Synthetic Organic Chemical Manufacturing – Fugitive Leaks	Leak detection and repair program	Reduce VOC leak detection threshold	Not Recommended - Evaluated for Attainment Advancement
	Soil Decontamination	None	Establish VOC emission control standards for soil vapor extraction systems, similar to rules adopted by BAAQMD and VCAPCD; Establish work practices to minimize VOC emissions from soil aeration similar to rule adopted by SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
454/466	Solvent Cleaning	VOC limits on solvents, or use airtight/airless cleaning systems	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement
413	Stationary Gas Turbines	NO_X emission limits on stationary gas turbines	Reduce NO_X emission limits to be as stringent as SCAQMD	Not Recommended - Evaluated for Attainment Advancement

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
	Wastewater Separators	None	Require solid cover, floating pontoon cover; double-deck cover, or vapor recovery system similar to rule adopted by SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
414	Water Heaters and Small Boilers	Point-of-sale NO_X emission standards on water heaters with rated heat input capacity less than 1 mmBtu/hr	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement
463	Wood Products Coatings	VOC limits on coatings	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement

Appendix E.5 El Dorado County Air Quality Management District (EDCAQMD)

Table E-2 EDCAQMD Stationary/Area Source Control Measures Considered

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
236	Adhesives and Sealants	VOC limits on adhesives and sealants	Reduce VOC limits on adhesives and sealants similar to rules adopted by SCAQMD and SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
215	Architectural Coatings	VOC limits on coatings	Reduce the VOC limits on architectural coatings similar to the SCM and rule adopted by SCAQMD	Not Recommended – SCM Evaluated for Attainment Advancement. Technical feasibility of SCAQMD requirements not demonstrated outside of SCAQMD
	Asphaltic Concrete	None	Establish NO_X emission standards for aggregate dryers similar to the rules adopted by SCAQMD and SJVUAPCD	Not Recommended – No Sources
230	Automotive Refinishing	VOC limits on coatings	Reduce the VOC limits on architectural coatings consistent with the SCM	Not Recommended - Evaluated for Attainment Advancement
229	Boilers	NO_X limits on boiler/steam generators with a rated heat input capacity of 5 mmBtu/hr or greater	Expand applicability to units ≥ 2 mmBtu/hr and reduce NO_X limits similar to SCAQMD and SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
	Brandy and Wine Aging	None	Establish VOC emissions standards to reduce evaporative VOC emissions from the fermentation process at distilleries and wineries similar to SJVUAPCD requirements	Not Recommended – No sources
	Can Coating	None	Establish VOC limits on can coatings similar to rule adopted by SMAQMD	Not Recommended – No sources

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
	Commercial Cooking	None	Establish standards to control VOC emissions from commercial charbroilers similar to SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
	Composting Operations	None	Establish work practice requirements to reduce VOC emissions from green waste composting similar to SCAQMD requirements	Not Recommended – No sources
	Confined Animal Facilities	None	Establish work practice requirements to reduce VOC emissions from confined animal facilities	Not Recommended – No sources
	Flares	None	Establish NO_X emission standards for flares similar to SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
	Furnaces (Residential)	None	Establish point-of-sale NO_X emissions standard for natural gas-fired central furnaces similar to SCAMQD requirements	Not Recommended - Evaluated for Attainment Advancement
	Further Control of High-Emitting Spray Booth Facilities	None	Require additional controls to reduce VOC emissions from spray booths at facilities emitting > 20 tons per year	Not Recommended – No sources
216/244	Organic Liquid Storage, Loading, and Degassing of Tanks and Pipelines, Bulk Plant Terminals	VOC emission standards for organic liquid storage tanks; vapor-recovery requirements for loading at bulk plants and bulk terminals	Reduce VOC emission limits for gasoline loading at bulk plants and bulk terminals to be as stringent as BAAQMD; establish VOC emission standards for degassing storage tanks and pipelines similar to SCAQMD requirements	Not Recommended - Evaluated for Attainment Advancement
	Glass Melting Furnaces	None	Establish NO_X emission limits for glass melting furnaces	Not Recommended – No sources
231	Graphic Arts	VOC limits on inks, coatings, adhesives or use emission control system	Reduce VOC limits for flexographic ink on porous substrates, extreme performance ink, and metallic ink to be as stringent as SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
233	IC Engines	NO_X limits on IC Engines	Reduce NO_X limits for IC engines similar to SCAQMD requirements	Not Recommended - Evaluated for Attainment Advancement
464	Industrial Wastewater	None	Establish emission control standards for wastewater systems	Not Recommended – No sources
	Metal Melting Furnaces	None	Establish NO_X emission limits for metal melting furnaces	Not Recommended – No sources
	Metal Parts and Products Coating	None	Establish VOC limits on metal parts and products coating similar to SMAQMD and SCAQMD requirements	Not Recommended - Evaluated for Attainment Advancement
	Metal Working Fluids	None	Establish VOC limits on metalworking fluids and direct-contact lubricants similar to the rules adopted by SCAQMD and VCAPCD	Not Recommended - Evaluated for Attainment Advancement
	Miscellaneous Coating	None	Establish VOC limits and application method requirements for coating operations not covered by other rules, similar to SCAQMD, SJVUAPCD, VCAPCD, and BAAQMD requirements	Not Recommended - Evaluated for Attainment Advancement
	Miscellaneous Combustion Sources	None	Establish NO_X emission limits on miscellaneous combustion equipment including dryers and ovens similar to rules adopted by SCAQMD and SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
	Mold Release Agents	None	Establish VOC limits on mold release agents similar to the control measure proposed by SCAQMD	Not Recommended – Has not yet been implemented in SCAQMD or any other area
	Municipal Landfill Gas	None	Establish requirements for landfills including gas collection and control systems	Not Recommended - Evaluated for Attainment Advancement

