CALIFORNIA AIR RESOURCES BOARD

Monitoring and Laboratory Division
Vapor Recovery and Fuel Transfer Branch
Vapor Recovery Regulatory Development Section

Project Number: VR-11-11
Report Number: VR-OP-G4

Overpressure Study
Technical Support Document

Evaluation of Pressure Driven Emissions from Gasoline Dispensing Facilities

Date: August 1, 2020

Table of Contents

List of Figures

List of Tables

Executive Summary

California Air Resources Board (CARB) staff has worked with Air Districts and industry to complete several multi-year field studies to assess how positive pressure in the headspace (ullage) of underground storage tanks (UST) at gasoline dispensing facilities (GDF) affects the performance of Phase II vacuum assist and balance vapor recovery systems and associated pressure driven emissions (PDE). CARB staff's analysis indicates PDE are higher and more variable than previously estimated. Consequently, CARB staff conducted an evaluation to assess whether PDE significantly impact local, regional, and statewide efforts to control emissions and attain ambient air quality standards.

To assess PDE significance, CARB staff evaluated the following comparisons:

1. Statewide: Comparison of previous and updated estimates of statewide PDE to other uncontrolled and controlled GDF emissions to assess the impact on the effectiveness of the statewide vapor recovery program.
2. Regional: Comparison of PDE estimates to State Implementation Plan (SIP) emission reduction commitments for the ten areas in California that do not attain federal ambient air quality standards for ozone ('Nonattainment Areas').
3. Site-specific: Comparison of GDF-specific PDE and total GDF emission estimates for 32 Long-Term Study sites to thresholds of significance used by Counties and Air Districts to assess the potential individual and cumulative impacts of projects on attainment of ambient air quality standards for ozone.

Key evaluation findings include the following:

- The updated estimate of PDE causes the statewide performance effectiveness of vapor recovery controls to decrease by less than 1 percent (0.7 percent), from 97.2 to 96.5 percent.
- PDE are only a fraction of a percent of the total ROG emissions in the attainment year for the 75 ppb 8-hour ozone standard for the ten Nonattainment Areas. In addition, photochemical modeling has shown that generally in California, oxides of nitrogen, or NO_x, have a greater impact on ozone formation than ROG.
- The 32 Long-Term Study GDFs' site-specific PDE estimates are all less than the most stringent (lowest) Air District/County threshold of significance. The PDE estimates do not cause any study site total GDF emissions to exceed the threshold.

These findings support the conclusion that PDE do not significantly impact the effectiveness of the statewide vapor recovery program. Further, the findings indicate that PDE do not result in a local or cumulatively significant net increase in ozone, and do not significantly impact District-specific SIP attainment demonstration.

I. Background

A. California's Vapor Recovery Program

Approximately 15 billion gallons of gasoline are consumed annually in California. As gasoline moves through the marketing network it may be transferred between storage tanks and delivery tanks several times and there is a final transfer from the GDF storage tank to the motor vehicle fuel tank. With each transfer there is a potential to emit gasoline vapors. The hydrocarbons contained in gasoline vapors contribute to air pollution. In the presence of sunlight, hydrocarbons combine with the oxides of nitrogen, another air pollutant that comes primarily from fuel combustion, to form ozone. Ozone is a strong irritant that damages human lung tissue and plant leaves.

The Vapor Recovery Program was first developed for GDFs in the early 1970s to prevent the formation of ozone and was later expanded to control benzene. At a typical GDF, gasoline vapor emissions are controlled during two types of gasoline transfer: Phase I vapor recovery collects vapors when a cargo tank fills the GDF storage tank; Phase II vapor recovery collects vapors during vehicle refueling. There are two types of Phase II vapor recovery systems in California: balance systems and vacuum assist systems (assist systems). Assist systems use a nozzle with a dedicated vapor return pathway and a dispenser-mounted vacuum pump to collect vapor from the vehicle fuel tank as gasoline is dispensed from the facility storage tank. Balance systems use nozzles with a dedicated low resistance vapor return pathway and rely on direct vapor displacement as gasoline is dispensed from the GDF storage tank to the vehicle fuel tank. Additional controls are designed to contain the vapor in the storage tank by managing storage tank headspace pressure and to limit the volume of liquid spillage from the nozzle during the vehicle refueling process.

Benzene is a constituent of gasoline identified by CARB in 1985 as a toxic air contaminant. In 1988, CARB adopted the Benzene Airborne Toxic Control Measure (ATCM), which requires the installation of Phase I and II vapor recovery systems for retailed GDFs to reduce public exposure to benzene [CARB, 1988]. Per State law, air pollution control and air quality management districts (Air Districts) are required to adopt regulations that are equal to or more stringent than CARB's ATCM and are responsible for determining acceptable health risk for benzene at GDFs. All Air Districts adopted such rules by the early 1990s.

B. CARB Certification Procedures

According to State law, vapor recovery equipment that is required by local Air District rules for the control of hydrocarbon and toxic emissions generated at GDFs must be certified by CARB. In 1975, CARB adopted the first certification and test procedures for vapor recovery systems installed at GDFs. The certification procedures contain the performance standards and specifications that must be met by equipment manufacturers to obtain CARB certification in the form of an Executive Order. Over the past few decades, CARB has periodically updated the certification procedures to reflect improvements in vapor recovery technologies, to modify requirements for existing installations to achieve additional emission reductions, and to improve cost-effectiveness.

CARB approved Enhanced Vapor Recovery (EVR) regulations for GDFs equipped with underground storage tanks (UST) in March 2000 and aboveground storage tanks (AST) in June 2007. The EVR regulations were enacted to achieve additional emission reductions and to increase equipment reliability. EVR regulations established new standards and test procedures for vapor recovery systems to reduce emissions during storage and transfer of gasoline and to increase reliability of vapor recovery components. EVR regulations resulted in a major change to the certification procedures by increasing testing requirements and adopting nearly 80 new performance standards or specifications. Among the numerous EVR requirements were more stringent controls for Phase II systems such as:

- Compatibility with newer vehicles that capture gasoline vapors during vehicle refueling using on board refueling vapor recovery (ORVR) systems;
- Pressure management to control emissions lost from storage tank headspace through vent lines, vapor processor exhaust, and fugitive leak sources;
- In-Station Diagnostic (ISD) systems to help maintain in-use effectiveness by identifying problems early so that repairs are done more quickly; and
- Standards designed to control the release of liquid gasoline at the nozzle, such as liquid retention, post fueling drips, and spillage.

C. Overpressure Issue

While many aspects of the EVR program have been highly successful, the requirement to limit storage tank headspace pressure in order to better contain vapors has been more difficult to implement than expected. Shortly after statewide implementation of Phase II EVR requirements in 2009, CARB staff became aware that some GDFs were experiencing frequent ISD system overpressure alarms, primarily during the wintertime, which indicate exceedance of UST pressure criteria. CARB staff investigations between 2009 and 2012 revealed that, in an overwhelming majority of instances, these alarms were not associated with any vapor recovery system malfunctions [CARB, 2016a and 2017d] and were likely attributed to the high volatility and evaporation rate of winter blend gasoline [CARB, 2017g].[1]

CARB staff initially believed ISD overpressure alarms only occurred at GDFs with limited operating hours (overnight shut down) and, because most GDFs operate 24/7, the efficiency loss resulting from pressure driven emissions (PDE) was relatively small and would not constitute an air quality concern in wintertime months when ozone formation is minimal. In September 2009, CARB staff, in cooperation with the California Air Pollution Control Officers Association (CAPCOA), issued Advisory 405, which allows GDF operators to clear ISD overpressure alarms during the winter fuel period [CARB, 2016b]. The advisory was

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[1] California's Phase 2 Reformulated Gasoline (CaRFG2) and Phase 3 Reformulated Gasoline (CaRFG3) regulations require refiners to produce gasoline that meets eight specifications to reduce air pollution from the gasoline used in motor vehicles. One of the eight specifications is a standard for Reid Vapor Pressure (RVP) that is designed to reduce evaporative emissions during the summer months when ambient temperatures are their highest. During the wintertime (typically November through February), gasoline RVP is uncontrolled. This is also commonly the time during which “winter blend gasoline” is distributed.

envisioned as a temporary mechanism to provide GDF operators with relief from the cost and inconvenience of responding to ISD overpressure alarms and to provide CARB staff the necessary time to collect and analyze field data to develop a regulatory solution.

