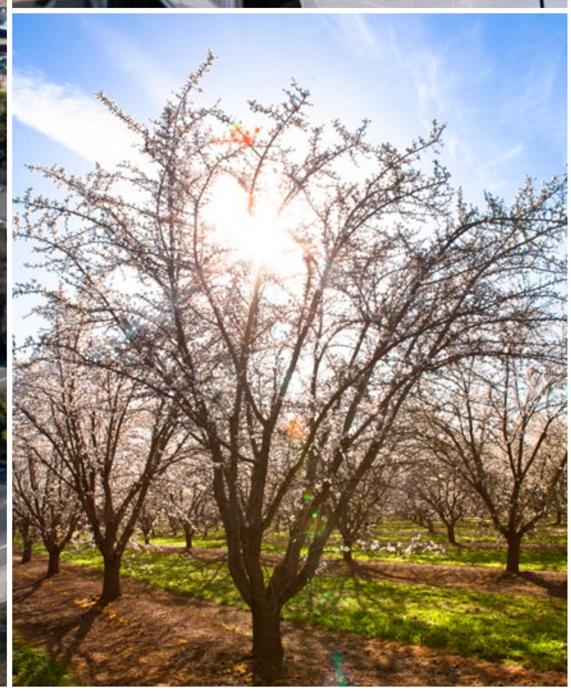
2018 Plan for the 1997, 2006, and 2012 PM2.5 Standards

Draft - August 31, 2018



San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

Executive Summary

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EXECUTIVE SUMMARY

The San Joaquin Valley Air Pollution Control District's (District) strategy for attaining the federal health-based 1997, 2006, and 2012 PM2.5 national ambient air quality standards (standards, or NAAQS) for PM2.5 builds upon comprehensive strategies already in place from previously adopted District air quality plans and measures. The District's multi-faceted approach to reducing emissions in the San Joaquin Valley (Valley) consists of a combination of innovative regulatory and non-regulatory measures. Building on the existing plans and regulations, this plan utilizes the latest science and best available information to lay out a strategy for demonstrating attainment of the federal standards for fine particulate matter (PM2.5) as expeditiously as possible.

Despite the progress made to improve the Valley's air quality through the implementation of these plans and clean air investments by Valley businesses and residents, the Valley faces significant challenges attaining federal PM2.5 standards. Significant additional emissions reductions will be needed, particularly with respect to mobile sources under California Air Resources Board (CARB) and U.S. Environmental Protection Agency (EPA) jurisdiction that make up over 85% of remaining Valley NOx emissions. In addition to mobile source measures, this plan includes a comprehensive suite of local measures for stationary and area sources, including measures to further reduce emissions from a variety of industrial sources, residential wood burning and commercial charbroiling.

As supported by extensive modeling and a strong scientific foundation, the significant emissions reductions achieved by the District's Plan in the coming years are projected to bring the Valley into attainment of all of the current PM2.5 air quality standards as expeditiously as practicable.

Plan Includes Comprehensive Strategy for Bringing Valley into Attainment and Protecting Public Health

This Plan demonstrates the District's ongoing efforts to improve air quality in the Valley through a comprehensive strategy that includes:

- *Valleywide regulatory measures* that build off existing stringent requirements, new potential stationary source measures that includes more stringent NOx and/or PM2.5 requirements to achieve greater emissions reductions from flaring activities, internal combustion engines, boilers/steam generators, glass melting furnaces, and agricultural operations.

- *Valleywide incentive-based measures* that accelerate the deployment of cleaner vehicles and technologies in a variety of sectors, including residential wood combustion, agricultural internal combustion engines, agricultural equipment, heavy duty trucks, off-road equipment, transit buses, school buses, freight equipment, passenger vehicles, locomotives, commercial lawn and garden equipment, and other sources.

- *Targeted "hot-spot" strategy* that focuses additional regulatory and incentive-based measures for residential wood burning and commercial charbroiling operations in remaining areas of the Valley that requires further regulatory and investment for attainment of the federal PM2.5 standards. Hot-spot areas include Fresno County, Kern County, and other specific areas as necessary for attainment.

- *State mobile source strategy* that reduces emissions from mobile sources under state and federal jurisdiction, including heavy duty trucks, agricultural equipment, locomotives, and off-road equipment.

- *Public outreach and education* that encourages and empowers the public to understand air quality issues, take advantage of District tools to stay informed regarding local air quality, take actions to protect themselves when necessary, understand the Valley's unique air quality challenges, and take actions to reduce emissions and improve the Valley's air quality.

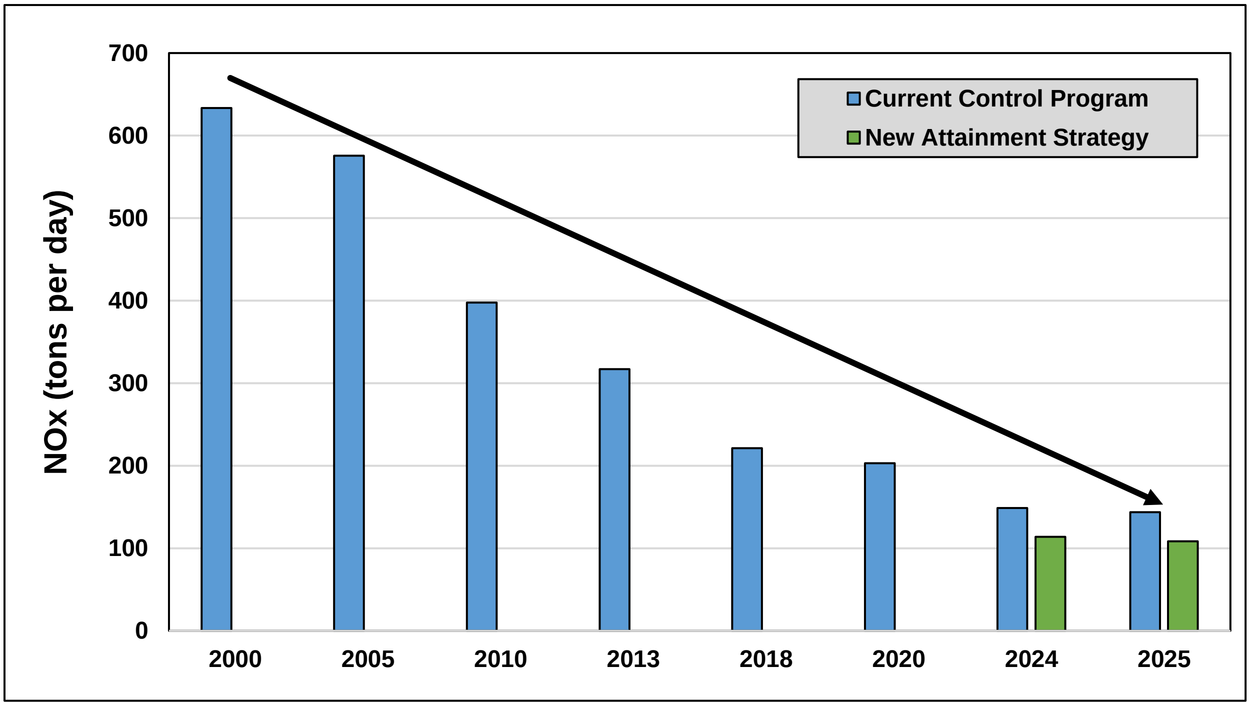
- *Technology advancement and demonstration* efforts to accelerate the deployment of innovative clean air technologies as rapidly as possible.

- *Call for action* by the state and federal governments to do their part in taking responsibility for regulating, and taking actions, to reduce emissions in the Valley. This includes working together to advocate and secure the significant new funding required to achieve the enormous emissions reductions necessary for attainment under this Plan through incentive-based measures.

Plan Builds on Successful Strategies that have Improved the Valley's Air Quality

The District's 2018 PM2.5 Plan builds on numerous plans and measures adopted by the District and CARB to address multiple federal air quality standards. Over 174 tons of NOx emission reductions will be achieved through measures included in existing control strategy already adopted by the District and CARB by the 2025 attainment date. In developing this plan, the District has conducted an extensive evaluation of all sources of emissions for potential strategies to reduce emissions. In addition to reducing direct emissions of PM2.5, this Plan focuses on reducing oxides of nitrogen (NOx) emissions, which is a predominant pollutant not only in the formation of PM2.5 in the Valley, but is also the focus of the District's ozone reduction strategies. This overlapping significance and emphasis on reducing NOx emissions helps to address both of the Valley's biggest air quality challenges, PM2.5 and ozone. Along with comprehensive efforts at the local level to reduce emissions, reducing mobile source emissions that are not under the direct authority of the District are critical to attaining the standard, and this Plan includes additional mobile source measures that will provide significant new emissions reductions in the coming years.

Reduction in Valley NOx and Further Reductions under New Attainment Strategy



The Valley's success in reducing its emissions through decades of clean-air efforts provides the foundation for this Plan. This success provides assurance that similar strategies employed in the future will provide the desired results in helping to improve the Valley's air quality. This Plan includes a comprehensive control strategy that builds on this past success, and identifies opportunities for reducing emissions from all Valley sectors, including the Valley's diverse range of businesses as well as the general public.

The District has a history of success in reducing particulate and ozone-forming emissions through a variety of ground-breaking rules and strategies. These innovative strategies, such as the first-of-their-kind Indirect Source Review and Employer Trip Reduction regulations that address emissions from development and employers, have proven to be highly effective, as evidenced by the steady rate of improvement in the Valley's air quality. The District's incentive program has become an increasingly important and effective strategy for reducing mobile source emissions that the District does not have direct regulatory authority over, with a public and private combined investment of $2.1 billion reducing over 150,000 tons of emissions since 1992. The District's landmark Conservation Management Practice rule proved critical in assisting the Valley to eliminate exceedances of the federal PM10 standard and reach attainment of the standard in 2005. In addition to reducing emissions from the Valley's various industries and businesses, significant reductions in emissions have also been achieved by the general public, such as through the residential wood burning curtailment efforts that have been critical in helping to reduce PM2.5 concentrations.

The following figure ES-1 displays the significant NOx reductions that have been achieved in the region through the Valley's numerous and comprehensive past ozone and PM2.5 attainment plans, highlighting a 77% reduction in NOx from the year 2000 to the expected NOx level in 2025. This figure also depicts the additional NOx reductions (green bars) that will be achieved by 2024 and 2025 through the implementation of the strategy for this Plan. Through the reductions realized over this time period, the Valley has experienced substantial air quality improvements in both ozone and PM2.5, as figures ES-2 through ES-6 display.

In more detail, Figure ES-2 indicates a 20% reduction in the Valley's 8-hour ozone design value from the year 2004 to 2017, with the year 2017 setting a record low value for the Valley. The annual and 24-hour PM2.5 design values have also decreased by 31% and 36%, respectively, from 2002 to 2017 (Figures ES-3 to ES-4). In addition, Figure ES-5 shows that the Valley's exceedances of the 35 µg/m^3 24-hour standard has decreased by 61% over the same time period, while winter season Good AQI days among the Valley's counties have increased substantially, while Unhealthy AQI days have decreased (Figure ES-6). These positive trends reflect the efficacy that the implementation of the Valley's current ozone and PM2.5 attainment plan strategies, providing confidence that the attainment strategy developed for this Plan will be effective and successful as well.

Figure ES-2 Downward Trend in Valley 8-hour Ozone Design Value

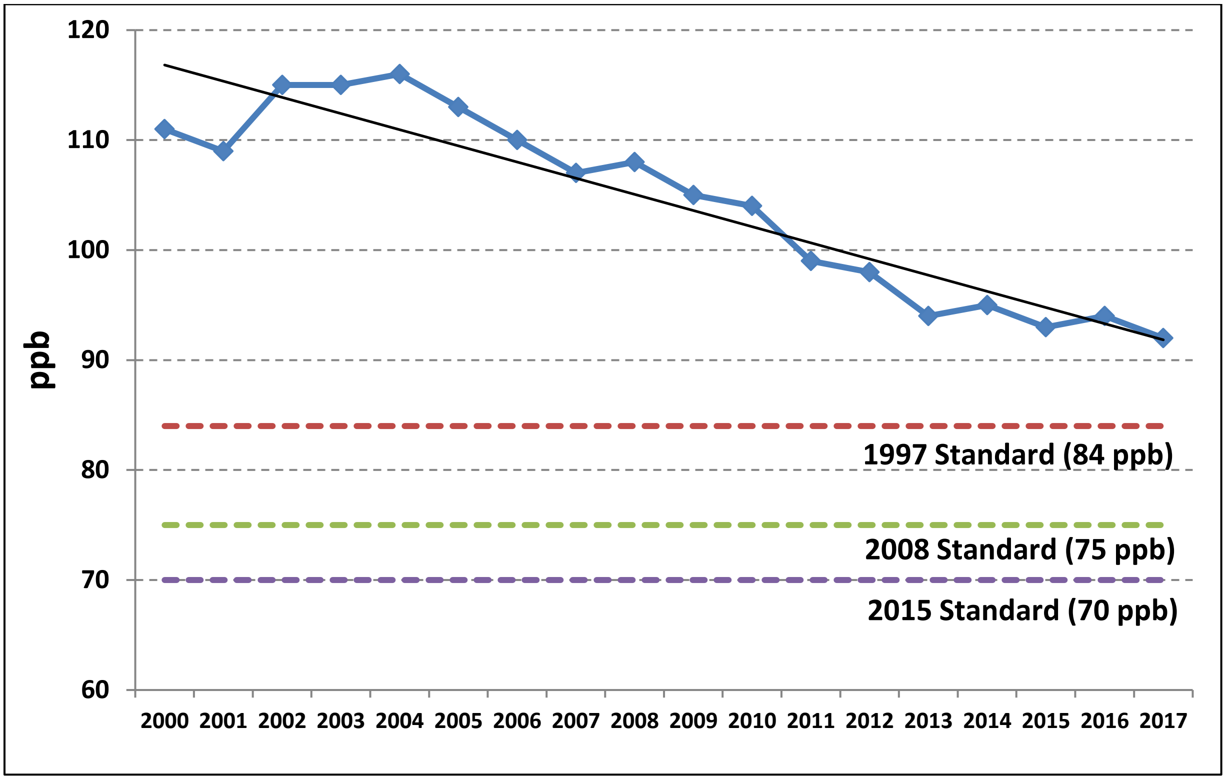


Figure ES-3 Downward Trend in Valley Annual PM2.5 Design Value

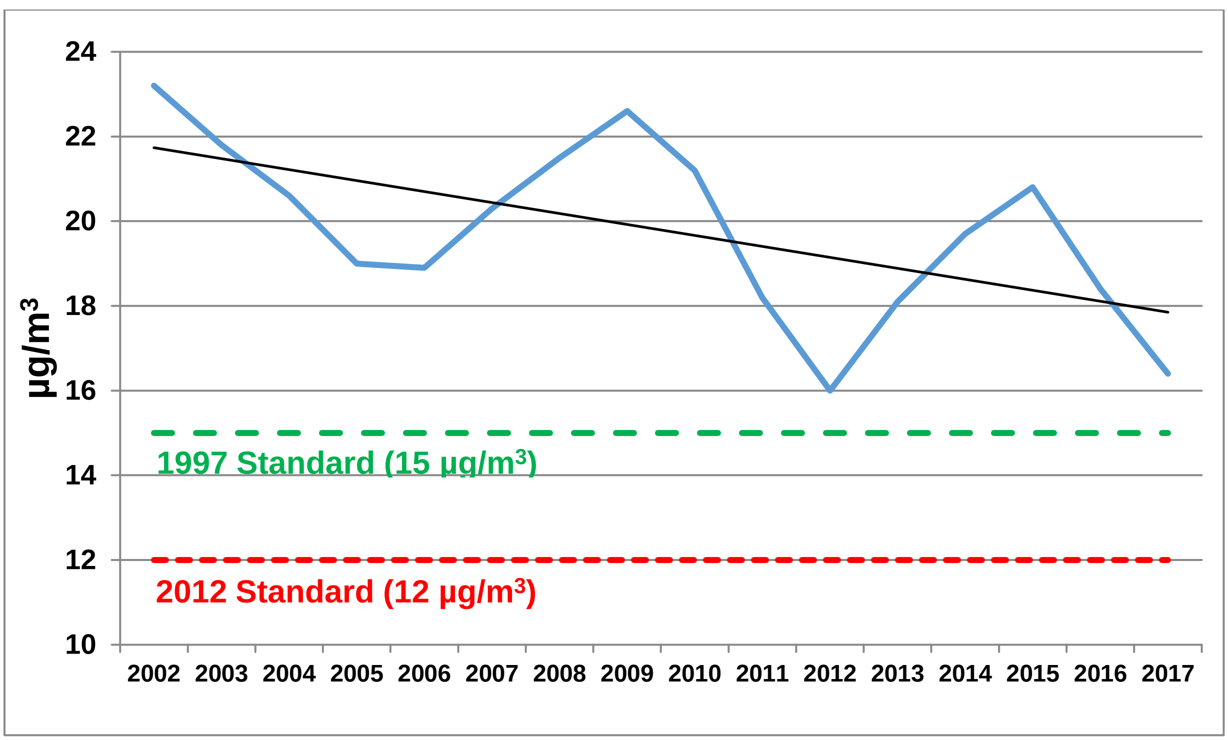


Figure ES-4 Downward Trend in Valley 24-hour PM2.5 Design Value

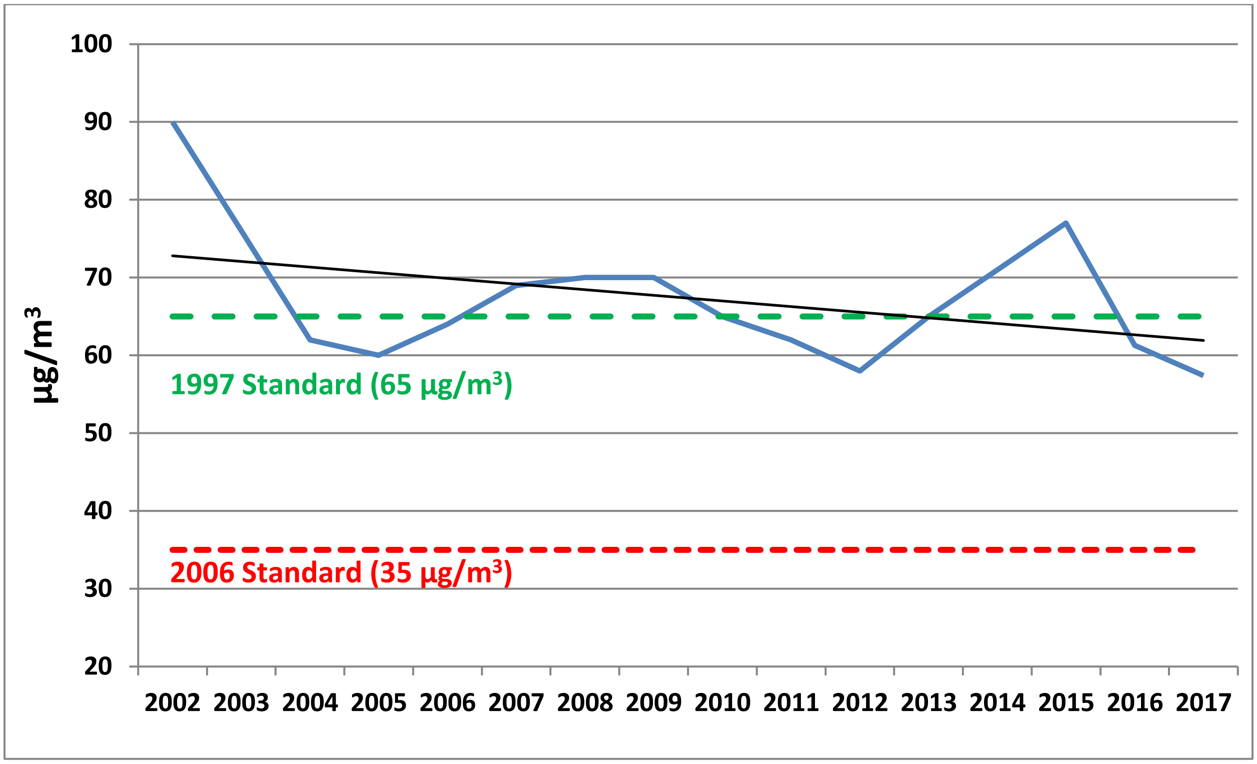


Figure ES-5 Decrease in Days Valley Exceeded 2006 Federal 24-hour PM2.5 Standard (35 µg/m³)

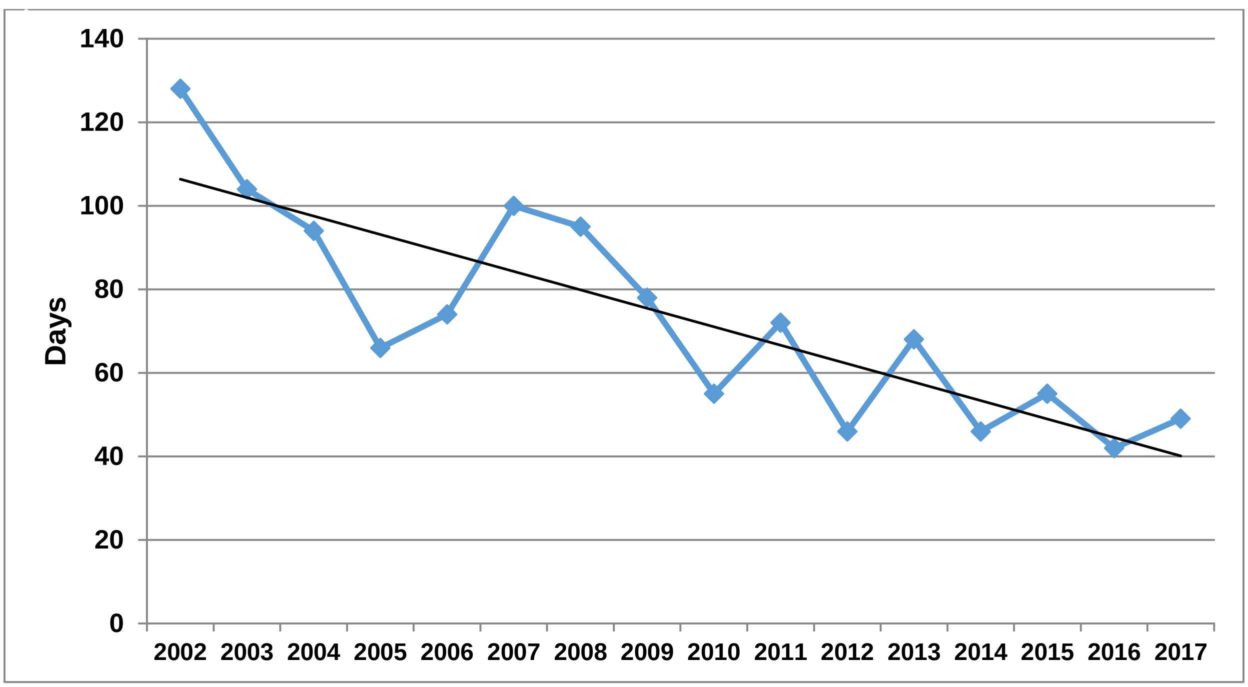
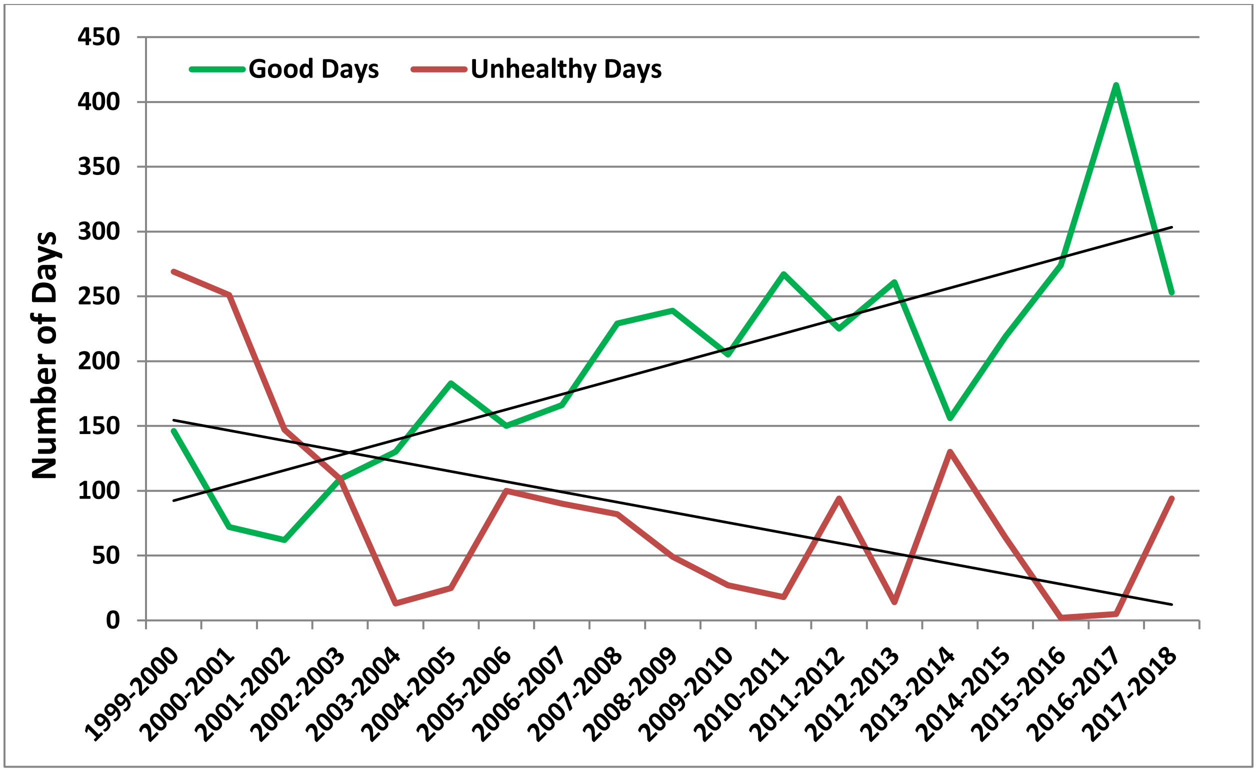


Figure ES-6 Increase in Good Air Quality Index (AQI) Days and Decrease in Unhealthy AQI Days during the Winter Season among All Valley Counties



Plan Addresses Multiple Federal Standards

This Plan addresses multiple PM2.5 standards. Preparing a single Plan instead of three separate Plans allows for development of a more robust and health-protective Plan that incorporates stronger control measures on a more expeditious timeframe than may otherwise be required. Furthermore, a focused public process provides greater opportunity for public engagement and participation in the PM2.5 attainment planning process. This plan addresses the following standards:

1997 PM2.5 Standard (24-hour 65 µg/m³ and Annual 15 µg/m³)

- Plan focus on annual standard – San Joaquin Valley has already attained 24-hour portion of the standard, based on monitoring data from the three year period from 2014 to 2016
- Attainment deadline December 31, 2015
- Serious area 5% Plan with attainment deadline of December 31, 2020

2006 24-hour PM2.5 standard of 35 µg/m³

- Serious area Plan with attainment deadline of December 31, 2024 with 5-year extension request

2012 annual PM2.5 standard of 12 µg/m³:

- Attainment deadline under “Serious” classification of December 31, 2025
- This Plan would be submitted three years ahead of 2022 federal submission deadline

Plan Integrates Multi-Faceted Approach through Implementation of Valleywide and Targeted Hot-Spot Strategies

This Plan integrates a comprehensive strategy that contains new potential stationary source measures that will be applied Valleywide and measures focused on reducing emissions in areas with the most difficult attainment challenges. Through the implementation of this comprehensive strategy, the Valley will experience progressive air quality improvements as the region attains the federal PM2.5 standards as expeditiously as practicable.

Under the federal Clean Air Act, the entire Valley is designated as not meeting the standard if any area in the Valley is not able to meet the standard. In developing the control strategies for past attainment plans, the District has used the traditional approach of quantifying reductions needed in areas with the most difficulty in meeting the standards, and then imposing broad controls throughout the Valley. After decades of imposing tough measures throughout the region, and given the significant additional emissions reductions necessary to meet the federal PM2.5 standards, in addition to imposing stringent new measures across all sources throughout the Valley, a targeted approach that focuses additional measures and limited resources in remaining “hot-spot” areas is necessary to meet the federal standards.

Therefore, this plan not only includes a comprehensive suite of regulatory and incentive-based measures for both stationary and mobile sources, but also includes a targeted hot-spot strategy that focuses new residential wood burning and commercial under-fired charbroiling emission reduction measures in Fresno County, Kern County, and other locations as necessary to demonstrate attainment of the standards.

Plan Prepared with Extensive Public Input

This Plan was prepared over the course of three years through an extensive public process that provided numerous opportunities for the general public and interested stakeholders to offer suggestions and comments for improving and strengthening the plan. The District has worked closely with these various stakeholders, including its partner agencies CARB, EPA, advocacy groups, and affected industry representatives to share information regarding the plan, and to receive comments and suggestions.

To ensure that the public has had the opportunity for meaningful participation in the development of this Plan, the District has provided multiple opportunities for the public to learn more about the air quality challenges facing the Valley and to provide the District with comments or suggestions. The District has presented regular updates on the Plan at public meetings, including meetings of the District Governing Board, Citizens

Advisory Committee (CAC), and Environmental Justice Advisory Group (EJAG) to provide opportunities for the public to ask questions or request additional information.

Additionally, the District reconvened the Public Advisory Workgroup (PAW) formed under direction from the District's Governing Board, with appointments made by the Executive Director/Air Pollution Control Officer. The PAW committee consists of representatives from regulated entities (industry, farms, dairy families and municipalities), community advocates, and advisors from EPA and CARB. The District hosted five PAW meetings to discuss specific aspects of the integrated Plan and strategies to attain the multiple PM2.5 standards. All PAW meetings are open to the public.

The District and CARB also hosted ten public workshops, each of which could be attended in-person in any one of the District's three regional offices (Fresno, Modesto, and Bakersfield) or online via webcast. In addition to meetings and workshops outlining the District's perspective and approach for developing this plan, the District collaborated with CARB to hold several public workshops that provided information about the scientific foundation of the plan, and provided additional opportunities for the public to ask questions and provide input. The District met with interested stakeholders throughout the plan development process to address specific questions and comments, and solicit further suggestions for control strategies.

Chapter 1
Introduction

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1. INTRODUCTION

The U.S. Environmental Protection Agency (EPA) periodically reviews and establishes health-based air quality standards (also referred to as National Ambient Air Quality Standards, or NAAQS) for ozone, particulates, and other pollutants. Although the San Joaquin Valley (Valley) experiences unique and significant difficulties in achieving these increasingly stringent standards, air quality in the Valley has improved considerably. Over the past couple of decades, the San Joaquin Valley Air Pollution Control District (District) has implemented several generations of emissions control measures for stationary and area sources under its jurisdiction. Similarly, the California Air Resources Board (CARB) has adopted regulations for mobile sources. Together, these efforts represent the nation's toughest air pollution emissions controls and have greatly contributed to reduced ozone and particulate matter (PM) concentrations in the Valley. In addition to having the toughest air regulations in the nation, the District also operates the most effective and efficient incentive grants program, investing over $2.1 billion in public/private funding towards clean air projects to date that have achieved over 150,000 tons of emissions reductions.

Due to the significant investments made by Valley businesses and residents and stringent regulatory programs by the District and CARB, the Valley's ozone and PM2.5 precursor emissions are at historically low levels and air quality over the past few years has been better than any other time on record. This Plan builds upon the District's 1-hour ozone, 8-hour ozone and particulate matter strategies. Under these combined efforts, the Valley's 8-hour ozone concentrations and 24-hour and annual PM2.5 concentrations have significantly improved and will continue to improve as the existing and future control measure strategies are implemented in the coming years. Emissions from stationary sources have been reduced by 85%, cancer risk from exposure to air pollutants has been reduced by 95%, population exposure to elevated PM2.5 levels have been reduced by 85%, and population exposure to elevated ozone levels have been reduced by 90%.

This Plan satisfies federal Clean Air Act (CAA) requirements for the 1997, 2006, and 2012 PM2.5 air quality standards.

1.1 NATIONAL AMBIENT AIR QUALITY STANDARDS FOR PM

1.1.1 EPA'S STANDARD SETTING PROCESS

CAA §108 and §109 require EPA to set health-based standards for six criteria pollutants, including PM2.5. EPA periodically reviews existing standards to consider the most recent health studies. These reviews are to be conducted every five years, though in the past, some standard revisions did not meet the 5-year deadline. The review process starts as the Clean Air Scientific Advisory Committee (CASAC) analyzes available science and then, if supported by research, suggests to EPA a range of revised standards that would protect public health from the adverse effects of air pollution. The EPA Administrator appoints CASAC members, who are non-EPA staff and who are experts in the fields of science, engineering, or the social sciences. The committee provides objective, independent advice to EPA on the technical basis for the standard. Thousands of peer-reviewed scientific studies are considered as EPA formulates its proposed standard, which is made available for scientific peer review and public comment. EPA then sets the standard. Setting new standards every five years results in confusing, overlapping standards, and duplicative requirements.

Once a standard is set, EPA designates an area as attainment or nonattainment based on the most recent three years of air quality data available. For particulate matter standards, EPA automatically classifies nonattainment areas as Moderate by order of law pursuant to CAA Subpart 4 requirements.[1]

EPA also adopts an Implementation Rule for each standard to provide guidance and EPA's interpretation of CAA requirements for states and local air districts as they prepare state implementation Plans[2] (SIPs) to ensure compliance with CAA requirements and bring areas into attainment with each standard. While EPA cannot consider costs or difficulty in setting the standards, costs and difficulty are inescapable for states and local air districts as they determine the best way to bring areas into attainment. That being said, local air districts must meet planning and attainment requirements to improve public health and to avoid federal sanctions. Upon development of an attainment strategy, an area submits the Plan to EPA for approval. Once EPA approves a Plan as an amendment to the SIP, that Plan becomes federally enforceable.

There are a number of serious penalties and risks associated with any failure to submit approvable attainment strategies for meeting federal standards. If EPA finds that an area has failed to submit an approvable plan on time; has failed to submit a revised plan or rule in response to an EPA disapproval; or has failed to implement commitments included in the plan after the plan has been approved, then the following sanctions may be applied under authority of the federal Clean Air Act:

- Two-to-one offset requirement for major sources, leading to a de facto ban on new and expanding business
- Loss of federal highway funds
- A federal implementation Plan (FIP), which would result in a loss of local control

1.1.2 FEDERAL PM2.5 NAAQS AND IMPLEMENTATION

Table 1-1 provides a summary of the 1997, 2006, and 2012 PM2.5 national ambient air quality standards and EPA and District actions under the standards consistent with CAA requirements.

[1] Clean Air Act Section 188(a)

[2] Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule. 81 Fed. Reg. 164, pp. 58010-58162. (2016, August 24). (to be codified at 40 CFR Parts 50, 51, and 93). https://www.gpo.gov/fdsys/pkg/FR-2016-08-24/pdf/2016-18768.pdf

Table 1-1 PM2.5 NAAQS and District Actions

	1997 PM2.5 NAAQS	2006 PM2.5 NAAQS	2012 PM2.5 NAAQS
1997-2006	EPA NAAQS (7/18/97): 24-hr: 65 µg/m³ Annual: 15 µg/m³ EPA designates Valley: Nonattainment (1/5/05)	EPA NAAQS (10/17/06): 24-hr: 35 µg/m³ Annual: 15 µg/m³	
2007	EPA issues Implementation Rule for (4/25/07)		
2008	District adopts *2008 PM2.5 Plan* (4/30/08)		
2009		EPA designates Valley: Nonattainment (11/13/09)	
2010			
2011	EPA approves *2008 PM2.5 Plan* (except contingencies) (11/9/11)		
2012		EPA issues Implementation Rule (3/2/12) District adopts *2012 PM2.5 Plan* (12/20/12)	EPA NAAQS (1/15/13): 24-hr: 35 µg/m³ Annual: 12 µg/m³
2013	D.C. Circuit Court remands EPA, found EPA erred in implementing 1997 NAAQS pursuant solely to General Implementation provisions of CAA Subpart 1, without also considering the PM-specific provisions of Subpart 4 (1/14/13)		
	District adopts contingencies for *2008 PM2.5 Plan* (6/20/13)		
2014	EPA approves *2008 PM2.5 Plan* contingencies (5/22/14) EPA classifies Valley: Moderate nonattainment (result of 2013 court finding) (6/2/14) District requests reclassification to Serious nonattainment (8/14)	EPA classifies Valley: Moderate nonattainment (result of 2013 court finding) (6/2/14) District adopts supplement to *2012 PM2.5 Plan* to address CAA Subpart 4 and request reclassification to Serious nonattainment (9/18/14)	
2015	EPA reclassifies Valley: Serious nonattainment (5/7/15) District adopts *2015 Plan for the 1997 PM2.5 Standard* with a request for deadline extension (April 16, 15) Attainment deadline as a Serious nonattainment area (12/31/15)		EPA designates Valley: Moderate nonattainment (1/15/2015)

	1997 PM2.5 NAAQS	2006 PM2.5 NAAQS	2012 PM2.5 NAAQS
2016	EPA proposes partial approval of *2015 Plan for the 1997 PM2.5 Standard*, and attainment date extension (2/9/16) EPA withdraws approval of *2008 PM2.5 Plan* contingencies (due to another court case) and as a result, disapproves *2008 PM2.5 Plan* (5/12/16) EPA fails to act on *2015 Plan for the 1997 PM2.5 Standard* by mandated date of July 2016, as a result: - EPA denies request for extension of attainment date (10/6/16) - EPA issues Finding of Failure to Attain (11/23/16) *5% Plan* due (12/31/16)	EPA reclassifies Valley: Serious nonattainment (effective 2/19/16) EPA approves *2012 PM2.5 [Moderate] Plan* (effective 9/30/16)	District adopts *2016 Moderate Area Plan for the 2012 PM2.5 Standard* (09/15/16) Moderate Area attainment plan due 10/15/16 CARB tables adoption of *2016 Moderate Area Plan for the 2012 PM2.5 Standard,* Plan not forwarded to EPA, CARB commits to revisit Plan later (10/20/16)
	EPA issues Implementation Rule to address CAA Subpart 4 requirements (8/24/16)		
2017		Serious nonattainment Plan due (8/19/17)	
2018			
2019		Attainment deadline as a Serious nonattainment area (12/31/19)	
2020	*2018 PM2.5 Plan* demonstrates attainment by 12/31/2020		
2021			
2022			
2023			
2024		5-year extension attainment deadline (if requested/granted) (12/31/24) *2018 PM2.5 Plan demonstrates attainment by 12/31/24*	
2025			Attainment deadline as a Serious nonattainment area (12/31/25) *2025: 2018 PM2.5 Plan demonstrates attainment by 12/31/25*

1.2 FEDERAL REQUIREMENTS

CAA Subparts 1 and 4 contain multiple statutory requirements that must be demonstrated in this Plan. Subpart 1 contains general requirements and subpart 4 contains requirements specific to PM2.5 nonattainment areas. These requirements are summarized in Table 1-2.

Table 1-2 Statutory Requirements

Requirement	Federal CAA	Description
CAA Subpart 1 – Nonattainment Areas in General		
Reasonable Further Progress	§172(c)(2)	Plan provisions shall require reasonable further progress (RFP)
Emissions Inventory	§172(c)(3)	A comprehensive, accurate, current inventory of actual emissions from all sources of the relevant pollutant or pollutants
Contingency Measures	§172(c)(9)	Specific measures to be undertaken if the area fails to make reasonable further progress, or to attain by the attainment date, as contingency measures to take effect in any such case without further action by the State or EPA
CAA Subpart 4 – Additional Provisions for Particulate Matter Nonattainment Areas		
Permit Program	§189(a)(1)(A)	A permit program providing that permits are required for the construction and operation of new and modified major stationary sources of PM
Attainment Demonstration – Moderate Areas	§188(c)(1), §189(a)(1)(B)	Attainment date shall be as expeditiously as practicable but no later than the end of the sixth calendar year after the areas designation as nonattainment, or a demonstration that attainment by such date is impracticable
Attainment Demonstration – Serious Areas	§188(c)(2) §189(b)(1)(A)	Attainment date shall be as expeditiously as practicable but no later than the end of the tenth calendar year after the areas designation as nonattainment
Extension of Attainment Date for Serious Areas	§188(e)	Demonstrations that 1) attainment by the attainment date is impracticable, 2) the State has complied with all requirements and commitments pertaining to the area in the implementation Plan, 3) the State demonstrates that the Plan includes the most stringent measures (MSM) feasible for the area, and 4) a attainment as expeditiously as practicable

Requirement	Federal CAA	Description
Reasonably Available Control Measures	§189(a)(1)(C)	Provisions to assure that reasonably available control measures (RACM) for the control of PM2.5 shall be implemented no later than 4 years after designation/classification as a Moderate nonattainment area
Best Available Control Measures and Best Available Control Technology	§189(b)(1)(B)	Serious Areas – Provisions to assure that the best available control measures (BACM) for the control of PM2.5 shall be implemented no later than 4 years after the date the area is classified (or reclassified) as a Serious nonattainment area
New Source Review Program Major Source Thresholds	§189(b)(3)	For any Serious Area – the terms “major source” and “major stationary source” include any stationary source or group of stationary sources located within a contiguous areas and under common control that emits, or has the potential to emit, at least 70 tons per year of PM2.5
Quantitative Milestones	§189(c)(1)	The Plan shall contain quantitative milestones which are to be achieved every three years until the area is redesignated attainment and which demonstrate reasonable further progress toward attainment by the applicable attainment date
5% Plan	§189(d)	Serious nonattainment areas that do not attain the standard by the applicable attainment date, shall submit within 12 months after the applicable attainment date, Plan revisions which provide for attainment of the PM2.5 standard, and, from the date of such submission, until attainment, for an annual reduction in PM2.5 or PM2.5 precursor emissions within the area of not less than 5 percent of the amount of such emissions as reported in the most recent inventory prepared for such area
PM2.5 Precursors	§189(e)	Control requirements applicable to major stationary sources of PM2.5 shall also apply to major stationary sources of PM2.5 precursors, except where EPA determines that such sources do not contribute significantly to PM2.5 levels which exceed the standard in the area

1.3 EXTENSIVE PUBLIC PROCESS

To ensure that the public has had the opportunity for meaningful participation in the development of this *2018 PM2.5 Plan,* the District has provided multiple opportunities for the public to learn more about this Plan and to provide the District with comments or to request more information. The District has presented regular updates on this plan at public meetings, such as meetings of District Governing Board, Citizens Advisory Committee (CAC), and Environmental Justice Advisory Group (EJAG), and each update was followed by an opportunity for the public to ask questions or request additional information.

Additionally, the District reconvened the Public Advisory Workgroup (PAW) formed under direction from the District's Governing Board, with appointments made by the Executive Director/Air Pollution Control Officer. The PAW committee consists of representatives from regulated entities (industry, farms, dairy families and municipalities), community advocates, and advisors from EPA and CARB. The District hosted five PAW meetings to discuss specific aspects of the integrated Plan and strategies to attain the multiple PM2.5 standards. All PAW meetings are open to the public.

The District and CARB also hosted ten public workshops, each of which could be attended in-person or online via webcast. The following is a summary of public workshops, meetings, and updates related to this Plan since May 2016.

- **On-going**. Monthly updates on Plan development and progress at District held public meetings of the Governing Board, Citizen's Advisory Committee, and Environmental Justice Advisory Group. Each update is followed by an opportunity for the public to provide comments and ask questions.
- **May 4th and 5th 2016**. Governing Board Study Session Meeting:
  - Review and provide feedback on risk tolerance with respect to District's Technology Advancement Program. The District's TAP program was developed to accelerate the development of technologies that can help reduce air pollutant emissions in the Valley to attain EPA's increasingly stringent ozone and particulate matter air quality standards
  - Use of incentive-based control measures in upcoming ozone and particulate matter attainment Plans
  - Approve development of San Joaquin Valley Healthy Soils Initiative
- **June 16, 2016**. Governing Board Meeting Board Item - Petition requesting that EPA adopt new national standards for on-road heavy-duty trucks and locomotives under federal jurisdiction. Mobile sources make up over 85% of the Valley's NOx emissions. This item is part of the strategy to reduce emissions from mobile sources.
- **August 18, 2016**. Governing Board Meeting Board Items:
  - Consider options for addressing the PM2.5 Clean Air Act mandates in light of federal EPA inaction on the District's 2015 PM2.5 Plan and attainment deadline extension request for the 1997 PM2.5 standard

    - Authorize initiative to secure additional state and national funding to support future incentive based state implementation Plans
- **September 15, 2016**. Governing Board public hearing to adopt the 2016 Moderate Area Plan for the 2012 PM2.5 Standard with an attainment impracticability demonstration and request for reclassification
- **October 20, 2016**. CARB Board Meeting at the District's Fresno Office for a public hearing on the *Moderate Area Plan for the 2012 PM2.5 Standard* and attainment impracticability demonstration with request for reclassification. CARB tabled the adoption of this plan with direction for their staff to come back at a later date.
- **December 1, 2016**. CARB public workshop to discuss strategies for meeting PM2.5 standards and science-based assessment of sources contributing to PM2.5 levels in the Valley, benefits of current controls programs, and initial assessment of the scope of further emissions reductions needed to meet annual and 24-hour PM2.5 standards over the next ten years
- **December 7, 2016**. District public workshop – Scoping Meeting
- **December 15, 2016**. Governing Board Item to adopt policy positions in working with CARB to prepare District's attainment strategy for PM2.5
- **January 11, 2017**. District Public Advisory Workgroup Meeting to discuss Air Quality Modeling
- **January 25, 2017**. District Public Advisory Workgroup Meeting to discuss CARB Mobile Source measures for the Valley
- **February 9, 2017**. District Public Advisory Workgroup Meeting to discuss District measures under consideration for 2017 Integrated PM2.5 Plan
- **February 16, 2017**. Governing Board Item to review the feasibility of potential options for pursuing additional emissions reductions from public fleet vehicles within the pre-2025 timeframe necessary to address federal PM2.5 standards. While the state and federal have the bulk of the responsibility over mobile sources, the District is exploring potential opportunities for further reducing emissions from public fleets.
- **March 9, 2017**. District public workshop to discuss the development of 2017 PM2.5 Plan
- **March 16, 2017**. Governing Board Meeting Board Items:
    - Review and reaffirm the District's existing position that draconian measures that impose no driving days and severe restrictions on commerce are not feasible
    - Review District's preliminary cost estimates for measures aimed at reducing directly emitted PM2.5 and NOx emissions in pursuit of the District's attainment strategy for federal PM2.5 standards
- **April 12, 2017**. District Public Advisory Workgroup Meeting to provide an update on air quality modeling and continue discussions on potential measures
- **May 8, 2017**. District public workshop to discuss potential District measures under consideration
- **May 17, 2017**. CARB Community Meeting held in Fresno to discuss strategies for meeting PM2.5 standards and to assess opportunities for reductions from

stationary and mobile sources as part of a comprehensive PM2.5 attainment strategy

- **May 18, 2017**. District public workshop to discuss the District's 5% Plan and PM10 Maintenance Plan
- **May 25, 2017**. CARB Board Meeting to provide an update to the Board on development of District's PM2.5 State Implementation Plan
- **August 17, 2017**. Governing Board Meeting Board Item discussions:
  - Review and action to submit a Clean Data Finding to EPA demonstrating that the District now meets the national 1997 24-hour PM2.5 standard of 65 µg/m³
  - Review the District's strategy to attain the 1997 PM2.5 annual standard of 15 µg/m³, the 2006 PM2.5 24-hr standard of 35 µg/m³, and the 2012 annual standard of 12 µg/m³
- **August 23, 2017. District** public Scoping Meeting workshop to present, discuss, and receive feedback on potential amendments to District Rule 4311 (Flares)
- **September 20th and 21st 2017**. Governing Board Study Session Meeting:
  - Discuss pursuing Community-Level-Targeted Strategies to regulate or incentivize control measures focusing on pollution sources which cause localized community concern
  - Update on current technologies and partnerships for underfired charbroilers pollution control units and to explore the best approaches to reduce air pollution from underfired charbroilers in the Valley
  - Consider to pursue targeted strategies focused on regional hot-spots to expedite attainment of federal standards in a more cost-effective fashion
- **September 26, 2017**. Joint public workshop hosted by CARB and the District to outline attainment strategy for meeting PM2.5 standards, specifically discuss and solicit public feedback on hot-spot strategy
- **September 28, 2017**. CARB Board Meeting to provide an update on the development of State Implementation Plan for meeting multiple PM2.5 standards and discuss the consideration of attainment contingency measures for the 1997 PM2.5 annual standard of 15 µg/m³
- **October 19, 2017**. Governing Board Meeting to discuss the District's initiative to facilitate good citizen science for utilizing personal air sensors in the Valley, which involves but limited to, engaging residents in the Valley with proper installation, operation, and interpretation of the data obtained.
- **November 14, 2017**. District Public Advisory Workgroup Meeting to discuss the development of the PM2.5 attainment strategy
- **November 16, 2017**. CARB Board Meeting to receive update on secondary PM2.5 formation in the San Joaquin Valley and research on potential controls
- **December 21, 2017**. Governing Board Meeting to provide update on PM2.5 Attainment Strategy
- **January 18, 2018**. Governing Board Meeting Item discussions:
  - Discuss the District's 2018 Legislative Platform
  - Review the significant findings from residential wood burning survey results and discuss options for program enhancements to the District's comprehensive residential wood burning programs.

- **February 15, 2018**. Governing Board Meeting Item discussions:
  - Report and consider recommendations from the Central Valley Summit on Alternatives to Open Burning of Agricultural Waste
  - Provide updates to development of new permitting program for commercial underfired charbroilers.
- **March 8, 2018**. District public workshop to present, discuss and solicit feedback on draft amendments to District Rule 4905 (Natural Gas-Fired, Fan-Type Central Furnaces)
- **March 8, 2018**. District public workshop to provide update on continued efforts in defining the final proposed attainment strategy and the remaining steps for development of the comprehensive Plan. The discussion include a review of potential District and CARB regulatory and incentive-based control measures and air quality modeling activities.
- **April 19, 2018**. Governing Board Meeting Item discussion: Report End-of-Season 2017-2018 Wood Burning Season
- **April 26, 2018**. District public workshop to discuss and receive comments on potential amendments to District Rule 4692 (Commercial Charbroiling) to assist the District in developing a strategy to reduce emissions from commercial charbroiling operations as part of the District's efforts to attain federal health-based standards for PM2.5.
- **June 21, 2018**. Governing Board Meeting Item discussions:
  - Adopt proposed amendments to Rule 4905 (Natural Gas-Fired, Fan-Type Central Furnaces)
  - Adopt proposed amendment to Rule 4692 (Commercial Charbroiling)
  - Review and set agenda for the September 2018 Governing Board Study Session for Educational and Strategic Planning purposes
- **July 31, 2018**. District and CARB hosted a joint workshop to present, discuss and solicit feedback on the 2018 PM2.5 Plan. The workshop discussion included updates on continued efforts toward air quality attainment modeling, proposed attainment strategy, and the next steps for development of the comprehensive strategy along with reviewing potential District and CARB regulatory and incentive-based control measures and air quality modeling activities.
- **August 28, 2018**. District, CARB, and EPA hosted a joint public workshop to present, discuss and solicit feedback on the 2018 PM2.5 Plan. The workshop discussion included updates on air quality attainment, proposed attainment strategy, and next steps for finalizing the draft attainment Plan.

In addition to the robust public process summarized above, the District provided multiple additional resources to the public, including the following:

- A new web page to provide updates, presentations, documents and other information related to the development of this Plan: http://www.valleyair.org/pmplans/
- A public mailing list, so members of the public can sign up to receive email notifications about activities related to this and future PM2.5 Plans at: http://lists.valleyair.org/mailman/listinfo/pm_plans
- An email address specifically for this plan for the public to submit comments to at their leisure: airqualityplans@valleyair.org

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Chapter 2

Air Quality Challenges and Trends

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2. AIR QUALITY CHALLENGES AND TRENDS

2.1 PM2.5 Challenges and Trends in the San Joaquin Valley

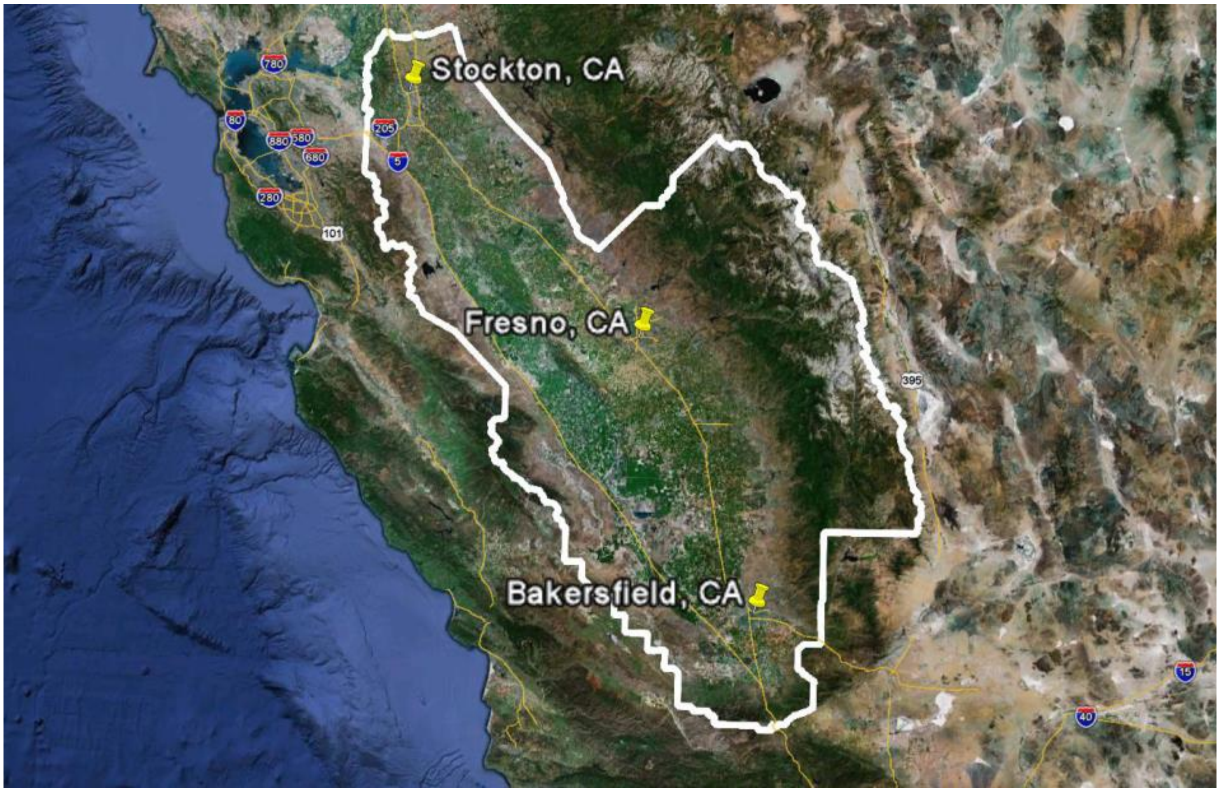
The San Joaquin Valley's (Valley) natural environment supports one of the most productive agricultural regions in the country; the Sierra Nevada provides the necessary water for growing the abundance of crops, and a temperate climate provides a long growing season. However, these same natural factors present significant challenges for air quality: the surrounding mountains trap pollution and block airflow, and the mild climate keeps pollutant-scouring winds at bay most of the year.

Despite these challenges, the San Joaquin Valley Air Pollution Control District (District) is making progress in attaining the national ambient air quality standards (NAAQS, or standards) and improving public health for Valley citizens. Due to the significant investments made by Valley businesses and residents and stringent regulatory programs by the District and the California Air Resources Board (CARB), the Valley's ozone and PM2.5 precursor emissions are at historically low levels and air quality over the past few years has been better than any other time on record. Emissions from stationary sources have been reduced by 85%, cancer risk from exposure to air pollutants has been reduced by 95%, population exposure to elevated PM2.5 levels have been reduced by 85%, and population exposure to elevated ozone levels have been reduced by 90%.

2.1.1 Unique Climate and Geography

The challenge to attaining the federal air quality standards in the Valley is grounded in the unique topographical and meteorological conditions found in the region. The Valley, as seen in Figure 2-1, is an inter-mountain valley encompassing nearly 25,000 square miles. Surrounded by mountain ranges to the west, east, and south; the airflow through the Valley can be blocked, leading to severely constrained dispersion. During the winter, high-pressure systems can cause the atmosphere to become stagnant for longer periods of time, where wind flow is calm and air movement is minimal. These stagnant weather systems can also cause severe nighttime temperature inversions, which exacerbate the build-up of PM2.5 and related precursors beneath the evening inversion layer.

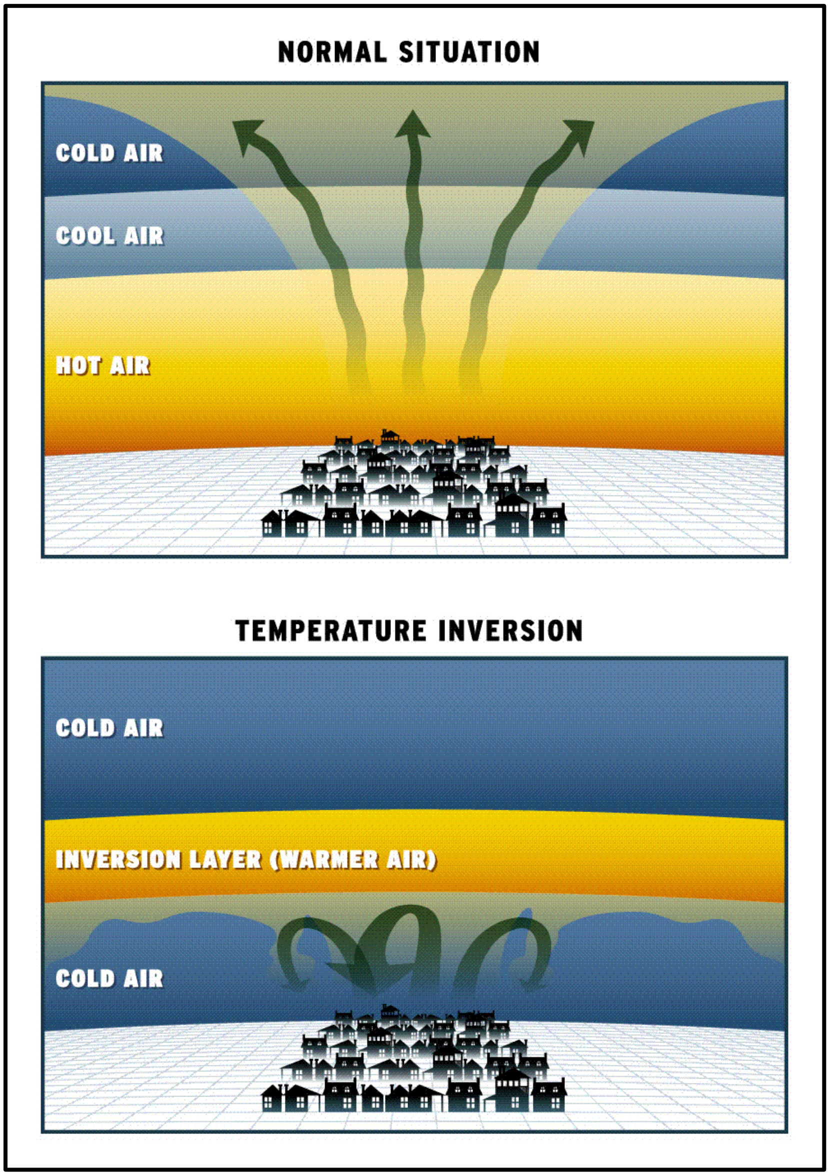
Figure 2-1 San Joaquin Valley Air Basin



Under normal conditions, temperature decreases with increasing altitude, but during temperature inversions the temperature gradient is reversed, with temperatures increasing with altitude, causing warmer air to be above cooler air. Figure 2-2 shows that this reversal of the "normal" pattern impedes the upward flow of air, causes poor dispersion, and traps pollutants near the earth's surface. Temperature inversions are common in the Valley throughout the year. Since the inversion is often lower than the height of the surrounding mountain ranges, the Valley effectively becomes a bowl capped with a lid that traps emissions near the surface. When horizontal dispersion (transport flow) and vertical dispersion (rising air) are minimized, PM2.5 concentrations can build quickly, especially in the winter. These naturally occurring meteorological conditions have the net effect of spatially concentrating direct PM2.5 concentrations near their sources; promoting the formation and regional buildup of secondary species, particularly ammonium nitrate; and chemically aged organic carbon species, resulting in an increase in their relative toxicity.

Given these challenges, the Valley needs even more effective emissions reductions to attain the PM2.5 standards; and the District continues to pursue these reductions through its numerous air quality attainment plans, regulatory control strategy and innovative non-regulatory emission reduction strategy, which includes a robust incentive program, a comprehensive legislative platform, and rigorous outreach and education efforts.

Figure 2-2 Atmosphere without and with Temperature Inversion[1]



2.1.2 THE VALLEY'S CARRYING CAPACITY

In the context of air quality, "carrying capacity" refers to the density of emissions that an air basin can "absorb" or "carry" and still meet ambient air quality standards for a given pollutant. The key factors that shape variations in a regional carrying capacity include meteorology, climate, and topography. The Valley's carrying capacity for PM2.5 is greatly affected by prevailing weather during the winter months and the region's topography (surrounding mountains). Temperature inversions are common during the winter months in the Valley. During these sometimes lengthy stagnant air episodes, PM2.5 emissions from daily activities rapidly build up to levels above the standard. It is during these events (or in anticipation of these events) that the District's Check-Before-

[1] Image source: http://ffden-2.phys.uaf.edu/212_spring2007.web.dir/Amber_Smith/Effects_of_Inversions.htm

You-Burn program and Real-time Air Advisory Network (RAAN) system intervene to inform (or require) the public to limit activity that generates PM2.5 emissions.

2.1.3 POPULATION GROWTH IN THE SAN JOAQUIN VALLEY

To further exacerbate current air quality challenges, the Valley is one of the fastest growing regions in California. The Population Research Unit of the California Department of Finance (DOF) released revised population growth projections in March 2017 that demonstrate how significantly the Valley's population is expected to grow in the coming years.

Based on the revised 2015 to 2030 DOF data, the Valley's population is expected to increase by 19.3% (Table 2-1). In contrast, the total population for the State of California is projected to increase by only 12.5% over the same time period. Increasing population generally means increases in air pollutant emissions as a result of increased consumer product use and more automobile and truck vehicle miles traveled (VMT). In addition to increased VMT resulting from increased Valley population, the Valley will also see increased vehicular traffic along the State's major goods and people movement arteries, both of which run the length of the Valley.

Table 2-1 Estimated Valley and State Populations by County, 2015-2030[2]

County	2015	2020	2025	2030
Fresno	979,636	1,033,095	1,088,990	1,145,673
Kern[3]	883,494	930,885	996,506	1,068,729
Kings	149,832	154,549	162,195	170,251
Madera	154,753	162,990	174,332	186,937
Merced	269,870	286,746	306,143	326,923
San Joaquin	728,110	782,662	838,755	894,330
Stanislaus	537,608	572,000	605,463	638,840
Tulare	464,337	487,733	513,541	540,580
VALLEY TOTAL	***4,167,640***	***4,410,660***	***4,685,925***	***4,972,263***
CALIFORNIA TOTAL	**39,059,415**	**40,639,392**	**42,326397**	**43,939,250**

While the bulk of the Valley's remaining emissions come from mobile sources outside of the District's regulatory authority, under the federal Clean Air Act (CAA), the responsibility to bring the region into attainment with the federal standards rests with the local air district. Additionally, the region will be subject to sanctions that would be devastating to the Valley's economy if mobile sources under federal regulatory authority are not adequately controlled. As such, given the enormity of the reductions needed for attainment, mobile sources, particularly in the goods movement sector, must transition

[2] *California Department of Finance. Retrieved July 18, 2018 from: http://www.dof.ca.gov/Forecasting/Demographics/projections/*
[3] *Includes entire Kern County population*

to zero or near-zero emission levels through the implementation of transformative measures. The District does not have the authority to implement regulations requiring ultra-low tailpipe emissions standards on mobile sources. New state and federal regulations coupled with a robust incentive-based emission reduction strategy are necessary to achieve the enormous reductions that are necessary to attain the federal standards. The U.S. Environmental Protection Agency (EPA) must take responsibility for implementing regulatory and incentive-based measures for sources under their jurisdiction. The District has been working closely with CARB to develop an attainment strategy that includes significant emissions reductions from mobile sources.

2.2 PM2.5 Emissions Inventory Trends

The emissions inventory is the foundation for the attainment planning process. The District and CARB maintain an accounting of PM2.5 and precursor emissions for the Valley based on known sources within the Valley and those sources outside the Valley that influence Valley air quality (inter-region transport). The District requires detailed accounting of emissions from regulated sources throughout the Valley. CARB makes detailed estimations of emissions from mobile, area, and geologic sources using known emissions factors for each source or activity and accounting for relevant economic and population data. Together, these feed into the emissions inventory that represents an estimate of how much direct pollution is going into the Valley air basin as a result of the cumulative pollutant-generating activities and sources.

The District uses the emissions inventory to develop control strategies, to determine the effectiveness of permitting and control programs, to provide input into air quality modeling, to fulfill reasonable further progress requirements, and to screen regulated sources for compliance investigations.

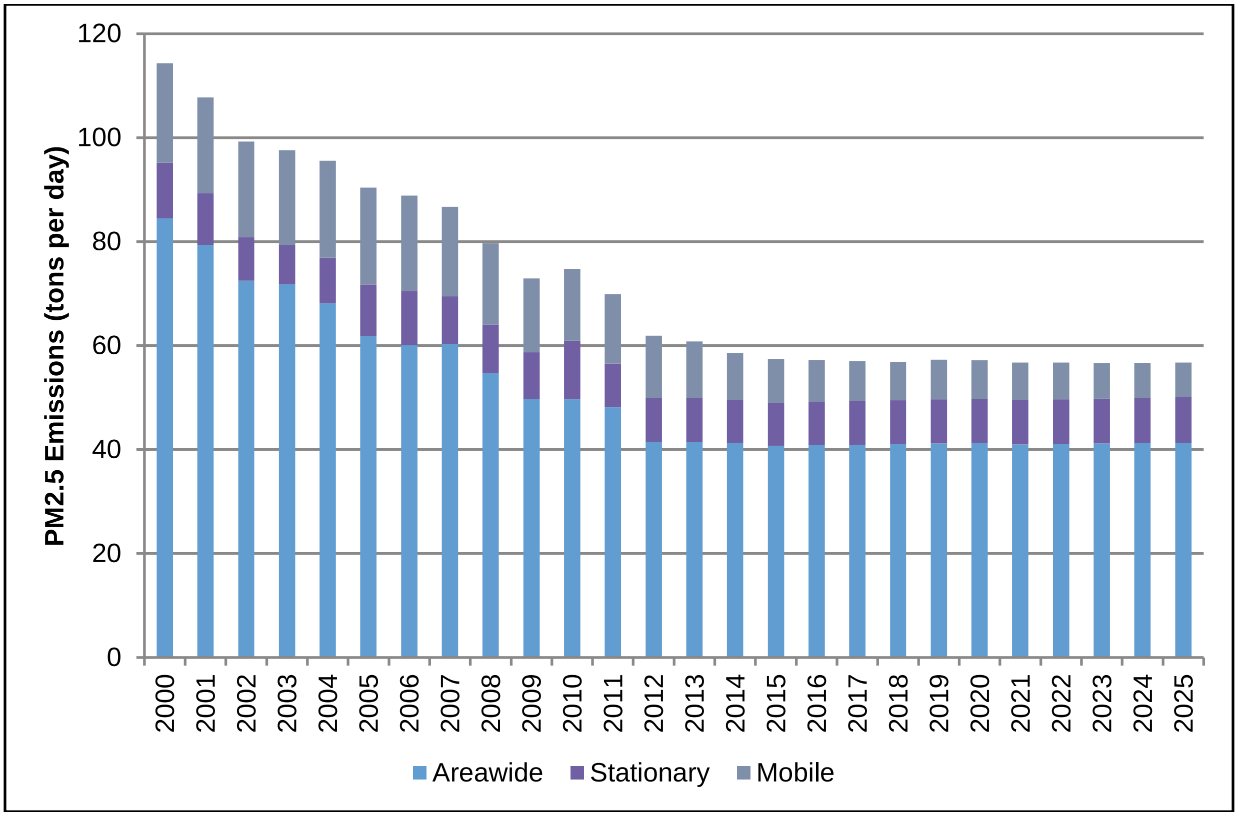
The following general list represents the major inventory categories for which emissions are recorded and tracked. Appendix B to this Plan contains the detailed accounting of the emissions inventory with projected emissions based on anticipated growth of each source and the anticipated control (regulatory or non-regulatory) of each source, if applicable.

- **Mobile sources** – motorized vehicles
    - On-road sources include automobiles, motorcycles, buses, and trucks
    - Other or off-road sources include farm and construction equipment, lawn and garden equipment, forklifts, locomotives, boats, aircraft, and recreational vehicles
- **Stationary sources** – fixed sources of air pollution
    - Power plants, refineries, and manufacturing facilities
    - Aggregated point sources, i.e. facilities (such as gas stations and dry cleaners) that are not typically inventoried individually, but are estimated as a group and reported as a single source category
- **Area sources** – human activity that takes place over a wide geographic area
    - Includes consumer products, residential wood burning, controlled burning, tilling, and unpaved road dust

- **Natural sources** – naturally occurring emissions
  - Geologic sources, such as petroleum seeps
  - Biogenic sources, such as emissions from plants
  - Wildfire sources

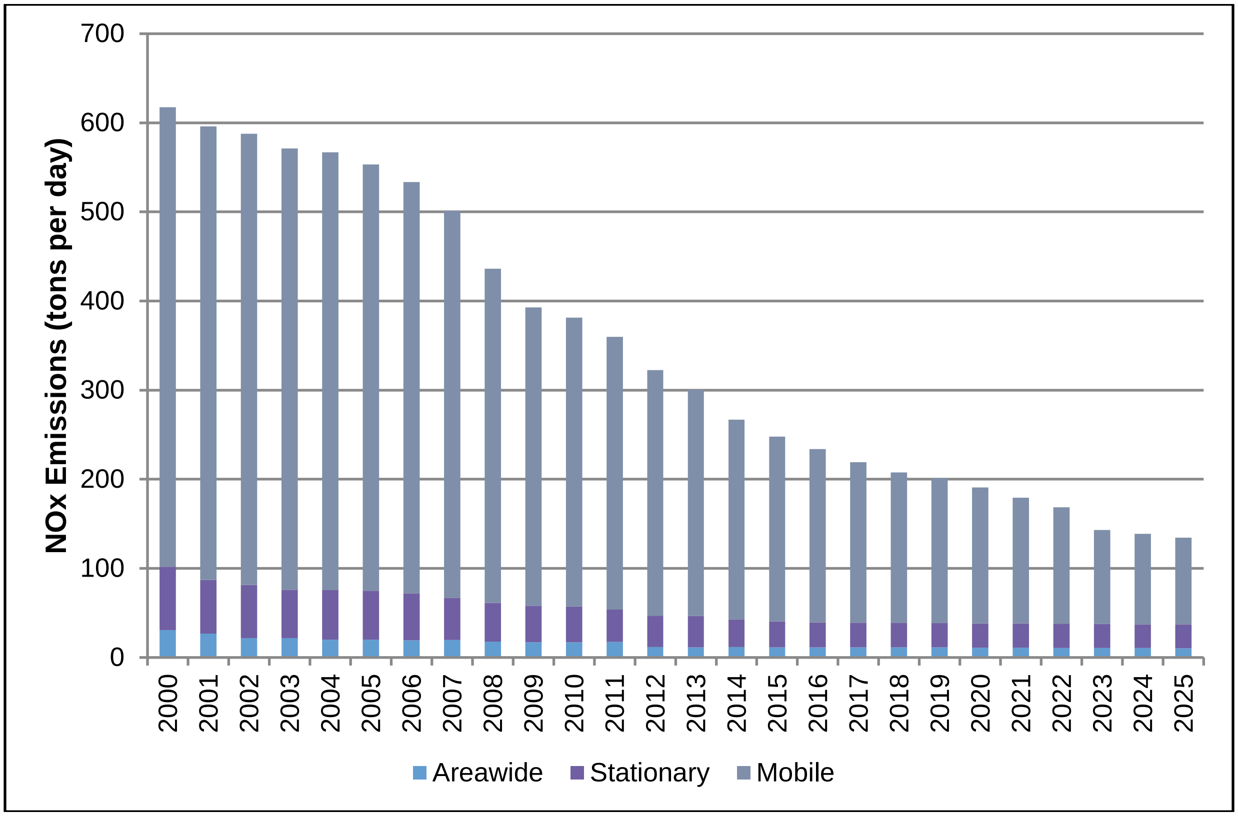
Figure 2-3 Valley PM2.5 Winter Emissions Inventory Trend shows the PM2.5 emissions inventory trend for the mobile, stationary, and area source categories.

Figure 2-3 Valley PM2.5 Winter Emissions Inventory Trend



Because NOx is a significant PM2.5 precursor and the Valley is NOx-limited, the District relies heavily on NOx emissions to reduce PM2.5 emissions. Figure 2-4 summarizes the NOx emissions inventory trends for the mobile, stationary, and area source categories. District and CARB control strategies for NOx play a significant role in reducing both ozone and PM2.5 emissions.

Figure 2-4 Valley Winter NOx Emissions Inventory Trend



Emissions inventory trends show the progress made through progressive regulatory and non-regulatory activities, e.g. as rules are amended with tighter emission limits, or as reduction technologies improve, overall emissions decrease. Winter PM2.5 emissions have decreased significantly, in large part due to the effectiveness of Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters). Continued emissions reductions are based on current control strategies that will continue to take effect into the future. In light of the Valley's projected increase in population, the projected emissions reductions highlight the success of the control measures adopted and enforced by the District, CARB, and other regulatory agencies.

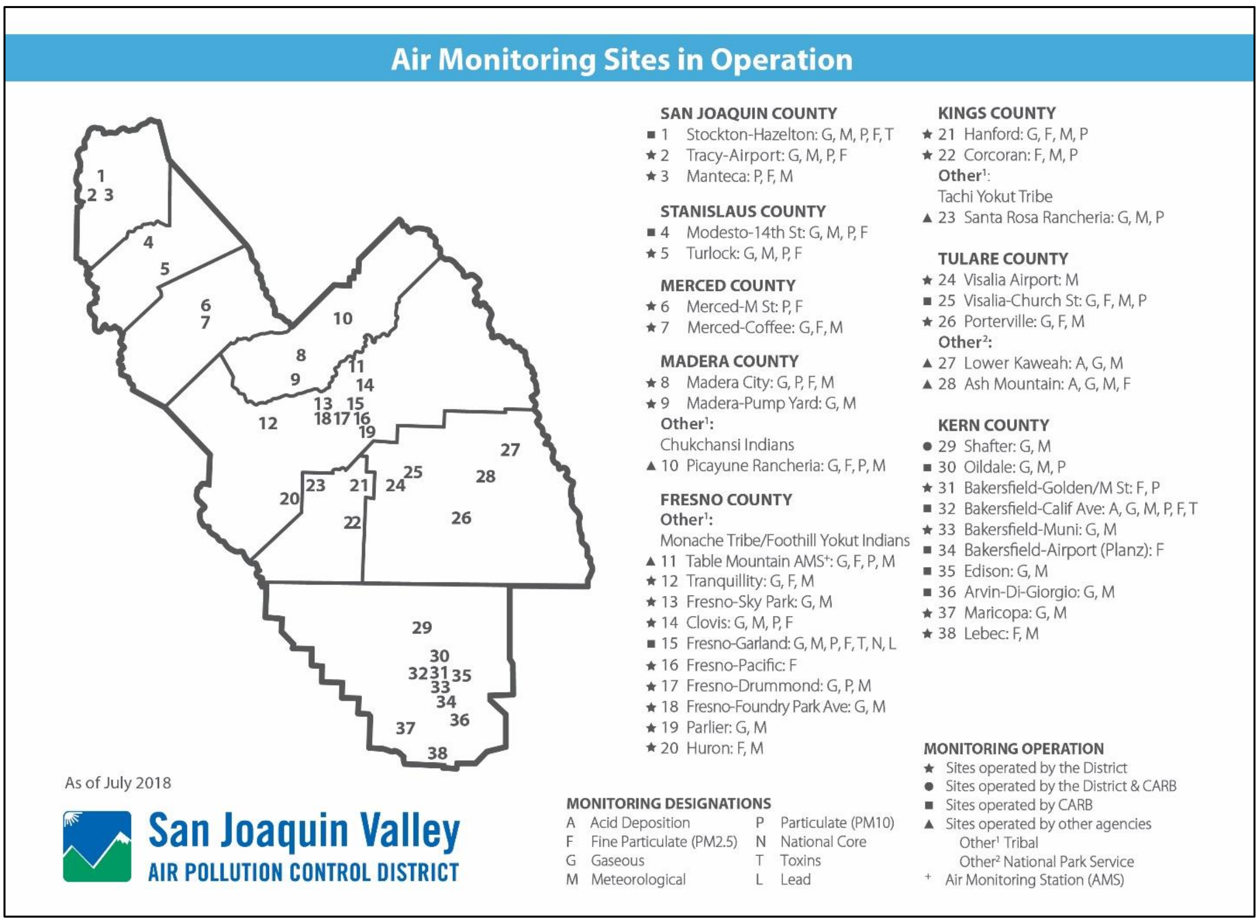
2.3 PM2.5 Air Quality Trends

As a public health agency charged with monitoring Valley air quality and ensuring progress toward meeting national air quality standards, the District has established an extensive air monitoring network that provides ongoing data for evaluating such progress. Information from this extensive monitoring network, which began measuring PM2.5 concentrations in 1999, allows the District to track air quality trends that show progress toward attainment and inform the planning process for reaching attainment.

2.3.1 AIR MONITORING NETWORK

Numerous pollutants and meteorological parameters are measured throughout the Valley on a daily basis using an extensive air monitoring network managed by the District, CARB, and other agencies. This network measures pollutant concentrations necessary to show progress toward compliance with the NAAQS. The network also provides real-time air quality measurements used for daily air quality forecasts, residential wood-burning declarations, Air Alerts, and RAAN. Air quality monitoring networks are designed to monitor areas with high population densities, areas with high pollutant concentrations, areas impacted by major pollutant sources, and areas representative of background concentrations. Together, the District, CARB, and other agencies operate 38 air monitoring stations throughout the Valley. Most air monitoring sites in the Valley represent population exposures and/or maximum concentrations representative of neighborhood and regional scales.

Figure 2-5 Valley Air Monitoring Sites



PM2.5 is measured and expressed as the mass of particles contained in a cubic meter of air (micrograms per cubic meter, or $\mu g/m^3$). The data collected from the District's network of PM2.5 monitors is used to calculate design values for the 24-hour and annual PM2.5 standards, as outlined in EPA guidance and regulations.[4,5]

2.3.2 AIR QUALITY PROGRESS

Air quality progress can be assessed in several ways. The calculation of *design values* is the official method used to determine whether an area is in attainment of a standard; however, other indicators can reveal more about the progress being made toward attaining that standard. Comparing the days per year when each monitor exceeded the PM2.5 24-hour NAAQS threshold from year to year shows the progress in reducing the number of days with the highest concentrations, while quarterly averages can help to show progress with respect to seasonal peaks in concentration levels. Some of the conclusions from these analyses are included below, followed by a more detailed discussion in Appendix A.

Rather than using yearly maximum concentrations for the PM2.5 standards, EPA requires the use of design values for the attainment metric, which represents a three-year average of air quality data. Details on how PM2.5 design values are calculated are provided in Appendix A of this Plan. As seen in Figure 2-6 and Figure 2-7, the Valley maximum 24-hour and annual average PM2.5 design value trends show that although there are some year-to-year variation, progress has been made in reducing PM2.5 concentrations over the long-term sampling record in the Valley. The Valley's peak 24-hour design value has decreased by over 43% over the 1999–2017 period, while the peak annual design value has decreased by 30% over the same period.

[4] Environmental Protection Agency [EPA]: Office of Air Quality Planning and Standards. (1999, April). *Guideline on Data Handling Conventions for the PM NAAQS* (EPA-454/R-99-008). Retrieved from http://www.epa.gov/ttn/oarpg/t1/memoranda/pmfinal.pdf

[5] Interpretation of the National Ambient Air Quality Standards for PM2.5, 40 CFR Pt. 50 Appendix N (2012).

Figure 2-6 Valley 24-hour PM2.5 Design Value Trend

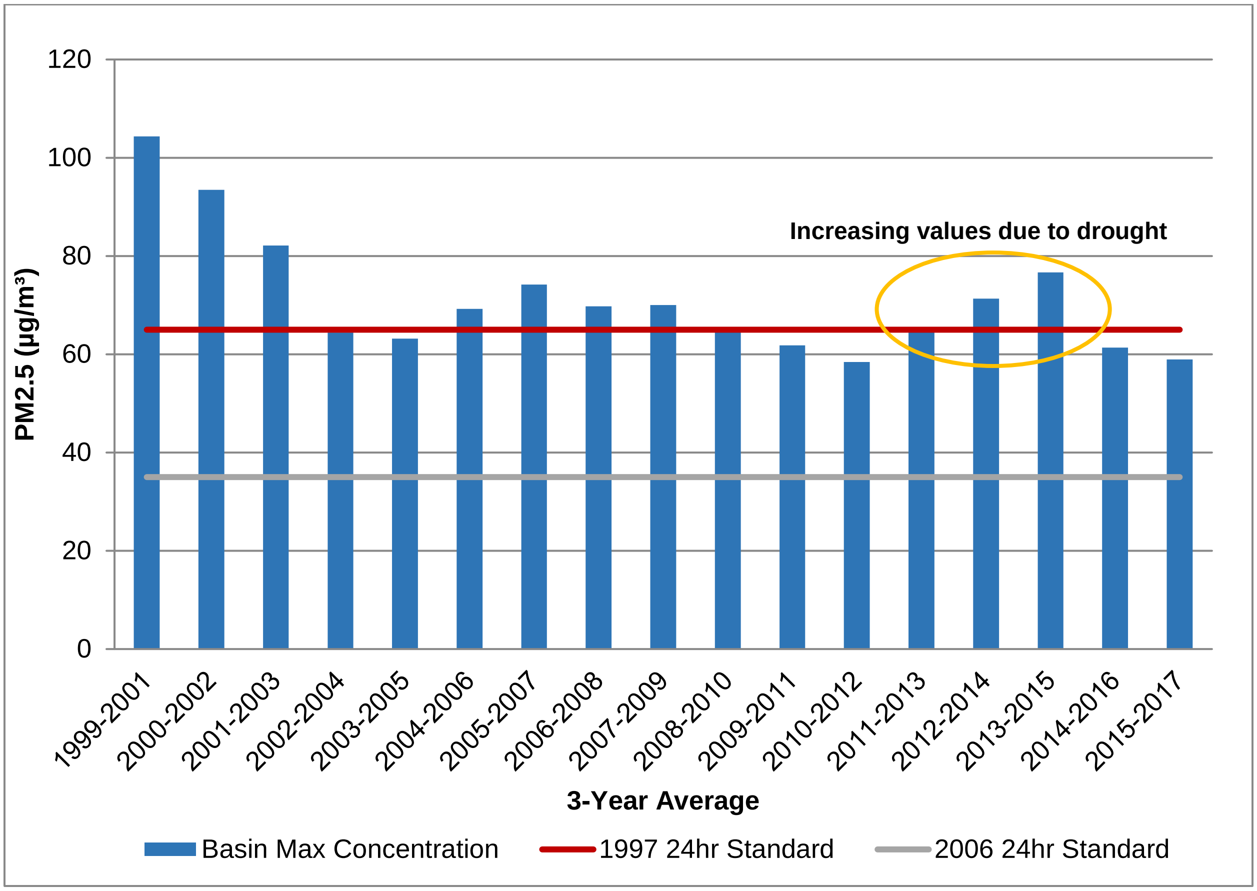
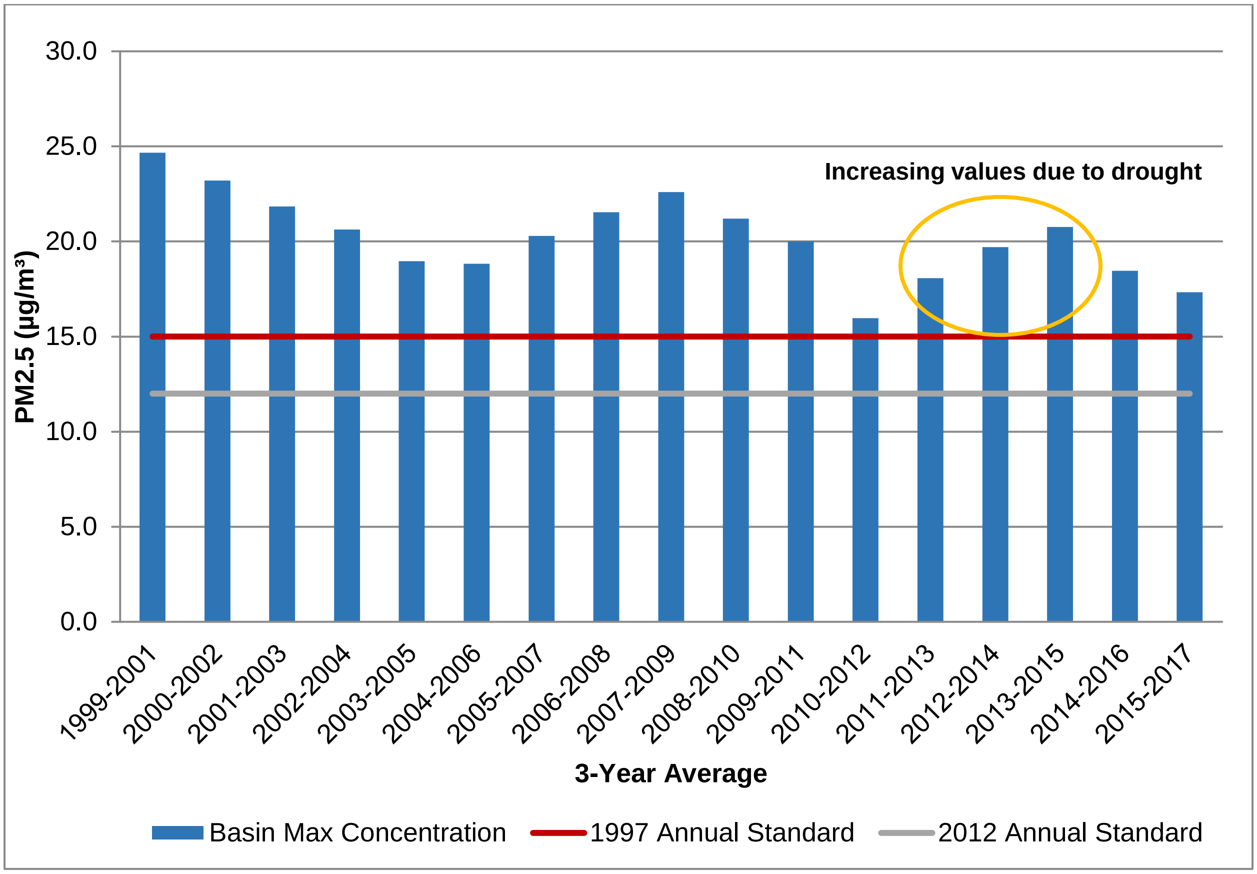


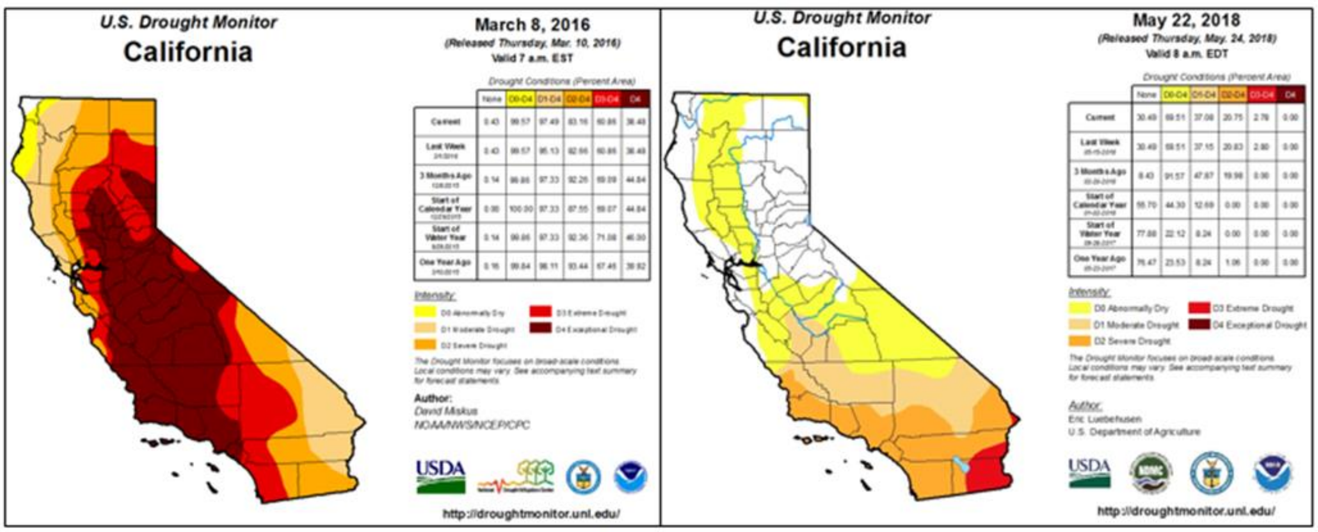
Figure 2-7 Valley Annual PM2.5 Design Value Trend



2.3.3 IMPACT OF EXCEPTIONAL DROUGHT-RELATED WEATHER CONDITIONS ON VALLEY PM2.5 CONCENTRATIONS

According to the U.S. Geological Survey, California experienced its worst drought in over a century between 2011 and 2015. The 2015-2016 winter season represented the fifth consecutive year of drought conditions in the Valley, and 2013-2014 was by far the driest winter during this time. On January 17, 2014, the Governor of California declared a drought emergency for all of California. Three years and two months later, the drought emergency declaration was finally lifted by the Governor of California on April 7, 2017. Figure 2-8 is a map produced by the National Drought Mitigation Center depicting the extent and severity of the drought affecting California as of March 8, 2016 and the degree of recovery that has occurred as of May 22, 2018.

Figure 2-8 Drought Extent and Severity in California



Many cities in California, including those in the Valley, had record low rainfall totals during 2013 calendar year, with some nearly 100-year old records being broken. Although rainfall totals slowly increased between 2015 and 2017, drought conditions have continued to persist despite a very wet 2016-2017 winter season (see Table 2-2).

Table 2-2 Rainfall Totals for Select Cities Across California

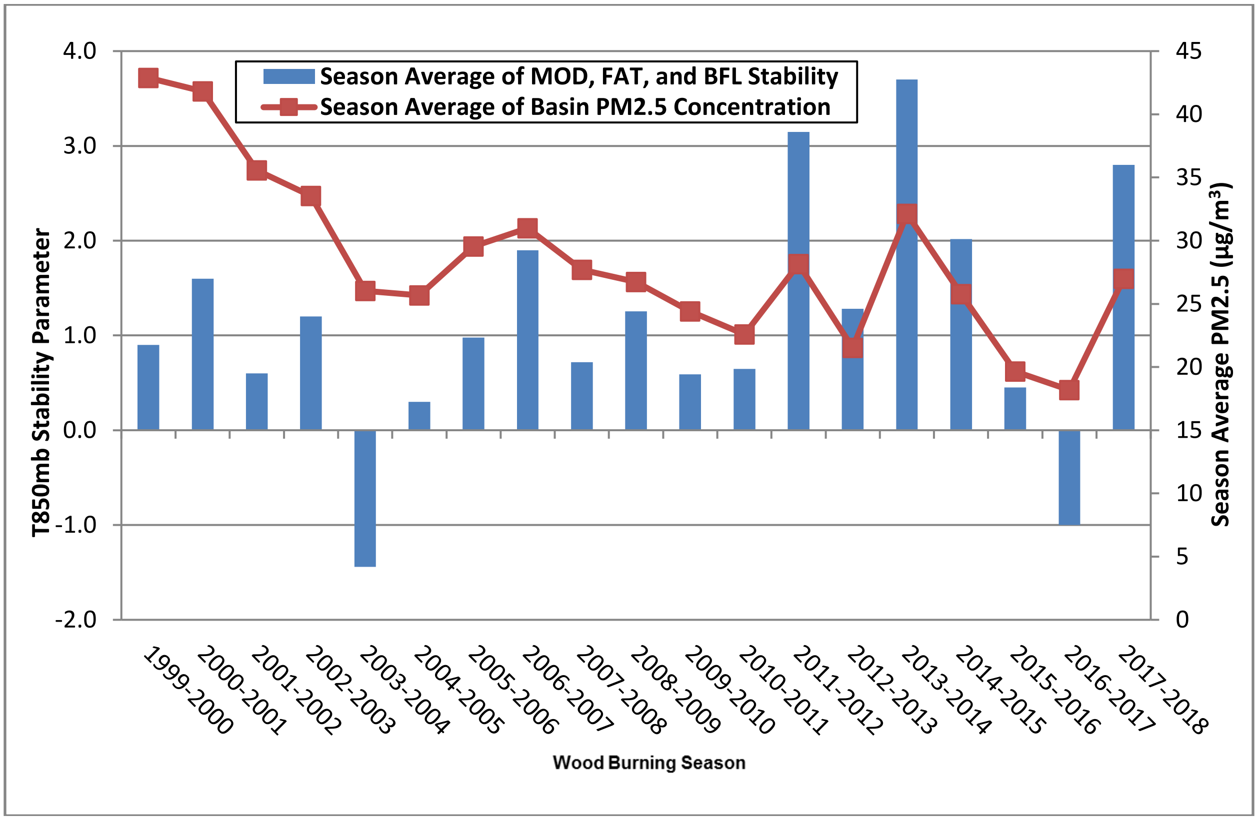
Region	City	1983-2013	2015	2016	2017	Record Low Rainfall	
		Average (inches)	Total (inches)	Total (inches)	Total (inches)	Year	Total (inches)
Northern California	San Francisco	19.73	8.45	25.5	26.62	2013	3.39
	Sacramento	17.6	8.53	22.92	27.16	2013	5.81
San Joaquin Valley	Modesto	12.17	7.25	16.24	12.93	2013	4.69
	Madera	12.3	4.14	16.02	10.61	2013	3.8
	Fresno	11.03	8.98	13.65	13.21	2013	3.01
	Visalia	9.91	5.33	8.94	11.52	2013	3.47
	Bakersfield	6.19	3.99	7.13	5.38	1959	1.87
Southern California	Los Angeles	12.32	5.96	10.27	12.26	1947	3.14
	San Diego	10.2	9.92	10.23	7.92	1953	3.41

NCDC https://www.ncdc.noaa.gov/cdo-web/search;jsessionid=8EECF3E54DC2BBA9D4F96C444434A990
NWS Hanford http://w2.weather.gov/climate/local_data.php?wfo=hnx
NWS San Diego http://w2.weather.gov/climate/local_data.php?wfo=sgx
California Nevada River Forecast Center http://www.cnrfc.noaa.gov/rainfall_data.php

During 2011–2015 winter seasons, extended periods of stagnation, and lack of ample precipitation were components of the historic drought that challenged the Valley's air quality during this period. These conditions overwhelmed the District's control measures and strategies, and contributed to the higher than expected PM2.5 concentrations and exceedances that occurred in the San Joaquin Valley during that period.

As demonstrated in Figure 2-9, the average PM2.5 concentration in the Valley has decreased over the period, despite low precipitation totals and increases in atmospheric stability over recent years. This provides evidence that District and CARB comprehensive strategy have been achieving permanent emissions reductions.

Figure 2-9 Seasonal Average Stability and PM2.5 Concentrations



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Chapter 3

Health Impacts and Health Risk Reduction Strategy

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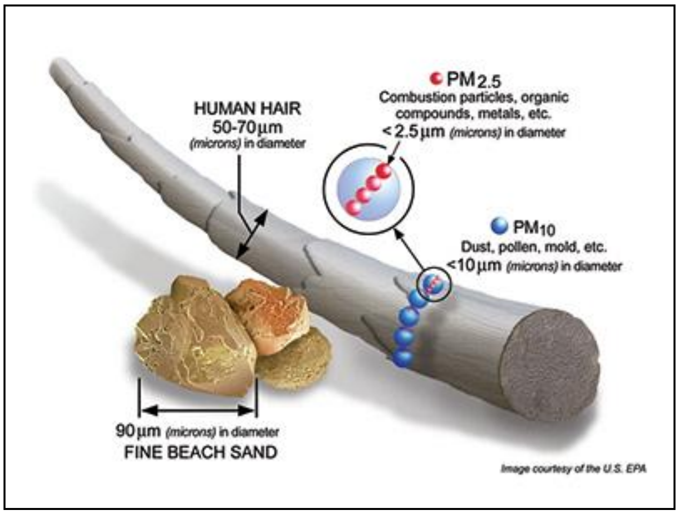
3. HEALTH IMPACTS AND HEALTH RISK REDUCTION STRATEGY

3.1 PM2.5 POLLUTION DEFINED

Particulate matter (PM) is a mixture of solid particles and liquid droplets in the air. PM can be emitted directly into the atmosphere (primary PM), or can form as secondary particulates in the atmosphere through the photochemical reactions of precursors (when precursors are energized by sunlight). Thus, PM is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles. PM10 is particulate matter that is 10 microns or less in diameter, and the PM2.5 subset includes smaller particles that are 2.5 microns or less in diameter (Figure 3-1).

Figure 3-1 Visual Comparison of PM10, PM2.5, Human Hair, and Fine Beach Sand



3.1.1 NATURE AND FORMATION OF PM2.5

The nature and formation of PM2.5 in the San Joaquin Valley (Valley) is highly complex, and attainment of a PM2.5 standard is not a one-size-fits-all effort. Significant differences in regional natural environments and the relative contribution of precursor emissions requires regionally specific modeling and regionally specific control strategies. Also, differences within PM2.5 itself, directly-emitted PM2.5 versus secondary PM2.5 forming in the atmosphere through series of chemical reactions, adds to the complexity inherent in modeling and planning efforts.

This complexity is accounted for in the modeling and other scientific analyses conducted for this Plan. The San Joaquin Valley Air Pollution Control District (District), California Air Resources Board (CARB), and researchers have developed and refined these analytical tools, including regional modeling, over many years. The District's regional modeling protocol notes that the Valley is one of the most studied airsheds in the world in terms of the number of publications in peer-reviewed scientific journals and other major reports. Such scientific analyses, and the field studies providing data for these analyses, are the foundation of the modeling efforts for this Plan. Public and private sector partnership through the San Joaquin Valleywide Air Pollution Study Agency (Study Agency) provided funding and coordination for many of these studies.

Unlike ozone, which is a fairly simple molecule of three oxygen atoms, PM2.5 can be composed of any material that has a diameter of 2.5 microns or less. PM2.5 can be emitted directly as primary PM2.5 from various sources or formed secondarily through chemical reactions in the atmosphere. Naturally occurring emissions from biogenic sources, such as plants, can also add to the formation of PM2.5.

The resulting ambient PM2.5 mixture can include aerosols (fine airborne solid particles and liquid droplets) consisting of components of nitrates, sulfates, elemental carbons, organic carbon compounds, acid aerosols, trace metals, geological materials, and more.

3.1.2 PM2.5 Species in the Valley

PM2.5 in the Valley is comprised of many species that contribute to the total PM2.5 mass, as summarized in Table 3-1 and Figure 3-2 below. This complex mixture is attributable to stationary, mobile, and area-wide sources, as well as naturally occurring emissions. Although the list of species contributing to PM2.5 in the Valley is lengthy, it can be grouped into larger representative categories. The following is a brief description of how each of these larger species categories are formed and emitted into the atmosphere.

Table 3-1 Summaries of PM2.5 Species

PM2.5 Species	Description
Organic carbon	Directly emitted, primarily from combustion sources (e.g. residential wood combustion). Also, smaller amounts attached to geologic material and road dusts. May also be emitted directly by natural/biogenic sources.
Elemental carbon	Also called soot or black carbon; formed during incomplete combustion of fuels (e.g. diesel engines).
Geologic material	Road dust and soil dust that are entrained in the air from activity, such as soil disturbance or airflow from traffic.
Trace metals	Identified as components from soil emissions or found in other particulates having been emitted in connection with combustion from engine wear, brake wear, and similar processes. Can also be emitted from fireworks.
Sea salt	Sodium chloride in sea spray where sea air is transported into the Valley.
Secondary organic aerosol	Secondary particulates formed from photochemical reactions of organic carbon.
Ammonium nitrate	Reaction of ammonia and nitric acid, where the nitric acid is formed from nitrogen oxide emissions, creating nitric acid in photochemical processes or nighttime reactions with ozone.

PM2.5 Species	Description
Ammonium sulfate	Reaction of ammonia and sulfuric acid, where the sulfuric acid is formed primarily from sulfur oxide emissions in photochemical processes, with smaller amounts forming from direct emissions of sulfur.
Combined water	A water molecule attached to one of the above molecules.

Figure 3-2 Bakersfield PM2.5 Speciation (Average 2011 to 2013)[1]

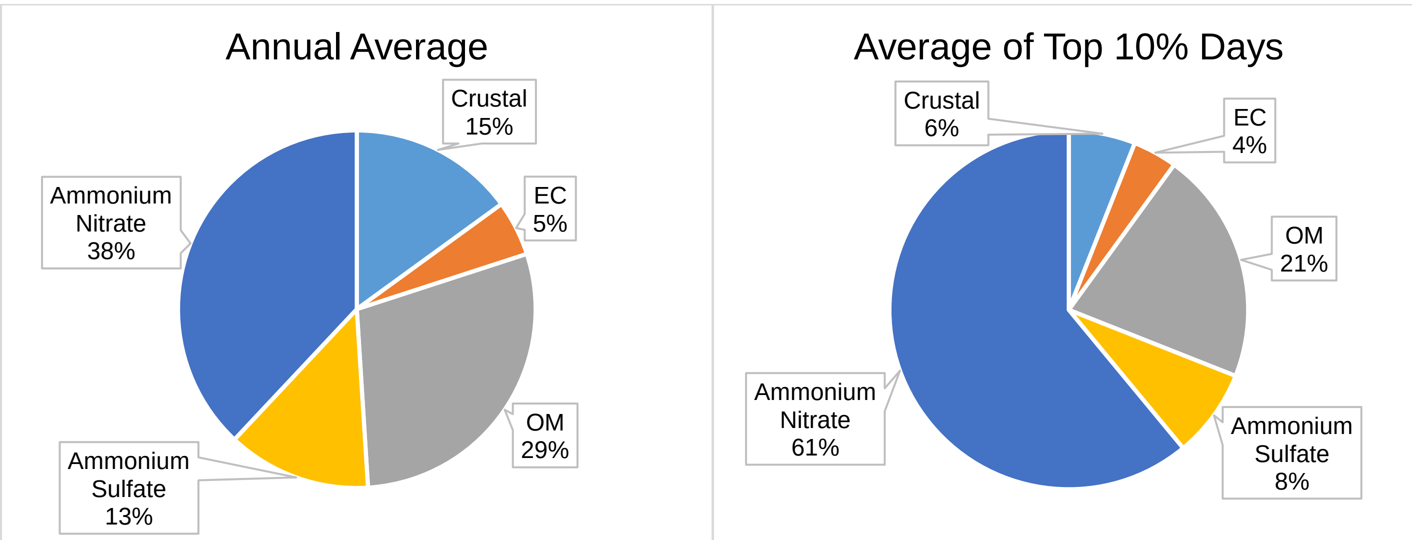
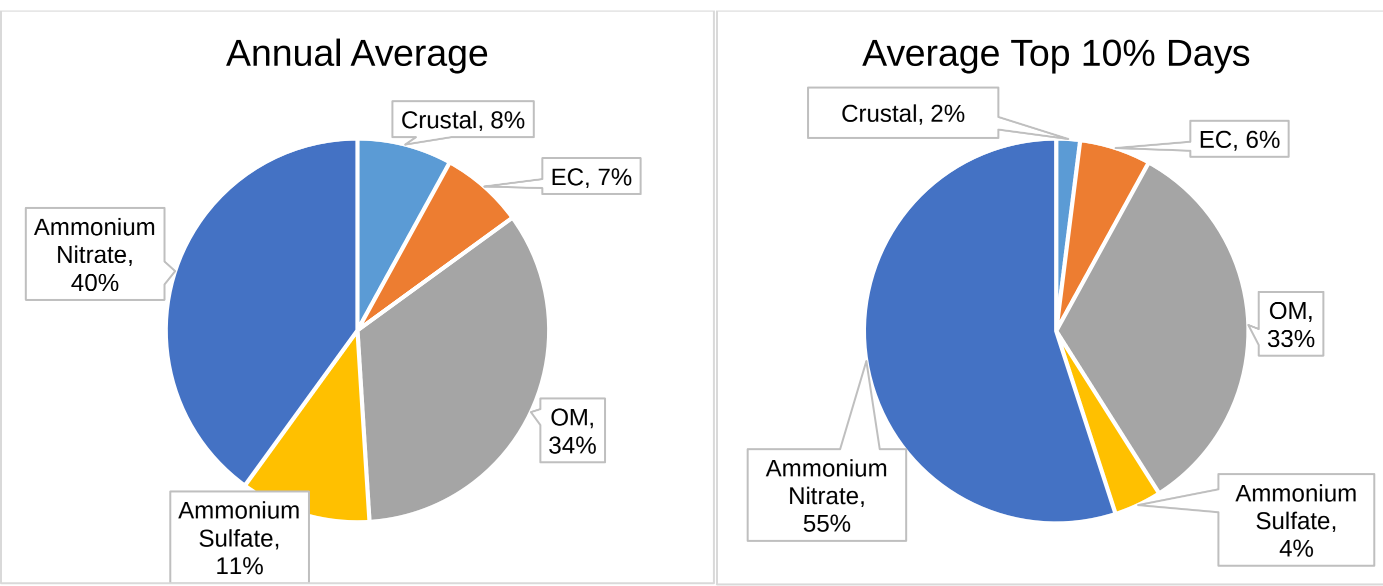


Figure 3-3 Fresno PM2.5 Speciation (Average 2011 to 2013)[2]



[1] Source: California Air Resources Board
[2] Source: California Air Resources Board

Figure 3-4 Modesto PM2.5 Speciation (Average 2011 to 2013)[3]

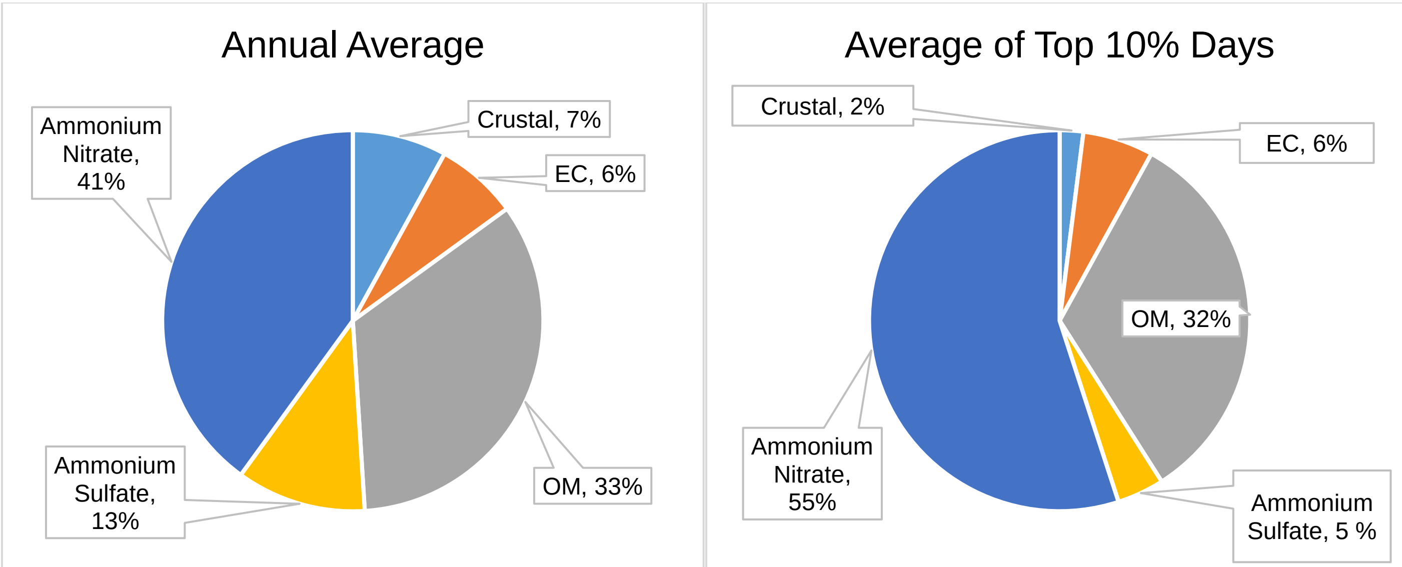
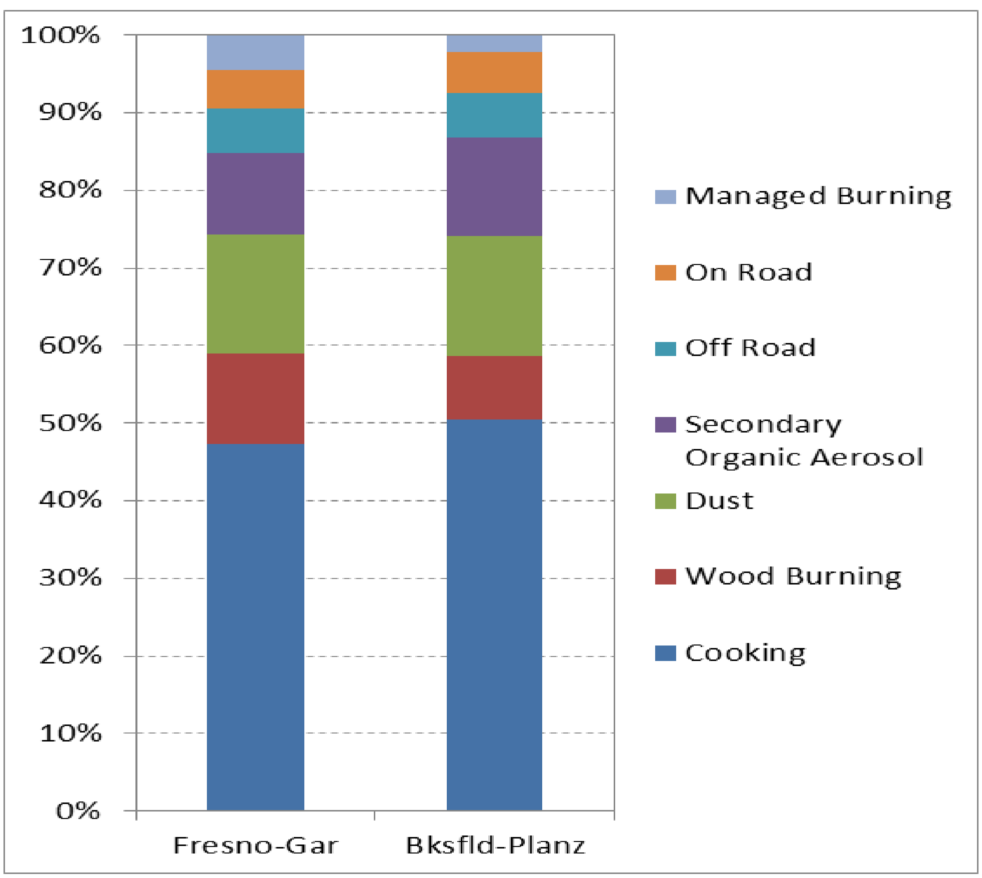


Figure 3-5 OM Source Contributions in 2025[4]



3.2 Health Impacts of PM2.5

Any particles 10 microns or less are considered respirable, meaning they can be inhaled into the body through the mouth or nose. PM10 can generally pass through the nose and throat and enter the lungs. PM2.5 can be inhaled more deeply into the gas exchange tissues of the lungs, where it can be absorbed into the bloodstream and carried to other parts of the body.

The potential health impacts of particle pollution are linked to the size of the particles, with the smaller particles having larger impacts. Numerous studies link PM2.5 to a variety of health problems, including aggravated asthma, increased respiratory symptoms (irritation of the airways, coughing, difficulty breathing), decreased lung function in children, development of chronic bronchitis, irregular heartbeat, non-fatal heart attacks, increased respiratory and cardiovascular hospitalizations, lung cancer, and premature death. Children, older adults, and individuals with heart or lung diseases are the most likely to be affected by PM2.5. Many studies have quantified and documented the health benefits of attaining the U.S. Environmental Protection Agency (EPA) air quality standards for PM.

Understanding various PM2.5 species, including how each species is formed, how much each contributes to the Valley's total PM2.5 concentrations, and how each is linked to different public health impacts, is of the utmost importance for the development of an effective, health-protecting control strategy. For example, ammonium nitrate is estimated to comprise about 40% of the Valley's annual average PM2.5 concentrations, but it is generally regarded as having relatively low toxicity compared to other PM2.5 species, such as organic or elemental carbon.

In addition to affecting human health, air pollution also affects the health of the natural environment. PM2.5 can be transported from sources hundreds of miles away to contribute to visibility problems at remote locations, such as the Sierra Nevada mountain range and associated national parks. As fine particulate matter settles out of the air, it can make lakes and streams acidic, change an ecosystem's nutrient balance, and affect ecosystem diversity. PM2.5 can affect vegetation by damaging foliage, disrupting the chemical processes within plants, reducing light adsorption, and disrupting photosynthesis. As the Valley progresses toward attainment of EPA's human-health-based PM2.5 standards, there will also be less harmful impacts to the surrounding natural environment.

3.3 Health Risk Reduction Strategy

EPA National Ambient Air Quality Standards (NAAQS, or standards) are the primary driving force for new emissions controls that result in air quality improvements and health benefits to Valley residents. In the conventional planning process for attaining these standards, success in protecting public health is defined by whether the standards are met at all air monitors. In effect, the reduction in PM2.5 mass, which shows

[3] Source: California Air Resources Board
[4] Source: CARB Model

progress toward attainment of the standard, serves as the surrogate for population exposure and risk.

NAAQS, as currently established, are essentially *mass-based* standards. In the case of PM2.5, the current standards do not account for particle size distribution, chemical species composition, surface area, and other factors of health risk. In contrast, recent health-science research has substantially deepened our knowledge of air pollutant health risk beyond the current Clean Air Act (CAA) framework and EPA standards. There is a growing recognition within the scientific community that the NAAQS alone can be incomplete measures of public exposure to air pollution. Thus, while the CAA NAAQS and state implementation Plan (SIP) process is motivated by public health, the process alone does not fully address public health impacts of ambient air pollution. To fully address potential public health benefits, an attainment strategy can use a more comprehensive, multidimensional population exposure assessment approach that goes beyond ambient mass measurements.[5]

In May 2013, the District Governing Board adopted the Health Risk Reduction Strategy (HRRS) to prioritize protection of public health in all clean actions undertaken by the District.

3.3.1 Background of the Health Risk Reduction Strategy

As a response to mounting epidemiological evidence that PM2.5 was more harmful than PM10, EPA established a PM2.5 NAAQS in 1997 to accompany the previously established PM10 NAAQS. PM10 occurs at larger mass concentrations than PM2.5, so the shift to PM2.5 somewhat conflicted with the time-tested toxicological precept of "the dose (mass) makes the poison." Particulate inhalation studies found that the smaller PM2.5 particles penetrate more deeply into the lungs, where particles more effectively avoid immune system defenses. Toxicological analyses of PM2.5 identified chemical species that acted differentially to promote respiratory and cardiovascular inflammation. While it was unclear at that time which PM2.5 chemicals were the most harmful, the scientific consensus was that the health risks stemmed from the chemicals rather than the particles themselves.

In the years since the first PM2.5 NAAQS was established, scientists have conducted numerous studies that have identified which chemical species of PM2.5 are most harmful and have pinpointed their sources.[6] Health researchers have also documented the negative cardiovascular and immune system effects of ultrafine particles, or particles that are 0.1 microns or smaller (PM0.1), based on these particles' ability to penetrate the alveolar region of the lungs and deliver chemicals into the bloodstream. This smaller-is-more-dangerous phenomenon parallels the previous discovery regarding

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[5] Lippman, M. (2012, April 16). Presentation: Results from National Particle Component Toxicity (NPACT) Program and NYU: Toxicology Findings, Integration, and implications. Presented at the Annual Meeting of the Health Effects Institute (HEI) in Chicago, IL, April 15–17, 2012. Presentation retrieved from http://www.healtheffects.org/Slides/AnnConf2012/Lippmann-MonPM.pdf

[6] U.S. Environmental Protection Agency [EPA]. (2009). Integrated Science Assessment for Particulate Matter: Final Report. Washington, D.C.: EPA/600/R-08/139F. Available at http://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=216546

the higher toxicity of PM2.5 particles compared to larger and heavier PM10 particles. In each case, the dose-makes-the-poison assumption governing the NAAQS for carbon monoxide, lead, ozone, and the other criteria pollutants does not apply to particulates.

Addressing the complexity of health risks posed by particulate pollution has been a motivating factor in the development and application of the HRRS. Rather than ignore this growing body of scientific knowledge, the District's HRRS seeks to embrace it to the extent possible within the current CAA to maximize public health benefits. In practice, this knowledge provides the District with the necessary scientific foundation for justifying and prioritizing the pollution control measures that are necessary for demonstrating attainment of federal standards. The outcome is stronger, more health-protective Plans that reflect the current trajectory of scientific knowledge toward a more complete understanding of population risk from PM2.5 particles.

The NAAQS-SIP process and the HRRS are complimentary strategies, not an either-or scenario. The HRRS should not be interpreted as a zero-sum tradeoff that emphasizes controls on certain forms and sources of high-risk PM2.5 while ignoring others. The current mass-based indicator (micrograms per cubic meter of air) will continue to serve as the final yardstick for PM2.5 attainment and as a surrogate for achieving significant health benefits.

A number of the District programs have been influenced by the underlying principles and goals of the HRRS and provide a model of the success and added potential benefits possible under this strategy.

- **District Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters) and the District's corresponding Check-Before-You-Burn program** have both been reducing harmful species of PM2.5 where and when those reductions are most needed—in impacted urbanized areas when the local weather is forecast to hamper dispersion. By decreasing emissions from residential wood burning, Rule 4901 decreases directly emitted PM2.5, as well as carbon monoxide, formaldehyde, sulfur dioxide, irritant gases, and known and suspected carcinogens, such as polycyclic aromatic hydrocarbons (PAH). In 2008, the Central Valley Health Policy Institute found that District wood burning curtailments on days with high PM concentrations reduced annual PM exposure by about 13% in Bakersfield and Fresno, resulting in an estimated 59 to 121 avoided cases of annual premature mortality.[7]

  Even though the *2008 PM2.5 Plan* was developed per EPA requirements for the 1997 PM2.5 standard (with a 24-hour standard of 65 µg/m³), the 2008 Plan included a commitment to amend Rule 4901 in 2009 (with implementation in 2010) to align the wood-burning curtailment threshold with the newer 2006 PM2.5 standard (with a 24-hour standard of 35 µg/m³). Then, based on research reiterating the effectiveness of Rule 4901 in protecting public health, as well as

[7] Lighthall, D., Nunes, D., & Tyner, T.R. (2009). Environmental Health Evaluation of Rule 4901: Domestic Wood Burning. Fresno, CA: Central Valley Health Policy Institute for the San Joaquin Valley Air Pollution Control District. Retrieved from http://www.fresnostate.edu/chhs/cvhpi/documents/wood-burning-report.pdf

public support for a stronger rule, the District amended and implemented Rule 4901 in 2008—one year ahead of the scheduled rule development and two years ahead of scheduled implementation. The amended rule also set the curtailment level lower than initially planned (to 30 µg/m³) to provide an extra margin of safety and to address air quality forecast uncertainties.

Similarly, the District's *2012 PM2.5 Plan* committed to amend the District Rule 4901 in 2016 with compliance beginning the winter season of 2016-2017 with an estimated 1.5 tons per day (tpd) of PM2.5 emission reductions. When the District Governing Board adopted the *2012 PM2.5 Plan,* guided by the HRRS*,* they directed the District to amend Rule 4901 in 2014. As a result, the District's residential wood burning program was amended in September 2014 with implementation in the winter season of 2014-2015, two years ahead of the SIP commitment. The rule was further strengthened and the curtailment threshold lowered to 20 µg/m³. The combination of the lowered curtailment threshold, tiered curtailments, increased public outreach and education, and increased incentive amounts and allocations result in a much greater estimated reduction of directly emitted PM2.5 emissions during the winter season than the previously estimated amount of 1.5 tpd.

The significant increase in the number of curtailment days resulting from the lower threshold has resulted in a parallel reduction in nighttime neighborhood exposure to PM0.1, including exposure that has been shown to occur as a result of indoor infiltration. This aspect of Rule 4901, i.e. reducing the frequency of elevated exposure to PM0.1 that induces immune system sensitization and cardiovascular inflammation, has been carried forward into the HRRS. The District's prioritization of Rule 4901 is one of the best examples of a District policy aimed at maximizing public health benefits based on a rigorous assessment of population exposure and risk.

- **District grant programs** reach beyond the current CAA NAAQS-SIP process to reduce emissions in advance of or beyond regulations. For example, through the District's popular Clean-Green-Yard-Machine grant program, the District has replaced close to 5,000 high-polluting gas-powered lawn mowers with clean electric mowers, and through the Burn Cleaner Incentive Program, the District has replaced over 14,000 high-polluting wood burning devices with cleaner alternatives. These grant programs result in a decrease in urban, localized health risks associated with the use of gas-powered equipment and wood burning devices.

- **The District's information and educational programs, such as the Real-Time Air Quality Advisory Network (RAAN),** also contribute to the HRRS. RAAN is the first of its kind system for communicating real-time neighborhood-level air quality by dividing the Valley into 4 km x 4 km grid cells (resulting in 3,600 neighborhoods) and taking into account meteorological conditions as well as observed air quality concentrations from the District's air monitoring network. RAAN provides air quality updates to schools and other subscribers.

Subscribers can use this information to make informed decisions and plan outdoor activities for times with the best air quality, reducing potential air quality health risks. Reflecting the latest science on PM2.5 exposure risk for sensitive individuals, ambient concentrations of PM2.5 that are used to trigger RAAN health risk warnings are more health protective than those used in the EPA's Air Quality Index.

- **The District tracks and sponsors health and PM2.5 research.** As part of the District's HRRS, the District is playing an active role in funding leading edge health research focusing on the Valley population. The District sponsored the first major epidemiological investigation of health effects of air pollution in the Valley, focusing on the populations of Modesto, Fresno, and Bakersfield.[1] The study found that daily exposure to high PM2.5 concentrations was significantly correlated with increased daily hospital and emergency room admission rates for asthma and other respiratory and cardiovascular diseases. To follow-up on this study, the District sponsored another epidemiological study to examine which of the chemical species found in Valley PM2.5 are most highly correlated with hospital admission rates. In more detail, the study explored statistical associations between varying concentrations of PM2.5 components (e.g. ammonium nitrate, ammonium sulfate, organic carbon, elemental carbon) and health outcomes, including emergency department visits and hospitalizations associated with selected cardiovascular and respiratory conditions.

  The District also sponsored a pilot study of PM0.1 (ultrafine particles) in Fresno, where UCSF-Fresno investigated the quantity and spatial distribution of PM0.1 plumes from motor vehicles, lawn care equipment, wood burning, and restaurants. Following this study, the District then funded a UC Davis research project to develop a model of PM0.1 population exposure in the Valley based on previous Valley observational research. PM0.1 exposure was correlated with short- and long-term health effects by making use of the large body of Valley epidemiological data that has been generated by the previous studies described above.

  In addition, the District sponsored a project with Providence Engineering to conduct a study examining differences in exposure to PM2.5 in residential neighborhoods. In this field project, Providence deployed approximately 30 passive PM samplers in neighborhoods across the Fresno area to provide a better spatial understanding of concentration variation in the urban area. The samples were analyzed later in a laboratory to provide particle size, mass, and speciation estimates, followed by source apportionment analysis. Overall, the project provided the District with a finer understanding of how the health risk of fine particles varies in different urban locations. The District will continue to seek out and fund research opportunities that further the understanding of PM-related impacts on public health.

[1] Capitman, J.A., & Tyner, T.R. (2011). *The Impacts of Short-Term Changes in Air Quality on Emergency Room and Hospital Use in California's San Joaquin Valley*. Fresno, CA: Central Valley Health Policy Institute for the San Joaquin Valley Air Pollution Control District. Retrieved from http://www.fresnostate.edu/chhs/cvhpi/publications/index.html

3.4 Toxicity of Chemical Species

PM2.5 particles vary in their toxicity depending on their chemical composition. PM2.5 particles are characterized by a widely diverse combination of chemicals depending on unique regional combinations of meteorology, topography, and pollution sources. In addition to experimental and clinical research that has identified these toxicity differences, epidemiological studies have found regional differences in health impacts despite comparable regional PM2.5 mass exposure.[8] Beyond the intrinsic toxicity of individual chemicals, the unique combinations of chemicals generated by some sources can actually magnify health risk above and beyond what their mass concentrations would suggest.[9]

Many emissions sources evaluated in this Plan are sources of direct (primary) PM2.5 emissions characterized by a unique combination of chemical species. Other sources emit chemical species such as ammonia and nitrogen oxides (NOx), precursors that contribute to the formation of secondary PM2.5 species. The PM2.5 chemical species categories adopted in the exposure characterization model include elemental carbon (carbon black), organic carbon compounds (OC), metals (elements), ammonium nitrate, ammonium sulfate, and geological. PM2.5 is regularly speciated at several Valley monitoring sites. The following discussion provides an overview of PM2.5 species and their associated health impacts.

Organic carbon (OC): OC species found in PM2.5 aerosol are generated as primary organic aerosol (POA), predominantly through the combustion of hydrocarbons. Key POA sources include cooking, industrial processes, mobile source exhaust, prescribed burning, tire wear, and wood burning.[10] Secondary organic aerosols (SOA) are formed from the oxidation of motor vehicle hydrocarbons, prescribed burning, wood burning, solvent use, and industrial processes.

OC is recognized as one of the most biologically reactive of PM2.5 chemical species categories, with ample evidence of high toxicity found in experimental, clinical, and epidemiological studies. OC, often in combination with metals such as iron, has been shown to generate reactive oxygen species (ROS) that drive several different mechanisms of pulmonary inflammation, including disruption of normal immune system functioning.[11] In addition, OC and metals have been shown to indirectly stimulate ROS production by macrophages, which are cells responsible for defending the lungs from pathogens and aerosols.

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[8] Bell, M.L. (2012). *Assessment of the Health Impacts of Particulate Matter Characteristics*. Research Report 161. Boston: MA. Health Effects Institute. Retrieved from http://pubs.healtheffects.org/getfile.php?u=685

[9] Kelly, F.J. (2006). Oxidative Stress: Its Role in Air Pollution and Adverse Health Effects. *Occupational Environmental Medicine, 60,* 612–616. Retrieved from http://oem.bmj.com/content/60/8/612.full doi: doi:10.1136/oem.60.8.612

[10] U.S. Environmental Protection Agency [EPA]. (2004, October). *Air Quality Criteria for Particulate Matter: Final Report*. Washington, D.C.: EPA 600/P-99/002aF-bF. Available at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=87903

[11] Ayres, J.G., Borm, P., Cassee, F.R., Castranova, V., Donaldson, K., Ghio, A. … Froines, J. (2008) Evaluating the Toxicity of Airborne Particulate Matter and Nanoparticles by Measuring Oxidative Stress Potential—A Workshop Report and Consensus Statement. *Inhalation Toxicology 20,* 75–99. Retrieved from http://faculty.unlv.edu/buckb/scanned%20pfd/Ayres%20et%20al%202008.pdf

One of the primary OC species categories is polycyclic aromatic hydrocarbons (PAH). PAH species fall into two categories: a high molecular weight fraction and a low molecular weight fraction. The former is found in diesel exhaust and engine oil and is a significant risk factor for lung cancer.[12] Low molecular weight PAH is found in other hydrocarbon combustion particles and serves as a precursor to the formation of an important OC species category known as quinones. Formed from atmospheric processing of PAH or within the body (in vivo), quinones have been shown to be one of the most important drivers of pulmonary oxidative stress, resulting in a host of negative spillover effects on immune system functioning.[13] Quinone formation via chemical aging of PAH occurs during multi-day winter stagnation events in the Valley. A District-funded clinical study of asthmatic patients in Fresno found that quinone levels in urine correlated with sustained (multi-day) high ambient concentrations of PM2.5 and was accompanied by decreased lung function.[14]

Elemental carbon (EC): Elemental carbon is found in combustion-based aerosols produced by mobile exhaust (mainly diesel), wood burning, and cooking (especially charbroiling). Compared to OC species, there is limited evidence of comparable impacts on ROS production, pulmonary inflammation, and immune system disruption. For example, EC appears not to be a significant agent for the induction of inflammation in macrophage cells, indicating a significantly lower toxicity level relative to OC species.[15] A recent study of PM 0.1-based exposure of EC in mice found modest cardiovascular effects. Pulmonary inflammation was noted but only at high doses beyond normal ambient concentrations.[16] A recent study in Mexico City found an association between exposure levels of EC and lung function decrements among asthmatic and non-asthmatic children.[17]

Characterization of health effects of elemental carbon from human exposure studies is complicated by the high correlation between EC, OC, and metals emitted by diesel exhaust. Exposure to EC is a PM2.5 risk factor, although there is more evidence to date that other chemical species, e.g. metals and OC, found in these particles are the primary drivers of negative health effects.

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[12] Landvik, N.E., Gorria, M., Arlt, V.M., Asare, N., Solhaug, A., Lagadic-Gossmann, D., & Holme, J.A. (2007). Effects of Nitrated-Polycyclic Aromatic Hydrocarbons and Diesel Exhaust Particle Extracts on Cell Signalling Related to Apoptosis:Possible Implications for their mutagenic and Carcinogenic Effects. Toxicology, 231, 159–174. doi:10.1016/J.tox.2006.12.009

[13] Bolton, J., Trush, M.A., Penning, T.M., Dryhurst, G., & Monks, T.J. (2000). Role of Quinones in Toxicology. *Chemical Research in Toxicology, 13(3)*, 135–160. doi: 10.1021/tx99

[14] Ikeda, A., Vu, K.K.-T., Lim, D., Tyner, T.R., Krishnan, V.V., & Hasson, A.L. (2012). An Investigation of the Use of Urinary Quinones as Environmental Biomarkers for Exposure to Ambient Particle-Borne Pollutants. *Science of the Total Environment* (submitted).

[15] Vogel, C.F., Sciullo, E., Wong, P., Kuzmicky, P., Kado, N. & Matsumura, F. (2005). Induction of Proinflammatory Cytokines and C-Reactive Protein in Human Macrophage Cell Line U937 Exposed to Air Pollution Particulates. *Environmental Health Perspectives 113(11)*, 1536–1541.

[16] Vesterdal, L.K., Folkmann, J.K., Jacobsen, N.R., Sheykhzade, M., Wallin, H., Loft, S., & Møller, P. (2010). Pulmonary Exposure to Carbon Black Nanoparticles and Vascular Effects. *Particle and Fibre Toxicology 7:33*. Retrieved from http://www.particleandfibretoxicology.com/content/7/1/33 doi: 10.1186/1743-8977-7-33

[17] Barraza-Villarreal, A., Escamilla-Nuñez M.C., Hernández-Cadena L., Texcalac-Sangrador. J.L., Sienra-Monge, J.J., Del Río-Navarro, B., Cortez-Lugo, M., Sly, P.D., & Romieu, I. (2011). Elemental Carbon Exposure and Lung Function in Schoolchildren from Mexico City. *European Respiratory Journal, 38,* 548–552.

Metals: A combination of clinical, experimental, and epidemiological studies have implicated several of the metals found in PM2.5 with negative respiratory or cardiovascular outcomes, sometimes in conjunction with the action of OC species. One of the most important is iron because of its ability to catalyze the production of hydrogen peroxide, leading to highly reactive hydroxyl radicals (OH). In turn, these highly reactive chemicals stimulate the production and action of cytokines by macrophages. Cytokines are cell-signaling molecules that are critical to normal functioning of the immune system. A recent experimental study examined the impact of iron in silica particles in triggering respiratory toxicity.[18] Compared to silica particles with no iron, silica particles with iron were found to have a significantly greater effect on oxidative stress via hydrogen peroxide production with subsequent stimulus of cytokines by macrophages.

Extensive research relates exposure in metals (particularly nickel and vanadium) in PM2.5 to cardiovascular effects. A national epidemiological study recently found that communities with higher fractions of nickel, vanadium, and EC in their PM2.5 also had higher risk of cardiovascular and respiratory hospitalization.[19] Specifically, cardiovascular hospitalizations were 26% higher in counties with a nickel fraction in the 75th percentile versus counties with nickel in the 25% percentile. In an investigation of the relatively higher association between PM2.5 daily concentrations and daily rates of cardiovascular mortality in New York City, the exceptionally high level of nickel and vanadium resulting from residual oil fly ash used for heating and as fuel for ships were identified as a principle cardiovascular risk factor.[20] In a related study, rats exposed to PM2.5 with high fractions of chromium, iron, and nickel fractions responded with significantly reduced heart rate variability and increased heart rates, each being an indicator of cardiovascular disruption and risk.[21]

In conclusion, metals found in PM2.5 produced from combustion of coal, residual oil, diesel fuel, and motor oil are recognized as chemical drivers of cardiovascular and respiratory morbidity and mortality. This has led some researchers to conclude that regional differences in U.S. cardiovascular mortality that cannot be explained by differences in average daily PM2.5 concentrations are likely to be caused by regional differences in coal combustion and resultant exposure to metals and OC.[22]

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[18] Premasekharan, G., Nguyen, K., Contreras, J., Ramon, V., Leppert, V.J. & Forman, H.J. (2011). Iron-Mediated Lipid Peroxidation and Lipid Raft Disruption in Low-Dose Silica-Induced Macrophage Cytokine Production. *Free Radical Biology and Medicine, 51(6)*, 1184–1194. doi: 10.1016/j.freeradbiomed.2011.06.018

[19] Bell, M.L., Ebisu, K., Peng, R.D., Samet, J.M. & Dominici, F. (2009). Hospital Admissions and Chemical Composition of Fine Particle Air Pollution. *American Journal of Respiratory Critical Care, 179*, 1115–1120. Retrieved from http://ajrccm.atsjournals.org/content/179/12/1115.full.pdf+html

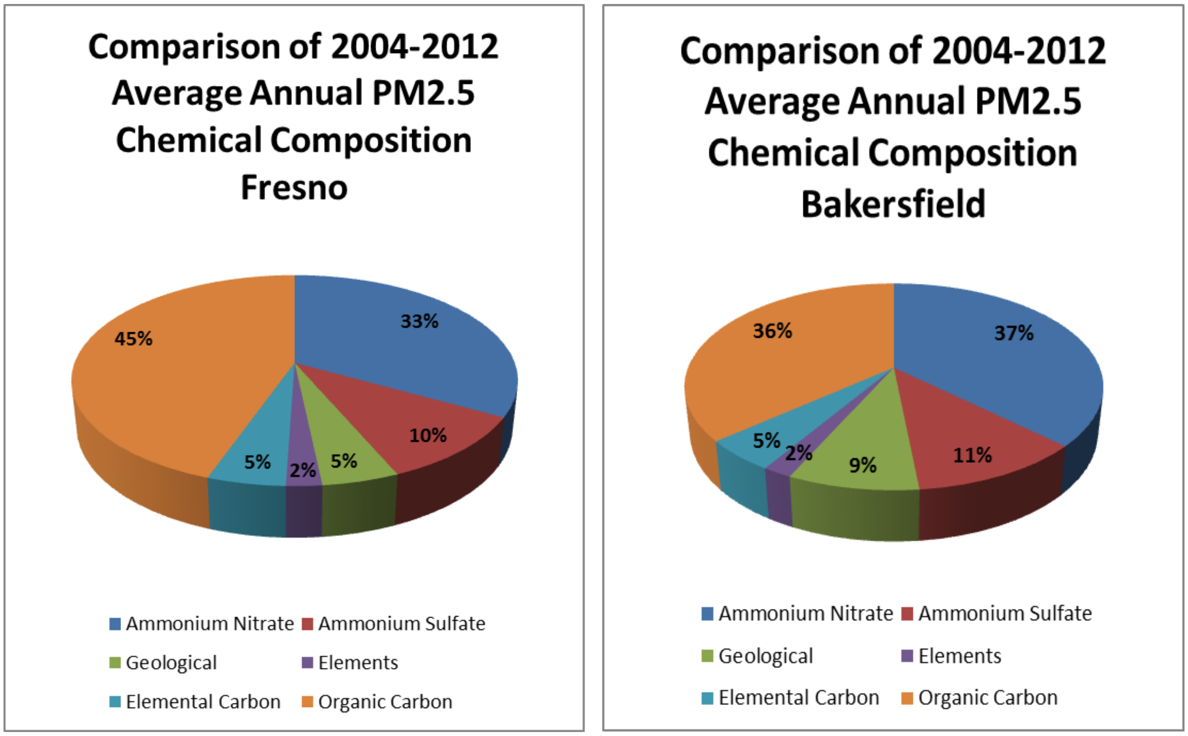
[20] Lippmann, M., Ito, K., Hwang, J-S., Maciejczyk, P., & Chen, L-C. (2006). Cardiovascular Effects of Nickel in Ambient Air. *Environmental Health Perspectives*, *114(11)*, 1662–1669. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1665439/

[21] Chen, L.C., & Lippmann, M. (2009). Effects of Metals within Ambient Air Particulate Matter (PM) on Human Health. *Inhalation Toxicology, 21(1),* 1–31. Retrieved from http://faculty.unlv.edu/buckb/scanned%20pfd/Chen%20and%20Lippmann%202009.pdf

[22] Lippman, M. (2012, April 16). Presentation: Results from National Particle Component Toxicity (NPACT) Program and NYU: Toxicology Findings, Integration, and implications. Presented at the Annual Meeting of the Health Effects Institute (HEI) in Chicago, IL, April 15–17, 2012. Presentation retrieved from http://www.healtheffects.org/Slides/AnnConf2012/Lippmann-MonPM.pdf

Ammonium nitrate: Ammonium nitrate is classified as a secondary inorganic species (not directly emitted) primary source of PM2.5, and it does not contain carbon. Nitrate is formed by atmospheric reactions between two precursors: ammonia and nitric acid. Prior to this reaction, nitric acid generally originates from the chemical processing of nitrogen oxides (NOx), largely from fuel combustion during multiday stagnation events. As seen in Figure 3-6, ammonium nitrate is significant because it can contribute up to almost 40% of PM2.5 mass on an annual average day basis.

Figure 3-6 Annual Average PM2.5 Chemical Composition



The relative toxicity of ammonium nitrate is an important issue given its substantial mass contribution to regional PM2.5. The oral toxicity of nitrate is very low, with an LD50 (dose causing death for 50% of the exposed subjects) reported to be two thirds that of table salt. This raises the question as to whether other factors intrinsic to inhalation could lead to health effects at considerably lower exposure concentrations. As seen in the case of OC species, the most compelling evidence of species toxicity is built on a foundation of experimental, clinical, and epidemiological research. In particular, epidemiological studies draw their inferences from statistical associations between exposure variables and health outcomes only. Uncovering the actual mechanisms of harm, therefore, requires further isolation of mechanisms through experimental and clinical research.

In the case of ammonium nitrate, evidence of toxicity is largely limited to epidemiological research alone. For example, a recent epidemiological study of traffic air toxics and pre-term birth in Los Angeles found statistical associations between nitrate mass, PAH, and several other air pollutants and the increased likelihood of pre-term birth.[23] The authors point to other experimental studies that identified very high oxidative stress potential resulting from PAHs, metals, and other OC species collected from Los Angeles traffic sources as being the likely mechanism for pre-term birth. They conclude by emphasizing the need to further study the links between pre-term birth and PAH exposure.

One experimental study was found that explicitly looked for toxic mechanisms driven by ammonium nitrate.[24] The study exposed rats to high concentrations of nitrate (70 to 420 $\mu g/m^3$) in combination with EC. After exposure, animals were sacrificed and a necropsy was performed, followed by a range of tests for pathological impacts between the control (non-exposed) and exposed groups. The authors did not find abnormalities that could be tied to the experimental exposure to nitrate alone or in combination with EC. This absence of experimental evidence for mechanisms of pathology for inhaled ammonium nitrate is consistent with its low oral toxicity.

Ammonium sulfate: Ammonium sulfate (sulfate) is also classified as a secondary inorganic species. It is formed when sulfuric acid, itself a product of oxidation of sulfur, reacts with ammonia. Mass concentrations of sulfate are significantly lower than for nitrate in the Valley, averaging from 10% to 11% of PM2.5 mass on an annual average basis. Fossil fuel combustion is the primary source of sulfate in the Valley, but globally, coal combustion is the primary source. Unlike nitrate, mass concentrations of sulfate are not appreciably different in cold and hot seasons.

Research findings regarding the toxicity of sulfate are comparable to that of nitrate. Oral toxicity is low and it is approved as a food additive by the US Food and Drug Administration and the European Union. One study[25] examined the response of 20 non-smoking subjects to four-hour exposure sessions in chambers containing 500 $\mu g/m^3$ of sulfate aerosol, a concentration over two orders of magnitude above ambient levels in the Valley. Pulmonary function tests were performed to assess the response of these exposures. No significant changes in pulmonary function or bronchial reactivity were observed immediately after the individual exposures or 24 hours after exposure. In an experimental study that also exposed rats to 500 $\mu g/m^3$ of sulfate for four to eight months, modest pulmonary impacts were noted.[26] After four months, cellular immunologic responsiveness was not impaired, but physiologic changes were detected, including enlargement of bronchial epithelial (surface) cells and in alveolar size.

[23] Wilhelm, M., Ghosh, J.K., Su, J., Cockburn, M., Jerrett, M. & Ritz, B. (2011). Traffic-Related Air Toxics and Preterm Birth: A Population-Based Case-Control Study in Los Angeles County, California. *Environmental Health 10: 89*. Available at http://www.ehjournal.net/content/10/1/89/ doi: 10.1186/1476-069X-10-89

[24] Cassee, F., Arts, J.H., Fokkens, P.H., Spoor, S.M., Boere, A.J., van Bree, L., & Dormans, J.A. (2002). Pulmonary Effects of Ultrafine and Fine Ammonium Salts Aerosols in Healthy and Monocrotaline-Treated Rats Following Short-Term Exposure. *Inhalation Toxicology, 14(12)*, 1215–1229. doi: 10.1080/08958370290084872

[25] Kulle, T.J., Sauder, L.R., Shanty, F., Kerr, H.D., Ferrell, B.P., Miller, W.R., & Milman, J.H. (1984). Sulfur Dioxide and Ammonium Sulfate Effects on Pulmonary Function and Bronchial Reactivity in Human Subjects. *American Industrial Hygiene Association Journal, 45(3)*, 156–161. ISSN:1542-8125

[26] Smith, L.G., Busch, R.H., Buschbom, R.L., Cannon, W.C., Loscutoff, S.M., & Morris, J.E. (1989). Effects of Sulfur Dioxide or Ammonium Sulfate Exposure, Alone or Combined, for 4 or 8 Months on Normal and Elastase-Impaired Rats. *Environmental Research 49(1)*, 60-78. doi: 10.1016/S0013-9351(89)80022-2

For each of these studies, the modest health impacts observed at very high exposure levels are consistent with the low intrinsic toxicity of sulfate. This is consistent with results of a review of the epidemiological and toxicological research on sulfate.[27] Researchers found that PM sulfate was a weaker indicator of health risk than PM2.5 mass. Because sulfate is correlated with PM2.5 mass, this result is inconsistent with sulfate having a strong health influence. The study concluded that the epidemiologic and toxicologic evidence provide little or no support for a causal association of sulfate and health risk at ambient concentrations.

Geological: Winter season and annual average PM2.5 found in the Valley contains a very small fraction of species that are termed *crustal*, i.e. having their origins in the earth's crust. This coarse fraction—PM 2.5-10—contains a much higher fraction, as do particles beyond the PM10 size category. Suspended dust consists mainly of oxides of aluminum, silicon, calcium, titanium, iron, and other metal oxides. The precise combination of these components depends on the geology, industrial, and agricultural processes of the area. Geological material typically consists of 5% to 15% PM particles.

Other researchers examined the respiratory inflammation potential of PM2.5 soil dust from windblown dust and vehicle-generated particles from unpaved roads, taken from nine different sites in the western U.S.[28] None of the sites were located in the Valley. Cultured human epithelial cells were exposed and then were assessed for their release of cytokines known to be triggered by oxidative stress. PM2.5 from five of the sites was found to be benign, three of the sites demonstrated measurable cytokine response, and PM2.5 from one site was found to be highly reactive. Endotoxin, a potentially reactive bio-aerosol that is often found in PM, was not found to be a contributing factor to the variations in inflammatory potential.

Although not technically a geologic species, respirable road dust (RRD) has been recognized and analyzed as a separate form of PM2.5 that has relevance to exposure characterization. In this context, RRD is defined as PM less than 2.5 microns in diameter that is deposited along paved roadways as a result of roadway breakdown, tire wear, brake wear, deposition of exhaust-related particles, and other anthropogenic sources. Speciation analysis[29] of RRD in southern California identified over 100 organic compounds including n-alkanes, n-alkanoic acids, n-alkenoic acids, n-alkanals, n-alkanols, benzoic acids, benzaldehydes, polyalkylene glycol ethers, PAH, oxy-PAH, steranes, hopanes, natural resins, and other compound classes. This relatively toxic mix of OC species is coincident with a range of metals associated with motor vehicle

[27] Reiss, R., Anderson, E.L., Cross, C.E., Hidy, G., Hoel, D., McClellan, R., Moolgavkar, S. (2007). Evidence of Health Impacts of Sulfate-and Nitrate-Containing Particles in Ambient Air. *Inhalation Toxicology, 19(5),* 419-449. doi:10.1080/08958370601174941

[28] Veranth, J., Rielly, C.A., Veranth, M.M., Moss, T.A., Langelier, C.R., Lanza, D.L., & Yost, G.S. (2004). Inflammatory Cytokines and Cell Death in BEAS-2B Lung Cells Treated with Soil Dust, Lipopolysaccharide, and Surface-Modified Particles. *Toxicological Science 82(1)*, 88–96. Retrieved from http://toxsci.oxfordjournals.org/content/82/1/88.full.pdf+html doi: 10.1093/toxsci/kfh24

[29] Rogge, W. F., Hildemann, L. M., Mazurek, M. A., Cass, G. R. and Simoneit, B. R. T. (1993). Sources of Fine Organic Aerosol—3. Road Dust, Tire Debris, and Organometallic Brake Lining Dust—Roads As Sources and Sinks. *Environmental Science & Technology 27(9),* 1892-1904.

exhaust and component wear. RRD particles are re-suspended by passing traffic, leaf blowers, and other sources for possible inhalation by individuals in or near the roadway.

To conclude, the geologic fraction of PM2.5 found in the Valley makes a relatively small contribution to overall PM2.5 mass and, by itself, has relatively low toxicity. RRD, while not of geologic origins, has been reviewed here because of its relevance to subsequent exposure characterization of sources.

3.5 PARTICLE SIZE AND DEPOSITION

Particle size has a significant bearing on bodily deposition, net exposure, and corresponding health risk, even within the PM2.5 size fraction. Key metrics for deposition assessment include the percentage of inhaled particles that remain deposited and not exhaled (known as the deposition fraction) and the location where particles are deposited within the body).[30] Within the PM2.5 size range, particles less than 0.1 microns (PM 0.1) and greater than 10 microns are least likely to be exhaled, and thus have higher deposition fractions.[31]

The relationship between particle size, zone of deposition, and deposition fraction are depicted in Figure 3-7 and is summarized as follows:

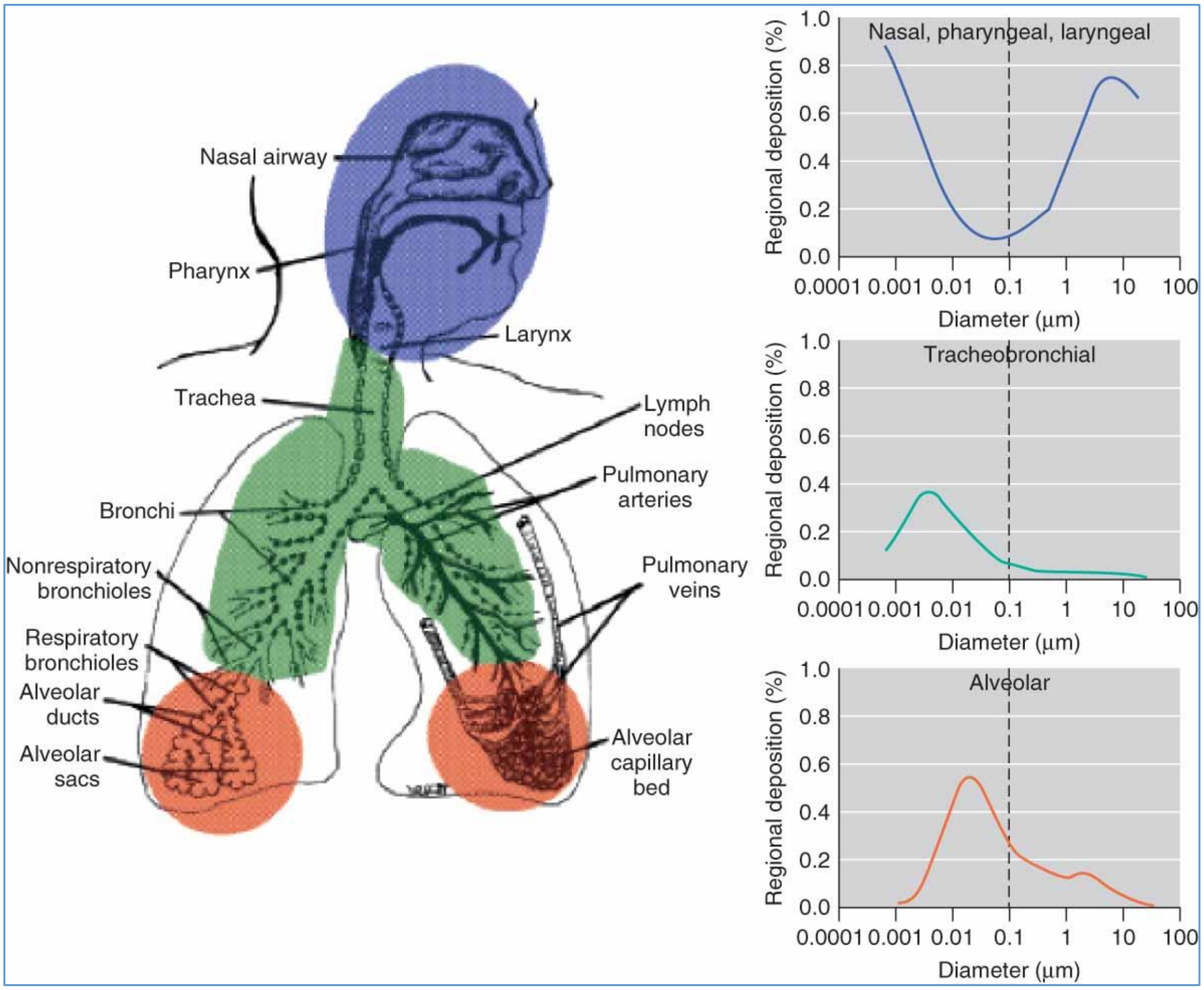
- **Nasal, pharyngeal, laryngeal:** The uppermost segment of the respiratory tract is the primary zone of deposition for the smallest and largest particles. Approximately 80% of extremely small particles of one nanometer (0.001 micron) diameter or less are retained here with a comparable deposition fraction in the 10 micron diameter.

- **Tracheobronchial:** The deposition fraction in this zone peaks at nearly 40% for particles with diameters between 1 and 10 nanometers. Almost 100% of the particles above the PM 0.1 size cut are either deposited in the other two deposition zones or exhaled.

- **Alveolar:** Deposition in the gas exchange zone of the lungs peaks in the 10 nanometer size with a gradual dissipation of deposition beyond the PM 0.1 size.

[30] International Commission on Radiological Protection [ICRP]. (1995). Human Respiratory Tract Model for Radiological Protection. ICRP Publication 66.. *Annals of the ICRP 24,* 1–3.
[31] U.S. Environmental Protection Agency [EPA]. (2004, October). *Air Quality Criteria for Particulate Matter: Final Report*. Washington, D.C.: EPA 600/P-99/002aF-bF. Available at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=87903

- **Figure 3-7 Relationships between Particle Size Distribution and Respiratory Deposition Zones**



Deposition of very small particles in the alveolar region of the lungs results in the delivery of their chemicals into the bloodstream where they promote cardiovascular disruption and immune system sensitization.[32] These chemicals can trigger heart attacks and premature death among individuals with pre-existing heart conditions.[33] Extremely small particles can also be absorbed into the brain via the nasal tract, bypassing the protection provided by the blood-brain barrier.[34] The effects of particles deposited primarily in the tracheobronchial region center on respiratory function.[35]

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[32] Delfino, R.J., Sioutas, C., & Malik, S. (2005). Potential Role of Ultrafine Particles in Associations between Airborne Particle Mass and Cardiovascular Health. *Environmental Health Perspectives 113(8),* 934–946. Retrieved from http://ehp03.niehs.nih.gov/article/fetchArticle.action?articleURI=info%3Adoi%2F10.1289%2Fehp.7938

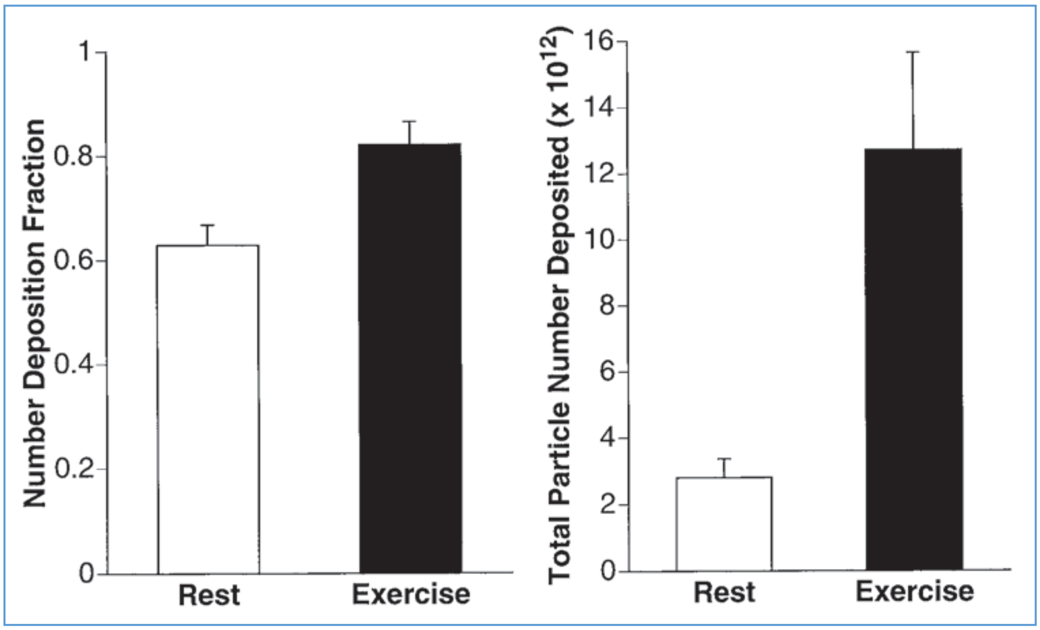
[33] Nel A. (2005). Air Pollution-Related Illness: Effects of Particles. *Science, 308(5723),* 804–806. doi: 10.1126/science.1108752

[34] Oberdorster, G., Sharp, Z., Atudorei, V., Elder, A., Gelein, R., Kreyling, W., & Cox, C. (2004). Translocation of Inhaled Ultrafine Particles to the Brain. *Inhalation Toxicology, 16(6-7)*, 437–445.

[35] U.S. Environmental Protection Agency [EPA]. (2009). *Integrated Science Assessment for Particulate Matter: Final Report*. Washington, D.C.: EPA/600/R-08/139F. Available at http://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=216546

As depicted in Figure 3-8, particle deposition and associated health risk is magnified by exercise in several ways. First, the amount of inhaled air per minute rises substantially when breathing faster and more deeply. Second, breathing harder means that particles, especially PM 0.1, are more likely to penetrate the alveolar region of the lungs where absorption into the bloodstream occurs. A 2003 study[36] found that during moderate exercise 80% of inhaled PM 0.1 was deposited in the lungs, compared with 60% lung retention while at rest (see left panel in Figure 3-8). However, because the volume of air exchanged per minute increases substantially during exercise, overall PM 0.1 deposition increased by 450% (right panel). This phenomenon underscores the health risk posed to individuals who work or exercise in areas where sources of hydrocarbon combustion result in very high PM 0.1 particle concentrations.

Figure 3-8 Particle Number Deposition Fraction (DF) and Total Particle Deposition of PM 0.1 at Rest and Exercise



3.6 Exposure to Ultrafine Particles (PM 0.1)

Elevated exposure to freshly emitted PM 0.1 is a critical health risk factor that often does not correspond to ambient PM2.5 concentrations at local monitors. PM 0.1 are formed through nucleation and gas-to-particle reactions and grow (or shrink) through a number of mechanisms including condensation, coagulation, and volatilization.[37] High concentrations of primary (directly emitted) PM 0.1 are typically found near fresh sources of hydrocarbon combustion, including coal plants, charbroiled meat, diesel and gasoline vehicles, wood combustion, and lawn care equipment. These combustion

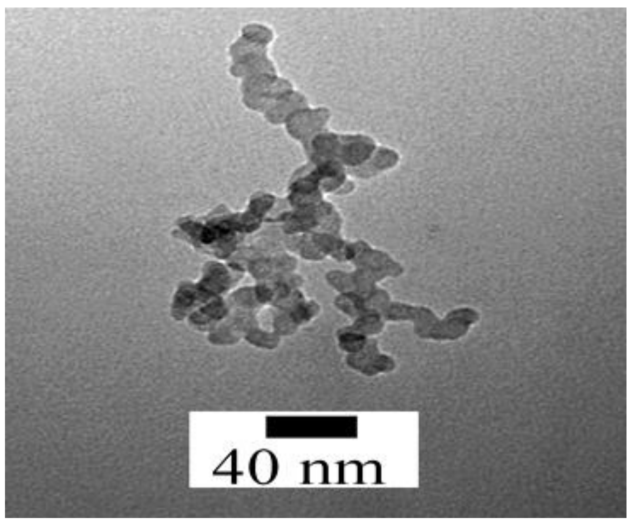
[36] Daigle, C., Chalupa, D.C., Gibb, F.R., Morrow, P.E., Oberdörster, G., Utell, M.J., & Frampton, M.W. (2003). Ultrafine Particle Deposition in Humans during Rest and Exercise. *Inhalation Toxicology, 15(6)*, 539–552. doi: 10.1080/08958370304468

[37] Solomon, P. (2012). An Overview of Ultrafine Particles in Ambient Air. *EM: Journal of the Air & Waste Management Association, May,* 18–26.

particles start out very small, grow larger over time and space, and evolve chemically at the same time. Secondary PM 0.1 typically is formed via particle nucleation from gas or liquids and is characterized by larger geographic scales and more uniform population exposure.

Despite being extremely small, PM 0.1 has an extremely high surface area, as seen in Figure 3-9. Compared to an equal mass of particles of two microns (PM 2.0) in diameter, ultrafine particles that are 1,000 times smaller (20 nanometers or PM 0.02) nonetheless have 125 times the surface area.[38] In addition, PM 0.1 produced by hydrocarbon combustion typically contain a rich mixture of chemicals with potential health effects, including nickel, iron, vanadium, PAH, and others.[39] Chemical potency, very high surface area, and alveolar deposition are signal characteristics of PM 0.1 from hydrocarbon combustion that result in significant health risks from chronic exposure.

Figure 3-9 Electron Micrograph of an Ultrafine Particle[40]



Sub-populations who live or work near sources of primary PM 0.1 from hydrocarbon combustion are particularly at risk. Health scientists have generated an overwhelming body of epidemiological (statistical) evidence that individuals near freeways (less than 300 meters) are being harmed via chronic inhalation of PM 0.1 from vehicles.[41] Similarly, a 2011 study of residential wood burning in Cambria, California found very high neighborhood concentrations of PM 0.1 from wood smoke even though concentrations of PM2.5 at the nearby ambient monitor met the federal health

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[38] Donaldson, K., Stone, V., Clouter, A., Renwick, L., & MacNee W. (2001). Ultrafine Particles. *Occupational Environmental Medicine 58*, 211–216.Retrieved from http://oem.bmj.com/content/58/3/211.short doi: 10.1136/oem.58.3.21

[39] Morawska, L., Ristovski, Z., & Jayaratne, E.R. (2008). Ambient Nano and Ultrafine Particles from Motor Vehicle Emissions: Characteristics, Ambient Processing and Implications on Human Exposure. *Atmospheric Environment, 42(35)*, 8113–8138. doi: 10.1016/j.atmosenv.2008.07.050

[40] Nel A. (2005). Air Pollution-Related Illness: Effects of Particles. *Science, 308(5723),* 804–806. doi: 10.1126/science.1108752

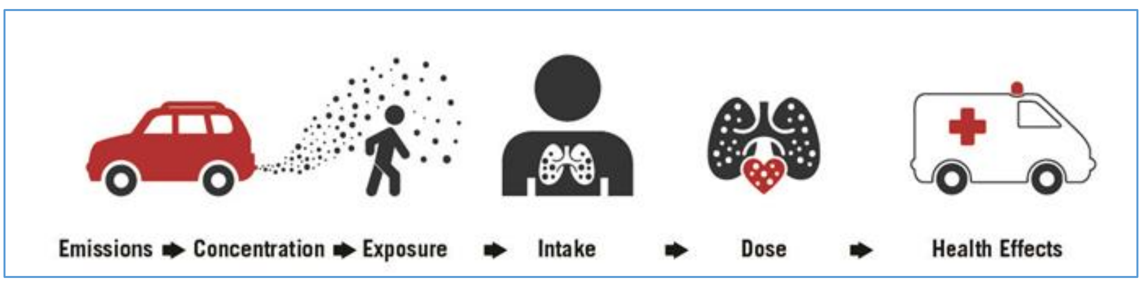
[41] Gauderman, W., Vora, H., McConnell, R., Berhane, K., Gilliland, F., Thomas, … Peters, J. (2007). Effect of Exposure to Traffic on Lung Development from 10 to 18 Years of Age: A Cohort Study. *The Lancet 369(9561*), 571–577. Retrieved from http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(07)60037-3/fulltext#article_upsell

standard.[42] The health risk from fresh sources of PM 0.1 has important environmental justice implications to the extent that elevated exposure to near-source PM 0.1 is concentrated in communities that already face sources of risk related to race or socioeconomic status.[43] Chronic exposure to near-source PM 0.1 commonly occurs in locations where local monitors are in attainment for PM2.5 standards and during seasons when ambient PM2.5 concentrations are below the annual daily standard.

3.7 Population Proximity and Intake Fraction

Estimating total exposure and net health risk from a given source of PM2.5 requires that population proximity and population density be considered in addition to the source's contribution to the regional PM2.5 emissions inventory and its toxicity. In addition to factors governing net deposition of inhaled particles reviewed above, net population exposure from the source in question is also shaped by the number of exposed individuals who inhale the emissions and the duration of exposure in conjunction with aerosol concentration levels (see Figure 3-10). Known as the intake fraction, this measure of population exposure is defined empirically as the pollutant mass inhaled divided by the mass emitted.[44] Intake fraction is useful in connecting emissions to health risk because the mass inhaled is a better indicator of health risk than the mass emitted or airborne concentration. Two different pollutant sources with very comparable emission rates of the same pollutant can nonetheless have significantly different intake fractions depending on the surrounding population density. For example, sources of PM2.5 located in rural areas may have an intake fraction that is 10 to 100 times smaller than a comparable source located within a densely populated city.

Figure 3-10 Simplified Intake Fraction Model



The relevance of the intake fraction concept can be seen in a recent study of neighborhood variability in wood smoke concentrations in Cambria, California.[45] The

[42] Thatcher, T. & Kirchstetter, T. (2011). *Assessing Near-Field Exposures from Distributed Residential Wood Smoke Combustion Sources*. Report prepared for the California Air Resources Board. Retrieved from http://www.arb.ca.gov/research/rsc/10-28-11/item2dfr07-308.pdf

[43] London, J., Huang, G., & Zagofsky, T. (2011). *Land of Risk, Land of Opportunity: Cumulative Environmental Vulnerabilities in California's San Joaquin Valley*. Davis, CA: University of California, Davis, Center for Regional Change. Retrieved from http://regionalchange.ucdavis.edu/publications/Report_Land_of_Risk_Land_of_Opportunity.pdf

[44] Marshall, J.D., & Nazaroff, W.W. (2004, October). *Using Intake Fraction to Guide CARB Policy Choices: The Case of Particulate Matter*. Unpublished California Air Resources Board Report.

[45] Thatcher, T. & Kirchstetter, T. (2011). *Assessing Near-Field Exposures from Distributed Residential Wood Smoke Combustion Sources*. Report prepared for the California Air Resources Board. Retrieved from http://www.arb.ca.gov/research/rsc/10-28-11/item2dfr07-308.pdf

winter study found very high concentrations of PM 0.1 on a neighborhood scale that were often not reflected in PM2.5 concentrations measured by local air quality monitors. In effect, a single wood-burning household had the effect of enveloping the adjacent and downwind homes with a PM 0.1 plume. Furthermore, the study also found that wood smoke PM 0.1 was infiltrating adjacent homes that were not burning, with an average indoor concentration found to be 74% as high as immediately outside the homes. Taking into consideration the length of PM 0.1 inhalation during sleeping hours, the relatively high concentration of PM 0.1 found in the plume, and the number affected of individuals in an urban neighborhood, the intake fraction resulting from the source of the wood smoke would be very high. Assuming that this nightly exposure occurred over the course of a season, the cumulative health risk to the neighborhood would be considerable and would almost certainly exceed the risk indicated by daily concentrations of PM2.5 measured by ambient monitors.

Chapter 4
Attainment Strategy for PM2.5

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4. ATTAINMENT STRATEGY FOR PM2.5

This chapter lays out the strategy for attainment of multiple PM2.5 national ambient air quality standards (standards, or NAAQS) of following. Preparing a single Plan addressing multiple standards instead of three separate Plans allows for development of a more robust and health-protective Plan that incorporates stronger control measures on a more expeditious timeframe than may otherwise be required. Furthermore, a focused public process provides greater opportunity for public engagement and participation in the PM2.5 attainment planning process.

1997 PM2.5 Standard (24-hour 65 µg/m³ and Annual 15 µg/m³)

- Plan focus on annual standard – San Joaquin Valley has already attained 24-hour portion of the standard, based on monitoring data from the three year period from 2014 to 2016
- Attainment deadline December 31, 2015
- Serious area 5% Plan with attainment deadline of December 31, 2020

2006 24-hour PM2.5 standard of 35 µg/m³

- Serious area Plan with attainment deadline of December 31, 2024 with 5-year extension request

2012 annual PM2.5 standard of 12 µg/m³:

- Attainment deadline under "Serious" classification of December 31, 2025
- This Plan would be submitted three years ahead of 2022 federal submission deadline

This Plan contains a comprehensive suite of regulatory and incentive-based measures to be implemented by the San Joaquin Valley Air Pollution Control District's (District) and California Air Resources Board (CARB) to achieve the emissions reductions necessary to attain the PM2.5 standards. This plan builds upon comprehensive strategies already in place from previously adopted District plans and CARB State strategies. As such, this attainment strategy relies on existing measures already in place for stationary, area, and mobile sources, as adopted and implemented by the District and CARB. The aggressive regulatory and incentive-based measures proposed by both the District and CARB, combined with existing measures achieving new emissions reductions will achieve the emissions reductions necessary to attain each federal PM2.5 standard as expeditiously as practicable, as evidenced by the photochemical air quality modeling performed by CARB (see Appendix K). This Plan demonstrates the District's ongoing efforts to improve air quality in the Valley through a comprehensive strategy as follows:

Regulatory measures that build off existing stringent requirements, including new stationary source measures to further strengthen NOx and/or PM2.5 requirements to achieve greater emissions reductions from flaring activities, internal combustion engines, boilers/steam generators, glass melting furnaces, agricultural operations, and other local sources.

Incentive-based measures that accelerate the deployment of cleaner vehicles and technologies in a variety of sectors, including residential wood combustion, agricultural internal combustion engines, agricultural equipment, heavy duty trucks, off-road equipment, transit buses, school buses, freight equipment, passenger vehicles, locomotives, commercial lawn and garden equipment, and other sources.

Targeted "hot-spot" strategy that focuses additional regulatory and incentive-based measures for residential wood burning and commercial charbroiling operations in remaining areas of the Valley that requires further regulatory and investment for attainment of the federal PM2.5 standards. Hot-spot areas include Fresno County, Kern County, and other specific areas as necessary for attainment.

State mobile source strategy that reduces emissions from mobile sources under state and federal jurisdiction, including heavy duty trucks, agricultural equipment, locomotives, and off-road equipment.

Public outreach and education that encourages and empowers the public to understand air quality issues, take advantage of District tools to stay informed regarding local air quality, take actions to protect themselves when necessary, understand the Valley's unique air quality challenges, and take actions to reduce emissions and improve the Valley's air quality.

Technology advancement and demonstration efforts to accelerate the deployment of innovative clean air technologies as rapidly as possible.

Call for action by the state and federal governments to do their part in taking responsibility for regulating, and taking actions, to reduce emissions in the Valley. This includes working together to advocate and secure the significant new funding required to achieve the enormous emissions reductions necessary for attainment under this Plan through incentive-based measures.

4.1 COMPREHENSIVE REGULATORY CONTROL STRATEGY

Since 1992, the District has adopted nearly 650 rules to implement an aggressive on-going control strategy to reduce emissions in the Valley. Many current rules are fourth or fifth generation, meaning that they have been revised and emission limits have been lowered, as new emission control technology has become available and cost-effective. The District's regulatory authority is limited to stationary sources and some area-wide sources. The District's stringent and innovative rules, such as those for residential fireplaces, glass manufacturing, and agricultural burning, have set benchmarks for California and the nation. States and the federal government, unlike the District, have the authority to directly regulate tailpipe emissions from mobile sources. CARB has adopted tough regulations for heavy-duty trucks, off-road equipment, and other mobile sources. However, the District has also adopted innovative regulations such as the Indirect Source Review and Employer-based Trip Reduction rules to reduce emissions from mobile sources within the District's limited jurisdiction over these sources.

Regulations implemented by the District have reduced emissions from stationary sources by over 80% to date. Air quality improvements in the Valley document the success of the District's innovative and effective rules. The Valley has attained the federal PM10 standard, the revoked one-hour ozone standard, and most recently, the 1997 PM2.5 24-hour standard[1] (65 µg/m^3).

4.1.1 District Rules Contributing to Continued PM2.5 Improvement

The District's current rules and regulations reflect technologies and methods that extend well beyond minimum required control levels. The stringent regulations already adopted under previous attainment plans also serve as control measures for this plan. These adopted regulations will reduce directly emitted PM2.5 and NOx as they are fully implemented in the coming years, contributing to the Valley's progress toward attainment of the multiple PM2.5 standards.

In addition to the significant ongoing reductions achieved and maintained through the District's currently adopted air quality regulations, the following table summarizes District adopted rules achieving new emissions reductions after 2013, the base year for this plan. These and other District and ARB rules already guarantee that emissions will continue to be reduced over the coming years. New control measures identified in this plan combined with other control strategies discussed in Appendices C and D will provide necessary emissions reductions to complement those already being achieved and contribute to PM2.5 air quality improvements in the Valley. Even pre-2013 emissions reductions are contributing and will continue to contribute to the Valley's progress toward attaining federal PM2.5 standards.

Table 4-1 District Regulations Achieving New Emissions Reductions after 2013 (Not Including District Regulations Achieving Ongoing Reductions)

Rule #	Adopted District Rule	Last Adoption Date
4307	Boilers, Steam Generators, and Process Heaters—2.0 MMBtu/hr to 5.0 MMBtu/hr	4/21/2016
4308	Boilers, Steam Generators, and Process Heaters—0.075 MMBtu/hr to less than 2.0 MMBtu/hr	11/14/2013
4311	Flares	6/18/2009
4320	Advanced Emission Reduction Options for Boilers, Steam Generators, and Process Heaters Greater than 5.0 MMBtu/hr	10/16/2008
4354	Glass Melting Furnaces	5/19/2011
4550	Conservation Management Practices	8/18/2004
4702	Internal Combustion Engines	11/14/2013
4901	Wood Burning Fireplaces and Wood Burning Heaters	9/18/2014
4902	Residential Water Heaters	3/19/2009
4905	Natural Gas-Fired, Fan-Type Central Furnaces	6/21/2018
9310	School Bus Fleets	9/21/2006
9410	Employer-based Trip Reduction	12/17/2009
9510	Indirect Source Review	12/21/2017

[1] SJVAPCD. Clean Data Finding to EPA for the 1997 24-Hour PM2.5 Standard and Proposed PM2.5 Attainment Strategy. (2017, August 17). http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2017/August/agenda.pdf

Rule #	Adopted District Rule	Last Adoption Date
Reg. VIII	Fugitive PM10 Prohibitions	9/16/2004

Rule 4307 Boilers, Steam Generators, and Process Heaters 2 to 5 MMBtu/hr

Rule 4307 is the most stringent rule in the nation for controlling emissions from fuel combustion-producing heat and energy for manufacturing and processing purposes. Emissions from these units are generally controlled through either combustion modification or exhaust gas treatment.

Rule 4308 Boilers, Steam Generators, and Process Heaters 0.075 to < 2 MMBtu/hr

Adopted in 2005 and amended in 2009 and 2013 to include more stringent NOx limits, Rule 4308 controls emissions from boilers, steam generators, and process heaters in the size range of 0.075 to less than 2 MMBtu/hr. As a point-of-sale rule, emissions are reduced when consumers replace older units with new, low-NOx units as of the January 1, 2015, compliance date.

Rule 4311 Flares

Amended on June 18, 2009, Rule 4311 controls emissions from flares used in the Valley at industries including oil and gas production facilities, sewage treatment plants, waste incineration and petroleum refining operations. Flare operators are required to submit Flare Minimization Plans (FMPs), perform extensive monitoring and record keeping, submit reports of planned and unplanned flaring activities to the District, and meet petroleum refinery SO2 performance targets. The District has completed two further studies that analyzed data from FMPs, annual monitoring reports, reportable flaring events reports, and made those studies available on the District web.[2] The District continuously seeks out potential opportunities to reduce emissions from these control and safety devices. The District committed in its *2016 Ozone Plan* to work closely with affected operators to undergo a regulatory amendment process for Rule 4311 to include additional ultra-low NOx flare emission limitations and additional flare minimization requirements to the extent that such controls are determined to be technologically and economically feasible to require in the Valley. The District is undergoing a rule amendment public process concurrently with the development of this attainment plan.

Rule 4320 Boilers, Steam Generators, and Process Heaters > 5 MMBtu/hr

The District adopted Rule 4320 in 2008, with multiple generations of Rules 4305 and 4306 preceding this rule to regulate this source category. This rule is the most stringent rule in the nation for controlling emissions from fuel combustion-producing heat and steam for manufacturing and processing purposes. Facilities generally control emissions from these sources through combustion modification or exhaust gas treatment.

[2] http://valleyair.org/Air_Quality_Plans/PM_Plans.htm

Rule 4354 Glass Melting Furnaces

District Rule 4354, adopted in 1994 and subsequently amended six times, is one of the most stringent rules in the nation for controlling NOx, SOx, and PM emissions from industrial glass manufacturing plants that make flat glass (window and automotive windshields), container glass (bottles and jars), and fiberglass (insulation). Subsequent amendments required more stringent NOx emission limits based on BACT level controls for container glass, fiberglass, and flat glass. The rule gives special consideration to container glass and fiberglass manufacturers who use 30% post-consumer materials under the state glass recycling regulations. The rule also includes a technology forcing limit for flat glass furnaces. As a result of Rule 4354 and continuing efforts on behalf of this industry to reduce emissions, the Valley's glass melting furnaces have significantly reduced NOx, SOx and PM emissions.

Rule 4550 Conservation Management Practices

Rule 4550 is the District's Conservation Management Practices (CMP) rule. Rule 4550 was the first rule of its kind in the nation to reduce fugitive particulate emissions from agricultural operations through the reduction of passes of agricultural equipment and implementation of other conservation practices. Rule 4550 uses a menu approach of control techniques to accommodate the variability of agricultural industries. The selected CMPs are listed on application forms that are submitted to the District for approval as a CMP Plan. Agricultural operations are required to maintain detailed records verifying use of the approved Conservation Management Practices. Approved CMP plans are enforced through onsite inspections and operators are required to submit applications and modify their plans when changing their conservation management practices. Through this rule, PM10 emissions have been reduced by 35.3 tons per day,[3] which is approximately a 24% reduction for this source category.

Rule 4702 Internal Combustion Engines

Adopted in 2003, this rule has subsequently been amended five times to implement stringent NOx limits for agricultural operations and to increase stringency of NOx limit for non-agricultural operations engines, and to extend rule applicability to include units with 25-50 brake horsepower (bhp). With multiple generations of rule amendments, Rule 4702 is the most stringent rule in the nation for this source category. Facilities generally control NOx emissions that result from the fuel combustion of internal combustion engines with advanced technologies, such as selective non-catalytic reduction and selective catalytic reduction.

Rule 4901 Wood-Burning Fireplaces and Wood-Burning Heaters

The District takes a multifaceted and proactive approach to reducing emissions from wood burning fireplaces and wood burning heaters in the Valley. District Rule 4901 reduces emissions from residential burning through stringent curtailment requirements during the wood-burning season. The District most recently amended Rule 4901 in September 2014, two years ahead of the commitment to amend the rule in the *2012 PM2.5 Plan.* Through the District *Check Before You Burn* program, the District has declared and enforced episodic wood burning curtailments, also called "No burn" days,

[3] SJVAPCD. *Conservation Management Practices Program Report for 2005.* (2006, January 19). Retrieved from http://www.valleyair.org/farmpermits/updates/cmp_program_report_for_2005.pdf

since 2003. *Check Before You Burn* and District Rule 4901 reduce harmful species of PM2.5 when and where those reductions are most needed, in impacted urbanized areas when the local weather is forecast to hamper particulate matter dispersion.

The District's Burn Cleaner Wood Stove Change-out Program (Burn Cleaner Program) plays a key role in the success of the transition from older more polluting wood burning heaters and fireplaces to cleaner wood burning heaters. Since 2006, the Burn Cleaner Program has been helping residents overcome some of the financial obstacles in purchasing cleaner alternatives. There are currently more than 30 hearth retailers in the Valley that have partnered with the District to successfully implement the Burn Cleaner Program. Additionally, the District has an extremely successful outreach and education program with regards to residential wood burning and educating Valley residents about air quality, the effects of air pollution on the population's health, and on options they can take to reduce emissions. In the latest wood-burning season (2017-2018) the District took part in 82 media interviews about extreme weather and wood burning.

Rule 4902 Residential Water Heaters

District Rule 4902 controls NOx emissions from natural gas-fired residential water heaters with heat input rates less than or equal to 75,000 Btu/hr by enforcing NOx emissions limit of 40 nanograms of NOx per Joule of heat output (ng/J). The District amended Rule 4902 in 2009 to further reduce emissions by lowering the limit to 10 ng/J for new or replacement water heaters and to a limit of 14 ng/J for instantaneous water heaters. Retailer compliance dates ranged from 2010 through 2012, depending on the unit type. As a point-of-sale rule, compliant units will be installed as the older units are replaced through attrition in the years following 2012. The rule has controlled NOx emissions by approximately 88% for this source category.

Rule 4905 Natural Gas-Fired, Fan-Type Residential Central Furnaces

Rule 4905 limits NOx emissions from residential central furnaces supplied, sold, or installed in the Valley with a rated heat input capacity of less than 175,000 Btu/hour. Amendments lowered the NOx emission limit for residential units from 40 ng/J to 14 ng/J and expanded rule applicability to include non-residential units and units installed in manufactured homes with compliance deadlines in 2018. Due to the limited number of certified compliant units that will be available by the compliance deadline dates, the rule was amended again on June 21, 2018 to extend the emissions fee option period with changes in fee structure to allow additional time necessary to continue technology development and the certification process while providing strong incentive for accelerated deployment of compliant units. As a point-of-sale rule, emissions are reduced when consumers replace older units with newer, low-NOx units through attrition.

Rule 9310 School Bus Fleets

The District adopted Rule 9310 in September 2006 to limit NOx, PM, and diesel toxic air contaminants from school bus fleets. Diesel-fueled school bus fleet operators must replace or retrofit all of their school buses to meet the applicable CARB and U.S. Environmental Protection Agency (EPA) emission standards for engines by 2016. The rule also requires all existing gasoline or alternative-fueled school buses and any diesel school buses manufactured after October 1, 2002 to be operated according to manufacturer specifications and, if replaced, to meet all applicable CARB and EPA current-year emissions standards for the year of delivery of that school bus engine and fuel type.

Rule 9410 Employer-Based Trip Reduction (eTRIP Rule)

The goal of the eTRIP Rule is to reduce single-occupancy-vehicle work commutes. The eTRIP Rule requires the Valley's larger employers, representing a wide range of locales and sectors, to select and implement workplace measures that make it easier for their employees to choose ridesharing and alternative transportation. Because of the diversity of employers covered by the eTRIP Rule, the rule was built with a flexible, menu-based approach. Employers choose from a list of measures, each contributing to a workplace that encourages employees to reduce their dependence on single-occupancy vehicles. Each eTRIP measure has a point value, and employer eTRIPs must reach specified point targets for each strategy over a phased-in compliance schedule (2010 – 2015). The District has continually provided employer assistance through training, guidance materials, promotional information, and online reporting options.

Rule 9510 Indirect Source Review

District Rule 9510 is the only rule of its kind in the State of California and throughout the nation which applies to new development projects, including residential and commercial development projects, and transportation and transit projects. The District's rule is recognized as the benchmark, or best available control, for regulating these indirect sources of emissions. The purpose of this rule is to reduce the growth in emissions from mobile and area sources associated with construction and operation of new development projects in the Valley, by encouraging clean air designs to be incorporated into the development project, or, if insufficient emissions reductions can be designed into the project, by paying a mitigation fee used to fund off-site emissions reduction projects.

Regulation VIII Fugitive PM10 Prohibitions

The Regulation VIII rules were adopted in November 2001, and subsequently amended in 2004 to incorporate more stringent requirements. These rules reduce fugitive dust from construction sites, earthmoving activities, parking and staging areas, open areas, agricultural operations, carryout and trackout, paved and unpaved roads, and material storage sites.

4.1.2 CARB Rules Contributing to Continued PM2.5 Improvement

Mobile source emissions make up over 85% of the Valley's NOx emissions, the primary driver in the formation of particulate and ozone pollution, and therefore reductions in mobile source emissions have become an ever-increasingly important part of the Valley's attainment strategy of federal air quality standards. Local air districts do not have the authority to implement regulations requiring ultra-low tailpipe emissions standards on mobile sources. With authority to regulate mobile source emissions, CARB has adopted and amended a number of regulations aimed at reducing exposure to diesel particulate matter (PM) and NOx from fuel sources, 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 emission reduction benefits in the coming years as the regulated fleets are retrofitted, and as older and dirtier fleet units are replaced with newer and cleaner models at an accelerated pace.

4.2 COMPREHENSIVE INCENTIVE-BASED STRATEGY

In addition to having the toughest air regulations in the nation, the District also operates the most effective and efficient incentive grants program, investing over $2 billion in public/private funding towards clean air projects to date that have achieved over 151,000 tons of emissions reductions. Through strong advocacy at the state and federal levels, the District has appropriated $350 million in incentive funding in the 2018-2019 District Budget to continue this robust program. Due to the significant investments made by Valley businesses and residents and stringent regulatory programs by the District and CARB, the Valley's ozone and PM2.5 precursor emissions are at historically low levels and air quality over the past few years has been better than any other time on record.

4.2.1 DISTRICT INCENTIVE-BASED STRATEGY CONTRIBUTING TO CONTINUED PM2.5 IMPROVEMENT

The District administers a comprehensive suite of other highly-successful voluntary incentive programs which are critical to the Valley's attainment of the federal air quality standards. The District operates a diverse variety of voluntary incentive programs, including the following:

- Public transportation subsidies
- Public benefit incentives
- School bus programs
- Drive Clean in the San Joaquin
- Incentive funding for electric vehicles and charging infrastructure
- Technology advancement programs
- Off-road equipment replacement and repowers
- Low-emission locomotive incentives
- Truck replacement programs
- Tractor replacement programs
- The Electrified Dairy Feed Mixing Program
- Measures to support the reduction of single occupant vehicle commutes
- Funding for new zero-emission lawn and garden equipment

In addition the District is also looking into improvements, expansions, and streamlining of these programs to increase accessibility, efficiency, and efficacy of its voluntary incentive programs. One example of a program expansion under consideration is the expansion of the Clean Green Yard Machine program to include commercial lawn and garden equipment bringing the emissions benefits of the program to Valley residents who utilize professional lawn care services. The District is also looking for technology partners to bring alternatives to open burning of agricultural biomass opportunities to the Valley agricultural sector. Details about the District's voluntary incentive programs can be found in Appendix E.

4.3 New District Emission Reduction Measures

This Plan integrates a comprehensive strategy that contains new potential stationary source measures that will be applied Valleywide and measures focused on reducing emissions in areas with the most difficult attainment challenges. Through the implementation of this comprehensive strategy, the Valley will experience progressive air quality improvements as the region attains the federal PM2.5 standards as expeditiously as practicable.

Under the federal Clean Air Act, the entire Valley is designated as not meeting the standard if any area in the Valley is not able to meet the standard. In developing the control strategies for past attainment plans, the District has used the traditional approach of quantifying reductions needed in areas with the most difficulty in meeting the standards, and then imposing broad controls throughout the Valley. After decades of imposing tough measures throughout the region, and given the significant additional emissions reductions necessary to meet the federal PM2.5 standards, in addition to imposing stringent new measures across all sources throughout the Valley, a targeted approach that focuses additional measures and limited resources in remaining "hot-spot" areas is necessary to meet the federal standards.

Therefore, this plan not only includes a comprehensive suite of regulatory and incentive-based measures for both stationary and mobile sources, but also includes a targeted hot-spot strategy that focuses new residential wood burning and commercial under-fired charbroiling emission reduction measures in Fresno County, Kern County, and other locations as necessary to demonstrate attainment of the standards. Given the innovative nature of this approach, the District has been working with EPA, CARB, and other stakeholders to ensure that the District's strategy is consistent with all applicable regulations.

4.3.1 Evaluating Control Measures for New Control Strategy Opportunities

The District expended extensive efforts to identify and evaluate potential emission reductions opportunities from each control measure source category. As part of the regulatory evaluation, District rules and source categories were compared to federal and state air quality regulations and standards, and the regulations and standards in other air districts. District rules and regulations were compared to such federal regulations and guidance documents as Control Techniques Guidelines (CTG),[4] Alternative Control Techniques (ACT),[5] New Source Performance Standards (NSPS),[6]

[4] EPA. Control Techniques Guidelines. Retrieved from http://www.epa.gov/groundlevelozone/SIPToolkit/ctgs.html
[5] EPA. Alternative Control Techniques. Retrieved from http://www.epa.gov/groundlevelozone/SIPToolkit/ctgs.html
[6] EPA. 40 CFR 60 – Standards of Performance for New Stationary Sources (NSPS). Retrieved from http://www.tceq.state.tx.us/permitting/air/rules/federal/60/60hmpg.html

National Emission Standards for Hazardous Air Pollutants (NESHAP),[7] and Maximum Achievable Control Technology (MACT)[8] standards. California state regulations, due to regulatory authority, are primarily applicable to mobile sources and consumer products. State regulations also include the California Health and Safety Code (CH&SC) and CARB Airborne Toxic Control Measures (ATCM) requirements which are applicable to stationary and area sources.[9] The District's regulatory evaluation includes state guidelines that are applicable to the source category. Rule comparison to analogous regulations adopted by California's most progressive air districts are included this comprehensive evaluation as agreed to by EPA for the *2009 RACT SIP*, which includes but not limited to South Coast Air Quality Management District[10], Bay Area Air Quality Management District[11], Sacramento Metropolitan Air Quality Management District[12], and Ventura County Air Pollution Control District.[13]

All potential best available control measures (BACM) and most stringent measures (MSM) identified through this regulatory evaluation were thoroughly evaluated using the key factors defined in EPA's 2016 *Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements*, to determine if potential opportunities qualify as BACM/MSM for the Valley. Key factors include a technological feasibility analysis to determine whether new control technologies can be integrated with the existing controls without reducing or delaying the emission reductions from the existing emission control technologies and ensuring that benefit of the new measure is greater than the existing measure.

Potential control determined to be technologically feasible is then evaluated for economic feasibility. The District looked for any control technologies not already required that might be available to further reduce emissions from sources of air pollution in the Valley. This includes new technologies and technologies that may not have been cost-effective in the past. The technologies used in BACT guidelines; permits; and other air districts' rules, regulations, guidelines, and studies were reviewed for their feasibility, including how commercially available the technology currently is and whether the technology has been used in practice. Cost effectiveness analyses of various control measures include examining the added cost, in dollars per year, of the control technology or technique, divided by the emissions reductions achieved, in tons per year. EPA cautions that the threshold for economic feasibility should be addressed on a case-by-case basis. The District does not have a pre-determined cost-effectiveness

[7] EPA. 40 CFR 61 – National Emission Standards for Hazardous Air Pollutants (NESHAPs). Retrieved from http://www.tceq.state.tx.us/permitting/air/rules/federal/61/61hmpg.html

[8] EPA. 40 CFR 63 – Maximum Achievable Control Technology (MACT). Retrieved from http://www.tceq.state.tx.us/permitting/air/rules/federal/63/63hmpg.html

[9] California Air Resources Board (ARB). Airborne Toxic Control Measures (ATCMs). Retrieved from

[10] South Coast Air Quality Management District (SCAQMD). Rules and Regulations. Retrieved from http://www.aqmd.gov/home/regulations/rules/scaqmd-rule-book/table-of-contents

[11] Bay Area Air Quality Management District (BAAQMD). Rules and Regulations. Retrieved from http://www.baaqmd.gov/Divisions/Planning-and-Research/Rules-and-Regulations.aspx

[12] Sacramento Metropolitan Air Quality Management District (SMAQMD). Rules and Regulations. Retrieved from http://www.airquality.org/rules/

[13] Ventura County Air Pollution Control District (VCAPCD). Rules and Regulation. Retrieved from http://www.vcapcd.org/Rulebook/RuleIndex.htm

threshold, but control options with extremely high cost-effectiveness (high dollars per ton of pollutant reduction) are generally unreasonable and not feasible for regulation.

Efforts to identify feasible emission reductions opportunities also includes the evaluation of additional control technologies or practices, if any, not already included in previously mentioned BACM/MSM evaluations for the area. This evaluation process considers any emission reduction opportunities that were previously adopted by the District plans that were determined to be beyond RACT at that time and also any new emission reduction opportunities adopted in California state implementation plans (SIP), SIPs in other states, or achieved in practice in other areas. Any potential BACM/MSM identified were then thoroughly evaluated for technological and economic feasibility. In evaluating the technological and economic feasibility of potential BACM/MSM, the District reviews staff reports and studies from other air districts, EPA technical guidance documents, and applicable study data from the scientific community to assist in evaluating. The District has evaluated all sectors and equipment types for additional emission reduction opportunities, as presented in Appendix C.

This Plan demonstrates that all District rules continue to meet or exceed measures identified by the EPA as reasonably available control measures (RACM), BACM, and MSM, as defined above and demonstrated in Appendix C.

4.3.2 New District Control Measure Commitments

The District and CARB are committing in this state implementation plan to aggregate emission reductions of direct PM2.5 and NOx beyond current measures implemented by the District and CARB (see Table below and Section 4.4). While the tables include estimates of the emission reductions from each individual measure, final measures as proposed for adoption into the SIP may provide more or less emission reductions as will be determined through the extensive public rule development process for each regulatory measure. These aggregate commitments will ensure that the total emission reductions will be achieved by the timeframes necessary under this Plan. While the District projects that the attainment strategy may provide up to 3.447 tons per day of PM2.5 emissions reductions through the combination of potential District measures, the District is committing in the SIP to attain an aggregate amount of 1.04 tons per day of PM2.5 emissions reductions from these new measures, as necessary for expeditious attainment through modeling conducted for this Plan.

Table 4-2 Emission Reductions from Proposed District Measures

Measure	PM2.5 (tpd)	NOx (tpd)
Flares	–	0.05
Boilers, Steam Generators, and Process Heaters - Phase 3	–	1.83
Advanced Emission Reduction Options for Boilers, Steam Generators, and Process Heaters Greater than 5.0 MMBtu/hr		
Internal Combustion Engines		
Glass Plants		
Solid Fuel-Fired Boilers, Steam Generators And Process Heaters		
Conservation Management Practices*	*0.65**	–
Commercial Charbroiling	0.57	–
Wood Burning Fireplaces and Wood Burning Heaters	0.47	–
Aggregate Emission Reductions Commitment	**1.04 – 1.69**	**1.88**

"–" denotes reductions have not been quantified
* District estimates potential reductions of up to 0.647 tpd PM2.5. Air quality modeling indicates limited attainment value and aggregate commitment does not include a specific reduction target pending further evaluation and research on control techniques and effectiveness as discussed below.

Regulatory Measures		Action Date	Implementation Begins
Rule 4311	Flares	2020	2024
Rule 4306 **Rule 4320**	Boilers, Steam Generators, and Process Heaters – Phase 3 Advanced Emission Reduction Options for Boilers, Steam Generators, and Process Heaters Greater than 5.0 MMBtu/hr	2020	2024
Rule 4702	Internal Combustion Engines	2020	2024
Rule 4354	Glass Melting Furnaces	2021	2024
Rule 4352	Solid Fuel-Fired Boilers, Steam Generators And Process Heaters	2021	2024
Rule 4550	Conservation Management Practices	2022	2024
Rule 4692	Commercial Under-fired Charbroiling (Hot-spot Strategy)	2020	2024
Rule 4901	Wood Burning Fireplaces and Wood Burning Heaters (Hot-spot Strategy)	2019	2019

Incentive Based Measures	Action Date	Implementation Begins
Replacement of Agricultural Internal Combustion Engines	2020	ongoing
Installation of Commercial Under-fired Charbroiling Controls (Hot-spot Strategy)	2020	ongoing
Replacement of Residential Wood Burning Devices (Valleywide and Hot-spot Strategy)	2020	ongoing

Rule 4311 Flares

Rule 4311 controls emissions from flares used in the Valley at facilities such as, but not limited to, oil and gas production facilities, sewage treatment plants, waste incineration and petroleum refining operations. Under Rule 4311, flare operators are required to submit flare minimization plans, perform extensive monitoring and record keeping, submit reports of planned and unplanned flaring activities to the District, and meet petroleum refinery SO2 performance targets.

Flaring activities in the Valley emit 0.55 tpd of NOx emissions, representing 0.22% of the annual average NOx emissions in the Valley. Despite this relatively small amount of emissions, in seeking all potential emission reduction opportunities, the District has invested significant resources into evaluating potential emissions reductions opportunities from flares. The District has made these further study reports available on the District web.[14]

As demonstrated in Appendix C, District Rule 4311 satisfies RACM, BACM, and MSM requirements for this source category.[15] Even though flares are not a significant source of PM2.5 and NOx in the Valley, the District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans. As demonstrated above, Rule 4311 currently has in place the most stringent measures feasible to implement in the Valley.

While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, the District will pursue the following potential opportunities that are projected to provide 0.05 tons NOx per day of additional emissions reductions towards the District's aggregate plan commitment. The District will continue to work closely with affected operators and other stakeholders to undergo a regulatory amendment process for Rule 4311 to include:

- Additional ultra-low NOx flare emission limitations for existing and new flaring activities at Valley facilities to the extent that such controls are technologically achievable and economically feasible, and
- Additional flare minimization requirements to the extent that such controls are technologically achievable and economically feasible
- Expand the applicability of the rule to apply to all sources (not limited to major sources)

Rule 4306 Boilers, Steam Generators, and Process Heaters - Phase 3
Rule 4320 Advanced Emission Reduction Options for Boilers, Steam Generators, and Process Heaters Greater than 5.0 MMBtu/hr

Rules 4306 and 4320 apply to any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input greater than 5 million British

[14] http://www.valleyair.org/Air_Quality_Plans/PM_Plans.htm
[15] SJVUAPCD. *2015 Plan for the 1997 PM2.5 Standard*. Appendix C Best Available Control Measures and Most Stringent Measures (2015, April 16). Retrieved from http://www.valleyair.org/Air_Quality_Plans/PM25Plans2015.htm

thermal units per hour (MMBtu/hr). Facilities with units subject to this rule represent a wide range of industries, including but not limited to electrical utilities, cogeneration, oil and gas production, petroleum refining, manufacturing and industrial processes, food and agricultural processing, and service and commercial facilities. NOx emissions from this source category have been reduced by 96% through District regulations.

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for emissions from boilers, steam generators, and process heaters. As demonstrated in Appendix C, Rules 4306 and 4320 currently have in place the most stringent measures feasible to implement in the Valley and therefore meet or exceed RACM, BACM, and MSM requirements for this source category.

While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, the District will work with affected operators to further reduce NOx emissions from boilers, steam generators, and process heaters to the extent that such controls are technologically and economically feasible. Technologies with the potential to further reduce emissions include the latest generation of ultra-low NOx burners, SCR, and ultra-low NOx burners combined with SCR. As demonstrated above, some of these technologies may not be cost-effective or feasible at this time. Therefore, the potential measures include lowering the emission limits for the class and category and lowering the more stringent Advanced Emission Reduction Option (AERO) limit further as follows:

- Boilers and process heaters >5.0 MMBtu/hr to ≤ 20 MMBtu/hr
    - Lower current emissions limitations of 6 ppmv (enhanced) and 9 ppmv (standard) to a new limitation as low as 2.5 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Boilers and process heaters > 20 MMBtu/hr
    - Lower current emissions limitations of 5 ppmv (enhanced) and 7 ppmv (standard) to a new limitation as low as 2 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Oil field steam generators >5.0 MMBtu/hr to ≤ 20 MMBtu/hr
    - Lower current emissions limitations of 6 ppmv (enhanced) and 9 ppmv (standard) to a new limitation as low as 3.5 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Oil field steam generators > 20 MMBtu/hr
    - Lower current emissions limitations of 5 ppmv (enhanced) and 7 ppmv (standard) to a new limitation as low as 2 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment

- Oil field steam generators < 50% PUC quality gas
  - Lower current emissions limitations of 12 ppmv (enhanced initial) and 9 ppmv (enhanced final) to a new limitation as low as 3.5 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Petroleum refinery boilers/process heaters >5.0 MMBtu/hr to ≤ 20 MMBtu/hr
  - Lower current emissions limitations of 9 ppmv to a new limitation as low as 3 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Petroleum refinery boilers/process heaters >20 MMBtu/hr to ≤ 110 MMBtu/hr
  - Lower current emissions limitations of 6 ppmv to a new limitation as low as 3 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Petroleum refinery boilers/process heaters >110 MMBtu/hr
  - Lower current emissions limitations of 5 ppmv to a new limitation as low as 3 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Petroleum refinery boilers/process heaters < 50% PUC quality gas
  - Lower current emissions limitations of 9 ppmv to a new limitation as low as 3 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment

The above potential measures are projected to provide 0.4 tons NOx per day of additional emissions reductions. The proposed commitments by the District and CARB will each achieve an aggregate emission reduction of direct PM2.5 and NOx. While the commitments include estimates of the emission reductions from each individual measure, final measures as proposed for adoption into the state implementation plan (SIP) may provide more or less emission reductions. The aggregate commitment will guarantee that the total emission reductions will be achieved to attain each NAAQS as expeditiously as practicable.

Rule 4352 Solid Fuel-Fired Boilers, Steam Generators and Process Heaters

Rule 4352 limits NOx and carbon monoxide (CO) emissions from any boiler, steam generator or process heater fired on solid fuel. Boilers, steam generators, and process heaters are used in a broad range of industrial, commercial, and institutional settings. Units subject to this rule fire on a variety of solid fuels: coal, petroleum coke, biomass, tire-derived fuel, and municipal solid waste facilities. This rule limits NOx emissions to 165 ppmv for municipal solid waste facilities, 90 ppmv for biomass facilities, and 65 ppmv for all other solid fuel fired units.

While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, this measure would further reduce NOx emissions by amending the rule to lower NOx limits for municipal solid waste-fired boilers to the extent that such controls are technologically achievable and economically feasible.

Municipal Waste-Fired Units

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this category. As demonstrated above, Rule 4352 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds both BACM and MSM requirements for this source category. The District's evaluation of potential control technologies has found that the Gore De-NOx and Selective Catalytic Reduction technologies demonstrated in Europe are extremely costly, require additional evaluation for feasibility, and are overall economically infeasible in this sector. The District's evaluation of the Covanta LN NOx technology has found that, while costly, installation of this technology may be cost-effective. While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, the District will pursue the following potential opportunities to reduce NOx emissions for municipal waste-fired units to the extent that additional NOx controls are technologically and economically feasible:

- Lower NOx limit from 165 ppmv @ 12% CO_2 to 110 ppmv @ 12% CO_2 over 24-hr period and 90 ppmv @ 12% CO_2 over annual period
- Evaluate feasibility of lower NOx emission levels

Biomass-Fired Units

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this category. As demonstrated above, Rule 4352 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds both BACM and MSM requirements for this source category.

The proposed commitments by the District and CARB will each achieve an aggregate emission reduction of direct PM2.5 and NOx. While the commitments include estimates of the emission reductions from each individual measure, final measures as proposed for adoption into the state implementation plan (SIP) may provide more or less emission reductions. The aggregate commitment will guarantee that the total emission reductions will be achieved to attain each NAAQS as expeditiously as practicable.

Rule 4354 Glass Melting Furnaces

District Rule 4354, adopted in 1994 and subsequently amended six times, is one of the most stringent rules in the nation for controlling NOx, SOx, and PM emissions from industrial glass manufacturing plants that make flat glass (window and automotive windshields), container glass (bottles and jars), and fiberglass (insulation). The last amendments to the rule included more stringent NOx emission limits based on BACT level controls for container glass, fiberglass, and flat glass. The rule gives special consideration to container glass and fiberglass manufacturers who use 30% post-consumer materials under the state glass recycling regulations. The rule also includes a technology forcing limit for flat glass furnaces. As a result of this stringent prohibitory rule and continuing efforts on behalf of this industry to reduce emissions, the Valley's glass melting furnaces use low-NOx firing technology.

While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, the District will pursue the following potential opportunities to reduce NOx emissions for container glass furnaces to the extent that additional NOx controls are technologically and economically feasible:

- Evaluate feasible ultra low-NOx control technologies (catalytic filtration, oxy-fuel combined with SCR, etc.)
- Lower NOx limit from 1.5 lb/ton to a level ranging from 1.0-1.2 lb-NOx/ton glass pulled or lower, based on a rolling 30-day average

The proposed commitments by the District and CARB will each achieve an aggregate emission reduction of direct PM2.5 and NOx. While the commitments include estimates of the emission reductions from each individual measure, final measures as proposed for adoption into the state implementation plan (SIP) may provide more or less emission reductions. The aggregate commitment will guarantee that the total emission reductions will be achieved to attain each NAAQS as expeditiously as practicable.

Rule 4550 Conservation Management Practices

Rule 4550 was adopted to help bring the Valley into attainment of federal PM10 standards, and applies to on-field farming and agricultural operation sites located within the Valley. Rule 4550 was the first rule of its kind in the nation to target fugitive particulate emissions from agricultural operations, and it has served as a model for other regions. The District worked extensively with numerous stakeholders, growers, and the Agricultural Technical Committee for the San Joaquin Valleywide Air Pollution Study Agency (AgTech) for two years prior to developing the Conservation Management Practices (CMP) Rule. The District also worked with agricultural stakeholders and other agencies, such as the Natural Resources Conservation Service (NRCS), following rule adoption to ensure affected sources were assisted as much as possible in understanding and complying with the requirements of Rule 4550. Implementation of Rule 4550 by agricultural operations has resulted in the reduction of PM2.5 emissions through the reduction of passes of agricultural equipment and implementation of other conservation practices. Through this rule, PM emissions have been reduced by 35.3 tons per day.

The attainment modeling has demonstrated that implementation of additional CMPs will not contribute to attaining the federal PM2.5 standards. However, to further develop the District's understanding of the effectiveness of CMP measures on controlling PM2.5 emissions in the Valley, the District is committing to:

- Undertaking scientific research on the PM2.5 content, constituents, and stability during wind events of the many soil types found throughout the Valley.
- Further evaluate ways to promote conservation tillage practices and to reduce windblown dust from agricultural operations to the extent that they are found to practicably reduce PM2.5, using the following process. The District will launch a

public rule development process and will work with the Agricultural Technical Committee to evaluate amending Rule 4550 (Conservation Management Practices) to potentially require the selection of additional control measures to specifically limit PM2.5 emissions from tilling and other land preparation activities during high wind events based on the research discussed above. The District will evaluate the feasibility of a rule amendment requiring CMPs on fallow lands that are tilled or otherwise worked with implements of husbandry, to reduce windblown PM2.5 emissions from disturbed fallowed acreage. More widespread implementation of conservation tillage practices, such as cover cropping, no till, low till, strip till, and precision agriculture, may help to further limit windblown PM2.5 in the Valley while also supporting State policy goals of promoting healthy soils. To this end, the District will evaluate measures to promote the selection of conservation tillage as a CMP for croplands.

- Evaluate lowering acreage applicability thresholds in order to further reduce PM2.5 emissions from this source category

The District will continue to collaborate with other agencies, including EPA and USDA-NRCS, and agricultural stakeholders to evaluate feasible opportunities to further reduce fugitive dust and emissions from agricultural operations.

As noted above, the existing District Rule 4550 has been found by the District and the federal EPA to establish RACM, BACM, and MSM level PM2.5 requirements for this source category.

While the attainment modeling process has demonstrated that additional CMPs will not significantly contribute to our attainment efforts, to further develop the District's understanding of the effectiveness of CMP measures on controlling PM2.5 emissions in the Valley, the District is committing to undertaking scientific research on the PM2.5 content, constituents, and stability during wind events of the many soil types found throughout the Valley. This research would be conducted in close coordination with USDA-NRCS, agricultural sources, researchers through established processes including the San Joaquin Valleywide Air Pollution Study Agency, Policy Committee, and Agricultural Technical Subcommittee.

Although Rule 4550 already meets BACM and MSM requirements for PM2.5, the District is also committing to further evaluate ways to promote conservation tillage practices and to reduce dust from agricultural operations to the extent that they are found to practicably reduce PM2.5, using the following process. The District will work with the Agricultural Technical Committee to evaluate the feasibility and effectiveness of requiring the selection of additional control measures to achieve additional PM2.5 emissions reductions from tilling and other land preparation activities based on the research discussed above. More widespread implementation of conservation tillage practices such as cover cropping, no till, low till, strip till, and precision agriculture, through additional incentives under Rule 4550, may help to further limit PM2.5 in the Valley. To this end, the District will evaluate measures to promote the selection of conservation tillage as a CMP for croplands.

The District will evaluate the feasibility and effectiveness of CMPs on fallow lands that are tilled or otherwise worked with implements of husbandry, to reduce windblown PM2.5 emissions from disturbed fallowed acreage. This evaluation will rely on additional research, in coordination with USDA-NRCS, agricultural sources, and researchers, that recognizes the Valley's unique soil characteristics and agricultural practices to ensure that Valley-specific solutions are considered in this process.

Rule 4692 Commercial Charbroiling

District Rule 4692 reduces PM emissions by requiring catalytic oxidizers for chain-driven charbroilers, including those used in many typical fast-food restaurants. Rule 4692 is among the most stringent rules in the nation for controlling emissions from commercial charbroiling operations. The original rule, adopted in March 2002, reduced PM2.5 emissions from chain-driven charbroilers by 84%. The September 2009 rule amendment expanded rule applicability to more chain-driven charbroilers. Rule 4692 has been fully implemented since 2011, reducing PM2.5 emissions by 0.018 tpd. The District also created a Charbroiler Incentive Program (CHIP) to fund the installation of PM2.5 controls on under-fired charbroilers and further investigate the economic feasibility and availability of such controls.

In addition to the existing emissions reductions already achieved through control requirements for chain-driven commercial charbroilers, this measure would seek to achieve additional emission reductions from commercial underfired charbroilers. While there are ongoing improvements in the technology available for commercial cooking emissions, the costs of installing controls for commercial underfired charbroilers remain high.

While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, using new survey and registration information, the District will pursue reductions in commercial underfired charbroiler emissions through an incentive-based approach to fund the installation of controls for commercial underfired charbroilers within urban boundaries in hot-spot areas, with a future year regulatory requirement to encourage participation by Valley businesses.

1. To ensure early and robust use of incentives for installation of controls and related modifications for existing underfired charbroilers within urban boundaries of hot-spots areas supplemented with regulatory backstop to encourage participation.

2. Require installation of control technologies at new larger restaurants within urban boundaries of hot-spot areas supplemented by incentives as feasible.

Rule 4702 Internal Combustion Engines

Rule 4702 applies to any internal combustion (IC) engine rated at 25 brake horsepower (bhp) or greater. The purpose of this rule is to limit NOx, CO, VOC, and SOx emissions from units subject to this rule. The rule originally established NOx limits between 25-50 ppmv achieving 90-96% control for non-agricultural operations rich-burn engines and

65-75 ppmv achieving 85-90% control for non-agricultural operations lean burn engines. In its continuous effort to improve air quality in the Valley, the District has adopted numerous amendments to Rule 4702 that have resulted in significant reductions of NOx and PM emissions. August 2011 amendments implemented more stringent NOx limits as low as 11 ppmv for non-agricultural operations spark-ignited engines.

Substantial emission reductions from agricultural IC engines have also been achieved through a combination of regulatory efforts and incentive actions. Rule 4702 has effectively reduced emissions from agricultural engines by 84% since 2005.

While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, the District will pursue the following potential opportunities that are projected to provide 1.4 tons NOx per day of additional emissions reductions towards the District's aggregate plan commitment:

- Non-Agricultural IC Engines: Work with affected operators to further reduce NOx emissions from non-ag IC engines to the extent that such controls are technologically achievable and economically feasible. Technologies evaluated with the potential to further reduce emissions include the installation of 3-way catalytic reduction for rich-burn IC engines and selective catalytic reduction for lean-burn IC engines. While the analysis above shows that many control technologies are not cost-effective, potential emission reduction opportunities for further evaluation include:
  - Rich Burn Engines ("not listed above" category): Lower existing limit of 11 ppmv to as low as 7 ppmv
  - Lean Burn Engines ("not listed above" category): Lower existing limit of 11 ppmv to as low as 5 ppmv
  - Limited Use Rich/Lean Burn: Lower existing limits of 25 and 65 ppmv to as low as 11 ppmv

- Agricultural IC Engines: Work with agricultural sources to further reduce NOx emissions through incentive-based/regulatory approach as technologically and economically feasible. While the analysis above demonstrates that the various control technologies are generally not cost-effective without financial assistance, and may not be technologically feasible for remote ag installations, potential emission reduction opportunities for further evaluation include:
  - Replacement of spark-ignited agricultural engines with electric motors where access to electricity is available, or Tier 4-equivalent engine technologies through incentive-based approach coupled with regulatory backstop to encourage participation.
  - Replacement of Tier 3 compression-ignited agricultural engines with electric motors where access to electricity is available, or Tier 4-equivalent engine technologies through incentive-based approach to achieve additional emissions reductions where cost-effective.

The proposed commitments by the District and CARB will each achieve an aggregate emission reduction of direct PM2.5 and NOx. While the commitments include estimates of the emission reductions from each individual measure, final measures as proposed for adoption into the state implementation plan (SIP) may provide more or less emission reductions. The aggregate commitment will guarantee that the total emission reductions will be achieved to attain each NAAQS as expeditiously as practicable.

Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters

The District takes a multidimensional and proactive approach to reducing emissions in the Valley. This philosophy is especially true for reducing emissions from residential wood burning; with a combination of regulatory controls through Rule 4901, rigorous public outreach and education efforts, *Check Before You Burn* program, and the District's Burn Cleaner Wood Stove Change-out Program (Burn Cleaner Program). The District's approach to reducing emissions from residential wood burning empowers Valley residents to play a major role in reducing emissions at almost no increased cost, and, in many cases, with savings in heating-related energy costs. Control measure analysis in Appendix C confirms this rule implements the most stringent measures feasible in its current form, additional components to the residential wood burning strategy go beyond MSM.

Through the District's *Check Before You Burn* program, the District has declared and enforced episodic wood burning curtailments since 2003. When ambient PM2.5 concentrations in a specific county are forecasted to be at or above 20 $\mu g/m^3$, the District only allows registered or exempt units within that county to burn that day. The tiered compliance thresholds in Rule 4901, which allow additional burn days for District registered EPA-certified devices, encourages the transition from high-polluting devices and open hearth fireplaces to cleaner alternatives. *Check Before You Burn* and District Rule 4901 reduce harmful species of PM2.5 when and where those reductions are most needed - in urbanized areas when the local weather conditions are forecast to inhibit particulate matter dispersion.

While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, this measure would further reduce emissions by implementing a more stringent wood burning curtailment program as follows:

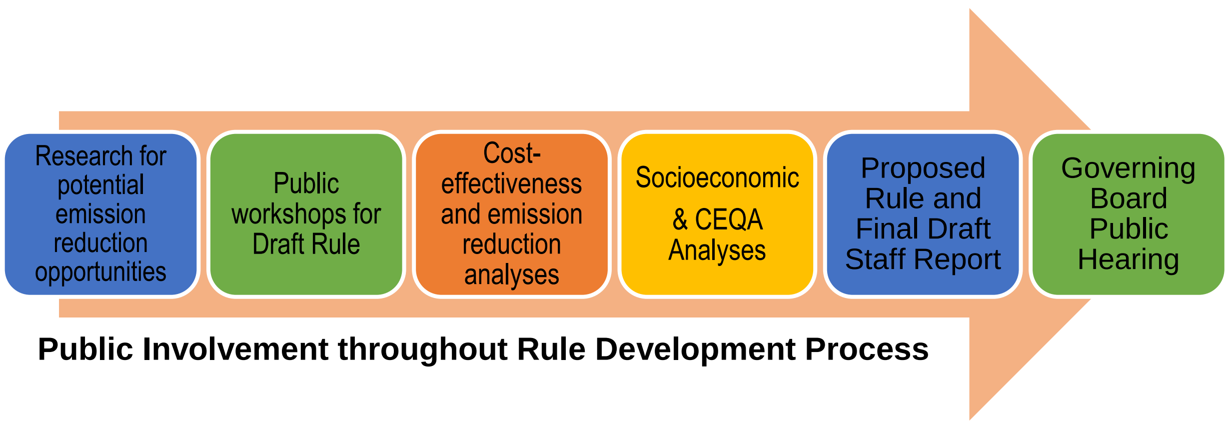
- Lower curtailment levels in targeted hot spot areas (Fresno County, Kern County except Frazier Park, other areas as necessary for attainment)
  - No burn for non-registered units at or above 12 $\mu g/m^3$
  - No burn for all devices above 35 $\mu g/m^3$
- Maintain current curtailment levels in rest of Valley
  - No burn for non-registered units at or above 20 $\mu g/m^3$
  - No burn for all devices above 65 $\mu g/m^3$
- Offer enhanced incentives in hot-spot areas
  - In hot-spot areas, incentive will only be provided for natural gas replacements
  - Enhanced levels of incentives provided in hot-spot areas to fund the full replacement of wood burning devices with natural gas units

- Continue to offer current level of incentives Valleywide in non-hot-spot areas
- Prohibit wood-burning devices in new construction (at higher elevations, only allow EPA-certified devices)
- Only allow seasoned wood to be burned
- Enhanced enforcement resources to assure continued high compliance rate
- Enhanced outreach and education efforts to increase awareness of residential wood burning health impacts and District's residential wood burning reduction strategy

4.3.3 RULE DEVELOPMENT PROCESS

After plan adoption, the District adopts or amends rules per the plan's regulatory control measure commitments. In these efforts, the District is committed to a transparent public process that includes stakeholder, industry, and other-agency input at every step possible.

Figure 4-1 Rule Development Process



Contrasting the broader plan development effort, the rule development process allows greater focus on a single sector or technology area. Early in the rule development process, prior to preparing a draft rule, staff researches technologies and explores options for emissions reductions, gathering preliminary data and performing literature reviews of relevant studies. Through a series of public workshops and focus group meetings, staff presents draft rule concepts and receives feedback on specific technology costs, technical insight, and general public comments. Staff uses this information gathering and discussion to refine the rule throughout the rule development process. Using this iterative process of gathering the most up-to-date cost and technical information, staff analyzes cost-effectiveness and potential emissions reductions. These analyses are shared with the public throughout the rule development process.

During the ongoing public workshop process, the District enlists the services of an economic consultant to analyze the proposed rule's socioeconomic impact, pursuant to California Health and Safety Code Section 40728.5. As with draft versions of the rule, the District gives the public and stakeholders the opportunity to review the analysis and provide further feedback. To the extent possible, the District minimizes significant economic and socioeconomic impacts by evaluating viable alternatives, adjusting proposed limits, or extending compliance schedules.

Staff presents the final draft version of the staff report and proposed rule, including the cost-effectiveness analysis, socioeconomic impact report, emissions reductions analysis, RACT analysis, and California Environmental Quality Assessment (CEQA), to the Governing Board during a public hearing. The Governing Board ultimately determines the balance between air quality improvement and rule impacts when adopting proposed rules.

Once adopted, the District forwards the rule through ARB to EPA for inclusion into the SIP, as appropriate. EPA evaluates the rule, determines if the rule meets federal requirements, and provides an opportunity for further public comment. After this review and comment period, EPA will amend the SIP to include the new rule, as appropriate.

Beyond the rule development and adoption process, District staff will continue to engage the public and affected source operators throughout implementation and compliance. Additionally, District staff continues public outreach and education through notifications to stakeholders of the rule adoption, issuance of compliance bulletins, and assistance through the District's Small Business Assistance program.

4.3.4 Incentive-based Control Measure Commitments

The District's strategy to reach attainment of the federal PM2.5 standards relies heavily on incentive programs to achieve cost-effective emission reductions of direct PM2.5 and PM2.5 precursors. Given the enormity of emissions reductions necessary to bring the Valley into attainment of the 1997, 2006, and 2012 federal PM2.5 standards, the Valley cannot reach attainment through regulatory measures alone, and significant additional emissions reductions through incentive-based measures are necessary. The incentive programs complement regulatory control measures by providing much needed reductions beyond those feasible through regulation, particularly with respect to mobile sources, which the District has limited direct authority to regulate.

District incentive programs have a positive impact on air quality and are also highly successful due to the fact that participation is voluntary and the emission reductions are both highly cost-effective and surplus to the reductions required by the regulatory control measure commitments in attainment plans. Through a combined public/private investment of more than $2 billion, the District has been able to reduce over 140,000 tons of harmful emissions through a variety of cost-effective, voluntary and often first-of-their-kind incentive programs. Recent audits conducted by CARB and Department of Finance (DOF) have confirmed that the District's programs are fiscally sound and are "efficiently and effectively achieving their emission reduction objective."

In crafting the new attainment plans, the District explores all feasible opportunities to further reduce stationary sources emissions. However, due to the maturity and effectiveness of District prohibitory rules, the Valley is reaching the point of diminishing returns from additional stationary source control measures. The magnitude of potential reductions from stationary sources is minute compared to reductions needed to attain federal PM2.5 and ozone standards. The District, CARB, and EPA agree that the bulk of emission reductions needed for attainment will have to come from mobile sources, primarily through the deployment of incentive-based measures. Additionally, unlike attainment plans for federal ozone standards, attainment plans for PM2.5 standards are not able to rely on “black box” reductions from yet-to-be identified technologies and measures. This plan requires defined and enforceable measures.

Developing aggressive incentive-based control measures that achieve the massive emissions reductions needed to bring the Valley into attainment will require significant funding. While the District has been able to generate significant local funding and successfully advocate for additional state and federal funding, the reductions needed to attain the standards require significant increase in public and private investment. For example, the necessary transition of the heavy duty trucking fleet to near zero emissions technology in the attainment timeline prescribed in the Clean Air Act can only be achieved with significant investment in infrastructure and fleet turnover. Dollars needed are well in excess of current or prospectively scheduled future appropriations.

Historically, states and local air agencies have not been able to obtain SIP credit for incentive-based emissions reductions. When given SIP credit, incentive-based emissions reductions can be used alongside regulatory-based emissions reductions to meet federal CAA requirements, such as demonstrating attainment with federal air quality standards at a future date. The District is proposing to use the emission reductions achieved through three incentives programs for the federal PM2.5 standards attainment demonstration. These measures will include the replacement of agricultural engines with electric motors; a woodstove and fireplace change-out program to emissions from residential wood combustion; and a program to incentivize the installation of pollution control equipment to reduce emissions from commercial underfired charbroilers. In addition, CARB is proposing to adopt SIP-creditable incentive measures for mobile sources in the Valley.

4.4 CARB Emission Reduction Commitment for the San Joaquin Valley

[*This section provided by the California Air Resources Board*]

CALIFORNIA AIR RESOURCES BOARD EMISSION REDUCTION COMMITMENT FOR THE SAN JOAQUIN VALLEY

CARB’s existing mobile source control program has achieved substantial reductions in in the Valley, and will continue to provide further emission reductions from ongoing implementation. Since 2000, NOx and PM2.5 emissions from mobile sources have been reduced by over 60 percent. Continued implementation of CARB’s current mobile source programs will result in significant further reductions by 2025, reducing NOx emissions from 2013 levels by 55 percent and PM2.5 emissions by nearly 40 percent.

The *2016 State Strategy for the State Implementation Plan* (2016 State SIP Strategy),[16] adopted by the CARB Board in March 2017, established Valley emission reductions commitments for ozone in 2031 and acknowledged that more emission reductions would be identified to meet PM2.5 standards in the Valley. CARB staff has further refined the final emission reduction needs and strategies, including funding mechanisms, to accelerate turnover to the technologies identified in the 2016 State SIP Strategy. This also includes efforts to reflect the benefits of additional transformational efforts underway in the Valley as part of other planning efforts that are anticipated to provide criteria emission reduction co-benefits. As an outcome of that process, the *San Joaquin Valley Supplement to the 2016 State Strategy for the State Implementation Plan* (Valley State SIP Strategy) includes updates to certain measures in the 2016 State SIP Strategy and proposes additional mobile source measures needed for the Valley's PM2.5 SIP. Appendix ?? further describes the updated 2016 State SIP Strategy measures and the Proposed State Measures for the Valley.

The measures in the Valley State SIP Strategy build upon the regulatory measures in the 2016 State SIP Strategy and accelerate turnover to the next generation of cleaner technologies in the Valley. The updated measures include new requirements that would ensure that on-road, heavy-duty vehicles remain as clean as possible throughout their lifetime, and the new incentive measures accelerate the turnover of agricultural tractors, heavy-duty on-road vehicles, and off-road equipment. Given their contribution to ambient PM2.5 levels in the Valley, District measures to achieve additional reductions from local sources of directly emitted PM2.5 will also be critical.

Combined, the actions in the 2016 State SIP Strategy and the Valley State SIP Strategy provide the share of mobile source reductions needed for attainment. Table 1 summarizes the combined reductions that will accrue through implementation of the current control program, the measures committed to in the 2016 State SIP Strategy, and the measures in the Valley State SIP Strategy. CARB's science-based assessment of a strategy focusing on both direct PM2.5 and NOx suggests emissions will need to be reduced from 2013 levels by 189 tpd NOx and 5.5 tpd PM2.5 in 2024, and 194 tpd NOx and 5.6 tpd PM2.5 in 2025.

Table 4-3 Emission Reductions from State Measures

	2024		2025	
	NOx (tpd)	PM2.5 (tpd)	NOx (tpd)	PM2.5 (tpd)
Current Control Program	157	4.6	162	4.7
Measures	32	0.9	32	0.9
2016 State SIP Strategy Measures	*9*	*0.1*	*12*	*0.1*

16 CARB (2017) "Revised Proposed 2016 State Strategy for the State Implementation Plan (State SIP Strategy)" https://www.arb.ca.gov/planning/sip/2016sip/2016sip.htm

	2024		2025	
Proposed State Measures for the Valley	*23*	*0.8*	*20*	*0.8*
Total Reductions	189	5.5	194	5.6

Together with the reductions from the current control program and the 2016 State SIP Strategy, the Valley State SIP Strategy is designed to achieve the mobile source NOx reductions necessary for the Valley's PM2.5 attainment needs.

The CARB commitment consists of two components:

1. A commitment to bring to the CARB Board or take action on the Proposed State Measures for the Valley; and
2. A commitment to achieve aggregate emission reductions in 2024 and 2025.

The commitment for the Valley would be submitted into the California SIP and would become federally enforceable upon approval by U.S. EPA. While the comprehensive mobile strategy for the San Joaquin Valley discussed in this document proposes a range of measures and indicates that CARB will undertake various actions, it remains a CARB staff proposal at this stage. The proposed commitment is subject to CARB's formal approval process and will not be final until the CARB Board formally takes action on the Valley State SIP Strategy.

4.4.1 Commitment to Act on Proposed State Measures for the Valley

Table 2 shows the full list of State measures and schedule for consideration to support attainment of federal PM2.5 standards in the Valley. The CARB Board has already approved the commitment for the 2016 State SIP Strategy measures and CARB is augmenting that commitment with additional State measures for the Valley. CARB staff proposes to commit to bring to the Board or take action on the list of Proposed State Measures for the Valley shown in the bottom portion of Table 2. CARB staff will initiate a SIP-creditable measure development process for each proposed measure according to the schedule outlined. This development process will provide additional opportunity for public and stakeholder input, as well as ongoing technology review, and assessment of costs and environmental impacts.

Table 4-4: State Measures and Schedule for the San Joaquin Valley

Measures	Agency	Action	Implementation Begins
2016 State SIP Strategy Measures			
Advanced Clean Cars 2 Reduced ZEV Brake and Tire Wear	CARB	2020 – 2021	2026
Lower In-Use Emission Performance Level:	CARB	2017 – 2020	2018 +
Lower Opacity Limits for Heavy-Duty Vehicles	CARB	2018	2018 – 2024
Amended Warranty Requirements for Heavy-Duty Vehicles	CARB	2018	2022
Heavy-Duty Vehicle Inspection and Maintenance Program	CARB	2020	2022 +
Low-NOx Engine Standard – California Action	CARB	2019	2023
Low-NOx Engine Standard – Federal Action	U.S. EPA	2019	2024
Innovative Clean Transit	CARB	2018 – 2019	2020
Advanced Clean Local Trucks (Last Mile Delivery)	CARB	2019	2020
Zero-Emission Airport Shuttle Buses	CARB	2018	2023
More Stringent National Locomotive Emission Standards	U.S. EPA	2017	2023 +
Zero-Emission Off-Road Forklift Regulation Phase 1	CARB	2020	2023
Zero-Emission Airport Ground Support Equipment	CARB	2019	2023
Small Off-Road Engines	CARB	2018 – 2020	2022
Transport Refrigeration Units Used for Cold Storage	CARB	2018 – 2019	2020 +
Low-Emission Diesel Fuel Requirement	CARB	by 2020	2023
Proposed State Measures for the Valley			
Accelerated Turnover of Trucks and Buses Existing Incentive Projects New Incentive Projects	CARB / SJVAPCD	by 2021	ongoing
Accelerated Turnover of Agricultural Tractors Existing Incentive Projects New Incentive Projects	CARB / SJVAPCD	by 2020	ongoing
Cleaner In-Use Agricultural Equipment	CARB	2025	2030
Accelerated Turnover of Off-Road Equipment New Incentive Projects	CARB / SJVAPCD	by 2021	ongoing

4.4.2 COMMITMENT TO ACHIEVE AGGREGATE EMISSION REDUCTIONS

The 2016 State SIP Strategy included an initial commitment to achieve an aggregate emission reduction of 8 tpd of NOx in the Valley by 2031, which serves as a down payment on the total emission reductions needed for the Valley's attainment of federal standards. This document proposes a commitment to achieve the aggregate emission reductions specified in Table 3 by 2024 and 2025.
CARB staff proposes to commit to achieve, in aggregate, 32 tpd of NOx emission reductions and 1 tpd of PM2.5 emission reductions in 2024, with those same emission reduction commitments carried through to 2025. These measures, in conjunction with the existing control program, identify all of the reductions required for the Valley's PM2.5 attainment needs. These measures reflect a combination of State actions and petitions for federal action to establish the policy and regulatory mechanisms to bring the needed advanced technologies into the California vehicle and equipment fleet, while pairing these actions with incentive and other programs to strategically accelerate the penetration of the cleanest technologies in each sector.

CARB's aggregate emission reduction commitment may be achieved through a combination of actions including but not limited to: the implementation of control measures; the expenditure of local, State or federal incentive funds; or through the implementation of other enforceable measures. In some cases, actions by federal agencies will be needed. CARB will include these emission reductions in its aggregate commitment to ensure that reductions are achieved regardless of federal action. For example, if a federal heavy-duty low-NOx engine standard is not established, CARB will look to achieve the necessary reductions from other source categories, such as stationary sources. In other cases, programmatic approaches must be developed and funding secured to achieve the reductions outlined.

While Table 3 includes estimates of the emission reductions from each of the individual measures, final measures as proposed by staff to the Board or adopted by the Board may provide more or less than the initial emission reduction estimates. CARB's overall commitment is to achieve the total emission reductions necessary to attain the federal air quality standards while reflecting the combined reductions from the existing control strategy and new measures. Therefore, if a particular measure does not get its expected emission reductions, the State is still committed to achieving the total aggregate emission reductions. If actual emission decreases occur that exceed the projections reflected in the current emissions inventory and the 2016 State SIP Strategy, CARB will submit an updated emissions inventory to U.S. EPA as part of a SIP revision. The SIP revision would outline the changes that have occurred and provide appropriate tracking to demonstrate that aggregate emission reductions sufficient for attainment are being achieved through enforceable emission reduction measures.

Table 4-5: San Joaquin Valley Expected Emission Reductions from State Measures

Reductions shown in tons per day (tpd)

Measures	2024		2025	
	NOx (tpd)	PM2.5 (tpd)	NOx (tpd)	PM2.5 (tpd)
2016 State SIP Strategy Measures				
Advanced Clean Cars 2	--	--	--	--
Reduced ZEV Brake and Tire Wear	--	NYQ	--	NYQ
Lower In-Use Emission Performance Level:	6.8	<0.1	6.8	<0.1
Lower Opacity Limits for Heavy-Duty Vehicles				
Amended Warranty Requirements for Heavy-Duty Vehicles				
Heavy-Duty Vehicle Inspection and Maintenance Program				
Low-NOx Engine Standard – California Action	0.7	--	2	--
Low-NOx Engine Standard – Federal Action	0.7	--	2	--
Innovative Clean Transit	<0.1	<0.1	<0.1	<0.1
Advanced Clean Local Trucks (Last Mile Delivery)	<0.1	<0.1	<0.1	<0.1
Zero-Emission Airport Shuttle Buses	NYQ	NYQ	NYQ	NYQ
More Stringent National Locomotive Emission Standards	0.1	<0.1	0.3	<0.1
Zero-Emission Off-Road Forklift Regulation Phase 1	--	--	--	--
Zero-Emission Airport Ground Support Equipment	<0.1	<0.1	<0.1	<0.1
Small Off-Road Engines	0.1	<0.1	0.2	<0.1
Transport Refrigeration Units Used for Cold Storage	NYQ	NYQ	NYQ	NYQ
Low-Emission Diesel Fuel Requirement	0.8	0.1	1	0.1
Total Reductions from 2016 State SIP Strategy Measures	**9**	**0.1**	**12**	**0.1**
Proposed State Measures for the Valley				
Accelerated Turnover of Trucks and Buses	10	NYQ	8	NYQ
Existing Incentive Projects				
New Incentive Projects				
Accelerated Turnover of Agricultural Tractors				
Existing Incentive Projects	3	0.2	2	0.2
New Incentive Projects	8	0.6	8	0.6
Cleaner In-Use Agricultural Equipment	NYQ	NYQ	NYQ	NYQ
Accelerated Turnover of Off-Road Equipment				
New Incentive Projects	2	NYQ	1.5	NYQ
Total Reductions from Proposed State Measures for Valley	**23**	**0.8**	**20**	**0.8**
Aggregate Emission Reductions	**32**	**1**	**32**	**1**

"NYQ" denotes emission reductions are Not Yet Quantified
"—" denotes no anticipated reductions
The measures as proposed by staff to the Board or adopted by the Board may provide more or less reductions than the amount shown.

4.4.3 IMPLEMENTING THE STATE MEASURES FOR THE VALLEY

Implementation of the current control program and new regulatory actions to establish requirements for cleaner technologies comprise the core of the overall strategy for the Valley. The remaining increment of reductions will be achieved through the suite of actions to accelerate the penetration of cleaner technologies through incentive programs. These actions will also further California's efforts to meet climate and risk reduction goals and enhance the continuing transformation to a cleaner, more efficient transportation system.

4.4.4 2016 STATE SIP STRATEGY MEASURES

4.4.4.1 Advanced Clean Cars 2

The *Advanced Clean Cars 2* measure is designed to ensure that near-zero and zero-emission technology options continue to be commercially available, with electric driving range improvements to address consumer preferences and maximize electric vehicle miles travelled. The regulation may include lowering fleet emissions further beyond the super-ultra-low-emission vehicle standard for the entire light-duty fleet through at least the 2030 model year, and look at ways to improve real world emissions through implementation programs. Additionally, new standards may be considered to further increase the sales of zero-emission vehicles (ZEV) and plug-in hybrid electric vehicles beyond the levels required in 2025.

4.4.4.2 Reduced ZEV Brake and Tire Wear

As an updated element of the *Advanced Clean Cars 2* measure, *Reduced ZEV Brake and Tire Wear* is designed to evaluate and quantify the benefits that will accrue from the expanded number of zero-emission vehicles and plug-in hybrid electric vehicles operating in California. As these vehicles continue to become more commercially available, the new technologies they employ, including regenerative braking and lower rolling resistance tires, can reduce criteria pollutant emissions from brake and tire wear. CARB staff would quantify these previously unaccounted-for criteria pollutant benefits of the Advanced Clean Cars program for SIP purposes in order to better inform future plans.

4.4.4.3 Lower In-Use Emission Performance Level for Heavy-Duty Vehicles

Since the adoption of the 2016 State SIP Strategy in March 2017, CARB staff has made substantial progress in refining its approach to controlling the in-use emissions from the on-road heavy-duty truck fleet, as originally described in the *Lower In-Use Emission Performance Level* 2016 State SIP Strategy measure. The actions initially proposed in the *Lower In-Use Emission Performance Level* measure are now reflected in this document as three separate, but related elements: *Lower Opacity Limits for Heavy-Duty Vehicles*; *Amended Warranty Requirements for Heavy-Duty Vehicles*; and *Heavy-Duty Vehicle Inspection and Maintenance Program*.

4.4.4.4 Lower Opacity Limits for Heavy-Duty Vehicles

The *Lower Opacity Limits for Heavy-Duty Vehicles* element is designed to ensure that in-use, heavy-duty vehicles continue to operate at their cleanest possible level. In May 2018, CARB staff proposed and the Board approved for adoption lower opacity limits for on-road heavy-duty vehicles which reflect the current emission control technology equipped on today's heavy-duty diesel vehicles. Lowering the opacity limits will ensure that the opacity limits are more representative of current particulate matter emission control technology and that vehicles operating with malfunctioning particulate emission control components are more readily identified and repaired.

4.4.4.5 Amended Warranty Requirements for Heavy-Duty Vehicles

The *Amended Warranty Requirements for Heavy-Duty Vehicles* element is designed to reduce NOx and PM emissions by encouraging vehicle owners to make emission-related repairs. In June 2018, CARB staff proposed and the Board approved for adoption lengthened warranty periods and longer maintenance intervals for on-road heavy-duty vehicles with gross vehicle weight ratings greater than 14,000 pounds. CARB staff plans to develop a second step of lengthened warranty period requirements for on-road heavy-duty vehicles which would be proposed for Board consideration in late 2019. Amendment requirements as described could encourage manufacturers to design more durable components.

4.4.4.6 Heavy-Duty Vehicle Inspection and Maintenance Program

The *Heavy-Duty Vehicle Inspection and Maintenance Program* element is designed to ensure that in-use, heavy-duty vehicle emission control components and systems are properly functioning so that these vehicles continue to operate at their cleanest possible levels. CARB staff would develop and propose a regulatory program that reflects the current state of advanced engine and exhaust emission control technologies including on-board diagnostics.

4.4.4.7 Low-NOx Engine Standard

The *Low-NOx Engine Standard* measure is designed to require engine technologies that will substantially lower NOx emissions from on-road heavy-duty vehicles. CARB began development of a new heavy-duty low-NOx emission standard in California in 2016, and Board action is expected in 2019. A California-only low-NOx standard would apply to all vehicles with new heavy-duty engines sold in California starting in 2023. In order to achieve the maximum emission reductions from this measure, CARB included in the 2016 State SIP Strategy a call for U.S. EPA to establish a new federal heavy-duty engine emission standard. Should U.S. EPA fail to initiate a rule development process, CARB would continue with its development and implementation efforts to establish a California-only low-NOx standard. CARB will coordinate its regulatory development efforts with any U.S. EPA regulatory efforts.

4.4.4.8 Innovative Clean Transit

The *Innovative Clean Transit* measure is designed to continue the transition of transit fleets to cleaner technologies to support NOx and GHG emission reduction goals. The measure will consider a variety of approaches to enhance the deployment of advanced clean technology and increase the penetration of the first wave of zero-emission heavy-duty technology into transit applications that are well suited to its use. CARB staff will develop and propose an Innovative Clean Transit measure with a combination of mechanisms, including incentives, which would result in transit fleets purchasing advanced technology buses during normal replacement and using renewable fuels when contracts are renewed.

4.4.4.9 Advanced Clean Local Trucks (Last Mile Delivery)

The *Advanced Clean Local Trucks* measure is designed to increase the penetration of advanced clean technology into applications that are well suited to its use. CARB staff would develop and propose a regulation that would result in the use of low-NOx engines and the purchase of zero-emission trucks for certain class 3-7 last mile delivery trucks in California. This measure would begin in 2020 with a small scale deployment and gradually ramp up to higher percentages of new vehicles sales.

4.4.4.10 Zero-Emission Airport Shuttle Buses

The *Zero-Emission Airport Shuttle Buses* measure is designed to achieve NOx and GHG emission reductions goals through advanced clean technology, and to increase the penetration of the first wave of zero-emission heavy-duty technology into applications that are well suited to its use. Like transit buses, the inclusion of zero-emission airport shuttles would serve as a stepping stone to encourage broader deployment of zero-emission technologies in the on-road sector. CARB staff would develop and propose a regulation or other measures to deploy zero-emission airport shuttles in order to further support market development of zero-emission technologies in the heavy-duty sector.

4.4.4.11 More Stringent National Locomotive Emission Standards

The *More Stringent National Locomotive Emission Standards* measure is designed to reduce emissions from new and remanufactured locomotives. Pursuant to this measure, in 2017, CARB petitioned U.S. EPA for new Tier 5 national locomotive emission standards for new locomotives and more stringent national requirements for remanufactured locomotives. CARB staff estimates that U.S. EPA could require manufacturers to implement the new locomotive emission regulations as early as 2023 for remanufactured locomotives, and 2025 for newly manufactured locomotives. A new federal standard could also facilitate development and deployment of zero-emission track mile locomotives and zero-emission locomotives by building incentives for those technologies into the regulatory structure.

4.4.4.12 Zero-Emission Off-Road Forklift Regulation Phase 1

The *Zero-Emission Off-Road Forklift Regulation Phase 1* measure is designed to increase penetration of ZEVs in off-road applications, advance ZEV commercialization, and to set a market signal to technology manufacturers and investors. CARB staff would develop and propose a regulation with specific focus on forklifts with lift capacities equal to or less than 8,000 pounds for which zero-emission technologies have already gained appreciable customer acceptance and market penetration.

4.4.4.13 Zero-Emission Airport Ground Support Equipment

The *Zero-Emission Airport Ground Support Equipment* measure is designed to increase the penetration of the first wave of zero-emission heavy-duty technology in applications that are well suited to its use, and to facilitate further technology development and infrastructure expansion. A conservative strategy would rely on incentives and natural turnover, along with current in-use requirements, to replace equipment where electric replacements are readily available. A more aggressive turnover and implementation strategy could utilize a memorandum of understanding, regulation, or a combination thereof, along with incentives for demonstration, to ensure an accelerated transition to zero-emission equipment. Under this measure, CARB staff would develop and propose a regulation to accelerate the transition of diesel and large spark ignition airport ground support equipment to zero-emission technology.

4.4.4.14 Small Off-Road Engines

The *Small Off-Road Engines* (SORE) measure is designed to reduce emissions from small off-road engines, and to increase the penetration of zero-emission technology. SORE that are subject to CARB regulations are used in residential and commercial lawn and garden equipment, and other utility applications. CARB will develop and propose tighter exhaust and evaporative emission standards, encourage increased use of zero-emission equipment, and enhance enforcement of current emission standards for SORE. Strategies will be developed for transitioning to zero-emission technologies, including an initial focus on incentives for use of zero-emission equipment, coupled with increasingly stringent emission standards for criteria pollutants and GHGs.

4.4.4.15 Transport Refrigeration Units Used for Cold Storage

The *Transport Refrigeration Units Used for Cold Storage* measure is designed to advance zero and near-zero emission technology commercialization by increasing the early penetration of hybrid electric and electric standby-equipped transport refrigeration units used for cold storage, and supporting the needed infrastructure developments. CARB staff would develop a regulation to reduce NOx, PM, and GHG emissions by reducing the amount of time that transport refrigeration units operate using internal combustion engines while refrigerated trucks, trailers, and shipping containers are parked at certain California facilities and other locations.

4.4.4.16 Low-Emission Diesel Fuel Requirement

The *Low-Emission Diesel Fuel Requirement* measure is designed to reduce emissions from the portion of the heavy-duty fleet that will continue to operate on internal combustion engines. CARB staff would bring to the Board a proposed low-emission diesel standard that would require diesel fuel providers to steadily decrease criteria pollutant emissions from their diesel products until 2031. The standard would complement existing CARB programs that incentivize increased use of renewable fuels as substitutes for conventional fuels, and will focus on more completely transitioning the fuel mix to a cleaner mix of diesel substitute fuels.

4.4.5 PROPOSED STATE MEASURES FOR THE VALLEY

4.4.5.1 Accelerated Turnover of Trucks and Buses

The *Accelerated Turnover of Trucks and Buses* measure is designed to provide incentive funding to accelerate the penetration of near-zero and zero-emission engines beyond the rate of natural turnover achieved through implementation of other measures identified for on-road heavy-duty trucks and buses. Using existing funding mechanisms, the measure would target technologies that meet CARB’s current optional low-NOx standard and the future low-NOx emission standard requirements. CARB staff would also develop a measure to use innovative funding programs to target technologies that exceed current standards.

4.4.5.2 Accelerated Turnover of Agricultural Tractors

The *Accelerated Turnover of Agricultural Tractors* measure is designed to use existing and new incentive funding programs to help accelerate the penetration of cleaner engines used in agricultural equipment beyond the rate of natural turnover. A portion of these SIP-creditable reductions would come from the quantification of reductions from projects already funded and executed to date that will continue to provide SIP-creditable reductions through 2024 and 2025. The remaining reductions correspond to accelerated turnover of additional tier 0 and 1 tractors using existing and innovative incentive funding programs.

4.4.5.3 Cleaner In-Use Agricultural Equipment

The *Cleaner In-Use Agricultural Equipment* measure is a rule designed to increase the penetration of cleaner agricultural equipment used in California, including advancing zero-emission technology where feasible. CARB staff would develop a regulation to serve as an overall emission reduction target and to act as a catalyst for attracting early replacement of agricultural equipment through incentives. The combination of this rule, incentive programs, and significant lead-time ensure that cleaner agricultural equipment will be used in the Valley.

4.4.5.4 Accelerated Turnover of Off-Road Equipment

The *Accelerated Turnover of Off-Road Equipment* measure is designed to provide incentive funding to accelerate the penetration of near-zero and zero-emission construction equipment, transport refrigeration units, and forklifts beyond the rate of natural turnover achieved through implementation of the other proposed measures identified for off-road equipment. CARB staff would use Carl Moyer and other innovative incentive funding programs to help increase the penetration of cleaner engine technology, achieving additional NOx reductions through accelerating the turnover of off-road engines.

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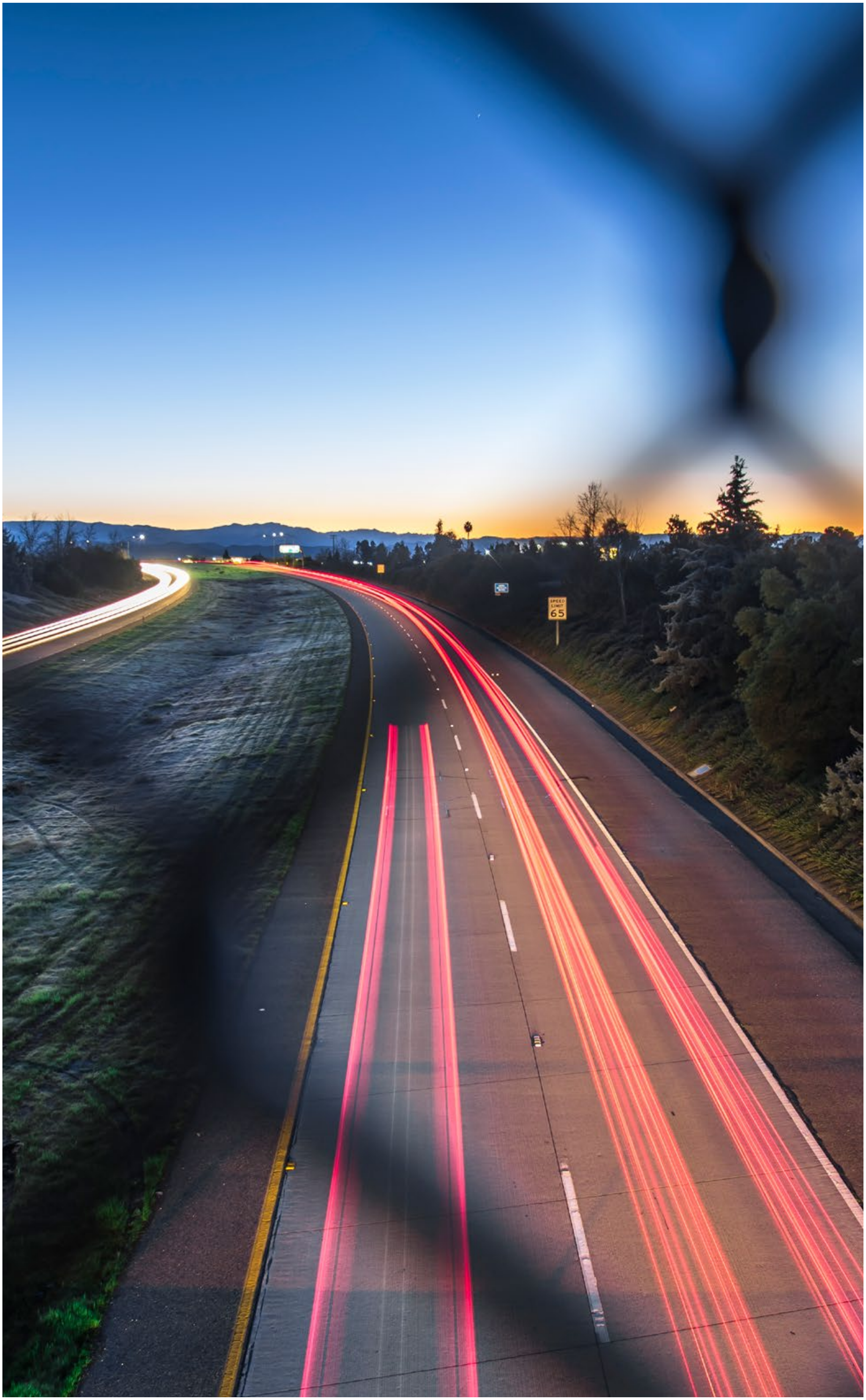

Chapter 5

Demonstration of Federal Requirements for 1997 PM2.5 Standards

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EPA's 1997 PM2.5 national ambient air quality standard (NAAQS, or standard) has two components: an annual average standard of 15 micrograms per cubic meter (µg/m^3), and a 24-hour average standard of 65 µg/m^3. EPA designated the San Joaquin Valley (Valley) as nonattainment effective April 2005, and finalized its implementation rule effective May 29, 2007 consistent with federal Clean Air Act (CAA) Subpart 1. On April 30, 2008, the District adopted the *2008 PM2.5 Plan* demonstrating attainment of the 1997 standard by April 2015 and satisfying all federal implementation requirements. EPA approved this Plan effective January 9, 2012. Subsequently, on January 4, 2013, the D.C. Circuit Court ruled that EPA erred by solely using Subpart 1 in establishing its PM2.5 implementation rule, without consideration of the PM-specific provisions in Subpart 4.[1]

Subpart 4 differs from Subpart 1 in its attainment Plan deadlines, the required level of emissions controls, and its handling of PM precursors. Another key difference is in the classification of nonattainment areas and corresponding attainment deadlines. Under Subpart 1, all areas were designated nonattainment without a corresponding classification. Under Subpart 4, nonattainment areas are initially classified as "Moderate," with six years from its initial nonattainment designation date to reach attainment (though two one-year extensions are available in certain circumstances). Areas can request reclassification to "Serious," with ten years from its initial attainment designation date to reach attainment. Subpart 4 allows for an additional extension of up to five years if the area demonstrates that the current attainment deadline is unfeasible, all requirements and commitments have been met, and SIP includes the most stringent measures (MSM) possible. If an area fails to attain an applicable attainment deadline, it must submit a SIP revision demonstrating expeditious attainment, with PM or PM precursor emissions reduced by at least 5% per year until attainment.

Following the 2013 D.C. Circuit Court ruling, EPA began redirecting all PM2.5 implementation efforts to be consistent with Subpart 4, but under a truncated schedule as compared to what would have occurred had EPA initially designated nonattainment areas under Subpart 4 in 2005. In June 2014, EPA classified the Valley as a Moderate nonattainment area under Subpart 4 with an attainment date of April 5, 2015. In August 2014, the District submitted a formal request to EPA to reclassify the Valley to Serious nonattainment. EPA granted the Valley's Serious reclassification request in April 2015, setting a new attainment date of December 31, 2015.

After implementing much of the commitments in the *2008 PM2.5 Plan*, the Valley had been on the verge of attaining the 1997 PM2.5 Standard. However, due to the extreme drought, stagnation, strong inversions, and historically dry conditions experienced over the winter of 2013-2014, it was clear in 2014 that attainment by 2015 (based on 2013-2015 data) would be impossible.

[1] *Nat. Res. Def. Council v. E.P.A.*, 706 F.3d 428 (D.C. Cir. 2013)

The District adopted the *2015 PM2.5 Plan for the 1997 PM2.5 Standard* (2015 PM2.5 Plan) in April 2015 with an MSM demonstration and an attainment date extension request of 2020, as provided for in Subpart 4. The District had worked closely with EPA for over a year developing this Plan to address concerns and ensure CAA requirements were satisfied. The *2015 PM2.5 Plan's* comprehensive control strategy would achieve a 38% reduction in NOx emissions between 2012 and 2020 as well as significant reductions in directly emitted PM2.5.

EPA formally proposed to approve portions of the Plan and the attainment date extension on February 9, 2016. EPA needed to finalize its approval of the Valley's attainment date extension by July 2016, but EPA failed to finalize this action. EPA subsequently denied the District's attainment extension request on the basis that they did not have enough information to act, and found that the Valley failed to attain the 1997 standard by its December 2015 attainment deadline effective December 23, 2016.[2]

Pursuant to CAA §189(d), EPA's 2016 PM2.5 Implementation Rule[3], and 40 CFR §51.1003(c), the District must now submit a SIP revision that meets the requirements shown in Table 5-1, commonly called a 5% Plan. Although this 1997 PM2.5 SIP update was technically due by December 2016, this was not feasible given the already-truncated schedule described above. Addressing these requirements as part of this *2018 PM2.5 Plan* allowed for better stakeholder involvement and harmonization of SIP elements between the 1997, 2006, and 2012 PM2.5 standards.

Table 5-1 Summary of 5% Plan Requirements

5% Plan Element	Source of Requirement	Location of Plan Where Element Satisfied
Emissions inventory that includes a base year inventory and an attainment projected inventory for the area	40 CFR §§51.1003(c) and 51.1008(c) 81 Fed Reg 58098	Appendix B
Identify Pollutants to be addressed	CAA 189(d) 81 Fed Reg 58099	Appendix G
Control Strategy Analysis	40 CFR §§ 51.1003(c)(1)(iii) and 51.1010(c)	Section 5.1 and Appendices C and D
5% Demonstration	CAA §189(d) 40 CFR §51.1003(c)	Section 5.2 and Chapter 4
Attainment demonstration and modeling	40 CFR §§ 51.1003(c)(1)(iv), 51.1010(c), and 51.1011	Section 5.3 and Appendices K and L
Reasonable Further Progress	40 CFR §§ 51.1003(c)(1)(v) and 51.1012	Section 5.4, Appendix H
Quantitative milestone	40 CFR §§ 51.1003(c)(1)(vi) and 51.1013(a)(3 and 4)	Section 5.5, Appendix H
Contingency measures	CAA §172(c)(9)	Section 5.6, Appendix H

[2] https://www.gpo.gov/fdsys/pkg/FR-2016-11-23/pdf/2016-28100.pdf
[3] 81 Fed. Reg. 58098-58106, available at https://www.gpo.gov/fdsys/pkg/FR-2016-08-24/pdf/2016-18768.pdf

5% Plan Element	Source of Requirement	Location of Plan Where Element Satisfied
	40 CFR §§ 51.1003(c)(1)(vii) and 51.1014.	
Nonattainment New Source Review requirements	CAA §189(b)(3) 40 CFR §51.1003(c)(1)(viii)	Section 5.7
Transportation Conformity Budgets	40 CFR §51.1003(d) 81 Fed. Reg. 58103	Section 5.8, Appendix D

5.1 Control Strategy

This CAA §189(d) Plan must include a control strategy satisfying the requirements of 40 CFR §§ 51.1003(c)(1)(iii) and 51.1010(c).[4] This control strategy must be sufficient to achieve the emissions reductions necessary for the 5% demonstration and expeditious attainment. The District's evaluation of emissions sources and emissions controls demonstrate that the most stringent measures, which includes all reasonably available emission reduction opportunities and best available control measures, are in place in the Valley for NOx and directly emitted PM2.5 emissions. Refer to Appendices C and D for these demonstrations.

5.2 5% Demonstration

Pursuant to 40 CFR §51.1003(c), this 189(d) Plan's control strategy must achieve a 5 percent annual reduction in either direct PM2.5 emissions *or* in the emissions of any PM2.5 Plan precursor based on the most recent emissions inventory[5]. Areas can vary between direct PM2.5 and PM2.5 precursors, or among precursors, from year to year. Areas are not penalized for achieving emissions reductions early, as they are permitted to carry forward any emissions reductions beyond the required minimum 5 percent in a given year to subsequent years.

The base year for this analysis should be one of the three years used to determine that the area failed to attain the 1997 PM2.5 standard. For the Valley, these years were 2013, 2014, and 2015. Using the 2013 as the inventory year, the following demonstrates that NOx emissions reductions achieved from already adopted control measures is sufficient to provide at least a 5% annual reduction from the Plan submittal date until attainment. The first year for this analysis is to be the year after the Plan submission date (which should have been 2016, making 2017 the first analysis year), and the final year is to be the new projected attainment date.

[4] See also 81 Fed. Reg. 58099-58100
[5] See also 81 Fed. Reg. 58100-58101.

Table 5-2 Summary of Emission Reductions in Valley Demonstrating 5% Annual Reductions Through Attainment (2013-2020)

		% reduction from 2013 base	5% Target (tpd NOx)	CEPAM Inventory v1.05 (tpd NOx)	Meets 5%
Base Year	2013			**317.3**	
	2014			283.5	
	2015			263.4	
	2016			248.4	
Year 1	2017	5%	301.3	233.4	YES
Year 2	2018	10%	285.5	221.5	YES
Year 3	2019	15%	269.6	214.5	YES
Year 4	2020	20%	253.8	203.3	YES

5.3 Attainment Demonstration

This CAA §189(d) Plan must demonstrate expeditious attainment pursuant to 40 CFR §§ 51.1003(c)(1)(iv), 51.1010(c), and 51.1011.[6] "Expeditious attainment" should be no later than five years from the date of EPA's finding of failure to attain, which EPA finalized in 2016. EPA may extend the attainment date by up to five additional years considering the severity of nonattainment and the availability and feasibility of pollution control measures. The modeling performed by CARB and the District demonstrates the Valley will attain the standard by 2020. See below for the summary of modeling results and Appendix K for the full discussion. This attainment Plan also demonstrates the Valley will attain the standard as expeditiously as practicable as demonstrated in Appendix H.

5.3.1 Summary of Modeling Results

[This section provided by California Air Resources Board]

Photochemical modeling plays a crucial rule in demonstrating attainment of the national ambient air quality standards based on projected future year emissions. Currently, San Joaquin Valley (SJV or Valley) is designated as a serious nonattainment area for the 1997 U.S. EPA annual (15 µg/m^3) and 24-hour (65 µg/m^3) $PM_{2.5}$ standards with an attainment deadline 2020 for both standards. Consistent with U.S. EPA guidance for model attainment demonstrations (U.S. EPA, 2014[7]), photochemical modeling was used to project $PM_{2.5}$ design values (DVs) to the future. 2020 annual and 24-hour $PM_{2.5}$ DVs

[6] See also 81 Fed. Reg. 58102-58103 and 58106.

[7] 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

at each monitoring site in the Valley show attainment of the 1997 annual and 24-hour $PM_{2.5}$ standards.

The findings from the model attainment demonstration are summarized below. A detailed description of the model inputs, modeling procedures, and attainment test can be found in the Modeling Attainment Demonstration and Modeling Protocol Appendices of this document.

The current modeling approach draws on the products of large-scale, scientific studies as well as past $PM_{2.5}$ SIPs in the region, collaboration among technical staff at state and local regulatory agencies, and from participation in technical and policy groups in the region (See Photochemical Modeling Protocol Appendix for further details). In this work, the Weather Research and Forecasting (WRF) model version 3.6 was utilized to generate the annual meteorological fields. The Community Multiscale Air Quality (CMAQ) Model version 5.0.2 with state-of-the-science aerosol treatment was used for modeling annual $PM_{2.5}$ in the Valley. Other model inputs and configuration, including the modeling domain definition, chemical mechanism, initial and boundary conditions, and emission processing can be found in the Photochemical Modeling Protocol and Modeling Emissions Inventory Appendices.

The U.S. EPA modeling guidance (U.S. EPA, 2014[1]) recommends using modeling in a "relative" rather than "absolute" sense. Based on analysis of recent years' ambient $PM_{2.5}$ levels and meteorological conditions leading to elevated $PM_{2.5}$ concentrations, the year 2013 was selected for baseline modeling calculations. In particular, in 2013 SJV experienced one of the worst years for $PM_{2.5}$ pollution in the Valley within the last decade.

Specifying the baseline design value is a key consideration in the model attainment test, because this value is projected forward to the future and used to test for future attainment of the standard at each monitor. To minimize the influence of year-to-year variability in demonstrating attainment, the U.S. EPA modeling guidance recommends using the average of three DVs, where one of the DV years is the same as the baseline emissions inventory and modeling year. This average DV is referred to as the baseline (or reference) DV. Here, the average DVs from 2012, 2013, and 2014 are used to calculate baseline DVs (see Tables 2 and 3 for the baseline DVs utilized in the attainment demonstration modeling).

In order to use the modeling in a relative sense, five simulations were conducted: 1) base year simulation for 2013, which demonstrated that the model reasonably reproduced the observed $PM_{2.5}$ concentrations in the Valley; 2) reference (or baseline) year simulation for 2013, which was the same as the base year simulation, but excluded exceptional event emissions such as wildfires; and 3) future year simulations for 2020. These simulations were the same as the reference year simulation, except projected anthropogenic emissions for 2020 were used in lieu of the 2013 emissions.

Table 1 shows the 2013 and 2020 Valley annual anthropogenic emissions for the five $PM_{2.5}$ precursors calculated from the model-ready emissions inventory. From 2013 to

2020, anthropogenic emissions in the Valley are estimated to drop approximately 35%, 8%, 6%, 8%, and 1% for nitrogen oxides (NO_x), reactive organic gases (ROG), primary $PM_{2.5}$, sulfur oxides (SO_x), and ammonia (NH_3), respectively. Among these five precursors, anthropogenic NO_x emissions show the largest relative reduction, dropping from 288.2 tons/day in 2013 to 187.1 tons/day in 2020. Note that the emission totals presented in the following table were calculated from the modeling inventory based on CEPAM.

Since the modeling inventory includes day-specific adjustments not included in the planning inventory, the planning and modeling inventories are expected to be comparable, but not identical.

Table 5-3 Valley Model-Ready Annual Emissions for 2013 and 2020

Category	NO_x	ROG	$PM_{2.5}$	SO_x	NH_3
2013 (tons/day)					
Stationary	38.5	90.8	8.5	7.2	13.9
Area	8.1	153.3	40.2	0.3	310.0
On-road Mobile	154.6	45.1	5.7	0.6	4.4
Other Mobile	87.1	35.8	6.2	0.3	6.0
Total	288.2	325.0	60.5	8.4	334.3
2020 (tons/day)					
Stationary	28.5	95.1	8.4	6.5	15.2
Area	7.8	151.8	40.0	0.3	306.9
On-road Mobile	81.0	22.4	3.2	0.6	3.6
Other Mobile	69.8	28.7	5.4	0.3	6.0
Total	187.1	298.0	57.0	7.7	331.7
Total change from 2013 to 2020	-35%	-8%	-6%	-8%	-1%

In this relative approach, the fractional change (or ratio) in $PM_{2.5}$ concentration between the modeled future year (2020) and modeled baseline year (or reference year, 2013) are calculated. These ratios are called relative response factors (RRFs). Since $PM_{2.5}$ is comprised of different chemical species, which respond differently to changes in emissions of various pollutants, separate RRFs were calculated for individual $PM_{2.5}$ species. In addition, because of potential seasonal differences in $PM_{2.5}$ formation mechanisms, RRFs for each species were also calculated separately for each quarter. The RRF for a specific $PM_{2.5}$ component *j* for each quarter is calculated using the following expression:

$$RRF_j = \frac{[C]_{j,\ future}}{[C]_{j,\ reference}} \qquad (1)$$

Where for the annual $PM_{2.5}$ standard, $[C]_{j,\ future}$ is the modeled quarterly mean concentration for component *j* predicted for the future year averaged over the 3x3 array of grid cells surrounding the monitor, and $[C]_{j,reference}$ is the same, but for the reference year simulation. For the 24-hour $PM_{2.5}$ standard, $[C]_{j,\ future}$ is the mean concentration for component *j* (for the top 10 percent of modeled $PM_{2.5}$ days in a quarter) predicted at the single grid cell which contains the monitor, and $[C]_{j,reference}$ is the same, but for the reference year simulation.

The measured FRM/FEM (i.e., Federal Reference Method/Federal Equivalent Method) $PM_{2.5}$ must be separated into its various chemical components. Species concentrations were obtained from the four $PM_{2.5}$ chemical speciation sites in the Valley. These four speciation sites are located at: Bakersfield – California Avenue, Fresno – Garland, Visalia – North Church, and Modesto – 14th Street. Since not all of the 16 FRM/FEM $PM_{2.5}$ sites in the Valley have collocated speciation monitors, the speciated $PM_{2.5}$ measurements at one of the four speciation sites were utilized to represent the speciation profile at each of the FRM/FEM sites based on geographic proximity, analysis of local emission sources, and measurements from previous field studies.

Since the FRM $PM_{2.5}$ monitors do not retain all of the $PM_{2.5}$ mass that is measured by the speciation samplers, the U.S. EPA modeling guidance recommends using the SANDWICH approach (Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbon Hybrid material balance) described by Frank (2006[8]) to apportion the FRM $PM_{2.5}$ mass to individual $PM_{2.5}$ species based on nearby chemical speciation measurements. Based on completeness of the data, $PM_{2.5}$ speciation data from 2010 – 2013 were utilized. For each quarter, percent contributions from individual chemical species to FRM/FEM $PM_{2.5}$ mass were calculated as the average of the corresponding quarter from 2010-2013 for the annual standard calculation. For the 24-hour standard calculation, only the top 10% of measured $PM_{2.5}$ days from that quarter were utilized for percentage calculations.

Projected 2020 annual and 24-hour $PM_{2.5}$ DVs for each site are given in Tables 2 and 3, respectively. For the annual standard, the Bakersfield-Planz site has the highest projected DV at 14.6 $\mu g/m^3$, which is below the 1997 annual $PM_{2.5}$ standard of 15 $\mu g/m^3$. For the 24-hour standard, the Bakersfield-California Avenue site has the highest projected DV at 47.6 $\mu g/m^3$, which is also below the 1997 U.S EPA 24-hour $PM_{2.5}$ standard of 65 $\mu g/m^3$. Since projecting future year $PM_{2.5}$ DVs is performed by projecting individual $PM_{2.5}$ components and then summing those components to get the total $PM_{2.5}$, it is useful to examine the RRFs associated with individual components to evaluate how the changes in each component contributes to the overall change in $PM_{2.5}$. From 2013 to 2020, there are modest reductions projected for ammonium nitrate, EC, and organic matter (OM), a slight reduction in sulfate, and a slight increase in crustal material. The reduction in ammonium nitrate is a direct result of NO_x emission reductions from 2013 to 2020. EC and OM reductions are primarily tied to the reduction in primary $PM_{2.5}$ emissions from 2013 to 2020. Detailed RRFs and base/future year concentrations for each individual species can be found in the Modeling Attainment Demonstration.

To evaluate the impact of reducing emissions of different $PM_{2.5}$ precursors to $PM_{2.5}$ DVs, a series of model sensitivity simulations were performed, for which anthropogenic emissions within the SJV were reduced by a certain percentage from the baseline

[8] Frank, N.H., 2006, Retained nitrate, hydrated sulfates, and carbonaceous mass in federal reference method fine particulate matter for six eastern U.S. cities, Journal of Air & Waste Management Association, 56, 500-511.

emissions. Following U.S. EPA precursor demonstration guidance[9] as well as considering SJV's control strategies, sensitivity runs involving 30% emission reductions were performed for NO_x and direct $PM_{2.5}$. For other precursors (i.e., ammonia, VOCs, and SO_x), both 30% and 70% emission reductions were performed. In addition, sensitivity simulations were performed for the years 2013, 2020, and 2024. The key conclusion from the sensitivity runs is that in 2024, reductions of direct $PM_{2.5}$ and NO_x emissions will continue to have a significant impact on annual and 24-hour $PM_{2.5}$ DVs, while reductions of ammonia, ROG, and SO_x have a much smaller impact compared to that of direct $PM_{2.5}$ and NO_x.

Table 5-4 Projected future year 2020 annual PM2.5 DVs at each monitor

Site AQS ID	Name	Base DV (µg/m³)	2020 Annual DV (µg/m³)
60290016	Bakersfield - Planz	17.2	14.6
60392010	Madera	16.9	14.2
60311004	Hanford	16.5	13.3
61072002	Visalia	16.2	13.5
60195001	Clovis	16.1	13.4
60290014	Bakersfield - California	16.0	13.5
60190011	Fresno-Garland	15.0	12.4
60990006	Turlock	14.9	12.5
60195025	Fresno - Hamilton & Winery	14.2	11.9
60771002	Stockton	13.1	11.4
60470003	Merced - S Coffee	13.1	10.9
60990005	Modesto	13.0	11.0
60472510	Merced - Main Street	11.0	9.3
60772010	Manteca	10.1	8.7
60192009	Tranquility	7.7	6.4

Table 5-5 Projected future year 2020 24-hour PM2.5 DVs at each monitor

Site AQS ID	Name	Base DV (µg/m³)	2020 24-hour DV (µg/m³)
60290014	Bakersfield – California	64.1	47.6
60190011	Fresno – Garland	60.0	44.3
60311004	Hanford	60.0	43.7
60195025	Fresno – Hamilton & Winery	59.3	45.6

[9] U.S. EPA, 2016, PM2.5 Precursor Demonstration Guidance, available at https://www.epa.gov/sites/production/files/2016-11/documents/transmittal_memo_and_draft_pm25_precursor_demo_guidance_11_17_16.pdf

Site AQS ID	Name	Base DV ($\mu g/m^3$)	2020 24-hour DV ($\mu g/m^3$)
60195001	Clovis	55.8	41.1
61072002	Visalia	55.5	42.8
60290016	Bakersfield – Planz	55.5	41.2
60392010	Madera	51.0	38.9
60990006	Turlock	50.7	37.8
60990005	Modesto	47.9	35.8
60472510	Merced – M. Street	46.9	32.9
60771002	Stockton	42.0	33.5
60470003	Merced – S Coffee	41.1	30.0
60772010	Manteca	36.9	30.1
60192009	Tranquility	29.5	21.5

5.4 Reasonable Further Progress

This CAA §189(d) Plan must demonstrate Reasonable Further Progress (RFP) pursuant to 40 CFR §§ 51.1003(c)(1)(v) and 51.1012.[10] RFP is the incremental emission reductions leading to the attainment date of a standard for an area. Refer to Appendix H for a full description and the RFP demonstration.

5.5 Quantitative Milestones

This CAA §189(d) Plan must include quantitative milestones pursuant to CAA §189(c) and 40 CFR §§ 51.1003(c)(1)(vi) and 51.1013(a)(3 and 4). Quantitative milestones are designed to track RFP, to track progress in achieving the minimum 5 percent annual emission reductions as well as control measures needed for expeditious attainment. See Appendix H for this demonstration.

5.6 Contingency Measures

This CAA §189(d) Plan must include contingency measures pursuant to CAA §172(c)(9) and 40 CFR §§ 51.1003(c)(1)(vii) and 51.1014. Contingency measures are additional control measures to be implemented in the event that an area fails to meet RFP requirements, fails to meet any quantitative milestone, fails to submit a quantitative milestone report or fails to attain the PM2.5 standard by the applicable attainment date. These measures must be fully adopted rules or control measures that are ready to be implemented upon a determination by the EPA that a failure occurred, and such measures are required to take effect without significant further action by the state or the EPA.[11] See Appendix H for this demonstration.

[10] See also 81 Fed. Reg. 58103-58104.

[11] Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule. 81 Fed. Reg. 164, pp. 58010-58162. (2016, August 24). (to be codified at 40 CFR Parts 50, 51, and 93). https://www.gpo.gov/fdsys/pkg/FR-2016-08-24/pdf/2016-18768.pdf

5.7 FULFILLMENT OF SERIOUS AREA PERMITTING REQUIREMENTS

Pursuant to CAA §189(b)(3) and 40 CFR §51.1003(c)(1)(viii), the District must provide a revision to the nonattainment new source review (NNSR) program to lower the applicable "major stationary source" thresholds from 100 tons per year (tpy) to 70 tpy. The District's New and Modified Stationary Source Review Rule (Rule 2201) identifies the major source emission thresholds for each pollutant. The District adopted amendments to Rule 2201 on February 18, 2016, to meet requirements related to the District's reclassification from Moderate to Serious nonattainment for the 1997 and 2006 federal standards for PM2.5. Currently, through Rule 2201, the District identifies the major source emission threshold for NOx major sources at 10 tpy and PM2.5 at 70 tpy. However, the rule amendments have not been submitted to EPA for inclusion into the SIP because CARB and EPA requested changes to some of the new rule language. The District hosted a public workshop on the proposed amendments on July 26, 2016. District staff had planned on presenting the rule to the Governing Board for adoption in September of 2016. While these revisions do not change the District's interpretation or implementation of the rule, these amendments must be adopted by the District Governing Board before CARB can submit the rule to EPA for inclusion into the State Implementation Plan. However, in August of 2016, EPA released long-overdue regulations on implementing the PM2.5 standards in NSR rules that require an assessment of the significance of precursor pollutant emissions using a specific type of air quality modeling. Due to these new requirements, EPA will not be able to approve an NSR rule that does not address EPA's implementation regulation, so adoption has been delayed until such modeling can be completed. The District anticipates taking rule amendments to the District's Governing Board in 2018.

5.8 TRANSPORTATION CONFORMITY BUDGETS

This CAA §189(d) Plan must include transportation conformity budgets for the attainment year pursuant to 40 CFR §51.1003(d)[12]. See Appendix D for more information.

[12] See also 81 Fed. Reg. 58103.

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Chapter 6
Demonstration of Federal Requirements for 2006 PM2.5 Standard

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6. DEMONSTRATION OF FEDERAL REQUIREMENTS FOR THE 2006 PM2.5 STANDARD: SERIOUS PLAN AND EXTENSION REQUEST

EPA's 2006 PM2.5 national ambient air quality standard (NAAQS, or standard) set the 24-hour average PM2.5 standard to 35 µg/m³ while retaining the annual average standard set in 1997.[1] Consistent with CAA Subpart 1, EPA finalized its implementation rule effective May 29, 2007 and designated the San Joaquin Valley as nonattainment for the standard effective December 2009[2]. The District adopted the *2012 PM2.5 Plan* to address the 2006 standard on December 20, 2012.[3] Just two weeks later, on January 4, 2013, the D.C. Circuit Court ruled that EPA erred by solely using Subpart 1 in establishing its PM2.5 implementation rule, without consideration of the PM-specific provisions in Subpart 4.[4]

Subpart 4 differs from Subpart 1 in its attainment Plan deadlines, the required level of emissions controls, and its handling of PM precursors. Another key difference is in the classification of nonattainment areas and corresponding attainment deadlines. Under Subpart 1, all areas were designated nonattainment without a corresponding classification. Under Subpart 4, nonattainment areas are initially classified as "Moderate," with six years from its initial nonattainment designation date to reach attainment (though two one-year extensions are available in certain circumstances). Areas can request reclassification to "Serious," with ten years from its initial attainment designation date to reach attainment. Subpart 4 allows for an additional extension of up to five years if the area demonstrates that the current attainment deadline is unfeasible, all requirements and commitments have been met, and SIP includes the most stringent measures (MSM) possible. If an area fails to attain an applicable attainment deadline, it must submit a SIP revision demonstrating expeditious attainment, with PM or PM precursor emissions reduced by at least 5% per year until attainment.

Following the 2013 D.C. Circuit Court ruling, EPA began redirecting all PM2.5 implementation efforts consistent with Subpart 4, but under a truncated schedule as compared to what would have occurred had EPA initially designated nonattainment areas under Subpart 4 in 2009. In June 2014, EPA classified the Valley (and all other PM2.5 nonattainment areas) as Moderate nonattainment under Subpart 4 with no consideration to the level of pollution and air quality challenges in the Valley. This set the attainment deadline at December 2015. However, at the time of this classification and attainment deadline setting, it was already clear that attainment by December 2015 (based on 2013-2015 data) was impossible, in part due to the extreme drought, stagnation, strong inversions, and historically dry conditions experienced over the winter of 2013-2014.

[1] National Ambient Air Quality Standards for Particulate Matter, 71 Fed. Reg, 200, pp. 61144-61233. (2006, October 17). (to be codified 40 CFR Part 50) http://www.gpo.gov/fdsys/pkg/FR-2006-10-17/pdf/06-8477.pdf

[2] Air Quality Designations for the 2006 24-Hour Fine Particle (PM2.5) National Ambient Air Quality Standards, 74 Fed. Reg. 218, pp. 58688-58781. (2009, November 13). (to be codified 40 CFR Part 81) https://www.gpo.gov/fdsys/pkg/FR-2009-11-13/pdf/E9-25711.pdf

[3] SJVPACD. PM2.5 Plan. (2012, December 20). Retrieved from http://www.valleyair.org/Air_Quality_Plans/PM25Plans2012.htm

[4] *Nat. Res. Def. Council v. E.P.A.*, 706 F.3d 428 (D.C. Cir. 2013)

In September 2014, the District submitted supplemental documentation to EPA with a request for reclassification to Serious nonattainment for the 2006 PM2.5 standard. The Valley was reclassified to Serious nonattainment effective February 19, 2016[5] with an attainment deadline of December 31, 2019. With this reclassification, EPA directed the District to submit a SIP revision meeting Serious area requirements. EPA approved the majority of the *2012 PM2.5 Plan* as meeting Moderate area requirements effective September 30, 2016.[6]

Unfortunately, despite the significant progress and stringent regulations on stationary and mobile sources, attainment by the current deadline of 2019 (based on 2017-2019 data) is not physically possible, and extensive modeling demonstrates that Valley will need enormous additional emission reductions to meet the 2006 PM2.5 standard (see Appendix K). Critical the CARB truck, bus, and off-road engine regulations will not be fully implemented until 2023.

Through this Serious Plan, the District is formally requesting an attainment deadline extension of the attainment deadline from 2019 to 2024 for the 2006 PM2.5 standard pursuant to Clean Air Act §188(e). The statute also includes factors that EPA may consider in determining whether to grant the extension and the length of the extension, including "the nature and extent of nonattainment, the types and numbers of sources or other emitting activities in the area (including the influence of uncontrollable natural sources and transboundary emissions from foreign countries), the population exposed to concentrations in excess of the standard, the presence and concentrations of potentially toxic substances in the mix of particulate emissions in the area, and the technological and economic feasibility of various control measures."

This attainment Plan satisfies statutory requirements for a Serious nonattainment area SIP submissions and attainment extension requests, shown in Table 6-1.[7]

[5] Designation of Areas for Air Quality Planning Purposes; California; San Joaquin Valley; Reclassification as Serious Nonattainment for the 2006 PM2.5 NAAQS; Final Rule. 81. Fed. Reg. 12, pp. 2993-3001. (2016, January 1). (to be codified at 40 CFR Parts 52 and 81). https://www.gpo.gov/fdsys/pkg/FR-2016-01-20/pdf/2016-00739.pdf
[6] 81 Fed. Reg. 59877 (Aug. 31, 2016). https://www.gpo.gov/fdsys/pkg/FR-2016-08-31/pdf/2016-20413.pdf
[7] See also 81 Fed. Reg. 58074-58097 (Aug. 24, 2016)

Table 6-1 Summary of Serious Nonattainment Area Plan Requirements

Serious Plan and Extension Request Elements	Source of Requirement	Location of Plan Where Element Satisfied
Current attainment date is impracticable	40 CFR §51.1005(b)(1)(i)	Section 6.1 Appendix K
Compliance with applicable SIP commitments	40 CFR §51.1005(b)(1)(ii)	Section 6.2
Base year and attainment projected emissions inventory	40 CFR §§51.1003(b), 51.1005(b)(2)(i) and 51.1008(b)	Appendix B
Most Stringent Measures (MSM) and Best Available Control Measures (BACM)	40 CFR §§ 51.1003(b), 51.1005(b)(1)(iii), and 51.1005(b)(2)(ii)	Section 6.3 and Appendices C and D
Attainment demonstration and modeling	40 CFR §§51.1005(b)(2)(iii) and 51.1011	Section 6.4 Appendices J, K, and L
Reasonable Further Progress	40 CFR §§ 51.1005(b)(2)(iv) and 51.1012	Section 6.5 Appendix H
Quantitative milestones	40 CFR §§51.1005(b)(2)(v) and 51.1013	Section 6.6 Appendix H
Contingency measures	40 CFR §§51.1005(b)(2)(vi) and 51.1014	Section 6.7 Appendix H
Nonattainment new source review Plan requirements	40 CFR §51.1005(b)(2)(vii) and 51.165	Section 6.8
Transportation Conformity	40 CFR §51.1003(b and d)	Section 6.9 and Appendix D

6.1 Demonstration of Impracticability

An impracticability demonstration uses modeling to show that the implementation of all BACM/BACT will not bring the area into attainment by the statutory Serious area attainment date.[8] Modeling for this Plan (see Appendix K) demonstrates that the Valley cannot practicably attain the 2006 PM2.5 standard before the statutory deadline of December 31, 2019.

6.2 Compliance with the Applicable SIP

The District's current SIP for the 2006 standard is its *2012 PM2.5 Plan*, which EPA approved effective September 30, 2016.[9] Table 6-2 summarizes this Plan's commitments (see Table 5-3 of the *2012 PM2.5 Plan*) and the completion date of such commitment. Although the District has not yet amended Rule 4692, overall, the District's adopted control strategies achieve emissions reductions in excess of the PM2.5 emission reduction commitment included in the *2012 PM2.5 Plan* (Table 6-2).

[8] CAA § 189(b)(1)(A)
[9] Approval and Promulgation of Air Quality State Implementation Plans; California; San Joaquin Valley; Moderate Area Plan for the 2006 PM2.5 NAAQS; Final Rule. 81 Fed. Reg. 169, pp. 59876-59901. (2016, August 31). (to be codified at 40 CFR Part 52). https://www.gpo.gov/fdsys/pkg/FR-2016-08-31/pdf/2016-20413.pdf

Table 6-2 Summary of Commitments in District *2012 PM2.5 Plan*

Rule	Amendment Date	Compliance Date	Emission Reduction Commitment	Commitment Satisfied?
Rule 4308 Boilers, Steam Generators, and Process Heaters 0.075 to <2 MMBtu/hr	2013	2015	TBD	**YES**
Rule 4692 Commercial Charbroiling	2016	2017	0.4 tpd PM2.5	**YES, Substitute reductions achieved**
Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	2016	2016/ 2017	1.5 tpd PM2.5	**YES**
Rule 4905 Natural Gas-Fired, Fan-Type Residential Central Furnaces	2014	2015	TBD	**YES**
Rule 9610 SIP-Creditability of Incentives	2013	2013	TBD	**YES**

Rule 4308 Boilers, Steam Generators, and Process Heaters 0.075 to <2 MMBtu/hr
Analysis for the *2012 PM2.5 Plan* indicated that lowering the NOx emission limit for instantaneous water heaters in the size range of 0.075–0.4 MMBtu/hr is technologically feasible and cost-effective. The District committed to amend Rule 4308 in 2013 to lower the NOx emission limit for instantaneous water heaters in the size range of 0.075–0.4 MMBtu/hr from the current level of 55 ppmv to 20 ppmv with an anticipated compliance date of 2015. The District adopted no specific emission reduction commitment.

The District Governing Board adopted amendments to Rule 4308 on November 14, 2013. Amendments lowered the NOx emission limit for instantaneous units from 55 ppmv to 20 ppmv effective January 1, 2015. Since Rule 4308 is a point-of-sale rule, emission reductions of approximately 1.82 tpy will be realized over a 20 year period from 2015 through 2034, reflecting a 62% reduction from baseline emissions from this source category.

Rule 4692 Commercial Charbroiling
Existing Rule 4692 achieves significant emissions reductions from chain-driven charbroilers. Analysis for the *2012 PM2.5 Plan* indicated that extending the applicability of the rule to include under-fired units could further reduce directly emitted PM2.5 emissions by 20% (0.4 tons per day (tpd)) from the baseline inventory. Research and demonstration projects to evaluate emission control technologies for under-fired charbroilers were already underway when the *2012 PM2.5 Plan* was adopted. As such, the District committed to amend Rule 4692 in 2016 to add requirements for under-fired charbroilers, with an anticipated compliance date of 2017. The control technology for under-fired units has continued to be developed, tested, and studied over the past few years, in part through the District, SCAQMD, and EPA technology demonstration efforts.

The District Governing Board authorized $500,000 of funding for the Charbroiler Incentive Program (ChIP) to advance development of under-fired charbroiler emissions control technologies. The ChIP was open for 18 months, and was advertised by the District to potential participants, however, the program did not receive any applications. Since 2009, the District partnered with South Coast AQMD, Bay Area AQMD, and EPA to further the research and evaluation of emission control technologies for under-fired charbroilers. Through this effort, under-fired charbroiler technology assessments have been conducted at UC Riverside College of Engineering's Center for Environmental Research and Technology (CE-CERT). The District provided in-kind technical support and research was funded with over $500,000 in contributions provided by South Coast AQMD, Bay Area AQMD, and EPA. The initial task under this effort was to review commercially available, prototype, and experimental charbroiler control technologies. The evaluation identified three technologies to be tested by CE-CERT. The three technologies represented a cross-section of control options, including a rooftop ventilation system design, a dedicated hood design, and a process design.

While the testing methods used in this CE-CERT testing process were rigorously evaluated and determined to be highly accurate, the entire process was performed in CE-CERT's charbroiler test kitchen. The preparation and execution of the cooking process was highly controlled and precisely repeated for every test run for each control system so that the results are comparable for each device. Although the controlled nature of this test kitchen is able to effectively quantify the control efficiency of each control system, it does not allow for an appropriate assessment of the feasibility of installation or ongoing operation and maintenance. Although under-fired charbroiler technology advancements have been made, the technologies had still been un-tested in real-life applications and needed further evaluation and demonstration at Valley restaurants.

During the summer of 2015, the District Governing Board approved $750,000 to fund the Restaurant Charbroiler Technology Partnership (RCTP) program to provide funding for restaurants to install particulate control systems for under-fired charbroilers as demonstration projects to assess their feasibility and effectiveness. The District has been working with restaurants and control technology manufacturers to test and demonstrate control technologies. Based on the performance of the demonstration funded by the District and control devices that are currently deployed on underfired charbroilers at other restaurants, the implementation of particulate matter control technology on underfired charbroilers in the Valley may be feasible.

The District has not yet adopted rule requirements for under-fired charbroilers in operation in the Valley. However, the Plan commitment to reduce 0.4 tpd of directly emitted PM2.5 by 2016 has been fulfilled through surplus PM2.5 reductions from the amendments to the District's Wood Burning Fireplaces and Wood Burning Heaters rule (Rule 4901).

Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters

District Rule 4901 and the associated Check Before You Burn program reduce harmful species of PM2.5 when and where those reductions are most needed – in urbanized areas when the local weather conditions are forecast to inhibit PM dispersion. The District committed to amend Rule 4901 in 2016 and to reduce 1.5 tpd direct PM2.5 emissions. Commitments include the following:

1. Lower threshold level for wood-burning curtailments from 30 μg/m³ to ≥20 μg/m³
2. Review meteorological conditions that lead to elevated PM2.5.
3. Consider expanding wood burning curtailment season to include October and/or March
4. Analyze feasibility of allowing use of cleanest certified wood burning devices at specified curtailment levels.

In alignment with the District's Health Risk Reduction Strategy, the District Governing Board directed staff to develop the necessary amendments for implementation in the winter of 2014/2015, a two full years ahead of schedule in the *2012 PM2.5 Plan*. District staff was also directed to investigate the feasibility of enhanced financial incentives to encourage Valley residents to upgrade to cleaner devices.

During the rule evaluation process for rule amendments, District staff reviewed meteorological conditions leading to elevated PM2.5 and analyzed the feasibility of expanding the wood burning season to include October and/or March. The estimated number of increased No Burn days would have been in the range of less than one day up to six days and therefore would not significantly benefit air quality in the Valley. As such, the wood burning season was not amended to include the extra month(s).

Adopted amendments include the following:

- Significant amendments to District Rule 4901 are summarized as follows:
  - Lower the No Burn threshold for high polluting wood burning heaters and fireplaces from the current 30 μg/m^3 to 20 μg/m^3.
  - Raising the No Burn threshold for cleaner certified wood burning devices to 65 μg/m^3.
  - Create a registration program for wood burning heaters
  - Create a registration program for wood burning hearth professionals
  - Allow a free interim registration during the 2014-15 Winter Season
  - Clarifications to existing rule requirements
- Amendments to the District's Burn Cleaner Program including:
  - Increased per-unit incentive amounts from $100-$500 to a maximum of $1,500 with an additional up to $500 for installation of gas-fired units
  - Increased per-unit incentive amounts for low-income qualified applicants from up to $1,500 to up to $2,500 with an additional up to $500 for installation of gas-fired units
  - Expand low-income provisions to include property owners who rent to low-income qualified tenants
  - Work with retailers to allow qualified low-income applicants to purchase devices through the Burn Cleaner program without requiring up-front payment
- Adopt new Rule 3901 (Fees for Registration of Wood Burning Heaters) to establish the fee required for the registration of a wood burning heater as defined in Rule 4901.

Rule 4905 Natural Gas-Fired, Fan-Type Residential Central Furnaces

The District committed to amend Rule 4905 in 2014 to lower the NOx emission limits for residential furnaces and to examine the possibility of incorporating NOx limits for natural gas-fired, fan-type, commercial central furnaces into the rule, with an anticipated compliance date of 2015.

The District partnered with the South Coast AQMD and provided $50,000 to fund a $1.5 million technology assessment project to develop and test low-NOx furnace technologies that could meet more stringent limits. The assessment project was completed in early 2014 and resulted in the successful development and testing of compliant units. Amendments to Rule 4905 were adopted on January 22, 2015 with compliance dates starting in 2015. To provide manufacturers sufficient time to complete the commercialization process for the new technologies, and to provide for regulatory consistency in California, the compliance dates were set to be analogous with those in the South Coast AQMD furnace rule (Rule 1111).

The District went beyond Plan commitments when amending the rule. As this is a point-of-sale rule, emissions reductions will occur over the 20 year lifespan of existing units as they are replaced with new units. Amendments result in approximately 2.10 tpd NOx emissions reductions upon full turnover by 2036, reflecting greater than 50% reduction from projected emissions for this source category. Rule amendments included the following:

- Lower the NOx limit for residential units to 14 ng/J for condensing units, non-condensing units, and weatherized units.
- Expand applicability to include commercial units with a 14 ng/J NOx limit for condensing, non-condensing, and weatherized units
- Expand applicability to include units installed in manufactured homes with a 40 ng/J NOx limit in 2015, and lowered to 14 ng/J in 2018
- Allow the sale of non-compliant units during the initial implementation period in exchange for the payment of an emissions fee for each non-compliant unit sold
- Revise definitions to remove redundancy and improve clarity
- Expire exemptions for units installed in manufactured homes, units using fuel other than natural gas, and nonfan-type units
- Add labeling requirements to ensure compliance with new limits

To qualify for any extension of a Serious area attainment date, CAA §188(e) requires a state to ‘‘demonstrate to the satisfaction of the Administrator that the Plan for the area includes the most stringent measures that are included in the implementation Plan of any state, or are achieved in practice in any state, and can feasibly be implemented in the area.’’ In prior guidance, EPA interpreted the term "MSM” to mean the maximum degree of emission reduction that has been required or achieved from a source or source category in any other attainment Plans or in practice in any other states and that can feasibly be implemented in the area seeking the extension, such as what LAER represents for new or modified sources under the NNSR permit program.

The process for determining MSM includes the following: update emissions inventories (see Appendix B); identify potential MSM and compare to control measures already adopted (see Appendix C); and adopt and implement any technologically and economically feasible MSM that are more stringent than measures that are already approved into the SIP (see Chapter 4). The District's overall evaluation of emissions sources and emissions controls demonstrate that the most stringent measures, which includes all reasonably available emission reduction opportunities, best available control measures, and most stringent measures are in place in the Valley for NOx and directly emitted PM2.5 emissions. Refer to Appendices C and D for these demonstrations.

6.3 Attainment Demonstration and Modeling

The Serious area Plan must demonstrate attainment, using air quality modeling, by the most expeditious date practicable after the statutory Serious area attainment date.[10] Although the Valley has some of the most stringent regulations in the nation that will continue to bring about significant reductions into the future, the Valley will need enormous additional emission reductions, specifically from sources that are under state and federal jurisdiction, in order to meet this standard. As shown below, and discussed in detail in Appendix K, attainment is not possible by the mandated Serious nonattainment area deadline of 2019 (based on 2017-2019 data). Air quality modeling demonstrates expeditious attainment of the standard in 2024.

6.3.1 Summary of Modeling Results

[This section provided by California Air Resources Board]

Photochemical modeling plays a crucial rule in demonstrating attainment of the national ambient air quality standards based on projected future year emissions. Currently, Valley is designated as a serious nonattainment area for the 2006 24-hour $PM_{2.5}$ standard (35 µg/m^3) with an attainment deadline of 2024. Consistent with U.S. EPA guidance for model attainment demonstrations (U.S. EPA, 2014[11]), photochemical modeling was used to project $PM_{2.5}$ design values (DVs) to the future. 2024 24-hour $PM_{2.5}$ DVs at each monitor in the Valley demonstrate attainment of the 2006 24-hour $PM_{2.5}$ standard.

The findings from the model attainment demonstration are summarized below. A detailed description of the model inputs, modeling procedures, and attainment test can be found in the Modeling Attainment Demonstration and Modeling Protocol Appendices of this document.

The current modeling approach draws on the products of large-scale, scientific studies as well as past $PM_{2.5}$ SIPs in the region, collaboration among technical staff at state and local regulatory agencies, and from participation in technical and policy groups in the

[10] Federal Clean Air Act §189(b)(1)(A)
[11] 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

region (See Photochemical Modeling Protocol Appendix for further details). In this work, the Weather Research and Forecasting (WRF) model version 3.6 was utilized to generate the annual meteorological fields. The Community Multiscale Air Quality (CMAQ) Model version 5.0.2 with state-of-the-science aerosol treatment was used for modeling annual $PM_{2.5}$ in the Valley. Other model inputs and configuration, including the modeling domain definition, chemical mechanism, initial and boundary conditions, and emission processing can be found in the Photochemical Modeling Protocol and Modeling Emissions Inventory Appendices.

The U.S. EPA modeling guidance (U.S. EPA, 2014[1]) recommends using modeling in a “relative” rather than “absolute” sense. Based on analysis of recent years’ ambient $PM_{2.5}$ levels and meteorological conditions leading to elevated $PM_{2.5}$ concentrations, the year 2013 was selected for baseline modeling calculations. In particular, in 2013 SJV experienced one of the worst years for $PM_{2.5}$ pollution in the Valley within the last decade.

Specifying the baseline design value is a key consideration in the model attainment test, because this value is projected forward to the future and used to test for future attainment of the standard at each monitor. To minimize the influence of year-to-year variability in demonstrating attainment, the U.S. EPA modeling guidance recommends using the average of three DVs, where one of the DV years is the same as the baseline emissions inventory and modeling year. This average DV is referred to as the baseline (or reference) DV. Here, the average DVs from 2012, 2013, and 2014 are used to calculate baseline DVs (see the table below for the baseline DVs utilized in the attainment demonstration modeling).

In order to use the modeling in a relative sense, five simulations were conducted: 1) base year simulation for 2013, which demonstrated that the model reasonably reproduced the observed $PM_{2.5}$ concentrations in the Valley; 2) reference (or baseline) year simulation for 2013, which was the same as the base year simulation, but excluded exceptional event emissions such as wildfires; and 3) future year simulations for 2024. These simulations were the same as the reference year simulation, except projected anthropogenic emissions for 2024 were used in lieu of the 2013 emissions.

The table below shows the 2013 and 2024 Valley annual anthropogenic emissions for the five $PM_{2.5}$ precursors calculated from the model-ready emissions inventory. Compared to 2013, anthropogenic emissions in the Valley in 2024 will drop by 63%, 9%, 12%, 6%, and 1% for NO_x, ROG, primary $PM_{2.5}$, SO_x, and ammonia, respectively. Among these five precursors, anthropogenic NO_x emissions show the largest relative reduction, dropping from 288.2 tons/day in 2013 to 107.6 tons/day in 2024. Note that the emission totals presented in the table were calculated from the modeling inventory based on CEPAM.

Since the modeling inventory includes day-specific adjustments not included in the planning inventory, the planning and modeling inventories are expected to be comparable, but not identical.

Table 6-3 Valley Model-Ready Annual Emissions for 2013 and 2024

Category	NO_x	ROG	$PM_{2.5}$	SO_x	NH_3
2013 (tons/day)					
Stationary	38.5	90.8	8.5	7.2	13.9
Area	8.1	153.3	40.2	0.3	310.0
On-road Mobile	154.6	45.1	5.7	0.6	4.4
Other Mobile	87.1	35.8	6.2	0.3	6.0
Total	288.2	325.0	60.5	8.4	334.3
2024 (tons/day)					
Stationary	26.1	99.2	8.5	6.7	16.2
Area	6.9	152.5	37.8	0.3	304.7
On-road Mobile	32.1	17.5	3.1	0.6	3.4
Other Mobile	42.5	25.9	3.8	0.3	6.0
Total	107.6	295.1	53.2	7.9	330.2
Total change from 2013 to 2024	-63%	-9%	-12%	-6%	-1%

In this relative approach, the fractional change (or ratio) in $PM_{2.5}$ concentration between the modeled future year (2024) and modeled baseline year (or reference year, 2013) are calculated. These ratios are called relative response factors (RRFs). Since $PM_{2.5}$ is comprised of different chemical species, which respond differently to changes in emissions of various pollutants, separate RRFs were calculated for individual $PM_{2.5}$ species. In addition, because of potential seasonal differences in $PM_{2.5}$ formation mechanisms, RRFs for each species were also calculated separately for each quarter. The RRF for a specific $PM_{2.5}$ component *j* for each quarter is calculated using the following expression:

$$RRF_j = \frac{[C]_{j,\ future}}{[C]_{j,\ reference}} \qquad (1)$$

For the 24-hour $PM_{2.5}$ standard, $[C]_{j,\ future}$ is the mean concentration for component *j* (for the top 10 percent of modeled $PM_{2.5}$ days in a quarter) predicted at the single grid cell which contains the monitor, and $[C]_{j,reference}$ is the same, but for the reference year simulation.

The measured FRM/FEM (i.e., Federal Reference Method/Federal Equivalent Method) $PM_{2.5}$ must be separated into its various chemical components. Species concentrations were obtained from the four $PM_{2.5}$ chemical speciation sites in the Valley. These four speciation sites are located at: Bakersfield – California Avenue, Fresno – Garland, Visalia – North Church, and Modesto – 14th Street. Since not all of the 16 FRM/FEM $PM_{2.5}$ sites in the Valley have collocated speciation monitors, the speciated $PM_{2.5}$ measurements at one of the four speciation sites were utilized to represent the speciation profile at each of the FRM/FEM sites based on geographic proximity, analysis of local emission sources, and measurements from previous field studies.

Since the FRM $PM_{2.5}$ monitors do not retain all of the $PM_{2.5}$ mass that is measured by the speciation samplers, the U.S. EPA modeling guidance recommends using the SANDWICH approach (Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbon Hybrid material balance) described by Frank (2006[12]) to apportion the FRM $PM_{2.5}$ mass to individual $PM_{2.5}$ species based on nearby chemical speciation measurements. Based on completeness of the data, $PM_{2.5}$ speciation data from 2010 – 2013 were utilized. For each quarter, percent contributions from individual chemical species to FRM/FEM $PM_{2.5}$ mass were calculated as the average of the corresponding quarter from 2010-2013 for the annual standard calculation. For the 24-hour standard calculation, only the top 10% of measured $PM_{2.5}$ days from that quarter were utilized for percentage calculations.

Projected 2024 24-hour $PM_{2.5}$ DVs for each monitor are given in the table below. The Fresno -Hamilton & Winery site has the highest projected DV at 35.1 µg/m^3, which meets the 2006 24-hour $PM_{2.5}$ standard at 35 µg/m^3 (technically, the form of the 24-hour $PM_{2.5}$ standard means that a DV needs to be less than 35.5 µg/m^3 to demonstrate attainment). The reduction in future year DVs are primarily attributed to significant reductions projected for ammonium nitrate and EC, with modest reductions in OM. Because of the large reduction in NO_x emissions from 2013 to 2024, significant reduction is projected for ammonium nitrate. Reductions in EC and OM are primarily due to emission reductions associated with primary $PM_{2.5}$ emission sources such as residential wood combustion and commercial cooking.

To evaluate the impact of reducing emissions of different $PM_{2.5}$ precursors to $PM_{2.5}$ DVs, a series of model sensitivity simulations were performed, for which anthropogenic emissions within the SJV were reduced by a certain percentage from the baseline emissions. Following U.S. EPA precursor demonstration guidance[13] as well as considering SJV's control strategies, sensitivity runs involving 30% emission reductions were performed for NO_x and direct $PM_{2.5}$. For other precursors (i.e., ammonia, VOCs, and SO_x), both 30% and 70% emission reductions were performed. In addition, sensitivity simulations were performed for the years 2013, 2020, and 2024. The key conclusion from the sensitivity runs is that in 2024, reductions of direct $PM_{2.5}$ and NO_x emissions will continue to have a significant impact on annual and 24-hour $PM_{2.5}$ DVs, while reductions of ammonia, ROG, and SO_x have a much smaller impact compared to that of direct $PM_{2.5}$ and NO_x.

[12] Frank, N.H., 2006, Retained nitrate, hydrated sulfates, and carbonaceous mass in federal reference method fine particulate matter for six eastern U.S. cities, Journal of Air & Waste Management Association, 56, 500-511.

[13] U.S. EPA, 2016, PM2.5 Precursor Demonstration Guidance, available at https://www.epa.gov/sites/production/files/2016-11/documents/transmittal_memo_and_draft_pm25_precursor_demo_guidance_11_17_16.pdf

Table 6-4 Projected Future Year 2024 24-hour PM2.5 DVs at Each Monitor

Site AQS ID	Name	Base DV (µg/m³)	2024 24-hr DV (µg/m³)
60290014	Bakersfield - California	64.1	33.3
60190011	Fresno-Garland	60.0	32.8
60311004	Hanford	60.0	30.1
60195025	Fresno – Hamilton & Winery	59.3	35.1
60195001	Clovis	55.8	30.7
61072002	Visalia	55.5	30.2
60290016	Bakersfield – Planz	55.5	30.0
60392010	Madera	51.0	30.2
60990006	Turlock	50.7	30.2
60990005	Modesto	47.9	29.1
60472510	Merced - M. Street	46.9	27.4
60771002	Stockton	42.0	28.6
60470003	Merced - S Coffee	41.1	24.2
60772010	Manteca	36.9	25.8
60192009	Tranquility	29.5	16.2

6.3.2 ATTAINMENT DEMONSTRATION

Attaining federal health-based air quality standards is an important milestone for improving public health. As detailed in Appendix K, this Plan demonstrates that the Valley will attain the federal 2006 PM2.5 standard as expeditiously as practicable, with all feasible measures and strategies being implemented to accomplish this goal.

Given the significant contribution of ammonium nitrate to the Valley's PM2.5 concentrations, reductions in NOx emissions are particularly important. To achieve the NOx reductions critical for reaching attainment in the Valley, CARB has adopted regulations that will significantly reduce NOx emissions from various mobile sources. Achieving this level of emissions reductions requires adequate time and carries a tremendous cost.

Modeling performed by CARB and the District demonstrates the Valley will attain the 2006 PM2.5 standard by 2024. See above for the summary of modeling results and Appendix K for the full discussion. This Plan also demonstrates the Valley will attain the standard as expeditiously as practicable as validated in Appendix H.

The attainment demonstration for this Plan includes the benefits of CARB and District control programs that provide ongoing emission reductions. The NOx reductions result from implementation of MSM, which includes the ongoing implementation of both new vehicle standards for passenger and heavy-duty diesel vehicles and equipment; and rules accelerating the turnover of legacy diesel fleets. Implementation of stringent requirements for new off-road engines and in-use off road equipment lead to further NOx reductions, along with District rules addressing stationary source NOx emissions.

6.4 Reasonable Further Progress (RFP)

Reasonable Further Progress (RFP) is the incremental emission reductions leading to the attainment date of a standard for an area. In its most recent Implementation Rule, EPA clarified that RFP requirements may be satisfied through generally linear progress, or through a stepwise demonstration. Stepwise emissions reductions would be slower than ‘‘generally linear’’ reductions for certain periods, and then would decline sharply (due to implementation of a new emission reduction program, or new operation of control technology on one or more stationary sources). See Appendix H for the full RFP discussion and demonstration.

6.5 Quantitative Milestones

CAA Subpart 4 §189(c)(1) requires Plans submitted to EPA to contain quantitative milestones which are to be achieved every three years until the area is re-designated attainment and which demonstrate reasonable further progress as defined in CAA §171. The quantitative milestones for the 2006 PM2.5 standard are 2017, 2020, 2023, and 2026.[14] This Plan satisfies quantitative milestone requirements as discussed at length in Appendix H.

6.6 Contingency Measures

All PM2.5 attainment Plans must contain contingency measures that are consistent with CAA §172(c)(9) and 40 CFR § 51.1014. Contingency measures are additional control measures to be implemented in the event that an area fails to meet RFP requirements, fails to meet any quantitative milestone, fails to submit a quantitative milestone report or fails to attain the PM2.5 standard by the applicable attainment date. These measures must be fully adopted rules or control measures that are ready to be implemented quickly upon a determination by the EPA that a failure occurred, and such measures are required to take effect without significant further action by the state or the EPA.[15] See Appendix H for this demonstration.

6.7 Fulfillment of Serious Area Permitting Requirements

Pursuant to Subpart 4 §189(b)(3) the District must provide a revision to the nonattainment new source review (NNSR) program to lower the applicable “major stationary source” thresholds from 100 tons per year (tpy) to 70 tpy. The District’s New and Modified Stationary Source Review Rule (Rule 2201) identifies the major source emission thresholds for each pollutant. The District adopted amendments to Rule 2201 on February 18, 2016, to meet requirements related to the District’s reclassification from

[14] 40 CFR 51.1013(a)(4)

[15] Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule. 81 Fed. Reg. 164, pp. 58010-58162. (2016, August 24). (to be codified at 40 CFR Parts 50, 51, and 93). https://www.gpo.gov/fdsys/pkg/FR-2016-08-24/pdf/2016-18768.pdf

Moderate to Serious nonattainment for the 1997 and 2006 federal standards for PM2.5. Currently, through Rule 2201, the District identifies the major source emission threshold for NOx major sources at 10 tpy and PM2.5 at 70 tpy. However, the rule amendments have not been submitted to EPA for inclusion into the SIP because CARB and EPA requested changes to some of the new rule language. The District hosted a public workshop on the proposed amendments on July 26, 2016. District staff had planned on presenting the rule to the Governing Board for adoption in September of 2016. While these revisions do not change the District's interpretation or implementation of the rule, these amendments must be adopted by the District Governing Board before CARB can submit the rule to EPA for inclusion into the State Implementation Plan. However, in August of 2016, EPA released long-overdue regulations on implementing the PM2.5 standards in NSR rules that require an assessment of the significance of precursor pollutant emissions using a specific type of air quality modeling. Due to these new requirements, EPA will not be able to approve an NSR rule that does not address EPA's implementation regulation, so adoption has been delayed until such modeling can be completed. The District anticipates taking rule amendments to the District's Governing Board in 2018.

6.8 TRANSPORTATION CONFORMITY

This Plan must address all Serious area SIP requirements, including transportation conformity budgets for the attainment year pursuant to 40 CFR §1003(d)[16]. See Appendix D for more information.

[16] See also 81 Reg. Reg. 58103.

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Chapter 7

Demonstration of Federal Requirements for 2012 PM2.5 Standard

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7. DEMONSTRATION OF FEDERAL REQUIREMENTS FOR THE 2012 PM2.5 STANDARD

7.1 THE VALLEY'S ATTAINMENT CLASSIFICATION FOR THE 2012 PM2.5 NAAQS

EPA's 2012 PM2.5 national ambient air quality standard (NAAQS, or standard) revised the annual average PM2.5 standard to 12 µg/m³, while retaining the 24-hour standard of 35 µg/m³ set in 2006.[1] In 2015, EPA designated the Valley as Moderate nonattainment for the 2012 PM2.5 standard, with an attainment deadline of December 31, 2021. Under the federal Clean Air Act (CAA) Subpart 4, nonattainment areas are initially classified as "Moderate," with six years from its initial nonattainment designation date to reach attainment (though two one-year extensions are available in certain circumstances).[2] Areas may request reclassification to "Serious," with ten years from its initial attainment designation date to reach attainment.

Pursuant to CAA Subpart 4 §188(b), a Moderate area may be reclassified to Serious nonattainment for one of the following two circumstances:

- Before the attainment date. Any Moderate area that EPA determines cannot practicably attain the NAAQS by the mandated attainment date.
- Upon failure to attain. Any Moderate area that EPA finds is not in attainment after the applicable attainment date shall be reclassified by operation of law as a Serious area.

Modeling and analysis by CARB and District staff has shown that the Valley cannot practicably attain the 2012 PM2.5 Standard by the end of the sixth calendar year following the effective date of designation of the area (2021). Due to the impracticability of achieving the standard by the Moderate area attainment date, the District adopted the *2016 Moderate Area Plan for the 2012 PM2.5 Standard* (2016 Moderate Plan), including an attainment impracticability demonstration and a request for reclassification of the Valley from Moderate nonattainment to Serious nonattainment. This plan was submitted to CARB in September of 2016.

In October 2016, CARB tabled the Plan at the request of the District and Valley stakeholders and directed CARB staff to return with additional measures to reduce mobile source emissions in the pre-2025 timeline that is critical for the Valley, and to work with the District to find additional measures to reduce directly emitted particulate matter from stationary sources. As detailed in Appendix C and D of this Plan, these additional measures have been incorporated into the District's PM2.5 attainment strategy. The 2016 Moderate Plan will be submitted to EPA by CARB as an addendum

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[1] National Ambient Air Quality Standards for Particulate Matter; Final Rule. 78 Fed. Reg. 10, pp. 3086-3287 (2013, January 15). (to be codified at 40 CFR Parts 50, 51, 52 et al. http://www.gpo.gov/fdsys/pkg/FR-2013-01-15/pdf/2012-30946.pdf

[2] Air Quality Designations for the 2012 Primary Annual Fine Particle (PM2.5) NAAQS; Final Rule 80 RF. Vol.80 No10. pp. 2206-2284 (2015, January 15) (to be codified at 40 CFR part 81) http://www.gpo.gov/fdsys/pkg/FR-2015-01-15/pdf/2015-00021.pdf

to this Plan to fulfil CAA requirements for a Moderate area that cannot practicably obtain the standard within six years of the effective date of designation.[3]

Pursuant to CAA language, after an area is reclassified to Serious under CAA §188(b)(1), the state shall submit a Serious area Plan to EPA four years after the reclassification.[4] However, waiting four years to prepare the Plan is not feasible for the Valley for this standard. Air quality modeling for this attainment Plan demonstrates that the Valley will attain the standard by 2025, but only if the most stringent feasible control measures are implemented as soon as possible. To achieve attainment of the annual 12 μg/m³ standard as expeditiously as practicable, District staff have included the Serious area attainment plan for the 2012 PM2.5 standard in this comprehensive PM2.5 plan. In order to obtain the 2012 standard, this Plan goes beyond the requirements for a Serious area attainment plan to include the most stringent measures feasible for implementation in the Valley (see Chapter 4), and will be submitted approximately 5 years ahead of the deadline that would otherwise be applicable.

7.2 FEDERAL REQUIREMENTS

The requirements for Moderate areas requesting a reclassification and Serious nonattainment area attainment plans are detailed in CAA Subpart 4 and EPA's 2016 *Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule*.[5] This attainment Plan satisfies statutory requirements for both Moderate and Serious nonattainment area SIP submissions, as shown below in Table 7-1.

Table 7-1 Summary of Moderate and Serious Nonattainment Area Plan Requirements

Moderate and Serious Plan Elements	Source of Requirement	Location of Plan Where Element Satisfied
Current Moderate area attainment date is impracticable	40 CFR §51.1002(b)(1)	Appendix K 2016 Moderate Plan
Base year and attainment projected emissions inventory	40 CFR §§51.1003(b), 51.1008(b)(1), and 51.1008(b)(2)	Appendix B 2016 Moderate Plan
Reasonably Available Control Measures (RACM)	40 CFR §§51.1003(b) and 51.1009(a)(3)	Appendix C 2016 Moderate Plan
Best Available Control Measures (BACM)	40 CFR §§51.1003(b)(iii) and 51.1010	Section 7.3 Appendices C and D
Attainment demonstration and modeling	40 CFR §§51.1003(b)(iv) and 51.1011	Section 7.4 Appendices K, L, M
Reasonable Further Progress	40 CFR §§51.1003(b)(v) and 51.1012	Section 7.5 Appendix H
Quantitative milestones	40 CFR §§51.1003(b)(vi) and 51.1013	Section 7.6 Appendix H

[3] 40 CFR §51.1009 (4)(i)
[4] Federal Clean Air Act §189(b)(2)
[5] See also 81 Fed. Reg. 58074-58097 (Aug. 24, 2016)

Moderate and Serious Plan Elements	Source of Requirement	Location of Plan Where Element Satisfied
Contingency measures	40 CFR §§51.1003(b)(vii) and 51.1014	Section 7.7 Appendix H
Nonattainment new source review Plan requirements	40 CFR §§51.1003(b)(viii) and 51.165	Section 7.8
Transportation Conformity	40 CFR §51.1003(b and d)	Section 7.9 and Appendix D

7.3 Best Available Control Measures (BACM)

This Plan demonstrates that the Valley can attain the 12 μ/m³ annual standard through the implementation of all feasible potential control measures by the applicable attainment date of 2025. As a part of the Serious area attainment demonstration for this standard, in addition to implementing all feasible measures identified as RACM and RACT through the Moderate Area analysis, the District is required to identify, adopt, and implement the best available control measures (BACM) that are feasible for implementation on sources of direct PM2.5 and PM2.5 precursors. The analysis of BACM for stationary sources is contained in Appendix C, and identified control measures will be implemented as discussed further in Chapter 4. The control measures included in this plan go beyond RACM and BACM to implement the most stringent measures (MSM) that are feasible for implementation in the Valley.

Although the Valley has some of the most stringent regulations in the nation that will continue to bring about significant reductions into the future, the region will need enormous additional emission reductions, specifically from sources that are under the state and federal jurisdiction, in order to meet this standard. Appendix D discusses BACM that will be implemented by CARB to achieve emission reductions from mobile sources.

Pursuant to CAA §51.1010, this plan addresses Serious Area attainment Plan requirements, including the adoption of measures that are BACM and BACT, by identifying all emission source categories that emit direct PM2.5 or a significant PM2.5 precursor (NOx) and providing an emissions inventory for those sources. These sources were analyzed for any further control that could be feasibly implemented beyond those already adopted under previous year SIP commitments. Measures implemented in other NAAQS nonattainment areas were also identified and evaluated in each control measure analysis for economic and technological feasibility of implementation in the Valley. Measures identified as feasible are outlined in Chapter 4 (Attainment Strategy), including the implementation schedule for the rule or policy. BACM and BACT are discussed further in Appendices C and D.

7.4 Attainment Demonstration and Modeling

Photochemical modeling shows that, while attainment of the 2012 PM2.5 NAAQS is impracticable by the Moderate area attainment date of 2021, the Valley will reach expeditious attainment of the 12 μg/m³ annual standard by the Serious area attainment deadline of 2025. Further details about modeling conducted for the 2012 PM2.5 standard are discussed below.

7.4.1 SUMMARY OF MODELING RESULTS

[This section provided by the California Air Resources Board]

Photochemical modeling plays a crucial rule in demonstrating attainment of the national ambient air quality standards based on projected future year emissions. Currently, Valley is designated as a moderate nonattainment area for the 2012 annual $PM_{2.5}$ standard (12 µg/m^3). However, the SJV Air Pollution Control District applied for a reclassification from a moderate to serious nonattainment area, which extended the attainment deadline to 2025. Consistent with U.S. EPA guidance for model attainment demonstrations (U.S. EPA, 2014[6]), photochemical modeling was used to project $PM_{2.5}$ design values (DVs) to the future. 2025 annual $PM_{2.5}$ DVs at each monitor in the Valley demonstrate attainment of the 2012 annual $PM_{2.5}$ standard.

The findings from the model attainment demonstration are summarized below. A detailed description of the model inputs, modeling procedures, and attainment test can be found in the Modeling Attainment Demonstration and Modeling Protocol Appendices of this document.

The current modeling approach draws on the products of large-scale, scientific studies as well as past $PM_{2.5}$ SIPs in the region, collaboration among technical staff at state and local regulatory agencies, and from participation in technical and policy groups in the region (See Photochemical Modeling Protocol Appendix for further details). In this work, the Weather Research and Forecasting (WRF) model version 3.6 was utilized to generate the annual meteorological fields. The Community Multiscale Air Quality (CMAQ) Model version 5.0.2 with state-of-the-science aerosol treatment was used for modeling annual $PM_{2.5}$ in the Valley. Other model inputs and configuration, including the modeling domain definition, chemical mechanism, initial and boundary conditions, and emission processing can be found in the Photochemical Modeling Protocol and Modeling Emissions Inventory Appendices.

The U.S. EPA modeling guidance (U.S. EPA, 2014[1]) recommends using modeling in a "relative" rather than "absolute" sense. Based on analysis of recent years' ambient $PM_{2.5}$ levels and meteorological conditions leading to elevated $PM_{2.5}$ concentrations, the year 2013 was selected for baseline modeling calculations. In particular, in 2013 SJV experienced one of the worst years for $PM_{2.5}$ pollution in the Valley within the last decade.

Specifying the baseline design value is a key consideration in the model attainment test, because this value is projected forward to the future and used to test for future attainment of the standard at each monitor. To minimize the influence of year-to-year

[6] 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

variability in demonstrating attainment, the U.S. EPA modeling guidance recommends using the average of three DVs, where one of the DV years is the same as the baseline emissions inventory and modeling year. This average DV is referred to as the baseline (or reference) DV. Here, the average DVs from 2012, 2013, and 2014 are used to calculate baseline DVs (see Tables 2 – 5 for the baseline DVs utilized in the attainment demonstration modeling).

In order to use the modeling in a relative sense, five simulations were conducted: 1) base year simulation for 2013, which demonstrated that the model reasonably reproduced the observed $PM_{2.5}$ concentrations in the Valley; 2) reference (or baseline) year simulation for 2013, which was the same as the base year simulation, but excluded exceptional event emissions such as wildfires; and 3) future year simulations for 2025. These simulations were the same as the reference year simulation, except projected anthropogenic emissions for 2025 were used in lieu of the 2013 emissions.

Table 1 shows the 2013 and 2025 Valley annual anthropogenic emissions for the five $PM_{2.5}$ precursors calculated from the model-ready emissions inventory. Relative to 2013, anthropogenic emissions in the SJV in 2025 will reduce by 64%, 9%, 11%, 6%, and 1% for NO_x, ROG, primary $PM_{2.5}$, SO_x, and ammonia, respectively. Among these five precursors, anthropogenic NO_x emissions show the largest relative reduction, dropping from 288.2 tons/day in 2013 to 104.6 tons/day in 2025. Note that the emission totals presented in Table 1 were calculated from the modeling inventory based on CEPAM.

Since the modeling inventory includes day-specific adjustments not included in the planning inventory, the planning and modeling inventories are expected to be comparable, but not identical. In addition, the 2024 and 2025 emission totals in Table 1 are from the attainment inventory, and so include additional emission reductions beyond the future baseline inventory for the respective year. Details about these additional emission reductions can be found in the model attainment demonstration appendix, while the actual emission commitments are outlined in the SIP.

Table 7-2 Valley Model-Ready Annual Emissions for 2013 and 2025

Category	NO_x	ROG	$PM_{2.5}$	SO_x	NH_3
2013 (tons/day)					
Stationary	38.5	90.8	8.5	7.2	13.9
Area	8.1	153.3	40.2	0.3	310.0
On-road Mobile	154.6	45.1	5.7	0.6	4.4
Other Mobile	87.1	35.8	6.2	0.3	6.0
Total	288.2	325.0	60.5	8.4	334.3
2025 (tons/day)					
Stationary	26.0	100.3	8.6	6.8	16.4
Area	6.8	152.9	38.5	0.3	304.1
On-road Mobile	30.5	16.9	3.1	0.6	3.4
Other Mobile	41.2	25.3	3.6	0.3	6.0
Total	104.6	295.4	53.7	7.9	330.0
Total change from 2013 to 2025	-64%	-9%	-11%	-6%	-1%

In this relative approach, the fractional change (or ratio) in $PM_{2.5}$ concentration between the modeled future year (2025) and modeled baseline year (or reference year, 2013) are calculated. These ratios are called relative response factors (RRFs). Since $PM_{2.5}$ is comprised of different chemical species, which respond differently to changes in emissions of various pollutants, separate RRFs were calculated for individual $PM_{2.5}$ species. In addition, because of potential seasonal differences in $PM_{2.5}$ formation mechanisms, RRFs for each species were also calculated separately for each quarter. The RRF for a specific $PM_{2.5}$ component *j* for each quarter is calculated using the following expression:

$$RRF_j = \frac{[C]_{j,\ future}}{[C]_{j,\ reference}} \quad (1)$$

Where for the annual $PM_{2.5}$ standard, $[C]_{j,\ future}$ is the modeled quarterly mean concentration for component *j* predicted for the future year averaged over the 3x3 array of grid cells surrounding the monitor, and $[C]_{j,reference}$ is the same, but for the reference year simulation.

The measured FRM/FEM (i.e., Federal Reference Method/Federal Equivalent Method) $PM_{2.5}$ must be separated into its various chemical components. Species concentrations were obtained from the four $PM_{2.5}$ chemical speciation sites in the Valley. These four speciation sites are located at: Bakersfield – California Avenue, Fresno – Garland, Visalia – North Church, and Modesto – 14th Street. Since not all of the 16 FRM/FEM $PM_{2.5}$ sites in the Valley have collocated speciation monitors, the speciated $PM_{2.5}$ measurements at one of the four speciation sites were utilized to represent the speciation profile at each of the FRM/FEM sites based on geographic proximity, analysis of local emission sources, and measurements from previous field studies.

Since the FRM $PM_{2.5}$ monitors do not retain all of the $PM_{2.5}$ mass that is measured by the speciation samplers, the U.S. EPA modeling guidance recommends using the SANDWICH approach (Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbon Hybrid material balance) described by Frank (2006[7]) to apportion the FRM $PM_{2.5}$ mass to individual $PM_{2.5}$ species based on nearby chemical speciation measurements. Based on completeness of the data, $PM_{2.5}$ speciation data from 2010 – 2013 were utilized. For each quarter, percent contributions from individual chemical species to FRM/FEM $PM_{2.5}$ mass were calculated as the average of the corresponding quarter from 2010-2013 for the annual standard calculation. For the 24-hour standard calculation, only the top 10% of measured $PM_{2.5}$ days from that quarter were utilized for percentage calculations.

Projected future year 2025 annual $PM_{2.5}$ DVs for each monitor are given in Table 5. The Bakersfield-Planz site has the highest projected DV at 12.0 $\mu g/m^3$, which meets the 2012 annual $PM_{2.5}$ standard at 12 $\mu g/m^3$. Similar to 2024, the reduction in 2025 annual $PM_{2.5}$ DVs is largely due to significant reduction in ammonium nitrate and EC, with

[7] Frank, N.H., 2006, Retained nitrate, hydrated sulfates, and carbonaceous mass in federal reference method fine particulate matter for six eastern U.S. cities, Journal of Air & Waste Management Association, 56, 500-511.

modest reductions in OM. As discussed previously, reductions in ammonium nitrate are a direct result of dramatic NO_x reductions from 2013 to 2025. Reductions in EC and OM are primarily due to emission reductions from primary $PM_{2.5}$ sources, such as residential wood combustion and commercial cooking.

To evaluate the impact of reducing emissions of different $PM_{2.5}$ precursors to $PM_{2.5}$ DVs, a series of model sensitivity simulations were performed, for which anthropogenic emissions within the SJV were reduced by a certain percentage from the baseline emissions. Following U.S. EPA precursor demonstration guidance[8] as well as considering SJV's control strategies, sensitivity runs involving 30% emission reductions were performed for NO_x and direct $PM_{2.5}$. For other precursors (i.e., ammonia, VOCs, and SO_x), both 30% and 70% emission reductions were performed. In addition, sensitivity simulations were performed for the years 2013, 2020, and 2024. The key conclusion from the sensitivity runs is that in 2024, reductions of direct $PM_{2.5}$ and NO_x emissions will continue to have a significant impact on annual and 24-hour $PM_{2.5}$ DVs, while reductions of ammonia, ROG, and SO_x have a much smaller impact compared to that of direct $PM_{2.5}$ and NO_x.

Table 7-3 Projected future year 2025 annual PM2.5 DVs at each monitor

Site AQS ID	Name	Base DV (µg/m^3)	2025 Annual DV (µg/m^3)
60290016	Bakersfield – Planz	17.2	12.0
60392010	Madera	16.9	11.9
60311004	Hanford	16.5	10.4
61072002	Visalia	16.2	11.1
60195001	Clovis	16.1	11.4
60290014	Bakersfield - California	16.0	11.0
60190011	Fresno-Garland	15.0	10.4
60990006	Turlock	14.9	11.1
60195025	Fresno - Hamilton & Winery	14.2	10.0
60771002	Stockton	13.1	10.6
60470003	Merced - S Coffee	13.1	9.6
60990005	Modesto	13.0	9.9
60472510	Merced – M. Street	11.0	8.6
60772010	Manteca	10.1	7.9
60192009	Tranquility	7.7	5.5

[8] U.S. EPA, 2016, PM2.5 Precursor Demonstration Guidance, available at https://www.epa.gov/sites/production/files/2016-11/documents/transmittal_memo_and_draft_pm25_precursor_demo_guidance_11_17_16.pdf

7.4.2 ATTAINMENT DEMONSTRATION

Attaining federal health-based air quality standards is an important milestone for improving public health. As detailed in Appendix K, this Plan demonstrates that the Valley will attain the federal 2012 PM2.5 standard as expeditiously as practicable, with all feasible measures and strategies being implemented to accomplish this goal.

Given the significant contribution of ammonium nitrate to the Valley's PM2.5 concentrations, reductions in NOx emissions are particularly important. To achieve the NOx reductions critical for reaching attainment in the Valley, CARB has adopted regulations that will significantly reduce NOx emissions from various mobile sources. Achieving this level of emissions reductions requires adequate time and carries a tremendous cost.

Modeling performed by CARB and the District demonstrates the Valley will attain the 2012 PM2.5 standard by 2025. See above for the summary of modeling results and Appendix K for the full discussion. This Plan also demonstrates the Valley will attain the standard as expeditiously as practicable as validated in Appendix H.

The attainment demonstration for this Plan includes the benefits of CARB and District control programs that provide ongoing emission reductions. The NOx reductions result from implementation of MSM, which includes the ongoing implementation of both new vehicle standards for passenger and heavy-duty diesel vehicles and equipment; and rules accelerating the turnover of legacy diesel fleets. Implementation of stringent requirements for new off-road engines and in-use off road equipment lead to further NOx reductions, along with District rules addressing stationary source NOx emissions. Appendix C and D contain an evaluation of BACM and MSM feasible for implementation in the Valley.

7.5 REASONABLE FURTHER PROGRESS (RFP)

This CAA §189(d) Plan must demonstrate Reasonable Further Progress (RFP) pursuant to 40 CFR §§ 51.1003(c)(1)(v) and 51.1012.[9] RFP is the incremental emission reductions leading to the attainment date of a standard for an area. Refer to Appendix H for a full description and the RFP demonstration.

7.6 QUANTITATIVE MILESTONES

CAA Subpart 4 §189(c)(1) requires Plans submitted to EPA to contain quantitative milestones which are to be achieved every three years until the area is re-designated attainment and which demonstrate reasonable further progress as defined in CAA §171. For a Serious nonattainment area, the quantitative milestones shall be achieved no later than milestone dates of 7.5 and 10.5 years from the date of designation. The Valley was designated Nonattainment for the 2012 PM2.5 NAAQS effective on April, 15,

[9] See also 81 Fed. Reg. 58103-58104.

2015.[10] Therefore, the quantitative milestones dates for the 2012 PM2.5 NAAQS for the San Joaquin Valley are 2019, 2022, and 2025.[11] Please refer to Appendix H for specific quantitative milestones for the 2012 PM2.5 standard.

7.7 CONTINGENCY

All PM2.5 attainment Plans must contain contingency measures that are consistent with CAA §172(c)(9). Contingency measures are additional control measures to be implemented in the event that an area fails to meet RFP requirements, fails to meet any quantitative milestone, fails to submit a quantitative milestone report or fails to attain the PM2.5 standard by the applicable attainment date. These measures must be fully adopted rules or control measures that are ready to be implemented quickly upon a determination by the EPA that a failure occurred, and such measures are required to take effect without significant further action by the state or the EPA.[12] The statutory contingency measure requirement at CAA §172(c)(9) is not superseded or subsumed by any requirement under subpart 4. This attainment Plan satisfies contingency requirements, see Appendix H for this demonstration.

7.8 FULFILLMENT OF SERIOUS AREA PERMITTING REQUIREMENTS

Pursuant to Subpart 4 §189(b)(3) the District must provide a revision to the nonattainment new source review (NNSR) program to lower the applicable "major stationary source" thresholds from 100 tons per year (tpy) to 70 tpy for areas designated Serious nonattainment. This Plan addresses this 2012 standard as both a Moderate and Serious nonattainment area. The District's New and Modified Stationary Source Review Rule (Rule 2201) identifies the major source emission thresholds for each pollutant. The District adopted amendments to Rule 2201 on February 18, 2016, to meet requirements related to the District's reclassification from Moderate to Serious nonattainment for the 1997 and 2006 federal standards for PM2.5. Currently, through Rule 2201, the District identifies the major source emission threshold for NOx major sources at 10 tpy and PM2.5 at 70 tpy. However, the rule amendments have not been submitted to EPA for inclusion into the SIP because CARB and EPA requested changes to some of the new rule language. The District hosted a public workshop on the proposed amendments on July 26, 2016. District staff had planned on presenting the rule to the Governing Board for adoption in September of 2016. While these revisions do not change the District's interpretation or implementation of the rule, these amendments must be adopted by the District Governing Board before CARB can submit the rule to EPA for inclusion into the State Implementation Plan. However, in August of 2016, EPA released long-overdue regulations on implementing the PM2.5 standards in NSR rules that require an assessment of the significance of precursor pollutant emissions using a specific type of air quality modeling. Due to these new requirements,

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[10] Air Quality Designations for the 2012 Primary Annual Fine Particle (PM2.5) NAAQS; Final Rule 80 RF. Vol.80 No10. pp. 2206-2284 (2015, January 15) (to be codified at 40 CFR part 81) http://www.gpo.gov/fdsys/pkg/FR-2015-01-15/pdf/2015-00021.pdf

[11] 40 CFR 51.1013(a)

[12] Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule. 81 Fed. Reg. 164, pp. 58010-58162. (2016, August 24). (to be codified at 40 CFR Parts 50, 51, and 93). https://www.gpo.gov/fdsys/pkg/FR-2016-08-24/pdf/2016-18768.pdf

EPA will not be able to approve an NSR rule that does not address EPA's implementation regulation, so adoption has been delayed until such modeling can be completed. The District anticipates taking rule amendments to the District's Governing Board in 2018.

7.9 TRANSPORTATION CONFORMITY

This CAA §189(d) Plan must include transportation conformity budgets for the attainment year pursuant to 40 CFR §51.1003(d)[13]. Please see Appendix D for more information.

[13] See also 81 Fed. Reg. 58103.

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Appendix A

Ambient PM2.5 Data Analysis

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A. AMBIENT PM2.5 DATA ANALYSIS

The concentration of ambient particulate matter that is 2.5 microns or less in diameter (PM2.5) at any given location in the San Joaquin Valley (Valley) is a function of meteorology, the natural environment, atmospheric chemistry, and emissions of directly emitted PM2.5 and PM2.5 precursors from regulated and unregulated sources. The San Joaquin Valley Air Pollution Control District (District), the California Air Resources Board (CARB), and other agencies[1] monitor PM2.5 concentrations throughout the Valley,[2] using filter-based monitoring (starting in 1999) and real-time concentration monitoring (starting in 2002). The U.S. Environmental Protection Agency (EPA) serves as the official repository of ambient PM2.5 data and analysis.[3]

The District uses the collected data to show air quality improvement through the standardized design value calculations, using EPA protocols to document basin-wide improvement and attainment of the National Ambient Air Quality Standards (NAAQS). As shown in this appendix, the design value (DV) data show steady, long-term air quality improvement that will lead to the attainment of the federal PM2.5 standards.

The District also uses the data to evaluate the impact of changing daily, quarterly, and annual PM2.5 concentrations on public health. These trend analyses provide the District with critical information about how to develop control measures and incentive programs that provide the most impact to public health improvements, as guided by the District's Health Risk Reduction Strategy (see Chapter 3).

This appendix provides the technical details used to evaluate and analyze the District's PM2.5 concentration data. It also shows the multiple factors that affect ambient PM2.5 concentrations in the Valley (e.g. meteorology, exceptional events) and the evidence for air quality improvement through District regulatory actions, including the District's highly successful Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters).

A.1 PM2.5 CONCENTRATIONS—MEASUREMENT AND INFLUENCES

The District, CARB, and other agencies manage an extensive air monitoring network throughout the Valley. The information obtained from the PM2.5 monitors within this network provide the District with necessary information for demonstrating attainment of the NAAQS and valuable information for protecting public health throughout the year. The monitoring network captures the spatial, seasonal, daily, weekly, and annual variations in PM2.5 concentrations throughout the Valley that result from changing meteorology, the occurrence of exceptional events (e.g. high winds and wildfires), and PM2.5 emissions from regulated and unregulated sources.

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[1] Other agencies include the Chukchansi and Tachi Yokut Tribe and the National Park Service.
[2] *San Joaquin Valley Air Pollution Control District Air Monitoring Network Plan*: June 21,2017 submittal to EPA. Available at https://www.valleyair.org/aqinfo/Docs/2017-Air-Monitoring-Network-Plan.pdf
[3] U.S. Environmental Protection Agency: Technology Transfer Network (TTN), Air Quality System (AQS): *AQS Web Application.* (2010). Available at https://www.epa.gov/aqs

A.1.1 PM2.5 Monitor Types

The District and CARB use three types of PM2.5 monitors in the Valley:

- Filter-based Federal Reference Method (FRM) monitors, defined as the standard for data collection;
- Real-time beta-attenuation method (BAM) monitors designated as federal equivalent method (FEM) monitors, and hereafter referred to as BAM/FEM monitors;
- Ordinary BAMs, not designated FEM, and hereafter referred to as BAM; and
- Filter-based speciation monitors, similar to FRM monitors.

Only FRM and BAM/FEM monitors produce data that is suitable for comparison with the NAAQS, and are therefore used for design value calculations. Real-time monitors (BAM/FEM and BAM) produce hourly measurements that the District uses every day to produce daily air quality forecasts, wood burning declarations, public health notifications, and Real-time Air Advisory Network (RAAN) notifications for schools.

The filter-based speciation monitors operate similarly to the standard FRM monitors; however, because of the specific analysis requirements for the different PM2.5 species (e.g. metals, silicon, chlorine, organics) multiple filter media are required, hence a multi-filter collection system. The evaluation and analysis of multiple PM2.5 species is critical to the development of an effective attainment strategy.

A.1.2 Meteorological Influences on PM2.5 Concentrations

Particulates in the atmosphere are dispersed by horizontal and vertical mixing within an air mass. Wind flow (horizontal mixing) and temperature instability (decreasing temperature with height leading to vertical mixing) provides the strongest mechanisms for dispersing pollutants. Wind speed can greatly influence the pollutant concentrations by horizontally mixing and dispersing pollutants over a large area. Generally, the higher the wind speed the lower the PM2.5 concentrations; however, in some cases, excessive winds may cause elevated PM2.5 levels as high winds entrain PM10 as well as PM2.5.

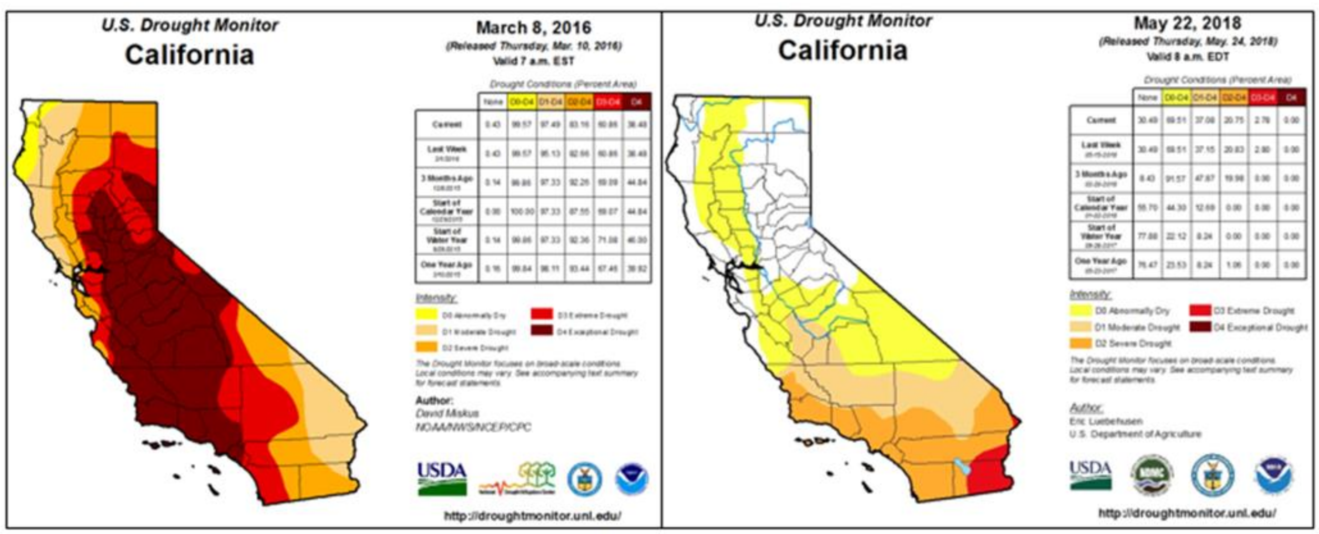
Vertical mixing of the air mass can result from atmospheric instability. A temperature inversion, or increasing temperature with increasing height, can inhibit the vertical mixing of an air mass, and create a situation in which pollutants remain trapped near the surface. Prolonged periods of high pressure and stable conditions with low wind speeds can cause stagnant conditions that trap pollutants near the surface. PM2.5 concentrations increase during these poor dispersion periods. During low pressure events, unstable conditions and stronger wind speeds occur. PM2.5 concentrations can decrease or increase depending on the strength and characteristics of the low pressure system.

Atmospheric weather patterns influence climate conditions, local meteorology, and PM2.5 concentrations. The next section describes the air quality impacts from the extreme drought.

A.1.2.1 Valley Drought

According to the U.S. Geological Survey, California experienced its worst drought in over a century between 2011 and 2015. The 2015-2016 winter season represented the fifth consecutive year of drought conditions in the Valley, and 2013-2014 was by far the driest winter during this time. On January 17, 2014, the Governor of California declared a drought emergency for all of California. Three years and two months later, the drought emergency declaration was finally lifted by the Governor of California on April 7, 2017. Figure A-1 is a map produced by the National Drought Mitigation Center depicting the extent and severity of the drought affecting California as of March 8, 2016 and the degree of recovery that has occurred as of May 22, 2018.

Figure A-1 Drought Extent and Severity in California



Many cities in California, including those in the Valley, had record low rainfall totals during 2013 calendar year, with some nearly 100-year old records being broken. Although rainfall totals slowly increased between 2015 and 2017, drought conditions have continued to persist despite a very wet 2016-2017 winter season (see Table A-1).

Table A-1 Rainfall Totals for Select Cities Across California

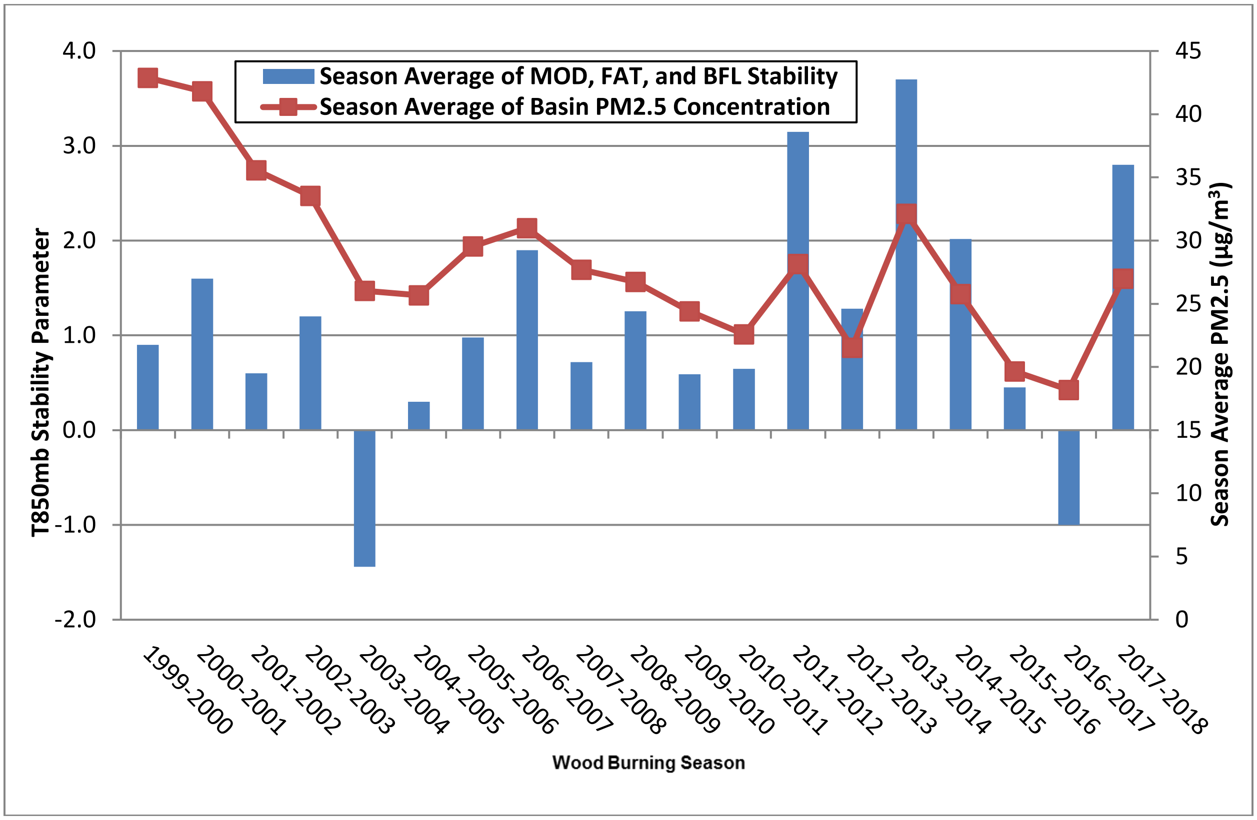
Region	City	1983-2013	2015	2016	2017	Record Low Rainfall	
		Average (inches)	Total (inches)	Total (inches)	Total (inches)	Year	Total (inches)
Northern California	San Francisco	19.73	8.45	25.5	26.62	2013	3.39
	Sacramento	17.6	8.53	22.92	27.16	2013	5.81
San Joaquin Valley	Modesto	12.17	7.25	16.24	12.93	2013	4.69
	Madera	12.3	4.14	16.02	10.61	2013	3.8
	Fresno	11.03	8.98	13.65	13.21	2013	3.01
	Visalia	9.91	5.33	8.94	11.52	2013	3.47
	Bakersfield	6.19	3.99	7.13	5.38	1959	1.87
Southern California	Los Angeles	12.32	5.96	10.27	12.26	1947	3.14
	San Diego	10.2	9.92	10.23	7.92	1953	3.41

NCDC https://www.ncdc.noaa.gov/cdo-web/search;jsessionid=8EECF3E54DC2BBA9D4F96C444434A990
NWS Hanford http://w2.weather.gov/climate/local_data.php?wfo=hnx
NWS San Diego http://w2.weather.gov/climate/local_data.php?wfo=sgx
California Nevada River Forecast Center http://www.cnrfc.noaa.gov/rainfall_data.php

During 2011-2015 winter seasons, extended periods of stagnation, and lack of ample precipitation were components of the historic drought that challenged the Valley's air quality during this period. These conditions overwhelmed the District's control measures and strategies, and contributed to the higher than expected PM2.5 concentrations and exceedances that occurred in the San Joaquin Valley during that period.

As demonstrated in Figure A-2, the average PM2.5 concentration in the Valley has decreased over the period, despite low precipitation totals and increases in atmospheric stability over recent years. This provides evidence that District and CARB control measures have been achieving permanent emissions reductions.

Figure A-2 Seasonal Average Stability and PM2.5 Concentrations



A.1.2.2 Exceptional Event Influences on PM2.5 Concentrations

Valley PM2.5 concentrations are also affected by exceptional events such as wildfires, high winds, and fireworks. An exceptional event is defined as an event that affects air quality; is not reasonably controllable or preventable; is caused by either a human activity that is unlikely to recur at a particular location or a natural event; and is determined by EPA to be an exceptional event.[4] Such events can result in PM2.5 concentration peaks, or even extended high-concentration episodes such as summertime wildfires.

Although not every event results in a formal submittal to EPA, the District tracks these events and their impact on attainment as part of its ongoing air quality analysis. These ongoing efforts help the District to more accurately characterize ambient PM2.5 concentrations and attainment progress. The District has experienced fireworks activity, high wind events, and wildfire events in the past that caused PM2.5 concentrations to exceed the federal PM2.5 standards.

The continued drought conditions that were experienced in the San Joaquin Valley and across the western United States from 2011-2015 has led to a number of conditions that have exacerbated the Valley's air quality challenge. Air pollution generated from

[4] Treatment of Air Quality Monitoring Data Influenced by Exceptional Events, 72 Fed. Reg. 55, pp. 13560–13581. (2007, March 22). (to be codified in 40 C.F.R. pts. 50 and 51), (40 CFR 50.14)

wildfires is enormous and can well exceed total industrial and mobile source emissions in the San Joaquin Valley, overwhelming all control measures and resulting in periods of excessively high particulate matter. For example in 2015, emissions from the Rough Fire in Fresno County consisted of heavy fuel loads with high emissions estimates per acre of fuel burned. As compared to the Valley's emissions, direct PM2.5 emissions from the Rough Fire at its peak day were 105 times greater than the PM2.5 emissions from the District's entire stationary, area, and mobile source inventories combined. Similarly, NOx emissions, a precursor to PM2.5, were 8 times greater than the District's inventory.

Due to the excessively dry conditions, the buildup of combustible materials, and the mortality of millions of trees from the drought and bark beetle infestation, the region has experienced a number of large wildfires and California has reached an all-time high for fire danger. The 2017 wildfire season has brought more wildfires across California compared to last year and the 5 year average through the same time period, as the following table displays.

Table A-2 Number of Wildfire Occurrences in California

Timeframe	Fires
January 1 through December 31, 2017	7,117
January 1 through December 31, 2016	4,785
5 Year Average (same interval)	4,835

Source: CAL FIRE

With proper documentation and EPA concurrence, data influenced by exceptional events can be excluded from official attainment demonstration design value calculations. Design values, which will be discussed fully in Section A.2, represent a three-year average of 24-hour and annual mean PM2.5 concentrations.

A.2 ATTAINMENT DEMONSTRATION—DESIGN VALUES

Design values represent the official metric for assessing air quality improvements and attainment of the NAAQS per the Federal Clean Air Act and EPA regulations. Design value calculations are three-year averages that follow EPA protocols for rounding, averaging conventions, data completeness, sampling frequency, data substitutions, and data validity. The results provide consistency and transparency to determine basin-wide attainment for both components of the 1997 PM2.5 standard, which includes the 24-hour PM2.5 standard of 65 $\mu g/m^3$ and the annual PM2.5 standard of 15.0 $\mu g/m^3$; the 2006 24-hour PM2.5 standard of 35 $\mu g/m^3$, and the 2012 annual PM2.5 standard of 12 $\mu g/m^3$. If any monitoring site within the air basin has either a 24-hour or annual PM2.5 design value higher than the respective standards, then the entire air basin is designated nonattainment.

Table A-3 provides the generalized descriptions of how the 24-hour average and annual average design values are calculated for PM2.5. EPA provides detailed guidelines and standards for the calculation[5] and data handling[6] methodologies.

Table A-3 General PM2.5 Design Value Calculation Methods

Averaging Period	Level	Calculation Method
24-hour	65 µg/m³ (1997) 35 µg/m³ (2006)	**Step 1:** *Determine the 98th percentile value for each year over a consecutive three year period.* **Step 2:** *Average the three 98th percentile values.* **Step 3:** *Round the resulting value to the nearest 1.0 µg/m³.* **Step 4:** *Compare the result to the standard.*
Annual	15.0 µg/m³ (1997) 12.0 µg/m³ (2012)	**Step 1:** *Calculate the average of each quarter of each year over a three year period.* **Step 2:** *Average the four quarters in a calendar year to determine the average for each year.* **Step 3:** *Average the three annual values.* **Step 4:** *Round the resulting value to the nearest 0.1 µg/m³.* **Step 5:** *Compare the result to the standard.*

Table A-4 through Table A-7 show the trend of the 24-hour average and annual average values for each PM2.5 monitoring site in the Valley by year as well as the three-year average design values for these metrics through the year 2016.

24-hour single-year 98th-percentile averages (Table A-4) are used to generate the three-year average 24-hour design values (Table A-5). Single-year average PM2.5 concentrations (Table A-6) are used to generate the three-year average annual design values (Table A-7). This data is shown graphically in
through
Figure A-18 for select sites within each county in the Valley.

Average ambient PM2.5 concentrations vary by monitoring site within the Valley. In general, monitoring sites in the northern part of the Valley record the lowest ambient PM2.5 concentrations, with concentrations increasing toward the central and southern portions of the Valley. For the 2015-17 period, all Valley air monitoring sites meet the 1997 24-hour average standard of 65 µg/m³, while a handful of sites still exceed the annual average standard of 15.0 µg/m³. With PM2.5 concentrations continuing to improve, both 24-hour and annual average design values are trending downward across the Valley, bringing the region closer to attaining the federal PM2.5 standards.

[5] Interpretation of the National Ambient Air Quality Standards for PM2.5, 40 C.F.R. Pt. 50 Appendix N (2012). Available at https://www.law.cornell.edu/cfr/text/40/appendix-N_to_part_50
[6] Environmental Protection Agency [EPA]: Office of Air Quality Planning and Standards. (1999, April). *Guideline on Data Handling Conventions for the PM NAAQS* (EPA-454/R-99-008). Retrieved from NEPIS.epa.gov

Table A-4 Single Year 24-hour Average PM2.5 98th Percentile Values (ug/m^3)

SJV Monitoring Sites	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Stockton-Hazelton	79	55	58	50	41	36	44	42	48	61.6	40.4	29.7	44.8	33.9	56.3	44.5	39.1	32.4	44.2
Manteca												44*	38.9	30.9	40.2	40	42.7	29.3	36.4
Modesto	100	71	69	69	47	45	55	52	57.4	53.9	54.5	37.3	54.7	40.8	56.4	49.5	30.8	36.2	51.1
Turlock										67.4	53.1	43.5	57.4	45.4	55.4	51.2	47.3	38.5	48
Merced - M St	91.9	68.4	49.3	57.6	44.7	46.9	48.6	52.5	53	53.6	49.8	39.1	38.5	41.8	67.3	45.9	39	34.6	40.3
Merced - Coffee											41.4*	39.9	47.4	35.6	42.3	43.8	40.3	32.8	44.7
Madera City												57*	59.1	43.2	54.6	56	43.7	35.7	45.8
Clovis	83.2	72.5	76.2	53.5	48.4	56	67.1	60.5	61.2	49.7	49	44.3	68.5	48	56.2	64.5	45.7	37.7	54
Fresno-Garland														52.6	63.8	66.7	52	42.7	68
Fresno-1st	120	90	75	75	56	52	71	51	67	57.4	55.8	48.8	69.5	93.4*					
Fresno 1st/Garland	120	90	75	75	56	52	71	51	67	57.4	55.8	48.8	69.5	52.6	63.8	66.7	52	42.7	68
Fresno-Pacific		65.1	72.1	73	52	52.1	74.1	65	57.9	46.4	52.3	40.2	67.5	51.3	71.6	61.8	42	40	73.2
Tranquillity											35.8	27*	27.5	26.9	35.7	31.2*	35.8	27	34.4
Corcoran	53	55.1	120.6	77.4	48.5	49.6	77.8	63.8	59.5	47.9	53.4	47.2	40.8	40	66	71		45.9	69.7
Hanford												48.5	64.6	48.3	67.6	81.9	51.4	43.3	68.7
Visalia	114	103	96	70	47	54	65	50	59.7	62.1	53.9	36.3	50.7	53.8	62.5	75.4	45.8	40.7	74.6
Bakersfield-Golden/M St	97.5	102.5	96.3	81.6	57.1	54.6	77.9	75.2	69.4	60.9	68.6						51.5	51.4	71.3
Bakersfield-CA	97.4	92.7	94.9	73	48.3	61.5	63.2	60.5	73	64.5	66.7	53.3	65.5	56.4	71.8	79.9	57.2	47	71.8
Bakersfield-Planz		76.5	90.6	66.8	47.5	47.6	66.4	64.7	72.2	72.3	65.5	56.2	43.2	40.6	96.7	76.7	56.5	50.7	69.7

* Values are incomplete causing concentrations unrepresentative of ambient conditions.

Table A-5 24-hour Average PM2.5 Design Values (Three-Year Averages, µg/m^3)

SJV Monitoring Sites	1999-2001	2000-2002	2001-2003	2002-2004	2003-2005	2004-2006	2005-2007	2006-2008	2007-2009	2008-2010	2009-2011	2010-2012	2011-2013	2012-2014	2013-2015	2014-2016	2015-2017
Stockton-Hazelton	64	54	50	42	40	41	45	51	50	44	38	36	45	45	47	39	39
Manteca											38	38	37	37	41	37	36
Modesto	80	70	62	54	49	51	55	54	55	49	49	44	51	49	46	39	39
Turlock										55	51	49	53	51	51	46	45
Merced-M St	70	58	51	50	47	49	51	53	52	48	42	40	49	52	51	40	38
Merced-Coffee										41*	43	41	42	41	42	39	39
Madera-City											58*	53	52	51	51	45	42
Clovis	77	67	59	53	57	61	63	57	53	48	54	54	58	56	55	49	46
Fresno-Garland												53*	58*	61	61	54	54
Fresno-1st	95	80	69	61	60	58	63	58	60	54	58	59*	70*				
Fresno-1st/Garland	95	80	69	61	60	58	63	58	60	54	58	57*	62*	61	61	54	54
Fresno-Pacific	69*	70	66	59	59	64	66	56	52	46	53	53	63	62	58	48	52
Tranquillity									36*	31*	30*	27*	30	31	34	31	32
Corcoran	76	84	82	59	59	64	67	57	54	50	47	43	49	59	*	*	*
Hanford										49*	57*	54	60	66	67	59	54
Visalia	104	90	71	57	55	56	58	57	59	51	47	47	56	64	61	54	54
Bakersfield-Golden/M St	99	93	78	64	63	69	74	69	66	65*	69*			*	*		58
Bakersfield-CA	95	87	72	61	58	62	66	66	68	62	62	58	65	69	70	61	59
Bakersfield-Planz	84*	78	68	54	54	60	68	70	70	65	55	47	60	71	77	61	59

* Values are incomplete causing concentrations unrepresentative of ambient conditions.

Table A-6 Single Year Annual Mean PM2.5 Concentrations (μg/m³)

SJV Monitoring Sites	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Stockton-Hazelton	19.7	15.5	13.9	16.7	13.6	13.2	12.5	13.1	12.9	14.4	11.3	10.6	11.3	12.4	17.7	12.1	12.8	11.8	12.1
Manteca												17.6*	10.7	8.1	11.6	9.8	12.6	9.8	11.1
Modesto	24.9	18.7	15.6	18.7	14.5	13.6	13.9	14.8	15	16	13	12.1	14.7	11.9	14.3	11.4	9.1*	11.1	12.9
Turlock										30.3*	16.1	12.7	17.1	14.8	15	12.3	14.2	12.6	12.7
Merced-M St.	22.6*	16.7	14.5	18.7	15.7	15.2	14.1	14.8	15.2	14.9*	13.6	11.2	10.4	9.5	13.5	11.2	12.6	11.2	12.6
Merced-Coffee											22.7*	16.3	15.6	11	13.3	10.8	12.7	11.9	13.3
Madera-City												21.1*	20.4	16	17.8	14	13.8	12	12.5
Clovis	19.8	16.3	18	16.2	18.5*	16.4	16.3	16.4	16.4	16.2	18.3	14.6	17.9	15.4	15.9	14.8	15	12.5	13.3
Fresno-Garland														14.1	16.8	15.1	14.4	12.7	14.9
Fresno-1st	27.6	24.5*	19.8	21.5	17.8	16.3	16.7	16.8	18.8	17.4	15.1	13	15.5	40.3*					
Fresno-1st/Garland	27.6	24.5*	19.8	21.5	17.8	16.3	16.7	16.8	18.8	17.4	15.1	13	15.5	14.1	16.8	15.1	14.4	12.7	14.9
Fresno-Pacific		18.4	18.6	21.3	17.8	17	16.9	17.6	16.8	16.5	14.6	13.4	15.4	12.7	15.9	13.8	14.1	13	15
Tranquillity											11.8*	7*	8.2	7	8.3	7.6*	10	7.7	8.3
Corcoran	14.3*	16.4	19.2	21.5	16.2	17.4	17.5	16.9	18.4	15.8	17.7	17.9	12.8*	16.5*	15.6	15.4	*	14.8	16
Hanford												14.5	18	14.8	18.2	17.5	16.5	15.5	17.2
Visalia	27.6	23.9	22.5	23.2	18.2	17	18.8	18.8	20.4	19.8	16	13.6	16.1	14.8	18.9	17.9	16.1	14.7	16.3
Bakersfield-Golden/M St	26.2	22.6	21.8	24.1	19.6	18.2	19.1	18.6	19.9	17.9*	20					*	16.7	14.8	16.2
Bakersfield-CA	23.8	22.5	21.2	22.7	17.1	18.9	18	18.7	22	21.9	19	14.2	16.2	13	20	18.6	16.3	14.8	15.9
Bakersfield-Planz		20.3	20.8	23.5	17.8	17.4	19.8	19.3	21.8	23.5	22.5	17.6	14.5	14.7	22.8	21.6	17.9	15.9	18.2

* Values are incomplete causing concentrations unrepresentative of ambient conditions.