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
	Oil and Natural Gas Production	None	Establish requirements to inspect and maintain equipment to reduce fugitive VOC emissions	Not Recommended – No sources
300	Open Burning	Burning of certain materials prohibited; burn procedures to minimize smoke; burning is not allowed on days declared no-burn day	Reduce the types of allowable agricultural burns similar to SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
	Paper, Fabric, and Film Coatings	None	Establish VOC limits on coatings similar to rule adopted by SJVUAPCD	Not Recommended – No sources
218	Petroleum Solvent Dry Cleaning	Emit no more than 0.6 kg of solvent per kg of wet waste or use a system that reduces waste losses below 0.01 kg per kg of clothes	Remove applicability threshold to include all dry cleaning solvents except for perchloroethylene and ban the use of open transfer systems	Not Recommended - Evaluated for Attainment Advancement
	Plastic Parts Coating	None	Establish VOC limits on plastic parts coatings similar to rule adopted by SCAMQD	Not Recommended - Evaluated for Attainment Advancement
	Polyester Resin/Plastic Product Manufacturing	None	Establish VOC standards on monomer content of resins and require vapor suppressants and use of close-mold systems similar to rules adopted by BAAQMD, SCAQMD, and SJVUAPCD	Not Recommended – No sources
	Polystyrene /Polymeric Cellular (Foam) Manufacturing	None	Require reduction of VOC emissions from EPS molding using an emission control device	Not Recommended - Evaluated for Attainment Advancement
	Portland Cement Manufacturing	None	Establish NO_X limits for Portland cement manufacturing	Not Recommended – No sources
	Semiconductor Manufacturing	None	Establish VOC limits for semiconductor manufacturing	Not Recommended – No sources

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
	Synthetic Organic Chemical Manufacturing – Fugitive Leaks	None	Establish VOC emissions standards for leak detection and repair program	Not Recommended – No sources
	Soil Decontamination	None	Establish VOC emission control standards for soil vapor extraction systems, similar to rules adopted by BAAQMD and VCAPCD; Establish work practices to minimize VOC emissions from soil aeration similar to rule adopted by SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
225/235	Solvent Cleaning	VOC limits on solvents	Reduce VOC limits of solvents similar to rules adopted by SMAQMD and PCAPCD.	Not Recommended - Evaluated for Attainment Advancement
	Stationary Gas Turbines	None	Establish NO_X emission limits to be as stringent as SCAQMD	Not Recommended – No sources
	Wastewater Separators	None	Require solid cover, floating pontoon cover; double-deck cover, or vapor recovery system similar to rule adopted by SJVUAPCD	Not Recommended – No sources
239	Water Heaters and Small Boilers	Point-of-sale NO_X emission standards on water heaters with rated heat input capacity less than 75,000 Btu/hr	Expand point-of-sale emission standards to include units ≥ 75,000 Btu/hr and < 1 mmBtu/hr similar to rule adopted by SMAQMD	Not Recommended - Evaluated for Attainment Advancement
237	Wood Products Coatings	VOC limits on coatings	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement

Appendix E.6 Feather River Air Quality Management District (FRAQMD)

Table E-3 FRAQMD Stationary/Area Source Control Measures Considered

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
	Adhesives and Sealants	None	Establish VOC limits on adhesives and sealants similar to rules adopted by SCAQMD and SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
3.15	Architectural Coatings	VOC limits on coatings	Reduce the VOC limits on architectural coatings similar to the rule adopted by SCAQMD	Not Recommended – Technical feasibility not demonstrated outside of SCAQMD
	Asphaltic Concrete	None	Establish NO_X standards similar to the rules adopted by SCAQMD/SJVUAPCD	Not Recommended – No sources
3.19	Automotive Refinishing	VOC limits on coatings	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement
3.21	Boilers	NO_X limits on boiler/steam generators with a rated heat input capacity of 1 mm Btu/hr or greater	Reduce NO_X limits similar to SCAQMD and SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
	Brandy and Wine Aging	None	Establish VOC emissions standards to reduce evaporative VOC emissions from the fermentation process at distilleries and wineries similar to SJVUAPCD requirements	Not Recommended – No sources
	Can Coating	None	Establish VOC limits on can coatings similar to rule adopted by SMAQMD	Not Recommended – No sources
	Commercial Cooking	None	Establish standards to control VOC emissions from commercial charbroilers similar to SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
	Composting Operations	None	Establish work practice requirements to reduce VOC emissions from green waste composting similar to SCAQMD requirements	Not Recommended – No sources
	Confined Animal Facilities	None	Establish work practice requirements to reduce VOC emissions from confined animal facilities	Not Recommended – No sources
	Flares	None	Establish NO_X emission standards for flares similar to SJVUAPCD requirements	Not Recommended – No sources
	Furnaces (Residential)	None	Establish point-of-sale NO_X emissions standard for natural gas-fired central furnaces similar to SCAMQD requirements	Not Recommended - Evaluated for Attainment Advancement
	Further Control of High-Emitting Spray Booth Facilities	None	Require additional controls to reduce VOC emissions from spray booths at facilities emitting > 20 tons per year	Not Recommended – No sources
3.9	Gasoline Storage, Loading, and Degassing of Tanks and Pipelines	VOC emission standards for organic liquid storage tanks; vapor-recovery requirements for loading at bulk plants and bulk terminals	Reduce VOC emission limits for gasoline loading at bulk plants and bulk terminals to be as stringent as BAAQMD; establish VOC emission standards for degassing storage tanks and pipelines similar to SCAQMD requirements	Not Recommended – No sources
	Glass Melting Furnaces	None	Establish NO_X emission limits for glass melting furnaces	Not Recommended – No sources
	Graphic Arts	None	Establish VOC limits on inks, coatings, or adhesives for graphic arts similar to SJVUAPCD requirements	Not Recommended – No sources
3.22	IC Engines	NO_X limits on IC Engines	Reduce NO_X limits for IC engines similar to SCAQMD requirements	Not Recommended – No sources
	Industrial Wastewater	None	Establish emission control standards for wastewater systems	Not Recommended – No sources

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
	LPG Transfer and Dispensing	None	Establish standards to control VOC emissions from LPG transfer and dispensing similar to the rules adopted by SCAQMD and VCAPCD	Not Recommended - Evaluated for Attainment Advancement
	Metal Melting Furnaces	None	Establish NO_X emission limits for metal melting furnaces	Not Recommended – No sources
	Metal Parts and Products Coating	None	Establish VOC limits on metal parts and products coating similar to SMAQMD and SCAQMD requirements	Not Recommended - Evaluated for Attainment Advancement
	Metal Working Fluids	None	Establish VOC limits on metalworking fluids and direct-contact lubricants similar to the rules adopted by SCAQMD and VCAPCD	Not Recommended - Evaluated for Attainment Advancement
	Miscellaneous Coating	None	Establish VOC limits and application method requirements for coating operations not covered by other rules, similar to SCAQMD, SJVUAPCD, VCAPCD, and BAAQMD requirements	Not Recommended - Evaluated for Attainment Advancement
	Miscellaneous Combustion Sources	None	Establish NO_X emission limits on miscellaneous combustion equipment including dryers and ovens similar to rules adopted by SCAQMD and SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
	Mold Release Agents	None	Establish VOC limits on mold release agents similar to the control measure proposed by SCAQMD	Not Recommended – Has not yet been implemented in SCAQMD or any other area
3.18	Municipal Landfill Gas	Landfill gas collection and control systems	No control strategies identified	Not Recommended – No sources
	Oil and Natural Gas Production	None	Establish requirements to inspect and maintain equipment to reduce fugitive VOC emissions	Not Recommended – No sources