During a public workshop in November 2012, new information became available that indicated the overpressure issue was more substantial at some sites, and more complex than initially considered. CARB staff collaborated with industry and staff members from the CAPCOA Vapor Recovery Subcommittee to conduct ten additional field studies from 2013 to 2019.[2] The goals of the studies were to better characterize the magnitude of the overpressure issue, identify primary causes, and develop effective solutions. Key findings and conclusions include the following:

- In addition to higher-volatility winter blend gasoline, excess air ingestion during ORVR vehicle refueling is a key contributor to overpressure. Excess air ingestion results in vapor growth due to increased evaporation within the storage tank headspace that leads to increased vent line and pressure driven fugitive emissions.
- Gasoline vapor is vented from idle (no fuel dispensing) balance system nozzles when the nozzle is left out of the dispenser with the vapor check valve held open.
- Changes in newer ORVR vehicle fill pipe designs result in a poor nozzle seal within the vehicle fill pipe interface. Refinement of existing vapor recovery nozzle and vehicle fill pipe dimension specifications are needed to reduce air ingestion and prevent further decline in system efficiency.

Once it became evident that an incompatibility existed between vapor recovery nozzles and certain vehicle fill pipe designs, CARB staff worked with the Society of Automotive Engineers (SAE) Fuel Systems J285/J1140 Task Force (SAE Task Force) to develop and test new dimension specifications to standardize the vapor recovery nozzle and fill pipe interface to improve compatibility [CARB, 2018a and 2018b]. The SAE Task Force was comprised of nozzle, vehicle, and fill pipe manufacturers. In 2018, the Board adopted these specifications in parallel rulemakings that amended nozzle dimension requirements in vapor recovery certification procedures and fill-pipe requirements in vehicle regulations. In 2019, the California Office of Administrative Law approved the regulations. The SAE Task Force included the new specifications in updated versions of these two SAE recommended practice documents:

- J285: Dispenser Nozzle Spouts for Liquid Fuels Intended for Use with Spark Ignition and Compression Ignition Engines. April 2019.
- J1140: Filler Pipes and Openings of Motor Vehicle Fuel Tanks. September 2019.

CARB staff anticipates that the combination of vehicle fill pipe improvements and nozzle dimension standardization will significantly improve vapor recovery system performance and reduce the performance decline that has been observed due to a poor seal within the nozzle

[2] A complete listing of these studies is available on CARB's vapor recovery program webpage at: https://ww2.arb.ca.gov/our-work/programs/vapor-recovery-overpressure.

and fill pipe interface. However, there are additional factors that will cause overpressure conditions to continue in some circumstances.

D. Implementation of Improved Nozzle

Joint CARB/CAPCOA studies conducted in 2015 found that the only nozzle certified for use with Phase II EVR assist systems, the Healy Model 900, had features that made it difficult to securely latch with vehicle fill pipes in some newer vehicles [CARB, 2017c and 2017e]. In response to the study results, the nozzle manufacturer, Franklin Fueling Systems, voluntarily made design enhancements to the spout assembly of the nozzle. The enhanced spout assembly, called "Enhanced ORVR-Vehicle Recognition" (EOR), enabled a better seal between the nozzle vapor collection boot and the vehicle fill pipe, thereby reducing excess air ingestion. CARB certified the Healy model 900 with EOR spout assembly ('EOR nozzle') on August 23, 2017, per "Revision V" of Executive Orders VR-201 and VR-202. Franklin Fueling Systems no longer manufactures nor distributes the previously certified assist nozzle that had latching issues. The EOR nozzle complies with the new nozzle dimension requirements adopted by the Board in 2018.[3]

Based on field study results, CARB staff estimated that installation of the EOR nozzle will reduce the amount of wintertime PDE by approximately 55 percent [CARB, 2018a]. By analyzing information available in early 2018 about nozzle replacement rates, CARB staff predicted that more than half of the previously certified assist nozzles will be replaced by the end of 2020, approximately 90 percent or more will be replaced by the end of 2023, and the rest by the end of 2026. A CARB field study conducted in early 2019 found a faster replacement rate: 45 percent of nozzles were already replaced with the EOR version by February/March 2019 [CARB, 2020b]. Figure 1 (page 16) illustrates CARB staff's updated prediction for the nozzle replacement rate. CARB staff now predicts that approximately 90 percent or more of the previously certified assist nozzles will be replaced with the EOR nozzle by mid-2022, and the rest by mid-2025.

II. Updated Estimates of Pressure Driven Emissions

CARB and Air Districts use estimates of GDF emissions combined with estimates for other emission sources to assess potential local and regional impacts on air quality and public health. CARB and most Air Districts use emission factors published by CARB in 2013 to estimate the emissions from GDFs based on the annual gasoline throughput of the GDFs [CARB, 2013]. However, as noted in prior sections, CARB has completed several multi-year field studies that improve our understanding of PDE and the implementation rate of nozzles designed to reduce overpressure conditions. Updated estimates of PDE are necessary to evaluate whether PDE are substantial enough to warrant amending EVR regulations to require additional controls for PDE. Updated PDE estimates are also necessary to determine the cost effectiveness of any proposed regulations intended to control PDE.

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[3] For a detailed description of EOR nozzle development, please refer to Chapter I in the 2018 CARB staff report: *Initial Statement of Reasons: Proposed Amendments to Enhanced Vapor Recovery Regulations to Standardize Gas Station Nozzle Spout Dimensions to Help Address Storage Tank Overpressure* [CARB, 2018a].

A. Data Collection and Methods

CARB field studies included two types of data collection:

- Short-term ‘Mega Blitzes’ (Blitz): Short-term data collection efforts lasting approximately two weeks. These data collection projects have been referred to as “Mega Blitz” monitoring events in past CARB reports, presentations and workshops and are described in detail in another CARB Technical Support Document [CARB, 2020b]. The Blitz monitoring events occurred in October 2013, December 2013, February 2014, December 2015 and December 2018. Each Blitz monitoring event included 283 to 395 GDFs. CARB selected GDFs with a variety of operating characteristics within defined geographic regions that collectively account for approximately 95 percent of the GDFs in California. CARB staff designed the site selection approach to produce monitoring data that can provide a relatively instantaneous “snapshot” of pressure conditions at the GDFs that, collectively, are representative of regional and statewide GDF operating conditions.
- Long-Term Study (LTS): Long-term data collection efforts lasting from several months to multiple years at a smaller number of GDFs. CARB selected GDFs to evaluate on a longer-term basis to provide information about GDF emissions that the Blitz monitoring events could not provide due to GDF equipment constraints. These monitoring efforts are described by several CARB staff technical documents [CARB, 2017f, 2017h, 2017i, 2020c, and 2020e].

As noted earlier, CARB staff also conducted an EOR nozzle survey in February/March 2019. CARB staff returned to 147 of the 168 assist GDFs monitored during the December 2018 Blitz. (Not all 168 GDFs could be surveyed due to poor road conditions due to winter weather and travel distance.) The survey objective was to determine the market penetration of the EOR nozzle. As illustrated by Figure 1, market penetration is occurring at a faster rate than predicted in past CARB staff reports. Pressure driven emissions will decrease as EOR nozzles are installed, with 100 percent replacement predicted in 2025.

CARB staff used the data collected by the short- and long-term studies and EOR nozzle survey to update the emission factor for pressure driven emissions (PDEF) previously published in 2013 [CARB, 2013 and 2020d] and estimate statewide seasonal and annual PDE for 2018, 2025, and 2030 (Table 1). To estimate statewide emissions, CARB staff used estimates of statewide gasoline consumption in 2018 [CEC, 2019] and gasoline consumption projections by the CARB Emission Factors (EMFAC) 2017 model, version 1.0.2 [CARB, 2019b and 2020d].

CARB staff estimated site-specific PDE and total GDF emissions for each of the Long-Term Study sites that had enough data to estimate site-specific summer and winter emissions (Table 2). In addition, staff used the CARB 2013 emission factors and the updated PDEF to estimate statewide vapor recovery program effectiveness and statewide emissions from GDFs (Table 3). All tables mentioned in this section and following sections are located after the Conclusions (section VI).

B. Results and Discussion

As summarized in Table 1, the updated PDEFs indicate PDE are currently about five times higher during the four-month winter season (November through February) than the eight-month summer season (March through October). Statewide PDE in 2018 are approximately 3.0 tons per day (TPD) annually, approximately 1.2 TPD during the summer, when ozone formation is of greatest concern, and approximately 6.4 TPD during the winter.

Tables 2 and 3 and Figure 2 compare the improved (2018) annual PDEF and statewide PDE emission estimate [CARB, 2020d] to those based on CARB's 2013 emission factor [CARB, 2013]. CARB staff's improved PDEF is about six times higher than previously estimated, 0.14 pounds per thousand gallons gasoline dispensed (lbs/kgal) compared to 0.024 lbs/kgal. Use of the improved PDEF increases the baseline (2018) statewide annualized average PDE estimate by approximately 2.5 TPD, from 0.5 to 3.0 TPD.

The difference between the prior and updated GDF emission estimates does not represent a change in actual emissions in 2018. This estimated difference reflects PDE emissions that have been occurring but were not accurately reflected in GDF emission estimates. The updated PDE estimates indicate we've been underestimating the magnitude of PDE by about 2.5 TPD statewide, on average throughout the year. In other words, we've seen a slightly lower emission reduction benefit than initially estimated for one piece of the EVR regulations related to PDE.

