2008 EIGHT-HOUR OZONE ATTAINMENT PLAN FOR SAN DIEGO COUNTY

FINAL - DECEMBER 2016

SAN DIEGO COUNTY
AIR POLLUTION CONTROL DISTRICT
10124 OLD GROVE ROAD
SAN DIEGO, CA 92131

2008 EIGHT-HOUR OZONE ATTAINMENT PLAN FOR SAN DIEGO COUNTY

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1.0 INTRODUCTION AND OVERVIEW

Federal clean air standards have been established for common outdoor air pollutants, including ozone, to protect public health and the environment from the harmful effects of air pollution. These standards, called *National Ambient Air Quality Standards* (NAAQS), are established by the U.S. Environmental Protection Agency (EPA) pursuant to requirements of the federal Clean Air Act (CAA).[1] Each area of the nation with air pollution levels violating a NAAQS must be designated by the EPA as a "nonattainment area" for that pollutant. Each nonattainment area must submit a "State Implementation Plan" (SIP) outlining the combination of local, state, and federal actions and emission control regulations necessary to bring the area into attainment as expeditiously as practicable.

San Diego County is currently designated as a Moderate nonattainment area for the 2008 eight-hour ozone NAAQS. Accordingly, the San Diego County Air Pollution Control District (District) must prepare and submit to the EPA, through the California Air Resources Board (ARB), a SIP identifying control measures and associated emission reductions as necessary to demonstrate attainment by July 20, 2018. This 2008 Eight-Hour Ozone Attainment Plan addresses these requirements.

1.1 BACKGROUND

1.1.1 Ozone

Ozone is a corrosive gas, composed of three oxygen atoms, that is found in two layers of the atmosphere. It occurs naturally in the stratosphere (upper atmosphere) where it absorbs and provides a protective shield against the sun's damaging ultraviolet radiation. Ozone also exists in the troposphere (lower atmosphere), near ground level, as a result of human activities. "Ground level" ozone—the subject of this Attainment Plan—is an air pollutant that can damage living tissue and break down certain materials.

Ozone is not usually emitted directly into the air, but at ground level is formed by chemical reactions of "precursor" pollutants—oxides of nitrogen (NOx) and volatile organic compounds (VOC)—in the presence of ultraviolet radiation (strong sunlight). NOx and VOC emissions are emitted from motor vehicles, industrial plants, consumer products, and many other sources.

Ozone concentrations are usually higher during the spring and summer months. Abundant sunshine promotes ozone formation and warm weather increases VOC emissions from fuel and solvent evaporation. Additionally, warm weather is often associated with stable atmospheric conditions and an inversion layer[2] in the lower atmosphere, reducing dispersion of ozone.

[1] Federal Clean Air Act requirements are codified, as amended, in the U.S. Code at 42 U.S.C. Sections 7401, et seq.
[2] An inversion layer is a stable layer of the atmosphere, which does not allow for upward air motion. An inversion often acts like a cap on the atmosphere, trapping air pollution below it.

1.1.2 Health and Welfare Effects

A significant body of research has shown that exposure to unhealthful levels of ozone can cause lung and airway inflammation, significant decreases in lung function and capacity, and other respiratory symptoms such as coughing and pain when taking a deep breath. Ozone exposure is a particular threat during the summer ozone season for people working, exercising, or playing outdoors, or who already have respiratory problems. Long-term exposure to moderate levels of ozone may cause permanent changes in lung structure, leading to premature aging of the lungs and worsening of chronic lung disease. Ozone also impacts the agriculture and forest industries, slowing plant growth and increasing susceptibility to disease, pests, and harsh weather.

1.1.3 National Ozone Air Quality Standards

The 2008 eight-hour ozone NAAQS was established by the EPA in 2008.[3] It is attained when the "three year average" of the "annual fourth highest daily maximum" eight-hour average ozone concentration—called the "design value"—is no greater than 0.0759 parts per million (ppm) at each EPA-approved ozone air quality monitor in the region. The "three-year average" and "annual fourth highest daily maximum" are statistical values that provide stability to the standard, moderating the influence of extreme meteorological conditions (over which an area has no control) that could cause the region's ozone compliance status to vacillate between attainment and nonattainment despite ongoing emission reductions.

On October 26, 2015, the EPA published a final rule in the Federal Register lowering the federal ozone NAAQS standards to a more health-protective 0.070 ppm. The final rule was effective December 28, 2015.[4] Preliminary state designation recommendations are due to the EPA by October 1, 2016, considering all certified air monitoring data from 2013 to 2015, and any preliminary data from 2016. The EPA anticipates making final designations considering each state recommendation and air monitoring data from 2014 to 2016. Similar to previous ozone standards, it is likely that San Diego County will be designated as a nonattainment area for the more health-protective 2015 eight-hour ozone NAAQS, either as a Marginal or Moderate nonattainment area.

This Attainment Plan addresses statutory requirements for the 2008 eight-hour ozone NAAQS as a Moderate nonattainment area. The emission control measures within this Attainment Plan will complement future efforts to attain the 2015 standard by required statutory deadlines.

1.1.4 Ozone Designation Status

The region's air quality designations for the NAAQS (attainment, nonattainment, or unclassifiable) are established by federal regulation.[5] San Diego County was initially designated a Marginal nonattainment area for the 2008 eight-hour ozone NAAQS, effective July 20, 2012. Marginal areas were required to attain the 2008 eight-hour ozone NAAQS by July 20, 2015. Despite substantial air quality progress, the region did not meet this attainment deadline. Consequently, on June 3, 2016, the EPA reclassified San Diego County as a Moderate nonattainment area,[6] which requires the

[3] 73 FR 16483
[4] 80 FR 65291
[5] 40 CFR 81.305, "Designation of Areas for Air Quality Planning Purposes – California."
[6] 81 FR 26697

District to submit a SIP meeting Moderate area requirements, including a demonstration of attainment by July 20, 2018. This Attainment Plan addresses those requirements.

1.1.5 Tribal Nations

Pursuant to federal requirements, none of the region's Tribal Nations are regulated by the District. Their ozone status does not affect this Attainment Plan, which only applies to non-tribal land.

1.2 EMISSION CONTROL EFFORTS

Air quality control in California is a shared responsibility among federal, state, and local agencies. At the national level, the EPA regulates emissions from off-road equipment and inter-state sources such as ships, trains, aircraft, and out-of-state vehicles. At the state level, the ARB regulates emissions from on-road motor vehicles, off-road vehicles and equipment, fuels, and consumer products.[7] The District regulates emissions from stationary sources, such as factories, power plants, gasoline stations, and other businesses and industrial operations.[8] Additionally, the District regulates some areawide sources such as coatings and industrial solvents. As a result of shared efforts, mobile and stationary sources in San Diego County are among the cleanest in the nation.

1.3 OZONE AIR QUALITY IMPROVEMENT

Total regionwide NOx and VOC emissions have been reduced by over 56% and 44%, respectively, during the 2000-2015 time period (see Section 2.1.4).[9] Further, ongoing implementation of existing rules and regulations will continue reducing total ozone precursor emissions for the foreseeable future. For example, new lower-emitting sources will replace older, higher-emitting sources at the end of their useful lives.

To gauge the region's progress, measurements of ambient air quality (including ozone levels) are continuously collected at numerous sites in the region.[10] This data demonstrates that San Diego County has achieved a 21% reduction (improvement) in the ozone design value between 2000 and 2015, as depicted in Figure 1-1.

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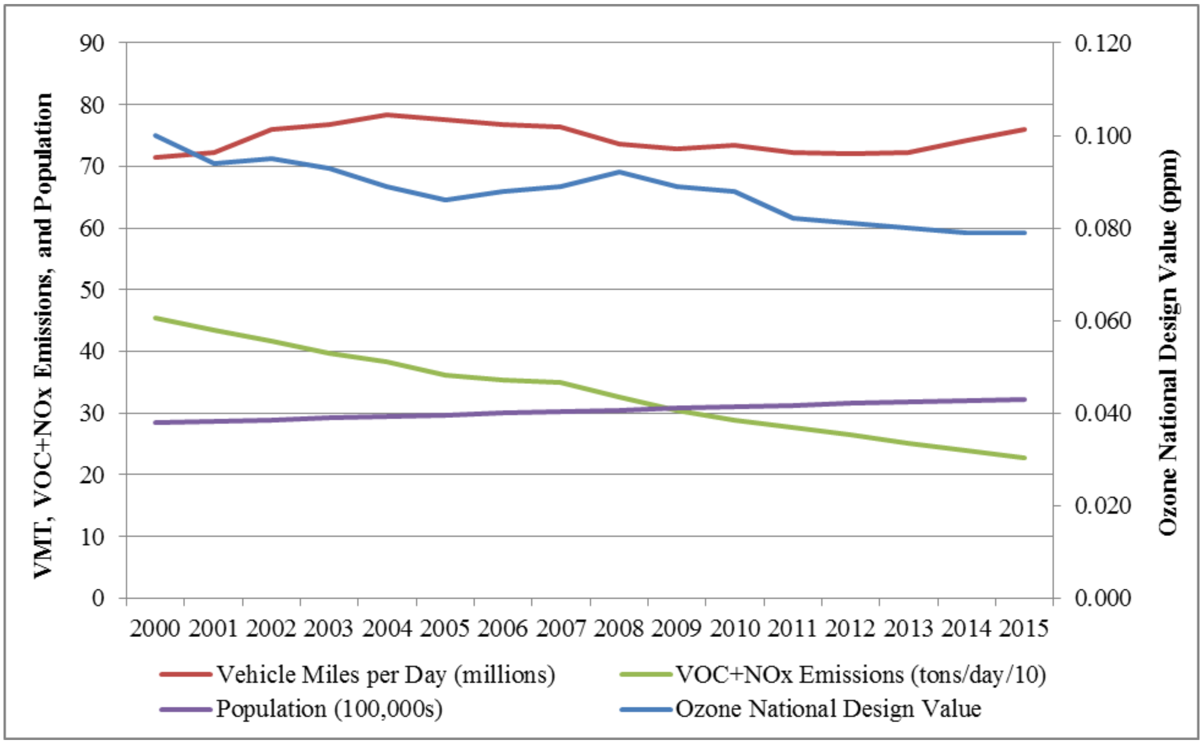
[7] A comprehensive overview of state regulations is provided in Attachments C and D.

[8] A comprehensive listing of District rules is included under separate cover in the "2008 Eight-Hour Ozone Reasonably Available Control Technology (RACT) Demonstration for San Diego County."

[9] Based on the ARB California Emissions Projection Analysis Model (CEPAM) emissions inventory, Version 1.04.

[10] 40 CFR Part 58, "Ambient Air Quality Surveillance."

FIGURE 1-1
Emissions, Air Quality, and Growth Trends in San Diego County



1.3.1 Transported Pollution

San Diego County is located downwind of the South Coast air basin, an Extreme nonattainment area.[11] Consequently, emissions from the South Coast can and often do increase ozone levels in the San Diego region. This is reflected in state regulation that identifies areas impacted by transported air pollution.[12]

Importantly, the South Coast Air Quality Management District (SCAQMD) has implemented an effective emissions control program resulting in a long-term trend of emission reductions and air quality improvement in the South Coast region. In turn, air pollution transported to San Diego County has decreased. Nevertheless, transported air pollution will continue to impact San Diego County's ability to expeditiously attain and maintain the 2008 and 2015 ozone NAAQS.

[11] The South Coast air basin includes Orange County and the metropolitan portions of Los Angeles, Riverside, and San Bernardino Counties.
[12] California Code of Regulations, Section 70500

2.0 GENERAL ATTAINMENT PLAN REQUIREMENTS

The EPA promulgated the final 2008 eight-hour ozone implementation rule on April 6, 2015, finalizing the planning and emission control requirements that affected regions must address in their implementation plans.[13] Pursuant to this rule, all nonattainment areas—including San Diego County—are subject to the general planning and emission control requirements of Subpart 2 (Title I, Part D) of the CAA. Subpart 2 requirements have long been implemented in San Diego County pursuant to the region's former status as a Subpart 2/Serious nonattainment area for the former 1979 one-hour ozone NAAQS,[14] and a Subpart 2/Moderate nonattainment area for the former 1997 eight-hour ozone NAAQS.

Subpart 2 general attainment plan requirements consist of the following:

- An **Emission Inventory** (Section 2.1) (CAA Section (§) 182(a)(1)), which is a comprehensive tabulation of air pollutants organized by emission source category. This Attainment Plan includes updated inventories of ozone precursor emissions (VOC and NOx) for the 2012 base year (the year from which future-year inventories are projected)[15] and the 2017 attainment year, representative of a typical summer weekday. Section 2.1 also identifies Emission Budgets for federal regulatory programs known as transportation and general conformity (see Section 2.1.3).

- An **Emission Statement Certification** (Section 2.2) (CAA §182(a)(3)(B)), which states whether the District's existing emission statement reporting rule (Rule 19.3) is sufficient and remains adequate for the purposes of the 2008 eight-hour ozone NAAQS for major sources. This Attainment Plan meets the federal requirement by certifying that the existing rule is sufficient for implementation of the 2008 eight-hour ozone NAAQS.

- A **New Source Review** (NSR) program (Section 2.3) (CAA §182(a)(2)), which is required to address emissions from new sources and major modifications to existing sources. The Attainment Plan meets this requirement through the District's NSR-series rules, which were updated in 2016. The applicability threshold for NSR remains at 50 tons of VOC or NOx per year, and the offset ratio remains at 1.2-to-1. These values are more conservative than required for a Moderate nonattainment area.

[13] 80 FR 12263

[14] Subpart 2/Serious Nonattainment provisions were fully satisfied in San Diego County pursuant to the 1994 One-Hour Ozone Attainment Plan, approved by the EPA (62 FR 1150). Compliance with Subpart 2 was reaffirmed by the EPA when redesignating the region to a Maintenance Area for one-hour ozone NAAQS (68 FR 13653).

[15] The ARB established 2012 as the emission inventory base year for eight-hour ozone planning purposes, which is the most recent year in which comprehensive emissions estimates was available. See "Transmittal Letter to EPA" Richard Corey, Executive Officer, ARB, July 17, 2014. (http://www.arb.ca.gov/planning/sip/2012iv/ARB_2012O3SIP_transltr_to_EPA.pdf).

2.1 EMISSION INVENTORY

2.1.1 Inventory Development Process

Emission inventories, projections, and trends in this Attainment Plan are based on the latest ozone SIP planning emission projections compiled and maintained by the ARB.[16] Supporting data were jointly developed by stakeholder agencies, including the ARB, the District, SCAQMD, the Southern California Association of Governments (SCAG), and the San Diego Association of Governments (SANDAG). Each agency plays a role in collecting and reviewing data as necessary to generate comprehensive emission inventories. The supporting data includes socio-economic projections, industrial and travel activity, emission factors, and emission speciation profiles.

The ARB compiles annual statewide emission inventories in its emission-related information database, the California Emission Inventory Development and Reporting System (CEIDARS). Emission projections for past and future years are generated using the ARB California Emission Projection Analysis Model (CEPAM), formerly the California Emission Forecasting System (CEFS), to track progress meeting emission reduction goals and mandates. CEPAM utilizes the most current growth and emissions control data available (and agreed upon by the stakeholder agencies) to provide comprehensive projections of anthropogenic (human activity-related) emissions for each year from 2000 to 2035.