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
Reg. II	Open Burning	Burning of certain materials prohibited; burn procedures to minimize smoke; burning is not allowed on days declared no-burn day	Reduce the types of allowable agricultural burns similar to SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
	Paper, Fabric, and Film Coatings	None	Establish VOC limits on coatings similar to rule adopted by SJVUAPCD	Not Recommended – No sources
	Petroleum Solvent Dry Cleaning	None	Establish VOC limits on solvents used and ban the use of open transfer systems	Not Recommended – No sources
	Plastic Parts Coating	None	Establish VOC limits on plastic parts coatings similar to rule adopted by SCAMQD	Not Recommended – No sources
	Polyester Resin/Plastic Product Manufacturing	None	Establish VOC standards on monomer content of resins and require vapor suppressants and use of close-mold systems similar to rules adopted by BAAQMD, SCAQMD, and SJVUAPCD	Not Recommended – No sources
	Polystyrene /Polymeric Cellular (Foam) Manufacturing	None	Require reduction of VOC emissions from EPS molding using an emission control device	Not Recommended – No sources
	Portland Cement Manufacturing	None	Establish NO_X limits for Portland cement manufacturing	Not Recommended – No sources
	Semiconductor Manufacturing	None	Establish VOC limits for semiconductor manufacturing	Not Recommended – No sources
	Synthetic Organic Chemical Manufacturing – Fugitive Leaks	None	Establish VOC emissions standards for leak detection and repair program	Not Recommended - Evaluated for Attainment Advancement

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
	Soil Decontamination	None	Establish VOC emission control standards for soil vapor extraction systems, similar to rules adopted by BAAQMD and VCAPCD; Establish work practices to minimize VOC emissions from soil aeration similar to rule adopted by SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
3.14	Solvent Cleaning	VOC limits on solvents	Reduce VOC limits of solvents similar to rules adopted by SMAQMD and PCAPCD.	Not Recommended - Evaluated for Attainment Advancement
	Stationary Gas Turbines	None	Establish NO_X emission limits to be as stringent as SCAQMD	Not Recommended – No sources
	Wastewater Separators	None	Require solid cover, floating pontoon cover; double-deck cover, or vapor recovery system similar to rule adopted by SJVUAPCD	Not Recommended – No sources
3.23	Water Heaters and Small Boilers	None	Establish point-of-sale emission standards for include units < 1 mmBtu/hr similar to rule adopted by SMAQMD	Not Recommended - Evaluated for Attainment Advancement
3.20	Wood Products Coatings	VOC limits on coatings	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement

Appendix E.7 Placer County Air Pollution Control District (PCAPCD)

Table E-4 PCAPCD Stationary/Area Source Control Measures Considered

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
235	Adhesives and Sealants	VOC limits on adhesives and sealants	Reduce VOC limits on adhesives and sealants similar to rules adopted by SCAQMD and SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
218	Architectural Coatings	VOC limits on coatings	Reduce the VOC limits on architectural coatings similar to rule adopted by SCAQMD	Not Recommended – Technical feasibility not demonstrated outside of SCAQMD
	Asphaltic Concrete	None	Establish NO_X emission standards for aggregate dryers similar to the rules adopted by SCAQMD and SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
234	Automotive Refinishing	VOC limits on coatings	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement
231/247	Boilers	NO_X limits on boiler/steam generators with a rated heat input capacity of 5 mmBtu/hr or greater	Expand applicability to units ≥ 2 mmBtu/hr and reduce NO_X limits similar to SCAQMD and SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
	Brandy and Wine Aging	None	Establish VOC emissions standards to reduce evaporative VOC emissions from the fermentation process at distilleries and wineries similar to SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
	Can Coating	None	Establish VOC limits on can coatings similar to rule adopted by SMAQMD	Not Recommended – No sources
	Commercial Cooking	None	Establish standards to control VOC emissions from commercial charbroilers similar to SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
	Composting Operations	None	Establish work practice requirements to reduce VOC emissions from green waste composting similar to SCAQMD requirements	Not Recommended – No sources
	Confined Animal Facilities	None	Establish work practice requirements to reduce VOC emissions from confined animal facilities	Not Recommended – No sources
	Flares	None	Establish NO_X emission standards for flares similar to SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
	Furnaces (Residential)	None	Establish point-of-sale NO_X emissions standard for natural gas-fired central furnaces similar to SCAMQD requirements	Not Recommended - Evaluated for Attainment Advancement
	Further Control of High-Emitting Spray Booth Facilities	None	Require additional controls to reduce VOC emissions from spray booths at facilities emitting > 20 tons per year	Not Recommended – No sources
212/215	Storage of Organic Liquids and Transfer of Gasoline into Tank Trucks, Trailers, and Railroad Tank Cars at Loading Facilities	VOC emission standards for organic liquid storage tanks; vapor-recovery requirements for loading at bulk plants and bulk terminals	Reduce VOC emission limits for gasoline loading at bulk plants and bulk terminals to be as stringent as BAAQMD; establish VOC emission standards for degassing storage tanks and pipelines similar to SCAQMD requirements	Not Recommended - Evaluated for Attainment Advancement
	Glass Melting Furnaces	None	Establish NO_X emission limits for glass melting furnaces	Not Recommended – No sources
239	Graphic Arts	VOC limits on inks, coatings, adhesives or use emission control system	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement
242	IC Engines	NO_X emission limits on IC engines located at stationary sources of NO_X	Reduce NO_X limits to be stringent as SCAQMD	Not Recommended - Evaluated for Attainment Advancement