PDE and total GDF emissions are expected to decrease during the next ten years due to the increasing percentage of gasoline throughput dispensed to vehicles with ORVR, implementation of the EOR nozzle, improved vehicle fill pipe designs, and reduced gasoline consumption statewide. CARB staff estimates PDE will decrease by about 25 percent during the summer and about 42 percent during the winter between 2018 and 2030 (Table 1).

Even so, PDE are higher than predicted for EVR implementation at the time CARB adopted the EVR regulations. Further, as illustrated by Table 2, PDE vary from GDF to GDF, irrespective of throughput. Site-specific PDEFs for the 32 Long-Term Study sites range from 0.005 to 0.75 lbs/kgal, and the sites with the highest PDE rates do not exhibit the highest total emission rates. It is the total site-specific emission rate that is relevant for determining the near-source air quality impact of a specific GDF.

Consequently, the next three report sections use the updated PDE estimates to evaluate whether PDE significantly impact statewide, regional, or local efforts to control emissions and attain ambient air quality standards.

III. Statewide: Impact on Effectiveness of Vapor Recovery Program

To assess whether statewide PDE have a significant impact on the effectiveness of the statewide vapor recovery program, CARB staff compared the updated 2018 PDEF to the emission factors for other uncontrolled and controlled GDF emissions. Table 3 and Figure 2 compare EVR performance efficiencies calculated using the CARB 2013 PDEF and the updated 2018 PDEF. The updated PDEF reduces the estimated emissions controlled by EVR systems from approximately 17.04 to 16.92 lbs/kgal, which causes the percentage of emissions that are controlled to decrease by less than 1 percent (0.7 percent), from 97.2 to 96.5 percent.

These findings indicate the increase in the statewide baseline PDE estimate does not significantly impact the overall effectiveness of CARB's GDF vapor recovery program.

IV. Regional: Comparison to State Implementation Plans

All geographic areas in California that are designated nonattainment of a National Ambient Air Quality Standard (NAAQS) are required by the federal Clean Air Act to submit a State Implementation Plan (SIP). Areas with more significant air quality challenges are required to include strategies to attain the relevant NAAQS. In 2007, CARB adopted SIPs for the federal 1997 80 parts per billion (ppb) 8-hour ozone NAAQS [CARB, 2007a]. The 2007 SIPs included a comprehensive State Strategy (2007 State SIP Strategy) and local attainment plans designed to attain the 1997 80 ppb 8-hour ozone NAAQS, as well as the 1997 65 $\mu g/m^3$ 24-hour and 15 $\mu g/m^3$ annual fine particulate matter (PM2.5) NAAQS, through a combination of technically feasible and cost-effective control strategies. In 2009 and 2011, CARB adopted revisions to the 2007 State SIP Strategy updating the assumptions and control strategy to demonstrate attainment [CARB, 2009 and 2011a].

While the 2007 State SIP Strategy did not include any measures for GDF emission reductions associated with EVR for underground storage tanks (USTs), the 2007 State SIP Strategy did, however, include measures reducing emissions associated with GDFs. These measures in the 2007 State SIP Strategy included:

- A measure that called for reducing ROG emissions by 90 percent from new ASTs at GDFs, by 76 percent from retrofitting existing nonagricultural ASTs, and by 60 percent from retrofitting existing agricultural ASTs, with anticipated statewide ROG emission reduction from ASTs of 2 TPD. The 2007 State SIP Strategy included an annualized statewide ROG emissions estimate of 3.1 TPD from all ASTs in 2004.
- A measure that called for setting an evaporative standard for permeation from GDF refueling hoses ("hose permeation"). CARB staff estimated that setting an evaporative standard for hose permeation would reduce ROG emissions by 70 to 98 percent. The 2007 State SIP Strategy included an annualized statewide ROG emissions estimate of 3 TPD for hose permeation.

CARB has since completed rulemaking actions to achieve the intent of the 2007 State SIP Strategy measures to reduce ROG emissions from ASTs and permeation from GDF refueling hoses [CARB, 2007b, 2011b, 2015 and 2019a].

The 2007 State SIP Strategy measures and subsequent CARB actions to reduce emissions from ASTs and GDF refueling hoses indicates the importance of reducing emissions from even relatively small emission sources as part of the broader effort to attain and maintain ambient air quality standards for ozone throughout California. The 2007 State SIP Strategy provided statewide average emission estimates of approximately 3 TPD each for ASTs and GDF refueling hoses, which are comparable in magnitude to the emission difference of approximately 2.5 TPD between the PDE estimates based on CARB's 2013 PDEF and updated (2018) PDEF (Tables 3 and 4). This comparison indicates the PDE estimate difference could conceivably be considered significant. However, average PDE emissions are substantially lower in the summer compared to the winter. During the eight-month summer season when ozone levels are higher in the state, the revised PDE estimate is lower, approximately 1.2 TPD statewide on average (Table 1). The revised PDE estimate is approximately 6.4 TPD during the winter fuel season when ozone is generally not a significant concern.

In addition, summer and winter PDE are expected to decrease by 25 percent and 42 percent, respectively, by 2030 due to the increasing percentage of vehicles with ORVR, implementation of the improved EOR nozzle and improved vehicle fill pipes, and reduced gasoline consumption statewide (Table 1). Also, as described in the next section, the site-specific PDE estimates are all below the most stringent Air District/County thresholds of significance, and PDE does not cause any individual study site's emissions to exceed the thresholds. These findings indicate the revised PDE estimates for current conditions do not significantly impact statewide SIP commitments or attainment demonstrations.

In 2017, CARB adopted the Revised Proposed 2016 State Strategy for the State Implementation Plan (2016 State SIP Strategy) [CARB, 2017a]. The 2016 State SIP Strategy included control measures to achieve the reductions necessary from mobile sources, fuels, and consumer products to meet the 1997 80 ppb 8-hour ozone, 2008 75 ppb 8-hour ozone, and 2012 12 $\mu g/m^3$ PM2.5 NAAQS. While the 2016 State SIP Strategy proposed a suite of regulatory and incentive programs, which, in combination with local actions, were designed to achieve emission reductions to meet the federal standards, there were no commitments or measures for GDF emission reductions.

To further evaluate the potential significance of PDE on District-specific attainment demonstrations for the more recent 75 ppb 8-hour ozone standard, CARB staff compared estimates of PDE within each Nonattainment Area with a submitted attainment demonstration during the eight-month summer season (March through October) to District-specific SIP summer emission inventories and the amount of emission reductions needed to attain ozone standards. To estimate summer PDE for each Nonattainment Area, staff multiplied the estimated 2018 statewide average daily summer PDE (1.2 TPD, from Table 1) by the percent of statewide retail gasoline sales that occurred in each Nonattainment Area in 2018. Table 5 provides the estimates of gasoline sales by County and Nonattainment Area, based on the California Energy Commission's 2018 California Annual Retail Fuel Outlet Report [CEC, 2019]. Table 6 provides the percent of gasoline sales summed for each Nonattainment Area (from Table 5) and the corresponding summer PDE estimate attributed to each Nonattainment Area. Table 7 provides two types of comparisons:

- Summer PDE estimate as a percent of the total ROG emissions in the relevant attainment year for the 75 ppb 8-hour ozone standard; and

- Summer PDE estimate as a percent of the ROG emissions reduction from baseline (2011) to attainment year (attainment year is not the same for all Nonattainment Areas and ranges from 2017 to 2031).

When compared to the total ROG emissions in the attainment year for the 75 ppb 8-hour ozone standard for the various Nonattainment Areas, the PDE estimates range between 0.04 percent and 0.18 percent. When taking an even more conservative approach and comparing the PDE estimate as a percentage of the ROG emissions reductions between the baseline year and the attainment year, the range is 0.12 percent to 0.83 percent. In both comparisons, GDF PDE are only a fraction of a percent of the compared ROG amount. In addition, photochemical modeling has shown that generally in California, oxides of nitrogen, or NO_x, have a greater impact on ozone formation than ROG; this is described as NO_x-limited.[4] The combination of the fact that the PDE estimates are exceedingly small in comparison to each area's ROG emissions, and the fact that California is generally NO_x-limited, supports the conclusion that PDE do not significantly impact District-specific SIP attainment demonstrations.

Importantly, note that the ozone SIPs for the air basins that are not yet in attainment of the ozone NAAQS do not have measures or commitments specific to GDF USTs.[5] In other words, while the information described above is useful for understanding the scope of the revised PDE estimates, the revised estimates would not affect the planned reductions from quantified SIP measures in these air basins.