Table A-7 Annual PM2.5 Design Values (Three-Year Averages, µg/m³)

SJV Monitoring Sites	1999-2001	2000-2002	2001-2003	2002-2004	2003-2005	2004-2006	2005-2007	2006-2008	2007-2009	2008-2010	2009-2011	2010-2012	2011-2013	2012-2014	2013-2015	2014-2016	2015-2017
Stockton-Hazelton	16.4	15.4	14.7	14.5	13.1	12.9	12.8	13.5	12.9	12.1	11.1	11.4	13.8	14.1	14.2	12.2	12.2
Manteca											10.7*	9.4*	10.1	9.8	11.3	10.7	11.2
Modesto	19.7	17.7	16.3	15.6	14.0	14.1	14.6	15.3	14.7	13.7	13.3	12.9	13.6	12.5	12.9*	10.5	11.0*
Turlock									16.1*	14.4*	15.3	14.9	15.6	14.0	13.8	13.0	13.2
Merced-M St.	15.6*	16.6	16.3	16.5	15.0	14.7	14.7	15.0*	14.4*	12.4*	11.7	10.4	11.1	11.4	12.4	11.7	12.1
Merced-Coffee										16.3*	16.0*	14.3	13.3	11.7	12.3	11.8	12.7
Madera-City											20.4*	18.2*	18.1	15.9	15.2	13.3	12.8
Clovis	18.0	16.8	17.1	16.3	16.4	16.4	16.4	16.3	17.0	16.4	16.9	16.0	16.4	15.4	15.2	14.1	13.6
Fresno-Garland												14.1	15.5	15.3	15.4	14.1	14.0
Fresno-1st	23.7*	20.7*	19.7	18.5	16.9	16.6	17.4	17.7	17.1	15.2	14.5	14.3*	15.5*				
Fresno-1st/Garland	23.7*	20.7*	19.7	18.5	16.9	16.6	17.4	17.7	17.1	15.2	14.5	14.2	15.5	15.3	15.4	14.1	14.0
Fresno-Pacific	18.5	19.4	19.2	18.7	17.2	17.2	17.1	17.0	16.0	14.8	14.5	13.8	14.7	14.1	14.6	13.6	14.0
Tranquillity											8.2*	7.6*	7.8	7.7	8.7	8.5	8.7
Corcoran	17.8	19.0	19.0	18.4	17.0	17.3	17.6	17.0	17.3	17.1	17.8*	17.9*	15.6*	15.5*	*	*	*
Hanford										14.5	16.3	15.8	17.0	16.8	17.4	16.5	16.4
Visalia	24.7	23.2	21.3	19.5	18.0	18.2	19.3	19.7	18.7	16.5	15.2	14.8	16.6	17.2	17.6	16.2	15.7
Bakersfield-Golden/M St	23.5	22.8	21.8	20.6	19.0	18.6	19.2	19.3	20.0	20.0	20.0				16.7*	15.8*	15.9
Bakersfield-CA	22.5	22.1	20.3	19.6	18.0	18.5	19.6	20.9	21.0	18.4	16.5	14.5	16.4	17.2	18.3	16.5	15.7
Bakersfield-Planz	20.6	21.5	20.7	19.6	18.3	18.8	20.3	21.5	22.6	21.2	18.2	15.6	17.3	19.7	20.8	18.4	17.3

Notes for Tables A-4, A-5, A-6, and A-7:

- Source: U.S. Environmental Protection Agency: Air Quality System AQS): AMP 480 Report, available at https://www.epa.gov/aqs , July 19, 2018.
- Empty cell: No data or insufficient data
- Asterisk (*) and highlighted cells: Values do not meet completeness criteria
- Corcoran 2015, 2016, 2017 design values are not representative of ambient concentrations due to incomplete data in 2015 resulting from the shelter being destroyed in a fire.
- Bakersfield-Golden/M St. is not shown since it was influenced by incomplete data in 2014 and is not representative of ambient conditions.

Figure A-3 San Joaquin County 24-hr Design Value Trend

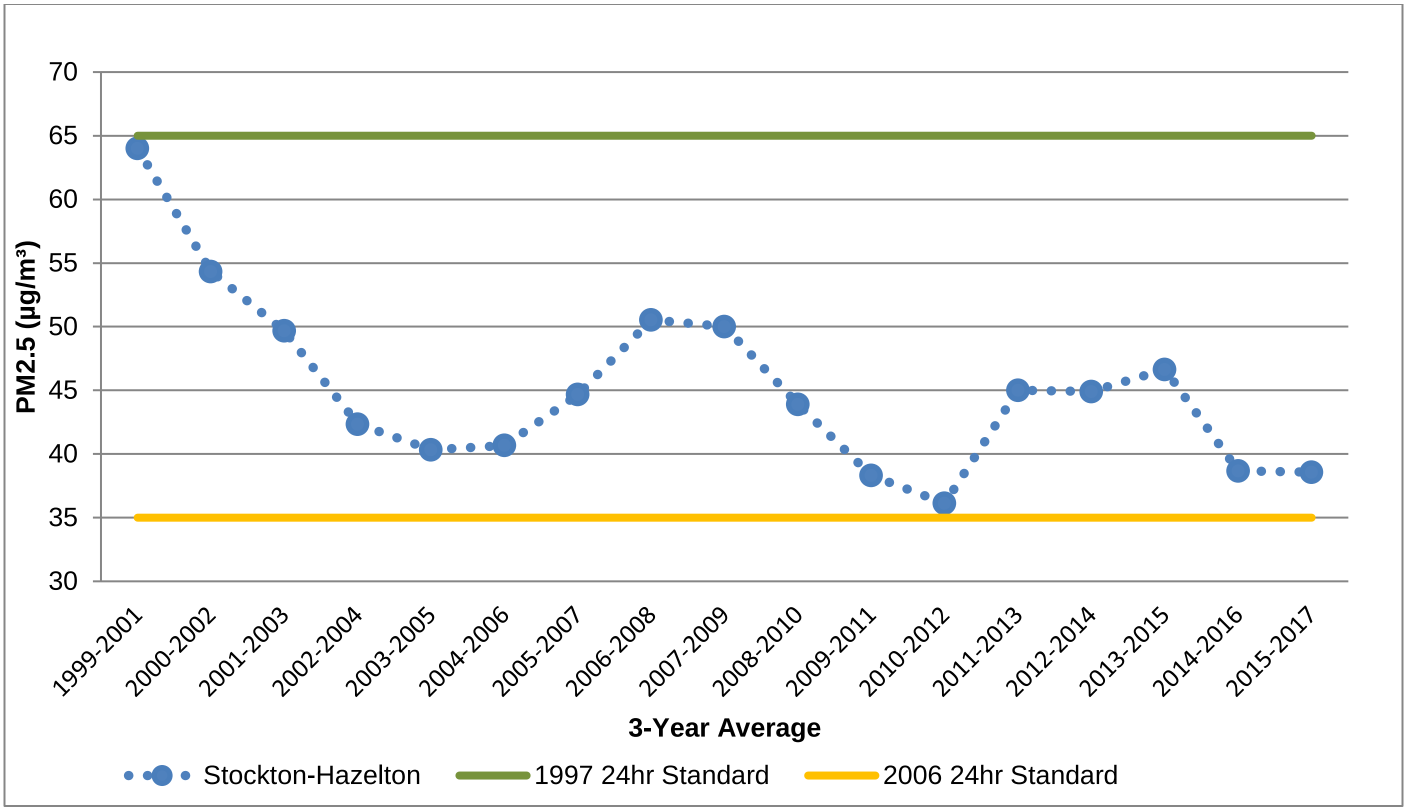


Figure A-4 San Joaquin County Annual Design Value Trend

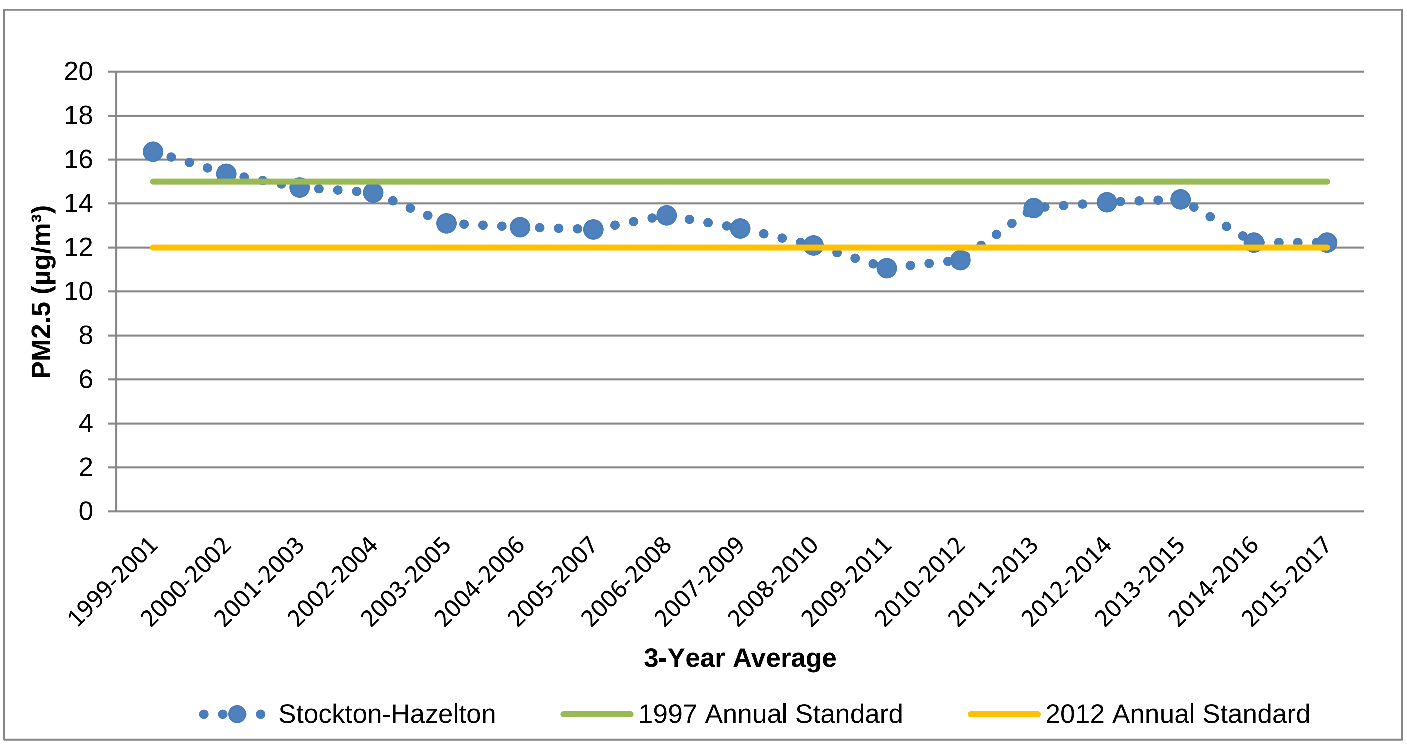


Figure A-5 Stanislaus County 24-Hour Design Value Trend

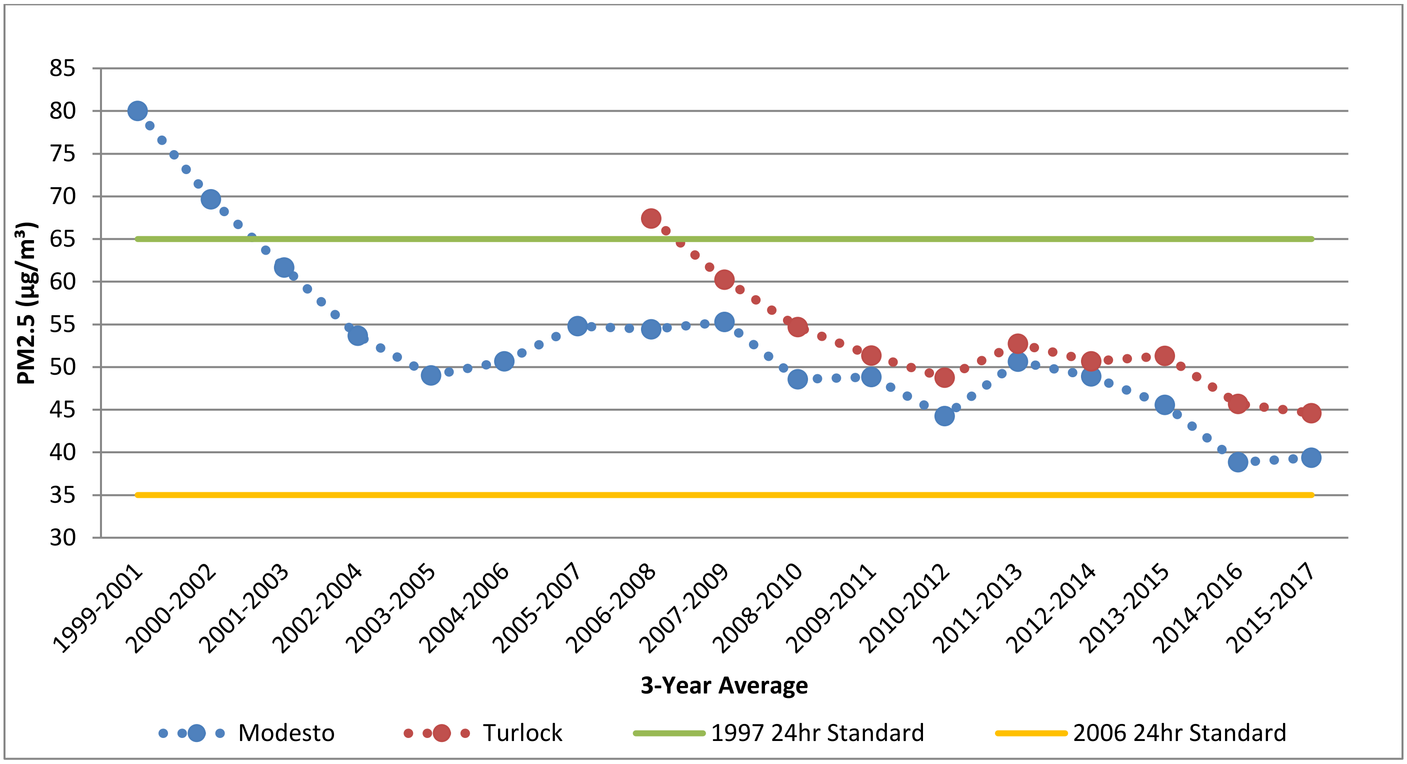


Figure A-6 Stanislaus County Annual Design Value Trend

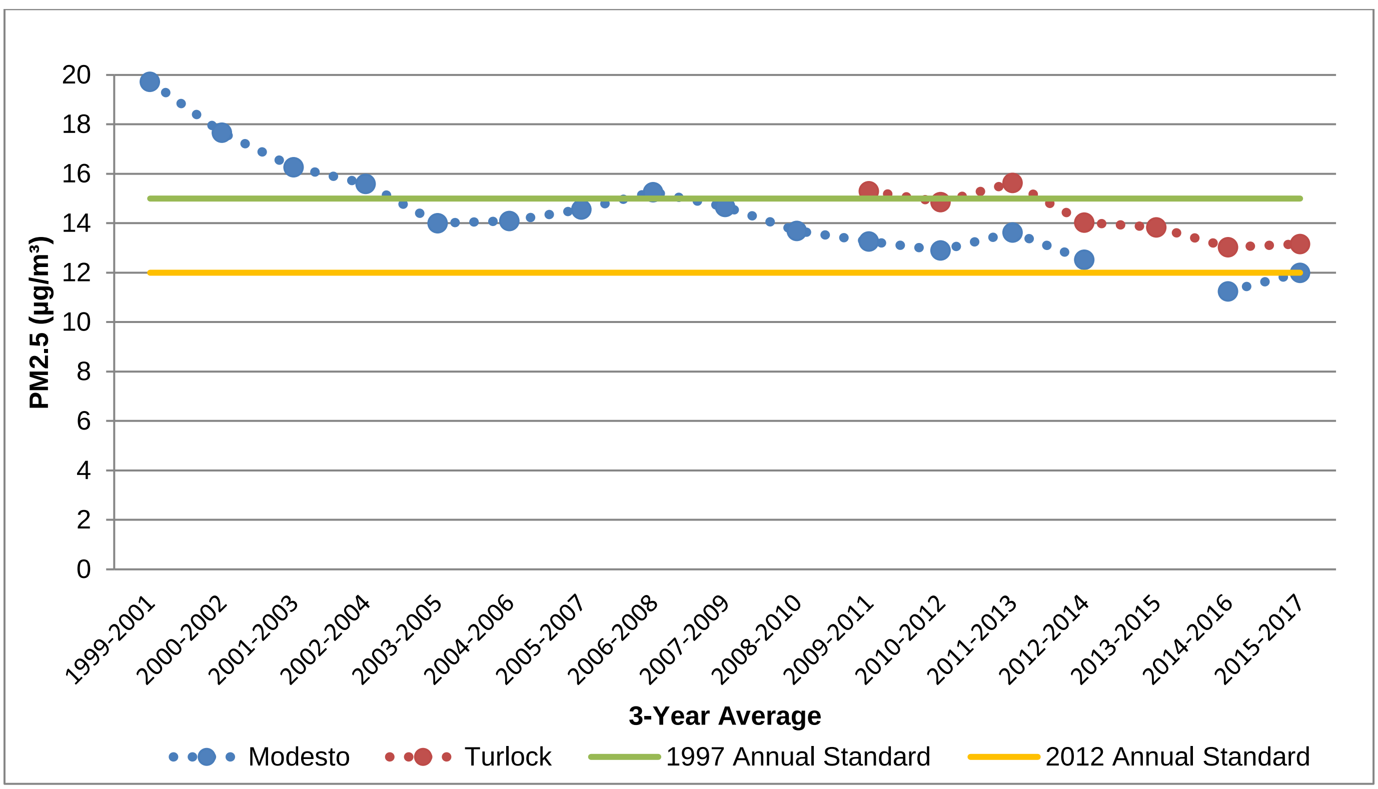


Figure A-7 Merced County 24-Hour Design Value Trend

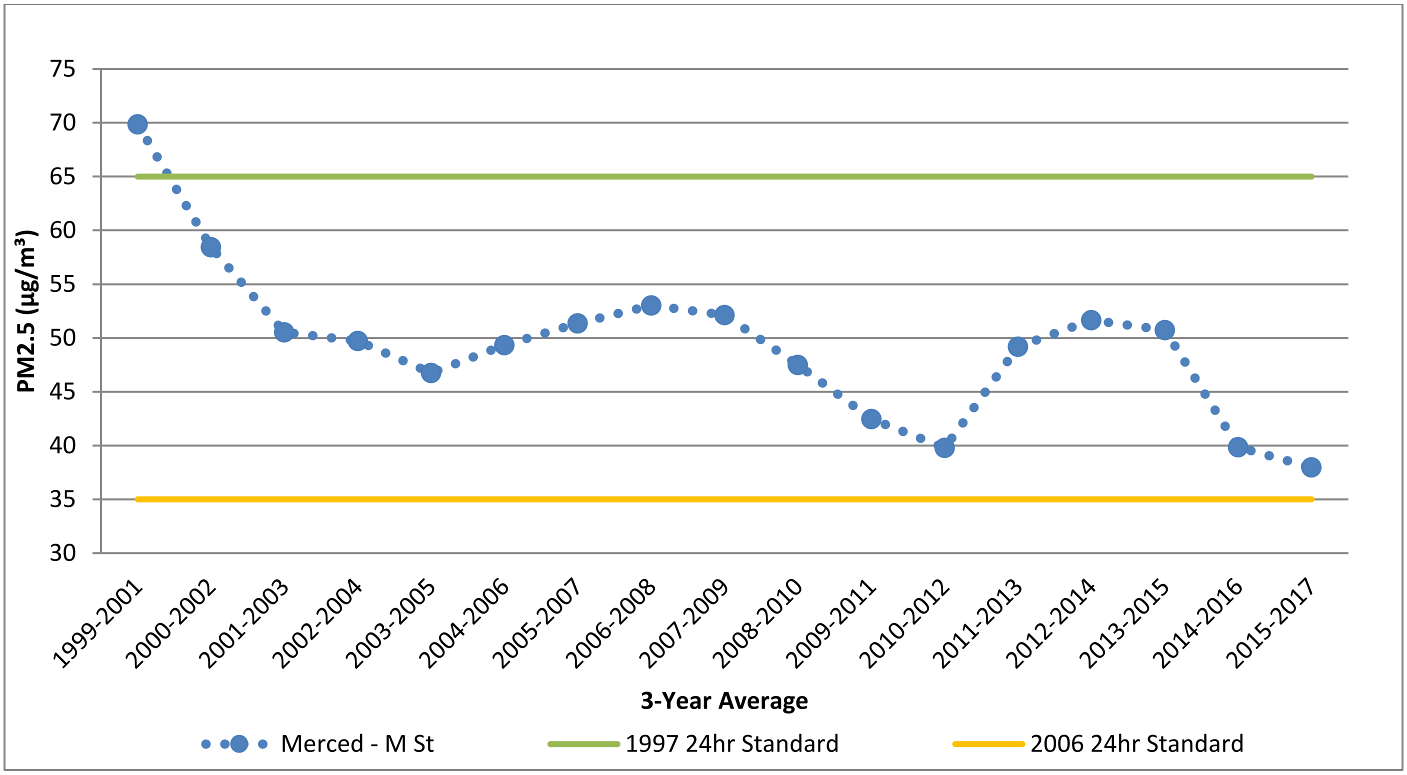


Figure A-8 Merced County Annual Design Value Trend

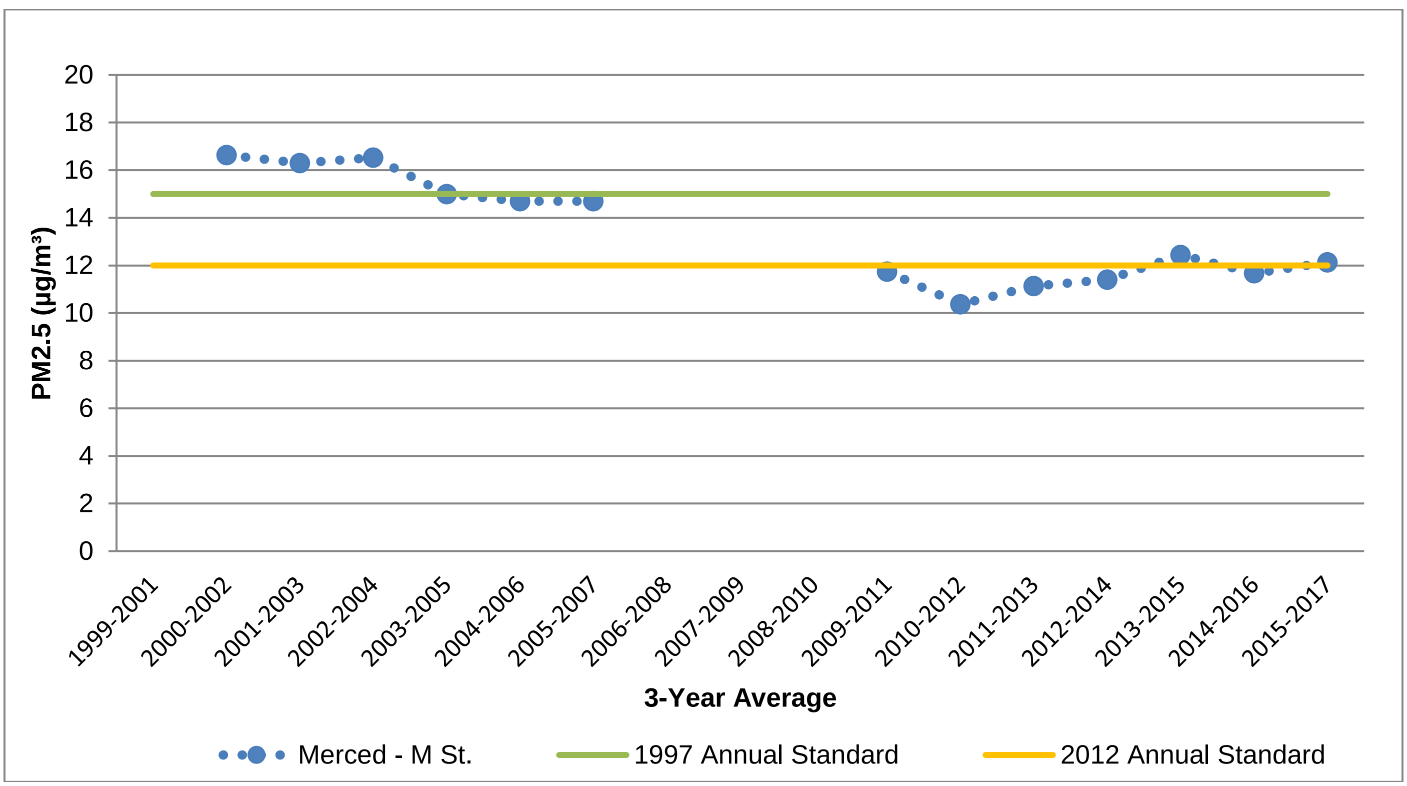


Figure A-9 Madera County[7] 24-Hour Design Value Trend

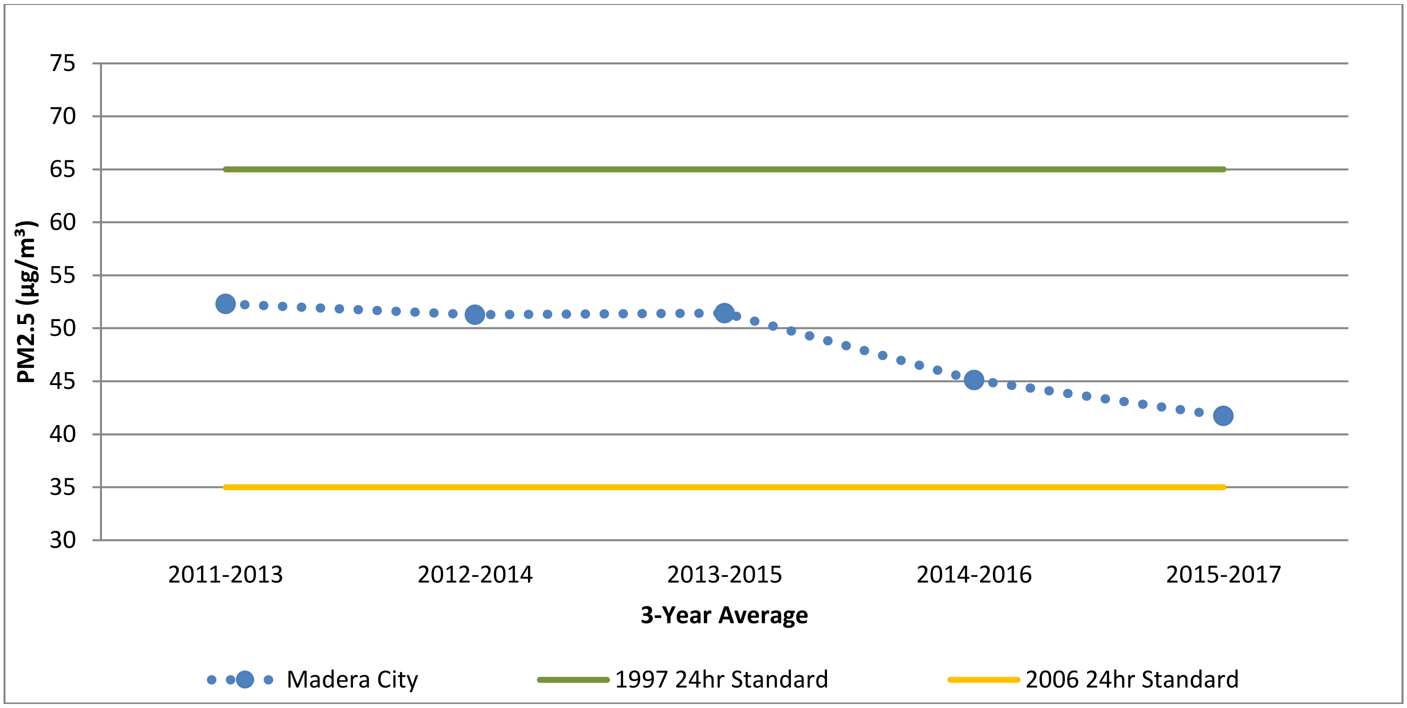
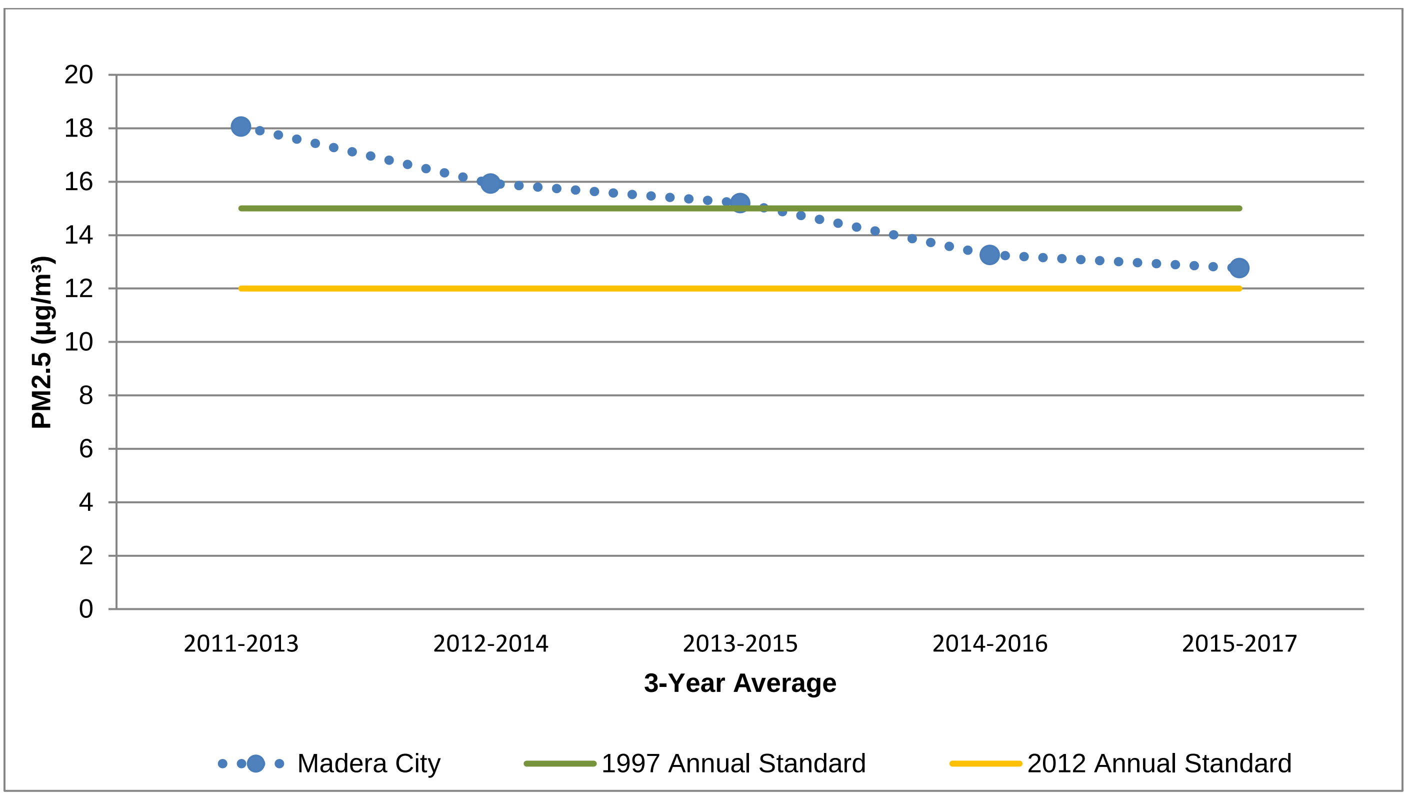


Figure A-10 Madera County Annual Design Value Trend



[7] PM2.5 monitoring in Madera began in 2010

Figure A-11 Fresno County 24-Hour Design Value Trend

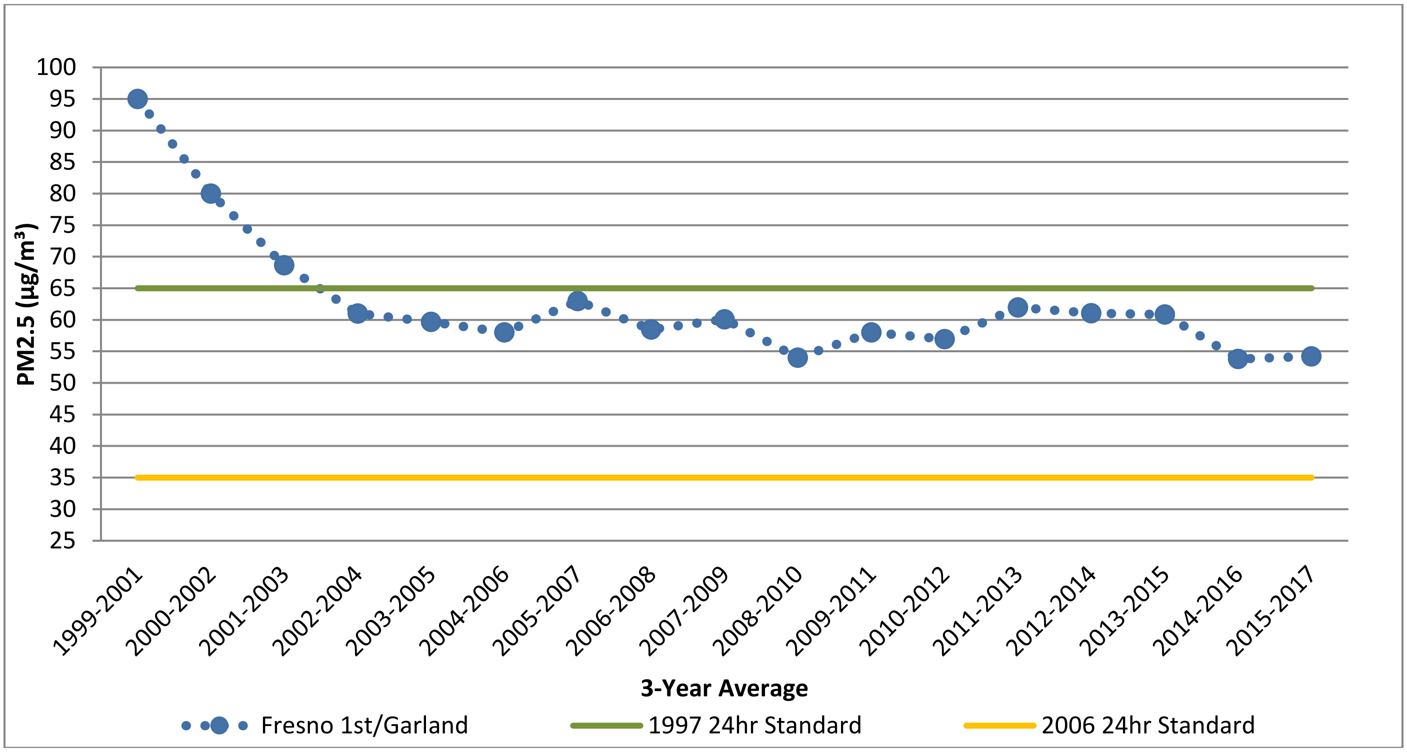


Figure A-12 Fresno County Annual Design Value Trend

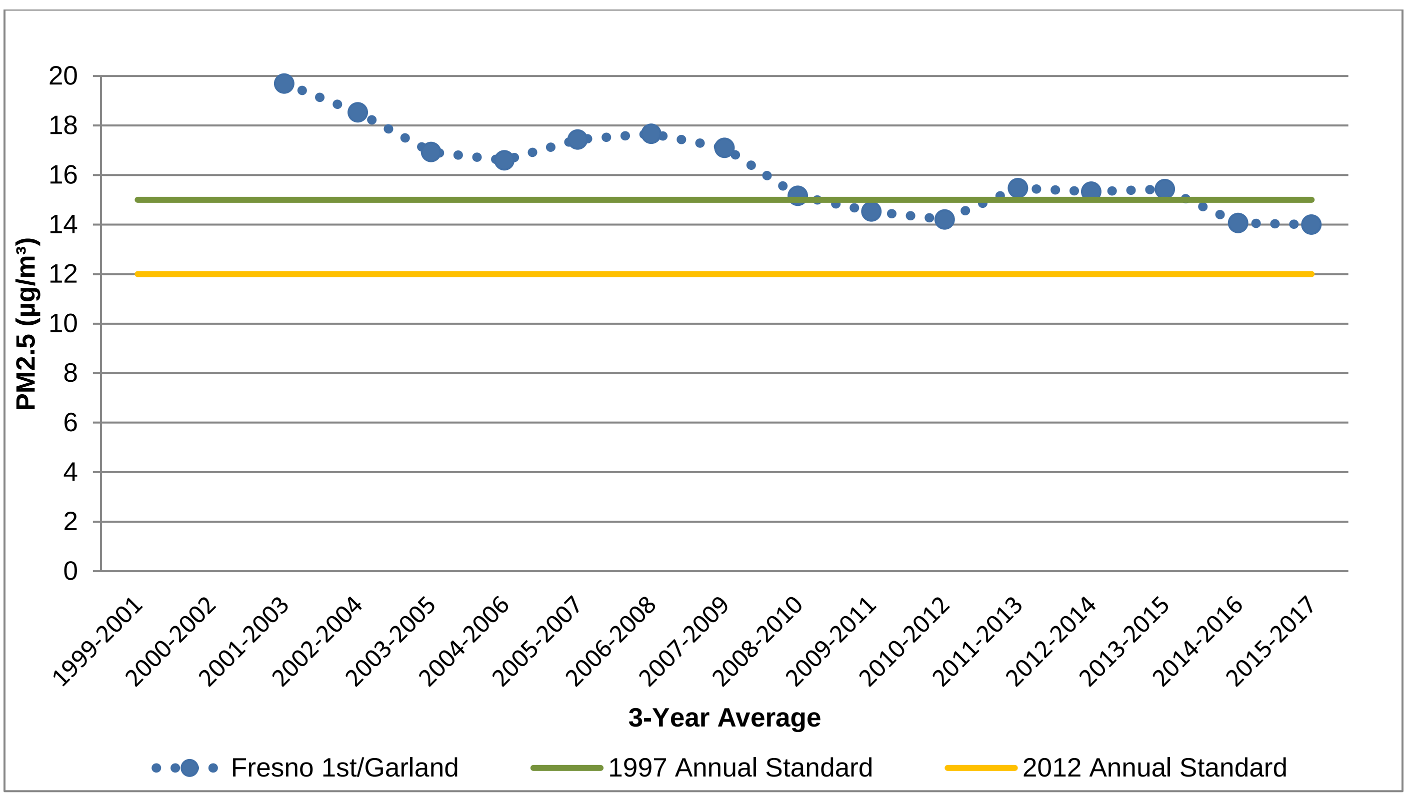


Figure A-13 Kings County 24-Hour Design Value Trend

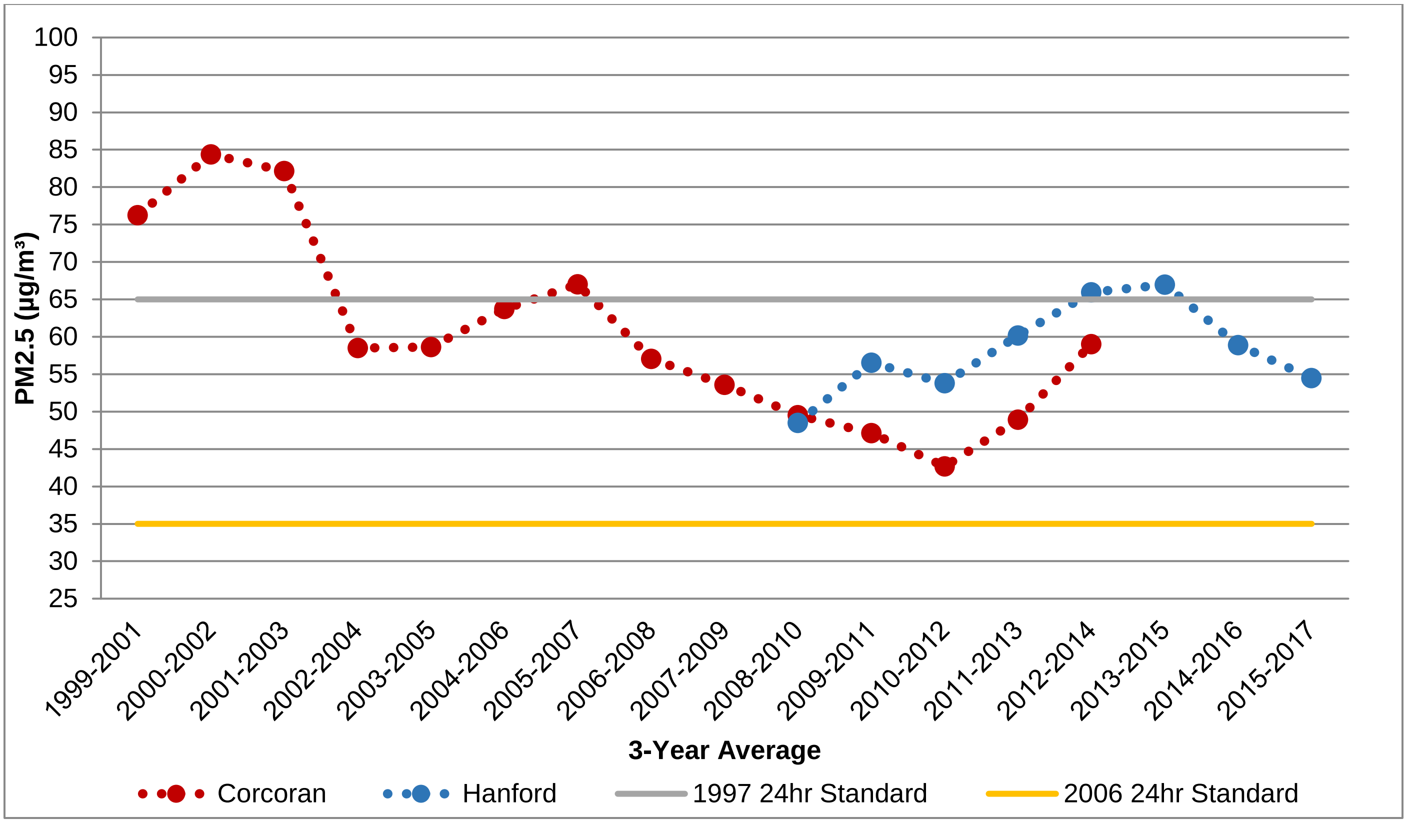


Figure A-14 Kings County Annual Design Value Trend

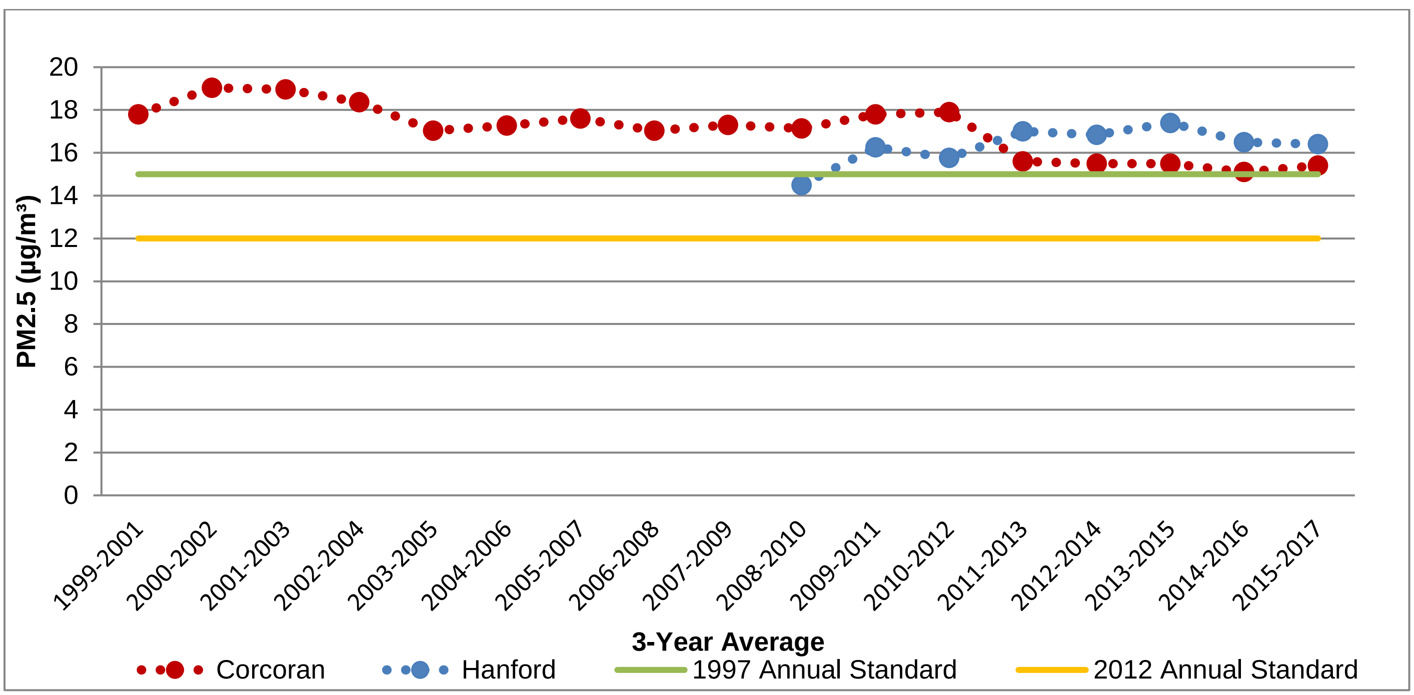


Figure A-15 Tulare County 24-Hour Design Value Trend

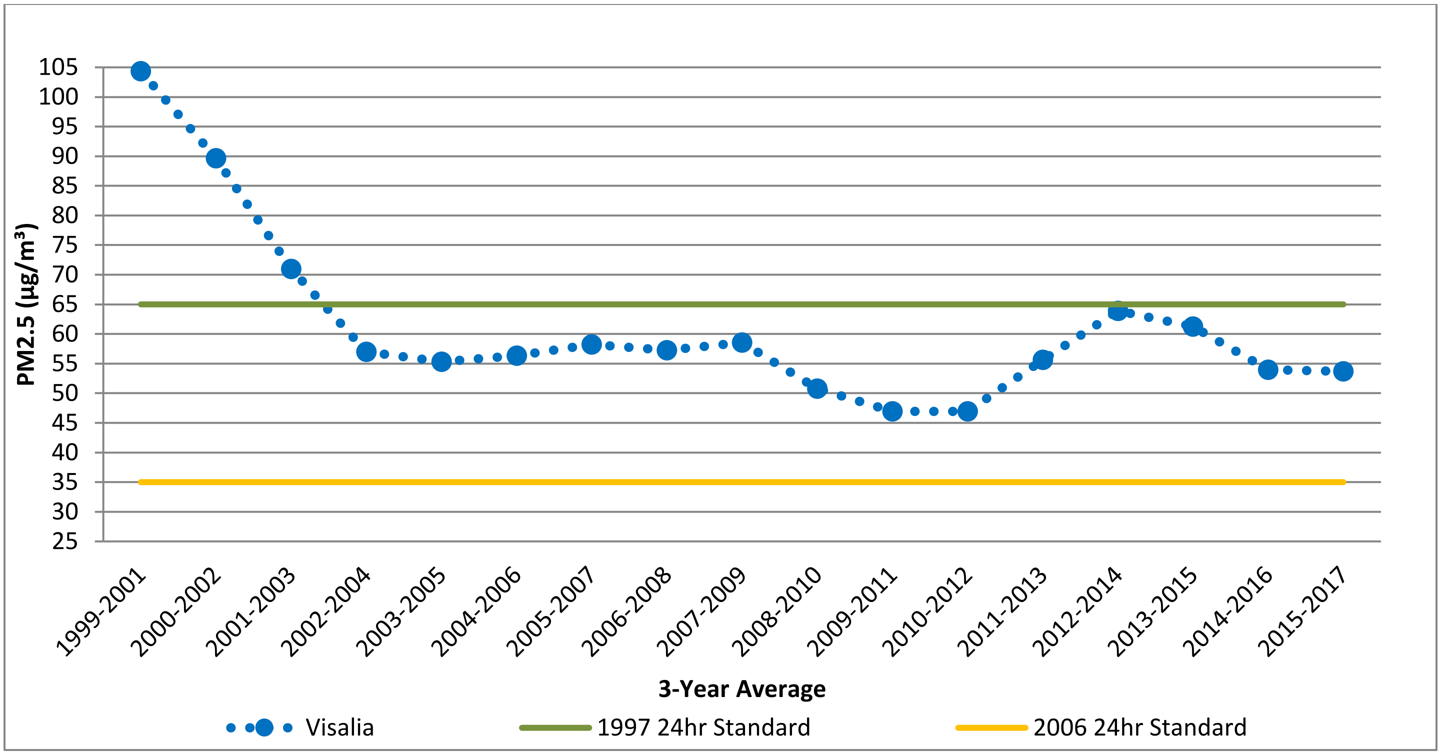


Figure A-16 Tulare County Annual Design Value Trend

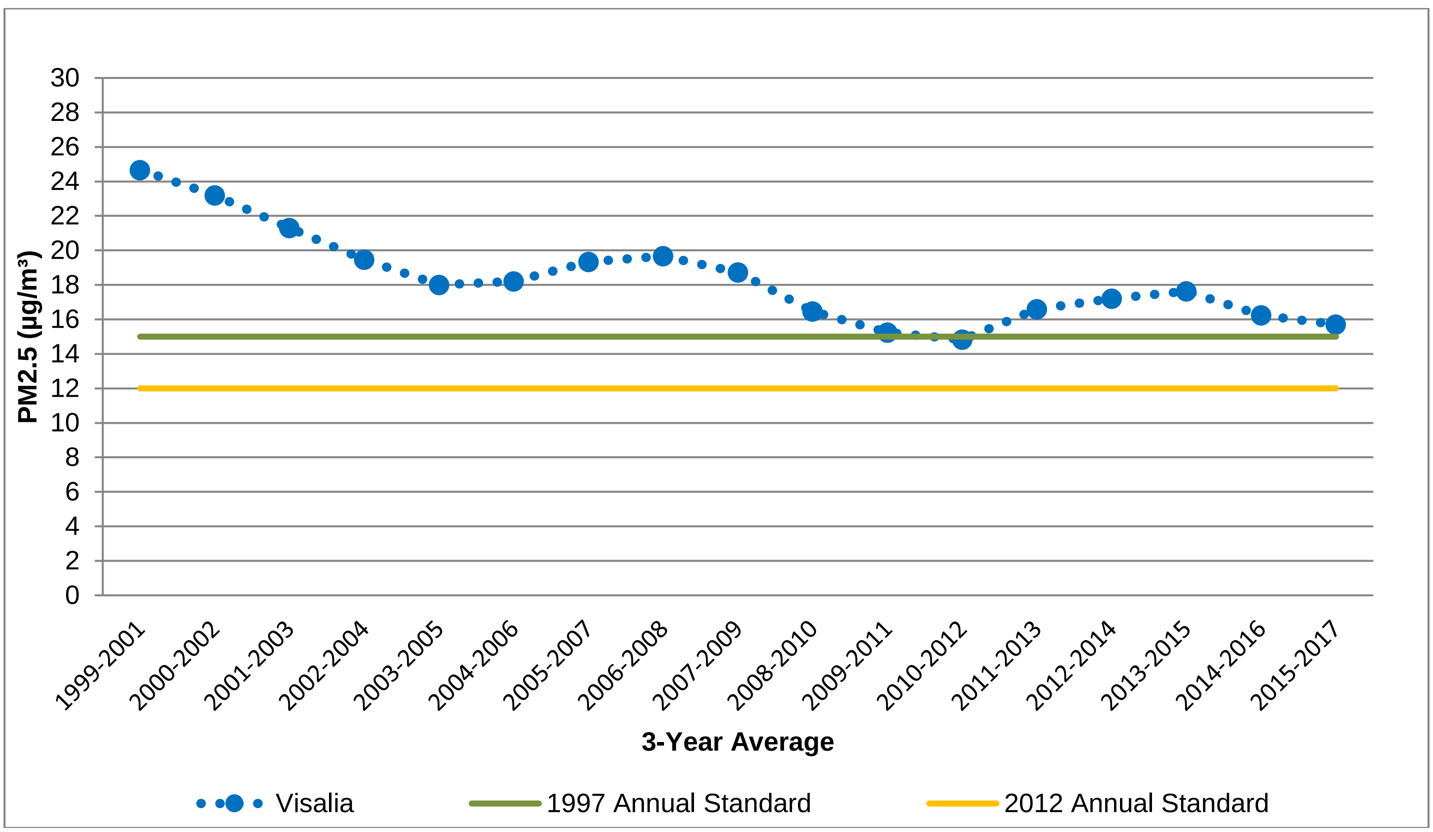


Figure A-17 Kern County 24-Hour Design Value Trend

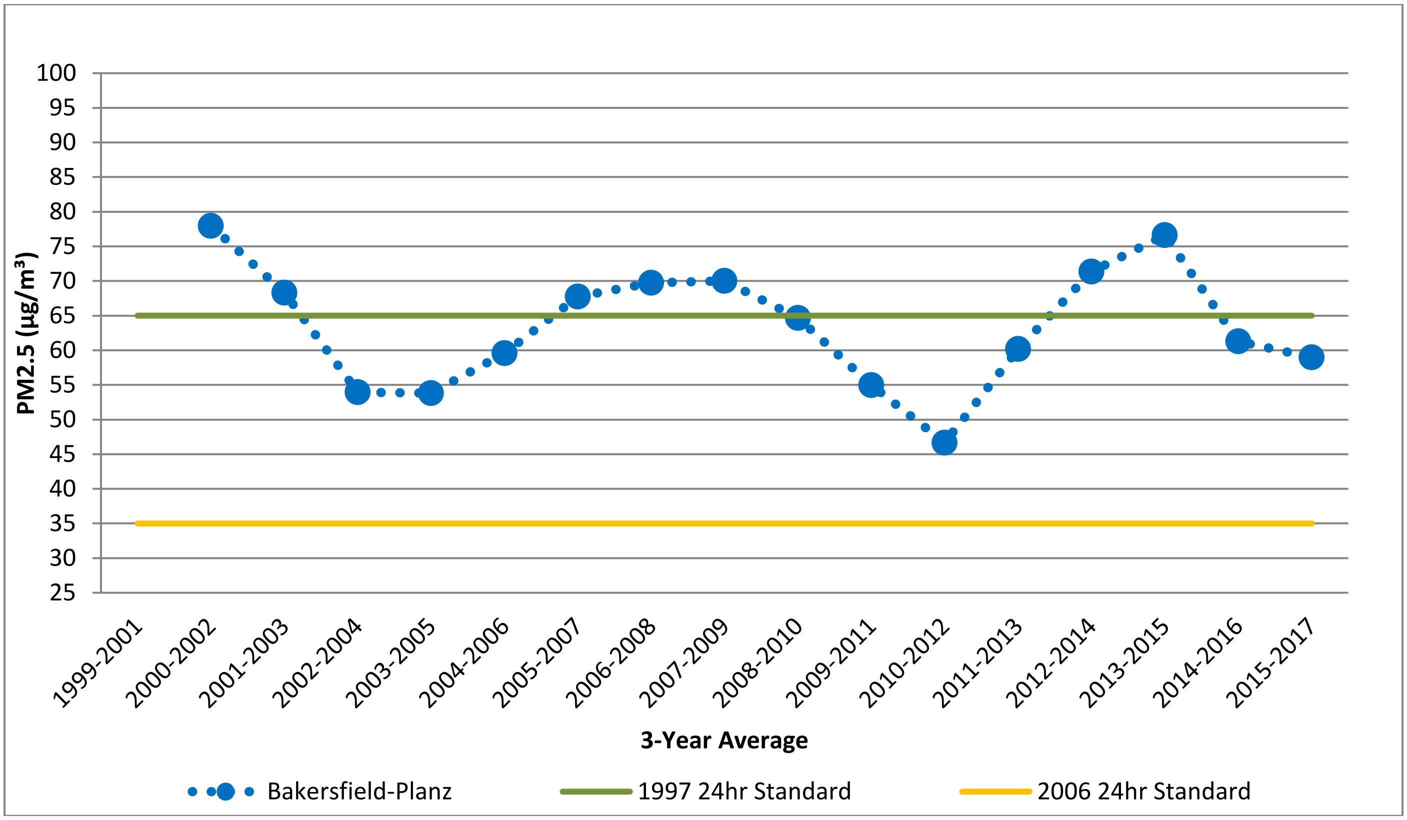
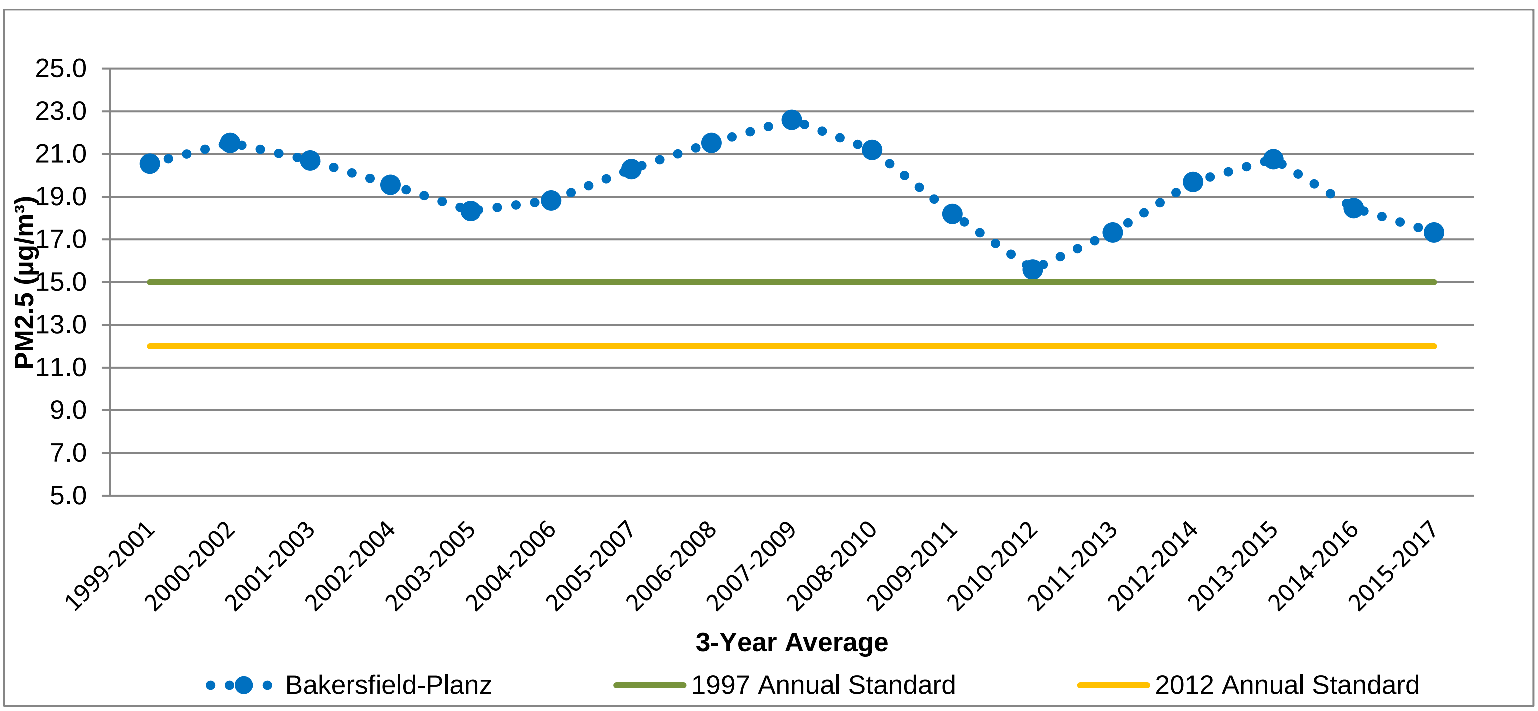


Figure A-18 Kern County Annual Design Value Trend



A.3 AMBIENT PM2.5 CONCENTRATION DATA TRENDS

Design values summarize data from a monitoring site with just two concentration values representing a three-year time period: an annual average and a value representing 24-hour peaks. These parameters are required for attainment demonstrations, but design values alone do not reveal the hourly, daily, weekly, seasonal, and regional PM2.5 effects on public health, nor do they track air quality improvements within such parameters. The District uses data from air monitoring sites to analyze air quality trends to provide a deeper understanding of changes in ambient PM2.5 concentrations as they relate to the implementation of District programs and to inform the attainment planning process and Health Risk Reduction Strategy.

A.3.1 DAYS OVER THE 24-HOUR PM2.5 STANDARD OF 65 UG/M³

The number of days over the 24-hour PM2.5 standard is another indicator of air quality progress.
Figure A-19 to Figure A-26 show the trend of the number of days above the 1997 24-hour PM2.5 standard of 65 µg/m^3 for select sites in each county within the District's jurisdiction. These counts have been estimated and normalized to account for the varying sampling schedules of the Valley's 1-in-6-day, 1-in-3-day, and daily PM2.5 monitors.

Design value calculations for the 24-hour standard use the 98th-percentile concentration value from each monitoring site (higher values in the 99th and 100th percentiles are not used to account for extreme outliers). Because of this, a region may experience a limited number of days over the standard, but still be considered in attainment.

As shown in
Figure A-19 to Figure A-26, the Valley has experienced a significant drop in the number of exceedances of the 65 µg/m³ standard since the turn of the last century (1999 and 2000). In 1999, approximately 105 exceedances of this standard occurred across the District. Comparing this to the 1 exceedance that occurred in 2016, this represents a 99% decrease in the number of violations throughout the District.

As these trends display, exceedances of the 1997 24-hour PM2.5 standard have become very rare in the Valley, despite some years influenced by drought or exceptionally poor dispersion conditions. This progress has brought the region into attainment of this portion of the standard. It is important note that the recent winter season of 2017-2018 was heavily influenced by wildfire emissions and long periods of poor dispersion conditions, both of which created conditions conducive for high concentrations of PM2.5 to form across the Valley.

Figure A-19 San Joaquin County - Days Over the 24-hour 65 µg/m³ Standard[8]

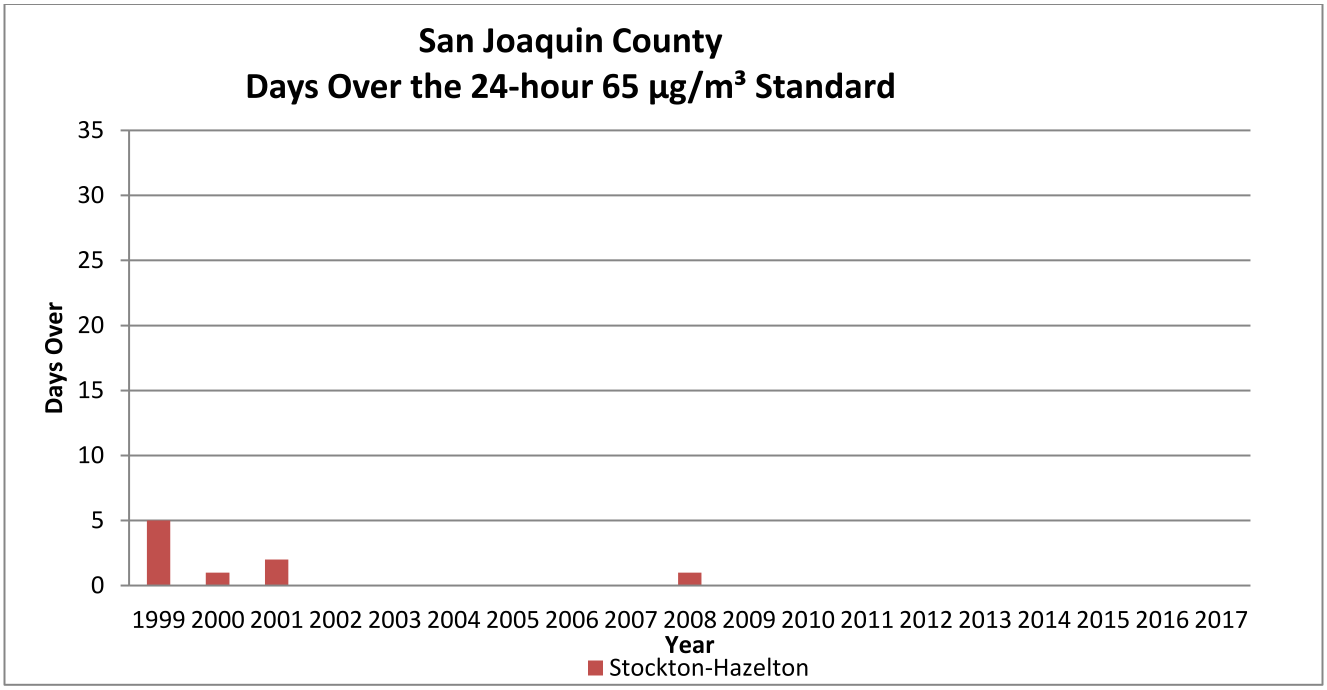
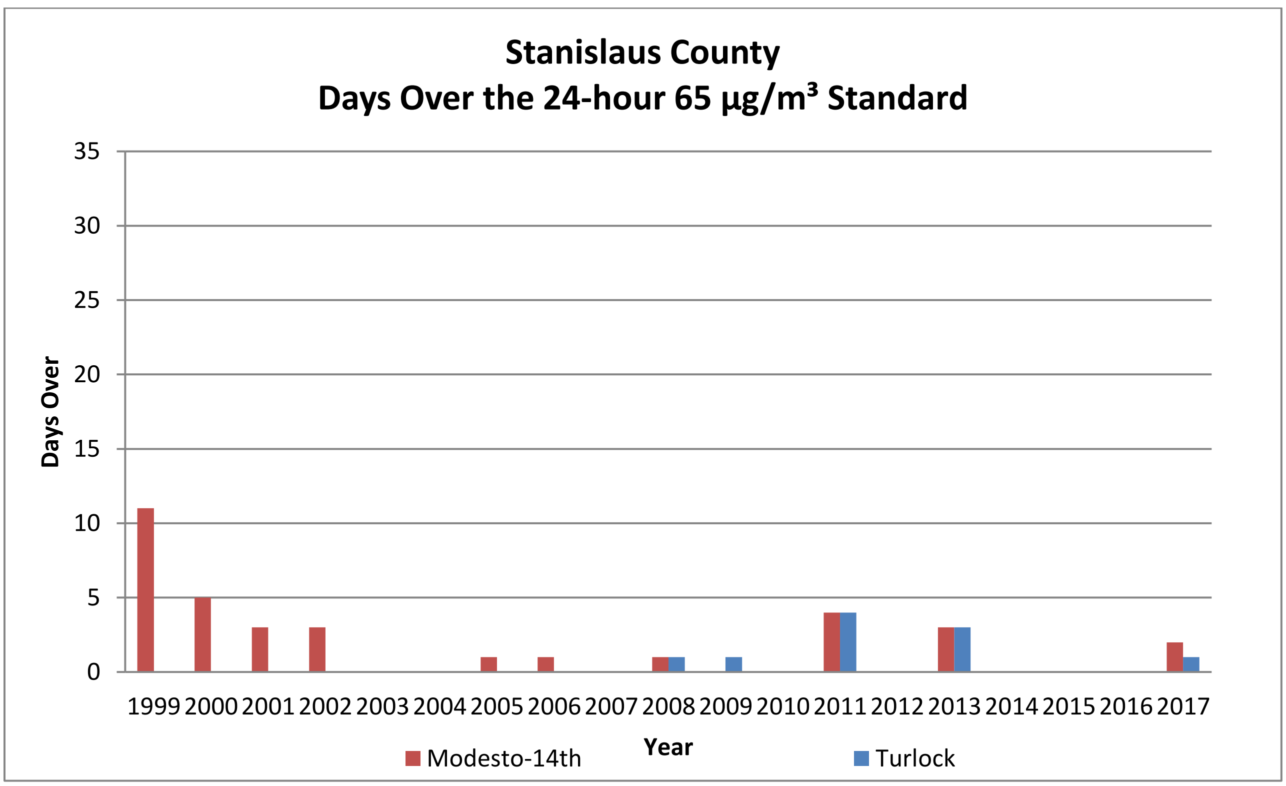
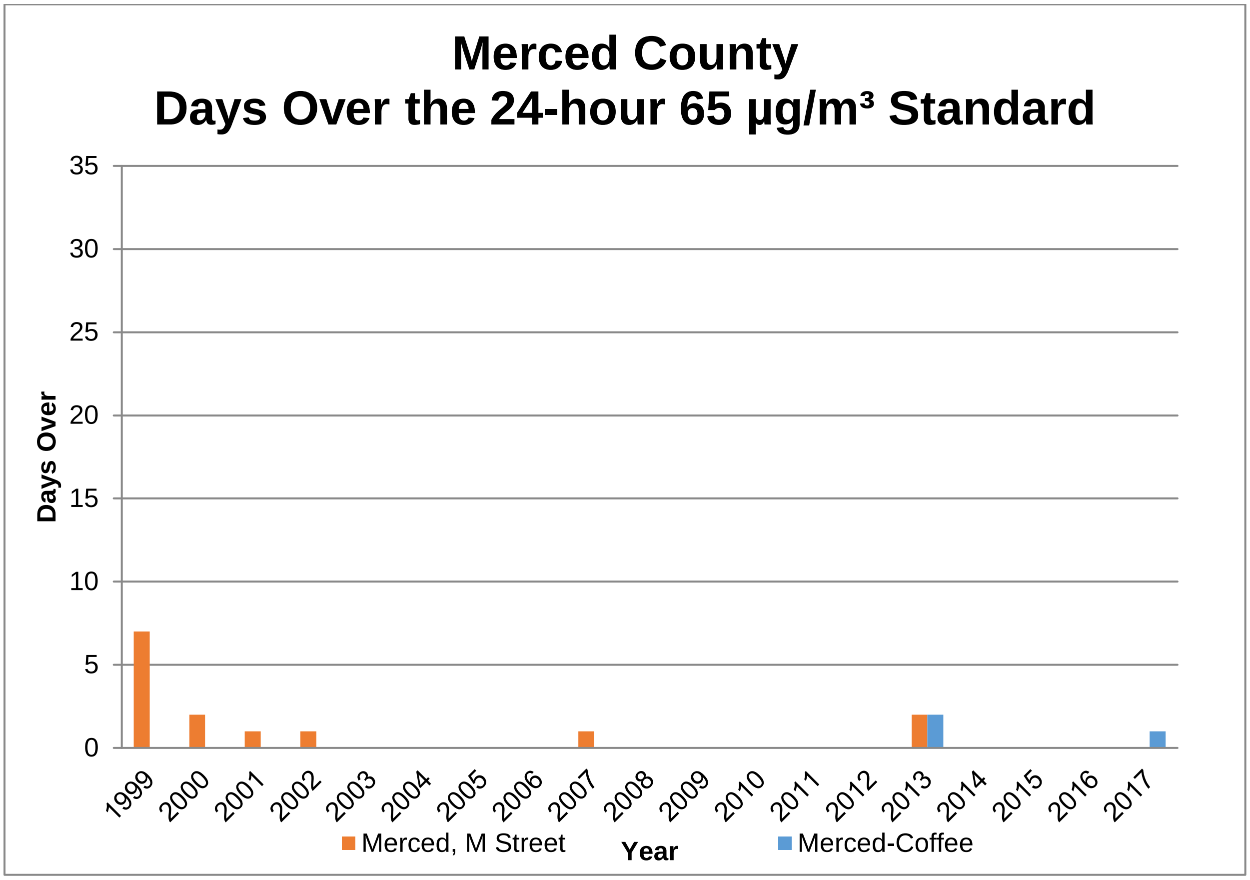


Figure A-20 Stanislaus County – Days Over the 24-hour 65 µg/m³ Standard[9]



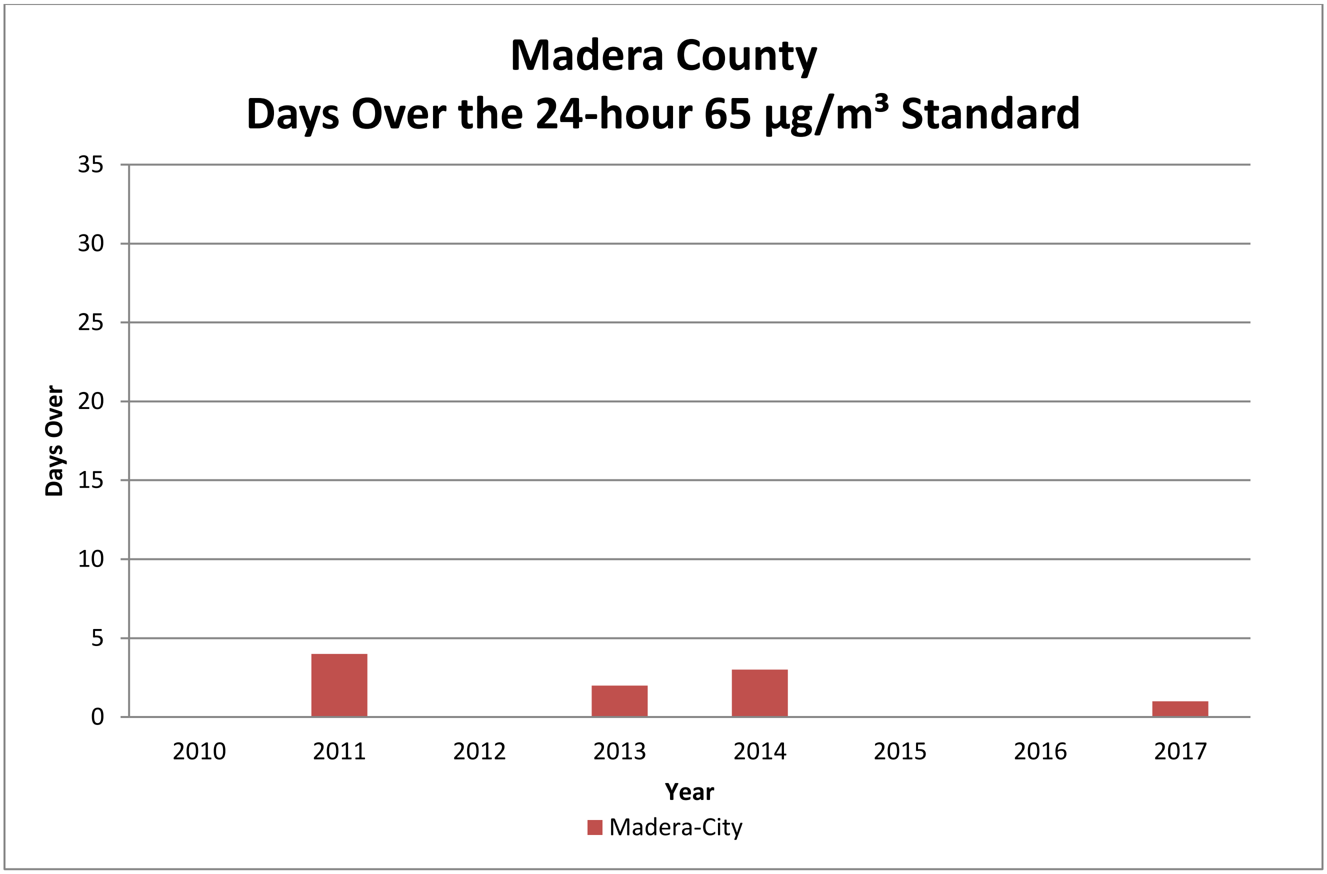
[8] Note: Years and sites with no data represent zero exceedances. 2017 data is preliminary.
[9] Note: Years and sites with no data represent zero exceedances. 2017 data is preliminary.

Figure A-21 Merced County - Days Over the 24-hour 65 µg/m³ Standard[10]



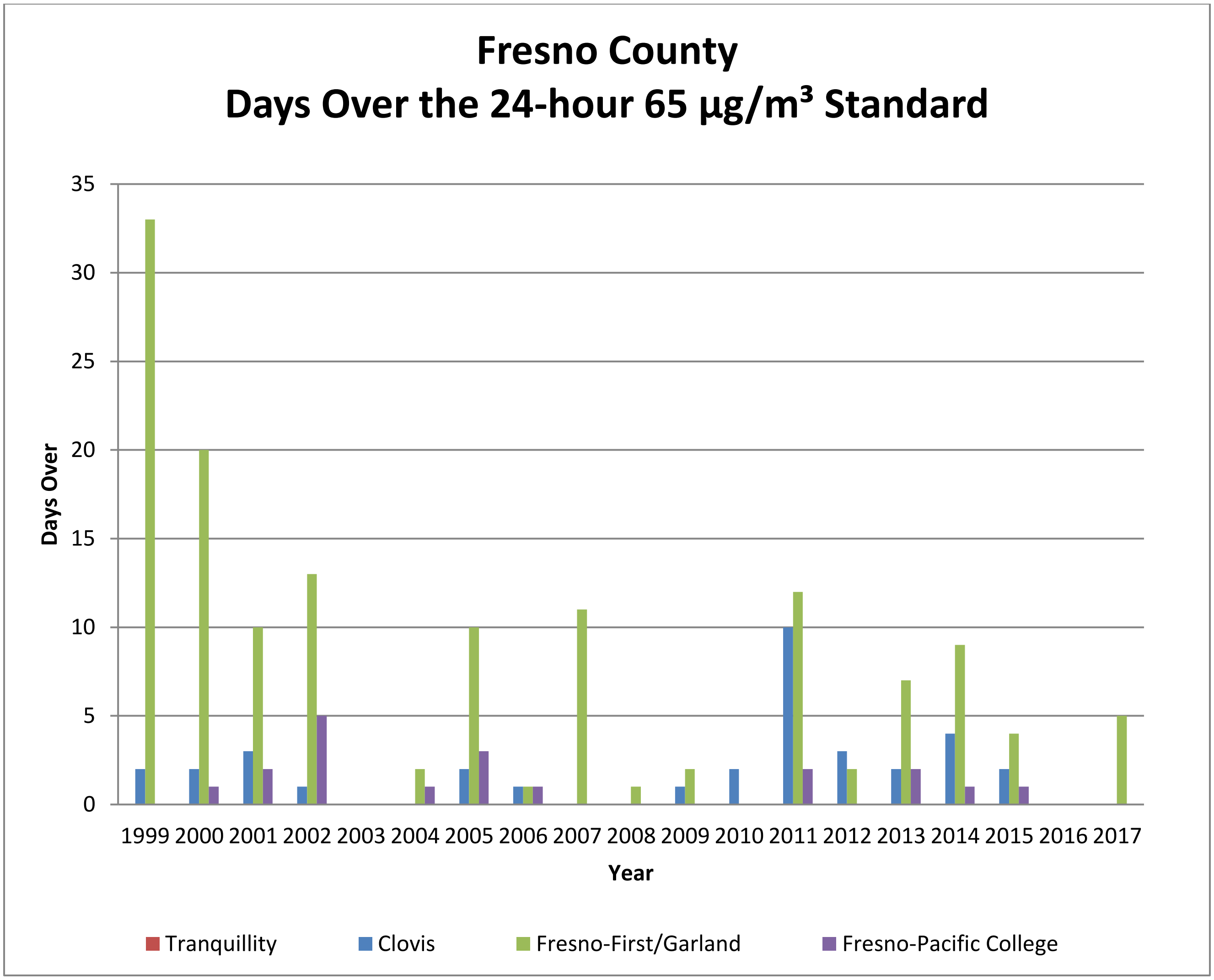
[10] Note: Years and sites with no data represent zero exceedances. 2017 data is preliminary

Figure A-22 Madera County[11] - Days Over the 24-hour 65 µg/m³ Standard[12]



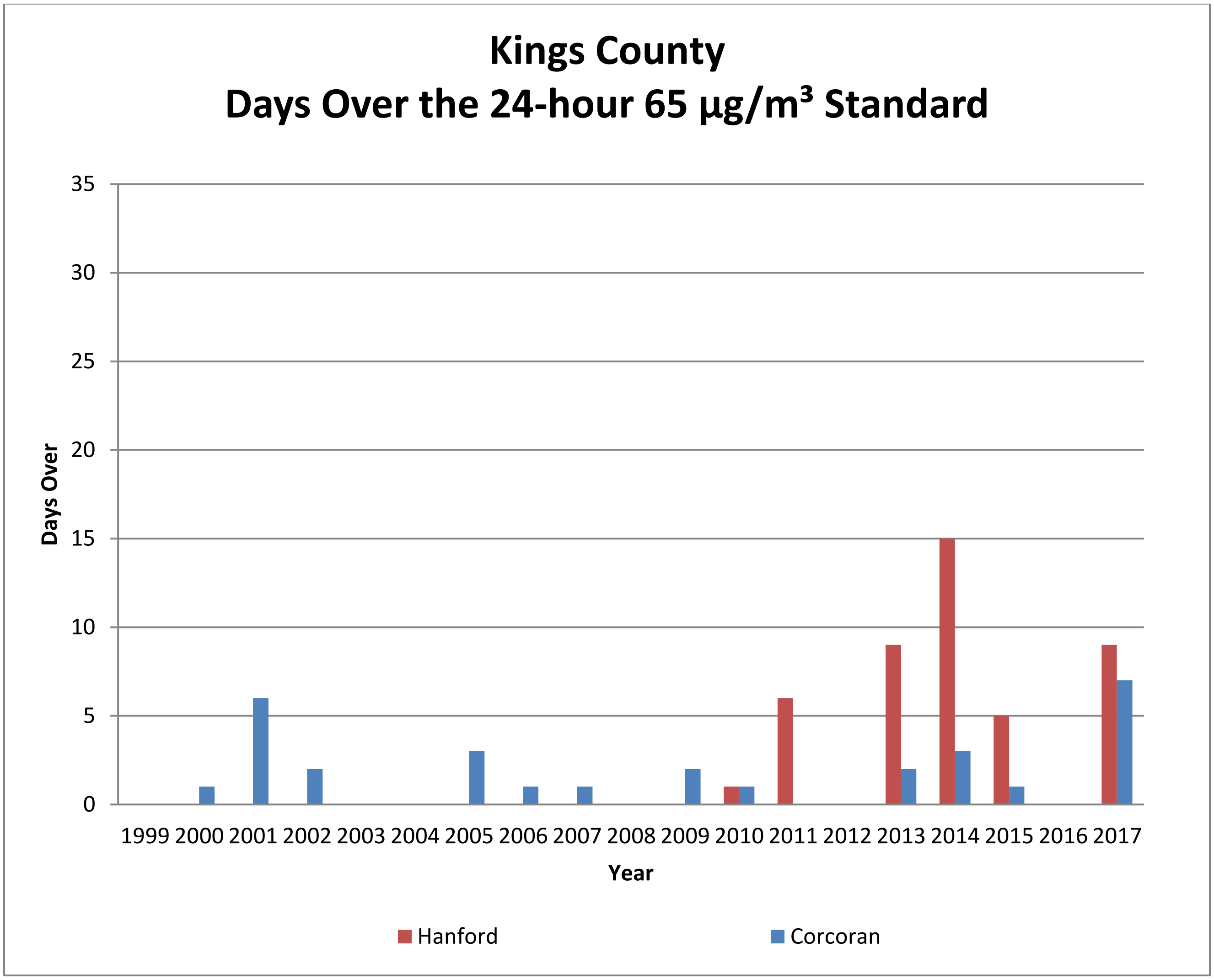
[11] PM2.5 monitoring in Madera began in 2010
[12] Note: Years and sites with no data represent zero exceedances. 2017 data is preliminary

Figure A-23 Fresno County - Days Over the 24-hour 65 µg/m³ Standard[13]



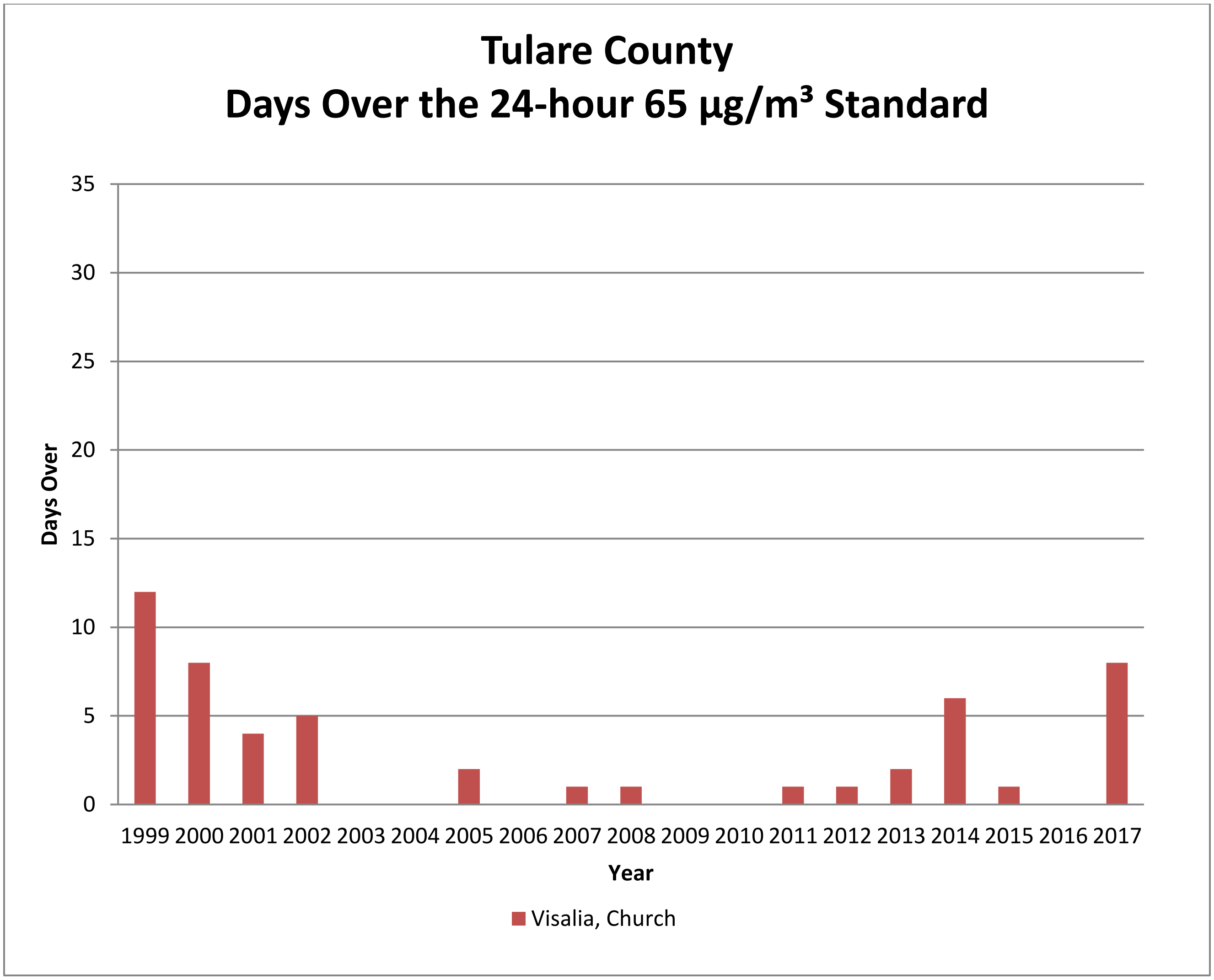
[13] Note: Years and sites with no data represent zero exceedances. 2017 data is preliminary.

Figure A-24 Kings County - Days Over the 24-hour 65 μg/m³ Standard[14]



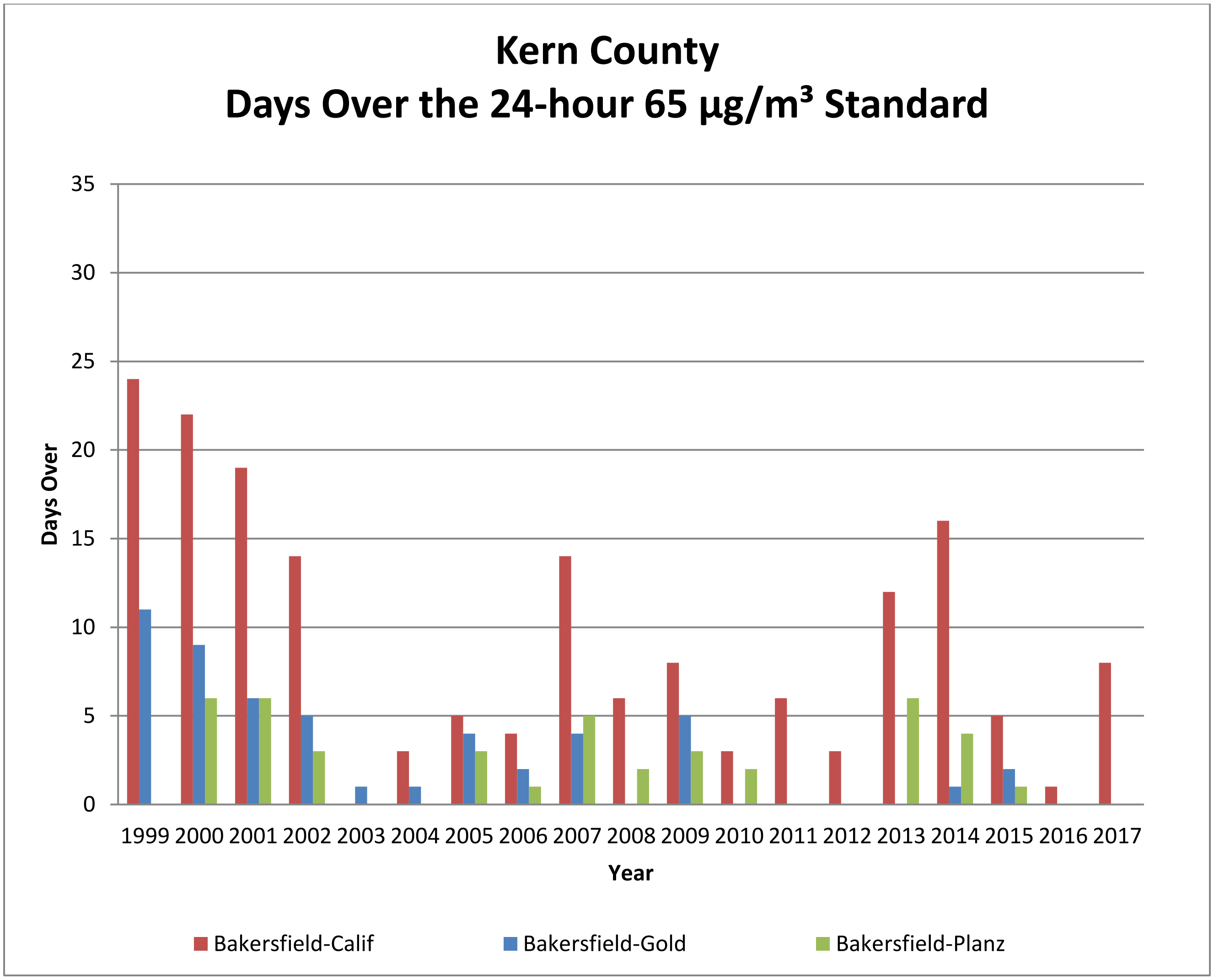
[14] Note: Years and sites with no data represent zero exceedances. 2017 data is preliminary.

Figure A-25 Tulare County - Days Over the 24-hour 65 µg/m³ Standard[15]



[15] Note: Years and sites with no data represent zero exceedances. 2017 data is preliminary

Figure A-26 Kern County - Days Over the 24-hour 65 µg/m³ Standard[16]



Trend in Days over the 2006 24-Hour PM2.5 Standard of 35 µg/m³ Figures A-27 to

Figure A-34 show the trend of exceedances of the 2006 24-hour PM2.5 standard of 35 µg/m³ at select sites in each county within the District's jurisdiction. These counts have been estimated and normalized to account for the varying sampling schedules of the Valley's 1-in-6-day, 1-in-3-day, and daily PM2.5 monitors.

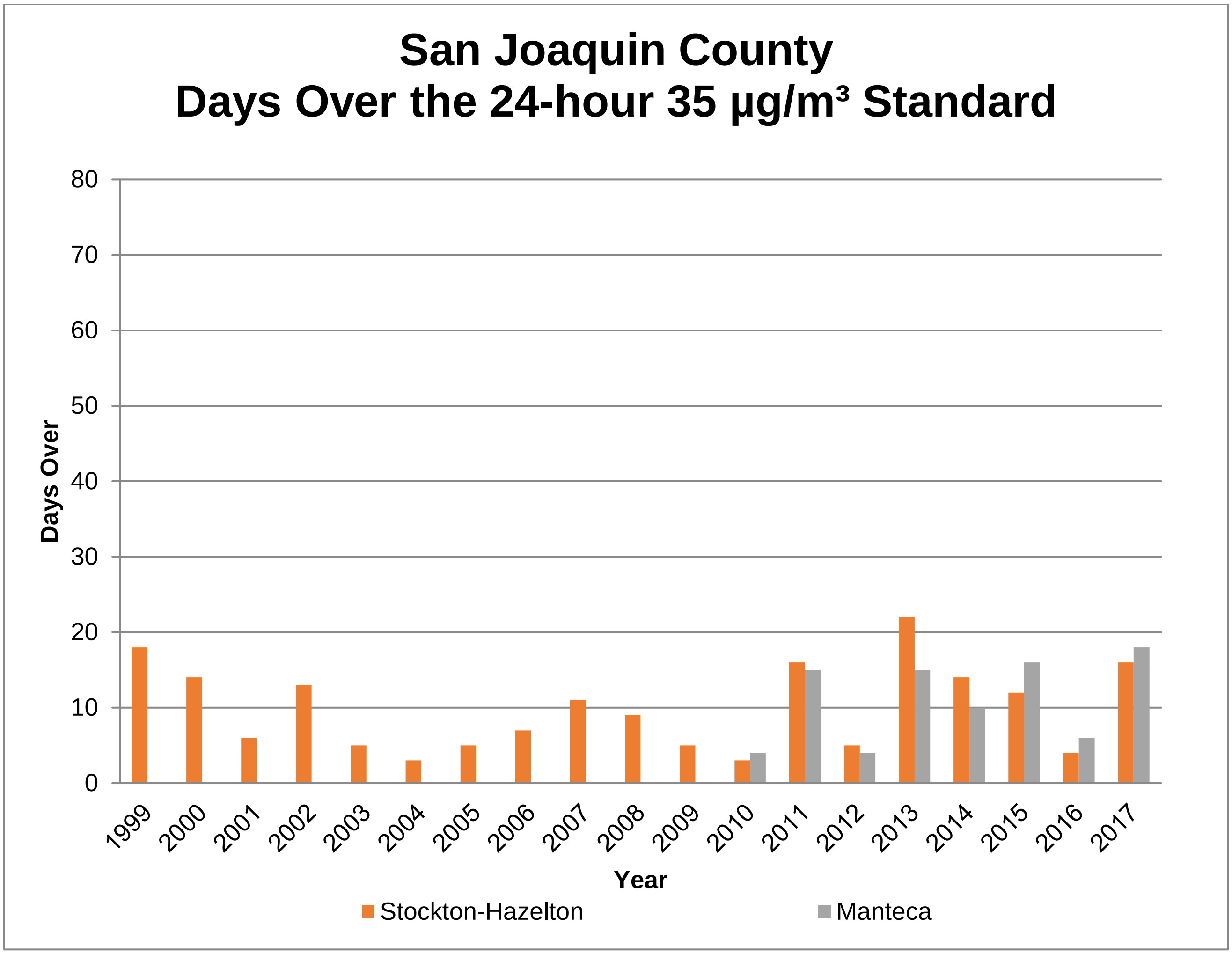
As shown in Figure A-27 to

Figure A-34, the Valley has experienced an overall decrease in the number of exceedances of the 35 µg/m³ standard since PM2.5 was monitored. During the height of drought years from 2013 to 2015, the valley saw an increase in days of

[16] Note: Years and sites with no data represent zero exceedances. 2017 data is preliminary

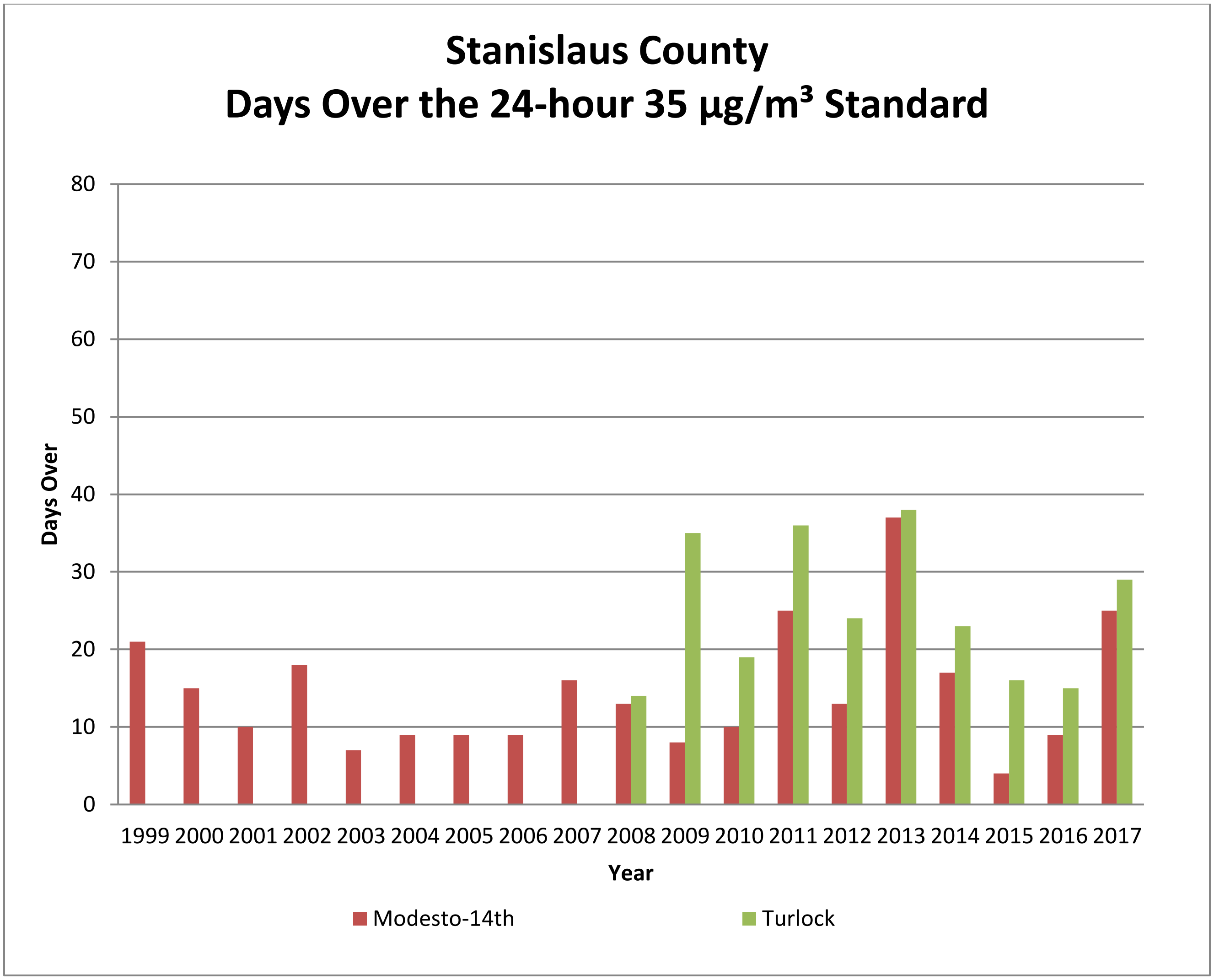
exceedances. In 1999, approximately 197 exceedances of this standard occurred across the District. Comparing this to the 77 exceedances that occurred in 2016 of the same stations that were operating in 1999, this represents a 61% decrease in the number of violations throughout the District despite the influence of the exceptional drought. It is important to note that the recent winter season of 2017-2018 was heavily influenced by wildfire emissions and long periods of poor dispersion conditions, both of which created conditions conducive for high concentrations of PM2.5 to form across the Valley.

Figure A-27 San Joaquin County - Days Over the 24-hour 35 µg/m³ Standard[17]



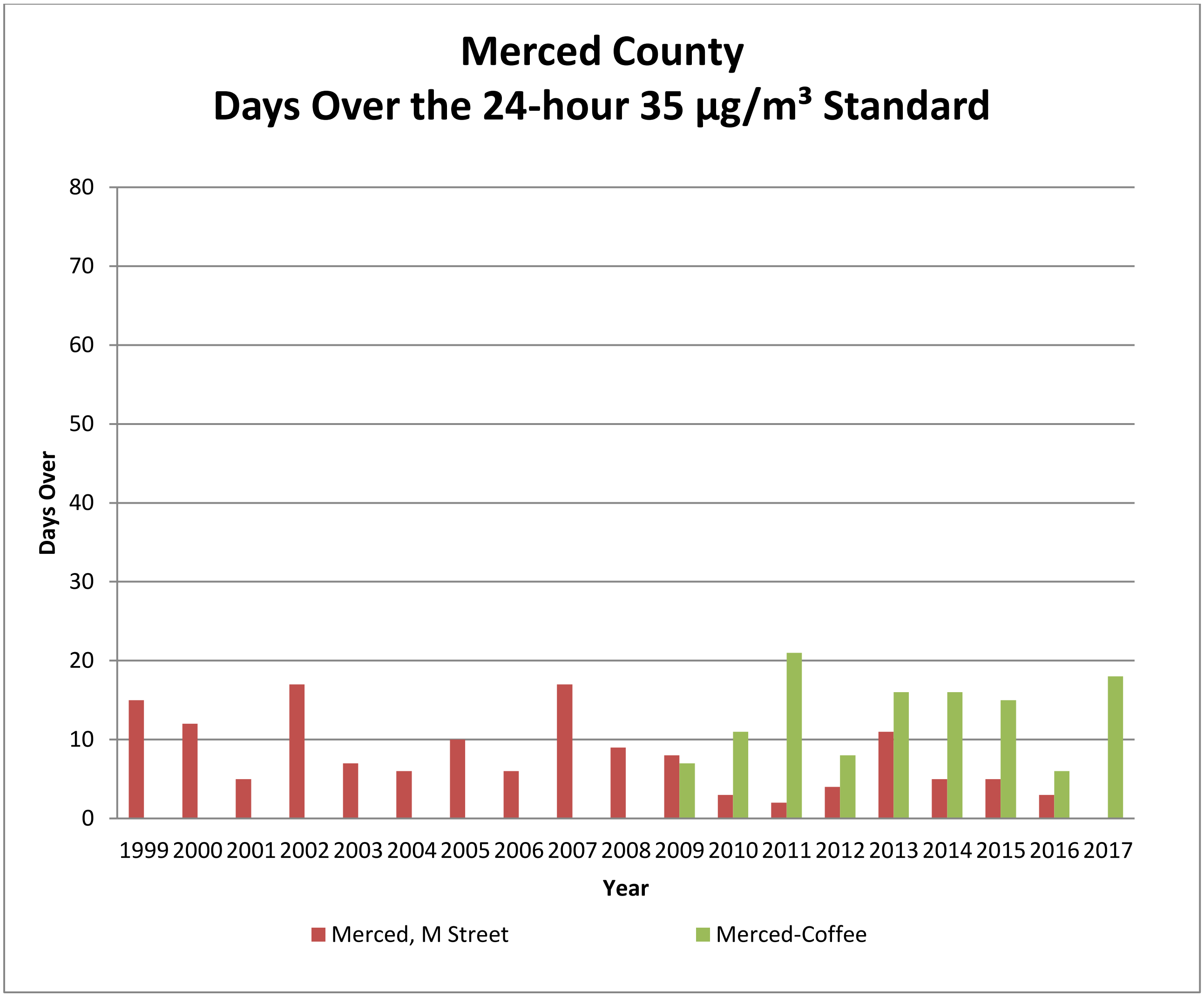
[17] Note: Years and sites with no data represent zero exceedances. 2017 data is preliminary.

Figure A-28 Stanislaus County - Days Over the 24-hour 35 µg/m³ Standard[18]



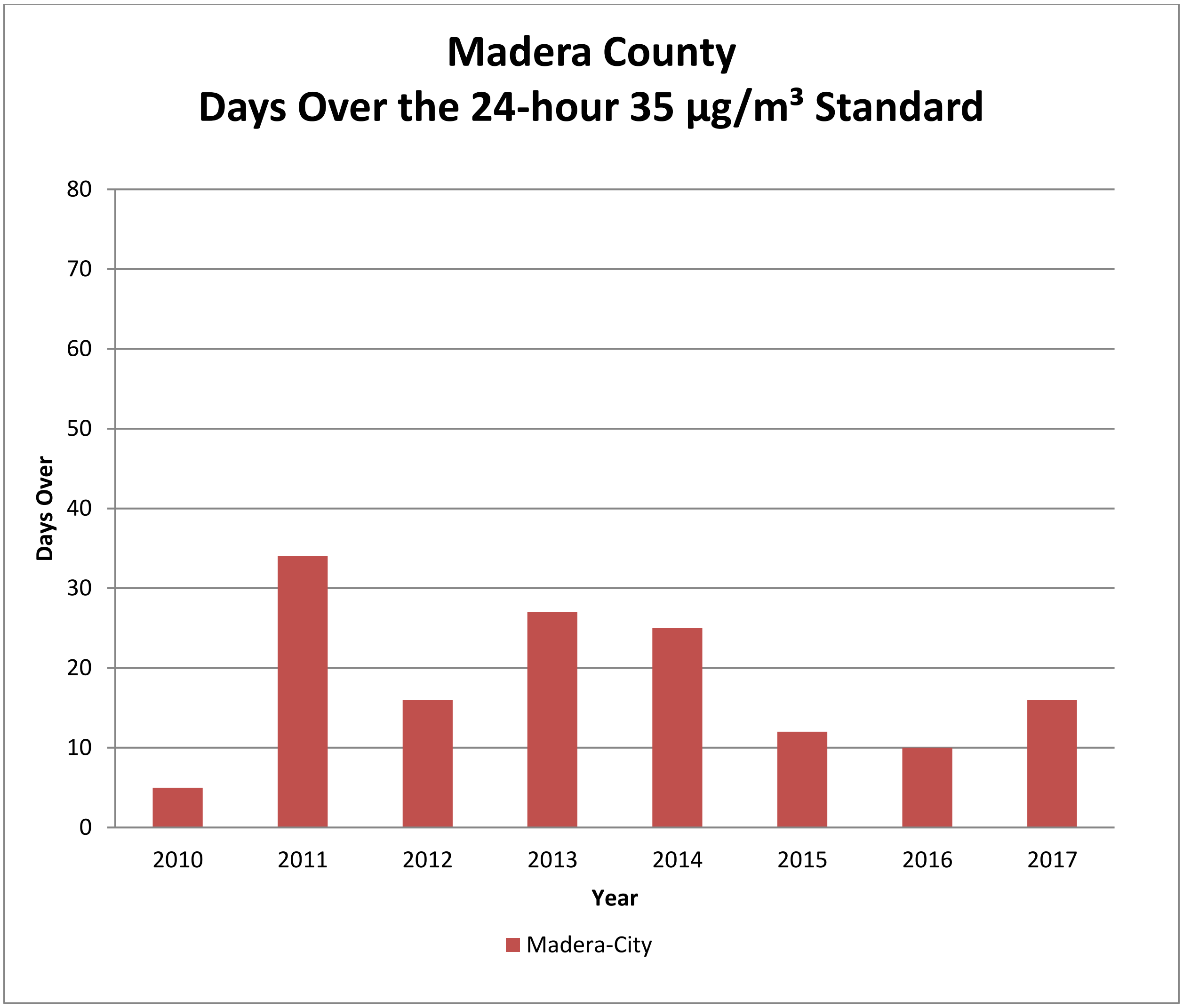
[18] Note: Years and sites with no data represent zero exceedances. 2017 data is preliminary

Figure A-29 Merced County - Days Over the 24-hour 35 µg/m³ Standard[19]



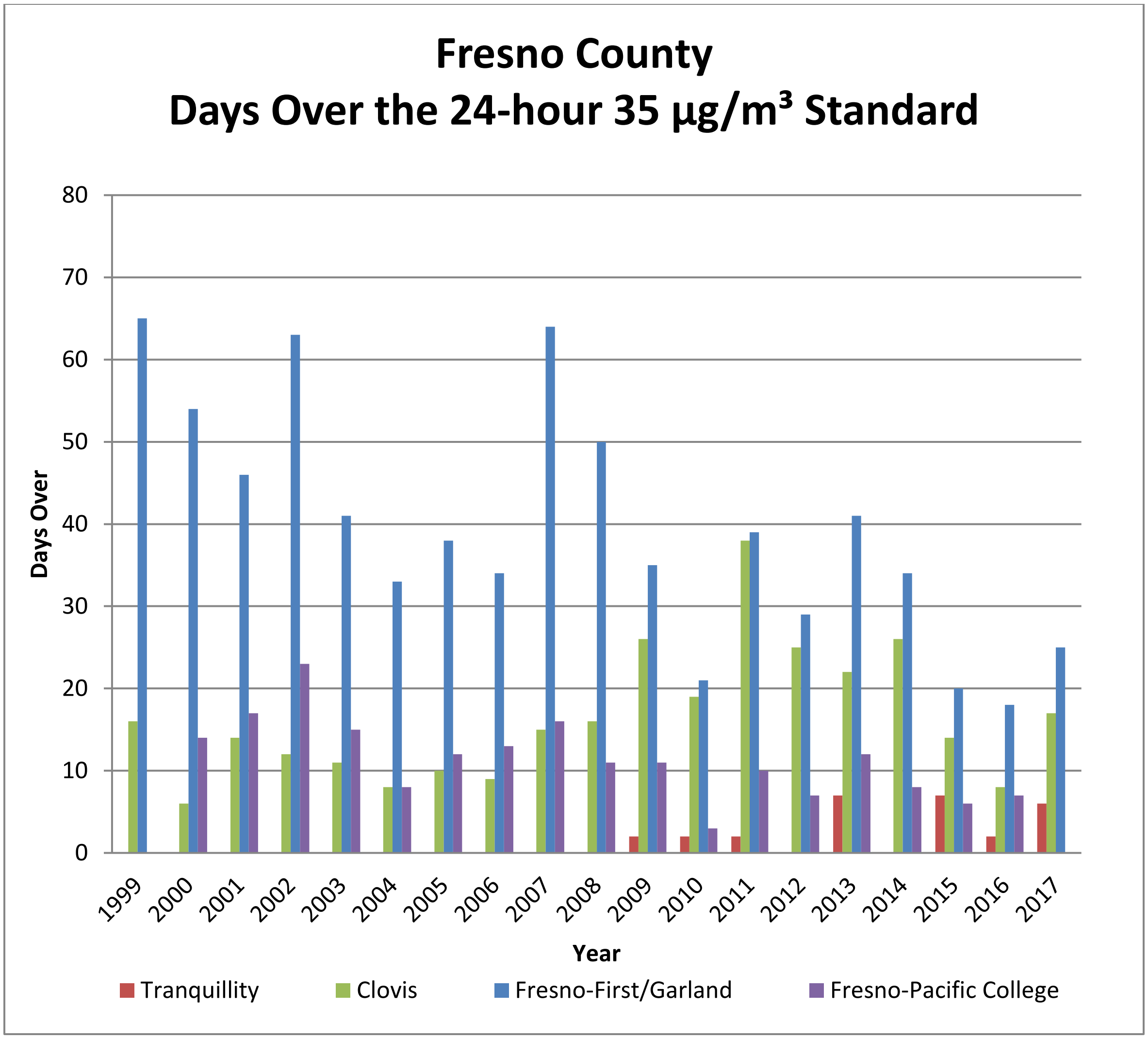
[19] Note: Years and sites with no data represent zero exceedances. 2017 data is preliminary

Figure A-30 Madera County[20] – Days Over the 24-hour 35µg/m³ Standard[21]



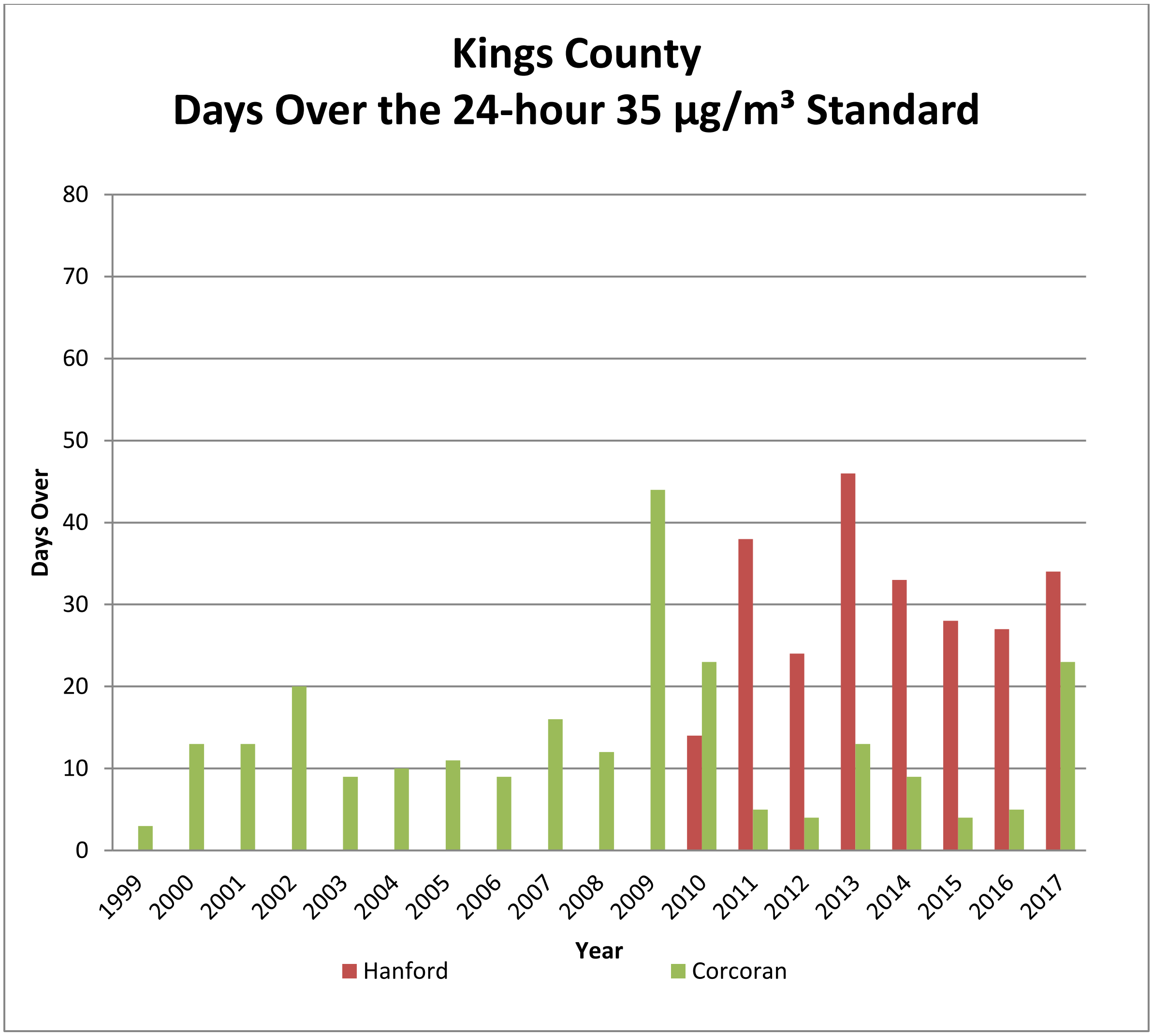
[20] PM2.5 monitoring in Madera began in 2010
[21] Note: Years and sites with no data represent zero exceedances. 2017 data is preliminary

Figure A-31 Fresno County - Days Over the 24-hour 35 µg/m³ Standard[22]



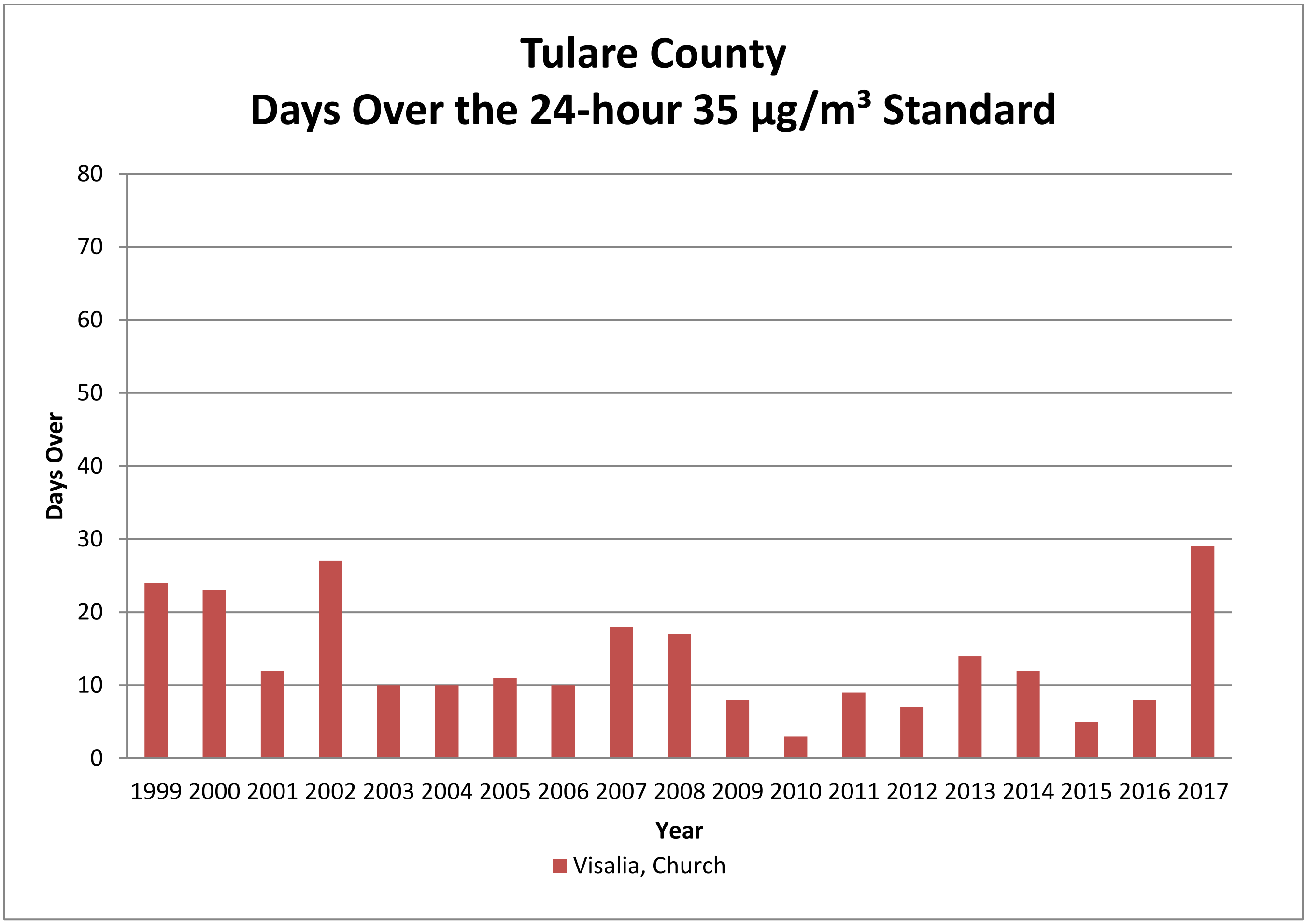
[22] Note: Years and sites with no data represent zero exceedances. 2017 data is preliminary

Figure A-32 Kings County - Days Over the 24-hour 35 µg/m³ Standard[23]



[23] Note: Years and sites with no data represent zero exceedances. 2017 data is preliminary

Figure A-33 Tulare County - Days Over the 24-hour 35 µg/m³ Standard[24]



[24] Note: Years and sites with no data represent zero exceedances. 2017 data is preliminary

Figure A-34 Kern County - Days Over the 24-hour 35 µg/m³ Standard[25]

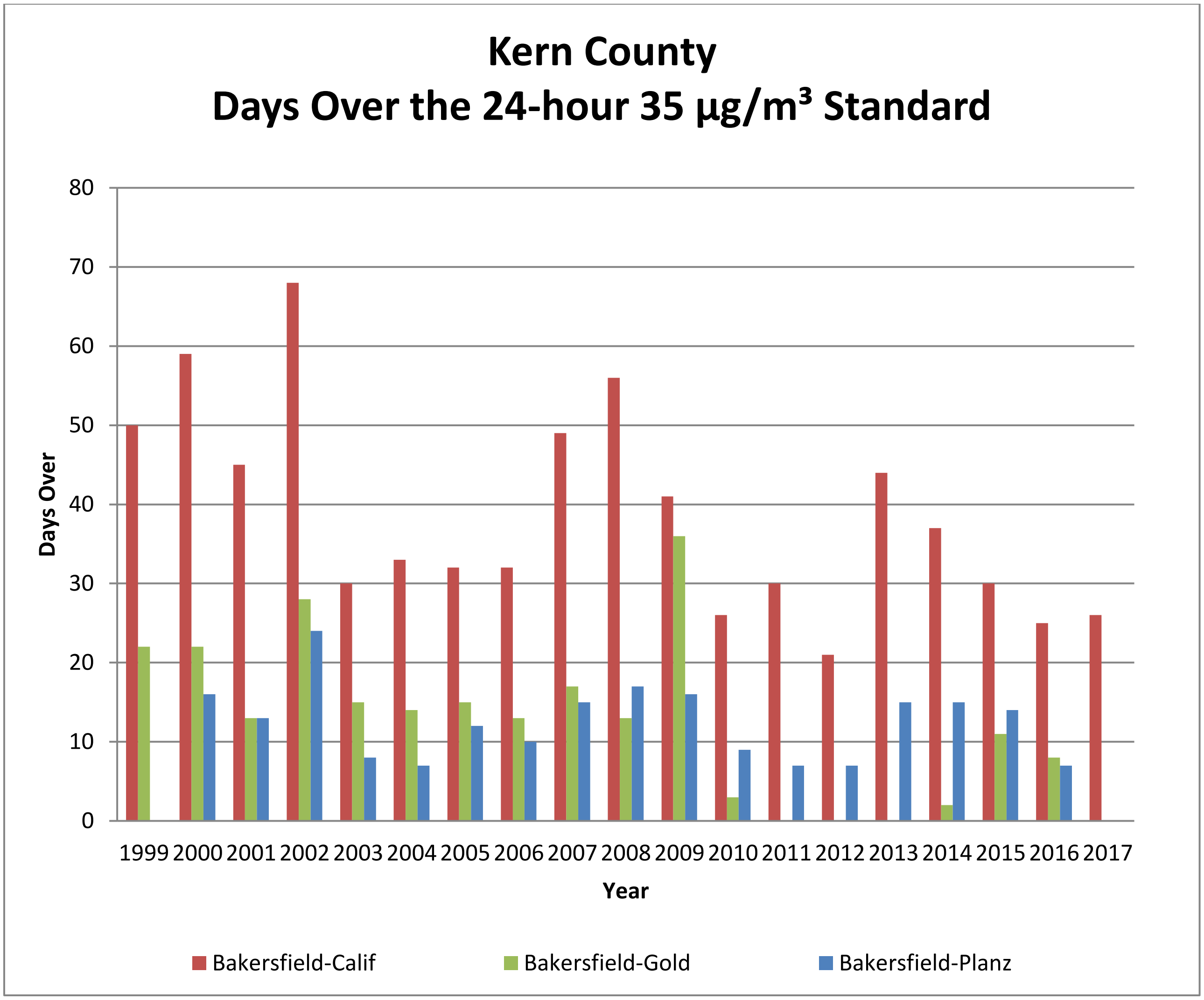


Table A-8 shows the number of days per month the Valley exceeded the 1997 24-hour PM2.5 standard of 65 µg/m³, and Table A-9 shows the number of days per month the Valley exceeded the 2006 24-hour PM2.5 standard of 35 µg/m³. The data are grouped by winter season instead of year, as to highlight the decrease in PM2.5 per season when concentrations are the highest in the year.

Starting in 2008, the District increased the number of real-time PM2.5 analyzers operating throughout its air monitoring network, allowing for more daily average samples being sampled instead of collecting samples every 3 or 6 days through filter-based methods. Through this change, the PM2.5 monitoring record is able to better demonstrate the day-to-day air quality trends throughout the Valley. As shown in Table A-8 and Table A-9, the Valley has shown a significant drop in the

[25] Note: Years and sites with no data represent zero exceedances. 2017 data is preliminary

number of exceedances of both the 65 and 35 µg/m³ standards, even with additional real-time analyzers added to the network.

In the 2000-2001 winter season, 42 days of exceedances of the 1997 24-hour PM2.5 standard occurred across the District. Comparing this to the 28 exceedances that occurred in the 2013-2014 period, this represents a 33% decrease in the number of violations throughout the District even with the addition of real-time monitors, and even with the exceptionally poor dispersion conditions that occurred during the 2013-2014 winter season. In recent years, exceedances of the 65 µg/m³ PM2.5 standard have become very rare. This difference demonstrates the progress that the District has made in improving the PM2.5 air quality throughout the Valley.

Additionally, the Valley has experienced a significant reduction in the number of days when the 2006 24-hour PM2.5 standard of 35 µg/m³ has been exceeded. As Table A-9 details, the 2002-2003 period recorded 90 days when this standard was exceeded somewhere in the Valley, while the 2017-2018 season recorded 62 exceedances, representing a 31% decrease in this metric.

As noted in section A.1.2, the 2011-2012 and 2013-2014 winter seasons had very stable atmospheric stagnation periods due to California's exceptional drought, which increased the District's PM2.5 concentrations. Despite the increase during the drought, the District has still experienced a downward trend in the number of exceedances of both the 65 µg/m³ and 35 µg/m³ standards compared to the beginning of PM2.5 measurements in the Valley during the 1999-2000 period, highlighting the efficacy of the Valley's attainment strategy.

Table A-8 Number of Days Valley Exceeded 65 µg/m³ PM2.5 Standard

Year	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
1999-00				2	12	19	7						***40***
2000-01					11	16	9	6					***42***
2001-02					12	1	4	10					***27***
2002-03					9	6							***15***
2003-04						1							***1***
2004-05					1	3							***4***
2005-06					5	11		3					***19***
2006-07					1	2	7	4					***14***
2007-08	2				6	5	2	3				2	***20***
2008-09					3	1	5						***9***
2009-10				2	1	4				1			***8***
2010-11	1					2							***3***
2011-12				1		13	5						***19***
2012-13							1	1			1		***3***
2013-14						13	13					2	***28***
2014-15					6		7						***13***
2015-16													***0***
2016-17						1							***11***
2017-18*					1	13	4						***18***

Note: Months with no data represent zero exceedances. 2018 data is preliminary.
*Winter of 2017-18 affected by smoke from wildfires, strong high pressure systems, and poor dispersion

Table A-9 Number of Days Valley Exceeded 35 µg/m³ PM2.5 Standard

Year	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
1999-00				12	22	26	19	3					***82***
2000-01				6	23	27	18	8	3				***85***
2001-02	1			4	18	15	25	17		1			***81***
2002-03		7		9	24	14	25	9	2				***90***
2003-04				4	14	9	18	5	5				***55***
2004-05	1			5	18	13	4	11	4				***56***
2005-06				4	15	15	13	12					***59***
2006-07			3	2	11	20	26	10					***72***
2007-08	2		2	5	22	13	13	11	2		1	8	***79***
2008-09	6		2	6	18	16	24	5					***77***
2009-10				8	14	22	11	7	1	1			***64***
2010-11	1		2	3	14	11	15	5				1	***52***
2011-12				8	10	28	22	3					***71***
2012-13					11	5	19	6	2		1		***44***
2013-14	5	3		3	15	26	28	3				3	***86***
2014-15	2			1	14	6	24	12	1	1			***61***
2015-16		3	3		6	8	6	9					***35***
2016-17			1		13	10	3	2	2		1		***32***
2017-18*	1		4	4	9	28	9	7					***62***

Note: Months with no data represent zero exceedances. 2018 data is preliminary.
*Winter of 2017-18 affected by strong high pressure systems, poor dispersion, and smoke from wildfires.

A.3.2 PM2.5 Driven Air Quality Index Analysis

The EPA and the District use the Air Quality Index (AQI) to provide daily information about the Valley's air quality, educate the public about how they can protect their health, and to inform the public about how unhealthy air may affect them. AQI scales exist for all of the criteria pollutants regulated by the Clean Air Act, including PM2.5. The current 24-hour average PM2.5 AQI scale is shown in Table A-10 below.

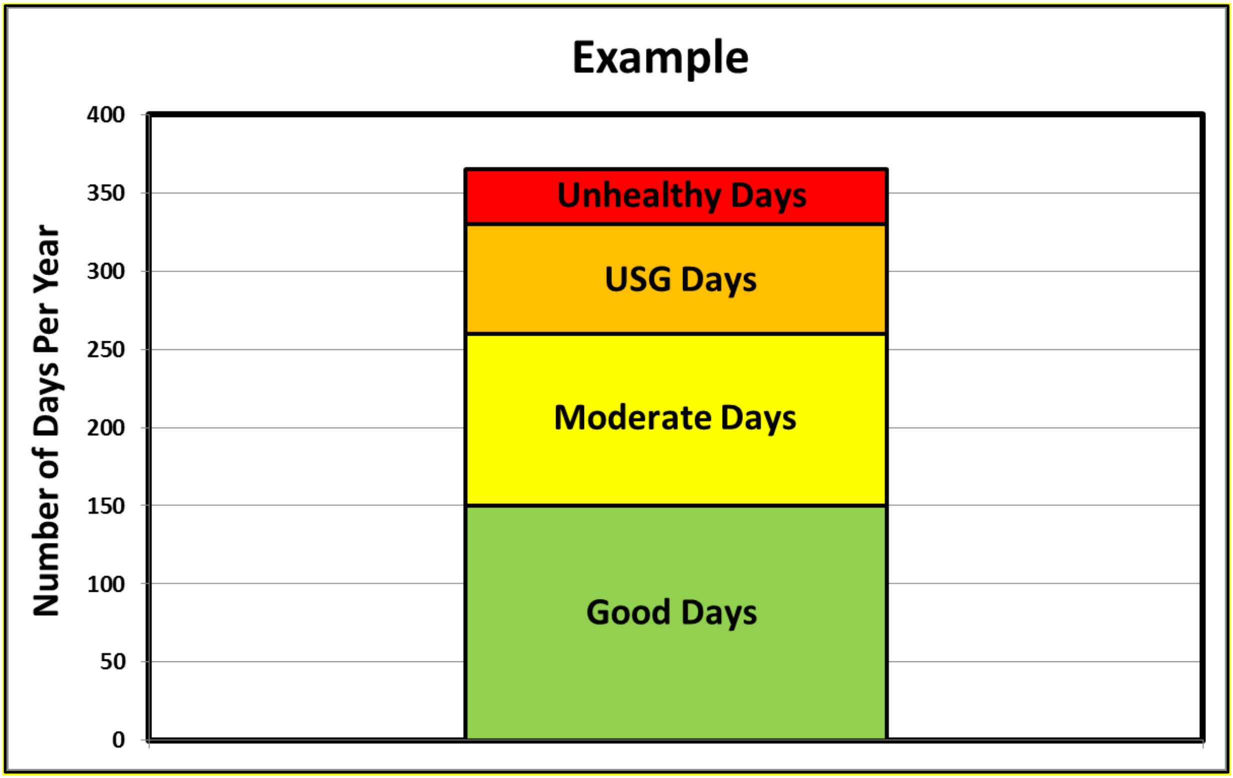
Table A-10 PM2.5 AQI Scale

AQI Category	Index Values	Concentration ($\mu g/m^3$, 24-hr average)
Good	0-50	0 – 12.0
Moderate	51-100	12.1 – 35.4
Unhealthy for Sensitive Groups (USG)	101-150	35.5 - 55.4
Unhealthy	151-200	55.5 - 150.4
Very Unhealthy	201-300	150.5 - 250.4
Hazardous	301+	250.5+

The District analyzed the trends in the PM2.5 data from the sites with at least two years of daily AQI observations based on real-time data. For this analysis, the AQI trends are based upon PM2.5 concentrations only, and do not include ozone, PM10, or other pollutants. By excluding the other pollutants, the District is able to isolate the change in air quality trends related to PM2.5 only.

Figure A-35 is shown as a reference for interpreting the AQI trends shown in Figure A-36 through Figure A-44. The stacked bars represent the number of days within each year that fell within each of the AQI categories (totaling 365 days). Because of regular maintenance or repairs, monitors may be non-operational for a day or longer. For years with “missing” days, proportional adjustments were made to estimate the missing days to provide a full year’s data to display. Within each stacked bar, the categories are ordered as Good, Moderate, etc. from the bottom up.

Figure A-35 Air Quality Index (AQI) Categories



For the majority of the Valley sites, the observed PM2.5 AQI data for the 2008-2016 timeframe shows an improvement in PM2.5 air quality. Over these 8 years, the frequency of Good AQI days increased, coupled with a decrease in the frequency of the Moderate, Unhealthy-for-Sensitive-Groups (USG), and Unhealthy AQI days. For example, at the Fresno-First /Garland site (see Figure A-40), the number of Good days increased from 190 in 2008, to 229 in 2017. At the same time, the Moderate and USG and higher AQI days decreased from 124 to 109, and 51 to 27, respectively.

A similar pattern occurred at other sites with the frequency of Good AQI days increasing and the frequency of the Moderate and USG AQI days decreasing. For example, at the Bakersfield-California site (see Figure A-44), the number of Good days increased from 112 in 2008 to 185 in 2017. At the same time, the Moderate and USG AQI days decreased from 189 to 152, and 65 to 28, respectively.

In Figure A-36 to Figure A-44, the data for each site was averaged for each year. Visual analysis of these figures, which are arranged from north to south, shows that the northern sites have more Good AQI days than the southern sites. For example, Stockton-Hazelton averaged nearly 66% Good AQI days, about 25 more percentage points in the Good AQI category than the Visalia and Bakersfield sites, which averaged around 41% Good AQI. Analysis of Figure A-36 to Figure A-44 demonstrates that the dominant annual PM2.5 AQI categories are the Good and Moderate across the Valley.

As noted above, over recent winter seasons, a persistent and strong high-pressure ridge over the eastern Pacific Ocean and the western United States effectively blocked weather disturbances from entering California that would normally have removed and replenishment of the valley's air with clean air. The historic strength and longevity of this high pressure resulted in a lack of rainfall and stagnation conditions leading to a subsequent increase in the suspended particulate matter in the atmosphere. In addition, the Valley was also impacted by multiple wildfires significantly elevating PM2.5 concentrations. This caused the exceptionally high PM2.5 concentrations found in the Valley and throughout the state of California. Despite these conditions, air quality has improved over the entire period of PM2.5 monitoring in the Valley, as this analysis indicates.

Figure A-36 Stockton-Hazelton PM2.5 AQI Trend

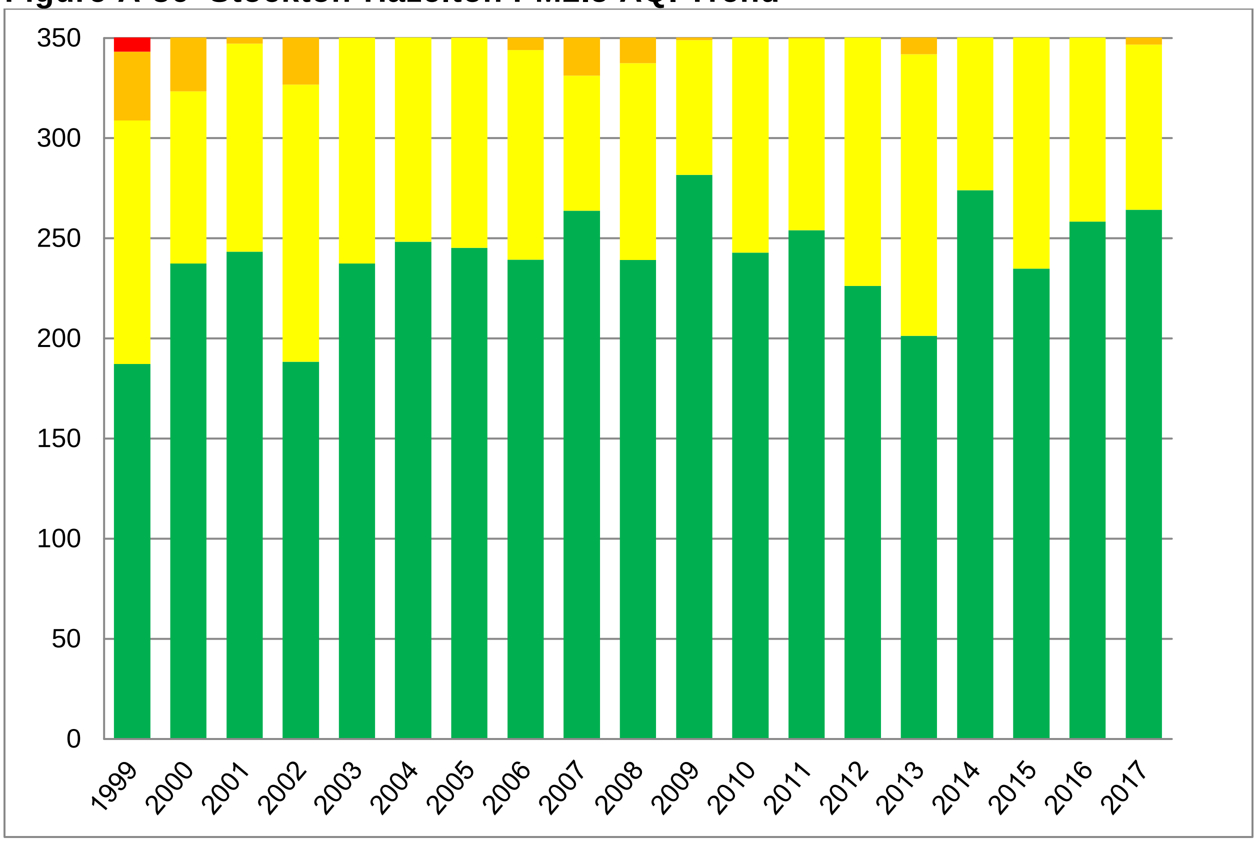


Figure A-37 Modesto-14th Street PM2.5 AQI Trend

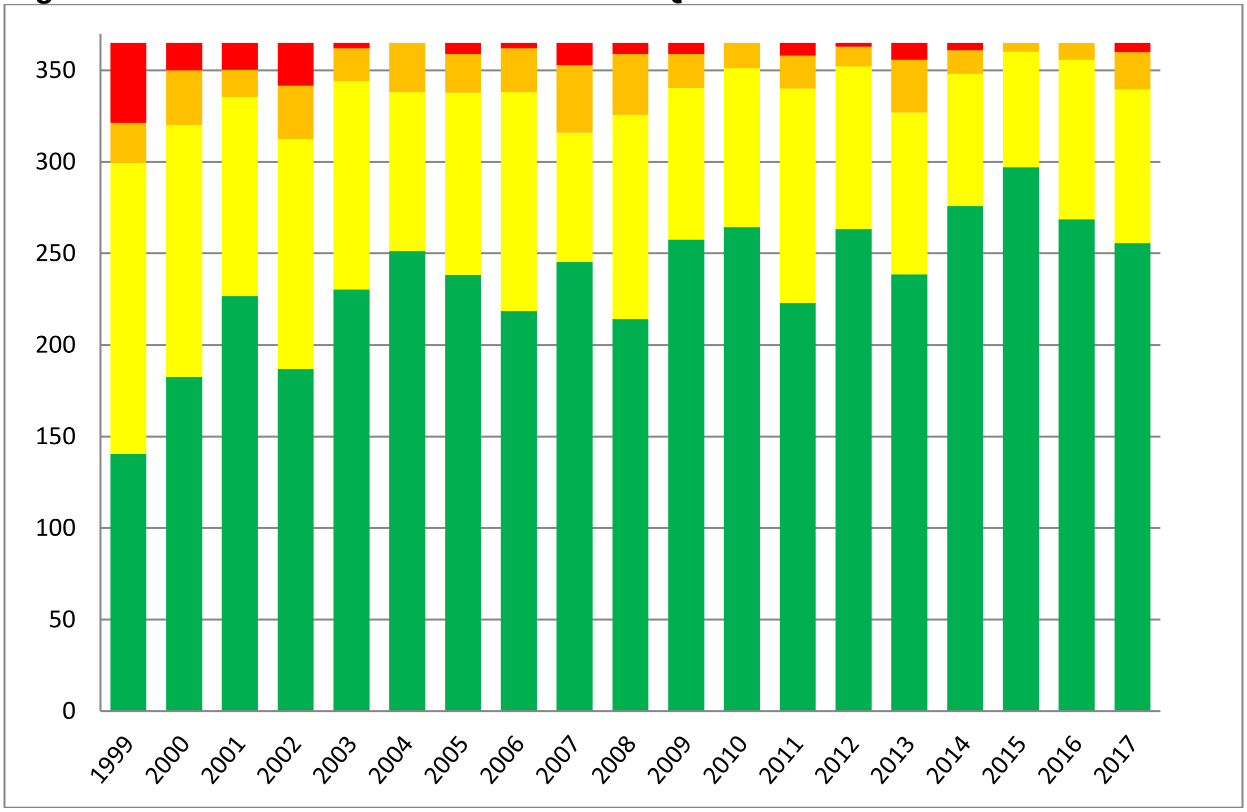


Figure A-38 Merced-M Street PM2.5 AQI Trend

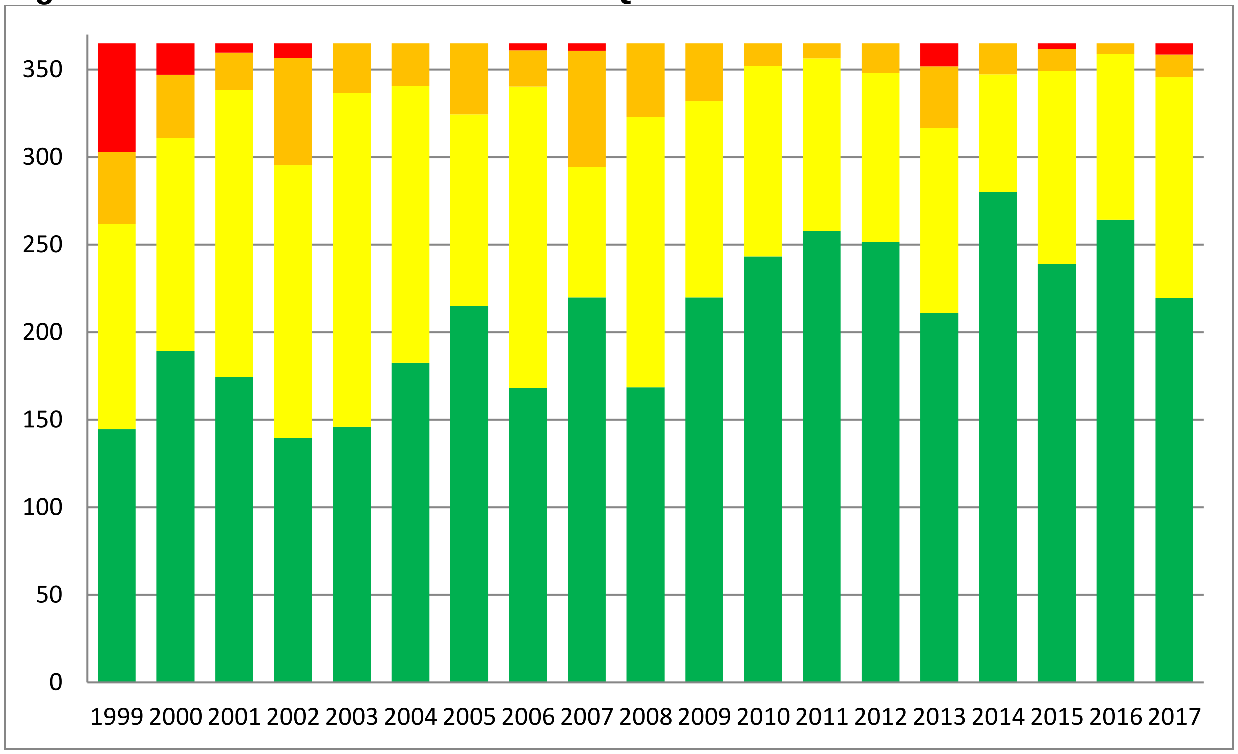


Figure A-39 Madera-City PM2.5 AQI Trend

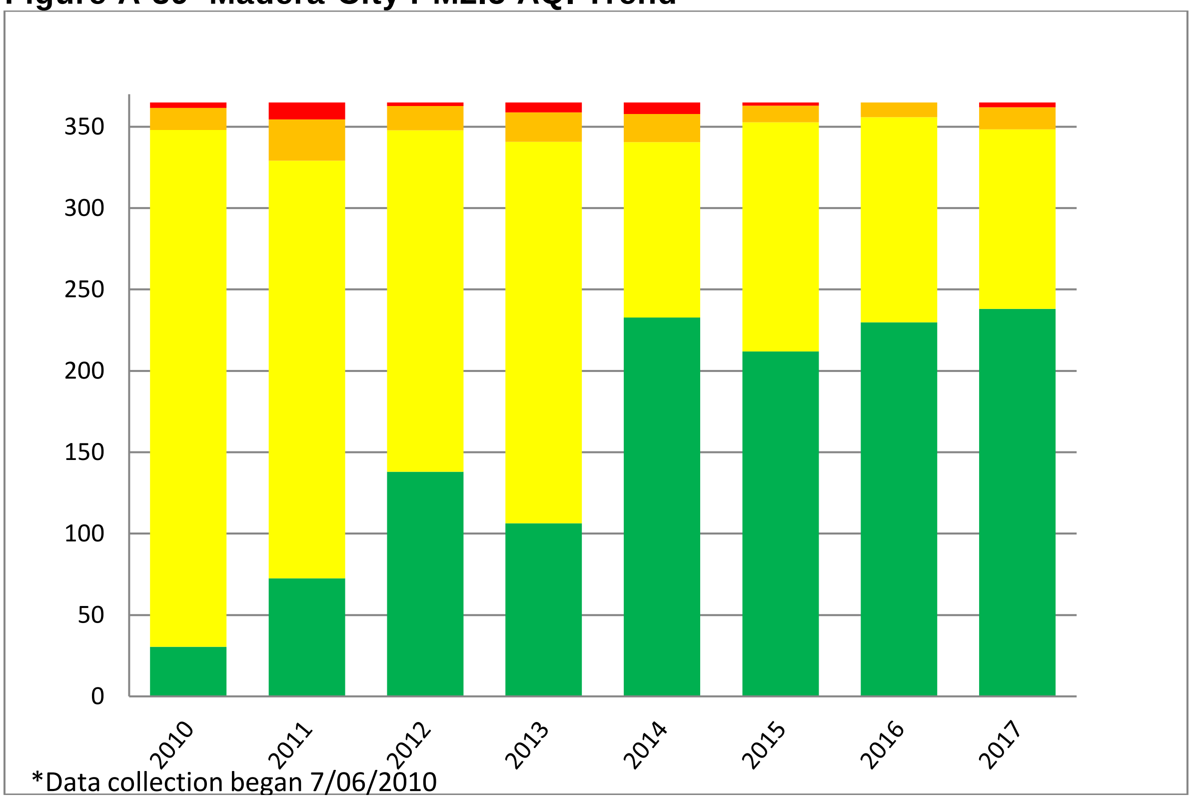


Figure A-40 Fresno-First/Garland PM2.5 AQI Trend

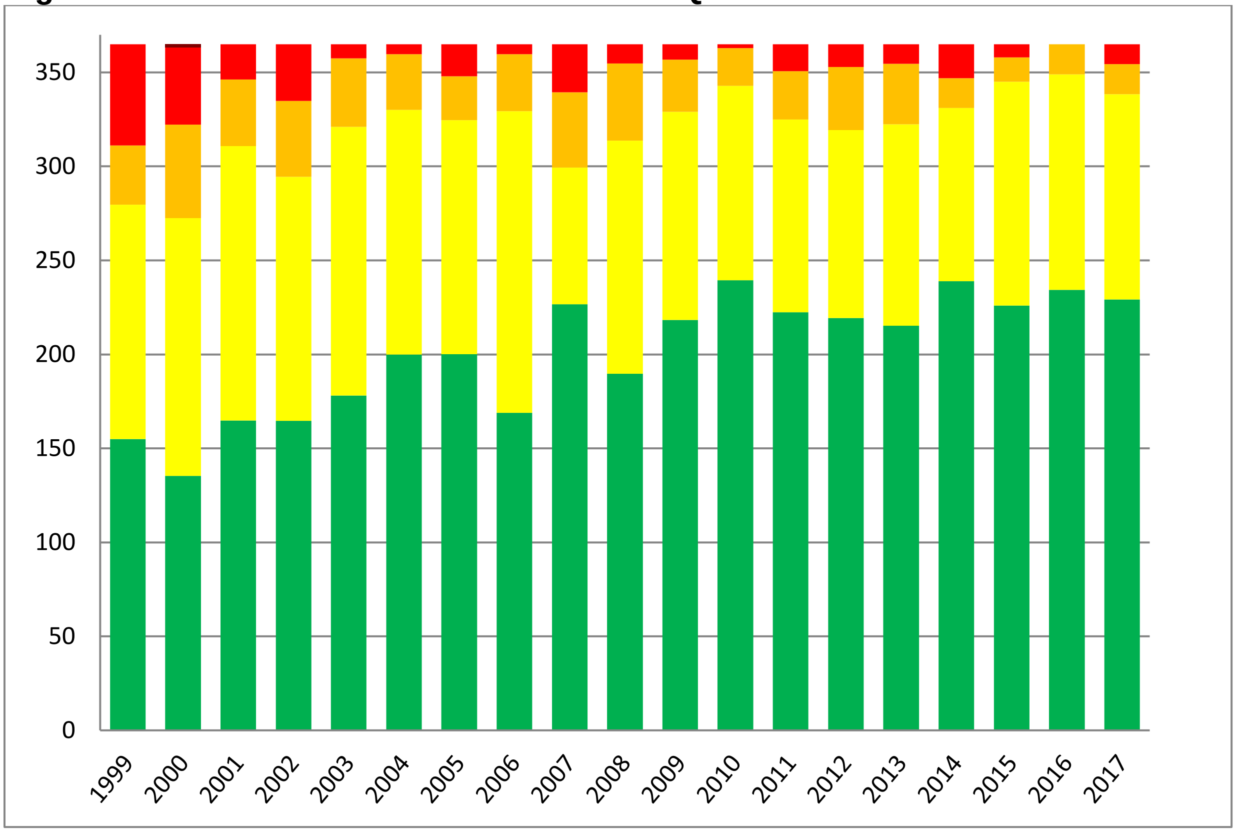
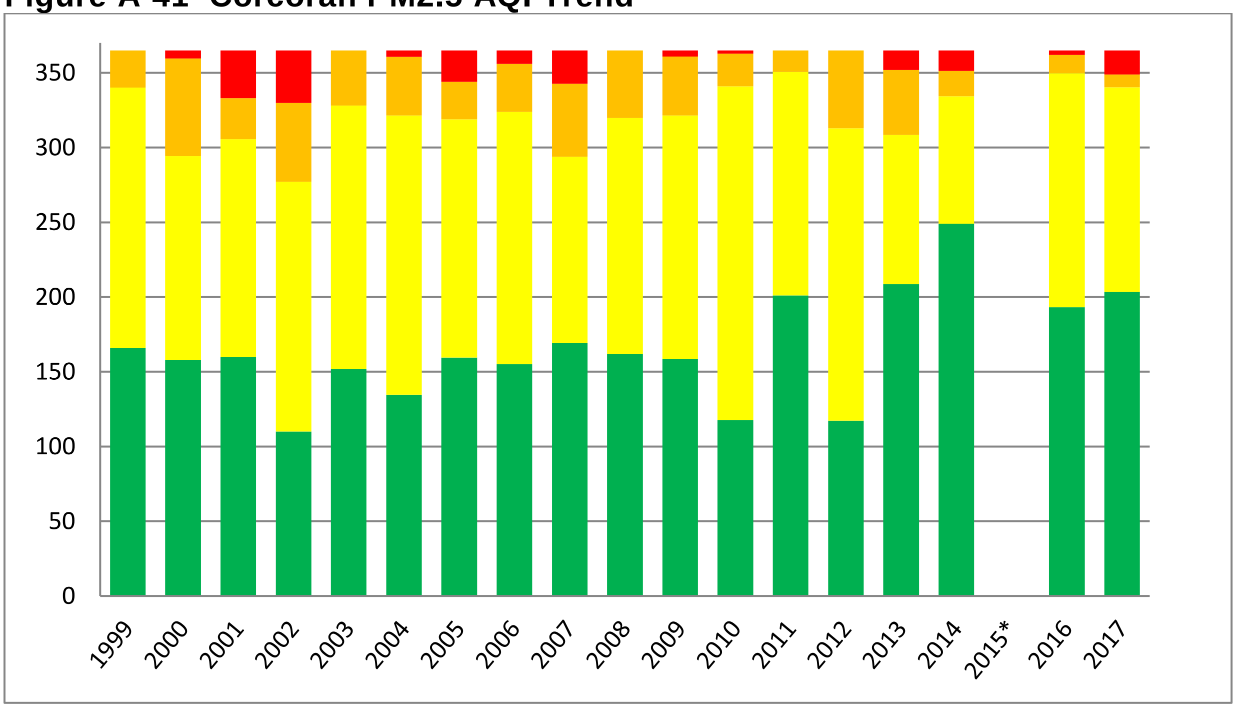


Figure A-41 Corcoran PM2.5 AQI Trend[26]



[26] Data not available in 2015 due to air monitoring site being damaged by fire

Figure A-42 Visalia-Church PM2.5 AQI Trend

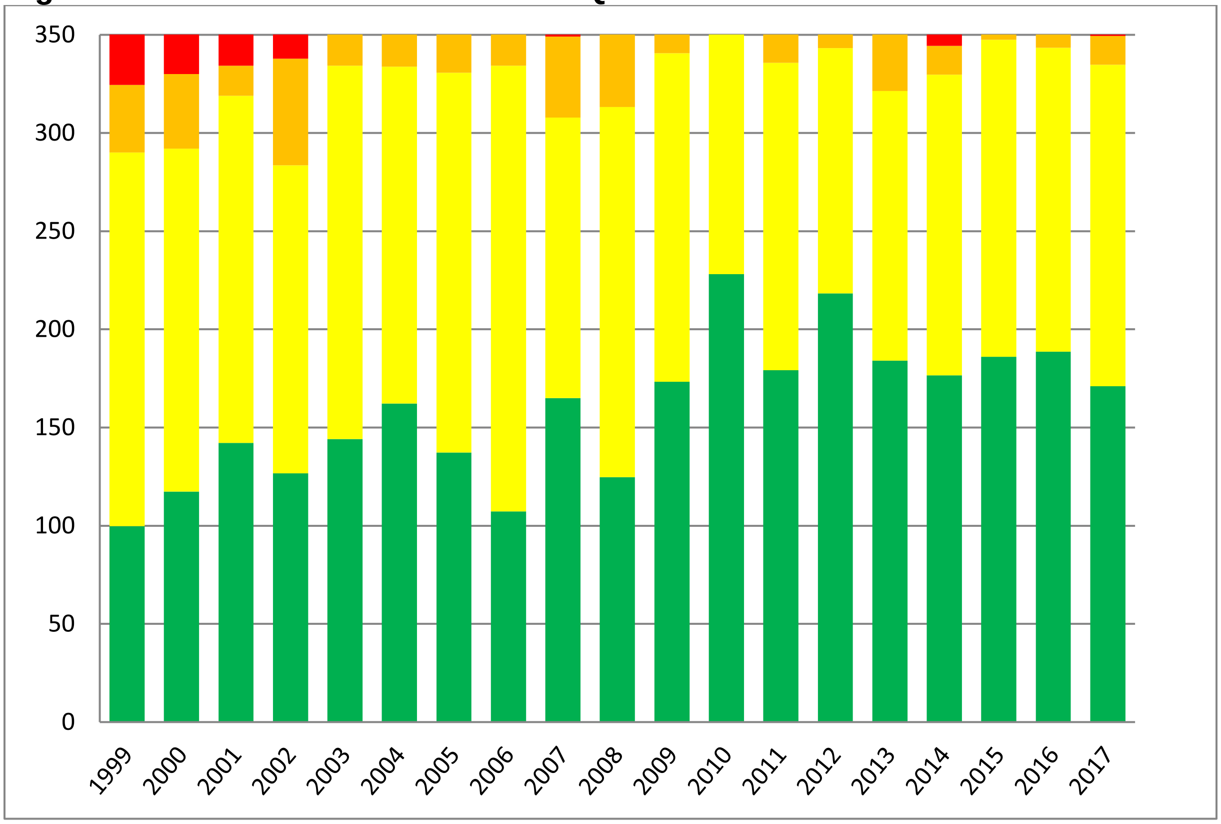


Figure A-43 Bakersfield-Planz PM2.5 AQI Trend

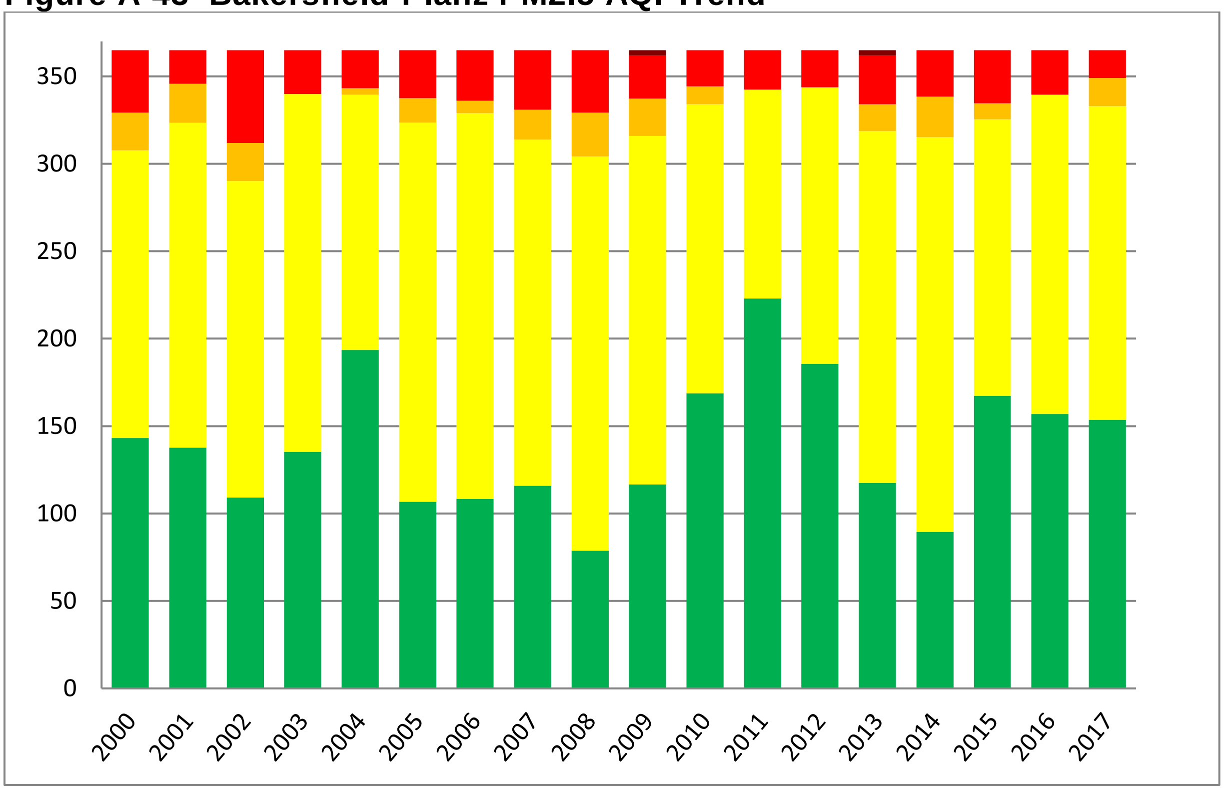


Figure A-44 Bakersfield-California PM2.5 AQI Trend

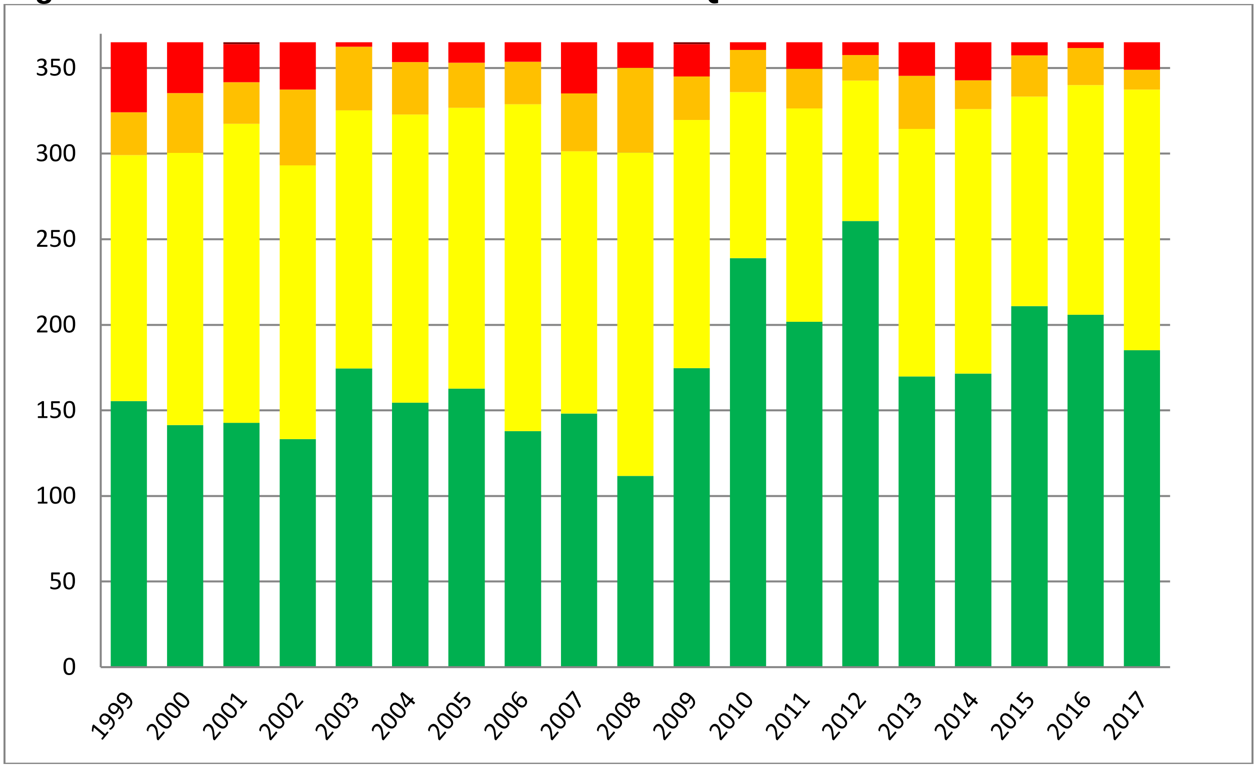


Figure A-45 shows the AQI category frequencies among all of the Valley's counties during the winter season and further illustrates the continuing trend of improving air quality. The recent 2016-2017 winter season recorded a historically low number of Unhealthy for Sensitive Group days and the highest number of Good days in the Valley's recorded history, marking a notable achievement for the region. Although the 2017-18 season experienced a decrease in Good days and an increase in Unhealthy for Sensitive Groups or worse days, this season was heavily influenced by strong atmospheric stability, poor dispersion, and wildfire emissions, as described earlier. However, over the entire period since the 1999-00 season, this analysis shows that the Valley has significantly increased its number of Good days and has decreased its number of Unhealthy days, both indicative of improving air quality.

Figure A-45 County-Day AQI Frequencies during the Winter Season[27]

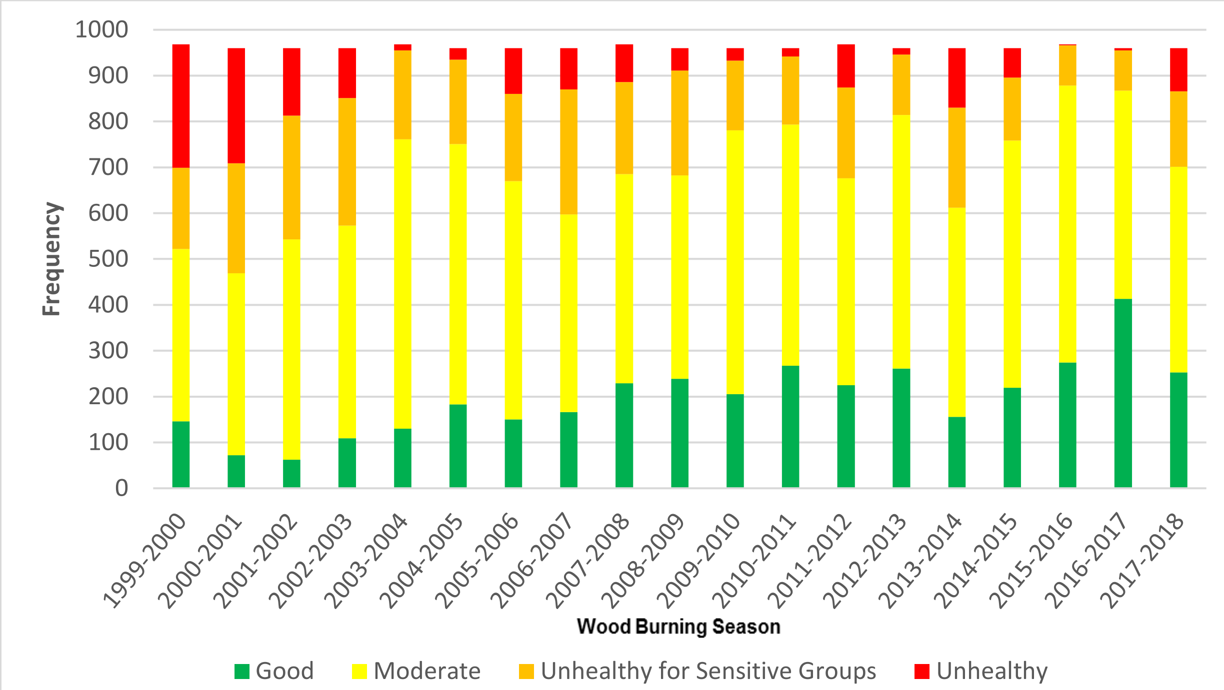


Figure A-46 to Figure A-51 compare the AQI categories for PM2.5 from 2000 and 2017 at the Stockton, Fresno, and Bakerfield stations. Each station shows a significant improvement within 17 years. Stockton shows an increase in Good and Moderate PM2.5 AQI categories from 323 days (88%) in 2000 to 347 days (95%) in 2017. Fresno, which has the greatest improvement, was 272 days (75%) in the Good to Moderate AQI categories for 2000, and in 2017 increased to 338 days (93%). Bakersfield changed from 300 days (82%) in 2000 to 337 days (93%) in 2017. This also demonstrates that the Unhealthy for Sensitive Groups and Unhealthy categories have decreased for PM2.5. The Stockton-Hazelton site had 6 days (2%) in the Unhealthy AQI category in 2000, and in 2017, there were zero. Fresno-First/Garland had 41 Unhealthy days (11%) and two Very Unhealthy days (<1%) in 2000. By 2017, the same station reported 11 Unhealthy days (3%) and zero Very Unhealthy days. A similar trend was experienced in Bakersfield, where in 2000, there were 30 Unhealthy days reported (8%) compared to 16 Unhealthy days (4%) in 2017.

[27] Note that for Leap Years (1999-2000, 2003-2004, 2007-2008, 2011-2012, and 2015-2016) the total County-Day AQI frequency total equals 968. For non-Leap Years, the total County-Day AQI frequency total equals 960.

Figure A-46 Percent AQI Days in Stockton 2000

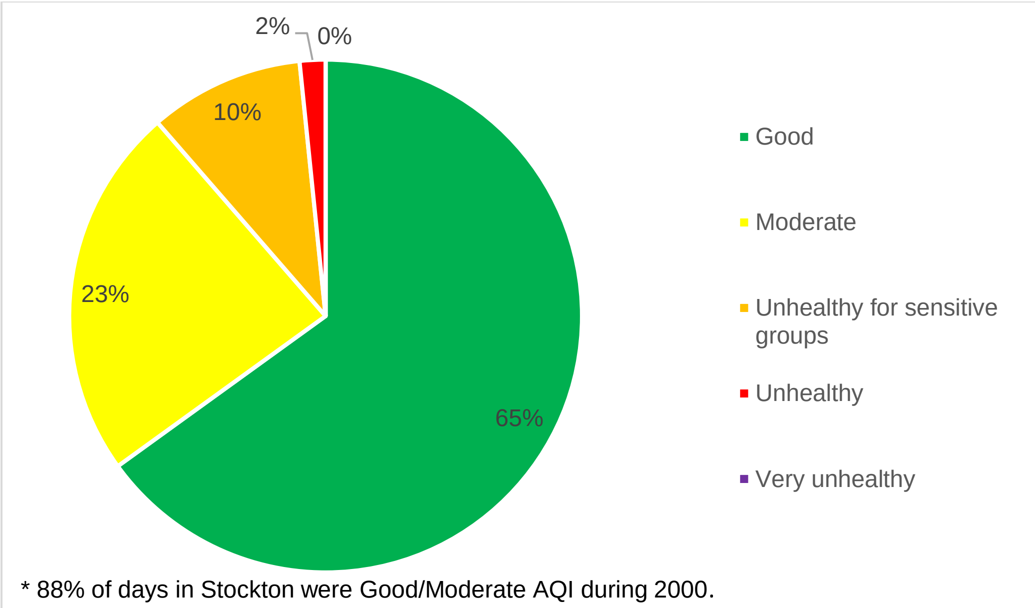


Figure A-47 Percent AQI Days in Stockton 2017

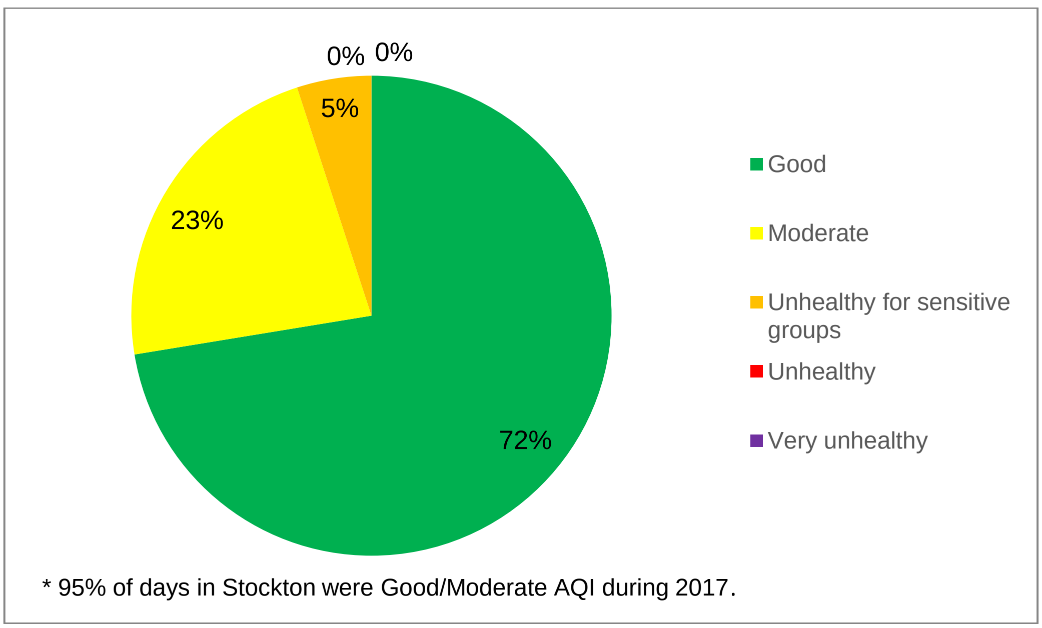
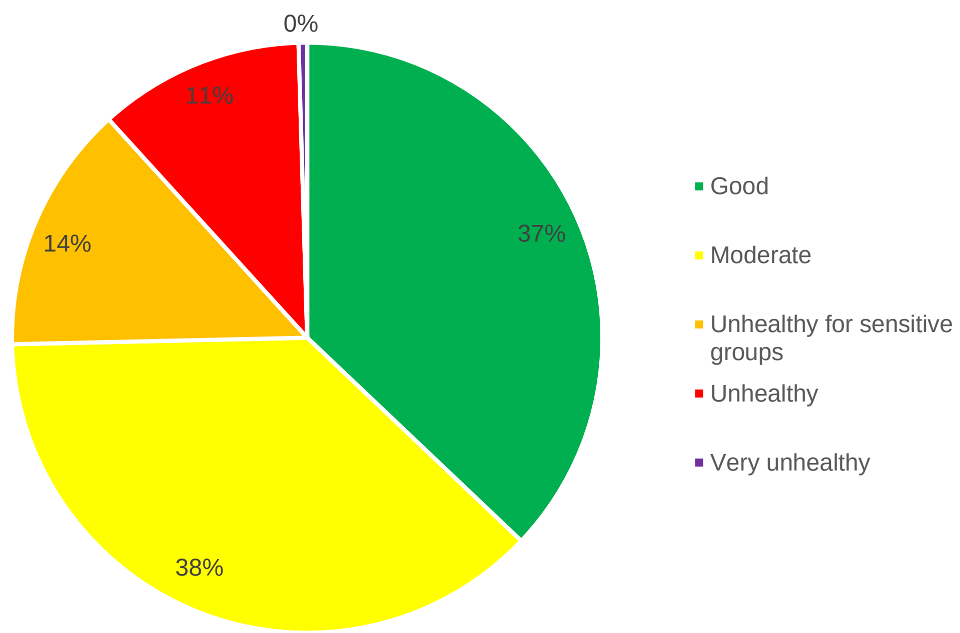
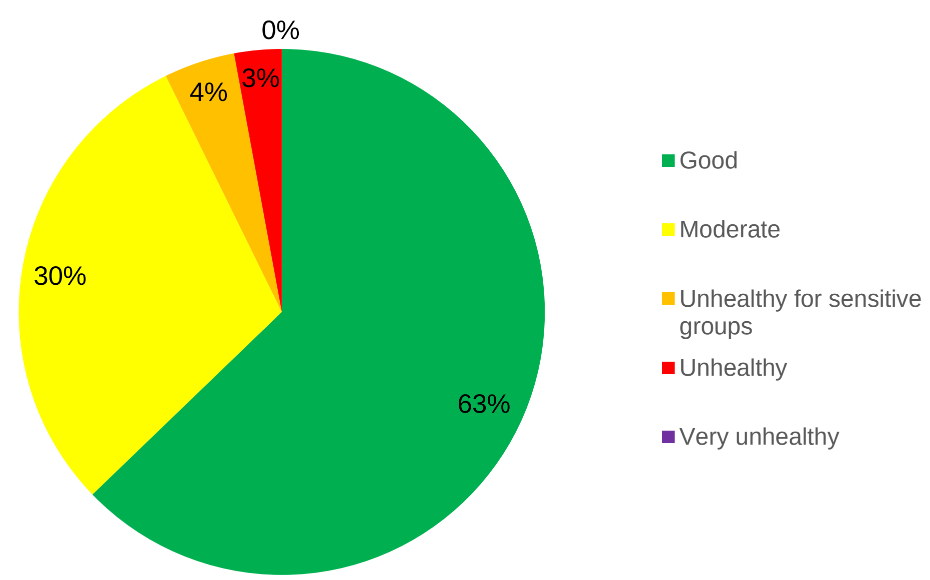


Figure A-48 Percent AQI Days in Fresno 2000



* 75% of days in Fresno were Good/Moderate AQI during 2000.

Figure A-49 Percent AQI Days in Fresno 2017



* 93% of days in Fresno County were Good/Moderate AQI during 2017.

Figure A-50 Percent AQI Days in Bakersfield-CA 2000

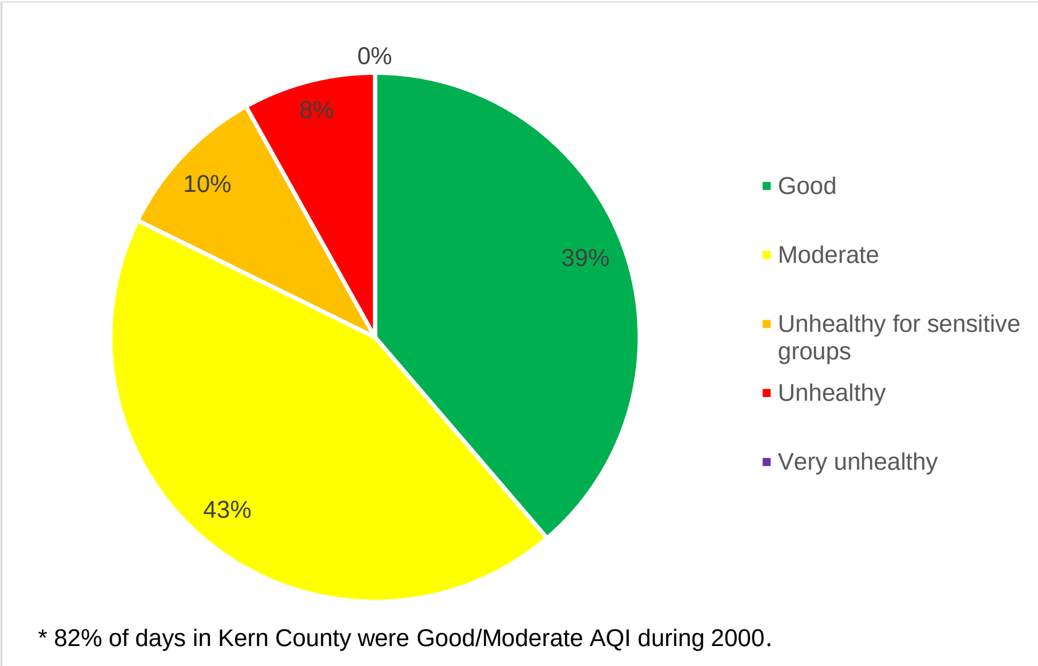
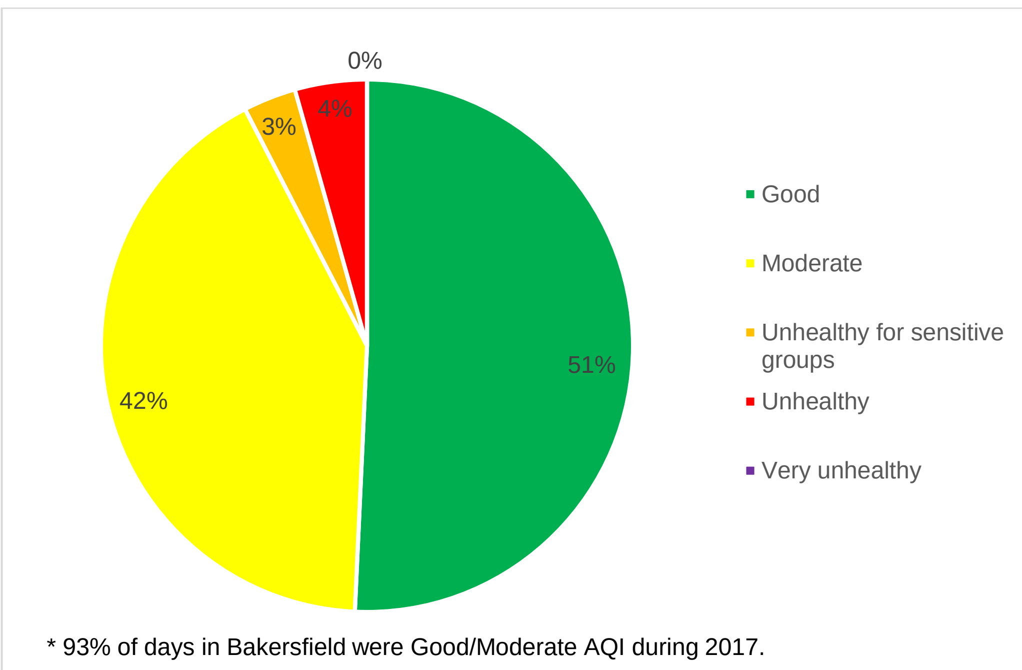


Figure A-51 Percent AQI Days in Bakersfield-CA 2017



Appendix B
Emissions Inventory

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B. EMISSIONS INVENTORY

Emissions inventories are one of the fundamental building blocks in the development of an attainment Plan. Emissions inventories serve as 1) a primary input to air quality modeling used in attainment demonstrations; 2) the emissions data used for developing control strategies; and 3) a means to track progress in meeting the emission reduction commitments. The inventories in this appendix are used to study and propose control measures, to track emissions for Reasonable Further Progress (RFP), to establish motor vehicle conformity budgets for transportation planning, and to assist in demonstrating attainment.

Emissions inventories are an estimate of the air pollution emissions that are actually released into the environment. They are not measurements of ambient concentrations. The following are examples of pollution sources by key sectors:

- Industrial or stationary point sources (e.g., power plants and oil refineries);
- Area-wide sources (e.g., consumer products and residential fuel combustion);
- On-road sources (e.g., passenger vehicles and heavy-duty trucks);
- Off-road mobile sources (e.g., aircraft, trains, ships, recreational boats, construction equipment and farm equipment); and
- Nonanthropogenic (natural) sources (e.g., biogenic or vegetation, geogenic (petroleum seeps), and wildfires).

Emissions inventories are usually developed at various geographical resolutions encompassing district, air basin, and county levels. The inventories presented in this appendix are the emissions for the San Joaquin Valley Air Basin.

This appendix includes emissions for the San Joaquin Valley Air Basin for the years 2013 through 2026. The tables in this appendix include:

- Table B-1 Directly Emitted PM2.5
- Table B-2 NOx
- Table B-3 SOx
- Table B-4 VOC
- Table B-5 Ammonia

Tables B-1 through B-5 are followed by an overview of emissions inventory calculations and revisions.

B.1 EMISSIONS INVENTORY TABLES

Table B-1 Directly Emitted PM2.5

SUMMARY CATEGORY NAME	PM2.5																	
	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
STATIONARY SOURCES																		
FUEL COMBUSTION																		
ELECTRIC UTILITIES	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.3
COGENERATION	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8
OIL AND GAS PRODUCTION (COMBUSTION)	1.7	1.6	1.5	1.4	1.4	1.3	1.3	1.3	1.3	1.7	1.6	1.5	1.4	1.4	1.3	1.3	1.3	1.3
PETROLEUM REFINING (COMBUSTION)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MANUFACTURING AND INDUSTRIAL	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
FOOD AND AGRICULTURAL PROCESSING	0.7	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3
SERVICE AND COMMERCIAL	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
OTHER (FUEL COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL FUEL COMBUSTION**	**5.0**	**4.6**	**4.6**	**4.6**	**4.5**	**4.5**	**4.5**	**4.5**	**4.5**	**4.8**	**4.5**	**4.5**	**4.5**	**4.5**	**4.4**	**4.4**	**4.4**	**4.4**
WASTE DISPOSAL																		
SEWAGE TREATMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LANDFILLS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
INCINERATORS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SOIL REMEDIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (WASTE DISPOSAL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL WASTE DISPOSAL**	**0.1**	**0.1**	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.1**	**0.1**	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
CLEANING AND SURFACE COATINGS																		
LAUNDERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEGREASING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COATINGS AND RELATED PROCESS SOLVENTS	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3
PRINTING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ADHESIVES AND SEALANTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (CLEANING AND SURFACE COATINGS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL CLEANING AND SURFACE COATINGS**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**
PETROLEUM PRODUCTION AND MARKETING																		
OIL AND GAS PRODUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SUMMARY CATEGORY NAME	PM2.5																	
	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
PETROLEUM REFINING	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
PETROLEUM MARKETING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL PETROLEUM PRODUCTION AND MARKETING**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
INDUSTRIAL PROCESSES																		
CHEMICAL	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
FOOD AND AGRICULTURE	0.8	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	0.8	0.8	0.9	0.9	0.9	0.9	1.0	1.0	1.0
MINERAL PROCESSES	1.4	1.5	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.3	1.5	1.6	1.6	1.6	1.7	1.7	1.8	1.8
METAL PROCESSES	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
WOOD AND PAPER	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
GLASS AND RELATED PRODUCTS	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
ELECTRONICS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (INDUSTRIAL PROCESSES)	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
*** TOTAL INDUSTRIAL PROCESSES**	**3.3**	**3.3**	**3.5**	**3.6**	**3.6**	**3.8**	**3.8**	**3.9**	**3.9**	**3.2**	**3.2**	**3.4**	**3.5**	**3.5**	**3.6**	**3.7**	**3.7**	**3.8**
**** TOTAL STATIONARY SOURCES**	**8.8**	**8.5**	**8.7**	**8.7**	**8.8**	**8.9**	**8.9**	**9.0**	**9.0**	**8.5**	**8.3**	**8.5**	**8.5**	**8.6**	**8.6**	**8.7**	**8.8**	**8.8**
AREA-WIDE SOURCES																		
SOLVENT EVAPORATION																		
CONSUMER PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PESTICIDES/FERTILIZERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ASPHALT PAVING / ROOFING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL SOLVENT EVAPORATION**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
MISCELLANEOUS PROCESSES																		
RESIDENTIAL FUEL COMBUSTION	3.7	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	7.0	6.1	6.2	6.2	6.2	6.2	6.2	6.2	6.2
FARMING OPERATIONS	13.4	13.3	13.1	13.1	13.0	13.0	12.9	12.9	12.8	12.3	12.2	12.0	12.0	11.9	11.8	11.8	11.7	11.7
CONSTRUCTION AND DEMOLITION	1.5	1.7	1.9	1.9	1.5	1.6	1.6	1.6	1.7	1.4	1.6	1.7	1.7	1.4	1.5	1.5	1.5	1.5
PAVED ROAD DUST	4.7	4.9	5.2	5.3	5.4	5.5	5.6	5.7	5.8	4.4	4.6	4.8	4.9	5.0	5.2	5.3	5.3	5.4
UNPAVED ROAD DUST	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.4	3.4	3.3	3.3	3.3	3.3	3.3	3.3	3.3
FUGITIVE WINDBLOWN DUST	7.5	7.4	7.3	7.3	7.3	7.2	7.2	7.1	7.1	4.8	4.7	4.6	4.6	4.6	4.5	4.5	4.5	4.4
FIRES	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
MANAGED BURNING AND DISPOSAL	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.2	4.2
COOKING	3.6	3.8	4.0	4.0	4.1	4.2	4.3	4.4	4.4	3.6	3.8	4.0	4.0	4.1	4.2	4.3	4.4	4.4
OTHER (MISCELLANEOUS PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL MISCELLANEOUS PROCESSES**	**41.5**	**41.4**	**41.7**	**41.8**	**41.5**	**41.7**	**41.8**	**41.9**	**42.0**	**41.4**	**40.8**	**41.1**	**41.2**	**41.0**	**41.1**	**41.2**	**41.3**	**41.4**

PM2.5																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
**** TOTAL AREA-WIDE SOURCES**	**41.5**	**41.4**	**41.7**	**41.8**	**41.5**	**41.7**	**41.8**	**41.9**	**42.0**	**41.4**	**40.8**	**41.1**	**41.2**	**41.0**	**41.1**	**41.2**	**41.3**	**41.4**
MOBILE SOURCES																		
ON-ROAD MOTOR VEHICLES																		
LIGHT DUTY PASSENGER (LDA)	1.0	1.1	1.2	1.2	1.2	1.3	1.3	1.4	1.4	1.0	1.1	1.2	1.2	1.2	1.3	1.3	1.4	1.4
LIGHT DUTY TRUCKS - 1 (LDT1)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
LIGHT DUTY TRUCKS - 2 (LDT2)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5
MEDIUM DUTY TRUCKS (MDV)	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3
LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDV1)	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDV2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY HEAVY DUTY GAS TRUCKS (HHDV)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT HEAVY DUTY DIESEL TRUCKS - 1 (LHDV1)	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
LIGHT HEAVY DUTY DIESEL TRUCKS - 2 (LHDV2)	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MEDIUM HEAVY DUTY DIESEL TRUCKS (MHDV)	0.8	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.8	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.2
HEAVY HEAVY DUTY DIESEL TRUCKS (HHDV)	3.2	1.2	0.8	0.7	0.7	0.6	0.6	0.6	0.6	3.2	1.2	0.8	0.7	0.7	0.6	0.6	0.6	0.6
MOTORCYCLES (MCY)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY DUTY DIESEL URBAN BUSES (UB)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
HEAVY DUTY GAS URBAN BUSES (UB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SCHOOL BUSES (SB)	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER BUSES (OB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOTOR HOMES (MH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL ON-ROAD MOTOR VEHICLES**	**6.4**	**4.0**	**3.5**	**3.4**	**3.3**	**3.2**	**3.2**	**3.2**	**3.3**	**6.4**	**4.0**	**3.5**	**3.4**	**3.3**	**3.2**	**3.2**	**3.2**	**3.3**
OTHER MOBILE SOURCES																		
AIRCRAFT	1.2	1.2	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.2	1.2	1.7	1.7	1.7	1.7	1.7	1.7	1.7
TRAINS	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
SHIPS AND COMMERCIAL BOATS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RECREATIONAL BOATS	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
OFF-ROAD RECREATIONAL VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFF-ROAD EQUIPMENT	1.1	1.0	0.8	0.8	0.8	0.7	0.7	0.6	0.6	1.0	0.9	0.7	0.7	0.6	0.6	0.5	0.5	0.5
FARM EQUIPMENT	2.8	2.5	2.2	2.1	2.0	1.8	1.7	1.6	1.5	1.7	1.5	1.4	1.3	1.2	1.1	1.0	1.0	0.9
FUEL STORAGE AND HANDLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL OTHER MOBILE SOURCES**	**5.8**	**5.3**	**5.2**	**5.1**	**4.9**	**4.5**	**4.4**	**4.2**	**4.1**	**4.4**	**4.1**	**4.1**	**4.0**	**3.9**	**3.6**	**3.5**	**3.4**	**3.3**

PM2.5																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
**** TOTAL MOBILE SOURCES**	**12.2**	**9.3**	**8.8**	**8.5**	**8.2**	**7.7**	**7.6**	**7.5**	**7.4**	**10.9**	**8.1**	**7.6**	**7.4**	**7.2**	**6.8**	**6.8**	**6.7**	**6.6**
GRAND TOTAL FOR SAN JOAQUIN VALLEY	**62.5**	**59.2**	**59.2**	**59.0**	**58.5**	**58.3**	**58.3**	**58.3**	**58.4**	**60.8**	**57.2**	**57.3**	**57.2**	**56.7**	**56.6**	**56.7**	**56.8**	**56.8**

Table B-2 NOx

NOx																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
STATIONARY SOURCES																		
FUEL COMBUSTION																		
ELECTRIC UTILITIES	4.4	4.2	4.3	4.3	4.3	4.3	4.4	4.5	4.5	4.2	3.9	4.1	4.0	4.0	4.1	4.2	4.2	4.3
COGENERATION	1.6	1.8	2.0	2.0	2.0	2.1	2.1	2.1	2.2	1.5	1.7	1.9	1.9	1.9	2.0	2.0	2.0	2.0
OIL AND GAS PRODUCTION (COMBUSTION)	3.1	2.7	2.5	2.4	2.3	2.2	2.1	2.0	2.0	3.1	2.7	2.5	2.4	2.3	2.2	2.1	2.0	2.0
PETROLEUM REFINING (COMBUSTION)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
MANUFACTURING AND INDUSTRIAL	5.2	5.2	5.2	5.2	5.2	5.3	5.2	5.3	5.3	5.3	5.2	5.3	5.3	5.3	5.3	5.3	5.3	5.3
FOOD AND AGRICULTURAL PROCESSING	11.5	6.0	5.2	5.0	4.8	4.4	4.2	4.0	3.8	7.9	4.3	3.7	3.6	3.4	3.2	3.0	2.9	2.8
SERVICE AND COMMERCIAL	4.6	4.6	4.6	4.6	4.6	4.6	4.5	4.5	4.5	4.9	4.9	5.0	5.0	5.0	5.0	4.9	4.9	4.8
OTHER (FUEL COMBUSTION)	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4
*** TOTAL FUEL COMBUSTION**	**31.2**	**25.1**	**24.4**	**24.1**	**23.9**	**23.4**	**23.1**	**23.0**	**22.8**	**27.6**	**23.4**	**23.0**	**22.7**	**22.6**	**22.2**	**22.0**	**21.9**	**21.8**
WASTE DISPOSAL																		
SEWAGE TREATMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LANDFILLS	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
INCINERATORS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SOIL REMEDIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (WASTE DISPOSAL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL WASTE DISPOSAL**	**0.2**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.2**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**
CLEANING AND SURFACE COATINGS																		
LAUNDERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEGREASING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRINTING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NOx																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
ADHESIVES AND SEALANTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (CLEANING AND SURFACE COATINGS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL CLEANING AND SURFACE COATINGS**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
PETROLEUM PRODUCTION AND MARKETING																		
OIL AND GAS PRODUCTION	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
PETROLEUM REFINING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM MARKETING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL PETROLEUM PRODUCTION AND MARKETING**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.3**	**0.3**	**0.3**	**0.3**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.3**	**0.3**	**0.3**	**0.3**
INDUSTRIAL PROCESSES																		
CHEMICAL	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4
FOOD AND AGRICULTURE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MINERAL PROCESSES	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
METAL PROCESSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WOOD AND PAPER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GLASS AND RELATED PRODUCTS	6.2	3.2	3.3	3.3	3.4	3.5	3.5	3.5	3.5	6.2	3.2	3.3	3.3	3.4	3.5	3.5	3.5	3.5
ELECTRONICS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (INDUSTRIAL PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL INDUSTRIAL PROCESSES**	**6.7**	**3.7**	**3.9**	**3.9**	**4.0**	**4.1**	**4.1**	**4.2**	**4.2**	**6.7**	**3.7**	**3.8**	**3.9**	**4.0**	**4.1**	**4.1**	**4.1**	**4.1**
**** TOTAL STATIONARY SOURCES**	**38.6**	**29.5**	**28.9**	**28.6**	**28.5**	**28.1**	**27.9**	**27.7**	**27.6**	**35.0**	**27.8**	**27.5**	**27.2**	**27.2**	**26.9**	**26.8**	**26.7**	**26.5**
AREA-WIDE SOURCES																		
SOLVENT EVAPORATION																		
CONSUMER PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PESTICIDES/FERTILIZERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ASPHALT PAVING / ROOFING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL SOLVENT EVAPORATION**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
MISCELLANEOUS PROCESSES																		
RESIDENTIAL FUEL COMBUSTION	6.4	6.4	6.3	6.2	6.1	5.8	5.8	5.7	5.7	8.9	8.9	8.7	8.6	8.5	8.1	8.0	7.9	7.8
FARMING OPERATIONS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION AND DEMOLITION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NOx																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
UNPAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FUGITIVE WINDBLOWN DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FIRES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANAGED BURNING AND DISPOSAL	1.7	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
COOKING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (MISCELLANEOUS PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL MISCELLANEOUS PROCESSES**	**8.1**	**8.1**	**7.9**	**7.9**	**7.8**	**7.5**	**7.4**	**7.4**	**7.3**	**11.5**	**11.5**	**11.3**	**11.1**	**11.0**	**10.6**	**10.5**	**10.4**	**10.3**
**** TOTAL AREA-WIDE SOURCES**	**8.1**	**8.1**	**7.9**	**7.9**	**7.8**	**7.5**	**7.4**	**7.4**	**7.3**	**11.5**	**11.5**	**11.3**	**11.1**	**11.0**	**10.6**	**10.5**	**10.4**	**10.3**
MOBILE SOURCES																		
ON-ROAD MOTOR VEHICLES																		
LIGHT DUTY PASSENGER (LDA)	9.6	6.9	4.9	4.5	4.1	3.5	3.3	3.1	2.9	10.5	7.5	5.4	4.9	4.5	3.9	3.6	3.4	3.2
LIGHT DUTY TRUCKS - 1 (LDT1)	2.8	1.8	1.1	1.0	0.9	0.7	0.6	0.5	0.5	3.1	2.0	1.2	1.1	0.9	0.7	0.7	0.6	0.5
LIGHT DUTY TRUCKS - 2 (LDT2)	7.0	4.9	3.3	2.9	2.6	2.2	2.0	1.9	1.7	7.7	5.4	3.6	3.2	2.9	2.4	2.2	2.0	1.9
MEDIUM DUTY TRUCKS (MDV)	10.0	7.6	5.3	4.7	4.1	3.1	2.7	2.4	2.1	11.0	8.3	5.9	5.2	4.5	3.4	3.0	2.6	2.3
LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDV1)	3.0	2.3	1.8	1.7	1.5	1.3	1.2	1.0	0.9	3.2	2.5	1.9	1.8	1.6	1.4	1.2	1.1	1.0
LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDV2)	0.4	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.4	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1
MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)	0.8	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.1	0.8	0.6	0.4	0.3	0.3	0.2	0.2	0.2	0.2
HEAVY HEAVY DUTY GAS TRUCKS (HHDV)	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
LIGHT HEAVY DUTY DIESEL TRUCKS - 1 (LHDV1)	11.0	8.9	6.8	6.1	5.5	4.4	3.9	3.5	3.1	11.2	9.0	6.9	6.2	5.6	4.5	4.0	3.5	3.1
LIGHT HEAVY DUTY DIESEL TRUCKS - 2 (LHDV2)	2.8	2.1	1.5	1.3	1.1	0.8	0.7	0.6	0.5	2.8	2.1	1.5	1.3	1.2	0.9	0.7	0.6	0.5
MEDIUM HEAVY DUTY DIESEL TRUCKS (MHDV)	18.2	13.0	10.2	8.3	6.5	5.0	5.1	5.2	5.2	18.5	13.2	10.3	8.4	6.6	5.1	5.2	5.2	5.3
HEAVY HEAVY DUTY DIESEL TRUCKS (HHDV)	110.1	76.7	64.4	61.5	57.2	33.1	32.9	32.6	32.4	111.8	77.8	65.2	62.3	57.8	33.4	33.2	32.9	32.7
MOTORCYCLES (MCY)	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
HEAVY DUTY DIESEL URBAN BUSES (UB)	3.4	2.5	1.8	1.6	1.5	1.2	1.1	0.9	0.9	3.5	2.6	1.9	1.7	1.5	1.2	1.1	1.0	0.9
HEAVY DUTY GAS URBAN BUSES (UB)	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1
SCHOOL BUSES (SB)	1.1	1.0	0.9	0.8	0.8	0.7	0.6	0.6	0.5	1.2	1.1	0.9	0.8	0.8	0.7	0.6	0.6	0.5
OTHER BUSES (OB)	1.2	0.9	0.7	0.7	0.6	0.3	0.3	0.3	0.4	1.2	0.9	0.7	0.7	0.6	0.3	0.4	0.4	0.4
MOTOR HOMES (MH)	0.4	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.4	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1
*** TOTAL ON-ROAD MOTOR VEHICLES**	**183.1**	**131.1**	**104.7**	**96.9**	**88.1**	**57.9**	**56.0**	**54.2**	**52.6**	**188.7**	**135.0**	**107.6**	**99.5**	**90.4**	**59.5**	**57.5**	**55.6**	**53.9**

NOx																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
OTHER MOBILE SOURCES																		
AIRCRAFT	2.5	2.5	4.6	4.6	4.6	4.6	4.5	4.5	4.5	2.4	2.4	4.5	4.5	4.5	4.5	4.5	4.5	4.5
TRAINS	12.5	11.6	10.2	9.8	9.5	8.8	8.3	7.9	7.5	12.5	11.6	10.2	9.8	9.5	8.8	8.3	7.9	7.5
SHIPS AND COMMERCIAL BOATS	1.0	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	1.0	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6
RECREATIONAL BOATS	1.5	1.4	1.3	1.3	1.3	1.2	1.2	1.2	1.2	0.9	0.9	0.8	0.8	0.8	0.7	0.7	0.7	0.7
OFF-ROAD RECREATIONAL VEHICLES	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
OFF-ROAD EQUIPMENT	21.4	20.3	17.5	17.2	16.5	14.7	14.4	13.4	12.9	18.3	17.2	14.8	14.5	13.9	12.5	12.2	11.4	11.0
FARM EQUIPMENT	48.4	43.1	38.6	36.2	34.0	30.1	28.3	26.6	25.1	30.1	26.7	23.9	22.5	21.2	18.7	17.6	16.6	15.6
FUEL STORAGE AND HANDLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL OTHER MOBILE SOURCES**	**87.4**	**79.6**	**72.9**	**69.8**	**66.6**	**60.1**	**57.6**	**54.4**	**51.9**	**65.3**	**59.6**	**54.9**	**52.8**	**50.6**	**46.0**	**44.2**	**41.9**	**40.0**
**** TOTAL MOBILE SOURCES**	**270.5**	**210.8**	**177.6**	**166.8**	**154.7**	**118.0**	**113.6**	**108.6**	**104.5**	**254.1**	**194.6**	**162.5**	**152.3**	**140.9**	**105.5**	**101.6**	**97.4**	**94.0**
GRAND TOTAL FOR SAN JOAQUIN VALLEY	**317.2**	**248.3**	**214.5**	**203.3**	**191.0**	**153.6**	**148.9**	**143.7**	**139.4**	**300.5**	**233.8**	**201.2**	**190.7**	**179.2**	**143.0**	**138.9**	**134.5**	**130.8**

Table B-3 SOx

SOx																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
STATIONARY SOURCES																		
FUEL COMBUSTION																		
ELECTRIC UTILITIES	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7
COGENERATION	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
OIL AND GAS PRODUCTION (COMBUSTION)	0.7	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.7	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2
PETROLEUM REFINING (COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANUFACTURING AND INDUSTRIAL	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
FOOD AND AGRICULTURAL PROCESSING	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
SERVICE AND COMMERCIAL	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4
OTHER (FUEL COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL FUEL COMBUSTION**	**2.9**	**2.3**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**	**2.9**	**2.3**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**
WASTE DISPOSAL																		
SEWAGE TREATMENT	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
LANDFILLS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
INCINERATORS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SOx																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
SOIL REMEDIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (WASTE DISPOSAL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL WASTE DISPOSAL**	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.1**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
CLEANING AND SURFACE COATINGS																		
LAUNDERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEGREASING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRINTING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ADHESIVES AND SEALANTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (CLEANING AND SURFACE COATINGS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL CLEANING AND SURFACE COATINGS**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
PETROLEUM PRODUCTION AND MARKETING																		
OIL AND GAS PRODUCTION	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
PETROLEUM REFINING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM MARKETING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL PETROLEUM PRODUCTION AND MARKETING**	**0.5**	**0.5**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.5**	**0.5**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**
INDUSTRIAL PROCESSES																		
CHEMICAL	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	1.0	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	1.0
FOOD AND AGRICULTURE	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
MINERAL PROCESSES	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5
METAL PROCESSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WOOD AND PAPER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GLASS AND RELATED PRODUCTS	2.0	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.8	2.0	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.8
ELECTRONICS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (INDUSTRIAL PROCESSES)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL INDUSTRIAL PROCESSES**	**3.6**	**3.4**	**3.5**	**3.6**	**3.6**	**3.7**	**3.8**	**3.8**	**3.9**	**3.4**	**3.1**	**3.2**	**3.3**	**3.3**	**3.4**	**3.5**	**3.5**	**3.5**
**** TOTAL STATIONARY SOURCES**	**7.2**	**6.3**	**6.5**	**6.5**	**6.6**	**6.7**	**6.7**	**6.8**	**6.8**	**6.9**	**6.0**	**6.2**	**6.2**	**6.3**	**6.4**	**6.4**	**6.4**	**6.5**
AREA-WIDE SOURCES																		
SOLVENT EVAPORATION																		
CONSUMER PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SOx																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PESTICIDES/FERTILIZERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ASPHALT PAVING / ROOFING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL SOLVENT EVAPORATION**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
MISCELLANEOUS PROCESSES																		
RESIDENTIAL FUEL COMBUSTION	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
FARMING OPERATIONS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION AND DEMOLITION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UNPAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FUGITIVE WINDBLOWN DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FIRES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANAGED BURNING AND DISPOSAL	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
COOKING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (MISCELLANEOUS PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL MISCELLANEOUS PROCESSES**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**
**** TOTAL AREA-WIDE SOURCES**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**
MOBILE SOURCES																		
ON-ROAD MOTOR VEHICLES																		
LIGHT DUTY PASSENGER (LDA)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
LIGHT DUTY TRUCKS - 1 (LDT1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT DUTY TRUCKS - 2 (LDT2)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MEDIUM DUTY TRUCKS (MDV)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDV1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDV2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY HEAVY DUTY GAS TRUCKS (HHDV)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT HEAVY DUTY DIESEL TRUCKS - 1 (LHDV1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT HEAVY DUTY DIESEL TRUCKS - 2 (LHDV2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MEDIUM HEAVY DUTY DIESEL TRUCKS (MHDV)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY HEAVY DUTY DIESEL TRUCKS (HHDV)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

SOx																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
MOTORCYCLES (MCY)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY DUTY DIESEL URBAN BUSES (UB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY DUTY GAS URBAN BUSES (UB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SCHOOL BUSES (SB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER BUSES (OB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOTOR HOMES (MH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL ON-ROAD MOTOR VEHICLES**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**
OTHER MOBILE SOURCES																		
AIRCRAFT	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
TRAINS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
SHIPS AND COMMERCIAL BOATS	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RECREATIONAL BOATS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFF-ROAD RECREATIONAL VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFF-ROAD EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FARM EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FUEL STORAGE AND HANDLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL OTHER MOBILE SOURCES**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**
**** TOTAL MOBILE SOURCES**	**1.0**	**0.9**	**1.0**	**1.0**	**1.0**	**0.9**	**0.9**	**0.9**	**0.9**	**1.0**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**
GRAND TOTAL FOR SAN JOAQUIN VALLEY	**8.5**	**7.5**	**7.8**	**7.8**	**7.9**	**8.0**	**8.0**	**8.0**	**8.1**	**8.4**	**7.4**	**7.6**	**7.6**	**7.7**	**7.8**	**7.8**	**7.8**	**7.9**

Table B-4 VOC

VOC																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
STATIONARY SOURCES																		
FUEL COMBUSTION																		
ELECTRIC UTILITIES	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
COGENERATION	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6
OIL AND GAS PRODUCTION (COMBUSTION)	1.2	1.1	1.0	1.0	1.0	0.9	0.9	0.9	0.9	1.2	1.1	1.0	1.0	1.0	0.9	0.9	0.9	0.9
PETROLEUM REFINING (COMBUSTION)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MANUFACTURING AND INDUSTRIAL	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

VOC																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
FOOD AND AGRICULTURAL PROCESSING	1.0	0.7	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.8	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4
SERVICE AND COMMERCIAL	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6
OTHER (FUEL COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL FUEL COMBUSTION**	**3.7**	**3.3**	**3.2**	**3.2**	**3.2**	**3.1**	**3.1**	**3.0**	**3.0**	**3.5**	**3.2**	**3.1**	**3.1**	**3.1**	**3.0**	**3.0**	**3.0**	**2.9**
WASTE DISPOSAL																		
SEWAGE TREATMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LANDFILLS	1.5	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.9	1.5	1.6	1.7	1.7	1.7	1.8	1.8	1.8	1.9
INCINERATORS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SOIL REMEDIATION	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
OTHER (WASTE DISPOSAL)	23.1	24.4	24.6	25.0	25.4	26.3	26.7	27.2	27.6	23.1	24.3	24.6	25.0	25.4	26.3	26.7	27.2	27.6
*** TOTAL WASTE DISPOSAL**	**24.7**	**26.1**	**26.4**	**26.9**	**27.3**	**28.2**	**28.7**	**29.2**	**29.7**	**24.7**	**26.1**	**26.4**	**26.8**	**27.3**	**28.2**	**28.7**	**29.2**	**29.6**
CLEANING AND SURFACE COATINGS																		
LAUNDERING	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
DEGREASING	1.7	1.8	1.8	1.8	1.9	2.0	2.0	2.1	2.1	1.6	1.8	1.8	1.8	1.9	2.0	2.0	2.1	2.1
COATINGS AND RELATED PROCESS SOLVENTS	8.3	8.9	9.3	9.4	9.6	10.1	10.3	10.6	10.9	8.2	8.8	9.2	9.4	9.6	10.0	10.3	10.6	10.8
PRINTING	5.3	5.6	5.8	5.9	5.9	6.1	6.1	6.2	6.2	5.3	5.6	5.8	5.9	5.9	6.1	6.1	6.2	6.2
ADHESIVES AND SEALANTS	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7
OTHER (CLEANING AND SURFACE COATINGS)	6.6	7.0	7.2	7.3	7.5	7.8	8.0	8.2	8.5	6.6	7.0	7.2	7.3	7.5	7.8	8.0	8.2	8.5
*** TOTAL CLEANING AND SURFACE COATINGS**	**22.5**	**23.9**	**24.8**	**25.2**	**25.6**	**26.7**	**27.3**	**27.9**	**28.5**	**22.5**	**23.9**	**24.8**	**25.2**	**25.6**	**26.6**	**27.2**	**27.8**	**28.5**
PETROLEUM PRODUCTION AND MARKETING																		
OIL AND GAS PRODUCTION	12.6	11.7	11.0	10.7	10.5	10.1	9.8	9.6	9.4	12.6	11.7	11.0	10.7	10.5	10.0	9.8	9.6	9.4
PETROLEUM REFINING	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
PETROLEUM MARKETING	5.5	5.4	5.1	5.1	5.0	4.8	4.8	4.7	4.6	5.5	5.4	5.1	5.1	5.0	4.8	4.8	4.7	4.6
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL PETROLEUM PRODUCTION AND MARKETING**	**18.8**	**18.0**	**16.9**	**16.6**	**16.3**	**15.7**	**15.4**	**15.1**	**14.9**	**18.8**	**18.0**	**16.9**	**16.6**	**16.3**	**15.7**	**15.4**	**15.1**	**14.8**
INDUSTRIAL PROCESSES																		
CHEMICAL	4.9	5.1	5.3	5.4	5.5	5.8	5.9	6.0	6.2	4.9	5.0	5.3	5.4	5.5	5.8	5.9	6.0	6.2
FOOD AND AGRICULTURE	11.2	11.7	12.5	12.7	12.8	13.2	13.4	13.5	13.7	11.0	11.5	12.2	12.4	12.5	12.9	13.0	13.2	13.4
MINERAL PROCESSES	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3
METAL PROCESSES	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
WOOD AND PAPER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GLASS AND RELATED PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

VOC																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
ELECTRONICS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (INDUSTRIAL PROCESSES)	0.8	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.1	1.1
*** TOTAL INDUSTRIAL PROCESSES**	**17.3**	**18.1**	**19.2**	**19.5**	**19.8**	**20.5**	**20.8**	**21.1**	**21.5**	**17.1**	**17.8**	**18.9**	**19.2**	**19.5**	**20.2**	**20.5**	**20.8**	**21.1**
**** TOTAL STATIONARY SOURCES**	**87.1**	**89.4**	**90.6**	**91.3**	**92.2**	**94.2**	**95.2**	**96.4**	**97.5**	**86.6**	**88.9**	**90.1**	**90.9**	**91.8**	**93.7**	**94.8**	**95.9**	**97.1**
AREA-WIDE SOURCES																		
SOLVENT EVAPORATION																		
CONSUMER PRODUCTS	20.6	21.3	22.2	22.5	22.8	23.4	23.8	24.1	24.4	20.6	21.3	22.1	22.5	22.8	23.4	23.7	24.1	24.4
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	9.0	9.3	9.7	9.9	10.0	10.3	10.5	10.6	10.8	7.8	8.0	8.4	8.5	8.6	8.9	9.0	9.2	9.3
PESTICIDES/FERTILIZERS	19.5	16.7	16.4	16.4	16.3	16.1	16.1	16.0	15.9	19.4	16.6	16.4	16.3	16.3	16.1	16.1	16.0	15.9
ASPHALT PAVING / ROOFING	0.9	1.0	1.2	1.2	1.2	1.3	1.3	1.3	1.3	0.9	1.0	1.2	1.2	1.2	1.3	1.3	1.3	1.3
*** TOTAL SOLVENT EVAPORATION**	**50.0**	**48.3**	**49.5**	**49.9**	**50.3**	**51.1**	**51.6**	**52.0**	**52.5**	**48.7**	**46.9**	**48.1**	**48.5**	**48.9**	**49.7**	**50.1**	**50.5**	**51.0**
MISCELLANEOUS PROCESSES																		
RESIDENTIAL FUEL COMBUSTION	4.2	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	7.9	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
FARMING OPERATIONS	96.0	96.0	96.0	96.0	96.0	96.0	96.0	96.0	96.0	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9
CONSTRUCTION AND DEMOLITION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UNPAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FUGITIVE WINDBLOWN DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FIRES	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MANAGED BURNING AND DISPOSAL	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3.7	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
COOKING	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7
OTHER (MISCELLANEOUS PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL MISCELLANEOUS PROCESSES**	**103.4**	**102.9**	**102.9**	**103.0**	**103.0**	**103.0**	**103.0**	**103.0**	**103.0**	**108.1**	**107.2**	**107.3**	**107.3**	**107.3**	**107.3**	**107.3**	**107.3**	**107.3**
**** TOTAL AREA-WIDE SOURCES**	**153.4**	**151.2**	**152.4**	**152.8**	**153.2**	**154.1**	**154.5**	**155.0**	**155.5**	**156.8**	**154.2**	**155.4**	**155.7**	**156.1**	**157.0**	**157.4**	**157.8**	**158.3**
MOBILE SOURCES																		
ON-ROAD MOTOR VEHICLES																		
LIGHT DUTY PASSENGER (LDA)	13.6	9.4	6.7	6.2	5.8	5.2	5.0	4.9	4.8	13.6	9.2	6.5	6.1	5.7	5.2	5.0	4.9	4.8
LIGHT DUTY TRUCKS - 1 (LDT1)	5.0	3.4	2.3	2.0	1.8	1.6	1.4	1.3	1.2	5.3	3.6	2.4	2.1	1.9	1.6	1.5	1.4	1.3
LIGHT DUTY TRUCKS - 2 (LDT2)	7.3	5.5	4.1	3.8	3.6	3.3	3.2	3.1	3.0	7.7	5.7	4.2	3.9	3.7	3.4	3.3	3.2	3.1
MEDIUM DUTY TRUCKS (MDV)	7.8	6.8	5.7	5.3	4.9	4.2	4.0	3.8	3.6	8.2	7.1	5.8	5.4	5.0	4.3	4.1	3.8	3.6
LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDV1)	2.3	1.8	1.5	1.4	1.3	1.1	1.0	0.9	0.9	2.5	2.0	1.6	1.5	1.4	1.2	1.1	1.0	0.9
LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDV2)	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)	0.6	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.7	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1

VOC																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
HEAVY HEAVY DUTY GAS TRUCKS (HHDV)	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT HEAVY DUTY DIESEL TRUCKS - 1 (LHDV1)	0.5	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.5	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2
LIGHT HEAVY DUTY DIESEL TRUCKS - 2 (LHDV2)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MEDIUM HEAVY DUTY DIESEL TRUCKS (MHDV)	1.5	0.9	0.6	0.4	0.2	0.1	0.1	0.1	0.1	1.5	0.9	0.6	0.4	0.2	0.1	0.1	0.1	0.1
HEAVY HEAVY DUTY DIESEL TRUCKS (HHDV)	6.8	2.9	2.1	2.0	1.9	1.3	1.3	1.3	1.3	6.8	2.9	2.1	2.0	1.9	1.3	1.3	1.3	1.3
MOTORCYCLES (MCY)	3.3	3.0	2.9	2.9	2.8	2.8	2.8	2.7	2.7	3.3	3.0	2.8	2.8	2.8	2.7	2.7	2.7	2.6
HEAVY DUTY DIESEL URBAN BUSES (UB)	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
HEAVY DUTY GAS URBAN BUSES (UB)	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
SCHOOL BUSES (SB)	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER BUSES (OB)	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
MOTOR HOMES (MH)	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL ON-ROAD MOTOR VEHICLES**	**49.8**	**35.1**	**26.8**	**24.9**	**23.3**	**20.4**	**19.5**	**18.8**	**18.3**	**51.1**	**35.8**	**27.1**	**25.1**	**23.5**	**20.5**	**19.7**	**19.0**	**18.4**
OTHER MOBILE SOURCES																		
AIRCRAFT	3.0	3.0	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.0	3.0	3.9	3.9	3.9	3.9	3.9	3.9	3.9
TRAINS	0.7	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.7	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.3
SHIPS AND COMMERCIAL BOATS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
RECREATIONAL BOATS	7.8	6.7	5.8	5.5	5.2	4.6	4.4	4.1	3.9	4.7	4.0	3.4	3.3	3.1	2.8	2.6	2.5	2.3
OFF-ROAD RECREATIONAL VEHICLES	2.6	2.4	2.3	2.2	2.2	2.1	2.0	2.0	2.0	2.5	2.3	2.2	2.2	2.1	2.0	2.0	2.0	1.9
OFF-ROAD EQUIPMENT	9.2	8.3	7.7	7.6	7.6	7.5	7.4	7.4	7.3	8.8	8.0	7.3	7.2	7.2	7.0	7.0	6.9	6.9
FARM EQUIPMENT	8.8	7.6	6.5	6.2	5.9	5.4	5.1	4.9	4.7	6.1	5.2	4.4	4.2	4.0	3.6	3.4	3.3	3.1
FUEL STORAGE AND HANDLING	1.7	1.5	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.6	1.4	1.3	1.2	1.2	1.2	1.1	1.1	1.1
*** TOTAL OTHER MOBILE SOURCES**	**33.8**	**30.1**	**28.0**	**27.2**	**26.5**	**25.1**	**24.5**	**23.9**	**23.4**	**27.4**	**24.4**	**23.0**	**22.3**	**21.9**	**20.9**	**20.4**	**20.0**	**19.6**
**** TOTAL MOBILE SOURCES**	**83.6**	**65.2**	**54.8**	**52.0**	**49.8**	**45.5**	**44.1**	**42.7**	**41.6**	**78.5**	**60.3**	**50.1**	**47.5**	**45.4**	**41.4**	**40.1**	**39.0**	**38.0**
GRAND TOTAL FOR SAN JOAQUIN VALLEY	**324.1**	**305.8**	**297.8**	**296.2**	**295.2**	**293.7**	**293.8**	**294.1**	**294.6**	**321.9**	**303.4**	**295.6**	**294.1**	**293.3**	**292.1**	**292.3**	**292.7**	**293.3**

Table B-5 Ammonia

AMMONIA																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
STATIONARY SOURCES																		
FUEL COMBUSTION																		
ELECTRIC UTILITIES	1.8	1.7	1.7	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.8
COGENERATION	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
OIL AND GAS PRODUCTION (COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM REFINING (COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANUFACTURING AND INDUSTRIAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD AND AGRICULTURAL PROCESSING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SERVICE AND COMMERCIAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (FUEL COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL FUEL COMBUSTION**	**2.3**	**2.1**	**2.2**	**2.2**	**2.2**	**2.2**	**2.3**	**2.3**	**2.3**	**2.2**	**2.1**	**2.2**	**2.1**	**2.2**	**2.2**	**2.2**	**2.3**	**2.3**
WASTE DISPOSAL																		
SEWAGE TREATMENT	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8
LANDFILLS	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8
INCINERATORS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SOIL REMEDIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (WASTE DISPOSAL)	8.7	9.1	9.6	9.8	9.9	10.3	10.4	10.6	10.8	8.7	9.1	9.6	9.8	9.9	10.3	10.4	10.6	10.8
*** TOTAL WASTE DISPOSAL**	**10.0**	**10.5**	**11.0**	**11.2**	**11.4**	**11.8**	**12.0**	**12.2**	**12.4**	**10.0**	**10.5**	**11.0**	**11.2**	**11.4**	**11.8**	**12.0**	**12.2**	**12.4**
CLEANING AND SURFACE COATINGS																		
LAUNDERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEGREASING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRINTING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ADHESIVES AND SEALANTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (CLEANING AND SURFACE COATINGS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL CLEANING AND SURFACE COATINGS**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
PETROLEUM PRODUCTION AND MARKETING																		
OIL AND GAS PRODUCTION	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM REFINING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

AMMONIA																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
PETROLEUM MARKETING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL PETROLEUM PRODUCTION AND MARKETING**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
INDUSTRIAL PROCESSES																		
CHEMICAL	1.1	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.4	1.5
FOOD AND AGRICULTURE	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
MINERAL PROCESSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METAL PROCESSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WOOD AND PAPER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GLASS AND RELATED PRODUCTS	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
ELECTRONICS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (INDUSTRIAL PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL INDUSTRIAL PROCESSES**	**1.5**	**1.6**	**1.7**	**1.7**	**1.8**	**1.8**	**1.9**	**1.9**	**1.9**	**1.5**	**1.6**	**1.7**	**1.7**	**1.8**	**1.8**	**1.9**	**1.9**	**1.9**
**** TOTAL STATIONARY SOURCES**	**13.9**	**14.3**	**15.0**	**15.2**	**15.4**	**15.9**	**16.2**	**16.4**	**16.7**	**13.9**	**14.3**	**15.0**	**15.2**	**15.4**	**15.9**	**16.1**	**16.4**	**16.7**
AREA-WIDE SOURCES																		
SOLVENT EVAPORATION																		
CONSUMER PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PESTICIDES/FERTILIZERS	117.6	115.7	113.8	113.1	112.5	111.2	110.6	109.9	109.3	97.9	96.2	94.5	94.0	93.4	92.3	91.7	91.2	90.6
ASPHALT PAVING / ROOFING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL SOLVENT EVAPORATION**	**117.6**	**115.7**	**113.8**	**113.1**	**112.5**	**111.2**	**110.6**	**109.9**	**109.3**	**97.9**	**96.2**	**94.5**	**94.0**	**93.4**	**92.3**	**91.7**	**91.2**	**90.6**
MISCELLANEOUS PROCESSES																		
RESIDENTIAL FUEL COMBUSTION	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
FARMING OPERATIONS	186.5	186.5	186.5	186.5	186.5	186.5	186.5	186.5	186.5	186.4	186.4	186.4	186.4	186.4	186.4	186.4	186.4	186.4
CONSTRUCTION AND DEMOLITION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UNPAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FUGITIVE WINDBLOWN DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FIRES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANAGED BURNING AND DISPOSAL	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
COOKING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (MISCELLANEOUS PROCESSES)	6.1	6.4	6.7	6.8	6.9	7.1	7.2	7.3	7.4	6.1	6.4	6.7	6.8	6.9	7.1	7.2	7.3	7.4
*** TOTAL MISCELLANEOUS PROCESSES**	**193.3**	**193.5**	**193.8**	**193.9**	**194.0**	**194.2**	**194.3**	**194.5**	**194.6**	**193.7**	**193.9**	**194.2**	**194.3**	**194.4**	**194.6**	**194.7**	**194.8**	**195.0**
**** TOTAL AREA-WIDE SOURCES**	**310.9**	**309.2**	**307.6**	**307.0**	**306.5**	**305.4**	**304.9**	**304.4**	**303.9**	**291.5**	**290.1**	**288.7**	**288.3**	**287.8**	**286.9**	**286.5**	**286.0**	**285.5**

AMMONIA																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
MOBILE SOURCES																		
ON-ROAD MOTOR VEHICLES																		
LIGHT DUTY PASSENGER (LDA)	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
LIGHT DUTY TRUCKS - 1 (LDT1)	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
LIGHT DUTY TRUCKS - 2 (LDT2)	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7	0.7	0.8	0.8
MEDIUM DUTY TRUCKS (MDV)	1.3	1.1	0.9	0.8	0.8	0.7	0.6	0.6	0.5	1.3	1.1	0.9	0.8	0.8	0.7	0.6	0.6	0.5
LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDV1)	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDV2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY HEAVY DUTY GAS TRUCKS (HHDV)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT HEAVY DUTY DIESEL TRUCKS - 1 (LHDV1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT HEAVY DUTY DIESEL TRUCKS - 2 (LHDV2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MEDIUM HEAVY DUTY DIESEL TRUCKS (MHDV)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
HEAVY HEAVY DUTY DIESEL TRUCKS (HHDV)	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4
MOTORCYCLES (MCY)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY DUTY DIESEL URBAN BUSES (UB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY DUTY GAS URBAN BUSES (UB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SCHOOL BUSES (SB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER BUSES (OB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOTOR HOMES (MH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL ON-ROAD MOTOR VEHICLES**	**4.4**	**4.0**	**3.7**	**3.6**	**3.5**	**3.5**	**3.4**	**3.4**	**3.4**	**4.4**	**4.0**	**3.7**	**3.6**	**3.5**	**3.5**	**3.4**	**3.4**	**3.4**
OTHER MOBILE SOURCES																		
AIRCRAFT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRAINS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHIPS AND COMMERCIAL BOATS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RECREATIONAL BOATS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFF-ROAD RECREATIONAL VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFF-ROAD EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FARM EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FUEL STORAGE AND HANDLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

AMMONIA																		
SUMMARY CATEGORY NAME	ANNUAL AVERAGE tons/day									WINTER AVERAGE tons/day								
	2013	2016	2019	2020	2021	2023	2024	2025	2026	2013	2016	2019	2020	2021	2023	2024	2025	2026
* TOTAL OTHER MOBILE SOURCES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
** TOTAL MOBILE SOURCES	4.4	4.0	3.7	3.6	3.6	3.5	3.5	3.5	3.4	4.4	4.0	3.7	3.6	3.6	3.5	3.5	3.4	3.4
GRAND TOTAL FOR SAN JOAQUIN VALLEY	329.2	327.6	326.3	325.9	325.5	324.9	324.6	324.3	324.0	309.8	308.4	307.4	307.1	306.8	306.3	306.1	305.8	305.6

B.2 EMISSIONS INVENTORY SUMMARY AND METHODOLOGY

[Section provided by California Air Resources Board]

Introduction

Emissions inventories are one of the fundamental building blocks in the development of a State Implementation Plan (SIP or Plan). In simple terms, an emissions inventory is a systematic listing of the sources of air pollution along with the amount of pollution emitted from each source or category over a given time period. This document describes the emissions inventory included in the 2017 PM2.5 Plan for the San Joaquin Valley Nonattainment Area (2017 PM2.5 Plan, or Plan).

The California Air Resources Board (CARB) and the San Joaquin Valley Air Pollution Control District (District) have developed a comprehensive, accurate, and current emissions inventory consistent with the requirements set forth in Section 182(a)(1) of the federal Clean Air Act. CARB and District staff conducted a thorough review of the inventory to ensure that the emission estimates reflect accurate emission reports for point sources, and that estimates for mobile and areawide sources are based on the most recent models and methodologies.

CARB also reviewed the growth profiles for point and areawide source categories and updated them as necessary to ensure that the emission projections are based on data that reflect historical trends, current conditions, and recent economic and demographic forecasts. Growth forecasts for most point and areawide sources were developed by CARB.

Emissions Inventory Overview

Emissions inventories are estimates of the amount and type of pollutants emitted into the atmosphere by industrial facilities, mobile sources, and areawide sources such as consumer products and paint. They are fundamental components of an air quality plan, and serve critical functions such as:

1) the primary input to air quality modeling used in attainment demonstrations;
2) the emissions data used for developing control strategies; and
3) a means to track progress in meeting the emission reduction commitments.

The United States Environmental Protection Agency (U.S. EPA) regulations require that the emissions inventory for a PM2.5 Plan contain emissions data for directly emitted PM2.5 and its precursors: oxides of nitrogen (NOx), sulfur oxides (SOx), volatile organic compounds (VOCs), and ammonia (NH3). The inventory included in this plan substitutes VOCs with reactive organic gases (ROG), which in general represent a slightly broader group of compounds than those in U.S. EPA's list of VOCs.

Agency Responsibilities

CARB and District staff worked jointly to develop the emissions inventory for the San Joaquin Valley (SJV) PM2.5 Nonattainment Area. The District worked closely with operators of major stationary facilities in their jurisdiction to develop the point source emission estimates. CARB staff developed the emission inventory for mobile sources, both on-road and off-road. The District and CARB shared responsibility for developing estimates for the nonpoint (areawide) sources such as paved road dust and agricultural burning. CARB worked with several State and local agencies such as the Department of Transportation (Caltrans), the Department of Motor Vehicles (DMV), the Department of Pesticide Regulation (DPR), and the California Energy Commission (CEC) to assemble activity information necessary to develop the mobile and areawide source emission estimates.

Inventory Base Year

The base year inventory forms the basis for all future year projections and also establishes the emission levels against which progress in emission reductions will be measured. U.S. EPA regulations establish that the base year inventory should be preferably consistent with the triennial reporting schedule required under the Air Emissions Reporting Requirements (AERR) rule. However, U.S. EPA allows a different year to be selected if justified by the state. CARB worked with the local air districts to determine the base year that should be used across the State. Since the South Coast Air Quality Management District typically aligns their base year inventory with the data collection period for their Multiple Air Toxics Exposure Study, which was last conducted in 2012, CARB selected 2012 as the base year to maintain consistency across the various plans being developed in the State.

Forecasted Inventories

In addition to a base year inventory, U.S. EPA regulations also require future year inventory projections for specific milestone years. Forecasted inventories are a projection of the base year inventory that reflects expected growth trends for each source category and emission reductions due to adopted control measures. CARB develops emission forecasts by applying growth and control profiles to the base year inventory.

Growth profiles for point and areawide sources are derived from surrogates such as economic activity, fuel usage, population, housing units, etc., that best reflect the expected growth trends for each specific source category. Growth projections were obtained primarily from government entities with expertise in developing forecasts for specific sectors, or in some cases, from econometric models. Control profiles, which account for emission reductions resulting from adopted rules and regulations, are derived from data provided by the regulatory agencies responsible for the affected emission categories.

Projections for mobile source emissions are generated by models that predict activity rates and vehicle fleet turnover by vehicle model year. As with stationary sources, the mobile source models include control algorithms that account for all adopted regulatory actions.

Temporal Resolution

Planning inventories typically include annual as well as seasonal (summer and winter) emission estimates. Annual emission inventories represent the total emissions over an entire year (tons per year), or the daily emissions produced on an average day (tons per day). Seasonal inventories account for temporal activity variations throughout the year, as determined by category-specific temporal profiles. Both an annual and a winter (November through April) inventory are used in this Plan.

Geographical Scope

The inventories presented in this Plan consist of emissions for the San Joaquin Valley PM2.5 Nonattainment Area, which consists of the seven full counties (Fresno, Kings, Madera, Merced, San Joaquin, Stanislaus and Tulare) and the portion of Kern County that comprise the San Joaquin Valley Air Basin.

Quality Assurance and Quality Control

CARB has established a quality assurance and quality control (QA/QC) process involving CARB and District staff to ensure the integrity and accuracy of the emissions inventories used in the development of air quality plans. QA/QC occurs at the various stages of SIP emission inventory development. Base year emissions are assembled and maintained in the California Emission Inventory Development and Reporting System (CEIDARS). CARB inventory staff works with District staff, who are responsible for developing and reporting point source emission estimates, to verify these data are accurate. The locations of point sources, including stacks, are checked to ensure they are valid. Areawide source emission estimates are reviewed by CARB and District staff before their inclusion in the emission inventory. Additionally, CEIDARS is designed with automatic system checks to prevent errors such as double counting of emission sources. The system also makes various reports available to assist staff in their efforts to identify and reconcile anomalous emissions.

Future year emissions are estimated using the California Emission Projection Analysis Model (CEPAM), 2016 SIP Baseline Emission Projections, Version 1.05. Growth and control factors are reviewed for each category and year along with the resulting emission projections. Year to year trends are compared to similar and past datasets to ensure general consistency. Emissions for specific categories are checked to confirm they reflect the anticipated effects of applicable control measures. Mobile categories are verified with mobile source staff for consistency with the on-road and off-road emission models.

A summary of the information supporting the San Joaquin Valley PM2.5 Nonattainment Area Plan emissions inventory is presented in the sections below.

Point Sources

The inventory reflects actual emissions from industrial point sources reported to the District by the facility operators through calendar year 2012, in accordance with the requirements set forth in U.S. EPA's AERR rule. The data elements in the 2012 baseline inventory are consistent with the data elements required by the AERR rule. Estimation methods include source testing, direct measurement by continuous emissions monitoring systems, or engineering calculations. Where appropriate, the PM2.5 emissions are the sum of filtered and condensable particulates.

The point source categories that occur in the PM2.5 nonattainment area are listed below in Table B-6.

Table B-6 Point Source Categories

Source Category	Subcategory
Fuel Combustion	Electrical Utilities
	Cogeneration
	Oil and Gas Production (Combustion)
	Petroleum Refining (Combustion)
	Manufacturing and Industrial
	Food and Agricultural Processing
	Service and Commercial
	Other (Fuel Combustion)
Waste Disposal	Sewage Treatment
	Landfills
	Incinerators
	Soil Remediation
	Other (Waste Disposal)
Cleaning and Surface Coatings	Laundering
	Degreasing
	Coatings and Thinners
	Printing
	Adhesives and Sealants
	Other (Cleaning and Surface Coatings)
Petroleum Production and Marketing	Oil and Gas Production
	Petroleum Refining
	Petroleum Marketing
	Other (Petroleum Production and Marketing)
Industrial Processes	Chemical
	Food and Agriculture
	Mineral Processes
	Metal Processes
	Wood and Paper
	Glass and Related Products

Source Category	Subcategory
	Electronics
	Other (Industrial Processes)

The point source inventory includes emissions from stationary area sources, which are categories such as internal combustion engines and gasoline dispensing facilities that are not inventoried individually, but are estimated as a group and reported as an aggregated total. The District's methodologies, encompassing over sixty individual stationary source subcategories, are available at: http://www.valleyair.org/Air_Quality_Plans/EmissionsMethods/EmissionsMethods.htm

Estimates for the following categories were developed by CARB:

Stationary Nonagricultural Diesel Engines

This category includes emissions from backup and prime generators and pumps, air compressors, and other miscellaneous stationary diesel engines that are widely used throughout the industrial, service, institutional, and commercial sectors. The emission estimates, including emission forecasts, are based on a 2003 CARB methodology derived from the OFFROAD model. Additional information on this methodology is available at: https://www.arb.ca.gov/ei/areasrc/FULLPDF/FULL1-2.pdf

Agricultural Diesel Irrigation Pumps

This category includes emissions from the operation of diesel-fueled stationary and mobile agricultural irrigation pumps. The emission estimates are based on a 2003 CARB methodology using statewide population and include replacements due to the Carl Moyer Program. Emissions are grown based on CARB projections of irrigated farmland acreage provided by the California Department of Conservation's Farmland Mapping and Monitoring Program (FMMP). Additional information on this category is available at: https://www.arb.ca.gov/ei/areasrc/arbfuelcombagric.htm

Waste Disposal, Composting Facilities

This category includes emissions from composting facilities that process organic materials via an open windrow composting or aerated static pile processes. Emission estimates were updated for 2012 based on a 2015 CARB methodology using facility specific emissions testing or an emission factor derived from testing at composting facilities. Growth is based on population forecasts from the California Department of Finance (DOF) and county economic forecasts from Regional Economic Models, Inc. (REMI). Additional information on this methodology is available at: https://www.arb.ca.gov/ei/areasrc/index2.htm

Laundering

This category includes emissions from perchloroethylene (perc) dry cleaning establishments. The emission estimates are based on a 2002 CARB methodology that used nationwide perc consumption rates allocated to the county level based on population and an emission factor of 10.125 pounds per gallon used. Emissions were grown from the original estimates to 2012 using population growth trends from DOF.

Additional information on this methodology is available at:
https://www.arb.ca.gov/ei/areasrc/onehtm/one3-1.htm

Degreasing

This category includes emissions from solvents in degreasing operations in the manufacturing and maintenance industries. The emissions estimates are based on a 2000 CARB methodology using survey and industry data, activity factors, emission factors and a user's fraction. Growth for this category is based on REMI county economic forecasts. Additional information on this methodology is available at:
https://www.arb.ca.gov/ei/areasrc/arbcleandegreas.htm

Coatings and Thinners

This category includes emissions from coatings and related process solvents. Auto refinishing emissions estimates are based on a 1990 CARB methodology using production data and a composite emission factor derived from surveys. Growth is based on the projected number of vehicles from CARB's on-road mobile sources model (EMFAC). Estimates for industrial coatings emissions are based on a 1990 CARB methodology using production and survey data, and emission factors derived from surveys. Estimates for thinning and cleaning solvents are based on a 1991 CARB methodology, census data and a default emission factor developed by CARB. Growth for these categories is projected using REMI county economic forecasts. Additional information on these methodologies is available at:
https://www.arb.ca.gov/ei/areasrc/arbcleancoatreproc.htm

Adhesives and Sealants

This category includes emissions from solvent-based and water-based solvents contained in adhesives and sealants. Emissions are estimated based on a 1990 CARB methodology using production data and default emission factors. Growth for this category is based on REMI county economic forecasts. Additional information on this methodology is available at: https://www.arb.ca.gov/ei/areasrc/arbcleanadhseal.htm

Oil and Gas Production

CARB staff updated the emission inventory for oil and natural gas production, which included the revision of emission estimates and the addition of emission categories that previously were not estimated. The revised emissions were calculated with a software tool developed by U.S. EPA that generates county-level emissions for upstream oil and gas activity. This tool uses 2011 as the base year, with activity data taken from the California Division of Oil, Gas, and Geothermal Resources (DOGGR) and an industry database, and default emission factors provided in an associated report. Staff incorporated data from CARB's 2007 Oil and Gas Industry Survey (e.g., typical component counts) and feedback from individual air districts (e.g., minimum controls required to operate in a certain district, with associated control factors) to improve these parameters and further adjust the tool's output. Emissions estimates for 2012 and other years were forecasted using the historical trend in statewide oil production from DOGGR, which assumes a 2.2 percent annual decline.

Gasoline Dispensing Facilities

CARB staff developed an updated methodology to estimate emissions from fuel transfer and storage operations at gasoline dispensing facilities (GDFs). The methodology addresses emissions from underground storage tanks, vapor displacement during vehicle refueling, customer spillage, and hose permeation. The updated methodology uses emission factors developed by CARB staff that reflect more current in-use test data and also accounts for the emission reduction benefits of onboard refueling vapor recovery (ORVR) systems. The emission estimates are based on the 2012 statewide gasoline sales data from the California Board of Equalization that were apportioned to the county level using fuel consumption estimates from EMFAC. Additional information on this category is available at: https://www.arb.ca.gov/ei/areasrc/arbpetprodmarkpm.htm

Areawide Sources

Areawide sources are categories such as consumer products, unpaved road dust, fireplaces, and prescribed burning for which emissions occur over a wide geographic area. Emissions for these categories are estimated by both CARB and the local air districts using various models and methodologies. The areawide sources are listed below in Table B-7.

Table B-7 Areawide Sources

Source Category	Subcategory
Solvent Evaporation	Consumer Products
	Architectural Coatings and Related Solvents
	Pesticides/Fertilizers
	Asphalt Paving and Roofing
Miscellaneous Processes	Residential Fuel Combustion
	Farming Operations
	Construction And Demolition
	Paved Road Dust
	Unpaved Road Dust
	Fugitive Windblown Dust
	Fires
	Managed Burning and Disposal
	Cooking
	Other (Miscellaneous Processes)

A summary of the areawide methodologies is presented below:

Ammonia Emissions from Publicly Owned Treatment Works, Landfills, Composting, Fertilizer Application, Domestic Activity, Native Animals, and Native Soils

CARB staff updated the ammonia emissions inventory methodology for publicly owned treatment works, landfills, composting, fertilizer application, domestic activity, native animals, and native soils. Revisions for these categories consist primarily of updated activity data for the 2008 calendar year. Emission factors were revised only for fertilizer application.

Ammonia Emissions, Miscellaneous Sources

Ammonia emissions from miscellaneous domestic processes (human respiration and perspiration, smoking, pets, untreated human waste, etc.) were grown from a 2005 CARB estimate using DOF population projections. Ammonia emissions for other categories such as residential wood combustion, livestock husbandry, managed burning, and on-road motor vehicles, were estimated as part of the methodologies for those specific area source categories.

Consumer Products

The consumer products category reflects the four most recent surveys conducted by CARB staff for the years 2003, 2006, 2008, and 2010. Together these surveys collected updated product information and ingredient information for approximately 350 product categories. Based on the survey data, CARB staff determined the total product sales and total VOC emissions for the various product categories. The growth trend for most consumer product subcategories is based on the latest DOF population growth projections, except for aerosol coatings. Staff determined that a no-growth profile would be more appropriate for aerosol coatings based on survey data that show relatively flat sales of these products over the last decade. Additional information on CARB's consumer products surveys is available at: https://www.arb.ca.gov/consprod/survey/survey.htm.

Architectural Coatings

The architectural coatings category reflects emission estimates based on a comprehensive CARB survey for the 2004 calendar year. The emission estimates include benefits of the 2000 and 2007 CARB Suggested Control Measures as adopted in District Rule 4601. These emissions are grown based on DOF population projections. Additional information about CARB's architectural coatings program is available at: https://www.arb.ca.gov/coatings/arch/arch.htm

Pesticides

DPR develops month-specific emission estimates for agricultural and structural pesticides. Each calendar year, DPR updates the inventory based on the Pesticide Use Report, which provides updated information from 1990 to the most current data year available. The inventory includes estimates through the 2014 calendar year. Emission forecasts for years 2015 and beyond are based on the average of the most recent five years. Growth for agricultural pesticides is based on CARB projections of FMMP farmland acreage. Growth for structural pesticides is based on REMI forecasts of expenditures on structures.

Asphalt Paving/Roofing

Asphalt paving emissions were grown from 2008 estimates and asphalt roofing emissions were grown from a 2007 estimate. Emissions for both categories were developed using District methodologies. Emissions are estimated based on tons of asphalt applied and a default emission factor for each type of asphalt operation. The growth profile for both categories is based on CARB's REMI county economic forecasting model. The inventory reflects the reductions from District Rule 4641. Additional information on the District's asphalt paving methodology is available at:
https://www.arb.ca.gov/ei/areasrc/districtmeth/sjvalley/sjvasphpav.pdf
http://www.valleyair.org/Air_Quality_Plans/EmissionsMethods/MethodForms/Current/AsphaltPaving2008.pdf
Additional information on the District's asphalt roofing methodology is available at:
http://www.valleyair.org/Air_Quality_Plans/EmissionsMethods/MethodForms/Current/AsphaltRoofing2007.pdf

Residential Wood Combustion

Emissions were estimated for 2012 using a 2016 District methodology. The methodology is based on CARB's 2011 methodology, with several refinements based on a 2014 District survey. The inventory reflects the regional distribution and use of wood burning devices, refined fuel usage rates for several types of devices, and emissions reductions from the District's Burn Cleaner Program. The emissions estimates reflect emission factors from U.S. EPA's National Emission Inventory. No growth is assumed for future years because of limits in new construction and the stringency of the requirements of District Rule 4901. The reduction benefits of Rule 4901 are reflected in the inventory. Additional information on this methodology is available at:
https://www.arb.ca.gov/ei/areasrc/arbmiscprocresfuelcom.htm

Residential Natural Gas Combustion

The inventory for residential natural gas combustion is based on 2006 data provided by the District. Emissions are estimated based on the percentages of total natural gas consumed by various residential uses (space heating, water heating, cooking, other) obtained from the CEC and U.S. EPA AP-42 emission factors. Emissions were grown from 2006 using CEC projections of natural gas consumption. The water heating inventory reflects the emission reductions from District Rule 4902. The District's methodology is available at:
http://www.valleyair.org/Air_Quality_Plans/EmissionsMethods/MethodForms/Current/ResidentialNG2006.pdf

Farming Operations

Emissions for Agricultural Land Preparation Operations and Agricultural Harvest Operations were updated based on 2012 harvested crop acreage from the USDA's National Agricultural Statistics Service (NASS). NASS data are based on reports compiled by County Agricultural Commissioner staff. Emission estimates for both categories are based on CARB methodologies and reflect crop and operation specific emission factors. Temporal profiles were updated based on crop specific activity profiles. Activity profiles for land preparation operations were developed by CARB, based on monthly harvesting activity for 20 representative crops. Temporal profiles for harvesting operations were developed by the District, based on monthly harvesting activity for 46 representative crops. The District expanded the number of crop profiles to more completely characterize distinctions among groups of crops.

Activity profiles for harvesting were developed by the District and reflect refinements to Harvesting Growth is based on projected FMMP farmland acreage for 2010-2020, which results in a slight annual decline. The inventory also reflects the emission reductions from District Rule 4550. The methodologies are available at:
https://www.arb.ca.gov/ei/areasrc/arbmiscprocresfarmop.htm

The dairy, feedlot, and range cattle emission estimates reflect livestock population data from the USDA's 2012 Census of Agriculture and emission factors for dairy support cattle provided by District staff. The emission estimates for other livestock categories are based on the USDA's 2007 Census of Agriculture. A seasonal adjustment was added to account for the suppression of dust emissions in months in which rainfall occurs. Dairy emissions growth assumptions were set to no-growth based on an analysis of the SJV historical dairy cow population, which shows a relatively flat profile since 2007. No growth is assumed for other livestock categories, based on an analysis of livestock population trends. The emissions reflect updated District control profiles to account for control requirements, including VOC controls from District Rule 4570 and fugitive dust controls from District Rule 4550.
Additional information on CARB's methodology is available at:
https://www.arb.ca.gov/ei/areasrc/arbmiscproclivestock.htm

Construction and Demolition

Emission estimates for building construction and road construction operations are based on CARB methodologies. Emissions are estimated by applying emission factors developed by Midwest Research Institute (MRI) to the acreage disturbed by construction. The emission estimates were grown from CARB estimates developed in 2002 and 1997, respectively. The growth profile for building construction is based on the REMI county economic forecast model. Road construction emissions are grown based on road construction forecasts by SJV transportation planning agencies (TPAs). The inventory reflects emission reductions from District Regulation VIII. Additional information on these methodologies is available at:
https://www.arb.ca.gov/ei/areasrc/arbmiscprocconstdem.htm

Paved Road Dust

Paved road dust emissions for 2012 were estimated using CARB methodology consistent with the current U.S. EPA AP-42 methodology (January 2011) for quantifying dust emissions. Revisions include California-specific reductions in silt loading values, updated 2012 vehicle miles traveled (VMT) provided by SJV MPOs, updated VMT distributions (travel fractions) from Caltrans for the year 2008, and incorporation of precipitation correction factors. Emissions were grown using VMT projections from the SJV MPOs. The inventory also reflects emission reductions from District Regulation VIII. Additional information is available at:
https://www.arb.ca.gov/ei/areasrc/arbmiscprocpaverddst.htm

Unpaved Road Dust – Farm Roads

Emissions for unpaved farm roads were updated based on CARB's methodology and 2012 harvested crop acreage from NASS. Emissions reflect crop specific VMT factors and an updated emission factor of 2.0 lbs PM10/VMT, based on California test data conducted by the University of California, Davis (UC Davis), and the Desert Research Institute (DRI). An updated particle size profile (CARB PM profile #470) was used, which reduces the PM2.5 fraction by about 50%. Temporal profiles were updated based on crop specific activity profiles. Growth is based on projected FMMP farmland acreage for 2010-2020, which results in a slight annual decline. In addition, the inventory reflects the emission reductions from District Rule 4550 and District Regulation VIII. The methodology is available at:
https://www.arb.ca.gov/ei/areasrc/arbmiscprocunpaverddst.htm

Unpaved Nonfarm Road Dust

Emissions from unpaved nonfarm roads were estimated from 2008 unpaved road data collected from the California Statewide Local Streets and Roads Needs Assessment, Caltrans, and the District. Dust emissions were calculated using the same emission factor (2.00 lbs PM10/VMT) and particle size fraction (CARB PM profile #470) described above for unpaved farm roads, and the addition of a rainfall adjustment factor. Temporal profiles were revised. Staff assumed no growth for this category based on the assumption that existing unpaved roads tend to get paved as vehicle traffic on them increases, which counteracts any additional emissions from new unpaved roads. The inventory includes the emission reduction benefits of District Regulation VIII. Additional information on this methodology is available at:
https://www.arb.ca.gov/ei/areasrc/arbmiscprocunpaverddst.htm

Fugitive Windblown Dust from Open Areas and Non-pasture Agriculture Lands

Fugitive windblown dust emissions were estimated using CARB's 1997 methodology. The methodology is based on 1993 harvested crop acreage and a wind erosion equation that incorporates climate, soil, and vegetative cover attributes. Emissions for agricultural lands were grown based on projected FMMP farmland acreage for 2010-2020, which results in a slight annual decline. No growth is assumed for non-agricultural lands. The inventory reflects emission reductions from District Regulation VIII. Additional information about CARB's methodology is available at:
https://www.arb.ca.gov/ei/areasrc/arbmiscprocfugwbdst.htm

Windblown Dust from Unpaved Roads and Associated Areas

Emissions for this source category were estimated based on a 1997 CARB methodology reflecting unpaved road mileage and local parameters that affect wind erosion. The estimates assume no growth. The inventory includes the emission reduction benefits of District Regulation VIII. Additional information on this methodology is available at:
https://www.arb.ca.gov/ei/areasrc/arbmiscprocfugwbdst.htm

Fires

Emissions from structural and automobile fires were estimated using CARB's 1999 methodology. Structural fire emissions are based on rates of structural and content material loss per fire, average combustible content, and emission factors obtained from test data. Automobile fire emissions are based on the number of vehicle fires per year and composite emission factors derived from AP-42 emission factors. No growth is assumed for this category. Additional information on this methodology is available at: https://www.arb.ca.gov/ei/areasrc/arbmiscprocfires.htm

Managed Burning & Disposal

CARB updated the emissions inventory to reflect burn data reported by District staff for 2012. Emissions are calculated using crop specific emission factors and fuel loadings. Temporal profiles reflect monthly burn activity. Growth for agricultural burning is based on linear regression analyses of 2000-2009 FMMP farmland acreage. Staff used a no-growth assumption for forest management emissions based on analyses of District reported data that don't show a discernible trend. No-growth was also used for burning associated with weed abatement as the emission levels for this category have been fairly stable since 2005. The inventory includes the benefits of reductions from District Rules 4103 and 4550. CARB's methodology for managed burning is available at: https://www.arb.ca.gov/ei/areasrc/distmiscprocwstburndis.htm
Additional background information is available here: https://www.arb.ca.gov/ei/see/see.htm

Commercial Cooking

The commercial cooking inventory is based on emissions data reported by the District for 2008. The emissions estimates were developed from the number of restaurants, the number and types of cooking equipment, the food type, and default emission factors from U.S. EPA's 2002 National Emissions Inventory. The growth profile reflects the latest population projections provided by the California DOF. The inventory also reflects the emission reductions from District Rule 4692. Additional information on the District's methodology is available at: https://www.arb.ca.gov/ei/areasrc/districtmeth/sjvalley/CommercialCooking2006.pdf

Point and Areawide Source Emissions Forecasting

Emission forecasts (2013 and subsequent years) are based on growth profiles that in many cases incorporate historical trends up to the base year or beyond. The growth surrogates used to forecast the emissions from these categories are presented below in Table B-8.

Table B-8 Growth Surrogates for Point and Areawide Sources

Source Category	Subcategory	Growth Surrogate
Electric Utilities	Natural Gas	CEC forecast
	Other Fuels	U.S. Energy Information Administration (EIA) forecast
Cogeneration	All	EIA forecast
Oil and Gas Production (Combustion)	All	DOGGR statewide total oil production (2.2% annual decline)
Petroleum Refining (Combustion)	All	No growth assumption

Source Category	Subcategory	Growth Surrogate
Manufacturing and Industrial	Natural Gas	CEC forecast
	Other Fuels	No growth assumption
Food and Agricultural Processing	Ag Irrigation I.C. Engines	FMMP irrigated farmland acreage projection
	Natural Gas	CEC forecast
	Other Fuels	EIA forecast
Service and Commercial	Natural Gas	CEC forecast
	Other Fuels	No growth assumption
Other (Fuel Combustion)	I.C. Reciprocating Engines	DOF population forecast
	Other Fuels	EIA forecast
Sewage Treatment	All	DOF population forecast
Landfills	All	DOF population forecast
Incinerators	All	DOF population forecast combined with REMI county economic forecast
Soil Remediation	All	DOF population forecast
Other (Waste Disposal)	All	DOF population forecast combined with REMI county economic forecast
Laundering	Dry Cleaning	DOF population forecast
Degreasing	All	REMI county economic forecast
Coatings & Related Process Solvents	Auto Refinishing	Vehicles from CARB EMFAC model
	Others	REMI county economic forecast
Printing	All	REMI county economic forecast
Adhesives & Sealants	All	REMI county economic forecast
Other (Cleaning and Surface Coatings)	All	REMI county economic forecast
Oil and Gas Production	All	DOGGR statewide total oil production (2.2% annual decline)
Petroleum Refining	All	No growth assumption
Petroleum Marketing	Gas Dispensing Facilities	Fuel use, CARB EMFAC2014 model
	Natural Gas Transmission Losses	CEC forecast
	Point Sources	REMI county economic forecast
Other (Petroleum Production & Marketing)	All	DOGGR statewide total oil production (2.2% annual decline)
Chemical	All	REMI county economic forecast
Food & Agriculture	All	REMI county economic forecast
Mineral Processes	All	REMI county economic forecast combined with Annual Energy Outlook (AEO) forecast

Source Category	Subcategory	Growth Surrogate
Metal Processes	All	REMI county economic forecast
Wood and Paper	All	REMI county economic forecast
Glass and Related Products	Container Glass, Other Glass	No growth assumption
	Flat Glass	Construction activity forecast
Electronics	All	REMI county economic forecast
Other Industrial Processes	All	REMI county economic forecast combined with EIA Annual Energy Outlook (AEO) forecast
Consumer Products	Consumer Products	DOF population forecast
	Aerosol Coatings	No growth assumption
Architectural Coatings and Related Process Solvents	All	DOF population forecast
Pesticides/Fertilizers	Agricultural Pesticides	FMMP farmland acreage projection
	Structural Pesticides	REMI forecast on spending on structures
Asphalt Paving/Roofing	All	REMI county economic forecast
Residential Fuel Combustion	Woodstoves & Fireplaces - Wood	No growth assumption
	Natural Gas	CEC forecast
	Other Residential Fuels	EIA forecast

Table B-9 Growth Surrogates for Point and Areawide Sources

Source Category	Subcategory	Growth Surrogate
Farming Operations	Tilling & Harvest Operations	FMMP farmland acreage projection
	Livestock, All	No growth
Construction & Demolition	Building Construction	REMI county economic forecast
	Road Construction	Road construction forecasts by TPAs
Paved Road Dust	All	VMT from MPOs
Unpaved Road Dust	Farm Roads	FMMP farmland acreage
	Others (Nonfarm)	No growth assumption
Fugitive Windblown Dust	Agricultural & Pasture Lands	FMMP farmland acreage projection
	Unpaved Roads & Associated Areas	No growth assumption
Fires	All	DOF population forecast
Managed Burning & Disposal	Agricultural Burning, Prunings & Field Crops	FMMP farmland acreage projection
	Forest Management	No growth assumption
	Weed Abatement	No growth assumption

Source Category	Subcategory	Growth Surrogate
Cooking	All	DOF population forecast

Stationary Source Control Profiles

The emissions inventory reflects emission reductions from point and areawide sources subject to District rules and CARB regulations. The rules and regulations reflected in the inventory are listed below in Table 4.

Table B-10 District and CARB Stationary Source Control Rules and Regulations Included in the Inventory

Agency	Rule/Reg No.	Rule Title	Source Categories Impacted
District	4103	Open Burning	Agricultural burning
District	4204	Cotton Gins	Agricultural crop processing losses – Cotton ginning facilities
District	4305	Boilers, Process Heaters, and Steam Generators - Phase 2	Fuel combustion - Boilers, Process Heaters, and Steam Generators
District	4306	Boilers, Process Heaters, and Steam Generators - Phase 3	Fuel combustion - Boilers, Process Heaters, and Steam Generators
District	4307	Boilers, Process Heaters, and Steam Generators - 2.0 MMBTU/HR to 5.0 MMBTU/HR	Fuel combustion - Boilers, Process Heaters, and Steam Generators
District	4308	Boilers, Process Heaters, and Steam Generators - 0.075 MMBTU/HR to Less Than 2.0 MMBTU/HR	Fuel combustion - Boilers, Process Heaters, and Steam Generators
District	4309	Dryers, Dehydrators, and Ovens	Laundering; manufacturing & industrial; service & commercial
District	4320	Advanced Emission Reduction Options for Boilers, Steam Generators, and Process Heaters	Fuel combustion - Boilers, Process Heaters, and Steam Generators
District	4351	Boilers, Process Heaters, and Steam Generators - Phase 1	Fuel combustion - Boilers, Process Heaters, and Steam Generators
District	4352	Solid Fuel Fired Boilers, Steam Generators and Process Heaters	Fuel combustion - Boilers, Process Heaters, and Steam Generators
District	4354	Glass Melting Furnaces	Glass manufacturing
District	4401	Steam-Enhanced Crude Oil Production Wells	Oil and gas production
District	4402	Crude Oil Production Sumps	Oil and gas production
District	4408	Glycol Dehydration Systems	Oil and gas production
District	4409	Components at Light Crude Oil Production Facilities, Natural Gas Production Facilities, and Natural Gas Processing Facilities	Oil and gas production

Table B-11 District and CARB Stationary Source Control Rules and Regulations Included in the Inventory

Agency	Rule/Reg No.	Rule Title	Source Categories Impacted
District	4455	Components at Petroleum Refineries, Gas Liquids Processing Facilities, and Chemical Plants	Petroleum refining
District	4550	Conservation Management Practices	Agricultural operations, dust and managed burning
District	4565	Biosolids, Animal Manure, and Poultry Litter Operations	Composting operations
District	4566	Organic Material Composting Operations	Composting operations
District	4570	Confined Animal Facilities	Livestock operations
District	4601	Architectural Coatings	Architectural coatings and related process solvents
District	4602	Motor Vehicle and Mobile Equipment Coating Operations	Coatings and related process solvents
District	4603	Surface Coating of Metal Parts and Products, Plastic Parts and Products, and Pleasure Crafts	Coatings and related process solvents
District	4604	Can and Coil Coating Operations	Coatings and related process solvents
District	4605	Aerospace Assembly and Component Coating Operations	Coatings and related process solvents
District	4606	Wood Coating Operations	Coatings and related process solvents
District	4607	Graphic Arts and Paper, Film, Foil and Fabric Coatings	Printing, coatings and related process solvents
District	4610	Glass Coating Operations	Coatings and related process solvents
District	4612	Automotive Coatings	Coatings and related process solvents
District	4621	Gasoline Transfer into Stationary Storage Containers, Delivery Vessels, and Bulk Plants	Petroleum marketing
District	4622	Gas Transfer into Vehicle Storage Fuel Tanks	Petroleum marketing
District	4623	Storage of Organic Liquids	Petroleum refining; petroleum marketing, oil and gas production
District	4624	Organic Liquid Loading	Petroleum marketing

Table B-12 District and CARB Stationary Source Control Rules and Regulations Included in the Inventory

Agency	Rule/Reg No.	Rule Title	Source Categories Impacted
District	4625	Wastewater Separators	Petroleum refining – Wastewater treatment
District	4641	Cutback, Slow Cure, and Emulsified Asphalt Paving and Maintenance Operations	Asphalt paving & roofing
District	4642	Solid Waste Disposal Sites	Landfills; waste disposal
District	4651	Volatile Organic Compound Emissions from Decontaminated Soil	Waste disposal - Soil remediation
District	4653	Adhesives and Sealants	Adhesives & sealants
District	4661	Organic Solvents	Coatings and related process solvents; cleaning and surface coatings
District	4662	Organic Solvent Degreasing Operations	Degreasing; thinning and cleanup solvent uses
District	4663	Organic Solvent Cleaning, Storage and Disposal	Degreasing; thinning and cleanup solvent uses; cleaning & surface coating
District	4672	Petroleum Solvent Dry Cleaners	Laundering
District	4681	Rubber Tire Manufacturing	Chemical - Rubber and rubber products manufacturing
District	4682	Polystyrene, Polyethylene, and Polypropylene Products Manufacturing	Chemical - Plastic and plastic products manufacturing
District	4684	Polyester Resin Operations	Chemical –Fiberglass and fiberglass products manufacturing
District	4691	Vegetable Oil Processing Operations	Food and agriculture
District	4692	Commercial Charbroiling	Cooking
District	4693	Bakery Ovens	Bakeries
District	4701	Internal Combustion Engines (Phase 1)	Fuel combustion
District	4702	Internal Combustion Engines (Phase 2)	Fuel combustion
District	4703	Stationary Gas Turbines	Fuel combustion
District	4901	Wood Burning Fireplaces and Wood Burning Heaters	Residential wood combustion
District	4902	Residual Water Heaters	Residential fuel combustion – Water heating

Table B-13 District and CARB Stationary Source Control Rules and Regulations Included in the Inventory

Agency	Rule/Reg No.	Rule Title	Source Categories Impacted
District	4905	Furnace Rule	Service and Commercial / Residential Fuel Combustion – Space Heating
District	REG VIII	Regulation VIII -- PM Control for Fugitive Dust	Construction and demolition; paved and unpaved road dust; fugitive windblown dust; mineral processes
CARB	CARB R003 & CARB R003_A	Consumer Product Regulations & Amendments	Consumer products
CARB	CARB R007	Aerosol Coating Regulations	Aerosol coatings
CARB	GDF HOSREG	Gasoline Dispensing Facility Hose Emission Regulation	Petroleum marketing
CARB	ORVR	Fueling emissions from ORVR systems	Petroleum marketing

Mobile Sources

CARB uses the EMFAC model to assess emissions from on-road vehicles. Off-road mobile source emissions are estimated using a new modular approach for different source categories. On-road and off-road models account for the effects of various adopted regulations, technology types, and seasonal conditions on emissions.

On-Road Mobile Sources

Emissions from on-road mobile sources, which include passenger vehicles, buses, and trucks, were estimated using outputs from CARB's EMFAC2014 model. The on-road emissions were calculated by applying EMFAC2014 emission factors to the transportation activity data provided by the local SJV TPAs from their 2014 adopted Regional Transportation Plan (2014 RTP).

EMFAC2014 includes data on California's car and truck fleets and travel activity. Light-duty motor vehicle fleet age, vehicle type, and vehicle population were updated based on 2012 DMV data. The model also reflects the emissions benefits of CARB's recent rulemakings such as the Pavley Standards and Advanced Clean Cars Program, and includes the emissions benefits of CARB's Truck and Bus Rule and previously adopted rules for other on-road diesel fleets.

EMFAC2014 utilizes a socio-econometric regression modeling approach to forecast new vehicle sales and to estimate future fleet mix. Light-duty passenger vehicle population includes 2012 DMV registration data along with updates to mileage accrual using Smog Check data. Updates to heavy-duty trucks include model year specific emission factors based on new test data, and population estimates using DMV data for in-state trucks and International Registration Plan (IRP) data for out-of-state trucks.

Additional information and documentation on the EMFAC2014 model is available at:

https://www.arb.ca.gov/msei/categories.htm#emfac2014

Off-Road Mobile Sources

Emissions from off-road sources were estimated using a suite of category-specific models or, where a new model was not available, the OFFROAD2007 model. Many of the newer models were developed to support recent regulations, including in-use off-road equipment, ocean-going vessels and others. The sections below summarize the updates made to specific off-road categories.

Locomotives

In 2016, CARB updated California's Class I and Class II line-haul locomotive model. The new model provides the following updates: age and model year distribution based on 2011 and 2014 rail company data, activity based on Freight Analysis Framework (FAF) data, fuel growth based on Board of Equalization historical rail data, and new locomotive populations, survival rates, and Tier distributions. To estimate emissions, CARB used duty cycle, fuel consumption and activity data reported by the rail lines in 2011. These results were combined with the Class III locomotive emissions inventory from previous SIPS, which were incorporated in the 2006 locomotive inventory, to create an overall California line-haul locomotive emissions inventory for the SIP. More information may be found at https://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles.

Ocean-Going Vessels (OGV)

CARB extensively revised and updated the OGV inventory in 2016. Activity data was updated through 2014. Emissions for all vessels were revised to incorporate efficiency changes for fuel slide valves. Emissions for bulk carriers, containerships, and oil tankers were revised to reflect reduced fuel consumption due to the recent widespread adoption of slower shipping speeds. Growth rates for containerships were updated to reflect the trend of larger ships visiting California. The inventory also reflects the delayed introduction of Tier 3 engines in California waters to 2020 through 2040, depending on the vessel type. Additional information is available at:
https://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles

Pleasure Craft and Recreational Vehicles

A new model was developed in 2011 to estimate emissions from pleasure craft and recreational vehicles. In both cases, population, activity, and emission factors were re-assessed using new surveys, registration information, and emissions testing. Additional information is available at:
https://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles

In-Use Off-Road Equipment

CARB developed this model in 2010 to support the analysis for amendments to the In-Use Off-Road Diesel Fueled Fleets Regulation. Staff updated the underlying activity forecast to reflect more recent economic forecast data, which suggests a slower rate of recovery through 2024 than previously anticipated. Additional information is available at:
https://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles

Transport Refrigeration Units (TRU)

This model reflects updates to activity, population, growth and turn-over data, and emission factors developed to support the 2011 amendments to the Airborne Toxic Control Measure for In-Use Diesel-Fueled Transport Refrigeration Units. Additional information is available at:
https://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles

Cargo Handling Equipment (CHE)

The emissions inventory for the Cargo Handling Equipment category has been updated to reflect new information on equipment population, activity, recessionary impacts on growth, and engine load. The new information includes regulatory reporting data which provide an accounting of all the cargo handling equipment in the State including their model year, horsepower and activity. Background and supporting documents for the Cargo Handling Equipment Regulation are available here:
https://www.arb.ca.gov/ports/cargo/cheamd2011.htm

Oil and Gas Wells: Workover Rigs, Drill Rigs and Support Equipment Allocation

The allocation of drill and work-over rigs and support equipment (such as pumps) for oil and gas wells was updated within the SJV Air Basin to reflect the physical location of wells instead of the registration location. This allocation was done at the county level, where the number of wells within a county in the SJV Air Basin was used to determine that county's share of emissions from specified equipment. The physical location and count of wells was updated using DOGGR Well Finder data from September 2013, supplied to CARB by the District. (DOGGR data are available at:
https://www.conservation.ca.gov/dog/Pages/Wellfinder.aspx)

Diesel Agricultural Equipment

The inventory for agricultural diesel equipment (such as tractors, harvesters, combines, sprayers and others) was revised based on a voluntary 2009 survey of farmers, custom operators, and first processors. The survey data, along with information from the 2007 USDA Farm Census, was used to revise almost every aspect of the agricultural inventory, including population, activity, age distribution, fuel use, and allocation. This updated inventory replaces general information on farm equipment in the United States with one specific to California farms and practices. The updated inventory was compared against other available data sources such as Board of Equalization fuel reports, USDA tractor populations and age, and Eastern Research Group tractor ages and activity, to ensure the results were reasonable and compared well against outside data sources. Agricultural growth rates through 2050 were developed through a contract with URS Corp. Additional information is available at:
https://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles

Fuel Storage and Handling

Emissions for fuel storage and handling were estimated using the OFFROAD2007 model. Additional information is available at:
https://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles

Mobile Source Forecasting

Table 5, below, summarizes the data and methods used to forecast future-year mobile source emissions by broad source category groupings.

Table B-14 Growth Surrogates for Mobile Sources

Category	Growth Methodology
On-Road Sources	
All	Match total VMT projections provided by MPOs
Off-Road Gasoline Fueled Equipment	
Lawn & Garden	Household growth projection
Off-Road Equipment	Employment growth projection
Recreational Boats	Housing starts (short-term) and human population growth (long-term)
Recreational Vehicles	Housing starts (short-term) and human population growth (long-term)
Off-Road Diesel-Fueled Equipment	
Commercial Harbor Craft	Growth rates provided by District, except for tugs and fishing vessels. Fishing fleet growth rates were adjusted to reflect a decline in fish landings. Assumed no growth for tugboats.
Construction and Mining	California construction employment data from U.S. Bureau of Labor Statistics
Farm Equipment	2011 study of forecasted growth by URS Corp.
Industrial Equipment	California construction employment data from Bureau of Labor Statistics
Oil Drilling	California oil and gas extraction gross domestic product from the U.S. Bureau of Economic Analysis, oil company diesel fuel use published by the U.S. Energy Information Administration, California rotary rig counts from Baker Hughes, and California oil and gas extraction employment from the U.S. Bureau of Labor Statistics
Ocean-Going Vessels	Projected commodity tonnage in the FAF Model developed by the Federal Highway Administration. Containership projection includes ship size breakdown from the 2013 San Pedro Bay Fleet Forecast Project.
Trains (line haul)	FAF 2015 growth projections and historical Bureau of Transportation Statistics locomotive fuel trends (1990-2013 data).
Transport Refrigeration Units	Projection of historical Truck/Trailer TRU sales from ACT Research, adjusted for recession.
Off-Road Equipment (Other Fuels)	
Aircraft	Forecast by CSU Fullerton for all aircraft except for Lemoore NAS in Kings County, which uses District estimates.

B.3 CONDENSABLE PARTICULATE MATTER

Background

Condensable particulate matter (PM) is "material that is vapor phase at stack conditions, but which condenses and/or reacts upon cooling and dilution in the ambient air to form solid or liquid PM immediately after discharge from the stack."[1] Condensable PM is a component of primary PM, which is the sum of condensable and filterable PM. Filterable PM comprises "particles that are directly emitted by a source as a solid or liquid [aerosol] at stack or release conditions."[2] All condensable PM is assumed to be smaller than 2.5 microns (µm) in diameter; therefore, PM2.5 primary is the sum of condensable PM and filterable PM less than 2.5µm, while PM10 primary is the sum of condensable PM and filterable PM less than 10µm.

The Air Emissions Reporting Rule (AERR) requires states to report annual emissions of filterable and condensable components of PM2.5 and PM10, "as applicable," for large sources every inventory year and for all sources every third inventory year, beginning with 2011.[3] Subsequent emissions inventory guidance[4] from the United States Environmental Protection Agency (U.S. EPA) clarifies the meaning of the phrase "as applicable" by providing a list of source types "for which condensable PM is expected by the AERR." These source types are stationary point and nonpoint combustion sources that are expected to generate condensable PM and include, for instance, commercial cooking, fuel combustion at electric generating utilities, industrial processes like cement or chemical manufacturing, and flares or incinerators associated with waste disposal. The District reports condensable PM from stationary and area sources using the methodology outlined below.

Mobile sources emit PM in both filterable and condensable form; however, the AERR does not require states to report filterable and condensable PM separately for mobile sources. Emissions from mobile sources are reported in the emissions inventory in Appendix [XX] as primary PM, e.g. the sum of filterable and condensable PM.

Methodology

For future emissions inventory cycles, the District intends to gather condensable PM data for stationary and area sources directly as part of routine data collection. In all previous inventories, however, the District has collected data on primary PM only, containing both filterable and condensable components without distinguishing between the two. Consequently, to be able to report emissions of the condensable component of PM2.5 separately as required by the AERR, the District must use conversion factors to convert primary PM2.5 to condensable PM.

[1] 40 CFR §51.50

[2] Ibid.

[3] 40 CFR §51.15(a)(1) and §51.30(b)(1)

[4] U.S. EPA. *Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations*. May 2017. https://www.epa.gov/sites/production/files/2017-07/documents/ei_guidance_may_2017_final_rev.pdf

U.S. EPA has published an augmentation tool[5] which contains conversion factors for each source classification code (SCC) to convert filterable PM10 (PM10FIL) to condensable PM (PMCON). In this form, these conversion factors ($CF_{PM10FIL\rightarrow PMCON}$) are not useful because the District does not directly collect PM10FIL data. But, the following formula adjusts U.S. EPA's existing conversion factors to obtain new conversion factors for each SCC that convert from primary PM10 (PM10PRI)—data which the District does collect—to condensable PM ($CF_{PM10PRI\rightarrow PMCON}$):

$$CF_{PM10PRI\rightarrow PMCON} = \frac{CF_{\mathrm{PM10FIL\rightarrow PMCON}}}{(1 + CF_{\mathrm{PM10FIL\rightarrow PMCON}})}$$

The formula was derived as follows:

$$PM10PRI = PM10FIL + PMCON$$

and

$$PMCON = PM10FIL\,(CF_{\mathrm{PM10FIL\rightarrow PMCON}})$$

and

$$PMCON = PM10PRI(CF_{\mathrm{PM10PRI\rightarrow PMCON}})$$

$$\therefore \quad PM10PRI = PM10FIL + PM10FIL\,(CF_{\mathrm{PM10FIL\rightarrow PMCON}})$$
$$= PM10FIL(1 + CF_{\mathrm{PM10FIL\rightarrow PMCON}})$$

and

$$CF_{\mathrm{PM10PRI\rightarrow PMCON}} = \frac{PMCON}{PM10PRI} = \frac{PMCON}{PM10FIL(1 + CF_{\mathrm{PM10FIL\rightarrow PMCON}})}$$
$$= \frac{PM10FIL\,(CF_{\mathrm{PM10FIL\rightarrow PMCON}})}{PM10FIL(1 + CF_{\mathrm{PM10FIL\rightarrow PMCON}})} = \frac{CF_{\mathrm{PM10FIL\rightarrow PMCON}}}{(1 + CF_{\mathrm{PM10FIL\rightarrow PMCON}})}$$

Since condensable PM is typically smaller than 2.5µm, a 1:1 ratio between PM10 and PM2.5 may be assumed, and the same conversion factors can likewise be applied to convert primary PM2.5 (PM25PRI) to condensable PM using the same method. That is, $CF_{PM10PRI\rightarrow PMCON} = CF_{PM25PRI\rightarrow PMCON}$ where $CF_{PM25PRI\rightarrow PMCON}$ represents the conversion factors that convert from primary PM2.5—again, data the District does collect—to condensable PM.

[5] U.S. EPA. *PM Augmentation*. Air Emissions Inventories. May 20, 2016. https://www.epa.gov/air-emissions-inventories/pm-augmentation

In the tables below, these calculated conversion factors ($CF_{PM25PRI \rightarrow PMCON}$), derived from the U.S. EPA conversion factors, are used to determine the condensable PM component of primary PM2.5 for applicable source types located in the District.

Condensable PM Tables

Source Category	2013			2017			2019			2020			2022			2023			2024			2025			2026			2028		
	Total $PM_{2.5}$ (tons/yr)	Condensable $PM_{2.5}$ (tons/yr)	Filterable $PM_{2.5}$ (tons/yr)	Total $PM_{2.5}$ (tons/yr)	Condensable $PM_{2.5}$ (tons/yr)	Filterable $PM_{2.5}$ (tons/yr)	Total $PM_{2.5}$ (tons/yr)	Condensable $PM_{2.5}$ (tons/yr)	Filterable $PM_{2.5}$ (tons/yr)	Total $PM_{2.5}$ (tons/yr)	Condensable $PM_{2.5}$ (tons/yr)	Filterable $PM_{2.5}$ (tons/yr)	Total $PM_{2.5}$ (tons/yr)	Condensable $PM_{2.5}$ (tons/yr)	Filterable $PM_{2.5}$ (tons/yr)	Total $PM_{2.5}$ (tons/yr)	Condensable $PM_{2.5}$ (tons/yr)	Filterable $PM_{2.5}$ (tons/yr)	Total $PM_{2.5}$ (tons/yr)	Condensable $PM_{2.5}$ (tons/yr)	Filterable $PM_{2.5}$ (tons/yr)	Total $PM_{2.5}$ (tons/yr)	Condensable $PM_{2.5}$ (tons/yr)	Filterable $PM_{2.5}$ (tons/yr)	Total $PM_{2.5}$ (tons/yr)	Condensable $PM_{2.5}$ (tons/yr)	Filterable $PM_{2.5}$ (tons/yr)	Total $PM_{2.5}$ (tons/yr)	Condensable $PM_{2.5}$ (tons/yr)	Filterable $PM_{2.5}$ (tons/yr)
STATIONARY SOURCES																														
FUEL COMBUSTION																														
ELECTRIC UTILITIES	487.5	153.0	334.5	447.6	127.0	320.6	452.7	127.0	325.6	441.2	119.0	322.2	446.5	119.6	326.8	448.8	119.8	329.0	454.4	120.3	334.1	460.6	120.8	339.8	465.2	121.2	344.0	472.2	121.8	350.4
COGENERATION	206.6	65.1	141.5	243.7	69.1	174.6	261.7	71.1	190.5	267.7	72.0	195.7	273.8	73.6	200.2	278.6	74.5	204.1	282.4	75.4	207.0	286.2	76.2	210.0	290.0	77.1	213.0	295.6	78.8	216.8
OIL AND GAS PRODUCTION (COMBUSTION)	609.7	373.8	235.9	557.8	342.0	215.8	533.4	327.1	206.4	521.7	319.8	201.9	499.1	306.0	193.1	488.1	299.3	188.9	477.3	292.6	184.7	466.8	286.2	180.6	456.6	279.9	176.7	436.7	267.7	169.0
PETROLEUM REFINING (COMBUSTION)	28.4	16.3	12.1	28.4	16.3	12.1	28.4	16.3	12.1	28.4	16.3	12.1	28.4	16.3	12.1	28.4	16.3	12.1	28.4	16.3	12.1	28.4	16.3	12.1	28.4	16.3	12.1	28.4	16.3	12.1
MANUFACTURING AND INDUSTRIAL	46.8	14.9	31.9	46.7	14.9	31.8	47.7	15.1	32.6	47.8	15.2	32.6	48.7	15.4	33.3	48.7	15.4	33.3	48.5	15.3	33.1	48.7	15.4	33.3	49.0	15.5	33.5	50.0	15.8	34.2
FOOD AND AGRICULTURAL PROCESSING	256.6	72.6	184.0	183.2	69.1	114.0	177.3	69.5	107.9	173.3	68.9	104.4	165.9	68.4	97.5	161.0	67.4	93.7	156.8	66.6	90.3	153.5	66.1	87.4	150.3	65.8	84.5	145.8	66.1	79.7
SERVICE AND COMMERCIAL	170.6	36.9	133.7	172.7	38.3	134.4	178.1	39.9	138.2	179.6	40.3	139.3	180.6	41.0	139.6	181.5	41.3	140.3	182.0	41.4	140.6	181.9	41.4	140.5	182.0	41.5	140.5	183.9	41.9	142.0
OTHER (FUEL COMBUSTION)	5.8	0.1	5.6	4.5	0.1	4.3	4.5	0.1	4.3	3.3	0.1	3.1	3.3	0.1	3.2	3.3	0.1	3.2	3.3	0.1	3.2	3.3	0.1	3.2	3.3	0.1	3.2	3.3	0.1	3.2
WASTE DISPOSAL																														
SEWAGE TREATMENT	2.4	0.8	1.6	2.4	0.8	1.6	2.5	0.8	1.7	2.6	0.8	1.7	2.6	0.8	1.7	2.6	0.9	1.8	2.7	0.9	1.9	2.8	0.9	1.9	2.8	0.9	1.9	2.9	0.9	1.9
LANDFILLS	41.4	19.3	22.1	43.2	20.1	23.1	44.3	20.6	23.7	44.9	20.9	24.0	46.2	21.5	24.7	46.8	21.8	25.0	47.5	22.1	25.4	48.3	22.5	25.8	49.0	22.8	26.1	50.6	23.6	27.0
INCINERATORS	4.6	1.0	3.6	4.9	1.1	3.8	4.9	1.1	3.9	5.0	1.1	3.9	5.1	1.1	4.0	5.1	1.1	4.0	5.2	1.2	4.0	5.2	1.2	4.1	5.4	1.2	4.2	5.5	1.2	4.3
SOIL REMEDIATION	0.3	0.0	0.3	0.3	0.0	0.3	0.3	0.0	0.3	0.3	0.0	0.3	0.3	0.0	0.3	0.3	0.0	0.3	0.3	0.0	0.3	0.3	0.0	0.3	0.3	0.0	0.3	0.3	0.0	0.3
OTHER (WASTE DISPOSAL)	2.2	0.3	2.0	2.3	0.3	2.1	2.4	0.3	2.1	2.4	0.3	2.1	2.4	0.3	2.1	2.5	0.3	2.2	2.6	0.3	2.2	2.6	0.3	2.2	2.6	0.3	2.2	2.7	0.3	2.3
CLEANING AND SURFACE COATINGS																														
LAUNDERING	0.5	0.0	0.5	0.5	0.0	0.5	0.5	0.0	0.5	0.5	0.0	0.5	0.5	0.0	0.5	0.6	0.0	0.6	0.6	0.0	0.6	0.6	0.0	0.6	0.6	0.0	0.6	0.6	0.0	0.6
DEGREASING	9.1	0.0	9.1	10.4	0.0	10.4	11.0	0.0	11.0	11.3	0.0	11.3	12.2	0.0	12.2	12.5	0.0	12.5	12.8	0.0	12.8	13.1	0.0	13.1	13.4	0.0	13.4	13.9	0.0	13.9
COATINGS AND RELATED PROCESS SOLVENTS	81.6	0.0	81.6	88.1	0.0	88.1	90.7	0.0	90.7	92.2	0.0	92.2	96.4	0.0	96.4	98.4	0.0	98.4	100.6	0.0	100.6	103.2	0.0	103.2	105.6	0.0	105.6	110.8	0.0	110.8
PRINTING	2.6	0.0	2.6	3.0	0.0	3.0	3.2	0.0	3.2	3.4	0.0	3.4	3.6	0.0	3.6	3.7	0.0	3.7	3.8	0.0	3.8	3.9	0.0	3.9	4.0	0.0	4.0	4.3	0.0	4.3
ADHESIVES AND SEALANTS	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1
OTHER (CLEANING AND SURFACE COATINGS)	2.8	0.0	2.8	3.1	0.0	3.1	3.1	0.0	3.1	3.1	0.0	3.1	3.2	0.0	3.2	3.3	0.0	3.3	3.4	0.0	3.4	3.4	0.0	3.4	3.5	0.0	3.5	3.6	0.0	3.6
PETROLEUM PRODUCTION AND MARKETING																														
OIL AND GAS PRODUCTION	15.5	8.5	7.1	14.2	7.7	6.5	13.6	7.4	6.2	13.4	7.3	6.1	12.8	6.9	5.8	12.4	6.8	5.7	12.2	6.6	5.6	11.9	6.5	5.4	11.6	6.3	5.3	11.1	6.0	5.1
PETROLEUM REFINING	31.5	0.6	30.9	31.5	0.6	30.9	31.5	0.6	30.9	31.5	0.6	30.9	31.5	0.6	30.9	31.5	0.6	30.9	31.5	0.6	30.9	31.5	0.6	30.9	31.5	0.6	30.9	31.5	0.6	30.9
PETROLEUM MARKETING	1.1	0.0	1.1	1.2	0.0	1.2	1.2	0.0	1.2	1.2	0.0	1.2	1.2	0.0	1.2	1.2	0.0	1.2	1.2	0.0	1.2	1.2	0.0	1.2	1.2	0.0	1.2	1.2	0.0	1.2
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INDUSTRIAL PROCESSES																														
CHEMICAL	78.9	4.7	74.3	83.2	5.0	78.2	86.2	5.1	81.1	88.1	5.3	82.8	92.1	5.5	86.6	94.1	5.6	88.5	96.3	5.7	90.5	98.4	5.9	92.5	101.0	6.0	95.0	106.2	6.3	99.9
FOOD AND AGRICULTURE	308.3	19.3	289.0	326.4	20.6	305.8	338.3	21.3	317.0	343.0	21.6	321.4	352.9	22.2	330.7	357.7	22.5	335.2	362.3	22.8	339.5	366.8	23.0	343.8	371.5	23.4	348.1	381.7	24.0	357.7
MINERAL PROCESSES	502.2	5.9	496.3	564.0	6.6	557.4	592.5	6.9	585.6	603.3	7.1	596.2	625.1	7.3	617.7	636.6	7.5	629.1	648.2	7.6	640.6	660.8	7.8	653.0	673.6	7.9	665.7	703.5	8.3	695.2
METAL PROCESSES	20.2	6.5	13.7	21.8	7.0	14.8	22.2	7.1	15.0	22.4	7.2	15.2	23.1	7.5	15.7	23.5	7.6	15.9	24.0	7.7	16.3	24.5	7.9	16.6	25.0	8.1	16.9	26.1	8.4	17.7
WOOD AND PAPER	83.0	1.1	81.8	83.1	1.1	82.0	83.1	1.1	82.0	82.9	1.1	81.8	82.4	1.1	81.3	82.3	1.1	81.2	82.3	1.1	81.2	82.3	1.1	81.2	82.4	1.1	81.3	83.3	1.1	82.2
GLASS AND RELATED PRODUCTS	125.6	27.6	98.1	65.3	14.6	50.7	66.5	14.9	51.6	67.1	15.0	52.0	71.6	16.1	55.6	71.6	16.1	55.6	71.6	16.1	55.6	71.6	16.1	55.6	71.6	16.1	55.6	71.6	16.1	55.6
ELECTRONICS	1.5	0.0	1.5	1.4	0.0	1.4	1.3	0.0	1.3	1.3	0.0	1.3	1.3	0.0	1.3	1.2	0.0	1.2	1.2	0.0	1.2	1.2	0.0	1.2	1.1	0.0	1.1	1.1	0.0	1.1
OTHER (INDUSTRIAL PROCESSES)	86.3	1.3	85.1	94.3	1.4	92.9	98.5	1.5	97.0	100.0	1.5	98.5	103.2	1.5	101.6	104.8	1.6	103.2	106.5	1.6	104.9	108.0	1.6	106.4	109.7	1.6	108.0	113.5	1.7	111.8
TOTAL STATIONARY SOURCE	3,213.6	829.5	2,384.1	3,129.2	763.6	2,365.5	3,181.7	754.9	2,426.8	3,182.7	741.4	2,441.3	3,215.8	732.9	2,482.8	3,231.3	727.5	2,503.8	3,249.8	722.4	2,527.4	3,271.1	717.8	2,553.3	3,292.2	713.7	2,578.5	3,342.0	707.2	2,634.9
AREAWIDE SOURCES																														
SOLVENT EVAPORATION																														
CONSUMER PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PESTICIDES/FERTILIZERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ASPHALT PAVING / ROOFING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MISCELLANEOUS PROCESSES																														
RESIDENTIAL FUEL COMBUSTION	1,362.5	0.0	1,362.5	1,209.4	0.0	1,209.4	1,214.8	0.0	1,214.8	1,215.7	0.0	1,215.7	1,218.2	0.0	1,218.2	1,219.5	0.0	1,219.5	1,220.2	0.0	1,220.2	1,220.8	0.0	1,220.8	1,221.6	0.0	1,221.6	1,223.8	0.0	1,223.8
FARMING OPERATIONS	4,892.1	1.9	4,890.3	4,827.1	1.9	4,825.2	4,794.6	1.9	4,792.8	4,778.5	1.9	4,776.6	4,745.9	1.9	4,744.1	4,729.7	1.9	4,727.8	4,713.5	1.9	4,711.6	4,697.2	1.9	4,695.3	4,681.0	1.9	4,679.1	4,648.6	1.9	4,646.7
CONSTRUCTION AND DEMOLITION	553.9	0.0	553.9	641.5	0.0	641.5	675.8	0.0	675.8	689.5	0.0	689.5	569.8	0.0	569.8	578.5	0.0	578.5	587.9	0.0	587.9	598.9	0.0	598.9	610.7	0.0	610.7	635.7	0.0	635.7
PAVED ROAD DUST	1,716.2	0.0	1,716.2	1,834.3	0.0	1,834.3	1,893.6	0.0	1,893.6	1,924.1	0.0	1,924.1	1,988.8	0.0	1,988.8	2,022.0	0.0	2,022.0	2,053.6	0.0	2,053.6	2,085.9	0.0	2,085.9	2,114.2	0.0	2,114.2	2,172.1	0.0	2,172.1
UNPAVED ROAD DUST	1,364.9	0.0	1,364.9	1,358.1	0.0	1,358.1	1,354.7	0.0	1,354.7	1,353.1	0.0	1,353.1	1,349.7	0.0	1,349.7	1,347.9	0.0	1,347.9	1,346.3	0.0	1,346.3	1,344.6	0.0	1,344.6	1,342.9	0.0	1,342.9	1,339.5	0.0	1,339.5
FUGITIVE WINDBLOWN DUST	2,752.9	0.0	2,752.9	2,701.5	0.0	2,701.5	2,675.9	0.0	2,675.9	2,663.1	0.0	2,663.1	2,637.3	0.0	2,637.3	2,624.5	0.0	2,624.5	2,611.7	0.0	2,611.7	2,598.8	0.0	2,598.8	2,586.1	0.0	2,586.1	2,560.4	0.0	2,560.4
FIRES	65.6	0.0	65.6	69.0	0.0	69.0	71.1	0.0	71.1	72.2	0.0	72.2	74.4	0.0	74.4	75.6	0.0	75.6	76.7	0.0	76.7	77.7	0.0	77.7	78.9	0.0	78.9	81.1	0.0	81.1
MANAGED BURNING AND DISPOSAL	1,105.5	0.0	1,105.5	1,098.2	0.0	1,098.2	1,094.5	0.0	1,094.5	1,092.6	0.0	1,092.6	1,088.8	0.0	1,088.8	1,086.9	0.0	1,086.9	1,085.1	0.0	1,085.1	1,083.2	0.0	1,083.2	1,081.3	0.0	1,081.3	1,077.6	0.0	1,077.6
COOKING	1,328.9	1,321.2	7.7	1,407.6	1,399.2	8.4	1,451.1	1,442.4	8.7	1,473.2	1,464.3	8.9	1,518.8	1,509.6	9.2	1,542.3	1,532.9	9.4	1,566.2	1,556.6	9.5	1,590.1	1,580.4	9.7	1,614.2	1,604.3	9.9	1,662.5	1,652.3	10.2
OTHER (MISCELLANEOUS PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL AREAWIDE SOURCE	15,142.5	1,323.0	13,819.5	15,146.8	1,401.1	13,745.7	15,226.2	1,444.3	13,781.9	15,262.0	1,466.2	13,795.8	15,191.7	1,511.5	13,680.2	15,226.9	1,534.8	13,692.1	15,261.1	1,558.5	13,702.6	15,297.3	1,582.3	13,715.0	15,330.8	1,606.2	13,724.6	15,401.2	1,654.2	13,747.1
MOBILE SOURCES *																														
ON-ROAD	2,351.5	0.0	0.0	1,356.7	0.0	0.0	1,287.1	0.0	0.0	1,248.1	0.0	0.0	1,207.0	0.0	0.0	1,161.2	0.0	0.0	1,173.1	0.0	0.0	1,184.7	0.0	0.0	1,196.3	0.0	0.0	1,213.6	0.0	0.0
OFF-ROAD	2,113.1	0.0	0.0	1,876.1	0.0	0.0	1,905.3	0.0	0.0	1,841.5	0.0	0.0	1,709.3	0.0	0.0	1,650.5	0.0	0.0	1,599.5	0.0	0.0	1,538.0	0.0	0.0	1,486.7	0.0	0.0	1,397.6	0.0	0.0
TOTAL MOBILE SOURCE	4,464.5	0.0	0.0	3,232.8	0.0	0.0	3,192.4	0.0	0.0	3,089.6	0.0	0.0	2,916.3	0.0	0.0	2,811.7	0.0	0.0	2,772.6	0.0	0.0	2,722.6	0.0	0.0	2,682.9	0.0	0.0	2,611.2	0.0	0.0

* EPA does not require condensable or filterable emissions data to be reported for mobile sources.

** U.S. EPA developed a separate augmentation tool specifically for commercial cooking, containing updated conversion factors from PM25PRI to PMCON for four commercial cooking source types. These conversion factors were applied to PM25PRI emissions to obtain PMCON for commercial cooking specific SCCs.]

Appendix C
Stationary Source Control Measure Analyses

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C. STATIONARY SOURCE CONTROL MEASURE ANALYSES

The San Joaquin Valley (Valley) faces significant challenges in attaining national ambient air quality standards (NAAQS, or standards) for PM2.5 and ozone. Despite the progress made to improve the Valley's air quality through the implementation of the multiple attainment plans adopted by the San Joaquin Valley Air Pollution Control District (District) and clean air investments by Valley businesses and residents, the Valley continues to face significant challenges attaining federal PM2.5 standards. Substantial additional emissions reductions are needed, particularly from mobile sources under California Air Resources Board (CARB) and U.S. Environmental Protection Agency (EPA) jurisdiction that make up over 85% of remaining Valley NOx emissions. The Valley has already attained the PM10 standard and the 1997 24-hour 65 μg/m³ standard. Tough and innovative rules, such as those for indirect source review, residential wood burning, and agricultural burning, have set benchmarks for California and the nation.

The District has adopted many regulatory control measures under the District's air quality attainment plans, including but not limited to the *2007 Ozone Plan, 2008 PM2.5 Plan, 2012 PM2.5 Plan, 2013 Plan for the Revoked 1-Hour Ozone Standard, 2015 Plan for the 1997 PM2.5 Standard, 2016 Plan for the 2008 8-Hour Ozone Standard,* and the *2016 Moderate Area Plan for the 2012 PM2.5 Standard*. Chapter 4 of this Plan includes a discussion about District regulations that have already been adopted and that achieve new emissions reductions after 2013 contributing to attainment. Appendix D contains mobile sources analyses and discussions.

While the District has adopted numerous rules to reduce emissions from stationary and area sources that will achieve significant emissions reductions in the coming years, for this Plan the District has evaluated all potential additional opportunities for reducing emissions to achieve expeditious attainment of the federal PM2.5 NAAQS. This appendix reflects the comprehensive evaluation performed by the District to examine emissions sources in the Valley to identify additional potential emission reduction strategies for inclusion in this Plan.

Given the significant emissions reductions already achieved through stationary and area source regulatory strategies and the significant investment necessary to achieve emissions reductions, the Valley is at the point of diminishing returns from new regulatory controls on stationary and area sources. The search for emission reduction opportunities goes beyond traditional regulatory strategies and considers other opportunities for timely, innovative, and cost effective emissions reductions, including new incentive programs.

This appendix consists of a literature review and evaluation of emission reduction opportunities for stationary and area source categories. District staff in multiple departments with expertise in these various sectors contributed to this effort. The evaluations in this appendix are intended to capture relevant background information, examine emission reduction opportunities for technological and economic feasibility, make recommendations for appropriate District actions moving forward, solicit public input during the Plan development process, and demonstrate compliance with Clean Air Act control strategy requirements for PM2.5 nonattainment areas.

CLEAN AIR ACT REQUIREMENTS

With respect to control strategy requirements, the Federal Clean Air Act (CAA) requires demonstration of Reasonably Available Control Measures for Moderate non-attainment areas under Section 189(a)(1)(C); Best Available Control Measures for Serious non-attainment areas under Section 189(b)(1)(B); and Most Stringent Measures for Serious non-attainment areas seeking an extension under section 188(e). The guidelines for demonstrating compliance with these requirements are provided in EPA's 2016 *Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule*, codified at 81 FR 58009. The control strategy requirements are based on the non-attainment status of the area.

For each federal PM2.5 standard, the San Joaquin Valley's nonattainment status is as follows:

- *2012 PM2.5 Standard*
    - Moderate nonattainment area that cannot practicably attain the standard by the applicable attainment deadline
    - If reclassified, Serious nonattainment area that can attain the standard by the applicable attainment deadline
- *2006 PM2.5 Standard*
    - Serious nonattainment area seeking an attainment deadline extension
- *1997 PM2.5 Standard*
    - Serious nonattainment area that failed to attain the standard by the applicable attainment deadline

MODERATE AREA CONTROL STRATEGY REQUIREMENTS

Pursuant to CFR Section 51.1009, the state shall identify, adopt, and implement control measures on sources of direct PM2.5 and significant PM2.5 precursors (NOx) located in any Moderate PM2.5 nonattainment area or portion thereof located within the state consistent with the following:

- The state shall identify potential control measures to reduce emissions from sources of direct PM2.5 and PM2.5 precursors (NOx)
- For any potential control measure, the area may make a demonstration that such measure is not technologically or economically feasible to implement in the area by the end of the sixth calendar year following the effective date of designation, and may eliminate such measure from further consideration.
    - **Technological feasibility** may include, but is not limited to, a source's processes and operating procedures, raw materials, physical plant layout, and potential environmental impacts such as increased water pollution, waste disposal, and energy requirements.

    - **Economic feasibility** may include but is not limited to capital costs, operating and maintenance costs, and cost effectiveness.
    - A detailed written justification for eliminating a potential control measure on the basis of technological or economic infeasibility shall be included with the control measure evaluation.
- **If the state demonstrates through air quality modeling that the area can attain** the applicable PM2.5 NAAQS by the end of the sixth calendar year following the effective date of designation of the area, the state shall adopt and implement all technologically and economically feasible control measures that are necessary to bring the area into attainment by such date.
    - The state shall also adopt and implement all other technologically and economically feasible measures that, when considered collectively, would advance the attainment date for the area by at least 1 year.
    - Any control measure that can be implemented by 4 years after the effective date of designation of the Moderate PM2.5 nonattainment area shall be considered RACM for the area. Any such control measure that is also a control technology shall be considered RACT for the area.
    - Any control measure that can only be implemented during the period beginning 4 years after the effective date of designation of the Moderate PM2.5 nonattainment area through the end of the sixth calendar year following the effective date of designation of the area shall be considered an *additional reasonable measure* for the area.
- **If the state demonstrates that the area cannot practicably attain** the applicable PM2.5 NAAQS by the end of the sixth calendar year following the effective date of designation of the area, the state must adopt all technologically and economically feasible control measures that can be implemented in whole or in part by the end of the sixth calendar year following the effective date of designation of the area.

The Valley is currently designated as Moderate non-attainment for the 2012 PM2.5 Standard and cannot practicably attain the 2012 PM2.5 Standard by the end of the sixth calendar year following the effective date of designation of the area. As such, as explained above, the state must adopt all technologically and economically feasible control measures that can be implemented in whole or in part by the end of the sixth calendar year (attainment deadline of 2021) following the effective date of designation of the area. The District adopted the *2016 Moderate Area Plan for the 2012 PM2.5 Standard*, including an attainment impracticability demonstration and a request for reclassification of the Valley from Moderate nonattainment to Serious nonattainment. This plan was submitted to CARB for review and consideration in September of 2016.

The control measure evaluations in this Appendix go beyond the level of analysis required to satisfy Clean Air Act Moderate Area attainment Plan requirements, including RACM and RACT, as follows:

✓ All emission source categories that emit direct PM2.5 or a significant PM2.5 precursor (NOx) have been evaluated.

- ✓ For each source category, source, or activity, an inventory of direct PM2.5 and PM2.5 precursors has been provided.
- ✓ Measures in other NAAQS nonattainment areas are identified and evaluated in each control measure analysis.
- ✓ Any other control measures or technologies achieved in practice in other areas are evaluated for technological and economic feasibility of implementation in the Valley.
- ✓ A detailed justification for the rejection of any measures based on technological or economic infeasibility has been provided.
- ✓ The control measure analysis evaluates technological and economic feasibility beyond those that can only be implemented within 4 years or 6 years.

SERIOUS AREA CONTROL STRATEGY REQUIREMENTS

The District is classified as Serious nonattainment for multiple PM2.5 standards. For each PM2.5 NAAQS, the Valley has a different attainment status, which results in different requirements for each standard. For the 2012 PM2.5 standard, the District is requesting that the Valley be reclassified from Moderate to Serious nonattainment, with a Serious area attainment date of 2025. For the 2006 PM2.5 standard, the Valley is classified as Serious nonattainment, and the District is requesting an attainment date extension to 2024.

As a result of the District's attainment status for the three different federal PM2.5 standards, the District must demonstrate an increasing stringency of analysis for evaluating the feasibility of control measures to reduce direct PM2.5 and PM2.5 precursors. The different requirements for each standard are outlined below.

CONTROL STRATEGY REQUIREMENTS FOR THE 1997 PM2.5 STANDARD

For the 1997 PM2.5 standard, the District is classified as Serious nonattainment. Per Section 189(d) of the CAA, the District is required to submit a Plan demonstrating that the annual emissions inventory for PM2.5 and significant PM2.5 precursors is reduced by at least 5% annually until the Valley reaches attainment. The District's 5% demonstration, contained in Chapter 5, relies on emission reductions occurring as a result of current control measures. The adoption and implementation of additional feasible measures identified in this Appendix will ensure that the emission inventory for direct PM2.5 and PM2.5 precursors will continue to be reduced and will ensure attainment of the 1997 PM2.5 standard no later than 2020.

CONTROL STRATEGY REQUIREMENTS FOR THE 2006 PM2.5 STANDARD

For the 2006 PM2.5 standard, the District is classified as Serious nonattainment and is requesting an attainment deadline date extension from 2019 to 2024 due to the impracticability of attaining the 24-hour 35 μ/m^3 standard by 2019. This Plan demonstrates that the District will attain the 2006 PM2.5 NAAQS by 2024.

Section 51.1010 (b) states that, for a Serious PM2.5 nonattainment area that cannot practicably attain the applicable PM2.5 NAAQS by the end of the tenth calendar year following the date of designation of the area, the state shall identify, adopt, and implement the most stringent control measures that are included in the attainment Plan for any state or are achieved in practice in any state and that can be feasibly implemented in the area, consistent with the following requirements:

1. The state shall identify all sources of direct PM2.5 emissions and all sources of PM2.5 precursors
2. The state shall identify potential control measures to reduce emissions from the identified sources as follows:
   a) The state shall identify the most stringent measures adopted into any SIP or used in practice to control emissions in any state.
   b) The state shall reconsider and reassess any measures previously rejected by the state during the development of any previous Moderate area or Serious area attainment control strategy for the area.
3. The state may make a demonstration that a measure identified is not technologically or economically feasible to implement in the area by 5 years after the applicable attainment date for the area, and may eliminate such whole or partial measure from further consideration.
   - A detailed written justification must be provided for eliminating any potential measure on the basis of technological or economic infeasibility.
4. The state shall adopt and implement all control measures identified as economically and technologically feasible that shall collectively achieve attainment as expeditiously as possible, and not later than five years after the applicable attainment date for the area.

Because BACM and BACT represent the ‘‘best’’ level of control feasible for an area, in some cases it may be possible for the MSM requirement to result in no more controls and no more emissions reductions in an area than result from the implementation of BACM and BACT. Stated another way, there may be sources or categories for which no other feasible controls exist beyond what a state has already adopted as BACM or BACT.

This Plan satisfies the requirements for a Serious nonattainment area seeking an attainment date extension as follows:

✓ The updated emissions inventory is included in this Plan.

✓ The control measure evaluations analyze all potential control measures achieved in practice or identified as potential MSM in other regions, as obtained from:
- A comprehensive review of other air district Plans and regulations
- A review of the RACT/BACT/LAER Clearinghouse
- A review of measures included in EPA’s Menu of Control Measures document[1]

✓ Measures rejected as BACM/BACT in previous District attainment Plans were reanalyzed to see if they were feasible for implementation given the longer time to the attainment date.

[1] The Menu of Control Measures document is available at: http://www3.epa.gov/ttn/naaqs/pdfs/MenuofControlMeasures.pdf

- ✓ Measures already implemented in the Valley were evaluated to see if an increase in coverage of the measure would increase emission reductions from the source category.
- ✓ A reasoned justification is provided for any potential MSM which was found to be technologically or economically infeasible for implementation in the Valley.

Measures identified as MSM which were found to be technologically and economically feasible for implementation in the Valley will be outlined in Chapter 4, Attainment Strategy; with the date for implementation of MSM being as soon as feasibly possible, and no later than 1-year prior to the requested extended attainment date of 2024.

CONTROL STRATEGY REQUIREMENTS FOR THE 2012 PM2.5 STANDARD

For the 2012 PM2.5 standard, the District is classified as Moderate nonattainment, and is requesting to be reclassified to Serious nonattainment due to the demonstrated impracticability of attaining the 2012 annual standard of 12 μ/m^3 by the Moderate attainment deadline date of 2021. A reclassification to Serious nonattainment for the 2012 NAAQS would change the Valley's attainment date for the 2012 PM2.5 standard to 2025.

This Plan demonstrates that the Valley can attain the 12 μ/m^3 annual standard by 2025 through the implementation of all feasible potential control measures by the applicable attainment date. As a part of the Serious area attainment demonstration for this standard, in addition to implementing all feasible measures identified as RACM and RACT through the Moderate Area analysis, the District is required to identify, adopt, and implement the best available control measures (BACM) on sources of direct PM2.5 and PM2.5 precursors consistent with the following:[2]

- Identify all potential control measures to reduce emissions from all sources of direct PM2.5 emissions and sources of emissions of PM2.5 Plan precursors in the nonattainment area by surveying other NAAQS nonattainment areas and identifying any measures for direct PM2.5 and PM2.5 Plan precursors not previously identified by the District during the development of the Moderate area attainment Plan
- Adopt and implement all feasible potential control measures.
  - Any control measure that can be implemented by the end of the fourth year following the date of reclassification of the area to Serious shall be considered BACM. Any such control measure that is also a control technology for a stationary source in the area shall be considered BACT for the area.
  - Any control measure that can be implemented between the end of the fourth year following the date of reclassification of the area to Serious and the applicable attainment date for the area shall be considered an *additional feasible measure*.

[2] § 51.1010 Serious area attainment Plan control strategy requirements

- The District may make a demonstration that any measure is not technologically or economically feasible to implement in whole or in part by the end of the tenth calendar year following the effective date of designation of the area, and may eliminate such whole or partial measure from further consideration.
    - For purposes of evaluating the technological feasibility of a potential control measure, the District may consider factors including but not limited to a source's processes and operating procedures, raw materials, physical plant layout, and potential environmental impacts such as increased water pollution, waste disposal, and energy requirements.
    - For purposes of evaluating the economic feasibility of a potential control measure, the District may consider capital costs, operating and maintenance costs, and cost effectiveness of the measure.
    - The District shall submit to the EPA as part of its Serious area attainment Plan submission a detailed written justification for eliminating from further consideration any potential control on the basis of technological or economic infeasibility.
    - For potential measures the District demonstrates are not technologically or economically feasible to implement, the written justification shall include an explanation of how the criteria for determining the technological and economic feasibility of potential control measures are more stringent than its criteria for determining the technological and economic feasibility of potential control measures for RACM for the same sources.

The control measure evaluations in this Appendix go beyond the level of analysis required to satisfy Clean Air Act Serious Area attainment Plan requirements, including BACM and BACT, as follows:

- ✓ All emission source categories that emit direct PM2.5 or a significant PM2.5 precursor (NOx) have been evaluated.
- ✓ For each source category, source, or activity, an inventory of direct PM2.5 and PM2.5 precursors has been provided.
- ✓ Measures in other NAAQS nonattainment areas are identified and evaluated in the "Potential Regulatory Emission Reductions" section of each control measure analysis.
- ✓ A comprehensive list of control measures considered for each source category is included as a part of each control measure evaluation.
- ✓ Building on the level of analysis required for a Moderate nonattainment Plan, the control measure evaluations go beyond RACM by evaluating all potential control measures achieved in practice that can feasibly be implemented by the attainment date of 2025
    - Control measure commitments and dates are identified in Chapter 4. Measures implemented within 4 years of a Serious PM2.5 designation are considered *BACM*, and associated control technologies are considered *BACT*.
    - Measures implemented after 4 years for a Serious area are considered *additional reasonable measures.*

- ✓ For measures determined not feasible, a thorough explanation of criteria used to make such determinations is provided.
- ✓ For each technologically feasible measure, the following information is provided in regards to economic feasibility:
    - The control efficiency by pollutant
    - The possible emission reductions by pollutant
    - The estimated cost per ton of pollutant reduced; and
    - A determination of whether the measure is economically feasible, including an explanation of the conclusion and quantitative supporting documentation
- ✓ For each technologically and economically feasible control measure, a date for implementation of the rule or policy is included; the date for implementation of control measures relied on for the attainment demonstration shall be as early as feasibly possible, and not later than the beginning of the attainment year.

SIGNIFICANT PRECURSORS

Pursuant to federal Clean Air Act §189(e), the sole explicit reference to the regulation of precursors in CAA Subpart 4, the control requirements applicable under Plans addressing a PM2.5 NAAQS shall also apply to major stationary sources of PM2.5 precursors, except where EPA determines that such sources do not contribute significantly to PM2.5 levels which exceed the standard in the area.

Regions are required to address all PM2.5 precursors unless EPA determines the precursor is not a significant contributor to exceedances of a standard for the region. CARB modeling performed for the development of this attainment Plan demonstrates that VOC, Ammonia, and SOx are not significant precursors for the formation of PM2.5 in the San Joaquin Valley. As such, the District is not required to evaluate its VOC, SOx, and ammonia regulations.

In an effort to continue to protect public health beyond the requirements of the NAAQS, the District has implemented the most stringent controls feasible for local sources of SOx and ammonia. Even though the District is not required to evaluate ammonia as part of this Plan, this Appendix includes a full analysis of the potential control of ammonia sources, including an evaluation of BACM and MSM feasible for implementation in the Valley.

APPENDIX C ORGANIZATION AND EVALUATION

Each control measure evaluation includes a discussion of the rule applicability and rule adoption/amendment history; an overview of the source category and affected sources; an emissions inventory table for the source category; a regulatory evaluation; a technological feasibility and cost effectiveness analysis of any other potential best available control measures (BACM) and most stringent measures (MSM); and a summary of the evaluation findings. The sections below elaborate in more detail with respect to the information included within each individual rule evaluation.

Discussion
This section provides an overview of rule applicability, identifies what types of emissions the rule controls, provides the rule adoption/amendment history, and discusses additional pertinent details, as necessary.

Emissions Inventory
Each emissions inventory table lists the annual average and wintertime average (November through April) PM2.5 and NOx emissions for the respective source category. The data provided in this section is a compilation of the data sources identified in the emission inventory appendix. See Appendix B (Emission Inventory) for additional information.

Source Category
This section discusses what types of units, industries, or operations are included in the respective source category.

HOW DOES THE DISTRICT RULE COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

As part of the regulatory evaluation, District rules and source categories are compared to federal and state air quality regulations and standards, and the regulations and standards in other air districts. The following regulations and guidelines are referenced in the comparisons:

Federal Regulations – Federal regulations include the following regulations and guidance documents:

- Control Techniques Guidelines (CTG)[3]
- Alternative Control Techniques (ACT)[4]
- New Source Performance Standards (NSPS)[5]
- National Emission Standards for Hazardous Air Pollutants (NESHAP)[6]

[3] EPA. Control Techniques Guidelines. Retrieved from http://www.epa.gov/groundlevelozone/SIPToolkit/ctgs.html
[4] EPA. Alternative Control Techniques. Retrieved from http://www.epa.gov/groundlevelozone/SIPToolkit/ctgs.html
[5] EPA. 40 CFR 60 – Standards of Performance for New Stationary Sources (NSPS). Retrieved from http://www.tceq.state.tx.us/permitting/air/rules/federal/60/60hmpg.html
[6] EPA. 40 CFR 61 – National Emission Standards for Hazardous Air Pollutants (NESHAPs). Retrieved from http://www.tceq.state.tx.us/permitting/air/rules/federal/61/61hmpg.html

- Maximum Achievable Control Technology (MACT)[7]

State Regulations – Generally, state regulations are specific to mobile sources and consumer products. However, there are some California Health and Safety Code (CH&SC) requirements and CARB Airborne Toxic Control Measures (ATCM)[8] that apply to stationary and area sources. While most of the rules evaluated in this Plan do not have a state regulation associated with their source category, any relevant state guidelines are evaluated within this section.

HOW DOES THE DISTRICT RULE COMPARE TO RULES IN OTHER AIR DISTRICTS?

As agreed to by EPA for the *2009 RACT SIP*, the rules were also compared to analogous regulations adopted by California's most progressive air districts. Control strategies and measures in other air districts and agencies include, but are not limited to the following air districts:

- South Coast Air Quality Management District (SCAQMD)[9]
- Bay Area Air Quality Management District (BAAQMD)[10]
- Sacramento Metropolitan Air Quality Management District (SMAQMD)[11]
- Ventura County Air Pollution Control District (VCAPCD)[12]

All potential BACM/MSM identified through this regulatory evaluation were then thoroughly evaluated using the following key factors, as defined in EPA's 2016 *Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule*, codified at 81 FR 58009, to determine if potential opportunities qualify as BACM/MSM for the Valley:

- **Technological feasibility**– This analysis determines if the new control can be integrated with the existing controls without reducing or delaying the emission reductions from the existing control. If it cannot, then it would not be considered to be technologically feasible for the area unless the emission benefit of the new measure is substantially greater than the existing measure.

- **Economic feasibility** – If the potential control is determined to be technologically feasible, it is then evaluated for economic feasibility. The District has evaluated the economic feasibility of various control measures by conducting cost

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[7] EPA. 40 CFR 63 – Maximum Achievable Control Technology (MACT). Retrieved from http://www.tceq.state.tx.us/permitting/air/rules/federal/63/63hmpg.html
[8] California Air Resources Board (CARB). Airborne Toxic Control Measures (ATCMs). Retrieved from http://www.arb.ca.gov/toxics/atcm/atcm.htm
[9] South Coast Air Quality Management District (SCAQMD). Rules and Regulations. Retrieved from http://www.aqmd.gov/home/regulations/rules/scaqmd-rule-book/table-of-contents
[10] Bay Area Air Quality Management District (BAAQMD). Rules and Regulations. Retrieved from http://www.baaqmd.gov/Divisions/Planning-and-Research/Rules-and-Regulations.aspx
[11] Sacramento Metropolitan Air Quality Management District (SMAQMD). Rules and Regulations. Retrieved from http://www.airquality.org/rules/
[12] Ventura County Air Pollution Control District (VCAPCD). Rules and Regulation. Retrieved from http://www.vcapcd.org/Rulebook/RuleIndex.htm

effectiveness analyses within this appendix. A cost effectiveness analysis examines the added cost, in dollars per year, of the control technology or technique, divided by the emissions reductions achieved, in tons per year. EPA cautions that the threshold for economic feasibility should be addressed on a case-by-case basis.

Additional Emission Reduction Opportunities

The District reviewed the following areas to identify any additional potential BACM/MSM, exclusive of potential BACM/MSM evaluated in the Regulatory Evaluation section:

- Any emission reduction opportunities identified/considered in previously adopted District Plans that were determined to be beyond reasonably available control technology (RACT) at that time.
- New emission reduction opportunities adopted in California SIPs, SIPs in other states, or achieved in practice in other areas.

All potential BACM/MSM identified were then thoroughly evaluated for technological and economic feasibility, as previously defined. The District reviewed staff reports and studies from other air districts, EPA technical guidance documents, and applicable study data from the scientific community to assist in evaluating the technological and economic feasibility of potential BACM/MSM.

Evaluation Findings

This section completes the control measure evaluation and provides a summary of the District's findings based on the control measure evaluation.

C.1 Rule 4103 (Open Burning)

Discussion

Historically, the practice for disposing of agricultural materials has been through the open burning of the materials in the field. Burning agricultural materials provided an economically feasible method for the timely disposal of these materials, helped prevent the spread of plant diseases, and controlled weeds and pests. The air quality impacts from open burning in the Valley have long been a significant concern for the District and Valley growers, and numerous measures have been successfully implemented over the years to minimize these impacts.

Rule 4103 was originally adopted on June 18, 1992, to regulate and coordinate the use of open burning while minimizing smoke impacts on the public. Rule 4103 has since been amended seven times and become progressively more stringent. In 2003, California Senate Bill (SB) 705 (CH&SC Section (§) 41855.5 and 41855.6) established a schedule to phase-out the open burning of agricultural material but provided for a postponement of the phase-out where justified by technical and economic impediments. The phase-out requirements of SB 705 have been incorporated into Rule 4103 and were implemented beginning June 1, 2005. The District also operates a comprehensive Smoke Management System (SMS) to manage open burning and only allow the limited amount of burning that is still permissible to take place on days with favorable meteorology and in amounts that will not cause a significant impact on air quality. Due to the management of open burning under the District's comprehensive SMS, modeling conducted as part of this Plan demonstrates that this source category does not significantly contribute to attainment of the applicable PM2.5 standards.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	2.27	2.25	2.24	2.23	2.23	2.22	2.22	2.21	2.21
NOx	1.60	1.59	1.58	1.57	1.57	1.57	1.56	1.56	1.55
	Winter Average - Tons per day								
PM2.5	3.46	3.44	3.42	3.41	3.40	3.40	3.39	3.38	3.37
NOx	2.44	2.42	2.40	2.39	2.39	2.38	2.38	2.37	2.36

Source Category

The San Joaquin Valley, in adherence with SB 705, has the toughest restrictions on agricultural burning in the state. Rule 4103 was last amended on April 5, 2010, to incorporate the final provisions of SB 705 phase-out schedule directly into the rule to more efficiently allow the District, with the concurrence of ARB, to consider the feasibility of non-burning alternatives for specific crops and materials and postpone burn prohibitions where it is determined there are no feasible alternatives.

Through Rule 4103, the District no longer allows the burning of field crops (with the exception of a certain percentage of rice), prunings (with the exception of pome fruit prunings, and a limited amount of surface harvested pruning acreage), and orchard removals (with the exception of small acreage removals, vineyard removals, pome fruit removals, and citrus removals). A limited amount of additional burning is allowed for disease prevention, noxious weeds, ditch banks and canals, ponding and levee banks, and diseased beehives provided rule requirements are met and meteorological conditions are appropriate.

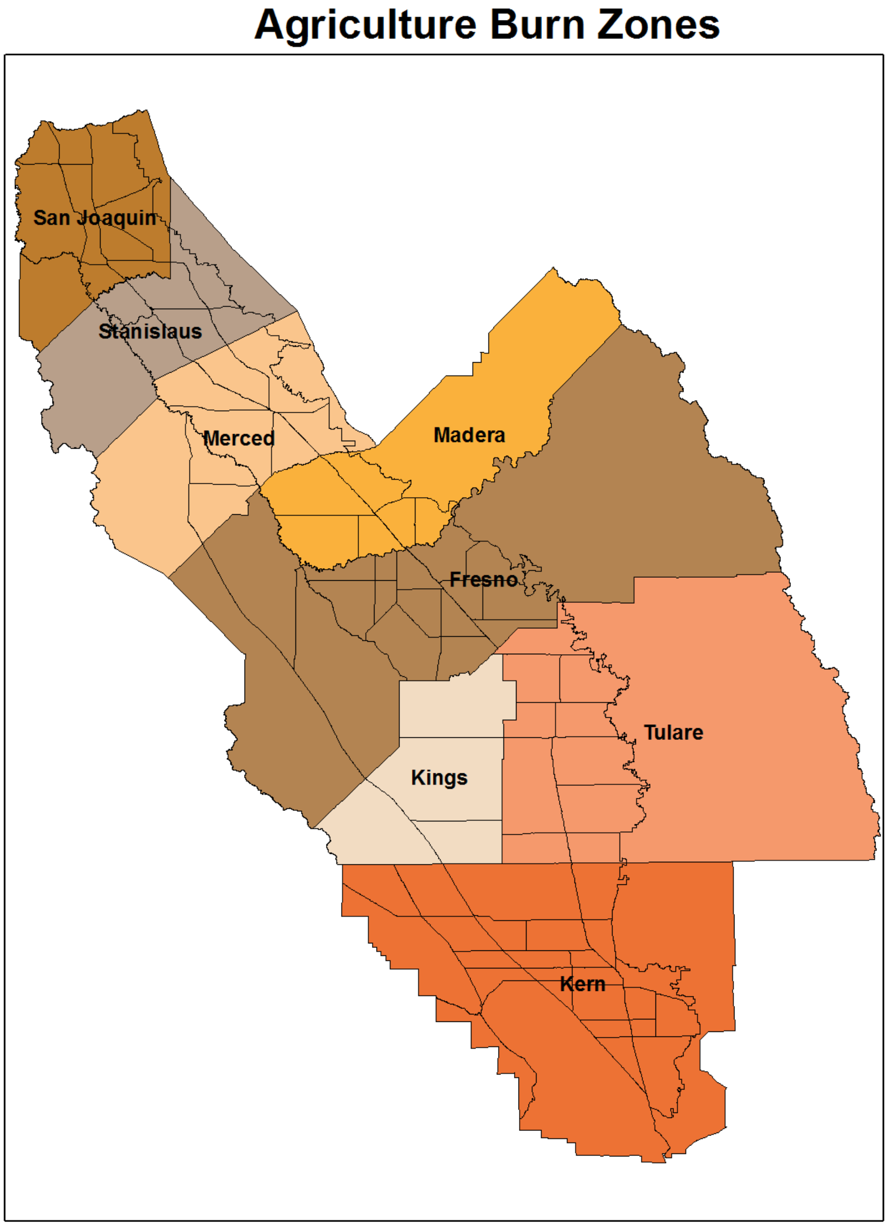
Rule 4103 also contains requirements for collecting, sorting, drying, and igniting agricultural materials; the timing, monitoring, and maintenance of burns; and specific requirements for field crop burning, ditch bank and levee maintenance, contraband materials, Russian thistle (tumbleweeds), and diseased materials. Additionally, the rule details a set of conditions that must be met for a burn permit to be issued.

Smoke Management System (SMS)

The District uses the SMS to manage the Valley's remaining open burning of agricultural crops and materials. On a daily basis, the District analyzes projected local meteorology, the air quality conditions, the atmospheric holding capacity, the amount of burning already approved in a given area, and the potential impacts on downwind populations. Through the results of this daily analysis, the District uses the SMS to manage 97 Valley burn zones (see Figure C-1) and allocates daily burning allowances if appropriate. This approach ensures the District limits the distribution of air pollutant emissions from open burning temporally and spatially, providing flexibility of burn days for growers while minimizing the impact on the public.

Properly managed burning allocations under the SMS ensures that air quality, health impacts, and public nuisance from open burning of agricultural materials are minimized to the fullest extent feasible.

Figure C-1 Agricultural Burn Zones Defined in the District SMS



HOW DOES DISTRICT RULE 4103 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations

There are no EPA CTG, ACT, NSPS, NESHAP, or MACT requirements for this source category.

State Regulations

- CH&SC §41850-41866 (Agricultural Burning)
- 17 CCR §80100-80330 (Smoke Management Guidelines for Agricultural and Prescribed Burning)

The requirements of the above state regulations are implemented through Rule 4103. The District has continued to work closely with Valley stakeholders to identify feasible alternatives to open burning of various agricultural materials and to meet its legal obligation under state law. Unlike other areas of the state that are prohibited from banning agricultural burning[13], the District is required to phase-out agricultural burning in accordance with CH&SC §41855.5, and has done so for most crop categories. In addition to the requirements of CH&SC §41855.5, state law requires the District to postpone the burn prohibition dates for specific types of agricultural material if the District makes three specific determinations and ARB concurs[14]. The determinations are: (1) there are no economically feasible alternatives to open burning for that type of material; (2) open burning for that type of material will not cause or substantially contribute to a violation of an air quality standard; and (3) there is no long-term federal or state funding commitment for the continued operation of biomass facilities in the Valley or the development of alternatives to burning.

The District has prepared three reports on agricultural burning activities in the Valley since 2010. The reports have evaluated every crop category for feasible alternatives to open burning and provided recommendations for allowing or prohibiting the open burning of each crop category as outlined by the Senate Bill.

- *2010 Final Staff Report and Recommendations on Agricultural Burning.* After working extensively with stakeholders to understand viable alternatives to open burning and the associated costs, the District provided recommendations for allowing or prohibiting the open burning of specific agricultural material categories. ARB provided a 2-year concurrence on District recommended postponements, based on the lack of feasible alternatives to open burning.
- *2012 Update: Recommendations on Agricultural Burning.* The 2012 report showed that in the two years since the 2010 report, there had been no significant changes in the economic feasibility of alternatives to agricultural burning, the amount of agricultural materials accepted at biomass facilities continued to fluctuate based on market conditions, and there were no long-term federal or state funding commitments for the operation of biomass facilities or development of alternatives to burning. ARB provided an additional 3-year concurrence on the District recommended postponements, based on the continued lack of feasible alternatives to open burning.
- *2015 Agricultural Burning Review.* The 2015 report demonstrated continued lack of feasible alternatives, a failing biomass industry resulting in less acceptance of agricultural materials, and a continued lack of long-term federal or state funding

[13] CH&SC §41850 requires that "agricultural burning be reasonably regulated and not prohibited."
[14] CH&SC §41855.6

commitments for the operation of biomass facilities of development of alternatives to open burning. ARB concurred with the District's findings.

The next report will be conducted in 2020. This analysis will contain a comprehensive analysis of the feasibility of alternatives to open burning for different crop categories, including costs and availability of emerging technologies. Once completed the report will be submitted to ARB for their review and concurrence.

HOW DOES DISTRICT RULE 4103 COMPARE TO RULES IN OTHER AIR DISTRICTS?

BAAQMD

- BAAQMD Regulation 5 (Open Burning) *(Amended June 19, 2013)*

	SJVAPCD	BAAQMD
Applicability	Open burning conducted in the San Joaquin Valley Air Basin, with the exception of prescribed burning and hazard reduction burning (regulated under District Rule 4106)	Open burning in the BAAQMD
Exemption	Fires used for cooking, campfires, and religious fires where the fuel is clean, dry wood or charcoal are exempt. Emergency burning by a fire agency, the respectful burning of an unserviceable American flag, bags used for agricultural chemicals, and raisin trays are also exempted. Specific exemptions and provisions for burning contraband and emergency ag burns that would cause economic loss if denied.	Fires set only for cooking of food for human beings; fires burning as safety flares or for the combustion of waste gases; the use of flame cultivation when the burning is performed with LPG or natural gas-fired burners designed and used to kill seedling grass and weeds and the growth is such that the combustion will not continue without the burner; fires set for the purposes of fire training using one gallon or less of flammable liquid per fire; further requirements for conditional exemptions (similar to SJV).
Requirements	No burning of garbage or other materials. Burning shall be allocated by the APCO dependent on dispersion conditions and shall avoid negative impacts to receptors. No permit shall be issued for the burning of the following categories of agricultural waste, except for crops covered by Section 5.5.2: 5.5.1.1 Field Crops,	No specific crop phase-outs or bans recreational fires allowed on non-curtailment days; on permissive burn days the following fires are allowed with permission from the APCO (specific requirements for each category): disease and pest, crop replacement, orchard pruning and attrition, double cropping stubble, stubble, hazardous materials

	SJVAPCD	BAAQMD
	5.5.1.2 Prunings, 5.5.1.3 Weed Abatement, except for categories covered by Section 5.5.3, 5.5.1.4 Orchard Removals, 5.5.1.5 Vineyard Removal Materials, 5.5.1.6 Surface Harvested Prunings, and 5.5.1.7 Other Materials. Additional requirements for burning times, drying times, contraband burning. Permit required for the burning of Russian Thistle, and a conditional burning permit required for diseased materials with specific requirements, burn plans required for fire suppression training, burning of contraband, BMP selection required for weed maintenance	(hazard reduction burning), fire training, flood debris, irrigation ditches, flood control, range management, forest management, marsh management, contraband, filmmaking, and public exhibition.

SCAQMD

- SCAQMD Rule 444 (Open Burning) *(Amended July 12, 2013)*

The District evaluated the requirements contained within SCAQMD's Rule 444 and found no requirements that were more stringent than those already in Rule 4103. SCAQMD Rule 444 was last amended on July 12, 2013 to expand rule applicability to include beach burning. The amendments apply to sources that do not exist within District's boundaries, and therefore are unnecessary to be required in the Valley to satisfy BACM or MSM requirements. Rule 444 also restricts burning on residential wood combustion curtailment days. This is a practice that has already been implemented by the District through the Smoke Management System procedures, and which is also included in District Rule 4103, Section 5.2, whereby "the APCO shall allocate burning based on the predicted meteorological conditions and whether the total tonnage to be emitted would allow the volume of smoke and other contaminants to cause a public nuisance, impact smoke sensitive areas, or create or contribute to an exceedance of an ambient air quality standard." District Rule 4103 is as stringent as, or more stringent than, SCAQMD Rule 444.

	SJVAPCD	SCAQMD
Applicability	Open burning conducted in the San Joaquin Valley Air Basin, with the exception of	Agricultural burning, Disposal of Russian thistle, Prescribed burning, Fire prevention/suppression training,

	SJVAPCD	SCAQMD
	prescribed burning and hazard reduction burning	Open detonation or use of pyrotechnics, Fire hazard removal, Disposal of infectious waste, other than hospital waste, Research of testing materials, equipment or techniques, Disposal of contraband, Residential burning, Beach burning
Exemption	Fires used for cooking, campfires, and religious fires where the fuel is clean, dry wood or charcoal are exempt. Emergency burning by a fire agency, the respectful burning of an unserviceable American flag, bags used for agricultural chemicals, and raisin trays are also exempted. Specific exemptions and provisions for burning contraband and emergency ag burns that would cause economic loss if denied.	Fire suppression training by fire agencies, open burning to protect crops from freezing (requires emergency burn plan to be submitted), open burning on islands located 15 miles or more from the mainland, fireworks displays, explosives detonation, recreational fires/ceremonial fires. Food prep fires and fires “for warmth at social gatherings” are allowed.
Requirements	No burning of garbage or other materials. Burning shall be allocated by the APCO dependent on dispersion conditions and shall avoid negative impacts to receptors. No permit shall be issued for the burning of the following categories of agricultural waste, except for crops covered by Section 5.5.2: 5.5.1.1 Field Crops, 5.5.1.2 Prunings, 5.5.1.3 Weed Abatement, except for categories covered by Section 5.5.3, 5.5.1.4 Orchard Removals, 5.5.1.5 Vineyard Removal Materials, 5.5.1.6 Surface Harvested Prunings, and	No specific crop phase-outs or bans burning of waste/garbage is prohibited. No burning unless it is a permissive burn day or a marginal burn day on which burning is permitted in the applicable source/receptor area and such burning is not prohibited by the applicable public fire protection agency. Specific requirements for burn authorization requests and permit conditions for each category of burning (similar to SJV).

	SJVAPCD	SCAQMD
	5.5.1.7 Other Materials. Additional requirements for burning times, drying times, contraband burning. Permit required for the burning of Russian Thistle, and a conditional burning permit required for diseased materials with specific requirements, burn plans required for fire suppression training, burning of contraband, BMP selection required for weed maintenance	

SMAQMD

- SMAQMD Rule 501 (Agriculture Burning) *(Amended April 3, 1997)*

The District evaluated the requirements contained within SMAQMD's Rule 501 and found no requirements that were more stringent than those already in Rule 4103.

	SJVAPCD	SMAQMD
Applicability	Open burning conducted in the San Joaquin Valley Air Basin, with the exception of prescribed burning and hazard reduction burning	Agricultural burning, including: ag waste (trees, prunings, rice straw and stubble, field crop residue) disease prevention, range improvement, wildlife/game habitat, irrigation system management, forest management, wild land vegetation management, paper containers of ag chemicals
Exemption	Fires used for cooking, campfires, and religious fires where the fuel is clean, dry wood or charcoal are exempt. Emergency burning by a fire agency, the respectful burning of an unserviceable American flag, bags used for agricultural chemicals, and raisin trays are also exempted. Specific exemptions and provisions for burning contraband and emergency ag burns that would cause economic loss if denied.	Similar exemptions as SJV for ag operations, including burning of bags used for agricultural chemicals and emergency agricultural burns which would cause economic loss if denied.

	SJVAPCD	SMAQMD
Requirements	No burning of garbage or other materials. Burning shall be allocated by the APCO dependent on dispersion conditions and shall avoid negative impacts to receptors. No permit shall be issued for the burning of the following categories of agricultural waste, except for crops covered by Section 5.5.2: 5.5.1.1 Field Crops, 5.5.1.2 Prunings, 5.5.1.3 Weed Abatement, except for categories covered by Section 5.5.3, 5.5.1.4 Orchard Removals, 5.5.1.5 Vineyard Removal Materials, 5.5.1.6 Surface Harvested Prunings, and 5.5.1.7 Other Materials. Additional requirements for burning times, drying times, contraband burning. Permit required for the burning of Russian Thistle, and a conditional burning permit required for diseased materials with specific requirements, burn plans required for fire suppression training, burning of contraband, BMP selection required for weed maintenance	No specific crop phase-outs or bans (subject to air basin-wide rice burning reduction) Permit holder must contact District for permission to burn and ensure that it is not a No Burn day, and must contact the fire protection agency having jurisdiction over the burn location. Specific drying time requirements for different ag materials (similar to SJV)

VCAPCD

- VCAPCD Rule 56 (Open Burning) *(Amended November 11, 2003)*
- The District evaluated the requirements contained within VCAPCD's Rule 56 and found no requirements that were more stringent than those already in Rule 4103.

	SJVAPCD	VCAPCD
Applicability	Open burning conducted in the San Joaquin Valley Air Basin, with the exception of prescribed burning and hazard reduction burning	Combustible materials in open outdoor fires
Exemption	Fires used for cooking, campfires, and religious fires where the fuel is clean, dry wood or charcoal are exempt. Emergency burning by a fire agency, the respectful burning of an unserviceable American flag, bags used for agricultural chemicals, and raisin trays are also exempted. Specific exemptions and provisions for burning contraband and emergency ag burns that would cause economic loss if denied.	This rule shall not apply to open outdoor fires used only for the heating or cooking of food for human consumption or for recreational purposes when such fires are confined to a fireplace or barbecue pit. Flag burning, fire suppression training, fire agency/public officer allowed to set fires to reduce hazards as needed (similar to SJV).
Requirements	No burning of garbage or other materials. Burning shall be allocated by the APCO dependent on dispersion conditions and shall avoid negative impacts to receptors. No permit shall be issued for the burning of the following categories of agricultural waste, except for crops covered by Section 5.5.2: 5.5.1.1 Field Crops, 5.5.1.2 Prunings, 5.5.1.3 Weed Abatement, except for categories covered by Section 5.5.3, 5.5.1.4 Orchard Removals, 5.5.1.5 Vineyard Removal Materials,	No specific crop phase-outs or bans Permit required for open burning, burning only allowed on permissive burn days. Open burning is allowed for the following purposes only: a. The disposal of agricultural wastes in the pursuit of agricultural operations. b. Range improvement burning. c. Wildland vegetation management burning. d. Levee, reservoir or ditch maintenance. e. The disposal of Russian thistle (*Salsola kali* or tumbleweed).

	SJVAPCD	VCAPCD
	5.5.1.6 Surface Harvested Prunings, and 5.5.1.7 Other Materials. Additional requirements for burning times, drying times. Permit required for the burning of Russian Thistle, and a conditional burning permit required for diseased materials with specific requirements, burn plans required for fire suppression training, burning of contraband, BMP selection required for weed maintenance	Specific burn times, drying times, and permit conditions also specified (similar to SJV).

Additional Emission Reduction Opportunities

As demonstrated above, in adherence with applicable state laws instituted under SB705, the San Joaquin Valley has the toughest restrictions on agricultural burning in the state. The District regulations have phased-out the burning of all field crops (with the exception of rice), almost all prunings, and almost all orchard removals.

Until 2014, the restrictions imposed by the District resulted in an 80% reduction in the open burning of agricultural waste in the Valley. The exceptional drought conditions that the Valley experienced from 2012 to 2016 resulted in hundreds of thousands of acres of orchards, vineyards and other agricultural crops being fallowed or removed. These conditions, paired with the demise of the biomass industry which had previously provided the primary alternative to agricultural burning for a significant amount of the agricultural waste generated in the Valley, has created a severe waste disposal issue. Additionally, there are currently no long-term federal or state funding commitments to support the operation of biomass facilities or development of alternatives to open agricultural burning. The combination of these factors has resulted in an increase in open burning over the past several years and threatens the District's ability to continue to maintain broad restrictions on open burning of agricultural waste into the future due to the lack of feasible alternatives capable of handling the volume of agricultural waste generated in the Valley each year.

Finding technologically feasible, cost-effective alternatives to open burning of agricultural waste is mandated by law if the current prohibitions are to be retained. Under CH&SC Section 41855.6, the District may postpone burn restrictions for any category of agricultural waste crop where all the following apply:

- There is no economically feasible alternative means of eliminating the waste

- There is no long-term federal or state funding commitment for the continued operation of biomass facilities or development of alternatives to burning
- The continued issuance of burn permits will not cause or substantially contribute to a violation of any air quality standard

As noted above, biomass power plants have historically provided the main alternative to the open burning of agricultural waste. Biomass burning of agricultural material has been preferable to open burning as it combusts the material more completely, results in fewer emissions, and provides an alternative source of renewable energy in the Valley.

Disposal of Ag Materials Severely Impacted by Biomass Power Plant Shutdowns

The biomass industry is primarily the product of the Public Utility Regulatory Policy Act (PURPA) which was enacted in 1978 at the height of the energy crisis to promote the use of alternative nonutility power generation. Today, these facilities are fully depreciated and have lost, or are nearing the ends of, their long-term contracts to sell their power to the utilities. In addition, biomass facilities are facing numerous obstacles to remain in operation including price disadvantage, demand for intermittent power instead of baseload power, and lack of federal and state funding.

Much has changed in the energy markets since PURPA was implemented. Natural gas has replaced oil for electricity generation, and supplies of natural gas have increased, driving down the wholesale cost of electricity. California has adopted a Renewable Portfolio Standard (RPS) that requires 33% of the power that is purchased by utilities be renewable. This has driven competition to fill the renewable energy needs of the state. Under the RPS, Investor Owned Utilities (IOUs) have tended to favor lower cost intermittent sources of renewable power, such as solar and wind. This has left the biomass industry in a position where the power that they produce is not desirable, since most biomass plants provide baseload power instead of intermittent power, and the current rate being paid for power does not allow them to remain viable.

Given the current energy policy, the biomass industry does not compete well under the current procurement policies of the state’s IOUs. Historically, the biomass facilities have demanded 12-13 cents per kilowatt-hour, which has been necessary to retain economic viability. Pricewise, this places biomass facilities at a competitive disadvantage with other renewable fuels that can be procured at a much lower cost. Under the state’s RPS, program pricing information is confidential, however, anecdotal evidence is that currently the IOUs are purchasing power from solar and wind facilities at approximately 8 cents per kilowatt-hour.

Another factor that negatively impacts the competitive position of biomass generated power is the fact that such plants provide “baseload” power. As baseload generators, biomass facilities cannot produce power that can be turned on quickly, and therefore, cannot meet the power system’s demand for “ramping services”. The demand for ramping services is compounded by continued increase in the use of wind and solar renewable sources, which is partially triggered by the state’s RPS goals. If current trends persist, this issue will worsen in the future. It is estimated that by 2020, solar and wind will account for three-quarters of the state's renewable power and 20% of the state's total electricity supply. The net effect of this is a further transition away from baseload generators to more flexible generators that can be turned-on and turned-off when needed. Under this scenario, not only do biomass facilities have difficulty competing directly on price, but they also do not provide the type of power that is desired. While under this scenario the state can meet its renewable power goals, the potential loss of biomass plants can impact the state's broader greenhouse gas reduction goals under AB 32 by increasing GHG emissions in sectors that currently rely on biomass plants for disposal of materials including the agricultural industry, landfills, and forests.

The biomass industry has long relied on a combination of state and federal financial incentives to directly support their relatively higher production costs. These incentives have ranged from tax credits to monetary grants, which have all expired over the last decade. Examples of these programs include the federal Renewable Electricity Production Tax Credit (expired in 2013), the state Existing Renewable Facilities Program (expired in 2011), and the state Biomass-to-Energy incentive Grant Program (expired in 2003). With the expiration of these programs, there are currently no long-term federal or state funding commitments for the operation of biomass facilities.

Since 2012, six Valley biomass facilities have shut down operations and now only five remain in operation. In 2015, the District took actions aimed at short- and long-term measures to alleviate the effect on agricultural growers of the biomass capacity shortfall in the Valley and to identify other alternatives to agricultural open burning. The District convened a workgroup with agricultural representatives to explore and advance waste disposal techniques as alternatives to open burning and traditional biomass power plants. In addition, the District requested that the Governor direct the California Public Utilities Commission to recognize the societal benefits of existing biomass facilities and their role in reducing emissions from agricultural open burning, and to extend Power Purchase Agreements with existing biomass facilities at current pricing levels.

Traditional biomass power plants need significant funding and legislative support, both of which are in short supply given state's current energy policies. The industry is on life support and is receiving some limited assistance due to the Governor's proclamation that ordered CPUC and California Energy Commission to enter into contracts with existing bioenergy facilities to take feedstock from high hazard zones. The District has not supported this approach as it shifts emissions from high altitude forests to the communities on the Valley floor. Further complicating the issue for traditional biomass power plants is the opposition they face from local communities. Many of these facilities are located in or near disadvantaged communities and community members and advocates have been critical of the emissions from these plants being concentrated in these communities.

Beyond Most Stringent Measures: District Efforts to Advance Alternatives

The loss of Valley biomass facilities has considerably reduced the available options to dispose of agricultural wood waste. Additionally, the extreme drought conditions that the Valley experienced from 2012-2016 resulted in hundreds of thousands of acres of orchards, vineyards and other agricultural crops to be fallowed or removed and replaced with other crops. As a result, many agricultural growers have lost the primary economically feasible disposal option for agricultural material and there has been an extreme build-up of agricultural waste material in the Valley.

As a part of District efforts to identify and advance cleaner alternatives to open burning of agricultural waste, in November of 2017 the District held the Central Valley Summit on Alternatives to Open Burning of Agricultural Waste to bring together Valley growers, researchers/experts, representatives from the biomass power industry, representatives from new and developing technology vendors, and Valley stakeholders. The Summit demonstrated that additional research and resources are necessary to propel forward several emerging technologies and practices which may offer feasible alternatives to open burning in the future.

The District has identified soil incorporation of woody biomass, composting, various scales of biomass-to-power technologies, and air curtain burners as potential measures which were evaluated for technological and economic feasibility of implementation in the Valley. These measures will be further discussed below.

Composting

District evaluation of composting has shown that composting is not technologically feasible as a large-scale alternative to open burning. Aggressive state policy designed to divert urban organic waste from landfills has led to the need to significantly expand composting infrastructure to meet legislative deadlines, limiting the ability of composting facilities to accommodate increased woody material from agricultural operations. Implementing composting solutions, either on farm or at local compost facilities, face permitting challenges and regulatory impediments as these operations increase VOC and methane emissions, and may pose water quality risks as well if not properly controlled and mitigated.

There are also cost-effectiveness issues which would need to be addressed in using large scale composting to process agricultural waste. The costs of landfilling or composting the agricultural material involves transporting the material off-site to a landfill or composting site that will accept them. A local bio solids compost site indicated that some agricultural waste would be acceptable for composting; however, they do not have space for any of this material at present. A compost operator in Kern County indicated that the problem for composters is a shortage of nitrogenous materials (and water). Taking on more wood waste (a carbonaceous material) would only make the carbon to nitrogen ratio worse (i.e., higher), hence, it would be unlikely that any composters would accept this material at any price due to the current surplus of woody material in the Valley.

Advanced Biomass to Power Technologies

Next generation bioenergy solutions appear to be on the verge of broader deployment, but currently do not present a feasible alternative to open burning. While advancements in bioenergy solutions are moving rapidly and technologies are becoming closer to broader deployment, more certainty about the availability of pipeline or electrical interconnection is necessary to assist with securing investments needed to get these projects off the ground. The Central Valley Summit included representatives from a broad range of technologies which included on-farm, off-site and transportable solutions covering large- and small-scale electrical power production, renewable natural gas pipeline injection, and transportation fuel production.

Cellulosic ethanol is an advanced next-generation biofuel that can be made from agricultural wastes, wood chips, switch grass, corn stover, forest wastes, fast-growing trees, and other plant material. Currently, ethanol produced in the United States is most commonly produced from corn kernels. In the United States, corn ethanol is primarily used as an alternative or additive to gasoline. Advanced biofuels are those that do not rely on the starch in corn kernels. Production of large quantities of ethanol from woody biomass will likely require the use of chemical treatment or enzymes to speed the breakdown of the cellulose in the biomass. Currently, the production of cellulosic ethanol is still in the demonstration phase of development.

Pyrolysis is a possible path to convert agricultural biomass to higher value products. Pyrolysis is the heating of an organic material, such as biomass, in the absence of oxygen. It is the first step of producing a flammable gas called synthetic gas (syngas). Burning syngas to produce power offers certain advantages over directly burning the biomass because the gas can be cleaned and filtered to remove problematic chemical compounds. Using syngas is also potentially more efficient than direct combustion of biomass because the gas can be combusted at higher temperatures. Syngas can also be used to produce methanol and hydrogen, or converted into a liquid fuel. This is a viable alternative for farm-scale or small-scale power production, with lower emissions than existing biomass combustion power plants. There are currently only a few operational units in California, including two in the Valley.

Gasification/Cogeneration Plant Cost Data:
The International Renewable Energy Agency (IRENA) publication titled "Renewable Energy Technologies: Cost Analysis Series (June 2012), includes costs for gasification technologies. The following rough cost estimates were derived from the data included in the IRENA publication.

Equipment Type	Approximate Capital Cost (including installation, equipment, site upgrades)	Annual Maintenance and Operating*	Fuel Cost (including Transportation)**
Gasifier Powering a 50 MW Gas Turbine ~650 short tons/day of biomass fuel	$57,805,000	$2,601,225/year	$3,153,000/year
Gasifier powering a 4 MW ICE	$1,778,400	$80,028/year	$158,080/year

Equipment Type	Approximate Capital Cost (including installation, equipment, site upgrades)	Annual Maintenance and Operating*	Fuel Cost (including Transportation)**
~50 tons/day of biomass fuel			
Gasifier Powering a 600 kW CHP system ~8 tons/day of biomass fuel	$907,200	$40,824/year	$59,875/year

*Pursuant to the publication, the annual maintenance and operating cost ranges from 3% to 6% of the Capital Cost. 4.5% was used to estimate the annual maintenance and operating costs (which don't include the fuel and fuel transportation costs).
** Fuel and transportation costs vary greatly from one country to the next and one site to the next. Therefore, the accuracy of the estimate from the IRENA document may not be entirely accurate for the valley.

Due to the high cost of the purchase and installation of these technologies, most of these types of projects have required funding from state, local, and federal governments. Questions remain as to whether these projects would be self-sustaining over the long term without incentives.

The District will make every effort to support the deployment of new technologies through incentive programs. Additionally, the District has an ongoing Technology Advancement Program solicitation to support the commercialization of technologies that provide alternatives to the open burning of biomass.

Air Curtain Burn Boxes

Air curtain burn boxes may serve as a viable alternative to reducing emissions from open burning of agricultural waste**.** Air curtain burn boxes have been shown to be up to 80% cleaner than open burning of wood waste, and when coupled with the District's smoke management systems have the potential to manage emissions from the disposal of agricultural waste very effectively. However, the process rate of these units (1 to 5 tons/hr) may limit the effectiveness of air curtain burn boxes as a feasible alternative capable of handling the volume of agricultural waste generated in the Valley each year as it may take several units operating for multiple days just to process even small acreage removals. Notwithstanding, the District is working to facilitate the use of air curtain burners to dispose of agricultural material under certain scenarios in combination with the District's smoke management systems.

The District will continue to evaluate alternatives to open burning of agricultural waste and will support the implementation of clean alternatives where technologically and economically feasible.

Evaluation Findings

District Rule 4103 remains more stringent than requirements for analogous rules in other regions and currently meets or exceeds RACM, BACM, and MSM level requirements for this source category. Additionally, due to the management of open burning under the District's comprehensive SMS, modeling conducted as part of this Plan demonstrates that this source category does not significantly contribute to attainment of the applicable PM2.5 standards. District analysis has confirmed for the development of this attainment plan that there continues to be a lack of feasible alternatives for open burning for the crop categories identified and there continues to be a lack of long-term federal and state funding commitments for the continued operation of biomass facilities in the Valley or development of alternatives to open burning as required by state law to phase-out open burning of agricultural waste.

Despite the insignificant effect of this source category on attainment of the applicable PM2.5 standards and the lack of feasible alternatives to open burning, the District intends to maintain the restrictions currently contained within the rule while continuing to undertake efforts aim at the development and deployment of feasible alternative technologies and practices to reduce open agricultural burning in the Valley. The District efforts will be conducted in close coordination with USDA-NRCS, agricultural sources, and researchers through established processes such as the Agricultural Technical Subcommittee. These efforts include the pursuit of the following:

- Continued implementation the District's Smoke Management System safeguards to ensure no adverse air quality impact from authorized agricultural open burning.

- Exploring the feasibility of utilizing air curtain burn boxes subject to the District's Smoke Management System safeguards as an extension of agricultural operations.

- Continued support for state and federal financial assistance to promote cleaner alternatives for the disposal of agricultural waste.

- Continued support and financial assistance as feasible for the emerging cleaner alternatives to the open burning of agricultural waste, with priority given to on-the-farm deployable (minimum or no transportation related emissions) and scalable technologies, considering the full life-cycle of emissions and associated impacts on air quality when assessing the feasibility of alternatives to open burning.

C.2 Rule 4104 (Emissions From The Reduction Of Animal Matter)

Discussion

Adopted in 1992, Rule 4104 limits the air contaminants from operations used for the reduction of animal matter by requiring gases, vapors, and gas-entrained effluent from the process to be incinerated at temperatures not less than 1200 degrees Fahrenheit or processed in an equally effective manner. Combustion units, the remaining portion of the operation that produces emissions, are regulated by other District rules; as such, those emissions are controlled by, and accounted for, as a part of other District rules.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day								
PM2.5	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source Category

The reduction of animal matter source category includes rendering, cooking, drying, dehydration, digesting, evaporating, and protein concentration processes. The criteria pollutant emissions from this category are relatively small. The primary source of concern from this source category is odor, which is minimized through a venturi scrubber, cyclone, or packed bed scrubber for particulate matter control followed by a thermal oxidizer for VOC control. These facilities generally use steam from a boiler (indirect-fired) or a rotary dryer (direct-fired) for their operations, which generates NOx emissions from these combustion units; these combustion units are regulated by other District rules. There are currently seven active permitted units in the Valley.

How does District Rule 4104 compare with federal and state rules and regulations?

Federal Regulations

There are no EPA CTG, ACT, NSPS, NESHAP, or MACT requirements for this source category.

State Regulations

There are no state regulations applicable to this source category.

How does District Rule 4104 compare to rules in other air districts?

SCAQMD

- SCAQMD Rule 472 (Reduction of Animal Matter)

	SJVAPCD	SCAQMD
Applicability	Any source operation used for the reduction of animal matter.	Any equipment for the reduction of animal matter.
Exemption	Rule 4104 shall not apply to any article, machine, equipment or other contrivance used exclusively for the processing of food for human consumption.	Rule 472 shall not apply to any equipment used exclusively for the processing of food for human consumption.
Requirements	All gases, vapors and gas-entrained effluent from such an article, machine, equipment or other contrivance are incinerated at temperatures of not less than 1200°F for a period of not less than 0.3 seconds;	All gases, vapors and gas entrained effluents from equipment are incinerated at temperatures of not less than 650°C (1202°F) for a period of not less than 0.3 second.

BAAQMD

- BAAQMD Regulation 12 Rule 2 (Rendering Plants)

	SJVAPCD	BAAQMD
Applicability	Any source operation used for the reduction of animal matter.	Plants whose purpose is the reduction of animal matter, commonly referred to as rendering plants.
Exemption	Rule 4104 shall not apply to any article, machine, equipment or other contrivance used exclusively for the processing of food for human consumption.	No exemptions
Requirements	All gases, vapors and gas-entrained effluent from such an article, machine, equipment or other contrivance are incinerated at temperatures of not less than 1200°F for a period of not less than 0.3 seconds;	All gases, vapors and gas-entrained effluents are incinerated at a temperature of not less than 650°C (1202°F) for a period of not less than 0.3 seconds.

SMAQMD

- SMAQMD Rule 410 (Reduction of Animal Matter)

	SJVAPCD	SMAQMD
Applicability	Any source operation used for the reduction of animal matter.	Odors from animal matter reduction facilities by treatment of gases, vapors and gas-entrained effluents.
Exemption	Rule 4104 shall not apply to any article, machine, equipment or other contrivance used exclusively for the processing of food for human consumption.	Rule 410 shall not apply to any article, machine, equipment or other contrivance used exclusively for the processing of food for human consumption.
Requirements	All gases, vapors and gas-entrained effluent from such an article, machine, equipment or other contrivance are incinerated at temperatures of not less than 1200°F for a period of not less than 0.3 seconds;	All gases, vapors and gas-entrained effluents from such an article, machine, equipment or other contrivance are incinerated at temperatures of not less than 650°C (1202°F) for a period of not less than 0.3 seconds

VCAPCD

- VCAPCD Rule 58 (Reduction of Animal Matter)

	SJVAPCD	SMAQMD
Applicability	Any source operation used for the reduction of animal matter.	Any article, machine, equipment or other contrivance for the reduction of animal matter.
Exemption	Rule 4104 shall not apply to any article, machine, equipment or other contrivance used exclusively for the processing of food for human consumption.	Rule 58 shall not apply to processing of food for human consumption.
Requirements	All gases, vapors and gas-entrained effluent from such an article, machine, equipment or other contrivance are incinerated at temperatures of not less than 1200°F for a period of not less than 0.3 seconds;	All gases, vapors and gas entrained effluents from such an article, machine, equipment or other contrivance incinerated at temperatures of not less than 1300 degrees Fahrenheit for a period of not less than 0.4 seconds.

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

Packed Bed Scrubbers

The District evaluated the potential opportunity to reduce emissions if facilities were to replace their thermal oxidizers with packed bed scrubbers. In certain installations, packed bed scrubbers may be more efficient at removing PM from the exhaust and additionally do not generate NOx or SOx emissions. However, determining the scrubber medium may take some experimenting on the part of the facility to ensure it does not cause an increase in emissions or violate other District rules. It would also need to be replaced periodically, adding to the cost of upkeep. Thermal oxidizers do not present similar issues. Also, facilities subject to Rule 4104 produce only a very small amount of directly emitted PM2.5 and are otherwise already required to have a high level of control for emissions, as shown in the above emissions inventory table.

Regenerative Thermal Oxidizers

The District evaluated the potential opportunity to reduce emissions from facilities by replacing traditional thermal oxidizers with regenerative thermal oxidizers (RTOs) with heat recovery, which is a current practice at some facilities in the Valley. RTO devices use less supplementary fuel. While using less fuel may reduce NOx emissions, this is not necessarily the case. The PM control efficiency is nearly the same for both thermal oxidizers and RTOs, and the total NOx emissions from this category are relatively small given that there are only a few units subject to this rule that are not already subject to other combustion rules limiting NOx emissions. Any new units would be evaluated through the District's Best Available Control Technology New Source Review requirements.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for the reduction of animal matter. As demonstrated above, Rule 4104 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM and MSM requirements for this source category.

C.3 Rule 4106 (Particulate Matter Emissions From Prescribed/Hazard Reduction Burning)

Discussion

Adopted in June 2001, Rule 4106 incorporates provisions made necessary by Title 17 of the California Code of Regulations. Recognizing the importance of both prescribed burning and hazard reduction burning, the purpose of Rule 4106 is to permit, regulate, and coordinate the use of prescribed burning and hazard reduction burning while minimizing smoke impacts on the public. Through Rule 4106, the District has expended considerable resources to ensure that the ignition of burn projects is only allowed when air quality and dispersion conditions are favorable, reducing health impacts and air quality impacts.

The District works closely with land managers and participates in daily conference calls with Land Management Agencies (LMAs), CARB staff, fire weather meteorologists, and neighboring air districts to discuss potential smoke impacts from wildfires and prescribed burning. This collaborative effort ensures that the ignition of burn projects occurs when air quality and dispersion conditions are favorable, thus lessening the impacts on air quality in the Valley. Once a prescribed burn is commenced, District staff conducts inspections as needed to ensure the burn is conducted properly and determine if smoke is impacting downwind receptors.

The extreme drought experienced in the San Joaquin Valley and across the western United States has made trees in many regions of California susceptible to epidemic infestations of native bark beetles, which are constrained under normal circumstances by the defense mechanisms of healthy trees. These drought conditions and resulting bark beetle infestations across broad areas have caused vast tree mortality throughout several regions of the state. The scale of this tree die-off is unprecedented in modern history, with the United States Forest Service estimating that there are currently over 129 million dead trees across California. This tree die-off is of such a scale that California has reached an all-time high for fire danger and the potential for devastating wildfires.