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
	Industrial Wastewater	None	Establish emission control standards for wastewater systems	Not Recommended – No sources
	LPG Transfer and Dispensing	None	Establish standards to control VOC emissions from LPG transfer and dispensing similar to the rules adopted by SCAQMD and VCAPCD	Not Recommended - Evaluated for Attainment Advancement
	Metal Melting Furnaces	None	Establish NO_X emission limits for metal melting furnaces	Not Recommended – No sources
245	Metal Parts and Products Coating	VOC limits on coatings, strippers, and solvent cleaner	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement
	Metal Working Fluids	None	Establish VOC limits on metalworking fluids and direct-contact lubricants similar to the rules adopted by SCAQMD and VCAPCD	Not Recommended - Evaluated for Attainment Advancement
	Miscellaneous Coating	None	Establish VOC limits and application method requirements for coating operations not covered by other rules, similar to SCAQMD, SJVUAPCD, VCAPCD, and BAAQMD requirements	Not Recommended - Evaluated for Attainment Advancement
	Miscellaneous Combustion Sources	None	Establish NO_X emission limits on miscellaneous combustion equipment including dryers and ovens similar to rules adopted by SCAQMD and SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
	Mold Release Agents	None	Establish VOC limits on mold release agents similar to the control measure proposed by SCAQMD	Not Recommended – Has not yet been implemented in SCAQMD or any other area
	Municipal Landfill Gas	None	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
	Oil and Natural Gas Production	None	Establish requirements to inspect and maintain equipment to reduce fugitive VOC emissions	Not Recommended – No sources
301-306	Open Burning	Burning of certain materials prohibited; burn procedures to minimize smoke; burning is not allowed on days declared no-burn day	Reduce the types of allowable agricultural burns similar to SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
	Paper, Fabric, and Film Coatings	None	Establish VOC limits on coatings similar to rule adopted by SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
	Petroleum Solvent Dry Cleaning	None	Establish VOC limits on solvents used and ban the use of open transfer systems	Not Recommended - Evaluated for Attainment Advancement
249	Plastic Parts Coating	VOC limits on coatings	Reduce VOC limits on plastic parts coatings similar to rule adopted by SCAMQD	Not Recommended - Evaluated for Attainment Advancement
243	Polyester Resin/Plastic Product Manufacturing	Limits on the monomer content of resin, use of vapor suppressants	Remove low-usage exemption, require non-atomizing equipment, and reduce monomer content similar to rules adopted by BAAQMD, SCAQMD, and SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
	Polystyrene /Polymeric Cellular (Foam) Manufacturing	None	Require reduction of VOC emissions from EPS molding using an emission control device	Not Recommended – No sources
	Portland Cement Manufacturing	None	Establish NO_X limits for Portland cement manufacturing	Not Recommended – No sources
244	Semiconductor Manufacturing	VOC limits on semiconductor manufacturing	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
	Synthetic Organic Chemical Manufacturing – Fugitive Leaks	None	Establish VOC emissions standards for leak detection and repair program	Not Recommended – No sources
	Soil Decontamination	None	Establish VOC emission control standards for soil vapor extraction systems, similar to rules adopted by BAAQMD and VCAPCD; Establish work practices to minimize VOC emissions from soil aeration similar to rule adopted by SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
216/240	Solvent Cleaning	VOC limits on solvents	Reduce VOC limits for solvents similar to rule adopted by SCAQMD	Not Recommended - Evaluated for Attainment Advancement
250	Stationary Gas Turbines	NO_X limits on stationary gas turbines	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement
	Wastewater Separators	None	Require solid cover, floating pontoon cover; double-deck cover, or vapor recovery system similar to rule adopted by SJVUAPCD	Not Recommended – No sources
246	Water Heaters and Small Boilers	None	Establish point-of-sale NO_X emission standards on water heaters with rated heat input capacity less than 1 mmBtu/hr	Not Recommended - Evaluated for Attainment Advancement
236	Wood Products Coatings	VOC limits on coatings	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement

Appendix E.8 Yolo-Solano Air Quality Management District (YSAQMD)

Table E-5 YSAQMD Stationary/Area Source Control Measures Considered

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
2.33	Adhesives and Sealants	VOC limits on adhesives and sealants	Reduce VOC limits on adhesives and sealants similar to rules adopted by SCAQMD and SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
2.14	Architectural Coatings	VOC limits on coatings	Reduce the VOC limits on architectural coatings similar to the rule adopted by SCAQMD	Not Recommended – Technical feasibility not demonstrated outside of SCAQMD
	Asphaltic Concrete	None	Establish NO_X emission standards for aggregate dryers similar to the rules adopted by SCAQMD and SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
2.26	Automotive Refinishing	VOC limits on coatings	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement
2.27	Boilers	NO_X limits on boiler/steam generators with a rated heat input capacity of 5 mmBtu/hr or greater	Expand applicability to units ≥ 2 mmBtu/hr and reduce NO_X limits similar to SCAQMD and SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
4695	Brandy and Wine Aging	None	Establish VOC emissions standards to reduce evaporative VOC emissions from the fermentation process at distilleries and wineries similar to SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
	Can Coating	VOC limits on coatings	No control strategies identified	Not Recommended – No sources
	Commercial Cooking	None	Establish standards to control VOC emissions from commercial charbroilers similar to SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
	Composting Operations	None	Establish work practice requirements to reduce VOC emissions from green waste composting similar to SCAQMD requirements	Not Recommended - Evaluated for Attainment Advancement
11.2	Confined Animal Facilities	Implement VOC emission mitigation measures from a menu of options	Reduce animal-count applicability thresholds; increase number of mitigation measures, and control efficiency	Not Recommended - Evaluated for Attainment Advancement
	Flares	None	Establish NO_X emission standards for flares similar to SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
2.44	Furnaces (Residential)	NO_X limits from natural gas-fired, fan-type central furnaces	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement
	Further Control of High-Emitting Spray Booth Facilities	None	Require additional controls to reduce VOC emissions from spray booths at facilities emitting > 20 tons per year	Not Recommended – No sources
2.21	Gasoline Storage, Loading, and Degassing of Tanks and Pipelines	VOC emission standards for organic liquid storage tanks; vapor-recovery requirements for loading at bulk plants and bulk terminals	Reduce VOC emission limits for gasoline loading at bulk plants and bulk terminals to be as stringent as BAAQMD; establish VOC emission standards for degassing storage tanks and pipelines similar to SCAQMD requirements	Not Recommended - Evaluated for Attainment Advancement
	Glass Melting Furnaces	None	Establish NO_X emission limits for glass melting furnaces	Not Recommended – No sources
2.29	Graphic Arts	VOC limits on inks, coatings, adhesives or use emission control system	Reduce VOC limits for flexographic ink on porous substrates, extreme performance ink, and metallic ink to be as stringent as SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
2.32	IC Engines	NO_X limits on IC engines located at stationary sources	Reduce NO_X limits to be stringent as SCAQMD	Not Recommended - Evaluated for Attainment Advancement
	Industrial Wastewater	None	Establish emission control standards for wastewater systems	Not Recommended – No sources
	LPG Transfer and Dispensing	None	Establish standards to control VOC emissions from LPG transfer and dispensing similar to the rules adopted by SCAQMD and VCAPCD	Not Recommended - Evaluated for Attainment Advancement
	Metal Melting Furnaces	None	Establish NO_X emission limits for metal melting furnaces	Not Recommended – No sources
2.25	Metal Parts and Products Coating	VOC limits on coatings, strippers, cleaning solvents	Reduce VOC limits for general one-component, extreme high gloss, and prefabricated architectural coatings, similar to SCAQMD requirements	Not Recommended - Evaluated for Attainment Advancement
	Metal Working Fluids	None	Establish VOC limits on metalworking fluids and direct-contact lubricants similar to the rules adopted by SCAQMD and VCAPCD	Not Recommended - Evaluated for Attainment Advancement
2.25-3	Miscellaneous Coating	None	Establish VOC limits and application method requirements for coating operations not covered by other rules, similar to SCAQMD, SJVUAPCD, VCAPCD, and BAAQMD requirements	Not Recommended - Evaluated for Attainment Advancement
	Miscellaneous Combustion Sources	None	Establish NO_X emission limits on miscellaneous combustion equipment including dryers and ovens similar to rules adopted by SCAQMD and SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
	Mold Release Agents	None	Establish VOC limits on mold release agents similar to the control measure proposed by SCAQMD	Not Recommended – Has not yet been implemented in SCAQMD or any other area