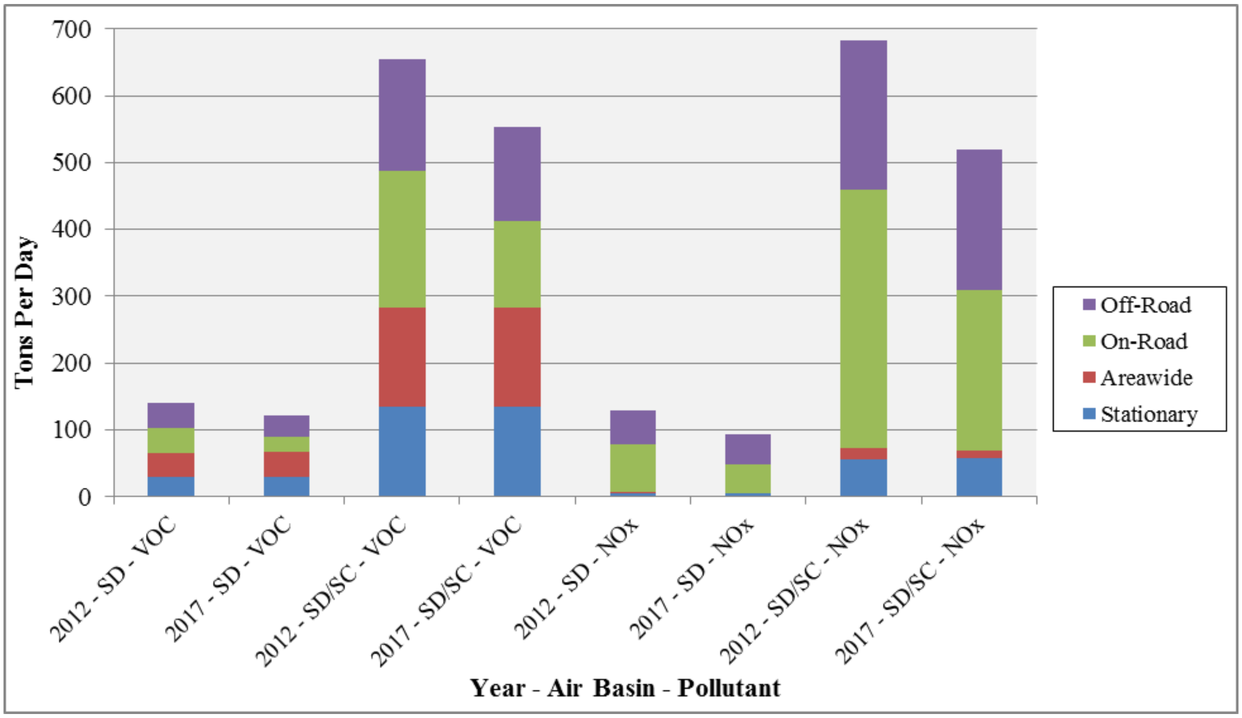
Local air districts are responsible for compiling emissions data for all point sources and many stationary areawide sources. For mobile sources, CEPAM integrates emission estimates from the ARB EMFAC2014 and OFFROAD models. SCAG and SANDAG incorporate data regarding highway and transit projects from their respective Travel Demand Models for estimating and projecting vehicle miles traveled (VMT) and speed. The ARB on-road emissions inventory (EMFAC2014) relies on these VMT and speed estimates. To complete the inventory, estimates of biogenic (naturally occurring) emissions are developed by the ARB using the Biogenic Emissions Inventory Geographic Information System (BEIGIS) model.

2.1.2 Inventories for 2012 Base Year and 2017 Attainment Year

Detailed inventories of VOC and NOx for the 2012 base year and 2017 attainment year are presented in Attachment A and Figure 2-1. Pursuant to the CAA, the ARB submitted the 2012 baseline emission inventory to the EPA for all California nonattainment areas on July 17, 2014. Consequently, the requirement for submittal of a baseline year emission inventory has been met. The 2012 emission inventory presented in Attachment A of this Plan reflects the submitted data. Since San Diego County's air quality is often affected by transported VOC and NOx from the South Coast air basin (see Section 1.3.1), both an inventory of San Diego County-only emissions and combined San Diego County plus South Coast air basin emissions are presented. The latter scenario is a general indicator of progress for the South Coast-San Diego County transport couplet.

[16] ARB CEPAM emissions inventory, Version 1.04.

FIGURE 2-1
Ozone Precursor Emissions in San Diego County and South Coast Air Basins



SD = San Diego Air Basin; SC = South Coast Air Basin
Source: ARB CEPAM emissions inventory, Version 1.04.

2.1.3 Emission Budgets

2.1.3.1 On-Road Motor Vehicle Emission Budgets For Transportation Conformity

The federal transportation conformity regulation[17] requires this Attainment Plan to specify on-road motor vehicle emission budgets for the 2017 attainment year.[18] These emission budgets will also apply to all subsequent transportation conformity analysis years, per the regulation.[19]

TABLE 2-1
On-Road Motor Vehicle Emission Budgets in San Diego County
For 2017 and Subsequent Years
(tons per day)

Pollutant	2017 and Subsequent Years
VOC	23
NOx	42

Note: Emission budgets are based on the ARB CEPAM emissions inventory (Version 1.04), which incorporates the EMFAC2014 model and reflect a "summer day."

The emission budgets presented in Table 2-1 represent the on-road motor vehicle emission levels projected for 2017, as determined using the ARB CEPAM emissions inventory, which incorporates the EMFAC2014 on-road motor vehicle emissions estimation model. Minor budget adjustments were made to account for imprecision in the on-road motor vehicle emissions modeling process.[20] The emission budgets are expressed as whole numbers; therefore, on-road motor vehicle emission estimates should be rounded up to the nearest whole number (in tons per day) prior to being compared to emission budgets for transportation conformity determinations.

2.1.3.2 Military Growth for General Conformity

The federal general conformity regulation[21] and corresponding District Rule 1501[22] require federal agencies proposing major federal actions to make a determination that proposed actions will conform to the applicable SIP. Specifically, proposed federal actions may not cause or contribute to a NAAQS violation or interfere with the purposes of the SIP. A method for demonstrating conformity is forecasting and accounting for reasonably anticipated emissions from future actions

[17] 40 CFR 93 ("Determining Conformity of Federal Actions to State or Federal Implementation Plans").
[18] 40 CFR 93.118 ("Criteria and Procedures: Motor Vehicle Emissions Budget").
[19] 40 CFR 93.118(b)(2).
[20] To establish the emission budgets, the 2017 on-road motor vehicle emissions estimates were adjusted by rounding up to the next whole number. A similar adjustment procedure was previously used in the District's approved One-Hour Ozone Maintenance Plan, 2007 Eight-Hour Ozone Attainment Plan, and 2012 Eight-Hour Ozone Maintenance Plan.
[21] 40 CFR 51, Subpart W ("Determining Conformity of General Federal Actions to State or Federal Implementation Plans").
[22] District Rule 1501, "Conformity of General Federal Actions," approved by the EPA on April 23, 1999 (64 FR 19916).

by federal agencies in the applicable SIP (attainment or maintenance plan).[23]

The Department of the Navy (DoN) and United States Marine Corps (USMC) previously developed a projection of future mobile source emissions from anticipated military actions for inclusion in the 1997 Eight-Hour Ozone NAAQS Maintenance Plan (2012). The projection encompassed actions that may occur during the twenty-year maintenance period.[24] The emission projections for the Maintenance Plan included a Military Growth Increment of 4.4 tons of NOx per day, and 1.0 tons of VOC per day. For this Attainment Plan, DoN has requested an additional growth increment of 1.51 tons per day of NOx and 0.08 tons per day of VOC (Attachment B). The additional growth accounts for projects that DoN has planned for implementation during the period in which this Attainment Plan is the applicable SIP (prior to attainment and subsequent replacement of this SIP by a new maintenance plan). This includes replacing older aircraft at Naval Air Station North Island with higher-emitting advanced-technology aircraft.

Attachment B presents preliminary schedules for implementation of the planned military projects through 2035. For purposes of analyzing the potential impact of these projects on 2017 ozone attainment, total emissions from full implementation of these projects were conservatively assumed to occur in 2017. The District worked with the ARB to incorporate this growth increment into the CEPAM emissions inventory (Version 1.04) in March 2016; therefore, a total growth allowance of 5.91 tons per day of NOx and 1.08 tons per day of VOC emissions has been incorporated into this Attainment Plan and subsequent modeling by SCAQMD. The analysis indicates this emissions growth allowance can be accommodated, i.e., without causing additional ozone exceedances.[25]

2.1.3.3 San Diego International Airport Growth for General Conformity

As discussed in Section 2.1.3.2, a method for demonstrating federal general conformity and compliance with Rule 1501 is forecasting and accounting for reasonably anticipated emissions from future actions by federal agencies in the applicable SIP (attainment or maintenance plan). Consequently, the San Diego County Regional Airport Authority (Authority) developed an emission inventory of criteria pollutant emissions at the San Diego International Airport (SDIA)[26] for inclusion in this Attainment Plan. The inventory is included for reference in Attachment C.

The Authority quantified actual emissions from 2012 for aviation and non-aviation sources on SDIA property, [27] including:

- Aircraft (airborne and ground modes)

[23] 40 CFR 51.858(a)(1).
[24] "Department of Navy Emissions Growth Increment Request for the San Diego Air Pollution Control District," Naval Facilities Engineering Command Southwest and Marine Corps Installations West, San Diego County, California, May 24, 2011.
[25] Comparison of modeling 2017 air quality with and without planned military projects indicates increases of NOx and VOC emissions would result in slightly higher ozone concentrations.
[26] See Attachment C - LeighFisher. *Emissions Inventory of Airport-Related Sources*. Report. 2016. Print.
[27] SDIA is San Diego County's largest commercial service airport, handling more than 190,000 aircraft operations annually. Owned by the Authority, it is considered to be the busiest single-runway airport in the United States. It is located on a 661-acre constrained site in downtown San Diego, three miles west of the downtown business district. In addition to commercial service, SDIA also accommodates the majority of regional cargo demand via passenger airlines (belly cargo) and dedicated all-cargo air carriers.

- Ground support equipment (GSE)
- Roadways and parking garages
- Construction (current and future)[28]
- Stationary sources

The Authority estimated future emissions at these sources based on actions anticipated to occur by the region's attainment year (2017) and within a future 20-year maintenance planning period (2020, 2030, and 2040).[29] The additional growth accounts for projects SDIA has planned for implementation during the period in which this Attainment Plan is projected to be the applicable SIP.

Some source categories identified in the SDIA inventory not accounted for in the regionwide emission inventory (Attachment A) include Auxiliary Power Units (APU), new jet fuel storage tanks, and large future construction projects planned between 2020 and 2037.[30] To analyze the construction projects' potential impact on 2017 ozone attainment, full build-out at SDIA was conservatively assumed to occur in 2017, and accordingly incorporated into the ARB CEPAM emissions inventory (Version 1.04) and the modeling for this Attainment Plan.[31]

The added emissions growth from SDIA totaled 1.756 tons per day of NOx, and 0.141 tons per day of VOC.[32] Analysis indicates this growth allowance can be accommodated without jeopardizing attainment of the 2008 eight-hour ozone NAAQS.[33]

2.1.3.4 Pre-Baseline Banked Emission Credits

The District's federally mandated NSR Rules require new and modified major stationary sources that increase emissions in amounts exceeding specified thresholds to provide emission reduction offsets to mitigate their emissions growth. Offsets represent either on-site emission reductions, or the use of banked emission reduction credits (ERCs), which are voluntary, surplus emission reductions previously achieved and registered with the District for future use as offsets.

[28] The Authority's Airport Development Plan concludes that substantial site modifications will be necessary to meet expected travel demand and geographical constraints by 2035.

[29] Attachment C - LeighFisher. *Emissions Inventory of Airport-Related Sources*. Report. 2016. Print.

[30] Table 7-2 of the SDIA inventory identifies 15 major projects targeted for completion by 2040. These include, but are not limited to: (1) demolition and replacement of Terminal 1, (2) construction of additional parking plazas, (3) construction of a temporary runway, and (4) complete reconstruction of the existing runway.

[31] These categories include aircraft, roadway/parking garage, construction, and selected stationary sources including boilers, emergency generators, and traffic marking paints. The District compared the regionwide emission inventory (Attachment A) against the SDIA emission inventory (Attachment C) to identify discrepancies and overlaps. For example, the regionwide estimate for aircraft emissions in Attachment A already contains an estimate for all aircraft within San Diego County, which includes SDIA as well as other County general aviation airports. Similarly, roadways and parking garage emission estimates identified in the SDIA inventory are already encompassed within the regionwide emission inventory in the On-Road Vehicle category.

[32] Calculations were derived from data within Attachment C assuming daily rates of emissions. The District voluntarily included approximately 1.3 tons of NOx per day, and 0.1 tons of VOC per day from 2017 to 2019 for simplicity during the emission inventory incorporation process. In actuality, these emissions are highly unlikely to be emitted prior to 2020. The initial regionwide estimate for ground support equipment (GSE) was also lower than the estimate submitted in the SDIA inventory. Using emission estimates derived in Attachment C, the District adjusted GSE emissions in the regionwide inventory upward to capture all potential emissions for the source category.

[33] Comparison of modeling 2017 with and without SDIA emissions indicates increases of NOx and VOC would result in slightly higher ozone concentrations.

As a result of offset requirements, there should be no net effect on emission inventories from future construction or modifications at major stationary sources; in other words, emission increases that otherwise would be added to the inventory are canceled out by reductions of other emissions in the inventory. The "no net effect on the inventory" result from offsetting new or modified major sources holds true only if the emissions that are reduced to provide offsets remain in the inventory.

To ensure construction or modification of major sources has no net effect on emission inventories used for demonstrating attainment of the 2008 eight-hour ozone NAAQS, banked ERCs derived from pre-2012 emission reductions—which otherwise would not be included as emissions in the baseline and subsequent inventories—must be added back into the inventories, pursuant to federal requirements.[34] Accordingly, Attachment F presents the pre-baseline ERCs currently in the District's credit bank that have been added to the 2017 attainment year emissions inventory.

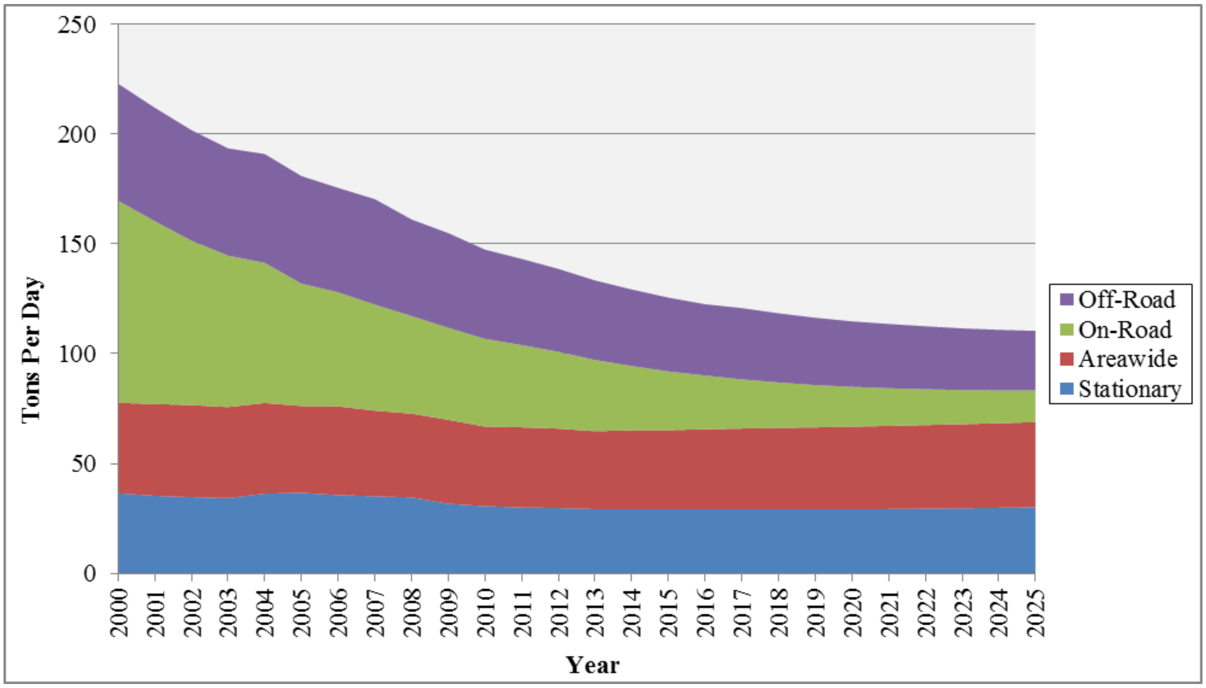
2.1.4 Long-Term Emission Trends

Projected emission reduction trends in San Diego County for VOC and NOx are illustrated in Figures 2-2 and 2-3, respectively. A 25-year time period, looking back to 2000 and forward to 2025, is presented. Only currently adopted emission control regulations are reflected in future year projections. The resulting data are disaggregated for on-road, off-road, areawide, and stationary source emissions.

As new lower-emitting motor vehicles gradually replace used, higher-emitting vehicles (per state tailpipe regulations), the share of VOC and NOx emissions from motor vehicles is projected to drop. Stationary source control measures continue to hold stationary source emissions relatively constant despite economic growth. Nevertheless, although not reflected in the figures, future ongoing implementation of the "all feasible control measures" requirement of state law will likely provide further reductions in emissions as additional cost-effective control technologies become available.