Air pollution generated from wildfires poses a significant risk to public health as emissions can routinely overwhelm emission reduction efforts in the San Joaquin Valley and result in periods of excessively high particulate matter and ozone concentrations. Wildfires have the potential to generate tremendous emissions, depending on the acreage burned, fuel loading, and fuel type, and can easily exceed the entire emissions inventory in the Valley from stationary, area, and mobile sources. The length of time it takes for these emissions to occur depends on the severity of the wildfire. In addition to causing elevated PM2.5 concentrations, wildfires also generate and transport ozone precursors. When wildfire emissions are combined with the Valley's common summertime high temperatures and stagnant conditions, the potential for the production of peak ground level ozone is elevated.

Due to the tremendous health and safety risks caused by the tree mortality epidemic, in October 2015, the Governor of California issued a state of emergency proclamation. The Governor's proclamation includes provisions to expedite the removal of dead and dying hazardous trees. This proclamation helps to identify high hazard zones for wildfire and falling trees, and also orders state and local agencies to take action to enable removal of hazard trees. Building on the emergency proclamation, in May 2018, the Governor issued an Executive Order which directs state agencies to work to reduce the threat of wildfires through improved forest management and restoration practices. The Order specifically directs CARB and local air districts to reduce barriers for prescribed burning projects and increase opportunities for prescribed burns as a means for reducing fuel loads and the threat of wildfires.

The District is committed to working with land managers and other stakeholders to support the expanded use of prescribed burning. District staff maintains a dialogue with the land managers and other stakeholders to craft and advance workable solutions. Every spring, the District holds the SJV Annual Cooperators' Meeting to provide a forum for the District and land management agencies to review the Unified Guidelines and Procedures for Smoke Management document and to discuss current smoke management issues. The land management agencies assess year-in-review/lessons learned, provide an outlook for the upcoming fire season, and share presentations. The District also actively participates in the Interagency Air and Smoke Council (IASC) and Air and Land Managers (ALM) annual meetings. The IASC meeting provides a forum for air regulators, land managers, and fire managers to discuss air quality and smoke management issues in California. The ALM meeting provides a forum for decision makers to gain a better perspective on federal, state and local issues associated with smoke management in California.

Due to the tree mortality epidemic, the need to reduce fuel across the forests through prescribed burning and mechanical vegetative thinning methods is increasingly important. Effective forest management is critical to improve the health of the forests, as well as to prevent catastrophic air quality impacts from wildfires in the region. The District will continue to advocate for more effective forest management, and is committed to working with land management agencies to facilitate the reduction in forest fuel loads through both prescribed burning and mechanical vegetative thinning.

EMISSIONS INVENTORY

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
NOx	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
	Winter Average - Tons per day								
PM2.5	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
NOx	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10

Source Category

Rule 4106 is applicable to all rangeland improvement burning, forest management burning, wildland vegetation management burning, and to hazard reduction burning in the wildland/urban interface within the Valley.

Most prescribed burning is conducted by state and federal land managers on public lands, with additional prescribed burning conducted by a variety of local entities, including utilities and private land owners. Similarly, hazard reduction burning occurs in communities that are within the wildland/urban interface, where homes and businesses in the foothills are often surrounded by dry brush. This fuel must be disposed of each year to ensure a barrier of fire protection of 100 feet in all directions.[15] This disposal is usually in the form of burning, and as with prescribed burning, burning is only allowed if the District forecasts favorable meteorological and air quality conditions.

How does District Rule 4106 compare with federal and state rules and regulations?

Federal Regulations

There are no EPA CTG, ACT, NSPS, NESHAP, or MACT requirements for this source category.

State Regulations

There are no state regulations applicable to this source category.

How does District Rule 4106 compare to rules in other air districts?

There are no analogous rules for this source category in [list all applicable air districts].

SCAQMD

- SCAQMD Rule 444 (Open Burning***)*** *(Last amended July 12, 2013)*

The District evaluated the requirements contained within SCAQMD's Rule 444 and found no requirements that were more stringent than those already in Rule 4106.

	SJVAPCD	SCAQMD
Applicability	The provisions of this rule shall apply to all prescribed burning, and to hazard reduction burning in wildland/urban interface.	Agricultural burning, Disposal of Russian thistle, Prescribed burning, Fire prevention/suppression training, Open detonation or use of pyrotechnics, Fire hazard removal, Disposal of infectious waste, other than hospital waste, Research of testing materials, equipment or

[15] 100 foot barrier of fire protection required pursuant to California Public Resources Code §4291

		techniques, Disposal of contraband, Residential burning, Beach burning
Exemptions	N/A	Fire suppression training by fire agencies, open burning to protect crops from freezing (requires emergency burn plan to be submitted), open burning on islands located 15 miles or more from the mainland, fireworks displays, explosives detonation, recreational fires/ceremonial fires. Food prep fires and fires "for warmth at social gatherings" are allowed.
Requirements	No burning of garbage or green waste is allowed. The District shall allocate burning based on the predicted meteorological conditions and whether the total tonnage to be emitted would allow the volume of smoke and other contaminants to impact smoke sensitive areas, or create or contribute to an exceedance of an ambient air quality standard. Specific requirements for minimizing smoke, using approved ignition devices, and having vegetation be free of dirt, soil, and moisture. **Prescribed Burning** Specific requirements for prescribed burn conductors to have taken a prescribed burning smoke management training class approved by the APCO. Additional prescribed burn requirements detailed by project size. **Permits for Hazard Reduction Burning** No Hazard Reduction Burning shall take place without a permit.	Burning of waste/garbage is prohibited. No burning unless it is a permissive burn day or a marginal burn day on which burning is permitted in the applicable source/receptor area and such burning is not prohibited by the applicable public fire protection agency. Specific requirements for burn authorization requests and permit conditions for each category of burning (similar to SJV).

	A Permit shall be valid only on those days during which burning is not prohibited by the CARB, by the District or other designated agencies. Further administrative requirements and Smoke Management Plan requirements are outlined by project size.	

BAAQMD

- BAAQMD Regulation 5 (Open Burning) *Last amended June, 19, 2013)*

The District evaluated the requirements contained within BAAQMD's Regulation 5 and found no requirements that were more stringent than those already in Rule 4106.

	SJVAPCD	BAAQMD
Applicability	The provisions of this rule shall apply to all prescribed burning, and to hazard reduction burning in wildland/urban interface.	Open burning in the BAAQMD
Exemption	N/A	Fires set only for cooking of food for human beings; fires burning as safety flares or for the combustion of waste gases; the use of flame cultivation when the burning is performed with LPG or natural gas-fired burners designed and used to kill seedling grass and weeds and the growth is such that the combustion will not continue without the burner; fires set for the purposes of fire training using one gallon or less of flammable liquid per fire; further requirements for conditional exemptions (similar to SJV).
Requirements	No burning of garbage or green waste is allowed. The District shall allocate burning based on the predicted meteorological conditions and whether the total tonnage to be emitted	Recreational fires allowed on non-curtailment days; on permissive burn days the following fires are allowed with permission from the APCO (specific requirements for each category): disease and pest,

	would allow the volume of smoke and other contaminants to impact smoke sensitive areas, or create or contribute to an exceedance of an ambient air quality standard. Specific requirements for minimizing smoke, using approved ignition devices, and having vegetation be free of dirt, soil, and moisture. **Prescribed Burning** Specific requirements for prescribed burn conductors to have taken a prescribed burning smoke management training class approved by the APCO. Additional prescribed burn requirements detailed by project size. **Permits for Hazard Reduction Burning** No Hazard Reduction Burning shall take place without a permit. A Permit shall be valid only on those days during which burning is not prohibited by the CARB, by the District or other designated agencies. Further administrative requirements and Smoke Management Plan requirements are outlined by project size.	crop replacement, orchard pruning and attrition, double cropping stubble, stubble, hazardous materials (hazard reduction burning), fire training, flood debris, irrigation ditches, flood control, range management, forest management, marsh management, contraband, filmmaking, and public exhibition.

SMAQMD

- SMAQMD Rule 501(Agricultural Burning) *(Last amended April 3, 1997)*

Rule 501 applies to the burning of agricultural waste, including forest management and prescribed burning. The District evaluated the requirements contained within SMAQMD's Rule 501 and found no requirements that were more stringent than those already in Rule 4106. Rule 501 was last amended April 3, 1997.

	SJVAPCD	SMAQMD

Applicability	The provisions of this rule shall apply to all prescribed burning, and to hazard reduction burning in wildland/urban interface.	Agricultural burning, including: ag waste (trees, prunings, rice straw and stubble, field crop residue) disease prevention, range improvement, wildlife/game habitat, irrigation system management, forest management, wild land vegetation management, paper containers of ag chemicals
Exemption	N/A	Similar exemptions as SJV for ag operations, including burning of bags used for agricultural chemicals and emergency agricultural burns which would cause economic loss if denied.
Requirements	No burning of garbage or green waste is allowed. The District shall allocate burning based on the predicted meteorological conditions and whether the total tonnage to be emitted would allow the volume of smoke and other contaminants to impact smoke sensitive areas, or create or contribute to an exceedance of an ambient air quality standard. Specific requirements for minimizing smoke, using approved ignition devices, and having vegetation be free of dirt, soil, and moisture. **Prescribed Burning** Specific requirements for prescribed burn conductors to have taken a prescribed burning smoke management training class approved by the APCO. Additional prescribed burn requirements detailed by project size. **Permits for Hazard Reduction Burning**	Permit holder must contact District for permission to burn and ensure that it is not a No Burn day, and must contact the fire protection agency having jurisdiction over the burn location. Specific drying time requirements for different ag materials (similar to SJV)

	No Hazard Reduction Burning shall take place without a permit. A Permit shall be valid only on those days during which burning is not prohibited by the CARB, by the District or other designated agencies. Further administrative requirements and Smoke Management Plan requirements are outlined by project size.	

VCAPCD

- VCAPCD Rule 56 (Open Burning) *(Last amended November 11, 2003)*

The District evaluated the requirements contained within VCAPCD's Rule 56 and found no requirements that were more stringent than those already in Rule 4106.

	SJVAPCD	VCAPCD
Applicability	The provisions of this rule shall apply to all prescribed burning, and to hazard reduction burning in wildland/urban interface.	Combustible materials in open outdoor fires, including prescribed burning
Exemption	N/A	This rule shall not apply to open outdoor fires used only for the heating or cooking of food for human consumption or for recreational purposes when such fires are confined to a fireplace or barbecue pit. Flag burning, fire suppression training, fire agency/public officer allowed to set fires to reduce hazards as needed (similar to SJV).
Requirements	No burning of garbage or green waste is allowed. The District shall allocate burning based on the predicted meteorological conditions and whether the total tonnage to be emitted would allow the volume of smoke and other contaminants to impact smoke sensitive areas, or create or contribute to an exceedance	Permit required for open burning, burning only allowed on permissive burn days. Open burning is allowed for the following purposes only: a. The disposal of agricultural wastes in the pursuit of agricultural operations. b. Range improvement burning.

	of an ambient air quality standard. Specific requirements for minimizing smoke, using approved ignition devices, and having vegetation be free of dirt, soil, and moisture. **Prescribed Burning** Specific requirements for prescribed burn conductors to have taken a prescribed burning smoke management training class approved by the APCO. Additional prescribed burn requirements detailed by project size. **Permits for Hazard Reduction Burning** No Hazard Reduction Burning shall take place without a permit. A Permit shall be valid only on those days during which burning is not prohibited by the CARB, by the District or other designated agencies. Further administrative requirements and Smoke Management Plan requirements are outlined by project size.	c. Wildland vegetation management burning. d. Levee, reservoir or ditch maintenance. e. The disposal of Russian thistle (Salsola kali or tumbleweed). Specific burn times, drying times, and permit conditions also specified (similar to SJV). Drying times not applicable to prescribed burns. Requirements for Smoke Management Plans detailed.

PCAPCD

- PCAPCD Rule 301 (Nonagricultural Burning Smoke Management) *(Last amended February 9, 2012)*

The District evaluated the requirements contained within PCAPCD Rule 301 and found no requirements that were more stringent than those already in Rule 4106.

	SJVAPCD	PCAQMD
Applicability	The provisions of this rule shall apply to all prescribed burning, and to hazard reduction burning in wildland/urban interface.	Fire hazard reduction burning, mechanized burners, fires set or permitted by public officers, and right of way clearing, levee, ditch, and reservoir maintenance, to better manage smoke in order to reduce its effects.
Exemption	N/A	Fire hazard reduction burning, recreational or cooking Fires, flag burning, are exempted. Certain burning categories are exempted from drying time requirements.
Requirements	No burning of garbage or green waste is allowed. The District shall allocate burning based on the predicted meteorological conditions and whether the total tonnage to be emitted would allow the volume of smoke and other contaminants to impact smoke sensitive areas, or create or contribute to an exceedance of an ambient air quality standard. Specific requirements for minimizing smoke, using approved ignition devices, and having vegetation be free of dirt, soil, and moisture. **Prescribed Burning** Specific requirements for prescribed burn conductors to have taken a prescribed burning smoke management training class approved by the APCO.	The only allowable combustibles that can be burned is vegetation originating on the premises which is reasonably free of dirt, soil, and visible surface moisture. A person shall not ignite or allow open outdoor burning without first obtaining a valid burn permit from the District. No burn permit shall be construed to authorize open outdoor fires for any day during when it is a no-burn day, or open burning is prohibited by a fire protection agency for fire control or prevention. Additional requirements for drying times, approved ignition devices, wind direction, 24 hour burn limit, and administrative requirements (similar to SJV).

	Additional prescribed burn requirements detailed by project size. **Permits for Hazard Reduction Burning** No Hazard Reduction Burning shall take place without a permit. A Permit shall be valid only on those days during which burning is not prohibited by the CARB, by the District or other designated agencies. Further administrative requirements and Smoke Management Plan requirements are outlined by project size.	

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

Beyond the review of current regulation and rule requirements, the District performed an extensive review of the feasibility of technologies and measures that have been implemented in practice in other regions and potential new technologies and measures that may be feasible for implementation in the near future.

While there are many factors that need to be evaluated and addressed in the pursuit of minimizing fuel buildup, more effective use of prescribed burning is an area where the District has direct regulatory authority and can take action. The District has long been supportive of fuel reduction efforts including prescribed burns, advocating that reducing fuels in a responsible way will improve the health of the forests and improve future air quality by lessening the severity of wildfires. Despite these efforts, the forest fuel buildup has continued to increase at an alarming rate over the years due to decades of forest mismanagement, with fire danger being at an all-time high due to the recent catastrophic tree mortality from the drought and pest infestation. This long-term buildup of forest fuel poses a significant risk of large-scale wildfires with potential devastating impacts on air quality and public health. This has increased the need and urgency for greater forest fuel reductions. Based on direction received from the District's Governing Board in November 2015, and input from land management agencies, the District has become even more flexible when identifying permissive burn days for prescribed burning, which has assisted in a more rapid reduction of fuels. These efforts will assist in further using prescribed burning as a measure to prevent catastrophic wildfires while simultaneously minimizing health impacts for local residents.

Mechanical Removal of Forest Biomass

Given the catastrophic nature of wildfires, contradictory environmental concerns that preclude the use of mechanized equipment to dispose of fuel supplies need further examination. On one hand there is concern that the transportation and operation of logging equipment can damage wildland ecosystems and impact endangered and threatened species, and that mechanical harvesting of vegetative fuel supplies could lead to overharvesting of the forests. On the other hand, if left unchecked, the fuel buildup can lead to large wildfires that cause the destruction of the very species that were intended to be protected by policies such as those under the federal Wilderness Act, and in turn result in devastating public health impacts due to air pollution. The District will work with federal land managers and environmental stakeholders to ascertain the wildland areas where ecosystem and species impacts are of less concern, and support mechanical fuel reduction methods as appropriate.

The District analyzed the possibility of mechanical removal as an alternative to prescribed burning, but found that mechanical removal of forest biomass was infeasible as a required alternative to prescribed burning, due to the inaccessibility of mountain terrain and the extreme amount of forest acreage needing biomass management.

However, the District will support the use of mechanical removal where feasible. Fire agencies are procuring and deploying chippers, portable saw mills, masticators and air curtain burners throughout the state, but primarily in the forested land surrounding the Valley. This process has been facilitated by emergency exemptions that have been invoked by the California Air Resources Board to waive the requirements for portable equipment and certain off-road equipment.

Air Curtain Burners

While air curtain burners are capable of being deployed in some areas of the forest and are a viable alternative to reduce emissions from prescribed burning in some cases, these units are limited in their ability to be a large-scale solution to the management of forest biomass. Forest managers face challenges in being able to locate the units in remote areas, and the equipment and staff time necessary to operate the units makes the wide-spread operation of air-curtain burners economically infeasible for land management agencies. Additionally, to prevent an accidental fire, air curtain burners must be operated in a cleared area, representing further challenges to the broad deployment of this technology. The vast amount of remote acreage and huge number of diseased or dead trees that must be removed from California forests make it infeasible for air curtain burners to be a regulatory requirement or a large-scale alternative to prescribed burning.

Due to the emissions reductions achieved through the use of air curtain burners, the District will support the deployment of air curtain burners for use where feasible. The use of air curtain burners has been hindered by regulatory hurdles at the federal level. EPA has opined that air curtain burners are subject to the federal New Source Performance Standard for Other Solid Waste Incinerators, which only allows exemptions for emergency or disaster relief for up to 8 weeks. To comply with the requirements beyond the 8-week period, the operator must comply with certain emission limitations and obtain a Title V operating permit which adds cost and complexity to the use of these devices. To provide some administrative relief, the District, along with members of the task force, were able to work with EPA to interpret the regulation as not requiring the Title V permits for at least 30 months after the units begin operation. The exemption from Title V Permitting Requirements for Air Curtain Incinerators was sent by letter from EPA to CAPCOA on February 16, 2017. The District will continue to support the use of air curtain burners as an alternative to prescribed burning where feasible.

District Support of Forest-Specific Biomass Projects

The District will also explore other avenues to encourage and support forest-specific biomass projects, such as the North Fork CDC Biomass Plant project in Madera County. This 2 MW power plant will gasify hazard-reduction forest material, where the gas is then burned in an exhaust controlled environment that produces very low levels of NOx. This project has been permitted and construction has commenced. The successful operation of this plant will be an important demonstration of gasification technology as a viable alternative to the open burning of forest debris. The operation of this project complements the Governor's October 30, 2015, State of Emergency Proclamation that directs state agencies to implement a number of measures to accelerate the removal of fuel in the state's forests, and which includes extending and expediting power purchase agreements with biomass facilities, seeking additional funding for biomass facilities to help offset higher feedstock costs, and exempting projects under the proclamation from CEQA requirements.

Due to the scale of acreage that requires management and due to access issues to remote forest areas, this is not a technologically feasible regulatory alternative to prescribed burning. However, the District will work to support forest-specific biomass projects in an effort to reduce transport emissions created from hauling forest biomass to the Valley floor for further processing.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this source category. As demonstrated above, Rule 4354 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category. No further emission reduction opportunities were found. Due to extensive forest mortality and the critical need to reduce the risks of catastrophic wildfires through prescribed burning in the region, District staff is unable to recommend any additional regulatory measures at this time.

As directed by the District's Governing Board in November 2015, District staff will continue to work to facilitate effective use of prescribed burning as a means to reduce the number and severity of future wildfires. The District will continue to work with local, state, and federal land managers and fire suppression agencies in an ongoing effort to identify gaps in land management and fire suppression policies and practices and develop solutions. The District will support federal and state legislation focused on enhancing and preserving funding for land and forest management. Additionally, the District will support and pursue legislative or administrative initiatives to allow for mechanical removal of forest fuel buildup in high hazard zones.

C.4 Rule 4203 (Incineration of Combustible Refuse)

Discussion

Rule 4203 limits the concentration of particulate matter emissions based on process weight rates, and prohibits the discharge of visible emissions. The rule was originally adopted on May 21, 1992 and subsequently amended for District rule number reorganization on December 17, 1992. The facility subject to this rule currently implements BACT level requirements which require the mitigation of air pollution to the maximum degree achievable using control technologies like baghouses and lime scrubbers.

Emissions Inventory

CEPAM v1.05 shows no annual or winter emissions for this source category, since there is only one facility subject to the rule.

Source Category

The incineration of combustible refuse source category includes any person, operation, or facility who uses an incinerator or other equipment to dispose of or process combustible refuse by incineration. There is currently one facility in operation in the Valley subject to Rule 4203. This facility uses a baghouse to control particulate emissions and lime slurry dry scrubber for the control of SO2 and acid gas emissions.

How does District Rule 4203 compare with federal and state rules and regulations?

Federal Regulations

There are no specific federal guidelines for particulate matter concentrations in terms of NSPS, CTG, ACT, MACT, and NESHAP. EPA BACT standards require the use of a fabric filter or baghouse. District BACT standards are as stringent and require the use of natural gas supplemental fuel with a baghouse.

State Regulations

There are no state regulations applicable to this source category.

How does District Rule 4203 compare to rules in other air districts?

There are no comparable rules for this source category in BAAQMD or in SMAQMD.

SCAQMD

- SCAQMD Rule 473 (Disposal of Solid and Liquid Wastes) (*Adopted May 7, 1976, no amendments)*

SCAQMD Rule 473 regulates the disposal of solid and liquid wastes by requiring the operator to use a multiple-chamber incinerator or in equipment found by SCAQMD to be equally effective for the purpose of air pollution control. The District evaluated the requirements contained within SCAQMD Rule 473 and found no requirements that were more stringent than those already in District Rule 4203.

	SJVAPCD	SCAQMD Rule 473
Applicability	The provisions of this rule shall apply to any person, operation, facility, incinerator or equipment used to dispose of or process combustible refuse.	Persons who burn combustible refuse in any incinerator except in a multi-chamber incinerator.
Exemption	The provisions of this rule shall not apply to incinerators which have been approved by the governing fire control agency and which are used to dispose of residential rubbish by open burning as permitted by Rule 4103 (Open Burning).	Multi-chamber incinerators
Requirements	- A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of or process combustible refuse by burning, having burning rates greater than 100 pounds per hour, particulate matter in excess of 0.10 grain per cubic foot of gas calculated to 12% of carbon dioxide (CO_2) at dry standard conditions, except as provided in Section 4.3. - A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of or process combustible refuse by burning, having burning rates less than or equal to 100 pounds per hour, particulate matter in excess of 0.30 grain per cubic foot of gas calculated to 12% of carbon dioxide (CO_2) at dry standard conditions, except as provided in Section 4.3. - A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of combustible refuse by burning, particulate matter in excess of 0.10 pounds per 100 pounds of combustible refuse charged. A person meeting this requirement is	(a) A person shall not burn any combustible refuse in any incinerator except in a multiple-chamber incinerator or in equipment found by the Air Pollution Control Officer to be equally effective for the purpose of air pollution control. (b) A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of combustible refuse by burning, having design burning rates greater than 50 kilograms (110 pounds) per hour, except as provided in subsection (d) of this rule, particulate matter in excess of 0.23 gram per cubic meter (0.1 grain per cubic foot) of gas calculated to 12 percent of carbon dioxide (CO_2) at standard conditions averaged over a minimum of 15 consecutive minutes and shall not discharge particles which are individually large enough to be visible while suspended in the

	not required to meet Sections 4.1 and 4.2. - A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of combustible refuse by burning any particles which are individually large enough to be visible while suspended in the atmosphere. 4.5 Any carbon dioxide produced by combustion of any liquid or gaseous fuel shall be excluded from the calculation to 12% of carbon dioxide (CO2).	atmosphere. Any carbon dioxide (CO2) produced by combustion of any liquid or gaseous fuels shall be excluded from the calculation of 12 percent of carbon dioxide (CO2) produced by combustion of any liquid or gaseous fuels shall be excluded from the calculation to 12 percent of carbon dioxide (CO2). (c) A person shall not discharge into the atmosphere from any equipment whatsoever, used to process combustible refuse, except as provided in subsection (d) of this rule, particulate matter in excess of 0.23 gram per cubic meter (0.1 grain per cubic foot) of gas calculated to 12 percent of carbon dioxide (CO2) at standard conditions averaged over a minimum of 15 consecutive minutes. Any carbon dioxide (CO2) produced by combustion of any liquid or gaseous fuels shall be excluded from the calculation to 12 percent of carbon dioxide (CO2). (d) A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of combustible refuse by burning, having design burning rates of 50 kilograms (110 pounds) per hour or less, or for which an application for permit was filed before January 1, 1972, particulate matter in excess of 0.69 gram per cubic meter (0.3 grain per cubic foot) of gas calculated to 12 percent

		of carbon dioxide (CO_2) at standard conditions averaged over a minimum of 15 consecutive minutes and shall not discharge particles which are individually large enough to be visible while suspended in the atmosphere. Any carbon dioxide (CO_2) produced by combustion of any liquid or gaseous fuels shall be excluded from the calculation to 12 percent of carbon dioxide (CO_2).

VCAPCD

- VCAPCD Rule 57 (Incinerators) *(Last amended January 11, 2005)*

VCAPCD Rule 57 is applicable to equipment used for the disposal of solid or liquid combustible refuse by burning in an incinerator or equipment found by VCAPCD to be equally effective for the purpose of air pollution control. The District evaluated the requirements contained within VCAPCD Rule 57 and found no requirements that were more stringent than those already in District Rule 4203.

	SJVAPCD	VCAPCD
Applicability	The provisions of this rule shall apply to any person, operation, facility, incinerator or equipment used to dispose of or process combustible refuse.	This rule applies to equipment used for the disposal of solid or liquid combustible refuse by burning.
Exemption	The provisions of this rule shall not apply to incinerators which have been approved by the governing fire control agency and which are used to dispose of residential rubbish by open burning as permitted by Rule 4103 (Open Burning).	This rule shall not apply to: 1. Crematoriums 2. Process equipment such as ovens used to remove contaminants or components from a part or assembly.
Requirements	- A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of or process combustible refuse by burning, having burning rates greater than 100 pounds per hour, particulate matter in excess of 0.10 grain per	1. No person shall burn solid or liquid combustible refuse in an incinerator except in a multiple chamber incinerator, or in equipment approved by the APCO and the U.S. Environmental Protection Agency

	cubic foot of gas calculated to 12% of carbon dioxide (CO_2) at dry standard conditions, except as provided in Section 4.3. - A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of or process combustible refuse by burning, having burning rates less than or equal to 100 pounds per hour, particulate matter in excess of 0.30 grain per cubic foot of gas calculated to 12% of carbon dioxide (CO_2) at dry standard conditions, except as provided in Section 4.3. - A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of combustible refuse by burning, particulate matter in excess of 0.10 pounds per 100 pounds of combustible refuse charged. A person meeting this requirement is not required to meet Sections 4.1 and 4.2. - A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of combustible refuse by burning any particles which are individually large enough to be visible while suspended in the atmosphere. 4.5 Any carbon dioxide produced by combustion of any liquid or gaseous fuel shall be excluded from the calculation to 12% of carbon dioxide (CO_2).	to be equally effective for the purpose of air pollution control. 2. No incinerator shall discharge particles individually large enough to be visible while suspended in the atmosphere.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this source category. As demonstrated above, Rule 4313 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM and MSM requirements for this source category.

C.5 RULE 4204 (COTTON GINS)

DISCUSSION

Cotton ginning is the process of separating the lint from the seed. Cotton gins have been operating within the San Joaquin Valley for decades and have become a highly efficient industry producing millions of bales of cotton. Modern ginning uses pneumatic conveyance, in the form of fans blowing air, which moves the cotton material throughout the ginning process. Particulate matter emissions are the unwanted by-products of this efficient means of transferring massive quantities of cotton material from one process to the next process, such as from the unloading stage to drying and cleaning stages. Since cotton gins use large quantities of air for conveying, cyclones are used for air pollution abatement. PM emissions from cotton ginning facilities occur mostly during a three-month period from October to December.

While the principle function of the cotton gin is to separate lint from seed, the gin must also be able to remove foreign matter, moisture, and other contaminants that significantly reduce the value of the ginned lint. Currently, all cotton gins in the Valley are required to operate using high-efficiency 1D3D cyclones.

EMISSIONS INVENTORY

Pollutant	2013	2016	2019	2020	2021	2022	2023	2024	2025	2026
	Annual Average - Tons per day									
PM2.5	0.22	0.22	0.24	0.24	0.24	0.25	0.25	0.25	0.26	0.26
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day									
PM2.5	0.35	0.35	0.37	0.37	0.38	0.38	0.39	0.39	0.40	0.40
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SOURCE CATEGORY

Rule 4204 was adopted on February 17, 2005, as part of the District's strategy to reduce PM10 emissions and satisfy the attainment goals contained in the 2003 PM10 Plan. Rule 4204 limits particulate matter emissions from cotton ginning operations.

HOW DOES DISTRICT RULE 4204 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations

There are no federal CTGs, ACTs, NSPSs, NESHAPs, or MACTs that are specific to cotton gins

No California state regulations have been identified that are applicable to cotton gins. However, the District has identified regulations in other states that have requirements applicable to cotton gins. These include the following regulations:

- New Mexico Administrative Code (NMAC) 20.2.66.1 (Cotton Gins)
- North Carolina Administrative Code (NCAC) Title 15A, Subchapter 2D, Section .0542 (Control of Particulate Emissions from Cotton Ginning Operations)
- South Carolina Air Pollution Control Regulations and Standards (SCAPCR), Regulation 61-62.5, Standard No. 4, Section V (Cotton Gins)
- Oklahoma Department of Environmental Quality (ODEQ), Air Pollution Control, 252:100-23 (Cotton Gins)
- Texas Commission on Environmental Quality (TECQ), Air Quality Standard Permit for Cotton Gin Facilities and Cotton Burr Tub Grinders

New Mexico Administrative Code (NMAC) 20.2.66.1 (Cotton Gins) (Adopted April 7, 2005)

The District compared the requirements of District Rule 4204 with the requirements contained within NMAC 20.2.66.1.

	SJVAPCD 4204	NMAC 20.2.66.1
Applicability	The provisions of this rule shall apply to all cotton ginning facilities within the District.	All persons who intend to construct or modify a cotton ginning facility as defined in this part, except as otherwise provided by this part.
Exemption	Cotton ginning facilities used for research purposes and limited to throughputs of not more than 4,000 pounds of seed cotton processed per day shall be exempt from the requirements of Section 5.0.	None specifically identified.

	SJVAPCD 4204	NMAC 20.2.66.1
Requirements	All emission points shall be controlled by 1D-3D cyclones or rotary drum filters. New cyclones or replacement parts of existing 1D-3D cyclones shall have the dimensional characteristics of the Enhanced 1D-3D cyclone, or the 1D-3D with a 2D-2D inlet and an expansion chamber trash outlet.	<u>High Pressure Exhaust:</u> Exhaust shall be controlled by the use of a high efficiency cyclone dust collectors. High efficiency cyclone dust collector means any cyclone collector of the 2D-2D or 1D-3D configuration. <u>Low Pressure Exhaust:</u> Exhausts shall be controlled by the use of screens with a mesh size of 70 by 70 or finer, or the use of perforated condenser drums with holes not exceeding 0.045 inches in diameter, or with equipment of equivalent or higher design efficiency, as determined by the department.

	Driver-under or pull through trash collection system for load-out purposes shall not load trash into a hopper or trailer unless one or more the following are utilized: • The trash loading area has an enclosure with four sides that are higher than the trash auger; at least two sides shall be solid and the remaining sides shall: have a flexible wind barrier, which extends below the top of the trash trailer sides; or have solid doors that remain shut while trash trailers are being loaded, except as necessary to accommodate trailer movement; or have a combination of flexible wind barriers and solid doors. • A solid-sided trailer is used when there is no enclosure, and the trash auger and opening of the loading device have a flexible shroud that extends just below the top of the trailer's solid sides, or • Fugitive PM10 emissions from load-out areas are reduced by an alternative method, which is approved by the APCO and the EPA. An owner/operator shall not operate a trash conveyance system dumping directly into a pile unless it meets the following requirements: • Both sides of the trash auger shall be equipped with wind barriers that extend, as measured vertically prior to trash pile build-up, one foot above and three feet below the auger or with an alternative control approved by the APCO and the EPA. • After the pile has built up to the height of the trash auger,	Permits shall include a fugitive dust management plan that includes the complete enclosure of the burr hoppers, the control of fugitive dust emissions from inside the gin building, the control of fugitive dust emissions from outside the gin building.

	SJVAPCD 4204	NMAC 20.2.66.1
	removing material from the pile shall be performed in such a way as to prevent free-falling trash from the stockpiling system. Dust management plans for facilities are subject to the requirements in District Rules 8011, 8021, 8031, 8041, 8051, 8061, 8071, and 8081.	
	Requirements for cotton gin dryers are included in District Rule 4309, *Dryers, Dehydrators, and Ovens*.	Opacity and fuel type limitations for fuel burning equipment.

The NMAC regulation requires the use of 2D-2D or 1D-3D cyclones on the exhaust of high pressure systems only while District Rule 4204 requires all systems to be controlled with 1D-3D cyclones. District Rule 4204 also requires that new cyclones be Enhanced 1D-3D cyclones with high control efficiency. Texas A&M reports tested efficiencies of 97% for 1D-3D cyclones up to 99% for Enhanced 1D-3D cyclones. Therefore, District Rule 4204 requirements result in higher PM control efficiency as compared to NMAC regulation requirements.

The NMAC regulation still allows screened enclosures on low pressure air systems while, as mentioned above, District Rule 4204 requires the use of high efficiency cyclone on all air systems. Therefore, the District rule is significantly more stringent with respect to trash systems.

While NMAC requires burr hoppers to be fully enclosed, District Rule 4204 requires that the trash loading area be an enclosure with four sides higher than the trash auger, which is equivalent to the NMAC requirement. In California cotton gins, all burrs (the hard casing around the cotton fiber) are captured in the trash system. District Rule 4204 is more stringent in this area as well.

Therefore, overall, District Rule 4204 is more stringent than the NMAC 20.2.66.1 regulation applying to cotton gin operations.

North Carolina Administrative Code (NCAC) Title 15A, Subchapter 2D, Section 0542 (Control of Particulate Emissions from Cotton Ginning Operations)
(Amended June 1, 2018)

The District compared the requirements of District Rule 4204 with the requirements contained within NCAC 02D.0542.

	SJVAPCD 4204	15A NCAC 02D.0542

Applicability	The provisions of this rule shall apply to all cotton ginning facilities within the District.	All existing, new, and modified cotton ginning operations.
Exemption	Cotton ginning facilities used for research purposes and limited to throughputs of not more than 4,000 pounds of seed cotton processed per day (equivalent to 4 bales/day at a trash-to-cotton ratio of 1-to-1) shall be exempt from the requirements of Section 5.0.	Existing facilities with a maximum rated capacity of less than 20 bales per hour that do not have cyclones on lint cleaners and battery condensers are not required to add emission control devices to lint cleaning exhausts and/or batter condenser exhausts if emissions from the lint cleaning and/or battery condenser are controlled by fine mesh screens.
Requirements	All emission points shall be controlled by 1D-3D cyclones or rotary drum filters. New cyclones or replacement parts of existing 1D-3D cyclones shall have the dimensional characteristics of the Enhanced 1D-3D cyclone, or the 1D-3D with a 2D-2D inlet and an expansion chamber trash outlet.	<u>High Pressure Exhaust:</u> Control all high pressure exhausts and lint cleaning exhausts with an emission control system that includes: A. one or more 1D-3D or 2D-2D cyclones to achieve 95 percent efficiency; or B. a device with at least a 95 percent efficiency. <u>Low Pressure Exhaust:</u> Control all low pressure exhausts, except lint cleaning exhausts, with an emission control system that includes: A. one or more 1D-3D or 2D-2D cyclones to achieve 90 percent efficiency; or B. a device with at least a 90 percent efficiency.
	Driver-under or pull through trash collection system for load-out purposes shall not load trash into a hopper or trailer unless one or more the following are utilized: • The trash loading area has an enclosure with four sides that are higher than the trash auger; at least two sides shall be solid and the remaining sides shall: have a flexible wind barrier, which extends	Minimize fugitive emissions by designing and maintaining trash systems, the gin yard, and the traffic area according to the guidelines in the regulation.

	below the top of the trash trailer sides; or have solid doors that remain shut while trash trailers are being loaded, except as necessary to accommodate trailer movement; or have a combination of flexible wind barriers and solid doors. • A solid-sided trailer is used when there is no enclosure, and the trash auger and opening of the loading device have a flexible shroud that extends just below the top of the trailer's solid sides, or • Fugitive PM10 emissions from load-out areas are reduced by an alternative method, which is approved by the APCO and the EPA. An owner/operator shall not operate a trash conveyance system dumping directly into a pile unless it meets the following requirements: • Both sides of the trash auger shall be equipped with wind barriers that extend, as measured vertically prior to trash pile build-up, one foot above and three feet below the auger or with an alternative control approved by the APCO and the EPA. • After the pile has built up to the height of the trash auger, removing material from the pile shall be performed in such a way as to prevent free-falling trash from the stockpiling system. Dust management plans for facilities are subject to the requirements in District Rules 8011, 8021, 8031, 8041, 8051, 8061, 8071, and 8081.	

The NCAC regulation requires the use of 2D-2D or 1D-3D cyclones while District Rule 4204 requires 1D-3D cyclones. District Rule 4204 also requires that new cyclones be Enhanced 1D-3D cyclones with high control efficiency, which exceeds standard 1D-3D cyclones control efficiency. For cyclones controlling exhaust on high pressure systems, the NCAC also specifies a 95% control efficiency. Texas A&M reports tested efficiencies of 97% for 1D-3D cyclones up to 99% for Enhanced 1D-3D cyclones. Therefore, District Rule 4204 requiring the use of 1D-3D cyclones on all systems and also requiring that new cyclones be Enhanced 1D-3D cyclones with PM control efficiency up to 99% exceeds NCAC requirements for high pressure systems with 95% PM control efficiency.

On low pressure systems, the NCAC regulation requires the use of 2D-2D or 1D-3D cyclones and identifies a 90% PM control efficiency. As discussed above, District Rule 4204 requires the use of 1D-3D cyclones or Enhanced 1D-3D cyclones when installing new cyclones. As mentioned, Texas A&M reports tested efficiencies of 97% for 1D-3D cyclones up to 99% for Enhanced 1D-3D cyclones. Therefore, District Rule 4204 requiring the use of 1D-3D cyclones or new Enhanced 1D-3D cyclones with PM control efficiency up to 99% exceeds NCAC requirements for low pressure systems with 90% PM control efficiency.

The NCAC regulation also provides an exemption for operations processing less than 20 bales per hour, which could represent approximately 20,000 bales per season. Since the District rule does not have such exemption (only contains a research-targeted exemption at less than 4 bales/day), District Rule 4204 is more stringent in this area as well.

Therefore, overall, District Rule 4204 is more stringent than the NCAC 02D.0542 regulation applying to cotton gin operations.

South Carolina Air Pollution Control Regulations and Standards (SCAPCR), Regulation 61-62.5, Standard No. 4, Section V (Cotton Gins) (Amended September 23, 2016)

The District compared the requirements of District Rule 4204 with the requirements contained within SCAPCR 61-62.5, Std4, Section V.

	SJVAPCD 4204	SCAPCR 62.5, Std4
Applicability	The provisions of this rule shall apply to all cotton ginning facilities within the District.	All existing, new, and modified cotton ginning operations.

Exemption	Cotton ginning facilities used for research purposes and limited to throughputs of not more than 4,000 pounds of seed cotton processed per day (equivalent to 4 bales/day at a trash-to-cotton ratio of 1-to-1) shall be exempt from the requirements of Section 5.0.	Existing facilities with a maximum gin stand rated capacity (or documented equipment limitation) of less than twenty (20) bales per hour that do not have cyclones on lint cleaning system exhausts and battery condenser exhausts as of promulgation date of this rule, will not be required to add the emission control devices in paragraph C.2 below to lint cleaning exhausts or battery condenser exhausts if emissions from these exhausts are controlled by fine mesh screens.
Requirements	All emission points shall be controlled by 1D-3D cyclones or rotary drum filters. New cyclones or replacement parts of existing 1D-3D cyclones shall have the dimensional characteristics of the Enhanced 1D-3D cyclone, or the 1D-3D with a 2D-2D inlet and an expansion chamber trash outlet.	Each cotton ginning operation shall install and operate a particulate emission control system on all high and low pressure exhausts and lint cleaning system exhausts that includes one (1) or more 1D-3D or 2D-2D cyclones.
	Driver-under or pull through trash collection system for load-out purposes shall not load trash into a hopper or trailer unless one or more the following are utilized: • The trash loading area has an enclosure with four sides that are higher than the trash auger; at least two sides shall be solid and the remaining sides shall: have a flexible wind barrier, which extends below the top of the trash trailer sides; or have solid doors that remain shut while trash trailers are being loaded, except as necessary to accommodate trailer movement; or have a combination of flexible wind barriers and solid doors. • A solid-sided trailer is used when there is no enclosure, and the trash auger and	Trash stacker areas shall contain one (1) of the following: a. A three (3) sided enclosure with a roof whose sides are high enough above the opening of the dumping device to prevent wind from dispersing dust or debris; or b. A device to provide wet suppression at the dump area of the trash cyclone and minimize free fall distance of waste material exiting the trash cyclone.

	opening of the loading device have a flexible shroud that extends just below the top of the trailer's solid sides, or • Fugitive PM10 emissions from load-out areas are reduced by an alternative method, which is approved by the APCO and the EPA. An owner/operator shall not operate a trash conveyance system dumping directly into a pile unless it meets the following requirements: • Both sides of the trash auger shall be equipped with wind barriers that extend, as measured vertically prior to trash pile build-up, one foot above and three feet below the auger or with an alternative control approved by the APCO and the EPA. • After the pile has built up to the height of the trash auger, removing material from the pile shall be performed in such a way as to prevent free-falling trash from the stockpiling system.	
	Dust management plans for facilities are subject to the requirements in District Rules 8011, 8021, 8031, 8041, 8051, 8061, 8071, and 8081.	Minimize fugitive emissions by designing and maintaining trash systems, the gin yard, and the traffic area according to the guidelines in the regulation.

SCAPC Regulation requires the use of 2D-2D or 1D-3D cyclones while District Rule 4204 requires 1D-3D cyclones and also requires that new cyclones be Enhanced 1D-3D cyclones with high control efficiency. Texas A&M reports tested efficiencies of 97% for 1D-3D cyclones up to 99% for Enhanced 1D-3D cyclones. Therefore, District Rule 4204 requirements result in higher PM control efficiency as compared to SCAPC regulation requirements.

The SCAPC regulation also provides an exemption for operations processing less than 20 bales per hour, which could represent approximately 20,000 bales per season. Since the District rule does not have such exemption (only contains a research-targeted exemption at less than 4 bales/day), District Rule 4204 is more stringent in this area as well.

While the SCAPC regulation requires the trash stacker be contained in a three-sided enclosure, District Rule 4204 requires that the trash loading area be an enclosure with four sides higher than the trash auger. District Rule 4204 is more stringent in this area as well.

Therefore, overall, District Rule 4204 is more stringent than the SCAPC 62.5, Std4 Section V regulation applying to cotton gin operations.

Oklahoma Department of Environmental Quality (ODEQ), Air Pollution Control, 252:100-23 (Cotton Gins) (Adopted February 17, 2017)

The District compared the requirements of District Rule 4204 with the requirements contained within ODEQ 252:100-23.

	SJVAPCD 4204	ODEQ 252:100-23
Applicability	The provisions of this rule shall apply to all cotton ginning facilities within the District.	All existing, new, and modified cotton ginning operations.
Exemption	Cotton ginning facilities used for research purposes and limited to throughputs of not more than 4,000 pounds of seed cotton processed per day (equivalent to 4 bales/day at a trash-to-cotton ratio of 1-to-1) shall be exempt from the requirements of Section 5.0.	No exemption listed.
Requirements	Opacity from cotton gins is limited to less than 20% pursuant to District Rule 4101.	Visible emissions shall not exceed 20% opacity.

	All emission points shall be controlled by 1D-3D cyclones or rotary drum filters. New cyclones or replacement parts of existing 1D-3D cyclones shall have the dimensional characteristics of the Enhanced 1D-3D cyclone, or the 1D-3D with a 2D-2D inlet and an expansion chamber trash outlet.	Low Pressure Exhaust: The use of screens with a mesh size of 70 by 70 or finer (U.S. Sieve), or the use of perforated condenser drums with holes not exceeding 0.045 inches in diameter or equipment of equivalent design efficiency. High Pressure Exhaust: The use of 2D-2D cyclones shall be required for existing gins. Existing gins shall install and use 1D-3D cyclone collectors or equivalent when the capital cost of repair or replacement of the existing 2D-2D cyclone exceeds 50% of the capital cost of a new 1D-3D cyclone. New or modified cotton gins shall utilize a 1D-3D cyclone collector or equipment of equivalent collection efficiency upon commencement of operation.
	Driver-under or pull through trash collection system for load-out purposes shall not load trash into a hopper or trailer unless one or more the following are utilized: • The trash loading area has an enclosure with four sides that are higher than the trash auger; at least two sides shall be solid and the remaining sides shall: have a flexible wind barrier, which extends below the top of the trash trailer sides; or have solid doors that remain shut while trash trailers are being loaded, except as necessary to accommodate trailer movement; or have a combination of flexible wind barriers and solid doors. • A solid-sided trailer is used when there is no enclosure, and the trash auger and opening of the loading device have a flexible shroud that extends just below the top of the trailer's solid sides, or	For emission control during dumping, burr hoppers at existing gin sites located within the corporate city limits of any city or within 300 feet of two or more occupied establishments must be totally enclosed. All new gin sites shall install and use a total enclosure on the burr hopper.

	• Fugitive PM10 emissions from load-out areas are reduced by an alternative method, which is approved by the APCO and the EPA. An owner/operator shall not operate a trash conveyance system dumping directly into a pile unless it meets the following requirements: • Both sides of the trash auger shall be equipped with wind barriers that extend, as measured vertically prior to trash pile build-up, one foot above and three feet below the auger or with an alternative control approved by the APCO and the EPA. • After the pile has built up to the height of the trash auger, removing material from the pile shall be performed in such a way as to prevent free-falling trash from the stockpiling system.	
	Dust management plans for facilities are subject to the requirements in District Rules 8011, 8021, 8031, 8041, 8051, 8061, 8071, and 8081.	Minimize fugitive emissions by designing and maintaining trash systems, the gin yard, and the traffic area according to the guidelines in the regulation.

The ODEC regulation requires the use of 2D-2D or 1D-3D cyclones on the exhaust of high pressure systems only while District Rule 4204 requires all systems to be controlled with 1D-3D cyclones. District Rule 4204 also requires that new cyclones be Enhanced 1D-3D cyclones with high control efficiency. Texas A&M reports tested efficiencies of 97% for 1D-3D cyclones up to 99% for Enhanced 1D-3D cyclones. Therefore, District Rule 4204 requirements result in higher PM control efficiency as compared to ODEC regulation requirements.

The ODEC regulation still allows screened enclosures on low pressure air systems while, as mentioned above, District Rule 4204 requires the use of high efficiency cyclone on all air systems. Therefore, the District rule is significantly more stringent with respect to trash systems.

Therefore, overall, District Rule 4204 is more stringent than the NCAC 20.2.66.1 regulation applying to cotton gin operations.

Texas Commission on Environmental Quality, Air Quality Standard Permit for Cotton Gin Facilities and Cotton Burr Tub Grinders

The District compared the requirements of District Rule 4204 with the requirements contained within TCEQ Air Quality Standard Permit for Cotton Gin Facilities and Cotton Burr Tub Grinders.

	SJVAPCD 4204	TCEQ, Air Quality Standard Permit for Cotton Gin Facilities and Cotton Burr Tub Grinders
Applicability	The provisions of this rule shall apply to all cotton ginning facilities within the District.	All existing, new, and modified cotton ginning operations.
Exemption	Cotton ginning facilities used for research purposes and limited to throughputs of not more than 4,000 pounds of seed cotton processed per day (equivalent to 4 bales/day at a trash-to-cotton ratio of 1-to-1) shall be exempt from the requirements of Section 5.0.	Replacement or addition of cotton gin stands where no other equipment change or additions are involved
Requirements	All emission points shall be controlled by 1D-3D cyclones or rotary drum filters. New cyclones or replacement parts of existing 1D-3D cyclones shall have the dimensional characteristics of the Enhanced 1D-3D cyclone, or the 1D-3D with a 2D-2D inlet and an expansion chamber trash outlet.	All rotary drum filter, fabric filter, and cyclone collection systems used to control particulate emissions from the cotton gin facilities authorized by this standard permit shall meet the following requirements, as applicable: • fabric filter and drum filter systems shall be designed to meet an outlet grain loading not to exceed 0.01 grains per dry standard cubic foot (combined front half and back half); • cyclone collectors shall be properly sized high efficiency cyclones with a cone length at least twice the diameter of the cyclone.

	Driver-under or pull through trash collection system for load-out purposes shall not load trash into a hopper or trailer unless one or more the following are utilized: • The trash loading area has an enclosure with four sides that are higher than the trash auger; at least two sides shall be solid and the remaining sides shall: have a flexible wind barrier, which extends below the top of the trash trailer sides; or have solid doors that remain shut while trash trailers are being loaded, except as necessary to accommodate trailer movement; or have a combination of flexible wind barriers and solid doors. • A solid-sided trailer is used when there is no enclosure, and the trash auger and opening of the loading device have a flexible shroud that extends just below the top of the trailer's solid sides, or • Fugitive PM10 emissions from load-out areas are reduced by an alternative method, which is approved by the APCO and the EPA. An owner/operator shall not operate a trash conveyance system dumping directly into a pile unless it meets the following requirements: • Both sides of the trash auger shall be equipped with wind barriers that extend, as measured vertically prior to trash pile build-up, one foot above and three feet below the auger or with an alternative control approved by the APCO and the EPA.	Fugitive emissions from burr hoppers authorized by this standard permit shall be minimized through the use of appropriate operational practices and/or other control methods to prevent visible emissions from traveling off property during trash dumping operations.

	• After the pile has built up to the height of the trash auger, removing material from the pile shall be performed in such a way as to prevent free-falling trash from the stockpiling system.	
	Requirements for cotton gin dryers are included in District Rule 4309, Dryers, Dehydrators, and Ovens. Requirements for engines are included in District Rule 4702, Internal Combustion Engines.	Fuel type limitations for burners and engines. Emissions and operating hour limits for engines.

Rather than requiring the use of high efficiency control device, TCEQ Regulation requires that devices (rotary drum filter, fabric filter, and cyclone collection systems) used to control PM be properly designed and operated. As opposed to TCEQ Regulation, District Rule 4204 requires the use of 1D-3D cyclones but also requires that new cyclones be Enhanced 1D-3D cyclones with high control efficiency which exceeds standard 1D-3D cyclones control efficiency. Texas A&M reports tested efficiencies of 97% for 1D-3D cyclones up to 99% for Enhanced 1D-3D cyclones.

Therefore, District Rule 4204 is more stringent than the TCEQ regulation applying to cotton gin operations.

How does District Rule 4204 compare to rules in other air districts?

There are no analogous rules for this source category in SCAQMD, BAAQMD, SMAQMD, and VCAQPCD

Additional Emission Reduction Opportunities

Beyond the review of current regulation and rule requirements, the District performed an extensive review of the feasibility of expanding applicability or removal of exemptions for this source category, technologies and measures that have been implemented in practice in other regions, and potential new technologies and measures that may be feasible for implementation in the near future. Based on this exhaustive review, District staff did not find any additional measures currently available or will be available prior to the 2025 attainment deadline date that could improve the effectiveness of this rule.

Research and PM2.5 Fraction

Research was completed in 2013 by the United States Department of Agriculture Agricultural Research Service (USDA-ARS), in partnership with cotton associations, EPA, ARB, and the District to measure actual PM10 and PM2.5 emissions from stack sources and fugitive emissions in and around several ginning facilities. This research provided emission factors for comparison to previous estimations that are included in emission inventories and provided data for both types of cotton gins currently in use in California. The project was designed to measure emissions from facilities with current emissions control technologies in place and to improve emissions estimations by measurement with the highest quality methods and instruments. The project was not designed to evaluate new technologies or measures to further reduce emissions. Results for the seven gins that were sampled for the project indicate the estimated ratio of PM2.5 to PM10 is approximately 16%.[16] This fraction of PM2.5 to PM10 is lower than indicated in the emissions inventory currently being used. Future research will include particle size analysis of EPA Method 17 samples, and modeling to compare model output and ambient sampling data and develop suggested modeling corrections.

Baghouse

Baghouses are not feasible at cotton gin operations because of the requirements for high volume of air, blinding from the fibrous material, temperature excursions across fabric filters, and introduction of moisture during the ginning operation.

A typical cotton ginning operation relies on an air cleaning system handling fibrous materials such as cotton and cotton waste in a cotton gin. This air cleaning system uses high volume of air to move the cotton throughout the ginning operation. Usually, these high volumes of air are much higher than any volumes of air passing through a baghouse. Throughout the various processes of the cotton gin operation air velocities range from 1,500 fpm to 5,000 fpm[17]. Another issue arises when higher-than-average gas volumes and particulate matter impact on bags. This causes bag blinding[18], where the increased velocity allows dust to penetrate into the fabric, and the cleaning system is unable to remove it.

In addition to the high volume of air, the baghouse would also see higher than normal temperature excursions. Excursions above the recommended temperature limit generally shorten bag life considerably. This same affect is obtained when seed cotton is first dried in large driers using heated air to reduce its moisture content, and if the seed cotton requires additional drying, gins will often run it through second or third drier.

Excess moisture is common to cotton grown in the more humid regions of the Cotton Belt, while cottons produced in the Southwest can be too dry because of the region's arid climate. Lack of moisture at ginning can also lower the quality of the fiber and contribute to ginning problems. That is why moisture is added with special humidifier that blow warm, humid air through the gin’s conveyor pipes. Moisture on the bags tends to alter the adhesion of the dust cake on and within the fabric structure, and “mudding” or blinding of the bags may occur because the cleaning system cannot remove this dust.

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[16] United States Department of Agriculture, Agricultural Research Service. (2013). *Characterization of Cotton Gin Particulate Matter Emissions.* Obtained from http://buser.okstate.edu/air-quality/cotton-gin/national-study/.

[17] Reference Agriculture Handbook No. 503 – Cotton Ginners Handbook, July 1977, page 59

[18] Blinding (*define*) – A closing of the filter medium pores which results in either a reduced gas flow or an increased pressure drop across the medium.

1D-3D Cyclones with Expansion Chamber
Currently, all cotton gins in the Valley are required to operate using a 1D-3D cyclone. There are currently 28 such units and about two thirds of the 1D-3D cyclones used in the Valley have an expanded chamber outlet. Research has shown that an expansion chamber allows for more flow since it is not as narrow. In initial tests, a larger D/3 size expanded chamber exit produced PM10 emissions that were about 8% lower than those resulting from use of the standard, small-diameter (D/4) exit.[19] The USDA study on PM2.5 emissions from cotton gins discussed above, which provided the District with the PM10/PM2.5 ratio for emissions from cotton gins, did not extend to the expected PM2.5 control efficiencies of control devices at cotton gins; therefore, there is no completed research indicating the effectiveness of reducing PM2.5 by installing an expansion chamber. As noted above, expansion chambers result in a minor increase in efficiency for PM10 emissions control, but PM2.5 is a very small fraction of the overall particulate in these systems and does not respond as well as PM10 to air flow changes such as those induced by an expansion chamber. Therefore, the District does not believe that expansion chambers would be a feasible control for PM2.5.

However, Rule 4204 is predominantly a PM10 control measure and does currently require all new cyclones or replacement parts of existing 1D3D cyclones have the dimensional characteristics of an Enhanced 1D3D cyclone, or a 1D-3D with a 2D-2D inlet and an expansion chamber trash outlet. Therefore, to the extent that PM2.5 may be minimally reduced by expansion chambers, all cyclones on cotton gins in the valley will eventually be replaced by either an Enhanced 1D-3D cyclone or a 1D-3D cyclone with an expansion chamber under the current PM10-targetted rule.

Mechanical Conveyance
Mechanical conveyance for the main trash handling system could be a potential opportunity to reduce emissions, but it has only been demonstrated as feasible for newly constructed or rebuilt cotton gins. Mechanical conveyance reduces emissions from cotton gin trash handling exhaust streams, which are otherwise moved pneumatically. The cotton gin trash handling systems only comprise a fraction of the emissions that are released from the full cotton ginning process.

Newer or rebuilt cotton gins are able to accommodate a mechanical conveyance system since they are able to design the cotton gin around the equipment and space needed. Operators that have installed a mechanical conveyance system for their cotton gin have had to build a lower floor, below the main level containing the major cotton gin equipment, to house the mechanical conveyors. Therefore, as confirmed by industry representatives and equipment manufacturers, it is not technologically feasible to retrofit existing cotton gins with mechanical conveyance systems to replace existing trash handling equipment.

Plenum Chambers

[19] Baker R.V. and Hughs S.E. (1998). *Influence of Air Inlet and Outlet Design and Trash Exit Size on 1D3D Cyclone Performance*. Transactions of the ASAE, vol. 42(1): 17-21.

Plenum chambers are in use at three cotton gins in the Valley. Plenum chambers are placed upstream of selected cyclones to remove large trash. No study has been found that demonstrates an increase in PM control efficiency with the utilization of a plenum chamber. Cotton ginning facilities that have installed plenum chambers are generally using those devices to reduce wear and tear on the cyclones, thus prolonging the life of the cyclones, and not for increased PM controls.

Evaluation Findings

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for cotton gins. As demonstrated above, Rule 4204 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM and MSM requirements for this source category.

C.6 Rule 4301 (Fuel Burning Equipment)

Discussion

Rule 4301 (Fuel Burning Equipment) has a very broad applicability, as it applies to all types of fuel burning equipment in use in the Valley. Since its early adoption in 1992, it has largely been superseded by several District rules with more stringent requirements for specific types of fuel burning equipment. See the control measure evaluations for Rules 4306, 4307, 4308, 4309, 4320, 4352, and 4703 for more specific information about the individual fuel burning equipment source categories.

Emissions Inventory

The emission inventory is not specific to Rule 4301 as it has been superseded by multiple District rules. See control measures for 4306, 4307, 4308, 4309, 4320, 4352, and 4703 for the individual emissions inventories.

Source Category

The purpose of this rule is to limit emissions of air contaminants from fuel burning equipment by specifying maximum emission rates for SOx, NOx, and PM (identified in the rule as combustion contaminant emissions). As previously mentioned, Rule 4301 has been superseded by more stringent requirements. See control measures for 4306, 4307, 4308, 4309, 4320, 4352, and 4703 for more specific evaluations about the individual fuel burning equipment sources categories.

How does District Rule 4301 compare with federal and state rules and regulations?

Facilities subject to Rule 4301 are subject to various state rules and federal requirements, such as CTG, ACT, NSPS, NESHAP, and MACT. However, several District rules have superseded Rule 4301 with more stringent requirements. Comparisons of those District rules to the applicable federal and state rules are discussed within those control measure evaluations.

How does District Rule 4301 compare to rules in other air districts?

Rule 4301 have been superseded by more stringent requirements. See Rules 4306, 4307, 4308, 4309, 4320, 4352, and 4703 for more specific evaluations about the individual fuel burning equipment sources categories.

Additional Emission Reduction Opportunities

Several District rules have superseded Rule 4301 with more stringent requirements. Discussion of feasibility of expanding applicability or removal of exemptions are discussed within those control measure evaluations.

Evaluation Findings

The requirements of Rule 4301 have been superseded by more stringent District rules that meet or exceed RACM, BACM, and MSM level requirements. All units subject to this rule are subject to more specific rules and discussed within those control measure evaluations. See Rules 4306, 4307, 4308, 4309, 4320, 4352, and 4703.

C.7 RULE 4306 AND 4320 (BOILERS, PROCESS HEATERS, AND STEAM GENERATORS GREATER THAN 5 MMBTU/HR)

DISCUSSION

Rules 4306 and 4320 apply to any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input greater than 5 million British thermal units per hour (MMBtu/hr). The purpose of these rules is to limit oxides of nitrogen (NOx), carbon monoxide (CO), and particulate matter emissions from boilers, steam generators, and process heaters of this size range.

Rule 4320 is the third generation rule for this source category. The first District rule for this source category, Rule 4305 (Boilers, Steam Generators, and Process Heaters) was adopted on December 16, 1993. Rule 4305 was superseded by Rule 4306 (Boilers, Steam Generators, and Process Heaters – Phase 3) on September 18, 2003 to implement a NOx emission reduction control measure from the District's ozone and PM10 attainment plans. Since adoption, Rule 4306 has been amended twice.

The most recent Rule 4306 amendment in October 2008 was initially proposed to lower the NOx limit from 9 ppmv to 6 ppmv for units greater than 20 MMBtu/hr. It was determined that the proposed NOx limits could be accomplished by using selective catalytic reduction (SCR) or a combination of SCR, ultra-low NOx burners (ULNBs), flue gas recirculation (FGR), and/or tuning, thus making the lower limit of 6 ppmv technologically feasible. However, through the public workshop process and additional research it was also determined that most of the units subject to Rule 4306 have already undergone several generations of NOx controls, and consequently, certain applications of SCR may not be cost effective and/or technologically infeasible because of physical limitations at the facilities. As a result of this public process, the lower NOx limits were included in new Rule 4320 and an option was provided in the rule that allows for the payment of an annual emissions fee based on total actual emissions, rather than installation of additional NOx controls, based on each operator's individual business situation. These fees are used by the District to achieve cost effective NOx reductions through District incentive programs, the District's Technology Advancement Program, and other District programs. The previous versions of Rule 4305 and 4306 combined with the implementation of Rule 4320 results in approximately 96% control of NOx emissions from this source category.

Rule 4320 also includes particulate matter control requirements. These requirements are in the form of limits on the sulfur content of fuel burned. During fuel combustion, the sulfur content in the fuel results in sulfur oxide (SOx) emissions. SOx emissions combine with ammonia in the atmosphere to form ammonium sulfate (a particulate). Reducing the sulfur content in the fuel burned results in lower levels of particulate matter generated by the combusting equipment.

The implementation of Rule 4320 does not substitute the requirements of Rule 4306, but enforces requirements supplementary to Rule 4306. As such, this evaluation is applicable to both Rule 4306 and Rule 4320.

EMISSIONS INVENTORY

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	1.24	1.17	1.12	1.10	1.08	1.06	1.04	1.02	1.01
NOx	1.80	1.53	1.39	1.35	1.31	1.26	1.22	1.18	1.14
	Winter Average - Tons per day								
PM2.5	1.22	1.16	1.10	1.08	1.07	1.05	1.03	1.01	0.99
NOx	1.75	1.49	1.36	1.31	1.28	1.23	1.19	1.15	1.11

SOURCE CATEGORY

Facilities with units subject to this rule represent a wide range of industries, including but not limited to electrical utilities, cogeneration, oil and gas production, petroleum refining, manufacturing and industrial processes, food and agricultural processing, and service and commercial facilities.

To recognize, and better regulate, the operational and technical differences between different types of equipment subject to Rules 4306 and 4320, the different equipment types were separated into several major categories, with different rule requirements, including the following:

- Units with a total rated heat input greater than 5.0 MMBtu/hr to 20.0 MMBtu/hr
- Units with a total rated heat input greater than 20.0 MMBtu/hr
- Oilfield steam generators of all ratings and fuel types
- Refinery units of all ratings and fuel types
- Low-use units limited by a Permit to Operate to an annual heat input greater than 1.8 billion Btu/year but less than or equal to 30 billion Btu/year
- Units at a wastewater treatment facility using less than 50% PUC quality fuel
- Small specialty units operated by a small producer

HOW DO DISTRICT RULES 4306 AND 4320 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations

There are no EPA CTG requirements for this source category.

Alternative Control Techniques (ACT)

- EPA-453/R-93-034 (ACT Document – NOx emissions from Process Heaters)

The District evaluated the requirements contained within the ACT for NOx Emissions from Process Heaters and found no requirements that were more stringent than those already in Rules 4306 and 4320.

- EPA-453/R-94-022 (ACTDocument – NOx Emissions from Industrial/Commercial/Institutional Boilers)

The District evaluated the requirements contained within the ACT for NOx Emissions from Industrial/Commercial/Institutional Boilers and found no requirements that were more stringent than those already in Rules 4306 and 4320.

- EPA-453/R-94-023 (ACTDocument – NOx Emissions from Utility Boilers)

The District evaluated the requirements contained within the ACT for NOx Emissions from Utility Boilers and found no requirements that were more stringent than those already in Rules 4306 and 4320.

NSPS

- 40 CFR 60 Subpart D (Standards of Performance for Fossil-Fuel Fired Steam Generators for Which Construction Is Commenced After August 17, 1971)

The District evaluated the requirements contained within 40 CFR 60 Subpart D and found no requirements that were more stringent than those already in Rules 4306 and 4320.

- 40 CFR 60 Subpart Db (Standards of Performance for Industrial-Commercial-Institutional Steam Generating Units)

The District evaluated the requirements contained within 40 CFR 60 Subpart Db and found no requirements that were more stringent than those already in Rules 4306 and 4320.

- 40 CFR 60 Subpart Dc (Standards of Performance for Small Industrial- Commercial-Institutional Steam Generating Units)

The District evaluated the requirements contained within 40 CFR 60 Subpart Dc and found no requirements that were more stringent than those already in Rules 4306 and 4320.

- NSPS – 40 CFR Subpart J (Standards of Performance for Petroleum Refineries)

The District evaluated the requirements contained within 40 CFR 60 Subpart J and found no requirements that were more stringent than those already in Rules 4306 and 4320.

- NSPS – 40 CFR Subpart Ja (Standards of Performance for Petroleum Refineries for Which Construction, Reconstruction, or Modification Commenced After May 14, 2007

The District evaluated the requirements contained within 40 CFR 60 Subpart Ja and found no requirements that were more stringent than those already in Rules 4306 and 4320.

NESHAP/ MACT

- 40 CFR 63 Subpart DDDDD (NESHAP for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters)

40 CFR 63 Subpart DDDDD was amended on January 31, 2013 to include new emission limits for PM, CO, and total selective metals (TSM), replace numeric dioxin emission limits with work practice standards, add new subcategories of facilities, and add alternative monitoring approaches for compliance with the PM limit. The PM limit in District Rule 4320 is more stringent for liquid fuels because it only allows liquid fuels to be burned during PUC quality natural gas curtailment periods. It is equivalent to DDDDD for all gasses burned except for gasses exceeding 40 $\mu g/m^3$ of mercury.

The District evaluated the requirements contained within the above NESHAP and found no requirements that were more stringent than those already in Rules 4306 and 4320.

State Regulations
There are no state regulations applicable to this source category.

HOW DO DISTRICT RULES 4306 AND 4320 COMPARE TO RULES IN OTHER AIR DISTRICTS?

There are no analogous rules for this source category in [list all applicable air districts].

SCAQMD

- SCAQMD Rule 1146 (Emissions of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters) *(Amended November 1, 2013)*

The District evaluated the requirements contained within SCAQMD's Rule 1146 and found no requirements that were more stringent than those already in Rule 4306 and 4320.

	SJVAPCD	SCAQMD
Applicability	Any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input greater than 5 million Btu per hour.	Boilers, steam generators, and process heaters of equal to or greater than 5 million Btu per hour rated heat input capacity used in industrial, institutional, and commercial operations.

Exemptions	Units regulated by other District rules such as solid fuel fired units, dryers, glass melting furnaces, kilns, and smelters. Any units while burning any fuel other than PUC quality natural gas that: Burns non-PUC gas no more than 168 cumulative hours in a calendar year plus 48 hours per calendar year for equipment testing; NOx emission do not exceed 150 ppmv.		(1) boilers used by electric utilities to generate electricity; and (2) boilers and process heaters with a rated heat input capacity greater than 40 million Btu per hour that are used in petroleum refineries; and (3) sulfur plant reaction boilers. (4) RECLAIM facilities (NOx emissions only)
Requirements	Category A Units 5-20 MMBtu/hr Except Categories C through G units	9 ppmv standard 6 ppmv enhanced	9 ppmv Excluding digester and landfill gas fired units, and process heaters.
	Category B Units > 20 MMBtu/hr Except Categories C through G units	7 ppmv standard 5 ppmv enhanced	9 ppmv for units <75 MMBtu/hr Excluding digester and landfill gas fired units, and process heaters. 5 ppmv for units ≥75MMbtu/hr Excluding process heaters.
	Category C.1 Oilfield Steam Generators 5-20 MMBtu/hr	9 ppmv standard 6 ppmv enhanced	9 ppmv standard 5 ppmv enhanced
	Category C.2 Oilfield Steam Generators >20 MMBtu/hr	7 ppmv standard 5 ppmv enhanced	9 ppmv for units <75 MMBtu/hr 5 ppmv for units ≥75MMBtu/hr
	Category C.3 Oilfield Steam Generators fired on less than 50% PUC quality gas	9 ppmv	25 ppmv for landfill gas fired units 15 ppmv for digester gas fired units
	Category D.1 Refinery Units 5-20 MMBtu/hr	9 ppmv standard 6 ppmv enhanced	9 ppmv standard 5 ppmv enhanced
	Category D.2 Refinery Units 20-110 MMBtu/hr	6 ppmv standard 5 ppmv enhanced	9 ppmv for units <75 MMBtu/hr 5 ppmv for units ≥75MMBtu/hr

	Category D.3 Refinery Units >110 MMBtu/hr	5 ppmv	5 ppmv
	Category D.4 Refinery Units fired on less than 50% PUC quality gas	9 ppmv	25 ppmv for landfill gas fired units 15 ppmv for digester gas fired units
	Category E Units with annual heat input >1.8 billion Btu/yr but <30 billion Btu/yr	9 ppmv	For units using 9.0 billion Btu/yr or less, tune up twice a year. For units over that limit, units must meet the following applicable limit: 25 ppmv landfill gas units, 15 ppmv digester gas units, otherwise, for other units: 9 ppmv for units <75 MMBtu/hr, 5 ppmv for units ≥75MMbtu/hr
	Category F Wastewater Treatment Facilities firing on less than 50% PUC quality gas	9 ppmv	15 ppmv for digester gas fired units
	Category G Units operated by a small producer in which the rated heat input of each burner is less than or equal to 5 MMBtu/hr but the total rated heat input of all the burners in a unit is rated between 5 MMBtu/hr and 20 MMBtu/hr, and in which the products of combustion do not come in contact with the products of combustion of any other burner.	9 ppmv	9 ppmv
	General category in SCAQMD Rule NOTE: This is a general category in	5 ppmv to 9 ppmv (as shown in the above categories)	30 ppmv

	SCAQMD's rule that is covered under multiple categories in District Rule 4320		

BAAQMD

- BAAQMD Regulation 9 Rule 7 (Nitrogen Oxides And Carbon Monoxide from Industrial, Institutional, and Commercial Boilers, Steam Generators, And Process Heaters) *(Amended May 4, 2011)*
- BAAQMD Regulation 9, Rule 10 (Nitrogen Oxides and Carbon Monoxide from Industrial, Institutional and Commercial Boilers, Steam Generators and Process Heaters in Petroleum Refineries) *(Amended May 4, 2011)*
- BAAQMD Regulation 9, Rule 11 (Nitrogen Oxides And Carbon Monoxide from Utility Electric Power Generating Boilers) *(Amended May 17, 2000)*

The District evaluated the requirements contained within BAAQMD Regulation 9 Rule 7, 10, and 11, and found no requirements that were more stringent than those already in Rule 4306 and 4320.

	SJVAPCD	BAAQMD
Applicability	Any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input greater than 5 million Btu per hour.	<u>Regulation 9, Rule 7</u> Industrial, institutional and commercial boilers, steam generators and process heaters. <u>Regulation 9, Rule 10</u> Boilers, steam generators, and process heaters, including CO boilers, in petroleum refineries. <u>Regulation 9, Rule 11</u> Electric power generating steam boilers.
Exemptions	Units regulated by other District rules such as solid fuel fired units, dryers, glass melting furnaces, kilns, and smelters. Any units while burning any fuel other than PUC quality natural gas that: Burns non-PUC gas no more than 168 cumulative hours in a calendar year plus 48 hours per calendar year for equipment testing; NOx emission do not exceed 150 ppmv.	<u>Regulation 9, Rule 7</u> Units ≤ 2.0 MMBtu/hr fire on NG Units < 1.0 MMBtu/hr any fuel Process heaters for radiant comfort heating Waste heat recovery boilers Kilns, ovens, dryers for baking, heat treating, cooking, calcining, vitrifying Low fuel use Tune Up, Startup and shutdown <u>Regulation 9, Rule 10</u> Units ≤ 2.0 MMBtu/hr fire on NG Units < 1.0 MMBtu/hr any fuel Waste heat recovery boilers Units that received an ATC prior to January 5, 1994 Low fuel use

	SJVAPCD		BAAQMD
			Regulation 9, Rule 11 Boilers < 250 MMBtu/hr Startup and shutdown Oil-burn readiness testing Units that operate with a capacity factor of less than 4% annually Heat recovery steam generators
Requirements	Category A Units 5-20 MMBtu/hr Except Categories C through G units	9 ppmv standard 6 ppmv enhanced	Regulation 9, Rule 7 15 ppmv
	Category B Units > 20 MMBtu/hr Except Categories C through G units	7 ppmv standard 5 ppmv enhanced	Regulation 9, Rule 7 20-75 MMBtu/hr – 9ppmv >75 MMBtu/hr – 5 ppmv Regulation 9, Rule 11 >1.75 billion Btu/hr – 10 ppmv 1.5 - 1.75 billion Btu/hr – 25 ppmv
	Category C.1 Oilfield Steam Generators 5-20 MMBtu/hr	9 ppmv standard 6 ppmv enhanced	Regulation 9, Rule 7 15 ppmv
	Category C.2 Oilfield Steam Generators >20 MMBtu/hr	7 ppmv standard 5 ppmv enhanced	Regulation 9, Rule 7 20-75 MMBtu/hr – 9ppmv >75 MMBtu/hr – 5 ppmv
	Category C.3 Oilfield Steam Generators fired on less than 50% PUC quality gas	9 ppmv	Regulation 9, Rule 7 30 ppmv
	Category D.1 Refinery Units 5-20 MMBtu/hr	9 ppmv standard 6 ppmv enhanced	Regulation 9, Rule 10 Refinery-wide emission rate not to exceed 0.033 lb per MMBtu (27.25 ppmv) based on an operating day average
	Category D.2 Refinery Units 20-110 MMBtu/hr	6 ppmv standard 5 ppmv enhanced	Regulation 9, Rule 10 Refinery-wide emission rate not to exceed 0.033 lb per MMBtu (27.25 ppmv) based on an operating day average

	SJVAPCD		BAAQMD
	Category D.3 Refinery Units >110 MMBtu/hr	5 ppmv	Regulation 9, Rule 10 Refinery-wide emission rate not to exceed 0.033 lb per MMBtu (27.25 ppmv) based on an operating day average
	Category D.4 Refinery Units fired on less than 50% PUC quality gas	9 ppmv	Regulation 9, Rule 10 Refinery-wide emission rate not to exceed 0.033 lb per MMBtu (27.25 ppmv) based on an operating day average
	Category E Units with annual heat input >1.8 billion Btu/yr but <30 billion Btu/yr	9 ppmv	Regulation 9, Rule 7 For units below 9.0 billion Btu/yr, tune up twice a year or meet 30 ppmv For units exceeding 9 billion Btu/yr, units must meet the following limits: 5-20 MMBtu/hr – 15 ppmv 20-75 MMBtu/hr – 9 ppmv >75 MMBtu/hr – 5 ppmv
	Category F Wastewater Treatment Facilities firing on less than 50% PUC quality gas	9 ppmv	Regulation 9, Rule 7 30 ppmv
	Category G Units operated by a small producer in which the rated heat input of each burner is less than or equal to 5 MMBtu/hr but the total rated heat input of all the burners in a unit is rated between 5 MMBtu/hr and 20 MMBtu/hr, and in which the products of combustion do not come in contact with the products of combustion of any other burner.	9 ppmv	Regulation 9, Rule 7 15 ppmv

SMAQMD

- SMAQMD Rule 411 (NOx from Boilers, Process Heaters and Steam Generators) *(Amended August 23, 2007)*

The District evaluated the requirements contained within SMAQMD's Rule 411 and found no requirements that were more stringent than those already in Rule 4306 and 4320.

	SJVAPCD		SMAQMD
Applicability	Any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input greater than 5 million Btu per hour.		Boilers, steam generators and process heaters) fired on gaseous or nongaseous fuels with a rated heat input capacity of 1 million Btu per hour or greater
Exemptions	Units regulated by other District rules such as solid fuel fired units, dryers, glass melting furnaces, kilns, and smelters. Any units while burning any fuel other than PUC quality natural gas that: Burns non-PUC gas no more than 168 cumulative hours in a calendar year plus 48 hours per calendar year for equipment testing; NOx emission do not exceed 150 ppmv.		Electric utility boilers, Process heaters, kilns, and furnaces where the products of combustion come into direct contact with the material to be heated, Waste heat recovery boilers. Units with low fuel usage
Requirements	Category A Units 5-20 MMBtu/hr Except Categories C through G units	9 ppmv standard 6 ppmv enhanced	15 ppmv
	Category B Units > 20 MMBtu/hr Except Categories C through G units	7 ppmv standard 5 ppmv enhanced	9 ppmv
	Category C.1 Oilfield Steam Generators 5-20 MMBtu/hr	9 ppmv standard 6 ppmv enhanced	15 ppmv
	Category C.2 Oilfield Steam Generators >20 MMBtu/hr	7 ppmv standard 5 ppmv enhanced	9 ppmv
	Category C.3 Oilfield Steam Generators fired on less than 50% PUC quality gas	9 ppmv	15 ppmv
	Category D.1 Refinery Units 5-20 MMBtu/hr	9 ppmv standard 6 ppmv enhanced	15 ppmv

	SJVAPCD		SMAQMD
	Category D.2 Refinery Units 20-110 MMBtu/hr	6 ppmv standard 5 ppmv enhanced	9 ppmv
	Category D.3 Refinery Units >110 MMBtu/hr	5 ppmv	9 ppmv
	Category D.4 Refinery Units fired on less than 50% PUC quality gas	9 ppmv	15 ppmv
	Category E Units with annual heat input >1.8 billion Btu/yr but <30 billion Btu/yr	9 ppmv	5-20 MMBtu/hr – 15 ppmv <20 MMBtu/hr – 9 ppmv
	Category F Wastewater Treatment Facilities firing on less than 50% PUC quality gas	9 ppmv	15 ppmv
	Category G Units operated by a small producer in which the rated heat input of each burner is less than or equal to 5 MMBtu/hr but the total rated heat input of all the burners in a unit is rated between 5 MMBtu/hr and 20 MMBtu/hr, and in which the products of combustion do not come in contact with the products of combustion of any other burner.	9 ppmv	15 ppmv

VCAPCD

- VCAPCD Rule 74.15 Boilers, Steam Generators and Process Heaters (5 MMBTUs and greater) *(Amended November 8, 1994)*

The District evaluated the requirements contained within VCAPCD's Rule 74.15 and found no requirements that were more stringent than those already in Rule 4306 and 4320.

	SJVAPCD		VCAPCD
Applicability	Any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input greater than 5 million Btu per hour.		Boilers, steam generators and process heaters, greater than 5 million Btu per hour used in all industrial, institutional and commercial operations
Exemptions	Units regulated by other District rules such as solid fuel fired units, dryers, glass melting furnaces, kilns, and smelters. Any units while burning any fuel other than PUC quality natural gas that: Burns non-PUC gas no more than 168 cumulative hours in a calendar year plus 48 hours per calendar year for equipment testing; NOx emission do not exceed 150 ppmv.		Electric utility boilers Water Heaters Units fired on alternate fuel during NG curtailment Emergency standby units Cold Startup
Requirements	Category A Units 5-20 MMBtu/hr Except Categories C through G units	9 ppmv standard 6 ppmv enhanced	40 ppmv
	Category B Units > 20 MMBtu/hr Except Categories C through G units	7 ppmv standard 5 ppmv enhanced	40 ppmv
	Category C.1 Oilfield Steam Generators 5-20 MMBtu/hr	9 ppmv standard 6 ppmv enhanced	40 ppmv
	Category C.2 Oilfield Steam Generators >20 MMBtu/hr	7 ppmv standard 5 ppmv enhanced	40 ppmv
	Category C.3 Oilfield Steam Generators fired on less than 50% PUC quality gas	9 ppmv	40 ppmv
	Category D.1 Refinery Units 5-20 MMBtu/hr	9 ppmv standard 6 ppmv enhanced	40 ppmv
	Category D.2 Refinery Units 20-110 MMBtu/hr	6 ppmv standard 5 ppmv enhanced	40 ppmv

	Category D.3 Refinery Units >110 MMBtu/hr	5 ppmv	40 ppmv
	Category D.4 Refinery Units fired on less than 50% PUC quality gas	9 ppmv	40 ppmv
	Category E Units with annual heat input >1.8 billion Btu/yr but <30 billion Btu/yr	9 ppmv	1.8 – 9 MMBtu – No NOx Limit 9 – 30 MMBtu – 40 ppmv
	Category F Wastewater Treatment Facilities firing on less than 50% PUC quality gas	9 ppmv	40 ppmv
	Category G Units operated by a small producer in which the rated heat input of each burner is less than or equal to 5 MMBtu/hr but the total rated heat input of all the burners in a unit is rated between 5 MMBtu/hr and 20 MMBtu/hr, and in which the products of combustion do not come in contact with the products of combustion of any other burner.	9 ppmv	40 ppmv

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

Over the years, the District has adopted numerous generations of rules and rule amendments for boilers greater than 5 MMBtu/hr that have significantly reduced NOx and PM emissions from this source category. As part of these regulatory efforts, hundreds of boilers in the Valley have been equipped with the best available NOx and PM control technologies. Even though significant effort has already been made to reduce emissions from this source category, the possibility of further reducing emissions from boilers greater than 5 MMBtu/hr is evaluated in the following discussion.

Clearsign Duplex Burners

The Clearsign Duplex burner employs a ceramic material for the fuel to burn on downstream from the actual burner. This reduces the temperature and length of the flame that results in reduced NOx formation without FGR or SCR add-on controls. The Clearsign technology is relatively new and has been installed or under evaluation at two refineries and one oilfield production facility in the Valley. Based on discussion with the facilities evaluating these technologies, additional work is required from the supplier to further improve the reliability and durability of this technology. Preliminary results indicate that this technology has potential to achieve NOx emissions less than 5 ppmv @ 3% O2. The wide spread viability of this technology is still to be determined.

Ultra Low-NOx Burners

Retrofitting 5 to 20 MMBtu/hr units

A boiler, steam generator or process heater in this size range may be retrofitted with ultra-low NOx burner system to achieve 6 ppmv NOx @ 3% O2. Pursuant to a local vendor, the cost of an ultra-low NOx burner with some form of FGR system would be about $40,000. Retrofitting a boiler may involve upgrades to various systems such as fuel train to comply with up to date codes, and may involve upgrades to air intake fans, as these units require more air for the burner to operate at its optimum level.

Description of Cost	Cost Factor	Cost	Source
Direct Costs			
Purchase equipment costs (PE)			
Burner System	A	40,000	Local Vendor
Instrumentation and controls	0.01 A	400	OAQPS
Sales Taxes	0.08 A	3,232	
Freight	0.05 A	2,000	OAQPS
Purchased equipment cost, PEC		45,632	
Direct installation costs (DI):			
Foundation & supports	0.08 B	--	See footnote
Handling and erection	0.14 B	6,388	OAQPS
Electrical	0.04 B	1,825	OAQPS
Piping	0.02 B	913	OAQPS
Insulation and ductwork:	0.01 B	456	OAQPS
Painting	0.01 B	456	OAQPS
Direct installation costs		10,038	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC		55,670	
Indirect Costs (Installation)			
Engineering	0.10 B	4,563	OAQPS
Construction and field expenses	0.05 B	2,282	OAQPS
Contractor fees	0.10 B	4,563	OAQPS
Contingencies	0.03 B	1,369	OAQPS
Start-up	0.02 B	913	OAQPS
Performance test	0.01 B	456	OAQPS

Total Indirect Costs, IC	0.31 B	14,146	
Total Capital Investments (TCI= DC + IC):		**69,816**	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**11,359**	
Direct annual costs (DAC)			
Operating and supervisory labor	--	--	See table footnote
Maintenance Costs (labor and material)	--	--	
Electricity Cost:	$0.08848/kWH	--	Not estimated
Indirect Annual Costs (IAC)			
Overhead:	--	--	See table footnote
Insurance:	--	--	See table footnote
Property Tax:	--	--	See table footnote
Administrative:	--	--	See table footnote
Total IAC:			
Total Annual Cost (DAC + IAC)	--	--	
Total annual cost (annualized TCI + Total annual cost)		**$11,359/yr**	

The potential NOx emission reduction for 5 to 20 MMBtu/hr units is determined by taking the difference between the permitted potential emissions and the potential emissions that may be achievable by an ultra-low NOx burner system. Ultra low-NOx burners are expected to achieve 6 ppmv NOx @ 3% O2. Each unit is presumed to be operated for 8,760 hours per year at the maximum rated capacity, unless restricted by annual heat input rate. The total cost for each category is determined by multiplying the number of units and $11,359 a typical annual cost of an ultra-low NOx burner system. Note that most of the units (Category A in Rule 4320 except Category C through G units) are already achieving 9 ppm NOx @ 3% O2 or less emissions.

Type of unit	Number of units	Potential NOx Reductions with ultra-low NOx burner Technology (tons/yr)	Total annualized cost of NOx Reductions with ultra-low NOx burner Technology ($/yr)	Cost effectiveness ($/ton of emission reduction)
Category A: >5.0 MMBtu/hr to ≤ 20 MMBtu/hr, Except Category C through G units	271*	82.7	$3,078,289/yr	**$37,222/ton**

*Total units = 279 – 8 permitted at 6 ppmv NOx or less emissions = 271 units

Retrofitting > 20 MMBtu/hr units

A boiler, steam generator or process heater in this size range may be retrofitted with ultra-low NOx burner to achieve 5 ppmv NOx @ 3% O2. Pursuant to a local vendor, the average cost of an ultra-low NOx burner with some form of FGR system would be about $150,000. Note that retrofitting a boiler may involve upgrades to various systems such as fuel train to comply with up to date codes, and may involve upgrades to air intake fans, as these units require more air for the burner to operate at its optimum level.

Description of Cost	Cost Factor	Cost	Source
Direct Costs			
Purchase equipment costs (PE)			
Burner System	A	150,000	Local Vendor
Instrumentation and controls	0.01 A	1,500	OAQPS
Sales Taxes	0.08 A	12,120	
Freight	0.05 A	7,500	OAQPS
Purchased equipment cost, PEC		171,120	
Direct installation costs (DI):			
Foundation & supports	0.08 B	--	See footnote
Handling and erection	0.14 B	23,957	OAQPS
Electrical	0.04 B	6,845	OAQPS
Piping	0.02 B	3,422	OAQPS
Insulation and ductwork:	0.01 B	1,711	OAQPS
Painting	0.01 B	1,711	OAQPS
Direct installation costs		37,646	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC		208,766	
Indirect Costs (Installation)			
Engineering	0.10 B	17,112	OAQPS
Construction and field expenses	0.05 B	8,556	OAQPS
Contractor fees	0.10 B	17,112	OAQPS
Contingencies	0.03 B	5,134	OAQPS
Start-up	0.02 B	3,422	OAQPS
Performance test	0.01 B	1,711	OAQPS
Total Indirect Costs, IC	0.31 B	53,047	
Total Capital Investments (TCI= DC + IC):		**261,813**	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**42,597**	
Direct annual costs (DAC)			
Operating and supervisory labor	--	--	See table footnote
Maintenance Costs (labor and material)	--	--	
Electricity Cost:	$0.08848/kWH	--	Not estimated
Indirect Annual Costs (IAC)			
Overhead:	--	--	See table footnote
Insurance:	--	--	See table footnote
Property Tax:	--	--	See table footnote
Administrative:	--	--	See table footnote
Total IAC:			
Total Annual Cost (DAC + IAC)	--	--	
Total annual cost (annualized TCI + Total annual cost)		**$42,597/yr**	

*The existing foundation and supports will not be replaced; direct annual cost and indirect annual costs are presumed to be same as the existing burner

The potential NOx emission reduction for greater than 20 MMBtu/hr units (Category B in Rule 4320 except Category C through G units) is determined by taking the difference between the permitted potential emissions and the emissions achievable by an ultra-low NOx burner system. Ultra low-NOx burner systems may potentially achieve 5 ppmv NOx @ 3% O2. Each unit is presumed to be operated for 8,760 hours per year at the maximum rated capacity, unless restricted by annual heat input rate. The total cost for each category is determined by multiplying the number of units and $42,597, a typical annual cost of an ultra-low NOx burner system.

Type of unit	Number of units	Potential NOx Reductions with ultra-low NOx burner Technology (tons/yr)	Total annualized cost of NOx Reductions with ultra-low NOx burner Technology ($/yr)	Cost effectiveness ($/ton of emission reduction)
Category B: >20.0 MMBtu/hr except Category C through G units	190*	123.7	$8,093,430/yr	**$65,428/ton**

*Total units = 221 – 31 with 5 ppmv NOx or less emissions = 190 units

Oilfield Steam Generators

A steam generator can be retrofitted with ultra-low NOx burner to achieve 5 ppmv NOx @ 3% O2. Note that retrofitting a steam generator may involve upgrades to various systems such as fuel train to comply with up to date codes, and may involve upgrades to air intake fans, as these units require more air for the burner to operate at it's optimum level. As many steam generators are one off built units, they may have different firebox configurations that may not accept the new burner without varrying degrees of modification. Pursuant to a local facility, the cost of retrofitting a steam generator to a 5 ppmv NOx burner would vary between about $450,000 to $1,800,000 depending on the extent of modifications or upgrades that are needed. Another facility has provided a cost estimate for a new 5 ppmv steam generator of $2,000,000.

Most of the steam generators that would need to be retrofit would be 62.5 MMBtu/hr units. Rule 4306 requires the units to meet 15 ppmv NOx. The cost effectiveness for retrofitting the units from 15 ppm to 5 ppmv is shown below.

{(0.012 lb/MMBtu)(62.5 MMBtu/hr)(8760 hr)(0.80 usage)}/2,000 lb/ton = 2.6 ton NOx

Capital costs $450,000 to $1,800,000 = $72,000 to $288,000 annualized (10 yrs, 10%)

Cost effectiveness = $27,692 to $110,769 per ton reduction

This variability in cost effectiveness is expected as the steam generators in the oilfields are highly variable in size, age, and state of repair.

Enhanced Selective Catalytic Reduction (SCR) Equipment

Facilities may add additional catalyst units onto existing systems and use them in series with the existing catalyst. The feasibility issues with additional catalyst include additional ammonia usage and storage. Ammonia is an extremely hazardous chemical so the additional storage and usage may not be appropriate. Existing units also may not have the footprint required for the additional SCR material needed. Extensive reconfiguration of the facility may be required. New facilities would be able to plan for increased SCR catalyst.

Many existing boilers, steam generators, and process heaters are not equipped with SCR. Installation of SCR on existing equipment may require significant modifications to the equipment be able to install SCR within the appropriate temperature range in the exhaust stream. Additionally, in some instances, the equipment is installed in a setting with other equipment, and there may be challenges regarding the space available to install an SCR catalyst and the requirement ancillary equipment, i.e. ammonia storage and handling equipment. Some boilers greater than 20.0 MMbtu/hr with low NOx burners and SCR were source tested below 5 ppmv NOx to as low as 2 ppmv.

Retrofitting with Selective Catalytic Reduction (SCR) as Potential Control for units between 5-20 MMBtu/hr

SCR technology is predominantly used to reduce NOx emissions from boilers, steam generators and process heaters. Since SCR is post-combustion control, an existing boiler can be retrofitted with this technology. Several units in the Valley are equipped with SCR system. According to information from SCR vendors, the average SCR system cost is $142,500 for the units between 5-20 MMBtu/hr. This information is used as a basis to estimate the annualized cost for this control technique.

Description of Cost	Cost Factor	Cost	Source
Direct Costs			
Purchase equipment costs (PE)			
SCR System	A	142,500	SCR vendors
Instrumentation and controls	0.01 A	1,425	OAQPS
Sales Taxes	0.08 A	11,514	
Freight	0.05 A	7,125	OAQPS
Purchased equipment cost, PEC	B = 1.14 A	162,564	
Direct installation costs (DI):			
Foundation & supports	0.08 B	13,005	OAQPS
Handling and erection	0.14 B	22,759	OAQPS
Electrical	0.04 B	6,503	OAQPS
Piping	0.02 B	3,251	OAQPS
Insulation and ductwork:	0.01 B	1,626	OAQPS
Painting	0.01 B	1,626	OAQPS
Direct installation costs	0.30 B	48,770	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC	1.30B + SP+ Bldg.	211,334	
Indirect Costs (Installation)			
Engineering	0.10 B	16,256	OAQPS
Construction and field expenses	0.05 B	8,128	OAQPS

Contractor fees	0.10 B	16,256	OAQPS
Contingencies	0.03 B	4,877	OAQPS
Start-up	0.02 B	3,251	OAQPS
Performance test	0.01 B	1,626	OAQPS
Total Indirect Costs, IC	0.31 B	50,394	
Total Capital Investments (TCI= DC + IC):	**1.61 B + SP + Bldg.**	**261,728**	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**$42,583/yr**	

Description of Cost	Cost Factor	Cost	Source
Direct Annual Costs (DAC)			
Operating and supervisory labor	--	--	See table footnote
Maintenance Costs (labor and material)	0.015 TCI	3,926	OAQPS
Reagent costs (anhydrous ammonia)		--	Not estimated
Electricity Cost:	$0.08848/kWH	--	Not estimated
Catalyst Replacement:	--	--	Catalyst is presumed to last at least over 10 years
	Total DAC:	3,926	
Indirect Annual Costs (IAC)			
Overhead:	--	--	See table footnote
Insurance:	0.01 TCI	2,617	OAQPS
Property Tax:	--	--	See table footnote
Administrative:	--	--	See table footnote
	Total IAC:	2,617	
Total Annual Cost (DAC + IAC)		6,543	
Total annual cost (Annualized TCI + Total annual cost)		**$49,126/yr**	

*Per EPA's Air Pollution Control Cost Manual (6th Edition), EPA/452/B-02-001 (1/02), operating and supervisory, overhead, administrative costs would be insignificant for an SCR system. In general, SCR does not require site preparation or additional buildings, and property taxes do not apply to capital improvements such as air pollution control equipment.

The potential NOx emission reduction for 5 to 20 MMBtu/hr units (Category A in Rule 4320 except Category C through G units) is determined by taking the difference between the permitted potential emissions and the emissions that could be reliably achievable by an SCR system. Source test results of various units with SCR systems indicate that an SCR can potentially achieve 3.5 ppmv NOx @ 3% O2 for units rated between 5 to 20 MMBtu/hr. Each unit is presumed to be operated for 8,760 hours per year at the maximum rated capacity, unless restricted by annual heat input rate. The total cost for this category is determined by multiplying the number of units and $49,126 a typical annual cost of an SCR system for a 5 to 20 MMBtu/hr unit.

Type of unit	Number of units	Potential NOx Reductions with SCR Technology (tons/yr)	Total annualized cost of NOx Reductions with SCR Technology ($/yr)	Cost effectiveness ($/ton of emission reduction)
Category A: >5.0 MMBtu/hr to ≤ 20 MMBtu/hr, Except Category C through G units	273*	129.0	13,411,398	**$103,964/ton**

*Total units = 279 - 6 units with SCR systems = 273 units

Retrofitting with Selective Catalytic Reduction (SCR) as Potential Control for units greater than 20 MMBtu/hr

SCR technology is predominantly used to reduce NOx emissions from boilers, steam generators and process heaters. Since SCR is post-combustion control, an existing boiler can be retrofitted with this technology. Several units in the Valley are equipped with SCR system. According to information from SCR vendors, the average SCR system cost is $210,000 for units between 20 to 95 MMBtu/hr. This information is used as a basis to estimate the annualized cost for this control technique.

Description of Cost	Cost Factor	Cost	Source
Direct Costs			
Purchase equipment costs (PE)			
SCR System	A	210,000	SCR vendors
Instrumentation and controls	0.01 A	2,100	OAQPS
Sales Taxes	0.08 A	16,968	
Freight	0.05 A	10,500	OAQPS
Purchased equipment cost, PEC	B = 1.14 A	239,568	
Direct installation costs (DI):			
Foundation & supports	0.08 B	19,165	OAQPS
Handling and erection	0.14 B	33,540	OAQPS
Electrical	0.04 B	9,583	OAQPS
Piping	0.02 B	4,791	OAQPS
Insulation and ductwork:	0.01 B	2,396	OAQPS
Painting	0.01 B	2,396	OAQPS
Direct installation costs	0.30 B	71,871	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC	1.30B + SP+ Bldg.	311,439	
Indirect Costs (Installation)			
Engineering	0.10 B	23,957	OAQPS
Construction and field expenses	0.05 B	11,978	OAQPS
Contractor fees	0.10 B	23,957	OAQPS
Contingencies	0.03 B	7,187	OAQPS
Start-up	0.02 B	4,791	OAQPS
Performance test	0.01 B	2,396	OAQPS
Total Indirect Costs, IC	0.31 B	74,266	
Total Capital Investments (TCI= DC + IC):	**1.61 B + SP + Bldg.**	**385,705**	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**62,754**	

Description of Cost	Cost Factor	Cost	Source
Direct Annual Costs (DAC)			
Operating and supervisory labor	--	--	See table footnote
Maintenance Costs (labor and material)	0.015 TCI	5,786	OAQPS
Reagent costs (anhydrous ammonia)		--	Not estimated
Electricity Cost:	$0.08848/kWH	--	Not estimated

Catalyst Replacement:	--	--	Catalyst is presumed to last at least over 10 years
	Total DAC:	5,786	
Indirect Annual Costs (IAC)			
Overhead:	--	--	See table footnote
Insurance:	0.01 TCI	3,857	OAQPS
Property Tax:	--	--	See table footnote
Administrative:	--	--	See table footnote
	Total IAC:	3,857	
Total Annual Cost (DAC + IAC)		9,643	
Total annual cost (Annualized TCI + Total annual cost)		**72,397**	

*Per EPA's Air Pollution Control Cost Manual (6th Edition), EPA/452/B-02-001 (1/02), operating and supervisory, overhead, administrative costs would be insignificant for an SCR system. In general, SCR does not require site preparation or additional buildings, and property taxes do not apply to capital improvements such as air pollution control equipment.

The potential NOx emission reduction for greater 20 MMBtu/hr units (Category B in Rule 4320 except Category C through G units) is determined by taking the difference between the permitted potential emissions and the emissions that could be reliably achievable by an SCR system. Source test results of various units with SCR system indicate that an SCR can reliably achieve 2.5 ppmv NOx @ 3% O2 (or less) emissions for units greater than 20 MMBtu/hr. Each unit is presumed to be operated for 8,760 hours per year at the maximum rated capacity, unless restricted by annual heat input rate. The total cost for this category is determined by multiplying the number of units and $72,397 a typical annual cost of an SCR system for a 5 to 20 MMBtu/hr unit.

Type of unit	Number of units	Potential NOx Reductions with SCR Technology (tons/yr)	Total annualized cost of NOx Reductions with SCR Technology ($/yr)	Cost effectiveness ($/ton of emission reduction)
Category B: >20.0 MMBtu/hr, except Category C through G units	190*	123.7	13,755,430	**$41,159/ton**

*Total units = 221 - 31 units with SCR systems = 190 units

Oilfield Steam Generators

The temperature required for SCR to work (600-800 F) is higher than the temperature that of oilfield steam generator exhaust(~250 F). The steam generators would have to be cut open to retrofit SCR into the convection section of the steam generator to operate the SCR system at the correct temperature. This would cause insurmountable heat loss, preventing the production of the steam necessary for the oil field operation. Therefore, oilfield facilities do not use SCR on their steam generators.

Some oilfield steam generators now are being proposed with NOx limits of 5 ppmv with burner controls and without SCR. These units have a ULN burner. Some units already installed and operating with ultra low nox burners combined with flue gas recirculation have demonstrated through source tests to achieve NOx emission levels as low as 3.0 ppmv.

Low Temperature Oxidation

Emerging technologies that may have the potential to reduce emissions were researched. A Low Temperature Oxidation (LTO) System was installed at a dairy in the SCAQMD and was able to reach NOx limits between 1.0 - 3.2 ppmv for loads 4.1 – 13.0 MMBtu/hr. The LTO system utilizes ozone to oxidize and control various pollutants, including NOx. According to the SCAQMD BACT database information, capital and installation costs ranged from $360,000 - $400,000 for the LTO system when it was installed in 1997[20]. Installation within the South Coast region was heavily subsidized with government funding and the installation costs appear cost prohibitive for an installation that is not subsidized. In addition, the LTO system is classified as “Other Technologies” in the SCAQMD BACT guidelines, which means that the technology has not met the achieved in practice (AIP) criteria of six months of continuous operation at a minimum of 50% operating capacity and does not qualify as the lowest achievable emission rate (LAER). Since the technology has not been achieved in practice and is cost prohibitive without significant subsidies, it will not be considered a feasible opportunity at this time.

EMx

The potential for emissions reductions through EMx, the second generation of the SCONOx technology, that is a post-combustion control that reduces NOx, SOx, CO, and volatile organic compound (VOC) emissions, was researched. This technology has not been AIP in the District and there is no available data that indicates that SCONOx or EMx has been installed on boilers even though the manufacturer’s website states that the technology is transferrable to industrial boilers. Based on research of the best available controls from EPA and other air districts, the SCONOx and EMx systems have only been utilized by power plants for control of turbine emissions. In fact, cost effectiveness analyses conducted by the District for the installation of SCONOx/EMx units on large power plant turbine installations within the San Joaquin Valley have been found to not be cost effective. Given the high cost effectiveness demonstrated for turbines and lack of demonstrated practice with boilers, the District does not expect this technology to be feasible or cost effective for reducing emissions from this category.

PM2.5 Limits for Alternative Fuels

The majority of boilers (>5 MMBtu/hr) in the Valley combust Public Utilities Commission (PUC) quality natural gas, which contains a very low sulfur content and inherently has low emissions. Few boilers in the Valley use alternative fuels for their combustion processes. Alternative fuels include digester gas, produced gas, and liquid fuel. Units fired on digester gas or produced gas are already required to use inlet gas scrubbers to meet District rule requirements.

Current rule language requires that liquid fuel shall be used only during a PUC-quality natural gas curtailment period provided it contains no more than 15 ppm sulfur. While the use of liquid fuel is strictly limited, the feasibility of reducing PM emissions through

[20] (2012). *SCAQMD Best Available Control Technology (BACT) Database*. Diamond Bar, CA: South Coast Air Quality Management District.

adding PM2.5 limits for units using liquid fuel was explored as part of the District's comprehensive control measure evaluation.

There are 62 units that are allowed to utilize liquid fuel during natural gas curtailments in the Valley (>5 MMBtu/hr) with a combined emissions inventory of approximately 0.02 tons per year of total PM. The low emissions inventory is attributed to the fact that these units utilize liquid fuel as a backup only if there is a natural gas curtailment. In fact, as there have been no recent natural gas curtailments in the Valley, actual emissions from the combustion of liquid fuel is likely zero.

The following three technologies were researched as potential opportunities to reduce PM emissions: baghouses, electrostatic precipitators (ESPs), and wet scrubbers. Baghouses control total PM and PM2.5 emissions by 90-99%; ESPs control total PM and PM2.5 emissions by 90-99%; and wet scrubbers control large particulates (>PM5) by 99% and PM2.5 emissions by approximately 50%[21]. However, baghouses are typically not used with liquid-fired boilers due to the potential clogging of the baghouse[22] and are therefore not a recommended technology due to infeasibility and safety issues.

Currently, there are a several produced gas fired steam generators operating in crude oil production facilities that are required by their permits to operate SOx scrubbers and ESPs (to reduce SOx emissions and visible emissions to burning high sulfur produced gas).

As illustrated below, neither PM control technology is a cost effective option for this source category. The cost of the ESP technology does not include costs of retrofitting equipment and/or the facility or compliance monitoring costs, which would drive the cost effectiveness up even more. In addition, the annualized costs provided by EPA for the wet scrubber system are in 2002 dollars, which means the value above would be even greater if it were adjusted to 2018 dollars.

PM Potential Emissions Reductions for an ESP and Scrubber

For the purposes of these calculations, the following assumptions were made:

1. For simplicity, the analysis will evaluate the cost effectiveness of these technologies for total PM reductions from liquid fuel fired units.
2. The PM control efficiency of an ESP is 99%.
3. The PM control efficiency of a scrubber is 99%.

Potential Emissions Reductions$_{ESP}$ = (Total PM Emissions) x (Control Efficiency)
Potential Emissions Reduction$_{ESP}$ = 0.02 tons/year X 0.99
Potential Emissions Reduction$_{ESP}$ = 0.0198 tons/ year (tpy)

[21] Northeast States for Coordinated Air Use Management. (November 2008) *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.*
[22] Northeast States for Coordinated Air Use Management. (November 2008) *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.*

Potential Emissions Reductions $_{scrubber}$ = (Total PM Emissions) x (Control Efficiency)
Potential Emissions Reduction $_{scrubber}$ = 0.02 tons/year X 0.99
Potential Emissions Reduction $_{scrubber}$ = 0.0198 tons/ year (tpy)

Annualized Cost of an ESP and Wet Scrubber

The capital cost for the installation of an ESP for a 1-5 MMBtu/hr boiler ranges from $90,000 - $100,000 and the annual maintenance cost is $1,000-$2,000.[23] For the wet scrubber system, EPA estimated the annualized cost at $5,300-$102,000 per sm^3/sec at an average air flow rate of 0.7- 47 sm^3/sec.[24] The following assumptions in the cost effectiveness calculations:

1. The capital cost of an ESP for a 5 MMBtu/hr boiler is assumed to be $100,000.
2. The annual maintenance cost of an ESP for a 5 MMBtu/hr boiler is assumed to be $2,000.
3. The annualized cost of a wet scrubber system is assumed to be the median of the range above ($53,650 per sm^3/sec).
4. The average air flow rate for a wet scrubber system is assumed to be the median of the range above (23.85 sm^3/sec).
5. The total capital and maintenance cost of an ESP will be calculated by multiplying the cost of 1 unit by the total number of units.
6. The total annualized cost of a wet scrubber will be calculated by multiplying the annualized cost of 1 unit by the total number of units.
7. Lifetime of the ESP is 10 years at 10% interest. To account for this, the annualized capital cost will be calculated by multiplying the total capital cost by the capital recovery factor of 0.1627 and adding the annual maintenance costs.

Annual Cost$_{ESP}$ = (Total Capital Cost) x (0.1627) + (Annual Maintenance Cost x 62)
Annual Cost$_{ESP}$ = ($100,000 x 62) x (0.1627) + ($2,000 x 62)
Annual Cost$_{ESP}$ = $1,132,740/year

Annual Cost$_{scrubber}$ = (Annualized Cost of 1 unit) x (Number of Units) x (Average Flow Rate)
Annual Cost$_{scrubber}$ = ($53,650/ sm^3/sec) x (62) x (23.85 sm^3/sec)
Annual Cost$_{scrubber}$ = $79,332,255 year

Cost Effectiveness of an ESP and Wet Scrubber

Cost Effectiveness = Annual Cost / Annual Emissions Reductions

Cost Effectiveness$_{ESP}$ = ($1,132,740/year) / (0.0198 tons/ year)
Cost Effectiveness$_{ESP}$ = $57,209,091/ton of PM

[23] Catherine Roberts. (March 2009) *Information on Air Pollution Control Technology for Woody Biomass Boilers.* Environmental Protection Agency Office of Air Quality Planning and Standards and Northeast States for Coordinated Air Use Management.
[24] (2002). *Air Pollution Control Technology Fact Sheet: Spray-Chamber/Spray-Tower Wet Scrubber.* Environmental Protection Agency.

Cost $Effectiveness_{scrubber}$ = ($79,332,255/year) / (0.0198 tons/ year)
Cost $Effectiveness_{scrubber}$ = $4,006,679,545/ton of PM

Solar Powered Oilfield Steam Generation

Emissions from oilfield steam generators that provide steam to reduce the viscosity of oil in thermally enhanced oil recovery operations have been significantly reduced through decades of increasingly stringent rule requirements. Instead of fuel oil, steam generators today are powered by natural gas or field gas which are significantly cleaner. To ensure that all potential emission reduction opportunities are evaluated, the District performed a comprehensive review of solar powered steam generators.

In the Valley, two small pilot projects were conducted to demonstrate the feasibility of solar powered steam generation technologies and found that such technologies were not feasible:

Berry Petroleum Company: This company installed a small pilot test facility designed to use solar energy to pre-heat feed water for the existing natural gas fired steam generators. The system consisted of mirrors in a glass greenhouse (supplied by Glasspoint Solar). The mirrors were designed to focus solar energy onto a pipe carrying water to heat the water. The heated water would then be sent to the input of the steam generators. The facility had a designed heat production of 300 kW. This project operated for a short time and was ultimately shut down based on the following shortcomings:

1) Significant heat loss: The heat losses to the water from the pipe runs from the solar installation to the actual steam generator locations were such that the water delivered to the steam generators was ambient or slightly warmer.
2) Excessively large footprint requirement: The footprint of the solar steam generators needed to provide the thermal output of one 85 MMBtu steam generator would be excessively large.
3) Inconsistent steam quality: The inability of the solar steam generators to consistently generate the quality of steam that is needed for injection that is currently supplied by the steam generators.
4) Unreliable power: The solar steam generators would still need to be supplemented by gas fired steam generators at night and during cloudy days.

Chevron: This company installed a pilot solar thermal steam plant near Coalinga, consisting of 7,600 mirrors that would direct solar energy towards a single solar collector tower (supplied by Brightsource Energy). The heat collected in the tower would turn water into steam. The installation had a footprint of 100 acres. This system discontinued operation in 2014. Although information from Chevron on their findings on the performance of this project is unavailable, based on news articles[25], the system was

[25] http://www.naturalgasintel.com/articles/103562-potential-for-solar-assisted-eor-in-california-oilfield-still-unfulfilled and https://gigaom.com/2011/10/12/brightsources-solar-steam-project-went-way-over-budget/

excessively costly. A news article referencing the manufacturer's SEC filings stated the company realized a 40 million dollar loss on the project.

Aera Energy: Despite the above-described challenges, Aera Energy is currently in collaboration with Glasspoint Solar to consider the potential installation of a large 770-acre solar steam generation system adjacent to an Aera Energy oil production operation in western Kern County. This system would generate the steam equivalent to approximately 10 gas-fired steam generators. The solar steam generators would still need to be supplemented by gas-fired steam generators at night and during cloudy days.

Based on discussions with Aera Energy, the project relies heavily on solar tax credits, the generation and sale of low carbon fuel standard (LCFS) credits, and the reduction in costs of greenhouse gas allowances for Aera. According to Aera Energy, there is no economic benefit to implementing such technologies. In fact, without the LCFS credits, the cost of steam using this solar technology would be as much as 3 times the current cost. AERA Energy is pursuing this technology to continue its effort in helping lead the industry to cleaner energy. The system proposed would be primarily funded by the solar steam generation equipment manufacturer and outside investors. Aera Energy would commit to purchasing the steam if successfully built.

The project also faces technical challenges, similar to the above pilot projects. Furthermore, the gas-fired steam generators that are required to supplement the system could face difficulty meeting current rule limits due to the need to ramp up and down. There has not been a successful large scale implementation of such technologies. The District is working closely with AERA to facilitate this project.

In summary, solar powered oilfield steam generators are not yet feasible and still face significant technical and economic challenges as outlined below:

- **Costs:** The use of solar steam generation rely on a complex set of funding sources to make the operations economically feasible, including the Federal 30% tax credit, the value of California low-carbon fuel standards credits that may be generated as a result of using solar steam generation to produce oil, and a reduction in the costs for the oil producer of AB32 cap-and-trade credits required for their operations in California. The value of the GHG credits generated varies based on the price of credits on the open market. As the value of the credits is not fixed, the economic viability of a project may change depending on the value of the credits prior to construction and during operation. Even with available credits, the costs continue to be a challenge.

- **Land Availability:** Adequate open land next to the steam injection wells is needed to house the solar collectors. Both the amount of land and the distance of the land to the injection point are important factors. It is estimated that to create the steam needed to replace one steam generator would require 60 acres of solar generation. Finding the required amount of land available next to oilfield operations may be difficult. The solar systems have to be close to the steam injection wells. Otherwise, additional solar capacity will need to be developed to account for the heat loss because of travel distance.

- **Variability of Solar Steam Generation Output:** Solar steam generation plants need sunny days to be able to collect enough energy to make steam. During cloudy days and also during the night, the solar equipment would not make enough steam. Oilfield operators will need to supplement the solar operation with natural gas fired steam generators for when the solar equipment is not producing enough steam. On partly cloudy days, the natural gas steam generators would need to cycle on and off depending on the cloud cover. This may cause operational difficulties as the gas fired steam generators are tuned to operate at constant load. A variable load could cause emissions variability and potentially have emissions higher than that allowed in permit limits and/or District prohibitory rules.

The District will continue to work with operators of boiler, steam generator, process heater to develop, demonstrate, and deploy new emission control technologies. This includes developing innovative strategies to address challenges like the variable load issue for solar steam generators that may cause individual steam generators to exceed current permitted limits. In such situations, a strategy that allows individual units to potentially operate at a higher level as long as the overall operation of the combined units as a whole results in additional emission reductions.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for emissions from boilers, steam generators, and process heaters. As demonstrated above, Rules 4306 and 4320 currently have in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, the District will work with affected operators to further reduce NOx emissions from boilers, steam generators, and process heaters to the extent that such controls are technologically and economically feasible. Technologies with the potential to further reduce emissions include the latest generation of ultra-low NOx burners, SCR, and ultra-low NOx burners combined with SCR. As demonstrated above, some of these technologies may not be cost-effective or feasible at this time. Therefore, the potential measures include lowering the emission limits for the class and category and lowering the more stringent Advanced Emission Reduction Option (AERO) limit further as follows:

- Boilers and process heaters >5.0 MMBtu/hr to ≤ 20 MMBtu/hr

  - Lower current emissions limitations of 6 ppmv (enhanced) and 9 ppmv (standard) to a new limitation as low as 2.5 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Boilers and process heaters > 20 MMBtu/hr
  - Lower current emissions limitations of 5 ppmv (enhanced) and 7 ppmv (standard) to a new limitation as low as 2 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Oil field steam generators >5.0 MMBtu/hr to ≤ 20 MMBtu/hr
  - Lower current emissions limitations of 6 ppmv (enhanced) and 9 ppmv (standard) to a new limitation as low as 3.5 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Oil field steam generators > 20 MMBtu/hr
  - Lower current emissions limitations of 5 ppmv (enhanced) and 7 ppmv (standard) to a new limitation as low as 2 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Oil field steam generators < 50% PUC quality gas
  - Lower current emissions limitations of 12 ppmv (enhanced initial) and 9 ppmv (enhanced final) to a new limitation as low as 3.5 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Petroleum refinery boilers/process heaters >5.0 MMBtu/hr to ≤ 20 MMBtu/hr
  - Lower current emissions limitations of 9 ppmv to a new limitation as low as 3 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Petroleum refinery boilers/process heaters >20 MMBtu/hr to ≤ 110 MMBtu/hr
  - Lower current emissions limitations of 6 ppmv to a new limitation as low as 3 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Petroleum refinery boilers/process heaters >110 MMBtu/hr
  - Lower current emissions limitations of 5 ppmv to a new limitation as low as 3 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Petroleum refinery boilers/process heaters < 50% PUC quality gas
  - Lower current emissions limitations of 9 ppmv to a new limitation as low as 3 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment

The above potential measures are projected to provide 0.4 tons NOx per day of additional emissions reductions. The proposed commitments by the District and CARB will each achieve an aggregate emission reduction of direct PM2.5 and NOx. While the commitments include estimates of the emission reductions from each individual measure, final measures as proposed for adoption into the state implementation plan (SIP) may provide more or less emission reductions. The aggregate commitment will guarantee that the total emission reductions will be achieved to attain each NAAQS as expeditiously as practicable.

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C.8 Rule 4307 (Emissions From Boilers Steam Generators And Process Heaters-2.0 MMBtu/Hr To 5.0 MMBtu/Hr)

Discussion

The purpose of Rule 4307 (Boilers, Steam Generators, and Process Heaters – 2.0 MMBtu/hr to 5.0 MMBtu/hr) is to limit emissions of NOx, carbon monoxide (CO), sulfur dioxide (SO2), and particulate matter from units subject to this rule.

Rule 4307 was adopted on December 15, 2005, to establish emissions limits and control requirements for these units which were previously exempt because of their smaller size. Since its adoption, the rule has been amended three times. The October 2008 amendments strengthened the rule by removing some exemptions, imposing NOx limits of 9 or 12 ppmv for new and replacement units, and adding a menu-approach for particulate matter control that also encompasses SOx controls. The rule was amended again in 2011 to specifically incorporate tree nut pasteurizers as a separate type of unit. EPA published a direct final approval of the 2011 amendments to Rule 4307 on February 12, 2015 and deemed this rule as being at least as stringent as established RACT requirements.[26] NOx emissions have been controlled by over 84% for units in this source category.

Emission Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.31	0.30	0.28	0.28	0.27	0.27	0.26	0.26	0.25
NOx	0.45	0.38	0.35	0.34	0.33	0.32	0.31	0.30	0.29
	Winter Average - Tons per day								
PM2.5	0.31	0.29	0.28	0.27	0.27	0.26	0.26	0.25	0.25
NOx	0.44	0.38	0.34	0.33	0.32	0.31	0.30	0.29	0.28

Source Category

This source category includes any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input of 2.0 million British thermal units per hour (MMBtu/hr) up to and including 5.0 MMBtu/hr. Based on District data, there are currently 642 active units subject to Rule 4307 requirements[27] permitted with Permits to Operate (PTOs) or Permit-Exempt Equipment Registration (PEER); with the majority of them being PEER units. Facilities with units subject to this rule represent a wide range of industries, including but not limited to, medical facilities, educational institutions, office buildings, prisons, military facilities, hotels, and industrial facilities.

[26] 80 FR 7803-7805
[27] Data based on the permit search conducted on November 17, 2016 and August 23, 2018

HOW DOES DISTRICT RULE 4307 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations

Emissions from this source category are lower than the BACM significance thresholds. The federal Clean Air Act does not require a control measure evaluation for this source category to satisfy BACM requirements. However, the District conducted a full control measure evaluation for this source category to ensure all feasible opportunities to reduce emissions and expedite attainment are pursued.

There are no EPA CTG or NSPS requirements for this source category.

Alternative Control Techniques (ACT)

- EPA–453/R-93-034 (Alternative Control Techniques Document–NOx Emissions from Process Heaters)

The District evaluated the requirements contained within the ACT for NOx Emissions from Process Heaters and found no requirements that were more stringent than those already in Rule 4307.

- EPA–453/R-94-022 (Alternative Control Techniques Document–NOx Emissions from Industrial/Commercial/Institutional Boilers)

The District evaluated the requirements contained within the ACT for NOx Emissions from Industrial/Commercial/Institutional Boilers and found no requirements that were more stringent than those already in Rule 4307.

- EPA–453/R-94-023 (Alternative Control Techniques Document–NOx Emissions from Utility Boilers)

The District evaluated the requirements contained within the ACT for NOx Emissions from Utility Boilers and found no requirements that were more stringent than those already in Rule 4307.

NESHAP/ MACT

- 40 CFR 63 Subpart DDDDD (NESHAP for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters)

40 CFR 63 Subpart DDDDD was amended on January 31, 2013 to include new emission limits for PM, CO, and total selective metals (TSM), replace numeric dioxin emission limits with work practice standards, add new subcategories of facilities, and add alternative monitoring approaches for compliance with the PM limit. The PM limits in 40 CFR 63 Subpart DDDDD would not apply to Rule 4307 sources. Subpart DDDDD contains alternative requirements for units less than 10 MMBtu/hr and requires tuning every 2-5 years.

The District evaluated the requirements contained within 40 CFR 63 Subpart DDDDD and found no requirements that were more stringent than those already in Rule 4307.

State Regulations
There are no state regulations applicable to this source category.

HOW DOES DISTRICT RULE 4307 COMPARE TO RULES IN OTHER AIR DISTRICTS?

BAAQMD

- BAAQMD Regulation 9, Rule 6 (Nitrogen Oxide Emissions From Natural Gas-Fired Boilers and Water Heaters) *(Amended November 7, 2007)*
  BAAQMD Regulation 9 Rule 6 regulates NOx and CO emissions from natural gas fired boilers and water heaters. The District compared the emission limits in District Rule 4307 and BAAQMD's Regulation 9 Rule 6 and concluded that NOx requirements in SJVAPCD rule are at least equivalent or more stringent than the BAAQMD rule limits for similarly rated units.

- Regulation 9 Rule 7 (Nitrogen Oxides and Carbon Monoxide From Industrial and Commercial Boilers, Steam Generators and Process Heaters) *(Last amended May 4, 2011)*
  BAAQMD Regulation 9 Rule 7 regulates NOx and CO emissions from industrial and commercial boilers, steam generators and process heaters. The District compared the emission limits in District Rule 4307 and BAAQMD's Regulation 9 Rule 7 and concluded that NOx requirements in SJVAPCD rule are at least equivalent or more stringent than the BAAQMD rule limits for similarly rated units.

- Regulation 9, Rule 10 (Nitrogen Oxides and Carbon Monoxide From Boilers, Steam Generators and Process Heaters in Petroleum Refineries) (Last Amended October 16, 2013)
  BAAQMD Regulation 9 Rule 10 regulates NOx and CO emissions from boilers, steam generators and process heaters in petroleum refineries. The District compared the remission limits in District Rule 4307 to the requirements contained within BAAQMD's Regulation 9 Rule 10 and found that NOx requirements in SJVAPCD rule are on an emission-unit by emission-unit basis, whereas, the emission limits in BAAQMD rule is on a refinery-wide basis, and therefore, cannot be compared.

SCAQMD

- Rule 1146.1 (Emissions of Oxides of Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters) *(Last amended November 1, 2013)*
  SCAQMD Rule 1146.1 regulates NOx and CO emissions from small industrial, institutional, and commercial boilers, steam generators, and process heaters. The District compared the emission limits in District Rule 4307 with SCAQMD Rule 1146.1and concluded that NOx requirements in SJVAPCD rule are at least equivalent or more stringent than the SCAQMD rule limits for similarly rated units.

- Rule 1146.2 (Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters) *(Last amended May 5, 2006)*
  SCAQMD Rule 1146.2 regulates NOx and CO emissions from large water heaters and small boilers and process heaters. The District compared the emission limits in District Rule 4307 with SCAQMD Rule 1146.2 and concluded that NOx requirements in SJVAPCD rule are more stringent than the SCAQMD rule limits for 2.0 MMBtu/hr boilers and process heaters.

- Rule 1109 (Emissions of Oxides of Nitrogen from Boilers and Process Heaters in Petroleum Refineries) *(Last amended August 5, 1988)*
  SCAQMD Rule 1146.2 regulates NOx and CO emissions from large water heaters and small boilers and process heaters. The units subject to Rule 4307 would not be subject to requirements of SCAQMD Rule 1109. Therefore, no further analysis is required.

SMAQMD

- Rule 411 (NOx from Boilers, Process Heaters and Steam Generators) *(August 23, 2007)*
  SMAQMD Rule 411 regulates NOx and CO emissions from boilers, process heaters and steam generators. The District compared the emission limits in District Rule 4307 with SMAQMD Rule 411 and concluded that NOx requirements in SJVAPCD rule are at least equivalent or more stringent than the SCAQMD rule limits for similarly rated units.

VCAPCD

- Rule 74.15.1 (Boilers, Steam Generators, and Process Heaters) *(Last amended June 23, 2015)*
  VCAPCD Rule 74.15.1 regulates NOx and CO emissions from boilers, steam generators, and process heaters. The District compared the emission limits in District Rule 4307 with VCAPCD and concluded that NOx requirements in SJVAPCD rule are equivalent to that of the VCAPCD rule limits for similarly rated units.

	SJVAPCD Rule 4307	BAAQMD Reg 9 Rule 6
Applicability	Rule applies to any gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2.0 MMBtu/hr to ≤5.0 MMBtu/hr	Rule applies to natural gas fired water heaters and boilers, and limits only NOx emissions
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where the products of combustion come into direct contact with the material to be heated • Unfired or fired waste heat recovery boilers that are used to recover or augment heat from the exhaust of combustion turbines or internal combustion engines • Burning other fuel during PUC quality natural gas curtailment as long as other fuel not be burned for more than 168 hour/year plus 48 hour/year for equipment testing and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	• Natural gas-fired boilers and water heaters rated at > 2 MMBtu/hr • Natural gas-fired water heaters used in recreational vehicles. • Water heaters using a fuel other than natural gas. • Natural gas-fired pool/spa heater with <0.4 MMBtu/hr used exclusively to heat swimming pools, hot tubs or spas
Requirements*	**NOx emission limits:** Existing units limited to 1.8 billion Btu/yr • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit twice per calendar year, OR • Operate and maintain the stack O_2 concentrations at 3% by vol. or less, OR • Certify unit to comply with 30 ppmv NOx (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units (see below). Existing atmospheric units in oilfield or refinery; each glycol reboiler; or each unit with heat input > 1.8 to < 5 billion Btu/yr: • 30 ppmv NOx (gaseous fuel) New and Replacement units: • 12 ppmv NOx (atmospheric units) • 9 ppmv NOx (non-atmospheric units) **Particulate matter control requirements:** • Use PUC quality natural gas, propane, butane, LPG or a combination of such gases, OR • Limit fuel sulfur content to no more than 5 grains/100 scf of gas; OR • Install and operate control system that reduces SO2 emissions at least 95% by wt., or limit exhaust SO2 concentration to ≤ 9 ppmv @ 3% O_2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppm sulfur	**NOx emission limits:** Natural gas-fired boilers and water heaters: • 20 ng-NOx/J of heat output or 30 ppm NOx for units >0.4 MMBtu/hr to 2 MMBtu/hr manufactured after Jan 1, 2008 • 14 ng-NOx/J of heat output or 20 ppm NOx for units >0.4 MMBtu/hr to 2 MMBtu/hr manufactured after Jan 1, 2013 **Particulate matter control requirements:** None
Conclusion	NOx requirements in SJVAPCD rule are at least equivalent to or more stringent than the BAAQMD rule for similarly rated units.	

*Unless otherwise stated, all ppmv values are on a dry basis and corrected to 3% stack oxygen by volume.

	SJVAPCD Rule 4307	BAAQMD Reg 9 Rule 7
Applicability	Rule applies to any gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2.0 MMBtu/hr to ≤5.0 MMBtu/hr	Rule applies to any industrial, institutional and commercial boilers, steam generator and process.
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where the products of combustion come into direct contact with the material to be heated • Unfired or fired waste heat recovery boilers that are used to recover or augment heat from the exhaust of combustion turbines or internal combustion engines • Burning other fuel during PUC quality natural gas curtailment as long as other fuel not be burned for more than 168 hour/year plus 48 hour/year for equipment testing and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	• Units ≤ 2MMBtu/hr if fired exclusively on natural gas, LPG, or any combination thereof • Units <1MMBtu/hr with any fuel • Units used in petroleum refineries • Boilers used by public electric utilities or qualifying small power production facilities • Waste heat recovery boilers used to recover sensible heat from the exhaust of combustion turbines or reciprocating internal combustion engines • Kilns, ovens, and furnaces used for drying, baking, heat treating, cooking, calcining or vitrifying • Process heater used to heat thermal fluid for radiant comfort heating
Requirements*	**NOx emission limits:** Existing units limited to 1.8 billion Btu/yr • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit twice per calendar year, OR • Operate and maintain the stack O_2 concentrations at 3% by vol. or less, OR • Certify unit to comply with 30 ppmv NOx (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units (see below). Existing atmospheric units in oilfield or refinery; each glycol reboiler; or each unit with heat input > 1.8 to < 5 billion Btu/yr: • 30 ppmv NOx (gaseous fuel) New and Replacement units: • 12 ppmv NOx (atmospheric units) • 9 ppmv NOx (non-atmospheric units) **Particulate matter control requirements:** • Use PUC quality natural gas, propane, butane, LPG or a combination of such gases, OR • Limit fuel sulfur content to no more than 5 grains/100 scf of gas; OR • Install and operate control system that reduces SO2 emissions at least 95% by wt., or limit exhaust SO2 concentration to ≤ 9 ppmv @ 3% O_2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppm sulfur	**NOx and CO emission limits:** Units with <10% of its annual maximum heat capacity in 12 consecutive months: • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit at least once per calendar year, OR • Comply with applicable NOx and CO limits (see below) Units >2 MMBtu/hr to 5 MMBtu/hr: • 30 ppm NOx (gaseous fuels, landfill gas, or digester gas) • 40 ppmv NOx (no-gaseous fuels) • Heat input weighted average limit for NOx (multiple fuels) **Particulate matter control requirements:** None
Conclusion	NOx in SJVAPCD rule are at least equivalent to (e.g., units limited to annual heat input rate) or more stringent (e.g. new and replacement units) than the BAAQMD rule for similarly rated units.	

*Unless otherwise stated, all ppmv values are on a dry basis and corrected to 3% stack oxygen by volume.

	SJVAPCD Rule 4307	BAAQMD Reg 9 Rule 10
Applicability	Rule applies to any gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2.0 MMBtu/hr to ≤5.0 MMBtu/hr	Rule applies to boilers, steam generator and process heaters, including CO boilers, in petroleum refineries
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where the products of combustion come into direct contact with the material to be heated • Unfired or fired waste heat recovery boilers that are used to recover or augment heat from the exhaust of combustion turbines or internal combustion engines • Burning other fuel during PUC quality natural gas curtailment as long as other fuel not be burned for more than 168 hour/year plus 48 hour/year for equipment testing and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	• Units < 2MMBtu/hr if fired exclusively on natural gas, LPG, or any combination thereof • Units <1MMBtu/hr with any fuel • Waste heat recovery boilers used to recover sensible heat from the exhaust of combustion turbines or reciprocating internal combustion engines • Waste heat recovery boilers recovering sensible heat from exhaust of combustion turbines or reciprocating IC engines • Units processing H2S process flue gas in sulfur recovery plants and their tail-gas treating units, or sulfuric acid manufacturing plants • Units on non-gaseous fuel when natural gas is unavailable for use • Units including CO boilers that receive ATC subject to BACT for NOx on or after 1/5/1994.
Requirements*	**NOx emission limits:** Existing units limited to 1.8 billion Btu/yr • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit twice per calendar year, OR • Operate and maintain the stack O_2 concentrations at 3% by vol. or less, OR • Certify unit to comply with 30 ppmv NOx (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units (see below). Existing atmospheric units in oilfield or refinery; each glycol reboiler; or each unit with heat input > 1.8 to < 5 billion Btu/yr: • 30 ppmv NOx (gaseous fuel) New and Replacement units: • 12 ppmv NOx (atmospheric units) • 9 ppmv NOx (non-atmospheric units) **Particulate matter control requirements:** • Use PUC quality natural gas, propane, butane, LPG or a combination of such gases, OR • Limit fuel sulfur content to no more than 5 grains/100 scf of gas; OR • Install and operate control system that reduces SO2 emissions at least 95% by wt., or limit exhaust SO2 concentration to ≤ 9 ppmv @ 3% O_2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppm sulfur	**NOx and CO emission limits:** Small unit(<10 MMBtu/hr) requirements: Meet at least one of the following: • Operate in a manner that maintains stack O2≤3% by vol. on dry basis; OR • Tune at least once every 12 months, or within 2 weeks of unit startup if not operated in the last 12 months; OR • Meet applicable limits - 0.033 lb-NOx/MMBtu; 0.2 lb-NOx/MMBtu for CO boilers Refinery-wide* NOx limit: 0.033 lb-NOx/MMBtu of heat input, based on an operating day average Federal refinery-wide NOx limit • 0.20 lb-NOx/MMBtu based on an operating day average (except CO boilers), except during startup, shutdown or curtailed operation Final NOx limit for CO boilers • 150 ppm NOx except during startup and shutdown for non-partial-burn CO boiler, except during startup, shutdown or curtailed operation • 125 ppmv NOx except during startup and shutdown for partial-burn CO boiler, except during startup, shutdown or curtailed operation *Refinery-wide limit is defined as the ratio of the total mass of discharge into the atmosphere of nitrogen oxides, in pounds, to the sum of the actual heat input, in million BTU, calculated over a twenty-four (24) hour operating day. **Particulate matter control requirements:** None
Conclusion	BAAQMD include refinery-wide NOx and CO limits in the rule, whereas SJVAPCD rule include NOx and CO limits on an emission unit basis. Therefore, the NOx cannot be compared.	

*Unless otherwise stated, all ppmv values are on a dry basis and corrected to 3% stack oxygen by volume.

	SJVAPCD Rule 4307	SCAQMD Rule 1146.1
Applicability	Rule applies to any gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2.0 MMBtu/hr to ≤5.0 MMBtu/hr	Rule applies to boilers, steam generator and process heaters >2 MMBtu/hr to <5 MMBtu/hr with the exception of RECLAIM facilities (NOx emissions only)
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where the products of combustion come into direct contact with the material to be heated • Unfired or fired waste heat recovery boilers that are used to recover or augment heat from the exhaust of combustion turbines or internal combustion engines • Burning other fuel during PUC quality natural gas curtailment as long as other fuel not be burned for more than 168 hour/year plus 48 hour/year for equipment testing and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	• None
Requirements*	**NOx emission limits:** Existing units limited to 1.8 billion Btu/yr • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit twice per calendar year, OR • Operate and maintain the stack O_2 concentrations at 3% by vol. or less, OR • Certify unit to comply with 30 ppmv NOx and 400 ppmv CO (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units (see below). Existing atmospheric units in oilfield or refinery; each glycol reboiler; or each unit with heat input > 1.8 to < 5 billion Btu/yr: • 30 ppmv NOx (gaseous fuel) New and Replacement units: • 12 ppmv NOx (atmospheric units) • 9 ppmv NOx (non-atmospheric units) **Particulate matter control requirements:** • Use PUC quality natural gas, propane, butane, LPG or a combination of such gases, OR • Limit fuel sulfur content to no more than 5 grains/100 scf of gas; OR • Install and operate control system that reduces SO2 emissions at least 95% by wt., or limit exhaust SO2 concentration to ≤ 9 ppmv @ 3% O_2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppm sulfur	**NOx emission limits:** Existing units (in operation prior to 9/5/08) limited to ≤1.8 billion Btu/yr • Operate and maintain stack O_2 concentrations at 3% by vol. or less for any 15-consecutive-minute averaging period, OR • Tune-in the unit twice per calendar year, OR • Comply with all applicable NOx requirements within 18 months after exceeding the annual limit (see limits below) Existing units in operation prior to 9/8/08 • 30 ppmv NOx or for natural gas-fired units 0.037 lb-NOx/MMBtu New and Replacement units: • 9 ppmv NOx for natural gas fired units • 12 ppmv NOx for natural gas-fired atmospheric units • 15 ppmv NOx for digester gas fired units • 25 ppmv NOx for landfill gas fired units • Weight average limit for multi-fuel units (e.g., units using both natural gas and digester gas, etc.); AND Note: natural gas units installed or modified prior to 9/5/08 complying with 12 ppmv NOx or less may defer compliance until units burner replacement **Particulate matter control requirements:** None
Conclusion	NOx requirements in SJVAPCD rule are equivalent to (e.g., units fired on natural gas fuel) or more stringent (e.g. digester gas or landfill gas NOx limit) than the SCAQMD rule for similarly rated units.	

*Unless otherwise stated, all ppmv values are on a dry basis and corrected to 3% stack oxygen by volume.

	SJVAPCD Rule 4307	SCAQMD Rule 1146.2
Applicability	Rule applies to any gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2.0 MMBtu/hr to ≤5.0 MMBtu/hr	Rule applies to natural gas-fired water heaters, boilers, and process heaters rated at ≤2.0 MMBtu/hr
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where the products of combustion come into direct contact with the material to be heated • Unfired or fired waste heat recovery boilers that are used to recover or augment heat from the exhaust of combustion turbines or internal combustion engines • Burning other fuel during PUC quality natural gas curtailment as long as other fuel not be burned for more than 168 hour/year plus 48 hour/year for equipment testing and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	• Units used in recreational vehicles. • Units subject to SCAQMD Rule 1121 (control of nitrogen oxides from residential type, natural gas-fired water heaters) – Rule 1121 applies to units rated at <0.075 MMBtu/hr • The provision of paragraph (c)(3), (c)(4) and (c)(5) shall not apply to: - Any residential unit* - Units with >0.4 & ≤2 MMBtu/hr, demonstrated to use less than 9,000 therms (i.e., 9 billion Btu/yr during every calendar year • Not applicable to units located at RECLAIM facilities Note: *Residential units >1 to ≤2 MMBtu/hr manufactured before 1/1/92 that does not meet 30 ppm NOx and 400 ppm CO; or residential units >1 to ≤2 MMBtu/hr more than 15 years old from date of manufacturing, manufactured on and after 1/1/92, and that does not meet 30 ppm NOx and 400 ppm CO; or residential units >0.4 to ≤1 MMBtu/hr more than 15 years old from data of manufacturing, manufactured on and after 1/1/92, and that does not meet 30 ppm NOx and 400
Requirements*	**NOx emission limits:** <u>Existing units limited to 1.8 billion Btu/yr</u> • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit twice per calendar year, OR • Operate and maintain the stack O_2 concentrations at 3% by vol. or less, OR • Certify unit to comply with 30 ppmv NOx (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units (see below). <u>Existing atmospheric units in oilfield or refinery; each glycol reboiler; or each unit with heat input > 1.8 to < 5 billion Btu/yr:</u> • 30 ppmv NOx (gaseous fuel) <u>New and Replacement units</u>: • **12 ppmv NOx (atmospheric units)** • **9 ppmv NOx (non-atmospheric units)** **Particulate matter control requirements:** • Use PUC quality natural gas, propane, butane, LPG or a combination of such gases, OR • Limit fuel sulfur content to no more than 5 grains/100 scf of gas; OR • Install and operate control system that reduces SO2 emissions at least 95% by wt., or limit exhaust SO2 concentration to ≤ 9 ppmv @ 3% O_2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppm sulfur	**NOx emission limits:** <u>Units >0.4 to ≤2 MMBtu/hr</u>: • **14 ng-NOx/J or 20 ppm NOx (On or after 1/1/2010)** <u>Units >1 to ≤2 MMBtu/hr</u>: • 30 ppmv NOx (on and after 7/1/2002 for units manufactured prior to 1/1/92, requirement is not applicable to units demonstrated to use <9 billion Btu/yr) • 30 ppmv NOx (on and after 1/1/2006 for units more than 15 year old, requirement is not applicable to units demonstrated to use <9 billion Btu/yr) **Particulate matter control requirements:** None
Conclusion	NOx requirements in SJVAPCD rule are more stringent than the SCAQMD rule for 2 MMBtu/hr boilers and process heaters.	

*Unless otherwise stated, all ppmv values are on a dry basis and corrected to 3% stack oxygen by volume.

	SJVAPCD Rule 4307	SCAQMD Rule 1109

Applicability	Rule applies to any gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2.0 MMBtu/hr to ≤5.0 MMBtu/hr	Rule applies to boilers and process heater in petroleum refineries
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where the products of combustion come into direct contact with the material to be heated • Unfired or fired waste heat recovery boilers that are used to recover or augment heat from the exhaust of combustion turbines or internal combustion engines • Burning other fuel during PUC quality natural gas curtailment as long as other fuel not be burned for more than 168 hour/year plus 48 hour/year for equipment testing and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	The requirements shall not apply to: • Boilers or process heater with maximum rated capacity ≤ 40 MMBtu/hr. • Sulfur plant reaction boilers. • Upon approval by the Executive Officer, units which are operated with a total heat input in a 12 month period of less than 10% of the maximum rated capacity for that period.
Requirements*	**NOx emission limits:** Existing units limited to 1.8 billion Btu/yr • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit twice per calendar year, OR • Operate and maintain the stack O_2 concentrations at 3% by vol. or less, OR • Certify unit to comply with 30 ppmv NOx (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units (see below). Existing atmospheric units in oilfield or refinery; each glycol reboiler; or each unit with heat input > 1.8 to < 5 billion Btu/yr: • 30 ppmv NOx (gaseous fuel) New and Replacement units: • 12 ppmv NOx (atmospheric units) • 9 ppmv NOx (non-atmospheric units) **Particulate matter control requirements:** • Use PUC quality natural gas, propane, butane, LPG or a combination of such gases, OR • Limit fuel sulfur content to no more than 5 grains/100 scf of gas; OR • Install and operate control system that reduces SO2 emissions at least 95% by wt., or limit exhaust SO2 concentration to ≤ 9 ppmv @ 3% O_2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppm sulfur	**NOx limit:** 0.03 lb-NOx/MMBtu Note that boilers or process heater with maximum rated capacity ≤ 40 MMBtu/hr would be exempt from the requirements in Rule 1109. **Particulate matter control requirements:** None
Conclusion	The unit subject to Rule 4307 would not be subject to requirements of SCAQMD Rule 1109. Therefore, no further analysis is required.	

*Unless otherwise stated, all ppmv values are on a dry basis and corrected to 3% stack oxygen by volume.

	SJVAPCD Rule 4307	SMAQMD Rule 411
Applicability	Rule applies to any gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2.0 MMBtu/hr to ≤5.0 MMBtu/hr	Applicable to boilers, steam generators, and process heaters fired on gaseous or non-gaseous fuels with a rated capacity ≥1 MMBtu/hr
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where the products of combustion come into direct contact with the material to be heated • Unfired or fired waste heat recovery boilers that are used to recover or augment heat from the exhaust of combustion turbines or internal combustion engines • Burning other fuel during PUC quality natural gas curtailment as long as other fuel not be burned for more than 168 hour/year plus 48 hour/year for equipment testing and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	• Electric utility boilers • Process heater, kilns and furnaces, where products of combustion come in direct contact with the material to be heated. • Waste heat recovery boilers. • Low fuel usage exemption (e.g., 40,000 therms/yr for 1 to <2.5 MMBtu/hr) • Standing pilot flame burners (heat input 5 MMBtu/hr or less and NOx emissions 30 ppmv or less).
Requirements*	**NOx emission limits:** Existing units limited to 1.8 billion Btu/yr • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit twice per calendar year, OR • Operate and maintain the stack O_2 concentrations at 3% by vol. or less, OR • Certify unit to comply with 30 ppmv NOx (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units (see below). Existing atmospheric units in oilfield or refinery; each glycol reboiler; or each unit with heat input > 1.8 to < 5 billion Btu/yr: • 30 ppmv NOx (gaseous fuel) New and Replacement units: • 12 ppmv NOx (atmospheric units) • 9 ppmv NOx (non-atmospheric units) **Particulate matter control requirements:** • Use PUC quality natural gas, propane, butane, LPG or a combination of such gases, OR • Limit fuel sulfur content to no more than 5 grains/100 scf of gas; OR • Install and operate control system that reduces SO2 emissions at least 95% by wt., or limit exhaust SO2 concentration to ≤ 9 ppmv @ 3% O_2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppm sulfur	**NOx emission limits** ***Gaseous fuels:*** Units ≥1 to <5 MMBtu/hr: • 30 ppm NOx (gaseous fuel) Units ≥ 5 to ≤ 20 MMBtu/hr: • 15 ppm NOx Gas fired reformer furnaces • 30 ppm NOx Units ≥5 MMBtu/hr fired on landfill gas or combination of landfill and natural gas: • 15 ppm NOx Load following units ≥5 MMBtu/hr • 15 ppm NOx ***Non-gaseous fuels:*** Units ≥1 MMBtu/hr • 40 ppmv NOx
Conclusion	NOx requirements in SJVAPCD rule are equivalent to or more stringent than the SMAQMD rule for similarly rated units.	

*Unless otherwise stated, all ppmv values are on a dry basis and corrected to 3% stack oxygen by volume.

	SJVAPCD Rule 4307	VCAPCD Rule 74.15.1
Applicability	Rule applies to any gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2.0 MMBtu/hr to ≤5.0 MMBtu/hr	Rule applies to any gaseous fuel or liquid fuel fired boiler, steam generator, or process heaters with a rated heat input capacity ≥1 MMBtu/hr and <5 MMBtu/hr
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where the products of combustion come into direct contact with the material to be heated • Unfired or fired waste heat recovery boilers that are used to recover or augment heat from the exhaust of combustion turbines or internal combustion engines • Burning other fuel during PUC quality natural gas curtailment as long as other fuel not be burned for more than 168 hour/year plus 48 hour/year for equipment testing and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	• The requirements shall not apply when a unit is operated on alternative fuel during natural gas curtailment period. Alternative fuel use shall not exceed the period of natural gas curtailment. Alternative fuel use is required to maintain the alternate fuel system, and in this case use shall not exceed 50 hours/year. • Portable oil well dewaxing process heater is not subject to 30 ppmv NOx, if annual heat input rate is less than 2.8 billion Btu.
Requirements*	**NOx emission limits:** <u>Existing units limited to 1.8 billion Btu/yr</u> • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit twice per calendar year, OR • Operate and maintain the stack O_2 concentrations at 3% by vol. or less, OR • Certify unit to comply with 30 ppmv NOx (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units (see below). <u>Existing atmospheric units in oilfield or refinery; each glycol reboiler; or each unit with heat input > 1.8 to < 5 billion Btu/yr:</u> • 30 ppmv NOx (gaseous fuel) <u>New and Replacement units</u>: • 12 ppmv NOx (atmospheric units) • 9 ppmv NOx (non-atmospheric units) **Particulate matter control requirements:** • Use PUC quality natural gas, propane, butane, LPG or a combination of such gases, OR • Limit fuel sulfur content to no more than 5 grains/100 scf of gas; OR • Install and operate control system that reduces SO2 emissions at least 95% by wt., or limit exhaust SO2 concentration to ≤ 9 ppmv @ 3% O_2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppm sulfur	**NOx emission limits** <u>Units with heat input rate ≥1.8 billion Btu/yr</u>: • 30 ppm NOx, <u>Units ≥ 1 to ≤ 2 MMBtu/hr</u>: • 20 ppm NOx, (natural gas-fired) <u>Units > 2 to < 5 MMBtu/hr</u>: • 12 ppm NOx (natural gas, atmospheric) • 9 ppm NOx (natural gas, pressurized) • 25 ppm NOx (landfill gas) • 15 ppm NOx (biogas) • 20 ppm NOx (LPG) • 15 ppm NOx (Produced oilfield gas, atmospheric) • 12 ppm NOx (Produced oilfield gas, pressurized) <u>Units ≥0.3 billion Btu/yr and <1.8 billion Btu/yr:</u> Comply with one of the following: • Units shall be tuned every 6 months or after 750 hours of operation, but in no case less than once per calendar year; OR • The unit shall comply with the emission and testing requirements **Particulate matter control requirements:** None
Conclusion	NOx requirements in SJVAPCD rule are equivalent to VCAPCD rule for similarly rated units.	

*Unless otherwise stated, all ppmv values are on a dry basis and corrected to 3% stack oxygen by volume.

Additional Emission Reduction Opportunities

The District has adopted numerous rule amendments over the years for boilers that have significantly reduced emissions from units subject to Rule 4307. Most units subject to Rule 4307 are fired on Public Utilities Commission (PUC) quality natural gas, and are inherently low-emitters of SOx and PM2.5 emissions. The following potential control techniques are evaluated to achieve further reductions:

Retrofitting with Selective Catalytic Reduction (SCR) as Potential Control
SCR technology is predominantly used to reduce NOx emissions from boilers, steam generators and process heaters. Since SCR is post-combustion control, an existing boiler can be retrofitted with this technology. In fact, two small boilers (each rated at 4.98 MMBtu/hr) in the Valley were equipped with SCR system. According to information from one of the facilities, the SCR system cost was $97,500 for the 4.98 MMBtu/hr boiler. This information is used as a basis to estimate the annualized cost for this control technique.

Description of Cost	Cost Factor	Cost	Source
Direct Costs			
Purchase equipment costs (PE)			
SCR System	A	97,500	District facility
Instrumentation and controls	0.01 A	975	OAQPS
Sales Taxes	0.08 A	7,878	
Freight	0.05 A	4,875	OAQPS
Purchased equipment cost, PEC	B = 1.14 A	111,228	
Direct installation costs (DI):			
Foundation & supports	0.08 B	8,898	OAQPS
Handling and erection	0.14 B	15,572	OAQPS
Electrical	0.04 B	4,449	OAQPS
Piping	0.02 B	2,225	OAQPS
Insulation and ductwork:	0.01 B	1,112	OAQPS
Painting	0.01 B	1,112	OAQPS
Direct installation costs	0.30 B	33,368	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC	1.30B + SP+ Bldg.	144,596	
Indirect Costs (Installation)			
Engineering	0.10 B	11,123	OAQPS
Construction and field expenses	0.05 B	5,561	OAQPS
Contractor fees	0.10 B	11,123	OAQPS
Contingencies	0.03 B	3,337	OAQPS
Start-up	0.02 B	2,225	OAQPS
Performance test	0.01 B	1,112	OAQPS
Total Indirect Costs, IC	0.31 B	34,481	
Total Capital Investments (TCI= DC + IC):	**1.61 B + SP + Bldg.**	**179,077**	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**29,136**	

Description of Cost	Cost Factor	Cost	Source
Direct Annual Costs (DAC)			
Operating and supervisory labor	--	--	See table footnote
Maintenance Costs (labor and material)	0.015 TCI	2,686	OAQPS
Reagent costs (anhydrous ammonia)		--	Not estimated
Electricity Cost:	$0.08848/kWH	--	Not estimated
Catalyst Replacement:	--	--	Catalyst is presumed to last at least over 10 years
	Total DAC:	2,686	
Indirect Annual Costs (IAC)			
Overhead:	--	--	See table footnote
Insurance:	0.01 TCI	1,791	OAQPS
Property Tax:	--	--	See table footnote
Administrative:	--	--	See table footnote
	Total IAC:	1,791	
Total Annual Cost (DAC + IAC)		4,477	
Total annual cost (Annualized TCI + Total annual cost)		**33,613**	

*Per EPA's Air Pollution Control Cost Manual (6th Edition), EPA/452/B-02-001 (1/02), operating and supervisory, overhead, administrative costs would be insignificant for an SCR system. In general, SCR does not require site preparation or additional buildings, and property taxes do not apply to capital improvements such as air pollution control equipment.

The potential NOx emission reduction for each category is determined by taking the difference between the potential emissions and the emissions that could be reliably achievable by an SCR system. SCR is expected to reliably achieve 5 ppmv NOx @ 3% O2. Each unit is presumed to be operated for 8,760 hours per year at the maximum rated capacity. The total cost for each category is determined by multiplying the number of units and $33,613 a typical annual cost of an SCR system.

Type of unit	Number of units	Potential NOx Reductions with SCR Technology (tons/yr)	Total annualized cost of NOx Reductions with SCR Technology ($/yr)	Cost effectiveness ($/ton of emission reduction)
New and replacement unit (atmospheric), 12 ppm NOx	18	2.1	605,034	**$292,924/ton**
New and replacement units (non atmospheric), 9 ppmv NOx	116	10	3,899,108	**$377,823/ton**
Existing units (gaseous fuel), 30 ppmv NOx	273	115.1	9,176,349	**$79,725/ton**
Existing units (gaseous fuel), Low-use, ≤1.8 billion Btu/yr	214	18.5	7,193,182	**$389,568/ton**
Existing units – Liquid fuel	2*	--	--	**--**
Existing units - Liquid fuel ≤5 billion Btu/yr	3**	--	--	**--**
Miscellaneous others, various NOx levels (15-27.2 ppmv NOx)	16	4.8	537,808	**$112,807/ton**

*Units are mounted on a nitrogen delivery trucks and are operated intermittently to vaporize nitrogen gas. **Three PEERs were identified originally (two PEERs were cancelled, one is in dormant is dormant non operation status). The cost-effectiveness analysis is not performed for these units.

Retrofit with Ultra low-NOx burner

A boiler, steam generator or process heater can be retrofitted with ultra-low NOx burner to reliably achieve 9 ppmv NOx @ 3% O2. Pursuant to a local vendor, the cost of an ultra-low NOx burner would be about $40,000. However, it is important to note that retrofitting an existing boiler may not always be feasible and if feasible, boiler may involve upgrades to various systems such as fuel train to comply with up to date codes, and upgrades to air intake fans, as these units require more air for the burner to operate at its optimum level. These additional items can add considerable costs to the retrofit, which are not included below.

Description of Cost	Cost Factor	Cost	Source
Direct Costs			
Purchase equipment costs (PE)			
Burner System	A	40,000	Local Vendor
Instrumentation and controls	0.01 A	300	OAQPS
Sales Taxes	0.08 A	2,424	
Freight	0.05 A	1,500	OAQPS
Purchased equipment cost, PEC		34,224	
Direct installation costs (DI):			
Foundation & supports	0.08 B	--	See footnote
Handling and erection	0.14 B	4,791	OAQPS
Electrical	0.04 B	1,369	OAQPS
Piping	0.02 B	684	OAQPS
Insulation and ductwork:	0.01 B	342	OAQPS
Painting	0.01 B	342	OAQPS
Direct installation costs		7,528	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC		51,752	
Indirect Costs (Installation)			
Engineering	0.10 B	3,422	OAQPS
Construction and field expenses	0.05 B	1,711	OAQPS
Contractor fees	0.10 B	3,422	OAQPS
Contingencies	0.03 B	1,027	OAQPS
Start-up	0.02 B	684	OAQPS
Performance test	0.01 B	342	OAQPS
Total Indirect Costs, IC	0.31 B	10,608	
Total Capital Investments (TCI= DC + IC):		**62,360**	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**10,146**	
Direct annual costs (DAC)			
Operating and supervisory labor	--	--	See table footnote
Maintenance Costs (labor and material)	--	--	
Electricity Cost:	$0.08848/kWH	--	Not estimated
Indirect Annual Costs (IAC)			
Overhead:	--	--	See table footnote
Insurance:	--	--	See table footnote

Property Tax:	--	--	See table footnote
Administrative:	--	--	See table footnote
Total IAC:			
Total Annual Cost (DAC + IAC)	--	--	
Total annual cost (annualized TCI + Total annual cost)		**10,146**	

*The existing foundation and supports will not be replaced; direct annual cost and indirect annual costs are presumed to be same as the existing burner

The potential NOx emission reduction for each category is determined by taking the difference between the potential emissions and the emissions that could be reliably achievable by an ultra-low NOx burner system. Ultra low-NOx burner is expected to reliably achieve 9 ppmv NOx @ 3% O2. Each unit is presumed to be operated for 8,760 hours per year at the maximum rated capacity. The total cost for each category is determined by multiplying the number of units and $8,519 a typical annual cost of an ultra-low NOx burner system.

Type of unit	Number of units	Potential NOx Reductions with ultra-low NOx burner Technology (tons/yr)	Total annualized cost of NOx Reductions with SCR Technology ($/yr)	Cost effectiveness ($/ton of emission reduction)
New and replacement unit (atmospheric), 12 ppm NOx	18	0.9	153,342	**$172,585/ton**
New and replacement units (non atmospheric), 9 ppmv NOx	116	Not needed, units are already equipped with 9 ppmv burner		
Existing units (gaseous fuel), 30 ppmv NOx	273	97.1	2,769,858	**$28,525/ton**
Existing units (gaseous fuel), Low-use, ≤1.8 billion Btu/yr	214	17.5	1,823,066	**$104,000/ton**
Existing units – Liquid fuel	2*	See Footnote below		
Existing units - Liquid fuel ≤5 billion Btu/yr	3**	See Footnote below		
Miscellaneous others, various NOx levels (15-27.2 ppmv NOx)	16	3.3	136,304	**$40,822/ton**

*Units are mounted on a nitrogen delivery truck and are operated intermittently to vaporize nitrogen gas. **Three PEERs were identified originally (two PEERs were cancelled, one is in dormant is dormant non operation status). The cost-effectiveness analysis is not performed for these units.

Replacing an older unit

Replacement of an older boiler in many cases may be the only way to reduce NOx emissions. The new units can reliably achieve 9 ppmv NOx @ 3% O2. The cost of these units depend on the heat input rate, use of unit (steam, hot water, etc.), control system, heat recovery systems (economizer etc.). Per local vendor, cost of a steam boiler rated at 5.0 MMBtu/hr (300 psi) with gas train, control system and economizer would be $122,000. Note that 94% of the unit are greater than 2.0 MMBtu/hr; therefore, it is reasonable to use this cost data for cost effectiveness analysis.

Description of Cost	Cost Factor	Cost	Source
Direct Costs			
Purchase equipment costs (PE)			
Burner System	A	122,000	Local Vendor
Instrumentation and controls	--	--	Included in the above price
Sales Taxes	0.08 A	9,760	
Freight	0.05 A	6,100	OAQPS
Purchased equipment cost, PEC		137,860	
Direct installation costs (DI):			
Foundation & supports	0.08 B	11,029	See footnote
Handling and erection	0.14 B	19,300	OAQPS
Electrical	0.04 B	5,514	OAQPS
Piping	0.02 B	2,757	OAQPS
Insulation and ductwork:	0.01 B	1,379	OAQPS
Painting	0.01 B	1,379	OAQPS
Direct installation costs		41,358	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC		179,218	
Indirect Costs (Installation)			
Engineering	0.10 B	13,786	OAQPS
Construction and field expenses	0.05 B	6,893	OAQPS
Contractor fees	0.10 B	13,786	OAQPS
Contingencies	0.03 B	4,136	OAQPS
Start-up	0.02 B	2,757	OAQPS
Performance test	0.01 B	1,379	OAQPS
Total Indirect Costs, IC	0.31 B	42,737	
Total Capital Investments (TCI= DC + IC):		**221,955**	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**36,112**	
Direct annual costs (DAC)			
Operating and supervisory labor	--	--	See table footnote
Maintenance Costs (labor and material)	--	--	
Electricity Cost:	$0.08848/kWH	--	Not estimated
Indirect Annual Costs (IAC)			
Overhead:	--	--	See table footnote
Insurance:	--	--	See table footnote
Property Tax:	--	--	See table footnote
Administrative:	--	--	See table footnote
Total IAC:			
Total Annual Cost (DAC + IAC)	--	--	
Total annual cost (annualized TCI + Total annual cost)		**36,112**	

*Direct annual cost and indirect annual costs are presumed to be same as the existing unit

The potential NOx emission reduction for each category is determined by taking the difference between the potential emissions and the emissions that could be reliably achievable by the use of a new unit equipped with ultra-low NOx burner system. Ultra low-NOx burner is expected to reliably achieve 9 ppmv NOx @ 3% O2. Each unit is presumed to be operated for 8,760 hours per year at the maximum rated capacity. The total cost for each category is determined by multiplying the number of units and $36,112 a typical annual cost of a unit with an ultra-low NOx burner system.

Type of unit	Number of units	Potential NOx Reductions with new unit equipped with ultra-low NOx burner Technology (tons/yr)	Total annualized cost of NOx Reductions with new unit equipped with ultra-low NOx burner Technology ($/yr)	Cost effectiveness ($/ton of emission reduction)
New and replacement unit (atmospheric), 12 ppm NOx	18	0.9	650,034	**$731,588/ton**
New and replacement units (non atmospheric), 9 ppmv NOx	116	Not needed, units are already equipped with 9 ppmv burner		
Existing units (gaseous fuel), 30 ppmv NOx	273	125.1	9,858,576	**78,776/ton**
Existing units (gaseous fuel), Low-use, ≤1.8 billion Btu/yr	214	17.5	7,727,968	**$440,855/ton**
Existing units – Liquid fuel	2*	--	--	**--**
Existing units - Liquid fuel ≤5 billion Btu/yr	3**	--	--	**--**
Miscellaneous others, various NOx levels (15-27.2 ppmv NOx)	16	3.3	577,792	**$175,088/ton**

*Units are mounted on a nitrogen delivery truck and are operated intermittently to vaporize nitrogen gas. **Three PEERs were identified originally (two PEERs were cancelled, one is in dormant is dormant non operation status). The cost-effectiveness analysis is not performed for these units.

EMx as Potential Control

The District researched post-combustion controls such as EMx, the second generation of the SCONOx technology that reduces NOx, SOx, CO, and volatile organic compound (VOC) emissions. Per EmeraChem, manufacturer/vendor of the technology, this technology has not been achieved in practice (AIP) for natural gas fired boilers. SCONOx and EMx systems have only been utilized by power plants for the control of turbine emissions. The cost of EMx system would be anywhere from 3 to 5 million or even up to 8 million in some cases for large power plant installations. Moreover, EMx system is ideal for new installation, and become extremely challenging and sometimes nearly impossible to retrofit an existing unit. In fact, cost effectiveness analyses conducted by the District for the installation of SCONOx/EMx units on large power plant turbine installations within the Valley have shown that this technology is not cost effective. Given the high cost effectiveness demonstrated for turbines and lack of demonstrated practice with boilers, this technology is not feasible or cost effective for reducing emissions from this category.

PM2.5 Limits for Alternative Fuels

The majority of boilers (2-5 MMBtu/hr) in the Valley combust PUC-quality natural gas; PUC natural gas contains a very low sulfur content and inherently has low emissions. Few boilers in the Valley use alternative fuels for their combustion processes. Alternative fuels include digester gas, produced gas, and liquid fuel. Units fired on digester gas or produced gas are already required to use inlet gas scrubbers to meet District rule requirements. Current rule language requires that on and after July 1, 2015 liquid fuel shall be used only during a PUC quality natural gas curtailment period provided it contains no more than 15 ppm sulfur. While the currently limited use of liquid fuel became even more strictly limited, the feasibility of reducing PM emissions through adding PM2.5 limits for units using liquid fuel is explored as part of the District's comprehensive control measure evaluation.

There are 19 permitted units in the Valley (2-5 MMBtu/hr) that are capable to burn diesel fuel; 17 of the 19 units were installed at healthcare and correctional facilities, 2 units were installed on a nitrogen gas delivery trucks. The units at healthcare and correctional facilities are primarily operated on natural gas, but they're required to have diesel as backup fuel, in case there is interruption in natural gas supply. The total potential emissions from these units while operating on diesel fuel are 0.233 tons/year (0.000061 tons per day) of total PM.

The following three technologies were evaluated as potential control options for reducing PM emissions: baghouses, electrostatic precipitators (ESPs), and wet scrubbers. Baghouses control total PM and PM2.5 emissions by 90-99%; ESPs control total PM and PM2.5 emissions by 90-99%; and wet scrubbers control large particulates (>PM5) by 99% and PM2.5 emissions by approximately 50%.[28] However, baghouses are typically not used with liquid-fired boilers due to the potential clogging of the baghouse and are therefore not a recommended technology due to infeasibility and safety issues.[29]

PM Potential Emissions Reductions for an ESP and Scrubber

For the purposes of these calculations, the following assumptions were made:

1. For simplicity, the analysis will evaluate the cost effectiveness of these technologies for total PM reductions from liquid fuel fired units.

[28] Northeast States for Coordinated Air Use Management. (November 2008) *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.* Retrieved from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB8QFjAA&url=http%3A%2F%2Fwww.nescaum.org%2Fdocuments%2Fici-boilers-20081118-final.pdf%2F&ei=7nfvVIivFai1sAT07IHIAg&usg=AFQjCNFBdQn7MVAibSTZIbHV7-ojXkVlXQ&bvm=bv.86956481,d.cWc.

[29] Northeast States for Coordinated Air Use Management. (November 2008) *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.* Retrieved from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB8QFjAA&url=http%3A%2F%2Fwww.nescaum.org%2Fdocuments%2Fici-boilers-20081118-final.pdf%2F&ei=7nfvVIivFai1sAT07IHIAg&usg=AFQjCNFBdQn7MVAibSTZIbHV7-ojXkVlXQ&bvm=bv.86956481,d.cWc.

2. The PM control efficiency of an ESP is 99%.
3. The PM control efficiency of a scrubber is 99%.

Potential Emissions Reductions $_{(ESP)}$ = (Total PM Emissions) x (Control Efficiency)
Potential Emissions Reductions $_{(ESP)}$ = 0.233 tons/year x 0.99
Potential Emissions Reductions $_{(ESP)}$ = 0.231 tons/ year (tpy)

Potential Emissions Reductions $_{(scrubber)}$ = (Total PM Emissions) x (Control Efficiency)
Potential Emissions Reductions $_{(scrubber)}$ = 0. 233 tons/year x 0.99
Potential Emissions Reductions $_{(scrubber)}$ = 0.231 tons/ year (tpy)

<u>Annualized Cost of an ESP and Wet Scrubber</u>
The capital cost for the installation of an ESP for a 1-5 MMBtu/hr boiler ranges from \$90,000 - \$100,000 and the annual maintenance cost is \$1,000-\$2,000.[30] For the wet scrubber system, EPA estimated the annualized cost at \$5,300-\$102,000 per sm^3/sec at an average air flow rate of 0.7- 47 sm^3/sec.[31] The following assumptions were made for this cost effectiveness analysis:

1. The capital cost of an ESP is assumed to be the median of the range above (\$95,000).
2. The annual maintenance cost of an ESP is assumed to be the median of the range above (\$1,500).
3. The annualized cost of a wet scrubber system is assumed to be the median of the range above (\$53,650 per sm^3/sec).
4. The average air flow rate for a wet scrubber system is assumed to be the median of the range above (23.85 sm^3/sec).
5. The total capital and maintenance cost of an ESP will be calculated by multiplying the cost of 1 unit by the total number of units.
6. The total annualized cost of a wet scrubber will be calculated by multiplying the annualized cost of 1 unit by the total number of units.
7. Lifetime of the ESP is 10 years at 10% interest. To account for this, the annualized capital cost will be calculated by multiplying the total capital cost by the capital recovery factor of 0.1627 and adding the annual maintenance costs.

Annual Cost $_{(ESP)}$ = (Total Capital Cost) x (0.1627) + (Annual Maintenance Cost)
Annual Cost $_{(ESP)}$ = (\$95,000 x 19) x (0.1627) + (\$1,500 x 19)
Annual Cost $_{(ESP)}$ = \$322,174/year

Annual Cost $_{(scrubber)}$ = (Annualized Cost of 1 unit) x (Number of Units) x (Average Flow Rate)
Annual Cost $_{(scrubber)}$ = (\$53,650/ sm^3/sec) x (19) x (23.85 sm^3/sec)
Annual Cost $_{(scrubber)}$ = \$24,311,498/ year

[30] Catherine Roberts. (March 2009) *Information on Air Pollution Control Technology for Woody Biomass Boilers.* Environmental Protection Agency Office of Air Quality Planning and Standards and Northeast States for Coordinated Air Use Management.
[31] EPA. (2002). *Air Pollution Control Technology Fact Sheet: Spray-Chamber/Spray-Tower Wet Scrubber.* Retrieved from http://www.epa.gov/ttncatc1/dir1/fsprytwr.pdf.

Cost Effectiveness of an ESP and Wet Scrubber

Cost Effectiveness = Annual Cost / Annual Emissions Reductions

Cost Effectiveness $_{(ESP)}$ = ($322,174/year) / (0.231 tons/ year)
Cost Effectiveness $_{(ESP)}$ = $1,394,693/ton of PM

Cost Effectiveness $_{(scrubber)}$ = ($24,311,498/year) / (0.231 tons/ year)
Cost Effectiveness $_{(scrubber)}$ = $105,244,580/ton of PM

As illustrated above, neither PM control technology is a cost effective option for this source category. The cost of the ESP technology does not include costs of retrofitting equipment and/or the facility or compliance monitoring costs, which would drive the cost effectiveness up even more.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for Boilers, Steam Generators, and Process Heaters in the 2.0 MMBtu/hr to 5.0 MMBtu/hr size range. As demonstrated above, Rule 4307 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

C.9 Rule 4308 (Emissions from Small Boilers, Steam Generators, and Process Heaters- 0.075 MMBtu/hr to less than 2.0 MMBtu/hr)

Discussion

The purpose of this rule is to limit oxides of nitrogen (NOx) and carbon monoxide (CO) emissions from units within this source category. As a point of sale rule, Rule 4308 achieves emissions reductions as units subject to the rule are replaced over time. This point-of-sale approach allows the District to achieve NOx emission reductions without forcing immediate replacement of existing units to comply with rule requirements and thus placing an undo financial burden on the consumer. This rule has resulted in more than 93% control of emissions from this source category.

Rule 4308 was adopted on October 20, 2005 to establish NOx emissions limits for these units which were previously exempt from District regulations because of their small size. The rule was amended in December 2009 to lower the NOx emissions limits to 20 ppmv for units fired on natural gas, with the exception of instantaneous water heaters and pool heaters greater than or equal to 0.075 MMBtu/hr but less than or equal to 0.4 MMBtu/hr. In 2013, the rule was amended to lower the NOx emission limit for instantaneous water heaters 0.075 MMBtu/hr to 0.4 MMBtu/hr to 20 ppmv. EPA published a direct final approval the 2013 amendments to Rule 4308 on February 12, 2015.[32]

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.59	0.56	0.53	0.52	0.52	0.50	0.49	0.48	0.47
NOx	0.86	0.73	0.67	0.64	0.62	0.58	0.56	0.54	0.52
	Winter Average - Tons per day								
PM2.5	0.58	0.55	0.53	0.52	0.51	0.49	0.48	0.47	0.47
NOx	0.84	0.71	0.65	0.63	0.61	0.57	0.55	0.53	0.51

Source Category

This source category includes any person who supplies, sells, offers for sale, installs, or solicits the installation of any boiler, steam generator, process heater or water heater with a rated heat input capacity greater than or equal to 0.075 MMBtu/hr and less than 2.0 MMBtu/hr. Units subject to Rule 4308 (Boilers, Steam Generators and Process Heaters – 0.75 MMBtu/hr to less than 2.0 MMBtu/hr) are used in a wide variety of settings including, but not limited to, apartment buildings, large homes, small businesses, commercial buildings, manufacturing facilities, government facilities, restaurants, hotels, hospitals, educational institutions, and religious organizations. Affected persons include water heater manufacturers, plumbing wholesalers, supply stores, plumbers, contractors, and end-users.

[32] 80 FR 7803-7805

HOW DOES DISTRICT RULE 4308 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations
There are no EPA CTG, NSPS, NESHAP, or MACT requirements for boilers, steam generators, and process heaters of such small size.

Alternative Control Techniques (ACT)

ACTs address potential emission control techniques for units with the potential to emit more than 25 tons of NOx per year. No units covered by District Rule 4308 have the potential to emit 25 tons per year and therefor ACTs are not directly applicable to this source category. However, ACTs do discuss various control technologies, and so the District has examined them, as follows:

- EPA – 453/R-93-034 (Alternative Control Techniques Document—NOx Emissions from Process Heaters)

The District evaluated the ACT for NOx Emissions from Process Heaters and found no applicable control requirements. As such, Rule 4308 is more stringent.

- EPA – 453/R-94-022 (Alternative Control Techniques Document—NOx Emissions from Industrial/Commercial/ Institutional Boilers)

The District evaluated the ACT for NOx Emissions from Industrial/Commercial/Institutional Boilers and found no applicable control techniques that were more stringent than those already in Rule 4308.

- EPA – 453/R-94-023 (Alternative Control Techniques Document—NOx Emissions from Utility Boilers)

The District evaluated the ACT for NOx Emissions from Utility Boilers and found no applicable control techniques that were more stringent than those already in Rule 4308.

State Regulations
There are no state regulations that apply to this source category.

HOW DOES DISTRICT RULE 4308 COMPARE TO RULES IN OTHER AIR DISTRICTS?

South Coast AQMD
- SCAQMD Rule 1146.2 Emissions of Oxides of Nitrogen From Large Water Heaters and Small Boilers and Process Heaters *(Last Amended May 5, 2006)*

SCAQMD Rule 1146.2 regulates NOx emissions from large water heaters and small boilers and process heaters. The District compared the emission limits in District Rule 4308 with SCAQMD Rule 1146.2 (see Table 4) and concluded that NOx limits in the

SJVAPCD rule are equivalent to the NOx limits in the SCAQMD rule for similarly rated units.

	SJVAPCD Rule 4308	SCAQMD 1146.2
Applicability	Applicable to boilers, steam generators and process heaters with rated heat input capacity of ≥0.075 MMBtu/hr and <2 MMBtu/hr	Applicable to natural gas-fired water heaters, boilers and process heaters with rated heat input capacity of ≤2 MMBtu/hr
Exemptions	• Units installed in manufactured homes. • Units installed in recreational vehicles. • Hot water pressure washers.	• Units used in recreational vehicles. • Units subject to SCAQMD Rule 1121 (control of nitrogen oxides from residential type, natural gas-fired water heaters) – Rule 1121 applies to units rated at <0.075 MMBtu/hr • The provision of paragraph (c)(3), (c)(4) and (c)(5) shall not apply to: - Any residential unit* - Units with >0.4 & ≤2 MMBtu/hr, demonstrated to use less than 9,000 therms during every calendar year • Not applicable to units located at RECLAIM facilities Note: *Residential units >1 to ≤2 MMBtu/hr manufactured before 1/1/92 that does not meet 30 ppm NOx and; or residential units >1 to ≤2 MMBtu/hr more than 15 years old from date of manufacturing, manufactured on and after 1/1/92, and that does not meet 30 ppm NOx and 400 ppm CO; or residential units >0.4 to ≤1 MMBtu/hr more than 15 years old from data of manufacturing, manufactured on and after 1/1/92, and that does not meet 30 ppm NOx.
Requirements*	1. Units ≥0.075 to ≤0.4 MMBtu/hr (except, instantaneous water heater and pool heaters below): • PUC gas - 20 ppmv NOx (0.024 lb/MMBtu); • Non-PUC or liquid – 77 ppmv NOx (0.093 lb/MMBtu) 2. Units >0.4 to <2.0 MMBtu/hr (except, instantaneous water heater and pool heaters below): • PUC gas – 20 ppmv NOx (0.024 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu) 3. Instantaneous water heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 4. Instantaneous water heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 5. Pool heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas – 55 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 6. Pool heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu)	Units ≥0.4 to ≤2 MMBtu/hr: • 14 ng-NOx/J of heat output or 20 ppmv NOx (or less) Units (excluding pool heaters) ≤0.4 MMBtu/hr: • 14 ng-NOx/J of heat output or 20 ppmv NOx (or less)

Bay Area AQMD

- BAAQMD Regulation 9, Rule 6 Nitrogen Oxide Emissions From Natural Gas-Fired Boilers and Water Heaters *(Last Amended November 7, 2007)*

BAAQMD Regulation 9 Rule 6 regulates NOx and CO emissions from natural gas fired boilers and water heaters. The District compared the emission limits in District Rule 4308 and BAAQMD's Regulation 9 Rule 6 (see Table 1) and concluded that NOx emission limits in SJVAPCD rule are equivalent to the BAAQMD rule limits for similarly rated units.

	SJVAPCD Rule 4308	BAAQMD Reg 9 Rule 6
Applicability	Applicable to boilers, steam generators and process heaters with rated heat input capacity of ≥0.075 MMBtu/hr and <2 MMBtu/hr	Rule applies to natural gas fired water heaters and boilers, and limits only NOx emissions
Exemptions	• Units installed in manufactured homes. • Units installed in recreational vehicles. • Hot water pressure washers.	• Natural gas-fired boilers and water heaters rated at > 2 MMBtu/hr • Natural gas-fired water heaters used in recreational vehicles. • Water heaters using a fuel other than natural gas. • Natural gas-fired pool/spa heater with <0.4 MMBtu/hr used exclusively to heat swimming pools, hot tubs or spas
Requirements*	1. Units ≥0.075 to ≤0.4 MMBtu/hr (except, instantaneous water heater and pool heaters below): • PUC gas - 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 2. Units >0.4 to <2.0 MMBtu/hr (except, instantaneous water heater and pool heaters below): • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu) 3. Instantaneous water heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 4. Instantaneous water heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 5. Pool heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas – 55 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 6. Pool heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu)	Natural gas-fired storage tank water heaters ≤0.075 MMBtu/hr: • 40 ng-NOx/J of heat output for units manufactured after July 1, 1992 • 10 ng-NOx/J* of heat output for 50 gal or less units manufactured after Jan 1, 2009; • 10 ng-NOx/J* of heat output for > 50 gal units manufactured after Jan 1, 2010; • 10 ng-NOx/J** of heat output for units manufactured after Jan 1, 2011; Notes: *The limit shall not apply to direct-vent, power-vent, power direct-vent water storage tanks heater and water heaters used for mobile homes. **This limit dos not apply to water heater used for mobile homes. Natural gas-fired boilers and water heaters >0.075 MMBtu/hr to ≤2 MMBtu/hr: • 40 ng-NOx/J of heat output for units >0.075 MMBtu/hr to 0.4 MMBtu/hr manufactured after Jan 1, 2008 • 14 ng-NOx/J of heat output for units >0.075 MMBtu/hr to 0.4 MMBtu/hr manufactured after Jan 1, 2013 • 20 ng-NOx/J of heat output or 30 ppm NOx for units >0.4 MMBtu/hr to 2 MMBtu/hr manufactured after Jan 1, 2008 • 14 ng-NOx/J of heat output or 20 ppm NOx for units >0.4 MMBtu/hr to 2 MMBtu/hr manufactured after Jan 1, 2013 Natural gas-fired mobile home water heaters: • 40 ng-NOx/J of heat output for units manufactured after Jan 1, 2008 Natural gas-fired pool/spa heaters: • 40 ng-NOx/J of heat output or 55 ppmv for units >0.4 MMBtu/hr to 2.0 MMBtu/hr manufactured after Jan 1, 2008 • 14 ng-NOx/J of heat output or 20 ppmv for units >0.4 MMBtu/hr to 2.0 MMBtu/hr manufactured after Jan 1, 2013

- BAAQMD Regulation 9, Rule 7 Nitrogen Oxides and Carbon Monoxide From Industrial, Institutional and Commercial Boilers, Steam Generators and Process Heaters *(Last Amended May 4, 2011)*

BAAQMD Regulation 9 Rule 7 regulates NOx and CO emissions from industrial and commercial boilers, steam generators and process heaters. The District compared the emission limits in District Rule 4308 and BAAQMD's Regulation 9 Rule 7 (see Table 2) and concluded NOx emission limits in SJVAPCD rule are equivalent to the BAAQMD rule limits for similarly rated units.

	SJVAPCD Rule 4308	BAAQMD Reg 9 Rule 7
Applicability	Applicable to boilers, steam generators and process heaters with rated heat input capacity of ≥0.075 MMBtu/hr and <2 MMBtu/hr	Rule applies to any industrial, institutional and commercial boilers, steam generator and process.
Exemptions	• Units installed in manufactured homes. • Units installed in recreational vehicles. • Hot water pressure washers.	• Units ≤ 2MMBtu/hr if fired exclusively on natural gas, LPG, or any combination thereof • Units <1MMBtu/hr with any fuel • Units used in petroleum refineries • Boilers used by public electric utilities or qualifying small power production facilities • Waste heat recovery boilers used to recover sensible heat from the exhaust of combustion turbines or reciprocating internal combustion engines • Kilns, ovens, and furnaces used for drying, baking, heat treating, cooking, calcining or vitrifying • Process heater used to heat thermal fluid for radiant comfort heating

	SJVAPCD Rule 4308	BAAQMD Reg 9 Rule 7
Requirements*	1. Units ≥0.075 to ≤0.4 MMBtu/hr (except, instantaneous water heater and pool heaters below): • PUC gas - 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 2. Units >0.4 to <2.0 MMBtu/hr (except, instantaneous water heater and pool heaters below): • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu) 3. Instantaneous water heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 4. Instantaneous water heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 5. Pool heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas – 55 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 6. Pool heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu)	Landfill or digester gas fired units ≥1 MMBtu/hr: • 30 ppm NOx Non-gaseous fuel fired units ≥1 MMBtu/hr: • 40 ppm NOx Multiple fuel fired units ≥1 MMBtu/hr: • Heat input weighted average limit for NOx Note that requirements for units with heat input rate > 2 MMBtu/hr are not listed, as these requirements are irrelevant for the purpose of Rule 4308, which applies to units with heat input rate of ≥0.075 MMBtu/hr and <2 MMBtu/hr

- BAAQMD Regulation 9, Rule 10 Nitrogen Oxides and Carbon Monoxide From Boilers, Steam Generators and Process Heaters in Petroleum Refineries *(Last Amended October 16, 2013)*

BAAQMD Regulation 9 Rule 10 regulates NOx and CO emissions from boilers, steam generators and process heaters in petroleum refineries. The District compared the remission limits in District Rule 4308 to the requirements contained within BAAQMD's Regulation 9 Rule 10 (see Table 3) and found that NOx requirements in SJVAPCD rule are on an emission-unit by emission-unit basis, whereas the emission limits in BAAQMD rule is on a refinery-wide basis, and therefore cannot be compared.

	SJVAPCD Rule 4308	BAAQMD Reg 9 Rule 10
Applicability	Applicable to boilers, steam generators and process heaters with rated heat input capacity of ≥0.075 MMBtu/hr and <2 MMBtu/hr	Rule applies to boilers, steam generator and process heaters, in petroleum refineries
Exemptions	• Units installed in manufactured homes. • Units installed in recreational vehicles. • Hot water pressure washers.	• Units < 2MMBtu/hr if fired exclusively on natural gas, LPG, or any combination thereof • Units <1MMBtu/hr with any fuel • Waste heat recovery boilers used to recover sensible heat from the exhaust of combustion turbines or reciprocating internal combustion engines

		• Waste heat recovery boilers recovering sensible heat from exhaust of combustion turbines or reciprocating IC engines • Units processing H_2S process flue gas in sulfur recovery plants and their tail-gas treating units, or sulfuric acid manufacturing plants • Units on non-gaseous fuel when natural gas is unavailable for use • Units including CO boilers that receive ATC subject to BACT for NOx on or after 1/5/1994.
Requirements*	1. Units ≥0.075 to ≤0.4 MMBtu/hr (except, instantaneous water heater and pool heaters below): • PUC gas - 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 2. Units >0.4 to <2.0 MMBtu/hr (except, instantaneous water heater and pool heaters below): • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu) 3. Instantaneous water heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 4. Instantaneous water heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 5. Pool heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas – 55 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 6. Pool heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu)	Small unit(<10 MMBtu/hr) requirements: Meet at least one of the following: • Operate in a manner that maintains stack O_2≤3% by vol. on dry basis; OR • Tune at least once every 12 months, or within 2 weeks of unit startup if not operated in the last 12 months; OR • Meet applicable limits - 0.033 lb-NOx/MMBtu; 0.2 lb-NOx/MMBtu for CO boilers Refinery-wide* NOx limit: 0.033 lb-NOx/MMBtu of heat input, based on an operating day average Federal refinery-wide NOx limit • 0.20 lb-NOx/MMBtu based on an operating day average (except CO boilers), except during startup, shutdown or curtailed operation Final NOx limit for CO boilers • 150 ppm NOx except during startup and shutdown for non-partial-burn CO boiler • 125 ppmv NOx except during startup and shutdown for partial-burn CO boiler *Refinery-wide limit is defined as the ratio of the total mass of discharge into the atmosphere of nitrogen oxides, in pounds, to the sum of the actual heat input, in million BTU, calculated over a twenty-four (24) hour operating day.

Sac Metro AQMD

- SMAQMD Rule 411 NOx From Boilers, Process Heaters, and Steam Generators *(Last Amended August 23, 2007)*

SMAQMD Rule 411 regulates NOx and CO emissions from boilers, process heaters and steam generators. The District compared the emission limits in District Rule 4308 with SMAQMD Rule 411 (see Table 5) and concluded that NOx emission limits in SJVAPCD rule are more stringent than the NOx limits in SMAQMD rule for similar rated units.

	SJVAPCD Rule 4308	SMAQMD Rule 411
Applicability	Applicable to boilers, steam generators and process heaters with rated heat input capacity of ≥0.075 MMBtu/hr and <2 MMBtu/hr	Applicable to boilers, steam generators, and process heaters fired on gaseous or non-gaseous fuels with a rated capacity ≥1 MMBtu/hr
Exemptions	• Units installed in manufactured homes. • Units installed in recreational vehicles. • Hot water pressure washers.	• Electric utility boilers • Process heater, kilns and furnaces, where products of combustion come in direct contact with the material to be heated. • Waste heat recovery boilers. • Low fuel usage exemption (e.g., 40,000 therms/yr for 1 to <2.5 MMBtu/hr) • Standing pilot flame burners (heat input 5 MMBtu/hr or less and NOx emissions 30 ppmv or less).
Requirements*	1. Units ≥0.075 to ≤0.4 MMBtu/hr (except, instantaneous water heater and pool heaters below): • PUC gas - 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 2. Units >0.4 to <2.0 MMBtu/hr (except, instantaneous water heater and pool heaters below): • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu) 3. Instantaneous water heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 4. Instantaneous water heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 5. Pool heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas – 55 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 6. Pool heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu)	**Gaseous fuels:** Units ≥1 to <5 MMBtu/hr: • 30 ppm NOx **Non-gaseous fuels:** Units ≥1 MMBtu/hr • 40 ppmv NOx

- SMAQMD Rule 414 Water Heaters, Boilers and Process Heaters Rated Less than 1 MMBtu/hr *(Last Amended March 25, 2010)*

SMAQMD Rule 414 regulates NOx and CO emissions from boilers, process heaters and steam generators. The District compared the emission limits in District Rule 4308 with SMAQMD Rule 414 (see Table 6) and concluded that for gaseous fuels, NOx emission limits in SJVAPCD rule are equivalent to the NOx limits in SMAQMD rule for similar rated units.

	SJVAPCD Rule 4308	SMAQMD Rule 414
Applicability	Applicable to boilers, steam generators and process heaters with rated heat input capacity of ≥0.075 MMBtu/hr and <2 MMBtu/hr	Applicable to boilers, steam generators, and process heaters fired on gaseous or non-gaseous fuels with a rated capacity of <1 MMBtu/hr
Exemptions	• Units installed in manufactured homes. • Units installed in recreational vehicles. • Hot water pressure washers.	• Water heaters in recreational vehicles • Pool/spa heater with a heat input rate <0.075 MMBtu/hr. • Water heaters, boilers and process heater fired on LPG fuel.
Requirements*	1. Units ≥0.075 to ≤0.4 MMBtu/hr (except, instantaneous water heater and pool heaters below): • PUC gas - 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 2. Units >0.4 to <2.0 MMBtu/hr (except, instantaneous water heater and pool heaters below): • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu) 3. Instantaneous water heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 4. Instantaneous water heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 5. Pool heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas – 55 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 6. Pool heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu)	Units <0.075 MMBtu/hr: • 40 ng/J of heat output or 55 ppm NOx for mobile home units • 10 ng/J of heat output or 15 ppm NOx for all other units Units ≥ 0.075 to <0.4 MMBtu/hr: • 40 ng/J of heat output or 55 ppm NOx for pool/spa units • 14 ng/J of heat output or 20 ppm NOx for all other units Units ≥ 0.4 to <1 MMBtu/hr: • 14 ng/J of heat output or 20 ppm NOx

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- VCAPCD Rule 74.11.1 – Large Water Heaters and Small Boilers *(Last Amended September 11, 2012)*

VCAPCD Rule 74.11.1 regulates NOx and CO emissions from boilers, steam generators, and process heaters. The District compared the emission limits in District Rule 4308 with VCAPCD (see Table 7) and concluded that NOx emission limits in SJVAPCD rule are equivalent to the NOx limits in VCAPCD rule for similar rated units.

	SJVAPCD Rule 4308	VCAPCD Rule 74.11.1
Applicability	Applicable to boilers, steam generators and process heaters with rated heat input capacity of ≥0.075 MMBtu/hr and <2 MMBtu/hr	Applicable to natural gas-fired water heater, boiler, steam generator or process heater with a rated heat input capacity ≥0.075 BTU/hr and < 1 MMBtu/hr

	SJVAPCD Rule 4308	VCAPCD Rule 74.11.1
Exemptions	• Units installed in manufactured homes. • Units installed in recreational vehicles. • Hot water pressure washers.	• None
Requirements*	1. Units ≥0.075 to ≤0.4 MMBtu/hr (except, instantaneous water heater and pool heaters below): • PUC gas - 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 2. Units >0.4 to <2.0 MMBtu/hr (except, instantaneous water heater and pool heaters below): • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu) 3. Instantaneous water heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 4. Instantaneous water heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 5. Pool heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas – 55 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 6. Pool heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu)	Units ≥ 0.075 to ≤0.4 MMBtu/hr: • 40 ng/J of heat output (93 lb/billion Btu), or 55 ppm NOx for units designed to heat swimming pools, hot tubs or spas. • 14 ng/J of heat output or 20 ppm NOx for all other units Units > 0.4 to <1 MMBtu/hr: • 14 ng/J of heat output or 20 ppm NOx for all units

- VCAPCD Rule 74.15.1 – Boilers, Steam Generators, and Process Heaters *(Last Amended June 23, 2015)*

VCAPCD Rule 74.15.1 regulates NOx and CO emissions from boilers, steam generators, and process heaters. The District compared the emission limits in District Rule 4308 with VCAPCD (see Table 8) and concluded that the NOx emission limits in SJVAPCD rule are equivalent to the NOx limits in VCAPCD rule for similar rated units.

	SJVAPCD Rule 4308	VCAPCD Rule 74.15.1
Applicability	Applicable to boilers, steam generators and process heaters with rated heat input capacity of ≥0.075 MMBtu/hr and <2 MMBtu/hr	Rule applies to any gaseous fuel or liquid fuel fired boiler, steam generator, or process heaters with a rated heat input capacity ≥1 MMBtu/hr and <5 MMBtu/hr
Exemptions	• Units installed in manufactured homes. • Units installed in recreational vehicles. • Hot water pressure washers.	• The requirements shall not apply when a unit is operated on alternative fuel during natural gas curtailment period. Alternative fuel use shall not exceed the period of natural gas curtailment. Alternative fuel use is required to maintain the alternate fuel system, and in this case use shall not exceed 50 hours/year.

	SJVAPCD Rule 4308	VCAPCD Rule 74.15.1
		• Portable oil well dewaxing process heater is not subject to 30 ppmv NOx, if annual heat input rate is less than 2.8 billion Btu.
Requirements*	1. Units ≥0.075 to ≤0.4 MMBtu/hr (except, instantaneous water heater and pool heaters below): • PUC gas - 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 2. Units >0.4 to <2.0 MMBtu/hr (except, instantaneous water heater and pool heaters below): • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu) 3. Instantaneous water heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 4. Instantaneous water heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 5. Pool heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas – 55 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 6. Pool heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu)	Units with heat input rate ≥1.8 billion Btu/yr: • 30 ppm NOx Units ≥ 1 to ≤ 2 MMBtu/hr: • 20 ppm NOx (natural gas-fired) Units ≥0.3 billion Btu/yr and <1.8 billion Btu/yr: Comply with one of the following: • Units shall be tuned every 6 months or after 750 hours of operation, but in no case less than once per calendar year; OR • The unit shall comply with the emission and testing requirements

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

Use of a Selective Catalytic Reduction system

SCR is a post combustion technology. Presuming units between 0.075 to <2 MMBtu/hr can be equipped with SCR system. The total annualized cost of deploying such technology would be at least $33,613 per year[33].

Assuming an SCR system reliably reduces NOx emissions from 20 ppmv @ 3% O_2 to 5 ppmv @ 3% O_2 for a 1.99 MMBtu/hr unit that operates 8,760 hours per year, the potential reductions would be 310 lb/year[34] (0.155 tons-NOx/yr).

The cost of achieving these potential NOx reductions would be at least $216,858/ton of emissions reduced. As such, this technology is not cost effective for reducing emissions from this category.

[33] See Rule 4307 draft control measure analysis. Note that there is no significant price difference for an SCR system on 2-5 MMBtu/hr unit or smaller units.
[34]Potential NOx reduction = (0.024 – 0.0062) lb-NOx/MMBtu x 1.99 MMBtu/hr x 8,760 hr/yr = 310 lb-NOx/yr

Use of ultra-low NOx burner technology
Ultra low NOx burners can reliably achieve at least 9 ppmv NOx @ 3% O_2 and are available for units rated between 2-5 MMBtu/hr. Presuming that this technology is also available for small size boilers for a given application, a unit may be equipped with an ultra-low NOx burner system. Per local vendor, cost of a 2 MMBtu/hr boiler would be $35,000 for hot water boiler. The cost effectiveness analysis is included below for this technology.

Description of Cost	Cost Factor	Cost	Source
Direct Costs			
Purchase equipment costs (PE)			
Burner System	A	35,000	Local Vendor
Instrumentation and controls	0.01 A	350	OAQPS
Sales Taxes	0.08 A	2,828	
Freight	0.05 A	1,750	OAQPS
Purchased equipment cost, PEC		39,928	
Direct installation costs (DI):			
Foundation & supports	0.08 B	3,194	See footnote
Handling and erection	0.14 B	5,590	OAQPS
Electrical	0.04 B	1,597	OAQPS
Piping	0.02 B	799	OAQPS
Insulation and ductwork:	0.01 B	399	OAQPS
Painting	0.01 B	399	OAQPS
Direct installation costs		51,906	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC		51,906	

Description of Cost	Cost Factor	Cost	Source
Indirect Costs (Installation)			
Engineering	0.10 B	3,993	OAQPS
Construction and field expenses	0.05 B	1,996	OAQPS
Contractor fees	0.10 B	3,993	OAQPS
Contingencies	0.03 B	1,198	OAQPS
Start-up	0.02 B	799	OAQPS
Performance test	0.01 B	399	OAQPS
Total Indirect Costs, IC	0.31 B	12,378	
Total Capital Investments (TCI= DC + IC):		**64,284**	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**10,459**	
Direct annual costs (DAC)			
Operating and supervisory labor	--	--	See table footnote
Maintenance Costs (labor and material)	--	--	
Electricity Cost:	$0.08848/kWH	--	Not estimated
Indirect Annual Costs (IAC)			
Overhead:	--	--	See table footnote
Insurance:	--	--	See table footnote
Property Tax:	--	--	See table footnote
Administrative:	--	--	See table footnote

Description of Cost	Cost Factor	Cost	Source
Total IAC:			
Total Annual Cost (DAC + IAC)	--	--	
Total annual cost (annualized TCI + Total annual cost)		**10,459**	

*Direct annual cost and indirect annual costs are presumed insignificant for new units and will likely be same when existing unit is being replaced

Assuming an ultra-low NOx burner system reliably reduces NOx emissions from 20 ppmv @ 3% O_2 to 9 ppmv @ 3% O_2 for a 1.99 MMBtu/hr unit that operates 8,760 hours per year, the potential reductions would be 227 lb/year[35] (0.114 tons-NOx/yr).

The cost of achieving these potential NOx reductions would be at least $91,746/ton of emissions reduced. As such, this technology is not cost effective for reducing emissions from this category.

EMx as Potential Control

The District researched post-combustion controls such as EMx, the second generation of the SCONOx technology that reduces NOx, SOx, CO, and volatile organic compound (VOC) emissions. Per EmeraChem, manufacturer/vendor of the technology, this technology has not been achieved in practice (AIP) for natural gas fired boilers. SCONOx and EMx systems have only been utilized by power plants for the control of turbine emissions. The cost of EMx system would be anywhere from 3 to 5 million or even up to 8 million in some cases for large power plant installations. Moreover, the EMx system is ideal for new installation, and become extremely challenging and sometimes nearly impossible to retrofit an existing unit. In fact, cost effectiveness analyses conducted by the District for the installation of SCONOx/EMx units on large power plant turbine installations within the Valley have shown that this technology is not cost effective. Given the high cost effectiveness demonstrated for turbines and lack of demonstrated practice with boilers, especially very small boilers such as those covered by this rule, this technology is not feasible or cost effective for reducing emissions from this category.

PM2.5 Limits for Alternative Fuels

The majority of units 0.075 to less than 2 MMBtu/hr in the Valley combust PUC-quality natural gas; PUC natural gas contains a very low sulfur content and inherently has low emissions. Few boilers in the Valley use alternative fuels for their combustion processes. Alternative fuels include digester gas, produced gas, and liquid fuel. Units fired on digester gas or produced gas are already required to use inlet gas scrubbers to meet District rule requirements. The feasibility of reducing PM emissions through adding PM2.5 limits for units using liquid fuel is explored as part of the District's comprehensive control measure evaluation.

The following three technologies were evaluated as potential control options for reducing PM emissions: baghouses, electrostatic precipitators (ESPs), and wet scrubbers. Baghouses control total PM and PM2.5 emissions by 90-99%; ESPs control

[35] Potential NOx reduction = (0.024 – 0.011) lb-NOx/MMBtu x 1.99 MMBtu/hr x 8,760 hr/yr = 227 lb-NOx/yr

total PM and PM2.5 emissions by 90-99%; and wet scrubbers control large particulates (>PM5) by 99% and PM2.5 emissions by approximately 50%.[36] However, baghouses are typically not used with liquid-fired boilers due to the potential clogging of the baghouse and are therefore not a recommended technology due to infeasibility and safety issues.[37] Furthermore, the District is unaware of installations of these types of controls on the small boilers covered by this regulation, generally due to the extraordinary cost associated with doing so. See below for cost and cost-effectiveness calculations.

PM Potential Emissions Reductions for an ESP and Scrubber

For the purposes of these calculations, the following assumptions were made:

4. For simplicity, the analysis will evaluate the cost effectiveness of these technologies for total PM reductions from liquid fuel fired units.
5. The PM combustion EF = 0.024 lb/MMBtu, based on maximum permitted EF for boilers 2-5 MMBtu/hr with option to use diesel fuel during natural gas curtailment.
6. Max rating of burner = 1.99 MMBtu/hr and assumed to operate 8,760 hours/yr.
7. The PM control efficiency of an ESP is 99%.
8. The PM control efficiency of a scrubber is 99%.
9. Due to lack of units in the Valley, the analysis is based on one known unit.

Potential Emissions Reductions $_{(ESP)}$ = (PM Emissions) x (Control Efficiency)
Potential Emissions Reductions $_{(ESP)}$ = (0.024 lb-PM/MMBtu x 1.99 MMBtu/yr
x 8,760 hr/yr x ton/2,000 lb) tons/year X 0.99
Potential Emissions Reductions $_{(ESP)}$ = 0.209 tons/yr x 0.99

Potential Emissions Reductions $_{(ESP)}$ = 0.207 tons/ year (tpy)

Potential Emissions Reductions $_{(scrubber)}$ = (PM Emissions) x (Control Efficiency)
Potential Emissions Reductions $_{(scrubber)}$ = 0.209 tons/year x 0.99
Potential Emissions Reductions $_{(scrubber)}$ = 0.207tons/ year (tpy)

Annualized Cost of an ESP and Wet Scrubber

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[36] Northeast States for Coordinated Air Use Management. (November 2008) *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.* Retrieved from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB8QFjAA&url=http%3A%2F%2Fwww.nescaum.org%2Fdocuments%2Fici-boilers-20081118-final.pdf%2F&ei=7nfvVIivFai1sAT07IHIAg&usg=AFQjCNFBdQn7MVAibSTZIbHV7-ojXkVlXQ&bvm=bv.86956481,d.cWc.

[37] Northeast States for Coordinated Air Use Management. (November 2008) *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.* Retrieved from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB8QFjAA&url=http%3A%2F%2Fwww.nescaum.org%2Fdocuments%2Fici-boilers-20081118-final.pdf%2F&ei=7nfvVIivFai1sAT07IHIAg&usg=AFQjCNFBdQn7MVAibSTZIbHV7-ojXkVlXQ&bvm=bv.86956481,d.cWc.

The capital cost for the installation of an ESP for a 1-5 MMBtu/hr boiler ranges from \$90,000 - \$100,000 and the annual maintenance cost is \$1,000-\$2,000.[38] For the wet scrubber system, EPA estimated the annualized cost at \$5,300-\$102,000 per sm^3/sec at an average air flow rate of 0.7- 47 sm^3/sec.[39] The following assumptions were made for this cost effectiveness analysis:

8. The capital cost of an ESP is assumed to be the median of the range above (\$95,000).
9. The annual maintenance cost of an ESP is assumed to be the median of the range above (\$1,500).
10. The annualized cost of a wet scrubber system is assumed to be the median of the range above (\$53,650 per sm^3/sec).
11. The average air flow rate for a wet scrubber system is assumed to be the median of the range above (23.85 sm^3/sec).
12. The total capital and maintenance cost of an ESP will be calculated by multiplying the cost of 1 unit by the total number of units.
13. The total annualized cost of a wet scrubber will be calculated by multiplying the annualized cost of 1 unit by the total number of units.
14. Lifetime of the ESP is 10 years at 10% interest. To account for this, the annualized capital cost will be calculated by multiplying the total capital cost by the capital recovery factor of 0.1627 and adding the annual maintenance costs.

Annual Cost $_{(ESP)}$ = (Total Capital Cost) x (0.1627) + (Annual Maintenance Cost)
Annual Cost $_{(ESP)}$ = (\$95,000 x 1) x (0.1627) + (\$1,500 x 1)
Annual Cost $_{(ESP)}$ = \$16,957/year

Annual Cost $_{(scrubber)}$ = (Annualized Cost of 1 unit) x (Number of Units) x (Average Flow Rate)
Annual Cost $_{(scrubber)}$ = (\$53,650/ sm^3/sec) x (1) x (23.85 sm^3/sec)
Annual Cost $_{(scrubber)}$ = \$1,279,553/ year

<u>**Cost Effectiveness of an ESP and Wet Scrubber**</u>

Cost Effectiveness = Annual Cost / Annual Emissions Reductions

Cost Effectiveness $_{(ESP)}$ = (\$16,957/year) / (0.207 tons/ year)
Cost Effectiveness $_{(ESP)}$ = \$81,918/ton of PM

Cost Effectiveness $_{(scrubber)}$ = (\$1,279,553/year) / (0.207 tons/ year)
Cost Effectiveness $_{(scrubber)}$ = \$6,181,413/ton of PM

[38] Catherine Roberts. (March 2009) *Information on Air Pollution Control Technology for Woody Biomass Boilers.* Environmental Protection Agency Office of Air Quality Planning and Standards and Northeast States for Coordinated Air Use Management.
[39] EPA. (2002). *Air Pollution Control Technology Fact Sheet: Spray-Chamber/Spray-Tower Wet Scrubber.* Retrieved from http://www.epa.gov/ttncatc1/dir1/fsprytwr.pdf.

As illustrated above, neither PM control technology is a cost effective option for this source category. The cost of the ESP technology does not include costs of retrofitting equipment and/or the facility or compliance monitoring costs, which would increase the cost even more.

Mobile Home Exemption

The District evaluated the possibility of removing the exemption for water heaters used in mobile homes because multiple air districts do not exempt these sources in their analogous rules. However, because those air districts have different rule structures with regards to the size of devices regulated, District Rule 4308 requirements are as stringent as the other districts' rules.

For example, SCAQMD Rule 1146.2 does not regulate mobile home water heaters, per the definition for type 1 units, because they are subject to Rule 1121 (Control of Nitrogen Oxides from Residential Type, Natural Gas-Fired Water Heaters). SCAQMD Rule 1121 regulates units less than 0.075 MMBtu/hr, which is out of the size range of District Rule 4308. Similarly, in SMAQMD Rule 414, mobile home units are regulated in the size range of units less than 0.075 MMBtu/hr. District Rule 4902 (Residential Water Heaters) applies to units less than 0.075 MMBtu/hr and currently regulates mobile home water heaters with the same emission limit contained in SCAQMD and SMAQMD rules. BAAQMD Rule Regulation 9 Rule 6 regulates all units less than 2 MMBtu/hr, essentially combining the requirements of District Rules 4308 and 4902.

In addition, after researching the size of mobile home water heaters, it was found that mobile home water heaters are not available in the 0.075-2.0 MMBtu/hr size range. Four mobile home retailers and three mobile home manufacturers were contacted to inquire about the size of mobile home water heaters. All seven contacts stated that the average size of a mobile home water heater is 30-40 gallons, whereas a 0.075 MMBtu/hr water heater is approximately 80 gallons. One manufacturer and one retailer stated that 50 gallon mobile home water heaters are available but rarely used. If the exemption for mobile home water heaters in Rule 4308 were to be removed, it would not result in any additional emissions reductions since such units are not available and do not exist in this size range.

Recreational Vehicle Exemption

The District evaluated the potential opportunity to remove the exemption for recreational vehicles (RVs). Stakeholder input indicates that there are very few units in RVs that fall under the size category subject to this rule. Most units in RVs are 12 gallons, which is significantly smaller than the 80 gallon size of a typical 0.075 MMBtu/hr unit.[40] Also, RV units are typically not used on a frequent basis and thus are small contributors to the NOx emissions of this source category. Other air districts, such as SCAQMD and BAAQMD, include this exemption in their rules. Removing this exemption would result in little to no emissions reductions because of the lack of units within this size range and the intermittent use of units in RVs.

[40] SJVAPCD. (2009). *Final Staff Report for Amendments to Rule 4308 (Boilers, Steam Generators, and Process Heaters—0.075 MMBtu/hr to less than 2.0 MMBtu/hr)*.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for the small boilers addressed by this rule. As demonstrated above, Rule 4308 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

C.10 Rule 4309 (Emissions from Dryers, Dehydrators, and Ovens)

Discussion

Rule 4309 (Dryers, Dehydrators, and Ovens) was adopted on December 15, 2005 to limit nitrogen oxides (NOx) and carbon monoxide (CO) emissions from dryers, dehydrators, or ovens fired on gaseous, liquid, or gaseous and liquid fuel sequentially that have a total rated heat input for the unit of 5.0 MMBtu/hr. The rule limits NOx emissions to between 3.5-12 ppmvd for four categories of equipment. The adoption of Rule 4309 has considerably reduced NOx and PM emissions from this source category, reducing the emissions inventory for NOx from dryers, dehydrators, and ovens from 1.93 tpd in 2005 to 0.22 tpd in 2016. Although this source category had a relatively small emissions inventory prior to the adoption of Rule 4309, stakeholders have installed control equipment and modified their operations considerably to reduce emissions to ultra-low levels. Given the significant effort and technology investments already made to reduce emissions from this source category, there are little remaining opportunities for obtaining additional emissions reductions.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.87	0.95	1.02	1.04	1.06	1.09	1.11	1.13	1.15
NOx	0.20	0.22	0.24	0.25	0.25	0.26	0.26	0.27	0.27
	Winter Average - Tons per day								
PM2.5	0.82	0.89	0.96	0.98	0.99	1.03	1.05	1.07	1.09
NOx	0.18	0.20	0.21	0.22	0.22	0.23	0.23	0.24	0.24

Source Category

This source category includes any dryer, dehydrator, or oven that is fired on gaseous fuel, liquid fuel, or is fired on gaseous and liquid fuel sequentially, and the total rated heat input for the unit is 5.0 million British thermal units per hour (MMBtu/hr) or greater. There are currently 120 units subject to this rule, ranging in size from 5.0 MMBtu/hr to 200 MMBtu/hr. Dryers, dehydrators, and ovens are utilized in a broad range of industries and can be grouped as: dehydrators; asphalt and concrete plants; milk, cheese, and dairy processing; and other processes. Dryers, dehydrators, and ovens are operated either seasonally or year-round depending on the industry type and the unit's purpose within the process.

How does District Rule 4309 compare with federal and state rules and regulations?

Federal Regulations

There are no EPA CTG, NSPS, NESHAP, or MACT requirements applicable for this source category.

Alternative Control Techniques (ACT)

EPA – 453/R-94-004 (Alternative Control Techniques Document–NOx Emissions from Cement Manufacturing)

The District evaluated the requirements contained within the ACT for NOx Emissions from Cement Manufacturing and found no applicable requirements that would be more stringent than those already in Rule 4309.

State Regulations
There are no state regulations applicable to this source category.

HOW DOES DISTRICT RULE 4309 COMPARE TO RULES IN OTHER AIR DISTRICTS?
There are no analogous rules for this source category in the BAAQMD

SCAQMD

- South Coast AQMD Rule 1147 (NOx Reductions from Miscellaneous Sources) *(last amended July 7, 2017)*

SCAQMD Rule 1147 establishes emission limits based on the process temperature, whereas District Rule 4309 does not consider the process temperature and instead establishes emissions limits based on the equipment categories. Where the rules can be compared, the District rule is more stringent in several categories, such as liquid fueled units, high temperature applications, evaporators, fryers, etc. In other categories, the NOx limits under the SCAQMD rule vary from 3.3 to 6.5 ppmv at 19% O2 with an average of 4.9 ppmv, while District Rule 4309 limits NOx emissions from 3.5 to 5.3 ppmv with most categories limited to 4.3 ppmv at 19% O2, independent of the process temperature. Therefore, overall, District Rule 4309 is as stringent as SCAQMD Rule 1147.

	SJVAPCD Rule 4309 (12/15/2005)	SCAQMD Rule 1147 (7/7/2017)
Applicability	Rule applies to any dryer, dehydrator, or oven that is fired on gaseous fuel, liquid fuel, or is fired on gaseous and liquid fuel sequentially, and the total rated heat input for the unit is 5.0 MMBtu/hr or greater.	Rule applies to manufacturers, distributors, retailers, installers, owners, and operators of ovens, dryers, dehydrators, heaters, kilns, calciners, furnaces, crematories, incinerators, heated pots, cookers, roasters, fryers, closed and open heated tanks and evaporators, distillation units, afterburners, degassing units, vapor incinerators, catalytic or thermal oxidizers, soil and water remediation units and other combustion equipment with nitrogen oxide emissions that require a District permit and are not specifically required to comply with a nitrogen oxide emission limit by other District Regulation XI rules. This rule does not apply to solid fuel-fired combustion equipment, internal combustion engines, turbines, food ovens, charbroilers, boilers, water heaters, thermal fluid heaters, enclosed process heaters and other combustion equipment subject to nitrogen oxide limits of other District Regulation XI rules.
Exemptions		
Rule 4309 Exemption Categories:	Sections of the Rule	
Column-type or tower dryers used to dry grains, or tree nuts.	Section 4.1.1	No such exemptions stated in the rule.

	SJVAPCD Rule 4309 (12/15/2005)	SCAQMD Rule 1147 (7/7/2017)			
Units to pre-condition onions or garlic prior to dehydration	Section 4.1.2				
Smokehouses or units used for roasting	Section 4.1.3				
Units used to dry lint cotton or cotton at cotton gins	Section 4.1.6				
Units to bake or fry food for human consumption	Section 4.1.4	SC Rule 1147 Exempts existing fryers installed and operated within specified dates as stated in Section (g)(6). New fryers installed after January 1, 2014 are subject to Table 1 emission limit of 60 ppmvd @3% O2 (or 6.5 ppmvd @ 19% O2). In-use food ovens, including ovens, dryers, smokers, and dry roasters, are exempt from Rule 1147 but subject to Rule 1153.1 with the following limits: Units operating ≤ 500° F, 40 ppmvd, (4.3 ppmvd @ 19% O2), or 0.042 lb/MMBtu Units operating > 500° F, 60 ppmvd, (6.5 ppmvd @ 19% O2), or 0.073 lb/MMBtu			
Charbroilers	Section 4.1.5 – Exempt from rule	Section (g)(2) - Exempt from rule			
Requirements					
Rule 4309 Equipment Categories:					
Gaseous Fuel-Fired Equipment	No process temperature	**Process Temperature**	≤ 800° F	> 800° F and < 1200°F	≥ 1200 ° F
Dehydrators	-	Oven, Dehydrator, Dryer, Heater, Kiln, Calciner, Cooker, Roaster, Furnace, or Heated Storage Tank	30 ppmvd (3.3 ppmvd @ 19% O2) or 0.036 lb/MMBtu (not specific to dehydrators)		60 ppmvd (6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu (not specific to dehydrators)
Asphalt/Concrete Plants	4.3 ppmvd @ 19 %O2	Asphalt Manufacturing Operation	40 ppmvd (4.3 ppmvd @ 19% O2)		No requirement
Milk, Cheese and Dairy Processing (<20 MMBtu/hr)	3.5 ppmvd @ 19% O2 (equates to 0.04 lb/MMBtu)	No such category			
Milk, Cheese and Dairy Processing (≥20 MMBtu/hr)	5.3 ppmvd @ 19% O2 (equates to 0.061 lb/MMBtu)				
Other processes not described above	4.3 ppmvd @ 19% O2 (equates to 0.049 lb/MMBtu)	Afterburner, Degassing Unit, Remediation Unit, Thermal Oxidizer, Catalytic Oxidizer or Vapor Incinerator[1]	60 ppmvd (6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu		
		Burn-off Furnace, Burnout Oven, Incinerator or Crematory with or without Integrated Afterburner			
		Evaporator, Fryer, Heated Process Tank, or Parts Washer	60 ppmvd (6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu		No requirement

	SJVAPCD Rule 4309 (12/15/2005)	SCAQMD Rule 1147 (7/7/2017)		
		Metal Heat Treating, Metal Melting Furnace, Metal Pot, or Tar Pot	60 ppmvd (6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu	
		Oven, Dehydrator, Dryer, Heater, Kiln, Crematory, Incinerator, Calciner, Cooker, Roaster, Furnace, or Heated Storage Tank	30 ppmvd (3.3 ppmvd @ 19% O2) or 0.036 lb/MMBtu	60 ppmvd (6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu
		Make-Up Air Heater or other Air Heater located outside of building with temperature controlled zone inside building	30 ppmvd (3.3 ppmvd @ 19% O2) or 0.036 lb/MMBtu	No requirement
		Tenter Frame or Fabric or Carpet Dryer	30 ppmvd (3.3 ppmvd @ 19% O2) or 0.036 lb/MMBtu	No requirement
		Other Unit or Process Temperature	30 ppmvd (3.3 ppmvd @ 19% O2) or 0.036 lb/MMBtu	60 ppmvd (6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu
Liquid Fuel-Fired Equipment		≤ 800° F	>800° F and <1200° F	≥ 1200 ° F
All liquid fuel-fired Units	Varies from 3.5 ppmvd @ 19% O2 to 12 ppmvd @ 19% O2	40 ppmvd (4.3 ppmvd @ 19% O2) or 0.053 lb/MMBtu		60 ppmvd (6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu

1. Emission limit applies to burners in units fueled by 100% natural gas that are used to incinerate air toxics, VOCs, or other vapors; or to heat a unit. The emission limit applies solely when burning 100% fuel and not when the burner is incinerating air toxics, VOCs, or other vapors. The unit shall be tested or certified to meet the emission limit while fueled with natural gas.

SMAQMD

- SMAQMD Rule 419 (NOx from Miscellaneous Combustion Units) *(Adopted July 26, 2018)*

SMAQMD Rule 419 only applies to miscellaneous combustion units located at Major Stationary Sources of NOx. Currently the District has 30 permitted dehydrators, with 60% of these units (18 units) located at non major source of NOx that would not be subject to SM Rule 419. For other units subject to District rule 4309, there are 90 permitted units with 70 located at non-Major Sources of NOx that would not be subject to SM Rule 419.

For units located at major sources of NOx, SM Rule 419 establishes emission limits based on the process temperature and does not consider the equipment categories, whereas District Rule 4309 does not consider the process temperature and instead establishes emissions limits based on the equipment categories. Under SMAQMD's Rule 419, the NOx limits vary from 3.3 to 6.5 ppmv at 19% O2 with an average of 4.9

ppmv, while District Rule 4309 limits NOx emissions from 3.5 to 5.3 ppmv with most categories limited to 4.3 ppmv at 19% O2, independent of the process temperature.

In conclusion, the vast the majority of the permitted units in the San Joaquin Valley subject to District rule 4309 are located at non-Major Sources of NOx would be exempt from NOx limits under SM Rule 419. Units located at Major Sources of NOx in the Valley are subject to District Rule 4309 NOx limits which are equivalent to those NOx limits under SM rule 419. Therefore, overall, District Rule 4309 is as stringent as SMAQMD Rule 419.

	SJVAPCD Rule 4309 (12/15/2005)	SMAQMD Rule 419 (7/26/2018)	
Applicability	Rule applies to dryer, dehydrator, or oven that is fired on gaseous fuel, liquid fuel, or is fired on gaseous and liquid fuel sequentially, and the total rated heat input for the unit is 5.0 MMBtu/hr or greater.	This rule applies to any miscellaneous combustion unit with a total rated heat input capacity of 2 million Btu per hour or greater located at a major stationary source of NOx.	
Exemptions			
Rule 4309 Exemption Categories:	**Sections of the Rule**		
Column-type or tower dryers used to dry grains, or tree nuts.	Section 4.1.1	No such exemption stated in the rule.	
Units to pre-condition onions or garlic prior to dehydration	Section 4.1.2		
Charbroilers	Section 4.1.5		
Units used to dry lint cotton or cotton at cotton gins	Section 4.1.6		
Smokehouses or units used for roasting	Section 4.1.3	Smokehouses are not listed among exempt categories. Whereas, rule exempts roasters.	
Units to bake or fry food for human consumption	Section 4.1.4	Section 114.4 exempts cooking units which are used for food preparation for human consumption.	
Requirements			
Rule 4309 Equipment Categories:			
	No process temperature	Process Temperature	
Gaseous Fuel-Fired Equipment		< 1200° F	≥ 1200° F
Dehydrators	-	For units located at a major stationary source of NOx 30 ppmvd (equates to 3.3 ppmvd @ 19% O2) or 0.036 lb/MMBtu	For units located at a major stationary source of NOx 60 ppmvd (equates to 6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu
Asphalt/Concrete Plants	4.3 ppmvd @ 19% O2 (equates to 0.0492 lb/MMBtu)		
Milk, Cheese and Dairy Processing (<20 MMBtu/hr)	3.5 ppmvd @ 19% O2 (equates to 0.04 lb/MMBtu)		
Milk, Cheese and Dairy Processing (≥20 MMBtu/hr)	5.3 ppmvd @ 19% O2 (equates to 0.061 lb/MMBtu)		
Other processes not described above	4.3 ppmvd @ 19% O2 equates to 0.0492 lb/MMBtu		
Liquid Fuel-Fired Equipment			
All liquid fuel-fired Units	Varies from 3.5 ppmvd @ 19% O2 to 12 ppmvd @ 19% O2	For units located at a major stationary source of NOx 40 ppmvd (equates to 4.3 ppmvd @ 19% O2) or 0.053 lb/MMBtu	For units located at a major stationary source of NOx 60 ppmvd (equates to 6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu

VCAPCD

- VCAPCD Rule 74.34 (NOx Reductions from Miscellaneous Sources) (Adopted December 13, 2016)

VCAPCD Rule 74.34 establishes emission limits based on the process temperature whereas District Rule 4309 does not consider the process temperature and instead establishes emissions limits based on the equipment categories. Where the rules can be compared, the District rule is more stringent in several categories, such as metal heat treatment, metal melting furnace, kiln, etc. In other categories, the NOx limits under the VCAPCD rule vary from 3.3 to 6.5 ppmv at 19% O2 with an average of 4.9 ppmv, while District Rule 4309 limits NOx emissions from 3.5 to 5.3 ppmv with most categories limited to 4.3 ppmv at 19% O2, independent of the process temperature. Therefore, overall, District Rule 4309 is as stringent as VCAPCD Rule 74.34.

<table>
<tr><th></th><th>SJVAPCD Rule 4309 (12/15/2005)</th><th colspan="2">VCAPCD Rule 74.34 (12/13/2016)</th></tr>
<tr><td>Applicability</td><td>Rule applies to dryer, dehydrator, or oven that is fired on gaseous fuel, liquid fuel, or is fired on gaseous and liquid fuel sequentially, and the total rated heat input for the unit is 5.0 MMBtu/hr or greater.</td><td colspan="2">This rule applies to dryers, furnaces, heaters, incinerators, kilns, ovens, and duct burners. This rule applies to any unit where the total rated heat input for the unit is 5 million BTU per hour or greater.</td></tr>
<tr><td>Exemptions</td><td></td><td colspan="2"></td></tr>
<tr><td>Rule 4309 Exemption Categories:</td><td>Sections of the Rule</td><td colspan="2"></td></tr>
<tr><td>Column-type or tower dryers used to dry grains, or tree nuts.</td><td>Section 4.1.1</td><td colspan="2" rowspan="6">No such exemption stated in the rule.</td></tr>
<tr><td>Units to pre-condition onions or garlic prior to dehydration</td><td>Section 4.1.2</td></tr>
<tr><td>Smokehouses or units used for roasting</td><td>Section 4.1.3</td></tr>
<tr><td>Units to bake or fry food for human consumption</td><td>Section 4.1.4</td></tr>
<tr><td>Charbroilers</td><td>Section 4.1.5</td></tr>
<tr><td>Units used to dry lint cotton or cotton at cotton gins</td><td>Section 4.1.6</td></tr>
<tr><td>Requirements</td><td></td><td colspan="2"></td></tr>
<tr><td>Rule 4309 Equipment Categories:</td><td></td><td colspan="2"></td></tr>
<tr><td>Dehydrators</td><td>-</td><td colspan="2">Dehydrators are not subject to this rule as they are not listed under applicability of the rule.</td></tr>
<tr><td>Asphalt/Concrete Plants</td><td>4.3 ppmvd @ 19% O2 (equates to 0.0492 lb/MMBtu)</td><td colspan="2">40 ppmvd (equates to 4.3 ppmvd @ 19% O2) or 0.048 lb/MMBtu</td></tr>
<tr><td>Milk, Cheese and Dairy Processing (<20 MMBtu/hr)</td><td>3.5 ppmvd @ 19% O2 (equates to 0.04 lb/MMBtu)</td><td colspan="2" rowspan="2">Equipment not listed, so it would be subject to emission limits of other processes (the last category listed below)</td></tr>
<tr><td>Milk, Cheese and Dairy Processing (≥20 MMBtu/hr)</td><td>5.3 ppmvd @ 19% O2 (equates to 0.061 lb/MMBtu)</td></tr>
<tr><td rowspan="2">Other processes not described above</td><td rowspan="2">4.3 ppmvd @ 19% O2 equates to 0.0492 lb/MMBtu</td><td>Sand and Gravel Processing (dryers)</td><td rowspan="2">40 ppmvd (equates to 4.3 ppmvd @ 19% O2) or 0.048 lb/MMBtu</td></tr>
<tr><td>Paper Products Manufacturing (Hot Air Furnace, Duct Burner, Paper Dryer)</td></tr>
</table>

		Metal Heat Treatment/Metal Melting Furnace	60 ppmvd (equates to 6.5 ppmvd @ 19% O2) or 0.072 lb/MMBtu	
		Kiln	80 ppmvd (equates to 8.7 ppmvd @ 19% O2) or 0.096 lb/MMBtu	
			Process Temperature	
			< 1200° F	≥ 1200° F
		Oven, Dryer (besides asphalt, sand or paper dryer), Heater, Incinerator, Other Furnaces, or Other Duct Burner (Not listed above in Table 1)	30 ppmvd (equates to 3.3 ppmvd @ 19% O2) or 0.036 lb/MMBtu	60 ppmvd (equates to 6.5 ppmvd @ 19% O2) or 0.072 lb/MMBtu

Additional Emission Reduction Opportunities

Asphalt Plants

PUC-quality natural gas fuel is the lowest emitting fuel for asphalt plants, and is generally required for new facilities in the District, BAAQMD, and SCAQMD, where natural gas is available. There are currently ten asphalt plants in the Valley that do not utilize PUC-quality natural gas because these facilities are physically too far removed from natural gas lines to use natural gas. Eight of these asphalt plants use LPG fuel or propane to comply with the same gaseous fuel fired limit as PUC-quality natural gas-fired facilities. The other two facilities utilize fuel oil #2; however, none of the facilities operate full time and their combined actual NOx emissions are 0.006 tons per day, an insignificant contributor to the inventory.

Dehydrators

Dehydrators in the Valley are used to process a very large variety of products such as onions, garlic, tomatoes, various fruits and vegetable. There are very specific operational and technical limitations associated with dehydrator operations depending on the type of product processed. More specifically, the District has determined that requiring low-NO_X burners is not feasible for vegetable dehydration operations due to product quality issues. For instance, low NOx burners inherently emit higher CO which causes dried garlic and onion to turn pink, negatively affecting product quality/value. The District will continue to evaluate the feasibility and cost-effectiveness of low-NOx burners for potential additional emission reduction opportunities.

Evaluation Findings

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for dryers, dehydrators, and ovens. As demonstrated above, Rule 4309 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM and MSM requirements for this source category.

C.11 Rule 4311 (Emissions from Flares)

Discussion

Rule 4311 was adopted in June 2002 to reduce VOC, NOx, and SOx emissions from operations involving the use of flares. Amendments were adopted on June 15, 2006 and June 18, 2009. The June 2009 amendment incorporated requirements for flare minimization plans and increased the stringency of existing requirements for sulfur emissions. In addition to Rule 4311 requirements, any new flare is subject to New Source Review (NSR) requirements (District Rule 2201) including Best Available Control Technology (BACT) requirements which would require implementation of even more stringent controls regardless of Rule 4311 requirements when applicable.

In 2017, flaring activities in the Valley emitted 0.57 tpd of NOx emissions and 0.16 tpd of PM2.5, representing 0.27% of the winter average NOx emissions and 0.28% of the winter average PM2.5 emissions in the Valley. Despite this relatively small amount of emissions, in keeping with its leave-no-stone-unturned approach, the District has invested significant resources into evaluating potential emissions reductions opportunities from flares.

The District committed to continue evaluating flares through a further study measure in the District's *2012 PM2.5 Plan* and *2013 Plan for the Revoked 1-Hour Ozone Standard*. The District completed and published the *Rule 4311 (Flares) Further Study* report on September 16, 2014 (*2014 Study*).[41] In that study, District staff reviewed the submitted Flare Minimization Plans, Annual Monitoring Report data, Reportable Flaring Event data, and new NSPS requirements to identify and evaluate potential opportunities to further reduce emissions from flaring. In addition to the review committed in the plans, the District also reviewed the flare emission inventory in the Valley and analogous rules in other air districts in California. In the *2014 Study*, the District concluded that operators of flares in the Valley were subject to the most stringent emission requirements and were proactively implementing alternatives and committing to activities that reduce flaring. Based on that conclusion, the District recommended no rulemaking action for Rule 4311 at that time.

On April 16, 2015, the District's Governing Board adopted the *2015 Plan for the 1997 PM2.5 Standard* (*2015 PM2.5 Plan*)[42]. As demonstrated in the District's *2015 PM2.5 Plan*, Rule 4311 already meets the Environmental Protection Agency's (EPA) Best Available Control Measures (BACM) and Most Stringent Measure (MSM) requirements. In fact, EPA approved Rule 4311 as satisfying all applicable federal requirements on November 3, 2011.[43] However, due to the need to demonstrate attainment for multiple federal ozone and PM2.5 standards in the coming years and the need to search for all available emissions reductions, the District committed to undertaking a comprehensive review of FMPs submitted under Rule 4311, publish a draft report for public review and commenting

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[41] SJVAPCD. (2014) *Rule 4311 (Flares) Further Study 2014*. Retrieved from http://www.valleyair.org/Air_Quality_Plans/docs/R4311.pdf.

[42] SJVAPCD. (2015). *2015 Plan for the 1997 PM2.5 Standard*. Retrieved from http://www.valleyair.org/Air_Quality_Plans/PM25Plans2015.htm

[43] EPA. 76 Federal Register 213, 68106-68107. 11/3/2011. http://www.gpo.gov/fdsys/pkg/FR-2011-11-03/pdf/2011-28391.pdf

on December 1, 2015, and finalize the report on March 31, 2016 after receiving input from flare operators and addressing public comments. That comprehensive study resulted in the following findings and recommendations:

1. **The District identified minimization practices currently performed at facilities that have the potential to be applied to other facilities.**

   a. **The District recommends conducting a thorough evaluation of the most effective flare minimization practices included in approved FMPs and requiring the implementation of these practices where technologically achievable and economically feasible**.

      Even though operators of flares in the Valley have already taken extensive measures to reduce flaring, through this study the District has identified effective minimization practices currently performed at some facilities that could be employed at other facilities to further reduce flaring. To further evaluate opportunities for emission reductions from flaring, the District will commit to performing an exhaustive evaluation of these flare minimization practices and propose potential rule amendments requiring the use of these practices where technologically achievable and economically feasible.

   b. **The District recommends exploring options to further promote the implementation of the most effective flare minimization practices during the FMP submittal and review process.**

      Under Rule 4311, FMPs are required to be submitted and approved for existing, new, and modified flaring systems. For existing systems, an updated FMP is required to be submitted and approved every five years. Working with operators to identify potential flare minimization practices during the FMP review process provides operators the opportunity to incorporate feasible flare minimization practices when new and modified systems are proposed and during the ongoing review of FMPs.

2. **Ultra-low NOx technologies with the potential to further reduce emissions from flaring have recently become available. The District recommends conducting a thorough evaluation of new ultra low NOx control technologies for flaring and requiring the implementation of these technologies where technologically achievable and economically feasible.**

   Through this further study, the District has identified new low NOx control technologies that may serve as suitable options for further reducing NOx emissions from flaring in the San Joaquin Valley. To further evaluate opportunities for emission reductions from flaring, the District will perform an exhaustive evaluation of NOx emission reduction control technologies and propose potential rule amendments requiring the use of these technologies where technologically achievable and economically feasible.

Given the enormity of reductions needed to develop plans that demonstrate attainment with the latest federal ozone and PM2.5 standards and based on findings from the recent flare further study, the District committed in its 2016 Ozone Plan to work closely with affected operators to undergo a regulatory amendment process for Rule 4311 to amend Rule 4311 to include:

- Additional ultra-low NOx flare emission limitations for existing and new flaring activities at Valley facilities to the extent that such controls are technologically achievable and economically feasible, and
- Additional flare minimization requirements to the extent that such controls are technologically achievable and economically feasible

This regulatory amendment process began last year, with the District hosting a scoping meeting on August 23, 2017. The District is in the process of working with stakeholders to evaluate the feasibility of additional flare minimization practices and ultra-low NOx flare technologies.

EMISSIONS INVENTORY

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.16	0.16	0.16	0.16	0.16	0.17	0.17	0.17	0.16
NOx	0.56	0.55	0.54	0.53	0.53	0.52	0.52	0.52	0.56
	Winter Average - Tons per day								
PM2.5	0.16	0.16	0.16	0.16	0.16	0.17	0.17	0.17	0.16
NOx	0.56	0.55	0.54	0.53	0.53	0.52	0.52	0.52	0.56

SOURCE CATEGORY

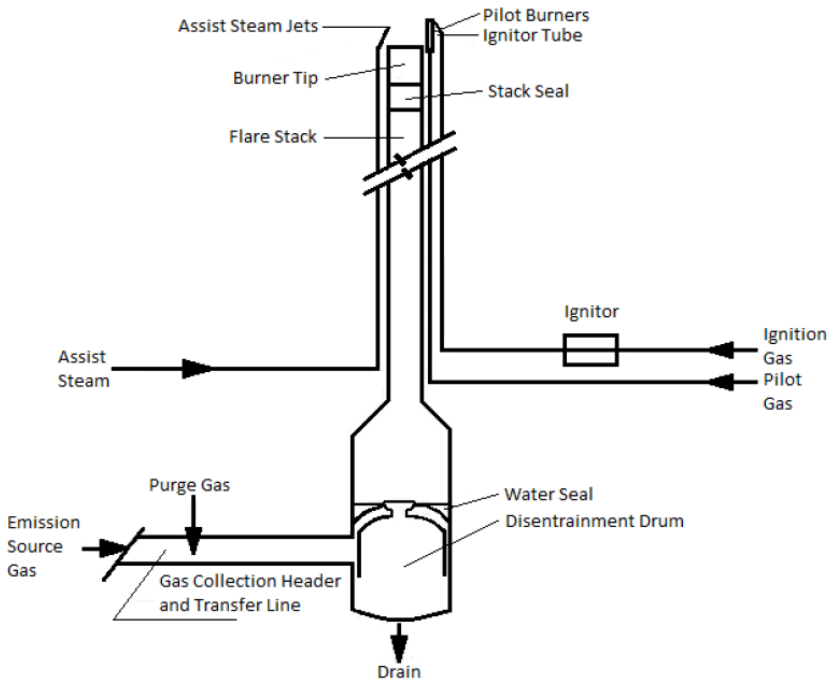
Flaring is a high temperature oxidation process used to burn combustible components, primarily hydrocarbons, of waste gases from industrial operations, primarily for the purpose of controlling emissions and as a safety device. The majority of waste gases flared are natural gas, propane, ethylene, propylene, butadiene and butane.

Combustion efficiency depends on flame temperature, residence time in the combustion zone, vent gas flammability, auto ignition temperature, heating value, and turbulent mixing. When operated at an optimal combination of these factors, flares have a destruction efficiency of 98 percent or greater. Complete combustion converts all VOCs to CO_2 and water; however incomplete combustion increases the presence of air pollutants such as carbon monoxide and particulate matter (as soot). Additionally, there is a possibility of pass through of hydrocarbons or H_2S if they have not been completely combusted. To prevent the creation of smoke or soot, which is influenced by fuel characteristics and the amount and distribution of oxygen in the combustion zone, most industrial flares are steam-assisted or air-assisted. In some cases, another fuel must be added to flare gas to achieve the minimum heating value of 200-250 Btu/ft^3 (or higher) required for complete combustion.

There are two general types of flares: elevated and enclosed ground flares. Flares are further categorized by the method of enhancing combustion by mixing at the flare tip (i.e., steam-assisted, air-assisted, pressure-assisted, or non-assisted).

Elevated flares are more common in the Valley and have larger capacities than enclosed ground flares. In an elevated flare, a waste gas stream is fed through a stack and is combusted near the tip of the stack. An elevated flare consists of five components: a gas collection header (to collect gases from various process units); a proprietary seal; a water seal, or purge gas supply (to prevent flash back); a single or multiple-burner unit in the flare stack; and gas pilots and an igniter. Figure 1, below, depicts a typical configuration for a steam-assisted elevated flare.

Figure 1. Flare Diagram



Enclosed ground flares, are less common in the Valley, vary in complexity and can consist of either conventional flare burners discharging horizontally with no enclosures or multiple burners in refractory-lined steel enclosures.

Flaring in the San Joaquin Valley

Flares serve two basic functions: as a safety device during unforeseeable and unpreventable emergency situations/standby situations and less commonly as a primary emissions control device for VOC emissions. As safety devices, flares are necessary to prevent catastrophic consequences such as the release of toxic gases and explosions, which could result in loss of property, injury, and loss of human life.

In the Valley, the vast majority of flares are employed in oil and gas production operations as emergency/standby control devices, which is in direct contrast with other regions, such as North Dakota, where flares are used for primary disposal of waste gas from oil and natural gas production. Also, while regions like North Dakota utilize flares to combust associated gas during the initial extraction phase of the production process (i.e., directly from the well), Valley flares are typically used further down the process chain, primarily as a safety device associated with gas collection systems, resulting in far lower quantities of flared gas.

Valley operators have generally evaluated all feasible and cost effective options for handling and disposing of the associated/waste gases generated by their facilities and installing a flare as the primary method of disposal would be the last resort. In addition to Rule 4311 requirements to evaluate and implement all feasible measures to reduce flaring activities, other associated rules also implement stringent capture and control of these gases. Therefore, most facilities have made significant investments to capture and utilize these process gases in a variety of methods and this ability has allowed facilities to maximize income generation. Some capture and treat these gases and sell them to natural gas/utility providers (generates monetary income), while others utilize these gases on-site to fuel equipment that generates electricity and/or provides process heating (saves fuel costs). In fact, most Valley facilities regard flaring events as a significant monetary cost, through directly lost profits or increased fuel costs.

In the District's evaluation of Valley flaring activities,[44] nearly all of the significant flaring events were either one-time events due to new control equipment installation or maintenance of existing equipment, and therefore not repeated, or in response to emergency situations or process upsets. For example, one Valley facility (light oil production facility) experienced abnormally high flaring due to the sales transmission pipeline being offline for repairs. Another facility (wastewater treatment plant) normally uses the fuel onsite to produce electricity and process heating but could not do so because additional air pollution control devices were being installed.

Flares in the Valley subject to the requirements in Rule 4311 are employed by a diverse group of industries for a wide variety of applications, as illustrated by the below list. In contrast, other air districts' flare rules generally limit the applicability of their rules to petroleum production facilities or refineries.

- Gas plants
- Heavy oil production/ thermally enhanced oil recovery

[44] SJVAPCD. *Rule 4311 (Flares) Further Study*. http://valleyair.org/Air_Quality_Plans/docs/R4311.pdf.

- Light oil production
- Refinery operations
- Wastewater treatment plants
- Cheese production
- Wine
- Dairy operations
- Flat glass production
- Correctional facility

HOW DOES DISTRICT RULE 4311 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations
There are no EPA CTG or ACT requirements for this source category.

The following federal regulations apply to Rule 4311 sources:

- NESHAP/MACT:
  - 40 CFR 63 Subpart SS (National Emission Standards for Closed Vent Systems, Control Devices, Recovery Devices and Routing to a Fuel Gas System or a Process)
- NSPS:
  - 40 CFR 60.18 (General Control Device and Work Practice Requirements)
  - 40 CFR 65.147 (Flares)
  - 40 CFR 60 Subpart OOOOa (Standards of Performance for Crude Oil and Natural Gas Facilities for Which Construction, Modification, or Reconstruction Commenced After September 15, 2015)
  - 40 CFR 60 Subpart Ja (Standards of Performance for Petroleum Refineries for Which Construction, Reconstruction, or Modification Commenced After May 14, 2007)

Rule 4311 is as stringent as or more stringent than the above NSPS and NESHAP requirements. The most recently amended NSPS (40 CFR 60 Subpart OOOO and 40 CFR 60 Subpart Ja) are discussed below.

40 CFR 60 Subpart OOOOa is a relatively new NSPS requirement that became effective on September 15, 2015. This NSPS may indirectly affect some Valley flares since there is a possibility that a flare is exempt from the majority of the requirements of Rule 4311 and is used as a control device for a vapor controlled tank that is subject to Subpart OOOOa.

Affected facilities under this subpart that may use flares as an approved control device include centrifugal compressors, storage vessels, and onshore natural gas processing plants. If the facility chooses to meet the control requirements, then the flare must be designed and operated in accordance with §60.18(b) and must conduct the compliance determination using Method 22 at 40 CFR part 60, appendix A-7, to determine visible emissions. §60.18(b) was last amended on December 22, 2008, which is before the last amendment for District Rule 4311 (June 18, 2009). The requirements of the 2008 amendments were closely evaluated during the District's 2009 Rule amendment. EPA deemed Rule 4311 as being at least as stringent as established RACT requirements on January 10, 2012.[45] Since Subpart OOOOa has no new requirements for flares after the 2012 EPA RACT approval, Rule 4311 continues to be at least as stringent as these requirements.

40 CFR 60 Subpart Ja was amended by EPA on September 12, 2012. Amendments clarified existing requirements and applicability, including what constitutes a flare modification, clarification of secondary flares, and clarification of the records that must be maintained by the operator. EPA also added new requirements to Subpart Ja as part of these amendments, including flare related unit and process descriptions, assessments, and evaluations; analyses of causes and corrective actions for reportable flaring events; and sulfur limits for petroleum refineries.

Subpart Ja did not implement more stringent requirements than District Rule 4311. Subpart Ja has one new exemption for continuous monitoring, which allows for fewer requirements than previously required in the NSPS, and therefore, is not more stringent than current rule language. While there may be some minor differences in terminology or requirements making direct comparisons not possible, the same level of controls and emission reductions are achieved through District regulations as through this NSPS. Additionally, the District's Permit Services Department continuously evaluates NSPS on a case-by-case basis to ensure the relevant flares comply with all federal requirements as they are promulgated. Rule 4311 is as stringent as, if not more stringent than, this NSPS.

As demonstrated by the discussion above, Rule 4311 is as stringent as or more stringent than the applicable federal regulations.

State Regulations
There are no analogous state regulations for this source category.

HOW DOES DISTRICT RULE 4311 COMPARE TO RULES IN OTHER AIR DISTRICTS?

As previously stated, EPA analysis of Rule 4311 resulted in the 2012 determination that Rule 4311 is as stringent as requirements in other air districts in California (76 FR 68106); however, in keeping with the methodology of this plan, the District conducted a thorough examination of rules in other air districts, including the following:

- BAAQMD Regulation 12 Rule 12 (Flares at Petroleum Refineries)
- SCAQMD Rule 1118 (Control of Emissions from Refinery Flares)
- SMAQMD and VCAPCD do not have an analogous rule for this source category.

[45] EPA. (2012, January 10). 77 FR 1417. Retrieved 2/11/15 from http://www.gpo.gov/fdsys/pkg/FR-2012-01-10/pdf/2012-139.pdf.

The District also conducted an exhaustive search for rules in all other air districts, including those outside of California, to identify any that might contain more stringent requirements.

The District prepared comparisons to Santa Barbara County Air Pollution Control District (SBCAPCD) Rule 359 and North Dakota Century Code 38-08-06.4. The following table compares major elements of Rule 4311 with those in other California air districts and the North Dakota rule.

SCAQMD

- South Coast AQMD Rule 1118 (Control of Emissions from Refinery Flares) *(Adopted Feb 13, 1998; Amended Nov 4, 2005, July 7, 2017)*

The District compared the requirements of District Rule 4311 with the requirements contained within SCAQMD's Rule 1118 and found no requirements that were more stringent than those already in Rule 4311.

	SJVAPCD	SCAQMD
Applicability	All flares	Flares used at: • Petroleum (petro.) refineries • Sulfur recovery plants • Hydrogen production plants
Exemptions	• Municipal solid waste landfill flares subject to Rule 4642 • Flares subject to 40 CFR 60 WWW or Cc • Stationary sources w/ potential to emit <10 tons VOC and <10 tons NOx per year (Not exempt from recordkeeping)	Exempt from sampling and analyses for higher heating values and sulfur concentration for flare event that: • Results from catastrophic event • Is safety hazard to sampling personnel; Sulfur dioxide (SO_2) emissions (emissions) from flaring events caused by: • External power curtailment beyond operator's control • Natural disasters • Acts of war or terrorism (Not exempt from flare monitoring system requirements)

	SJVAPCD	SCAQMD
Requirements	For sources greater than 10 tpy NO_x or VOC: Open flares (air-assisted, steam-assisted, or non-assisted): Comply with 40 CFR 60.18: Ground level enclosed flares without steam assist: 0.0051 lb-VOC/MMBtu, 0.0952 lb-NOx/MMBtu (<10 MMBtu/hr); 0.0027 lb-VOC/MMBtu, 0.1330 l-NOx/MMBtu (10-100 MMBtu/hr); 0.0013 lb-VOC/MMBtu, 0.5240 lb-NOx/MMBtu (> 100 MMBtu/hr). Ground level enclosed flares with steam assist: 0.14 lb-VOC/MMBtu (as TOG), 0.068 lb-NOx/MMBtu (all ratings); Recordkeeping and reporting; Flare minimization plan for refinery flares or flares ≥ 5.0 MMBtu/hr at major sources of NO_x or VOC.	No emission limit requirements

BAAQMD

- Bay Area AQMD Rule 12-12 (Flares at Petroleum Refineries) *(Adopted Jul 20, 2005, amended Apr 5, 2006)*

The District compared the requirements of District Rule 4311 with the requirements contained within BAAQMD's Rule 12-12 and found no requirements that were more stringent than those already in Rule 4311.

	SJVAPCD	BAAQMD
Applicability	All flares	Flares used at petroleum refineries
Exemptions	• Municipal solid waste landfill flares subject to Rule 4642 • Flares subject to 40 CFR 60 WWW or Cc • Stationary sources w/ potential to emit <10 tons VOC and <10 tons NOx per	Flares and thermal oxidizers used for: • Emissions from organic liquid storage vessels (subj. to R. 8-5) • Emissions from loading racks (subj. to R. 8-6, 8-33, or 8-39)

	SJVAPCD	BAAQMD
	year (Not exempt from recordkeeping)	• Emissions from marine vessel loading terminals (subj. to R. 8-44) Thermal oxidizers used for: • Emissions from wastewater treatment systems (subj. to R. 8-8) • Emissions from pump seals (subj. to R. 8-18) (except when emissions from pump are routed to flare header) Monitoring and reporting total hydrocarbon (HC) or methane composition doesn't apply to flare that burns flexicoker gas if weekly sampling shows methane/non-methane content of vent gas flared is <2%/<1% by volume
Requirements	For sources greater than 10 tpy NO_x or VOC: Open flares (air-assisted, steam-assisted, or non-assisted): Comply with 40 CFR 60.18: Ground level enclosed flares without steam assist: 0.0051 lb-VOC/MMBtu, 0.0952 lb-NOx/MMBtu (<10 MMBtu/hr); 0.0027 lb-VOC/MMBtu, 0.1330 l-NOx/MMBtu (10-100 MMBtu/hr); 0.0013 lb-VOC/MMBtu, 0.5240 lb-NOx/MMBtu (> 100 MMBtu/hr). Ground level enclosed flares with steam assist: 0.14 lb-VOC/MMBtu (as TOG), 0.068 lb-NOx/MMBtu (all ratings); Recordkeeping and reporting;	No emission limit requirements

	SJVAPCD	BAAQMD
	Flare minimization plan for refinery flares or flares ≥ 5.0 MMBtu/hr at major sources of NO_x or VOC.	

SBAPCD

- SBAPCD Rule 359 (Flares and Thermal Oxidizers) *(Adopted Jun 28, 1994)*

SBCAPCD Rule 359 was adopted on June 28, 1994. Provisions of this rule apply to the use of flares and thermal oxidizers at oil and gas production sources, petroleum refinery and related sources, and natural gas services. Rule 359 sets specific requirements for the sulfur content in gaseous fuels, technology based standards, flare minimization plans, emergency events, and emission and operational limits.

The District compared the requirements of District Rule 4311 with the requirements contained within SBAPCD's Rule 359 and found no requirements that were more stringent than those already in Rule 4311.

	SJVAPCD	SBAPCD
Applicability	All flares	Flares and thermal oxidizers used at: • Oil and gas production • Petro. refinery • Natural gas services and transportation • Wholesale trade in petro./petro. Products •
Exemptions	• Municipal solid waste landfill flares subject to Rule 4642 • Flares subject to 40 CFR 60 WWW or Cc • Stationary sources w/ potential to emit <10 tons VOC and <10 tons NOx per year (Not exempt from recordkeeping)	Burning of sulfur, hydrogen sulfide, acid sludge, or other sulfur compounds in manufacturing of sulfur or sulfur compounds For oil and gas sources that recover sulfur as by-product of gas treating/sweetening, manufacturing exemption applies only to those specific processes (Except technology-based std.) Burning gas w/ net heating value <300 Btu/scf if fuel used to

	SJVAPCD	SBAPCD
		incinerate gas has sulfur compounds: • <15 grain/100 ft3 in Southern Zone • <50 grain/100 ft3 in Northern Zone Flare and thermal oxidizer units rated <u><</u>1.7 MMBtu/hr., unless total cumulative rating of all such units at a source is <u>></u>5 MMBtu/hr. (Not exempt from sulfur content std., technology std., monitoring, recordkeeping, and recording.) Flares and thermal oxidizers exempt from FMP: • Rated at <15 MMBtu/hr, unless cumulative rating >50 MMBtu/hr. Operations of only planned, continuous flaring due to non-availability of a produced gas pipeline outlet
Requirements	For sources greater than 10 tpy NO_x or VOC: Open flares (air-assisted, steam-assisted, or non-assisted): Comply with 40 CFR 60.18: Ground level enclosed flares without steam assist: 0.0051 lb-VOC/MMBtu, 0.0952 lb-NOx/MMBtu (<10 MMBtu/hr); 0.0027 lb-VOC/MMBtu, 0.1330 l-NOx/MMBtu (10-100 MMBtu/hr); 0.0013 lb-VOC/MMBtu, 0.5240 lb-NOx/MMBtu (> 100 MMBtu/hr). Ground level enclosed flares with steam assist: 0.14 lb-VOC/MMBtu (as TOG), 0.068 lb-NOx/MMBtu (all ratings); Recordkeeping and reporting;	Sulfur limits on planned flaring of 15 gr (as H_2S) in Southern Zone, 50 gr (as H_2S) in Northern Zone. FMP for flares ≥ 15 MMBtu/hr. Ground level enclosed flares without steam assist: 0.0051 lb-VOC/MMBtu, 0.0952 lb-NOx/MMBtu (<10 MMBtu/hr); 0.0027 lb-VOC/MMBtu, 0.1330 l-NOx/MMBtu (10-100 MMBtu/hr); 0.0013 lb-VOC/MMBtu, 0.5240 lb-NOx/MMBtu (> 100 MMBtu/hr). Ground level enclosed flares with steam assist: 0.14 lb-VOC/MMBtu (as TOG), 0.068 lb-NOx/MMBtu (all ratings)

	SJVAPCD	SBAPCD
	Flare minimization plan for refinery flares or flares ≥ 5.0 MMBtu/hr at major sources of NO_x or VOC.	

Rule 350 Section D.3 requires a FMP be submitted by any source subject to this rule that operates a flare rated at 15 MMBtu/hour or greater. For planned flaring, the FMP for all sources subject to this rule shall list a targeted maximum monthly flared gas volume, which shall not exceed 5% of the average monthly gas handled/produced/treated at the source unless the operator demonstrates such a maximum volume to be infeasible based on safety, engineering or cost constraints and proposes a different percentage. Any flaring that causes an exceedance of the emission limits or standards of Rule 359 is also not considered to be in violation if the operator demonstrates that the exceedance resulted from an emergency event.

Additionally, under SBCAPCD Rule 359, flares for which flaring operations solely consist of planned, continuous flaring due to the non-availability of a produced gas pipeline are exempt from FMP requirements.

Although FMPs in SBCAPCD Rule 359 are required to list a targeted maximum monthly flared gas volume of five percent (5%) of the average monthly gas handled/produced/treated, the operator can obtain approval of a higher percentage by demonstrating that the maximum flare volume limit is infeasible based on safety, engineering, or cost constraints, which leaves the rule open to allow a higher amount of flaring. The District evaluated the percentage of gas flared in the Valley and found that the average percentage of gas flared between 2009 and 2013 was well below SBCAPCD's 5% theoretical level at 3.8% as shown in the table below.

Table C-1 Percent of Gas Flared at Valley Facilities

Year Of Data	Gas Produced (MCF)	5% Flared (if meeting SBCAPCD target) (Mscf)	Actual Flared (Mscf)	Percent of gas flared
2009	223,220,118	11,161,006	7,134,977	3.2
2010	241,676,822	12,083,841	7,884,879	3.3
2011	240,000,594	12,000,030	8,324,237	3.5
2012	216,232,509	10,811,625	10,147,080	4.7
2013	238,058,188	11,902,909	10,581,415	4.4
			Total Average Percent of Gas Flared in Valley	**3.8%**

In addition, unlike SBCAPCD rule 359, Rule 4311 does not allow an exceedance of any emissions limits or the requirement to minimize flaring activity, regardless of the cause. Allowing such a measure in the Valley would result in a serious relaxation of rule requirements and a potential increase in emissions. Under the District's rule, any exceedance or excess flaring not allowed under Rule 4311, regardless of the cause, would result in a violation and be subject to enforcement action. Flares subject to SBCAPCD Rule 359 whose flaring operations solely consist of planned, continuous flaring due to the non-availability of a produced gas pipeline outlet are also exempt from FMP requirements while such flares subject to Rule 4311 are not exempt from FMP requirements and are still required to identify and implement actions that reduce flaring.

Based on the discussion above, District Rule 4311 is clearly more stringent than SBCAPCD Rule 359 for the following reasons:

- Rule 4311 applies to a broader range of sources than SBCAPCD Rule 359
- SBCAPCD Rule 359 includes a performance standard for the volume of gas flared (5%), but also includes APCO discretion for allowing unlimited flaring activity
- SBCAPCD Rule 359 contains several exemptions not allowed in Rule 4311, including the allowance for exceedance of emission limits
- EPA analysis resulted in the 2012 determination that Rule 4311 is as stringent as requirements in SBCAPCD Rule 359 in terms of core RACT requirements
- Overall, Rule 4311 results in significantly less flared gas relative to flaring capacity in the District as compared the allowable levels of flaring under SBCAPCD

State of North Dakota

- Century Code 38-08-06.4[46]
- Industrial Commission Order[47]

North Dakota Century Code 38-08-06.4 applies to flaring of gas produced with crude oil from an oil well. The North Dakota rule allows for the uncontrolled flaring of all gases during the first year after opening a new crude oil production well, after which flaring of the entire volume of gas must cease and the well must be:

- Capped;
- Connected to a gas gathering line;
- Equipped with an electrical generator that consumes at least seventy-five percent (75%) of the gas from the well;
- Equipped with a system that intakes at least seventy-five percent (75%) of the gas and natural gas liquids volume from the well for beneficial consumption by means of compression to liquid for use as fuel, transport to a processing facility, production of petrochemicals or fertilizer, conversion to liquid fuels, separating

[46] North Dakota Legislative Branch. (2013, August). *Century Code 38-08-06.4 Flaring of Gas Restricted – Imposition of Tax – Payment of Royalties – Industrial Commission Authority. Retrieved February 13, 2015 from* http://www.legis.nd.gov/cencode/t38c08.pdf?20150213153521.

[47] North Dakota Industrial Commission. (2014, July 1). *Order of the Commission*. Obtained February 3, 2015 from https://www.dmr.nd.gov/oilgas/or24665.pdf.

and collecting over fifty percent (50%) of the propane and heavier hydrocarbons; ***or***

- Equipped with other value-added processes as approved by the industrial commission, which reduce the volume or intensity of the flare by more than sixty percent (60%).

The intent of this rule is to minimize the “waste” of a natural resource, and to assure that mineral rights owners were compensated for the oil and gas produced from their properties. This rule had a collateral benefit of reducing emissions from flaring activities.

Because of large amount flaring that has historically occurred in North Dakota, the North Dakota Industrial Commission acted on a motion of the commission to consider amending the current oil production rule to reduce the amount of flared gas by issuing an order in July 2014 to increase gas capture from oil wells. The order requires 74% of gas capture (instead of flaring) by October 2014, 77% by January 2015, 85% by 2016, and 90% by 2020. By contrast, in the Valley, the quantity of gas captured is over 96%, i.e. only approximately 3.8% of gas produced is flared (see table above).

Due to the mature nature of oil production operations in the Valley, many of the sources subject to Rule 4311 design and operate their equipment and processes in a manner that inherently results in minimal flaring activity. Flare gas is typically flared further along in the process, rather than directly from production wells, resulting in less flaring activity. In contrast, sources in North Dakota flare large portions of the gas generated at oil production wells. This is oil production method is often seen in regions with little to no history of emission regulations and/or no pipeline infrastructure to transport produced gasses.

The District has two rules specific to the operation of crude oil wells. Rule 4401 (Steam-Enhanced Crude Oil Production Wells) and Rule 4409 (Components at Light Crude Oil Production Facilities, Natural gas Production Facilities, and Natural Gas Processing Plants). These rules contain control requirements including a minimum 95% capture and control, periodic leak detection, and repair requirements for steam enhanced wells and light oil wells. These rules also require the development of an Operator Management Plan (OMP) that describes how a facility will comply. The OMP must be updated annually to reflect any changes to the OMP, including changes to address newly installed wells. These prohibitory rules are applicable to both existing and new wells.

As discussed above, Rule 4311, and the common practices of the mature local oil production operations to recover the vast majority of produced gas, are more stringent than the North Dakota rule.

Additional Emission Reduction Opportunities

Ultra-Low NOx Flares

While the modernization of flare technology will not reduce the frequency or volume of flaring activities, it can reduce the emissions from such activities, thereby accomplishing the same end goal.

The District has identified a new class of VOC destruction devices that are similar to enclosed flares but operate with mixing controls and are being put into practice as control devices. These devices offer ultra-low NOx emissions of approximately 0.018 – 0.025 lb-NOx/MMBtu (compared to existing District Rule 4311 requirement of 0.068 lb-NOx/MMBtu). These devices may not be considered flares by the Rule 4311 definition, but are an alternative method for VOC control. One Permit to Operate and at least eight Authority to Construct permits have been issued to facilities in the Valley for these new devices.

These devices appear more suitable for use at sites with more steady gas disposal needs. These new devices may not be a viable replacement for some emergency flares, particularly those with high intermittent gas volume capacity requirements.

Cost effectiveness varies depending on usage rates. For example, based on cost information from E&B Natural Resources, the cost for a 3.4 MMBtu/hr flare is estimated at $800,000 (capital and installation) with $1,000 monthly ongoing operational costs. Assuming an average $1.2 million initial cost estimate to account for larger flares, the annualized cost effectiveness ranges from $23,000 per ton of NOx reduced to as high as $1,000,000 per ton of NOx reduced, depending on flare usage.

Flare Minimization Practices

District staff conducted a detailed review of all approved FMPs to identify the variety of flare minimization practices used by affected facilities. In addition, District staff also worked closely with affected facilities to gain more in-depth understanding of the minimization practices. The District found a variety of flare minimization practices specific to each facility that could potentially be employed at other facilities to further reduce flaring at their operations. These practices may not only serve to reduce flaring activities and associated emissions but may also provide economic, safety, and other benefits to affected facilities. Because of the unique nature of each facility, the technological achievability and economic feasibility of transferring these minimization practices or technologies from one facility to another needs to be considered.

Even though operators of flares in the Valley have already taken extensive measures to reduce flaring, the District is currently undergoing a robust public process to amend Rule 4311 to evaluate and require the use of these practices where technologically achievable and economically feasible.

Alternatives to Flaring

The following alternative uses for flare gas were identified in submitted FMPs.

- **Use gas as a fuel for equipment rather than flaring.** Capturing gas and routing it into a fuel gas system to power various processes is a means of utilizing gas that would otherwise be flared. There is a financial incentive to utilize this practice to the greatest extent feasible across all facility types as the gas can be used to supplement, or in some cases even completely supply, the process energy needed, (i.e. IC engines) to produce electricity, and boilers for steam generation and process heating.

While many oil production operations in the Valley do use produced gas in their steam generation operations, there are several barriers to implementing this practice in all situations where gas is currently flared. Some facilities do not have a use for combustion equipment on-site. For those that do have a use for the combustion equipment, it may not be economically feasible to purchase, install and operate such equipment, the multiple stages of treatment equipment to make the gas suitable for use at the facility, and the infrastructure required to connect process streams and utilities to the fuel gas system. Additionally, the installation of extra equipment to handle the waste gas can potentially add more complexity to the maintenance and testing, and can increase the number of potential points of failure.

- **Injection of oil field gas into DOGGR-approved disposal wells**. Reinjection of gas into subsurface geologic formations disposal wells is a potential alternative to flaring. These wells are regulated by the California Department of Conservation, Division of Oil, Gas and Geothermal Resources (DOGGR). However, the permits for these wells can be extremely difficult to obtain from the state, and require significant capital investment to complete the various studies and installation of infrastructure in California. Additionally, the permits place a limit on volume reinjected that if exceeded requires the facility to dispose of gas by other means.

- **Send oilfield gas to a sales gas line**. Gas that is of high enough quality (i.e. high energy content, low sulfur or nitrogen content) can be sold through a sales gas line. While many oil production operations in the Valley do sell their produced gas, there can be many barriers associated with implementing this alternative including proximity to an existing gas line, quantity and quality of gas generated, and the economics of purchasing, installing, and maintaining a new sales gas line and all the associated treatment and transmission equipment and infrastructure.

Preventative Maintenance

A proactive and preventative maintenance program can greatly reduce flaring by minimizing downtime from equipment failure which can lead to flaring of produced gas. The following preventative maintenance practices were identified in submitted FMPs to minimize flaring.

- **Implement a preventative maintenance program to predict failure in pipelines and stationary equipment (measure corrosion)**. The gas going through pipelines and stationary equipment can be very corrosive. A predictive method such as using x-rays to measure pipe thickness is used to determine when to replace the equipment. This testing is performed on a periodic basis as dictated by the equipment type and the service it is in.

- **Install high-pressure alarms on process vessels**. Installation of alarms on process vessels can indicate a high pressure build-up (before pressure relief valves opens and directs gasses to flares) so that operators can intervene before flaring occurs.

- **Inspect pressure relief valves routinely to ensure proper operation**. If a pressure relief valve improperly seats or is otherwise defective, gases will leak and be combusted in the flare. In an attempt to reduce such occurrences, the pressure relief valves can be inspected periodically.

- **Maintain and calibrate flare gas control valves on a routine schedule**. Flare gas lines are typically equipped with control valves to regulate the volume of gas going to flares. Should these valves malfunction, it is possible that excessive gas would be directed to the flare. These valves could be calibrated on a routine schedule.

- **Retain spare parts onsite to minimize system downtime**. Quick and easy access to spare parts reduces equipment downtime and associated flaring. While the economic feasibility of purchasing and maintaining backup equipment will need to be considered on a case-by-case basis for each facility, some facilities maintained the following types of equipment onsite to minimize flaring:

    - **Compressors**. Compressors are ubiquitous in the gas and petroleum industry and play a critical role in many different stages of oil and gas production, processing/refining, and transmission.

    - **Sulfur scrubber components/media**. If the sulfur scrubber system is down, the fuel cannot be processed for onsite use and must be flared instead.

    - **Spare parts for primary combustion equipment (blowers, etc.)**. If the primary combustion equipment is down, the fuel cannot be utilized onsite and must be flared instead.

Procedures to Reduce Flaring During Maintenance and Shutdowns

Another effective flare minimization measure is to optimize and coordinate maintenance activities so that equipment failure and downtime is minimized to the extent feasible. A proactive and preventative maintenance program can greatly reduce downtime and thereby minimize flaring. However, during maintenance and shutdown events, operators can take additional measures to avoid or reduce flaring. The following procedures were identified in submitted FMPs.

- **Perform maintenance on one area without impacting other operations on site.** Designing a facility in a manner that allows maintenance to be performed in one area of a facility without affecting other operations can reduce flaring. This allows the other operations to continue normally without the need to flare excess gas.

- **Curtail oil/gas production during planned shutdown of sales line**. In the event of a planned shutdown of a sales gas pipeline, and/or major maintenance activities, oil/gas production can be curtailed. This could potentially result in lost revenue.

- **Close oil well casing vents during vapor control system maintenance**. Casing gas remains in reservoir instead of being flared, but this can potentially result in reduced oil production rate until vents are opened.

- **Store gas in bladder tank.** For waste water treatment plants, limited amounts of digester gas can be stored in bladder tanks during maintenance, testing, or process upsets and later be routed to combustion devices for beneficial use on-site.

- **Plan maintenance activities during optimal periods.** Scheduling maintenance during periods of minimum capacity needs and/or following planned process unit shutdowns has the potential of minimizing flaring activities.

- **Optimize planned shutdowns for major maintenance.** Most inspection, repair, and minor maintenance work can be performed while a facility is in operation. However, there are times when a facility has to shut down and flare process gas to conduct major maintenance work. The management of a facility shutdown is known as a "turnaround". Scheduled facility shutdowns are expensive and labor intensive due to the loss of production and the expense of the turnaround itself. While turnaround procedures are primarily focused on minimizing downtime, the following specific procedures were identified in submitted FMPs to minimize flaring during plant turnaround.
  - Have extra personnel on site to re-start the plant as quickly as possible
  - Recycle discharge gas back to compressor inlets until minimum operating pressure is obtained
  - Prior to turnaround, identify critical equipment to be serviced to avoid refinery downtime and associated flaring
  - Phase equipment and process unit shutdowns to minimize fuel gas imbalances that may result in additional flaring
  - Identify alternate disposition of process gases to minimize flaring;
  - Identify key process unit operations such as fuel gas systems and sulfur recovery operations that must remain in operation to minimize flaring of sulfur-containing gases

Phase equipment and process unit start-ups to minimize start-up duration and the flaring associated with these transitional operations

Redundant Systems

Even with the most rigorous and proactive maintenance programs in place, there is always the potential for critical equipment failure. Installing redundant systems minimizes the potential of downtime by allowing operators to quickly switch from one system to another in the event of equipment failure or during maintenance. The following redundant systems were identified in FMPs to minimize flaring.

- **Redundant compressors.** Compressors can fail, and as a result the gas may need to be flared. Installation of a redundant secondary compressor can minimize flaring when the primary compressor is down.

- **Redundant gas treatment systems (sulfur scrubber).** This allows gas to continue to be treated and burned in combustion equipment when one unit is not available.

- **Redundant digester gas-fired turbines.** Some wastewater treatment plants have incorporated redundant digester-gas-fired turbines into their system design. The redundant system allows the turbines to be maintained without the need to flare. This has potential to reduce a considerable amount of flaring, as the turbines for these types of operations typically require frequent maintenance. In addition, a redundant system reduces downtime and extends the life of the turbines.

Procedures to Prevent or Mitigate the Effects of Power Outages to Reduce Flaring
A power outage has the potential to result in flaring as vapors are sent to flares to protect the facility from being over-pressurized. The following specific procedures were identified in submitted FMPs to mitigate the effects of power outages and reduce flaring.

- **Backup generators.** Install emergency IC engine/generators to power equipment during power outages.

- **Power outage alarm.** Send alarms to all operators when power outage occurs to ensure rapid response.

- **Infrared testing.** Implement infrared testing of electrical equipment on a routine basis to identify hot-spots that could result in a power outage.

- **Avian guards.** Install avian guarding in substations to deter birds from contacting energized equipment.

EVALUATION FINDINGS

Even though flares are not a significant source of PM2.5 and NOx in the Valley, the District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans. As demonstrated above, Rule 4311 currently has in place the most stringent measures feasible to implement in the Valley.

While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, the District will pursue the following potential opportunities that are projected to provide 0.05 tons NOx per day of additional emissions reductions towards the District's aggregate plan commitment. The District will continue to work closely with affected operators and other stakeholders to undergo a regulatory amendment process for Rule 4311 to include:

- Additional ultra-low NOx flare emission limitations for existing and new flaring activities at Valley facilities to the extent that such controls are technologically achievable and economically feasible, and
- Additional flare minimization requirements to the extent that such controls are technologically achievable and economically feasible
- Expand the applicability of the rule to apply to all sources (not limited to major sources)

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C.12 Rule 4313 (Lime Kilns)

Discussion

Lime kilns can be used in a variety of manufacturing and processing operations, including food and agriculture. In 2003, there were a total of three lime kilns in the Valley, used at two sugar processing plants; however, these plants have been non-operational since 2008. There are currently no lime kilns operating in the Valley.

Emissions Inventory

There is no emissions inventory associated with lime kilns because there are no lime kilns operating in the Valley. District staff have verified that there are no lime kilns in the preliminary permitting process to become operational in the Valley, nor are any lime kilns expected to be operated in the Valley in the future.

How does District Rule 4313 compare with federal and state rules and regulations?

Federal Regulations

There are no EPA CTG or ACT requirements for this source category.

NSPS

- 40 CFR 60 Subpart HH (Standards of Performance for Lime Manufacturing Plants)

The District evaluated the requirements contained within 40 CFR 60 Subpart HH and found no requirements that were more stringent than those already in Rule 4313.

NESHAP/ MACT

- 40 CFR 63 Subpart AAAAA (National Emission Standards for Hazardous Air Pollutants for Lime Manufacturing Plants)

The District evaluated the requirements contained within 40 CFR 63 Subpart AAAAA and found no requirements that were more stringent than those already in Rule 4313.

State Regulations

There are no state regulations applicable to this source category.

How does District Rule 4313 compare to rules in other air districts?

There are no lime kiln rules in SCAQMD, BAAQMD, SMAQMD, and VCAPCD.

Evaluation Findings

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this source category. As demonstrated above, Rule 4313 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

C.13 Rule 4352 (Solid Fuel-Fired Boilers, Steam Generators, and Process Heaters)

Discussion

The purpose of Rule 4352 is to limit oxides of nitrogen (NOx) and carbon monoxide (CO) emissions from any boiler, steam generator or process heater fired on solid fuel. The adoption of Rule 4352 on September 14, 1994, established NOx limits of 200 parts per million volume (ppmv) for municipal solid waste facilities (MSW), 0.35 pounds per million British thermal units per hour (lb/MMBtu) for biomass facilities, and 0.20 Ib/MMBtu for all other solid fuel fired units. Since its adoption, the rule has been amended three times. The most recent amendments, in December 2011, strengthened the rule by lowering NOx emissions limits for all three source categories. However, no emissions reductions were quantified because the rule amendments were meant to satisfy EPA RACT requirements and all units were determined to be operating at the new emission limits. EPA finalized approval of Rule 4352 on November 6, 2012.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.64	0.75	0.83	0.86	0.87	0.90	0.92	0.94	0.96
NOx	2.49	2.85	3.07	3.18	3.20	3.28	3.35	3.43	3.49
	Winter Average - Tons per day								
PM2.5	0.65	0.76	0.84	0.87	0.88	0.91	0.93	0.95	0.97
NOx	2.77	3.14	3.36	3.47	3.49	3.58	3.65	3.73	3.79

Source Category

Boilers, steam generators, and process heaters are used in a broad range of industrial, commercial, and institutional settings. Units subject to this rule fire on a variety of solid fuels: coal, petroleum coke, biomass, tire-derived fuel, and municipal solid waste (MSW). The two primary methods of controlling NOx emissions from boilers, steam generators, and process heaters are either to change the combustion parameters to reduce NOx formation (i.e., combustion modification, lower combustion temperature, etc) or to treat the NOx formed in the process before the NOx is emitted into the atmosphere (i.e., post-combustion control or flue gas treatment). While previous rule-amending projects for Rule 4352 have not quantified specific emissions reductions, the use of biomass facilities in the Valley has fostered emissions reductions.

<u>Permitted Sources - Biomass</u>

Twelve biomass-fired units are currently permitted within the District; however, only five biomass-fired units are currently operating. All five operating units are used to generate electricity for electric utilities. The remaining seven units have been shut down and are dormant.

As an energy source, biomass can either be used directly or converted into other energy products such as biofuel. Biomass facilities in the Valley reduce the amount of pollutants created by open burning practices and the landfilling of potential biofuels such as agricultural materials, and urban and forest wood waste products by utilizing these materials.

Permitted Sources – Municipal Solid Waste

Two of the solid fuel-fired units permitted with in the District are fired on municipal solid waste. The municipal solid waste fired units are located at a single facility that generates electricity for electric utilities.

Permitted Sources – Other

One solid fuel-fired unit permitted with in the District may be fired on coal and petcoke. This particular unit is also permitted to be fired on biomass has been exclusively fired on biomass since 2013.

HOW DOES DISTRICT RULE 4352 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations
There are no EPA CTG or MACT requirements for this source category.

The District evaluated the requirements contained within the Clean Air Act (ACT) for NOx Emissions from Industrial/Commercial/Institutional Boilers and the ACT for NOx Emissions from Utility Boilers and found no requirements that were more stringent than those already in Rule 4352.

The District evaluated the requirements contained within the NSPS in 40 CFR 60 Subpart Cb (Large Municipal Waste Combustors), Subpart D (Fossil-Fuel-Fired Steam Generators), and Subpart Db (Industrial-Commercial-Institutional Steam Generating Units) and found no requirements that were more stringent than those already in Rule 4352.

The NESHAP in 40 CFR 63 Subpart DDDDD (Industrial, Commercial, and Institutional Boilers and Process Heaters) was amended on January 31, 2013 to include new emission limits for PM, CO, and total selective metals (TSM), replace numeric dioxin emission limits with work practice standards, add new subcategories of facilities, and add alternative monitoring approaches. The District evaluated the requirements contained within this NESHAP and found no requirements that were more stringent than those already in Rule 4352 and required by District permits.

State Regulations
There are no California state regulations applicable to this source category.

HOW DOES DISTRICT RULE 4352 COMPARE TO RULES IN OTHER AIR DISTRICTS?
There are no analogous rules for this source category in Ventura County APCD.

SCAQMD

- South Coast AQMD Rule 1146 (Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters) *(Amended November 1, 2013)*

The District evaluated the requirements contained within SCAQMD Rule 1146 and the 40 ppmv @ 3% O_2 limit for non-gaseous fuels is potentially more stringent than those already in District Rule 4352. However, all of the remaining solid-fuel fired boilers operating within the Valley are used by electric utilities to generate electricity, a category which South Coast AQMD specifically exempts from the requirements of Rule 1146. Furthermore, it was determined that there are no biomass-fired power plants in South Coast District and there are two municipal solid waste-fired power plants generating electricity for electric utilities that are therefore not subject to 40 ppm requirement. In conclusion, no sources in SCAQMD are currently complying with the 40 ppmv limit of SCAQMD Rule 1146.[48] In summary, the District found no requirements that were more stringent than those already required by the District.

	SJVAPCD	SCAQMD
Applicability	NOx emission limit is applicable to any boiler, steam generator or process heater fired on solid fuel	Boilers, steam generators, and process heaters ≥ 5 MMBtu/hr rated heat input capacity used in all industrial, institutional, and commercial operations
Exemption	NOx emission limits do not apply to units operated at a Stationary Source that has a potential to emit < 10 tpy of NOx	Units rated heat ≤ 5 MMBtu/hr. Boilers used by electric utilities to generate electricity. NOx emissions from RECLAIM facilities
Requirements Emission Limits	<u>Municipal Solid Waste</u> ≤ 165 ppmv NOx corrected to 12% CO_2 <u>Biomass</u> ≤ 90 ppmv NOx corrected to 3% O_2 <u>All others</u> ≤ 65 ppmv NOx corrected to 3% O_2	<u>Non-gaseous</u> < 40 ppmv NOx corrected to 3% O_2

[48] Approval and Disapproval of California Air Plan; San Joaquin Valley Serious Are Plan and Attainment Date Extension for the 1997 PM2.5 NAAQS. Final Rule. 81 Fed. Reg. 26, pp. 6936-6986. (2016, February 9) (to be codified at 40 CFR Parts 52 and 81) https://www.gpo.gov/fdsys/pkg/FR-2016-02-09/pdf/2016-02325.pdf and http://www.calbiomass.org/facilities-map/

BAAQMD

- BAAQMD Regulation 9 Rule 7 (Nitrogen Oxides and Carbon Monoxide from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters) *(Amended May 4, 2011)*

The District evaluated the requirements contained within BAAQMD Regulation 9 Rule 7 and the 40 ppmv @ 3% O_2 limit for non-gaseous fuels is potentially more stringent than those already in District Rule 4352. However, all of the solid-fuel fired boilers operating within the Valley are used by electric utilities to generate electricity or are qualifying small power producing facilities, a category which BAAQMD exempts from the requirements of Regulation 9, Rule 7. Therefore, the District found no requirements that were more stringent than those already required by District Rule 4352 for the categories of solid-fuel fired units located in the Valley.

	SJVAPCD	BAAQMD
Applicability	NOx emission limit is applicable to any boiler, steam generator or process heater fired on solid fuel	Boilers, steam generators, and process heaters with a rated heat input ≥ 1 MMBtu/hr used in all industrial, institutional, and commercial operations
Exemption	Stationary Source that has a potential to emit < 10 tpy of NOx	Boilers used by public electric utilities or qualifying small power production facilities, as defined in Section 228.5 of the PUC code, to generate electricity
Requirements Emission Limits	<u>Municipal Solid Waste</u> ≤ 165 ppmv NOx corrected to 12% CO_2 <u>Biomass</u> ≤ 90 ppmv NOx corrected to 3% O_2 <u>All others</u> ≤ 65 ppmv NOx corrected to 3% O_2	<u>Non-gaseous fuel:</u> ≤ 40 ppmv NOx corrected to 3% O_2

BAAQMD

- Bay Area AQMD Regulation 9 Rule 11 (Nitrogen Oxides and Carbon Monoxide from Utility Electric Power Generating Boilers) *(Adopted May 17, 2000)*

The District evaluated the requirements contained within BAAQMD Regulation 9, Rule 11 and found that the NOx limitations in Regulation 9 Rule 11 are more stringent than those already in District Rule 4352. However, there are no biomass facilities and no municipal solid-waste fired power plants in BAAQMD. Therefore no solid-fuel fired units in BAAQMD are currently complying with the BAAQMD Rule 411 limits for non-gaseous fuel.[49]

	SJVAPCD	BAAQMD
Applicability	NOx emission limit is applicable to any boiler, steam generator or process heater fired on solid fuel	NOx emission limit is applicable to any electric power generating steam boiler with rated heat input capacity ≥ 1.5 BBtu/hr
Exemption	Stationary Source that has a potential to emit < 10 tpy of NOx Duration of startup and shutdown period may not exceed 12 hours	Boilers with a rated heat input capacity < 0.250 MMBtu/hr Boilers ≥ 5 BBtu/hr during startup period may not exceed 20 hours unless catalytic reaction temperature has not been reached, if applicable Boilers with rated heat input capacity of < 5 BBtu/hr during startup period may not exceed 12 hours unless catalytic reaction temperature has not been reached, if applicable Duration of shutdown period may not exceed 8 hours
Requirements NOx Emission Limits	<u>Municipal Solid Waste</u> ≤ 165 ppmv NOx corrected to 12% CO_2 <u>Biomass</u> ≤ 90 ppmv NOx corrected to 3% O_2 <u>All others</u> ≤ 65 ppmv NOx corrected to 3% O_2	<u>Non-Gaseous Fuel (Boilers with rated heat input capacity ≥ 1.75 MMBtu/hr)</u> ≤ 25 ppmv NOx corrected to 3% O_2, and Boilers shall not be fired on non-gaseous fuel from May 1 to October 31 unless gaseous fuel is not available because of a force majeure natural gas curtailment

SMAQMD

- Sacramento Metropolitan AQMD Rule 411 (NOx from Boilers, Process Heaters, and Steam Generators) (Amended August 23, 2007)

[49] Approval and Disapproval of California Air Plan; San Joaquin Valley Serious Are Plan and Attainment Date Extension for the 1997 PM2.5 NAAQS. Final Rule. 81 Fed. Reg. 26, pp. 6936-6986. (2016, February 9) (to be codified at 40 CFR Parts 52 and 81) https://www.gpo.gov/fdsys/pkg/FR-2016-02-09/pdf/2016-02325.pdf and http://www.calbiomass.org/facilities-map/

For biomass units, the District Rule 4352 NOx limit is more stringent than SMAQMD Rule 411. While SMAQMD Rule 411 includes a 40 ppm NOx @ 3% O_2 limit for non-gaseous fired units that may be more stringent than the District's Rule 4352 limits for non-biomass fired units, the non-biomass fired units in the District are used by electric utilities to generate electricity, which is a category that is exempt from SMAQMD Rule 411 requirements. Therefore, the District found no requirements that were more stringent than those already required by District Rule 4352 for the categories of solid-fuel fired units located in the Valley.

	SJVAPCD	SMAQMD
Applicability	NOx emission limit is applicable to any boiler, steam generator or process heater fired on solid fuel	Boilers, steam generators, and process heaters ≥ 1 MMBtu/hr rated heat input capacity
Exemption	Stationary Source that has a potential to emit < 10 tpy of NOx	Unit used by electric utility to generate electricity and waste heat recovery
Requirements Emission Limits	Municipal Solid Waste ≤ 165 ppmv NOx corrected to 12% CO_2 Biomass ≤ 90 ppmv NOx corrected to 3% O_2 All others ≤ 65 ppmv NOx corrected to 3% O_2	Non-gaseous: ≤ 40 ppmv NOx corrected to 3% O_2 Biomass ≤ 70 ppmv corrected to 12% CO_2 (Equivalent to 99 ppmv corrected to 3% O_2)

Yolo Solano AQMD

- YSAQMD Rule 2-43 (Biomass Boilers) (Amended November 10, 2010)

The District evaluated the requirements contained within YSAQMD Rule 2-43 and found no requirements to be more stringent than those already in District Rule 4352.

	SJVAPCD	YSAQMD
Applicability	NOx emission limit is applicable to any boiler, steam generator or process heater fired on solid fuel	Boilers and steam generators with rated heat input of ≥ 5 MMBtu/hr used with biomass fuel

Exemption	Stationary Source that has a potential to emit < 10 tpy of NOx	Combustion units primarily used to burn municipal solid waste.
Requirements Emission Limits, corrected at 3% O_2	Municipal Solid Waste ≤ 165 ppmv NOx corrected to 12% CO_2 Biomass ≤ 90 ppmv NOx corrected to 3% O_2 All others ≤ 65 ppmv NOx corrected to 3% O_2	Biomass ≤ 90 ppmv corrected to 3% O_2

Eldorado County APCD

- ECAPCD Rule 232 (Biomass Boilers) (Amended September 25, 2001)

The District evaluated the requirements contained within EDCAPCD Rule 232 and found no requirements to be more stringent than those already in District Rule 4352.

	SJVAPCD	EDCAPCD
Applicability	NOx emission limit is applicable to any boiler, steam generator or process heater fired on solid fuel	Boilers and steam generators with rated heat input of ≥ 5 MMBtu/hr that have a primary energy source of biomass that consist of a minimum of 75% of the total annual heat input
Exemption	Stationary Source that has a potential to emit < 10 tpy of NOx	Combustion units primarily used to burn municipal solid waste.
Requirements	Municipal Solid Waste ≤ 165 ppmv NOx corrected to 12% CO_2 Biomass ≤ 90 ppmv NOx corrected to 3% O_2 All others ≤ 65 ppmv NOx corrected to 3% O_2	Biomass ≤ 115 ppmv NOx corrected to 12% CO_2 (equivalent to 163 ppmv NOx corrected to 3% O_2)

Placer County APCD

- PCAPCD Rule 233 (Biomass Boilers) (Amended June 14, 2012)

The District evaluated the requirements contained within PCAPCD Rule 233 and found no requirements to be more stringent than those already in District Rule 4352.

	SJVAPCD R4352	PCAPCD R233
Applicability	NOx emission limit is applicable to any boiler, steam generator or process heater fired on solid fuel	Stoker and circulating fluidized bed boilers and steam generators with rated heat input of < 500 MMBtu/hr a potential to emit 25 tons of NOx emissions in which have a primary energy source of biomass consisting of a minimum of 75% of the total annual heat input
Exemption	Stationary Source that has a potential to emit < 10 tpy of NOx	Combustion units primarily used to burn municipal solid waste.
Requirements	Municipal Solid Waste ≤ 165 ppmv NOx corrected to 12% CO_2 Biomass ≤ 90 ppmv NOx corrected to 3% O_2 All others ≤ 65 ppmv NOx corrected to 3% O_2	Biomass Units less than 500 MMBtu/hr ≤ 68 ppmv NOx corrected to 12% CO_2 (equivalent to 96 ppmv NOx corrected to 3% O_2) Biomass Units greater than 500 MMBtu/hr ≤ 115 ppmv NOx corrected to 12% CO_2 (Equivalent to 163 ppm NOx corrected to 3% O_2)

The District evaluated the requirements contained within PCAPCD Rule 233 and found no requirements to be more stringent than those already in District Rule 4352.

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

Municipal Solid Waste

Current Status of Municipal Solid Waste Facilities in the Valley

One facility in the Valley operates two Municipal Solid Waste-fired units in the Valley. Each unit is equipped with a baghouse for PM10 control, a dry lime scrubber for SOx control, and a selective non-catalytic reduction system for NOx control.

Potential NOx Control Technologies

MSW facilities nationwide are generally equipped with Selective Non-Catalytic Reduction (SNCR) and utilize this technology to meet emission limits ranging between

165 ppmv corrected to 12% CO_2 to 210 ppmv corrected to 12% CO_2. The District identified the following NOx control technologies that can achieve lower emission rates.

Selective Catalytic Reduction (SCR) is an add-on control system that may be used to reduce NOx emissions from MSW-fired units. SCR systems reduce NOx emissions by converting the emissions to water and elemental nitrogen in the presence of a catalyst. While no SCR retrofits of MSW-fired units were identified in the U.S., several European MSW-fired plants have been retrofitted with selective catalytic reduction systems. For example, Acegas in Padova Italy retrofitted two municipal solid waste units with a selective catalytic reduction system, achieving a permitted NOx limit of 50 ppmv corrected to 7% O_2 (equivalent to 47 ppmv NOx @ 12% CO_2). While sometimes possible, retrofits of MSW-fired units with selective catalytic reduction systems can be infeasible since the retrofit often requires major changes to existing building structures, results in lost revenue due to extensive down-time of the MSW unit, and requires new natural gas pipelines be installed to provide supplemental fuel for required auxiliary burners.

In addition to conventional SCR, Gore & Associates Inc. manufactures DeNOx filter bags that include a catalytic insert for the reduction of NOx emissions from MSW plants. Installation of the Gore De-NOx filter bags simply requires removing the filter bags in the existing baghouse serving the MSW unit and replacing them with Gore De-NOx filter bags that include the catalytic insert. The catalytic insert reduces NOx emissions in the same manner that an SCR catalyst reduces NOx emissions. According to the manufacturer, nine units in Europe have been retrofitted with Gore De-NOx systems and the typical guaranteed NOx emission level for units with this system is 60 ppmv corrected to 7% O_2 (equivalent to 57 ppmv NOx corrected to 12% CO_2). Unlike installations of conventional SCR, Gore De-NOx retrofits do not require extensive building modifications and do not result in significant downtime of the MSW unit. However, the Gore De-NOx system does have several limitations. First, the system requires the baghouse inlet temperature be maintained within a tight operating range of 180 °C to 230 °C. In some instances, facilities can control their temperature to be within this range by adjusting the dilution water flow to the dry lime scrubbers. Secondly, the catalytic filters are only guaranteed by the manufacturer for three years and must be replaced periodically. Finally and most importantly, SOx emissions at the baghouse inlet cannot exceed 10 ppmv corrected to 7% O_2; otherwise ammonia sulfate and ammonium disulfate can form and poison the catalytic filter inserts. In practice, maintaining such low SOx levels requires the operator to vigilantly inspect and remove construction debris from the municipal solid waste fuel. Specifically, gypsum-containing drywall is known to cause spikes in SOx emissions when combusted in MSW plants.

Additional control technologies for MSW plants were identified. In partnership with Martin GMBH of Germany, Covanta Inc. has developed two proprietary NOx control systems for reducing NOx emissions from MSW-fired units. The first technology, known as VLN™, uses a unique combustion system design which, in addition to conventional primary and secondary air systems, features a new internal stream of “VLN™-gas” which is drawn from the combustor and re-injected into the furnace. The gas flow distribution between the primary air, secondary air, and VLN^{TM} gas is controlled to yield the optimal flue gas composition and furnace temperature profile to minimize NOx formation and optimize combustion. In conjunction with an optimized SNCR system, VLN^{TM} technology reduces NOx to levels below 60 ppm @ 7% O_2 (equivalent to 57 ppm NOx @ 12% CO_2). However, this system is only available for new units and is not technologically feasible as a retrofit technology.

Covanta Inc. has also developed a simplified version of the VLN^{TM} technology, known as LN^{TM}. This technology was specifically designed for retrofits of existing MSW combustors. Like VLN^{TM}, the LN^{TM} technology adds a stream of "LN^{TM} gas" and optimizes the gas flow distribution between the primary air, secondary air, and the LN^{TM} gas streams to reduce NOx emissions. Unlike VLN^{TM}, LN^{TM} gas is drawn from outside the furnace. In conjunction with an optimized SNCR system, Covanta guarantees NOx emission rates of 110 ppmv corrected to 12% CO_2 on a 24-hour basis and 90 ppmv corrected to 12% CO_2 on a rolling 12-month basis. Covanta LN^{TM} technology has been used at multiple sites within the US. For example, Covanta LN^{TM} technology with an optimized SNCR system is used to reduce NOx emissions from three existing MSW units at the Montgomery County Resource Recovery Facility in Maryland.

Cost Effectiveness of Selective Catalytic Reduction for Municipal Solid Waste Units

The District performed a cost analysis to determine the cost effectiveness of installing a selective catalytic reduction system for a municipal solid waste unit. The District used the following methodology and assumptions for this cost effectiveness analysis:

Assumptions:

- Baseline emission factor is 0.286 lb-NOx/MMBtu (equivalent to 165 ppmv @ 12% CO2)
- SCR provides control to 50 ppmv at 7% O2 (equivalent to 47 ppmv @ 12% CO2)

Cost data was obtained from a preconstruction approval by the Florida Department of Environmental Protection (FDEP) issued on December 23, 2010. The approval was issued for an MSW-fired combustor equipped with SCR for NOx control. The control equipment costs from the FDEP application include uncontrolled NOx emissions of 250 ppmv and controlled NOx emissions of 50 ppmv which represents an 80% reduction in NOx from the SCR. However, 80% reduction from 165 ppmv @ 12% CO2 would yield controlled emissions of 33 ppmv, which is well below BACT. Therefore, controlled emissions are evaluated at the BACT limit of 47 ppmv @ 12% CO2.

The FDEP SCR installation was sized for a unit rated at approximately 460 MMBtu/hr used to produce superheated steam for an electrical generator. The District reviewed the expected exhaust parameters and found them comparable to the parameters for solid fuel-fired boilers in the Valley. Therefore, it is believed that this cost estimate provides a valid basis for estimating costs for installing SCR on MSW-fired boilers in the Valley.

To maximize the emission reductions and economies of scale in estimating the retrofit costs, it is assumed that a 350 MMBtu/hr unit operating at full fire at 100% capacity factor year round for the MSW facility. The purpose of these assumptions is to err on the conservative side throughout the analysis.

Emissions are calculated in the following table:

Table C-1 Emissions from MSW Unit

Fuel	Rating (MMBtu/hr)	Time (hr/yr)	EF (lb/MMBtu)	Emissions (lb/yr)	Emissions (tons/yr)
MSW (baseline)	350	8,760	0.286	876,876	438
MSW (controlled with SCR)	350	8,760	0.081	248,346	124

The capital and operational costs are sized to the facility size using the six-tenths rule, where:

$C_B = C_A \times (S_B \div S_A)^{0.6}$

- CA is a known cost of equipment of size A
- CB is the estimated cost of equipment of size B
- SB is the size of equipment B
- SA is the size of equipment A

It is standard District policy for Best Available Control Technology (BACT) analyses to use a 10 year life and 10% interest rate unless information indicates otherwise; therefore the capital recovery factor (CRF) of 0.1627 will be used to annualize the capital costs.

It is noted that the FDEP cost analysis is for a new unit with an adequately-sized induced draft (ID) fan. However, for a new unit the ductwork can be designed in a way that minimizes pressure losses, allowing for a smaller ID fan than may be required for a retrofit. Affected sources have provided some estimates for additional electrical costs associated with the larger ID fan required for a retrofit, so these have been incorporated into the analysis. In addition, the FDEP analysis is for a new unit so it does not include the loss of revenue from taking a unit off-line to retrofit the new technology. For each unit it is estimated that the retrofit would require at least six months of downtime at $118/MW-hr; this will be added to the capital cost. Finally, the FDEP analysis specifically ignored sales tax on capital equipment on the grounds it is exempt from sales tax in Florida. This would not be the case in California, so 8% sales tax has been included. The cost effectiveness analysis for installing SCR on a MSW unit is as follows:

Table C-2 Cost Effectiveness for Installing SCR on a MSW Unit

Description of Cost	Cost Factor	Cost	Source
Direct Capital Costs (DC):			
Purchase Equipment Costs (PE):			
(A) Basic Equipment:			
1) SCR System (Quote from Babcock Power)		$6,790,099	FDEP[50]
2) Additional Ductwork (220 ft)	$1,800/ft	$336,110	FDEP
3) Increased ID fan size		$7,384	FDEP
Subtotal of Basic Equipment	A	$7,133,593	
(B) Instrumentation and controls: (1% of A)	0.01 A	$71,336	OAQPS
(C) Freight: (5% of A)	0.05 A	$356,680	OAQPS
(D) Taxes	0.08 (A+B+C)	$604,929	OAQPS
PE Total:		$8,166,538	
Direct Installation Costs (DI): Assume Modular SCR w/ simple installation			
Foundation and Supports:	0.16 PE	$1,306,646	OAQPS
Handling and Erection:	0.40 PE	$3,266,615	OAQPS
Electrical: (quote from CH2M Hill)	0.10 PE	$816,654	Industry
Piping: (quote from CH2M Hill)	0.20 PE	$1,633,308	Industry
Insulation:	0.01 PE	$81,665	OAQPS
Painting:	0.01 PE	$81,665	OAQPS
Costs for Expansion of APC Building for SCR Components (quote Malcolm Pirnie)		$366,665	FDEP
DI Total:		$7,553,218	
Retrofit (Deconstruct existing building/structures, estimated equal to DI total)		$7,553,218	District
Natural gas pipeline (replace fuel oil #2)		$3,000,000	Industry
Site Preparation and Buildings			
DC Total = PE + DI + retrofit + pipeline:		$26,272,974	
Indirect Costs (IC):			
Engineering:	0.10 PE	$816,654	OAQPS
Construction and Field Expenses:	0.05 PE	$408,327	OAQPS
Contractor Fees:	0.10 PE	$816,654	OAQPS
Contingencies:	0.15 PE	$1,224,981	FDEP
Start-up:	0.02 PE	$163,331	OAQPS
Performance Testing:	0.01 PE	$81,665	OAQPS
Retrofit Downtime (6 months minimum, electricity sales and tipping fees)		$11,000,000	Industry
IC Total:		$14,511,612	

[50] All costs from FDEP size-adjusted using six-tenths rule from 460 MMBtu/hr to 350 MMBtu/hr.

Description of Cost	Cost Factor	Cost	Source
Total Capital Investments (TCI = DC + IC):		**$40,794,586**	
Direct Annual Costs (DAC):			
Operating Costs (O): (≈ 1,095 shifts/year @ 3 shifts/day)			
Operator: 1.0 hr/shift	$50/hr	$54,750	FDEP
Supervisor:	15% operator	$8,213	OAQPS
Maintenance Costs (M):			
Labor: 1.0 hr/shift	$50/hr	$54,750	FDEP
Material:	100% labor	$54,750	FDEP
Utility Costs (U):			
Performance loss:	$0.08848/kW-hr	$386,495	FDEP
Electricity Cost: (additional 818 kW[51])	$0.08848/kWhr	$634,019	Industry
Catalyst Replace:		$123,071	FDEP
Total DAC:		$1,316,048	
Indirect Annual Costs (IAC):			
Overhead:	60% O & M	$87,828	OAQPS
Insurance:	0.01 TCI	$407,946	OAQPS
Property Tax:	0.01 TCI	$407,946	OAQPS
Administrative:	0.02 TCI	$815,892	OAQPS
Annualized Total Capital Investment:			
interest rate (%) 10			
Period (years): 10	0.1627 TCI	$6,637,279	District Policy
Total IAC:		$9,672,939	
Total Annual Cost (DAC + IAC):		**$9,672,939**	

Table C-3 Summary of Cost Effectiveness for Installing SCR on a MSW Unit

Fuel Type	Baseline Emissions (tons/yr)	Controlled Emissions (tons/yr)	Emissions Reduced (tons/yr)	Adjusted Annualized Cost ($/yr)	Cost Effectiveness ($/ton)
MSW	438	124	314	$9,672,939	**$30,806/ton**

The cost effectiveness for installing SCR on a MSW fired boiler is $30,806 per ton of NOx reduced. It is important to note that this calculation is based off of a new installation of SCR, not a retrofit as would be required by Valley facilities. While some retrofit expenses have been included, operators would incur significant additional costs when retrofitting to incorporate SCR including expenses for additional ductwork, installation of a new natural gas pipeline to replace the existing fuel oil supply, and

[51] Resized from industry estimate of 2 trains, 628 kW/train, for a 715 MMBtu/hr facility, resized to 350 MMBtu/hr

labor; therefore, District staff assumes the cost effectiveness is even higher than presented in this analysis.

Cost Effectiveness of Gore De-NOx for Municipal Solid Waste Units

The District performed a cost analysis to determine the cost effectiveness of Gore De-NOx for a municipal solid waste unit. The District used the following methodology and assumptions for this cost effectiveness analysis:

Assumptions:

- Baseline emission factor is 0.286 lb-NOx/MMBtu (equivalent to 165 ppmv @ 12% CO2)
- Gore De-NOx provides control to 60 ppmv at 7% O2 (equivalent to 57 ppmv @ 12% CO2)
- Capital cost annualized at 10% interest for 10 years
- The Current ID Fan is sufficient for the Gore De-NOx system (per Manufacturer)
- 3-year catalytic insert life (guarantee from manufacturer)
- De-NOx filter replacements will be financed.

Capital cost data was obtained from the manufacturer. To maximize the emission reductions and economies of scale in estimating the retrofit costs, it is assumed that a 350 MMBtu/hr unit operating at full fire at 100% capacity factor year round for the MSW facility. A 350 MMBtu/hr unit is assumed to be equivalent to approximately an 800 ton/day MSW plant. The purpose of these assumptions is to err on the conservative side throughout the analysis.

Emissions are calculated in the following table:

Table C-4 Emissions from a MSW Unit

Fuel	Rating (MMBtu/hr)	Time (hr/yr)	EF (lb/MMBtu)	Emissions (lb/yr)	Emissions (tons/yr)
MSW (baseline)	350	8,760	0.286	876,876	438
MSW (controlled, Gore De-NOx)	350	8,760	0.099	303,534	152

It is standard District policy for Best Available Control Technology (BACT) analyses to use a 10 year life and 10% interest rate unless information indicates otherwise; therefore the capital recovery factor (CRF) of 0.1627 will be used to annualize the capital costs. The cost effectiveness analysis for installing Gore De-NOx on a MSW unit is as follows:

Table C-5 Cost Effectiveness for Installing Gore De-NOx on a MSW Unit

Description of Cost	Cost Factor	Cost	Source
Direct Capital Costs (DC):			

Description of Cost	Cost Factor	Cost	Source
Purchase Equipment Costs (PE):			
(A) Basic Equipment:			
1) Initial Catalytic Filter Bag Installation		$3,224,000	Manufacturer
2) Two Catalytic Filter Bag Replacements during 10 year span.		$6,448,000	Manufacturer
Subtotal of Basic Equipment	A	$9,672,000	
(B) Instrumentation and controls: (1% of A)		0	Manufacturer
(C) Freight: (5% of A)	0.05 A	$483,600	District
(D) Taxes	0.08 (A+B)	$773,760	Local Rate
PE Total:		$10,929,360	
Direct Installation Costs (DI):			
Foundation and Supports:		0	Manufacturer
Handling and Erection:	0.40 PE	$4,371,744	OAQPS
Electrical: (quote from CH2M Hill)		0	Manufacturer
Piping: (quote from CH2M Hill)		0	Manufacturer
Insulation:		0	Manufacturer
Painting:		0	Manufacturer
DI Total:		$4,371,744	
DC Total = PE + DI:		$15,301,104	
Indirect Costs (IC):			
Engineering:	0.10 PE	$1,092,936	OAQPS
Construction and Field Expenses:	0.05 PE	$546,468	OAQPS
Contractor Fees:	0.10 PE	$1,092,936	OAQPS
Contingencies:	0.15 PE	$1,639,404	OAQPS
Start-up:	0.02 PE	$218,587	OAQPS
Performance Testing:	0.01 PE	$109,294	OAQPS
Retrofit Downtime (1 week for initial install and 2 weeks for replacement, electricity sales and tipping fees)		$1,375,000	Based on estimate in 2015 Plan for 1997 PM2.5 Standard
IC Total:		$6,074,625	
Total Capital Investments (TCI = DC + IC):		$21,375,729	
Direct Annual Costs (DAC):			
Operating Costs (O): (≈ 1,095 shifts/year @ 3 shifts/day)			
Operator: 1.0 hr/shift	$50/hr	$54,750	FDEP
Supervisor:	15% operator	$8,213	OAQPS
Maintenance Costs (M):			
Labor: 1.0 hr/shift	$50/hr	$54,750	FDEP

Description of Cost	Cost Factor	Cost	Source
Material:	100% labor	$54,750	OAQPS
Construction Material Sorting Cost: 292,000 tons sorted/year, Based on 800 tons/day @ 365 days/year	$15/ton	$4,380,000	EU Report[52]
Total DAC:		$4,552,463	
Indirect Annual Costs (IAC):			
Overhead:	60% O & M	$87,828	OAQPS
Insurance:	0.01 TCI	$213,757	OAQPS
Property Tax:	0.01 TCI	$213,757	OAQPS
Administrative:	0.02 TCI	$427,515	OAQPS
Annualized Total Capital Investment: interest rate (%) 10			
Period (years): 10	0.1627 TCI	$3,477,831	District Policy
Total IAC:		$4,420,688	
Total Annual Cost (DAC + IAC):		**$8,973,151**	

Table C-2 Summary of Cost Effectiveness for Installing Gore De-NOx on a MSW Unit

Fuel Type	Baseline Emissions (tons/yr)	Controlled Emissions (tons/yr)	Emissions Reduced (tons/yr)	Adjusted Annualized Cost ($/yr)	Cost Effectiveness ($/ton)
MSW	438	152	286	$8,973,151	**$31,375/ton**

Cost Effectiveness of Covanta LN™ for Municipal Solid Waste Units

The District performed a cost analysis to determine the cost effectiveness of Covanta LN™ for a municipal solid waste unit. The District used the following methodology and assumptions for this cost effectiveness analysis:

Assumptions:

- Baseline emission factor is 0.286 lb-NOx/MMBtu (equivalent to 165 ppmv @ 12% CO_2)
- LN^TN provides control to 90 ppmv @ 12% CO_2, on an annual average (per Covanta)
- Capital cost annualized at 10% interest for 10 years

[52] Source: "Costs for Municipal Waste Management in the EU: Final Report to Directorate General Environment, European Commission" lists a MSW sorting cost range of €14/tonne to €22/tonne, depending on the type of material sorted from the waste. The District conservatively used €14/tonne (equivalent to $15/ton) to estimate the cost to sort construction material from the waste, which is necessary to prevent catalyst poisoning).

Since the Covanta LN™ system is proprietary, capital and operating costs are difficult to obtain directly from the manufacturer. However, the total capital investment and operating costs for an actual; LN™ installation were obtained from the "NOx RACT for Municipal Waste Combustors (MWCs)", a presentation by the Maryland Department of Environment at a stakeholder meeting on January 17, 2017. For three 600 ton/day MSW units, the combined total capital investment for LN™ was approximately $7,500,000 (2017 dollars), or $2,500,000/unit. Per the presentation, the annual combined operating cost was $566,000/year, or about $189,000/unit.

To maximize the emission reductions and economies of scale in estimating the retrofit costs, it is assumed that a 350 MMBtu/hr unit operating at full fire at 100% capacity factor year round for the MSW facility. A 350 MMBtu/hr unit is assumed to be equivalent to approximately an 800 ton/day MSW plant. The purpose of these assumptions is to err on the conservative side throughout the analysis.

The capital and operational costs are sized to the facility size using the six-tenths rule, where:

- CA is a known cost of equipment of size A
- CB is the estimated cost of equipment of size B
- SB is the size of equipment B
- SA is the size of equipment A

$C_B = C_A \times (S_B \div S_A)^{0.6}$

Emissions are calculated in the following table:

Table C-3 Emissions from a MSW Unit

Fuel	Rating (MMBtu/hr)	Time (hr/yr)	EF (lb/MMBtu)	Emissions (lb/yr)	Emissions (tons/yr)
MSW (baseline)	350	8,760	0.286	876,876	438
MSW (controlled, LN™)	350	8,760	0.156	478,296	239

It is standard District policy for Best Available Control Technology (BACT) analyses to use a 10 year life and 10% interest rate unless information indicates otherwise; therefore the capital recovery factor (CRF) of 0.1627 will be used to annualize the capital costs.

The cost effectiveness analysis for installing LN™ on a MSW unit is as follows:

Table C-8 Cost Effectiveness for Installing LN™ on a MSW Unit

Description of Cost	Cost Factor	Cost	Source
Total Capital Investment			
TCI, including 3-months lost revenue for downtime.		$10,300,000	Maryland RACT Presentation[53]
Direct Annual Costs (DAC):			
Total DAC:		225,000	Maryland RACT Presentation[6]
Indirect Annual Costs (IAC):			
Insurance:	0.01 TCI	$103,000	OAQPS
Property Tax:	0.01 TCI	$103,000	OAQPS
Administrative:	0.02 TCI	$206,000	OAQPS
Annualized Total Capital Investment: interest rate (%) 10 Period (years): 10	0.1627 TCI	$1,675,810	District Policy
Total IAC:		$2,087,810	
Total Annual Cost (DAC + IAC):		**$2,312,810**	

Table C-9 Summary of Cost Effectiveness for Installing LN™ on a MSW Unit

Fuel Type	Baseline Emissions (tons/yr)	Controlled Emissions (tons/yr)	Emissions Reduced (tons/yr)	Adjusted Annualized Cost ($/yr)	Cost Effectiveness ($/ton)
MSW	438	239	199	$2,312,810	**$11,622/ton**

In May 2018, the District issued an Authority to Construct to Covanta municipal solid waste combustion operation to implement Covanta LN technology to lower NOx emissions from 165 ppm at 12% CO_2 on a daily average to 110 ppm at 12% CO_2 on a daily average and 90 ppm at 12% CO_2 on an annual average. However, the construction has not started and the feasibility of this technology remains to be demonstrated on a continuous basis. The District will continue to monitor the progress of the implementation of this new technology.

Biomass Facilities

[53] All costs from Maryland RACT Presentation were size-adjusted using six-tenths rule from a 600 tons/day MSW Unit to an 800 ton/day MSW Unit. An additional 7.3 million in lost revenue was added to the adjusted cost from the Maryland RACT presentation. This value was based on an estimated 4-month installation timeline, equivalent to the March through June 2006 timeline for a VLN installation in Bristol Connecticut. The revenue lost was based on a linear adjustment of the revenue losses listed in the 2015 Ozone plan for an MSW plant downtime of 6 months.

Current Status of Biomass Facilities in the Valley and District Exploration of Biomass Alternatives

Historically, the presence of biomass facilities in the Valley has played a vital role in reducing NOx and PM emissions from open burning practices. Until 2014, District restrictions reduced open burning of agricultural waste in the Valley by 80% and much of that waste was diverted to biomass-fired power plants. However, the biomass industry has indicated that given current energy policy in California there is concern that biomass power facilities are in jeopardy. Many biomass plants in the Valley are nearing, or have come to, the end of their long-term contracts with utilities and find themselves in a position where the power that they provide is not the type of power that utilities are seeking (base load vs. intermittent) and that the prices being offered for new contracts are too low to support their operations.

Since 2012, six of the valley's biomass plants have shut down, reducing the valley's biomass power plant capacity by more than 50%. With additional biomass facilities on the brink of closure, it has become even more infeasible to require citrus orchard removals to be sent for use in biomass power plants. At the same time, drought and increase in fallowed land has resulted in an increased need to dispose of agricultural waste. The District anticipates open burning emissions to increase without cost effective alternatives for the disposal of agricultural waste.

The District has convened a number of productive meetings with agricultural stakeholders and representatives of the biomass industry in order to more fully understand the issues faced by the industry and develop a common vision of the future of biomass power amongst the stakeholders in the Valley. The meetings have been helpful in forging a better working relationship between agriculture representatives and biomass power producers and developing consensus on long-term solutions.

In June 2014, the District's Governing Board adopted positions on two pieces of legislation that impact the biomass industry. The District adopted a position in support of AB 2363 (Dahle), which was sponsored by the biomass industry, and would make biomass plants more competitive by fully accounting for the costs associated with intermittent sources of renewable power (solar and wind) when comparing them to other sources of power. AB 2363 was signed by the Governor and will begin to help level the renewable energy playing field. The District also took a position in opposition to SB 1139 (Hueso) that would have given preferential treatment to new geothermal power plants by requiring that utilities purchase specified amounts of new geothermal power. Ultimately, AB 1139 was not passed by the legislature.

On November 14 and 15, 2017, the District hosted the *Central Valley Summit on Alternatives to Open Burning of Agricultural Waste.* In addition to traditional biomass power plants, alternatives to open burning discussed included soil re-incorporation of agricultural waste, composting, conversion of agricultural waste into electrical power or fuels, biochar plants, on-site/portable power production for electrical generation and irrigation well pump power, and air curtain incineration. The district has recently permitted, or is in the process of permitting, permits for several air curtain incinerators and permits for a forest waste gasification/pyrolysis operation that provides syn-gas to two engines for the production of electricity. Additionally, Aemetis has approached the District with a proposal to install a biomass to ethanol plant in Riverbank, and several biochar manufacturers have approached the District with proposals for biochar manufacturing operations. However, traditional biomass power producers continue to play the largest role in reducing the open burning of agricultural waste.

There is consensus that biomass power producers currently are not on a level playing field in competing with other renewable sources of power for utility contracts. They are also not receiving any preferential treatment for the societal benefits for providing a cleaner alternative to the open burning of agricultural waste and assisting with meeting landfill diversion goals. Contracts between power producers and utilities are confidential, but the current market rate that the biomass plants can garner is approximately 6 cents/KWH. This is the rate that the utilities obtain through contracts with solar power providers. This low cost is made possible largely due to government subsidies provided for solar power production. Biomass power producers have indicated that it takes approximately 9-10 cents/KWH for the plants to cover their operating costs.

The District and representatives from agriculture and biomass industries are working to develop and pursue specific actions with the legislative branch, utilities, Public Utility Commission, CalRecycle, and other government agencies to help level the playing field and allow the biomass industry to fairly compete. The District will also continue to work with the stakeholders including the Federal Department of Energy, California Energy Commission, and other partner agencies to pursue clean alternatives to biomass power production for agricultural waste disposal.

Potential Control Technologies to Reduce NOx emissions from Biomass-fired Units

Most existing Biomass fired power plants in the Valley control NOx using selective non-catalytic reduction (SNCR), also referred to as ammonia injection. NOx emission limits for biomass power plants controlled with SNCR systems range from 0.08 lb-NOx/MMBtu to 0.1 lb-NOx/MMBtu (daily average). The current rule 4352 limits NOx emissions from biomass-fired boilers to 90 ppm @ 3% O_2 (equivalent to 0.12 lb/MMBtu using an F-Factor of 9420 dscf/MMBtu).

Selective Catalytic Reduction (SCR) add-on control systems are considered BACT for biomass-fired power plants. SCR systems reduce NOx emissions by converting the emissions to water and elemental nitrogen in the presence of a catalyst. One known issue with the use of SCR systems on biomass-fired power plants is catalyst poisoning and subsequent catalyst activity reduction. In particular, catalyst poisoning by alkali metals is an issue that is unique for biomass-fired plants that are equipped with SCR catalysts. To reduce the potential for catalyst poisoning by alkali metals, SCR systems for biomass-fired units are nearly always tail-end systems, where the SCR catalyst is located downstream of a particulate matter control device. Additionally, wet flue-gas desulfurization systems may be used after the particulate matter control device and prior to the SCR inlet to further reduce the quantity of ash and soluble alkali metals from reaching and poisoning the SCR catalyst. Biomass plants with Selective Catalytic Reduction typically are able to achieve emission rates of 0.065 lb-NOx/MMBtu (daily average), which is just under 50 ppmvd @ 3% O_2.

Cost Effectiveness of Selective Catalytic Reduction for Biomass Plants

As mentioned earlier, most existing facilities in the valley are equipped with SNCR and although it appears that facilities could possibly achieve a lower NOx limit beyond the revised proposed rule amendments, additional NOx control technology such as SCR would be needed. In fact, the installations that are achieving lower NOx emissions are typically installed as new installations equipped with the SCR technology, with one exception. One facility in the Valley has installed SCR on a smaller existing boiler under an experimental research exemption approved in February 2008. In March 2009, the District approved the facility's application to replace the existing SNCR (which had become inoperable) with the SCR installed under the experimental research exemption. This modification did not result in any reduction in permitted emissions as the SCR-equipped boiler is only required to comply with the same emission limit the SNCR-equipped boiler was. This modification was incorporated into the Title V permit in September 2010. While this example may indicate that SCR is technologically feasible as a retrofit for smaller sized biomass-fired boilers, there are many other considerations unique to each facility that may inhibit the retrofit of a SCR system. It is important to note that this cost effectiveness analysis does not take into consideration the current economic struggles of the biomass industry, as previously described.

The District used the following methodology and assumptions for this cost effectiveness analysis:

Assumptions

- Baseline emission factor is 0.11 lb-NOx/MMBtu for Biomass (equivalent to 85ppmv @ 3% O2)
- SCR reduces NOx emissions to 0.004 lb-NOx/MMBtu (annual average, based on review of annual CEMS data for a permitted biomass unit with SCR)
- Capital cost annualized at 10% interest for 10 years

Cost data was obtained from a preconstruction approval by the FDEP issued on December 23, 2010, as described above in the MSW section.

To maximize the emission reductions and economies of scale in estimating the retrofit costs, it is assumed that a 350 MMBtu/hr unit is operating at full fire at 100% capacity factor year round is representative for the Valley biomass facilities. The purpose of these assumptions is to err on the conservative side throughout the analysis.

Table C-10 Emissions from a Biomass Unit

Fuel	Rating (MMBtu/hr)	Time (hr/yr)	EF (lb/MMBtu)	Emissions (lb/yr)	Emissions (tons/yr)
Biomass (baseline)	350	8,760	0.11	337,260	169
Biomass (controlled, SCR)	350	8,760	0.04	122,640	61

It is standard District policy for Best Available Control Technology (BACT) analyses to use a 10 year life and 10% interest rate unless information indicates otherwise; therefore the capital recovery factor (CRF) of 0.1627 will be used to annualize the capital costs.

The cost effectiveness analysis for installing SCR on a biomass unit is as follows:

Table C-4 Cost Effectiveness for Installing SCR on a Biomass Unit

Description of Cost	Cost Factor	Cost	Source
Direct Capital Costs (DC):			
Purchase Equipment Costs (PE):			
(A) Basic Equipment:			
1) SCR System (Quote from Babcock Power)		$6,790,099	FDEP[54]
2) Additional Ductwork (220 ft)	$1,800/ft	$336,110	FDEP
3) Increased ID fan size		$7,384	FDEP
Subtotal of Basic Equipment	A	$7,133,593	
(B) Instrumentation and controls: (1% of A)	0.01 A	$71,336	OAQPS
(C) Freight: (5% of A)	0.05 A	$356,680	OAQPS
(D) Taxes	0.08 (A+B+C)	$604,929	OAQPS
PE Total:		$8,166,538	
Direct Installation Costs (DI): Assume Modular SCR w/ simple installation			
Foundation and Supports:	0.16 PE	$1,306,646	OAQPS
Handling and Erection:	0.40 PE	$3,266,615	OAQPS
Electrical: (quote from CH2M Hill)	0.10 PE	$816,654	Industry
Piping: (quote from CH2M Hill)	0.20 PE	$1,633,308	Industry
Insulation:	0.01 PE	$81,665	OAQPS
Painting:	0.01 PE	$81,665	OAQPS
DI Total:		$7,186,553	
DC Total = PE + DI		$15,353,091	
Indirect Costs (IC):			

[54] All costs from FDEP size-adjusted using six-tenths rule from 460 MMBtu/hr to 350 MMBtu/hr.

Description of Cost	Cost Factor	Cost	Source
Engineering:	0.10 PE	$1,535,309	OAQPS
Construction and Field Expenses:	0.05 PE	$767,655	OAQPS
Contractor Fees:	0.10 PE	$1,535,309	OAQPS
Contingencies:	0.15 PE	$2,302,964	FDEP
Start-up:	0.02 PE	$307,062	OAQPS
Performance Testing:	0.01 PE	$153,531	OAQPS
IC Total:		$6,601,829	
Total Capital Investments (TCI = DC + IC):		$21,954,920	
Direct Annual Costs (DAC): Assume SCR requires 0.5 hrs/shift			
Operating Costs (O): (≈ 1,095 shifts/year @ 3 shifts/day)			
Operator: 1.0 hr/shift	$50/hr	$54,750	FDEP
Supervisor:	15% operator	$8,213	OAQPS
Maintenance Costs (M):			
Labor: 1.0 hr/shift	$50/hr	$54,750	FDEP
Material:	100% labor	$54,750	FDEP
Utility Costs (U):			
Performance loss:	$0.08848/kW-hr	$386,495	FDEP
Electricity Cost: (additional 818 kW[55])	$0.08848/kWhr	$634,019	Industry
Catalyst Replace:		$123,071	FDEP
Total DAC:		$1,316,048	
Indirect Annual Costs (IAC):			
Overhead:	60% O & M	$87,828	OAQPS
Insurance:	0.01 TCI	$219,549	OAQPS
Property Tax:	0.01 TCI	$219,549	OAQPS
Administrative:	0.02 TCI	$439,098	OAQPS
Annualized Total Capital Investment: interest rate (%) 10			
Period (years): 10	0.1627 TCI	$3,572,065	District Policy
Total IAC:		$4,538,089	
Total Annual Cost (DAC + IAC):		**$5,854,137**	

Emissions are calculated in the following table:

Table C-5 Summary of Cost Effectiveness for installing SCR on a Biomass Unit

Fuel Type	Baseline Emissions (tons/yr)	Controlled Emissions (tons/yr)	Emissions Reduced (tons/yr)	Adjusted Annualized Cost ($/yr)	Cost Effectiveness ($/ton)

[55] Resized from industry estimate of 2 trains, 628 kW/train, for a 715 MMBtu/hr facility, resized to 350 MMBtu/hr

Biomass	169	61	108	5,854,137	**$54,205/ton**

Other Solid Fuels

Current Status of Other Solid Fuel Fired Units in the Valley

One facility in the Valley operates a unit that is permitted to fire on coal/biomass; however, the unit has only been fired on biomass since 2013. This facility is equipped with a baghouse for PM10 control, dry lime injection for SOx control, and a selective non-catalytic reduction system for NOx control.

Potential NOx Control Technologies for Other Solid Fuel Fired Units

Other solid fuel fired facilities are generally equipped with Selective Non-Catalytic Reduction (SNCR) and utilize this technology to meet emission the Rule 4352 emission limit of 65 ppmv @ 3% O_2. Selective Catalytic Reduction (SCR) is an add-on control system that may be used to reduce NOx emissions from other solid fuel fired units. SCR systems reduce NOx emissions by converting the emissions to water and elemental nitrogen in the presence of a catalyst. Using SCR, other solid fuel fired units would be expected to achieve emission rates at low as 0.04 lb-NOx/MMBtu on an annual average. The District used the following methodology and assumptions for this cost effectiveness analysis:

Assumptions

- Baseline emission factor is 0.09 lb-NOx/MMBtu coal/petcoke/other fuels (equivalent to 65ppmv @ 3% O2)
- SCR reduces NOx emissions to 0.04 lb-NOx/MMBtu (annual average, based on review of annual CEMS data for a permitted biomass unit with SCR)
- Capital cost annualized at 10% interest for 10 years

Cost data was obtained from a preconstruction approval by the FDEP issued on December 23, 2010 as described above in the MSW section.

To maximize the emission reductions and economies of scale in estimating the retrofit costs, it is assumed that a 350 MMBtu/hr unit is operating at full fire at 100% capacity factor year round is representative for the Valley solid-fired fuel facilities. The purpose of these assumptions is to err on the conservative side throughout the analysis.

Table C-6 Emissions from an Other Solid Fuel Fired Unit

Fuel	Rating (MMBtu/hr)	Time (hr/yr)	EF (lb/MMBtu)	Emissions (lb/yr)	Emissions (tons/yr)
Other(baseline)	350	8,760	0.09	275,940	138
Other (controlled, SCR)	350	8,760	0.04	122,640	61

It is standard District policy for Best Available Control Technology (BACT) analyses to use a 10 year life and 10% interest rate unless information indicates otherwise; therefore the capital recovery factor (CRF) of 0.1627 will be used to annualize the capital costs. The cost effectiveness analysis for installing SCR on an other solid fuel fired unit is as follows:

Table C-7 Cost Effectiveness for Installing SCR on Other Solid Fired Fuel Unit

Description of Cost	Cost Factor	Cost	Source
Direct Capital Costs (DC):			
Purchase Equipment Costs (PE):			
(A) Basic Equipment:			
4) SCR System (Quote from Babcock Power)		$6,790,099	FDEP[56]
5) Additional Ductwork (220 ft)	$1,800/ft	$336,110	FDEP
6) Increased ID fan size		$7,384	FDEP
Subtotal of Basic Equipment	A	$7,133,593	
(B) Instrumentation and controls: (1% of A)	0.01 A	$71,336	OAQPS
(C) Freight: (5% of A)	0.05 A	$356,680	OAQPS
(D) Taxes	0.08 (A+B+C)	$604,929	OAQPS
PE Total:		$8,166,538	
Direct Installation Costs (DI): Assume Modular SCR w/ simple installation			
Foundation and Supports:	0.16 PE	$1,306,646	OAQPS
Handling and Erection:	0.40 PE	$3,266,615	OAQPS
Electrical: (quote from CH2M Hill)	0.10 PE	$816,654	Industry
Piping: (quote from CH2M Hill)	0.20 PE	$1,633,308	Industry
Insulation:	0.01 PE	$81,665	OAQPS
Painting:	0.01 PE	$81,665	OAQPS
DI Total:		$7,186,553	
DC Total = PE + DI		$15,353,091	
Indirect Costs (IC):			
Engineering:	0.10 PE	$1,535,309	OAQPS
Construction and Field Expenses:	0.05 PE	$767,655	OAQPS
Contractor Fees:	0.10 PE	$1,535,309	OAQPS
Contingencies:	0.15 PE	$2,302,964	FDEP
Start-up:	0.02 PE	$307,062	OAQPS
Performance Testing:	0.01 PE	$153,531	OAQPS
IC Total:		$6,601,829	
Total Capital Investments (TCI = DC + IC):		$21,954,920	
Direct Annual Costs (DAC): Assume SCR requires 0.5 hrs/shift			
Operating Costs (O): (≈ 1,095 shifts/year @ 3 shifts/day)			

[56] All costs from FDEP size-adjusted using six-tenths rule from 460 MMBtu/hr to 350 MMBtu/hr.

Description of Cost	Cost Factor	Cost	Source
Operator: 1.0 hr/shift	$50/hr	$54,750	FDEP
Supervisor:	15% operator	$8,213	OAQPS
Maintenance Costs (M):			
Labor: 1.0 hr/shift	$50/hr	$54,750	FDEP
Material:	100% labor	$54,750	FDEP
Utility Costs (U):			
Performance loss:	$0.08848/kW-hr	$386,495	FDEP
Electricity Cost: (additional 818 kW[57])	$0.08848/kWhr	$634,019	Industry
Catalyst Replace:		$123,071	FDEP
Total DAC:		$1,316,048	
Indirect Annual Costs (IAC):			
Overhead:	60% O & M	$87,828	OAQPS
Insurance:	0.01 TCI	$219,549	OAQPS
Property Tax:	0.01 TCI	$219,549	OAQPS
Administrative:	0.02 TCI	$439,098	OAQPS
Annualized Total Capital Investment: interest rate (%) 10			
Period (years): 10	0.1627 TCI	$3,572,065	District Policy
Total IAC:		$4,538,089	
Total Annual Cost (DAC + IAC):		**$5,854,137**	

Table C-8 Summary of Cost Effectiveness for installing SCR on Other Solid Fuel Fired Unit

Fuel Type	Baseline Emissions (tons/yr)	Controlled Emissions (tons/yr)	Emissions Reduced (tons/yr)	Adjusted Annualized Cost ($/yr)	Cost Effectiveness ($/ton)
Other	138	61	77	5,854,137	**$76,028/ton**

Controls for Direct PM2.5 Emissions from All Unit Types

The District researched the potential opportunity of specifying required controls for direct PM2.5 emissions. Three technologies were recognized as being able to potentially reduce direct PM2.5 emissions: electrostatic precipitators (ESPs), baghouses, and cyclones.

An ESP is a particulate collection device that removes particles from a flowing gas using the force of an electrostatic charge with a 90- 99.9% control efficiency of PM2.5 for solid

[57] Resized from industry estimate of 2 trains, 628 kW/train, for a 715 MMBtu/hr facility, resized to 350 MMBtu/hr

fuel fired boilers within the 100-500 MMBtu/hr size range of District units.[58] A baghouse, on the other hand, is a technology in which particulates are removed from a stream of exhaust gases as the stream passes through a large cloth bag. Baghouses have a PM2.5 removal effectiveness of 90-99.9% for solid fuel fired boilers in the size range of District units.[59] Coal and coke-fired units generally use baghouses, but biomass boilers usually use ESPs because of the health and safety risk of the burning embers causing a fire in the baghouse. However, when cyclones are combined with the use of a baghouse, the burning embers are extinguished and allow for the use of a baghouse in a biomass facility[60]. This also reduces acid gases and some PM2.5 compared to the use of a baghouse alone.

All of the facilities subject to Rule 4352 have installed either a baghouse or ESP particulate matter removal system due to permitting requirements. Since the control efficiency ranges for both technologies are equivalent, there are currently no other PM controls more effective than current practices.

Start-up Periods

The possibility of reducing the allowed start-up period of solid fuel fired boilers was considered, since facilities are exempt from emissions limits during this period. Facilities subject to Rule 4352 are currently subject to a start-up limit of 96 hours. Operators currently limit their start-up and shut-down times as much as possible since down time results in reduced productivity and profits. However, facilities periodically perform "cold repairs" on their solid fuel fired boilers for maintenance or trouble-shooting purposes. This requires operators to completely shut down the boilers, which in turn requires a longer start-up period to return to correct operating temperature. When the solid fuel fired boilers are starting up, the units are not operating with a full load which reduces emissions. Therefore, this is not a technologically feasible option for solid fuel fired facilities given the needs of current work practices.

EVALUATION FINDINGS

Municipal Waste-Fired Units

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this category. As demonstrated above, Rule 4352 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds both BACM and MSM requirements for this source category. The District's evaluation of potential control technologies has found that the Gore De-NOx and Selective Catalytic Reduction technologies demonstrated in Europe are extremely costly, require

[58] Senior, C., Afonso, R. (January 2009). *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.* Northeast States for Coordinated Air Use Management.
[59] Senior, C., Afonso, R. (January 2009). *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.* Northeast States for Coordinated Air Use Management.
[60] Roberts, C. (2009). *Information on Air Pollution Control Technology for Woody Biomass Boilers.* Northeast States for Coordinated Air Use Management and the EPA Office of Air Quality Planning and Standards.

additional evaluation for feasibility, and are overall economically infeasible in this sector. The District's evaluation of the Covanta LN NOx technology has found that, while costly, installation of this technology may be cost-effective. While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, the District will pursue the following potential opportunities to reduce NOx emissions for municipal waste-fired units to the extent that additional NOx controls are technologically and economically feasible:

- Lower NOx limit from 165 ppmv @ 12% CO_2 to 110 ppmv @ 12% CO_2 over 24-hr period and 90 ppmv @ 12% CO_2 over annual period
- Evaluate feasibility of lower NOx emission levels

<u>Biomass-Fired Units</u>

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this category. As demonstrated above, Rule 4352 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds both BACM and MSM requirements for this source category.

The proposed commitments by the District and CARB will each achieve an aggregate emission reduction of direct PM2.5 and NOx. While the commitments include estimates of the emission reductions from each individual measure, final measures as proposed for adoption into the state implementation plan (SIP) may provide more or less emission reductions. The aggregate commitment will guarantee that the total emission reductions will be achieved to attain each NAAQS as expeditiously as practicable.

C.14 Rule 4354 (Emissions from Glass Melting Furnaces)

Discussion

The provisions of Rule 4354 are applicable to glass melting furnaces in the San Joaquin Valley. The purpose of this rule is to limit nitrogen oxides (NOx), sulfur oxides (SOx), volatile organic compounds (VOC), carbon monoxide (CO), and particulate matter (PM_{10}) emissions from glass melting furnaces.

Rule 4354 was adopted on September 14, 1994, and has been subsequently amended six times. EPA finalized approval of the most recent amendments to Rule 4354 on January 31, 2013, and deemed this rule as being as stringent as, if not more stringent than, established RACT requirements. As a result of this stringent prohibitory rule and continuing efforts on behalf of this industry to reduce emissions, the Valley is home to six glass-making facilities with glass melting furnaces that utilize the most advanced low-NOx firing technology. The NOx emission limits contained within Rule 4354 require the installation of the best available NOx technology (i.e. oxy-fuel firing or SCR systems).

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.34	0.17	0.18	0.18	0.19	0.20	0.20	0.20	0.20
NOx	6.21	3.20	3.30	3.32	3.41	3.50	3.50	3.50	3.50
	Winter Average - Tons per day								
PM2.5	0.34	0.17	0.18	0.18	0.19	0.20	0.20	0.20	0.20
NOx	6.21	3.20	3.30	3.32	3.41	3.50	3.50	3.50	3.50

Source Category

Industrial glass making is a continuous process with raw materials supplied to the furnace at the front end, and product taken off the line at the back end of the process. The raw materials for making glass are silica sand and soda ash. Melting these basic materials and forming them into the desired product geometry creates the final glass product. The different end products vary widely in raw material additives, processing equipment and conditions, and product quality requirements. The emission limits of Rule 4354 depend on the type of glass produced, furnace firing technology and the emission-averaging period.

How does District Rule 4354 compare with federal and state rules and regulations?

Federal Regulations

There are no EPA CTG requirements for this source category

Alternative Control Techniques (ACT)

- EPA-453/R-94-37 - NOx Emissions from Glass Manufacturing (June 1994)

The District evaluated the requirements contained within the ACT for NO_X Emissions from glass melting furnaces and found no requirements that were more stringent than those already required by Rule 4354.

New Source Performance Standards (NSPS)

- 40 CFR 60 Subpart CC - Standards of Performance for Glass Manufacturing Plants (Amended October 17, 2000)

40 CFR 60 Subpart CC was last amended on October 17, 2000. However, this subpart only applies to glass melting furnaces that commenced construction or modification after June 15, 1979. All of the glass melting furnaces currently located within the District commenced construction prior to June 15, 1979 and have not been modified (as defined in subpart CC) since that time. Therefore, none of the glass plants located within the District are subject to the requirements of Subpart CC and its requirements have not been included as a part of this control measure source category evaluation.

- 40 CFR 60 Subpart PPP - Standards of Performance for Wool Fiberglass Manufacturing Plants (Amended October 17, 2000)

The District evaluated the requirements contained within Subpart PPP and found no requirements that were more stringent than those already in Rule 4354.

National Emissions Standards for Hazardous Air Pollutants (NESHAP)/Maximum Achievable Control Technology (MACT)

- 40 CFR 61 Subpart N – National Emission Standard for Inorganic Arsenic Emissions from Glass Manufacturing Plants

40 CFR 61 Subpart N was last amended on February 27, 2014; however, this NESHAP only regulates inorganic arsenic emissions and therefore does not apply to this control measure source category evaluation.

- 40 CFR 63 Subpart NN – National Emission Standards for Hazardous Air Pollutants for Wool Fiberglass Manufacturing at Area Sources

The District evaluated the requirements contained within Subpart NN and found no requirements that were more stringent than those already in Rule 4354.

- 40 CFR 63 Subpart NNN – National Emission Standards for Hazardous Air Pollutants for Wool Fiberglass Manufacturing

The District evaluated the requirements contained within Subpart NNN and found no requirements that were more stringent than those already in Rule 4354.

- 40 CFR 63 Subpart HHHH – National Emission Standards for Hazardous Air Pollutants for Wet-Formed Fiberglass Mat Production

40 CFR 63 Subpart HHHH was last amended on April 20, 2006; however, this NESHAP only contains emission limits and regulations to reduce formaldehyde emissions. Formaldehyde is an organic compound which is most closely related to VOC emissions. This control measure analysis does not apply to VOC emissions. Therefore, the requirements of Subpart HHHH have not been included as a part of this control measure source category evaluation.

- 40 CFR 63 Subpart SSSSSS – National Emission Standards for Hazardous Air Pollutants for Glass Manufacturing Area Sources

The District evaluated the requirements contained within Subpart SSSSSS and found no requirements that were more stringent than those already in Rule 4354.

State Regulations
There are no state regulations applicable to this source category.

HOW DOES DISTRICT RULE 4354 COMPARE TO RULES IN OTHER AIR DISTRICTS?

There are no analogous rules for this source category in SMAQMD and VCAPCD

SCAQMD

- SCAQMD Rule 1117 (Emissions of Oxides of Nitrogen from Glass Melting Furnaces) *(Amended January 6, 1984)*

The District evaluated the control requirements in SCAQMD Rule 1117, and found no requirements that were more stringent than those already in Rule 4354.

	SJVAPCD	SCAQMD
Applicability	The provisions of this rule shall apply to any glass melting furnaces for the production of, container glass, fiberglass, and flat glass	This rule limits the emission of nitrogen oxides (NOx) from glass melting furnaces.
Exemption	• Electric furnaces which all heat is provided by electric current from electrodes. • Any glass melting furnace that is part of a stationary source with a total potential to emit for all processes, less than 10.0 tons/yr of NOx and less than 10.0 tons/yr of VOC. • A unit that meets all of the following criteria is not subject to the PM_{10} emission limits or the PM_{10} monitoring requirements of the rule:	• Furnaces which are limited by Permit to operate to 15 lbs/hour of NOx or less. • Glass remelt facilities using exclusively glass cullet, marbles, chips, or similar feedstock in lieu of basic glass-making raw materials. • Furnaces used in the melting of glass for the production of glass tableware exclusively. • Flat glass melting furnaces.

	- Furnace has permitted glass production capacity less 5 tons/day. - Total actual NO_X emissions for a facility less than 8 tons/year. - Total actual VOC emissions for a facility less than 8 tons/year.		• Furnaces used in the melting of glass for the production of fiberglass exclusively. • Idling furnaces.
Requirements	The operator of any glass melting furnace shall not operate a furnace in such a manner that results in NO_X or PM_{10} emissions exceeding the following limits:		After December 31, 1992, no person shall operate a furnace capable of discharging NO_X into the atmosphere unless such discharge of NO_X in to the atmosphere is limited to the following:
	Container Glass:		
	NO_X	1.5 lb/ton[B]	4.0 lb/ton[A]
	PM_{10}	0.50 lb/ton[A]	No Limit Specified
	Fiberglass:		
	NO_X	1.3 lb/ton[A, C] 3.0 lb/ton[A, D]	No Limit Specified, Exempt
	PM_{10}	0.50 lb/ton[A]	No Limit Specified, Exempt
	Flat Glass:		
	NO_X Standard Option	3.7 lb/ton[A] 3.2 lb/ton[B]	No Limit Specified, Exempt
	NO_X Enhanced Option	3.4 lb/ton[A] 2.9 lb/ton[B]	
	PM_{10}	0.70 lb/ton[A]	No Limit Specified, Exempt

[A] Block 24-hour average
[B] Rolling 30-day average
[C] Not subject to California Public Resources Code Section 19511
[D] Subject to California Public Resources Code Section 19511

BAAQMD

- BAAQMD Regulation 9 Rule 12 (Nitrogen Oxide Emissions from Glass Melting Furnaces) *(Adopted January 19, 1994)*

The District evaluated the control requirements in BAAQMD Rule 9-12, and found no requirements that were more stringent than those already in Rule 4354.

	SJVAPCD		BAAQMD
Applicability	The provisions of this rule shall apply to any glass melting furnaces for the production of, container glass, fiberglass, and flat glass		This rule limits the emission of nitrogen oxides (NOx) from glass melting furnaces.
Exemption	• Electric furnaces which all heat is provided by electric current from electrodes. • Any glass melting furnace that is part of a stationary source with a total potential to emit for all processes, less than 10.0 tons/yr of NOx and less than 10.0 tons/yr of VOC. • A unit that meets all of the following criteria is not subject to the PM_{10} emission limits or the PM_{10} monitoring requirements of the rule: - Furnace has permitted glass production capacity less 5 tons/day. - Total actual NO_X emissions for a facility less than 8 tons/year - Total actual VOC. emissions for a facility less than 8 tons/year.		• Electric furnaces which all heat is provided by electric current from electrodes. • Furnaces with a production capacity of 4550 kg (5 short tons) of glass per day or less.
Requirements	The operator of any glass melting furnace shall not operate a furnace in such a manner that results in NO_X or PM_{10} emissions exceeding the following limits:		A person subject to this rule shall reduce nitrogen oxide emissions (NO_X) from any glass melting furnace until emissions do not exceed the following limits:
	Container Glass:		
	NO_X	1.5 lb/ton[B]	5.5 lb/ton, averaged over any consecutive 3-hour period
	PM_{10}	0.50 lb/ton[A]	No Limit Specified

	Fiberglass:		
	NO_X	1.3 lb/ton[A, C]	5.5 lb/ton, averaged over any consecutive 3-hour period
		3.0 lb/ton[A, D]	
	PM_{10}	0.50 lb/ton[A]	No Limit Specified
	Flat Glass:		
	NO_X Standard Option	3.7 lb/ton[A]	5.5 lb/ton, averaged over any consecutive 3-hour period
		3.2 lb/ton[B]	
	NO_X Enhanced Option	3.4 lb/ton[A]	
		2.9 lb/ton[B]	
	PM_{10}	0.70 lb/ton[A]	No Limit Specified

[A] Block 24-hour average
[B] Rolling 30-day average
[C] Not subject to California Public Resources Code Section 19511
[D] Subject to California Public Resources Code Section 19511

Additional Emission Reduction Opportunities

Owens-Brockway Facility Location in Vernon, CA (SCAQMD)

Owens-Brockway operates a glass container manufacturing facility located in Vernon, CA. Prior to 2017, the facility consisted of two oxy-fuel fired glass melting furnaces. In the 4th quarter of 2017, this facility underwent construction and modification to install a Tri-Mer UltraCat ceramic catalytic filtration system (SCR system) on the exhaust of each of the oxy-fuel fired glass furnaces operated at this facility. This type of installation, pairing an oxy-fuel fired glass melting furnace with an SCR system, is the first of its kind anywhere in the world. Tri-Mer, the manufacturer and supplier of the SCR system installed at this facility, stated that with these two NO_X control systems in operation together, these glass furnaces could be able to achieve NO_X emission rates at a level as low as 0.20 pounds of NO_X per ton of glass produced.

The Owens-Brockway facility has been operating the oxy-fuel fired glass furnaces with the new SCR systems since the 1st quarter of 2018. Their preliminary source test data shows their furnace emissions levels are meeting 0.20 pounds of NO_X per ton of glass produced, on a 1-hour average basis. However, based on discussions the District has had with Owens-Brockway facility staff, they have experienced wide ranging spikes in their NO_X emissions from the glass furnaces while operating the new control systems and are still tuning the glass furnaces and control system operating parameters to optimize their NO_X emission control and still have the ability to produce a quality product. At this time, it is also not known how the new ceramic catalyst will perform over time and if the facility will be able to sustain emission rates as low as 0.20 pounds of NO_X per ton of glass produced.

In addition, despite continued efforts, the District has not been able to obtain the necessary information to reconcile Continuous Emission Monitoring System (CEMS) data with production data from the plant (glass pulled per hour, day, and month) to demonstrate continuous compliance with the 0.20 lb-NOx/tons of glass produced RECLAIM target. In conclusion, this technology is still under development, has not yet been achieved in practice, is not established as an enforceable permit limit or control measure, and cannot yet be considered a feasible technology at this time.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for glass melting furnaces. As demonstrated above, Rule 4354 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, the District will pursue the following potential opportunities to reduce NOx emissions for container glass furnaces to the extent that additional NOx controls are technologically and economically feasible:

- Evaluate feasible ultra low-NOx control technologies (catalytic filtration, oxy-fuel combined with SCR, etc.)
- Lower NOx limit from 1.5 lb/ton to a level ranging from 1.0-1.2 lb-NOx/ton glass pulled or lower, based on a rolling 30-day average

The proposed commitments by the District and CARB will each achieve an aggregate emission reduction of direct PM2.5 and NOx. While the commitments include estimates of the emission reductions from each individual measure, final measures as proposed for adoption into the state implementation plan (SIP) may provide more or less emission reductions. The aggregate commitment will guarantee that the total emission reductions will be achieved to attain each NAAQS as expeditiously as practicable.

C.15 RULE 4550 (CONSERVATION MANAGEMENT PRACTICES)

DISCUSSION

Rule 4550 is the District's Conservation Management Practices (CMP) rule. Rule 4550 was the first rule of its kind in the nation to reduce fugitive particulate emissions from agricultural operations through the required reduction in the number of passes through a field taken by agricultural equipment and through the implementation of other conservation practices. Rule 4550 established a then-unique menu approach of control techniques to accommodate the wide variability of agricultural industries found in the San Joaquin Valley, which approach has since been duplicated by other agencies. The selected CMPs are listed on application forms that are submitted to the District for approval as a CMP Plan. Approved CMP plans are enforced through onsite inspections and operators are required to submit applications to modify their plans when changing their conservation management practices. Agricultural operations are then required to maintain detailed records verifying use of the approved Conservation Management Practices. Through this rule, PM10 emissions have been reduced by 35.3 tons per day, which is approximately a 24% reduction for this source category.

The District worked extensively with stakeholders, growers, and the Agricultural Technical Committee for the San Joaquin Valley-wide Air Pollution Study Agency (AgTech) for two years prior to developing the original Conservation Management Practices (CMP) Rule, researching and gathering information on conservation management practices, their effectiveness in reducing PM10 emissions, and variations in effectiveness varied with various soil parameters, crop and animal types, and agronomic practices. Rule 4550 was adopted on August 19, 2004, as a PM10 control measure to help bring the Valley into attainment of federal PM10 standards. As noted above, Rule 4550 has since served as a model for other regions seeking to reduce fugitive PM10 emissions from agricultural sources.

Upon adoption of Rule 4550, the District embarked on an ambitious implementation strategy, working extensively with agricultural stakeholders to ensure that affected sources were assisted as much as possible in complying with the requirements, and consequently ensuring that the CMP Program was successful. To this end, the District created special CMP application forms, which were designed to allow growers to select approved practices from simplified checklists. A special web page was created that contains answers to frequently asked questions, application forms, and other forms of assistance for agricultural operations. The District hired additional staff, including additional Small Business Assistance (SBA) staff, and took part in over 40 workshops throughout the Valley to assist sources in completing and submitting the required CMP application forms. The workshops were coordinated with agricultural stakeholders, and tremendous outreach was performed to ensure that as many affected sources as possible would attend and receive assistance at the workshops.

As a result of these efforts, the District's CMP Program realized the following notable achievements:

- Approximately 4,000 participants attended workshops, with many of the participants submitting CMP Plan applications during the workshops.
- The District received and processed over 6,000 CMP Plan applications during 2005.
- The practices used by Valley agricultural sources encompass 3.2 million acres of farmland, and over 30,000 miles of unpaved roads.
- The PM10 reductions are quantifiable and enforceable through approved CMP plans and subsequent inspections.
- The collaborative effort that resulted in the CMP program received US EPA Region IX's "2005 Environmental Award for Outstanding Achievement."

The District also conducted an additional 60 workshops throughout the Valley since 2005 for the purpose of assisting sources to comply with the CMP rule and other ag-related issues and requirements.

EPA finalized approval of Rule 4550 on February 14, 2006 and determined that the rule met BACM requirements.[61] Subsequent to EPA's approval of Rule 4550, two separate lawsuits were filed challenging EPA's approval of the rule as satisfying BACM. The Ninth District Court of Appeals, in both cases, agreed with EPA's approval and reaffirmed EPA's finding that the District's Rule 4550 meets BACM requirements.[62,63]

EMISSIONS INVENTORY

While Rule 4550 was designed to reduce PM10, and was very successful in doing so, it also generates reductions of PM2.5, as discussed in more detail later in this chapter. The emissions inventory for the category, as impacted by the current rule, is as follows:

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	18.78	18.54	18.30	18.22	18.14	18.06	17.98	17.90	17.82
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day								
PM2.5	15.05	14.82	14.59	14.51	14.43	14.35	14.28	14.20	14.12
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

[61] 71 Federal Register 30, 7683-7688. (2006, February 14). *Revisions to the California State Implementation Plan; San Joaquin Valley Unified Air Pollution Control District*. Retrieved from http://www.gpo.gov/fdsys/pkg/FR-2006-02-14/pdf/06-1311.pdf

[62] U.S. Court of Appeals for the Ninth Circuit. *Latino Issues Forum v. EPA.* Retrieved from http://njlaw.rutgers.edu/collections/resource.org/fed_reporter/NEWcircs/cir9/0671907_cir9.html

[63] SJVAPCD. *Court rules in favor of Air District ag rule. Second decision this week affirms PM progress.* Retrieved from https://www.valleyair.org/recent_news/Media_releases/2009/PR%20Court%20decision%20favors%20District%20ag%20rule.pdf

SOURCE CATEGORY

This rule is applicable to on-field farming and agricultural operation sites located within the Valley, and was adopted to reduce emissions of PM10 from such operations. Rule 4550 limits fugitive dust emissions from farming operations by requiring CMP plans for farms with 100 acres or more, dairies with 500 or more mature cows, cattle feedlots with 190 or more cows, turkey ranches with 55,000 or more turkeys, chicken ranches with 125,000 or more chickens, and chicken egg ranches with 82,000 or more laying hens.

Rule 4550 specifies that agricultural operations must select at least one CMP from each of the identified applicable CMP categories discussed below, and as many as three CMPs per category, to control PM10 emissions. There are five CMP categories for the cropland source category, four CMP categories for the dairy source category, four CMP categories for the feedlot source category, and five CMP categories for the poultry source category. Animal feeding operation (AFO) sources subject to Rule 4550 that also grow field crops must select CMPs for their field crops, as well as their AFO. The selected CMPs must be noted on the applications provided and then submitted to the District for approval. Completed applications constitute a CMP Plan once approved by the District.

Emissions from agricultural operations vary by many factors, some beyond the control of the agricultural operations. Particulate emissions (primarily PM10) are generated during land preparation activities, harvest activities, and post-harvest activities. Emissions are caused by the mechanical disturbance of the soil by implements and the tractors pulling them, resulting in the entrainment of soil or plant materials into the air. Wind blowing across exposed agricultural land also causes the entrainment of particulates into the air. In addition, particulate emissions can also become entrained from vehicular travel over unpaved roads and unpaved parking/equipment areas. Conservation management practices fall into several broad categories and are intended to reduce emissions as follows:

- The reduction of soil or manure disturbance;
- Soil protection from wind erosion;
- Equipment modifications to physically produce less particulates; and
- Application of water or dust suppressants on unpaved roads and other travel areas to reduce emissions entrained by moving vehicles and equipment.

<u>Fugitive PM2.5 Dust Emissions from Agricultural Operations</u>

Rule 4550 was intended and designed to reduce PM10, and it has been successful in doing so, reducing 35.3 tons per day of PM10 from agricultural operations. However, as discussed in more detail below, recent studies have indicated that the PM2.5 fraction of emissions makes up a small portion of the total particulate emissions from agricultural operations, and therefore Rule 4550 and other conservation management-based rules are less effective at reducing PM2.5.

Additionally, particulate emissions from agricultural operations are geologic in nature (dust). Analysis of data from ambient PM2.5 monitors has demonstrated that these geologic particulate emissions make up a relatively small portion of the overall PM2.5 concentrations during the winter season.[64] In addition, these geologic particulate emissions in the San Joaquin Valley have relatively low toxicity relative to the organic carbon fraction of PM2.5 and to re-suspended road dust. [65]

Accordingly, particulate emissions from agricultural sources do not play a significant role with regard to attainment of the PM2.5 standards addressed by this plan, and Rule 4550 remains primarily a PM10 reduction strategy. For example, the latest available speciation analyses of PM2.5 from the Speciated Trends Network in Bakersfield, Modesto, and Visalia found that the annual average geologic fraction during 2011-2013 was 12%, 5%, and 6%, respectively, and the speciation analysis of PM2.5 in Fresno during 2012-2014, found that the annual average geologic fraction was 7%.[66] Given that PM2.5 emissions from agricultural field operations are generally subject to deposition near their source, the predominant source of this geologic PM2.5 would be urban re-suspended road dust with relatively little contribution from agricultural activities.[67]

As discussed below, the most recent science has demonstrated that PM2.5 emissions from agricultural field operations had previously been significantly over-estimated in absolute terms due to species differences between the fine and coarse fractions of geologic emissions. For example, in 2003, Countess Environmental estimated the PM2.5/PM10 ratios for the predominant trace elements found in fugitive dust using Valley ambient measurements of such elements. The average ratio for aluminum and silicon was 0.05 and ranged between 0.10 to 0.16 for calcium, titanium, and iron. Based on the relative abundances of these elements in fugitive dust, the overall PM2.5/PM10 ratio was estimated to be 0.06 (6%).[68] This ratio estimate is substantially

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[64] See: California Air Resources Board (2016) Meeting PM2.5 Standards in the San Joaquin Valley. Public Workshop. Fresno, CA. December 1, 2016. https://www.arb.ca.gov/planning/sip/sjvpm25/workshopslides.pdf and California Air Resources Board (2012) ARB Staff Report: Proposed Revision to the PM2.5 State Implementation Plan (SIP) for the San Joaquin Valley, Appendix B: Weight of Evidence Analysis. https://www.arb.ca.gov/planning/sip/sjvpm25/2012plan_appendix_b.pdf

[65] Veranth, J., Rielly, C.A., Veranth, M.M., Moss, T.A., Langelier, C.R., Lanza, D.L., & Yost, G.S. (2004). Inflammatory Cytokines and Cell Death in BEAS-2B Lung Cells Treated with Soil Dust, Lipopolysaccharide, and Surface-Modified Particles. *Toxicological Science 82(1)*, 88–96. http://toxsci.oxfordjournals.org/content/82/1/88.full.pdf+html doi: 10.1093/toxsci/kfh24

Rogge, W. F., Hildemann, L. M., Mazurek, M. A., Cass, G. R. and Simoneit, B. R. T. *Sources of Fine Organic Aerosol—3. Road Dust, Tire Debris, and Organometallic Brake Lining Dust—Roads as Sources and Sinks*. Environmental Science & Technology 27(9), 1892-1904. 1993.

[66] California Air Resources Board (2016) ARB Staff Report: ARB Review of San Joaquin Valley 2016 Moderate Area Plan for the 2012 PM2.5 Standard https://www.arb.ca.gov/planning/sip/sjvpm25/2016pm25/2016pm25staffreport.pdf

San Joaquin Valley Air Pollution Control District (SJVAPCD) 2016 Moderate Area Plan for the 2012 PM2.5 Standard, Chapter 2 Risk-Based Strategy. http://www.valleyair.org/Air_Quality_Plans/docs/PM25-2016/2016-Plan.pdf

California Air Resources Board (2015) Modeling Documentation for the 2015 PM2.5 Plan for the San Joaquin Valley, Methodology and Results - Attainment Demonstration for the San Joaquin Valley 2015 PM2.5 Plan for the Annual (15 µg/m3) and 24-Hour (65 µg/m3) Standards. https://www.arb.ca.gov/planning/sip/planarea/Attainment_Demo_Methodology_and_Results.pdf

[67] Countess, R. (2001) Methodology for Estimating Fugitive Windblown and Mechanically Resuspended Road Dust Emissions Applicable for Regional Air Quality Modeling, 10th Annual EPA Emissions Inventory Meeting, Denver, CO. May 1-3, 2001. https://www3.epa.gov/ttnchie1/conference/ei10/fugdust/countess.pdf

[68] Countess, R. (2003) Reconciling Fugitive Dust Emission Inventories with Ambient Measurements, 12th Annual EPA Emissions Inventory Meeting, San Diego, CA. April 29-May 1, 2003.

lower than the ratio of 0.20 that Midwest Research Institute (MRI) previously recommended, based on limited supporting data and broad assumptions, as an interim revision to the PM2.5/PM10 ratio for agricultural crops nationwide in 1996. Note that the MRI's1996 interim revision to the PM2.5/PM10 ratios for fugitive dust sources was meant to improve the PM2.5/PM10 ratios that MRI had previously developed based on data from cascade impactors in the 1980's, which had also been shown to significantly overestimate PM2.5 emissions. As described by Thomas Pace of US EPA at the 2005 US EPA Emissions Inventory Conference, MRI's1996 interim revision to the PM2.5/PM10 ratios for fugitive dust still appeared to overestimate PM2.5 emissions. Pace's review of the most recent research on PM2.5/PM10 ratios nationally shows a consistent mid-point estimate of between 0.10 and 0.12, [69] which is consistent with the higher-end values seen in the Valley. To summarize, PM2.5 comprises a small fraction of total PM10 emissions from agricultural field operations in the Valley, approximately 6% to 12%.

Pace concludes that both PM2.5 emissions from agricultural field operations as well as their contribution to ambient PM2.5 concentrations had previously been significantly overestimated. Factors that contributed to this previous overestimation of PM2.5 emissions from agricultural operations included: (1) the multiplier used to infer PM2.5 from PM10 emissions, (2) difficulty in obtaining activity data to apply to emission factor algorithms, and (3) modeling transport over-estimation (especially in the treatment of particles near their point of emissions).**Error! Bookmark not defined.**

In respect to over-estimation of PM2.5 transport, much of the ground level fugitive dust from soil disturbance is likely to be removed close to the source.[70] This is due to the low release height and turbulence which keeps particles temporarily close to the surface where they are subject to removal by impaction on nearby surfaces, including vegetation and structures. Equally significant in respect to the previous over-estimation of PM10 and PM2.5, earlier grid models ignored all removal processes in the grid cell where the emissions originate. Given that 4 kilometers is a typical grid dimension, a considerable fraction of PM2.5 emitted under normal field operations could and often would be deposited within that cell, but models ignored such deposition.

Wind-blown Dust in the Valley

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https://www.epa.gov/ttn/chief/conference/ei12/fugdust/countess.pdf
https://www.epa.gov/ttn/chief/conference/ei12/fugdust/present/countess.pdf

[69] Pace, T.G., US EPA (2005) Examination of the Multiplier Used to Estimate PM2.5 Fugitive Dust Emissions from PM10, 14th Annual EPA Emissions Inventory Meeting, Las Vegas, Nevada, April 11 - 14, 2005.
https://www3.epa.gov/ttnchie1/conference/ei14/session5/pace.pdf
https://www3.epa.gov/ttnchie1/conference/ei14/session5/pace_pres.pdf

[70] Countess, R. (2001) Methodology for Estimating Fugitive Windblown and Mechanically Resuspended Road Dust Emissions Applicable for Regional Air Quality Modeling, 10th Annual EPA Emissions Inventory Meeting, Denver, CO. May 1-3, 2001. https://www3.epa.gov/ttnchie1/conference/ei10/fugdust/countess.pdf
Fitz, D., Pankratz, D., Philbrick, R., and Li, G. (2003) Evaluation of Fugitive Dust Deposition Rates Using Lidar, 12th Annual EPA Emissions Inventory Meeting, San Diego, CA. April 29-May 1, 2003.
https://www3.epa.gov/ttnchie1/conference/ei12/fugdust/fitz.pdf
https://www.epa.gov/ttn/chief/conference/ei12/fugdust/present/fitz.pdf

Although the Valley may occasionally experience wind-blown dust events from time to time, these events typically do not coincide with the winter period in which the PM2.5 concentrations in the Valley are the highest. For example, both Fresno and Bakersfield have seasonal variation in wind speeds throughout the year with the highest average wind speeds in Fresno occurring from April to July with highest wind speeds in late May and early June, and the highest average wind speeds in Bakersfield occurring from late March to mid-July with the highest wind speeds typically in late May. [71] These high wind events are less likely to occur during the winter season, in which PM2.5 concentrations are elevated during stagnation events that are characterized by low wind speeds, moderate temperatures, vertical atmospheric stability, and high relative humidity.

These high wind events primarily cause higher PM10 concentrations, but rarely result in elevated PM2.5 concentrations. In addition to the rarity of elevated PM2.5 concentrations during high-wind events, the PM2.5 values recorded during the strong stagnation periods of the winter season are usually much higher than those recorded during wind events. Because of this, the Valley's PM2.5 design values are driven primarily by high winter-time concentrations, mostly due to organic carbon and the secondary formation of ammonium nitrate. Comparatively, the geologic component of the Valley's peak PM2.5 concentrations is only a fraction of the mass formed through secondary processes and other sources (less than 6%).[72]

As a result of the facts discussed above, the wind events experienced in the Valley are not a significant contributor to the 24-hr PM2.5 attainment challenges for the region, and have essentially no impact on annual PM2.5 averages. While placing further controls on this source will not make a substantial difference in the District's PM2.5 design values, the District will be analyzing additional CMP options for fallow lands and tillage operations, as discussed in section C.1.5 below.

HOW DOES DISTRICT RULE 4550 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations
There are no air quality requirements such as federal NSPS, NESHAP, MACT, CTGs, and ACTs for this source category.

State Regulations
There are no state regulations that are applicable to this source category.

HOW DOES DISTRICT RULE 4550 COMPARE TO RULES IN OTHER AIR DISTRICTS?

Rule 4550 has served as a model for other regions seeking to reduce fugitive particulate emissions from agricultural sources. EPA finalized approval of Rule 4550 on February 14, 2006, and determined that the rule met Best Available Control Measure (BACM)

[71] Retrieved from https://weatherspark.com
[72] California Air Resources Board (2012) ARB Staff Report: Proposed Revision to the PM2.5 State Implementation Plan (SIP) for the San Joaquin Valley, Appendix B: Weight of Evidence Analysis. https://www.arb.ca.gov/planning/sip/sjvpm25/2012plan_appendix_b.pdf

requirements of the Clean Air Act (CAA) 189(b).

For this Plan, the PM2.5 reduction requirements and applicability of Rule 4550 were compared to analogous rules in other air districts and states to determine the stringency of Rule 4550 compared to those other rules. The District found three analogous rules, in Arizona, South Coast AQMD, and Imperial County APCD.

However, it should be noted that our examination found that each of the rules discussed below were developed to reduce PM10 emissions from agricultural operations in PM10 non-attainment areas. This was the situation for the SJVAPCD CMP rule, as well – in fact, we believe that the District's ground-breaking CMP program was a significant contributor to the District's subsequent attainment of the PM10 standard.

None of these rules was developed or modified for the purpose of generating PM2.5 reductions, or as a part of a PM2.5 attainment planning process. As discussed above, PM2.5 is a small fraction of the PM10 from agricultural operations, and the effectiveness of controlling PM2.5 with such measures is not as well understood as the effectiveness of controlling PM10. Since the degree of effectiveness in controlling PM2.5 is not well understood, the corresponding cost effectiveness of implementing CMPs for the purposes of controlling PM2.5 is also unknown. Because of these factors, none of the three rules listed below can be considered to establish BACM or MSM for PM2.5.