V. Site-Specific: Comparison to Project-Level Thresholds of Significance

As part of their California Environmental Quality Act (CEQA) review and air quality permitting processes, Counties and Air Districts use thresholds to assess the potential significance of emissions from discrete development projects and stationary sources ('projects'). In general, reactive organic gas (ROG) emissions from a given project are considered significant if they would individually or cumulatively jeopardize attainment of the federal ozone standards, and thus have a significant adverse impact on air quality. Table 3 provides a compilation of project-level significance thresholds for ROG developed by Air Districts and Counties throughout California. Comparing these thresholds to site-specific GDF PDE estimates and total emissions estimates, regardless of the locations of the GDFs, provides an extremely conservative method for evaluating whether the emissions could significantly impact local efforts to attain ozone standards.[6]

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[4] Citations: Duncan *et al.*, 2009 and 2010; Jin *et al*., 2017; and Martin *et al*., 2004.

[5] Citations: AVAQMD, 2017; CARB, 2017b; EKAPCD, 2017; ICAPCD, 2017; MDAQMD, 2017; NSAQMD, 2018; SCAQMD, 2017; SJVAQMD, 2016; SMAQMD *et al*., 2017; and VCAPCD, 2017.

[6] Note that comparison to County Air District thresholds of significance is not required here, as those significance thresholds are typically used to determine the significance of emissions from discrete development projects or stationary sources, not for statewide planning and regulation. Furthermore, the thresholds are specific to the individual Counties and Air Districts, and again are not developed for purposes of assessing the significance of statewide planning and regulatory actions. However, for the purposes of this evaluation, CARB has included reference to the thresholds as a useful metric for helping the public understand the relative magnitude of GDF pressure driven emissions numbers discussed in this evaluation.

For comparison, Table 2 provides CARB staff's estimates of annualized average daily total emissions from 32 Long-Term Study sites throughout California. Table 2 also provides site-specific estimates of PDE, and the differences between the portion of site-specific PDE values predicted by the old emission factor and the updated site-specific PDE values ('site-specific PDE estimate difference'). Total GDF emission rates for the study sites range from 1.00 to 12.77 lbs/day, PDE rates range from 0.05 to 2.78 lbs/day, and the site-specific PDE estimate differences range from -0.21 to 2.68 lbs/day. The sites with the highest PDE rates do not exhibit the highest total emission rates. As noted earlier, it is the total site-specific emission rate that is relevant for determining the near-source air quality impact of a specific GDF.

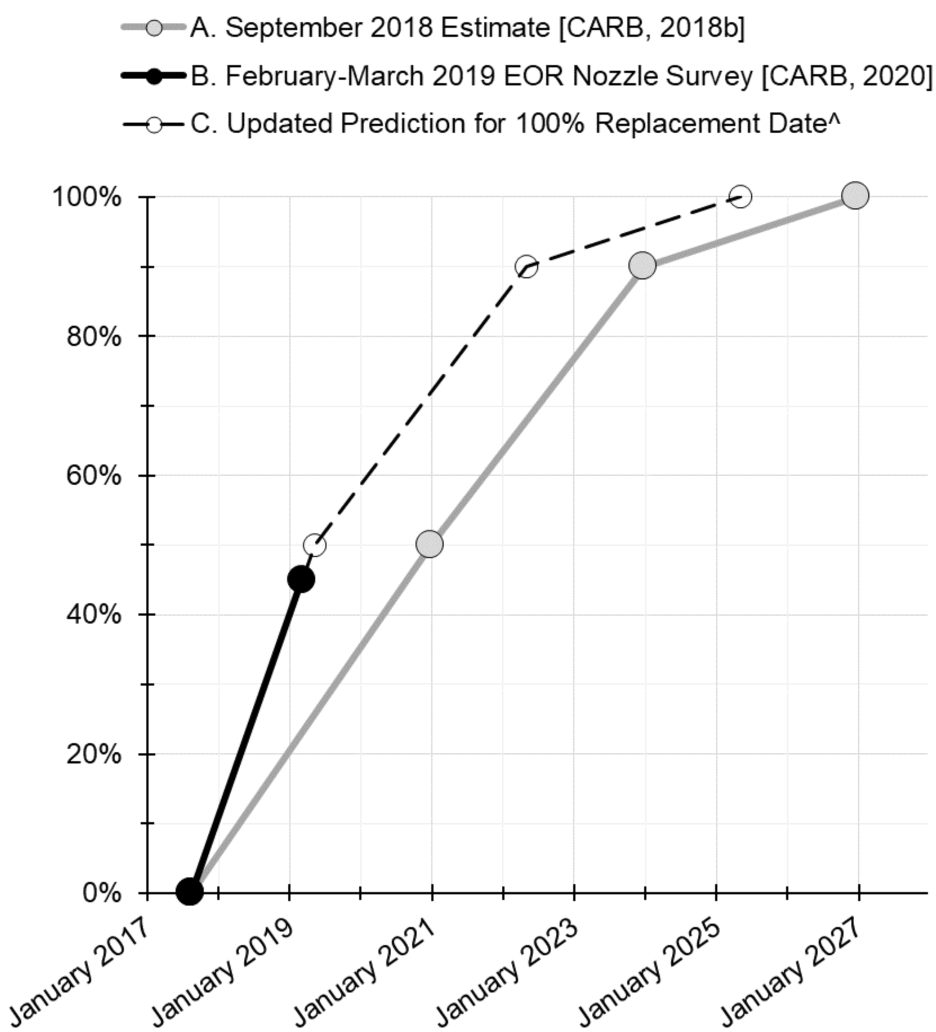
The five largest Air Districts—South Coast, Bay Area, San Joaquin Valley Unified, San Diego, and Sacramento—account for approximately 80 percent of GDFs and gasoline sales throughout the state [Tables 4 and 5; CEC, 2020a; CARB, 2020a]. The most stringent (lowest) threshold for any of these five Air Districts is 54 lbs/day (Table 5). Three smaller Air Districts have the most stringent threshold of 11 lbs/day (2 tons per year). As illustrated in Table 2 and Figure 3, the study GDFs' site-specific PDE are all less than the most stringent Air District/County threshold of significance, and none of the site-specific PDE differences are the cause of any study site total GDF emissions exceeding the threshold. Only one study site has total emissions that exceed the most stringent threshold, and its emissions would exceed the threshold even if it had no PDE. These findings indicate that site-specific GDF PDE do not result in an individually or cumulatively significant net increase in ozone and do not affect implementation of any air quality plan.

VI. Conclusions and Recommendations

CARB field studies completed between 2009 and 2019 found that pressure driven emissions of reactive organic gases (ROG) from GDFs with USTs are higher and more variable than previously estimated. Even so, the evaluation results described in Sections III, IV, and V indicate PDE do not have a significant impact on local, regional, and statewide efforts to control GDF emissions and attain ambient air quality standards for ozone. In addition, PDE are expected to decrease during the next ten years due to the increasing percentage of vehicles with ORVR, implementation of the EOR nozzle and vehicle fill pipe designs, and reduced gasoline consumption statewide. CARB staff estimates PDE will decrease by approximately 25 percent during the summer and about 42 percent during the winter between 2018 and 2030.

VII. Figures

Figure 1. Estimated percent of nozzles replaced with the EOR nozzle at GDFs with Phase II vacuum assist vapor recovery systems



^ Prediction assumes same replacement rate between 0% and 50% as the rate observed by the 2019 EOR Nozzle Survey. To provide a conservative estimate, prediction assumes same replacement rates between 50% and 90%, and between 90% and 100%, as the September 2018 Estimate.

Figure 2. Comparison of statewide vapor recovery program effectiveness using CARB's 2013 emission factors and using the updated pressure driven emissions factor (PDEF)

(See Table 3 for emission factor values.)