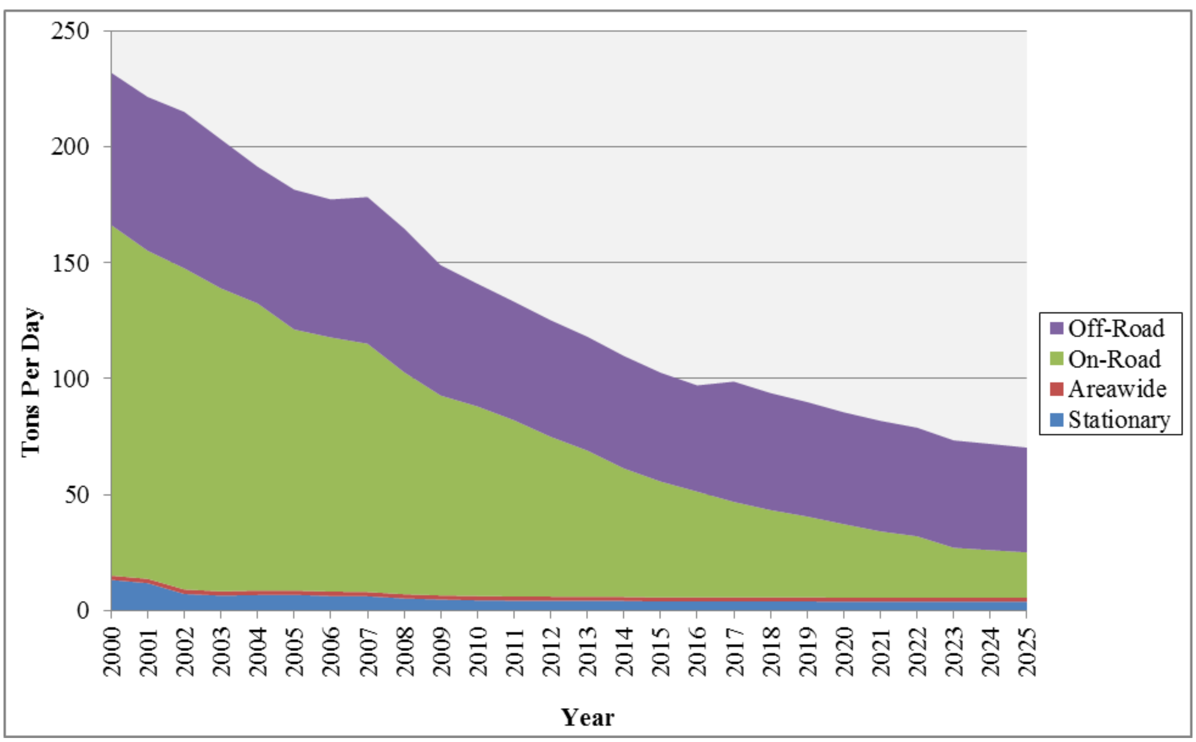
[34] 70 FR 71676.

FIGURE 2-2
VOC Emissions Trend in San Diego County



Source: ARB CEPAM emissions inventory, Version 1.04.

FIGURE 2-3
NOx Emissions Trend in San Diego County



Source: ARB CEPAM emissions inventory, Version 1.04.

2.2 EMISSION STATEMENT CERTIFICATION

CAA §182(a)(3)(B) requires ozone nonattainment areas to mandate submittal of emission statement data from certain sources of VOC or NOx. The CAA stipulates the following emission statement requirements be met:

CAA Requirements	District Response
"Within two years after November 15, 1990, the state (or District) is required to submit a revision to the State Implementation Plan requiring stationary sources of NOx or VOC to provide the agency with a statement, in such form as the Administrator may prescribe (or accept an equivalent alternative developed by the state), for classes or categories of sources, showing the actual emissions of NOx or VOC from that source." (CAA §182(a)(3)(B)(i))	Rule 19.3 adopted April 6, 1993; Rule 19.3 amended May 15, 1996; Amended Rule 19.3 promulgated into SIP on March 9, 2000 (65 FR 12472).
"Submittal of the first statement was required to be submitted within three years after November 15, 1990. Submittal of subsequent statements is required at least every year thereafter." (CAA §182(a)(3)(B)(i))	The District reports emission data electronically to the EPA through the ARB on an annual basis. Data has been submitted annually since 1993.
"Statements shall contain a certification that the information contained in the statement is accurate to the best knowledge of the individual certifying the statement." (CAA §182(a)(3)(B)(i))	Each statement contains a certification that the information contained in the statement is accurate to the best knowledge of the completer.
"The state (or District) may elect to waive the application of clause (i) to any class or category of stationary sources which emit less than 25 tons per year of VOC or NOx if the state provides an inventory of emissions from such class or category of source, based on the use of the emission factors established by the Administrator or other methods acceptable to the Administrator." (CAA §182(a)(3)(B)(ii))	N/A

The 2008 eight-hour ozone standard implementation rule[35] acknowledges that if an area has a previously approved emission statement rule in force for the former 1997 eight-hour or 1979 one-hour ozone NAAQS, the existing rule is likely sufficient for meeting the emission statement requirement for the 2008 eight-hour ozone NAAQS. The District adopted Rule 19.3 (Emission Statement) on April 6, 1993, and amended it on May 15, 1996, to cover all of San Diego County. The nonattainment area for San Diego County has not been significantly modified since that time. Additionally, the implementation rule recommends that air districts review the existing rule to ensure adequacy in the form of a written statement to the EPA.

The District reviewed Rule 19.3 for adequacy, pursuant to the CAA requirements and subsequent EPA guidance and associated memoranda.[36] The rationale is specified in the table above. Consequently, the District determines that existing Rule 19.3 meets all federal CAA requirements set forth in the implementation rule. The District certifies that Rule 19.3, as promulgated into the SIP on March 9, 2000, remains adequate for the purposes of implementing the 2008 eight-hour ozone NAAQS.

[35] 80 FR 12263

[36] Guidance on the Implementation of an Emission Statement Program – Draft. July, 1992. http://www3.epa.gov/ttn/chief/eidocs/draft-implement_jul1992.pdf.
"Emission Statement Requirement Under 8-hour Ozone NAAQS Implementation" Memorandum. March 14, 2006. http://www3.epa.gov/ttnchie1/eidocs/eiguid/8hourozone_naaqs_031406.pdf

2.3 NEW SOURCE REVIEW (NSR)

NSR rules are required by CAA §182(c)(10) for new or modified major stationary sources of VOC or NOx. For purposes of implementing the 2008 eight-hour ozone NAAQS, NSR rules must have applicability thresholds and offset ratios at least as stringent as mandated in the CAA for the nonattainment area's classification. Initially, San Diego County was designated under Subpart 2 as a Marginal nonattainment area, mandating the applicability threshold for VOC and NOx emissions at 100 tons per year, and an offset ratio of at least 1-to-1. With the recent reclassification of the region to Moderate, the same applicability threshold for VOC and NOx emissions applies (100 tons per year), but the required offset ratio increased to 1.15-to-1.

The District's NSR rules (Rules 20.1 – 20.4) were initially adopted in 1998 when San Diego County was classified as a Serious nonattainment area for the former 1979 one-hour ozone NAAQS. The NSR rules were never approved in the SIP due to regulatory complications. With a goal to achieve SIP-approval of a current set of NSR rules and replace the outdated versions, the District again revised NSR Rules 20.1-20.4 on April 27, 2016. The revisions reflect a renewed effort to address past and current EPA-identified rule deficiencies, CAA and EPA regulatory requirements, and state guidance regarding Senate Bill (SB) 288 requirements. In addition, the revisions reflect changes to ambient air quality standards, the attainment/nonattainment status of the San Diego air basin, incorporation of greenhouse gas requirements, and experience implementing the 1998 NSR rules. The applicability threshold in the NSR rules adopted in 2016 is 50 tons per year and the offset ratio is 1.2-to-1. Both values exceed the requirements for a Moderate nonattainment area. The rules also require Lowest Achievable Control Technology and other requirements mandated for nonattainment areas.

The revised rules strengthen the District's NSR program within the San Diego portion of the California SIP. Accordingly, the District certifies that the recently adopted NSR rules are sufficient for the purposes of the 2008 eight-hour ozone NAAQS, and fulfills the requirements of a Moderate nonattainment area under Subpart 2.

3.0 MODERATE AREA ATTAINMENT PLAN REQUIREMENTS

As previously discussed, the EPA's 2008 eight-hour ozone implementation rule requires that all nonattainment areas — including San Diego County — comply with planning and emission control requirements found in CAA Subpart 2 (Title I, Part D). Since San Diego County was recently reclassified as a Moderate nonattainment area for the 2008 eight-hour ozone NAAQS, additional planning and emission control demonstrations are necessary to comply with the CAA, beyond the General elements specified in Section 2.0 of this Plan. These additional Moderate nonattainment area requirements include the following:

- A summary of **Emission Control Measures** (Section 3.1) identifying a comprehensive set of stationary and mobile source control measures necessary to achieve attainment of the 2008 eight-hour ozone NAAQS as expeditiously as practicable. A summary of the measures is not required by the CAA, but is necessary to understand the region's comprehensive strategy for attainment.

- An analysis of **Reasonably Available Control Measures** (RACM) (Section 3.2) (CAA §172(c)), to verify that all RACM (including stationary, transportation-related, and mobile) are being implemented as expeditiously as practicable. The stringency and comprehensiveness of adopted control requirements on emission sources in San Diego County significantly reduce the availability of new measures that could provide additional emission reductions sufficient to advance the attainment year. This Attainment Plan's RACM analysis demonstrates there are no additional economically and technologically feasible control measures (alone or in conjunction with others) that could advance the attainment year from 2017 to 2016.

- A **Reasonably Available Control Technology** (RACT) Demonstration (CAA §182(b)(2)), to determine whether the control measures relied on in this Attainment Plan meet RACT requirements.[37] Subpart 2 nonattainment areas classified as Moderate or above must reevaluate and assure RACT requirements are met for each applicable category of VOC and NOx stationary sources.[38] RACT is federally defined as the lowest emission limitation that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility. RACT is further defined as being necessary for all sources of VOC or NOx subject to an EPA Control Techniques Guideline (CTG), or major sources of VOC or NOx that are not subject to a CTG. The District's RACT Demonstration can be found under separate cover in the *"2008 Eight-Hour Ozone Reasonably Available Control Technology (RACT) Demonstration for San Diego County."*

- A demonstration of **Reasonable Further Progress** (RFP) (Section 3.3) (CAA §182(b)(1)), which is required pursuant to the EPA's implementation rule for areas classified as Moderate or above.[39] The CAA requires such areas to demonstrate RFP for the six-year period

[37] 40 CFR 51.912(a).

[38] RACT compliance options for Subpart 2 areas include (1) certifying that ongoing RACT rules for one-hour ozone implementation represent RACT for eight-hour ozone purposes; or (2) making a new RACT determination and any associated rule revisions.

[39] 40 CFR 51.910(a)(i).

referenced in CAA §182(b)(1), beginning on January 1 of the year following the emission inventory base year (i.e. January 1, 2013). The six-year period would normally conclude on January 1, 2019. However, this date goes beyond the region's Moderate attainment deadline of July 20, 2018. Additionally, San Diego County's baseline emission inventory is 2012 instead of 2011. In such circumstances, the EPA has allowed regions to demonstrate RFP over five years instead of six. Thus, the RFP Demonstration for San Diego County concludes on January 1, 2018 (i.e. 2017 ozone season), and must provide for a 15% emission reduction during 2012-2017. Due to the EPA's previous approval of the region's 15% VOC rate-of-progress demonstration[40] in 1997,[41] the RFP demonstration for this Attainment Plan may use either NOx or VOC reductions to demonstrate the 15% reduction.

- An **Attainment Demonstration** (Section 3.4) (CAA §182(c)(2)(A)), developed pursuant to federal requirements, which is comprised of photochemical air quality simulation modeling and other approved analytical techniques (collectively called the "Weight of Evidence"). Together, these analyses demonstrate the ability of the Emission Control Measures (Section 3.1) to provide for attainment of the 2008 eight-hour ozone NAAQS as expeditiously as practicable. Ozone nonattainment areas are required to model attainment in the ozone season[42] prior to the area's attainment date.[43] For San Diego County, the demonstrated attainment year is 2017 as a Moderate nonattainment area, representing the first full ozone season prior to the July 20, 2018, attainment date.

- **Contingency Measures** (Section 3.5) (CAA §179(c)(9)), which must be implemented in the event of failure to achieve RFP milestones or to attain the NAAQS by the attainment deadline. The Contingency Measures requirement is intended to ensure emission reduction progress continues while the failure is being corrected. Typically, contingency measures are held in reserve and implemented only if required. However, California's stringent emissions control program and on-going emissions reduction trend create a unique situation, allowing this Attainment Plan to identify several mobile source control regulations as contingency measures that will be implemented regardless of contingency measure requirements. These measures provide additional emission reductions beyond those relied on in the Attainment Demonstration.

- **Additional Subpart 2 Requirements** have long been implemented in San Diego County, pursuant to the region's former status as a Serious nonattainment area for the former 1979 one-hour ozone NAAQS.[44] These requirements continue to be implemented in the region and are required under federal anti-backsliding provisions. These include the following:

    - Enhanced vehicle inspection and maintenance program (CAA §182(c)(3));

[40] 40 CFR 51.910(b)(2)(ii).

[41] 62 FR 1150

[42] San Diego County's ozone season (when eight-hour ozone exceedances can be expected) has long been specified in federal regulation (40 CFR Part 58, Appendix D, Section 2.5) as January through December. However, based on eight-hourozone levels in recent years, the region's ozone season is more likely May through September. Regardless, for purposes herein, the full ozone season remains January through December.

[43] 40 CFR 51.908(d).

[44] Subpart 2/Serious Nonattainment provisions were fully satisfied in San Diego County pursuant to the 1994 One-Hour Ozone Attainment Plan, approved by EPA (62 FR 1150). Compliance with Subpart 2 was reaffirmed by EPA when redesignating the region to a Maintenance Area for one-hour ozone (68 FR 13653).

- Stage II gasoline vapor recovery (CAA §182(b)(3));
- Reformulated gasoline (CAA§211(k));
- Periodic emissions inventory and source emission statement regulations (CAA §182(a)(3)); and
- Enhanced ambient monitoring (Photochemical Assessment Monitoring Stations (PAMS), CAA §182(c)(1)).

3.1 EMISSION CONTROL MEASURES

Over the past two decades, ozone air quality in San Diego County has improved significantly due to comprehensive control measures implemented to reduce pollution from mobile and stationary emission sources (see Section 1.3). Ongoing implementation of existing District, state, and federal regulations will provide additional reductions in ozone precursors for the foreseeable future (see Sections 2.1.4 and 3.4.4.8 for emission trends), and are a primary basis for this Attainment Plan. Currently adopted rules and regulations at the state and federal levels (Section 3.1.1), combined with local control measures (Section 3.1.2), are collectively referred to as "Emission Control Measures."

3.1.1 State and Federal Control Programs

The ARB is responsible for numerous emission control regulations, including those addressing consumer products and mobile sources (except where federal law preempts the ARB's authority). The ARB also develops fuel specifications, adopts statewide control measures for air toxics, establishes gasoline vapor recovery standards, and certifies vapor recovery systems. The agency has regulated mobile sources since the 1960s and consumer products since the early 1990s, and has continued to further control and tighten those regulations many times over the years.

Other state agencies, such as the Department of Pesticide Regulation (DPR) and the Bureau of Automotive Repair (BAR), also regulate emissions through their respective roles. DPR is responsible for control of agricultural, commercial and structural pesticides. BAR runs the state's Smog Check programs to identify and repair higher polluting cars.

At the national level, the EPA is authorized to control emissions from mobile sources, including sources under exclusive federal jurisdiction (such as interstate trucks, some farm and construction equipment, locomotives, aircraft, and marine vessels based in the U.S.). International organizations also develop standards for aircraft and marine vessels that operate outside the U.S. Federal agencies have the lead role in representing the U.S. in the development of international standards.

Attachments C and D list the suite of ARB-implemented regulations in place since 1985. The regulations have helped the region attain the former 1979 one-hour and 1997 eight-hour ozone NAAQS, as well as support the effort to attain the 2008 eight-hour ozone NAAQS. With the assistance of these regulations, daily ozone precursor emissions are projected to decrease by more than 47 tons between 2012 and 2017, as presented in Table 3-1. This equates to an approximate 21% reduction in VOC and NOx emissions in the specified source categories.

TABLE 3-1
2012-2017 San Diego County Emission Reductions from Existing State and Federal Control Programs (tons per day)

Source Category	VOC Reductions	NOx Reductions
Consumer Products	0.4	0.0
On-road Motor Vehicles	12.6	27.7
Commercial Boats	0.0	0.9
Recreational Boats	3.5	0.4
Res/Ind/Const Equipment	1.2	-0.3
Farm Equipment	0.1	0.4
Gasoline Cans	0.5	0.0
Pesticides	0.1	0.0
TOTAL	18.4	29.1

Source: ARB CEPAM emissions inventory, Version 1.04.
Negative numbers represent a minor emission increase in the selected categories.