Nonetheless, the District examined the following rules and found that District Rule 4550 was, overall, as stringent or more stringent than each of them:

Arizona Department of Environmental Quality-Agricultural Best Management Practices (BMPs) *(Amended June 30, 2010)*

SCAQMD Rule 403 (Fugitive Dust) *(Amended June 3, 2005)*

Imperial County APCD Rule 806 (Conservation Management Practices) *(Amended October 16, 2012)*

In January of 2016, the federal EPA agreed with this position, as published in their evaluation of the District's CMP rule as a part of a Technical Support Document (TSD) related to their proposed approval of the District's 2015 PM2.5 Plan. In that TSD, EPA found that District Rule 4550 meets BACM and MSM requirements and "is at least as stringent as the analogous rules implemented elsewhere." In their approval, EPA specifically cited the significantly superior enforcement mechanisms in the District regulation, including:

- It is the only rule to require applications to be filed, specifying the CMPs to be employed,
- It requires an approval process of the chosen CMPs, unlike the other analogous rules,
- It is the only rule to require owner/operators to maintain records for five years,

- It is the only rule to require confirmation of CMP implementation and demonstrations for claimed exemptions.

EVALUATION FINDINGS

As noted above, the existing District Rule 4550 has been found by the District and the federal EPA to establish RACM, BACM, and MSM level PM2.5 requirements for this source category.

While the attainment modeling process has demonstrated that additional CMPs will not significantly contribute to our attainment efforts, to further develop the District's understanding of the effectiveness of CMP measures on controlling PM2.5 emissions in the Valley, the District is committing to undertaking scientific research on the PM2.5 content, constituents, and stability during wind events of the many soil types found throughout the Valley. This research would be conducted in close coordination with USDA-NRCS, agricultural sources, researchers through established processes including the San Joaquin Valleywide Air Pollution Study Agency, Policy Committee, and Agricultural Technical Subcommittee.

Although Rule 4550 already meets BACM and MSM requirements for PM2.5, the District is also committing to further evaluate ways to promote conservation tillage practices and to reduce dust from agricultural operations to the extent that they are found to practicably reduce PM2.5, using the following process. The District will work with the Agricultural Technical Committee to evaluate the feasibility and effectiveness of requiring the selection of additional control measures to achieve additional PM2.5 emissions reductions from tilling and other land preparation activities based on the research discussed above. More widespread implementation of conservation tillage practices such as cover cropping, no till, low till, strip till, and precision agriculture, through additional incentives under Rule 4550, may help to further limit PM2.5 in the Valley. To this end, the District will evaluate measures to promote the selection of conservation tillage as a CMP for croplands.

The District will evaluate the feasibility and effectiveness of CMPs on fallow lands that are tilled or otherwise worked with implements of husbandry, to reduce windblown PM2.5 emissions from disturbed fallowed acreage. This evaluation will rely on additional research, in coordination with USDA-NRCS, agricultural sources, and researchers, that recognizes the Valley's unique soil characteristics and agricultural practices to ensure that Valley-specific solutions are considered in this process.

C.16 Rule 4692 (Commercial Charbroiling)

Discussion

The charbroiling source category consists of two types of commercial charbroilers: chain-driven and under-fired. A chain-driven charbroiler is a semi-enclosed broiler that moves food mechanically through the device on a grated grill to cook the food for a specific amount of time. An under-fired charbroiler has a metal "grid," a heavy-duty grill similar to that of a home barbecue, with gas burners, electric heating elements, or solid fuel (wood or charcoal) located under the grill to provide heat to cook the food. The smoke and vapors generated by cooking on either type of charbroiler contain water, VOCs, and PM. Larger particles and grease are typically captured by the grease filter of the ventilation hood over the charbroiler. The remaining VOCs and particulate pollution are exhausted outside the restaurant, unless a secondary control is installed.

The emission inventory for the source category of commercial charbroiling is comprised of both chain-driven and underfired charbroilers (see table below). Underfired charbroiling is responsible for approximately 89% of the PM 2.5 emissions for this source category, or 2.57 tons per day (tpd) of the 2.89 tpd emitted from commercial charbroiling in the Valley in 2013. Commercial charbroiling emissions contribute a significant fraction of the PM2.5 found in urban areas. A California Regional Particulate Air Quality Study (CRPAQS) study conducted in Fresno estimated that meat cooking contributed 6 to 14% of organic carbon aerosol found in the city. The same study found that charbroiled hamburger emits up to 40 grams of fine aerosol per kilogram of meat cooked, versus 7 grams per kilogram for extra lean meat. As under-fired charbroilers are the majority of the remaining total commercial charbroiling inventory, and because these units are currently unregulated in the Valley, there is a large potential to achieve emissions reductions from the regulation of under-fired charbroiling emissions.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	2.89	3.02	3.16	3.21	3.25	3.30	3.36	3.41	3.46
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day								
PM2.5	2.89	3.02	3.16	3.20	3.25	3.30	3.35	3.41	3.46
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source Category

Currently, District Rule 4692 reduces emissions by requiring catalytic oxidizers for chain-driven charbroilers that meet rule applicability thresholds. Charbroiler exhaust is directed through the catalytic oxidizer with little loss of temperature. As high-temperature exhaust goes through the heated catalyst, PM and VOC are oxidized to carbon dioxide and water vapor. This chemical reaction releases energy that heats the catalyst and is transferred to a heat recovery system, so no additional fuel is needed for the unit. Rule 4692 requires emission controls for chain-driven charbroilers that cook

400 pounds of meat or more per week. Rule 4692 does not currently require emissions controls for under-fired charbroilers.

Catalytic oxidizers are not effective for reducing emissions from under-fired charbroilers because the exhaust from these devices loses heat as it is directed to the control device, and the reactions at the catalyst cannot take place under these lower temperatures. In a chain-driven charbroiler, charbroiling exhaust is directed through the catalytic oxidizer with little loss of temperature. As high-temperature exhaust goes through the heated catalyst, PM and VOC are oxidized to carbon dioxide and water vapor. This chemical reaction releases energy that heats the catalyst and is transferred to a heat recovery system, so no additional fuel is needed for the unit. Controlling emissions from under-fired charbroilers has proven to be far more challenging. To date, no cost effective technologies have been demonstrated as achieved in practice. As such, the rule currently does not have requirements specific to underfired charbroilers.

The original rule, adopted in March 2002, reduced PM2.5 emissions from chain-driven charbroilers by 84%. The September 2009 rule amendment expanded rule applicability to more chain-driven charbroilers, reducing 25% of the remaining PM2.5 chain-driven charbroiler emissions. EPA finalized approval for Rule 4692 on November 3, 2011[73]. The District evaluated Rule 4692 in its RACT State Implementation Plan (SIP) demonstration; however, EPA noted in its Technical Support Document (TSD) for the approval of Rule 4692 that the rule is not subject to RACT because it is not subject to Control Techniques Guidelines (CTG) requirements and it does not regulate major sources.

HOW DOES DISTRICT RULE 4692 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations
There are no EPA CTG, ACT, NSPS, NESHAP, or MACT requirements for this source category.

State Regulations
There are no state regulations applicable to air quality from commercial charbroiling activities.

HOW DOES DISTRICT RULE 4692 COMPARE TO RULES IN OTHER AIR DISTRICTS?
There are no analogous rules for this source category in SMAQMD.

BAAQMD

- BAAQMD Regulation 6 Rule 2 (Commercial Cooking Equipment) *(Last amended December, 5, 2007)*

BAAQMD Regulation 6 Rule 2 regulates both chain-driven and under-fired units, and was adopted on December 5, 2007. Operations that become subject to the rule

[73] EPA Federal Register, Volume 76 No. 213. (November 3, 2011). Codified at: 40 C.F.R. pt. 52

requirements with chain-driven charbroilers are required to install a certified control device to limit PM10 emissions to not more than 1.3 pounds PM10 per 1,000 lbs of beef cooked. Newly installed under-fired units with more than 10 square feet of cooking area are required to limit emissions to 1 lb of PM10 per 1,000 lbs of cooked beef. Effective January 2013, the same emissions requirements also apply to pre-existing units. This rule exempts low-use chain-driven charbroilers that grill less than 400 lbs of beef per week, and exempts underfired charbroilers that grill less than 800 lbs of beef per week. Although this rule was adopted in 2007 and has had requirements in effect since 2010, the majority of under-fired charbroilers in the Bay Area are able to avoid the control requirements based on the established grill size and throughput exemptions. Additionally, since adoption of the rule, the BAAQMD has not certified any compliant control devices. BAAQMD has not been enforcing this rule or doing inspections on restaurants until they create a list of certified, approved technology, and as a result, no installations of controls has occurred under this rule.

The District evaluated the requirements contained within BAAQMD's Regulation 6, Rule 2 and found no requirements that were more stringent than those already in Rule 4692 for chain-driven charbroilers.

	SJVAPCD	BAAQMD
Applicability	Chain-driven charbroilers and underfired charbroilers at commercial cooking operations.	Chain-driven charbroilers and underfired charbroilers at commercial cooking operations.
Exemption	Charbroilers that cook less than 400 lbs of meat per week, or less than 10,800 lbs of meat per week and the total amount of meat cooked per week does not exceed 875 lbs.	Chain-driven charbroilers that cook less than 400 lbs of beef per week; underfired charbroilers which cook less than 800 lbs of beef per week
Requirements	Requires that chain-driven charbroilers reduce PM emissions by 83% through the installation of an approved catalytic oxidizer. Registration requirements for under-fired charbroilers. Weekly record-keeping requirement for both charbroiler categories.	Requires the installation of a certified catalytic oxidizer (controlled to 1.3 lbs of PM10 and 0.32 lbs VOCs per 1,000 lbs of beef cooked) Underfired Charbroiler requirements specify that emissions be limited to no more that 1lb PM10 per 1000 lbs of beef cooked for new and existing units.

New York Department of Environmental Protection (NYDEP)

- City of New York Title 24 of the Administrative Code, Section 24-149.4 (Emission Reduction Technologies for Char Broilers) *(Amended May, 2016)*

Passed in May, 2016, this rule essentially requires the installation of a control device which is certified to provide at least 75% emissions reductions for new underfired charbroilers and for any new or existing chain-driven charbroiler used to cook 875 lbs or more of meat per week. Registration and the payment of a $100 administration fee are required for existing charbroiler units. Consideration of control requirements for existing units has been pushed back until at least 2019 due to the feasibility questions and higher cost of retrofitting existing operations. New York staff are in the introductory stages of establishing an inventory and planning for inspections and enforcement, with no control installations yet required under the rule.

The requirements of District Rule 4692 are more stringent that those found in NYC's Section 24-149.4 for chain-driven charbroilers. The District has recently amended Rule 4692 to require the registration of underfired charbroiler units, and is evaluating the feasibility of controls for new and existing underfired units.

	SJVAPCD	NYDEP
Applicability	Chain-driven charbroilers and underfired charbroilers at commercial cooking operations	Chain-driven charbroilers and underfired charbroilers at commercial cooking operations
Exemption	Charbroilers that cook less than 400 lbs of meat per week, or less than 10,800 lbs of meat per week and the total amount of meat cooked per week does not exceed 875 lbs.	Charbroilers that cook less than 875 lbs of meat per week
Requirements	Requires that chain-driven charbroilers reduce PM emissions by 83% through the installation of an approved catalytic oxidizer. Registration requirements for under-fired charbroilers. Weekly record-keeping requirement for both charbroiler categories.	**Chain-driven**: requires catalytic oxidizer or control of PM10 by 75%. **Under-fired:** Registration requirement for existing units. New units required to install control devices to limit PM emissions by 75% (currently unenforced)

SCAQMD

- SCAQMD Rule 1138 (Control of Emissions from Restaurant Operations) *(Amended November 14, 1997)*

In November 1997 South Coast Air Quality Management District (SCAQMD) adopted Rule 1138, which achieved 0.5 tons per day of PM10 emissions from chain-driven charbroilers. In 1999 they amended their attainment plan to include a commitment to further reduce 0.9 tons per day of VOC and 7.0 tons per day of PM10 emissions. However, in August 2000, SCAQMD staff reported that cost-effective controls for under-fired charbroilers were limited and recommended substituting the remaining 0.9 tons per day of VOC emissions reductions assigned to this category with reductions from another control measure. Their 2003 air quality management plan (AQMP) included reducing PM10 from under-fired charbroilers by 1 ton per day by 2010. A report to the SCAQMD Board in 2004 demonstrated that controls from under-fired charbroilers were infeasible and again substituted emissions reductions from other adopted rules. To help advance the demonstration of these technologies, South Coast recommended funding for demonstration projects and their Board approved $200,000 to fund six to eight new or retrofit demonstration sites on large restaurants. However, no applications were received for that program. In 2008-2009, AQMD staff reinitiated rule development for restaurants with under-fired charbroilers and held a series of working group meetings and a public workshop. Due to lack of demonstrable cost-effective and affordable control technologies SCAQMD staff determined rule adoption at that time was not feasible.

The recent amendment of the SCAQMD air quality management plan included the future adoption of a rule for underfired charbroilers as a contingency measure.
The District evaluated the requirements contained within SCAQMD's Rule 1138 and found no requirements that were more stringent than those already in Rule 4692.

	SJVAPCD	SCAQMD
Applicability	Chain-driven charbroilers and underfired charbroilers at commercial cooking operations	Chain-driven charbroilers
Exemption	Charbroilers that cook less than 400 lbs of meat per week, or less than 10,800 lbs of meat per week and the total amount of meat cooked per week does not exceed 875 lbs	Exempt if (1) accept a permitting condition limiting the amount of meat cooked to less than 875 lbs per week; or (2) submit testing showing that emissions are less that 1lb per day
Requirements	Requires that chain-driven charbroilers reduce PM emissions by 83% through the installation of an approved catalytic oxidizer. Registration requirements for under-fired charbroilers. Weekly record-keeping requirement for both charbroiler categories.	Only operate a chain-driven charbroiler with an approved catalyst, plus maintenance requirements and recordkeeping.

VCAPCD

- VCAPCD Rule 74.25 (Restaurant Cooking Operations) *(Amended October 12, 2004)*

VCAPCD Rule 74.25 applies to all conveyorized charbroilers, and requires that the owner of a conveyorized charbroiler reduce ROG and PM emissions by 83% through the installation of a certified control device. The rule exempts charbroilers placed into service before October 12, 2005 that cook less than 875 pounds per week. The District evaluated the requirements contained within VCAPCD's Rule 74.25 and found no requirements that were more stringent than those already in Rule 4692.

	SJVAPCD	VCAQMD
Applicability	Chain-driven charbroilers and underfired charbroilers at commercial cooking operations	Conveyorized (chain-driven) charbroilers)
Exemption	Charbroilers that cook less than 400 lbs of meat per week, or less than 10,800 lbs of meat per week and the total amount of meat cooked per week does not exceed 875 lbs.	Charbroilers placed into service prior to Oct. 2005 that cook less than 875 lbs per week (no exemption for throughputs for units installed after Oct. 2005)
Requirements	Requires that chain-driven charbroilers reduce PM emissions by 83% through the installation of an approved catalytic oxidizer. Registration requirements for under-fired charbroilers. Weekly record-keeping requirement for both charbroiler categories.	Requires the installation of an approved control device to reduce PM emissions by 83%.

Additional Emission Reduction Opportunities

EPA interprets MSM to assure additional controls that can be feasibly implemented beyond the set of measures adopted as BACM are implemented. This is done through evaluation of expanding rule applicability, or re-analyzing measures that were rejected during the BACM analysis to see if they are now feasible. Beyond the review of current regulation and rule requirements, the District performed an extensive review of the feasibility of expanding applicability or removal of exemptions for this source category, technologies and measures that have been implemented in practice in other regions, and potential new technologies and measures that may be feasible for implementation in the near future.

Pursuant to District Rule 4692 and District Rule 2010 (Permits Required), all chain-driven charbroilers are required to have a Permit to Operate. A 2018 review of District permits showed that all commercial cooking operations with a permit for chain-driven charbroilers had applied for a permit level which exceeds the 400 lbs. per week limit, even if their actual throughput was below this amount. These operations installed and maintain an approved catalytic oxidizer for compliance with their permit requirements. Due to the requirement for all operations with a chain-driven charbroiler to obtain a Permit to Operate, and because all permits are currently for an amount above the exemption limit, all permitted charbroilers in the Valley have installed a catalytic oxidizer. No emission reductions would occur from lowering the exemption level for chain-driven charbroilers.

For this attainment plan, the District evaluated the feasibility of requiring pollution controls for commercial cooking operations with underfired charbroilers. District staff have made the following findings with respect to the current state of underfired charbroiling control technologies:

- *There has been an increasing number of particulate control technology installations primarily at new or newer restaurants in response to local ordinances and nuisance concerns*: Based on discussions with control technology manufacturers and vendors, an increasing number of particulate control technologies have been installed at restaurants in dense urban areas to address nuisance requirements and concerns. The majority of these installations have been at new or newer restaurants. It is unclear how many of these installations have been at restaurants with underfired charbroilers as it has been difficult to obtain this information from technology vendors and restaurants directly. Restaurants that the District has been able to identify as having installed underfired charbroiling control technologies include Chipotle (multiple installations outside of Valley), Yard House (multiple installations outside of Valley), Bourbon's Steak & Pub at Levi's Stadium (San Francisco, CA), Deli Delicious (Visalia, CA), Season's 52 (multiple installations outside of Valley), Capital Grill (multiple installations outside of Valley), and the Habit Burger Grill (multiple installations inside and outside of Valley).

- *Retrofitting controls on existing restaurants can be prohibitively expensive and technologically infeasible*: Based on discussions with restaurant operators, technology vendors, and other regulatory agencies, it can be extremely difficult and cost-prohibitive to add controls on existing restaurants. The installation may require structural, electrical, or water-line modifications that may not be feasible. This makes installation costs much higher for existing restaurants compared to new restaurants that can integrate emissions controls into the design. The existing structure may not have the necessary space or structural support for the control unit. Installing the control equipment may require the restaurant to temporarily shut down, resulting in loss of revenue. Furthermore, the existing restaurant may not have the authority to make changes to the building if the space is leased and the landlord is unwilling to accommodate.

- *Installation cost of controls can be prohibitively expensive*: The cost of control units themselves are expensive, ranging from $30,000 up to $80,000 for the most complicated unit configurations. In addition, installation costs range from $10,000 to $20,000 for new construction and $20,000 to $60,000 or higher, depending on the structural and electrical modifications required, for retrofits. It is possible that some high-volume restaurants may be able to support this cost, but restaurants with less income would be financially unable to install these units without incentive support.

- *Maintenance of controls can be prohibitively expensive*: Regular maintenance of control devices is critical to ensure control effectiveness. Depending on the control technology and the type and volume of food cooked, filter change-out is required on a monthly or quarterly basis, with more in-depth filter replacement or unit cleaning required annually. Annual maintenance costs including both labor and materials starts around $6,000 and can exceed $100,000 for the highest volume restaurants with solid-fuel fired underfired charbroilers.

- *Maintenance requires specially trained staff that may not be accessible to all restaurants*: Control device cleaning is a complex process, requiring specially trained staff. Training restaurant staff to perform this task may not be feasible, and service companies capable of performing the maintenance may not be readily available nearby. Any delays in required maintenance could cause significant economic impacts to restaurants.

Due to the potential lack of economic and technological feasibility of requiring these controls, the District is first seeking to require registration of underfired charbroilers pursuant to Rule 2250 (Permit-Exempt Equipment Registration) and recently amended Rule 4692 to require the submittal of a one-time report from all Valley commercial cooking operations with an underfired charbroiler. This report will detail meat throughputs, hours of operation, and any installed control technology. Information obtained through the registration and reporting process will be used to further evaluate the feasibility of requiring controls for this source category.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this source category. As demonstrated above, Rule 4692 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

After thorough review of potential opportunities to reduce emissions from this source category, the District amended Rule 4692 to implement a registration and reporting requirement for underfired charbroiler operations in order to gather better inventory and emissions information for this source category. Using new survey and registration information, the District will pursue reductions in commercial underfired charbroiler emissions through an incentive-based approach to fund the installation of controls for commercial underfired charbroilers within urban boundaries in hot-spot areas, with a future year regulatory requirement to encourage participation by Valley businesses.

1. To ensure early and robust use of incentives for installation of controls and related modifications for existing underfired charbroilers within urban boundaries of hot-spots areas supplemented with regulatory backstop to encourage participation.

2. Require installation of control technologies at new larger restaurants within urban boundaries of hot-spot areas supplemented by incentives as feasible.

C.17 Rule 4702 (Emissions from Internal Combustion Engines)

Discussion

Rule 4702 applies to any internal combustion (IC) engine rated at 25 brake horsepower (bhp) or greater. The purpose of this rule is to limit NOx, carbon monoxide (CO), VOC, and SOx emissions from units subject to this rule.

The District's original IC engine rule, Rule 4701 (Internal Combustion Engines – Phase 1), was adopted on May 21, 1992, superseded by Rule 4702, adopted on August 21, 2003, and subsequently amended five times. The rule established NOx limits between 25-50 ppmv achieving 90-96% control for non-agricultural operation rich-burn engines, and 65-75 ppmv achieving 85-90% control for non-agricultural operation lean-burn engines.

Substantial emission reductions from agricultural IC engines have also been achieved through a combination of regulatory efforts and incentive actions. Rule 4702 has reduced emissions from agricultural engines by 84% since the 2005 amendments to the rule, with substantial investments being made by the affected sources to comply with the rule. This effort included working closely with agricultural sources, publicly owned utilities, and the U.S. Department of Agriculture-Natural Resources Conservation Service to develop a collaborative model of extensive outreach, strong incentives to assist in defraying high costs, and significant investments from agricultural sources to replace thousands of agricultural engines to comply with Rule 4702. The rule was further strengthened in August 2011 when rule amendments implemented more stringent NOx limits as low as 11 ppmv for spark-ignited engines used in non-agricultural operations.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.36	0.25	0.23	0.22	0.22	0.20	0.20	0.19	0.19
NOx	9.37	5.56	5.01	4.79	4.67	4.33	4.20	4.08	3.97
	Winter Average - Tons per day								
PM2.5	0.49	0.32	0.29	0.28	0.27	0.25	0.24	0.23	0.22
NOx	12.94	7.29	6.46	6.18	5.99	5.52	5.34	5.16	5.00

Source Category

An internal combustion engine is an engine that operates by burning its fuel inside the engine. Engines generate power by the combustion of an air/fuel mixture. The main types of engines are spark-ignited engines and compression-ignited (or diesel) engines. In the case of spark-ignited engines, a spark plug ignites the air/fuel mixture. Spark-ignited engines come in several designs, including rich-burn and lean-burn. Spark-ignited engines may use one or more fuels, such as natural gas, propane, butane, liquefied petroleum gas, oil field gas, digester gas, landfill gas, methanol, ethanol, and gasoline. Compression-ignited engines rely on heating of the inducted air during the compression stroke to ignite the injected diesel fuel. In addition to being classified into compression-ignited and spark-ignited, IC engines can be further divided into two-stroke and four-stroke engines. While larger diesel engines may be two-stroke, most diesel engines are four-stroke. Natural gas fired spark-ignited engines are usually four-stroke, two-stroke engines may be more appropriate for certain applications.

Internal combustion engines are used by a variety of private businesses and public agencies throughout the Valley for a number of purposes. Primary uses of IC engines in the Valley include powering irrigation pumps, compressors, or electrical generators. Examples of businesses and industries that use IC engines include schools and universities, agriculture, oil and gas production and pipelines, petroleum refining, manufacturing facilities, food processing, electrical power generation, landfill and waste water treatment facilities, and water districts. Many IC engines in the Valley are limited or low use in nature, such as emergency standby engines that provide backup power when electric service is interrupted.

HOW DOES DISTRICT RULE 4702 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations
There are no EPA Control Technique Guidelines (CTG) requirements for this source category.

Alternative Control Technology (ACT)

- EPA – 453/R-93-032 (Alternative Control Techniques Document – NOx Emissions from Stationary Internal Combustion Engines)

The District evaluated the requirements contained within the EPA – 453/R-93-032 ACT document and found no requirements that were more stringent than those already in Rule 4702.

Standards of Performance for New Stationary Sources (NSPS)

- 40 CFR 60 Subpart IIII (Standards of Performance for Stationary Compression Ignition Internal Combustion Engines)

The District evaluated the requirements contained within 40 CFR 60 Subpart IIII and found no requirements that were more stringent than those already in Rule 4702.

- 40 CFR 60 Subpart JJJJ (Standards of Performance for Stationary Spark Ignition Internal Combustion Engines)

The District evaluated the requirements contained within 40 CFR 60 Subpart JJJJ and found no requirements that were more stringent than those already in Rule 4702.

NESHAP/ MACT

- 40 CFR 63 Subpart ZZZZ (NESHAP for Stationary Reciprocating Internal Combustion Engines)

The District evaluated the requirements contained within 40 CFR 63 Subpart ZZZZ NESHAP and found no requirements that were more stringent than those already in Rule 4702.

State Regulations

The following state regulations apply to sources covered under Rule 4702:

- 17 CCR 93114 (ATCM to Reduce Particulate Emissions from Diesel-Fueled Engines—Standards for Nonvehicular Diesel Fuel)
- 17 CCR 93115 (ATCM for Stationary Compression Ignition Engines)

The District implements the requirements of 17 CCR 93114 and 17 CCR 93115 through Rule 4702 and the District's new source review permitting program (Rule 2201).

HOW DOES DISTRICT RULE 4702 COMPARE TO RULES IN OTHER AIR DISTRICTS?

The requirements and applicability of Rule 4702 were compared to analogous rules in other air districts and states to determine the stringency of Rule 4702 compared to those other rules.

BAAQMD

- BAAQMD Regulation 9 Rule 8 (Nitrogen Oxides and Carbon Monoxide from Stationary Internal Combustion Engines) *(Amended July 25, 2007)*

Although for one minor limited use category the BAAQMD rule may apply a more stringent limit, SJVAPCD's Rule 4702 has significantly more stringent limits all other categories of engines. In addition, ag engines are exempt from the BAAQMD rule, while SJVAPCD's Rule 4702 has established NOx and PM limits for ag engines for many years. Therefore, the District found the requirements contained within BAAQMD Regulation 9 Rule 8 are not more stringent than those already in District Rule 4702.

	SJVAPCD	BAAQMD
Applicability	Internal combustion engine rated at ≥ 25 bhp	Internal combustion engine rated at ≥ 50 bhp
Exemption	Limited to operate less than 100 hrs/yr De-rated engine that has been physically limited and restricted by permit to an operational level of < 50 hp not used in agricultural operation (prior to 6/1/04) De-rated engine that has been physically limited and restricted by permit to an	Engines rated by < 50 bhp Low Use Engines (varying from 100 hrs to 200 hrs) Engines used directly and exclusively for the growing of crops or the raising of animals

	operational level of < 50 bhp used in agricultural operation (prior to 6/1/05)		
	NOx Emission Limits **Non-Agricultural Operations (Non-AO) Engines Rated >50 bhp** *(corrected to 15% oxygen on a dry basis)*		
	Rich Burn-Waste Gas Fueled	50 ppmv or 90% reduction	70 ppmv
	Rich-Burn Cyclic Loaded, Field Gas Fueled	50 ppmv	No such category
	Rich-Burn Limited Use	25 ppmv	No such category
	Rich-Burn Engine, “not listed above"	11 ppmv	25 ppmv
	Lean-Burn Two-Stroke, Gaseous Fueled, >50 bhp and < 100 bhp	65 ppmv	No such category
	Lean-Burn Limited Use	65 ppmv	No such category
	Lean-Burn Engine Used for Gas Compression	65 ppmv or 93% reduction	65 ppmv
	Lean-Burn Waste Gas Fueled	65 ppmv or 90% reduction	70 ppmv
	Lean-Burn Engine, "not listed above"	11 ppmv	65 ppmv
	NOx Emission Limits for Agricultural Operations (AO) **Spark-Ignited Engines Rated >50 bhp** *(corrected to 15% oxygen on a dry basis)*		
	Rich-Burn Spark	90 ppmv or 80% reduction	Exempt
	Lean-Burn Spark	150 ppmv or 70% reduction	Exempt
	NOx Emission Limits for Agricultural Operations (AO) **Certified Compression-Ignited Engine** *(corrected to 15% oxygen on a dry basis)*		

	Tier 1 or Tier 2	Meet EPA Tier 4 by12 years after installation date, but not later than 6/1/2018	Exempt
	Tier 3 or Tier 4	Meet certified compression-ignited engine standard in effect at time of installation	Exempt

SMAQMD

- SMAQMD Rule 412 (Stationary Internal Combustion Engines at Major Stationary Sources of NOx) *(Adopted June 1, 1995)*

Although in theory the SMAQMD's general limits for rich burn engines may be more stringent than some specialized categories found in the SJVAPCD rule, it is unlikely that engines exist in many of those categories in the SMAQMD. SJVAPCD's Rule 4702 has significantly more stringent limits for all identified engine categories, including the largest non-specialized use categories. In addition, ag engines are exempt from the SMAQMD rule, while SJVAPCD's Rule 4702 has established NOx limits for ag engines for many years. Therefore, the District found the requirements contained within SMAQMD Rule 412 are not more stringent than those already in District Rule 4702.

	SJVAPCD		SMAQMD
Applicability	Internal combustion engine rated at ≥ 25 bhp		Emissions limits apply to Internal combustion engine rated at ≥ 50 bhp
Exemption	Limited to operate less than 100 hrs/yr De-rated engine that has been physically limited and restricted by permit to an operational level of < 50 hp not used in agricultural operation (prior to 6/1/04) De-rated engine that has been physically limited and restricted by permit to an operational level of < 50 used in agricultural operation (prior to 6/1/05)		Engines used directly and exclusively for agricultural operations
	NOx Emission Limits **Non-Agricultural Operations (Non-AO) Engines Rated >50 bhp** *(corrected to 15% oxygen on a dry basis)*		
	Rich Burn-Waste Gas Fueled	50 ppmv or 90% reduction	No such category
	Rich-Burn Cyclic Loaded, Field Gas Fueled	50 ppmv	No such category
	Rich-Burn Limited Use	25 ppmv	No such category
	Rich-Burn Engine, "not listed above"	11 ppmv	25 ppmv

	Lean-Burn Two-Stroke, Gaseous Fueled, >50 bhp and < 100 bhp	65 ppmv	No such category
	Lean-Burn Limited Use	65 ppmv	No such category
	Lean-Burn Engine Used for Gas Compression	65 ppmv or 93% reduction	No such category
	Lean-Burn Waste Gas Fueled	65 ppmv or 90% reduction	No such category
	Lean-Burn Engine, "not listed above"	11 ppmv	65 ppmv
	NOx Emission Limits for Agricultural Operations (AO) Spark-Ignited Engines Rated >50 bhp *(corrected to 15% oxygen on a dry basis)*		
	Rich-Burn Spark	90 ppmv or 80% reduction	Exempt
	Lean-Burn Spark	150 ppmv or 70% reduction	Exempt
	NOx Emission Limits for Agricultural Operations (AO) Certified Compression-Ignited Engine *(corrected to 15% oxygen on a dry basis)*		
	Tier 1 or Tier 2	EPA Tier 4 12 years after installation date, but not later than 6/1/2018	Exempt
	Tier 3 or Tier 4	Meet certified compression-ignited engine standard in effect at time of installation	Exempt

VCAPCD

- VCAPCD Rule 74.9 (Stationary Internal Combustion Engines) *(Amended November 8, 2005)*

Although in theory the VCAPCD's general limits for lean burn engines may be more stringent than some specialized categories found in the SJVAPCD rule, it is unlikely that engines exist in many of those categories in the VCAPCD. SJVAPCD's Rule 4702 has significantly more stringent limits for all identified engine categories, including the largest non-specialized use categories. In addition, ag engines are exempt from the

VCAPCD rule, while SJVAPCD's Rule 4702 has established NOx limits for ag engines for many years. Therefore, the District found the requirements contained within VCAPCD Rule 74.9 are not more stringent than those already in District Rule 4702.

	SJVAPCD		VCAPCD
Applicability	Internal combustion engine rated at ≥ 25 bhp		Internal combustion engine rated at ≥ 50 bhp
Exemption	Limited to operate <100 hrs/yr De-rated engine that has been physically limited and restricted by permit to an operational level of < 50 hp not used in agricultural operation (prior to 6/1/04) De-rated engine that has been physically limited and restricted by permit to an operational level of < 50 used in agricultural operation (prior to 6/1/05)		Engines rated < 50 hp Engines operating < 200 hrs/yr Engines rated < 100 hp, emitting no more than The rule exempts engines used directly and exclusively for the growing of crops or the raising of animals
	NOx Emission Limits **Non-Agricultural Operations (Non-AO) Engines Rated >50 bhp** *(corrected to 15% oxygen on a dry basis)*		
	Rich Burn-Waste Gas Fueled	50 ppmv or 90% reduction	50 ppmv
	Rich-Burn Cyclic Loaded, Field Gas Fueled	50 ppmv	No such category
	Rich-Burn Limited Use	25 ppmv	No such category
	Rich-Burn Engine, "not listed above"	11 ppmv	25 ppmv
	Lean-Burn Two-Stroke, Gaseous Fueled, >50 bhp and < 100 bhp	65 ppmv	No such category
	Lean-Burn Limited Use	65 ppmv	No such category
	Lean-Burn Engine Used for Gas Compression	65 ppmv or 93% reduction	No such category
	Lean-Burn Waste Gas Fueled	65 ppmv or 90% reduction	125 ppmv
	Lean-Burn Engine, "not listed above"	11 ppmv	65 ppmv
	NOx Emission Limits for Agricultural Operations (AO) **Spark-Ignited Engines Rated >50 bhp** *(corrected to 15% oxygen on a dry basis)*		
	Rich-Burn Spark	90 ppmv or 80% reduction	Exempt

	Lean-Burn Spark	150 ppmv or 70% reduction	Exempt
	NOx Emission Limits for Agricultural Operations (AO) **Certified Compression-Ignited Engine** *(corrected to 15% oxygen on a dry basis)*		
	Tier 1 or Tier 2	Meet EPA Tier 4 by12 years after installation date, but not later than 6/1/2018	Exempt
	Tier 3 or Tier 4	Meet certified compression-ignited engine standard in effect at time of installation	Exempt

SCAQMD

- SCAQMD Rule 1110.2 (Emissions from Gaseous- and Liquid-Fueled Engines) (*Amended June 3, 2016*)

South Coast Air Quality Management District (SCAQMD) regulates the emissions from IC engines through a combination of control measures. SCAQMD 1110.2 is directly applicable to IC engines and includes emissions limitations for various applications. SCAQMD's RECLAIM program (Rules 2000 – 2020) allows operators to purchase credits in lieu of instituting engine emissions controls otherwise required under SCAQMD 1110.2. Therefore, their limits must not be compared to emissions limitations included in District rules that must be met and do not have RECLAIM exemptions. Given these overlapping sets of requirements, Rule 4702 must be compared in context of both regulations. Additionally, many of the engine applications found in the San Joaquin Valley vary substantially from engine applications in SCAQMD; for example, based on discussion with SCAQMD, there are only two rich-burn engines used in agricultural operations operating hours of 1,900 hrs/yr and 1,500 hrs/yr. No lean-burn ag engines are operating in SCAQMD.

	SJVAPCD	SCAQMD
Applicability	Internal combustion engine rated at ≥ 25 bhp	Emissions limits apply to Internal combustion engine rated at ≥ 50 bhp
Exemption	Limited to operate less than 100 hrs/yr De-rated engine that has been physically limited and restricted by permit to an operational level of < 50 hp not used in agricultural operation (prior to 6/1/04)	Engines operating < 500 hr/yr or < 1 billion Btu/hr Agricultural where electrical motor is not possible due to

	De-rated engine that has been physically limited and restricted by permit to an operational level of < 50 used in agricultural operation (prior to 6/1/05)		utility company rejecting service Does not qualify for funding under CHSC Section 44229 to replace, retrofit or repower the engine Engines installed prior to 2/1/08, engines installed by electric utility on Santa Catalina Island, engines installed at remote locations without access to natural gas and electrical power RECLAIM facilities (NOx emissions only)
	NOx Emission Limits **Non-Agricultural Operations (Non-AO) Engines Rated >50 bhp** *(corrected to 15% oxygen on a dry basis)*		
	Rich Burn-Waste Gas Fueled	50 ppmv or 90% reduction	No such category
	Rich-Burn Cyclic Loaded, Field Gas Fueled	50 ppmv	No such category
	Rich-Burn Limited Use	25 ppmv	No such category
	Rich-Burn Engine, “not listed above"	11 ppmv	11 ppmv*
	Lean-Burn Two-Stroke, Gaseous Fueled, >50 bhp and < 100 bhp	65 ppmv	No such category
	Lean-Burn Limited Use	65 ppmv	No such category
	Lean-Burn Engine Used for Gas Compression	65 ppmv or 93% reduction	No such category
	Lean-Burn Waste Gas Fueled	65 ppmv or 90% reduction	No such category
	Lean-Burn Engine, "not listed above"	11 ppmv	11 ppmv*
	NOx Emission Limits for Agricultural Operations (AO) **Spark-Ignited Engines Rated >50 bhp** *(corrected to 15% oxygen on a dry basis)*		

	Rich-Burn Spark[74]	90 ppmv or 80% reduction	11 ppmv*
	Lean-Burn Spark[75]	150 ppmv or 70% reduction	11 ppmv*
	NOx Emission Limits for Agricultural Operations (AO) Certified Compression-Ignited Engine *(corrected to 15% oxygen on a dry basis)*		
	Tier 1 or Tier 2	Meet EPA Tier 4 by January 1, 2015 or 12 years after installation date, but no later than June 1, 2018	Tier 1: 11 ppmv NOx or Tier 4 by July 1, 2008* Tier 2: 11 ppmv NOx or Tier 4 by January 1, 2010*
	Tier 3 or Tier 4	Meet certified compression-ignited engine standard in effect at time of installation	11 ppmv NOx or Tier 4 by January 1, 2010*

**Sources not required to meet these limits through RECLAIM*

Medium and large operators in the South Coast Air Basin are most likely part of the South Coast RECLAIM program and are subsequently not required to meet the engine emission limitations included in Rule 1110.2. All facilities that emit over a certain threshold are required to participate in the RECLAIM program. As part of the RECLAIM program, certain companies receive emission allocations every year, usable for 12 months. The portion of the allocation not needed to offset the operator's own emissions can be sold to other companies. If the operator does not receive an emission allocation, they must buy emission credits from operators with unused emission allocations. In this way, the RECLAIM program is similar to a cap-and-trade program. The District does not have a RECLAIM-type program for this source category; therefore, all operators are required to meet the stringent emission limitations included in Rule 4702.

Although the SCAQMD emission level of 11 ppm has not yet been proven as technologically feasible in the remote agricultural settings found in the San Joaquin Valley, and it is unclear what percentage of facilities are complying with the current SCAQMD NOx limits for non-ag categories, the District evaluated the cost-effectiveness and feasibility of implementing an 11 ppmv NOx emission limit for the following categories of IC engines:

- Non-Agricultural Operations (Non-AO) Waste Gas Engines
- Non-AO Spark-Ignited Engines
    - Cyclic Loaded, Field Gas Fueled

[74] There are only 2 rich-burn spark ignited engines operating in SCAQMD per discussions with their staff
[75] There are no lean-burn spark ignited ag engines operating in SCAQMD per discussions with their staff

    - Limited Use Engines
        - Lean-Burn Engines
        - Rich-Burn Engines
    - Two-Stroke, Gaseous Fueled Engines 50-100 bhp
    - Lean-Burn Engines Used for Gas Compression
- Agricultural Operations (AO) Spark-Ignited Engines

To determine potential emissions reductions, the District used the following equations:

NOx = (BHP x HR x EF x LF) / (CF)

Where:

NOx	=	Current annual NOx emissions or potential annual NOx emissions in ton/year
BHP	=	engine power
HR	=	annual hours of operation
EF	=	NOx emission factor
LF	=	engine load factor
CF	=	conversion factor from grams to pounds

The estimated annual NOx emissions reduction was calculated using the following equation:

Potential Emissions Reduction = current annual NOx emissions – potential annual NOx emissions

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

NOx Emission Limitation for Non-Agricultural Operations (Non-AO) Waste Gas Engines:

The District analyzed the technological feasibility of lowering the NOx emission limit for waste gas engines and determined that due to the variability of waste gas, additional levels of NOx control on existing waste gas engines can pose significant technical and feasibility challenges.

Waste gas includes landfill gas, which is generated at landfills, and digester gas, which is generated from anaerobic digestion. Both landfill and digester gas result from the decomposition of organic matter by microorganisms in the absence of oxygen. Unlike pipeline natural gas, the composition of waste gas is not consistent or guaranteed. The heating value and composition of the gas (e.g. methane and oxygen contents) will vary with the type of materials that enter the landfill or digester and can fluctuate seasonally or even daily. Both landfill and digester gases contain impurities, such as siloxanes, sulfur compounds, and halides. Landfill gas also contains entrained particulate matter, and emissions from both landfill and digester gas may contain particulates that result from combustion of the impurities in the gas. The contaminants in waste gas can coat and/or poison catalysts, rendering them ineffective. Because of its variable composition and contaminants, untreated waste gas is not interchangeable with pipeline-quality natural gas and extensive and costly cleanup would be necessary to allow the use of catalytic emission controls needed to achieve 11 ppmv. This is not a practical option for most existing waste gas-fired engines, which were not designed to include the required gas systems and catalytic controls.

In addition to the District's efforts to identify additional potential technology options for this category, SCAQMD has also been evaluating this issue. In February 2008, SCAQMD amended Rule 1110.2 to include an 11 ppmv limit for waste gas engines rated at >50 bhp. The original compliance date for this emissions limit was July 1, 2012, with the assumption that SCAQMD would complete a Technology Assessment to verify the feasibility of available control technologies for waste gas engines. However, SCAQMD had to amend Rule 1110.2 in September 2012 to extend the compliance deadline for waste gas engines from 2012 to 2016 in order to allow for more time to complete their Final Technology Assessment. Following further evaluation, SCAQMD amended the rule to extend the compliance date to January 1, 2017 for all biogas engines with the exception of demonstration projects prior to January 2015 would be required to comply with emissions limit of 11 ppmv by January 1, 2018 or defer compliance to January 1, 2019 through an alternative compliance option. Additionally, these sources may also have been in a position to avoid installing additional NOx control technologies through their participation in SCAQMD's RECLAIM program.

District Rule 4702 contains the most stringent limits feasible for existing waste gas-fueled engines based on the use of combustion processes that minimize emissions without the use of post-combustion catalytic controls. Therefore, Rule 4702 meets or exceeds BACM and MSM for non-AO waste gas fueled spark-ignited engines. Additionally, the District continues to investigate potential NOx and SOx control technologies for waste gas engines through its Technology Advancement Program, with projects currently approved for funding that will continue to demonstrate new technologies in this sector.

<u>NOx Emission Limitation for Non-AO Spark-Ignited Engines</u>:

Cyclic Loaded, Field Gas Fueled

Cyclic-loaded, field gas fueled engines can achieve some level of control, but not the stringent level of control that can be imposed on engines that operate in a narrow and more stable range of loads. The exhaust gas temperature of cyclic loaded engines varies as a function of the engine load; however, catalyst chemistry is dependent on a minimum temperature to be effective in reducing emissions. When the cyclic load engine is operating in a particular engine load range, the exhaust gas temperature can reach the catalyst's effective range and allow for emissions to be well-controlled; however, as the engine cycles out of this load range, the exhaust gas temperature becomes too low for effective emissions control. Since the exhaust temperature fluctuates frequently for this category of units, it is technologically infeasible to require a lower NOx limit for cyclic loaded field-gas fueled engines. The current emission limit for this category of engines meets or exceeds BACM and MSM for these sources.

Limited Use Engines

During the 2011 amendments to Rule 4702, the District created this category of engines based on the high costs and cost effectiveness associated with the installation of additional controls for these engines (<4,000 hours of operation). The NOx emission reductions foregone from not lowering the existing NOx limits to 11 ppmv for limited use engines was insignificant (about 0.004 tons per day in 2011).[76]

The District re-evaluated the cost effectiveness of lowering the NOx emission limits to 11 ppmv for limited use non-AO rich-burn and lean-burn engines. The costs in the analyses below were gathered from information in the District's Permits database, IC engine manufacturers, emission control system manufacturers and suppliers, and operators.

Limited Use Lean-Burn Engines

When evaluating the ability to lower NOx emissions to 11 ppmv, an operator can either retrofit the existing lean-burn IC engine with a selective catalytic reduction (SCR) system or install a new lean-burn engine with an SCR system. In many cases, retrofitting an existing IC engine is technologically infeasible or may require substantial additional unanticipated costs (such as the incompatibility of an older engine with less sophisticated operating controls with additional control technology, additional labor/maintenance costs, etc.). However, for the purpose of evaluating all potential controls, the District has included both options in the below analysis.

Table C-9 Annual Costs for Retrofitting an Existing Limited Use Lean-Burn Engine and Installing a New Limited Use Lean-Burn Engine with SCR

Item	Assumptions/Methodology	Cost
Average Engine Power Rating	1,100 brake horsepower (bhp)	n/a
Annual Operation	2,500 hours (hr)	n/a
Capital Costs		
New Engine Cost (without SCR)	Includes: engine, freight, installation, start-up, additional equipment (belt guards, fuel connection, etc.), and tax	$300,000
Annualized Engine Capital Costs (10 years, 10%)	0.163 x New Engine Cost	**$48,900**
SCR Equipment & Installation Costs		

[76] SJVAPCD. (2011, August 18). *Adopt Revised Proposed Amendments to Rule 4702 (Internal Combustion Engines).* Retrieved from http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2011/August/Agenda_Item_10_Aug_18_2011.pdf

Item	Assumptions/Methodology	Cost
Total Equipment & Installation Costs	$143,000 per engine Includes catalyst element, urea injection system, and related installation equipment and costs	$143,000
Annualized SCR Capital Costs (10 years, 10%)	0.163 x Total SCR Capital Costs	**$23,309**
Annual Operating and Maintenance Costs		
Annual Reagent (urea) Cost	$2.5 per gallon; 1.2 gallon/hr Cost = $2.5 x 1.2 x 2500 hr	$7,500
Annual Increase in Fuel Cost (due to drop in fuel efficiency with SCR)	Fuel usage = 8,483.3 standard cubic feet per hour (scf/hr) (based on 33% HHV mechanical efficiency) Fuel cost (per 1,000 scf) = $8.39 Fuel cost (per hour) = (8,483.3 x $8.39) / 1,000) Fuel cost (per year) = hourly cost x 2,500 hr 2.5% drop in fuel efficiency Added Fuel Cost = Annual fuel cost x 2.5%	$3,711
Annual Electricity Cost (for compressor)	3 hp compressor = 2.24 kW power rating Electricity rate for industrial operations = $0.18462/kW-hr Hourly electricity cost = 2.24 kW x $0.18462/kW-hr Daily meter charge = $0 (no new electric meter installed) Annual electricity cost = hourly cost x 2,500 hr Total utility cost = Annual electricity cost + Annual meter charge	$1,034
Annual Catalyst Cost	Life of catalyst = 5 years Cost per catalyst = $20,000 Catalyst costs for 10 years = $20,000 x 2 Annualized cost = $40,000 x 0.163	$6,520
Annual Maintenance Cost	Maintenance = $0.015 per bhp per hour of operation Annual cost = $0.015 x 1,100 bhp x 2,500 hr	$41,250
Annual Operating & Maintenance (O&M) Costs	Annual O&M = Annual Reagent Cost+ Annual Increase in Fuel Cost + Annual Electricity Cost + Annual Catalyst Cost + Annual Maintenance Cost	**$60,015**
Annual Cost for Retrofit of LB Engine with SCR	Annual O&M = Annual Reagent Cost+ Annual Increase in Fuel Cost + Annual Electricity Cost + Annual Catalyst Cost + Annual Maintenance Cost	**$83,324**
Annual Cost for New LB Engine with SCR	Annualized Engine Capital Cost + Annualized SCR Capital Cost + Annual O&M Cost	**$132,224**

The emissions reductions are calculated below:

BHP = 1,100 bhp
HR = 2,500 hours/year (hr/yr)
EF1 = 0.838 g-NOx/bhp-hr (equivalent to 65 ppmvd NOx at 15% O2; assuming 33% mechanical efficiency)
EF2 = 0.142 g-NOx/bhp-hr (equivalent to 11 ppmvd NOx at 15% O2; assuming 33% mechanical efficiency)
Load factor (LF) = 0.8
CF = 453.59 grams/pound (g/lb)

Current NOx = (BHP x HR x EF1 x LF) / (CF)
= (1,100 bhp x 2,500 hr/yr x 0.838 g-NOx/bhp-hr x 0.8) / (453.59 g/lb)
= 4,064 lb-NOx/year

Potential NOx = (BHP x HR x EF2 x LF) / (CF)
= (1,100 bhp x 2,500 hr/yr x 0.142 g-NOx/bhp-hr x 0.8) / (453.59 g/lb)
= 689 lb-NOx/year

Potential Emissions Reduction = Current NOx – Potential NOx
Potential Emissions Reduction = (4,064-689 lb) x (1 ton / 2,000 lb)
Potential Emissions Reduction = 1.69 tons/year

Cost Effectiveness (Limited Use Lean-Burn Engines)
The cost effectiveness is the added cost, in dollars per year, of the control technology, divided by the emissions reductions achieved, in tons per year. Based on the calculations above, the cost effectiveness of retrofitting or replacing current limited use lean-burn spark-ignited engines is as follows:

- Retrofitted limited use lean-burn engine with SCR: $49,304/ton of NOx reduced
- New limited use lean-burn engine with SCR: $78,239/ton of NOx reduced

Limited Use Rich-Burn Engines
An existing rich-burn IC engine operating in this category must use advanced emission control technology such as a non-selective catalytic reduction (NSCR) system in order to operate at the already low NOx emissions level of 25 ppmv. When evaluating the ability to lower NOx emissions to 11 ppmv, an engine will already be equipped with the major components for the required NSCR system like three-way catalyst (three-way catalyst), air-to-fuel ratio controller, sensors, and ignition system. However, the existing three-way catalyst element will not likely be able to achieve further NOx reductions and will need to be replaced. It is likely that the other components like air-to-fuel ratio controller and sensors would also need to be replaced since the existing components may be worn or even outdated (e.g., an older, single-point air-to-fuel ratio controller may not be able to consistently maintain the much lower NOx limit as well as a more modern and advanced multi-point controller). Thus, the replacement of the entire NSCR system may be needed. For the purposes of evaluating both feasible scenarios, the following analysis includes retrofitting an existing engine with a replacement catalyst element and retrofitting an existing engine with an entirely new NSCR system.

Table C-10 Annual Costs for Retrofitting an Existing Limited Use Rich-Burn Engine

Item	Assumptions/Methodology	Cost
Average Engine Power Rating	1,400 bhp	n/a
Annual Operation	2,000 hours (hr)	n/a
New NSCR System Capital Costs		
New NSCR System	Includes: NSCR catalyst element, air-to-fuel ratio controller, sensors, ignition system, and installation equipment and costs	$21,000
Annualized Catalyst Capital Cost (10 years, 10%)	0.163 x New NSCR System	**$3,423**
New NSCR Catalyst Element Capital Costs		
New NSCR System	Includes: NSCR catalyst element and installation	$5,000
Annualized Catalyst Capital Cost (10 years, 10%)	0.163 x New NSCR Catalyst Element	**$815**
Annual Cost for Retrofit of RB Engine with New NSCR System	Annualized NSCR System Capital Cost	**$3,423**
Annual Cost for Retrofit of RB Engine with New NSCR Catalyst Element	Annualized NSCR Catalyst Element Capital Cost	**$815**

The emissions reductions are calculated below:

BHP = 1,400 bhp
HR = 2,000 hours/year (hr/yr)
EF1 = 0.322 g-NOx/bhp-hr (equivalent to 25 ppmvd NOx at 15% O2; assuming 33% mechanical efficiency)
EF2 = 0.142 g-NOx/bhp-hr (equivalent to 11 ppmvd NOx at 15% O2; assuming 33% mechanical efficiency)
Load Factor (LF) = 0.8
CF = 453.59 grams/pound (g/lb)

Current NOx = (BHP x HR x EF1 x LF) / (CF)
= (1,400 bhp x 2,000 hr/yr x 0.322 g-NOx/bhp-hr x 0.8) / (453.59 g/lb)
= 1,590 lb-NOx/year

Potential NOx = (BHP x HR x EF2 x LF) / (CF)
= (1,400 bhp x 2,000 hr/yr x 0.142 g-NOx/bhp-hr x 0.8) / (453.59 g/lb)
= 701 lb-NOx/year

Potential Emissions Reduction = Current NOx – Potential NOx

Potential Emissions Reduction = (1,590 - 701 lb) x (1 ton / 2,000 lb)
Potential Emissions Reduction = 0.44 tons/year

Cost Effectiveness (Limited Use Rich-Burn Engines)
The cost effectiveness is the added cost, in dollars per year, of the control technology, divided by the emissions reductions achieved, in tons per year. Based on the calculations above, the cost effectiveness of retrofitting or replacing current limited use rich-burn spark-ignited engines is as follows:

- Retrofitted limited use rich-burn engine with new NSCR system: $7,780/ton of NOx reduced
- Retrofitted limited use rich-burn engine with new NSCR catalyst element: $1,852/ton of NOx reduced

Two-Stroke, Gaseous Fueled Engines 50-100 bhp
There is no control technology compatible with two-stroke, gaseous fueled engines, including SCR, which will allow these units to achieve a NOx emission limit below 75 ppmv. An 11 ppmv NOx emission limit is not technologically feasible for these engines; the current limit implements BACM and MSM for two-stroke, gaseous fueled engines less than 100 bhp.

Lean-Burn Engines Used in Gas Compression:

During the rule amendment in 2011, the District created this category of engines based on the technological infeasibility to control these types of engines. Lean-burn engines used in gas compression in the Valley are used in natural gas distribution and storage service, and these engines frequently experience changing load conditions. As noted in EPA's Stationary IC Engine Technical Support Document[77], SCR use is problematic for these engines due to the fluctuations over a broad range of conditions. For this reason, EPA states that there is an insufficient basis to conclude that SCR is an appropriate technology for large lean-burn engines used for gas compression. The current emission limit is achievable through low-NOx combustion technology, which includes changes to the engine's timing, enhanced control of the air-fuel ratio, and other changes that lower NOx emissions. Due to the technological complexities associated with lean-burn engines used in gas compression, the current emissions limit implements MSM for these units.

Lean-Burn "Not Listed Above"

During the rule amendments in 2011, the District identified categories of non-ag spark-ignited engines and corresponding NOx emission limits that took into account the differences between engines used for different applications. The "not listed above" category accounts for all engines other than those that fit into a specific named category and provides a NOx emissions limit of 11 ppmv for lean-burn engines.

[77] EPA. (2003, October). *Stationary Reciprocating Internal Combustion Engines Technical Support Document for NOx SIP Call*.

Through complying with the current rule limit, engines in this category have already achieved significant NOx emissions reductions through use of advanced emissions controls like SCR systems. Since a lean-burn engine in this category will already be equipped with an SCR system, the engine will also already be equipped with the major components for the required SCR system like SCR catalyst element, air-to-fuel ratio controller, sensors, and urea injection system. However, the existing SCR catalyst element will not likely be able to achieve further NOx reductions and will need to be replaced. It is also likely that older engines in this category cannot reliably achieve the emissions reductions required to achieve a NOx emissions limit of 5 ppmv with just a replacement SCR catalyst element. In this case, an entirely new lean-burn engine with new SCR system will be required. For the purposes of evaluating both feasible scenarios, the following analysis includes retrofitting an existing engine with a replacement SCR catalyst element and installing an entirely new lean-burn engine with new SCR system.

Table C-11 Annual Costs for Replacing an Existing SCR Catalyst Element in a Lean-Burn Engine and Installing a New Lean-Burn Engine with SCR System

Item	Assumptions/Methodology	Cost
Average Engine Power Rating	4,157 brake horsepower (bhp)	n/a
Annual Operation	4,000 hours (hr)	n/a
New Engine Capital Costs		
New Engine Cost (without SCR)	Includes: engine, freight, installation, start-up, additional equipment (belt guards, fuel connection, etc.), and tax (SCR system is a separate cost)	$300,000
Annualized Engine Capital Costs (10 years, 10%)	0.163 x New Engine Capital Cost	**$48,900**
SCR System Capital Costs		
SCR System Cost	Includes catalyst element, urea injection system, catalyst housing, and related installation equipment and costs	$143,000
Annualized SCR System Capital Costs (10 years, 10%)	0.163 x SCR System Capital Costs	**$23,309**
Replacement SCR Catalyst Element Capital Costs		
SCR Catalyst Element	Includes catalyst element, catalyst housing, and related installation costs	$50,000
Annualized SCR Catalyst Element Capital Costs (10 years, 10%)	0.163 x SCR Catalyst Element Capital Costs	**$8,150**
Annual Cost for New LB IC Engine with New SCR System	Annualized Engine Capital Cost + Annualized SCR System Cost	**$72,209**

Item	Assumptions/Methodology	Cost
Annual Cost for New SCR Catalyst Element	Annualized SCR Catalyst Element Capital Cost	**$8,150**

The emissions reductions are calculated below:

BHP = 4,157 bhp
HR = 4,000 hours/year (hr/yr)
EF1 = 0.142 g-NOx/bhp-hr (equivalent to 11 ppmvd NOx at 15% O2; assuming 33% mechanical efficiency)
EF2 = 0.063 g-NOx/bhp-hr (equivalent to 5 ppmvd NOx at 15% O2; assuming 33% mechanical efficiency)
Load Factor (LF) = 0.8
CF = 453.59 grams/pound (g/lb)

Current NOx = (BHP x HR x EF1 x LF) / (CF)
= (4,157 bhp x 4,000 hr/yr x 0.142 g-NOx/bhp-hr x 0.8) / (453.59 g/lb)
= 4,164 lb-NOx/year

Potential NOx = (BHP x HR x EF2 x LF) / (CF)
= (4,157 bhp x 4,000 hr/yr x 0.063 g-NOx/bhp-hr x 0.8) / (453.59 g/lb)
= 1,848 lb-NOx/year

Potential Emissions Reduction = Current NOx – Potential NOx
Potential Emissions Reduction = (4,164 - 1,848 lb) x (1 ton / 2,000 lb)
Potential Emissions Reduction = 1.16 tons/year

Cost Effectiveness (Lean-Burn "Not Listed Above", 5 ppmv)
The cost effectiveness is the added cost, in dollars per year, of the control technology, divided by the emissions reductions achieved, in tons per year. Based on the calculations above, the cost effectiveness of retrofitting or replacing current limited use lean-burn spark-ignited engines is as follows:

- New lean-burn engine with new SCR system: $62,249/ton of NOx reduced
- New SCR Catalyst Element: $7,026/ton of NOx reduced

Rich Burn "Not Listed Above"

During the rule amendments in 2011, the District identified categories of non-ag spark-ignited engines and corresponding NOx emission limits that took into account the differences between engines used for different applications. The "not listed above" category accounts for all engines other than those that fit into a specific named category and provides a NOx emissions limit of 11 ppmv for rich-burn engines.

Through complying with the current rule limit, engines in this category have already achieved significant NOx emissions reductions through use of advanced emissions controls such as a NSCR systems. When evaluating the feasibility of achieving additional reductions to meet a NOx emissions limit of 7 ppmv, an engine will already be equipped with the major components for the required NSCR system like three-way catalyst (three-way catalyst), air-to-fuel ratio controller, sensors, and ignition system. However, the existing three-way catalyst will not likely be able to achieve further NOx reductions and will need to be replaced. It is likely that the other components like air-to-fuel ratio controller and sensors would also need to be replaced since the existing components may be worn or even outdated (e.g., an older, single-point air-to-fuel ratio controller may not be able to consistently maintain the much lower NOx limit as well as a more modern and advanced multi-point controller). Thus, the replacement of the entire NSCR system may be needed. For the purposes of evaluating both feasible scenarios, the following analysis includes retrofitting an existing engine with a replacement catalyst element and retrofitting an existing engine with an entirely new NSCR system.

Table C-12 Annual Cost for Installing a New Rich-Burn Engine with an NSCR System

Item	Assumptions/Methodology	Cost
Average Engine Power Rating	162 bhp	n/a
Annual Operation	4,000 hr	n/a
New NSCR System Capital Costs		
NSCR System	Includes: NSCR catalyst element, air-to-fuel ratio controller, sensors, ignition system, and installation equipment and costs	$21,000
Annualized NSCR System Capital Costs (10 years, 10%)	0.163 x Total NSCR System Capital Costs	**$3,423**
New NSCR Catalyst Element Capital Costs		
New NSCR System	Includes: NSCR catalyst element and installation	$5,000
Annualized Catalyst Capital Cost (10 years, 10%)	0.163 x New NSCR Catalyst Element	**$815**
Annual Cost for Retrofit of RB Engine with New NSCR System	Annualized NSCR System Capital Cost	**$3,423**
Annual Cost for Retrofit of RB Engine with New NSCR Catalyst Element	Annualized Three-Way Catalyst Element Capital Cost	**$815**

The emissions reductions are calculated below:

BHP = 162 bhp
HR = 4,000 hours/year
EF1 = 0.142 g-NOx/bhp-hr (equivalent to 11 ppmv at 30% HHV mechanical efficiency)

EF2 = 0.089 g-NOx/bhp-hr (equivalent to 7 ppmv at 30% HHV mechanical efficiency)
Load Factor (LF) = 0.80
CF = 453.59 grams/pound

Current NOx = (BHP x HR x EF1 x LF) / (CF)
= (162 bhp x 4,000 hr/yr x 0.142 g-NOx/bhp-hr x 0.8) / (453.59 g/lb)
= 162 lb-NOx/year

Potential NOx = (BHP x HR x EF2 x LF) / (CF)
= (162 bhp x 4,000 hr/yr x 0.089 g-NOx/bhp-hr x 0.8) / (453.59 g/lb)
= 102 lb-NOx/year

Potential Emissions Reduction = Current NOx – Potential NOx
Potential Emissions Reduction = (162 - 102 lb) x (1 ton / 2,000 lb)
Potential Emissions Reduction = 0.03 tons/year

Cost Effectiveness (Rich-Burn "Not Listed Above", 7 ppmv)
The cost effectiveness is the added cost, in dollars per year, of the control technology, divided by the emissions reductions achieved, in tons per year. Based on the calculations above, the cost effectiveness of replacing current engines in the rich-burn "not listed above" category is as follows:

- Retrofitted rich-burn engine with new NSCR system: $114,100/ton of NOx reduced
- Retrofitted rich-burn engine with new three-way catalyst element: $27,167/ton of NOx reduced

NOx Emission Limitation for Agricultural Operation (AO) Spark-Ignited Engines:

Feasibility Considerations: AO Spark-Ignited Engines
Over the past decade, AOs have invested significant capital to retrofit and replace thousands of irrigation pump and other engines reducing emissions by over 80% in this category, and continue to do so as emission limitations and associated compliance deadlines materialize under Rule 4702. In addition to the high cost-effectiveness and potential technical infeasibility associated with retrofitting or replacing existing AO spark ignited engines, requiring additional costly controls on existing AO engines is economically challenging and potentially infeasible.

Retrofitting existing spark-ignited engines poses several challenges that are not present when installing new, replacement engines. The District had to overcome many obstacles and challenges in retrofitting existing AO engines when the District adopted its current emission limit of 90 ppm and has worked closely with AO engine owners and operators and control system manufacturers to ensure compliance with this stringent emission limit. Efforts to ensure compliance with the current rule limit are continuing today. Lowering the emission limit from 90 ppmv 11 ppm, results in even greater challenges for existing engines to consistently meet because of the much lower tolerance for being out of compliance. These challenges are outlined in the following list. Details are provided below:

Challenges with retrofitting existing engines:

1. Engine power losses from adding controls
2. Existing engines may require overhaul
3. Existing engines cannot meet lower emissions levels due to narrower margin of compliance
4. Control systems must be custom designed
5. Errors generated during control system installation
6. Retrofit controls can damage an engine
7. Engine can damage a control system
8. Compliance costs
9. Engines operated in remote locations

1. Engine power losses from adding controls

An engine is chosen based on its ability to provide the required power output at a reasonable engine speed (rpm) that will not over-stress the engine over its expected service life. Add-on emission control systems result in additional loads that the engine may not have been originally designed to accommodate.
In addition, due to the extreme drought conditions, engine owners and operators have needed to increase the power output for well pump engines as the water table has dropped. As the engines work harder to pump water, there is less power output available to accommodate emission control systems.

2. Existing engines may require overhaul

The engines in use at AOs have been in service for many years, even decades, and are heavily worn. A worn engine can burn oil, leak fluids, and run rough. For an uncontrolled engine, some of the effects of engine wear do not have a major effect on the engine's ability to do its job (e.g. pumping water). However, the operation of a catalytic emission control system requires that the engine be operated consistently smooth. An expensive major engine overhaul or rebuild would be necessary to ensure smooth engine operation prior to installing a catalytic emission control system. Many AOs do not have the resources (e.g., staff, experience, technical training, etc.) to complete an engine overhaul or rebuild without outside assistance. Meeting more stringent/lower emission standards increases the need for the engine to operate properly.

3. Existing engines cannot meet lower emissions levels due to narrower margin of compliance

As emission limits are lowered, there is a narrower margin of compliance and proper engine operation becomes more critical. AOs in the District have to constantly ensure that their engine is properly maintained and within all the appropriate specifications to ensure compliance with the current emission limit, more so than newer engines. The lower emissions levels will result in additional stresses on the engine and increased maintenance and monitoring efforts that result from operating a retrofitted engine. Even then, due to the age of the engine and based on engine not appropriately designed for additional add-on systems and the associated loads, engines will not be able to meet the lower limits.

4. Control systems must be custom designed
For proper control system design, the engine condition, make, model, power output, and exhaust gas flow rate and temperature must be considered. There are not universal, off-the-shelf, one size-fits-all systems available for purchase. Control system design also assumes that an engine is operating properly and smoothly per the engine manufacturer's specifications. To ensure proper operation of the control system, an engine may need to be overhauled or rebuilt prior to installation of the control system.

A common problem with many retrofit emission control systems is installation of a system on an engine that is not operating smoothly or to engine manufacturer specifications. Installing a control system on a rough running engine will result in poor control system operation and eventually system and engine damage. Proper system design and engine operation is more important as emission limits are lowered since the margin of compliance will be much less.

5. Errors generated during control system installation
Site conditions like gas supply pressure can cause an existing engine to operate rough. If site issues are not addressed prior to installation of a control system, the control system will not operate correctly. An installer may attempt to correct rough engine operation by making the combustion more fuel rich; however, this technique will not provide lasting results and will cause accelerated engine and control system wear and eventually failure. An emission control system that is designed to meet lower emission limits will require a larger catalyst element which will be more expensive to replace if permanently damaged.

6. Retrofit controls can damage an engine
For proper control of exhaust pollutants, a catalyst must be operated at a certain temperature range that is higher than normal exhaust temperatures. Additional fuel is often injected into the engine with the intent that the additional fuel will pass through the combustion chamber and ignite in the exhaust system prior to the catalyst (the high catalyst temperature ignites the fuel). This extra fuel results in higher engine operating temperatures since some of the extra fuel is combusted during normal engine combustion. The increased engine temperature leads to accelerated engine wear and reduced engine reliability. Due to wear and older design, increased combustion temperatures lead to engine failure and permanent engine damage.

7. Engine can damage a control system
An existing, worn engine can burn oil and run rough. Oil in the exhaust stream will foul/mask a catalyst which will result in reduced emission control efficiency

and likely permanent damage to a catalyst element. The air-fuel ratio controller will attempt to adjust engine operation (e.g., injecting more fuel) to keep the control system operating within the specified parameters; however, adjusting engine operation will not correct a fouled catalyst. Continued operation with a damaged catalyst will lead to permanent catalyst damage. An emission control system that is designed to meet lower emission limits will require a larger catalyst element which will be more expensive to replace if permanently damaged and this cycle will be repeated further adding to the cost.

8. Compliance costs
Unlike many industries, AOs compete on an international basis and cannot pass increased production costs on to consumers. AOs must absorb the compliance costs associated with lower emission standards, for example: retrofit and replacement costs; additional maintenance costs; additional monitoring costs; and additional testing costs. These additional regulatory costs put them at an economic disadvantage to their competitors.

9. Engines operated in remote locations
AO spark-ignited engines are generally located in rural, hard to access areas with minimal oversight since AOs have limited resources and staffing. With seasonal labor and minimal year-round staffing, it is difficult for AOs to provide the frequent and complex maintenance required for retrofitted or new engines equipped with advanced emission controls. Lower emission limits are achieved only through well maintained engines and control systems. Lower emissions limits lead to increased maintenance and monitoring efforts. The oil production industry is the only other major industry in the Valley that has IC engines located in remote locations; however, with the highly technical nature of oil production and refining as compared to agricultural production and additional economic resources, it is feasible for the oil and gas production industry to hire qualified staff dedicated to maintaining and operating IC engines and other equipment on-site.

Retrofitting AO engines with emission control systems to meet increasingly stringent emission limits poses unique challenges that are not applicable when installing replacement engines. Based on the challenges outlined above, meeting 25 ppm or even 11 ppm with existing AO engines is not practicable. The additional maintenance, monitoring, and testing, along with the cost of rebuilding engines and the cost of the emission control system, may even be more costly than installing a replacement engine.

Despite the technological feasibility issues associated with retrofitting or replacing existing AO spark-ignited engines, the District evaluated the cost effectiveness and feasibility of achieving an 11 ppmv NOx emission limit for the following scenarios:

- Installing a new IC lean-burn engine with SCR as a replacement for an existing unit
- Retrofitting an existing lean-burn IC engine with SCR

- Installing a new rich-burn engine with a three-way catalyst system as a replacement for an existing unit

The District gathered costs information from District's Permits database, IC engine manufacturers, emission control system manufacturers and suppliers, and agricultural industry representatives to determine the costs in the analyses below.

AO Lean-Burn Engines (11 ppmv)

When evaluating the ability to lower NOx emissions to 11 ppmv, an agricultural operator can either retrofit the existing lean-burn IC engine with a selective catalytic reduction (SCR) system or install a new lean-burn engine with an SCR system.

Table C-13 Annual Costs for Retrofitting an Existing AO Lean-Burn Engine with SCR and Installing a New AO Lean-Burn Engine with SCR

Item	Assumptions/Methodology	Cost
Average Engine Power Rating	241 brake horsepower (bhp)	n/a
Annual Operation	2500 hours (hr)	n/a
Capital Costs (Engine)		
New Engine Cost (without SCR)	Includes: engine, freight, installation, start-up, additional equipment (belt guards, fuel connection, etc.), and tax	$109,480
Annualized Engine Capital Costs (10 years, 10%)	0.163 x New Engine Cost	**$17,845**
SCR Equipment & Installation Costs		
Total SCR Equipment and Installation Costs	$100,000 per engine, includes catalyst element, urea injection system, and related installation equipment and costs	$100,000
Annualized SCR Capital Costs (10 years, 10%)	0.163 x Total SCR Capital Costs	**$16,300**
Annual Operating and Maintenance Costs (SCR)		
Annual Reagent (urea) Cost	$2.5 per gallon; 0.3 gallon/hr Cost = $2.5/gal x 0.3 gal/hr x 2,500 hr	$1,875
Annual Increase in Fuel Cost (due to drop in fuel efficiency with SCR)	Fuel usage = 2,044.5 standard cubic feet per hour (scf/hr) Fuel cost (per 1,000 scf) = $8.39 Fuel cost (per hour) = (2,044.5 scf/hr x $8.39) / 1,000 scf Fuel cost (per year) = hourly cost x 2,500 hr 2.5% drop in fuel efficiency Added Fuel Cost = Annual fuel cost x 2.5%	$1,072
Annual Electricity Cost (for compressor)	3 hp compressor = 2.24 kW power rating Electricity rate for AO = $0.18462/kW-hr Hourly electricity cost = 2.24 kW x $0.18462/kW-hr Annual electricity cost = hourly cost x 2,500 hr	$1,034

Item	Assumptions/Methodology	Cost
Annual Catalyst Cost	Life of catalyst = 5 years Cost per catalyst = $5,000 Catalyst costs for 10 years = $5,000 x 2 Annualized cost = $10,000 x 0.163	$1,630
Annual Maintenance Cost	Maintenance = $0.018 per bhp per hour of operation Annual cost = $0.018 x 241 bhp x 2,500 hr	$10,845
Annual Operating & Maintenance (O&M) Costs	Annual O&M = Annual Reagent Cost+ Annual Increased Fuel Cost + Annual Electricity Cost + Annual Catalyst Cost + Annual Maintenance Cost	**$16,456**
Annual Cost for Retrofit of LB Engine with SCR	Annualized SCR Capital Cost + Annual O&M Cost	**$32,756**
Annual Cost for New LB Engine with SCR	Annualized Engine Capital Cost + Annualized SCR Capital Cost + Annual O&M Cost	**$50,601**

The emissions reductions are calculated below:

BHP = 241 bhp
HR = 2,500 hours/year (hr/yr)
EF1 = 2.126 g-NOx/bhp-hr (equivalent to 150 ppmv at 30% mechanical efficiency)
EF2 = 0.156 g-NOx/bhp-hr (equivalent to 11 ppmv at 30% mechanical efficiency)
Load Factor (LF) = 0.80
CF = 453.59 grams/pound (g/lb)

Current NOx = (BHP x HR x EF1 x LF) / (CF)
= (241 bhp x 2,500 hr/yr x 2.126 g-NOx/bhp-hr x 0.80) / (453.59 g/lb)
= 2,259 lb-NOx/year

Potential NOx = (BHP x HR x EF2 x LF) / (CF)
= (241 bhp x 2,500 hr/yr x 0.156 g-NOx/bhp-hr x 0.80) / (453.59 g/lb)
= 166 lb-NOx/year

Potential Emissions Reduction = Current NOx – Potential NOx
Potential Emissions Reduction = (2,259-166 lb) x (1 ton / 2,000 lb)
Potential Emissions Reduction = 1.05 tons/year

Cost Effectiveness (AO Lean-Burn, 11 ppmv)

The cost effectiveness is the added cost, in dollars per year, of the control technology, divided by the emissions reductions achieved, in tons per year. Based on the calculations above, the cost effectiveness of retrofitting or replacing current AO lean-burn spark-ignited engines is as follows:

- Retrofitted lean-burn engine with SCR: $31,196/ton of NOx reduced[78]
- New lean-burn engine with SCR: $48,191 of NOx reduced

AO Rich-Burn Engines (11 ppmv)

When evaluating the ability to lower NOx emissions to 11 ppmv, an agricultural operator can install a new rich-burn engine with 3-way catalyst.

Table C-14 Annual Cost for Installing a New AO Rich-Burn Engine with a 3-way Catalyst

Item	Assumptions/Methodology	Cost
Average Engine Power Rating	256 bhp	n/a
Annual Operation	2,500 hr	n/a
Total Capital Costs		
New Engine Cost	Includes: engine with 3-way catalyst, freight, installation, and tax	$95,000
Annualized Engine Capital Costs (10 years, 10%)	0.163 x New Engine Cost	**$15,485**
Annual Operating and Maintenance Costs (SCR)		
Annual Added Fuel Cost (due to drop in fuel efficiency with catalyst)	Fuel usage = 2,171.7 scf/hr Fuel cost (per 1,000 scf) = $8.39 Fuel cost (per hour) = (2,171.7 scf/hr x $8.39) / 1,000 scf Fuel cost (per year) = hourly cost x 2,500 hr Assume 2.5% drop in fuel efficiency Added Fuel cost = Annual fuel cost x 2.5%	$1,139
Annual Catalyst Cost	Life of catalyst = 5 years Cost per catalyst = $5,000 Catalyst costs for 10 years = $5,000 x 2 Annualized Catalyst Cost = $10,000 x 0.163	$1,630
Annual Maintenance Cost	Maintenance = $0.018 per bhp per hour of operation Annual Maintenance Cost = $0.018/bhp-hr x 256 bhp x 2500 hr	$11,520
Annual Operating & Maintenance (O&M) Costs	Annual O&M = Annual Added Fuel Cost + Annual Catalyst Cost + Annual Maintenance Cost	**$14,289**
Annual Cost for New RB Engine with 3-way	Annualized Engine Capital Cost + Annual O&M Cost	**$29,774**

[78] Due to the remoteness of these engines, it is likely that most sites will not have existing electricity to power the electrical compressor for the urea injection system. The costs provided in this section do not include costs to bring electricity to the site. Overall costs will be significantly higher if this additional cost is added.

The emissions reductions are calculated below:

BHP = 256 bhp
HR = 2,500 hours/year
EF1 = 1.276 g-NOx/bhp-hr (equivalent to 90 ppmv at 30% HHV mechanical efficiency)
EF2 = 0.156 g-NOx/bhp-hr (equivalent to 11 ppmv at 30% HHV mechanical efficiency)
Load Factor (LF) = 0.80
CF = 453.59 grams/pound

Current NOx = (BHP x HR x EF1 x LF) / (CF)
= (256 bhp x 2,500 hr/yr x 1.276 g-NOx/bhp-hr x 0.80) / (453.59 g/lb)
= 1,440 lb-NOx/year

Potential NOx = (BHP x HR x EF2 x LF) / (CF)
= (256 bhp x 2,500 hr/yr x 0.156 g-NOx/bhp-hr x 0.80) / (453.59 g/lb)
= 176 lb-NOx/year

Potential Emissions Reduction = Current NOx – Potential NOx
Potential Emissions Reduction = (1,440-176 lb) x (1 ton / 2,000 lb)
Potential Emissions Reduction = 0.63 tons/year

Cost Effectiveness (AO Rich-Burn, 11 ppmv)

The cost effectiveness is the added cost, in dollars per year, of the control technology, divided by the emissions reductions achieved, in tons per year. Based on the calculations above, the cost effectiveness of replacing current AO rich-burn engines is as follows:

- New rich-burn engine with a 3-way catalyst to meet 11 ppmv: $47,260/ton of NOx reduced

AO Spark-Ignited Engines (Replace with Electric Motors or Tier 4-Equivalent Engines through Incentive/Regulatory Measure)

As demonstrated above, the replacement of agricultural operation rich-burn and lean-burn engines with new engines and control systems is not cost-effective or feasible. Building on the prior successful model of pursuing transition to advanced engine technologies through an incentive-based approach, it may be possible to achieve additional cost-effective reductions through the transition of spark-ignited to electric motors where access to electricity is available, or Tier 4-equivalent engine technologies (0.30 g/hp-hr, ~20 ppmv NOx). This approach would rely on strong incentives for both the motor/engine costs and electrical infrastructure, outreach through a collaborative effort with affected sources, USDA-NRCS, and other stakeholders and would potentially be coupled with a regulatory backstop to encourage participation. In partnership with agricultural stakeholders, the District has been in discussions with utilities to explore the potential of developing enhance rate structures to further incentivize the transition to electrification where feasible.

AO Compression-Ignited Engines (Replace with Electric Motors or Tier 4-Equivalent Engines through Incentive Measure)

Working closely with the agricultural community, publically owned utilities, USDA-NRCS, and other stakeholders, emissions from agricultural compression-ignited engines have been reduced by up to 80% through a whole-scale transition from uncontrolled Tier 0 engines to lower-emitting Tier 1 and Tier 2 engines, and then again through transition to even lower-emitting Tier 3, Tier 4, and electric engines/motors. While the current stringent requirements satisfy all federal requirements for RACM, BACM, and MSM, additional reductions may be possible through an incentive-based approach. Building on the prior successful model of pursuing transition to advanced engine technologies through an incentive-based approach, it may be possible to achieve additional cost-effective reductions through the transition of compression-ignited engines to electric motors where access to electricity is available, or Tier 4-equivalent engine technologies (0.30 g/hp-hr, ~20 ppmv NOx). This approach would rely on strong incentives for both the motor/engine costs and electrical infrastructure, and outreach through a collaborative effort with affected sources, USDA-NRCS, and other stakeholders. In partnership with agricultural stakeholders, the District has been in discussions with utilities to explore the potential of developing enhanced rate structures to further incentivize the transition to electrification where feasible.

SOx and PM limitations

Rule 4702 contains stringent requirements requiring the combustion of Public Utilities Commission (PUC) quality natural gas, or other equivalent ultra-low sulfur fuels, and diesel engines subject to Rule 4702 are required to be EPA Tier 3 or Tier 4 certified, depending on the size of the engine and the annual operating hours. EPA Tier 3 and 4 certifications require the units to meet low PM limits and Tier 4 engines are required to meet even lower PM emissions through the use of particulate filters. Given the low PM2.5 and SOx emissions from IC engines and existing rule requirements, the District determined that no further requirements were needed to address PM2.5 and SOx emissions.

Evaluation Findings

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for emissions from internal combustion engines. As demonstrated above, Rule 4702 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, the District will pursue the following potential opportunities that are projected to provide 1.4 tons NOx per day of additional emissions reductions towards the District's aggregate plan commitment:

- Non-Agricultural IC Engines: Work with affected operators to further reduce NOx emissions from non-ag IC engines to the extent that such controls are technologically achievable and economically feasible. Technologies evaluated with the potential to further reduce emissions include the installation of 3-way catalytic reduction for rich-burn IC engines and selective catalytic reduction for lean-burn IC engines. While the analysis above shows that many control technologies are not cost-effective, potential emission reduction opportunities for further evaluation include:
  - Rich Burn Engines ("not listed above" category): Lower existing limit of 11 ppmv to as low as 7 ppmv
  - Lean Burn Engines ("not listed above" category): Lower existing limit of 11 ppmv to as low as 5 ppmv
  - Limited Use Rich/Lean Burn: Lower existing limits of 25 and 65 ppmv to as low as 11 ppmv

- Agricultural IC Engines: Work with agricultural sources to further reduce NOx emissions through incentive-based/regulatory approach as technologically and economically feasible. While the analysis above demonstrates that the various control technologies are generally not cost-effective without financial assistance, and may not be technologically feasible for remote ag installations, potential emission reduction opportunities for further evaluation include:
  - Replacement of spark-ignited agricultural engines with electric motors where access to electricity is available, or Tier 4-equivalent engine technologies through incentive-based approach coupled with regulatory backstop to encourage participation.
  - Replacement of Tier 3 compression-ignited agricultural engines with electric motors where access to electricity is available, or Tier 4-equivalent engine technologies through incentive-based approach to achieve additional emissions reductions where cost-effective.

The proposed commitments by the District and CARB will each achieve an aggregate emission reduction of direct PM2.5 and NOx. While the commitments include estimates of the emission reductions from each individual measure, final measures as proposed for adoption into the state implementation plan (SIP) may provide more or less emission reductions. The aggregate commitment will guarantee that the total emission reductions will be achieved to attain each NAAQS as expeditiously as practicable.

C.18 Rule 4703 (NOx Emissions from Stationary Gas Turbines)

Discussion

The provisions of this rule are applicable to all stationary gas turbine systems, which are subject to District permitting requirements, and with electrical generation ratings equal to or greater than 0.3 megawatt (MW) or a maximum heat input rating of more than 3 million British Thermal Units per hour (MMBtu/hr), and that are used for the generation of electrical power. The purpose of this rule is to limit NOx emissions from these stationary gas turbines.

Rule 4703 was adopted on August 18, 1994. Since its adoption, the rule has been amended six times. The latest rule amendment in September 2007 strengthened the rule by establishing more stringent NOx limits for existing stationary gas turbines. EPA finalized approval for Rule 4703 on October 21, 2009 and deemed this rule as being at least as stringent as established RACT requirements. NOx emissions have been controlled by over 86% for this source category.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	1.30	1.13	1.16	1.12	1.12	1.13	1.14	1.15	1.15
NOx	3.29	2.89	2.98	2.87	2.89	2.92	2.94	2.95	2.97
	Winter Average - Tons per day								
PM2.5	1.29	1.12	1.15	1.11	1.12	1.13	1.13	1.14	1.15
NOx	3.20	2.82	2.90	2.80	2.82	2.85	2.87	2.88	2.90

Source Category

The requirements of rule 4703 affect owners and operators of stationary gas turbine systems used to pump, compress, generate electricity, or perform other tasks. The four major industry groups using this type of equipment are oil and gas production, utilities, manufacturing, and government.

In complying with this rule, all affected entities are required to control NOx and CO emissions by installing approved emissions control devices. Early in the rule development process, the District identified four different emissions control technologies that could be used to achieve proposed limits for stationary gas turbines. Of the four options, three mainly control NOx emissions, while the other one controls CO emissions. The three NOx control technologies are:

- Diluent (water or steam) injection systems,
- Dry, low-NOx, and
- Selective Catalytic reduction

Emissions limits vary by size, cycle, annual operating hours, and fuel type. The emissions limits in this rule by category are summarized in the tables below.

How does District Rule4703 compare with federal and state rules and regulations?

Federal Regulations
There are no EPA CTG requirements for this source category.

Alternative Control Techniques (ACT)

- EPA–453/R-93-007 (Alternative Control Techniques Document—NOx Emissions from Stationary Gas Turbines)

The District evaluated the requirements contained within the ACT for NOx Emissions from Stationary Gas Turbines and found no requirements that were more stringent than those already in Rule 4703.

New Source Performance Standards (NSPS)

- 40 CFR 60 Subpart GG (Standards of Performance for Stationary Gas Turbines)

The District evaluated the requirements contained within Subpart GG and found no emission requirements that were more stringent than those already in Rule 4703.

- 40 CFR 60 Subpart KKKK (Standards of Performance for Stationary Combustion Turbines)

The District evaluated the requirements contained within Subpart KKKK and found no emission requirements that were more stringent than those already in Rule 4703.

National Emissions Standards for Hazardous Air Pollutants (NESHAP)/Maximum Achievable Control Technology (MACT)

- 40 CFR 63 Subpart YYYY (National Emission Standards for Hazardous Air Pollutants for Stationary Combustion Turbines)

40 CFR 63 Subpart YYYY was last amended on April 20, 2006; however, this NESHAP only contains emission limits and regulations to reduce formaldehyde emissions. Formaldehyde is an organic compound which is most closely related to VOC emissions. This control measure analysis does not apply to VOC emissions. Therefore, the requirements of Subpart YYYY have not been included as a part of this control measure source category evaluation.

State Regulations
There are no state regulations applicable to this source category.

HOW DOES DISTRICT RULE 4703 COMPARE TO RULES IN OTHER AIR DISTRICTS?

There are no analogous rules for this source category in SMAQMD

BAAQMD

- BAAQMD Regulation 9 Rule 9 (Nitrogen Oxides from Stationary Gas Turbines *(Amended December 6, 2006)*

  The District evaluated the requirements contained within BAAQMD's Rule 9-9 and found no requirements that were more stringent than those already in Rule 4703.

	SJVAPCD	BAAQMD
Applicability	Gas turbines ≥ 0.3 MW or a maximum heat input rating of 3 MMBtu/hr	Gas turbines ≥ 5.0 MMBtu/hr
Exemption	• Laboratory turbines used in research and testing for the advancement of gas turbine technology. • Units limited by permit condition to be operated exclusively for firefighting and/or flood control. • Emergency standby turbines limited by permit condition to operate less than 100 hours per calendar year for maintenance and testing purposes.	• Testing of aircraft gas turbine engines for flight certification. • Gas turbines used solely for firefighting and/or flood control. • Gas turbines used solely for firefighting and/or flood control. Gas turbines rated less than 50 MMBtu/hr heat input that operate less than 877 hours in any 12-month period.
Requirements	The operator of any stationary gas turbine shall not operate a unit in such a manner that results in NO_X emissions, referenced at 15% O_2, shall not exceed the following limits:	A person shall not operate a stationary gas turbine unless NO_X emission concentrations, referenced at 15% O_2, do not exceed the following limits:
	Units Rated < 3 MW	
	Gas Fuel - 9 ppm Liquid Fuel - 25 ppm	Natural Gas - 42 ppm Refinery, Waste, or LPG - 50 ppm Non-Gaseous – 65 ppm
	Units Rated ≥ 3 MW and < 10 MW	

	• *Pipeline Gas:* Steady State Operation – 8 ppm Non-Steady State Operation – 12 ppm Liquid Fuel – 25 ppm • *< 877 hr/yr:* Gas Fuel - 9 ppm Liquid Fuel - 25 ppm • *≥ 877 hr/year and not listed above:* Gas Fuel - 5 ppm Liquid Fuel - 25 ppm	• *Units without Water Injection, Steam Injection, or Dry Low NO_X (DLN) Technology Available :* Natural Gas - 42 ppm Refinery, Waste, or LPG - 50 ppm Non-Gaseous – 65 ppm • *Units with Water Injection or Steam Injection Available :* Natural Gas - 35 ppm Refinery, Waste, or LPG - 50 ppm Non-Gaseous – 65 ppm • *Units with DLN Technology Available:* Natural Gas - 25 ppm Refinery, Waste, or LPG - 50 ppm Non-Gaseous – 65 ppm
	Units Rated ≥ 10 MW	
	• *Combined Cycle:* Gas Fuel - 5 ppm (standard) Gas Fuel – 3 ppm (enhanced) Liquid Fuel – 25 ppm • *Simple Cycle and ≥ 877 hr/yr:* Gas Fuel - 5 ppm (standard) Gas Fuel - 3 ppm (enhanced) Liquid Fuel – 25 ppm • *Simple Cycle and > 200 hr/yr and < 877 hr/yr:* Gas Fuel - 5 ppm Liquid Fuel – 25 ppm • *Simple Cycle and ≤ 200 hr/yr:* Gas Fuel - 25 ppm Liquid Fuel – 42 ppm	• *≥ 10 and < 19 MW:* Natural Gas - 15 ppm Refinery, Waste, or LPG 15 ppm Non-Gaseous – 42 ppm • *≥ 19 and < 40 MW:* Natural Gas - 9 ppm Refinery, Waste, or LPG 9 ppm Non-Gaseous – 25 ppm • *≥ 40 MW:* Natural Gas - 5 ppm Refinery, Waste, or LPG 9 ppm Non-Gaseous – 25 ppm

SCAQMD

- SCAQMD Rule 1134 (Emissions of Oxides of Nitrogen from Stationary Gas Turbines) *(Amended August 8, 1997)*

  The District evaluated the requirements contained within SCAQMD's Rule 1134 and found that overall rule 4703 is more stringent than SCAQMD Rule 1134.

	SJVAPCD	SMAQMD
Applicability	Gas turbines rated ≥ 0.3 MW or with a maximum heat input rating of > 3 MMBtu/hr	Gas turbines rated ≥ 0.3 MW output or with a maximum heat input rating of > 3 MMBtu/hr and operated on gaseous and/or liquid fuel
Exemption	• Laboratory turbines used in research and testing for the advancement of gas turbine technology. • Units limited by permit condition to be operated exclusively for firefighting and/or flood control. • Emergency standby turbines limited by permit condition to operate less than 100 hours per calendar year for maintenance and testing purposes.	• Emergency standby units used to provide electrical power, water pumping for flood control or firefighting, potable water pumping, or sewage pumping provided the following are met: - Maintenance operation shall not exceed 100 hr/yr, and - Total operation of the unit shall be limited to 200 hr/yr, and - Operation of the unit shall not be for supplying power to a serving utility for distribution on the grid, and - Operation of the unit for other than maintenance purposes shall be limited to emergency situations only. • Laboratory units used in research and testing for the advancement of gas turbine technology.
Requirements	The operator of any stationary gas turbine shall not operate a unit in such a manner that results in NO_X emissions, referenced at 15% O_2, shall not exceed the following limits:	A person shall not operate a stationary gas turbine unless NO_X emission concentrations, referenced at 15% O_2, do not exceed the following limits:
	Units Rated < 3 MW	
	Gas Fuel - 9 ppm Liquid Fuel - 25 ppm	Gas Fuel – 42.0 ppm Liquid Fuel – 65.0 ppm
	Units Rated ≥ 3 MW and < 10 MW	

	• *Pipeline Gas:* Steady State Operation – 8 ppm Non-Steady State Operation – 12 ppm Liquid Fuel – 25 ppm • *< 877 hr/yr:* Gas Fuel - 9 ppm Liquid Fuel - 25 ppm • *≥ 877 hr/year and not listed above:* Gas Fuel - 5 ppm Liquid Fuel - 25 ppm	• *< 877 hr/yr:* Gas Fuel – 42.0 ppm Liquid Fuel – 65.0 ppm • *≥ 877 hr/year:* Gas Fuel – 25.0 ppm Liquid Fuel – 65.0 ppm
	Units Rated ≥ 10 MW	
	• *Combined Cycle:* Gas Fuel - 5 ppm (standard) Gas Fuel – 3 ppm (enhanced) Liquid Fuel – 25 ppm • *Simple Cycle and ≥ 877 hr/yr:* Gas Fuel - 5 ppm (standard) Gas Fuel - 3 ppm (enhanced) Liquid Fuel – 25 ppm • *Simple Cycle and > 200 hr/yr and < 877 hr/yr:* Gas Fuel - 5 ppm Liquid Fuel – 25 ppm • *Simple Cycle and ≤ 200 hr/yr:* Gas Fuel - 25 ppm Liquid Fuel – 42 ppm	• *< 877 hr/yr:* Gas Fuel – 42.0 ppm Liquid Fuel – 65.0 ppm • *≥ 10 MW, no SCR:* Gas Fuel – 15.0 ppm Liquid Fuel – 42.0 ppm • *≥ 10 MW, with SCR:* Gas Fuel – 9.0 ppm Liquid Fuel – 25.0 ppm

VCAPCD

- VCAPCD Rule 74.23 (Stationary Gas Turbines) *(Amended January 8, 2002)*

  The District evaluated the requirements contained within VCAPCD's Rule 74.23 and found no requirements that were more stringent than those already in Rule 4703.

	SJVAPCD	VCAPCD
Applicability	Gas turbines rated ≥ 0.3 MW or with a maximum heat input rating of > 3 MMBtu/hr	Gas turbines rated ≥ 0.3 MW and operated on gaseous and/or liquid fuel
Exemption	• Laboratory turbines used in research and testing for the	• Laboratory units used in research and testing for the advancement of gas turbine technology.

	advancement of gas turbine technology. • Units limited by permit condition to be operated exclusively for firefighting and/or flood control. • Emergency standby turbines limited by permit condition to operate less than 100 hours per calendar year for maintenance and testing purposes.	• Units operated exclusively for firefighting and/or flood control. • Units operated less than 200 hours per calendar year. • Emergency standby units operating during either an emergency or maintenance operation. Maintenance operation is limited to 104 hours per calendar year.
Requirements	The operator of any stationary gas turbine shall not operate a unit in such a manner that results in NO_X emissions, referenced at 15% O_2, shall not exceed the following limits:	A person shall not operate a stationary gas turbine unless NO_X emission concentrations, referenced at 15% O_2, do not exceed the following limits:
	Units Rated < 3 MW	
	Gas Fuel - 9 ppm Liquid Fuel - 25 ppm	Gas Fuel – 42.0 ppm Liquid Fuel – 65.0 ppm
	Units Rated ≥ 3 MW and < 10 MW	
	• *Pipeline Gas:* Steady State Operation – 8 ppm Non-Steady State Operation – 12 ppm Liquid Fuel – 25 ppm • *< 877 hr/yr:* Gas Fuel - 9 ppm Liquid Fuel - 25 ppm • *≥ 877 hr/year and not listed above:* Gas Fuel - 5 ppm Liquid Fuel - 25 ppm	• *< 877 hr/yr:* Gas Fuel – 42.0 ppm Liquid Fuel – 65.0 ppm • *≥ 877 hr/year:* Gas Fuel – 25.0 ppm Liquid Fuel – 65.0 ppm
	Units Rated ≥ 10 MW	

	• *Combined Cycle:* Gas Fuel - 5 ppm Liquid Fuel – 25 ppm • *Simple Cycle and ≥ 877 hr/year:* Gas Fuel - 5 ppm Liquid Fuel – 25 ppm • *Simple Cycle and > 200 hr/yr and < 877 hr/yr:* Gas Fuel - 5 ppm Liquid Fuel – 25 ppm • *Simple Cycle and ≤ 200 hr/yr:* Gas Fuel - 25 ppm Liquid Fuel – 42 ppm	• *< 877 hr/yr:* Gas Fuel – 42.0 ppm Liquid Fuel – 65.0 ppm • *≥ 10 MW, no SCR:* Gas Fuel – 15.0 ppm Liquid Fuel – 42.0 ppm • *≥ 10 MW, with SCR:* Gas Fuel – 9.0 ppm Liquid Fuel – 25.0 ppm

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

The District has adopted numerous rule amendments to the turbine rule that have successfully and significantly reduced emissions from this source category. The emissions inventory for NOx from turbines has been reduced from 31.9 tpd in 1994 to 2.8 tpd in 2017. Significant emission reductions have been achieved through the implementation of the most stringent regulations in the nation for this source category and significant investments by stakeholders to implement effective and innovative emission control technologies. Given the significant efforts and investments already made to reduce emissions from this source category, there are little remaining feasible opportunities for obtaining additional emissions reductions.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for stationary gas turbines. As demonstrated above, Rule 4703 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

C.19 Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters)

Discussion

The District takes a multidimensional and proactive approach to reducing emissions in the Valley. This philosophy is especially true for reducing emissions from residential wood burning, with a combination of regulatory controls through Rule 4901, rigorous public outreach and education efforts, Check Before You Burn program, and the District's Burn Cleaner Wood Stove Change-out Program (Burn Cleaner Program). The District's approach to reducing emissions from residential wood burning empowers Valley residents to play a major role in reducing emissions at almost no increased cost, and, in many cases, with savings in heating-related energy costs. Valley residents are encouraged to transition from older, more polluting wood burning heaters and wood burning fireplaces (also commonly called open hearth fireplaces) to cleaner alternatives, by decreasing the number of allowable burn days for high polluting wood burning heaters and fireplaces while at the same time increasing the number of burn days allowed for registered clean wood burning heaters through a tiered episodic wood burning curtailment program.

Through the District's Check Before You Burn program, which is based on Rule 4901, the District has declared and enforced episodic wood burning curtailments, also called "No burn" days, since 2003. Check Before You Burn and District Rule 4901 reduce harmful species of PM2.5 when and where those reductions are most needed, in impacted urbanized areas when the local weather is forecast to hamper particulate matter dispersion.

Rule 4901 was first adopted in 1993 and has been subsequently amended three times. The 1993 adoption of Rule 4901 established a public education program on techniques to reduce wood burning emissions. It also enforced EPA Phase II requirements for new wood burning heaters, prohibited the sale of used wood burning heaters, established a list of prohibited fuel types, and required the District to request voluntary curtailment of wood burning on days when the ambient air quality was unhealthy.

The 2003 rule amendments added episodic wood burning curtailments when air quality was forecast to be at 150 or higher on the air quality index (AQI), which is equivalent to a PM2.5 concentration of 65 $\mu g/m^3$, and added restrictions on the installation of wood burning devices in new residential developments, based on housing density. The 2008 rule amendments lowered the mandatory curtailment level to a PM2.5 concentration of 30 $\mu g/m^3$, and added an attainment plan contingency measure that would lower the wood burning curtailment level to 20 $\mu g/m^3$ if EPA were to find that the Valley did not attain the 1997 PM2.5 NAAQS in 2014.

In September 2014, the District amended Rule 4901 continuing to solidify its standing as the most comprehensive wood burning curtailment program in the nation. Amendments to Rule 4901 imposed a virtual ban on the use of dirty wood burning devices for significant portions of the winter season while allowing more burn days for Valley residents who have invested in cleaner burning devices that are 20-50 times cleaner. The enhanced Burn Cleaner program provides meaningful financial assistance to encourage Valley residents to upgrade to cleaner devices. Successful implementation not only reduces particulate emissions on "No Burn Days", but also reduces emissions on "Burn Days" as more dirty units are replaced with cleaner devices. The 2014 amendments eliminated the attainment plan contingency measure to lower the curtailment level to 20 µg/m³ because the rule now requires it for high polluting devices.

EMISSIONS INVENTORY

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	3.26	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82
NOx	0.49	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
	Winter Average - Tons per day								
PM2.5	6.35	5.49	5.49	5.49	5.49	5.49	5.49	5.49	5.49
NOx	0.95	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82

SOURCE CATEGORY

The wood burning fireplaces and wood burning heaters source category includes emissions from wood burning fireplaces, wood burning heaters, and outdoor wood burning devices. Rule 4901 reduces emissions from this source category through wood burning curtailments in areas with natural gas service. Rule 4901 also restricts the sale and transfers of non-compliant wood burning devices, and limits the installation of wood burning devices in new residential developments.

HOW DOES DISTRICT RULE 4901 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

There are no federal EPA CTGs, ACTs, NESHAPs, or MACT guidelines for this source category.

NSPS

- 40 CFR Part 60 Subpart AAA (Standards of Performance for New Residential Wood Heaters)

EPA published in the Federal Register on March 16, 2015, and effective May 15, 2015, amendments to 40 CFR Part 60 Subpart AAA.[79] District Rule 4901 points to the NSPS for emission limits and is therefore as stringent as the newly promulgated NSPS.

The 2015 NSPS significantly lowered the certification emission limits for wood-burning heaters that are required to be certified and sets certification limits for a broader range of wood-burning heaters by removing the existing certification criteria from the 1988 version of the rule. Standards apply not only to adjustable burn rate wood heaters (the focus of the original regulation), but also to single burn rate wood heaters/stoves, pellet

[79] Standards of Performance for New Residential Wood Heaters, New Residential Hydronic Heaters and Forced-Air Furnaces. Final Rule. 80 FR 3672. https://www.gpo.gov/fdsys/pkg/FR-2015-03-16/pdf/2015-03733.pdf

heaters/stoves, and any other affected appliance as defined in revised Subpart AAA as a “room heater.”

Although they did not require EPA certification under the 1988 NSPS, 96% of pellet heaters meet the new Step 1 PM emissions limit of 4.5 grams per hour. Single burn rate wood heaters are incapable of operating at the lowest burn rates, and it is the lower burn rates that result in the highest level of PM emissions; therefore, most single burn rate wood heaters also meet the Step 1 PM emissions limit. Manufacturers of such units were not initially required to modify their design if they already met the emissions standard and will automatically be deemed as certified to meet the Step 1 emission limits.

EPA promulgated a two-step compliance approach that applies to all new adjustable burn rate wood heaters, single burn rate wood heaters and pellet heaters/stoves. Under this approach, Step 1 emission limits for these sources apply to each unit manufactured on or after the effective date of the final rule (May 15, 2015) or sold at retail on or after December 31, 2015. Step 2 emission limits for these units apply to each heater manufactured or sold at retail on or after May 15, 2020. EPA is allowing an alternative compliance option for manufacturers who choose to certify using cord wood (rather than crib wood) to meet the Step 2 limits.

Subpart AAA PM Emissions Limits

2-Step, 5-Year Phase-In		
Step	**PM limit**	**Compliance deadline**
1	4.5 g/hr	May 15, 2015
2	2.0 g/hr	May 15, 2020
	2.5 g/hr (Cord wood alternative compliance option)	

State Regulations

- **Puget Sound Clean Air Agency Article 13: (Solid Fuel Burning Device Standards)**

The District evaluated the requirements contained within Albuquerque City Ordinance § 9-5 and found that District rule 4901 when evaluated holistically is more stringent.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	Puget Sound Clean Air Agency Article 13: (Solid Fuel Burning Device Standards)
	Requirement	**Requirement**
Last amended	9/18/2014	10/25/2012
Sole Source exemption	Those for whom a wood burning fireplace or wood burning heater is the sole available source of heat in a residence. This includes times of temporary service outages, as determined by the gas or electrical utility service are exempt from wood burning curtailments	A residence or commercial building that has no adequate source of heat other than a solid fuel heating device and the building: i. was constructed or substantially remodeled after July 1, 1992; and ii. is outside an urban growth area, as defined in RCW 36.70A; and iii. is outside an area designated by EPA as a PM2.5 or PM10 particulate nonattainment area.
No burn Day (Nov-Feb)	Level 1 Curtailment called when PM2.5 is 20-65 µg/m^3 • Wood burning fireplace, low mass fireplace, masonry heater, outdoor wood burning device, or nonregistered wood burning heater shall not be operated • Registered wood burning heater may be operated provided it's fired on approved fuel, maintained, operated according to manufacturer instructions, and has no visible smoke	No person in a residence or commercial establishment shall operate a solid fuel burning device under any of the following conditions: • Whenever the Agency has declared the **first stage** of impaired air quality for a geographical area • New solid fuel shall be withheld from any solid fuel burning device already in operation for the duration of

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	Puget Sound Clean Air Agency Article 13: (Solid Fuel Burning Device Standards)
	Requirement	**Requirement**
	Level 2 Curtailment called when PM is >65 µg/m^3 for all Units	the first stage of impaired air quality if that device is restricted from operating • Smoke visible from a chimney, flue, or exhaust duct after three hours has elapsed from the declaration of a first stage of impaired air quality shall constitute prima facie evidence of unlawful operation of a solid fuel burning device if that solid fuel burning device is restricted from operating during a first stage of impaired air quality. This presumption may be refuted by demonstration that the smoke was not caused by a solid fuel burning device. • Whenever the Agency has declared the **second stage** of impaired air quality for a geographical area • New solid fuel shall be withheld from any solid fuel burning device already in operation for the duration of the second stage of impaired air quality if that device is restricted from operating • Smoke visible from a chimney, flue, or exhaust duct after three hours has elapsed from the declaration of a second stage of impaired air quality shall constitute prima facie evidence of unlawful operation of a solid fuel burning device if that solid fuel burning device is restricted from operating during a second stage of impaired air quality. This presumption may be refuted by demonstration that the smoke was not caused by a solid fuel burning device.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	Puget Sound Clean Air Agency Article 13: (Solid Fuel Burning Device Standards)
	Requirement	**Requirement**
Sale, resale, or installation of wood-burning devices	Sale or transfer of wood burning heaters • New. No person shall advertise, sell, offer for sale, supply, install, or transfer a new wood burning heater unless it is EPA Phase II or more stringent certification as currently enforced by NSPS at time of sale or transfer or a pellet-fueled heater exempt from certification until such time NSPS removes exemption, then it must comply with NSPS Used. No person shall advertise, sell, offer for sale, supply, install, or transfer a used wood burning heater unless it has been rendered permanently inoperable, satisfies NSPS, or is a low mass fireplace, masonry heater, or other wood burning device of a make and model that meets all federal requirements and has been approved in writing by the APCO.	Solid fuel burning devices. A person shall not advertise to sell, offer to sell, sell, bargain, exchange, give away, or install a solid fuel burning device unless it meets both subsections (1) and (2): • It has been certified and labeled in accordance with procedures and criteria specified in "40 CFR 60 Subpart AAA - Standards of 12/12 13-7 Regulation I Performance for Residential Wood Heaters" as amended through July 1, 1990; and • It meets the following particulate air contaminant emission standards and the test methodology of EPA in effect on January 1, 1991, or an equivalent standard under any test methodology adopted by EPA subsequent to such date: (A) Two and one-half grams per hour for catalytic woodstoves; and (B) Four and one-half grams per hour for all other solid fuel burning devices. **Fireplaces.** A person shall not advertise to sell, offer to sell, sell, bargain, exchange, give away, or install a factory-built fireplace unless it meets the 1990 EPA standards for wood stoves or an equivalent standard that may be established by the state building code council by rule.

Requirements for non-certified units	Rule requires only EPA certified units be sold in the area.	(1) Any person who owns or is responsible for a wood stove that is both (a) not a certified wood stove and (b) is located in the Tacoma, Washington fine particulate nonattainment area must remove and dispose of it or render it permanently inoperable by September 30, 2015. (2) Any person who owns or is responsible for a coal-only heater located in the Tacoma, Washington fine particulate nonattainment area must remove and dispose of it or render it permanently inoperable by September 30, 2015. 12/12 13-8 Regulation I (3) Subsection (1) above does not apply to: (A) A person in a residence or commercial establishment that does not have an adequate source of heat without burning wood; or (B) A person with a shop or garage that is detached from the main residence or commercial establishment that does not have an adequate source of heat in the detached shop or garage without burning wood. (4) The owner or person responsible for removing or rendering permanently inoperable a wood stove or a coal-only heater must provide documentation of the removal and disposal or rendering permanently inoperable to the Agency using the Agency's procedures within 30 days of the removal or rendering permanently inoperable. (b) PM10. Subsection (b) of this section is established for the sole purpose of a contingency measure for PM10 nonattainment and maintenance areas. If the EPA makes written findings that: (1) an area has failed to attain or maintain the National Ambient Air Quality Standard for PM10, and (2) in consultation with Ecology and the Agency, finds that the emissions from solid fuel burning devices are a contributing factor to such failure to attain or maintain the standard, the use of wood stoves not meeting the standards set forth in RCW 70.94.457 shall be prohibited within the area determined by the Agency to have contributed to the violation.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	**Puget Sound Clean Air Agency Article 13: (Solid Fuel Burning Device Standards)**
	Requirement	**Requirement**
		This provision shall take effect one year after such a determination.
Visible emissions	A registered EPA unit may be operated if it has no visible smoke when operated under normal operating conditions may be used during a Level 1 curtailment.	A person shall not cause or allow emission of a smoke plume from any solid fuel burning device to exceed an average of twenty percent opacity for six consecutive minutes in any one-hour period.
Prohibited fuels	No person shall cause or allow any of the following materials to be burned in a wood burning fireplace, wood burning heater, or outdoor wood burning device: garbage, treated wood, plastic products, rubber products, waste petroleum products, paints and paint solvents, coal, or any other material not intended by a manufacturer for use as a fuel in a wood burning fireplace, wood burning heater, or outdoor wood burning device	A person shall cause or allow only the following materials to be burned in a solid fuel burning device: • Properly seasoned fuel wood; or • An amount of paper necessary for starting a fire; or • Wood pellets; or • Biomass fire logs intended for burning in a wood stove or fireplace; or • Coal with sulfur content less than 1.0% by weight burned in a coal-only heater. All other materials are prohibited from being burned

- **Albuquerque City Ordinance § 9-5**

The District evaluated the requirements contained within Albuquerque City Ordinance § 9-5 and found that District rule 4901 when evaluated holistically is more stringent.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	Albuquerque City Ordinance § 9-2
	Requirement	Requirement
Last amended	9/18/2014	Unknown
No Burn Season	November through February	October through February
EPA Certified Exemption	EPA certified units are not exempt from rule requirements	Certified heaters may be operated during a no burn period provided that no visible emissions are produced beyond a 20-minute startup period.
Sole Source exemption	Those for whom a wood burning fireplace or wood burning heater is the sole available source of heat in a residence. This includes times of temporary service outages, as determined by the gas or electrical utility service are exempt from wood burning curtailments	The following are exempt: If the wood burning device is the sole source of heat Medical necessity of a wood burning device Low income status
Limited Exemption: loss of NG and/or electrical power	Those for whom a wood burning fireplace or wood burning heater is the sole available source of heat in a residence. This includes times of temporary service outages, as determined by the gas or electrical utility service are exempt from wood burning curtailments	Emergency situations such as failure of residence's primary heating system
Wood Burning Season	November through February	October through February

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	Albuquerque City Ordinance § 9-2
	Requirement	**Requirement**
No burn Day	Level 1 Curtailment called when PM2.5 is 20-65 µg/m3 • Wood burning fireplace, low mass fireplace, masonry heater, outdoor wood burning device, or nonregistered wood burning heater shall not be operated • Registered wood burning heater may be operated provided it's fired on approved fuel, maintained, operated according to manufacturer instructions, and has no visible smoke	No burn periods shall be declared by the Director upon review of available meteorological data and a determination that expected atmospheric conditions will not reasonably disperse wood smoke.
	Level 2 Curtailment called when PM is >65 µg/m3 for all Units	
Visible emissions	A registered EPA unit may be operated if it has no visible smoke when operated under normal operating conditions may be used during a Level 1 curtailment.	Certified wood heaters may be operated during a no burn period provided that no visible emissions are produced beyond a 20-minute start up period

HOW DOES DISTRICT RULE 4901 COMPARE TO RULES IN OTHER AIR DISTRICTS?

There are no analogous rules for this source category in VCAPCD.

SCAQMD

- SCAQMD Rule 445 (Wood Burning Devices)

The District evaluated the requirements contained within SCAQMD Rule 445 and found that District rule 4901 when evaluated holistically is more stringent.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	SCAQMD Rule 445 (Wood Burning Devices)
	Requirement	**Requirement**
Last amended	9/18/2014	5/3/2013
Applicability	Rule 4901 applies to any person who manufactures, sells, offers for sale, or operates a wood burning fireplace, wood burning heater, or outdoor wood burning device. Any person who sells, offers for sale, or supplies wood intended for burning in a wood burning fireplace or wood burning heater. Any person who transfers or receives a wood burning heater as part of a real property sale or transfer. Any person who installs a wood burning fireplace or wood burning heater in a new residential development.	The provisions of this rule shall apply to specified persons or businesses within the South Coast Air Basin portion of the South Coast Air Quality Management District: Any person that manufacturers, sells, offers for sale, or installs a wood-burning device; Any commercial firewood seller that sells, offers for sale, or supplies wood or other wood-based fuels intended for burning in a wood burning-device or portable outdoor wood-burning device; and Any property owner or tenant that operates a wood-burning device or portable outdoor wood-burning device.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	SCAQMD Rule 445 (Wood Burning Devices)
	Requirement	**Requirement**
General Exemption	The following devices are exempt from the provisions of this rule: Devices that are exclusively gaseous-fueled. Cook stoves, as described in Code of Federal Regulations 60.531. Any burning occurring on the ground is open burning and is subject to requirements of District Rule 4103.	The provisions of this rule shall not apply to wood-fired cooking devices designed and used for commercial purposes. The provisions of paragraph (d)(2) shall not apply to an indoor or outdoor wood-burning device that is permanently installed and included in the sale or transfer of any existing development. The provisions shall not apply to properties that are registered as a historical site, or are contributing structures located in a Historic Preservation Overlay Zone, as determined by the applicable, federal, State, or local agency. Contributing structures are those buildings which are examples of the predominate styles of the area, built during the time period when the bulk of the structures were built in the Historic Preservation Overlay Zone. The provisions of (d)(3) shall not apply to manufactured firelogs. The provisions of (d)(5) shall not apply to wood-based fuel intended for the cooking, smoking, or flavoring of food. The provisions of subdivision (e) shall not apply under the following circumstances: A low income household; or Residential or commercial properties located 3,000 or more feet above mean sea level; or Ceremonial fires exempted under Rule 444 - Open Burning.
Natural gas exemption	Locations where natural gas is not available are not subject to episodic curtailments (propane & butane are not considered natural gas)	Residential or commercial properties where there is no existing infrastructure for natural gas service within 150 feet of the property line or those 3,000 or more feet above mean sea level

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	**SCAQMD Rule 445 (Wood Burning Devices)**
	Requirement	**Requirement**
Sole Source exemption	Those for whom a wood burning fireplace or wood burning heater is the sole available source of heat in a residence. This includes times of temporary service outages, as determined by the gas or electrical utility service are exempt from wood burning curtailments.	Residential or commercial properties where a wood-burning device is the sole source of heat; or
No burn Day **(Nov-Feb)**	Level 1 Curtailment called when PM2.5 is 20-65 µg/m3 • Wood burning fireplace, low mass fireplace, masonry heater, outdoor wood burning device, or nonregistered wood burning heater shall not be operated • Registered wood burning heater may be operated provided it's fired on approved fuel, maintained, operated according to manufacturer instructions, and has no visible smoke	No person shall operate an indoor or outdoor wood-burning device, portable outdoor wood-burning device, or wood-fired cooking device during the wood burning season when a mandatory winter burning curtailment is forecast for the specific region where the device is located if the PM2.5 is forecast to exceed 30 µg/m³; or on a basin wide basis with a forecast > 30 µg/m³ is predicted for a source receptor area containing a monitoring station that has recorded a violation of the federal 24-hour PM2.5 National Ambient Air Quality Standard for either of the two previous three-year design value periods. The design value is the three-year average of the annual 98th percentile of the 24-hour values of monitored ambient PM2.5 data
	Level 2 Curtailment called when PM is >65 µg/m3 for all units	
	Sale or transfer of wood burning heaters	

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	**SCAQMD Rule 445 (Wood Burning Devices)**
	Requirement	**Requirement**
Sale, resale, or installation of wood-burning devices	• New. No person shall advertise, sell, offer for sale, supply, install, or transfer a new wood burning heater unless it is EPA Phase II or more stringent certification as currently enforced by NSPS at time of sale or transfer or a pellet-fueled heater exempt from certification until such time NSPS removes exemption, then it must comply with NSPS • Used. No person shall advertise, sell, offer for sale, supply, install, or transfer a used wood burning heater unless it has been rendered permanently inoperable, satisfies NSPS, or is a low mass fireplace, masonry heater, or other wood burning device of a make and model that meets all federal requirements and has been approved in writing by the APCO.	No person shall sell, offer for sale, supply, or install, a new or used permanently installed indoor or outdoor wood-burning device or gaseous-fueled device unless it is one of the following: A) USEPA Certified wood-burning heater; or B) Pellet-fueled wood-burning heater; or C) A masonry heater; or D) A dedicated gaseous-fueled fireplace
Requirements for real property	5.2.1 No person shall sell or transfer any real property which contains a wood burning heater without first assuring it complies with NSPS, is pellet-fueled, or is permanently inoperable 5.2.2 Upon the sale or transfer, the seller shall provide to the recipient, and the APCO, documentation with compliance to 5.2.1.	EPA certification requirements do not apply to: 1) Indoor or outdoor wood-burning device that is permanently installed and included in the sale or transfer of any existing development 2) Properties that are registered as a historical site, or are contributing structures located in a Historic Preservation Overlay Zone, as determined by the applicable, federal, State, or local agency. Contributing structures are those buildings which are examples of the predominate styles of the area, built during the time period when the bulk of the structures were built in the Historic Preservation Overlay Zone.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	SCAQMD Rule 445 (Wood Burning Devices)
	Requirement	**Requirement**
Requirements for new building construction	Limitations on wood burning fireplaces or wood burning heaters in new residential developments - No wood burning fireplace in a new residential development with density >2 dwelling units per acre - No more than 2 EPA units per acre in a new residential development with density >2 dwelling units per acre - No more than 1 fireplace or EPA unit in a new residential development with density ≤2 dwelling units per acre New Residential Development: any single or multi-family housing unit, for which construction began on or after 1/1/2004. Construction began when the foundation for the structure was constructed.	No person shall permanently install a wood-burning device into any new development

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	**SCAQMD Rule 445 (Wood Burning Devices)**
	Requirement	**Requirement**
Solid wood fuel or wood sale	Advertising Requirements for Sale of Wood - No person shall sell, offer for sale, or supply any wood which is orally or in writing, advertised, described, or in any way represented to be "seasoned wood" unless the wood has a moisture content of ≤ 20% by weight. - The APCO may delegate another person or agency the authority to test wood for moisture content and determine compliance	A commercial firewood seller shall only sell seasoned wood from July 1 through the end of February the following year. Any commercial firewood seller may sell seasoned as well as non-seasoned wood during the remaining months. No commercial firewood seller shall sell, offer for sale, or supply wood-based fuel without first attaching a permanently affixed indelible label to each package or providing written notice to each buyer at the time of purchase of bulk firewood that at a minimum states the following: "Use of this and other solid fuel products may be restricted at times by law. Please check (1-877-4NO-Burn) or (www.8774NOBURN.org) before burning." Labeling requirements do not apply to wood-based fuel intended for cooking, smoking, or flavoring of food. Alternative language, toll-free telephone number or web address for the information specified in subdivision (g) may be used, subject to Executive Officer approval. The Executive Officer shall specify guidelines for the aforementioned labeling requirements
Prohibited fuels	No person shall cause or allow any of the following materials to be burned in a wood burning fireplace, wood burning heater, or outdoor wood burning device: garbage, treated wood, plastic products, rubber products, waste petroleum products, paints and paint solvents, coal, or any other material not intended by a manufacturer for use as a fuel in a wood burning fireplace, wood burning heater, or outdoor wood burning device	No person shall burn any product not intended for use as fuel in a wood-burning device including, but not limited to, garbage, treated wood, particle board, plastic products, rubber products, waste petroleum products, paints, coatings or solvents, or coal. Manufactured logs are exempt from this requirement

SMAQMD

- SMAQMD Rule 417 (Wood Burning Appliances)

The District evaluated the requirements contained within SMAQMD Rule 417 and and found the District rule 4901 when evaluated holistically is more stringent.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	**SMAQMD Rule 417 (Wood Burning Appliances)**
	Requirement	**Requirement**
Last amended	9/18/2014	10/26/2006
General Exemption	Cook stoves	Cook stoves, or Commercial products manufactured expressly for starting a fire in a wood fired appliance

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	SMAQMD Rule 417 (Wood Burning Appliances)
	Requirement	**Requirement**
Wood heater manufacturers & retailers	Sale or transfer of wood burning heaters • New. No person shall advertise, sell, offer for sale, supply, install, or transfer a new wood burning heater unless it is EPA Phase II or more stringent certification as currently enforced by NSPS at time of sale or transfer or a pellet-fueled heater exempt from certification until such time NSPS removes exemption, then it must comply with NSPS • Used. No person shall advertise, sell, offer for sale, supply, install, or transfer a used wood burning heater unless it has been rendered permanently inoperable, satisfies NSPS, or is a low mass fireplace, masonry heater, or other wood burning device of a make and model that meets all federal requirements and has been approved in writing by the APCO.	Effective October 26, 2007, no person shall sell, offer for sale, supply, install, or transfer a new wood burning appliance unless it is one of the following: A U.S. EPA Phase II Certified wood burning heater, A pellet-fueled wood burning heater, A masonry heater, or an appliance or fireplace determined to meet the U.S. EPA particulate matter emission standard set forth in Title 40 CFR, Part 60, Subpart AAA, and approved in writing by the Air Pollution Control Officer. No person shall advertise, sell, offer for sale, supply, install, or transfer a used wood burning appliance unless it meets the requirements of section 301.1, or has been rendered permanently inoperable All wood burning appliances shall be installed and operated according to the manufacturer's specifications. Any U.S. EPA Phase II certified wood burning appliance which has been altered, installed, or disassembled in any way not specified by the manufacturer, or is operated in any manner that would result in emissions exceeding the standards set forth in Title 40 CFR, Part 60, Subpart AAA, shall not be considered a U.S. EPA Phase II certified appliance.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	SMAQMD Rule 417 (Wood Burning Appliances)
	Requirement	**Requirement**
Public awareness information	Retailers selling or offering for sale new wood burning heaters shall supply public awareness information with each sale … in the form of pamphlets, brochures, or fact sheets on the following: proper installation, operation, and maintenance, fuel, health effects, weatherization methods for the home, proper sizing of wood burning heaters, and Burn Curtailments	Appliances shall distribute public awareness information with each wood burning appliance, in the form of pamphlets, brochures, or fact sheets on the following topics: 1. Proper installation, operation, and maintenance of the wood burning appliance, 2. Proper fuel selection and use, 3. Health effects from wood smoke, and 4. Weatherization methods for the home
Solid wood fuel or wood sale	Advertising Requirements for Sale of Wood - No person shall sell, offer for sale, or supply any wood which is orally or in writing, advertised, described, or in any way represented to be "seasoned wood" unless the wood has a moisture content of ≤ 20% by weight. - The APCO may delegate another person or agency the authority to test wood for moisture content and determine compliance	No person shall sell, offer for sale, or supply any wood which orally, or in writing, is advertised, described, or in any way represented to be "seasoned" or "dry" wood unless the wood has a moisture content of 20 percent or less by weight

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	SMAQMD Rule 417 (Wood Burning Appliances)
	Requirement	**Requirement**
Prohibited fuels	No person shall cause or allow any of the following materials to be burned in a wood burning fireplace, wood burning heater, or outdoor wood burning device: garbage, treated wood, plastic products, rubber products, waste petroleum products, paints and paint solvents, coal, or any other material not intended by a manufacturer for use as a fuel in a wood burning fireplace, wood burning heater, or outdoor wood burning device	No person shall cause or allow any of the following materials to be burned in a wood burning appliance: Garbage, Treated wood, Plastic products, Rubber products, Waste petroleum products, Paints and other coatings, Solvents, Coal, Glossy or colored paper, Particle board, Any other material not intended by a manufacturer for use as fuel in a solid fuel burning device.

- SMAQMD Rule 421 (Mandatory Episodic Curtailment of Wood and other Solid Fuel Burning)

The District evaluated the requirements contained within SMAQMD Rule 421 and found the District rule 4901 when evaluated holistically is more stringent.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	SMAQMD Rule 421 (Mandatory Episodic Curtailment of Wood and other Solid Fuel Burning)
	Requirement	**Requirement**
Last amended	9/18/2014	09/24/2009
General Exemption	Cook stoves	Cook stoves The provisions of this rule shall not apply to fires conducted as part of a religious ceremony. The provisions of Section 301 shall not apply to any person who has an approved Hardship Waiver for economic reasons

<table>
<tr><th></th><th>SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters</th><th>SMAQMD Rule 421 (Mandatory Episodic Curtailment of Wood and other Solid Fuel Burning)</th></tr>
<tr><th></th><th>Requirement</th><th>Requirement</th></tr>
<tr><td>Sole Source exemption</td><td>Those for whom a wood burning fireplace or wood burning heater is the sole available source of heat in a residence. This includes times of temporary service outages, as determined by the gas or electrical utility service are exempt from wood burning curtailments</td><td>The provisions of this rule shall not apply to wood burning devices that are the sole source of heat in a residence</td></tr>
<tr><td rowspan="2">No burn Day

(Nov-Feb)</td><td>Level 1 Curtailment called when PM2.5 is 20-65 µg/m3
Wood burning fireplace, low mass fireplace, masonry heater, outdoor wood burning device, or nonregistered wood burning heater shall not be operated
Registered wood burning heater may be operated provided it’s fired on approved fuel, maintained, operated according to manufacturer instructions, and has no visible smoke</td><td rowspan="2">The requirements of this section shall be in effect during the burning season.
1) No person may have a fire or operate a wood burning device when a Mandatory Curtailment is in effect.
2) The Air Pollution Control Officer will declare a Stage 1 Mandatory Curtailment whenever he or she determines that the 24-hour average PM2.5 concentration may exceed 31 µg/m3 but is not likely to exceed 35 µg/m3.
3) The Air Pollution Control Officer will declare a Stage 2 Mandatory Curtailment whenever he or she determines that the 24-hour average PM2.5 concentration may exceed 35 µg/m3.

The Air Pollution Control Officer will declare a Voluntary Curtailment whenever he or she determines that the 24-hour average PM2.5 concentration may exceed 25 µg/m3 but is not likely to exceed 31 µg/m3

Burn curtailments do not apply to U.S. EPA Phase II Certified wood burning heaters and pellet fueled wood burning heaters provided the devices do not emit visible smoke and a Stage 1 Mandatory Curtailment is in effect.</td></tr>
<tr><td>Level 2 Curtailment called when PM is >65 µg/m3 for all

Units</td></tr>
</table>

BAAQMD

- BAAQMD Regulation 6 Rule 3 (Wood-Burning Devices)

The District evaluated the requirements contained within BAAQMD Regulation 6 Rule 3 and found the District rule 4901 when evaluated holistically is more stringent.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	BAAQMD Rule 6-3Particulate Matter and Visible Emissions – Wood Burning Devices
	Requirement	**Requirement**
Last amended	9/18/2014	10/21/2015
Natural gas exemption	Locations where natural gas is not available are not subject to episodic curtailments (propane & butane are not considered natural gas)	No exemption (exemption (§ 6-3-10) deleted during the 2015 amendments)
Sole Source exemption	Those for whom a wood burning fireplace or wood burning heater is the sole available source of heat in a residence. This includes times of temporary service outages, as determined by the gas or electrical utility service are exempt from wood burning curtailments	Burn Bans are not applicable to any person whose **sole source of heat is an EPA certified wood-burning device that is registered** with the District per the requirements of Sections 6-3-404 and 405 and who does not have available to them a permanently-installed NG, propane, or electric heating device.
		Rental properties subject to Section 6-3-305 located in areas with NG service no longer qualify for exemption
		Any person seeking exemption under Section 6-3-110 must have previously registered their EPA certified wood heater in the District's registration program and must maintain documentation that the device is operated according to manufacturer's specifications. The following wood heaters are eligible to registered: **404.1** Wood heaters that are EPA certified to meet performance and emission standards of 7.5 g/hr or less **404.2** A pellet-fueled wood heater exempt from EPA certification requirements pursuant to 40 CFR 60 AAA at the time of purchase or installation
		Registration is a 5-year term

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	BAAQMD Rule 6-3Particulate Matter and Visible Emissions – Wood Burning Devices
	Requirement	**Requirement**
Limited Exemption: loss of NG and/or electrical power	Those for whom a wood burning fireplace or wood burning heater is the sole available source of heat in a residence. This includes times of temporary service outages, as determined by the gas or electrical utility service are exempt from wood burning curtailments	Mandatory burn bans shall not apply to a person whose dwelling is in an area that has a temporary loss of gas and/or electric utility service and there is no alternate form of heat available. Qualification for exemption is subject to verification.
Limited Exemption: non-functional permanently installed heater	Those for whom a wood burning fireplace or wood burning heater is the sole available source of heat in a residence. This includes times of temporary service outages, as determined by the gas or electrical utility service are exempt from wood burning curtailments	Mandatory burn bans do not apply to any person whose only non-wood burning, permanently installed source of heat is non-functional and requires repair to resume operations. A dwelling may qualify for a 30-day exemption if there is no alternate form of heat and the non-functional heater is repaired to resume function within 30 days. Qualification for this exemption is subject to verification and must be supported by documentation of repair, which must be submitted to the District within 10 days of a receipt of a request for such records.
No burn Day (Nov-Feb)	Level 1 Curtailment called when PM2.5 is 20-65 µg/m^3 • Wood burning fireplace, low mass fireplace, masonry heater, outdoor wood burning device, or nonregistered wood burning heater shall not be operated • Registered wood burning heater may be operated provided it’s fired on approved fuel, maintained, operated according to manufacturer instructions, and has no visible smoke Level 2 Curtailment called when PM is >65 µg/m^3 for all Units	35 µg/m^3 results in a Mandatory Burn Ban (all devices) • 6-3-301: No person shall operate or combust wood or solid-fuel products in any wood-burning device during a Mandatory Burn Ban

<table>
<tr><th></th><th>SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters</th><th>BAAQMD Rule 6-3Particulate Matter and Visible Emissions – Wood Burning Devices</th></tr>
<tr><th></th><th>Requirement</th><th>Requirement</th></tr>
<tr><td>Wood heater manufacturers & retailers</td><td rowspan="2">Sale or transfer of wood burning heaters
New. No person shall advertise, sell, offer for sale, supply, install, or transfer a new wood burning heater unless it is EPA Phase II or more stringent certification as currently enforced by NSPS at time of sale or transfer or a pellet-fueled heater exempt from certification until such time NSPS removes exemption, then it must comply with NSPS
Used. No person shall advertise, sell, offer for sale, supply, install, or transfer a used wood burning heater unless it has been rendered permanently inoperable, satisfies NSPS, or is a low mass fireplace, masonry heater, or other wood burning device of a make and model that meets all federal requirements and has been approved in writing by the APCO.</td><td>No manufacturer or retailer shall advertise, sell, offer for sale or resale, supply, install or transfer a new or used wood-burning device … unless the device meets or exceeds 40 CFR 60 AAA
- Effective 12/31/15: certified to meet 4.5 g/hr
- Effective 5/15/2020: certified to meet 2.5 g/hr if crib tested or 2.0 g/hr if cordwood tested</td></tr>
<tr><td>Sale, resale, or installation of wood-burning devices</td><td>No person shall advertise, sell, offer for sale or resale, supply, install or transfer a new or used wood-burning device unless it meets 60 CFR 60 AAA. This requirement does not apply if a wood-burning device is an installed fixture in the sale or transfer of any real property</td></tr>
<tr><td>Requirements for real property</td><td>No person shall sell or transfer any real property which contains a wood burning heater without first assuring it complies with NSPS, is pellet-fueled, or is permanently inoperable

Upon the sale or transfer, the seller shall provide to the recipient, and the APCO, documentation with compliance to 5.2.1.</td><td>Any person selling, renting or leasing a real property shall provide sale or rental disclosure documents that describe the health hazards of PM2.5 (in accordance with BAAQMD guidance) from burning wood or any solid fuel as a source</td></tr>
<tr><td>Requirements for rental properties</td><td>None</td><td>Effective 11/1/2018, all real property offered for lease or rent in areas with natural gas service shall have a permanently-installed form of heat that does not burn solid fuel.</td></tr>
</table>

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	BAAQMD Rule 6-3Particulate Matter and Visible Emissions – Wood Burning Devices
	Requirement	**Requirement**
Requirements for new building construction	Limitations on wood burning fireplaces or wood burning heaters in new residential developments - No wood burning fireplace in a new residential development with density >2 dwelling units per acre - No more than 2 EPA units per acre in a new residential development with density >2 dwelling units per acre - No more than 1 fireplace or EPA unit in a new residential development with density ≤2 dwelling units per acre New Residential Development: any single or multi-family housing unit, for which construction began on or after 1/1/2004. Construction began when the foundation for the structure was constructed.	No person or builder shall install a wood-burning device in a new building construction
Requirements for remodeling a fireplace or chimney	None	No person shall remodel a fireplace or chimney unless a gas-fueled, electric, or EPA certified device is installed that meets requirements of 40 CFR 60 AAA. This requirement is triggered by a fireplace or chimney remodel where a total cost exceeds $15,000 and requires a local building permit.
Visible emissions	A registered EPA unit may be operated if it has no visible smoke when operated under normal operating conditions may be used during a Level 1 curtailment.	No person shall cause or allow a visible emission that exceeds Ringlemann 1 (20% opacity) for a period or periods aggregating more than 3 minutes in any hour. Visible emissions from startup shall not exceed 20 consecutive minutes in any consecutive four-hour period.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	BAAQMD Rule 6-3Particulate Matter and Visible Emissions – Wood Burning Devices
	Requirement	**Requirement**
Public awareness information	Retailers selling or offering for sale new wood burning heaters shall supply public awareness information with each sale … in the form of pamphlets, brochures, or fact sheets on the following: proper installation, operation, and maintenance, fuel, health effects, weatherization methods for the home, proper sizing of wood burning heaters, and Burn Curtailments	Any person offering for sale, selling or installing a new or used wood-burning device shall provide public awareness information to each purchaser of a wood-burning device in the form of pamphlets, brochures, or fact sheets. The information shall include the following statement: "Wood smoke contains harmful particulate matter (PM) which is associated with numerous negative health impacts."
Solid wood fuel or wood sale	Advertising Requirements for Sale of Wood - No person shall sell, offer for sale, or supply any wood which is orally or in writing, advertised, described, or in any way represented to be "seasoned wood" unless the wood has a moisture content of ≤ 20% by weight. - The APCO may delegate another person or agency the authority to test wood for moisture content and determine compliance	Any person offering for sale, selling or providing solid fuel or wood intended for use in a wood-burning device shall: - Attach a label to each package of solid fuel or wood sold that states the following: "Use of this and other solid fuels may be restricted at times by law. Please check 1877-4-NO-BURN or www.8774noburn.org before burning." - If wood is seasoned (not to include manufactured logs), then the label must also state: "This wood meets air quality regulations for moisture content to be less then 20% (percent) by weight for cleaner burning." - If wood is NOT seasoned "This wood does **NOT** meet air quality regulations for moisture content and must be properly dried before burning."
Prohibited fuels	No person shall cause or allow any of the following materials to be burned in a wood burning fireplace, wood burning heater, or outdoor wood burning device: garbage, treated wood, plastic products, rubber products, waste petroleum products, paints and paint solvents, coal, or any other material not intended by a manufacturer for use as a fuel in a wood burning fireplace, wood burning heater, or outdoor wood burning device	No person shall cause or allow any of the following materials to be burned in a wood-burning device: garbage, treated wood, non-seasoned wood, used or contaminated wood pallets, plastic products, rubber products, waste petroleum products, paints and paint solvents, coal, animal carcasses, glossy or colored paper, salt water driftwood, particle board, and any material not intended by the manufacturer for use as a fuel in a wood-burning device

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

Curtailment Level in hot-spot areas

The District hot-spot strategy involves imposing more stringent requirements on sources that contribute to elevated pollution concentrations at Hot Spot locations. This strategy focuses resources on the control measures and areas in the Valley that will be most cost-effective and most impactful towards achieving attainment. Since the District already has the toughest air regulations in place, adding to the stringency of these regulations may be cost prohibitive and technology forcing. However, strategic use of incentive dollars may provide additional cost-effective opportunities that may otherwise not be feasible. The hot-spot strategy will not include any rollback or relaxation of existing regulatory requirements, but instead will focus on new measures such as targeted use of incentive funds and regulations and reduced overall cost to all regions by achieving attainment of federal standards more expeditiously. For regions that may face more stringent future measures, added regulatory cost will be mitigated by added incentives. CARB and EPA believe the Hot Spot strategy is permissible under existing law. The District evaluated achieving further reductions through more stringent wood burning curtailment program in Hot Spot areas by lowering burn prohibitions for non-registered units from 20 $\mu g/m^3$ to 12 $\mu g/m^3$. Hot Spot areas include Kern County, Fresno County, and other areas as necessary to demonstrate attainment.

Enhanced levels of incentives would replace wood burning devices with only natural gas or propane units in the Hot Spot areas. The Burn Cleaner program would continue to offer the current level of incentives (see below) Valleywide. The District estimates incentive monies will be $80 million total cost with $60 million dedicated to Hot Spot areas.

Encouraging the Transition to Clean Burning Heaters through Non-Regulatory Measures

Upgrading a home's wood burning device reduces directly emitted PM2.5 emissions on days when wood burning is allowed. By operating more efficiently, these devices can also lower the overall home heating cost. The District encourages such upgrades through its public outreach and through its Burn Cleaner Program, which provides funding to Valley residents to upgrade their current wood-burning devices and open fireplaces to natural gas or propane gas devices, to certified wood stoves or inserts, or to pellet devices. The District's webpage[80] has more information on program eligibility and qualified devices.

There are several types of wood burning devices and device inserts available. Wood stoves, especially newer models, are generally safe and efficient devices for home heating. There are two types of wood stoves: catalytic and non-catalytic. EPA's Phase II certified wood stoves produce only 2 to 7 grams of smoke per hour, compared to 15 to 30 grams of smoke per hour from older, uncertified devices, and in future years the EPA certified devices will emit even less.

[80] www.valleyair.org/Grant_Programs/GrantPrograms.htm#WoodStoveChangeOut

Pellet stoves are similar in appearance to wood stoves, but burn compressed pellets made of ground, dried wood and other biomass wastes. Pellet stoves are generally more expensive than wood stoves and require electricity for operation; however, they are typically more efficient than wood stoves due to the better fuel-to-air ratio in the combustion chamber.

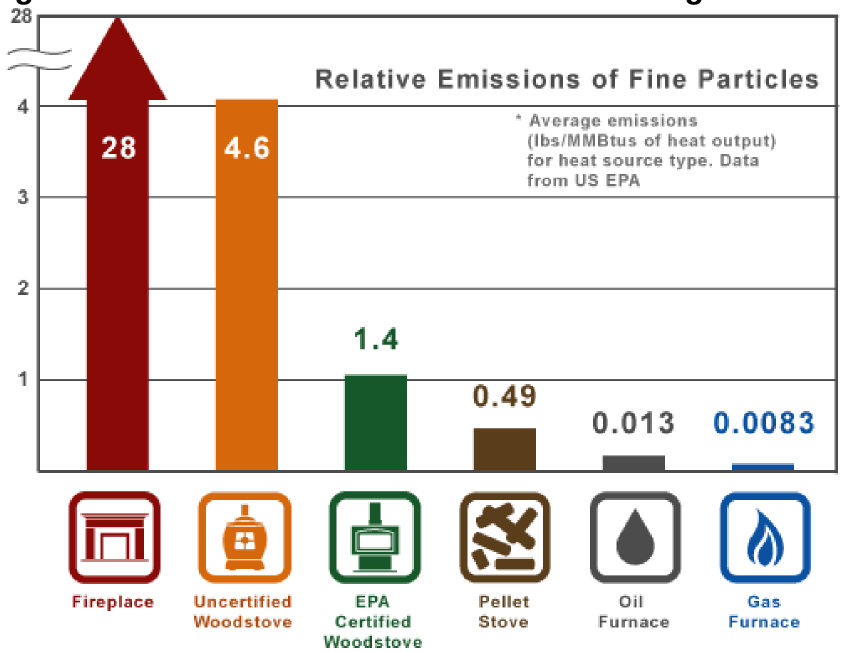
Wood burning fireplaces include traditional masonry fireplaces built into brick or stone, constructed in the home, and “low mass” fireplaces that are pre-fabricated prior to installation. Most fireplaces are not used as a primary source of heat, but serve as a secondary heating source or for ambiance. Fireplaces generate much more emissions than wood stoves or pellet stoves, but fireplace inserts are available to reduce emissions. EPA does not certify fireplaces or fireplace inserts, but does have a voluntary program for devices that meet qualifications to be considered cleaner burning than typical fireplaces and fireplace inserts. While these devices reduce emissions relative to uncontrolled fireplaces, their emissions are still relatively higher than certified wood stoves and pellet stoves.

Gas stoves and gas fireplaces burn natural gas or propane, emit very little air pollution, and require little maintenance. Gas devices are not subject to the requirements of Rule 4901, so they can be used on “No burn” days. For more information about the various types of wood burning devices available, see EPA’s Burn Wise program webpages[81].

The following figure illustrates the average PM2.5 emissions based on various heat sources.

[81] www.epa.gov/burnwise

Average PM2.5 Emissions Based on Wood Burning Heater Type[82]



Residential Wood Burning Survey

The District hired a third party company, Gomez Research, to survey Valley residents to gauge he District's current efforts, including Check Before You Burn and Burn Cleaner programs, and evaluate potential future strategies that will continue to reduce pollution from residential wood burning. Gomez Research surveyed over 1,500 Valley residents by November 2017. The survey consisted of both a general, random population of residents throughout the Valley as well as a supplemental sample, or "high-incidence area," of 500 residents living in targeted zip codes believed to have higher concentrations of wood burning devices in Fresno and Kern Counties, where the Valley's peak PM2.5 air monitoring stations are located. The general sample was designed to capture a broad understanding of public awareness and perception of the District's wood burning program, while the supplemental sample was designed to elicit more information about regional wood burning control strategies. Overall, the large survey response by Valley residents provides statistically significant results that can be relied upon to enhance our understanding of residential wood burning behavior in the San Joaquin Valley.

[82]EPA. (2012, November 14). *Consumers – Energy Efficiency and Wood-Burning Stoves and Fireplaces*. Retrieved from http://www.epa.gov/burnwise/energyefficiency.html.

The significant findings from the survey are categorized and summarized as follows:

A. Public Knowledge and General Beliefs about Wood Smoke

1. A total of 36% of residents who use their wood-burning devices reported that they believe wood smoke is dangerous. One-in-five Valley residents (20%) who burn do not believe wood smoke is dangerous to their health, and 8% believe it actually provides health benefits.
2. Ten percent of residents believe that someone in their household experiences health problems as a result of wood burning.
3. Findings suggest that residents who know that wood smoke is dangerous to their health tend to be English-speakers with above median incomes (greater than $50,000), although a larger sample would be needed to confirm this demographic profile statistically.

B. Presence and Use of Wood Burning Devices

1. A total of 29% of the general population surveyed reported having some type of wood burning device.
2. A total of 41% of residents living in the supplemental sample zip codes in Fresno and Bakersfield urban areas reported having some type of woodburning device. Of this population, 88% reported having an open-hearth fireplace.
3. For residents who have a wood burning device, 52% do not use their device, followed by 16% who use their device less than once a week, 14% several days a week, 9% nearly every day, and 7% once a week.
4. A total of 18% of residents living in the Fresno and Bakersfield metropolitan areas reported that they burn wood once a week or more, compared to 34% among the general population, a statistically significant difference.
5. Most residents typically burn in the evenings. Nearly two-thirds of residents typically burn in the evening (63%), followed by 17% who typically burn throughout the day, 8% who typically burn in the morning, and 7% who typically burn in the afternoon.
6. Once started, wood-burning devices in the Fresno and Bakersfield metropolitan areas were used for 3.96 hours, compared to 6.16 hours in other areas.
7. Nearly a third (32%) of all English speakers reported having a wood-burning device at their residence compared to 11% among Spanish speakers.
8. One third (33%) of residents with household incomes of $50,000 or higher were more likely to report that they had wood-burning devices compared to 23% of those below-median income.
9. Only 9% of the respondents in the general population who use a wood burning device indicated that it is their sole source of heat.

C. Awareness and Compliance with District Wood Burning Prohibitions

1. Among residents in the Fresno and Bakersfield metropolitan areas, 85% reported that they had heard of Check Before You Burn, compared to 63% among residents living elsewhere in the Valley.
2. More than half of all residents surveyed (58%) are aware of checking the burn day status using the toll-free hotline or website. Over one third (36%) of all residents were aware of email and text notifications for burn status. These figures

do not include a larger segment of the population that obtains burn status information from television, radio, and other mass media.

3. Nearly 97% of the respondents who checked for no-burn restrictions “all the time” or “most of the time” replied that they always comply with the rule. The sample size for this question was smaller and therefore the statistical significance is questionable.

D. Awareness and Interest in District *Burn Cleaner* Incentive Program

1. A total of 61% of Valley residents believe the District should provide financial assistance to encourage people to switch to cleaner-burning devices rather than institute a Valleywide ban on residential wood-burning.
2. A total of 29% of higher-income residents were aware of the Burn Cleaner incentive program, compared to 17% among lower-income residents.
3. More than 27% of English-speakers were aware of the Burn Cleaner incentive program, compared to 10% of Spanish-speakers.
4. Approximately 17% of residents with wood-burning devices would participate in the Burn Cleaner incentive program if the rebate were offered at 25%.
5. An additional 12% of residents with wood-burning devices would participate in the Burn Cleaner incentive program if the incentives was at least 50%.
6. An additional 15% of residents were willing to participate in the Burn Cleaner Burn Cleaner incentive program if a 75% rebate level was offered, for a total of 44% of residents willing to participate at or below this incentives level. Similar results were seen for the supplemental sample.

E. Public Opinion and Sentiments Related to Possible Changes to Wood Burning Program

1. Two-thirds of Valley residents (67%) believe the current burn restrictions are reasonable, followed by 14% believing current restrictions are too aggressive and should be relaxed, and 10% believing that current restrictions are too lenient.
2. Less than one third (29%) of residents surveyed in the Fresno and Bakersfield areas say they would be willing to replace their traditional devices if they could burn wood on some no-burn days, compared to 39% of residents in the rest of the Valley.
3. Only 6% of residents in the Northern Region reported that the “current restrictions don’t go far enough” compared to 12% of residents in the Central Region and 13% in the Southern Region, a statistically significant difference.
4. Residents who believe wood smoke causes air pollution are more likely to support tougher burn restrictions. Among residents who recognize a correlation between wood burning and air quality, 15% reported that the current burn restrictions “don’t go far enough,” compared to 6% among other residents.

Burn Cleaner Incentive Program

The District’s Burn Cleaner Wood Stove Change-out Program (Burn Cleaner Program) plays a key role in the success of the transition from older more polluting wood burning heaters and fireplaces to cleaner wood burning heaters. Since 2006, the Burn Cleaner Program has been helping residents overcome some of the financial obstacles in purchasing cleaner alternatives providing $20 million to replace nearly 15,000 wood burning devices throughout the Valley. There are currently more than 30 hearth retailers in the Valley that have partnered with the District to successfully implement the Burn Cleaner Program.

The Burn Cleaner Program offers multiple levels of incentive funding, increased as of the 2014-2015 wood burning season:

Table C-15 Multiple Levels of Incentive Funding for Burn Cleaner Program

NEW DEVICE TO BE PURCHASED	INCENTIVE AMOUNT
Certified wood insert/freestanding stove	Up to $1,000
Certified pellet insert/freestanding stove	Up to $1,000
Natural gas insert/freestanding stove	Up to $1,000
Any eligible device if applicant is eligible for low-income	Up to $2,500
Additional incentive towards gas device (for both Standard and Low-income)	Up to $500*

**Applies only to eligible installation costs beyond the funding amount*

Table C-C-16 Eligibility Requirements for Burn Cleaner Program

ELIGIBILITY

The old device must be located at a residence within the District boundaries. Applicants must submit an application and obtain an approved voucher from the District prior to purchasing the new device.

The following table outlines the eligibility of the new device based on the old device type.

	NEW DEVICE (YES = ELIGIBLE, NO = NOT ELIGIBLE)					
OLD DEVICE	FREESTANDING GAS STOVE	GAS INSERT OR GAS FIREPLACE1	FREESTANDING CERTIFIED PELLET STOVE	CERTIFIED PELLET INSERT	FREESTANDING CERTIFIED WOOD STOVE	CERTIFIED WOOD INSERT
Open hearth wood fireplace	Yes	Yes	Yes	Yes	Yes	Yes
Non-certified wood fireplace/insert/stove	Yes	Yes	Yes	Yes	Yes	Yes
Certified wood fireplace/insert/stove	Yes	Yes	No	No	No	No
Pellet stove/insert	Yes	Yes	No	No	No	No
Gas stove/insert, Gas fireplaces, Gas logs	No	No	No	No	No	No

New gas fireplaces must be certified as heater-rated. Gas fireplaces designed exclusively for aesthetic and decorative use are not eligible.

The District continuously re-evaluates the Burn Cleaner Program and implements enhancements to the program. In addition to increased incentive amounts, the District has also recently implemented the following enhancements:

- Reducing a substantial portion of the upfront, out-of-pocket cost of a new qualifying unit for low-income qualified applicants. The District has partnered with contracted hearth retailers to allow low-income qualified applicants to make the purchase at a reduced price by deducting the incentive amount from the invoice at the point of purchase. Allowing the incentive funding to be directly applied when purchase is made makes it more feasible for additional low-income applicants to take advantage of the program.
- Refining the low-income eligibility form to streamline the determination process and identifying the hearth retailers that provide the reduced upfront cost option.
- Program documents are now available in Spanish to further extend the outreach efforts to the local community.
- Updates to program documents to make them more user-friendly and to improve the process during the application, installation, and claim for payment request phases.

- The document submittal process has been updated to allow applications and claim for payment requests to now be emailed to the District for faster processing. Also, supplemental forms have been developed further streamline the review process and help keep the retailers and applicants informed on the status of projects.

Given this program's critical role in supporting the District's efforts to reduce the impact of residential wood burning and continued high demand in the program the District has allocated $12,821,900 in funding for the Burn Cleaner program in the District's 2018-19 Budget.

Collaboration with participating hearth retailers
As part of the District's initiative to increase the effectiveness of the Burn Cleaner program, District staff has worked closely with participating hearth retailers on outreach efforts and provided them with promotional tools, such as flyers and quick screens with information about the Program.

Public Outreach and Education
The District has an extremely successful outreach and education program with regards to residential wood burning and educating Valley residents about air quality, the effects of air pollution on the population's health, and on options they can take to reduce emissions. In the latest wood-burning season the District took part in 82 media interviews about extreme weather and wood burning.

The District's informational *Check Before You Burn* program minimizes elevated PM2.5 concentrations throughout winter. The PM2.5 air quality improvements that the Valley has experienced since the adoption of Rule 4901 have been assisted by strong multimedia outreach by the District and a resultant increase in public awareness and participation in winter District programs.

During each wood-burning season, the District Outreach staff receives hundreds of public calls and emails specific to residential wood burning. An interesting new trend has surfaced regarding public opinion, an increased number of the phone calls were in support of an outright ban on residential wood burning year-round (with the exception of residents for whom wood burning is the sole source of heat). This is attributed to heightened awareness among the general population of the deleterious effects of wood burning on public health.

Since the inception of *Check Before You Burn*, the District's complementary tools, such as the Real-time Air Advisory Network (RAAN) and the "Valley Air" app, have continued to gain in popularity. Annual public calls and website "hit" statistics, plus growth in the District's social media pages, also illustrate continued growth in wood-burning awareness. Survey results also showed an increased public awareness with eight out of ten respondents being aware of the District's *Check Before You Burn* program, 78% of whom confirmed reduced wood-burning activities as a direct result of the program.

The District also incorporates wood-burning messaging into other public outreach products, including Healthy Air Living Schools materials, Healthy Air Heroes elementary kids kits and other materials.

Multimedia Advertising Campaigns

The District's seasonal public outreach advertising campaigns are retooled each year to include timely and relevant messaging. In the past few seasons, this messaging has been delivered by the District's Governing Board members, with billboards in English and Spanish strategically placed throughout the Valley, radio and TV spots, and value-added messaging delivered by media throughout the Valley. The messaging of these campaigns reminds residents of the *Check Before You Burn* program and encourages them to take advantage of the *Burn Cleaner* grant program.

Expanding New Media Outreach

The most significant evolution of *Check Before You Burn* messaging has occurred with the expanded and accelerated use of new media for advertising. Specific wintertime campaigns have been used to reach a new audience within the District's geographic boundaries. This has proven to be a valuable way to deliver immediate messaging regarding the wood-burning rule, and the benefits of clean burning devices, in addition to providing a platform for direct, two-way interaction with the public.

Strengthening Media Partnerships

The District maintains partnerships with television, newspaper, radio, outdoor and print, as well as internet advertising. During seasonal *Check Before You Burn* campaigns, the District runs media on broadcast television stations in the Fresno and Bakersfield markets, including Spanish stations, as well as networks in four cable markets including zoned cable in Stockton, Modesto, Turlock and Manteca.

With these purchases come added value in the form of bonus spots, news sponsorships, and extra billboards and overages in outdoor messaging. Outdoor messaging is strategically placed in high-traffic areas as well as neighborhood and rural communities to ensure a wide reach in those areas where residential wood burning might be common.

The District has also found tremendous benefit from creating a versatile campaign utilizing new media trends like Pandora (digital radio) and internet/digital advertising to reach Valley audiences. Both Pandora and digital web campaign messaging allow the District to target certain listener demographics and behaviors in specific geographic areas and allow listeners to respond to the message by actively clicking through to the valleyair.org site to check their county's wood burning status.

Evaluation Findings

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this source category. As demonstrated above, Rule 4901 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

This measure would further reduce emissions by implementing a more stringent wood burning curtailment program as follows:

- Lower curtailment levels in targeted hot spot areas (Fresno County, Kern County except Frazier Park, other areas as necessary for attainment)
  - No burn for non-registered units at or above 12 $\mu g/m^3$
  - No burn for all devices above 35 $\mu g/m^3$
- Maintain current curtailment levels in rest of Valley
  - No burn for non-registered units at or above 20 $\mu g/m^3$
  - No burn for all devices above 65 $\mu g/m^3$
- Offer enhanced incentives in hot-spot areas
  - In hot-spot areas, incentive will only be provided for natural gas replacements
  - Enhanced levels of incentives provided in hot-spot areas to fund the full replacement of wood burning devices with natural gas units
- Continue to offer current level of incentives Valleywide in non-hot-spot areas
- Prohibit wood-burning devices in new construction (at higher elevations, only allow EPA-certified devices)
- Only allow seasoned wood to be burned
- Enhanced enforcement resources to assure continued high compliance rate
- Enhanced outreach and education efforts to increase awareness of residential wood burning health impacts and District's residential wood burning reduction strategy

C.20 RULE 4902 (RESIDENTIAL WATER HEATERS)

DISCUSSION

Rule 4902 is a point-of-sale rule that limits NOx emissions from natural gas-fired residential water heaters. Rule 4902 was adopted on July 17, 1993 and subsequently amended in March 2009. The original rule enforced a NOx emissions limit of 40 nanograms of NOx per Joule of heat output (ng/J). The March 2009 amendments strengthened the rule by enforcing a limit of 10 ng/J for new or replacement water heaters and a limit of 14 ng/J for instantaneous water heaters. EPA finalized approval for Rule 4902 on May 5, 2010.[83]

Manufacturers have focused on combustion modifications to meet the lower NOx limit as required in other California air districts. Combustion modification systems are designed to reduce thermal NOx formation by changing the flame characteristics to reduce peak flame temperature. Combustion modification for residential water heaters is achieved by different burner designs such as low NOx and ultra-low NOx burners. Some of the design principles used in low NOx and ultra-low NOx burners include staged air burners, staged fuel burners, pre-mix burners, internal recirculation, and radiant burners.

EMISSION INVENTORY

Pollutant	2013	2016	2019	2020	2021	2022	2023	2024	2025	2026
	Annual Average - Tons per day									
NOX	2.15	2.11	2.05	2.02	1.99	1.97	1.94	1.90	1.91	1.92
PM2.5	0.21	0.22	0.22	0.22	0.23	0.23	0.23	0.23	0.23	0.23
	Winter Average - Tons per day									
NOX	2.85	2.80	2.72	2.68	2.65	2.62	2.58	2.53	2.54	2.55
PM2.5	0.27	0.29	0.30	0.30	0.30	0.30	0.31	0.31	0.31	0.31

SOURCE CATEGORY

Rule 4902 is a point of sale rule that affects water heater manufacturers, plumbing wholesalers, retail home supply stores, plumbers and contractors, and homeowners. This source category encompasses several types of water heaters, including conventional storage water heaters, demand water heaters, heat pump water heaters, solar water heaters, and tankless coil and indirect water heaters. Water heater options also vary by fuel type which includes electricity, fuel oil, geothermal energy, natural gas, propane, and solar energy.

Conventional storage water heaters are the most common. They have an insulated tank sized from 20 to 80 gallons and natural gas fired units have a gas burner under the tank regulated by a thermostat. Demand water heaters, also known as instantaneous

[83] EPA. Revisions to the California State Implementation Plan, San Joaquin Valley Unified Air Pollution Control District. Final Rule. 75 Fed. Reg. 24408. (2010, May 5). (to be codified at 40 CFR 52). https://www.gpo.gov/fdsys/pkg/FR-2010-05-05/pdf/2010-10404.pdf

water heaters, heat water as it is required and do not use a storage tank. As soon as there is a demand for hot water, a gas burner heats cold water as it travels through a pipe in the unit.

Natural gas fired units provide hot water at a rate upwards of 5 gallons per minute. A tankless coil water heater heats water flowing through a heat exchanger installed in a furnace or boiler. Similar to the tankless coil water heater an indirect water heater uses a furnace or boiler. Fluid heated by the furnace or boiler is circulated through a heat exchanger in a storage tank.

HOW DOES DISTRICT RULE 4902 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations
There is currently no federal guidance given for this source category under the federal CTG, Alternative Control Techniques (ACT), New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), and Maximum Achievable Control Technology (MACT) requirements.

State Regulations
There are no state regulations applicable to air quality from commercial charbroiling activities.

HOW DOES DISTRICT RULE 4902 COMPARE TO RULES IN OTHER AIR DISTRICTS?

SCAQMD

- SCAQMD Rule 1121 (Control of Nitrogen Oxides from Residential Type, Natural Gas-Fired Water Heaters) *(September 3, 2004)*

The District evaluated the requirements contained within the SCAQMD Rule and found no requirements that were more stringent than those already in District Rule 4902.

	SJVAPCD	SCAQMD
Applicability	Manufacturers, distributors, retailers, and installers of PUC quality natural gas-fired residential water heaters with heat input rates ≤ 75,000 Btu/hr	Manufacturers, distributors, retailers, and installers of natural gas-fired water heaters, with heat input rates < 75,000 Btu/hr
Exemption	• PUC quality natural gas fired water heaters with rated heat input of > 75,000 Btu/hr • Water heaters using fuels other than PUC quality natural gas • Water heaters used exclusively in recreational vehicles	• Water heaters with a rated heat input capacity of ≥75,000 Btu/hr • Water heaters used in recreational vehicles.
Requirements	• No person shall manufacture for sale, distribute, sell, offer for sale, or install within the District	• No person shall manufacture for sale, distribute, sell, offer for sale, or install within SCAQMD any gas-fired water

	any PUC quality natural gas-fired: • Mobile home water heater unless it is certified to a NOx emission level of ≤ 40 ng/J. • Pool heater unless it is certified to a NOx emission level of ≤ 40 ng/J. • Water heater, excluding mobile home water heaters, instantaneous water heaters, and pool heaters, unless it is certified to a NOx emission level of ≤ 10 ng/J. • instantaneous water heater unless it is certified to a NOx emission level of ≤ 14 ng/J.	heaters unless it is certified to a NOx emission level of ≤ 10 ng/J; or 15 ppmv at 3% O2, dry • No person shall manufacture for sale, distribute, sell, offer for sale, or install within SCAQMD any gas-fired mobile home water heater unless it is certified to a NOx emission level of ≤ 40 ng/J; or 55 ppmv at 3% O2, dry

SMAQMD

- SMAQMD Rule 414 (Water Heaters, Boilers and Process Heaters Rated Less than 1,000,000 BTU Per Hour) *(March 25, 2010)*

The District evaluated the requirements contained within SMAQMD Rule and found no requirements that were more stringent than those already in District Rule 4902. Requirements for units with a rating greater than 75,000 Btu/hr but less than 2,000,000 Btu/hr are included under District Rule 4308 and have at least as stringent or more stringent limits than those in SMAQMD Rule.

	SJVAPCD	SMAQMD
Applicability	Manufacturers, distributors, retailers, and installers of PUC quality natural gas-fired residential water heaters with heat input rates ≤ 75,000 Btu/hr	Any person who manufactures, distributes, offers for sale, sells, or installs any type of water heater (such as tank or tankless/instantaneous), boiler or process heater, with a rated heat input capacity < 1,000,000 Btu/hr, fired with gaseous or nongaseous fuels, for use in this District.
Exemption	• PUC quality natural gas fired water heaters with rated heat input of > 75,000 Btu/hr • Water heaters using fuels other than PUC quality natural gas • Water heaters used exclusively in recreational vehicles	• Water heaters used in recreational vehicles. • Pool/spa heaters with a heat input rating of less than 75,000 Btu/hr. • Water heaters, boilers and process heaters fired with liquefied petroleum gas.
Requirements	• No person shall manufacture for sale, distribute, sell, offer for sale, or install within the District any PUC quality natural gas-fired:	A person shall only distribute, offer for sale, sell, or install within the SMAQMD a water heater, boiler or process heater with

	• mobile home water heater unless it is certified to a NOx emission level of ≤ 40 ng/J.
	• pool heater unless it is certified to a NOx emission level of ≤ 40 ng/J.
	• water heater, excluding mobile home water heaters, instantaneous water heaters, and pool heaters, unless it is certified to a NOx emission level of ≤ 10 ng/J.
	• instantaneous water heater unless it is certified to a NOx emission level of ≤ 14 ng/J.
		certified NOx and CO emissions ≤ the following limits:
		• < 75,000 Btu/hr:
		  ○ Mobile home: 40 ng/J
		  ○ All others: 10 ng/J
		• 75,000 - <400,000 Btu/hr:
		  ○ Pool/Spa: 40 ng/J
		  ○ All others: 14 ng/J
		• 400,000 to <1 million Btu/hr:
		  ○ All types: 14 ng/J NOx and 400 ppmv CO @ 3% O2

BAAQMD

- BAAQMD Regulation 9 Rule 6 (Nitrogen Oxides Emissions from Natural Gas-Fired Boilers and Water Heaters) *(November 7, 2007)*

The District evaluated the requirements contained within BAAQMD and found no requirements that were more stringent than those already in District. Requirements for units with a rating greater than 75,000 Btu/hr but less than 2,000,000 Btu/hr are included under District Rule 4308 and have at least as stringent or more stringent limits than those in SMAQMD Rule.

	SJVAPCD	BAAQMD
Applicability	Manufacturers, distributors, retailers, and installers of PUC quality natural gas-fired residential water heaters with heat input rates ≤ 75,000 Btu/hr	This rule limits the emissions of nitrogen oxides from natural gas-fired water heaters and boilers
Exemption	• PUC quality natural gas fired water heaters with rated heat input of > 75,000 Btu/hr • Water heaters using fuels other than PUC quality natural gas • Water heaters used exclusively in recreational vehicles	The requirement *[No person shall sell, install, or offer for sale within the District any natural gas-fired storage tank water heater, manufactured after July 1, 1992, with a rated heat input capacity of 75,000 BTU/Hour or less, that emits more than 40 ng/J.]* shall not apply to the following: • Natural gas-fired boilers and water heaters with a rated heat input capacity > 2,000,000 BTU/hr. • Natural gas-fired water heaters used in recreational vehicles • Water heaters using a fuel other than natural gas

		• Natural gas-fired pool/spa heaters with < 400,000 BTU/hr rated heat input capacity used exclusively to heat swimming pools, hot tubs or spas
Requirements	No person shall manufacture for sale, distribute, sell, offer for sale, or install within the District any PUC quality natural gas-fired: • mobile home water heater unless it is certified to a NOx emission level of ≤ 40 ng/J. • pool heater unless it is certified to a NOx emission level of ≤ 40 ng/J. • water heater, excluding mobile home water heaters, instantaneous water heaters, and pool heaters, unless it is certified to a NOx emission level of ≤ 10 ng/J. • instantaneous water heater unless it is certified to a NOx emission level of ≤ 14 ng/J.	Natural gas-fired storage tank water heaters with a rated heat input capacity ≤ 75,000 Btu/hr: • No person shall sell, install, or offer for sale within the District any natural gas-fired storage tank water heater that emits > 10 ng/J. This subsection shall not apply to water heaters used for mobile homes. Natural gas-fired boilers and water heaters with a rated heat input capacity of 75,001 to 2,000,000 Btu/hr: • No person shall sell, install, or offer for sale within the District any large natural gas-fired boiler, storage tank water heater, or instantaneous water heater with a rated heat input capacity from 75,001 to 400,000 Btu/hr, inclusive, manufactured after January 1, 2013, that emits more than 14 ng/J. • No person shall sell, install, or offer for sale within the District any large natural gas-fired boiler, storage tank water heater, or instantaneous water heater with a rated heat input capacity from 400,001 to 2,000,000 Btu/hr, inclusive, manufactured after January 1, 2013, that emits more than 14 ng/J, or more than 20 ppm NOx at 3% O2, dry. No person shall sell, install, or offer for sale within the District any natural gas-fired mobile home water heater that emits > 40 ng/J. No person shall sell, install, or offer for sale within the District any natural gas-fired pool/spa heater

		with an input rating from 400,001 to 2,000,000 Btu/hr that emits > 14 ng/J, or > 20 ppm NOx at 3% O2, dry.

VCAPCD

- VCAQPCD Rule 74.11 (Natural Gas-Fired Water Heaters)

The District evaluated the requirements contained within VCAQMD and found no requirements that were more stringent than those already in District Rule 4902. Requirements for units with a rating greater than 75,000 Btu/hr but less than 2,000,000 Btu/hr are included under District Rule 4308 and have at least as stringent or more stringent limits than those in SMAQMD Rule.

	SJVAPCD	VCACPD
Applicability	Manufacturers, distributors, retailers, and installers of PUC quality natural gas-fired residential water heaters with heat input rates ≤ 75,000 Btu/hr	Any person selling, offering for sale, or installing natural gas-fired water heaters, including mobile home water heaters, rated at < 75,000 Btu/hr in Ventura County
Exemption	• PUC quality natural gas fired water heaters with rated heat input of > 75,000 Btu/hr • Water heaters using fuels other than PUC quality natural gas • Water heaters used exclusively in recreational vehicles	The provisions of this rule shall not apply to: 1. Water heaters with a rated heat input ≥ 75,000 Btu/hr 2. Water heaters used in recreational vehicles
Requirements	• No person shall manufacture for sale, distribute, sell, offer for sale, or install within the District any PUC quality natural gas-fired: • mobile home water heater unless it is certified to a NOx emission level of ≤ 40 ng/J. • pool heater unless it is certified to a NOx emission level of ≤ 40 ng/J. • water heater, excluding mobile home water heaters, instantaneous water heaters, and pool heaters, unless it is certified to a NOx emission level of ≤ 10 ng/J. • instantaneous water heater unless it is certified to a NOx emission level of ≤ 14 ng/J.	• No person shall sell, offer for sale, or install within Ventura County any natural gas-fired water heater unless the water heater is certified to a NOx emission level ≤: ○ 10 ng/J; or ○ 15 ppmv at 3% O2, dry • No person shall sell, offer for sale, or install within Ventura County any natural gas-fired mobile home water heater unless the water heater is certified to a NOx emission level ≤: • 40 ng/J; or • 55 ppmv at 3% O2, dry

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

Beyond the review of current regulation and rule requirements, the District performed an extensive review of the feasibility of expanding applicability or removal of exemptions for this source category, technologies and measures that have been implemented in practice in other regions, and potential new technologies and measures that may be feasible for implementation in the near future. Based on this exhaustive review, District staff did not find any additional measures currently available or will be available prior to the 2025 attainment deadline date that could improve the effectivity of this rule.

As stated above, the most recent amendment of Rule 4902 strengthened the emission limit and as a result, NOx emissions have been controlled by approximately 88% for this source category. Units subject to Rule 4902 are fired on PUC quality natural gas, and are inherently low-emitters of SOx and PM2.5 emissions. Given the significant efforts and investments already made to reduce emissions from this source category, there are little remaining opportunities for obtaining additional emissions reductions. For the sake of thoroughness, the possibility of further reducing emissions from natural-gas fired water heaters is evaluated in the following discussion.

The potential opportunity evaluated is the possibility of achieving additional emission reductions from this category by taking advantage of lower emitting water heating technology. Rule 4902 is a point of sale rule, and nearly all water heaters sold in the District are conventional storage water heaters that operate on natural gas. The potential opportunity would be to replace natural gas and propane water heaters with units that run on electricity. A comparison of three water heaters that utilize the different fuel types with an emissions reduction and cost effectiveness analysis for these units is summarized below.

Emissions Reductions and Cost Effectiveness of Water Heaters by Fuel Type

Fuel Type	Low NOx Natural Gas	Propane	Electricity
Capacity[1]	50 gallons	50 gallons	50 gallons
Shipping Weight[1]	146 lbs	146 lbs	117 lbs
Energy Factor[1]	0.62	0.62	0.93
Purchase Price[1]	$895.00	$1,132.00	$650.00
Estimated Life Expectancy[2]	13 years	13 years	13 years
Lifetime Energy Use[2]	3,133 therms	2,867 gallons of LP	62,439 kWh
Lifetime Energy Costs[3]	$3,919	$6,852	$9,922
Lifetime NOx Emissions[4]	30.60 lbs	48.09 lbs	0.00 lbs
Annual NOx Emissions	2.35 lbs	3.70 lbs	0.00 lbs
Comparing Natural Gas and Propane to Electricity			N/A
Annualized capital cost[5]	$105.76	$105.76	
Annual Operating Cost Savings Compared to Electric	$461.71	$236.11	
Cost per pound NOx	$241.50	$92.40	
Cost per ton NOx	**$482,945**	**$184,792**	

[1] Unit specifications and prices acquired from Grainger Industrial Supply as of June 14, 2018
[2] Data from US Department of Energy – Energy Cost Calculator for Electric and Gas Water Heaters http://www1.eere.energy.gov/femp/technologies/eep_waterheaters_calc.html
[3] Cost data based on the of the average cost of units of energy in 2017 according to the US Energy Information Administration. http://www.eia.gov/
[4] Emissions factors derived from Appendix EA-1 of US Department of Energy's Energy Assessment for Proposed Energy Conservation Standards for Residential Clothes Washers
[5] The annualized capital equipment cost is calculated by multiplying the installed equipment cost by the capital recovery factor of 0.1627.

The operating cost for electric water heaters is higher than for propane and natural gas units, due to the higher cost of electricity over propane and natural gas. However, the initial purchase price is considerably lower for electric units. Converting to an electric water heater also may require modifications to the residence and have associated costs, though electric water heaters are amongst the safest units available. Electric units also weigh considerably less, due to the lack of safety equipment needed on a gas fueled water heater. While the lifetime cost of an electric water heater is higher than that of propane and natural gas, the emissions benefits may make converting to electric water heating a viable control strategy.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this source category. As demonstrated above, Rule 4902 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category. As the District continues to develop new attainment plans that address more stringent National Ambient Air Quality Standards, the District will continue to evaluate potential opportunities to reduce emissions from this source category in the Valley.

C.21 RULE 4905 (NATURAL GAS-FIRED, FAN-TYPE CENTRAL FURNACES)

DISCUSSION

District Rule 4905 is a point of sale rule that applies to any person who sells, offers for sale, installs or solicits the installation of natural-gas-fired, fan-type central furnaces for use in the Valley with a rated heat input capacity of less than 175,000 Btu/hour, and for combination heating and cooling units with a rated cooling capacity of less than 65,000 Btu/hour. Adopted on October 20, 2005, Rule 4905 established NOx limits for residential central furnaces supplied, sold, or installed in the Valley. The rule NOx emission limit was set at 0.093 pounds per million Btu of heat output (lb/MMBtu). January 2015 amendments lowered the NOx emission limit for residential units from 40 ng/J (0.093 lb/MMBtu) to 14 ng/J, expanded rule applicability to include commercial units with a NOx emission limit of 14 ng/J and units installed in manufactured homes with a NOx emission limit of 40 ng/J to be lowered to 14 ng/J in 2018. EPA approved these amendments into the SIP effective April 28, 2016.[84] Due to the limited number of certified compliant units that will be available by the compliance deadline dates, the rule was amended again on June 21, 2018 to extend the implementation period for another 12 months to allow an additional period of time necessary to continue technology development and the certification process while providing strong incentive for accelerated deployment of compliant units.

EMISSIONS INVENTORY

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.20	0.21	0.21	0.21	0.22	0.22	0.22	0.22	0.22
NOx	2.44	2.54	2.43	2.38	2.33	2.24	2.18	2.13	2.07
	Winter Average - Tons per day								
PM2.5	0.26	0.27	0.28	0.28	0.29	0.29	0.29	0.29	0.30
NOx	3.25	3.38	3.23	3.16	3.10	2.98	2.90	2.83	2.75

SOURCE CATEGORY

This source category includes natural gas-fired central furnaces in the Valley that have a rated heat input capacity of less than 175,000 British thermal units per hour (Btu/hr), and combination heating and cooling units with a rated cooling capacity of less than 65 Btu/hr. All heating systems have three basic components: a heat source, a heat distribution system, and a control system. The control system is usually a programmable thermostat. The heat source, which generally determines the type of distribution system used, is selected based on many factors. The most important factor is geographical location, which determines the climate and types of available fuel. Most commercial and residential buildings in the Valley have access to natural gas, which is typically the cheapest and most convenient fuel source in areas where it is available. Furnaces fueled by natural gas use forced air distribution, the most common type of heating system for residential and commercial buildings. Central furnaces are

[84] Approval of California Air Plan Revisions, San Joaquin Valley Unified Air Pollution Control District and South Coast Air Quality Management District. Final Rule. 81 Fed. Reg. 17390. (2016, March 29). (to be codified at 40 CFR Part 52). https://www.gpo.gov/fdsys/pkg/FR-2016-03-29/pdf/2016-06962.pdf

controlled by a thermostat, which sends signals to turn the device on or off when the building temperature does not match a chosen set point. A valve then opens to send natural gas to the burners, which combust the gas directly into the heat exchangers. A blower pulls air from outside the building through a filter, across the heat exchanger, and through a series of ducts and vents to different areas of the building. Exhaust from the combustion exits the building through a separate duct.

Condensing units use an additional heat exchanger to extract the latent heat in the flue (exhaust) gas by cooling the combustion gasses to near ambient temperature and thereby increase the heating efficiency by up to 10%. The water vapor in the flue gas is condensed, collected, and drained.

Units installed in manufactured homes utilize the same types of materials and operating principles as commercial and residential units; however, significant differences exist. Furnaces installed in manufactured homes use sealed combustion and, pre-heat the air typically to 50-60°F, using a concentric vent, and exhaust gases are vented through the inside core of the vent pipe. Furnaces installed in manufactured homes also have to comply with strict space restrictions.[85]

HOW DOES DISTRICT RULE 4905 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

The District identified federal, state, and local air quality regulations and compared them to analogous District rules to identify potential emission reductions opportunities. Any potential opportunities identified were then analyzed to determine if they are technologically and economically feasible to require in Valley.

Federal Regulations

There are no EPA CTG, ACT, NSPS, NESHAP, or MACT requirements for this source category.

State Regulations

There are no state regulations applicable to this source category.

HOW DOES DISTRICT RULE 4905 COMPARE TO RULES IN OTHER AIR DISTRICTS?

There are no analogous rules for this source category in SMAQMD.

SCAQMD

- SCAQMD Rule 1111 (Reduction of NOx Emissions from Natural) *(Amended July 6, 2018)*

As summarized above, the District evaluated the requirements contained within SCAQMD Rule 1111 and found no requirements that were more stringent than those already in Rule 4905.

[85] U.S. Department of Energy. (2014, July 7). *Energy Conservation Program for Consumer Products: Energy Conservation Standards for Residential Furnace Fans.* Retrieved 9/23/14 from https://www.federalregister.gov/articles/2014/07/03/2014-15387/energy-conservation-program-for-consumer-products-energy-conservation-standards-for-residential.

	SJVAPCD	SCAQMD
Applicability	Residential and commercial furnaces with rated heat input capacity of < 175,000 btu/hr or < 65,000 btu/hr for combination heating and cooling units	Residential and commercial furnaces with rated heat input capacity of < 175,000 btu/hr or < 65,000 btu/hr for combination heating and cooling units
Exemption	• Natural gas furnace not exceeding NOx emissions of 40 ng/J and installed with propane conversion kit for propane firing only	• Furnaces installed in mobile homes before October 1, 2012 • Natural gas furnace installed with propane conversion kit for propane firing only
Requirements	Furnaces must not exceed NOx limit of 14 ng/J	Furnaces must not exceed NOx limit of 14 ng/J

BAAQMD

- BAAQMD Regulation 9 Rule 4 (Nitrogen Oxides from Fan Type Residential Central Furnaces) *(Amended December 7, 1983)*

The District evaluated the requirements contained within BAAQMD Regulation 9 Rule 4 and found no requirements that were more stringent than those already in Rule 4905.

	SJVAPCD	BAAQMD
Applicability	Residential and commercial furnaces with rated heat input capacity of < 175,000 btu/hr or < 65,000 btu/hr for combination heating and cooling units	Residential central furnaces with rated heat input capacity of < 175,000 btu/hr, excluding heating/cooling units utilizing three phase electric current
Exemption	• Natural gas furnace not exceeding NOx emissions of 40 ng/J and installed with propane conversion kit for propane firing only	Although BAAQMD does not explicitly provide any exemptions, the rule only applies to residential furnaces and excludes heating/cooling units
Requirements	Furnaces must not exceed NOx limit of 14 ng/J	Furnaces must not exceed NOx limit of 40 ng/J

VCAPCD

- VCAQPCD Rule 74.22 (Natural Gas-Fired, Fan-Type Central Furnaces) *(Adopted November 9, 1993)*
-

The District evaluated the requirements contained within VCAPCD Rule 74.22 and found no requirements that were more stringent than those already in Rule 4905.

	SJVAPCD	VCAPCD
Applicability	Residential and commercial furnaces with rated heat input capacity of < 175,000 btu/hr or < 65,000 btu/hr for combination heating and cooling units	Residential and commercial furnaces with rated heat input capacity of < 175,000 btu/hr or < 65,000 btu/hr for combination heating and cooling units
Exemption	• Natural gas furnace not exceeding NOx emissions of 40 ng/J and installed with propane conversion kit for propane firing only	Units installed in manufactured housing
Requirements	Furnaces must not exceed NOx limit of 14 ng/J	Furnaces must not exceed NOx limit of 40 ng/J

SCAPCD

- SDAPCD Rule 69.6 (Natural Gas-Fired Fan Type Central Furnaces) *(Adopted June 17, 1998)*

The District evaluated the requirements contained within San Diego APCD Rule 69.6 and found no requirements that were more stringent than those already in Rule 4905.

	SJVAPCD	San Diego APCD
Applicability	Residential and commercial furnaces with rated heat input capacity of < 175,000 btu/hr or < 65,000 btu/hr for combination heating and cooling units	Furnaces with rated heat input capacity of < 175,000 btu/hr or < 65,000 btu/hr for combination heating and cooling units
Exemption	• Natural gas furnace not exceeding NOx emissions of 40 ng/J and installed with propane conversion kit for propane firing only	Units installed in mobile homes
Requirements	Furnaces must not exceed NOx limit of 14 ng/J	Furnaces must not exceed NOx limit of 40 ng/J

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

This rule implements requirements that go beyond most stringent measures feasible to implement in the Valley, as evidenced by the need for the District to amend this rule this year to extend the deadlines to provide manufacturers additional time to research, develop, certify, and commercialize compliant units. As such, there are no additional emission reductions opportunities identified at this time.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this source category. As demonstrated above, Rule 4905 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category. As the District continues to develop new attainment plans that address more stringent National Ambient Air Quality Standards, the District will continue to evaluate potential opportunities to reduce emissions from this source category in the Valley.

C.22 Regulation VIII (Fugitive PM10 Prohibitions)

Discussion

The District's Regulation VIII series (Fugitive PM10 Prohibitions) was adopted in November 2001, and subsequently amended in 2004. This series contain a comprehensive suite of rules to reduce fugitive PM10 emissions from a range of sources as described below:

Rule 8011: General Requirements
The provisions of Rule 8011 are applicable to specified outdoor fugitive dust sources. The definitions, exemptions, requirements, administrative requirements, recordkeeping requirements, and test methods set forth in this rule are applicable to all rules under District Regulation VIII (Fugitive PM10 Prohibitions). The rules were developed pursuant to EPA guidelines for serious PM10 nonattainment areas. In 2004, the District adopted amendments to Regulation VIII to upgrade existing RACM level rules to meet the more stringent BACM level required in serious PM10 nonattainment areas.

Rule 8021: Construction, Demolition, Excavation, Extraction, and Other Earthmoving Activities
Rule 8021 applies to construction or demolition related disturbances of soil, including land clearing, grubbing, scraping, excavation, extraction, land leveling, grading, cut and fill operations, travel on the site, travel access roads to and from the site, and demolition activities. The rule also applies to construction of new landfill disposal sites or modifications to existing landfill disposal sites prior to commencement of landfilling activities. In 2004, Rule 8021 was amended to add dust suppression requirements, and to require submittal of Dust Control Plans on residential construction sites 10.0 acres or more in size and on non-residential construction sites 5.0 acres or more in size.

Rule 8031: Bulk Materials
Rule 8031 applies to the outside storage and handling of any unpackaged material, which emits or has the potential to emit dust when stored or handled. Rule 8031 requires bulk handling and storage facilities to restrict dust from material transfer, and reduce emissions from transport material and storage piles that emit dust. Facilities subject to Rule 8031 are required to use control measures to ensure that visible dust emissions are limited to 20% opacity or less. These control measures can include application of water or other dust stabilizers, covering of bulk materials, construction of wind barriers, covering of haul trucks, and other measures. In 2004, Rule 8031 was

amended to require construction and maintenance of wind barriers when handling bulk materials.

Rule 8041: Carryout and Trackout

Rule 8041 applies to the prevention and cleanup of mud and dirt whenever it is deposited (carryout and trackout) onto public paved roads from activities subject to the requirements of Rules 8021, 8031, 8061, and 8071. The rule contains requirements for: removing carryout and trackout at the end of each workday; thresholds for any site with 150 daily vehicle trips; addressing carryout and trackout in Dust Control Plans; removing carryout and trackout in urban areas; paved interior roads; and prevention of carryout and trackout. In 2004, Rule 8041 was amended to require a threshold for vehicles with three or more axles to takes actions for carryout/trackout. Amendments included a threshold for projects located in rural areas, a provision requiring actions within half an hour if specified measures are insufficient to prevent carryout/trackout, and specifications for dust collectors, gravel pads, and paved surfaces.

Rule 8051: Open Areas

Rule 8051 applies to any open area 0.5 acres or more within urban areas, or 3.0 acres or more within rural areas that contains at least 1,000 square feet of disturbed surface area. The rule has requirements for limiting visible dust emissions (VDE) to 20% opacity, to comply with the conditions of a stabilized surface, and to install barriers to prevent unauthorized vehicles from accessing the stabilized areas. In 2004, Rule 8051 was amended to add applicability thresholds for rural and urban areas.

Rule 8061: Paved and Unpaved Roads

Rule 8061 establishes standards for the construction of new and modified paved roads in accordance with published guidelines by the American Association of State Highway and Transportation Officials for road construction and applies to any paved, unpaved, or modified public or private road, street highway, freeway, alley way, access drive, access easement, or driveway. The rule also allows alternative means of achieving the same level of dust reduction. Rule 8061 also establishes thresholds that when exceeded require that roads are treated to reduce visible dust emissions. In 2004, Rule 8061 was amended to replace the existing 75 maximum daily vehicle trip threshold with a 26 annual average daily vehicle trips (AADT) threshold on unpaved roads, and require all new unpaved roads within urban areas be paved.

Rule 8071: Unpaved Vehicle/Equipment Traffic Areas

Rule 8071 is applicable to unpaved vehicle/equipment areas, parking, fueling and service areas, and shipping, receiving, and transfer areas. The rule contains requirements for when vehicle traffic reaches or exceeds specified thresholds, limitations on visible dust emissions (VDE), compliance requirements with the conditions of a stabilized surface, and lists control techniques, which could be implemented to limit VDE and to comply with the conditions of a stabilized surface. In 2004, Rule 8071 was amended to remove the 1.0 acre or larger threshold; change the vehicle threshold from 75 vehicle daily trips to 50 annual average daily trips; add a single day peak threshold of 150 VDT or require control for sources that exceed the 150 VDT threshold limit on at least 30 days per year; and add a requirement whenever 25 or more three-axle vehicle trips will occur on an unpaved vehicle/equipment traffic area.

Rule 8081: Agricultural Sources

Rule 8081 applies to "off-field" agricultural sources including, but not limited to, unpaved roads, unpaved vehicle/equipment traffic areas, and bulk materials. The rule contains requirements to limit visible dust emissions (VDE) and/or to comply with the conditions of a stabilized surface, and lists control techniques which could be implemented to limit VDE and to comply with the conditions of a stabilized surface. In 2004, Rule 8081 was amended to add an exemption to the rule for vehicle/equipment traffic areas if they are less than one acre in size and more than one mile from an urban area; expand rule applicability by updating the vehicle threshold from 75 vehicle daily trips to 50 annual average vehicle trips; and add a requirement specific to whenever 26 or more three-axle vehicle trips will occur on an unpaved vehicle/equipment traffic area.

EMISSIONS INVENTORY

Rule 8021: Construction, Demolition, Excavation, Extraction, and Other Earthmoving Activities

Pollutant	2013	2016	2019	2020	2021	2022	2023	2024	2025	2026
	Annual Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	1.52	1.70	1.85	1.89	1.54	1.56	1.58	1.61	1.64	1.67
	Winter Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	1.39	1.55	1.70	1.73	1.41	1.43	1.45	1.48	1.50	1.53

Rule 8031: Bulk Materials

Pollutant	2013	2016	2019	2020	2021	2022	2023	2024	2025	2026
	Annual Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06
	Winter Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06

Rule 8041: Carryout and Trackout

Pollutant	2013	2016	2019	2020	2021	2022	2023	2024	2025	2026

	Annual Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	3.26	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82
	Winter Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	6.35	5.49	5.49	5.49	5.49	5.49	5.49	5.49	5.49	5.49

Rule 8051: Open Areas

Pollutant	2013	2016	2019	2020	2021	2022	2023	2024	2025	2026
	Annual Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
	Winter Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21

Rule 8061: Paved and Unpaved Roads

The emissions from this source category are included in Rule 8061 (Paved and Unpaved Roads).

Rule 8071: Unpaved Vehicle/Equipment Traffic Areas

Pollutant	2013	2016	2019	2020	2021	2022	2023	2024	2025	2026
	Annual Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
	Winter Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52

Rule 8081: Agricultural Sources

Pollutant	2013	2016	2019	2020	2021	2022	2023	2024	2025	2026
	Annual Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	1.20	1.18	1.17	1.17	1.16	1.16	1.15	1.15	1.14	1.14
	Winter Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0

PM2.5	1.47	1.45	1.43	1.43	1.42	1.42	1.41	1.41	1.40	1.39

HOW DOES DISTRICT REGULATION VIII COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations
There are no EPA CTG, ACT, NSPS, NESHAP, or MACT guidelines for this source category. The following federal regulations apply to sources covered under Regulation VIII:

- Rule 57 FR 13498 (General Preamble for Title I of CAA)

The District evaluated the requirements contained within the General Preamble and found no requirements that were more stringent than those already in Regulation VIII.

- EPA-450/2-92-004 (Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures (BACM))

The District evaluated the requirements contained within the Fugitive Dust Background Document and Technical Information Document for BACM and found no requirements that were more stringent than those already in Regulation VIII.

State Regulations
There are no state regulations applicable to this source category.

HOW DOES DISTRICT REGULATION VIII COMPARE TO RULES IN OTHER AIR DISTRICTS?

There are no analogous rules for this source category in BAAQMD.

SCAQMD

- Rule 1156 (Further Reductions of Particulate Emissions from Cement Manufacturing Facilities) (Amended November 6, 2015)

The District evaluated the requirements contained within SCAQMD Rule 1156 and found no requirements that were more stringent than those already in Regulation VIII.

- Rule 1157 (PM10 Emission Reductions form Aggregate and Related Operations) (Amended September 8, 2008)

The District evaluated the requirements contained within SCAQMD 1157 and found no requirements that were more stringent than those already in Regulation VIII.

SMAQMD

- Rule 403 (Fugitive Dust) (Amended August 3, 1977)

The District evaluated the requirements contained within SMAQMD Rule 403 and found no requirements that were more stringent than those already in Regulation VIII.

VCAPCD

- Rule 55 (Fugitive Dust) (Adopted June 10, 2008)

The District evaluated the requirements contained within VCAPCD Rule 55 and found no requirements that were more stringent than those already in Regulation VIII.

Clark County Department of Air Quality (CCDAQ)

- Section 41 (Fugitive Dust) (Adopted April 15, 2014)

The District evaluated the requirements contained within CCDAQ Section 41 and found no requirements that were more stringent than those already in Regulation VIII.

- Section 91 (Fugitive Dust from Unpaved Roads, Unpaved Alleys, and Unpaved Easement Roads) (Amended April 15, 2014)

The District evaluated the requirements contained within CCDAQ Section 91 and found no requirements that were more stringent than those already in Regulation VIII.

- Section 92 (Fugitive Dust from Unpaved Parking Lots and Storage Areas) (Amended April 15, 2014)

The District evaluated the requirements contained within CCDAQ Section 92 and found no requirements that were more stringent than those already in Regulation VIII.

- Section 93 (Fugitive Dust from Paved Roads and Street Sweeping Equipment) (Amended April 15, 2014)

The District evaluated the requirements contained within CCDAQ Section 93 and found no requirements that were more stringent than those already in Regulation VIII.

- Section 94 (Permitting and Dust Control for Construction Activities) (Amended July 1, 2004)

The District evaluated the requirements contained within CCDAQ Section 94 and found no requirements that were more stringent than those already in Regulation VIII.

Great Basin APCD Rule 433 (Control of Particulate Emissions at Owens Lake)

- Section 41 (Fugitive Dust) (Adopted April 13, 2016)

The District evaluated the requirements contained within Great Basin APCD Rule 433 and found no requirements that were more stringent than those already in Regulation VIII.

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

Regulation VIII currently employs the best dust mitigation techniques. There are no additional potential opportunities for further emissions reductions from this source category.

Furthermore, while District Regulation VIII was critical in the District's attainment of the PM10 standards, a variety of studies have been conducted which may indicate that the PM2.5 fraction of the PM emissions from this source category may not be as significant as the PM coarse fraction. A better quantification of the PM2.5 fraction is required to develop a more accurate emissions inventory for the various activities under Rule 8021 and to indicate the level of significance of those PM2.5 emissions. Modeling results show that the geologic fraction of PM2.5 found in the Valley makes a relatively small contribution to overall PM2.5 mass. In addition, studies have shown that geologic dust alone has relatively low toxicity.

EVALUATION FINDINGS

The District has evaluated all potential requirements achieved in practice in other areas or included in other state implementation plans. As demonstrated above, Regulation VIII currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

C.23 RULE 9510 (INDIRECT SOURCE REVIEW)

DISCUSSION

Rule 9510 Indirect Source Review (ISR) was adopted in December 15, 2005 and amended in December 2017 and is the only rule of its kind in the State of California and throughout the nation. The District's rule is recognized as the benchmark, or best available control, for regulating these indirect sources of emissions. State and federal laws are prescriptive in establishing the District's authority regulating indirect sources. These complex legal requirements were well documented and litigated as the District spent over five years successfully defending its existing rule through the highest courts at the state and federal levels. The emission control requirements under the District's current rule are as stringent as possible in adherence with all applicable state and federal regulations and case law.

The California Air Resources Board, South Coast Air Quality Management District, Bay Area Air Quality Management District and other air districts are currently attempting to replicate the success of the rule in the development of their own Indirect Source Review rules by utilizing San Joaquin Valley Air District's experience and regulatory language to help guide their efforts.

The rule is to reduce the growth in NOx and PM emissions from mobile and area sources associated with construction and operation of new development projects in the Valley. The ISR rule applies to developers of new residential, commercial and industrial projects and to transportation and transit projects whose emissions will exceed certain thresholds contained in the rule. The ISR rule encourages clean air designs to be incorporated into the development project, or, if insufficient emissions reductions can be designed into the project, by paying a mitigation fee that will be used to fund off-site emissions reduction projects. A significant improvement has occurred in the design of development projects in the Valley through the incorporation of features that result in reduced emissions. Since adoption of the rule, developers have voluntarily begun to incorporate many air-friendly design changes into their projects. For instance, significant reductions in emissions have occurred through the use of a "construction clean fleet", which is defined as a construction fleet mix cleaner than the State fleet average. Another noteworthy change is that developers of large distribution centers are continuing to reduce operational emissions and associated impacts through voluntarily committing to use newer heavy-duty on-road fleet vehicles and maintaining a fleet replacement schedule that ensures older vehicles are replaced in a timely manner. In 2006, the first year of implementation, only 14.3% of approved projects reduced construction exhaust impacts through use of a clean construction equipment fleet. The percentage has risen to approximately 33% for the entire history of the ISR program, and 46% for the reporting period of 2017.

The population in the San Joaquin Valley is expected to be one of the fastest growing regions in the state through at least 2033. The Demographic Research Unit of the Department of Finance released interim revised population growth projections in January 2018 and expects approximately 21.8% growth in the Valley's population during the 2018 to 2033 period. In contrast, the total population for the State of

California is projected to increase by only 12.7% over the same period.86 As land development and population in the San Joaquin Valley continue to increase, area source emissions from activities such as consumer product use, fuel combustion for heating and cooking, and landscape maintenance will increase. The total number of vehicle miles traveled (VMT) also increases with population growth, resulting in more emissions due to the combustion of vehicle fuels.

The projected growth in these so called "indirect source" emissions erodes some of the progress generated by emission reductions achieved through the District's stationary source program and state and federal mobile source controls. The emissions are called indirect because they do not come directly from a smokestack, like traditional industry emissions, but rather the emissions are indirectly caused by this growth in population.

Mobile source emissions make up over 85% of the Valley's primary driver in the formation of particulate matter (PM) and ozone pollution, and therefore reductions in mobile source emissions have become an ever-increasingly important part of the District's clean air strategies. Although the San Joaquin Valley Air Pollution Control District (District) has no regulatory authority to control tailpipe emissions from motor vehicles, the District undertook groundbreaking action to reduce vehicle miles traveled by adopting Rule 9510 Indirect Source Review (ISR).

EMISSIONS INVENTORY

There is no emission inventory specific to Rule 9510.

SOURCE CATEGORY

The ISR rule applies to developers of new residential, commercial and industrial projects and to transportation and transit projects whose emissions will exceed certain applicability thresholds contained in the rule. The rule requires a development project construction to reduce NOx emissions by 20% and reduce a development project's operational NOx emissions by 33.3% and 50%, when compared to unmitigated project baseline emissions. NOx emissions can come from the combustion of fuels in motor vehicles, and other off-road vehicles such as construction equipment. PM emissions can be from fugitive dust particles or fine particles directly emitted from combustion processes.

A development project is subject to the ISR rule if it received its final discretionary approval from a public agency on or after March 1, 2006, and meets or exceeds any one of the following District applicability thresholds:

2,000 sq. ft commercial	25,000 sq. ft. light industrial	100,000 sq. ft. heavy industrial
20,000 sq. ft. medical office	39,000 sq. ft general office	9,000 sq. ft. educational
10,000 sq. ft. government	20,000 sq. ft. recreational	50 residential units
9,000 sq. ft. of space not included in the list		

[86] State Population Projections (2010-2060). Total Population by County (1-year increments). (2018, January) *Retrieved from*: http://www.dof.ca.gov/Forecasting/Demographics/Projections/

A development project meeting or exceeding any one of the following District "Large Development Project" applicability thresholds is subject to ISR if it received its project-level approval from a public agency on or after March 21, 2018:

10,000 sq. ft commercial	125,000 sq. ft. light industrial	500,000 sq. ft. heavy industrial
100,000 sq. ft. medical office	195,000 sq. ft general office	45,000 sq. ft. educational
50,000 sq. ft. government	100,000 sq. ft. recreational	250 residential units
45,000 sq. ft. of space not included in the list		

Developers of projects subject to Rule 9510 must reduce emissions occurring during construction and operational phases through on-site emission reduction measures, or by paying off-site mitigation fees. One hundred percent of all off-site mitigation fees are used by the District to fund emission reduction projects through its Emission Reduction Incentive Programs, achieving emission reductions on behalf of the project. The use of clean air project design elements that reduce the vehicle miles travelled associated with a project, operational measures such as the use of clean trucking fleets, and construction measures such as the use of clean construction fleets have resulted in 12,500 tons of NOx and PM10 reductions over the life of the program. In addition, project proponents that have found the payment of offsite mitigation fees to be a more feasible and cost effective manner to meet the requirements of Rule 9510 have generated another 6,900 tons of NOx and PM10 reductions through the investment of those mitigation fees in local emissions reduction projects utilizing the District's incentive grant programs.

HOW DOES DISTRICT RULE 9510 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations

Federal requirements such as NSPS, NESHAP, MACT, CTGs, and ACTs and state regulations are not applicable to this source category.

State Regulations

There are no state regulations applicable to this source category.

HOW DOES DISTRICT RULE 9510 COMPARE TO RULES IN OTHER AIR DISTRICTS?

The requirements and applicability of Rule 9510 were compared to analogous rules in other air districts and states to determine the stringency of Rule 9510 compared to those other rules. The District has not identified any agencies with indirect source regulations analogous to Rule 9510.

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

The District is the only air quality agency in the nation that has established a regulatory framework for reducing indirect mobile source-related emissions from development.

EVALUATION FINDINGS

The ISR rule have been successfully reducing the growth in NOx and PM10 emissions associated with the construction and operation of new development projects, including transportation and transit development projects in the San Joaquin Valley since the inception of the rule. The District publishes annual reports on the District's ISR program, which provides documentation that the ISR rule and VERA are effective in reducing emissions associated with the construction and operation of new development projects in the Valley.

C.24 Ammonia in the San Joaquin Valley

Extensive scientific research and technical analyses demonstrate that ammonia reductions do not contribute to the Valley's PM2.5 attainment (see Appendix G) and, therefore, does not need to be addressed as a part of the District's review of BACM and MSM. Even though ammonia is an insignificant PM2.5 precursor in the Valley, the following analysis shows that the Valley's ammonia emissions have been significantly reduced through stringent regulations, that additional ammonia control measures are infeasible, and that Valley sources are already implementing BACM and MSM.

As demonstrated in Appendix B of this Plan, the three main sources of ammonia emissions in the Valley from stationary and area sources that account for 95% of the Valley's ammonia emissions are as follows (based on CEPAM v1.05 Annual Average Emissions Inventory for 2018):

- Farming Operations with 186.5 tons per day (tpd), and
- Solvent evaporation from Agricultural Fertilizers at 114.4 tpd, and
- Composting Solid Waste Operations at 6.2 tpd.

The following discussion evaluates:

- Confined Animal Facilities (District Rule 4570)
- Agricultural Fertilizers
- Biosolids, Animal Manure, and Poultry Litter Operations (District Rule 4565)
- Organic Material Composting (District Rule 4566)
- Major Sources of Ammonia

RULE 4750 (CONFINED ANIMAL FACILITIES)

Discussion

District Rule 4570, was originally adopted on June 15, 2006 and was most recently amended on October 21, 2010. The purpose of this rule is to limit emissions of volatile organic compounds (VOC) from Confined Animal Facilities (CAF). District Rule 4570 applies to facilities where animals are corralled, penned, or otherwise caused to remain in restricted areas and primarily fed by a means other than grazing for at least 45 days in any twelve-month period. In addition to limiting VOC emissions, District Rule 4570 also includes measures that control ammonia (NH_3) emissions from these operations; the required measures have reduced ammonia emissions by over 100 tpd[87].

Source Category

Confined Animal Facilities are used for the raising of animals including, but not limited to, cattle, calves, chickens, ducks, goats, horses, sheep, swine, rabbits, and turkeys, which are corralled, penned, or otherwise caused to remain in restricted areas for

[87] Appendix F of the Staff Report for the June 2009 re-adoption of Rule 4570, starting on the 329th page of the pdf available here http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2009/June/Agenda%20Item_10_June_18_200.pdf

commercial agricultural purposes and fed by a means other than grazing. (CH&SC §39011.5 (a)(1)). The major categories of Confined Animal Facilities are listed below.

- Dairy Operations - Dairy operations are those operations producing milk or animals for facilities that produce milk.
- Poultry Operations - Poultry facilities operate either as layer ranches for egg production or as broiler ranches where birds are grown for the fresh meat market.
- Beef Cattle Feeding Operations – Beef cattle facilities are facilities that raise beef cattle (heifers and steers) for their meat.
- Swine Operations – These operations raise pigs for their meat. The production cycle for hogs has three (3) phases: farrowing (giving birth), nursing, and finishing.

Rule 4570 Applicability Thresholds

The thresholds for a facility to be classified as a large CAF in the Valley and the thresholds for a facility to be subject to District Rule 4570 are shown in the following table. The large CAF thresholds are based on the definition of a large CAF adopted by ARB as required by California Senate Bill (SB) 700. District Rule 4570 applies to confined animal facilities that have the capacity to house a number of animals equal to or exceeding the Rule 4570 regulatory thresholds, which are lower than the large CAF thresholds for certain facilities.

Rule 4570 Applicability for Regulation		
Livestock Category	**SJVAPCD Large CAF Thresholds**	**Rule 4570 Regulatory Thresholds**
Dairy	1,000 milking cows	500 milking cows
Beef Feedlots	3,500 beef cattle	3,500 beef cattle
Other Cattle Facility	7,500 calves, heifers, or other cattle	7,500 calves, heifers, or other cattle
Poultry Facilities		
Chicken	650,000 head	400,000 head
Duck	650,000 head	400,000 head
Turkey	100,000 head	100,000 head
Swine Facility	3,000 head	3,000 head
Horses Facility	3,000 head	3,000 head
Sheep and Goat Facilities	15,000 head of sheep, goats, or any combination of the two	15,000 head of sheep, goats, or any combination of the two
Any livestock facility not listed above	30,000 head	30,000 head

Emission Control Requirements of District Rule 4570

District Rule 4570 requires multiple mitigation measures from the following CAF categories: Dairy, Beef Feedlots, Other Cattle Facilities, Swine Facilities, Poultry facilities, and various other smaller operations. Each of these facilities consists of multiple sources of emissions within the facility. Since these facilities generally cover a large area and have different processes, a single mitigation measure or technology is generally not sufficient to control overall emissions from the facility. Mitigation measures required by Rule 4570 have been tailored for each source of emissions, thereby ensuring that the overall emissions from a facility are reduced. The current methodology in Rule 4570 allows for the greatest overall control from the entire facility.

District Rule 4570 recognized the following five emission sources for all of the CAFs: Feed, Housing, Solid Waste, Liquid Waste, and Land Application of Manure. Rule 4570 requires each CAF to implement a certain number of mitigation measures for each of these sources. District Rule 4570 also distinguishes between the different types of housing configurations (freestall vs open corrals) for cattle and, as such, requires specific mitigation measures for each type of housing. By requiring mitigation measure(s) for each source of emissions at a facility, District Rule 4570 ensures that reductions are achieved throughout the facility.

Ammonia is produced on livestock operations when urea (present in urine) is broken down by the enzyme urease (present in feces and soil) to form ammonia gas and carbamine acid, which further decomposes to release another molecule of ammonia gas and carbon dioxide. When urine mixes with feces or soil, ammonia is volatilized (lost to the air) within minutes, but the reaction may continue for several hours depending on a variety of factors, taking anywhere from a few hours to days to reach peak levels. The rate is dependent on the amount of urea and urease available for reaction, as well as meteorological conditions such as temperature and wind speed. Production of ammonia is an inevitable part of livestock production, but ammonia emissions can be reduced through management practices, such as those required by District Rule 4550, that help to prevent ammonia formation and volatilization.

The following describes some of the mitigation measures required by District Rule 4570, and the ways in which these measures reduce ammonia emissions:

- Nutritional management: Ammonia emissions result from the decomposition of undigested nitrogen compounds in animal waste. Proper nutritional management, with diets formulated to feed proper amounts of protein, improves nitrogen utilization by the animal, reducing production of ammonia from animal waste.[88]

- Increased cleaning and removal of manure and litter from animal housing areas: Because animal waste is the primary source of ammonia emissions at confined animal facilities, increased removal of waste from animal housing areas will reduce ammonia emissions. Proper management of the waste will stabilize the nitrogen compounds, which will reduce the rate that these compounds are converted to ammonia that can be lost to the atmosphere. In addition, ammonia is highly soluble in water; therefore, when a flush system is used, ammonia emissions will be reduced because much of the ammonia will dissolve in the water rather than volatilize to the air.

[88] Hristov, A. N., Heyler, K., Schurman, E., Griswold, K., Topper, P., Hile, M., ... & Dinh, S. (2015). CASE STUDY: Reducing dietary protein decreased the ammonia emitting potential of manure from commercial dairy farms. The Professional Animal Scientist, 31(1), 68-79.

Research by Schmidt, Card, Gaffney, and Hoyt (2005) indicated significantly lower NH3 emissions after cleaning of the lanes at a dairy. Research by Beene, Krauter, and Goorahoo (2005) also indicated lower NH3 emissions after cleaning of the lanes at the dairies monitored[89]. Other research by Card and Schmidt supports that management of manure in corrals reduces NH3 emissions from the corrals and points out that of the two dairies tested, the NH3 emissions from the dairy with constantly managed corrals (Dairy 2) had "exceptionally low ammonia emissions".[90]

- Incorporation of manure into fields: Incorporation of manure in fields reduces volatilization of gaseous pollutants by minimizing the amount of time that the manure is exposed to the atmosphere. Once the waste has been incorporated into the soil, VOCs and ammonia are absorbed onto soil particles, providing the opportunity for these soil microbes to oxidize these compounds into carbon dioxide, water, and nitrates.

NH3 emissions from confined animal facilities result from the microbial decomposition of nitrogenous compounds in manure and the subsequent volatilization of the ammonia that is produced. The study "Emissions of Volatile Organic Compounds Originating from UK Livestock Agriculture" (2004) by Hobbs, Webb, Mottram, Grant, and Misselbrook determined that, "there is a close association between ammonia and NMVOC (non-methane volatile organic compound) productions from manure" and "NMVOC emissions remain in a relatively constant ratio to those of ammonia". [91] Other researchers have also found similar relationships between NMVOC and NH3. For example, a correlation between NH3 and several individual NMVOCs was found in a study by Feilberg, Liu, Adamsen, Hansen, and Jonassen (2010).[92] This is expected because many of the VOCs emitted from confined animal facilities, including dairies, also originate from the decomposition of undigested protein in manure. Therefore, the measures included in District Rule 4570 to reduce VOC emissions from manure are also expected to reduce NH3 emissions.

Research has demonstrated that silage and silage-based total mixed ration (TMR) are one of the largest sources of VOC emissions at cattle facilities, but are not significant

[89] Schmidt, C.E., Card, T., Gaffney, P., and Hoyt., S. (2005) California Air Resource Board (ARB) and Central California Ozone Study (CCOS) Project: Assessment of Reactive Organic Gases and Amines from a Northern California Dairy Using the USEPA Surface Emissions Isolation Flux Chamber. 14th USEPA Annual Emissions Inventory Conference Las Vegas, Nevada, April, 2005. Technical Paper. Available at: http://www.epa.gov/ttn/chief/conference/ei14/session1/schmidt.pdf

[90] Card, T. and Schmidt, C. (2006) Dairy Air Emissions Report: Summary of Dairy Emission Estimation Procedures (May 2006). Final Report to California Air Resource Board (ARB).
http://www.arb.ca.gov/ag/caf/SchmidtDairyEmissions2005.pdf
http://www.arb.ca.gov/ag/caf/SchmidtDairyTestData2005.pdf

[91] Hobbs, P.J. Webb, J. Mottram, T.T. Grant, B. Misselbrook, T.M. (2004) Emissions of Volatile Organic Compounds Originating from UK Livestock Agriculture. 2004©. Society of Chemical Industry. J Sci Food Agric 84:1414-1420 http://www.valleyair.org/busind/pto/dpag/VOC_from_UK_livestock.pdf

[92] Feilberg, A, Liu, D., Adamsen, A.P.S., Hansen M.J., Jonassen K.E.N. (2010). Odorant Emissions from Intensive Pig Production Measured by Online Proton-Transfer-Reaction Mass Spectrometry. Environmental Science & Technology Vol.44:5894–900.

sources of NH3 emissions. Therefore, the measures that specifically apply to management of silage and TMR will not be discussed in detail in this analysis.

It should be noted that, although Rule 4570 includes some options to provide flexibility to the operators of CAFs and that the majority of these measures are expected to reduce NH3 emissions, it also specifically requires certain measures that reduce NH3 emissions. Examples of mitigation measures specifically required in Rule 4570 that reduce NH3 emissions include the mitigation measures required at dairies and other cattle facilities for the areas in which the cattle are housed (e.g. barns, exercise pens, and corrals), such as increased cleaning and manure removal from lanes in freestall barns, corrals, and pens, and increased cleaning and manure removal from corrals and pen housing areas. These required measures have been shown to reduce NH3 emissions from these areas. Research has shown that for dairies and other cattle facilities the vast amount of NH3 emissions are from the areas in which the cattle are housed.[93, 94] Based on the current District NH3 emission factors,[95] the areas that house cattle are responsible for more than 72% of the NH3 emissions from dairies and other cattle facilities. Rule 4570 mitigation measures that are specifically required for the areas in which the cattle are housed include the following:

Rule 4570 Dairy CAF Phase II Mitigation Measures (Required)

Freestall Barns

1. Pave feedlanes, where present, for a width of at least eight (8) feet along the corral side of the feedlane fence for milk and dry cows and at least six (6) feet along the corral side of the feedlane for heifers.
2. a) Flush, scrape, or vacuum freestall flush lanes immediately prior to, immediately after, or during each milking; or b) Flush or scrape freestall flush lanes at least three (3) times per day.

Corrals/Pens

1. Pave feedlanes, where present, for a width of at least 8 feet along the corral side of the feedlane fence for milk and dry cows and at least 6 feet along the corral side of the feedlane for heifers.
2. a) Clean manure from corrals at least four (4) times per year with at least sixty (60) days between cleaning; or b) Clean corrals at least once between April and July and at least once between September and December.
3. a) Scrape, vacuum, or flush concrete lanes in corrals at least once every day for mature cows and every seven (7) days for support stock; or b). Clean concrete lanes such that the depth of manure does not exceed twelve (12) inches at any point or time.

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[93] Schmidt, C. Card, T., and Gaffney, P. (2005). Assessment of Reactive Organic Gases and Amines from a Northern California Dairy Using the USEPA Surface Emission Isolation Flux Chamber. Presented at the Livestock Emissions Research Symposium held on January 26, 2005 at the San Joaquin Valley Air Pollution Control District, Fresno. https://www.arb.ca.gov/ag/agadvisory/schmidt05jan26.pdf

[94] Card, T. and Schmidt, C. (2006) Dairy Air Emissions Report: Summary of Dairy Emission Estimation Procedures (May 2006). Final Report to California Air Resource Board (ARB).

[95] SJVAPCD. (2018). Dairy Emission Factors. Retrieved from: https://www.valleyair.org/busind/pto/dpag/Dairy%20emission%20Factors.pdf

4. Inspect water pipes and troughs and repair leaks at least once every seven (7) days.
5. a) Slope the surface of the corrals at least 3% where the available space for each animal is 400 square feet or less. Slope the surface of the corrals at least 1.5% where the available space for each animal is more than 400 square feet per animal; or b) Maintain corrals to ensure proper drainage preventing water from standing more than forty-eight (48) hours; or c) Harrow, rake, or scrape corrals sufficiently to maintain a dry surface.
6. If the Confined Animal Facility (CAF) has shade structures, they must choose one of the following: a) Install shade structures such that they are constructed with a light permeable roofing material; or b) Install all shade structures uphill of any slope in the corral; or c) Clean manure from under corral shades at least once every fourteen (14) days, when weather permits access into the corral; or d) Install shade structure so that the structure has a North/South orientation.

Rule 4570 Beef Feedlot Phase II Mitigation Measures (Required)

Housing

1. Scrape corrals twice a year with at least ninety (90) days between cleanings, excluding the removal of in-corral mounds.
2. Inspect water pipes and troughs and repair leaks at least once every seven (7) days.
3. a) Slope the surface of the corrals at least 3% where the available space for each animal is 400 square feet or less. Slope the surface of the corrals at least 1.5% where the available space for each animal is more than 400 square feet per animal; or b) Maintain corrals to ensure proper drainage preventing water from standing more than forty-eight (48) hours; or c) Harrow, rake, or scrape corrals sufficiently to maintain a dry surface.
4. If the Confined Animal Facility (CAF) has shade structures, they must choose one of the following: a) Install shade structures such that they are constructed with a light permeable roofing material; or b) Install all shade structures uphill of any slope in the corral; or c) Clean manure from under corral shades at least once every fourteen (14) days, when weather permits access into the corral; or d) Install shade structure so that the structure has a North/South orientation.

Rule 4570 Other Cattle Phase II Mitigation Measures (Required)

Freestall Barns

1. Vacuum, scrape, or flush freestalls at least once every seven (7) days.
2. Pave feedlanes, where present, for a width of at least six (6) feet along the corral side of the feedlane.

Corrals/Pens

1. Scrape corrals twice a year with at least 90 days between cleanings, excluding in-corral mounds.

2. a) Scrape, vacuum, or flush concrete lanes in corrals at least once every seven (7) days; or b) Clean concrete lanes such that the depth of manure does not exceed twelve (12) inches at any point or time.
3. Inspect water pipes and troughs and repair leaks at least once every seven (7) days.
4. a) Slope the surface of the corrals at least 3% where the available space for each animal is 400 square feet or less. Slope the surface of the corrals at least 1.5% where the available space for each animal is more than 400 square feet per animal; or b) Maintain corrals to ensure proper drainage preventing water from standing more than forty-eight (48) hours; or c) Harrow, rake, or scrape corrals sufficiently to maintain a dry surface.
5. If the Confined Animal Facility (CAF) has shade structures, they must choose one of the following: a) Install shade structures such that they are constructed with a light permeable roofing material; or b) Install all shade structures uphill of any slope in the corral; or c) Clean manure from under corral shades at least once every fourteen (14) days, when weather permits access into the corral; or d) Install shade structure so that the structure has a North/South orientation.

In addition to these measures, which are specifically required for cattle CAFs by Rule 4570, CAFs must also choose to implement additional measures of Rule 4570 that are also expected to reduce NH3 emissions.

Estimated NH3 Reductions from Rule 4570 for Cattle Facilities

The NH3 reductions from cattle facilities as a result of the measures required below are conservatively estimated below based on the information that is currently available.

Increased cleaning of freestall lanes:

Research by Schmidt, Card, Gaffney, and Hoyt (2005) indicated significantly lower NH3 emissions after cleaning of the lanes at a dairy.[96] Research by Beene, Krauter, and Goorahoo (2005)[97] also indicated lower NH3 emissions after cleaning of the lanes at the dairies they monitored. Emission models have also indicated that increased cleaning of barns will reduce NH3 emissions. Research by Mendes, Pieters, Snoek and others (2017) using a process-based model indicated that scraping manure or scraping

[96] Schmidt, C.E., Card, T., Gaffney, P., and Hoyt., S. (2005) California Air Resource Board (ARB) and Central California Ozone Study (CCOS) Project: Assessment of Reactive Organic Gases and Amines from a Northern California Dairy Using the USEPA Surface Emissions Isolation Flux Chamber. 14th USEPA Annual Emissions Inventory Conference Las Vegas, Nevada, April, 2005. Technical Paper. Available at: http://www.epa.gov/ttn/chief/conference/ei14/session1/schmidt.pdf

[97] Beene, M., Krauter, C., and Goorahoo D., (2005) Ammonia Fluxes from Animal Housing at a California Free Stall Dairy. Presented at the EPA 15th Emissions Inventory Conference, May 15-18, 2006, New Orleans, LA. Technical Paper: https://www3.epa.gov/ttnchie1/conference/ei15/session6/beene.pdf

manure combined with flushing reduced total NH3 emissions from a barn housing cattle by 17-27%.[98]

a) Non-Manure Bedding in Freestall Barns, b) Remove Manure from Freestall Bedding or Management of Freestall Bedding, or c) Have no animals in exercise pens or corrals at any time

Rule 4570 requires dairies and other cattle facilities to implement one of the following mitigation measures to reduce emissions from freestall barns:

a) Use non-manure-based bedding and non-separated solids based bedding for at least 90% of the bedding material, by weight, for freestalls (e.g. rubber mats, almond shells, sand, or waterbeds)

b) Remove manure that is not dry from individual cow freestall beds or rake, harrow, scrape, or grade freestall bedding at least once every seven (7) days for a large Dairy CAF (1,000 milk cows or more) or at least once every fourteen (14) days for a medium Dairy CAF (500 milk cows or more)

c) Have no animals in exercise pens or corrals at any time

Dairies and other cattle facilities that are subject to Rule 4570 must implement one of the practices above or request approval for an alternative mitigation that has been determined by the District, ARB, and EPA to achieve reductions that are equal to or exceed the reductions that would be achieved by complying with the requirements of Rule 4570. Each of the mitigation measures listed above is expected to reduce NH3 emissions. The greatest NH3 reductions would result from option 3, have no corrals animals in corrals or exercise pens at any time. Based on the District NH3 emission factors for dairies approximately 57% of NH3 emissions from dairies are from the corrals and pens. This is because of the very large surface area of corrals/pens where manure is excreted by cattle, which results in greater emissions.

Restricting animals from corrals and pens would reduce the overall area from which NH3 could be emitted and result in increased cleaning of manure excreted in barns. This would significantly reduce NH3 emissions but would not be practical for all dairies because not all cattle facilities have barns, others use different management strategies, and total confinement of cattle without access to exercise areas may also raise concerns about animal health and welfare.

Option 2 above - Use non-manure-based/non-separated solids based bedding would result in the next greatest NH3 reductions. The typical bedding used for cattle in freestall barns is composted/dried separated solids or manure. This manure contains nitrogen that can be emitted as NH3 as the manure decomposes and nitrogenous

[98] Mendes, L.B., Pieters, J.G., Snoek, D., Ogink N.W.M., Brusselman, E., Demeyer, P. (2017) Reduction of Ammonia Emissions from Dairy Cattle Cubicle Houses via Improved Management or Design-Based Strategies: A Modeling Approach, In Science of The Total Environment, Volume 574, 2017, Pages 520-531, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2016.09.079.

organic matter in the manure mineralizes to non-organic nitrogen. Replacing manure or separated solids based bedding with non-manure, non-separated solids based bedding would eliminate nearly all of the NH3 emissions that result from decomposition of the bedding and the only NH3 emissions from the bedding would be from the fresh manure excreted by the cattle. However, this option is not practical for all dairy facilities because of different management practices and the cost of purchasing and replacing bedding materials in the freestalls barns (e.g. mattresses, sand, etc.)

Option 3 above – Remove manure that is not dry from individual freestall beds or rake, harrow, scrape, or grade freestall beds will also reduce NH3 from freestall bedding by removing manure that emits NH3 when it decomposes and managing the bedding to allow urine to drain away from the bedding. Nitrogen in urine is primarily in the form of urea. Nitrogen from the urea in urine is emitted as NH3 after it has been hydrolyzed to NH3. The conversion of urea to NH3 is catalyzed by the enzyme urease, which is predominantly found in feces. Reducing contact between urine and feces has been shown to be an effective approach to reduce NH3 emissions. In a study by Braam (1997), a floor sloped by 3%, allowing urine to drain away from manure, was found to reduce NH3 emissions by 21%.

a) Clean manure from corrals at least four times per year with at least 60 days between cleaning; or b) Clean corrals at least once between April and July and at least once between September and December

Rule 4570 requires dairies and other cattle facilities to implement one of the following mitigation measures to reduce emissions from corrals/pens:

a) Clean manure from corrals at least four (4) times per year with at least sixty (60) days between cleaning;

b) Clean corrals at least once between April and July and at least once between September and December

Each of the mitigation measures listed above is expected to reduce NH3 emissions. Based on the District NH3 emission factors for dairies, approximately 57% of NH3 emissions from dairies are from corrals and pens. This is because of the very large surface area of corrals/pens where manure is excreted by cattle, which results in greater emissions. Research by Card and Schmidt (2005) supports that management of manure in corrals reduces NH3 emissions from the corrals and points out that of the two dairies tested, the NH3 emissions from the dairy with constantly managed corrals (Dairy 2) had "exceptionally low ammonia emissions". Follow-up research by Card and Schmidt (2009) at one of the dairies studied (Dairy 1) indicated that NH3 emissions were significantly reduced (> 80% reduction comparing 2008 to 2005 reported NH3 emissions) when the frequency of management of the manure in the corrals was increased.[99]

[99] Schmidt, C. Card, T. (2009) 2008 Dairy Emissions Study: Summary of Dairy Emission Factors and Emission Estimation Procedures. August 2009. Final Report to San Joaquin Valley Air Pollution Control District

a) Slope the surface of the corrals/pens; b) Maintain corrals to ensure proper drainage preventing water from standing; or c) Harrow, rake, or scrape corrals sufficiently to maintain a dry surface

Rule 4570 requires dairies and other cattle facilities to implement one of the following mitigation measures to reduce emissions from corrals/pens:

a) Slope the surface of the corrals at least 3% where the available space for each animal is 400 square feet or less; Slope the surface of the corrals at least 1.5% where the available space for each animal is more than 400 square feet per animal;

b) Maintain corrals to ensure proper drainage preventing water from standing more than forty-eight (48) hours; or

c) Harrow, rake, or scrape corrals and corrals sufficiently to maintain a dry surface, unless the corrals have not held animals in the last thirty (30) days

Proper sloping or management of corrals/pens will reduce NH_3 from corral/pens by allowing urine drain away from the corrals/pens. Nitrogen in urine is primarily in the form of urea. As explained above, nitrogen from the urea in urine is emitted as NH_3 after it has been hydrolyzed to NH_3. The conversion of urea to NH_3 is catalyzed by the enzyme urease, which is predominantly found in feces. Reducing contact between urine and feces has been shown to be an effective approach to reduce NH_3 emissions. As discussed above, a floor sloped by 3%, allowing urine to drain away from manure, was found to reduce NH_3 emissions by 21%.

a) Within 72 hours of removal from housing, either Remove dry manure from the facility or Cover dry manure outside the housing with a weatherproof covering from October through May; or b) Within 72 hours of removal from the drying process, either remove separated solids from the facility; or cover separated solids outside the housing with a weatherproof covering from October through May

Rule 4570 requires large dairy CAFs (at least 1,000 milk cows) and other cattle facilities that handle or store solid manure or separated manure solids outside of the animal housing to implement one of the following mitigation measures (or an approved alternative mitigation measure) to reduce emissions from the solid manure or separated manure solids:

a) Within seventy-two (72) hours of removal from housing, either:
    a. Remove dry manure from the facility; or
    b. Cover dry manure outside the housing with a weatherproof covering from October through May, except for times when wind events remove the covering, not to exceed twenty-four (24) hours per event.

b) Within seventy-two (72) hours of removal from the drying process, either:

a. Remove separated solids from the facility; or
b. Cover separated solids outside the housing with a weatherproof covering from October through May, except for times when wind events remove the covering, not to exceed twenty-four (24) hours per event.

Large dairy CAFs and other cattle facilities that are subject to the Rule 4570 must implement one of the practices above or request approval for an alternative mitigation that has been determined by the District, ARB, and EPA to achieve reductions that are equal to or exceed the reductions that would be achieved by complying with the requirements of Rule 4570. Dairies and other cattle facilities may have both scraped solid manure and separated solids and will only be required to implement a mitigation measure for one of these types of solid manure, while beef cattle generally will not have separated solids and must implement a mitigation measure for the solid manure handled outside of corrals. Research by Chadwick (2005) indicated that covering manure piles reduced NH3 emissions by an average of 90%.[100]

a) Incorporate all solid manure within 72 hours of land application; or b) Only apply solid manure that has been treated with an anaerobic treatment lagoon, aerobic lagoon, or digester system; or c) Apply no solid manure with a moisture content of more than 50%

Rule 4570 requires dairies and other cattle facilities that apply solid manure to cropland to implement one of the following mitigation measures (or an approved alternative mitigation measure) to reduce emissions from the land application of solid manure:

a) Incorporate all solid manure within seventy-two (72) hours of land application; or

b) Only apply solid manure that has been treated with an anaerobic treatment lagoon, aerobic lagoon, or digester system; or

c) Apply no solid manure with a moisture content of more than 50%

Dairies and other cattle facilities that are subject to Rule 4570 must implement one of the practices above or request approval for an alternative mitigation that has been determined by the District, ARB, and EPA to achieve reductions that are equal to or exceed the reductions that would be achieved by complying with the requirements of Rule 4570. Based on a review of Valley facilities that Rule 4570 apply to, the mitigation measure that nearly all dairy and other cattle facilities have selected to implement is Mitigation Measure a) *Incorporate all solid manure within 72 hours of land application*. The Alberta, Canada Agriculture and Forestry publication, *Ammonia Volatilization from Manure Application,*[101] indicates average ammonium-nitrogen losses of 35% for manure incorporated in three days compared to 66% for manure that is not incorporated.

[100] Chadwick, D.R. (2005) Emissions of Ammonia, Nitrous Oxide and Methane from Cattle Manure Heaps: Effect of Compaction and Covering. Atmosphere Environment, 39: 787-799. Available at: http://www.sciencedirect.com/science/article/pii/S135223100400994X
[101] Atia, A. (2008). Ammonia volatilization from manure application. Alberta Agriculture, Food and Rural Development.

a) Only apply liquid manure that has been treated with an anaerobic treatment lagoon, aerobic lagoon, or digester system; or b) Allow liquid manure to stand in the fields for no more than twenty-four (24) hours after irrigation; or c. Apply liquid/slurry manure via injection with drag hose or similar apparatus

Rule 4570 requires dairies and other cattle facilities that apply liquid manure to cropland to implement one of the following mitigation measures (or an approved alternative mitigation measure) to reduce emissions from the land application of liquid manure:

a) Only apply liquid manure that has been treated with an anaerobic treatment lagoon, aerobic lagoon, or digester system; or

b) Allow liquid manure to stand in the fields for no more than twenty-four (24) hours after irrigation; or

c) Apply liquid/slurry manure via injection with drag hose or similar apparatus

Dairies and other cattle facilities that are subject to Rule 4570 must implement one of the mitigation measures above or request approval for an alternative mitigation that has been determined by the District, ARB, and EPA to achieve reductions that are equal to or exceed the reductions that would be achieved by complying with the requirements of Rule 4570.

The actual NH3 emissions from the application of liquid manure in the San Joaquin Valley are expected to be minimal because of the typical practices that are utilized when applying liquid manure in the San Joaquin Valley. The report, *Managing Dairy Manure in the Central Valley of California,* prepared by the University of California Division of Agricultural and Natural Resources Committee of Experts on Dairy Manure Management (2005) indicates that in California "nearly all" manure from lagoons used for land application is diluted with irrigation water and applied via surface gravity irrigation systems and that "during irrigations, farmers commonly dilute lagoon water with 5 to 10 parts of fresh source water." The report goes on to state that, "in systems with frequent, but well diluted manure water applications, ammonia losses from the ground surface will commonly be minimal during the irrigation (10% or less)."

For application of liquid manure, the mitigation measure that nearly all dairy and other cattle facilities have selected to implement is Mitigation Measure b) *Allow liquid manure to stand in the fields for no more than 24 hours after irrigation*. This is because, in comparison, the other options are more costly and difficult to implement. In addition, for many facilities implementation of the other options is impractical. There are few cattle facilities with properly designed anaerobic treatment lagoons, and no lagoons for dairy manure operating in the San Joaquin Valley have been identified that satisfy the requirements for aerobic treatment lagoons as specified in District Rule 4570. As mentioned above, there are approximately a dozen anaerobic digesters currently operating in the San Joaquin Valley, so this option is not feasible due to the large number of dairies in the San Joaquin Valley.

Application of liquid or slurry manure with a drag hose or similar apparatus could result in significant NH3 reductions, but has higher costs compared to flood or furrow irrigation of liquid manure. This practice is not currently common and is not feasible during times when a crop is growing. Therefore, it will be conservatively assumed that all dairies and other cattle facilities implement Mitigation Measure b) Allow liquid manure to stand in the fields for no more than 24 hours after irrigation. In order for liquid manure to remain standing in the field for no more than 24 hours, it must infiltrate the crop soil within this time and this can be assumed to be approximately equivalent to incorporation of the liquid manure. The Alberta, Canada Agriculture and Forestry publication, *Ammonia Volatilization from Manure Application*,[102] indicates average ammonium-nitrogen losses of 25% for manure incorporated in one day, compared to 66% for manure that is not incorporated. At a San Joaquin Valley dairy measured during a 2008 dairy emissions study by Schmidt, the net NH3 emissions from liquid manure application up to 24 hours were approximately 46% of total net NH3 emissions from liquid manure application (up to 100 hours).[103] This indicates an overall reduction of approximately 54% if liquid manure applied to land completely infiltrates the soil within 24 hours.

The analysis below focuses on how District Rule 4570 limits NH3 emissions in comparison to other rules and regulations.

How does District Rule 4570 compare with federal and state rules and regulations?

Federal requirements such as NSPS, NESHAP, MACT, CTGs, and ACTs and state regulations are not applicable to this source category.

How does District Rule 4570 compare to rules in other air districts?

As the largest agricultural area in California, the District took the lead in devising a list of mitigation measures for the various emission sources during the initial development of District Rule 4570. This list of mitigation measures was essentially utilized, almost identically, by all air districts in their rules. However, during the last amendments to District Rule 4570, all of the mitigation measures were reevaluated in light of the latest available science. In comparison to the previous version of the rule, the current rule lowered threshold limits to bring in additional CAFs, requires additional mitigation measures, clarified previous mitigation measures, and added additional monitoring, testing, and recordkeeping to improve enforceability.

The following California air district rules were compared to District Rule 4570:

- SCAQMD Rule 223, adopted June 2, 2006
- SCAQMD Rule 1127, adopted August 6, 2004
- BAAQMD Regulation 2 Rule 10, adopted July 19, 2006
- VCAPCD Rule 23 (Exemptions), amended November 12, 2013
- SMAQMD Rule 496, adopted August, 24, 2006

[102] Atia, A. (2008). Ammonia volatilization from manure application. Alberta Agriculture, Food and Rural Development.
[103] Chadwick, D.R. (2005) Emissions of Ammonia, Nitrous Oxide and Methane from Cattle Manure Heaps: Effect of Compaction and Covering. Atmosphere Environment, 39: 787-799. Available at: http://www.sciencedirect.com/science/article/pii/S135223100400994X

- Imperial County APCD (ICAPCD) Rule 217 and Policy Number 38, adopted February 9, 2016

Idaho Administrative Procedure Act (IDAPA) 58.01.01 Sections 760-764 was also compared with District Rule 4570 and the analysis is shown below.

It is important to note that only District Rule 4570, SMAQMD Rule 496, and SCAQMD Rule 1127 are prohibitory rules. For this reason, these rules include detailed recordkeeping as well as monitoring and testing requirements. Generally, the level of detail in a prohibitory rule is absent from permits rules because the purpose of a permit rule is different from the purpose of a prohibitory rule.

South Coast AQMD

- SCAQMD Rule 223 (Emission Reduction Permits for Large Confined Animal Facilities) *(Adopted June 2, 2006)*

Based on the analysis of the CAF categories in District Rule 4570 and SCAQMD Rule 223, it is clear that District Rule 4570 is more stringent than SCAQMD Rule 223. District Rule 4570 requires facilities to choose more mitigation measures and makes several mitigation measures mandatory.

District Rule 4570 also provides mitigation for more CAF categories (beef feedlots, other cattle, and swine) that are not addressed by SCAQMD Rule 223, and also has much more detailed recordkeeping requirements to demonstrate implementation of selected mitigation measures.

	SJVAPCD Rule 4570	SCAQMD Rule 223	Conclusion
Applicability	Applies to large CAFs as defined by ARB. Requirements apply to horse facilities with at least 3,000 head In addition to Large CAFs, also applies to Dairies with at least 500 milk cows (Large CAF threshold 1,000 milk cows) and Broiler, Duck, and Layer facilities with at least 400,000 birds (Large CAF threshold 650,000 birds)	Applies to large CAFs as defined by ARB Defines a large CAF for horses as having at least 2,500 head (Note: There are currently no CAFs in the SJV with at least 2,500 horses and no horse CAFs in the SJV are expected to exceed this threshold in the foreseeable future)	Rule 4570 is more stringent regarding applicability

Requirements for Dairy CAFs		
	SJVAPCD Rule 4570	SCAQMD Rule 223
Requirements: Feed Mitigation Measures	Operators must implement four mandatory feed mitigation measures and chose one other option from a list of three, for a total of five feed mitigation measures	Nine optional feed mitigation measures, from which an operator must choose five to implement

Requirements: Milk Parlor Mitigation Measures	Flush or hose milking parlor immediately prior to, immediately after, or during each milking. Class Two mitigation measures removed due to infeasibility (see the Staff Report for the October 21, 2010 amendments to Rule 4570 for more detail)	Includes option of choosing one class 1 measure (Flush or hose milking parlor immediately prior to, immediately after, or during each milking) or one Class 2 measure
Requirements: Freestall Mitigation Measures	Operators must implement a total of three mitigation measures - two mandatory mitigation measures and choose one additional measure from three possible options	Operators must choose to implement two mitigation measures from eight possible options
Requirements: Corral Mitigation Measures	Operators must implement a total of seven mitigation measures – six mandatory mitigation measures and choose one additional measure from three possible options	Operators must choose to implement six mitigation measures from 14 possible Class One mitigation measures and two possible Class Two mitigation measures
Requirements: Solid Manure and Separated Solids Mitigation Measures	Operators must choose to implement at least one mitigation measure from two possible options	Operators must implement two mitigation measures chosen from three possible Class One mitigation measures and three possible Class Two mitigation measures. However, for practical purposes only one mitigation measure must be implemented. The Class one mitigation measures include: 1) Covering dry manure piles outside the pens with a waterproof covering from October through May, 2) Covering dry separated solids outside the pens with a waterproof covering from October through May, and 3) Removal of manure from the facility within seventy-two (72) hours of removal from the pens or corrals. Dairies in the SCAQMD are generally dry scrape dairies and will not have separated solids and many dairies store manure in the pens until it can be removed for use as fertilizer or compost.
Requirements: Liquid Manure Mitigation Measures	Operators must choose to implement at least one mitigation measure from four possible options	Operators must choose to implement one mitigation measures from five possible Class One mitigation measures and five possible Class Two mitigation measures
Requirements: Manure Land Application Mitigation Measures	Operators must choose to implement one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application measures from six possible options	Operators must choose to implement two mitigation measures from four possible options

Requirements for Poultry CAFs		
	SJVAPCD Rule 4570	**SCAQMD Rule 223**

Requirements: Feed Operations	Operators must choose to implement one feed mitigation measure from four possible options	Operators must choose to implement five mitigation measures from six possible options
Requirements: Poultry Housing	Operators required to implement two mitigation measures for layers, four mitigation measures for broilers or ducks, and five mitigation measures for turkeys	Operators must choose to implement four mitigation measures from 11 possible Class One mitigation measures and two possible Class Two mitigation measures
Requirements: Solid Manure or Separated Solids	Operators must choose to implement one mitigation measure	Operators must choose to implement one mitigation measures from three possible Class One mitigation measures and three possible Class Two mitigation measures
Requirements: Liquid Manure	Operators that handle manure in liquid form must choose to implement one mitigation measure	Operators that handle manure in liquid form must choose to implement one mitigation measures from four possible Class One mitigation measures and three possible Class Two mitigation measures

Requirements for Other CAF Categories		
	SJVAPCD Rule 4570	**SCAQMD Rule 223**
Requirements:	District Rule 4570 provides specific mitigation measures for beef cattle feedlots, other cattle, and swine CAFs	SCAQMD Rule 223 does not address mitigation measures for beef cattle feedlots, other cattle, and swine CAFs

Suspension and Substitution of Mitigation Measures		
	SJVAPCD Rule 4570	**SCAQMD Rule 223**
Requirements:	Allows temporary suspension of a mitigation measure upon the determination by a certified veterinarian or nutritionist that such a suspension is necessary for animal health purposes. The District must be notified within 48 hours, and a new measure must be implemented if the suspension is expected to last longer than 30 days. Allows for substitution of one mitigation measure with an equivalent or more stringent measure	Allows temporary suspension of a mitigation measure upon the determination by a certified veterinarian or nutritionist that such a suspension is necessary for animal health purposes. The District must be notified within 48 hours, and a new measure must be implemented if the suspension is expected to last longer than 30 days. Allows for substitution of one mitigation measure with an equivalent or more stringent measure

South Coast AQMD

- SCAQMD Rule 1127 (Emission Reductions from Livestock Waste) *(Adopted August 6, 2004)*

For dairy CAFs, District Rule 4570 is more stringent than SCAQMD Rule 1127. District Rule 4570 requires emission reductions from additional emission categories that are not addressed by SCAQMD Rule 1127 (e.g. milk parlors, freestall barns, and liquid manure), as well as requiring emission reductions from CAFs from other animal species. District Rule 4570 exemption is more stringent because it is only a temporary suspension that cannot exceed 30 days, whereas SCAQMD Rule 1127's exemption may be permanent, without requiring substitution of another measure. District Rule 4570 requires facilities to choose more mitigation measures and makes several mitigation measures mandatory. District Rule 4570 also provides specific mitigation measures for beef cattle feedlots, other cattle, poultry, and swine CAFs, while SCAQMD Rule 1127 does not. District Rule 4570 is therefore more stringent than SCAQMD Rule 1127.

	SJVAPCD Rule 4570	SCAQMD Rule 1127
Applicability	Applies to dairy CAFs with at least 500 milking cows; Also applies to other CAFs, Applies to more than just manure-handling	Applies to dairies with 50 or more cows, heifers, and/or calves. Applies to dairy farms and related operations such as heifer and calf farms and the manure produced on them

Requirements for Dairy CAFs		
	SJVAPCD Rule 4570	**SCAQMD Rule 1127**
Requirements: Milking Parlor and Freestall Mitigation Measures	For milking parlors, operators must implement one mandatory mitigation measure For Freestalls, operators must implement a total of three mitigation measures - two mandatory mitigation measures and choose one additional measure from three possible options	No requirements for milking parlors and freestalls
Requirements: Corral Mitigation Measures	Operators must implement a total of seven mitigation measures – six mandatory mitigation measures and choose one additional measure from three possible options	Mitigation measures required by SCAQMD Rule 1127 specify the removal of manure from the corrals, the minimization of water in the corrals, and the cleaning schedule and cleaning strategy for the corrals
Requirements: Mitigation Measures For Solid Manure, Separated Solids, Liquid Manure, and Manure Land Application	Operators must choose one mitigation measure for solid manure/separated solids, one mitigation measure for liquid manure, and one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application	SCAQMD Rule 1127 requires that manure removed must be either treated at an approved manure processing operation, or applied on agricultural land with local approval. SCAQMD Rule 1127 does not specify mitigation measures for solid manure, separated solids, or liquid manure

Requirements: Corral Mitigation Measures	Operators must implement a total of seven mitigation measures – six mandatory mitigation measures and choose one additional measure from three possible options	Operators must choose to implement six mitigation measures from 14 possible Class One mitigation measures and two possible Class Two mitigation measures
Requirements: Solid Manure and Separated Solids Mitigation Measures	Operators must choose to implement at least one mitigation measure from two possible options	Operators must implement two mitigation measures chosen from three possible Class One mitigation measures and three possible Class Two mitigation measures. However, for practical purposes only one mitigation measure must be implemented. The Class one mitigation measures include: 1) Covering dry manure piles outside the pens with a waterproof covering from October through May, 2) Covering dry separated solids outside the pens with a waterproof covering from October through May, and 3) Removal of manure from the facility within seventy-two (72) hours of removal from the pens or corrals. Dairies in the SCAQMD are generally dry scrape dairies and will not have separated solids and many dairies store manure in the pens until it can be removed for use as fertilizer or compost.

Requirements for Other CAF Categories		
	SJVAPCD Rule 4570	**SCAQMD Rule 1127**
Requirements:	District Rule 4570 provides specific mitigation measures for beef cattle feedlots, other cattle, poultry, and swine CAFs	SCAQMD Rule 223 does not address mitigation measures for beef cattle feedlots, poultry, and swine CAFs

Suspension and Substitution of Mitigation Measures		
	SJVAPCD Rule 4570	**SCAQMD Rule 1127**
Requirements:	Allows temporary suspension of a mitigation measure upon the determination by a certified veterinarian or nutritionist that such a suspension is necessary for animal health purposes. The District must be notified within 48 hours, and a new measure must be implemented if the suspension is expected to last longer than 30 days. Allows for substitution of one mitigation measure with an equivalent or more stringent measure	Allows one exemption per year from one of the corral clearings required every 90 days if the moisture content in the corrals is greater than 50%. The operator is required to notify SCAQMD 30 days before the required cleaning, and test moisture content weekly.

Bay Area AQMD

- BAAQMD Regulation 2 Rule 10 (Rule 2-10) (Large Confined Animal Facilities) *(Adopted July 19, 2006)*

District Rule 4570 requires facilities to choose specific mitigation measures and makes several mitigation measures mandatory. In addition, District Rule 4570 has lower applicability thresholds for dairies, chickens, and ducks. Based on this information and the discussion above, District Rule 4570 is far more stringent than BAAQMD Rule 2-10.

	SJVAPCD Rule 4570	BAAQMD Rule 2-0
Applicability	Applies to large CAFs as defined by ARB. Requirements apply to horse facilities with at least 3,000 head In addition to Large CAFs, also applies to Dairies with at least 500 milk cows (Large CAF threshold 1,000 milk cows) and Broiler, Duck, and Layer facilities with at least 400,000 birds (Large CAF threshold 650,000 birds)	Applies to large CAFs as defined by ARB Defines a large CAF for horses as having at least 2,500 head (Note: There are currently no CAFs in the SJV with at least 2,500 horses and no horse CAFs in the SJV are expected to exceed this threshold in the foreseeable future)

Requirements for CAFs		
	SJVAPCD Rule 4570	**BAAQMD Rule 2-0**
Requirements:	Requires specific mitigation measures for various emission sources (e.g. feed, housing, manure handling, etc.) for the different types of CAFs	Requires permit conditions that implement control measures that represent Reasonably Available Control Technology (RACT) to reduce emissions of VOC, NOx and PM from the facility Currently no CAFs subject to rule and no approved list of RACT measures that must be implemented

Ventura County APCD

- VCAPCD Rule 23 (Exemptions from Permit) *(Amended November 11, 2013)*

In response to California Senate Bill (SB) 700, VCAPCD revised its "Exemptions from Permit" rule to remove an exemption for agricultural operations, including CAFs. VCAPCD does not have a specific rule for CAFs. In its staff report for the rule revision, VCAPCD staff noted that no facilities in their jurisdiction would meet the "large CAF" definition and there was no expectation that a large CAF would move into the area in the foreseeable future; therefore, no separate CAF rule was necessary. VCAPCD does not have a specific rule for CAFs; therefore, District Rule 4570 is more stringent.

	SJVAPCD Rule 4570	VCAPCD Rule 23
Applicability	Applies to large CAFs as defined by ARB. Requirements apply to horse facilities with at least 3,000 head In addition to Large CAFs, also applies to Dairies with at least 500 milk cows (Large CAF threshold 1,000 milk cows) and Broiler, Duck, and Layer facilities with at least 400,000 birds (Large CAF threshold 650,000 birds)	Adopted ARBs definition of large CAFs Defines a large CAF for horses as having at least 2,500 head (Note: There are currently no CAFs in the SJV with at least 2,500 horses and no horse CAFs in the SJV are expected to exceed this threshold in the foreseeable future)

Requirements for CAFs		
	SJVAPCD Rule 4570	VCAPCD Rule 23
Requirements:	Requires specific mitigation measures for various emission sources (e.g. feed, housing, manure handling, etc.) for the different types of CAFs	No specific requirements or rules for CAFs There are currently no facilities in VCAPCD that are large CAFs and no large CAF is expected to move into the area in the foreseeable future; therefore, VCAPCD determined no separate CAF rule was necessary

Sacramento Metro AQMD

- SMAQMD Rule 496 (Large Confined Animal Facilities) *(Adopted August 24, 2006)*

District Rule 4570 is more stringent than SMAQMD Rule 496 because District Rule 4570 requires emission reductions from four additional emission categoriesat dairy CAFs - milk parlors, feed, freestall barns, and liquid manure - that are not addressed by SMAQMD Rule 496 as well as having specific requirements for other types of CAFs. District Rule 4570 also requires facilities to choose more mitigation measures and mandates several mitigation measures. In addition, Rule 4570 applies to dairies with greater than 500 milk cows and 400,000 layers and broilers while SMAQMD Rule 496 applies to dairies with 1,000 milk cows or more and broiler and layer operations with more than 650,000 birds.

	SJVAPCD Rule 4570	SMAQMD Rule 496
Applicability	Applies to large CAFs as defined by ARB. Requirements apply to horse facilities with at least 3,000 head In addition to Large CAFs, also applies to Dairies with at least 500 milk cows (Large CAF threshold 1,000 milk cows) and Broiler, Duck, and Layer facilities with at least 400,000 birds (Large CAF threshold 650,000 birds)	Applies to large CAFs as defined by ARB Defines a large CAF for horses as having at least 2,500 head (Note: There are currently no CAFs in the SJV with at least 2,500 horses and no horse CAFs in the SJV are expected to exceed this threshold in the foreseeable future)

Requirements for Dairy CAFs		
	SJVAPCD Rule 4570	**SMAQMD Rule 496**
Requirements: Feed Mitigation Measures	Operators must implement four mandatory feed mitigation measures (excluding silage) and chose one other option from a list of three, for a total of five feed mitigation measures	Nine optional feed mitigation measures (excluding silage), from which an operator must choose to implement four feed mitigation measures. Operators must also choose one silage mitigation measure
Requirements: Milk Parlor Mitigation Measures	Flush or hose milking parlor immediately prior to, immediately after, or during each milking. Class Two mitigation measures removed due to infeasibility (see the Staff Report for the October 21, 2010 amendments to Rule 4570 for more detail)	Includes option of choosing one class 1 measure (Flush or hose milking parlor immediately prior to, immediately after, or during each milking) or one Class 2 measure
Requirements: Freestall Mitigation Measures	Operators must implement a total of three mitigation measures - two mandatory mitigation measures and choose one additional measure from three possible options	Operators must choose to implement two mitigation measures from eight possible Class One mitigation measure options and two possible Class Two mitigation measure options
Requirements: Corral Mitigation Measures	Operators must implement a total of seven mitigation measures – six mandatory mitigation measures and choose one additional measure from three possible options	Operators must choose to implement six mitigation measures from 15 possible Class One mitigation measure options and three possible Class Two mitigation measure options
Requirements: Solid Manure and Separated Solids Mitigation Measures	Operators must choose to implement at least one mitigation measure from two possible options	Operators must implement two mitigation measures chosen from three possible Class One mitigation measures and three possible Class Two mitigation measures.
Requirements: Liquid Manure Mitigation Measures	Operators must choose to implement at least one mitigation measure from four possible options	Operators must choose to implement one mitigation measures from four possible Class One mitigation measures and four possible Class Two mitigation measures

Requirements: Manure Land Application Mitigation Measures	Operators must choose to implement one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application measures from six possible options	Operators must choose to implement two mitigation measures from four possible options

Requirements for Poultry CAFs		
	SJVAPCD Rule 4570	**SMAQMD Rule 496**
Requirements: Feed Operations	Operators must choose to implement one feed mitigation measure from four possible options	Operators must choose to implement five mitigation measures from nine possible options
Requirements: Poultry Housing	Operators are required to implement two mitigation measures for layers, four mitigation measures for broilers or ducks, and five mitigation measures for turkeys	Operators must choose to implement four mitigation measures from 16 possible options
Requirements: Solid Manure or Separated Solids	Operators must choose to implement one mitigation measure	Operators must choose to implement one mitigation measures from three possible Class One mitigation measures and two possible Class Two mitigation measures
Requirements: Liquid Manure	Operators that handle manure in liquid form must choose to implement one mitigation measure	Operators that handle manure in liquid form must choose to implement one mitigation measures from four possible Class One mitigation measures and three possible Class Two mitigation measures

Requirements for Other CAF Categories		
	SJVAPCD Rule 4570	**SMAQMD Rule 496**
Requirements:	District Rule 4570 provides specific mitigation measures for beef cattle feedlots, other cattle, and swine CAFs	SMAQMD Rule 496 does not address mitigation measures for beef cattle feedlots, other cattle, and swine CAFs

Suspension and Substitution of Mitigation Measures		
	SJVAPCD Rule 4570	**SMAQMD Rule 496**
Requirements:	Allows temporary suspension of a mitigation measure upon the determination by a certified veterinarian or nutritionist that such a suspension is necessary for animal health purposes. The District must be notified within 48 hours, and a new measure must be implemented if the suspension is expected to last longer than 30 days. Allows for substitution of one mitigation measure with an equivalent or more stringent measure	Allows temporary suspension of a mitigation measure upon the determination by a certified veterinarian or nutritionist that such a suspension is necessary for animal health purposes. The District must be notified within 48 hours, and a new measure must be implemented if the suspension is expected to last longer than 30 days. Allows for substitution of one mitigation measure with an equivalent or more stringent measure

Imperial County APCD

- ***ICAPCD Rule 217 (Large Confined Animal Facilities Permits Required)*** *(Amended February 9, 2016)*

ICAPCD Rule 217 indicates that the purpose of the rule is to limit emissions of VOCs and NH3 from Large Confined Animal Facilities. ICAPCD Rule 217 was originally adopted on October 10, 2006, but was recently amended on February 9, 2016. The amendments were intended to address deficiencies that US EPA and ARB identified in the rule as originally adopted and resulted in requirements that were essentially identical to District Rule 4570, which had already been approved for inclusion in the State Implementation Plan (SIP). District Rule 4570 and ICAPCD Rule 217 contain fundamentally identical requirements and therefore are of equal stringency.

	SJVAPCD Rule 4570	ICAPCD Rule 217
Applicability	Applies to the Large CAFs and other Confined Animal Facilities with the following numbers of animals: • Dairy: 500 Milk Cows • Beef Feedlots: 3,500 Beef Cattle • Other Cattle: 7,500 cattle • Chickens: 400,000 birds • Ducks: 400,000 birds • Turkeys: 100,000 birds • Swine: 3,000 head • Horses: 3,000 head • Sheep and Goats: 15,000 head • Other: 30,000 head	Applies to the Large CAFs and other Confined Animal Facilities with the following numbers of animals: • Dairy: 500 Milk Cows • Beef Feedlots: 3,500 Beef Cattle • Other Cattle: 3,500 cattle • Chickens: 400,000 birds • Ducks: 400,000 birds • Turkeys: 100,000 birds • Swine: 3,000 head • Horses: 2,500 head • Sheep and Goats: 15,000 head • Other: 30,000 head (Note: There are currently no CAFs in the SJV with at least 2,500 horses and no horse CAFs in the SJV are expected to exceed this threshold in the foreseeable future)

Requirements for Dairy CAFs		
	SJVAPCD Rule 4570	**ICAPCD Rule 217**
Requirements: Feed Mitigation Measures	Operators must implement four mandatory feed mitigation measures (excluding silage) and chose one other option from a list of three, for a total of five feed mitigation measures	Operators must implement four mandatory feed mitigation measures (excluding silage) and chose one other option from a list of three, for a total of five feed mitigation measures
Requirements: Milk Parlor Mitigation Measures	Flush or hose milking parlor immediately prior to, immediately after, or during each milking.	Flush or hose milking parlor immediately prior to, immediately after, or during each milking.
Requirements: Freestall Mitigation Measures	Operators must implement a total of three mitigation measures - two mandatory mitigation measures and choose one additional measure from three possible options	Operators must implement a total of three mitigation measures - two mandatory mitigation measures and choose one additional measure from three possible options
Requirements: Corral Mitigation Measures	Operators must implement a total of seven mitigation measures – six mandatory mitigation measures and choose one additional measure from three possible options	Operators must implement a total of seven mitigation measures – six mandatory mitigation measures and choose one additional measure from three possible options

Requirements: Solid Manure and Separated Solids Mitigation Measures	Operators must choose to implement at least one mitigation measure from two possible options	Operators must choose to implement at least one mitigation measure from two possible options
Requirements: Liquid Manure Mitigation Measures	Operators must choose to implement at least one mitigation measure from four possible options	Operators must choose to implement at least one mitigation measure from four possible options
Requirements: Manure Land Application Mitigation Measures	Operators must choose to implement one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application measures from six possible options	Operators must choose to implement one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application measures from six possible options

Requirements for Beef CAFs		
	SJVAPCD Rule 4570	**ICAPCD Rule 217**
Requirements: Feed Mitigation Measures	Operators must implement two feed mitigation measures from four possible options	Operators must implement two feed mitigation measures from four possible options
Requirements: Housing Mitigation Measures	Operators must implement a total of five mitigation measures - four mandatory mitigation measures and choose one additional measure from two possible options	Operators must implement a total of five mitigation measures - four mandatory mitigation measures and choose one additional measure from two possible options
Requirements: Solid Manure and Separated Solids Mitigation Measures	Operators must choose to implement at least one mitigation measure from two possible options	Operators must choose to implement at least one mitigation measure from two possible options
Requirements: Liquid Manure Mitigation Measures	Operators must choose to implement at least one mitigation measure from four possible options	Operators must choose to implement at least one mitigation measure from four possible options
Requirements: Manure Land Application Mitigation Measures	Operators must choose to implement one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application measures from six possible options	Operators must choose to implement one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application measures from six possible options

Requirements for Other Cattle CAFs		
	SJVAPCD Rule 4570	**ICAPCD Rule 217**
Requirements: Feed Mitigation Measures	Operators must implement two feed mitigation measures from four possible options	Operators must implement two feed mitigation measures from four possible options
Requirements: Freestall Mitigation Measures	Operators must implement a total of three mitigation measures - two mandatory mitigation measures and choose one additional measure from two possible options	Operators must implement a total of three mitigation measures - two mandatory mitigation measures and choose one additional measure from two possible options

Requirements: Corral Mitigation Measures	Operators must implement a total of six mitigation measures – five mandatory mitigation measures and choose one additional measure from three possible options	Operators must implement a total of six mitigation measures – five mandatory mitigation measures and choose one additional measure from three possible options
Requirements: Solid Manure and Separated Solids Mitigation Measures	Operators must choose to implement at least one mitigation measure from two possible options	Operators must choose to implement at least one mitigation measure from two possible options
Requirements: Liquid Manure Mitigation Measures	Operators must choose to implement at least one mitigation measure from four possible options	Operators must choose to implement at least one mitigation measure from four possible options
Requirements: Manure Land Application Mitigation Measures	Operators must choose to implement one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application measures from six possible options	Operators must choose to implement one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application measures from six possible options

Requirements for Swine CAFs		
	SJVAPCD Rule 4570	**ICAPCD Rule 217**
Requirements: Feed Mitigation Measures	Operators must implement two feed mitigation measures	Operators must implement two feed mitigation measures
Requirements: Housing Mitigation Measures	Operators must implement three housing mitigation measures	Operators must implement three housing mitigation measures
Requirements: Liquid Manure Mitigation Measures	Operators must implement one liquid manure mitigation measures	Operators must implement one liquid manure mitigation measures
Requirements: Manure Land Application Mitigation Measures	Operators must choose to implement one mitigation measure for manure land application	Operators must choose to implement one mitigation measure for manure land application

Requirements for Poultry CAFs		
	SJVAPCD Rule 4570	**ICAPCD Rule 217**
Requirements: Feed Operations	Operators must choose to implement one feed mitigation measure from four possible options	Operators must choose to implement one feed mitigation measure from four possible options
Requirements: Poultry Housing	Operators are required to implement two mitigation measures for layers, four mitigation measures for broilers or ducks, and five mitigation measures for turkeys	Operators are required to implement two mitigation measures for layers, four mitigation measures for broilers or ducks, and five mitigation measures for turkeys
Requirements: Solid Manure or Separated Solids	Operators must choose to implement one mitigation measure	Operators must choose to implement one mitigation measure

Requirements: Liquid Manure	Operators that handle manure in liquid form must choose to implement one mitigation measure	Operators that handle manure in liquid form must choose to implement one mitigation measure

Suspension and Substitution of Mitigation Measures		
	SJVAPCD Rule 4570	**ICAPCD Rule 217**
Requirements:	Allows temporary suspension of a mitigation measure upon the determination by a certified veterinarian or nutritionist that such a suspension is necessary for animal health purposes. The District must be notified within 48 hours, and a new measure must be implemented if the suspension is expected to last longer than 30 days. Allows for substitution of one mitigation measure with an equivalent or more stringent measure	Allows temporary suspension of a mitigation measure upon the determination by a certified veterinarian or nutritionist that such a suspension is necessary for animal health purposes. The District must be notified within 48 hours, and a new measure must be implemented if the suspension is expected to last longer than 30 days. Allows for substitution of one mitigation measure with an equivalent or more stringent measure

Idaho Administrative Procedure Act (IDAPA)

- ***IDAPA 58.01.01 Sections 760-764 (Rules for the Control of Ammonia from Dairy Farms)***

IDAPA 58.01.01 Sections 760-763 was adopted on March 30, 2007 and IDAPA 58.01.01 Subsection 764.02: Table – Ammonia Control Practices for Idaho Dairies was last amended on May 8, 2009.

Pursuant to IDAPA 58.01.01 Section 761, Sections 760-764 apply to dairies of the following sizes. The thresholds are based on estimating the number of cattle required to produce 100 tons of ammonia emissions annually. Different thresholds are given for drylot dairies, dairies with scraped freestalls, and dairies with flushed freestalls.

District Rule 4570 is far more stringent than IDAPA 58.01.01 Sections 760-764. Unlike IDAPA 58.01.01 Sections 760-764, District Rule 4570 requires specific practices for the various operations at dairies. District Rule 4570 exemption is more stringent because it is a temporary suspension that cannot exceed 30 days, whereas the IDAPA 58.01.01 Sections 760-764 exemption may last one year, without any requirement to substitute another measure. District Rule 4570 also provides specific mitigation measures for beef cattle feedlots, other cattle facilities, poultry facilities, and swine facilities, while IDAPA 58.01.01 Sections 760-764 does not.

	SJVAPCD Rule 4570	IDAPA 58.01.01 Sections 760-764
Applicability	Applies to the Large CAFs and other Confined Animal Facilities with the following numbers of animals: • Dairy: 500 Milk Cows • Beef Feedlots: 3,500 Beef Cattle • Other Cattle: 7,500 cattle • Chickens: 400,000 birds • Ducks: 400,000 birds • Turkeys: 100,000 birds • Swine: 3,000 head • Horses: 3,000 head • Sheep and Goats: 15,000 head • Other: 30,000 head	Applies to dairies with the following number of cattle: • Drylot Dairy: minimum of 4,589 milk cow equivalents • Freestall Scrape Dairy: minimum of 2,643 milk cow equivalents • Freestall Flush Dairy: minimum of 1,638 milk cow equivalents

Requirements for Dairy CAFs		
	SJVAPCD Rule 4570	**IDAPA 58.01.01 Sections 760-764**
Requirements:	District Rule 4570 requires specific mitigation measures to address emissions from various sources at dairies (e.g. milking parlor, corrals, freestalls, manure management, and manure land application)	Must employ Best Management Practices (BMPs) (e.g. solid separation, corral cleaning, composting, etc.)

Requirements for Other CAF Categories		
	SJVAPCD Rule 4570	**IDAPA 58.01.01 Sections 760-764**
Requirements:	District Rule 4570 provides specific mitigation measures for beef cattle feedlots, other cattle, swine, and poultry CAFs	IDAPA 58.01.01 Sections 760- 764 only applies to dairies and does not apply to beef cattle feedlots, other cattle, swine, or poultry CAFs

Suspension and Substitution of Mitigation Measures		
	SJVAPCD Rule 4570	**IDAPA 58.01.01 Sections 760-764**
Requirements:	Allows temporary suspension of a mitigation measure upon the determination by a certified veterinarian or nutritionist that such a suspension is necessary for animal health purposes. The District must be notified within 48 hours, and a new measure must be implemented if the suspension is expected to last longer than 30 days. Allows for substitution of one mitigation measure with an equivalent or more stringent measure	Allows exemption for up to one year for a dairy that become subject to the rule as a result of an emergency for example if a dairy farmer takes additional cows due to unforeseen circumstances)

Additional Emission Reduction Opportunities

Recent studies have cited the episodic application of sodium bisulfate (SBS) onto manure at dairies as a potential control strategy to reduce ammonia emissions.

SCAQMD included a potential control measure within their 2012 Air Quality Management Plan (AQMP) to evaluate the use of SBS at dairies to determine the technical and economic feasibility of its application in reducing ammonia emissions as well as potential impacts to groundwater. The District did not find any agency requiring the use of SBS. The District has evaluated SBS as a potential control measure and determined that for a variety of reasons that this control strategy is infeasible and ineffective for reducing PM2.5 concentrations in the Valley.

SBS is an acid salt that has been used to reduce pH and bacterial levels in the bedding for dairy cattle. Application of SBS on fresh manure or corral surfaces has the potential to reduce ammonia emissions by reducing the pH of the manure or corral surface. With a lower pH, a greater fraction of the ammonia is converted to non-volatile ammonium (NH4+). The ammonium combines with sulfate to form ammonium sulfate, which is retained in the manure or on the surface of the corral.

There are a number of potential issues that need to be considered related to the application of SBS at dairies including, but not limited to, the health and safety of dairy workers and dairy cattle, impacts on water quality, and overall cost and effectiveness. The SCAQMD 2012 AQMP states: that potential use of SBS would be specific to dairies in the SCAQMD and may be unique to localized operations, that “the requirements may not be applicable to dairies elsewhere where a site-specific assessment would need to be made relative to those particular conditions”, and that it is likely that each air district would need to conduct an assessment as to the feasibility of SBS application in their jurisdiction.

The SCAQMD AQMP focuses on episodic controls to reduce ammonia emissions during periods of high PM2.5 concentrations. PM concentrations in the Valley are highest during the winter season (November – February). Unlike the SCAQMD where the majority of dairies are open corral facilities, most dairies in the Valley utilize a freestall design and generally restrict the cows’ access to corrals during the winter months since the corrals are wet and muddy. As a result, there would be very little to no fresh manure excreted in corrals during the winter period. In addition, once wet conditions set in, it is not feasible to utilize tractors in the corrals to apply SBS since the tractors tend to get stuck in mud. Application by hand at large dairies would be very labor intensive, time consuming, extremely costly, and would potentially pose health and safety risks to the workers.

Although SBS is generally considered to be safe in small quantities, excessive loading of salts is a major water quality concern in the central and southern regions of the Valley where many dairies are located. A dairy would also need to work with the Regional Water Quality Control Board to determine if the application of SBS is allowed. In addition, applying SBS to corrals, which for many dairies can be greater than several acres in size, is not practical or feasible. Also, because flush dairies are common in the Valley (both freestall and open corral), the heavy use areas will generally be paved, and frequent flushing of the freestall or corral lanes (as required by Rule 4570) already significantly reduces ammonia emissions; therefore, application of SBS to only these areas would not provide significant additional reductions in ammonia emissions. By design, SBS will be flushed to a lagoon or pond where the high buffering capacity would render it ineffective and possibly increase H2S emissions.

There are significant costs associated with the application of SBS. Iowa State University Extension estimates the costs of SBS to be $660/ton. District estimates show that 1,304 lb-1,955 lb/cow-yr of SBS would be needed for application to one entire corral area, costing $430-$645/cow-yr. Using the District's corral ammonia emission factor for milk cows and assuming a conservatively high estimate of 50% reduction in overall ammonia emissions, the cost of the ammonia reductions would be at least $41,067/ton to $61,601/ton or higher depending on corral size. Applying SBS to large areas also requires significant amounts of SBS to be applied. The application of SBS will also be short lived and conflict with requirements from Rule 4550 which requires dairies to scrape their corrals on a frequent basis at least once every two weeks, making the application of SBS ineffective and costly due to the constant need to reapply. Information from Iowa State shows reduced costs of $129-$193/cow-yr for only treating heavy use areas, such as feed bunks and water troughs. It is not clear how much manure is excreted in heavy use areas, but even if the resulting cost per ton of reduction was cut in half, the costs would still be significant.

Due to the barriers to widespread implementation of SBS application to Valley cattle facilities, as well as the high costs of effective application to control ammonia emissions, the application of SBS is not a feasible regulatory requirement.

Evaluation Findings

While BACM and MSM requirements do not apply to ammonia since it is not a significant precursor to PM2.5 formation in the Valley, District staff concludes that District Rule 4570 meets BACM and MSM requirements for ammonia emissions from CAFs. The District evaluated the feasibility of additional ammonia emissions reductions and did not identify any additional feasible measures.

Ammonia Emissions from Agricultural Fertilizer

The District does not have statutory authority to regulate the application of agricultural fertilizers. However, in recent years, California has begun increasing efforts to improve the efficiency of nitrogen usage to minimize environmental impacts from the use of fertilizers and manure in California agriculture. One of the primary drivers for these efforts is to reduce nitrate contamination in groundwater. An additional goal of these efforts is to minimize losses of reactive nitrogen to the atmosphere through volatilization. As part of the efforts to improve the efficiency of nitrogen use in California, the University of California, Davis, Agricultural Sustainability Institute produced the report The California Nitrogen Assessment: Challenges and Solutions for People, Agriculture, and the Environment.[104] The California Nitrogen Assessment began in 2009 with goals of providing insights into balancing the benefits of nitrogen in California's modern economy, including agriculture, and the effects of surplus nitrogen in the environment and

[104] Tomich, T. P., Brodt, S. B., Dahlgren, R. A., & Scow, K. M. (Eds.). (2016). The California Nitrogen Assessment: Challenges and solutions for people, agriculture, and the environment. Univ of California Press. Executive summary available at: http://asi.ucdavis.edu/programs/sarep/research-initiatives/are/nutrient-mgmt/california-nitrogen-assessment/ExecutiveSummaryLayout_FINAL_reduced.pdf

comparing options to improve the management of nitrogen and mitigate the negative impacts of surplus nitrogen in the environment. The final report for the California Nitrogen Assessment was completed in 2015. The California Nitrogen Assessment executive summary states, "*Nitrogen, in various reactive forms, is indispensable to the productivity of California agriculture. And yet, only about half the nitrogen applied ends up where we intend; the balance leaks, polluting our air and water, with detrimental effects on our environment and human health.*" … "*California can lead the way for the world in seeking a better balance between managing nitrogen as an essential agricultural input and minimizing its negative impacts on communities and the environment.*" The information from the California Nitrogen Assessment will be used to help agricultural producers continue to improve methods of fertilizer and manure application to maximize nitrogen use efficiency and minimize environmental impacts, such as contamination of groundwater and emissions of NH3 to the atmosphere.

As part of the efforts to reduce the environmental impacts of nitrogen usage on California farms, California regulations have been adopted that apply to the use of manure and fertilizers in agricultural operations. These regulations have been adopted by the State Water Resources Control Board, which enforces state and federal water quality protection laws and regulates agricultural sources to ensure compliance with these laws. The State Water Resources Control Board consists of Regional Water Quality Control Boards (Regional Boards) that develop objectives and plans to protect the beneficial uses of water, recognizing local differences in climate, topography, geology and hydrology. The Central Valley Regional Water Quality Control Board adopts water quality regulations in California's Central Valley and monitors compliance with these regulations. The Central Valley Regional Water Quality Control Board has recently adopted regulations that will reduce the amount of nitrogen that agricultural facilities can apply to cropland and will result in decreased emissions of NH3.

These regulations include the Waste Discharge Requirements General Order for Existing Milk Cow Dairies (Dairy General Order, adopted in 2007 and revised and re-issued in 2013), the Waste Discharge Requirements General Order for Confined Bovine Feeding Operations (Bovine Feedlot General Order, adopted in 2017), and the Waste Discharge Requirements General Order for Confined Poultry Operations (Poultry General Order, adopted in 2016). The Dairy General Order applies to dairy operations, the Bovine Feedlot General Order applies to facilities other than dairies in which cattle are confined, and the Poultry General Order applies to poultry operations of a certain size. In addition to the water quality regulations that apply to confined animal feeding operations, the Central Valley Regional Water Quality Control Board ensures compliance with water quality objectives on commercial agricultural land that is not covered under another order, including managing nitrogen applied to cropland, through the Irrigated Lands Regulatory Program. The Irrigated Lands Regulatory Program initially began as a means to prevent agricultural runoff from polluting surface waters, subsequently groundwater regulations were added to the program in 2012. Agricultural operations throughout the Central Valley are subject to waste discharge requirements that protect both surface water and groundwater.

Agricultural operations that are not subject to a general order or the Irrigated Lands Regulatory Program are generally regulated via individual orders that ensure compliance with the same requirements. The requirements of these orders for Confined Animal Feeding Operations include:

- A Nutrient Management Plan (NMP), prepared by a certified professional crop advisor or equivalent, designed to control nutrient losses for protection of surface water and groundwater and ensure compliance with the requirements for the whole farm nitrogen balance;
- A Waste Management Plan (WMP), prepared by a licensed engineer, designed to ensure that waste generated at the facility is properly managed and stored until such time that it can be applied to cropland;
- Environmental sampling and monitoring of soil, manure, water and plant tissue for compliance;
- Periodic site inspections, record-keeping, and reporting; and
- Additional groundwater monitoring to assess ongoing water quality protection

The requirements for agricultural operations that are subject to the Irrigated Lands Regulatory Program include preparation of a Nitrogen Management Plan that accounts for all of the nitrogen applied to fields through irrigation water and fertilizers and the nitrogen removed by crops.

The purpose of these regulations is to minimize the impacts that these operations have on the quality of surface and groundwater, including prevention of runoff and leaching of nitrogen compounds to the environment. This has generally required reductions in the amount of nitrogen that has traditionally been applied to agricultural lands, which also results in reductions in emissions of NH3 to the atmosphere.

The Nutrient Management Plan and Nitrogen Management Plan are designed to assure that the amount of nitrogen applied to agricultural lands is in reasonable balance with the needs of crops grown at the farm. Nitrogen from manure at confined animal feeding operations in excess of crop needs must be exported off the farm to where it can be used by other crops. Manure used on the farm is required to be stored safely until it is used and then only applied to agricultural fields in the amounts needed and during periods when it is required by crops growth. Over-application or mistimed application of nitrogen fertilizers can result in unnecessary losses of nitrogen to the environment, both as seepage below the root zone (in the form of nitrate or other nitrogen compounds)[105] or as air emissions of NH3 gas and oxides of nitrogen.

In accordance with the recommendations contained in the University of California document Managing Dairy Manure in the Central Valley of California (2005), the Central Valley Regional Water Quality Control Board Dairy General Order, Bovine Feedlot

[105]See Chang, A., Harter, T., Letey, J., Meyer, D., Meyer, R.D., Campbell-Mathews, M., Mitloehner, F., Pettygrove, S., Robinson, P., Zhang, R., (2005) Managing Dairy Manure in the Central Valley of California. Publication 9004, Division of Agriculture and Natural Resources. University of California. Available at: http://groundwater.ucdavis.edu/files/136450.pdf

General Order, and Poultry General Order generally prohibit the amount of total nitrogen applied to agricultural fields from exceeding 1.4 times the amount that will be removed from the field in the harvested portion of the crop. To comply with these more stringent targets for nitrogen application, many confined animal feeding operations have had to greatly increase the precision of their manure and fertilizer applications, while also reducing the overall amount of nitrogen applied to their crops.[106] For instance, on a group of San Joaquin Valley dairy farms, it was estimated that prior to adoption of the General Order in 2007, the total inputs of nitrogen were 1,070 lb-N/acre-year, the amount of nitrogen removed by crops was 500 lb-N/acre-year, and potential losses of nitrogen to groundwater alone ranged from 370 to 570 lb-N/acre-year.[107] Based on this study, it can be estimated that, as a result of full implementation of the Dairy General Order, the total amount of nitrogen applied to cropland at dairies will be reduced by approximately 35% compared to conditions prior to the Dairy General Order, with resulting reductions in NH3 emissions. Similar reductions in the amount of nitrogen applied to agricultural fields associated with other cattle facilities and poultry facilities and resulting NH3 emissions can reasonably be expected as a result of implementation of the Bovine Feedlot General Order and Poultry General Order.

Adjusting the timing of nitrogen application to increase nitrogen uptake by crops is also expected to reduce emissions of NH3 by reducing the amount of nitrogen that is available for volatilization. Some research already suggests that lower emissions of reactive nitrogen will occur by timing applications of nitrogen to better coincide with the needs for crop growth. The California Nitrogen Assessment suggests that synchronizing fertilizer application with crop demand will reduce emissions of NH3 and N2O to the atmosphere, while also reducing the flow of nitrates to groundwater. The California Air Resource Board report Assessment of Nitrous Oxide Emissions in California's Dairy Systems[108] states regarding synchronizing nitrogen application with crop demand, "Once the N requirement for each crop stage is known, the N applications can be adjusted accordingly. This strategy should lead to improved N use efficiency and likely lower N2O emissions."

Agricultural operations in California are continuing to improve management practices to improve nitrogen utilization and minimize nitrate leaching in crop production. These practices will also result in reduced emissions of reactive nitrogen. Researchers at UC Cooperative Extension have been studying the nitrogen use efficiency for various crop types and have begun identifying the point at which the application of additional nitrogen no longer significantly increases crop quality and yields. This will allow growers to apply fertilizer with more precision to reduce the amount of nitrogen left in the soil. Because of the recent efforts in California to address the environmental impacts of reactive nitrogen,

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[106] Harter, T., Menke, J., (2005) Cow Numbers and Water Quality – Is There a Magic Limit? – A Groundwater Perspective. Revised Manuscript from Proceedings, National Alfalfa Symposium, December 13-15, 2004, San Diego, CA. UC Cooperative Extension, University of California, Davis 95616. Available at: http://groundwater.ucdavis.edu/files/136450.pdf

[107] Harter, T., Menke, J., (2005)

[108] Horwath, W. R., Burger, M., Pettygrove, S. (November 2013) Assessment of Nitrous Oxide Emissions in California's Dairy Systems. Final Report to the California Air Resources Board, Contract No. 09-325. Available at: https://www.arb.ca.gov/research/apr/past/09-325.pdf

the overall efficiency of nitrogen usage at California farms is expected to increase and emissions of reactive nitrogen, including NH3, are expected to decrease significantly.

RULE 4565 (BIOSOLIDS, ANIMAL MANURE, AND POULTRY LITTER OPERATIONS)

Discussion

District Rule 4565 was adopted on March 15, 2007. The primary purpose of this rule is to limit emissions of volatile organic compounds (VOC) from operations involving the management of biosolids, animal manure, or poultry litter. District Rule 4565 applies to operations that landfill, land apply, compost, or co-compost these materials. Composting facilities subject to Rule 4565 fall into one of three categories based on the wet tons of compostable materials received at the facility for processing annually (annual throughput): facilities with throughputs less than 20,000 tons per year; those with at least 20,000 tons, but less than 100,000 tons per year; and those with throughputs of at least 100,000 tons per year. In addition to limiting VOC emissions, the measures required by District Rule 4565 have also been demonstrated to limit ammonia (NH3) emissions from these operations.

NH3 emissions from biosolids, animal manure, and poultry litter result from the microbial decomposition of nitrogenous compounds in these materials and the subsequent volatilization of the ammonia that is produced. In general, the class one mitigation measures required by District Rule 4565 consist of management practices that facilitate stabilization of the nitrogen during co-composting operations and reduce volatilization of gaseous pollutants. The class two mitigation measures required by District Rule 4565 apply to the largest composting operations and involve use of a control device, typically a biofilter.

Descriptions of some of the mitigation measures required by District Rule 4565 and the ways in which these measures reduce NH3 emissions are provided below:

- Injection, land incorporation, or covering biosolids, animal manure, and poultry litter that is land applied into fields: Injection, incorporation, or covering biosolids, animal manure, or poultry litter applied to cropland reduces volatilization of gaseous pollutants by minimizing the amount of time that these materials are exposed to the atmosphere. Once the waste has been injected into the soil, incorporated into the soil, or covered with soil, NH3 and VOCs are absorbed onto soil particles, providing the opportunity for soil microbes to oxidize these compounds into nitrates, carbon dioxide, and water.[109]

- Covering Active and Curing Compost Piles with a waterproof covering, six inches of finished compost, or six inches of soil: Covering composting piles with a waterproof covering reduces exposure of the VOCs and NH3 to the atmosphere

[109] US EPA Emissions Standards Division, Office of Air Quality Planning and Standards (August 2001). Emissions from Animal Feeding Operations (Draft). EPA Contract 68-D6-0011. Available at: https://www3.epa.gov/ttn/chief/ap42/ch09/draft/draftanimalfeed.pdf

thereby reducing volatilization of these compounds. Covering the compost piles with finished compost or soil reduces emissions in the same manner as a biofilter; microorganisms in the finished compost or soil facilitate conversion of VOCs and NH3 to carbon dioxide, nitrogen, water, and biomass before the compounds are emitted to the atmosphere. Source testing of engineered covers for compost piles (e.g. Gore covers) have demonstrated control efficiencies of greater than 90% for VOC and 60% for NH3 (without venting to a biofilter). Additionally, the report prepared by CalRecycle for the San Joaquin Valley Air Pollution Control District Technology Advancement Program (TAP) project: Greenwaste Compost Site Emissions Reductions from Solar-Powered Aeration and Biofilter Layer (5/14/2013)[110] demonstrated control efficiencies greater than 90% for VOC and between 53% to greater than 83% for NH3 for compost piles covered with one foot of finished compost.

- Aerated Static Piles (ASPs) or In-Vessel Composting Vented to a Biofilter: For large composting facilities with annual throughputs of at least 100,000 tons per year, District Rule 4565 requires implementation of at least one Class Two Mitigation Measure. The Class two mitigation measures require active composting or curing of compost to be conducted using aerated static piles or in-vessel composting vented to a control device with a minimum control efficiency of 80% for VOC, or implementation of an equivalent mitigation measure. As previously mentioned, because of practical and economic considerations, large composting operations that must control emissions and/or odors almost universally use biofilters as control devices. Although District Rule 4565 only specifies a VOC control efficiency of 80%, when biofilters are designed and operated to achieve the required VOC control efficiency, they also result in a similar control efficiency for NH3 emissions.

  The SCAQMD Final Staff Report for Proposed Amended Rule 1133.1 – Chipping and Grinding Activities and Proposed Rule 1133.3 – Emission Reductions from Greenwaste Composting Operations (July 2011)[111] states "*Based on the information collected on existing biofilter composting applications, overall control efficiencies of about 80 to 90 percent for VOC and 70 to over 90 percent for ammonia have been achieved*." and also states "*Based on source tests data from existing cocomposting operations (Inland Empire Regional Composting Facilities and City of Los Angeles Sanitation Bureau), properly designed and maintained biofilters have demonstrated over 90 percent destruction efficiencies for both VOC and ammonia emissions.*"

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[110] CalRecycle – Principal Study Author Robert Horowitz (5/14/2013) Greenwaste Compost Site Emissions Reductions from Solar-Powered Aeration and Biofilter Layer. Funded by and prepared for the San Joaquin Valley Air Pollution Control District Technology Advancement Program (TAP). Available at: http://www.valleyair.org/Grant_Programs/TAP/documents/C-15636-ACP/C-15636_ACP_FinalReport.pdf

[111] South Coast AQMD (July 2011) Final Staff Report for Proposed Amended Rule 1133.1 – Chipping and Grinding Activities and Proposed Rule 1133.3 – Emission Reductions from Greenwaste Composting Operations. Available at: http://www.aqmd.gov/docs/default-source/Agendas/Governing-Board/2011/2011-jul8-037.pdf?sfvrsn=2

Source Category

Composting facilities subject to Rule 4565 fall into one of three categories based on the wet tons of compostable materials received at the facility for processing annually (annual throughput): facilities with throughputs less than 20,000 tons per year; those with at least 20,000 tons, but less than 100,000 tons per year; and those with throughputs of at least 100,000 tons per year or greater.

Emissions from Composting Facilities Subject to District Rule 4565:

The composting mitigation measures included in District Rule 4565 focus on the following three primary emission sources at composting facilities: (a) receiving/mixing areas, (b) active-phase compost piles, and (c) curing-phase compost piles.

The following discussion describes the assumptions used to estimate the District Rule 4565 NH3 control efficiencies for the different emissions sources identified for composting operations.

<u>NH3 Emissions from the Receiving and Mixing (Scraping) Areas</u>

At a composting facility, compostable material is delivered, unloaded, mixed, and then transferred to the active composting area, which may consist of piles, windrows, or engineered systems. During these initial steps, the NH3 is emitted from the compostable material. NH3 from these operations can be reduced by properly maintaining the receiving and mixing areas by scraping or sweeping on a regular basis (Class One Mitigation Measure #1). This will also reduce the total surface area of these materials that is exposed to the atmosphere from which emissions occur. It is assumed that the magnitude of the emissions flux during this process equals the emissions flux during the active phase of composting, but the total time of emissions from these processes is limited.

The following assumptions will be used to estimate the District Rule 4565 NH3 control efficiency receiving and mixing compostable materials:

- The NH3 emissions factor for compostable materials in the receiving and mixing area is 0.00046 lb-NH3/ton-hr. This is a conservative value based on flux chamber source testing results from uncontrolled active-phase co-composting as determined by Schmidt and Card (2002, 2004).[112]

- Total NH3 emissions are based on the annual throughput of the facility, assuming that all compostable material (throughput) sits in the scraping area for two hours per day, six days per week, and 50 weeks per year, for a total of 600 hours per year.

[112] Card, T. and Schmidt, C. (2002). *Emissions Evaluation of Aerated Static Pile Composting of Anaerobically Digested Biosolids at the Davenport Composting Facility* (Draft Report). Prepared for Southern California Alliance of Publicly Owned Treatment Works and updated in 2004.

NH3 Emissions from Active-Phase and Curing Phase Composting

The NH3 emission factor for co-composting operations is based on South Coast Air Quality Management District (SCAQMD) Rule 1133.2 (Emission Reductions from Co-composting Operations), which is 2.93 lb-NH3/ton. This emission factor accounts for the NH3 emissions during both the active phase and curing phase of composting. For purposes of estimating the NH3 control efficiency for District Rule 4565, it is assumed that the percentage of the co-composting NH3 emission factor attributed to the active and curing phases of composting is the same as the percentage of the VOC emission factor attributed to each of these phases. The District document "Compost VOC Emission Factors" (September 15, 2010)[113] indicates that 90% of composting VOC emissions are attributed to the active phase and 10% to the curing phase. The same ratio of 90% of emissions from the active phase of composting and 10% for the curing phase of composting will be assumed for NH3 emissions.

District Rule 4565 Control Measure Efficiencies:

The estimated NH3 control efficiencies for the District Rule 4565 mitigation measures are summarized in the table below.

Overall NH3 Control Efficiencies for Rule 4565 Mitigation Measures	
Class 1 Measures	**Overall Control Efficiency**
Scrape to ≤ 1"	10%
Cover Active Piles ≥ 6"	60%
Cover Curing Piles ≥ 6"	60%
Class 2 Measures	**Overall Control Efficiency**
Active-Phase ASPs to ≥ 80% control device	26%
Active-Phase in-vessel to ≥ 80% control device	80%
Curing-Phase ASPs to ≥ 80% control device	26%
Curing-Phase in-vessel to ≥ 80% control device	80%
ASPs + Compost Cover	**Control Efficiency**
Active-Phase ASPs to ≥ 80% control device + Compost Cover	70%
Curing-Phase ASPs to ≥ 80% control device + Compost Cover	70%

[113] San Joaquin Valley Air Pollution Control District [SJVAPCD]. (September 15, 2010). Compost VOC Emission Factors. Fresno, CA: San Joaquin Valley Air Pollution Control District. Available at: http://www.valleyair.org/busind/pto/emission_factors/Criteria/Criteria/Composting/Compost%20EF.pdf

As mentioned above, the CalRecycle report prepared for San Joaquin Valley Air Pollution Control District TAP Project: Greenwaste Compost Site Emissions Reductions from Solar-Powered Aeration and Biofilter Layer (5/14/2013) demonstrated control efficiencies of between 53% to greater than 83% for NH3 for compost piles covered with one foot of finished compost. Based on data from a study prepared for the San Joaquin Valleywide Air Pollution Study Agency (2009),[114] the District previously estimated that a finished compost cover would achieve a VOC reduction of 56% compared to an uncontrolled pile; therefore, the compost cover is conservatively estimated to have a control efficiency of 60% for NH3. The NH3 control efficiency for aerated static piles with a compost cover is estimated to be 70% also based the CalRecycle project report. The remaining NH3 control efficiencies for scraping and the Class 2 measures are assumed to be the same as the VOC control efficiencies that were used in the original 2006 rulemaking process for Rule 4565 and as used by SCAQMD for SCAQMD Rule 1133.2 (Emission Reductions from Co-composting Operations).

NH3 Control Efficiencies for Class One Mitigation Measures

- Scraping: A conservative NH3 control efficiency of 10% is assumed for scraping and maintaining the areas for receiving and mixing compostable materials

- Compost Cover: The District estimated 60% control efficiency for NH3 during the active phase of composting based on an emissions profile derived from SJVAPSA (2011). Given the use of the same type of compost cover and the nature of the emissions, the District also estimates 60% control efficiency for compost cover during the curing phase.

NH3 Control Efficiencies for Class two Mitigation Measures

- Active phase and curing-phase aerated static pile systems (ASPs) venting to a control device with 80% control efficiency: The District conservatively assumes a 33% capture efficiency for an uncovered aerated static pile system. Applying an 80% control to the captured emissions results in an overall NH3 control efficiency of 26%, as shown below:

  Overall Control: 0.33 x 0.8 x 100 = 26%

- In-vessel active and curing-phase composting venting to a control device with 80% control efficiency: Engineered in-vessel composting systems are expected to capture 100% of the emissions from the composting operation. Applying 80% control efficiency to 100% capture results in an overall NH3 control efficiency of 80%.

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[114] San Joaquin Valleywide Air Pollution Study Agency [SJVAPSA]. (2011). *Comparison of Mitigation Measures for Reduction of Emissions Resulting from Greenwaste Composting*. Fresno, CA: San Joaquin Valleywide Air Pollution Study Agency. Retrieved from website: http://www.valleyair.org/busind/pto/emission_factors/Criteria/Criteria/Composting/FINAL-COMPOST-STUDY-REPORT.pdf (Final Report)

- ASPs plus compost cover: Alternatively, a facility may choose to use ASPs with a compost cover that is vented to a control device with 80% control efficiency. As mentioned above, based on the study report prepared for the San Joaquin valley Technology Advancement Program (2013), the control efficiency of an ASP with a compost cover is 70%.

The minimum expected overall District Rule 4565 NH3 control efficiencies for land application of biosolids, animal manure, or poultry litter and co-composting facilities with throughputs of less than 20,000 tons per year, 20,000 tons but less than 100,000 tons per year, and 100,000 tons per year or more are summarized in the tables below.

Estimated Overall NH3 Control Efficiencies for Rule 4565 Mitigation Measures for Land Application of Biosolids, Animal Manure, and Poultry Litter	
Rule 4565 Requirements for Land Application	**Estimated Overall NH3 Control Efficiency**
Direct injection within three hours of receipt at the facility **Or** Land incorporation within three hours of receipt at the facility; Materials received after 6 pm must be land incorporated by noon of the following calendar day **Or** Cover the biosolids, animal manure, or poultry litter with waterproof cover, six inches of finished compost, or six inches of soil within three hours of receipt at the facility	50%*

* *Injection, incorporation, and covering biosolids, animal manure, or poultry litter are expected to have a similar control efficiency as covering compost piles; however, an NH3 control efficiency of 50% rather than 60% has been used for a more conservative estimate*

Estimated Minimum Overall NH3 Control Efficiencies for Rule 4565 Mitigation Measures for Co-Composting Facilities of Different Sizes		
Facility Throughput (wet tons/yr)	**Rule 4565 Requirements**	**Estimated Overall NH3 Control Efficiency**
< 20,000 wet tons per year	At least three Class One mitigation measures or At least two Class One mitigation measures in addition to one Class Two mitigation measure for active composting	10%
20,000 but < 100,000 wet tons per year	At least four Class One mitigation measures or At least three Class One mitigation measures in addition to one Class Two mitigation measure for active composting	10%
≥ 100,000 wet tons per year	At least four Class One mitigation measures in addition to one Class Two mitigation measure for active composting or	31%

	At least two Class One mitigation measures, in addition to one Class Two mitigation measure for active composting and one Class Two mitigation measure for curing composting	

How does District Rule 4565 compare with federal and state rules and regulations?

For the 2018 PM2.5 Plan, the District identified federal, state, and local air quality regulations and compared them to analogous District rules to identify potential emission reductions opportunities. Any potential opportunities identified were then analyzed to determine if they are technologically and economically feasible to require in Valley.

Federal requirements such as NSPS, NESHAP, MACT, CTGs, and ACTs and state regulations are not applicable to this source category.

How does District Rule 4565 compare to rules in other air districts?

District staff compared District Rule 4565 with the rules for biosolids, animal manure, and poultry litter operations from other California air districts. District staff only located one other air district rule that applied to similar sources, which was SCAQMD Rule 1133.2. No other air district rules that applied to similar sources were found.

SCAQMD

- SCAQMD Rule 1133.2 - Emission Reductions from Co-Composting Operations *(Adopted January 10, 2003)*

SCAQMD Rule 1133.2 was adopted in 2003, and the rule has not since been amended. This rule applies to new and existing co-composting operations in the SCAQMD. The table below summarizes the significant differences between SCAQMD Rule 1133.2 and SJVAPCD Rule 4565. For purposes of this analysis, the NH3 control efficiency for the requirements of District Rule 4565 are assumed to be the same as the VOC control efficiency for these requirements since the same measures generally result in similar control efficiencies for both VOC and NH3 from these operations.

For example, covering compost with a waterproof covering, finished compost, or soil is assumed to have a control efficiency of 60% for both VOCs and NH3. As discussed above, a properly designed and operated biofilter can achieve a control efficiency of greater than 90% for NH3 and VOC emissions, but will conservatively assumed to have a control efficiency of 80% for purposes of this analysis.

It should also be noted that in practice, the facilities that are actually subject to SCAQMD Rule 1133.2 will have much larger throughputs than 1,000 ton per year throughput threshold given in the rule. SCAQMD Rule 1133.2 includes the following exemptions for existing co-composting operations with a design capacity of less than 35,000 tons of throughput per year containing no more than 20 percent biosolids by volume and new and existing municipal facilities using aeration and processing less than 5,000 tons of biosolids or manure per year. Many operations in the SCAQMD have found it to be economical to transport these materials to other jurisdictions for processing. An example of this is the Synagro South Kern Compost Manufacturing Facility, which is a newer facility located in the Valley and processes biosolids transported from SCAQMD.

Because some mitigation measures are only cost-effective for larger facilities, District staff developed the concept of Class One and Class Two mitigation measures. Class One mitigation measures are cost effective options for all facilities, regardless of size. These measures are management practices found to be best practices for all composting operations. Class Two mitigation measures are the technology options and achieve reductions greater than Class One mitigation measures; however, they were determined to not be cost effective for facilities with throughputs of less than 100,000 wet tons per year. District Rule 4565 requires reductions from two additional categories (landfilling and land applying) when compared to SCAQMD Rule 1133.2. For the third category, composting, District staff determined it is not cost effective to require in-vessel (enclosed) composting.

Category	SCAQMD Rule 1133.2	SJVUAPCD Rule 4565	Reason
Facilities Other Than Co-Composting (Landfilling, Land Applying)	Rule does not apply to these operations	Management practice requirements	Knowledge of control options has increased since Rule 1133.2 adoption and staff believes that cost effective methods of controlling VOC and NH3 emissions from these facilities exist.
Co-Composting Threshold for Applicability	Facilities with at least 1,000 tpy throughput	Facilities that handle 100 tpy or more of biosolids, animal manure, or poultry litter	Staff believes that there are reasonable options that are not exceedingly costly for facilities with throughputs of ≥100 tpy that would not impose an undue burden on operators.
Composting Control Requirements	In-vessel composting with 70% control efficiency for VOC and NH3 for existing facilities and 80% control efficiency for VOC and NH3 for new facilities	Control efficiency of 10%-80% for VOC (and NH3) depending on type of operation and facility throughput	Management practices (mitigation measures) are effective, reasonable, and have been achieved in practice for smaller facilities. In-vessel composting is not cost-effective for smaller or medium facilities and there are no known, unsubsidized facilities in the SCAQMD that would comply with such rule requirements.

Additional Emission Reduction Opportunities

Beyond the review of current regulation and rule requirements, the District performed an extensive review of the feasibility of expanding applicability or removal of exemptions for this source category, technologies and measures that have been implemented in practice in other regions, and potential new technologies and measures that may be feasible for implementation in the near future. Based on this review, District staff did not find any additional measures currently available or that will be available prior to the 2025 attainment deadline date that could improve the effectivity of this rule.

Evaluation Findings

While BACM and MSM requirements do not apply to ammonia since it is not a significant precursor to PM2.5 formation in the Valley, District staff concludes that District Rule 4565 and major sources of ammonia in the Valley satisfy BACM and MSM requirements for ammonia emissions from biosolids, animal manure, and poultry litter operations.

RULE 4566 (ORGANIC MATERIAL COMPOSTING OPERATIONS)

Discussion

District Rule 4566 (Organic Material Composting Operations) was adopted on August 18, 2011, to limit VOC emissions from composting facilities whose feedstock consists of greenwaste and/or food waste. The rule applies to new and existing organic material composting and stockpiling facilities in which the feedstock consists of green material (e.g. vegetative waste material generated from gardening, agriculture, or landscaping activities, etc.) and/or food waste with <100 ton/yr biosolids or manure. In addition to limiting VOC emissions, the measures required by District Rule 4566 have also been demonstrated to limit ammonia (NH3) emissions from these operations. However, it should be noted that the NH3 emissions from greenwaste and food waste composting are generally low, with the NH3 measurements often resulting in values below the detection limit of measurement methods.[115]

NH3 emissions from green material and food waste result from the microbial decomposition of nitrogenous compounds in these materials and the subsequent volatilization of the ammonia that is produced. The mitigation measures required by District Rule 4566 include management practices that facilitate stabilization of the nitrogen during composting operations and reduce volatilization of gaseous pollutants. Examples of the mitigation measures required by District Rule 4566 that reduce VOC and NH3 emissions include use of a watering system to maintain sufficient moisture in the compost and covering windrows with at least six inches of finished compost. In addition, District Rule 4566 requires the largest green material and food waste composting facilities to demonstrate VOC reductions of at least 80% during the active phase through use of a control device, such as a biofilter, which would also reduce NH3 emissions.

Additional information on the ways in which the mitigation measures required by District Rule 4566 reduce NH3 emissions is provided below:

- Watering Systems: The use of watering systems to maintain sufficient moisture in the compost windrows reduces NH3 emissions from the compost because NH3 is very soluble in water; therefore, when sufficient moisture is maintained in the compost windrows much of the NH3 will dissolve in the water, thereby reducing emissions. Regarding the effect that moisture has on the NH3 emission rate from

[115] For example the CalRecycle Report: Emissions Testing of Volatile Organic Compounds from Greenwaste Composting at the Modesto Compost Facility in the San Joaquin Valley (Revised May 2008). Publication #442-07-009. Available at: https://www2.calrecycle.ca.gov/Publications/Download/860 states, "*Note that ammonia was not detected by the laboratory to a method detection limit of 0.02 ppmv*"

manure, the draft EPA report Emissions from Animal Feeding Operations (August 2001) [116] states "*Because of its high solubility in water, the loss of ammonia to the atmosphere will be more rapid when drying of manure occurs."* This is also true for NH3 emissions from composting because NH3 emissions from composting and manure are the result of the same basic processes. In addition, because NH3 is a weak base, when NH3 dissolves in water, a portion of the NH3 will be converted to ammonium (NH4+), which unlike NH3, is not volatile. This results in a greater amount of ammonical nitrogen (NH3/NH4+) remaining in the windrows and becoming stabilized in the compost rather than volatilizing to the air. The additional moisture from the watering system will also reduce the air-filled porosity at the surface of compost windrows, thereby reducing the diffusion of NH3 to the surface of the windrow and subsequent volatilization. Information from the report Gaseous Emissions from Management of Solid Waste: a Systematic Review (2015) indicates that the measured NH3 emissions from solid waste under moist conditions was 33% lower than under dry conditions. [117] In addition, the final report Comparison of Mitigation Measures for Reduction of Emissions from Greenwaste Composting (2011)[118] prepared for the San Joaquin Valleywide Air Pollution Study Agency (SJVAPSA) demonstrated a significant VOC control efficiency (at least 20%) for irrigation of compost windrows. Although, the NH3 emissions from composting of greenwaste are much lower than VOC emissions, based on the available information, the control efficiency for NH3 is expected to be similar.

- Covering Compost Piles with Finished Compost: Covering the compost piles with finished compost or soil reduces emissions in the same manner as a biofilter; microorganisms in the finished compost or soil facilitate conversion of VOCs and NH3 to carbon dioxide, nitrogen, water, and biomass before the compounds are emitted to the atmosphere. The report prepared by CalRecycle for the San Joaquin Valley Air Pollution Control District Technology Advancement Program (TAP) project: Greenwaste Compost Site Emissions Reductions from Solar-Powered Aeration and Biofilter Layer (5/14/2013) [119] demonstrated control efficiencies greater than 90% for VOC and between 53% to greater than 83% for NH3 for compost piles covered with one foot of finished compost.

[116] US EPA Emissions Standards Division, Office of Air Quality Planning and Standards (August 2001). Emissions from Animal Feeding Operations (Draft). EPA Contract 68-D6-0011. Available at: https://www3.epa.gov/ttn/chief/ap42/ch09/draft/draftanimalfeed.pdf

[117] Pardo, G., Moral, R., Aguilera, E., Del Prado, A. (2015) Gaseous Emissions from Management of Solid Waste: a Systematic Review; (2015); Global Change Biology; 21, 2015, 1313-1327. https://doi.org/10.1111/gcb.12806

[118] Büyüksönmez, F. (2011) Comparison of Mitigation Measures for Reduction of Emissions from Greenwaste Composting. Funded by and prepared for t the San Joaquin Valleywide Air Pollution Study Agency (SJVAPSA). 09-01-CCOS. Available at: http://valleyair.org/busind/pto/emission_factors/Criteria/Criteria/Composting/FINAL-COMPOST-STUDY-REPORT.pdf

[119] CalRecycle – Principal Study Author Robert Horowitz (5/14/2013) Greenwaste Compost Site Emissions Reductions from Solar-Powered Aeration and Biofilter Layer. Funded by and prepared for the San Joaquin Valley Air Pollution Control District Technology Advancement Program (TAP). Available at: http://www.valleyair.org/Grant_Programs/TAP/documents/C-15636-ACP/C-15636_ACP_FinalReport.pdf

- District and EPA Approved Mitigation Measures that Demonstrates at Least 80% VOC Reduction by Weight: For the largest green material and food waste composting facilities with annual throughputs of at least 750,000 wet tons per year, District Rule 4566 requires implementation of a mitigation measure that demonstrates a VOC control efficiency of 80% during the active phase of composting. There are currently no greenwaste or food waste composting operations of this size in the San Joaquin Valley that would be subject to District Rule 4566. However, because of practical and economic considerations, large composting operations that must control emissions and/or odors almost universally use biofilters as control devices. Although District Rule 4566 only specifies a VOC control efficiency, when biofilters are designed and operated to achieve the required VOC control efficiency, they also result in a similar control efficiency for NH3 emissions. The SCAQMD Final Staff Report for Proposed Amended Rule 1133.1 – Chipping and Grinding Activities and Proposed Rule 1133.3 – Emission Reductions from Greenwaste Composting Operations (July 2011)[120] states "*Based on the information collected on existing biofilter composting applications, overall control efficiencies of about 80 to 90 percent for VOC and 70 to over 90 percent for ammonia have been achieved*." and also states "*Based on source tests data from existing cocomposting operations (Inland Empire Regional Composting Facilities and City of Los Angeles Sanitation Bureau), properly designed and maintained biofilters have demonstrated over 90 percent destruction efficiencies for both VOC and ammonia emissions.*"

Composting facilities subject to District Rule 4566 fall into one of three categories based on the wet tons of compostable materials processed at the facility annually (annual throughput): facilities with throughputs less than 200,000 wet tons per year; those with throughputs of at least 200,000 wet tons per year, but less than 750,000 wet tons per year; and those with throughputs of at least 750,000 wet tons per year.

The mitigation measures required by District Rule 4566 focus on the active phase of composting because the active phase of composting is the part of the composting process in which the compost feedstock is rapidly decomposing resulting in the highest emissions. The District document "Compost VOC Emission Factors" (September 15, 2010)[121] indicates that 90% of composting VOC emissions are attributed to the active phase and 10% to the curing phase. Based on the information from the source test reports, the NH3 emissions measurements resulted in a similar profile with vast majority of NH3 emissions occurring during the active phase of composting. Therefore, the same ratio of 90% of emissions from the active phase of composting and 10% for the curing phase of composting will be assumed for NH3 emissions.

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[120] South Coast AQMD (July 2011) Final Staff Report for Proposed Amended Rule 1133.1 – Chipping and Grinding Activities and Proposed Rule 1133.3 – Emission Reductions from Greenwaste Composting Operations. Available at: http://www.aqmd.gov/docs/default-source/Agendas/Governing-Board/2011/2011-jul8-037.pdf?sfvrsn=2

[121] San Joaquin Valley Air Pollution Control District [SJVAPCD]. (September 15, 2010). Compost VOC Emission Factors. Fresno, CA: San Joaquin Valley Air Pollution Control District. Available at: http://www.valleyair.org/busind/pto/emission_factors/Criteria/Criteria/Composting/Compost%20EF.pdf

Source Category

As discussed above, the mitigation measures required by SJVAPCD Rule 4566 will reduce both VOC and NH3 from these operations. As previously mentioned, the report Gaseous Emissions from Management of Solid Waste: a Systematic Review (2015) indicates that the measured NH3 emissions from solid waste under moist conditions was 33% lower than under dry conditions; however, for purposes of this analysis, the NH3 control efficiency achieved for implementation of the watering system mitigation measure will be conservatively assumed to be equivalent to the minimum required VOC control efficiency of 19%. The NH3 control efficiency for implementation of the Finished Compost Cover Mitigation measure will also be assumed to be equivalent to the minimum required VOC control efficiency of 60% for facilities with an annual throughput of 200,000 wet tons to less than 750,000 wet tons. As discussed above, this control efficiency is supported by the information in the report prepared by CalRecycle for the San Joaquin Valley Air Pollution Control District Technology Advancement Program (TAP) project: Greenwaste Compost Site Emissions Reductions from Solar-Powered Aeration and Biofilter Layer (5/14/2013). For the largest greenwaste and food waste composting operations with annual throughputs 750,000 wet tons or more, it is expected that they will use a biofilter as a control device, which will achieve a minimum NH3 control efficiency of 75%.

District Rule 4566 Control Measure Efficiencies:
The minimum expected overall District Rule 4566 NH3 control efficiencies for green material and food waste composting facilities with throughputs of less than 200,000 wet tons per year, 200,000 wet tons but less than 750,000 wet tons per year, and 750,000 wet tons per year or more are summarized in the tables below.

Estimated Minimum Overall NH3 Control Efficiencies for Rule 4566 Mitigation Measures for Greenwaste and Food Waste Composting Facilities of Different Sizes		
Facility Throughput (wet tons/yr)	**Rule 4566 Requirements**	**Estimated Overall NH3 Control Efficiency***
< 200,000 wet tons per year	For windrow composting only, implement at least three turns during the active phase and one of the mitigation measures for the Watering Systems in Table 1. or Implement an APCO and EPA approved alternative mitigation measure that demonstrates at least a 19% reduction, by weight, in VOC emissions.	17.1%
200,000 but < 750,000 wet tons per year	For windrow composting only, implement all of the following: - At least three turns during the active phase; - One of the mitigation measures for the Watering Systems in Table 1; and - The Finished Compost Cover mitigation measure. or	54%

	Implement an APCO and EPA approved alternative mitigation measure that demonstrates at least 60% reduction, by weight, in VOC emissions.	
≥ 750,000 wet tons per year	An operator of a composting operation with a total throughput of greater than or equal to 750,000 wet tons per year of organic material shall implement an APCO and EPA approved mitigation measure that demonstrates at least 80% reduction, by weight, in VOC emissions for organic material during the active phase.	67.5%**

* *These mitigation measures are only required during the active phase of composting. Based on the emission measurements at composting operations, it is assumed that 90% of the total VOC and NH3 emissions occur during the active phase of composting; therefore, the overall control efficiency will be the minimum required control efficiency multiplied by 90%.*

** *NH3 control efficiency conservatively assumed to be 75% for active phase of composting*

How does District Rule 4566 compare with federal and state rules and regulations?

Federal requirements such as NSPS, NESHAP, MACT, CTGs, and ACTs and state regulations are not applicable to this source category.

How does District Rule 4566 compare to rules in other air districts?

District staff compared District Rule 4566 with the rules for greenwaste and foodwaste composting operations from other California air districts. The results of the analysis are discussed below. District staff only located one other air district rule that applied to similar sources: SCAQMD Rule 1133.3. No rules that apply to organic materials composting operations were located for Bay Area Air Quality Management District, Sacramento Metropolitan Air Quality Management District, or Ventura County Air Pollution Control District.

SCAQMD

- SCAQMD Rule 1133.3 - Emission Reductions from Greenwaste Composting Operations *(Adopted July 8, 2011)*

The purpose of SCAQMD Rule 1133.3 is to reduce emissions of VOCs and NH3 from greenwaste and food waste composting operations. The table below compares the significant similarities and differences between SJVAPCD Rule 4566 and SCAQMD Rule 1133.3. For purposes of this analysis, the ammonia control efficiencies achieved by the requirements of SJVAPCD Rule 4566 are assumed to be the same as the VOC control efficiencies since the same control measures will reduce both VOC and NH3 from these operations. Greenwaste/food waste composting produces about 16% of the ammonia emissions on a per ton basis compared to co-composting.[122]

As shown in the table below, based on discussions with SCAQMD permitting and rule development staff, SCAQMD does not have any greenwaste composting production facilities subject to the 80% ammonia reduction requirement of Rule 1133.3.

[122] SCAQMD Rule 1133.3, baseline NH_3 emissions from greenwaste/foodwaste composting = 0.46 lb-NH3/ton-throughput. SCAQMD Rule 1133.2, baseline NH_3 emissions from co-composting = 2.93 lb-NH3/ton-throughput.

In previous conversations and correspondence with District staff, SCAQMD staff has indicated that the SCAQMD does not currently permit open windrow composting operations or require them to comply with SCAQMD Rule 1133.2.[123] This would be the majority of composting operations, particularly in the District where there is more land available.

Based on the information from SCAQMD staff, there is currently only one facility (Inland Empire Regional Composting Facility) in the SCAQMD that performs full-scale co-composting inside a building that vents the exhaust through a biofilter.[124]

Rancho Las Virgenes Composting Facility may also have enclosed composting vented to a biofilter. However, this facility appears to be exempt from SCAQMD Rule 1133.2 since it is an existing composting operation (composting began in 1993 or 1994) with less than 10,000 tons per year of throughput. Controls were likely added to prevent nuisance odors from affecting the surrounding area. Moreover the throughput for Las Virgenes has been nil since 2012 according to SCAQMD's annual emissions reporting.

It must also be noted that many operations in the SCAQMD have found it to be economical to transport materials to other jurisdictions, such as the SJVAPCD, for composting. An example of this is the Synagro South Kern Compost Manufacturing Facility, which is a facility located in the San Joaquin Valley and processes biosolids transported from SCAQMD.

Because SCAQMD has no existing production greenwaste composting facilities that are subject to the 80% ammonia control requirement of Rule 1133.3, and the new facilities are permitted under experimental research exemptions, then Rule 1133.3 should not be used to establish BACM or MSM as 80% for that category/throughput level of greenwaste composting.

[123] Email correspondence between SJVAPCD Air Quality Engineer, Brian Clerico, and SCAQMD Planning and Rules Manager, Tracy Goss, June 16, 2015.
[124] Email correspondence between SJVAPCD Air Quality Engineer, Brian Clerico, and SCAQMD Air Quality Specialist, Jong Hoon Lee, June 25, 2015.

Rule Section	SCAQMD Rule 1133.3	District Rule 4566	Explanation of Differences
Applicability	New and existing greenwaste and food waste composting operations.	New and existing organic material composting and stockpiling facilities. (Organic material is defined as green material, food material, or mixtures of the two, with <100 ton/yr biosolids or manure.)	SCAQMD Rule 1133.3 limits food waste stockpiling time (48 hr), whereas District Rule 4566 limits organic material stockpiling time (3 or 10 days, depending on throughput).
Exemptions	Applicability/exemptions based on facility type, not throughput.	Applicability/exemptions based on facility type, not throughput.	The same types of facilities are exempt in both rules: facilities subject to a co-composting rule (SCAQMD Rule 1133.2 or District Rule 4565), nursery, household, recreational, and community composting facilities. District Rule 4566 also exempts agricultural facilities which are subject to District Rules 4204, 4550, or 4570.
Composting Control Requirements	• ≤5,000 ton/yr food waste or ≤20% manure (watering and finished compost cover or ≥20% control for NH3) • >5,000 ton/yr food waste, (emission control device with ≥80% control for NH3)	• <200,000 ton/yr organic material (watering system or ≥19% control for NH3) • ≥200,000 and <750,000 ton/yr organic material (watering system and finished compost cover or ≥60% control for NH3) • ≥750,000 ton/yr organic material (emission control device with ≥80% control for NH3)	The throughput/control levels in Rule 4566 are based on cost effectiveness and socioeconomic studies conducted by the District as part its Final Staff Report for the Revised Proposed New Rule 4566 (Appendices C and D, August 18, 2011). Rule 4566 requires the same management practices and control requirements as Rule 1133.3; however, the throughput levels at which the stricter control requirements in Rule 4566 become triggered are much higher than in Rule 1133.3. Thus, on paper, Rule 1133.3 appears to be more stringent than Rule 4566. However, SCAQMD does not have any greenwaste composting facilities (that are not under an experimental research permit) subject to the 80% control requirements of Rule 1133.3.

Additional Emission Reduction Opportunities

District Rule 4566 (Organic Material Composting) is the most stringent rule in the nation for controlling emissions from composting operations; additional controls are infeasible.

Evaluation Findings

While BACM and MSM requirements do not apply to ammonia since it is not a significant precursor to PM2.5 formation in the Valley, District staff concludes that District Rule 4566 meets BACM and MSM requirements for ammonia emissions from greenwaste and foodwaste composting operations. The District evaluated the feasibility of additional ammonia emissions reductions and did not identify any additional feasible measures. The District has taken every regulatory action feasible to reduce emissions from this source and continues to seek additional methods to reduce emissions through innovative strategies, such as the support of research and technology demonstrations.

C.25 EMISSION INVENTORY CODE (EIC) TABLE

Control Measure	Emission Inventory Codes
Rule 4103 (Open Burning)	670-660-0262-9842; 670-660-0262-9862; 670-660-0262-9874; 670-660-0262-9884; 670-660-0262-9888; 670-660-0262-9892; 670-662-0262-9878; 670-668-0200-9858; 670-668-0200-9872; 670-668-0200-9886; 670-995-0240-9848
Rule 4104 (Reduction of Animal Matter)	420-995-6004-0000
Rule 4106 (Prescribed Burns)	670-666-0200-0000; 670-670-0200-0000
Rule 4203 (Particulate Matter Emissions from the Incineration of Combustible Refuse)	010-005-0243-0000
Rule 4204 (Cotton Gins)	420-418-6028-0000; 420-420-6028-0000
Rule 4301 (Fuel Burning Equipment)	
Rule 4307 (Boilers, Steam Generators and Process Heaters 2 – 5 MMBtu/hr)	010-005-0110-0000; 010-005-0124-0000; 010-005-0130-0000; 010-005-0300-0000; 010-005-1220-0000; 020-005-0110-0000; 030-005-0110-0000; 030-005-0124-0000; 030-005-0130-0000; 030-005-1220-0000; 030-005-1530-0000; 030-010-0110-0000; 030-010-0130-0000; 030-010-1220-0000; 030-010-1600-0000; 030-015-0110-0000; 030-015-0130-0000; 040-005-0110-0000; 040-005-1530-0000; 040-010-0100-0000; 040-010-0110-0000; 040-010-0120-0000; 040-010-0130-0000; 040-010-1000-0000; 050-005-0110-0000; 050-005-0122-0000; 050-005-0124-0000; 050-005-0130-0000; 050-005-0320-0000; 050-005-1100-0000; 050-005-1220-0000; 050-005-1510-0000; 050-005-1520-0000; 050-005-3220-0000; 050-010-0110-0000; 050-010-0120-0000; 050-010-0320-0000; 050-010-1220-0000; 050-010-1500-0000; 052-005-0110-0000; 052-005-0124-0000; 052-005-1220-0000; 052-010-0110-0000; 052-010-0120-0000; 052-010-1224-0000; 060-005-0110-0000; 060-005-0122-0000; 060-005-0124-0000; 060-005-0130-0000; 060-005-0142-0000; 060-005-0144-0000; 060-005-0320-0000; 060-005-1220-0000; 060-005-1510-0000; 060-005-1520-0000; 060-010-0100-0000; 060-010-0110-0000; 060-010-0120-0000; 060-010-0142-0000 The EICs are the same for Rules 4306/4320, 4307, and 4308; the three rules share a combined emission inventory. Baseline emissions from the 2008 and 2009 rule amendments of these rules were used to determine the percentage of emissions for each rule. Those respective percentages are applied to the combined inventory to get the individual emission inventories.
Rule 4308 (Boilers, Steam Generators and Process Heaters 0.075 to less than 2.0 MMBtu/hr)	The EICs are the same for Rules 4306/4320, 4307, and 4308; the three rules share a combined emission inventory. Baseline emissions from the 2008 and 2009 rule amendments of these rules were used to determine the percentage of emissions for each rule. Those respective percentages are applied to the combined inventory to get the individual emission inventories. See Rule 4307 for the EICs.
Rule 4309 (Dryers)	430-422-7078-0000; 430-424-7006-0000; 430-995-7000-0000; 499-995-0000-0000; 499-995-5630-0000

Control Measure	Emission Inventory Codes
Rule 4311 (Flares)	110-132-0130-0000; 110-132-0146-0000; 120-132-0136-0000; 130-132-0110-0000; 130-132-0130-0000; 130-132-0136-0000; 310-320-0010-0000; 310-320-0110-0000; 310-320-0120-0000; 310-320-0130-0000; 310-320-0136-0000; 310-320-1600-0000; 320-320-0010-0000; 320-320-0110-0000; 320-320-0120-0000; 320-320-0130-0000
Rule 4313 (Lime Kilns)	Lime kilns are not included in the CARB emissions inventory. There are no lime kilns currently operating in the Valley.
Rule 4320 (AERO for Boilers, Steam Generators, and Process Heaters >5 MMBtu/hr)	The EICs are the same for Rules 4306/4320, 4307, and 4308; the three rules share a combined emission inventory. Baseline emissions from the 2008 and 2009 rule amendments of these rules were used to determine the percentage of emissions for each rule. Those respective percentages are applied to the combined inventory to get the individual emission inventories. See Rule 4307 for the EICs.
Rule 4352 (Solid Fuel Fired Boilers, Steam Generators, and Process Heaters)	010-005-0214-0000; 010-005-0218-0000; 010-005-0220-0000; 010-005-0240-0000; 010-005-0243-0000; 010-005-0254-0000; 020-005-0218-0000; 020-005-0230-0000; 030-005-0214-0000; 050-005-0214-0000; 050-005-0240-0000; 050-005-0254-0000; 052-005-0240-0000; 060-005-0240-0000; 060-005-0264-0000
Rule 4354 (Glass Melting Furnaces)	460-460-7037-0000; 460-460-7038-0000; 460-460-7039-0000
Rule 4550 (Conservation Management Practices)	620-614-5400-0000; 620-615-5400-0000;650-650-5400-0000; 650-651-5400-0000
Rule 4641 (Cutback, Slow Cure, and Emulsified Asphalt, Paving and Maintenance Operations)	540-560-0400-0000; 540-562-0400-0000; 540-564-0400-0000; 540-566-0400-0000
Rule 4692 (Commercial Charbroiling)	690-680-6000-0000
Rule 4702 (Internal Combustion Engines)	010-040-0110-0000; 010-040-1200-0000; 020-040-0110-0000; 020-040-1200-0000; 030-040-0110-0000; 030-040-0124-0000; 030-040-1200-0000; 030-040-1210-0000; 040-040-0110-0000; 050-040-0012-0000; 050-040-0110-0000; 050-040-0124-0000; 050-040-1200-0000; 052-040-0110-0000; 052-040-1200-0000; 052-042-0110-0000; 052-042-1200-0000; 052-042-1200-0010; 052-042-1200-0011; 060-040-0110-0000; 060-040-0124-0000; 060-040-0142-0000; 060-040-0146-0000; 060-040-1100-0000; 060-040-1200-0000; 060-040-1210-0000; 060-995-1220-0000; 099-040-1200-0000
Rule 4703 (Stationary Gas Turbines)	010-045-0110-0000; 010-045-1200-0000; 020-045-0110-0000; 030-045-0110-0000; 040-045-0134-0000; 050-045-1200-0000; 060-045-0110-0000; 060-045-1200-0000
Rule 4802 (Sulfuric Acid Mist)	410-400-2058-0000
Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters)	610-600-0230-0000; 610-602-0230-0000
Rule 4902 (Residential Water Heaters)	610-608-0110-0000
Rule 4905 (Natural Gas – Fired, Fan Type Residential Central Furnace)	610-606-0110-0000
Rule 8011 (General Requirements)	There is no specific emissions inventory associated with Rule 8011.

Control Measure	Emission Inventory Codes
Rule 8021 (Construction, Demolition, Excavation, Extraction, and Other Earthmoving Activities)	630-622-5400-0000; 630-624-5400-0000; 630-626-5400-0000; 630-628-5400-0000; 630-634-5400-0000
Rule 8031 (Bulk Materials)	430-436-7006-0000; 430-436-7078-0000; 430-995-7064-0000
Rule 8041 (Carryout and Trackout)	The EICs are included in Rule 8061 (Paved and Unpaved Roads).
Rule 8051 (Open Areas)	650-652-5400-0000
Rule 8061 (Paved and Unpaved Roads)	640-635-5400-0000; 640-637-5400-0000; 640-639-5400-0000; 640-641-5400-0000; 640-643-5400-0000; 645-638-5400-0000; 645-640-5400-0000; 645-644-5400-0000; 645-648-5400-0000
Rule 8071 (Unpaved Vehicle Traffic)	645-645-5400-0000; 645-647-5400-0000. The CARB Emissions Inventory database does not contain emissions data on unpaved vehicle and equipment traffic areas.
Rule 8081 (Ag Sources)	645-646-5400-0000
Lawn Care Equipment	860-902-1100-4065; 860-902-1100-4094; 860-902-1100-4095; 860-902-1100-4102; 860-902-1100-4103; 860-902-1100-4112; 860-902-1100-4113; 860-902-1100-4124; 860-902-1100-4125; 860-902-1100-5672; 860-902-1100-5673; 860-902-1100-5684; 860-902-1100-5685; 860-902-1100-5692; 860-902-1100-5693; 860-902-1100-5704; 860-902-1100-5705; 860-902-1100-5724; 860-902-1100-5725; 860-902-1100-7604; 860-902-1100-7605; 860-902-1100-7614; 860-902-1100-7615; 860-902-1100-8104; 860-902-1100-8105; 860-902-1100-8112; 860-902-1100-8113; 860-902-1100-8344; 860-902-1100-8345; 860-902-1100-8352; 860-902-1100-8353; 860-902-1100-8364; 860-902-1100-8365; 860-902-1100-8372; 860-902-1100-8373; 860-902-1100-8384; 860-902-1100-8385; 860-902-1100-9074; 860-902-1100-9075; 860-902-1100-9542; 860-902-1100-9543; 860-902-1100-9554; 860-902-1100-9555; 860-902-1100-9834; 860-902-1100-9835; 860-903-1100-1394; 860-903-1100-1395; 860-903-1100-1404; 860-903-1100-1405; 860-903-1100-4084; 860-903-1100-4085; 860-903-1100-5744; 860-903-1100-5745; 860-903-1100-5754; 860-903-1100-5755; 860-903-1210-1190; 860-903-1210-1200; 860-903-1210-1210; 860-903-1210-1220; 860-903-1210-1230; 860-903-1210-1240; 860-903-1210-1250; 860-903-1210-1350; 860-903-1210-1380; 860-903-1210-4050; 860-903-1210-4070; 860-903-1210-4130; 860-903-1210-4140; 860-903-1210-4150; 860-903-1210-5710; 860-903-1210-5730; 860-903-1210-8390; 860-903-1210-8400; 860-903-1210-8410

Appendix D

Mobile Source Control Measure Analyses

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Best Available Control Measures (BACM) and Most Stringent Measures (MSM) Analysis of Mobile Source Control Programs for the San Joaquin Valley's 2016 Comprehensive PM2.5 SIP

[This chapter provided by the California Air Resources Board]

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D. EXECUTIVE SUMMARY

The Clean Air Act (the Act) specifies required levels of emission controls in a State Implementation Plan (SIP), depending upon the severity of the air quality problem and amount of time a nonattainment area needs to meet the PM2.5 standard. The State has conducted this analysis for each mobile source category in the San Joaquin Valley (SJV or Valley). The suite of control measures that is currently being implemented by California Air Resources Board (CARB or Board) – both the current control program and new measures proposed for the Valley – satisfy the applicable control requirements for Best Available Control Measures (BACM) and Most Stringent Measures (MSM) for the four PM2.5 standards addressed in this plan. This analysis finds that California's mobile source control program is the most stringent and far-reaching suite of mobile source control measures that is currently implemented in the nation, and meets the required levels of emissions controls.

In conducting this analysis, CARB staff followed a four-step process of assessing California's mobile source program. First, staff identified mobile source emissions as a significant contributor to ambient PM2.5 emissions. Next, staff identified potential control measures for each mobile source sector, including an analysis of California's mobile source control program, other control measures in practice throughout the nation, and reconsideration of control measures that were previously considered to be infeasible. Staff then assessed the stringency and feasibility of the potential control measures that were identified. And finally, while many of the measures identified in this analysis are already measures in the California SIP, additional control measures have been included as commitments in the Valley's proposed SIP.

In aggregate, California's comprehensive suite of new vehicle and engine emission standards, in-use control measures, fuel specifications, and incentive programs for mobile sources represent the most stringent level of controls in the nation, and achieve the maximum feasible emission reductions for this category:

- California's control measures for the passenger vehicle fleet includes new vehicle emission standards, fuel specifications, and the most rigorous in-use inspection program for on-road light-and medium-duty vehicles in the country. The suite of on-road light-duty vehicle control measures included in the Valley's plan is anticipated to achieve the maximum feasible emission reductions possible, and is comprised of the most stringent level of control measures for this category in the nation.

- California's heavy-duty on-road vehicle and engine control program is comprised of the most stringent emission standards for new engines in the nation (i.e. new vehicle tailpipe emission and evaporative emission standards; certification, testing, and verification requirements; warranty and useful life requirements, and OBD system requirements). Additionally, to reduce in-use emissions and accelerate fleet turnover to cleaner engines, California's in-use control measures include the most stringent inspection and maintenance program, idling requirements, and legacy fleet requirements for on-road heavy-duty fleets in the nation. Finally, California's clean diesel regulations provide the most stringent emission controls in the nation for conventional and renewable diesel fuels and diesel substitute fuels. In aggregate, the suite of on-road heavy-duty control measures included in the Valley's plan is anticipated to achieve the maximum feasible emission reductions possible, and is comprised of the most stringent level of control measures for this category in the nation.

- California's off-road engine and equipment control program includes the most stringent emission standards for new engines in the nation, comprehensive in-use fleet requirements to address emissions from the legacy fleets, and the cleanest off-road diesel fuel specifications in the nation. California's in-use control measures are national models for aggressive and successful efforts to reduce in-use emissions and accelerate fleet turnover to cleaner engines. In aggregate, the suite of off-road mobile source control measures included in the Valley's plan is anticipated to achieve the maximum feasible emission reductions possible, and is comprised of the most stringent level of control measures for this category in the nation.

D.1 CHAPTER I. CLEAN AIR ACT REQUIREMENTS FOR EMISSION CONTROL MEASURES

The particulate matter provisions in the Act establish a step-wise process for classifications and attainment dates:

- The first step is a Moderate area SIP, with an initial attainment date six years after the area is designated nonattainment;
- If attainment within six years is impracticable given the severity of the PM2.5 challenge in that area, then U.S. EPA re-classifies the area to Serious, and establishes requirements for a second SIP submittal that must show attainment within 10 years after the area was originally designated nonattainment.

Likewise, the Act specifies a step-wise process for the required level of emission controls in a SIP, depending upon the severity of the air quality problem and amount of time a nonattainment area needs to meet the PM2.5 standard:

- For a Moderate nonattainment area, the required level of control is Reasonably Available Control Measures (RACM).[1]
- For a Serious PM2.5 nonattainment area, BACM is the required level of control. U.S. EPA defines BACM to be the maximum degree of emission reductions achievable from a source or source category determined on a case-by-case basis considering energy, economic, and environmental impacts.[2]
- For a Serious PM2.5 nonattainment area for which air quality modeling demonstrates that the area cannot practicably attain by the end of the tenth calendar year (i.e. designated as “Serious with Extension”), MSM is the required level of control.[3] U.S. EPA defines MSM as, “the maximum degree of emission reductions that has been required or achieved from a source or source category in any other attainment plans or in practice in any other states and that can feasibly be implemented in the area.”[4] MSM is also inclusive of BACM requirements.
- For a Serious PM2.5 nonattainment area that has not attained by the applicable attainment date (i.e. designated as “Serious – 5% Plan”), the required level of control is also MSM.[5]

The Valley is a Serious nonattainment area for each of the four PM2.5 standards discussed in this plan.

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[1] RACM requirements are addressed in the Moderate SIP for the Valley. For further information see https://www.arb.ca.gov/planning/sip/planarea/sanjqnvllysip.htm

[2] U.S. EPA 1994 Addendum to the General Preamble p. 42010

[3] 40 CFR 51.1010(b)(2)(i)

[4] See U.S. EPA “Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements” pp. 326 July 2016 https://www.epa.gov/sites/production/files/2016-07/documents/pm25-naaqs-implementation-final-preamble-rule-signature.pdf

[5] 40 CFR 51.1003(c)(2)(i)

D.1.1 REQUIRED STRINGENCY OF CONTROL MEASURES: DEFINING BACM AND MSM

Based on the Valley's current classification for each standard, Table 1 describes the level of control measures required for each of the applicable four PM2.5 standards.

Table 1: Stringency of Control Measures Required[6]

Standard	Classification	Type of Plan	Control Measure Requirements
12 µg/m3 Annual (2012)	Moderate with Request to Serious	Serious	**Best Available Control Measures** "The state shall identify, adopt, and implement best available control measures, including control technologies, on sources of direct PM2.5 emissions and sources of emissions of PM2.5 plan precursors." 40 CFR 51.1010(a)
35 µg/m^3 24-Hour (2006)	Serious with Extension	Most Stringent Measures (MSM)	**Most Stringent Measures** "The state shall identify, adopt, and implement the most stringent control measures that… can be feasibly implemented in the area." 40 CFR 51.1010(b)
15 µg/m^3 Annual (1997)	Serious, failed to attain by attainment date	5% Plan*	**Most Stringent Measures** "For the sources and source categories represented in the emission inventory for the nonattainment area, the state shall identify the most stringent measures for reducing direct PM2.5 and PM2.5 plan precursors." 40 CFR 51.1010(c)(2)(i)
65 µg/m^3 24-Hour (1997)			

* 5% plan means than a 5% reduction in directly emitted PM2.5/precursor emissions per year in the nonattainment area is required until attainment (which must be achieved as expeditiously as possible).

For areas like that Valley that are nonattainment for multiple PM2.5 standards that have become more stringent over time, classification is influenced by the timing of when the standards were finalized. Due to the step-wise nature of reclassification for PM2.5 standards, the Valley's control measures for this plan must satisfy U.S. EPA's requirements for both BACM and MSM.

The variance in the required levels of control measure stringency among the four standards shown in Table 1 is due to timing differences in when the standards were finalized, as this – along with the severity of its air quality – influences the Valley's classification status. Although the older standards are less stringent in value, the emission control requirements are most stringent for the 1997 standards because they were finalized earlier than the other standards (which were finalized in 2006 and 2012, respectively). Therefore, the Valley is furthest along in the step-wise process for the 1997 standards, relative to the more recent 2006 and 2012 standards.

D.1.1.1 Best Available Control Measures

BACM is the level of stringency required for the 2012 Annual Standards of 12 µg/m^3. The Act defines BACM as, "any technologically and economically feasible control

[6] The Valley's Comprehensive PM2.5 SIP has been developed to provide the necessary elements for each of the PM2.5 standards for which the Valley is classified as nonattainment. This appendix has been developed to meet a subset of these requirements; namely the requirement that staff demonstrate that the mobile source control strategies used to model the Valley's attainment demonstration for the PM2.5 standards listed in Table 2 satisfy U.S. EPA's requirements for Serious area attainment plan control strategy requirements, as set forth in § 51.1010.

measure that can be implemented in whole or in part within four years after the date of reclassification of a Moderate PM2.5 nonattainment area to Serious and that generally can achieve greater permanent and enforceable emissions reductions in direct PM2.5 emissions and/or emissions of PM2.5 plan precursors from sources in the area than can be achieved through the implementation of RACM on the same source."[7] U.S. EPA has further clarified that BACM-level of controls are:[8]

- The maximum degree of emissions reductions achievable from a source or source category, which is determined on a case-by-case basis considering energy, economic and environmental impacts;
- More stringent than RACM, but less stringent than the lowest achievable emission rate (LAER), which doesn't take into consideration the cost effectiveness of implementing a particular control measure;
- Additive to RACM, as BACM will generally consist of a more extensive implementation of RACM measures; and
- Inclusive of Best Available Control Technology (BACT).

U.S. EPA defines BACT similarly to BACM as an emission limitation based on the, "maximum degree of reduction of each pollutant emitted from or which results from any major emitting facility, which the permitting authority, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such facility through application of production processes and available methods, systems, and techniques."[9] BACT is also at least as stringent as new source performance standards (NSPS) and national emissions standards for hazardous air pollutants (NESHAPs)[10]

D.1.1.2 Most Stringent Measures

MSM is the level of stringency required for the 2006 24-Hour Standard of 35 µg/m^3, the 1997 Annual Standard of 15 µg/m^3, and the 24-Hour Standard of 65 µg/m^3. The Act defines MSM as, "any permanent and enforceable control measure that achieves the most stringent emissions reductions in direct PM2.5 emissions and/or emissions of PM2.5 plan precursors from among those control measures which are either included in the SIP for any other National Ambient Air Quality Standard (NAAQS), or have been achieved in practice in any state, and that can feasibly be implemented in the relevant PM2.5 NAAQS nonattainment area."[11]

U.S. EPA indicates that MSM is inclusive of the requirements and process for determining BACM, but with one additional step of comparing the potentially MSM against the measures already adopted in the area to determine if the existing measures are the most stringent.[12] Further U.S. EPA guidance defined MSM as "the maximum

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[7] Code of Federal Regulations (CFR) Title 40 – Protection of Environment § 51.1000 – Definitions https://www.gpo.gov/fdsys/pkg/CFR-2017-title40-vol2/xml/CFR-2017-title40-vol2-sec51-1000.xml

[8] U.S. EPA 1994 "Addendum to the General Preamble" pp. 42009 -42013

[9] 42 U.S. Code § 7479 – Definitions https://www.gpo.gov/fdsys/pkg/USCODE-2011-title42/html/USCODE-2011-title42-chap85-subchapI-partC-subparti-sec7479.htm See § 7479(3) BACT

[10] U.S. EPA 1994 "Addendum to the General Preamble" pp. 42009 -42013

[11] Code of Federal Regulations (CFR) Title 40 – Protection of Environment § 51.1000 – Definitions https://www.gpo.gov/fdsys/pkg/CFR-2017-title40-vol2/xml/CFR-2017-title40-vol2-sec51-1000.xml

[12] U.S. EPA 2001 *Final TSD for Maricopa County PM10 Nonattainment Area*. Available at https://www3.epa.gov/region9/air/phoenixpm/pdf/tsd0901.pdf

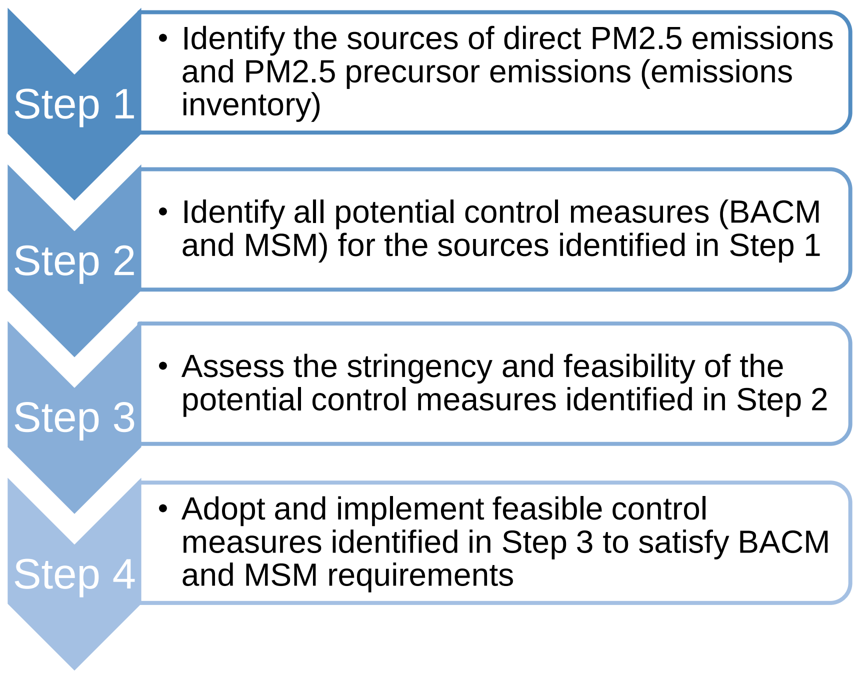
degree of emission reduction that has been required or achieved from a source or source category in any other attainment plans or in practice in any other states and that can feasibly be implemented in the area seeking the extension, such as what LAER represents for new or modified sources under the New Source Review permit program."[13]

[13] U.S. EPA 1994. *Addendum to the General Preamble*, 59 FR 41998 page 42010

D.2 Chapter II. Process for Determining BACM and MSM

U.S. EPA prescribes a four-step process for the identification and determination of whether the control measures satisfy the Serious area attainment plan control strategy requirements.

Figure 1 Process for Determining BACM and MSM



This process starts with identifying the sources of PM2.5 emissions (both direct and precursor emissions; then expands the analysis to identify all potential BACM/MSM control measures to reduce emissions. Step 3 begins to narrow the scope of analysis by refining the list of all potential BACM/MSM control measures to determine which of the control measures are sufficiently stringent to meet the applicable BACM and MSM requirements, and that are technically and economically feasible. The final step to adopt any control measures identified through this process, if they are feasible to implement in the Valley.

The process for identifying MSM generally follow the same steps as the process for identifying BACM.[14] This is because the Serious area attainment plan control strategy requirements described in § 51.1010 are additive as the plans become more stringent. That is to say, the MSM requirements are inclusive of the requirements for BACM, with additional requirements added to reflect the increased stringency in control levels that result from a bump-up in classification.[15] Table 2 delves more deeply into this process, showing each required element in the steps listed above for each of the four applicable PM2.5 Standards.

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[14] In accordance with U.S. EPA's prescribed process described in the *TSD for the Maricopa County Serious Area PM10 Plan – 24-Hour Standard* (U.S. EPA 2001), which states, "Given this similarity between the BACM requirement and the MSM requirement, we believe that determining MSM should follow a process similar to determining BACM, but with one additional step, to compare the potentially most stringent measure against the measures already adopted in the area to determine if the existing measures are most stringent." Document is available at: https://www3.epa.gov/region9/air/phoenixpm/pdf/tsd0901.pdf

[15] § 51.1003(b)(2)(iii) requires that a submittal requesting a Serious area attainment date extension that is simultaneous with the Serious area attainment plan shall meet the most stringent measure (MSM) requirements set forth at § 51.1010(b), in addition to the BACM and BACT and additional feasible measure requirements set forth at § 51.1010(a)". For more details, see the Serious area attainment plan control strategy requirements identified in 40 CFR § 51.1010(a)(5), § 51.1010(b)(5), and § 51.1010(c)(5)

Table 2: BACM/BACT and MSM Requirements

Standard	12 ug/m3 Annual (2012)	35 ug/m3 24-Hour (2006)	15 ug/m3 Annual (1997) 65 ug/m3 24-Hour (1997)
Classification	Serious	Serious with Extension	Serious - 5% Plan
Control Strategy	BACM/BACT	MSM	MSM
Step 1: Identify sources of direct PM2.5 and precursor emissions (emissions inventory)	Required "The state shall identify all sources of direct PM2.5 emissions and all sources of emissions of PM2.5 precursors in the nonattainment area in accordance with the emissions inventory requirements…" § 51.1010(a)(1)	Required "The state shall identify all sources of direct PM2.5 emissions and sources of emissions of PM2.5 precursors in the nonattainment area in accordance with the emissions inventory requirements…" § 51.1010(b)(1)	Required "The state shall identify all sources of direct PM2.5 emissions and sources of emissions of PM2.5 precursors in the nonattainment area in accordance with the emissions inventory requirements…" § 51.1010(c)(1)
Step 2: Identify all potential control measures	Required "The State shall identify all potential control measures to reduce emissions from all sources of direct PM2.5 emissions and sources of emissions of PM2.5 plan precursors" § 51.1010(a)(2)	Required "The State shall identify all potential control measures to reduce emissions from all sources of direct PM2.5 emissions and sources of emissions of PM2.5 plan precursors" § 51.1010(b)(2)	Required "The State shall identify all potential control measures to reduce emissions from all sources of direct PM2.5 emissions and sources of emissions of PM2.5 plan precursors" § 51.1010(c)(2)
Step 2(a): Begin with the area's current control measures	Recommended Begin identification of potential control measures by updating list of control measures already in the nonattainment area	Recommended[16] "A state… should be able to start its process using the work already undertaken for the nonattainment area's RACM and BACM demonstrations and to make updates to the list of potential control measures"	Recommended "A state… should be able to start its process using the work already undertaken for the nonattainment area's RACM and BACM demonstrations and to make updates to the list of potential control measures"
Step 2(b): Survey other states and nonattainment areas for additional potential control measures	Required "The state shall survey other NAAQS nonattainment areas in the U.S. and identify any measures for direct PM2.5 and PM2.5 plan precursors not previously identified" § 51.1010(a)(2)(i)	Required "The state shall identify the most stringent measures for reducing direct PM2.5 and PM2.5 plan precursors adopted into any SIP or used in practice to control emissions in any state" § 51.1010(b)(2)(i)	Required "The state shall identify the most stringent measures for reducing direct PM2.5 and PM2.5 plan precursors adopted into any SIP or used in practice to control emissions in any state" § 51.1010(c)(2)(i)
Step 2(c): Reconsider and reassess any measures previously rejected	Not required for BACM/BACT	Required "The state shall reconsider and reassess any measures previously rejected by the state during the development of any previous Moderate area or Serious area attainment plan control strategy" § 51.1010(b)(2)(ii)	Required "The state shall reconsider and reassess any measures previously rejected by the state during the development of any Moderate area or Serious area attainment plan control strategy for the area" § 51.1010(c)(2)(ii)
Step 3: Assess potential control measures' stringency and feasibility	Required	Required	Required
Step 3(a): Evaluate stringency	Required BACT/BACM control levels required	Required MSM control levels required	Required MSM control levels required
Step 3(b): Assess technological and economic feasibility	Required "The state may make a demonstration that any measure identified… is not technologically or economically feasible to implement in whole or in part by the end of the tenth calendar year following the effective date of designation of the area, and may eliminate such whole or partial measure from further consideration" § 51.1010(a)(3)	Required "The state may make a demonstration that a measure identified… is not technologically or economically feasible to implement in whole or in part by 5 years after the applicable attainment date for the area, and may eliminate such whole or partial measure from further consideration" § 51.1010(b)(3)	Required "The state may make a demonstration that a measure identified… is not technologically or economically feasible to implement in whole or in part within 5 years or such longer period as the EPA may determine is appropriate after the EPA's determination that the area failed to attain by the Serious area attainment date, and may eliminate such whole or partial measure from further consideration" § 51.1010(c)(3)
Step 4: If found to be economically and technologically feasible, adopt control measures	Required "The state shall identify, adopt, and implement best available control measures, including control technologies, on sources of direct PM2.5 emissions and sources of emissions of PM2.5 plan precursors located in any Serious PM2.5	Required "The state shall identify, adopt, and implement the most stringent control measures that are included in the attainment plan for any state or are achieved in practice in any state, and can be feasibly implemented in the area" § 51.1010(b)	Required "Except as provided under paragraph (c)(3) of this section, the state shall adopt and implement all control measures …that collectively achieve attainment of the standard as

[16] See U.S. EPA "Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements" July 2016 https://www.epa.gov/sites/production/files/2016-07/documents/pm25-naaqs-implementation-final-preamble-rule-signature.pdf

	nonattainment area“ § 51.1010(a)		expeditiously as practicable” § 51.1010(c)(4)

D.2.1 STEP 1: MOBILE SOURCE EMISSIONS OF DIRECT PM2.5 AND NOX

The first step required in the Act's specified BACM and MSM evaluation process is to identify and quantify the sources of PM2.5, including direct PM2.5 emissions and emissions of precursor pollutants.

In the Valley, air quality measurements and modeling have shown that emissions from mobile sources – cars, trucks, and a myriad of off-road equipment – are a significant contributor to ambient PM2.5 levels. Overall, mobile sources contribute to approximately 50 to 60 percent of the particles that make up PM2.5 in the Valley. These contributions come through both directly emitted PM2.5 and gaseous precursors such as NOx, the key precursor to atmospheric formation of PM2.5 in the Valley.

D.2.2 STEPS 2 AND 3: IDENTIFICATION AND EVALUATION OF POTENTIAL BACM/MSM CONTROL MEASURES

The second and third steps required in the Act's BACM / MSM evaluation process have been grouped together in this appendix so that the control measures for each mobile sector (i.e. passenger vehicles, on-road heavy-duty trucks and buses, off-road mobile sources, and fuels) canbe more cohesively identified and evaluated.

D.2.2.1 Step 2: Identification of Potential BACM/MSM Control Measures

Step 2 calls for the identification of all possible control measures for each of the mobile sources of PM2.5 and NOx identified in Step 1.[17] To satisfy the Act's MSM requirements, this is a three-part process.[18]

D.2.2.2 Step 2(a): California's Control Measures

The identification of all potential mobile source control measures begins with an analysis of California's mobile control program. Due in part to the severity of its air quality needs, and in part to unique authority provided under the Act, California's mobile source controls go far beyond other states' and even national programs, and thus provides an excellent starting place in identifying a comprehensive range of control measures as required by the Act. This approach also aligns with U.S. EPA guidance, which suggests starting the identification process with any controls previously identified in prior Moderate or Serious SIPs for the nonattainment area.[19]

Section 209(b) Waiver Authority

In recognition of California's early efforts and extent of air quality challenges, the State has unique authority to regulate emissions from some source categories more stringently than the federal government under the Act's §209(b) waiver provision. While U.S. EPA has primary authority for interstate trucks, aircraft, ships, locomotives,

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[17] In a departure from previous SIP guidance, EPA guidance indicates that are no *de minimis* source categories for this plan. Thus, emissions of direct PM2.5 and PM2.5 precursors (i.e. NOx) from all mobile source categories must be controlled in the Valley, and meet the applicable BACM/BACT and MSM requirements. See U.S. EPA April 2016 "SIP Requirements Rule" 81 FR 58010 https://www.gpo.gov/fdsys/pkg/FR-2016-08-24/pdf/2016-18768.pdf

[18] Step 2(c), the identification of any control measures that were previously rejected as infeasible in prior Moderate or Serious SIPs for the Valley is a requirement for MSM, not BACM. See 40 CFR § 51.1010(b)(2)(ii) and § 51.1010(c)(2)(ii)

[19] U.S. EPA "Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements" July 2016

and some farm and construction equipment, this waiver provision also allows California to seek a waiver from U.S. EPA to enact more stringent emission standards for passenger vehicles, heavy-duty trucks, and certain off-road vehicles and engines.

Over nearly five decades, CARB has consistently sought waivers and authorizations for its new motor vehicle regulations and has received waivers and authorizations for over 100 regulations. CARB's history of progressively strengthening standards as technology advances, coupled with the waiver process requirements, ensures that California's regulations remain the most stringent in the nation, and that necessary emission reductions from the mobile sector continue.

This provision preserves a critical role for California in the control of emissions from new motor vehicles, recognizing that California plays an important leadership role and serves as a "laboratory" state for more stringent motor vehicle emission standards. For example, CARB's LEV I and LEV II, and the ZEV Programs have resulted in the production and sales of hundreds of thousands of ZEVs in California since first adopted in 1990.

D.2.2.3 Step 2(b): Other States' and Nonattainment Areas' Control Measures

The second component required to identify all potential BACM/MSM control measures is the identification of any additional control measures used in other states or nonattainment areas, and an assessment of their stringency relative to the control measures in the Valley's attainment plan and demonstration.[20, 21] The purpose is to identify whether there are additional potential BACM/MSM control measures used to control mobile emissions of direct PM2.5 and/or NOx in other states or nonattainment areas that are more stringent than the measures included in the Valley's attainment plan and demonstration. If this assessment finds that there are more stringent measures in use elsewhere – and if they are found to be sufficiently stringent and technically and economically feasible to implement in the Valley (see Step 3) – statute requires that any such measures are adopted and implemented in the Valley's plan (see Step 4), in order to meet the requirements that the area, "attain the standard as expeditiously as practicable."[22]

Identification

U.S. EPA guidance provides recommendations for possible resources to assist in the search for other control measures used in other states or nonattainment areas, including:[23]

- Other states' control programs (including those measures identified in U.S. EPA's list of national, state and/or local air quality agencies' control measures);[24]
- U.S. EPA's "Menu of Control Measures" for PM2.5; [25] and

[20] § 51.1010(a)(2)(i), § 51.1010(b)(2)(i), and § 51.1010(c)(2)(i)

[21] U.S. EPA "Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements" July 2016

[22] For the 35 µg/m3 24-Hour PM2.5 Standard (2006), see § 51.1010(b)(4). For the 15 µg/m3 Annual PM2.5 Standard (1997) and 65 µg/m3 24-Hour PM2.5 Standard (1997), see § 51.1004(a)(3)

[23] U.S. EPA April 2016 "SIP Requirements Rule" 81 FR 58010 https://www.gpo.gov/fdsys/pkg/FR-2016-08-24/pdf/2016-18768.pdf

[24] U.S. EPA https://www.epa.gov/pm-pollution/epa-summaries-and-reports-several-state-and-local-pm-control-measures. Accessed April 24, 2018

[25] U.S. EPA 2016 "*Menu of Control Options*" Accessed April 2018 at https://www.epa.gov/air-quality-implementation-plans/menu-control-measures-naaqs-implementation

- U.S. EPA's mobile-specific control measures for PM2.5.[26]

Beyond these suggested resources, CARB staff has also taken additional steps to identify any additional mobile source control measures currently in use in jurisdictions outside of California. This process included inquiries to U.S. EPA staff in Region 9, as well as inquiries to CARB technical staff that are engaged in developing control strategies across a wide range of mobile sources throughout the agency, including passenger vehicles, heavy-duty trucks and buses, off-road equipment, and fuels. Furthermore, CARB staff has performed internet searches of other jurisdictions' mobile control measures to ensure that our research process for this appendix identifies any control programs that have been more recently developed and which therefore may not otherwise be reflected in the abovementioned resources specified by U.S. EPA.

Assessment

In order to identify the most stringent suite of control measures currently, "adopted into any SIP or used in practice to control emissions in any state,"[27] staff has identified in the tables included in Chapter IV Step 2(b) the most stringent suite of control measures in the nation, for each mobile source category. Staff has assessed the relative stringency of measures based on the efficiency of a given measure or control technology to reduce the level of emissions from category of the mobile source fleet – for example, by comparing the technical capacity for a given control measure to reduce in-use emissions from the on-road heavy-truck fleet, relative to other potential control measures that target the same emission source(s) for reductions. This assessment demonstrates that, for each mobile source category, the suite of control measures included in the Valley's attainment plan and demonstration are the most stringent that are in use in any state or adopted into any SIP.

D.2.2.4 Step 2(c) Reconsideration and reassessment of any control measures previously rejected as infeasible

The final component required to identify all potential BACM/MSM control measures is to reconsider and reassess any control measures proposed in prior Moderate or Serious SIPs for the Valley that were previously rejected as infeasible.[28]

CARB staff reviewed all previous Valley PM2.5 SIPs[29] and found that there are no mobile source control measures that were proposed in previous Moderate or Serious attainment plan control strategies for the Valley but which were not adopted by CARB. Thus, there are no applicable control measures previously rejected as infeasible that would need to be reconsidered for the purposes of this BACM/MSM demonstration process.

[26] U.S. EPA https://www.epa.gov/advance/control-measures-programs-pm. Accessed April 24, 2018

[27] Per MSM requirements in 40 CFR § 51.1010(b)(2)(i) and § 51.1010(c)(2)(i), which call for the identification of the most stringent suite of control measures in any state or nonattainment area.

[28] Identification of any control measures that were previously rejected as infeasible in prior Moderate or Serious SIPs for the area is a requirement for MSM, not BACM. See 40 CFR § 51.1010(b)(2)(ii) and § 51.1010(c)(2)(ii)

[29] See CARB's list of San Joaquin Valley Air Quality Management Plans at https://www.arb.ca.gov/planning/sip/planarea/sanjqnvllysip.htm

D.2.3 STEP 3: EVALUATION OF STRINGENCY AND FEASIBILITY

While the focus of Step 2 is on expanding the scope of analysis to ensure that all possible control measures are identified and incorporated into a list of potential BACM/MSM control measures, Step 3 focuses on narrowing that list to identify and discard from further consideration any measures that do not satisfy the applicable requirements for stringency and feasibility. Step 3 therefore calls for an evaluation of each of the potential BACM/MSM control measures identified in Step 2, in order to evaluate first whether they satisfy the level of stringency of each control measure (i.e. do they meet the definition of BACM or MSM); and secondly, whether they are technically and economically feasible to implement in the Valley.

Step 3(a): Evaluating Stringency

For a potential control measure to meet the definition of BACM and/or MSM as identified in Chapter I, staff must demonstrate that the measure satisfies stringency requirements in terms of both:

(i) the efficiency of a given measure or control technology to reduce the level of emissions from a specific mobile source, relative to emission controls in place in other states and nonattainment areas; and

(ii) the timing of when each control measure will begin to be implemented, relative to each plan's timing milestones and deadlines.

Much of the assessment required to evaluate the efficiency of the level of control provided by a given control measure or technology is included in Step 2(b), wherein staff analyzes the control measures in the Valley's plan relative to those in other states and nonattainment areas. In order to evaluate the stringency of implementation schedule requirements relative to the attainment deadline, staff has identified in Step 3(a) when each control measure has begun to be implemented or is anticipated to begin to be implemented, and compared that timeframe to the applicable timing milestones and deadlines for each of the four PM2.5 standards discussed in this plan.

As was discussed in the introduction, the Act requires differing levels of stringency in control measures, depending on the severity of the area's classification for each standard and status of where the plan falls in the step-wise process called for in the Act's particulate matter provisions.

For BACM, a measure must be implemented in whole or in part by the end of the fourth year following the date of reclassification of the area to Serious.[30] BACM measures fall within one of two sub-categories, depending on implementation timeframes:

- BACT a BACM measure is considered BACT if it can be implemented in whole or in part by the end of the fourth year following the date of reclassification of the area to Serious."[31]
- Additional Feasible Measure (AFM) a BACM measure is considered AFM if it can be implemented in whole or in part between the end of the fourth year following

[30] 40 CFR § 51.1010(a)(3)(i)

[31] 40 CFR § 51.1010(a)(3)(i)

the date of reclassification of the area to Serious and the applicable attainment date for the area."[32]

Unlike BACM, the Act does not specify an implementation deadline for MSM; U.S. EPA states that MSM should be implemented, "as expeditiously as practicable".[33]

For each of the applicable four PM2.5 standards discussed in this plan, Table 3 summarizes the required levels of control measures and the required timeframe for implementation in order to meet the definition of BACM and/or MSM.

Table 3: Implementation and Timing Requirements for BACM and MSM

Standard	12 ug/m3 Annual (2012)	35 ug/m3 24-Hour (2006)	15 ug/m3 Annual (1997) 65 ug/m3 24-hour (1997)
Classification Status	Moderate with request to Serious	Serious with Extension	Serious (5% plan)
Type of Plan Required	Serious	MSM	5% Plan
Control Measure Requirements	BACM	MSM	MSM
Definition of BACM and MSM (regarding timing)	BACM**:** implemented in whole or in part by the end of the fourth year following the date of reclassification of the area to Serious.[34] BACM has two sub-categories: • BACT: implemented in whole or in part by the end of the fourth year following the date of reclassification of the area to Serious[35] • AFM: implemented in whole or in part between the end of the fourth year following the date of reclassification of the area to Serious and the applicable attainment date for the area[36]	MSM: implemented in whole or in part by 5 years after the applicable attainment date for the area[37]	MSM: implemented in whole or in part within 5 years or such longer period as the EPA may determine is appropriate after the EPA's determination that the area failed to attain by the Serious area attainment date[38]
Attainment deadline	2025	2024	2020
Timeframe for Implementation to be Considered BACM/MSM	BACM if implemented ≤ 2025 Either: • BACT if ≤2019 • AFM if 2020 - 2025	MSM if implemented ≤ 2029	MSM if implemented ≤ 2021

[32] 40 CFR § 51.1010(a)(3)(ii)

[33] U.S. EPA, 2001 *Final TSD for Maricopa County PM10 Nonattainment Area* (page 31). Available at https://www3.epa.gov/region9/air/phoenixpm/pdf/tsd0901.pdf

[34] 40 CFR § 51.1010(a)(3)(i)

[35] 40 CFR § 51.1010(a)(3)(i)

[36] 40 CFR § 51.1010(a)(3)(ii)

[37] 40 CFR § 51.1010(b)(3)

[38] 40 CFR § 51.1010(c)(3)

Given the timing of when each control measure has begun or is anticipated to begin implementation, staff has assessed each control measure in order to categorized each as falling into MSM or BACM 'bins' (the BACM bin is further subdivided into BACT or ADF). It is important to note that the variance in timing of each standard's attainment date means that the definition of which control measures fall into the MSM or BACM bin may differ among the standards. In other words, a measure may fall into different bins for each standard, due to the timing differences in when the standards were finalized. This is because the requirements to determine of feasibility for each measure also vary among the standards, depending on when the control measures are anticipated to be implemented relative to the standards' attainment dates.[39]

In addition to timing considerations, the bin into which each potential control measure falls into correlates with how hard each measure pushes to control emissions. The determination of whether each control measure falls into the BACM/BACT, BACM/ADF, or MSM bin thus indicates both the control measure' stringency and the control measures' implementation schedule, relative to the varying attainment dates among the Valley's four PM2.5 SIPs. Generally speaking, the control measures included in CARB's current control program meet the definition of BACM, and the new measures included in the Valley SIP Strategy satisfy MSM requirements. The new measures have been identified to push beyond the stringency of controls required in the current control program and have been developed to achieve "the maximum degree of emission reduction… that can be feasibly implemented in the area."[40] This is also in keeping with U.S. EPA's interpretation of BACM as, "more stringent than reasonably available control measure (RACM), but less stringent than the lowest achievable emission rate (LAER), which doesn't take into consideration the cost effectiveness of implementing a particular control measure,"[41] while MSM has been defined as, "what LAER represents for new or modified sources under the New Source Review permit program."[42]

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[39] For the 2012 Annual Standard of 12 ug/m^3, the Valley has not yet been reclassified to Serious. In order to proceed with the assessment and determination of whether control measures satisfy the timing requirements for BACM, BACT and/or AFM for this standard, CARB staff has inferred an effective date of 2015 as the redesignation year: per § 51.1010(a)(5), the attainment deadline for a Serious plan is ten years from date of designation as Serious. Because staff's air quality modeling shows that the Valley's projected attainment date for this plan is 2025, CARB staff has assigned 2015 as the proxy date of redesignation to Serious *for purposes of identifying BACM/BACT.* Continuing with this assumption, a control measure would therefore be considered BACT if implemented before or during 2019, and would be considered an AFM if implemented between 2020 and 2025.