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
2.38	Municipal Landfill Gas	Landfill gas collection and control systems	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement
2.23	Oil and Natural Gas Production	Leak detection and repair standards for components used in natural gas production and processing	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement
6.0	Open Burning	Burning of certain materials prohibited; burn procedures to minimize smoke; burning is not allowed on days declared no-burn day	Reduce the types of allowable agricultural burns similar to SJVUAPCD requirements	Not Recommended - Evaluated for Attainment Advancement
2.29-2	Paper, Fabric, and Film Coatings	None	Establish VOC limits on coatings similar to rule adopted by SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
9.7	Petroleum Solvent Dry Cleaning	Use of closed-loop machine with primary control system; newer facilities must install close loop with both primary and secondary control systems	Expand applicability to include all non-halogenated solvents	Not Recommended - Evaluated for Attainment Advancement
2.25-2	Plastic Parts Coating	None	Establish VOC limits on plastic parts coatings similar to rule adopted by SCAMQD	Not Recommended - Evaluated for Attainment Advancement
2.30	Polyester Resin/Plastic Product Manufacturing	Limits on the monomer content of resin, use of vapor suppressants, use of close-mold systems, or emission capture and control system	Remove low-usage exemption, require non-atomizing equipment, and reduce monomer content similar to rules adopted by BAAQMD, SCAQMD, and SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
2.41	Polystyrene /Polymeric Cellular (Foam) Manufacturing	VOC limits for the manufacturing of expanded polystyrene products	No control strategies identified	Not Recommended – No sources
	Portland Cement Manufacturing	None	Establish NO_X limits for Portland cement manufacturing	Not Recommended – No sources
	Semiconductor Manufacturing	None	Establish VOC limits for semiconductor manufacturing	Not Recommended – No sources
	Synthetic Organic Chemical Manufacturing – Fugitive Leaks	None	Establish VOC emissions standards for leak detection and repair program	Not Recommended – No sources
	Soil Decontamination	None	Establish VOC emission control standards for soil vapor extraction systems, similar to rules adopted by BAAQMD and VCAPCD; Establish work practices to minimize VOC emissions from soil aeration similar to rule adopted by SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement
2.31	Solvent Cleaning	VOC limits on solvents, or use airtight/airless cleaning systems	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement
2.34	Stationary Gas Turbines	NO_X limits on stationary gas turbines	Reduce NO_X emission limits to be as stringent as SCAQMD	Not Recommended - Evaluated for Attainment Advancement
	Wastewater Separators	None	Require solid cover, floating pontoon cover; double-deck cover, or vapor recovery system similar to rule adopted by SJVUAPCD	Not Recommended – No sources

Measure No.	Title	Current Requirements	Opportunity for Strengthening	Conclusion
2.37	Water Heaters and Small Boilers	Point-of-sale NO_X emission standards on water heaters with rated heat input capacity less than 1 mmBtu/hr	No control strategies identified	Not Recommended - Evaluated for Attainment Advancement
2.39	Wood Products Coatings	VOC limits on coatings	Reduce VOC limits on wood coatings similar to rules adopted by SCAQMD/SJVUAPCD	Not Recommended - Evaluated for Attainment Advancement

Appendix E.9 Sacramento Area Council of Governments (SACOG)

Transportation Control Measures Considered

Information for this chapter was provided by SACOG based on a TCM RACM analysis (Sierra Research, 2015). A small number of control measures were identified during the TCM review, which have not been implemented in the Sacramento region. These were advanced for further RACM analysis and assessed based on the criteria specified in the 2015 Ozone Implementation Rule and USEPA's RACM guidance. Factors considered included technical and economic feasibility, enforceability, local applicability, and ability to provide emission reductions before attainment deadline (advancement of attainment). These measures are discussed in more detail below.

Table E-6 RACM Analysis for Transportation Control Measures

Economic Feasibility		
TCM	**Measure Description**	**Justification**
Free transit during special events	Provide free alternative transportation to special events	Not cost-effective. SACOG cannot mandate that Transit Agencies provide free service.
Free rail-to-bus/bus-to-rail transfers	Vanpool and shuttle services at non-intermodal centers	Not cost-effective. SACOG cannot mandate that Transit Agencies provide free service.
Close roads for use of non-motorized traffic	Convert roadways to bike/pedestrian paths	Not cost-effective. The same emission reductions could be achieved with Complete Streets planning through road widening to create new bike and pedestrian paths and appropriate landscaping to provide a safe active transportation environment.
Free bikes	Provide free bikes to transit users	Not cost-effective. This voluntary measure does not guarantee emission reductions. Consumers could sell bikes for profit.
Truck Stop Electrification	Self-explanatory	Very costly to implement. May require state or federal subsidies. Cost-effectiveness >$34,000/ton
Promote business closure on high ozone days	Self-explanatory	Would impact economic activity in the region and would not be socially and economically acceptable.
Cash incentives for carpoolers	Self-explanatory	Not cost-effective. SACOG's TDM Funding Program will address this with employers through education and outreach.