Significant progress and reductions have already been achieved through these existing measures. However, the ARB has acknowledged that further reductions are necessary in the San Joaquin and South Coast air basins to meet the 2008 (and future 2015) eight-hour ozone NAAQS. To address this situation, the ARB developed a 2016 Mobile Source Strategy that contains additional local, state, and federal measures that will provide substantial emission reductions beyond current conditions when fully implemented, and significantly improve air quality. These measures, identified in Table 3-2, will either be implemented nationally, statewide or targeted specifically for certain regions, such as the South Coast air basin. Emission reductions in the South Coast region will also benefit San Diego County, which frequently receives transported pollution from the South Coast air basin.

TABLE 3-2
Measures Identified in the 2016 Mobile Source Strategy

New Measures	Implementing Agency	Expected Action	Expected Implementation
On-Road Light Duty			
Advanced Clean Cars 2	ARB	2020	2026
In-Use Performance Assessment	ARB/BAR	N/A	Ongoing
Further Deployment of Cleaner Technologies	ARB/Local	Ongoing	2016
On-Road Heavy-Duty			
Lower In-Use Emission Performance Level	ARB	2016	2017
Low-NOx Engine Standard – California Action	ARB	2017 - 2019	2023
Low-NOx Engine Standard – Federal Action	EPA	2017 – 2019	2024
Medium and Heavy-Duty GHG Phase II	ARB/EPA	2016 – 2019	2018
Advanced Clean Transit	ARB	2017	2018
Last Mile Delivery	ARB	2018	2020
Innovative Technology Certification Flexibility	ARB	2016	2016
Zero Emission Airport Shuttle Buses	ARB	2018	2023
Incentive Funding to Achieve Further Emission Reductions from On-Road Heavy-Duty Vehicles	ARB/Local	Ongoing	2016
Further Deployment of Cleaner Technologies	ARB/Local	Ongoing	2016
Off-Road Federal and International Sources			
More stringent National Locomotive Emissions Standards	EPA	2016	2023
Tier 4 Vessel Standards	ARB/IMO	2015 – 2018	2025
Incentivize Low Emission Efficient Ship Visits	ARB	2017 – 2018	2018
At-Berth Regulation Amendments	ARB	2017 – 2018	2022
Further Deployment of Cleaner Technologies	EPA/ARB/Local	Ongoing	2016
Off-Road Equipment Sources			
Zero Emission Off-Road Forklift Regulation Phase 1	ARB	2020	2023
Zero Emission Off-Road Emission Reduction Assessment	ARB	2025	-
Zero Emission Off-Road Worksite Emission Reduction Assessment	ARB	TBD	-
Zero Emission Airport Ground Support Equipment	ARB	2018	2023
Small Off-Road Engines	ARB	2018	2022
Transport Refrigeration Units Used for Cold Storage	ARB	2017 – 2018	2020
Low-Emission Diesel Requirement	ARB	By 2020	2023
Further Deployment of Cleaner Technologies	ARB/Local	Ongoing	2016

Source: "Mobile Source Strategy," ARB. May, 2016.

3.1.2 Local Control Measures

A comprehensive listing of District rules is included under separate cover in the *"2008 Eight-Hour Ozone Reasonably Available Control Technology (RACT) Demonstration for San Diego County."* These rules apply to many stationary and areawide sources, which include but are not limited to: factories, power plants, chemical plants, landfills, gas stations, dry cleaners, coating operations, stationary engines, boilers, and furnaces. These rules are implemented through District permits that are specific to each facility or operation, and stipulate the conditions that must be met to ensure compliance. Periodic inspections at the facilities are also conducted by District staff to verify ongoing compliance.

3.2 REASONABLY AVAILABLE CONTROL MEASURES (RACM) DEMONSTRATION

3.2.1 RACM Requirements

The CAA requires a demonstration that all reasonably available control measures are being implemented as expeditiously as practicable. Specifically, the air district must consider a wide range of potential additional measures (beyond those already being implemented) to further control emissions from stationary, transportation, and mobile sources. A potential additional measure is considered "reasonably available" and thus must be implemented if it, (alone or in combination with other feasible measures), would advance attainment by one year (i.e., from 2017 to 2016). (In other words, the reasonably available measures would need to reduce emissions to 2017 levels by 2016.) Based on the analysis herein, the District finds that there are no potential additional measures that can reduce emissions to 2017 levels by 2016.

As mentioned in Section 1.3.1, transport from the South Coast region frequently contributes to high ozone levels in San Diego County. Accordingly, this RACM analysis has been evaluated using projected emissions from the San Diego County-South Coast transport couplet. Table 3-3 identifies the increment of emission reductions needed in 2016 for San Diego County to reach attainment. Specifically, 13.4 tons per day of additional VOC reductions and 19.9 tons per day of additional NOx reductions (33.3 tons total) would be necessary in 2016 to advance the attainment year from 2017 to 2016 in San Diego County. These emission reduction values account for the impact of transported emissions from the South Coast region, as well as locally generated emissions in San Diego County.

TABLE 3-3
Projected Total Daily Emissions in 2016 versus 2017
San Diego and South Coast Air Basins

VOC Emissions (tons per day)			NOx Emissions (tons per day)		
2016	**2017**	**Difference**	**2016**	**2017**	**Difference**
566.9	553.5	13.4	539.7	519.8	19.9

Source: ARB CEPAM emissions inventory, Version 1.04.

3.2.2 Identifying Potential RACM for Stationary Sources

Identifying additional control measures for consideration as potential RACM is challenging in San Diego County because the District is already required to adopt every feasible control measure as expeditiously as practicable, in response to the stringent requirements of state law. These existing measures usually fulfill federal RACT requirements for sources covered by a CTG, or for any major stationary source of VOC and/or NOx.[45] The District continues to implement all feasible control measures to control emissions from stationary source categories in the County. Most rules have been submitted into the SIP (or will be submitted concurrent to this Attainment Plan and corresponding RACT Demonstration), to fulfill federal requirements for RACT.

Additionally, state law requires Best Available Retrofit Control Technology (BARCT), which is more stringent than RACT. Accordingly, the District already adopted BARCT level of control for sources subject to state requirements. The District's existing BARCT rules cannot be considered as potential RACM because they have already been implemented and would not provide new additional emission reductions that could advance the attainment year.

To identify potential RACM, the District has relied on an ongoing control measure evaluation process required under state law to adopt all feasible measures. Specifically, the District is required

[45] See *"2008 Eight-Hour Ozone Reasonably Available Control Technology (RACT) Demonstration for San Diego County."*

to consider, for each emission source category, whether adopting some or all of the requirements of the most stringent adopted rule in the state would be feasible for local sources.

The District's review of other air district rules identified several source categories (Table 3-4) that contain more stringent requirements than current District rules. All but one has been adopted in Extreme ozone nonattainment areas, which far exceed San Diego County's classification as a Moderate nonattainment area. Table 3-4 also estimates the implementation period (in years) that would be necessary to fully realize the emission reductions if the more stringent controls were adopted locally. The one-to-three year implementation periods indicated for VOC control measures, and the one-to-20 year implementation periods for NOx control measures, represent the time necessary to obtain lower emitting materials, install control equipment, and/or replace existing units at the end of their useful lives. Thus, even if all measures were adopted concurrent with this Attainment Plan in 2016 (which is not feasible due to the lead time necessary for rule development and adoption), the reductions could not be fully realized before the beginning of 2016. Consequently, these measures are not available for advancing the attainment year to 2016.

A detailed analysis of each of the potential control measures identified in Table 3-4 is presented in Attachment G. The analysis concludes that, if all such stationary measures were adopted, an additional 3.75 tons of VOC reductions per day and 1.62 tons of NOx reductions per day could be expected.

TABLE 3-4
Stationary Source Categories for Which More Stringent Control Requirements Have Been Adopted by Another Air District

Control Measure	San Diego Rule Number	Other Air District Rule Number*	Estimated Emission Reduction Potential (Tons/Day) VOC	Estimated Emission Reduction Potential (Tons/Day) NOx	Implementation Period (Years)
Receiving and Storing Volatile Organic Compounds at Bulk Plants and Bulk Terminals	61.1	SC 1178	0.03		3
Transfer of Organic Compounds into Mobile Transport Tanks	61.2	SJV 4621 SJV 4622	0.01		1
Architectural Coatings	67.0.1	SC 1113	2.4		1
Aerospace Coating Operations	67.9	SC 1124 SJV 4605	0.005		1
Graphic Arts Operations	67.16	SC 1130 SJV 4607	0.05		1
Marine Coating Operations	67.18	SC 1106	0.01		1
Adhesive Material Application Operations	67.21	SC 1168 SJV 4653	0.9		1
Composting Operations	No comparable rule	SC 1133.3	0.3		1
Industrial and Commercial Boilers, Process Heaters and Steam Generators	69.2	SJV 4306		0.1	2
Small Boilers, Process Heaters, and Steam Generators	69.2.1	SJV 4308		0.80	15 **
Natural Gas-Fired Fan-Type Central Furnaces	69.6	SC 1111		0.46	10 **
Equipment Leaks	No comparable rules	BA 8-18	0.01		1
Commercial Food Ovens		SC 1153.1		0.01	10 **
Food Products Manufacturing/Processing		SC 1131	0.03		1
Medium Boilers, Process Heaters, and Steam Generators		SC 1146.2		0.25	20 **
TOTAL EMISSION REDUCTIONS			**3.745**	**1.62**	

* SC = South Coast Air Quality Management District; BA = Bay Area Air Quality Management District; SJV = San Joaquin Valley Air Pollution Control District;

** Emissions reductions would occur gradually, as new low-emitting units replace existing higher-emitting units at the end of their useful lives.

3.2.3 Identifying Potential RACM for Transportation Sources

Potential RACM also include Transportation Control Measures (TCMs), which are strategies to reduce motor vehicle trips, vehicle miles traveled, or vehicle idling and associated air pollution. Table 3-5 lists the 16 TCMs identified in CAA §108(f) and their implementation status in San Diego County. A discussion of each TCM, further describing the status of implementation, follows Table 3-5.

As indicated, 13 of the 16 TCMs have been implemented, including transit and traffic flow improvements, ridesharing, high occupancy vehicle (HOV) lanes, pedestrian-only streets, control of extended idling, and seven other measures. The agencies responsible for developing and implementing these TCMs include SANDAG (the transportation planning agency for the San Diego region) and other state and local agencies.

Five of the implemented TCMs — TCMs 1, 3, 5, 8, and 10 — were included in the 1982 SIP Revision for San Diego County.[46] Descriptions herein of any ongoing implementation beyond the 1982 SIP commitments do not constitute submittal of additional implementation commitments into the SIP. Such submittal would be required only if the TCMs meet the RACM qualifications specified in Section 3.2.1. TCMs that have already been implemented cannot provide additional emissions reductions in 2016 sufficient to advance the attainment year from 2017 to 2016. Therefore, they cannot be considered RACM.

Table 3-5 and the subsequent discussion also address the three TCMs that have not been implemented and the reasons for non-implementation. These measures address trip-reduction ordinances, peak-period vehicle restrictions, and vehicle emissions in extremely cold environments.

[46] In the 1982 SIP, TCMs 3 and 8 were combined into one comprehensive TCM, the "Ridesharing" TCM.

TABLE 3-5
Transportation Control Measures listed in CAA §108(f)
Implementation Status in San Diego County

Transportation Control Measures	Implemented	In 1982 SIP
1. Programs for improved public transit	Yes	Yes
2. Restriction of certain roads or lanes to, or construction of such roads or lanes for use by, passenger buses or high occupancy vehicles	Yes	
3. Employer-based transportation management plans, including incentives	Yes	Yes
4. Trip-reduction ordinances	No*	
5. Traffic flow improvement programs that achieve emission reductions	Yes	Yes
6. Fringe and transportation corridor parking facilities serving multiple occupancy vehicle programs or transit service	Yes	
7. Programs to limit or restrict vehicle use in downtown areas or other areas of emission concentration particularly during periods of peak use	No	
8. Programs for the provision of all forms of high-occupancy, shared-ride services	Yes	Yes
9. Programs to limit portions of road surfaces or certain sections of the metropolitan area to the use of non-motorized vehicles or pedestrian use, both as to time and place	Yes	
10. Programs for secure bicycle storage facilities and other facilities, including bicycle lanes, for the convenience and protection of bicyclists, in both public and private areas	Yes	Yes
11. Programs to control extended idling of vehicles	Yes	
12. Programs to reduce motor vehicle emissions, consistent with Title II, which are caused by extreme cold start conditions	Not Applicable	
13. Employer-sponsored programs to permit flexible work schedules	Yes	
14. Programs and ordinances to facilitate non-automobile travel, provision and utilization of mass transit, and to generally reduce the need for single- occupant vehicle travel, as part of transportation planning and development efforts of a locality, including programs and ordinances applicable to new shopping centers, special events, and other centers of vehicle activity	Yes	
15. Programs for new construction and major reconstructions of paths, tracks or areas solely for the use by pedestrian or other non-motorized means of transportation when economically feasible and in the public interest	Yes	
16. Program to encourage the voluntary removal from use and the marketplace of pre-1980 model year light duty vehicles and pre-1980 model light duty trucks	Yes	

*Adopted in 1994, but rescinded in 1995 when federal and state laws were amended eliminating the mandate for such measures.

3.2.3.1 Implementation Status of Transportation Control Measures

TCM 1 – Improved Public Transit

The Transit measure commitments included in the 1982 SIP were fully implemented by 1995. Total regional transit rail and bus ridership in FY 2015 (107 million) represents an increase of more than 23% since FY 2004. Bus revenue miles[47] in San Diego County increased six percent since FY 2004-2005, totaling over 30.9 million miles in 2015. Concurrently, rail transit services have continued to improve. The light rail San Diego Trolley,[48] SPRINTER,[49] and COASTER[50] commuter rail service, have together increased to over 10.6 million revenue car miles in 2015. In addition, total passengers per revenue mile (a measure of system productivity) have increased by more than 23% over that same period.

The Trolley Renewal Project, completed in 2015, funded the purchase of 65 new, low-floor trolley cars that are easier to board (especially for persons with disabilities) and provide better operations in the downtown area. Several stations along the lines required renovation for easier and safer access to the new cars. Additionally, pre-construction activities have begun for an 11-mile extension to the Blue Line ("Mid-Coast Trolley Extension"), with revenue service anticipated to begin in 2021. Ridership along the 22-mile SPRINTER rail line connecting Oceanside to Escondido has also steadily increased since opening in 2008.

San Diego County's Bus Rapid Transit (BRT) service ("Rapid") started revenue service in 2014. BRT service utilizes standard and articulated compressed natural gas (CNG) buses to provide fast, limited-stop, service in the Interstate 15 (I-15) and Mid-City corridors utilizing freeway managed lanes and arterial transit priority measures to improve speed and travel time reliability. Construction on an additional 26-mile South Bay Rapid route connecting Otay Mesa, Chula Vista, and downtown San Diego began in 2016. Revenue service is anticipated to begin in 2018. The region's two operators also continue to make improvements to the local bus system, with higher frequency service on several lines.

While many areas of San Diego County have developed around low-density, auto-oriented development patterns, local jurisdictions have been updating their general plans to shift development toward urban areas and along existing and planned rail/Rapid bus corridors. The transit strategy included in SANDAG's San Diego Forward: The Regional Plan (Regional Plan) focuses transit improvements in Regional Smart Growth centers and key corridors, to provide transportation options and greater connectivity. Several major transit improvements are planned for the near-term, and the system will continue to mature over the life of the Regional Plan.

TCM 2 – High Occupancy Vehicle (HOV) Lanes

Currently, there are three freeways in the San Diego region with HOV lanes: I-5 (San Diego Freeway), I-805 (Jacob Dekema Freeway), and I-15 (Escondido Freeway). Additional HOV lanes are currently under construction on I-805.

The I-5 HOV lane extends 7.8 miles from the I-5/I-805 junction to just south of Manchester Avenue.

[47] Revenue (car) miles are the total distance that a fleet travels while available for passenger service.
[48] The San Diego Trolley is a 54-mile light rail transit system serving southern San Diego County.
[49] The SPRINTER is a 22-mile light rail line, connecting Oceanside to Escondido that began service in January 2008.
[50] The COASTER is a 42-mile passenger rail line between Oceanside and downtown San Diego that began service in 1996.