[40] U.S. EPA definition of MSM from the 2001 *Final TSD for Maricopa County PM10 Nonattainment Area* (page 31). Available at https://www3.epa.gov/region9/air/phoenixpm/pdf/tsd0901.pdf

[41] U.S. EPA 1994 "Addendum to the General Preamble" (*59 FR 41998* pages 42009 -42013) Available at https://www3.epa.gov/ttn/naaqs/aqmguide/collection/cp2/19940816_59fr_41998-42017_addendum_general_preamble.pdf

[42] U.S. EPA 1994 "Addendum to the General Preamble" (*59 FR 41998* pages 42009 -42013) Available at https://www3.epa.gov/ttn/naaqs/aqmguide/collection/cp2/19940816_59fr_41998-42017_addendum_general_preamble.pdf

Comparing the Stringency of the Valley's Plan to the Current Control Program

The final step called for in U.S. EPA's process to demonstrate that the suite of control measures included in the Valley's attainment plan satisfy the stringency definition for MSM is to compare the measures included in the Valley's plan against the measures already adopted in the Valley's SIP to determine if the existing control measures alone are more stringent.[43] Staff has compared the current control program to the control measures included in the Valley's attainment plan and demonstration, and has found that:

- The suite of control measures in the Valley's attainment plan and demonstration include all of the potential BACM and MSM measures identified through the processes described above, including measures in the current control program.
- The suite of control measures in the Valley's attainment plan is more stringent than the existing control program alone because the plan encompasses both the existing suite of control programs and the new measures from the State SIP Strategy and the Valley SIP Strategy. The new measures exceed the stringency of the current control program for control requirements applying to all mobile source categories, including the passenger vehicle fleet, the on-road heavy-duty fleet, and off-road equipment and engines.
- The Valley's attainment demonstration provides further evidence that the additional stringency of the control measures included in the Valley's plan, relative to the current control program: the additional emission reductions provided by the new measures in the plan (i.e. those from the State SIP Strategy and Valley SIP Strategy) are needed for the Valley to attain its PM2.5 targets.

Step 3(b): Determination of Technical and Economic Feasibility

The second half of the required process for evaluating the potential BACM/MSM measures is an assessment of their economic and technical feasibility. As part of this process, statute directs that the State may eliminate any control measures identified in Step 2 from further consideration if it is demonstrated to be technologically or economically infeasible to implement in the Valley within the specified timeframes.

Per U.S. EPA's guidance and precedence, this requirement is not required to be applied unless a potential BACM/MSM control measure is rejected from inclusion in the SIP on the grounds of feasibility.[44] For this appendix, staff's proposed SIP and attainment demonstration for the Valley do not recommend eliminating any of the potential BACM/MSM control measures identified in Step 2 on the basis of technical or economic infeasibility. Thus, the assessment of technological and economic feasibility for purposes of eliminating such measures in whole or part from further consideration

[43] U.S. EPA's 2001 *Final TSD for Maricopa County PM10 Nonattainment Area* see page 32. Available at https://www3.epa.gov/region9/air/phoenixpm/pdf/tsd0901.pdf

[44] See page 400 of U.S. EPA's 2001 *Technical Support Documentation for Maricopa County PM10 Nonattainment Area* https://www3.epa.gov/region9/air/phoenixpm/pdf/tsd30102.pdf where EPA staff explain that they are applying to Maricopa County's SIP the decision from a Phoenix Serious SIP not to apply this requirement if no potential control measures are rejected.

(i.e. Step 3(b)) is not applicable for this plan, and is not substantively addressed in this appendix beyond this section.

Nonetheless, staff has conducted an initial assessment of technical feasibility for the proposed control measures in the State SIP Strategy and Valley SIP Strategy through the ongoing technology assessments that CARB staff has been conducting in collaboration with U.S. EPA and the National Highway Traffic Safety Administration. These Technology Assessments have identified the current technological potential for more stringent emission control measures for on- and off-road heavy-duty applications, together with the fuels necessary to power them, along with ongoing review of advanced vehicle technologies for the light-duty sector.[45]

Additionally, an economic impact analysis was conducted for many of the newly proposed measures that were first identified in the Mobile Source Strategy.[46] Furthermore, all control measures that are regulatory in nature must also undergo a rule-specific, rigorous public review process when proposed by staff and/or approved by the Board, as specified by the Administrative Procedures Act (APA). These requirements include an Initial Statement of Reasons (ISOR) prepared for each proposed CARB regulation, an Environmental Analysis to satisfy California Environmental Quality Act (CEQA) requirements, and an Economic Analysis, including a Standardized Regulatory Impact Assessment (SRIA) for any proposed regulation has an economic impact exceeding $50 million.

While these processes occur beyond the requirements addressed in this plan, these requirements ensure there will be further opportunity for public and stakeholder input, as well as ongoing technology review and a more refined assessment of costs and environmental impacts as the measures move through CARB's public process for development into proposed regulations.

D.2.4 STEP 4: ADOPT AND IMPLEMENT FEASIBLE CONTROL MEASURES

The final step required by the Act's step-wise process is to adopt and implement the feasible control measures identified in Step 3, in order to satisfy BACM and MSM requirements. Staff's proposed SIP for the Valley to attain all four of the PM2.5 standards this document discusses includes all of the measures identified as BACM and/or MSM in Step 3. The process for adoption and implementation of these control measures is discussed in more detail in the body of the main document to which this analysis is appended.

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[45] Technology and Fuel Assessments http://www.arb.ca.gov/msprog/tech/tech.htm

[46] CARB 2016 "Mobile Source Strategy Appendix A: Economic Impact Analysis" https://www.arb.ca.gov/planning/sip/2016sip/2016mobsrc.htm

D.3 Chapter III. Step 1: Mobile Source Emissions of Direct PM2.5 and NOx

Tables 4 and 5 show the mobile emissions of direct PM2.5 and NOx, the key precursor to secondary formation of PM2.5 in the Valley.[47] It is important to note that, as this appendix is an assessment of mobile sources control measures, these tables reflect only a subset of the total emissions in the Valley, and do not reflect emissions from stationary and areawide sources.

Table 4: Direct PM2.5 Emissions (tpd) from Mobile Sources in the Valley

	2013	2020	2024	2025	2030
On-Road Light-Duty Vehicles	1.9	2.1	2.2	2.2	2.4
On-Road Heavy-Duty Vehicles	4.5	1.3	1.0	1.0	1.0
Off-Road Federal and International Sources	1.5	1.8	1.8	1.8	1.8
Aircraft	1.2	1.7	1.7	1.7	1.7
Railroad	0.2	0.1	0.1	0.1	0.1
Off-Road Equipment	4.3	3.2	2.6	2.4	1.8
Total Direct PM2.5 from Mobile Sources	**12**	**8**	**8**	**7**	**7**

**Numbers may not add up due to rounding.*

Table 5: NOx Emissions (tpd) from Mobile Sources in the Valley

	2013	2020	2024	2025	2030
On-Road Light-Duty Vehicles	34	16	11	10	7
On-Road Heavy-Duty Vehicles	149	81	45	44	40
Off-Road Federal and International Sources	15	15	13	13	11
Aircraft	2	5	5	5	5
Railroad	13	10	8	8	6
Off-Road Equipment	72	55	45	42	33
Total NOx from Mobile Sources	**270**	**167**	**114**	**109**	**91**

**Numbers may not add up due to rounding.*

[47] Data from CEPAM 2016 Ozone SIP Version 1.05 with external adjustments http://outapp.arb.ca.gov/cefs/2016ozsip/index.php

D.4 Chapter IV. Steps 2 and 3: Identification and Evaluation of Potential Mobile Source Control Measures

The second and third steps required in the Act's BACM / MSM evaluation process have been grouped together in this appendix so that staff can more cohesively identify and analyze control measures for each mobile sector (i.e. passenger vehicles, on-road heavy-duty trucks and buses, and off-road mobile sources).

D.4.1 On-Road Light-Duty Vehicles

On-road light-duty vehicles, often referred to as passenger vehicles, include motorcycles, passenger cars, and light to mid-sized trucks and SUVs. The vast majority of these vehicles currently have gasoline powered internal combustion engines, however this sector is projected to increasingly rely on electric drive vehicles of varying types (e.g. battery electric, plug-in hybrid, or fuel cell electric vehicles).

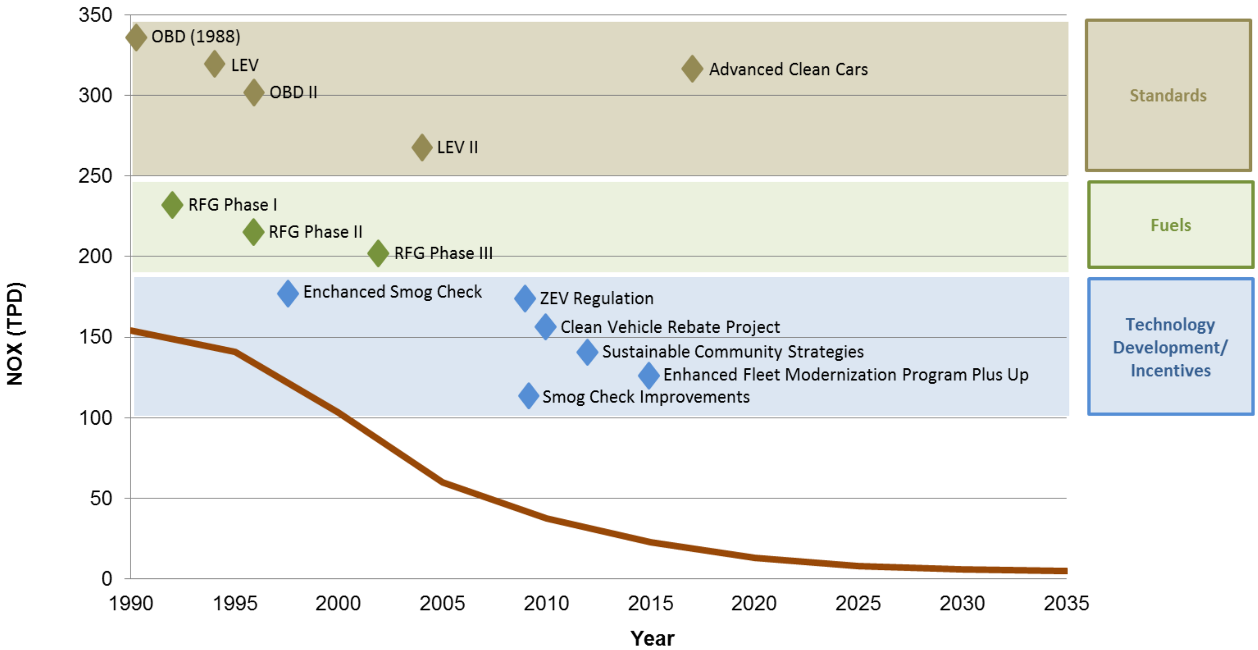
D.4.1.1 Step 2(a): California's Light-Duty control measures

Since setting the nation's first motor vehicle exhaust emission standards in 1966 that 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 NOx emissions along with hydrocarbon emissions. The simultaneous control of emissions from motor vehicles and fuels led to the use of cleaner-burning gasoline that has removed the emissions equivalent of 3.5 million vehicles from California's roads. Since first adopted in 1990, CARB's LEV I and LEV II, and the ZEV Programs have resulted in the production and sales of hundreds of thousands of ZEVs in California.

In the light-duty sector, the maturity of advanced technologies required under currently adopted control programs results in NOx emission reductions of over 70 percent between 2013 and 2025, as shown in Figure 2.

The historical improvement in NOx emissions largely is the result of new engine standards that have significantly reduced emissions from conventionally fueled vehicles (LEV programs). Alongside these programs, Zero-Emission Vehicle (ZEV) technologies have achieved commercial status, and sales mandates are increasing ZEV penetration. The major regulatory and programmatic control measures that provide for the needed emission reductions in the on-road light-duty mobile source category are described subsequently.

Figure 2 Adopted Control Programs Reducing NOx Emissions from the Light-Duty Vehicle Fleet in the Valley



D.4.1.2 *New Vehicle Standards*

Emission Standards

California is the only state with the authority to adopt and enforce emission standards for new motor vehicle engines that differ from the federal emission standards, which enables CARB to develop more stringent motor vehicle control measures than other states. Adopted in 2012, the ***Advanced Clean Car (ACC)*** program is a suite of regulations that ensure emission reductions from the State's passenger vehicle fleet. In 2013, U.S. EPA issued a waiver for the ACC Program.[48]

CARB's (ACC) program has in recent years been a major driver of turnover to and zero and near-zero emission vehicles in the light-duty sector, providing significant emission reduction benefits. The ACC brought together three major regulations that were previously separate, combining the control of criteria pollutants and greenhouse gas emissions into a single coordinated set of requirements for light-duty vehicles of model years 2015 through 2025.

- Two of these regulations, the ***LEV III GHG*** and ***LEV III Criteria Emission*** rules, are fleet average performance standards for new vehicles that provide for continued annual emission reductions as the stringency increases through 2025. When fully phased-in, these requirements will achieve near-zero emission levels from new light-duty vehicles. These programs apply to the entire light-duty fleet

[48] U.S. EPA 2013 "California State Motor Vehicle Pollution Control Standards; Advanced Clean Car Program; Final Notice of Decision" Federal Register January 9, 2013 Volume 78, Number 6 pp. 2211 – 2145. https://www.gpo.gov/fdsys/pkg/FR-2013-01-09/pdf/2013-00181.pdf

by setting an average emissions requirement across all new vehicles that creates inherent market flexibility for compliance.

- The third regulation, the ***ZEV Regulation***, focuses on advanced technology development and fleet penetration of ZEVs (i.e. battery electric vehicles and hydrogen fuel cell vehicles), and plug-in hybrid electric vehicles (PHEVs) in order to enable manufacturers to successfully meet 2018 and subsequent model year requirements. The ZEV regulation ensures that advanced electric drive technology is commercialized and brought to production scale for cost reductions by 2025, in order to ensure that these low-emission technology vehicles transition from demonstration phase to full commercialization in a reasonable timeframe to meet long-term emission reductions goals. The ZEV amendments for 2018 and subsequent model years in the ACC program are intended to achieve commercialization through simplifying the regulation and pushing technology to higher volume production in order to achieve cost reductions.

The ACC Program will continue produce increasing benefits over time as new cleaner cars enter the fleet, displacing older and dirtier vehicles. In this manner, the benefits in 2023 will be realized through the cumulative reduction in emissions achieved by new cars entering the fleet in 2017 through 2023. This program will continue to provide benefits well after 2023 as vehicles meeting the new standards replace older, higher-emitting vehicles and continue to provide ongoing emission reduction benefits over their lifecycle, relative to the older, dirtier vehicles replaced.

Pushing beyond those requirements, the State SIP Strategy also included a commitment to develop the next generation of requirements for the passenger vehicle fleet through the ***Advanced Clean Cars 2*** measure. CARB will consider expanded California-specific standards for new light-duty vehicles to increase the number of new ZEVs and PHEVs sold in California, with the goal to make sure that near-zero and zero-emission technology options continue to be commercially available. The Advanced Clean Cars 2 measure is designed to ensure that near-zero and zero-emission technology options continue to be commercially available, with electric driving range improvements to address consumer preferences and maximize electric vehicle miles travelled (eVMT). The regulation may include lowering fleet emissions further beyond the super-ultra-low-emission vehicle standard for the entire light-duty fleet through at least the 2030 model year, and look at ways to improve real world emissions through implementation programs. As these vehicles continue to be commercially available, the new technologies they employ, including regenerative braking and lower rolling resistance tires, can reduce criteria pollutant emissions from brake and tire wear. CARB would quantify these previously unaccounted-for criteria pollutant co-benefits of ACC 2 in order to better inform future planning. Additionally, new standards would be considered to further increase the sales of zero-emission vehicles (ZEV) and plug-in hybrid electric vehicles (PHEVs) beyond the levels required in 2025.

Additionally, under the ***Reduced ZEV Brake and Tire Wear*** measure, CARB will quantify the emission reductions that will accrue from new technologies employed in fuel cell and plug-in electric vehicles, including regenerative braking and lower rolling resistance tires, which can reduce emissions from brake and tire wear. As increasing numbers of zero-emission vehicles enter the fleet over the coming decade, these technologies offer opportunities to reduce PM2.5 emissions from the passenger vehicle fleet.

On-Board Diagnostic (OBD) Systems

In addition to emission standards for the light-duty fleet, CARB's suite of control measure requirements for new vehicles also includes actions to ensure that vehicles continues to operate as cleanly as possible once they are part of the in-use fleet. These measures include requirements that new vehicles come equipped with in-use inspections and on-board self-diagnostic equipment. On-Board Diagnostics (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. Studies show that the highest emitting 20 percent of the light-duty fleet contribute well over 50 percent of the fleet's total emissions, emphasizing the need to identify and repair these high emitting vehicles.[49]

On-Board Diagnostics II (OBD II) is the second generation of requirements for on-board, self-diagnostic equipment that monitors a passenger vehicle's control components to ensure they are functioning correctly. 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. 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. U.S. EPA granted CARB a waiver of preemption for the OBD II regulation in 2016.[50]

Emissions Standards for Motorcycles

While representing a relatively small fraction of the emissions coming from the passenger vehicle fleet, CARB has also taken a comprehensive control approach for emissions from motorcycles. For the most part, motorcycles are on-road two-wheeled, self-powered vehicles with engine displacements of 50 cubic centimeters (cc) or greater. First adopted in 1975, ***California's on-road motorcycle regulation*** obtained its first waiver of preemption from U.S. EPA in 1976. The 1975 regulation set emission standards for all motorcycles with engine displacements of at least 50 cc. The 1998 amendments affected only Class 3 motorcycles (280 cc or greater) and set a Tier I and Tier II standard for 2004 and 2008 model years, respectively. While CARB has the same emission standard as the federal standard, the California standard applies to engines starting in 2008 rather than 2010 under the federal requirement. The California Motorcycle Regulation controls both exhaust emission standards and test procedures

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[49] CARB 2015 https://www.arb.ca.gov/msprog/obdprog/obdfaq.htm

[50] U.S. EPA 2016 "California State Motor Vehicle Pollution Control Standards; Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines; Final Notice of Decision" https://www.gpo.gov/fdsys/pkg/FR-2016-11-07/pdf/2016-26861.pdf November 7, 2016 Federal Register Volume 81, Number 215 pp. 78143-78149

for on-road motorcycles and motorcycle engines. U.S. EPA granted CARB a waiver of preemption for the 1998 amendments in August 2006.[51]

D.4.1.3 Reducing In-Use Emissions

Inspection and Maintenance (I/M) Program

Although new vehicles sold in California are the cleanest in the world, the millions of passenger vehicles on California roads, and the increasing miles they travel each day make them our single greatest source of NOx emissions. While the new vehicles in California may start out with very low emissions, improper maintenance or faulty components can cause vehicle emission levels to sharply increase. Studies estimate that approximately 50 percent of the total emissions from late-model vehicles are excess emissions, meaning that they are the result of emission-related malfunctions. California's ***Smog Check Program*** works to ensure that the vehicles remain as clean as possible over their entire life. The Bureau of Automotive Repair (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 light-duty vehicles by requiring periodic inspections for emission control system problems, and by requiring repairs for any problems found. Technicians are required to perform an OBD II check (visual and functional) during the Smog Check inspection.

Additionally, CARB has committed in the State SIP Strategy to work with BAR staff to perform a joint agency, ***comprehensive evaluation*** of California's in-use performance-focused inspection procedures and, if necessary, make ***improvements to increase the Smog Check Program's effectiveness***. Assembly Bill (AB) 2289 (Eng, Chapter 258, Statutes of 2010) required BAR to implement a new protocol for testing 2000 and newer model-year vehicles, effective in 2015. This new test, which relies primarily on the vehicle's OBD system, provides for a faster and more cost effective inspection compared to tailpipe testing. To facilitate state-of-the-art OBD-based testing, BAR developed equipment specifications for a new OBD communications device, referred to as the Data Acquisition Device (DAD), which is a component of the new OBD Inspection System (OIS) that replaces the EIS. These changes are aimed at providing for quicker and potentially less costly Smog Check inspections for consumers, and lower Smog Check station operating costs, all while preserving, or even enhancing the emission benefits associated with the Smog Check Program. However, because the OBD inspection procedure does not provide for direct measurement of vehicle emission levels, CARB believes it is prudent to monitor the effectiveness of the new procedure in identifying vehicles in need of emission repairs, and to implement changes necessary to address any issues that are uncovered. As part of the comprehensive evaluation, CARB will conduct a study to further evaluate California's in-use performance inspection procedures through analysis of the Smog Check database and vehicle sampling obtained through BAR's Random Roadside Inspection Program to improve inspection test procedures as necessary, address program fraud, improve the

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[51] https://www.epa.gov/state-and-local-transportation/vehicle-emissions-california-waivers-and-authorizations See Code of Federal Regulations Volume 71, Number 149 pp. 44027-44029

effectiveness and durability of emission-related repair work, and to improve the regulations governing the design of in-use performance systems on motor vehicles.

Additionally, the ***Lower In-Use Emission Performance Assessment*** committed to in the State SIP Strategy is designed to ensure that in-use passenger vehicles continue to operate at their cleanest possible level by evaluating California's in-use performance-focused inspection procedures and, if necessary, making improvements to further the program's effectiveness. Results from the assessment may be used to improve inspection test procedures, address program fraud, improve the effectiveness and durability of emission-related repair work, and to improve the regulations governing the design of in-use performance systems on motor vehicles to the extent necessary.

Finally, CARB staff's discovery of Volkswagen's (VW's) use of illegal defeat devices—software designed to cheat on emissions tests—in certain 2009 to 2016 model year diesel cars that were sold in California illustrates the success and stringency of California's program to control emissions from the in-use passenger vehicle fleet, and to identify excess in-use emissions. Due to the discovery of VW's emissions cheating scandal and subsequent actions to remediate the environmental damages caused by these vehicles' excess emissions, the VW Environmental Mitigation Trust provides about $423 million for California to fund projects that accelerate the turnover of mobile sources to cleaner, lower-emitting vehicles and engines.

D.4.1.4 Fuels

Cleaner fuel has an immediate impact in reducing emissions from the mobile source, and thus represent an important component in reducing NOx and VOC emissions from the passenger vehicle fleet. California's stringent air quality programs treat motor vehicles and their fuels holistically (as a system, rather than as separate components). As a result, CARB's fuels programs achieve significant reductions in criteria emissions from gasoline-fueled vehicles used in California.

California's Reformulated Gasoline program (CaRFG) sets stringent standards for California gasoline that produced cost-effective emission reductions from gasoline-powered vehicles. Reformulated gasoline (RFG) is gasoline blended to burn more cleanly than conventional gasoline and to reduce smog-forming and toxic pollutants in the air we breathe. Since the Valley was reclassified to a Serious ozone nonattainment in December 2001, the use of cleaner-burning gasoline that is at least as stringent as federal RFG requirements has been required since December 2002. The CaRFG program has been implemented in three phases.

- Phase 1, which was implemented in 1991, eliminated lead from gasoline and set regulations for deposit control additives and reid vapor pressure (RVP).
- Phase 2 CaRFG (CaRFG2 in 1994) set specifications for sulfur, aromatics, oxygen, benzene, T50, T90, Olefins, and RVP and established a Predictive Model.
- The final and current phase, Phase 3 CaRFG, eliminated in 1996 the use of methyl-tertiary-butyl-ether in California gasoline.

Phase 3 CaRFG also revised specifications for Phase 3 gasoline that reduces ozone precursor emissions (including aromatic hydrocarbons and olefins) by ~15 percent and toxic air contaminant emissions by about 40 percent, compared with CaRFG2. The regulation strengthened specification requirements for cleaner-burning gasoline, including:

- Reduced sulfur content. Sulfur inhibits the effectiveness of catalytic converters. Cleaner-burning gasoline enables catalytic converters to work more effectively and further reduce tailpipe emissions.
- Reduced benzene content. Benzene is known to cause cancer in humans. Cleaner-burning gasoline has about one-half the benzene of earlier gasoline, thus reducing cancer risks.
- Reduced levels of aromatic hydrocarbons (ozone precursor)
- Reduced levels of olefins (ozone precursor)
- Reduced vapor pressure, which ensures that gasoline evaporates less readily.
- Two specifications for reduced distillation temperatures, which ensure the gasoline burns more completely, and
- Use of an oxygen-containing additive, such ethanol, which also helps the gasoline burn more cleanly.

More recently, CARB developed ***the LCFS and ADF regulations,*** which work together to reduce emissions from renewable fuels, including criteria emissions, and further incentivizes the use of ZEV technologies. The LCFS and ADF regulations (as amended in 2014) reduce the carbon intensity of the California fuel supply while requiring limits on criteria emissions from alternative fuels and/or alternative fuel mix blends (a mix of fuels made from renewable feedstocks, which are then blended with conventional gasoline or diesel).

D.4.1.5 Step 2(b): Other States' and Nonattainment Areas' Light-Duty control Measures

Table 6 summarizes the most stringent control measures currently in use in any state or nonattainment that have been identified and discussed for on-road light-duty vehicles. Each of the measures identified in this table are discussed in more detail in this section, below.

Table 6: Summary of Most Stringent Light-Duty Control Measures Identified

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Light-Duty Vehicles			
New Vehicle Standards			
New Vehicle Standards • Emission standards	LEV III program (CARB) *(part of Advanced Clean Cars program)* CARB anticipated to propose to further increase stringency *(ACC 2 measure)*	12 states have matched California's Low Emission Vehicle III (LEV III) program, which set fleet average performance standards for new passenger vehicles. CARB may further increase the stringency of CARB's emission standards beyond SULEV. *(NOTE: CARB has committed to develop the ACC 2 measure but it has not yet been proposed to the Board for approval/adoption.)*	12 Section 177 states (LEV III): • CT, DE, ME, MD, MA, NJ, NY, OR, PA, RI, WA, and VT
New Vehicle Standards • ZEV regulation	ZEV program (CARB) *(part of Advanced Clean Cars program)* CARB anticipated to propose to further increase stringency *(ACC 2 measure)*	9 states have matched California's ZEV Regulation for battery electric vehicles (BEVs), hydrogen fuel cell vehicles (FCEVs), and plug-in hybrid electric vehicles (PHEVs). CARB may further increase the stringency of sales requirements for ZEVs and PHEVs beyond the levels required in 2025. *(NOTE: CARB has committed to develop the ACC 2 measure but it has not yet been proposed to the Board for approval/adoption.)*	9 Section 177 states (ZEV Regulation): • CT, ME, MD, MA, NJ, NY, OR, RI, and VT
New Vehicle Standards • On-Board Diagnostic (OBD) systems requirements	California OBD II Requirements (CARB)	CARB's On-Board Diagnostic II (OBD II) Systems Requirements exceed Federal requirements in stringency. OBD II ensures that the in-use fleet continues to operate as cleanly as possible.	In practice, virtually all vehicles sold in the U.S. are designed and certified to meet California's OBD II requirements, regardless of where in the U.S. they are sold.
New Vehicle Standards • Motorcycle emission standards	On-Road Motorcycle Regulation (CARB)	CARB's emission standards and in-use testing for on-road motorcycles exceeds the stringency of any other in the nation.	California is the only state with emission control requirements for exhaust emission standards and test procedures for on-road motorcycles that exceed the stringency of U.S. EPA requirements.
In-Use Emission Controls			
In-Use Emissions Controls • Inspection and maintenance program (I/M program)	Smog Check Program (CARB & Bureau of Automotive Repair)	The Inspection / Maintenance (I/M) Program testing and in-use emission controls in the San Joaquin Valley are consistent with the most stringent of any other I/M program in the nation. Biennial SmogCheck inspections ensure that the in-use passenger vehicle fleet continues to operate as cleanly as possible.	• 33 State and local areas (including CA) require vehicle emissions tests. • 30 other states and local areas have an I/M program in at least a portion of their state (AK, AZ, CO, CA, CT, DE, GA, ID, IL, IN, KY, LA, ME, MD, MA, NV, NH, NJ, NM, NC, OH, OR, PA, RI, UT, TN, TX, VT, WA, WI, and DC); the majority use U.S. EPA OBD Requirements. • Three more states will require OBD checks in the future (MS, NY, VA).

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Light-Duty Vehicles			
Fuel Controls			
Fuels Standards Gasoline Standards	CaRFG Phase 3 (CARB)	The CaRFG Phase III program requires that California gasoline is the lowest-emitting and cleanest-burning in the nation. It includes more stringent requirements for emission controls than the applicable federal standard (U.S. EPA's RFG Phase II).	U.S. EPA RFG Phase II is currently required in nonattainment areas in 17 states and the District of Columbia (including the Valley) • Areas of CA, CT, DE, the District of Columbia, IL, IN, MD, NJ, NY, PA, TX, VA, WI Other "opt in" areas for Federal RFG Phase II • Entire states: CT and DE • Portions of states: IL, KT, MD, ME, MA, MS, NH, NJ, NY, RI, TX, VA
Fuels Standards Alternative Fuel Standards (Gasoline substitutes)	LCFS and ADF (CARB)	The LCFS and ADF regulations work together to reduce the carbon intensity of the California fuel supply while requiring limits on criteria emissions from alternative fuels and/or alternative fuel mix blends.	No other state has set as stringent of criteria emission requirements on alternative fuels and alternative fuel blends than California.

D.4.1.6 New vehicle standards

Emission standards and ZEV Regulation

CARB's new vehicle standards for on-road light-duty vehicles are consistent with the most stringent of any other area in the nation. Due to constraints in the Act, California is the only state that can set new vehicle standards (including control measures such as emission standards, ZEV sales mandates, warranty provisions, and on-board diagnostic (OBD) requirements) that are more stringent than U.S. EPA's national standards.

As a result of CARB's efforts, and as provided for in the Act, a number of other states have now adopted CARB's LEV III and ZEV programs, as listed below in Table 7. Other states can adopt California programs for which U.S. EPA has provided California with waivers.[52] These states are also known as the "Section 177 States" in reference to this provision of the Act.

Table 7: Section 177 States: LD Emission Standards and ZEV Regulation

Section 177 States	2012 ZEV	2012 LEVIII
Connecticut	X	X
Delaware		X
Maine	X	X
Maryland	X	X
Massachusetts	X	X
New Jersey	X	X
New York	X	X
Oregon	X	X
Pennsylvania		X
Rhode Island	X	X
Washington		X
Vermont	X	X

On-Board Diagnostics (OBD) Requirements

California's OBD requirements for on-road light-duty vehicles are consistent with the most stringent of any other area in the nation. CARB's OBD II program requires that all 1996 and newer model year gasoline and alternate fuel passenger cars and trucks are required to be equipped from the factory with an OBD II system. All 1997 and newer model year diesel fueled passenger cars and trucks are required to meet the OBD II requirements.

U.S. EPA also requires all 1996 and newer model year passenger cars and trucks sold

[52] The Clean Air Act allows other states to adopt California's on- and off-road vehicle or engine emission standards under section 209(e)(2)(B). Section 209(e)(2)(B) requires, among other things, that such standards be identical to the California standards for which an authorization has been granted. States are not required to seek U.S. EPA approval to adopt standards identical to the California standards that have received a waiver authorization.

in any state to meet the U.S. EPA OBD requirements.[53] While U.S. EPA's OBD requirements differ slightly from California's OBD II requirements, virtually all vehicles sold in the U.S. are designed and certified to meet the more stringent California's OBD II requirements, regardless of where in the U.S. they are sold.[54] U.S. EPA issued a waiver for California's OBD II program in November 2016, indicating that the California OBD II system requirements are at least as protective of public health as U.S. EPA's OBD requirements.[55]

New vehicle standards and in-use emissions testing for motorcycles

CARB's emission standards and in-use testing for on-road motorcycles exceeds the stringency of any other in the nation. California is the only state with emission control requirements for exhaust emission standards and test procedures for on-road motorcycles that exceed the stringency of U.S. EPA requirements.

D.4.1.7 Reducing In-Use emissions

The Inspection / Maintenance (I/M) Program testing and in-use emission controls in the Valley are consistent with the most stringent of any other I/M program in the nation. California's Smog Check Program is designed to reduce air pollution from California-registered passenger vehicles by requiring periodic inspections for emission control system problems, and by requiring repairs for any problems found. In California, technicians are required to perform an OBD II check (visual and functional) during the Smog Check inspection. On board, self diagnostic equipment monitors a passenger vehicle's control components to ensure they are functioning correctly. Specifically, the technician visually checks to make sure the warning light is functional, and then the Smog Check test equipment communicates with the on-board computer for fault information. If a fault is currently causing the light to be on, the malfunctioning component must be repaired in order to pass the inspection.

- Stringency of I/M Program

  Thirty-three states and local jurisdictions have an I/M program in at least a portion of their state that require vehicle emissions tests.[56] Thirty other states and local areas have an I/M program in at least a portion of their state; the majority use U.S. EPA Requirements, which are less stringent than California's.[57,58]

[53] CARB 2015 "On-Board Diagnostic II (OBD II) Systems - Fact Sheet / FAQs" https://www.arb.ca.gov/msprog/obdprog/obdfaq.htm

[54] CARB 2009 https://www.arb.ca.gov/msprog/smogcheck/march09/transitioning_to_obd_only_im.pdf

[55] U.S. EPA 2016 "California State Motor Vehicle Pollution Control Standards; Malfunction and Diagnostic System Requirements and Enforcement for 2004 and Subsequent Model Year Passenger Cars, Light Duty Trucks, and Medium Duty Vehicles and Engines; Notice of Decision" https://www.gpo.gov/fdsys/pkg/FR-2016-11-07/pdf/2016-26861.pdf Federal Register Vol. 81, No. 215 pp. 78143

[56] U.S. EPA "On-Board Diagnostics (OBD): Status of State and Local (OBD) Inspection/Maintenance (I/M) Programs" https://www.epa.gov/state-and-local-transportation/board-diagnostics-obd-status-state-and-local-obd Accessed 4/25/2018

[57] U.S. EPA "On-Board Diagnostics (OBD): Status of State and Local (OBD) Inspection/Maintenance (I/M) Programs" https://www.epa.gov/state-and-local-transportation/board-diagnostics-obd-status-state-and-local-obd Accessed 4/25/2018

[58] U.S. EPA 2016 "California State Motor Vehicle Pollution Control Standards; Malfunction and Diagnostic System Requirements and Enforcement for 2004 and Subsequent Model Year Passenger Cars, Light Duty Trucks, and Medium Duty Vehicles and Engines; Notice of Decision" https://www.gpo.gov/fdsys/pkg/FR-2016-11-07/pdf/2016-26861.pdf Federal Register Vol. 81, No. 215 pp. 78143

- Effectiveness of Inspection and Testing Methodology

  Nearly every state besides California that has an I/M program currently relies exclusively on vehicle OBD II system inspections as the basis for its emission inspections of 1996 and newer vehicles.[59] Only California and Colorado still use tailpipe testing: Colorado relies on tailpipe testing exclusively; California's Smog Check program currently includes two overlapping inspection procedures. Under California's SmogCheck program, each 1996 and newer model year vehicles vehicle is subjected to a tailpipe emission test, and also to an inspection of its On-Board Diagnostic II (OBD II) system, which independently monitors the performance of the vehicle's emission control systems and related components during everyday driving.

  U.S. EPA acknowledges the viability of OBD II inspections by providing full emission credits to state I/M programs that are based on OBD II only inspections. While U.S. EPA and CARB have generally found that OBD II systems are more effective in detecting emission-related malfunctions on in-use vehicles compared to existing tailpipe testing procedures, the SmogCheck program utilizes both approaches – erring on the side of increased stringency – to ensure each vehicle passes both tests.[60]

  Furthermore, to ensure that California's I/M program remains as effective as possible, CARB has committed in the State SIP Strategy to work with BAR staff to perform a joint agency, comprehensive evaluation of California's in use performance focused inspection procedures and, if necessary, make improvements to increase the Smog Check Program's effectiveness. CARB will conduct a study to further evaluate California's in-use performance inspection procedures through analysis of the Smog Check database and vehicle sampling obtained through BAR's Random Roadside Inspection Program. This will, as necessary: inform improvements in inspection test procedures; address program fraud; improve the effectiveness and durability of emission related repair work; and improve the regulations governing the design of in-use performance systems on motor vehicles.

- Frequency of I/M

  The Valley nonattainment area requires biennial SmogCheck, which is as frequent as SmogCheck requirements as any other part of California. This is consistent with the most stringent of any other area in the nation, and is the same frequency as the only other Extreme nonattainment area for PM2.5 in the country, the South Coast.

D.4.1.8 Fuels

Since 1995, U.S. EPA has required federal reformulated gasoline (RFG) to be used in the nine worst-polluted areas in the nation – including the Valley and other California nonattainment areas (Federal RFG Phase I 1995 requirements). Effective in 2000,

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[59] CARB 2009 https://www.arb.ca.gov/msprog/smogcheck/march09/transitioning_to_obd_only_im.pdf

[60] California's Smog Check data indicates that vehicles are more than twice as likely to fail an OBD II-based inspection than the required tailpipe emissions test. CARB 2009 https://www.arb.ca.gov/msprog/smogcheck/march09/transitioning_to_obd_only_im.pdf

U.S. EPA increased the stringency of the federal RFG requirements under the RFG II program. In 2014, U.S. EPA adopted its most recent amendments, Tier 3 Fuel standards, which require lower sulfur content in gasoline to a maximum of 10ppm beginning in 2017 on an annual average basis, and lower Reid Vapor Pressure to zero, reducing fuel vapor emissions to near zero levels. The program also reduces PM emissions by approximately 70 percent, and NOx and VOCs emissions by approximately 80 percent, relative to the former federal Phase II levels (which were set in 1995). Sulfur content in gasoline is reduced from 30 parts per million (ppm) to 10 ppm on average.

In aggregate, the Phase III RFG requirements bring federal gasoline fuel controls in line with those already in place in California. However, CARB's gasoline specifications under the CaRFG requirements are still more stringent than the Federal Phase III program. CARB significantly controls NOx emissions under requirements in CaRFG Phase III that are not mirrored by comparably stringent controls on NOx emissions under the federal RFG Phase III requirements. Additionally, CARB requires sulfur contents to be capped at 10 ppm, rather than an annual average of 10 ppm as required federally.

Beyond the Federal Phase III requirements described above, the Act also allows states to adopt unique fuel programs to meet local air quality needs, which are referred to as Boutique Fuel Programs. Most of these programs set lower gasoline volatility requirements than the federal standards, and most are effective for only part of the year. As of January 19, 2017 U.S. EPA provided as snapshot of these programs that had been approved in SIPs,[61] which are listed below in Table 8 below. Table 8 also compares the stringency of the boutique fuel requirements in these areas to CARB's CaRFG Phase III. This comparison shows that the CaRFG Phase III program requires that California gasoline is the lowest-emitting and cleanest-burning in the nation.

Table 8: Boutique Gasoline Fuel Programs in the U.S.

Type of Fuel Control	State	Comparison to CaRFG Phase III
Reid Vapor Pressure (RVP) of 7.8 psi	PA and IN (year-round) TX (May 1 – Oct 1)	CaRFG Phase III sets flat limits of RVP of 7.0 psi (oxygenated fuels) and 6.9 psi (non-oxygenated fuels)
RVP of 7.0 psi	KS, MI, MO, TX	CaRFG Phase III sets flat limits of RVP of 7.0 psi (oxygenated fuels) and 6.9 psi (non-oxygenated fuels)
Cleaner Burning Gasoline (Summer)	AZ	As of 2005, AZ requires CARB's CaRFG Phase III in certain areas
Cleaner Burning Gasoline (non-Summer)	AZ	As of 2005, AZ requires CARB's CaRFG Phase III in certain areas
Winter Gasoline (aromatics & sulfur)	NV	In 1999, Clark County (Las Vegas) adopted California sulfur and aromatics limits

[61] U.S. EPA, 2017 https://19january2017snapshot.epa.gov/gasoline-standards/state-fuels_.html

D.4.2 STEP 3(A): EVALUATION OF STRINGENCY: LIGHT-DUTY CONTROL MEASURES

Step 3(a) calls for an evaluation of each of the control measures identified in Step 2, in order to evaluate their stringency and determine whether they meet all applicable requirements to satisfy the definitions of BACM and/or MSM discussed in Chapter I and Chapter II.

in order to determine whether each potential MSM/BACM measure meets the definition of MSM and/or BACM, staff has assessed each potential MSM/BACM on-road light-duty vehicle control measure identified in Steps 2(a) and 2(b). Based on this assessment, staff then characterized each potential MSM / BACM measure as falling into 'bins' representing whether it meets the definition of MSM or BACM for each of the four PM2.5 standards covered in this document (note that the BACM bin is further subdivided into BACT or ADF). The determination of which bin each control measure falls into thus indicates both the control measure' stringency and the control measures' implementation schedule, relative to the varying attainment dates among the Valley's four PM2.5 SIPs. In other words, the bin into which each control measure falls correlates with how hard each measure pushes to control emissions, given the implementation timeframes associated with each standards' plan. Generally speaking, the control measures included in CARB's current control program meet the definition of BACM; the new measures included in the Valley SIP Strategy satisfy MSM requirements.
Figure 3 shows the timing for implementation of each potential MSM / BACM on-road light-duty vehicle control measure identified in the prior sections (i.e. Steps 2(a) and 2(b)), for each of the four PM2.5 standards discussed in this SIP.

Figure 3: Timeline for Implementation of BACM / MSM Light-Duty Control Measures

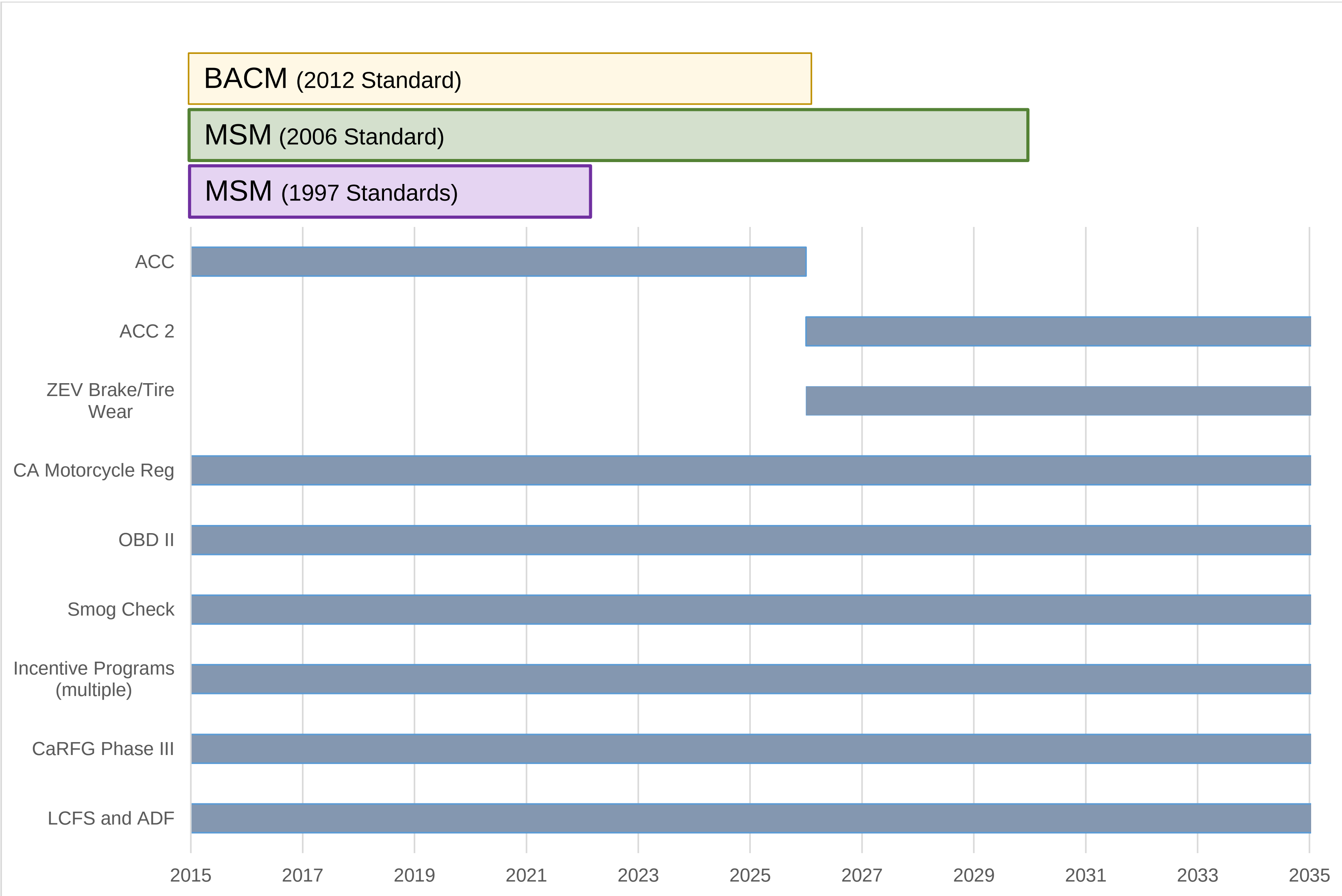


Table 9 summarizes which of the categories of stringency (i.e. BACM/BACT, BACM/ADF, or MSM) that each light-duty control measure falls into, for each PM2.5 standard. It is important to note that some measures CARB has committed to in the State SIP Strategy and proposed in the Valley SIP Strategy have anticipated implementation dates that exceed the timeframe thresholds of this analysis for some standards. Specifically, implementation of the Advanced Clean Cars 2 and Zero-Emission Vehicle Brake and Tire Wear measures is anticipated to begin in 2026, which falls after the 2025 threshold of the analysis for the 2012 Annual Standard, and the 2021 threshold of the analysis for the 1997 Annual and 24-Hour Standards. While these measures may not meet the timeline requirements to fall into the strict definition of MSM for these standards, the intent behind these measures is nonetheless to continue pushing for additional emission reductions to ensure that attainment is achieved as expeditiously as possible, which aligns with the broader purpose of MSM.

Table 9: Identification of Light-Duty Control Measures as BACM and/or MSM

Measures	Implementation Begins	12 ug/m3 Annual (2012)	35 ug/m3 24-Hour (2006)	15 ug/m3 Annual (1997)	65 ug/m3 24-hour (1997)
Current Control Measures					
Advanced Clean Cars (ACC) (Includes both LEV III and ZEV Program)	ongoing	BACM - BACT	MSM	MSM	MSM
California Motorcycle Regulation	ongoing	BACM - BACT	MSM	MSM	MSM
On-Board Diagnostics II (OBD II)	ongoing	BACM - BACT	MSM	MSM	MSM
Smog Check	ongoing	BACM - BACT	MSM	MSM	MSM
Light-Duty Incentive Programs	ongoing	BACM - AFM	MSM	MSM	MSM
California's Reformulated Gasoline (CaRFG) Phase III	ongoing	BACM - AFM	MSM	MSM	MSM
Low Carbon Fuel Standard (LCFS) and Alternative Diesel Fuel (ADF)	ongoing	BACM - BACT	MSM	MSM	MSM
State SIP Strategy Measures (with Commitment)					
Advanced Clean Cars 2	2026	--	MSM	--	--
Reduced ZEV Brake and Tire Wear		--	MSM	--	--

D.4.3 STEP 3(B): EVALUATION OF FEASIBILITY: LIGHT-DUTY CONTROL MEASURES

Step 3(b) calls for an assessment of the feasibility of implementing any measure that is not included in the Valley's proposed SIP and attainment demonstration, but which is identified as a potential BACM/MSM control measure in Step 2. For this plan, staff's proposed SIP and attainment demonstration do not recommend eliminating any of the potential BACM/MSM control measures identified in Step 2 on the basis of technical or economic infeasibility. Thus, a feasibility assessment for purposes of eliminating such measures from further consideration (i.e. Step 3(b)) is not applicable.

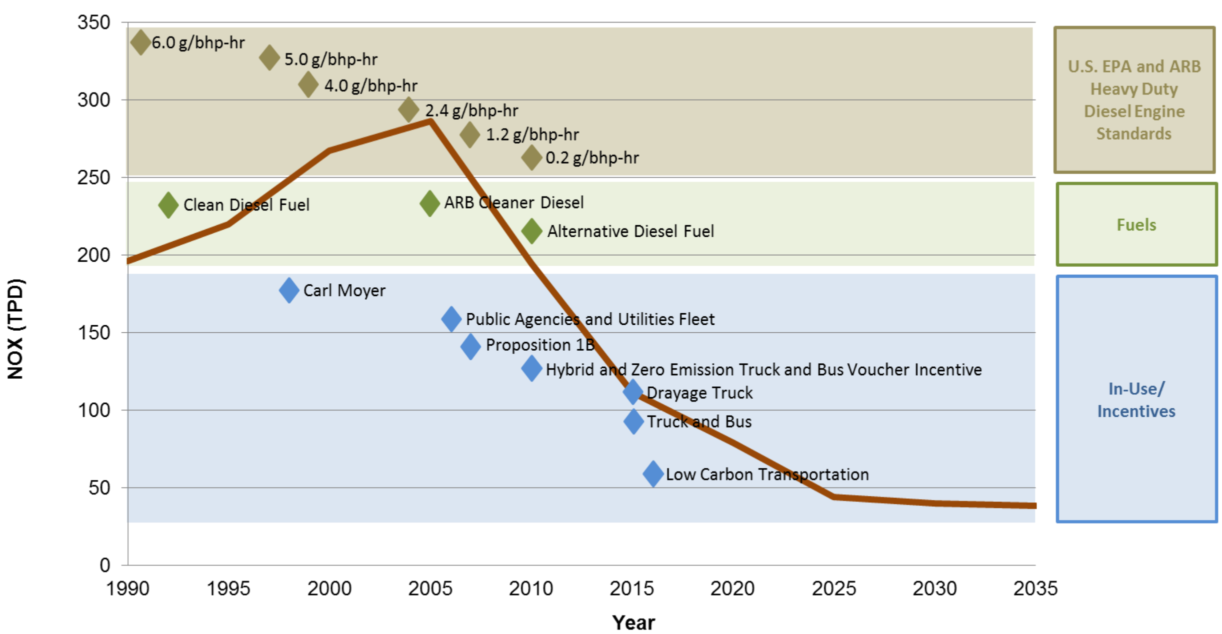
D.4.4 ON-ROAD HEAVY-DUTY VEHICLES

On-road heavy-duty vehicles include buses and trucks over 8,500 pounds gross vehicle weight rate (GVWR). The majority of these vehicles operate on diesel-cycle engines, especially in the higher weight classes. Gasoline and natural gas Otto-cycle spark-ignited engines are also used in heavy-duty trucks, primarily in the lower weight classifications.

D.4.4.1 Step 2(a): California's Current Heavy-Duty Control Program

Through ongoing efforts, CARB has developed the most stringent and successful heavy-duty vehicle emission control program in the world. Regulatory programs include requirements for increasingly tighter new engine standards, address vehicle idling, certification procedures, on-board diagnostics, emission control device verification, and requires accelerated turnover of the in-use fleet to cleaner, lower-emitting emission control and engine technologies. Ongoing implementation of CARB's current heavy-duty control programs is anticipated to result in a 70 percent reduction in NOx emissions from the on-road heavy-duty sector between 2013 and 2025, as shown in Figure 4.

Figure 4: Programs reducing NOx emissions from heavy-duty trucks in the Valley



The major regulatory and programmatic control measures that provide emission reductions in the on-road heavy-duty mobile source category are described below.

D.4.4.2 New Vehicle and Engine Standards

Heavy-duty engine emission standards (mandatory standards)

California is the only state with the authority to adopt and enforce emission standards for new motor vehicle engines that differ from the federal emission standards. A central element of CARB's heavy-duty diesel vehicle program is requiring that new trucks, buses and on-road diesel engines meet increasingly stringent engine emission standards. CARB has phased-in implementation of these increasingly stringent ***new heavy-duty vehicle and engine emission standards*** since the mid 1980's, resulting in significant emission reductions.

As shown in Table 10, California PM and NOx engine emission standards have historically been more stringent than applicable federal standards on several occasions, as indicated in the darker shaded portions of the table. In these instances, California has, functioning as a 'laboratory' state, paved the way for later federal increases in the stringency of PM and NOx emission standards. These standards reflect the increased efficiency in control technologies over time, as innovations in vehicles, engines, and emission-capturing technology progress. Since 1990***,*** heavy-duty engine NOx 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 NOx standard, which took effect in 2010. Due to these requirements, new heavy-duty trucks sold since 2010 emit 98 percent less NOx and PM2.5 than new trucks sold in 1986.

On August 26, 2005, CARB obtained a waiver from the federal preemption for the Engine Standards for 2007 and Subsequent Model Year Heavy-Duty Diesel Engines/Vehicles regulation, which generally aligned California's mandatory heavy-duty emission exhaust standards with the federal standards for 2007 and subsequent model year vehicles and engines. Subsequent mandatory exhaust emission standards for heavy-duty engines CARB has developed and adopted have aligned with federal standards.

Beyond the requirements currently in place for heavy-duty engine emission standards, the State SIP Strategy includes a commitment for CARB to develop the next generation of even more stringent Low-NOx Engine Standards for On-Road Heavy-Duty Trucks. CARB began development of new heavy-duty low-NOx emission standards in 2016, and Board action is expected in 2019. CARB staff will continue to coordinate as much as possible with U.S. EPA and urge U.S. EPA to develop a similar federal standard. A ***California low-NOx standard*** would apply to vehicles with new heavy-duty engines sold in California starting in 2023. While CARB's Truck and Bus Regulation will ensure that nearly every heavy-duty vehicle operated in California by 2023 will meet 2010 heavy-duty engine emission standards, even this a highly aggressive full-fleet

Table 10: Adopted California and Federal Heavy-Duty Engine Emission Standards
(for compression-ignition engines, shown in g/bhp-hr)

Model Year	California NOx		Federal NOx	California PM		Federal PM	
	General	Urban Buses		General	Urban Buses	General	Urban Buses
1985 - 86	10.7		10.7	n/a		n/a	
1987	6.0		10.7	0.60		n/a	
1988 - 89	6.0		10.7	0.60		0.60	
1990	6.0		6.0	0.60		0.60	
1991 - 92	5.0		5.0	0.25	0.10	0.25	
1993	5.0		5.0	0.25	0.10	0.25	0.10
1994 - 95	5.0	5.0 3.50 - 0.50 Optional (1995+)	5.0	0.10	0.07	0.10	0.07
1996 - 97	5.0	4.0 2.50 - 0.50 Optional	5.0	0.10	0.05* *(*0.07 in-use)*	0.10	0.05* *(*0.07 in-use)*
1998 - 03	4.0 2.50 - 0.50 Optional		4.0	0.10 0.03 – 0.01 Optional (2002+)	0.05* *(*0.07 in-use)*	0.10	0.05* *(*0.07 in-use)*
2004 - 06	2.0	0.50 - 0.01	2.0	0.10 0.03 – 0.01 Optional	0.01	0.10	0.05* *(*0.07 in-use)*
2007 - 09	0.20* *phased-in (*fleet avg ~1.2)*	0.20	0.20* *phased-in (*fleet avg ~1.2)*	0.01		0.01	
2010 - 14	0.20		0.20	0.01		0.01	
2015+	0.20 0.10 – 0.02 Optional		0.20	0.01		0.01	

penetration of 2010-compliant engines would not provide sufficient NOx reductions to attain the standards in the timeframe required. This drives the need for progressively more stringent heavy-duty engine NOx emission standards. For this reason, the adoption of a more stringent engine performance standard reflecting technology that is effectively 90 percent cleaner than today's standards (i.e. a 0.02 g/bhp-hr low-NOx standard) is a key component of the control strategy for mobile sources in the Valley.

Due to the preponderance of interstate trucking's contribution to in State VMT, federal action would be far more effective at reducing in-State emissions than a California only standard. Federal low-NOx standards could apply to all new heavy-duty trucks sold nationwide starting in 2024 or later. This would ensure that mobile source control measures that are under federal control also satisfy the same BACT/MSM requirements that are discussed in this SIP, and ensure that all trucks traveling within California would eventually be equipped with an engine meeting the lower NOx standard. Federal action is critical to implement this emission standard, since emission reductions from a California-only CARB regulation would come mostly from Class 4-6 vehicles (as most

Class 7 and 8 vehicles operating in California were originally purchased outside the State).

To facilitate this effort, CARB staff has been working with U.S. EPA to support the development of federal low-NOx requirements. The San Joaquin Valley District, in partnership with 18 other states and local jurisdictions, submitted petitions to U.S. EPA requesting federal action.[62, 63] As a result of this ongoing engagement, in their final rulemaking on the Phase 2 Greenhouse Gas (GHG) Standards in August of 2016[64], U.S. EPA signaled their intent to begin developing more stringent federal low-NOx emission requirements. Moreover, on December 20, 2016, U.S. EPA responded to the petitions, acknowledging the need for federal action to achieve further NOx reductions from on-road heavy-duty vehicles, and announcing it would initiate the work necessary to begin rulemaking efforts, targeting standards going into effect in the 2024 timeframe.[65] CARB will continue to call on U.S. EPA to move expeditiously in developing these requirements in recognition of the critical public health benefits it will provide.

Optional heavy-duty engine emission standards

In addition to mandatory NOx standards, CARB has also adopted several generations of ***optional lower NOx standards*** over the past 15 years. The optional standards allow local air districts and CARB to preferentially provide incentive funding to buyers of cleaner trucks, which encourages the development of cleaner engines.

- From 1998 to 2003, optional NOx standards ranged from 0.5 g/bhp-hr to 2.5 g/bhp-hr, at 0.5 g/bhp-hr increments, which was much lower than the mandatory 4 g/bhp-hr limit.

- Starting in 2004, engine manufacturers could choose to certify to optional NOx + non--methane hydrocarbon (NMHC) standards ranging from 0.3 g/bhp-hr to 1.8 g/bhp-hr, at 0.3 g/bhp-hr increments, which was significantly below the mandatory 2.4 g/bhp-hr NOx+NMHC standard.

- Most recently, in ongoing efforts to go beyond federal standards and achieve further reductions, CARB adopted in 2014 the ***Optional Reduced Emissions Standards for Heavy-Duty Engines*** regulation, which established the new generation of optional NOx emission standards for heavy-duty engines, and a certification pathway for a new generation of requirements for heavy-duty engines. Starting in 2015, engine manufacturers could certify to three optional NOx 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). This optional standard has resulted in substantial

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[62] SJVAPCD, 2016 *Petition Requesting that EPA Adopt New National Standards for On-Road Heavy-Duty Trucks and Locomotives under Federal Jurisdiction* is available at https://www.epa.gov/sites/production/files/2016-11/documents/san_joaquin_valley_petition_for_hd_and_locomotive.pdf

[63] South Coast AQMD et al, 2016 *Petition to U.S. EPA for Rulemaking to Adopt Ultra-Low NOx Exhaust Emission Standards for On-Road Heavy-Duty Trucks and Engines* is available at https://www.epa.gov/sites/production/files/2016-09/documents/petition_to_epa_ultra_low_nox_hd_trucks_and_engines.pdf

[64] U.S. EPA Phase 2 Greenhouse Gas Standards available at: https://www.epa.gov/regulations-emissions-vehicles-and-engines/final-rule-greenhouse-gas-emissions-and-fuel-efficiency.

[65] https://www.epa.gov/regulations-emissions-vehicles-and-engines/petitions-revised-nox-standards-highway-heavy-duty

investments in California's heavy-duty fleets over the past decade in order to adopt modern, lower-emitting vehicles and equipment.

Warranty Requirements and Useful Life

In 1978, CARB adopted ***emission warranty regulations*** to clarify the rights and responsibilities of individual motor vehicle and engine owners, motor vehicle and engine manufacturers, and the service industry. The emission warranty is used to cover any repairs needed to correct defects in materials or workmanship which would cause an engine or vehicle not to meet its applicable emission standards. In 1982, CARB adopted regulations that established California's first in-use recall program. These regulations were intended to reduce vehicular emissions by ensuring that noncompliant vehicles are identified, recalled, and repaired to comply with the applicable emission standards and regulations during customer use, and to encourage manufacturers to improve the design and durability of emission control components to avoid the expense of a recall. In 1982 and 1984, U.S. EPA promulgated heavy-duty vehicle useful life and warranty requirements identical to those adopted in California. Both U.S. EPA and CARB require that heavy-duty vehicles meet emission standards throughout their useful life periods. The current heavy-duty vehicle emission warranty period is 100,000 miles for all categories of heavy-duty vehicles with GVWR greater than 14,000 lbs.

Beyond the current California requirements described above, the Valley's plan also includes a proposed commitment to ensure that trucks continue to operate as cleanly as possible over their entire useful life. The ***Amended Warranty Requirements for On-Road Heavy-Duty Vehicles*** measure proposes developing lengthened warranty period requirements for on-road heavy-duty vehicles with gross vehicle weight rating (GVWR) greater than 14,000 lbs. The primary goal of this proposed measure is to reduce NOx and PM emissions by encouraging vehicle owners to make emission-related repairs. This measure may also incentivize manufacturers to design more durable components. The current heavy-duty vehicle emission warranty period is 100,000 miles for all categories of heavy-duty vehicles with GVWR greater than 14,000 lbs. This mileage is typically reached relatively early in vehicle lives, especially for vehicles with GVWR greater than 33,000 lbs., and well before the mileage at which rebuild typically occurs. Furthermore, recent CARB studies have identified some heavy-duty vehicles with NOx emission levels significantly above their applicable certification standards while still within the vehicles' useful lives. For this proposed measure, CARB staff would propose lengthening the 100,000 mile emissions warranty, potentially to the useful life for each classification of heavy-duty vehicle type. For example, the new warranty mileage period for Class 8 heavy-duty diesel vehicles could become 435,000 miles, ensuring that emission-related parts are warranted throughout a greater portion of the vehicles' service life.

OBD Requirements

In addition to new vehicle emission standards for the heavy-duty fleet, CARB's suite of control measures also includes actions to ensure that the in-use fleet continues to operate as cleanly as possible through requiring that new vehicles come equipped with in-use inspections and on-board self-diagnostic equipment. On-Board Diagnostics (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 adopted ***heavy-duty specific OBD requirements (HD OBD)*** in 2005, which applies to 2010 and subsequent model year heavy-duty engines and vehicles (i.e., vehicles with a gross vehicle weight rating greater than 14,000 pounds). This regulation required by 2013 that all heavy-duty engines offered for sale in California come equipped with OBD systems. U.S. EPA issued a waiver of preemption for the California 2010 Model Year Heavy-Duty Vehicle and Engine On-Board Diagnostic Standards in 2008, and has also issued two subsequent waivers for amendments CARB has made to the heavy-duty OBD requirements in later years to increase the stringency of these requirements.[66]

D.4.4.3 Reducing In-Use Emissions

While increasingly stringent standards for new vehicles and engines collectively ensure that new vehicles are as clean as possible, older, higher-emitting heavy-duty vehicles with long useful lifecycles can remain on the road for many years. To address this legacy fleet, CARB has adopted heavy-duty vehicle in-use control measures to significantly reduce PM2.5 and NOx emissions from existing diesel vehicles operating in California. These measures fall within three categories: measures that utilize inspections and maintenance programs in order to improve in-use emission performance levels; truck idling requirements; and fleet turnover rules.

Inspection and Maintenance (I/M) Program

CARB also adopted a suite of control measures to lower in-use emission performance levels to ensure that the heavy-duty vehicles in the in-use fleet continue to operate at their cleanest possible level.

Opacity Limits

The ***Heavy-Duty Vehicle Inspection Program (HDVIP)***, adopted into law in 1988, requires heavy-duty vehicles to be inspected for smoke opacity (i.e., excessive smoke), tampering, and engine certification label compliance. Any heavy-duty vehicle operating in California, including vehicles registered in other states and foreign countries, may be inspected. Inspections are performed by CARB inspection teams at border crossings, California Highway Patrol weigh stations, fleet facilities, and randomly selected roadside locations. Currently, under HDVIP, vehicles equipped with a 1991 model year (MY) or newer engine must meet a 40 percent opacity limit, while vehicles operating with a 1990 MY or older engine must meet a 55 percent opacity limit.

To ensure that in-use heavy-duty vehicles continue to operate at their cleanest possible level, the Valley's plan also includes new, supplemental actions to address in-use emissions. The ***Lower Opacity Limits for Heavy-Duty Vehicles*** measure would ensure that in-use, heavy-duty vehicles continue to operate at their cleanest possible level. CARB staff would develop and propose new, supplemental actions to lower the opacity limits for on-road heavy-duty trucks. The current HDVIP and PSIP opacity limits

[66] U.S. EPA 2012 "California State Motor Vehicle Pollution Control Standards; Amendments to the California Heavy-Duty Engine On-Board Diagnostic Regulation; Waiver of Preemption; Final Notice of Decision" Federal Register Volume 77, Number 237 pp. 73459-73461 https://www.gpo.gov/fdsys/pkg/FR-2012-12-10/pdf/2012-29792.pdf

(40 and 55 percent) are no longer adequate to identify and require repairs of vehicles operating with damaged PM emission control components. Even vehicles with heavily damaged and malfunctioning emission control systems emit exhaust at opacity levels below the current, out-of-date, opacity limits. Because of this, many HD vehicles operating in California are emitting excess PM emissions. For this measure, CARB staff would develop and propose lower opacity limits which reflect the current emission control technology equipped on today's HD diesel vehicles. The proposed amendments are intended to improve the identification and repair of malfunctioning PM emission control components on HD diesel vehicles in California. Lowering the opacity limits to the proposed levels would ensure that the opacity limits are more representative of current PM emission control technology and that vehicles operating with malfunctioning PM emission control components are more readily identified and repaired.

I/M Testing

All heavy-duty vehicles in California are subject to in-use inspections in order to control excessive smoke emissions and tampering. The ***Periodic Smoke Inspection Program (PSIP)***, adopted into law in 1990, requires heavy-duty vehicle fleet owners to conduct annual smoke opacity inspections of their vehicles, and have them repaired if excessive smoke emissions are observed. In addition, CARB has the authority to randomly audit these fleets, by reviewing the owners' maintenance and inspection records, and conducting opacity inspections on a representative sample of the vehicles. The current PSIP opacity limits are the same as for HDVIP (40 and 55 percent).

To ensure that in-use heavy-duty vehicles continue to operate at their cleanest possible level, the Valley's plan also includes new, supplemental actions to address in-use emissions and compliance. The ***Lower In-Use Performance*** measure will ensure that in-use, heavy-duty vehicles' emission control components and systems are properly functioning so that these vehicles continue to operate at their cleanest possible levels for the duration of their on-road operation. For this measure, CARB staff would develop and propose a regulatory program that reflects the current state of advanced engine and exhaust emission control technologies, including on-board diagnostics (OBD). For this proposed measure, CARB staff would develop and propose a comprehensive, multi-pollutant HD I/M program that that may be based largely on the extensive capabilities of OBD systems in newer engines (2013 and later model year engines) for monitoring the performance of nearly every engine and emission control component. Under the staff's current concept for the HD I/M program, heavy-duty vehicles would be required to demonstrate annual compliance with HD I/M program requirements in order to register with the Department of Motor Vehicles. This program concept also includes the use of telematics for OBD data transmittal to provide ease-of-of access to truckers, as well as an inspection component at physical locations, primarily for program validation and directed vehicle testing, for out-of-State vehicles entering California, or for older vehicles with pre-OBD engines.

Idling Requirements

To reduce idling emissions from new heavy-duty diesel vehicles and emissions from auxiliary power units used as alternatives to heavy-duty vehicle idling, the Airborne Toxic Control Measure (ATCM) to Limit Diesel-Fueled Commercial Motor Vehicle Idling ***(Heavy-Duty Diesel Vehicle Idling Reduction Program)*** requires, among other things, that drivers of diesel-fueled commercial motor vehicles with gross vehicle weight ratings greater than 10,000 pounds, including buses and sleeper berth equipped trucks, not idle the vehicle's primary diesel engine longer than five minutes at any location. First adopted in July 2004 and subsequently amended, the regulation consists of new engine and in-use truck requirements and emission performance requirements for technologies used as alternatives to idling the truck's main engine. Under the new engine requirements, 2008 and newer model year heavy-duty diesel engines need to be equipped with a non-programmable engine shutdown system that automatically shuts down the engine after five minutes of idling. In 2012, U.S. EPA issued a waiver of preemption for the most recent amendments made to the Idling Reduction Program in 2006, beginning in model year 2008.[67]

The ***School Bus Idling Airborne Toxic Control Measure*** (School Bus ATCM) limits bus and commercial motor vehicle idling near schools or at school bus destinations to only when necessary for safety or operational concerns. It has been in effect since July 16, 2003 and reduces emissions from more than 26,000 school buses that operate daily at or near schools. The program targets school buses, school pupil activity buses, youth buses, paratransit vehicles, transit buses, and heavy-duty commercial motor vehicles that operate at or near schools. In 2009, Senate Bill 124, Oropeza (SB 124) acknowledged and codified CARBs ATCM limiting school bus idling raising the minimum penalty for a violation of this rule from $100 to $300. The bill also clarifies local peace officer and air district authority to enforce the state's school bus idling program. SB 124 became effective on January 1, 2010, and the existing regulation was revised to reflect this change.

Fleet rules

CARB's ***Cleaner In-Use Heavy-duty Truck Regulation (Truck and Bus Regulation)*** is the largest measure of this type of control measures, in terms of emission reductions achieved. The Truck and Bus Regulation impacts approximately one million inter- and intra-state vehicles, and requires privately and federally owned diesel fueled trucks and buses and privately and publicly owned school buses to fully upgrade to newer, cleaner engines by 2023. This measure leverages the benefits provided by new truck emission standards by accelerating introduction of the cleanest trucks. The Truck and Bus Regulation was adopted in December 2008, and was amended in both December 2010 and December 2014. The rule represents a multi-year effort to turn over the legacy fleet of engines and replace them with the cleanest technology available. While heavy-duty engine technology has become significantly cleaner in the past few decades, the long useful lives of some heavy-duty engines means that older, higher-emitting trucks remain on the road for many years after newer generations of engine standards have gone into effect.

Starting in 2012, the Truck and Bus Regulation phases in requirements so that by 2014, nearly all vehicles operating in California will have PM emission controls, and by 2023 nearly all vehicles will meet 2010 model year engine emissions levels. The regulation applies to nearly all diesel fueled trucks and buses with a GVWR greater than 14,000

[67] U.S. EPA 2012 "California State Motor Vehicle and Nonroad Engine Pollution Control Standards; Truck Idling Requirements; Final Notice of Decision" Federal Register Volume 77, Number 32, pp. 9239-9250 http://www.gpo.gov/fdsys/pkg/FR-2012-02-16/pdf/2012-3690.pdf

pounds that are privately or federally owned, including on-road and off-road agricultural yard goats, cargo handling equipment, drayage trucks, solid waste collection vehicles, and school buses. Moreover, the regulation applies to any person, 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 sellers of a vehicle subject to the regulation must disclose the regulation's potential applicability to buyers of the vehicles. In January 2017, U.S. EPA granted a waiver of preemption for the portions of the Truck and Bus Regulation for which a waiver was required.[68]

The remainder of CARB's in-use heavy-duty truck regulations focus on fleets by trade vocations. These regulations control in-use emissions, and were developed with the unique duty cycles of vehicles and engines engages in these vocational applications in mind.

- The ***2007 Drayage Truck (Port or Yard) Regulation*** accelerates PM and NOx emission reductions from diesel fueled engines involved in moving goods into and out of California's ports, railyards, and intermodal facilities. This regulation requires drayage trucks to utilize engine Model Year 2007 or newer emission controls until December 31, 2022 for ports and rail yards in California, and requires 2010 Model Year or newer engines to continue entering ports and rail yards starting on January 1, 2023. Additionally, drayage trucks are subject to requirements under the Truck and Bus regulation.

- The ***Solid Waste Collection Vehicle Regulations*** were adopted in 2003 to reduce toxic diesel particulate matter (diesel PM) from approximately 12,000 diesel-fueled commercial and residential solid waste collection vehicle (SWCV) and recycling collection vehicles operated in California. The rule applies to all SWCVs of 14,000 pounds or more that run on diesel fuel, have engines in model years (MY) from 1960 through 2006, and collect waste for a fee. Additionally, SWCVs are subject to requirements under the Truck and Bus regulation.

- California's ***Diesel Particulate Matter Control Measure for Municipality or Utility On-Road Heavy-Duty Diesel Fueled Vehicles*** (***Public Agency and Utility Regulation***) requires a municipality or utility that owns, leases or operates on-road diesel fueled vehicles with engine model year 1960 or newer and GVWR greater than 14,000 pounds to reduce PM2.5 emissions to 0.01 g/bhp-hr. This can be done by repowering, retrofitting, or retiring the vehicle. Implementation of the rule started in 2007, with a compliance schedule based on the engine model year. Additionally, public agencies and utilities' fleets may be subject to requirements under the Truck and Bus regulation.

- Adopted in 2000, the ***Fleet Rule for Transit Agencies (Transit Fleet Rule)*** requires reductions in diesel PM and NOx emissions from urban buses and

[68] U.S. EPA 2017 "Final Notice of Decision - On-Highway Heavy-Duty Vehicle and Engine Regulations for 2007 and Subsequent Model Years" Accessed April 30, 2017 at https://www.gpo.gov/fdsys/pkg/FR-2017-01-17/pdf/2017-00940.pdf Federal Register / Vol. 82, No. 10 / Tuesday, January 17, 2017 pp. 4867

transit fleet vehicles, and required future zero-emission bus purchases. Urban bus fleets were required to select either the diesel path or the alternative-fuel path. Transit agencies on the diesel path needed to demonstrate zero-emission buses, and to meet the zero-emission bus purchase requirements sooner, while agencies on the alternative-fuel path had to ensure that 85 percent of urban bus purchases were alternative fueled without a demonstration requirement. The Transit Fleet Rule was amended in 2004, and again in 2006. The 2006 amendments temporarily postponed the zero-emission bus purchase requirement (until 2011 and 2012, depending on the compliance path) and expanded the initial demonstration with a subsequent advanced technology demonstration phase. In 2009, CARB staff provided a technology update to the Board on the commercial readiness of zero-emission buses, and received Board direction to research and develop commercial readiness metrics to be used as criteria to initiate the zero-emission bus purchase requirement, and to conduct a technology assessment on the readiness of zero-emission bus technologies. U.S. EPA granted CARB a waiver of preemption for the Fleet Rule for Transit Agencies in 2013.[69] Additionally, transit fleets are subject to requirements under the Truck and Bus regulation.

Although ZEV and PHEV technologies are not as mature for heavy-duty trucks as they are in the passenger vehicle sector, Class 3 - 7 delivery trucks and urban buses provide opportunities for introducing ZEV technologies. Several control measures committed to in the State SIP Strategy therefore focus on the deployment of zero-emission technologies in targeted applications, due to their duty cycle, are well-suited to the initial introduction of heavy-duty zero-emission engines, beginning in 2018 to 2020. For example, transit buses, last mile delivery vehicles, and airport shuttle buses are typically operated on short-distance fixed routes and are centrally housed, and may be captive to the District – characteristics that make these applications ideally suited to deploying zero-emission vehicles in targeted heavier applications preceding broader penetration in the heavy-duty engine market. These initial deployments provide a foundation for subsequent migration of zero-emission technology to other heavier platforms, in order to continue to expand heavy-duty ZEV requirements in the long term, especially in certain vocational classes and fleets that are under California regulatory authority.

- The ***Innovative Clean Transit*** measure will support the transition to a suite of cleaner transit options and reduce emissions from transit fleets. Under this measure, CARB staff will develop mechanisms to support the transition to a suite of innovative clean transit options, achieving emission reductions by supporting timely implementation of advanced technologies and improving efficiencies of the transit system.

- To reduce emissions from Classes 3-7 heavy-duty delivery trucks predominately used in urban areas to deliver freight from warehouses and distribution centers to its final point of sale or use, the ***Advanced Clean Local Trucks*** measure will

[69] U.S. EPA 2013, "California State Motor Vehicle Pollution Control Standards; Urban Buses; Request for Waiver of Preemption; Final Notice of Decision" Federal Register July 23, 2013 Volume 78, Number 141 pp. 44112-44117 https://www.gpo.gov/fdsys/pkg/FR-2013-07-23/pdf/2013-17700.pdf

increase the use of low-NOx engines and accelerate the deployment of zero-emission trucks. Experience gained from demonstrating the viability of advanced technologies in these fleets will benefit the market and enable the same technologies to be used in other heavy-duty vehicle applications.

- The ***Zero-Emission Airport Shuttle Bus*** measure is also designed to achieve NOx emission reductions through deployment of zero-emission airport shuttles. Airport shuttle buses transport passengers between car parking lots, airport terminals, and airport car rental facilities. Like transit buses and last mile delivery trucks, the inclusion of zero-emission airport shuttles would serve as a stepping stone to encourage broader deployment of zero-emission technologies in the on-road sector.

D.4.4.4 Fuels

In addition to new engine and in-use standards, cleaner burning fuels represent an important component in reducing emissions from on-road heavy-duty diesel trucks and buses. Cleaner fuel has an immediate impact in reducing emissions from the mobile source, and thus represent an important component in reducing NOx and diesel PM emissions from the on-road heavy-duty fleet. California's stringent air quality programs treat motor vehicles and their fuels holistically (as a system, rather than as separate components). As a result, CARB's fuels programs achieve significant reductions in criteria emissions from motor vehicles used in California.

CARB Diesel Fuel Regulations

The California diesel fuel program sets stringent standards for diesel fuel sold in California, and ensures that in-use diesel engines continue to operate as cleanly as possible. CARB's Diesel Fuel Regulations have, over time, phased in more stringent requirements for fuel mixture specifications for aromatic hydrocarbons and sulfur (a precursor to formation of secondary PM), and have establish a lubricity standard which apply fuels used in on- and off-road applications in California. ***"CARB diesel" Specifications*** adopted in 1988 limited the allowable sulfur content of diesel fuel 500 parts per million by weight (ppmw), and the aromatic hydrocarbon content to 10 percent, and became effective in 1993.

In 2003, ***CARB's Ultra Low Sulfur Diesel (ULSD) Regulation*** increased the stringency of the sulfur content limits in to 15 ppm, which harmonized with the 1993 U.S. EPA regulation that also limited sulfur in on-road diesel fuels to the same level. Both the California and federal ULSD regulations began implementation in 2006. CARB's ULSD Regulation had an immediate impact in reducing emissions from the in-use on-road heavy-duty fleet, while also enabling the use of advanced emissions control technologies, including the use of catalyzed diesel particulate filters (DPF), NOx after-treatment, and other advanced after-treatment based emission control technologies that higher sulfur levels would have inhibit the performance of (at the time of CARB's ULSD rulemaking, the average sulfur content of California diesel was approximately 140 ppmw).

Controlling Criteria Emissions from Renewable Fuels

The ***Low Carbon Fuel Standard (LCFS) and Alternative Diesel Fuel (ADF) Regulations,*** as amended in 2014, work together to reduce the carbon intensity of the

California fuel supply. The regulations also limit criteria emissions from alternative fuels and/or alternative fuel mix blends (a mix of fuels made from renewable feedstocks, which are then blended with conventional gasoline or diesel).

Beyond the current fuels control program, CARB committed to develop a ***Low Emission Diesel*** Measure that will require diesel fuel providers to steadily decrease criteria pollutant emissions from their diesel products. The use of low-emission diesel in on-road vehicles and off-road equipment will reduce tailpipe NOx and PM emissions, in addition to other criteria pollutants. Some studies carried out to date on hydrotreated vegetable oil have reported NOx emission reductions of 6 percent to 25 percent and PM emission reductions of 28 percent to 46 percent, depending on the types of fuels, drive cycles tested, and diesel engines used. This standard is anticipated to both increase consumption of low-emission diesel fuels, and to reduce emissions from conventional fuels. This measure is anticipated to provide NOx benefits predominately from legacy (pre-2010) on-road heavy-duty vehicles, off-road engines, stationary engines, portable engines, marine vessels and locomotives, as well as NOx and diesel PM benefits in potentially all model year off-road engines, stationary engines, portable engines, marine vessels and locomotives. Interstate vehicles, even those registered out-of-State but operating on CARB diesel blended with low-emission diesel, are also anticipated to provide emission reduction benefits.

D.4.4.5 Step 2(b): Other States' and Nonattainment Areas' on-road Heavy-Duty Control Measures

Table 11 summarizes the most stringent control measures currently in use in any state or nonattainment that have been identified and discussed for on-road heavy-duty vehicles. Each of the measures identified in this table are discussed in more detail in this section, below.

Table 11: Summary of Most Stringent Heavy-Duty Control Measures Identified

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
New Engine Standards			
New Vehicle and Engine Standards • Heavy-duty engine emission standards (mandatory standards)	Current CARB and U.S. EPA limit exhaust emissions to same levels: • NOx: 0.2 g/bhp-hr • PM: 0.01 g/bhp-hr CARB anticipated to propose to further increase stringency to ~0.02 g/bhp-hr (NOx). • *(Low-NOx Truck measure)*	CARB's current emission standards for heavy-duty engines (NOx and PM) are set at the same level of stringency as Federal standards. CARB is anticipated to further increase the stringency of controls by proposing California NOx standards that are effectively 90 percent cleaner than today's federal NOx standards (i.e. 0.02 g/bhp-hr) *(NOTE: CARB has committed to develop the Low-NOx Truck measure but it has not yet been proposed to the Board for approval/adoption.)*	No other state has more stringent exhaust emission standards than California.
New Vehicle and Engine Standards • Optional heavy-duty engine emission standards	Optional Low NOx Emission Standard (CARB) • 0.1 g/bhp hr, 0.05 g/bhp-hr, or 0.02 g/bhp-hr	CARB's optional standards accelerate the pace of innovation and development of cleaner engine technologies by certifying engines that go beyond the stringency of federal standards. Starting in 2015, engine manufacturers could choose to certify to three optional NOx 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). Together with the mandatory standards that harmonize with federal emission requirements, this program makes California's suite of HD engine emission controls the most stringent in the nation.	California is the only state with optional exhaust emission standards for heavy-duty engines that exceed the stringency of U.S. EPA requirements.
New Vehicle and Engine Standards • Warranty Requirements and Useful Life	CARB's warranty requirements are currently set at the same level of stringency as Federal standards. CARB anticipated to propose to further increase stringency *(Amended Warranty Requirements for On-Road HD Vehicles measure)*	Both U.S. EPA and CARB currently require that heavy-duty vehicles meet emission standards throughout their useful life periods of 5 years / 100,000 miles (GVWR > 14,000 lbs.) CARB is anticipated to further increase the stringency of controls by proposing lengthened warranty period requirements, potentially up to >400,000 miles. *(NOTE: CARB has not yet been proposed the Amended Warranty Requirements for On-Road HD Vehicles measure to the Board for approval/adoption.)*	No other state has more stringent warranty requirements than California.
New Vehicle and Engine Standards • OBD Requirements	Heavy-Duty OBD (CARB) and OBD II (CARB)	CARB and federal OBD regulations for heavy-duty vehicles generally align for MY2013 and newer engines, although CARB's program has been amended to be more stringent than U.S. EPA's for certain vehicle types. California OBD requirements are at least as stringent as applicable federal requirements.	No other state has more stringent OBD requirements than California.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
In-Use Emission Controls			
In-Use Emissions Controls • I/M program (opacity limits)	New Jersey (NJ) has more stringent opacity limits than CARB's currently adopted regulations. However, the Valley's plan proposes to increase the stringent of CARB's opacity limits, which would it the most stringent in the nation. *(Lower Opacity Limits measure)*	CARB's current HVIP program sets opacity limits at 40% (for MY1991 and newer) and 55% (MY1990 and older). CARB is anticipated to further increase the stringency of controls by proposing to lower the opacity limits for non-DPF-equipped vehicles to a range equivalent to NJ's program (20% – 40%), and to 5% for DPF-equipped engines. *(NOTE: CARB has committed to develop the Lower Opacity Limits measure but it has not yet been proposed to the Board for approval/adoption.)*	New Jersey's opacity limits range from 40% - 20%
In-Use Emissions Controls • I/M program (Testing)	California's current I/M program for heavy-duty vehicles is the most stringent in the nation. CARB anticipated to propose to further increase stringency. *(Lower In-Use Performance Level measure)*	CARB's I/M program (including the HDVIP and PSIP regulations) is the most stringent in the nation, with further increases in stringency anticipated to be proposed. *(NOTE: CARB has committed to develop the Heavy-Duty Vehicle Inspection and Maintenance Program measure, but it has not yet been proposed to the Board for approval/adoption.)*	Three other states also test OBD in heavy-duty vehicles (MA, NJ, and WI), but none aside from California are currently enforcing on OBD scans for vehicles >14,000 lb. GVWR. Additionally, they do not control emissions from out-of-state trucks, or include the potential use of telematics like CARB.
In-Use Emissions Controls • Idling requirements	Heavy-Duty Diesel Vehicle Idling Reduction Program (CARB)	CARB's program the most stringent in the nation. It limits idling time to five minutes, and requires that MY 2008 and newer engines are equipped to automatically shut down after five minutes of idling. While other jurisdictions have adopted similar idling time limits requirements – some with more stringent time limits than CARB – none surpassed the stringency of California's program in effect, because emission performance requirements for idle reduction technologies are unique to California's program.	Areas with more stringent time limits: • 2 minute restrictions, no exemptions: Philadelphia, PA • 2 minute restrictions, some exemptions: Salt Lake City and Salt Lake County, UT • 3 minute restrictions, some exemptions: CT, DC, City of Ketchum (ID), New York City (NY), the Village of Larchmont (NY), the Village of Mamaroneck (NY), the County of Westchester (NY), Park City (UT), and the City of Birmingham (VT) Areas with less stringent time limits: • 3 minute restrictions, some exemptions DE, Chicago (IL), NJ, Town of Mamaroneck (NY), and Rockland County (NY)

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
In-Use Emissions Controls • Fleet Rules (Truck and Bus)	Truck and Bus Regulation (CARB)	CARB's Truck and Bus regulation is the most comprehensive and stringent mandatory heavy-duty fleet turnover rule in the nation, affecting approximately one million inter- and intra-state on-road diesel vehicles. The regulation applies to nearly all privately or federally owned diesel-fueled trucks and buses > 14,000 lbs., GVWR, including on-road and off-road agricultural yard goats, cargo handling equipment, drayage trucks, solid waste collection vehicles, and school buses. Its phased-in requirements mandate diesel particulate filters in early years, eventually requiring vehicles to fully upgrade to newer, cleaner engines that meet MY 2010 engine equivalent emissions levels when fully implemented in 2023.	No other state requires diesel particulate filters (DPF) and MY 2010 + equivalent engines as a mandatory fleet rule affecting nearly the entire on-road diesel fleet
In-Use Emissions Controls • Fleet Rules (Drayage Trucks)	Drayage Truck (Port or Yard) Regulation and Truck and Bus Regulation (CARB)	California's emission controls for drayage trucks are the most stringent in the country. The Drayage Truck (Port or Yard) Regulation requires 2010 Model Year or newer engines at ports and rail yards starting in 2023.	No other jurisdiction mandates more stringent fleet requirements for drayage trucks.
In-Use Emissions Controls • Fleet Rules (Solid Waste Collection Vehicles)	Solid Waste Collection Vehicle Regulations and Truck and Bus Regulation (CARB)	California's solid waste collection vehicles (SWCVs) fleet control program is the most stringent in the nation. Compared to New York City's program, CARB's Solid Waste Collection Vehicles regulation limits PM emissions at approximately the same level of stringency; because these vehicles are also subject to more stringent requirements under Truck and Bus, however, the overall level of emission controls are more stringent in California than any other jurisdiction.	New York City (NY) requires that at least 90 percent of the ~8,300 qualifying privately and publicly-owned SWCVs meet the U.S. EPA's 2007 diesel standard for PM. Comparatively, CARB controls ~12,000 SWCVs (MYs 1960 through 2006) at approximately the same level of PM control (i.e. equivalent to the 2007 MY standard of 0.01 g/bhp-hr).
In-Use Emissions Controls • Fleet Rules (Public fleets)	Public Agency and Utility Regulation and Truck and Bus Regulation (CARB)	California's public fleet controls are the most stringent in the nation. CARB's Public Agency and Utility Regulation requires similar stringency in PM emissions limits as the Boston, MA program; because these fleets are also subject to more stringent requirements under Truck and Bus, the overall level of emission controls are more stringent in CA than any other jurisdiction.	The city of Boston (MA) requires by 2018 all pre-2007 diesel vehicles and equipment not previously retrofit to be controlled to achieve emission reductions of at least 85 percent (approximately equivalent to the 2007 PM standard of 0.01 g/bhp-hr). Comparatively, CARB limits are set equivalent to the 2007 MY standard of 0.01 g/bhp-hr for engine MY 1960 or newer, GVWR > 14,000 lbs.
In-Use Emissions Controls • Fleet Rules (Transit fleets)	Transit Fleet Rule (CARB) CARB anticipated to propose to further increase stringency. *(Innovative Clean Transit measure)*	California's emission controls for transit vehicles are the most stringent in the country. The Transit Fleet Rule requires emission reductions (PM and NOx) from urban buses and transit fleet vehicles, and required future zero-emission bus purchases. Further increases in the stringency of public fleet controls are anticipated under the Innovative Clean Transit measure.	No other jurisdiction mandates more stringent fleet requirements for transit fleets.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
		(NOTE: CARB has committed to develop Innovative Clean Transit measure, but it has not yet been proposed to the Board for approval/adoption.)	
In-Use Emissions Controls • Fleet Rules (Last mile delivery trucks)	Truck and Bus Regulation (CARB) CARB anticipated to propose to further increase stringency. *(Advanced Clean Local Trucks measure)*	California's emission controls for last mile delivery vehicles (Class 3-7 heavy-duty delivery trucks used to deliver freight from warehouses and distribution centers to the final point of sale or use) are the most stringent in the country. Truck and Bus requires MY 2010 or equivalent engines by 2023. Further increases in the stringency of last mile delivery fleets are anticipated under the Advanced Clean Local Trucks measure. *(NOTE: CARB has committed to develop the Advanced Clean Local Trucks measure, but it has not yet been proposed to the Board for approval/adoption.)*	No other jurisdiction mandates more stringent fleet requirements for last mile delivery trucks.
In-Use Emissions Controls • Fleet Rules (Airport shuttle buses)	Truck and Bus Regulation (CARB) CARB anticipated to propose to further increase stringency. *(Zero-Emission Airport Shuttle Bus measure)*	California's emission controls for airport shuttle buses (vehicles used to transport passengers between car parking lots, airport terminals, and airport car rental facilities) are the most stringent in the country. Truck and Bus requires MY 2010 or equivalent engines by 2023. Further increases in the stringency of airport shuttle buses and similar fleets are anticipated under the Zero-Emission Airport Shuttle Bus measure. *(NOTE: CARB has committed to develop Zero-Emission Airport Shuttle Bus measure, but it has not yet been proposed to the Board for approval/adoption.)*	No other jurisdiction mandates more stringent fleet requirements for airport shuttle buses.
In-Use Emissions Controls • Fleet Rules (School Buses)	Truck and Bus Regulation (CARB)	California's emission controls for school buses are the most stringent in the nation. The Truck and Bus regulation requires that all school buses fully upgrade by 2023 to engines that meet MY 2010 engine emissions levels. Since 2003, California also limits bus and vehicle idling time near schools or at school bus destinations through the School Bus ATCM, reducing emissions from >26,000 school buses operating daily at or near schools.	Colorado (CO) controls emissions from school buses through a School Bus Retrofit Program funded by DERA Grants from U.S. EPA. This voluntary program began in 2009, and controls PM emissions through retrofits. CARB staff is unaware of any other jurisdictions that mandate retrofits or turnover of the school bus fleet to ensure engines meet MY2010-equivalent level of controls.
Fuels Programs			
Fuels Standards • Diesel Standards	CARB Diesel Fuel Regulations and Ultra Low Sulfur Diesel (CARB)	CARB Diesel Fuel Regulations include stringent requirements for fuel mixture specifications for aromatic hydrocarbons and sulfur, and have establish a lubricity standard and applies to sales of fuel used in on-road vehicles and off-road vehicles and locomotives in California	No state requires cleaner burning diesel than California. The California diesel fuel regulations exceed federal requirements in stringency.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
		CARB's Ultra-Low Sulfur Diesel (ULSD) program reduces ozone precursor emissions significantly relative to U.S. EPA requirements (providing approximately 7 percent more NOx reductions and 25 percent more dPM reductions than federal diesel).	
Fuels Standards • Alternative Fuel Standards (Diesel substitutes)	LCFS and ADF (CARB) CARB is anticipated to propose to further increase stringency. *(Low Emission Diesel measure)*	The LCFS and ADF regulations work together to reduce the carbon intensity of the California fuel supply while requiring limits on criteria emissions from alternative fuels and/or alternative fuel mix blends. CARB is anticipated to further increase the stringency of controls on criteria pollutant emissions diesel products. *(NOTE: CARB has committed to develop the Low Emission Diesel measure, but it has not yet been proposed to the Board for approval/adoption.)*	No other state has set as stringent of criteria emission requirements on alternative fuels and alternative fuel blends than California.

D.4.4.6 New heavy-duty vehicle and engine standards

Heavy-duty engine emission standards

CARB's truck engine standards for on-road heavy-duty engines are consistent with the most stringent of any other area in the nation. Due to constraints in the Act, California is the only state that can set new engine standards (including control measures such as emission standards, warranty provisions, and on-board diagnostic (OBD) requirements) that are more stringent than U.S. EPA's national standards. Other states may adopt California programs for which U.S. EPA has provided California with waivers (under provisions specified in Section 177). These states are also known as the "Section 177 States" in reference to this provision of the Act. The ability to set more stringent controls than U.S. EPA, however is unique to California, and thus ensures that the California control measures for new engine and truck standards are at least equal in stringency to the most stringent controls in the nation.

Similar to the light-duty sector, as provided for in the Act, a number of other states have historically followed California's lead and adopted at least one of California's heavy-duty regulations. These states are listed below in Table 12.

Table 12: Section 177 for CARB's Heavy-Duty Engine Emission Standards

Section 177 States	Heavy-Duty Diesel Engine Regulation
Connecticut	X
Delaware	X
Georgia	X
Maine	X
Massachusetts	X
New Jersey	X
New York	X
North Carolina	X
Pennsylvania	X

CARB's current heavy-duty engine emission standards sets exhaust emission standards for PM2.5 at 0.01 g/bhp-hr and NOx at 0.2 g/bhp-hr. This aligns with the applicable federal standards set by U.S. EPA, which are also set at the same levels of stringency.[70]

With the adoption and implementation of the proposed Low-NOx Standards for Heavy-Duty Vehicles, CARB will further increase the stringency of these requirements to reduce NOx exhaust emissions standards to 0.02 g/bhp-hr (i.e. 90 percent lower than the current mandatory standard).

Optional engine emission standards

To achieve further reductions and incentivize ongoing development of increasingly more efficient engine technologies, CARB has also provided certification to optional emission standards at levels 50 percent, 75 percent, and 90 percent cleaner than currently mandated emission standards. This allows CARB and local air districts to preferentially

[70] U.S. EPA 2016 "Heavy-Duty Highway Compression-Ignition Engines and Urban Buses: Exhaust Emission Standards" https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100O9ZZ.pdf accessed May 1, 2018.

incentivize and fund the purchase of cleaner trucks and engines than would have otherwise met the mandatory standard. CARB staff is unaware of any other state with a similar control program.

Certification and Warranty Requirements

CARB's certification and warranty requirements for new on-road heavy-duty vehicles exceeds the stringency of any other in the nation. California is the only state with certification and warranty requirements for new on-road heavy-duty engines that exceed the stringency of U.S. EPA requirements.

Lower In-Use Emission Performance Standards and Test Procedures

CARB's in-use emission performance standards and test procedures for new on-road heavy-duty engines and vehicles exceeds the stringency of any other in the nation. California is the only state with emission performance standards and test procedures for new on-road heavy-duty engines and vehicles that exceed the stringency of U.S. EPA requirements.

OBD Requirements

CARB's OBD requirements for new on-road heavy-duty vehicles exceeds the stringency of any other in the nation. California is the only state with OBD requirements for new on-road heavy-duty engines that exceed the stringency of U.S. EPA requirements.

D.4.4.7 In-use emission controls for heavy-duty vehicles

In-Use Inspection Program

The Inspection / Maintenance (I/M) Program testing and in-use emission controls in the Valley for on-road heavy-duty trucks and buses are consistent with the most stringent of any other I/M program in the nation.

Opacity Limits

During the current year of 2018, New Jersey has more stringent opacity limits than California[71], but this differential will be fully addressed through the ***Lower Opacity Limits for Heavy-Duty Vehicles*** measure as described in the Valley's plan; when implemented in 2019, California opacity limits will once again become the most stringent in the nation.

I/M Testing

CARB's HDVIP program requires heavy-duty trucks and buses to be inspected for excessive smoke and tampering, and engine certification label compliance, including all applicable OBD requirements. Any heavy-duty vehicle traveling in California, including vehicles registered in other states and foreign countries, may be tested. Tests are performed by CARB inspection teams at border crossings, weigh stations, fleet facilities, and randomly selected roadside locations. Owners of trucks and buses found in violation are subject to minimum penalties starting at $300 per violation. The PSIP program requires that diesel and bus fleet owners conduct annual smoke opacity inspections of their vehicles and repair those with excessive smoke emissions to ensure compliance. CARB randomly audits fleets, maintenance and inspection records and tests a representative sample of vehicles. All vehicles that do not pass the test must be

[71] For more information on the New Jersey Opacity Limits, please see http://www.nj.gov/dep/bmvim/bmvim_emisStds.htm

repaired and retested. A fleet owner that neglects to perform the annual smoke opacity inspection on applicable vehicles is subject to a penalty of $500.00 per vehicle, per year.

Comparatively, three other states have efforts to include OBD testing on heavy-duty vehicles, which are summarized below:

- Massachusetts currently requires opacity testing for diesel engines over 14,000 lbs., GVWR, and OBD testing starting at 2007, with plans to develop a more stringent OBD testing program that will include OBD testing on vehicles 14,000 lbs., GVWR and above.
- New Jersey currently requires opacity testing for diesel engines over 18,000 lbs., GVWR, and has announced the award of a new program to include OBD testing on all diesels over 18,000 lbs., GVWR
- Wisconsin currently requires OBD testing for diesel engines up to 14,000 lbs., GVWR, which began in 2007. Wisconsin is considering an option to move toward testing OBD on 14,000 lbs., GVWR and above in the future.

While Massachusetts and New Jersey are developing similar I/M programs as California (all three states are collecting OBD test data for vehicles over 14,000 lbs., GVWR) no jurisdictions aside from California are currently enforcing on OBD scans for vehicles over 14,000 lb. GVWR. Furthermore, none include the potential use of telematics or are trying to also capture out-of-State trucks in the program as California's control program does. Thus, CARB's I/M testing controls are the most stringent in the nation.

Idling Requirements

The idling requirements in the Valley's plan are aligned with the most stringent in the nation. California has a 5-minute idling time restriction. In addition, it has emission performance requirements for alternative idle reduction technologies such as auxiliary power units (APU) and fuel-fired heaters. While other states have adopted similar HD idling requirements as California, none have surpassed the stringency of California requirements in effect, due to the unique exemptions provided California under the CAA that enables CARB to set emissions performance requirements that exceed the stringency of those required by U.S. EPA. The following states, counties and cities have more stringent timing requirements for idling time restrictions. However, they do not set performance requirements for idle reduction technologies to reduce the intensity of emissions emitted over a given amount of time.

- The City of Philadelphia (PA) has the most stringent idling restriction of 2-minutes with no exemptions.
- Salt Lake City and Salt Lake County in Utah have also idling restrictions of 2 minutes with some exemptions but still more stringent than California idling restrictions.
- Connecticut, the District of Columbia, City of Ketchum (Idaho), New York City (NY), the Village of Larchmont (NY), the Village of Mamaroneck (NY), the

County of Westchester (NY), Park City (Utah), and the City of Birmingham (Vermont) have idling time restriction of 3 minutes with some exemptions.

- Delaware, Chicago (Illinois), New Jersey, Town of Mamaroneck (NY), and Rockland County (NY) also have 3-minute idling restrictions, but their exemptions make their rules less stringent than California idling rule.

Only California has emission performance requirements for idle reduction technologies. Therefore, even if another jurisdiction has an idle time restriction shorter than California's 5-minute idling restriction, for sleeper cabs that use APUs as an alternative technology, California's regulation is more stringent because of the differences in APU emissions. Thus, all other state, county, or city idling rules are less stringent than California's idling restriction.

Heavy-Duty Fleet Rules

California's fleet rules for heavy-duty trucks and buses are the most stringent of any in the nation. The Truck and Bus regulation requires that by 2014, nearly all vehicles operating in California will have PM emission controls, and by 2023 nearly all vehicles will meet 2010 model year engine emissions levels. The regulation applies to nearly all diesel fueled trucks and buses with a gross vehicle weight rating greater than 14,000 pounds that are privately or federally owned, including on-road and off-road agricultural yard goats, and privately and publicly owned school buses. Moreover, the regulation applies to any person, business, school district, or federal government agency that owns, operates, leases or rents affected vehicles.

Additionally, California has adopted and implemented fleet-specific rules that are consistent with the most stringent in the nation.

- Public Fleet Rules
  The city of Boston (MA) requires that all pre-2007 City-owned or operated vehicles to have equipment that reduces diesel emissions by at least 20 percent by the end of 2015, and that all pre-2007 diesel vehicles and equipment not previously retrofit would be required to have retrofits achieving at least 85-percent—or best available—pollution reductions by the end of 2018.

  Comparatively, California's statewide Public Agency and Utility Regulation requires any municipality or utility that owns, leases or operates on-road diesel fueled vehicles with engine model year 1960 or newer and GVWR greater than 14,000 pounds to reduce PM2.5 emissions to 0.01 g/bhp-hr. This can be done by repowering, retrofitting, or retiring the vehicle. Implementation of the rule started in 2007, with a compliance schedule based on the engine model year.

- Solid Waste Vehicles
  New York City (NY) is implementing a control measure that began in 2017 to modernize the city's fleet of diesel-powered solid waste vehicles of approximately 2,000 trucks used for picking up residential waste and recyclables with newer, less-polluting models. This program requires that at least 90 of qualifying vehicles must meet the tougher emission control standards for diesel trucks that

the federal Environmental Protection Agency set in 2007.[72] A newly proposed control measure would strengthen those requirements to apply to approximately 8,300 private collection trucks to meet the same federal emissions standards by 2020, three years after the deadline for the municipal fleet. This new proposal has not been adopted by the City Council, whose vote is required.[73]

Comparatively, California's Solid Waste Collection Vehicle Regulation was adopted in 2003 to reduce toxic diesel PM from approximately 12,000 diesel fueled commercial and residential SWCV and recycling collection vehicles operated in California. The rule applies to all SWCVs of 14,000 pounds or more that run on diesel fuel, have engines in MYs from 1960 through 2006, and collect waste for a fee.

- School Buses
  Colorado controls emissions from school buses through a School Bus Retrofit Program funded by DERA Grants from U.S. EPA. This program began in 2009, and reduces emissions of diesel exhaust by retrofitting school buses with proven emissions-reduction technologies, including diesel-oxidation catalysts, engine preheaters and closed-crankcase filtration systems.

  Comparatively, California's Truck and Bus regulation requires that all privately and publicly owned school buses to fully upgrade by 2023 to newer, cleaner engines that meet 2010 model year engine emissions levels. California also limits bus and vehicle idling time near schools or at school bus destinations through the School Bus ATCM. It has been in effect since 2003 and reduces emissions from more than 26,000 school buses that operate daily at or near schools. The program targets school buses, school pupil activity buses, youth buses, paratransit vehicles, transit buses, and heavy-duty commercial motor vehicles that operate at or near schools.

D.4.4.8 Fuels

Diesel Fuel Regulations

U.S. EPA began regulating sulfur content in diesel in 1993. At that time, uncontrolled fuels (i.e. non-CARB diesel) contained approximately 5,000 parts per million (ppm) of sulfur. In 2006, U.S. EPA began to phase-in more stringent requirements under the federal Ultra-Low Sulfur Diesel (ULSD) regulations, which lowered the amount of sulfur in on-road diesel fuel to 15 ppm. The Onroad (Highway) Diesel Fuel Standard was phased-in from 2006 to 2010, and since 2011 have required that all highway diesel fuel supplied to the market be ULSD, and that all highway diesel vehicles must use ULSD. CARB's ultra-low sulfur diesel program limits sulfur content at the same levels as U.S. EPA's on-road ULSD program (i.e. at 15 ppm); however, due to other specifications that uniquely apply to CARB diesel, the California program reduces

[72] https://www.nytimes.com/2016/08/19/opinion/how-garbage-trucks-can-drive-a-green-future.html
[73] ibid

emissions significantly relative to federal diesel, about 7 percent reduction in NOx and 25 percent in diesel PM.[74]

Beyond the federal diesel requirements described above, the Act also allows states to adopt unique fuel programs to meet local air quality needs, which are referred to as Boutique Fuel Programs. As of January 19, 2017 U.S. EPA identified only one boutique fuel programs that had been approved in a SIP,[75] the Low Emission Diesel Program in Texas (TxLED). The fuel specifications for the TxLED are based on CARB diesel requirements,[76] and fuel formulations approved by CARB are also considered approved by the Texas Commission on Environmental Quality (TCEQ), and may be used to comply with the TxLED regulations.[77] Additionally, independent analysis of TxLED, CARB ULSD and federal ULSD shows that the TxLED fuel emissions performance does not provide as significant of emission reduction benefits as the California specifications,[78] although U.S. EPA credited the TxLED program with providing approximately a 5% NOx emission reduction benefit over federal ULSD fuels.[79] Furthermore, the stringency of Texas' testing requirements are based on the federal Complex Model, which is less stringent and nuanced than the California Predictive Model that is used to determine compliance with California fuel requirements.

Controlling Criteria Emissions from Renewable Fuels

The Low Carbon Fuel Standard (LCFS) and Alternative Diesel Fuel (ADF) regulations work together to limit criteria emissions from alternative fuels. While other states have adopted or are considering adopting similar programs to the California LCFS, no other state has set criteria emission requirements on alternative fuels. U.S. EPA's Renewable Fuel Standard (RFS II) does not specify criteria emission requirements for alternative fuels. Furthermore, CARB is anticipated to further increase the stringency of controls on criteria pollutant emissions diesel products under the Low Emission Diesel measure. No other state or nonattainment area controls criteria emissions from renewable fuels more stringently than CARB.

[74] Beyond sulfur limits at 15 ppm, CARB's program also requires the aromatic hydrocarbon content of the diesel fuel sold in the state not to exceed 10 percent by volume. Alternative diesel fuel formulations can be used to demonstrate equivalent compliance without actually meeting the aromatic limit.

[75] U.S. EPA, 2017 https://19january2017snapshot.epa.gov/gasoline-standards/state-fuels_.html

[76] Texas Administrative Code Title 30 Part I Chapter 114 Subchapter H, Division 2 Rule §114.312 http://texreg.sos.state.tx.us/public/readtac%24ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=30&pt=1&ch=114&rl=312

[77] Texas Commission on Environmental Quality https://www.tceq.texas.gov/assets/public/implementation/air/sip/texled/List%20of%20TCEQ-Approved%20Alternative%20Diesel%20Formulations.pdf

[78] American Transportation Research Institute (ATRI) 2008 "Energy and Other Fuel Property Changes with On-Road Ultra-Low Sulfur Diesel Fuel" http://www.atri-online.org/research/results/environmentalfactors/2008ATRIDiesel.pdf

[79] U.S. EPA 2001, "Approval and Promulgation of Air Quality State Implementation Plans (SIP); Texas: Low Emission Diesel Fuel" https://www.federalregister.gov/documents/2001/11/14/01-27581/approval-and-promulgation-of-air-quality-state-implementation-plans-sip-texas-low-emission-diesel Federal Register Vol. 66, No. 220 pages 57196-57219

D.4.5 Step 3(a): Evaluation of Stringency: On-Road Heavy-Duty Control Measures

Step 3(a) calls for an evaluation of each of the control measures identified in Step 2, in order to evaluate their stringency and determine whether they meet all applicable requirements to satisfy the definitions of BACM and/or MSM discussed in Chapter 1 and Chapter 2.

in order to determine whether each potential MSM/BACM measure meets the definition of MSM and/or BACM, staff has assessed each potential MSM/BACM on-road heavy-duty vehicle control measure identified in Steps 2(a) and 2(b). Based on this assessment, staff then characterized each potential MSM / BACM measure as falling into ‘bins’ representing whether it meets the definition of MSM or BACM for each of the four PM2.5 standards covered in this document (note that the BACM bin is further subdivided into BACT or ADF). The determination of which bin each control measure falls into thus indicates both the control measure’ stringency and the control measures’ implementation schedule, relative to the varying attainment dates among the Valley’s four PM2.5 SIPs. In other words, the bin into which each control measure falls correlates with how hard each measure pushes to control emissions, given the implementation timeframes associated with each standards’ plan. Generally speaking, the control measures included in CARB’s current control program meet the definition of BACM; the new measures included in the Valley SIP Strategy satisfy MSM requirements.

Figure 5 shows the timing for implementation of each potential MSM / BACM on-road heavy-duty vehicle control measure identified in the prior sections (i.e. Steps 2(a) and 2(b)), for each of the four PM2.5 standards discussed in this SIP.

Figure 5: Timeline for Implementation of BACM / MSM Heavy-Duty Control Measures

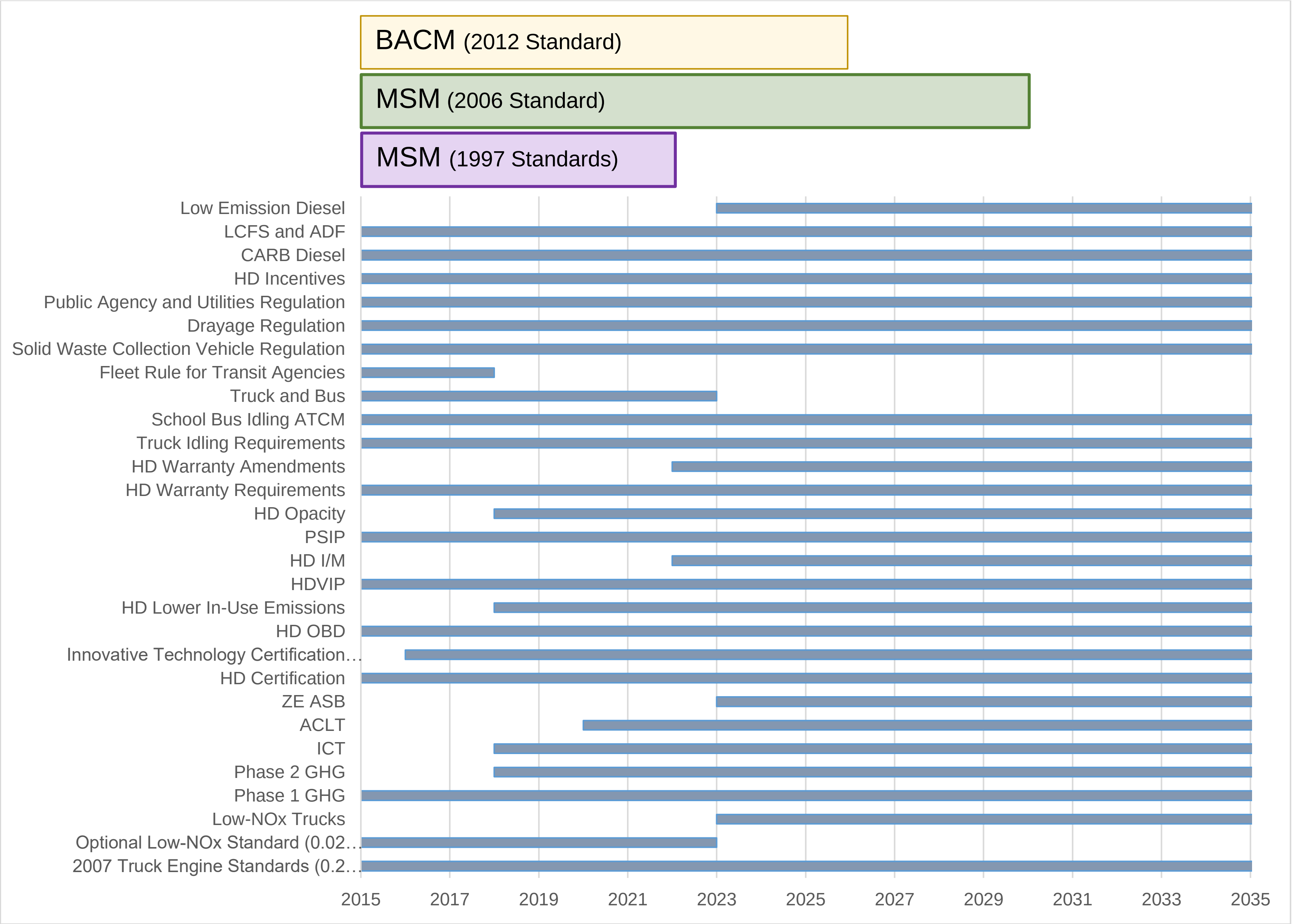

BACM (2012 Standard)
MSM (2006 Standard)
MSM (1997 Standards)
Low Emission Diesel
LCFS and ADF
CARB Diesel
HD Incentives
Public Agency and Utilities Regulation
Drayage Regulation
Solid Waste Collection Vehicle Regulation
Fleet Rule for Transit Agencies
Truck and Bus
School Bus Idling ATCM
Truck Idling Requirements
HD Warranty Amendments
HD Warranty Requirements
HD Opacity
PSIP
HD I/M
HDVIP
HD Lower In-Use Emissions
HD OBD
Innovative Technology Certification…
HD Certification
ZE ASB
ACLT
ICT
Phase 2 GHG
Phase 1 GHG
Low-NOx Trucks
Optional Low-NOx Standard (0.02…
2007 Truck Engine Standards (0.2…
2015
2017
2019
2021
2023
2025
2027
2029
2031
2033
2035

Table 13 summarizes which of the categories of stringency (i.e. BACM/BACT, BACM/ADF, or MSM) that each heavy-duty control measure falls into, for each PM2.5 standard. It is important to note that some measures CARB has committed to in the State SIP Strategy have anticipated implementation dates that exceed the timeframe thresholds of this analysis for some standards. Specifically, implementation of the Low-NOx Engine Standard, Zero-Emission Airport Shuttle Bus, and Low-Emission Diesel measures is anticipated to begin in 2023, which falls after the 2021 threshold of the analysis for the 1997 Annual and 24-Hour Standards. While these measures may not meet the timeline requirements to fall into the strict definition of MSM for these standards, the intent behind their development is nonetheless to continue pushing for additional emission reductions to ensure that attainment is achieved as expeditiously as possible, which aligns with the broader purpose of MSM.

Table 13: Identification of On-Road Heavy-Duty Control Measures as BACM and/or MSM

Measures	Implementation Begins	12 ug/m3 Annual (2012)	35 ug/m3 24-Hour (2006)	15 ug/m3 Annual (1997)	65 ug/m3 24-Hour (1997)
Adopted Heavy-Duty Vehicle Control Measures					
HD Exhaust Emission Standards for MY 2007+ Diesel Engines and Vehicles (0.2 g/bhp-hr)	ongoing	BACM - BACT	MSM	MSM	MSM
Optional Reduced Emission Standards for Heavy-Duty Engines (0.02 g/bhp-hr)	ongoing	BACM - AFM	MSM	MSM	MSM
HD On-Board Diagnostics (HD OBD)	ongoing	BACM - BACT	MSM	MSM	MSM
HD Diesel Vehicle Inspection Program (HD VIP)	ongoing	BACM - BACT	MSM	MSM	MSM
Periodic Smoke Inspection Program	ongoing	BACM - BACT	MSM	MSM	MSM
HD Emissions Warranty Requirements	ongoing	BACM - BACT	MSM	MSM	MSM
School Bus Idling ATCM	ongoing	BACM - BACT	MSM	MSM	MSM
ATCM to Limit Diesel-Fueled Commercial Motor Vehicle Idling (Diesel Idling Reduction Program)	ongoing	BACM - BACT	MSM	MSM	MSM
On-Road Heavy-Duty Diesel Vehicle In-Use Regulation (Truck and Bus)	ongoing	BACM - AFM	MSM	MSM	MSM
Fleet Rule for Transit Agencies	ongoing	BACM - BACT	MSM	MSM	MSM
Solid Waste Collection Vehicle Regulation	ongoing	BACM - BACT	MSM	MSM	MSM
Drayage (Port or Rail Yard) Regulation	ongoing	BACM - BACT	MSM	MSM	MSM
Diesel PM Control Measure for Municipality or Utility On-Road HD Diesel Fueled Vehicles (Public Agency and Utility Regulation)	ongoing	BACM - BACT	MSM	MSM	MSM
CARB Ultra Low Sulfur Diesel	ongoing	BACM - BACT	MSM	MSM	MSM
Low Carbon Fuel Standard (LCFS) and Alternative Diesel Fuel (ADF)	ongoing	BACM - BACT	MSM	MSM	MSM
State SIP Strategy Measures (with Commitment)					
Lower In-Use Emission Performance Level:	2018 +	BACM - BACT	MSM	MSM	MSM
Lower Opacity Limits for Heavy-Duty Vehicles	2018 – 2024	BACM - BACT	MSM	MSM	MSM
Amended Warranty Requirements for Heavy-Duty Vehicles	2022	BACM - AFM	MSM	MSM	MSM
Inspection and Maintenance Program for Heavy-Duty Vehicles	2022 +	BACM - AFM	MSM	MSM	MSM
Low-NOx Engine Standard – California Action	2023	BACM - AFM	MSM	--	--
Innovative Clean Transit	2018	BACM - BACT	MSM	MSM	MSM

Table 13: Identification of On-Road Heavy-Duty Control Measures as BACM and/or MSM

Measures	Implementation Begins	12 ug/m3 Annual (2012)	35 ug/m3 24-Hour (2006)	15 ug/m3 Annual (1997)	65 ug/m3 24-Hour (1997)
Advanced Clean Local Trucks (Last Mile Delivery)	2020	BACM - AFM	MSM	MSM	MSM
Zero-Emission Airport Shuttle Buses	2023	BACM - AFM	MSM	--	--
Zero-Emission Off-Road Forklift Regulation Phase 1	2023	BACM - AFM	MSM	--	--
Zero-Emission Airport Ground Support Equipment	2023	BACM - AFM	MSM	--	--
Small Off-Road Engines	2022	BACM - AFM	MSM	--	--
Transport Refrigeration Units Used for Cold Storage	2020 +	BACM - AFM	MSM	MSM	MSM
Low-Emission Diesel Requirement	2023	BACM - AFM	MSM	MSM	MSM

D.4.6 STEP 3(B): EVALUATION OF FEASIBILITY: HEAVY-DUTY CONTROL MEASURES

Step 3(b) calls for an assessment of the feasibility of implementing any measure that is not included in the Valley's proposed SIP and attainment demonstration, but which is identified as a potential BACM/MSM control measure in Step 2. For this plan, staff's proposed SIP and attainment demonstration do not recommend eliminating any of the potential BACM/MSM control measures identified in Step 2 on the basis of technical or economic infeasibility. Thus, a feasibility assessment for purposes of eliminating such measures from further consideration (i.e. Step 3(b)) is not applicable.

D.4.7 OFF-ROAD SOURCES

Off-road mobile sources include a wide variety of engines ranging from locomotives, ships, and aircraft, to equipment used in the agricultural, construction, mining, and freight / goods movement industries. This category is composed of off-road compression ignition (diesel) engines and equipment, small spark ignition off-road engines and equipment less than 25 hp (including lawn and garden equipment, and small industrial equipment), off-road large spark ignition (gasoline and liquefied petroleum gas) engines and equipment 25 hp and greater (including industrial equipment, forklifts, and portable generators), airport ground support equipment, and cargo handling equipment used at railyards, warehouses, and the Port of Stockton.

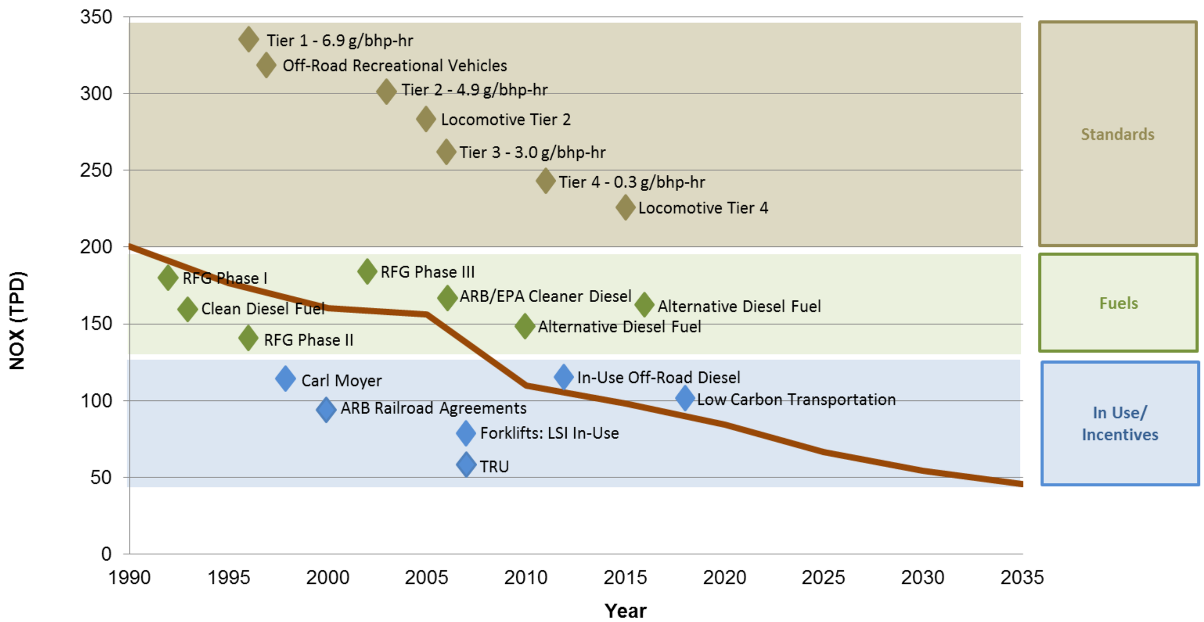
As the Valley is home to one of the most productive agricultural regions in the world, farm equipment is also an important off-road source category for the Valley. The farm equipment category is composed of agricultural equipment that includes tractors, agricultural tractor-trailers, harvesting equipment, sprayers, and other agricultural equipment and engines. Similar to the on-road sectors, California has a comprehensive program for reducing emissions from off-road equipment that goes well beyond current requirements in place elsewhere in the nation.

While emission standards for locomotives are set by U.S. EPA, CARB has accelerated reductions from these sources through efforts that have focused on cleaner fuel requirements, and increasing use of cleaner locomotives. Regulations requiring cleaner diesel fuel requirements for intrastate locomotives have reduced NOx and diesel PM emissions from these sources. CARB staff and the Class I railroads have also been implementing a memorandum of understanding to accelerate the introduction of cleaner locomotives. Further emission reductions from combustion engines beyond current engine standards for locomotives are feasible with the use of aftertreatment technologies such as oxidation or three-way catalysts, diesel particulate filters, or selective catalytic reduction.

D.4.8 STEP 2(A): CALIFORNIA'S CURRENT OFF-ROAD CONTROL PROGRAM

Emission reductions from ongoing implementation of the current control program are projected to reduce NOx emissions from the off-road sector by approximately 40 percent between 2013 and 2025. Achieving reductions in the off-road sectors remains a greater challenge than in the on-road sector due to the diverse nature of these sources, regulatory authority that rests outside of CARB in many cases, and the length of time sources remain in the fleet.

Figure 6: Current Control Programs Reducing NOx Emissions from Off-road Sources



The major regulatory and programmatic control measures that provide these emissions reductions are described below.

D.4.8.1 New Vehicle, Equipment, and Engine Standards

Off-Road Equipment (General)

To control emissions from off-road equipment, CARB adopted in 2004 a fourth tier of increasingly stringent PM and NOx standards based on the use of advanced aftertreatment emission controls. U.S. EPA also adopted the Tier 4 standards in 2004. California's current standards are equal in stringency to current federal standards. These ***"Tier 4" standards*** apply to new off-road compression-ignition engines, and were phased-in across product lines from 2008 through 2015 and reduced exhaust emission levels by up to 95 percent compared to previous control strategies. New engine standard requirements vary according to the power rating of engines. Table 14 shows the schedule for phasing in tiered requirements for new off-road engines with a power rating between 175 and 300 hp. Beginning in 2014, new Tier 4 construction equipment must emit about 96 percent less NOx and PM than new Tier 1 equipment sold in the year 2000.

Table 14: Phase-in of Off-Road Engine Standards

Model year	Level of Control	Applicable Emission Standard for New Off-road Engines 175<hp<300 g/bhp-hr	
		NOx	PM
1996-2002	Tier 1	6.9	0.4
2003-2005	Tier 2	4.9*	0.15
2006-2010	Tier 3	3.0*	0.15
2011-2013	Tier 4 interim	1.5	0.015
2014+	Tier 4 final	0.3	0.015

*Reflects combined limit for non-methane hydrocarbons and NOx

Given the diversity of types of engines, vehicles, and equipment used in the off-road sector, CARB's control strategy includes multiple requirements that are specific to categories of sources within the off-road sector. This includes:

Agricultural Equipment

In 2004, U.S. EPA and California adopted equivalent standards that require additional reductions from off-road engines, including engines used in mobile agricultural equipment. These new ***Tier 4 Engine Standards*** will achieve substantial reductions in PM2.5 and NOx as new farm equipment is introduced into the fleet.

Airport Ground Support Equipment (GSE)

Engines used in newly manufactured GSE operating on gasoline, LPG, and CNG are required to meet California's new engine emission standards for LSI. The ***LSI engine standard*** for engines greater than 1.0 liter (typical for GSE) is 0.6 g/bhp-hr of hydrocarbons (HC) and NOx. Engines meeting this standard are 70 percent cleaner than LSI engines produced as recent as 2009. Additionally, fleets operating LSI GSE must meet the in-use LSI engine fleet requirements. Adopted in 2006, the LSI fleet rule requires GSE fleets to maintain an average emission level of no more than 2.5 g/bhp hr HC+NOx, starting January 1, 2013. Diesel engines in newly manufactured GSE must meet the ***Tier 4 emission standards*** applicable to off-road compression-ignition engines. These standards vary by horsepower and are more than 90 percent cleaner than the emissions levels of engines produced twenty years ago. Lastly, non-mobile GSE such as portable air-start units, ground power units and air conditioners may be subject to the ***Portable Diesel-Engines Air Toxic Control Measure*** (ATCM). The ATCM reduces PM emissions by requiring engine replacement in a schedule based on a fleet's weighted PM emission average.

Cargo Handling Equipment (CHE)

Cargo handling equipment (CHE) is used to transfer goods or perform maintenance and repair activities and includes equipment such as yard trucks (hostlers), rubber-tired gantry cranes, top handlers, side handlers, forklifts, and loaders at ports and intermodal rail yards. California's ***Cargo Handling Equipment regulation*** was adopted in 2005 and amended in 2011. CARB obtained authorization for the 2005 version of the regulation in 2012. CARB's CHE regulations set performance standards for engines in newly acquired, as well as in-use, mobile CHE at ports or intermodal rail yards in California.

Commercial Harbor Craft (CHC)

There are several types of commercial harbor craft (CHC) used in California, including crew and supply boats, charter fishing vessels, commercial fishing vessels, ferry/excursion vessels, pilot vessels, towboats or push boats, tug boats, and work boats. The ***Commercial Harbor Craft regulation*** pertains to the reduction of diesel PM and NOx. The Board adopted the first CHC regulation in 2007 that implemented in-use limits and upgraded engine requirements. For this regulation, CARB obtained an authorization of preemption in 2011 from U.S. EPA.

In addition, the Board approved an amended CHC regulation in 2010, which extended the in-use engine requirements to other types of CHC, deleting certain exemptions, defining swing engines, clarifying certain in-use requirements, adding replacement engine exemptions, expanding compliance extension options, and allowing continued use of existing engines in certain circumstances. On January 19, 2017, U.S. EPA issued a final notice of rulemaking for these amendments.[80]

Forklifts

Forklifts operate in many different industry sectors but are most prevalent in manufacturing and at locations such as warehouses, distribution centers, and ports. Forklift fleets can be subject to either the LSI fleet regulation, if fueled by gasoline or propane, or the off-road diesel fleet regulation if fueled by diesel.[81] Both regulations require fleets to retire, repower, or replace higher-emitting equipment in order to maintain fleet average standards. Diesel-fueled forklifts were first subject to engine standards and durability requirements in 1996. The ***off-road diesel regulation*** was adopted by the Board in 2007 with implementation beginning in 2010. It is applicable to all diesel-fueled, self-propelled off-road equipment with at least 25 HP. Forklifts are included in the fleet average along with other equipment. 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. Forklifts powered by 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. Additionally, the ***LSI fleet regulation*** (which was originally adopted with requirements beginning in 2009) requires fleets with four or more LSI forklifts to meet fleet average emission standards. 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.

Beyond the requirements of the current control program, the ***Zero-Emission Off-Road Forklift Regulation Phase 1*** measure as described in the State SIP Strategy will accelerate the deployment of zero-emission technologies in off-road equipment types that are already primed for the technologies that exist today, and will facilitate further technology development and infrastructure expansion by demonstrating its viability. Under this measure, CARB has committed to develop a regulation that focuses on forklifts with lift capacities equal to or less than 8,000 pounds, for which zero-emission technologies have already gained appreciable customer acceptance and market penetration.[82] There are approximately 100,000 forklifts operating in California, most of which are battery-electric, propane, diesel, or gasoline-fueled. Although battery-electric forklifts offer reduced maintenance requirements, lifetime cost savings, and cleaner tailpipe emissions, electric forklift usage has not changed significantly relative to internal combustion forklift usage over the past 20 years. This regulation is intended to send a

[80] U.S. EPA 2017 "California State Nonroad Engine Pollution Control Standards; Diesel Engines on Commercial Harbor Craft; Notice of Decision" https://www.gpo.gov/fdsys/pkg/FR-2017-01-19/pdf/2017-01261.pdf Federal Register Volume 82, Number 12, pp. 6500-6506

[81] The Act 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 Section 209(e)(2), but must receive authorization from U.S. EPA before it may enforce the adopted standards.

[82] The Act 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 Section 209(e)(2), but must receive authorization from U.S. EPA before it may enforce the adopted standards.

market signal to technology manufacturers and investors that zero-emission technologies will be strongly supported moving forward. This proposed measure would advance ZEV commercialization by increasing the penetration of zero-emission technologies. Experience gained from demonstrating the viability of advanced technologies in heavier-duty applications will spur market development and enable the technologies to be transferred to larger, higher power-demand off-road equipment types, such as high lift-capacity forklifts and other equipment types in the construction, industrial, and mining sectors.

Locomotives

Under the Act, U.S. EPA has the sole authority to establish emissions standards for new locomotives.[83] U.S. EPA has previously promulgated two sets of national locomotive emission regulations (1998 and 2008). In 1998, U.S. EPA approved national regulations that primarily emphasized NOx reductions through Tier 0, 1, and 2 emission standards. Tier 2 NOx emission standards reduced older uncontrolled locomotive NOx emissions by up to 60 percent, from 13.2 to 5.5 g/bhp-hr.

In 2008, U.S. EPA 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. U.S. EPA 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/bhp-hr), for model years 2012-2014, is the same as the Tier 2+ remanufacture PM emission standard. The 2008 regulations also included new ***Tier 4 locomotive NOx and PM emission standards*** (2015 and later model years). U.S. EPA Tier 4 NOx and PM emission standards further reduced emissions by approximately 90 percent from uncontrolled levels.

Beyond the currently adopted levels of controls, CARB staff has petitioned U.S. EPA to promulgate by 2020 both Tier 5 national emission standards for newly manufactured locomotives, and more stringent national requirements for remanufactured locomotives, as committed to in the ***More Stringent National Locomotive Emission Standards*** measure. This would reduce emissions of criteria and toxic pollutants, fuel consumption, and GHG emissions. CARB staff estimates that U.S. EPA could require manufacturers to implement the new locomotive emission regulations by as early as 2023 for remanufactures and 2025 for newly manufactured locomotives. As documented in the Final Technology Assessment for Freight Locomotives,[84] CARB staff believes the most technologically feasible advanced technology for near-term deployment is the installation of a compact aftertreatment system (e.g., combination of selective catalytic reduction (SCR) and diesel oxidation catalyst (DOC)) onto new and remanufactured diesel-electric freight interstate line haul locomotives. Newly manufactured locomotives can also be augmented with on-board batteries to provide an additional 10-25 percent reduction in diesel fuel consumption and GHG emissions to achieve the Tier 5 emission levels. On board batteries could also provide zero emission track mile capabilities in and around railyards to further reduce diesel PM and the

[83] 42 United States Code (U.S.C.) §7547, (a)(5)
[84] Final Technology Assessment for Freight Locomotives available at: https://www.arb.ca.gov/msprog/tech/report.htm

associated health risks.

A new federal standard could also facilitate development and deployment of zero-emission track mile locomotives and zero-emission locomotives by building incentives for those technologies into the regulatory structure. The compact SCR and DOC aftertreatment system could also be retrofitted to existing Tier 4 locomotives to be able to achieve a Tier 4+ emissions standard, when Tier 4 locomotives are scheduled for remanufacture (every 7 to 10 years). Based on the typical remanufacture schedule, all Tier 4 locomotives could potentially be retrofitted with aftertreatment between 2025 and 2037. Existing locomotives originally manufactured to meet Tier 2 or Tier 3 standards could also be upgraded with the same compact aftertreatment system upon remanufacture to achieve emissions equal to Tier 4 levels.

Off-Highway Recreational Vehicles (OHRV)

Off-road recreation vehicles, also known as off-highway recreational vehicles (OHRV), primarily include off-highway motorcycles, all-terrain vehicles (ATVs), and utility-terrain vehicles, off-road sport and utility vehicles, sand cars, and golf carts. In 1994, CARB adopted ***exhaust emission standards for OHRVs***. At that time, there were no equivalent federal standards regulating exhaust emissions from the vehicles and engines covered by California's OHRV regulations (U.S. EPA first set exhaust emission limits for OHRVs in 2002). U.S. EPA granted authorization for CARB's 1994 OHRV regulations in 1996. CARB subsequently amended the regulations to increase the stringency of controls and expand the categories of OHRVs controlled under the program; first in 1999, subsequently in 2003, and finally in 2007. All three OHRV Engine Emission Standard amendments were granted authorization concurrently by U.S. EPA in 2014.[85]

The 2007 amendments to CARB's OHRV program also set ***evaporative emission standards*** beginning in MY 2008, establishing a fuel tank permeation limit of 1.5 grams per square meter per day (g/m^2/day) of total organic gas (TOG) for a 3-day diurnal period, and a fuel hose permeation limit of 15 g/m^2/day. At the time, these limits were identical to the national limits set by U.S. EPA. In July 2013, CARB adopted more stringent evaporative emission control standards for OHRVs that established a new test procedure and reduced evaporative emission limits to 1.0 g/m^2/day. Authorization was granted by U.S. EPA in 2017.[86]

Recreational Boats

The recreational boat (marine) engine program is another important element in CARB's efforts to address emissions from all mobile source sectors. In 1998, CARB approved ***exhaust emission regulations for spark-ignition marine engines*** that accelerated implementation of the federal standards for 2006 engines for personal watercraft (PWC) and outboard (OB) marine engines in California to 2001. In 2001, CARB adopted Tier I and ***Tier II emission standards for inboard and stern-drive marine engines***. In

[85] U.S. EPA, 2014. "California State Nonroad Engine Pollution Control Standards; Off-Highway Recreational Vehicles and Engines; Notice of Decision" https://www.gpo.gov/fdsys/pkg/FR-2014-02-04/pdf/2014-02297.pdf Federal Register, Vol. 79, No. 23

[86] U.S. EPA, 2017. "California State Nonroad Engine Pollution Control Standards; Evaporative Emission Standards and Test Procedures for Off-Highway Recreational Vehicles (OHRVs); Notice of Decision" https://www.gpo.gov/fdsys/pkg/FR-2017-01-19/pdf/2017-01259.pdf Federal Register, Vol. 82, No. 12

2007, U.S. EPA granted California authorization to enforce CARB's regulations for OB/PWC engines and Tier I of the California inboard and stern-drive marine engine emissions standards. In 2011, U.S. EPA granted California authorization to enforce CARB's Tier II exhaust emission standards for spark ignited inboard and stern-drive marine engines. While CARB has the same exhaust emission standard as the federal standard, the California standard applies to engines starting in 2008 rather than 2010 under the federal requirement.

In February 2015, CARB Board approved more stringent ***Evaporative Emission Control Standards*** than those set forth by the U.S. EPA's 2008 rule for gasoline-fueled spark-ignition marine watercraft configured with engines greater than 30 kilowatts.

Small Off-Road Equipment (SORE)

SORE are spark-ignited engines rated at or below 19 kilowatts. This category includes handheld and non-handheld lawn and garden and industrial equipment such as string trimmers, leaf blowers, walk-behind lawn mowers, generators, and lawn tractors. They are used in applications such as lawn and garden, industrial, construction and mining, logging, airport ground support, commercial utility, and farm equipment, golf carts, and specialty vehicles. Staff estimates that there are approximately 16.5 million pieces of SORE equipment in California, the majority of which are spark-ignition (SI) engines used in residential and commercial lawn and garden applications, together with other utility and small industrial applications.

CARB first adopted ***SORE Exhaust Emission Standards and Test Procedures*** in 1990, with amendments in 1998 that increased the stringency and extended the types of engines and equipment applicable to the standard. In September 2003, CARB adopted more stringent exhaust emission standards, and set the first ***Evaporative Emission Standards*** for SORE. Prior to the adoption of these standards, evaporative emissions were uncontrolled. U.S. EPA granted full authorization for this suite of waivers in 2006, and these more stringent standards were phased-in for model-years 2006 through 2013.[87]

In 2010, CARB set ***Standards for Zero-Emission SORE Equipment***.[88] In 2011, CARB again amended the regulation, modifying CARB's existing test procedures and aligned California procedures to be consistent with U.S. EPA's amendments to the federal certification and exhaust emission testing requirements (see Title 40 CFR Parts 1054 and 1065.11). The 2011 Amendments also set ***Exhaust Emission Certification Test Fuel Amendments*** for using ethanol blends of up to 10 percent (E10) in Off-Road SI SORE Engines, if it is certified by U.S. EPA. U.S. EPA approved the full suite of

[87] U.S. EPA, 2006. "California State Non-road Engine and Vehicle Pollution Control Standards; Decision of the Administrator" https://www.gpo.gov/fdsys/pkg/FR-2006-12-15/pdf/E6-21378.pdf Federal Register / Vol. 71, No. 241

[88] CARB 2010. "Final Regulations Order" accessed June 2018 https://www.arb.ca.gov/regact/2008/sore2008/soreresubfro.pdf?_ga=2.218709145.1039751104.1528225837-29497060.1519676686

2011 Amendments in 2015.[89] In 2016, CARB amended its evaporative emission standards for the entire category of SORE to increase stringency.[90]

Beyond the measures included in the current control program, the ***Small Off-Road Engines*** measure committed to in the State SIP Strategy will reduce emissions through actions to promote increased use of zero-emission equipment, propose tighter exhaust and evaporative emission standards, and enhance enforcement of current emission standards for SORE. Additionally, high failure rates have been observed in evaporative emissions testing of SORE, preventing previously-claimed emission reductions from being realized. Exhaust and evaporative emissions from SORE would be reduced through enhanced enforcement of the current emission standards, adoption of tighter exhaust and evaporative emission standards, and increased use of zero-emission equipment. Strategies will be developed for transitioning to zero-emission technologies, including an initial focus on incentives for use of zero-emission equipment, coupled with increasingly stringent emission standards for criteria pollutants.

D.4.8.2 Reducing In-Use Emissions

Fleet Rules

Off-Road Equipment (General)

Large diesel off-road equipment typically remains in use for long periods of time. As with heavy-duty trucks, this long life means that newer, lower-emitting engines would be introduced into fleets relatively slowly. To address this, ***the Cleaner In-use Off-Road Equipment Regulation (Off-Road Regulation)*** was adopted in 2007, and amended in 2010. The Off-Road Regulation requires off-road fleets to reduce their emission by retiring, replacing or repowering older engines. This regulation expanded the penetration of existing clean technology to ensure that the engines and vehicles used today are as clean as possible. U.S. EPA provided their authorization for this regulation in 2013. The types of off-road equipment controlled by this regulation are used in construction, manufacturing, the 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 is an extensive program designed to accelerate the penetration of the cleanest equipment into California's fleets. This regulation will significantly reduce emissions of diesel PM and NOx from the over 150,000 in-use off-road diesel vehicles that operate in California by requiring their owners to modernize their fleets and install exhaust retrofits. In 2015, this extensive program will have affected 10,447 vehicles used in 838 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 by 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

[89] U.S. EPA 2015. "California State Non-road Engine Pollution Control Standards; Small Off-Road Engines Regulations; Notice of Decision

[90] CARB 2016. "Final Regulations Order" accessed June 2018 https://www.arb.ca.gov/regact/2016/sore2016/finalreg.pdf?_ga=2.102358145.1039751104.1528225837-29497060.1519676686

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.

Additionally, CARB has developed and implemented control measures that target specific to categories of sources within the off-road sector, which are described below.

Agricultural Equipment

The 2007 SIP included the ***2007 Cleaner In-Use Agricultural Equipment Measure*** (Ag Measure) to achieve 5 to 10 tpd of NOx reductions in 2017 by modernizing agricultural equipment in the Valley. The Valley agricultural industry immediately began working on implementing this SIP measure by leveraging federal and local incentives to provide farmers assistance to replace their older, higher polluting equipment with the cleanest available technology. Specifically, new incentive funds were secured through the federal Farm Bill to be used alongside funds from existing programs. Since 2009, over 400 million dollars in private and public funding has been invested in the Valley for the replacement of older agricultural tractors with newer, cleaner models, with significant continued investments ongoing. Through 2016, the U.S. Department of Agriculture's Natural Resource Conservation Service's grant program and the District has provided over $129 million replacing over 5,000 tier 0 and tier 1 tractors to implement the Ag Measure and meet the 2017 SIP goal. The incentives targeted the largest and most used tractors in addition to other types of farm equipment.

To push beyond the 2007 Ag Equipment Measure, CARB staff is proposing in the Valley SIP Strategy the ***Cleaner In-Use Agricultural Equipment*** measure, which would electrify agricultural equipment less than 25 horsepower, such as utility quads and small yard tractors used on farms and ranches. CARB will develop a SIP measure designed to identify the agricultural equipment that is well suited for electrification with requirements in place by 2024.

In parallel with electrifying agricultural equipment less than 25 horsepower, CARB staff is also proposing in the Valley SIP Strategy an incentive measure to accelerate the turnover of large tier 0, tier 1 and tier 2 agriculture tractors to tier 4 through existing projects and new projects. Incentives are cost-effective in replacing old high-polluting tractors on most farms. However, there are many of these high-polluting tractors still in service on small farms in which the cost of the new tractor is not feasible even with incentives. To provide cleaner tractors to small farms, CARB staff along with the District and the agricultural industry are working to implement a new tractor trade up program through funding provided by a CARB grant. The trade-up program is designed to assist small farmers overcome potential financial barriers to accessing cleaner mobile agricultural technologies, and is intended to accelerate emission reductions by replacing the oldest tractors with cleaner used models. This is accomplished through a multi-step transaction in which an owner of an older, high-emitting piece of mobile agricultural equipment agrees to scrap that equipment in exchange for a previously used and reconditioned piece of equipment with a cleaner diesel engine at little or no out-of-pocket cost. The owner of the used equipment is provided incentive funding to assist in the purchase of new equipment that employs the cleanest, commercially available technology.

While identifying and securing incentive funding will be an important element going forward, the Cleaner In-Use Agricultural Equipment measure is designed to function as a backstop rule, serving as an overall emission reduction target, while at the same time acting as a catalyst for attracting early replacement of agricultural equipment using incentives. The backstop rule could require that by 2030 all agricultural equipment operating in the Valley be Tier 2 or cleaner. In combination, the backstop rule, tractor trade-up, incentives and significant lead time, ensures cleaner agricultural equipment will be used in the Valley through 2030.

Airport Ground Support Equipment (GSE)

In addition to adopting regulations limiting emissions from new engines used in GSE, California has adopted regulations to reduce emissions from existing, in-use GSE. On 2007, California adopted the ***In-Use Off-Road Diesel-Fueled Fleets Regulation,*** which requires fleets operating in-use diesel equipment to meet an annual fleet average emissions target that decreases over time. For example, for equipment over 175 and under 750 HP, the final 2023 NOx fleet average target is 1.5 g/bhp hr, which is equivalent to the interim Tier 4 NOx standard for newly produced engines. Fleets that do not meet the required annual fleet average must meet the BACT requirements that require turnover, repower or retrofit of a specific percent of a fleet's total HP. These requirements are currently being phased in.

Cargo Handling Equipment (CHE)

As described earlier, the ***Cargo Handling Equipment regulation*** (adopted in 2005, amended in 2011) includes performance standards for in-use, mobile CHE at ports or intermodal rail yards in California.

Commercial Harbor Craft (CHC)

As described earlier, the ***Commercial Harbor Craft regulation*** (adopted in 2007) includes in-use limits that require diesel PM and NOx emission controls. The 2010 amendments extended the types of CHC for which in-use engine requirements apply.

Forklifts

As described earlier, forklift fleets subject to both the ***LSI Fleet Regulation*** (if powered by gasoline or propane), and the ***Off-Road Diesel Fleet Regulation*** (if powered by diesel) are required to retire, repower, or replace higher-emitting equipment in order to maintain fleet average standards.

Off-Highway Recreational Vehicles (OHRV)

In 1999, CARB's amendments to the OHRV program added a new control measure by requiring in-use controls for OHRV that do not meet the applicable exhaust emission standards, known as the ***"Red Sticker" program***. These amendments established a new compliance category beginning with the 2003 model year, and designates OHRVs as either "green sticker" or "red sticker", depending on whether the engine meets or exceeds the applicable emission standard. Non-emission compliant OHRVs are identified with a red registration sticker issued from the Department of Motor Vehicles (DMV), while emission-compliant OHRVs are identified with a green sticker. Red sticker OHRVs are subject to in-use restrictions that do not apply to green sticker OHRVs;

namely, the red sticker limits operation at certain off-highway recreational vehicle parks located in non-attainment areas during peak ozone season.

Transport Refrigeration Units (TRU)

TRUs are refrigeration systems powered by an internal combustion engine (inside the unit housing), designed to control the environment of temperature sensitive products that are transported in refrigerated trucks, trailers, railcars, and shipping containers. TRUs operate in large numbers at distribution centers, food manufacturing facilities, packing houses, truck stops, and intermodal facilities, and are used to haul perishable products including food, beverages, pharmaceuticals, flowers, medical products, industrial chemicals, and explosives. TRUs may be capable of both cooling and heating. They deliver perishable goods to retail outlets, such as grocery stores, restaurants, cafeterias, convenience stores, etc. Although TRU engines are relatively small (ranging from 9 to 36 hp) significant numbers of these engines congregate at distribution centers, truck stops, and other facilities, exacerbating air quality challenges and resulting in potential for health risks to those that live and work nearby. The growth rate of TRUs is tied to population, since food is the main product type that is hauled.

CARB adopted its ***ATCM for In-Use Diesel-Fueled TRUs and TRU Generator Sets*** in 2004. The TRU regulations establish in-use performance standards for diesel-fueled TRUs and TRU generator sets which operate in California, and facilities where TRUs operate. The regulation is designed to reduce the diesel particulate matter (PM) emissions from in-use TRU and TRU generator set engines that operate in California, using a phased-in implementation approach over about 12 years by requiring engines to meet in-use emission standards by the end of the seventh year after manufacture. Implementation of the TRU ATCM began in 2009, and applies to in-use diesel-fueled TRUs and TRU generator sets that operate in California, whether they are registered in or outside the State. U.S. EPA issued a waiver of preemption for the TRU regulation in 2009.[91] CARB subsequently amended the TRU ATCM in 2010 and again in 2011 to provide owners of TRU engines with certain flexibilities to facilitate compliance, clarify recordkeeping requirements, and establish requirements for businesses that arrange, hire, contract, or dispatch the transport of goods in TRU-equipped trucks, trailers, or containers. U.S. EPA approved waivers for the 2010 Amendments in 2013 and the 2011 Amendments in 2017, respectively.[92, 93]

Beyond the emission controls included in the current control program, the Valley's plan also includes the ***Transport Refrigeration Units Used for Cold Storage*** measure, which will reduce NOx and PM emissions by reducing the amount of time TRUs operate using internal combustion engines while refrigerated trucks, trailers, and shipping

[91] U.S. EPA, 2009. "California State Nonroad Engine and Vehicle Pollution Control Standards; Authorization of Transport Refrigeration Unit Engine Standards; Notice of Decision" Federal Register Volume 74, Number 11, pp. 3030-3033

[92] U.S. EPA, 2013. "California State Nonroad Engine Pollution Control Standards; Within-the-Scope Determination for Amendments to California's ''Airborne Toxic Control Measure for In-Use Diesel-Fueled Transport Refrigeration Units (TRU) and TRU Generator Sets and Facilities Where TRUs Operate''; Notice of Decision" https://www.gpo.gov/fdsys/pkg/FR-2013-06-28/pdf/2013-15437.pdf Federal Register Vol. 78, No. 125

[93] U.S. EPA, 2017. "California State Nonroad Engine Pollution Control Standards; In-Use Diesel-Fueled Transport Refrigeration Units (TRUs) and TRU Generator Sets and Facilities Where TRUs Operate; Notice of Decision" https://www.gpo.gov/fdsys/pkg/FR-2017-01-19/pdf/2017-01225.pdf Federal Register Vol. 82, No. 12

containers are parked (stationary) at certain California facilities and other locations. The time limit would decrease on a phased compliance schedule. Compliance options include the use of commercially available hybrid electric TRUs, TRUs equipped with electric standby motors, and cryogenic transport refrigeration systems. Hybrid electric and electric standby-equipped TRUs would plug into electric power plugs while stationary and use diesel engine power while on the road. Facilities may be required to provide the necessary electric infrastructure to support this action. CARB is currently offering funding through the Proposition 1B Goods Movement Emission Reduction Program to support both purchase of TRUs that can plug in and the stationary electric infrastructure. Cryogenic transport refrigerators use liquid nitrogen and liquid carbon dioxide to provide cooling. Development and use of zero-emission technologies, such as all-electric plug-in / advanced battery transport refrigeration systems would be encouraged, as well as adequately sized cold storage facilities, and more efficient inbound delivery appointment and outbound dispatch scheduling.

Other In-Use Emission Controls for Locomotives

In addition to the fleet rules described above, CARB has worked closely with the major railroads in California, together with other stakeholders, to develop innovative measures to reduce in-use emissions from locomotives, a major source of NOx and PM emissions in the Valley, but a source category over which CARB has limited regulatory authority. While emission standards for locomotives are set by U.S. EPA, CARB has accelerated reductions from these sources through efforts that have focused on cleaner fuel requirements, and increasing use of cleaner locomotives. CARB staff and the Class I railroads have also been implementing through the ***Statewide Rail Yard Agreement for California Rail Yards,*** a Memorandum of Understanding (MOU) to accelerate the introduction of cleaner locomotives since 2010.[94] This agreement obligates the railroads to significantly reduce emissions in and around rail yards in California, and established a statewide visible emissions reduction and repair program, provided a detailed evaluation of advanced control measures, and an assessment of remote sensing technology (RST) to identify high-emitting locomotives.

D.4.8.3 Fuels

In addition to new engines and in-use standards, cleaner burning fuels represent an important component in reducing emissions from the off-road mobile fleet. Cleaner fuel has an immediate impact in reducing emissions from the mobile source, and thus represent an important component in reducing NOx and PM emissions from off-road engines. California's stringent air quality programs treat mobile sources and their fuels holistically (as a system, rather than as separate components). As a result, CARB's fuels programs achieve significant reductions in criteria emissions from vehicles and mobile engines used in California.

CARB Diesel Fuel Regulations

The California diesel fuel program sets stringent standards for diesel fuel sold in California and produces cost-effective emission reductions from diesel-powered vehicles. More stringent fuel requirements further ensure that diesel engines are operating as cleanly as possible. ***CARB Diesel Fuel Regulations*** have, over time,

[94] CARB 2005 "ARB/Railroad Statewide Agreement: Particulate Emissions Reduction Program at California Rail Yards" https://www.arb.ca.gov/railyard/ryagreement/083005mouexecuted.pdf

phased in more stringent requirements for fuel mixture specifications for aromatic hydrocarbons and sulfur, and have establish a lubricity standard. The program applies to sales of fuel used in on-road vehicles and off-road vehicles and locomotives in California. . ***"CARB diesel" Specifications*** adopted in 1988 limited the allowable sulfur content of diesel fuel 500 parts per million by weight (ppmw), and the aromatic hydrocarbon content to 10 percent, and became effective in 1993.

In 2003, ***CARB's Ultra Low Sulfur Diesel (ULSD) Regulation*** increased the stringency of the sulfur content limits in to 15 ppm, which harmonized with the 1993 U.S. EPA regulation that also limited sulfur in on-road diesel fuels to the same level. Both the California and federal ULSD regulations began implementation in 2006. CARB's ULSD Regulation had an immediate impact in reducing emissions from the in-use on-road heavy-duty fleet, while also enabling the use of advanced emissions control technologies, including the use of catalyzed diesel particulate filters (DPF), NOx after-treatment, and other advanced after-treatment based emission control technologies that higher sulfur levels would have inhibit the performance of (at the time of CARB's ULSD rulemaking, the average sulfur content of California diesel was approximately 140 ppmw).

Controlling Criteria Emissions from Renewable Fuels

The ***Low Carbon Fuel Standard (LCFS) and Alternative Diesel Fuel (ADF) Regulations,*** as amended in 2014, work together to reduce the carbon intensity of the California fuel supply. The regulations also limit criteria emissions from alternative fuels and/or alternative fuel mix blends (a mix of fuels made from renewable feedstocks, which are then blended with conventional gasoline or diesel).

Beyond the current fuels control program, CARB committed to develop a ***Low Emission Diesel*** Measure that will require diesel fuel providers to steadily decrease criteria pollutant emissions from their diesel products. The use of low-emission diesel in on-road vehicles and off-road equipment will reduce tailpipe NOx and PM emissions, in addition to other criteria pollutants. Some studies carried out to date on hydrotreated vegetable oil have reported NOx emission reductions of 6 percent to 25 percent and PM emission reductions of 28 percent to 46 percent, depending on the types of fuels, drive cycles tested, and diesel engines used. This standard is anticipated to both increase consumption of low-emission diesel fuels, and to reduce emissions from conventional fuels. This measure is anticipated to provide NOx benefits predominately from legacy (pre-2010) on-road heavy-duty vehicles, off-road engines, stationary engines, portable engines, marine vessels and locomotives, as well as NOx and diesel PM benefits in potentially all model year off-road engines, stationary engines, portable engines, marine vessels and locomotives. Interstate vehicles, even those registered out-of-State but operating on CARB diesel blended with low-emission diesel, are also anticipated to provide emission reduction benefits.

Cleaner Burning Fuels Requirements (for Locomotives)

While emission standards for locomotives are set by U.S. EPA, CARB has accelerated reductions from these sources through efforts that have focused on cleaner fuel requirements, and increasing use of cleaner locomotives. The Railroud MOU includes a control measure that maximizes the use of lower emitting fuels (i.e. CARB and U.S. EPA low sulfur diesel) in locomotives fueled in California. ***Requiring cleaner diesel***

fuel requirements for intrastate locomotives have reduced NOx and diesel PM emissions from these sources.

D.4.9 STEP 2(B): OTHER STATES' AND NONATTAINMENT AREAS' OFF-ROAD CONTROL MEASURES

Table 15 summarizes the most stringent control measures currently in use in any state or nonattainment that have been identified and discussed for on-road heavy-duty vehicles. Each of the measures identified in this table are discussed in more detail in this section, below.

Table 15: Summary of Most Stringent Off-Road Mobile Control Measures Identified

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
New Engine Standards			
New Engine Standards • Off-road diesel engine emission standards (general)	Currently CARB and U.S. EPA limit exhaust emissions to same "Tier 4" levels: • NOx: 0.3 g/bhp-hr • PM: 0.015 g/bhp-hr	CARB's current emission standards for new off-road engines with a power rating between 175 and 300 hp are set at the same level of stringency as Federal standards, and requires Tier 4 emission standards (which use advanced after treatment technologies such as diesel particulate filters and selective catalytic reduction). This regulation is applicable to all diesel-fueled, self-propelled off road equipment with at least 25 HP.	No other state has more stringent exhaust emission standards for off-road equipment than California.
New Engine Standards • Agricultural equipment	Tier 4 Engine Standards (U.S. EPA and CARB)	U.S. EPA and California adopted equivalent Tier 4 standards in 2004 that require additional emission reductions from off-road engines, including those used in mobile agricultural equipment.	No state has more stringent requirements for new emission performance standards for agricultural equipment engines than California.
New Engine Standards • Airport Ground Support Equipment (GSE)	Large Spark Ignition (LSI) Fleet Regulation and Tier 4 Engine Standards (CARB) CARB anticipated to propose to further increase stringency. *(Zero-Emission Airport Ground Support Equipment measure)*	NOx limits for the LSI Engine Standard for engines > 1.0 liter (the typical engine size for GSE) is 0.6 g/bhp-hr. Engines meeting this standard are 70 percent cleaner than LSI engines produced as recent as 2009. Additionally, diesel engines in newly manufactured GSE must meet the Tier 4 emission standards applicable to off-road compression ignition engines. CARB is anticipated to further increase the stringency of emission controls with the Zero-Emission Airport Ground Support Equipment measure. *(NOTE: CARB has committed to develop the Zero-Emission Airport Ground Support Equipment measure, but it has not yet been proposed to the Board for approval/adoption.)*	No other state has more stringent exhaust emission standards for airport ground support equipment than California.
New Engine Standards • Cargo Handling Equipment (CHE)	Cargo Handling Regulation (CARB)	CARB's Cargo Handling Equipment regulation sets performance standards for newly acquired engines, as well as in-use mobile CHE at ports or intermodal rail yards.	No other state has more stringent exhaust emission standards for cargo handling equipment than California.
New Engine Standards • Commercial Harbor Craft (CHC)	Commercial Harbor Craft Regulation (CARB)	CARB's CHC Regulation controls NOx and PM emissions from crew and supply boats, charter fishing vessels, commercial fishing vessels, ferry/excursion vessels, pilot vessels, towboats or push boats, tug boats, and work boats. U.S. EPA has granted a waiver of preemption under §209(b).	No other state has more stringent exhaust emission standards for commercial harbor craft than California.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
New Engine Standards • Forklifts	Off-road Diesel Regulation, Tier 4 Engine Standards, and LSI Fleet Regulation (CARB) CARB anticipated to propose to further increase stringency. *(Zero-Emission Off-Road Forklift Regulation Phase 1 measure)*	Forklifts powered by LSI engines (gasoline and natural gas) are subject to new engine standards that include both criteria pollutant and durability requirements since 2001 with the cleanest requirements phased-in starting in 2010. Diesel Forklifts > 25 HP are subject to fleet average emission requirements under the Off-Road Diesel Regulation starting in 2010 and Tier 4 Final emission standards (based on the use of advanced after-treatment technologies such as diesel particulate filters and selective catalytic reduction) starting in 2013. CARB is anticipated to further increase the stringency of emission controls with a measure designed to accelerate the deployment of zero-emission forklift technologies. *(NOTE: CARB has committed to develop the Heavy-Duty Vehicle Inspection and Maintenance Program measure, but it has not yet been proposed to the Board for approval/adoption.)*	No state has more stringent requirements for new emission performance standards for forklifts engines than California.
New Engine Standards • Locomotives	U.S. EPA Tier 4 NOx and PM emission standards CARB has petitioned U.S. EPA to further increase stringency. *(More Stringent National Locomotive Emission Standards measure)*	U.S. EPA has the sole authority to establish emissions standards for locomotives. CARB petitioned U.S. EPA in 2017 to increase stringency by developing Tier 5 national emission standards for newly manufactured locomotives, and more stringent national requirements for remanufactured locomotives (by ~2020) *(NOTE: CARB has petitioned U.S. EPA for more stringent locomotive standards given the needs in California's nonattainment areas, but approval/adoption of this MSM rests exclusively with U.S. EPA and is thus beyond the purview of CA.)*	No state has emission standards for locomotives that differ from U.S. EPA's.
New Engine Standards • Off-Highway Recreational Vehicles (OHRVs)	Exhaust Emission Standards for OHRVs and Evaporative Emission Standards (CARB)	CARB's exhaust emission standards (2006) and evaporative emission standards (2007) control emissions from motorcycles, all-terrain vehicles, and utility-terrain vehicles at more stringent levels than applicable national standards set by U.S. EPA.	No other state has the authority to set exhaust emission and/or evaporative emission standards that exceed the stringency of U.S. EPA's national standards.
New Engine Standards • Recreational Boats	Exhaust Emission Regulations for Spark-Ignition Marine Engines, Tier II Emission Standards for Inboard and Stern-Drive Marine Engines, and Evaporative Emission Control Standards (CARB)	CARB's recreational boats and marine engine program exceeds the stringency of U.S. EPA's federal standards: • The Exhaust Emission Regulations for Spark-Ignition Marine Engines (1998) controls emissions at the same level of stringency as national regulations; • The Tier II Emission Standards for Inboard and Stern-Drive Marine Engines (2001) controls	No other state has the authority to set exhaust emission and/or evaporative emission standards that exceed the stringency of U.S. EPA's national standards.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
		emissions at the same level of stringency as national regulations; and • The Evaporative Emission Control Standards (2015) exceeds the stringency of applicable national regulations set by U.S. EPA in 2008 for gasoline-fueled spark-ignition marine watercraft >30 kilowatts.	
New Engine Standards • Small Off-Road Equipment (SORE)	Exhaust and Evaporative Standards for Small Off-Road Engines (CARB) CARB is anticipated to propose to further increase stringency. *(Small Off-Road Equipment (SORE) measure)*	CARB's SORE program sets more stringent exhaust and evaporative standards for SORE than applicable federal standards (Exhaust and Evaporative Emission Standards for Small Off-Road Engines (2003)), and sets requirements for Zero-Emission SORE equipment. CARB is anticipated to further increase the stringency of emission controls with a measure designed to accelerate the deployment of zero-emission technologies, set tighter exhaust and evaporative emission standards, and enhance enforcement of current emission standards for SORE. *(NOTE: CARB has committed to develop the Small Off-Road Equipment (SORE) measure, but it has not yet been proposed to the Board for approval/adoption.)*	No other state has the authority to set exhaust emission and/or evaporative emission standards that exceed the stringency of U.S. EPA's national standards.
In-Use Emission Controls			
In-Use Emissions Controls • Fleet Rules (Off-Road Equipment – General)	Cleaner In-use Off Road Equipment Regulation (Off-Road Regulation) (CARB)	CARB's off-road regulation controls diesel PM and NOx emissions from >150,000 in-use off-road engines by requiring their owners to retire, replace, or repower older engines, and/or installing verified exhaust retrofit control technologies. Additionally, all vehicles are reported and labeled, and older, dirtier vehicles are restricted from entering fleets.	While Chicago (IL) and New York City (NY) have in-use fleet controls for construction equipment, no other state or nonattainment area controls in-use off-road equipment fleets more stringently than CARB.
In-Use Emissions Controls • Fleet Rules (Agricultural Equipment)	Cleaner In-Use Agricultural Equipment Measure (CARB) CARB is anticipated to proposed to further increase stringency *(Cleaner In-Use Agricultural Equipment measure)*	The Valley's 2007 SIP included the Cleaner In-Use Agricultural Equipment (Ag Equipment) measure; under this program, the District has replaced over 5,000 tier 0 and tier 1 tractors to meet the targeted NOx emission reductions of 5 to 10 tpd by 2017. CARB is anticipated to further increase the stringency of in-use emission controls a measure designed to accelerate emission reductions from the in-use ag equipment fleet. *(NOTE: CARB is proposing the Cleaner In-Use Agricultural Equipment measure, but this measure has yet to be proposed to the Board for approval/adoption.)*	CARB's agricultural equipment fleet controls are among the most stringent in the nation.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
In-Use Emissions Controls • Fleet Rules (Airport Ground Support Equipment)	In-Use Off Road Diesel-Fueled Fleets Regulation (CARB)	The In-Use Off Road Diesel-Fueled Fleets Regulation requires fleets to meet fleet average NOx emission targets equivalent to the interim Tier 4 standards for newly produced engines (i.e. equivalent to MSM).	No other state or nonattainment area controls airport GSE more stringently than CARB.
In-Use Emissions Controls • Fleet Rules (Cargo Handling Equipment)	Cargo Handling Equipment Regulation (CARB)	The Cargo Handling Equipment regulation (adopted in 2005, amended in 2011) includes performance standards for in-use, mobile CHE at ports or intermodal rail yards in California.	No other state or nonattainment area has more stringent in-use fleet requirements for CHE than California.
In-Use Emissions Controls • Fleet Rules (Commercial Harbor Craft)	Commercial Harbor Craft Regulation (CARB)	The Commercial Harbor Craft regulation (adopted in 2007) includes in-use limits that require diesel PM and NOx emission controls. The 2010 amendments extended the types of CHC for which in-use engine requirements apply.	No other state or nonattainment area controls in-use CHC emissions more stringently than CARB.
In-Use Emissions Controls • Fleet Rules (Forklifts)	Off-road Diesel Regulation, Tier 4 Engine Standards, and LSI Fleet Regulation (CARB)	Forklift fleets subject to both the LSI fleet regulation (if powered by gasoline or propane), and the off-road diesel fleet regulation (if powered by diesel) are required to retire, repower, or replace higher-emitting equipment in order to maintain fleet average standards.	No other state or nonattainment area has more stringent fleet requirements for in-use forklifts than CARB.
In-Use Emissions Controls • Fleet Rules (Off-Highway Recreational Vehicles)	OHRV "Red Sticker" program (CARB)	CARB's "Red Sticker" program requires in-use Off-Highway Recreational Vehicles (OHRVs) that do not meet the applicable exhaust emission standards display a red registration sticker that limits operation at certain off-highway recreational vehicle parks located in non-attainment areas during peak ozone season.	No other state or nonattainment area controls in-use emissions from OHRV more stringently than CARB.
In-Use Emission Controls (Fleet Standard) • Transport Refrigeration Units (TRU)	Air Toxic Control Measure (ATCM) for Transport Refrigeration Units (TRU) and TRU Generator Sets (CARB) CARB is anticipated to propose to further increase stringency. *(Transport Refrigeration Units (TRU) Used for Cold Storage measure)*	CARB's ATCM for In-Use Diesel-Fueled TRUs requires engines to meet in-use diesel PM emission standards by the end of the seventh year after manufacture, and applies to TRUs that operate in California, regardless of whether they are registered in or outside of the State. CARB's program is the most stringent of its type in the nation. CARB is anticipated to further increase the stringency of emission controls with a measure designed to limit NOx and PM emissions by reducing the amount of time TRUs operate while stationary. *(NOTE: CARB has committed to develop the Transport Refrigeration Units (TRU) Used for Cold Storage measure, but it has not yet been proposed to the Board for approval/adoption.)*	No other state or nonattainment area controls in-use emissions from TRUs more stringently than CARB.
In-Use Emission Controls (Locomotives) • Memorandum of Understanding	Statewide Rail Yard Agreement for California Rail Yards (CARB)	CARB has developed a Statewide Rail Yard Agreement for California Rail Yards, a Memorandum of Understanding (MOU) with the Class I Railroads to accelerate the introduction of cleaner locomotives.	No other state has an agreement with Class I railroads to accelerate the introduction of cleaner locomotive engines.
Fuels			

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
Fuels Standards • Diesel Standards	CARB Diesel Fuel Regulations and Ultra Low Sulfur Diesel (CARB)	CARB Diesel Fuel Regulations include stringent requirements for fuel mixture specifications for aromatic hydrocarbons and sulfur, and have establish a lubricity standard and applies to sales of fuel used in on-road vehicles and off-road vehicles and locomotives in California CARB's Ultra-Low Sulfur Diesel (ULSD) program reduces ozone precursor emissions significantly relative to U.S. EPA requirements (providing approximately 7 percent more NOx reductions and 25 percent more PM reductions than federal diesel standards).	No state requires cleaner burning diesel than California. The California diesel fuel regulations exceed federal requirements in stringency.
Fuels Standards • Alternative Fuel Standards (Diesel substitutes)	LCFS and ADF (CARB) CARB is anticipated to propose to further increase stringency. *(Low Emission Diesel measure)*	The LCFS and ADF regulations work together to reduce the carbon intensity of the California fuel supply while requiring limits on criteria emissions from alternative fuels and/or alternative fuel mix blends. CARB is anticipated to further increase the stringency of controls on criteria pollutant emissions diesel products. *(NOTE: CARB has committed to develop the Low Emission Diesel measure, but it has not yet been proposed to the Board for approval/adoption.)*	No other state has set criteria emission requirements on alternative fuels and alternative fuel blends. The Federal Renewable Fuel Standard (RFS II) does not specify criteria requirements for alternative fuels.
In-Use Emission Controls (Locomotives) Cleaner Burning Fuels Requirement	Statewide Rail Yard Agreement for California Rail Yards (CARB)	The Railroad MOU includes requirements to maximize the use of lower emitting diesel fuels for locomotives fueled in California.	No other state or nonattainment has an agreement with Class I railroads to burn cleaner fuels in their jurisdictional boundaries.

D.4.9.1 Emission standards for new engines and equipment

Off-Road Equipment (General)

CARB Tier 4 Off-Road Equipment Standards that are nearly identical to those finalized by U.S. EPA in its Clean Air Nonroad Diesel Rule. These regulations require engine manufacturers to meet aftertreatment-based exhaust standards for PM and NOx starting in 2011 that are over 90 percent lower than the previous engine generation's emission levels. CARB's new engine standards for off-road equipment is thus aligned with most stringent control program of any in the nation.

Due to constraints in the Act, California is the only state that can set new engine standards (including control measures such as emission standards, sales mandates, warranty provisions, and on-board diagnostic (OBD) requirements) that are more stringent than U.S. EPA's national standards. Other states can adopt California programs for which U.S. EPA has provided California with waivers. While the Act allows other states to adopt CARB's regulations for off-road engine or off-road vehicles (provided that such standards are identical to the CARB standards for which an authorization has been obtained), other states have not yet adopted off-road engine emission standards equivalent to the California off-road regulation, although there are some states currently considering doing so.

Agricultural Equipment

CARB's new engine standards for off-road agricultural equipment (ag equipment) is consistent with the most stringent of any in the nation. In 2004, U.S. EPA and California adopted equivalent Tier 4 Off-Road Engine Emission Standards, which includes requirements for ag equipment engines.

Airport Ground Support Equipment (GSE)

CARB's new engine standards for airport GSE is the most stringent of any in the nation. New airport GSE is subject to emission standards under CARB's Large Spark Ignition (LSI) Fleet Regulation (natural gas and gasoline engines), and under CARB's Tier 4 Engine Standards (diesel engines). NOx limits for the LSI Engine Standard for engines > 1.0 liter (the typical engine size for GSE) is 0.6 g/bhp-hr. Engines meeting this standard are 70 percent cleaner than LSI engines produced as recent as 2009. Additionally, diesel engines in newly manufactured GSE must meet the Tier 4 emission standards applicable to off-road compression ignition engines. Non-mobile GSE such as portable air-start units, ground power units and air conditioners may be subject to the Portable Diesel-Engines Air Toxic Control Measure (ATCM). The ATCM reduces PM emissions by requiring engine replacement in a schedule based on a fleet's weighted PM emission average. No other state has more stringent exhaust emission standards for airport GSE than CARB. Furthermore, CARB is anticipated to further increase the stringency of emission controls under the the Zero-Emission Airport Ground Support Equipment measure committed to in the State SIP Strategy.

Cargo Handling Equipment (CHE)

CARB's Cargo Handling Regulation established engine performance standards for new CHE used to transfer goods or perform maintenance and repair activities and includes equipment such as yard trucks (hostlers), rubber-tired gantry cranes, top handlers, side handlers, forklifts, and loaders at ports and intermodal rail yards. CARB CHE emission standards are the most stringent of any in the nation. CARB obtained U.S. EPA authorization for a waiver in 2012. No other state or nonattainment area has more stringent exhaust emission standards for CHE than California.

Commercial Harbor Craft (CHC)

CARB's new engine standards for CHC is the most stringent of any in the nation. The Commercial Harbor Craft Regulation controls NOx and PM emissions from crew and supply boats, charter fishing vessels, commercial fishing vessels, ferry/excursion vessels, pilot vessels, towboats or push boats, tug boats, and work boats. U.S. EPA has granted a waiver of preemption under §209(b). No other state has more stringent exhaust emission standards for commercial harbor craft than California.

Forklifts

CARB's new engine standards for forklifts are the most stringent of any in the nation. Forklifts powered by LSI engines (gasoline and natural gas) are subject to new engine standards that include both criteria pollutant and durability requirements since 2001 with the cleanest requirements phased-in starting in 2010. Diesel Forklifts > 25 HP are subject to fleet average emission requirements under the Off-Road Diesel Regulation starting in 2010 and Tier 4 Final emission standards (based on the use of advanced after-treatment technologies such as diesel particulate filters and selective catalytic reduction) starting in 2013. Furthermore, the stringency of these requirements is anticipated to increase under the Zero-Emission Off-Road Forklift Regulation Phase 1 measure committed to in the State SIP Strategy. No other state has more stringent forklift emission standards than CARB.

Locomotives

U.S. EPA sets nationwide emission standards for locomotives. No state, including California, has the authority to regulate emission standards for locomotives. Thus, CARB's locomotive controls are equivalent to the controls used in all other nonattainment areas in the nation. Nonetheless, further increases in stringency of locomotive emission controls are needed for California nonattainment areas, including the Valley, to attain federal ambient air quality standards. For this reason, CARB has petitioned U.S. EPA to set more stringent emission controls for locomotives.

Off-Highway Recreational Vehicles (OHRVs)

CARB's new engine standards for OHRV are the most stringent of any in the nation. CARB's program sets exhaust emissions standards (2006) and evaporative emission standards (2007) for OHRV, together with amendments to the testing procedures to ensure the most stringent level of emission reductions are achieved (2007). U.S. EPA has issued waivers of authorization for CARB's OHRV regulations. No other state or nonattainment area controls emissions from new OHRV more stringently than CARB.

Recreational Boats

CARB's new engine standards for recreational boats are the most stringent of any in the nation, and exceed the stringency of U.S. EPA federal standards:

- The Exhaust Emission Regulations for Spark-Ignition Marine Engines (1998) controls emissions at the same level of stringency as national regulations;
- The Tier II Emission Standards for Inboard and Stern Drive Marine Engines (2001) controls emissions at the same level of stringency as national regulations; and

- The Evaporative Emission Control Standards (2015) exceeds the stringency of applicable national regulations set by U.S. EPA in 2008 for gasoline-fueled spark-ignition marine watercraft >30 kilowatts.

No other state has the authority to set exhaust emission and/or evaporative emission standards that exceed the stringency of U.S. EPA's national standards.

Small Off-Road Engines (SORE)

CARB's new engine standards for SORE are the most stringent of any in the nation. CARB's Exhaust and Evaporative Standards for SORE set more stringent exhaust and evaporative standards than applicable federal standards, and includes requirements for Zero-Emission SORE equipment. Furthermore, CARB is anticipated to further increase the stringency of emission controls with a measure designed to accelerate the deployment of zero-emission technologies, set tighter exhaust and evaporative emission standards, and enhance enforcement of current emission standards for SORE. No other state has the authority to set exhaust emission and/or evaporative emission standards that exceed the stringency of U.S. EPA's national standards.

D.4.9.2 In-Use emission controls for off-road engines and equipment

Fleet Rules

Off-Road Equipment (General)

In aggregate, CARB's fleet requirements for off-road equipment are the most stringent in the nation. CARB's Cleaner In-Use Off-Road Equipment Regulation (Off-Road Regulation) controls diesel PM and NOx emissions from >150,000 in-use off-road engines by requiring their owners to retire, replace, or repower older engines, and/or installing verified exhaust retrofit control technologies to BACT-equivalent engines. Additionally, all vehicles are reported and labeled, and older, dirtier vehicles are restricted from entering fleets.

CARB's off-road equipment controls emissions from aerial lifts, aircraft tugs, backhoes, baggage tugs, belt loaders, cargo loaders, crawler tractors (such as bulldozers), excavators, forklifts, graders, loaders, mowers, rollers, rough terrain forklifts, rubber tired loaders, scrapers, skid steer loaders, snow blowers, tractors, trenchers, as well as several types of on-road vehicles, such as two-engine vehicles, and workover rigs. Some nonattainment areas have fleet requirements that also require BACT-equivalent levels of controls for some off-road equipment (i.e. construction equipment), which are described below.

- New York City's Local Law 77 requires use of ultra-low sulfur diesel fuel and BACT for reducing emissions from non-road equipment above 37 kW used on city construction projects.
- Chicago (IL) Clean Diesel Construction Ordinance bans high-polluting diesel equipment from City construction sites. While the California program requires fleets to turnover to Tier 4 or equivalent control levels, the Chicago ordinance only requires fleets to turnover to Tier 2 or equivalent control levels (on-road vehicles MY 1998 and earlier and pre-US Environmental Protection Agency Tier 1 equipment will be banned under the Chicago ordinance.)

No other state or nonattainment area controls in-use off-road equipment fleets more stringently than CARB. Neither of these programs cover the full suite of off-road equipment engine types and applications that are regulated under CARB's program. Additionally, they do not have as stringent of labeling and reporting requirements as CARB. Finally, the use of ULSD in off-road equipment in New York provides significantly less emission reductions than the use of ULSD inside of California (as is required – see fuels section for more information), as federal USLD specifications allow significantly less stringent caps on sulfur and aromatic hydrocarbon content in fuels than CARB diesel specifications.

Beyond the Off-Road Regulation, CARB also controls sub-categories of off-road equipment through specific fleet requirements, as described below.

Agricultural Equipment

CARB's agricultural equipment fleet controls are among the most stringent in the nation. The 2007 Cleaner In-Use Agricultural Equipment Measure modernizes agricultural equipment in the Valley; under this program, the District has, since 2009, replaced over 5,000 tier 0 and tier 1 tractors to meet the targeted NOx emission reductions of 5 to 10 tpd by 2017. CARB is anticipated to further increase the stringency of in-use emission controls with the Cleaner In-Use Ag Equipment measure proposed in the Valley SIP Strategy, which is designed to accelerate emission reductions from the in-use ag equipment fleet.

Airport Ground Support Equipment (GSE)

CARB's airport GSE fleet requirements are the most stringent in the nation. CARB's In-Use Off-Road Diesel-Fueled Fleets Regulation requires fleets operating in-use diesel equipment to meet an annual fleet average emissions target that decreases over time to become equivalent to the interim Tier 4 NOx standard for newly produced engines. No other state or nonattainment area controls airport GSE more stringently than CARB.

Cargo Handling Equipment (CHE)

CARB's Cargo Handling Equipment Regulation includes in-use limits that require diesel PM and NOx emission controls for mobile CHE at ports or intermodal rail yards. No other state or nonattainment area has more stringent in-use fleet requirements for CHE than California.

Commercial Harbor Craft (CHC)

The Commercial Harbor Craft regulation (adopted in 2007) includes in-use limits that require diesel PM and NOx emission controls. The 2010 amendments extended the types of CHC for which in-use engine requirements apply. No other state or nonattainment area controls in-use CHC emissions more stringently than CARB.

Forklifts

California forklifts are subject to either the LSI Fleet Regulation (if powered by gasoline or propane), and the Off-Road Diesel Fleet Regulation (if powered by diesel). Under both regulations, forklift fleets are required to retire, repower, or replace higher-emitting equipment in order to maintain fleet average standards. No other state or nonattainment area has more stringent fleet requirements for in-use forklifts than CARB.

Off-Highway Recreational Vehicles (OHRV)

CARB's In-Use controls for OHRV under the "Red Sticker" program controls in-use emissions from OHRV more stringently than any other state or nonattainment area in the nation. Under this program, engines that do not meet the applicable emission standard for new engines are subject to in-use restrictions that limits operation at certain off-highway recreational vehicle parks located in non attainment areas during peak ozone season. No other state or nonattainment area controls in-use emissions from OHRV more stringently than CARB.

Transport Refrigeration Units (TRU)

The Air Toxic Control Measure (ATCM) for Transport Refrigeration Units (TRU) and TRU Generator Sets (CARB's ATCM for In-Use Diesel-Fueled TRUs) requires engines to meet in-use diesel PM emission standards by the end of the seventh year after manufacture, and applies to TRUs that operate in California, regardless of whether they are registered in or outside of the State. CARB's program is the most stringent of its type in the nation. Furthermore, CARB is anticipated to further increase the stringency of emission controls under the TRU measure committed to in the State SIP Strategy, which is anticipated to increase NOx and PM emission reductions by reducing the amount of time TRUs operate while stationary. No other state or nonattainment area controls in-use emissions from TRUs more stringently than CARB.

Other In-Use Emission Controls for Locomotive Emissions

While emission standards for locomotives are set by U.S. EPA, CARB has accelerated reductions from these sources through efforts that have focused on cleaner fuel requirements, and increasing use of cleaner locomotives. The Statewide Rail Yard Agreement for California Rail Yards (Railroad MOU) accelerates the introduction of cleaner locomotives, obligates the railroads to significantly reduce emissions in and around rail yards in California, and established a statewide visible emissions reduction and repair program. No other state or nonattainment area has achieved similarly significant levels of emission reductions from in-use locomotives than CARB.

D.4.9.3 Fuels

CARB Diesel Fuel Regulations

U.S. EPA began regulating sulfur content in diesel in 1993. At that time, uncontrolled fuels (i.e. non-CARB diesel) contained approximately 5,000 parts per million (ppm) of sulfur. In 2006, U.S. EPA began to phase-in more stringent requirements under the federal Ultra-Low Sulfur Diesel (ULSD) regulations, which lowered the amount of sulfur allowed in federal diesel fuels. U.S. EPA's Nonroad Diesel Fuel Standards were phased in from 2007 to 2014, and require that all off-road engines, including those used in locomotives and off-road equipment, use ULSD fuel (with some exemptions for older locomotives and marine engines). The Nonroad Standards also require that diesel fuel sold into the market for off-road use must be ULSD. It is important to note that while U.S. EPA defines ULSD as ≤ 15 ppm for on-road applications, the definition of off-road ULSD is significantly less stringent, defined as ≤ 500 ppm standard.

For the off-road fleet, CARB's current ULSD regulation is significantly more stringent than the applicable current federal ULSD standards (Phase III):

- Whereas the federal ULSD program differs in requirements for on- and off-road fuels, CARB's ultra-low sulfur diesel program sets the same requirements for fuels burned in on- and off-road applications. CARB limits sulfur content at 15 ppm rather than the federal limit of 500 ppm for off-road ULSD. Compared with CARB ULSD standards, federal off-road ULSD allows 33 times the sulfur content.
- CARB's ULSD significantly reduces emissions relative to federal on-road ULSD, which is much cleaner than federal off-road ULSD. Both federal on-road ULSD

and CARB ULSD limit sulfur content (a precursor to secondary atmospheric formation of PM2.5) to 15 ppm, yet CARB's fuel emits ~25 percent less PM. Given that federal off-road ULSD sulfur content is capped at levels 3,000 percent higher than CARB's ULSD, the California program is significantly more stringent in terms of its ability to control emissions of sulfur oxide emissions.

- In addition, CARB controls hydrocarbons and aromatics, unlike U.S. EPA requirements.

As was discussed in the on-road diesel fuel section, only one other state has a boutique fuel program with requirements that differ from federal specifications, the Low Emission Diesel Program in Texas (TxLED). CARB diesel specifications are more stringent than federal and other states' programs.

Controlling Criteria Emissions from Renewable Fuels

The Low Carbon Fuel Standard (LCFS) and Alternative Diesel Fuel (ADF) regulations work together to reduce the carbon intensity of the California fuel supply while requiring limits on criteria emissions from alternative fuels and/or alternative fuel mix blends. While other states have adopted or are considering adopting similar programs to the California LCFS, no other state has set criteria emission requirements on alternative fuels and alternative fuel blends. The Federal Renewable Fuel Standard (RFS II), which is the most equivalent program type at the federal level, increases the renewable content of the fuel mix nationally (as the LCFS does in California), however it does not specify criteria requirements for alternative fuels. Furthermore, CARB is anticipated to further increase the stringency of controls on criteria pollutant emissions diesel products under the Low Emission Diesel measure committed to in the State SIP Strategy. No other state or nonattainment area controls criteria emissions from renewable fuels more stringently than CARB.

Cleaner Burning Fuels Requirements (for Locomotives)

While emission standards for locomotives are set by U.S. EPA, CARB has accelerated reductions from these sources through efforts that have focused on cleaner fuel requirements, and increasing use of cleaner locomotives. The Railroad MOU includes a control measure that maximizes the use of lower emitting fuels (i.e. CARB and U.S. EPA low sulfur diesel) in locomotives fueled in California. ***Requiring cleaner diesel fuel requirements for intrastate locomotives*** have reduced NOx and diesel PM emissions from these sources.

D.4.10 Step 3(a): Evaluation of Stringency: Off-Road Control Measures

Step 3(a) calls for an evaluation of each of the potential BACM/MSM control measures identified in Step 2, in order to evaluate their stringency and determine whether they meet all applicable requirements to satisfy the definitions of BACM and/or MSM discussed in Chapter 1 and Chapter 2.

in order to determine whether each potential MSM/BACM measure meets the definition of MSM and/or BACM, staff has assessed each potential MSM/BACM off-road mobile source control measure identified in Steps 2(a) and 2(b). Based on this assessment, staff then characterized each potential MSM / BACM measure as falling into 'bins' representing whether it meets the definition of MSM or BACM for each of the four PM2.5 standards covered in this document (note that the BACM bin is further subdivided into BACT or ADF). The determination of which bin each control measure falls into thus indicates both the control measure' stringency and the control measures' implementation schedule, relative to the varying attainment dates among the Valley's four PM2.5 SIPs. In other words, the bin into which each control measure falls correlates with how hard each measure pushes to control emissions, given the implementation timeframes associated with each standards' plan. Generally speaking, the control measures included in CARB's current control program meet the definition of BACM; the new measures included in the Valley SIP Strategy satisfy MSM requirements.

Figure 7 shows the timing for implementation of each potential MSM / BACM off-road control measure identified in the prior sections (i.e. Steps 2(a) and 2(b)), for each of the four PM2.5 standards discussed in this SIP.

Figure 7: Timeline for Implementation of BACM / MSM Off-Road Control Measures

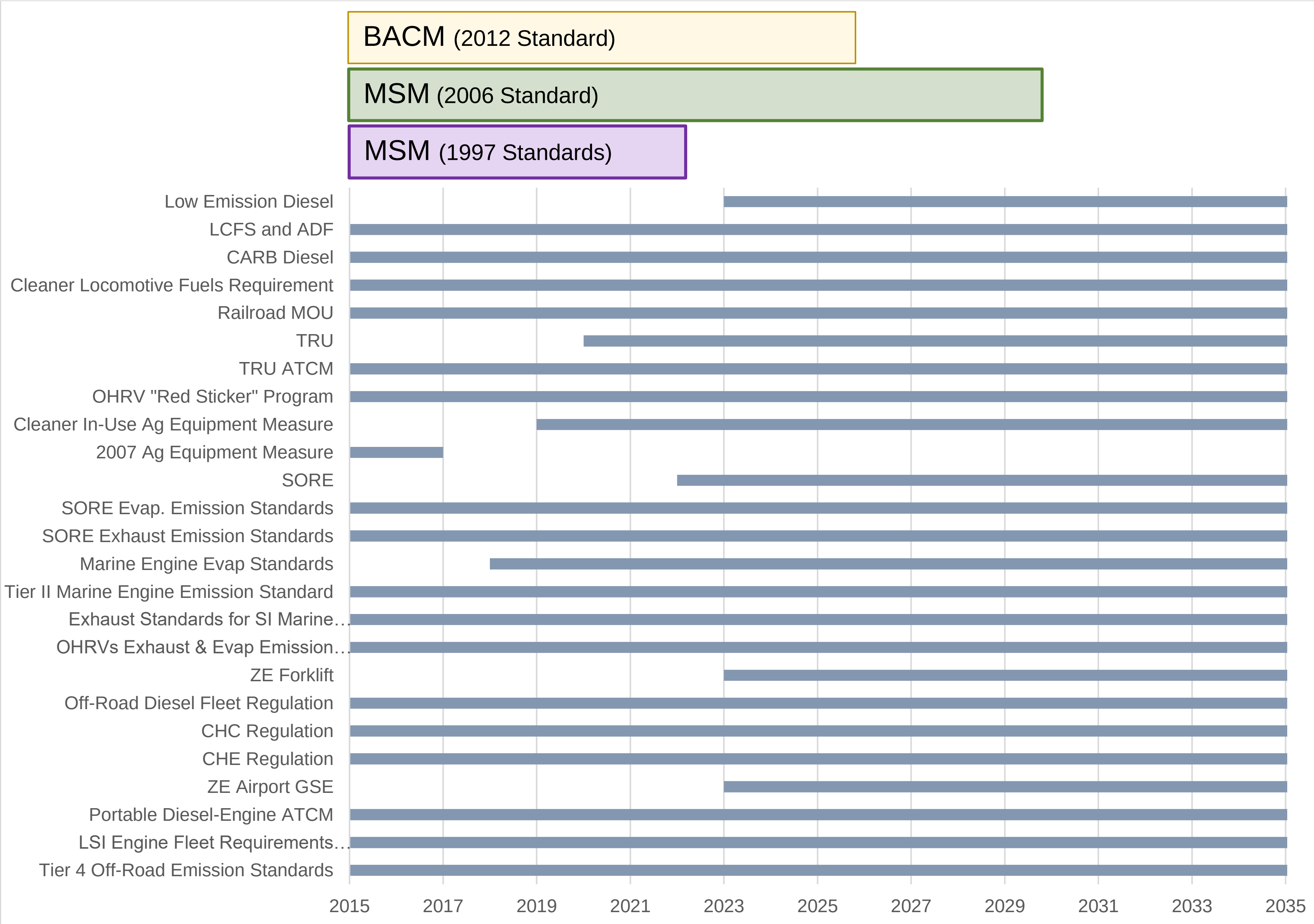

BACM (2012 Standard)
MSM (2006 Standard)
MSM (1997 Standards)
Low Emission Diesel
LCFS and ADF
CARB Diesel
Cleaner Locomotive Fuels Requirement
Railroad MOU
TRU
TRU ATCM
OHRV "Red Sticker" Program
Cleaner In-Use Ag Equipment Measure
2007 Ag Equipment Measure
SORE
SORE Evap. Emission Standards
SORE Exhaust Emission Standards
Marine Engine Evap Standards
Tier II Marine Engine Emission Standard
Exhaust Standards for SI Marine…
OHRVs Exhaust & Evap Emission…
ZE Forklift
Off-Road Diesel Fleet Regulation
CHC Regulation
CHE Regulation
ZE Airport GSE
Portable Diesel-Engine ATCM
LSI Engine Fleet Requirements…
Tier 4 Off-Road Emission Standards
2015
2017
2019
2021
2023
2025
2027
2029
2031
2033
2035

Table 16 summarizes which of the categories of stringency (i.e. BACM/BACT, BACM/ADF, or MSM) that each off-road mobile source control measure falls into, for each PM2.5 standard. It is important to note that some measures CARB has committed to in the State SIP Strategy and proposed in the Valley SIP Strategy have anticipated implementation dates that exceed the timeframe thresholds of this analysis for some standards. Specifically, implementation of the SORE measure is anticipated to begin in 2022, while implementation of the Zero-Emission Airport Ground Support Equipment (GSE) measure, Zero-Emission Forklift Regulation Phase I measure, and the Low-Emission Diesel measure is anticipated to begin in 2023, after the 2021 threshold of the analysis for the 1997 Annual and 24-Hour Standards. While these measures may not meet the timeline requirements to fall into the strict definition of MSM for these standards, the intent behind these measures is nonetheless to continue pushing for additional emission reductions to ensure that attainment is achieved as expeditiously as possible, which aligns with the broader purpose of MSM.

Table 16: Identification of Off-Road Control Measures as BACM and/or MSM

Measures	Implementation Begins	12 ug/m3 Annual (2012)	35 ug/m3 24-Hour (2006)	15 ug/m3 Annual (1997)	65 ug/m3 24-Hour (1997)
Adopted Off-Road Control Measures					
Tier 4 Off-Road Emission Standards	ongoing	BACM - BACT	MSM	MSM	MSM
Large Spark Ignition (LSI) Engine Fleet Standards	ongoing	BACM - AFM	MSM	MSM	MSM
Portable Diesel-Engine ATCM	ongoing	BACM - BACT	MSM	MSM	MSM
Cargo Handling Equipment (CHE) Regulation	ongoing	BACM - BACT	MSM	MSM	MSM
Commercial Harbor Craft (CHC) Regulation	ongoing	BACM - BACT	MSM	MSM	MSM
Off-Road Diesel-Fueled Fleets Regulation (Off-Road Regulation)	ongoing	BACM - BACT	MSM	MSM	MSM
Exhaust and Evaporative Emission Standards for OHRVs	ongoing	BACM - BACT	MSM	MSM	MSM
Exhaust Standards for Spark-Ignition Marine Engines	ongoing	BACM - BACT	MSM	MSM	MSM
Tier II Emission Standards for Inboard and Stern-Drive Marine Engines	ongoing	BACM - BACT	MSM	MSM	MSM
Marine Engine Evaporative Emission Control Standards	ongoing	BACM - BACT	MSM	MSM	MSM
SORE Exhaust Emission Standards and Test Procedures	ongoing	BACM - AFM	MSM	MSM	MSM
Evaporative Emission Standards for SORE	ongoing	BACM - BACT	MSM	MSM	MSM
2007 Cleaner In-Use Agricultural Equipment Measure	ongoing	BACM - BACT	MSM	MSM	MSM
Off-Highway Recreational Vehicle (OHRV) "Red Sticker" Program	ongoing	BACM - BACT	MSM	MSM	MSM
ATCM for In-Use Diesel-Fueled Transport Refrigeration Units (TRUs) and TRU Generator Sets	ongoing	BACM - BACT	MSM	MSM	MSM
Statewide Rail Yard Agreement for California Rail Yards (Railroad MOU)	ongoing	BACM - BACT	MSM	MSM	MSM
Cleaner Burning Fuels Requirements for Locomotives	ongoing	BACM - BACT	MSM	MSM	MSM
CARB Ultra Low Sulfur Diesel (ULSD)	ongoing	BACM - BACT	MSM	MSM	MSM
Low Carbon Fuel Standard (LCFS) and Alternative Diesel Fuel (ADF)	ongoing	BACM - BACT	MSM	MSM	MSM

Table 16: Identification of Off-Road Control Measures as BACM and/or MSM

Measures	Implementation Begins	12 ug/m3 Annual (2012)	35 ug/m3 24-Hour (2006)	15 ug/m3 Annual (1997)	65 ug/m3 24-Hour (1997)
State SIP Strategy Off-Road Measures (with Commitment)					
Zero-Emission Airport Ground Support Equipment (GSE)	2023	BACM - AFM	MSM	--	--
Zero-Emission Off-Road Forklift Regulation Phase 1	2023	BACM - AFM	MSM	--	--
Small Off-Road Engines (SORE)	2022	BACM - BACT	MSM	--	--
Transport Refrigeration Units Used for Cold Storage	2020	BACM - AFM	MSM	MSM	MSM
Low-Emission Diesel Requirement	2023	BACM - AFM	MSM	--	--
Valley SIP Strategy Off-Road Measures (Proposed in Valley SIP)					
Cleaner In-Use Agricultural Equipment Measure	2019	BACM - AFM	MSM	MSM	MSM

D.4.11 Step 3(b): Evaluation of Feasibility: Off-Road Control Measures

Step 3(b) calls for an assessment of the feasibility of implementing any measure that is not included in the Valley's proposed SIP and attainment demonstration, but which is identified as a potential BACM/MSM control measure in Step 2. For this plan, staff's proposed SIP and attainment demonstration do not recommend eliminating any of the potential BACM/MSM control measures identified in Step 2 on the basis of technical or economic infeasibility. Thus, a feasibility assessment for purposes of eliminating such measures from further consideration (i.e. Step 3(b)) is not applicable.

D.4.12 Summary of Steps 2 and 3

D.4.12.1 Step 2: Potential Mobile Source Control Measures Identified

The purpose of Step 2 is to identify all potential BACM/MSM control measures for the emission sources identified Step 1. Per U.S. EPA guidance, staff began to identify the list of all potential BACM/MSM control measures by starting with California's control program (Step 2(a)), which includes:

- Control measures adopted in the SIP for the Valley (i.e. the current control program)
- Control measures committed to in the State SIP Strategy; and
- Control measures proposed in the Valley State SIP Strategy.

In Step 2(b), staff expanded the scope of focus beyond California's controls to identify any additional potential BACM/MSM control measures that are in use in other nonattainment areas and states, and which exceed the stringency of California's controls identified in Step 2(a). The analysis undertaken for Step 2(b) found that, while there are some measures in use in other jurisdictions that are more stringent than the currently adopted mobile source control programs in California, the stringency of similar control measures committed to in the State SIP Strategy and proposed in the Valley State SIP Strategy meets and/or exceeds the stringency of the controls in use in other jurisdictions. Thus, Step 2(b) did not identify any additional potential BACM/MSM control measures in use in other jurisdictions that are more stringent than the California control measures previously identified in Step 2(a).

To meet statutory requirements for the MSM plans, staff also reviewed all previous Valley PM2.5 SIPs in Step 2(c), and found no mobile source control measures that were proposed in previous Moderate or Serious attainment plan control strategies for the Valley that were not subsequently adopted.

As there are no applicable control measures previously rejected as infeasible for the Valley's BACM/MSM demonstration process, Step 2(c) did not identify any additional potential BACM/MSM control measures beyond the control measures identified in Steps 2(a) and 2(b).

D.4.12.2 Step 3: Analysis of Stringency and Feasibility

The analysis of stringency and feasibility for each possible BACM/MSM control measure identified in Step 2 has shown that California's mobile source control program is at least consistent with the most stringent of any nonattainment area or state in the nation, with the majority of California control measures exceeding the stringency of controls in use in the rest of the nation. These findings generally correlate with the ongoing technology assessments CARB staff has been conducting in collaboration with U.S. EPA and the National Highway Traffic Safety Administration. These Technology Assessments have been undertaken in order to identify the next generation of technologies and fuels that will need to comprise California's transition to a cleaner, more efficient transportation system.[95] This effort has enabled CARB to identify the types of technologies that will be needed as part of a cleaner, more efficient transportation system that meets California's multiple air quality, and climate goals, including attainment of U.S. EPA's health-based ambient air quality standards for PM2.5 and other criteria air pollutants. The major findings of the Technology Assessments are shown in Figure 8.

Figure 8: Key Technology Assessment Findings

Key Technology Assessment Findings

In the light-duty sector, conventional hybrid electric vehicles have gained significant market share, and ZEV commercialization is well underway, with increasing numbers of BEV, PHEV and FCEV vehicles available for sale.

In the heavy-duty sector, near-zero combustion technologies that provide ultra-low NOx emissions and operate on renewable fuels are beginning to enter the market. Low-NOx natural gas engines in some sizes, certified to an optional 0.02 g/bhp-hr standard are now becoming available, with low-NOx diesel engines certified to the optional standard of either 0.05 or 0.1 g/bhp-hr available thereafter.

The development of heavy-duty zero emission technologies is also underway. Zero-emission vehicles are already available in a number of applications such as forklifts and airport ground support equipment. Battery electric and fuel cell buses are in the early commercialization phase and demonstration projects are underway in additional applications such as zero-emission drayage and last mile delivery trucks, certain types of off-road equipment, and at distribution centers, warehouses and intermodal facilities.

Further emission reductions beyond current engine standards for locomotives and ocean going vessels are feasible with the use of aftertreatment technologies such as oxidation or three-way catalysts, diesel particulate filters, or selective catalytic reduction.

Renewable fuels can provide significant GHG and petroleum reductions, as well as NOx and PM reductions in applications where combustion technologies will continue to operate. Vehicle grid integration and power to gas technologies can also help support a high renewable portfolio electrical grid.

The Technology Assessment findings illustrate that the control measures included in the Valley's attainment plan and demonstration represent the suite of emission control approaches align with the most stringent levels of control feasible, given the current status of technology and its potential in the near future. Furthermore, CARB staff has not received any public comments to date indicating that more stringent control technologies than those identified in the Technology Assessments would be

[95] Technology and Fuels Assessments can be found at: https://www.arb.ca.gov/msprog/tech/tech.htm

commercially available and/or technologically and economically feasible to implement in the Valley in the timeframe required for the area's PM2.5 SIPs.

D.5 CHAPTER V. STEP 4: ADOPTION OF MOBILE SOURCE CONTROL MEASURES

The final step required by the Act's step-wise process is to adopt and implement feasible control measures identified in Step 3 to satisfy BACT/BACM and MSM requirements.

Staff's proposed SIP for the Valley recommends adoption and implementation all of the measures identified as BACM and MSM in Step 3 that have not already been adopted and/or implemented. The control measures included in the Valley's attainment demonstration and shown to meet the required BACM/MSM requirements in this appendix are in varying stages of the adoption and implementation process at CARB.

- Many of the measures identified as BACM and/or MSM have already been adopted by the Board, submitted into the SIP, and are currently being implemented as part of CARB's current control program.
- Additional control measures have been committed to in the State SIP Strategy, which the Board adopted in March 2017, yet many of these control measures themselves have not yet been adopted by the Board. The Board's adoption of the State SIP Strategy created a commitment to adopt measures according to a defined schedule, an initial commitment to achieve specified emission reductions in the Valley, and a commitment to return to the Board with a comprehensive plan to attain the PM2.5 standards in the Valley.
- Finally, the Valley State SIP Strategy proposes additional control measures which the Board has not yet considered.

Board adoption of the proposed SIP – including the proposed new mobile source control measures described in the Valley SIP Strategy – will satisfy the requirements of Step 4. The process for adoption and implementation of these control measures is discussed in more detail in the body of the main document to which this analysis is appended.

D.6 CHAPTER VI. CONCLUSION: FINDINGS OF MSM AND BACM ANALYSIS

California's long history of comprehensive and innovative emissions control has resulted in the strongest mobile source control program in the nation. U.S. EPA has acknowledged the strength of these programs in their approval of CARB's regulations and through the waiver process. In addition, U.S. EPA has provided past determinations that CARB's mobile source control programs meet BACM and MSM requirements as part of their 2004 approval of the Valley's 2003 PM10 Plan:

> "We believe that the State's control programs constitute BACM at this time for the mobile source and fuels categories, since the State's measures reflect the most stringent emission control programs currently available, taking into account economic and technological feasibility."

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. These efforts not only ensure that all source sectors continue to achieve maximum emission reductions through implementation of the cleanest current technologies, but also promote the ongoing development of more advanced zero and near-zero technologies. As a result, California's mobile source control programs reflect the most stringent and feasible level of emissions control in the nation and fully meet the requirements for BACM/BACT and MSM.

In conclusion, CARB followed the procedures outlined by U.S. EPA for determining BACM and MSM, and have determined that California's mobile source program satisfies the applicable requirements for each PM2.5 standard in this analysis.

The attached table lists all of CARB's regulatory control measures since 1985.

Table 17: CARB Regulatory Mobile Source Control Measures since 1985

Board Action	Hearing Date
Public Hearing to Consider Proposed Amendments to the Airborne Toxic Control Measure For Diesel Particulate Matter from Portable Engines Rated at 50 Horsepower and Greater – and to the Statewide Portable Equipment Registration Program Regulation: The proposed amendments will provide more time for cleaner engine replacement while preserving the expected emission reductions, and make other improvements to the ATCM. PERP will have corresponding amendments and make other improvements to the program.	11/16/17
Public Hearing to Consider the Proposed Amendments to California's Evaluation Procedures for New Aftermarket Catalytic Converters: The proposed amendments are for procedures used to evaluate and approve aftermarket catalytic converters designed for use on California passenger cars and trucks to allow them to be used for Low Emission Vehicle III emission standards.	9/28/17

Public Meeting to Consider Proposed Revisions to the Carl Moyer Memorial Air Quality Standards Attainment Program Guidelines: The updated Carl Moyer Memorial Air Quality Standards Attainment Program 2017 Guidelines implement changes directed by Senate Bill 513 and redesign the Program to meet California's need to transition to the very low and zero-emission technologies of the future.	4/27/17
Public Meeting to Consider the Proposed Amendments to the Evaporative Emission Requirements for Small Off-Road Engines: The proposed amendments will address to non-compliance of small off-road engines (SORE) with existing evaporative emission standards, as well as amendments to streamline the certification process by harmonizing where feasible with federal requirements.	11/17/16
Notice of Public Hearing to Consider Proposed Regulation to Provide Certification Flexibility for Innovative Heavy-Duty Engine and California Certification and Installation Procedures for Medium and Heavy-Duty Vehicle Hybrid Conversion Systems: This proposed regulation's certification flexibility is tailored to encourage development and market launch of heavy-duty engines meeting California's optional low oxides of oxides of nitrogen emission standards, robust heavy-duty hybrid engines, and high-efficiency heavy-duty engines.	10/20/16
Public Hearing to Consider Proposed Amendments to the Large Spark-Ignition Engine Fleet Requirements Regulation: The proposed amendment will establish new reporting and labeling requirements and extend existing recordkeeping requirements. The proposed regulatory amendments are expected to improve the reliability of the emission reductions projected for the existing LSI Fleet Regulation by increasing enforcement effectiveness and compliance rates.	7/21/16
Public Hearing to Consider Proposed Evaluation Procedure for New Aftermarket Diesel Particulate Filters Intended as Modified Parts for 2007 through 2009 Model Year On-Road Heavy-Duty Diesel Engines: The proposed amendment would establish a path for exempting aftermarket modified part DPFs intended for 2007 through 2009 on-road heavy-duty diesel engines from the prohibitions of the current vehicle code. Staff is also proposing to incorporate a new procedure for the evaluation of such DPFs.	4/22/16
Amendments to the Portable Fuel Container Regulation Amendments to the Portable Fuel Container (PFC) regulation, which include requiring certification fuel to contain 10 percent ethanol, harmonizing aspects of the Board's PFC certification and test procedures with those of the U.S. EPA, revising the ARB's certification process, and streamlining, clarifying, and increasing the robustness of ARB's certification and test procedures.	2/18/16
Technical Status and Proposed Revisions to On-Board Diagnostic System Requirements and Associated Enforcement Provisions for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines (OBD II) Amendments to the OBD II regulations that update requirements to account for LEV III applications and monitoring requirements for gasoline and diesel vehicles, and clarify and improve the regulation; also, updates to the associated OBD II enforcement regulation to align it with the proposed amendments to the OBD II regulations and a minor amendment to the definition of "emissions-related part" in title 13, CCR section 1900.	9/25/15
2015 Low Carbon Fuel Standard (LCFS) Amendments (2 of 2) Re-adoption of the Low Carbon Fuel Standard, which includes updates and revisions to the regulation now in effect. The proposed regulation was first presented to the Board at its February 2015 public hearing, at which the Board directed staff to make modifications to the proposal.	9/24/15
Proposed Regulation on the Commercialization of Alternative Diesel Fuels (2 of 2) Regulation governing the introduction of alternative diesel fuels into the California commercial market, including special provisions for biodiesel.	9/24/15
Intermediate Volume Manufacturer Amendments to the Zero Emission Vehicle Regulation (2 of 2) Amendments regarding intermediate volume manufacturer compliance obligations under the Zero Emission Vehicle regulation.	5/21/15

2015 Amendments to Certification Procedures for Vapor Recovery Systems at Gasoline Dispensing Facilities—Aboveground Storage Tanks and Enhanced Conventional Nozzles Amendments would establish new performance standards and specifications for nozzles used at fleet facilities that exclusively refuel vehicles equipped with onboard vapor recovery systems, would provide regulatory relief for owners of certain existing aboveground storage tanks, and would ensure that mass-produced vapor recovery equipment matches the specifications of equipment evaluated during the ARB certification process.	4/23/15
Proposed Regulation for the Commercialization of Alternative Diesel Fuels (1 of 2) Regulation governing the introduction of alternative diesel fuels into the California commercial market, including special provisions for biodiesel. This is the first of two hearings on the item, and the Board will not take action to approve the proposed regulation.	2/19/15
Evaporative Emission Control Requirements for Spark-Ignition Marine Watercraft Regulation for controlling evaporative emissions from spark-ignition marine watercraft. The proposed regulation will harmonize, to the extent feasible, with similar federal requirements, while adding specific provisions needed to support California's air quality needs.	2/19/15
2015 Low Carbon Fuel Standard (LCFS) Amendments (1 of 2) Regulation for a Low Carbon Fuel Standard that includes re- adoption of the existing Low Carbon Fuel Standard with updates and revisions. This is the first of two hearings on the item, and the Board will not take action to approve the proposed regulation.	2/19/15
2014 Amendments to ZEV Regulation Additional compliance flexibility to ZEV manufacturers working to bring advanced technologies to market.	10/23/14
LEV III Criteria Pollutant Requirements for Light- and Medium-Duty Vehicles the Hybrid Electric Vehicle Test Procedures, and the HD Otto-Cycle and HD Diesel Test Procedures Applies to the 2017 and subsequent model years.	10/23/14
Low Carbon Fuel Standard 2014 Update As a result of a California Court of Appeal decision, ARB will revisit the LCFS rulemaking process to meet certain procedural requirements of the APA and CEQA. Following incorporation of any modifications to the regulation, the Board will consider the proposed regulation for adoption at a second hearing held in the spring of 2015.	7/24/14
Revisions to the Carl Moyer Memorial Air Quality Standards Attainment Program Guidelines for On-Road Heavy-Duty Trucks Revisions to 1) reduce surplus emission reduction period, 2) reduce minimum CA usage requirement, 3) prioritize on-road funding to small fleets, 4) include light HD vehicles 14000-19500 libs, and 5) clarify program specifications.	7/24/14
Amendments to Enhanced Fleet Modernization (Car Scrap) Program Amendments consistent with SB 459 which requires ARB to increase benefits for low-income California residents, promote cleaner replacement vehicles, and enhance emissions reductions.	6/26/14
Truck and Bus Rule Update Amendments to the Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen, and Other Criteria Pollutants From In-Use On-Road Diesel-Fueled Vehicles: increasing low-use vehicle thresholds, allowing owners to newly opt-in to existing flexibility provisions, adjusting "NOx exempt" vehicle provisions, and granting additional time for fleets in certain areas to meet PM filter requirements.	4/24/14

Heavy-Duty GHG Phase I: On-Road Heavy-Duty GHG Emissions Rule, Tractor-Trailer Rule, Commercial Motor Vehicle Idling Rule, Optional Reduced Emission Standards, Heavy-Duty Hybrid-Electric Vehicles Certification Procedure New GHG standards for MD and HD engines and vehicles identical to those adopted by the USEPA in 2011 for MYs 2014-18.	12/12/13
Agricultural equipment SIP credit rule Incentive-funded projects must be implemented using Carl Moyer Program Guidelines; must be surplus, quantifiable, enforceable, and permanent, and result in emission reductions that are eligible for SIP credit.	10/25/13
Zero emission vehicle test procedures Existing certification test procedures for plug-in hybrid vehicles need to be updated to reflect technology developments. The ZEV regulation will require minor modifications to address clarity and implementation issues.	10/24/13
Alternative fuel certification procedures Amendments to current alternative fuel conversion certification procedures for motor vehicles and engines that will allow small volume conversion manufacturers to reduce the upfront demonstration requirements and allow systems to be sold sooner with lower certification costs than with the current process, beginning with MY 2018.	9/26/13
Vapor Recovery for Gasoline Dispensing Facilities Amendments to certification and test procedures for vapor recovery equipment used on cargo tanks and at gasoline dispensing facilities.	7/25/13
Off-highway recreational vehicle evaporative emission control Staff proposes to set evaporative emission standards to control hydrocarbon emissions from Off-Highway Recreational Vehicles. The running loss, hot soak, and diurnal performance standards can be met by using proven automobile type control technology.	7/25/13
Gasoline and diesel fuel test standards Adopted amendments to add test standards for the measurement of prohibited oxygenates at trace levels specified in existing regulations.	1/25/13
LEV III and ZEV Programs for Federal Compliance Option Adopted amendments to deem compliance with national GHG new vehicle standards in 2017-2025 as compliance with California GHG standards for the same model years.	11/15/12 12/6/12 EO
Amendments to Verification Procedure, Warranty and In-Use Compliance Requirements for In-Use Strategies to Control Emissions from Diesel Engines Approved amendments to the verification procedure used to evaluate diesel retrofits through emissions, durability, and field testing. Amendments will lower costs associated with required in-use compliance testing, streamline the in-use compliance process, and will extend time allowed to complete verifications.	8/23/2012 EO 07/02/13
Amendments to On-Board Diagnostics (OBD I and II) Regulations Approved amendments to the light- and medium-duty vehicle and heavy-duty engine OBD regulations.	8/23/2012 EO 06/26/13
Vapor recovery defect list Adopted amendments to add defects and verification procedures for equipment approved since 2004, and make minor changes to provide clarity	6/11/12 EO
Advanced Clean Cars (ACC) Regulation: Low-Emission Vehicles and GHG Adopted more stringent criteria emission standards for MY 2015-2025 light and medium duty vehicles (LEV III), amended GHG emission standards for model year 2017-2025 light and medium duty vehicles (LEV GHG), amended ZEV Regulation to ensure the successful market penetration of ZEVs in commercial volumes, amended hydrogen fueling infrastructure mandate of the Clean Fuels Outlet regulation, and amended cert fuel for light duty vehicles from an MTBE-containing fuel to an E10 certification fuel.	1/26/12

Zero Emission Vehicle (ZEV) Adopted amendments to increase compliance flexibility, add two new vehicle categories for use in creating credits, increase credits for 300 mile FCVs, increase requirements for ZEVs and TZEVs, eliminate credit for PZEVs and AT PZEVs, expand applicability to smaller manufacturers, base ZEV credits on range, and make other minor changes in credit requirements	1/26/12
Amendments to Low Carbon Fuel Standard Regulation The amendments address several aspects of the regulation, including: reporting requirements, credit trading, regulated parties, opt-in and opt-out provisions, definitions, and other clarifying language.	12/16/11 10/10/12 EO
Amendments to Small Off-Road Engine and Tier 4 Off-Road Compression-Ignition Engine Regulations And Test Procedures; also "Recreational Marine" Spark-Ignition Marine Engine Amendments (Recreational Boats) adopted. Aligns California test procedures with U.S. EPA test procedures and requires off-road CI engine manufacturers to conduct in-use testing of their entire product lines to confirm compliance with previously established Not-To-Exceed emission thresholds.	12/16/2011 10/25/12 EO
Regulations and Certification Procedures for Engine Packages used in Light-Duty Specially Constructed Vehicles (Kit Cars) Ensures that certified engine packages, when placed into any Kit Car, would meet new vehicle emission standards, and be able to meet Smog Check requirements.	11/17/11 9/21/12 EO
Amendments to the California Reformulated Gasoline Regulations Corrects drafting errors in the predictive model, deletes outdated regulatory provisions, updates the notification requirements, and changes the restrictions on blending CARBOB with other liquids.	10/21/11 8/24/12 EO
Amendments to the In-Use Diesel Transport Refrigeration Units (TRU) ATCM Mechanisms to improve compliance rates and enforceability.	10/21/11 8/31/12 EO
Amendments to the Regulation for Cargo Handling Equipment (CHE) at Ports and Intermodal Rail Yards (Port Yard Trucks Regulation) Provides additional compliance flexibility, and maintains anticipated emissions reductions. As applicable to yard trucks and two-engine sweepers.	9/22/11 8/2/12 EO
Amendments to the Enhanced Vapor Recovery Regulation for Gasoline Dispensing Facilities New requirement for low permeation hoses at gasoline dispensing facilities.	9/22/11 7/26/12 EO
Amendments to Cleaner Main Ship Engines and Fuel for Ocean-Going Vessels Adjusts the offshore regulatory boundary. Aligns very low sulfur fuel implementation deadlines with new federal requirements.	6/23/11 9/13/12 EO
Particulate Matter Emissions Measurement Allowance For Heavy-Duty Diesel In-Use Compliance Regulation Emission measurement allowances provide for variability associated with the field testing required in the regulation.	6/23/11
Low Carbon Fuel Standard Carbon Intensity Lookup Table Amendments Adds new pathways for vegetation-based fuels	2/24/11
Amendments to Cleaner In-Use Heavy-Duty On-Road Diesel Trucks and LSI Fleets Regulations Amends five regulations to provide relief to fleets adversely affected by the economy, and take into account the fact that emissions are lower than previously predicted.	12/16/10 9/19/11 EO
Amendments to Cleaner In-Use Off-Road Diesel-Fueled Fleets Regulation Amendments provide relief to fleets adversely affected by the economy, and take into account the fact that emissions are lower than previously predicted.	12/16/10 10/28/11 EO
In-Use On-Road Diesel-Fueled Heavy-Duty Drayage Trucks at Ports and Rail Yard Facilities Amendments add flexibility to fleets' compliance schedules, mitigate the use of noncompliant trucks outside port and rail properties, and provide transition to the Truck and Bus regulation.	12/16/10 9/19/11 EO

Amendment of the ATCM for Diesel Transportation Refrigeration Units (TRU) Amendments expand the compliance options and clarify the operational life of various types of TRUs.	11/18/10 2/2/11 EO
Amendments to the ATCM for Stationary Compression Ignition Engines Approved amendments to closely align the emission limits for new emergency standby engines in the ATCM with the emission standards required by the federal Standards of Performance.	10/21/10 3/25/11 EO
Diesel Vehicle Periodic Smoke Inspection Program Adopted amendments to exempt medium duty diesel vehicles from smoke inspection requirements if complying with Smog Check requirements.	10/21/10 8/23/11 EO
Renewable Electricity Standard Regulation Approved a regulation that will require electricity providers to obtain at least 33% of their retail electricity sales from renewable energy resources by 2020.	9/23/10
Energy Efficiency at Industrial Facilities Adopted standards for the reporting of GHG emissions and the feasibility of emissions controls by the largest GHG-emitting stationary sources.	7/22/10 5/9/11 EO
Amendments to Commercial Harbor Craft Regulation Approved amendments to require the use of cleaner engines in diesel-fueled crew and supply, barge, and dredge vessels.	6/24/10 4/11/11 EO
Accelerated Introduction of Cleaner Line-Haul Locomotives Agreement with railroads sets prescribed reductions in diesel risk and target years through 2020 at four major railyards.	6/24/10
Sulfur Hexafluoride (SF6) Regulation Regulation to reduce emissions of sulfur hexafluoride (SF6), a high-GWP GHG, from high-voltage gas-insulated electrical switchgear.	2/25/10 12/15/10 EO
Amendments to the Statewide Portable Equipment Registration Regulation and Portable Engine ATCM Approved amendments that extend the deadline for removal of certain uncertified portable engines for one year.	1/28/10 8/27/10 EO 12/8/10 EO
Diesel Engine Retrofit Control Verification, Warranty, and Compliance Regulation Amendments Approved amendments to require per-installation compatibility assessment, performance data collection, and reporting of additional information, and enhance enforceability.	1/28/10 12/6/10 EO
Amendments to Limit Ozone Emissions from Indoor Air Cleaning Devices Adopted amendments to delay the labeling compliance deadlines by one to two years and to make minor changes in testing protocols.	12/9/09
Emission Warranty Information Reporting Regulation Amendments Repealed the 2007 regulation and readopted the 1988 regulation with amendments to implement adverse court decision.	11/19/09 9/27/10 EO
Amendments to Maximum Incremental Reactivity Tables Added many new compounds and modified reactivity values for many existing compounds in the tables to reflect new research data.	11/3/09 7/23/10 EO
Passenger Motor Vehicle Greenhouse Gas Limits Amendments Approved amendments granting credits to manufacturers for compliant vehicles sold in other states that have adopted California regulations.	9/24/09 2/22/10 EO
Amendments to In-Use Off-Road Diesel-Fueled Fleets Regulation Approved amendments to implement legislatively directed changes and provide additional incentives for early action.	7/23/09 12/2/09 EO 6/3/10 EO
Methane Emissions from Municipal Solid Waste Landfills Approved a regulation to require smaller and other uncontrolled landfills to install gas collection and control systems, and also requires existing and newly installed systems to operate optimally.	6/25/09 5/5/10 EO
Cool Car Standards Approved a regulation requiring the use of solar management window glass in vehicles up to 10,000 lb GVWR.	6/25/09
Enhanced Fleet Modernization (Car Scrap) Approved guidelines for a program to scrap up to 15,000 light duty vehicles statewide.	6/25/09 7/30/10 EO

Amendments to Heavy-Duty On-Board Diagnostics Regulations Approved amendments to the light and medium-duty vehicle and heavy duty engine OBD regulations.	5/28/2009 4/6/10 EO
Smog Check Improvements BAR adopted amendments to implement changes in state law and SIP commitments adopted by ARB between 1996 and 2007.	5/7/09 by BAR 6/9/09 EO
AB 118 Air Quality Improvement Program Guidelines The Air Quality Improvement Program provides for up to $50 million per year for seven years beginning in 2009-10 for vehicle and equipment projects that reduce criteria pollutants, air quality research, and advanced technology workforce training. The AQIP Guidelines describe minimum administrative, reporting, and oversight requirements for the program, and provide general criteria for how the program shall be implemented.	04/23/09 08/28/09 EO
Pesticide Element Reduce volatile organic compound (VOC) emissions from the application of agricultural field fumigants in the South Coast, Southeast Desert, Ventura County, San Joaquin Valley, and Sacramento Metro federal ozone nonattainment areas.	4/20/09 10/12/09 EO (2) 8/2/11 EO
Low Carbon Fuel Standard Approved new standards to lower the carbon content of fuels.	4/20/09 11/25/09 EO
Pesticide Element for San Joaquin Valley DPR Director approved pesticide ROG emission limit of 18.1 tpd and committed to implement restrictions on non-fumigant pesticide use by 2014 in the San Joaquin Valley.	4/7/09 DPR
Tire Pressure Inflation Regulation Approved a regulation requiring automotive service providers to perform tire pressure checks as part of every service.	3/26/09 2/4/10 EO
Sulfur Hexafluoride from Non-Utility and Non-Semiconductor Applications Approved a regulation to phase out use of Sulfur Hexafluoride over the next several years.	2/26/09 11/12/09 EO
Semiconductor Operations Approved a regulation to set standards to reduce fluorinated gas emissions from the semiconductor and related devices industry.	2/26/09 10/23/09 EO
Plug-In Hybrid Electric Vehicles Test Procedure Amendments Amends test procedures to address plug-in-hybrid electric vehicles.	1/23/09 12/2/09 EO
In-Use Off-Road Diesel-Fueled Fleets Amendments Makes administrative changes to recognize delays in the supply of retrofit control devices.	1/22/09
Aftermarket Critical Emission Parts on Highway Motorcycles Allows for the sale of certified critical emission parts by aftermarket manufacturers.	1/22/09 6/19/09 EO
Cleaner In-Use Heavy-Duty Diesel Trucks (Truck and Bus Regulation) Approved a regulation to reduce diesel particulate matter and oxides of nitrogen through fleet modernization and exhaust retrofits. Makes enforceability changes to public fleet, off-road equipment, and portable equipment regulations.	12/11/08 10/19/09 EO 10/23/09 EO
Large Spark-Ignition Engine Amendments Approved amendments to reduce evaporative, permeation, and exhaust emissions from large spark-ignition (LSI) engines equal to or below 1 liter in displacement.	11/1/08 3/12/09 EO
Small Off-Road Engine (SORE) Amendments Approved amendments to address the excessive accumulation of emission credits.	11/21/08 2/24/10 EO
Proposed AB 118 Air Quality Guidelines for the Air Quality Improvement Program and the Alternative and Renewable Fuel and Vehicle and Technology Program. The California Alternative and Renewable Fuel, Vehicle Technology, Clean Air, and Carbon Reduction Act of 2007 (AB 118) requires ARB to develop guidelines for both the Alternative and Renewable Fuel and Vehicle Technology Program and the Air Quality Improvement Program to ensure that both programs do not adversely impact air quality.	09/25/08 EO 05/20/09
Portable Outboard Marine Tanks and Components (part of Additional Evaporative Emission Standards) Approved a regulation that establishes permeation and emission standards for new portable outboard marine tanks and components.	9/25/08 7/20/09 EO

Cleaner Fuel in Ocean Going Vessels Approved a regulation that requires use of low sulfur fuel in ocean-going ship main engines, and auxiliary engines and boilers.	7/24/08 4/16/09 EO
Spark-Ignition Marine Engine and Boat Amendments Provides optional compliance path for > 500 hp sterndrive/inboard marine engines.	7/24/08 6/5/09 EO
Zero emission vehicles Updated California's ZEV requirements to provide greater flexibility with respect to fuels, technologies, and simplifying compliance pathways. Amendments give manufacturers increased flexibility to comply with ZEV requirements by giving credit to plug-in hybrid electric vehicles and establishing additional ZEV categories in recognition of new developments in fuel cell vehicles and battery electric vehicles.	3/27/08 12/17/08 EO
Amendments to the Verification Procedure, Warranty, and In-Use Compliance Requirements for In-Use Strategies to Control Emissions from Diesel Engines Adds verification requirements for control technologies that only reduce NOx emissions, new reduction classifications for NOx reducing technologies, new testing requirements, and conditional extensions for verified technologies.	1/24/08 12/4/08 EO
Gaseous Pollutant Measurement Allowances for In-Use Heavy-Duty Diesel Compliance Measurement accuracy margins are to be determined through an ongoing comprehensive testing program performed by an independent contractor. Amendments include these measurement accuracy margins into the regulation.	12/6/07 10/14/08 EO
Ocean-Going Vessels While at Berth (aka Ship Hoteling) - Auxiliary Engine Cold Ironing and Clean Technology Approved a regulation that reduces emissions from auxiliary engines on ocean-going ships while at-berth.	12/6/07 10/16/08 EO
In-Use On-Road Diesel-Fueled Heavy-Duty Drayage Trucks at Ports and Rail Yard Facilities Approved a regulation that establishes emission standards for in-use, heavy-duty diesel-fueled vehicles that transport cargo to and from California's ports and intermodal rail facilities.	12/6/07 10/12/08 EO
Commercial Harbor Craft Approved a regulation that establishes in-use and new engine emission limits for both auxiliary and propulsion diesel engines on ferries, excursion vessels, tugboats, and towboats.	11/15/07 9/2/08 EO
Suggested Control Measure for Architectural Coatings Amendments Approved amendments to reduce the recommended VOC content of 19 categories of architectural coatings.	10/26/07
Aftermarket Catalytic Converter Requirements Approved amendments that establish more stringent emission performance and durability requirements for used and new aftermarket catalytic converters offered for sale in California.	10/25/07 2/21/08 NOD
Limiting Ozone Emissions from Indoor Air Cleaning Devices Approved ozone emission limit of 0.050 ppm for portable indoor air cleaning devices in response to requirements of AB 2276 (2006).	9/27/07 8/7/08 EO
Pesticide Commitment for Ventura County in 1994 SIP Approved substitution of excess ROG emission reductions from state motor vehicle program for 1994 SIP reduction commitment from pesticide application in Ventura County.	9/27/07 11/30/07 EO
In-Use Off-Road Diesel Equipment Approved a regulation that requires off-road diesel fleet owners to modernize their fleets and install exhaust retrofits.	7/26/07 4/4/08 EO
Emission Control and Environmental Performance Label Regulations Approved amendments to add a Global Index Label and modify the formal of the Smog Index Label on new cars.	6/21/07 5/2/08 EO

Vapor Recovery from Aboveground Storage Tanks Approved a regulation to establish new performance standards and specifications for the vapor recovery systems and components used with aboveground storage tanks.	6/21/07 5/2/08 EO
CaRFG Phase 3 amendments Approved amendments to mitigate the increases in evaporative emissions from on-road motor vehicles resulting from the addition of ethanol to gasoline.	6/14/07 4/25/08 EO 8/7/08 EO
Formaldehyde from Composite Wood Products Approved an ATCM to limit formaldehyde emissions from hardwood plywood, particleboard, and medium density fiberboard to the maximum amount feasible.	4/26/07 3/5/08 EO
Portable equipment registration program (PERP) and airborne toxic control measure for diesel-fueled portable engines Approved amendments to allow permitting of Tier 0 portable equipment engines used in emergency or low use duty and to extend permitting of certain Tier 1 and 2 "resident" engines to 1/1/10.	3/22/07 7/31/07 EO
Perchloroethylene Control Measure Amendments Approved amendments to the Perchloroethylene ATCM to prohibit new Perc dry cleaning machines beginning 2008 and phase out all Perc machines by 2023.	1/25/07 11/7/07 EO
Amendments to Emission Warranty Information Reporting & Recall Regulations Approved amendments that tighten the provisions for recalling vehicles for emissions-related failures, helping ensure that corrective action is taken to vehicles with defective emission control devices or systems.	12/7/06 3/22/07 10/17/07 EO
Voluntary accelerated vehicle retirement regulations Approved amendments that authorize the use of remote sensing to identify light-duty high emitters and that establish protocols for quantifying emissions reductions from high emitters proposed for retirement.	12/7/06
Emergency regulation for portable equipment registration program (PERP), airborne toxic control measures for portable and stationary diesel-fueled engines	12/7/06
Amendments to the Hexavalent Chromium ATCM Approved amendments that require use of best available control technology on all chrome plating and anodizing facilities.	12/7/06
Requirements for Stationary Diesel In-Use Agricultural Engines Approved amendments to the stationary diesel engine ATCM which set emissions standards for in-use diesel agricultural engines.	11/16/06 7/3/07 NOD
Ships - Onboard Incineration Approved amendments to cruise ship incineration ATCM to include all oceangoing ships of 300 gross registered tons or more.	11/16/06 9/11/07 EO
Zero Emission Bus Approved amendments postponing the 15 percent purchase requirement three years for transit agencies in the diesel path and one to two years for transit agencies in the alternative fuel path, in order to keep pace with developments in zero emission bus technology, and adding an Advanced Demonstration requirement to offset emission losses.	10/19/06 8/27/07 EO
Distributed generation certification Approved amendments improving the emissions durability and testing requirements, adding waste gas emission standards, and eliminating a redundant PM standard in the current 2007 emission standards.	10/19/06 5/17/07 NOD
Heavy-Duty Diesel In-Use Compliance Regulation Approved amendments to the heavy-duty diesel engine regulations and test procedures to create a new in-use compliance program conducted by engine manufacturers. The amendments would help ensure compliance with applicable certification standards throughout an engine’s useful life.	9/28/06 7/19/07 NOD
Revisions to OBD II and the Emission Warranty Regulations Approved amendments to the OBD II regulation to provide for improved emission control monitoring including air-fuel cylinder imbalance monitoring, oxygen sensor monitoring, catalyst monitoring, permanent fault codes for gasoline vehicles and new thresholds for diesel vehicles.	9/28/06 8/9/07 EO

Off-Highway Recreational Vehicle Amendments Approved amendments to the Off-Highway Recreational Vehicle Regulations including harmonizing evaporative emission standards with federal regulations, expanding the definition of ATVs, modifying labeling requirements, and adjusting riding seasons.	7/20/06 6/1/07 EO
Portable Equipment Registration Program (PERP) Amendments Approved amendments to the Statewide Portable Equipment Registration program that include installation of hour meters on equipment, and revisions to recordkeeping, reporting, and fees.	6/22/06 11/13/06 NOD
Heavy Duty Vehicle Service Information Approved amendments to the Service Information Rule to require manufacturers to make available diagnostic equipment and information for sale to the aftermarket.	6/22/06 5/3/07 EO
LEV II technical amendments Approved amendments to evaporative emission test procedures, four-wheel drive dynamometer provisions, and vehicle label requirements.	6/22/06 9/27/06 NOD
Dry Cleaning ATCM Amendments Approved amendments to the Dry Cleaning ATCM to limit siting of new dry cleaners, phase out use of Perc at co-residential facilities, phase out higher emitting Perc sources at other facilities, and require enhanced ventilation at existing and new Perc facilities.	5/25/06
Forklifts and other Large Spark Ignition (LSI) Equipment Adopted a regulation to reduce emissions from forklifts and other off-road spark-ignition equipment by establishing more stringent standards for new equipment, and requiring retrofits or engine replacement on existing equipment. Adopts EPA's standards for 2007; adopts more stringent standards for 2010.	5/25/06 3/2/07 EO
Enhanced Vapor Recovery Amendments Approved amendments to the vapor recovery system regulation and adopted revised test procedures.	5/25/06
Diesel Retrofit Technology Verification Procedure Approved amendments to the Diesel Emission In-use Control Strategy Verification Procedure to substitute a 30% increase limit in NOx concentration for an 80% reduction requirement from PM retrofit devices.	3/23/06 12/21/06 NOD
Heavy duty vehicle smoke inspection program amendments Approved amendments to impose a fine on trucks not displaying a current compliance certification sticker.	1/26/06 12/4/06 EO
Ocean-going Ship Auxiliary Engine Fuel Approved a regulation to require ships to use cleaner marine gas oil or diesel to power auxiliary engines within 24 nautical miles of the California coast.	12/8/05 10/20/06 EO
Diesel Cargo Handling Equipment Approved a regulation to require new and in-use cargo handling equipment at ports and intermodal rail yards to reduce emissions by utilizing best available control technology.	12/8/05 6/2/06 EO
Public and Utility Diesel Truck Fleets Approved a regulation to reduce diesel particulate matter emissions from heavy duty diesel trucks in government and private utility fleets.	12/8/05 10/4/06 EO
Cruise ships – Onboard Incineration Adopted an Air Toxic Control Measure to prohibit cruise ships from conducting onboard incineration within three nautical miles of the California coast.	11/17/05 2/1/06 NOD
Inboard Marine Engine Rule Amendments Approved amendments to the 2001 regulation to include additional compliance options for manufacturers.	11/17/05 9/26/06 EO
Heavy-Duty Diesel Truck Idling Technology Approved a regulation to limit sleeper truck idling to 5 minutes. Allows alternate technologies to provide cab heating/cooling and power.	10/20/05 9/1/06 EO
Automotive Coating Suggested Control Measure Approved an SCM for automotive coatings for adoption by air districts. The measure will reduce the VOC content of 11 categories of surface protective coatings.	10/20/05

2007-09 Model-year heavy duty urban bus engines and the fleet rule for transit agencies Adopted amendments to align urban bus emission limits with on-road heavy duty truck emission limits and allow for the purchase of non- complying buses under the condition that bus turnover increase to offset NOx increases.	10/20/05 10/27/05 7/28/06 EO
Portable fuel containers (part 2 of 2) Approved amendments to revise spout and automatic shutoff design.	9/15/05 7/28/06 EO
Portable Fuel Containers (part 1 of 2) Approved amendments to include kerosene containers in the definition of portable fuel containers.	9/15/05 11/9/05 NOD
2007-09 Model-year heavy duty urban bus engines and the fleet rule for transit agencies Adopted amendments to require all transit agencies in SCAQMD to purchase only alternate fuel versions of new buses.	9/15/05 Superceded by 10/20/05
Reid vapor pressure limit emergency rule Approved amendments to relax Reid vapor pressure limit to accelerate fuel production for Hurricane Katrina victims.	9/8/05 Operative for September and October 2005 only
Heavy-Duty Truck OBD Approved a regulation to require on-board diagnostic (OBD) systems for new gas and diesel trucks, similar to the systems on passenger cars.	7/21/05 12/28/05 EO
Definition of Large Confined Animal Facility Adopted a regulation to define the size of a large CAF for the purposes of air quality permitting and reduction of ROG emissions to the extent feasible.	6/23/05 4/13/06 EO
ATCM for stationary compression ignition engines Approved emergency amendments (3/17/05) and permanent amendments (5/26/05) to relax the diesel PM emission limits on new stationary diesel engines to current off-road engine standards to respond to the lack of availability of engines meeting the original ATCM standard.	3/17/05 5/26/05 7/29/05 EO
Transit Fleet Rule Approved amendments to add emission limits for non-urban bus transit agency vehicles, require lower bus and truck fleet-average NOx and PM emission limits, and clarify emission limits for CO, NMHC, and formaldehyde.	2/24/05 10/19/05 NOD
Thermal Spraying ATCM Approved a regulation to reduce emissions of hexavalent chromium and nickel from thermal spraying operations.	12/9/04 7/20/05 EO
Tier 4 Standards for Small Off-Road Diesel Engines (SORE) Approved new emission standards for off-road diesel engines to be phased in between 2008 and 2015.	12/9/04 10/21/05 EO
Emergency Regulatory Amendment Delaying the January 1, 2005 Implementation Date for the Diesel Fuel Lubricity Standard Adopted an emergency regulation delaying the lubricity standard compliance deadline by five months to respond to fuel pipeline contamination problems.	11/24/04 12/10/04 EO
Enhanced vapor recovery compliance extension Approved amendments to the EVR regulation to extend the compliance date for onboard refueling vapor recovery compatibility to the date of EVR compliance.	11/18/04 2/11/05 EO
CaRFG Phase 3 amendments Approved amendments correcting errors and streamlining requirements for compliance and enforcement of CaRFG Phase 3 regulations adopted in 1999.	11/18/04
Clean diesel fuel for harborcraft and intrastate locomotives Approved a regulation that required harborcraft and locomotives operating solely within California to use clean diesel fuel.	11/18/04 3/16/05 EO
Nonvehicular Source, Consumer Product, and Architectural Coating Fee Regulation Amendment Approved amendments to fee regulations to collect supplemental fees when authorized by the Legislature.	11/18/04
Greenhouse gas limits for motor vehicles Approved a regulation that sets the first ever greenhouse gas emission standards on light and medium duty vehicles starting with the 2009 model year.	9/24/04 8/4/05 EO

Gasoline vapor recovery system equipment defects list Approved the addition of defects to the VRED list for use by compliance inspectors.	8/24/04 6/22/05 EO
Unihose gasoline vapor recovery systems Approved an emergency regulation and an amendment to delay the compliance date for unihose installation to the date of dispenser replacement.	7/22/04 11/24/04 EO
General Idling Limits for Diesel Trucks Approved a regulation that limits idling of heavy-duty diesel trucks operating in California to five minutes, with exceptions for sleeper cabs.	7/22/04
Urban bus engines/fleet rule for transit agencies Approved amendments to allow for the purchase of hybrid diesel buses and revise the zero emission bus demonstration and purchase timelines.	6/24/04
Engine Manufacturer Diagnostics Approved a regulation that would require model year 2007 and later heavy duty truck engines to be equipped with engine diagnostic systems to detect malfunctions of the emission control system.	5/20/04
Chip Reflash Approved a voluntary program and a backstop regulation to reduce heavy duty truck NOx emissions through the installation of new software in the engine's electronic control module.	3/25/04 3/21/05 EO
Portable equipment registration program (PERP) Approved amendments to allow uncertified engines to be registered until December 31, 2005, to increase fees, and to modify administrative requirements.	2/26/04 1/7/05 EO 6/21/05 EO
Portable Diesel Engine ATCM Adopted a regulation to reduce diesel PM emissions from portable engines through a series of emission standards that increase in stringency through 2020.	2/26/04 1/4/05 EO
California motor vehicle service information rule Adopted amendments to allow for the purchase of heavy duty engine emission-related service information and diagnostic tools by independent service facilities and aftermarket parts manufacturers.	1/22/04 5/20/04
Transportation Refrigeration Unit ATCM Adopted a regulation to reduce diesel PM emissions from transport refrigeration units by establishing emission standards and facility reporting requirements to streamline inspections.	12/11/03 2/26/04 11/10/04 EO
Diesel engine verification procedures Approved amendments that reduced warranty coverage to the engine only, delayed the NOx reduction compliance date to 2007, added requirements for proof-of-concept testing for new technology, and harmonized durability requirements with those of U.S. EPA.	12/11/03 2/26/04 10/17/04
Chip Reflash Approved a voluntary program and a backstop regulation to reduce heavy duty truck NOx emissions through the installation of new software in the engine’s electronic control module.	12/11/03 3/27/04 3/21/05 EO
Revised tables of maximum incremental reactivity values Approved the addition of 102 more chemicals with associated maximum incremental reactivity values to existing regulation allowing these chemicals to be used in aerosol coating formulations.	12/3/03
Stationary Diesel Engines ATCM Adopted a regulation to reduce diesel PM emissions from stationary diesel engines through the use of clean fuel, lower emission standards, operational practices.	11/20/03 12/11/03 2/26/2004 9/27/04 EO
Solid waste collection vehicles Adopted a regulation to reduce toxic diesel particulate emissions from solid waste collection vehicles by over 80 percent by 2010. This measure is part of ARB's plan to reduce the risk from a wide range of diesel engines throughout California.	9/25/03 5/17/04 EO
Small off-road engines (SORE) Adopted more stringent emission standards for the engines used in lawn and garden and industrial equipment, such as string trimmers, leaf blowers, walk-behind lawn mowers, generators, and lawn tractors.	9/25/03 7/26/04 EO

Off-highway recreational vehicles Changes to riding season restrictions.	7/24/03
Clean diesel fuel Adopted a regulation to reduce sulfur levels and set a minimum lubricity standard in diesel fuel used in vehicles and off-road equipment in California, beginning in 2006.	7/24/03 5/28/04 EO
Ozone Transport Mitigation Amendments Adopted amendments to require upwind districts to (1) have the same no-net-increase permitting thresholds as downwind districts, and (2) Adopt "all feasible measures."	5/22/03 10/2/03 NOD
Zero emission vehicles Updated California's ZEV requirements to support the fuel cell car development and expand sales of advanced technology partial ZEVs (like gasoline-electric hybrids) in the near-term, while retaining a role for battery electric vehicles.	3/27/03 12/19/03 EO
Heavy duty gasoline truck standards Aligned its existing rules with new, lower federal emission standards for gasoline-powered heavy-duty vehicles starting in 2008.	12/12/02 9/23/03 EO
Low emission vehicles II Minor administrative changes.	12/12/02 9/24/03 EO
Gasoline vapor recovery systems test procedures Approved amendments to add advanced vapor recovery technology certification and testing standards.	12/12/02 7/1/03 EO 10/21/03 EO
CaRFG Phase 3 amendments Approved amendments to allow for small residual levels of MTBE in gasoline while MTBE is being phased out and replaced by ethanol.	12/12/02 3/20/03 EO
School bus Idling Adopted a measure requiring school bus drivers to turn off the bus or vehicle engine upon arriving at a school and restart it no more than 30 seconds before departure in order to limit children's exposure to toxic diesel particulate exhaust.	12/12/02 5/15/03 EO
California Interim Certification Procedures for 2004 and Subsequent Model Year Hybrid-Electric Vehicles in the Urban Transit Bus and Heavy-Duty Vehicle Classes Regulation Amendment Adopted amendments to allow diesel-path transit agencies to purchase alternate fuel buses with higher NOx limits, establish certification procedures for hybrid buses, and require lower fleet-average PM emission limits.	10/24/02 9/2/03 EO
CaRFG Phase 3 amendments Approved amendments delaying removal of MTBE from gasoline by one year to 12/31/03.	7/25/02 11/8/02 EO
Diesel retrofit verification procedures, warranty, and in-use compliance requirements Adopted regulations to specify test procedures, warranty, and in-use compliance of diesel engine PM retrofit control devices.	5/16/02 3/28/03 EO
On-board diagnostics for cars Adopted changes to the On-Board Diagnostic Systems (OBD II) regulation to improve the effectiveness of OBD II systems in detecting motor vehicle emission-related problems.	4/25/02 3/7/03 EO
Voluntary accelerated light duty vehicle retirement regulations Establishes standards for a voluntary accelerated retirement program.	2/21/02 11/18/02 EO
Residential burning Adopted a measure to reduce emissions of toxic air contaminants from outdoor residential waste burning by eliminating the use of burn barrels and the outdoor burning of residential waste materials other than natural vegetation.	2/21/02 12/18/02 EO
California motor vehicle service information rule Adopted regulations to require light- and medium-duty vehicle manufacturers to offer for sale emission-related service information and diagnostic tools to independent service facilities and aftermarket parts manufacturers.	12/13/01 7/31/02 EO
Vapor recovery regulation amendments Adopted amendments to expand the list of specified defects requiring equipment to be removed from service.	11/15/01 9/27/02 EO

Distributed generation guidelines and regulations Adopted regulations requiring the permitting by ARB of distributed generation sources that are exempt from air district permitting and approved guidelines for use by air districts in permitting non-exempt units.	11/15/01 7/23/02 EO
Low emission vehicle regulations (LEV II) Approved amendments to apply PM emission limits to all new gasoline vehicles, extend gasoline PZEV emission limits to all fuel types, and streamline the manufacturer certification process.	11/15/01 8/6/02 EO
Gasoline vapor recovery systems test methods and compliance procedures Adopted amendments to add test methods for new technology components, streamline test methods for liquid removal equipment, and***.	10/25/01 7/9/02 EO
Heavy-duty diesel trucks Adopted amendments to emissions standards to harmonize with EPA regulations for 2007 and subsequent model year new heavy-duty diesel engines.	10/25/01
Inboard and sterndrive marine engines Lower emission standards for 2003 and subsequent model year inboard and sterndrive gasoline-powered engines in recreational marine vessels.	7/26/01 6/6/02 EO
Asbestos from construction, grading, quarrying, and surface mining Adopted an Airborne Toxic Control Measure for construction, grading, quarrying, and surface mining operations requiring dust mitigation for construction and grading operations, road construction and maintenance activities, and quarries and surface mines to minimize emissions of asbestos-laden dust.	7/26/01 6/7/02 EO
Zero emission vehicle infrastructure and standardization of electric vehicle charging equipment Adopted amendments to the ZEV regulation to alter the method of quantifying production volumes at joint-owned facilities and to add specifications for standardized charging equipment.	6/28/01 5/10/02 EO
Pollutant transport designation Adopted amendments to add two transport couples to the list of air basins in which upwind areas are required to adopt permitting thresholds no less stringent than those adopted in downwind areas.	4/26/01
Zero emission vehicle regulation amendments Adopted amendments to reduce the numbers of ZEVs required in future years, add a PZEV category and grant partial ZEV credit, modify the ZEV range credit, allow hybrid-electric vehicles partial ZEV credit, grant ZEV credit to advanced technology vehicles, and grant partial ZEV credit for several other minor new programs.	1/25/01 12/7/01 EO 4/12/02 EO
Heavy duty diesel engines supplemental test procedures Approved amendments to extend "Not-To-Exceed" and EURO III supplemental test procedure requirements through 2007 when federal requirements will include these tests.	12/7/00
Light and medium duty low emission vehicle alignment with federal standards Approved amendments that require light and medium duty vehicles sold in California to meet the more restrictive of state or federal emission standards.	12/7/00 12/27/00 EO
Exhaust emission standards for heavy duty gas engines Adopted amendments that establish 2005 emission limits for heavy duty gas engines that are equivalent to federal limits.	12/7/00 12/27/00 EO
CaRFG Phase 3 amendments Approved amendments to regulate the replacement of MTBE in gasoline with ethanol.	11/16/00 4/25/01 EO
CaRFG Phase 3 test methods Approved amendments to gasoline test procedures to quantify the olefin content and gasoline distillation temperatures.	11/16/00 7/11/01 EO 8/28/01 EO
Diesel risk reduction plan Adopted plan to reduce toxic particulate from diesel engines through retrofits on existing engines, tighter standards for new engines, and cleaner diesel fuel.	9/28/00
Conditional rice straw burning regulations Adopted regulations to limit rice straw burning to fields with demonstrated disease rates reducing production by more than 5 percent.	9/28/00

Asbestos from unpaved roads Tightened an existing Air Toxic Control Measure to prohibit the use of rock containing more than 0.25% asbestos on unsurfaced roads.	7/20/00
Enhanced vapor recovery emergency regulation Adopted a four-year term for equipment certifications.	5/22/01 EO
Enhanced vapor recovery Adopted amendments to require the addition of components to reduce spills and leakage, adapt to onboard vapor recovery systems, and continuously monitor system operation and report equipment leaks immediately.	3/23/00 7/25/01 EO
Agricultural burning smoke management Adopted amendments to add marginal burn day designations, require day-specific burn authorizations by districts, and smoke management plans for larger prescribed burn projects.	3/23/00 1/22/01 EO
Urban transit buses Adopted a public transit bus fleet rule and emissions standards for new urban buses that mandates a lower fleet-average NOx emission limit, PM retrofits, lower sulfur fuel use, and purchase of specified percentages of zero emission buses in future years.	1/27/00 2/24/00 11/22/00 EO 5/29/01 EO
Small Off-Road (diesel) Equipment (SORE) Adopted amendments to conform with new federal requirements for lower and engine power-specific emission limits, and for the averaging, banking, and trading of emissions among SORE manufacturers.	1/28/00
CaRFG Phase 3 MTBE phase out Adopted regulations to enable refiners to produce gasoline without MTBE while preserving the emissions benefits of Phase 2 cleaner burning gasoline.	12/9/99 6/16/00 EO
Portable fuel cans Adopted a regulation requiring that new portable fuel containers, used to refuel lawn and garden equipment, motorcycles, and watercraft, be spill-proof beginning in 2001.	9/23/99 7/6/00 EO
Clean fuels at service stations Adopted amendments rescinding requirements applicable to SCAB in 1994-1995, modifying the formula for triggering requirements, and allowing the Executive Officer to make adjustments to the numbers of service stations required to provide clean fuels.	7/22/99
Gasoline vapor recovery Adopted amendments to certification and test methods.	6/24/99
Reformulated gasoline oxygenate Adopted amendments rescinding the requirement for wintertime oxygenate in gasoline sold in the Lake Tahoe Air Basin and requiring the statewide labeling of pumps dispensing gasoline containing MTBE.	6/24/99
Marine pleasurecraft Adopted regulations to control emissions from spark-ignition marine engines, specifically, outboard marine engines and personal watercraft.	12/11/98 2/17/00 EO 6/14/00 EO
Voluntary accelerated light duty vehicle retirement Adopted regulation setting standards for voluntary accelerated retirement program.	12/10/98 10/22/99 EO
Off-highway recreational vehicles and engines Approved amendments to allow non-complying vehicles to operate in certain seasons and in certain ORV-designated areas.	12/10/98 10/22/99 EO
On-road motorcycles Amended on-road motorcycle regulations, to lower the tailpipe emission standards for ROG and NOx.	12/10/98
Portable equipment registration program (PERP) Approved amendments to exclude non-dredging equipment operating in OCS areas and equipment emitting hazardous pollutants, include NSPS Part OOO rock crushers, require SCR emission limits and onshore emission offsets from dredging equipment operating in OCS areas, set catalyst emission limits for gasoline engines, and relieve certain retrofitted engines from periodic source testing.	12/10/98
Liquid petroleum gas motor fuel specifications Approved amendment rescinding 5% propene limit and extending 10% limit indefinitely.	12/11/98

Reformulated gasoline Approved amendments to rescind the RVP exemption for fuel with 10% ethanol and allow for oxygen contents up to 3.7% if the Predictive Model weighted emissions to not exceed original standards.	12/11/98
Low-emission vehicle program (LEV II) Adopted regulations adding exhaust emission standards for most sport utility vehicles, pick-up trucks and mini-vans, lowering tailpipe standards for cars, further reducing evaporative emission standards, and providing additional means for generating zero-emission vehicle credits.	11/5/98 9/17/99 EO
Off-road engine aftermarket parts Approved implementation of a new program to test and certify aftermarket parts in gasoline and diesel, light-duty through heavy duty, engines used in off-road vehicles and equipment.	11/19/98 10/1/99 EO 7/18/00 EO
Off-road spark ignition engines Adopted new emission standards for small and large spark ignition engines for off-road equipment, a new engine certification program, an in-use compliance testing program, and a three-year phase-in for large LSI.	10/22/98
Gasoline deposit control additives Adopted amendments to decertify pre-RFG additives, tighten the inlet valve deposit limits, add a combustion chamber deposit limit, and modify the test procedures to align with the characteristics of reformulated gasoline formulations.	9/24/98 4/5/99 EO
Stationary source test methods Adopted amendments to stationary source test methods to align better with federal methods.	8/27/98 7/2/99 EO
Locomotive MOA for South Coast Memorandum of agreement (MOA) signed by ARB, U.S. EPA and major railroads to concentrate cleaner locomotives in the South Coast by 2010 and fulfill 1994 ozone SIP commitment.	7/2/98
Gasoline vapor recovery Adopted amendments to certification and test methods to add methods for onboard refueling vapor recovery, airport refuelers, and underground tank interconnections, and make minor changes to existing methods.	5/21/98 8/27/98
Reformulated gasoline Approved amendments to rescind the wintertime oxygenate requirement, allow for sulfur content averaging, and make other minor technical amendments.	8/27/98
Ethylene oxide sterilizers Adopted amendments to the ATCM to streamline source testing requirements, add EtO limits in water effluent from control devices, and make other minor changes.	5/21/98
Chrome platers Adopted amendments to ATCM to harmonize with requirements of federal NESHAP standards for chrome plating and chromic acid anodizing facilities.	5/21/98
On-road heavy-duty vehicles Approved amendments to align on-road heavy duty vehicle engine emission standards with EPA's 2004 standards and align certification, testing, maintenance, and durability requirements with those of U.S. EPA.	4/23/98 2/26/99 EO
Small off-road engines (SORE) Approved amendments to grant a one-year delay in implementation, relaxation of emissions standards for non-handheld engines, emissions durability requirements, averaging/banking/trading, harmonization with the federal diesel engine regulation, and modifications to the production line testing requirements.	3/26/98
Heavy duty vehicle smoke inspection program Adopted amendments to require annual smoke testing, set opacity limits, and exempt new vehicles from testing for the first four years.	12/11/97 3/2/98 EO

Light-duty vehicle off-cycle emissions Adopted standards to control excess emissions from aggressive driving and air conditioner use in light duty vehicles and added two light duty vehicle test methods for certification of new vehicles under these standards.	7/24/97 3/19/98 EO
Enhanced evaporative emissions standards Adopted amendments extending the compliance date for ultra-small volume vehicle manufacturers by one year.	5/22/97
Emission reduction credit program Adopted standards for District establishment of ERC programs including certification, banking, use limitation, and reporting requirements.	5/22/97
Lead as a toxic air contaminant Adopted an amendment to designate inorganic lead as a toxic air contaminant.	4/24/97
Portable engine registration program (PERP) Adopted standards for (1) the permitting of portable engines by ARB and (2) District recognition and enforcement of permits.	3/27/97
Liquefied petroleum gas Adopted amendments to extend the compliance deadline from January 1, 1997, to January 1, 1999, for the 5% propene limit in liquefied petroleum gas used in motor vehicles.	3/27/97
Onboard diagnostics, phase II Adopted amendments to extend the phase-in of enhanced catalyst monitoring, modify misfire detection requirements, add PVC system and thermostat monitoring requirements, and require manufacturers to sell diagnostic tools and service information to repair shops.	12/12/96
Pollutant transport designation Adopted amendments to modify transport couples from the Broader Sacramento area and add couples to the newly formed Mojave Desert and Salton Sea Air Basins.	11/21/96
Diesel fuel certification test methods Approved amendments specifying the test methods used for quantifying the constituents of diesel fuel.	10/24/96 6/4/97 EO
Wintertime requirements for utility engines & off-highway vehicles Optional hydrocarbon and NOx standards for snow throwers and ice augers, raising CO standard for specialty vehicles under 25hp.	9/26/96
Large off-road diesel Statement of Principles National agreement between ARB, U.S. EPA, and engine manufacturers to reduce emissions from heavy-duty off-road diesel equipment four years earlier than expected in the 1994 SIP for ozone.	9/13/96
Regulatory improvement initiative Rescinded two regulations relating to fuel testing in response to Executive Order W-127-95.	5/30/96
Zero emission vehicles Adopted amendments to eliminate zero emission vehicle quotas between 1998 and 2002, and approved MOUs with seven automobile manufacturers to accelerate release of lower emission "49 state" vehicles.	3/28/96 7/24/96 EO
CaRFG variance requirements Approved amendments to add a per gallon fee on non-compliant gasoline covered by a variance and to made administrative changes in variance processing and extension.	1/25/96 2/5/96 EO 4/2/96 EO
Utility and lawn and garden equipment engines Adopted an amendment to relax the CO standard from 300 to 350 ppm for Class I and II utility engines.	1/25/96
National security exemption of military tactical vehicles Such vehicles would not be required to adhere to exhaust emission standards.	12/14/95
CaRFG regulation amendments Approved amendments to allow for downstream addition of oxygenates and expansion of compliance options for gasoline formulation.	12/14/95
Required additives in gasoline (deposit control additives) Terms, definitions, reporting requirements, and test procedures for compliance are to be clarified.	11/16/95

CaRFG test method amendments Approved amendments to designate new test methods for benzene, aromatic hydrocarbon, olefin, and sulfur content of gasoline.	10/26/95
Motor vehicle inspection and maintenance program Handled by BAR.	10/19/95 by BAR
Antiperspirants and deodorants, consumer products, and aerosol coating products Ethanol exemption for all products, modifications to aerosol special requirements, modifications for regulatory language consistency, modifications to VOC definition.	9/28/95
Low emission vehicle (LEV III) standards Reactivity adjustment factors, introduction of medium-duty ULEVs, window labels, and certification requirements and test procedures for LEVs.	9/28/95
Medium- and heavy-duty gasoline trucks Expedited introduction of ultra-low emission medium-duty vehicles and lower NOx emission standards for heavy-duty gasoline trucks to fulfill a 1994 ozone SIP commitment.	9/1/95
Retrofit emission standards: all vehicle classes to be included in the alternate durability test plan, kit manufacturers to be allowed two years to validate deterioration factors under the test plan, update retrofit procedures allowing manufacturers to disable specific OBDs if justified by law.	7/27/95
Gasoline vapor recovery systems Adopts revised certification and test procedures.	6/29/95
Onboard refueling vapor recovery standards 1998 and subsequent MY engine cars, LD trucks, and MD trucks less than 8500 GVWR.	6/29/1995 4/24/96 EO
Heavy duty vehicle exhaust emission standards for NOx Amendments to standards and test procedures for 1985 and subsequent MY HD engines, amendments to emission control labels, amendments to Useful Life definition and HD engines and in-use vehicle recalls.	6/29/95
Aerosol coatings regulation Adopted regulation to meet California Clean Air Act requirements and a 1994 ozone SIP commitment.	3/23/95
Periodic smoke inspection program Delays start of PSIP from 1995 to 1996.	12/8/94
Onboard diagnostics phase II Amendments to clarify regulation language, ensure maximum effectiveness, and address manufacturer concerns regarding implementation.	12/8/94
Alternative control plan (ACP) for consumer products A voluntary, market-based VOC emissions cap upon a grouping of consumer products, flexible by manufacturer that will minimize overall costs of emission reduction methods and programs.	9/22/94
Diesel fuel certification: new specifications for diesel engine certification fuel, amended oxygen specification for CNG certification fuel, and amended commercial motor vehicle liquefied petroleum gas regulations.	9/22/94
Utility and lawn and garden equipment (UGLE) engines Modification to emission test procedures, ECLs, defects warranty, quality-audit testing, and new engine compliance testing.	7/28/94
Evaporative emissions standards and test procedures Adopted evaporative emissions standards for medium-duty vehicles.	2/10/94
Off-road recreational vehicles Adopted emission control regulations for off-road motorcycles, all-terrain vehicles, go-karts, golf carts, and specialty vehicles.	1/1/94
Perchloroethylene from dry cleaners Adopted measure to control perchloroethylene emissions from dry cleaning operations.	10/1/93

Wintertime oxygenate program Amendments to the control time period for San Luis Obispo County, exemption for small retailers bordering Nevada, flexibility in gasoline delivery time, calibration of ethanol blending equipment, gasoline oxygen content test method.	9/9/93
Onboard diagnostic phase II	7/9/93
Urban transit buses Amended regulation to tighten state NOx and particulate matter (PM) standards for urban transit buses beyond federal standards beginning in 1996.	6/10/93
1-year implementation delay in emission standards for utility engines	4/8/93
Non-ferrous metal melting Adopted Air Toxic Control Measure for emissions of cadmium, arsenic, and nickel from non-ferrous metal melting operations.	1/1/93
Certifications requirements for low emission passenger cars, light-duty trucks & medium duty vehicles	1/14/93
Airborne toxic control measure for emissions of toxic metals from non-ferrous metal melting	12/10/92
Periodic self-inspection program Implemented state law establishing a periodic smoke self-inspection program for fleets operating heavy-duty diesel-powered vehicles.	12/10/92
Notice of general public interest for consumer products	11/30/92
Substitute fuel or clean fuel incorporated test procedures	11/12/92
New vehicle testing using CaRFG Phase 2 gasoline Approved amendments to require the use of CaRFG Phase 2 gasoline in the certification of exhaust emissions in new vehicle testing.	8/13/92
Standards and test procedures for alternative fuel retrofit systems	5/14/92
Alternative motor vehicle fuel certification fuel specification	3/12/92
Heavy-duty off-road diesel engines Adopted the first exhaust emission standards and test procedures for heavy-duty off-road diesel engines beginning in 1996.	1/9/92
Wintertime oxygen content of gasoline Adopted regulation requiring the addition of oxygenates to gasoline during winter to satisfy federal Clean Air Act mandates for CO nonattainment areas.	12/1/91
CaRFG Phase 2 Adopted CaRFG phase 2 specifications including lowering vapor pressure, reducing the sulfur, olefin, aromatic, and benzene content, and requiring the year-round addition of oxygenates to achieve reductions in ROG, NOx, CO, oxides of sulfur (SOx) and toxics.	11/1/91
Low emissions vehicles amendments revising reactivity adjust factor (RAF) provisions and adopting a RAF for M85 transitional low emission vehicles	11/14/91
Onboard diagnostic, phase II	11/12/91
Onboard diagnostics for light-duty trucks and light & medium-duty motor vehicles	9/12/91
Utility and lawn & garden equipment Adopted first off-road mobile source controls under the California Clean Air Act regulating utility, lawn and garden equipment.	12/1/90
Control for abrasive blasting	11/8/90
Roadside smoke inspections of heavy-duty vehicles Adopted regulations implementing state law requiring a roadside smoke inspection program for heavy-duty vehicles.	11/8/90
CaRFG Phase I Adopted CaRFG Phase I reformulated gasoline regulations to phase-out leaded gasoline, reduce vapor pressure, and require deposit control additives.	9/1/90

Low-emission vehicle (LEV) and clean fuels Adopted the landmark LEV/clean fuel regulations which called for the gradual introduction of cleaner cars in California. The regulations also provided a mechanism to ensure the availability of alternative fuels when a certain number of alternative fuel vehicles are sold.	9/1/90
Evaporative emissions from vehicles Modified test procedure to include high temperatures (up to 105 F) and ensure that evaporative emission control systems function properly on hot days.	8/9/90
Dioxins from medical waste incinerators Adopted Airborne Toxic Control Measure to reduce dioxin emissions from medical waste incinerators.	7/1/90
CA Clean Air Act guidance for permitting Approved California Clean Air Act permitting program guidance for new and modified stationary sources in nonattainment areas.	7/1/90
Medium duty vehicle emission standards Adopted three new categories of low emission MDVs, required minimum percentages of production, and established production credit and trading.	6/14/90
Medium-duty vehicles Amended test procedures for medium-duty vehicles to require whole-vehicle testing instead of engine testing. This modification allowed enforcement of medium-duty vehicle standards through testing and recall.	6/14/90
Ethylene oxide sterilizers Adopted Airborne Toxic Control Measure to reduce ethylene oxide emissions from sterilizers and aerators.	5/10/90
Asbestos in serpentine rock Adopted Airborne Toxic Control Measure for asbestos-containing serpentine rock in surfacing applications.	4/1/90
Certification procedure for aftermarket parts	2/8/90
Residential woodstoves Approved suggested control measure for the control of emissions from residential wood combustion.	11/1/89
On-Board Diagnostic Systems II Adopted regulations to implement the second phase of on-board diagnostic requirements which alert drivers of cars, light-trucks and medium-duty vehicles when the emission control system is not functioning properly.	9/1/89
Cars and light-duty trucks Adopted regulations to reduce ROG and CO emissions from cars and light trucks by 35 percent.	6/1/89
Reformulated Diesel Fuel Adopted regulations requiring the use of clean diesel fuel with lower sulfur and aromatic hydrocarbons beginning in 1993.	11/1/88
Vehicle Recall Adopted regulations implementing a recall program which requires auto manufacturers to recall and fix vehicles with inadequate emission control systems (Vehicles are identified through in-use testing conducted by the ARB).	9/1/88
Suggested control measure for oil sumps Approved a suggested control measure to reduce emissions from sumps used in oil production operations.	8/1/88
Suggested control measure for boilers Approved suggested control measure to reduce NOx emissions from industrial, institutional, and commercial boilers, steam generators and process heaters.	9/1/87
Benzene from service stations Adopted Airborne Toxic Control Measure to reduce benzene emissions from retail gasoline service stations (Also known as Phase II vapor recovery).	7/1/87
Agricultural burning guidelines Amended existing guidelines to add provisions addressing wildland vegetation management.	11/1/86

Heavy-duty vehicle certification Amended certification of heavy-duty diesel and gasoline-powered engines and vehicles to align with federal standards.	4/1/86
Cars and light-duty trucks Adopted regulations reducing NOx emissions from passenger cars and light-duty trucks by 40 percent.	4/1/86
Sulfur in diesel fuel Removed exemption for small volume diesel fuel refiners.	6/1/85
On-Board Diagnostics I Adopted regulations requiring the use of on-board diagnostic systems on gasoline-powered vehicles to alert the driver when the emission control system is not functioning properly.	4/1/85
Suggested control measure for wood coatings Approved a suggested control measure to reduce emissions from wood furniture and cabinet coating operations.	3/1/85
Suggested control measure for resin manufacturing Approved a suggested control measure to reduce ROG emissions from resin manufacturing.	1/1/85

D.7 TRANSPORTATION CONFORMITY

[*This section provided by the California Air Resources Board*]

Section 176(c) of the Federal Clean Air Act (CAA) establishes transportation conformity requirements which are intended to ensure that transportation activities do not interfere with air quality progress. The CAA requires that transportation Plans, programs, and projects that obtain Federal funds or approvals *conform to* applicable state implementation Plans (SIP) before being approved by a Metropolitan Planning Organization (MPO). Conformity to a SIP means that proposed 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.

A SIP analyzes the region's total emissions inventory from all sources for purposes of demonstrating rate of progress (RFP), attainment, or maintenance. The portion of the total emissions inventory from on-road highway and transit vehicles in these analyses becomes the "motor vehicle emissions budget."[96] Motor vehicle emissions budgets are the mechanism for ensuring that transportation planning activities conform to the SIP. Budgets are set for each criteria pollutant or its precursors, for all RFP milestone years and attainment years. Subsequent transportation Plans and programs produced by transportation planning agencies are required to conform to the SIP by demonstrating

[96] 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.

that the emissions from the proposed Plan, program, or project do not exceed the budget levels established in the applicable SIP.

D.7.1 PM2.5 REQUIREMENTS FOR CONFORMITY

The United States Environmental Protection Agency (U.S. EPA) has promulgated separate rule makings addressing the PM2.5 emission categories and precursors that must be considered in PM2.5 transportation conformity determinations.

D.7.1.1 PM2.5 Motor Vehicle Emission Category Requirements

Guidance on the motor vehicle emission categories that must be considered in transportation conformity determinations is found in the July 1, 2004, Final Rule amending the Transportation Conformity Rule to implement criteria and procedures for the 8-hour ozone and PM2.5 standards (69 FR 40004):

> [A]ll regional emissions analyses in PM2.5 nonattainment and maintenance areas [must] consider directly emitted PM2.5 motor vehicle emissions from the tailpipe, brake wear, and tire wear…Sections IX. and X. [of the Final Rule] provide information on when re-entrained road dust and construction-related dust must also be included in PM2.5 conformity analyses…[T]he analysis for direct PM2.5 must include:
>
> - Tailpipe exhaust particles,
> - Brake and tire wear particles,
> - Re-entrained road dust, if before a SIP is submitted EPA or the state air agency has made a finding of significance or if the applicable or submitted SIP includes re-entrained road dust in the approved or adequate budget, and
> - Fugitive dust from transportation-related construction activities, if the SIP has identified construction emissions as a significant contributor to the PM2.5 problem. (69 FR 40331-40333)[97]

D.7.1.2 PM2.5 Motor Vehicle Emission Precursor Requirements

Following the July 1, 2004, Final Rule identifying the motor vehicle emission categories that must be considered in transportation conformity determinations, U.S. EPA issued the May 6, 2005, Final Rule (70 FR 24280) amending the Transportation Conformity Regulation to indicate the PM2.5 precursors that must be considered in regional transportation conformity determinations. In this Final Rule, U.S. EPA "identifies four transportation-related PM2.5 precursors—nitrogen oxides (NO_X), volatile organic compounds (VOCs), sulfur oxides (SO_X)[98], and ammonia (NH_3)—for consideration in the conformity process in PM2.5 nonattainment and maintenance areas." (70 FR 24282)[99] Of these PM2.5 precursors, the Final Rule indicates NO_X is required to be included in the regional transportation conformity determination unless it is found to be an insignificant contributor to the regional PM2.5 air quality problem per Section

[97] Codified in Sections 93.102(b)(1) and (3) and Section 93.122(f) of the Conformity Regulation.

[98] U.S. EPA revised the transportation conformity rule to revise PM2.5 precursors from SO_X to SO_2 for consistency with the broader PM2.5 implementation strategy. (73 FR 4435)

[99] Codified in Sections 93.102(b)(2)(iv) and (v) of the Conformity Regulation.

93.102(f) of the Conformity Regulation. (70 FR 24282)[100] Conversely, VOCs, SO_2, and NH_3 are not required unless any of these precursors are found to be significant contributors to the regional PM2.5 air quality problem. If it is determined through the SIP process that the on-road contribution of a precursor is a significant contributor the regional air quality problem, then an emissions budget must be prepared for that precursor in the SIP and MPOs are required to provide a conformity determination for each precursor for which there is an adequate or approved budget in the SIP. (70 FR 24287)

D.7.1.3 Factors for Determining Significance

As previously indicated, Sections 93.102(b)(2)(iv) and (v) of the Conformity Regulation require motor vehicle emissions budgets for PM2.5 precursors if they are deemed significant contributors to the regional air quality problem, while Section 93.102(b)(3) of the Conformity Regulation identifies re-entrained road dust from paved and unpaved roads as a PM2.5 emission category that must also have a motor vehicle emissions budget if deemed significant. Finally, Section 93.122(f) of the Conformity Regulation requires an emissions budget for fugitive dust PM2.5 emissions from highway and transit construction if they are deemed significant.

Within the context of transportation conformity, Section 93.109(f) of the Transportation Conformity Rule indicates that U.S. EPA considers a number of factors when making a finding that a SIP demonstrates that its motor vehicle pollutant or precursor emissions are insignificant contributors to regional air quality problems for a given air quality standard.[101] These factors used by U.S. EPA to make the finding of significance include “the percentage of motor vehicle emissions in the context of the total SIP inventory, the current state of air quality as determined by monitoring data for that NAAQS, the absence of SIP motor vehicle control measures, and historical trends and future projections of the growth of motor vehicle emissions.” (Section 93.109(f))

It should be noted that while PM2.5 precursors must be included if they are found to be significant contributors to the regional PM2.5 air quality problem, SO_2 is deemed insignificant in all areas and conformity determinations are not required for this precursor. (70 FR 24283)

Based on guidance from the July 1, 2004, Final Rule, the significance finding for re-entrained road dust emissions will be based on a review of the following factors: “the contribution of road dust to current and future PM2.5 nonattainment, an area’s current design value for the PM2.5 standard, whether control of road dust appears necessary to reach attainment, and whether increases in re-entrained dust emissions may interfere with attainment.” (69 FR 40033) Such a review would include consideration of local air quality data, air quality modeling results, or emissions modeling results.

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[100] Codified in § 93.119(f)(9) and (10) of the Conformity Regulation.

[101] Pollutants and/or precursors from <u>all sources</u> may be found to be a significant contributor to the regional $PM_{2.5}$ air quality problem; however, the contribution of the motor vehicle emissions to these pollutants and/or precursors may be found insignificant based on the criteria indicated in Section 93.109(f) of the Transportation Conformity Regulation. Consequently, the pollutants and/or precursors found to be insignificant per Section 93.109(f) would not require regional transportation conformity determinations.

D.7.2 ASSESSMENT OF SIGNIFICANCE

This Plan establishes motor vehicle emission budgets for primary emissions of PM2.5 from vehicle exhaust, tire and brake wear, and the precursor NOx. As discussed above, VOCs, SO_2, and ammonia are not required to be included in the regional transportation conformity determination unless found to be significant contributors to the regional PM2.5 air quality problem. Based on the criteria from Section 93.109(f), VOCs, SO_2, and ammonia are not found to be significant for the reasons discussed in the sections below, and therefore this Plan does not establish motor vehicle emissions budgets for conformity purposes for these precursors. Please see Appendix B, Emissions Inventory, for a detailed description of the Valley's emissions inventory that was used to estimate the percentage of the Valley's total emissions inventory that are comprised from on-road mobile emissions.

VOC: On-road mobile emissions account for approximately ten percent of the Valley's total VOC emissions in the budget years. Air quality modeling for this Plan indicates that control of VOC is generally ineffective in the control of PM2.5 and in some cases may actually result in increases in PM2.5 levels. (See Appendix G) Therefore, on-road VOC emissions are considered insignificant and this Plan does not establish VOC motor vehicle emissions budgets for conformity purposes.

SO_2: SO_2 is deemed insignificant in all areas and conformity determinations are not required for this precursor. (70 FR 24283) In addition, on-road mobile exhaust estimates are less than one ton per day Valley-wide in the budget years which equates to less than ten percent of the total SO_2 emissions inventory. SO_2 controls are focused on industrial sources, which contribute almost 80 percent of the total inventory. Therefore, on-road SO_2 emissions are considered insignificant and this Plan does not establish SO_2 motor vehicle emissions budgets for conformity purposes.

Ammonia: The contribution of ammonia from on-road motor vehicles is approximately one percent of the total Valley-wide ammonia inventory. Consequently, ammonia emissions are not included in the motor vehicle emissions budgets for conformity purposes. Past research has demonstrated that ammonia is abundant throughout the Valley and does not act as a limiting precursor in the formation of PM2.5. Through performing sensitivity-based analysis and considering relevant contextualizing information such as emissions trends, studies, and available controls, the California Air Resources Board has determined that emissions of ammonia do not contribute significantly to PM2.5 levels that exceed the 1997, 2006, or 2012 NAAQS in the area. (See Appendix G for further discussion.)

Paved Road Dust: Paved road dust PM2.5 emissions account for less than ten percent of the Valley's total direct PM2.5 emissions inventory in the budget years. While there are no additional paved road dust controls included in the attainment demonstration for this Plan, paved road dust is controlled through the PM10 Plan and evaluated as part of PM10 conformity determinations. Analysis of average composition data from ambient air monitoring stations shows paved road dust contributes about two percent to the design values in the Valley. Therefore, paved road dust emissions are considered insignificant and this Plan does not establish paved road dust motor vehicle emissions budgets for conformity purposes.

Unpaved Road Dust: Total unpaved road dust is less than seven percent of the Valley's total direct PM2.5 emissions inventory in the budget years. Local roads are one of seven subcategories of unpaved road dust, and, as noted above, on-road dust makes a small contribution to design values in the Valley. While there are no additional unpaved road dust controls included in the Plan, unpaved road dust is controlled via the PM10 Plan (including the prohibition of any new local unpaved roads), and unpaved road dust is evaluated as part of PM10 conformity determinations. Analysis of average composition data from ambient air monitoring stations shows unpaved road dust contributes less than two percent to the design values in the Valley. Therefore, unpaved road dust is considered insignificant and this Plan does not establish emissions budgets for unpaved road dust for conformity purposes.

Construction Dust: Total construction and demolition dust is less than five percent of the Valley's total direct PM2.5 emissions inventory in the budget years. Because road construction is one of five subcategories of construction dust, its contribution to the total direct PM2.5 inventory would be even less than the total construction and demolition category. While there are no additional construction dust controls included in the Plan, road construction dust is controlled extensively via the PM10 Plan and is evaluated as part of PM10 conformity determinations. Therefore, road construction dust is considered insignificant and this Plan does not establish emissions budgets for road construction dust for conformity purposes.

D.7.3 CONFORMITY BUDGETS

Conformity budgets must be set for the attainment year for each PM2.5 NAAQS as well as each year for which reasonable further progress (RFP) is demonstrated. The attainment years are as follows:

- 1997 24-hour and annual standard: 2020
- 2006 24-hour standard: 2024
- 2012 annual standard: 2025

The RFP years for the various PM2.5 standards are as follows:

- 1997 24-hour and annual standard: 2017, 2020, and 2023
- 2006 24-hour standard: 2017, 2020, 2023, and 2026
- 2012 annual standard: 2019, 2022, 2025, and 2028

Note that the attainment year is also an RFP year for the 1997 and 2012 standards, while these years do not coincide for the 2006 standard.

Average daily emissions are used in the Plan consistent with how the standard is measured. Consequently, conformity budgets were calculated in EMFAC2014 using annual average daily emissions for the 1997 and 2012 standards, while winter average daily emissions were used to calculate conformity budgets for the 2006 standard, for the analysis years listed above.

Section 93.124(e) of the Federal Conformity Regulation states that nonattainment areas with more than one MPO may establish motor vehicle emission budgets for each MPO in the non-attainment area. This Plan establishes county-level emission budgets for each of the eight MPOs[102] in the Valley.

The transportation conformity budgets developed for this Plan include recent travel activity projections provided by the Valley MPOs. This travel activity is consistent with the Final 2017 Federal Transportation Improvement Plan (2017 FTIP) for each of the eight Valley MPOs. Using this recent activity results in on-road emissions approximately one percent lower than the 2020, 2024, and 2025 attainment demonstration inventories for the 1997, 2006, and 2012 standards, respectively.

The budgets have been constructed to be consistent with the on-road emissions inventory using the following method:

1) Sum the emissions results for each county.
2) Calculate the budget by rounding each county's values to the nearest tenth ton (for both NOx and PM2.5) using conventional rounding.

This Plan establishes sub-area county emission budgets for PM2.5 and NOx for the horizon years listed above as summarized in Tables 8-1, 8-2, and 8-3 below.

Table D-18 San Joaquin Valley 1997 24-Hour and Annual PM2.5 Motor Vehicle Emissions Budgets* (Annual average tons per day)

County	2017		2020		2023	
	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx
Fresno	0.9	28.5	0.9	25.3	0.8	15.1
Kern (SJV)	0.8	28.0	0.8	23.3	0.7	13.3
Kings	0.2	5.8	0.2	4.8	0.2	2.8
Madera	0.2	5.3	0.2	4.2	0.2	2.5
Merced	0.3	10.7	0.3	8.9	0.3	5.3
San Joaquin	0.7	14.9	0.6	11.9	0.6	7.6
Stanislaus	0.4	11.9	0.4	9.6	0.4	6.1
Tulare	0.4	10.8	0.4	8.5	0.4	5.2

* Budgets based on the most recently amended 2017 FSTIP for each MPO as of January 2018. Budgets are rounded up to the nearest tenth of a ton.

[102] The boundary of the Kern Council of Governments encompasses all of Kern County, while the portion of Kern County located within the PM2.5 non-attainment area only includes the portion located within the San Joaquin Valley Air Basin (SJVAB)/San Joaquin Valley Air Pollution Control District (SJVAPCD). Consequently, the motor vehicle emissions budgets for Kern County only include the non-attainment area located within the SJVAB/SJVAPCD.

Table D-19 San Joaquin Valley 2006 24-Hour PM2.5 Motor Vehicle Emissions Budgets* (Winter average tons per day)

County	2017		2020		2023		2024		2026	
	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx
Fresno	0.9	29.3	0.9	25.9	0.8	15.5	0.8	15.0	0.8	14.3
Kern (SJV)	0.8	28.7	0.8	23.8	0.7	13.6	0.7	13.4	0.8	12.8
Kings	0.2	5.9	0.2	4.9	0.2	2.9	0.2	2.8	0.2	2.7
Madera	0.2	5.5	0.2	4.4	0.2	2.6	0.2	2.5	0.2	2.3
Merced	0.3	11.0	0.3	9.1	0.3	5.5	0.3	5.3	0.3	4.9
San Joaquin	0.7	15.5	0.6	12.3	0.6	7.9	0.6	7.6	0.6	6.9
Stanislaus	0.4	12.3	0.4	9.8	0.4	6.2	0.4	6.0	0.4	5.6
Tulare	0.4	11.2	0.4	8.7	0.4	5.3	0.4	5.1	0.4	4.6
* Budgets based on the most recently amended 2017 FSTIP for each MPO as of January 2018. Budgets are rounded up to the nearest tenth of a ton.										

Table D-20 San Joaquin Valley 2012 Annual PM2.5 Motor Vehicle Emissions Budgets* (Annual average tons per day)

County	2019		2022		2025		2028	
	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx	PM2.5	NOx
Fresno	0.9	27.6	0.9	21.2	0.8	14.3	0.9	13.5
Kern (SJV)	0.8	25.1	0.8	19.4	0.8	12.8	0.8	11.9
Kings	0.2	5.1	0.2	4.1	0.2	2.7	0.2	2.5
Madera	0.2	4.6	0.2	3.5	0.2	2.3	0.2	2.0
Merced	0.3	9.4	0.3	7.6	0.3	5.0	0.3	4.5
San Joaquin	0.6	12.7	0.6	10.0	0.6	6.9	0.6	6.3
Stanislaus	0.4	10.5	0.4	8.1	0.4	5.6	0.4	5.2
Tulare	0.4	9.3	0.4	6.9	0.4	4.7	0.4	4.2
* Budgets based on the most recently amended 2017 FSTIP for each MPO as of January 2018. Budgets are rounded up to the nearest tenth of a ton.								

D.7.4 EMISSIONS TRADING MECHANISM

Section 93.124(b) of the Federal Conformity Regulation allows for the SIP to establish emissions trading mechanisms between budgets for pollutants or precursors, or among budgets allocated to mobile and other sources. The 2008 PM2.5 Plan (as revised in 2011) included an emissions trading mechanism, approved by U.S. EPA effective January 9, 2012, to be used for analysis years after 2014.

Air quality modeling to support the SIP was used to determine the ratios for trading from the motor vehicle emissions budget for the PM2.5 precursor NOx to the motor vehicle emissions budget for primary PM2.5 in the San Joaquin Valley (SJV). To determine the NOx:PM2.5 trading ratios on both an annual and a 24-hour wintertime basis, two modeling sensitivity simulations were performed, reducing 30 percent of NO_x and PM2.5 emissions from on-road transportation in the SJV. The baseline model simulation was the 2024 attainment run, and only sources included in the transportation conformity process (i.e. on-road vehicles, paved road dust, unpaved road dust, and road construction dust) were scaled in the analysis.

Based on the 30 percent emission reduction sensitivity runs, reductions in both annual and 24-hour PM2.5 design values (DVs) were calculated. Results for two sites in Bakersfield and two sites in Fresno are shown below since those two regions generally control the annual and 24-hour DVs in the SJV. Tables 8-4 and 8-5 show the change in DV per ton of emissions reduction at the four selected sites. For annual PM2.5 standards, annual emission totals are used, and for the 24-hour PM2.5 standards, wintertime emission totals are used. Dividing the change in DV per ton of PM2.5 emissions reduction by the change in DV per ton of NO_x emissions reduction yields the NOx:PM2.5 trading ratios, summarized in Table 8-6, which are the number of tons of NOx that achieve the same DV impact as one ton of direct PM2.5.

Table D-21 Change in Annual DV per ton of PM2.5 or NOx Emissions Reduction from Transportation Related Sources in the SJV (µg/m3/ton emissions)

Site	2024 annual DVs	ΔDV/ton of PM2.5 reduction	ΔDV/ton of NO_x reduction
Bakersfield-California Avenue	10.9	0.105	0.015
Bakersfield – Planz	11.9	0.118	0.017
Fresno – Garland	10.4	0.068	0.012
Fresno – Hamilton & Winery	10.0	0.068	0.012

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Appendix E
Incentive-Based Strategy

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E. APPENDIX E: INCENTIVE-BASED STRATEGY

The San Joaquin Valley Air Pollution Control District (District) has increasingly relied on its advocacy efforts to secure state and federal funding sources, and locally-generated funding to implement incentive programs that have become a crucial component of the District's overall strategy for achieving the emissions reductions necessary to bring the Valley into attainment. These programs provide an effective way to accelerate emissions reductions and encourage technology advancement, particularly from mobile sources, a sector not directly under the District's regulatory jurisdiction. Given that over 80% of the NOx emissions in the Valley come from mobile sources, these successful voluntary incentive grant programs help the Valley achieve highly cost-effective emissions reductions that are surplus of the regulatory emissions reductions.

This Appendix will first review the District's existing longstanding and successful incentive programs then will move into future potential incentive-based strategies under evaluation for this *2018 PM2.5 Plan.*

Since inception, the District has provided incentive funding to purchase, replace, or retrofit thousands of pieces of equipment, including the following:

- 7,000 agricultural irrigation pump engines
- 4,400 agricultural equipment replacements
- 1,200 off-road equipment repowers
- 6,500 heavy-duty trucks
- 2,300 school bus retrofits
- 590 school bus replacements
- 4,800 lawnmower replacements
- 14,500 fireplace change-outs
- 198,000 commuter subsidies
- 54 locomotive replacements
- 8,400 new alternative-fuel, light-duty vehicles
- 27 bicycle infrastructure projects (bike paths)
- 25,658 light-duty vehicle repairs
- 1,233 high-emitting vehicle replacements
- 26 natural gas fueling infrastructure
- 261 electric vehicle charging infrastructure

The District's incentive programs continue to be a model for other agencies throughout the state. Recent audits noted the District's efficient and effective use of incentive grant funds in reducing air pollution.

E.1 District's Incentive Program

The District operates one of the largest and most well-respected voluntary incentive programs. Through strong advocacy at the state and federal levels, the District has increased its funding levels over the past decade and has appropriated $350 million in incentive funding in the 2018-2019 District Budget. Since the District's inception in 1992, considerable funding has been invested into thousands of clean-air projects throughout the Valley. These projects have achieved significant emissions reductions with corresponding air quality and health benefits.

The District typically requires match funding of 30% to 70% from grant recipients. To date, grant recipients have provided $1 billion in matching funds, with a combined District and grant recipient funding investment of more than $2 billion.

Table E-1 Summary of Grant Expenditures and Results

District Incentive Funding ($)	Grant Recipient Match Funding ($)	Emissions Reductions (tons)	Cost-Effectiveness ($/ton)
$1,040,000,000	$1,070,000,000	151,000	$6,877

E.1.1 SIP Creditability for Incentive-Based Emissions Reductions

When provided SIP credit, incentive-based emissions reductions can be used alongside regulatory-based emissions reductions to meet federal Clean Air Act (CAA) requirements, such as demonstrating attainment with federal air quality standards at a future date. Given the substantial investment from the public and private sectors in replacing equipment under these voluntary incentives, establishing a general framework to receive SIP credit for these emissions reductions was critical. Recognizing the importance of this issue, the U.S. Environmental Protection Agency (EPA), California Air Resources Board (CARB), and the United States Department of Agriculture – Natural Resources Conservation Service (USDA-NRCS) worked together with the District to create a Statement of Principles (MOU). Signed in December 2010, this MOU established a general framework for ensuring that reductions in air emissions resulting from voluntary incentives to replace off-road agricultural equipment received credit in the SIP. The MOU states that the District, USDA-NRCS, CARB and EPA would work collaboratively to develop a mechanism to provide SIP credit for emissions from incentive programs that are surplus, quantifiable, enforceable, and permanent. Continuing these efforts, in July 2012, EPA and USDA agreed to implement this concept to ensure that emissions reductions from incentive programs were given proper credit in the SIP context.

As a result of these collaborative efforts, the District adopted Rule 9610 (State Implementation Plan Credit for Emission Reductions Generated Through Incentive Programs) on June 20, 2013. District Rule 9610 establishes the administrative mechanism through which SIP credit may be quantified for emissions reduced in the Valley through incentives. EPA approved District Rule 9610 on April 9, 2015.

As with prohibitory rules, EPA guidance requires that emissions reductions achieved through voluntary incentive programs be surplus, quantifiable, permanent, and enforceable in order for those reductions to receive SIP credit. Additionally, EPA guidance requires extensive documentation of emissions reductions proposed for SIP credit with ongoing follow-up and tracking of the emissions reductions.

District incentive programs are generally designed to meet SIP-creditability criteria. In order to be surplus, emissions reductions from voluntary incentive programs must provide emission reductions ahead or beyond any local, state, or federal regulations. Quantifiable emissions reductions are calculated using publically developed methodologies. To ensure enforceable and permanent emissions reductions, programs require mechanisms such as legally binding agreements with program participants and physical inspections to verify the completion of projects.

E.1.2 INCENTIVE STRATEGY

The District derives its incentive funding from a variety of local, state, and federal sources. Traditional sources have included motor vehicle fees, Indirect Source Review, and other local sources. State sources have included the Carl Moyer Program, Proposition 1B Goods Movement Emission Reduction Program, Lower Emission School Bus, and, more recently, AB 134 and FARMER funding. Federal sources have included Diesel Emission Reduction Act (DERA) and Targeted Airshed funding.

Each of the funding sources administered by the District includes different guidelines and statutory requirements for using the funds. Beyond the specific guidelines of each funding source, the District considers the following common factors when deciding how and where to spend incentive funds:

E.1.2.1 Cost Effectiveness

An important factor when considering where to invest District funds is determining which types of projects and programs will give the District the greatest return on its investment. This is typically represented in dollars per ton of emissions reduced. While cost-effectiveness is a primary factor, the District also considers projects that may not have the highest cost-effectiveness, but that provide other benefits, such as the advancement of new technology or community involvement.

E.1.2.2 Inventory of Available Projects

This factor is critical in all District incentive programs. To date, the District has been extremely successful in designing incentive programs that have broad appeal and applicability across multiple industries. Over the past 10 years, this level of interest has resulted in a substantial backlog of eligible projects waiting for funding. Unfortunately, in most cases, many of those on waiting lists have since moved into a regulated class, making them ineligible for funding. As a result, the District must continue to not only work within the existing regulations to find cost-effective, surplus project categories, but also to focus future funding in areas where a significant inventory of eligible projects still exists.

E.1.2.3 Required Expenditure Timeframes

Each funding source that the District administers generally requires obligation and expenditure by certain deadlines. These deadlines greatly impact funding priorities and choice of projects. The District may prioritize a funding category over others because of the timeframe associated with a particular funding source. For instance, priority may be given to certain projects that can reasonably be expected to finish prior to the deadline for that specific fund over other projects of equal relevance or cost-effectiveness, but with longer expected completion times. Again, the flexibility of this option works in concert with the dynamic nature of the incentive programs, projects, expenditure deadlines.

E.1.2.4 Upcoming Regulatory Deadlines

To ensure that incentive programs obtain the maximum SIP-creditable emissions reductions, the District performs a thorough analysis of all local, state, and federal regulations relating to the target categories. In addition, the District works proactively with the regulating agencies during the rule development process to understand the potential impacts of that rule on incentive projects and to ensure that opportunities for early incentive funding are maximized. These analyses determine which types of projects can be funded, for how long projects can be funded, which also impacts the potential cost-effectiveness of certain projects.

E.1.2.5 Health Benefits

In addition to emissions reductions needed to attain air quality standards, the District also seeks incentive projects that provide direct health benefits to Valley residents. For instance, the District’s Lower-Emission School Bus Program focuses primarily on the localized toxic risk involved in children’s exposure to diesel particulates. While not the largest source of regional particulate pollution, replacing or retrofitting aging school buses has an enormous impact on the toxic risk of school transportation.

E.1.2.6 Environmental Justice

The District places a strong emphasis in providing funding in a manner that benefits environmental justice communities. The District has worked cooperatively with the Environmental Justice Advisory Group to understand the Valley’s environmental justice issues and to craft programs that reduce emissions in these areas.

E.1.2.7 Community Involvement and Benefits

The District develops and administers programs with an emphasis on community involvement. Some examples of these are the Clean-Green-Yard-Machine program, Drive Clean! Rebate program, Burn Cleaner program, Transit Pass Subsidy program, and the Polluting-Automobile Scrap and Salvage program.

E.1.3 STATUTORY CONSTRAINTS ON INCENTIVE FUNDING

As previously mentioned, the District derives its current incentive funding comes from a range of local, state, and federal funding sources. These funding sources contain restrictions on the types of projects that may be funded, funding limitations, expenditure deadlines, and the administrative approach for funding distribution. These requirements vary significantly from one funding source to another, resulting in a complex matrix of funding categories and program requirements.

E.2 EMISSION REDUCTIONS AND INCENTIVE FUNDING

The District's 2018 PM2.5 Plan relies on a combination of mobile and stationary source incentives programs for attainment. As an integral part of this, CARB has committed to funding mobile source incentive based measures. Table E-3 indicates CARBs aggregate commitment for NOx and PM2.5 emission reductions along with their estimations by project type of emission reductions to meet that aggregate commitment.

Table E-2 CARB Incentive Based Emission Reduction Commitments

Proposed CARB Incentive Measure	2024 Emission Reductions	
	NOx (tpd)	PM2.5 (tpd)
Accelerated Turnover of Trucks and Buses	10	—
Accelerated Turnover of Agricultural Tractors		
Existing Incentive Projects	3	0.2
New Incentive Projects	8	0.6
Cleaner In-Use Agricultural Tractors	—	—
Accelerated Turnover of Off-Road Equipment	2	—
Aggregate CARB Incentive Emission Reductions	23	0.8

"—" denotes emission reductions have not been estimated by CARB

The District has a long history of effective collaboration with CARB in ensuring funding allocated to the Valley in their statewide programs is obligated and expended expeditiously and in accordance with strict guidelines assuring surplus, quantifiable, permanent, and enforceable emissions reductions. This collaboration will continue in these programs.

The District will also achieve incentive based emission reductions from programs targeting stationary sources of emissions. Table E-4 indicates the aggregated emission reduction commitments from stationary incentive programs, along with estimations by project type of emission reductions to meet that aggregate commitment.

Table E-3 District Incentive Based Emission Reduction Measures

Proposed Stationary Incentive Measure	2024 Emission Reductions	
	NOx (tpd)	PM2.5 (tpd)
Agricultural Pump Engine Replacement	1.07	-
Woodstove and Fireplace Changeout	-	0.47*
Underfired Charbroiler Incentive Measure	-	0.57
Total Projected Incentive-based Emission Reductions	1.07	1.04

*This is an aggregate combination of both regulatory and incentive based reductions

These emission reductions are based on full implementation and best available information as of the adoption of this plan. A more thorough evaluation of control techniques and feasibility will be conducted at the time of program guideline development and adoption.

These emission reduction projections represent only a portion of the total emission reductions that will be achieved by the District's incentive programs. Many of the programs the District operates are not included above and will achieve additional emission reductions beyond these projections.

E.3 INCENTIVE PROGRAMS

Given the severity of the Valley's air quality challenges and the need for ongoing emission reductions, the CARB and the District have worked together to implement the most stringent mobile source emissions control program in the nation. Together, the two agencies have replaced hundreds of older, high-polluting vehicles and agricultural equipment with the cleanest available technologies. Despite these efforts, the District and CARB acknowledge the need for additional mobile source emissions reductions beyond those achieved through the current suite of programs. As such, CARB has committed to achieving an additional 32 tpd of NOx in the Valley though a combination of regulatory and incentive-based control measures beyond what is already in place.

The District has worked closely with CARB to establish more incentive-based measures and ensure the District procures the necessary funding for these programs to transition the Valley's mobile source fleets to the cleanest available zero and near-zero emissions technologies. These voluntary incentive programs are critical in accelerating fleet turnover and realizing the necessary reductions in time.

Within the District's expansive suite of incentive programs, in addition to CARB's mobile source incentive commitments, the District's Plan attainment strategy includes emission reductions from the implementation of three specific programs. These incentive measures will include the replacement of agricultural irrigation pump engines with electric motors or Tier-4 equivalent engine technologies, a program to incentivize the installation of pollution control equipment to reduce emissions from commercial underfired charbroilers, and a woodstove change-out program to reduce pollution from residential wood combustion.

E.3.1 HEAVY DUTY TRUCKS

The heavy-duty trucks category is composed of light-heavy-duty to heavy-heavy-duty diesel trucks with a gross vehicle weight rating (GVWR) of 14,001 and greater. Light-heavy-duty trucks have a GVWR of 14,001 to 19,500, medium-heavy-duty trucks have a GVWR of 19,501 to 33,000 and heavy-heavy-duty trucks have a GVWR greater than 33,001. Emission reductions in the heavy-duty truck fleet must be achieved through accelerated fleet turnover to the cleanest engines meeting ultra-low NOx emissions levels, which are 90% cleaner than engines currently required.

While CARB rulemaking efforts like CARB's Truck and Bus Regulation, and current funding programs like Prop 1B, are helping transition California fleets to clean engines meeting the 2010 0.2 g/bhp-hr NOx standard, these efforts are not enough to bring the Valley into attainment with the federal PM2.5 standards by the mandated deadlines. In an effort to encourage the transition to near-zero technologies and achieve reductions faster, CARB established optional ultra-low NOx standards of 0.1, 0.05, and 0.02 g/bhp-hr, which are up to 90% lower than the current heavy-duty truck standard. These optional standards have pushed progressive engine manufacturers to explore and develop new engine technologies. As such, engines that meet the optional ultra-low NOx standards for various classes of heavy-duty trucks are already available or are currently undergoing the certification process.

Cummins Westport has commercially released both an 8.9-liter and an 11.9-liter natural gas engine certified to the optional 0.02 g/bhp-hr standard and a 6.7-liter natural gas engine certified to the optional 0.10 g/bhp-hr NOx standard. Additionally, Cummins and other engine manufactures are continuing to develop engines in various other sizes that meet the ultra-low NOx levels in the coming years.

The zero emission technologies for heavy-duty trucks, such as battery electric vehicles, have limited range and are only currently available for short-range duty cycles, such as last-mile delivery trucks. However, development and demonstration are beginning for longer-range zero emissions options, including hydrogen fuel cells as range-extenders for battery electric vehicles, with some remaining uncertainty as to their technological achievability, economic feasibility upon commercialization, and ultimate pace of adoption.

Aside from battery electric or fuel cell electric vehicles, natural gas and propane engines are currently the only fuel-type certified or undergoing the certification process to meet the 0.02 g/bhp-hr ultra-low NOx emissions standards. While the timing of availability of low-NOx engines across multiple weight classes is still evolving, natural gas is currently the only available option for long-range heavy-duty applications. As such, the District must work with EPA, CARB, and industry to establish the appropriate natural gas fueling network to support the proposed fleet turnover.

E.3.1.1 Heavy-Duty Truck Incentive Successes

Despite lack of direct regulatory authority, the District has helped increase the effectiveness of state and federal heavy-duty on-road emissions regulations through the administration of established state incentives programs and the adoption of local programs. Continuing to transition the heavy-duty truck fleet over to zero and near-zero emissions technologies is a critical component of District's control strategy. The District aims to accelerate the turnover of trucks to newer, cleaner vehicles, primarily focusing on the ultra-low NOx engines certified to 0.02 g/bhp-hr.

The District has administered numerous incentive programs over the years, using federal, state, and locally generated funds to replace older on-road heavy-duty trucks with the cleanest available technologies.

Proposition 1B (Prop 1B): The Prop 1B Goods Movement Emission Reduction Program was the single largest source of funding for the District's heavy-duty on-road incentive program. Prop 1B used bond funds for a variety of state transportation priorities, including the replacement of heavy-duty trucks, transportation refrigeration units, and locomotives used in the goods movement corridors. The District aggressively pursued its share of Proposition 1B funding, and the Valley has received over $250 million over the life of the program, replacing 2,900 trucks.

Truck Voucher Program (TVP): The District's Truck Voucher Program (TVP) was designed to provide an alternative source of incentive funding for heavy-duty truck operators that were unable to obtain funding through the proposition 1B program. The District contracts with Valley dealerships and makes the review and approval process efficient and streamlined to provide vouchers to truck owners. The District provides up to 35% of the cost of a new truck that meets or exceeds the 2010 emission standard for heavy-duty trucks. The District has replaced over 1,600 heavy-duty trucks, funded by grants from EPA and locally generated incentive funds totaling over $73 million in funding.

A typical TVP project can take as little as a month to complete, which is from the time a complete application is received by the District to the time the applicant is driving the new truck off of the lot. The program can operate at this pace because the contracted dealers that partner with the District reduce the voucher amount from the overall cost of the truck, which lowers the applicants' loan amount for the truck. After the truck is purchased the District validates the voucher with the dealer and mails a check to the dealer for the voucher amount.

E.3.1.2 Heavy-Duty Truck Incentive Program Improvements

As a part of the effort to continue to accelerate fleet transition to the cleanest available engines, the District submitted a petition on June 22, 2016, with CARB support, urging EPA to establish a national tailpipe point-of-sale 0.02 g/bhp-hr NOx emissions standard for heavy-duty trucks, 90% lower than the 2010 emissions limit required by current regulations. Despite these efforts, the District and CARB will need to continue to incentivize the turnover of trucks to ultra-low NOx engines certified to 0.02 g/bhp-hr. Additionally, CARB has committed to taking state action on an ultra-low NOx engine standard. As noted above, engine manufacturers are beginning commercialization of these ultra-low NOx engines, and the District's incentive programs aim to accelerate the penetration of this technology into the Valley's truck fleets.

The District's award-winning incentive program strives for constant improvement in ease of access, streamlining, and stakeholder engagement growing the capacity for accelerating adoption of cleaner trucks. The program has been successful in implementing its truck replacement programs and navigating applicants through complicated eligibility requirements for various funding sources. Successful collaboration with CARB to engage the Valley's truck owners and ensure all interested applicants are guided through the process and identifying the most appropriate funding sources for their projects will be essential to meeting CARBs emission reduction commitments in the Valley.

Expansion of Funding for Transition to Zero/Near-Zero Heavy-Duty Trucks: CARB has proposed a measure to use new and existing incentive programs for on-road, heavy-duty vehicles to increase the penetration of near-zero and zero- emission vehicles and engines. Through this proposal, CARB expects to achieve 10 tpd NOx reductions from heavy-duty trucks by 2024 towards its aggregate emission reduction commitment. As such, the District has committed to redesigning its truck replacement programs into a single, streamlined program that will provide additional incentives to zero/near zero heavy-duty trucks. The District's current appropriations for the heavy duty trucks category through 2025 includes a total of $442,353,700 from various federal, state, and local funds including Cap and Trade, Federal DERA, Moyer funds, AB 2522 and AB 923 fees, AB 617 funding, and ISR rule fees.

Provide higher incentives for truck technologies that meet zero and ultra-low NOx emissions standards: Under the District's new Truck Replacement Program, the District will provide additional incentive for lower emissions technologies. Project participants retiring an eligible old truck will receive enhanced funding based on the type of clean truck technology powering the replacement, as described in Table E-5 below.

Table E-4 Truck Replacement Program Incentive Schedule

Clean Truck Technology	Potential Incentive
0.02 g/bhp-hr certified engine	$100,000
Hybrid truck capable of zero emission miles	$150,000
Zero emission truck	$200,000

Provide new incentives for fleet expansions with new clean trucks: Historically, truck funding was limited to replacement projects where an older vehicle is scrapped and a new vehicle is purchased. The District supports clean heavy-duty vehicle fleet expansion in which incentives are provided for new vehicle purchases without the requirement to scrap an existing vehicle. As part of the new Truck Replacement Program, a fleet expansion option has been added to provide up to $20,000 towards the purchase of a hybrid, eltra-low NOx, or zero emission truck without the requirement to scrap an older truck.

Provide new incentives for heavy-duty vehicle repair: Current heavy-duty vehicle funding is limited to replacement and fleet expansion projects. The Districts new Heavy-Duty Vehicle Repair Program (HDVRP) will provide financial assistance to small fleet owners (fleets with fewer than 20 heavy-duty vehicles), to provide durable repairs for failed emission components or emission control systems on heavy-duty vehicles. Failed emission control systems result in elevated NOx emissions. CARB has awarded the District $1,000,000 to administer the HDVRP pilot project.

E.3.2 Passenger Cars, Light-Duty Vehicles, Medium-Duty Vehicles

This category includes classes of vehicles used primarily for personal transportation. When the light-duty truck and medium-duty vehicle categories were first established, the majority of vehicles in the medium-duty vehicle category were primarily used for work purposes. The popularity and high sales volumes of full size pick-up trucks and SUVs have altered the light- and medium-duty truck use patterns. It is now common for trucks and SUVs to be used primarily for personal transportation.[1]

Passenger cars are vehicles designed primarily for transportation of persons and having a capacity of twelve or less. Light-duty trucks are trucks with a gross vehicle weight rating (GVWR) less than 5,750 lbs. Medium-duty vehicles have a GVWR between 5,751 lbs. and 8,500 lbs.

California has the Nation's longest history of passenger car emissions standards and an accompanying inspection and maintenance program. Continued reductions in emissions from this category while the overall size of the fleet is increasing relies on vehicle turn-over, proper maintenance of legacy vehicles, and continual improvement of new vehicle emissions. The District has operated programs to address each of these needs.

E.3.2.1 Passenger Car, Light-, and Medium-Duty Incentive Program Successes

Despite lack of direct regulatory authority, the District has helped increase the effectiveness of state and federal light-duty on-road vehicle regulations through the administration of established state incentives programs and state leading innovation in the adoption of local programs.

Tune In Tune Up: Since 2010, the District has partnered with Valley Clean Air Now (Valley CAN) to administer the Tune In Tune Up vehicle repair program. Initial funding for Tune In Tune Up came from the state's Reformulated Gasoline Settlement Fund and resulted in the repair of more than 2,900 vehicles. Because of the success of this initial effort and benefits to the residents of the Valley, the District has budgeted additional funding for the program hosting 132 events, repairing 25,000 vehicles, using $31,500,000 of locally generated incentive funds.

[1] California Air Resources Board [CARB]. (1999). *"Lev II" And "Cap 2000" Amendments To The California Exhaust And Evaporative Emission Standards And Test Procedures For Passenger Cars, Light-Duty Trucks And Medium-Duty Vehicles, And To The Evaporative Emission Requirements For Heavy-Duty Vehicles: Final Statement Of Reasons.* Retrieved from http://www.arb.ca.gov/msprog/levprog/levii/pstfrpt.pdf

With a focus on outreach to low income communities, this award-winning program provides Valley residents with the opportunity and necessary funding to make emissions-related repairs to their vehicles, significantly reducing emissions throughout the Valley, particularly in disadvantaged communities. In partnership with Valley CAN, this program has grown to become the most effective, targeted vehicle repair program in the state. In addition to the significant emissions benefits of the program, the Tune In Tune Up program has produced extremely valuable data regarding the true nature and extent of high-polluting, largely unregistered vehicles in the Valley, particularly amongst the Valley's low income population.

Through this partnership with Valley CAN, the District has provided much-needed funding for vehicle repairs with the vast majority of these vehicles operating within the Valley's disadvantaged communities. An additional benefit of this program is follow-up with owners of vehicles that are unregistered due to smog-related issues to help ensure that their vehicles are re-registered after repair. In fact, 98% owners of previously unregistered vehicles have registered their vehicles after completing repairs through the program.

Enhanced Fleet Modernization Program (EFMP) and EFMP Plus UP: In recognition that not all vehicles that participate in the Tune In Tune Up weekend events are good candidates for repair, the District developed a first-of-its-kind vehicle replacement pilot program, implemented in partnership with Valley CAN. This program identified vehicles at weekend events which were not good candidates for repair and provided additional funding to retire and replace those vehicles with cleaner, more efficient vehicles. Based on the initial success, this pilot program served as a model for developing the statewide EFMP and EFMP Plus Up programs.

Since 2015, the District has incorporated a vehicle replacement component into the Tune In Tune Up weekend events. The EFMP program provides between $4,500 to a maximum of $9,500 per vehicle to replace high emitting vehicles identified at Tune In Tune Up events. The incentive amount is based on the type of replacement vehicle purchased, the income level of the participant and whether or not they reside in a disadvantaged community. The highest incentive is given to applicants with the lowest income (less than 225% of the federal poverty level) that choose the cleanest available vehicles (generally battery-electric).

These programs are funded through CARB's AB 118 program and Greenhouse Gas Reduction Fund (GGRF), more commonly referred to as the Cap and Trade Program. To date, the District and Valley CAN have replaced more than 1,256 vehicles with newer, cleaner vehicles with approximately 96% of the participants meeting the program's definition of low income and 99% of the vehicles residing within the Valley's disadvantaged communities.

Drive Clean! Rebate Program: Today's market provides consumers with a wide variety of clean-air vehicle options. This program provides rebates to Valley residents and businesses for the purchase or lease of new, clean-air vehicles. The Valley has traditionally lagged other areas of the state in electric vehicle use and ownership. This is evidenced by the low participation of Valley residents in statewide incentive programs for electric and other advanced passenger vehicle technology. Only about 3% of participants in the statewide Clean Vehicle Rebate Program have been from the San Joaquin Valley. This program has further encouraged Valley residents to drive these cleaner alternatives. Since the launch of the Drive Clean! Rebate Program in March 2012, the District has issued almost 7,000 rebates, totaling more than $19 million in grant funding.

Public Benefits Grants Program, New Alternative Fuel Vehicle Purchase component: The Public Benefit Grant Program was developed to help address the needs and challenges faced by Valley public agencies in their efforts to secure funding for clean-air projects. The program was designed to provide necessary flexibility and leveraging to ensure the success of these projects. The New Alternative Fuel Vehicle Purchase component provides funding for the purchase of new, light duty alternative fuel vehicles including natural gas, electric and plug-in hybrids. Since the launch of the program in 2011, $24 million has been awarded for the purchase of clean alternative fuel vehicles such as zero-emission motorcycles, full battery-electric and plug-in hybrid electric vehicles.

Vanpool Voucher Incentive Program: The Valley is an expansive region and many of its residents make long commutes for work on a daily basis. To offset some of these miles traveled, the Vanpool Voucher Incentive program provides incentives to Valley residents to participate in vanpools in lieu of using single occupant vehicle commutes to work. The program encourages commuter rideshare practices among frequent long distance riders (greater than 20 miles) in the Valley. The District has issued a total of 198,654 vouchers to Valley commuters for $5.9 million.

E.3.2.2 Passenger Car, Light-, and Medium-duty Incentive Program Improvements

With the success by the Valley in advocating for a ten-fold increase in state funding towards for vehicle retirement and replacement programs, the District has developed an enhanced program that facilitates broader participation beyond the traditional weekend event based model. To accommodate significantly increased funding, the District is implementing numerous enhancements to its light-duty vehicle programs to increase efficiency and broaden access to the program. This includes rebranding the program for mass consumption, new and enhanced outreach strategies, innovative technology solutions for easier access by Valley residents and more efficient program administration.

Drive Clean in the San Joaquin!: The District is integrating its Drive Clean! Rebate Program with the vehicle repair and replacement programs. Creating a new branding for the combined effort as part of an enhanced outreach strategy. The new branding will go along with further growth of existing strong community partnerships, targeted marketing, one or more kick-off media events, an expanded auto dealership network, and an online application process designed to increase program participation rates. Integral to this update to the programs, the District will maintain the high level of accountability and strict fiscal controls to which this and all District programs adhere.

The state legislature recently approved funding for the Enhanced Fleet Modernization Program up to $60 million statewide and has allocated up to $25 million to the District. The District has received an initial allocation of $18.5 million in EFMP funding for FY 2018-19, with the likelihood of sustained funding at or near these levels for the foreseeable future. Furthermore, the District expects another significant increase in state funding for this program as a result of the recently enacted legislation to extend the Cap and Trade program (AB 398 and AB 617).

E.3.3 AGRICULTURAL EQUIPMENT

This category includes off-road agricultural equipment such as tractors, backhoes, wheel loaders, and other off-road farming vehicles that are widely used in the Valley. Off-road agricultural equipment replacements and repowers play a crucial role in reducing emissions, and significant emission reductions have already been achieved through accelerated fleet turnover to the cleanest available Tier 4 technologies.

Although the increasingly stringent new engine standards for off-road equipment will reduce emissions from mobile agricultural equipment over time, most existing off-road agricultural equipment operates for several decades before being retired due to their durability and relatively low cost to maintain. Furthermore, the useful life of a tractor in the Valley is much longer other parts of the country due to the Valley's hot, dry summers and mild, wet winters.

While most of the equipment in this category are tractors, a significant portion consists of harvesters, loaders, sprayers, conditioners, balers, cotton pickers and other specialized equipment types. Some types of non-tractor mobile agricultural equipment have unique and specific roles within an operation based on the commodity produced and usually require specialized functions of the equipment. Non-tractors often have specialized roles that are specific to certain functions and limit their usefulness for multiple operations, causing non-tractors to be significantly more expensive than tractors. The large cost deters operators from replacing and purchasing specialized equipment which leads to less turnover of older, more polluting equipment within the specialized mobile agricultural equipment population.

In 2012, CARB staff began to develop the framework for mobile agricultural equipment to become eligible to receive SIP credit. That process included in-depth research of the unique economical and operational characteristics of mobile agricultural equipment in the agricultural industry, which included reviewing and analyzing the cost and availability of Tier 4 technologies for mobile agricultural equipment. It was determined that a two-step regulatory process that ensures SIP credit for voluntary incentive program mobile agricultural projects in the near-term and a longer-term effort to accelerate use of Tier 4 equipment would better serve to maximize the air quality benefits over time while also meeting SIP goals. As a result, in October 2013 the CARB adopted their Regulation for State Implementation Plan Credit from Mobile Agricultural Equipment that relies on voluntary incentive measures to achieve reductions from this essential category.

E.3.3.1 Agricultural Equipment Program Successes

Despite lack of direct regulatory authority over mobile agricultural equipment, the District has helped accelerate emission reductions from this category ahead of state regulation through the administration of established state incentives programs and the adoption of local programs. The District's successes in its partnerships with Valley growers, USDA-NRCS and CARB to replace tractors through voluntary incentives is a great example of how effective incentive-based strategies can lead to more emission reductions in an expeditious fashion.

Tractor Replacement Program: Since 2009, the District and the USDA-NRCS have implemented and provided funding for a voluntary incentive program that has replaced more than 6,600 agricultural tractors for San Joaquin Valley farmers. To date, approximately $500 million in public/private investment has reduced over 17 tons per day of NOx emissions in the Valley. Funding for this program includes Federal AQIP, Federal Targeted Airshed Grants, Diesel Emissions Reduction Act, motor vehicle fees, ISR fees, Voluntary Emission Reduction Agreements, and the Carl Moyer Program.

Tractor Trade-Up Pilot Program: There are still many old, high polluting tractors used in the San Joaquin Valley by small farmers for whom the cost of the new tractor is not feasible even with the District's current incentive program. The District launched the first-of-its-kind Ag Tractor Trade-Up Pilot Program in the spring of 2016. When coupled with an expanded agricultural equipment replacement program, the trade-up program has the potential to achieve significant additional cost-effective emissions reductions.

Electrified Dairy Feed Mixing Program: The District completed a highly successful demonstration of an electrified feed mixing system as a part of the Technology Advancement Program. Informed by that project's success, the District developed this new pilot incentive program to target the installation of electric feed mixing equipment and further reduce diesel emissions from tractors and other mobile equipment and vehicles at Valley dairies and other confined animal feeding operations (CAFOs). The primary emission reductions from this program derive from the elimination of existing agricultural tractors that mix and deliver feed, the elimination or reduction in usage of on-road trucks used to deliver feed, and reduction in usage of any remaining off-road equipment used in the feeding process. Further emission reductions and cost-savings to Valley dairies and CAFO's will be achieved through increased efficiencies of the new systems that result in an overall reduction in feed mixing equipment usage. Since launching the program in January 2018 the program has received over $23 million in incentive funding application requests from Valley dairies pursuing transition to electrified and much cleaner feed systems.

E.3.3.2 Agricultural Equipment Incentive Program Enhancements

Expanded Funding for Transition to Tier 4 Agricultural Equipment: CARB has proposed a measure to use new and existing incentive programs for agricultural equipment to increase the penetration of Tier 4 vehicles. Through this proposal, CARB had expects to achieve 11 tpd NOx reductions from agricultural equipment by 2024 towards its aggregate emission reduction commitment. A portion of these SIP-creditable reductions would come from the quantification of reductions from projects already funded and executed to date that will continue to provide SIP-creditable reductions through 2024. The remaining reductions correspond to accelerated turnover of additional tier 0 and 1 tractors using existing and innovative incentive funding programs.

Agricultural Material Technology Demonstration and Deployment Efforts: The San Joaquin Valley, in adherence with applicable state laws instituted under SB705 (2003 Florez), has the toughest restrictions on agricultural burning in the state. The District regulations no longer allow the burning of all field crops (with the exception of rice), almost all prunings and almost all orchard removals. The District also operates a comprehensive Smoke Management System, which only allows the limited amount of burning that is still permissible to take place on days with favorable meteorology and in amounts that will not cause a significant impact on air quality.

The exceptional drought conditions that the Valley has experienced in recent years and the demise of the biomass power industry has resulted in an increase in the open burning of wood waste and threatens the District's ability to continue to maintain broad restrictions on open burning of agricultural waste into the future. Despite the insignificant effect of this source category on attainment of the applicable PM2.5 standards and the lack of feasible alternatives to open burning, the District intends to maintain the restrictions currently contained within the rule while continuing to undertake efforts aim at the development and deployment of feasible alternative technologies and practices to reduce open agricultural burning in the Valley. The District efforts will be conducted in close coordination with USDA-NRCS, agricultural sources, and researchers through established processes such as the Agricultural Technical Subcommittee. These efforts include providing support and financial assistance as feasible for the emerging cleaner alternatives to the open burning of agricultural waste, with priority given to on-the-farm deployable (minimum or no transportation related emissions) and scalable technologies, considering the full life-cycle of emissions and associated impacts on air quality when assessing the feasibility of alternatives to open burning.

Almond Harvester Incentive Program: While District modeling indicates that reducing almond harvester emissions in rural areas has negligible impact on the Valley's peak urban sites that drive the Valley's federal attainment mandates, District staff are working to develop strategies to reduce localized community impacts from this source category. In partnership with USDA-NRCS and agricultural stakeholders, the District supported the development of a new USDA-NRCS incentive program for the deployment of low-dust harvesters which is now in operation. Additionally, given limitations in the USDA program, the District is evaluating the feasibility and effectiveness of implementing a new District incentive program to promote the use of low-emission nut harvester technologies.

In partnership with the Almond Board of California and Texas A&M University, the San Joaquin Valleywide Air Pollution Study Agency recently funded a study of the effectiveness of low-dust technology harvesters. This research, combined with data obtained from a recent survey conducted of almond and walnut harvesting operations

Valleywide, will be used to inform the evaluation of a potential incentive program to advance the deployment of low-dust harvester equipment in the Valley.

Expanded Tractor Trade-Up: Due to the success of the Tractor Trade-Up Pilot Program, the District was awarded an additional $3,000,000 in Cap and Trade funds for an expanded Ag Tractor Trade-Up Program in the Valley. The $3,000,000 award from CARB will be matched with $3,258,750 in funds from the District and approximately $1,303,500 from the grant recipients. This funding will enable the District to replace approximately 50 Tier 2/3 tractors with Tier 4 tractors, which are 80% cleaner. Then, through the trade-up process, the District will replace approximately 50 older Tier 0 or Tier 1 tractors with Tier 2/3 tractors, which are also 80% cleaner. Specifically, the program proceeds as follows:

1. District solicits farmers that currently operate old, high-polluting (Tier 0/1) tractors, and catalogs needs for replacement tractors.
2. District utilizes the contracted dealership(s) to identify and catalog late model midrange (Tier 2/3) tractors that appear to be good candidates for the trade-up program.
3. Using information from both parties, District matches needs of Tier 0/1 operator with available Tier 2/3 tractors and notifies Tier 0/1 operator.
4. District and contracted equipment dealer evaluate Tier 2/3 tractors and generate estimates and approved funding amounts for refurbishment to pre-determined usable condition.
5. Equipment dealer performs prescribed tractor refurbishment using project funding and delivers refurbished Tier 2/3 tractor to Tier 0/1 operator.
6. Equipment dealer takes possession of the Tier 0/1 tractor and delivers it to a dismantler under contract with the District.
7. Original operator of Tier 2/3 tractor purchases and places into service a new Tier 4 tractor using trade-up Awardee incentive.

E.3.4 LOCOMOTIVES

The emissions from goods movement are a significant source of diesel particulate matter (PM) in the Valley and the state, and many of the larger cities in the Valley are home to locomotive rail yards. Locomotives, in particular, present a considerable health risk from diesel PM emissions. Residential areas located near rail yards have shown a significant increase in cancer risk and can equal or exceed the regional background or regional health risk levels.

Locomotives are divided into three groups: interstate line-haul locomotives, medium-horsepower locomotives that are used primarily in California or regional service, and switcher locomotives. This component also includes emissions from other off-road equipment used at rail yards, including: cranes, yard tractors, and material handling equipment such as forklifts.

Interstate line- haul locomotives are generally newer (built 1995 and later), higher horsepower (greater than 4,000 Hp) locomotives that operate over long distances and in many states. Medium Horsepower (MHP) Locomotives are typically older locomotives that may have once served in interstate line haul service but are now used in regional service. Switcher (Yard) Locomotives are typically used to push railcars together to form trains within rail yards, but can also be used to power local and regional service trains.[2]

E.3.4.1 Locomotive Program Successes

Heavy-Duty Engine Program, Locomotive Component: This program component awards up to 85% grant funding for newer, cleaner diesel locomotive engines and locomotive replacements. The locomotive component of the Proposition 1B Program funded up to 80% for the replacement of an uncontrolled, Tier 0 through Tier 2 locomotive with a new locomotive that meets or exceeds Tier 4 standards (1.30 g/b-bhp-hr NOx and 0.03 g/bhp-hr PM). Eligible projects are funded with local, state, and federal sources, including but not limited to the Carl Moyer Program, the Federal Diesel Air Shed Grant, and DERA funding.

The District has funded idle reduction technology, repower and replacement of 41 locomotives, with more projects currently in the queue. One of the major benefits of the locomotive repower and replacement program is increased efficiency and longevity as a result of the revolutionary GenSet engine technology. The GenSet system uses multiple smaller off-road tier-4 emission level engines mounted on a single chassis. This system allows for each of the engines to be used independently so as little as one of the engines can be used during non-peak conditions, helping to reduce unnecessary emissions. In addition, this system comes equipped with idle reduction technology that will shut down the engine during periods of inactivity.

The District funds locomotive repower or replacement projects through an RFP procurement process, and reviews and selects recipients based on established scoring criteria. During the pre-inspections, all necessary locomotive engine information is verified by District inspectors and documented in digital photographs. Upon verification of all information, the District enters into an agreement with the recipient for the project. Once the replacement switcher locomotive engine has been purchased and the original engine has been dismantled, the recipient will complete and return the claim-for-payment packet, and a post-inspection is performed, prior to payment, to verify the new information. Monitoring and reporting continue for the duration of the agreement to ensure the emissions reductions from the project are real and quantifiable.

Proposition 1B Locomotive: The District has funded the replacement of 13 locomotives totaling $25.2 million in funding through the Proposition 1B program. These projects achieve 77 tons of PM and 1,413 tons of NOx emissions over the life of the projects.

[2] California Air Resources Board [CARB]. (2009). Recommendations to Implement Further Locomotive and Railyard Emission Reductions. Retrieved from http://www.arb.ca.gov/railyard/ted/drftrec090909.pdf

E.3.5 School Bus Replacement and Retrofit

This category includes diesel-fueled buses, including those from public school districts and other qualifying agencies that service public schools, with a gross vehicle weight rating (GVWR) over 14,000 pounds. The number of buses that are in this source category is relatively small (less than 4,000 in 2011, EMFAC2011) compared to the number of heavy-duty trucks also meeting the 14,000 GVWR limit and covered by the State Truck and Bus Regulation. School bus replacements and retrofits play a vital role in reducing school children's exposure to both cancer-causing and smog-forming pollution.

E.3.5.1 School Bus Program Successes

The School Bus Replacement and Retrofit programs provide grant funding for new, safer school buses and air pollution control equipment (retrofit devices) on buses that are already on the road. Public school districts in California that own their buses are eligible to receive funding. Eligible projects are funded with local, state, and federal funds including DERA funding and state and local mitigation fees.

The District has provided funding to retrofit 2,254 school buses and replace 503 school buses. New buses purchased to replace older buses may be fueled with diesel or an alternative fuel, such as compressed natural gas (CNG) or electricity, provided that the required emissions standards specified in the current guidelines for the Lower-Emission School Bus Program are met. Funds are also available for replacing on-board CNG tanks on older school buses and for updating deteriorating natural gas fueling infrastructure. Commercially available zero-emission electric school buses are eligible for additional funding through the state’s Hybrid Voucher Incentive Program (HVIP).

Eligible school buses are selected based on specific program requirements, including replacing the oldest models first. After determining eligibility, school districts are awarded contracts that provide a reasonable time period for project completion. A claim must also be submitted before funds can be reimbursed.

E.3.6 Alternative Fuel Infrastructure

The impact of emissions generated from cars and trucks on the Valley’s air quality is significant. More than 85% of the NOx emissions inventory in the Valley is attributed to mobile sources. The Valley’s topography, climate, geography and the presence of two major transportation corridors connecting northern and southern California all contribute to the region’s problem. Due to the significant source of vehicle emissions, the District has developed and implemented a broad, multi-faceted portfolio of innovative strategies and policies to reduce emissions from cars, trucks, buses and other heavy-duty vehicles. As part of its strategy, the District has created several successful programs incentivizing clean vehicles. However, the District also recognizes that clean vehicle technology cannot be viable without the necessary fueling infrastructure that would not only allow such technology to be accepted by Valley residents and businesses, but also thrive in the region. For this reason, the District has developed incentive programs for the purchase and installation of alternative fueling infrastructure to support clean vehicle technology.

Although utilizing zero-emission technology would yield the greatest reductions in emissions, the rural and expansive nature of the Valley limits its use for various and current real-world applications. Other alternative fuel technology, such as ultra-low NOx natural gas vehicles, help address some of these shortcomings of all-electric and hydrogen-fuel vehicles. In addition, the cost of a zero-emission vehicle is typically and substantially greater than a comparable natural gas option. Even though ownership of a zero-emission vehicle may have longer-term economic benefits, the high upfront cost is fiscally impractical for many Valley businesses and agencies. Until the further advancement of zero-emission technology and the costs of the vehicles become more competitive, the District is supportive of both types of technologies and has created infrastructure incentive programs that would help each. The District fully supports zero-emission technology and recognizes the long-term air quality gains from the large-scale deployment of such vehicles and equipment. However, short-term emission reduction benefits can be achieved with near-zero emission technology until zero-emission technology becomes a more feasible option Valley-wide.

E.3.6.1 Alternative Fuel Infrastructure Program Successes

Charge Up! Program: This program provides funding for the purchase and installation of electric vehicle (EV) chargers. Although EV charging infrastructure has steadily improved in the San Joaquin Valley, the continued deployment of such infrastructure is still needed as an increasing number of residents have adopted EV technology. The Charge Up program was recently enhanced to adapt to ever changing trends in the market and needs of current and potential EV owners. Workplace charging was incorporated as many consumers considered purchasing an EV because of the ability to charge at their place of employment. In addition, changing the program to a voucher-based system has helped streamline the process for Valley agencies and businesses to leverage additional funding provided by the state and utility companies. With the ability to stack incentive funds from multiple sources, many program participants have significantly reduced out-of-pocket costs and found the investment of installing EV chargers worthwhile. Since the launch of the program in June 2015, the District has awarded more than $1.4 million in incentives for the siting and installation of 260 level 2 and level 3 electric vehicle chargers.

Public Benefit Grants Program, Alternative Fuel Infrastructure Component: The Alternative Fuel Infrastructure component funds projects from Valley public agencies for the expansion of an existing in-use infrastructure facility, or the development of a new one. The District implements this program to provide much needed funding to local public agencies towards infrastructure projects to supplement the growth and advancement of clean-air, alternative fuel vehicles. Under the Alternative Fuel Infrastructure component, $8 million has been awarded to support large-scale compressed natural gas infrastructure and heavy-duty electric vehicle charging projects.

E.3.6.2 Alternative Fuel Infrastructure Program Improvements

As a direct result of the District's advocacy efforts at the state level and working closely with Valley stakeholders, the District has received significant monies to implement various incentive programs that will greatly assist in achieving enormous emission reductions from both passenger and commercial fleets. One of the components that the District is currently developing is a new grant solicitation for alternative fuel infrastructure that will support the burgeoning zero- and near-zero emission medium and heavy-duty vehicle private fleet market.

The medium and heavy-duty vehicle private fleet market has seen a rapid growth with new types and models of vehicles coming to market on a consist basis. For these new advanced commercial fleet vehicles to succeed and proliferate in the market, there must be an equivalent investment towards the alternative fuel infrastructure to power these fleets. To support this expanding and critical vehicle market, the District is in the process of launching a new alternative fuel infrastructure program that will provide critical funding for both public and private fleets to develop new fueling stations so that they can replace their existing vehicles to a more advanced clean-air fleet.

E.3.7 Community-Based Incentive Programs

The District offers several programs that provide incentives for specific projects that focus getting the community involved in achieving emissions reductions through clean air projects and practices. These programs fall into two major categories: programs that reduce local vehicle miles traveled and programs that reduce residential-generated emissions. For programs that reduce vehicle emissions, funds are allocated to support cost-effective projects that have the greatest motor vehicle emissions reductions, resulting in long-term impacts on air pollution problems in the Valley. In addition to vehicle emissions, the District recognizes that focus should also be placed on reducing emissions that are generated from sources at the residential level that directly affect neighborhoods as much as vehicles. All projects under these programs must have a direct air quality benefit in the Valley.

E.3.7.1 Community-Based Incentive Program Successes

These programs provide funding to help reduce emissions generated at the community level. The importance of these community-based programs cannot be underestimated as they help change the nature of how individuals within each community commutes, conducts business, and resides in the Valley. These programs succeed in incentivizing and supporting changes in individual behavior in ways that help reduce air pollution with the prospects that shifting behavior and habits will transform the community at-large.

Bicycle Infrastructure: This program provides funding for bicycle infrastructure projects, including Class I (Bicycle Path Construction), Class II (Bicycle Lane Striping), and Class III (Bicycle Route) projects. The program provides funding to assist with the development or expansion of a comprehensive bicycle-transportation network which will provide a viable transportation option for travel to school, work and commercial sites. Almost $x 1.5 million dollars has been awarded for bicycle infrastructure projects throughout the San Joaquin Valley.

Alternative-Fuel Mechanics Training: This program provides funding to develop and advance the education of personnel from qualifying agencies that are using alternative fuel or are transitioning to alternative fuels on the mechanics, safe operation and maintenance of alternative fuel vehicles and infrastructure. As clean new vehicle technology adoption has been dramatically increasing, there has been a reciprocal need for personnel training. The District has awarded over $85,000 towards these projects.

E-Mobility: This program provides funding for the development or expansion of telecommunications services and electronic technology applications to directly replace vehicle travel by the general public. Funding is available for eligible projects such as video teleconferencing, Internet business transactions, and telework sites. The District has awarded almost $1 million towards these projects.

Public Transportation Subsidy and Park & Ride: This program provides funding for the construction of Park & Ride lots to promote ridesharing and public transportation subsidies to encourage new ridership. Over $1.1 million dollars has been awarded to subsidize and encourage the growth of these ridesharing activities.

Clean Green Yard Machines Program: This rebate program provides incentives for Valley residents to replace their old gas lawn mowers in favor of nonpolluting electric lawn mowers. Participants can receive up to $250 for the purchase of an electric lawnmower. Since the program requires the replacement of an existing lawn mower, participants are required to take their old units to a dismantler to be recycled or permanently dismantled. Under this program, the District has awarded over $1.1 million and replaced over 4,800 gas-powered lawn mowers.

Public Benefits Grants Program, Enhanced Transportation Strategies Component: This component provides funding to Valley public agencies to fund projects that achieve quantifiable emission reductions through the deployment of clean alternative fuels and commute strategies that reduce vehicle miles traveled and emissions. Under the program, 13 projects have been awarded for a total funding amount of $2,008,730.

Public Benefits Grants Program, Community Improvement Projects that Reduce Vehicle Use and Emissions Component: This component provides funding for specific land use and community development projects that are eligible under the Cap and Trade funded Affordable Housing and Sustainable Communities Program and other state and federal funding opportunities. Projects awarded from this program promote a reduction in vehicle miles travelled and associated emissions through enhanced walkability and increased use of zero emission transportation alternatives. The funding provided under this component is intended to be used as match to give Valley projects a competitive advantage, especially in statewide and national solicitations. Projects submitted through this program are awarded on a first-come, first-serve basis pending eligibility.

E.3.7.2 Community-Based Incentive Program Improvements

The District continuously reviews areas where emission reductions can be achieved, especially on the community level where poor air quality has a direct impact on the residents of the San Joaquin Valley.

Funding Commercial Zero-Emission Lawn and Garden Equipment: In addition to replacing old residential lawn mowers with cleaner options, the District intends to focus on equipment used in commercial applications. Many Valley residents and businesses utilize professional lawn care services and these services are often performed with older gas-powered lawn and garden equipment. To encourage the use of cleaner, electric options, the District intends to expand the Clean Green Yard Machines Program to include the replacement of lawn and garden equipment from commercial end-users. This new program would be designed to assist public agencies and private businesses purchase zero emission equipment to perform their services. Zero emission lawn and garden equipment have advanced in the past few years, not only in the area of durability, but also dependability with longer battery lives that can be used in commercial settings where the equipment is typically used for long durations. In addition to lawn mowers, the expanded category can include additional equipment that are often used in commercial applications such as edgers, blowers, chain saws, and trimmers.

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Appendix F
Public Education and Technology Advancement

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F. ADDITIONAL AIR QUALITY STRATEGIES

Despite major reductions in emissions and corresponding improvements in air quality, the San Joaquin Valley (Valley) continues to face difficult challenges in meeting the national ambient air quality standards (NAAQS, or standards). Achieving attainment of the Environmental Protection Agency's (EPA) increasingly stringent standards will require the development and implementation of transformative zero/near-zero emissions technology over the coming decades.

F.1 Technology Advancement Program

On March 18, 2010, the San Joaquin Valley Air Pollution Control District (District) Governing Board approved the Technology Advancement Program (TAP), a strategic and comprehensive program to identify, solicit, and support technology advancement opportunities. The program represents a significant step forward in the District's efforts to attain ever-tightening federal air quality standards and fulfill the District's public health mission. The primary goal of TAP is to advance technology and accelerate the deployment of innovative clean air technologies that can bring about emission reductions as rapidly as practicable. To address the Valley's needs with respect to both ozone and PM2.5, which are largely driven by NOx emissions, the Technology Advancement Program has placed a particular focus on NOx emissions reduction technologies. The program is implemented through a coordinated and collaborative process that engages technology developers and potential end-users through:

- Grant funding for technology advancement projects in the San Joaquin Valley through competitive processes
- Integration of technology advancement goals into existing grant programs
- Comprehensive outreach to identify potential technology and demonstration partners
- Ongoing review and feedback on new technologies
- Building partnerships with other agencies
- Building local capacity for research and development in the San Joaquin Valley

F.1.1 Technology Focus Areas

The District has structured the Technology Advancement Program to encourage participation within three focus areas. These focus areas represent the current needs of the Valley; they also reflect the types of proposals previously received by the District within this and other programs. Throughout implementation of this PM2.5 Plan and future air quality plans, the District will continue to evaluate and, if necessary, update these technology focus areas to address the Valley's air quality challenges.

I. **Renewable Energy**. Renewable energy projects focus on overcoming the barriers that prevent the use or adoption of zero-emission renewable energy sources or reduce emissions from renewable energy systems to make them cleaner than comparable non-renewable alternatives.

II. **Waste Solutions**. Waste solutions projects focus on zero and near-zero emission technologies that minimize or eliminate emissions from waste management systems and processes, including waste-to-fuel systems, such as dairy digesters and other bio-fuel applications.

III. **Mobile Sources**. Mobile source projects focus on zero and near-zero emission technologies with emphasis on goods and people movement, off-road equipment, and agricultural equipment.

F.1.2 District Action to Promote the Use of Natural Gas Technology for Goods Movement

Heavy-duty trucks are the largest source of NOx emissions in the Valley, and attaining the health-based ozone and particulate standards will require significant additional reductions in truck emissions through the development and implementation of advanced truck technology. Additionally, reducing emissions from heavy-duty trucks will provide significant health benefits for communities in the Valley and throughout the state, particularly those communities located near major freight corridors.

Much of the state's investment in recent technology development and demonstration efforts has focused on electrification. Although there have been significant advances in battery and fuel cell electric vehicle technologies, pursuing the advancement and deployment of clean natural gas heavy-duty vehicles and other more readily available and suitable near-zero emission technologies will help the Valley address our significant air quality challenges in a faster manner than solely relying on electrification technology due to current range limitations. Near-zero natural gas truck technology is already available commercially for limited applications and has the potential to reduce emissions. With additional advances in technology in the near term, near-zero emissions natural gas truck technology could be expanded to more applications, serving as a vital component of the strategy to bring transformational change to the goods movement sector.

To address this gap, the District adopted its *Action Plan for Promoting the Use of Natural Gas Technology for Goods Movement in the San Joaquin Valley* (Action Plan).[1] The Action Plan is a multifaceted plan for promoting the deployment of near-zero emissions natural gas vehicles and infrastructure in the San Joaquin Valley. The elements of the Action Plan are:

1. Support policy changes and legislation that help create a market for development, promotion, and deployment of near-zero emissions natural gas technology.

[1] San Joaquin Valley Air Pollution Control District. (2015, May 6). *Item Number 5: Review and Approve Action Plan for Promoting the Use of Natural Gas Technology for Goods Movement in the San Joaquin Valley.* http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2015/May/StudySession/final/05.pdf

2. Increase outreach efforts to communicate benefits and encourage transition to natural gas technology by Valley fleet operators.

3. Provide additional incentives for natural gas vehicles and infrastructure.

4. Promote technology advancement for near-zero emissions natural gas technologies through the District's Technology Advancement Program.

5. Continue to evaluate and support, as appropriate, the development and deployment of hydrogen fuel cell technology in the heavy-duty truck sector.

F.1.3 DEMONSTRATION PROJECTS

To date, the District has completed four Technology Advancement Program competitive funding RFPs, receiving over 137 proposals for clean technology demonstration projects through these RFPs. In total, the District has approved 35 of the proposed projects for a total funding of over $12.6 million. To date, many successful demonstration projects have been completed, including the following:

- **Electric Powered Yard Truck:** Transportation Power, Inc. demonstrated a zero emission electric yard tractor which was placed into operation at IKEA to primarily move shipping containers and trailers around the facility at its main California Distribution Center in Lebec, CA. A Kalmar Ottawa diesel tractor was converted to battery-electric propulsion. The tractor accumulated a total of more than 12,500 miles of operation during the one-year demonstration phase of this project, producing a wealth of valuable data. This technology met or exceeded diesel yard tractor throughput while producing zero emissions at a higher rate of energy efficiency than the diesel counterparts. Operational costs for the electric tractor were considerably lower, with an energy cost of 31 cents per mile, compared with $1.12 per mile for an equivalent diesel yard tractor for an operational cost savings of $5,000 to $6,000 per year. This technology was proven successful and has the potential for widespread implementation.

- **Greenwaste Compost Site Emissions Reductions from Solar-Powered Aeration and Biofilter Layer:** The Association of Compost Producers and their partners conducted a research project that involved building and emissions testing a prototype commercial-scale Aerated Static Pile (ASP) compost system. Three piles were built abutting each other to create an extended design collectively known as an eASP. Each eASP zone was placed on a foundation of aeration pipes and coarse-ground woody material, and was capped with a 1-foot-thick layer of finished, unscreened compost acting as a biofilter. The eASP was built using electric conveyors in place of diesel equipment, and was aerated using power provided by an on-site photovoltaic array. The prototype eASP and conventional windrows of the same age and feedstock were maintained for one month, during which time emissions of VOCs, ammonia and greenhouse gases were sampled using flux chambers. Emissions from the eASP during the active composting phase were significantly reduced for total non-methane, VOCs, ammonia, and NOx compared to the control windrows. The project also reduced the amount of fuel, water, and land necessary for active-phase composting.

- **Ultra-low NOx Biogas Engine and Emissions Control System:** California Bioenergy developed and tested at the Bidart Stockdale Dairy in Kern County a novel internal combustion engine/generator utilizing exhaust gas recirculation (EGR) and non-selective catalytic reduction (NSCR) controls. The objective was to demonstrate that such a system could achieve ultra-low NOx emissions of 0.07 pounds of NOx per megawatt-hour of useful energy output when fueled by biogas from a heated covered lagoon dairy manure digester. During the demonstration, the engine initially achieved the targeted emissions level but eventually overheated and failed due to malfunction of the temperature controls and cooling system. This project was largely successful in demonstrating that the control technology was effective in achieving the targeted emissions level - the operational difficulties the engine experienced were not related to the control technology. The encouraging results of this demonstration show this technology may be worth pursuing for further development.

- **Restaurant Charbroiler Technology Partnership:** District Rule 4692 achieves significant emissions reductions from chain-driven charbroilers. A variety of technologies for capturing emissions from under-fired charbroilers have been developed or improved in recent years. Under-fired charbroiler technologies still need further evaluation and demonstration at Valley restaurants before these technologies can be considered for amendments to Rule 4692. Technological feasibility issues and logistical issues such as the need to modify hoods and exhaust systems and reinforce roof supports in addition to the purchase, installation, maintenance, and labor costs must all be evaluated.

  During the summer of 2015 the District's Governing Board approved $750,000 to fund the Restaurant Charbroiler Technology Partnership (RCTP) program which provides funding for restaurants to install particulate control systems for under-fired charbroilers as demonstration projects to assess their feasibility and effectiveness. This information will assist in evaluating potential amendments to Rule 4692. The first demonstration unit funded under the RCTP program successfully completed in September 2017. Several additional projects are expected to be funded in the near future.

- **Zero-Emission Transport Refrigeration Unit:** Together with eNow Inc., Great Dane-Johnson Refrigerated Truck Bodies, Emerson, and Challenge Dairy Products, Inc., the Valley Air District and EPA Region 9 officials successfully demonstrated California's first zero-emissions transport refrigeration unit (TRU). TRUs are refrigeration units mounted on trucks and are traditionally powered by high-pollution small diesel engines to provide the needed cooling to transport chilled products.

  This demonstration of the Challenge Dairy "Rayfrigeration" delivery truck was the first trial for this type of zero-emissions transport refrigeration unit in the nation. The total cost of this project was over $1.2 million, with the Valley Air District providing

$400,000 through the Technology Advancement Program, funded in part through EPA Region 9.

To date, the technology has been successfully developed and tested, and is currently being demonstrated in use by Challenge Dairy on their local delivery routes. This demonstration phase has been underway since April 18, 2017, when the truck was successfully delivered from Johnson Refrigerated Truck Bodies in Rice Lake, WI to Challenge in Fresno, CA. Project partners estimate operation and maintenance cost reductions of over 90% as compared with conventional TRUs.

- **Dairy Feed Mixing Electrification:** A demonstration project with Philip Verwey Farms, a dairy in Hanford, involved converting several elements of its feeding operation from diesel power to electricity. The project was successful in demonstrating that diesel emissions could be significantly reduced at dairies and other animal feeding operations throughout the District in a cost-effective manner and subsequently throughout the Valley. As a result, the District worked closely with the agricultural industry and technology providers, to develop the Dairy Feed Mixing Electrification Program and allocated $4 million to expand the installation of electric feed mixing equipment and further reduce diesel emissions from mobile equipment at Valley dairies and other confined animal feeding operations.

In 2018, the District expects to open its fifth competitive solicitation for proposals. In addition to directly funding demonstration projects, the District actively seeks opportunities to collaborate with technology innovators in seeking additional funding.

F.2 PUBLIC EDUCATION AND PARTICIPATION

The District's mission to protect public health by improving air quality in the San Joaquin Valley relies on the public's awareness and understanding of the District's air-quality improvement programs. The Valley cannot meet these public health goals on the back of businesses alone. Valley businesses are subject to some of the most stringent air quality regulations in the nation. As Valley businesses continue to be subject to additional rounds of prohibitory regulations, the role of the public becomes increasingly important in reaching attainment of federal standards.

Emissions from public behavior such as driving, residential wood burning and lawn-care maintenance continue to be a key factor in the Valley's emissions inventory. Consequently, public acceptance of concepts such as alternative commute options, as well as specific clean-air strategies, like Check Before You Burn, the Air Alert program and Healthy Air Living (HAL), requires widespread lifestyle changes. To that end, the District Governing Board has placed a high priority on conducting an active and effective public education and outreach program.

The District's comprehensive public education and outreach program is composed of numerous elements that are designed to allow the District to leverage opportunities to advance the District's multiple strategic objectives, such as:

- Encourage and enlist the general public to do their part to reduce air pollution
- Empower and inform the public to protect themselves during episodes of poor air quality by providing them timely air quality information as well as scientific and comprehendible information on the health effects of air pollution
- Provide accurate and objective information about Valley efforts to reduce air pollution; measurable results and achievements; and challenges that remain.

F.2.1 Public Education and Outreach Activities

Engaging the public in efforts to reduce emissions is a key element of the District's attainment strategy. Education increases public support and understanding of new and controversial regulations. The District's education and information program has expanded and evolved over the years. The following is a partial list of the District's Public Education and Outreach Activities:

- Executing successful outreach campaigns for District grant programs
  - Promoting and conducting close to 15 years of Clean Green Yard Machines (CGYM) lawn mower-exchange programs
  - Promoting the Burn Cleaner Woodstove Change-out program
  - Developing and implementing the Tune In, Tune Up vehicle emissions check program
  - Developing Proposition 1B "Calling All Truckers" radio, print and billboard campaign
    - Working with Operation Clean Air (OCA), Coalition for Clean Air, and members of the goods movement Industry
    - Supporting the Drive Clean! vehicle program
- Developing seasonal, strong "Make One Change" bilingual messages in primarily two languages in English and Spanish across the three distinct media markets of the Valley (Sacramento, Fresno, Bakersfield)
- Launching and updating the Air Alert program
- Developing strong media relationship with reporters throughout the Valley and conducting hundreds of English and Spanish media interviews annually
- Regular meetings with Valley newspaper editorial boards and placement of op-eds in local papers
- Launching the amended Check Before You Burn residential wood-burning curtailment program
- Coordinating targeted outreach to foothill and mountain communities to solicit their participation and understanding in reducing particulate matter
- Producing the District's yearly "Annual Report to the Community"
- Developing the Real-time Air Advisory Network (RAAN) and the accompanying smart phone app
- Enhanced RAAN to provide residents with air quality information for their neighborhood by entering their address; the first of its kind system for

communicating real-time neighborhood-level air quality, taking into account the meteorological conditions as well as observed air quality concentrations from the District's air monitoring network.

- Developed and deployed display device to provide a visual indicator for school staff, students and parents to follow real-time changes to the RAAN levels throughout the day.
- Launching the Healthy Air Living Schools program, including developing branded program materials
  - Enrolling more than 1,000 schools in the program to follow RAAN
  - Engaging hundreds of Valley schools in the "Turn the Key Be Idle Free" no-idling campaign
  - Guiding schools to use the Real-Time Outdoor Activity Risk (ROAR) guidelines that provide health recommendations for outdoor exercise based on the duration of student's exposure, the intensity of their exercise and the air quality conditions
- Developing the Web-based Archived Air Quality (WAAQ) system to give the public historical air quality information
- Creating a new Healthy Air Heroes educational activity kit geared for kids in grades K-6, which includes an activity book, pencil, crayons, stickers and a toy.
- Improving the District's widely used 1-800-SMOG Info line that provides callers daily air quality forecasts and burn status information by county
- Launching HAL and creating understanding with the public through a variety of different outreach strategies and materials, including:
  - HAL logo development
  - Quick screen displays for events and District lobbies
  - HAL Website
- Assisting with public workshops
- Creating and administering the annual HAL Kids Calendar featuring youth artwork
- Developing materials and crafting outreach targeted to the District's environmental justice areas
- Advertising through Cinemedia and movie lobby posters program during peak movie-going seasons (summer, holidays)
- Creating "Don't Burn Trash" messaging and placed in strategic areas in response to public needs and observations of the District's Compliance Department
- Valley Air District Air Quality Reports: Free media - branded daily air quality reports – Spanish- and English-language radio & TV
- Developing campaign targeting real estate brokers to ensure they are in compliance with the wood stove change-out program upon each home sale, included direct mail, internet ads, Eblasts, flyers and radio sponsorship on real estate shows
- Leveraging partnerships with bike coalition groups, asthma coalitions and local COGS to promote "Earth Day," "Bike to Work" and "Rideshare" weeks
- Developing "New Media" strategy for the District, which leverages the power of social media sites such as Facebook, Twitter, Instagram and YouTube

- Utilizing video more aggressively to communicate key website information in a more exciting way and to provide District-focused footage to media outlets
- Producing outreach pieces on a wide variety of District programs including grants, asbestos, compliance, permitting, etc.
- Redeveloping the District's valleyair.org homepage to make it easier to navigate, including:
    - Major overhaul of the grants section to better serve potential applicants
    - Creation of a widget or digital tool to allow schools to place RAAN monitoring information directly on their homepage
- Conducting a series of successful symposiums, conferences, town hall meetings and community meetings
    - Central Valley Summit on Alternatives to Open Burning of Ag Waste, November 2017
    - The 2015 Transboundary Ozone Conference
    - The 2012 PM and Lawn care Symposium
    - Multiple general air quality conferences
- Conducting hundreds of presentations throughout the Valley on air quality topics, and responding to tens of thousands of public calls and emails

F.2.2 PUBLIC EDUCATION AND OUTREACH PROGRAMS

Air pollution levels can vary greatly during the day. While the District issues a daily air quality forecast for each county in the air basin, localized air quality often deviates from these generalized, county-wide, daily forecasts. Numerous pollutants and meteorological parameters are measured throughout the Valley on a daily basis using an extensive air monitoring network managed by the District and the California Air Resources Board (CARB). The network measures pollutant concentrations necessary to show progress toward compliance with the national ambient air quality standards. The network also provides real-time air quality measurements used for daily air quality forecasts, residential wood-burning declarations, Air Alerts, and RAAN.

F.2.2.1 Air Alerts

The District alerts the public during unique air quality episodes like wildfires and windblown dust events. Health caution notices are prepared and public notification is provided through the District's website, social media and press releases to media and County health offices. Additionally, the District has collaborated with the National Weather Service (NWS) to issue Air Quality Alerts when major parts of the Valley are experiencing impacts from these unique episodes. During these alerts, the District utilizes the NWS public notification system to encourage that anyone being exposed to poor air quality or wildfire smoke move inside to an air-conditioned environment and limit their outdoor exertion. The District also advises individuals that if they can smell smoke or see ash that is an indication that they should be treating air quality conditions as "Unhealthy" (RAAN Level 4 or higher) and remain indoors.

F.2.2.2 Real – Time Air Advisory Network (RAAN)

The District launched the Real-time Air Advisory Network (RAAN) in 2010. This program is the first communication network in the nation to provide automated notification of poor or changing local air quality to the public throughout the air basin. While the District initially developed the program for schools as a tool to determine appropriate levels of outdoor activity for their students, the District expanded the program in 2011, and it is now available to all Valley residents.

The District combines local air quality information with specific, concentration-based health recommendations that allow RAAN subscribers to make informed decisions about when and for whom outdoor activities should be limited. The knowledge that exercise magnifies the health risks of PM2.5 exposure motivated the District to develop the RAAN program. Anyone can subscribe to RAAN at www.myraan.com; all that is required is the subscriber's email address. Once subscribed, the District will send email notifications with a link to the real-time data of the closest monitoring station within the District's extensive monitoring network. The District sends automated notifications on an hourly basis when air quality deteriorates or improves.

The District has provided Valley residents with a free smartphone app capable of delivering real-time air quality information, as well as other related information, since 2012. The District has since reengineered the app in-house and has released a brand new version in the spring of 2018, which serves both iPhone and android devices. The app provides easy access to RAAN data, notification of whether residential wood burning is allowed during the Check Before You Burn season, and the ability for a user to file an air quality complaint directly to the District, with photos if desired. A new feature of the app will be the users' ability to receive air quality information for their current location utilizing GPS, as well as other location addresses that can all be stored for quick reference. The District is expecting that the usage of the new app will be widespread and will help Valley residents receive timely air quality information that can be used to coordinate outdoor activities during periods of the best air quality.

To provide residents with the air quality information for their address, the District developed a first of its kind system for communicating neighborhood-level air quality by dividing the Valley into 4 km x 4 km grid cells (resulting in 3,600 neighborhoods) and taking into account the real-time meteorological conditions in each of the grid cells as well as observed air quality concentrations from the District's air monitoring network. This enhanced neighborhood RAAN was released in Spring 2018.

F.2.2.3 Real-Time Electronic Air Quality Display (READ)

When the District retired its colored Air Quality Flag Program in 2014, it intensified its focus on connecting schools to the RAAN because it is a far more health-protective outreach tool. While the flag program was based on the air quality forecast for the day, RAAN links the public to actual hourly readings from a network of local air monitors. The District developed a prototype display device to provide a visual indicator for school staff, students and parents to follow real-time changes to the RAAN levels throughout the day. These devices, or Real-time Electronic Air-quality Displays (READs) were designed to replace the air quality colored flags and the District plans to deploy 20 of them in a pilot project in schools throughout the Valley's eight counties. The 24-inch and 32-inch LED monitors connect to the internet and link to RAAN to provide the air quality level for the neighborhood in which it is located. The monitor fetches data every

30-60 seconds ensuring that the display is updated promptly when the hourly data becomes available. The first monitors were installed in schools in early 2018. An assessment of the pilot program will be performed at the end of the school year.[2]

F.2.2.4 Real-time Outdoor Activity Risk (ROAR)

To support the expanded RAAN program, the District developed the Real-time Outdoor Activity Risk (ROAR) scale. The levels of this scale provide specific recommendations and limitations for increasing levels of activity, from recess through competitive athletic events. This scale is based on the Air Quality Index system that is used for the daily air quality forecasts, but provides more detailed activity recommendations based on the latest health science. The ROAR system, when used in conjunction with RAAN notices and daily air quality forecasts, is part of a comprehensive set of tools available to schools and the public for effective health protection.

F.2.2.5 Web–Based Archived Air Quality (WAAQ) System

Providing accurate and up to date air quality information to Valley residents is a top priority for the District. This is especially important since there are times when the Valley's unique geography, topography, and meteorology overwhelm all clean air measures and lead to high pollution concentrations that may be unhealthy for Valley residents. High pollution concentrations also occur when exceptional events such as wildfires are experienced. Under these circumstances, the best course of action is to provide notifications to Valley residents so that sensitive individuals, in particular, can take precautions to minimize exposure.

Following-up on the success of the RAAN program, the District developed a system that provides air quality conditions on a neighborhood by neighborhood (4km x 4km) scale as opposed to being limited to only the readings from monitors. The District unveiled a state-of-the-art web tool for exploring historical air quality information at the neighborhood level. WAAQS allows anyone to compare air quality information over the past two decades in any Valley neighborhood. The District has now implemented WAAQS and it is available to the public on the District web at: http://www.valleyair.org/waaqs/

F.2.2.6 Check Before You Burn

The Check Before You Burn outreach program is critical to the implementation of District Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters). Rule 4901, along with the Check Before You Burn program, is credited with reducing levels of PM2.5 emissions during the winter season to historically low levels. The rule and outreach program was amended in 2008 and again in 2014 to reflect more stringent federal health-based standards, and together they have achieved the highest level of public recognition and compliance of any District program, with 80% of Valley residents professing awareness based on a 2014 public survey.[3] Recently, the District developed

[2] SJVAPCD 2017-18 Report to the Community. Available at http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2017/March/final/06.pdf

[3] San Joaquin Valley Air Pollution Control District: Memorandum to SJVUAPCD Governing Board, District's Public Opinion Survey Relating to Residential Wood Burning and Other Habits of Valley Residents. Fresno, CA: Public Governing Board Meeting, March 20, 2014. Available at http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2014/march/final/09.pdf

a new, more complete survey to assess wood burning behaviors and public perception of the District's programs. The results of the new survey will help the District gain more specific information for a comprehensive assessment of the District's current efforts and potential future strategies to further reduce pollution from residential wood burning.[4]

Annual Check Before You Burn outreach campaigns feature District Governing Board members in television, outdoor and print. media speaking to the public about how to get involved in clean air activities. The District continues to benefit from well established relationships with Valley meteorologists and daily burn status announcements in the weather segments of the evening news. The District also uses extensive social media posts (Facebook,Twitter and Instagram) to reach even more segments of the Valley's population. In addition, the District's toll-free information line and website receives thousands of "hits" during the wood-burning season, specifically to access daily wood burning status information.