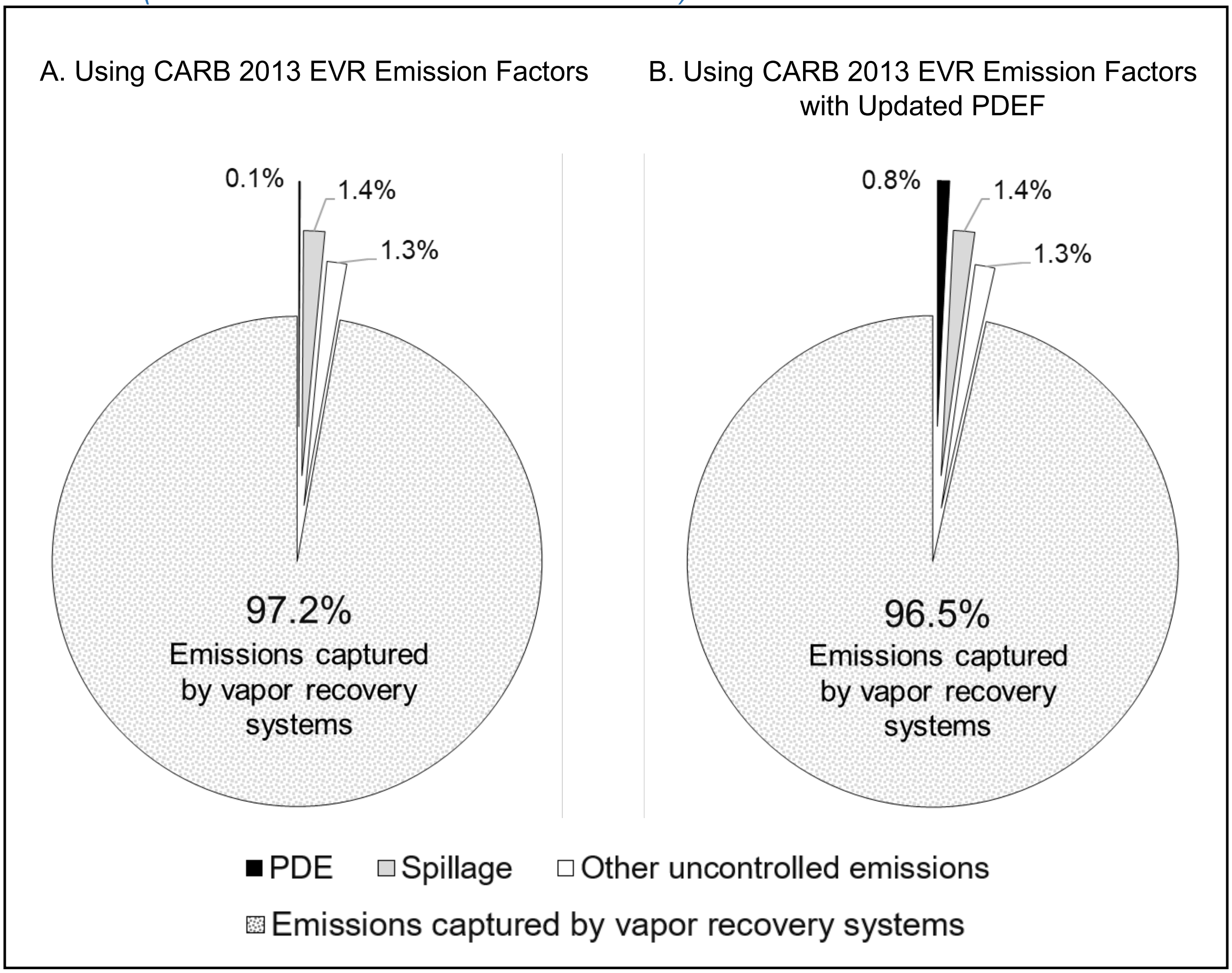
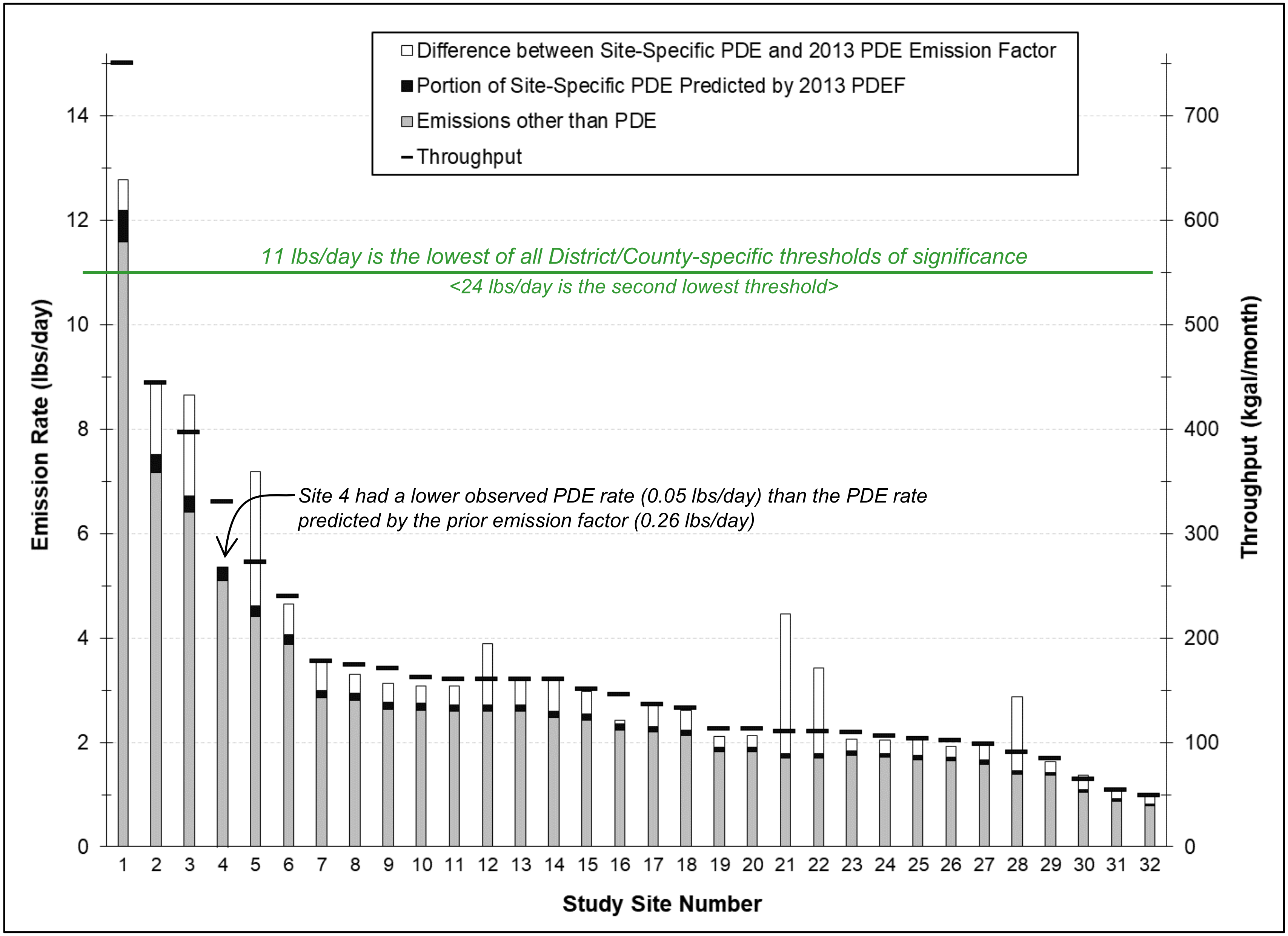


Figure 3. Emissions at Long-Term Study sites with site-specific PDEFs compared to the lowest of Air District/County thresholds of significance



VIII. Tables

Table 1. Summary of updated pressure driven emissions factors and updated statewide emission estimates for 2018, 2025, and 2030

Period [a]	Pressure Driven Emissions Factors (lbs/kgal) [b]			Estimated Pressure Driven Emissions (TPD) [c]			Percent Decrease in Emissions 2018-2030
	2018	2025	2030	2018	2025	2030	
Summer	0.056	0.055	0.055	1.2	1.0	0.9	25%
Winter	0.30	0.24	0.23	6.4	4.3	3.7	42%
Annual Average	0.14	0.12	0.11	3.0	2.1	1.8	40%

(a) Emission factors and emission estimates based on summer period of March through October and winter period of November through February [CARB, 2020d].

(b) The pressure driven emissions factor is predicted to decrease between 2018 and 2025 as EOR nozzles are installed at GDFs with Phase II EVR vacuum assist systems.

(c) Emission estimates based on annual gasoline throughput of 15,471,229,347 gallons estimated for 2018 [CEC, 2019b] and projected throughputs of 13,065,649,500 gallons for 2025 and 11,788,121,123 gallons for 2030 [EMFAC2017 projections corrected with 2018 throughput].

Table 2. Site-specific estimates of PDE and total GDF emissions for each Long-Term Study site

Emission Factors & Rates / Study Site #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Phase II Fueling - Non-ORVR Vehicles Emission Factor (EF) (lbs/kgal)	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
Phase II Fueling - ORVR Vehicles EF (lbs/kgal)	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021
Combined Phase II EF (lbs/kgal)	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067
Phase 1 Bulk Transfer Losses EF (lbs/kgal)	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154
Site-Specific Pressure Driven Emission Factor (PDEF) (lbs/kgal)	0.047	0.117	0.170	0.005	0.306	0.096	0.114	0.086	0.090	0.086	0.092	0.242	0.116	0.134	0.109	0.038
Phase II Fueling - Spillage EF (lbs/kgal)	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Hose Permeation EF (lbs/kgal)	0.0031	0.0242	0.0242	0.0031	0.0242	0.0242	0.0242	0.0242	0.0031	0.0242	0.0242	0.0242	0.0242	0.0031	0.0242	0.0031
Total EF (lbs/kgal)	0.511	0.602	0.655	0.469	0.791	0.581	0.599	0.571	0.554	0.571	0.577	0.727	0.601	0.598	0.594	0.502
Non-PDE Factor (lbs/kgal)	0.464	0.485	0.485	0.464	0.485	0.485	0.485	0.485	0.464	0.485	0.485	0.485	0.485	0.464	0.485	0.464
Throughput - Annual Average (kgal/month)	750	444	396	330	272	240	177	174	170	162	160	160	160	160	150	145
Total Emission Rate - Annual Average (lbs/day)	12.77	8.91	8.65	5.16	7.19	4.64	3.53	3.31	3.14	3.08	3.09	3.89	3.21	3.19	2.98	2.43
Non-Pressure Driven Emissions	11.59	7.17	6.40	5.10	4.40	3.88	2.86	2.81	2.63	2.62	2.59	2.59	2.59	2.47	2.43	2.24
Site-Specific PDE Emission Rate - Annual Average (lbs/day)	1.18	1.74	2.24	0.05	2.78	0.77	0.67	0.50	0.51	0.46	0.49	1.29	0.62	0.72	0.55	0.18
Portion of Site-Specific PDE Predicted by 2013 PDEF	0.59	0.35	0.31	0.26	0.21	0.19	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.12	0.11
Difference between Site-Specific PDE and 2013 PDE Emission Factor	0.59	1.39	1.93	-0.21	2.57	0.58	0.53	0.36	0.38	0.34	0.37	1.17	0.49	0.59	0.43	0.07