The current configuration of the I-805 HOV lane is segmented, consisting of ten miles between Mira Mesa Boulevard and Manchester Avenue at I-5, and another eight miles between East Naples Street and State Route (SR) 94. The I-15 Express Lanes extend 20 miles from SR 163 to just south of SR 78. Direct access is available at the north and south ends, and Direct Access Ramps are available at Hale Avenue, Del Lago Boulevard, West Bernardo Drive, SR 56/Ted Williams Parkway, and Hillary Drive. Intermediate Access Points that provide direct access from the main lanes to the Express Lanes are approximately every two to three miles. Vehicles with two or more occupants (or powered by certain alternative fuels), buses, and motorcycles may use the I-15 Express Lanes for free, and solo drivers participating in the FasTrak® Program may use the Express Lanes for a per-trip toll. Finally, a buses-only northbound lane on SR 163, extending 0.4 miles from A Street in downtown San Diego to I-5, enables buses to bypass general purpose traffic entering SR 163.

Other HOV Lane development in the region includes:

- Metered Ramps. HOV preferential lanes are provided at 181 (57%) of the 318 metered ramps on the region's freeways. The HOV preferential lanes do not bypass the meters but they do provide a shorter queue, reducing travel time.

- I-15 Express Lanes. The region has committed $1.4 billion to the I-15 Express Lanes project to ease traffic congestion, support Rapid bus service, and provide multimodal travel in the I-15 corridor from SR 163 to SR 78 in Escondido. Construction began in November 2003 with the middle segment being completed in 2009 and the north and final segment being completed in 2012.

  The project includes four lanes with a moveable median barrier to accommodate two to three lanes in the peak direction and one to two lanes in the opposite direction. The Express Lanes facility provides priority to HOVs such as carpools and vanpools, regular transit services, certain clean air vehicles, and the BRT system. Excess capacity in these lanes is "sold" to solo drivers for a fee, as is the case with the FasTrak® program. The Express Lanes are separated from the general purpose lanes by a barrier, with access provided every two to three miles.

- I-5 North Coast Express Lanes. This project will be modeled after the I-15 Express Lanes project. The I-5 North Coast Express Lanes will feature multiple access points to/from the facility to the general purpose lanes and direct access ramps that connect local arterials directly to the Express Lanes facility. A number of project alternatives are under study, including value pricing.[51]

- Managed Lanes/HOV Network. SANDAG's San Diego Forward: The Regional Plan (Regional Plan), has developed a robust Managed Lane (Express Lane)/HOV network. Shared by highway and transit users, the Managed Lanes/HOV system will be expanded from the current 28 miles to include over 160 miles in the future. The Regional Plan includes:
  - Four-lane Managed Lane facilities on I-5, I-15, and I-805 with value pricing;
  - Two-lane Managed Lane facilities on SR 52, SR 54, SR 78, SR 94, and SR 125; and

[51] Variable tolls for solo drivers based on traffic congestion in the general lanes.

- In addition to mainline Managed Lane improvements, the Plan includes direct HOV to HOV connectors at the I-5/I-805 merge, and at seven other interchanges where major HOV facilities intersect.

TCM 3 – Employer-Based Transportation Management Plans

In the 1982 SIP, the Employer-Based Transportation Management Plans measure (TCM 3) was combined with the Shared-Ride Services measure (TCM 8) to form a more comprehensive measure, the "Ridesharing" TCM. The Ridesharing TCM commitments included in the 1982 SIP were fully implemented by 1988.

Traffic Abatement Plan requirements of District Rule 132 were included as part of the Ridesharing TCM. Pursuant to federal requirements for abating air pollution emergency episodes,[52] employer-based Traffic Abatement Plan measures are triggered by ozone levels exceeding 0.35 ppm. No ozone concentrations of this level or higher have been recorded in San Diego County since 1979.

TCM 4 – Trip-Reduction Ordinances

A regional trip-reduction ordinance was adopted by the District as part of the 1994 Ozone SIP, but was rescinded in 1995 when federal and state laws were amended, eliminating the mandate for such measures based on public opposition.

TCM 5 – Traffic Flow Improvements to Reduce Emissions

Traffic Flow Improvements mostly consist of traffic signal improvements to reduce idling and associated emissions. The Traffic Flow Improvements TCM commitments included in the 1982 SIP were fully implemented by 1990.

Further implementation of the Traffic Flow Improvements TCM continues. All federally funded traffic signal projects selected with the federal transportation funding program (TEA-21) have been implemented (117 projects). The 2014 Regional Transportation Improvement Plan (RTIP) includes two state funded projects, as well as 26 locally funded traffic signal improvements. These projects are also inclusive of the Regional Arterial Management System (RAMS) program. This program includes the installation of the regional traffic signal management software and linking of the local agencies to a common system. The system was recently launched and is now being implemented by local agencies throughout the County, with assistance from SANDAG.

TCM 6 – Park-and-Ride Facilities

Currently, there are 61 Park-and-Ride lots in the San Diego region, with 3,600 spaces available. More lots are anticipated as funding becomes available. In addition, transit parking at commuter rail stations has been developed and is currently available at six COASTER and 13 SPRINTER stations, with 3,800 spaces available. The San Diego Trolley also provides parking at 25 of its stations and five Rapid stations, with approximately 7,200 spaces.

TCM 7 – Peak-Period Vehicle Restrictions in Downtown Areas

This measure is feasible only in high-density portions of compact metropolitan areas with an extensive transit system. Given the San Diego region's historically low-density land use pattern,

[52] 40 CFR 51.150 et seq.

and therefore longer transit travel times, this measure is not yet feasible. However, SANDAG's Smart Growth Incentive Program provides funding to cities for infrastructure projects which enhance alternatives to driving in higher density areas.

TCM 8 – Shared-Ride Services

As mentioned above, in the 1982 SIP, TCM 8 was combined with TCM 3 in a "Ridesharing" TCM. The Ridesharing TCM commitments included in the 1982 SIP were fully implemented by 1988.

Further implementation of the Shared-Ride Services TCM continues. SANDAG partners with the "511" transportation information service in support of "iCommute" (http://www.icommutesd.com), the regional transportation demand management program charged with providing shared-ride services and education to employers and individuals on all ridesharing and biking options. Example services include:

- Carpool Ride Matching Service – The iCommute TripPlanner tool allows users to compare transportation choices in addition to finding vanpool and carpool matches.
- Employer services – iCommute provides assistance and tools to help local employers design and implement customized commuter benefit programs to support employee use of alternative modes of travel.
- Guaranteed Ride Home Service – Qualifying ride sharers are provided with three vouchers per year for taxi fares, or 24-hour rental cars to travel home to address a personal unscheduled event.
- Promotion of Teleworking and Alternative Work Schedules (see TCM 13) – iCommute works with employers and employees to create programs offering alternative work arrangements (such as flex time and teleworking) to reduce commute trips and peak hour traffic congestion.
- Park and Ride Programs (see TCM 6) – Caltrans and other agencies provide Park-and-Ride facilities, which are promoted by iCommute.
- Vanpool Program – iCommute operates and promotes the SANDAG Vanpool Program. As of March 2016, 720 vanpools were operating in the San Diego region, carrying 5,459 passengers, a 37% increase over 2006 levels. Additional vanpools are anticipated as SANDAG expands its marketing efforts to the region's large employers.
- Bike Parking Program – Provides secure bike parking spaces at more than sixty transit stops and some Park and Ride lots throughout San Diego County, in addition to a Regional Bike Map which has been updated to show bike paths, lanes, and routes.
- Walk, Ride, and Roll to School – Part of the Safe Routes to School program, this service supports active transportation to and from K-12 schools including biking, walking, skating, skateboarding, or riding a scooter to promote physical activity and healthier lifestyles for students.

TCM 9 – Road Surface Restrictions for Motor Vehicles in Metro Areas

Numerous examples of road surface restrictions exist in the San Diego region. In downtown San Diego, portions of C Street are limited to the Trolley and pedestrian use, and a block of B Street was closed and transformed into the Civic Center Concourse. In Old Town San Diego State Historic Park, portions of San Diego Avenue, Calhoun Street, and Mason Street have been restricted to pedestrian-only use. In Balboa Park, the eastern end of El Prado is also restricted to pedestrian-only use. North of Sorrento Valley, a segment of Sorrento Valley Road is closed to traffic and reserved for bicycle and pedestrian uses. Additionally, in downtown Escondido, a one-block section of Maple Street was reconfigured to create a pedestrian plaza between W. Grand Ave and W. Valley Parkway when needed. This measure is also implemented on a limited or recurring temporary basis for certain recreational areas, weekly farmer's markets, and yearly festivals/street fairs.

TCM 10 – Bicycle Facilities

The Bicycling TCM commitments included in the 1982 SIP were fully implemented by 1995. However, further implementation of the Bicycling TCM continues. The bikeway system currently includes 1,136 miles of bikeways in the San Diego region, consisting of Class I (exclusive bicycle path separated from roadway), Class II (striped on-street bicycle lane), and Class III (shared with motor vehicles) facilities. Additionally, front-mounted bike racks are available on nearly all transit buses. Bikes are also allowed on all light rail cars in the County network.

In September 2013, the SANDAG Board of Directors approved a $200 million Regional Bike Plan Early Action Program that focuses on the region's highest priority bicycle corridors. As of July 2014, SANDAG is also implementing approximately 35 miles of regional bikeway projects that are in various phases of planning, preliminary engineering, design and construction.

SANDAG also maintains a system of over 850 bike locker spaces available throughout the region at most Trolley stations, all COASTER stations, and select Park-and-Ride locations. Currently, 306 spaces are electronic, on-demand spaces. All remaining locker spaces will be converted to electronic, on-demand spaces over the next four years. Unlike conventional lockers assigned to a single user, the converted spaces are available any time they are not in use to anyone participating in the bike locker program. Consequently, each converted space will serve three to five times as many commuters as a non-converted unit.

TCM 11 – Idling Controls

The ARB has adopted several diesel-fueled vehicle idling limitation programs, which include but are not limited to:

- School buses (www.arb.ca.gov/toxics/sbidling/sbidling.htm);
- On-road trucks (http://www.arb.ca.gov/msprog/truck-idling/factsheet.pdf);
- Off-road equipment (http://www.arb.ca.gov/enf/advs/advs377.pdf); and,
- Locomotives (www.arb.ca.gov/railyard/ryagreement/ryagreement.htm)

More information is available on the ARB website at the specified web addresses.

TCM 12 – Vehicle Cold Start Emissions in Extreme Cold Conditions

This measure is not applicable due to the mild climate in the San Diego region.

TCM 13 – Flexible Work Schedules

This measure has been implemented by the iCommute program, as previously identified under TCM 8 (see http://www.icommutesd.com/telework/telework-default). Staff from iCommute work with employers and employees to create programs for offering alternative work arrangements (such as flex time and teleworking) to reduce commute trips and peak hour traffic congestion.

TCM 14 – Programs and Ordinances Facilitating Non-Automotive Travel
This measure has been implemented in San Diego County via the progressive iterations of the RTP, adopted by SANDAG, which includes investments in public transportation, bike paths, and pedestrian improvements. These include a greater reliance on non-automotive travel through increased development densities, more mass transit usage, and increased bicycling and walking for transportation. Pursuant to the Regional Plan, SANDAG has designated existing and potential Smart Growth Areas, and provides funding incentives for local jurisdictions to increase densities and provide for mixed uses and additional transit, bicycling and walking facilities in these areas. Most of the region's local jurisdictions have adopted general plans consistent with this approach. Developers in the region have responded to these policies, and to market forces, by initiating a number of large-scale smart growth developments. Thousands of new units have also been added to existing communities well-served by transit and amenable to non-motorized travel.

Additionally, in 2004, voters extended the region's half-cent sales tax ordinance for transportation ("TransNet"), and added additional funding categories such as the Smart Growth Incentive Program, and improvements to transit, bicycling, and pedestrian facilities. The ordinance requires routine accommodation of these modes for all TransNet-funded local roadway projects.

TCM 15 – Paths or Areas Encouraging Non-Motorized Travel
The San Diego region has implemented an extensive network of bicycling facilities, many of which also serve pedestrians. Four regional, multi-use trails are still under development— the Bayshore Bikeway (26 miles around the San Diego Bay), the Inland Rail Trail (22 miles from the Escondido Transit Center to the Oceanside Transit Center), the Coastal Rail Trail (44 miles from northern Oceanside to downtown San Diego), and the San Diego River Trail (18 miles from Ocean Beach in the City of San Diego to the City of Santee). These four trails are expected to be used by commuters as well as recreational users. Additionally, due to land use plans, regional transportation funding formulas, and the nature of the housing market, a number of new smart growth developments have been built which include paths and trails that encourage non-motorized travel (see TCM 14).

TCM 16 – Removal of Older, Higher-Polluting Light Duty Vehicles
Under a program administered by the District using Vehicle Registration Fee funds, a total of 4,277 older vehicles were permanently retired through 2005, resulting in an estimated reduction of 470 tons of ozone-precursor emissions. Further, a state-run vehicle retirement program continues, administered by the California Department of Consumer Affairs' Bureau of Automotive Repair (http://www.smogcheck.ca.gov/Consumer/Consumer_Assistance_Program/).

3.2.3.2 Emission Reduction Potential of Transportation Control Measures

Trip Reduction Ordinances alone (TCM 4) have been estimated to reduce on-road vehicle emissions by less than two percent.[53] That analysis also estimated that all other TCMs combined would not be more effective than Trip Reduction Ordinances (i.e., would not provide combined emission reductions exceeding two percent). Consequently, it is assumed that the maximum emission reduction potential of implementing all unimplemented TCMs (TCMs 4, 7, and 12) would be two

[53] "Transportation Control Measures for the Air Quality Plan," San Diego Association of Governments, 1992.

percent of on-road vehicle emissions. Projected on-road motor vehicle emissions in San Diego County in 2017 are approximately 22.4 tons of VOC per day and 41.2 tons per day of NOx (see Table A-1 in Attachment A). Therefore, the maximum emissions reduction potential of implementing all unimplemented TCMs, assuming a two percent reduction in on-road emissions, is an estimated 0.4 tons per day reduction of VOC emissions, and 0.8 tons per day reduction of NOx emissions.

3.2.4 Identifying Potential RACM for Mobile Sources

Most California regions face challenges in reducing emissions from mobile sources. Over one-third of total daily ozone-precursor emissions in Southern California are attributable to mobile sources. Given the severity of these air quality challenges, the ARB has implemented one of the most stringent mobile source emissions control programs in the nation.

The ARB maintains regulatory authority over most mobile sources in California, which include: light, medium, and heavy-duty on-road vehicles, off-road equipment, motorcycles, recreational boats, cargo handling equipment, commercial harbor craft, and the fuels powering mobile equipment. Measures usually take a comprehensive approach to reduce emissions by continually establishing stringent engine standards, deadlines for procurement, fuel specifications, and incentive programs to encourage early adoption of lower-emitting equipment. Many California air districts rely on mobile source emission reduction measures to achieve timely attainment of state and federal air quality standards. Consequently, most ARB measures are as stringent as practicable and cannot provide additional reductions to advance attainment by one year.

An analysis reviewing possible RACM for mobile sources in the San Diego region was completed by the ARB (see Attachment H). The analysis concluded that the current California mobile source control program has no additional reasonably available measures (and consequently, no additional emission reductions) that could advance San Diego County's attainment of the 2008 eight-hour ozone NAAQS by one year.

3.2.5 RACM Analysis Conclusion

The combination of potential additional stationary source measures (Table 3-4), transportation measures (Table 3-5), and mobile source measures, if implemented, could provide a total of 6.6 tons of VOC and NOx reductions per day. This combined value falls short of the 33.3 tons of VOC and NOx reductions per day necessary to advance attainment from 2017 to 2016. Furthermore, to be considered reasonably available, these additional measures would need to have been adopted at the beginning of the 2016 ozone season (i.e. January 1, 2016), which has already passed. Therefore, none of the potential additional control measures are considered reasonably available, and therefore, none require adoption for the purposes of this RACM analysis and Attainment Plan.

3.3 REASONABLE FURTHER PROGRESS (RFP)

3.3.1 RFP Requirements

CAA §172(c)(2) and §182(b)(1) requires nonattainment areas to show continual progress ("Reasonable Further Progress," or RFP). RFP is defined in CAA §171(1) as annual incremental reductions for the purpose of ensuring attainment by the region's attainment year (2017). This requirement for emission reductions between the baseline year and attainment year ensures that nonattainment areas will not delay implementation of emission control programs until immediately prior to the attainment deadline. The region must achieve annual reductions in emissions as necessary to attain the applicable standard.