F.2.2.7 Healthy Air Living (HAL)

Most of the District's outreach activities and programs are covered by the HAL umbrella. As a year-round message, the HAL goal of "make one change" promotes and encourages Valley residents and businesses to implement voluntary measures to reduce emissions and improve air quality. Many of the emission-reduction recommendations address PM2.5 emissions, either directly emitted or as byproducts of other pollutants (e.g. reducing the number of miles traveled in a car reduces NOx and, therefore, particulates).

Components of the HAL message include: *Healthy Air Heroes* kids activity kits aimed at elementary school students and their parents; the *Healthy Air Living Kids Calendar* for kindergarteners through high-school students; and *Healthy Air Living Schools program* which provides tools for educators to protect their students' health from the harmful effects of air pollution. In addition to these specific programs and others, the HAL logo and message are incorporated into the District's communications, collateral, incentive materials, and outreach efforts.

F.2.2.8 Healthy Air Living Partners

Through the HAL Partners program, adopted in 2009, the District provides participating businesses and entities with tools and educational materials to promote voluntary actions by employers and their employees to reduce emissions or shift emission-producing activities to non-peak periods.

F.2.3 PUBLIC PARTICIPATION

Non-regulatory strategies help accelerate attainment and have been an important part of the District's air quality attainment plans. The following strategies are supported by the District as alternative methods for the public to implement to reduce emissions in the Valley.

[4] San Joaquin Valley Air Pollution Control District: Memorandum to SJVUAPCD Governing Board, District's Residential Wood Burning Survey Results. Fresno, CA: Public Governing Board, January 18, 2018. Available at http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2018/January/final/10.pdf

F.2.3.1 Green Purchasing and Contracting

Valley businesses and government agencies can get involved in air quality improvements by considering the environmental impacts when making purchasing and contracting decisions. Green purchasing and contracting is the selection of goods, services, and vehicles that have a reduced impact on human health and the environment when compared with other products that serve the same purpose. These efforts can reduce waste, energy consumption and the overall impact of day to day operations. When making purchasing decisions, preference should be given to environmentally responsible products, materials and supplies; fuel-efficient, low-emission and hybrid vehicles; energy-efficient and water-efficient appliances; and service providers who employ greener methods.

The District has created the *Green Purchasing and Contracting: A guide to reducing environmental impacts through the procurement process* guideline and made it available on the District webpage.[5] The District has also set an example for other agencies by adopting and implementing its own Green Procurement & Sustainable Practices Policy in January 2012. The District will continue to support Valley organizations in adopting policies and practices to make green purchasing and contracting a routine part of their operations.

F.2.3.2 Energy Efficiency and Conservation

California has been on the forefront of developing renewable energy sources and has implemented regulations to ensure cleaner non-renewable energy. The District's involvement in energy efficiency and renewable energy is guided by its Regional Energy Efficiency Strategy (REES), adopted in January 2010.[6] This policy identifies the District's commitment to fostering energy efficiency and clean energy alternatives as opportunities for emissions reductions. The District continues to work with stakeholders and state agencies to expand net metering and feed-in tariffs for use of solar and other renewable energy sources, promote energy efficiency programs for energy end users that will result in lower emissions and a more stable electrical distribution system, and develop measures that incentivize and encourage low-emission technologies for use of waste gas as an alternative to waste-gas venting or flaring.

F.2.3.3 Roadmap for Incorporating Energy Efficiency and Renewable Energy Policies and Programs into State Implementation Plans

On July 3, 2012, EPA released the first version of The Roadmap for incorporating Energy Efficiency/ Renewable Energy Policies and Programs into State and Tribal Implementation Plans which is part of EPA's effort to encourage state, tribal, and local agencies to consider incorporating energy efficiency and renewable energy policies and programs in their state and Tribal Implementation Plans (SIPs/TIPs). The initiative,

[5] SJVAPCD. *Green Purchasing and Contracting: A guide to reducing environmental impacts through the procurement process.* Available at http://www.valleyair.org/Programs/FastTrack/2011/GreenPurchasingReport4-6-11%20_2_.pdf.
[6] San Joaquin Valley Air Pollution Control District. (2010). *Approval of the District's Regional Energy Efficiency Strategy*. Memorandum to the SJVAPCD Governing Board. Public Hearing, January 21, 2010. http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2010/January/Agenda_Item_7_Jan_21_2010.pdf

available at http://www.epa.gov/airquality/eere/, includes a manual, training, tools, and technical assistance.

F.2.3.4 Eco-Driving

Finding ways, through education and outreach, to reduce emissions from mobile sources in the Valley is critical to attainment of federal air quality standards. One such program in development is Eco-Driving. Eco-Driving refers to everyday techniques that drivers can do to maximize the fuel economy of their vehicles. These include: observing good operating maintenance, such as proper tire pressure, wheel alignment, and oil viscosity; improving aerodynamics; traveling at efficient speeds; choosing the appropriate gear for manual transmissions; driving defensively to avoid unnecessary braking; accelerating at a constant pace; and other simple, yet often forgotten, driving techniques. As with other informational activities conducted by the District, an Eco-Driving program could be encompassed under the Healthy Air Living umbrella.

F.2.3.5 Alternative Energy Production

The District encourages cleaner ways of generating electricity and mechanical power, and moving vehicles, in addition to overall reductions in energy use. These alternative energy choices include renewable energy, waste-to-energy systems, and alternative fuels and vehicle technologies. The District also encourages the use of alternative energy sources that are clearly cleaner than industry standards in terms of criteria pollutants. The District's *Alternative Energy: On the Fast Track to Clean Air*[7], is a guideline for considering clean energy options in the Valley that discuss, and provide additional resources for, the District's current recommendations regarding the most advantageous and viable alternative energy systems. Alternative energy choices include solar energy, wind turbines, biomass, dairy digesters, and electric irrigation pumps, just to name a few.

F.2.3.6 Replacement of High-Polluting Devices

The residents of the Valley can reduce emissions through the replacement of high-polluting devices with cleaner technologies. Two examples include the replacement of open hearth fireplaces and higher polluting wood burning devices with natural gas or certified EPA wood burning devices and the replacement of gas powered lawnmowers with electric lawnmowers. The District supports these transitions by providing incentive funding to replace high polluting units with cleaner alternatives. The District also supports the efforts of Valley residents to replace and/or repair motor vehicles through additional incentive programs. Examples of District incentive programs aimed at residents of the Valley include:

- Burn Cleaner
- Clean Green Yard Machine
- Tune-in & Tune-Up
- Vanpool Voucher
- Drive Clean in the San Joaquin

[7] SJVAPCD. *Alternative Energy: On the Fast Track to Clean Air. A Guide for Considering Clean Energy Options in the San Joaquin Valley.* Available at http://www.valleyair.org/Programs/FastTrack/2011/Alternative%20Energy.pdf

Additional details of these programs can be found on the District website at: http://valleyair.org/grants/

F.2.3.7 Employer-Based Trip Reduction

The goal of District Rule 9410 (Employer-Based Trip Reduction) (eTRIP Rule) is to reduce single-occupancy-vehicle work commutes. The eTRIP Rule requires the Valley's larger employers, representing a wide range of locales and sectors, to select and implement workplace measures that make it easier for their employees to choose ridesharing and alternative transportation. Because of the diversity of employers covered by the eTRIP Rule, the rule was built with a flexible, menu-based approach. Using the eTRIP Plan, employers choose from a list of measures, each contributing to a workplace that encourages employees to reduce their dependence on single-occupancy vehicles. Each eTRIP measure has a point value, and employer eTRIP Plans must reach specified point targets for each strategy. The District has continually provided employer assistance through training, guidance materials, promotional information, and online reporting options.

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Appendix G
Precursor Demonstration

San Joaquin Valley Air Pollution Control District
2018 PM2.5 SIP

Precursor Demonstrations for Ammonia, SOx, and ROG

Appendix: Precursor Demonstrations for Ammonia, SOx, and ROG
San Joaquin Valley PM2.5 SIP

INTRODUCTION

Fine particulate matter ($PM_{2.5}$) is made up of many constituent particles that are either directly emitted, such as soot and dust, or formed through complex reactions of gases in the atmosphere. Oxides of nitrogen (NOx), sulfur dioxide (SO_2), volatile organic compounds (VOCs), and ammonia (NH_3) are gases that are precursors to $PM_{2.5}$, transforming into particles through physical and chemical atmospheric processes.

The United States Environmental Protection Agency (U.S. EPA) finalized a $PM_{2.5}$ State Implementation Plan (SIP) Requirements Rule[1] (Rule) that identifies the four $PM_{2.5}$ precursor pollutants—NOx, SO_2, VOCs, and ammonia—that "must be evaluated for potential control measures in any $PM_{2.5}$ attainment plan."[2] The Rule permits air agencies to "submit an optional precursor demonstration designed to show that for a specific $PM_{2.5}$ nonattainment area, emissions of a particular precursor from sources within the nonattainment area do not or would not contribute significantly to $PM_{2.5}$ levels that exceed" the National Ambient Air Quality Standards (NAAQS).[3] If the agency's demonstration is approved by U.S. EPA, the attainment plan "may exclude that precursor from certain control requirements under the Clean Air Act."[4]

This appendix includes precursor demonstrations for three $PM_{2.5}$ precursors: ammonia, oxides of sulfur (SOx), and reactive organic gases (ROG). The California Air Resources Board (CARB) inventory tracks SOx rather than SO_2 specifically, but SOx consists mostly of SO_2. ROG is similar, although not identical, to U.S. EPA's term "VOC."[5] CARB's inventory tracks ROG as a subset of total organic gases (TOG). This appendix does not include a precursor demonstration for NOx, since NOx is an important and significant precursor to $PM_{2.5}$ and is controlled extensively in the SIP, and because reductions of NOx emissions are essential to the attainment strategy for the San Joaquin Valley (Valley).

Following U.S. EPA guidance, the three precursor demonstrations analyze "the relationship between precursor emissions and the formation of secondary $PM_{2.5}$ components"[6] using an air quality model, and take into consideration additional relevant factors.

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[1] 81 FR 58010 (August 24, 2016)
[2] United States Environmental Protection Agency. *$PM_{2.5}$ Precursor Demonstration Guidance: Draft for Public Review and Comment*. 17 Nov. 2016. Web. 3 Oct. 2017. <www.U.S. EPA.gov/sites/production/files/2016-11/documents/transmittal_memo_and_draft_pm25_precursor_demo_guidance_11_17_16.pdf>. Page 7
[3] Ibid. 7
[4] Ibid. 7
[5] See: California Air Resources Board. "FACT SHEET #1: Development of Organic Emission Estimates For California's Emission Inventory and Air Quality Models." Aug. 2000. Web. 24 May 2018. <www.arb.ca.gov/ei/speciate/factsheetsmodeleispeciationtog082000.pdf>
See also: California Air Resources Board. "Definitions of VOC and ROG." Jan. 2009. Web. 24 May 2018. <www.arb.ca.gov/ei/speciate/voc_rog_dfn_1_09.pdf>
[6] U.S. EPA. *$PM_{2.5}$ Precursor Demonstration Guidance: Draft for Public Review and Comment*. Page 26

U.S. EPA $PM_{2.5}$ PRECURSOR DEMONSTRATION GUIDANCE

In November 2016, U.S. EPA published a draft guidance document to "assist air agencies who may wish to submit $PM_{2.5}$ precursor demonstrations."[7] The document provides recommendations or guidelines, as authorized under the Clean Air Act, "that will be useful to air agencies in developing the precursor demonstrations by which the EPA can ultimately determine whether sources of a particular precursor contribute significantly to $PM_{2.5}$ levels that exceed the standard in a particular nonattainment area."[8] Recommendations include modeling procedures for conducting the required analysis and contribution thresholds to determine the impact of a precursor on $PM_{2.5}$ levels.[9] The guidance also describes an analytical process to perform the precursor demonstration, involving a sensitivity-based analysis followed by a consideration of additional information.

Sensitivity-Based Analysis

The evaluation of the precursors begins with a sensitivity-based analysis to determine whether precursor emissions contribute to total $PM_{2.5}$ concentrations. According to the guidance:

> This modeling analysis examines the sensitivity of ambient $PM_{2.5}$ concentrations in the nonattainment area to certain amounts of decreases in the precursor emissions in the area…. Where decreases in emissions of the precursor result in negligible air quality impacts (i.e., the area is "not sensitive" to decreases), such a small degree of impact is not significant and can be considered to not "contribute" to $PM_{2.5}$ concentrations for the purposes of determining whether control requirements should apply.[10]

Generally, U.S. EPA recommends that the precursor demonstration "should be based on current conditions to demonstrate that precursor emissions do not contribute significantly to $PM_{2.5}$ concentrations in the nonattainment area."[11] This means evaluating emissions in a selected base year, which may be the present or a previous year.

For each existing $PM_{2.5}$ monitor location in the area,[12] the first step for estimating $PM_{2.5}$ impacts from ammonia, SOx, or ROG in the base year is to estimate the average $PM_{2.5}$ concentration on an annual and 24-hour basis. The second step is to calculate the annual and 24-hour average $PM_{2.5}$ concentration at each monitor with a specified percent reduction in precursor emissions, still in the base year.[13] The difference between these two calculated $PM_{2.5}$ values is the impact on $PM_{2.5}$ levels from precursor emissions reductions.[14] Note that "precursor demonstrations do not examine changes in emissions *between a base year and a future year*. Instead, the calculation of relative

[7] Ibid. 7
[8] Ibid. 7-8
[9] Ibid. 9
[10] Ibid. 25
[11] Ibid. 33
[12] Ibid. 16
[13] Ibid. 36
[14] Ibid. 36

changes in $PM_{2.5}$ concentrations occur *between a modeled case with all emissions and a modeled case with reduced precursor emissions*" (emphasis added).[15] In addition, U.S. EPA recommends modeling reductions of between 30 and 70 percent of precursor emissions.[16]

The third step in the sensitivity-based analysis is to compare the modeled impact on $PM_{2.5}$ levels from a decrease in ammonia, SOx, or ROG emissions to contribution thresholds for annual and 24-hour $PM_{2.5}$.[17] U.S. EPA recommends values for these thresholds, or air quality concentrations below which air quality impacts are not statistically significantly different from "the inherent variability in the measured atmospheric conditions," and thus do not contribute to $PM_{2.5}$ concentrations that exceed the NAAQS.[18] These thresholds are 0.2 micrograms per cubic meter ($\mu g/m^3$) for the annual $PM_{2.5}$ standard, and 1.3 $\mu g/m^3$ for the 24-hour $PM_{2.5}$ standard.[19] If the calculated $PM_{2.5}$ impact is greater than 0.2 $\mu g/m^3$ for the annual standard or greater than 1.3 $\mu g/m^3$ for the 24-hour standard, then $PM_{2.5}$ levels are sensitive to the modeled percent reduction in ammonia, SOx, or ROG emissions.

Consideration of Additional Information

To supplement modeling analysis, U.S. EPA guidance also allows an air agency to consider additional information, assessing the significance of a precursor "'based on the facts and circumstances of the area.'"[20] The guidance states:

> If the estimated air quality impact exceeds the recommended contribution thresholds…, this fact does not necessarily preclude approval of the precursor demonstration. There may be cases where it could be determined that precursor emissions have an impact above the recommended contribution thresholds, yet do not "significantly contribute" to levels that exceed the standard in the area.[21]

In these cases, an air agency may "provide the [U.S.] EPA with information related to other factors they believe should be considered in determining whether the contribution of emissions of a particular precursor to levels that exceed the NAAQS is 'significant' or not."[22] Such factors may include: trends in emissions of other precursors such as NOx,[23] anticipated growth or loss of emissions sources,[24] and the consequent appropriateness of modeling impacts in a future year instead of a base year;[25] "available emissions controls,"[26] and "the severity of nonattainment at relevant monitors."[27] These factors are discussed in the context of the precursor analyses for the Valley in the subsequent sections.

[15] Ibid. 34
[16] Ibid. 29
[17] Ibid. 25
[18] Ibid. 14, 15
[19] Ibid. 15-16
[20] Ibid. 17
[21] Ibid. 17
[22] Ibid. 17
[23] Ibid. 17
[24] Ibid. 17
[25] Ibid. 33
[26] Ibid. 29
[27] Ibid. 17

Other factors the agency may consider are: the amount by which a precursor's contribution exceeds the recommended contribution thresholds; source characteristics (e.g., source type, stack height, location); analyses of speciation data and precursor emission inventories; chemical tracer studies; and special intensive measurement studies to evaluate specific atmospheric chemistry in an area. The agency may also provide other information not listed here.[28]

The following sections contain sensitivity-based analyses and supplemental information demonstrating that ammonia, SOx, and ROG are not significant precursors to $PM_{2.5}$ in the Valley.

[28] Ibid. 17

AMMONIA ANALYSIS

Ammonium nitrate (NH_4NO_3) is a constituent of $PM_{2.5}$, making up about 40 percent of fine particulate matter mass in the Valley. Ammonium nitrate forms when nitrogen dioxide (NO_2) reacts with highly oxidizing species in the atmosphere to form nitric acid (HNO_3). Nitric acid then reacts with ammonia (NH_3) to yield ammonium nitrate as a particle. Since ammonia reacts chemically in this way to form a particle, ammonia is a precursor to $PM_{2.5}$.

Lowering $PM_{2.5}$ concentrations to levels that meet the NAAQS will rely upon an effective control strategy for ammonium nitrate. The amount of ammonium nitrate that can form in the atmosphere is limited by whichever precursor, either NOx or ammonia, is in least supply, and research studies confirm that there are relatively fewer NOx molecules in the air in the Valley than ammonia. This implies that reducing NOx, the limiting precursor in this case, is more effective for reducing ammonium nitrate concentrations and thus improving $PM_{2.5}$ air quality.

Following the analytical process outlined in the U.S. EPA precursor demonstration guidance and summarized above, CARB has evaluated ammonia in the Valley. The results of the sensitivity-based analysis and consideration of additional information are presented below.

Sensitivity-Based Analysis

CARB staff used an air quality model to estimate the $PM_{2.5}$ design value for the annual and 24-hour standards in the base year of 2013 at each Valley monitor. Then, CARB staff applied the recommended lower bound of a 30 percent reduction to ammonia emissions and used the air quality model to estimate the $PM_{2.5}$ design values, as shown in Table 1. The difference between the two design values represents the modeled impact on $PM_{2.5}$ levels of a 30 percent reduction in ammonia emissions in 2013. This is the value that is compared to U.S. EPA's recommended contribution thresholds of 0.2 $\mu g/m^3$ for the annual standard and 1.3 $\mu g/m^3$ for the 24-hour standard to establish if $PM_{2.5}$ levels are sensitive to this level of ammonia reduction.

Table 1. Base Year 2013 $PM_{2.5}$ – 30 Percent Ammonia Reduction

	Annual			24-Hour		
Site*	**2013 Baseline DV**	**2013 DV with 30% Ammonia Reduction+**	**Difference**	**2013 Baseline DV**	**2013 DV with 30% Ammonia Reduction**	**Difference**
Bakersfield-Planz	17.19	16.76	0.43	55.5	53.3	2.2
Madera	16.93	16.29	0.64	51.0	49.2	1.7
Hanford	16.54	15.82	0.72	60.0	57.8	2.1
Visalia	16.20	15.82	0.38	55.5	53.5	2.0
Clovis	16.12	15.80	0.32	55.8	54.0	1.9
Bakersfield-California	16.02	15.58	0.44	64.1	60.8	3.3
Fresno-Garland	14.98	14.69	0.29	60.0	58.0	2.0
Turlock	14.88	14.46	0.42	50.7	49.3	1.5
Fresno-HW	14.22	13.95	0.27	59.3	57.4	2.0
Stockton	13.14	12.84	0.30	42.0	41.0	1.0
Merced-S Coffee	13.10	12.65	0.45	41.1	40.0	1.1
Modesto	13.03	12.66	0.37	47.9	46.5	1.5
Merced-M	10.97	10.77	0.20	46.9	45.9	1.0
Manteca	10.09	9.85	0.24	36.9	36.0	0.9
Tranquility	7.72	7.33	0.39	29.5	27.2	2.2

* The site at Corcoran does not have a valid design value because of missing data, and is thus excluded from all precursor analyses.
+ Numbers may not sum exactly due to rounding.

For completeness, CARB staff repeated this analysis, applying instead the U.S. EPA-recommended upper bound of a 70 percent reduction to ammonia emissions in the base year, as shown in Table 2.

Table 2. Base Year 2013 $PM_{2.5}$ – 70 Percent Ammonia Reduction

	Annual			24-Hour		
Site	**2013 Baseline DV**	**2013 DV with 70% Ammonia Reduction**	**Difference**	**2013 Baseline DV**	**2013 DV with 70% Ammonia Reduction**	**Difference**
Bakersfield-Planz	17.19	15.72	1.47	55.5	46.5	9.0
Madera	16.93	14.81	2.12	51.0	43.4	7.6
Hanford	16.54	14.24	2.30	60.0	50.6	9.4
Visalia	16.20	14.80	1.40	55.5	45.8	9.7
Clovis	16.12	14.95	1.17	55.8	47.0	8.8
Bakersfield-California	16.02	14.47	1.55	64.1	51.7	12.4
Fresno-Garland	14.98	13.91	1.07	60.0	52.5	7.5
Turlock	14.88	13.46	1.42	50.7	44.4	6.3
Fresno-HW	14.22	13.17	1.05	59.3	49.7	9.6
Stockton	13.14	12.10	1.04	42.0	37.9	4.1
Merced-S Coffee	13.10	11.60	1.50	41.1	36.6	4.5
Modesto	13.03	11.78	1.25	47.9	41.6	6.4
Merced-M	10.97	10.23	0.74	46.9	41.9	5.0
Manteca	10.09	9.27	0.82	36.9	33.4	3.5
Tranquility	7.72	6.46	1.26	29.5	20.7	8.8

From this analysis, the estimated air quality impact of reducing ammonia emissions by the lower bound of 30 percent in the base year exceeds U.S. EPA's recommended thresholds at all but a few Valley monitors, for both the annual and 24-hour standards. Reducing emissions by the upper bound of 70 percent also shows impacts above the thresholds.

It is not possible, however, to conclude from this analysis that emissions of ammonia "significantly contribute." In this case, ammonia emissions have an impact above the recommended contribution thresholds even at the lower bound, but, as the U.S. EPA guidance indicates, this does not necessarily mean the precursor contributes significantly to $PM_{2.5}$ levels that exceed the NAAQS. Making the appropriate determination about the ammonia emission reduction impact requires further analysis of additional factors.

Consideration of Additional Information

To supplement modeling analysis, U.S. EPA guidance also allows an air agency to consider additional information, assessing the significance of a precursor "'based on the facts and circumstances of the area.'"[29] CARB staff believes that there are several critical factors that must be considered in determining whether ammonia is a significant precursor to $PM_{2.5}$ in the Valley.

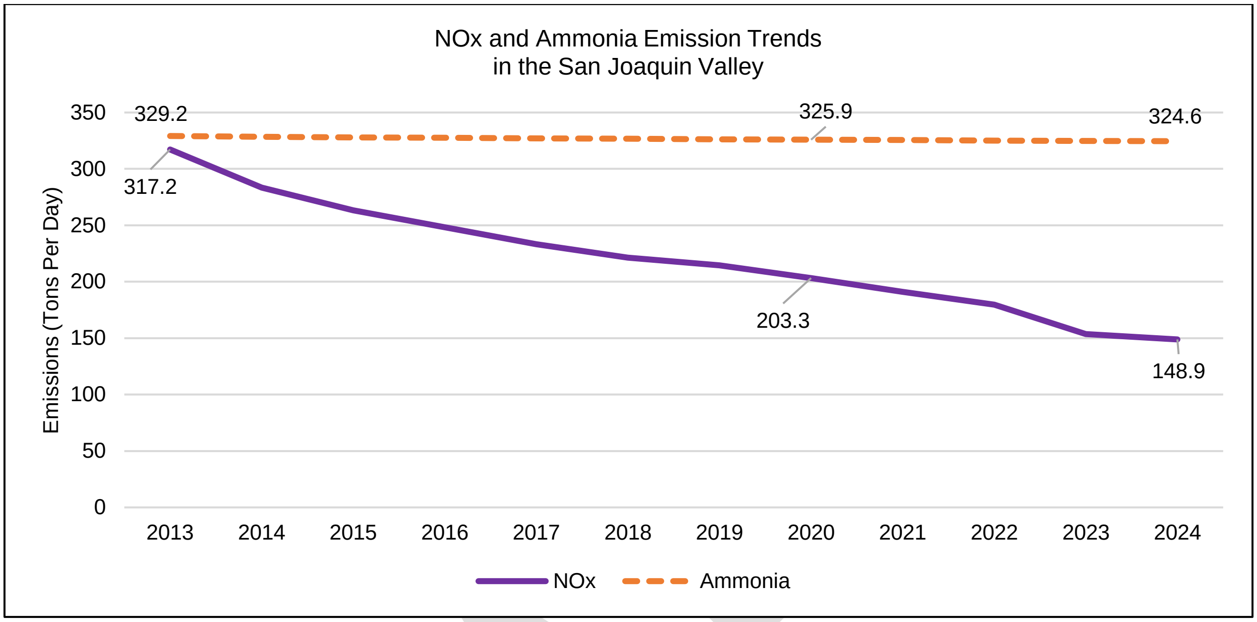
Emissions Trends and Studies

CARB has an extensive suite of measures in place to reduce NOx emissions from mobile sources that reduce ammonium nitrate. Between 2013 and 2020—the attainment year for the 1997 annual and 24-hour $PM_{2.5}$ standards—total NOx emissions are expected to decline 36 percent, and between 2013 and 2024—the attainment year for the 2006 24-hour $PM_{2.5}$ standard—total NOx emissions are projected to decline 53 percent. Meanwhile, total ammonia emissions are expected to remain flat, as shown in Figure 1. The San Joaquin Valley Air Pollution Control District (District) adopted four rules[30] between 2004 and 2011 with measures that provided ammonia emissions reductions in the Valley of approximately 50 tons per day (tpd); however, reductions from these existing control measures are already accounted for in the inventory, prior to the base year of 2013. In the future, emissions from the main sources of ammonia—dairies, fertilizer, and non-dairy livestock operations—are not anticipated to either increase or decrease substantially.

[29] Ibid. 17

[30] District Rule 4550: Conservation Management Practices (adopted 2004); Rule 4565: Biosolids, Animal Manure, and Poultry Litter Operations (adopted 2007); Rule 4566: Organic Material Composting Operations (adopted 2011); and Rule 4570: Confined Animal Facilities (adopted 2006, amended 2010)

Figure 1. NOx and ammonia emission trends in the San Joaquin Valley between 2013 and 2024



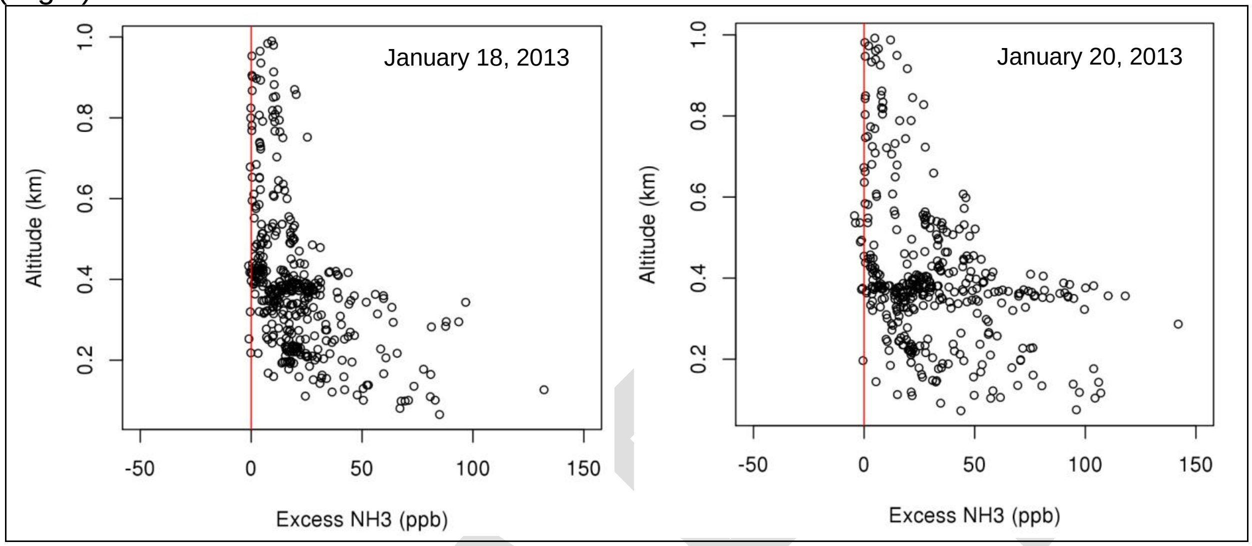
Source: CEPAM Inventory version 1.05

The steep downward trend of NOx emissions and the stability of ammonia emissions between 2013 and 2024 lead CARB staff to conclude that modeling the impact of ammonia emissions reductions in the future, rather than the base year, is appropriate and more representative of the Valley's emissions conditions. U.S. EPA guidance states that, in some situations, it may be "more appropriate to model future conditions that provide a more representative sensitivity analysis."[31] This approach is applicable in the Valley. Although emissions of NOx and ammonia are of roughly similar magnitude in the base year, thereby leading to some modeled sensitivity of $PM_{2.5}$ levels to a 30 percent reduction in ammonia emissions, these conditions do not persist and are not representative in the future.

Recent research further supports the fact that ammonia emissions are already in excess in the Valley. Field study measurements conducted during the 2013 DISCOVER-AQ study indicate that ammonia is in excess of NOx on peak $PM_{2.5}$ days in the Valley, as illustrated in Figure 2. These data imply that ammonium nitrate formation in the Valley is limited by the amount of NOx present in the air.

[31] U.S. EPA. *$PM_{2.5}$ Precursor Demonstration Guidance: Draft for Public Review and Comment*. Page 33

Figure 2. Excess ammonia (NH_3) in the San Joaquin Valley on Jan 18 (Left) and Jan 20 (Right) based on NASA aircraft measurements in 2013



This finding that nitrate formation in the Valley is in a NO_x-limited regime is consistent with previous research. For instance, Lurmann et al. (2006) note that "[t]he consistent excess of NH_3 over nitric acid levels indisputably shows that secondary ammonium nitrate formation is more limited by nitric acid availability than NH_3 within the SJV and in the foothills."[32] Since ammonium nitrate formation is limited by NOx, reducing NOx emissions is the more effective strategy for reducing ammonium nitrate and $PM_{2.5}$. Other research has found that ammonia concentrations in the San Joaquin Valley have increased, further confirming that NOx reductions are the most effective path to reducing $PM_{2.5}$.

Future Year Modeling

CARB staff therefore repeated the sensitivity-based analysis of ammonia for the future attainment years of 2020 and 2024.[33] Staff used an air quality model to estimate the $PM_{2.5}$ design value for the annual and 24-hour standards in 2020 and 2024 at each Valley monitor. Then, CARB staff applied a 30 percent reduction to ammonia emissions and used the air quality model to estimate the $PM_{2.5}$ design values in 2020 and 2024, shown in Tables 3 and 4 respectively. The difference between the two design values represents the modeled impact on $PM_{2.5}$ levels of a 30 percent reduction in ammonia emissions in each attainment year.

[32] Lurmann et al. "Processes influencing secondary aerosol formation in the San Joaquin Valley during winter." Journal of the Air & Waste Management Association. 2006. Web. 3 Oct. 2017. <http://www.tandfonline.com/doi/pdf/10.1080/10473289.2006.10464573>. Page 1688

[33] CARB did not conduct sensitivity analysis for the 2025 attainment year for the 2012 annual $PM_{2.5}$ standard due to the close proximity of the attainment years for the 2012 and 2006 standards. Precursor sensitivities in 2025 are assumed to be very similar to those modeled in 2024.

Table 3. Future Year 2020 $PM_{2.5}$ – 30 Percent Ammonia Reduction

	Annual			24-Hour		
Site	**2020 Baseline DV**	**2020 DV with 30% Ammonia Reduction**	**Difference**	**2020 Baseline DV**	**2020 DV with 30% Ammonia Reduction**	**Difference**
Bakersfield-Planz	14.58	14.34	0.24	41.2	39.8	1.4
Madera	14.15	13.79	0.36	38.9	37.8	1.0
Hanford	13.30	12.88	0.42	43.7	42.3	1.4
Visalia	13.51	13.28	0.23	42.8	41.5	1.3
Clovis	13.43	13.25	0.18	41.1	40.3	0.9
Bakersfield-California	13.48	13.24	0.24	47.6	45.7	1.9
Fresno-Garland	12.42	12.25	0.17	44.3	43.2	1.1
Turlock	12.47	12.20	0.27	37.8	36.8	1.0
Fresno-HW	11.86	11.70	0.16	45.6	44.5	1.1
Stockton	11.43	11.23	0.20	33.5	32.8	0.7
Merced-S Coffee	10.86	10.60	0.26	30.0	29.4	0.5
Modesto	10.97	10.74	0.23	35.8	34.9	0.9
Merced-M	9.34	9.22	0.12	32.9	32.3	0.6
Manteca	8.67	8.51	0.16	30.1	29.6	0.5
Tranquility	6.40	6.19	0.21	21.5	20.3	1.2

In 2020, the modeled air quality impact of reducing ammonia emissions by 30 percent falls under U.S. EPA's recommended threshold at all but four Valley monitors for the 24-hour standard. The air quality impact remains above U.S. EPA's recommended annual threshold at most sites.

Table 4. Future Year 2024 $PM_{2.5}$ – 30 Percent Ammonia Reduction

	Annual			24-Hour		
Site	**2024 Baseline DV**	**2024 DV with 30% Ammonia Reduction**	**Difference**	**2024 Baseline DV**	**2024 DV with 30% Ammonia Reduction**	**Difference**
Bakersfield-Planz	12.03	11.79	0.12	30.0	29.2	0.7
Madera	11.98	11.77	0.21	30.2	29.5	0.7
Hanford	10.52	10.26	0.26	30.1	29.1	1.0
Visalia	11.09	10.97	0.12	30.2	29.4	0.8
Clovis	11.37	11.27	0.10	30.7	30.0	0.7
Bakersfield-California	11.01	10.78	0.12	33.3	32.2	1.0
Fresno-Garland	10.43	10.33	0.10	32.8	32.1	0.7
Turlock	11.14	10.95	0.19	30.2	29.5	0.7
Fresno-HW	10.02	9.92	0.10	35.1	34.4	0.8
Stockton	10.66	10.50	0.16	28.6	28.1	0.5
Merced-S Coffee	9.65	9.47	0.18	24.2	23.8	0.4
Modesto	9.97	9.79	0.18	29.1	28.5	0.6
Merced-M	8.61	8.53	0.08	27.4	27.0	0.5
Manteca	7.97	7.85	0.12	25.8	25.4	0.4
Tranquility	5.54	5.42	0.12	16.2	15.6	0.6

In 2024, the modeled air quality impact of reducing ammonia emissions by 30 percent falls under U.S. EPA's recommended annual threshold at all but two Valley monitors, and falls under the 24-hour threshold at all sites.

For completeness, CARB staff repeated this analysis, applying instead the U.S. EPA-recommended upper bound of a 70 percent reduction to ammonia emissions in 2020 and 2024, as shown in Tables 5 and 6.

Table 5. Future Year 2020 $PM_{2.5}$ – 70 Percent Ammonia Reduction

	Annual			24-Hour		
Site	**2020 Baseline DV**	**2020 DV with 70% Ammonia Reduction**	**Difference**	**2020 Baseline DV**	**2020 DV with 70% Ammonia Reduction**	**Difference**
Bakersfield-Planz	14.58	13.79	0.79	41.2	35.8	5.4
Madera	14.15	12.97	1.18	38.9	35.2	3.6
Hanford	13.30	12.00	1.30	43.7	39.1	4.6
Visalia	13.51	12.72	0.79	42.8	37.0	5.8
Clovis	13.43	12.79	0.64	41.1	36.4	4.7
Bakersfield-California	13.48	12.66	0.82	47.6	41.2	6.4
Fresno-Garland	12.42	11.82	0.60	44.3	39.7	4.6
Turlock	12.47	11.62	0.85	37.8	34.5	3.2
Fresno-HW	11.86	11.23	0.63	45.6	39.8	5.8
Stockton	11.43	10.77	0.66	33.5	31.4	2.1
Merced-S Coffee	10.86	10.02	0.84	30.0	27.8	2.2
Modesto	10.97	10.22	0.75	35.8	32.5	3.3
Merced-M	9.34	8.93	0.41	32.9	30.6	2.3
Manteca	8.67	8.15	0.52	30.1	28.5	1.6
Tranquility	6.40	5.76	0.64	21.5	17.6	4.0

Table 6. Future Year 2024 $PM_{2.5}$ – 70 Percent Ammonia Reduction

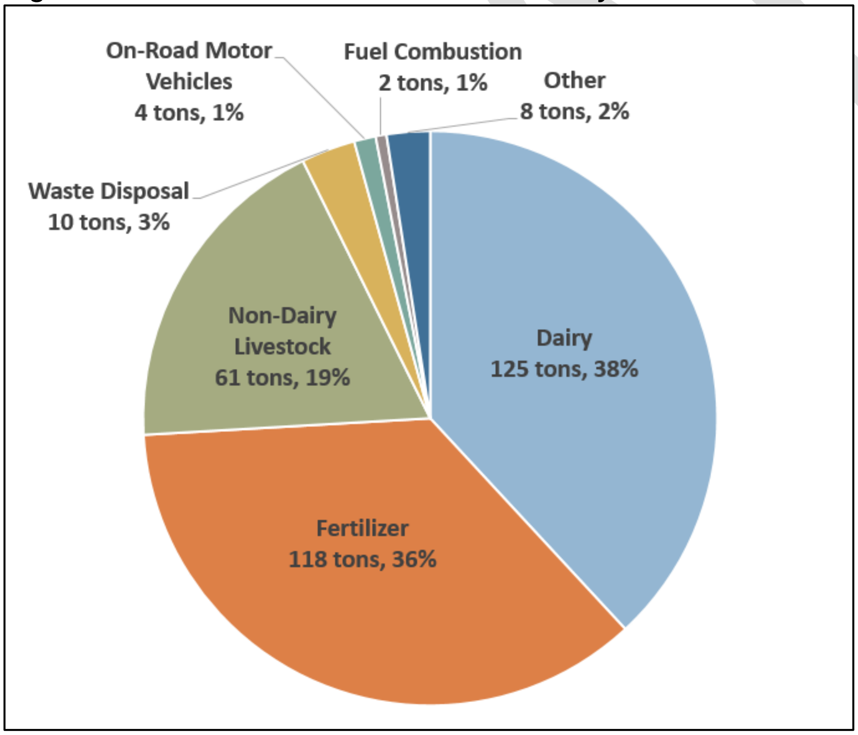
	Annual			24-Hour		
Site	**2024 Baseline DV**	**2024 DV with 70% Ammonia Reduction**	**Difference**	**2024 Baseline DV**	**2024 DV with 70% Ammonia Reduction**	**Difference**
Bakersfield-Planz	12.03	11.55	0.36	30.0	27.6	2.2
Madera	11.98	11.32	0.66	30.2	28.6	1.6
Hanford	10.52	9.77	0.75	30.1	27.1	3.0
Visalia	11.09	10.71	0.38	30.2	27.6	2.5
Clovis	11.37	11.05	0.32	30.7	28.4	2.3
Bakersfield-California	11.01	10.54	0.36	33.3	30.3	2.8
Fresno-Garland	10.43	10.22	0.32	32.8	30.9	1.9
Turlock	11.14	10.53	0.61	30.2	28.1	2.1
Fresno-HW	10.02	9.68	0.34	35.1	32.2	2.9
Stockton	10.66	10.14	0.52	28.6	27.1	1.5
Merced-S Coffee	9.65	9.12	0.53	24.2	23.0	1.2
Modesto	9.97	9.41	0.56	29.1	26.9	2.2
Merced-M	8.61	8.35	0.26	27.4	26.0	1.4
Manteca	7.97	7.57	0.40	25.8	24.4	1.4
Tranquility	5.54	5.19	0.35	16.2	14.4	1.8

From this analysis, the estimated air quality impact of reducing ammonia emissions by the upper bound of 70 percent in 2020 and 2024 exceeds U.S. EPA's recommended thresholds for both the annual and 24-hour standards at all sites except one.

Available Emissions Controls

Available emissions controls on ammonia are also relevant to the decision-making process, influencing the extent of reasonable modeled reductions. While U.S. EPA recommends modeling emissions reductions of between 30 and 70 percent to estimate $PM_{2.5}$ impacts,[34] CARB staff have not identified controls that are technologically and economically feasible to achieve reductions even at the low end of the recommended sensitivity range (i.e. 30 percent). Emissions of ammonia in the Valley are approximately 329 tpd, as shown in Figure 3, meaning reductions would need to be in the range of approximately 99 to 230 tpd (30 to 70 percent). The District's existing rules that provide ammonia emissions reductions reflect the best available control measures for ammonia sources in the Valley, and implementation of these measures cannot feasibly reduce emissions by 30 percent. Therefore, CARB staff determined that modeled emissions reductions of 30 percent were an upper bound for potential ammonia reductions.

Figure 3. Sources of ammonia in the Valley, 2013



Source: CEPAM Inventory version 1.05

Relevant Monitors

The impact of ammonia on $PM_{2.5}$ at monitors that form the basis of the attainment finding for the Valley is the focus of this analysis. For purposes of demonstrating

[34] U.S. EPA. *$PM_{2.5}$ Precursor Demonstration Guidance: Draft for Public Review and Comment*. Page 29

attainment of all three $PM_{2.5}$ NAAQS, the relevant monitor is at the site in Bakersfield which currently records the highest levels. U.S. EPA guidance permits consideration of "the severity of nonattainment at relevant monitors,"[35] and in 2024, $PM_{2.5}$ levels are not sensitive to ammonia reductions at this relevant site.

The sites at Madera and Hanford show an impact over the recommended threshold for the annual standard. Madera's design value, however, is not representative of air quality in the area; CARB has previously documented that this design value is an artifact of inaccurate monitor data. In addition, the Madera monitor is already nearing the 12 $\mu g/m^3$ $PM_{2.5}$ standard. For Hanford, while the impact is over U.S. EPA's recommended significance level, achieving the level of controls needed for a 30 percent reduction of ammonia is not feasible, as discussed above.

Conclusion

CARB has followed U.S. EPA guidance to evaluate whether ammonia contributes significantly to $PM_{2.5}$ levels that exceed the NAAQS. Considering relevant contextualizing information such as emissions, research, and available controls, along with performing sensitivity-based analysis in future years, CARB determined that emissions of ammonia do not contribute significantly to $PM_{2.5}$ levels that exceed the 1997, 2006, or 2012 NAAQS in the area. Therefore, CARB has excluded ammonia from control requirements in the SIP.

[35] Ibid. 17

SULFUR DIOXIDE ANALYSIS

Ammonium sulfate ($[NH_4]_2SO_4$) is a constituent of $PM_{2.5}$, making up about 10 percent of fine particulate matter mass in the Valley. Sulfur oxides (SOx) emitted from stationary and mobile combustion sources, mostly as sulfur dioxide (SO_2), are oxidized in the atmosphere to ultimately form sulfuric acid (H_2SO_4). Sulfuric acid then combines with ammonia to form ammonium sulfate. Since SOx reacts chemically in this way to form a particle, SOx is a precursor to $PM_{2.5}$.

Following the analytical process outlined in the U.S. EPA precursor demonstration guidance and summarized above, CARB has evaluated SOx in the Valley. The results of the sensitivity-based analysis and consideration of additional information are presented below.

Sensitivity-Based Analysis

CARB staff used an air quality model to estimate the $PM_{2.5}$ design value for the annual and 24-hour standards in the base year of 2013 at each Valley monitor. Then, CARB staff applied the recommended lower bound of a 30 percent reduction to SOx emissions and used the air quality model to estimate the $PM_{2.5}$ design values, as shown in Table 7. The difference between the two design values represents the modeled impact on $PM_{2.5}$ levels of a 30 percent reduction in SOx emissions in 2013. This is the value that is compared to U.S. EPA's recommended contribution thresholds of 0.2 µg/m^3 for the annual standard and 1.3 µg/m^3 for the 24-hour standard to establish if $PM_{2.5}$ levels are sensitive to this level of SOx reduction.

Table 7. Base Year 2013 $PM_{2.5}$ – 30 Percent SOx Reduction

	Annual			24-Hour		
Site	**2013 Baseline DV**	**2013 DV with 30% SOx Reduction**	**Difference**	**2013 Baseline DV**	**2013 DV with 30% SOx Reduction**	**Difference**
Bakersfield-Planz	17.19	17.15	0.04	55.5	55.9	-0.4
Madera	16.93	16.92	0.01	51.0	51.3	-0.3
Hanford	16.54	16.53	0.01	60.0	60.4	-0.4
Visalia	16.20	16.15	0.05	55.5	55.8	-0.3
Clovis	16.12	16.11	0.01	55.8	56.0	-0.2
Bakersfield-California	16.02	15.98	0.04	64.1	64.5	-0.4
Fresno-Garland	14.98	14.95	0.03	60.0	60.1	-0.1
Turlock	14.88	14.83	0.05	50.7	50.8	-0.1
Fresno-HW	14.22	14.18	0.04	59.3	59.4	-0.1
Stockton	13.14	13.07	0.07	42.0	41.8	0.2
Merced-S Coffee	13.10	13.08	0.02	41.1	41.2	-0.1
Modesto	13.03	12.97	0.06	47.9	47.9	0.1
Merced-M	10.97	10.95	0.02	46.9	47.0	-0.1
Manteca	10.09	10.02	0.07	36.9	36.6	0.2
Tranquility	7.72	7.73	-0.01	29.5	29.5	0.0

For completeness, CARB staff repeated this analysis, applying instead the recommended upper bound of a 70 percent reduction to the SOx emissions in the base year, as shown in Table 8.

Table 8. Base Year 2013 $PM_{2.5}$ – 70 Percent SOx Reduction

	Annual			24-Hour		
Site	**2013 Baseline DV**	**2013 DV with 70% SOx Reduction**	**Difference**	**2013 Baseline DV**	**2013 DV with 70% SOx Reduction**	**Difference**
Bakersfield-Planz	17.19	17.11	0.08	55.5	56.5	-1.0
Madera	16.93	16.95	-0.02	51.0	52.2	-1.2
Hanford	16.54	16.54	0.00	60.0	61.4	-1.4
Visalia	16.20	16.10	0.10	55.5	56.3	-0.8
Clovis	16.12	16.10	0.02	55.8	56.4	-0.6
Bakersfield-California	16.02	15.95	0.07	64.1	65.2	-1.1
Fresno-Garland	14.98	14.93	0.05	60.0	60.6	-0.6
Turlock	14.88	14.77	0.11	50.7	51.1	-0.4
Fresno-HW	14.22	14.15	0.07	59.3	59.8	-0.5
Stockton	13.14	12.99	0.15	42.0	41.9	0.2
Merced-S Coffee	13.10	13.08	0.02	41.1	41.4	-0.3
Modesto	13.03	12.90	0.13	47.9	48.0	-0.1
Merced-M	10.97	10.93	0.04	46.9	47.2	-0.3
Manteca	10.09	9.95	0.14	36.9	36.4	0.5
Tranquility	7.72	7.77	-0.05	29.5	29.7	-0.2

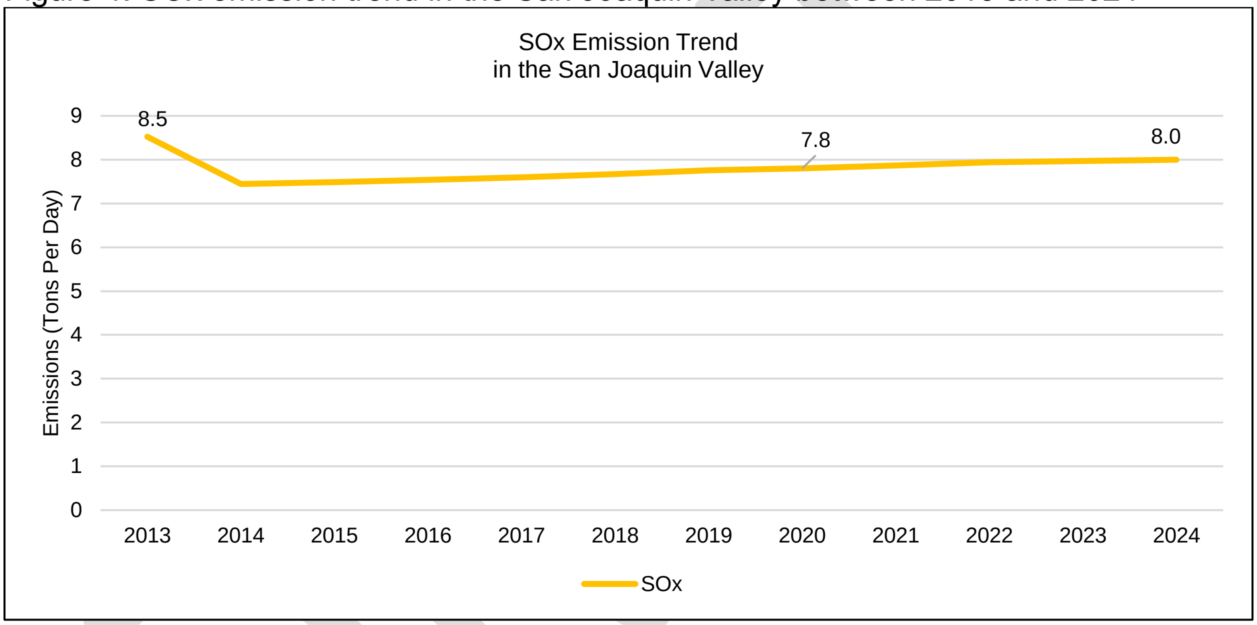
From this analysis, the estimated air quality impact of reducing SOx emissions in the base year by the lower bound of 30 percent is well under U.S. EPA's recommended thresholds at all Valley monitors for both the annual and 24-hour standards. In fact, in some cases, the estimated air quality impact is negative, implying that a reduction in SOx emissions would in fact increase the modeled design value at certain sites. Reducing emissions by the upper bound of 70 percent also shows impacts below the recommended thresholds.

Consideration of Additional Information

To supplement modeling analysis, U.S. EPA guidance also allows an air agency to consider additional information. Accordingly, CARB evaluated the trend of SOx emissions in the Valley to support the sensitivity-based analysis.

Emissions Trend
CARB's SOx inventory indicates that emissions remain roughly constant between 2013 and 2024, as shown in Figure 4. Ammonia emissions also remain flat over the same time frame, as shown above in Figure 1. Thus, conditions for ammonium sulfate formation are similar in the base and future years, with relative levels of ammonia and SOx remaining the same. The sensitivity-based analysis performed for 2013 and reflected in Tables 7 and 8 above is therefore representative into the future, and it is redundant to additionally model the sensitivity of $PM_{2.5}$ formation to SOx emissions reductions in 2020 or 2024. Precursor sensitivities in the future years are assumed to be very close to those modeled in 2013 due to the similarity of emissions conditions over time, so 2020 and 2024 analyses are not included here.

Figure 4. SOx emission trend in the San Joaquin Valley between 2013 and 2024



Source: CEPAM Inventory version 1.05

Conclusion
CARB has followed U.S. EPA guidance to evaluate whether SOx contributes significantly to $PM_{2.5}$ levels that exceed the NAAQS. Using sensitivity-based analysis in the base year and considering that base year conditions are representative into the future, CARB determined that emissions of SOx do not contribute significantly to $PM_{2.5}$ levels that exceed the 1997, 2006, or 2012 NAAQS in the area. Therefore, CARB has excluded SOx from control requirements in the SIP.

ROG ANALYSIS

Following the analytical process outlined in the U.S. EPA precursor demonstration guidance and summarized above, CARB has evaluated ROG in the San Joaquin Valley. The results of the sensitivity-based analysis and consideration of additional information are presented below.

Sensitivity-Based Analysis

CARB staff used an air quality model to estimate the $PM_{2.5}$ design value for the annual and 24-hour standards in the base year of 2013 at each Valley monitor. Then, CARB staff applied the recommended lower bound of a 30 percent reduction to ROG emissions and used the air quality model to estimate the $PM_{2.5}$ design values, as shown in Table 9. The difference between the two design values represents the modeled impact on $PM_{2.5}$ levels of a 30 percent reduction in ROG emissions in 2013. This is the value that is compared to U.S. EPA's recommended contribution thresholds of 0.2 $\mu g/m^3$ for the annual standard and 1.3 $\mu g/m^3$ for the 24-hour standard to establish if $PM_{2.5}$ levels are sensitive to this level of ROG reduction.

Table 9. Base Year 2013 $PM_{2.5}$ – 30 Percent ROG Reduction

	Annual			24-Hour		
Site	**2013 Baseline DV**	**2013 DV with 30% ROG Reduction**	**Difference**	**2013 Baseline DV**	**2013 DV with 30% ROG Reduction**	**Difference**
Bakersfield-Planz	17.19	17.08	0.11	55.5	54.3	1.2
Madera	16.93	16.83	0.10	51.0	50.1	0.9
Hanford	16.54	16.47	0.07	60.0	58.8	1.1
Visalia	16.20	16.04	0.16	55.5	53.6	1.9
Clovis	16.12	16.01	0.11	55.8	54.9	0.9
Bakersfield-California	16.02	15.92	0.10	64.1	62.8	1.4
Fresno-Garland	14.98	14.87	0.11	60.0	59.1	0.9
Turlock	14.88	14.80	0.08	50.7	50.1	0.7
Fresno-HW	14.22	14.10	0.12	59.3	58.2	1.1
Stockton	13.14	13.09	0.05	42.0	41.5	0.5
Merced-S Coffee	13.10	13.04	0.06	41.1	40.7	0.4
Modesto	13.03	12.97	0.06	47.9	47.4	0.6
Merced-M	10.97	10.92	0.05	46.9	46.5	0.4
Manteca	10.09	10.03	0.06	36.9	36.3	0.5
Tranquility	7.72	7.71	0.01	29.5	29.4	0.1

For completeness, CARB staff repeated this analysis, applying instead the U.S. EPA-recommended upper bound of a 70 percent reduction to ROG emissions in the base year, as shown in Table 10.

Table 10. Base Year 2013 $PM_{2.5}$ – 70 Percent ROG Reduction

	Annual			24-Hour		
Site	**2013 Baseline DV**	**2013 DV with 70% ROG Reduction**	**Difference**	**2013 Baseline DV**	**2013 DV with 70% ROG Reduction**	**Difference**
Bakersfield-Planz	17.19	16.90	0.29	55.5	52.4	3.0
Madera	16.93	16.69	0.24	51.0	48.8	2.1
Hanford	16.54	16.35	0.19	60.0	56.9	3.0
Visalia	16.20	15.80	0.40	55.5	50.7	4.8
Clovis	16.12	15.84	0.28	55.8	53.6	2.2
Bakersfield-California	16.02	15.76	0.26	64.1	60.5	3.6
Fresno-Garland	14.98	14.73	0.25	60.0	57.7	2.2
Turlock	14.88	14.68	0.20	50.7	49.1	1.6
Fresno-HW	14.22	13.94	0.28	59.3	56.7	2.7
Stockton	13.14	13.01	0.13	42.0	40.7	1.3
Merced-S Coffee	13.10	12.96	0.14	41.1	40.1	1.0
Modesto	13.03	12.88	0.15	47.9	46.7	1.3
Merced-M	10.97	10.85	0.12	46.9	45.9	1.0
Manteca	10.09	9.96	0.13	36.9	35.6	1.2
Tranquility	7.72	7.67	0.05	29.5	29.2	0.2

From this analysis, the estimated air quality impact of reducing ROG emissions in the base year by the lower bound of 30 percent is under U.S. EPA's recommended thresholds at all but two Valley monitors for the 24-hour standard, and falls below the recommended annual threshold at all sites. Reducing emissions by the upper bound of 70 percent shows impacts above the thresholds at about half the sites.

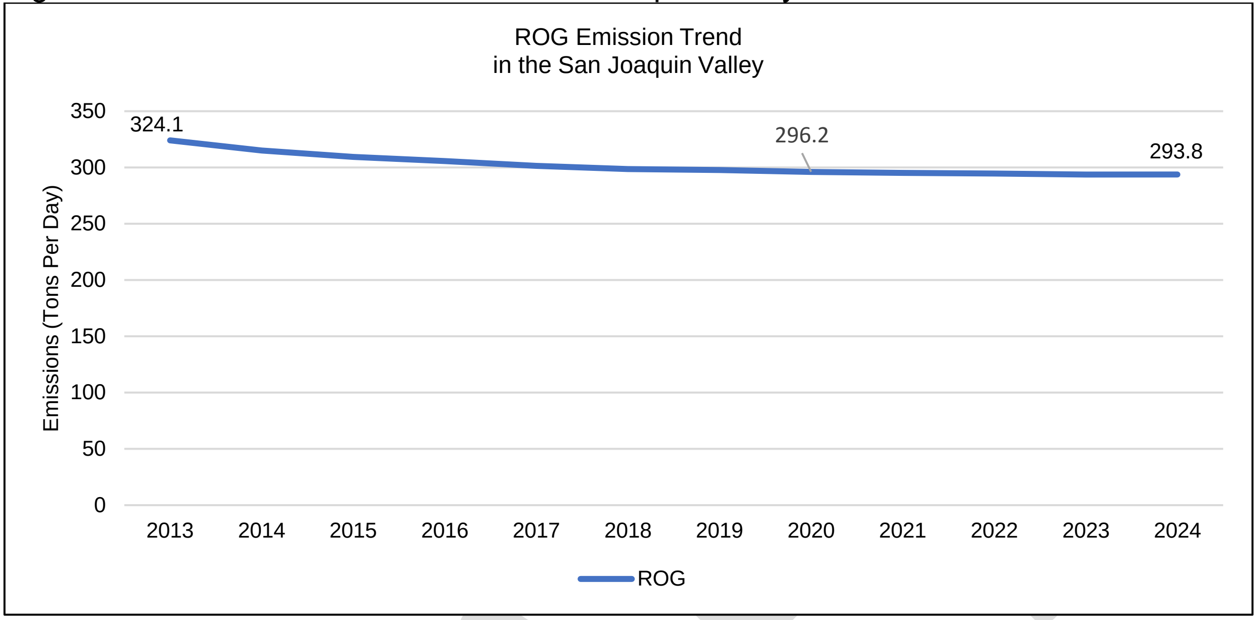
Consideration of Additional Information

To supplement modeling analysis, U.S. EPA guidance also allows an air agency to consider additional information. Accordingly, CARB evaluated the trend of ROG emissions in the Valley to support the sensitivity-based analysis and conducted future year sensitivity modeling.

Emissions Trend

CARB has an extensive suite of measures in place to reduce ROG emissions, particularly in the area of regulating consumer products. In addition, the District has numerous rules that provide ROG emissions reductions in the Valley. CARB's ROG inventory indicates that these existing controls reduce emissions by approximately 30 tons, or nine percent, between 2013 and 2024, as shown in Figure 5. Thus, the role ROG plays in $PM_{2.5}$ formation may differ in the base and future years, and the sensitivity-based analysis performed for 2013 is not representative into the future.

Figure 5. ROG emission trend in the San Joaquin Valley between 2013 and 2024



Source: CEPAM Inventory version 1.05

Future Year Modeling

Even though the estimated air quality impact of reducing ROG emissions in the base year by 30 percent is under U.S. EPA's recommended thresholds at all but two Valley monitors for the 24-hour standard, and falls below the recommended annual threshold at all sites, CARB staff repeated the sensitivity-based analysis of ROG for the future attainment years of 2020 and 2024 for completeness.[36] Staff used an air quality model to estimate the $PM_{2.5}$ design value for the annual and 24-hour standards in 2020 and 2024 at each Valley monitor. Then, CARB staff applied a 30 percent reduction to ROG emissions and used the air quality model to estimate the $PM_{2.5}$ design values in 2020 and 2024, shown in Tables 11 and 12 respectively. The difference between the two design values represents the modeled impact on $PM_{2.5}$ levels of a 30 percent reduction in ROG emissions in each attainment year.

[36] CARB did not conduct sensitivity analysis for the 2025 attainment year for the 2012 annual $PM_{2.5}$ standard due to the close proximity of the attainment years for the 2012 and 2006 standards. Precursor sensitivities in 2025 are assumed to be very similar to those modeled in 2024.

Table 11. Future Year 2020 $PM_{2.5}$ – 30 Percent ROG Reduction

	Annual			24-Hour		
Site	**2020 Baseline DV**	**2020 DV with 30% ROG Reduction**	**Difference**	**2020 Baseline DV**	**2020 DV with 30% ROG Reduction**	**Difference**
Bakersfield-Planz	14.58	14.55	0.03	41.2	40.9	0.3
Madera	14.15	14.12	0.03	38.9	38.6	0.2
Hanford	13.30	13.35	-0.50	43.7	43.7	0.0
Visalia	13.51	13.47	0.04	42.8	42.2	0.6
Clovis	13.43	13.37	0.06	41.1	40.9	0.3
Bakersfield-California	13.48	13.47	0.01	47.6	47.5	0.1
Fresno-Garland	12.42	12.37	0.05	44.3	44.0	0.3
Turlock	12.47	12.46	0.01	37.8	37.7	0.1
Fresno-HW	11.86	11.80	0.06	45.6	45.2	0.4
Stockton	11.43	11.42	0.01	33.5	33.4	0.1
Merced-S Coffee	10.86	10.86	0.00	30.0	29.9	0.0
Modesto	10.97	10.96	0.01	35.8	35.7	0.1
Merced-M	9.34	9.33	0.01	32.9	32.9	0.0
Manteca	8.67	8.66	0.01	30.1	30.0	0.1
Tranquility	6.40	6.41	-0.01	21.5	21.6	-0.1

Table 12. Future Year 2024 $PM_{2.5}$ – 30 Percent ROG Reduction

	Annual			24-Hour		
Site	**2024 Baseline DV**	**2024 DV with 30% ROG Reduction**	**Difference**	**2024 Baseline DV**	**2024 DV with 30% ROG Reduction**	**Difference**
Bakersfield-Planz	12.03	11.92	-0.01	30.0	30.0	-0.2
Madera	11.98	11.99	-0.01	30.2	30.3	-0.1
Hanford	10.52	10.59	-0.07	30.1	30.5	-0.4
Visalia	11.09	11.1	-0.01	30.2	30.4	-0.3
Clovis	11.37	11.34	0.03	30.7	30.7	0.0
Bakersfield-California	11.01	10.91	-0.01	33.3	33.5	-0.4
Fresno-Garland	10.43	10.41	0.02	32.8	32.9	-0.1
Turlock	11.14	11.16	-0.02	30.2	30.3	-0.1
Fresno-HW	10.02	9.99	0.03	35.1	35.2	0.0
Stockton	10.66	10.67	-0.01	28.6	28.6	-0.1
Merced-S Coffee	9.65	9.67	-0.02	24.2	24.3	-0.1
Modesto	9.97	9.98	-0.01	29.1	29.2	-0.1
Merced-M	8.61	8.61	0.00	27.4	27.8	-0.1
Manteca	7.97	7.98	-0.01	25.8	25.8	0.0
Tranquility	5.54	5.55	-0.01	16.2	16.3	-0.1

In both 2020 and 2024, the modeled air quality impact of reducing ROG emissions by 30 percent falls under U.S. EPA's recommended thresholds at all sites.

For completeness, CARB staff repeated this analysis, applying instead the recommended upper bound of a 70 percent reduction to ROG emissions in 2020 and 2024, as shown in Tables 13 and 14.

Table 13. Future Year 2020 $PM_{2.5}$ – 70 Percent ROG Reduction

	Annual			24-Hour		
Site	**2020 Baseline DV**	**2020 DV with 70% ROG Reduction**	**Difference**	**2020 Baseline DV**	**2020 DV with 70% ROG Reduction**	**Difference**
Bakersfield-Planz	14.58	14.51	0.07	41.2	40.3	1.0
Madera	14.15	14.09	0.06	38.9	38.3	0.6
Hanford	13.30	13.40	-0.10	43.7	43.5	0.2
Visalia	13.51	13.40	0.11	42.8	41.3	1.5
Clovis	13.43	13.27	0.16	41.1	40.4	0.7
Bakersfield-California	13.48	13.44	0.04	47.6	47.2	0.5
Fresno-Garland	12.42	12.29	0.13	44.3	43.5	0.8
Turlock	12.47	12.43	0.04	37.8	37.5	0.2
Fresno-HW	11.86	11.71	0.15	45.6	44.6	1.0
Stockton	11.43	11.41	0.02	33.5	33.2	0.3
Merced-S Coffee	10.86	10.85	0.01	30.0	29.8	0.1
Modesto	10.97	10.95	0.02	35.8	35.6	0.2
Merced-M	9.34	9.30	0.04	32.9	32.9	0.1
Manteca	8.67	8.64	0.03	30.1	29.8	0.3
Tranquility	6.40	6.41	-0.01	21.5	21.7	-0.2

In 2020, the modeled air quality impact of reducing ROG emissions by 70 percent falls under U.S. EPA's recommended annual threshold at all sites, and under the recommended 24-hour threshold at all sites but one.

Table 14. Future Year 2024 $PM_{2.5}$ – 70 Percent ROG Reduction

	Annual			24-Hour		
Site	**2024 Baseline DV**	**2024 DV with 70% ROG Reduction**	**Difference**	**2024 Baseline DV**	**2024 DV with 70% ROG Reduction**	**Difference**
Bakersfield-Planz	12.03	11.94	-0.03	30.0	30.3	-0.5
Madera	11.98	12.01	-0.03	30.2	30.4	-0.3
Hanford	10.52	10.70	-0.18	30.1	31.1	-1.0
Visalia	11.09	11.11	-0.02	30.2	30.7	-0.5
Clovis	11.37	11.29	0.08	30.7	30.7	0.0
Bakersfield-California	11.01	10.94	-0.04	33.3	34.0	-0.9
Fresno-Garland	10.43	10.37	0.06	32.8	33.0	-0.2
Turlock	11.14	11.19	-0.05	30.2	30.5	-0.3
Fresno-HW	10.02	9.95	0.07	35.1	35.2	-0.1
Stockton	10.66	10.67	-0.01	28.6	28.7	-0.1
Merced-S Coffee	9.65	9.69	-0.04	24.2	24.5	-0.3
Modesto	9.97	9.99	-0.02	29.1	29.3	-0.2
Merced-M	8.61	8.60	0.01	27.4	27.7	-0.3
Manteca	7.97	7.98	-0.01	25.8	25.9	-0.1
Tranquility	5.54	5.57	-0.03	16.2	16.6	-0.4

In 2024, the modeled air quality impact of reducing ROG emissions by 70 percent falls under U.S. EPA's recommended thresholds at all sites.

Conclusion

CARB has followed U.S. EPA guidance to evaluate whether ROG contributes significantly to $PM_{2.5}$ levels that exceed the NAAQS. Using sensitivity-based analysis in the base and future years, CARB determined that emissions of ROG do not contribute significantly to $PM_{2.5}$ levels that exceed the 1997, 2006, or 2012 NAAQS in the area. Therefore, CARB has excluded ROG from control requirements in the SIP.

Appendix H
RFP, Quantitative Milestones, and Contingency

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H. RFP, QUANTITATIVE MILESTONES, AND CONTINGENCY

Pursuant to federal Clean Air Act (CAA) requirements, states are required to submit a state implementation plan (SIP) to EPA for areas designated nonattainment of National Ambient Air Quality Standards (NAAQS, or standards) for PM2.5.[1] This appendix fulfills the following federal Clean Air Act requirements for PM2.5 nonattainment areas as identified in the CAA, codified in the code of federal regulations,[2] and clarified in the 2016 PM2.5 Implementation Rule:[3]

1. Reasonable Further Progress [CAA §172(c)(2)]
2. Quantitative Milestones [CAA §189(c)]
3. Contingency [CAA §172(c)(9)]

For standard-specific demonstrations of federal requirements refer to the following plan chapters:

- 1997 PM2.5 Standard Demonstration – Chapter 5
- 2006 PM2.5 Standard Demonstration – Chapter 6
- 2012 PM2.5 Standard Demonstration – Chapter 7

H.1 REASONABLE FURTHER PROGRESS (RFP)

The term “reasonable further progress” means such annual incremental reductions in emissions of the relevant air pollutant as are required for the purpose of ensuring attainment of the applicable NAAQS by the applicable date.[4] Each attainment plan for a PM2.5 nonattainment area shall include an RFP plan that demonstrates that sources in the area will achieve such annual incremental reductions in emissions of PM2.5 and PM2.5 plan precursors as are necessary to ensure attainment of the applicable PM2.5 NAAQS as expeditiously as practicable. In the case of the San Joaquin Valley, air quality modeling has demonstrated NOx is the significant precursor to PM2.5 (see Appendix G).

Regardless of whether a state is submitting a Moderate area plan, a Serious area plan, or a plan required pursuant to CAA §189(d) (5% Plans), to satisfy the statutory requirements for RFP at CAA §172(c)(2), a state must submit an RFP plan.

Linear emission reductions

Historically, EPA’s interpretation of the RFP requirement has been “generally linear progress” from the base year to the attainment year, demonstrated at RFP milestone years.[5]

[1] Clean Air Act, Title 1, Part D Subpart 1 and CAA Title 1, Part D Subpart 4
[2] CFR part 51 – Requirements for preparation, adoption, and submittal of implementation Plans
[3] Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule. 81 Fed. Reg. 164, pp. 58010-58162. (2016, August 24). (to be codified at 40 CFR Parts 50, 51, and 93). https://www.gpo.gov/fdsys/pkg/FR-2016-08-24/pdf/2016-18768.pdf
[4] Clean Air Act Section 171(1)
[5] 72 FR 20633, codified at 40 CFR 51 Subpart Z § 51.1000 (definitions)

Stepwise emission reductions
In its most recent Implementation Rule, EPA clarified that RFP requirements may be satisfied through generally linear progress, or through a stepwise demonstration. Stepwise emissions reductions would be slower than ''generally linear'' reductions for certain periods, and then would decline sharply (due to implementation of a new emission reduction program, or new operation of control technology on one or more stationary sources).

For example, in one area new emission standards for mobile sources may achieve reductions in a generally linear manner over time, as a portion of the existing vehicle fleet is replaced each year with new vehicles meeting the more stringent standards. In another area, regulations to reduce emissions from certain stationary source sectors could have a single compliance date by which controls must be in place, which could result in a significant drop in emissions in a "stepwise" manner over a relatively short period. In the first case, the EPA expects that, so long as the attainment date is as expeditious as practicable, then generally linear progress toward attainment by that date would satisfy the RFP requirement. In the second case, where progress is slower than generally linear, the state is required to submit a clear rationale and supporting information to explain why generally linear progress is not appropriate (*e.g.,* due to the nature of the nonattainment problem, the types of sources contributing to PM2.5 levels in the area and the implementation schedule for control requirements at such sources).

H.1.1 RFP Plan Requirements

Each attainment plan for a PM2.5 nonattainment area shall include an RFP plan that demonstrates that sources in the area will achieve such annual incremental reductions in emissions of direct PM2.5 and PM2.5 plan precursors as are necessary to ensure attainment of the applicable PM2.5 NAAQS as expeditiously as practicable. [6]

The RFP plan shall include the following:[7]

1. A schedule describing the implementation of control measures during each year of the applicable attainment Plan.
2. RFP projected emissions for direct PM2.5 and NOx for each applicable milestone year, based on the anticipated implementation schedule for control measures.
3. An analysis that presents the schedule of control measures and estimated emissions changes to be achieved by each milestone year, and that demonstrates that the control strategy will achieve RFP toward attainment between the base year and the attainment year. The analysis shall rely on information from the base year inventory and the attainment projected inventory for the nonattainment area, in addition to the RFP projected emissions required.
4. An analysis that demonstrates that by the end of the calendar year for each milestone date for the area, pollutant emissions will be at levels that reflect either generally linear progress or stepwise progress in reducing emissions on an annual basis between the base year and the attainment year. A demonstration

[6] 40 CFR §51.1012 Reasonable further progress requirements.
[7] 40 CFR § 51.1012

of stepwise progress must be accompanied by appropriate justification for the selected implementation schedule.

5. At the state's election, an analysis that identifies air quality targets associated with the RFP projected emissions identified for the milestone years at the design value monitor locations.

H.1.2 DETERMINATION OF RFP YEARS

The baseline year for this Plan for all three PM2.5 standards is 2013. Analyses and modeling performed for this Plan demonstrate the following attainment dates to be the most expeditious attainment dates practicable:

- 1997 annual PM2.5 standard attainment year is 2020
- 2006 24-hour PM2.5 standard attainment year is 2024
- 2012 annual PM2.5 standard attainment year is 2025

RFP years for an attainment Plan for a particulate matter air quality standard shall be determined by the quantitative milestone deadlines.[8] Refer to the Quantitative Milestone Requirements section below to see how milestone years were determined for each NAAQS.

Table H-1 Summary of Significant RFP and Quantitative Milestone Dates

Federal PM2.5 Standard	Base Year	Attainment Year	RFP and Quantitative Milestone Years
1997 PM2.5 NAAQS	2013	2020	2017, 2020, 2023
2006 PM2.5 NAAQS	2013	2024	2017, 2020, 2023, 2026
2012 PM2.5 NAAQS	2013	2025	2019, 2022, 2025, 2028

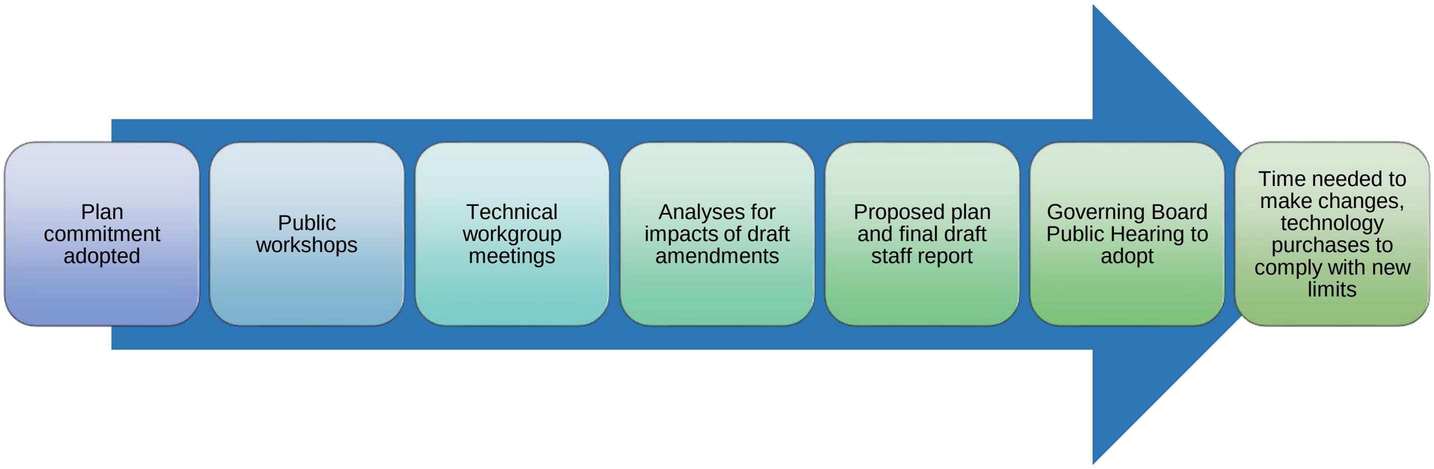
H.1.3 RFP MILESTONE REQUIREMENT TARGETS AND ATTAINMENT DEMONSTRATIONS

The following analysis demonstrates linear RFP for the 1997 PM2.5 standard and stepwise RFP for the 2006 and 2012 PM2.5 standards. The 2006 and 2012 PM2.5 RFP demonstration is a stepwise due to the necessary time required by the District and CARB to go through the process necessary to amend rules, develop programs, and implement the emission reduction measures.

The regulatory measures need time to undergo a robust public rulemaking process and implementation after the Plan adoption. In these efforts, the District and CARB is committed to a transparent public process that includes stakeholder, industry, and other-agency input at every step possible. As illustrated in Figure H-1, the rule amendment process is a robust process that can take significant time, sometimes years, to complete and implement.

[8] 40 CFR 51.1012(a)(4)

Figure H-1 Rule Development and Implementation Process



For the incentive-based measures, the total emission reductions can only be achieved over multiple years due to availability of willing participants and significant funding required. Modeling demonstrates attainment as expeditiously as practicable.

H.1.4 RFP CALCULATION METHODOLOGY AND DEMONSTRATION

1. Determine the Emissions Inventory of the Valley with the Plan control strategy for the baseline year, the RFP years, and the attainment year.

Table H-2 Annual Average Emission Inventory (tpd) (see Appendix B)

Pollutant	2013	2017	2019	2020	2021	2022	2023	2024	2025	2026
Direct PM2.5	62.5	58.9	59.2	59.0	58.5	58.4	58.3	58.3	58.3	58.4
NOx	317.2	233.3	214.5	203.3	191.0	179.8	153.6	148.9	143.7	139.4

2. Identify additional annual average emission reductions from control measure commitments (see Chapter 4).

Table H-3 Annual Average Emissions Reduced from Control Measure Commitments (tpd)

Pollutant	2013	2017	2019	2020	2021	2022	2023	2024	2025	2026
Direct PM2.5	0	0	0	0	0	0	0	1.94	1.94	1.94
NOx	0	0	0	0	0	0	0	33.88	33.88	33.88

3. Subtract the emission reductions from Plan commitments from the existing inventory to determine the Plan inventory. (Table H-6 minus Table H-7)

Table H-4 Projected Emissions Inventory after Control Measures (tpd)

Pollutant	2013	2017	2019	2020	2021	2022	2023	2024	2025	2026
Direct PM2.5	62.5	58.9	59.2	59.0	58.5	58.4	58.3	56.4	56.4	56.4
NOx	317.2	233.3	214.5	203.3	191.0	179.8	153.6	115.0	109.8	105.5

4. Determine the total reductions from the 2013 baseline emission inventory that must be achieved to reach attainment.

Table H-5 Total Reductions Necessary to Reach Attainment (tpd)

Pollutant	A	B	C	D	E	F	G
	2013 Base year Emissions	1997 NAAQS Attainment Emissions (2020)	1997 NAAQS Reductions Needed (A-B)	2006 NAAQS Attainment Emissions (2024)	2006 NAAQS Reductions Needed (A-D)	2012 NAAQS Attainment Emissions (2025)	2012 NAAQS Reductions Needed (A-F)
Direct PM2.5	62.53	59.00	3.53	56.380	6.15	56.40	6.13
NOx	317.21	203.25	113.96	148.87	168.34	109.82	207.39

5. Determine the fraction of reductions that are achieved in each RFP milestone year.

   Where (milestone year – base year) / (attainment year – base year)

Table H-6 Milestone Year Fractions Achieved in Each Milestone Year

	Milestone Years		
	2017	2020	2023
1997 NAAQS	57.10%	100.00%	142.90%
2006 NAAQS	36.40%	63.60%	90.90%
	2019	2022	2025
2012 NAAQS	50.00%	75.00%	100.00%

6. Determine the RFP target emissions levels using reduction fractions.

Table H-7 Target Emissions Levels for RFP Milestone Years (tpd)

	A	B	C	D	E	F	G	H
			2017		2020		2023	
1997 NAAQS	2013 base year emission inventory	Reductions Needed to attain NAAQS	tons to be reduced (B x 2017 milestone percentage)	**RFP target emissions level (A - C)**	tons to be reduced (B x 2020 milestone percentage)	**RFP target emissions level (A - E)**	tons to be reduced (B x 2023 milestone percentage)	**RFP target emissions level (A - G)**
Direct PM2.5	62.53	3.53	2.02	60.51	3.53	59.00	5.04	57.49
NOx	317.21	113.96	65.07	252.14	113.96	203.25	162.85	154.36
2006 NAAQS								
Direct PM2.5	62.53	6.15	2.24	60.29	3.91	58.62	5.59	56.94
NOx	317.21	168.34	61.28	255.93	107.06	210.15	153.02	164.19
			2019		2022		2025	
2012 NAAQS	2013 base year emission inventory	Reductions Needed to attain NAAQS	tons to be reduced (B x 2019 milestone percentage)	**RFP target emissions level (A - C)**	tons to be reduced (B x 2022 milestone percentage)	**RFP target emissions level (A - E)**	tons to be reduced (B x 2025 milestone percentage)	**RFP target emissions level (A - G)**
Direct PM2.5	62.53	8.45	4.23	58.31	6.34	56.19	8.45	54.08
NOx	317.21	175.26	87.63	229.58	131.45	185.77	175.26	141.95

7. Compare RFP Target emissions level to the projected emissions inventory to demonstrate RFP

Table H-8 Demonstration of Compliance with RFP Targets for 1997 NAAQS

1997 NAAQS	2017			2020		
	RFP target emissions level	Attainment Emissions Inventory	**Linear RFP target met?**	RFP target emissions level	Attainment Emissions Inventory	**Linear RFP target met?**
Direct PM2.5	60.51	58.93	**YES**	59	59.00	**YES**
NOx	252.14	233.31	**YES**	203.25	203.25	**YES**

Table H-9 Demonstration of Compliance with Stepwise RFP Targets for 2006 NAAQS

2006 NAAQS	2017			2020			2023		
	RFP target emissions level	Attainment Emissions Inventory	**Stepwise RFP target met?**	RFP target emissions level	Attainment Emissions Inventory	**Stepwise RFP target met?**	RFP target emissions level	Attainment Emissions Inventory	**Stepwise RFP target met?**
Direct PM2.5	60.29	58.93	**YES**	59.00	59.00	**YES**	58.27	58.27	**YES**
NOx	255.93	233.31	**YES**	210.15	203.25	**YES**	164.19	153.63	**YES**

Table H-10 Demonstration of Compliance with Stepwise RFP Targets for 2012 NAAQS

2012 NAAQS	2019			2022			2025		
	RFP target emissions level	Attainment Emissions Inventory	**Stepwise RFP target met?**	RFP target emissions level	Attainment Emissions Inventory	**Stepwise RFP target met?**	RFP target emissions level	Attainment Emissions Inventory	**Stepwise RFP target met?**
Direct PM2.5	59.18	59.18	**YES**	58.42	58.42	**YES**	56.40	56.40	**YES**
NOx	229.58	214.45	**YES**	185.77	179.75	**YES**	141.95	109.82	**YES**

H.2 QUANTITATIVE MILESTONES

Consistent with CAA §189(c)(1), the state must submit in each attainment Plan for a PM2.5 nonattainment area specific quantitative milestones that demonstrate reasonable further progress toward attainment of the applicable PM2.5 NAAQS in the area.

H.2.1 QUANTITATIVE MILESTONE REQUIREMENTS

Quantitative milestones in a state implementation Plan shall meet the following requirements:[9]

1. **Nonattainment areas initially classified as Moderate**
    a. Milestones achieved no later than a milestone date of 4.5 years and 7.5 years from the date of designation of the area.
    b. Milestones that provide for objective evaluation of reasonable further progress toward timely attainment of the applicable PM2.5 NAAQS in the area. At a minimum, each quantitative milestone Plan must include a milestone for tracking progress achieved in implementing the SIP control measures, including RACM and RACT, by each milestone date.

2. **Areas reclassified as Serious**
    a. For areas that can attain the NAAQS by the end of the tenth calendar year following the effective date of designation, milestone dates of 7.5 years and 10.5 years respectively, from the date of designation of the area
    b. For areas that cannot attain the NAAQS by the end of the tenth calendar year following the effective date of designation, milestone dates of 7.5 years, 10.5 years, and 13.5 years from the date of designation. If the attainment date is beyond 13.5 years from the date of designation, such Plan shall also contain a quantitative milestone to be achieved no later than milestones dates of 16.5 years, respectively from the date of designation of the area.
    c. Milestones that provide for objective evaluation of RFP toward timely attainment of the NAAQS in the area. At a minimum each quantitative milestone Plan must include a milestone for tracking progress achieved in implementing SIP control measures, including BACM and BACT by each milestone date.

3. **Serious areas that fail to attain by the applicable Serious area attainment date**
    a. If the attainment Plan is due prior to a date 13.5 years from designation of the area, then the Plan shall contain milestones to be achieved by no later than a milestone date of 13.5 years from the date of designation of the area, and every three years thereafter, until the milestone date that falls within three years *after* the applicable attainment date.
    b. If the attainment Plan is due later than a date 13.5 years from designation, then the Plan shall contain milestones to be achieved by no later than a milestone date of 16.5 years from the date of designation of the area, and

[9] 40 CFR §51.1013 Quantitative milestone requirements.

every three years thereafter, until the milestone date that falls within three years *after* the applicable attainment date.

c. Milestones that provide for objective evaluation of RFP toward timely attainment of the NAAQS. At a minimum, each quantitative milestone Plan must include a milestone for tracking progress achieved in implementing the SIP control measures by each milestone date.

4. Areas designated for 1997 and/or 2006 PM2.5 NAAQS before January 15, 2015

a. Each attainment Plan submission for an area designated nonattainment for the 1997 and/or 2006 PM2.5 NAAQS before January 15, 2015, shall contain quantitative milestone to be achieved no later than 3 years after December 31, 2014, and every three years thereafter until the milestone date that falls within three years *after* the applicable attainment date.

H.2.1.1 1997 NAAQS

As discussed throughout this Plan, EPA designated the Valley for the 1997 NAAQS on January 5, 2005 (see Chapter 1 for a timeline). Additionally, the Valley failed to attain by the applicable Serious area attainment date. As such, the quantitative milestones for this Plan are guided by requirement 3.c and 4 above. The Valley will attain the 1997 NAAQS in 2020. See Table H-11 for milestone years. Table H-1

H.2.1.2 2006 NAAQS

As discussed throughout this Plan, EPA designated the Valley for the 2006 NAAQS on November 13, 2009 (see Chapter 1 for a timeline). The Valley is designated Serious nonattainment for this standard. As such, the quantitative milestones for this Plan are guided by requirement 2.c and 4 above. The Valley will attain the 2006 NAAQS in 2024. See Table H-11 for milestone years.

H.2.1.3 2012 NAAQS

The Valley is designated Moderate for this NAAQS. This Plan will satisfy Moderate area requirements and the District is proactively satisfying Serious area requirements simultaneously in this Plan. The quantitative milestones for this Plan are guided by requirement 1 and 2 above. The Valley will attain the 2012 NAAQS in 2025. See Table H-11 for quantitative milestone years.

Table H-11 Quantitative Milestone Dates and Deadlines

NAAQS	Quantitative Milestone Dates	Milestone Report Due Date
1997	December 31: 2017, 2020, 2023	March 31: 2018, 2021, 2024
2006	December 31: 2017, 2020, 2023, 2026	March 31: 2018, 2021, 2024, 2027
2012	October 15: 2019, 2022, 2025, 2028	January 15: 2020, 2023, 2026, 2029

H.2.3 STATIONARY SOURCES QUANTITATIVE MILESTONE COMMITMENTS

The District will report on milestones for implementation of stationary source reductions set forth in District Board-adopted attainment Plans as well as this this 2018 PM2.5 Plan.

H.2.3.1 1997 NAAQS Quantitative Milestones

The 1997 65 µg/m^3 24-hour and 15 µg/m^3 annual standards have quantitative milestone years in 2017, 2020, and 2023.

2017

For the 2018 milestone report for the 2017 milestone, the District is reporting on the following milestones (see Attachment B):

- Implementation of amendments to the District's residential wood burning program from 2014 through 2017 that required lower No Burn thresholds for high polluting wood burning heaters and fireplaces and enhancements to the District Burn Cleaner incentive program;
- Implementation of Rule 4308 (Boilers, Steam Generators, and Process Heaters (0.075 to <2 MMBtu/hr)) regulation requirements from 2015 through 2017 that required lower NOx emission limits for instantaneous water heaters with a rated heat input of 0.075 to 0.4 MMBtu/hr;
- Implementation of Rule 4354 (Glass Melting Furnaces) regulation requirements from 2013 through 2017 that required lower emission limits for NOx, SOx, and PM10 on glass melting furnaces in the Valley;
- Implementation of Rule 4702 (Internal Combustion Engines) regulation requirements from 2013 through 2017 that required lower NOx and SOx emission limits for various types of engines;
- Implementation of Rule 4902 (Residential Water Heaters) regulation requirements from 2013 through 2017 that required lower NOx emission limits for new residential natural gas-fired water heaters; and
- Implementation of Rule 4905 (Reduction of NOx Emissions from Natural Gas-Fired, Fan-Type Central Furnaces) regulation requirements from 2015 through 2017 that required lower NOx emission limits for natural gas-fired, fan-type, central furnaces.

2020

For the 2020 milestone year, the District is reporting on the following milestones:

- The status of SIP measures adopted between 2017 and 2020 as per the schedule included in the adopted Plan, including *Residential Wood Burning Strategy* and *Commercial Under-Fired Charbroiler* incentive-based strategy.

2023
For the 2023 milestone year, the District is reporting on the following milestones:

- The status of SIP measures adopted between 2017 and 2020 as per the schedule included in the adopted Plan, including *Residential Wood Burning Strategy* and *Commercial Under-Fired Charbroiler* incentive-based strategy.

H.2.3.2 2006 NAAQS Quantitative Milestones
The 2006 35 µg/m^3 24-hour standard has quantitative milestone years in 2017, 2020, 2023, and 2026.

2017
The For the 2017 milestone year, the District is reporting on the following milestones (see Attachment B to this Plan):

- Implementation of amendments to the District's residential wood burning program from 2014 through 2017 that required lower No Burn thresholds for high polluting wood burning heaters and fireplaces and enhancements to the District Burn Cleaner incentive program;
- Implementation of Rule 4308 (Boilers, Steam Generators, and Process Heaters (0.075 to <2 MMBtu/hr)) regulation requirements from 2015 through 2017 that required lower NOx emission limits for instantaneous water heaters with a rated heat input of 0.075 to 0.4 MMBtu/hr;
- Implementation of Rule 4354 (Glass Melting Furnaces) regulation requirements from 2013 through 2017 that required lower emission limits for NOx, SOx, and PM10 on glass melting furnaces in the Valley;
- Implementation of Rule 4702 (Internal Combustion Engines) regulation requirements from 2013 through 2017 that required lower NOx and SOx emission limits for various types of engines;
- Implementation of Rule 4902 (Residential Water Heaters) regulation requirements from 2013 through 2017 that required lower NOx emission limits for new residential natural gas-fired water heaters; and
- Implementation of Rule 4905 (Reduction of NOx Emissions from Natural Gas-Fired, Fan-Type Central Furnaces) regulation requirements from 2015 through 2017 that required lower NOx emission limits for natural gas-fired, fan-type, central furnaces.

2020
For the 2020 milestone year, the District is reporting on the following milestones:

- The status of SIP measures adopted between 2017 and 2020 as per the schedule included in the adopted Plan, including *Residential Wood Burning Strategy* and *Commercial Under-Fired Charbroiler* incentive-based strategy.

2023
For the 2023 milestone year, the District is reporting on the following milestones:

- The status of SIP measures adopted between 2020 and 2023 as per the schedule included in the adopted Plan, including *Residential Wood Burning Strategy* and *Commercial Under-Fired Charbroiler* incentive-based strategy.

2026
For the 2026 milestone year, the District is reporting on the following milestones:

- Implementation of amendments to *Residential Wood Burning Strategy*, including any regulatory amendments and enhancements to the District Burn Cleaner incentive program;
- Implementation of amendments to the *Commercial Under-Fired Strategy*, including any regulatory amendments and implementation of related incentive-based strategy
- The status of SIP measures adopted between 2023 and 2026 as per the schedule included in the adopted Plan.

H.2.3.3 2012 NAAQS Quantitative Milestones
The 2012 12 µg/m^3 annual standard has quantitative milestone years in 2019, 2022, 2025, and 2028.

2019
For the 2019 milestone year, the District is reporting on the following milestones:

- The status of SIP measures adopted between 2017 and 2019 as per the schedule included in the adopted Plan, including *Residential Wood Burning Strategy* and *Commercial Under-Fired Charbroiler* incentive-based strategy.

2022
For the 2022 milestone year, the District is reporting on the following milestones:

- The status of SIP measures adopted between 2019 and 2022 as per the schedule included in the adopted Plan, including *Residential Wood Burning Strategy* and *Commercial Under-Fired Charbroiler* incentive-based strategy.

2025
For the 2025 milestone year, the District is reporting on the following milestones:

- Implementation of amendments to *Residential Wood Burning Strategy*, including any regulatory amendments and enhancements to the District Burn Cleaner incentive program;
- Implementation of amendments to the *Commercial Under-Fired Strategy*, including any regulatory amendments and implementation of related incentive-based strategy

- The status of SIP measures adopted between 2022 and 2025 as per the schedule included in the adopted Plan.

2028
For the 2028 milestone year, the District is reporting on the following milestones:

- Implementation of amendments to *Residential Wood Burning Strategy*, including any regulatory amendments and enhancements to the District Burn Cleaner incentive program;
- Implementation of amendments to the *Commercial Under-Fired Strategy*, including any regulatory amendments and implementation of related incentive-based strategy
- The status of SIP measures adopted between 2023 and 2026 as per the schedule included in the adopted Plan.

H.2.4 MOBILE SOURCES QUANTITATIVE MILESTONE COMMITMENTS

[This section provided by the California Air Resources Board]

Mobile Source Quantitative Milestones for the San Joaquin Valley

CARB will report on milestones for implementation of mobile source reductions set forth in the *2016 State Strategy for the State Implementation Plan* (State SIP Strategy) and new measures in the *Proposed San Joaquin Valley Supplement to the 2016 State Strategy for the State Implementation Plan* (Valley State SIP Strategy).

The 1997 **65** µg/m^3 24-hour and **15** µg/m^3 annual standards have quantitative milestone years in **2017**, **2020**, and **2023**.

2017
For the 2017 milestone year, CARB is reporting on the following three milestones:

1. Implementation of the *On-Road Heavy-Duty Diesel Vehicles (In-Use) Regulation* (the Truck and Bus Regulation) between 2012 and 2017 that required particulate filters and cleaner engine standards on existing California heavy-duty diesel trucks and buses;
2. Implementation of the *Advanced Clean Cars Program* (the ACC Program) between 2014 and 2017 that required manufacturers of new light-duty passenger vehicles sold in California to limit emissions; and
3. Implementation of *In-Use Off-Road Diesel-Fueled Fleets Regulation* (the Off-Road Regulation) that began in 2014 for large fleets and in 2017 for medium fleets and limited emissions from existing off-road diesel vehicles operated in California.

2020
For the 2020 milestone year, CARB is reporting on the following two milestones:

1. Implementation of the *On-Road Heavy-Duty Diesel Vehicles (In-Use) Regulation* (the Truck and Bus Regulation) between 2017 and 2020 that required particulate

filters and cleaner engine standards on existing California heavy-duty diesel trucks and buses; and

2. The status of SIP measures adopted between 2017 and 2020, including *Advanced Clean Cars 2* and the *Heavy-Duty Vehicle Inspection and Maintenance Program* as part of the *Lower In-Use Emission Performance Level* measure.

2023

For the 2023 milestone year, CARB is reporting on the following two milestones:

1. Implementation of the *On-Road Heavy-Duty Diesel Vehicles (In-Use) Regulation* (the Truck and Bus Regulation) between 2020 and 2023 that required particulate filters and cleaner engine standards on existing California heavy-duty diesel trucks and buses; and
2. Implementation of the California *Low-NOx Engine Standard* for new on-road heavy-duty engines used in medium- and heavy-duty trucks purchased in California.

The 2006 **35** µg/m^3 24-hour standard has quantitative milestone years in **2017**, **2020**, **2023**, and **2026**.

2017

For the 2017 milestone year, CARB is reporting on the following three milestones:

1. Implementation of the *On-Road Heavy-Duty Diesel Vehicles (In-Use) Regulation* (the Truck and Bus Regulation) between 2012 and 2017 that required particulate filters and cleaner engine standards on existing California heavy-duty diesel trucks and buses;
2. Implementation of the *Advanced Clean Cars Program* (the ACC Program) between 2014 and 2017 that required manufacturers of new light-duty passenger vehicles sold in California to limit emissions; and
3. Implementation of *In-Use Off-Road Diesel-Fueled Fleets Regulation* (the Off-Road Regulation) that began in 2014 for large fleets and in 2017 for medium fleets and limited emissions from existing off-road diesel vehicles operated in California.

2020

For the 2020 milestone year, CARB is reporting on the following two milestones:

1. Implementation of the *On-Road Heavy-Duty Diesel Vehicles (In-Use) Regulation* (the Truck and Bus Regulation) between 2017 and 2020 that required particulate filters and cleaner engine standards on existing California heavy-duty diesel trucks and buses; and
2. The status of SIP measures adopted between 2017 and 2020, including *Advanced Clean Cars 2* and the *Heavy-Duty Vehicle Inspection and Maintenance Program*.

2023

For the 2023 milestone year, CARB is reporting on the following two milestones:

1. Implementation of the *On-Road Heavy-Duty Diesel Vehicles (In-Use) Regulation* (the Truck and Bus Regulation) between 2020 and 2023 that required particulate filters and cleaner engine standards on existing California heavy-duty diesel trucks and buses; and

2. Implementation of the California *Low-NOx Engine Standard* for new on-road heavy-duty engines used in medium- and heavy-duty trucks purchased in California.

2026
For the 2026 milestone year, CARB is reporting on the following two milestones:
1. Identify the number of pieces of agricultural equipment turned over to Tier 4 Final due to the *Accelerated Turnover of Agricultural Tractors Measure* through 2026; and
2. Identify the number of trucks and buses turned over to a low-NOx engine or cleaner due to the *Accelerated Turnover of Trucks and Buses Measure* through 2026.

The 2012 **12** µg/m^3 annual standard has quantitative milestone years in **2019**, **2022**, **2025**, and **2028**.

2019
For the 2019 milestone year, CARB is reporting on the following three milestones:
1. Implementation of the *On-Road Heavy-Duty Diesel Vehicles (In-Use) Regulation* (the Truck and Bus Regulation) between 2017 and 2019 that required particulate filters and cleaner engine standards on existing California heavy-duty diesel trucks and buses;
2. Implementation of *In-Use Off-Road Diesel-Fueled Fleets Regulation* (the Off-Road Regulation) that began in 2014 for large fleets and in 2017 for medium fleets and limited emissions from existing off-road diesel vehicles operated in California.
3. The status of SIP measures adopted between 2017 and 2019, including the California *Low-NOx Engine Standard* for new on-road heavy-duty engines used in medium- and heavy-duty trucks purchased in California.

2022
For the 2022 milestone year, CARB is reporting on the following two milestones:
1. Implementation of the *On-Road Heavy-Duty Diesel Vehicles (In-Use) Regulation* (the Truck and Bus Regulation) between 2019 and 2022 that required particulate filters and cleaner engine standards on existing California heavy-duty diesel trucks and buses;
2. The status of SIP measures adopted between 2019 and 2022, including *Advanced Clean Cars 2* and the *Heavy-Duty Vehicle Inspection and Maintenance Program*.

2025
For the 2025 milestone year, CARB is reporting on the following three milestones:
1. Identify the number of pieces of agricultural equipment turned over to Tier 4 Final due to the *Accelerated Turnover of Agricultural Tractors Measure* through 2025;
2. Identify the number of trucks and buses turned over to a low-NOx engine or cleaner due to the *Accelerated Turnover of Trucks and Buses Measure* through 2025; and
3. The status of SIP measures adopted between 2022 and 2025, including the proposed *Cleaner In-Use Agricultural Equipment Measure* to incentivize the penetration of cleaner agricultural equipment used in California.

2028
For the 2028 milestone year, CARB is reporting on the following milestone:

1. Implementation of the *Advanced Clean Cars 2* requirements between 2026 and 2028.

H.3 CONTINGENCY MEASURES

The Clean Air Act provides that a nonattainment SIP shall provide for the implementation of specific measures to be undertaken in the future[10] if the area fails to make reasonable further progress, or to attain the national primary ambient air quality standard by the 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 by EPA.

- **RFP contingencies:** Used if planned emissions controls fail to reach the emissions targets specified in the attainment Plan for RFP. The need to implement RFP contingencies is based on the emissions inventory in the RFP milestone years.
- **Attainment contingencies:** Used if a region fails to attain a federal standard by the final attainment date. The need to implement attainment contingencies is based on ambient air quality data as of the end of the attainment year. If EPA finds that an area fails to attain a standard on time.

H.3.1 WHAT QUALIFIES AS A CONTINGENCY MEASURE?

Contingency measures must be fully adopted rules or control measures that are ready to be implemented quickly without significant additional action by the state or local agency or by EPA.[11] The Plan should contain trigger mechanisms and a schedule for the contingency measure implementation.

H.3.2 CONTINGENCIES

The District is working closely with CARB to develop EPA approvable contingency commitments for this Plan.

As discussed above, contingencies are required for the following years:

- 1997 65 µg/m^3 24-hour and 15 µg/m^3 annual standards: 2017, 2020, and 2023
- 2006 35 µg/m^3 24-hour standard: 2017, 2020, 2023, and 2026
- 2012 12 µg/m^3 annual standard: 2019, 2022, 2025, and 2028

[10] US Court of Appeals for the Ninth Circuit. Sandra L. Bahr; David Matusow v. US EPA; Gina McCarthy, Jared Blumenfeld, EPA Region IX. No. 14-72327 (2016, September 12)
[11] Clean Air Act Section 172(c)9, 40 CFR 51.1012.

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Appendix I

New Source Review and Emission Reduction Credits

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I. NEW SOURCE REVIEW AND EMISSION REDUCTION CREDITS

I.1 INTRODUCTION

The San Joaquin Valley Air Pollution Control Air District (District) requires most new and modified stationary sources that increase emissions in amounts in excess of specific emission offset thresholds to obtain emission reduction credits (ERCs) to offset the growth in emissions. District Rule 2201 (New and Modified Stationary Source Review, or NSR, Rule) contains the offset requirements. Offsets represent either on-site reductions or the use of banked ERCs. The District expects that some pre-baseline credits (pre-2013 for the modeling used in this PM2.5 Plan) will be used to mitigate growth from permitted stationary sources during the period of this plan. This Appendix discusses the use of such ERCs in the San Joaquin Valley.

I.2 PRE-BASELINE EMISSION REDUCTION CREDITS

The General Preamble to the Federal Clean Air Act (57 FR 13498) states that the pre-baseline ERCs must be reflected as growth and included in the attainment demonstration "*to the extent that the State expects that such credits will be used as offsets or netting prior to attainment of the ambient standards.*" The August 26, 1994 memorandum from John Seitz, EPA's Director of Office of Air Quality Planning and Standards, to David Howekamp of EPA Region IX, provides two ways for inclusion of these ERCs as growth by stating that "*A state may choose to show that the magnitude of the pre-1990* (pre-baseline) *ERCs (in absolute tonnage) was included in the growth factor, or the state may choose to show that it was not included in the growth factor, but in addition to anticipated general growth.*"

By including the pre-baseline ERCs in the growth factor, the District has selected the first methodology provided in Seitz's memorandum. However, in either case, the purpose is to show that this plan, by including pre-baseline ERCs as a part of expected growth, will result in a projected inventory adequate to attain the NAAQS and achieve any applicable rate of progress:

projected inventory = baseline inventory + growth + ERCs(pre-baseline) – offsets – reductions

where: growth = non-permitted growth + permitted growth

offsets = ERCs(post-baseline) + ERCs(pre-baseline)

reductions = reductions required by the measures in the Plan

Growth Estimates: The emissions trends and growth estimates in this plan were generated using the reports from the California Emissions Projection Analysis Model (CEPAM). The emissions inventory and associated emissions projections are based on ARB's latest PM 2.5 SIP Planning Projections (California Emissions Projection Analysis Model: 2016 Ozone SIP External Adjustment Reporting Tool version 1.05). CEPAM's computer tools were used to develop projections and emission estimates based on the most current available growth and control data available at the time of the forecast runs. CEPAM was first developed in the 1990s (called CEFS at the time) to assist in developing air quality plans, determining how and where air pollution can be reduced, tracking progress towards meeting plans goals and mandates, and constructing emission trends, and has been updated regularly since then.

A key component of CEPAM is the growth data. The growth estimates generated by CEPAM include growth in emissions requiring offsets under the New Source Review Rule as well as that which can be accommodated without triggering offsets. Tables I-1 through I-4 show total projected growth from stationary sources of 1.01 tons/day of directly emitted PM2.5, and, for PM2.5 precursors, growth of 1.35 tons/day of NOx, 0.64 tons/day of SOx, and 15.11 tons/day of VOC, for the period of 2013 through 2025. Ammonia is not included in the analysis. Although a PM2.5 precursor, ARB modeling has demonstrated that ammonia is not a significant precursor in the Valley (see Precursor Demonstration Appendix) and ERCs are not issued for ammonia, so no accounting for ammonia ERCs is necessary or appropriate. The CEPAM inventory shows negative growth for some segments of the economy, representing a shrinking emissions inventory even before considering reductions required by District plans. However, for the purposes of this ERC-use analysis, the District did not include these negative growth numbers (by setting negative growth to zero), as only positive growth requires offsetting with ERCs.

The CEPAM projected inventory for 2025 does incorporate the projected growth (both positive and negative) as well as the expected controls from the measures contained in prior plans. Notwithstanding slight rounding factors, the projected 2025 inventory equals the baseline inventory plus the projected growth minus the expected reductions from the controls contained in previously adopted plans. Reductions due to this PM2.5 plan are not incorporated in these projections, and do not affect the amount of offsets estimated to mitigate the projected growth.

<u>Emissions Offset Requirements:</u> Under District's New Source Review Rule 2201, new sources with emissions exceeding the following level must offset their emissions:

NOx ……………………………..	20,000 lbs/year
VOC……………………………..	20,000 lbs/year
PM10…………………………….	29,200 lbs/year
SOx………………………………	54,750 lbs/year

Additionally, for existing facilities with emissions meeting or exceeding the above levels, any increase in emissions that is not due solely to increased utilization allowed by their current permits must be offset.

Also, PM2.5 offsets would only be required for any new major PM2.5 source (exceeding 70 tons per year of direct PM2.5 emissions), or for major modifications at existing major

PM2.5 sources (emissions increases of 10 tons per year of direct PM2.5 at an existing major PM2.5 source).

Use of Interpollutant Offsets: Rule 2201 allows the use of interpollutant trading amongst criteria pollutants and their precursors upon the appropriate scientific demonstration of an adequate trading ratio. At this time, EPA has not approved an interpollutant trading ratio for PM2.5 precursors. Until EPA approves such ratios in response to the submittal from the District of a future PM2.5 precursor trading analysis, the District will not allow the use of precursor ERCs to offset PM2.5 emissions increases.

Pre-Baseline Offset Usage Estimate: The amount of offsets expected to be consumed during this plan's period was estimated by establishing the percentage of permitting actions for each source category that would be subject to offset requirements under Rule 2201. For each source category, this percentage was established based on past permitting history, the fraction of sources in the category with emissions at or above the offset trigger levels, and any expected changes in permitting activity for the source category. The following factors were used in estimating the potential need for offsets:

- All increases from modifications to existing sources with potential emissions at or above the above offset thresholds would require offsets (District Rule 2201).

- New sources with emissions exceeding the above offset thresholds would require offsets (District Rule 2201).

- The percentage of sources that meet any of the above criteria was estimated by examining past permitting history and by projecting future permitting based on the estimated growth. For instance, the majority of permitting actions with increases in emissions from oil production facilities come from sources with potential emissions in excess of the above offset thresholds. Therefore, for that source category, it was assumed that 80-100% of increases in overall emissions due to facility modifications would require offsets.

The quantity of required offsets was then established by multiplying the expected growth in emissions for each source category (from CEPAM) by this percentage and the expected offset ratio. District Rule 2201 establishes offset ratios ranging from 1.0:1 to 1.5:1 based on the distance from the source of ERCs to the source with increase in emissions. An offset ratio of 1.5:1 applies to all transactions where the distance is greater than 15 miles, and to all off-site VOC and NOx offsetting. District Rule 2201 also has provisions to allow for interpollutant ratios that are determined on a case-by-case and apply in conjunction with distance offset ratios. For the period of January 2013 through August 6, 2018, the average offset ratio for all permitting actions varied from 1.47:1 for NOx, to 1.44:1 for SOx, to 1.53:1 for PM10, to 1.48:1 for VOC. Tables I-1 through I-4 contain the expected growth, percentage of activities subject to offset requirements, and the expected quantity of offsets for each pollutant.

Although some offsets are expected to come from post-baseline reductions, this plan conservatively assumes that all offsets will be pre-baseline. See Table I-5 for a current list of District-issued ERCs, as of August 2018. These ERCs and future ERCs (and any ERCs generated from them) are available to be used in the District's NSR program.

The expected ERC usage after 2013 and through 2025, as shown in Tables I-1 through I-4, has been estimated in this plan as follows:

	Expected ERC Use (tpd)	**Growth (tpd)**
PM 2.5	0.75	1.01
NOx	1.26	1.35
SOx	0.29	0.64
VOC	8.07	15.11

As shown above, the quantity of pre-baseline offsets (conservatively considering all ERCs used to be pre-baseline ERCs) that are expected to be used between 2013 and 2025 ("Expected ERC Use" column) is less than the plan's estimated growth in emissions for each pollutant ("Growth" column).

Therefore, if growth in new and modified sources occurs at the rate estimated in this plan, the use of offsets as required in Rule 2201 will ensure that permitted increases in emissions will not interfere with progress toward attainment of federal PM2.5 standards. As discussed in Chapter 3, the District also satisfies the requirement for reasonable further progress with the above-mentioned projected inventories and without taking credit for the ERCs required of and provided by new and modified stationary sources permitted during this period.

Finally, because all projected annual use of ERCs is included in the plan's estimated growth, this ERC use is surplus of all plan requirements and may be included as such in the District's annual offset equivalency demonstration required by section 7 of District Rule 2201.

<u>Safeguards to assure plan integrity despite the use of pre-baseline credits:</u> In order to assure that the use of pre-baseline ERCs does not interfere with attainment effort and the applicable rate of progress, this plan incorporates the following safeguards:

- The District will place a cap on the amount of pre-baseline credits that can be used. Although the District has relied on a number of conservative assumptions in estimating the usage quantity of pre-baseline credits, some degree of uncertainty exists. For instance, unexpected growth or irregular permitting activity may occur for one or more source categories. The cap on the use of pre-baseline ERCs will be enforced by tracking the use of such credits and disallowing the use of pre-baseline credits in permitting actions when the above-specified growth levels are reached. The second column of the table above lists expected ERC use for stationary source growth, for each pollutant. The third column of the table above lists the cap on stationary source growth, for each pollutant. In addition, Rule 2201 allows the use of interpollutant trading amongst criteria pollutants and their precursors upon the appropriate scientific demonstration of an adequate trading ratio. These caps also apply to the use of VOC, NOx, and SOx ERCs in their application as offsets for direct emissions and in their use as PM 2.5 precursor interpollutant offsets. Thus, to the extent that precursor ERCs are used to offset PM 2.5 increases, these same ERCs will no longer be available to offset direct increases of these same precursors. At this time, EPA has not approved an interpollutant trading ratio for PM2.5 precursors. Until EPA approves such ratios, the District will not allow the use of precursor ERCs to offset PM2.5 emissions increases. The appropriate proportion of PM10 credits used as PM 2.5 credits for offsetting purposes will be included in the PM2.5 cap. These ERC usage caps replace any caps established in prior plans.

- Although some ERCs will come from post-baseline reductions, this plan conservatively assumes that all offsets will come from pre-baseline reductions. As discussed earlier, federal law only requires the pre-baseline ERCs to be included in the growth and the attainment demonstration. This plan assumes that all ERCs used to offset emission increases will be pre-baseline ERCs and, therefore, includes them all within the projected inventory as growth. Using this higher projected inventory leads to conservative conclusions relating to the attainment and rate of progress demonstrations.

Table I-1 Estimated PM2.5 Growth, Control, and Estimated Offset Use

SUMMARY CATEGORY NAME	2013 Emissions Tons/day	Growth Factor (%)	Estimated Growth (tons/day)	Control Factor (%)	Reductions (tons/day)	2025 Emissions Tons/day	Percent Requiring Offsets	Estimated Offsets* (tons/day)
FUEL COMBUSTION								
ELECTRIC UTILITIES	1.34	-5.50	0.00	-4.93	-0.07	1.26	50	0.00
COGENERATION	0.57	38.53	0.22	-3.66	-0.02	0.78	50	0.17
OIL AND GAS PRODUCTION (COMBUSTION)	1.68	-23.45	0.00	2.22	0.04	1.28	80	0.00
PETROLEUM REFINING (COMBUSTION)	0.08	0.00	0.00	0.00	0.00	0.08	80	0.00
MANUFACTURING AND INDUSTRIAL	0.13	4.05	0.01	2.10	0.00	0.13	25	0.00
FOOD AND AGRICULTURAL PROCESSING	0.70	33.92	0.24	-33.49	-0.24	0.42	20	0.07
SERVICE AND COMMERCIAL	0.47	6.63	0.03	-0.86	0.00	0.50	25	0.01
OTHER (FUEL COMBUSTION)	0.02	18.43	0.00	-44.80	-0.01	0.01	25	0.00
TOTAL PM2.5: FUEL COMBUSTION	**4.97**		**0.50**		**-0.29**	**4.47**		**0.26**
WASTE DISPOSAL								
SEWAGE TREATMENT	0.01	16.92	0.00	0.00	0.00	0.01	25	0.00
LANDFILLS	0.11	16.67	0.02	-0.53	0.00	0.13	50	0.01
INCINERATORS	0.01	13.49	0.00	-1.59	0.00	0.01	25	0.00
SOIL REMEDIATION	0.00	14.29	0.00	0.00	0.00	0.00	25	0.00
OTHER (WASTE DISPOSAL)	0.01	14.75	0.00	-6.56	0.00	0.01	25	0.00
TOTAL PM2.5: WASTE DISPOSAL	**0.14**		**0.02**		**0.00**	**0.16**		**0.02**
CLEANING AND SURFACE COATINGS								
LAUNDERING	0.00	23.08	0.00	0.00	0.00	0.00	25	0.00
DEGREASING	0.02	44.18	0.01	-10.44	0.00	0.04	50	0.01
COATINGS AND RELATED PROCESS SOLVENTS	0.22	26.43	0.06	-2.50	-0.01	0.28	25	0.02
PRINTING	0.01	52.86	0.00	-1.43	0.00	0.01	10	0.00
ADHESIVES AND SEALANTS	0.00	0.00	0.00	0.00	0.00	0.00	10	0.00
OTHER (CLEANING AND SURFACE COATINGS)	0.01	20.51	0.00	-2.56	0.00	0.01	50	0.00

SUMMARY CATEGORY NAME	2013 Emissions Tons/day	Growth Factor (%)	Estimated Growth (tons/day)	Control Factor (%)	Reductions (tons/day)	2025 Emissions Tons/day	Percent Requiring Offsets	Estimated Offsets* (tons/day)
TOTAL PM2.5: CLEANING AND SURFACE COATINGS	**0.00**		**0.00**		**-0.01**	**0.34**		**0.03**
PETROLEUM PRODUCTION AND MARKETING								
OIL AND GAS PRODUCTION	0.04	-23.47	0.00	2.11	0.00	0.03	80	0.00
PETROLEUM REFINING	0.09	0.00	0.00	0.00	0.00	0.09	80	0.00
PETROLEUM MARKETING	0.00	10.00	0.00	0.00	0.00	0.00	80	0.00
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.00	0.00	0.00	0.00	0.00	0.00	80	0.00
TOTAL PM2.5: PETROLEUM PRODUCTION AND MARKETING	**0.13**		**0.00**		**0.00**	**0.12**		**0.00**
INDUSTRIAL PROCESSES								
CHEMICAL	0.22	24.64	0.05	-1.16	0.00	0.27	25	0.02
FOOD AND AGRICULTURE	0.84	20.33	0.17	-2.92	-0.02	1.01	50	0.13
MINERAL PROCESSES	1.38	31.58	0.43	-2.51	-0.03	1.81	50	0.34
METAL PROCESSES	0.06	21.12	0.01	-7.40	0.00	0.07	80	0.01
WOOD AND PAPER	0.23	-0.84	0.00	0.18	0.00	0.23	50	0.00
GLASS AND RELATED PRODUCTS	0.34	-43.00	0.00	-53.60	-0.18	0.20	50	0.00
ELECTRONICS	0.00	-19.51	0.00	-2.44	0.00	0.00	25	0.00
OTHER (INDUSTRIAL PROCESSES)	0.24	25.16	0.06	-1.95	0.00	0.30	25	0.02
TOTAL PM2.5: INDUSTRIAL PROCESSES	**3.30**		**0.73**		**-0.25**	**3.87**		**0.53**
TOTAL PM2.5: STATIONARY SOURCES	**8.55**		**1.25**		**-0.56**	**8.97**		**0.84**

*Offset distance ratio of 1.53:1 used.
California Emissions Projection Analysis Model: 2016 Ozone SIP External Adjustment Reporting Tool version 1.05

Table I-2 Estimated NOx Growth, Control, and Estimated Offset Use

SUMMARY CATEGORY NAME	2013 Emissions Tons/day	Growth Factor (%)	Estimated Growth (tons/day)	Control Factor (%)	Reductions (tons/day)	2025 Emissions Tons/day	Percent Requiring Offsets	Estimated Offsets* (tons/day)
FUEL COMBUSTION								
ELECTRIC UTILITIES	4.41	1.56	0.07	-4.71	-0.21	4.46	100	0.10
COGENERATION	1.61	33.31	0.54	-3.16	-0.05	2.15	100	0.79
OIL AND GAS PRODUCTION (COMBUSTION)	3.08	-21.68	0.00	-12.00	-0.37	2.03	100	0.00
PETROLEUM REFINING (COMBUSTION)	0.19	2.90	0.01	-17.37	-0.03	0.15	100	0.01
MANUFACTURING AND INDUSTRIAL	5.19	2.66	0.14	-0.05	0.00	5.26	40	0.08
FOOD AND AGRICULTURAL PROCESSING	11.49	-0.60	0.00	-63.90	-7.34	3.99	25	0.00
SERVICE AND COMMERCIAL	4.57	7.28	0.33	-7.73	-0.35	4.50	30	0.15
OTHER (FUEL COMBUSTION)	0.64	14.10	0.09	-34.90	-0.22	0.43	25	0.03
TOTAL NOx: FUEL COMBUSTION	**31.19**		**1.17**		**-8.58**	**22.97**		**1.16**
WASTE DISPOSAL								
SEWAGE TREATMENT	0.03	17.58	0.01	0.00	0.00	0.04		0.00
LANDFILLS	0.17	17.47	0.03	-0.47	0.00	0.20	30	0.01
INCINERATORS	0.04	16.79	0.01	-2.80	0.00	0.05	90	0.01
SOIL REMEDIATION	0.01	1.92	0.00	1.92	0.00	0.01		0.00
OTHER (WASTE DISPOSAL)	0.00	7.69	0.00	0.00	0.00	0.00		0.00
TOTAL NOx: WASTE DISPOSAL	**0.25**		**0.04**		**0.00**	**0.29**		**0.02**
CLEANING AND SURFACE COATINGS								
LAUNDERING	0.00	0.00	0.00	0.00	0.00	0.00		0.00
DEGREASING	0.00	0.00	0.00	0.00	0.00	0.00		0.00
COATINGS AND RELATED PROCESS SOLVENTS	0.00	0.00	0.00	0.00	0.00	0.00		0.00
PRINTING	0.00	0.00	0.00	0.00	0.00	0.00		0.00
ADHESIVES AND SEALANTS	0.00	0.00	0.00	0.00	0.00	0.00		0.00
OTHER (CLEANING AND SURFACE COATINGS)	0.00	0.00	0.00	0.00	0.00	0.00		0.00

SUMMARY CATEGORY NAME	2013 Emissions Tons/day	Growth Factor (%)	Estimated Growth (tons/day)	Control Factor (%)	Reductions (tons/day)	2025 Emissions Tons/day	Percent Requiring Offsets	Estimated Offsets* (tons/day)
TOTAL NOx: CLEANING AND SURFACE COATINGS	**0.00**		**0.00**		**0.00**	**0.00**		**0.00**
PETROLEUM PRODUCTION AND MARKETING								
OIL AND GAS PRODUCTION	0.36	-23.41	0.00	2.27	0.01	0.28	100	0.00
PETROLEUM REFINING	0.01	0.00	0.00	0.00	0.00	0.01	100	0.00
PETROLEUM MARKETING	0.04	-0.26	0.00	2.36	0.00	0.04	20	0.00
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00
TOTAL NOx: PETROLEUM PRODUCTION AND MARKETING	**0.41**		**0.00**		**0.01**	**0.33**		**0.00**
INDUSTRIAL PROCESSES								
CHEMICAL	0.31	24.61	0.08	-1.20	0.00	0.38	50	0.06
FOOD AND AGRICULTURE	0.00	0.00	0.00	0.00	0.00	0.00	10	0.00
MINERAL PROCESSES	0.21	30.90	0.06	-2.54	-0.01	0.27	25	0.02
METAL PROCESSES	0.00	0.00	0.00	0.00	0.00	0.00	10	0.00
WOOD AND PAPER	0.00	0.00	0.00	0.00	0.00	0.00		0.00
GLASS AND RELATED PRODUCTS	6.21	-13.80	0.00	-52.12	-3.24	3.50	100	0.00
ELECTRONICS	0.00	0.00	0.00	0.00	0.00	0.00		0.00
OTHER (INDUSTRIAL PROCESSES)	0.00	0.00	0.00	0.00	0.00	0.00	25	0.00
TOTAL NOx: INDUSTRIAL PROCESSES	**6.73**		**0.14**		**-3.25**	**4.16**		**0.08**
TOTAL NOx: STATIONARY SOURCES	**38.57**		**1.35**		**-11.82**	**27.74**		**1.26**

*Offset distance ratio of 1.47:1 used.
California Emissions Projection Analysis Model: 2016 Ozone SIP External Adjustment Reporting Tool version 1.05

Table I-3 Estimated SOx Growth, Control, and Estimated Offset Use

SUMMARY CATEGORY NAME	2013 Emissions Tons/day	Growth Factor (%)	Estimated Growth (tons/day)	Control Factor (%)	Reductions (tons/day)	2025 Emissions Tons/day	Percent Requiring Offsets	Estimated Offsets* (tons/day)
FUEL COMBUSTION								
ELECTRIC UTILITIES	0.61	4.92	0.03	-3.44	-0.02	0.63	50	0.02
COGENERATION	0.19	54.27	0.10	-4.76	-0.01	0.30	50	0.08
OIL AND GAS PRODUCTION (COMBUSTION)	0.72	-23.44	0.00	-56.97	-0.41	0.23	80	0.00
PETROLEUM REFINING (COMBUSTION)	0.02	0.00	0.00	-47.57	-0.01	0.01	100	0.00
MANUFACTURING AND INDUSTRIAL	0.82	2.68	0.02	-4.60	-0.04	0.81	25	0.01
FOOD AND AGRICULTURAL PROCESSING	0.25	9.69	0.02	-60.24	-0.15	0.09	10	0.00
SERVICE AND COMMERCIAL	0.35	6.01	0.02	-8.21	-0.03	0.34	25	0.01
OTHER (FUEL COMBUSTION)	0.00	7.41	0.00	-44.44	0.00	0.00		0.00
TOTAL SOx: FUEL COMBUSTION	**2.95**		**0.20**		**-0.66**	**2.41**		**0.12**
WASTE DISPOSAL								
SEWAGE TREATMENT	0.07	16.64	0.01	-0.46	0.00	0.08		0.00
LANDFILLS	0.07	17.39	0.01	-0.29	0.00	0.08		0.00
INCINERATORS	0.01	17.17	0.00	-1.01	0.00	0.01	25	0.00
SOIL REMEDIATION	0.00	15.38	0.00	-7.69	0.00	0.00		0.00
OTHER (WASTE DISPOSAL)	0.00	14.29	0.00	0.00	0.00	0.00		0.00
TOTAL SOx: WASTE DISPOSAL	**0.15**		**0.03**		**0.00**			**0.00**
CLEANING AND SURFACE COATINGS								
LAUNDERING	0.00	0.00	0.00	0.00	0.00	0.00		0.00
DEGREASING	0.00	0.00	0.00	0.00	0.00	0.00		0.00
COATINGS AND RELATED PROCESS SOLVENTS	0.00	0.00	0.00	0.00	0.00	0.00		0.00
PRINTING	0.00	0.00	0.00	0.00	0.00	0.00		0.00

SUMMARY CATEGORY NAME	2013 Emissions Tons/day	Growth Factor (%)	Estimated Growth (tons/day)	Control Factor (%)	Reductions (tons/day)	2025 Emissions Tons/day	Percent Requiring Offsets	Estimated Offsets* (tons/day)
ADHESIVES AND SEALANTS	0.00	0.00	0.00	0.00	0.00	0.00		0.00
OTHER (CLEANING AND SURFACE COATINGS)	0.00	0.00	0.00	0.00	0.00	0.00		0.00
TOTAL SOx: CLEANING AND SURFACE COATINGS	**0.00**		**0.00**		**0.00**	**0.00**		**0.00**
PETROLEUM PRODUCTION AND MARKETING								
OIL AND GAS PRODUCTION	0.47	-23.38	0.00	2.28	0.01	0.36	90	0.00
PETROLEUM REFINING	0.01	0.00	0.00	0.00	0.00	0.01	100	0.00
PETROLEUM MARKETING	0.00	0.00	0.00	0.00	0.00	0.00		0.00
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.00	0.00	0.00	0.00	0.00	0.00	80	0.00
TOTAL SOx: PETROLEUM PRODUCTION AND MARKETING	**0.48**		**0.00**		**0.01**	**0.37**		**0.00**
INDUSTRIAL PROCESSES								
CHEMICAL	0.77	24.52	0.19	-1.27	-0.01	0.96	25	0.07
FOOD AND AGRICULTURE	0.38	21.54	0.08	-1.83	-0.01	0.46	50	0.06
MINERAL PROCESSES	0.37	30.78	0.11	-2.60	-0.01	0.49	25	0.04
METAL PROCESSES	0.00	0.00	0.00	-13.33	0.00	0.00	25	0.00
WOOD AND PAPER	0.00	0.00	0.00	0.00	0.00	0.00		0.00
GLASS AND RELATED PRODUCTS	2.00	-11.95	0.00	-23.24	-0.47	1.76	50	0.00
ELECTRONICS	0.00	0.00	0.00	0.00	0.00	0.00		0.00
OTHER (INDUSTRIAL PROCESSES)	0.11	25.10	0.03	-2.00	0.00	0.13	25	0.01
TOTAL SOx: INDUSTRIAL PROCESSES	**3.64**		**0.41**		**-0.49**	**3.81**		**0.18**
TOTAL SOx: STATIONARY SOURCES	**7.22**		**0.64**		**-1.15**	**6.60**		**0.30**

*Offset distance ratio of 1.44:1 used.
California Emissions Projection Analysis Model: 2016 Ozone SIP External Adjustment Reporting Tool version 1.05

Table I-4 Estimated VOC Growth, Control, and Estimated Offset Use

SUMMARY CATEGORY NAME	2013 Emissions Tons/day	Growth Factor (%)	Estimated Growth (tons/day)	Control Factor (%)	Reductions (tons/day)	2025 Emissions Tons/day	Percent Requiring Offsets	Estimated Offsets* (tons/day)
FUEL COMBUSTION								
ELECTRIC UTILITIES	0.22	-12.37	0.00	-5.17	-0.01	0.20	100	0.00
COGENERATION	0.50	18.50	0.09	-1.87	-0.01	0.59	90	0.12
OIL AND GAS PRODUCTION (COMBUSTION)	1.16	-23.46	0.00	2.17	0.03	0.89	95	0.00
PETROLEUM REFINING (COMBUSTION)	0.10	0.00	0.00	0.00	0.00	0.10	100	0.00
MANUFACTURING AND INDUSTRIAL	0.18	4.10	0.01	1.88	0.00	0.18	25	0.00
FOOD AND AGRICULTURAL PROCESSING	1.02	-2.90	0.00	-46.50	-0.47	0.51	10	0.00
SERVICE AND COMMERCIAL	0.51	8.25	0.04	-0.80	0.00	0.55	25	0.02
OTHER (FUEL COMBUSTION)	0.04	18.41	0.01	-41.47	-0.02	0.03	10	0.00
TOTAL VOC: FUEL COMBUSTION	**3.72**		**0.15**		**-0.49**	**3.04**		**0.14**
WASTE DISPOSAL								
SEWAGE TREATMENT	0.03	16.31	0.01	-0.92	0.00	0.04	25	0.00
LANDFILLS	1.52	20.24	0.31	-0.72	-0.01	1.83	50	0.23
INCINERATORS	0.01	19.09	0.00	0.00	0.00	0.01		0.00
SOIL REMEDIATION	0.11	17.80	0.02	-0.56	0.00	0.13	10	0.00
OTHER (WASTE DISPOSAL)	23.07	22.42	5.17	-7.21	-1.66	27.19	25	1.91
TOTAL VOC: WASTE DISPOSAL	**24.75**		**5.51**		**-1.68**	**29.20**		**2.15**
CLEANING AND SURFACE COATINGS								
LAUNDERING	0.09	19.33	0.02	-0.79	0.00	0.11	0	0.00
DEGREASING	1.65	25.48	0.42	-4.78	-0.08	2.07	10	0.06
COATINGS AND RELATED PROCESS SOLVENTS	8.26	28.98	2.39	-5.27	-0.44	10.59	50	1.77
PRINTING	5.30	16.55	0.88	-8.29	-0.44	6.17	25	0.32

SUMMARY CATEGORY NAME	2013 Emissions Tons/day	Growth Factor (%)	Estimated Growth (tons/day)	Control Factor (%)	Reductions (tons/day)	2025 Emissions Tons/day	Percent Requiring Offsets	Estimated Offsets* (tons/day)
ADHESIVES AND SEALANTS	0.57	23.47	0.13	-2.08	-0.01	0.71	25	0.05
OTHER (CLEANING AND SURFACE COATINGS)	6.63	24.18	1.60	-6.97	-0.46	8.23	50	1.19
TOTAL VOC: CLEANING AND SURFACE COATINGS	**22.49**		**5.44**		**-1.43**	**27.87**		**3.39**
PETROLEUM PRODUCTION AND MARKETING								
OIL AND GAS PRODUCTION	12.56	-23.42	0.00	2.23	0.28	9.62	80	0.00
PETROLEUM REFINING	0.79	0.00	0.00	0.00	0.00	0.79	90	0.00
PETROLEUM MARKETING	5.47	3.89	0.21	-9.68	-0.53	4.70	40	0.13
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.02	-10.37	0.00	-0.61	0.00	0.02	80	0.00
TOTAL VOC: PETROLEUM PRODUCTION AND MARKETING	**18.83**		**0.21**		**-0.25**	**15.12**		**0.13**
INDUSTRIAL PROCESSES								
CHEMICAL	4.86	24.56	1.19	-1.22	-0.06	6.05	25	0.44
FOOD AND AGRICULTURE	11.22	20.56	2.31	-2.55	-0.29	13.53	50	1.71
MINERAL PROCESSES	0.24	30.78	0.07	-2.67	-0.01	0.31	25	0.03
METAL PROCESSES	0.17	10.42	0.02	-3.09	-0.01	0.18	25	0.01
WOOD AND PAPER	0.01	0.00	0.00	0.00	0.00	0.01	25	0.00
GLASS AND RELATED PRODUCTS	0.02	0.00	0.00	0.00	0.00	0.02	100	0.00
ELECTRONICS	0.00	0.00	0.00	0.00	0.00	0.00		0.00
OTHER (INDUSTRIAL PROCESSES)	0.82	24.97	0.20	-2.10	-0.02	1.02	25	0.08
TOTAL VOC: INDUSTRIAL PROCESSES	**17.33**		**3.79**		**-0.37**	**21.13**		**2.26**
TOTAL VOC: STATIONARY SOURCES	**87.12**		**15.11**		**-4.21**	**96.36**		**8.07**

*Offset distance ratio of 1.48:1 used.
California Emissions Projection Analysis Model: 2016 Ozone SIP External Adjustment Reporting Tool version 1.05

Table I-5 List of Emission Reduction Credits PM10 and PM2.5 Precursors

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
AERA ENERGY LLC	S	32	4	PM10	0	0	69	120
AERA ENERGY LLC	S	202	4	PM10	123	100	70	88
AERA ENERGY LLC	S	215	4	PM10	403	362	361	406
AERA ENERGY LLC	S	254	4	PM10	1,093	1,174	0	913
AERA ENERGY LLC	S	255	4	PM10	4,184	1,519	0	1,074
AERA ENERGY LLC	S	256	4	PM10	10,145	5,624	0	0
AERA ENERGY LLC	S	259	4	PM10	1,483	1,747	0	705
AERA ENERGY LLC	S	260	4	PM10	1,858	1,946	286	633
AERA ENERGY LLC	S	272	4	PM10	806	760	721	693
AERA ENERGY LLC	S	319	4	PM10	449	650	497	499
AERA ENERGY LLC	S	790	4	PM10	153	102	117	167
AERA ENERGY LLC	S	802	4	PM10	734	1,218	47	623
AERA ENERGY LLC	S	862	4	PM10	1,257	1,129	1,090	1,193
AERA ENERGY LLC	S	863	4	PM10	5	5	10	9
AERA ENERGY LLC	S	913	4	PM10	846	548	530	785
AERA ENERGY LLC	S	983	4	PM10	503	106	151	756
AERA ENERGY LLC	S	1006	4	PM10	991	1,085	445	696
AERA ENERGY LLC	S	1008	4	PM10	80	100	30	21
AERA ENERGY LLC	S	1010	4	PM10	1,975	2,028	0	2,074
AERA ENERGY LLC	S	1012	4	PM10	350	748	479	91
AERA ENERGY LLC	S	1013	4	PM10	269	2,280	694	170
AERA ENERGY LLC	S	1026	4	PM10	278	579	252	201
AERA ENERGY LLC	S	1040	4	PM10	0	961	467	0
AERA ENERGY LLC	S	1057	4	PM10	72	81	66	65
AERA ENERGY LLC	S	1091	4	PM10	97	119	120	121
AERA ENERGY LLC	S	1424	4	PM10	787	1,901	1,476	380
AERA ENERGY LLC	S	1476	4	PM10	262	0	0	74

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
AERA ENERGY LLC	S	1477	4	PM10	455	0	0	128
AERA ENERGY LLC	S	1927	4	PM10	1,854	2,703	2,734	2,332
AERA ENERGY LLC	S	2025	4	PM10	1,028	714	726	684
AERA ENERGY LLC	S	2361	4	PM10	4	1	0	2
AERA ENERGY LLC	S	2575	4	PM10	2,301	1,770	0	548
AERA ENERGY LLC	S	2774	4	PM10	443	368	369	489
AERA ENERGY LLC	S	2782	4	PM10	61	60	58	63
AERA ENERGY LLC	S	3265	4	PM10	1,591	0	0	0
AGRI-CEL INC	S	3631	4	PM10	31	38	35	4
ALON BAKERSFIELD REFINING	S	3463	4	PM10	2,445	2,476	2,506	2,506
ALON BAKERSFIELD REFINING	S	3464	4	PM10	2,500	2,500	2,500	2,500
ALON BAKERSFIELD REFINING	S	4798	4	PM10	1,426	1,689	1,612	1,777
ALTA VISTA GIN/MURRIETA FARM	C	1445	4	PM10	0	0	0	7,858
AMERICAN MOULDING & MILLWORK	N	63	4	PM10	1,106	701	809	471
ANDERSEN RACK SYSTEMS, INC	N	950	4	PM10	300	303	306	306
ANDERSON CLAYTON CORP/IDRIA #1	C	959	4	PM10	0	0	0	26,896
ANDERSON CLAYTON CORPORATION	N	737	4	PM10	979	0	0	19,767
ARDAGH GLASS INC	C	1345	4	PM10	18	18	18	18
ARDAGH GLASS INC	N	1293	4	PM10	0	0	0	167
ARDAGH GLASS INC	S	4496	4	PM10	0	0	0	118
BAKERSFIELD CITY WOOD SITE	S	2969	4	PM10	18	24	26	22
BAR VP DAIRY	C	797	4	PM10	0	0	0	2,180
BAR VP DAIRY	C	798	4	PM10	0	0	0	3,204
BAR VP DAIRY	C	799	4	PM10	0	0	0	4,111
BENTA ENERGY LLC	C	1435	4	PM10	6,374	0	0	9,215
BERRY PETROLEUM COMPANY, LLC	N	1441	4	PM10	896	896	896	896
BERRY PETROLEUM COMPANY, LLC	N	1442	4	PM10	2,122	2,122	2,122	2,122
BERRY SEED & FEED COMPANY	N	1406	4	PM10	17,448	15,153	16,686	18,791

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
BRIAN ANDERSON	C	1374	4	PM10	0	0	0	20,729
BRITZ AG FINANCE CO., INC.	C	558	4	PM10	0	0	0	5,780
BRITZ AG FINANCE CO., INC.	C	559	4	PM10	0	0	0	35,897
BRITZ GIN PARTNERSHIP	S	475	4	PM10	0	0	0	4,259
BRITZ GIN PARTNERSHIP II	C	871	4	PM10	0	0	0	10,903
BRITZ INCORPORATED	C	159	4	PM10	0	0	0	715
BRITZ INCORPORATED	C	586	4	PM10	0	0	0	19,720
BROWN SAND INC	N	46	4	PM10	1,107	1,474	840	1,099
BRUCE CARTER INDUSTRIES INC	S	4038	4	PM10	14	18	16	2
BUTTONWILLOW GINNING CO	S	2937	4	PM10	0	0	0	28,460
BUTTONWILLOW GINNING CO	S	4634	4	PM10	0	0	0	13,495
CALAVERAS MATERIALS INC	C	89	4	PM10	45	41	47	38
CALAVERAS MATERIALS INC.	C	233	4	PM10	243	652	759	479
CALIFORNIA DAIRIES	N	498	4	PM10	273	313	128	186
CALIFORNIA DAIRIES INC	S	2152	4	PM10	0	0	0	99
CALIFORNIA DAIRIES INC	S	2204	4	PM10	0	0	0	405
CALIFORNIA DAIRIES, INC.	N	1343	4	PM10	4	4	4	4
CALIFORNIA RESOURCES ELK HILLS LLC	S	826	4	PM10	71	67	60	68
CALIFORNIA RESOURCES ELK HILLS LLC	S	829	4	PM10	68	72	85	69
CALIFORNIA RESOURCES ELK HILLS LLC	S	4906	4	PM10	300	172	839	958
CALIFORNIA RESOURCES ELK HILLS, LLC	C	1439	4	PM10	80	80	80	80
CALIFORNIA RESOURCES ELK HILLS, LLC.	N	1460	4	PM10	0	0	985	0
CALIFORNIA RESOURCES ELK HILLS, LLC.	N	1461	4	PM10	0	0	3,215	0
CALIFORNIA RESOURCES PRODUCTION CORP	N	1115	4	PM10	51	40	67	47
CALIFORNIA RESOURCES PRODUCTION CORP	N	1116	4	PM10	136	113	42	96

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
CALIFORNIA RESOURCES PRODUCTION CORP	N	1169	4	PM10	398	398	225	398
CALIFORNIA RESOURCES PRODUCTION CORP	N	1171	4	PM10	0	0	173	0
CALIFORNIA RESOURCES PRODUCTION CORP	N	1200	4	PM10	5	5	10	0
CALIFORNIA RESOURCES PRODUCTION CORP	S	3036	4	PM10	29	29	29	29
CALIFORNIA RESOURCES PRODUCTION CORP	S	3996	4	PM10	76	26	48	52
CALIFORNIA RESOURCES PRODUCTION CORP	S	4647	4	PM10	204	204	203	203
CALIFORNIA RESOURCES PRODUCTION CORP.	C	1227	4	PM10	23	69	108	96
CALIFORNIA RESOURCES PRODUCTION CORP.	C	1288	4	PM10	0	0	0	1,409
CALMAT CO.	C	50	4	PM10	15	16	23	24
CALMAT OF FRESNO	C	40	4	PM10	75	359	165	553
CALPINE CORP	S	1577	4	PM10	489	0	0	23,085
CALPINE CORP	S	1683	4	PM10	0	0	0	1,462
CALPINE CORP	S	1689	4	PM10	0	0	0	2,604
CALPINE CORP	S	1693	4	PM10	1,091	1,103	1,115	1,115
CALPINE CORP	S	2877	4	PM10	421	0	176	0
CALPINE CORP	S	3198	4	PM10	0	0	0	8,699
CALPINE CORP	S	3288	4	PM10	0	0	987	8,059
CALPINE CORPORATION	C	448	4	PM10	1,067	1,067	1,067	1,067
CALPINE CORPORATION	C	449	4	PM10	82	28	373	674
CALPINE CORPORATION	C	942	4	PM10	50,845	67,976	8,408	841
CALPINE CORPORATION	N	208	4	PM10	715	8,177	6,581	715

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
CALPINE CORPORATION	N	297	4	PM10	0	0	101	66,394
CALPINE ENERGY SERVICES LP	S	3090	4	PM10	751	812	634	694
CALPINE ENERGY SERVICES LP	S	3091	4	PM10	0	0	0	7,210
CALPINE ENERGY SERVICES, L.P.	C	1010	4	PM10	1,029	0	0	13,916
CAMPBELL SOUP COMPANY	N	127	4	PM10	416	289	261	308
CAMPBELL SOUP SUPPLY CO.	N	31	4	PM10	0	434	1,064	0
CANANDAIGUA WINE COMPANY INC	C	702	4	PM10	423	422	449	411
CANDLEWICK YARNS	C	507	4	PM10	11	9	7	7
CASTLE AIRPORT AVIATION & DEVELOP CENTER	N	109	4	PM10	6,262	6,332	6,402	6,402
CERTAINTEED CORPORATION	C	816	4	PM10	600	600	600	600
CHEVRON USA INC	C	331	4	PM10	3,766	3,767	3,767	3,767
CHEVRON USA INC	C	339	4	PM10	11,300	11,300	11,301	11,301
CHEVRON USA INC	C	966	4	PM10	144	144	144	144
CHEVRON USA INC	S	77	4	PM10	3,067	2,768	2,607	3,422
CHEVRON USA INC	S	357	4	PM10	137	116	114	153
CHEVRON USA INC	S	629	4	PM10	24	21	21	21
CHEVRON USA INC	S	702	4	PM10	1,861	1,881	1,902	1,902
CHEVRON USA INC	S	1485	4	PM10	1,890	1,911	1,932	1,932
CHEVRON USA INC	S	3544	4	PM10	1,086	1,185	913	966
CHEVRON USA INC	S	3604	4	PM10	699	1,081	1,219	805
CHEVRON USA INC	S	3679	4	PM10	5,317	2,839	3,598	5,227
CHEVRON USA INC	S	4202	4	PM10	1,144	1,194	1,244	1,244
CHEVRON USA INC	S	4304	4	PM10	711	831	839	1,007
CHEVRON USA INC	S	4377	4	PM10	297	912	1,284	1,251
CHEVRON USA INC	S	4668	4	PM10	23,064	17,442	24,065	20,486
CHEVRON USA INC LOST HILLS GP	S	4659	4	PM10	328	306	337	324
CHEVRON USA INC REFINERY	S	2275	4	PM10	490	1,911	1,932	532

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
CHEVRON USA PRODUCTION INC	S	147	4	PM10	50	57	46	46
CHEVRON USA PRODUCTION INC	S	3228	4	PM10	74	85	147	56
CHEVRON USA PRODUCTION INC	S	3533	4	PM10	101	106	124	122
CHEVRON USA, INC.	C	1147	4	PM10	136	140	95	131
CHEVRON USA, INC.	C	1372	4	PM10	26	61	29	9
CHRISTOPHER RANCH LLC	C	1430	4	PM10	0	0	0	16,009
CLEAN HARBORS BUTTONWILLOW LLC	S	49	4	PM10	567	573	580	580
CONAGRA CONSUMER FROZEN FOODS	N	672	4	PM10	135	48	91	137
CORCORAN IRRIGATION DISTRICT	C	560	4	PM10	75	77	74	44
COUNTY LINE GIN	C	997	4	PM10	0	0	0	8,549
COUNTY OF SAN JOAQUIN SOLID WASTE DIV	S	2264	4	PM10	0	0	0	471
COUNTY OF SAN JOAQUIN SOLID WASTE DIV	S	2266	4	PM10	0	0	0	1,000
COUNTY OF SAN JOAQUIN SOLID WASTE DIV	S	2267	4	PM10	0	0	0	8,813
CRAYCROFT BRICK COMPANY	C	71	4	PM10	50	40	39	40
CRESTWOOD WEST COAST LLC	S	4241	4	PM10	16	48	30	8
CRIMSON RESOURCE MANAGEMENT	S	2161	4	PM10	20	17	12	24
CRIMSON RESOURCE MANAGEMENT	S	3392	4	PM10	1,745	1,292	1,258	941
CXA LA PALOMA, LLC	N	1456	4	PM10	11,695	16,203	9,929	8,254
DEL MONTE FOODS MODESTO PLANT 1	N	58	4	PM10	0	0	8,410	0
DEL MONTE FOODS MODESTO PLANT 1	N	1238	4	PM10	221	189	388	83
DIAMOND FOODS, LLC	N	645	4	PM10	49	0	4	0
DIAMOND PET FOOD PROCESSORS OF RIPON	N	1136	4	PM10	5,198	5,320	5,320	5,442
DIAMOND PET FOOD PROCESSROS OF RIPON LLC	S	4977	4	PM10	0	0	0	8,225
DOLE PACKAGED FOODS LLC	N	520	4	PM10	5	20	72	14

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
E & J GALLO WINERY	C	1071	4	PM10	32	32	31	29
E&B NATURAL RESOURCES MGMT	S	4774	4	PM10	135	145	150	148
E&B NATURAL RESOURCES MGMT	S	4878	4	PM10	0	0	0	58
E&B NATURAL RESOURCES MGMT	S	4959	4	PM10	46	46	46	44
EAGLE VALLEY GINNING LLC	N	847	4	PM10	0	0	0	29,098
ECKERT FROZEN FOODS	N	133	4	PM10	5	20	72	14
ELBOW ENTERPRISES INC	S	3071	4	PM10	0	0	0	19,406
ELEMENT MARKETS EMISSIONS LLC	C	1447	4	PM10	516	748	553	434
ELEMENT MARKETS EMISSIONS LLC	C	1449	4	PM10	515	749	552	435
ELEMENT MARKETS, LLC	N	1327	4	PM10	254	228	279	271
EVOLUTION MARKETS INC	S	2878	4	PM10	0	0	0	11,831
EVOLUTION MARKETS INC.	C	941	4	PM10	0	0	0	41,215
F & T FARMS	C	1177	4	PM10	0	0	0	17,034
FJ MANAGEMENT INC.	N	1334	4	PM10	0	0	320	0
FJ MANAGEMENT INC.	N	1335	4	PM10	0	0	1,322	0
FOSTER FARMS- PORTERVILLE PLANT	S	2337	4	PM10	40	40	40	40
FRESNO/CLOVIS REGIONAL WWTP	C	1211	4	PM10	5	5	4	4
FRITO-LAY INC	N	888	4	PM10	0	0	2,339	0
FRITO-LAY INC	N	890	4	PM10	61	0	0	0
FRITO-LAY INC	S	3412	4	PM10	7,136	7,320	7,507	7,506
FRITO-LAY INC	S	3414	4	PM10	0	0	0	6,935
FRITO-LAY INC	S	3416	4	PM10	0	8	306	310
FRITO-LAY INC	S	3417	4	PM10	0	0	0	2,531
FRITO-LAY INC	S	3418	4	PM10	5,000	5,000	5,000	5,000
FRITO-LAY INC	S	3419	4	PM10	132	132	133	134
FRITO-LAY INC	S	3453	4	PM10	17	68	208	207
FRITO-LAY, INC.	C	1068	4	PM10	69	70	67	63
FRITO-LAY, INC.	C	1069	4	PM10	286	280	268	259

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
FRITO-LAY, INC.	C	1136	4	PM10	0	0	0	699
FRITO-LAY, INC.	S	3437	4	PM10	210	288	195	174
GALLO GLASS COMPANY	N	1474	4	PM10	22,986	22,743	24,106	22,397
GARY STOWE	C	1441	4	PM10	828	0	0	9,223
GENERAL CABLE INDUSTRIES, LLC	C	524	4	PM10	2	1	2	1
GENERAL MILLS INC	S	3218	4	PM10	0	0	0	4,525
GENERAL MILLS OPERATIONS, INC	N	608	4	PM10	178	0	385	298
GRANITE CONSTRUCTION COMPANY	C	1065	4	PM10	0	0	0	2
H & H COTTON GINNING COMPANY	C	105	4	PM10	0	0	0	9,954
H. J. HEINZ COMPANY	N	60	4	PM10	0	42	226	4
H. J. HEINZ COMPANY	N	694	4	PM10	0	0	1,372	0
H. J. HEINZ COMPANY	N	1085	4	PM10	72	73	63	31
H. J. HEINZ COMPANY, L.P.	N	21	4	PM10	0	60	180	60
HERSHEY CHOCOLATE & CONF. CORP	N	952	4	PM10	254	230	240	228
HOGAN MANUFACTURING, INC	N	34	4	PM10	1,972	4,031	2,344	2,712
HURON GINNING CO	C	521	4	PM10	8	373	186	631
INGREDION INCORPORATED	N	1086	4	PM10	1,392	853	1,662	1,400
J D HEISKELL & CO	S	415	4	PM10	643	322	356	1,039
J G BOSWELL COMPANY OIL MILL	C	92	4	PM10	670	460	648	916
J G BOSWELL COMPANY OIL MILL	C	93	4	PM10	2,810	2,418	2,082	4,097
J R SIMPLOT COMPANY	C	1039	4	PM10	988	1,900	877	1,470
KERN DELTA CO LLC	S	4317	4	PM10	0	0	0	26,563
KERN OIL & REFINING CO.	S	4971	4	PM10	2,702	3,199	2,947	4,468
KERN RIVER HOLDINGS, INC.	C	1370	4	PM10	0	0	0	5,298
KOCH SUPPLY & TRADING LP	C	1311	4	PM10	0	0	0	2,881
KOCH SUPPLY & TRADING LP	N	1154	4	PM10	165	308	333	5,030
KOCH SUPPLY & TRADING LP	N	1156	4	PM10	0	4,710	4,761	4,191
KOCH SUPPLY & TRADING LP	N	1161	4	PM10	0	0	0	8,300

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
KOCH SUPPLY & TRADING LP	S	4148	4	PM10	0	0	0	18,971
KOCH SUPPLY & TRADING LP	S	4149	4	PM10	0	0	0	3,789
KOCH SUPPLY & TRADING LP	S	4150	4	PM10	0	0	0	1,956
KODA FARMS	C	856	4	PM10	0	0	0	1,396
KODA FARMS MILLING INC	S	3196	4	PM10	0	0	0	856
KODA FARMS MILLING INC	S	3197	4	PM10	0	0	0	3,144
KODA FARMS MILLING INC	S	3796	4	PM10	0	0	0	4,820
KODA FARMS, INC.	N	1042	4	PM10	0	0	0	5,180
KRAFT HEINZ FOODS CO	S	4033	4	PM10	8	70	112	71
LA PALOMA GENERATING CO, LLC	C	1055	4	PM10	0	0	0	360
LAND O' LAKES INC	S	4924	4	PM10	15	15	15	15
LAWRENCE LIVERMORE NATL. LAB	N	464	4	PM10	8	3	0	6
LIDESTRI FOODS, INC	N	391	4	PM10	0	0	1,056	0
LOS BANOS GRAVEL GROUP, ASPHLT	N	125	4	PM10	85	162	376	168
LOS GATOS TOMATO PRODUCTS	C	1021	4	PM10	0	24	0	0
M CARATAN INC	S	2516	4	PM10	0	0	14	3
MACPHERSON OIL COMPANY	C	1321	4	PM10	0	0	0	8
MACPHERSON OIL COMPANY	C	1361	4	PM10	0	0	0	1,843
MALAGA POWER, LLC	C	1354	4	PM10	0	0	0	138
MARTIN ANDERSON	C	1051	4	PM10	32	48	28	2
MESA VERDE TRADING CO INC	S	4309	4	PM10	4,439	67	0	1,328
MEYERS FARMING LLC	C	1112	4	PM10	0	6,074	7,699	3,185
MID-SET COGENERATION COMPANY	S	4860	4	PM10	3,847	3,914	3,899	3,885
MID-VALLEY COTTON GROWERS INC	S	3803	4	PM10	0	0	0	2,128
MOLYCORP MINERALS LLC	S	3539	4	PM10	373	329	313	238
MONTEREY RESOURCES, INC.	S	432	4	PM10	906	918	753	837
NAS LEMOORE	C	330	4	PM10	17	17	17	17
NAS LEMOORE	C	1050	4	PM10	7,799	3,198	5,638	1,626

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
NESTLE PURINA PETCARE CO	S	4764	4	PM10	150	150	150	150
OAKWOOD LAKE RESORT	N	601	4	PM10	0	9	15	0
OCEANAIR ENVIRONMENTAL	N	1420	4	PM10	3,269	3,660	3,947	2,974
OLAM SVI	N	1428	4	PM10	500	1,387	1,737	15
OLAM SVI	N	1431	4	PM10	231	598	1,264	789
OLDUVAI GORGE LLC	S	4978	4	PM10	0	0	0	38,729
OLDUVAI GORGE, LLC	C	789	4	PM10	0	0	0	40,000
OLDUVAI GORGE, LLC	C	1319	4	PM10	0	0	0	25,891
OLDUVAI GORGE, LLC	C	1376	4	PM10	0	0	0	779
OLDUVAI GORGE, LLC	C	1380	4	PM10	0	0	0	702
OLDUVAI GORGE, LLC	C	1424	4	PM10	0	0	0	1,574
OLDUVAI GORGE, LLC	N	1410	4	PM10	0	0	3,362	512
OWENS-BROCKWAY GLASS CONTAINER	N	517	4	PM10	0	0	0	490
PACIFIC PIPELINE SYSTEM LLC	S	575	4	PM10	0	0	108	0
PACIFIC PIPELINE SYSTEM LLC	S	576	4	PM10	0	203	181	0
PACIFIC PIPELINE SYSTEM LLC	S	577	4	PM10	710	860	899	899
PACTIV, LLC	S	3865	4	PM10	33	29	7	15
PARAMOUNT FARMS	N	1321	4	PM10	0	0	65	0
PARAMOUNT FARMS, INC	N	1084	4	PM10	27	1,770	275	275
PARAMOUNT FARMS, INC.	C	1207	4	PM10	0	0	188	20
PARAMOUNT FARMS, INC.	C	1357	4	PM10	0	1,000	16,305	0
PILKINGTON NORTH AMERICA INC	S	4562	4	PM10	0	0	0	6,679
PILKINGTON NORTH AMERICA INC	S	4584	4	PM10	0	0	0	23,321
PILKINGTON NORTH AMERICA, INC	C	1356	4	PM10	1,000	0	19,695	12,000
PILKINGTON NORTH AMERICA, INC	N	1289	4	PM10	9,505	9,322	9,357	10,678
PILKINGTON NORTH AMERICA, INC	N	1320	4	PM10	0	0	0	52,685
POHL ALMOND HULLING	N	212	4	PM10	0	0	4,279	8,511
P-R FARMS, INC.	C	126	4	PM10	0	0	357	180

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
R M WADE & COMPANY	C	152	4	PM10	14	17	17	16
RANCHERS COTTON OIL	C	817	4	PM10	1,327	1,325	1,323	1,323
RIO BRAVO FRESNO	C	244	4	PM10	1,000	0	0	0
RIO BRAVO JASMIN	S	4944	4	PM10	3,215	2,232	3,377	3,479
RIO BRAVO POSO	S	4765	4	PM10	1,042	2,482	3,268	1,828
RIVERSIDE DAIRY	C	819	4	PM10	1,225	409	0	3,469
RIVERSIDE DAIRY	C	820	4	PM10	4,335	0	0	6,111
SALIDA HULLING ASSOCIATION	N	44	4	PM10	0	0	12,246	0
SAN JOAQUIN FACILITIES MGMT	S	1253	4	PM10	27	30	32	30
SAN JOAQUIN FACILITIES MGMT	S	1509	4	PM10	7	9	9	9
SAN JOAQUIN FACILITIES MGMT	S	1735	4	PM10	23	20	15	12
SAPUTO CHEESE USA INC	S	4655	4	PM10	0	0	0	7
SC JOHNSON HOME STORAGE INC	C	107	4	PM10	326	315	281	269
SC JOHNSON HOME STORAGE INC	C	1173	4	PM10	271	360	355	366
SENECA RESOURCES	C	1410	4	PM10	0	0	0	589
SENECA RESOURCES	C	1428	4	PM10	0	0	0	200
SENECA RESOURCES	N	1409	4	PM10	0	0	468	1,403
SENECA RESOURCES CORP.	C	1408	4	PM10	0	0	0	22
SENTINEL PEAK RESOURCES CA LLC	C	1415	4	PM10	0	0	0	2
SENTINEL PEAK RESOURCES CA LLC	C	1421	4	PM10	85	0	375	329
SENTINEL PEAK RESOURCES CA LLC	C	1422	4	PM10	0	0	0	2,180
SENTINEL PEAK RESOURCES CA LLC	N	1419	4	PM10	0	0	0	510
SENTINEL PEAK RESOURCES CA LLC	S	4840	4	PM10	0	0	0	8,500
SENTINEL PEAK RESOURCES CA LLC	S	4841	4	PM10	0	0	0	10,572
SHAFTER HAY & CUBE LLC	S	3804	4	PM10	0	691	1,099	154
SHAFTER-WASCO GINNING CO	S	3268	4	PM10	0	0	0	4,695
SIERRA POWER CORPORATION	S	4847	4	PM10	6,369	5,406	5,241	5,790
SOC RESOURCES INC	S	3089	4	PM10	5	4	4	4

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
SOUTH VALLEY GINS INC	S	3554	4	PM10	0	0	0	8,671
SOUTH VALLEY GINS INC	S	4635	4	PM10	1,223	0	0	12,164
STOCKTON EAST WATER DISTRICT	N	763	4	PM10	214	299	301	271
SWANSON HULLING	N	10	4	PM10	0	0	2,984	0
TAFT PRODUCTION CO	S	2670	4	PM10	1,914	1,959	2,000	2,000
TAUBER OIL COMPANY	C	1284	4	PM10	0	0	0	1
TEXACO EXPLOR & PROD INC	S	20250361	4	PM10	41	43	37	40
THE DOW CHEMICAL COMPANY	N	799	4	PM10	73	82	83	72
THE ENVIRONMENTAL RESOURCES TRUST, INC	C	1013	4	PM10	418	418	418	418
THE NESTLE COMPANY INC	N	93	4	PM10	5,602	5,688	4,414	7,118
TKV CONTAINERS, INC.	C	1015	4	PM10	0	349	349	0
TRI-CITY GROWERS INC	S	4392	4	PM10	1,694	0	0	7,175
TULE RIVER CO-OP GIN INC	S	2913	4	PM10	0	0	0	484
TURLOCK IRRIGATION DISTRICT	C	510	4	PM10	0	0	0	6,430
TURLOCK IRRIGATION DISTRICT	N	433	4	PM10	0	0	0	4,720
UNITED STATES GYPSUM CO	S	2543	4	PM10	0	0	0	8,032
UNITED STATES GYPSUM CO	S	2576	4	PM10	0	0	0	5,078
UNITED STATES GYPSUM CO	S	2577	4	PM10	0	0	350	17,130
UNITED STATES GYPSUM CO	S	2578	4	PM10	0	0	0	14,051
UNITED STATES GYPSUM CO	S	2580	4	PM10	1,340	0	0	0
UNITED STATES GYPSUM CO	S	2581	4	PM10	2,953	0	0	8,168
UNITED STATES GYPSUM CO	S	2582	4	PM10	0	0	0	2,736
UNITED STATES GYPSUM CO	S	2583	4	PM10	87	0	721	10,072
UNITED STATES GYPSUM CO	S	2584	4	PM10	0	0	0	6,407
UNITED STATES GYPSUM COMPANY	C	818	4	PM10	0	0	0	18,935
UNITED STATES GYPSUM COMPANY	C	827	4	PM10	0	0	0	4,000
UNITED STATES GYPSUM COMPANY	C	828	4	PM10	0	0	0	2,848

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
UNITED STATES GYPSUM COMPANY	C	829	4	PM10	0	0	0	1,649
UNITED STATES GYPSUM COMPANY	C	830	4	PM10	0	0	0	5,824
UNITED STATES GYPSUM COMPANY	C	831	4	PM10	0	0	0	5,395
UNITED STATES GYPSUM COMPANY	C	832	4	PM10	0	0	0	5,112
UNITED STATES GYPSUM COMPANY	C	833	4	PM10	1,006	44	0	943
UNITED STATES GYPSUM COMPANY	C	834	4	PM10	0	0	0	6,788
UNITED STATES GYPSUM COMPANY	C	835	4	PM10	0	0	0	5,357
UNITED STATES GYPSUM COMPANY	C	836	4	PM10	0	0	0	6,688
UNITED STATES GYPSUM COMPANY	C	837	4	PM10	0	0	0	18,959
UNITED STATES GYPSUM COMPANY	C	838	4	PM10	0	0	0	5,098
UNITED STATES GYPSUM COMPANY	C	839	4	PM10	0	0	0	5,476
UNITED STATES GYPSUM COMPANY	C	840	4	PM10	0	0	0	3,470
UNITED STATES GYPSUM COMPANY	C	841	4	PM10	0	0	0	2,642
UNITED STATES GYPSUM COMPANY	C	842	4	PM10	0	0	0	3,471
UNITED STATES GYPSUM COMPANY	C	843	4	PM10	0	0	0	7,953
UNITED STATES GYPSUM COMPANY	C	845	4	PM10	0	0	0	10,655
UNITED STATES GYPSUM COMPANY	C	846	4	PM10	0	0	0	11,928
UNITED STATES GYPSUM COMPANY	C	847	4	PM10	0	0	0	26,284
UNITED STATES GYPSUM COMPANY	N	659	4	PM10	0	0	0	23,209
UNITED STATES GYPSUM COMPANY	N	660	4	PM10	0	0	0	23,515
VALLEY GRAIN/AZTECA MILLING	C	1042	4	PM10	0	0	0	2,847
VAN GRONINGEN ORCHARDS	N	894	4	PM10	0	0	2,306	1,327
VANDERHAM WEST	S	2410	4	PM10	0	0	0	5,765
VANDERHAM WEST	S	2411	4	PM10	0	0	0	7,592
VANDERHAM WEST	S	2412	4	PM10	0	0	7	3,945
VANDERHAM WEST	S	2413	4	PM10	9	0	0	4,701
VARCO PRUDEN BUILDINGS, INC.	N	898	4	PM10	3,827	4,258	7,700	6,665
VECTOR ENVIRONMENTAL INC	S	4039	4	PM10	58	70	66	8

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
WEST ISLAND COTTON GROWERS INC	C	55	4	PM10	0	0	0	4,365
WEST ISLAND COTTON GROWERS INC	C	1017	4	PM10	607	0	1,193	1,800
WESTERN MILLING LLC	S	2634	4	PM10	0	0	0	579
WESTERN MILLING LLC	S	4220	4	PM10	0	0	0	3,065
WESTERN MILLING, LLC	C	621	4	PM10	152	152	152	152
WESTERN MILLING, LLC	C	670	4	PM10	0	0	0	10,844
WESTERN STONE PRODUCTS, INC.	N	17	4	PM10	513	513	558	558
WESTSIDE FARMERS COOP #2 & #3	C	1038	4	PM10	3,311	0	0	37,809
WESTSIDE FARMERS COOP. GIN	C	352	4	PM10	0	0	0	33,444
WONDERFUL PISTACHIOS & ALMONDS	S	1446	4	PM10	0	0	1,088	18,586
AERA ENERGY LLC	C	219	2	NOx	1,738	1,923	2,100	1,931
AERA ENERGY LLC	C	1401	2	NOx	22,209	22,209	22,209	22,208
AERA ENERGY LLC	S	135	2	NOx	5,032	1,152	0	0
AERA ENERGY LLC	S	137	2	NOx	5,115	6,792	5,437	9,206
AERA ENERGY LLC	S	139	2	NOx	11,686	11,816	11,946	11,946
AERA ENERGY LLC	S	140	2	NOx	36,695	46,397	47,292	36,806
AERA ENERGY LLC	S	158	2	NOx	38,057	29,690	32,405	43,791
AERA ENERGY LLC	S	162	2	NOx	128,454	152,970	128,743	130,786
AERA ENERGY LLC	S	163	2	NOx	96,698	107,197	101,158	78,678
AERA ENERGY LLC	S	470	2	NOx	3,478	4,930	5,390	5,212
AERA ENERGY LLC	S	662	2	NOx	9,433	18,919	3,766	817
AERA ENERGY LLC	S	784	2	NOx	7,140	3,993	228	0
AERA ENERGY LLC	S	838	2	NOx	442	218	338	338
AERA ENERGY LLC	S	865	2	NOx	6,713	6,788	6,863	6,863
AERA ENERGY LLC	S	883	2	NOx	632	160	2,073	2,061
AERA ENERGY LLC	S	1061	2	NOx	8,071	8,777	10,695	9,555
AERA ENERGY LLC	S	1062	2	NOx	8,530	9,784	10,046	9,903

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
AERA ENERGY LLC	S	1063	2	NOx	9,423	10,057	12,159	9,776
AERA ENERGY LLC	S	1064	2	NOx	5,126	5,705	5,881	6,709
AERA ENERGY LLC	S	1065	2	NOx	10,366	10,483	11,017	8,841
AERA ENERGY LLC	S	1066	2	NOx	5,542	7,367	5,038	6,117
AERA ENERGY LLC	S	1067	2	NOx	1,255	893	2,650	4,592
AERA ENERGY LLC	S	1068	2	NOx	7,648	9,620	6,968	8,415
AERA ENERGY LLC	S	1069	2	NOx	4,713	5,029	4,352	2,082
AERA ENERGY LLC	S	1070	2	NOx	495	4,228	2,744	99
AERA ENERGY LLC	S	1092	2	NOx	348	242	246	236
AERA ENERGY LLC	S	1270	2	NOx	4,586	4,637	4,688	4,688
AERA ENERGY LLC	S	1437	2	NOx	42,372	49,588	46,800	43,954
AERA ENERGY LLC	S	1476	2	NOx	1,242	0	0	350
AERA ENERGY LLC	S	1477	2	NOx	2,153	0	0	607
AERA ENERGY LLC	S	1821	2	NOx	5,974	7,291	7,466	4,158
AERA ENERGY LLC	S	1851	2	NOx	914	455	0	1,154
AERA ENERGY LLC	S	1935	2	NOx	474	508	543	543
AERA ENERGY LLC	S	2023	2	NOx	1,108	636	737	993
AERA ENERGY LLC	S	2361	2	NOx	30	4	0	12
AERA ENERGY LLC	S	2774	2	NOx	5,817	4,899	4,757	8,181
AERA ENERGY LLC	S	2782	2	NOx	329	323	318	341
AERA ENERGY LLC	S	3267	2	NOx	5,519	3,439	0	2,156
AERA ENERGY LLC	S	3312	2	NOx	2,432	4,568	1,346	162
AERA ENERGY LLC	S	3689	2	NOx	76,465	88,497	87,135	83,102
AERA ENERGY LLC	S	3831	2	NOx	8,498	5,583	30	1,326
AERA ENERGY LLC	S	4063	2	NOx	573	515	438	663
AERA ENERGY LLC	S	4064	2	NOx	359	564	674	586
AERA ENERGY LLC	S	4422	2	NOx	6,370	2,050	2,897	6,316
AERA ENERGY LLC	S	4932	2	NOx	90,546	80,916	29,850	74,333

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
AGRI-CEL INC	S	3631	2	NOx	54	67	63	8
ALON BAKERSFIELD REFINING	S	3460	2	NOx	4,645	5,658	5,190	4,325
ALON BAKERSFIELD REFINING	S	4692	2	NOx	1,080	1,344	1,267	1,431
ALON BAKERSFIELD REFINING	S	4986	2	NOx	90,450	92,839	95,280	95,280
ALTA VISTA GIN/MURRIETA FARM	C	1445	2	NOx	0	0	0	171
ANDERSON CLAYTON CORP/IDRIA #1	C	1279	2	NOx	0	0	0	754
AVENAL POWER CENTER LLC	S	2814	2	NOx	6,121	13,869	18,914	11,461
AVENAL POWER CENTER LLC	S	4946	2	NOx	49,500	49,500	49,500	49,500
AVENAL POWER CENTER, LLC	C	899	2	NOx	2,243	2,243	2,243	2,243
AVENAL POWER CENTER, LLC	C	902	2	NOx	13,879	6,131	1,086	8,539
AVENAL POWER CENTER, LLC	N	720	2	NOx	0	9	1,255	437
AVENAL POWER CENTER, LLC	N	722	2	NOx	0	1,166	88,317	1,422
AVENAL POWER CENTER, LLC	N	726	2	NOx	0	0	4,728	0
AVENAL POWER CENTER, LLC	N	728	2	NOx	10,542	3,731	2,487	5,171
BAKER COMMODITIES INC	N	482	2	NOx	1,194	1,194	1,196	1,194
BAKERSFIELD CITY WOOD SITE	S	2969	2	NOx	1,564	2,135	2,265	1,857
BERRY PETROLEUM COMPANY LLC	S	4888	2	NOx	0	0	77	278
BERRY PETROLEUM COMPANY LLC	S	4889	2	NOx	8,556	0	0	0
BERRY PETROLEUM COMPANY, LLC	N	1443	2	NOx	112	112	112	112
BERRY PETROLEUM COMPANY, LLC	N	1444	2	NOx	2,234	2,234	2,234	2,234
BREITBURN OPERATING LP	S	4057	2	NOx	7	9	7	6
BRITZ AG FINANCE CO., INC.	C	557	2	NOx	0	0	0	232
BRITZ GIN PARTNERSHIP II	C	871	2	NOx	0	0	0	585
BRITZ INCORPORATED	C	586	2	NOx	0	0	0	381
BROWN SAND INC	N	46	2	NOx	90	98	46	83
BRUCE CARTER INDUSTRIES INC	S	4038	2	NOx	25	31	29	4
BUILDING MATERIALS MFG CORP (DBA GAF)	S	1662	2	NOx	5,832	5,840	5,848	5,848

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
BUTTONWILLOW GINNING CO	S	4634	2	NOx	0	0	0	520
CALAVERAS MATERIALS INC	C	89	2	NOx	284	257	294	236
CALAVERAS MATERIALS INC.	C	233	2	NOx	1,265	3,371	3,913	2,469
CALIFORNIA DAIRIES	N	1341	2	NOx	1,486	265	264	264
CALIFORNIA DAIRIES INC	S	2293	2	NOx	32	33	32	32
CALIFORNIA DAIRIES INC	S	2731	2	NOx	50	0	24	1,282
CALIFORNIA DAIRIES, INC.	C	635	2	NOx	22	22	22	22
CALIFORNIA DAIRIES, INC.	C	658	2	NOx	0	0	102	75
CALIFORNIA DAIRIES, INC.	C	1364	2	NOx	450	126	356	79
CALIFORNIA DAIRIES, INC.	N	707	2	NOx	0	1,270	1,363	226
CALIFORNIA HEAVY OIL, INC.	N	1219	2	NOx	0	162	162	0
CALIFORNIA HEAVY OIL, INC.	N	1233	2	NOx	0	87	131	0
CALIFORNIA NATURAL COLOR	C	1209	2	NOx	13	13	12	15
CALIFORNIA RESOURCES ELK HILLS LLC	S	3249	2	NOx	89	208	73	157
CALIFORNIA RESOURCES ELK HILLS LLC	S	4196	2	NOx	109	69	138	148
CALIFORNIA RESOURCES ELK HILLS LLC	S	4436	2	NOx	1,735	332	662	1,082
CALIFORNIA RESOURCES ELK HILLS LLC	S	4701	2	NOx	0	0	0	543
CALIFORNIA RESOURCES ELK HILLS LLC	S	4707	2	NOx	10,221	11,071	14,626	14,976
CALIFORNIA RESOURCES ELK HILLS LLC	S	4904	2	NOx	8,394	8,394	8,394	8,393
CALIFORNIA RESOURCES ELK HILLS LLC	S	4945	2	NOx	1,500	1,500	1,500	1,500
CALIFORNIA RESOURCES ELK HILLS LLC	S	4998	2	NOx	15,781	15,781	15,781	15,781
CALIFORNIA RESOURCES PRODUCTION CORP	N	1165	2	NOx	456	465	456	456
CALIFORNIA RESOURCES PRODUCTION CORP	N	1235	2	NOx	3,614	0	0	0
CALIFORNIA RESOURCES PRODUCTION CORP	N	1245	2	NOx	1,219	0	0	0

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
CALIFORNIA RESOURCES PRODUCTION CORP	S	3586	2	NOx	0	1,512	6,228	0
CALIFORNIA RESOURCES PRODUCTION CORP	S	3588	2	NOx	1,847	0	0	0
CALIFORNIA RESOURCES PRODUCTION CORP	S	4088	2	NOx	80	80	80	80
CALIFORNIA RESOURCES PRODUCTION CORP	S	4093	2	NOx	159	0	0	0
CALIFORNIA RESOURCES PRODUCTION CORP	S	4361	2	NOx	1,476	1,476	1,476	1,476
CALIFORNIA RESOURCES PRODUCTION CORP	S	4434	2	NOx	0	5,255	2,832	6,776
CALIFORNIA RESOURCES PRODUCTION CORP	S	4484	2	NOx	860	860	860	861
CALIFORNIA RESOURCES PRODUCTION CORP.	C	1231	2	NOx	186	186	186	186
CALIFORNIA RESOURCES PRODUCTION CORP.	C	1329	2	NOx	428	428	428	428
CALIFORNIA RESOURCES PRODUCTION CORP.	C	1335	2	NOx	456	456	456	456
CALIFORNIA RESOURCES PRODUCTION CORP.	C	1343	2	NOx	4,973	4,972	4,973	4,738
CALIFORNIA STATE PRISON - CORCORAN	S	3112	2	NOx	135	137	137	138
CALMAT CO.	C	50	2	NOx	104	111	154	159
CALMAT OF FRESNO	C	40	2	NOx	74	355	163	547
CALNEV PIPE LINE LLC	S	2553	2	NOx	1,886	1,886	1,886	1,886
CALPINE CORP	S	3298	2	NOx	2,103	9,681	19,140	9,076
CALPINE CORP	S	3541	2	NOx	0	242	0	0
CALPINE ENERGY SERVICES LP	S	3138	2	NOx	0	0	0	760
CALPINE ENERGY SERVICES LP	S	3277	2	NOx	6,400	0	3,870	1,876

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
CALPINE ENERGY SERVICES, L.P.	C	1014	2	NOx	302	0	0	852
CALPINE ENERGY SERVICES, L.P.	C	1040	2	NOx	0	0	0	684
CALPINE ENERGY SERVICES, L.P.	N	845	2	NOx	4,089	4,089	4,089	3,093
CALPINE ENERGY SERVICES, L.P.	N	846	2	NOx	4,429	4,429	4,429	3,353
CALPINE ENERGY SERVICES, L.P.	N	903	2	NOx	5,833	5,834	5,834	5,833
CAMPBELL SOUP COMPANY	N	127	2	NOx	1,515	454	409	924
CANANDAIGUA WINE COMPANY INC	C	1203	2	NOx	354	358	380	334
CANDLEWICK YARNS	C	507	2	NOx	90	77	63	58
CASTLE AIRPORT AVIATION & DEVELOP CENTER	N	109	2	NOx	38,954	39,386	39,819	39,819
CHEMICAL WASTE MANAGEMENT, INC	N	687	2	NOx	7	7	6	6
CHEVRON U S A INC	S	1428	2	NOx	1,968	1,990	2,011	2,011
CHEVRON U.S.A. INC.	N	1051	2	NOx	15,566	8,173	19,366	19,259
CHEVRON U.S.A. INC.	N	1052	2	NOx	0	0	8,139	0
CHEVRON U.S.A. INC.	N	1053	2	NOx	0	0	9,120	180
CHEVRON U.S.A. INC.	N	1054	2	NOx	500	500	500	500
CHEVRON USA INC	C	221	2	NOx	2,311	2,557	2,792	2,567
CHEVRON USA INC	C	331	2	NOx	23,739	23,739	23,740	23,740
CHEVRON USA INC	C	364	2	NOx	30,130	29,673	29,217	29,217
CHEVRON USA INC	C	1158	2	NOx	0	0	0	132
CHEVRON USA INC	C	1159	2	NOx	0	0	0	137
CHEVRON USA INC	C	1160	2	NOx	175	0	0	1,230
CHEVRON USA INC	C	1161	2	NOx	0	0	0	846
CHEVRON USA INC	S	77	2	NOx	2,038	1,840	1,733	2,274
CHEVRON USA INC	S	436	2	NOx	12,891	9,861	9,530	10,101
CHEVRON USA INC	S	629	2	NOx	2,316	2,041	2,088	1,975
CHEVRON USA INC	S	909	2	NOx	3,990	3,412	3,474	3,072
CHEVRON USA INC	S	1100	2	NOx	62,167	62,857	63,548	63,548

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
CHEVRON USA INC	S	1102	2	NOx	57,160	57,795	58,430	58,430
CHEVRON USA INC	S	1106	2	NOx	11,814	11,942	12,075	12,075
CHEVRON USA INC	S	1256	2	NOx	45,238	45,741	46,244	46,244
CHEVRON USA INC	S	1419	2	NOx	4,875	4,928	4,983	4,983
CHEVRON USA INC	S	1445	2	NOx	17,602	20,114	20,328	15,867
CHEVRON USA INC	S	1487	2	NOx	11,663	11,793	11,923	11,923
CHEVRON USA INC	S	1605	2	NOx	5,672	7,143	7,028	6,447
CHEVRON USA INC	S	1967	2	NOx	973	955	855	984
CHEVRON USA INC	S	2031	2	NOx	5,694	4,723	4,406	0
CHEVRON USA INC	S	2111	2	NOx	7,823	15,506	21,032	12,182
CHEVRON USA INC	S	2456	2	NOx	32,003	32,799	31,884	32,561
CHEVRON USA INC	S	3156	2	NOx	12,415	12,563	12,710	12,710
CHEVRON USA INC	S	3544	2	NOx	3,027	3,303	2,542	2,691
CHEVRON USA INC	S	3604	2	NOx	1,948	3,037	3,398	2,243
CHEVRON USA INC	S	3784	2	NOx	47,002	47,880	48,758	48,758
CHEVRON USA INC	S	3817	2	NOx	0	0	9,568	154
CHEVRON USA INC	S	3818	2	NOx	0	6,312	0	5,064
CHEVRON USA INC	S	3819	2	NOx	6,000	6,000	6,000	6,000
CHEVRON USA INC	S	4304	2	NOx	1,983	2,317	2,340	2,807
CHEVRON USA INC	S	4551	2	NOx	132,708	132,708	132,708	132,708
CHEVRON USA INC	S	4652	2	NOx	19,428	12,602	13,035	11,552
CHEVRON USA INC	S	4666	2	NOx	39,135	39,676	40,218	40,218
CHEVRON USA INC	S	4857	2	NOx	5,065	39	1,663	4,084
CHEVRON USA INC	S	20410281	2	NOx	3,806	3,765	3,765	3,848
CHEVRON USA INC	S	40410441	2	NOx	20,385	20,612	20,838	20,838
CHEVRON USA INC LOST HILLS GP	S	704	2	NOx	5,564	5,626	5,687	5,687
CHEVRON USA INC LOST HILLS GP	S	1470	2	NOx	780	789	797	797
CHEVRON USA INC LOST HILLS GP	S	4659	2	NOx	72	68	74	72

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
CHEVRON USA INC REFINERY	S	4573	2	NOx	24,199	24,787	25,374	25,374
CHEVRON USA PRODUCTION INC	S	674	2	NOx	507	781	226	485
CHEVRON USA PRODUCTION INC	S	3228	2	NOx	139	161	275	104
CHEVRON USA PRODUCTION INC	S	3533	2	NOx	181	188	224	219
CHRISTOPHER RANCH LLC	C	1430	2	NOx	0	0	0	484
CITY OF TULARE	N	902	2	NOx	0	436	436	471
CITY OF TULARE	S	3398	2	NOx	501	0	0	0
CITY OF VISALIA	N	317	2	NOx	0	0	7,160	0
CITY OF VISALIA	N	1465	2	NOx	403	0	0	0
CITY OF VISALIA	N	1467	2	NOx	1,085	1,097	0	807
CLARK BROTHERS-DERRICK GIN	C	511	2	NOx	0	0	0	43
CLIMECO CORPORATION	N	1324	2	NOx	525	525	525	525
CON AGRA FOOD INGREDIENTS CO	S	2201	2	NOx	6	6	5	5
CONAGRA CONSUMER FROZEN FOODS	N	487	2	NOx	356	163	243	300
CONAGRA CONSUMER FROZEN FOODS	N	856	2	NOx	0	0	1,749	0
CORCORAN IRRIGATION DISTRICT	C	560	2	NOx	352	356	321	209
COTTON ASSOCIATES, INC	S	25	2	NOx	0	0	0	157
CRAYCROFT BRICK COMPANY	C	71	2	NOx	417	336	328	332
CRESTWOOD WEST COAST LLC	S	4236	2	NOx	47	137	86	23
CRESTWOOD WEST COAST LLC	S	4240	2	NOx	125	125	125	125
CRESTWOOD WEST COAST LLC	S	4242	2	NOx	14	14	14	14
CRIMSON RESOURCE MANAGEMENT	S	2251	2	NOx	316	272	186	375
CRIMSON RESOURCE MANAGEMENT	S	3388	2	NOx	4,704	3,393	3,449	2,696
CRIMSON RESOURCE MANAGEMENT	S	3389	2	NOx	95	299	319	166
CRIMSON RESOURCE MANAGEMENT	S	3441	2	NOx	5	4	4	5
CXA LA PALOMA, LLC	N	1457	2	NOx	0	9,612	22,455	0
DAIRY FARMERS OF AMERICA, INC.	C	689	2	NOx	0	0	253	0
DARLING INGREDIENTS INC	C	1298	2	NOx	0	0	0	270

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
DARLING INGREDIENTS INC	S	4346	2	NOx	911	860	804	641
DARLING INGREDIENTS INC.	N	1225	2	NOx	0	51	107	0
DIAMOND FOODS, LLC	N	573	2	NOx	1	1	0	0
DIAMOND FOODS, LLC	N	826	2	NOx	4,443	2,607	2,618	0
E & J GALLO WINERY	C	1071	2	NOx	612	605	563	535
E & J GALLO WINERY	N	849	2	NOx	0	14	111	0
E & J GALLO WINERY	N	1011	2	NOx	625	625	625	625
E & J GALLO WINERY	N	1012	2	NOx	545	545	545	545
E & J GALLO WINERY	N	1221	2	NOx	9,542	9,542	10,501	9,541
E & J GALLO WINERY	N	1270	2	NOx	1,276	909	1,275	1,275
E & J GALLO WINERY	N	1272	2	NOx	0	0	0	953
E & J GALLO WINERY	N	1380	2	NOx	1,224	1,225	1,225	1,225
E&B NATURAL RESOURCES MGMT	S	4774	2	NOx	91	93	100	102
E&B NATURAL RESOURCES MGMT	S	4880	2	NOx	0	0	0	83
E&B NATURAL RESOURCES MGMT	S	4957	2	NOx	38	38	36	36
E&B NATURAL RESOURCES MGMT	S	4985	2	NOx	5,250	5,250	5,250	5,250
EAGLE VALLEY GINNING LLC	N	847	2	NOx	0	0	0	427
ECKERT FROZEN FOODS	N	133	2	NOx	146	545	2,047	395
ELBOW ENTERPRISES INC	S	2535	2	NOx	0	0	0	1,168
ELEMENT MARKETS, LLC	N	1327	2	NOx	364	328	400	391
ELK HILLS POWER LLC	S	1622	2	NOx	1,373	1,389	1,404	1,404
ELK HILLS POWER LLC	S	1994	2	NOx	12,485	12,624	12,762	12,762
EVOLUTION MARKETS INC.	C	944	2	NOx	0	298	1,590	300
EVOLUTION MARKETS INC.	C	945	2	NOx	0	286	1,530	289
EVOLUTION MARKETS INC.	N	776	2	NOx	875	927	771	876
EXXONMOBIL CORP	S	4544	2	NOx	5,175	5,197	5,494	4,871
EXXONMOBIL CORP	S	4545	2	NOx	3,010	2,818	2,052	3,565
EXXONMOBIL CORP	S	4546	2	NOx	1,648	1,666	1,685	1,685

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
FARMERS COOPERATIVE GIN INC	S	2533	2	NOx	0	0	0	598
FORWARD INC LANDFILL	N	1328	2	NOx	131	130	131	130
FRESNO/CLOVIS REGIONAL WWTP	C	1211	2	NOx	65	65	65	65
FRESNO/CLOVIS REGIONAL WWTP	N	1452	2	NOx	6,473	4,904	7,584	4,704
FRESNO/CLOVIS REGIONAL WWTP	N	1454	2	NOx	0	0	1,109	0
FRESNO/CLOVIS REGIONAL WWTP	N	1455	2	NOx	0	0	1,010	0
FRESNO/CLOVIS REGIONAL WWTP	S	4867	2	NOx	1,696	3,526	1,536	1,221
FRESNO/CLOVIS REGIONAL WWTP	S	4868	2	NOx	1,313	1,378	1,443	1,443
FRESNO/CLOVIS REGIONAL WWTP	S	4914	2	NOx	130	131	132	132
FRESNO/CLOVIS REGIONAL WWTP	S	4915	2	NOx	0	4,802	0	0
FRESNO/CLOVIS REGIONAL WWTP	S	4917	2	NOx	3,233	0	0	5,000
FRESNO/CLOVIS REGIONAL WWTP	S	4918	2	NOx	765	765	766	765
FRITO-LAY INC	S	3765	2	NOx	7,432	7,619	7,790	7,789
FRITO-LAY, INC.	S	3763	2	NOx	287	442	182	53
G.I.C. FINANCIAL SERVICES, INC.	C	1391	2	NOx	19,830	19,688	19,996	19,903
GALLO GLASS COMPANY	N	768	2	NOx	14,634	12,268	15,814	10,504
GALLO GLASS COMPANY	N	966	2	NOx	63,525	46,849	57,176	61,929
GALLO GLASS COMPANY	N	1476	2	NOx	61,327	62,429	63,828	58,922
GARY STOWE	C	1441	2	NOx	107	0	0	1,195
GENERAL MILLS INC	S	3217	2	NOx	0	0	0	30
GENERAL MILLS OPERATIONS, INC	N	610	2	NOx	52	3	0	100
GLOBAL AMPERSAND LLC	S	2976	2	NOx	239	239	239	239
GROWERS COOP	S	88	2	NOx	0	0	22	406
GUARDIAN INDUSTRIES, LLC	C	1433	2	NOx	11,746	11,746	11,745	11,744
H. J. HEINZ COMPANY	N	534	2	NOx	0	360	3,207	0
H. J. HEINZ COMPANY	N	694	2	NOx	0	43	2,570	0
H. J. HEINZ COMPANY	N	1085	2	NOx	69	70	60	30
H. J. HEINZ COMPANY, L.P.	N	21	2	NOx	0	1,026	3,112	1,060

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
HANSEN BROTHERS	C	249	2	NOx	0	0	0	256
HERSHEY CHOCOLATE & CONF. CORP	N	952	2	NOx	114	106	125	125
HILMAR CHEESE CO	S	2138	2	NOx	0	0	0	1,070
HOLMES WESTERN OIL CORP	S	3377	2	NOx	1,633	1,632	1,632	1,632
HYDROGEN ENERGY CA LLC	C	1058	2	NOx	10,100	10,100	10,100	10,100
HYDROGEN ENERGY CALIFORNIA LLC	S	3273	2	NOx	120,500	120,500	120,500	120,500
INGREDION INCORPORATED	N	1384	2	NOx	32,807	20,182	28,536	31,750
J.G. BOSWELL CO. (EL RICO)	C	135	2	NOx	14	4	0	40
JOHN T HOPPER	C	712	2	NOx	0	55	295	56
KAWEAH DELTA DISTRICT HOSPITAL	S	2657	2	NOx	100	441	536	667
KERN DELTA CO LLC	S	4315	2	NOx	0	0	0	622
KERN LAKE COOP GIN	S	2074	2	NOx	0	0	0	309
KERN OIL & REFINING CO.	S	2653	2	NOx	94	277	91	215
KERN OIL & REFINING COMPANY	C	1443	2	NOx	2,485	3,533	2,106	118
KERN OIL & REFINING COMPANY	N	1470	2	NOx	48	74	123	93
KERN RIVER HOLDINGS, INC.	C	1368	2	NOx	1,038	1,037	1,037	1,037
KRAFT FOODS INC	C	149	2	NOx	284	284	284	284
KRAFT FOODS INC	C	386	2	NOx	9,774	9,883	9,992	9,992
KRAFT FOODS INC	C	387	2	NOx	5	5	4	4
KRAFT FOODS INC	C	1138	2	NOx	0	0	0	1,632
KRAFT HEINZ FOODS CO	S	4027	2	NOx	0	0	3,425	1,107
KRAFT HEINZ FOODS CO	S	4028	2	NOx	2,070	0	0	94
KRAFT HEINZ FOODS CO	S	4035	2	NOx	0	0	0	24
KRAFT HEINZ FOODS CO	S	4036	2	NOx	0	0	165	0
KRAFT HEINZ FOODS CO	S	4037	2	NOx	1,227	3,443	0	733
LAWRENCE LIVERMORE NATL. LAB	N	464	2	NOx	83	31	0	61
LEPRINO FOODS	N	108	2	NOx	2,335	2,529	2,412	2,143
LEPRINO FOODS COMPANY	C	60	2	NOx	7,878	7,985	7,810	7,898

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
LIBERTY COMPOSTING INC	S	3855	2	NOx	925	925	925	925
LIDESTRI FOODS, INC	N	391	2	NOx	0	0	1,527	0
LOCKHEED MARTIN AERONAUTICS COMPANY	N	1437	2	NOx	500	500	500	500
LOCKHEED MARTIN AERONAUTICS COMPANY	N	1471	2	NOx	500	500	500	500
LOS BANOS GRAVEL GROUP, ASPHLT	N	125	2	NOx	23	113	359	120
LOS GATOS TOMATO PRODUCTS	C	1021	2	NOx	0	4	0	0
LOVELACE & SONS FARMING	C	807	2	NOx	0	0	0	257
M CARATAN INC	S	2516	2	NOx	0	0	189	46
MACPHERSON OIL CO	S	4132	2	NOx	145	145	145	145
MACPHERSON OIL COMPANY	C	1195	2	NOx	73	73	73	73
MACPHERSON OIL COMPANY	N	1339	2	NOx	1,368	1,367	1,368	1,368
MADERA DP 2, LLC	S	4989	2	NOx	2,100	2,100	2,100	2,100
MALAGA POWER, LLC	C	1355	2	NOx	0	0	1,029	0
MARTIN ANDERSON	C	1051	2	NOx	52	77	45	3
MEMORIAL MEDICAL CENTER	S	2268	2	NOx	2,550	2,550	2,550	2,550
MEYERS FARMING LLC	C	1112	2	NOx	0	3,701	5,023	2,200
MID-SET COGENERATION COMPANY	S	4860	2	NOx	9,685	9,949	10,041	10,012
MIDWAY PEAKING LLC	S	4234	2	NOx	283	283	496	354
MODESTO IRRIGATION DISTRICT	C	1111	2	NOx	0	0	74	5,923
MODESTO IRRIGATION DISTRICT	N	430	2	NOx	0	0	273	0
MONTEREY RESOURCES, INC.	S	432	2	NOx	2,053	2,081	1,707	1,898
NAS LEMOORE	C	1048	2	NOx	26	26	25	25
NORTHERN CALIFORNIA POWER AGENCY	C	1132	2	NOx	0	137	122	117
NORTHERN CALIFORNIA POWER AGENCY	C	1268	2	NOx	0	0	2,196	1,831
NORTHERN CALIFORNIA POWER AGENCY	N	751	2	NOx	0	0	10,015	0
NORTHERN CALIFORNIA POWER AGENCY	N	752	2	NOx	0	791	835	0

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
NORTHERN CALIFORNIA POWER AGENCY	N	1028	2	NOx	0	274	790	147
NORTHERN CALIFORNIA POWER AGENCY	S	2854	2	NOx	0	1,437	0	0
NORTHERN CALIFORNIA POWER AGENCY	S	2857	2	NOx	0	0	0	1,031
NORTHERN CALIFORNIA POWER AGENCY	S	2895	2	NOx	0	0	0	3,406
NORTHERN CALIFORNIA POWER AGENCY	S	4180	2	NOx	0	0	0	1,865
NORTHROP GRUMMAN CORPORATION	N	992	2	NOx	2,000	2,000	2,000	2,000
OAKWOOD LAKE RESORT	N	601	2	NOx	0	117	188	0
OCEANAIR ENVIRONMENTAL	N	1420	2	NOx	899	877	794	502
OLAM SVI	N	1426	2	NOx	0	0	1,641	329
OLDUVAI GORGE LLC	S	4641	2	NOx	14,283	649	2,200	4,032
OLDUVAI GORGE LLC	S	4940	2	NOx	0	22,553	0	0
OLDUVAI GORGE, LLC	C	998	2	NOx	0	0	0	815
OLDUVAI GORGE, LLC	N	1184	2	NOx	2,154	287	335	1,351
OLDUVAI GORGE, LLC	N	1472	2	NOx	53,565	51,678	51,516	55,752
OXY USA, INC	N	1196	2	NOx	0	396	665	0
PACIFIC COAST PRODUCERS	N	753	2	NOx	195	605	3,088	312
PACIFIC GAS & ELECTRIC CO	S	4404	2	NOx	30	16	55	63
PACIFIC PIPELINE SYSTEM LLC	S	575	2	NOx	0	4,693	10,418	3,569
PACIFIC PIPELINE SYSTEM LLC	S	1099	2	NOx	0	13,703	12,649	0
PACIFIC PIPELINE SYSTEM LLC	S	2286	2	NOx	1,278	2,194	2,438	2,438
PACTIV, LLC	S	3863	2	NOx	233	199	51	109
PARAMOUNT FARMS	N	1325	2	NOx	14,475	14,475	14,475	14,475
PARAMOUNT FARMS, INC	N	284	2	NOx	3,670	3,580	3,488	3,488
PARAMOUNT FARMS, INC.	C	1035	2	NOx	0	0	155	334
PARAMOUNT FARMS, INC.	C	1326	2	NOx	1,000	1,070	1,035	1,035
PARAMOUNT FARMS, INC.	C	1327	2	NOx	0	930	2,965	1,965
PASTORIA ENERGY FACILITY LLC	S	1543	2	NOx	10,354	8,381	11,018	11,467
PASTORIA ENERGY FACILITY LLC	S	4163	2	NOx	164,079	166,154	168,230	169,711

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
PASTORIA ENERGY LLC	C	755	2	NOx	2,525	1,011	0	2,038
PHILLIPS 66 PIPELINE LLC	C	1163	2	NOx	0	0	17	0
PILKINGTON NORTH AMERICA, INC	N	410	2	NOx	272	4	43	275
PILKINGTON NORTH AMERICA, INC	N	1396	2	NOx	49,362	48,227	55,802	52,152
PLAINS LPG SERVICES, L.P.	C	717	2	NOx	1,024	1,024	1,023	1,023
R F MACDONALD	C	579	2	NOx	0	8	0	0
R M WADE & COMPANY	C	152	2	NOx	326	373	379	370
RIO BRAVO JASMIN	S	4944	2	NOx	58,526	46,575	59,247	60,160
RIO BRAVO POSO	S	4711	2	NOx	29,232	44,918	57,018	38,395
SAN JOAQUIN REFINING CO	S	4452	2	NOx	0	1	1	0
SAN JOAQUIN REFINING COMPANY	C	1341	2	NOx	616	8	41	283
SAPUTO CHEESE USA INC.	N	834	2	NOx	1,810	1,810	1,810	1,810
SENECA RESOURCES	N	906	2	NOx	183	517	517	517
SENECA RESOURCES	N	1416	2	NOx	226	227	225	225
SENECA RESOURCES	S	4578	2	NOx	18	18	18	18
SENECA RESOURCES CORP	S	1427	2	NOx	88	57	76	98
SENECA RESOURCES CORP	S	3718	2	NOx	0	118	0	0
SENECA RESOURCES CORP	S	4821	2	NOx	735	735	734	735
SENECA RESOURCES CORP	S	4829	2	NOx	18	18	18	18
SENECA RESOURCES CORP	S	4864	2	NOx	27	27	27	26
SENTINEL PEAK RESOURCES CA LLC	S	4835	2	NOx	13,229	10,050	6,765	15,163
SENTINEL PEAK RESOURCES CA LLC	S	4836	2	NOx	10,010	10,691	10,155	6,716
SENTINEL PEAK RESOURCES CA LLC	S	4837	2	NOx	4,630	4,632	4,633	4,632
SENTINEL PEAK RESOURCES CA LLC	S	4838	2	NOx	1,411	73	1,449	2,071
SENTINEL PEAK RESOURCES CA LLC	S	4839	2	NOx	148	148	148	148
SHAFTER-WASCO GINNING CO	S	3268	2	NOx	0	0	0	232
SIERRA POWER CORPORATION	S	4990	2	NOx	18,209	15,568	15,117	16,621
SIERRA POWER CORPORATION	S	2910001	2	NOx	2,115	2,138	2,162	2,162

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
SOUTH VALLEY GINS INC	S	3554	2	NOx	0	0	0	192
SOUTH VALLEY GINS INC	S	4635	2	NOx	77	0	0	752
SOUTHERN CALIF GAS CO	S	1016	2	NOx	283	288	289	289
SOUTHERN CALIFORNIA GAS CORPORATION	N	299	2	NOx	0	1,311	1,415	0
STOCKTON EAST WATER DISTRICT	N	763	2	NOx	2,654	3,705	3,750	3,359
STRATAS FOODS LLC	C	1020	2	NOx	0	0	0	108
SUN GARDEN-GANGI CANNING CO LL	N	222	2	NOx	0	0	12,886	540
TAUBER OIL CO	S	4870	2	NOx	229	1,146	451	195
TAUBER OIL COMPANY	N	1438	2	NOx	750	750	750	750
TAUBER OIL COMPANY	N	1446	2	NOx	1,250	1,250	1,250	1,250
TEXACO EXPLOR & PROD INC	S	20250361	2	NOx	7,037	7,356	6,314	6,778
THE BEVERAGE SOURCE	N	92	2	NOx	220	800	520	900
THE NESTLE COMPANY INC	N	508	2	NOx	2,975	2,444	1,853	3,352
TKV CONTAINERS, INC.	C	1015	2	NOx	0	13	14	0
TRIANGLE PACIFIC CORPORATION	N	18	2	NOx	187	54	54	161
TRI-CITY GROWERS INC	S	4392	2	NOx	54	0	0	229
TURLOCK IRRIGATION DISTRICT	S	3707	2	NOx	3,442	2,862	2,277	2,277
UNITED STATES GYPSUM CO	S	2543	2	NOx	0	0	0	311
UNITED STATES GYPSUM CO	S	2815	2	NOx	39,560	6,703	27,282	33,352
UNITED STATES GYPSUM COMPANY	C	818	2	NOx	0	0	0	734
UNITED STATES GYPSUM COMPANY	N	662	2	NOx	308	36,838	15,649	308
VALLEY AIR CONDITIONING & REPAIR INC	C	693	2	NOx	0	0	108	0
VECTOR ENVIRONMENTAL INC	S	4039	2	NOx	102	125	117	15
VINTAGE PETROLEUM	N	346	2	NOx	0	165	1,432	14
VINTAGE PRODUCTION CALIFORNIA LLC	N	1211	2	NOx	443	443	443	435
WELLHEAD POWER PANOCHE, LLC.	C	874	2	NOx	0	3	3	0
WESTERN STONE PRODUCTS, INC.	N	17	2	NOx	543	543	619	619

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
WESTLAKE FARMS INC	C	645	2	NOx	0	0	0	498
WESTSIDE FARMERS COOP #2 & #3	C	1038	2	NOx	109	0	0	1,122
WILTON RANCHERIA	N	1395	2	NOx	26,875	26,875	26,875	26,875
WONDERFUL PISTACHIOS & ALMONDS	C	1270	2	NOx	770	770	770	770
WONDERFUL PISTACHIOS & ALMONDS	C	1313	2	NOx	10,770	10,770	10,770	10,770
3H CATTLE CO	S	3672	5	SOx	0	14	0	0
AERA ENERGY LLC	S	272	5	SOx	1,735	2,907	1,810	2,494
AERA ENERGY LLC	S	284	5	SOx	19,831	12,103	6,514	16,106
AERA ENERGY LLC	S	395	5	SOx	4,836	5,200	5,928	5,651
AERA ENERGY LLC	S	548	5	SOx	2,803	26	0	0
AERA ENERGY LLC	S	556	5	SOx	1,379	869	781	989
AERA ENERGY LLC	S	790	5	SOx	2	1	1	2
AERA ENERGY LLC	S	841	5	SOx	26,339	26,631	26,924	26,924
AERA ENERGY LLC	S	847	5	SOx	153	227	173	72
AERA ENERGY LLC	S	863	5	SOx	6	7	13	12
AERA ENERGY LLC	S	989	5	SOx	0	2,808	0	0
AERA ENERGY LLC	S	998	5	SOx	735	0	0	0
AERA ENERGY LLC	S	1000	5	SOx	138	2,811	489	10
AERA ENERGY LLC	S	1001	5	SOx	275	583	0	0
AERA ENERGY LLC	S	1032	5	SOx	28,371	72,172	48,856	9,900
AERA ENERGY LLC	S	1057	5	SOx	4	5	4	3
AERA ENERGY LLC	S	1071	5	SOx	10,682	10,682	10,682	10,682
AERA ENERGY LLC	S	1072	5	SOx	5	4	4	4
AERA ENERGY LLC	S	1073	5	SOx	2	2	2	2
AERA ENERGY LLC	S	1075	5	SOx	0	1	0	0
AERA ENERGY LLC	S	1076	5	SOx	12	11	13	11
AERA ENERGY LLC	S	1077	5	SOx	79	176	164	173

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
AERA ENERGY LLC	S	1091	5	SOx	57	70	71	71
AERA ENERGY LLC	S	1133	5	SOx	436	877	687	281
AERA ENERGY LLC	S	1295	5	SOx	1,289	2,983	696	488
AERA ENERGY LLC	S	1339	5	SOx	102,863	63,756	0	10,468
AERA ENERGY LLC	S	1476	5	SOx	21	0	0	6
AERA ENERGY LLC	S	1477	5	SOx	36	0	0	10
AERA ENERGY LLC	S	1865	5	SOx	5,592	4,295	5,749	5,942
AERA ENERGY LLC	S	2010	5	SOx	0	3,320	0	0
AERA ENERGY LLC	S	2019	5	SOx	582	589	597	597
AERA ENERGY LLC	S	2361	5	SOx	542	71	2	215
AERA ENERGY LLC	S	3310	5	SOx	281	227	223	281
AERA ENERGY LLC	S	3363	5	SOx	21,065	27,266	29,310	28,564
AERA ENERGY LLC	S	3525	5	SOx	1,902	1,902	1,902	1,902
AERA ENERGY LLC	S	3685	5	SOx	52,466	53,256	54,044	54,044
AERA ENERGY LLC	S	3833	5	SOx	16,508	18,345	2,147	8,994
AERA ENERGY LLC	S	4286	5	SOx	16,674	26,211	11,387	5,910
AERA ENERGY LLC	S	4424	5	SOx	101,854	66,432	0	24,770
AERA ENERGY LLC	S	4934	5	SOx	85,022	40,042	56,575	91,420
AGRI-CEL INC	S	3631	5	SOx	12	14	13	1
ALON BAKERSFIELD REFINING	S	4694	5	SOx	2,802	13,301	9,451	16,907
ALON BAKERSFIELD REFINING	S	4757	5	SOx	5,174	5,397	4,576	5,615
ALON BAKERSFIELD REFINING	S	4984	5	SOx	4,577	4,354	5,173	4,134
ALTA VISTA GIN/MURRIETA FARM	C	1445	5	SOx	0	0	0	19
ANDERSON CLAYTON CORP	S	314	5	SOx	0	0	0	2
ANDERSON CLAYTON CORP	S	471	5	SOx	0	0	0	1
ANDERSON CLAYTON CORP	S	1045	5	SOx	0	0	0	3
ANDERSON CLAYTON CORP	S	1171	5	SOx	0	0	0	3
ANDERSON CLAYTON CORP	S	1262	5	SOx	0	0	0	2

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
ANDERSON CLAYTON CORP	S	1263	5	SOx	1	0	0	3
ANDERSON CLAYTON CORP.	N	181	5	SOx	0	0	0	1
ANDERSON CLAYTON CORP.	N	499	5	SOx	0	0	0	24
ANDERSON CLAYTON CORP/BURREL	C	806	5	SOx	3	0	0	7
ANDERSON CLAYTON CORP/BUTTE	C	699	5	SOx	0	0	0	31
ANDERSON CLAYTON CORP/CORCORAN	C	81	5	SOx	0	0	0	2
ANDERSON CLAYTON CORP/DAIRYLAN	C	332	5	SOx	0	0	0	9
ANDERSON CLAYTON CORP/DAIRYLND	C	472	5	SOx	0	0	0	21
ANDERSON CLAYTON CORP/EL DORAD	C	427	5	SOx	0	0	0	3
ANDERSON CLAYTON CORP/FIVE PTS	C	78	5	SOx	0	0	0	31
ANDERSON CLAYTON CORP/HANFORD	C	863	5	SOx	0	0	0	4
ANDERSON CLAYTON CORP/IDRIA #1	C	959	5	SOx	0	0	0	53
ANDERSON CLAYTON CORP/IDRIA #2	C	250	5	SOx	0	0	0	42
ANDERSON CLAYTON CORP/KEARNY	C	75	5	SOx	0	0	0	28
ANDERSON CLAYTON CORP/KERMAN	C	428	5	SOx	0	0	0	48
ANDERSON CLAYTON CORP/KINGSRIV	C	460	5	SOx	0	0	0	4
ANDERSON CLAYTON CORP/MURIT #1	C	334	5	SOx	0	0	0	9
ANDERSON CLAYTON CORP/MURIT #2	C	336	5	SOx	0	0	0	9
ANDERSON CLAYTON CORP/MURRAY	C	234	5	SOx	0	0	0	6
ANDERSON CLAYTON CORP/NAPA GIN	C	335	5	SOx	0	0	0	6
ANDERSON CLAYTON CORP/PLSNT VA	C	326	5	SOx	0	0	0	22
ANDERSON CLAYTON CORP/SAN JOAQ	C	79	5	SOx	0	0	0	22
ANDERSON CLAYTON CORP/SETTER	C	76	5	SOx	0	0	0	3
ANDERSON CLAYTON CORP/SUNSET	C	333	5	SOx	0	0	0	6
ANDERSON CLAYTON CORP/TRANQLTY	C	80	5	SOx	0	0	0	2
ANDERSON CLAYTON CORPORATION	N	135	5	SOx	0	0	0	1
ANDERSON CLAYTON CORPORATION	N	737	5	SOx	0	0	0	3
ANDERSON CLAYTON-MARICOPA GIN	S	697	5	SOx	0	0	0	3

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
AVENAL POWER CENTER LLC	S	2788	5	SOx	5	7	3	6
AVENAL POWER CENTER LLC	S	2789	5	SOx	6	14	12	8
AVENAL POWER CENTER LLC	S	2790	5	SOx	12,862	491	0	8,499
AVENAL POWER CENTER LLC	S	2791	5	SOx	92,179	23,666	69,157	96,288
AVENAL POWER CENTER, LLC	N	762	5	SOx	21,000	21,000	21,000	21,000
BAKERSFIELD CITY WOOD SITE	S	2969	5	SOx	3	5	5	4
BAR 20 PARTNERS LTD	N	612	5	SOx	0	0	79	0
BAR 20 PARTNERS LTD	N	617	5	SOx	0	0	304	0
BAR 20 PARTNERS LTD	N	778	5	SOx	0	0	1	0
BAR VP DAIRY	C	810	5	SOx	250	1,096	0	682
BAR VP DAIRY	C	811	5	SOx	919	0	117	80
BAR VP DAIRY	N	638	5	SOx	0	0	0	32
BAR VP DAIRY	N	639	5	SOx	10	10	0	7
BAR VP DAIRY	N	640	5	SOx	0	0	16,147	0
BAR VP HEIFER RANCH	S	4289	5	SOx	0	1	49	50
BERRY PETROLEUM COMPANY LLC	S	4893	5	SOx	0	0	833	2,467
BERRY PETROLEUM COMPANY, LLC	N	1440	5	SOx	1,424	1,424	1,424	1,424
BREITBURN OPERATING LP	S	4056	5	SOx	16	20	16	13
BRITZ AG FINANCE CO., INC.	C	557	5	SOx	0	0	0	33
BRITZ GIN PARTNERSHIP II	C	871	5	SOx	0	0	0	4
BRITZ INCORPORATED	C	586	5	SOx	0	0	0	11
BROWN SAND INC	N	46	5	SOx	3	3	2	3
BRUCE CARTER INDUSTRIES INC	S	4038	5	SOx	5	7	6	1
BUILDERS CONCRETE, INC.	C	41	5	SOx	8	8	8	8
BUTTONWILLOW GINNING CO	S	2937	5	SOx	0	0	0	4
BUTTONWILLOW GINNING CO	S	4634	5	SOx	0	0	0	20
CALAVERAS MATERIALS INC.	C	233	5	SOx	998	2,716	3,181	1,989
CALIFORNIA DAIRIES INC	S	3058	5	SOx	1,401	1,401	1,399	1,399

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
CALIFORNIA DAIRIES, INC.	N	986	5	SOx	9,000	9,000	9,000	9,000
CALIFORNIA OLIVE GROWERS	C	21	5	SOx	10	10	10	10
CALIFORNIA RESOURCES ELK HILLS LLC	S	826	5	SOx	5	5	4	5
CALIFORNIA RESOURCES ELK HILLS LLC	S	4196	5	SOx	8	5	14	15
CALIFORNIA RESOURCES ELK HILLS LLC	S	4211	5	SOx	13	12	16	16
CALIFORNIA RESOURCES ELK HILLS LLC	S	4709	5	SOx	4,691	4,683	4,680	4,680
CALIFORNIA RESOURCES ELK HILLS, LLC.	N	1387	5	SOx	450	456	456	455
CALIFORNIA RESOURCES PRODUCTION CORP	N	1079	5	SOx	0	0	0	936
CALIFORNIA RESOURCES PRODUCTION CORP	N	1080	5	SOx	0	0	9,774	0
CALIFORNIA RESOURCES PRODUCTION CORP	N	1118	5	SOx	250	250	250	250
CALIFORNIA RESOURCES PRODUCTION CORP	N	1129	5	SOx	212	212	212	212
CALIFORNIA RESOURCES PRODUCTION CORP	N	1150	5	SOx	250	250	250	250
CALIFORNIA RESOURCES PRODUCTION CORP	N	1215	5	SOx	4,612	4,612	4,612	4,612
CALIFORNIA RESOURCES PRODUCTION CORP	N	1249	5	SOx	3,933	3,933	3,932	3,932
CALIFORNIA RESOURCES PRODUCTION CORP	N	1422	5	SOx	22,250	19,587	12,645	22,826
CALIFORNIA RESOURCES PRODUCTION CORP	S	3035	5	SOx	2	2	4	4
CALIFORNIA RESOURCES PRODUCTION CORP	S	3593	5	SOx	494	494	492	492
CALIFORNIA RESOURCES PRODUCTION CORP	S	4016	5	SOx	325	0	0	0

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
CALIFORNIA RESOURCES PRODUCTION CORP	S	4017	5	SOx	5	0	0	0
CALIFORNIA RESOURCES PRODUCTION CORP.	C	1201	5	SOx	1,598	0	0	0
CALIFORNIA RESOURCES PRODUCTION CORP.	C	1259	5	SOx	132	132	132	132
CALIFORNIA RESOURCES PRODUCTION CORP.	C	1295	5	SOx	6,500	6,500	6,500	6,500
CALIFORNIA RESOURCES PRODUCTION CORP.	C	1325	5	SOx	4,493	4,493	4,493	4,493
CALIFORNIA RESOURCES PRODUCTION CORP.	C	1331	5	SOx	76	76	76	76
CALIFORNIA RESOURCES PRODUCTION CORP.	C	1333	5	SOx	280	280	280	280
CALMAT CO.	C	50	5	SOx	39	41	58	59
CALMAT OF FRESNO	C	40	5	SOx	25	120	55	185
CALPINE CORPORATION	N	844	5	SOx	6,925	7,045	7,164	7,164
CALPINE ENERGY SERVICES LP	S	3075	5	SOx	5,080	12,043	7,319	15,177
CALPINE ENERGY SERVICES LP	S	3279	5	SOx	1,625	0	0	1,339
CALPINE ENERGY SERVICES LP	S	3281	5	SOx	3,875	5,500	5,500	4,161
CALPINE ENERGY SERVICES LP	S	3294	5	SOx	4,000	4,000	4,000	4,000
CALPINE ENERGY SERVICES LP	S	3348	5	SOx	9,536	6,336	6,163	6,545
CALPINE ENERGY SERVICES LP	S	3356	5	SOx	24,000	24,000	24,000	24,000
CALPINE ENERGY SERVICES LP	S	4165	5	SOx	4,332	1,562	709	3,781
CALPINE ENERGY SERVICES, L.P.	N	841	5	SOx	3,041	1,167	5,891	3,122
CALPINE ENERGY SERVICES, L.P.	N	893	5	SOx	0	0	0	52,748
CAMPBELL SOUP COMPANY	N	127	5	SOx	18	13	11	13
CAMPBELL SOUP SUPPLY CO.	N	31	5	SOx	0	52	128	0
CANANDAIGUA WINE COMPANY INC	C	702	5	SOx	33	34	35	32

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
CANDLEWICK YARNS	C	507	5	SOx	5	5	4	4
CANTUA COOPERATIVE GIN, INC.	C	760	5	SOx	0	0	0	4
CASTLE AIRPORT AVIATION & DEVELOP CENTER	N	109	5	SOx	3,179	3,214	3,249	3,249
CENTRAL VALLEY EGGS LLC	S	4759	5	SOx	5,785	5,785	5,785	5,785
CHEVRON USA INC	C	331	5	SOx	1,576	1,577	1,577	1,577
CHEVRON USA INC	C	339	5	SOx	4,730	4,730	4,731	4,731
CHEVRON USA INC	S	891	5	SOx	2,712	2,742	2,773	2,773
CHEVRON USA INC	S	906	5	SOx	2,470	2,498	2,526	2,526
CHEVRON USA INC	S	907	5	SOx	1,527	1,306	1,330	1,176
CHEVRON USA INC	S	1485	5	SOx	1,890	1,911	1,931	1,931
CHEVRON USA INC	S	1542	5	SOx	25,189	21,032	18,790	30,130
CHEVRON USA INC	S	2454	5	SOx	9,938	15,295	38,474	24,993
CHEVRON USA INC	S	4200	5	SOx	7,613	17,935	24,182	23,612
CHEVRON USA INC	S	4570	5	SOx	20,808	21,063	21,319	21,319
CHEVRON USA INC	S	4672	5	SOx	13,830	11,370	8,398	3,752
CHEVRON USA INC	S	4674	5	SOx	10,743	16,072	22,931	32,748
CHEVRON USA INC	S	4882	5	SOx	31,253	31,717	32,161	32,144
CHRISTOPHER RANCH LLC	C	1430	5	SOx	0	0	0	52
CITY OF TULARE	S	3396	5	SOx	26	26	26	26
CLARK BROTHERS-DERRICK GIN	C	511	5	SOx	0	0	0	3
COALINGA FARMERS CO-OP GIN	C	537	5	SOx	0	0	0	14
COIT RANCH	C	532	5	SOx	0	0	0	4
CONAGRA CONSUMER FROZEN FOODS	N	489	5	SOx	7	4	5	6
CORCORAN IRRIGATION DISTRICT	C	560	5	SOx	4	5	4	3
COTTON ASSOCIATES, INC	S	25	5	SOx	0	0	0	1
COVANTA DELANO INC	S	2721	5	SOx	890	916	941	941
CRANBROOK ASSOCIATES LLC	N	140	5	SOx	24	24	391	31

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
CRAYCROFT BRICK COMPANY	C	71	5	SOx	2	2	2	2
CRESTWOOD WEST COAST LLC	S	4238	5	SOx	290	290	290	290
DANELL BROTHERS INC	N	682	5	SOx	10,000	10,000	10,000	10,000
DEL MONTE FOODS MODESTO PLANT 1	N	1238	5	SOx	17	15	43	8
DIAMOND FOODS, LLC	N	645	5	SOx	2,699	2,294	2,340	1,357
DOLE PACKAGED FOODS LLC	N	520	5	SOx	1	3	9	8
DUNAVANT OF CALIFORNIA	C	297	5	SOx	22	29	19	25
DUNCAN ENTERPRISES	C	33	5	SOx	3	3	3	2
E & J GALLO WINERY	C	1071	5	SOx	1	2	1	1
E & J GALLO WINERY	S	4214	5	SOx	1,750	1,750	1,750	1,750
E & J GALLO WINERY	S	4215	5	SOx	6,377	6,377	6,376	6,376
E & J GALLO WINERY	C	1280	5	SOx	20	20	21	21
E & J GALLO WINERY	C	1281	5	SOx	2,603	2,603	2,603	2,603
E&B NATURAL RESOURCES MGMT	S	4983	5	SOx	2,750	2,750	2,750	2,750
EAGLE VALLEY GINNING LLC	N	847	5	SOx	0	0	0	3
ECKERT FROZEN FOODS	N	133	5	SOx	1	3	9	8
ELBOW ENTERPRISES INC	S	2535	5	SOx	0	0	0	33
ELEMENT MARKETS, LLC	N	1327	5	SOx	20	18	22	22
ELK HILLS POWER LLC	S	1950	5	SOx	496	306	118	118
EVOLUTION MARKETS INC	S	2632	5	SOx	11,102	11,225	11,348	11,348
EVOLUTION MARKETS INC	S	2741	5	SOx	0	0	8,706	0
EVOLUTION MARKETS INC	S	2742	5	SOx	5,836	1,652	9,106	19,927
EVOLUTION MARKETS INC	S	2743	5	SOx	0	0	2,666	551
EVOLUTION MARKETS INC	S	2750	5	SOx	0	0	0	28
EVOLUTION MARKETS INC.	C	882	5	SOx	0	0	0	23
FARMERS COOPERATIVE GIN INC	S	2533	5	SOx	0	0	0	4
FARMERS FIREBAUGH GINNING CO.	C	956	5	SOx	2	0	0	6
FIBREBOARD CORP.	N	209	5	SOx	9	7	4	10

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
FOSTER FARMS SPERRY RANCH	S	3795	5	SOx	175	175	0	0
FRESNO/CLOVIS REGIONAL WWTP	N	1448	5	SOx	0	0	4,196	4,195
FRESNO/CLOVIS REGIONAL WWTP	N	1450	5	SOx	4,195	4,196	0	0
FRITO-LAY INC	S	3767	5	SOx	5,203	5,000	8,796	8,796
FRITO-LAY, INC.	S	3423	5	SOx	137	176	113	64
FRITO-LAY, INC.	S	3427	5	SOx	8	8	9	9
G.I.C. FINANCIAL SERVICES, INC.	C	1059	5	SOx	70,500	70,500	70,500	70,500
GARY STOWE	C	1441	5	SOx	12	0	0	130
GENERAL MILLS OPERATIONS, INC	N	139	5	SOx	2	2	2	2
GLOBAL AMPERSAND LLC	S	2978	5	SOx	29	0	0	0
GRIMMIUS CATTLE CO	S	4739	5	SOx	0	0	404	0
GRIMMIUS CATTLE COMPANY	N	636	5	SOx	21,307	28,000	6,627	20,577
GROWERS COOP	S	88	5	SOx	0	0	0	3
GUARDIAN INDUSTRIES, LLC	C	1434	5	SOx	5,217	5,217	5,217	5,217
H. J. HEINZ COMPANY	N	60	5	SOx	0	0	32	0
H. J. HEINZ COMPANY	N	694	5	SOx	0	0	117	0
H. J. HEINZ COMPANY	N	1085	5	SOx	6	6	4	3
HANSEN BROTHERS	C	249	5	SOx	0	0	0	2
HARBERT ERC, LLC	C	1386	5	SOx	1,694	1,889	1,916	2,778
HERSHEY CHOCOLATE & CONF. CORP	N	373	5	SOx	2	2	2	2
HERSHEY CHOCOLATE & CONF. CORP	N	952	5	SOx	3	3	3	3
HOLLY COMMERCE CENTER LLC	N	1226	5	SOx	0	2,146	1,749	1,492
HYDROGEN ENERGY CA LLC	C	1058	5	SOx	24,500	24,500	24,500	24,500
HYDROGEN ENERGY CALIFORNIA LLC	S	3275	5	SOx	42,000	42,000	42,000	42,000
INGREDION INCORPORATED	N	264	5	SOx	39,050	39,050	39,050	39,050
INGREDION INCORPORATED	N	1086	5	SOx	51,681	26,912	37,684	61,746
INTERLAKE MATERIAL HANDLING	N	414	5	SOx	8	8	7	8
J G BOSWELL CO. (SEED STORAGE)	C	47	5	SOx	2	1	2	2

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
J R SIMPLOT COMPANY	N	1250	5	SOx	10,191	18,116	16,984	11,323
J.G. BOSWELL CO. (EL RICO)	C	135	5	SOx	2	1	0	5
JR SIMPLOT CO	S	3570	5	SOx	688	715	742	742
KERMAN CO-OP GIN & WAREHOUSE 1	C	1002	5	SOx	0	0	0	2
KERN DELTA CO LLC	S	4313	5	SOx	0	0	0	15
KERN DELTA CO LLC	S	4318	5	SOx	0	0	0	4
KERN LAKE COOP GIN	S	2074	5	SOx	0	0	0	14
KERN OIL & REFINING CO.	S	3106	5	SOx	78,598	78,599	51,520	78,598
KERN OIL & REFINING CO.	S	4963	5	SOx	7,216	7,216	7,215	7,215
LATON CO-OP GIN, INC.	C	746	5	SOx	0	0	0	3
LAWRENCE LIVERMORE NATL. LAB	N	464	5	SOx	30	11	0	22
LIDESTRI FOODS, INC	N	391	5	SOx	0	0	84	0
LODI GAS STORAGE LLC	N	515	5	SOx	5	5	5	5
LOS BANOS GRAVEL GROUP, ASPHLT	N	125	5	SOx	4	22	72	24
LOS GATOS TOMATO PRODUCTS	C	1021	5	SOx	0	1	0	0
M CARATAN INC	S	2516	5	SOx	0	0	2	0
MACPHERSON OIL CO	S	3927	5	SOx	0	3	13	4
MADERA CO-OP GIN, INC.	C	943	5	SOx	0	0	0	2
MARTIN ANDERSON	C	1051	5	SOx	18	27	16	1
MEYERS FARMING LLC	C	1112	5	SOx	0	26,875	37,739	16,268
MID-SET COGENERATION COMPANY	S	4860	5	SOx	92	94	94	93
MID-VALLEY COTTON GROWERS INC	S	2989	5	SOx	0	0	0	4
MINTURN CO-OP GIN	N	441	5	SOx	0	0	0	31
MODESTO IRRIGATION DISTRICT	C	599	5	SOx	2,078	1,671	0	0
MODESTO IRRIGATION DISTRICT	N	989	5	SOx	23,945	25,082	12,500	0
MODESTO IRRIGATION DISTRICT	S	2686	5	SOx	25,188	2,688	78	8,578
MOLYCORP MINERALS, LLC	N	938	5	SOx	8,250	8,250	8,250	8,250
MOLYCORP MINERALS, LLC	N	939	5	SOx	21,899	23,000	0	14,704

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
NAS LEMOORE	C	138	5	SOx	16	6	13	4
NAS LEMOORE	C	330	5	SOx	1	1	1	1
NAVERUS INC	N	526	5	SOx	1	1	1	1
NORTHERN CALIFORNIA POWER AGENCY	N	1022	5	SOx	0	0	5,751	0
NORTHERN CALIFORNIA POWER AGENCY	S	4182	5	SOx	1,504	0	9,485	9,940
NRG POWER MARKETING INC	C	426	5	SOx	16	13	5	15
OAKWOOD LAKE RESORT	N	601	5	SOx	0	0	1	0
OCEANAIR ENVIRONMENTAL	N	1420	5	SOx	171	178	172	93
OLAM SVI	N	1430	5	SOx	7,118	18,526	23,007	910
OLAM SVI	N	1431	5	SOx	50	144	271	166
OLDUVAI GORGE LLC	S	2483	5	SOx	0	0	1,600	0
OLDUVAI GORGE LLC	S	2604	5	SOx	0	0	0	6
OLDUVAI GORGE LLC	S	2671	5	SOx	1,744	1,744	1,744	1,744
OLDUVAI GORGE LLC	S	2692	5	SOx	22,146	30,918	8,240	22,190
OLDUVAI GORGE LLC	S	4825	5	SOx	918	1,079	1,237	1,238
OLDUVAI GORGE, LLC	N	769	5	SOx	13	12	12	12
OLDUVAI GORGE, LLC	N	786	5	SOx	46	46	40	36
OLDUVAI GORGE, LLC	N	1087	5	SOx	63,898	63,775	13,652	13,652
OLDUVAI GORGE, LLC	N	1262	5	SOx	762	60,023	0	0
OLDUVAI GORGE, LLC	N	1264	5	SOx	46,372	2,294	0	0
OLDUVAI GORGE, LLC	N	1458	5	SOx	0	0	399	396
OLDUVAI GORGE, LLC	N	1459	5	SOx	15,043	19,226	0	0
PACIFIC PIPELINE SYSTEM LLC	S	575	5	SOx	1	39	115	24
PACIFIC PIPELINE SYSTEM LLC	S	576	5	SOx	0	175	161	0
PACIFIC PIPELINE SYSTEM LLC	S	577	5	SOx	42	57	61	61
PANOCHE ENERGY CENTER, LLC	N	1177	5	SOx	2,784	0	0	1,787
PANOCHE ENERGY CENTER, LLC	N	1179	5	SOx	0	0	24,703	0
PANOCHE GINNING CO	C	904	5	SOx	0	0	0	5

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
PARAMOUNT FARMS, INC.	C	291	5	SOx	0	0	8	1
PARAMOUNT FARMS, INC.	C	501	5	SOx	26	81	126	112
PASTORIA ENERGY FACILITY LLC	S	2744	5	SOx	11,324	11,450	11,576	11,576
PG & E ENERGY TRADING POWER LP	N	200	5	SOx	8	999	321	8
PILKINGTON NORTH AMERICA, INC	N	1289	5	SOx	33,330	33,017	37,136	36,864
PSEG GLOBAL LLC	C	1385	5	SOx	1,694	1,889	1,917	2,778
R M WADE & COMPANY	C	152	5	SOx	2	2	2	2
R W MARTELLA	S	3108	5	SOx	0	351	351	922
RICHARD OPPEDYK	S	2620	5	SOx	2,750	2,750	2,750	2,750
RIO BRAVO JASMIN	S	4620	5	SOx	19,750	16,305	19,093	20,056
RIO BRAVO POSO	S	4717	5	SOx	4,906	9,631	13,827	6,905
RIVER RANCH FARMS	S	2930	5	SOx	4,702	0	0	11,853
RON VANDER WEERD/ROSALINDA VANDER WEERD	N	1108	5	SOx	0	0	6,702	0
RON/ROSALINDA VANDER WEERD	C	883	5	SOx	0	3,800	3,800	0
RON/ROSALINDA VANDER WEERD	C	884	5	SOx	3,750	0	66	3,751
RON/ROSALINDA VANDER WEERD	S	2751	5	SOx	6,250	6,200	6,134	6,249
SAN JOAQUIN REFINING CO	S	4450	5	SOx	3	2	2	2
SAN JOAQUIN VALLEY ENERGY	N	129	5	SOx	391	555	565	244
SAPUTO CHEESE USA INC	N	1361	5	SOx	1	0	0	0
SEMI TROPIC COOP GIN	S	426	5	SOx	0	0	0	2
SENECA RESOURCES	S	4580	5	SOx	4	4	4	4
SENECA RESOURCES CORP	S	3720	5	SOx	0	0	0	20
SENECA RESOURCES CORP	S	4824	5	SOx	194	194	194	193
SENECA RESOURCES CORP	S	4827	5	SOx	4	4	4	4
SENECA RESOURCES CORP	S	4831	5	SOx	59	58	59	58
SENECA RESOURCES CORP	S	4866	5	SOx	1	0	0	0
SENTINEL PEAK RESOURCES CA LLC	C	1412	5	SOx	61	55	49	49

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
SENTINEL PEAK RESOURCES CA LLC	C	1413	5	SOx	6	0	16	17
SENTINEL PEAK RESOURCES CA LLC	C	1414	5	SOx	22	22	22	22
SENTINEL PEAK RESOURCES CA LLC	N	1417	5	SOx	2,087	2,087	2,087	2,087
SENTINEL PEAK RESOURCES CA LLC	N	1418	5	SOx	35	35	33	33
SENTINEL PEAK RESOURCES CA LLC	S	4842	5	SOx	5	5	3	3
SENTINEL PEAK RESOURCES CA LLC	S	4843	5	SOx	674	350	28	28
SHAFTER-WASCO GINNING CO	S	3268	5	SOx	0	0	0	19
SIERRA POWER CORPORATION	S	4585	5	SOx	5,028	4,439	4,338	4,674
SJVEP I, L.P. (CHOW II)	C	137	5	SOx	298	263	274	342
SOC RESOURCES INC	S	3089	5	SOx	94	89	87	90
SOUTH LAKES DAIRY	S	2638	5	SOx	300	300	300	300
SOUTH VALLEY GINS INC	S	3554	5	SOx	0	0	0	5
SOUTH VALLEY GINS INC	S	4635	5	SOx	2	0	0	240
STOCKTON EAST WATER DISTRICT	N	763	5	SOx	8	10	11	9
SUN GARDEN-GANGI CANNING CO LL	N	100	5	SOx	0	0	23,440	4
SUNLAND REFINING CORPORATION	S	698	5	SOx	1,293	1,123	1,211	1,241
TAFT PRODUCTION CO	S	2672	5	SOx	1,695	1,733	1,771	1,771
TAUBER OIL CO	S	4216	5	SOx	123	123	124	124
TAUBER OIL COMPANY	C	1308	5	SOx	2,090	2,090	2,090	2,090
TAUBER OIL COMPANY	N	1240	5	SOx	90	90	90	90
THE ENVIRONMENTAL RESOURCES TRUST, INC	C	1013	5	SOx	9,823	9,823	9,823	9,823
THE NESTLE COMPANY INC	N	93	5	SOx	2,491	39	48	6,273
TKV CONTAINERS, INC.	C	1015	5	SOx	0	0	1	0
TRI-CITY GROWERS INC	S	4392	5	SOx	2	0	0	6
TRICOR REFINING LLC	S	4862	5	SOx	75	74	75	75
TULE RIVER CO-OP GIN INC	S	2682	5	SOx	0	0	0	3
TURLOCK IRRIGATION DISTRICT	S	3709	5	SOx	29,865	14,110	0	32,286

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
TWIN EAGLE RESOURCE MANAGEMENT LLC	S	4425	5	SOx	13,197	17,604	0	0
TWIN EAGLE RESOURCE MANAGEMENT, LLC	N	1265	5	SOx	0	12,555	0	0
TWIN EAGLE RESOURCE MANAGEMENT, LLC	N	1266	5	SOx	9,370	0	0	0
UNITED STATES GYPSUM CO	S	2543	5	SOx	0	0	0	9
UNITED STATES GYPSUM COMPANY	C	818	5	SOx	0	0	0	5
UNIVERSITY ENERGY SERVICES	S	561	5	SOx	63	54	59	61
VALLEY AIR CONDITIONING & REPAIR INC	C	438	5	SOx	41	105	154	162
VALLEY AIR CONDITIONING & REPAIR INC	C	502	5	SOx	7	22	36	30
VANDER WOUDE DAIRY	S	4055	5	SOx	3,613	0	3,800	3,160
VANDERHAM WEST	S	3233	5	SOx	1,453	1,452	1,452	1,452
VECTOR ENVIRONMENTAL INC	S	4039	5	SOx	22	27	25	3
WESTERN COTTON SERVICES	S	98	5	SOx	0	0	0	27
WESTERN STONE PRODUCTS, INC.	N	17	5	SOx	636	636	725	725
WESTLAKE FARMS INC	C	645	5	SOx	0	0	0	29
WESTSIDE FARMERS COOP #2 & #3	C	1038	5	SOx	1	0	0	10
WESTSIDE FARMERS COOP GIN #6	C	592	5	SOx	10	0	0	71
WESTSIDE FARMERS COOP. GIN	C	164	5	SOx	0	0	0	37
AERA ENERGY LLC	C	219	1	VOC	268	297	324	298
AERA ENERGY LLC	C	1399	1	VOC	7,943	8,397	8,437	8,139
AERA ENERGY LLC	S	663	1	VOC	544	495	483	454
AERA ENERGY LLC	S	868	1	VOC	724	735	729	672
AERA ENERGY LLC	S	1058	1	VOC	8,179	8,280	8,354	8,353
AERA ENERGY LLC	S	1138	1	VOC	162	233	2	25
AERA ENERGY LLC	S	1142	1	VOC	39,631	39,976	40,411	40,489

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
AERA ENERGY LLC	S	1162	1	VOC	713	719	730	730
AERA ENERGY LLC	S	1476	1	VOC	190	0	0	54
AERA ENERGY LLC	S	1477	1	VOC	329	0	0	93
AERA ENERGY LLC	S	1587	1	VOC	26	28	26	26
AERA ENERGY LLC	S	1681	1	VOC	10	10	10	10
AERA ENERGY LLC	S	1874	1	VOC	40	10	1	22
AERA ENERGY LLC	S	1880	1	VOC	360	591	251	0
AERA ENERGY LLC	S	2136	1	VOC	3,772	3,393	3,836	3,913
AERA ENERGY LLC	S	2237	1	VOC	5,394	5,463	5,539	5,539
AERA ENERGY LLC	S	2361	1	VOC	27	4	0	11
AERA ENERGY LLC	S	2725	1	VOC	65,082	65,830	66,578	66,578
AERA ENERGY LLC	S	2774	1	VOC	8,176	5,745	5,185	3,973
AERA ENERGY LLC	S	2782	1	VOC	44	43	42	46
AERA ENERGY LLC	S	2939	1	VOC	6,264	3,536	3,647	6,483
AERA ENERGY LLC	S	3110	1	VOC	21,914	22,310	22,708	22,708
AERA ENERGY LLC	S	3223	1	VOC	16	16	16	17
AERA ENERGY LLC	S	3272	1	VOC	2,642	2,701	2,759	2,759
AERA ENERGY LLC	S	3308	1	VOC	2,266	1,066	1,090	2,320
AERA ENERGY LLC	S	3451	1	VOC	20,480	438	2,608	1,572
AERA ENERGY LLC	S	3687	1	VOC	17,245	18,573	17,870	17,768
AERA ENERGY LLC	S	4063	1	VOC	157	140	120	181
AERA ENERGY LLC	S	4064	1	VOC	98	154	184	160
AERA ENERGY LLC	S	4624	1	VOC	50,080	50,508	51,652	52,619
AERA ENERGY LLC	S	4733	1	VOC	178,135	180,723	183,366	183,419
AERA ENERGY LLC	S	4767	1	VOC	6,395	7,457	9,040	6,324
AERA ENERGY LLC	S	4783	1	VOC	582	960	904	537
AERA ENERGY LLC	S	5005	1	VOC	116,782	118,234	119,687	119,687
AGRI-CEL INC	S	3631	1	VOC	21,495	26,078	24,122	2,902

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
ALON BAKERSFIELD REFINING	S	4939	1	VOC	19,865	19,865	19,865	19,866
ALON BAKERSFIELD REFINING	S	4967	1	VOC	29,099	29,898	30,307	30,215
ALTA VISTA GIN/MURRIETA FARM	C	1445	1	VOC	0	0	0	6
ANDERSEN RACK SYSTEMS, INC	N	950	1	VOC	7,335	7,335	7,335	7,335
ANDERSON CLAYTON CORP	C	903	1	VOC	0	0	0	4
ANDERSON CLAYTON CORP	S	314	1	VOC	0	0	1	18
ANDERSON CLAYTON CORP	S	471	1	VOC	0	0	0	9
ANDERSON CLAYTON CORP	S	1045	1	VOC	0	0	0	22
ANDERSON CLAYTON CORP	S	1171	1	VOC	3	0	0	24
ANDERSON CLAYTON CORP	S	1262	1	VOC	1	0	0	19
ANDERSON CLAYTON CORP	S	1263	1	VOC	9	0	0	24
ANDERSON CLAYTON CORP.	N	181	1	VOC	0	0	0	6
ANDERSON CLAYTON CORP.	N	499	1	VOC	0	0	0	15
ANDERSON CLAYTON CORP/BURREL	C	806	1	VOC	14	0	0	42
ANDERSON CLAYTON CORP/BUTTE	C	699	1	VOC	0	0	0	19
ANDERSON CLAYTON CORP/CORCORAN	C	81	1	VOC	0	0	0	15
ANDERSON CLAYTON CORP/DAIRYLAN	C	332	1	VOC	0	0	0	7
ANDERSON CLAYTON CORP/DAIRYLND	C	472	1	VOC	0	0	0	13
ANDERSON CLAYTON CORP/EL DORAD	C	427	1	VOC	1	0	0	17
ANDERSON CLAYTON CORP/FIVE PTS	C	78	1	VOC	0	0	0	8
ANDERSON CLAYTON CORP/HANFORD	C	74	1	VOC	0	0	0	5
ANDERSON CLAYTON CORP/HANFORD	C	863	1	VOC	0	0	0	36
ANDERSON CLAYTON CORP/IDRIA #1	C	959	1	VOC	0	0	0	76
ANDERSON CLAYTON CORP/IDRIA #2	C	250	1	VOC	0	0	0	9
ANDERSON CLAYTON CORP/KEARNY	C	75	1	VOC	0	0	0	7
ANDERSON CLAYTON CORP/KERMAN	C	428	1	VOC	0	0	0	11
ANDERSON CLAYTON CORP/KINGSRIV	C	460	1	VOC	2	0	0	31
ANDERSON CLAYTON CORP/MURIT #1	C	334	1	VOC	0	0	0	7

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
ANDERSON CLAYTON CORP/MURIT #2	C	336	1	VOC	0	0	0	7
ANDERSON CLAYTON CORP/MURRAY	C	234	1	VOC	0	0	0	12
ANDERSON CLAYTON CORP/NAPA GIN	C	335	1	VOC	0	0	0	5
ANDERSON CLAYTON CORP/PLSNT VA	C	326	1	VOC	0	0	0	18
ANDERSON CLAYTON CORP/SAN JOAQ	C	79	1	VOC	0	0	0	5
ANDERSON CLAYTON CORP/SETTER	C	76	1	VOC	0	0	0	7
ANDERSON CLAYTON CORP/STRATFOR	C	56	1	VOC	0	0	0	4
ANDERSON CLAYTON CORP/SUNSET	C	333	1	VOC	0	0	0	5
ANDERSON CLAYTON CORP/TRANQLTY	C	80	1	VOC	0	0	0	12
ANDERSON CLAYTON CORPORATION	N	135	1	VOC	0	0	0	5
ANDERSON CLAYTON CORPORATION	N	737	1	VOC	1	0	0	16
ANDERSON CLAYTON-MARICOPA GIN	S	697	1	VOC	0	0	0	25
APTCO LLC	C	663	1	VOC	0	147	788	148
APTCO LLC	C	664	1	VOC	0	149	796	150
APTCO LLC	C	665	1	VOC	0	141	758	143
APTCO LLC	C	684	1	VOC	0	138	241	139
APTCO LLC	N	390	1	VOC	1,370	1,266	1,618	948
APTCO LLC	N	397	1	VOC	12,104	11,748	9,416	0
APTCO LLC	N	540	1	VOC	5,000	5,000	5,000	5,000
APTCO LLC	N	854	1	VOC	3,141	4,397	2,894	0
APTCO LLC	S	872	1	VOC	9	8	9	9
APTCO LLC	S	1990	1	VOC	1,306	1,709	1,829	1,157
ARCO PIPELINE FACILITY	C	271	1	VOC	419	417	417	417
ARDAGH GLASS INC	C	1344	1	VOC	0	0	0	7
ARDAGH GLASS INC	N	1292	1	VOC	0	0	0	135
ARDAGH GLASS INC	S	4497	1	VOC	0	0	0	34
ASV WINES	C	1395	1	VOC	0	0	379	0
ASV WINES, INC.	N	892	1	VOC	0	0	189	0

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
AVENAL POWER CENTER LLC	S	2988	1	VOC	0	69	0	0
AVENAL POWER CENTER LLC	S	4948	1	VOC	10,000	10,000	10,000	10,000
AVENAL POWER CENTER, LLC	C	897	1	VOC	45	45	45	45
AVENAL POWER CENTER, LLC	C	898	1	VOC	5,480	6,496	4,696	6,616
AVENAL POWER CENTER, LLC	N	724	1	VOC	0	0	241	0
AVENAL POWER CENTER, LLC	N	725	1	VOC	0	0	709	0
BAKERSFIELD CITY WOOD SITE	S	2969	1	VOC	46	59	61	52
BAKERSFIELD CRUDE TERMINAL LLC	S	4189	1	VOC	3,821	3,819	9,800	5,042
BAKERSFIELD CRUDE TERMINAL LLC	S	4190	1	VOC	877	878	30	0
BAKERSFIELD CRUDE TERMINAL LLC	S	4191	1	VOC	8,302	8,303	3,170	7,958
BAR 20 PARTNERS LTD	S	2593	1	VOC	0	9	345	350
BAR 20 PARTNERS LTD	S	2594	1	VOC	7	15	38	38
BAR 20 PARTNERS LTD	S	2595	1	VOC	873	882	892	892
BAR 20 PARTNERS LTD	S	2915	1	VOC	445	419	50	45
BERRY PETROLEUM COMPANY LLC	S	4883	1	VOC	6,945	6,943	6,943	6,943
BERRY PETROLEUM COMPANY LLC	S	4884	1	VOC	842	5,769	3,922	152
BERRY PETROLEUM COMPANY LLC	S	4885	1	VOC	1,536	1,536	1,536	1,536
BERRY PETROLEUM COMPANY LLC	S	4886	1	VOC	22,190	22,190	22,190	22,189
BERRY PETROLEUM COMPANY LLC	S	4887	1	VOC	2,415	1,551	0	1,322
BERRY PETROLEUM COMPANY, LLC	N	1445	1	VOC	0	573	0	0
BREA OIL COMPANY, INC.	S	3355	1	VOC	149	391	193	112
BREITBURN OPERATING LP	S	4059	1	VOC	15	19	16	13
BRITZ AG FINANCE CO., INC.	C	557	1	VOC	0	0	0	8
BRITZ GIN PARTNERSHIP II	C	871	1	VOC	0	0	0	32
BRITZ INCORPORATED	C	586	1	VOC	0	0	0	21
BRONCO WINE CO	S	3732	1	VOC	125	125	125	125
BROWN SAND INC	N	46	1	VOC	2	2	1	2
BRUCE CARTER INDUSTRIES INC	S	4038	1	VOC	10,031	12,170	11,257	1,354

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
BUILDERS CONCRETE, INC.	C	41	1	VOC	35	35	35	35
BUTTONWILLOW GINNING CO	S	2937	1	VOC	0	0	0	40
BUTTONWILLOW GINNING CO	S	4634	1	VOC	0	0	0	105
CALAVERAS MATERIALS INC	C	89	1	VOC	92	83	95	76
CALAVERAS MATERIALS INC.	C	233	1	VOC	148	410	483	300
CALIFORNIA DAIRIES	N	497	1	VOC	33	33	33	33
CALIFORNIA DAIRIES, INC.	C	683	1	VOC	0	0	454	0
CALIFORNIA RESOURCES ELK HILLS LLC	S	1703	1	VOC	394	1,333	1,998	1,038
CALIFORNIA RESOURCES ELK HILLS LLC	S	1713	1	VOC	1,093	2,620	3,078	1,181
CALIFORNIA RESOURCES ELK HILLS LLC	S	1714	1	VOC	1,290	3,038	3,527	1,472
CALIFORNIA RESOURCES ELK HILLS LLC	S	1717	1	VOC	1,239	3,804	4,274	1,639
CALIFORNIA RESOURCES ELK HILLS LLC	S	1719	1	VOC	928	1,948	2,037	1,118
CALIFORNIA RESOURCES ELK HILLS LLC	S	1722	1	VOC	1,132	2,723	3,230	1,359
CALIFORNIA RESOURCES ELK HILLS LLC	S	1723	1	VOC	1,723	4,185	4,934	2,003
CALIFORNIA RESOURCES ELK HILLS LLC	S	1725	1	VOC	1,169	2,764	3,251	1,348
CALIFORNIA RESOURCES ELK HILLS LLC	S	1726	1	VOC	1,603	3,911	4,662	1,932
CALIFORNIA RESOURCES ELK HILLS LLC	S	1727	1	VOC	1,061	2,580	3,064	1,240
CALIFORNIA RESOURCES ELK HILLS LLC	S	1728	1	VOC	1,692	4,025	4,596	2,098
CALIFORNIA RESOURCES ELK HILLS LLC	S	2488	1	VOC	9	4,650	5,387	2,519
CALIFORNIA RESOURCES ELK HILLS LLC	S	2627	1	VOC	52	52	52	52
CALIFORNIA RESOURCES ELK HILLS LLC	S	3225	1	VOC	648	1,755	1,926	805
CALIFORNIA RESOURCES ELK HILLS LLC	S	3627	1	VOC	3,730	3,448	3,015	3,510
CALIFORNIA RESOURCES ELK HILLS LLC	S	3947	1	VOC	83	2,429	3,196	464
CALIFORNIA RESOURCES ELK HILLS LLC	S	3951	1	VOC	75,129	76,311	77,494	77,493
CALIFORNIA RESOURCES ELK HILLS LLC	S	4196	1	VOC	74	74	74	74
CALIFORNIA RESOURCES ELK HILLS LLC	S	4470	1	VOC	55,150	63,829	66,405	61,718
CALIFORNIA RESOURCES ELK HILLS LLC	S	4643	1	VOC	435	2,800	3,881	892
CALIFORNIA RESOURCES ELK HILLS LLC	S	4704	1	VOC	1,700	2,072	5,392	4,827

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
CALIFORNIA RESOURCES ELK HILLS LLC	S	4747	1	VOC	0	2,050	6,327	0
CALIFORNIA RESOURCES ELK HILLS LLC	S	4795	1	VOC	0	1,895	2,768	0
CALIFORNIA RESOURCES ELK HILLS LLC	S	4947	1	VOC	2,500	2,500	2,500	2,500
CALIFORNIA RESOURCES ELK HILLS LLC	S	5001	1	VOC	346	380	413	413
CALIFORNIA RESOURCES ELK HILLS LLC	S	5003	1	VOC	1,499	1,907	2,634	1,500
CALIFORNIA RESOURCES PRODUCTION CORP	N	1125	1	VOC	179	179	179	179
CALIFORNIA RESOURCES PRODUCTION CORP	N	1153	1	VOC	885	885	885	885
CALIFORNIA RESOURCES PRODUCTION CORP	N	1193	1	VOC	1,604	1,604	1,604	1,604
CALIFORNIA RESOURCES PRODUCTION CORP	S	4049	1	VOC	32	796	1,783	481
CALIFORNIA RESOURCES PRODUCTION CORP	S	4062	1	VOC	26	178	115	66
CALIFORNIA RESOURCES PRODUCTION CORP	S	4080	1	VOC	0	255	0	0
CALIFORNIA RESOURCES PRODUCTION CORP	S	4256	1	VOC	87	19	0	4
CALIFORNIA RESOURCES PRODUCTION CORP	S	4258	1	VOC	0	1,513	676	0
CALIFORNIA RESOURCES PRODUCTION CORP	S	4297	1	VOC	0	2,124	2,849	0
CALIFORNIA RESOURCES PRODUCTION CORP	S	4350	1	VOC	738	4,013	5,529	908
CALIFORNIA RESOURCES PRODUCTION CORP	S	4388	1	VOC	846	4,119	5,670	1,044
CALIFORNIA RESOURCES PRODUCTION CORP	S	4432	1	VOC	0	116	741	0
CALIFORNIA RESOURCES PRODUCTION CORP	S	4440	1	VOC	74	74	74	74

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
CALIFORNIA RESOURCES PRODUCTION CORP	S	4454	1	VOC	170	170	170	170
CALIFORNIA RESOURCES PRODUCTION CORP	S	4482	1	VOC	0	325	774	0
CALIFORNIA RESOURCES PRODUCTION CORP	S	4630	1	VOC	70	138	199	152
CALIFORNIA RESOURCES PRODUCTION CORP	S	4785	1	VOC	0	908	1,259	7
CALIFORNIA RESOURCES PRODUCTION CORP	S	4849	1	VOC	0	1,196	0	0
CALIFORNIA RESOURCES PRODUCTION CORP	S	4992	1	VOC	8,611	8,611	8,611	8,610
CALIFORNIA-WASHINGTON CAN CO.	N	77	1	VOC	2,664	0	0	1,583
CALMAT CO.	C	50	1	VOC	2	2	3	3
CALMAT OF FRESNO	C	40	1	VOC	2	11	5	17
CALPINE CORP	S	1666	1	VOC	0	0	0	9
CALPINE CORP	S	3116	1	VOC	1,440	1,546	1,621	1,621
CALPINE CORPORATION	C	1080	1	VOC	2,235	2,037	1,988	2,251
CALPINE ENERGY SERVICES LP	S	3261	1	VOC	4,454	4,972	3,890	4,155
CALPINE ENERGY SERVICES LP	S	3283	1	VOC	0	150	171	0
CALPINE ENERGY SERVICES LP	S	3292	1	VOC	4,804	6,146	6,632	3,338
CALPINE ENERGY SERVICES LP	S	3300	1	VOC	4,636	4,705	4,774	4,771
CALPINE ENERGY SERVICES LP	S	3368	1	VOC	1,500	1,500	1,500	1,500
CALPINE ENERGY SERVICES LP	S	3503	1	VOC	5,500	5,500	5,500	5,500
CALPINE ENERGY SERVICES LP	S	3504	1	VOC	1,000	1,000	1,000	1,000
CALPINE ENERGY SERVICES LP	S	3555	1	VOC	5,000	5,000	5,000	5,000
CALPINE ENERGY SERVICES, L.P.	N	927	1	VOC	10,503	10,981	11,573	11,536
CAMPBELL SOUP COMPANY	N	127	1	VOC	84	58	52	61
CANANDAIGUA WINE COMPANY INC	C	1085	1	VOC	21	17	30	15

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
CANDLEWICK YARNS	C	507	1	VOC	23	20	16	14
CANTUA COOPERATIVE GIN, INC.	C	760	1	VOC	0	0	0	38
CASTLE AIRPORT AVIATION & DEVELOP CENTER	N	523	1	VOC	31,801	32,175	32,549	32,549
CENTRAL CALIFORNIA SHEETS LLC	S	4754	1	VOC	1	0	0	0
CENTRAL VALLEY EGGS LLC	S	4855	1	VOC	7,131	7,130	7,130	7,130
CHEMICAL WASTE MANAGEMENT INC	S	2645	1	VOC	1,513	2,602	2,033	2,038
CHEMICAL WASTE MANAGEMENT, INC	N	1284	1	VOC	5,785	0	0	10,355
CHEVRON USA INC	C	221	1	VOC	357	395	431	396
CHEVRON USA INC	C	277	1	VOC	2,209	2,209	2,209	2,209
CHEVRON USA INC	C	331	1	VOC	1,220	1,220	1,221	1,221
CHEVRON USA INC	S	77	1	VOC	42	38	36	47
CHEVRON USA INC	S	165	1	VOC	2,970	3,003	3,036	3,036
CHEVRON USA INC	S	647	1	VOC	235	699	540	95
CHEVRON USA INC	S	703	1	VOC	2,084	2,107	2,130	2,130
CHEVRON USA INC	S	1049	1	VOC	3,461	0	0	0
CHEVRON USA INC	S	1793	1	VOC	1,420	1,443	1,335	1,334
CHEVRON USA INC	S	2107	1	VOC	651	638	666	666
CHEVRON USA INC	S	2373	1	VOC	11,698	11,110	8,970	9,796
CHEVRON USA INC	S	2430	1	VOC	2,459	2,142	1,336	1,543
CHEVRON USA INC	S	2674	1	VOC	1,848	1,848	1,848	1,848
CHEVRON USA INC	S	2675	1	VOC	1,835	1,835	1,835	1,835
CHEVRON USA INC	S	2708	1	VOC	1,605	1,634	1,664	1,664
CHEVRON USA INC	S	3518	1	VOC	1,780	1,780	1,780	1,780
CHEVRON USA INC	S	3701	1	VOC	25,142	25,559	25,976	25,976
CHEVRON USA INC	S	3811	1	VOC	3,947	4,032	4,121	4,125
CHEVRON USA INC	S	4066	1	VOC	1,281	1,477	1,673	1,673
CHEVRON USA INC	S	4068	1	VOC	522	567	615	615

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
CHEVRON USA INC	S	4198	1	VOC	37,461	38,412	39,324	39,358
CHEVRON USA INC	S	4355	1	VOC	6,428	6,428	6,428	6,428
CHEVRON USA INC	S	4576	1	VOC	99,488	100,764	102,130	102,151
CHEVRON USA INC	S	4670	1	VOC	116,015	117,519	119,022	119,022
CHEVRON USA INC	S	4820	1	VOC	0	44	157	393
CHEVRON USA INC	S	4899	1	VOC	306	306	306	306
CHEVRON USA INC	S	4952	1	VOC	3,641	3,822	4,003	3,343
CHEVRON USA INC	S	4955	1	VOC	26,038	26,963	27,887	27,882
CHEVRON USA INC LOST HILLS GP	S	1847	1	VOC	2,764	2,793	2,825	2,825
CHEVRON USA INC REFINERY	S	657	1	VOC	35,011	35,399	35,788	35,788
CHEVRON USA PRODUCTION INC	S	674	1	VOC	5,779	5,851	5,903	5,902
CHEVRON USA, INC.	C	1372	1	VOC	14	36	12	9
CHRISTOPHER RANCH LLC	C	1430	1	VOC	0	0	0	18
CILION INC	S	3373	1	VOC	2,978	2,979	2,979	2,978
CILION INC	S	4975	1	VOC	9,862	13,000	13,000	13,000
CITY OF TULARE	C	1063	1	VOC	0	107	678	109
CLARK BROTHERS-DERRICK GIN	C	511	1	VOC	0	0	0	2
CLEAN HARBORS BUTTONWILLOW LLC	S	685	1	VOC	31,195	31,541	31,888	31,888
COALINGA FARMERS CO-OP GIN	C	537	1	VOC	0	0	0	8
COIT RANCH	C	532	1	VOC	0	0	0	8
CONAGRA CONSUMER FROZEN FOODS	N	858	1	VOC	5	0	0	8
CONOCOPHILLIPS COMPANY	N	1276	1	VOC	1,445	766	67	0
CORCORAN IRRIGATION DISTRICT	C	560	1	VOC	154	163	159	90
COTTON ASSOCIATES, INC	S	25	1	VOC	0	0	0	8
CRAYCROFT BRICK COMPANY	C	71	1	VOC	24	20	19	19
CRESTWOOD WEST COAST LLC	S	4237	1	VOC	7	22	14	4
CRESTWOOD WEST COAST LLC	S	4239	1	VOC	197	24	0	1
CRESTWOOD WEST COAST LLC	S	4293	1	VOC	1,079	1,108	1,139	1,137

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
CRIMSON RENEWABLE ENERGY LP	S	4730	1	VOC	131	131	131	132
CRIMSON RESOURCE MANAGEMENT	S	2161	1	VOC	54	49	31	63
CRIMSON RESOURCE MANAGEMENT	S	3386	1	VOC	67	138	142	94
CRIMSON RESOURCE MANAGEMENT	S	3387	1	VOC	23,009	20,107	19,072	13,925
CRIMSON RESOURCE MANAGEMENT	S	3441	1	VOC	13	4	13	22
DART CONTAINER CORPORATION	C	555	1	VOC	30,481	26,626	14,213	50,680
DEL MONTE FOODS MODESTO PLANT 1	N	1238	1	VOC	82	71	116	28
DELTA TRADING L P	S	4735	1	VOC	1,844	1,941	2,034	2,037
DIAMOND FOODS, LLC	N	572	1	VOC	126	45	138	120
DIAMOND FOODS, LLC	N	645	1	VOC	1,695	1,419	1,451	783
DIAMOND FOODS, LLC	N	828	1	VOC	1,495	671	1,063	1,914
DOLE PACKAGED FOODS LLC	N	520	1	VOC	3	11	41	8
DTE STOCKTON LLC	S	3715	1	VOC	1,450	1,450	1,450	1,450
DUNCAN ENTERPRISES	C	33	1	VOC	26	26	27	18
E & J GALLO WINERY	C	1404	1	VOC	6,369	6,365	5,752	5,631
E & J GALLO WINERY	S	4442	1	VOC	7,039	7,032	7,025	7,013
E & J GALLO WINERY	S	4751	1	VOC	14,349	14,341	16,065	16,065
E & J GALLO WINERY	S	4769	1	VOC	2,761	2,761	1,087	1,083
E & J GALLO WINERY	S	4773	1	VOC	827	771	56	41
E & J GALLO WINERY	S	4780	1	VOC	16,794	16,752	16,723	16,701
E & J GALLO WINERY	S	4942	1	VOC	66,042	116,042	116,036	116,036
E & J GALLO WINERY	S	4994	1	VOC	42,785	42,765	39,825	39,816
E&B NATURAL RESOURCES	S	4408	1	VOC	9	11	11	10
E&B NATURAL RESOURCES MGMT	S	2773	1	VOC	7	12	5	9
E&B NATURAL RESOURCES MGMT	S	3791	1	VOC	7,500	7,500	7,500	7,500
E&B NATURAL RESOURCES MGMT	S	4774	1	VOC	41	44	47	45
EAGLE VALLEY GINNING LLC	N	847	1	VOC	0	0	0	23
ECKERT FROZEN FOODS	N	133	1	VOC	3	11	41	8

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
ELBOW ENTERPRISES INC	S	2535	1	VOC	0	0	0	70
ELEMENT MARKETS LLC	S	3370	1	VOC	5	4	4	4
ENRON OIL & GAS CO	S	1044	1	VOC	5,516	5,576	5,638	5,638
EQUILON ENTERPRISES LLC	N	1167	1	VOC	23	3	20	19
EVERGREEN BEVERAGE PACKAGING	S	4412	1	VOC	5	6	4	5
EXXONMOBIL CORP	S	4547	1	VOC	128	130	131	131
FARMERS COOPERATIVE GIN INC	S	2533	1	VOC	0	0	0	39
FARMERS FIREBAUGH GINNING CO.	C	956	1	VOC	16	0	0	47
FIBREBOARD CORP.	N	209	1	VOC	41	34	16	45
FJ MANAGEMENT INC	S	4996	1	VOC	493,467	435,690	460,137	464,896
FOSTER FOOD PRODUCTS	S	1501	1	VOC	432	437	442	442
FOSTER FOOD PRODUCTS	S	1502	1	VOC	68	63	58	58
FRESNO BEE	C	1440	1	VOC	2,728	2,572	2,291	2,977
FRESNO/CLOVIS REGIONAL WWTP	C	1211	1	VOC	6	6	5	5
FRITO-LAY INC	S	3411	1	VOC	4,018	6,573	9,128	9,128
FRITO-LAY, INC.	S	3426	1	VOC	380	474	377	337
FRITO-LAY, INC.	S	3429	1	VOC	55	57	58	58
FRITO-LAY, INC.	S	3430	1	VOC	76	96	74	72
G3 ENTERPRISES	S	4076	1	VOC	183	183	182	182
G3 ENTERPRISES	S	4371	1	VOC	137	137	137	136
G3 ENTERPRISES	S	4763	1	VOC	139	139	139	138
GARY STOWE	C	1441	1	VOC	4	0	0	44
GENERAL MILLS OPERATIONS, INC	N	139	1	VOC	16	13	13	19
GROWERS COOP	S	88	1	VOC	0	0	1	15
GUARDIAN INDUSTRIES, LLC	S	4900	1	VOC	1,461	1,549	1,353	1,378
H. J. HEINZ COMPANY	N	60	1	VOC	0	23	129	0
H. J. HEINZ COMPANY	N	694	1	VOC	0	0	701	0
H. J. HEINZ COMPANY	N	1085	1	VOC	52	53	45	23

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
H. J. HEINZ COMPANY, L.P.	N	21	1	VOC	0	60	180	60
HANSEN BROTHERS	C	249	1	VOC	0	0	0	13
HECK CELLARS	S	4053	1	VOC	9,715	9,715	9,715	9,715
HERSHEY CHOCOLATE & CONF. CORP	N	42	1	VOC	1	1	1	1
HERSHEY CHOCOLATE & CONF. CORP	N	373	1	VOC	9	11	13	11
HERSHEY CHOCOLATE & CONF. CORP	N	952	1	VOC	5	5	6	6
HOLMES WESTERN OIL CORP	S	4032	1	VOC	216	562	641	200
HOLMES WESTERN OIL CORPORATION	C	823	1	VOC	0	0	0	10
HOLMES WESTERN OIL CORPORATION	N	652	1	VOC	324	326	311	301
HOLMES WESTERN OIL CORPORATION	N	653	1	VOC	30	30	25	24
HOLMES WESTERN OIL CORPORATION	N	1390	1	VOC	23	22	21	21
HUNTER EDISON OIL DEVELOPMENT	S	3723	1	VOC	2,186	2,256	2,234	2,282
HYDROGEN ENERGY CALIFORNIA LLC	S	3305	1	VOC	14,625	14,625	14,625	14,625
HYDROGEN ENERGY CALIFORNIA LLC	S	3557	1	VOC	11,437	11,438	11,438	11,437
HYDROGEN ENERGY CALIFORNIA LLC	S	3605	1	VOC	7,937	7,938	7,938	7,937
INGREDION INCORPORATED	S	4696	1	VOC	416	415	415	414
INTERNATIONAL PAPER CO	S	2995	1	VOC	875	875	875	875
J.G. BOSWELL CO. (EL RICO)	C	135	1	VOC	1	0	0	1
KAWEAH DELTA DISTRICT HOSPITAL	S	2656	1	VOC	460	738	828	938
KERMAN CO-OP GIN & WAREHOUSE 1	C	1002	1	VOC	0	0	0	13
KERN DELTA CO LLC	S	4311	1	VOC	0	0	0	17
KERN DELTA CO LLC	S	4314	1	VOC	0	0	0	38
KERN LAKE COOP GIN	S	2074	1	VOC	0	0	0	134
KERN OIL & REFINING CO.	S	4394	1	VOC	808	808	808	808
KERN OIL & REFINING CO.	S	4649	1	VOC	29	29	29	29
KERN OIL & REFINING CO.	S	4776	1	VOC	240	254	239	386
KERN OIL & REFINING CO.	S	4966	1	VOC	5,000	5,000	5,000	5,000
KERN OIL & REFINING CO.	S	4973	1	VOC	828	828	828	828

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
KERN OIL & REFINING CO.	S	4982	1	VOC	828	827	826	826
KERN RIVER HOLDINGS INC	S	4598	1	VOC	54	54	54	53
LAND O' LAKES INC	S	4920	1	VOC	0	0	0	19
LAND O' LAKES INC	S	4922	1	VOC	103	167	197	0
LATON CO-OP GIN, INC.	C	746	1	VOC	0	0	0	8
LAWRENCE LIVERMORE NATL. LAB	N	464	1	VOC	2	1	0	1
LEPRINO FOODS COMPANY	C	60	1	VOC	137	139	136	138
LIDESTRI FOODS, INC	N	391	1	VOC	0	0	389	0
LIVE OAK LIMITED	S	3	1	VOC	198	200	202	202
LOS ANGELES CNTY SANITATION DIST NO.2	N	472	1	VOC	5,953	6,019	6,086	6,086
LOS ANGELES CNTY SANITATION DIST NO.2	N	1068	1	VOC	269	1,452	271	426
LOS ANGELES COUNTY SANITATION DISTRICT 2	S	2147	1	VOC	12,500	12,500	12,500	12,500
LOS BANOS GRAVEL GROUP, ASPHLT	N	125	1	VOC	16	81	258	86
LOS GATOS TOMATO PRODUCTS	C	1021	1	VOC	0	3	0	0
M CARATAN INC	S	2516	1	VOC	0	0	26	6
MACPHERSON OIL CO	S	4419	1	VOC	2	2	2	2
MACPHERSON OIL COMPANY	N	1254	1	VOC	0	0	0	493
MACPHERSON OIL COMPANY	N	1337	1	VOC	1,428	1,428	1,428	935
MADERA CO-OP GIN, INC.	C	943	1	VOC	0	0	0	11
MALIBU BOATS LLC	N	942	1	VOC	13,753	22,879	14,803	14,093
MALIBU BOATS LLC	S	2555	1	VOC	5,000	5,000	5,000	5,000
MARTIN ANDERSON	C	1051	1	VOC	8,699	12,348	6,585	90
MATTHEW T. BAKKE	S	4938	1	VOC	5,000	5,000	5,000	5,000
MESA VERDE TRADING CO INC	S	4307	1	VOC	4	0	0	1
MEYERS FARMING LLC	C	1112	1	VOC	0	767	1,032	454

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
MID VALLEY DISPOSAL INC	S	4969	1	VOC	69	69	69	69
MID-VALLEY COTTON GROWERS INC	S	317	1	VOC	0	0	0	6
MID-VALLEY COTTON GROWERS INC	S	2989	1	VOC	0	0	0	16
MIDWAY PEAKING LLC	S	4233	1	VOC	0	0	0	10
MINTURN CO-OP GIN	N	441	1	VOC	0	0	0	20
MODESTO IRRIGATION DISTRICT	C	1109	1	VOC	4,342	4,331	4,373	4,371
MODESTO IRRIGATION DISTRICT	N	479	1	VOC	0	0	305	0
MODESTO IRRIGATION DISTRICT	N	739	1	VOC	0	0	27	0
MONTEREY RESOURCES, INC.	S	4814	1	VOC	368	282	126	148
NAS LEMOORE	C	1046	1	VOC	1,607	453	1,066	59
NORTHERN CALIFORNIA POWER AGENCY	S	3744	1	VOC	240	103	0	0
NUSTAR ENERGY LP	S	3634	1	VOC	227	226	226	226
OAKWOOD LAKE RESORT	N	601	1	VOC	0	72	115	0
OCEANAIR ENVIRONMENTAL	N	1420	1	VOC	268	292	209	184
OILDALE ENERGY LLC	S	1096	1	VOC	100	100	100	100
OLAM SVI	N	1427	1	VOC	0	0	3	0
OLAM SVI	N	1431	1	VOC	118	338	652	425
OLDUVAI GORGE, LLC	N	1366	1	VOC	89	0	0	0
OLDUVAI GORGE, LLC	N	1412	1	VOC	8,969	0	385	0
O'NEILL VINTNERS & DISTILLERS	S	3886	1	VOC	404	404	404	404
PACIFIC ETHANOL VISALIA	S	4778	1	VOC	991	989	988	982
PACIFIC GAS & ELECTRIC CO	S	4965	1	VOC	8	8	8	7
PACIFIC GAS & ELECTRIC CO.	N	1382	1	VOC	393	5,292	4,501	81
PACIFIC PIPELINE SYSTEM LLC	S	776	1	VOC	28	67	77	34
PACTIV CORPORATION	N	1062	1	VOC	27,192	27,192	27,192	27,192
PACTIV, LLC	C	1182	1	VOC	9,986	9,206	9,494	9,041
PACTIV, LLC	C	1183	1	VOC	2,001	1,688	2,462	1,110
PACTIV, LLC	C	1184	1	VOC	47,518	2,227	0	17,129

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
PACTIV, LLC	C	1185	1	VOC	51,342	0	0	0
PACTIV, LLC	N	1241	1	VOC	23,529	14,812	15,264	14,520
PACTIV, LLC	S	3862	1	VOC	1,513	1,972	1,571	1,510
PANOCHE GINNING CO	C	904	1	VOC	0	0	0	49
PARAMOUNT FARMS, INC.	C	291	1	VOC	0	0	63	12
PELCO INC A DELAWARE CORPORATION	C	1121	1	VOC	374	374	349	349
PELCO INC A DELAWARE CORPORATION	C	1122	1	VOC	1,842	2,601	2,219	1,756
PHILLIPS 66 PIPELINE LLC	N	1447	1	VOC	184	165	202	196
PHILLIPS 66 PIPELINE LLC	S	4913	1	VOC	155	174	138	144
PHILLIPS 66 PIPELINE LLC	S	4979	1	VOC	184	165	202	196
PHOENIX BIO INDUSTRIES LLC	C	824	1	VOC	500	500	500	500
PILKINGTON NORTH AMERICA, INC	N	1198	1	VOC	79	78	99	93
PLAINS LPG SERVICES LP	S	3793	1	VOC	583	583	583	583
PLAINS LPG SERVICES LP	S	4561	1	VOC	0	972	1,020	381
RIO BRAVO JASMIN	S	4980	1	VOC	53	22	40	51
RIO BRAVO POSO	S	4715	1	VOC	7	165	212	78
SAN JOAQUIN FACILITIES MGMT	S	3801	1	VOC	228	225	223	223
SAN JOAQUIN FACILITIES MGMT	S	4446	1	VOC	0	0	13	8
SAN JOAQUIN FACILITIES MGMT	S	4448	1	VOC	34	8	34	39
SAN JOAQUIN FACILITIES MGMT	S	4910	1	VOC	33,091	27,806	31,888	37,172
SC JOHNSON HOME STORAGE INC	C	1173	1	VOC	1,055	1,415	1,403	1,447
SEALED AIR CORPORATION	C	851	1	VOC	19,000	19,000	19,000	19,000
SEMI TROPIC COOP GIN	S	426	1	VOC	1	0	1	28
SENECA RESOURCES	N	1411	1	VOC	134	0	401	0
SENECA RESOURCES	N	1414	1	VOC	43	42	42	42
SENECA RESOURCES	N	1433	1	VOC	0	0	1	0
SENECA RESOURCES CORP	S	3440	1	VOC	0	0	0	339
SENTINEL PEAK RESOURCES CA LLC	C	1419	1	VOC	892	0	1,736	2,684

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
SENTINEL PEAK RESOURCES CA LLC	C	1420	1	VOC	2,299	2,271	2,242	2,243
SENTINEL PEAK RESOURCES CA LLC	S	4832	1	VOC	821	821	822	822
SENTINEL PEAK RESOURCES CA LLC	S	4833	1	VOC	840	840	840	840
SENTINEL PEAK RESOURCES CA LLC	S	4834	1	VOC	24	24	24	24
SENTINEL PEAK RESOURCES CA LLC	S	4995	1	VOC	5,000	5,000	5,000	5,000
SEQUOIA FOREST INDUSTRIES	C	67	1	VOC	2	9	0	6
SEQUOIA FOREST INDUSTRIES	C	72	1	VOC	7	0	1	1
SFPP LP	S	4188	1	VOC	2,374	2,374	2,372	2,372
SHAFTER-WASCO GINNING CO	S	3268	1	VOC	0	0	0	13
SHELL CALIFORNIA PIPELINE COMPANY LLC	C	467	1	VOC	185	0	0	0
SHELL OIL PRODUCTS US	S	4223	1	VOC	0	20	3	3
SHELL OIL PRODUCTS US	S	4251	1	VOC	431	460	493	492
SHELL OIL PRODUCTS US	S	4336	1	VOC	61	33	0	0
SHELL PIPELINE COMPANY LP	S	2303	1	VOC	0	658	431	0
SILGAN CONTAINERS LODI MFG CORP	N	431	1	VOC	5,103	3,464	3,573	3,865
SILGAN CONTAINERS MANUFAC CORP	C	1208	1	VOC	4,279	3,921	3,042	3,166
SOUTH KERN INDUSTRIAL CENTER LLC	S	3006	1	VOC	0	190	382	0
SOUTH VALLEY GINS INC	S	3554	1	VOC	0	0	0	10
SOUTH VALLEY GINS INC	S	4635	1	VOC	4	0	0	42
SOUTHERN CALIF GAS CO	S	671	1	VOC	570	576	583	583
SOUTHERN CALIF GAS CO	S	1739	1	VOC	1,322	1,337	1,354	1,352
STOCKTON EAST WATER DISTRICT	N	763	1	VOC	1,627	2,271	2,299	2,059
SYNAGRO WEST, INC DBA CENTRL VLY COMPOST	N	1394	1	VOC	8	0	47	0
TAUBER OIL CO	S	4725	1	VOC	500	500	500	500
TAUBER OIL CO	S	4902	1	VOC	563	618	745	749
TAUBER OIL COMPANY	N	1239	1	VOC	234	203	211	182

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
TESORO LOGISTICS OPERATIONS LLC	N	1463	1	VOC	1,249	1,249	1,249	1,247
TESORO LOGISTICS OPERATIONS LLC	S	4736	1	VOC	4,937	4,938	4,937	4,938
THE DOW CHEMICAL COMPANY	N	799	1	VOC	218	212	236	224
THE NESTLE COMPANY INC	N	93	1	VOC	997	1,820	1,874	1,007
THE WINE GROUP LLC	S	4761	1	VOC	179	179	179	179
TKV CONTAINERS, INC.	C	1015	1	VOC	0	83	83	0
TRC CYPRESS GROUP LLC	S	2292	1	VOC	1,412	1,412	1,412	1,412
TRC OPERATION CO INC	S	767	1	VOC	394	399	403	403
TRI-CITY GROWERS INC	S	4392	1	VOC	3	0	0	14
TULARE CITY WASTEWATER PLANT	S	2697	1	VOC	60	60	60	87
TULE RIVER CO-OP GIN INC	S	2682	1	VOC	0	0	0	13
TURLOCK IRRIGATION DISTRICT	C	607	1	VOC	297	297	297	297
TURLOCK IRRIGATION DISTRICT	C	1116	1	VOC	1,080	1,080	1,079	1,079
UNITED STATES GYPSUM CO	S	2543	1	VOC	0	0	0	17
UNITED STATES GYPSUM CO	S	2816	1	VOC	20,000	20,000	20,000	20,000
UNITED STATES GYPSUM COMPANY	C	818	1	VOC	0	0	0	40
UNITED STATES GYPSUM COMPANY	N	661	1	VOC	15,000	16,335	16,334	12,331
UNIVERSITY ENERGY SERVICES	S	561	1	VOC	63	54	59	61
VANDERHAM WEST	S	3235	1	VOC	240	240	240	240
VARCO PRUDEN BUILDINGS, INC.	N	898	1	VOC	5,404	6,473	10,921	8,632
VECTOR ENVIRONMENTAL INC	S	4039	1	VOC	40,127	48,678	45,027	5,416
VINTAGE PRODUCTION CALIFORNIA LLC	N	1213	1	VOC	163	163	163	163
VISALIA WASTEWATER TREATMENT	S	1837	1	VOC	5,067	2,634	4,107	4,614
WESTERN COTTON SERVICES	S	606	1	VOC	0	0	0	9
WESTERN STONE PRODUCTS, INC.	N	17	1	VOC	6	6	7	7
WESTLAKE FARMS INC	C	645	1	VOC	0	0	0	18
WESTSIDE FARMERS COOP #2 & #3	C	1038	1	VOC	5	0	0	57
WESTSIDE FARMERS COOP GIN #6	C	592	1	VOC	6	0	0	44

Facility Name	Emissions Reduction Certificate (ERC) Number			Pollutant	Emissions Reduction (lb/qtr)			
					1st qtr	2nd qtr	3rd qtr	4th qtr
WESTSIDE FARMERS COOP. GIN	C	164	1	VOC	0	0	0	31

Appendix J
Modeling Emission Inventory

Modeling Emission Inventory for the PM2.5 State Implementation Plan in the San Joaquin Valley

Prepared by

California Air Resources Board

San Joaquin Valley Air Pollution Control District

Prepared for

United States Environmental Protection Agency Region IX

June 19, 2018

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Development of $PM_{2.5}$ Emissions Inventories

Emission inputs for air quality modeling (commonly and interchangeably referred to as 'modeling inventories' or 'gridded inventories') have been developed by CARB and district staff. These inventories support multiple SIPs across California to address nonattainment of the federal $PM_{2.5}$ (particulate matter 2.5µ in diameter and smaller) standards. CARB maintains an electronic database of emissions and other useful information to generate aggregate emission estimates at the county, air basin and district level. 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 air quality models.

The following sections of this document describe how base and future year emissions inventory estimates are prepared.

1.1. Inventory Coordination

The California Air Resources Board convened the SIP Inventory Working Group (SIPIWG) to provide an opportunity and means for interested parties (CARB, districts, etc.) to discuss issues pertaining to the development and review of base year, future year, planning and gridded inventories to be used in SIP modeling. The group met every four to six weeks from March 2013 to May 2016 (ARB, 2016). 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, CARB established the SIPIWG Spatial Surrogate Sub-committee, which focuses on improving input data to spatially disaggregate emissions at a more refined level needed for air quality modeling. Local air districts that participate include San

Joaquin Valley 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} (particulate matter 10µ in diameter and smaller) /$PM_{2.5}$ 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: CARB, 35 local air pollution control and air quality management districts (Districts), regional transportation planning agencies (RTPAs), and the California Department of Transportation (Caltrans). CARB is responsible for the compilation of the final statewide emission inventory, and for maintaining this information in CEIDARS. In addition to the statewide emission inventory, emissions from northern Mexico (Kwong, 2017) 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 can be derived from the amount of product produced, solvent used, or fuel used.

The district reported and CARB estimated emissions totals are stored in the CEIDARS database for any given pollutant. Both criteria 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 PM_{10} and $PM_{2.5}$ are estimated from total particulate matter (PM). Details about chemical and size resolved speciation of emissions for modeling can be found in Section 0. Additional information on CARB 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) used to project air quality to future years, the terms used in the preparation of the emission inventory scenarios must be clearly defined. In this document, the following inventory definitions will be used:

1.3.1. Base Case Modeling Inventory (2013)

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 2013 includes day-specific emissions for certain sectors. This includes, for instance, available day-specific activities and emission adjustments. Actual district reported point source emissions were gathered for the year 2012 and forecasted to 2013. The year 2013 was selected to coincide with the year selected for baseline design values (described below). The U.S. EPA modeling guidance states that once the model has been shown to perform adequately, the use of day-specific emissions is no longer needed. In preparation for SIP development, both CARB and the local air districts began a comprehensive review and update of the emission inventory several years ago resulting in a comprehensive emissions inventory for 2013.

1.3.2. Reference Year Modeling Inventory (2013)

The reference year inventory is intended to be a representation of emission patterns occurring through the baseline design value period and the emission patterns expected in the future year. U.S. EPA modeling guidance describes the reference year modeling inventory as “a common starting point” that represents average or “typical” conditions that are consistent with the baseline design value period. U.S. EPA guidance also states “using a ‘typical’ or average reference year inventory provides an appropriate platform for comparisons between baseline and future years.” The 2013 reference year inventory represents typical average conditions and emission patterns through the 2013 design value period. This reference emissions inventory is not developed to capture day-specific emission characteristics. However, this reference inventory includes temperature, relative humidity and solar insolation effects, for 2013.

1.3.3. Future Year Modeling Inventory (2020/2024/2025)

Future year modeling inventories, along with the reference year modeling inventory, are used in the model-derived RRF calculation. Projected inventory years were chosen to address the following standards:

- 2020 is the modeled attainment year for the 24-hour 1997 $PM_{2.5}$ standard of 65µg/m^3 and the annual 1997 $PM_{2.5}$ standard of 15µg/m^3.
- 2024 is the modeled attainment year for the 24-hour 2006 $PM_{2.5}$ standard of 35µg/m^3.
- 2025 is the modeled attainment year for the annual 2012 $PM_{2.5}$ standard of 12 µg/m^3.

Each of these years reflects the date by which attainment can be achieved as expeditiously as practicable for the relevant $PM_{2.5}$ standard.

These inventories maintain the “typical”, average patterns of the 2013 reference year modeling inventory. The 2020, 2024 or 2025 inventory will include temperature, relative humidity, and solar insolation effects from reference year (2013) meteorology. Future year point and area source emissions are projected from the 2012 baseline emissions used in the 2013 reference year modeling inventory. Additionally, future year on-road emission inventories are used, as projected by EMFAC. The application of control measure reduction factors is discussed in section 3.8.

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 **Error! Reference source not found.**.

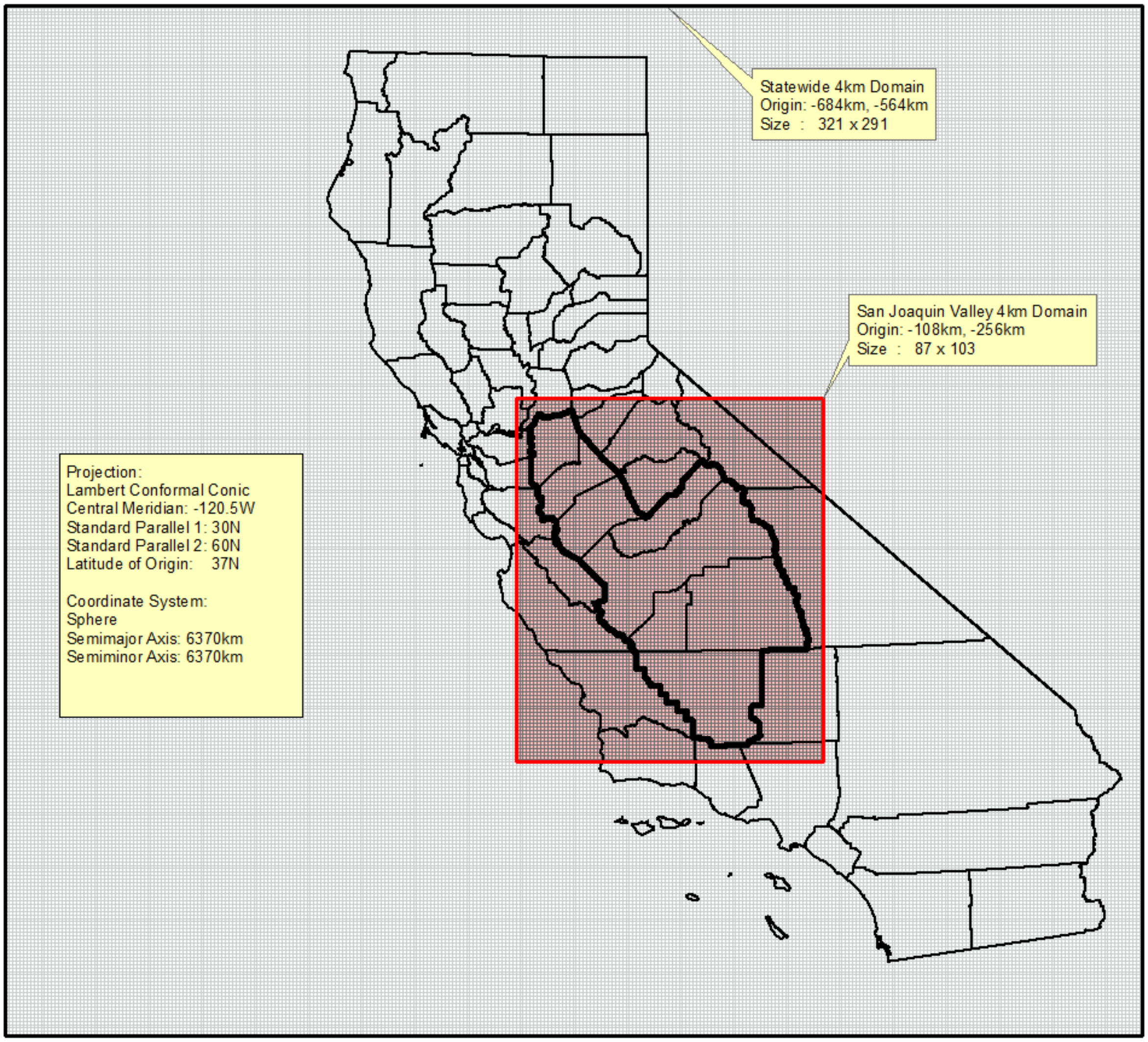

Figure 1 Spatial coverage and parameter summary of modeling domains

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 extends entirely over California and 100 nautical miles west over the Pacific Ocean. A smaller 4km x 4km subdomain is used for the San Joaquin Valley. The specifications for the statewide and San Joaquin Valley domains are summarized in **Error! Reference source not found.**.

Table 1 Modeling domain parameters

Parameter	Statewide domain	San Joaquin Valley Subdomain
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	87 x 103 cells
Lambert origin	(-684,000 m, -564,000 m)	(-108,000 m, -256,000 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 each of the sectors within 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. **Error! Reference source not found.** 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 (San Joaquin Valley Air Pollution Control District) 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

The emissions are temporally resolved by month, week, day and hour to more accurately gauge model performance and ultimately to better assess the influence of control measures on attainment. This section covers the temporal distributions of the point, area, and off-road mobile sources. The temporal distribution of the emissions from on-road, biogenic and ocean-going vessel (OGV) are discussed in Sections 3.4, 3.5 and 3.6. The temporal distribution of residential wood combustion (RWC) and agricultural ammonia sectors are described in Section 3.7.5 and Section 3.7.6, respectively.

Temporal data are stored in CARB's emission inventory database. Each local air district assigns temporal data for all processes at each facility in their district to represent when emissions at each process occur. For example, emissions from degreasing may operate differently than a boiler. CARB or district staff also assign 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. CARB's emission inventory database stores the relative monthly fractional activity for each process, the sum of which is 100. Using an example of emission sources that typically operate the same over each season, emissions from refinery heaters and line haul locomotives would have a monthly fraction (throughput) of 8.33 for each month (calculated as 100/12 = 8.33). This is considered a flat monthly profile. To apply monthly variations to create a gridded inventory, the annual average day's emissions (yearly emissions divided by 365) is multiplied by the typical monthly throughput. For example, a typical monthly throughput in July for recreational boats of 15 results in about 1.8 times higher (15 / 8.33 = 1.8) emissions than a day in a month with a 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. **Error! Reference source not found.** shows the current DPWK codes and **Error! Reference source not found.** 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; half as much activity on week days	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 whereas many businesses operate 8 hours per day. Other emissions sources vary significantly over a day, such as residential space heating or pesticide application. Each process or emission category is assigned an hours-per-day (HPDY) code. **Error! Reference source not found.** displays the daily variation factors or current HPDY codes. These codes are mostly current except for Code 33 which changed in response to RWC temporal allocation methods (see section 3.7.5). Specifically, the morning-evening peak pattern is replaced with an evening-only profile up to midnight. Table 18 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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	3 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
4	4 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
5	5 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
6	6 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
7	7 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
8	8 HOURS PER DAY - UNIFORM ACTIVITY FROM 8 A.M. TO 4 P.M. (NORMAL WORKING SHIFT)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
9	9 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
10	10 HOURS PER DAY	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
11	11 HOURS PER DAY	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
12	12 HOURS PER DAY	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
13	13 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
14	14 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
15	15 HOURS PER DAY	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
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	1	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

2.3. Spatial Allocation

Once the base case, reference or future year inventories are developed, the next step of modeling inventory development is to spatially allocate the emissions. Air quality models attempt to replicate the physical (e.g. transport) and chemical processes that occur in the atmosphere within a modeling domain. Therefore, it is important that the physical location of emissions be specified as accurately as possible. Ideally, the actual location of all emissions would be known exactly. 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 that vary geographically. Sonoma Technology, Inc. (STI) (Funk, et al., 2001) under CCOS contract originally developed many of the spatial surrogates by creating a base year (2000) and various future year surrogate inventories. STI updated the underlying spatial data and developed new surrogates (Reid, et al., 2006), completing the project in 2008. CARB and districts have since continued to update and improve many of the spatial surrogates, adding new ones as more data become available.

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 when 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, CARB and district staffs have continued to search for more recent or improved sources of data, since the underlying data used by STI were prior to the 2007-2009 recession. CARB 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. 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 CARB Equipment

Registration database for the Transport Refrigeration Unit (TRU) ATCM and the Drayage Truck Regulation.

- Development of a wilderness mask for application of population based spatial surrogates (see below paragraphs)
- Utilization of Digital Map Products California state-wide parcel database to develop a new fireplace surrogate (see section 2.3.7)

In all, 99 unique surrogates are available for use. A summary of the spatial surrogates for which spatial allocation factors were developed is shown below in **Error! Reference source not found.**.

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

Surrogate Name	Surrogate Definition
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
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 publicly owned treatment works (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
FIREPLACES	Spatial distribution of residential wood heating actually being used by RWC woodstoves and fireplaces
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,golf 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

Recent updates to the spatial surrogates include the creation of a wilderness mask. A wilderness mask was developed by CARB staff to incorporate land area in certain grid cells that had reported population from the census block but in reality are remote or desolate wilderness. **Error! Reference source not found.** illustrates a "wilderness surrogate" developed based on compiled data from the USFS (United States Forest Service), National Park Service, BLM (Bureau of Land Management) and state park systems. Wilderness is defined as an area of undeveloped land without permanent improvements or human habitation (Funk, et al., 2001).

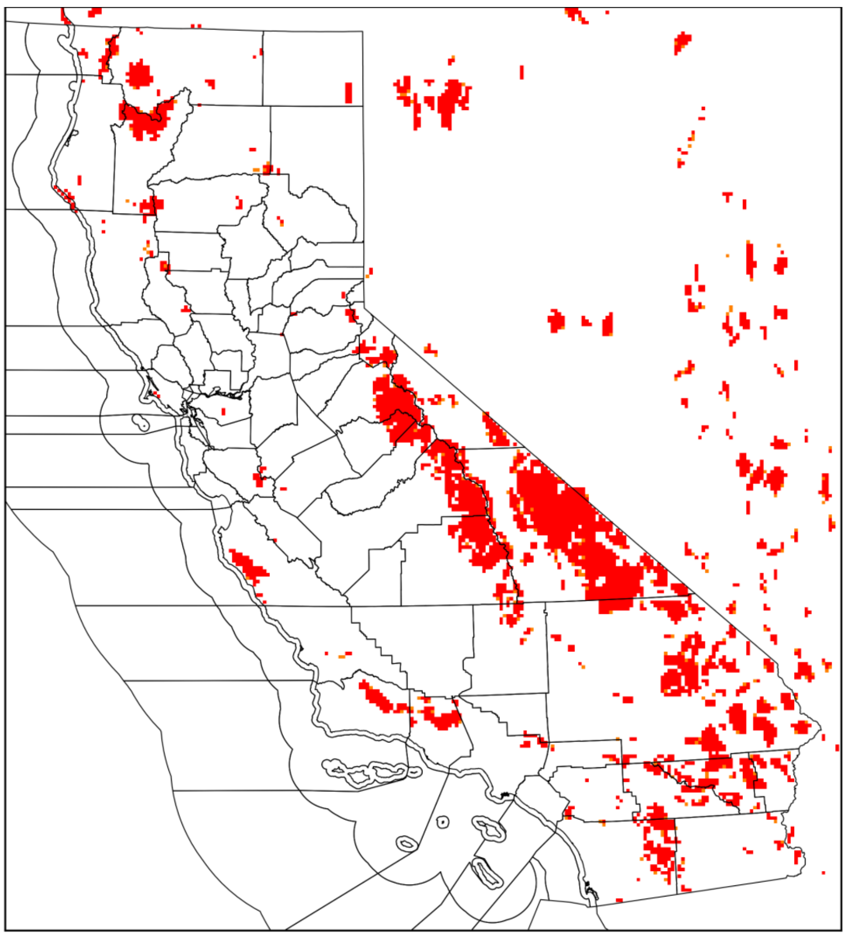

Figure 2 Wilderness mask on ca-4km state domain

The wilderness "mask" was applied to approximately 20 surrogates to remove fractions of disaggregated emissions in areas where no humans live. **Error! Reference source not found.**3 illustrates how the wilderness mask removes county fractions in certain areas in the population surrogate while table 6 describes all surrogates in which the mask was applied.

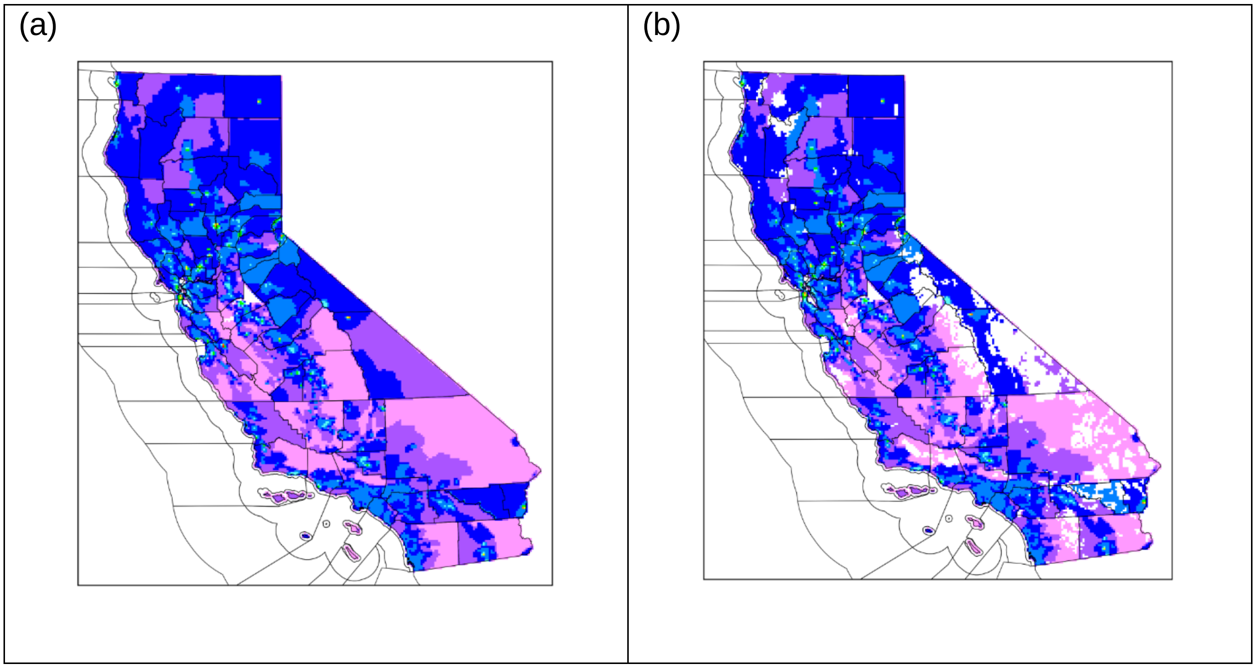

Figure 3 Example of population surrogate before (a) and after (b) wilderness mask application

Table 6 List of Surrogates in which the wilderness mask was applied

Number / Shape File Name	Description
180 – Employ Roads	Spatial distribution of total employment and road density (all paved roads)
230 – HE_Sqft	Computed surrogate based on housing and employment (est. ft2 / person)
250 – Housing	Spatial distribution of total housing
260 – Housing Autobody	Spatial distribution of housing and auto-body refinishing shops
270 – Housing_Com_Emp	Spatial distribution of total housing and commercial employment
280 – Housing_Restaurants	Spatial distribution of total housing and restaurants/bakeries
300 – Industrial_Emp	Spatial distribution of industrial employment
440 – Population	Population
450 – Pop_ComEmp_Hos	Spatial distribution of hospitals, population and commercial employment
530 – ResGasHeating	Spatial distribution of homes using gas supplied by a utility as primary source of heating
540 - Residential Change	Computed surrogate based on spatial distribution of residential areas
550 - Res Non Res Change Industrial Employment	Spatial distribution of industrial employment and residential/non-residential change
570 - Res Wood Heating	Spatial distribution of homes using wood as primary source of heating
571 - Res Oil Heating	Spatial distribution of homes using fuel oil or kerosene as primary source of heating
572 - Res LPG Heating	Spatial distribution of homes using gas (bottled, tank or LP) as primary source of heating
573 - Fireplaces	Spatial distribution of residential wood heating actually being used by RWC woodstoves and fireplaces
580 - Res Non Res Change	Computed surrogate based on spatial distribution of residential and non-residential areas
620 - Service Com Employment	Spatial distribution of service and commercial employment

650 - Ser Com Emp Schools Golf Course Cemeteries	Spatial distribution of service and commercial employment, schools, cemeteries, golf courses
672 - Developed Land High Density	Spatial distribution of developed land - low density, medium density and high density

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 CARB'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, Sparse Matrix Operator Kernel Emissions (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 3.7.1.

2.3.4 Spatial Allocation of Ocean going vessels (OGV)

Ship emissions are allocated to the grids corresponding to the vessel traffic lanes in CARB's OGV model (ARB-PTSD, 2011) These traffic lanes were estimated from three different sources: 1.) National Waterway Network, 2.) The Ship Traffic and 3.) Energy and Environment Model 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 factors 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/.

2.3.7 Spatial Allocation of Residential Wood Combustion Emissions

A parcel database developed by Digital Map Products was utilized to create a new spatial surrogate for residential wood combustion. The CA-statewide parcel data included a vast amount of data regarding property information. A specific "true/false" tag for fireplaces was provided for each parcel of land. The database was filtered for properties that had a fireplace tag set to true and then manually filtered for inconsistencies based on land type and reported tag (example: non-residential and vacant agricultural parcels that were reported to have a fireplace tag were removed based on conversation with CARB staff).

For some counties, the data were extremely limited. This may be the result of building restrictions and permit issues for fireplaces in new homes. Therefore, for the counties in which the parcel data seemed unreasonable, the original RWC surrogate (570) was used as default. The counties where the original default surrogate was applied are San Diego, Los Angeles, Mendocino, Ventura, Santa Barbara, San Louis Obispo, Imperial, Contra Costa, Alameda, and Del Norte.

Error! Reference source not found. shows the new fireplace surrogate, # 573 and illustrates the spatial distribution of residential wood heating being used by woodstoves and fireplaces.

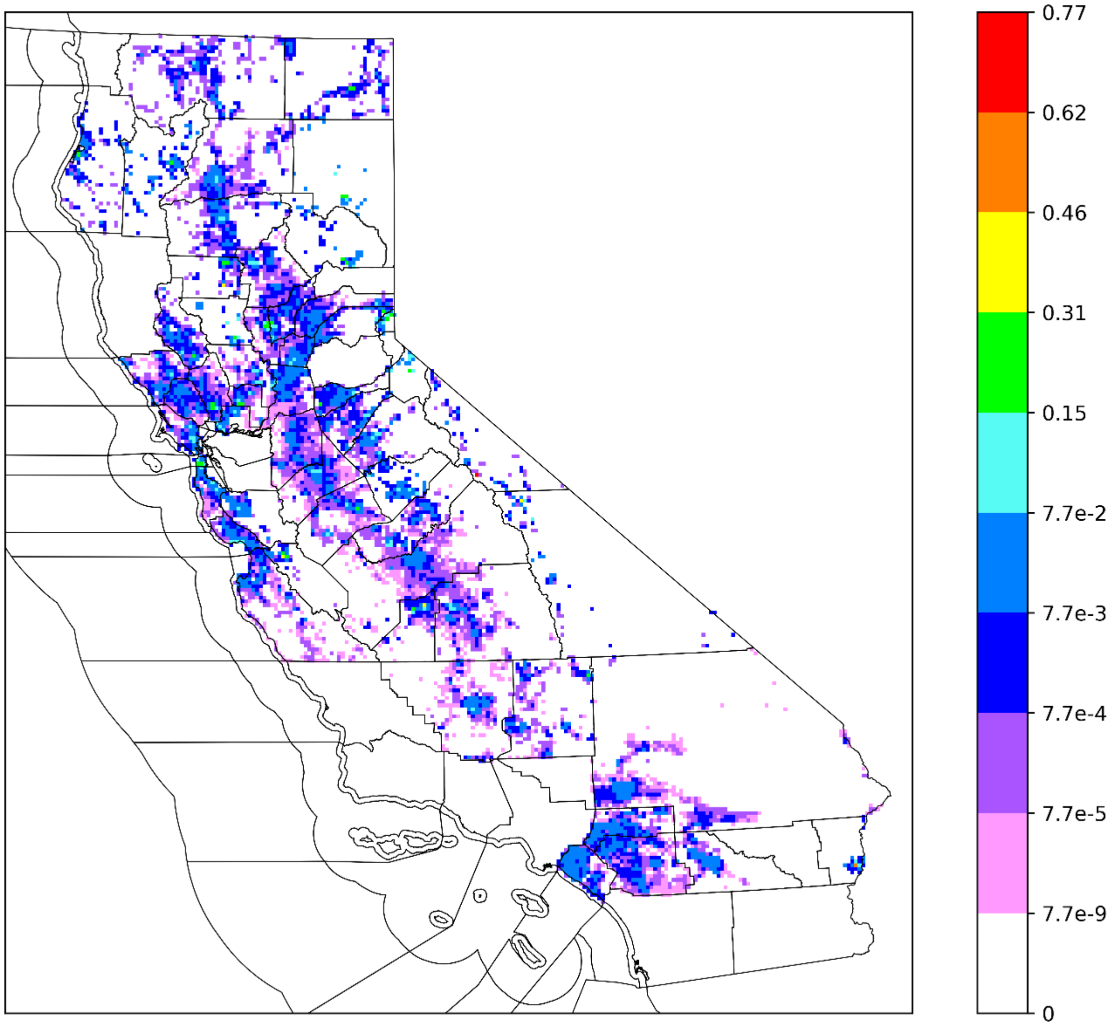

Figure 4 New spatial surrogate of fireplaces based on housing population (2017)

Residential wood curtailment (i.e. no-burn days) was applied after spatial allocation for each district. Figure 5 illustrates where emissions are reduced due to residential wood curtailment programs in three air districts, and more description regarding curtailment methods are discussed in section 3.7.5.

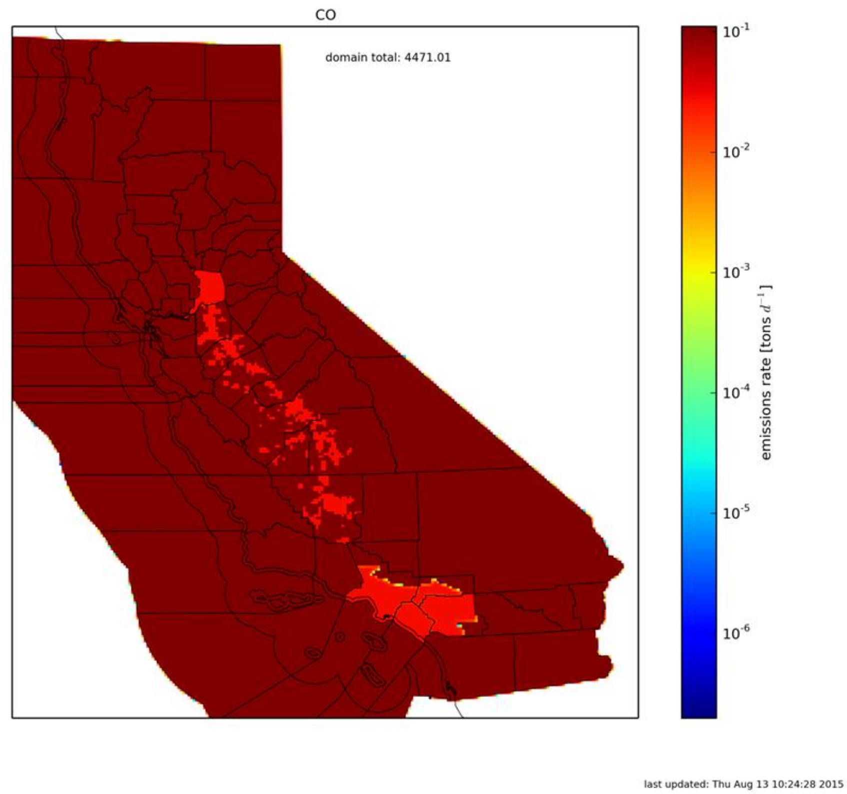

Figure 5 Map of residential wood curtailment areas

In the San Joaquin Valley, a reduction in emissions due to curtailment was only applied to areas where natural gas service is available (e.g. provided by a municipality) as reflected in Rule 4901 (October 2008 version of the rule). In the South Coast, emission reductions due to curtailment were applied to locations below 3000 feet, as stated in Rule 445. For Sacramento, curtailment was applied to all of Sacramento County per Rule 421.

2.4 Speciation Profiles

CARB'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 PM. CO and NH3 each are single species; NOx emissions are composed of NO, NO_2 and HONO; and SOx emissions are composed of SO_2 and SO_3. TOG and PM potentially contain over hundreds of different chemical species, and speciation is the process of disaggregating those inventory pollutants into individual chemical species components or groups of species. CARB 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 as well as less reactive compounds that are of concern from a health or visibility standpoint. 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 CARB's emission inventory are the basis for deriving the Reactive Organic Gas (ROG) emission components, which are also reported in the inventory. ROG is defined as TOG minus CARB's exempt compounds (e.g., methane, ethane, various chlorinated fluorocarbons, acetone, perchloroethylene, volatile methyl siloxanes, etc.). ROG is nearly identical to U.S. EPA's Volatile Organic Compounds (VOC), which is based on EPA's exempt list. For all practical purposes, use of the terms ROG and VOC are interchangeable.

The OG speciation profiles are applied to estimate the amounts of various organic compounds that make up TOG emissions. A speciation profile contains a list of organic compounds and the weight fraction that each compound comprises of the TOG emissions from a particular source type. In addition to the chemical name for each chemical constituent, the file also shows the 5-digit CARB internal identification chemical code The speciation profiles are applied to TOG to develop both the photochemical model inputs and the emission inventory for ROG. 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 distribution 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 original OG profiles and PM profiles are available for download from CARB's web site at: http://www.arb.ca.gov/ei/speciate/speciate.htm. Based on these original profiles, a model-ready speciation file, gspro, was generated for a specific chemical mechanism (for example, SAPRC07) to separate aggregated inventory pollutant emission totals into emissions of model species required by the AQM (air quality model).

Each process or product category is keyed to one of the OG profiles and one of the PM profiles. Also available for download from CARB's web site (see link in previous paragraph) is a cross-reference file that indicates which OG profile and PM profile are assigned to each category in the inventory. The inventory source categories are represented by an 8-digit source classification code (SCC) for point sources, or a 14-digit emission inventory code (EIC) for area and mobile sources. Some of the 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 emissions control devices such as diesel particulate filters (DPFs).. Details can be found in CARB's documentation of speciation profile development. Mapping of each category to OG and PM profiles is summarized in rogpm and gsref files.

Research studies are conducted regularly to improve CARB's speciation profiles. These profiles support ozone and PM modeling studies but are also designed to be used for regional toxics modeling. Other health or welfare related modeling studies where the compounds of interest cannot always be anticipated make use of these profiles. Therefore, speciation profiles need to be as complete and accurate as possible. CARB has an ongoing effort to update speciation profiles as data become available, such as through 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 CARB's speciation profiles include (ARB, 2017) :

(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, Baseline, and Future Projected Emissions Inventories

As mentioned in Section 0, the base case and reference inventories include temperature, humidity and solar insolation effects for some emission categories; development of these data is described in Sections 3.1 and 3.2. The remaining sections of Chapter 3 detail how the base case and reference inventories were created for different sectors of the inventory such as point, area, on-road motor vehicles, biogenic, OGV 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 various meteorological variables. As an example, 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. Therefore, 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 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 modeling system (https://www.cmascenter.org/smoke/). California-specific improvements to SMOKE were implemented under a CARB contract for version 4.0 of SMOKE (Baek, 2015). However, GenTpro, a pre-SMOKE utility program that modulates annual hourly temporal profiles based on modeled meteorology, cannot run in CARB SMOKE due to the fact that it does not recognize the COABDIS defined region code as an acceptable alphanumeric parameter. In 2018, CARB SMOKE was replaced with the CMAS-released SMOKEv4.0 (referred as Official SMOKE hereafter) and included changes to the GenTpro program that accepted the numeric CARB GAI region code. COABDIS based cross-reference files were subsequently changed to GAI in order to match the Official SMOKE format.

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 **Error! Reference source not found.** and **Error! Reference source not found.** are reformatted into an input-ready format as explained in the SMOKE user's manual. Chemical speciation profiles, as described in Section 0, and emissions source cross-reference files used as inputs for SMOKE are developed by CARB staff. SMOKE uses the files for the chemical speciation of NOx, SOx, TOG and PM to produce the species needed by photochemical air quality models.

Emissions for area sources are allocated to grid cells as stated 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 CARB 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, different spatial surrogates are created for a winter and a summer day.

At the time of the development of these inventories the most recent version of EMFAC that has been approved by USEPA for SIP and conformity purposes is EMFAC2014 (80 FR 77337). 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 runs 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 runs for every county for a summer day and a winter day. Lastly, the activity module runs 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 on CALMET.

EMFAC provides vehicle-class and fuel 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 CARB's Integrated Transportation Network (ITN) version 3 database.

The overall processing of on-road emissions to create the gridded emissions inventory is shown in **Error! Reference source not found.**6. 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.

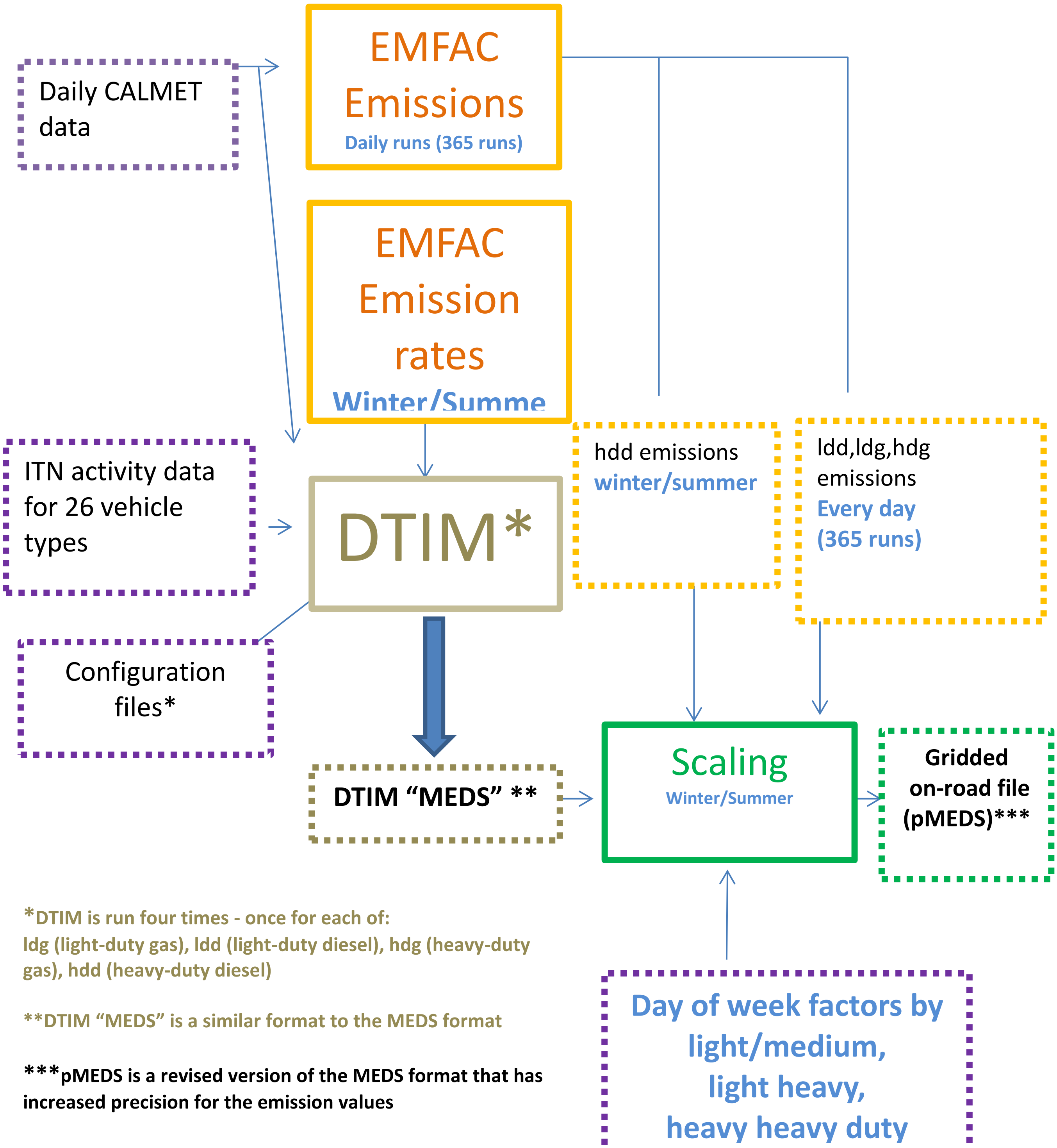

Figure 6 Block diagram for on-road processing

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 **Error! Reference source not found.**7. 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 7 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 8. The categories are represented by the listed source classification codes (SCC) developed by CARB 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 8 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
203	303			Catalyst Running
204	304			Non-catalyst Start
205	305			Non-catalyst
206	306			Hot Soak
207	307			Diurnal
		808	408, 508	Diesel Exhaust
209	309			Running
210	310			Resting
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
		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 9. 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 **Error! Reference source not found.**9 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 9 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 enable emissions estimation for other days including Friday, Saturday, Sunday and Monday. The DOW adjustment factors are developed using California Vehicle Activity Database (CalVAD) data. CalVAD, developed by UC Irvine for CARB, is a system that fuses available ground-truth data sources from California Department of Transportation (CalTrans) to produce a “best estimate” of vehicle activity by vehicle class. The CalVAD data set includes hourly ground-truth measurements of Vehicle Miles Travelled (VMT) on the road network covers all California roadways at a fine spatial (state 4k grid) and temporal (hourly) resolution. However, DOW adjustment filtered out counties that have missing data, malfunctioned detectors, and so on. Therefore, only 34 of the 58 counties had good quality 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 used as a substitute. The temporal fractions are developed for three categories of vehicles: passenger cars (LD), light- and medium-duty trucks (LM), and heavy-heavy duty trucks (HHDT). **Error! Reference source not found.**9 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 are 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 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 is 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 hourly DOW fractions to travel network volumes.
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) 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 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:

$$E_{P,ij,hr,cat} = \frac{EF_{P,daily,cat,cnty} \times DTIM_{P,ij,hr,cat}}{DTIM_{P,daily,cat,cnty}}$$

Where the variables above are defined as:

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 (Network Common Data Form) file usable by the CMAQ (Community Multiscale Air Quality) photochemical model.

3.4.7. Adjustment to the Future Year On-road Emissions

ARB is committed to reduce the diesel NOx emissions for medium heavy duty diesel trucks and heavy heavy duty diesel trucks in the San Joaquin Valley for 2024 and 2025. The reductions are 18.2 tpd and 18.8 tpd for 2024 and 2025 respectively. The county specific factors are applied to the 2024 and 2025 on-road emissions for medium heavy duty diesel trucks and heavy heavy duty diesel trucks. The factors for 2024 and 2025 are shown in Table 10 and Table 11 respectively.

Table 10 County specific factors for 2024

County	Factor
Fresno	0.409
Kern	0.430
King	0.444
Madera	0.432
Merced	0.439
San Joaquin	0.829
Stanislaus	0.829
Tulare	0.409

Table 11 County specific factors for 2025

County	Factor
Fresno	0.407
Kern	0.429
King	0.444
Madera	0.431
Merced	0.438
San Joaquin	0.828
Stanislaus	0.828
Tulare	0.407

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 Ocean-going Vessel (OGV) Emissions

As of March 2018, an average-day OGV emission file was provided by an in house CARB OGV model (ARB-PTSD) and ship emissions were allocated corresponding to the vessel traffic lanes. These traffic lanes were estimated from three different sources:

- National Waterway Network,
- The Ship Traffic, Energy and Environment Model, and

- Automated instrumentation system (AIS) telemetry data collected in 2007.

The emission data output from the OGV model contains criteria pollutants as well as fuel consumption. The South Coast Air Quality Management District (SCAQMD) provided port activity data for 2012. The weekly port activity for every month of the year were applied to the entire south coast subdomain.

After applying the port activity factors mentioned above, emissions were separated by at berth and everything else. At berth emissions are processed through SMOKE and plume rise is calculated for every day of the year Kwok (2015). For transit, maneuvering, and anchorage, emissions are distributed evenly in two vertical layers (2 and 3) as described in Kwok (2015).

It is worth nothing that the minimal impact from OGV emissions for the San Joaquin Valley domain is limited to emissions at the port of Stockton and emissions at sea off the coast of San Luis Obispo.

3.7 Estimation of Other Day-Specific Sources

Day-specific data were used for preparing base case inventories when data were available. CARB and district staff were able to gather hourly/daily emission information for 1) wildfires and prescribed burns, 2) paved and unpaved road dust, and 3) agricultural burns in six districts (more details highlighted below). Additionally, CARB and district staff reflected residential wood curtailment programs in the base case, reference and future year modeling inventories. In addition, emissions in future years were removed for facilities that have closed after 2013.

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

3.7.1 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 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).

3.7.2 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, 2006).

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, CARB 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 CARB staff that stores meteorological data collected from outside sources. The specific data sources for these data include: Remote Automated Weather Stations (RAWS), Atmospheric Infrared Sounder (AIRS), California Irrigation Management Information System (CIMIS) networks, SFBMET (San Francisco Bay Area Meteorology), 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.

3.7.3 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, 2006). The equation adjusts emissions based on annual precipitation; these precipitation-adjusted emissions were placed in the CEIDARS database. Similar to paved road dust, CARB 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.

Start with the daily uncontrolled emissions for each county/air basin as estimated from CARB's methodology. In other words, no precipitation adjustments have been incorporated in the emission estimates.

Use the same daily precipitation data as for paved road dust (see above)

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.

Replace the annual average emissions with day-specific emissions for every day.

3.7.4 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 2013 when agricultural burning occurred. Emissions were estimated for the burning of pruning, 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 2013 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 2013 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 2013 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 2013 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 3.7.4. 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.

3.7.5 Residential Wood Curtailment

Emissions were reduced to reflect residential wood curtailment days (no burn days) in three districts: San Joaquin Valley APCD, South Coast AQMD, and Sacramento Metropolitan AQMD. As of March 2018, there are two major changes in the SMOKE processing of RWC, and one major change in future-year curtailment.

The first change in the SMOKE-processing of RWC is in temporal allocation. In the past, SMOKE temporally allocated RWC emissions with monthly, weekly and diurnal profiles provided by CARB planning staff. Now the profiles are replaced with the ones based on modeled ambient temperature from WRF with respect to the reference model year (2013). Specifically, a pre-SMOKE utility program called GentPro is used to generate county-specific temporal profiles taking into account average temperature by grid cell (Manual 3.1, Manual 4.0, Kwok 2016a). Emissions for any given county will only be allocated whenever the daily average temperature by grid cell is below 50 F. In addition, the diurnal profile has also changed. In previous versions the profile consisted of morning-evening peaks however now the profile reflects evening-only activities beginning from 7pm and ending at midnight, with each hour carrying an equal weight.

The second change in the SMOKE-processing of RWC is in spatial allocation. A new spatial surrogate for fireplaces was constructed based on the population of houses, apartments, and any other residential dwellings with fireplaces (see section 2.3.7). This surrogate is applied to both woodstoves and fireplaces emissions in SMOKE.

The change in RWC curtailment programs is only for San Joaquin Valley (SJV); the corresponding programs remain unchanged for South Coast (SC) and Sacramento Valley (SACV). The following describes the current curtailment programs for SC, SACV, and SJV as well as proposed changes to SJV's curtailment program.

San Joaquin Valley

In San Joaquin Valley (SJV), current RWC curtailment programs for base year 2013 and future years 2020, 2024 and 2025 are in effect. The programs are also referred to as Rule 4901. Additional RWC reductions are expected as areas of gas utility accessibility increase and a woodstove swap-out program (Burn Cleaner program) rolls out. Here, we summarize the current curtailment programs before describing the new woodstove swap-out program in detail.

Current program

Base Year (2013): SJVAPCD staff provided the dates in 2013 when a residential wood curtailment was declared based on the October 2008 district rule 4901. When observed $PM_{2.5}$ reached or exceeded 35 µg/m^3, the curtailment was declared. Consequently, emissions were reduced by 65% (i.e. 35% remaining) in the appropriate geographic regions (see Section 2.3.7).

Future Years (2020, 2024 and 2025): RWC in future years reflect the latest revision to Rule 4901, based on a September 2014 three-level curtailment program:

Level 0 – burning allowed

Level 1 – burning permitted by cleaner-burning woodstoves only

Level 2 – no burning

The consecutive levels are partitioned by values called cut-points, which are also based on the observed $PM_{2.5}$ concentrations. For example, cut-points 20-65 denotes the observed $PM_{2.5}$ at 20 µg/m^3 and 65 µg/m^3, respectively. Cut-point-20 applies the Level 1 curtailment, whereas cut-point-65 applies a more restrictive Level 2 curtailment.

Updates to the Current Program

The SJV RWC curtailment program has been updated to include the Burn Cleaner program. The Burn Cleaner program is applied to the uncurtailed SJV RWC emissions inventory prior to application of Rule 4901. In the Burn Cleaner program, the SJVAPCD staff identified hotspots within the SJV air basin as shown in Figure 7. The hotspots are either new areas of gas utility or areas deemed to have persistently poor air quality. The SJVAPCD provides Burn Cleaner reduction factors (or equivalently retention factors) for both the hotspots and the remaining areas, as shown in Table 12. These factors are applied to registered woodstoves only; fireplace emissions are subject to 97% compliance at Level 1 or above.

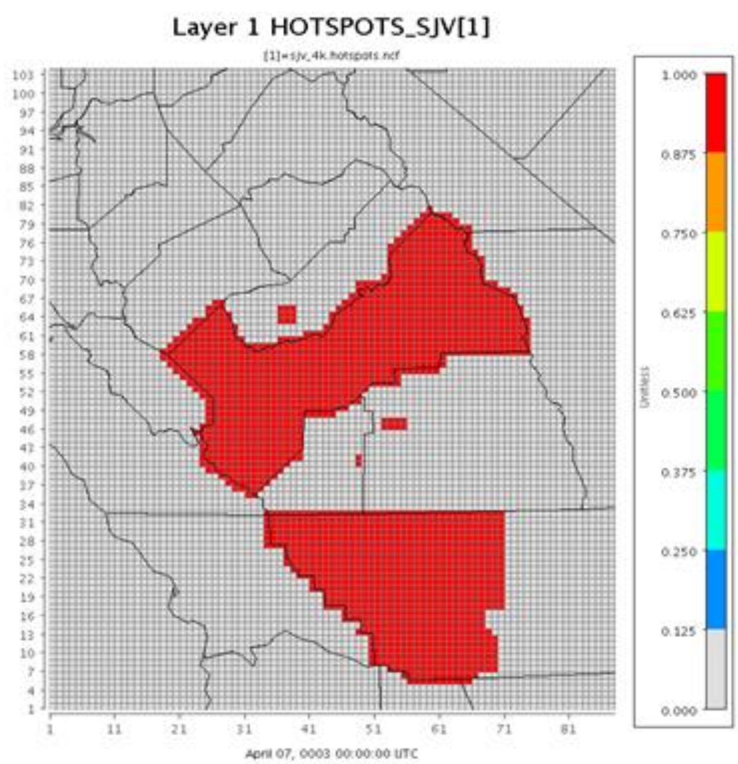

Figure 7 Hot spot areas in San Joaquin Air Basin

Table 12 County specific burn cleaner retention factors

County Number	County Name	Hotspot Retention	Non-hotspot Retention
10	Fresno	0.564	1.000
15	Kern	0.635	1.000
16	Kings	0.800	0.900
20	Madera	0.800	0.900
24	Merced	1.000	0.922
39	San Joaquin	1.000	0.812
50	Stanislaus	1.000	0.872
54	Tulare	0.800	0.900

Based on the remaining emissions after the Burn Cleaner reductions are applied, county-specific curtailment is then determined. However, the county-specific curtailment criteria are defined differently for hotspots versus non-hotspots areas. Hotspot areas have curtailment on days where observed $PM_{2.5}$ is greater than or equal to 12 $\mu g/m^3$, prompting the Level 1 measure. If $PM_{2.5}$ hits 35 $\mu g/m^3$, then the Level 2 measure is triggered. For non-hotspot areas, curtailment occurs on days where $PM_{2.5}$ is greater than 20 $\mu g/m^3$, prompting a level 1 measure, or greater than 65 $\mu g/m^3$ prompting a level 2 measure.

For a level 2 curtailment, declared measured emissions were reduced by 97% (i.e. 3% remaining) in the appropriate geographic regions.

Greater reductions due to curtailment are assumed in the future years to reflect increased public awareness and thus greater compliance with district rules. To avoid double-counting emission reductions on curtailment days, the modeling inventories were only grown without the control profile applied. Since emissions from RWC have flat growth, the same reductions are used for all future years (2015 and later).

South Coast

SCAQMD staff provided the dates in 2013 when a residential wood combustion curtailment (RWCC) was declared based on district rule 455. When a RWCC was declared emissions were reduced by 75% (i.e. 25% remaining) in the appropriate geographic regions (see Section 2.3.7). In future years, emissions continued to be reduced by 75%, using the same dates as in 2013.

Sacramento

SMAQMD staff provided the dates in 2013 when a RWCC was declared based on district rule 421. Per this rule, a mandatory curtailment (no burning) is called when:

> Stage 1: the 24-hour average $PM_{2.5}$ concentration may exceed 31 $\mu g/m^3$ but is not likely to exceed 35 $\mu g/m^3$
>
> Stage 2: the 24-hour average $PM_{2.5}$ concentration may exceed 35 $\mu g/m^3$

When a RWC was declared, emissions in Sacramento County (see Section 2.3.7) were reduced as follows:

> For Stage 1: 57% (i.e. 43% remaining)
>
> For Stage 2: 70% (i.e. 30% remaining)

In future years, emissions were continued to be reduced by 57% and 70% for stage 1 and stage 2, respectively. The same calendar dates from 2013 were used in future years.

3.7.6 Estimation of Agricultural Ammonia Emissions:

Ammonia emissions from fertilizers/pesticides (EIC3 530) and livestock (EIC3 620) are separated from the aggregated area source inventory as they are affected by local meteorology. In previous work, a flat temporal profile was assigned to both sectors but due to the dependence on meteorology factors a more realistic approach to temporal representation was needed. For EIC3 530, the depending factors are WRF's two-meter temperature and ten-meter wind speed. For EIC3 620, the factors are WRF's ground temperature and aerodynamic resistance. Through GenTpro these meteorological factors are averaged by county before creating year-long hourly profiles for each of the respective sectors. All algorithms are described in the SMOKE Manual 4.0, while the results of CARB in-house tests are presented by Kwok (2016).

3.7.7 Closed Facilities

Emissions in future years were removed for facilities that have closed beyond the reference 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 2013. Local air district staff members provided the lists of these facilities.

3.8 Application of Control Measure Reduction Factors in San Joaquin Valley

Controls were applied to reduce emissions in the future year attainment modeling inventories for 2020, 2024, and 2025. Control strategies for targeted emissions categories (e.g. charbroiling) are outlined in Sections 3.8.1 to 3.8.2. A summary of the control strategies applied to each future year is described in Sections 3.8.3 and 3.8.4.

3.8.1 Charbroiling

Control strategies to reduce $PM_{2.5}$ emissions from under-fired charbroilers are expected to be achieved by:

- Funding 100% of equipment and installation cost plus two years' operation and maintenance cost of emissions control systems for 30% (Vanderspek, 2017) of existing restaurants with charbroilers within urban boundaries in hot spot areas. (SJVUAPCD, 2017)

- Funding 50% of equipment and installation cost plus two years' (Vanderspek, 2017) operation and maintenance cost of emissions control systems for large new restaurants with charbroilers within urban boundaries of hot spot areas (SJVUAPCD, 2017).

$PM_{2.5}$ reductions are applied to Hot Spot regions as identified in **Error! Reference source not found.**.

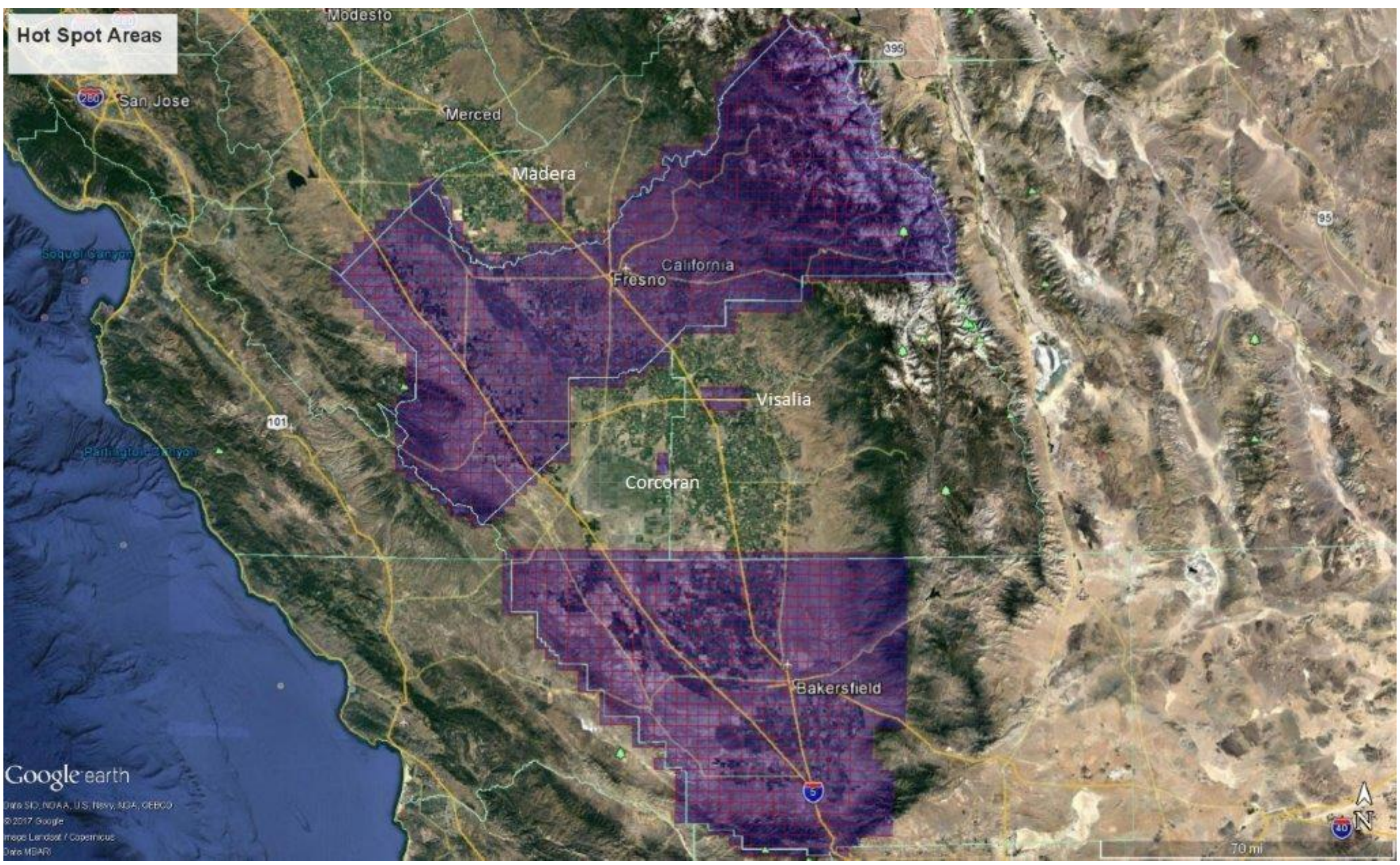

Figure 8 Hot Spot Areas for application of under-fired charbroiling $PM_{2.5}$ reductions.

3.8.2 Residential Wood Combustion

Control strategies to reduce emissions from residential wood combustion (RWC) were applied in accordance with future year curtailment rules described in Section **Error! Reference source not found.**.

3.8.3 Future Year 2020

The only controls applied on top of the projected 2020 inventory emissions were to RWC. Prior to reduction, the RWC emissions were allocated to locations by the new fireplace surrogates. Subsequently, the RWC emissions were reduced according to future year baseline curtailment rules using a compliance rate of 97% (refer to Section **Error! Reference source not found.**).

3.8.4 Future Years 2024 and 2025

Residential Wood Combustion

For future year attainment modeling of 2024 and 2025, RWC emissions are subject to more stringent controls. RWC emissions are reduced per the Burn Cleaner program as explained in Section **Error! Reference source not found.**. The value of the RWC emissions reductions is expected to the same for 2024 and 2025 given the lack of growth in RWC emissions, and the application of the curtailment is the same in both years.

Charbroiling

For both future years 2024 and 2025, emissions from under-fired charbroilers are reduced in Hot Spot regions (described in Section 3.8.1).

Other reductions

In addition to reductions from RWC and charbroiling, control strategies are applied to other sources in order to further reduce NOx and $PM_{2.5}$ emissions in future years 2024 and 2025 (refer to Table Table **13** or a list of these sources).

Table 13 NOx and $PM_{2.5}$ other sources reduced

Reduction Source	**NOx**	**$PM_{2.5}$**
Electrification of ag IC engines (50% reduction)	X	X
Reduce stationary source fuel combustion	X	
Reduce ag equipment	X	X
Reduce off-road equipment	X	
Reduce locomotives	X	
Reduce heavy duty diesel trucks	X	
Reduce flaring operations (20% reduction)	X	
Enhanced conservation management practices (tillage)		X
Enhanced conservation management practices (fallow land)		X
Reduce urban dust in Bakersfield (25% reduction)		X
Reduce woodchips at Bakersfield-Planz monitor (75% reduction)		X

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 CARB staff. Annual and forecasted emissions are carefully reviewed before input into SMOKE. CARB 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 **9** Example of a spatial plot by source categoryFigure 9 are carefully screened for proper spatial distribution of emissions.