Table 2. Site-specific estimates of PDE and total GDF emissions for each Long-Term Study site, *continued*

Emission Factors & Rates / Study Site #	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Phase II Fueling - Non-ORVR Vehicles Emission Factor (EF) (lbs/kgal)	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
Phase II Fueling - ORVR Vehicles EF (lbs/kgal)	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021
Combined Phase II EF (lbs/kgal)	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067
Phase 1 Bulk Transfer Losses EF (lbs/kgal)	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154
Site-Specific Pressure Driven Emission Factor (PDEF) (lbs/kgal)	0.114	0.107	0.076	0.083	0.754	0.470	0.083	0.094	0.113	0.086	0.108	0.492	0.096	0.157	0.109	0.135
Phase II Fueling - Spillage EF (lbs/kgal)	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Hose Permeation EF (lbs/kgal)	0.0242	0.0242	0.0242	0.0242	0.0031	0.0031	0.0242	0.0242	0.0242	0.0242	0.0242	0.0031	0.0242	0.0242	0.0242	0.0242
Total EF (lbs/kgal)	0.598	0.592	0.561	0.568	1.218	0.934	0.568	0.579	0.598	0.570	0.593	0.956	0.581	0.642	0.594	0.620
Non-PDE Factor (lbs/kgal)	0.485	0.485	0.485	0.485	0.464	0.464	0.485	0.485	0.485	0.485	0.485	0.464	0.485	0.485	0.485	0.485
Throughput - Annual Average (kgal/month)	136	132	113	112	110	110	109	106	103	102	98	90	84	64	54	49
Total Emission Rate - Annual Average (lbs/day)	2.72	2.61	2.11	2.13	4.46	3.42	2.06	2.04	2.06	1.93	1.93	2.87	1.63	1.37	1.07	1.00
Non-Pressure Driven Emissions	2.20	2.13	1.82	1.82	1.70	1.70	1.76	1.71	1.67	1.64	1.58	1.39	1.36	1.04	0.87	0.79
Site-Specific PDE Emission Rate - Annual Average (lbs/day)	0.52	0.47	0.29	0.31	2.76	1.72	0.30	0.33	0.39	0.29	0.35	1.48	0.27	0.34	0.20	0.22
Portion of Site-Specific PDE Predicted by 2013 PDEF	0.11	0.10	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.07	0.07	0.05	0.04	0.04
Difference between Site-Specific PDE and 2013 PDE Emission Factor	0.41	0.37	0.20	0.22	2.68	1.64	0.22	0.25	0.31	0.21	0.27	1.41	0.20	0.29	0.15	0.18

Table 3. Comparison of CARB's 2013 emission factors to the updated 2018 emission factor for pressure driven emissions and calculation of Vapor Recovery Program effectiveness

	Annualized Emission Factors (lbs/kgal)		
	Uncontrolled (No Vapor Recovery Controls)	**2013 EVR Emission Factors**	**2013 EVR Emission Factors with Updated 2018 PDEF**
Emission Types			
Phase 1 Bulk Transfer Losses	7.7	0.15	0.15
Phase II Fueling	8.4	0.066	0.066
Phase II Fueling - Spillage	0.61	0.24	0.24
Pressure Driven Emissions (PDE)	0.76	0.024	0.14
Hose Permeation	0.062	0.015	0.015
Total GDF Emissions	**17.532**	**0.495**	**0.611**
Vapor Recovery Program Effectiveness			
GDF Emissions Controlled by CARB Regulations [a, b]		17.037 lbs/kgal (97.2% efficient)	16.921 lbs/kgal (96.5% efficient)

(a) Calculation of GDF Emissions Controlled by CARB Regulations = Total Uncontrolled Emissions - Total GDF Emissions
With 2013 EVR Emission Factors = 17.532 lbs/kgal - 0.495 lbs/kgal = 17.037 lbs/kgal
With updated PDEF = 17.532 lbs/kgal - 0.611 lbs/kgal = 16.921 lbs/kgal

(b) Percentage of GDF Emissions Controlled by CARB Regulations:
= GDF Emissions Controlled by CARB Regulations ÷ Total Uncontrolled Emissions (No Vapor Recovery Controls)
With 2013 EVR Emission Factors = 17.037 lbs/kgal ÷ 17.532 lbs/kgal = 97.2%
With updated PDEF = 16.921 lbs/kgal ÷ 17.532 lbs/kgal = 96.5%

Table 4. Comparison of annualized statewide emissions (TPD) estimates

Emission Type	**Estimated Annualized Statewide Emissions (TPD) Based on:**	
	CARB 2013 EVR Emission Factors	CARB 2013 EVR Emission Factors with Updated 2018 PDEF
Pressure Driven Emissions	0.5	3.0
Nozzle Spillage Emissions	5.1	5.1
Other GDF Emissions	4.9	4.9
Total GDF Emissions	**10.5**	**13.0**

Table 5. Estimated total retail gasoline sold in 2018 and number of retail GDFs by County and Nonattainment Area

County	Air District	2018 Estimated Total Retail Gasoline Sales by County [(a)]		2018 Estimated Total Retail GDFs by County [(a)]		75 ppb Ozone Nonattainment Area [(b)]		
		Millions of Gallons	% of Total	Count	% of Total	Name	Estimated County and Subdivision Populations [(b)]	Subdivision Population as % of County Population
Statewide		**15,471**	**100.00%**	**10,266**	**100%**			
Alameda	Bay Area	569	3.68%	361	3.5%			
Amador	Amador County	17	0.11%	29	0.3%			
Butte	Butte County	86	0.56%	95	0.9%			
Calaveras	Calaveras County	15	0.10%	27	0.3%			
Colusa	Colusa County	13	0.08%	19	0.2%			
Contra Costa	Bay Area	397	2.57%	255	2.5%			
Del Norte	North Coast Unified	7	0.05%	13	0.1%			
El Dorado		76	0.49%	76	0.7%		183,000	
Lake Tahoe Basin	El Dorado County	*12*	*0.08%*	12	0.1%		29,711	16%
Western/Central	El Dorado County	*64*	*0.41%*	64	0.6%	Sacramento Metro	153,289	84%
Fresno	San Joaquin Valley Unified	368	2.38%	338	3.3%	San Joaquin Valley		
Glenn	Glenn County	17	0.11%	20	0.2%			
Humboldt	North Coast Unified	58	0.37%	83	0.8%			
Imperial	Imperial County	89	0.58%	82	0.8%	Imperial County		
Inyo	Great Basin Unified	18	0.12%	24	0.2%			
Kern		396	2.56%	364	3.5%		871,337	
Eastern	Kern County	*60*	*0.39%*	55	0.5%	Eastern Kern County	131,956	15%
Western	San Joaquin Valley Unified	*336*	*2.17%*	309	3.0%	San Joaquin Valley	739,381	85%
Kings	San Joaquin Valley Unified	60	0.39%	63	0.6%	San Joaquin Valley		
Lake	Lake County	23	0.15%	39	0.4%			
Lassen	Lassen County	5	0.03%	12	0.1%			