An RFP Demonstration must meet two requirements outlined in the CAA. First, Moderate or above nonattainment areas must demonstrate a one-time 15% reduction in VOC-only emissions during a six-year period following enactment of the 1990 CAA amendments. This requirement was previously fulfilled with the District's Attainment Plan for the former 1979 one-hour ozone NAAQS.[54] The second condition requires a Moderate or above nonattainment area to reduce VOC and/or NOx emissions by at least 15% from the baseline year (2012) to the attainment year (2017).[55]

Additionally, CAA §172(c)(9) requires that attainment plans provide for contingency measures in case the area fails to demonstrate RFP. The EPA has interpreted this requirement to represent one year's worth of emission reduction progress, amounting to a three percent reduction, from measures that are already in place or that would take effect without further rulemaking action. This requirement is addressed in Section 3.5 of this Attainment Plan.

3.3.2 RFP Demonstration

Table 3-6 demonstrates that a 19% reduction of forecasted VOC and NOx emissions from existing control measures are projected to occur between 2012 and 2017. Both VOC and NOx emission reductions are necessary to meet the RFP reduction targets. NOx substitution was used on a percentage basis to cover a two percent shortfall in VOC reduction. Therefore, the RFP requirement (15% reductions in VOC and/or NOx) is met.

[54] The EPA's final implementation rule for RFP concludes that if the EPA has already approved a rate-of-progress plan (15% VOC-only) for the federal one-hour ozone standard, the region is not required to demonstrate another 15% of VOC-only emissions in attainment plans for the eight-hour ozone standard. The EPA approved the San Diego County one-hour ozone 15% VOC rate-of-progress analysis required by the CAA in 1997 (62 FR 1150). Consequently, San Diego County has satisfied the first component of RFP.

[55] The RFP analysis normally addresses a six-year period starting from the baseline year (2012). In San Diego County's case, the six-year period goes beyond the region's attainment date as a Moderate nonattainment area (July 20, 2018). Therefore, the time period analyzed is condensed to demonstrate the required 15% VOC and/or NOx through the region's attainment year (2017).

TABLE 3-6
RFP Demonstration – 2012 to 2017

Line	Year	2012	2017
A	Baseline VOC (tons/day)	137.8	119.9
B	Required % change since previous milestone year (VOC or NOx)		15%
C	Require % change since 2012 (VOC or NOx)		15%
D	Target VOC level (tons/day)		117.1
E	Shortfall (-)/Surplus (+) in VOC reductions needed to meet target (tons/day)		-2.8
F	Shortfall (-)/Surplus (+) in VOC reductions needed to meet target (%)		-2.0%
G	VOC reductions since 2012 used for contingency in this milestone year (%)		0.0%
H	VOC reductions shortfall previously provided by NOx substitution (%)		0.0%
I	Actual VOC reductions Shortfall (-)/Surplus (+)		-2.0%
Line	**Year**	**2012**	**2017**
J	NOx (with existing measures) (tons/day)	109.6	82.8
K	Change in NOx since 2012 (tons/day)		26.8
L	Change in NOx since 2012 (%)		24.5%
M	NOx reductions since 2012 already used for VOC substitution & contingency through last milestone year (%)		0.0%
N	NOx reductions since 2012 available for VOC substitution & contingency in this milestone year (%)		24.5%
O	NOx reductions since 2012 used for VOC substitution in this milestone year (%)		2.0%
P	NOx reductions since 2012 used for contingency in this milestone year (%)		3.0%
Q	NOx reductions since 2012 surplus after meeting VOC substitution & contingency needs in this milestone year (%)		19.4%
R	RFP Shortfall (-) in reductions needed to meet target (if any) (%)		0.0%
S	Total Shortfall (-) for RFP and contingency (if any) (%)		0.0%
T	**RFP Met?**		**YES**
U	**Contingency Met?**		**YES**

Source: ARB. August, 2016. Emission data obtained from ARB CEPAM emission inventory (Version 1.04), San Diego Air Basin, Summer Day.

3.4 ATTAINMENT DEMONSTRATION

3.4.1 Background

Pursuant to CAA and EPA requirements,[56] the Attainment Demonstration summarizes the results of photochemical air quality simulation modeling and supplemental Weight of Evidence analyses. The Attainment Demonstration seeks to demonstrate that the Emission Control Measures discussed in Section 3.1 reduce ozone precursor emissions sufficiently to provide for attainment of the 2008 eight-hour ozone NAAQS by the statutory deadline of July 20, 2018 (i.e. 2017 attainment year).

Ozone formation in the atmosphere is a complex photochemical process, and sophisticated photochemical air quality simulation modeling is a valuable tool to help predict the amount of precursor emission reductions needed for attainment of the 2008 eight-hour ozone NAAQS. The air quality model is computer-driven and simulates weather patterns, emissions, and

[56] The Attainment Demonstration follows EPA's Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze (December 2014).

photochemical processes in the atmosphere to predict future ozone levels in the region.

As with other predictive tools, photochemical modeling has inherent uncertainties and cannot be expected to produce absolutely accurate results. Such models require detailed three-dimensional and time-varying inputs of emissions and meteorological data for the days being considered. Limitations in these inputs, as well as limitations in the model's formulations for simulating photochemical reactions, pollutant dispersion, and deposition lead to uncertainties in model predictions.

To address the inherent modeling uncertainties, EPA Guidance established comprehensive procedures for demonstrating attainment of the NAAQS. These procedures include, but are not limited to:

1. The Modeled Attainment Test is based on relative, rather than absolute, use of the modeling results. That is, the test relies on the ability of the photochemical modeling system to simulate the change in ozone due to emission reductions, rather than considering the modeling results to represent exact values for future-year ozone concentrations. Specifically, the model is run for both the 2012 baseline conditions and future 2017 scenario. The results of the baseline and future scenario model runs are compared to derive "Relative Response Factors" (RRFs) which predict the relative reduction in ozone concentrations between 2012 and 2017 resulting from control strategy implementation in the future year. The RRFs are then applied to monitored base-year (2012) design values to produce predicted future-year (2017) design values. The Modeled Attainment Test is "passed" if the predicted future-year design values at each site fall at or below 75.9 parts per billion (ppb).[57]

2. In recognition of the inherent uncertainties in the Modeled Attainment Test (described above), the Attainment Demonstration must also include a Weight of Evidence Demonstration incorporating a variety of statistical and other analyses — such as monitored air quality, emissions trends, and meteorological analyses — that provide support that the Emission Control Measures are sufficient to provide for timely attainment. Further, in areas where the Modeled Attainment Test is narrowly failed, the Weight of Evidence Demonstration can be used for additional analysis showing that attainment is possible.

3.4.2 Summary of Results

As discussed in detail below, the Modeled Attainment Test predicts a 2017 design value in San Diego County of 75.9 ppb. To further substantiate that attainment in 2017 is expected, this Attainment Demonstration incorporates a supplementary Weight of Evidence Demonstration. The Demonstration (Section 3.4.4) concludes that attainment of the 75.9 ppb standard in 2017 is possible. Historical weather patterns suggest that the region may experience cooler temperatures in future years, resulting in less formation of ozone. Combined with the Modeled Attainment Test, the resulting evidence confirms that the existing Emission Control Measures are adequate to continue reducing ozone concentrations to the level of the 2008 eight-hour ozone NAAQS by July 20, 2018.

[57] Design values for the 2008 eight-hour ozone NAAQS (0.075 ppm) are truncated to the 3rd decimal digit. The EPA Modeling Guidance states that "[…] 0.0759 ppm (75.9 ppb) is considered attainment, and 0.0760 ppm (76.0 ppb) is considered nonattainment. When discussing photochemical simulation modeling, the EPA uses parts per billion (ppb) rather than parts per million (ppm). Therefore, Section 3.4 identifies ozone concentrations in ppb.

3.4.3 Modeled Attainment Test

Photochemical modeling used in the Modeled Attainment Test, prepared by SCAQMD, was developed using the EPA-supported community Multiscale Air Quality (CMAQ) (Version 5.0.2) modeling platform with a four-kilometer grid resolution.[58] Statewide Air Pollution Research Center (SAPRC-07) chemistry and Weather Research and Forecasting Model (WRF)(Version 3.6) meteorological fields were also incorporated.[59] The Modeled Attainment Test focused the base year average regional performance model between May 2012 and September 2012, specifically on days where maximum eight-hour ozone levels were at least 60 ppb. The simulations were conducted over an area with a western boundary over 100 miles west of the Los Angeles coastline, an eastern boundary slightly beyond the Colorado River, and northern and southern boundaries extending up to the San Joaquin Valley and down to northern Mexico, respectively.

The Modeled Attainment Test is site-specific and, therefore, must be performed for each monitoring site in the nonattainment area. In San Diego County, only the Alpine monitoring site violates the 2008 eight-hour ozone NAAQS. The Alpine site is located in the inland foothills at an elevation of approximately 2,000 feet. Other monitoring sites in San Diego County have occasionally recorded exceedances of the 2008 eight-hour ozone NAAQS, but not frequently enough to violate the standard.

The 2012 baseline ozone design value used in the Modeled Attainment Test is the average of design values calculated for 2012 (based on 2010-2012 data), 2013 (2011-2013 data), and 2014 (2012-2014). The EPA recommends averaging the three design values to smooth the impact of weather-related variability, providing a more representative air quality baseline. For the Alpine monitoring site, the 2012 baseline ozone design value equates to 80.0 ppb. Pursuant to the EPA Modeling Guidance, only monitoring sites with more than 74.5% of the hourly measurements during each month of the ozone season were included in the final analysis.

Additional analysis of the model, its development, and overall performance metrics can be found in Attachments J, L, and L of this Attainment Plan. Attachment J was completed by SCAQMD as part of their draft 2016 Air Quality Management Plan (AQMP),[60] which modeled all of Southern California.[61] Additional modeling information is appended in Appendix V of the 2016 AQMP.

[58] Day-specific point source emissions were extracted from air district stationary source and ARB emission inventories. Mobile source emissions include day and hour real-time profiles, based on (1) the Caltrans Performance Measurement System and weight-in-motion profiles, (2) the EMFAC2014 emissions model, and (3) vehicle population and transportation analysis zone (TAZ) data provided by local Metropolitan Planning Organizations. Mobile source and selected area source data were subjected to daily WRF-derived temperature corrections to account for enhanced evaporative emissions on warmer days. Gridded daily biogenic VOC emissions were provided by the ARB using the MEGAN biogenic emissions model. The simulations benefited from enhancements made to the emissions inventory, such as day-specific adjustments in traffic volumes when generating on-road emissions, as well as improvements in gridding surrogates for spatial allocations of area and off-road emissions.

[59] The most recent version of WRF (Version 3.6.1) was utilized at the time of SCAQMD protocol preparation, and was evaluated with a set of input data, which includes land-use classification and sea-surface temperature initialization fields. The WRF simulations were initialized from National Centers for Environmental Prediction (NCEP) analyses and run for three-day increments with four-dimensional data assimilation (FDDA).

[60] "Draft 2016 Air Quality Management Plan" SCAQMD, June 30, 2016. http://www.aqmd.gov/home/library/clean-air-plans/air-quality-mgt-plan/Draft2016AQMP

[61] References to particulate matter and one-hour ozone modeling protocol are not applicable in San Diego County.

3.4.3.1 Ozone Representativeness

As previously mentioned, the EPA Modeling guidance recommends the use of RRFs in photochemical modeling scenarios, bridging the gap between air quality model predictions and ambient measurements. RRFs are a ratio of the future year predicted air quality to the simulated air quality in the base year, representing the model-predicted change in air quality in response to predicted emissions changes.

The Modeled Attainment Test itself must also account for day-to-day variability in meteorology. Past ozone Modeled Attainment Tests evaluated a set of meteorological conditions conducive to air pollutant build-up or evaluated episodes occurring during concurrent intensive field monitoring programs. These episodic periods were categorized based on how representative they were in reference to the ozone standard being evaluated. The 2007 "Eight-Hour Ozone Attainment Plan for San Diego County" was the first plan to use RRFs in future year ozone projections, addressing the former 1997 eight-hour ozone NAAQS. Episodes were selected to fully capture both typical meteorological variations in the ozone season, and the response of ozone formation for different daily emission profiles.

The Modeled Attainment Test for this Attainment Plan uses a different approach. Instead of episode-based simulation days, the modeling includes season-long ozone comprehensive CMAQ simulations (May to September); a total of 153 simulation days. Only the top 10 exceedance days were used to calculate the RRFs. The Modeled Attainment Test analyzed these simulation days and chose the days based on specific criteria.[62] The maximum modelled grid cell in the three-by-three grid centered at each monitoring site was retrieved from the base and future simulations. Simulations were also conducted for each hour in the 2012 ozone season (May 1 to September 30) in San Diego County.

3.4.3.2 Model-Predicted 2017 Design Value

The predicted 2017 design value for the region was calculated from the required five years of ambient ozone data from the Alpine monitoring site. The Modeled Attainment Test predicts a 2017 design value of 75.9 ppb (Table 3-7), which exactly equals the 2008 eight-hour ozone NAAQS.

TABLE 3-7
Calculation of Model-Predicted 2017 Design Value at the Alpine Monitoring Site

Station Name	Station Number	2012 Design Value (ppb)	2017 Design Value (ppb)
Alpine	1006	80.0	75.9

To provide a comprehensive analysis and further substantiate that attainment in 2017 is expected,

[62] The selection criteria were as follows: (1) the predicted daily maximum was within 20% of the site-specific design value, (2) the unpaired daily maximum prediction error was less than 20%, and (3) the prediction was higher than the federal standard of 75 ppb.

this Attainment Demonstration includes a supplementary Weight of Evidence Demonstration. This statistical analysis, based on a preponderance of all available evidence, concludes that the Emission Control Measures outlined in this Attainment Plan are sufficient to continue reducing ozone concentrations to the level of the 2008 eight-hour ozone NAAQS by July 20, 2018 (i.e. 2017 attainment year).

3.4.3.3 Model Performance Analysis

EPA Guidance recommends that a number of statistical metrics be used to evaluate the accuracy of the ozone CMAQ model in the region's modeled base-year. Accordingly, SCAQMD has conducted a Model Performance Analysis to confirm that the Modeled Attainment Test's base-year accurately predicts base-year emissions compared to observed emission data. The analysis for San Diego County monitoring sites is summarized in Attachment K of this Attainment Plan, with greater detail provided in Appendix V of the draft 2016 AQMP.

3.4.3.4 Unmonitored Area Analysis

The Modeled Attainment Test is designed to focus on monitoring sites and thus does not consider future ozone concentrations in areas that are not near a monitor. To address this possible discrepancy, EPA Guidance recommends a procedure for predicting future ozone concentrations in areas that are not near a monitor. The focus of the recommended procedure is to identify areas where the model predicts ozone concentrations significantly higher than those predicted near a monitor. The analysis for San Diego County is summarized in Attachment L of this Attainment Plan.

3.4.4 <u>Weight of Evidence Demonstration</u>

The Weight of Evidence includes a statistical and other analyses that further support a conclusion that existing Emission Control Measures in San Diego County are sufficient to attain the 2008 eight-hour ozone NAAQS by 2017. All analysis methods have innate strengths and weaknesses; therefore, examining an air quality problem in a variety of ways can aid in offsetting any limitations or uncertainties inherent to individual methods. This approach also provides a better understanding of the overall air quality problem, as well as insight about the level and mix of emissions controls needed for attainment.

The scope of the Weight of Evidence Demonstration is different for each nonattainment area, depending on the complexity of the air quality problem, the attainment deadline, and data/modeling availability. Similar to previous plan submittals, this Weight of Evidence Demonstration includes statistical air quality and emission trends and meteorological analyses. Results of each analysis have been considered in concert, along with the results of the Modeled Attainment Test, to determine that the Emission Control Measures outlined within this Plan are sufficient to reduce ozone concentrations in San Diego County to the level of the 2008 eight-hour ozone NAAQS by 2017.

3.4.4.1 Physical Context

Ozone forms in the lower atmosphere through a complex set of processes that are initiated by sunlight; therefore, ozone is considered a photochemical pollutant. Energy from the sun also drives meteorological processes through diurnal cycles (day-to-day), and seasonal cycles (year-to-year). As a result of these processes, the "ozone season" in San Diego County is generally considered, for this document, to be May through October. (See Section 3.4.4.8 – Shortened Ozone Season)

The San Diego air basin covers roughly 4,200 square miles, lies in the southwest corner of California, and encompasses all of San Diego County and a portion of the Salton Sea air basin.[63] The population and emissions are concentrated mainly in the densely populated western portion of the County. The topography of San Diego County is highly varied, comprised of coastal plains and lagoons, flatlands and mesas, broad valleys, canyons, foothills, mountains, and deserts. Structures within the San Diego air basin are usually congregated on the flatlands, mesas, and valleys, while the canyons and foothills tend to be sparsely developed. This segmentation has carved the region into a conglomeration of separate cities characterized by low density housing and an automobile-centric environment. The topography also drives pollutant levels, as the San Diego air basin has been identified as a transport recipient of ozone, NOx, and VOC. Pollutants from the South Coast air basin to the north and, when the wind shifts direction, Tijuana, Mexico, to the south, frequently impact air quality in the San Diego region.