Advancement of Attainment		
TCM	**Measure Description**	**Justification**
Bus queue jumps	Installing special lanes and signals to allow transit to get ahead in traffic	Due to infrastructure needs, cannot be implemented in time to advance attainment or by 2026.
Reduce idling at drive-throughs, parking lots and in traffic	Self-explanatory	No clear demonstration of air quality benefits; not easily enforceable
Reversible lanes	Change direction of travel during special events or during congestion periods	Will not advance attainment due to minimal emission reductions from this episodic strategy
Central Business District vehicle restrictions	Restrict vehicle use in downtown areas	Minimal air quality benefits that will not advance attainment

Implementation Authority		
TCM	**Measure Description**	**Justification**
Bus and carpool lanes on arterials	Provide fixed lanes for buses and carpools on arterial streets	No implementation authority; would require state agency authority and funds (Caltrans and California Transportation Commission (CTC))
Express toll lanes/ high-occupancy toll (HOT) lanes	Construct toll lanes to reduce congestion	No implementation authority; would require state agency authority and funds (Caltrans and CTC)
Mandatory bike racks for worksites	Mandate that employers install bike racks at businesses	No implementation authority; CA Health and Safety Code (HSC) §40717.6 prohibits mandatory employer-based trip reduction programs
Pay-As-You-Drive Insurance	Charge insurance fees based on driving patterns	No implementation authority; would require changes to state insurance practices and regulations
Express Busways/Dedicated Bus Lanes	Construct bus-only lanes	No implementation authority; would require state agency authority and funds (Caltrans and CTC)
Income tax credit to telecommuters	Self-explanatory	No implementation authority; would require changes to California tax law

TCM	Measure Description	Justification
Speed limit reduction	Reduce freeway speed limit to 55mph	No implementation authority; would require changes to California Vehicle Code
Off-peak goods movement	Require trucks to operate during off-peak hours	No implementation authority; would not be economically or socially acceptable
Truck only lanes	Construct or convert lanes for use by heady-duty trucks only	No authority to implement; would require state agency authority and funds (Caltrans and CTC)
Divert Trucks from Nonattainment Areas	Require pass-through trucks to choose routes away from the Sacramento region	No authority to implement; would require state agency authority and funds (CARB, Caltrans, and CTC)
Satellite Work Centers	Work centers set-up closer to where employers live	No authority to implement; CA HSC §40717.6 prohibits mandatory employer-based trip reduction programs

Conclusions

Out of the approximately 20 candidate TCMs identified as candidate RACM, no measures were found to meet the criteria for RACM implementation. Based on a comprehensive review of TCM projects in other nonattainment areas, it was determined that the TCMs being implemented in the Sacramento region represent all RACM.

Appendix E.10 California Air Resource Board (CARB)

Mobile sources Reasonably Available Control Measure (RACM) Evaluation

Introduction

CARB is responsible for measures to reduce emissions from mobile sources needed to attain the NAAQS. This section of the Appendix will discuss how California's mobile source measures meet RACM.

CARB's comprehensive strategy to reduce emissions from mobile sources includes stringent emissions standards for new vehicles, in-use programs to reduce emissions from existing vehicle and equipment fleets, cleaner fuels that minimize emissions, and incentive programs to accelerate the penetration of the cleanest vehicles beyond that achieved by regulations alone. Taken together, California's mobile program meets RACM requirements in the context of ozone nonattainment.

CARB developed its SIP strategy through a multi-step measure development process, including extensive public consultation, to develop and evaluate potential strategies for mobile source categories under CARB's regulatory authority that could contribute to expeditious attainment of the standard. First, CARB developed a series of technology assessments for heavy-duty mobile source applications and the fuels necessary to power them[1] along with ongoing review of advanced vehicle technologies for the light-duty sector in collaboration with USEPA and the National Highway Traffic Safety Administration. CARB staff then used a scenario planning tool to examine the magnitude of technology penetration necessary, as well as how quickly technologies need to be introduced to meet attainment of the standard.

CARB staff released a discussion of draft Mobile Source Strategy[2] for public comment in October 2015. This strategy specifically outlined a coordinated suite of proposed actions to not only meet federal air quality standards, but also achieve greenhouse gas emission reduction targets, reduce petroleum consumption, and decrease health risk from transportation emissions over the next 15 years. CARB staff held a public workshop on October 16, 2015 in Sacramento, and on October 22, 2015, CARB held a public Board meeting to update the Board and solicit public comment on the Mobile Source Strategy in Diamond Bar.

CARB Staff continued to work with stakeholders to refine the measure concepts for incorporation into related planning efforts including the 75 ppb 8-hour ozone SIPs. In May 2016, CARB released an updated Mobile Source Strategy. On May 17, 2016, CARB released the proposed SIP strategy for a 45-day public comment period.

1 Technology and Fuel assessments http://www.arb.ca.gov/msprog/tech/tech.htm
2 2016 Mobile Source Strategy http://www.arb.ca.gov/planning/sip/2016sip/2016mobsrc.htm

The current mobile source program and proposed measures included in the SIP Strategy provide attainment of the ozone standard as expeditiously as practicable and meet RFP requirements.

Waiver Approvals

While the CAA preempts states from adopting emission standards and other emission-related requirements for new motor vehicles and engines, it allows states to seek a waiver from the federal preemption to enact emission standards and other emission-related requirements for new motor vehicles and engines that are at least as protective as applicable federal standards, except for locomotives and engines used in farm and construction equipment which are less than 175 horsepower (hp). The CAA also allows California to seek authorization for more stringent standards for new and in-use off-road vehicles and engines, and allows other states to adopt the standards after USEPA authorization.

Over the years, California has received waivers and authorizations for over 100 regulations. The most recent California standards and regulations that have received waivers and authorizations are Advanced Clean Cars (including ZEV and LEV III) for light-duty vehicles, and On-Board Diagnostics, Heavy-Duty Idling, Malfunction and Diagnostics System, In-Use Off-Road Diesel Fleets, Large Spark Ignition Fleet, Mobile Cargo Handling Equipment for heavy-duty engines. Other authorizations include Off-Highway Recreational Vehicles and the Portable Equipment Registration Program.

Finally, CARB obtained an authorization from USEPA to enforce adopted emission standards for off-road engines used in yard trucks and two-engine sweepers. CARB adopted the off-road emission standards as part of its “Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen and Other Criteria Pollutants from In-Use Heavy-Duty Diesel-Fueled Vehicles,” (Truck and Bus Regulation). The bulk of the regulation applies to in-use heavy-duty diesel on-road motor vehicles with a gross vehicle weight rating in excess of 14,000 pounds, which are not subject to preemption under section CAA section 209(a) and do not require a waiver under CAA section 209(b).

Light- and Medium-Duty Vehicles

Light- and medium-duty vehicles are currently regulated under California’s Advanced Clean Cars program including the Low-Emission Vehicle III (LEV III) and Zero-Emission Vehicle (ZEV) programs. Other California programs such as the 2012 Governor Brown Executive Order (B-16-2012) to put 1.5 million zero-emission vehicles on the road by 2025, and California’s Reformulated Gasoline program (CaRFG) will produce substantial and cost-effective emission reductions from gasoline-powered vehicles.