County	Air District	2018 Estimated Total Retail Gasoline Sales by County [a]		2018 Estimated Total Retail GDFs by County [a]		75 ppb Ozone Nonattainment Area [b]		
		Millions of Gallons	% of Total	Count	% of Total	Name	Estimated County and Subdivision Populations [b]	Subdivision Population as % of County Population
Los Angeles		3,638	23.51%	2,078	20.2%		10,057,155	
Southwestern	South Coast	*3,569*	*23.07%*	2,038	19.9%	South Coast Air Basin	9,865,456	98%
Northeastern	Antelope Valley	*69*	*0.45%*	40	0.4%	Western Mojave Desert	191,699	2%
Madera	San Joaquin Valley Unified	57	0.37%	64	0.6%	San Joaquin Valley		
Marin	Bay Area	82	0.53%	53	0.5%			
Mariposa	Mariposa County	7	0.05%	21	0.2%			
Mendocino	Mendocino County	40	0.26%	59	0.6%			
Merced	San Joaquin Valley Unified	132	0.85%	112	1.1%	San Joaquin Valley		
Mono	Great Basin Unified	7	0.05%	22	0.2%			
Monterey	Monterey Bay Unified	181	1.17%	142	1.4%			
Napa	Bay Area	61	0.39%	39	0.4%			
Nevada		38	0.25%	40	0.4%		98,639	
Eastern	Northern Sierra	*3*	*0.02%*	3	0.03%		8,874	9%
Western	Northern Sierra	*35*	*0.22%*	36	0.4%	Western Nevada Co.	89,765	91%
Orange	South Coast	1,402	9.06%	669	6.5%	South Coast Air Basin		
Placer		206	1.33%	132	1.3%		370,571	
Lake Tahoe Basin	Placer County	*5*	*0.03%*	3	0.0%		8,355	2%
Western/Central	Placer County	*201*	*1.30%*	129	1.3%	Sacramento Metro	362,216	98%
Plumas	Northern Sierra	6	0.04%	27	0.3%			
Riverside		1,052	6.80%	582	5.7%		2,323,892	
Western	South Coast	*841*	*5.43%*	465	4.5%	South Coast Air Basin	1,857,079	80%
Central	South Coast	*5*	*0.03%*	3	0.0%		11,495	0%
Coachella Valley	South Coast	*199*	*1.29%*	110	1.1%	Coachella Valley	440,537	19%
Eastern	Mojave Desert	*7*	*0.04%*	4	0.0%		14,781	1%
Sacramento	Sacramento Metropolitan	586	3.79%	381	3.7%	Sacramento Metro		
San Benito	Monterey Bay Unified	17	0.11%	15	0.1%			

County	Air District	2018 Estimated Total Retail Gasoline Sales by County [a]		2018 Estimated Total Retail GDFs by County [a]		75 ppb Ozone Nonattainment Area [b]		
		Millions of Gallons	% of Total	Count	% of Total	Name	Estimated County and Subdivision Populations [b]	Subdivision Population as % of County Population
San Bernardino		990	6.40%	616	6.0%		2,106,754	
Central/Northeastern	Mojave Desert	*242*	*1.56%*	150	1.5%	Western Mojave Desert	514,486	24%
Southwestern	South Coast	*748*	*4.84%*	466	4.5%	South Coast Air Basin	1,592,268	76%
San Diego	San Diego County	1,387	8.97%	784	7.6%	San Diego County		
San Francisco	Bay Area	120	0.78%	80	0.8%			
San Joaquin	San Joaquin Valley Unified	336	2.17%	240	2.3%	San Joaquin Valley		
San Luis Obispo	San Luis Obispo County	150	0.97%	111	1.1%			
San Mateo	Bay Area	304	1.96%	188	1.8%			
Santa Barbara	Santa Barbara County	191	1.23%	131	1.3%			
Santa Clara	Bay Area	643	4.16%	374	3.6%			
Santa Cruz	Monterey Bay Unified	90	0.58%	78	0.8%			
Shasta	Shasta County	87	0.56%	136	1.3%			
Siskiyou	Siskiyou County	28	0.18%	47	0.5%			
Solano		216	1.40%	143	1.4%		429,596	
Eastern	Yolo/Solano	*68*	*0.44%*	45	0.4%	Sacramento Metro	135,733	32%
Western	Bay Area	*148*	*0.96%*	98	1.0%		293,863	68%
Sonoma		*192*	*1.24%*	139	1.4%		*497,776*	
Northern	Northern Sonoma County	*31*	*0.20%*	23	0.2%		*81,514*	*16%*
Southern	Bay Area	*161*	*1.04%*	116	1.1%		*416,262*	*84%*
Stanislaus	San Joaquin Valley Unified	244	1.58%	193	1.9%	San Joaquin Valley		
Sutter		40	0.26%	38	0.4%		95,406	
Northern	Feather River	*39*	*0.25%*	37	0.4%		92,060	96%
Southern	Feather River	*1*	*0.01%*	1	0.01%	Sacramento Metro	3,347	4%
Tehama	Tehama County	31	0.20%	41	0.4%			
Trinity	North Coast Unified	4	0.03%	18	0.2%			
Tulare	San Joaquin Valley Unified	168	1.09%	207	2.0%	San Joaquin Valley		

County	Air District	2018 Estimated Total Retail Gasoline Sales by County (a)		2018 Estimated Total Retail GDFs by County (a)		75 ppb Ozone Nonattainment Area (b)		
		Millions of Gallons	% of Total	Count	% of Total	Name	Estimated County and Subdivision Populations (b)	Subdivision Population as % of County Population
Tuolumne	Tuolumne County	25	0.16%	31	0.3%			
Ventura	Ventura County	342	2.21%	200	1.9%	Ventura County		
Yolo	Yolo/Solano	110	0.71%	77	0.8%	Sacramento Metro		
Yuba	Feather River	46	0.30%	44	0.4%			
Other Counties (c)	(c)	1	0.01%	14	0.1%			

(a) Estimated retail gasoline sales and GDF counts by County for 2018 obtained from California Energy Commission's 2018 California Annual Retail Fuel Outlet Report [CEC, 2019].

(b) 75 ppb Ozone Nonattainment Areas (NA) identified by *CARB's 2018 Updates to the California State Implementation Plan* [CARB, 2018d]. Some NAs encompass multiple Counties. Some Counties are entirely within a NA, some have only a portion included in a NA, and some have multiple portions each included in different NAs. Where only a portion of a County is within a given NA, CARB staff estimated the amount of retail gasoline sold and number of GDFs in that portion by multiplying the ratio of population of that portion to the population of the entire County ("Subdivision Population as Percent of County Population") by the 'Total Retail Gasoline Sales (Millions of Gallons)' and '2018 Estimated Total Retail GDFs (Count)' for that County. Estimated County and subdivision populations obtained from maps of the U.S. Census Bureau's 2010 Census and the 2012-2016 American Community Survey presented by StatisticalAtlas.com.

(c) "Other Counties" include Alpine, Sierra, and Modoc Counties, which are in the Great Basin Unified Air District, Northern Sierra Air District, and Modoc County Air District, respectively.

Table 6. Estimation of summer GDF pressure driven emissions within each 75 ppb Ozone Nonattainment Area

Estimated 2018 Statewide Average Daily Summer Pressure Driven Emissions (TPD): [from Table 1]	**1.2**

75 ppb Ozone Nonattainment Area Name (Classification)	**2018 Estimated Total Retail Gasoline Sales as % of Statewide Total by Nonattainment Area** [(a)]	**Estimated Summer 2018 Pressure Driven Emissions by Nonattainment Area (TPD)** [(b)]
Coachella Valley (severe)	1.29%	0.015
Eastern Kern County (moderate)	0.39%	0.0047
Imperial County (moderate)	0.58%	0.007
Sacramento Metro Area (severe)	6.66%	0.08
San Diego County (moderate)	8.97%	0.11
San Joaquin Valley (extreme)	11.00%	0.13
South Coast Air Basin (extreme)	42.40%	0.51
Ventura County (serious)	2.21%	0.027
Western Mojave Desert (severe)	2.01%	0.024
Western Nevada County (serious)	0.22%	0.0026

(a) See Table 4 for method used to estimate total retail gasoline sales by Nonattainment Area.

(b) CARB staff calculated the ‘Estimated 2018 Pressure Driven Emissions by Nonattainment Area (TPD)’ by multiplying the ‘Estimated 2018 Statewide Pressure Driven Emissions’ (1.2 TPD) by the ‘2018 Estimated Total Retail Gasoline Sales as % of Statewide Total by Nonattainment Area’ for each Nonattainment Area.