The climate of San Diego County is classified as Mediterranean, but is incredibly diverse because of the topography. The climate is dominated by the Pacific High pressure system that results in mild, dry summers and mild, wet winters. The San Diego region experiences an average of 201 days above 70° F. Annual rainfall averages 9-13", occurring primarily between November and March. In recent years, El Niño and La Niña weather patterns have significantly affected annual rainfall, as well as overall climatic conditions.[64]

The 2010 census population estimate for San Diego County was approximately 3.0 million, while 2016 population estimates are approximately 3.3 million. Population has been increasing by about 1.3% per year.

3.4.4.2 Air Quality Trends

In San Diego County, only the Alpine site violates the 2008 eight-hour ozone NAAQS. However, the highest ozone levels today are much lower than they were 10 years ago. At the same time, ozone has become increasingly responsive to meteorological conditions.

Figure 3-1 shows the countywide design value trend for operational monitoring sites between 2010 and 2015. A line denoting the 2008 eight-hour ozone NAAQS has been included for reference.

[63] The western portion of the County is beaches and the Pacific Ocean. To the south are Tijuana, Mexico and the Baja California Peninsula. To the east are portions of the Laguna mountain range, and to the north is the South Coast air basin (the greater Los Angeles-Riverside-San Bernardino area).

[64] An El Niño is a warming of the surface waters of the eastern Pacific Ocean. It is a climate pattern that occurs across the tropical Pacific Ocean that is associated with drastic weather occurrences, including enhanced rainfall in Southern California. La Niña is a term for cooler than normal sea surface temperatures across the Eastern Pacific Ocean. San Diego typically receives less normal rainfall during La Niña years.

FIGURE 3-1
Design Value Concentrations for Monitoring Sites in San Diego County

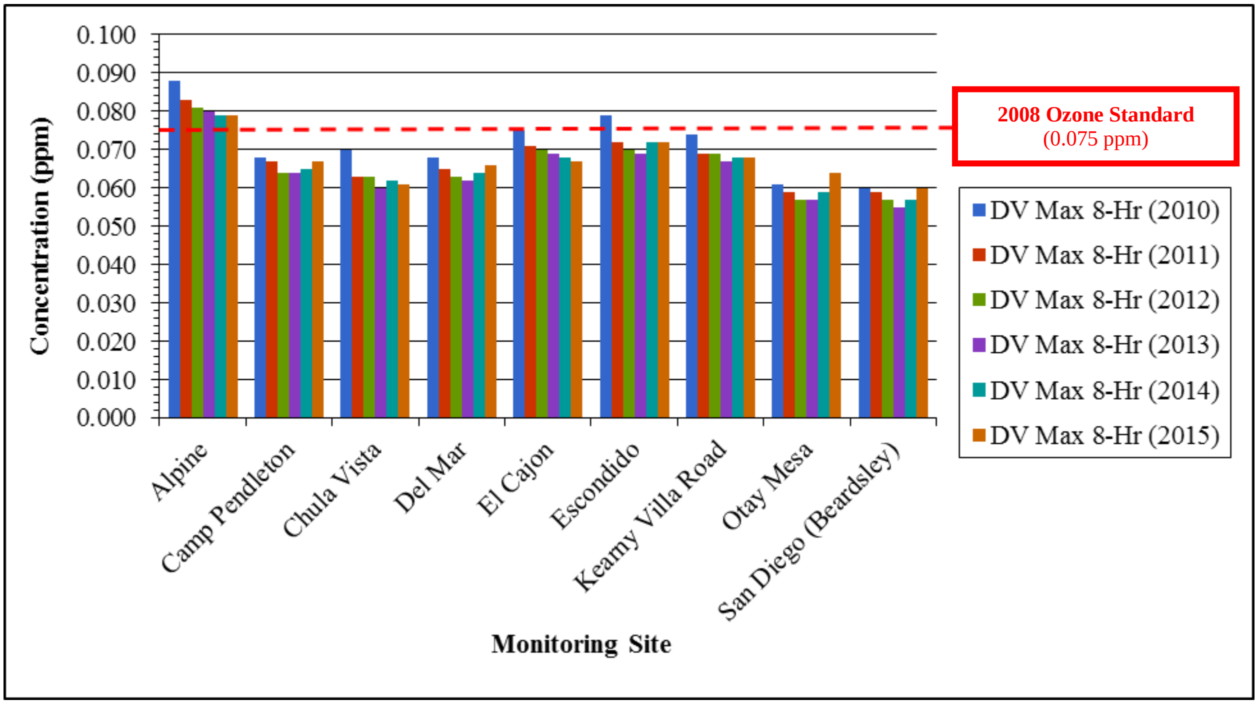


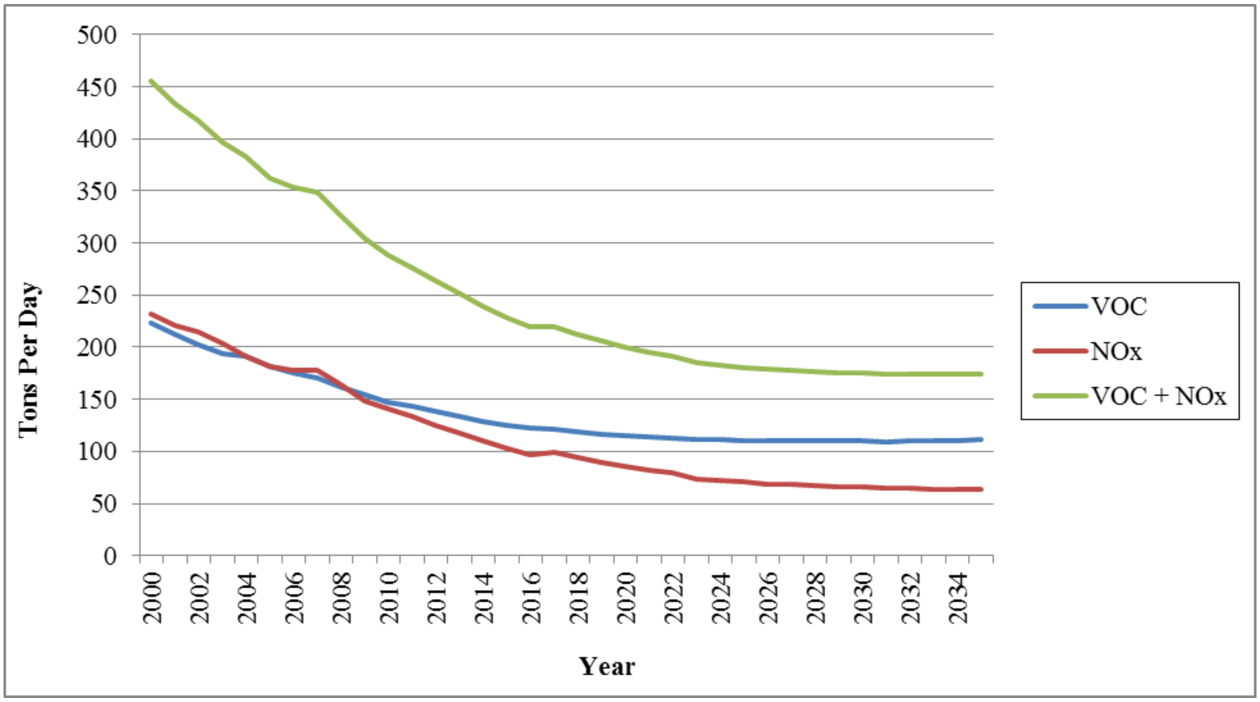
Figure 3-1 confirms that regional design values have been steadily decreasing over time. Between 2010 and 2015, the design value for the Alpine monitoring site decreased over 10%. All other monitoring sites in the region also exhibited long-term decreases, but also recorded a small increase during the 2014 and 2015 ozone seasons. The reason for this is further documented in the following sections.

3.4.4.3 Emission Trends

Projected emission reduction trends in San Diego County for VOC and NOx (categorized by source category) are illustrated in Figures 2-2 and 2-3, respectively. As lower-emitting motor vehicles gradually replace higher-emitting models, the share of VOC and NOx emissions from motor vehicles is projected to decline. Stationary and areawide source controls are expected to hold these emissions relatively constant despite economic growth. Ongoing implementation of state–required "all feasible control measures" will continue providing further emission reductions as cost-effective control technologies become available.

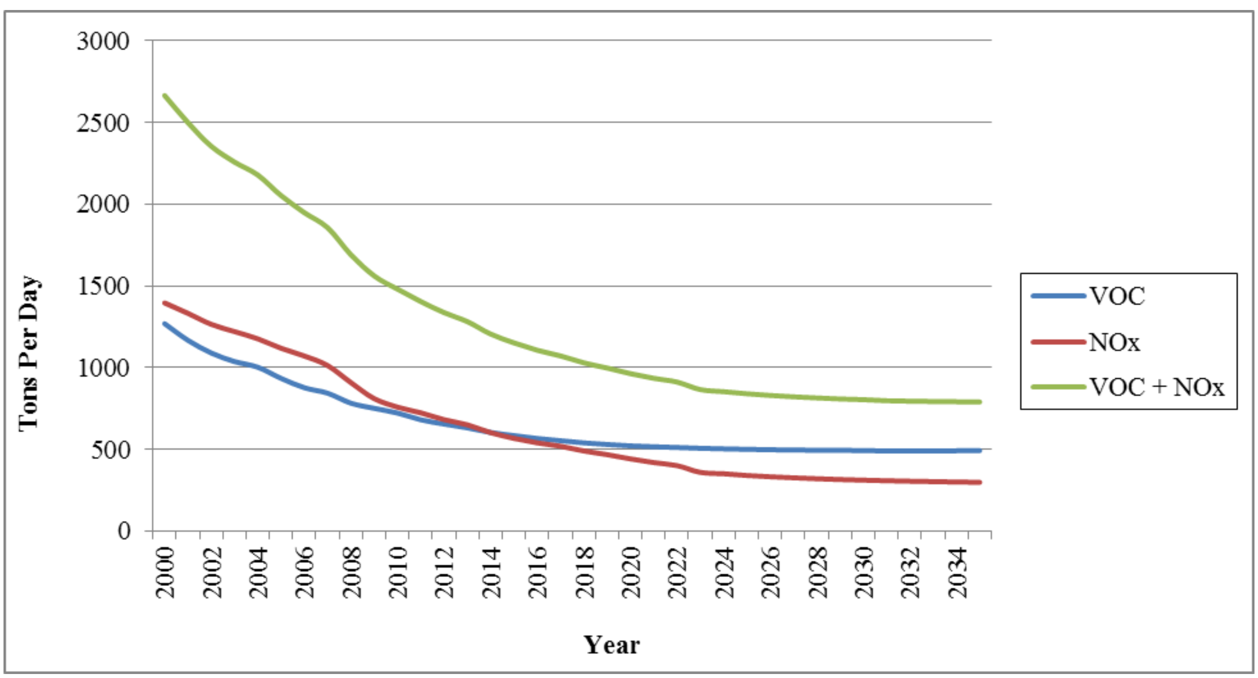
Ozone precursor emissions (VOC and/or NOx) are projected to decrease through 2035 due to existing emission control regulations. Figure 3-2 presents expected San Diego County emission trends for ozone precursors. Figure 3-3 presents combined emission trends for both San Diego and South Coast air basins, to reflect all emissions contributing to regional ozone formation. The continuous improvement trend supports the adequacy of the Emission Control Measures in this Attainment Plan, and helps substantiate the conclusion that San Diego County can attain the 2008 eight-hour ozone NAAQS by 2017.

FIGURE 3-2
San Diego County Emissions Trends, 2000 to 2035



Source: ARB CEPAM emissions inventory, Version 1.04.

FIGURE 3-3
San Diego & South Coast Air Basin Emissions Trends, 2000 to 2035



Source: ARB CEPAM emissions inventory, Version 1.04.

These trends signal future high VOC/NOx ratios in the region, for both San Diego County and the San Diego/South Coast region as a whole. Thus, it is anticipated that the Southern California region will become more NOx-limited. As a result, additional NOx controls will become an increasingly effective strategy for lowering regional ozone concentrations. Section 3.1.1 details the enhanced efforts that the ARB is taking to address future mobile source NOx emissions, a main focus of the region's Emission Control Measures to attain national ozone standards.

3.4.4.4 Eight-Hour Ozone Design Value Trend Statistical Analysis

The District conducted an air quality trend statistical analysis of the monitored eight-hour ozone design values at the Alpine monitoring site. Extrapolation of the best-fit trend line through the last 10 years of ozone data points (Figure 3-4) suggests that attainment can be expected to occur in 2017. Figure 3-4 shows a significant decline in ozone concentrations between 2008 and 2014, with a leveling off period between 2014 and 2015. Similarly, Figure 3-5 shows substantial overall reductions in exceedance days from 1979 to 2015, with a leveling off period in 2014 and 2015.

FIGURE 3-4
San Diego County Eight-Hour Ozone Design Value – Linear Trend, 2006 to 2015

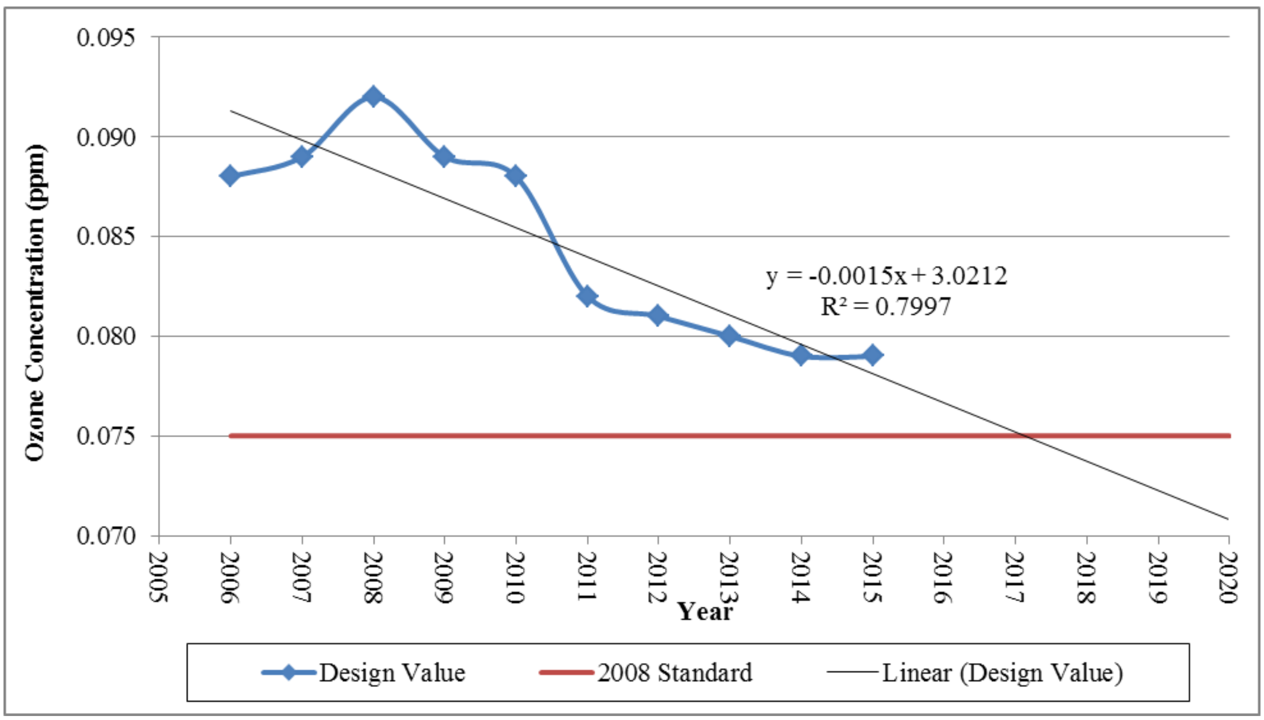
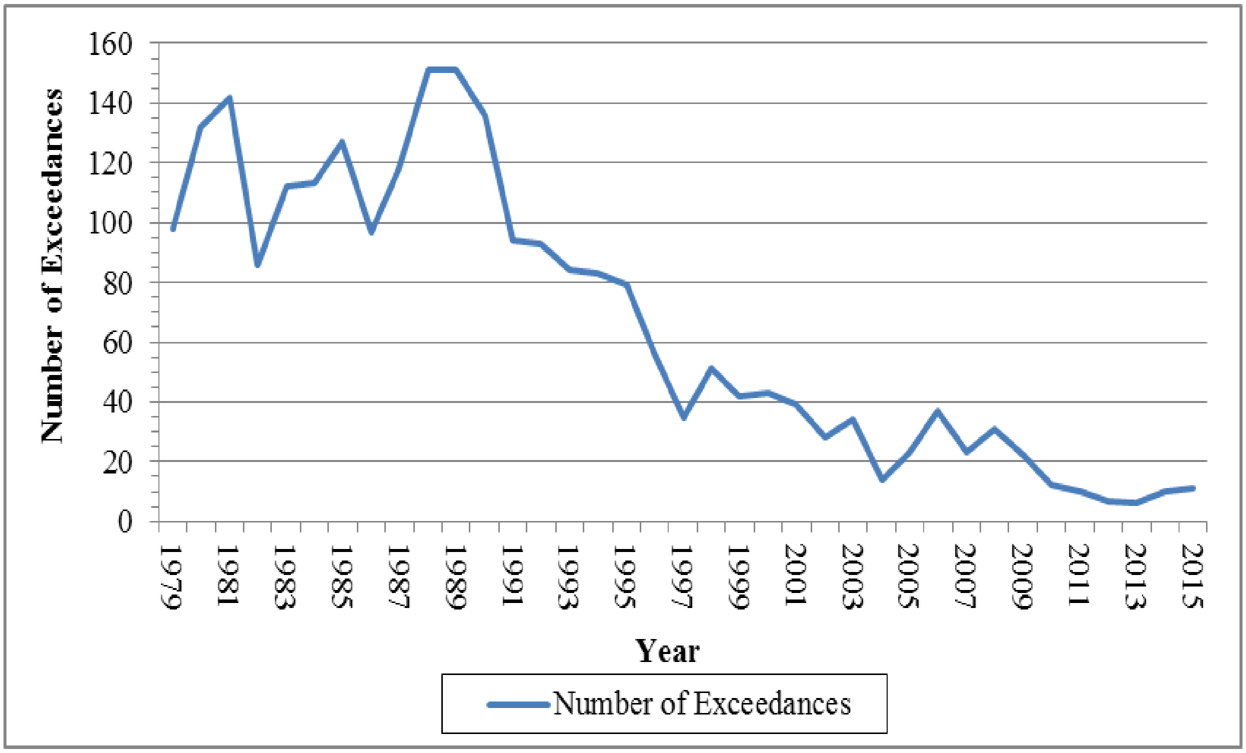