CARB is also active in implementing programs for owners of older dirtier vehicles to retire them early. The “car scrap” programs, like the Enhanced Fleet Modernization Program, and Clean Vehicle Rebate Project provide monetary incentives to replace old vehicles with zero-emission vehicles. The Air Quality Improvement Program (AQIP) is a voluntary incentive program to fund clean vehicles.

Taken together, California’s emission standards, fuel specifications, and incentive programs for on-road light- and medium-duty vehicles represent all measures that are technologically and economically feasible in the context of a RACM assessment.

Heavy-Duty Vehicles

California’s heavy-duty vehicle emissions control program includes requirements for increasingly tighter new engine standards and address vehicle idling, certification procedures, on-board diagnostics, emissions control device verification, and in-use vehicles. This program is designed to achieve an on-road heavy-duty diesel fleet with 2010 engines emitting 98 percent less NO_X and $PM_{2.5}$ than trucks sold in 1986.

Most recently in the ongoing efforts to go beyond federal standards and achieve further reductions, CARB adopted the Optional Reduced Emissions Standards for Heavy-Duty Engines regulation in 2014 that establishes the new generation of optional NO_X emission standards for heavy-duty engines.

The recent in-use control measures include On-Road Heavy-Duty Diesel Vehicle (In-Use) Regulation, Drayage (Port or Rail Yard) Regulation, Public Agency and Utilities Regulation, Solid Waste Collection Vehicle Regulation, Heavy-Duty (Tractor-Trailer) Greenhouse Gas Regulation, ATCM to Limit Diesel-Fueled Commercial Motor Vehicle Idling, Heavy-Duty Diesel Vehicle Inspection Program, Periodic Smoke Inspection Program, Fleet Rule for Transit Agencies, Lower-Emission School Bus Program, and Heavy-Duty Truck Idling Requirements. In addition, CARB’s significant investment in incentive programs provides an additional mechanism to achieve maximum emission reductions from this source sector.

Taken together, California’s emission standards, fuel specifications, and incentive programs for heavy-duty vehicles represent all measures that are technologically and economically feasible in the context of a RACM assessment.

Off-Road Vehicles and Engines

California regulations for off-road equipment include not only increasingly stringent standards for new off-road diesel engines, but also in-use requirements and idling restrictions. The Off-Road Regulation is an extensive program designed to accelerate the penetration of the cleanest equipment into California’s fleets, and impose idling limits on off-road diesel vehicles. The program goes beyond emission standards for new engines through comprehensive in-use requirements for legacy fleets.

Taken together, California's comprehensive suite of emission standards, fuel specifications, and incentive programs for off-road vehicles and engines represent all measures that are technologically and economically feasible in the context of a RACM assessment.

Other Sources and Fuels

The emission limits established for other mobile source categories, coupled with USEPA waivers and authorization of preemption establish that California's programs for motorcycles, recreational boats, off-road recreational vehicles, cargo handling equipment, and commercial harbor craft sources meet the requirements for RACM.

Cleaner burning fuels also play an important role in reducing emissions from motor vehicles and engines as CARB has adopted a number of more stringent standards for fuels sold in California, including the Reformulated Gasoline program, low sulfur diesel requirements, and the Low Carbon Fuel Standard. These fuel standards, in combination with engine technology requirements, ensure that California's transportation system achieves the most effective emission reductions possible.

Taken together, California's emission standards, fuel specifications, and incentive programs for other mobile sources and fuels represent all measures that are technologically and economically feasible in the context of a RACM assessment.

Mobile Source Summary

California's long history of comprehensive and innovative emissions control has resulted in the most stringent mobile source control program in the nation. USEPA has previously acknowledged the strength of the program in their approval of CARB's regulations and through the waiver process. Since then, CARB has continued to substantially enhance and accelerate reductions from our mobile source control programs through the implementation of more stringent engine emissions standards, in-use requirements, incentive funding, and other policies and initiatives as described in the preceding sections.

The CARB process for developing the proposed State measures included an extensive public process and is consistent with USEPA RACM guidance. Through this process CARB found that there are no additional RACM that would advance attainment of the 75 ppb 8-hour ozone standard in the SFNA from emissions reductions associated with unused regulatory control measures. As a result, California's mobile source control programs fully meet the requirements for RACM.

Appendix E.11 References

USEPA (57 FR 13498). *General Preamble for the Implementation of Title I of the Clean Air Act Amendments of 1990.* Federal Register, Volume 57, 16 April, 1992, p.13498. Print.

USEPA. (80 FR 12282 - 12283) *Final Rule to Implement the 2008 8-Hour Ozone National Ambient Air Quality Standard for Ozone: SIP Requirements.* Federal Register, Volume 80, 6 March 2015, p. 12282-12283. Print.

USEPA. *Guidance on the Reasonably Available Control Measures (RACM) Requirement and Attainment Demonstration Submissions for Ozone Nonattainment Areas.* United States Environmental Protection Agency, December [1999.] Print.

Sierra Research. *Reasonably Available Control Measures Analysis for the Sacramento Area Council of Governments.* Sacramento, CA: Sierra Research, 12 November [2015.] Print.

SMAQMD, et al. *Sacramento Regional 8-Hour Ozone Attainment and Reasonable Further Progress Plan (2013 SIP Revision).* Sacramento, CA: Sacramento Metropolitan Air Quality Management District, 26 September [2013.]

APPENDIX F

Federal Clean Air Act Requirements

Appendix F Federal Clean Air Act Requirements

Table F-1 General Nonattainment Plan Requirements

Required Plan Element	Description	Location in Plan
Reasonably Available Control Measures (RACM) [Section 172(c)(1)]	The plan should provide for the implementation of all reasonably available control measures as expeditiously as practicable, including reduction in emissions from existing sources through the adoption of reasonably available control technology.	Chapter 7 (Control Measures) Appendix E (RACM Analysis)
Reasonable Further Progress (RFP) [Section 172(c)(2)]	The plan should meet reasonable further progress requirements for emission reduction.	Chapter 12 (RFP Demonstration) Appendix D (RFP Progress Demonstrations)
Emissions Inventory [Section 172(c)(3)]	The plan should include a comprehensive, accurate, current inventory of actual emissions from all sources of the relevant pollutant or pollutants in such area, including periodic revisions as the Administrator may determine necessary to assure that the requirements of this part are met.	Chapter 5 (Emissions Inventory) Appendix A (Emissions Inventory)
Identification and Quantification [Section 172(c)(4)]	The plan should identify and quantify the emissions, if any, of any such pollutant or pollutants, which will be allowed, in accordance with section 173(a)(1)(B), from the construction and operation of major new or modified stationary sources in each such area. The plan shall demonstrate to the satisfaction of the United States Environmental Protection Agency (USEPA) that the emissions quantified for this purpose will be consistent with the achievement of reasonable further progress and will not interfere with attainment of the applicable national ambient air quality standard by the applicable attainment date.	Chapter 5, Sections 5.2 (Emissions Inventory Forecasts) Chapter 8 (Attainment Demonstration) Chapter12 (RFP Demonstration)
Permits for new and modified stationary sources [Section 172(c)(5)]	The plan provisions should require permits for the construction and operation of new or modified major stationary sources anywhere in the nonattainment area, in accordance with section 173.	Chapter 3, Section 3.5 (NSR Review Requirements)
Other Measures [Section 172(c)(6)]	The plan provisions shall should include enforceable emission limitations, and such other control measures, means or techniques (including economic incentives such as fees, marketable permits, and auctions of emission rights), as well as schedules and timetables for compliance, as may be necessary or appropriate to provide for attainment by the applicable date.	Chapter 7 (Control Measures)