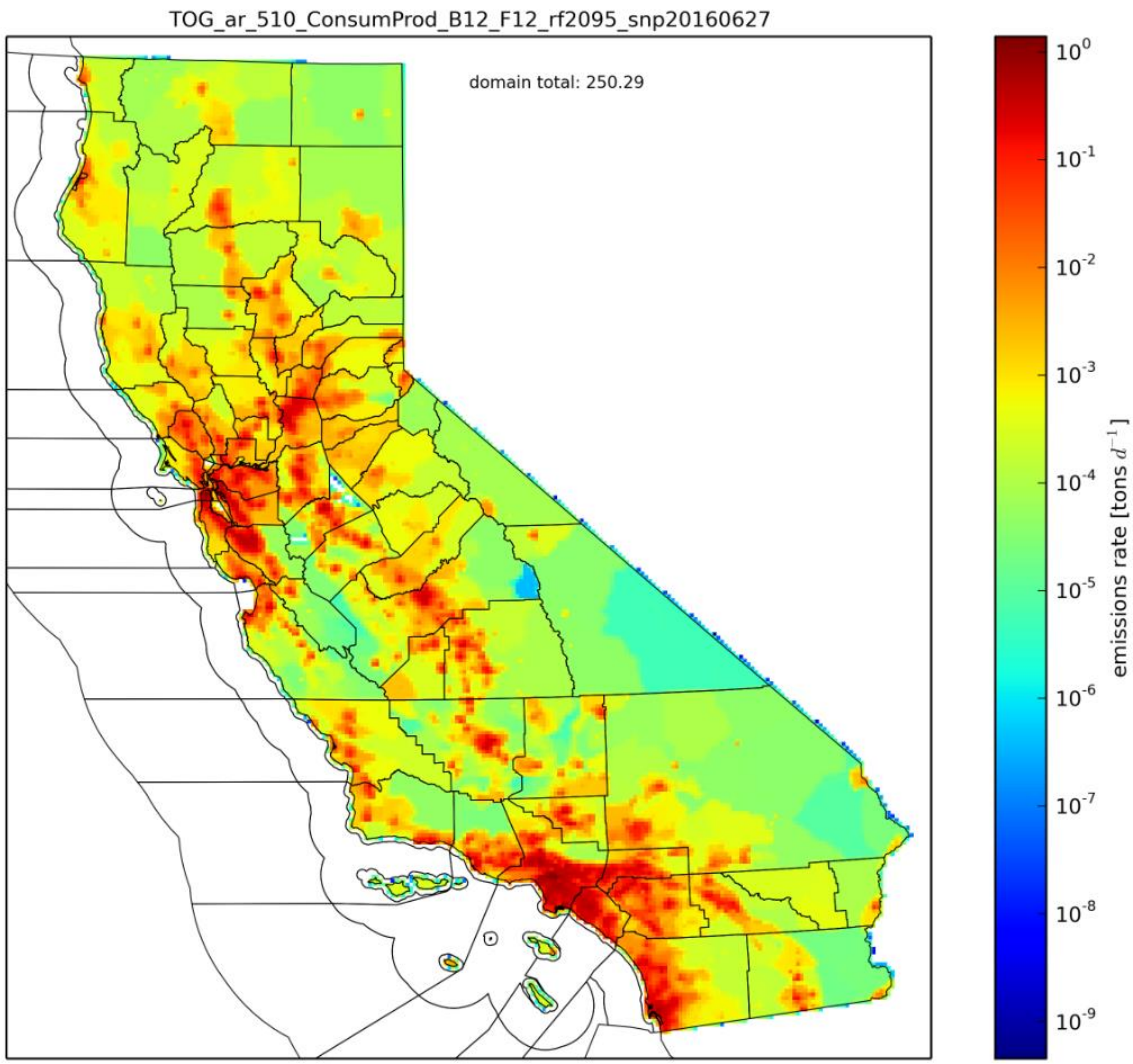

Figure 9 Example of a spatial plot by source category

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. CARB 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 10.

```
# 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 10 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 CARB 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 CARB 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

GIS records for 364 wildfires and 125 prescribed wildland burn events reported for 2013 were downloaded from http://frap.cdf.ca.gov and imported to a geodatabase. Data fields included wildfire or burn project name, burned area, start and end dates. A series of geoprocessing steps were used to map and overlay wildfire and prescribed burn footprint polygons on the statewide vegetation fuels (FCCS) and moisture raster datasets, to retrieve associated fuel loadings and moisture values for use as input to FOFEM. Wildfire and prescribed burn footprint polygons were also overlaid on the statewide 4-km modeling grid to assign grid cell IDs to each wildfire and prescribed burn. Emission estimates for each wildfire and prescribed burn event were generated by FOFEM and summarized in an Access database.

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. The reduction efficiency for unpaved roads is increased to 100% on precipitation days.

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.

4.4 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 11 provides a screen capture of a report that summarizes different emission categories for San Luis Obispo County. Please note that this table is <u>only an example</u> 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 11 Screenshot of comparison of inventories report

Staff also review how modeling emissions vary over a year. Figure 12 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>.

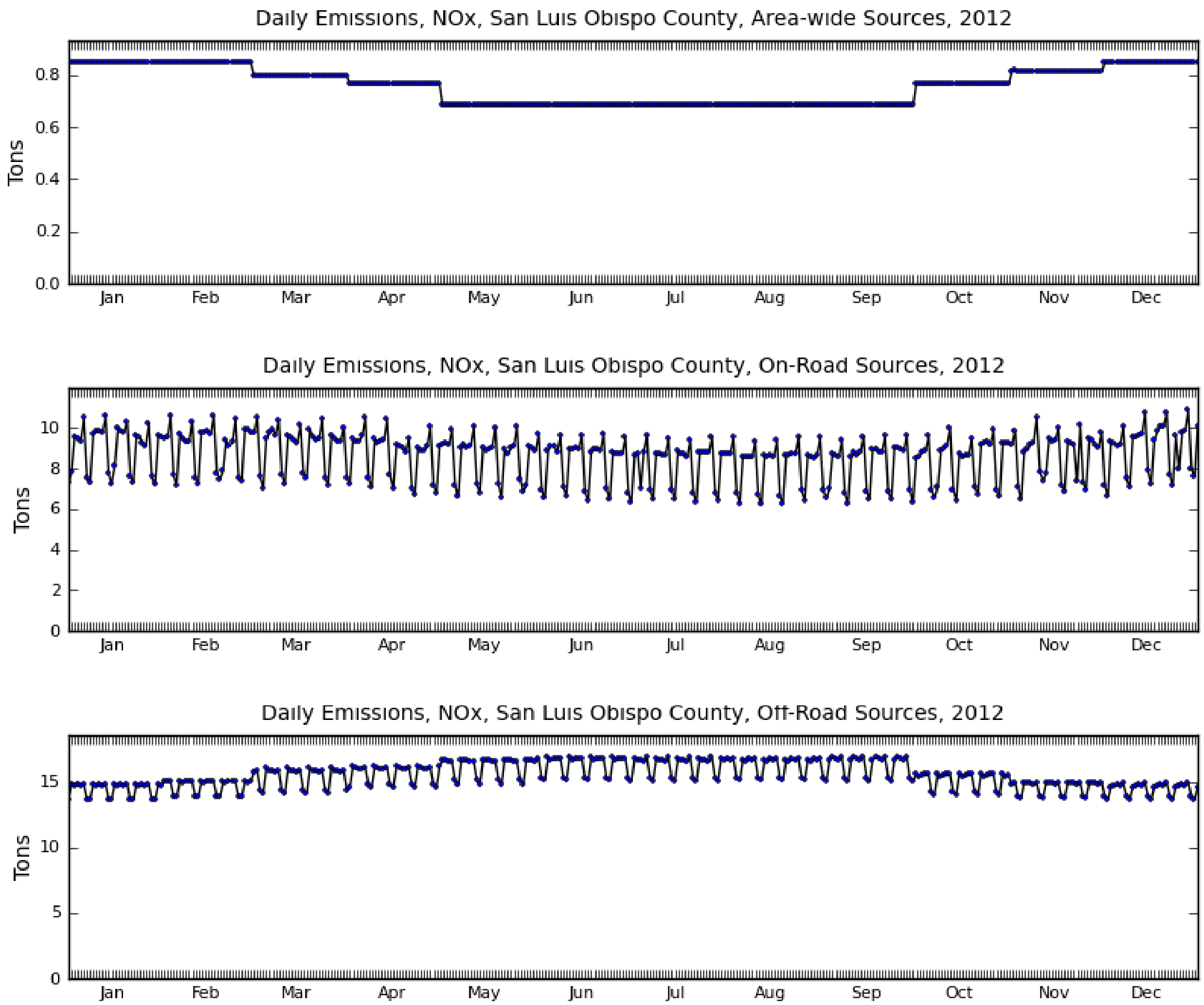

Figure 12 Daily variation of NOx emissions for mobile sources for San Luis Obispo

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 CARB 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 the constituents of each daily model-ready emissions file as an additional means of verifying that each daily model-ready inventory is complete.

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Appendix A: Day of week redistribution factors by vehicle type and county

The factors shown in 13 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 14 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
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
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
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
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

County	Day of Week	LD	LM	HH
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
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
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
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
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
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
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
San Benito	Holiday	1.083	0.755	0.607
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

County	Day of Week	LD	LM	HH
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
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
Solano	Sunday	1.008	0.589	0.36
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
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

County	Day of Week	LD	LM	HH
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

Appendix B: Hour of Day Profiles by vehicle type and county

The factors shown in Table 15 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 15 Hour of Day Profiles by vehicle type and county

		Alameda			Alpine			Amador			Calaveras			Contra Costa			El Dorado			Fresno		
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	0.02	0.041	0.061	0.01	0.014	0.032	0.01	0.014	0.032	0.01	0.014	0.032	0.019	0.038	0.053	0.013	0.02	0.031	0.015	0.033	0.043
Sunday	1	0.013	0.039	0.056	0.007	0.011	0.024	0.007	0.011	0.024	0.007	0.011	0.024	0.012	0.034	0.047	0.008	0.016	0.028	0.01	0.03	0.04
Sunday	2	0.01	0.039	0.052	0.005	0.011	0.022	0.005	0.011	0.022	0.005	0.011	0.022	0.008	0.031	0.043	0.006	0.013	0.026	0.008	0.027	0.037
Sunday	3	0.007	0.038	0.049	0.004	0.01	0.021	0.004	0.01	0.021	0.004	0.01	0.021	0.006	0.03	0.04	0.005	0.012	0.025	0.005	0.025	0.034
Sunday	4	0.007	0.037	0.046	0.004	0.01	0.02	0.004	0.01	0.02	0.004	0.01	0.02	0.006	0.029	0.038	0.005	0.012	0.025	0.006	0.024	0.034
Sunday	5	0.01	0.038	0.044	0.007	0.013	0.021	0.007	0.013	0.021	0.007	0.013	0.021	0.01	0.031	0.038	0.008	0.015	0.027	0.01	0.026	0.034
Sunday	6	0.016	0.038	0.043	0.012	0.019	0.026	0.012	0.019	0.026	0.012	0.019	0.026	0.016	0.033	0.039	0.013	0.02	0.03	0.017	0.029	0.036
Sunday	7	0.022	0.039	0.042	0.019	0.023	0.029	0.019	0.023	0.029	0.019	0.023	0.029	0.023	0.036	0.04	0.022	0.028	0.034	0.022	0.032	0.037
Sunday	8	0.032	0.04	0.041	0.032	0.035	0.038	0.032	0.035	0.038	0.032	0.035	0.038	0.033	0.04	0.042	0.034	0.041	0.04	0.032	0.038	0.04
Sunday	9	0.046	0.043	0.041	0.051	0.051	0.053	0.051	0.051	0.053	0.051	0.051	0.053	0.048	0.046	0.044	0.048	0.055	0.046	0.044	0.046	0.044
Sunday	10	0.059	0.046	0.041	0.067	0.067	0.071	0.067	0.067	0.071	0.067	0.067	0.071	0.062	0.051	0.045	0.064	0.068	0.052	0.055	0.052	0.046
Sunday	11	0.065	0.047	0.039	0.08	0.081	0.085	0.08	0.081	0.085	0.08	0.081	0.085	0.067	0.053	0.046	0.075	0.075	0.055	0.063	0.057	0.047
Sunday	12	0.069	0.048	0.038	0.083	0.081	0.076	0.083	0.081	0.076	0.083	0.081	0.076	0.07	0.054	0.046	0.082	0.079	0.058	0.071	0.062	0.049
Sunday	13	0.071	0.049	0.036	0.085	0.082	0.074	0.085	0.082	0.074	0.085	0.082	0.074	0.073	0.055	0.05	0.084	0.079	0.058	0.076	0.064	0.049
Sunday	14	0.072	0.049	0.035	0.085	0.083	0.069	0.085	0.083	0.069	0.085	0.083	0.069	0.073	0.055	0.047	0.084	0.077	0.057	0.077	0.063	0.048
Sunday	15	0.071	0.049	0.034	0.084	0.081	0.066	0.084	0.081	0.066	0.084	0.081	0.066	0.073	0.053	0.041	0.082	0.073	0.057	0.077	0.061	0.047
Sunday	16	0.07	0.048	0.033	0.082	0.079	0.06	0.082	0.079	0.06	0.082	0.079	0.06	0.072	0.052	0.039	0.079	0.068	0.055	0.075	0.059	0.046
Sunday	17	0.069	0.048	0.034	0.076	0.07	0.053	0.076	0.07	0.053	0.076	0.07	0.053	0.07	0.05	0.038	0.072	0.062	0.053	0.073	0.056	0.045
Sunday	18	0.063	0.045	0.033	0.064	0.056	0.043	0.064	0.056	0.043	0.064	0.056	0.043	0.063	0.047	0.036	0.06	0.052	0.049	0.066	0.05	0.044
Sunday	19	0.057	0.043	0.035	0.049	0.043	0.035	0.049	0.043	0.035	0.049	0.043	0.035	0.056	0.044	0.035	0.05	0.043	0.045	0.057	0.044	0.042
Sunday	20	0.052	0.041	0.036	0.038	0.033	0.024	0.038	0.033	0.024	0.038	0.033	0.024	0.051	0.041	0.036	0.041	0.035	0.042	0.05	0.038	0.041
Sunday	21	0.045	0.037	0.039	0.026	0.022	0.02	0.026	0.022	0.02	0.026	0.022	0.02	0.042	0.038	0.037	0.031	0.026	0.039	0.04	0.033	0.04
Sunday	22	0.033	0.032	0.043	0.017	0.014	0.017	0.017	0.014	0.017	0.017	0.014	0.017	0.03	0.032	0.039	0.021	0.019	0.036	0.03	0.028	0.04
Sunday	23	0.021	0.027	0.049	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.02	0.019	0.027	0.043	0.013	0.015	0.033	0.02	0.023	0.039
Monday	0	0.009	0.026	0.032	0.006	0.01	0.017	0.006	0.01	0.017	0.006	0.01	0.017	0.007	0.023	0.029	0.008	0.014	0.027	0.009	0.019	0.024
Monday	1	0.004	0.027	0.032	0.004	0.009	0.016	0.004	0.009	0.016	0.004	0.009	0.016	0.003	0.022	0.028	0.005	0.012	0.025	0.005	0.018	0.023
Monday	2	0.003	0.028	0.033	0.003	0.009	0.016	0.003	0.009	0.016	0.003	0.009	0.016	0.002	0.022	0.029	0.004	0.012	0.025	0.004	0.018	0.023
Monday	3	0.005	0.03	0.035	0.005	0.011	0.019	0.005	0.011	0.019	0.005	0.011	0.019	0.003	0.023	0.03	0.006	0.014	0.027	0.005	0.02	0.025
Monday	4	0.014	0.033	0.039	0.008	0.017	0.024	0.008	0.017	0.024	0.008	0.017	0.024	0.012	0.028	0.035	0.011	0.019	0.03	0.011	0.023	0.027
Monday	5	0.034	0.039	0.044	0.019	0.028	0.036	0.019	0.028	0.036	0.019	0.028	0.036	0.033	0.041	0.042	0.023	0.03	0.036	0.024	0.034	0.033
Monday	6	0.051	0.046	0.048	0.036	0.041	0.05	0.036	0.041	0.05	0.036	0.041	0.05	0.054	0.051	0.048	0.042	0.047	0.043	0.044	0.047	0.041
Monday	7	0.064	0.053	0.052	0.051	0.044	0.065	0.051	0.044	0.065	0.051	0.044	0.065	0.066	0.058	0.053	0.06	0.061	0.048	0.069	0.064	0.048
Monday	8	0.064	0.055	0.053	0.053	0.056	0.068	0.053	0.056	0.068	0.053	0.056	0.068	0.062	0.06	0.055	0.059	0.062	0.05	0.063	0.062	0.049
Monday	9	0.058	0.054	0.054	0.059	0.065	0.08	0.059	0.065	0.08	0.059	0.065	0.08	0.055	0.056	0.054	0.056	0.061	0.05	0.055	0.056	0.047
Monday	10	0.053	0.053	0.054	0.067	0.074	0.087	0.067	0.074	0.087	0.067	0.074	0.087	0.052	0.054	0.053	0.058	0.064	0.051	0.055	0.056	0.048
Monday	11	0.051	0.054	0.054	0.071	0.075	0.082	0.071	0.075	0.082	0.071	0.075	0.082	0.053	0.055	0.054	0.062	0.066	0.053	0.057	0.059	0.05
Monday	12	0.052	0.056	0.054	0.074	0.074	0.08	0.074	0.074	0.08	0.074	0.074	0.08	0.054	0.056	0.054	0.066	0.068	0.054	0.061	0.061	0.052
Monday	13	0.054	0.057	0.054	0.074	0.075	0.075	0.074	0.075	0.075	0.074	0.075	0.075	0.056	0.056	0.054	0.067	0.067	0.054	0.063	0.062	0.054
Monday	14	0.061	0.059	0.053	0.077	0.076	0.065	0.077	0.076	0.065	0.077	0.076	0.065	0.063	0.059	0.056	0.07	0.069	0.055	0.069	0.065	0.056
Monday	15	0.066	0.059	0.051	0.082	0.076	0.058	0.082	0.076	0.058	0.082	0.076	0.058	0.069	0.063	0.058	0.073	0.069	0.055	0.074	0.068	0.058

		Alameda			Alpine			Amador			Calaveras			Contra Costa			El Dorado			Fresno		
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	16	0.069	0.057	0.048	0.081	0.073	0.045	0.081	0.073	0.045	0.081	0.073	0.045	0.072	0.06	0.052	0.075	0.067	0.054	0.079	0.068	0.059
Monday	17	0.07	0.053	0.044	0.071	0.059	0.035	0.071	0.059	0.035	0.071	0.059	0.035	0.073	0.056	0.047	0.073	0.061	0.052	0.076	0.062	0.057
Monday	18	0.062	0.045	0.037	0.052	0.042	0.023	0.052	0.042	0.023	0.052	0.042	0.023	0.061	0.045	0.039	0.056	0.046	0.045	0.053	0.043	0.05
Monday	19	0.048	0.035	0.031	0.037	0.03	0.017	0.037	0.03	0.017	0.037	0.03	0.017	0.045	0.033	0.031	0.04	0.031	0.039	0.037	0.03	0.043
Monday	20	0.036	0.028	0.026	0.027	0.022	0.013	0.027	0.022	0.013	0.027	0.022	0.013	0.035	0.026	0.026	0.031	0.022	0.035	0.03	0.023	0.039
Monday	21	0.031	0.022	0.023	0.02	0.016	0.01	0.02	0.016	0.01	0.02	0.016	0.01	0.031	0.022	0.024	0.025	0.017	0.032	0.024	0.018	0.035
Monday	22	0.024	0.018	0.023	0.015	0.012	0.009	0.015	0.012	0.009	0.015	0.012	0.009	0.023	0.017	0.023	0.017	0.012	0.03	0.018	0.013	0.032
Monday	23	0.016	0.015	0.025	0.009	0.007	0.01	0.009	0.007	0.01	0.009	0.007	0.01	0.014	0.014	0.025	0.012	0.009	0.03	0.012	0.01	0.029
Tues/Wed/Thurs	0	0.008	0.026	0.034	0.005	0.009	0.017	0.005	0.009	0.017	0.005	0.009	0.017	0.006	0.022	0.031	0.008	0.014	0.029	0.007	0.018	0.027
Tues/Wed/Thurs	1	0.004	0.027	0.034	0.003	0.008	0.017	0.003	0.008	0.017	0.003	0.008	0.017	0.003	0.021	0.03	0.004	0.011	0.027	0.004	0.017	0.027
Tues/Wed/Thurs	2	0.003	0.028	0.035	0.002	0.009	0.017	0.002	0.009	0.017	0.002	0.009	0.017	0.002	0.021	0.03	0.004	0.011	0.027	0.003	0.017	0.027
Tues/Wed/Thurs	3	0.005	0.03	0.037	0.003	0.01	0.022	0.003	0.01	0.022	0.003	0.01	0.022	0.003	0.023	0.031	0.005	0.013	0.029	0.004	0.019	0.028
Tues/Wed/Thurs	4	0.014	0.034	0.041	0.006	0.014	0.025	0.006	0.014	0.025	0.006	0.014	0.025	0.011	0.028	0.036	0.01	0.018	0.031	0.009	0.023	0.031
Tues/Wed/Thurs	5	0.035	0.04	0.046	0.018	0.027	0.039	0.018	0.027	0.039	0.018	0.027	0.039	0.034	0.04	0.044	0.022	0.029	0.037	0.024	0.032	0.036
Tues/Wed/Thurs	6	0.055	0.047	0.05	0.037	0.042	0.052	0.037	0.042	0.052	0.037	0.042	0.052	0.056	0.052	0.049	0.042	0.047	0.044	0.044	0.047	0.044
Tues/Wed/Thurs	7	0.067	0.054	0.053	0.053	0.047	0.064	0.053	0.047	0.064	0.053	0.047	0.064	0.068	0.059	0.054	0.06	0.061	0.05	0.07	0.064	0.051
Tues/Wed/Thurs	8	0.064	0.056	0.054	0.054	0.056	0.07	0.054	0.056	0.07	0.054	0.056	0.07	0.063	0.06	0.056	0.06	0.062	0.051	0.065	0.063	0.051
Tues/Wed/Thurs	9	0.057	0.054	0.055	0.059	0.068	0.083	0.059	0.068	0.083	0.059	0.068	0.083	0.055	0.055	0.053	0.055	0.06	0.05	0.055	0.057	0.049
Tues/Wed/Thurs	10	0.051	0.053	0.054	0.064	0.069	0.081	0.064	0.069	0.081	0.064	0.069	0.081	0.051	0.053	0.052	0.056	0.061	0.051	0.054	0.056	0.05
Tues/Wed/Thurs	11	0.049	0.054	0.054	0.068	0.069	0.077	0.068	0.069	0.077	0.068	0.069	0.077	0.05	0.054	0.052	0.059	0.064	0.052	0.055	0.058	0.051
Tues/Wed/Thurs	12	0.05	0.055	0.054	0.069	0.071	0.074	0.069	0.071	0.074	0.069	0.071	0.074	0.052	0.055	0.053	0.061	0.065	0.053	0.058	0.06	0.051
Tues/Wed/Thurs	13	0.053	0.056	0.053	0.072	0.073	0.074	0.072	0.073	0.074	0.072	0.073	0.074	0.054	0.056	0.054	0.064	0.066	0.053	0.061	0.062	0.053
Tues/Wed/Thurs	14	0.06	0.058	0.052	0.077	0.076	0.067	0.077	0.076	0.067	0.077	0.076	0.067	0.062	0.059	0.054	0.068	0.068	0.053	0.068	0.065	0.054
Tues/Wed/Thurs	15	0.064	0.058	0.05	0.084	0.078	0.058	0.084	0.078	0.058	0.084	0.078	0.058	0.067	0.063	0.056	0.073	0.069	0.053	0.074	0.067	0.056
Tues/Wed/Thurs	16	0.067	0.056	0.047	0.082	0.074	0.048	0.082	0.074	0.048	0.082	0.074	0.048	0.07	0.06	0.051	0.075	0.067	0.052	0.08	0.067	0.056
Tues/Wed/Thurs	17	0.067	0.052	0.042	0.074	0.061	0.036	0.074	0.061	0.036	0.074	0.061	0.036	0.071	0.057	0.046	0.074	0.063	0.05	0.078	0.063	0.054
Tues/Wed/Thurs	18	0.061	0.044	0.036	0.053	0.044	0.023	0.053	0.044	0.023	0.053	0.044	0.023	0.062	0.047	0.039	0.059	0.048	0.044	0.055	0.045	0.047
Tues/Wed/Thurs	19	0.05	0.035	0.03	0.038	0.031	0.016	0.038	0.031	0.016	0.038	0.031	0.016	0.048	0.035	0.031	0.043	0.034	0.038	0.039	0.032	0.04
Tues/Wed/Thurs	20	0.038	0.027	0.025	0.03	0.025	0.012	0.03	0.025	0.012	0.03	0.025	0.012	0.038	0.027	0.026	0.035	0.025	0.034	0.032	0.024	0.035
Tues/Wed/Thurs	21	0.033	0.022	0.022	0.023	0.018	0.01	0.023	0.018	0.01	0.023	0.018	0.01	0.033	0.022	0.024	0.029	0.019	0.031	0.027	0.019	0.032
Tues/Wed/Thurs	22	0.026	0.017	0.022	0.017	0.013	0.01	0.017	0.013	0.01	0.017	0.013	0.01	0.024	0.017	0.022	0.02	0.013	0.029	0.02	0.014	0.028
Tues/Wed/Thurs	23	0.016	0.014	0.023	0.01	0.008	0.01	0.01	0.008	0.01	0.01	0.008	0.01	0.015	0.013	0.024	0.013	0.009	0.028	0.013	0.01	0.025
Friday	0	0.009	0.027	0.036	0.005	0.009	0.019	0.005	0.009	0.019	0.005	0.009	0.019	0.008	0.022	0.033	0.007	0.014	0.032	0.007	0.019	0.03
Friday	1	0.005	0.028	0.037	0.003	0.008	0.019	0.003	0.008	0.019	0.003	0.008	0.019	0.004	0.021	0.031	0.005	0.011	0.03	0.004	0.018	0.03
Friday	2	0.004	0.029	0.038	0.002	0.008	0.019	0.002	0.008	0.019	0.002	0.008	0.019	0.003	0.022	0.032	0.004	0.011	0.03	0.003	0.017	0.029
Friday	3	0.005	0.031	0.039	0.002	0.008	0.021	0.002	0.008	0.021	0.002	0.008	0.021	0.004	0.023	0.033	0.005	0.012	0.03	0.004	0.019	0.031
Friday	4	0.013	0.034	0.043	0.005	0.013	0.024	0.005	0.013	0.024	0.005	0.013	0.024	0.01	0.028	0.036	0.008	0.016	0.033	0.009	0.023	0.034
Friday	5	0.032	0.04	0.048	0.013	0.023	0.037	0.013	0.023	0.037	0.013	0.023	0.037	0.03	0.039	0.044	0.017	0.026	0.038	0.02	0.032	0.039
Friday	6	0.049	0.046	0.052	0.026	0.035	0.049	0.026	0.035	0.049	0.026	0.035	0.049	0.05	0.049	0.05	0.033	0.04	0.045	0.037	0.044	0.046
Friday	7	0.06	0.052	0.055	0.039	0.04	0.06	0.039	0.04	0.06	0.039	0.04	0.06	0.063	0.057	0.055	0.049	0.054	0.05	0.059	0.06	0.053
Friday	8	0.059	0.054	0.056	0.043	0.049	0.068	0.043	0.049	0.068	0.043	0.049	0.068	0.059	0.057	0.056	0.051	0.057	0.052	0.057	0.059	0.053
Friday	9	0.054	0.053	0.056	0.049	0.057	0.073	0.049	0.057	0.073	0.049	0.057	0.073	0.053	0.054	0.054	0.05	0.057	0.052	0.052	0.056	0.052
Friday	10	0.051	0.053	0.056	0.058	0.063	0.078	0.058	0.063	0.078	0.058	0.063	0.078	0.051	0.053	0.053	0.054	0.061	0.054	0.053	0.057	0.052
Friday	11	0.052	0.055	0.055	0.064	0.069	0.077	0.064	0.069	0.077	0.064	0.069	0.077	0.053	0.055	0.054	0.06	0.066	0.055	0.056	0.059	0.053
Friday	12	0.054	0.056	0.055	0.066	0.071	0.076	0.066	0.071	0.076	0.066	0.071	0.076	0.056	0.057	0.055	0.063	0.067	0.055	0.059	0.061	0.053
Friday	13	0.056	0.057	0.054	0.071	0.074	0.077	0.071	0.074	0.077	0.071	0.074	0.077	0.058	0.058	0.056	0.066	0.068	0.054	0.062	0.063	0.054
Friday	14	0.061	0.058	0.052	0.076	0.077	0.07	0.076	0.077	0.07	0.076	0.077	0.07	0.064	0.059	0.056	0.07	0.07	0.054	0.068	0.066	0.055
Friday	15	0.063	0.058	0.049	0.083	0.079	0.06	0.083	0.079	0.06	0.083	0.079	0.06	0.066	0.062	0.056	0.073	0.07	0.052	0.073	0.067	0.055
Friday	16	0.064	0.055	0.045	0.083	0.077	0.05	0.083	0.077	0.05	0.083	0.077	0.05	0.067	0.059	0.05	0.074	0.067	0.05	0.077	0.067	0.053
Friday	17	0.064	0.051	0.04	0.075	0.064	0.038	0.075	0.064	0.038	0.075	0.064	0.038	0.067	0.055	0.046	0.072	0.063	0.047	0.074	0.061	0.05
Friday	18	0.059	0.044	0.034	0.062	0.051	0.025	0.062	0.051	0.025	0.062	0.051	0.025	0.06	0.047	0.039	0.063	0.051	0.042	0.06	0.047	0.043
Friday	19	0.052	0.035	0.027	0.05	0.039	0.018	0.05	0.039	0.018	0.05	0.039	0.018	0.049	0.036	0.03	0.05	0.039	0.035	0.046	0.034	0.036
Friday	20	0.042	0.028	0.022	0.041	0.03	0.013	0.041	0.03	0.013	0.041	0.03	0.013	0.04	0.029	0.023	0.041	0.029	0.03	0.038	0.026	0.03
Friday	21	0.036	0.023	0.019	0.036	0.025	0.01	0.036	0.025	0.01	0.036	0.025	0.01	0.035	0.023	0.02	0.037	0.023	0.028	0.034	0.02	0.026
Friday	22	0.032	0.019	0.017	0.03	0.019	0.011	0.03	0.019	0.011	0.03	0.019	0.011	0.03	0.019	0.019	0.03	0.017	0.026	0.028	0.015	0.023

		Alameda			Alpine			Amador			Calaveras			Contra Costa			El Dorado			Fresno		
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	23	0.023	0.015	0.018	0.018	0.012	0.009	0.018	0.012	0.009	0.018	0.012	0.009	0.022	0.015	0.02	0.019	0.011	0.024	0.02	0.011	0.02
Saturday	0	0.016	0.033	0.052	0.01	0.015	0.027	0.01	0.015	0.027	0.01	0.015	0.027	0.015	0.03	0.044	0.013	0.019	0.038	0.015	0.028	0.041
Saturday	1	0.01	0.033	0.051	0.007	0.012	0.023	0.007	0.012	0.023	0.007	0.012	0.023	0.009	0.027	0.04	0.008	0.015	0.034	0.01	0.025	0.038
Saturday	2	0.008	0.033	0.049	0.005	0.011	0.022	0.005	0.011	0.022	0.005	0.011	0.022	0.006	0.026	0.039	0.006	0.014	0.032	0.008	0.024	0.037
Saturday	3	0.006	0.034	0.048	0.004	0.01	0.025	0.004	0.01	0.025	0.004	0.01	0.025	0.005	0.025	0.037	0.006	0.013	0.031	0.006	0.023	0.036
Saturday	4	0.008	0.035	0.048	0.005	0.013	0.028	0.005	0.013	0.028	0.005	0.013	0.028	0.006	0.027	0.037	0.007	0.014	0.032	0.009	0.024	0.037
Saturday	5	0.014	0.037	0.049	0.01	0.021	0.034	0.01	0.021	0.034	0.01	0.021	0.034	0.013	0.03	0.04	0.011	0.018	0.034	0.016	0.029	0.04
Saturday	6	0.023	0.039	0.05	0.017	0.028	0.039	0.017	0.028	0.039	0.017	0.028	0.039	0.023	0.035	0.042	0.019	0.026	0.039	0.026	0.036	0.045
Saturday	7	0.033	0.041	0.051	0.029	0.036	0.053	0.029	0.036	0.053	0.029	0.036	0.053	0.034	0.041	0.047	0.032	0.038	0.046	0.036	0.043	0.049
Saturday	8	0.045	0.044	0.052	0.044	0.045	0.06	0.044	0.045	0.06	0.044	0.045	0.06	0.046	0.047	0.049	0.045	0.051	0.052	0.045	0.05	0.052
Saturday	9	0.054	0.047	0.052	0.059	0.061	0.071	0.059	0.061	0.071	0.059	0.061	0.071	0.055	0.051	0.05	0.057	0.062	0.056	0.053	0.055	0.054
Saturday	10	0.06	0.05	0.051	0.073	0.074	0.078	0.073	0.074	0.078	0.073	0.074	0.078	0.061	0.054	0.051	0.067	0.071	0.06	0.06	0.061	0.056
Saturday	11	0.064	0.052	0.05	0.081	0.077	0.083	0.081	0.077	0.083	0.081	0.077	0.083	0.065	0.056	0.052	0.074	0.076	0.061	0.066	0.064	0.056
Saturday	12	0.066	0.053	0.048	0.078	0.077	0.075	0.078	0.077	0.075	0.078	0.077	0.075	0.066	0.058	0.055	0.075	0.075	0.06	0.069	0.065	0.056
Saturday	13	0.066	0.053	0.045	0.075	0.072	0.06	0.075	0.072	0.06	0.075	0.072	0.06	0.067	0.059	0.058	0.075	0.074	0.057	0.069	0.063	0.054
Saturday	14	0.066	0.053	0.042	0.075	0.068	0.055	0.075	0.068	0.055	0.075	0.068	0.055	0.067	0.058	0.057	0.074	0.071	0.055	0.07	0.063	0.053
Saturday	15	0.066	0.053	0.04	0.075	0.068	0.052	0.075	0.068	0.052	0.075	0.068	0.052	0.068	0.057	0.051	0.072	0.068	0.051	0.069	0.06	0.049
Saturday	16	0.065	0.051	0.037	0.072	0.07	0.047	0.072	0.07	0.047	0.072	0.07	0.047	0.068	0.056	0.047	0.07	0.064	0.048	0.067	0.057	0.046
Saturday	17	0.065	0.05	0.034	0.066	0.063	0.04	0.066	0.063	0.04	0.066	0.063	0.04	0.067	0.054	0.044	0.066	0.057	0.044	0.063	0.051	0.042
Saturday	18	0.06	0.046	0.031	0.058	0.052	0.031	0.058	0.052	0.031	0.058	0.052	0.031	0.06	0.048	0.036	0.056	0.047	0.038	0.056	0.044	0.036
Saturday	19	0.05	0.041	0.028	0.047	0.041	0.026	0.047	0.041	0.026	0.047	0.041	0.026	0.049	0.041	0.029	0.046	0.037	0.033	0.047	0.036	0.031
Saturday	20	0.043	0.036	0.025	0.038	0.031	0.02	0.038	0.031	0.02	0.038	0.031	0.02	0.043	0.036	0.025	0.04	0.03	0.028	0.041	0.031	0.027
Saturday	21	0.042	0.033	0.024	0.031	0.025	0.016	0.031	0.025	0.016	0.031	0.025	0.016	0.041	0.033	0.024	0.035	0.025	0.025	0.038	0.027	0.023
Saturday	22	0.039	0.029	0.023	0.025	0.02	0.018	0.025	0.02	0.018	0.025	0.02	0.018	0.037	0.029	0.023	0.028	0.019	0.023	0.034	0.024	0.021
Saturday	23	0.029	0.025	0.023	0.016	0.013	0.018	0.016	0.013	0.018	0.016	0.013	0.018	0.028	0.024	0.022	0.02	0.014	0.021	0.024	0.019	0.019
Holiday	0	0.015	0.028	0.035	0.008	0.011	0.02	0.008	0.011	0.02	0.008	0.011	0.02	0.013	0.027	0.034	0.01	0.016	0.028	0.013	0.023	0.029
Holiday	1	0.008	0.029	0.035	0.005	0.009	0.018	0.005	0.009	0.018	0.005	0.009	0.018	0.007	0.026	0.033	0.006	0.013	0.027	0.007	0.022	0.027
Holiday	2	0.006	0.031	0.036	0.003	0.01	0.018	0.003	0.01	0.018	0.003	0.01	0.018	0.004	0.025	0.033	0.004	0.012	0.026	0.005	0.022	0.027
Holiday	3	0.005	0.032	0.037	0.004	0.01	0.021	0.004	0.01	0.021	0.004	0.01	0.021	0.003	0.025	0.033	0.005	0.013	0.027	0.004	0.021	0.028
Holiday	4	0.009	0.035	0.04	0.005	0.012	0.02	0.005	0.012	0.02	0.005	0.012	0.02	0.007	0.029	0.035	0.008	0.016	0.029	0.008	0.024	0.03
Holiday	5	0.019	0.037	0.043	0.009	0.018	0.031	0.009	0.018	0.031	0.009	0.018	0.031	0.017	0.034	0.039	0.014	0.023	0.032	0.016	0.031	0.034
Holiday	6	0.029	0.042	0.045	0.018	0.023	0.038	0.018	0.023	0.038	0.018	0.023	0.038	0.029	0.04	0.044	0.025	0.033	0.036	0.028	0.039	0.038
Holiday	7	0.038	0.046	0.048	0.029	0.031	0.043	0.029	0.031	0.043	0.029	0.031	0.043	0.038	0.045	0.047	0.036	0.044	0.042	0.04	0.046	0.041
Holiday	8	0.046	0.049	0.051	0.041	0.044	0.056	0.041	0.044	0.056	0.041	0.044	0.056	0.045	0.05	0.051	0.046	0.053	0.048	0.045	0.049	0.043
Holiday	9	0.049	0.05	0.052	0.058	0.057	0.075	0.058	0.057	0.075	0.058	0.057	0.075	0.049	0.053	0.052	0.054	0.059	0.05	0.049	0.052	0.047
Holiday	10	0.055	0.053	0.053	0.076	0.083	0.087	0.076	0.083	0.087	0.076	0.083	0.087	0.056	0.056	0.053	0.065	0.069	0.053	0.057	0.059	0.049
Holiday	11	0.06	0.056	0.054	0.084	0.086	0.088	0.084	0.086	0.088	0.084	0.086	0.088	0.062	0.059	0.055	0.074	0.074	0.057	0.065	0.063	0.051
Holiday	12	0.064	0.058	0.055	0.085	0.087	0.089	0.085	0.087	0.089	0.085	0.087	0.089	0.067	0.061	0.056	0.077	0.074	0.056	0.07	0.067	0.054
Holiday	13	0.066	0.059	0.054	0.083	0.081	0.078	0.083	0.081	0.078	0.083	0.081	0.078	0.07	0.062	0.056	0.076	0.074	0.058	0.072	0.067	0.056
Holiday	14	0.069	0.06	0.053	0.08	0.074	0.068	0.08	0.074	0.068	0.08	0.074	0.068	0.073	0.062	0.057	0.075	0.073	0.056	0.074	0.066	0.055
Holiday	15	0.069	0.058	0.051	0.078	0.074	0.06	0.078	0.074	0.06	0.078	0.074	0.06	0.071	0.061	0.054	0.074	0.07	0.055	0.076	0.067	0.056
Holiday	16	0.068	0.056	0.047	0.078	0.072	0.049	0.078	0.072	0.049	0.078	0.072	0.049	0.07	0.057	0.05	0.072	0.066	0.054	0.076	0.064	0.055
Holiday	17	0.066	0.051	0.043	0.071	0.066	0.041	0.071	0.066	0.041	0.071	0.066	0.041	0.067	0.053	0.044	0.068	0.059	0.051	0.072	0.058	0.052
Holiday	18	0.06	0.044	0.037	0.057	0.049	0.033	0.057	0.049	0.033	0.057	0.049	0.033	0.059	0.045	0.038	0.057	0.049	0.045	0.058	0.046	0.049
Holiday	19	0.052	0.036	0.031	0.043	0.04	0.022	0.043	0.04	0.022	0.043	0.04	0.022	0.051	0.036	0.031	0.047	0.036	0.041	0.047	0.035	0.043
Holiday	20	0.046	0.03	0.027	0.033	0.026	0.013	0.033	0.026	0.013	0.033	0.026	0.013	0.046	0.031	0.028	0.039	0.029	0.037	0.039	0.028	0.04
Holiday	21	0.042	0.025	0.024	0.024	0.018	0.011	0.024	0.018	0.011	0.024	0.018	0.011	0.041	0.026	0.026	0.03	0.02	0.033	0.032	0.022	0.036
Holiday	22	0.035	0.02	0.024	0.017	0.012	0.009	0.017	0.012	0.009	0.017	0.012	0.009	0.033	0.021	0.025	0.023	0.015	0.031	0.026	0.017	0.032
Holiday	23	0.024	0.016	0.026	0.01	0.008	0.01	0.01	0.008	0.01	0.01	0.008	0.01	0.021	0.017	0.026	0.015	0.01	0.029	0.018	0.013	0.029

		Glenn			Inyo			Kern			Kings			Los Angeles			Madera			Mariposa		
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	0.015	0.01	0.015	0.01	0.014	0.032	0.014	0.028	0.041	0.016	0.031	0.042	0.025	0.043	0.051	0.014	0.037	0.044	0.01	0.014	0.032
Sunday	1	0.01	0.006	0.011	0.007	0.011	0.024	0.01	0.024	0.038	0.01	0.025	0.038	0.018	0.033	0.044	0.008	0.032	0.04	0.007	0.011	0.024
Sunday	2	0.007	0.004	0.012	0.005	0.011	0.022	0.007	0.022	0.034	0.007	0.026	0.036	0.014	0.028	0.04	0.005	0.028	0.037	0.005	0.011	0.022
Sunday	3	0.006	0.004	0.012	0.004	0.01	0.021	0.006	0.02	0.033	0.005	0.022	0.031	0.009	0.022	0.035	0.004	0.026	0.035	0.004	0.01	0.021
Sunday	4	0.006	0.005	0.017	0.004	0.01	0.02	0.007	0.021	0.033	0.004	0.02	0.031	0.008	0.021	0.034	0.004	0.025	0.034	0.004	0.01	0.02
Sunday	5	0.01	0.011	0.029	0.007	0.013	0.021	0.012	0.024	0.033	0.008	0.023	0.031	0.012	0.024	0.035	0.009	0.027	0.034	0.007	0.013	0.021
Sunday	6	0.016	0.017	0.037	0.012	0.019	0.026	0.016	0.027	0.034	0.018	0.029	0.036	0.018	0.029	0.037	0.016	0.03	0.036	0.012	0.019	0.026
Sunday	7	0.023	0.029	0.051	0.019	0.023	0.029	0.024	0.032	0.035	0.023	0.03	0.035	0.025	0.034	0.039	0.022	0.033	0.036	0.019	0.023	0.029
Sunday	8	0.033	0.043	0.071	0.032	0.035	0.038	0.032	0.039	0.038	0.034	0.04	0.04	0.035	0.04	0.042	0.033	0.039	0.04	0.032	0.035	0.038
Sunday	9	0.047	0.063	0.091	0.051	0.051	0.053	0.042	0.045	0.04	0.048	0.049	0.046	0.047	0.05	0.045	0.046	0.047	0.044	0.051	0.051	0.053
Sunday	10	0.057	0.075	0.084	0.067	0.067	0.071	0.051	0.051	0.042	0.059	0.057	0.049	0.057	0.056	0.047	0.056	0.052	0.046	0.067	0.067	0.071
Sunday	11	0.067	0.083	0.079	0.08	0.081	0.085	0.059	0.056	0.045	0.071	0.064	0.052	0.062	0.059	0.047	0.065	0.057	0.048	0.08	0.081	0.085
Sunday	12	0.074	0.09	0.07	0.083	0.081	0.076	0.066	0.06	0.046	0.084	0.077	0.057	0.065	0.06	0.047	0.071	0.059	0.049	0.083	0.081	0.076
Sunday	13	0.078	0.089	0.061	0.085	0.082	0.074	0.071	0.063	0.047	0.083	0.077	0.056	0.068	0.06	0.046	0.073	0.059	0.049	0.085	0.082	0.074
Sunday	14	0.079	0.081	0.057	0.085	0.083	0.069	0.075	0.065	0.047	0.08	0.072	0.055	0.068	0.058	0.044	0.076	0.059	0.048	0.085	0.083	0.069
Sunday	15	0.08	0.079	0.053	0.084	0.081	0.066	0.078	0.064	0.048	0.076	0.065	0.052	0.067	0.055	0.043	0.076	0.058	0.047	0.084	0.081	0.066
Sunday	16	0.079	0.075	0.045	0.082	0.079	0.06	0.077	0.063	0.048	0.074	0.062	0.05	0.065	0.052	0.042	0.077	0.058	0.047	0.082	0.079	0.06
Sunday	17	0.075	0.066	0.043	0.076	0.07	0.053	0.074	0.06	0.047	0.068	0.056	0.046	0.063	0.049	0.04	0.074	0.055	0.046	0.076	0.07	0.053
Sunday	18	0.066	0.054	0.039	0.064	0.056	0.043	0.069	0.055	0.046	0.059	0.044	0.042	0.059	0.045	0.04	0.068	0.048	0.043	0.064	0.056	0.043
Sunday	19	0.055	0.042	0.037	0.049	0.043	0.035	0.061	0.049	0.046	0.05	0.037	0.037	0.056	0.042	0.039	0.06	0.043	0.041	0.049	0.043	0.035
Sunday	20	0.045	0.031	0.03	0.038	0.033	0.024	0.053	0.042	0.045	0.043	0.032	0.037	0.052	0.04	0.04	0.052	0.039	0.04	0.038	0.033	0.024
Sunday	21	0.035	0.022	0.024	0.026	0.022	0.02	0.042	0.035	0.044	0.036	0.028	0.035	0.047	0.038	0.041	0.042	0.034	0.039	0.026	0.022	0.02
Sunday	22	0.023	0.013	0.018	0.017	0.014	0.017	0.032	0.03	0.045	0.028	0.022	0.034	0.036	0.034	0.042	0.031	0.028	0.038	0.017	0.014	0.017
Sunday	23	0.014	0.008	0.015	0.01	0.01	0.02	0.021	0.025	0.046	0.015	0.015	0.033	0.024	0.029	0.042	0.018	0.023	0.037	0.01	0.01	0.02
Monday	0	0.006	0.002	0.006	0.006	0.01	0.017	0.013	0.022	0.025	0.005	0.013	0.019	0.012	0.018	0.025	0.007	0.021	0.024	0.006	0.01	0.017
Monday	1	0.004	0.002	0.007	0.004	0.009	0.016	0.009	0.019	0.024	0.002	0.012	0.019	0.007	0.015	0.023	0.003	0.02	0.024	0.004	0.009	0.016
Monday	2	0.003	0.002	0.01	0.003	0.009	0.016	0.008	0.019	0.024	0.001	0.014	0.02	0.006	0.015	0.023	0.002	0.02	0.024	0.003	0.009	0.016
Monday	3	0.003	0.004	0.012	0.005	0.011	0.019	0.011	0.022	0.026	0.001	0.012	0.019	0.007	0.017	0.024	0.004	0.023	0.026	0.005	0.011	0.019
Monday	4	0.007	0.009	0.021	0.008	0.017	0.024	0.021	0.029	0.028	0.003	0.015	0.021	0.016	0.024	0.03	0.012	0.028	0.029	0.008	0.017	0.024
Monday	5	0.018	0.024	0.037	0.019	0.028	0.036	0.04	0.041	0.033	0.012	0.021	0.027	0.038	0.042	0.038	0.029	0.039	0.036	0.019	0.028	0.036
Monday	6	0.041	0.051	0.055	0.036	0.041	0.05	0.047	0.046	0.034	0.034	0.04	0.038	0.054	0.056	0.044	0.05	0.051	0.044	0.036	0.041	0.05
Monday	7	0.078	0.069	0.066	0.051	0.044	0.065	0.056	0.054	0.038	0.07	0.071	0.056	0.061	0.062	0.049	0.072	0.063	0.051	0.051	0.044	0.065
Monday	8	0.067	0.077	0.077	0.053	0.056	0.068	0.05	0.052	0.038	0.073	0.071	0.056	0.059	0.061	0.049	0.063	0.059	0.049	0.053	0.056	0.068
Monday	9	0.057	0.071	0.08	0.059	0.065	0.08	0.049	0.052	0.039	0.061	0.062	0.053	0.054	0.058	0.049	0.058	0.056	0.049	0.059	0.065	0.08
Monday	10	0.057	0.071	0.077	0.067	0.074	0.087	0.052	0.053	0.042	0.059	0.062	0.054	0.052	0.057	0.05	0.057	0.057	0.051	0.067	0.074	0.087
Monday	11	0.06	0.074	0.073	0.071	0.075	0.082	0.057	0.056	0.044	0.059	0.063	0.056	0.052	0.058	0.051	0.059	0.059	0.053	0.071	0.075	0.082
Monday	12	0.063	0.072	0.071	0.074	0.074	0.08	0.061	0.059	0.046	0.062	0.064	0.056	0.054	0.058	0.052	0.06	0.062	0.055	0.074	0.074	0.08
Monday	13	0.063	0.072	0.068	0.074	0.075	0.075	0.064	0.06	0.049	0.064	0.067	0.058	0.055	0.058	0.052	0.061	0.061	0.054	0.074	0.075	0.075
Monday	14	0.067	0.077	0.064	0.077	0.076	0.065	0.068	0.063	0.052	0.073	0.071	0.064	0.059	0.06	0.052	0.066	0.062	0.057	0.077	0.076	0.065
Monday	15	0.078	0.08	0.056	0.082	0.076	0.058	0.074	0.067	0.057	0.078	0.072	0.064	0.062	0.06	0.052	0.071	0.064	0.058	0.082	0.076	0.058
Monday	16	0.086	0.077	0.049	0.081	0.073	0.045	0.073	0.065	0.058	0.086	0.073	0.062	0.063	0.058	0.051	0.075	0.062	0.057	0.081	0.073	0.045
Monday	17	0.087	0.062	0.041	0.071	0.059	0.035	0.067	0.058	0.057	0.087	0.07	0.062	0.064	0.055	0.05	0.074	0.058	0.055	0.071	0.059	0.035
Monday	18	0.051	0.038	0.03	0.052	0.042	0.023	0.05	0.044	0.053	0.056	0.046	0.053	0.059	0.047	0.047	0.052	0.041	0.047	0.052	0.042	0.023
Monday	19	0.036	0.024	0.024	0.037	0.03	0.017	0.037	0.034	0.049	0.037	0.028	0.038	0.049	0.036	0.042	0.037	0.03	0.039	0.037	0.03	0.017
Monday	20	0.026	0.018	0.023	0.027	0.022	0.013	0.032	0.028	0.048	0.029	0.021	0.033	0.039	0.028	0.038	0.03	0.022	0.034	0.027	0.022	0.013
Monday	21	0.02	0.012	0.021	0.02	0.016	0.01	0.026	0.023	0.048	0.023	0.015	0.029	0.034	0.023	0.037	0.025	0.017	0.031	0.02	0.016	0.01
Monday	22	0.013	0.007	0.017	0.015	0.012	0.009	0.021	0.018	0.044	0.016	0.01	0.024	0.027	0.02	0.036	0.019	0.014	0.027	0.015	0.012	0.009
Monday	23	0.008	0.004	0.015	0.009	0.007	0.01	0.014	0.015	0.042	0.009	0.007	0.021	0.017	0.016	0.035	0.012	0.011	0.024	0.009	0.007	0.01
Tues/Wed/Thurs	0	0.006	0.003	0.01	0.005	0.009	0.017	0.01	0.021	0.032	0.004	0.013	0.022	0.011	0.019	0.029	0.005	0.02	0.027	0.005	0.009	0.017
Tues/Wed/Thurs	1	0.003	0.002	0.011	0.003	0.008	0.017	0.006	0.019	0.031	0.002	0.012	0.021	0.006	0.016	0.028	0.001	0.019	0.026	0.003	0.008	0.017
Tues/Wed/Thurs	2	0.003	0.002	0.013	0.002	0.009	0.017	0.006	0.019	0.031	0	0.011	0.021	0.005	0.016	0.027	0.001	0.019	0.027	0.002	0.009	0.017
Tues/Wed/Thurs	3	0.003	0.003	0.015	0.003	0.01	0.022	0.009	0.022	0.031	0	0.012	0.021	0.007	0.017	0.028	0.002	0.022	0.028	0.003	0.01	0.022
Tues/Wed/Thurs	4	0.006	0.008	0.022	0.006	0.014	0.025	0.019	0.029	0.034	0.003	0.014	0.023	0.015	0.025	0.033	0.01	0.027	0.032	0.006	0.014	0.025
Tues/Wed/Thurs	5	0.017	0.024	0.037	0.018	0.027	0.039	0.039	0.041	0.037	0.012	0.021	0.029	0.037	0.042	0.041	0.027	0.037	0.039	0.018	0.027	0.039
Tues/Wed/Thurs	6	0.041	0.053	0.054	0.037	0.042	0.052	0.048	0.046	0.039	0.035	0.04	0.042	0.054	0.056	0.047	0.05	0.05	0.047	0.037	0.042	0.052

		Glenn			Inyo			Kern			Kings			Los Angeles			Madera			Mariposa		
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	7	0.077	0.069	0.066	0.053	0.047	0.064	0.058	0.053	0.042	0.07	0.066	0.055	0.061	0.062	0.051	0.074	0.063	0.054	0.053	0.047	0.064
Tues/Wed/Thurs	8	0.066	0.077	0.077	0.054	0.056	0.07	0.052	0.052	0.042	0.073	0.071	0.058	0.059	0.062	0.051	0.065	0.059	0.052	0.054	0.056	0.07
Tues/Wed/Thurs	9	0.057	0.071	0.08	0.059	0.068	0.083	0.049	0.05	0.041	0.06	0.062	0.054	0.054	0.058	0.05	0.057	0.057	0.051	0.059	0.068	0.083
Tues/Wed/Thurs	10	0.056	0.071	0.077	0.064	0.069	0.081	0.05	0.051	0.042	0.057	0.06	0.054	0.052	0.057	0.051	0.055	0.057	0.052	0.064	0.069	0.081
Tues/Wed/Thurs	11	0.058	0.071	0.074	0.068	0.069	0.077	0.054	0.054	0.044	0.058	0.063	0.056	0.052	0.057	0.051	0.056	0.058	0.052	0.068	0.069	0.077
Tues/Wed/Thurs	12	0.062	0.07	0.069	0.069	0.071	0.074	0.059	0.056	0.046	0.06	0.064	0.056	0.053	0.057	0.051	0.057	0.059	0.053	0.069	0.071	0.074
Tues/Wed/Thurs	13	0.063	0.073	0.067	0.072	0.073	0.074	0.062	0.058	0.047	0.061	0.064	0.057	0.055	0.058	0.05	0.059	0.06	0.054	0.072	0.073	0.074
Tues/Wed/Thurs	14	0.066	0.076	0.063	0.077	0.076	0.067	0.068	0.062	0.05	0.071	0.07	0.059	0.059	0.059	0.05	0.065	0.063	0.055	0.077	0.076	0.067
Tues/Wed/Thurs	15	0.079	0.08	0.056	0.084	0.078	0.058	0.075	0.067	0.053	0.077	0.072	0.062	0.06	0.058	0.049	0.072	0.064	0.056	0.084	0.078	0.058
Tues/Wed/Thurs	16	0.087	0.076	0.045	0.082	0.074	0.048	0.075	0.066	0.054	0.086	0.073	0.06	0.062	0.056	0.048	0.078	0.064	0.055	0.082	0.074	0.048
Tues/Wed/Thurs	17	0.088	0.062	0.04	0.074	0.061	0.036	0.07	0.06	0.053	0.087	0.072	0.06	0.062	0.053	0.046	0.079	0.061	0.053	0.074	0.061	0.036
Tues/Wed/Thurs	18	0.054	0.039	0.031	0.053	0.044	0.023	0.052	0.046	0.048	0.059	0.051	0.051	0.058	0.046	0.043	0.055	0.043	0.044	0.053	0.044	0.023
Tues/Wed/Thurs	19	0.036	0.026	0.023	0.038	0.031	0.016	0.039	0.036	0.044	0.039	0.032	0.038	0.051	0.036	0.039	0.04	0.031	0.036	0.038	0.031	0.016
Tues/Wed/Thurs	20	0.028	0.019	0.021	0.03	0.025	0.012	0.033	0.03	0.042	0.032	0.023	0.032	0.042	0.028	0.036	0.033	0.024	0.032	0.03	0.025	0.012
Tues/Wed/Thurs	21	0.021	0.013	0.02	0.023	0.018	0.01	0.029	0.025	0.041	0.026	0.017	0.028	0.037	0.024	0.034	0.028	0.019	0.028	0.023	0.018	0.01
Tues/Wed/Thurs	22	0.014	0.007	0.016	0.017	0.013	0.01	0.023	0.02	0.039	0.018	0.011	0.023	0.03	0.02	0.033	0.021	0.014	0.025	0.017	0.013	0.01
Tues/Wed/Thurs	23	0.009	0.004	0.013	0.01	0.008	0.01	0.015	0.017	0.038	0.01	0.007	0.019	0.019	0.016	0.032	0.013	0.011	0.023	0.01	0.008	0.01
Friday	0	0.007	0.003	0.011	0.005	0.009	0.019	0.009	0.021	0.035	0.006	0.014	0.024	0.012	0.021	0.032	0.005	0.02	0.029	0.005	0.009	0.019
Friday	1	0.004	0.003	0.012	0.003	0.008	0.019	0.007	0.019	0.034	0.002	0.012	0.024	0.008	0.017	0.03	0.002	0.019	0.029	0.003	0.008	0.019
Friday	2	0.004	0.003	0.015	0.002	0.008	0.019	0.006	0.019	0.034	0.001	0.011	0.022	0.007	0.017	0.03	0.001	0.019	0.029	0.002	0.008	0.019
Friday	3	0.004	0.004	0.017	0.002	0.008	0.021	0.008	0.021	0.035	0.001	0.013	0.024	0.007	0.018	0.031	0.003	0.021	0.03	0.002	0.008	0.021
Friday	4	0.006	0.007	0.024	0.005	0.013	0.024	0.015	0.027	0.037	0.002	0.015	0.025	0.014	0.025	0.035	0.008	0.026	0.034	0.005	0.013	0.024
Friday	5	0.015	0.022	0.039	0.013	0.023	0.037	0.031	0.037	0.04	0.011	0.021	0.031	0.033	0.04	0.044	0.022	0.036	0.04	0.013	0.023	0.037
Friday	6	0.035	0.045	0.055	0.026	0.035	0.049	0.039	0.043	0.043	0.031	0.039	0.043	0.049	0.054	0.05	0.039	0.047	0.048	0.026	0.035	0.049
Friday	7	0.063	0.063	0.064	0.039	0.04	0.06	0.048	0.05	0.045	0.063	0.064	0.057	0.057	0.06	0.053	0.059	0.058	0.054	0.039	0.04	0.06
Friday	8	0.058	0.072	0.074	0.043	0.049	0.068	0.045	0.05	0.045	0.067	0.069	0.059	0.056	0.06	0.054	0.054	0.058	0.054	0.043	0.049	0.068
Friday	9	0.052	0.068	0.075	0.049	0.057	0.073	0.045	0.049	0.046	0.057	0.062	0.057	0.052	0.058	0.054	0.051	0.056	0.054	0.049	0.057	0.073
Friday	10	0.055	0.071	0.074	0.058	0.063	0.078	0.049	0.053	0.047	0.057	0.063	0.056	0.052	0.058	0.054	0.052	0.057	0.054	0.058	0.063	0.078
Friday	11	0.06	0.074	0.074	0.064	0.069	0.077	0.054	0.055	0.048	0.059	0.065	0.058	0.053	0.059	0.054	0.054	0.059	0.054	0.064	0.069	0.077
Friday	12	0.063	0.072	0.069	0.066	0.071	0.076	0.058	0.057	0.049	0.061	0.064	0.058	0.054	0.059	0.054	0.056	0.06	0.055	0.066	0.071	0.076
Friday	13	0.065	0.076	0.069	0.071	0.074	0.077	0.063	0.06	0.05	0.062	0.066	0.058	0.056	0.059	0.052	0.059	0.062	0.055	0.071	0.074	0.077
Friday	14	0.069	0.078	0.063	0.076	0.077	0.07	0.068	0.063	0.051	0.07	0.069	0.058	0.057	0.059	0.051	0.065	0.063	0.055	0.076	0.077	0.07
Friday	15	0.078	0.08	0.055	0.083	0.079	0.06	0.072	0.067	0.053	0.073	0.069	0.06	0.058	0.057	0.049	0.071	0.064	0.056	0.083	0.079	0.06
Friday	16	0.085	0.075	0.047	0.083	0.077	0.05	0.073	0.064	0.052	0.079	0.073	0.06	0.059	0.055	0.046	0.077	0.062	0.053	0.083	0.077	0.05
Friday	17	0.082	0.061	0.039	0.075	0.064	0.038	0.07	0.059	0.05	0.079	0.065	0.055	0.059	0.051	0.044	0.076	0.057	0.049	0.075	0.064	0.038
Friday	18	0.059	0.041	0.029	0.062	0.051	0.025	0.06	0.048	0.044	0.061	0.05	0.047	0.057	0.045	0.04	0.063	0.046	0.042	0.062	0.051	0.025
Friday	19	0.042	0.028	0.024	0.05	0.039	0.018	0.049	0.039	0.039	0.045	0.034	0.036	0.051	0.037	0.035	0.05	0.035	0.035	0.05	0.039	0.018
Friday	20	0.032	0.021	0.021	0.041	0.03	0.013	0.042	0.032	0.035	0.036	0.023	0.028	0.045	0.029	0.03	0.042	0.026	0.029	0.041	0.03	0.013
Friday	21	0.027	0.015	0.02	0.036	0.025	0.01	0.037	0.027	0.032	0.031	0.017	0.024	0.04	0.024	0.027	0.037	0.021	0.025	0.036	0.025	0.01
Friday	22	0.021	0.011	0.016	0.03	0.019	0.011	0.031	0.023	0.029	0.028	0.013	0.019	0.036	0.021	0.026	0.03	0.015	0.02	0.03	0.019	0.011
Friday	23	0.014	0.007	0.015	0.018	0.012	0.009	0.021	0.018	0.027	0.017	0.008	0.016	0.027	0.017	0.024	0.021	0.012	0.018	0.018	0.012	0.009
Saturday	0	0.012	0.007	0.021	0.01	0.015	0.027	0.016	0.028	0.043	0.013	0.022	0.035	0.02	0.031	0.046	0.012	0.031	0.042	0.01	0.015	0.027
Saturday	1	0.008	0.005	0.016	0.007	0.012	0.023	0.011	0.023	0.041	0.008	0.019	0.032	0.013	0.025	0.041	0.008	0.027	0.039	0.007	0.012	0.023
Saturday	2	0.006	0.004	0.02	0.005	0.011	0.022	0.009	0.022	0.04	0.005	0.017	0.031	0.011	0.023	0.039	0.006	0.025	0.038	0.005	0.011	0.022
Saturday	3	0.005	0.004	0.022	0.004	0.01	0.025	0.009	0.021	0.04	0.003	0.016	0.03	0.008	0.02	0.037	0.005	0.024	0.036	0.004	0.01	0.025
Saturday	4	0.006	0.008	0.024	0.005	0.013	0.028	0.014	0.025	0.041	0.004	0.016	0.031	0.01	0.022	0.038	0.008	0.027	0.037	0.005	0.013	0.028
Saturday	5	0.012	0.017	0.039	0.01	0.021	0.034	0.027	0.034	0.044	0.01	0.022	0.033	0.017	0.028	0.042	0.017	0.032	0.041	0.01	0.021	0.034
Saturday	6	0.021	0.028	0.049	0.017	0.028	0.039	0.034	0.038	0.045	0.023	0.031	0.041	0.027	0.036	0.046	0.026	0.039	0.046	0.017	0.028	0.039
Saturday	7	0.034	0.041	0.058	0.029	0.036	0.053	0.042	0.045	0.047	0.036	0.041	0.048	0.037	0.046	0.051	0.036	0.045	0.05	0.029	0.036	0.053
Saturday	8	0.045	0.057	0.067	0.044	0.045	0.06	0.05	0.052	0.05	0.045	0.049	0.053	0.046	0.052	0.054	0.047	0.052	0.054	0.044	0.045	0.06
Saturday	9	0.054	0.068	0.074	0.059	0.061	0.071	0.056	0.056	0.052	0.053	0.054	0.057	0.053	0.057	0.056	0.055	0.057	0.056	0.059	0.061	0.071
Saturday	10	0.063	0.08	0.073	0.073	0.074	0.078	0.06	0.057	0.053	0.061	0.063	0.059	0.057	0.06	0.056	0.062	0.062	0.06	0.073	0.074	0.078
Saturday	11	0.068	0.082	0.071	0.081	0.077	0.083	0.063	0.059	0.053	0.067	0.072	0.062	0.06	0.062	0.056	0.067	0.063	0.058	0.081	0.077	0.083
Saturday	12	0.074	0.083	0.068	0.078	0.077	0.075	0.065	0.061	0.052	0.071	0.072	0.064	0.062	0.062	0.054	0.068	0.062	0.056	0.078	0.077	0.075
Saturday	13	0.074	0.079	0.062	0.075	0.072	0.06	0.066	0.061	0.05	0.071	0.069	0.06	0.062	0.06	0.051	0.068	0.059	0.054	0.075	0.072	0.06

		Glenn			Inyo			Kern			Kings			Los Angeles			Madera			Mariposa		
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	14	0.074	0.076	0.057	0.075	0.068	0.055	0.067	0.06	0.049	0.071	0.07	0.06	0.062	0.058	0.048	0.068	0.059	0.051	0.075	0.068	0.055
Saturday	15	0.073	0.074	0.052	0.075	0.068	0.052	0.067	0.06	0.048	0.07	0.067	0.055	0.062	0.056	0.045	0.068	0.056	0.049	0.075	0.068	0.052
Saturday	16	0.073	0.067	0.045	0.072	0.07	0.047	0.064	0.056	0.044	0.07	0.061	0.049	0.062	0.053	0.042	0.068	0.054	0.046	0.072	0.07	0.047
Saturday	17	0.069	0.058	0.039	0.066	0.063	0.04	0.058	0.052	0.041	0.066	0.056	0.046	0.06	0.049	0.038	0.064	0.05	0.041	0.066	0.063	0.04
Saturday	18	0.058	0.047	0.034	0.058	0.052	0.031	0.051	0.046	0.036	0.059	0.048	0.038	0.057	0.044	0.034	0.057	0.042	0.035	0.058	0.052	0.031
Saturday	19	0.046	0.036	0.029	0.047	0.041	0.026	0.044	0.037	0.032	0.049	0.036	0.03	0.051	0.037	0.029	0.049	0.034	0.029	0.047	0.041	0.026
Saturday	20	0.04	0.028	0.024	0.038	0.031	0.02	0.039	0.033	0.028	0.043	0.032	0.027	0.046	0.033	0.026	0.043	0.03	0.025	0.038	0.031	0.02
Saturday	21	0.036	0.022	0.023	0.031	0.025	0.016	0.035	0.029	0.026	0.04	0.027	0.022	0.043	0.03	0.024	0.039	0.027	0.022	0.031	0.025	0.016
Saturday	22	0.029	0.016	0.017	0.025	0.02	0.018	0.03	0.024	0.024	0.037	0.024	0.02	0.042	0.029	0.024	0.035	0.024	0.019	0.025	0.02	0.018
Saturday	23	0.02	0.011	0.017	0.016	0.013	0.018	0.023	0.02	0.02	0.024	0.017	0.017	0.033	0.026	0.022	0.025	0.02	0.018	0.016	0.013	0.018
Holiday	0	0.01	0.004	0.012	0.008	0.011	0.02	0.015	0.023	0.028	0.011	0.017	0.026	0.017	0.024	0.031	0.01	0.023	0.027	0.008	0.011	0.02
Holiday	1	0.006	0.004	0.011	0.005	0.009	0.018	0.009	0.021	0.028	0.006	0.018	0.023	0.011	0.02	0.028	0.004	0.024	0.028	0.005	0.009	0.018
Holiday	2	0.004	0.003	0.012	0.003	0.01	0.018	0.007	0.02	0.028	0.002	0.018	0.027	0.009	0.019	0.027	0.002	0.022	0.027	0.003	0.01	0.018
Holiday	3	0.004	0.005	0.015	0.004	0.01	0.021	0.008	0.021	0.028	0.001	0.019	0.027	0.007	0.019	0.028	0.001	0.023	0.028	0.004	0.01	0.021
Holiday	4	0.007	0.009	0.024	0.005	0.012	0.02	0.013	0.024	0.028	0.002	0.015	0.027	0.012	0.023	0.03	0.006	0.026	0.03	0.005	0.012	0.02
Holiday	5	0.014	0.02	0.037	0.009	0.018	0.031	0.027	0.032	0.032	0.01	0.021	0.027	0.024	0.033	0.036	0.016	0.033	0.035	0.009	0.018	0.031
Holiday	6	0.03	0.036	0.047	0.018	0.023	0.038	0.033	0.037	0.033	0.026	0.034	0.037	0.034	0.041	0.04	0.028	0.04	0.039	0.018	0.023	0.038
Holiday	7	0.044	0.052	0.061	0.029	0.031	0.043	0.039	0.043	0.036	0.043	0.046	0.041	0.042	0.047	0.043	0.037	0.045	0.042	0.029	0.031	0.043
Holiday	8	0.052	0.066	0.075	0.041	0.044	0.056	0.043	0.047	0.037	0.05	0.052	0.042	0.045	0.05	0.045	0.044	0.051	0.045	0.041	0.044	0.056
Holiday	9	0.053	0.071	0.081	0.058	0.057	0.075	0.05	0.05	0.04	0.051	0.052	0.05	0.048	0.053	0.047	0.051	0.053	0.048	0.058	0.057	0.075
Holiday	10	0.059	0.076	0.081	0.076	0.083	0.087	0.055	0.055	0.042	0.06	0.067	0.052	0.054	0.058	0.05	0.06	0.06	0.053	0.076	0.083	0.087
Holiday	11	0.066	0.076	0.071	0.084	0.086	0.088	0.064	0.06	0.047	0.067	0.07	0.059	0.058	0.061	0.051	0.068	0.064	0.055	0.084	0.086	0.088
Holiday	12	0.071	0.078	0.074	0.085	0.087	0.089	0.068	0.061	0.05	0.073	0.077	0.064	0.061	0.063	0.053	0.072	0.066	0.056	0.085	0.087	0.089
Holiday	13	0.071	0.076	0.065	0.083	0.081	0.078	0.071	0.066	0.051	0.075	0.072	0.057	0.063	0.064	0.053	0.071	0.067	0.058	0.083	0.081	0.078
Holiday	14	0.07	0.078	0.06	0.08	0.074	0.068	0.073	0.064	0.052	0.076	0.07	0.062	0.064	0.064	0.053	0.073	0.064	0.058	0.08	0.074	0.068
Holiday	15	0.075	0.075	0.053	0.078	0.074	0.06	0.075	0.067	0.055	0.072	0.073	0.063	0.065	0.061	0.051	0.075	0.062	0.054	0.078	0.074	0.06
Holiday	16	0.079	0.07	0.044	0.078	0.072	0.049	0.072	0.064	0.055	0.075	0.066	0.057	0.064	0.057	0.05	0.076	0.06	0.054	0.078	0.072	0.049
Holiday	17	0.074	0.064	0.041	0.071	0.066	0.041	0.066	0.059	0.054	0.071	0.059	0.053	0.063	0.053	0.048	0.073	0.056	0.053	0.071	0.066	0.041
Holiday	18	0.058	0.044	0.034	0.057	0.049	0.033	0.056	0.046	0.049	0.059	0.046	0.048	0.058	0.046	0.045	0.061	0.044	0.046	0.057	0.049	0.033
Holiday	19	0.047	0.033	0.026	0.043	0.04	0.022	0.047	0.042	0.05	0.047	0.032	0.038	0.052	0.038	0.042	0.05	0.035	0.04	0.043	0.04	0.022
Holiday	20	0.038	0.025	0.025	0.033	0.026	0.013	0.039	0.033	0.046	0.04	0.029	0.033	0.047	0.032	0.039	0.043	0.029	0.037	0.033	0.026	0.013
Holiday	21	0.03	0.018	0.021	0.024	0.018	0.011	0.031	0.027	0.046	0.034	0.024	0.033	0.042	0.028	0.038	0.035	0.022	0.032	0.024	0.018	0.011
Holiday	22	0.024	0.011	0.017	0.017	0.012	0.009	0.025	0.021	0.043	0.03	0.015	0.031	0.037	0.025	0.037	0.028	0.018	0.029	0.017	0.012	0.009
Holiday	23	0.014	0.007	0.014	0.01	0.008	0.01	0.016	0.018	0.041	0.018	0.009	0.022	0.025	0.02	0.036	0.018	0.014	0.026	0.01	0.008	0.01

		Mendocino			Merced			Mono			Monterey			Napa			Plumas			Riverside		
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	0.014	0.025	0.037	0.01	0.014	0.032	0.019	0.01	0.029	0.017	0.035	0.054	0.015	0.01	0.015	0.022	0.036	0.05
Sunday	1	0.013	0.008	0.01	0.009	0.019	0.032	0.007	0.011	0.024	0.02	0.008	0.023	0.011	0.03	0.047	0.01	0.006	0.011	0.015	0.028	0.044
Sunday	2	0.012	0.006	0.008	0.007	0.016	0.029	0.005	0.011	0.022	0.02	0.007	0.021	0.007	0.028	0.044	0.007	0.004	0.012	0.011	0.023	0.04
Sunday	3	0.014	0.005	0.007	0.005	0.015	0.028	0.004	0.01	0.021	0.02	0.007	0.019	0.006	0.026	0.043	0.006	0.004	0.012	0.009	0.02	0.036
Sunday	4	0.014	0.004	0.011	0.006	0.016	0.028	0.004	0.01	0.02	0.024	0.012	0.019	0.006	0.025	0.038	0.006	0.005	0.017	0.009	0.02	0.035
Sunday	5	0.017	0.009	0.019	0.01	0.019	0.029	0.007	0.013	0.021	0.026	0.017	0.021	0.009	0.027	0.038	0.01	0.011	0.029	0.012	0.023	0.036
Sunday	6	0.021	0.014	0.028	0.015	0.023	0.031	0.012	0.019	0.026	0.029	0.024	0.026	0.014	0.03	0.038	0.016	0.017	0.037	0.019	0.029	0.039
Sunday	7	0.026	0.02	0.036	0.021	0.029	0.035	0.019	0.023	0.029	0.031	0.03	0.034	0.02	0.033	0.039	0.023	0.029	0.051	0.026	0.035	0.041
Sunday	8	0.031	0.032	0.043	0.031	0.038	0.04	0.032	0.035	0.038	0.035	0.038	0.04	0.031	0.038	0.042	0.033	0.043	0.071	0.036	0.045	0.044
Sunday	9	0.04	0.05	0.054	0.043	0.05	0.047	0.051	0.051	0.053	0.038	0.049	0.049	0.047	0.047	0.046	0.047	0.063	0.091	0.049	0.054	0.047
Sunday	10	0.047	0.064	0.067	0.055	0.06	0.051	0.067	0.067	0.071	0.041	0.057	0.057	0.06	0.054	0.046	0.057	0.075	0.084	0.057	0.061	0.047
Sunday	11	0.055	0.079	0.062	0.063	0.065	0.054	0.08	0.081	0.085	0.047	0.068	0.061	0.066	0.056	0.047	0.067	0.083	0.079	0.064	0.065	0.048
Sunday	12	0.061	0.087	0.065	0.07	0.07	0.055	0.083	0.081	0.076	0.051	0.074	0.063	0.067	0.056	0.045	0.074	0.09	0.07	0.067	0.066	0.047
Sunday	13	0.065	0.092	0.064	0.075	0.071	0.056	0.085	0.082	0.074	0.053	0.073	0.065	0.07	0.056	0.042	0.078	0.089	0.061	0.069	0.065	0.045
Sunday	14	0.067	0.087	0.065	0.077	0.069	0.055	0.085	0.083	0.069	0.059	0.078	0.065	0.071	0.057	0.038	0.079	0.081	0.057	0.069	0.063	0.044

		Mendocino			Merced			Mono			Monterey			Napa			Plumas			Riverside		
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	15	0.072	0.086	0.067	0.078	0.07	0.053	0.084	0.081	0.066	0.061	0.078	0.066	0.071	0.052	0.037	0.08	0.079	0.053	0.068	0.06	0.042
Sunday	16	0.077	0.086	0.072	0.077	0.067	0.052	0.082	0.079	0.06	0.064	0.074	0.06	0.072	0.055	0.036	0.079	0.075	0.045	0.067	0.056	0.041
Sunday	17	0.07	0.075	0.058	0.075	0.062	0.049	0.076	0.07	0.053	0.063	0.068	0.053	0.071	0.052	0.035	0.075	0.066	0.043	0.064	0.052	0.04
Sunday	18	0.067	0.059	0.054	0.068	0.055	0.046	0.064	0.056	0.043	0.064	0.06	0.049	0.068	0.051	0.036	0.066	0.054	0.039	0.061	0.047	0.039
Sunday	19	0.062	0.045	0.05	0.061	0.047	0.042	0.049	0.043	0.035	0.06	0.052	0.046	0.062	0.048	0.037	0.055	0.042	0.037	0.057	0.042	0.039
Sunday	20	0.054	0.035	0.047	0.051	0.039	0.04	0.038	0.033	0.024	0.055	0.043	0.041	0.056	0.046	0.038	0.045	0.031	0.03	0.053	0.037	0.039
Sunday	21	0.045	0.024	0.039	0.041	0.031	0.038	0.026	0.022	0.02	0.05	0.034	0.037	0.046	0.038	0.038	0.035	0.022	0.024	0.044	0.031	0.039
Sunday	22	0.033	0.015	0.033	0.029	0.024	0.036	0.017	0.014	0.017	0.039	0.022	0.031	0.033	0.032	0.043	0.023	0.013	0.018	0.032	0.024	0.038
Sunday	23	0.022	0.009	0.032	0.019	0.019	0.037	0.01	0.01	0.02	0.03	0.016	0.025	0.02	0.027	0.05	0.014	0.008	0.015	0.021	0.018	0.038
Monday	0	0.01	0.003	0.007	0.011	0.017	0.023	0.006	0.01	0.017	0.023	0.006	0.009	0.01	0.024	0.031	0.006	0.002	0.006	0.011	0.018	0.027
Monday	1	0.009	0.002	0.007	0.007	0.015	0.022	0.004	0.009	0.016	0.024	0.007	0.009	0.005	0.023	0.031	0.004	0.002	0.007	0.008	0.016	0.026
Monday	2	0.01	0.003	0.01	0.006	0.015	0.022	0.003	0.009	0.016	0.025	0.009	0.01	0.004	0.022	0.03	0.003	0.002	0.01	0.007	0.016	0.027
Monday	3	0.012	0.006	0.012	0.009	0.018	0.025	0.005	0.011	0.019	0.025	0.011	0.014	0.005	0.023	0.032	0.003	0.004	0.012	0.011	0.02	0.03
Monday	4	0.014	0.009	0.013	0.018	0.027	0.032	0.008	0.017	0.024	0.033	0.023	0.019	0.014	0.03	0.037	0.007	0.009	0.021	0.024	0.033	0.038
Monday	5	0.022	0.022	0.026	0.03	0.039	0.039	0.019	0.028	0.036	0.039	0.042	0.024	0.039	0.041	0.044	0.018	0.024	0.037	0.04	0.049	0.045
Monday	6	0.037	0.047	0.044	0.044	0.051	0.045	0.036	0.041	0.05	0.044	0.06	0.031	0.05	0.049	0.051	0.041	0.051	0.055	0.053	0.059	0.049
Monday	7	0.045	0.058	0.058	0.058	0.058	0.05	0.051	0.044	0.065	0.041	0.056	0.038	0.059	0.058	0.056	0.078	0.069	0.066	0.059	0.064	0.051
Monday	8	0.047	0.062	0.067	0.053	0.058	0.051	0.053	0.056	0.068	0.043	0.058	0.045	0.055	0.056	0.055	0.067	0.077	0.077	0.056	0.062	0.052
Monday	9	0.05	0.065	0.078	0.051	0.059	0.053	0.059	0.065	0.08	0.045	0.063	0.053	0.053	0.057	0.058	0.057	0.071	0.08	0.053	0.059	0.051
Monday	10	0.051	0.065	0.08	0.054	0.062	0.056	0.067	0.074	0.087	0.046	0.065	0.059	0.055	0.06	0.058	0.057	0.071	0.077	0.052	0.058	0.051
Monday	11	0.056	0.067	0.083	0.057	0.064	0.057	0.071	0.075	0.082	0.05	0.066	0.061	0.057	0.058	0.058	0.06	0.074	0.073	0.053	0.058	0.052
Monday	12	0.058	0.069	0.081	0.06	0.064	0.058	0.074	0.074	0.08	0.052	0.068	0.065	0.058	0.06	0.059	0.063	0.072	0.071	0.055	0.058	0.051
Monday	13	0.063	0.074	0.076	0.061	0.064	0.058	0.074	0.075	0.075	0.056	0.069	0.063	0.059	0.059	0.055	0.063	0.072	0.068	0.057	0.059	0.051
Monday	14	0.067	0.076	0.074	0.067	0.066	0.058	0.077	0.076	0.065	0.057	0.07	0.065	0.064	0.058	0.053	0.067	0.077	0.064	0.061	0.06	0.051
Monday	15	0.073	0.087	0.062	0.072	0.065	0.057	0.082	0.076	0.058	0.058	0.07	0.066	0.068	0.058	0.05	0.078	0.08	0.056	0.065	0.061	0.05
Monday	16	0.076	0.084	0.053	0.075	0.063	0.055	0.081	0.073	0.045	0.059	0.067	0.06	0.071	0.058	0.046	0.086	0.077	0.049	0.067	0.059	0.049
Monday	17	0.075	0.075	0.04	0.074	0.055	0.051	0.071	0.059	0.035	0.058	0.062	0.057	0.07	0.054	0.042	0.087	0.062	0.041	0.066	0.054	0.047
Monday	18	0.057	0.047	0.032	0.055	0.042	0.042	0.052	0.042	0.023	0.055	0.043	0.053	0.055	0.041	0.035	0.051	0.038	0.03	0.056	0.043	0.042
Monday	19	0.05	0.031	0.029	0.042	0.031	0.036	0.037	0.03	0.017	0.045	0.029	0.048	0.043	0.032	0.028	0.036	0.024	0.024	0.044	0.031	0.037
Monday	20	0.043	0.02	0.021	0.034	0.023	0.031	0.027	0.022	0.013	0.041	0.022	0.045	0.035	0.026	0.024	0.026	0.018	0.023	0.035	0.023	0.033
Monday	21	0.035	0.015	0.02	0.027	0.018	0.028	0.02	0.016	0.01	0.035	0.017	0.039	0.03	0.022	0.021	0.02	0.012	0.021	0.03	0.017	0.031
Monday	22	0.025	0.009	0.014	0.02	0.014	0.027	0.015	0.012	0.009	0.026	0.011	0.035	0.023	0.018	0.022	0.013	0.007	0.017	0.023	0.012	0.029
Monday	23	0.016	0.005	0.013	0.014	0.011	0.025	0.009	0.007	0.01	0.02	0.007	0.033	0.016	0.015	0.025	0.008	0.004	0.015	0.016	0.009	0.028
Tues/Wed/Thurs	0	0.01	0.004	0.008	0.008	0.016	0.025	0.005	0.009	0.017	0.02	0.006	0.023	0.009	0.023	0.033	0.006	0.003	0.01	0.01	0.017	0.03
Tues/Wed/Thurs	1	0.009	0.003	0.008	0.005	0.014	0.024	0.003	0.008	0.017	0.022	0.007	0.021	0.005	0.021	0.031	0.003	0.002	0.011	0.007	0.015	0.029
Tues/Wed/Thurs	2	0.01	0.002	0.012	0.005	0.014	0.025	0.002	0.009	0.017	0.023	0.007	0.021	0.004	0.021	0.031	0.003	0.002	0.013	0.006	0.015	0.029
Tues/Wed/Thurs	3	0.011	0.005	0.014	0.008	0.018	0.028	0.003	0.01	0.022	0.025	0.01	0.022	0.005	0.022	0.032	0.003	0.003	0.015	0.01	0.019	0.032
Tues/Wed/Thurs	4	0.015	0.01	0.021	0.017	0.026	0.034	0.006	0.014	0.025	0.03	0.019	0.024	0.013	0.028	0.039	0.006	0.008	0.022	0.022	0.032	0.04
Tues/Wed/Thurs	5	0.024	0.024	0.035	0.03	0.039	0.042	0.018	0.027	0.039	0.037	0.037	0.029	0.036	0.04	0.046	0.017	0.024	0.037	0.039	0.048	0.047
Tues/Wed/Thurs	6	0.037	0.048	0.048	0.044	0.05	0.047	0.037	0.042	0.052	0.043	0.057	0.038	0.048	0.048	0.051	0.041	0.053	0.054	0.053	0.06	0.051
Tues/Wed/Thurs	7	0.045	0.059	0.065	0.059	0.059	0.052	0.053	0.047	0.064	0.042	0.057	0.046	0.059	0.056	0.056	0.077	0.069	0.066	0.059	0.064	0.053
Tues/Wed/Thurs	8	0.047	0.063	0.069	0.055	0.058	0.052	0.054	0.056	0.07	0.045	0.062	0.05	0.056	0.057	0.057	0.066	0.077	0.077	0.056	0.062	0.053
Tues/Wed/Thurs	9	0.05	0.064	0.074	0.051	0.059	0.054	0.059	0.068	0.083	0.046	0.063	0.055	0.052	0.055	0.056	0.057	0.071	0.08	0.052	0.059	0.052
Tues/Wed/Thurs	10	0.051	0.065	0.075	0.052	0.06	0.056	0.064	0.069	0.081	0.047	0.061	0.058	0.053	0.057	0.057	0.056	0.071	0.077	0.051	0.058	0.052
Tues/Wed/Thurs	11	0.055	0.065	0.076	0.054	0.061	0.057	0.068	0.069	0.077	0.049	0.065	0.06	0.053	0.058	0.057	0.058	0.071	0.074	0.051	0.058	0.051
Tues/Wed/Thurs	12	0.057	0.068	0.076	0.057	0.062	0.057	0.069	0.071	0.074	0.051	0.066	0.06	0.055	0.058	0.056	0.062	0.07	0.069	0.053	0.058	0.051
Tues/Wed/Thurs	13	0.061	0.07	0.071	0.06	0.063	0.056	0.072	0.073	0.074	0.054	0.069	0.059	0.057	0.06	0.055	0.063	0.073	0.067	0.056	0.059	0.051
Tues/Wed/Thurs	14	0.066	0.074	0.068	0.066	0.065	0.056	0.077	0.076	0.067	0.058	0.072	0.059	0.064	0.061	0.053	0.066	0.076	0.063	0.06	0.061	0.05
Tues/Wed/Thurs	15	0.073	0.084	0.062	0.073	0.066	0.055	0.084	0.078	0.058	0.059	0.072	0.057	0.069	0.061	0.05	0.079	0.08	0.056	0.064	0.061	0.048
Tues/Wed/Thurs	16	0.078	0.086	0.053	0.077	0.064	0.053	0.082	0.074	0.048	0.06	0.07	0.053	0.072	0.058	0.046	0.087	0.076	0.045	0.066	0.06	0.047
Tues/Wed/Thurs	17	0.077	0.078	0.041	0.076	0.057	0.049	0.074	0.061	0.036	0.058	0.063	0.051	0.072	0.055	0.041	0.088	0.062	0.04	0.066	0.055	0.044
Tues/Wed/Thurs	18	0.059	0.047	0.03	0.058	0.044	0.041	0.053	0.044	0.023	0.052	0.044	0.046	0.058	0.044	0.035	0.054	0.039	0.031	0.058	0.045	0.04
Tues/Wed/Thurs	19	0.048	0.031	0.027	0.044	0.032	0.034	0.038	0.031	0.016	0.049	0.032	0.041	0.047	0.035	0.028	0.036	0.026	0.023	0.046	0.032	0.035
Tues/Wed/Thurs	20	0.041	0.021	0.02	0.036	0.025	0.03	0.03	0.025	0.012	0.043	0.024	0.037	0.039	0.029	0.024	0.028	0.019	0.021	0.038	0.024	0.032
Tues/Wed/Thurs	21	0.036	0.017	0.02	0.028	0.019	0.026	0.023	0.018	0.01	0.038	0.018	0.034	0.033	0.022	0.021	0.021	0.013	0.02	0.033	0.018	0.029

		Mendocino			Merced			Mono			Monterey			Napa			Plumas			Riverside		
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	22	0.025	0.009	0.014	0.021	0.014	0.025	0.017	0.013	0.01	0.029	0.011	0.03	0.025	0.018	0.022	0.014	0.007	0.016	0.025	0.012	0.027
Tues/Wed/Thurs	23	0.017	0.005	0.012	0.015	0.012	0.023	0.01	0.008	0.01	0.022	0.008	0.026	0.017	0.015	0.025	0.009	0.004	0.013	0.017	0.008	0.026
Friday	0	0.009	0.004	0.008	0.008	0.016	0.027	0.005	0.009	0.019	0.02	0.006	0.022	0.009	0.022	0.034	0.007	0.003	0.011	0.011	0.018	0.031
Friday	1	0.009	0.003	0.009	0.006	0.014	0.025	0.003	0.008	0.019	0.02	0.006	0.021	0.005	0.022	0.032	0.004	0.003	0.012	0.007	0.015	0.03
Friday	2	0.009	0.003	0.011	0.005	0.014	0.026	0.002	0.008	0.019	0.022	0.007	0.021	0.004	0.021	0.034	0.004	0.003	0.015	0.007	0.016	0.03
Friday	3	0.011	0.005	0.016	0.008	0.017	0.029	0.002	0.008	0.021	0.024	0.009	0.022	0.005	0.022	0.034	0.004	0.004	0.017	0.009	0.019	0.033
Friday	4	0.013	0.009	0.022	0.014	0.024	0.035	0.005	0.013	0.024	0.028	0.018	0.024	0.011	0.026	0.039	0.006	0.007	0.024	0.02	0.03	0.041
Friday	5	0.021	0.021	0.039	0.024	0.035	0.042	0.013	0.023	0.037	0.035	0.033	0.029	0.029	0.038	0.046	0.015	0.022	0.039	0.034	0.045	0.048
Friday	6	0.033	0.041	0.054	0.036	0.045	0.047	0.026	0.035	0.049	0.041	0.05	0.038	0.039	0.045	0.052	0.035	0.045	0.055	0.046	0.055	0.052
Friday	7	0.039	0.052	0.065	0.049	0.053	0.052	0.039	0.04	0.06	0.039	0.049	0.046	0.048	0.051	0.057	0.063	0.063	0.064	0.053	0.061	0.054
Friday	8	0.044	0.059	0.074	0.047	0.054	0.053	0.043	0.049	0.068	0.041	0.056	0.05	0.047	0.051	0.057	0.058	0.072	0.074	0.051	0.059	0.054
Friday	9	0.047	0.06	0.078	0.047	0.056	0.055	0.049	0.057	0.073	0.045	0.058	0.055	0.047	0.055	0.058	0.052	0.068	0.075	0.05	0.058	0.053
Friday	10	0.048	0.067	0.075	0.051	0.06	0.058	0.058	0.063	0.078	0.047	0.062	0.059	0.052	0.057	0.059	0.055	0.071	0.074	0.051	0.059	0.053
Friday	11	0.054	0.068	0.077	0.054	0.062	0.06	0.064	0.069	0.077	0.05	0.067	0.06	0.055	0.058	0.059	0.06	0.074	0.074	0.053	0.06	0.053
Friday	12	0.06	0.072	0.079	0.057	0.063	0.06	0.066	0.071	0.076	0.051	0.067	0.06	0.059	0.06	0.058	0.063	0.072	0.069	0.055	0.061	0.053
Friday	13	0.063	0.075	0.072	0.061	0.065	0.059	0.071	0.074	0.077	0.056	0.071	0.062	0.064	0.061	0.052	0.065	0.076	0.069	0.058	0.061	0.052
Friday	14	0.068	0.078	0.067	0.068	0.067	0.058	0.076	0.077	0.07	0.06	0.075	0.059	0.067	0.061	0.051	0.069	0.078	0.063	0.061	0.062	0.05
Friday	15	0.073	0.083	0.06	0.074	0.067	0.056	0.083	0.079	0.06	0.06	0.074	0.06	0.069	0.061	0.048	0.078	0.08	0.055	0.062	0.061	0.048
Friday	16	0.076	0.082	0.049	0.076	0.064	0.053	0.083	0.077	0.05	0.06	0.07	0.055	0.069	0.058	0.045	0.085	0.075	0.047	0.063	0.058	0.046
Friday	17	0.074	0.072	0.038	0.075	0.058	0.048	0.075	0.064	0.038	0.06	0.064	0.049	0.068	0.051	0.04	0.082	0.061	0.039	0.062	0.053	0.043
Friday	18	0.06	0.05	0.026	0.064	0.048	0.04	0.062	0.051	0.025	0.054	0.049	0.044	0.06	0.046	0.034	0.059	0.041	0.029	0.058	0.045	0.039
Friday	19	0.052	0.034	0.024	0.052	0.037	0.032	0.05	0.039	0.018	0.05	0.036	0.04	0.054	0.039	0.027	0.042	0.028	0.024	0.05	0.035	0.034
Friday	20	0.043	0.022	0.017	0.043	0.029	0.026	0.041	0.03	0.013	0.045	0.028	0.037	0.048	0.033	0.023	0.032	0.021	0.021	0.043	0.026	0.03
Friday	21	0.04	0.018	0.016	0.035	0.022	0.022	0.036	0.025	0.01	0.038	0.021	0.032	0.039	0.026	0.019	0.027	0.015	0.02	0.039	0.02	0.027
Friday	22	0.031	0.012	0.011	0.027	0.016	0.02	0.03	0.019	0.011	0.031	0.015	0.029	0.031	0.02	0.02	0.021	0.011	0.016	0.032	0.014	0.024
Friday	23	0.022	0.007	0.012	0.02	0.012	0.018	0.018	0.012	0.009	0.023	0.01	0.026	0.022	0.016	0.021	0.014	0.007	0.015	0.023	0.009	0.021
Saturday	0	0.012	0.008	0.014	0.015	0.026	0.04	0.01	0.015	0.027	0.023	0.011	0.03	0.014	0.029	0.051	0.012	0.007	0.021	0.017	0.027	0.047
Saturday	1	0.013	0.006	0.014	0.01	0.02	0.035	0.007	0.012	0.023	0.025	0.01	0.027	0.009	0.024	0.044	0.008	0.005	0.016	0.012	0.021	0.042
Saturday	2	0.013	0.004	0.011	0.008	0.018	0.032	0.005	0.011	0.022	0.025	0.009	0.026	0.007	0.022	0.041	0.006	0.004	0.02	0.01	0.019	0.04
Saturday	3	0.012	0.004	0.014	0.008	0.019	0.032	0.004	0.01	0.025	0.027	0.011	0.024	0.006	0.023	0.04	0.005	0.004	0.022	0.009	0.019	0.039
Saturday	4	0.014	0.008	0.02	0.011	0.021	0.035	0.005	0.013	0.028	0.031	0.02	0.025	0.007	0.023	0.041	0.006	0.008	0.024	0.012	0.021	0.041
Saturday	5	0.02	0.016	0.034	0.017	0.028	0.039	0.01	0.021	0.034	0.038	0.034	0.03	0.013	0.029	0.045	0.012	0.017	0.039	0.018	0.029	0.045
Saturday	6	0.025	0.025	0.043	0.025	0.036	0.045	0.017	0.028	0.039	0.038	0.047	0.04	0.021	0.033	0.047	0.021	0.028	0.049	0.028	0.039	0.05
Saturday	7	0.03	0.031	0.058	0.034	0.044	0.05	0.029	0.036	0.053	0.042	0.047	0.046	0.03	0.038	0.053	0.034	0.041	0.058	0.039	0.048	0.055
Saturday	8	0.036	0.041	0.07	0.044	0.053	0.055	0.044	0.045	0.06	0.043	0.055	0.05	0.042	0.046	0.052	0.045	0.057	0.067	0.047	0.056	0.056
Saturday	9	0.043	0.053	0.079	0.054	0.061	0.06	0.059	0.061	0.071	0.047	0.062	0.055	0.054	0.054	0.058	0.054	0.068	0.074	0.054	0.062	0.057
Saturday	10	0.052	0.069	0.082	0.062	0.068	0.063	0.073	0.074	0.078	0.047	0.067	0.062	0.063	0.058	0.055	0.063	0.08	0.073	0.058	0.064	0.056
Saturday	11	0.054	0.076	0.075	0.067	0.071	0.064	0.081	0.077	0.083	0.049	0.068	0.063	0.068	0.06	0.052	0.068	0.082	0.071	0.062	0.066	0.054
Saturday	12	0.061	0.08	0.07	0.069	0.07	0.062	0.078	0.077	0.075	0.055	0.071	0.06	0.069	0.06	0.052	0.074	0.083	0.068	0.063	0.065	0.052
Saturday	13	0.063	0.082	0.064	0.07	0.067	0.058	0.075	0.072	0.06	0.054	0.07	0.059	0.067	0.057	0.047	0.074	0.079	0.062	0.064	0.064	0.05
Saturday	14	0.065	0.081	0.062	0.07	0.064	0.054	0.075	0.068	0.055	0.055	0.066	0.058	0.067	0.057	0.045	0.074	0.076	0.057	0.064	0.062	0.047
Saturday	15	0.067	0.08	0.054	0.069	0.061	0.049	0.075	0.068	0.052	0.055	0.065	0.056	0.067	0.057	0.044	0.073	0.074	0.052	0.064	0.059	0.044
Saturday	16	0.071	0.081	0.051	0.068	0.057	0.045	0.072	0.07	0.047	0.057	0.065	0.052	0.068	0.054	0.038	0.073	0.067	0.045	0.063	0.056	0.041
Saturday	17	0.068	0.072	0.037	0.064	0.051	0.04	0.066	0.063	0.04	0.056	0.053	0.047	0.066	0.054	0.035	0.069	0.058	0.039	0.061	0.051	0.037
Saturday	18	0.062	0.053	0.032	0.056	0.042	0.033	0.058	0.052	0.031	0.052	0.044	0.042	0.06	0.049	0.032	0.058	0.047	0.034	0.056	0.043	0.033
Saturday	19	0.059	0.04	0.029	0.048	0.034	0.027	0.047	0.041	0.026	0.049	0.039	0.039	0.052	0.044	0.03	0.046	0.036	0.029	0.049	0.035	0.028
Saturday	20	0.051	0.032	0.021	0.041	0.029	0.024	0.038	0.031	0.02	0.043	0.031	0.035	0.046	0.04	0.028	0.04	0.028	0.024	0.044	0.03	0.024
Saturday	21	0.047	0.026	0.023	0.037	0.024	0.021	0.031	0.025	0.016	0.038	0.025	0.029	0.042	0.035	0.025	0.036	0.022	0.023	0.042	0.026	0.022
Saturday	22	0.037	0.019	0.02	0.031	0.02	0.019	0.025	0.02	0.018	0.03	0.017	0.026	0.036	0.03	0.023	0.029	0.016	0.017	0.037	0.022	0.02
Saturday	23	0.028	0.014	0.021	0.023	0.016	0.017	0.016	0.013	0.018	0.023	0.011	0.02	0.026	0.024	0.024	0.02	0.011	0.017	0.029	0.017	0.018
Holiday	0	0.01	0.004	0.009	0.013	0.02	0.027	0.008	0.011	0.02	0.024	0.008	0.016	0.014	0.028	0.038	0.01	0.004	0.012	0.015	0.023	0.032
Holiday	1	0.014	0.004	0.008	0.009	0.017	0.025	0.005	0.009	0.018	0.022	0.009	0.015	0.008	0.024	0.033	0.006	0.004	0.011	0.01	0.018	0.03
Holiday	2	0.01	0.003	0.014	0.007	0.015	0.024	0.003	0.01	0.018	0.024	0.007	0.015	0.005	0.026	0.033	0.004	0.003	0.012	0.008	0.018	0.029
Holiday	3	0.014	0.005	0.012	0.007	0.016	0.026	0.004	0.01	0.021	0.024	0.009	0.017	0.004	0.025	0.034	0.004	0.005	0.015	0.009	0.02	0.031
Holiday	4	0.014	0.006	0.017	0.011	0.02	0.029	0.005	0.012	0.02	0.031	0.019	0.019	0.008	0.025	0.035	0.007	0.009	0.024	0.016	0.027	0.035

		Mendocino			Merced			Mono			Monterey			Napa			Plumas			Riverside		
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	5	0.019	0.018	0.028	0.019	0.028	0.033	0.009	0.018	0.031	0.033	0.029	0.024	0.017	0.03	0.04	0.014	0.02	0.037	0.026	0.036	0.041
Holiday	6	0.028	0.034	0.042	0.027	0.035	0.038	0.018	0.023	0.038	0.038	0.042	0.03	0.024	0.036	0.044	0.03	0.036	0.047	0.035	0.044	0.044
Holiday	7	0.039	0.045	0.052	0.035	0.042	0.042	0.029	0.031	0.043	0.04	0.044	0.037	0.03	0.042	0.049	0.044	0.052	0.061	0.041	0.049	0.046
Holiday	8	0.041	0.051	0.059	0.04	0.048	0.046	0.041	0.044	0.056	0.037	0.05	0.041	0.039	0.047	0.049	0.052	0.066	0.075	0.046	0.054	0.049
Holiday	9	0.044	0.057	0.066	0.048	0.055	0.05	0.058	0.057	0.075	0.046	0.057	0.048	0.048	0.055	0.057	0.053	0.071	0.081	0.051	0.057	0.05
Holiday	10	0.05	0.069	0.075	0.059	0.064	0.055	0.076	0.083	0.087	0.048	0.066	0.056	0.06	0.06	0.056	0.059	0.076	0.081	0.056	0.061	0.051
Holiday	11	0.056	0.072	0.077	0.065	0.07	0.06	0.084	0.086	0.088	0.055	0.077	0.063	0.066	0.064	0.055	0.066	0.076	0.071	0.061	0.065	0.053
Holiday	12	0.058	0.08	0.078	0.069	0.072	0.061	0.085	0.087	0.089	0.052	0.074	0.065	0.068	0.063	0.06	0.071	0.078	0.074	0.063	0.066	0.053
Holiday	13	0.063	0.077	0.069	0.071	0.071	0.061	0.083	0.081	0.078	0.055	0.071	0.069	0.069	0.062	0.055	0.071	0.076	0.065	0.064	0.066	0.053
Holiday	14	0.068	0.083	0.067	0.072	0.069	0.059	0.08	0.074	0.068	0.05	0.071	0.067	0.071	0.06	0.055	0.07	0.078	0.06	0.064	0.064	0.052
Holiday	15	0.071	0.082	0.064	0.073	0.068	0.058	0.078	0.074	0.06	0.061	0.068	0.068	0.071	0.064	0.054	0.075	0.075	0.053	0.064	0.061	0.05
Holiday	16	0.075	0.083	0.061	0.073	0.065	0.055	0.078	0.072	0.049	0.062	0.069	0.058	0.068	0.057	0.046	0.079	0.07	0.044	0.064	0.058	0.048
Holiday	17	0.072	0.076	0.044	0.07	0.057	0.05	0.071	0.066	0.041	0.058	0.062	0.058	0.067	0.055	0.041	0.074	0.064	0.041	0.064	0.053	0.045
Holiday	18	0.054	0.048	0.04	0.06	0.046	0.044	0.057	0.049	0.033	0.054	0.05	0.049	0.061	0.042	0.038	0.058	0.044	0.034	0.059	0.046	0.043
Holiday	19	0.056	0.036	0.029	0.05	0.036	0.039	0.043	0.04	0.022	0.049	0.037	0.047	0.053	0.037	0.029	0.047	0.033	0.026	0.052	0.036	0.038
Holiday	20	0.049	0.025	0.029	0.042	0.029	0.034	0.033	0.026	0.013	0.046	0.032	0.043	0.049	0.029	0.024	0.038	0.025	0.025	0.045	0.029	0.036
Holiday	21	0.04	0.019	0.023	0.034	0.023	0.03	0.024	0.018	0.011	0.04	0.025	0.038	0.042	0.028	0.024	0.03	0.018	0.021	0.039	0.022	0.032
Holiday	22	0.029	0.012	0.018	0.027	0.017	0.028	0.017	0.012	0.009	0.031	0.016	0.032	0.035	0.022	0.025	0.024	0.011	0.017	0.029	0.016	0.03
Holiday	23	0.025	0.01	0.019	0.018	0.014	0.026	0.01	0.008	0.01	0.02	0.008	0.028	0.023	0.018	0.026	0.014	0.007	0.014	0.021	0.011	0.028

		Sacramento			San Benito			San Joaquin			San Luis Obispo			Santa Barbara			Santa Clara			Santa Cruz		
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	0.019	0.031	0.044	0.019	0.01	0.029	0.016	0.024	0.039	0.017	0.009	0.017	0.02	0.017	0.032	0.018	0.036	0.052	0.011	0.032	0.036
Sunday	1	0.013	0.025	0.039	0.02	0.008	0.023	0.01	0.017	0.034	0.017	0.006	0.012	0.021	0.015	0.026	0.011	0.034	0.046	0.006	0.031	0.036
Sunday	2	0.009	0.021	0.036	0.02	0.007	0.021	0.007	0.015	0.031	0.018	0.005	0.009	0.02	0.012	0.022	0.008	0.032	0.042	0.003	0.03	0.037
Sunday	3	0.007	0.019	0.034	0.02	0.007	0.019	0.006	0.014	0.03	0.018	0.004	0.011	0.019	0.01	0.022	0.005	0.032	0.039	0.002	0.034	0.035
Sunday	4	0.008	0.02	0.034	0.024	0.012	0.019	0.008	0.015	0.03	0.019	0.005	0.009	0.023	0.014	0.023	0.005	0.032	0.037	0.003	0.035	0.038
Sunday	5	0.011	0.023	0.034	0.026	0.017	0.021	0.011	0.018	0.031	0.022	0.009	0.012	0.023	0.017	0.029	0.008	0.033	0.036	0.006	0.035	0.035
Sunday	6	0.017	0.027	0.037	0.029	0.024	0.026	0.017	0.022	0.033	0.026	0.015	0.017	0.029	0.024	0.031	0.014	0.035	0.037	0.013	0.036	0.036
Sunday	7	0.025	0.033	0.039	0.031	0.03	0.034	0.023	0.027	0.036	0.03	0.024	0.025	0.031	0.029	0.031	0.021	0.037	0.039	0.022	0.038	0.039
Sunday	8	0.035	0.042	0.043	0.035	0.038	0.04	0.032	0.036	0.04	0.037	0.037	0.039	0.036	0.042	0.037	0.032	0.04	0.04	0.034	0.036	0.04
Sunday	9	0.049	0.052	0.047	0.038	0.049	0.049	0.045	0.048	0.046	0.043	0.056	0.05	0.042	0.054	0.047	0.047	0.046	0.044	0.051	0.043	0.043
Sunday	10	0.06	0.06	0.049	0.041	0.057	0.057	0.056	0.059	0.05	0.051	0.072	0.068	0.046	0.065	0.055	0.061	0.051	0.047	0.064	0.044	0.047
Sunday	11	0.066	0.063	0.049	0.047	0.068	0.061	0.063	0.067	0.054	0.054	0.079	0.08	0.049	0.072	0.059	0.068	0.053	0.047	0.071	0.047	0.046
Sunday	12	0.072	0.066	0.049	0.051	0.074	0.063	0.068	0.071	0.056	0.058	0.089	0.088	0.055	0.078	0.062	0.073	0.054	0.046	0.073	0.046	0.043
Sunday	13	0.074	0.067	0.049	0.053	0.073	0.065	0.071	0.074	0.055	0.059	0.085	0.081	0.057	0.074	0.057	0.075	0.055	0.045	0.076	0.047	0.041
Sunday	14	0.074	0.064	0.047	0.059	0.078	0.065	0.073	0.073	0.054	0.062	0.085	0.075	0.06	0.072	0.051	0.075	0.055	0.044	0.078	0.052	0.047
Sunday	15	0.072	0.061	0.046	0.061	0.078	0.066	0.073	0.071	0.053	0.065	0.081	0.066	0.061	0.07	0.051	0.075	0.054	0.042	0.081	0.054	0.051
Sunday	16	0.071	0.059	0.045	0.064	0.074	0.06	0.073	0.068	0.05	0.067	0.076	0.063	0.063	0.066	0.049	0.073	0.053	0.041	0.082	0.055	0.051
Sunday	17	0.068	0.056	0.043	0.063	0.068	0.053	0.072	0.063	0.049	0.065	0.07	0.064	0.064	0.059	0.049	0.071	0.051	0.04	0.08	0.058	0.052
Sunday	18	0.061	0.049	0.041	0.064	0.06	0.049	0.067	0.055	0.044	0.063	0.058	0.055	0.061	0.054	0.046	0.064	0.047	0.039	0.069	0.051	0.048
Sunday	19	0.053	0.042	0.04	0.06	0.052	0.046	0.061	0.047	0.041	0.057	0.046	0.044	0.059	0.046	0.043	0.057	0.044	0.038	0.058	0.051	0.047
Sunday	20	0.048	0.038	0.039	0.055	0.043	0.041	0.054	0.04	0.039	0.053	0.037	0.035	0.053	0.04	0.043	0.05	0.04	0.037	0.048	0.047	0.044
Sunday	21	0.04	0.032	0.039	0.05	0.034	0.037	0.044	0.031	0.036	0.045	0.026	0.032	0.045	0.031	0.046	0.041	0.034	0.038	0.036	0.039	0.039
Sunday	22	0.029	0.027	0.038	0.039	0.022	0.031	0.031	0.024	0.035	0.034	0.016	0.025	0.035	0.023	0.045	0.029	0.029	0.04	0.022	0.033	0.036
Sunday	23	0.019	0.023	0.039	0.03	0.016	0.025	0.019	0.019	0.036	0.023	0.01	0.024	0.026	0.017	0.042	0.018	0.024	0.044	0.011	0.028	0.032
Monday	0	0.009	0.018	0.028	0.023	0.006	0.009	0.01	0.012	0.022	0.018	0.004	0.008	0.016	0.005	0.012	0.007	0.022	0.028	0.004	0.024	0.033
Monday	1	0.005	0.015	0.026	0.024	0.007	0.009	0.006	0.01	0.021	0.017	0.003	0.008	0.015	0.004	0.014	0.003	0.022	0.027	0.001	0.025	0.031
Monday	2	0.004	0.015	0.026	0.025	0.009	0.01	0.006	0.01	0.022	0.018	0.003	0.01	0.016	0.005	0.016	0.002	0.023	0.028	0.001	0.025	0.034
Monday	3	0.006	0.018	0.028	0.025	0.011	0.014	0.011	0.015	0.025	0.02	0.006	0.014	0.018	0.007	0.019	0.003	0.025	0.03	0.002	0.025	0.034
Monday	4	0.013	0.026	0.033	0.033	0.023	0.019	0.029	0.028	0.033	0.024	0.011	0.019	0.02	0.013	0.028	0.007	0.029	0.033	0.007	0.031	0.038
Monday	5	0.029	0.04	0.04	0.039	0.042	0.024	0.043	0.043	0.042	0.031	0.027	0.029	0.028	0.025	0.038	0.024	0.035	0.04	0.026	0.034	0.038

		Sacramento			San Benito			San Joaquin			San Luis Obispo			Santa Barbara			Santa Clara			Santa Cruz		
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	6	0.052	0.057	0.048	0.044	0.06	0.031	0.053	0.052	0.048	0.04	0.048	0.041	0.037	0.048	0.045	0.047	0.046	0.049	0.061	0.043	0.049
Monday	7	0.071	0.066	0.051	0.041	0.056	0.038	0.061	0.059	0.053	0.046	0.065	0.053	0.048	0.071	0.046	0.065	0.054	0.057	0.082	0.053	0.056
Monday	8	0.066	0.064	0.052	0.043	0.058	0.045	0.055	0.057	0.053	0.049	0.066	0.057	0.054	0.083	0.052	0.068	0.057	0.06	0.079	0.054	0.059
Monday	9	0.056	0.059	0.052	0.045	0.063	0.053	0.051	0.056	0.055	0.051	0.069	0.064	0.054	0.078	0.055	0.065	0.055	0.055	0.073	0.053	0.053
Monday	10	0.052	0.057	0.052	0.046	0.065	0.059	0.051	0.058	0.056	0.051	0.07	0.073	0.053	0.069	0.06	0.056	0.053	0.054	0.064	0.05	0.052
Monday	11	0.053	0.058	0.053	0.05	0.066	0.061	0.052	0.06	0.058	0.054	0.07	0.074	0.056	0.072	0.066	0.052	0.054	0.054	0.059	0.055	0.054
Monday	12	0.056	0.059	0.053	0.052	0.068	0.065	0.054	0.061	0.058	0.055	0.07	0.07	0.06	0.073	0.069	0.053	0.055	0.054	0.055	0.06	0.059
Monday	13	0.057	0.059	0.053	0.056	0.069	0.063	0.056	0.063	0.057	0.058	0.071	0.07	0.062	0.072	0.064	0.054	0.056	0.053	0.056	0.054	0.052
Monday	14	0.062	0.06	0.053	0.057	0.07	0.065	0.063	0.068	0.058	0.064	0.076	0.067	0.065	0.075	0.062	0.062	0.06	0.054	0.059	0.061	0.057
Monday	15	0.07	0.064	0.052	0.058	0.07	0.066	0.069	0.072	0.059	0.068	0.083	0.061	0.07	0.077	0.06	0.068	0.063	0.055	0.063	0.06	0.051
Monday	16	0.076	0.063	0.051	0.059	0.067	0.06	0.072	0.071	0.056	0.068	0.079	0.053	0.067	0.067	0.052	0.071	0.063	0.054	0.067	0.059	0.051
Monday	17	0.073	0.057	0.048	0.058	0.062	0.057	0.07	0.065	0.052	0.064	0.065	0.047	0.058	0.046	0.041	0.074	0.062	0.052	0.069	0.058	0.047
Monday	18	0.056	0.044	0.043	0.055	0.043	0.053	0.055	0.045	0.041	0.051	0.041	0.04	0.05	0.034	0.037	0.065	0.05	0.042	0.057	0.051	0.04
Monday	19	0.04	0.031	0.037	0.045	0.029	0.048	0.041	0.031	0.033	0.043	0.026	0.036	0.045	0.025	0.035	0.052	0.037	0.031	0.04	0.042	0.034
Monday	20	0.032	0.024	0.033	0.041	0.022	0.045	0.033	0.023	0.028	0.037	0.018	0.03	0.036	0.017	0.033	0.036	0.028	0.025	0.028	0.03	0.025
Monday	21	0.028	0.019	0.03	0.035	0.017	0.039	0.027	0.017	0.026	0.031	0.014	0.027	0.03	0.013	0.034	0.03	0.022	0.022	0.023	0.024	0.02
Monday	22	0.021	0.015	0.028	0.026	0.011	0.035	0.021	0.013	0.023	0.024	0.009	0.026	0.024	0.01	0.032	0.022	0.016	0.02	0.015	0.018	0.017
Monday	23	0.014	0.011	0.027	0.02	0.007	0.033	0.014	0.01	0.022	0.017	0.005	0.021	0.016	0.007	0.03	0.014	0.012	0.022	0.009	0.013	0.017
Tues/Wed/Thurs	0	0.008	0.018	0.031	0.02	0.006	0.023	0.009	0.011	0.024	0.016	0.004	0.017	0.016	0.005	0.022	0.006	0.022	0.029	0.004	0.023	0.029
Tues/Wed/Thurs	1	0.005	0.015	0.03	0.022	0.007	0.021	0.006	0.01	0.023	0.016	0.003	0.014	0.015	0.004	0.022	0.003	0.022	0.029	0.001	0.024	0.032
Tues/Wed/Thurs	2	0.004	0.015	0.029	0.023	0.007	0.021	0.005	0.01	0.023	0.016	0.003	0.014	0.015	0.004	0.021	0.002	0.023	0.029	0.001	0.025	0.032
Tues/Wed/Thurs	3	0.006	0.017	0.031	0.025	0.01	0.022	0.01	0.014	0.026	0.018	0.004	0.017	0.017	0.006	0.024	0.003	0.025	0.031	0.001	0.027	0.034
Tues/Wed/Thurs	4	0.012	0.024	0.036	0.03	0.019	0.024	0.027	0.026	0.034	0.021	0.009	0.022	0.019	0.012	0.033	0.007	0.028	0.034	0.006	0.029	0.036
Tues/Wed/Thurs	5	0.027	0.038	0.043	0.037	0.037	0.029	0.043	0.041	0.042	0.03	0.023	0.032	0.026	0.025	0.045	0.025	0.036	0.042	0.026	0.032	0.038
Tues/Wed/Thurs	6	0.052	0.057	0.05	0.043	0.057	0.038	0.054	0.051	0.049	0.041	0.049	0.046	0.039	0.051	0.052	0.05	0.047	0.052	0.065	0.04	0.045
Tues/Wed/Thurs	7	0.071	0.066	0.053	0.042	0.057	0.046	0.062	0.059	0.054	0.048	0.066	0.057	0.051	0.072	0.052	0.067	0.055	0.059	0.084	0.055	0.056
Tues/Wed/Thurs	8	0.066	0.063	0.053	0.045	0.062	0.05	0.056	0.057	0.054	0.049	0.067	0.06	0.056	0.083	0.056	0.069	0.058	0.061	0.08	0.055	0.055
Tues/Wed/Thurs	9	0.056	0.059	0.053	0.046	0.063	0.055	0.051	0.055	0.055	0.05	0.066	0.065	0.056	0.079	0.057	0.065	0.055	0.055	0.074	0.054	0.056
Tues/Wed/Thurs	10	0.051	0.057	0.053	0.047	0.061	0.058	0.049	0.056	0.056	0.052	0.066	0.067	0.054	0.07	0.06	0.055	0.053	0.054	0.062	0.052	0.053
Tues/Wed/Thurs	11	0.052	0.057	0.053	0.049	0.065	0.06	0.05	0.058	0.056	0.053	0.067	0.071	0.057	0.072	0.064	0.051	0.053	0.053	0.057	0.053	0.055
Tues/Wed/Thurs	12	0.054	0.058	0.053	0.051	0.066	0.06	0.052	0.059	0.056	0.056	0.069	0.067	0.06	0.071	0.062	0.051	0.055	0.053	0.054	0.057	0.055
Tues/Wed/Thurs	13	0.056	0.059	0.052	0.054	0.069	0.059	0.055	0.062	0.056	0.06	0.071	0.065	0.063	0.072	0.06	0.054	0.056	0.052	0.054	0.058	0.054
Tues/Wed/Thurs	14	0.061	0.061	0.051	0.058	0.072	0.059	0.062	0.068	0.057	0.063	0.076	0.064	0.064	0.075	0.058	0.061	0.059	0.052	0.058	0.061	0.056
Tues/Wed/Thurs	15	0.07	0.064	0.05	0.059	0.072	0.057	0.069	0.074	0.058	0.069	0.084	0.058	0.067	0.076	0.052	0.067	0.063	0.054	0.062	0.061	0.055
Tues/Wed/Thurs	16	0.075	0.063	0.048	0.06	0.07	0.053	0.072	0.074	0.057	0.07	0.081	0.05	0.064	0.065	0.044	0.07	0.064	0.053	0.065	0.06	0.053
Tues/Wed/Thurs	17	0.073	0.057	0.044	0.058	0.063	0.051	0.07	0.067	0.053	0.063	0.067	0.045	0.056	0.045	0.036	0.072	0.062	0.051	0.067	0.057	0.047
Tues/Wed/Thurs	18	0.059	0.046	0.041	0.052	0.044	0.046	0.056	0.048	0.041	0.053	0.044	0.039	0.05	0.036	0.034	0.065	0.052	0.042	0.058	0.05	0.043
Tues/Wed/Thurs	19	0.041	0.033	0.035	0.049	0.032	0.041	0.043	0.033	0.033	0.044	0.029	0.034	0.044	0.026	0.031	0.053	0.037	0.03	0.041	0.041	0.034
Tues/Wed/Thurs	20	0.034	0.026	0.031	0.043	0.024	0.037	0.034	0.025	0.028	0.038	0.021	0.028	0.037	0.019	0.029	0.038	0.027	0.024	0.029	0.032	0.028
Tues/Wed/Thurs	21	0.03	0.021	0.029	0.038	0.018	0.034	0.028	0.019	0.025	0.032	0.016	0.026	0.031	0.015	0.031	0.032	0.021	0.021	0.024	0.024	0.021
Tues/Wed/Thurs	22	0.022	0.016	0.027	0.029	0.011	0.03	0.021	0.014	0.022	0.025	0.01	0.023	0.025	0.011	0.027	0.023	0.016	0.019	0.017	0.018	0.019
Tues/Wed/Thurs	23	0.015	0.012	0.027	0.022	0.008	0.026	0.015	0.01	0.021	0.018	0.006	0.019	0.018	0.008	0.026	0.014	0.011	0.02	0.009	0.012	0.015
Friday	0	0.009	0.019	0.034	0.02	0.006	0.022	0.008	0.012	0.025	0.016	0.004	0.016	0.016	0.006	0.024	0.007	0.022	0.032	0.005	0.023	0.03
Friday	1	0.005	0.016	0.032	0.02	0.006	0.021	0.006	0.01	0.024	0.016	0.003	0.014	0.016	0.005	0.022	0.004	0.023	0.031	0.002	0.022	0.031
Friday	2	0.004	0.016	0.031	0.022	0.007	0.021	0.005	0.01	0.024	0.016	0.003	0.014	0.016	0.005	0.021	0.003	0.024	0.032	0.001	0.024	0.032
Friday	3	0.006	0.017	0.033	0.024	0.009	0.022	0.009	0.013	0.027	0.017	0.004	0.017	0.016	0.006	0.025	0.003	0.025	0.033	0.002	0.027	0.034
Friday	4	0.011	0.024	0.037	0.028	0.018	0.024	0.022	0.023	0.034	0.02	0.007	0.022	0.02	0.011	0.033	0.007	0.029	0.036	0.005	0.03	0.038
Friday	5	0.024	0.036	0.044	0.035	0.033	0.029	0.036	0.036	0.042	0.027	0.018	0.031	0.025	0.022	0.043	0.022	0.035	0.044	0.022	0.033	0.041
Friday	6	0.045	0.053	0.051	0.041	0.05	0.038	0.046	0.045	0.048	0.038	0.042	0.045	0.038	0.046	0.05	0.044	0.045	0.053	0.054	0.04	0.046
Friday	7	0.063	0.063	0.054	0.039	0.049	0.046	0.053	0.052	0.053	0.044	0.058	0.054	0.046	0.068	0.051	0.06	0.052	0.058	0.075	0.049	0.055
Friday	8	0.059	0.061	0.055	0.041	0.056	0.05	0.049	0.051	0.054	0.048	0.061	0.059	0.053	0.079	0.056	0.063	0.054	0.06	0.071	0.047	0.05
Friday	9	0.052	0.058	0.054	0.045	0.058	0.055	0.046	0.052	0.055	0.049	0.064	0.065	0.054	0.079	0.062	0.06	0.054	0.057	0.068	0.049	0.051
Friday	10	0.05	0.057	0.054	0.047	0.062	0.059	0.048	0.055	0.057	0.052	0.068	0.07	0.053	0.071	0.063	0.054	0.053	0.056	0.061	0.051	0.053
Friday	11	0.053	0.059	0.054	0.05	0.067	0.06	0.05	0.058	0.059	0.054	0.07	0.072	0.058	0.074	0.066	0.053	0.055	0.056	0.061	0.056	0.054
Friday	12	0.056	0.06	0.053	0.051	0.067	0.06	0.054	0.061	0.058	0.056	0.072	0.07	0.059	0.073	0.061	0.055	0.057	0.056	0.058	0.056	0.053

		Sacramento			San Benito			San Joaquin			San Luis Obispo			Santa Barbara			Santa Clara			Santa Cruz		
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	13	0.058	0.06	0.052	0.056	0.071	0.062	0.058	0.065	0.058	0.06	0.074	0.068	0.064	0.073	0.058	0.058	0.058	0.054	0.06	0.059	0.058
Friday	14	0.063	0.062	0.051	0.06	0.075	0.059	0.065	0.07	0.059	0.064	0.079	0.066	0.066	0.073	0.056	0.064	0.061	0.053	0.064	0.062	0.056
Friday	15	0.07	0.063	0.049	0.06	0.074	0.06	0.069	0.075	0.059	0.067	0.083	0.058	0.067	0.074	0.052	0.067	0.063	0.054	0.065	0.061	0.055
Friday	16	0.072	0.06	0.046	0.06	0.07	0.055	0.071	0.073	0.057	0.068	0.078	0.051	0.064	0.062	0.045	0.069	0.062	0.051	0.065	0.062	0.054
Friday	17	0.069	0.055	0.043	0.06	0.064	0.049	0.069	0.069	0.053	0.062	0.064	0.047	0.057	0.046	0.038	0.069	0.06	0.048	0.064	0.059	0.049
Friday	18	0.06	0.046	0.039	0.054	0.049	0.044	0.061	0.052	0.041	0.056	0.048	0.039	0.05	0.036	0.035	0.063	0.049	0.038	0.056	0.053	0.046
Friday	19	0.046	0.035	0.033	0.05	0.036	0.04	0.05	0.038	0.031	0.047	0.033	0.032	0.046	0.028	0.031	0.053	0.037	0.028	0.044	0.043	0.035
Friday	20	0.038	0.026	0.028	0.045	0.028	0.037	0.042	0.029	0.026	0.042	0.025	0.028	0.038	0.022	0.029	0.039	0.028	0.021	0.032	0.034	0.027
Friday	21	0.035	0.022	0.026	0.038	0.021	0.032	0.035	0.022	0.022	0.036	0.019	0.024	0.032	0.017	0.029	0.033	0.022	0.018	0.027	0.027	0.022
Friday	22	0.029	0.018	0.024	0.031	0.015	0.029	0.028	0.017	0.019	0.028	0.014	0.021	0.027	0.014	0.026	0.028	0.017	0.016	0.023	0.019	0.016
Friday	23	0.02	0.013	0.023	0.023	0.01	0.026	0.02	0.012	0.017	0.021	0.009	0.017	0.019	0.01	0.024	0.021	0.013	0.016	0.015	0.014	0.013
Saturday	0	0.016	0.027	0.046	0.023	0.011	0.03	0.014	0.021	0.037	0.018	0.007	0.027	0.022	0.013	0.039	0.015	0.029	0.046	0.009	0.028	0.038
Saturday	1	0.011	0.022	0.042	0.025	0.01	0.027	0.009	0.016	0.032	0.02	0.006	0.022	0.021	0.01	0.032	0.009	0.028	0.042	0.005	0.028	0.038
Saturday	2	0.008	0.02	0.039	0.025	0.009	0.026	0.007	0.014	0.031	0.02	0.005	0.02	0.022	0.009	0.03	0.007	0.028	0.04	0.003	0.029	0.042
Saturday	3	0.007	0.019	0.038	0.027	0.011	0.024	0.007	0.015	0.031	0.021	0.005	0.021	0.022	0.01	0.032	0.005	0.029	0.038	0.002	0.032	0.042
Saturday	4	0.009	0.022	0.039	0.031	0.02	0.025	0.011	0.018	0.033	0.022	0.007	0.023	0.024	0.014	0.04	0.006	0.03	0.039	0.003	0.032	0.042
Saturday	5	0.014	0.027	0.042	0.038	0.034	0.03	0.018	0.025	0.037	0.025	0.013	0.031	0.028	0.021	0.046	0.011	0.033	0.042	0.009	0.035	0.041
Saturday	6	0.023	0.035	0.046	0.038	0.047	0.04	0.027	0.033	0.042	0.032	0.024	0.039	0.035	0.035	0.053	0.02	0.037	0.046	0.019	0.034	0.043
Saturday	7	0.034	0.044	0.05	0.042	0.047	0.046	0.036	0.042	0.048	0.038	0.041	0.051	0.04	0.048	0.054	0.032	0.041	0.05	0.033	0.038	0.041
Saturday	8	0.045	0.052	0.053	0.043	0.055	0.05	0.045	0.05	0.054	0.047	0.053	0.055	0.046	0.059	0.057	0.045	0.046	0.053	0.049	0.041	0.046
Saturday	9	0.054	0.059	0.055	0.047	0.062	0.055	0.054	0.059	0.058	0.05	0.067	0.062	0.05	0.068	0.06	0.055	0.051	0.056	0.059	0.046	0.046
Saturday	10	0.061	0.063	0.055	0.047	0.067	0.062	0.061	0.067	0.062	0.054	0.078	0.069	0.053	0.07	0.059	0.062	0.054	0.056	0.066	0.047	0.047
Saturday	11	0.066	0.065	0.055	0.049	0.068	0.063	0.065	0.071	0.063	0.059	0.084	0.078	0.057	0.073	0.059	0.067	0.057	0.056	0.068	0.052	0.052
Saturday	12	0.068	0.065	0.053	0.055	0.071	0.06	0.067	0.072	0.062	0.06	0.082	0.07	0.059	0.074	0.056	0.069	0.057	0.054	0.067	0.053	0.05
Saturday	13	0.068	0.064	0.051	0.054	0.07	0.059	0.067	0.07	0.059	0.061	0.079	0.064	0.061	0.07	0.051	0.069	0.057	0.051	0.067	0.055	0.049
Saturday	14	0.068	0.061	0.048	0.055	0.066	0.058	0.067	0.068	0.056	0.06	0.074	0.061	0.061	0.068	0.048	0.069	0.057	0.049	0.069	0.053	0.049
Saturday	15	0.067	0.059	0.045	0.055	0.065	0.056	0.067	0.065	0.052	0.062	0.072	0.053	0.061	0.061	0.045	0.069	0.057	0.045	0.072	0.056	0.049
Saturday	16	0.067	0.056	0.042	0.057	0.065	0.052	0.066	0.061	0.048	0.061	0.066	0.05	0.059	0.059	0.041	0.068	0.055	0.043	0.074	0.055	0.048
Saturday	17	0.064	0.052	0.039	0.056	0.053	0.047	0.063	0.055	0.043	0.059	0.059	0.044	0.057	0.053	0.036	0.067	0.052	0.038	0.074	0.055	0.046
Saturday	18	0.057	0.045	0.034	0.052	0.044	0.042	0.057	0.045	0.036	0.053	0.05	0.037	0.052	0.046	0.033	0.061	0.047	0.034	0.066	0.052	0.04
Saturday	19	0.048	0.037	0.03	0.049	0.039	0.039	0.049	0.036	0.03	0.048	0.038	0.031	0.045	0.036	0.029	0.05	0.04	0.029	0.054	0.045	0.035
Saturday	20	0.042	0.031	0.027	0.043	0.031	0.035	0.043	0.03	0.026	0.043	0.032	0.029	0.041	0.031	0.029	0.042	0.035	0.025	0.044	0.041	0.033
Saturday	21	0.04	0.029	0.025	0.038	0.025	0.029	0.04	0.026	0.023	0.037	0.027	0.025	0.035	0.027	0.024	0.04	0.031	0.023	0.039	0.037	0.032
Saturday	22	0.036	0.026	0.024	0.03	0.017	0.026	0.035	0.023	0.021	0.028	0.018	0.021	0.029	0.023	0.023	0.036	0.027	0.023	0.032	0.031	0.028
Saturday	23	0.026	0.02	0.022	0.023	0.011	0.02	0.025	0.017	0.019	0.021	0.013	0.017	0.023	0.019	0.021	0.026	0.022	0.022	0.02	0.025	0.025
Holiday	0	0.013	0.023	0.032	0.024	0.008	0.016	0.012	0.015	0.027	0.018	0.006	0.012	0.02	0.01	0.02	0.012	0.025	0.032	0.008	0.024	0.031
Holiday	1	0.008	0.019	0.03	0.022	0.009	0.015	0.008	0.013	0.025	0.019	0.004	0.009	0.021	0.008	0.02	0.007	0.025	0.031	0.003	0.025	0.034
Holiday	2	0.006	0.018	0.03	0.024	0.007	0.015	0.006	0.012	0.025	0.019	0.003	0.011	0.019	0.006	0.018	0.004	0.026	0.032	0.002	0.025	0.034
Holiday	3	0.006	0.019	0.03	0.024	0.009	0.017	0.008	0.014	0.026	0.022	0.005	0.013	0.021	0.008	0.023	0.003	0.027	0.032	0.001	0.024	0.029
Holiday	4	0.01	0.023	0.033	0.031	0.019	0.019	0.015	0.02	0.03	0.022	0.008	0.015	0.022	0.012	0.028	0.005	0.029	0.034	0.004	0.03	0.034
Holiday	5	0.019	0.032	0.037	0.033	0.029	0.024	0.023	0.028	0.035	0.028	0.017	0.021	0.027	0.023	0.037	0.014	0.034	0.038	0.012	0.033	0.041
Holiday	6	0.031	0.041	0.043	0.038	0.042	0.03	0.031	0.035	0.039	0.034	0.03	0.031	0.031	0.034	0.042	0.027	0.039	0.044	0.028	0.037	0.045
Holiday	7	0.042	0.049	0.046	0.04	0.044	0.037	0.036	0.04	0.043	0.041	0.044	0.04	0.042	0.06	0.045	0.039	0.043	0.048	0.043	0.035	0.038
Holiday	8	0.048	0.054	0.049	0.037	0.05	0.041	0.041	0.045	0.047	0.046	0.055	0.046	0.048	0.073	0.051	0.05	0.048	0.052	0.052	0.048	0.053
Holiday	9	0.052	0.057	0.051	0.046	0.057	0.048	0.047	0.051	0.05	0.05	0.065	0.062	0.051	0.075	0.059	0.054	0.052	0.054	0.058	0.051	0.053
Holiday	10	0.057	0.06	0.052	0.048	0.066	0.056	0.055	0.061	0.056	0.052	0.076	0.072	0.053	0.071	0.058	0.058	0.055	0.056	0.064	0.049	0.054
Holiday	11	0.063	0.065	0.054	0.055	0.077	0.063	0.063	0.069	0.061	0.052	0.082	0.088	0.057	0.076	0.066	0.061	0.058	0.057	0.069	0.055	0.05
Holiday	12	0.067	0.065	0.054	0.052	0.074	0.065	0.066	0.072	0.062	0.058	0.086	0.085	0.059	0.079	0.07	0.063	0.06	0.057	0.067	0.057	0.059
Holiday	13	0.068	0.066	0.055	0.055	0.071	0.069	0.068	0.074	0.062	0.061	0.081	0.082	0.061	0.072	0.056	0.066	0.062	0.057	0.068	0.069	0.064
Holiday	14	0.069	0.065	0.053	0.05	0.071	0.067	0.07	0.073	0.06	0.059	0.076	0.075	0.06	0.073	0.06	0.069	0.062	0.056	0.073	0.058	0.06
Holiday	15	0.07	0.063	0.052	0.061	0.068	0.068	0.071	0.072	0.058	0.064	0.077	0.065	0.064	0.072	0.055	0.071	0.062	0.054	0.072	0.07	0.056
Holiday	16	0.069	0.06	0.049	0.062	0.069	0.058	0.071	0.068	0.054	0.068	0.072	0.057	0.06	0.061	0.05	0.072	0.06	0.051	0.071	0.059	0.052
Holiday	17	0.066	0.054	0.046	0.058	0.062	0.058	0.068	0.061	0.05	0.062	0.063	0.046	0.059	0.047	0.037	0.071	0.057	0.047	0.07	0.058	0.048
Holiday	18	0.058	0.046	0.042	0.054	0.05	0.049	0.06	0.05	0.042	0.053	0.044	0.039	0.053	0.038	0.036	0.064	0.048	0.039	0.063	0.054	0.045
Holiday	19	0.049	0.036	0.037	0.049	0.037	0.047	0.051	0.04	0.037	0.047	0.035	0.037	0.049	0.029	0.036	0.054	0.038	0.032	0.052	0.035	0.029

		Sacramento			San Benito			San Joaquin			San Luis Obispo			Santa Barbara			Santa Clara			Santa Cruz		
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	20	0.043	0.03	0.034	0.046	0.032	0.043	0.044	0.031	0.032	0.041	0.027	0.028	0.04	0.024	0.032	0.045	0.031	0.026	0.043	0.035	0.027
Holiday	21	0.037	0.024	0.031	0.04	0.025	0.038	0.037	0.025	0.029	0.035	0.019	0.023	0.036	0.02	0.038	0.039	0.025	0.024	0.036	0.029	0.026
Holiday	22	0.029	0.019	0.029	0.031	0.016	0.032	0.029	0.019	0.026	0.027	0.014	0.022	0.028	0.017	0.034	0.031	0.019	0.022	0.024	0.021	0.022
Holiday	23	0.02	0.014	0.029	0.02	0.008	0.028	0.02	0.013	0.024	0.021	0.01	0.02	0.021	0.013	0.031	0.02	0.014	0.024	0.015	0.016	0.015

		Solano			Stanislaus			Sutter			Tulare			Tuolumne			Ventura			Yolo		
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	0.017	0.037	0.059	0.014	0.025	0.037	0.013	0.02	0.031	0.022	0.015	0.017	0.01	0.014	0.032	0.014	0.036	0.048	0.016	0.026	0.044
Sunday	1	0.011	0.032	0.052	0.009	0.019	0.032	0.008	0.016	0.028	0.024	0.015	0.009	0.007	0.011	0.024	0.009	0.026	0.042	0.011	0.019	0.036
Sunday	2	0.009	0.03	0.048	0.007	0.016	0.029	0.006	0.013	0.026	0.023	0.011	0.008	0.005	0.011	0.022	0.006	0.021	0.038	0.008	0.017	0.033
Sunday	3	0.007	0.027	0.044	0.005	0.015	0.028	0.005	0.012	0.025	0.023	0.009	0.01	0.004	0.01	0.021	0.004	0.018	0.036	0.006	0.015	0.03
Sunday	4	0.007	0.028	0.042	0.006	0.016	0.028	0.005	0.012	0.025	0.024	0.01	0.018	0.004	0.01	0.02	0.004	0.018	0.035	0.007	0.016	0.029
Sunday	5	0.01	0.029	0.042	0.01	0.019	0.029	0.008	0.015	0.027	0.026	0.018	0.025	0.007	0.013	0.021	0.008	0.021	0.036	0.011	0.02	0.032
Sunday	6	0.016	0.032	0.042	0.015	0.023	0.031	0.013	0.02	0.03	0.03	0.031	0.042	0.012	0.019	0.026	0.014	0.027	0.038	0.016	0.025	0.034
Sunday	7	0.021	0.035	0.043	0.021	0.029	0.035	0.022	0.028	0.034	0.034	0.035	0.05	0.019	0.023	0.029	0.022	0.034	0.041	0.023	0.031	0.04
Sunday	8	0.031	0.041	0.045	0.031	0.038	0.04	0.034	0.041	0.04	0.035	0.042	0.052	0.032	0.035	0.038	0.034	0.044	0.044	0.034	0.041	0.046
Sunday	9	0.046	0.048	0.046	0.043	0.05	0.047	0.048	0.055	0.046	0.04	0.057	0.047	0.051	0.051	0.053	0.049	0.057	0.047	0.048	0.054	0.051
Sunday	10	0.059	0.053	0.045	0.055	0.06	0.051	0.064	0.068	0.052	0.044	0.066	0.054	0.067	0.067	0.071	0.065	0.07	0.05	0.06	0.063	0.054
Sunday	11	0.067	0.055	0.044	0.063	0.065	0.054	0.075	0.075	0.055	0.047	0.07	0.055	0.08	0.081	0.085	0.074	0.076	0.051	0.067	0.067	0.054
Sunday	12	0.069	0.055	0.041	0.07	0.07	0.055	0.082	0.079	0.058	0.051	0.076	0.058	0.083	0.081	0.076	0.078	0.077	0.051	0.071	0.07	0.053
Sunday	13	0.07	0.055	0.038	0.075	0.071	0.056	0.084	0.079	0.058	0.054	0.073	0.07	0.085	0.082	0.074	0.08	0.074	0.049	0.072	0.07	0.052
Sunday	14	0.071	0.053	0.036	0.077	0.069	0.055	0.084	0.077	0.057	0.056	0.071	0.068	0.085	0.083	0.069	0.079	0.068	0.047	0.073	0.069	0.05
Sunday	15	0.071	0.052	0.035	0.078	0.07	0.053	0.082	0.073	0.057	0.059	0.071	0.067	0.084	0.081	0.066	0.077	0.062	0.045	0.073	0.067	0.047
Sunday	16	0.071	0.051	0.033	0.077	0.067	0.052	0.079	0.068	0.055	0.06	0.066	0.066	0.082	0.079	0.06	0.075	0.057	0.043	0.072	0.063	0.045
Sunday	17	0.07	0.051	0.033	0.075	0.062	0.049	0.072	0.062	0.053	0.061	0.063	0.064	0.076	0.07	0.053	0.07	0.05	0.041	0.07	0.059	0.043
Sunday	18	0.066	0.048	0.033	0.068	0.055	0.046	0.06	0.052	0.049	0.06	0.052	0.056	0.064	0.056	0.043	0.062	0.04	0.038	0.063	0.051	0.041
Sunday	19	0.06	0.046	0.034	0.061	0.047	0.042	0.05	0.043	0.045	0.059	0.05	0.051	0.049	0.043	0.035	0.055	0.034	0.037	0.057	0.044	0.038
Sunday	20	0.055	0.043	0.035	0.051	0.039	0.04	0.041	0.035	0.042	0.055	0.037	0.04	0.038	0.033	0.024	0.046	0.028	0.036	0.051	0.038	0.036
Sunday	21	0.045	0.039	0.039	0.041	0.031	0.038	0.031	0.026	0.039	0.048	0.029	0.028	0.026	0.022	0.02	0.037	0.024	0.036	0.042	0.032	0.037
Sunday	22	0.032	0.033	0.043	0.029	0.024	0.036	0.021	0.019	0.036	0.038	0.018	0.029	0.017	0.014	0.017	0.026	0.02	0.035	0.03	0.025	0.037
Sunday	23	0.02	0.028	0.049	0.019	0.019	0.037	0.013	0.015	0.033	0.028	0.014	0.019	0.01	0.01	0.02	0.015	0.018	0.037	0.019	0.02	0.04
Monday	0	0.01	0.026	0.035	0.011	0.017	0.023	0.008	0.014	0.027	0.022	0.004	0.006	0.006	0.01	0.017	0.006	0.015	0.027	0.01	0.018	0.028
Monday	1	0.006	0.025	0.034	0.007	0.015	0.022	0.005	0.012	0.025	0.023	0.004	0.004	0.004	0.009	0.016	0.003	0.012	0.026	0.006	0.015	0.026
Monday	2	0.005	0.024	0.034	0.006	0.015	0.022	0.004	0.012	0.025	0.023	0.004	0.005	0.003	0.009	0.016	0.002	0.012	0.026	0.005	0.014	0.026
Monday	3	0.006	0.026	0.035	0.009	0.018	0.025	0.006	0.014	0.027	0.024	0.006	0.011	0.005	0.011	0.019	0.003	0.013	0.028	0.007	0.016	0.028
Monday	4	0.015	0.032	0.04	0.018	0.027	0.032	0.011	0.019	0.03	0.027	0.015	0.02	0.008	0.017	0.024	0.008	0.019	0.032	0.016	0.025	0.034
Monday	5	0.037	0.043	0.046	0.03	0.039	0.039	0.023	0.03	0.036	0.035	0.035	0.032	0.019	0.028	0.036	0.024	0.034	0.039	0.032	0.04	0.043
Monday	6	0.05	0.051	0.05	0.044	0.051	0.045	0.042	0.047	0.043	0.04	0.056	0.05	0.036	0.041	0.05	0.049	0.055	0.045	0.048	0.052	0.05
Monday	7	0.061	0.058	0.053	0.058	0.058	0.05	0.06	0.061	0.048	0.044	0.063	0.057	0.051	0.044	0.065	0.075	0.072	0.05	0.066	0.065	0.056
Monday	8	0.056	0.057	0.055	0.053	0.058	0.051	0.059	0.062	0.05	0.046	0.071	0.059	0.053	0.056	0.068	0.071	0.071	0.052	0.064	0.064	0.057
Monday	9	0.054	0.056	0.055	0.051	0.059	0.053	0.056	0.061	0.05	0.046	0.066	0.06	0.059	0.065	0.08	0.057	0.064	0.052	0.057	0.062	0.056
Monday	10	0.055	0.058	0.056	0.054	0.062	0.056	0.058	0.064	0.051	0.049	0.07	0.066	0.067	0.074	0.087	0.053	0.062	0.053	0.055	0.061	0.057
Monday	11	0.056	0.057	0.055	0.057	0.064	0.057	0.062	0.066	0.053	0.051	0.07	0.065	0.071	0.075	0.082	0.056	0.063	0.054	0.056	0.062	0.056
Monday	12	0.057	0.058	0.054	0.06	0.064	0.058	0.066	0.068	0.054	0.056	0.072	0.066	0.074	0.074	0.08	0.058	0.064	0.054	0.058	0.062	0.056
Monday	13	0.058	0.057	0.052	0.061	0.064	0.058	0.067	0.067	0.054	0.055	0.073	0.071	0.074	0.075	0.075	0.058	0.061	0.053	0.059	0.061	0.055
Monday	14	0.064	0.057	0.051	0.067	0.066	0.058	0.07	0.069	0.055	0.058	0.073	0.07	0.077	0.076	0.065	0.063	0.063	0.053	0.062	0.062	0.054
Monday	15	0.069	0.056	0.048	0.072	0.065	0.057	0.073	0.069	0.055	0.061	0.077	0.074	0.082	0.076	0.058	0.072	0.065	0.052	0.068	0.063	0.053
Monday	16	0.071	0.054	0.044	0.075	0.063	0.055	0.075	0.067	0.054	0.061	0.073	0.064	0.081	0.073	0.045	0.078	0.064	0.05	0.073	0.062	0.051
Monday	17	0.07	0.05	0.04	0.074	0.055	0.051	0.073	0.061	0.052	0.059	0.059	0.057	0.071	0.059	0.035	0.08	0.06	0.049	0.072	0.057	0.046
Monday	18	0.054	0.041	0.035	0.055	0.042	0.042	0.056	0.046	0.045	0.05	0.037	0.047	0.052	0.042	0.023	0.063	0.046	0.043	0.053	0.043	0.039
Monday	19	0.042	0.032	0.028	0.042	0.031	0.036	0.04	0.031	0.039	0.045	0.024	0.036	0.037	0.03	0.017	0.042	0.029	0.038	0.039	0.03	0.031

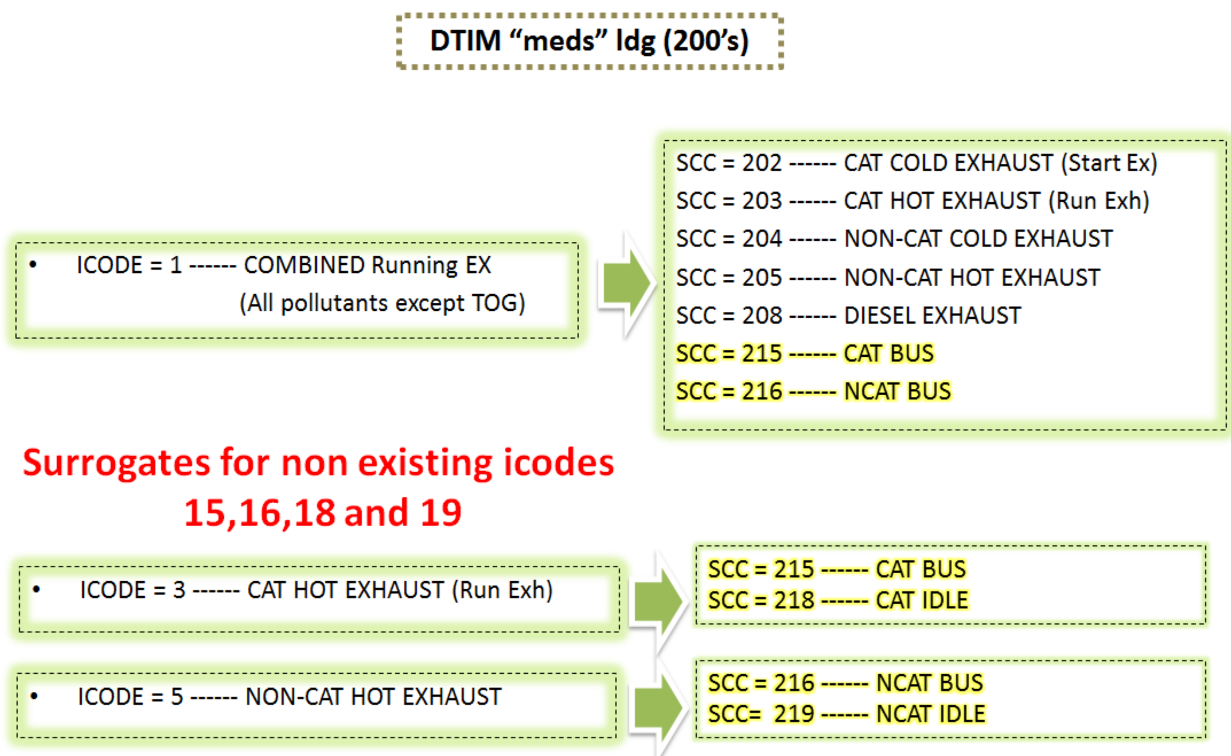
		Solano			Stanislaus			Sutter			Tulare			Tuolumne			Ventura			Yolo		
Day of Week	**Hour**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**	**LD**	**LM**	**HH**
Monday	20	0.035	0.026	0.025	0.034	0.023	0.031	0.031	0.022	0.035	0.04	0.017	0.031	0.027	0.022	0.013	0.031	0.02	0.033	0.032	0.023	0.026
Monday	21	0.029	0.022	0.023	0.027	0.018	0.028	0.025	0.017	0.032	0.035	0.013	0.023	0.02	0.016	0.01	0.025	0.015	0.032	0.027	0.018	0.024
Monday	22	0.023	0.018	0.024	0.02	0.014	0.027	0.017	0.012	0.03	0.029	0.01	0.017	0.015	0.012	0.009	0.016	0.01	0.03	0.021	0.014	0.023
Monday	23	0.016	0.016	0.028	0.014	0.011	0.025	0.012	0.009	0.03	0.022	0.006	0.011	0.009	0.007	0.01	0.009	0.008	0.03	0.014	0.011	0.025
Tues/Wed/Thurs	0	0.009	0.025	0.037	0.008	0.016	0.025	0.008	0.014	0.029	0.021	0.004	0.009	0.005	0.009	0.017	0.005	0.015	0.032	0.009	0.017	0.031
Tues/Wed/Thurs	1	0.005	0.023	0.036	0.005	0.014	0.024	0.004	0.011	0.027	0.021	0.004	0.007	0.003	0.008	0.017	0.002	0.012	0.03	0.006	0.014	0.028
Tues/Wed/Thurs	2	0.004	0.023	0.036	0.005	0.014	0.025	0.004	0.011	0.027	0.022	0.004	0.009	0.002	0.009	0.017	0.001	0.012	0.03	0.005	0.014	0.028
Tues/Wed/Thurs	3	0.005	0.025	0.037	0.008	0.018	0.028	0.005	0.013	0.029	0.024	0.005	0.012	0.003	0.01	0.022	0.002	0.013	0.031	0.006	0.016	0.03
Tues/Wed/Thurs	4	0.013	0.03	0.041	0.017	0.026	0.034	0.01	0.018	0.031	0.028	0.014	0.018	0.006	0.014	0.025	0.007	0.019	0.035	0.014	0.023	0.036
Tues/Wed/Thurs	5	0.035	0.042	0.048	0.03	0.039	0.042	0.022	0.029	0.037	0.035	0.033	0.032	0.018	0.027	0.039	0.022	0.034	0.043	0.029	0.037	0.044
Tues/Wed/Thurs	6	0.05	0.05	0.052	0.044	0.05	0.047	0.042	0.047	0.044	0.041	0.056	0.052	0.037	0.042	0.052	0.049	0.055	0.049	0.046	0.051	0.052
Tues/Wed/Thurs	7	0.061	0.057	0.054	0.059	0.059	0.052	0.06	0.061	0.05	0.044	0.067	0.06	0.053	0.047	0.064	0.075	0.072	0.052	0.066	0.065	0.057
Tues/Wed/Thurs	8	0.056	0.056	0.055	0.055	0.058	0.052	0.06	0.062	0.051	0.046	0.071	0.063	0.054	0.056	0.07	0.071	0.071	0.054	0.065	0.064	0.057
Tues/Wed/Thurs	9	0.053	0.056	0.055	0.051	0.059	0.054	0.055	0.06	0.05	0.047	0.067	0.065	0.059	0.068	0.083	0.057	0.064	0.053	0.057	0.062	0.057
Tues/Wed/Thurs	10	0.052	0.057	0.055	0.052	0.06	0.056	0.056	0.061	0.051	0.049	0.069	0.065	0.064	0.069	0.081	0.052	0.061	0.053	0.053	0.061	0.057
Tues/Wed/Thurs	11	0.052	0.057	0.054	0.054	0.061	0.057	0.059	0.064	0.052	0.052	0.071	0.062	0.068	0.069	0.077	0.054	0.062	0.053	0.054	0.061	0.057
Tues/Wed/Thurs	12	0.054	0.057	0.053	0.057	0.062	0.057	0.061	0.065	0.053	0.054	0.069	0.065	0.069	0.071	0.074	0.056	0.063	0.053	0.056	0.061	0.056
Tues/Wed/Thurs	13	0.057	0.057	0.051	0.06	0.063	0.056	0.064	0.066	0.053	0.056	0.072	0.067	0.072	0.073	0.074	0.057	0.061	0.051	0.058	0.061	0.055
Tues/Wed/Thurs	14	0.064	0.058	0.049	0.066	0.065	0.056	0.068	0.068	0.053	0.059	0.074	0.07	0.077	0.076	0.067	0.063	0.063	0.05	0.062	0.062	0.053
Tues/Wed/Thurs	15	0.07	0.058	0.046	0.073	0.066	0.055	0.073	0.069	0.053	0.061	0.08	0.071	0.084	0.078	0.058	0.071	0.065	0.049	0.069	0.063	0.051
Tues/Wed/Thurs	16	0.073	0.056	0.043	0.077	0.064	0.053	0.075	0.067	0.052	0.06	0.072	0.063	0.082	0.074	0.048	0.078	0.063	0.046	0.074	0.062	0.048
Tues/Wed/Thurs	17	0.072	0.052	0.039	0.076	0.057	0.049	0.074	0.063	0.05	0.057	0.059	0.054	0.074	0.061	0.036	0.079	0.06	0.044	0.073	0.058	0.044
Tues/Wed/Thurs	18	0.058	0.043	0.033	0.058	0.044	0.041	0.059	0.048	0.044	0.051	0.037	0.043	0.053	0.044	0.023	0.065	0.047	0.04	0.056	0.045	0.037
Tues/Wed/Thurs	19	0.046	0.034	0.028	0.044	0.032	0.034	0.043	0.034	0.038	0.045	0.025	0.036	0.038	0.031	0.016	0.044	0.031	0.034	0.041	0.032	0.03
Tues/Wed/Thurs	20	0.038	0.028	0.024	0.036	0.025	0.03	0.035	0.025	0.034	0.041	0.019	0.027	0.03	0.025	0.012	0.034	0.021	0.03	0.034	0.025	0.025
Tues/Wed/Thurs	21	0.032	0.023	0.022	0.028	0.019	0.026	0.029	0.019	0.031	0.035	0.014	0.021	0.023	0.018	0.01	0.028	0.016	0.029	0.029	0.02	0.023
Tues/Wed/Thurs	22	0.025	0.018	0.023	0.021	0.014	0.025	0.02	0.013	0.029	0.029	0.01	0.015	0.017	0.013	0.01	0.018	0.011	0.028	0.022	0.015	0.022
Tues/Wed/Thurs	23	0.016	0.015	0.028	0.015	0.012	0.023	0.013	0.009	0.028	0.022	0.006	0.011	0.01	0.008	0.01	0.01	0.008	0.03	0.015	0.011	0.023
Friday	0	0.009	0.025	0.04	0.008	0.016	0.027	0.007	0.014	0.032	0.02	0.004	0.01	0.005	0.009	0.019	0.006	0.016	0.033	0.009	0.017	0.032
Friday	1	0.006	0.024	0.039	0.006	0.014	0.025	0.005	0.011	0.03	0.021	0.003	0.007	0.003	0.008	0.019	0.003	0.013	0.031	0.006	0.014	0.03
Friday	2	0.005	0.024	0.039	0.005	0.014	0.026	0.004	0.011	0.03	0.023	0.004	0.008	0.002	0.008	0.019	0.002	0.012	0.031	0.005	0.014	0.03
Friday	3	0.005	0.025	0.04	0.008	0.017	0.029	0.005	0.012	0.03	0.022	0.005	0.013	0.002	0.008	0.021	0.003	0.014	0.032	0.006	0.015	0.032
Friday	4	0.011	0.03	0.044	0.014	0.024	0.035	0.008	0.016	0.033	0.027	0.013	0.02	0.005	0.013	0.024	0.007	0.019	0.036	0.012	0.022	0.037
Friday	5	0.027	0.04	0.05	0.024	0.035	0.042	0.017	0.026	0.038	0.034	0.032	0.033	0.013	0.023	0.037	0.02	0.032	0.042	0.024	0.034	0.044
Friday	6	0.039	0.047	0.053	0.036	0.045	0.047	0.033	0.04	0.045	0.038	0.051	0.057	0.026	0.035	0.049	0.043	0.052	0.049	0.038	0.047	0.052
Friday	7	0.05	0.053	0.056	0.049	0.053	0.052	0.049	0.054	0.05	0.042	0.062	0.063	0.039	0.04	0.06	0.067	0.068	0.052	0.054	0.059	0.058
Friday	8	0.048	0.054	0.057	0.047	0.054	0.053	0.051	0.057	0.052	0.046	0.07	0.063	0.043	0.049	0.068	0.064	0.069	0.054	0.055	0.059	0.059
Friday	9	0.048	0.055	0.057	0.047	0.056	0.055	0.05	0.057	0.052	0.047	0.066	0.063	0.049	0.057	0.073	0.054	0.062	0.053	0.051	0.059	0.058
Friday	10	0.052	0.056	0.056	0.051	0.06	0.058	0.054	0.061	0.054	0.05	0.07	0.066	0.058	0.063	0.078	0.053	0.061	0.054	0.052	0.06	0.058
Friday	11	0.056	0.058	0.055	0.054	0.062	0.06	0.06	0.066	0.055	0.052	0.071	0.063	0.064	0.069	0.077	0.057	0.064	0.054	0.056	0.062	0.058
Friday	12	0.059	0.058	0.053	0.057	0.063	0.06	0.063	0.067	0.055	0.054	0.07	0.067	0.066	0.071	0.076	0.059	0.064	0.053	0.059	0.063	0.056
Friday	13	0.063	0.058	0.051	0.061	0.065	0.059	0.066	0.068	0.054	0.056	0.072	0.067	0.071	0.074	0.077	0.061	0.065	0.052	0.062	0.064	0.055
Friday	14	0.067	0.058	0.048	0.068	0.067	0.058	0.07	0.07	0.054	0.058	0.074	0.07	0.076	0.077	0.07	0.065	0.065	0.05	0.066	0.064	0.053
Friday	15	0.069	0.057	0.045	0.074	0.067	0.056	0.073	0.07	0.052	0.059	0.075	0.068	0.083	0.079	0.06	0.071	0.065	0.049	0.07	0.063	0.05
Friday	16	0.07	0.054	0.041	0.076	0.064	0.053	0.074	0.067	0.05	0.059	0.07	0.059	0.083	0.077	0.05	0.075	0.063	0.046	0.071	0.061	0.046
Friday	17	0.067	0.05	0.037	0.075	0.058	0.048	0.072	0.063	0.047	0.055	0.057	0.055	0.075	0.064	0.038	0.074	0.059	0.043	0.069	0.057	0.041
Friday	18	0.061	0.044	0.031	0.064	0.048	0.04	0.063	0.051	0.042	0.053	0.041	0.043	0.062	0.051	0.025	0.064	0.046	0.04	0.06	0.047	0.037
Friday	19	0.054	0.037	0.026	0.052	0.037	0.032	0.05	0.039	0.035	0.045	0.027	0.036	0.05	0.039	0.018	0.048	0.032	0.034	0.049	0.036	0.029
Friday	20	0.047	0.031	0.022	0.043	0.029	0.026	0.041	0.029	0.03	0.042	0.02	0.026	0.041	0.03	0.013	0.037	0.022	0.029	0.041	0.028	0.024
Friday	21	0.039	0.025	0.02	0.035	0.022	0.022	0.037	0.023	0.028	0.039	0.017	0.019	0.036	0.025	0.01	0.032	0.017	0.027	0.036	0.023	0.021
Friday	22	0.03	0.02	0.02	0.027	0.016	0.02	0.03	0.017	0.026	0.032	0.014	0.015	0.03	0.019	0.011	0.024	0.012	0.027	0.029	0.018	0.019
Friday	23	0.021	0.016	0.022	0.02	0.012	0.018	0.019	0.011	0.024	0.026	0.011	0.01	0.018	0.012	0.009	0.016	0.009	0.027	0.019	0.013	0.019
Saturday	0	0.014	0.031	0.057	0.015	0.026	0.04	0.013	0.019	0.038	0.025	0.01	0.013	0.01	0.015	0.027	0.011	0.024	0.043	0.014	0.024	0.05
Saturday	1	0.009	0.028	0.052	0.01	0.02	0.035	0.008	0.015	0.034	0.025	0.007	0.01	0.007	0.012	0.023	0.006	0.018	0.04	0.009	0.019	0.042
Saturday	2	0.007	0.027	0.049	0.008	0.018	0.032	0.006	0.014	0.032	0.026	0.007	0.011	0.005	0.011	0.022	0.004	0.016	0.038	0.008	0.017	0.039

		Solano			Stanislaus			Sutter			Tulare			Tuolumne			Ventura			Yolo		
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	3	0.006	0.026	0.046	0.008	0.019	0.032	0.006	0.013	0.031	0.027	0.009	0.013	0.004	0.01	0.025	0.003	0.015	0.037	0.007	0.016	0.037
Saturday	4	0.008	0.028	0.047	0.011	0.021	0.035	0.007	0.014	0.032	0.029	0.014	0.024	0.005	0.013	0.028	0.005	0.017	0.038	0.009	0.019	0.038
Saturday	5	0.014	0.031	0.049	0.017	0.028	0.039	0.011	0.018	0.034	0.036	0.033	0.032	0.01	0.021	0.034	0.011	0.023	0.041	0.014	0.025	0.043
Saturday	6	0.022	0.037	0.052	0.025	0.036	0.045	0.019	0.026	0.039	0.042	0.056	0.054	0.017	0.028	0.039	0.021	0.033	0.045	0.023	0.033	0.049
Saturday	7	0.032	0.042	0.054	0.034	0.044	0.05	0.032	0.038	0.046	0.041	0.055	0.068	0.029	0.036	0.053	0.034	0.046	0.05	0.034	0.044	0.055
Saturday	8	0.044	0.049	0.056	0.044	0.053	0.055	0.045	0.051	0.052	0.043	0.057	0.069	0.044	0.045	0.06	0.046	0.057	0.053	0.046	0.055	0.059
Saturday	9	0.056	0.054	0.055	0.054	0.061	0.06	0.057	0.062	0.056	0.045	0.061	0.069	0.059	0.061	0.071	0.057	0.065	0.055	0.057	0.064	0.061
Saturday	10	0.065	0.057	0.052	0.062	0.068	0.063	0.067	0.071	0.06	0.048	0.066	0.068	0.073	0.074	0.078	0.065	0.071	0.056	0.065	0.07	0.063
Saturday	11	0.068	0.058	0.05	0.067	0.071	0.064	0.074	0.076	0.061	0.05	0.067	0.068	0.081	0.077	0.083	0.07	0.076	0.056	0.069	0.071	0.059
Saturday	12	0.067	0.057	0.047	0.069	0.07	0.062	0.075	0.075	0.06	0.052	0.068	0.065	0.078	0.077	0.075	0.072	0.074	0.054	0.069	0.068	0.056
Saturday	13	0.066	0.056	0.044	0.07	0.067	0.058	0.075	0.074	0.057	0.053	0.067	0.068	0.075	0.072	0.06	0.072	0.071	0.053	0.069	0.065	0.052
Saturday	14	0.066	0.055	0.041	0.07	0.064	0.054	0.074	0.071	0.055	0.055	0.07	0.07	0.075	0.068	0.055	0.072	0.068	0.05	0.068	0.063	0.047
Saturday	15	0.066	0.054	0.038	0.069	0.061	0.049	0.072	0.068	0.051	0.058	0.077	0.065	0.075	0.068	0.052	0.072	0.063	0.047	0.067	0.06	0.043
Saturday	16	0.066	0.053	0.034	0.068	0.057	0.045	0.07	0.064	0.048	0.057	0.066	0.055	0.072	0.07	0.047	0.072	0.059	0.044	0.066	0.056	0.039
Saturday	17	0.065	0.05	0.031	0.064	0.051	0.04	0.066	0.057	0.044	0.054	0.053	0.05	0.066	0.063	0.04	0.068	0.051	0.04	0.063	0.052	0.035
Saturday	18	0.058	0.046	0.029	0.056	0.042	0.033	0.056	0.047	0.038	0.052	0.04	0.039	0.058	0.052	0.031	0.059	0.041	0.035	0.057	0.045	0.029
Saturday	19	0.05	0.04	0.026	0.048	0.034	0.027	0.046	0.037	0.033	0.046	0.034	0.03	0.047	0.041	0.026	0.048	0.031	0.03	0.048	0.035	0.025
Saturday	20	0.045	0.036	0.023	0.041	0.029	0.024	0.04	0.03	0.028	0.042	0.027	0.021	0.038	0.031	0.02	0.04	0.024	0.027	0.042	0.03	0.021
Saturday	21	0.041	0.033	0.023	0.037	0.024	0.021	0.035	0.025	0.025	0.038	0.023	0.018	0.031	0.025	0.016	0.037	0.022	0.024	0.039	0.027	0.02
Saturday	22	0.035	0.029	0.023	0.031	0.02	0.019	0.028	0.019	0.023	0.032	0.019	0.011	0.025	0.02	0.018	0.031	0.019	0.023	0.034	0.023	0.02
Saturday	23	0.026	0.023	0.023	0.023	0.016	0.017	0.02	0.014	0.021	0.025	0.014	0.008	0.016	0.013	0.018	0.022	0.016	0.022	0.024	0.018	0.019
Holiday	0	0.013	0.029	0.038	0.013	0.02	0.027	0.01	0.016	0.028	0.024	0.008	0.009	0.008	0.011	0.02	0.009	0.019	0.032	0.012	0.022	0.032
Holiday	1	0.008	0.027	0.038	0.009	0.017	0.025	0.006	0.013	0.027	0.024	0.007	0.01	0.005	0.009	0.018	0.005	0.016	0.03	0.008	0.017	0.029
Holiday	2	0.005	0.025	0.037	0.007	0.015	0.024	0.004	0.012	0.026	0.023	0.006	0.007	0.003	0.01	0.018	0.003	0.014	0.029	0.006	0.015	0.029
Holiday	3	0.005	0.026	0.037	0.007	0.016	0.026	0.005	0.013	0.027	0.023	0.007	0.011	0.004	0.01	0.021	0.003	0.015	0.031	0.006	0.017	0.029
Holiday	4	0.008	0.028	0.039	0.011	0.02	0.029	0.008	0.016	0.029	0.027	0.016	0.017	0.005	0.012	0.02	0.007	0.018	0.032	0.011	0.021	0.032
Holiday	5	0.018	0.034	0.043	0.019	0.028	0.033	0.014	0.023	0.032	0.033	0.03	0.032	0.009	0.018	0.031	0.016	0.029	0.038	0.019	0.03	0.038
Holiday	6	0.025	0.04	0.046	0.027	0.035	0.038	0.025	0.033	0.036	0.035	0.045	0.052	0.018	0.023	0.038	0.031	0.042	0.043	0.027	0.038	0.044
Holiday	7	0.032	0.045	0.05	0.035	0.042	0.042	0.036	0.044	0.042	0.04	0.052	0.064	0.029	0.031	0.043	0.047	0.056	0.047	0.037	0.046	0.05
Holiday	8	0.041	0.05	0.053	0.04	0.048	0.046	0.046	0.053	0.048	0.043	0.065	0.066	0.041	0.044	0.056	0.051	0.059	0.049	0.046	0.054	0.053
Holiday	9	0.051	0.055	0.055	0.048	0.055	0.05	0.054	0.059	0.05	0.045	0.061	0.058	0.058	0.057	0.075	0.052	0.061	0.051	0.053	0.059	0.056
Holiday	10	0.062	0.06	0.055	0.059	0.064	0.055	0.065	0.069	0.053	0.05	0.075	0.055	0.076	0.083	0.087	0.059	0.066	0.053	0.061	0.065	0.058
Holiday	11	0.068	0.063	0.056	0.065	0.07	0.06	0.074	0.074	0.057	0.049	0.076	0.055	0.084	0.086	0.088	0.066	0.069	0.054	0.067	0.069	0.06
Holiday	12	0.07	0.061	0.054	0.069	0.072	0.061	0.077	0.074	0.056	0.058	0.075	0.06	0.085	0.087	0.089	0.068	0.072	0.055	0.069	0.068	0.059
Holiday	13	0.071	0.062	0.052	0.071	0.071	0.061	0.076	0.074	0.058	0.052	0.069	0.068	0.083	0.081	0.078	0.07	0.07	0.053	0.069	0.068	0.057
Holiday	14	0.072	0.06	0.051	0.072	0.069	0.059	0.075	0.073	0.056	0.055	0.069	0.07	0.08	0.074	0.068	0.071	0.068	0.053	0.07	0.066	0.055
Holiday	15	0.068	0.056	0.046	0.073	0.068	0.058	0.074	0.07	0.055	0.062	0.07	0.078	0.078	0.074	0.06	0.073	0.064	0.05	0.069	0.065	0.052
Holiday	16	0.066	0.054	0.044	0.073	0.065	0.055	0.072	0.066	0.054	0.065	0.074	0.069	0.078	0.072	0.049	0.073	0.061	0.049	0.067	0.06	0.049
Holiday	17	0.064	0.05	0.04	0.07	0.057	0.05	0.068	0.059	0.051	0.053	0.057	0.062	0.071	0.066	0.041	0.071	0.056	0.046	0.064	0.055	0.044
Holiday	18	0.058	0.042	0.034	0.06	0.046	0.044	0.057	0.049	0.045	0.051	0.04	0.046	0.057	0.049	0.033	0.061	0.045	0.041	0.057	0.046	0.039
Holiday	19	0.051	0.037	0.029	0.05	0.036	0.039	0.047	0.036	0.041	0.047	0.031	0.041	0.043	0.04	0.022	0.049	0.032	0.036	0.05	0.036	0.033
Holiday	20	0.047	0.031	0.025	0.042	0.029	0.034	0.039	0.029	0.037	0.046	0.027	0.026	0.033	0.026	0.013	0.041	0.024	0.033	0.044	0.029	0.028
Holiday	21	0.042	0.026	0.024	0.034	0.023	0.03	0.03	0.02	0.033	0.04	0.019	0.021	0.024	0.018	0.011	0.034	0.019	0.032	0.039	0.023	0.025
Holiday	22	0.033	0.022	0.025	0.027	0.017	0.028	0.023	0.015	0.031	0.034	0.014	0.014	0.017	0.012	0.009	0.025	0.014	0.031	0.03	0.018	0.024
Holiday	23	0.022	0.018	0.029	0.018	0.014	0.026	0.015	0.01	0.029	0.024	0.011	0.011	0.01	0.008	0.01	0.016	0.012	0.032	0.02	0.014	0.026

Appendix C: Scaling procedures after DTIM processing

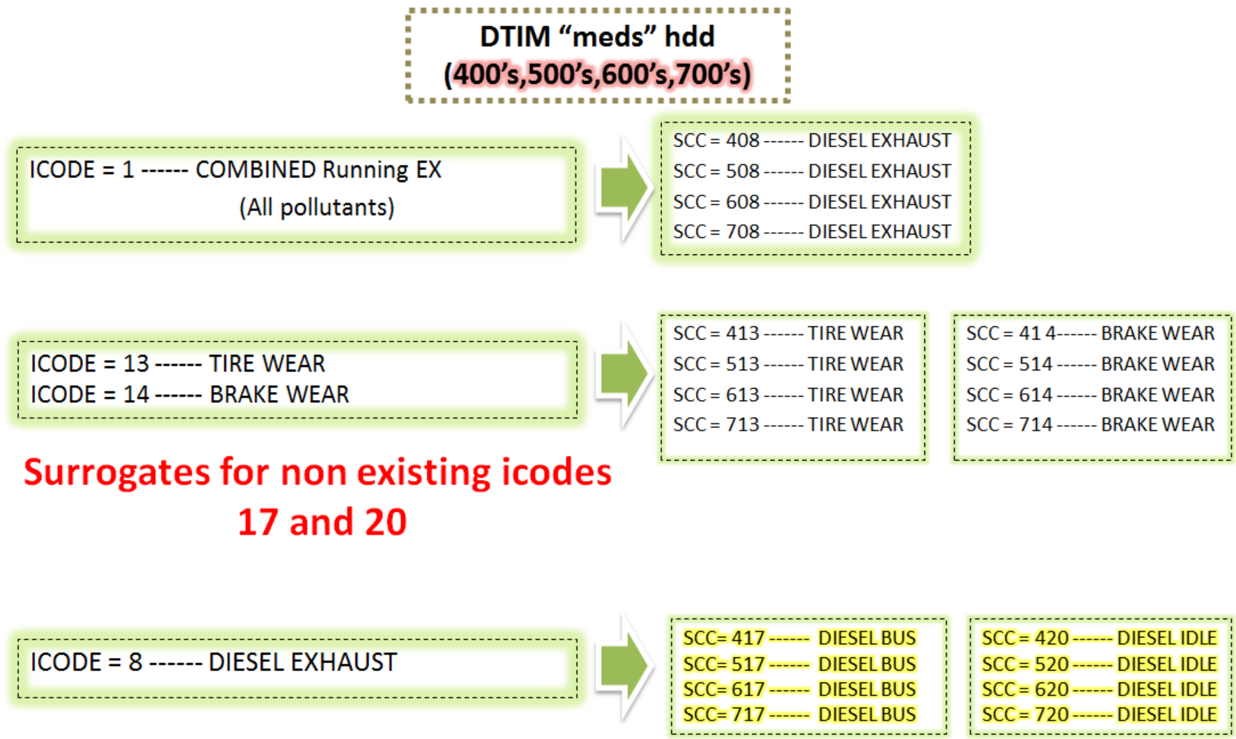
C1. Block Diagram of Scaling Process: ldg (gas: heavy- and light-duty; diesel: light-duty)

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.



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 16 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

Code	M	T	W	TH	F	S	S
243	63	186	136	175	187	134	120
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 17 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
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

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
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 K
Modeling Attainment Demonstration

San Joaquin Valley Air Pollution Control District
2018 PM2.5 SIP

Photochemical Modeling

Photochemical Modeling for the 2018 San Joaquin Valley Annual/24-Hour $PM_{2.5}$ State Implementation Plan

Prepared by

California Air Resources Board
San Joaquin Valley Air Pollution Control District

Prepared for

United States Environmental Protection Agency Region IX

June, 2018

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ACRONYMS

ARB – Air Resources Board

BCs – Boundary Conditions

CMAQ Model – Community Multi-scale Air Quality Model

CRPAQS – California Regional Particulate Air Quality Study

CSN – Chemical Speciation Network

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

DV – Design Value

EC – Elemental Carbon

FEM – Federal Equivalent Method

FRM – Federal Reference Method

GEOS-5 – Goddard Earth Observing System Model, Version 5

GMAO – Global Modeling and Assimilation Office

ICs – Initial Conditions

MEGAN – Model of Emissions of Gases and Aerosols from Nature

MFB – Mean Fractional Bias

MFE – Mean Fractional Error

MOZART – Model for Ozone and Related chemical Tracers

NARR – North American Regional Reanalysis

NASA – National Aeronautics and Space Administration

NCR – National Center for Atmospheric Research

NMB – Normalized Mean Bias

NME – Normalized Mean Error

NO_x – Oxides of Nitrogen

OC – Organic Carbon

OM – Organic Matter

$PM_{2.5}$ – Particulate Matter of Aerodynamic Diameter less than 2.5 micrometers

RMSE – Root Mean Square Error

ROG – Reactive Organic Gases

RRF – Relative Response Factors

SANWICH – Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbon Hybrid material balance

SAPRC – Statewide Air Pollution Research Center

SIP – State Implementation Plan

SJV – San Joaquin Valley

SOA – Secondary Organic Aerosol

SO_x – Sulfur oxides

U.S. EPA – United States Environmental Protection Agency

VOCs – Volatile Organic Compounds

WRF – Weather and Research Forecasting

1 INTRODUCTION

The purpose of this document is to demonstrate the attainment of multiple National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$ in the San Joaquin Valley nonattainment area (SJV or the Valley), which forms the scientific basis for the 2018 SJV $PM_{2.5}$ State Implementation Plan (SIP). Specifically, the plan addresses the following $PM_{2.5}$ standards.

1.) 1997 annual $PM_{2.5}$ standard (15 µg/m^3) and 24-hour $PM_{2.5}$ standard (65 µg/m^3) with an attainment deadline of 2020 for both standards.
2.) 2006 24-hour $PM_{2.5}$ standard (35 µg/m^3) with an attainment deadline of 2024.
3.) 2012 annual $PM_{2.5}$ standard (12 µg/m^3) with an attainment deadline of 2025.

Modeling for these standards shows that:

1.) In 2020, the highest projected annual $PM_{2.5}$ design value (DV) under a future baseline emissions scenario (i.e., no additional emission reductions beyond what will be achieved by the current regulatory program) is 14.6 µg/m^3 at the Bakersfield-Planz site, and the highest projected 24-hour $PM_{2.5}$ DV is 47.6 µg/m^3 at the Bakersfield-California Avenue site, which demonstrates that SJV will attain the 1997 annual and 24-hour $PM_{2.5}$ standards by 2020.
2.) In 2024, the highest projected 24-hour $PM_{2.5}$ DV under the future attainment emissions scenario (i.e., including additional emission reductions beyond the future baseline emissions) is 35.1 µg/m^3 at the Fresno-HW site, which demonstrates that SJV will attain the 2006 24-hour $PM_{2.5}$ standard by 2024 (based on the form of the standard, the DV can be as high as 35.4 µg/m^3 and still be in attainment).
3.) In 2025, the highest projected annual $PM_{2.5}$ DV under the future attainment emission scenario is 11.9 µg/m^3 at both the Madera and Bakersfield-Planz sites, which demonstrates that SJV will attain the 2012 annual $PM_{2.5}$ standard by 2025.

The remainder of this document is organized as follows: Section 2 describes the general approach for projecting design values (DVs) to future years (i.e., 2020, 2024, and 2025). Section 3 discusses the meteorological modeling and evaluation. Section 4 describes the emissions inventory. Section 5 shows $PM_{2.5}$ model performance, projected future year DVs (i.e., 2020, 2024, 2025), $PM_{2.5}$ precursor sensitivities for 2013, 2020, and 2024, and the un-monitored area analysis. A more detailed description of the modeling and development of the model-ready emissions inventory can be found in the Photochemical Modeling Protocol and Modeling Emission Inventory Appendices.

2 APPROACHES

This section briefly describes the Air Resources Board's (ARB's) procedures, based on U.S. EPA guidance (U.S. EPA, 2014), for projecting future year annual and 24-hour $PM_{2.5}$ Design Values (DVs) using model output and a Relative Response Factor (RRF) approach.

2.1 METHODOLOGY

The U.S. EPA modeling guidance (U.S. EPA, 2014) outlines the approach for using models to predict future year annual and 24-hour $PM_{2.5}$ DVs. The guidance recommends using model predictions in a "relative" rather than "absolute" sense. In this relative approach, the fractional change (or ratio) in $PM_{2.5}$ concentration between the model future year and model baseline year are calculated for all valid monitors. These ratios are called relative response factors (RRFs). Since $PM_{2.5}$ is comprised of different chemical species, which respond differently to changes in emissions of various pollutants, separate RRFs are calculated for the individual $PM_{2.5}$ species. Baseline DVs are then projected to the future on a species-by-species basis, where the DV is separated into individual $PM_{2.5}$ species and each species is multiplied by its corresponding RRF. The individual species are then summed to obtain the future year $PM_{2.5}$ DV.

A brief summary of the modeling procedures utilized in this attainment analysis, as prescribed by the U.S. EPA modeling guidance (U.S. EPA, 2014), is provided below. A more detailed description can be found in the Photochemical Modeling Protocol Appendix.

2.2 MODELING PERIOD

Based on analysis of recent years' ambient $PM_{2.5}$ levels and meteorological conditions leading to elevated $PM_{2.5}$ concentrations, the year 2013 was selected for baseline modeling calculations. The National Aeronautics and Space Administration (NASA) launched the DISCOVER-AQ (Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality) field campaign in the SJV from January 16th to Mid-February, 2013. This field study provided unprecedented observations of wintertime $PM_{2.5}$ and its precursors not available in the SJV since the CRPAQS (i.e., California Regional Particulate Air Quality Study) study more than 15 years ago. These observations aided in development of the modeling platform used in this SIP work.

2.3 BASELINE DESIGN VALUES

Specifying the baseline DV is a key consideration in the model attainment test, because this value is projected forward to the future and used to test for future attainment of the standard at each monitor. U.S. EPA guidance (2014) defines the annual $PM_{2.5}$ DV for a given year as the 3-year average (ending in that year) of the annual average $PM_{2.5}$ concentrations, where the annual average is calculated as the average of the quarterly averages for each calendar quarter (e.g., January-March, April-June, July-September, October-December). For example, the 2012 $PM_{2.5}$ DV is the average of the annual $PM_{2.5}$ concentrations from 2010, 2011, and 2012. Similarly, the 24-hour $PM_{2.5}$ DV for a given year is also defined as the 3-year average of the measured 98th percentile concentration from each of those 3 years. For example, the 2012 24-hour $PM_{2.5}$ DV is the average of the 98th percentile 24-hour $PM_{2.5}$ concentrations from years 2010, 2011, and 2012, respectively.

To minimize the influence of year-to-year variability in demonstrating attainment, the U.S. EPA (2014) optionally allows the averaging of three DVs, where one of the years is the baseline emissions inventory and modeling year. This average DV is referred to as the baseline DV. Since each DV represents an average over three years, observational data from 2010, 2011, 2012, 2013, and 2014 will influence the average DV, with each year receiving a different weighting. Table 1 illustrates the observational data from each year that goes into the baseline DV.

Table1. Illustrates the data from each year that are utilized in the baseline DV calculation.

DV Year	Years averaged for the DV				
2012	2010	2011	2012		
2013		2011	2012	2013	
2014			2012	2013	2014

Yearly weighting for the baseline DV calculation*

$$2012 - 2014\ Average = \frac{PM2.5_{2010} + 2 \times PM2.5_{2011} + 3 \times PM2.5_{2012} + 2 \times PM2.5_{2013} + PM2.5_{20}}{9}$$

*: For annual $PM_{2.5}$, $PM_{2.5}$ for a particular year is the annual average of that year. For 24-hour $PM_{2.5}$, $PM_{2.5}$ for a particular year is the 98th percentile 24-hour concentration from that year.

Table 2 shows the 2012-2014 average annual DVs (or annual baseline DVs) for each Federal Reference Method (FRM) /Federal Equivalent Method (FEM) site in the SJV, which had sufficient data to calculate a DV. For two sites with incomplete data, assumptions were made to calculate the baseline DVs and the assumptions were annotated following Table 2. The highest DV occurred at the Bakersfield – Planz site with a baseline DV of 17.2 µg/m^3.

Table 2. Average baseline DVs for each FRM monitoring site in the SJV, as well as the yearly annual DVs from 2012-2014 utilized in calculating the baseline DVs.**

AQS site ID	Monitoring Site Name	2012	2013	2014	2012-2014 Average Baseline
60290016	Bakersfield - Planz	15.3	16.9	19.3	17.2
60392010	Madera		18.1	15.8	16.9*
60311004	Hanford	15.8	17.0	16.8	16.5
61072002	Visalia	14.8	16.6	17.2	16.2
60195001	Clovis	16.0	16.4	16.0	16.1
60290014	Bakersfield – California Ave.	14.5	16.4	17.2	16.0
60190011	Fresno –Garland	14.2	15.4	15.3	15.0
60990006	Turlock	14.9	15.7	14.1	14.9
60195025	Fresno –Hamilton & Winery	13.9	14.7	14.1	14.2
60771002	Stockton	11.6	13.8	14.1	13.1
60470003	Merced – S Coffee	14.3	13.3	11.7	13.1
60990005	Modesto	12.9	13.6	12.5	13.0
60472510	Merced -Main Street	10.4	11.1	11.4	11.0
60772010	Manteca		10.2	9.9	10.1*
60192009	Tranquility	7.5	7.9	7.7	7.7

* Because of incomplete data at Madera and Manteca, DVs from 2013 and 2014 were averaged to determine the baseline DV for these two sites.
** Note that a design value for the Corcoran monitor cannot be calculated due to missing/incomplete data.

Table 3 shows the 2012-2014 average 24-hour DVs (or 24-hour baseline DVs) for each FRM/FEM site in the SJV, which had sufficient data to calculate a DV. For Manteca with incomplete data, assumption was made to calculate the baseline DVs and that assumption was annotated following Table 3. The highest DV occurred at the Bakersfield – California Avenue site with a baseline DV of 64.1 µg/m^3.

Table 3. Average baseline 24-hour DVs for each FRM/FEM monitoring site in the SJV, as well as the yearly 24-hour DVs from 2012-2014 utilized in calculating the baseline DVs.**

AQS site ID	Monitoring Site Name	2012	2013	2014	2012-2014 Average Baseline
60290014	Bakersfield – California Ave.	58.4	64.6	69.4	64.1
60311004	Hanford	53.8	60.2	65.9	60.0
60190011	Fresno –Garland	57.0	62.0	61.0	60.0
60195025	Fresno –Hamilton & Winery	53.0	63.5	61.6	59.3
60195001	Clovis	53.6	57.6	56.3	55.8
60290016	Bakersfield - Planz	43.7	55.8	67.0	55.5
61072002	Visalia	46.9	55.7	63.9	55.5
60392010	Madera	51.0	52.3	49.6	51.0
60990006	Turlock	48.8	52.7	50.7	50.7
60990005	Modesto	44.3	50.6	48.9	47.9
60472510	Merced -Main Street	39.8	49.2	51.7	46.9
60771002	Stockton	36.1	45.0	44.9	42.0
60470003	Merced – S Coffee	41.0	41.8	40.6	41.1
60772010	Manteca		36.7	37.0	36.9*
60192009	Tranquility	27.1	30.0	31.3	29.5

* Due to incomplete data, DVs for 2013 and 2014 are averaged to obtain baseline DV for Manteca.
** Note that a design value for the Corcoran monitor cannot be calculated due to missing/incomplete data.

2.4 BASE, REFERENCE, AND FUTURE YEARS

The modeling assessment consists of the following five primary model simulations, which all utilized the same model inputs for meteorology, chemical boundary conditions, and biogenic emissions. The only difference between the simulations was the year represented by the anthropogenic emissions (2013 versus 2020, 2024, and 2025) and certain day-specific emissions.

1. *Base Year (or Base Case) Simulation*
   The base year simulation for 2013 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, as well as known wildfire and agricultural burning events.

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 2013 reference year modeling, the only category/emissions source that was excluded was wildfires, which are difficult to predict in the future and can significantly influence the model response to anthropogenic emissions reductions in regions with large fires.

3. *Future Year Simulations*
   The future year simulations are identical to the reference year simulation, except that projected future years' (2020, 2024, and 2025) anthropogenic emission levels were used rather than 2013 emission levels. All other model inputs (e.g., meteorology, chemical boundary conditions, biogenic emissions, and calendar for day-of-week specifications in the inventory) were the same as those used in the reference year simulation.

To summarize (Table 4), the base year 2013 simulation was used for evaluating model performance, while the reference (or baseline) 2013 and future years 2020, 2024, and 2025 simulations were used to project the average DVs to the future as described in the Photochemical Modeling Protocol Appendix and in subsequent sections of this document.

Table 4. Description of CMAQ model simulations used to evaluate model performance and project baseline design values to the future years.

Simulation	Anthropogenic Emissions	Biogenic Emissions	Meteorology	Chemical Boundary Conditions
Base year (2013)	2013 w/ wildfires	2013 MEGAN	2013 WRF	2013 MOZART
Reference year (2013)	2013 w/o wildfires	2013 MEGAN	2013 WRF	2013 MOZART
Future year (2020)	2020 w/o wildfires	2013 MEGAN	2013 WRF	2013 MOZART
Future year (2024)	2024 w/o wildfires	2013 MEGAN	2013 WRF	2013 MOZART
Future year (2025)	2025 w/o wildfires	2013 MEGAN	2013 WRF	2013 MOZART

2.5 $PM_{2.5}$ SPECIES CALCULATIONS

Since $PM_{2.5}$ consists of different chemical components, it is necessary to assess how each individual component will respond to emission reductions. As a first step in this process, the measured total $PM_{2.5}$ must be separated into its various components. In the SJV, the primary components on the filter based $PM_{2.5}$ measurements include sulfates, nitrates, ammonium, organic carbon (OC), elemental carbon (EC), particle-bound water, other primary inorganic particulate matter, and passively collected mass (blank mass). Species concentrations were obtained from the four chemical speciation network (CSN) sites in the SJV. These four CSN sites are located at: Bakersfield – California Avenue, Fresno – Garland, Visalia – North Church, and Modesto – 14th Street. Chemical species were measured once every three or six days at those sites. Since not all of the 16 FRM/FEM $PM_{2.5}$ sites in the Valley have collocated speciation monitors, it was necessary to utilize the speciated $PM_{2.5}$ measurements at one of the four CSN sites to represent the speciation profile at each of the FRM/FEM sites. The choice of which CSN site to represent the speciation profile at a given FRM monitor (Table 5) was determined based on geographic proximity, analysis of local emission sources, and measurements from previous field studies (e.g., CRPAQS), and is consistent with previous $PM_{2.5}$ SIPs in the Valley.

Table 5. $PM_{2.5}$ speciation data used for each $PM_{2.5}$ design site.

AQS Site ID	$PM_{2.5}$ Design Site (FRM/FEM Monitor)	$PM_{2.5}$ Speciation Site
60290016	Bakersfield – Planz	Bakersfield – California
60392010	Madera	Fresno – Garland
60311004	Hanford	Visalia – Church
61072002	Visalia	Visalia – Church
60195001	Clovis	Fresno – Garland
60290014	Bakersfield – California Ave.	Bakersfield – California
60190011	Fresno – Garland	Fresno – Garland
60990006	Turlock	Modesto – 14th
60195025	Fresno – Hamilton & Winery	Fresno – Garland
60771002	Stockton	Modesto – 14th
60470003	Merced – S Coffee	Modesto – 14th
60990005	Modesto	Modesto – 14th
60472510	Merced – Main Street	Modesto – 14th
60772010	Manteca	Modesto – 14th
60192009	Tranquility	Fresno – Garland

Since the FRM $PM_{2.5}$ monitors do not retain all of the $PM_{2.5}$ mass that is measured by the speciation samplers, the U.S. EPA (2014) recommends using the SANDWICH approach (Sulfate, Adjusted Nitrate, Derived Water, Inferred Carbon Hybrid material balance) described by Frank (2006) to apportion the FRM $PM_{2.5}$ mass to individual $PM_{2.5}$ species based on nearby CSN speciation data. A detailed description of the SANDWICH method can be found in the modeling protocol and in the U.S. EPA (2014) modeling guidance. In addition, based on completeness of the data, $PM_{2.5}$ speciation data from 2010 – 2013 were utilized. For the annual DV calculation, for each quarter, percent contributions from individual chemical species to FRM $PM_{2.5}$ mass were calculated as the average of the corresponding quarters from 2010-2013. For the 24-hour DV calculation, percent contributions were calculated for each quarter as the average of the top 10% measured $PM_{2.5}$ days from the corresponding quarter from 2010-2013. In general, the inter-annual variability of the species fractions is small compared to the variability in the species concentrations and so the use of average data from 2010 – 2013 is appropriate.

2.6 FUTURE YEAR DESIGN VALUES

The approach to projecting future year annual and 24-hour $PM_{2.5}$ DVs is described briefly below. See U.S. EPA (2014) and the Photochemical Modeling Protocol Appendix for additional details. Projecting baseline annual $PM_{2.5}$ DVs to the future involves the following steps.

Step 1: Compute observed quarterly weighted average concentrations (consistent with the weighted average DV calculation) at each monitor for the following species: ammonium, nitrate, sulfate, organic carbon, elemental carbon, and other primary PM. This is done by multiplying quarterly weighted average FRM $PM_{2.5}$ concentrations by the fractional composition of $PM_{2.5}$ species for each quarter.

Step 2: Compute the component-specific RRF for each quarter and each species at each monitor based on the reference and future year modeling. The RRF for a specific component *j* is calculated using the following expression:

$$RRF_j = \frac{[C]_{j,\ future}}{[C]_{j,\ reference}} \quad (1)$$

Where $[C]_{j,\ future}$ is the modeled quarterly mean concentration for component *j* predicted for the future year averaged over the 3x3 array of grid cells surrounding the monitor, and $[C]_{j,reference}$ is the same, but for the reference year simulation. An RRF was calculated for each species in Step 1 and at each monitor and for each quarter.

Step 3: Apply the component specific RRF from Step 2 to the observed quarterly weighted average concentrations from Step 1 to obtain projected quarterly species concentrations.

Step 4: Use the online E-AIM model (http://www.aim.env.uea.ac.uk/aim/aim.php) to calculate future year particle-bound water for each quarter at each monitor based on projected ammonium sulfate and ammonium nitrate concentrations.

Step 5: The projected concentration for each quarter is summed over all species, including particle bound water from Step 4, as well as a blank mass of 0.5 $\mu g/m^3$ to obtain the future quarterly average $PM_{2.5}$ concentration. Finally, the future annual $PM_{2.5}$ DVs are calculated as the average of the projected $PM_{2.5}$ concentrations from the four quarters. If the projected annual DV is ≤ NAAQS, then the attainment test is passed.

Similarly, projecting baseline 24-hour $PM_{2.5}$ DVs to the future involves the steps outlined below. See U.S. EPA (2014) and the Photochemical Modeling Protocol Appendix for additional details.

Step 1: Determine the top eight days with the highest observed 24-hour $PM_{2.5}$ concentrations in each quarter and year used in the design value calculation (a total of 32 days per 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, other primary $PM_{2.5}$ material). The “high” days are represented by the top 10% of measured 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: 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 from the reference year. 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).

Step 4: Apply the component and quarter specific RRF to observed daily species concentrations from Step 2 to obtain future year concentrations of ammonium, sulfate, nitrate, elemental carbon, organic carbon and other primary $PM_{2.5}$.

Step 5: Calculate future year concentrations for particle bound water using the E-AIM model for each of the top days from each quarter. Then, sum the concentration of each of the species components plus a blank mass of 0.5 $\mu g/m^3$ to obtain 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 following the standard protocol for calculating design values (see Table 3). 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.

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 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 (Fosberg and Schroeder, 1966; Bao et al., 2008). In wintertime, periods of high atmospheric pressure bring light winds and, sometimes, low solar insolation (Daly et al. 2009) to the Central Valley. Because of the topographical features surrounding San Joaquin Valley, under such conditions, a layer of cold and wet air can be overlaid by warm air aloft creating strong and long-lasting stagnation in the area (Whiteman et al. 2001). It is under such conditions that high surface particulate matter concentrations typically occur (Gilles et al. 2010; Baker et al. 2011).

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 which are important to air quality (e.g., Jackson et al., 2006). In this work, the state-of-the-science Weather and Research Forecasting (WRF) prognostic model (Skamarock et al., 2005) 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) uniform horizontal grid spacing (Figure 1). WRF was run simultaneously for the three nested domains with two-way feedback between the parent and the nest 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 6), with the major physics options for each domain listed in Table 7.

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 adequately constrained and did not deviate from the observed meteorology. No nudging was used on the two inner domains to allow model physics to work fully without externally imposed forcing (Rogers et al., 2013).

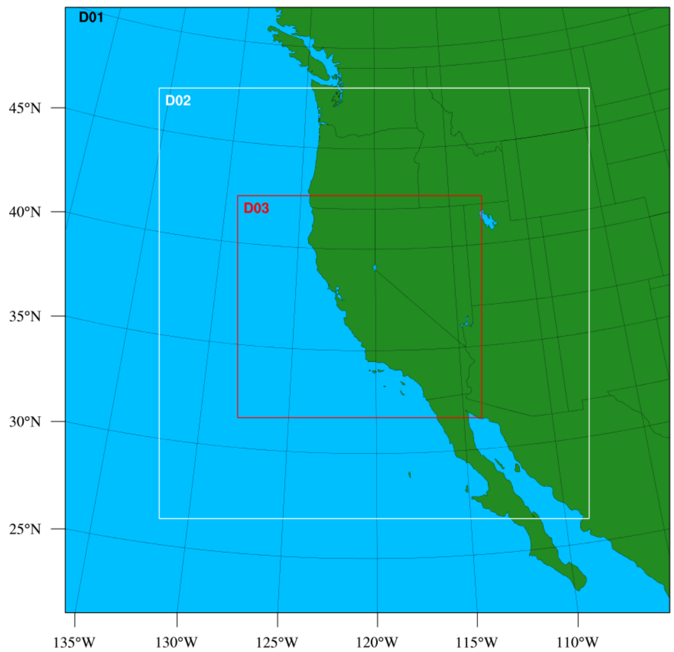


Figure 1. WRF modeling domains (D01 36km; D02 12km; and D03 4km).

Table 6. 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 7. 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	TD Scheme (Jan., Feb., Nov. and Dec.) Pleim-Xiu LSM (others)	TD Scheme (Jan., Feb., Nov. and Dec.) Pleim-Xiu LSM (others)	TD Scheme (Jan., Feb., Nov. and Dec.) Pleim-Xiu LSM (others)
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 77 surface stations in the SJV. Observational data for the surface stations were obtained from the ARB's archived meteorological database (http://www.arb.ca.gov/aqmis2/aqmis2.php). Table 8 lists the observational stations and the parameters measured at each station, including wind speed and direction (wind), temperature (T) and relative humidity (RH). The location of each of these sites is shown in Figure 2. Quarterly and annual quantitative performance metrics for 2013 were used to compare hourly surface observations and modeled estimates: mean bias (MB), mean error (ME) and index of agreement (IOA) based on recommendations from Simon et al. (2012). A summary of these statistics by performance region is shown in Tables 9 through 13. The performance regions cover roughly the Modesto, Fresno, Visalia, and Bakersfield regions, as well as one for the entire San Joaquin Valley (SJV), respectively. The region around Modesto includes sites 5737, 2833, and 2080. The region surrounding Fresno encompasses sites 5741, 2449, 2013, and 2844. The region around Visalia includes sites 2032, 5386, and 3250, while the region covering Bakersfield includes sites 5287 and 3146 (note that valid relative humidity observations in the Bakersfield area were only available at site 5287 for the months of January through May 2013). Model performance statistical metrics were calculated using all of the available data. All the sites in the valley are included in the SJV performance region (in addition to the sites mentioned above). The distribution of daily mean bias and mean error are shown in Figures 3 and 4. Figures 5 and 6 show observed vs. modeled scatter plots.

From a valley-wide perspective, the wind speed biases were positive in each quarter of 2013. At Bakersfield the biases turn slightly negative throughout the year, and are mostly less than 0.6 m/s. The annual temperature biases are less than 1 K in all performance regions, with the quarterly temperature biases reaching as high as -1.87 K in Bakersfield during the second quarter of 2013. Simulated temperature is generally in good agreement with the observations in all regions with the index of agreement (IOA) above 0.90 (1.0 represents perfect agreement). Relative humidity biases are positive except in the Modesto region. The annual bias values range from -1.53% to 12.47%, with the largest bias occurring in Visalia. These results are comparable to other recent WRF modeling efforts in California investigating ozone formation in Central California (e.g., Hu et al., 2012) and modeling analysis for the CalNex and CARES field studies (e.g., Fast et al., 2014; Baker et al., 2013; Kelly et al., 2014; Angevine et al., 2012). Detailed hourly time-series of surface temperature, relative humidity, wind speed, and wind direction for SJV can be found in the supplementary material, together with 2013 quarterly mean bias and mean error distributions of these parameters.

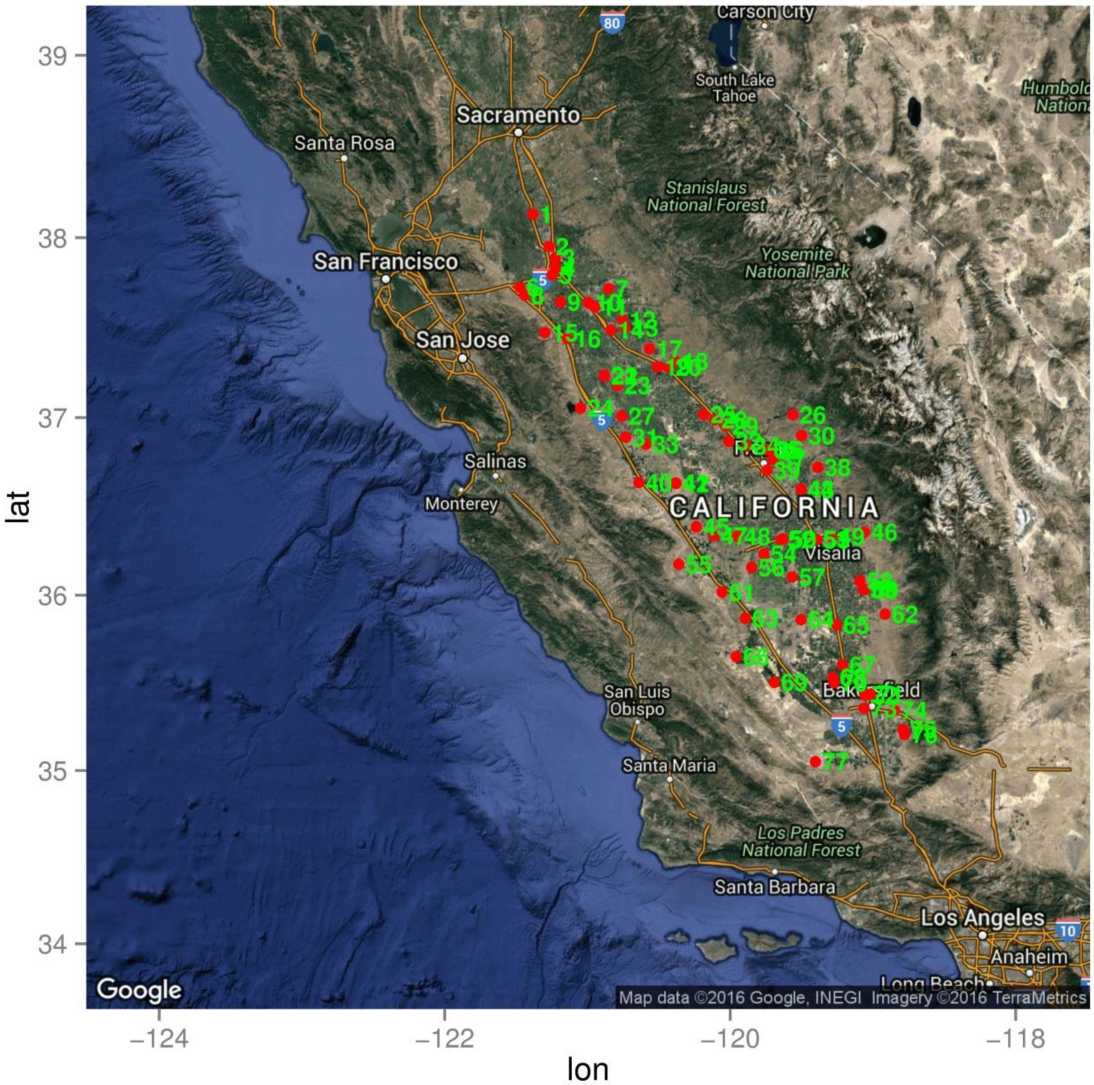


Figure 2. Meteorological observation sites in San Joaquin Valley. The numbers correspond to the sites listed in Table 8.

Table 8. Meteorological monitor location and parameter(s) measured.

Site	Site ID	Site Name	Parameter Measured	Site	Site ID	Site Name	Parameter Measured
1	5809	LodiWest	T, RH	40	3309	PanocheRd	Wind, T, RH
2	2094	Stockton-Haz	Wind, T, RH	41	3759	Tranquility	Wind, T
3	5362	StocktonArpt	Wind, T	42	5757	Westlands	T, RH
4	5736	Manteca	T, RH	43	5723	Parlier2	T, RH
5	3772	Manteca-Fish	Wind, T	44	2114	Parlier	Wind, T, RH
6	5810	Tracy	T, RH	45	5828	FivePointsSW	T, RH
7	5831	Oakdale2	T, RH	46	5746	Lindcove	T, RH
8	3696	Tracy_Air	Wind, T	47	5708	FivePoints2	T, RH
9	5737	Modesto3	T, RH	48	2544	Lemoore-Met	Wind, T
10	2833	Modesto-14th	Wind	49	2032	Visalia-NChu	Wind, T
11	2080	Modesto-Met	Wind, T	50	5308	HanfordMuni	Wind, T
12	7233	DenairII	T, RH	51	5386	VisaliaMuni	Wind, T
13	3303	RosePeak	Wind, T, RH	52	3129	Hanford-Irwn	Wind, T
14	2996	Turlock-SMin	Wind, T	53	3250	Visalia-Airp	Wind, T, RH
15	3449	Pulgas	Wind, T, RH	54	3712	StRosaRnchria	Wind, T
16	5805	Patterson2	T, RH	55	6028	CoalingaCIM	T, RH
17	2814	Merced-AFB	Wind, T	56	5715	Stratford2	T, RH
18	5793	Merced	T, RH	57	3194	Corcoran-Pat	Wind, T
19	5318	MercedMuni	Wind, T	58	5812	Portervl	T, RH
20	3022	Merced-SCofe	Wind, T	59	5351	PortervlMuni	Wind, T
21	6079	MERCED 23WSW	T	60	3763	Portrvlle-Ne	Wind, T
22	5752	Kesterson	T, RH	61	3330	KettlemanHls	Wind, T, RH
23	3647	SanLuisNWR	Wind, T, RH	62	3350	FountnSpr	Wind, T, RH
24	3307	LosBanos	Wind, T, RH	63	5717	Kettleman	T, RH
25	5790	Madera	T, RH	64	6813	Alpaugh	T, RH
26	3522	Hurley1	Wind, T, RH	65	5823	Delano2	T, RH
27	5730	LosBanos2	T, RH	66	5729	BlackwllCnr	T, RH
28	5317	MaderaMuni	Wind, T	67	5783	Famoso	T, RH
29	3771	Madera-Av14	Wind, T, RH	68	5709	ShafterUSDA	T, RH
30	3346	FancherCreek	Wind, T, RH	69	5791	Belridge	T, RH
31	5770	Panoche	T, RH	70	2981	Shafter-Wlkr	Wind, T, RH
32	3211	Madera-Rd29	Wind, T, RH	71	2772	Oildale-3311	Wind, T
33	5711	Firebgh-Tel	T, RH	72	5287	MeadowsFld	Wind, T
34	2844	Fresno-Sky#2	Wind, T	73	3146	Baker-5558Ca	Wind, T, RH
35	5741	FSU2	T, RH	74	2312	Edison	Wind, T
36	3026	Clovis	Wind, T, RH	75	3758	Arvin-DiG	Wind, T
37	2449	Fresno-FAT	Wind, T	76	5771	Arvin-Edison	T, RH
38	5787	OrangeCove	T, RH	77	2919	Maricopa-Stn	Wind, T
39	2013	Fresno-Drmnd	Wind, T				

Table 9. Hourly surface wind speed, temperature and relative humidity statistics in Modesto.

Quarter	Observed Mean	Modeled Mean	Mean Bias	Mean Error	IOA
		Wind Speed (m/s)			
Q1	2.08	2.62	0.54	1.16	0.74
Q2	3.04	3.51	0.46	1.43	0.73
Q3	2.64	2.94	0.30	1.18	0.65
Q4	1.66	2.35	0.69	1.23	0.68
Annual	2.41	2.89	0.49	1.26	0.73
		Temperature (K)			
Q1	282.62	282.93	0.31	2.16	0.94
Q2	293.18	292.86	-0.32	2.07	0.96
Q3	295.98	297.06	1.07	2.35	0.93
Q4	283.95	285.73	1.78	2.73	0.93
Annual	288.93	289.65	0.71	2.33	0.97
		Relative Humidity (%)			
Q1	73.52	74.38	0.86	9.14	0.89
Q2	57.03	53.28	-3.75	10.99	0.86
Q3	62.17	55.26	-6.91	13.98	0.72
Q4	67.75	71.40	3.66	11.48	0.85
Annual	65.10	63.57	-1.53	11.40	0.86

Table 10. Hourly surface wind speed, temperature and relative humidity statistics in Fresno.

Quarter	Observed Mean	Modeled Mean	Mean Bias	Mean Error	IOA
		Wind Speed (m/s)			
Q1	1.47	1.90	0.43	1.11	0.56
Q2	2.54	3.12	0.58	1.53	0.59
Q3	2.14	2.65	0.51	1.42	0.47
Q4	1.12	1.69	0.57	1.05	0.52
Annual	1.85	2.37	0.52	1.29	0.61
		Temperature (K)			
Q1	283.76	282.90	-0.86	1.79	0.96
Q2	295.23	294.04	-1.19	2.16	0.95
Q3	299.69	299.22	-0.47	2.22	0.94
Q4	285.65	286.01	0.36	1.93	0.96
Annual	291.18	290.65	-0.53	2.03	0.98
		Relative Humidity (%)			
Q1	71.46	76.39	4.93	10.71	0.86
Q2	48.01	53.07	5.06	11.88	0.83
Q3	45.12	51.45	6.33	14.95	0.65
Q4	64.03	70.79	6.77	13.49	0.83
Annual	57.09	62.87	5.78	12.77	0.86

Table 11. Hourly surface wind speed, temperature and relative humidity statistics in Visalia.

Quarter	Observed Mean	Modeled Mean	Mean Bias	Mean Error	IOA
		Wind Speed (m/s)			
Q1	1.48	1.64	0.16	0.82	0.55
Q2	2.07	2.53	0.45	1.04	0.65
Q3	1.91	2.22	0.31	0.86	0.59
Q4	1.62	1.58	-0.04	0.73	0.60
Annual	1.77	2.00	0.24	0.88	0.65
		Temperature (K)			
Q1	283.66	282.87	-0.79	1.85	0.95
Q2	294.38	293.09	-1.29	2.23	0.95
Q3	298.73	298.42	-0.31	2.56	0.91
Q4	285.19	286.03	0.84	2.11	0.95
Annual	290.03	289.55	-0.48	2.16	0.97
		Relative Humidity (%)			
Q1	73.28	80.72	7.44	11.11	0.82
Q2	47.80	59.94	12.13	17.23	0.73
Q3	47.08	63.07	15.99	21.49	0.49
Q4	61.22	75.43	14.21	16.36	0.77
Annual	57.37	69.84	12.47	16.56	0.76

Table 12. Hourly surface wind speed, temperature and relative humidity statistics in Bakersfield (valid RH data available from January through May only; statistics are based on the available data).

Quarter	Observed Mean	Modeled Mean	Mean Bias	Mean Error	IOA
		Wind Speed (m/s)			
Q1	1.84	1.80	-0.04	0.88	0.59
Q2	2.63	2.47	-0.15	1.03	0.74
Q3	2.12	2.10	-0.02	1.10	0.68
Q4	2.23	1.86	-0.37	0.98	0.61
Annual	2.21	2.09	-0.12	1.00	0.70
		Temperature (K)			
Q1	284.94	283.97	-0.97	1.91	0.95
Q2	295.66	293.78	-1.87	2.44	0.94
Q3	301.17	299.54	-1.63	2.63	0.90
Q4	286.85	286.97	0.12	1.73	0.97
Annual	291.33	290.17	-1.16	2.16	0.97
		Relative Humidity (%)			
Q1	62.65	72.70	10.04	15.15	0.81
Q2	36.94	51.46	14.52	16.82	0.74
Annual	52.27	64.12	11.85	15.83	0.83

Table 13. Hourly surface wind speed, temperature and relative humidity statistics in the San Joaquin Valley.

Quarter	Observed Mean	Modeled Mean	Mean Bias	Mean Error	IOA
		Wind Speed (m/s)			
Q1	2.08	2.62	0.54	1.16	0.74
Q2	3.04	3.51	0.46	1.43	0.73
Q3	2.64	2.94	0.30	1.18	0.65
Q4	1.66	2.35	0.69	1.23	0.68
Annual	2.41	2.89	0.49	1.26	0.73
		Temperature (K)			
Q1	283.31	283.30	-0.01	2.17	0.94
Q2	294.23	293.42	-0.81	2.46	0.94
Q3	298.22	298.21	-0.02	2.82	0.90
Q4	285.08	286.20	1.12	2.65	0.93
Annual	290.19	290.25	0.07	2.52	0.96
		Relative Humidity (%)			
Q1	69.36	71.65	2.29	12.87	0.81
Q2	47.95	52.53	4.57	13.73	0.79
Q3	46.35	54.48	8.12	17.33	0.59
Q4	58.62	68.35	9.72	16.00	0.75
Annual	55.70	61.84	6.14	14.96	0.79

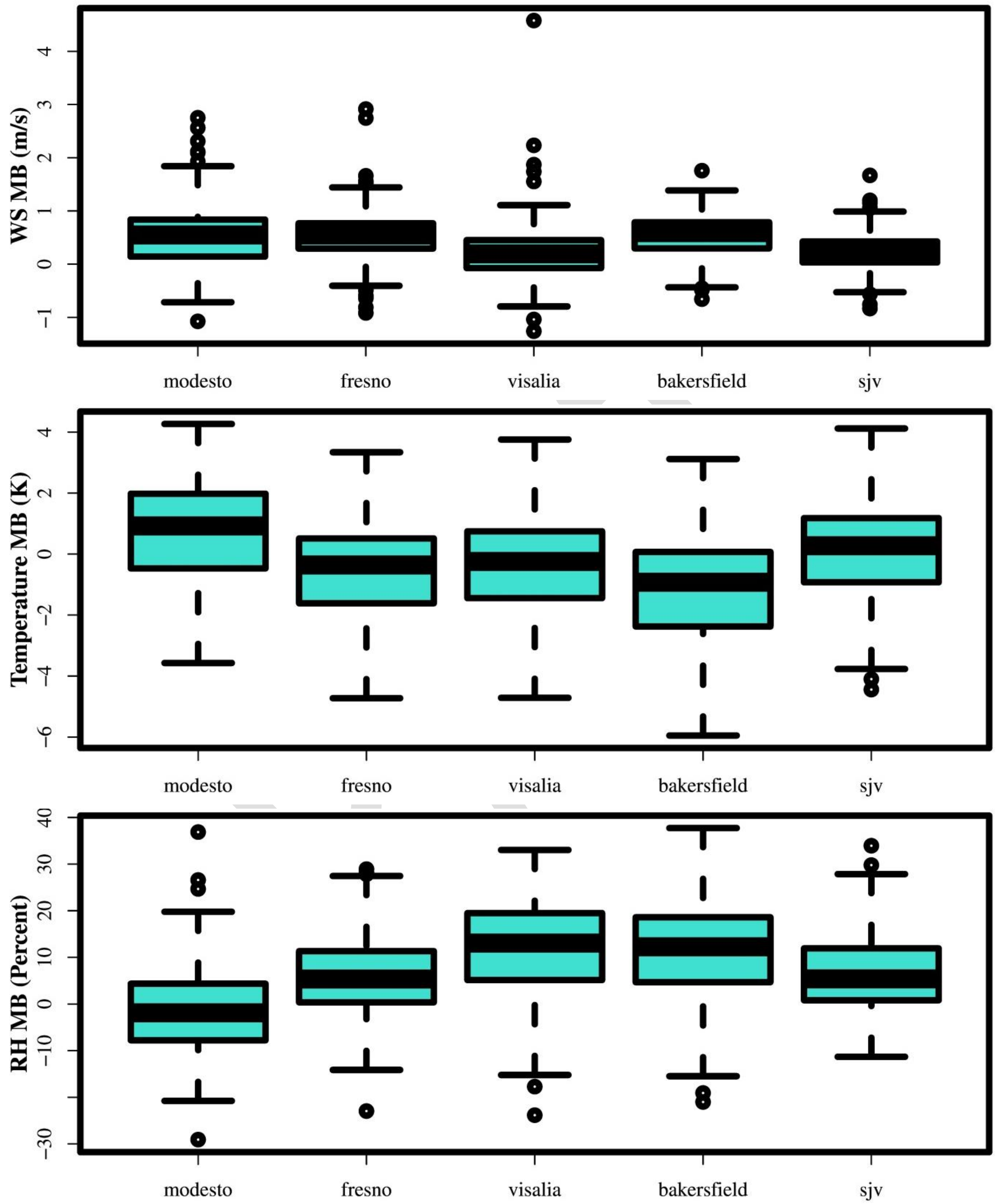


Figure 3. Distribution of model daily mean bias for Modesto, Fresno, Visalia, Bakersfield and SJV. Results are shown for wind speed (top), temperature (middle), and Relative Humidity (bottom).

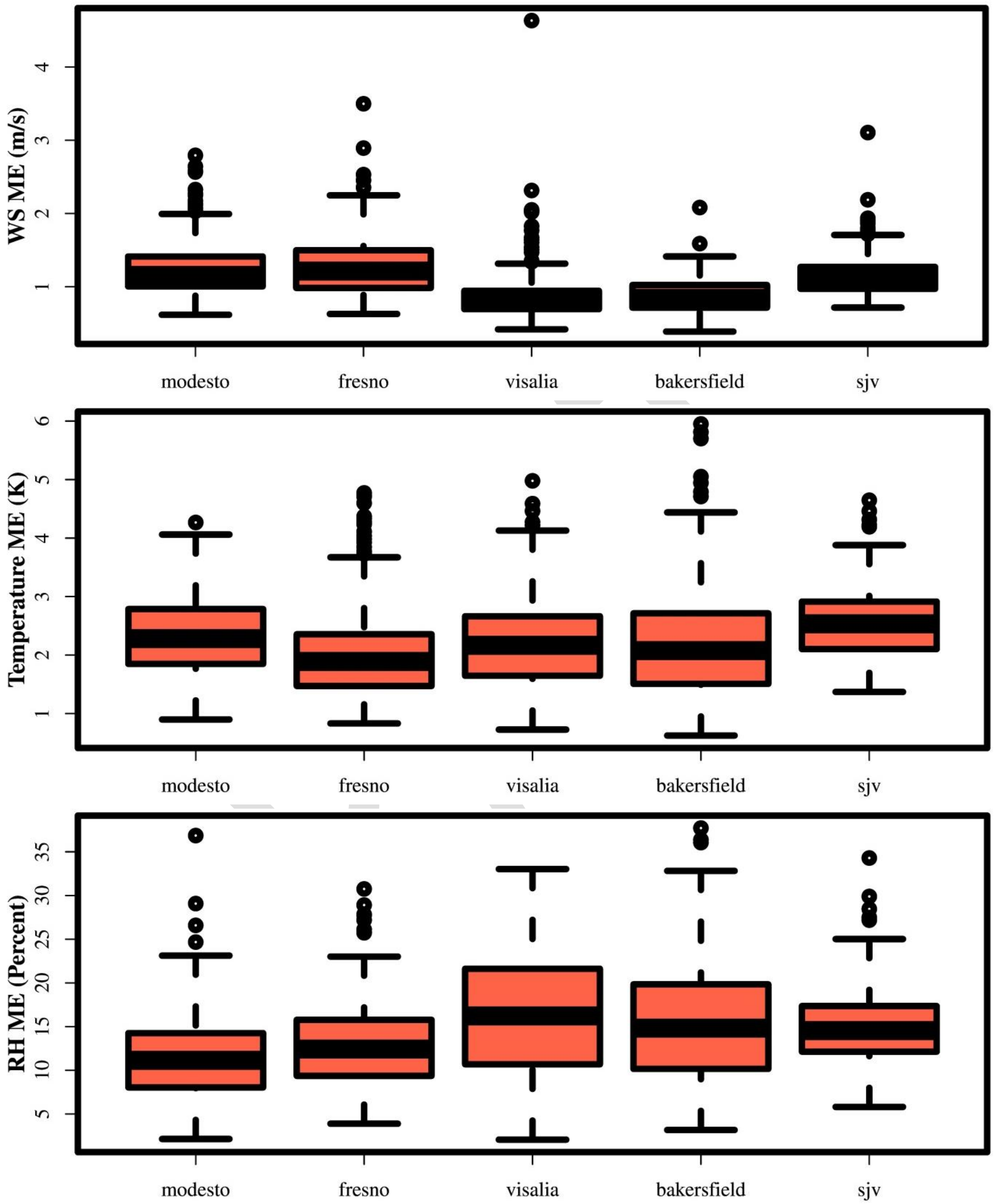


Figure 4. Distribution of model daily mean error for Modesto, Fresno, Visalia, Bakersfield and SJV. Results are shown for wind speed (top), temperature (middle), and Relative Humidity (bottom).

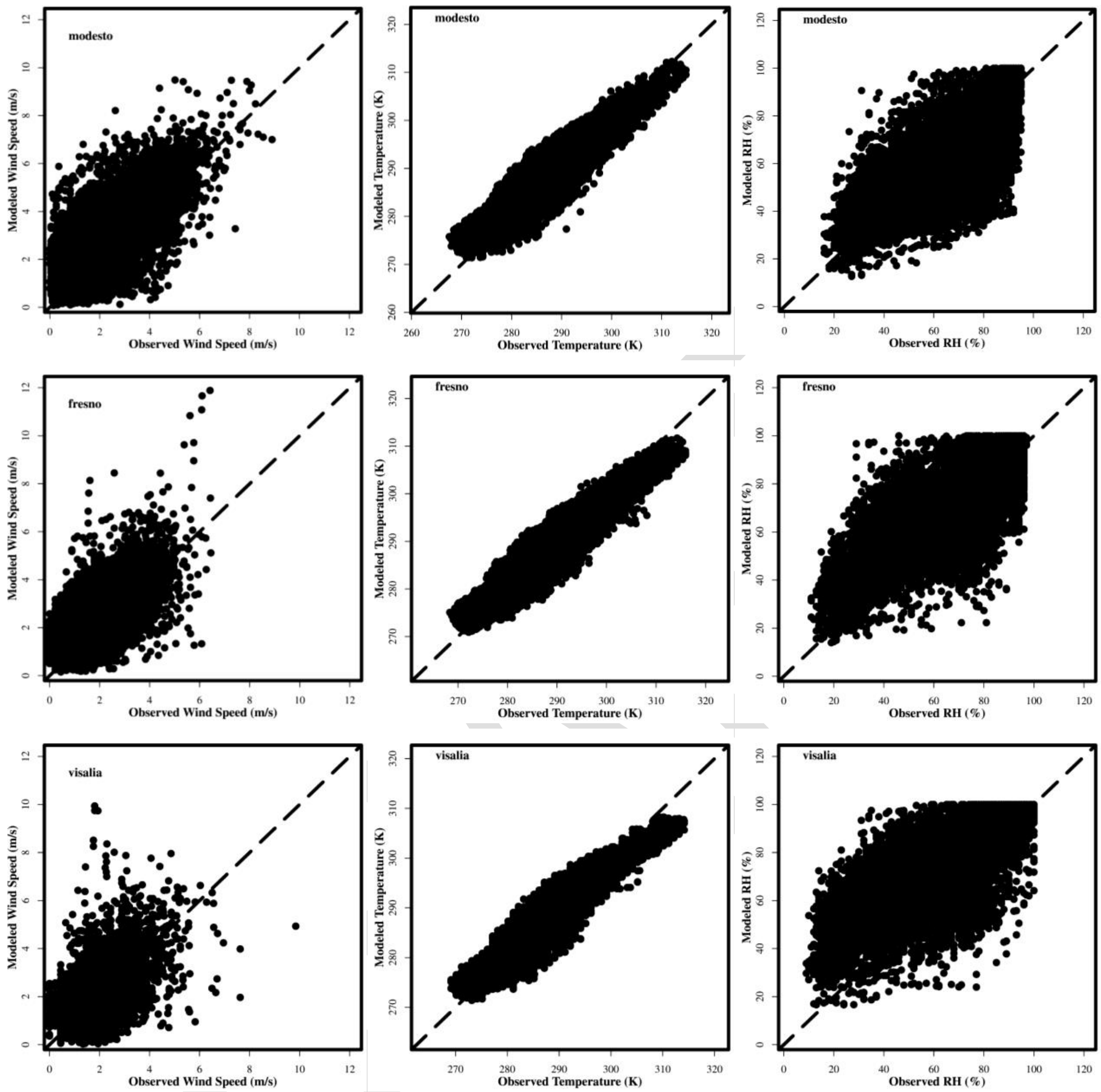


Figure 5. Comparison of modeled and observed hourly wind speed (left column), 2-meter temperature (middle column), and relative humidity (right column). Results for Modesto are shown in the top row, Fresno in the middle row, and Visalia in the bottom row.

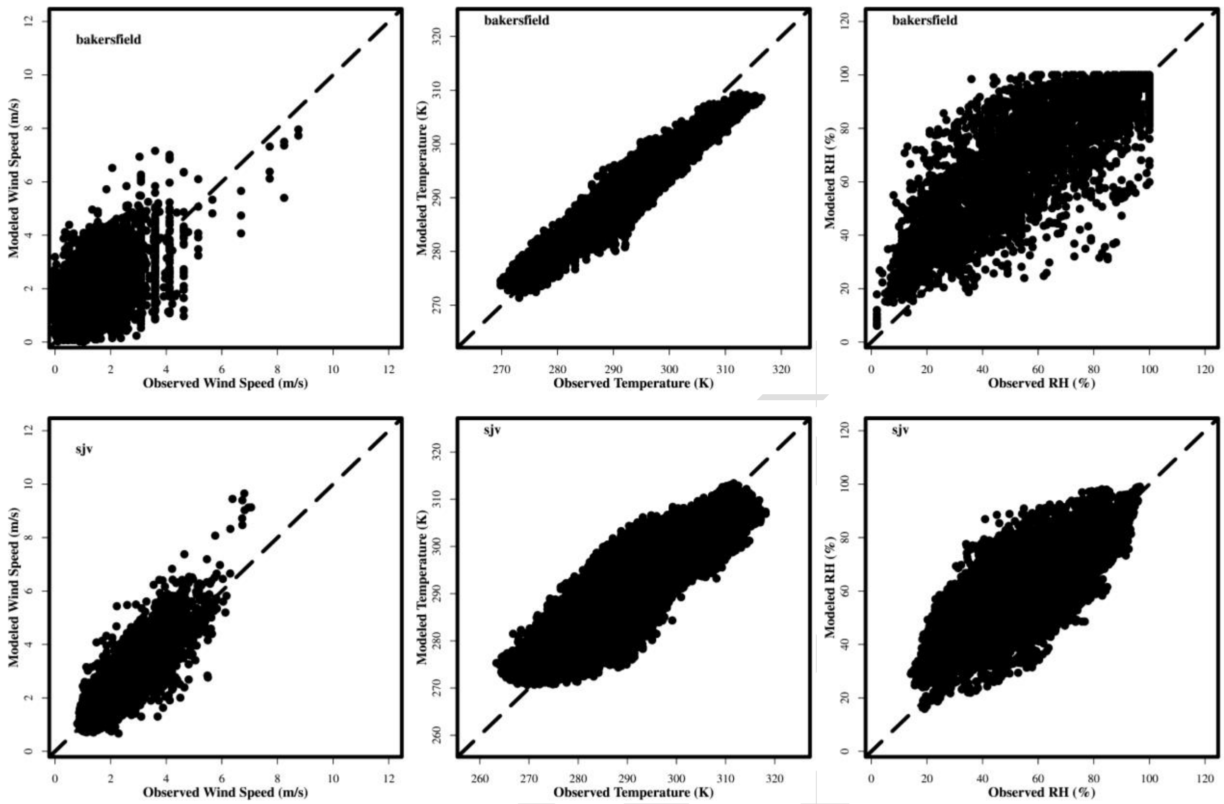


Figure 6. Comparison of modeled and observed hourly wind speed (left column), 2-meter temperature (middle column), and relative humidity (right column). Results for Bakersfield are shown in the top row and SJV in the bottom row.

3.2.1 PHENOMENOLOGICAL EVALUATION

Conducting a detailed phenomenological evaluation for all modeled days can be resource intensive given that the entire year was modeled. However, some insight and confidence that the model is able to reproduce the meteorological conditions leading to elevated particulate matter can be gained by investigating the meteorological conditions during a period of peak PM within the Valley in more detail. The highest $PM_{2.5}$-conducive meteorological conditions in the Valley occurred around January 20, 2013. Surface weather analysis shows that on January 20, the western US was under a typical Great Basin high pressure system. In the 500 hPa map (not shown), a strong high pressure ridge extends from Northern California along the west Pacific coast all the way to Alaska. As shown in Figures 7, 8, and 9, the winds, though weak, are mainly offshore along the northern California coast. Under this type of weather system, conditions in SJV are driven by diurnal cycles of the local winds. Figure 7 shows that at 13:00 PST, January 20, the upslope flows along the eastern side of the Coastal Ranges and the western side of the Sierras, lead to a weak northwesterly flow on the floor of the valley. The downslope winds form at nighttime and in the early morning (Figure 8 and Figure 9). They converge towards the valley and the winds in the center of the valley floor turn southeasterly. At the southern end of the valley, an eddy-like pattern occurs due to the interaction of the katabatic flows. The surface wind distributions of the modeled and observed winds indicate the model was able to capture many of the important features of the meteorological fields in the SJV.

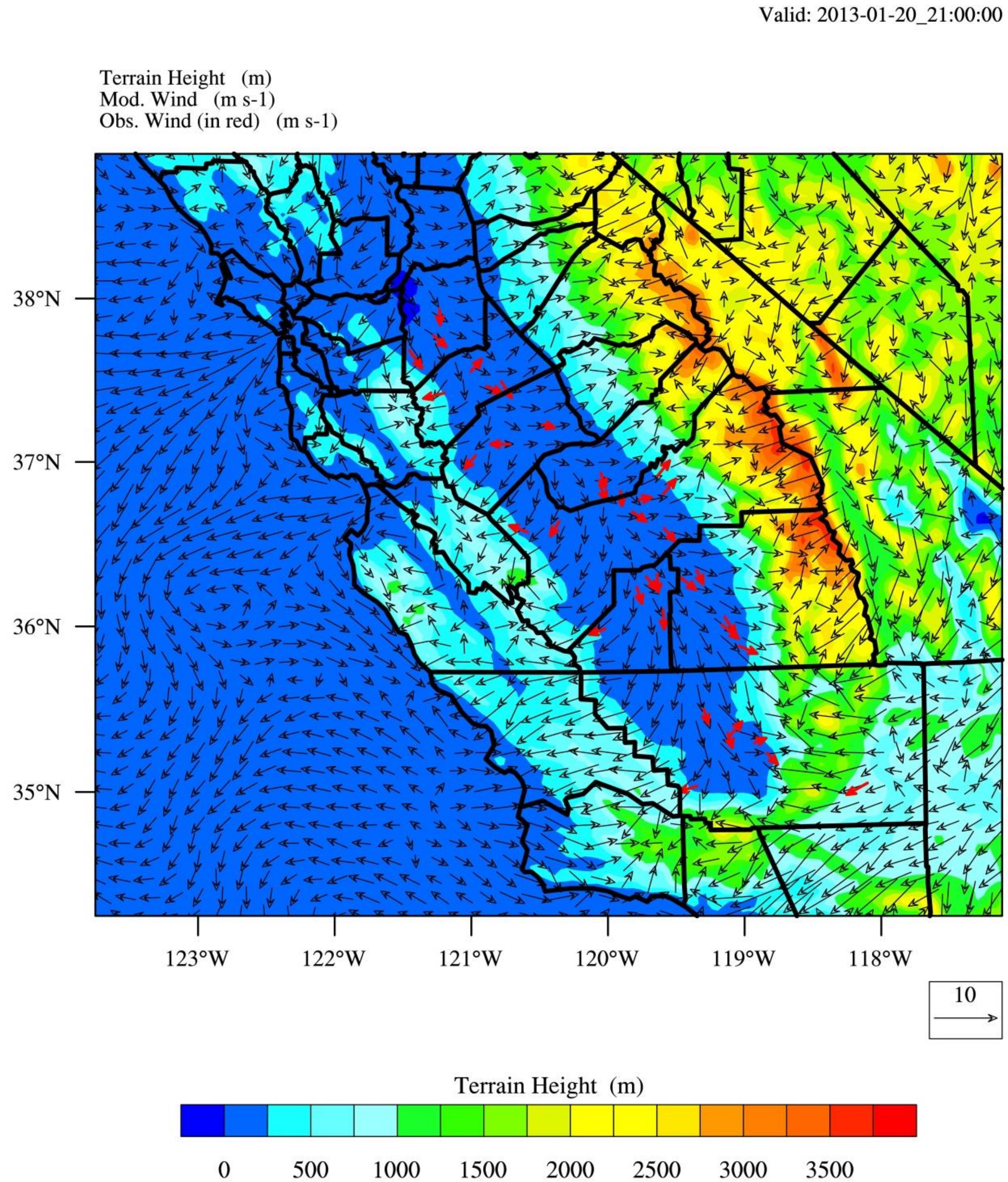


Figure 7. Surface wind field at 13:00 PST January 20, 2013.

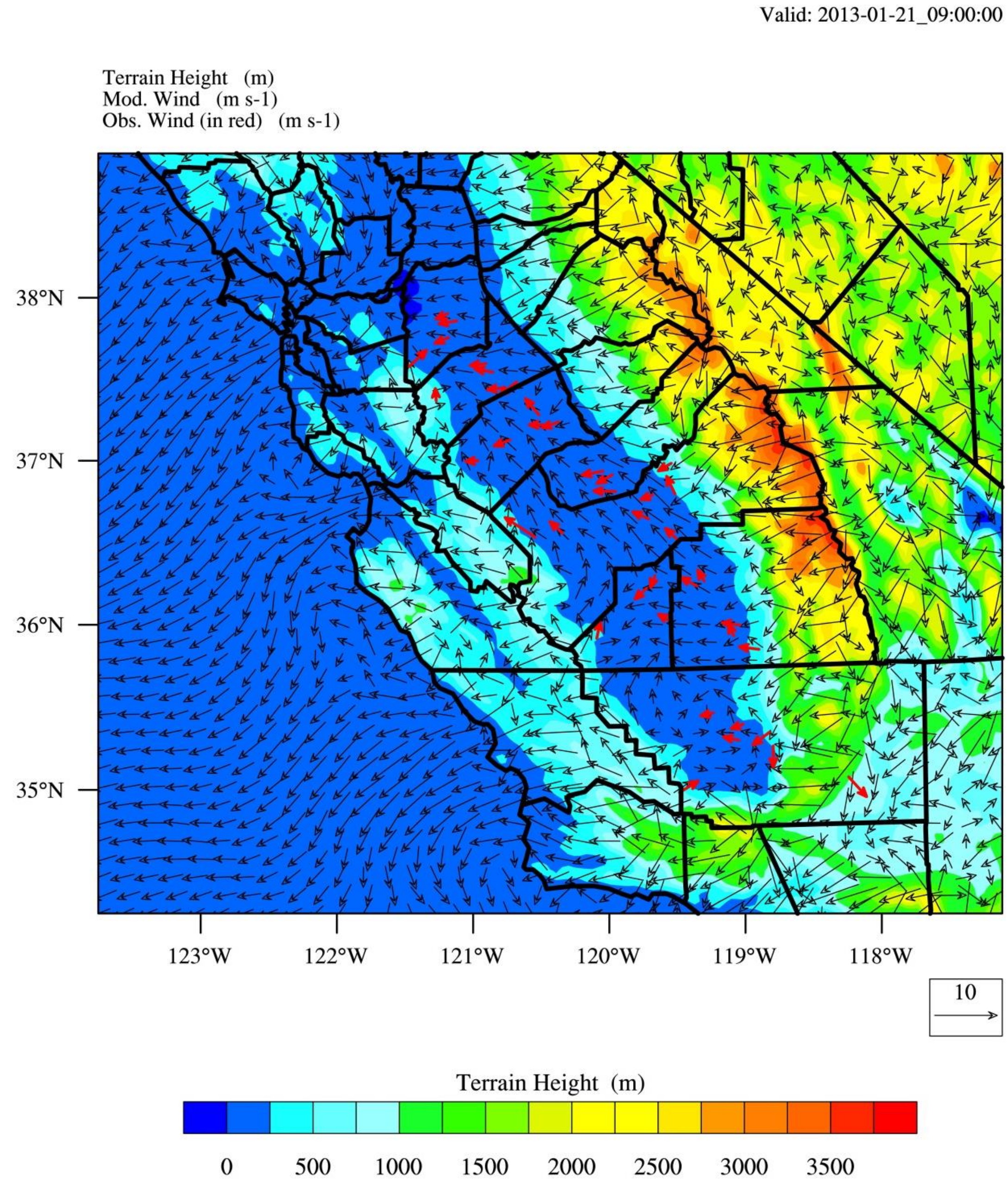


Figure 8. Surface wind field at 01:00 PST January 21, 2013.

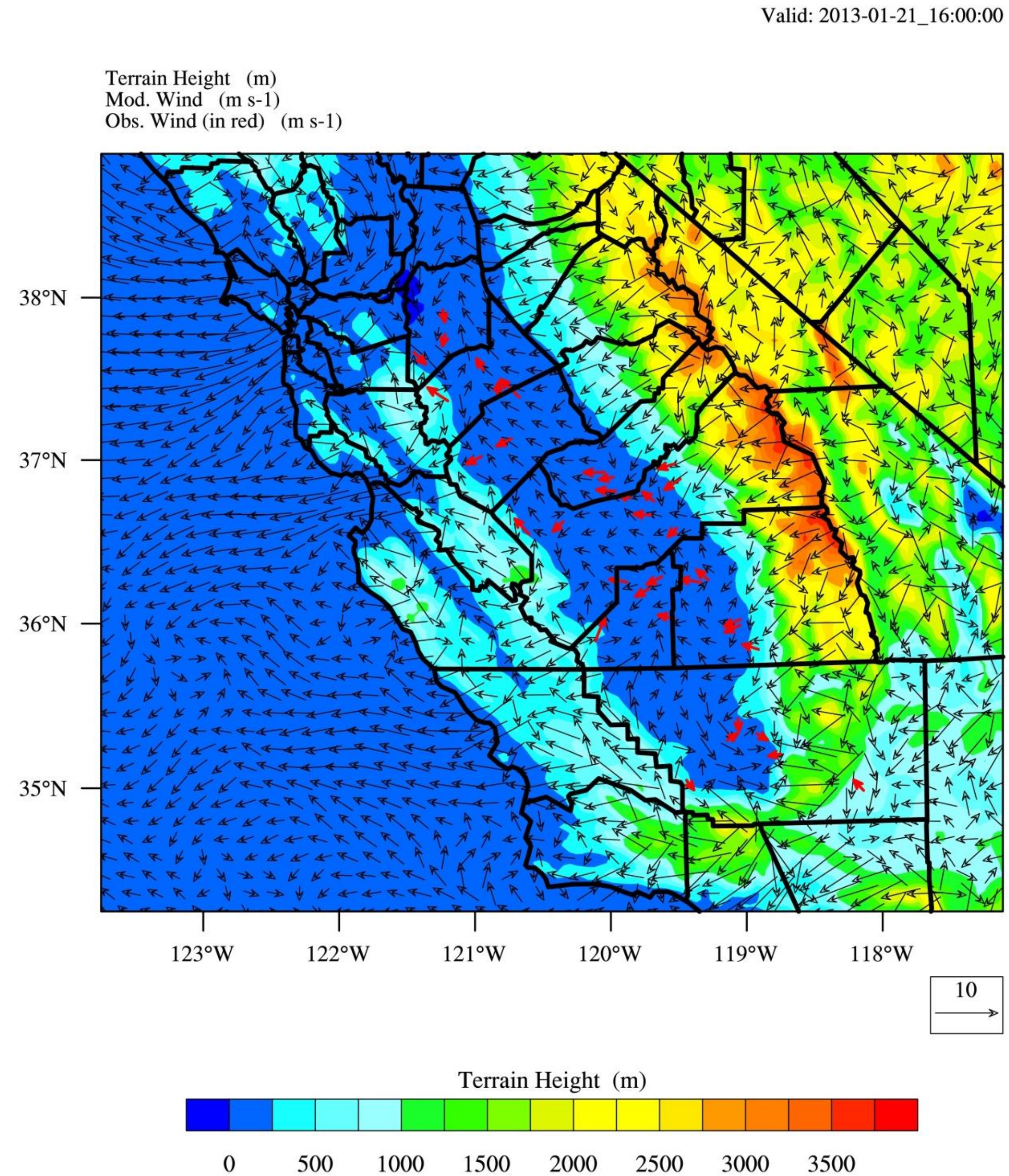


Figure 9. Surface wind field at 08:00 PST January 21, 2013.

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 and projected to 2013 under growth and control conditions (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 14 summarizes 2013, 2020, 2024, and 2025 SJV annual anthropogenic emissions for the five $PM_{2.5}$ precursors. These emission totals are based on the model-ready emission inventory and are inherently different from the planning emission inventory because the model-ready inventory considers additional factors such as weekday/weekend differences in on-road mobile emissions, day-to-day changes in residential wood burning activity, and the effects of meteorology on ammonia emissions. From 2013 to 2020, anthropogenic emissions in the SJV will drop approximately 35%, 8%, 6%, 8%, and 1% for NO_x, ROG, primary $PM_{2.5}$, SO_x, and NH_3, respectively. Among these five precursors, anthropogenic NO_x emissions show the largest relative reduction, dropping from 288 tons/day in 2013 to 187 tons/day in 2020. Anthropogenic $PM_{2.5}$ emissions will drop from 61 tons/day to 57 tons/day, reflecting a 6% reduction from 2013 to 2020. From 2020 to 2024, NO_x and $PM_{2.5}$ emissions will further drop by 42% and 7%, respectively, while emissions of other pollutants will stay nearly flat. From 2024 to 2025, NO_x emissions will drop a further 3%, while emissions of other pollutants remain relatively constant.

Note that the emission totals presented in Table 14 were calculated from the modeling inventory based on CEPAM version 1.0.5. Since the modeling inventory includes day-specific adjustments not included in the planning inventory, the planning and modeling inventories are expected to be comparable, but not identical. In addition, the 2024 and 2025 emission totals in Table 14 are from the attainment inventory, and so include additional emission reductions beyond the future baseline inventory for the respective year. These additional emission reductions for 2024 and 2025 are summarized in Tables 15-16 for NO_x and $PM_{2.5}$, respectively. A description of these emission control measures can be found in the SIP under the chapter describing the control strategy. Here, only the control factors for under-fired charbroil and residential wood combustion (RWC) are described in more detail.

Table 14. SJV annual modeling emissions for 2013, 2020 (baseline), 2024 (attainment), and 2025 (attainment)*.

Category	NO_x	ROG	$PM_{2.5}$	SO_x	NH_3
2013 (tons/day)					
Stationary	38.5	90.8	8.5	7.2	13.9
Area	8.1	153.3	40.2	0.3	310.0
On-road Mobile	154.6	45.1	5.7	0.6	4.4
Other Mobile	87.1	35.8	6.2	0.3	6.0
Total	288.2	325.0	60.5	8.4	334.3
2020 (tons/day)					
Stationary	28.5	95.1	8.4	6.5	15.2
Area	7.8	151.8	40.0	0.3	306.9
On-road Mobile	81.0	22.4	3.2	0.6	3.6
Other Mobile	69.8	28.7	5.4	0.3	6.0
Total	187.1	298.0	57.0	7.7	331.7
2024 (tons/day)					
Stationary	26.1	99.2	8.5	6.7	16.2
Area	6.9	152.5	37.8	0.3	304.7
On-road Mobile	32.1	17.5	3.1	0.6	3.4
Other Mobile	42.5	25.9	3.8	0.3	6.0
Total	107.6	295.1	53.2	7.9	330.2
2025 (tons/day)					
Stationary	26.0	100.3	8.6	6.8	16.4
Area	6.8	152.9	38.5	0.3	304.1
On-road Mobile	30.5	16.9	3.1	0.6	3.4
Other Mobile	41.2	25.3	3.6	0.3	6.0
Total	104.6	295.4	53.7	7.9	330.0

*: Note: emissions here are based on the model-ready inventory, which considers additional factors such as weekday/weekend difference in on-road mobile emissions. Therefore, emission values here are different from planning inventory presented in other documents.

Table 15: Additional NO_x emission reductions (tons/day) implemented in the 2024 and 2025 attainment inventories.

Emission Reduction	2024	2025
Electrification of agricultural combustion engines (50% reduction)	0.79	0.77
Stationary source fuel combustion	1.04	1.04
Agricultural equipment	11.50	10.00
Off-road equipment	2.10	1.70
Locomotives	1.40	1.30
Heavy duty diesel trucks	18.20	18.90
Flaring operations (20% reduction)	0.05	0.05

Table 16: Additional $PM_{2.5}$ emission reductions (tons/day) implemented in the 2024 and 2025 attainment inventories.

Emission Reduction	2024	2025
Residential wood combustion	0.47	0.47
Under-fired charbroils	0.56	0.57
Electrification of agricultural combustion engines (50% reduction)	0.025	0.024
Agricultural equipment	0.80	0.80
Enhanced conservation management practices (tillage)	0.46	0.46
Enhanced conservation management practices (fallow land)	0.19	0.19
Woodchips at Bakersfield (75% reduction)	0.00012	0.00012

In an effort to achieve the emission reductions needed to attain the $PM_{2.5}$ standards, a control strategy has been developed to reduce $PM_{2.5}$ emissions from under-fired charbroilers by approximately 30%. The strategy includes $PM_{2.5}$ emission reductions from large new restaurants and existing restaurants with charbroilers within urban boundaries in what are classified as hot spot areas. The percent reduction in direct $PM_{2.5}$ emissions from under-fired charbroilers for each county fully or partially classified as a hot spot area is given in Table 17. In addition, Figure 10 shows the hot spot areas in which the under-fired charbroiling $PM_{2.5}$ reductions will be applied.

Table 17. $PM_{2.5}$ percent reductions from under-fired charbroiling controls in 2024 (the same reductions were applied to 2025).

County / City	Reduction from existing restaurants	Reduction from large new restaurants	Total reductions
Fresno County	22.8%	7.8%	30.6%
Kern County	22.5%	7.8%	30.3%
City of Corcoran	22.9%	7.8%	30.7%
City of Madera	22.5%	7.8%	30.3%
City of Visalia	22.5%	7.8%	30.3%

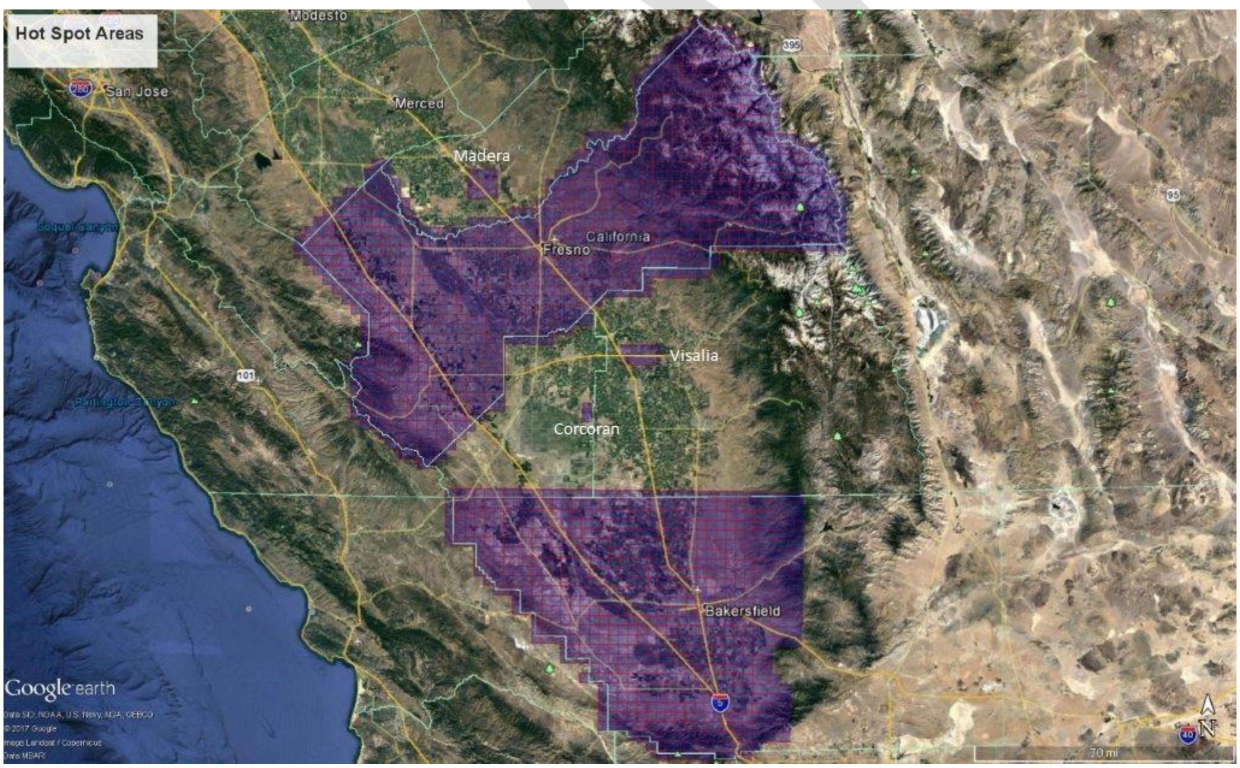


Figure 10. Hot spot areas for application of under-fired charbroiling/residential wood combustion $PM_{2.5}$ reductions

In 2024 and 2025, RWC emissions are subject to more stringent control. First, RWC emissions are reduced through the enhanced Burn Cleaner program, which focuses on changing out old high emitting wood stoves with cleaner burning stoves (a description of the Burn Cleaner program can be found in the chapter describing the control strategy). Table 18 shows the county-specific Burn Cleaner reductions (expressed as retention factors) for each county, which was provided by the San Joaquin Valley Air Pollution Control District. The RWC hot spot zones are defined to be the same as those for the charbroiling control, so no hot spot area is specified for the counties of Merced, San Joaquin, and Stanislaus.

Table 18: County-specific burn cleaner retention factors for 2024 (the same retention factors were applied for 2025).

County	Hot spot area retention factor	Non-hot spot area retention factor
Fresno	0.564	1.000
Kern	0.635	1.000
Kings	0.800	0.900
Madera	0.800	0.900
Merced	N/A	0.922
San Joaquin	N/A	0.812
Stanislaus	N/A	0.872
Tulare	0.800	0.900

In addition to the Burn Cleaner program, the current RWC curtailment program implemented in the SJV will be strengthened. Currently, the SJV has the following RWC curtailment program:

1.) Level 0 – burning allowed if forecasted $PM_{2.5}$ concentration is less than 20 μg/m^3
2.) Level 1 – burning permitted by registered, clean-burning devices if forecasted $PM_{2.5}$ concentration is between 20 μg/m^3 and 65 μg/m^3
3.) Level 2 – no burning is allowed if forecasted $PM_{2.5}$ concentration is higher than 65 μg/m^3

The curtailment program is applied on a county-specific basis (i.e., curtailment only applies to that county where forecasted $PM_{2.5}$ is above the threshold) and only applies to areas with access to natural gas service. In 2024/2025, in hot spot areas (shown in Figure 10, for Fresno/Kern counties, curtailment hot spot is limited to areas with access to natural gas service), the Level 1 threshold of the Burn Cleaner program is strengthened and will be triggered when forecasted $PM_{2.5}$ is greater than 12 μg/m^3, while Level 2 is triggered when forecasted $PM_{2.5}$ is greater than 35 µg/m^3. For non-hotspot areas, the current triggering thresholds are maintained. A compliance rate of 97% is assumed in 2024/2025 when curtailment is triggered. Finally, RWC emission reductions are assumed to be the same for 2024 and 2025 given the lack of growth in RWC emissions and the application of the same curtailment program.

Monthly biogenic ROG totals for 2013 in the SJV are shown in Figure 11 (note that the 2013 biogenic emissions were used for all model runs). Biogenic ROG emissions are highest in the summer at nearly 1800 tons/day in July when temperature, insolation, and leaf area are generally at their peak, and drop to near zero during winter months.

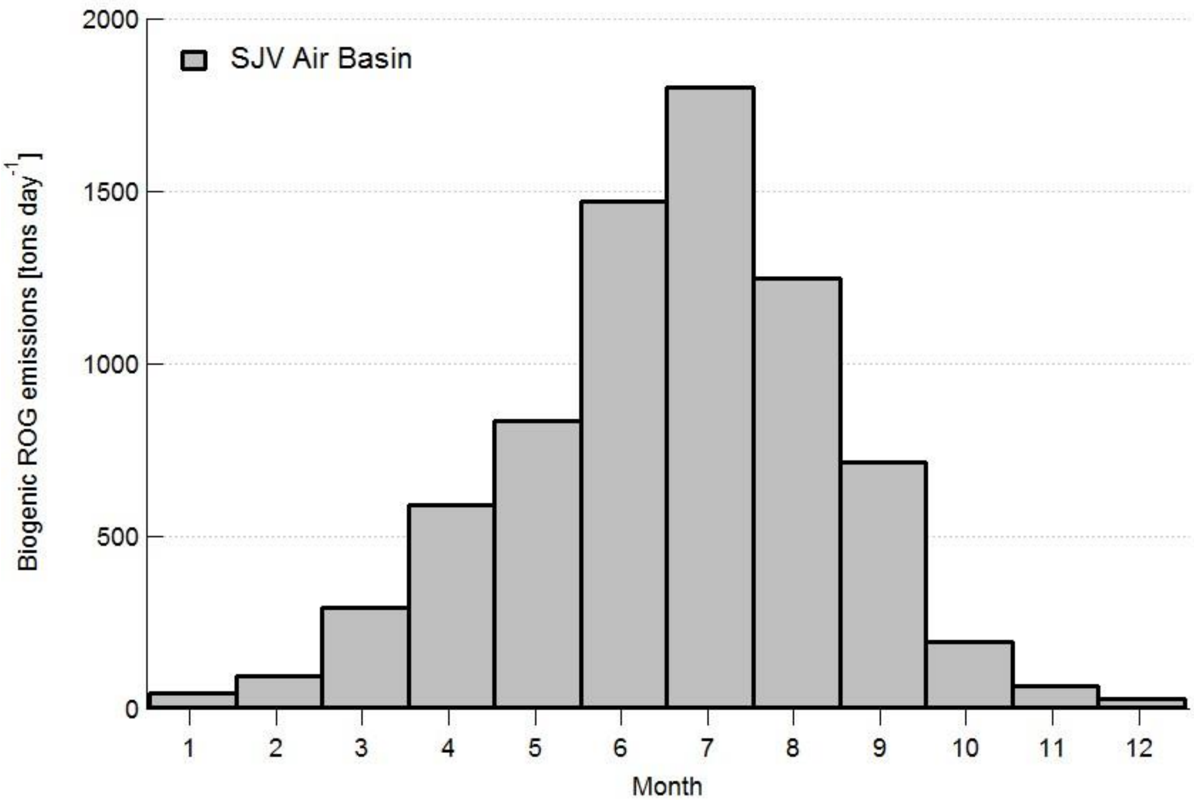


Figure 11. Monthly average biogenic ROG emissions for 2013.

5 $PM_{2.5}$ MODELING

5.1 CMAQ MODEL SETUP

Figure 12 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 107 x 97 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 covering the SJV region has a finer scale 4 km grid resolution and includes 87 x 103 lateral grid cells. While the nested domain is smaller than that used for ozone modeling in the Valley (see the Photochemical Modeling Protocol), as long as the larger statewide 12 km domain is utilized to provide dynamic boundary condition inputs to the smaller 4 km domain, there is no appreciable difference in simulated $PM_{2.5}$ predictions between the smaller domain utilized for $PM_{2.5}$ modeling and the larger domain used for ozone modeling. Both the 12 km and 4 km domains are based on a Lambert Conformal Conic projection with reference longitude at – 120.5ºN and 60ºN, 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 a majority of the vertical layers fall within the planetary boundary layer (see the Photochemical Modeling Protocol for details).

The CMAQ model version 5.0.2 (http://www.airqualitymodeling.org/cmaqwiki/index.php?title=CMAQ_version_5.0.2_%28April_2014_release%29_Technical_Documentation) released by the U.S. EPA in May 2014 was used for all air quality model simulations, consistent with the 2016 SJV $PM_{2.5}$ SIP (CARB, 2016). The SAPRC07 chemical mechanism and aerosol module aero6 were selected as the gas-phase and aerosol modules, respectively. Further details of the CMAQ configuration can be found in Table 19 and in the Photochemical Modeling Protocol. The same configuration was used for all simulations.

Annual simulations were conducted on a simultaneous month-by-month basis, rather than one single continuous simulation. 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 were set to the default CMAQ initial conditions. These outer domain simulations were used to provide initial and lateral boundary conditions for the inner 4 km simulation, which utilized a three day spin-up period.

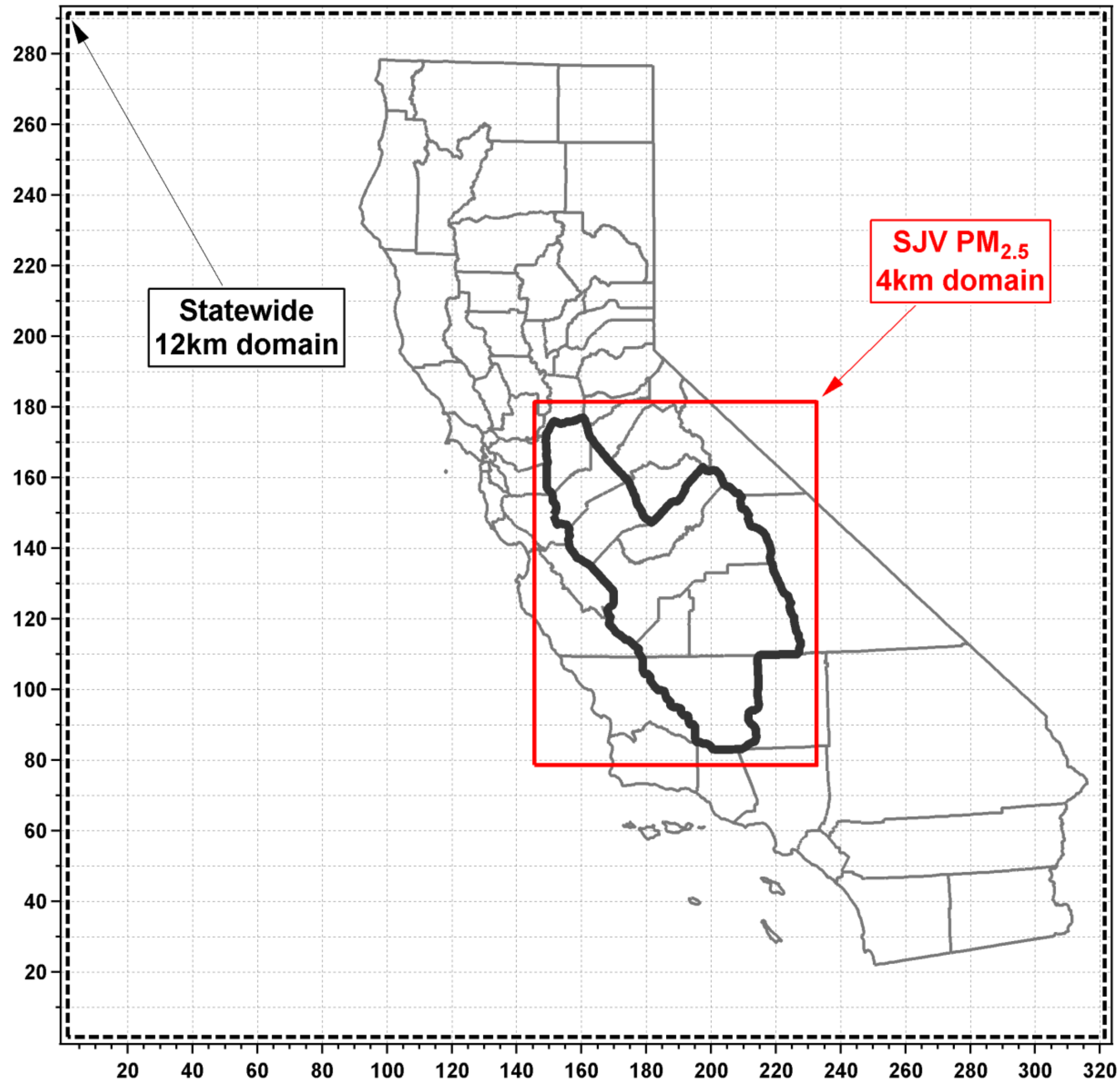


Figure 12. CMAQ modeling domains utilized in the modeling assessment.

Chemical boundary conditions 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., 2014). The MOZART-4 model output for 2013 was obtained from the National Center for Atmospheric Research (NCAR; https://www2.acom.ucar.edu/gcm/mozart) using 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 in all simulations.

Table 19. 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 version "B"
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

CMAQ model performance was evaluated for $PM_{2.5}$ mass, individual $PM_{2.5}$ chemical species, as well as a number of gas-phase species based on observations from an extensive network of monitors in the SJV.

Time series of observed and modeled $PM_{2.5}$ chemical species based on CSN measurements are shown in the supplemental material (Figures S37-S40 of the supplemental materials for Bakersfield, Fresno, Modesto, and Visalia, respectively). $PM_{2.5}$ species are measured every 3 or 6 days at these sites. Observed $PM_{2.5}$ concentrations are higher in winter months and are much lower in summer months.

During winter months, $PM_{2.5}$ in the SJV is dominated by ammonium nitrate and directly emitted OC. The CMAQ model was able to reasonably reproduce these key characteristics of $PM_{2.5}$ pollution in the SJV, including successfully capturing many elevated wintertime nitrate events, which is key for accurately simulating both peak wintertime $PM_{2.5}$ as well as annual average $PM_{2.5}$ in the SJV.

Tables 20-23 summarize the key model performance metrics for major $PM_{2.5}$ chemical species at the four CSN sites. Model performance was evaluated on a quarterly basis for each species at each monitor. Average observations, average modeled values, mean bias, mean error, mean fractional bias (MFB), and mean fractional error (MFE) are given for individual $PM_{2.5}$ species at these four sites. Detailed definitions for these metrics can be found in the Photochemical Modeling Protocol Appendix. In general, model performance was similar at different monitors. Modeling somewhat over predicted $PM_{2.5}$ concentrations for quarter one, but in general under predicted $PM_{2.5}$ concentrations for other quarters. Boylan and Russell (2006) proposed two criteria for model performance evaluation: Model performance goals are considered as the level of accuracy that is close to the best a model can be expected to achieve. Model performance criteria are considered as the level of accuracy that is acceptable for modeling applications. For more abundant species (e.g., concentrations $\geqslant$ 3 μg/m^3), model performance criteria are met when MFE $\leqslant$ 75% and MFB $\leqslant$ ±60%; model performance goals are met when MFE $\leqslant$ 50% and MFB $\leqslant$ ± 30%. For less abundant species, the performance criteria and goals are less stringent. A graphical representation of the quarterly MFB and MFE values in Tables 20-23 is shown in Figure 13 for each CSN site, along with suggested model performance goals and criteria (green and red lines, respectively) from Boylan and Russell (2006). Based on these metrics, the current CMAQ modelling system met the model performance criteria and in many instances exceeded model performance goals.

Table 20. Quarterly $PM_{2.5}$ model performance based on CSN measurement at Fresno – Garland.

Quarter	Species	# of Obs.	Avg. Obs. (µg/m³)	Avg. Mod. (µg/m³)	Mean bias (µg/m³)	Mean error (µg/m³)	MFB	MFE
1	$PM_{2.5}$	30	21.1	23.6	2.5	7.2	0.24	0.40
1	Ammonium	30	1.7	2.3	0.6	1.0	0.36	0.62
1	Nitrate	30	5.8	7.7	1.9	3.1	0.25	0.55
1	Sulfate	30	0.8	0.9	0.1	0.3	0.18	0.41
1	OC	28	4.9	5.4	0.4	1.9	0.22	0.41
1	EC	28	1.2	1.9	0.7	0.8	0.58	0.62
2	$PM_{2.5}$	30	7.8	6.0	-1.8	2.5	-0.29	0.39
2	Ammonium	30	0.4	0.2	-0.3	0.3	-0.81	0.87
2	Nitrate	30	0.9	0.4	-0.5	0.5	-0.94	0.97
2	Sulfate	30	1.1	0.6	-0.5	0.5	-0.50	0.56
2	OC	29	1.8	1.7	0.0	0.4	-0.06	0.26
2	EC	29	0.3	0.6	0.3	0.3	0.65	0.65
3	$PM_{2.5}$	30	9.4	6.3	-3.1	3.7	-0.36	0.44
3	Ammonium	30	0.4	0.1	-0.2	0.3	-0.83	0.94
3	Nitrate	30	0.7	0.2	-0.6	0.6	-1.41	1.45
3	Sulfate	30	0.9	0.7	-0.2	0.3	-0.19	0.36
3	OC	30	2.4	1.7	-0.8	0.9	-0.31	0.39
3	EC	30	0.5	0.6	0.1	0.2	0.25	0.34
4	$PM_{2.5}$	29	25.8	22.9	-2.9	8.9	-0.03	0.36
4	Ammonium	29	2.9	2.0	-0.9	1.6	-0.23	0.64
4	Nitrate	28	9.0	7.2	-1.8	4.3	-0.27	0.55
4	Sulfate	28	1.0	0.8	-0.2	0.3	-0.19	0.32
4	OC	29	6.0	4.7	-1.3	1.9	-0.16	0.36
4	EC	29	1.6	1.8	0.2	0.6	0.22	0.40

Table 21. Quarterly $PM_{2.5}$ model performance based on CSN measurement at Visalia.

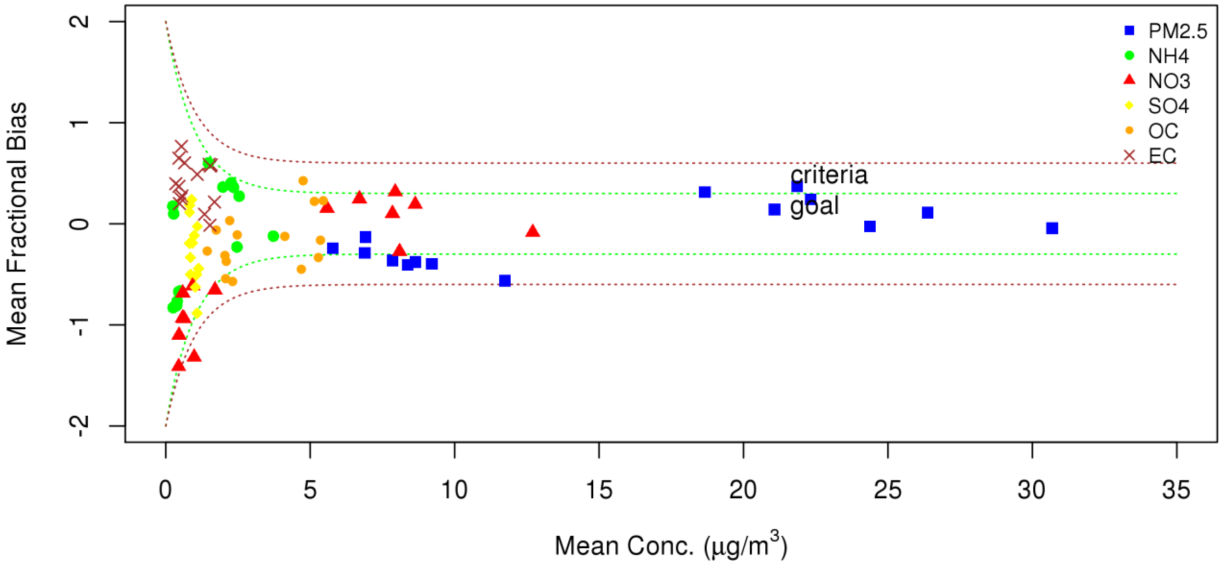
Quarter	Species	# of Obs.	Avg. Obs. (µg/m³)	Avg. Mod. (µg/m³)	Mean bias (µg/m³)	Mean error (µg/m³)	MFB	MFE
1	$PM_{2.5}$	15	20.5	21.7	1.2	5.6	0.14	0.32
1	Ammonium	15	2.0	2.7	0.8	1.1	0.36	0.59
1	Nitrate	15	6.7	9.2	2.6	3.3	0.32	0.50
1	Sulfate	15	1.0	0.7	-0.4	0.4	-0.33	0.46
1	OC	15	4.6	3.7	-0.9	1.6	-0.12	0.34
1	EC	15	0.9	1.3	0.4	0.5	0.49	0.52
2	$PM_{2.5}$	15	9.8	7.0	-2.8	2.8	-0.41	0.41
2	Ammonium	15	0.7	0.3	-0.3	0.3	-0.66	0.73
2	Nitrate	10	2.2	1.3	-0.9	0.9	-0.65	0.66
2	Sulfate	15	1.6	0.6	-1.0	1.0	-0.88	0.88
2	OC	17	2.6	1.6	-1.0	1.0	-0.54	0.54
2	EC	17	0.4	0.5	0.2	0.2	0.37	0.38
3	$PM_{2.5}$	17	10.5	6.7	-3.8	4.1	-0.38	0.45
3	Ammonium	17	0.6	0.2	-0.4	0.4	-0.77	0.81
3	Nitrate	17	1.6	0.3	-1.3	1.3	-1.32	1.32
3	Sulfate	17	1.4	0.8	-0.6	0.6	-0.50	0.51
3	OC	17	2.9	1.7	-1.2	1.4	-0.57	0.60
3	EC	17	0.5	0.6	0.2	0.2	0.28	0.31
4	$PM_{2.5}$	16	33.1	28.2	-4.9	12.5	-0.04	0.35
4	Ammonium	16	4.3	3.1	-1.2	2.1	-0.12	0.46
4	Nitrate	16	14.3	11.1	-3.2	6.6	-0.08	0.44
4	Sulfate	16	1.4	0.8	-0.6	0.7	-0.44	0.51
4	OC	16	5.8	3.6	-2.2	2.3	-0.45	0.49
4	EC	16	1.3	1.4	0.2	0.5	0.09	0.31

Table 22. Quarterly $PM_{2.5}$ model performance based on CSN measurement at Bakersfield.

Quarter	Species	# of Obs.	Avg. Obs. (µg/m³)	Avg. Mod. (µg/m³)	Mean bias (µg/m³)	Mean error (µg/m³)	MFB	MFE
1	$PM_{2.5}$	21	20.5	23.2	2.7	9.6	0.37	0.54
1	Ammonium	21	2.2	2.4	0.2	1.4	0.41	0.69
1	Nitrate	19	7.9	7.8	0.0	3.6	0.10	0.45
1	Sulfate	21	0.9	0.8	-0.1	0.4	0.11	0.52
1	OC	22	3.9	5.6	1.7	2.2	0.43	0.49
1	EC	22	1.1	1.9	0.8	0.8	0.59	0.59
2	$PM_{2.5}$	25	11.0	7.4	-3.6	4.1	-0.40	0.46
2	Ammonium	25	0.6	0.3	-0.3	0.3	-0.67	0.71
2	Nitrate	25	1.1	0.8	-0.3	0.6	-0.61	0.80
2	Sulfate	25	1.4	0.7	-0.7	0.7	-0.63	0.64
2	OC	22	2.2	2.3	0.1	0.5	0.03	0.23
2	EC	22	0.4	0.7	0.4	0.4	0.77	0.77
3	$PM_{2.5}$	19	15.5	8.0	-7.5	8.0	-0.56	0.60
3	Ammonium	19	0.5	0.2	-0.3	0.3	-0.81	0.86
3	Nitrate	19	0.8	0.4	-0.4	0.5	-0.93	1.04
3	Sulfate	19	1.3	0.8	-0.6	0.6	-0.51	0.51
3	OC	17	2.6	2.4	-0.2	0.9	-0.11	0.34
3	EC	17	0.5	0.9	0.4	0.4	0.60	0.60
4	$PM_{2.5}$	0	NA	NA	NA	NA	NA	NA
4	Ammonium	0	NA	NA	NA	NA	NA	NA
4	Nitrate	0	NA	NA	NA	NA	NA	NA
4	Sulfate	0	NA	NA	NA	NA	NA	NA
4	OC	0	NA	NA	NA	NA	NA	NA
4	EC	0	NA	NA	NA	NA	NA	NA

Table 23. Quarterly $PM_{2.5}$ model performance based on CSN measurement at Modesto.

Quarter	Species	# of Obs.	Avg. Obs. (µg/m³)	Avg. Mod. (µg/m³)	Mean bias (µg/m³)	Mean error (µg/m³)	MFB	MFE
1	$PM_{2.5}$	15	17.3	20.0	2.7	5.6	0.31	0.41
1	Ammonium	15	1.0	2.0	1.0	1.0	0.60	0.70
1	Nitrate	15	5.0	6.2	1.2	1.6	0.15	0.39
1	Sulfate	15	0.8	1.0	0.2	0.4	0.24	0.39
1	OC	14	5.5	5.5	0.0	2.2	0.23	0.44
1	EC	14	1.2	1.8	0.6	0.7	0.57	0.61
2	$PM_{2.5}$	15	6.5	5.0	-1.5	2.5	-0.24	0.40
2	Ammonium	15	0.3	0.3	0.0	0.1	0.10	0.44
2	Nitrate	13	0.7	0.5	-0.2	0.4	-0.68	0.81
2	Sulfate	15	1.0	0.8	-0.2	0.3	-0.18	0.36
2	OC	15	1.6	1.2	-0.4	0.6	-0.27	0.36
2	EC	15	0.3	0.4	0.1	0.1	0.40	0.40
3	$PM_{2.5}$	14	7.9	6.0	-1.9	3.1	-0.13	0.35
3	Ammonium	15	0.3	0.2	0.0	0.1	0.17	0.48
3	Nitrate	15	0.7	0.2	-0.5	0.5	-1.10	1.10
3	Sulfate	15	1.1	0.9	-0.2	0.3	-0.11	0.28
3	OC	15	2.6	1.5	-1.1	1.2	-0.37	0.40
3	EC	15	0.4	0.5	0.1	0.2	0.20	0.35
4	$PM_{2.5}$	17	25.6	27.1	1.5	4.1	0.11	0.21
4	Ammonium	17	2.4	2.6	0.2	0.6	0.27	0.38
4	Nitrate	17	8.2	9.0	0.8	2.2	0.19	0.32
4	Sulfate	17	1.1	1.1	-0.1	0.3	-0.02	0.25
4	OC	17	6.2	4.3	-1.9	1.9	-0.33	0.33
4	EC	17	1.6	1.5	-0.1	0.3	-0.01	0.22



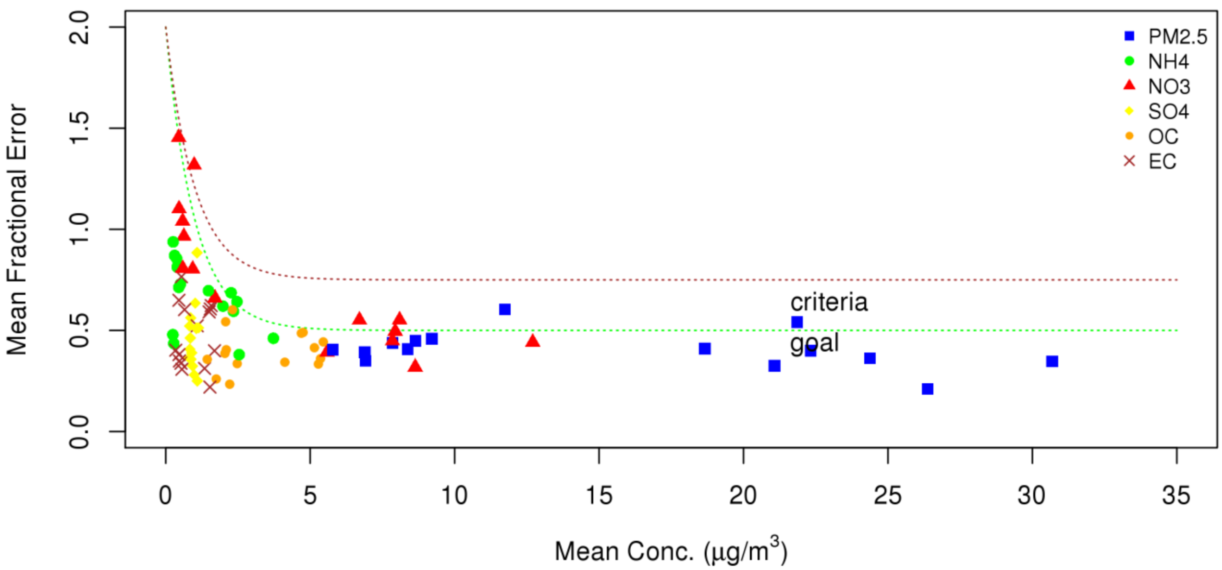


Figure 13. Bugle plot of quarterly $PM_{2.5}$ model performance in terms of MFB and MFE at the four CSN sites in the SJV (i.e., Bakersfield, Fresno, Modesto, and Visalia).

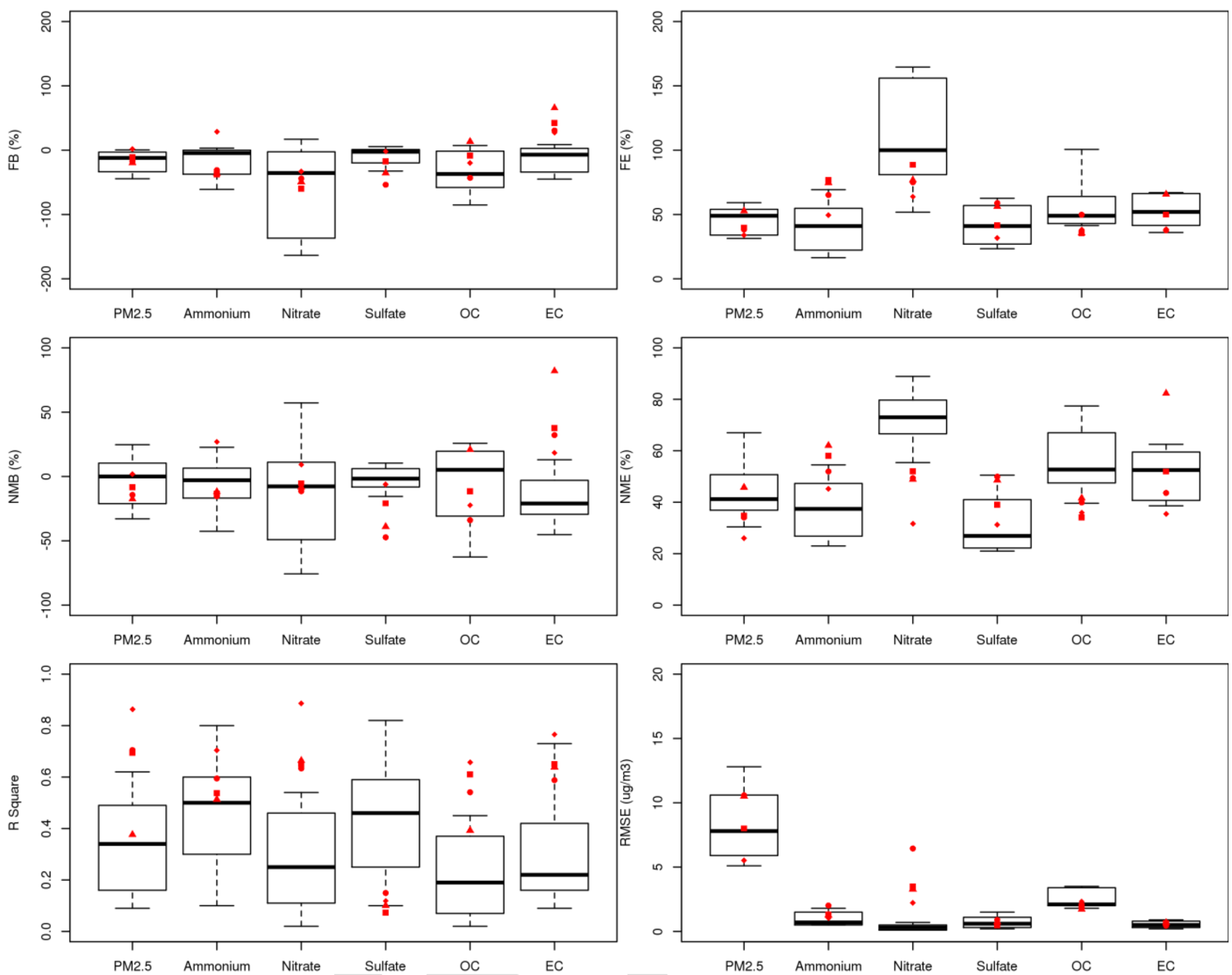


Figure 14. Comparison of annual $PM_{2.5}$ model performance to other modeling studies in Simon et al. (2012). Red symbols represent performance at the four CSN sites in the SJV.

In addition to evaluating the standard statistical performance metrics, it is also informative to put these performance statistics in the context of other studies published in the scientific literature. Figure 14 compares key performance statistics from the modeling platform presented in this document to the range of published performance statistics from 2006 to 2012 and summarized in Simon et al. (2012). In Figure 14, the black centerline shows the median value (i.e., median model performance) from those studies, the boxes outline the 25^{th} and 75^{th} percentile values, and the whiskers show the 10^{th} and 90^{th} percentile values. The model performance for each of the four CSN sites in the SJV is shown in red. Performance metrics including MFB, MFE, normalized mean bias (NMB), normalized mean error (NME), R squared, and root mean square error (RMSE) are compared. Definitions for these statistics can be found in the

Photochemical Modeling Protocol or Simon et al. (2012). Model performance metrics in the SJV are typically equal to or better than the corresponding statistics from other studies. One exception is the higher RMSE for nitrate in the SJV, which is simply a reflection of the higher nitrate concentrations in the SJV compared to other regions. In fact, MFB, MFE, NME, and R squared for nitrate in the SJV is consistently better than the majority of the model studies summarized in Simon et al. (2012). Finally, the model performance is also comparable to that of the 2012 SJV $PM_{2.5}$ SIP (Chen et al., 2014).

Since CSN monitors do not measure $PM_{2.5}$ on a daily basis, it is also advantageous to compare modeled 24-hour average $PM_{2.5}$ concentrations to observations from continuous $PM_{2.5}$ samplers, which typically report 24-hour average $PM_{2.5}$ concentrations on a daily basis. Figures S-41 – S-52 show the time series of modeled and observed 24-hour average $PM_{2.5}$ concentrations at these sites located throughout the SJV. Distinct seasonal variations in $PM_{2.5}$ concentrations are observed throughout the Valley, and are also reasonably captured by the model. Of particular importance, the modeling system was able to capture the elevated $PM_{2.5}$ events during the winter months and the lower $PM_{2.5}$ which is common in the summer months. In addition, Table 24 summarizes the corresponding model performance statistics at these sites. All the sites met or exceeded the $PM_{2.5}$ model performance criteria defined in Boyland and Russell (2006).

In addition to the $PM_{2.5}$ performance evaluation, gas phase model performance was also evaluated for nitrogen dioxide (NO_2) and ozone, which are key products of the photochemical processes in the atmosphere. Scatter plots of observed and modeled one-hour NO_2 mixing ratios at 16 sites are shown in Figures S-53 to S-68 in the supplemental materials. On average, there is good agreement between observed and modeled NO_2 mixing ratios. The slope of the regression line between the observed and modeled hourly NO_2 mixing ratios is within ±30% of the 1:1 correlation line at most of the sites. Scatter plots of observed and modeled hourly O_3 mixing ratios at 25 sites are shown in Figures S-69 to S-93 in the supplemental materials. Modeled O_3 mixing ratios show excellent agreement with observed mixing ratios and the slopes of the regression lines between observed and modeled O_3 are all within ±15% of the 1:1 correlation line.

Table 24. Model performance for 24-hour $PM_{2.5}$ concentrations measured from continuous $PM_{2.5}$ monitors.

Sites	# of Obs.	Avg. Obs. (µg/m³)	Avg. Mod. (µg/m³)	Mean bias (µg/m³)	Mean error (µg/m³)	MFB	MFE
Fresno-Drummond Street	246	14.8	13.0	-1.8	4.9	-0.20	0.40
Clovis	300	16.4	13.6	-2.7	6.1	-0.26	0.46
Bakersfield-California Avenue	267	20.2	15.7	-4.4	7.7	-0.31	0.47
Tranquility	301	8.5	8.6	0.1	4.1	-0.19	0.51
Fresno-Garland	312	19.3	15.0	-4.3	6.7	-0.36	0.47
Stockton	302	18.0	13.2	-4.8	7.5	-0.54	0.63
Merced	326	13.2	12.7	-0.6	5.3	-0.19	0.46
Hanford	329	18.0	14.6	-3.4	6.3	-0.33	0.49
Madera	323	18.0	12.0	-6.0	8.1	-0.57	0.67
Manteca	325	11.7	13.1	1.4	6.0	-0.13	0.56
Visalia	309	18.6	17.0	-1.7	6.6	-0.19	0.43
Modesto	315	14.4	14.3	-0.1	5.1	-0.06	0.43
Turlock	316	14.8	14.2	-0.6	4.5	-0.08	0.43

5.3 FUTURE YEAR 2020 DESIGN VALUES

Projected future year 2020 annual $PM_{2.5}$ and 24-hour $PM_{2.5}$ DVs for each site are given in Tables 25 and 26, respectively. For the annual standard, the Bakersfield-Planz site has the highest projected DV at 14.6 $\mu g/m^3$, which is below the 15 $\mu g/m^3$ annual $PM_{2.5}$ standard established by the U.S. EPA in 1997. For the 24-hour standard, the Bakersfield-California Avenue site has the highest projected DV at 47.6 $\mu g/m^3$, which is also below the 65 $\mu g/m^3$ 24-hour $PM_{2.5}$ standard established by the U.S. EPA in 1997.

The Corresponding Relative Response Factors (RRFs) for both the annual $PM_{2.5}$ and 24-hour $PM_{2.5}$ are given in Tables 27-28, respectively (Note, RRF is calculated on a quarterly basis in the actual DV calculation, so the annual RRF is shown for illustrative purposes only). From 2013 to 2020, there are modest reductions projected for ammonium nitrate, EC, and organic matter (OM), a slight decrease in sulfate, but a slight increase in crustal material (i.e., other primary $PM_{2.5}$ such as fugitive dust emissions). The reduction in ammonium nitrate is a direct result of NO_x emission reductions in 2020 compared to 2013, while EC and OM reductions are primarily tied to the reduction in primary $PM_{2.5}$ emissions. Because future year projection is performed for each individual $PM_{2.5}$ specie, the base year annual and 24-hour based $PM_{2.5}$ compositions are given in Tables 29-30, respectively. In addition, the projected 2020 annual and 24-hour $PM_{2.5}$ compositions are shown in Tables 31-32, respectively. In 2020, for the annual $PM_{2.5}$ standard, OM is the dominant $PM_{2.5}$ component followed by ammonium nitrate, while for the 24-hour $PM_{2.5}$ standard, ammonium nitrate and OM are roughly equivalent in terms of their contribution to total $PM_{2.5}$.

Table 25. Projected future year 2020 annual $PM_{2.5}$ DVs at each monitor.

Site AQS ID	Name	Base DV (µg/m³)	2020 Annual DV (µg/m³)
60290016	Bakersfield - Planz	17.2	14.6
60392010	Madera	16.9	14.2
60311004	Hanford	16.5	13.3
61072002	Visalia	16.2	13.5
60195001	Clovis	16.1	13.4
60290014	Bakersfield - California	16.0	13.5
60190011	Fresno - Garland	15.0	12.4
60990006	Turlock	14.9	12.5
60195025	Fresno - Hamilton & Winery	14.2	11.9
60771002	Stockton	13.1	11.4
60470003	Merced - S Coffee	13.1	10.9
60990005	Modesto	13.0	11.0
60472510	Merced - Main Street	11.0	9.3
60772010	Manteca	10.1	8.7
60192009	Tranquility	7.7	6.4

Table 26. Projected future year 2020 24-hour $PM_{2.5}$ DVs at each monitor.

Site AQS ID	Name	Base DV (µg/m³)	2020 24-hour DV (µg/m³)
60290014	Bakersfield – California	64.1	47.6
60190011	Fresno – Garland	60.0	44.3
60311004	Hanford	60.0	43.7
60195025	Fresno – Hamilton & Winery	59.3	45.6
60195001	Clovis	55.8	41.1
61072002	Visalia	55.5	42.8
60290016	Bakersfield – Planz	55.5	41.2
60392010	Madera	51.0	38.9
60990006	Turlock	50.7	37.8
60990005	Modesto	47.9	35.8
60472510	Merced – Main Street	46.9	32.9
60771002	Stockton	42.0	33.5
60470003	Merced – S Coffee	41.1	30.0
60772010	Manteca	36.9	30.1
60192009	Tranquility	29.5	21.5

Table 27. 2020 Annual RRFs for $PM_{2.5}$ components.

Site	RRF for $PM_{2.5}$	RRF for NH_4	RRF for NO_3	RRF for SO_4	RRF for OM	RRF for EC	RRF for Crustal
Bakersfield - Planz	0.85	0.67	0.69	0.98	0.88	0.52	1.05
Madera	0.84	0.74	0.70	0.99	0.89	0.67	1.05
Hanford	0.80	0.71	0.67	1.02	0.91	0.70	1.00
Visalia	0.83	0.68	0.70	1.00	0.86	0.62	1.04
Clovis	0.83	0.71	0.71	1.00	0.84	0.61	1.08
Bakersfield - California	0.84	0.66	0.67	0.98	0.88	0.52	1.06
Fresno - Garland	0.83	0.73	0.72	0.99	0.84	0.57	1.07
Turlock	0.84	0.75	0.73	0.98	0.89	0.65	1.06
Fresno - H&W	0.83	0.75	0.75	1.00	0.84	0.55	1.06
Stockton	0.87	0.80	0.75	1.01	0.92	0.69	1.08
Merced - S Coffee	0.83	0.73	0.70	0.99	0.89	0.66	1.05
Modesto	0.84	0.75	0.73	0.98	0.90	0.65	1.06
Merced - Main St	0.85	0.72	0.70	0.99	0.88	0.66	1.06
Manteca	0.86	0.79	0.76	0.98	0.90	0.68	1.06
Tranquility	0.83	0.71	0.63	1.00	0.93	0.73	1.03

Table 28. 2020 24-hour RRFs for $PM_{2.5}$ components.

Site	RRF for $PM_{2.5}$	RRF for NH_4	RRF for NO_3	RRF for SO_4	RRF for OM	RRF for EC	RRF for Crustal
Bakersfield - California	0.74	0.70	0.70	0.98	0.77	0.45	1.07
Fresno – Garland	0.74	0.75	0.75	0.99	0.71	0.50	1.07
Hanford	0.73	0.67	0.68	1.04	0.84	0.65	1.02
Fresno - H&W	0.78	0.78	0.79	0.99	0.75	0.51	1.07
Clovis	0.73	0.72	0.73	1.00	0.72	0.54	1.08
Visalia	0.77	0.77	0.77	1.01	0.73	0.53	1.05
Bakersfield – Planz	0.73	0.73	0.73	0.97	0.66	0.42	1.05
Madera	0.76	0.75	0.75	0.99	0.76	0.60	1.07
Turlock	0.74	0.71	0.72	0.97	0.77	0.58	1.06
Modesto	0.75	0.73	0.72	0.98	0.75	0.58	1.07
Merced – Main St	0.70	0.71	0.71	0.97	0.65	0.53	1.06
Stockton	0.80	0.74	0.74	1.00	0.88	0.67	1.07
Merced – S Coffee	0.72	0.72	0.72	0.97	0.67	0.54	1.06
Manteca	0.82	0.80	0.80	0.97	0.82	0.68	1.07
Tranquility	0.72	0.61	0.61	1.05	0.85	0.72	1.08

Table 29. Base year Annual $PM_{2.5}$ compositions.*

Name	Base $PM_{2.5}$ (µg/m³)	Base NH_4 (µg/m³)	Base NO_3 (µg/m³)	Base SO_4 (µg/m³)	Base OM (µg/m³)	Base EC (µg/m³)	Base Crustal (µg/m³)
Bakersfield - Planz	17.2	1.38	2.61	1.66	6.65	0.99	2.53
Madera	16.9	1.74	4.07	1.49	6.06	0.91	1.22
Hanford	16.5	2.15	5.47	1.50	3.84	0.70	1.21
Visalia	16.2	1.41	2.99	1.45	7.13	0.68	1.15
Clovis	16.1	1.11	2.14	1.30	8.43	0.88	1.06
Bakersfield – Cali.	16.0	1.31	2.60	1.48	6.19	0.92	2.22
Fresno – Garland	15.0	1.04	2.15	1.11	7.80	0.82	0.90
Turlock	14.9	1.60	3.94	1.22	5.11	0.77	0.87
Fresno - H&W	14.2	0.99	2.05	1.05	7.39	0.78	0.85
Stockton	13.1	1.38	3.29	1.13	4.61	0.66	0.82
Merced - S Coffee	13.1	1.38	3.31	1.13	4.56	0.66	0.81
Modesto	13.0	1.39	3.41	1.08	4.46	0.67	0.77
Merced - M Street	11.0	0.82	1.70	0.88	5.40	0.56	0.62
Manteca	10.1	1.06	2.59	0.83	3.42	0.51	0.59
Tranquility	7.7	0.77	1.85	0.61	2.67	0.40	0.50

*: $PM_{2.5}$ compositions were based on CSN speciation measurement adjusted by the EPA SANDWICH method. Particle-bound water and blank mass are not shown. The same applies to the base year 24-hour DV compositions.

Table 30. Base year 24-hour $PM_{2.5}$ standard DV compositions.

Name	Base $PM_{2.5}$ (µg/m³)	Base NH_4 (µg/m³)	Base NO_3 (µg/m³)	Base SO_4 (µg/m³)	Base OM (µg/m³)	Base EC (µg/m³)	Base Crustal (µg/m³)
Bakersfield – Cali.	64.1	7.6	21.9	3.2	18.9	2.7	4.7
Fresno – Garland	60.0	6.7	20.8	1.7	22.9	2.5	0.9
Hanford	60.0	9.1	28.6	2.2	11.2	1.7	1.1
Fresno – H&W	59.3	6.4	20.3	1.4	23.2	2.7	0.9
Clovis	55.8	6.1	19.1	1.3	21.8	2.5	0.8
Visalia	55.5	7.6	23.5	2.1	14.7	1.6	1.0
Bakersfield - Planz	55.5	6.5	18.1	3.4	17.9	2.5	2.8
Madera	51.0	6.1	19.3	1.2	17.1	2.3	0.8
Turlock	50.7	6.5	20.0	1.9	14.6	2.4	1.0
Modesto	47.9	6.1	18.9	1.8	13.8	2.3	0.9
Merced - M Street	46.9	5.3	16.1	1.7	17.1	2.2	0.9
Stockton	42.0	5.4	15.9	2.1	11.8	2.2	1.0
Merced - S Coffee	41.1	5.4	16.1	1.8	11.6	1.8	0.8
Manteca	36.8	4.7	14.5	1.4	10.5	1.7	0.7
Tranquility	29.5	3.5	10.8	0.9	10.0	1.4	0.4

Table 31. Projected 2020 Annual $PM_{2.5}$ compositions.

Name	Future $PM_{2.5}$ (µg/m³)	Future NH_4 (µg/m³)	Future NO_3 (µg/m³)	Future SO_4 (µg/m³)	Future OM (µg/m³)	Future EC (µg/m³)	Future Crustal (µg/m³)	Future Water (µg/m³)	Blank (µg/m³)
Bakersfield – Planz	14.6	0.92	1.81	1.62	5.84	0.51	2.66	0.72	0.5
Madera	14.2	1.30	2.85	1.47	5.40	0.61	1.28	0.75	0.5
Hanford	13.3	1.53	3.68	1.53	3.50	0.49	1.21	0.86	0.5
Visalia	13.5	0.96	2.09	1.45	6.16	0.42	1.20	0.72	0.5
Clovis	13.4	0.78	1.52	1.29	7.06	0.54	1.15	0.60	0.5
Bakersfield - California	13.5	0.86	1.75	1.44	5.45	0.48	2.34	0.65	0.5
Fresno – Garland	12.4	0.76	1.55	1.10	6.54	0.47	0.96	0.54	0.5
Turlock	12.5	1.20	2.90	1.20	4.56	0.50	0.92	0.69	0.5
Fresno – H &W	11.9	0.74	1.53	1.05	6.20	0.43	0.90	0.52	0.5
Stockton	11.4	1.10	2.48	1.14	4.27	0.46	0.88	0.61	0.5
Merced - S Coffee	10.9	1.00	2.30	1.12	4.07	0.44	0.85	0.58	0.5
Modesto	11.0	1.05	2.49	1.05	4.03	0.44	0.82	0.60	0.5
Merced –Main St	9.3	0.59	1.19	0.88	4.77	0.37	0.65	0.40	0.5
Manteca	8.7	0.84	1.98	0.81	3.09	0.35	0.63	0.47	0.5
Tranquility	6.4	0.54	1.16	0.61	2.47	0.29	0.51	0.30	0.5

Table 32. Projected 2020 24-hour $PM_{2.5}$ compositions

Name	Future $PM_{2.5}$ (µg/m³)	Future NH_4 (µg/m³)	Future NO_3 (µg/m³)	Future SO_4 (µg/m³)	Future OM (µg/m³)	Future EC (µg/m³)	Future Crustal (µg/m³)	Future Water (µg/m³)	Blank (µg/m³)
Bakersfield – California	47.6	5.8	17.8	2.3	12.6	1.2	4.1	3.5	0.5
Fresno - Garland	44.3	4.9	15.4	1.4	16.7	1.4	1.0	3.0	0.5
Hanford	43.7	6.1	19.3	2.3	9.5	1.2	1.1	3.8	0.5
Fresno – H&W	45.6	4.9	15.0	1.9	17.5	1.3	1.5	3.1	0.5
Clovis	41.1	3.8	12.0	1.4	18.4	1.6	1.0	2.3	0.5
Visalia	42.8	5.9	18.2	2.1	10.7	0.9	1.0	3.5	0.5
Bakersfield – Planz	41.2	5.3	14.9	3.5	10.8	1.0	2.3	3.0	0.5
Madera	38.9	4.5	14.5	1.2	13.1	1.4	0.8	2.8	0.5
Turlock	37.8	4.6	14.4	1.8	11.2	1.4	1.1	2.8	0.5
Modesto	35.8	4.5	13.3	2.1	10.0	1.4	1.3	2.6	0.5
Merced-Main St	32.9	3.8	11.5	1.6	11.2	1.2	1.0	2.2	0.5
Stockton	33.5	3.8	11.3	1.8	11.4	1.3	1.1	2.2	0.5
Merced – S Coffee	30.0	3.9	11.6	2.0	7.9	1.0	0.8	2.3	0.5
Manteca	30.1	3.8	11.7	1.3	8.7	1.2	0.8	2.3	0.5
Tranquility	21.5	2.1	6.6	0.9	8.6	1.0	0.5	1.3	0.5

5.4 FUTURE YEAR 2024 DESIGN VALUES

Projected future year 2024 annual $PM_{2.5}$ DVs and 24-hour $PM_{2.5}$ DVs for each site are given in Tables 33 and 34, respectively. For the 24-hour standard, the Fresno – Hamilton & Winery site has the highest projected DV at 35.1 µg/m^3, which meets the 35 µg/m^3 24-hour $PM_{2.5}$ standard established by the U.S. EPA in 2006 (technically, the form of the 24-hour $PM_{2.5}$ standard means that a DV needs to be less than 35.5 µg/m^3 to demonstrate attainment). Although attainment of the annual $PM_{2.5}$ standard is due in 2025 and not 2024, all monitors meet the annual $PM_{2.5}$ standard in 2024. The Bakersfield-Planz and Madera monitors have the highest projected 2024 annual DV of 12.0 µg/m^3, which is below the 12 µg/m^3 annual $PM_{2.5}$ standard established by the U.S. EPA in 2012 (technically, the annual DV needs to be less than 12.05 µg/m^3 to show attainment).

Correspondingly, RRFs for both the annual $PM_{2.5}$ and 24-hour $PM_{2.5}$ are provided in Tables 35-36, respectively (note that the RRF is calculated on a quarterly basis in the actual DV calculation, so the annual RRFs are given for illustrative purposes only). From 2013 to 2024, there are significant reductions projected for ammonium nitrate and EC, modest reductions in OM, almost no change in sulfate, and a slight increase in crustal material (i.e., other primary $PM_{2.5}$ such as fugitive dust emissions). Again, because of the significant reduction in NO_x emissions from 2013 to 2024, there is a significant reduction projected for ammonium nitrate. The larger reductions in EC and modest reductions in OM are primarily due to emission reductions associated with primary $PM_{2.5}$ emission sources such as residential wood combustion and commercial cooking. Since future year projections are performed for each individual $PM_{2.5}$ species and then summed to obtain total $PM_{2.5}$, the projected 2024 annual and 24-hour $PM_{2.5}$ composition is shown in Tables 37-38, respectively. In 2024, for the 24-hour standard, OM and ammonium nitrate remain the two largest components. In contrast, for the annual standard, OM is the dominant component.

Table 33. Projected future year 2024 annual $PM_{2.5}$ DVs at each monitor

Site AQS ID	Name	Base DV (µg/m^3)	2024 Annual DV (µg/m^3)
60290016	Bakersfield - Planz	17.2	12.0
60392010	Madera	16.9	12.0
60311004	Hanford	16.5	10.5
61072002	Visalia	16.2	11.1
60195001	Clovis	16.1	11.4
60290014	Bakersfield - California	16.0	11.0
60190011	Fresno-Garland	15.0	10.4
60990006	Turlock	14.9	11.1
60195025	Fresno - Hamilton & Winery	14.2	10.0
60771002	Stockton	13.1	10.7
60470003	Merced - S Coffee	13.1	9.7
60990005	Modesto	13.0	10.0
60472510	Merced - Main Street	11.0	8.6
60772010	Manteca	10.1	8.0
60192009	Tranquility	7.7	5.5

Table 34. Projected future year 2024 24-hour $PM_{2.5}$ DVs at each monitor

Site AQS ID	Name	Base DV (µg/m^3)	2024 24-hour DV (µg/m^3)
60290014	Bakersfield – California	64.1	33.3
60190011	Fresno – Garland	60.0	32.8
60311004	Hanford	60.0	30.1
60195025	Fresno – Hamilton & Winery	59.3	35.1
60195001	Clovis	55.8	30.7
61072002	Visalia	55.5	30.2
60290016	Bakersfield – Planz	55.5	30.0
60392010	Madera	51.0	30.2
60990006	Turlock	50.7	30.2
60990005	Modesto	47.9	29.1
60472510	Merced – Main Street	46.9	27.4
60771002	Stockton	42.0	28.6
60470003	Merced – S Coffee	41.1	24.2
60772010	Manteca	36.9	25.8
60192009	Tranquility	29.5	16.2

Table 35. 2024 Annual RRFs for $PM_{2.5}$ components

Site	RRF for $PM_{2.5}$	RRF for NH_4	RRF for NO_3	RRF for SO_4	RRF for OM	RRF for EC	RRF for Crustal
Bakersfield - Planz	0.70	0.36	0.35	0.96	0.74	0.38	1.06
Madera	0.71	0.55	0.44	0.99	0.81	0.53	1.03
Hanford	0.64	0.48	0.38	1.01	0.85	0.55	0.92
Visalia	0.68	0.39	0.38	1.00	0.75	0.45	1.04
Clovis	0.71	0.46	0.43	0.99	0.72	0.49	1.11
Bakersfield - California	0.69	0.36	0.34	0.96	0.73	0.38	1.06
Fresno - Garland	0.70	0.48	0.45	0.98	0.72	0.44	1.09
Turlock	0.75	0.57	0.53	0.99	0.88	0.55	1.07
Fresno - H&W	0.70	0.50	0.47	0.99	0.72	0.43	1.08
Stockton	0.81	0.68	0.60	1.02	0.92	0.62	1.09
Merced - S Coffee	0.74	0.54	0.47	1.00	0.88	0.57	1.06
Modesto	0.77	0.60	0.54	0.99	0.90	0.57	1.08
Merced - Main St	0.78	0.52	0.47	1.00	0.87	0.58	1.07
Manteca	0.79	0.66	0.60	1.00	0.89	0.60	1.06
Tranquility	0.72	0.51	0.37	1.00	0.88	0.60	1.02

Table 36. 2024 24-hour RRF for $PM_{2.5}$ components

Site	RRF for $PM_{2.5}$	RRF for NH_4	RRF for NO_3	RRF for SO_4	RRF for OM	RRF for EC	RRF for Crustal
Bakersfield - California	0.52	0.35	0.36	0.96	0.70	0.37	1.04
Fresno – Garland	0.54	0.46	0.47	0.96	0.61	0.39	1.08
Hanford	0.50	0.37	0.38	1.03	0.80	0.53	0.89
Fresno - H&W	0.59	0.50	0.50	0.99	0.66	0.42	1.09
Clovis	0.60	0.43	0.44	0.99	0.70	0.46	1.10
Visalia	0.54	0.44	0.45	1.03	0.66	0.42	1.05
Bakersfield – Planz	0.58	0.37	0.39	0.96	0.68	0.35	1.04
Madera	0.59	0.47	0.48	0.99	0.72	0.53	1.05
Turlock	0.60	0.46	0.47	0.96	0.77	0.52	1.07
Modesto	0.62	0.50	0.49	0.98	0.76	0.53	1.09
Merced – Main St	0.59	0.48	0.48	0.97	0.66	0.49	1.07
Stockton	0.69	0.53	0.53	1.00	0.88	0.62	1.08
Merced – S Coffee	0.58	0.48	0.49	0.97	0.68	0.49	1.05
Manteca	0.69	0.59	0.60	0.99	0.82	0.61	1.06
Tranquility	0.54	0.31	0.31	1.05	0.82	0.61	1.10

Table 37. Projected 2024 Annual $PM_{2.5}$ compositions

Name	Future $PM_{2.5}$ (µg/m³)	Future NH_4 (µg/m³)	Future NO_3 (µg/m³)	Future SO_4 (µg/m³)	Future OM (µg/m³)	Future EC (µg/m³)	Future Crustal (µg/m³)	Future Water (µg/m³)	Blank (µg/m³)
Bakersfield – Planz	12.0	0.50	0.93	1.59	4.90	0.37	2.67	0.57	0.5
Madera	12.0	0.96	1.81	1.47	4.90	0.48	1.25	0.61	0.5
Hanford	10.5	1.03	2.10	1.52	3.26	0.39	1.11	0.62	0.5
Visalia	11.1	0.55	1.15	1.45	5.38	0.31	1.20	0.56	0.5
Clovis	11.4	0.51	0.91	1.28	6.07	0.43	1.17	0.50	0.5
Bakersfield - California	11.0	0.47	0.88	1.41	4.54	0.35	2.36	0.51	0.5
Fresno – Garland	10.4	0.50	0.96	1.09	5.59	0.36	0.98	0.44	0.5
Turlock	11.1	0.91	2.10	1.21	4.51	0.42	0.94	0.56	0.5
Fresno – H &W	10.0	0.50	0.96	1.04	5.35	0.33	0.91	0.42	0.5
Stockton	10.7	0.94	1.97	1.15	4.27	0.42	0.89	0.53	0.5
Merced - S Coffee	9.7	0.74	1.57	1.12	4.01	0.38	0.86	0.47	0.5
Modesto	10.0	0.83	1.85	1.06	4.02	0.38	0.83	0.49	0.5
Merced - Main St	8.6	0.43	0.80	0.88	4.68	0.32	0.66	0.34	0.5
Manteca	8.0	0.70	1.55	0.83	3.06	0.30	0.63	0.40	0.5
Tranquility	5.5	0.39	0.69	0.61	2.35	0.24	0.51	0.23	0.5

Table 38. Projected 2024 24-hour $PM_{2.5}$ compositions

Name	Future $PM_{2.5}$ (µg/m³)	Future NH_4 (µg/m³)	Future NO_3 (µg/m³)	Future SO_4 (µg/m³)	Future OM (µg/m³)	Future EC (µg/m³)	Future Crustal (µg/m³)	Future Water (µg/m³)	Blank (µg/m³)
Bakersfield – California	33.3	2.7	8.6	2.4	12.8	1.1	3.4	1.8	0.5
Fresno - Garland	32.8	3.0	9.7	1.3	14.4	1.0	1.0	1.9	0.5
Hanford	30.1	3.3	10.8	2.3	9.0	1.0	0.9	2.2	0.5
Fresno – H&W	35.1	3.2	10.3	1.4	15.5	1.1	1.0	2.0	0.5
Clovis	30.7	2.2	6.7	1.9	15.1	1.0	1.7	1.6	0.5
Visalia	30.2	3.4	10.6	2.1	9.7	0.7	1.0	2.1	0.5
Bakersfield – Planz	30.0	2.3	6.1	4.3	11.6	0.7	2.6	1.9	0.5
Madera	30.2	2.9	9.3	1.2	12.4	1.2	0.8	1.8	0.5
Turlock	30.2	3.0	9.4	2.1	11.0	1.2	1.1	1.9	0.5
Modesto	29.1	3.0	9.0	2.1	10.0	1.3	1.3	1.8	0.5
Merced – Main Street	27.4	2.5	7.8	1.6	11.3	1.1	1.0	1.6	0.5
Stockton	28.6	2.7	8.1	1.8	11.5	1.2	1.1	1.7	0.5
Merced – S Coffee	24.2	2.6	8.0	1.7	8.2	1.0	0.8	1.6	0.5
Manteca	25.8	2.8	8.8	1.4	8.7	1.1	0.8	1.7	0.5
Tranquility	16.2	1.1	3.4	0.9	8.3	0.9	0.5	0.7	0.5

5.5 FUTURE YEAR 2025 DESIGN VALUES

Projected future year 2025 annual $PM_{2.5}$ and 24-hour $PM_{2.5}$ DVs for each site are given in Tables 39 and 40, respectively. For the annual standard, the Bakersfield-Planz site has the highest projected DV at 12.0 µg/m^3, which meets the 12 µg/m^3 annual $PM_{2.5}$ standard established by the U.S. EPA in 2012 ((technically, the form of the annual $PM_{2.5}$ standard means that a DV needs to be less than 12.04 µg/m^3 to demonstrate attainment). For reference and to illustrate the effect of emission reductions on 24-hour $PM_{2.5}$ from 2024 to 2025, the Fresno – Hamilton & Winery monitor had the highest 24-hour $PM_{2.5}$ levels in 2025 and showed a reduction in DV from 35.1 µg/m^3 in 2024 to 34.7 µg/m^3 in 2025, with all of the reduction coming from lower ammonium nitrate levels resulting from NO_x reductions.