Table 7. Comparison of State Implementation Plan baseline ROG emissions and 75 ppb 8-hour ozone standard attainment year ROG emissions to revised estimates of summer GDF pressure driven emissions in 2018 by Nonattainment Area

75 ppb Ozone Nonattainment Area Name (Classification)	Baseline 2011 Summer ROG Emissions (TPD) (1)	Attainment Year Summer ROG Emissions (TPD) (1)	75 ppb Ozone Attainment Year (1)	2011 to Attainment Year ROG Reduction (TPD)	Summer GDF PDE Estimate (TPD) (2)	**Summer PDE Estimate as % of Summer ROG Emissions**	**Summer PDE Estimate as % of 2011 to Attainment Year Reduction**
Coachella Valley (severe)	16.9	15.1	2026	1.8	0.015	0.10%	0.83%
Eastern Kern County (moderate)	8.6	6.8	2020	1.8	0.0047	0.07%	0.26%
Imperial County (moderate) (3)	19.5	13.5	2017	6	0.007	0.05%	0.12%
Sacramento Metro (severe)	111.6	82.9	2024	28.7	0.08	0.10%	0.28%
San Diego County (5) (moderate)	142.4	110.8	2017	31.7	0.11	0.10%	0.35%
San Joaquin Valley (extreme)	378.7	302.9	2031	75.8	0.13	0.04%	0.17%
South Coast Air Basin (extreme)	522	289.9 (4)	2031	232.1	0.51	0.18%	0.22%
Ventura County (serious)	38.1	30.4	2020	7.7	0.027	0.09%	0.35%
Western Mojave Desert (severe)	48.7	40.5	2026	8.2	0.024	0.06%	0.29%
Western Nevada County (6) (serious)	5.5	4.3	2020	1.2	0.0026	0.06%	0.22%

(1) Citation: CARB, 2018d.
(2) See Tables 4 and 5 for methods used to estimate GDF pressure driven emissions (PDE) by Nonattainment Area.
(3) Emissions in Imperial County are at a level sufficient to attain the 75 ppb 8-hour ozone standard absent the impact of emissions from Mexico [CARB, 2018d]. Consequently, the 2017 emission estimate for Imperial County is entered for the "Summer ROG Attainment" emission value.
(4) Reflects emissions used to demonstrate attainment in the South Coast 2016 AQMP (emissions inventory values minus expected reductions from District and CARB measures in the attainment year) [SCAQMD, 2017].
(5) ROG emissions from CARB 2016 CEPAM version 1.05; San Diego County did not attain in 2017, and a new attainment plan is in development by the District for submittal to U.S. EPA in 2020 that will establish a new attainment year.
(6) ROG emissions from CARB 2016 CEPAM version 1.05 as included in the 2018 NSAQMD Ozone Attainment Plan Western Nevada County [CARB, 2018c; NSAQMD, 2018].

Table 8. Air District/County significance thresholds for reactive organic gases

Air Basin (North to South)	Air District [(a)]	Annual Threshold [(b)] Tons per Year	Annual Threshold [(b)] Pounds per Day [(c)]	Daily Threshold [(b)] Pounds per Day	Threshold Citations and Notes
Northeast Plateau	Lassen Co.	2	11	-	Lassen Co. APCD, 2001
	Modoc				na [(d)]
	Siskiyou				na
North Coast	Mendocino	40	219	-	MCAQMD, 2013
	North Coast Unified	40	219	50	NCUAQMD, 2015 & 2019
	Northern Sonoma	40	219	-	NSCAPCD, 2017
Sacramento Valley	Butte Co.	-		25	BCAQMD, 2014
	Colusa				na
	Feather River	-		25	FRAQMD, 2010
	Glenn	25	137	-	CGAPCD, 2010
	Placer Co.	-		55	PCAPCD, 2016
	Sacramento Metro	-		65	SMAQMD, 2015-2018
	Shasta			25 / 137	Shasta County, 2004
	Tehama	-		25 / 137	TCAPCD, 2015
	Yolo-Solano	10	55	-	YSAQMD, 2007
Mountain Counties	Amador	5	27	-	ACAPCD, 2001
	Calaveras Co.	-		150	Calaveras Co., 2018
	El Dorado Co.	-		82	EDCAQMD, 2002
	Mariposa	100	548	-	Mariposa Co. APCD 2019a&b
	Northern Sierra			24 / 136	NSAQMD, 2009
	Placer Co.	-		55	PCAPCD, 2016
	Tuolumne	100	548	1,000	Tuolumne Co. APCD, 2019
Lake Tahoe	El Dorado Co.	-		82	EDCAQMD, 2002
	Placer	-		55	PCAPCD, 2016
	Tahoe Regional Planning Agency	-		17.6 / 125.7	TRPA, 2019
Lake County	Lake Co.	2	11	-	LCAQMD, 2006
San Francisco Bay Area	Bay Area	10		54	BAAQMD, 2017
San Joaquin Valley	San Joaquin Valley	10	55	-	SJVAPCD, 2015
Great Basin Valleys	Great Basin Unified	2	11	-	GBUAPCD, 1995 & 2001
North Coast Central	Monterey Bay Unified	-		137	MBUAPCD. 2008
South Central Coast	San Luis Obispo	-		25	SLOCAPCD, 2012 & 2017
	Santa Barbara	25	137	55	CSBPDD, 2018; SBCAPCD, 2015, 2016, 2017
	Ventura Co. [(e)]	-		25	VCAPCD, 2003
Mojave Desert	Antelope Valley	25	137	137	AVAQMD, 2016
	Kern Co. (eastern)	25	137	-	KCAPCD, 1999 & 2000
	Mojave Desert	25	137	137	MDAQMD, 2016
	South Coast	-		55	SCAQMD, 2019
South Coast	South Coast	-		55	SCAQMD, 2019
Salton Sea	Imperial	-		137	IMAPCD, 2017
	South Coast (Coachella Valley)	-		75	SCAQMD, 2019
San Diego County\City	San Diego	13.7\15	75\82	75\137	Co. of San Diego, 2007 City of San Diego, 2016 SDAPCD, 2016a&b

Table 8 Notes:

(a) Some Air Districts/Counties are entirely within a single air basin and some have multiple portions each included in different air basins.

(b) This table includes CEQA and air quality permitting thresholds of significance for reactive organic gases (ROG) specified by Counties and Air Districts. If thresholds for ROG were not specified, but thresholds for reactive organic compounds (ROC) or volatile organic compounds (VOCs) were specified, these thresholds are included. In regions where available documents provide conflicting thresholds (e.g., annual threshold that, when converted to pounds per day, is higher than the daily threshold), CARB staff used the lowest threshold in their evaluation.

(c) County and Air District documents typically present annual thresholds as tons per year; these values were converted to pounds per day for comparison to daily thresholds. Pounds per day = tons per year x 2,000 ÷ 365.

(d) Not available (na). CARB staff could not locate any thresholds for these Districts/Counties.

(e) Ventura County has two thresholds for reactive organic compounds, 5 lbs/day for the Ojai Planning Area and 25 lbs/day for the remainder of Ventura County (VCAPCD, 2003). The Ojai Valley Planning Area is small valley comprised almost entirely of designated ‘Non-Growth Areas.’ As a result, the unusually low threshold used by Ventura County for the Ojai Planning Area is not appropriate for use in a statewide evaluation.

\- Air District/County has either an annual threshold or a daily threshold, but not both.

/ Air District/County has multi-level thresholds

Table 9. Estimated total retail gasoline sold and number of retail GDFs in 2018 by Air District

Air District [(a)]	**Gasoline Sales**		**Retail GDFs**	
	Millions of Gallons	% of Total	Count	% of Total
South Coast AQMD	6,764	43.72%	3,751	36.54%
Bay Area AQMD	2,484	16.06%	1,564	15.24%
San Joaquin Valley Unified APCD	1,701	10.99%	1,526	14.86%
San Diego County APCD	1,387	8.97%	784	7.64%
Sacramento Metropolitan AQMD	586	3.79%	381	3.71%
Ventura County APCD	342	2.21%	200	1.95%
Monterey Bay Unified APCD	288	1.86%	235	2.29%
Mojave Desert	248	1.61%	154	1.50%
Placer County APCD	206	1.33%	132	1.29%
Santa Barbara County APCD	191	1.23%	131	1.28%
Yolo/Solano AQMD	178	1.15%	122	1.19%
San Luis Obispo County APCD	150	0.97%	111	1.08%
Imperial County APCD	89	0.58%	82	0.80%
Shasta County AQMD	87	0.56%	136	1.32%
Butte County AQMD	86	0.56%	95	0.93%
Feather River AQMD	86	0.56%	82	0.80%
El Dorado County APCD	76	0.49%	76	0.74%
Antelope Valley AQMD	69	0.45%	40	0.39%
North Coast Unified AQMD	69	0.45%	114	1.11%
Kern County APCD	60	0.39%	55	0.54%
Northern Sierra AQMD	44	0.28%	67	0.65%
Mendocino County AQMD	40	0.26%	59	0.57%
Northern Sonoma County APCD	31	0.20%	23	0.22%
Tehama County APCD	31	0.20%	41	0.40%
Siskiyou County APCD	28	0.18%	47	0.46%
Great Basin Unified APCD	25	0.16%	46	0.45%
Tuolumne County APCD	25	0.16%	31	0.30%
Lake County AQMD	23	0.15%	39	0.38%
Amador County APCD	17	0.11%	29	0.28%
Glenn County APCD	17	0.11%	20	0.19%
Calaveras County APCD	15	0.10%	27	0.26%
Colusa County APCD	13	0.08%	19	0.19%
Mariposa County APCD	7	0.05%	21	0.20%
Lassen County AQMD	5	0.03%	12	0.12%
Modoc County APCD, Great Basin Unified APCD (Alpine Co.), Northern Sierra AQMD (Sierra Co.)	1	0.01%	14	0.14%

(a) See Table 5 footnotes for explanation.

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