Required Plan Element	Description	Location in Plan
Compliance with Section 110(a)(2) [Section 172(c)(7)]	The plan provisions should meet the applicable provisions of section 110(a)(2). Section 110(a)(2) includes reasonable notice and public hearing requirements for plan adoptions.	Chapters 2, Section 2.4.4 (Public Input and Review Process)
Equivalent Techniques [Section 172(c)(8)]	Upon application by any State, the USEPA may allow the use of equivalent modeling, emission inventory, and planning procedures, unless USEPA determines that the proposed techniques are, in the aggregate, less effective than the methods specified by the USEPA.	Not Applicable – Standard methods employed in chapters.
Contingency Measures [Section 172(c)(9)]	The plan should include the implementation of specific measures to be undertaken if the area fails to make reasonable further progress, or to attain the national primary ambient air quality standard by the applicable attainment date. Such measures shall be included in the plan revision as contingency measures to take effect in any such case without further action by the State or the USEPA.	Chapter 8, Section 8.2 (Attainment Demonstrations Evaluation) Chapter 12, Section 12.3 (Contingency Measure Requirement)
Demonstration of attainment of the standard as expeditiously as practicable but not later than 20 years after designation [Section 181(a)]	Each area designated nonattainment for ozone pursuant to section 107(d) shall be classified at the time of such designation, as a Marginal Area, a Moderate Area, a Serious Area, a Severe Area, or an Extreme Area based on the design value for the area. For each area classified under this subsection, the primary standard attainment date for ozone shall be as expeditiously as practicable.	Chapter 3 (Federal Clean Air Act Requirements) Chapter 8 (Attainment Demonstration)

Table F-2 Severe Area Plan Requirements for Ozone Nonattainment Areas

Required Plan Element	Description	Location in Plan
Inventory [Section 182(a)(1)]	Submit a comprehensive, accurate, current inventory of actual emissions from all sources.	Chapter 5 (Emissions Inventory) Appendix A (Emissions Inventory)
Emissions Statement [Section 182(a)(3)(B)]	Within 2 years after the date of the enactment of the CAA Amendments of 1990, the State shall submit a revision to the SIP to require that the owner or operator of each stationary source of oxides of nitrogen or volatile organic compounds provide the State with a statement, in such form as the Administrator may prescribe (or accept an equivalent alternative developed by the State) for classes or categories of sources, showing the actual emissions of oxides of nitrogen and volatile organic compounds from that source.	Chapter 5 (Emissions Inventory)
Reasonably Available Control Technology [Section 182(b)(2)]	Implementation of control technologies for VOC sources covered by control technique guidelines (CTG) documents and all other major stationary sources of VOCs that are located in the area.	Chapter 3, Section 3.9 (RACT Requirements)
Motor Vehicle Inspection and Maintenance [Section 182(b)(4)]	Provide for a vehicle inspection and maintenance program as described in Section 182(a)(2)(B).	Chapter 7, Section 7.3.1.5 (California Enhanced Smog Check Program)
Enhanced Monitoring [Section 182 (c)(1)]	The State shall commence such actions as may be necessary to adopt and implement a program based on enhanced monitoring (Photochemical Assessment Monitoring Stations, PAMS), to improve monitoring for ambient concentrations of ozone, oxides of nitrogen and volatile organic compounds and to improve monitoring of emissions of oxides of nitrogen and volatile organic compounds.	Chapter 4, Section 4.1.1 (Ozone Monitoring Sites)
Attainment demonstration [Section 182(c)(2)(A)]	A demonstration that the plan will provide for attainment of the national ambient air quality standard as expeditiously as practicable by the applicable attainment date. The attainment demonstration must be based on photochemical grid modeling.	Chapter 4 (Air Quality Trends) Chapter 6 (Air Quality Modeling Analysis) Chapter 8 (Attainment Demonstration) Appendix B (Photochemical Modeling)
Reasonable Further Progress demonstration [Section 182(c)(2)(B) and (C)]	A demonstration that the plan will result in VOC emissions (and/or NO_X emissions) reductions from the baseline emissions of an average of at least three percent each year.	Chapter 12 (RFP demonstration)

Required Plan Element	Description	Location in Plan
Enhanced vehicle inspection and maintenance program [Section 182(c)(3)]	The State shall provide for an enhanced program to reduce hydrocarbon emissions and NO_X emissions from in-use motor vehicles registered in each urbanized area.	Chapter 7, Section 7.3.1.5 (California Enhanced Smog Check Program) and Chapter 5, Section 5.3.2 (on-road motor vehicle emissions EMFAC2014)
Clean-Fuel Vehicle Programs [Section 182(c)(4)]	The State will develop a Program including all measures necessary to make the use of clean alternative fuels in clean-fuel vehicles (as defined in part C of title II) economic from the standpoint of vehicle owners.	Chapter 7, Section 7.3 (State and Federal Control Measures)
Vehicle Miles Traveled Offset [Section 182(d)(1)(A)]	The Plan shall identify and adopt specific enforceable transportation control strategies and transportation control measures to offset any growth in emissions from growth in vehicle miles traveled or numbers of vehicle trips.	Appendix C (VMT Offset Analysis)
General Offset requirements [Section 182(d)(2)]	The ratio of total emission reductions of volatile organic compounds (VOCs) to total increased emissions of such air pollutant shall be at least 1.3 to 1.	Chapter 3, Section 3.5 (NSR Review Requirements)
Milestones [Section 182(g)]	Provide a report every three years after the designation to determine whether the nonattainment area has achieved a reduction in emissions during the preceding interval equivalent to the total emission reductions required to be achieved by the attainment date given in the plan.	Chapter 3, Section 3.10 (Milestone Reports)