RRFs corresponding to the future DVs for both annual and 24-hour $PM_{2.5}$ are provided in Tables 41-42, respectively (as noted above, the RRF is actually calculated on a quarterly basis and the annual RRF is shown for illustrative purposes only). From 2013 to 2025, there were significant reductions projected for ammonium nitrate and EC, modest reductions in OM, almost no change in sulfate, and a slight increase in crustal material (i.e., other primary $PM_{2.5}$ such as fugitive dust emissions). As discussed previously, reductions in ammonium nitrate are a direct result of dramatic NO_x emission reductions from 2013 to 2025. Reductions in EC and OM are primarily due to emission reductions from primary $PM_{2.5}$ sources, such as residential wood combustion, commercial cooking and mobile sources. Because the future year projection is performed for each individual $PM_{2.5}$ species, the projected 2025 annual and 24-hour $PM_{2.5}$ composition is given in Tables 43 and 44, respectively. In 2025, OM will be the dominant component for the annual standard, and for the 24-hour standard, OM and ammonium nitrate remain the two largest components.

Table 39. Projected future year 2025 annual $PM_{2.5}$ DVs at each monitor.

Site AQS ID	Name	Base DV (µg/m³)	2025 Annual DV (µg/m³)
60290016	Bakersfield - Planz	17.2	12.0
60392010	Madera	16.9	11.9
60311004	Hanford	16.5	10.4
61072002	Visalia	16.2	11.1
60195001	Clovis	16.1	11.4
60290014	Bakersfield - California	16.0	11.0
60190011	Fresno-Garland	15.0	10.4
60990006	Turlock	14.9	11.1
60195025	Fresno - Hamilton & Winery	14.2	10.0
60771002	Stockton	13.1	10.6
60470003	Merced - S Coffee	13.1	9.6
60990005	Modesto	13.0	9.9
60472510	Merced - Main Street	11.0	8.6
60772010	Manteca	10.1	7.9
60192009	Tranquility	7.7	5.5

Table 40. Projected future year 2025 24-hour $PM_{2.5}$ DVs at each monitor.

Site AQS ID	Name	Base DV (µg/m³)	2025 24-hour DV (µg/m³)
60290014	Bakersfield – California	64.1	32.7
60190011	Fresno – Garland	60.0	32.3
60311004	Hanford	60.0	29.4
60195025	Fresno – Hamilton & Winery	59.3	34.7
60195001	Clovis	55.8	30.5
61072002	Visalia	55.5	29.7
60290016	Bakersfield – Planz	55.5	29.7
60392010	Madera	51.0	29.7
60990006	Turlock	50.7	29.6
60990005	Modesto	47.9	28.6
60472510	Merced – Main Street	46.9	27.0
60771002	Stockton	42.0	28.1
60470003	Merced – S Coffee	41.1	23.8
60772010	Manteca	36.9	25.4
60192009	Tranquility	29.5	16.0

Table 41. 2025 Annual RRFs for $PM_{2.5}$ components.

Site	RRF for $PM_{2.5}$	RRF for NH_4	RRF for NO_3	RRF for SO_4	RRF for OM	RRF for EC	RRF for Crustal
Bakersfield – Planz	0.70	0.35	0.34	0.96	0.74	0.37	1.06
Madera	0.70	0.54	0.43	0.99	0.81	0.52	1.03
Hanford	0.63	0.47	0.37	1.01	0.85	0.54	0.92
Visalia	0.68	0.38	0.37	1.00	0.76	0.44	1.05
Clovis	0.71	0.45	0.42	1.00	0.72	0.49	1.12
Bakersfield – California	0.69	0.35	0.33	0.96	0.74	0.37	1.07
Fresno - Garland	0.69	0.47	0.43	0.99	0.72	0.44	1.09
Turlock	0.74	0.56	0.52	0.99	0.89	0.54	1.08
Fresno - H&W	0.70	0.49	0.45	0.99	0.73	0.42	1.08
Stockton	0.81	0.67	0.58	1.02	0.93	0.62	1.10
Merced - S Coffee	0.73	0.53	0.46	1.00	0.88	0.56	1.07
Modesto	0.76	0.59	0.53	0.99	0.90	0.57	1.08
Merced - Main St	0.78	0.51	0.46	1.00	0.87	0.57	1.07
Manteca	0.79	0.65	0.58	1.00	0.90	0.59	1.07
Tranquility	0.71	0.51	0.36	1.00	0.88	0.59	1.02

Table 42. 2025 24-hour RRFs for $PM_{2.5}$ components.

Site	RRF for $PM_{2.5}$	RRF for NH_4	RRF for NO_3	RRF for SO_4	RRF for OM	RRF for EC	RRF for Crustal
Bakersfield - California	0.52	0.33	0.35	0.96	0.70	0.36	1.04
Fresno – Garland	0.54	0.44	0.45	0.96	0.61	0.38	1.08
Hanford	0.51	0.36	0.36	1.03	0.82	0.52	0.90
Fresno - H&W	0.58	0.48	0.49	0.99	0.66	0.41	1.10
Clovis	0.54	0.41	0.43	1.01	0.65	0.45	1.13
Visalia	0.53	0.43	0.44	1.04	0.66	0.41	1.06
Bakersfield – Planz	0.57	0.36	0.37	0.96	0.68	0.35	1.05
Madera	0.58	0.46	0.47	1.00	0.72	0.52	1.06
Turlock	0.59	0.44	0.45	0.97	0.77	0.52	1.08
Modesto	0.59	0.46	0.47	0.98	0.77	0.51	1.07
Merced – Main St	0.58	0.46	0.47	0.98	0.67	0.49	1.07
Stockton	0.66	0.51	0.51	1.01	0.87	0.62	1.08
Merced – S Coffee	0.57	0.46	0.48	0.98	0.68	0.49	1.05
Manteca	0.68	0.57	0.58	1.00	0.82	0.61	1.07
Tranquility	0.54	0.30	0.30	1.06	0.82	0.61	1.10

Table 43. Projected 2025 Annual $PM_{2.5}$ composition.

Name	Future $PM_{2.5}$ (µg/m³)	Future NH_4 (µg/m³)	Future NO_3 (µg/m³)	Future SO_4 (µg/m³)	Future OM (µg/m³)	Future EC (µg/m³)	Future Crustal (µg/m³)	Future Water (µg/m³)	Blank (µg/m³)
Bakersfield – Planz	12.0	0.49	0.89	1.59	4.93	0.36	2.68	0.57	0.5
Madera	11.9	0.94	1.76	1.48	4.91	0.48	1.26	0.60	0.5
Hanford	10.4	1.00	2.03	1.53	3.26	0.38	1.11	0.61	0.5
Visalia	11.1	0.53	1.11	1.45	5.39	0.30	1.21	0.55	0.5
Clovis	11.4	0.49	0.89	1.29	6.11	0.43	1.19	0.50	0.5
Bakersfield - California	11.0	0.46	0.85	1.41	4.56	0.34	2.36	0.50	0.5
Fresno – Garland	10.4	0.49	0.93	1.10	5.61	0.36	0.98	0.43	0.5
Turlock	11.1	0.89	2.04	1.21	4.52	0.42	0.94	0.55	0.5
Fresno – H &W	10.0	0.49	0.93	1.04	5.37	0.33	0.92	0.42	0.5
Stockton	10.6	0.93	1.92	1.16	4.28	0.41	0.90	0.52	0.5
Merced - S Coffee	9.6	0.73	1.53	1.12	4.02	0.37	0.86	0.46	0.5
Modesto	9.9	0.82	1.80	1.07	4.03	0.38	0.83	0.49	0.5
Merced - Main St	8.6	0.42	0.77	0.89	4.69	0.32	0.66	0.34	0.5
Manteca	7.9	0.69	1.51	0.83	3.07	0.30	0.64	0.40	0.5
Tranquility	5.5	0.39	0.67	0.61	2.36	0.24	0.51	0.23	0.5

Table 44. Projected 2025 24-hour $PM_{2.5}$ composition.

Name	Future $PM_{2.5}$ (µg/m³)	Future NH_4 (µg/m³)	Future NO_3 (µg/m³)	Future SO_4 (µg/m³)	Future OM (µg/m³)	Future EC (µg/m³)	Future Crustal (µg/m³)	Future Water (µg/m³)	Blank (µg/m³)
Bakersfield – California	32.7	2.6	8.2	2.4	12.9	1.0	3.4	1.7	0.5
Fresno - Garland	32.3	2.9	9.3	1.4	14.4	1.0	1.0	1.8	0.5
Hanford	29.4	3.0	9.4	2.4	9.8	1.0	1.4	2.0	0.5
Fresno – H&W	34.7	3.1	10.0	1.4	15.5	1.1	1.0	2.0	0.5
Clovis	30.5	2.6	8.3	1.6	13.8	1.1	0.9	1.7	0.5
Visalia	29.7	3.2	10.3	2.2	9.7	0.7	1.0	2.1	0.5
Bakersfield - Planz	29.7	2.2	5.9	4.3	11.7	0.7	2.6	1.9	0.5
Madera	29.7	2.8	9.0	1.2	12.4	1.2	0.8	1.8	0.5
Turlock	29.6	2.9	9.0	2.1	11.1	1.2	1.1	1.8	0.5
Modesto	28.6	2.9	8.8	1.7	10.7	1.2	1.0	1.8	0.5
Merced – Main Street	27.0	2.4	7.5	1.6	11.4	1.1	1.0	1.5	0.5
Stockton	28.1	2.8	8.4	2.0	10.7	1.2	0.8	1.7	0.5
Merced – S Coffee	23.8	2.5	7.7	1.7	8.2	1.0	0.8	1.6	0.5
Manteca	25.4	2.8	8.5	1.4	8.8	1.1	0.8	1.7	0.5
Tranquility	16.0	1.0	3.2	0.9	8.3	0.8	0.5	0.7	0.5

5.6 $PM_{2.5}$ PRECURSOR SENSITIVITY ANALYSIS

To evaluate the impact of reducing emissions of different $PM_{2.5}$ precursors on $PM_{2.5}$ DVs, a series of model sensitivity simulations were performed, for which anthropogenic emissions of the precursor species were reduced by a certain percentage from the baseline emissions. The U.S. EPA (USEPA, 2016) recommends a range of 30-70% reduction in precursor emissions in the nonattainment area, and that recommendation is followed here.

Comparing the difference in $PM_{2.5}$ DVs from the precursor reduction simulations and the baseline modeling shows the sensitivity of the $PM_{2.5}$ DVs to changes in baseline precursor emissions. Given the nature of $PM_{2.5}$ formation, the effect of reductions in the following $PM_{2.5}$ precursors were investigated: direct $PM_{2.5}$ (or primary $PM_{2.5}$), nitrogen oxides (NO_x), sulfur oxides (SO_x), ammonia (NH_3), and volatile organic compounds (VOCs). For each precursor sensitivity, only anthropogenic emissions in the San Joaquin Valley were reduced. Natural emissions and emissions outside of SJV were kept constant. Since it is known that NO_x and direct $PM_{2.5}$ contribute significantly to $PM_{2.5}$ formation in the SJV (Pusede et al., 2016) and the current control program already relies heavily on NO_x and direct $PM_{2.5}$ emission reductions, for NO_x and direct $PM_{2.5}$ only sensitivity runs for a 30% emission reduction were performed. Given the lower contribution of other precursor species to total $PM_{2.5}$ (i.e., ammonia, VOCs, and SO_x), both 30% and 70% emission reductions were performed for those species.

The precursor sensitivity modeling was performed for the 2013 base year, as well as future years 2020 and 2024. Given the small change in emissions between 2024 and 2025, precursor reduction simulations were not performed for 2025 because $PM_{2.5}$ sensitivity to precursor reductions is expected to be very similar between 2024 and 2025.

Tables 45 and 46 show the impact from precursor reductions on annual and 24-hour $PM_{2.5}$ DVs for 2013, respectively. 30% PM and 30% NO_x reductions clearly show significant impact on $PM_{2.5}$ DVs. Direct PM reduction is more effective than NO_x for the annual standard, while their impacts are roughly comparable for the 24-hour standard. Although both NO_x and ammonia contribute to ammonium nitrate formation, the impact on $PM_{2.5}$ DVs from ammonia reduction is less than that from NO_x reductions, because ammonium nitrate formation in the SJV is limited by the availability of nitric acid instead of by ammonia (Lurmann et al., 2006; Markovic, 2014; Parworth, et al., 2017; Prabhakar et al., 2017), and so ammonia reduction is less effective than NO_x reductions in reducing ammonium nitrate concentrations. This is consistent with previous modeling studies (Chen et al., 2014; Kleeman et al., 2005; Pun et al., 2009). Reducing SO_x emissions has a very small impact on annual DVs, and may have dis-benefit for 24-hour

DVs at many sites. The negative impact on 24-hour DVs from SO_x emission reductions is due to the non-linearity in inorganic thermodynamics that governs the partitioning of ammonium and nitrate onto particles (e.g., West et al., 2011). Reducing VOC emissions has a small positive impact on both annual and 24-hour DVs. In 2013, reducing VOC emissions reduced secondary organic aerosol (SOA) formation as well as slightly lowering ammonium nitrate formation, as demonstrated in Kleeman et al. (2005) and Pun et al. (2009).

Tables 47 and 48 show the impact on annual and 24-hour DVs from precursor reductions in 2020, respectively. Similar to 2013, 30% PM and 30% NO_x reductions lead to substantial reductions in both annual and 24-hour $PM_{2.5}$ DVs in 2020. While ammonia reduction also leads to reductions in both annual and 24-hour $PM_{2.5}$ DVs, an equivalent percentage of ammonia reduction is typically less effective than NO_x reductions, due to the excess of ammonia in the SJV (Parworth et al., 2017; Prabhaker et al., 2017). While NO_x emissions in 2020 exhibit substantial reductions from 2013 levels, ammonia emission tends are relatively flat, meaning ammonia is even more in excess in 2020 (i.e., NH_3 reductions will be even less effective at reducing $PM_{2.5}$ in 2020). Reducing SO_x emissions leads to a slight increase in annual DVs but a slight decrease in 24-hour DVs at most sites, which is consistent with the 2013 results. Reducing VOC emissions has a very small impact on annual DVs but do result in a small reduction in the 24-hour DVs.

Tables 49 and 50 show the impact on annual and 24-hour DVs from precursor reductions in 2024, respectively. For both PM and NO_x emissions, a 30% reduction leads to significant reductions in both annual and 24-hour DVs, similar to years 2013 and 2020. Ammonia reduction is less effective than the same percent reduction in NO_x emissions. As previously stated, in the SJV ammonia is in excess and as NO_x emissions decrease further into the future, ammonia becomes even more in excess. This means that ammonium nitrate formation is even more limited by the availability of nitric acid than by ammonia in 2024 compared to 2013. Similar to 2013 and 2020, reducing SO_x emissions also has a slightly negative impact on 24-hour DVs at several sites due to the non-linearity of inorganic aerosol thermodynamics (e.g., West et al., 2011). The impact of SO_x emission reductions on the annual DVs is fairly small, primarily because of the limited amount of SO_x emissions in the SJV. Reducing VOC emissions has essentially no effect on the annual DVs, and a slightly negative impact on 24-hour DVs. Reducing VOC emissions can reduce SOA formation. However, under 2024 emission levels, reducing VOC emissions can slightly increase ammonium nitrate formation in the wintertime. This is different from the reference year 2013, because modeled ammonium nitrate concentration is much smaller in 2024 than in 2013, such that the response in ammonium nitrate formation to VOC emission reductions is reversed. A previous modeling study by CARB (2016) utilizing the Integrated Reaction Rate (IRR) technique in the CMAQ model shows that reduced VOC emissions can lead to less peroxyacetyle nitrate (PAN) formation (Meng et al., 1997), increased availability of nitrogen dioxide and more nighttime nitric acid formation. However, since lower VOC levels also reduce daytime hydroxyl radical concentrations and result in less daytime nitric acid formation, these processes compete with each other and lead to a different net impact on ammonium nitrate formation depending on the NOx and VOC emission levels.

Table 45. Difference in Annual $PM_{2.5}$ DVs between the 2013 baseline run and precursor emission reduction runs.

Sites	Baseline DV	30% PM*	30% NO_x	30% NH_3	70% NH_3	30%ROG	70%ROG	30% SO_x	70% SO_x
Bakersfield - Planz	17.2	2.7	0.9	0.4	1.5	0.1	0.3	0.0	0.1
Madera	16.9	1.7	0.9	0.6	2.1	0.1	0.2	0.0	0.0
Hanford	16.5	1.4	1.7	0.7	2.3	0.1	0.2	0.0	0.0
Visalia	16.2	2.1	0.9	0.4	1.4	0.2	0.4	0.1	0.1
Clovis	16.1	2.5	0.6	0.3	1.2	0.1	0.3	0.0	0.0
Bakersfield - California	16.0	2.5	0.9	0.4	1.6	0.1	0.3	0.0	0.1
Fresno - Garland	15.0	2.3	0.5	0.3	1.1	0.1	0.3	0.0	0.1
Turlock	14.9	1.4	0.6	0.4	1.4	0.1	0.2	0.1	0.1
Fresno - H&W	14.2	2.2	0.4	0.3	1.1	0.1	0.3	0.0	0.1
Stockton	13.1	0.9	0.3	0.3	1.0	0.1	0.1	0.1	0.2
Merced - S Coffee	13.1	1.2	0.7	0.4	1.5	0.1	0.1	0.0	0.0
Modesto	13.0	1.2	0.5	0.4	1.3	0.1	0.1	0.1	0.1
Merced - M Street	11.0	1.2	0.4	0.2	0.7	0.1	0.1	0.0	0.0
Manteca	10.1	0.6	0.2	0.2	0.8	0.1	0.1	0.1	0.1
Tranquility	7.7	0.5	0.6	0.4	1.3	0.0	0.0	0.0	0.0

*: 30% PM means that anthropogenic PM emissions within SJV are reduced by 30% from the baseline emissions inventory. Same meaning applies to other precursor reduction runs.

Table 46. Difference in 24-hour $PM_{2.5}$ DVs between the 2013 baseline run and precursor emission reduction runs.

Sites	Baseline DV	30% PM*	30% NO_x	30% NH_3	70% NH_3	30%ROG	70%ROG	30% SO_x	70% SO_x
Bakersfield – California	64.1	8.1	6.8	3.3	12.4	1.4	3.6	-0.4	-1.1
Fresno – Garland	60.0	7.6	3.5	2.0	7.5	0.9	2.2	-0.1	-0.6
Hanford	60.0	4.5	7.8	2.1	9.4	1.1	3.0	-0.4	-1.4
Fresno – H&W	59.3	7.2	2.5	1.9	9.6	1.1	2.7	-0.1	-0.5
Clovis	55.8	7.6	3.8	1.9	8.8	0.9	2.2	-0.2	-0.6
Visalia	55.5	5.4	3.5	2.0	9.7	1.9	4.8	-0.3	-0.8
Bakersfield – Planz	55.5	7.6	4.2	2.2	9.0	1.2	3.0	-0.4	-1.0
Madera	51.0	5.2	3.0	1.7	7.6	0.9	2.1	-0.3	-1.2
Turlock	50.7	3.8	3.6	1.5	6.3	0.7	1.6	-0.1	-0.4
Modesto	47.9	3.6	3.1	1.5	6.4	0.6	1.3	0.1	-0.1
Merced – M Street	46.9	5.0	2.7	1.0	5.0	0.4	1.0	-0.1	-0.3
Stockton	42.0	2.6	2.0	1.0	4.1	0.5	1.3	0.2	0.2
Merced – S Coffee	41.1	3.3	2.9	1.1	4.5	0.4	1.0	-0.1	-0.3
Manteca	36.9	1.9	1.1	0.9	3.5	0.5	1.2	0.2	0.5
Tranquility	29.5	2.1	3.9	2.2	8.8	0.1	0.2	0.0	-0.2

*: 30% PM means that anthropogenic PM emissions within SJV are reduced by 30% from the baseline emissions inventory. Same meaning applies to other precursor reduction runs.

Table 47. Difference in Annual $PM_{2.5}$ DVs between the 2020 baseline run and precursor emission reduction runs.

Sites	Baseline DV	30% PM*	30% NO_x	30% NH_3	70% NH_3	30%ROG	70%ROG	30% SO_x	70% SO_x
Bakersfield - Planz	14.6	2.3	0.8	0.2	0.8	0.0	0.1	0.0	0.1
Madera	14.2	1.4	0.9	0.4	1.2	0.0	0.1	0.0	0.0
Hanford	13.3	1.2	1.4	0.4	1.3	0.0	-0.1	0.0	0.0
Visalia	13.5	1.8	0.9	0.2	0.8	0.0	0.1	0.1	0.1
Clovis	13.4	2.0	0.6	0.2	0.6	0.1	0.2	0.0	0.0
Bakersfield - California	13.5	2.2	0.8	0.2	0.8	0.0	0.0	0.0	0.1
Fresno - Garland	12.4	1.9	0.5	0.2	0.6	0.1	0.1	0.0	0.1
Turlock	12.5	1.1	0.7	0.3	0.9	0.0	0.0	0.1	0.1
Fresno - H&W	11.9	1.7	0.5	0.2	0.6	0.1	0.1	0.0	0.1
Stockton	11.4	0.8	0.4	0.2	0.7	0.0	0.0	0.1	0.2
Merced - S Coffee	10.9	1.0	0.6	0.3	0.8	0.0	0.0	0.0	0.0
Modesto	11.0	1.0	0.5	0.2	0.8	0.0	0.0	0.1	0.1
Merced - M Street	9.3	1.0	0.3	0.1	0.4	0.0	0.0	0.0	0.1
Manteca	8.7	0.5	0.3	0.2	0.5	0.0	0.0	0.1	0.1
Tranquility	6.4	0.4	0.4	0.2	0.6	0.0	0.0	0.0	0.0

*: 30% PM means that anthropogenic PM emissions within SJV are reduced by 30% from the baseline emissions inventory. Same meaning applies to other precursor reduction runs.

Table 48. Difference in 24-hour $PM_{2.5}$ DVs between the 2020 baseline run and precursor emission reduction runs.

Sites	Baseline DV	30% PM*	30% NO_x	30% NH_3	70% NH_3	30%ROG	70%ROG	30% SO_x	70% SO_x
Bakersfield – California	47.6	5.8	7.4	1.9	6.4	0.1	0.5	-0.2	-0.9
Fresno – Garland	44.3	5.0	4.8	1.1	4.6	0.3	0.8	-0.1	-0.5
Hanford	43.7	3.2	7.3	1.4	4.6	0.0	0.2	-0.5	-1.3
Fresno – H&W	45.6	4.9	4.3	1.1	5.8	0.4	1.0	-0.1	-0.2
Clovis	41.1	4.9	4.5	0.9	4.7	0.3	0.7	-0.1	-0.4
Visalia	42.8	3.7	6.5	1.3	5.8	0.6	1.5	-0.2	-0.5
Bakersfield – Planz	41.2	5.2	6.0	1.4	5.4	0.3	1.0	-0.1	-0.3
Madera	38.9	3.3	4.1	1.0	3.6	0.2	0.6	-0.3	-0.9
Turlock	37.8	2.4	4.2	1.0	3.2	0.1	0.2	0.0	-0.2
Modesto	35.8	2.2	3.6	0.9	3.3	0.1	0.2	0.2	0.0
Merced – M Street	32.9	2.7	2.9	0.6	2.3	0.0	0.1	-0.1	-0.2
Stockton	33.5	2.0	2.5	0.7	2.1	0.1	0.3	0.2	0.4
Merced – S Coffee	30.0	2.1	2.9	0.5	2.2	0.0	0.1	-0.1	-0.2
Manteca	30.1	1.1	1.9	0.5	1.6	0.1	0.3	0.2	0.5
Tranquility	21.5	1.4	3.0	1.2	4.0	-0.1	-0.2	0.0	0.0

*: 30% PM means that anthropogenic PM emissions within SJV are reduced by 30% from the baseline emissions inventory. Same meaning applies to other precursor reduction runs.

Table 49. Difference in Annual $PM_{2.5}$ DVs between the 2024 baseline run and precursor emission reduction runs

Sites	Baseline DV	30% PM*	30% NO_x	30% NH_3	70% NH_3	30%ROG	70%ROG	30% SO_x	70% SO_x
Bakersfield - Planz	12.0	1.9	0.5	0.1	0.4	0.0	0.0	0.1	0.1
Madera	12.0	1.2	0.6	0.2	0.7	0.0	0.0	0.0	0.1
Hanford	10.5	1.0	0.8	0.3	0.8	-0.1	-0.2	0.0	0.1
Visalia	11.1	1.5	0.6	0.1	0.4	0.0	0.0	0.1	0.2
Clovis	11.4	1.6	0.4	0.1	0.3	0.0	0.1	0.0	0.1
Bakersfield - California	11.0	1.8	0.5	0.1	0.4	0.0	0.0	0.1	0.1
Fresno - Garland	10.4	1.5	0.4	0.1	0.3	0.0	0.1	0.0	0.1
Turlock	11.1	1.1	0.5	0.2	0.6	0.0	0.0	0.1	0.1
Fresno - H&W	10.0	1.4	0.4	0.1	0.3	0.0	0.1	0.1	0.1
Stockton	10.7	0.8	0.3	0.2	0.5	0.0	0.0	0.1	0.2
Merced - S Coffee	9.7	0.9	0.4	0.2	0.5	0.0	0.0	0.0	0.1
Modesto	10.0	1.0	0.4	0.2	0.6	0.0	0.0	0.1	0.2
Merced - M Street	8.6	0.9	0.2	0.1	0.3	0.0	0.0	0.0	0.1
Manteca	8.0	0.4	0.3	0.1	0.4	0.0	0.0	0.1	0.1
Tranquility	5.5	0.3	0.2	0.1	0.4	0.0	0.0	0.0	0.0

*: 30% PM means that anthropogenic PM emissions within SJV are reduced by 30% from the baseline emissions inventory. Same meaning applies to other precursor reduction runs.

Table 50. Difference in 24-hour $PM_{2.5}$ DVs between the 2024 baseline run and precursor emission reduction runs

Sites	Baseline DV	30% PM*	30% NO_x	30% NH_3	70% NH_3	30%ROG	70%ROG	30% SO_x	70% SO_x
Bakersfield – California	33.3	5.1	4.0	1.0	2.8	-0.4	-0.9	-0.3	-0.7
Fresno – Garland	32.8	3.8	3.3	0.7	1.9	-0.1	-0.2	-0.1	-0.3
Hanford	30.1	2.6	4.5	1.0	3.0	-0.4	-1.0	-0.3	-1.1
Fresno – H&W	35.1	4.0	4.0	0.8	2.9	0.0	-0.1	0.0	-0.1
Clovis	30.7	4.2	3.4	0.7	2.3	0.0	0.0	0.0	0.0
Visalia	30.2	3.0	5.1	0.8	2.5	-0.3	-0.5	-0.1	-0.2
Bakersfield – Planz	30.0	4.0	3.6	0.7	2.2	-0.2	-0.5	0.1	0.2
Madera	30.2	2.9	2.6	0.7	1.6	-0.1	-0.3	-0.1	-0.6
Turlock	30.2	2.3	2.6	0.7	2.1	-0.1	-0.3	0.1	0.0
Modesto	29.1	2.3	2.6	0.6	2.2	-0.1	-0.2	0.2	0.2
Merced – M Street	27.4	2.6	2.1	0.5	1.4	-0.1	-0.3	0.0	-0.1
Stockton	28.6	2.1	2.1	0.5	1.5	-0.1	-0.1	0.3	0.6
Merced – S Coffee	24.2	2.1	1.9	0.4	1.2	-0.1	-0.3	-0.1	-0.1
Manteca	25.8	1.1	1.8	0.4	1.4	0.0	-0.1	0.3	0.6
Tranquility	16.2	1.2	1.5	0.6	1.8	-0.1	-0.4	0.0	0.1

*: 30% PM means that anthropogenic PM emissions within SJV are reduced by 30% from the baseline emissions inventory. Same meaning applies to other precursor reduction runs.

5.7 UNMONITORED AREA ANALYSIS

The unmonitored area analysis is performed 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 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 are utilized in this analysis.

For annual $PM_{2.5}$ standards, the unmonitored area analysis involves the following steps:

Step 1: At each grid cell, the annual average $PM_{2.5}$ (total and by species) is calculated as the average of the 3x3 surrounding grid cells (i.e., consistent with the way that annual RRF is calculated) from the future year simulation, and a gradient in the annual averages between each grid cell and grid cells which contain a monitor is calculated.

Step 2: The annual future year speciated $PM_{2.5}$ design values are obtained for each design site from the attainment test. For each grid cell, the monitors within its Voronoi Region are identified, and the speciated $PM_{2.5}$ values are then interpolated using normalized inverse distance squared weightings for all monitors within a grid cell's Voronoi Region. The interpolated speciated $PM_{2.5}$ fields are further adjusted based on the appropriate gradients from Step 1.

Step 3: The concentration of each of the component $PM_{2.5}$ species are summed to calculate the total $PM_{2.5}$ concentration (or DV) for each grid cell.

Step 4: The future year gridded annual average $PM_{2.5}$ estimates are then compared to the annual $PM_{2.5}$ NAAQS to determine compliance.

The unmonitored area analysis for the 24-hour $PM_{2.5}$ standard 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) is calculated from the future year simulation, and a gradient in these quarterly speciated averages between each grid cell and grid cells which contain a monitor is calculated.

Step 2: The 24-hour future year speciated $PM_{2.5}$ design values are obtained for each design site from the attainment test. For each grid cell, the monitors within its Voronoi Region are identified, and the speciated $PM_{2.5}$ values are then interpolated using normalized inverse distance squared weightings for all monitors within a grid cell's Voronoi Region. The interpolated speciated $PM_{2.5}$ fields are further adjusted based on the appropriate gradients from Step 1.

Step 3: The concentration of each of the component $PM_{2.5}$ species are summed to calculate the total $PM_{2.5}$ concentration (or DV) for each grid cell.

Step 4: The future year gridded 24-hour average $PM_{2.5}$ estimates are then compared to the 24-hour $PM_{2.5}$ NAAQS to determine compliance.

For the year 2020, an unmonitored area analysis was performed for the USEPA 1997 annual and 24-hour $PM_{2.5}$ standards. For the year 2024, an unmonitored area analysis was performed for the USEPA 2006 24-hour $PM_{2.5}$ standard only, and for the year 2025, an unmonitored area analysis was performed for the USEPA 2012 annual $PM_{2.5}$ standard only.

Figure 15 shows the spatial distribution of projected 2020 annual $PM_{2.5}$ DVs in the SJV nonattainment area. Projected 2020 annual $PM_{2.5}$ DVs at every grid cell are below the threshold needed for attainment (15.04 $\mu g/m^3$), except for a few cells surrounding the Lemoore military facility, where the greater $PM_{2.5}$ levels are due to localized emissions associated with that facility. A similar $PM_{2.5}$ hotspot associated with the Lemoore military facility was observed in past SJV $PM_{2.5}$ SIPs as well. This demonstrates that all unmonitored areas within the SJV will attain the 15 $\mu g/m^3$ annual $PM_{2.5}$ standard (technically, DVs not greater than 15.04 $\mu g/m^3$ are considered as attainment) established by the USEPA in 1997, except for a small area surrounding the Lemoore military facility.

Figure 16 shows the spatial distribution of projected 2020 24-hour $PM_{2.5}$ DVs in the SJV nonattainment area. Projected 2020 24-hour $PM_{2.5}$ DVs within the SJV do not exceed 65.4 $\mu g/m^3$ except for a few grid cells surrounding the Lemoore military facility, again due to the localized emissions associated with that facility. This demonstrates that all unmonitored areas within the SJV will attain the 65 $\mu g/m^3$ 24-hour $PM_{2.5}$ standard (technically, DVs not greater than 65.4 $\mu g/m^3$ are considered as attainment) established by the USEPA in 1997, except for a small area surrounding the Lemoore military facility.

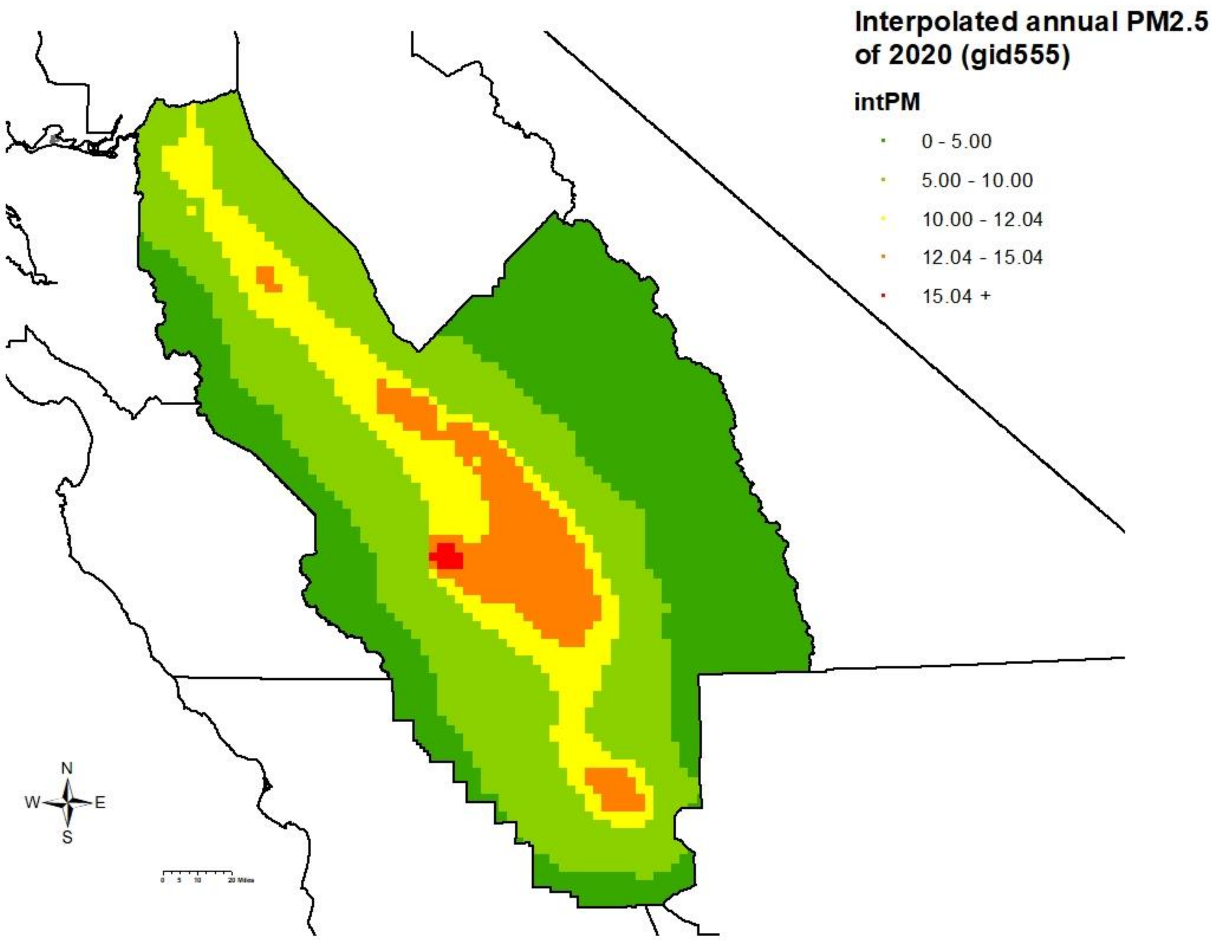


Figure 15. Spatial distribution of projected 2020 annual $PM_{2.5}$ DVs within the SJV nonattainment area. All grid cells have DVs not greater than 15.04 µg/m^3 except for a few cells surrounding the Lemoore Naval facility.

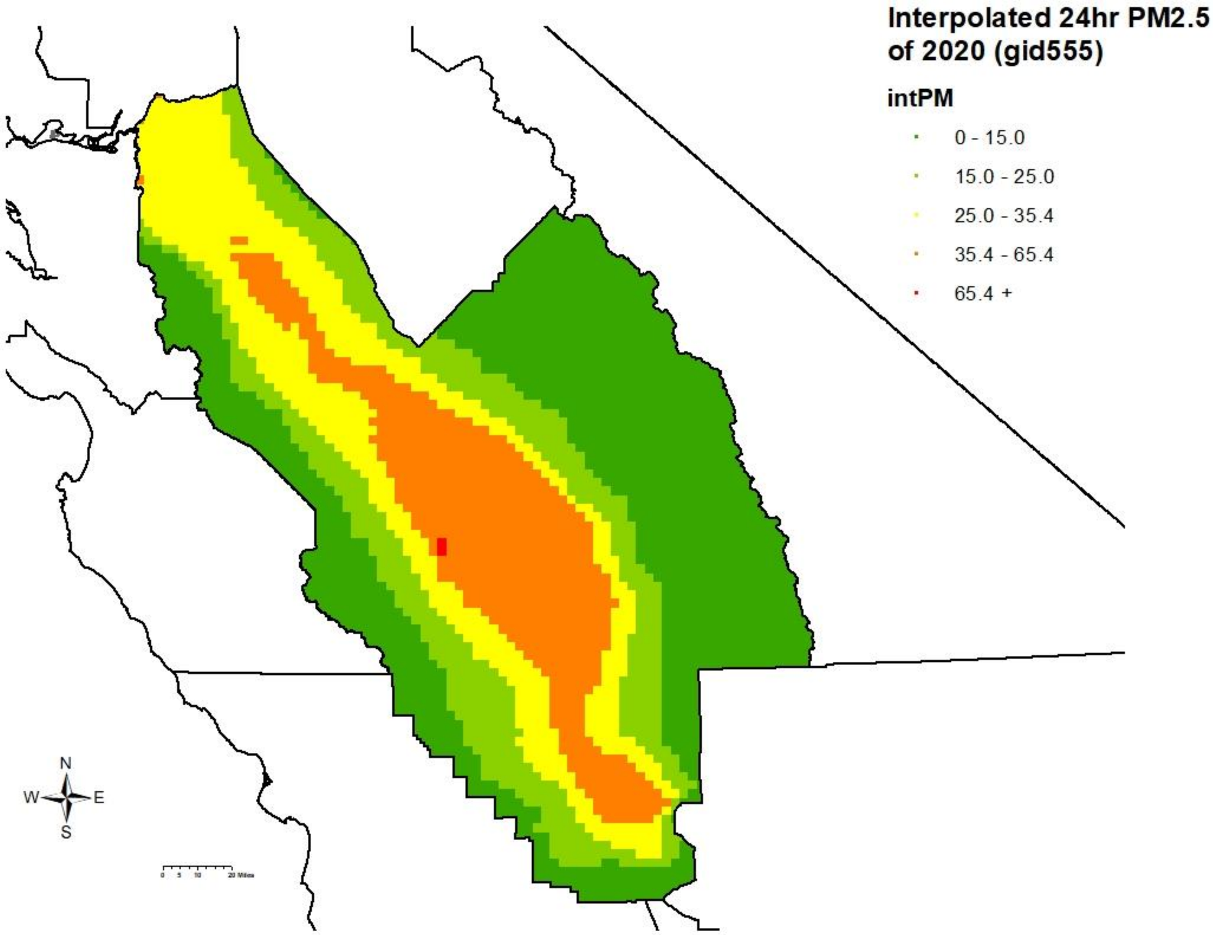


Figure 16. Spatial distribution of projected 2020 24-hour $PM_{2.5}$ DVs within the SJV nonattainment area. All grid cells have DVs not greater than 65.4 µg/m^3 except a few cells surrounding the Lemoore Naval facility.

Figure 17 shows the spatial distribution of projected 2024 24-hour $PM_{2.5}$ DVs in the SJV nonattainment area. Projected 2024 24-hour $PM_{2.5}$ DVs within the SJV do not exceed 35.4 µg/m^3 (technically, DVs not greater than 35.4 µg/m^3 are considered attainment for the 2006 35 µg/m^3 24-hour $PM_{2.5}$ standard), except for a few grid cells located to the southeast of the Fresno metropolitan area as well as a few grid cells surrounding the Lemoore Navy facility. Again, the elevated concentrations surrounding the Lemoore Naval facility are due to localized emissions associated with military operations. The area exceeding the standard to the southeast of the main Fresno metropolitan area is primarily due to elevated ammonium nitrate and organic carbon levels in the modeling system, which are likely due to a combination of transport of polluted air masses and some local emissions within the exceedance area in 2024. ARB plans to assess the elevated ammonium nitrate and organic carbon levels in the region and if appropriate, monitor $PM_{2.5}$ air quality levels.

Figure 18 shows the spatial distribution of projected 2025 annual $PM_{2.5}$ DVs in the SJV nonattainment area. Projected 2025 annual $PM_{2.5}$ DVs within the SJV are below 12.04 µg/m^3 (technically, DVs not greater than 12.04 µg/m^3 are considered attainment for the 2012 12 µg/m^3 annual $PM_{2.5}$ standard) except for a few cells surrounding the Lemoore Navy facility. Again, grid cells exceeding the standard surrounding the Lemoore Navy facility are due to localized emissions associated with the operations of that facility.

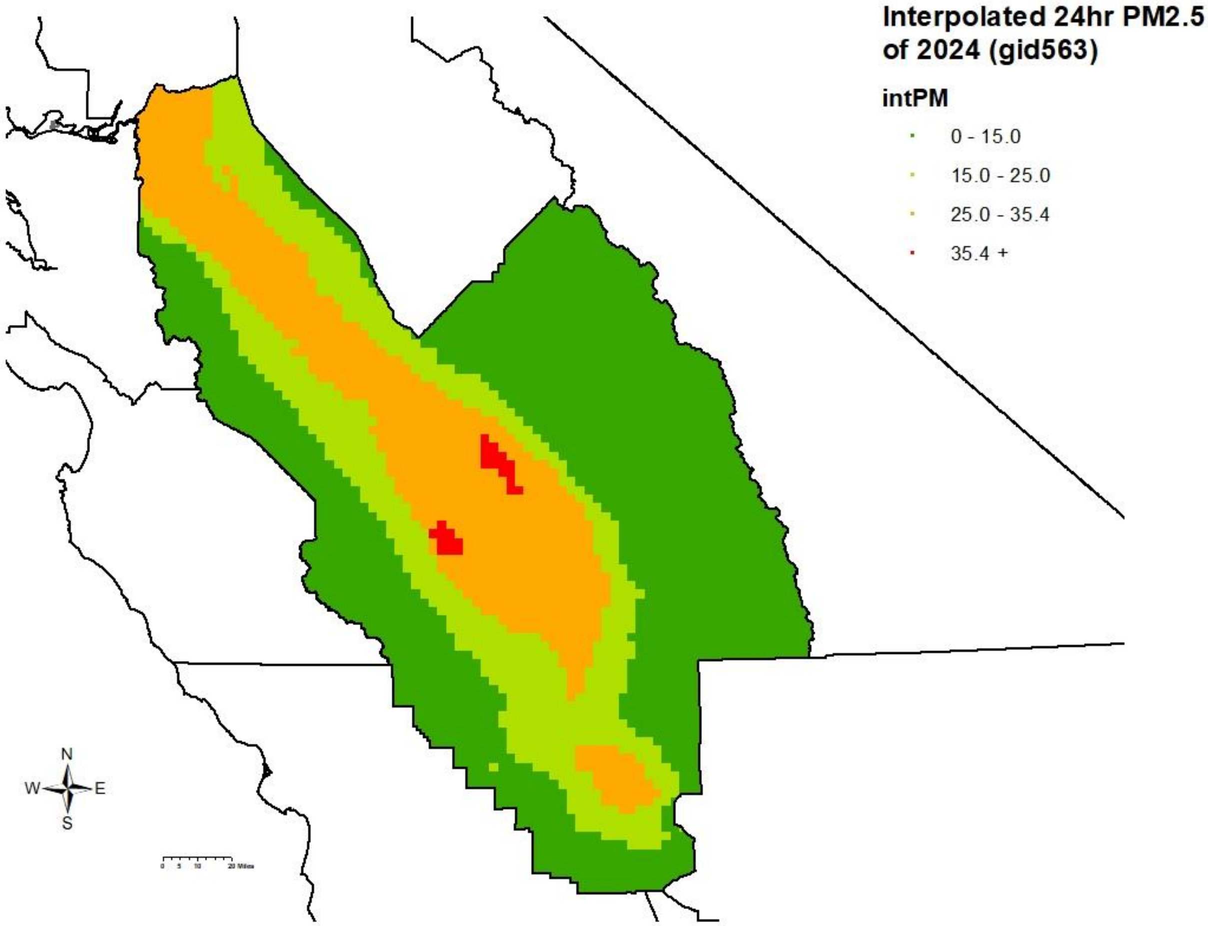


Figure 17. Spatial distribution of projected 2024 24-hour $PM_{2.5}$ DVs within the SJV nonattainment area. All grid cells have DVs not greater than 35.4 µg/m^3 except for a few cells located to the southeast of the main Fresno metropolitan area, as well as surrounding the Lemoore Naval facility.

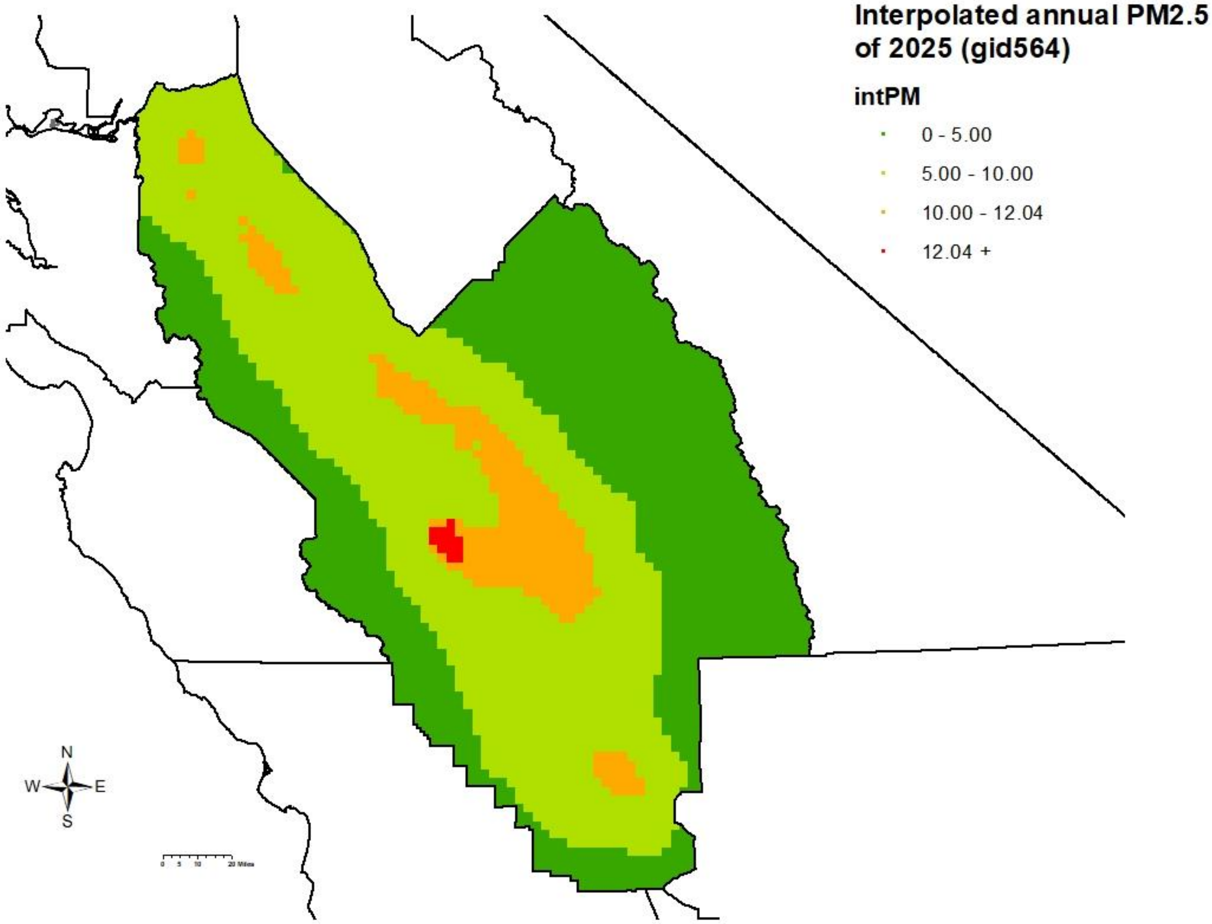


Figure 18. Spatial distribution of projected 2025 annual $PM_{2.5}$ DVs within the SJV nonattainment area. All grid cells have DVs not greater than 12.04 µg/m^3 except for a few cells surrounding the Lemoore Naval facility.

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SUPPLEMENTAL MATERIALS

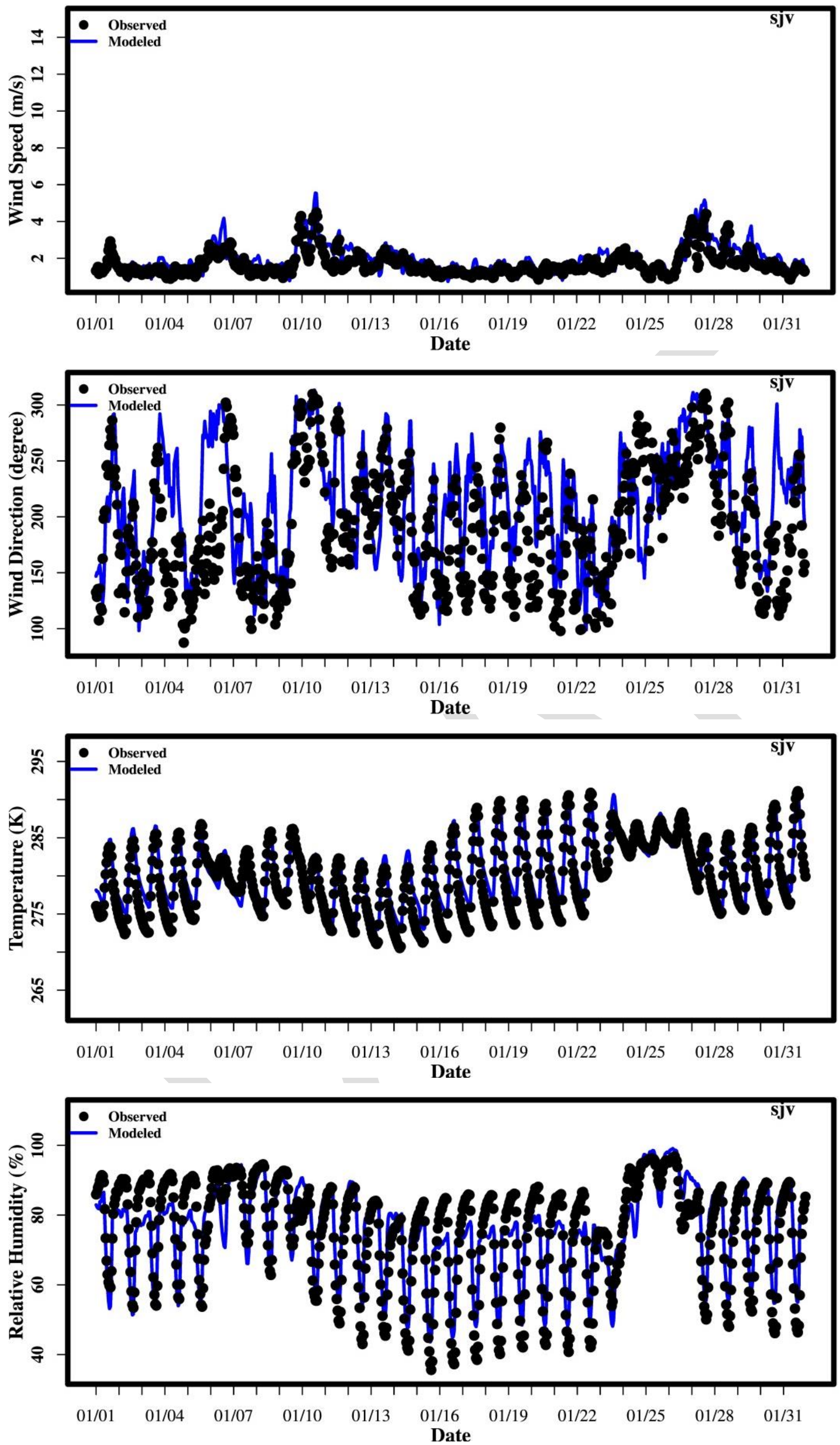

Figure S. 1 Time series of wind speed, direction, temperature and relative humidity for San Joaquin Valley in January 2013.

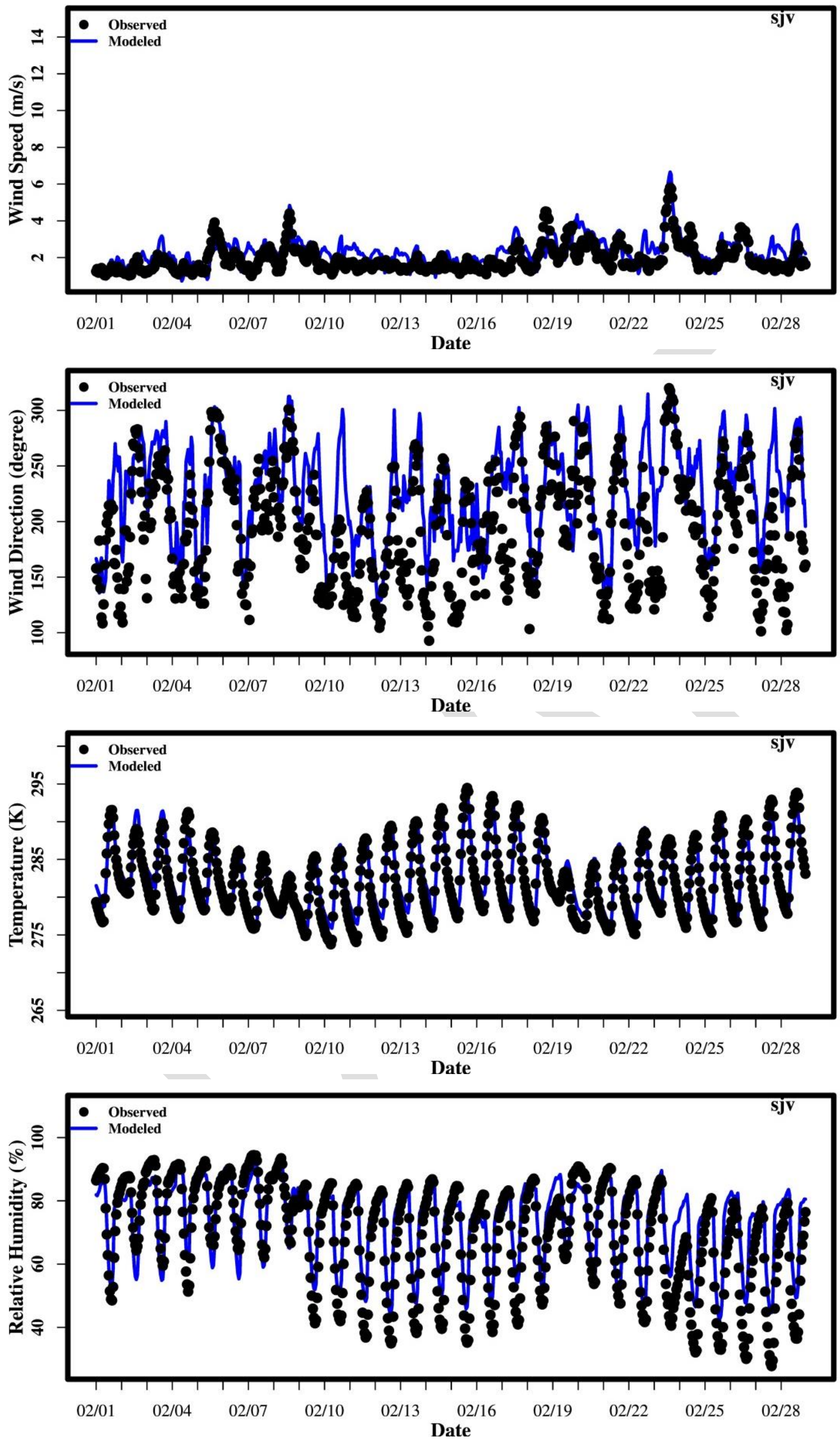

Figure S. 2 Time series of wind speed, direction, temperature and relative humidity for San Joaquin Valley in February 2013.

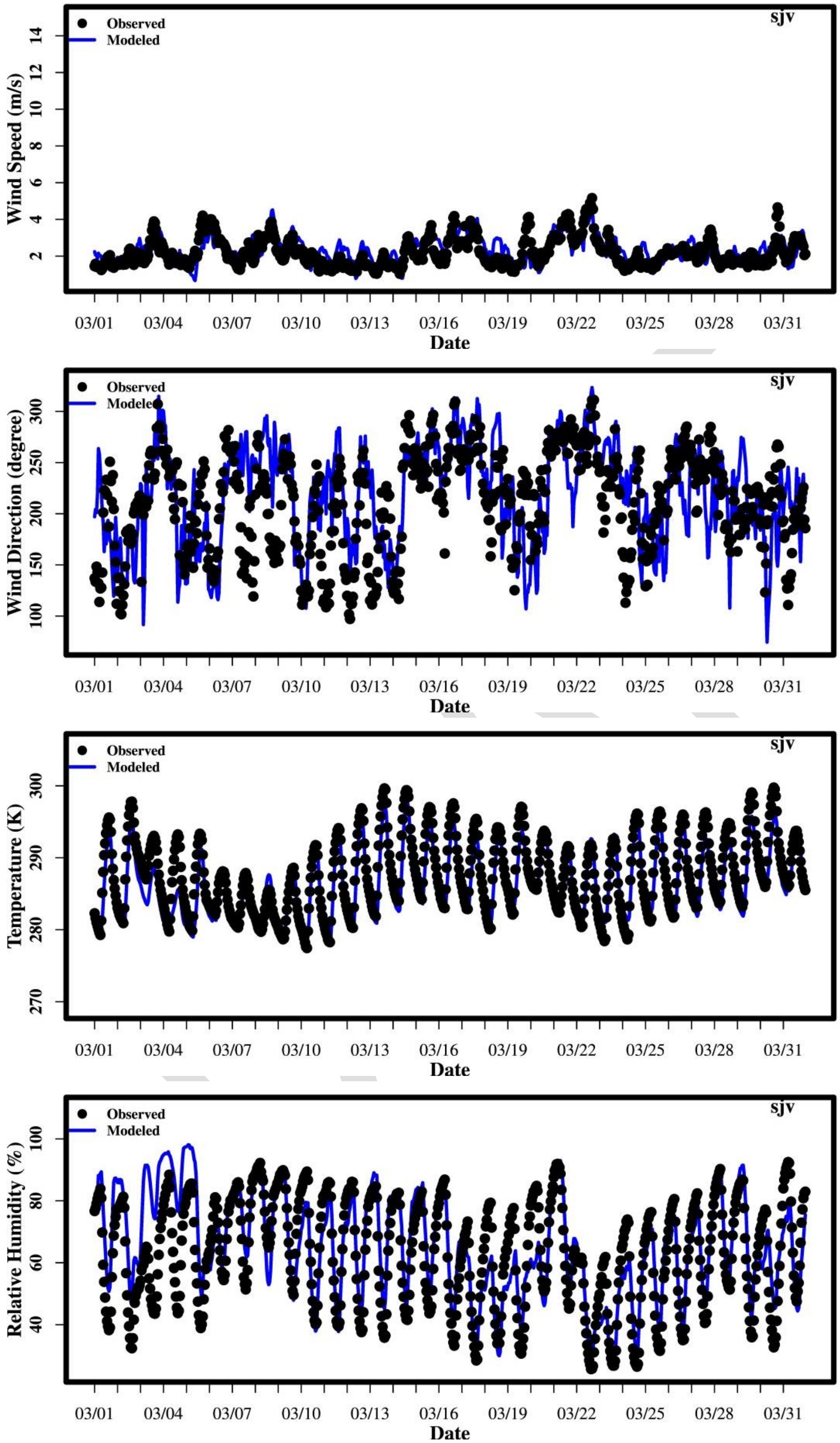

Figure S. 3 Time series of wind speed, direction, temperature and relative humidity for San Joaquin Valley in March 2013.

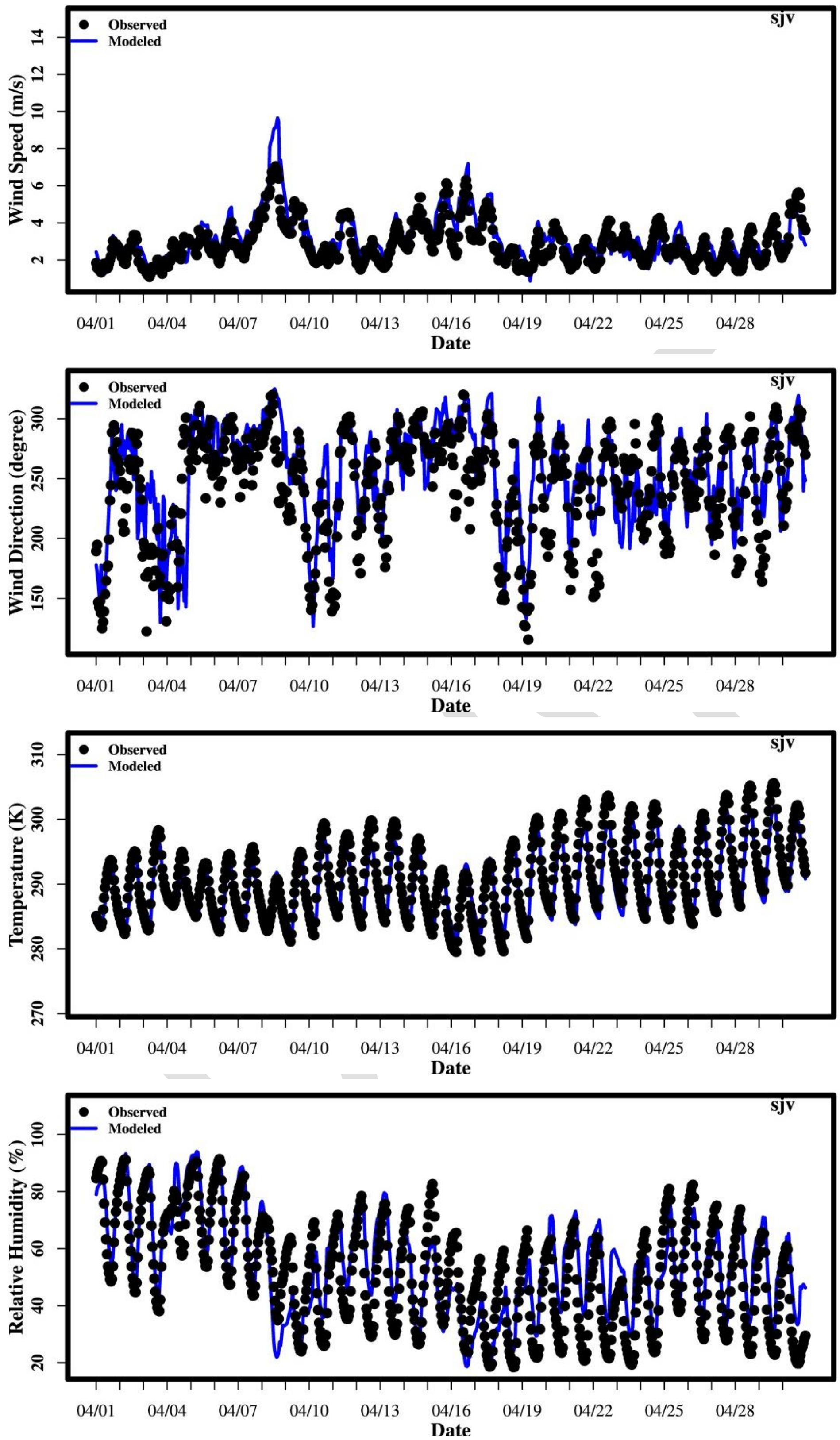

Figure S. 4 Time series of wind speed, direction, temperature and relative humidity for San Joaquin Valley in April 2013.

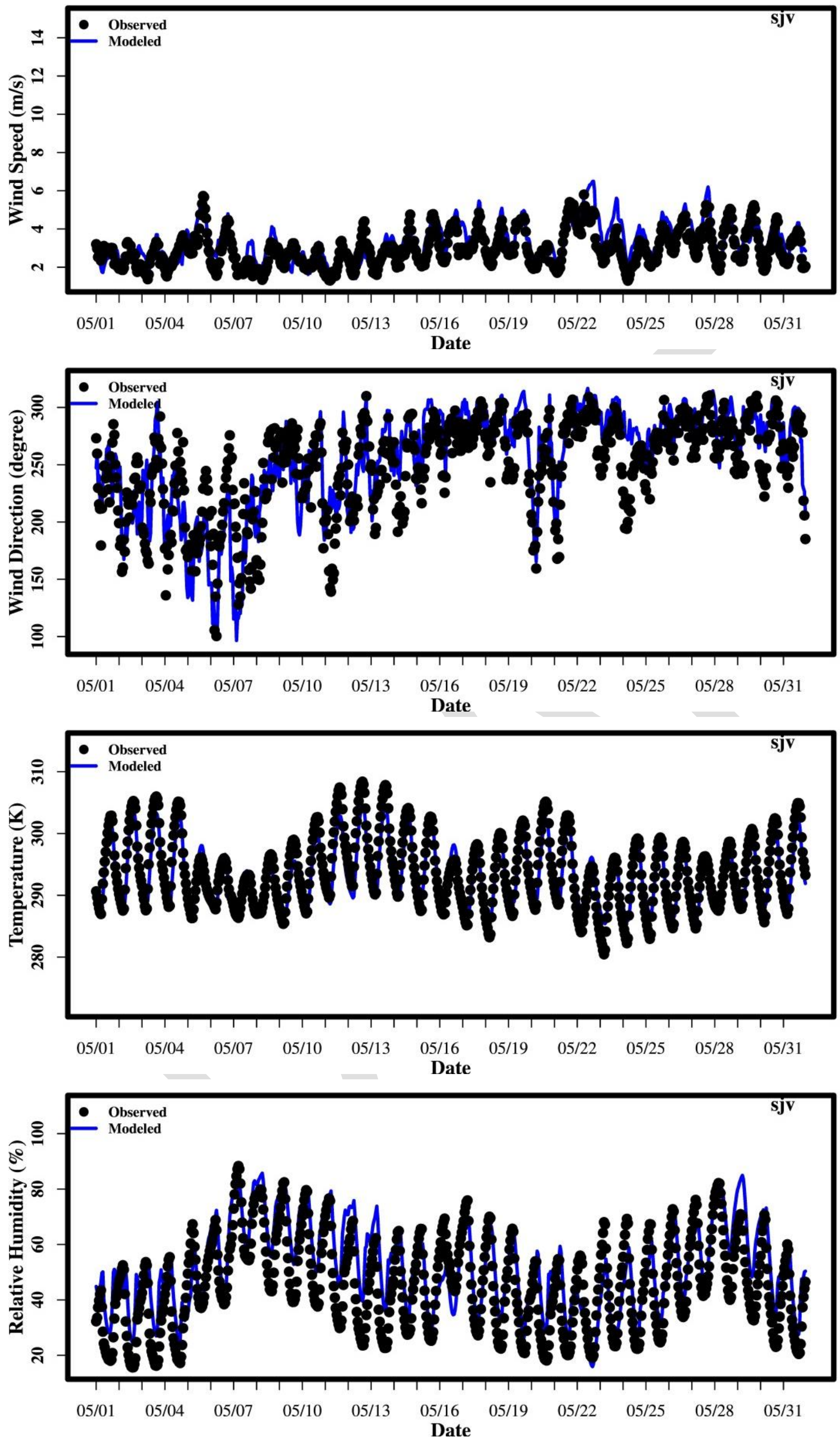

Figure S. 5 Time series of wind speed, direction, temperature and relative humidity for San Joaquin Valley in May 2013.

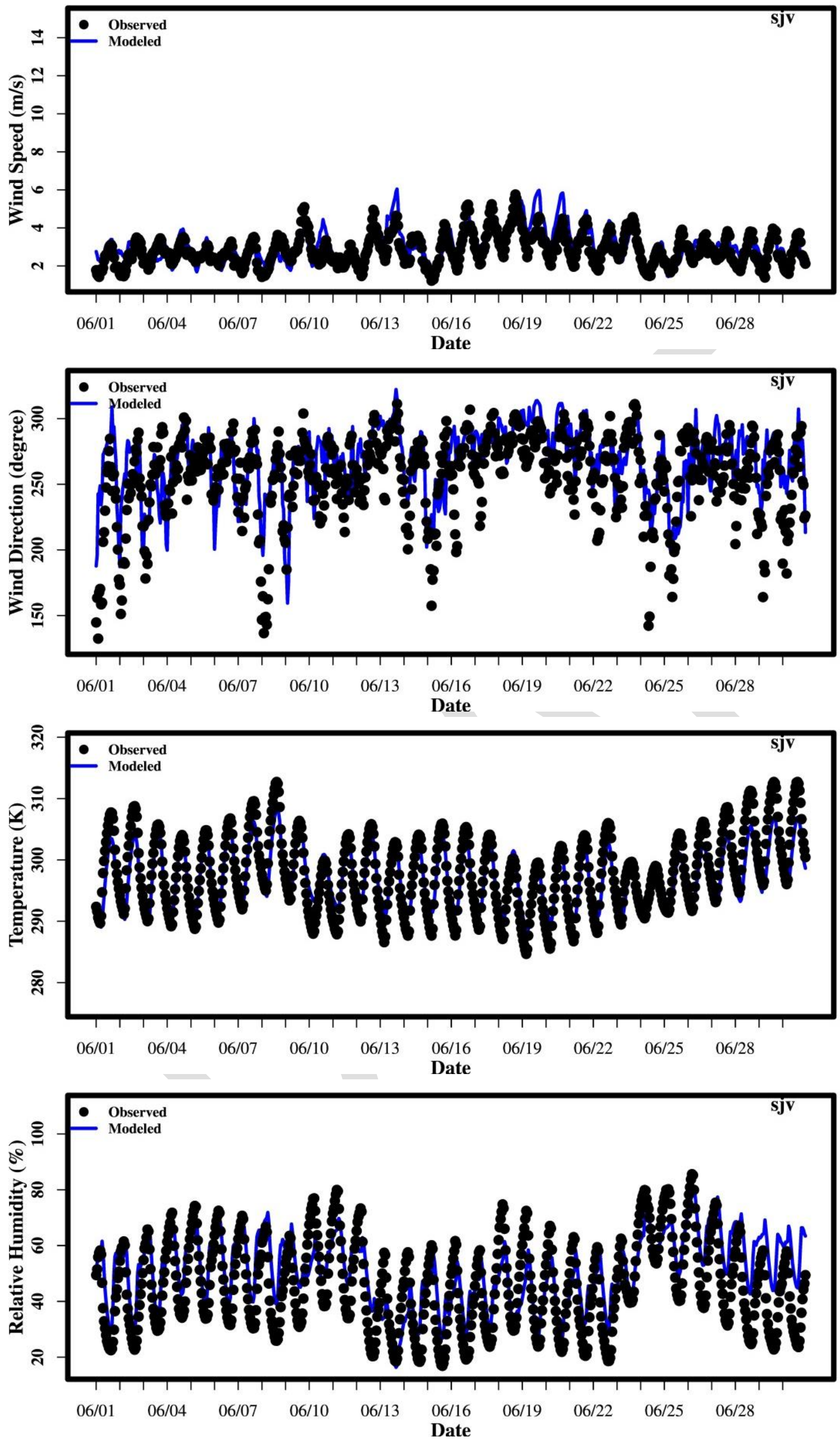

Figure S. 6 Time series of wind speed, direction, temperature and relative humidity for San Joaquin Valley in June 2013.

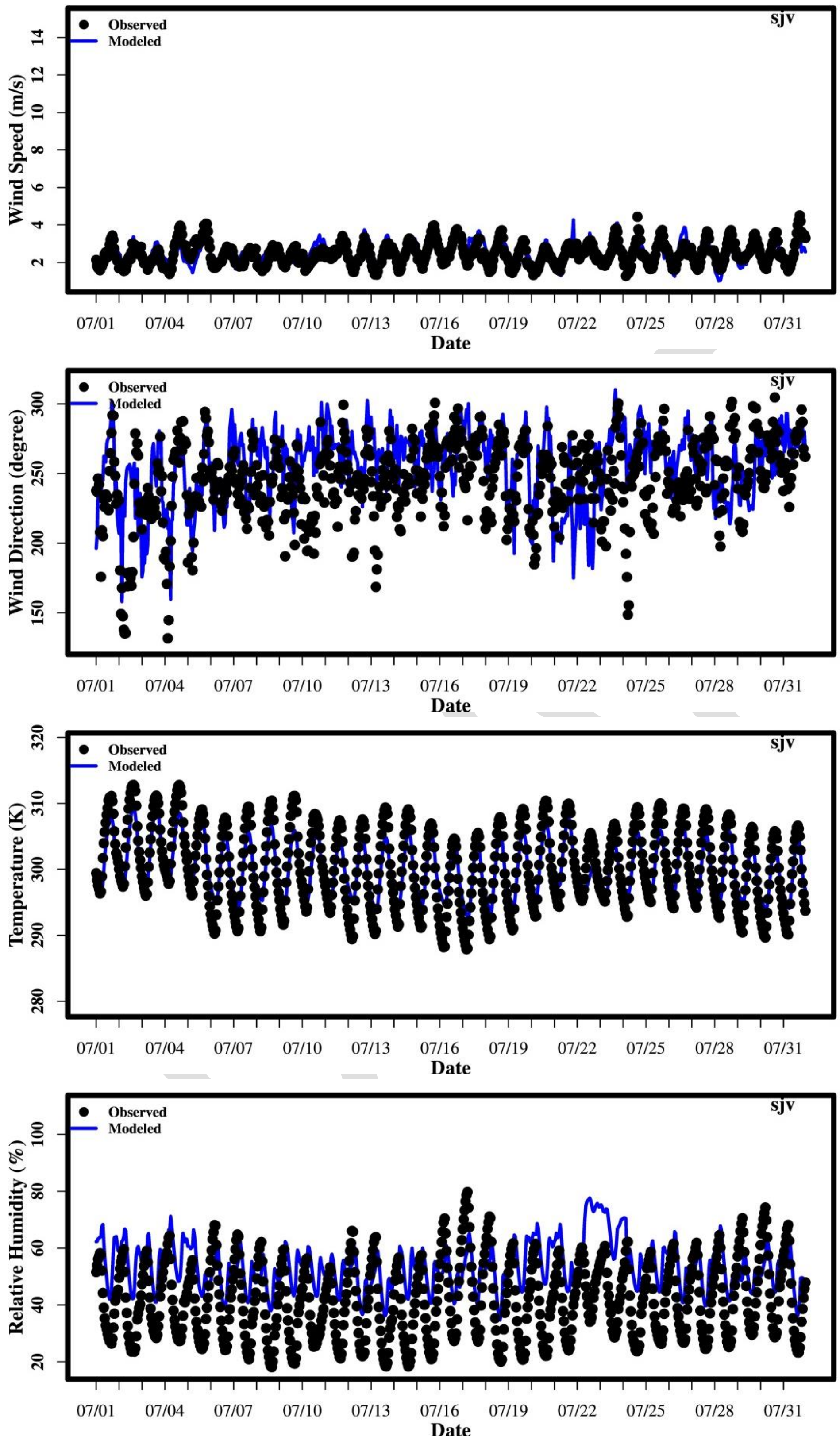

Figure S. 7 Time series of wind speed, direction, temperature and relative humidity for San Joaquin Valley in July 2013.

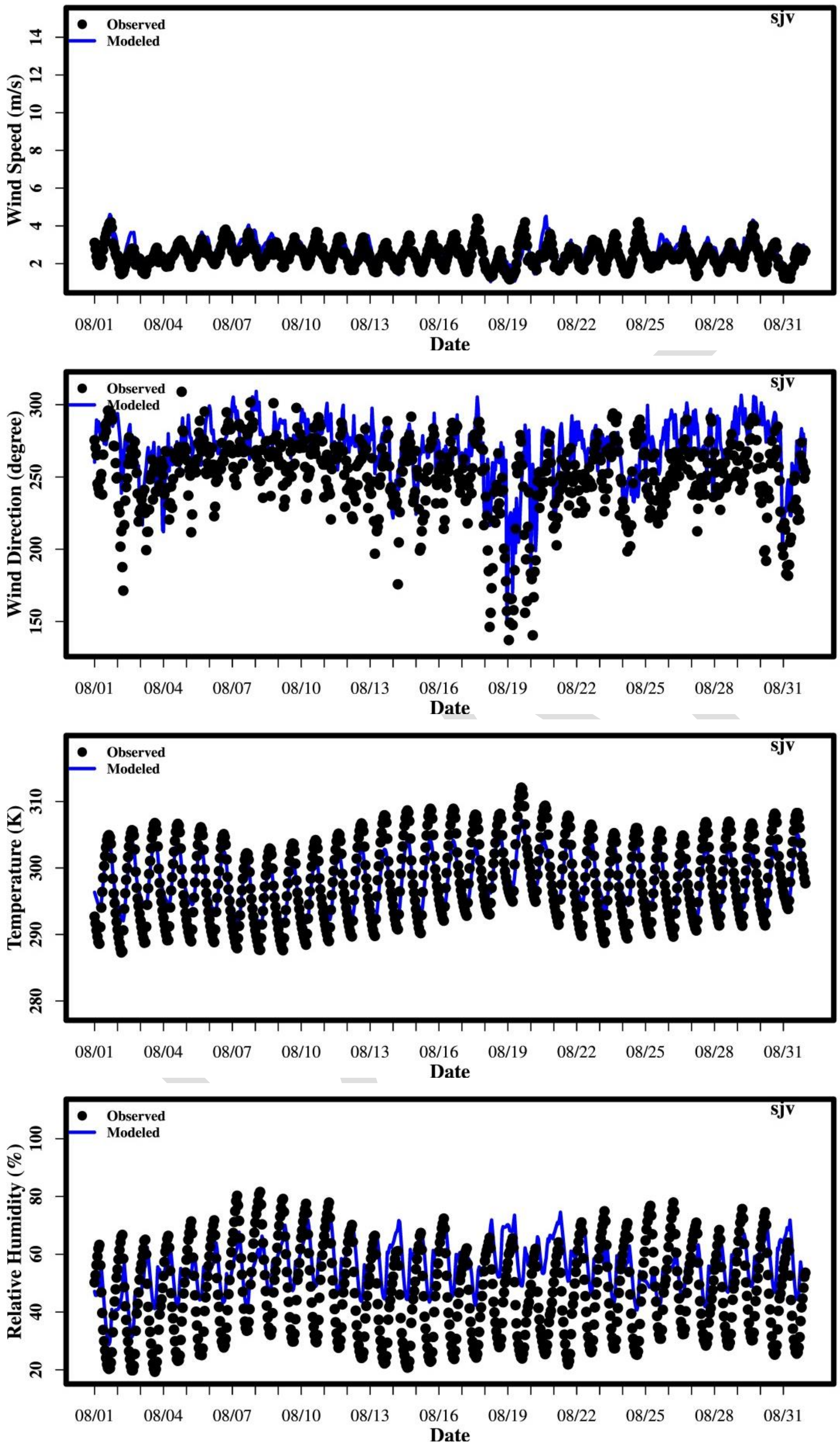

Figure S. 8 Time series of wind speed, direction, temperature and relative humidity for San Joaquin Valley in August 2013.

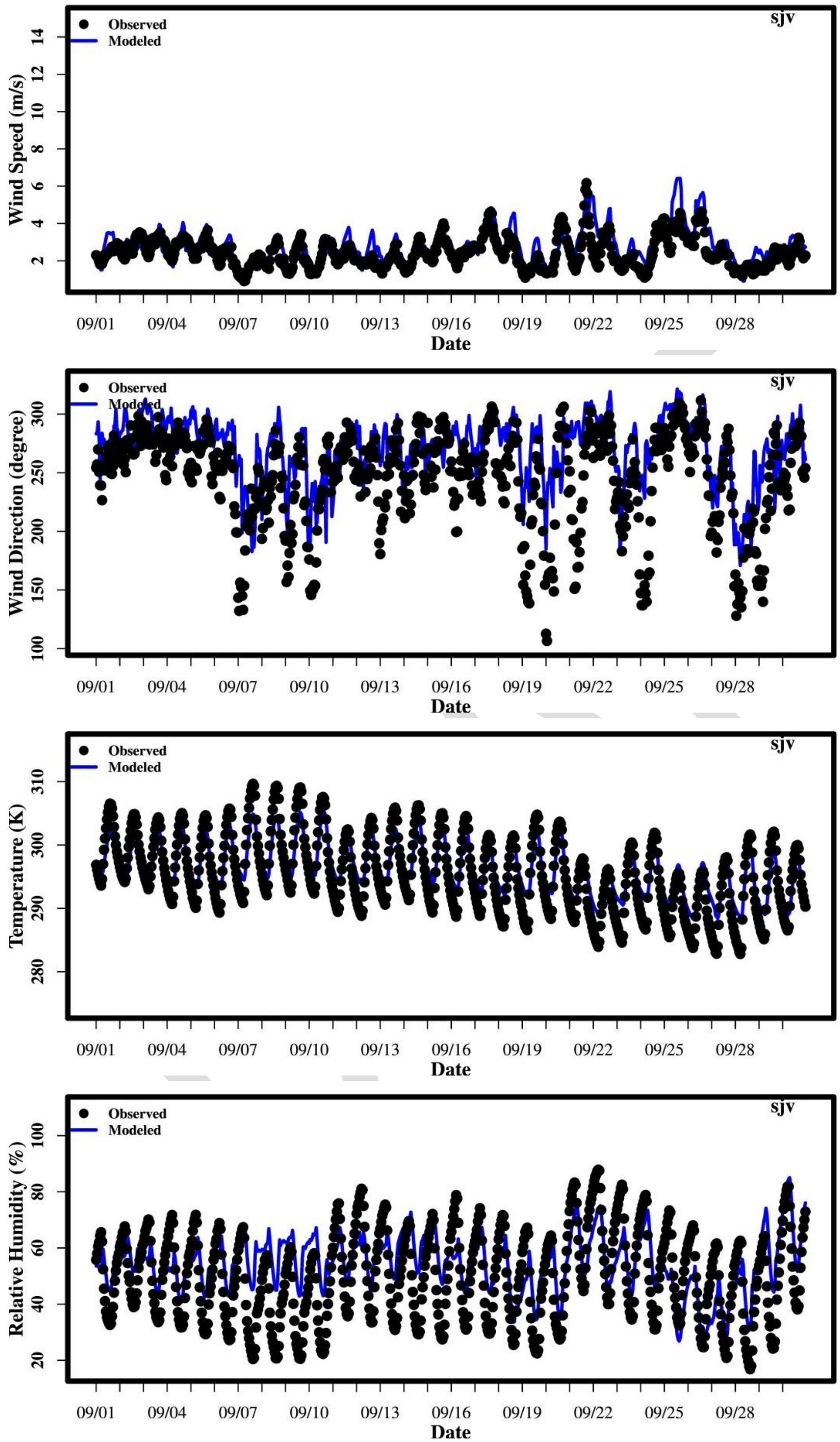

Figure S. 9 Time series of wind speed, direction, temperature and relative humidity for San Joaquin Valley in September 2013.

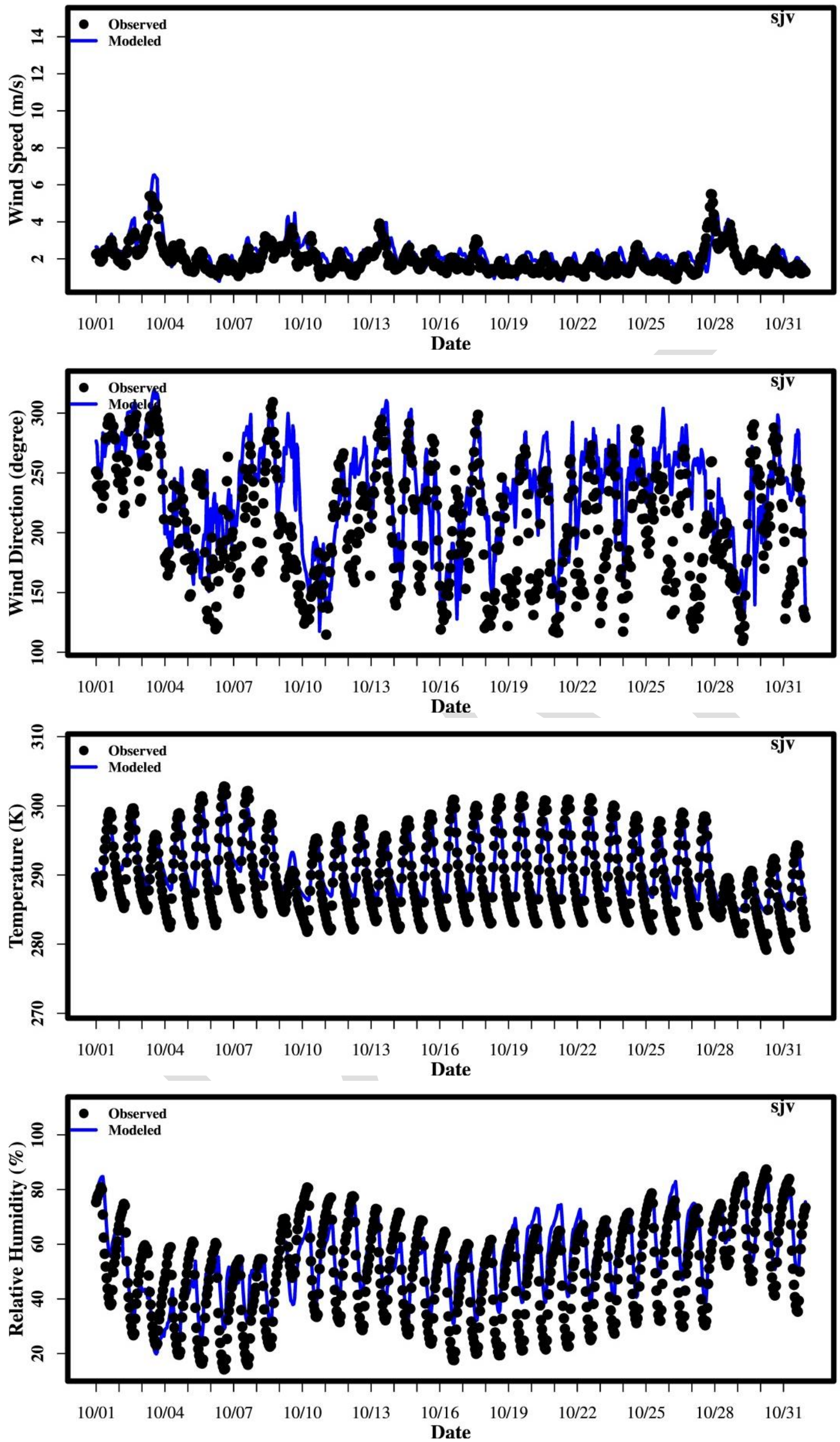

Figure S. 10 Time series of wind speed, direction, temperature and relative humidity for San Joaquin Valley in October 2013.

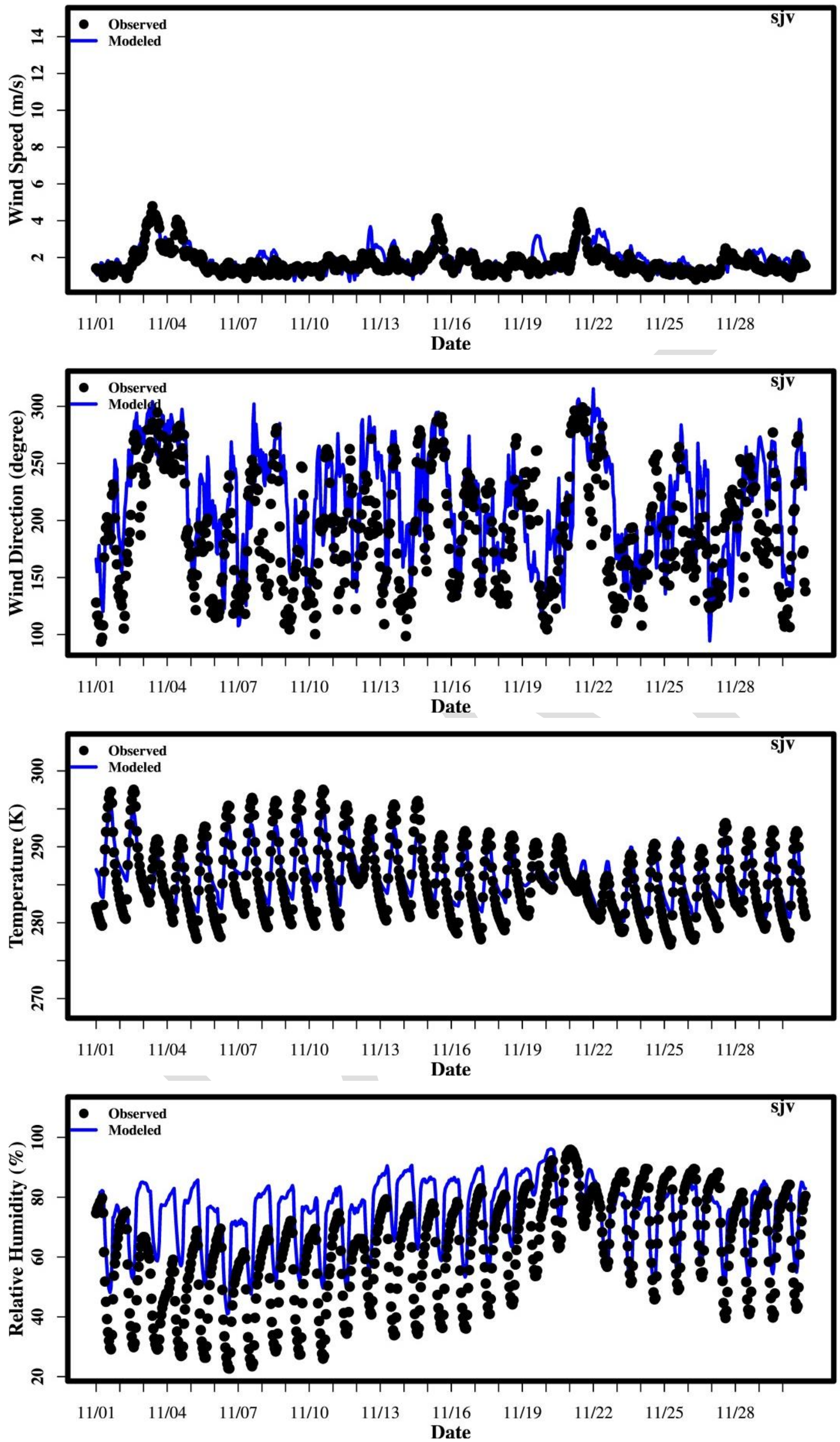

Figure S. 11 Time series of wind speed, direction, temperature and relative humidity for San Joaquin Valley in November 2013.

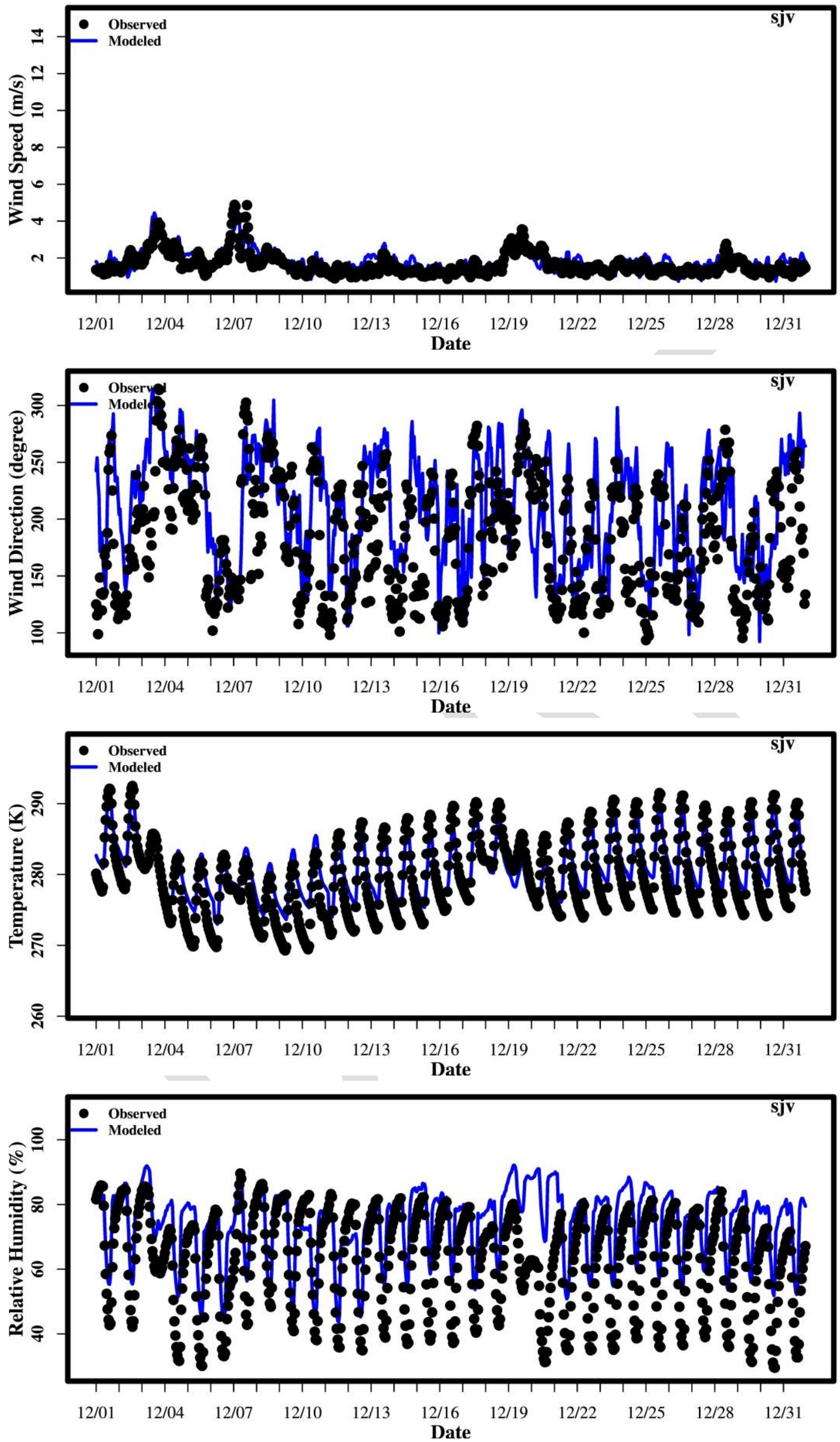

Figure S. 12 Time series of wind speed, direction, temperature and relative humidity for San Joaquin Valley in December 2013.

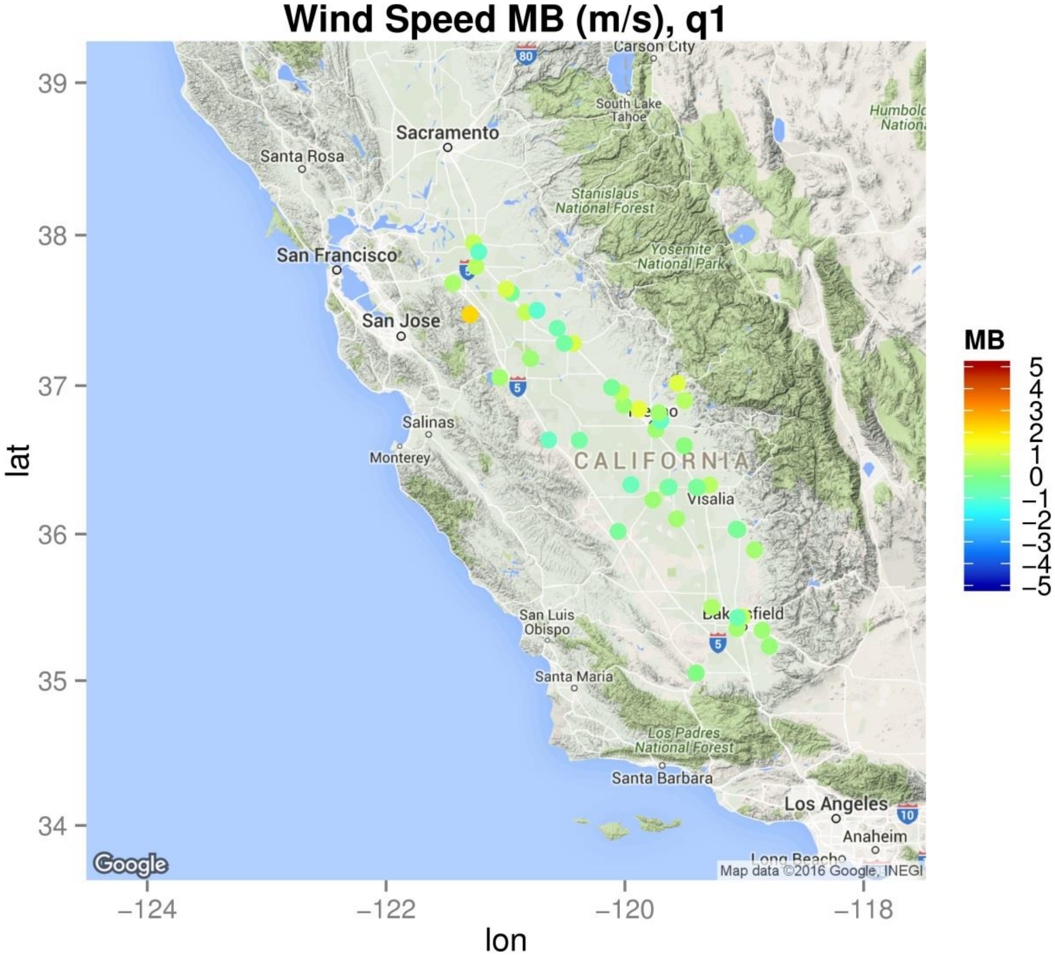

Figure S. 13 Hourly wind speed mean error in the first quarter of 2013

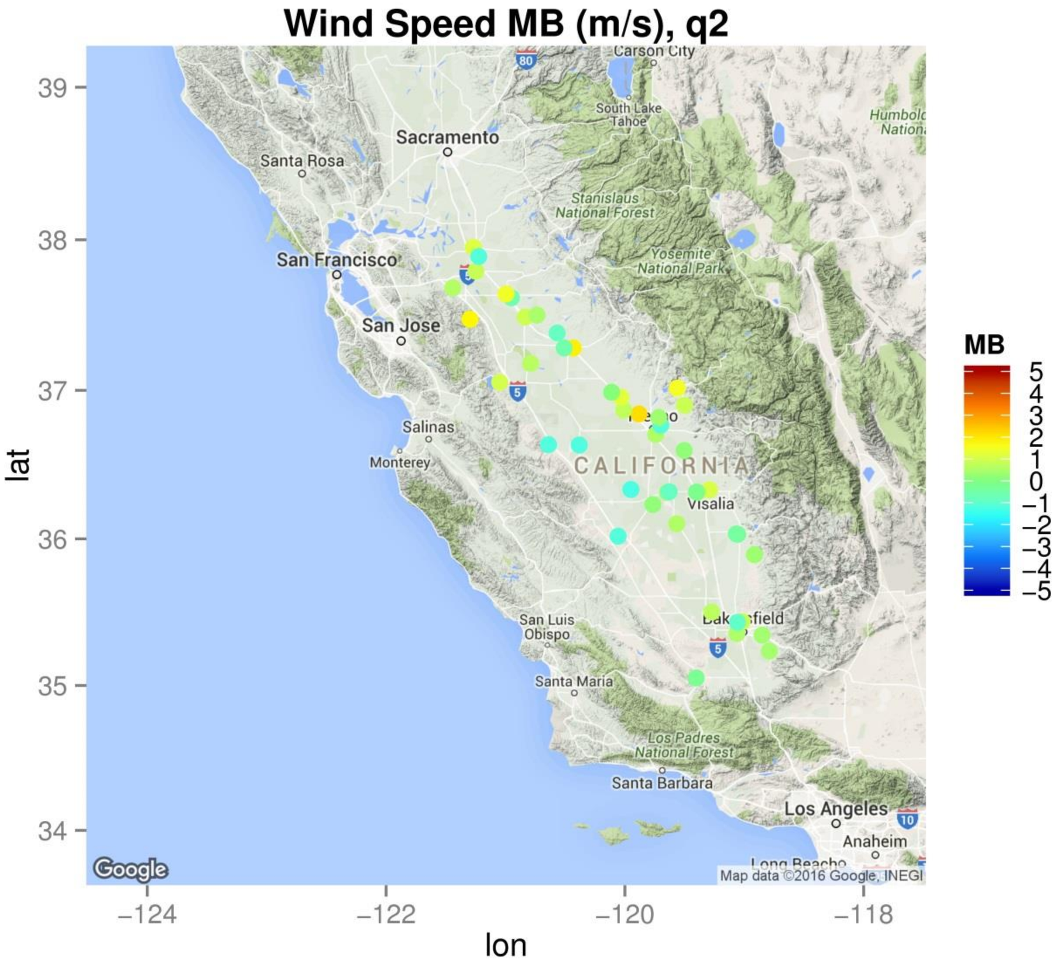

Figure S. 14 Hourly wind speed mean bias in the second quarter of 2013

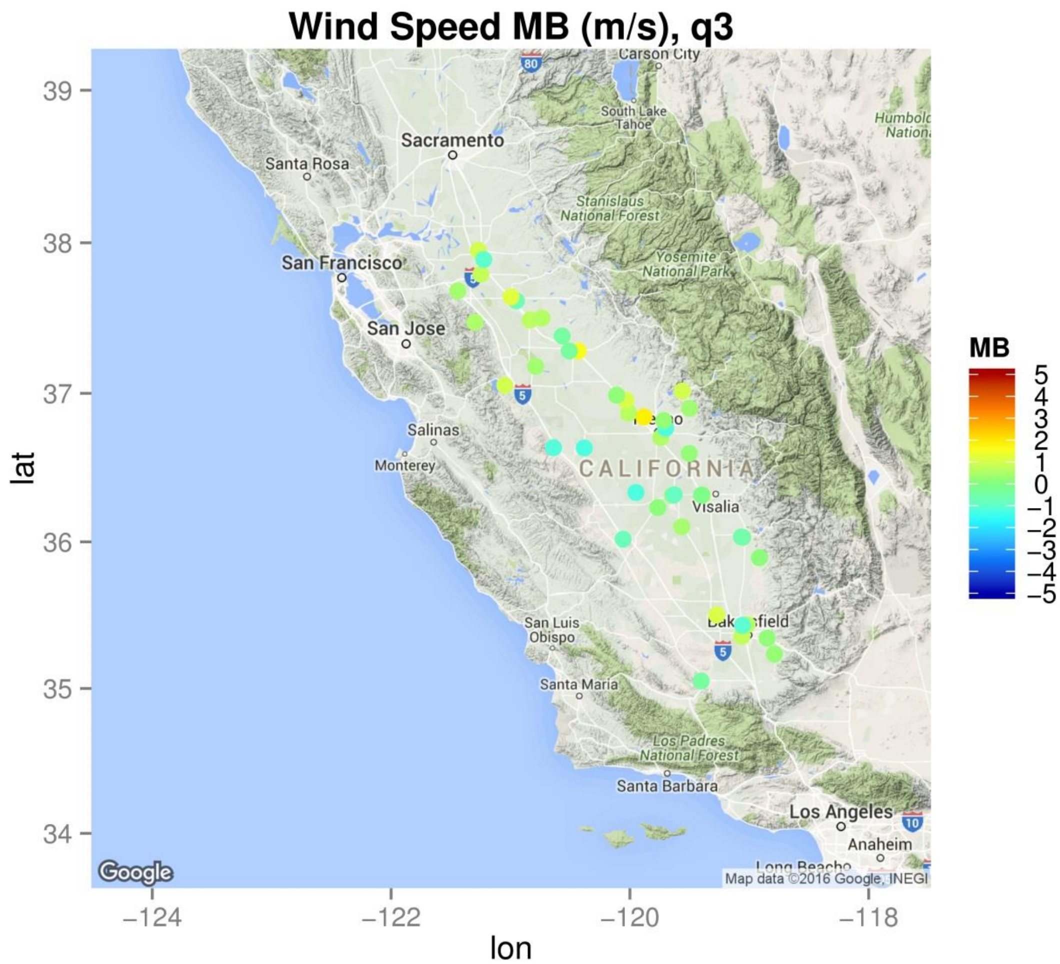

Figure S. 15 Hourly wind speed mean bias in the third quarter of 2013

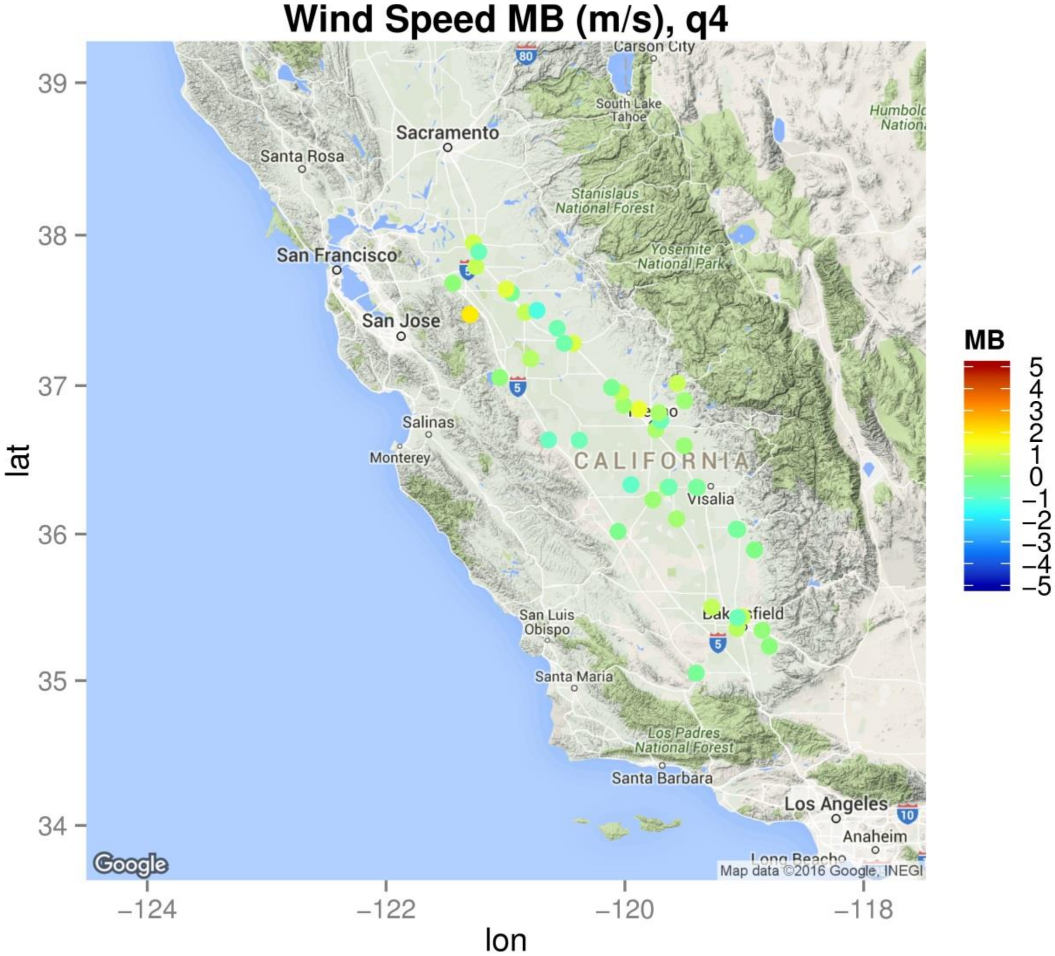

Figure S. 16 Hourly wind speed mean bias in the fourth quarter of 2013

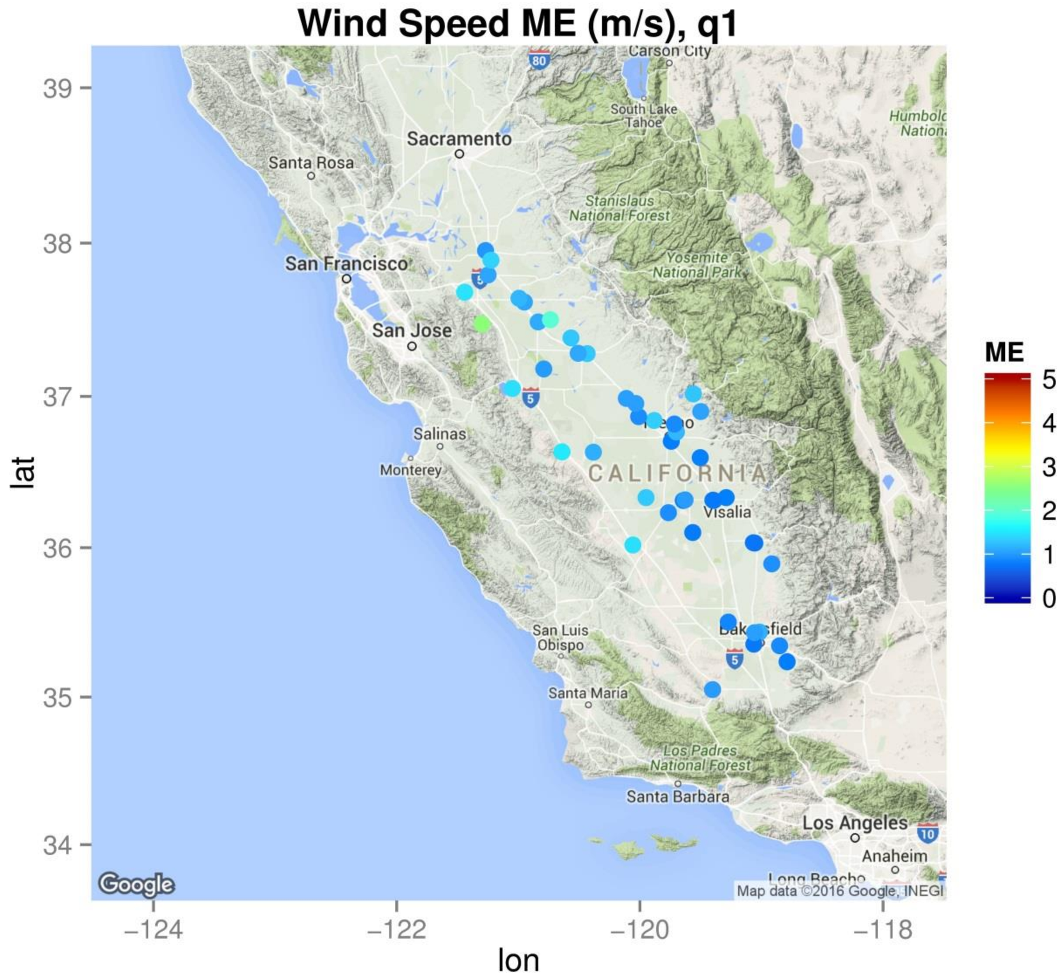

Figure S. 17 Hourly wind speed mean error in the first quarter of 2013

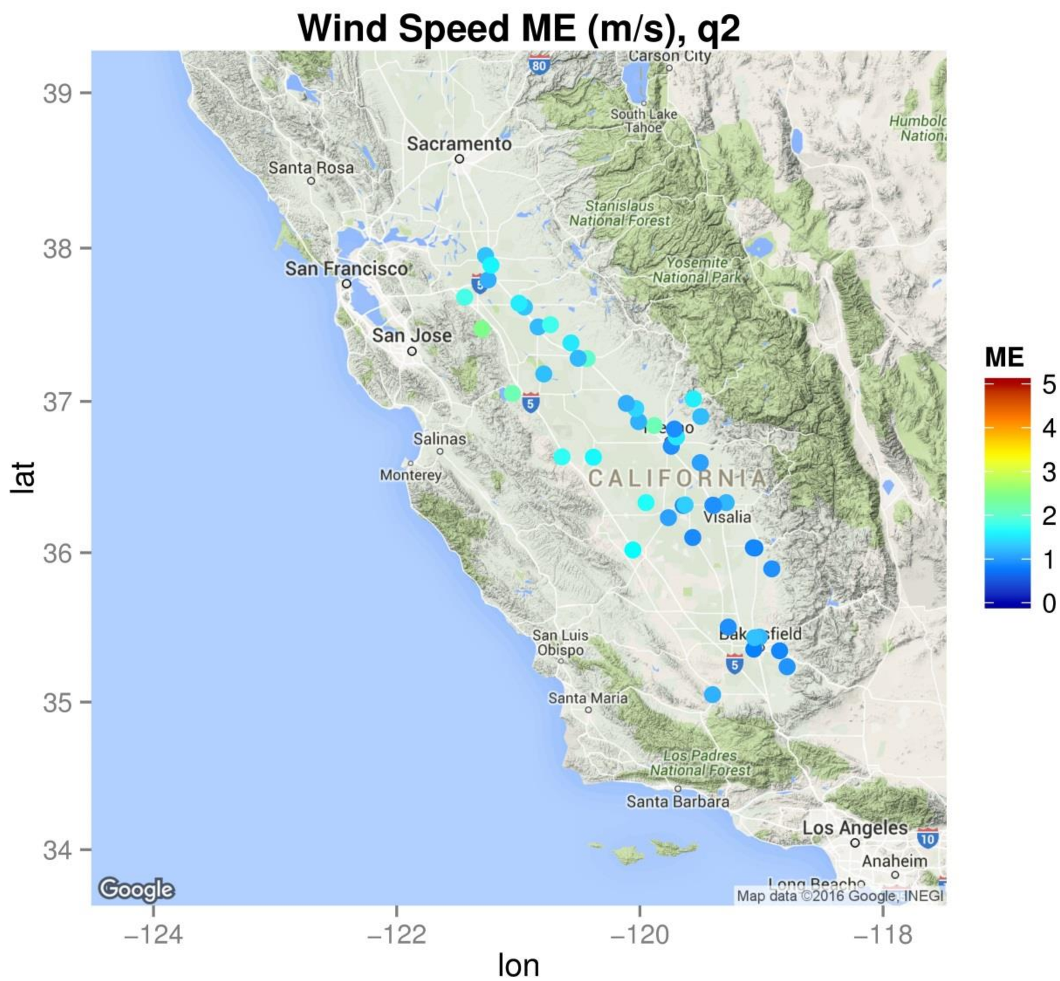

Figure S. 18 Hourly wind speed mean error in the second quarter of 2013

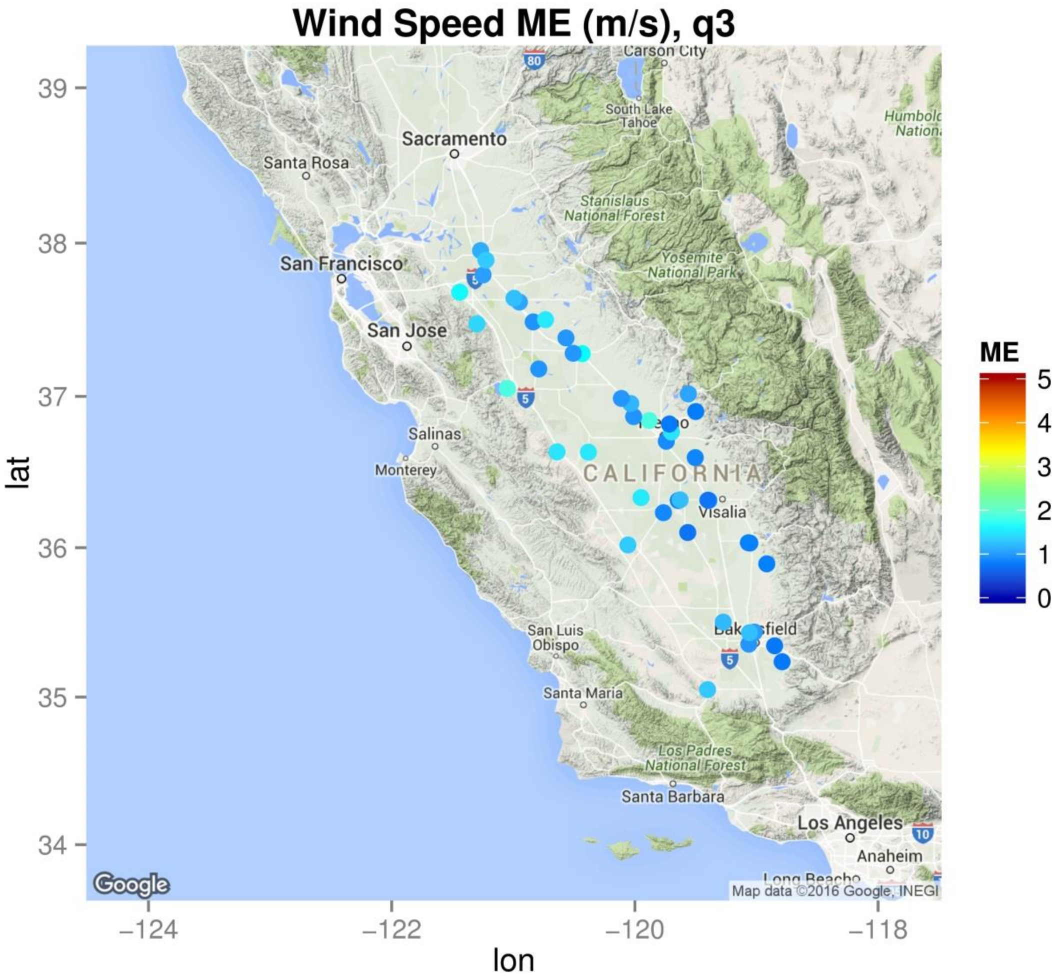

Figure S. 19 Hourly wind speed mean error in the third quarter of 2013

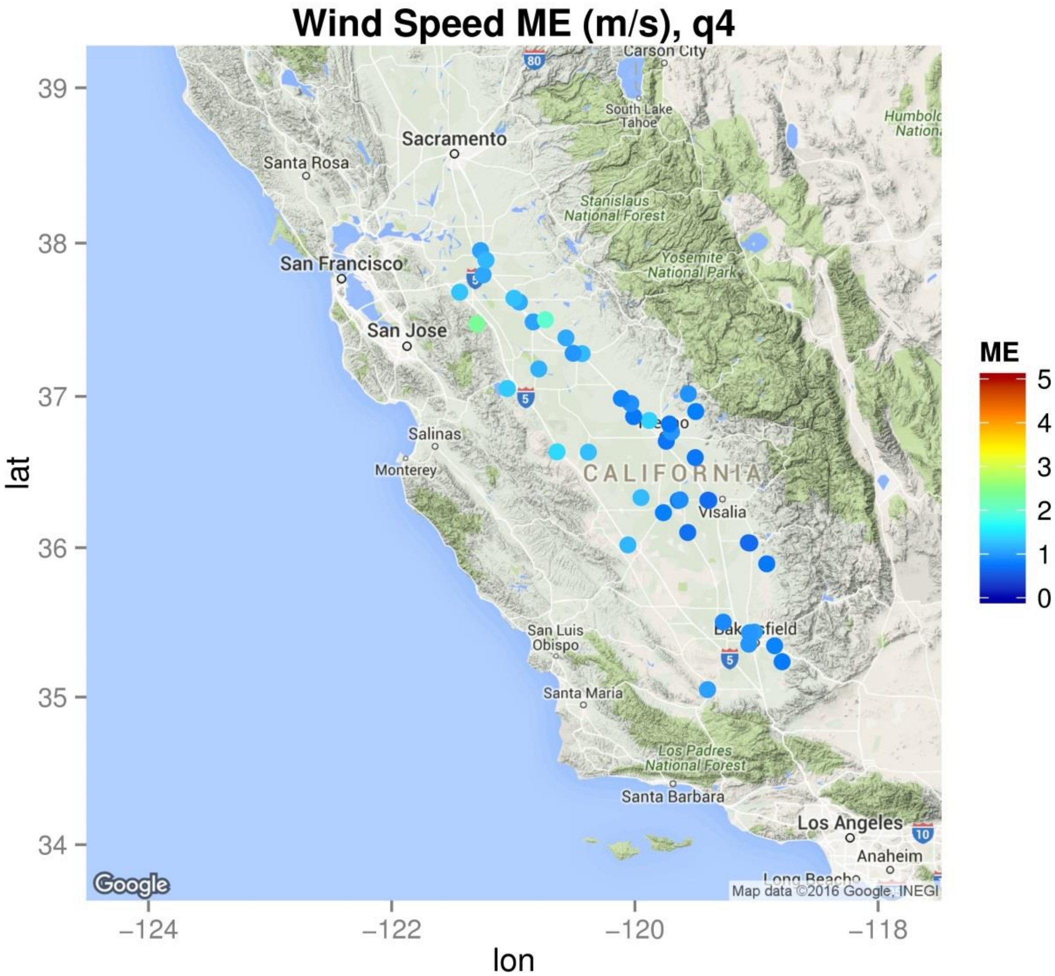

Figure S. 20 Hourly wind speed mean error in the fourth quarter of 2013

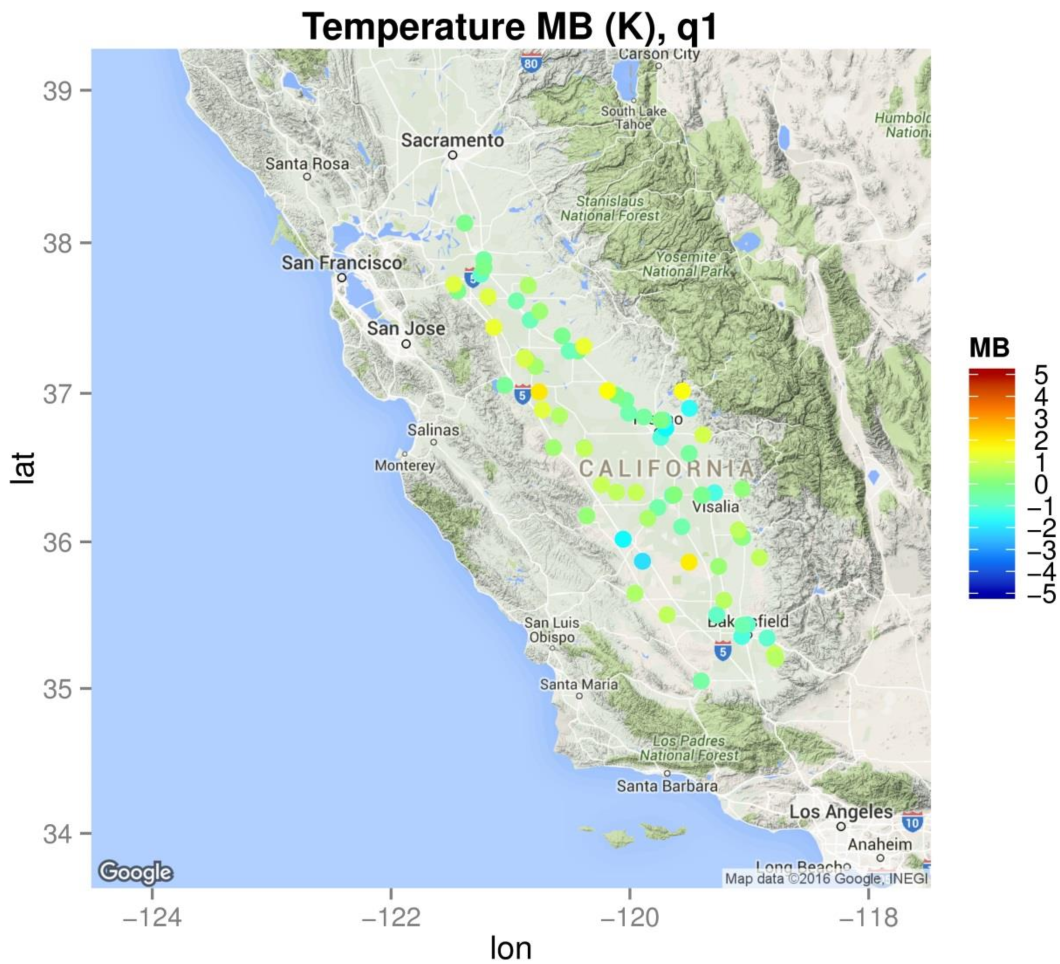

Figure S. 21 Hourly temperature mean bias in the first quarter of 2013

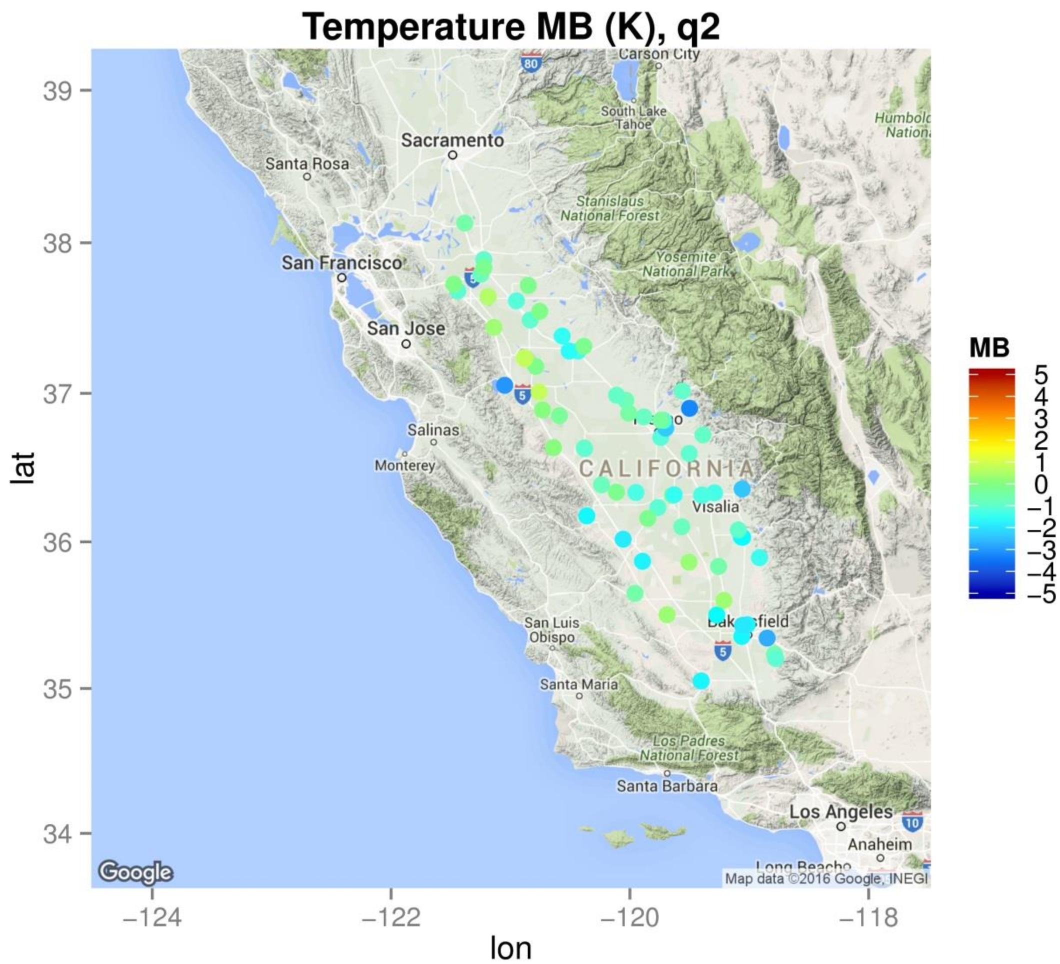

Figure S. 22 Hourly temperature mean bias in the second quarter of 2013

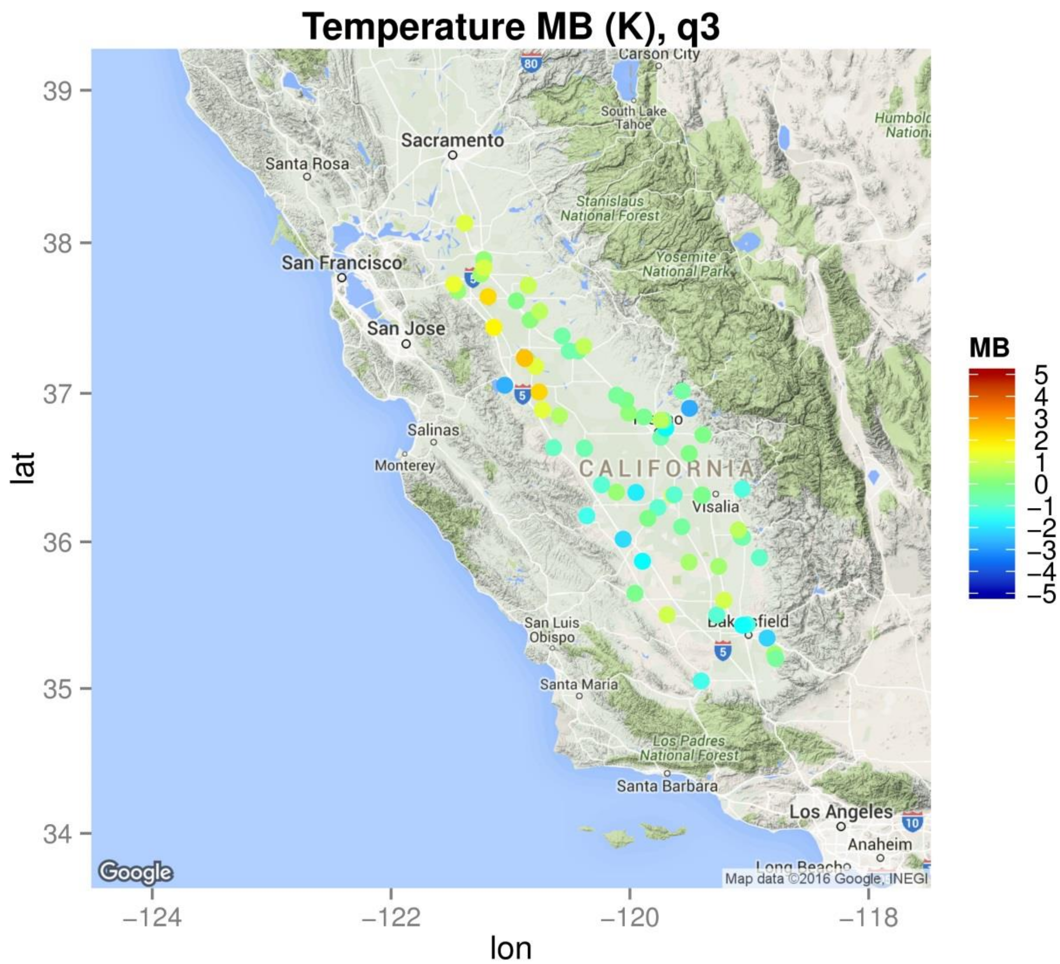

Figure S. 23 Hourly temperature mean bias in the third quarter of 2013

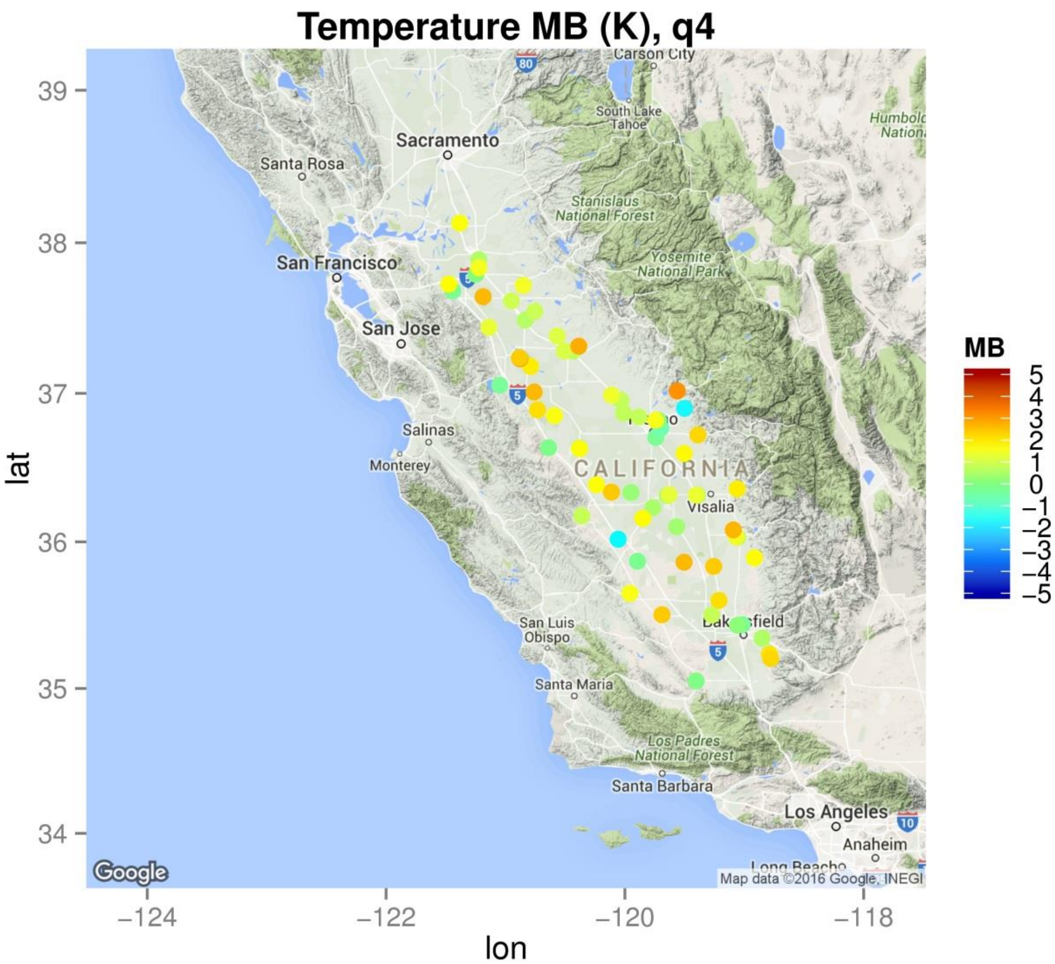

Figure S. 24 Hourly temperature mean bias in the fourth quarter of 2013

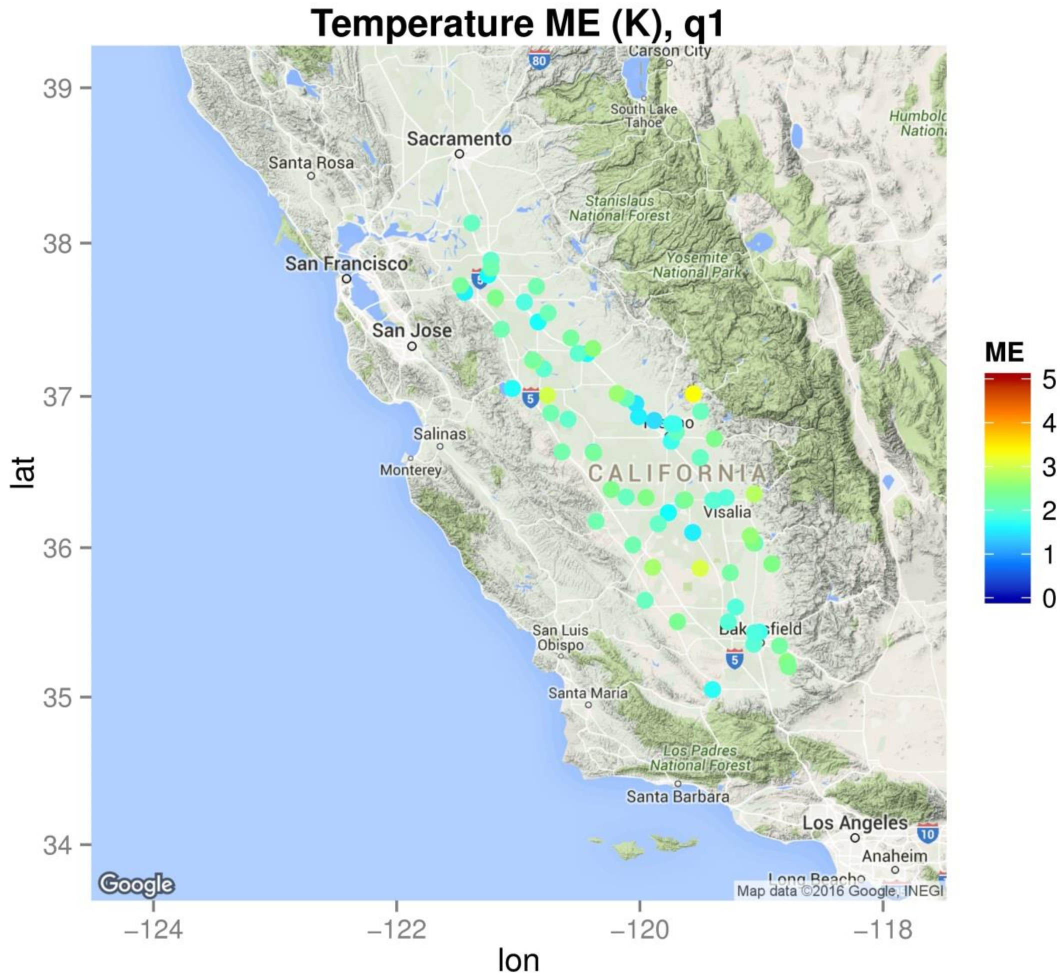

Figure S. 25 Hourly temperature mean error in the first quarter of 2013

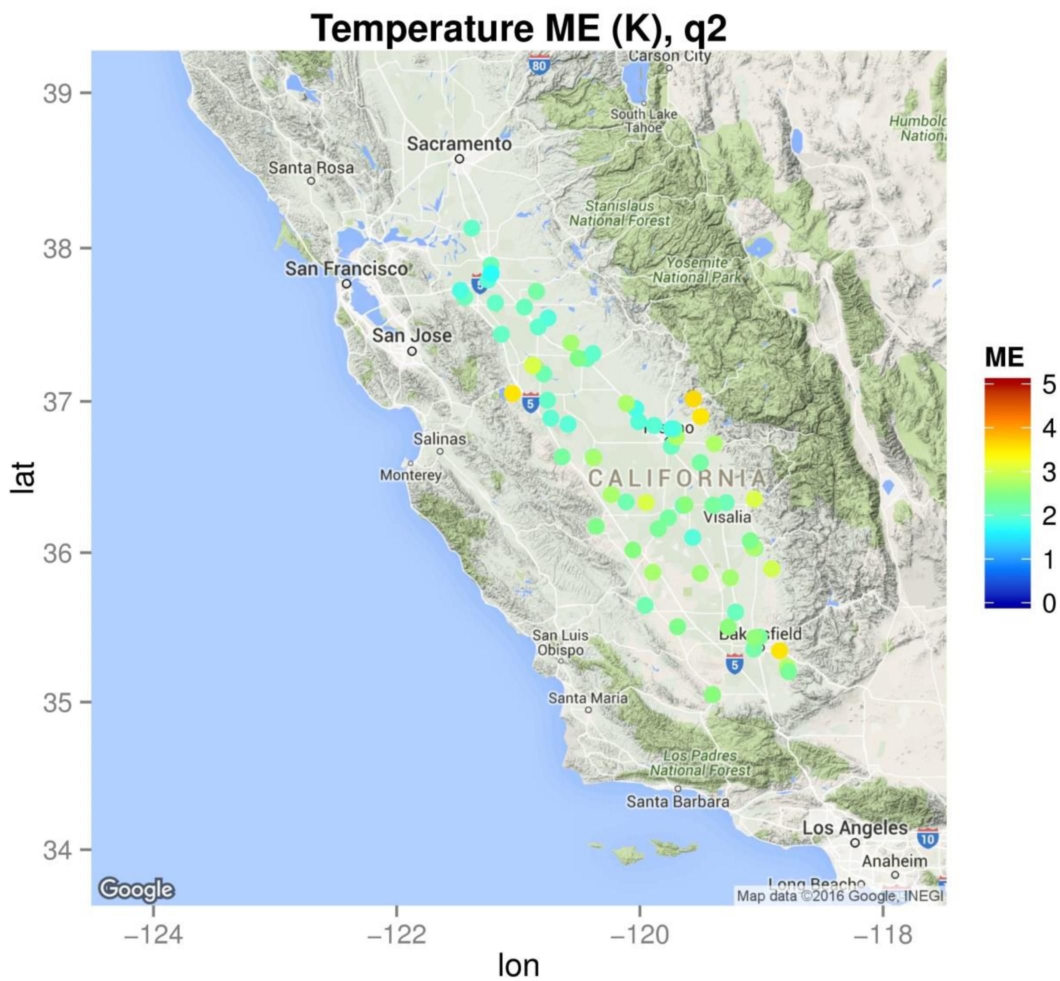

Figure S. 26 Hourly temperature mean error in the second quarter of 2013

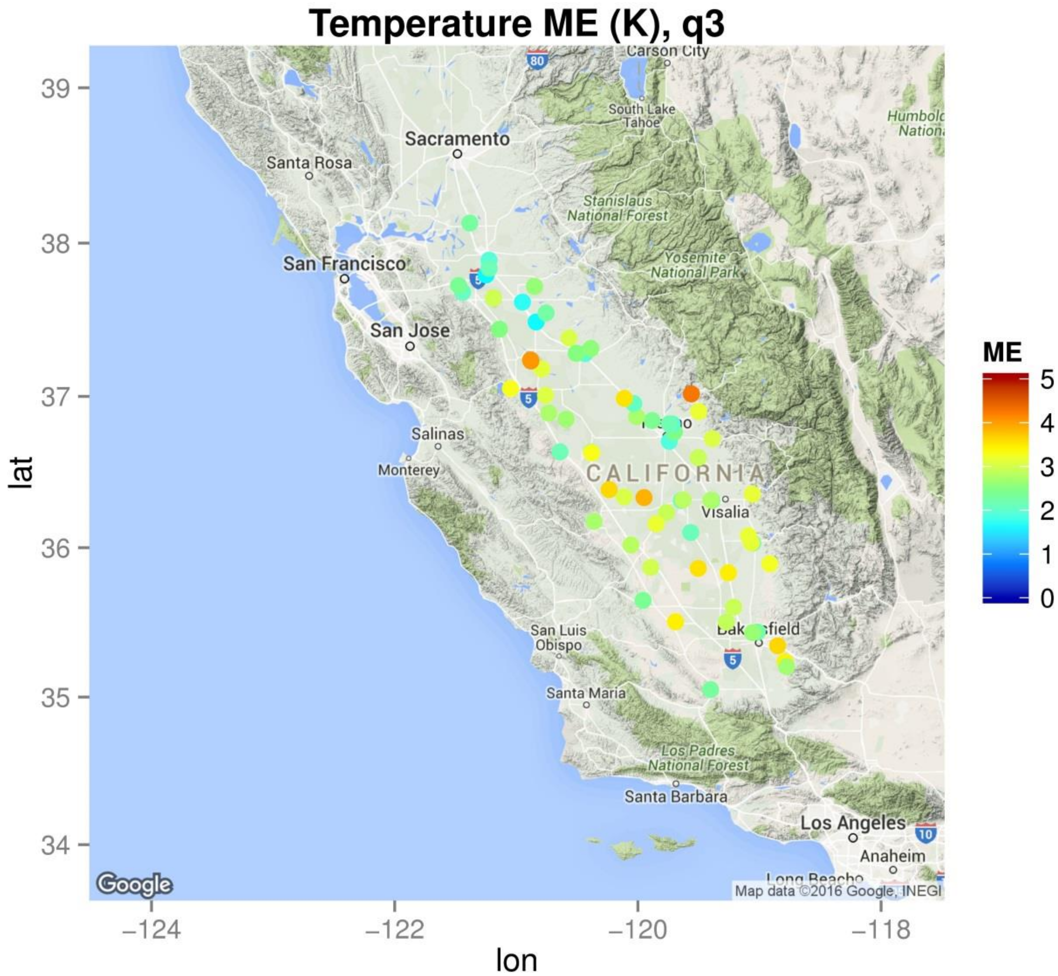

Figure S. 27 Hourly temperature mean error in the third quarter of 2013

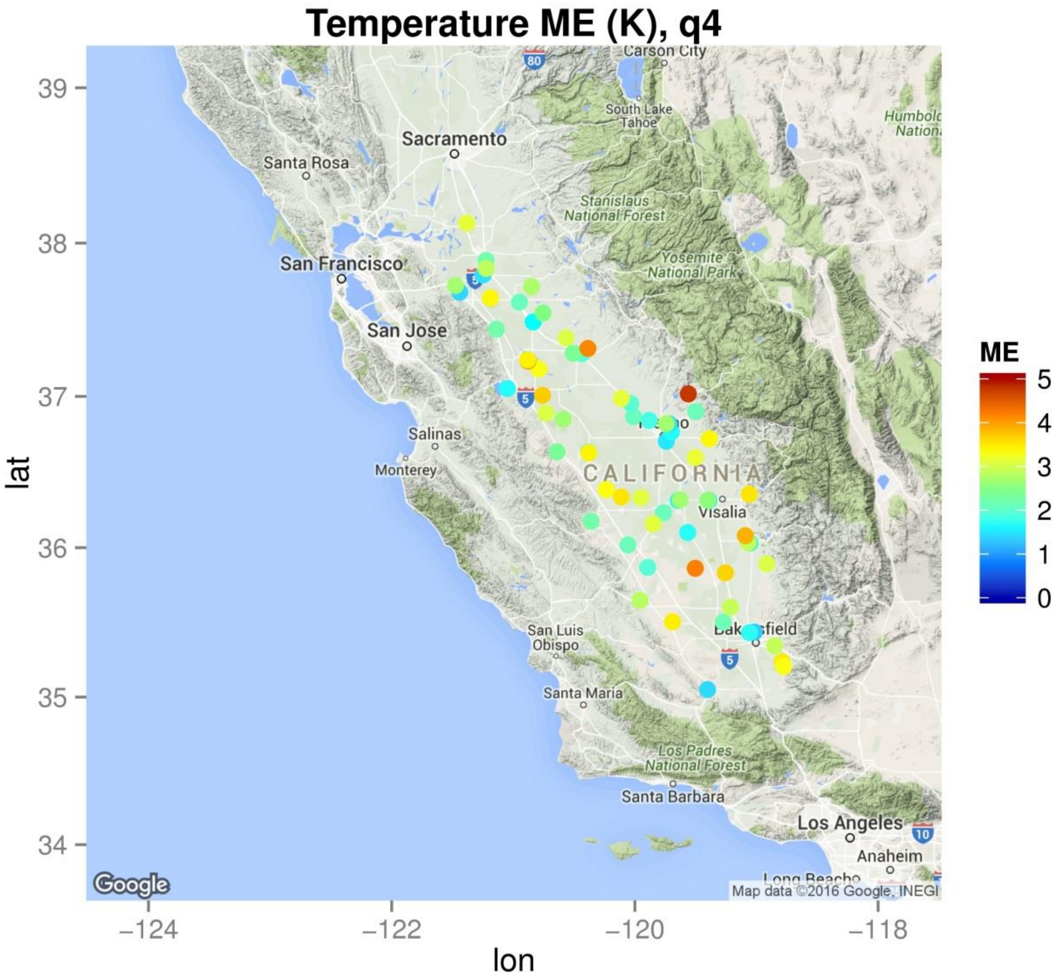

Figure S. 28 Hourly temperature mean error in the fourth quarter of 2013

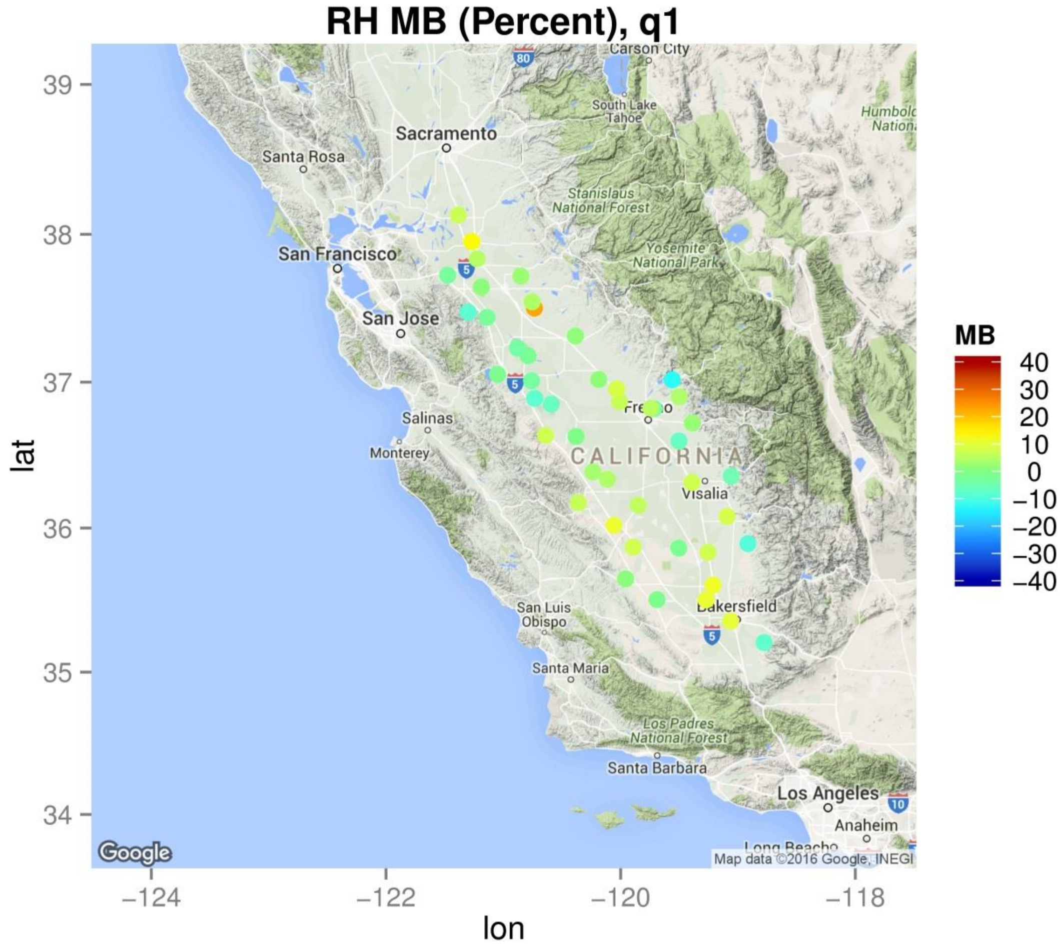

Figure S. 29 Hourly relative humidity mean bias in the first quarter of 2013

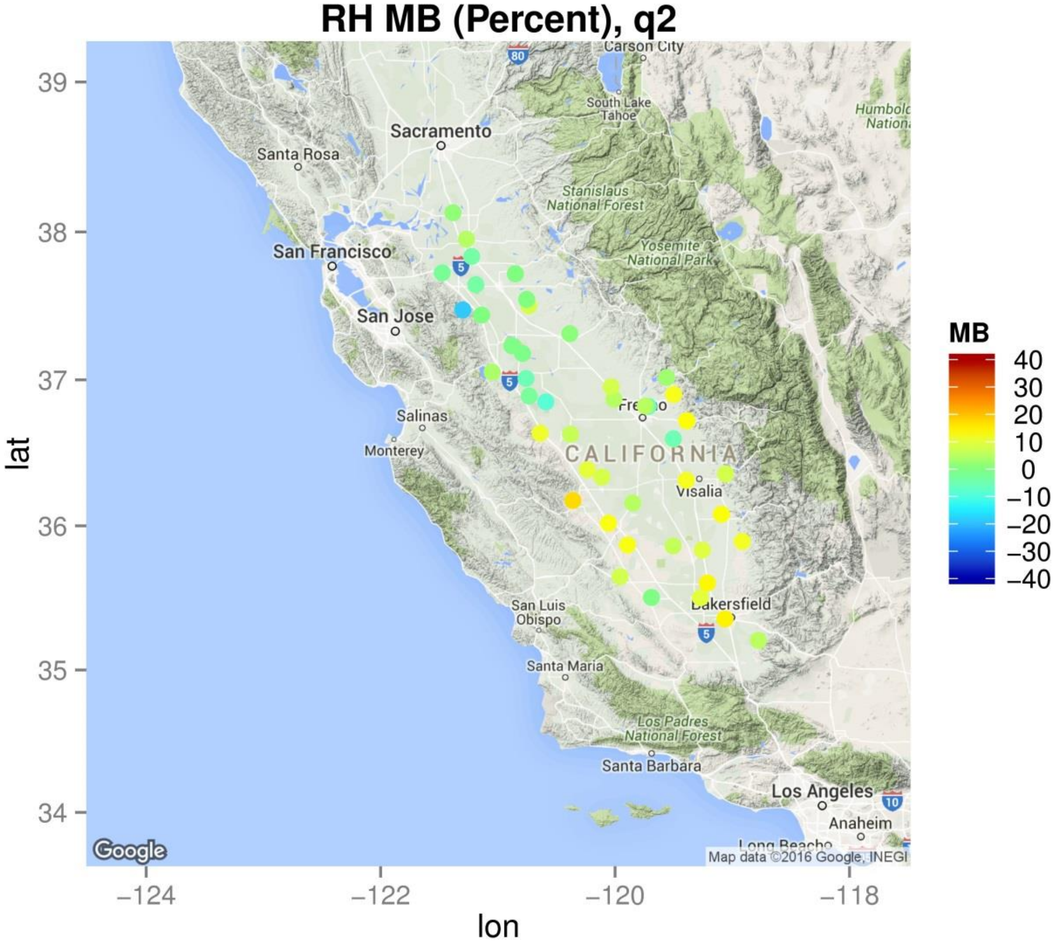

Figure S. 30 Hourly relative humidity mean bias in the second quarter of 2013

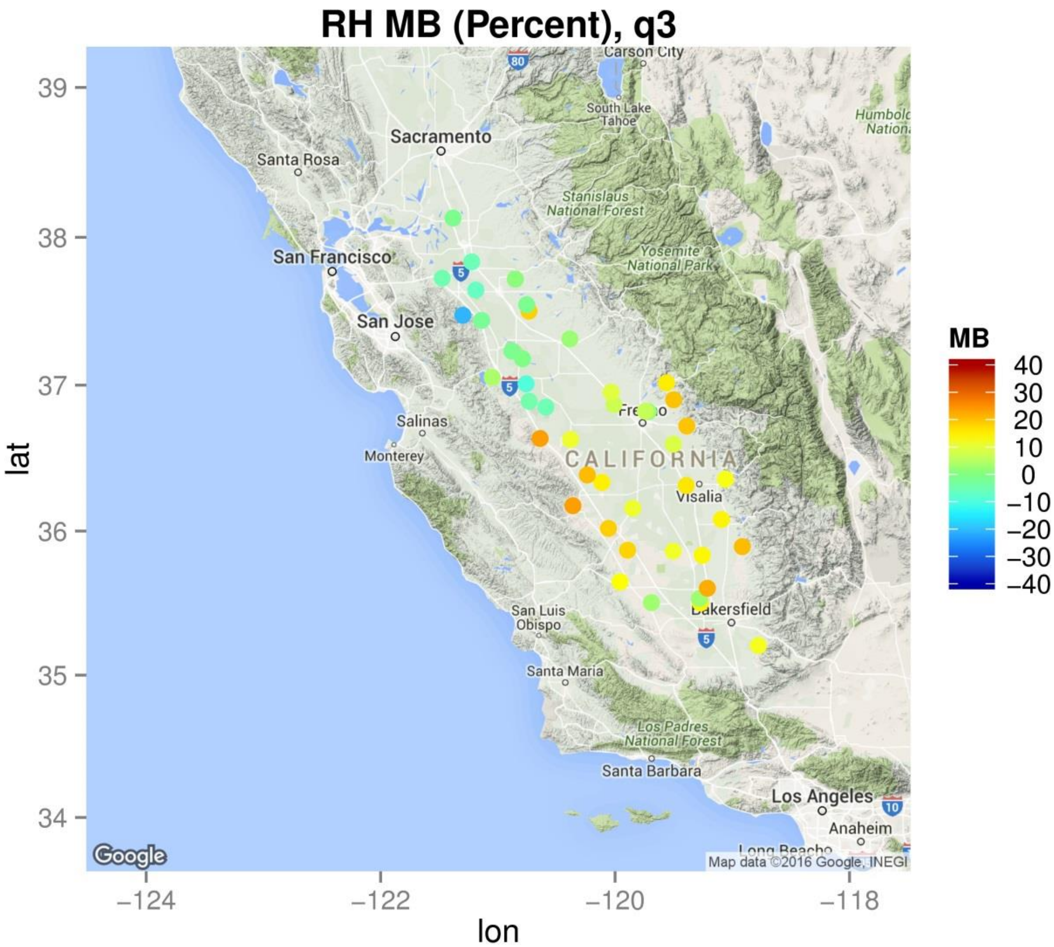

Figure S. 31 Hourly relative humidity mean bias in the third quarter of 2013

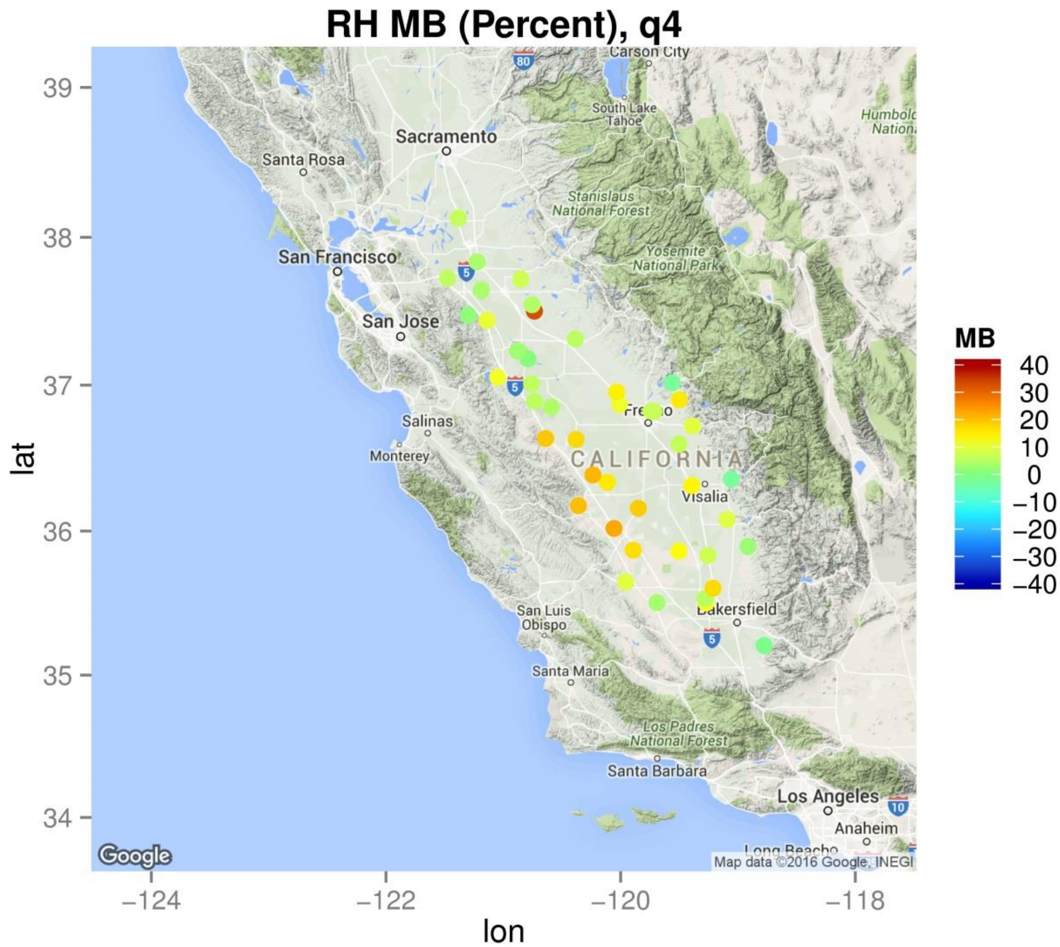

Figure S. 32 Hourly relative humidity mean bias in the fourth quarter of 2013

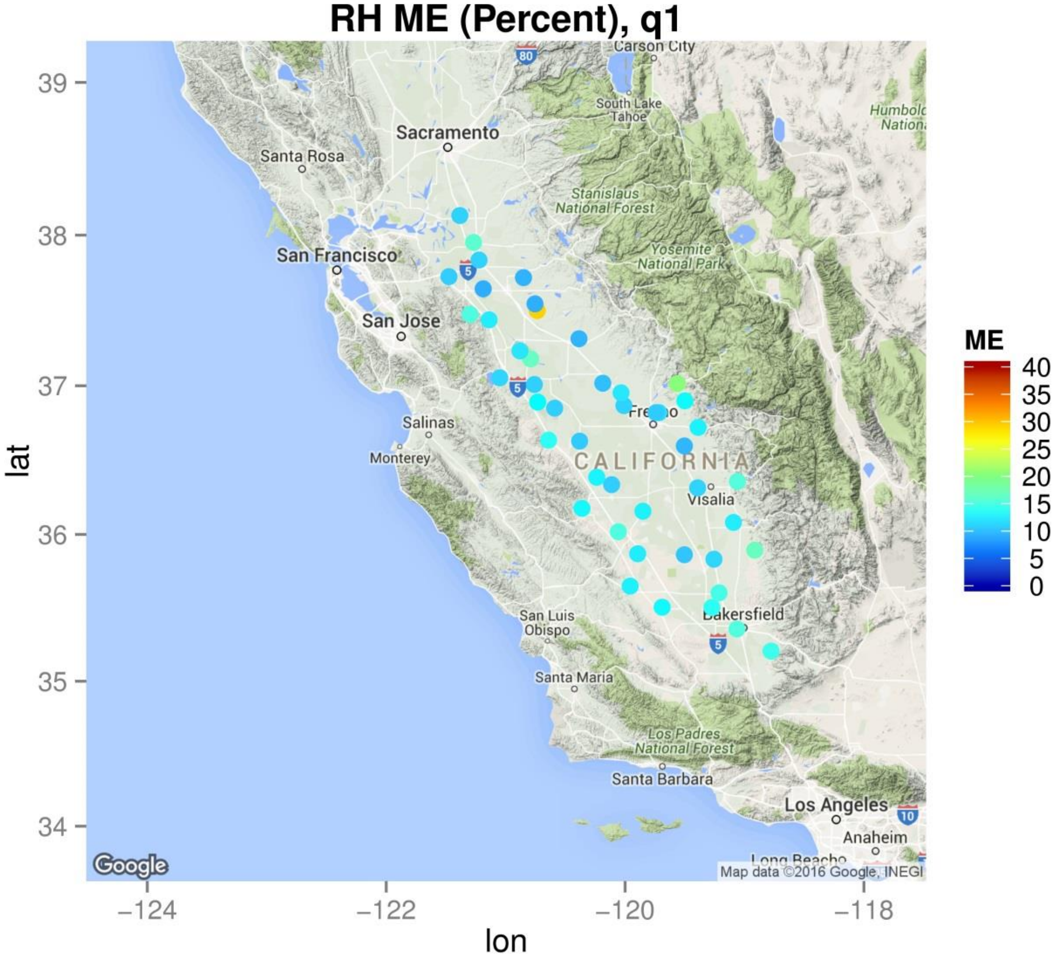

Figure S. 33 Hourly relative humidity mean error in the first quarter of 2013

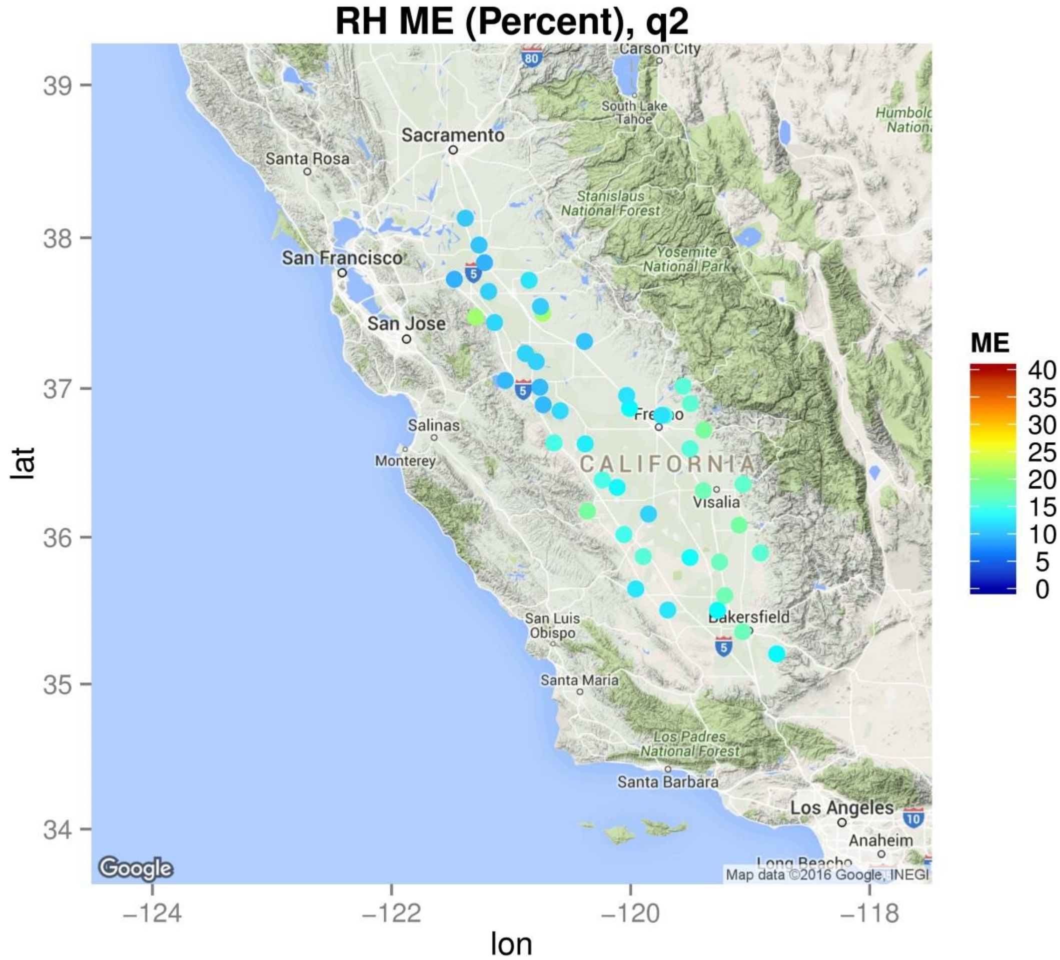

Figure S. 34 Hourly relative humidity mean error in the second quarter of 2013

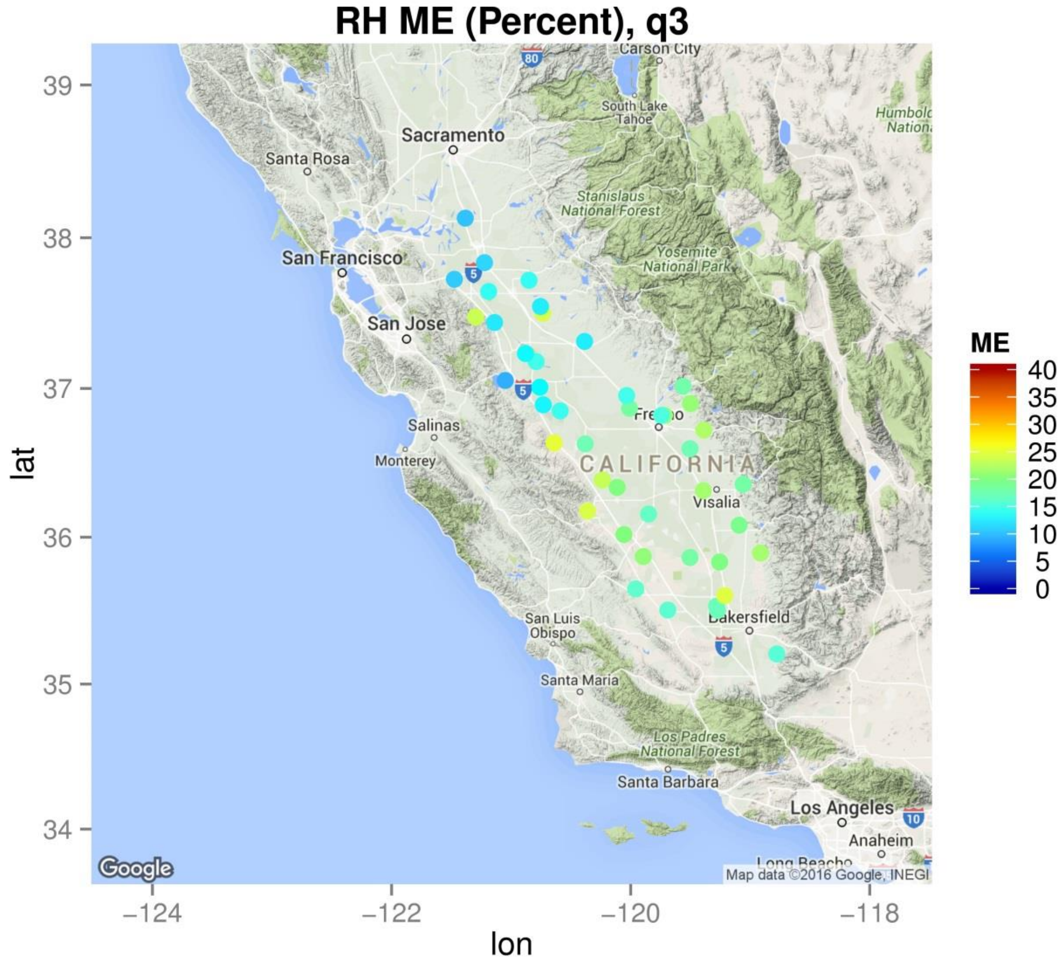

Figure S. 35 Hourly relative humidity mean error in the third quarter of 2013

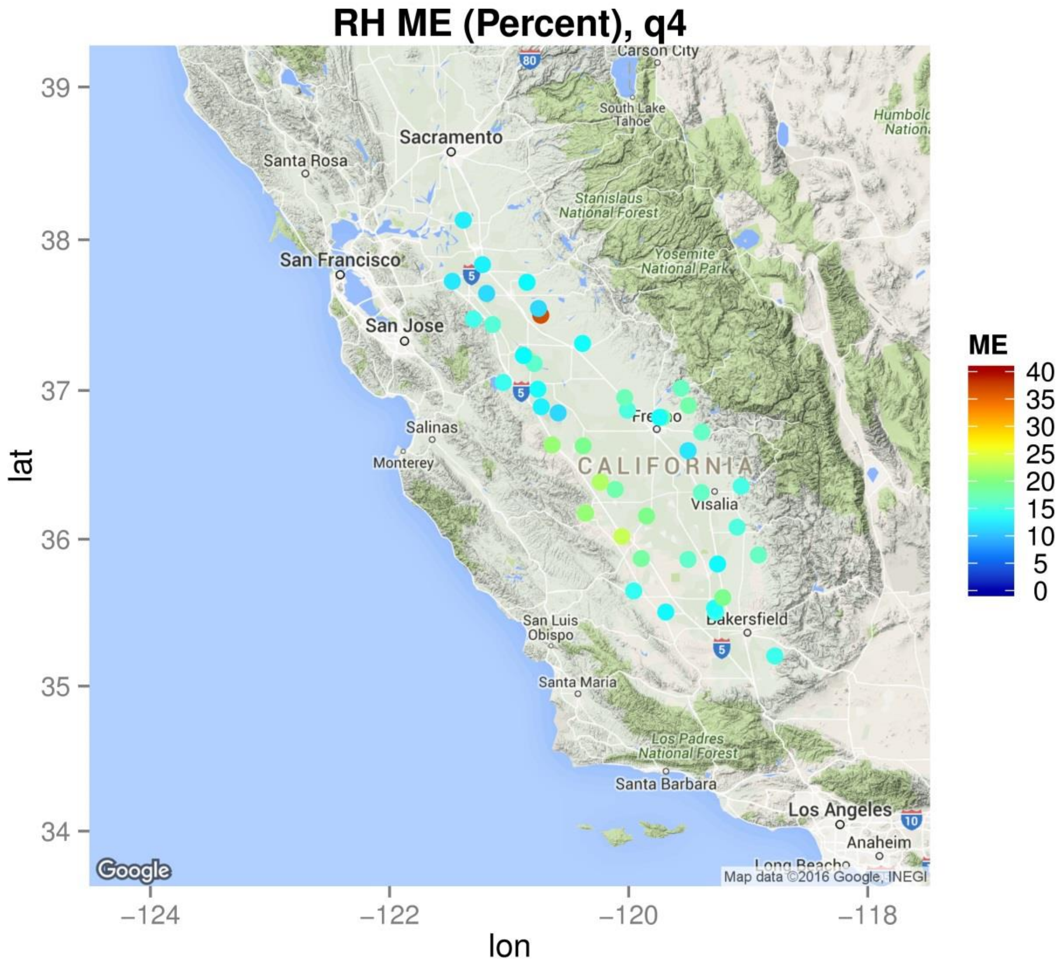

Figure S. 36 Hourly relative humidity mean error in the fourth quarter of 2013

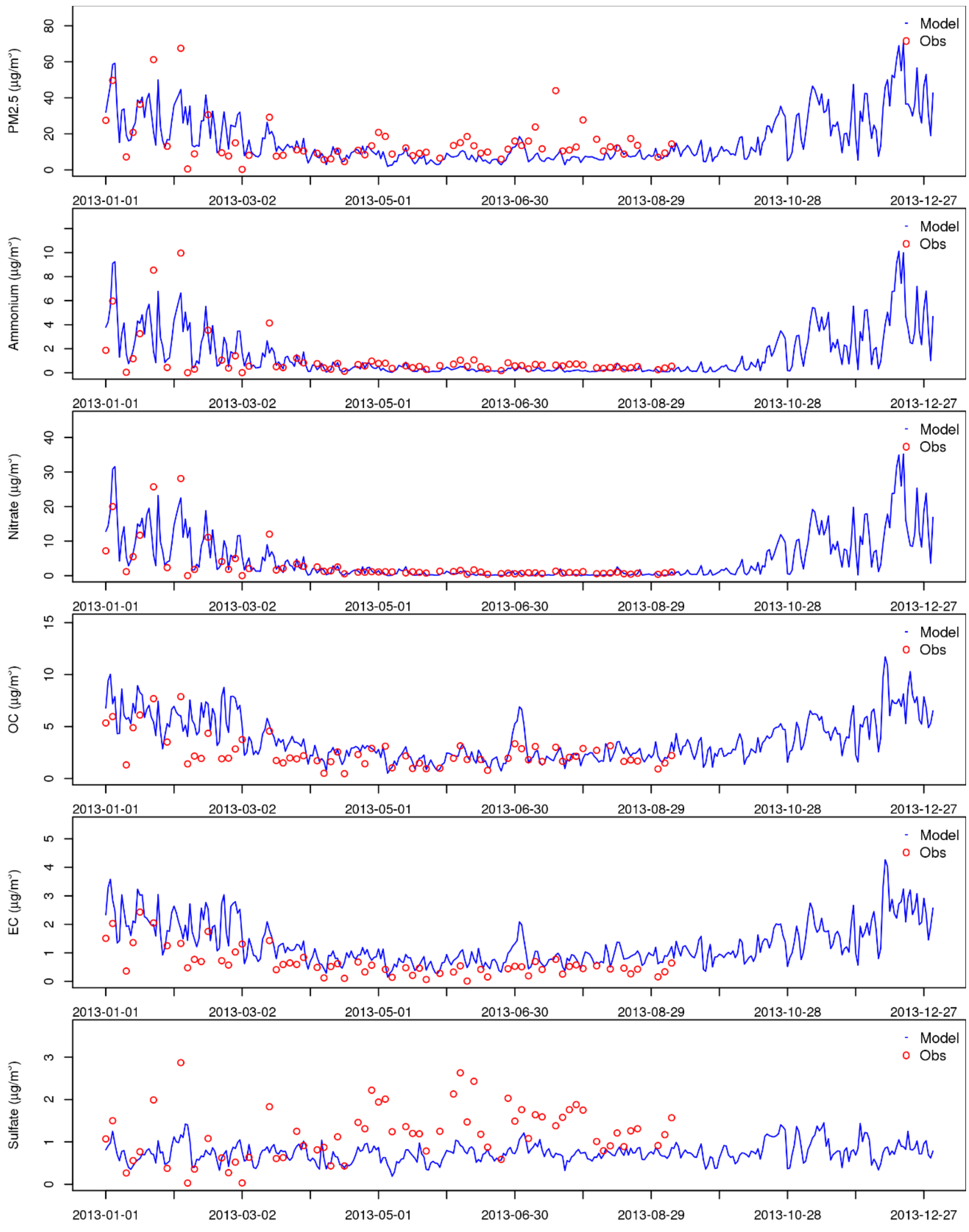

Figure S. 37 Comparison of time series of observed (from CSN measurement) and modeled $PM_{2.5}$ species at Bakersfield

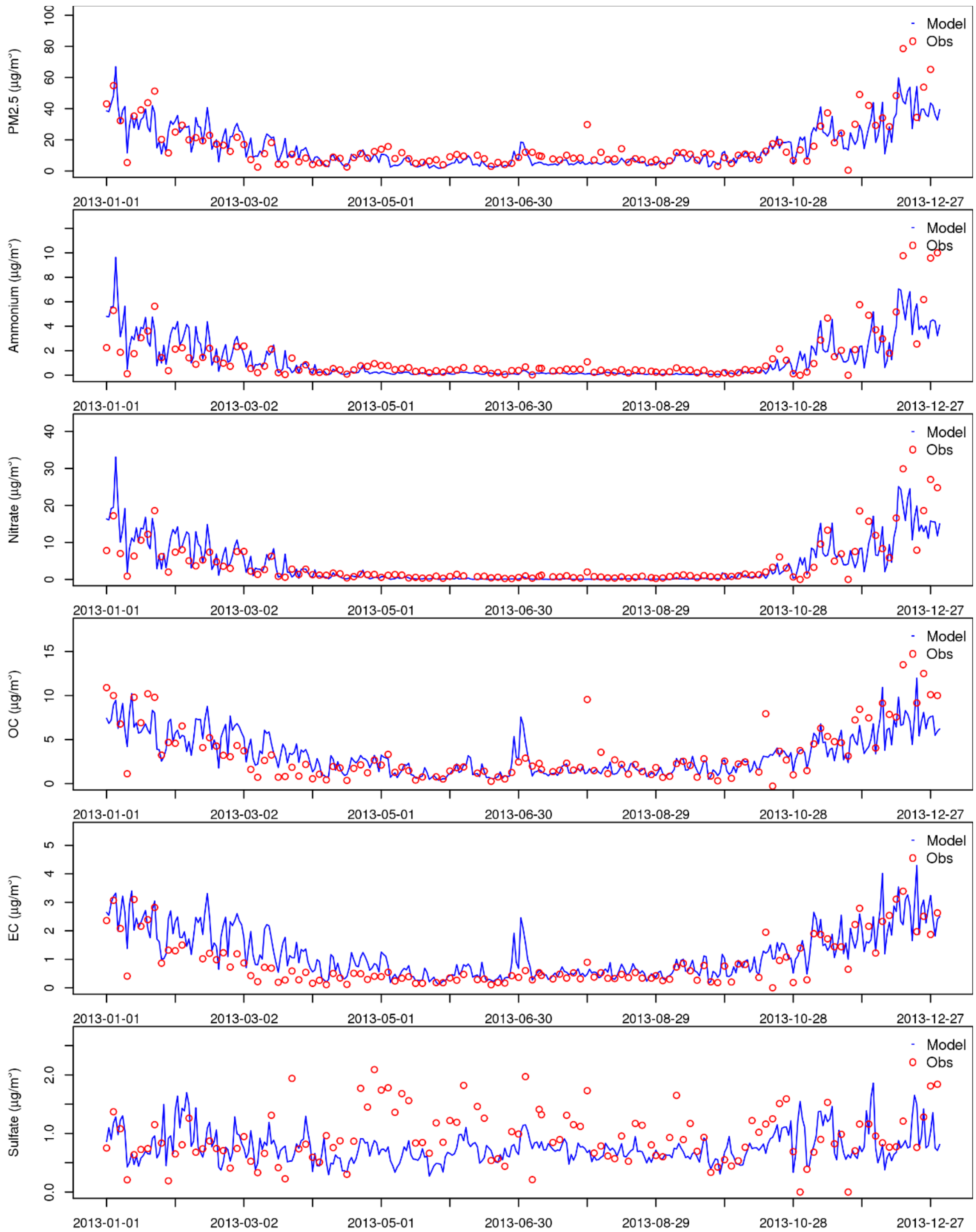

Figure S. 38 Comparison of time series of observed (from CSN measurement) and modeled $PM_{2.5}$ species at Fresno

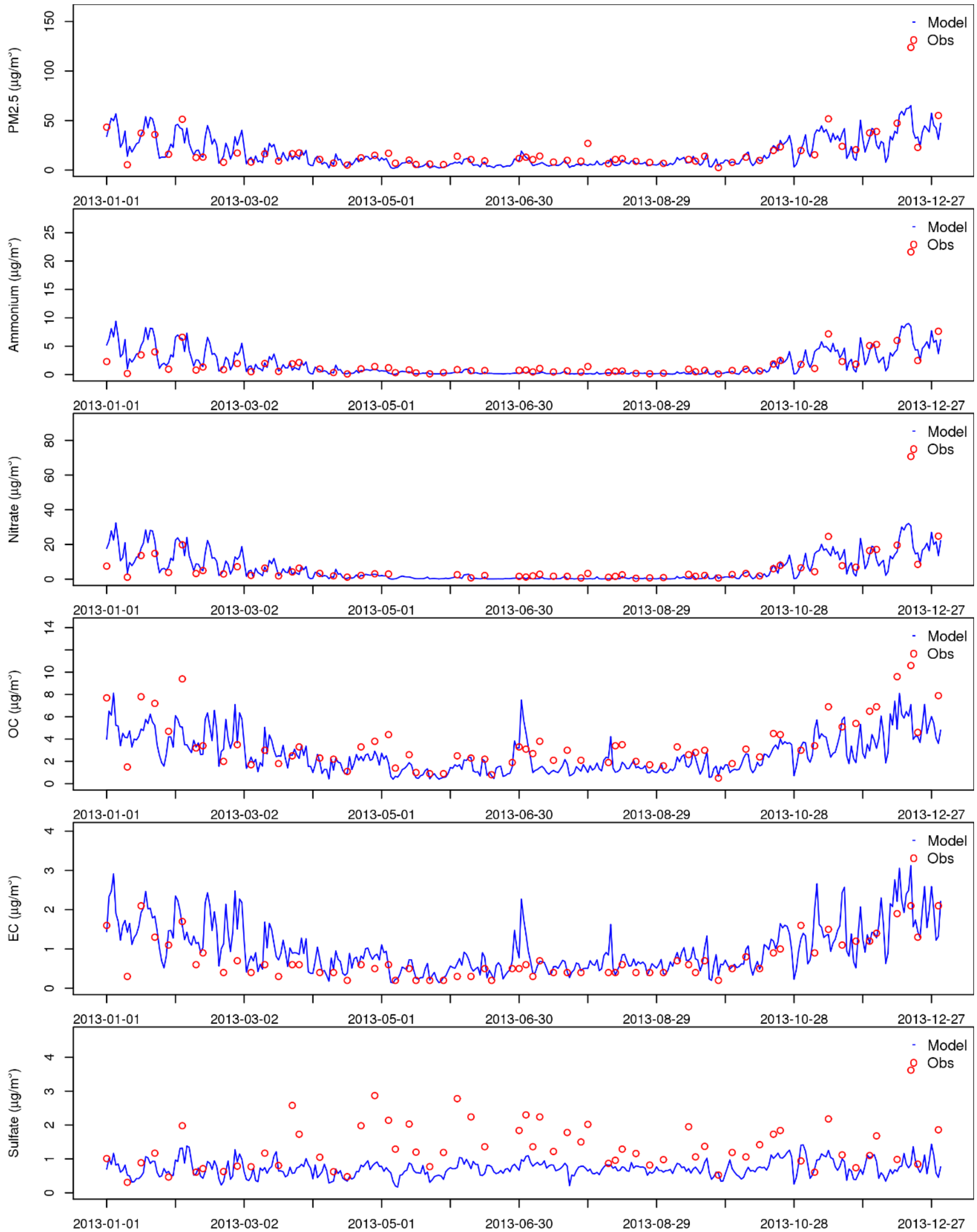

Figure S. 39 Comparison of time series of observed (from CSN measurement) and modeled $PM_{2.5}$ species at Visalia

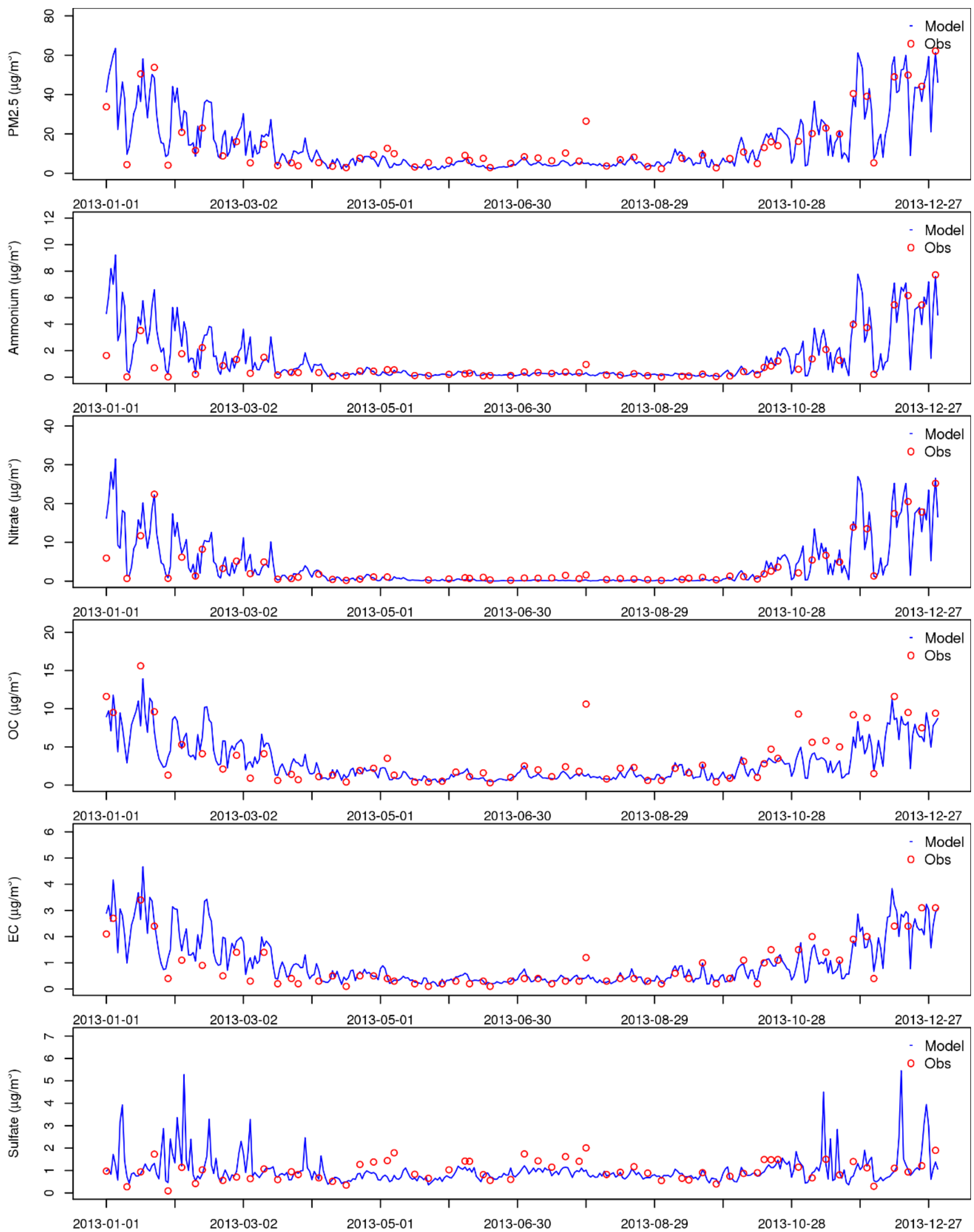

Figure S. 40 Comparison of time series of observed (from CSN measurement) and modeled $PM_{2.5}$ species at Modesto

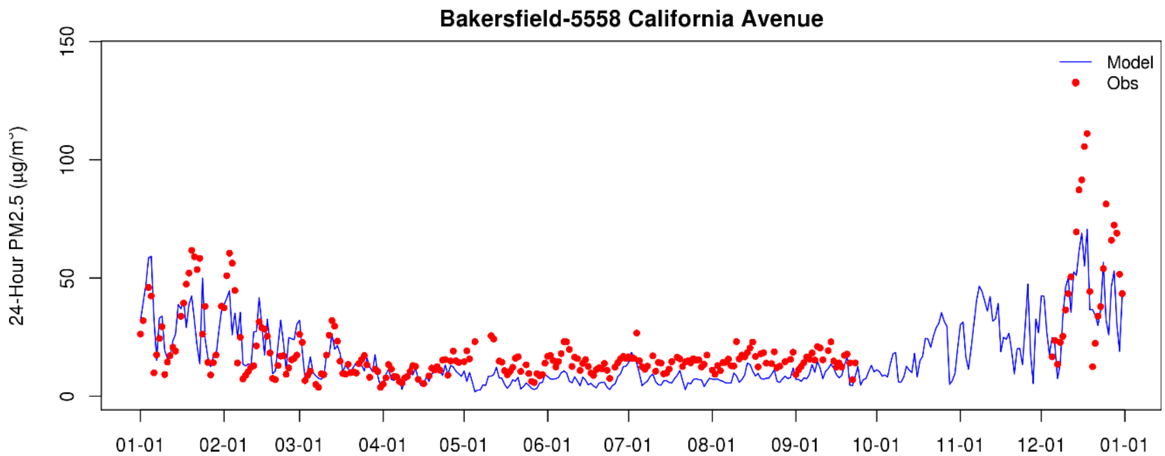

Figure S. 41 Observed and modeled 24-hour average $PM_{2.5}$ at Bakersfield – California Avenue.

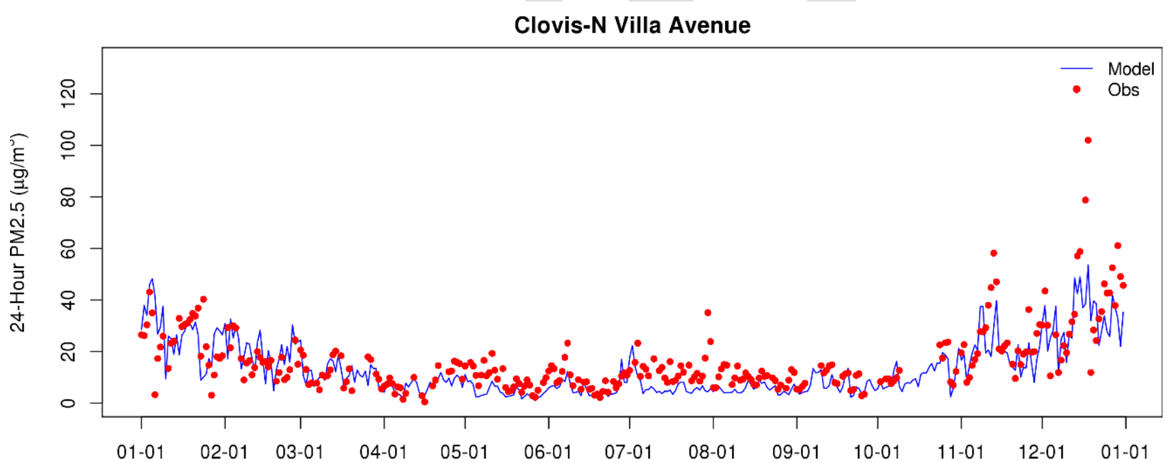

Figure S. 42 Observed and modeled 24-hour average $PM_{2.5}$ at Clovis – Villa Avenue

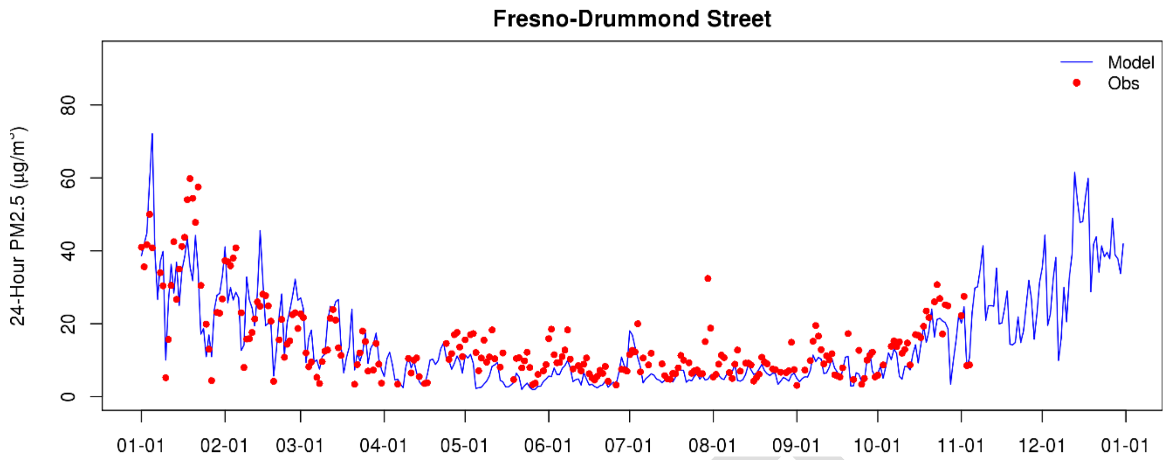

Figure S. 43 Observed and modeled 24-hour average $PM_{2.5}$ at Fresno – Drummond Street

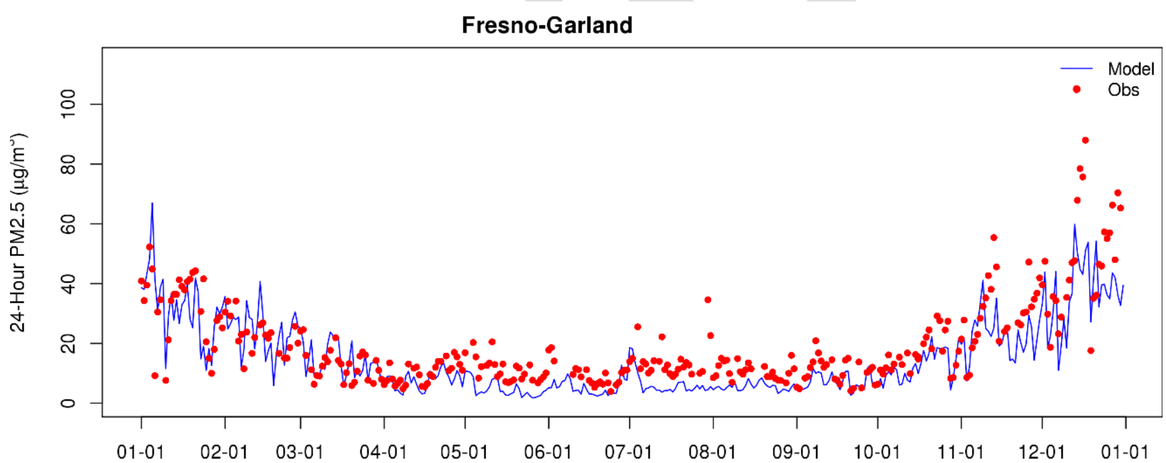

Figure S. 44 Observed and modeled 24-hour average $PM_{2.5}$ at Fresno – Garland

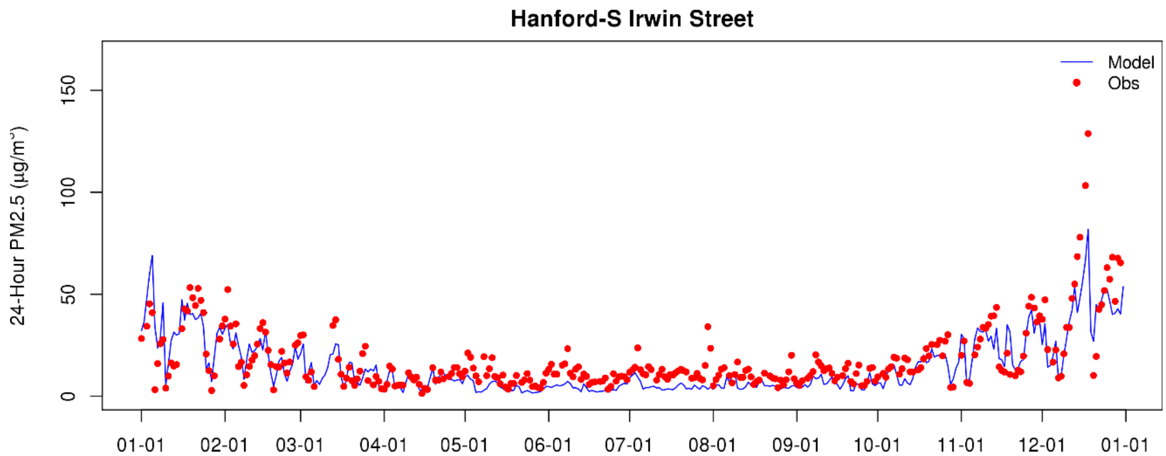

Figure S. 45 Observed and modeled 24-hour average $PM_{2.5}$ at Hanford – Irwin Street

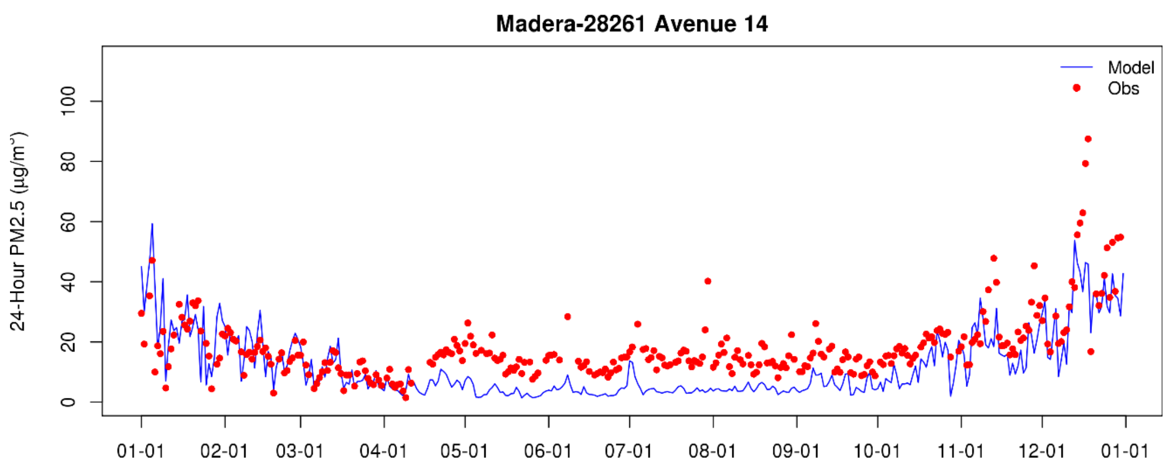

Figure S. 46 Observed and modeled 24-hour average $PM_{2.5}$ at Madera – Avenue 14

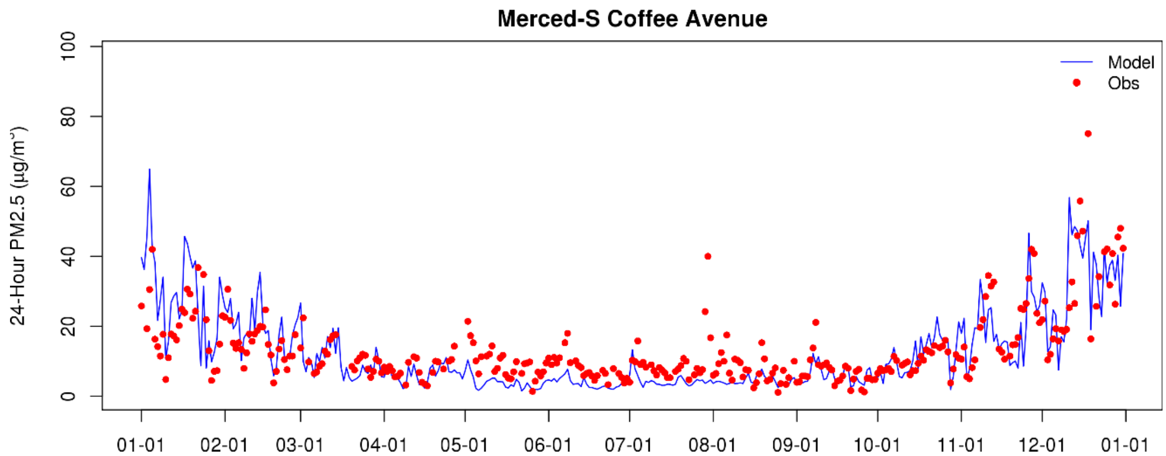

Figure S. 47 Observed and modeled 24-hour average $PM_{2.5}$ at Merced – S Coffee Avenue

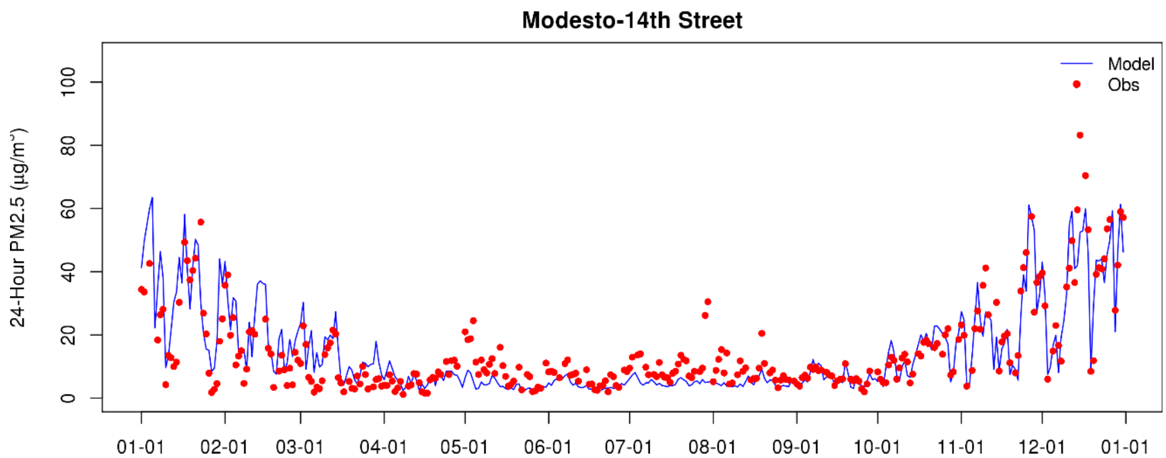

Figure S. 48 Observed and modeled 24-hour average $PM_{2.5}$ at Modesto – 14th Street

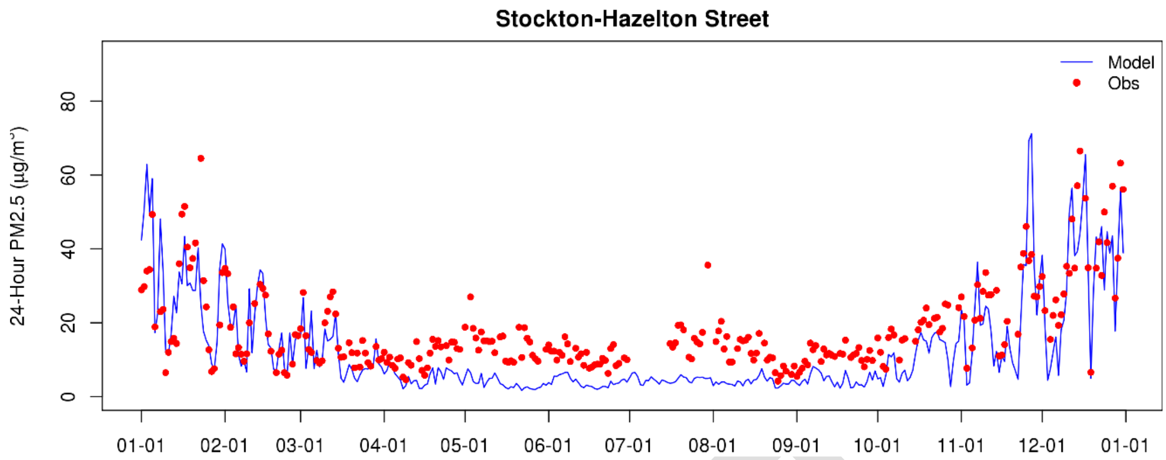

Figure S. 49 Observed and modeled 24-hour average $PM_{2.5}$ at Stockton – Hazelton Street

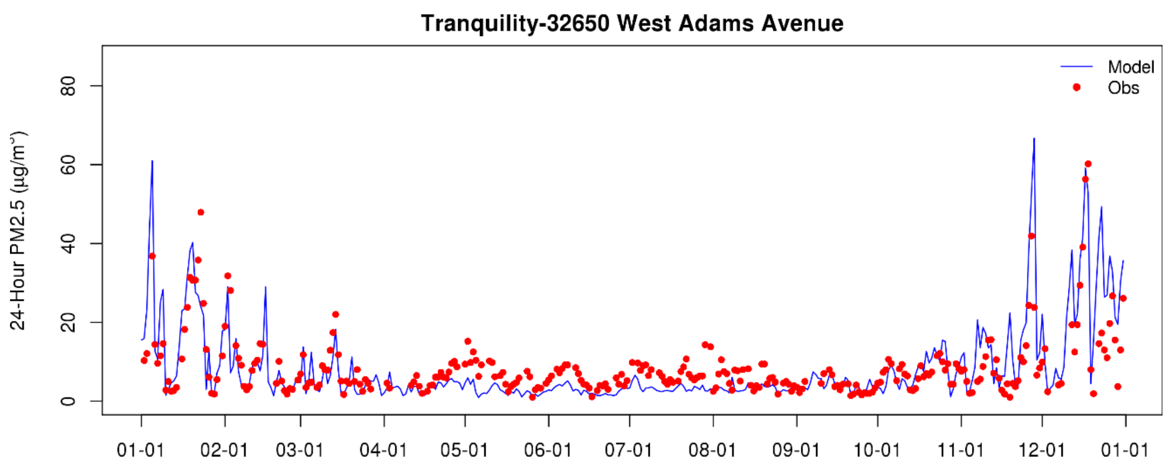

Figure S. 50 Observed and modeled 24-hour average $PM_{2.5}$ at Tranquility – West Adams Avenue

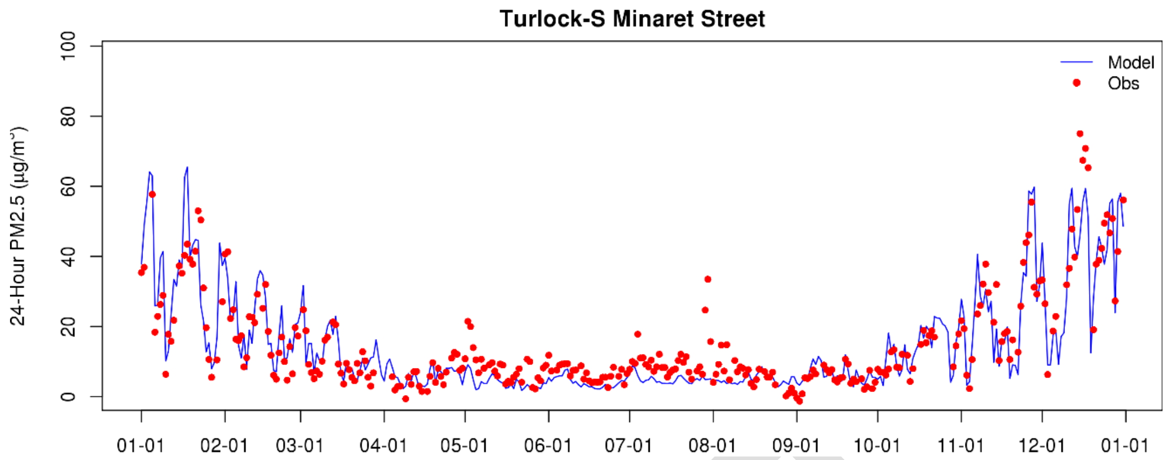

Figure S. 51 Observed and modeled 24-hour average $PM_{2.5}$ at Turlock – Minaret Street

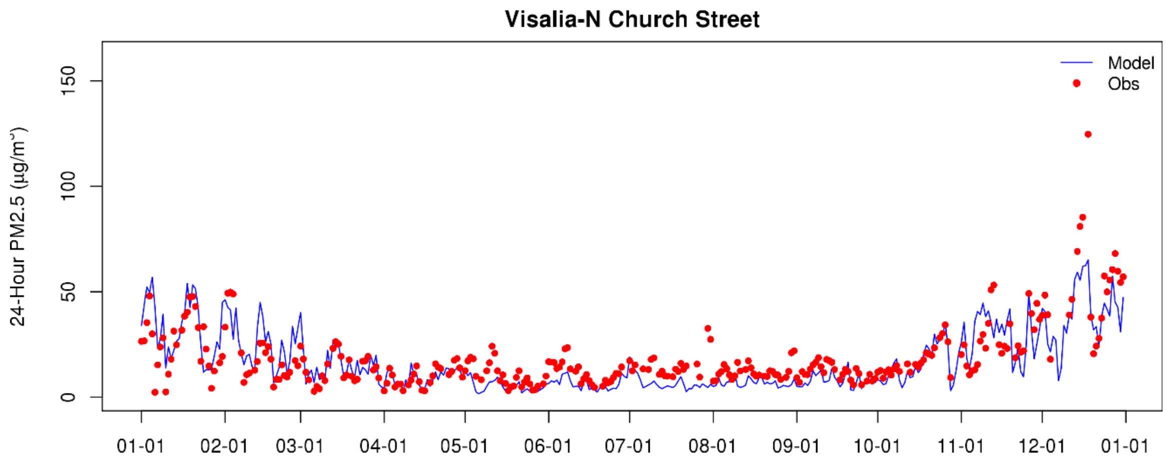

Figure S. 52 Observed and modeled 24-hour average $PM_{2.5}$ at Visalia – Church Street

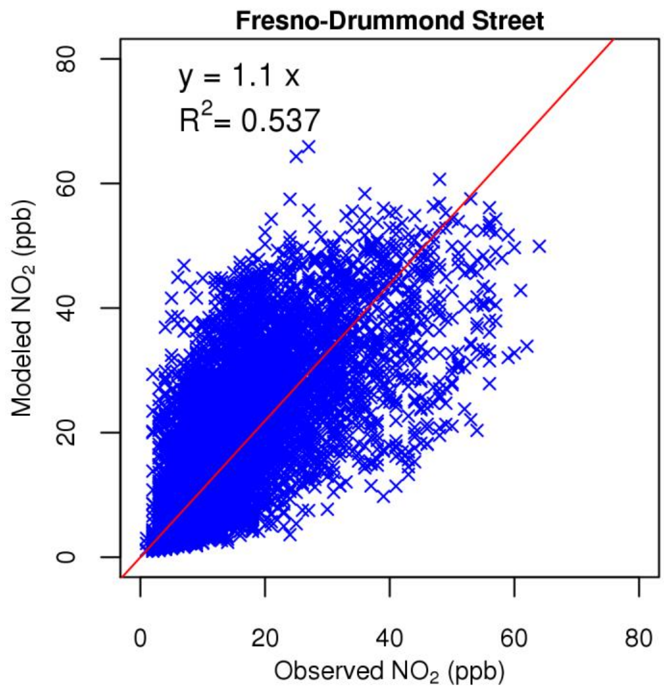

Figure S. 53 Scattering plot of observed and modeled 1-hour NO_2 mixing ratio at Fresno – Drummond Street

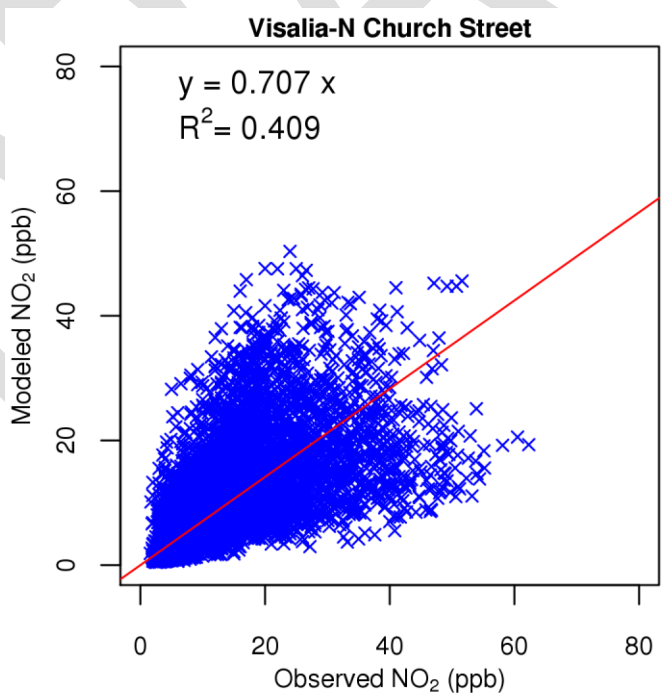

Figure S. 54 Scattering plot of observed and modeled 1-hour NO_2 mixing ratio at Visalia

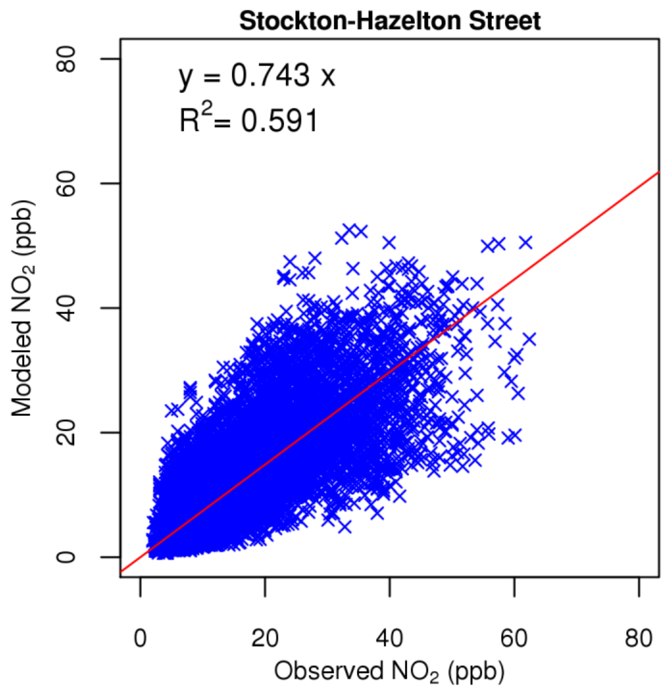

Figure S. 55 Scattering plot of observed and modeled 1-hour NO_2 mixing ratio at Stockton

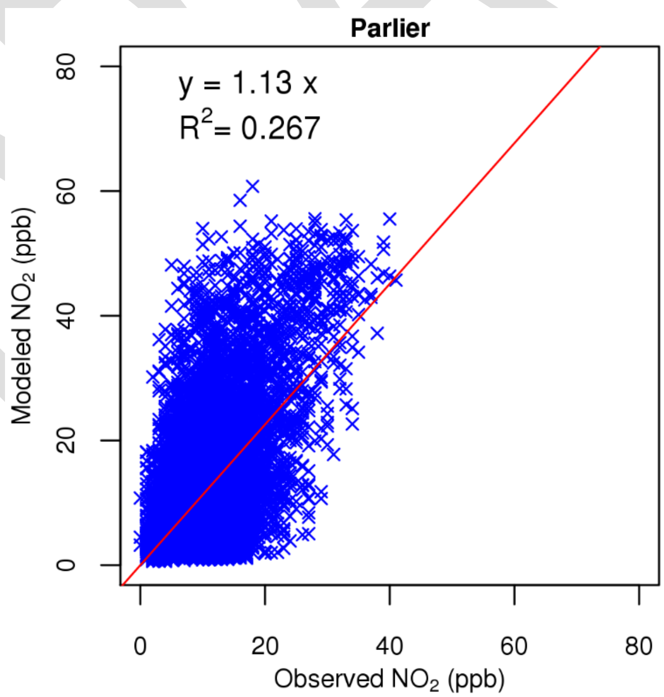

Figure S. 56 Scattering plot of observed and modeled 1-hour NO_2 mixing ratio at Parlier

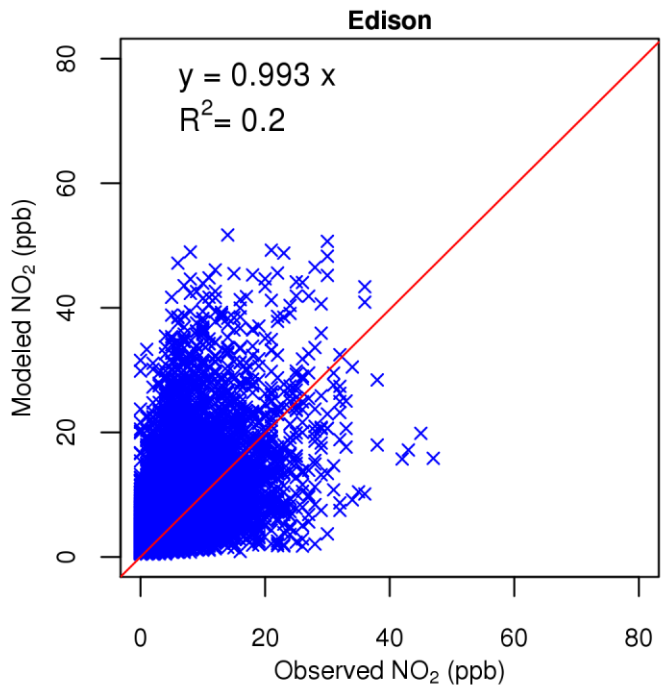

Figure S. 57 Scattering plot of observed and modeled 1-hour NO_2 mixing ratio at Edison

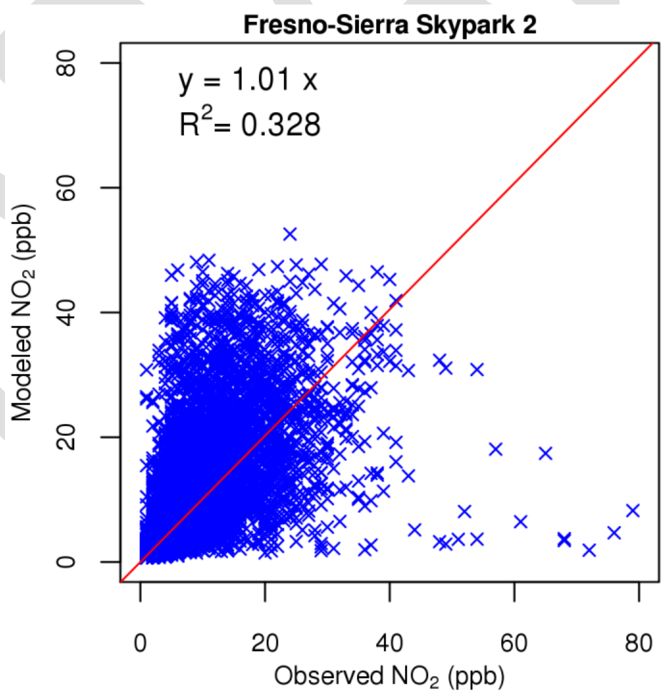

Figure S. 58 Scattering plot of observed and modeled 1-hour NO_2 mixing ratio at Fresno – Sierra Sky Park

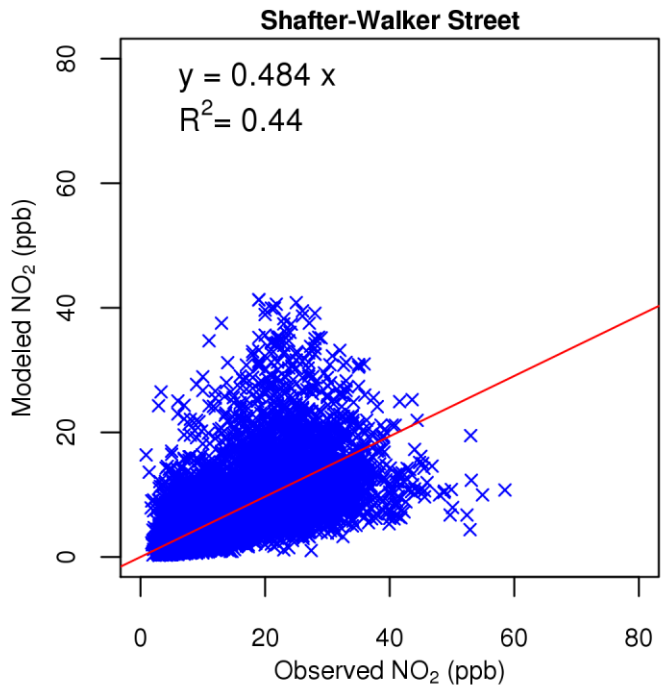

Figure S. 59 Scattering plot of observed and modeled 1-hour NO_2 mixing ratio at Shafter

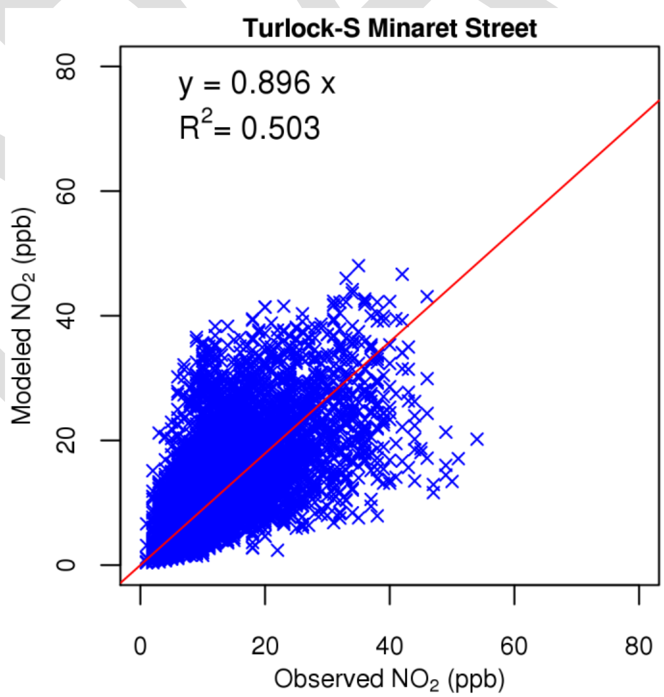

Figure S. 60 Scattering plot of observed and modeled 1-hour NO_2 mixing ratio at Turlock

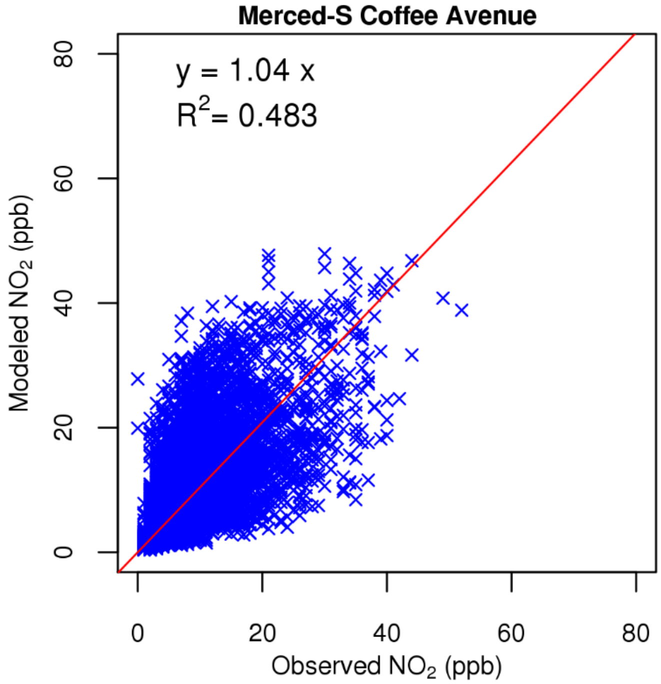

Figure S. 61 Scattering plot of observed and modeled 1-hour NO_2 mixing ratio at Merced

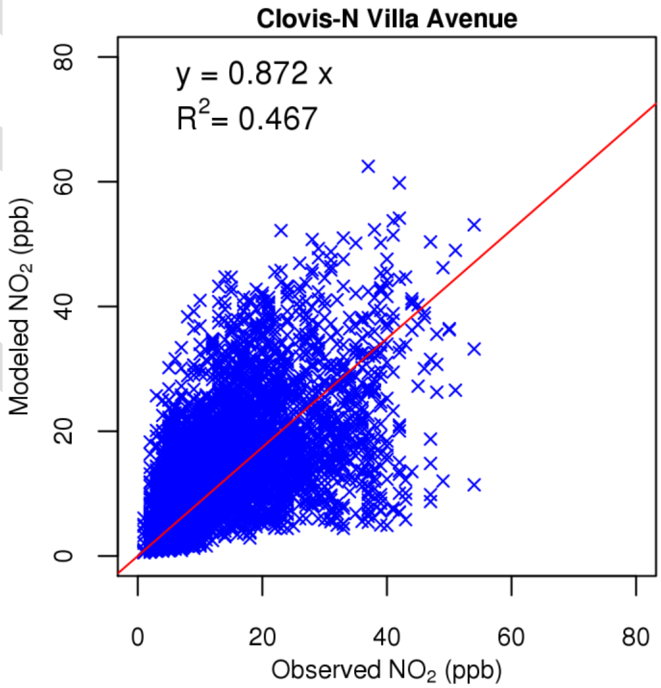

Figure S. 62 Scattering plot of observed and modeled 1-hour NO_2 mixing ratio at Clovis

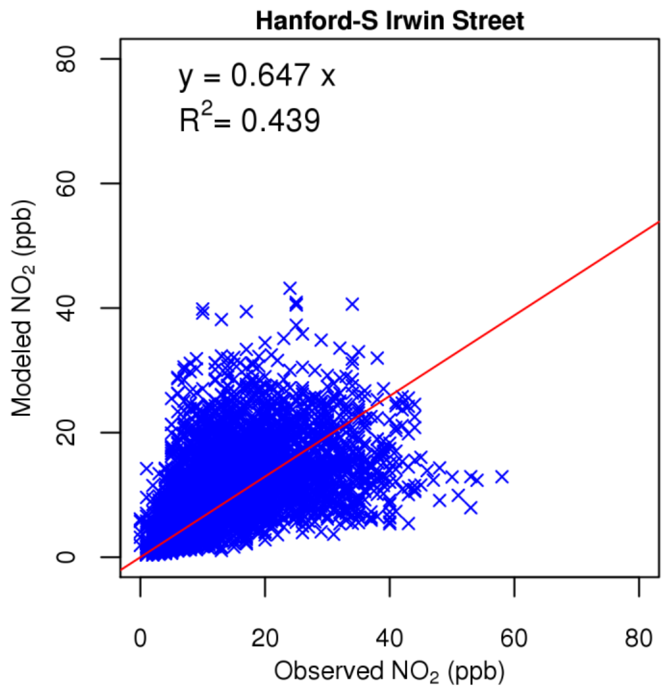

Figure S. 63 Scattering plot of observed and modeled 1-hour NO_2 mixing ratio at Hanford

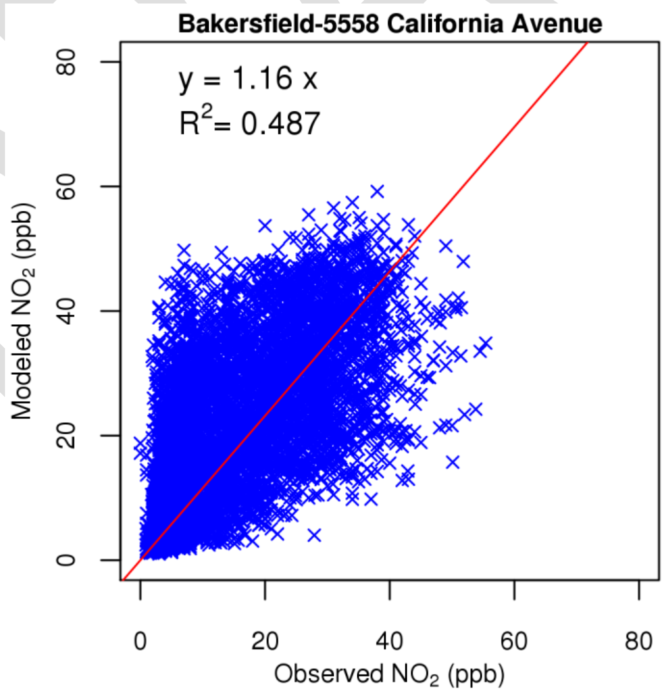

Figure S. 64 Scattering plot of observed and modeled 1-hour NO_2 mixing ratio at Bakersfield – California Avenue

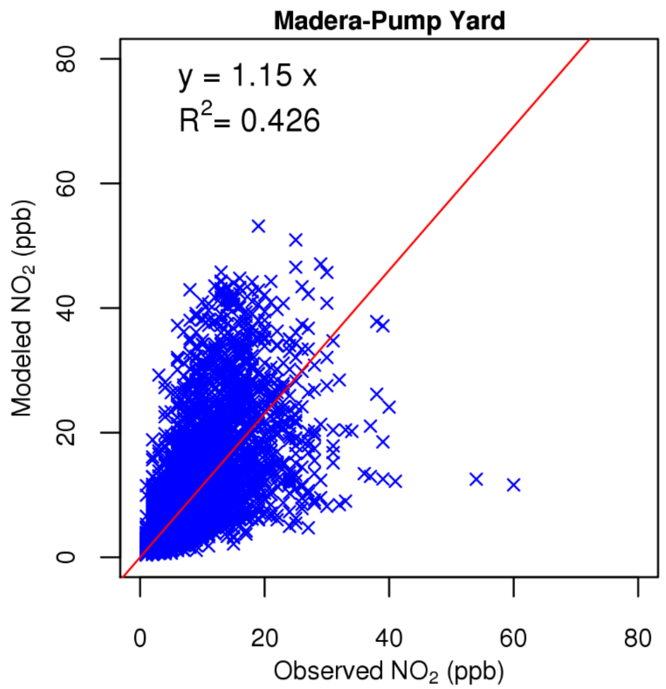

Figure S. 65 Scattering plot of observed and modeled 1-hour NO_2 mixing ratio at Madera

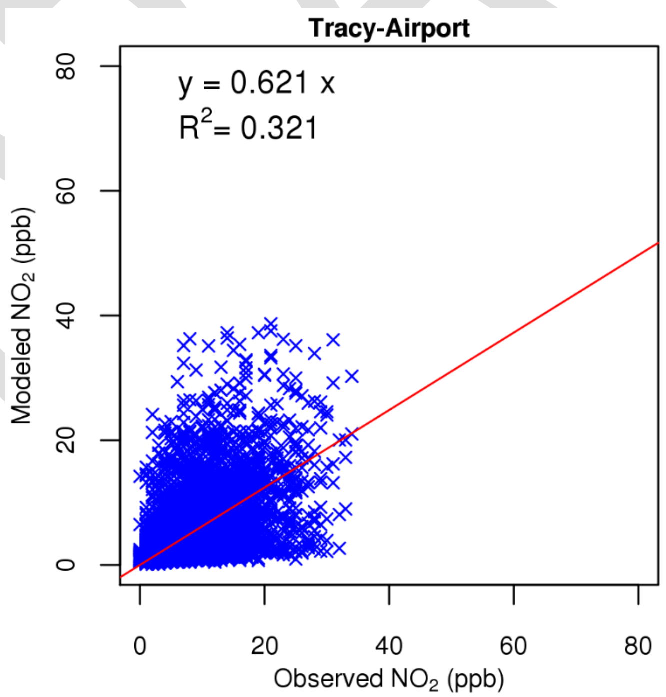

Figure S. 66 Scattering plot of observed and modeled 1-hour NO_2 mixing ratio at Tracy

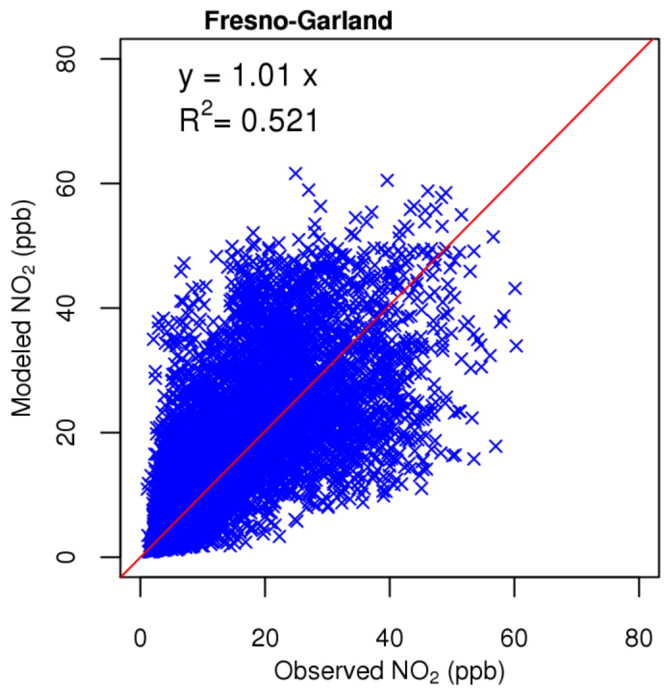

Figure S. 67 Scattering plot of observed and modeled 1-hour NO_2 mixing ratio at Fresno – Garland

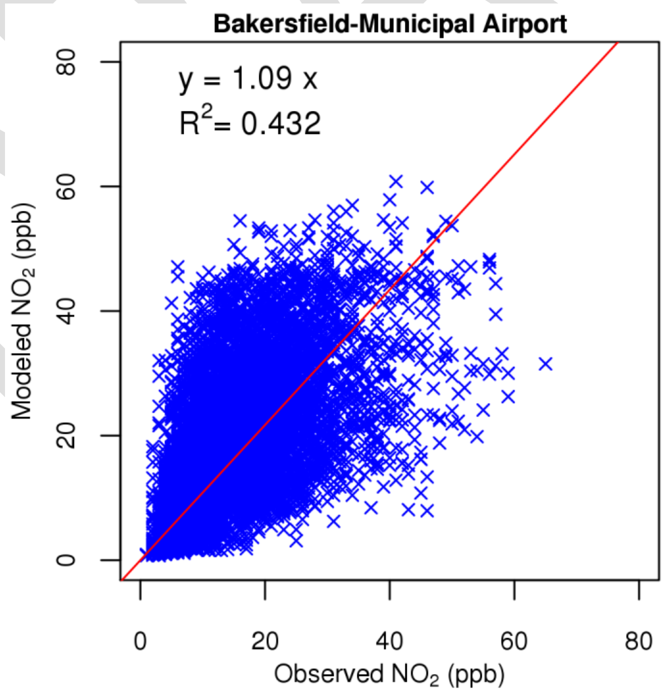

Figure S. 68 Scattering plot of observed and modeled 1-hour NO_2 mixing ratio at Bakersfield – Municipal Airport

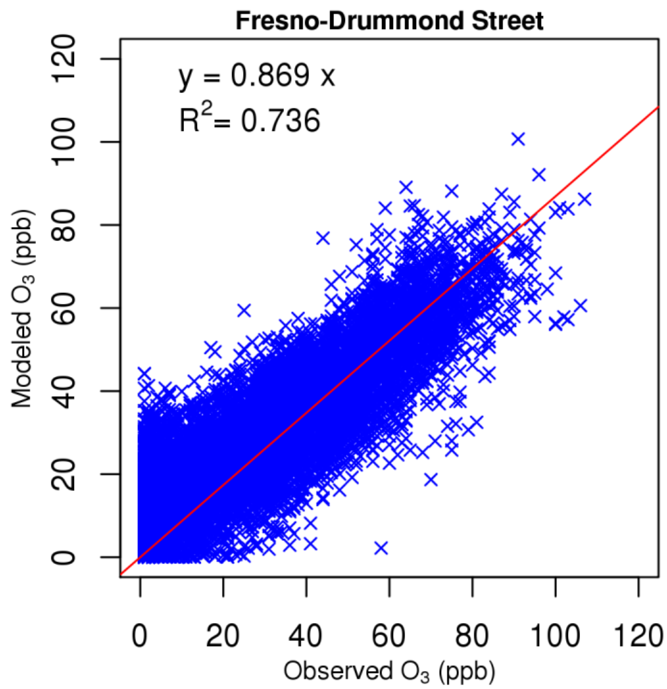

Figure S. 69 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Fresno – Drummond Street

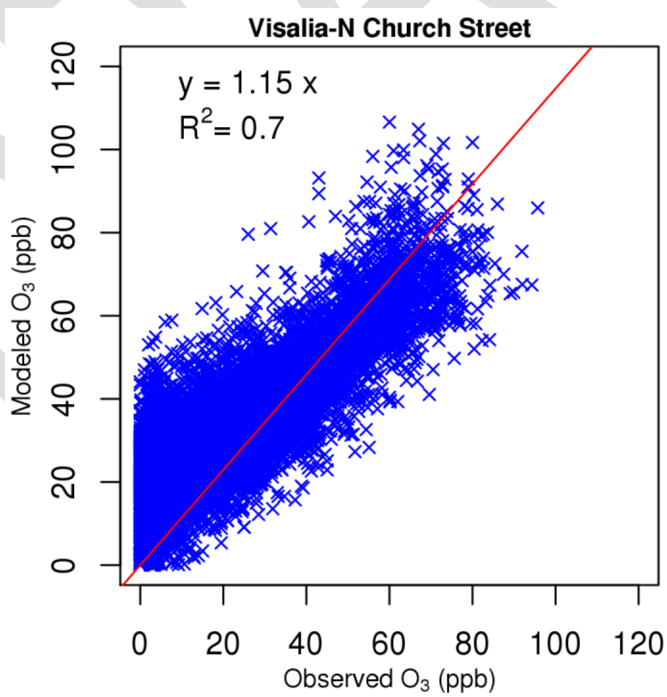

Figure S.70 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Visalia

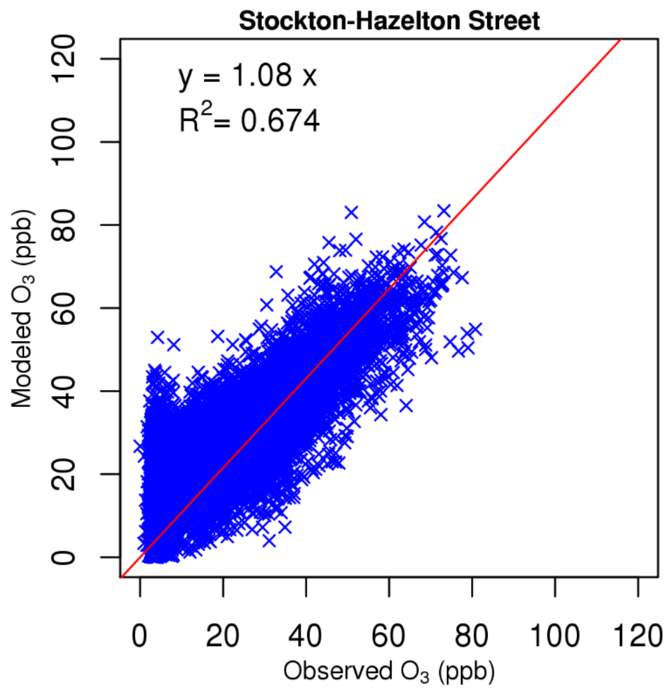

Figure S. 71 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Stockton

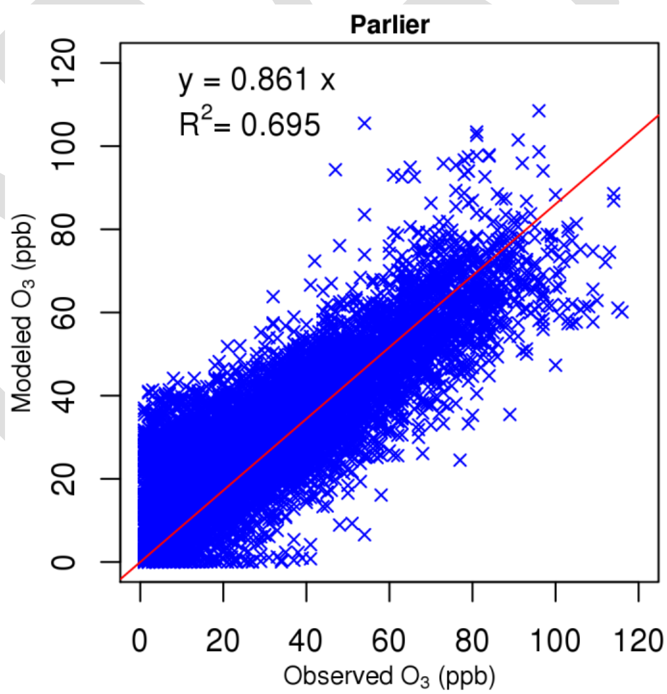

Figure S. 72 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Parlier

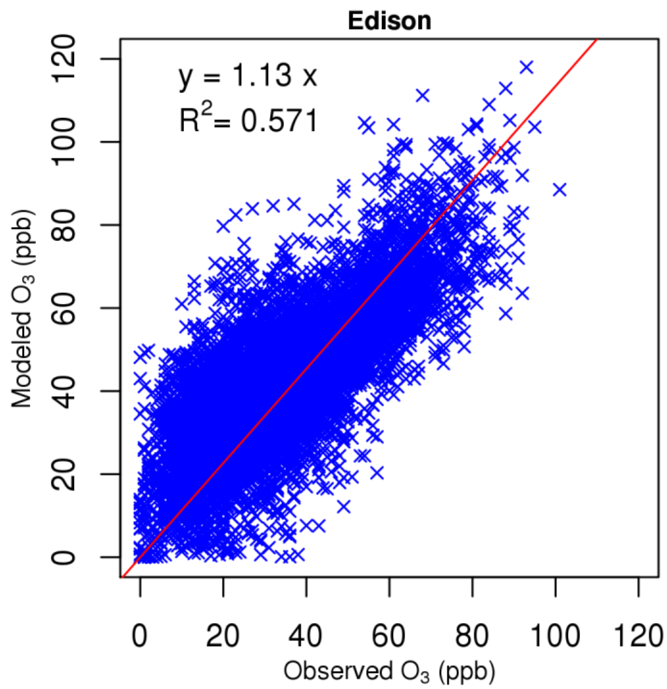

Figure S. 73 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Edison

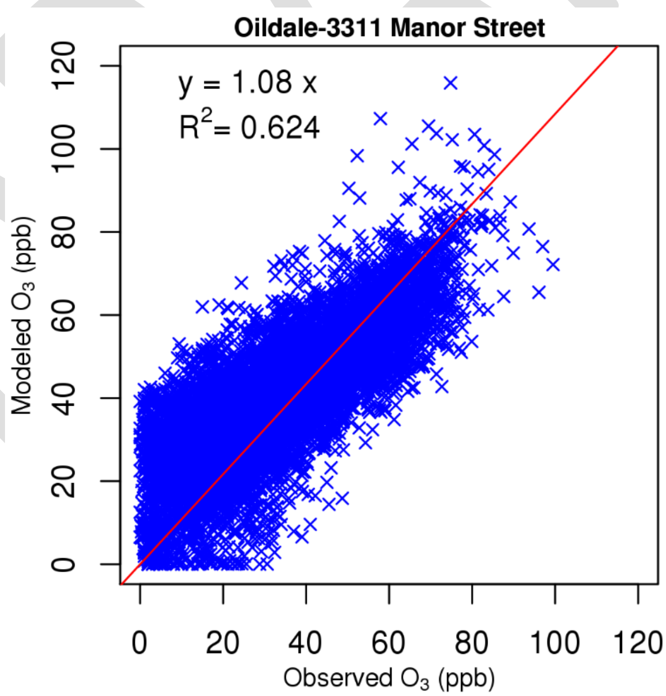

Figure S. 74 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Oildale

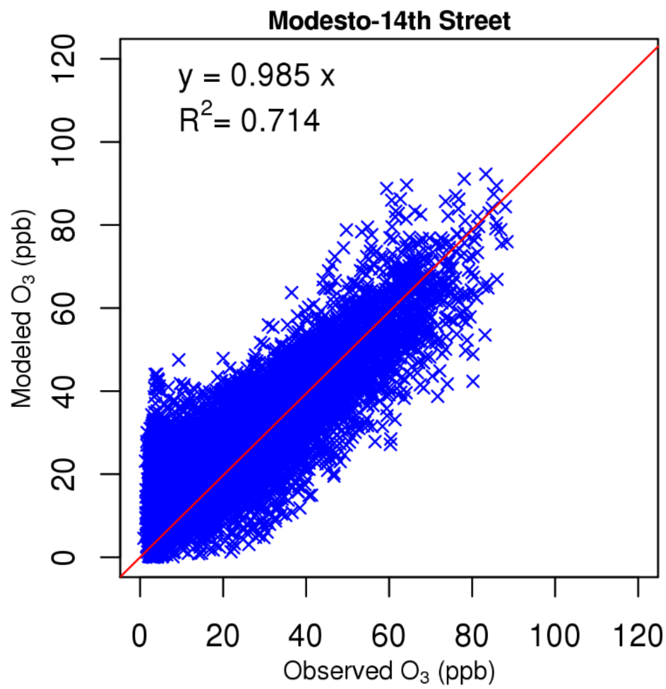

Figure S. 75 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Modesto -14th Street

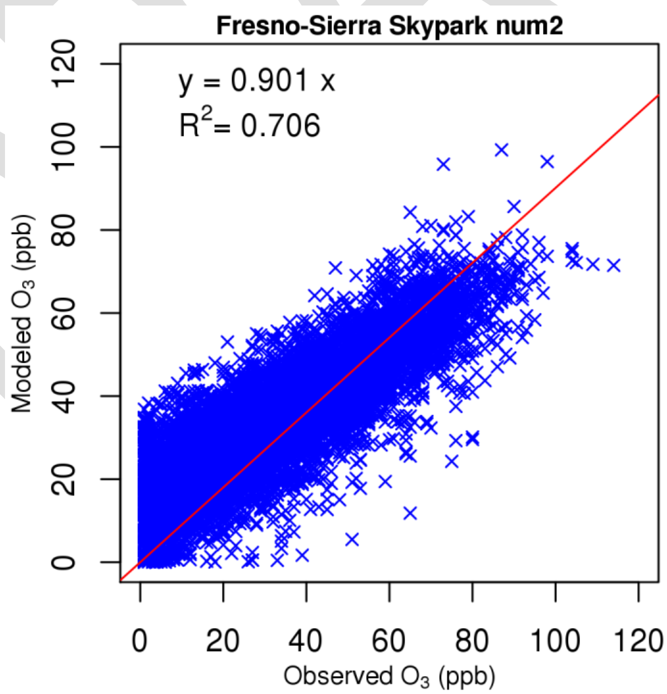

Figure S.76 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Fresno – Sierra Sky Park #2

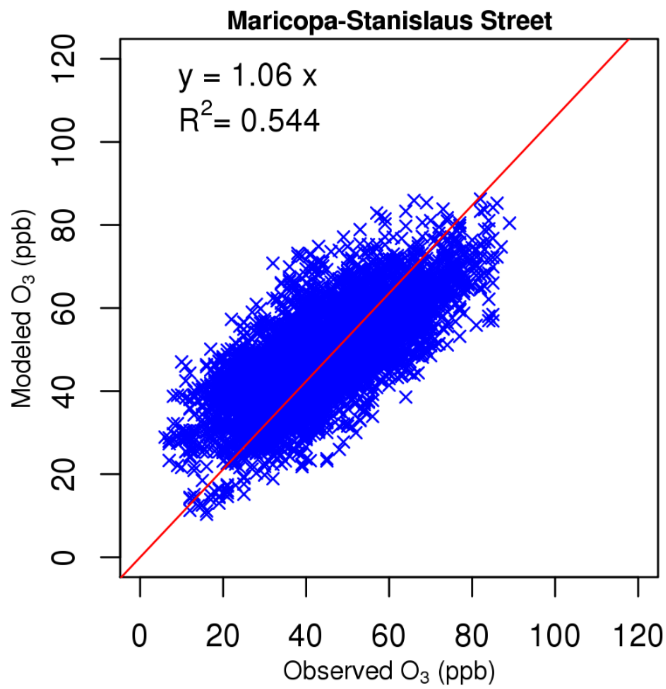

Figure S. 77 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Maricopa

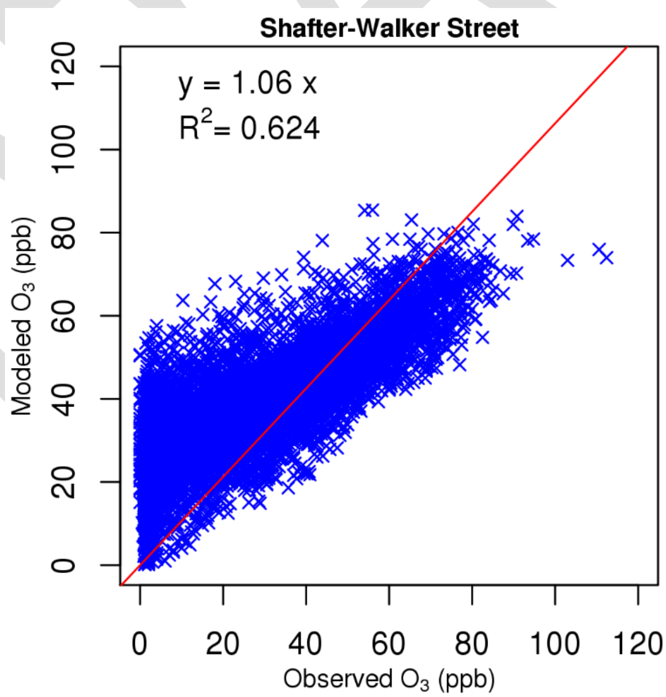

Figure S. 78 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Shafter

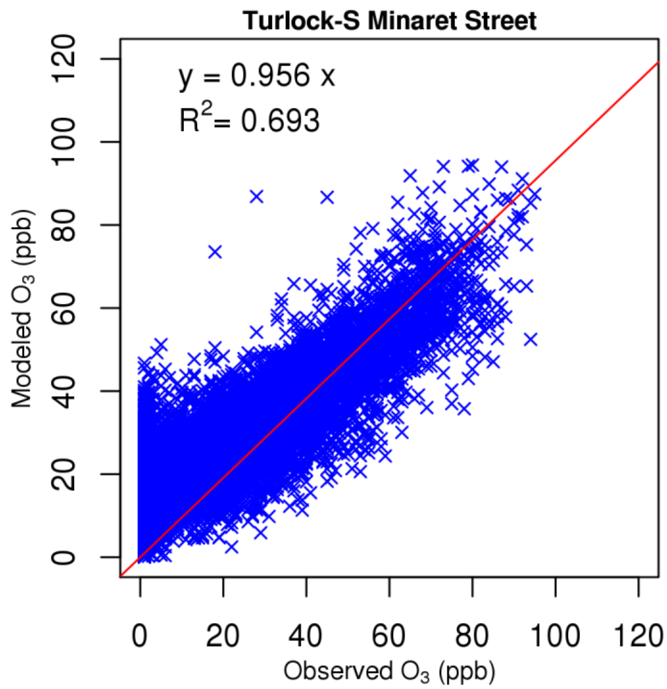

Figure S. 79 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Turlock

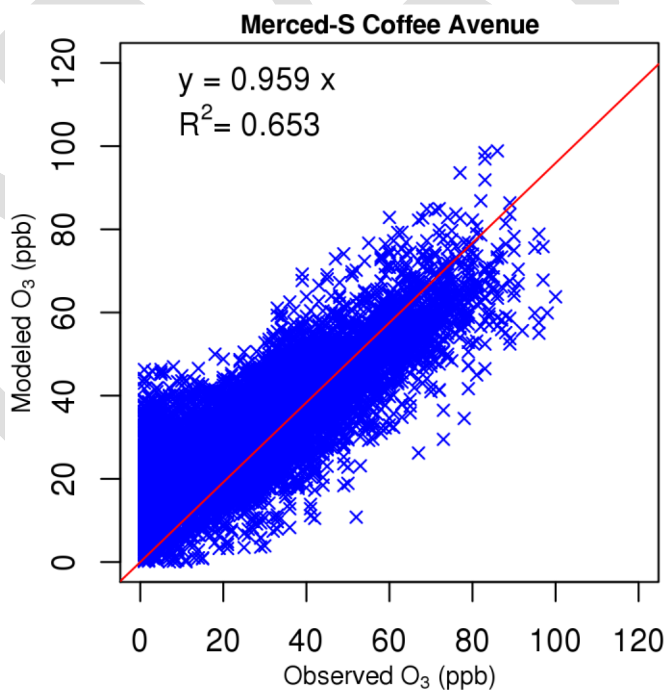

Figure S. 80 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Merced – S Coffee Avenue

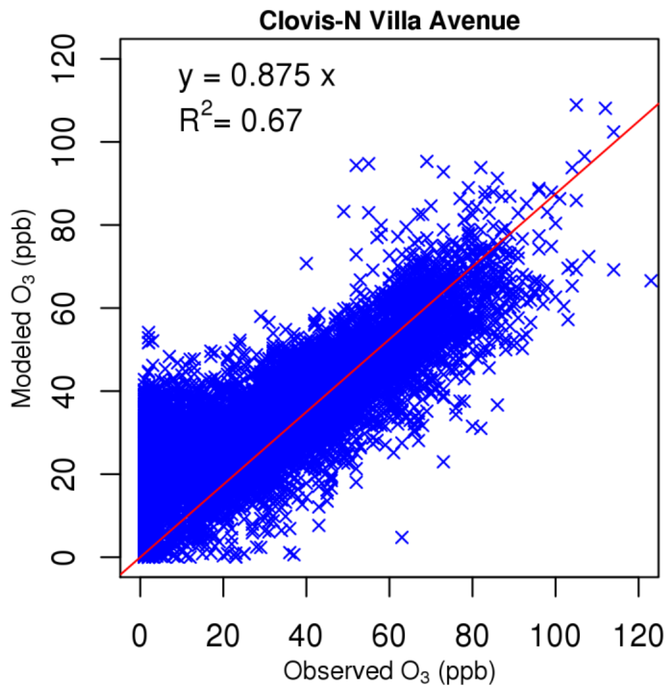

Figure S. 81 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Clovis

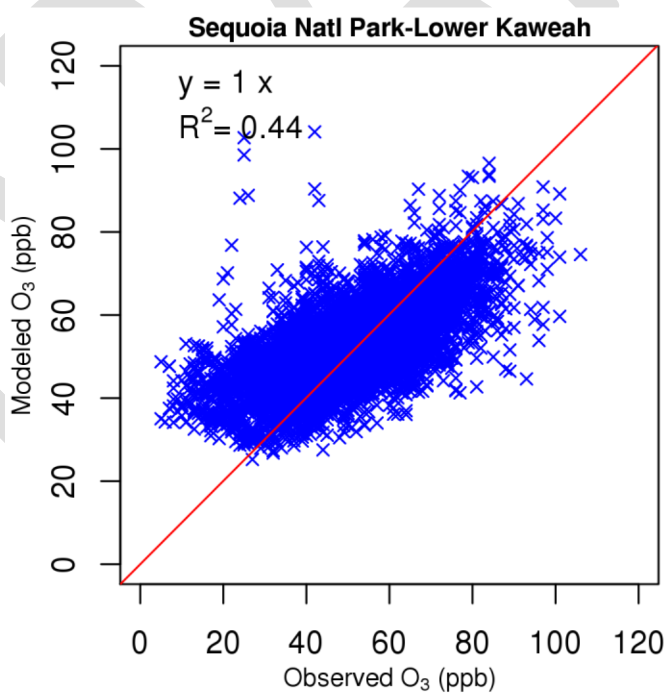

Figure S. 82 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Sequoia National Park

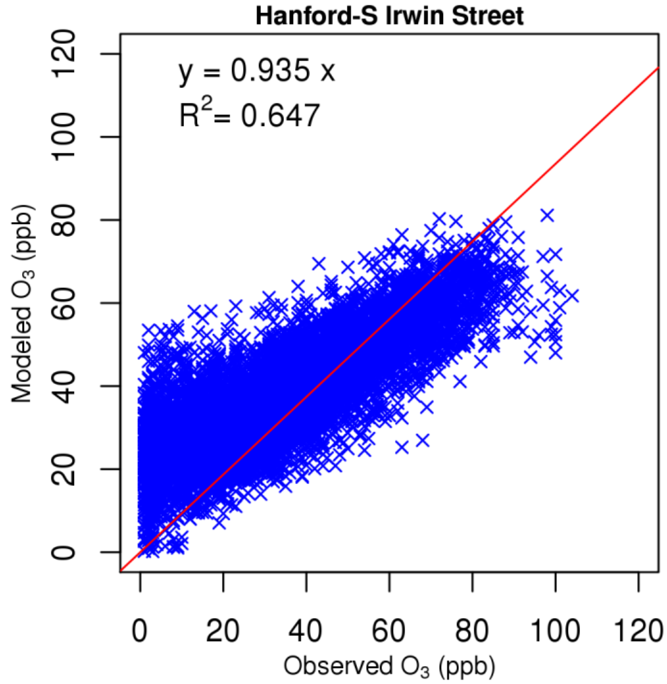

Figure S. 83 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Hanford

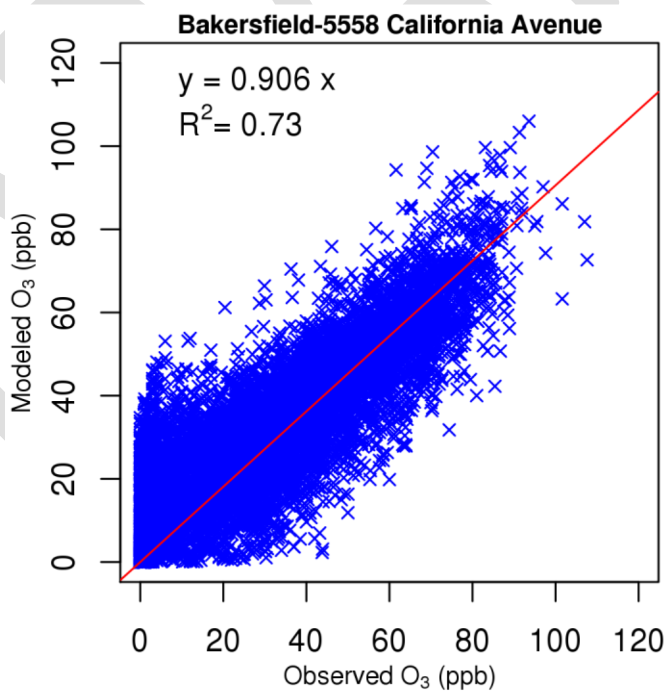

Figure S. 84 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Bakersfield – California Avenue

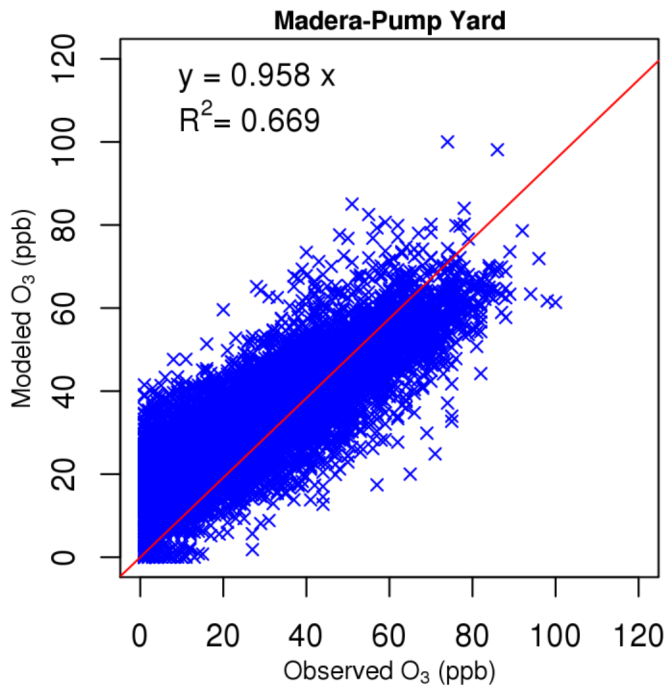

Figure S. 85 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Madera – Pump Yard

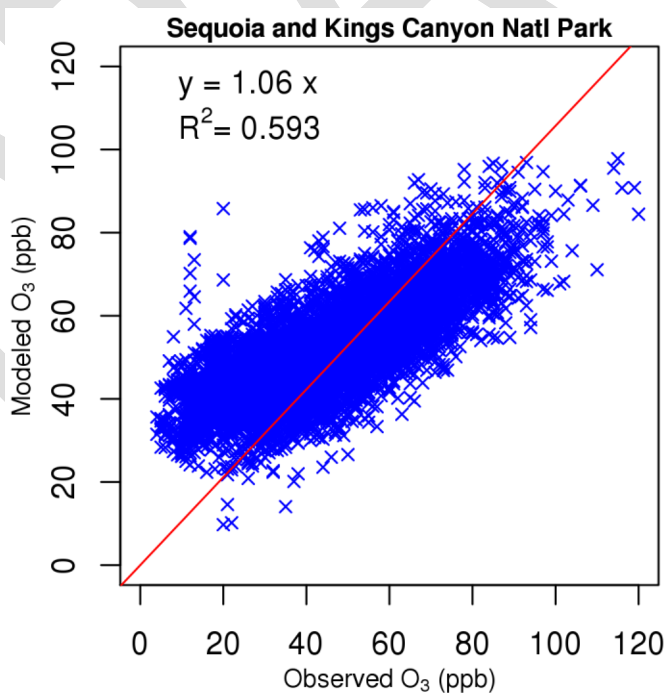

Figure S. 86 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Sequoia and Kings Canyon National Park

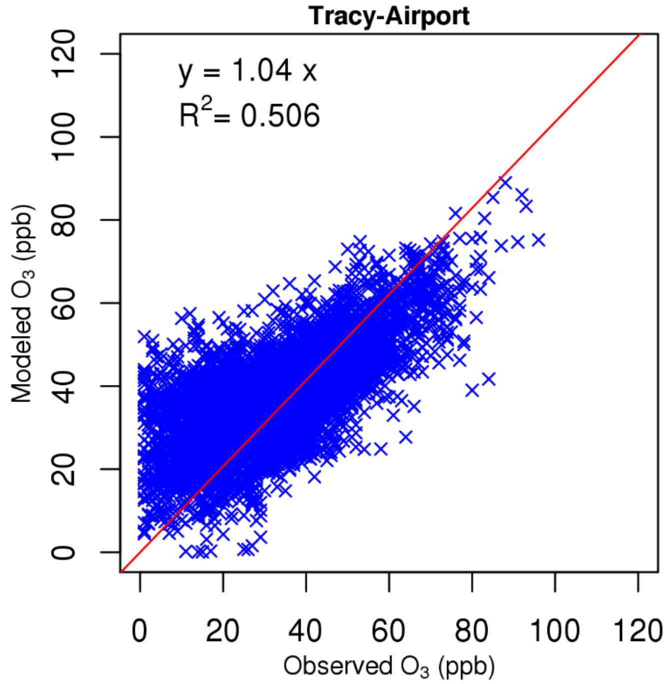

Figure S. 87 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Tracy

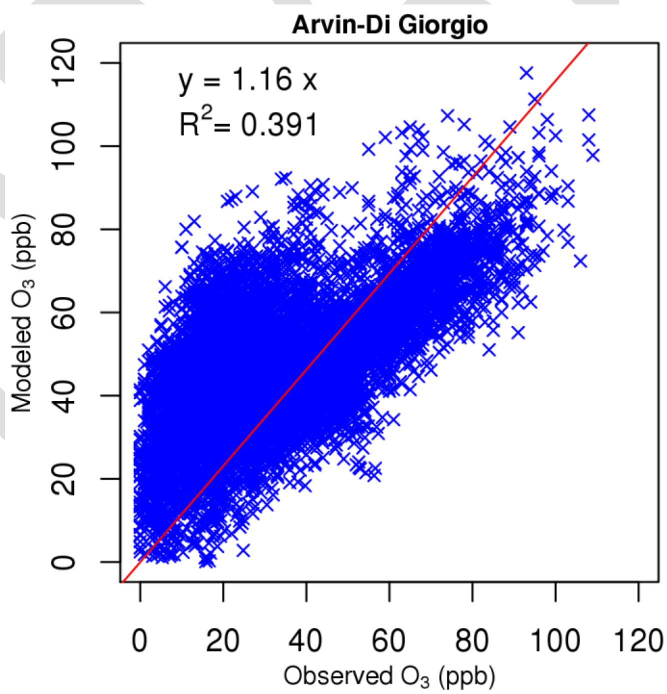

Figure S. 88 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Arvin

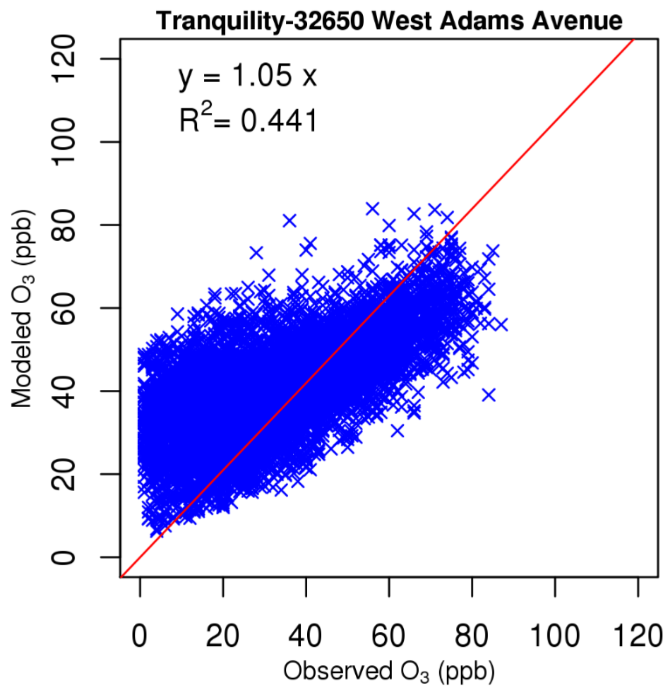

Figure S. 89 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Tranquility

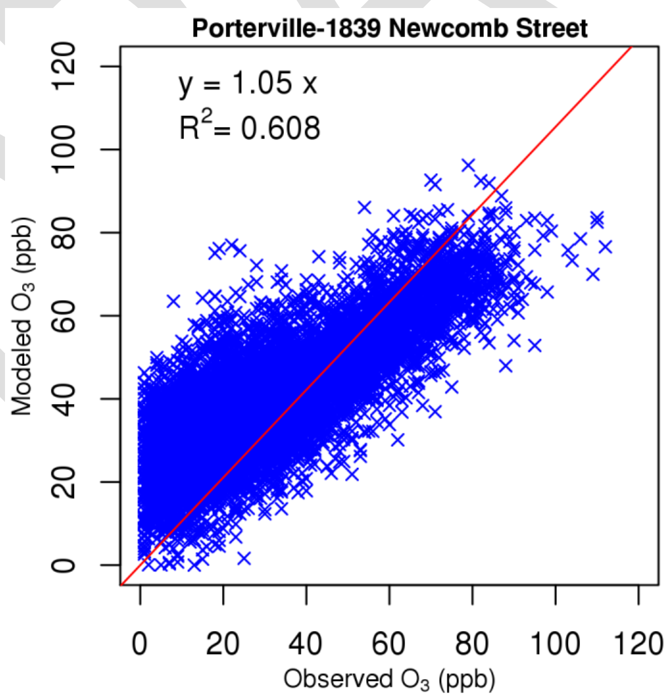

Figure S. 90 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Porterville

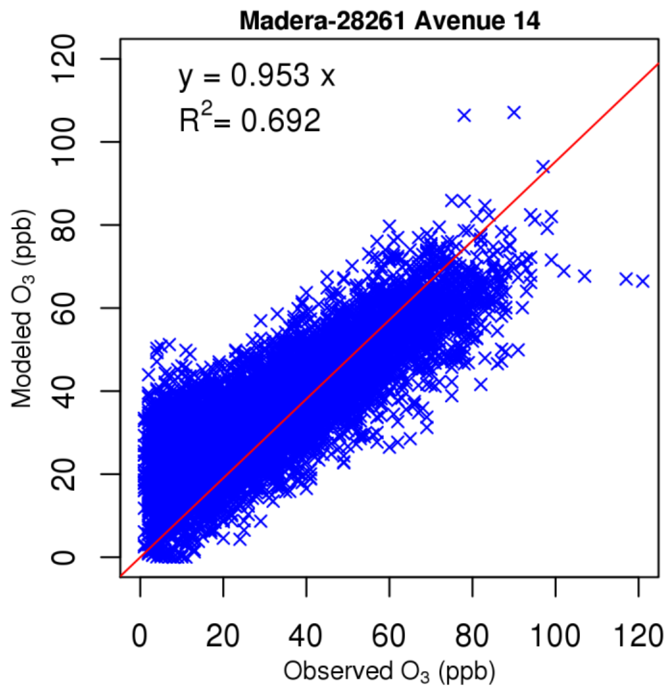

Figure S. 91 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Madera – 28261 Avenue 14

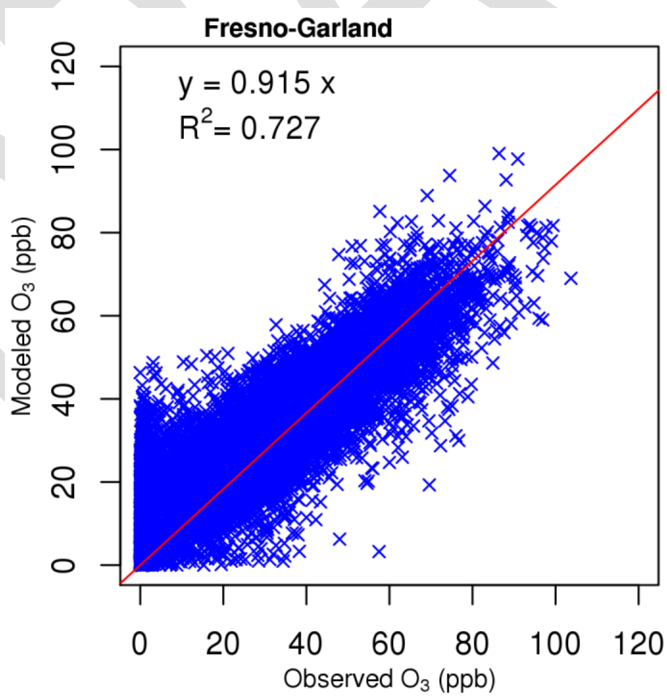

Figure S. 92 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Fresno-Garland

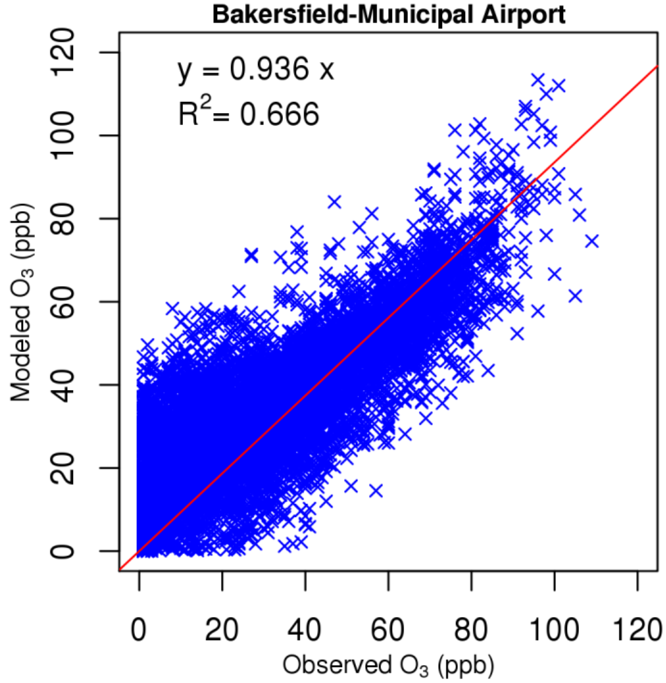

Figure S. 93 Scattering plot of observed and modeled 1-hour O_3 mixing ratio at Bakersfield – Municipal airport

Appendix L
Modeling Protocol

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

November 6, 2017

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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 jointly develop the emission inventories, which are an integral part of the modeling. Working closely with the Districts, the ARB performs the meteorological and air quality modeling used in the development and adoption of a local air quality plan by each District. 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.

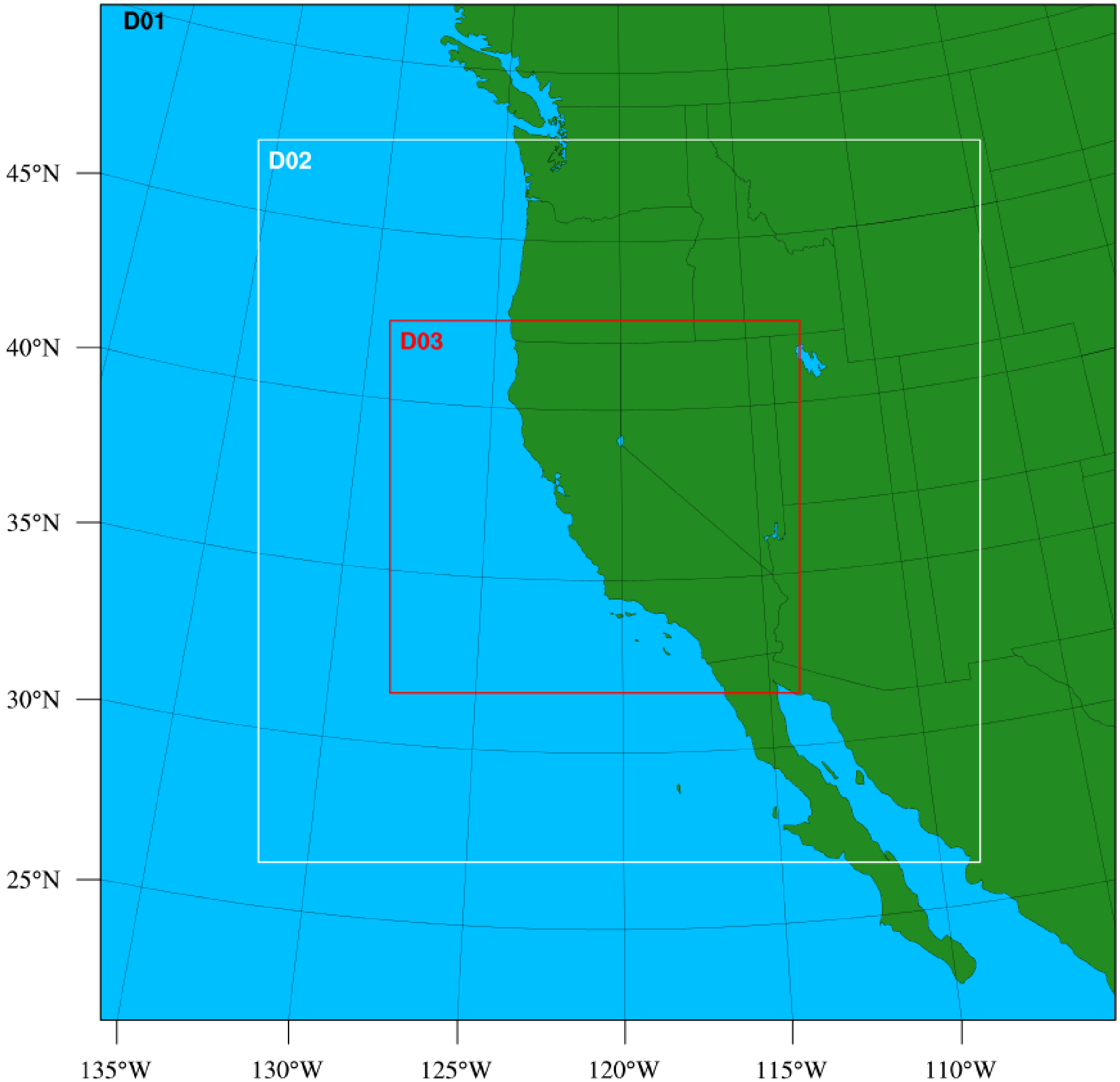

Figure 5-1. The three nested grids for the WRF model (D01 36km; D02 12km; and D03 4km).

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/$PM_{2.5}$ 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.

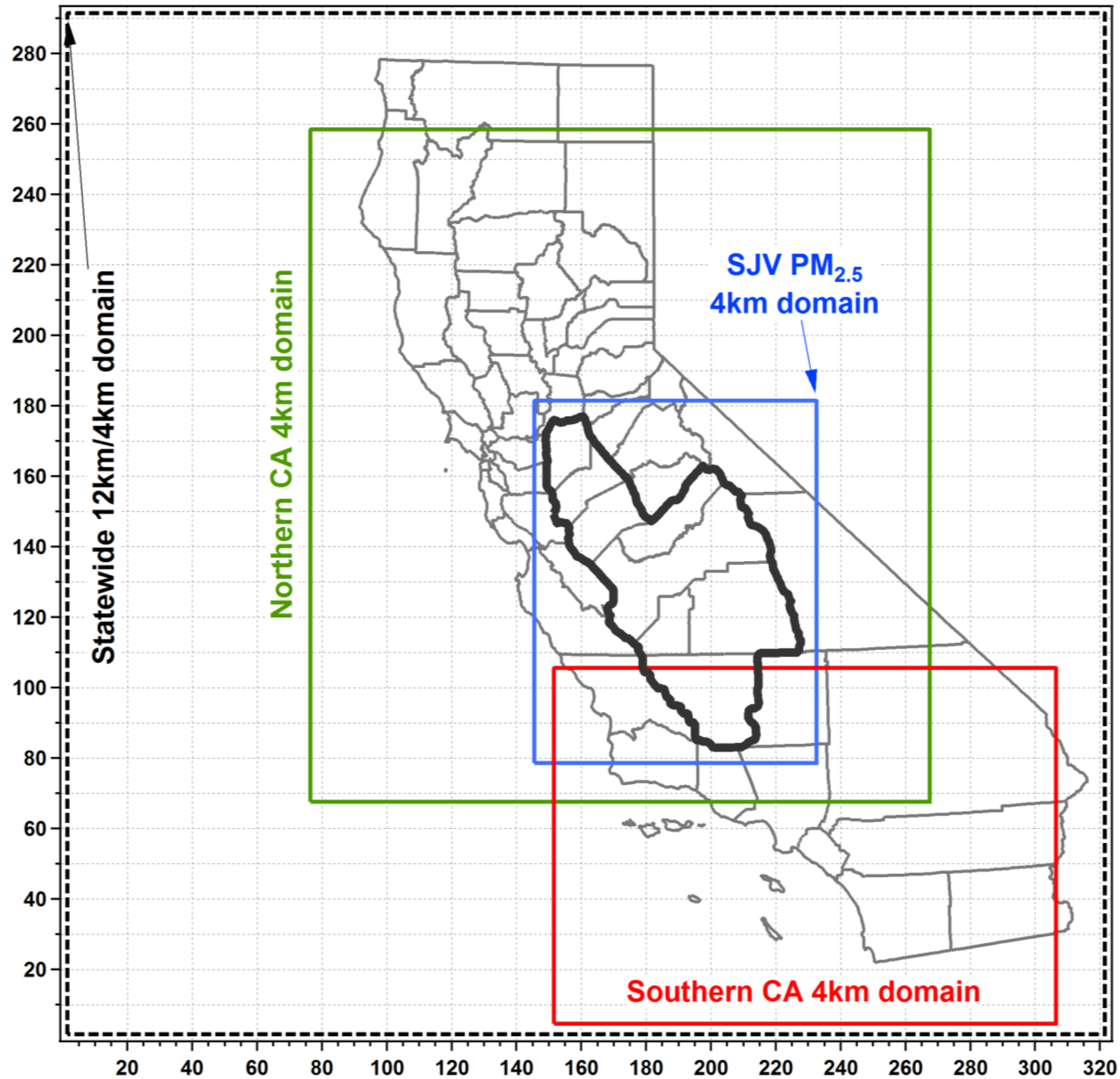

Figure 5-2. CMAQ modeling domains used in this SIP modeling platform. The outer domain (dashed black line) represents the extent of the California statewide domain (shown here with a 4 km horizontal resolution, but utilized in this modeling platform with a 12 km horizontal resolution). Nested higher 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.

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).

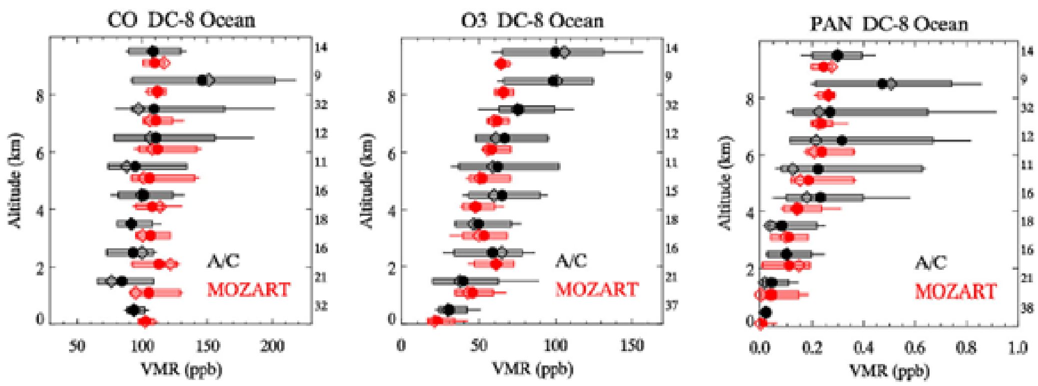

Figure 5-3. Comparison of MOZART (red) simulated CO (left), ozone (center), and PAN (right) to observations (black) along the DC-8 flight track. Shown are mean (filled symbol), median (open symbols), 10th and 90th percentiles (bars) and extremes (lines). The number of data points per 1-km wide altitude 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 regions, valley floor, and mountain ranges, make California 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:

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

$$ME = \frac{1}{N}\sum_{1}^{N}\left|\text{Model} - \text{Obs}\right| \tag{6-2}$$

$$NMB = \frac{\sum_{1}^{N}(\text{Model} - \text{Obs})}{\sum_{1}^{N}\text{Obs}} \times 100\%, \tag{6-3}$$

$$RSME = \sqrt{\frac{\sum_{1}^{N}(\text{Model} - \text{Obs})^2}{N}} \tag{6-4}$$

$$IOA = 1 - \frac{\sum_{1}^{N}(Model - Obs)^2}{\sum_{1}^{N}\left[(Model - Obs) + (Model + Obs)\right]^2}, \tag{6-5}$$

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.

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.

$$MB = \frac{1}{N}\sum_{1}^{N}(\text{Model} - \text{Obs}) \tag{7-1}$$

$$ME = \frac{1}{N}\sum_{1}^{N}\left|\text{Model} - \text{Obs}\right| \tag{7-2}$$

$$MFB = \frac{2}{N}\sum_{1}^{N}\left(\frac{\text{Model} - \text{Obs}}{\text{Model} + \text{Obs}}\right)\times 100\%, \tag{7-3}$$

$$MFE = \frac{2}{N}\sum_{1}^{N}\left(\frac{\left|\text{Model} - \text{Obs}\right|}{\text{Model} + \text{Obs}}\right)\times 100\%, \tag{7-4}$$

$$\mathrm{NMB} = \frac{\sum_{1}^{N}(\mathrm{Model} - \mathrm{Obs})}{\sum_{1}^{N}\mathrm{Obs}} \times 100\%, \qquad (7\text{-}5)$$

$$\mathrm{NME} = \frac{\sum_{1}^{N}|\,\mathrm{Model} - \mathrm{Obs}\,|}{\sum_{1}^{N}\mathrm{Obs}} \times 100\%, \qquad (7\text{-}6)$$

$$\mathrm{RSME} = \sqrt{\frac{\sum_{1}^{N}(\mathrm{Model} - \mathrm{Obs})^2}{N}} \qquad (7\text{-}7)$$

$$R^2 = \left(\frac{\sum_{1}^{N}((\mathrm{Model} - \overline{\mathrm{Model}}) \times (\mathrm{Obs} - \overline{\mathrm{Obs}}))}{\sqrt{\sum_{1}^{N}(\mathrm{Model} - \overline{\mathrm{Model}})^2 \sum_{1}^{N}(\mathrm{Obs} - \overline{\mathrm{Obs}})^2}}\right)^2 \qquad (7\text{-}8)$$

$$\mathrm{MNB} = \frac{1}{N}\sum_{1}^{N}\left(\frac{\mathrm{Model} - \mathrm{Obs}}{\mathrm{Obs}}\right) \times 100\%, \qquad (7\text{-}9)$$

$$\mathrm{MNGE} = \frac{1}{N}\sum_{1}^{N}\left(\frac{|\mathrm{Model} - \mathrm{Obs}|}{\mathrm{Obs}}\right) \times 100\%. \qquad (7\text{-}10)$$

where, “Model” is the simulated mixing ratio, “$\overline{\mathrm{Model}}$” is the simulated mean mixing ratio, “Obs” is the observed value, “$\overline{\mathrm{Obs}}$” 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 4th highest 8-hour ozone mixing ratio, 98th 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 4th 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).

$$\text{RRF} = \frac{\text{average } (O_3 \text{ or } PM_{2.5})_{\text{future}}}{\text{average } (O_3 \text{ or } PM_{2.5})_{\text{reference}}} \quad (8\text{-}1)$$

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.

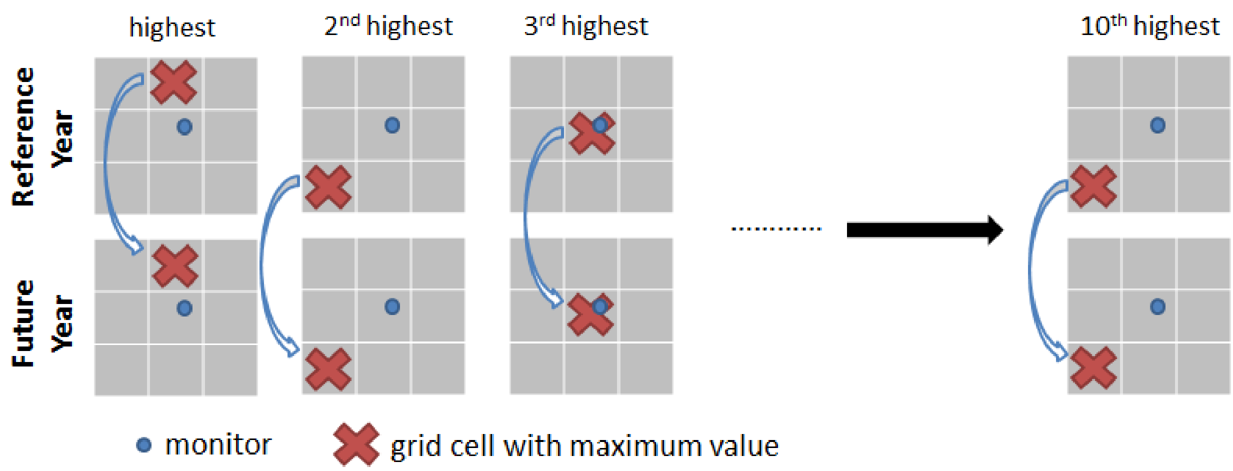

Figure 8-1. Example showing how the location of the MDA8 ozone for the top ten days in the reference and future years are chosen.

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:

$$\text{Retained Nitrate = STN nitrate} - 745.7/T_R \times (\kappa - \gamma) \times \frac{1}{24}\sum_{i=1}^{24}\sqrt{K_i},$$

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.

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 annual average $PM_{2.5}$ (total and by species) will be calculated from the future year simulation, and a gradient in the annual averages between each grid cell and grid cells which contain a monitor will be calculated.

Step 2: The annual future year speciated $PM_{2.5}$ design values will be obtained for each design site as described in section 8.4. For each grid cell, the monitors within its Voronoi Region will be identified, and the speciated $PM_{2.5}$ values are then interpolated using normalized inverse distance squared weightings for all monitors within a grid cell's Voronoi Region. The interpolated speciated $PM_{2.5}$ fields are then adjusted based on the appropriate gradients from Step 1.

Step 3: The concentration of each of the component $PM_{2.5}$ species are summed to calculate the total $PM_{2.5}$ concentration (or DV) for each grid cell.

Step 4: The future year gridded annual average $PM_{2.5}$ estimates are 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 future year simulation, and a gradient in these quarterly speciated averages between each grid cell and grid cells which contain a monitor will be calculated.
>
> Step 2: The 24-hour future year speciated $PM_{2.5}$ design values will be obtained for each design site as described in section 8.4. For each grid cell, the monitors within its Voronoi Region will be identified, and the speciated $PM_{2.5}$ values are then interpolated using normalized inverse distance squared weightings for all monitors within a grid cell's Voronoi Region. The interpolated speciated $PM_{2.5}$ fields are then adjusted based on the appropriate gradients from Step 1.
>
> Step 3: The concentration of each of the component $PM_{2.5}$ species are summed to calculate the total $PM_{2.5}$ concentration (or DV) for each grid cell.
>
> Step 4: The future year gridded 24-hour average $PM_{2.5}$ estimates are then compared to the 24-hour $PM_{2.5}$ NAAQS to determine compliance.

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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APPENDIX: San Joaquin Valley $PM_{2.5}$ SIP (2018)

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ACRONYMS

ACHEX - Aerosol Characterization Experiment

ARCTAS - Arctic Research of the Composition of the Troposphere from Aircraft and Satellites

BEARPEX - Biosphere Effects on Aerosols and Photochemistry Experiment

CABERNET - California Airborne BVOC Emission Research in Natural Ecosystem Transects

CalNex - Research at the Nexus of Air Quality and Climate Change

CARB – California Air Resources Board

CARES - Carbonaceous Aerosols and Radiative Effects Study

CCOS - Central California Ozone Study

CIRPAS - Center for Interdisciplinary Remotely-Piloted Aircraft Studies

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

CSN – Chemical Speciation Network

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

FEM – Federal Equivalent Method

FRM – Federal Reference Method

IMPROVE - Interagency Monitoring of Protected Visual Environments

IMS - Integrated Monitoring Study

NASA – National Aeronautics and Space Administration

NOAA – National Oceanic and Atmospheric Administration

OC – Organic Carbon

OM – Organic Matter

PAMS - Photochemical Assessment Monitoring Stations

$PM_{2.5}$ – Particulate matter with aerodynamic diameter less than 2.5 µm

SJV - San Joaquin Valley

SJVAB - San Joaquin Valley Air Basin

SJVAPCD - San Joaquin Valley 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

SOA – Secondary Organic Aerosol

SoCAB - Southern California Air Basin

U.S. EPA – United States Environmental Protection Agency

VOC – Volatile Organic Compounds

1. TIMELINE OF THE PLAN

Table 1-1. Timeline for Completion of the Plan

Timeline	Action
April 2018	Emission Inventory Completed
June 2018	Modeling Completed
October 2018	San Joaquin Valley Governing Board Hearing to consider the Draft Plan
November 2018	ARB Board Hearing to consider the SJV Adopted Plan
December 2018	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 San Joaquin Valley (SJV) air basin is perhaps the second most studied air basin in the world, in terms of the number of publications in peer-reviewed international scientific/technical journals and other major reports, with the Los Angeles air basin being the first. Major Field studies that have taken place in the SJV and surrounding areas are listed in Table 2-1.

The first major air quality study in the SJV, dubbed Project Lo-Jet, took place in 1970 and resulted in the identification of the Fresno Eddy (Lin and Jao, 1995 and references therein). The first Valley-wide study that formed the foundation for a SIP was 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). A 1-hour Extreme Ozone Attainment Demonstration Plan based on the SARMAP Study was submitted to the U.S. EPA in 2004 and was approved in 2010 (74 FR 33933; 75 FR 10420). 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). IMS-95 formed the technical basis for the 2003 PM10 SIP which was approved by the U.S. EPA in 2006 (71 FR 63642). The area was re-designated as attainment in 2008 (73 FR 66759). The first annual field campaign in the SJV was CRPAQS, and embedded in it was the Central California Ozone Study (CCOS) that took place during the summer of 2000 (Fujita et al., 2001). CRPAQS was a component of the technical foundation for the 2008 annual $PM_{2.5}$ SIP which was approved by the U.S. EPA in 2011 (76 FR 41338; 76 FR 69896), and CCOS was part of the technical basis for the 2007 8-hour O_3 SIP (76 FR 57846). While CRPAQS is still highly relevant to the current annual 24-hour $PM_{2.5}$ SIP, there are additional, more recent studies with relevance to $PM_{2.5}$ formation in the Valley and surrounding regions: 1) ARCTAS-CARB 2008, 2) CalNex 2010, 3) CARES 2010, 4) BEARPEX 2007 & 2009, 5) CABERNET 2011, and 6) DISCOVER-AQ 2013. Each of these studies has contributed significantly to our understanding of various atmospheric processes in the Valley.

The ARCTAS-CARB aircraft field campaign was a joint research effort by NASA and CARB and took place from June 18 to 24, 2008. During the study, the NASA DC-8 aircraft performed two flights over southern California on June 18 and 24 with a focus on the Southern California Air Basin (SoCAB), one flight over northern California with a focus on the San Joaquin Valley Air Basin (SJVAB) on June 20, and one flight off shore on June 22 to quantify the pollutant levels in air masses entering California from the Pacific Ocean. During the campaign, large wildfires occurred in California, particularly in the north. The DC-8 aircraft encountered many of the fire plumes, which allowed for the study of fire emissions and their chemical composition, as well as evaluation of the simulated fire impacts. 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 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, one of which was located in Bakersfield. Analysis of the data collected during CalNex has shown that photochemical ozone production in the southern and central portions of the Valley is transitioning to a NO_x-limited chemistry regime, where further NO_x reductions are expected to lead to a more rapid reduction in ozone than what was observed over the past decade or more (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 SJV (Gentner et al., 2014a,b). In addition, findings also suggest that NO_x emissions control nighttime secondary organic aerosol formation in Bakersfield, thus reductions in NOx emissions should reduce organic aerosol concentrations in Bakersfield and the surrounding region (Rollins et al., 2012).

The CARES field campaign took place in the Sacramento region of central California 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 measurement 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 are then entrained into the growing boundary layer the following day. Although the CARES study did not take place within the SJV itself, it remains relevant to the SJV for two reasons: 1) CARES took place within the delta region north of the SJV, which can influence air quality in the northern SJV (see Section 2.4), and 2) the improved scientific understanding of the interaction between urban emissions and downwind biogenic emissions gained during CARES is applicable to the SJV, which experiences a similar confluence of anthropogenic and biogenic emissions.

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 three. 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 in 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. 2013). 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).

The DISCOVER-AQ (Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality) field campaign took place in the SJV from January 16th through mid-February 2013. The campaign was organized by NASA, with the primary goal of relating column observations (e.g., from satellites) to surface measurements of $PM_{2.5}$ and key trace gases such as O_3, NO_2, and formaldehyde. The campaign captured two elevated $PM_{2.5}$ episodes in the SJV when 24-hour $PM_{2.5}$ concentrations in Bakersfield exceeded 60 µg/m^3. During the campaign, sampling by two aircrafts focused on agricultural and vehicle traffic emission sources from Bakersfield to Fresno. In addition to the aircraft measurements there were also intensive ground-based data collection in Fresno and Porterville. The field campaign provided unprecedented observations of $PM_{2.5}$ and its precursors with broad horizontal spatial coverage, at the surface as well as aloft, and also at a finer temporal resolution (i.e., minutes compared to daily or multiple hours in the past) than was previously available. The combination of highly resolved spatial and temporal measurements presented a unique opportunity to update the conceptual model for wintertime $PM_{2.5}$ formation in the SJV that was initially developed from CRPAQS field study. Pusede et al. (2016) analyzed the DISCOVER-AQ dataset and historical ammonium nitrate records in the SJV and concluded that NO_x emissions control in the valley in the past decade has substantially decreased nighttime ammonium nitrate formation in the nocturnal residual layer and continued reduction in NO_x emissions in the SJV will lead to fewer wintertime exceedances of the 24-hour $PM_{2.5}$ standard. This study lends support to the emissions control policies in the SJV that have historically focused on NO_x emissions.

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 $PM_{2.5}$ and PM_{10} 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 O_3 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 $PM_{2.5}$ and PM_{10}
Summer 1990	San Joaquin Valley Air Quality Study/Atmospheric Utilities Signatures Predictions and Experiments (SJVAQS/AUSPEX) – Also known as SARMAP (SJVAQS/AUSPEX Regional Modeling Adaptation Project)	First central California regional study of O_3 and $PM_{2.5}$
July and August 1991	California Ozone Deposition Experiment	Measurements of dry deposition velocities of O_3 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 PM_{10}/$PM_{2.5}$ Air Quality Study (CRPAQS) and Central California Ozone Study (CCOS)	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
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 San Joaquin Valley covers an area of 23,490 square miles and is home to approximately 4 million residents. The Valley is bordered on the west by the coastal mountain ranges and on the east by the Sierra Nevada range. These ranges converge at the southern end of the basin at the Tehachapi Mountains. The majority of the population is centered in the large urban areas of Bakersfield, Fresno, Modesto, and Stockton. The nonattainment area includes seven full counties (San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, and Tulare) and one partial county Kern (only the western portion of Kern County, which lies in the jurisdiction of the SJVAPCD, is included).

The Valley can be divided into three regions that are characterized by distinct geography, meteorology, and air quality: 1) northern SJV (San Joaquin, Stanislaus, and Merced counties), 2) central SJV (Madera, Fresno, and King counties), and 3) southern

SJV (Tulare and Western Kern counties). A third of the Valley population lives in the northern SJV. This lowland area is bordered by the Sacramento Valley and Delta lowland to the north, the central portion of the SJV to the south, and mountain ranges to the east and west. Because of the marine influence, which extends into this area through gaps in the coastal mountains to the west, the northern SJV experiences a more temperate climate than the rest of the Basin. These more moderate temperatures (cooler in the summer and warmer in the winter) and the predominant air flow patterns generally favor better air quality. Similar to the northern SJV, the central and southern SJV are also low lying areas, flanked by mountains on their west and east sides. The worst air quality within the Valley occurs in these two regions, where the population is primarily clustered around the Fresno and Bakersfield urban areas. In these regions the interaction between geography, climate, and a mix of natural (biogenic) and anthropogenic emissions pose significant challenges to air quality progress. The southern SJV represents the terminus of the Valley and is flanked by mountains on the south, as well. The surrounding mountains in both areas act as barriers to air flow, and combined with recirculation patterns and stable air to trap emissions and pollutants near the valley floor. The more extreme temperatures and stagnant conditions in these two regions lead to a build-up of $PM_{2.5}$ and ozone, and overall poorer air quality. In addition to the urban air quality problems, emissions and pollutants from these areas are transported downwind, resulting in poor air quality in downwind areas.

As discussed above, the Valley's diverse area includes several major metropolitan areas, vast expanses of agricultural land, industrial sources, and highways, all of which pose many issues to air quality. The San Joaquin Valley Air Pollution Control District (SJVAPCD or District), the California Air Resources Board (CARB), and the National Park Service work together and operate an extensive network of air quality monitors throughout the Valley to help improve and protect public health. The data collected from the Valley 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 towards health-based air quality standards.

Figure 2-1 shows the spatial distribution of the $PM_{2.5}$, ozone, NO_x, and PAMS (Photochemical Assessment Monitoring Stations) monitors in the Valley (see Table 2-2 for longitude/latitude information for each monitor). The monitors are located throughout the Valley floor, at higher elevation locations, and within higher population density urban areas, and have been shown to sufficiently capture the highest ozone mixing ratios and the corresponding precursors under various weather conditions and in all major population centers. A detailed discussion about the monitoring network and its adequacy can be found in the Valley's 2017 Air Monitoring Network Plan (http://www.valleyair.org/aqinfo/Docs/2017-Air-Monitoring-Network-Plan.pdf) and 2014 California Infrastructure SIP (http://www.arb.ca.gov/planning/sip/infrasip/docs/i-sip.pdf).

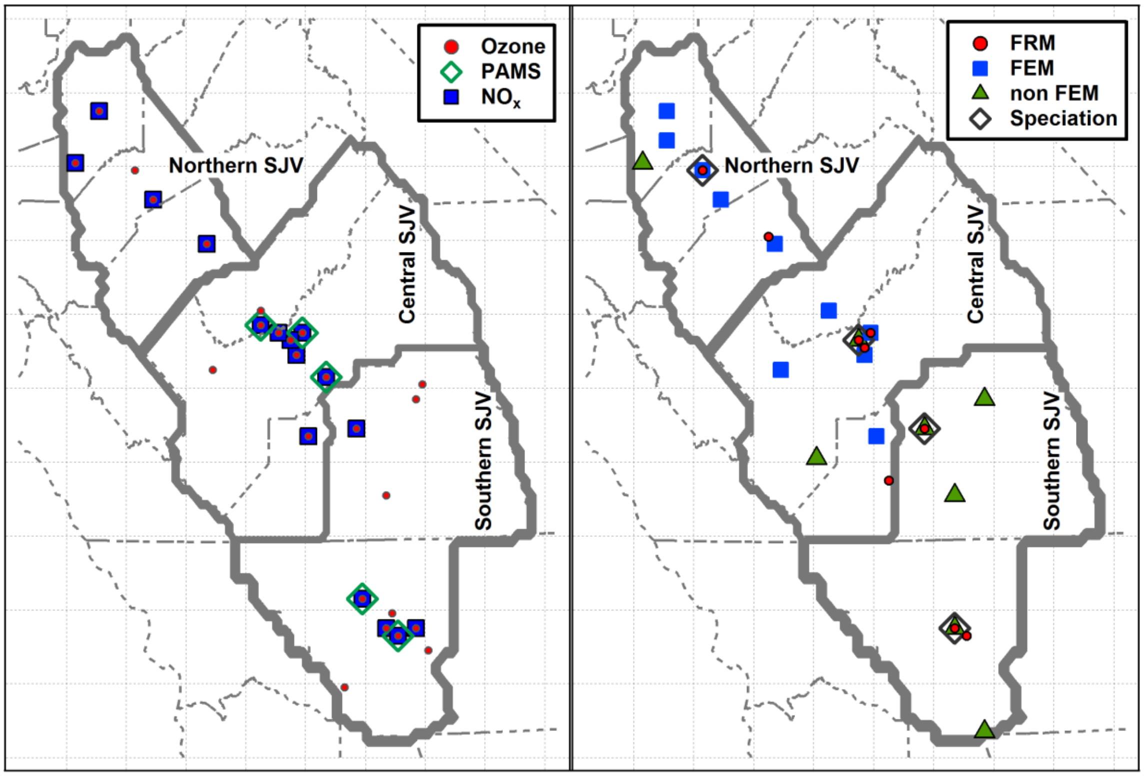

Figure 2-1. Map of the ambient monitoring network in the San Joaquin Valley.

Table 2-2. 2012-2015 San Joaquin Valley $PM_{2.5}$, ozone, NO_x, and PAMS Sites

Site ID (AQS/ARB)	Sub Region	Site	PM2.5				Gaseous			Location	
			FRM	FEM	non-FEM	Speciation	NO_x	Ozone	PAMS	Latitude	Longitude
Fresno County											
060195001 3026	Central SJV	Clovis-N Villa Avenue	X	X			X	X	X	36.8193	-119.7164
060190008 3009	Central SJV	Fresno-1st Street					X	X		36.7819	-119.7731
060190007 2013	Central SJV	Fresno-Drummond Street					X	X		36.7056	-119.7414
060190011 3781	Central SJV	Fresno-Garland	X		X	X	X	X		36.7854	-119.7732
060195025 3485	Central SJV	Fresno – Hamilton and Winery	X							36.7262	-119.7325
060190242 2844	Central SJV	Fresno-Sierra Skypark #2					X	X		36.8416	-119.8744
060192008 3768	Central SJV	Huron-16875 4th Street			X					36.1987	-120.1012
060194001 2114	Central SJV	Parlier					X	X	X	36.5974	-119.5037
060192009 3759	Central SJV	Tranquility-32650 West Adams Avenue		X				X		36.6342	-120.3823

Kern County											
060295002 3758	Southern SJV	Arvin-Di Giorgio						X		35.2392	-118.7886
060290016 3496	Southern SJV	Bakersfield-410 E Planz Road	X							35.3246	-118.9976
060290014 3146	Southern SJV	Bakersfield-5558 California Avenue	X		X	X	X	X		35.3567	-119.0626
060292012 3787	Southern SJV	Bakersfield-Municipal Airport					X	X	X	35.3316	-119.000
060290007 2312	Southern SJV	Edison					X	X		35.3456	-118.8518
060292009 3769	Southern SJV	Lebec-Beartrap Road			X					34.8416	-118.8606
060290008 2919	Southern SJV	Maricopa-Stanislaus Street						X		35.0516	-119.4026
060290232 2772	Southern SJV	Oildale-3311 Manor Street						X		35.4380	-119.0168
060296001 2981	Southern SJV	Shafter-Walker Street					X	X	X	35.5035	-119.2726
Kings County											
060310004 3194	Central SJV	Corcoran-Patterson Avenue	X	X						36.1022	-119.5656

060311004 3129	Central SJV	Hanford-S Irwin Street		X			X	X		36.3157	-119.6432
Madera County											
060392010 3771	Central SJV	Madera-28261 Avenue 14	X	X				X		36.9533	-120.0342
060390004 3211	Central SJV	Madera-Pump Yard					X	X	X	36.8672	-120.01
Merced County											
060470003 3022	Northern SJV	Merced-S Coffee Avenue		X			X	X		37.2818	-120.4337
060472510 3253	Northern SJV	Merced-2334 M Street	X							37.3083	-120.4805
San Joaquin County											
060772010 3772	Northern SJV	Manteca-530 Fishback Rd		X						37.7934	-121.2478
060771002 2094	Northern SJV	Stockton-Hazelton Street		X			X	X		37.9508	-121.2690
060773005 3696	Northern SJV	Tracy-Airport			X		X	X		37.6827	-121.4424
Stanislaus County											
060990005 2833	Northern SJV	Modesto-14th Street	X	X		X		X		37.6422	-120.9942
060990006 2996	Northern SJV	Turlock-S Minaret Street		X			X	X		37.4882	-120.8359

Tulare County

061072010 3763	Southern SJV	Porterville -1839 Newcomb Street		X			X	36.0318	-119.055
061070009 3484	Southern SJV	Sequoia and Kings Canyon Natl Park		X			X	36.4894	-118.8291
061070006 3036	Southern SJV	Sequoia Natl Park-Lower Kaweah					X	36.5661	-118.7777
061072002 2032	Southern SJV	Visalia-N Church Street	X	X	X	X	X	36.3325	-119.2910

2.3 $PM_{2.5}$ Air Quality Trends

Tables 2-3 and 2-4 show the annual average $PM_{2.5}$ concentrations and the annual $PM_{2.5}$ design values (i.e., 3-year average), from 1999 to 2016, for FRM and FEM sites in the SJV, respectively. Correspondingly, Tables 2-5 and 2-6 show the annual 98^{th} percentile and annual 24-hour design values (i.e., 3-year average), from 1999 to 2016, respectively. In most recent years (i.e., 2013-2016), in general, the two sites in Bakersfield have highest 24-hour design values in the valley. Figure 2-2 shows the trend in peak valley-wide annual average $PM_{2.5}$ concentrations and 98^{th} percentile of the 24-hour $PM_{2.5}$ concentrations, as well as the approximate number of days above the 24-hour standard in the valley from 1999 to 2016. The extreme drought conditions experienced by much of California since 2012 coupled with persistent and strong high pressure systems over the SJV in recent winters, has led to elevated levels of $PM_{2.5}$ in the SJV that have not been seen in over a decade. This is clearly illustrated by the "U" shaped curve of the 98^{th} percentile 24-hour $PM_{2.5}$ shown in Figure 2-2. Despite the recent increase in peak 24-hour $PM_{2.5}$ levels, the SJV has seen significant improvement in $PM_{2.5}$ concentrations over the last 15 years, with steady decreases in both annual average $PM_{2.5}$ and in the number of days above the 24-hour standard, which coincide with the large emission reductions experienced in the valley (Figure 2-3).

Table 2-3: Annual Average $PM_{2.5}$ ($\mu g/m^3$)

SJV Monitoring Site	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Stockton	19.7	15.5	13.9	16.7	13.6	13.2	12.5	13.1	12.9	14.4	11.3	11.0	11.3	12.4	17.7	12.1	12.8	11.8
Manteca													10.8	8.3	11.7	9.9	12.6	9.8
Modesto	24.9	18.7	15.6	18.7	14.5	13.6	13.9	14.8	15.0	16.0	13.0	12.3	14.7	11.9	14.3	11.4		11.2
Turlock											16.1	12.7	17.1	14.8	15.1	12.3	14.2	12.7
Merced-Coffee												16.3	15.6	11.0	13.3	10.8	12.8	12.0
Merced-M		16.7	14.5	18.7	15.7	15.2	14.1	14.8	15.2		13.6	11.2	10.4	9.5	13.5	11.2	12.6	11.2
Madera-City													20.4	16.0	17.8	13.5	13.8	12.0
Fresno-First	27.6		19.8	21.5	17.8	16.3	16.7	16.8	18.8	17.4	15.1	13.0	15.5					
Fresno-Garland														14.1	16.8	15.1	14.4	12.7
Fresno-Winery		18.4	18.6	21.3	17.8	17.0	16.9	17.6	16.8	16.5	14.6	13.4	15.4	12.7	15.9	13.8	14.1	13.0
Clovis	19.8	16.3	18.0	16.2	18.5	16.4	16.3	16.4	16.4	16.2	18.3	14.7	17.9	15.4	15.9	16.6	15.0	12.6
Tranquility												7.0	8.2	7.1	8.4	7.7	10.0	7.9
Corcoran		16.4	19.2	21.5	16.2	17.4	17.5	16.9	18.4	15.8	17.7	17.9			15.6	15.4		14.8
Hanford												14.5	18.0	14.8	18.2	17.5	16.5	15.5
Visalia	27.6	23.9	22.5	23.2	18.2	17.0	18.8	18.8	20.4	19.8	16.0	13.6	16.1	14.8	18.9	17.9	16.1	14.7
Bakersfield-California	27.4	22.5	21.2	22.7	17.1	18.9	18.0	18.7	22.0	21.9	19.0	14.2	16.2	13.0	20.0	18.6	16.3	14.8
Bakersfield-Planz		20.3	20.8	23.5	17.8	17.4	19.8	19.3	21.8	23.5	22.5	16.8	14.4	14.7	21.7	21.6	17.9	15.9

Table 2-4: Annual $PM_{2.5}$ Design Value (three-year average, $\mu g/m^3$)

SJV Monitoring site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Stockton	16.4	15.3	14.7	14.5	13.1	12.9	12.8	13.5	12.9.	12.2	11.2	11.6	13.8	14.1	14.2	12.2
Manteca													10.2	9.9	11.4	10.8
Modesto	19.7	17.7	16.2	15.6	14.0	14.1	14.6	15.3	14.7	13.8	13.3	12.9	13.6	12.5		
Turlock											15.3	14.9	15.7	14.1	13.9	13.1
Merced-Coffee												14.3	13.3	11.7	12.3	11.9
Merced-M		16.6	16.3	16.5	15.0	14.7	14.7				11.7	10.4	11.1	11.4	12.5	11.7
Madera-City													18.1	15.8	15.0	13.1
Fresno-First			19.7	18.6	16.9	16.6	17.4	17.7	17.1	15.2	14.5					
Fresno-Garland													15.4	15.3	15.4	14.1
Fresno-Winery		19.4	19.2	18.7	17.2	17.2	17.1	17.0	16.0	14.9	14.5	13.9	14.7	14.1	14.6	13.6
Clovis	18.0	16.8	17.6	17.0	17.1	16.4	16.4	16.4	17.0	16.4	17.0	16.0	16.4	16.0	15.8	14.7
Tranquility												7.5	7.9	7.7	8.7	8.5
Corcoran		19.0	19.0	18.4	17.0	17.2	17.6	17.0	17.3	17.1						
Hanford												15.8	17.0	16.8	17.4	16.5
Visalia	24.7	23.2	21.3	19.5	18.0	18.2	19.3	19.7	18.8	16.5	15.2	14.8	16.6	17.2	17.6	16.2
Bakersfield-California	23.7	22.1	20.3	19.6	18.0	18.5	19.6	20.9	21.0	18.4	16.5	14.5	16.4	17.2	18.3	16.6
Bakersfield-Planz		21.5	20.7	19.6	18.4	18.9	20.3	21.5	22.6	20.9	17.9	15.3	16.9	19.3	20.4	18.5

Table 2-5: Annual 98th percentile $PM_{2.5}$ ($\mu g/m^3$)

SJV Monitoring Site	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Stockton	79.0	55.0	58.0	50.0	41.0	36.0	44.0	42.0	48.0	61.6	40.4	29.7	44.8	33.9	56.3	44.5	39.1	32.4
Manteca													38.9	30.9	40.2	40.0	42.7	29.3
Modesto	100.0	71.0	69.0	69.0	47.0	45.0	55.0	52.0	57.4	53.9	54.5	37.3	54.7	40.8	56.4	49.5	30.8	36.2
Turlock										67.4	53.1	43.5	57.4	45.4	55.4	51.2	47.3	38.5
Merced-Coffee											41.4	39.9	47.4	35.6	42.3	43.8	40.3	32.8
Merced-M	91.9	60.0	49.3	55.1	44.2	43.0	48.3	43.8	52.7	54.0	45.2	39.1	38.5	41.8	67.3	45.9	39.0	34.6
Madera-City												50.6	59.1	43.2	54.6	51.0	43.7	35.7
Fresno-First	120.0	90.0	75.0	75.0	56.0	52.0	71.0	51.0	67.0	57.4	55.8	48.8	69.5					
Fresno-Garland														52.6	63.8	66.7	52.0	43.7
Fresno-Winery		64.8	61.5	71.9	49.7	49.4	71.2	55.0	57.4	44.5	48.2	40.2	67.5	51.3	71.6	61.8	42.0	40.0
Clovis	59.2	72.5	71.5	53.2	48.1	52.4	63.0	51.3	60.9	49.0	49.0	44.3	68.5	48.0	56.2	64.6	45.7	36.1
Tranquility											35.8	27.0	27.5	26.9	35.7	31.2	35.8	27.0
Corcoran	53.0	55.1	89.5	65.1	42.2	49.4	74.5	50.1	57.9	47.9	53.4	47.2			66.0	71.0		45.9
Hanford												48.5	64.6	48.3	67.6	81.9	51.4	43.3
Visalia	114.0	103.0	96.0	70.0	47.0	54.0	65.0	50.0	59.7	62.1	53.9	36.3	50.7	53.8	62.5	75.4	45.8	40.7
Bakersfield-California	98.0	92.7	94.9	73.0	48.3	61.5	63.2	60.5	73.0	64.5	66.7	53.3	65.5	56.4	71.8	79.9	57.2	47.0
Bakersfield-Planz		76.5	90.6	66.8	47.5	47.6	66.4	64.7	72.2	72.3	65.5	47.2	43.2	40.6	83.6	76.7	56.5	50.7

Table 2-6: 24-hour $PM_{2.5}$ Design Values (three-year average, $\mu g/m^3$)

SJV Monitoring site	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Stockton	64	54	50	42	40	41	45	51	50	44	38	36	45	45	47	39
Manteca													37	37	41	37
Modesto	80	70	62	54	49	51	55	54	55	49	49	44	51	49	46	39
Turlock										55	51	49	53	51	51	46
Merced-Coffee											43	41	42	41	42	39
Merced-M	67	55	50	47	45	45	48	50	51	46	41	40	49	52	47	40
Madera-City												51	52	50	50	43
Fresno-First	95	80	69	61	60	58	63	58	60	54	58					
Fresno-Garland														61	61	54
Fresno-Winery		66	61	57	57	59	61	52	50	44	52	53	64	62	54	48
Clovis	68	66	58	51	55	56	58	54	53	47	54	54	58	56	56	49
Tranquility												27	30	31		
Corcoran	66	70	66	52	55	58	61	52	53	49	47				75	
Hanford												54	60	66	67	59
Visalia	104	90	71	57	55	56	58	57	59	51	47	47	56	64	61	54
Bakersfield-California	95	87	72	61	58	62	66	66	68	62	62	58	65	69	70	61
Bakersfield-Planz		78	68	54	54	60	68	70	70	62	52	44	56	67	72	61

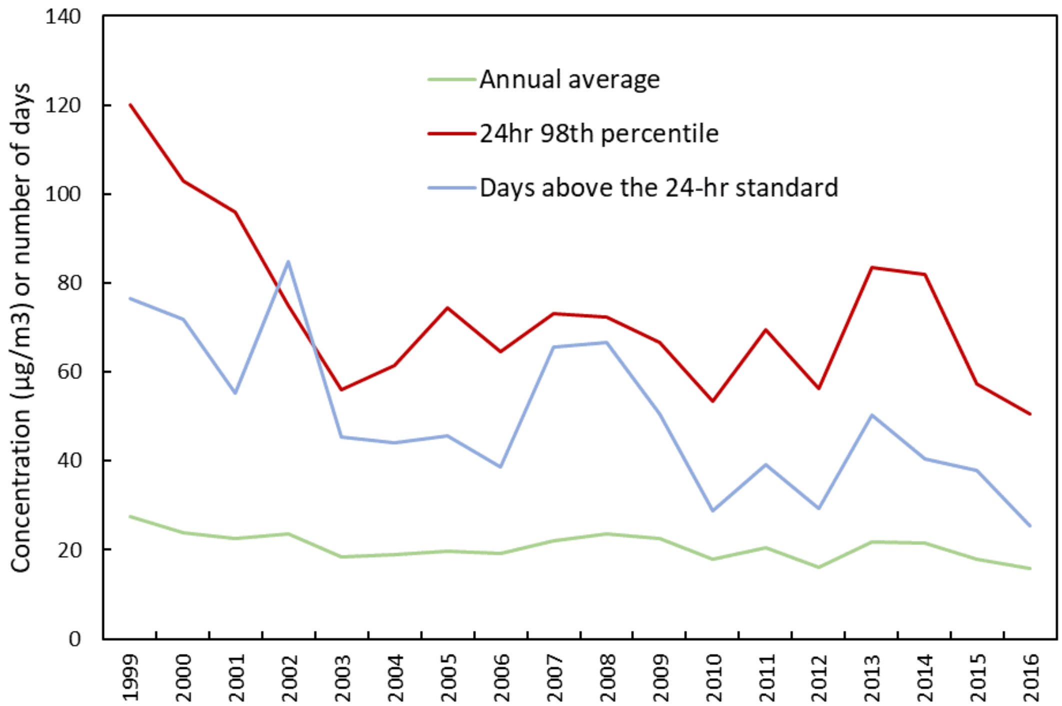

Figure 2-2. Trends in valley-wide annual average, 24-hour 98th percentile $PM_{2.5}$, and approximate number of days above the 24-hour standard

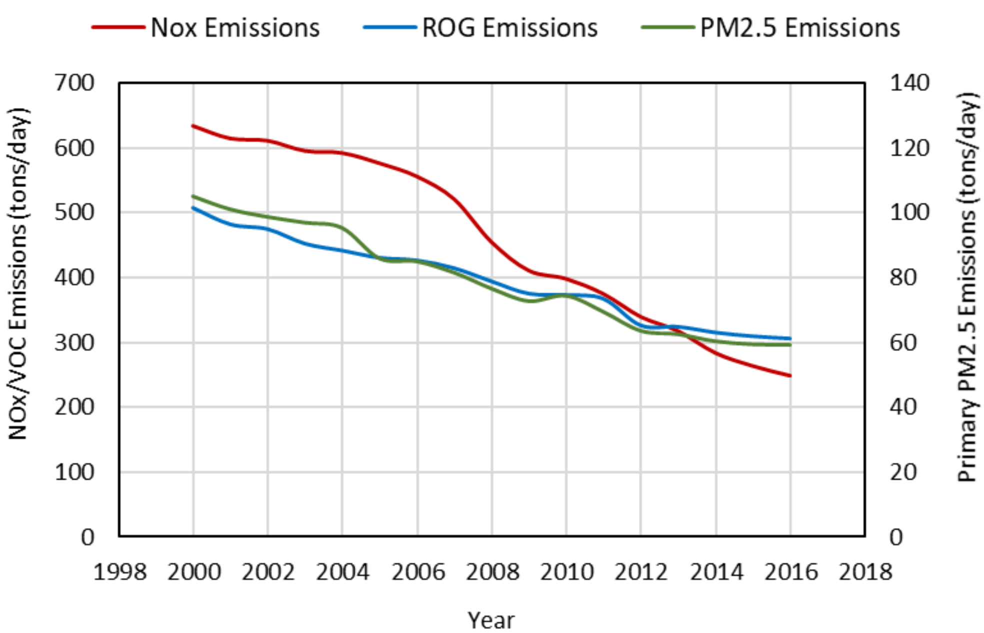

Figure 2-3. San Joaquin Valley trends in $PM_{2.5}$, NO_x, and VOC emissions.

2.4 Major $PM_{2.5}$ Components

Four monitoring sites collect $PM_{2.5}$ chemical composition data in the San Joaquin Valley: Bakersfield-California, Fresno-Garland, Modesto, and Visalia. The Bakersfield and Fresno speciation monitors are part of the national Chemical Speciation Network (CSN) while Modesto and Visalia are part of the State and Local Air Monitoring Stations (SLAMS) network. All four sites use SASS samplers (Spiral Aerosol Speciation Sampler, Met One, Grants Pass, OR.) for data collection. The CSN data are analyzed by the Research Triangle Institute and the SLAMS data are analyzed by ARB. In recent years, changes were made to the carbon sampling and analysis method. The collection method changed from the MetOne SASS to the URG3000N sampler, which is very similar to the IMPROVE module C sampler. The analytical method was changed from the NIOSH-like thermal optical transmittance method to IMPROVE_A thermal optical reflectance. At Bakersfield, Modesto, and Visalia these changes were implemented in May of 2007, and the Fresno site switched to the new carbon system in April of 2009.

Figure 2-4 illustrates the average of the 2011-2013 annual average $PM_{2.5}$ compositions, as well as average of the top 10 percent of days at Bakersfield, Fresno, and Modesto over the same time period (Note that this composition can be somewhat different from those used in the DV calculation since DV is based on the FRM filter measurement and there is filter and measurement technique difference between FRM and CSN methods. More detail can be found in the main body of the modeling protocol or the USEPA modeling guidance). Organic matter (OM) was calculated by multiplying measured OC by 1.5 according to the OM/OC ratio measured at Fresno (Ge et al., 2012). Ammonium nitrate is the largest contributor to $PM_{2.5}$ on annual basis, accounting for approximately 40% of the $PM_{2.5}$ mass. Its contribution is even higher on peak $PM_{2.5}$ days, accounting for 55-60% of $PM_{2.5}$ mass. Formation mechanisms for ammonium nitrate are discussed in Section 2.5. OM is the second most abundant component, constituting approximately 30% of the $PM_{2.5}$ mass on an annual basis. Activities such as residential wood combustion, cooking, biomass burning, and mobile sources contribute to OM levels in the atmosphere. In addition, OM can also be formed in the atmosphere from oxidation of VOCs. Ammonium sulfate contributes approximately 10% of the $PM_{2.5}$ on an annual basis. Its contribution is half that on peak days, at approximately 5%. Elemental carbon and crustal materials typically contribute less than 10% to $PM_{2.5}$ levels in these cities, except at Bakersfield, where crustal materials contributed more than 10% on an annual basis.

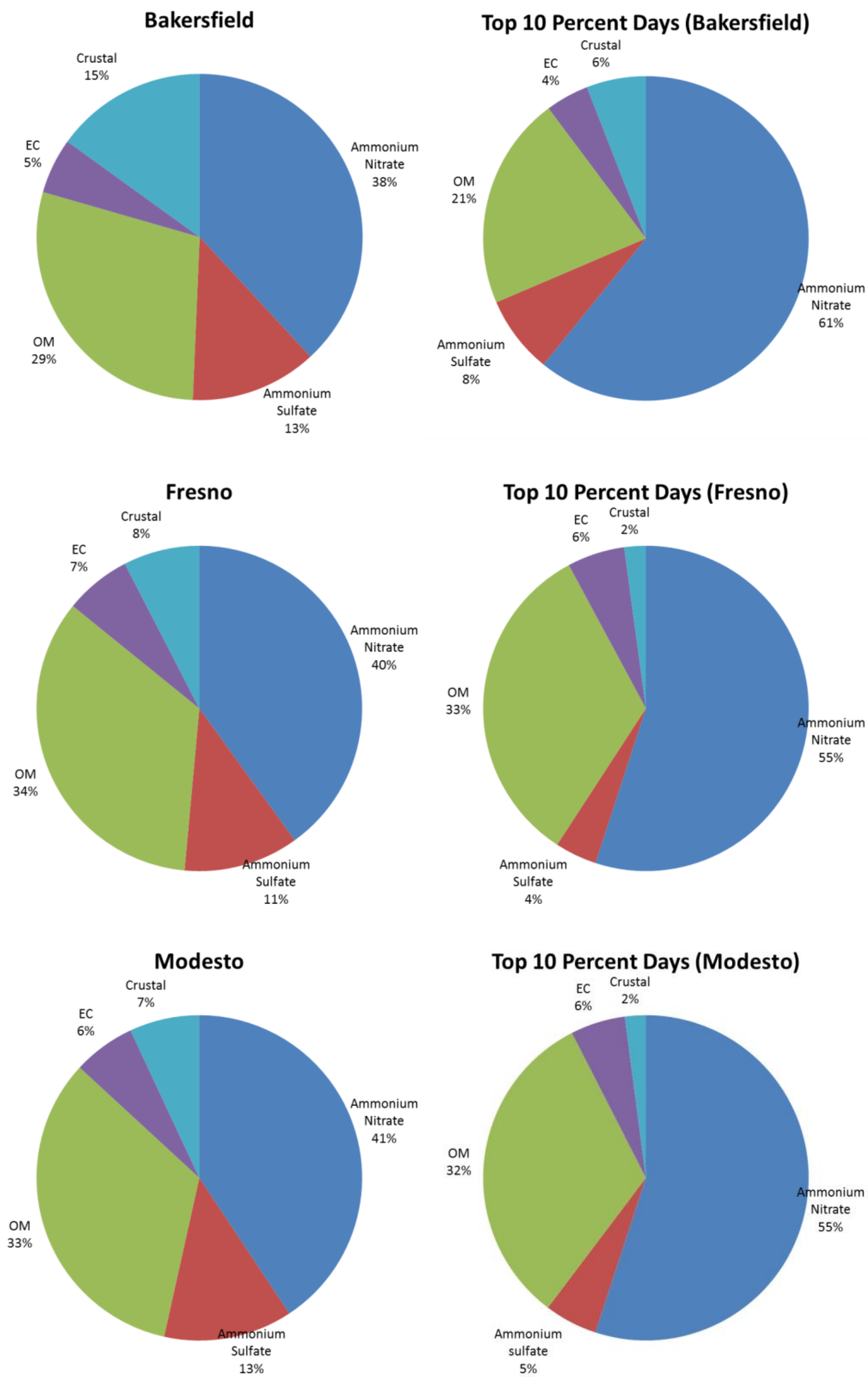

Figure 2-4. Three-year average (2011-2013) and average peak day (top 10 percent over the same three years) $PM_{2.5}$ compositions at Bakersfield, Fresno, and Modesto.

2.5 Seasonality of $PM_{2.5}$ and Meteorological Conditions Leading to Elevated $PM_{2.5}$

$PM_{2.5}$ concentrations in the San Joaquin Valley exhibit a strong seasonal variability, with the highest concentrations occurring during the months of November through February. For example, Figure 2-5 represents the time series of 24-hour $PM_{2.5}$ concentrations at Bakersfield - California Avenue in 2013, which shows a vast majority of the elevated $PM_{2.5}$ episodes occurred in the first two and last two months of the year. The predominance of elevated $PM_{2.5}$ episodes during winter months results from a confluence of meteorological conditions conducive to the formation and buildup of $PM_{2.5}$, as well as wintertime sources of directly emitted $PM_{2.5}$.

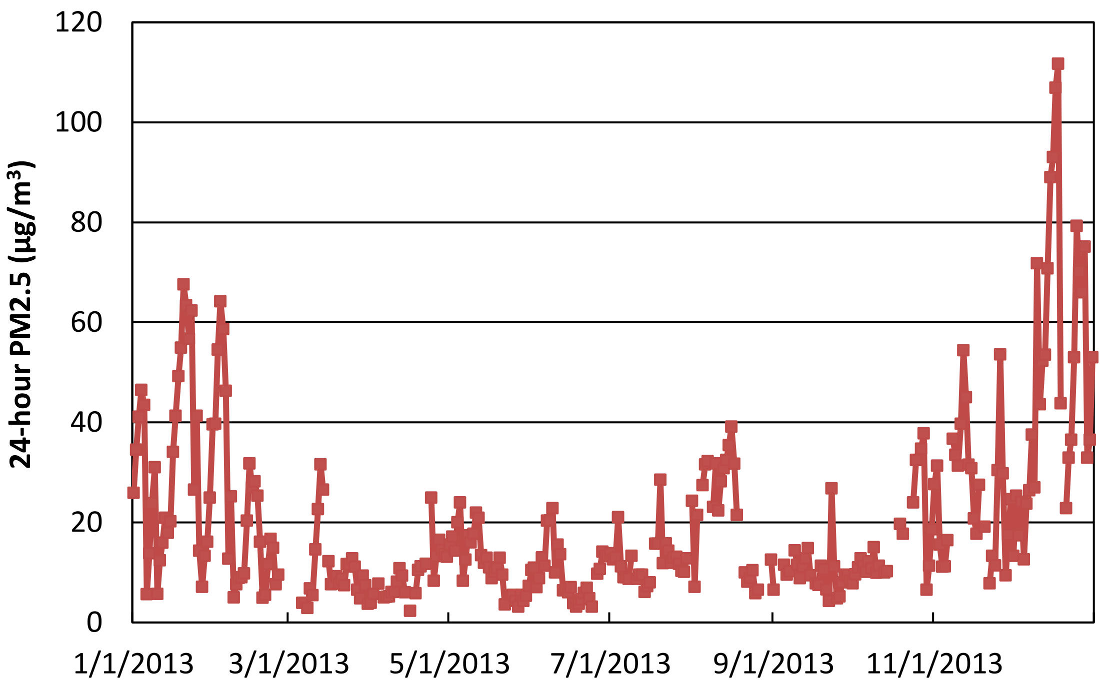

Figure 2-5. 24-hour $PM_{2.5}$ concentrations at Bakersfield- California Avenue in 2013.

High $PM_{2.5}$ concentrations typically build up during multiday episodes under stagnant winter weather when a high pressure system (the Great Basin High) reduces the ventilation in the Valley (Ferreria et al., 2005). These stagnation events, sandwiched between two weather systems, are characterized by low wind speeds, moderate temperatures, vertical atmospheric stability, and high relative humidity. This stable atmosphere prevents precursor gases and primary (or directly emitted) $PM_{2.5}$ released at the surface in the Valley from rapidly dispersing. The moderate temperatures and high relative humidity also enhance the formation of secondary particulate matter, especially ammonium nitrate and sulfate. In contrast, hotter and drier weather conditions in summer favor the evaporation of semi-volatile species from particles. Greater mixing height in summer can also help the ventilation of air pollutants. As a result, summertime $PM_{2.5}$ concentrations in the SJV are typically much lower compared to wintertime.

Wintertime $PM_{2.5}$ episodes can last for many days. At the beginning of an episode, concentrations are low but increase daily because of both the accumulation of primary pollutants and formation of secondary pollutants (Watson et al, 2002). Concentrations continue to build until there is a change in the weather significant enough to wash out particles through rainfall or increased ventilation of the Valley. For example, the two main episodes captured during the CRPAQS field study (starting in late 1999) had up to 18 days with $PM_{2.5}$ concentrations exceeding 65 $\mu g/m^3$ (Turkiewicz et al., 2006). At the end of 2013 and the beginning of 2014, Bakersfield experienced 18 days with $PM_{2.5}$ concentrations greater than 35 $\mu g/m^3$. During such episodes, urban sites typically record elevated concentrations earlier than rural sites, and as a consequence, have a greater number of days with high concentrations. However, due to the buildup of $PM_{2.5}$ concentrations, rural sites can achieve concentrations with similar magnitude as urban sites by the end of an episode.

The elevated wintertime $PM_{2.5}$ concentrations observed during pollution episodes are the result of both directly emitted particulates (known as primary particulate matter) and particulate matter formed via chemical and physical processes in the atmosphere (known as secondary particulate matter). Ammonium nitrate, the dominant $PM_{2.5}$ component throughout the Valley, is formed in the atmosphere as a result of chemical reactions between precursor pollutants such as NO_x, VOC, and ammonia. Carbonaceous aerosol, the second most abundant component, is mostly directly emitted, and is the result of contributions from wood combustion (e.g., wood burning for heating), mobile sources, and cooking.

As shown in Figure 2-4, carbonaceous aerosols and ammonium nitrate together comprise approximately 80 percent of the $PM_{2.5}$ mass. In winter, most of the carbonaceous aerosol is emitted into the atmosphere as directly emitted particles from sources such as wood burning, cooking, and vehicles (Ge et al., 2012; Young et al., 2016), and its transport is much more limited compared to gaseous precursors of ammonium nitrate. Ammonium nitrate can be formed both at the surface and aloft and can be fairly uniform across urban and rural sites. The spatial homogeneity of ammonium nitrate is influenced by higher wind speeds aloft (which allow more efficient transport), and the diurnal variation in mixing heights (which allow entrainment of ammonium nitrate down to the surface).

Ammonium nitrate is also formed via both daytime and nighttime chemistry. The amount of ammonium nitrate produced will be limited by the relative abundance of its precursors in the atmosphere. In the San Joaquin Valley, the nighttime formation is considered to be the most important pathway (Lurmann et al., 2006; Prabhakar et al., 2017). The nighttime pathway involves oxidation of NO_2, followed by reaction with ammonia to form ammonium nitrate. Since ammonia is abundant in the Valley in the winter, NO_x is considered to be the limiting precursor (Chen, et al., 2014; Kleeman, et al., 2005; Parworth, et al., 2017; Prabhakar et al., 2017). In contrast, the daytime pathway also involves VOCs. Modeling studies that investigated winter episodes in the Valley estimated that reductions in VOC emissions have a small impact on nitrate concentrations only at very high $PM_{2.5}$ concentrations (Pun, et al., 2009). However, at current $PM_{2.5}$ levels the impact was very limited, and in some cases VOC reductions lead to an increase in $PM_{2.5}$ concentrations (Chen et al., 2014; Kleeman, et al., 2005).

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Attachment A

Supplement to the Revised Proposed 2016 State Strategy for the SIP

DRAFT

San Joaquin Valley Supplement to the Revised 2016 State Strategy for the State Implementation Plan

AUGUST 27, 2018

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Chapter 1: Introduction

Purpose of the Supplement to the State SIP Strategy

The *2016 State Strategy for the State Implementation Plan* (2016 State SIP Strategy)[1] was adopted in March 2017 by the California Air Resources Board (CARB or Board) and describes the State's initial commitment to take action on measures and to achieve the emission reductions necessary to attain federal ozone and fine particulate matter (PM2.5) standards across California. At the March 2017 Board meeting, CARB staff committed to identifying additional emission reductions for meeting PM2.5 standards in the San Joaquin Valley (Valley). The *San Joaquin Valley Supplement to the 2016 State Strategy for the State Implementation Plan* (Valley State SIP Strategy) describes CARB staff's proposal for a supplemental State commitment for measures and emission reductions to attain health-based federal air quality standards for PM2.5 in the Valley.

Under the federal Clean Air Act (Act), the United States Environmental Protection Agency (U.S. EPA) is required to periodically review the latest health research to ensure that ambient air quality standards remain protective of public health. Based on research demonstrating adverse health effects at lower exposure levels, U.S. EPA has set a series of increasingly health protective air quality standards. The Valley has the most burdensome PM2.5 challenge in the country, and is nonattainment for both the 65 and 35 micrograms per cubic meter ($\mu g/m^3$) 24-hour PM2.5 standards, with attainment dates of 2020 and 2024, respectively; and both the 15 and 12 $\mu g/m^3$ annual standards, with attainment dates of 2020 and 2025, respectively. The Valley is also one of only two areas in the country classified as an Extreme ozone nonattainment area.

Meeting the standards throughout the State will provide essential public health protection for the approximately 12 million Californians currently living in communities that exceed the federal standards for ozone and PM2.5. The health and economic impacts of exposure to elevated levels of ozone and PM2.5 in California are considerable, and meeting federal standards will pay substantial dividends in terms of reducing costs associated with emergency room visits and hospitalization for heart and lung related causes, lost work and school days and reducing incidences of asthma. Most critically, exposure to PM2.5 and ozone is also associated with increased risk of premature mortality, which has been estimated to contribute to 7,500 premature deaths each year in California.

[1] CARB (2017) "Revised Proposed 2016 State Strategy for the State Implementation Plan (State SIP Strategy)" https://www.arb.ca.gov/planning/sip/2016sip/2016sip.htm

Further, Assembly Bill (AB) 617, passed by the California Legislature in 2017, recognized that some communities still suffer greater impacts than others. Communities near ports, railyards, warehouses, and freeways, for example, experience significantly higher air pollution than other areas due to emissions from mobile sources such as cars, trucks, and locomotives. AB 617 along with CARB's new Community Air Protection Program prioritizes efforts in low-income and disadvantaged communities to address cumulative impacts in these communities. Measures in the 2016 State SIP Strategy and the Valley State SIP Strategy will provide substantial benefits for the State's communities most impacted by air pollution.

Given U.S. EPA's recent revisions to air quality standards that established lower, more health protective levels, substantial reductions from both mobile and stationary sources are necessary to reach attainment. This requires comprehensive actions to transform the technologies and fuels we use, the design of our communities, and the way we move people and freight throughout the State.

Such actions to control mobile sources are possible because of California's unique authority to regulate emissions from certain source categories more stringently than the federal government under the Act's §209(b) waiver provision. Over nearly five decades, CARB has consistently sought waivers and authorizations for its new motor vehicle regulations and has received waivers and authorizations for over 100 regulations. CARB's history of progressively strengthening standards as technology advances, coupled with the waiver process requirements, ensures that California's regulations remain the most stringent in the nation, and that necessary emission reductions from the mobile sector continue and ensures that all Californians will be able to breath healthy air in the future.

Mobile sources – cars, trucks, and myriad off-road equipment – and the fossil fuels that power them are the largest contributors to the formation of ozone, PM2.5, toxic diesel particulate matter (diesel PM), and greenhouse gas (GHG) emissions in California. The significant contribution of mobile sources, and the interconnected nature of strategies to meet California's goals, has fostered an integrated planning approach demonstrating the need for a comprehensive transformation to cleaner vehicle technologies, fuels, and energy sources. The measures included in the 2016 State SIP Strategy represent the elements of CARB's Mobile Source Strategy, coupled with measures to reduce emissions from consumer products, necessary to meet Act requirements.

The 2016 State SIP Strategy incorporated the most recently available inventory data, as well as refinements to measures in response to stakeholder feedback and continued technology assessments. The 2016 State SIP Strategy also includes an initial identification of emission reductions for PM2.5 attainment in the Valley, as well as a discussion of estimated funding needs and a process for securing funds to support needed reductions via accelerated turnover of older, dirtier engines and vehicles to the cleanest available technologies.

The Board adopted the 2016 State SIP Strategy on March 23, 2017, creating a commitment to adopt measures according to a defined schedule and a commitment to achieve specified emission reductions in the South Coast and the Valley by specific dates. Specifically for the Valley, the 2016 State SIP Strategy included a commitment for reductions in oxides of nitrogen (NOx) emissions to accelerate ozone progress for the 75 ppb 8-hour ozone standard, and a commitment to return to the Board with a comprehensive plan to attain the PM2.5 standards in the Valley, with a commitment to achieve additional reductions from mobile sources. Staff also received direction from the Board to address emissions from agricultural equipment. The Valley State SIP Strategy builds upon the actions in the 2016 State SIP Strategy and addresses Board direction to define the remainder of the commitment needed for the Valley to meet federal PM2.5 standards.

The Valley State SIP Strategy includes the State SIP Strategy as Appendix A and describes the complete strategy to control emissions from mobile sources to achieve the necessary reductions for attainment of federal PM2.5 standards in the Valley. At the same time, the San Joaquin Valley Air Pollution Control District (District) has developed new actions to further control emissions from stationary and area-wide sources. It is a broad suite of actions to reduce emissions across both the mobile and stationary source sectors that will provide a pathway for the Valley to meet federal PM2.5 standards.

Valley Emission Reduction Needs for PM2.5

The Valley has the most critical PM2.5 challenge in the nation, and - together with the South Coast - is one of only two Extreme ozone nonattainment areas. The Valley is nonattainment for multiple PM2.5 standards including: the 65 µg/m^3 24-hour standard, 15 µg/m^3 annual standard, the 35 µg/m^3 24-hour standard, and the 12 µg/m^3 annual standard, as shown in Table 1.

Table 1: Valley Attainment Dates for PM2.5 Standards

Standard	Attainment Date
65 µg/m^3 24-hour PM2.5 standard (1997 standard)	2020
15 µg/m^3 annual PM2.5 standards (1997 standard)	2020
35 µg/m^3 24-hour PM2.5 standard (2006 standard)	2024
12 µg/m^3 annual PM2.5 standard (2012 standard)	2025

The PM2.5 attainment strategy for the Valley must take into consideration the diversity of sources that contribute to PM2.5, as well as the specific timeframes of meeting both the annual and 24-hour PM2.5 standards. PM2.5 in the Valley comes from a variety of sources, including directly emitted particles such as carbon (smoke and soot), and dust, as well as particles that are formed through interactions between precursor gases, such as ammonium nitrate and ammonium sulfate.

Air quality measurements and modeling have shown that mobile source emissions are a significant contributor to PM2.5 levels in the Valley. These contributions come through both directly emitted PM2.5, and gaseous precursors such as NOx, which can form secondary PM2.5 in the atmosphere. Overall, mobile sources contribute to about 50 to 60 percent of the particles that make up PM2.5 in the Valley. They are the dominant contributor to NOx emissions in the Valley, accounting for approximately 85 percent of NOx. Mobile sources also account for over 95 percent of toxic diesel particulate matter emissions. Diesel particulate matter is part of the carbon particles that are dominated by local sources such as residential wood burning and commercial cooking. The overall contribution of mobile sources to Valley PM2.5 pollution highlights the role of reducing emissions from these sources as part of a successful control strategy.

Current Control Program

CARB's existing mobile source control program has achieved substantial reductions in in the Valley, and will continue to provide further emission reductions from ongoing implementation. Since 2000, NOx and PM2.5 emissions from mobile sources have been reduced by over 60 percent. Continued implementation of CARB's current mobile source programs will result in significant further reductions by 2025, reducing NOx emissions from 2013 levels by 55 percent and PM2.5 emissions by nearly 40 percent.

These reductions have relied on a suite of policy and regulatory mechanisms that includes establishing emissions and performance standards for new vehicles and fuels, setting mandates and sales requirements for advanced technologies, creating pilot programs to encourage development of new technologies, and implementing incentive and other programs to accelerate technology deployment. Together, these approaches are designed to achieve progressively cleaner emission levels for the entire mobile fleet.

Unique to the Valley is the significant presence of agricultural operations throughout the area, with agricultural equipment emitting 18 percent of the total NOx emissions. The agricultural industry in the Valley has a long and successful history of efforts to secure funding for incentives to turn over the fleet of agricultural vehicles and engines that power these operations. Since 1992, the District's incentive program have provided over $688 million in incentive funds. This has been matched by cost-sharing on the part of participating businesses in the industry, public agencies, and residents, who together have invested over $526 million, for a total public/private investment of well over $1.2 billion in low and zero emissions equipment and operations. These combined efforts have accelerated the adoption of cleaner technologies achieving over 117,000 tons of lifetime emission reductions.[2]

[2] SJVAPCD "2017 Annual Demonstration Report" (August 2017) http://www.valleyair.org/MOP/docs/2017_Final_AnnualDemonstrationReport_AppendixAB.PDF

2016 State SIP Strategy

Although the current control programs will continue to provide substantial reductions through 2025, significant further reductions will be required to meet air quality standards. Technology assessments have identified the next generation of technologies and fuels now becoming available that will need to comprise California's transition to a cleaner, more efficient transportation system.[3] The 2016 State SIP Strategy identified a suite of regulatory and incentive programs, referred to as SIP measures, designed to deploy the cleaner technologies and fuels identified in the technology assessments.

SIPs must contain enforceable commitments to achieve the level of emissions necessary to meet federal air quality standards as defined by the attainment demonstration. The 2016 State SIP Strategy that the Board approved in March 2017 included a commitment to bring to the Board or otherwise take action on defined measures according to the schedule identified. Shown in Table 2 are the measures that are a part of the mobile source program for the Valley; Table 2 does not include measures to further deployment of advanced technology included in the State SIP Strategy exclusively for the South Coast Air Basin as permitted under Clean Air Act section 182(e)(5).

[3] Technology and Fuels Assessments can be found at: https://www.arb.ca.gov/msprog/tech/tech.htm

Table 2: 2016 State SIP Strategy Measures and Schedule for the San Joaquin Valley

Measures	Agency	Action	Implementation Begins
2016 State SIP Strategy Measures			
Advanced Clean Cars 2 Reduced ZEV Brake and Tire Wear	CARB	2020 – 2021	2026
Lower In-Use Emission Performance Level: Lower Opacity Limits for Heavy-Duty Vehicles Amended Warranty Requirements for Heavy-Duty Vehicles Inspection and Maintenance Program for Heavy-Duty Vehicles	CARB	2017 – 2020	2018 +
Low-NOx Engine Standard – California Action	CARB	2019	2023
Low-NOx Engine Standard – Federal Action	U.S. EPA	2019	2024
Innovative Clean Transit	CARB	2018 – 2019	2020
Advanced Clean Local Trucks (Last Mile Delivery)	CARB	2019	2020
Zero-Emission Airport Shuttle Buses	CARB	2018	2023
More Stringent National Locomotive Emission Standards	U.S. EPA	2017	2023 +
Zero-Emission Off-Road Forklift Regulation Phase 1	CARB	2020	2023
Zero-Emission Airport Ground Support Equipment	CARB	2019	2023
Small Off-Road Engines	CARB	2018 – 2020	2022
Transport Refrigeration Units Used for Cold Storage	CARB	2018 – 2019	2020 +
Low-Emission Diesel Fuel Requirement	CARB	by 2020	2023

The 2016 State SIP Strategy also included an aggregate emission reduction commitment for 8 tpd of NOx reductions in the Valley from measures under CARB direct regulatory authority. This commitment, when coupled with strong action at the federal level, will achieve a total of 17 tpd of NOx emission reductions in the Valley in 2031, as shown in Table 3. While the commitment for quantified reductions in the San Joaquin Valley was adopted only for the year 2031, expected emission reductions from the measures in the 2016 State SIP Strategy were also calculated for 2025. These reductions reflect the benefits of new vehicles entering the fleet due to the regulatory measures in the 2016 State SIP Strategy to accelerate ozone progress, and serve as a down payment on the reductions needed to meet PM2.5 standards.

Table 3: Expected Emission Reductions in the San Joaquin Valley from 2016 State SIP Strategy Measures

Measures	2025^		2031
	NOx (tpd)	PM2.5 (tpd)	NOx (tpd)
2016 State SIP Strategy Measures			
Advanced Clean Cars 2 Reduced ZEV Brake and Tire Wear	--	--	0.2
Lower In-Use Emission Performance Level Lower Opacity Limits for Heavy-Duty Vehicles Amended Warranty Requirements for Heavy-Duty Vehicles Inspection and Maintenance Program for Heavy-Duty Vehicles	NYQ	<0.1	NYQ
Low-NOx Engine Standard – California Action	2	--	7
Low-NOx Engine Standard – Federal Action	2	--	8
Innovative Clean Transit	<0.1	<0.1	<0.1
Advanced Clean Local Trucks (Last Mile Delivery)	<0.1	<0.1	0.2
Zero-Emission Airport Shuttle Buses	--	--	<0.1
More Stringent National Locomotive Emission Standards	0.1	<0.1	1
Zero-Emission Off-Road Forklift Regulation Phase 1	--	<0.1	<0.1
Zero-Emission Airport Ground Support Equipment	<0.1	<0.1	<0.1
Small Off-Road Engines	0.1	<0.1	0.3
Transport Refrigeration Units Used for Cold Storage	NYQ	NYQ	NYQ
Low-Emission Diesel Fuel Requirement	1	0.1	0.5
Aggregate Emission Reductions	**6**	**0.1**	**17**

"NYQ" denotes emission reductions are Not Yet Quantified
"—" denotes no anticipated reductions
^ 2025 reductions quantified, but not committed to in the 2016 State SIP Strategy
The SIP-creditable measures as proposed by staff to the Board or adopted by the Board may provide more or less reductions than the amount shown.

For adopted measures that are not under CARB's regulatory authority, CARB staff committed to take the appropriate actions as identified in the proposed measure descriptions. These actions include petitioning U.S. EPA for federal action on sources under their authority and working with the California Bureau of Automotive Repair to conduct an In-Use Performance Assessment. The measures committed to in the 2016 State SIP Strategy are fully described in Appendix A.

While Table 3 includes estimates of the emission reductions from each of the individual measures, CARB's overall commitment is to achieve the total emission reductions necessary to attain the federal air quality standards, reflecting the combined reductions from the existing control strategy and new measures. Therefore, if a particular measure does not get its expected emission reductions, the State is still committed to achieving the total aggregate emission reductions. CARB's aggregate emission reduction commitments may be achieved through a combination of actions including but not limited to the implementation of control measures; the expenditure of local, State or federal incentive funds; or through the implementation of other enforceable measures.

Included in the 2016 State SIP Strategy was a call for action by U.S. EPA to develop a national low-NOx engine standard. In addition, local air districts in the State have formally petitioned U.S. EPA to adopt 0.02 g/bhp-hr NOx standards for medium- and heavy-duty truck engines nationally. As CARB moves forward with actions under its authority, staff continues to work with federal and international agencies to advocate for more stringent emission standards for sources that are not under CARB's regulatory purview.

Proposed State Measures for the Valley

Given the earlier attainment dates for PM2.5 compared to ozone, accelerating the pace of NOx reductions will be necessary. While ongoing mobile source NOx reductions will provide for significant regional improvement, strategic use of incentive funding will be essential to achieve earlier penetration of cleaner technologies. CARB's science-based assessment of a strategy focusing on both direct PM2.5 and NOx suggests that a total of 32 tpd of NOx reductions in 2024, in addition to the 157 tpd of NOx reductions from the existing program, would provide the share of mobile source NOx reductions needed to meet both the annual and 24-hour PM2.5 standards in the Valley.

Since Board adoption of the 2016 State SIP Strategy in March 2017, CARB staff has further refined the final emission reduction needs and strategies, including funding mechanisms, to accelerate turnover to the technologies identified in the State SIP Strategy. This also includes efforts to reflect the benefits of additional transformational efforts underway in the Valley as part of other planning efforts that are anticipated to provide criteria emission reduction co-benefits, such as climate programs and the Sustainable Freight Action Plan. As an outcome of that process, the Valley State SIP Strategy includes updates to certain measures in the 2016 State SIP Strategy and proposes additional mobile source measures needed for the Valley's PM2.5 SIP. Chapter 2 describes the updated 2016 State SIP Strategy measures and the Proposed State Measures for the Valley, and Chapter 3 describes CARB staff's proposed commitment for the Valley's PM2.5 SIP.

The measures in the Valley State SIP Strategy build upon the regulatory measures in the 2016 State SIP Strategy and accelerate turnover to the next generation of cleaner technologies in the Valley. These additional measures include new requirements that would ensure that on-road, heavy-duty vehicles remain as clean as possible throughout their lifetime, and incentive measures to accelerate the turnover of agricultural tractors, on-road heavy-duty vehicles, and off-road equipment. Given their contribution to ambient PM2.5 levels in the Valley, District measures to achieve additional reductions from local sources of directly emitted PM2.5 will also be critical.

Combined, the actions in the 2016 State SIP Strategy and the Valley State SIP Strategy provide the share of mobile source reductions needed for attainment. Table 4 summarizes the combined reductions that will accrue through implementation of the current control program, the measures committed to in the 2016 State SIP Strategy, and the measures in the Valley State SIP Strategy. In aggregate, they will reduce emissions from 2013 levels by 189 tpd NOx and 5.5 tpd PM2.5 by 2024, and 194 tpd NOx and 5.6 tpd PM2.5 by 2025.

Table 4: Emission Reductions from State Measures

	2024		2025	
	NOx (tpd)	**PM2.5** (tpd)	**NOx** (tpd)	**PM2.5** (tpd)
Current Control Program	157	4.6	162	4.7
Measures	32	0.9	32	0.9
2016 State SIP Strategy Measures	*9*	*0.1*	*12*	*0.1*
Proposed State Measures for the Valley	*23*	*0.8*	*20*	*0.8*
Total Reductions	189	5.5	194	5.6

Over 70 percent of the reductions needed to meet the standards in 2024 and 2025 will come from regulatory actions associated with ongoing implementation of the existing control program, combined with regulatory measures identified in the Valley State SIP Strategy. The remaining reductions will come from additional efforts to enhance the deployment of these cleaner technologies through new incentive funding. Given the need for near-term reductions, significant investments to support incentive programs will be critical to accelerate the penetration of the cleanest technologies.

Overview of Strategy

Regulatory actions comprise the core of the overall attainment strategy, although the relative proportion varies by sector reflecting differences in the maturity of the current control program, regulatory authority, and status of technology development. For on-road sectors, implementation of the current control program, coupled with new regulatory measures to require introduction of even cleaner technologies for cars and trucks, provides a 70 percent reduction in NOx emissions by 2025 from 2013 levels. This strategy also includes a proposed commitment for additional reductions from accelerating the penetration of the cleanest near-zero and zero-emission trucks and buses. The success of current incentive programs provides a model for expanded funding to achieve this additional deployment. Combined, actions in this strategy for on-road sources will reduce NOx emissions over 80 percent by 2025, from 2013 levels.

Achieving reductions in the off-road sectors remains a greater challenge due to the diverse nature of these sources, regulatory authority that rests outside of CARB in many cases, and the length of time sources remain in the fleet. The 2016 State SIP Strategy includes key regulatory actions to establish the next tier of cleaner combustion for locomotives, and introduction of ZEV technologies for smaller off-road equipment. These actions, when coupled with current regulatory programs will reduce NOx emissions from off-road and federal sources by 37 percent by 2025, from 2013 levels. While regulatory actions will continue to drive the introduction of the cleanest mobile technologies in off-road sectors, the natural pace of fleet turnover will need to be accelerated to provide sufficient reductions to meet the Valley's PM2.5 attainment needs. CARB and District staff have identified opportunities for additional emission reductions through accelerating the turn-over of older, higher-emitting engines to the cleanest technologies including agricultural tractors, forklifts, transport refrigeration units, construction equipment, and drilling rigs. Accelerating the deployment of cleaner technologies in these categories provides the mechanism for additional reductions, which in combination with regulatory actions, will reduce NOx emissions from off-road sectors 51 percent by 2025, from 2013 levels.

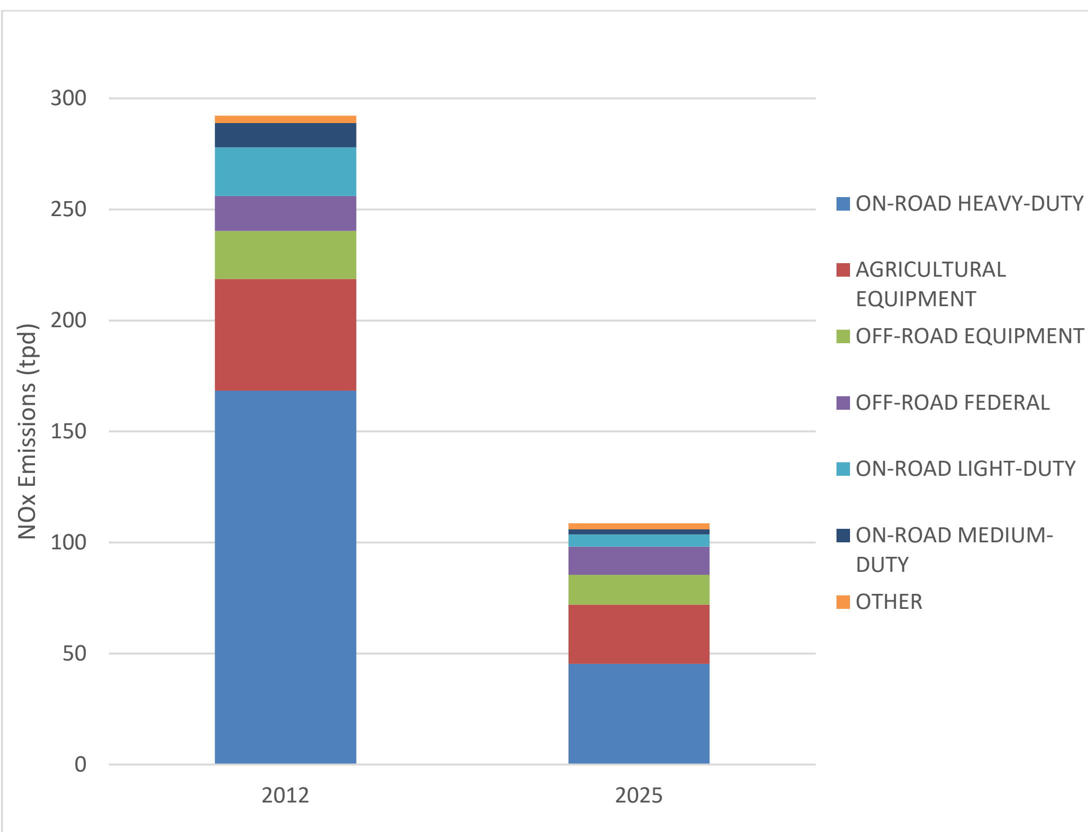
This document describes CARB staff's mobile source control strategy for attaining federal PM2.5 standards in the San Joaquin Valley. The 2016 State SIP Strategy, included here as Attachment A, included regulatory measures to require introduction of cleaner technologies for cars, trucks, and certain off-road equipment. The supplement provided in this document include updates and expansions to two measures in the adopted strategy, *Advanced Clean Cars 2* and *Lower In-Use Emission Performance Level,* as well as new measures. The new measures, titled the Proposed State Measures for the Valley, were developed specifically to reach attainment of PM2.5 standards in the Valley by accelerating turnover of both on- and off-road engines to near-zero and zero emission technology. Staff's proposal contained within the Valley State SIP Strategy is to adopt the Proposed State Measures for the Valley and to achieve the specified aggregate reductions in the 2024/2025 timeframe.

Chapter 2: Measures

Staff has identified certain categories as the best opportunities for additional PM2.5-related emission reductions from mobile sources in the Valley. The measures described in this chapter include actions that are updated elements of measures in the 2016 State SIP Strategy as well as the Proposed State Measures for the Valley. In addition, further opportunities to gain SIP-creditable criteria pollutant emission reductions from programs already in place have been identified and are described in this chapter.

As can be seen in Figure 1, on-road heavy-duty vehicles, agricultural equipment, and off-road equipment are the largest sources and contribute over 75 percent of mobile source NOx emissions in the Valley. Consequently, the measures in the Valley State SIP Strategy will target these three source categories through both regulatory and incentive measures.

Figure 1: Mobile Source NOx Emissions in the Valley
(under current program)



Updated State SIP Strategy Measures

Heavy-duty trucks with a gross vehicle weight rating (GVWR) over 8,500 pounds are the fastest growing transportation sector in the United States and are responsible for about 33 percent of total Statewide NOx emissions, approximately 26 percent of total Statewide diesel PM emissions, and are a significant source of GHG emissions. As shown in Figure 2, on-road heavy-duty vehicles are the single largest source of NOx emissions in the Valley, reflecting the role the Valley plays as an essential transportation corridor through the State. As such, the heavy-duty truck strategy for the Valley includes measures to reduce emissions from this sector through both regulatory and incentive programs.

Substantial progress has been made in refining staff's approach to controlling the in-use emissions from the on-road heavy-duty truck fleet, as originally described in the *Lower In-Use Emission Performance Level* 2016 State SIP Strategy measure. The actions initially proposed are now reflected in this document in three updated and separate descriptions: the *Lower Opacity Limits for Heavy-Duty Vehicles* element; the *Amended Warranty Requirements for On-Road Heavy-Duty Vehicles* element; and the *Heavy-Duty Vehicle Inspection and Maintenance Program* element.

Passenger cars and light trucks (up to 8,500 lbs., otherwise called light-duty vehicles), are another significant contributor to NOx emissions in California. The State's 39 million residents collectively own approximately 25 million passenger vehicles and drive more than most other Americans. The vast majority of these vehicles have internal combustion engines and use gasoline. A small portion is powered by diesel compression ignition engines, and a smaller portion has electric powertrains. The light-duty vehicle sector is projected to increasingly rely on new technology such as battery electric, plug-in hybrid, and fuel cell electric vehicles.

The 2016 State SIP Strategy also included the *Advanced Clean Cars 2* measure for CARB to consider expanded California-specific standards for new light-duty vehicles to increase the number of new ZEVs and plug-in hybrid electric vehicles (PHEV) sold in California, with the goal to make sure that near-zero and zero-emission technology options continue to be commercially available. CARB's Advanced Clean Cars program has in recent years been a driver of turnover to low- and zero-emission vehicles in the light-duty sector; the program combines the control of criteria pollutants and greenhouse gas emissions into a single coordinated set of requirements for light-duty vehicles of model years 2015 through 2025 ensuring the development of environmentally superior passenger cars and other vehicles.

In addition to the benefits of the SIP measure, there are criteria pollutant emission reductions from the Advanced Clean Cars program which have not been quantified for SIP purposes. Action to quantify these SIP-creditable reductions is described in the *Reduced ZEV Brake and Tire Wear* element.

Table 5 includes the full list of four items developed as updates to measures in the 2016 State SIP Strategy.

Table 5: Updates to 2016 State SIP Strategy Measures

2016 State SIP Strategy Measures
Lower In-Use Emission Performance Level
Lower Opacity Limits for Heavy-Duty Vehicles
Amended Warranty Requirements for On-Road Heavy-Duty Vehicles
Heavy-Duty Vehicle Inspection and Maintenance Program
Advanced Clean Cars 2
Reduced ZEV Brake and Tire Wear

Proposed State Measures for the Valley

On-road heavy-duty vehicles represent the first category to be targeted for accelerated turnover of the older, higher-emitting vehicles and engines to the cleanest technologies available. Given that there is potential to use both existing and new incentive funding, all possibilities are discussed in the *Accelerated Turnover of Trucks and Buses* measure.

In addition to on-road vehicles, tractors used in agricultural applications are a mobile category that offers the potential to achieve substantial further emission reductions by accelerating turnover. Since 2009, over $400 million in private and public funding has been invested in the Valley for the replacement of older agricultural tractors with newer, cleaner models, with significant continued investments ongoing. Further reductions from agricultural tractors will continue to play a significant role in our efforts to reduce emissions from mobile sources. The *Accelerated Turnover of Agricultural Tractors* measure describes the State's plan to use incentive funding to accelerate the turnover of these tractors in the near-term.

The *Cleaner In-Use Agricultural Equipment* measure is a proposed measure that is designed to increase the penetration of cleaner agricultural equipment in California. This measure would be developed by 2025 and incorporate a phase-in approach to support the use of tier 2 or cleaner engines in agricultural tractors in the Valley by 2030. The backstop could serve as an overall target, while at the same time acting as a catalyst for attracting early replacement of agricultural equipment using incentives.

Aside from agricultural tractors, other off-road equipment categories that offer the potential to achieve further emission reductions for the Valley through accelerated turnover include construction equipment, transport refrigeration units (TRU), forklifts, and drilling rigs. Of the construction equipment group, the greatest opportunity for NOx reductions lies in continuing to incentivize turnover to the current tier 4 new engine standard beyond the accelerated turnover already required by CARB's in-use off-road diesel vehicle regulation Replacing TRU combustion engines is another means for emission reductions as there are many lower-emission engine options already commercially available. Given the nearly 4,000 forklifts and numerous drill rigs operating in the Valley, accelerating the turnover of combustion engines used in these applications to cleaner engines represents another excellent opportunity for NOx emission reductions.

Table 6 shows the measures in the Valley State SIP Strategy developed by CARB to achieve the mobile source emission reductions needed to attain federal PM2.5 standards in the Valley. Given the diversity of equipment and duty cycles that comprises these categories, each measure includes a more detailed description of the specific source.

Table 6: Measures in the Valley State SIP Strategy

Proposed State Measures for the Valley
Accelerated Turnover of Trucks and Buses
Existing Incentive Projects
New Incentive Projects
Accelerated Turnover of Agricultural Equipment
Existing Incentive Projects
New Incentive Projects
Cleaner In-Use Agricultural Equipment
Accelerated Turnover of Off-Road Equipment
New Incentive Projects

The remainder of this chapter includes the full descriptions of the updated 2016 State SIP Strategy measures and Proposed State Measures for the Valley.

Lower Opacity Limits for Heavy-Duty Vehicles (Updated 2016 State SIP Strategy Measure)

Overview:

As supplemental action of the original *Lower In-Use Emission Performance Level* measure, this element consists of lowering opacity limits for heavy-duty vehicles to limits that better reflect the current emission control technology equipped on today's heavy-duty diesel vehicles. The goal of this action is to ensure that in-use, heavy-duty vehicles continue to operate at their cleanest possible level. In July of 2018, the Board approved the staff-recommended lower opacity limits for heavy-duty trucks.

Background:

Heavy-duty vehicles in California are subject to in-use inspections in order to control excessive smoke emissions and tampering. CARB's current heavy-duty vehicle inspection programs are described below:

- The Heavy-Duty Vehicle Inspection Program (HDVIP), adopted into law in 1988, requires heavy-duty vehicles to be inspected for smoke opacity (i.e., excessive smoke), tampering, and engine certification label compliance. Any heavy-duty vehicle operating in California, including vehicles registered in other states and foreign countries, may be inspected. Inspections are performed by CARB inspection teams at border crossings, California Highway Patrol weigh stations, fleet facilities, and randomly selected roadside locations.

- The Periodic Smoke Inspection Program (PSIP), adopted into law in 1990, requires heavy-duty vehicle fleet owners to conduct annual smoke opacity inspections of their vehicles, and repair them if excessive smoke emissions are observed. In addition, CARB has the authority to perform random fleet audits, by reviewing the owners' maintenance and inspection records, and conducting opacity inspections on a representative sample of the vehicles.

- The Emissions Control Label Inspection Program requires all vehicles operating in California be equipped with engines that meet California and/or U.S. EPA emission standards. The engine must have an emissions control label which is legible, displayed as originally installed by the engine manufacturer, and must match the engine serial number stamped on the engine. Owners of applicable vehicles not meeting the emissions control label requirements are subject to a penalty.

The Board is in the process of changing the opacity limits required under the HDVIP and PSIP, which are currently 40 percent for 1991 model year (MY) and newer engines and 55 percent for pre-1991 MY engines. These opacity limits are no longer adequate to identify and require repairs of vehicles operating with damaged PM emission control components. To meet U.S. EPA and CARB new engine standards, beginning with the

2007 model year, all new heavy-duty engines come equipped with a diesel particulate filter (DPF). Because CARB has also established fleet rules that accelerate turnover to the 2007 and newer engines and require older vehicles to be retrofitted with DPFs, the vast majority of heavy-duty diesel vehicles on California's roads are equipped with a DPF. Vehicles operating with properly functioning DPFs emit exhaust at opacity levels at or near zero percent. Even vehicles with heavily damaged and malfunctioning emission control systems emit exhaust at opacity levels below the out-of-date, 40 and 55 percent opacity limits.

Actions:

In July of 2018, the Board approved for adoption staff's proposal to lower the opacity limits for heavy-duty trucks to limits that better reflect the current emission control technology equipped on today's heavy-duty diesel vehicles. The approved amendments lower the opacity limits to 5 percent for vehicles equipped with a DPF and also reduce the opacity limits for non-DPF equipped vehicles from their previous levels.

Lowering the opacity limits to the proposed levels will help ensure that the opacity limits are more representative of current PM emission control technology and that vehicles operating with malfunctioning PM emission control components are more readily identified and repaired.

Amended Warranty Requirements for On-Road Heavy-Duty Vehicles (Updated 2016 State SIP Strategy Measure)

Overview:

As supplemental action of the original *Lower In-Use Emission Performance Level* measure, this element consists of developing lengthened warranty period requirements for on-road heavy-duty vehicles with GVWR greater than 14,000 lbs. The primary goal of this action is to reduce NOx and PM emissions by encouraging vehicle owners to make emission-related repairs. This action may also encourage manufacturers to design more durable components.

Background:

In 1978, CARB adopted emission warranty regulations to clarify the rights and responsibilities of individual motor vehicle and engine owners, motor vehicle and engine manufacturers, and the service industry. The emission warranty is used to cover any repairs needed to correct defects in materials or workmanship which would cause an engine or vehicle not to meet its applicable emission standards.

In 1982, CARB adopted regulations that established California's first in-use recall program. These regulations were intended to reduce vehicular emissions by ensuring that noncompliant vehicles are identified, recalled, and repaired to comply with the applicable emission standards and regulations during customer use, and to encourage manufacturers to improve the design and durability of emission control components to avoid the expense of a recall.

In 1982 and 1984, U.S. EPA promulgated heavy-duty vehicle useful life and warranty requirements identical to those adopted in California. Both CARB and U.S. EPA require that heavy-duty vehicles meet emission standards throughout their useful life periods.

The current heavy-duty vehicle emission warranty period is 100,000 miles for all categories of heavy-duty vehicles with GVWR greater than 14,000 lbs. This mileage is typically reached relatively early in vehicle lives, especially for vehicles with GVWR greater than 33,000 lbs., and well before the mileage at which rebuild typically occurs.

Recent CARB studies have identified some heavy-duty vehicles with NOx emission levels significantly above their applicable certification standards while still within the vehicles' useful lives, and the Board is in the process of lengthening the warranty periods and making other improvements to the heavy-duty warranty requirements.

Actions:

In June of 2018, the Board approved for adoption staff's proposal to lengthen the current 100,000 mile emissions warranty period up to as high as 350,000 miles, as well as to strengthen maintenance intervals, link warranty to illumination of the on-board diagnostic malfunction indicator light, and clarify regulatory language. The June 2018 rulemaking is a first step, and will help ensure that emission-related parts are warranted throughout a greater portion of the vehicles' service life. A later second step is expected to be proposed within the next few years that could lengthen the mileage warranty periods further, potentially to the useful life or beyond, as applicable, for each classification of heavy-duty engine type.

Heavy-Duty Vehicle Inspection and Maintenance Program (Updated 2016 State SIP Strategy Measure)

Overview:

As a supplemental action of the original *Lower In-Use Emission Performance Level* measure, the goal of the Heavy-Duty Vehicle Inspection and Maintenance (HD I/M) program would be to ensure that in-use emission control components and systems are properly functioning so that these vehicles continue to operate at their cleanest possible levels for the duration of their on-road operation. For this action, CARB staff would develop and propose a regulatory program that reflects the current state of advanced engine and exhaust emission control technologies, including on-board diagnostics (OBD).

Background:

CARB's existing inspection programs for heavy-duty vehicles test for excessive smoke emissions and tampering, but not for other pollutants of concern from the heavy-duty vehicle sector. These programs, the HDVIP and the PSIP, are described below and discussed in more detail in the section on the measure for Lower Opacity Limits for Heavy-Duty Vehicles. These inspection programs have been successfully implemented since the early 1990s, and with recent amendments, better reflect the current emission control technology equipped on today's heavy-duty diesel vehicles.

- HDVIP, adopted into law in 1988, requires heavy-duty vehicles to be inspected for smoke opacity (i.e., excessive smoke), tampering, and engine certification label compliance. Any heavy-duty vehicle operating in California, including vehicles registered in other states and foreign countries, may be inspected. Inspections are performed by CARB inspection teams at border crossings, California Highway Patrol weigh stations, fleet facilities, and randomly selected roadside locations, and also include emissions control label inspections as described in the Lower Opacity Limits measure.

- PSIP, adopted into law in 1990, requires heavy-duty vehicle fleet owners to conduct annual smoke opacity inspections of their vehicles, and repair them if excessive smoke emissions are observed. In addition, CARB has the authority to perform random fleet audits, by reviewing the owners' maintenance and inspection records, and conducting opacity inspections on a representative sample of the vehicles.

Actions:

CARB staff's current concept for a comprehensive, multi-pollutant HD I/M program is based largely on the extensive capabilities of OBD systems in newer engines (2013 and later model year engines) for monitoring the performance of nearly every engine and emission control component. Under this program concept, heavy-duty vehicles would be required to demonstrate annual compliance with the HD I/M program in order to register with the Department of Motor Vehicles. This program concept also includes the use of telematics for OBD data transmittal to provide ease-of-of access to truckers, kiosks located at border weigh stations to obtain OBD data from out-of-state vehicles entering California, physical testing for older vehicles with pre-OBD engines (e.g., smoke opacity testing), and a program validation component.

While CARB has overarching authority to regulate emissions from on-road heavy-duty vehicles, staff believes additional legislation that will enhance the regulatory authority for a HD I/M program sufficient to achieve the targeted reductions would be beneficial. In 2017, State Senator Connie Leyva introduced legislation (draft Senate Bill 210; 2017) that directed CARB to work with appropriate State agency partners to develop and implement a HD I/M program. While Senate Bill 210 did not move forward during the 2018 legislative session, CARB staff anticipates that HD I/M legislation will be re-introduced in the 2019 session.

Reduced ZEV Brake and Tire Wear (Updated 2016 State SIP Strategy Measure)

Overview:

As part of the *Advanced Clean Cars 2* measure, the goal of this action is to evaluate and quantify the benefits that will accrue from the expanded number of new ZEVs and PHEVs sold in California, which is driven by the Advanced Clean Cars program. As these vehicles continue to be commercially available, the new technologies they employ, including regenerative braking and lower rolling resistance tires, may reduce emissions from brake and tire wear.

Background / Regulatory History:

Since setting the nation's first motor vehicle exhaust emission standards in 1966 that 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 NOx emissions along with hydrocarbon emissions, which together form smog. The simultaneous control of emissions from motor vehicles and fuels led to the use of cleaner-burning gasoline that has removed the emissions equivalent of 3.5 million vehicles from California's roads. Since CARB first adopted it in 1990, the LEV I and LEV II, and the ZEV Programs have resulted in the production and sales of hundreds of thousands of ZEVs in California. More recently, there is a focus on reducing GHGs from motor vehicles. Transportation is California's largest source of carbon dioxide, with passenger vehicles and light-duty trucks creating more than 30 percent of total climate change emissions. CARB adopted the first GHG emission standards for new passenger vehicles in the United States, effective with the 2009 model year.

Actions:

For this element, CARB staff would quantify the benefits that may accrue from new technologies employed in fuel cell and plug-in electric vehicles, including regenerative braking and lower rolling resistance tires, which can reduce emissions from brake and tire wear. As increasing numbers of zero-emission vehicles enter the fleet over the coming decade, these technologies could offer opportunities to reduce PM2.5 emissions from the passenger vehicle fleet.

Estimated Emission Reductions:

While emission reductions have not been identified at this time, CARB will quantify any emission reductions from this action during the SIP-creditable measure development process.

Accelerated Turnover of Trucks and Buses (Proposed State Measure for the Valley)

Overview:

The goal of this proposed measure is to provide incentive funding to accelerate the penetration of near-zero and zero-emission engines beyond the rate of natural turnover achieved through implementation of the other measures identified for on-road heavy-duty trucks and buses. Reductions may also be quantified from projects already funded and executed that will provide SIP-creditable reductions in 2024 and 2025.

Background / Regulatory History:

While regulatory actions will continue to drive the introduction of the cleanest mobile technologies for heavy-duty trucks, the natural pace of fleet turnover will need to be accelerated to provide sufficient reductions to meet the Valley's PM2.5 attainment needs. Additional NOx emission reductions can be achieved through the use of existing and future incentive funds to help increase the penetration of the cleanest heavy-duty engine technology. The District's existing Truck Voucher Program has replaced more than 1,200 Valley-based heavy-duty trucks with newer, cleaner trucks to date, through allocation of over $50 million in incentive funds. The Truck Voucher Program operates as a partnership with Valley truck companies and truck dealerships to replace older, higher-polluting trucks with new, low-emission trucks. In January 2017, the District received an additional $2.5 million from U.S. EPA, which will be combined with a required District match of $2.9 million in incentive funds, which together is anticipated to fund approximately 45 percent of the cost of turning over 112 heavy-duty trucks.[4] The District has already achieved approximately 2 tpd of NOx reductions through allocation of existing incentive investments, which has helped to fund the replacement of over 2,700 heavy-duty trucks and buses.[5]

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. These programs include the Carl Moyer Air Quality Standards Attainment Program, the Goods Movement Emission Reduction Program (Prop 1B), the Air Quality Improvement Program, and the Low Carbon Transportation Program. More recently, the Community Air Protection Program and the Funding Agricultural Replacement Measures for Emission Reductions (FARMER) Program have made additional funds available for these purposes. These programs are described in depth in Chapter 3. Beyond these Statewide programs, the District receives local funds to improve air quality from sources

[4] SJVAPCD January 2017 "Governing Board Meeting Minutes January 19, 2017: Item Number 8: Accept and Appropriate $4,954,500 in Additional Revenue from the U.S. EPA to Fund the Replacement of Heavy-Duty Trucks and Wood Burning Devices"
http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2017/January/final/08.pdf
[5] SJVAPCD August 2016 "2016 Annual Demonstration Report"
http://www.valleyair.org/MOP/docs/AnnualDemonstrationReport_081816.pdf

including vehicle registration fees authorized by Assembly Bill (AB) 2766, AB 923, Senate Bill (SB) 709, and AB 2522.

At the Federal level, U.S. EPA's Diesel Emission Reduction Act (DERA) funds projects that reduce diesel emissions from on-road heavy-duty engines, including school buses, Class 5 – 8 heavy-duty interstate vehicles, locomotive engines, marine engines, and non-road engines, equipment or vehicles used in construction, cargo handling equipment, and off-road equipment used in agricultural, mineral, or energy production industries.

Proposed Actions:

This proposed measure would use existing and newly identified funding programs to help increase the penetration of near-zero and zero emission heavy-duty trucks targeting large fleets with significant activity in the Valley. Funding mechanisms would target technologies that meet or exceed an optional low-NOx standard until implementation of a new federal low-NOx standard begins and part of the current round of Moyer Program funding ends.

CARB staff is proposing to achieve a total of 10 tpd of NOx emission reductions through accelerating the turnover of heavy-duty diesel trucks. It is estimated that approximately 2 tpd would come from the quantification of reductions from the portion of the approximately 2,700 projects already funded or executed to date that will continue to provide SIP-creditable reductions in 2024 and 2025.

In addition, there remains opportunity to incentivize turnover of the remaining population of heavy-duty diesel vehicles. CARB staff is proposing to provide incentives to turn over approximately 33,000 heavy-duty diesel trucks including long haul trucks, trucks servicing the Port of Oakland and travelling through the Valley and garbage and other public fleets to the optional low-NOx standard or cleaner to reduce NOx emissions in the Valley by 8 tpd in 2024. It is expected that 2 tpd of these reductions will be achieved using funding from existing programs in future years, with the remaining 6 tpd to be achieved using funding sources to be defined during the measure development process.

While a majority of the incentivized on-road heavy-duty vehicles under this measure will be turnover to meet the California low-NOx engine standard, CARB continues to provide funding for zero-emission technologies where feasible. Additionally, there remains opportunities to achieve reductions from vehicles currently operating at higher emissions levels even than the 2010 engine standard. For example, when including natural turnover, the 2024 population of heavy-duty vehicles in the Valley is estimated to include around 2,500 solid waste collection and public fleet vehicles. Unlike most on-road heavy-duty vehicles, these types of vehicles are not required to meet CARB's 2010 engine standards by 2023 and provide an excellent opportunity to achieve surplus emission reductions by providing incentive funds to replace these engines or vehicles with cleaner technologies.

Implementation of this measure would require a commitment of State and District incentive funds through the programs described above to truck and bus replacement projects. In recent years, the CARB and the District have received elevated levels of funding for on-road heavy-duty vehicle and other incentive projects. For instance, through annual appropriation by the Legislature, CARB's Low Carbon Transportation and AQIP have in recent years received a total level of funding of more than $400 million per year. Of that annual amount, on-road heavy-duty vehicle projects in the Valley have received funding and will continue to receive funding through 2024. Recent legislation established a new funding source, the Community Air Protection Program, and appropriated about $250 million Statewide in each the 2017 and 2018 State Budgets. In 2017, $80 million went to heavy-duty projects in the Valley, with 2018 District allocations still pending. These funds, as well as others, could be used to help increase the penetration of the cleanest heavy-duty engine technology, with a focus on targeting applications that are well-suited for initial ZEV heavy-duty technologies.

It is important to note that funds under the control of the District may also be used to fund other types of projects, including off-road vehicles. Identifying the most effective use of funds in order to maximize emission reductions will depend on the incremental cost of technologies, cost effectiveness, and the type of financing mechanism employed. Accordingly, the use of these funds to maximize emission reductions for 2024 may be further refined in a future SIP-approvable measure.

Timing:

Proposed CARB Board hearing:	by 2021
Proposed implementation schedule:	on-going

Proposed SIP Commitment:

CARB staff proposes to commit to bring this measure to the Board as one or more SIP-creditable measures by 2021. Measures developed and proposed for Board approval may include implemented projects, projects funded with existing funding, and projects funded with future funding. CARB staff will initiate measure development processes designed to achieve the NOx and PM2.5 emission reductions in 2024 and 2025 shown in Table 4 for the San Joaquin Valley nonattainment area. The SIP-creditable measure(s) as proposed by staff to the Board or adopted by the Board may provide more or less emission reductions than the amount shown in Table 8.

Accelerated Turnover of Agricultural Equipment (Proposed State Measure for the Valley)

Overview:

The goal of this proposed measure is to provide incentive funding to accelerate beyond the rate of natural turnover the penetration of cleaner engines used in agricultural equipment. Reductions will also be quantified from projects already funded and executed that will provide SIP-creditable reductions in 2024 and 2025.

Background:

While regulatory actions will continue to drive the introduction of the cleanest mobile technologies in off-road sectors, the natural pace of fleet turnover will need to be accelerated to provide sufficient reductions to meet the Valley's PM2.5 attainment needs. Tractors used in agricultural applications are an off-road category that offers the potential to achieve further emission reductions through accelerating the turn-over of older, higher-emitting vehicles and engines to the cleanest technologies available.

Since 2009, the agricultural industry has helped secure over $500 million in private and public funding for the replacement of older agricultural tractors with newer, cleaner technology in the Valley. To implement the agricultural equipment measure in the 2007 SIP, the U.S. Department of Agriculture's (USDA) Natural Resource Conservation Service's grant program[6] in combination with the District's incentive programs, has provided over $129 million to date in incentive funding to assist farmers in replacing diesel-powered agricultural equipment, with significant continued investment currently ongoing. That 2007 SIP measure established an emission reduction goal to be achieved through incentives, with the potential for regulatory action as a backstop. The incentive funding invested to date has exceeded the SIP goal for 2017. Further reductions from agricultural tractors will continue to play a significant role in our efforts to reduce emissions from mobile sources.

CARB recently developed the FARMER Program, a program which will facilitate the distribution of State funds allocated by the California Legislature to incentivize turnover of agricultural equipment. The FARMER program guidelines, adopted in March 2018, detail the types of projects eligible for funding from the applicable allocations and specify the amount of funding various districts throughout the State will receive. The allocations recently adopted include $108 million for the Valley in fiscal year 2017-18. The 2018-19 fiscal year included $132 million Statewide for the FARMER program of which a portion will be allocated to the San Joaquin Valley. Further, the District receives local funds to improve air quality from sources that can be used to incentivize the accelerated turnover of agricultural equipment.

[6] SJVAPCD "2017 Annual Demonstration Report" (August 2017) http://www.valleyair.org/MOP/docs/2017_Final_AnnualDemonstrationReport_AppendixAB.PDF

In addition to these efforts to provide funding for the cleanest agricultural equipment engines, CARB staff are working with the District and the agricultural industry to implement a new tractor trade-up program through funding originally provided by an AQIP grant and now an eligible project in the FARMER program. The trade-up program is designed to assist small farmers overcome potential financial barriers to accessing cleaner mobile agricultural technologies, and is intended to accelerate emission reductions by replacing the oldest tractors with cleaner used models. This is accomplished through a multi-step transaction in which an owner of an older, high-emitting piece of mobile agricultural equipment agrees to scrap that equipment in exchange for a previously used and reconditioned piece of equipment with a cleaner diesel engine at little or no out-of-pocket cost. The owner of the used equipment is provided incentive funding to assist in the purchase of new equipment that employs the cleanest, commercially available technology.

Proposed Actions:

CARB staff is proposing to use existing and new incentive funding programs to help increase the penetration of cleaner agricultural equipment to achieve a total of 11 tpd of NOx emission reductions from projects already funded and executed to date, and new projects. Implementation of this measure in conjunction with the *Cleaner In-Use Agricultural Equipment Measure* would require a commitment of State and District incentive funds through the programs described above to fund agricultural replacement projects. CARB staff is proposing to provide incentives to accelerate turnover of approximately 12,000 tier 0, tier 1 and tier 2 agricultural equipment to the cleanest equipment available to achieve the necessary NOx emission reductions in the Valley. In addition, eligible projects include electrifying agricultural equipment such as utility quads and small yard tractors that are used on farms and ranches.

It is important to note that funds under the control of the District may also be used to fund other types of projects, including on-road and other off-road vehicles. Identifying the most effective use of funds in order to maximize emission reductions will depend on the incremental cost of technologies, cost effectiveness, and the type of financing mechanism employed. Accordingly, the use of these funds to maximize emission reductions for 2024 and 2025 may be further refined in a future SIP-approvable measure.

While identifying and securing incentive funding will be an important element going forward, the proposed *Cleaner In-Use Agricultural Equipment* measure will serve as an overall emission reduction target and catalyst for attracting additional near-term investments.

Timing:

Proposed CARB Board hearing:	by 2020
Proposed implementation schedule:	on-going

Proposed SIP Commitment:

CARB staff proposes to commit to take action to gain SIP credit for reductions from this measure by 2020; actions could include inventory updates and one or more SIP-creditable measures for Board consideration. Measures developed and proposed for Board approval may include implemented projects, projects funded with existing funding, and projects funded with future funding. CARB staff will initiate measure development processes designed to achieve the NOx and PM2.5 emission reductions in 2024 and 2025 shown in Table 4 for the San Joaquin Valley nonattainment area. The SIP-creditable measure(s) as proposed by staff to the Board or adopted by the Board may provide more or less emission reductions than the amount shown in Table 8.

Cleaner In-Use Agricultural Equipment (Proposed State Measure for the Valley)

Overview:

The goal of this proposed measure is to increase the penetration of cleaner agricultural equipment used in California including advancing zero emission technology where feasible.

Background/Regulatory History:

San Joaquin Valley is home to one of the most productive agricultural regions in the world. The agricultural sector is an important partner in developing strategies that provide meaningful reductions while supporting economic growth and meeting our federal air quality standards and State greenhouse gas reduction targets. As such, understanding the economics of the industry while continuing to pursue regulatory and voluntary programs that encourage emission reductions through a variety of actions, including use of best practices to manage greenhouse gases, utilizing the cleanest available technologies, and others is essential.

New engines used in agricultural equipment, primarily tractors, must meet the same standards as other off-road engines ensuring that new equipment becomes progressively cleaner. Just as in other off-road applications, diesel agricultural equipment can remain in use for long periods of time. This long life means that equipment with new, lower emitting engines are introduced into the fleet at a relatively slower pace than what is needed to meet air quality standards. The cleanup of agricultural in-use equipment is primarily an issue in the San Joaquin Valley with their large agricultural economy.

The 2007 SIP included the Cleaner In-Use Agricultural Equipment Measure (Ag Measure) to achieve 5 to 10 tpd of NOx reductions in 2017 by modernizing agricultural equipment in the San Joaquin Valley. The San Joaquin Valley agricultural industry immediately began working on implementing this SIP measure by leveraging federal and local incentives to provide farmers assistance to replace their older, higher-polluting equipment with the cleanest available technology. Specifically, new incentive funds were secured through the federal Farm Bill to be used alongside funds from existing programs. Since 2009, over $400 million dollars in private and public funding has been invested in the San Joaquin Valley for the replacement of older agricultural tractors with newer, cleaner models, with significant continued investments ongoing. Through 2016, the USDA’s Natural Resource Conservation Service’s grant program, in combination with the District’s program, has provided over $129 million that has helped in replacing over 5,000 tier 0 and tier 1 tractors to implement the Ag Measure and meet the 2017 SIP goal. The incentives targeted the largest and most used tractors in addition to other types of farm equipment. Figure 2 and Figure 3 highlight the success of implementing the 2007 SIP Cleaner In-Use Agricultural Equipment Measure and reducing emissions from the dirtiest tier 0 engines.

Figure 2: Impact of Valley Incentive Reductions through 2016

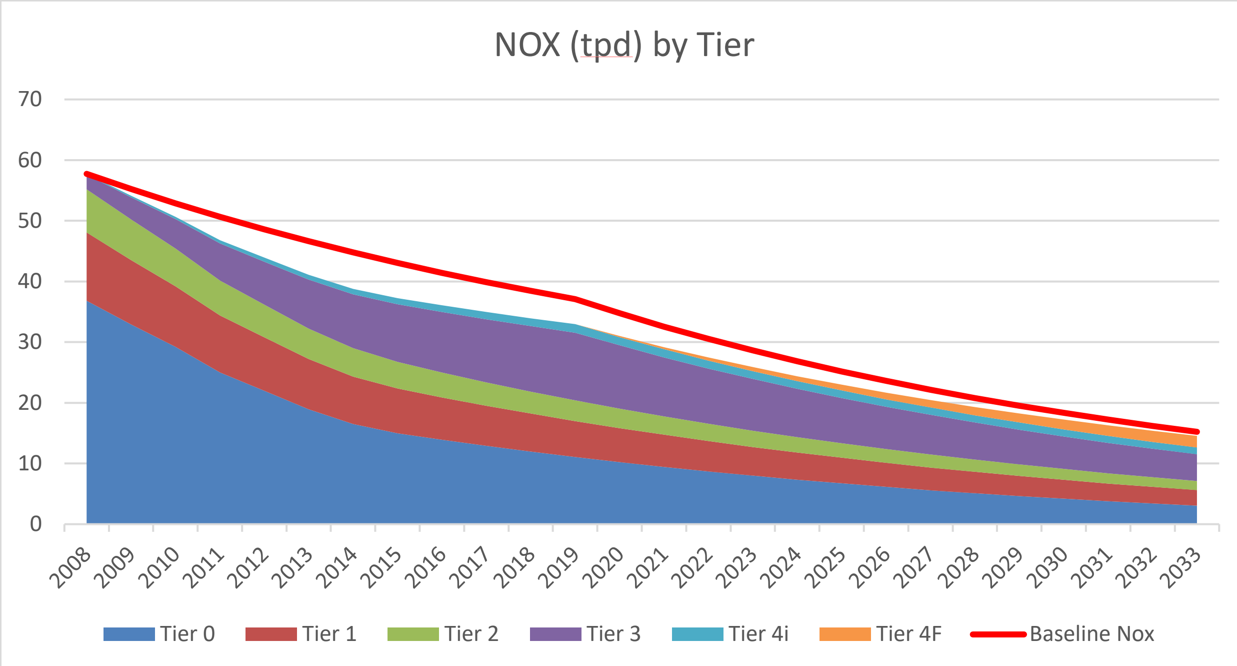
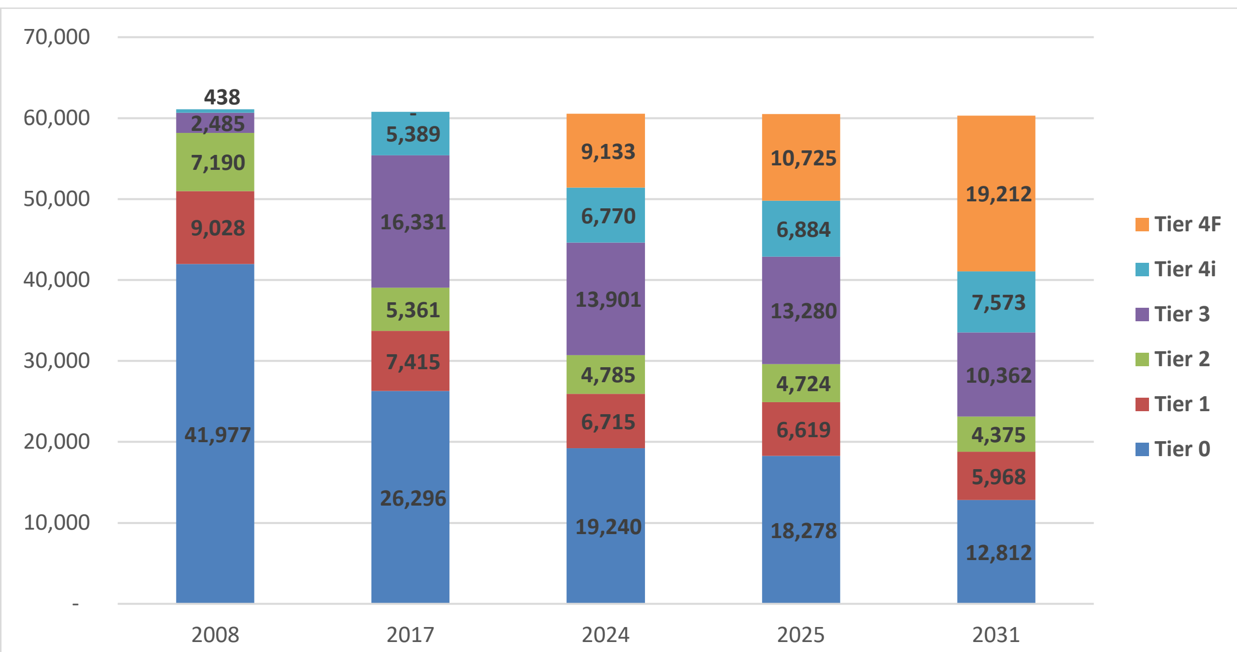
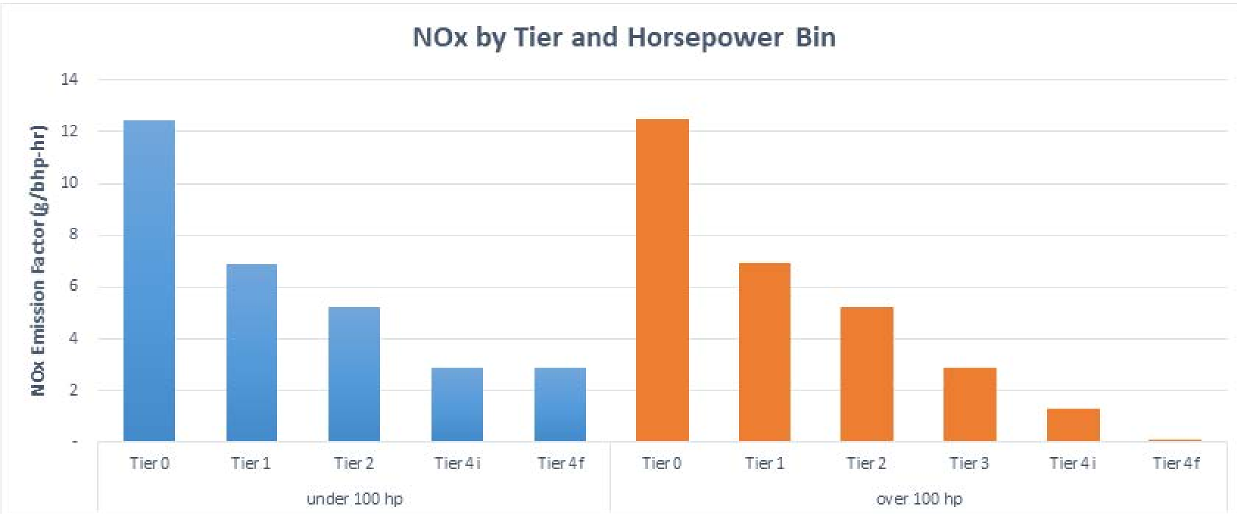


Figure 3: Change in Tractor Population
(with incentives to 2016)



Due to the success of these incentives, the agriculture industry continues to advocate for additional funding to incentivize the replacement of farm equipment. Since 2016, NRCS and the District have funded an additional 1000 projects. Overall, the incentive projects have targeted the larger horsepower farm equipment. Figure 4 shows that smaller tier 4 engines have significantly higher NOx rates than the larger horsepower engines and therefore, are not as cost effective per emission reductions. Further, it may be more cost effective to go to zero for these smaller engines. In addition, their duty-cycles may be more primed to go to zero emissions.

Figure 4: NOx Emission Rates by Agricultural Engine Tier and Horsepower Bin



In conjunction with the *Accelerated Turnover of Agricultural Equipment Measure*, the goal of this measure is to accelerate fleet turnover to equipment with cleaner tier 4 engines. The advantage of setting a goal to tier 4 is that it ultimately results in the cleanest fleet. Since the current agricultural equipment emissions are based on a 2008 survey, during the measure development, CARB will also update agriculture equipment emissions by surveying farms on the use, size, age, etc. of their agriculture equipment.

Farmers face a unique market structure that affects their ability to pass costs on to their buyers. For some operations, especially the largest with advantage of economic scale, an equipment replacement schedule will already be part of their business plan. But for smaller operations or expensive equipment, the business plan may be to retain existing equipment as long as possible. To provide cleaner tractors to small farms, CARB staff along with the District and the agricultural industry are working to implement a new tractor trade up program through funding provided by two previous CARB AQIP grants and with the FARMER Program. This tractor trade up program is designed to assist small farmers in overcoming potential financial barriers to accessing cleaner mobile agricultural technologies, and is intended to accelerate emission reductions by replacing the oldest tractors with cleaner used models. Maximizing reductions in light of these factors that farmers face will require careful design of the measure and the optimum use of incentives.

Proposed Actions:

While identifying and securing incentive funding will be an important element going forward, similar to the 2007 SIP Ag Measure, a potential measure could serve as an overall emission reduction target, while at the same time acting as a catalyst for attracting early replacement of agricultural equipment using incentives . This measure will backstop the *Accelerated Turnover of Agricultural Equipment Measure* and ensure that by 2030 agricultural equipment operating in the Valley will be tier 2 or cleaner. In combination, the measure tractor trade-up, incentives and significant lead time, ensures cleaner agricultural equipment will be used in the Valley through 2030.

Timing:

Proposed CARB Board hearing:	2025
Proposed implementation schedule:	2030

Proposed SIP Commitment:

CARB staff will initiate a measure development process in 2024 designed to achieve the NOx and PM2.5 emission reductions shown in Table 4 for the San Joaquin Valley nonattainment area. The measure as proposed by staff to the Board or adopted by the Board may provide more or less emission reductions than the amount shown in Table 8.

Accelerated Turnover of Off-Road Equipment (Proposed State Measure for the Valley)

Overview:

The goal of this proposed measure is to provide incentive funding to accelerate the penetration of near-zero and zero-emission engines beyond the rate of natural turnover achieved through implementation of the other measures identified for off-road equipment.

Background:

While regulatory actions will continue to drive the introduction of the cleanest mobile technologies in off-road sectors, the natural pace of fleet turnover will need to be accelerated to provide sufficient reductions to meet the Valley's PM2.5 attainment needs. Off-road equipment categories that offer the potential to achieve further emission reductions for the Valley through accelerated turn-over are discussed below:

- *Construction Equipment:* The current construction equipment engine standard for newly purchased units is tier 4. Therefore, continuing to incentivize the current tier 4 engines standard by replacing older tiers provides the greatest opportunity for NOx reductions in this source sub-category.

- *Transport Refrigeration Units (TRUs):* Replacing TRU combustion engines with electrical engines represents the greatest opportunity in reductions, as hybrid electric TRUs, TRUs equipped with electric standby motors, and cryogenic transport refrigeration systems are commercially available.

- *Forklifts:* There are approximately 3,900 forklifts operating in the Valley, most of which are battery-electric, propane, diesel, or gasoline-fueled. Replacing forklift combustion engines with electric motors represent the greatest opportunity for emission reductions.

In addition to these categories, CARB staff is also exploring opportunities for additional cost-effective reductions from accelerating the turnover of drilling rigs to reduce emissions from these off-road engines. There are many drill rigs operating in the Valley, including diesel-power oil drilling rigs, water-well drilling rigs, and work-over rigs. Accelerating the turnover to cleaner, modern tier 4 engines for drill rigs represents the greatest opportunity to reduce emissions.

Proposed Actions:

This proposed measure would use innovative incentive funding programs to help increase the penetration of cleaner engine technology in off-road applications. CARB staff is proposing to achieve a total of 2 tpd of NOx emission reductions through accelerating the turnover of off-road engines. Implementation of this measure would require a commitment of State and District incentive funds through the programs described above to off-road equipment replacement projects.

It is important to note that funds under the control of the District may also be used to fund other types of projects. Identifying the most effective use of funds in order to maximize emission reductions will depend on the incremental cost of technologies, cost effectiveness, and the type of financing mechanism employed. Accordingly, the use of these funds to maximize emission reductions for 2024 and 2025 may be further refined in a future SIP-approvable measure.

Timing:

Proposed CARB Board hearing:	by 2021
Proposed implementation schedule:	on-going

Proposed SIP Commitment:

CARB staff proposes to commit to bring this measure to the Board as a SIP-creditable measure by 2021. CARB staff will initiate a measure development process designed to achieve the NOx and PM2.5 emission reductions in 2024 and 2025 shown in Table 4 for the San Joaquin Valley nonattainment area. The SIP-creditable measure as proposed by staff to the Board or adopted by the Board may provide more or less emission reductions than the amount shown in Table 8.

Chapter 3: Supplemental State Commitment from the Proposed State Measures for the Valley

This document proposes a commitment for the Valley that, upon adoption by the Board, would create a commitment for new emission reductions by the applicable attainment deadlines. This commitment consists of two components:

1. A commitment to bring to the Board or take action on the Proposed State Measures for the Valley; and
2. A commitment to achieve aggregate emission reductions in 2024 and 2025.

The commitment for the Valley would be submitted into the California SIP and would become federally enforceable upon approval by U.S. EPA. While the comprehensive mobile strategy for the San Joaquin Valley discussed in this document proposes a range of measures and indicates that CARB will undertake various actions, it remains a staff proposal at this stage. The proposed commitment is subject to CARB's formal approval process and will not be final until the Board formally takes action.

Commitment to Act on Proposed State Measures for the Valley

Table 7 shows the full list of State measures and schedule for consideration to support attainment of federal PM2.5 standards in the Valley. The Board has already approved the commitment for the 2016 State SIP Strategy measures and we are augmenting that commitment with additional State measures for the Valley. CARB staff proposes to bring to the Board or take action on the list of Proposed State Measures for the Valley shown in the bottom portion of Table 7. CARB staff will initiate a SIP-creditable measure development process for each proposed measure according to the schedule outlined. This development process will provide additional opportunity for public and stakeholder input, as well as ongoing technology review, and assessment of costs and environmental impacts.

Table 7: State Measures and Schedule for the San Joaquin Valley

Measures	Agency	Action	Implementation Begins
2016 State SIP Strategy Measures			
Advanced Clean Cars 2 Reduced ZEV Brake and Tire Wear	CARB	2020 – 2021	2026
Lower In-Use Emission Performance Level:	CARB	2017 – 2020	2018 +
Lower Opacity Limits for Heavy-Duty Vehicles	CARB	2018	2018 – 2024
Amended Warranty Requirements for Heavy-Duty Vehicles	CARB	2018	2022
Heavy-Duty Vehicle Inspection and Maintenance Program	CARB	2020	2022 +
Low-NOx Engine Standard – California Action	CARB	2019	2023
Low-NOx Engine Standard – Federal Action	U.S. EPA	2019	2024
Innovative Clean Transit	CARB	2018 – 2019	2020
Advanced Clean Local Trucks (Last Mile Delivery)	CARB	2019	2020
Zero-Emission Airport Shuttle Buses	CARB	2018	2023
More Stringent National Locomotive Emission Standards	U.S. EPA	2017	2023 +
Zero-Emission Off-Road Forklift Regulation Phase 1	CARB	2020	2023
Zero-Emission Airport Ground Support Equipment	CARB	2019	2023
Small Off-Road Engines	CARB	2018 – 2020	2022
Transport Refrigeration Units Used for Cold Storage	CARB	2018 – 2019	2020 +
Low-Emission Diesel Fuel Requirement	CARB	by 2020	2023
Proposed State Measures for the Valley			
Accelerated Turnover of Trucks and Buses Existing Incentive Projects New Incentive Projects	CARB / SJVAPCD	by 2021	ongoing
Accelerated Turnover of Agricultural Equipment Existing Incentive Projects New Incentive Projects	CARB / SJVAPCD	by 2020	ongoing
Cleaner In-Use Agricultural Equipment	CARB	2025	2030
Accelerated Turnover of Off-Road Equipment New Incentive Projects	CARB / SJVAPCD	by 2021	ongoing

Commitment to Achieve Aggregate Emission Reductions

The 2016 State SIP Strategy included an initial commitment to achieve an aggregate emission reduction of 8 tpd of NOx in the Valley by 2031, which serves as a down payment on the total emission reductions needed for the Valley's attainment of federal standards. This document proposes a commitment to achieve the aggregate emission reductions specified in Table 8 by 2024 and 2025.

CARB staff proposes to commit to achieve, in aggregate, 32 tpd of NOx emission reductions and 1 tpd of PM2.5 emission reductions in 2024, with those same emission reduction commitments carried through to 2025. These measures, in conjunction with the existing control program, identify all of the reductions required from mobile sources for the Valley's PM2.5 attainment needs. These measures reflect a combination of State actions and petitions for federal action to establish the policy and regulatory mechanisms to bring the needed advanced technologies into the California vehicle and equipment fleet, while pairing these actions with incentive and other programs to strategically accelerate the penetration of the cleanest technologies in each sector.

CARB's aggregate emission reduction commitment may be achieved through a combination of actions including but not limited to: the implementation of control measures; the expenditure of local, State or federal incentive funds; or through the implementation of other enforceable measures. In some cases, actions by federal agencies will be needed. CARB will include these emission reductions in its aggregate commitment to ensure that reductions are achieved regardless of federal action. For example, if a federal heavy-duty low-NOx engine standard is not established, CARB will look to achieve the necessary reductions from other source categories, such as stationary sources. In other cases, programmatic approaches must be developed and funding secured to achieve the reductions outlined.

While Table 8 includes estimates of the emission reductions from each of the individual measures, final measures as proposed by staff to the Board or adopted by the Board may provide more or less than the initial emission reduction estimates. CARB's overall commitment is to achieve the total emission reductions necessary to attain the federal air quality standards while reflecting the combined reductions from the existing control strategy and new measures. Therefore, if a particular measure does not get its expected emission reductions, the State is still committed to achieving the total aggregate emission reductions. If actual emission decreases occur that exceed the projections reflected in the current emissions inventory and the Valley State SIP Strategy, CARB will submit an updated emissions inventory to U.S. EPA as part of a SIP revision. The SIP revision would outline the changes that have occurred and provide appropriate tracking to demonstrate that aggregate emission reductions sufficient for attainment are being achieved through enforceable emission reduction measures.

Table 8: San Joaquin Valley Expected Emission Reductions from State Measures

Reductions shown in tons per day (tpd)

Measures	2024		2025	
	NOx (tpd)	PM2.5 (tpd)	NOx (tpd)	PM2.5 (tpd)
2016 State SIP Strategy Measures				
Advanced Clean Cars 2	--	--	--	--
Reduced ZEV Brake and Tire Wear	--	NYQ	--	NYQ
Lower In-Use Emission Performance Level:	6.8	<0.1	6.8	<0.1
Lower Opacity Limits for Heavy-Duty Vehicles				
Amended Warranty Requirements for Heavy-Duty Vehicles				
Heavy-Duty Vehicle Inspection and Maintenance Program				
Low-NOx Engine Standard – California Action	0.7	--	2	--
Low-NOx Engine Standard – Federal Action	0.7	--	2	--
Innovative Clean Transit	<0.1	<0.1	<0.1	<0.1
Advanced Clean Local Trucks (Last Mile Delivery)	<0.1	<0.1	<0.1	<0.1
Zero-Emission Airport Shuttle Buses	NYQ	NYQ	NYQ	NYQ
More Stringent National Locomotive Emission Standards	0.1	<0.1	0.3	<0.1
Zero-Emission Off-Road Forklift Regulation Phase 1	--	--	--	--
Zero-Emission Airport Ground Support Equipment	<0.1	<0.1	<0.1	<0.1
Small Off-Road Engines	0.1	<0.1	0.2	<0.1
Transport Refrigeration Units Used for Cold Storage	NYQ	NYQ	NYQ	NYQ
Low-Emission Diesel Fuel Requirement	0.8	0.1	1	0.1
Total Reductions from 2016 State SIP Strategy Measures	**9**	**0.1**	**12**	**0.1**
Proposed State Measures for the Valley				
Accelerated Turnover of Trucks and Buses	10	NYQ	8	NYQ
Existing Incentive Projects				
New Incentive Projects				
Accelerated Turnover of Agricultural Equipment				
Existing Incentive Projects	3	0.2	2	0.2
New Incentive Projects	8	0.6	8	0.6
Cleaner In-Use Agricultural Equipment	NYQ	NYQ	NYQ	NYQ
Accelerated Turnover of Off-Road Equipment				
New Incentive Projects	2	NYQ	1.5	NYQ
Total Reductions from Proposed State Measures for Valley	**23**	**0.8**	**20**	**0.8**
Aggregate Emission Reductions	**32**	**1**	**32**	**1**

"NYQ" denotes emission reductions are Not Yet Quantified
"—" denotes no anticipated reductions
The measures as proposed by staff to the Board or adopted by the Board may provide more or less reductions than the amount shown.

Implementing the Proposed State Measures for the Valley

Implementation of the current control program and new regulatory actions to establish requirements for cleaner technologies comprise the core of the overall strategy for the Valley. The remaining increment of reductions will be achieved through the suite of actions described in Chapter 2 to accelerate the penetration of cleaner technologies through incentive programs. These actions will also further California's efforts to meet climate and risk reduction goals and enhance the continuing transformation to a cleaner, more efficient transportation system.

Air Quality Incentive Programs

The State in partnership with the air districts have a well-established history of using incentive programs to achieve emission reductions towards attainment of federal air quality standards. Since 1998, CARB and air districts have been administering incentives for cleaner heavy-duty vehicles, starting with the Carl Moyer Memorial Air Quality Standards Attainment Program (Carl Moyer Program). The scope and scale of California's air quality incentive programs has expanded greatly in the past 20 years in recognition of the key role the incentives play in complementing State and local air quality regulations to reduce emissions. Many new incentive programs have been established building on the success of the Carl Moyer Program.

Each of CARB's incentive programs has its own statutory requirements, emission reduction goals, and eligible projects making the portfolio diverse and far reaching. These programs fit together to address multiple goals, including:

- Turning over the legacy fleet to achieve cost-effective, near-term emission reductions in support of SIP, air toxics, and community air protection goals.
- Accelerating the introduction and deployment of zero-emitting technologies to meet California's longer-term air quality and climate change goals.
- Improving access to clean transportation for low-income households and investing in the disadvantaged and low-income communities most impacted by pollution.
- Supporting a green economy.

Carl Moyer Program: Provides incentives for vehicle and equipment owners to reduce pollution early or in excess of regulatory requirements by repowering or replacing engines or vehicles with commercialized cleaner engines or vehicles. The program pays the incremental cost of cleaner-than-required vehicles, engines, and equipment. Typical projects include clean trucks, buses, off-road construction and agricultural equipment, agricultural pumps, marine vessels, and locomotives. The program was established in 1998 to help air districts achieve cost-effective NOx emission reductions called for in the SIP by accelerating the turnover of older equipment and vehicles and later expanded to also consider ROG and toxic particulate matter emissions. Annual statewide funding is $70-80 million based on dedicated revenue from the DMV smog abatement fee and a fee on the purchase of new tires. The District's share in recent years has been about $8 million. CARB and air districts partner to run the program, with CARB developing guidelines and districts making funding decisions for their regions.

AB 617 Community Air Protection: In 2017, the Legislature created a new Community Air Protection incentive program to achieve early emission reductions in communities most impacted by air pollution to support community emission reduction programs being developed pursuant to AB 617 (Garcia, Chapter 136, Statutes of 2017). In the 2017 State Budget, the Legislature appropriated $250 million in Cap-and-Trade auction proceeds to the program, including $80 million for the San Joaquin Valley. The Legislature also directed that the program be implemented using the existing Carl Moyer Program and Proposition 1B Goods Movement Emission Reduction Program framework for the first year, so it could be launched quickly. In the 2018 State Budget, the Legislature provided an additional $245 million in Cap-and-Trade auction proceeds for Community Air Protection incentives; air district allocations have not yet been set. The Legislature expanded the possible uses of these second year funds to include: Carl Moyer and Proposition 1B eligible projects with a priority on zero-emission projects; zero-emission charging infrastructure; stationary source projects; and additional projects developed by air districts through a public process with community input. CARB and air districts partner to run the program, with CARB developing guidelines and the districts making funding decisions for their regions. Funding for the Community Air Protection incentives is appropriated annually at the discretion of the Legislature. Unlike the Carl Moyer Program, this program does not have a dedicated funding source.

FARMER Program: As part of the 2017 State Budget, the Legislature appropriated of $135 million to CARB to reduce agricultural sector emissions through grants, rebates, and other financial incentives for agricultural harvesting equipment, trucks, agricultural pump engines, tractors, and other equipment used in agricultural operations. CARB developed the new FARMER Program and approved guidelines in that establish the program framework, eligible projects, reporting requirements, and oversight provisions. CARB is directing this funding to air districts to administer for agricultural truck and equipment replacement projects. For 2017-18 budget cycle, $108 million is allocated to the San Joaquin Valley. For the first year, CARB is patterning the FARMER Program after existing incentive programs to expedite implementation. Funding is available for agricultural vehicle and equipment projects eligible under the Carl Moyer Program as well as zero-emission agricultural utility terrain vehicles and off-road agricultural equipment trade-ups in the San Joaquin Valley, both of which were piloted under the Air Quality Improvement Program (AQIP). The guidelines provide flexibility to add project categories as necessary. In the 2018 State Budget, the Legislature provided an additional $132 million; air district allocations have not yet been set. Funding is appropriated annually at the discretion of the Legislature. Unlike the Carl Moyer Program, this program does not have a dedicated funding source.

Low Carbon Transportation Program: This program, funded with Cap-and-Trade auctions proceeds, funds projects that accelerate the transition to low carbon freight and passenger transportation with a priority on providing health and economic benefits to California's most disadvantaged communities, low-income communities, and low-income households. These investments support the State's climate change, air quality, ZEV deployment, and petroleum reduction goals, focusing on introduction and deployment of zero-emission technologies where feasible. Low Carbon Transportation funding is unique among CARB's incentives in that it can be used for pre-commercial demonstration projects and early commercial pilot deployment when a technology may not be fully proven. The Legislature has appropriated a total of $1.5 billion in Low Carbon Transportation Program funding to CARB since the 2013-14 budget cycle, including $455 million in the 2018 budget. The program funds: zero-emission and plug-in hybrid passenger vehicles through the Clean Vehicle Rebate Project (CVRP); transportation equity projects to increase access to the cleanest vehicles in and near disadvantaged communities and for low-income Californians; clean trucks and buses using zero-emission, hybrid, and low nitrogen NOx technologies through the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP); and demonstration and early commercial deployment of zero- and near zero-emission freight equipment. Funding for the program is subject to annual appropriations of Cap-and-Trade auction proceeds by the Legislature; it does not have dedicated funding.

Air Quality Improvement Program (AQIP): AQIP is a voluntary, mobile source incentive program established through AB 118 (Núñez, Chapter 750, Statutes of 2007) to reduce criteria pollutant and toxics emissions with concurrent reductions in greenhouse gas emissions. Funding for AQIP comes primarily from the DMV smog abatement fee. AQIP has an annual budget of about $25-30 million. AB 8 (Perea, Chapter 401, Statutes of 2013) extended program funding through 2024. In the initial years of AQIP, CARB focused these investments on technology advancing projects that support California's long-term air quality and climate change goals in addition to providing immediate emissions benefits, including CVRP, HVIP, and advanced technology freight demonstrations. These projects are now funded through the Low Carbon Transportation, and AQIP funds are primarily directed to the Truck Loan Assistance Program that helps small business truckers to secure financing for newer trucks and diesel exhaust retrofits to meet compliance deadlines for CARB's Truck and Bus Regulation.

Proposition 1B Goods Movement Emission Reduction Program: Proposition 1B, passed in 2006, authorized the Legislature to appropriate $1 billion in bond funding to CARB to reduce air pollution emissions and health risks from freight movement along California's four priority trade corridors – Los Angeles/Inland Empire, the Central Valley and Sacramento region, the San Francisco Bay Area, and the San Diego/Mexican border region. The program is a partnership between CARB and local air districts and ports. CARB established the program guidelines and awards funding to local agencies. The local agencies then use a competitive process to provide funding to equipment owners for cleaner technology upgrades. Eligible projects include cleaner trucks, locomotives, ships-at-birth, cargo handling equipment, transportation refrigeration units, and harbor craft. The program is now in its last round of funding, and nearly all of the funding has been awarded. However, the last clean truck and equipment replacement projects are still coming online to provide additional emission reductions. The program framework will live on as a mechanism to award clean truck funds. The Legislature has specified in its budget appropriations for the AB 617 Community Air Protection Program that air districts have the option of using the Proposition 1B guidelines to evaluate possible truck projects.

In addition to these State-funded programs, the District has significant local funding from DMV fees and other sources available for incentives to help meet these SIP commitments. In partnership with efforts of the State, the District has long been effectively identifying funding and implementing incentive programs. – to date, programs managed by the District have invested over $2.1 billion in public and private funding, resulting in over 151,000 tons of lifetime emission reductions.

At the Federal level, U.S. EPA's Diesel Emission Reduction Act (DERA) program funds projects that reduce diesel emissions from on-road heavy-duty engines, including school buses, Class 5 – 8 heavy-duty interstate vehicles, locomotive engines, marine engines, and non-road engines, equipment or vehicles used in construction, cargo handling equipment, and off-road equipment used in agricultural, mineral, or energy production industries.

With the establishment of new programs by the Legislature, the San Joaquin Valley received about $200 million in the 2017-18 budget year in State funding through the Carl Moyer Program, FARMER, and AB 617 Community Air Protection incentive funding and is expected to receive a similar amount of funding in 2018-19. However, it should be noted that FARMER and AB 617 Community Air Protection funding is appropriated annually at the Legislature's discretion; these programs do not have a dedicated funding source. An expansion of current programs would provide an effective framework for achieving the necessary funding stream. Funding efforts may also be coordinated with those of the South Coast, as the need for cleaner technologies are similar and there are strong synergies in the deployment of cleaner trucks in both regions. For example, approximately 20 percent of truck travel through the San Joaquin Valley originates in the South Coast. Combined investments can therefore benefit both regions and reduce overall funding needs, while providing a strong platform to advocate for the health and economic benefits of meeting clean air standards.

CARB staff will also coordinate with U.S. EPA to develop the programmatic structure for use of incentive-based measures in the SIP to satisfy Clean Air Act requirements. These requirements include: 1) demonstration that the incentive program reductions are quantifiable, enforceable, permanent, and surplus; 2) provisions for an enforceable commitment; 3) technical analyses and supporting documentation; 4) demonstration of funding and legal authority; 5) procedures for public disclosure of information; and 6) provisions to measure and track program results.

Other Programs Facilitating Transformation

Beyond individual funding mechanisms, there are multiple State level programs and legislative mandates that are facilitating the overall transformation to cleaner, more efficient technologies in California. These programs are designed to provide an overall framework to support needed technology development and infrastructure, increase consumer awareness and outreach, and provide for focused investments in individual communities. These efforts will also help meet the State's transportation electrification goals under SB 350 through pursuit of programs to catalyze widespread transportation electrification. Examples of the State's high level commitment to supporting this transformation include:

- Volkswagen (VW) Settlement Agreement: The VW California settlement agreement includes both a Mitigation Trust to mitigate the excess NOx emissions caused by the company's use of illegal defeat devices in their vehicles, as well as a ZEV Investment Commitment to help grow the State's expanding ZEV program. The Mitigation Trust includes approximately $423 million for California. Per the Beneficiary Mitigation Plan approved by CARB in 2018, this funding will be used to replace older heavy-duty trucks, buses, and freight vehicles and equipment with cleaner models with a focus on zero-emission technologies where available and low NOx everywhere else, as well as fund light-duty ZEV infrastructure. The emission reductions from the program will mitigate the excess NOx from the VW vehicles, so these investments will not provide SIP-creditable reductions. However, they will help accelerate the introduction of zero-emission technologies and support the transformation of the fleet.

  The ZEV Investment Commitment includes $800 million for California to support transportation electrification and the next generation of electric vehicles. Key focus areas will include installing zero-emission vehicle fueling infrastructure (for both battery electric and fuel cell electric cars), funding brand-neutral consumer awareness campaigns to increase the zero-emission vehicle market, and investing in projects such as car-sharing programs that will increase access to zero-emission vehicles for all consumers in California. The ZEV Investment Commitment funding also includes a Green City initiative that will demonstrate in a concentrated fashion the operation of car sharing services, ZEV/shuttle transit services, and ZEV freight transport projects.

- Transformative Climate Communities: The State of California is investing $150 million of cap-and-trade auction proceeds in the State's most disadvantaged communities through the Transformative Climate Communities Program, which integrates multiple, cross-cutting approaches to reduce GHG emissions. These revenues – $70 million for Fresno, $35 million for Los Angeles, and $35 million in a third location – are for broad-based GHG emission reduction projects that provide local economic, environmental, and health benefits to disadvantaged communities.[7]

- ZEV Action Plan: In October 2016, the Governor's Office released the 2016 ZEV Action Plan[8], which builds on the successful implementation of the 2013 ZEV Action Plan and identifies new actions State agencies will collaboratively take to raise consumer awareness about ZEVs; ensure ZEV accessibility to a broad range

[7] http://sgc.ca.gov/programs/tcc/
[8] https://www.gov.ca.gov/docs/2016_ZEV_Action_Plan.pdf

of Californians; achieve ZEV commercial availability in targeted heavy-duty applications and in the freight sector; and aid ZEV market growth beyond California.

- Veloz: Formerly the California Plug-In Electric Vehicle Collaborative, Veloz is a public/private organization focused on accelerating the adoption of plug-in electric vehicles (PEV) to meet California's economic, energy and environmental goals. Using the expertise of each member, Veloz follows emerging PEV market trends and works to address challenges and enable strong PEV market growth. The PEV Collaborative's 2010 Strategic Plan, ***Taking Charge***, was designed to facilitate PEV market growth so that, by the end of the decade, hundreds of thousands of PEVs will be sold annually in California, and the market will contribute significantly to California's ongoing economic, energy and environmental policy objectives. Its strategic focus is to solidify California as a technological, manufacturing, economic, and policy leader that benefits from – and shapes – the global PEV market for decades to come.

- California Fuel Cell Partnership: The California Fuel Cell Partnership is a collaboration of organizations, including auto manufacturers, energy providers, government agencies and fuel cell technology companies, that work together to promote the commercialization of hydrogen fuel cell vehicles. By working together, the Partnership helps ensure that vehicles, stations, regulations and people are in step with each other as the technology comes to market.

- California Sustainable Freight Action Plan: The California Sustainable Freight Action Plan outlines an integrated approach to coordinate State agency priorities and timing on actions to influence freight transportation and energy infrastructure, vehicle and equipment technologies, and facility and operations efficiency, rather than the traditional and separate planning efforts for transportation, environment, and energy. The Action Plan is the beginning of a process, and signals State government's interest in collaborating with stakeholders on defining the actions necessary to make the 2050 Vision for a sustainable freight transport system a reality. The Action Plan also includes 2030 targets to guide the State towards meeting this vision, as well as focused pilot projects to achieve near-term progress.

Programs to Support Continued Technology Advancement

CARB, along with other public and private partners, continue to sponsor research and demonstration programs to further promote advanced technology development. This will occur through CARB's annual research program, grant programs, and other cooperative agreements. For example, CARB, U.S. EPA, the San Joaquin Valley, and the South Coast are partners in a memorandum of understanding that commits to developing and testing new sustainable technologies by aligning resources and evaluating innovative technologies. CARB also supports technology demonstrations through various grant programs, including the aforementioned Transformative Climate Communities Program. These investments will be focused in the State's most disadvantaged communities, and help to fund projects that integrate multiple, cross-cutting approaches to reduce emissions. Investments of these types will help support the comprehensive transformation needed for the Valley's attainment needs, while providing an overall framework to support needed technology development and infrastructure, increase consumer awareness and outreach, and provide for focused investments in individual communities.

In addition, several measures focus on deploying the cleanest technologies possible, including use of zero-emission vehicles and equipment in initial applications that are currently well-suited for broader market deployment. Depending upon the success of these applications and ongoing technology assessment, further regulatory mechanisms for additional applications may be feasible. For instance, NOx emissions from off-road compression-ignition engines are currently the second largest category of mobile source emissions subject to CARB regulation. Off-road compression-ignition engine NOx emissions are projected to make up 24 percent of the mobile source diesel emissions inventory, and 34 percent of the PM inventory, in 2030. The primary goal of this program would be to reduce emissions from new, off-road compression-ignition engines by adopting more stringent exhaust standards for all power categories, including those that do not currently utilize advanced exhaust aftertreatment. The standards would be more stringent than current U.S. EPA and European Stage V emission requirements. CARB could unilaterally lower standards for non-preempted off-road engines, but for farm and construction equipment under 175 horsepower, which is preempted by the federal Clean Air Act, federal action would be needed to adopt lower standards.

CARB will work with federal and international agencies to advocate for more stringent emission standards for sources that are not under CARB's regulatory purview. The status of technology development and identification of schedules for development of further regulatory approaches will be reported through workshops, conferences, symposia, and briefings to the Board.

Appendix A

Revised Proposed 2016 State Strategy for the State Implementation Plan

APPENDIX A TO BE INCLUDED IN FUTURE DRAFTS

Appendix B

Addendum Environmental Analysis Prepared for the San Joaquin Valley Supplement to the Revised Proposed 2016 State Strategy for the State Implementation Plan

APPENDIX B TO INCLUDED IN FUTURE DRAFTS

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