FIGURE 3-5
Alpine Monitoring Site – Number of Exceedance Days (2008 Standard), 1979 to 2015

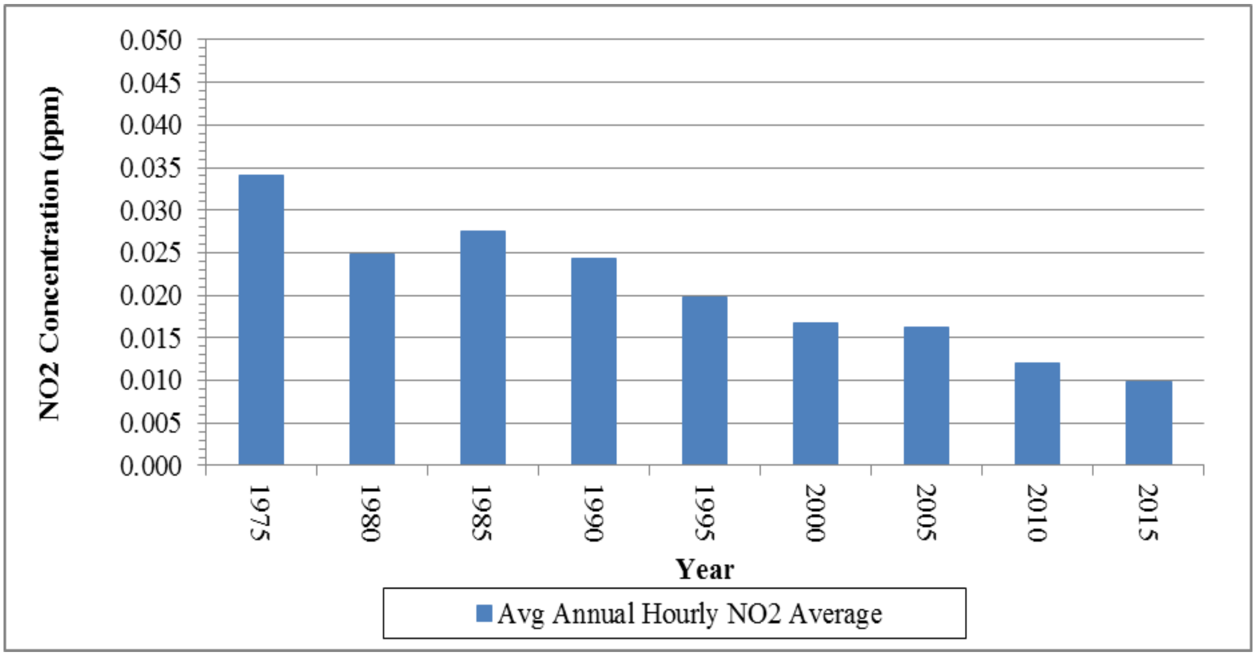


3.4.4.5 Recent Ozone Concentration Increases

The data confirms that the San Diego region experienced increases in ozone concentrations and exceedance days during 2014 and 2015 despite continued emission reductions. To determine why these abnormalities occurred, an analysis of local ozone formation factors during these years was conducted.

A widely employed approach to analyzing ozone formation is to examine historic nitrogen dioxide (NO_2) and VOC concentrations, to evaluate whether control technologies are actually working. Figure 3-6 shows the annual average NO_2 concentrations at the District's Chula Vista monitoring site, which has the longest record of continuous operation in San Diego County. The data show that NO_2 concentrations from 1975 to 2015 have steadily decreased, suggesting that NOx reductions from enhanced control technologies are working.

FIGURE 3-6
Chula Vista Monitoring Site - Annual Average Hourly NO_2 Concentrations, 1975 to 2015



Similarly, annual average VOC emission data has been tracked at the Alpine monitoring site since 2003 through the District's Photochemical Assessment Modeling Network (PAMS). Samples were collected at the same time of day from 2003 to 2014 (the latest available data). As with the Chula Vista site, a clear trend of VOC emission reductions is exhibited (Figure 3-7). This trend demonstrates that various VOC control strategies implemented locally and statewide are working to reduce regional emissions. Consequently, ozone precursor emissions alone are unlikely to have been responsible for the recent increases in ozone concentrations and exceedance days.

FIGURE 3-7
Alpine Monitoring Site - Annual Average Sum of VOC Concentrations, 2003 to 2014

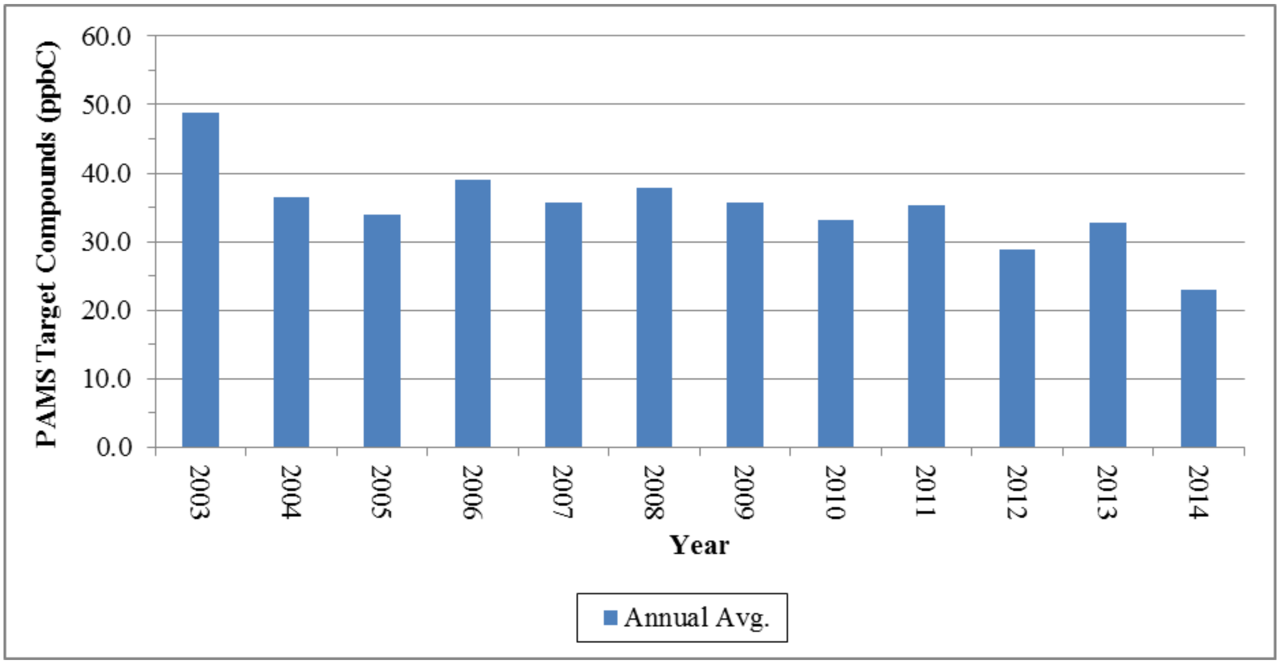
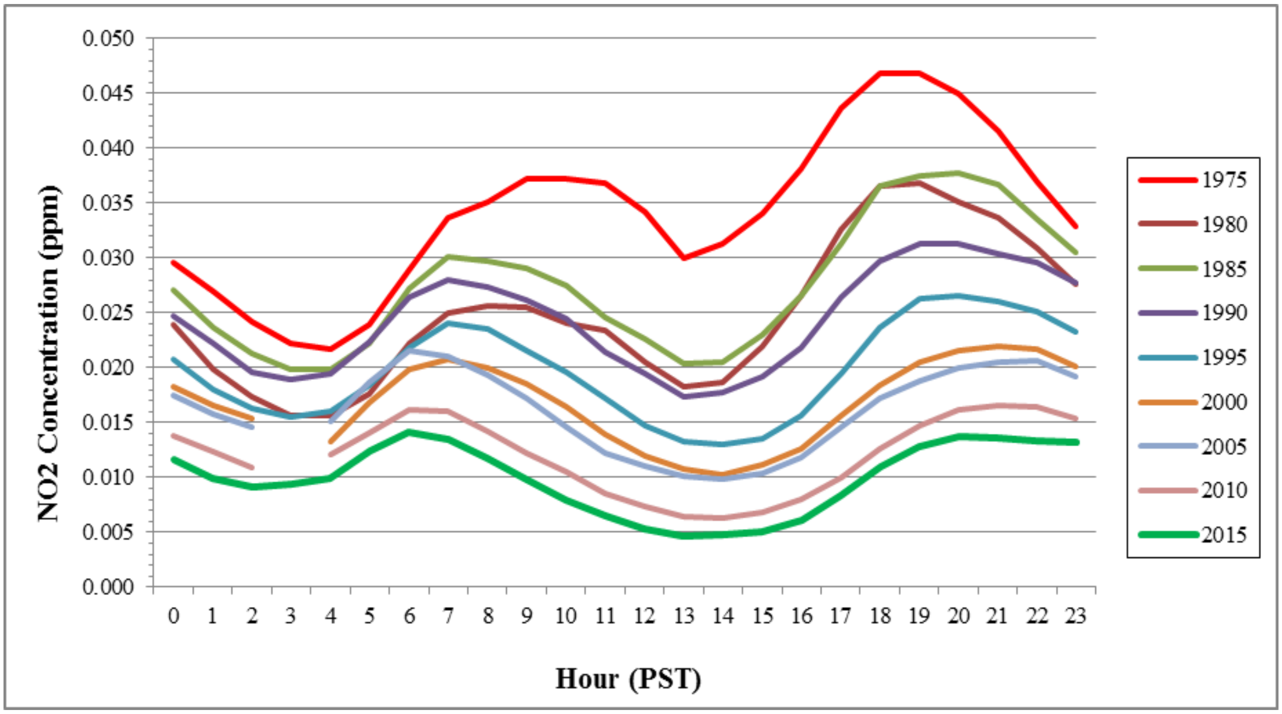


Figure 3-8 shows the historical hourly diurnal trend of NO_2 concentrations at the Chula Vista monitoring site over the same time period. The data clearly demonstrate that concentrations are heavily influenced by morning and evening commute patterns. However, while the pattern remained unchanged, NO2 concentrations have significantly declined over the 40-year timeframe analyzed. Thus, diurnal fluctuations in emissions are also unlikely to have been responsible for recent increases in ozone concentrations and exceedance days.

FIGURE 3-8
Chula Vista Monitoring Site –
Annual Average Hourly NO_2 Concentrations (Diurnal), 1975 to 2015

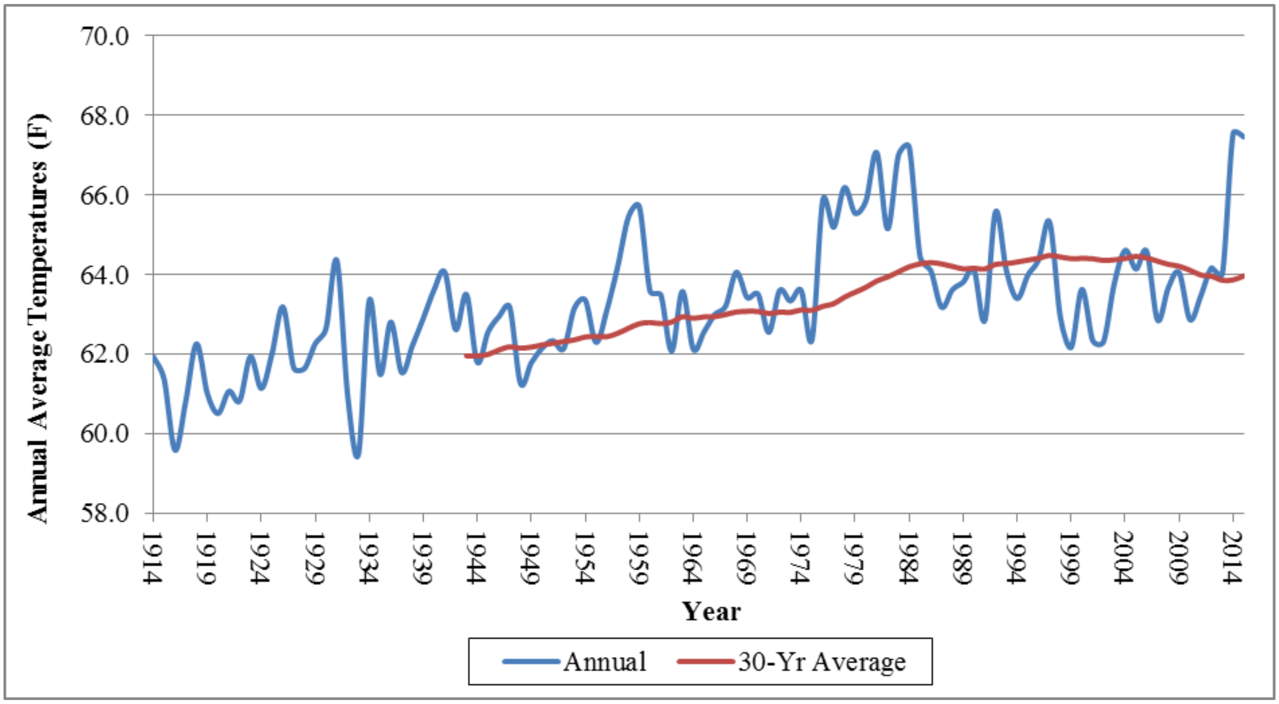


3.4.4.6 Meteorological Representativeness of Recent Years

Since total and diurnal fluctuations in emissions are unlikely to have been responsible for the recent increases in ozone concentrations and exceedance days, the District analyzed recent meteorological patterns to determine if they were a contributing factor. Figure 3-9 shows the annual average temperature for San Diego (SAN) over a 100-year period (as measured by the National Weather Service). The graph includes a rolling 30-year average for reference.[65] Clearly, an abrupt and significant temperature increase occurred in 2014 and 2015, the highest annual average temperatures recorded at any point in SAN's history.

[65] 30-year averages are standard for climatological averaging.

FIGURE 3-9
San Diego (SAN) Annual Temperature Averages, 1914-2015



Source: National Weather Service (NWS).

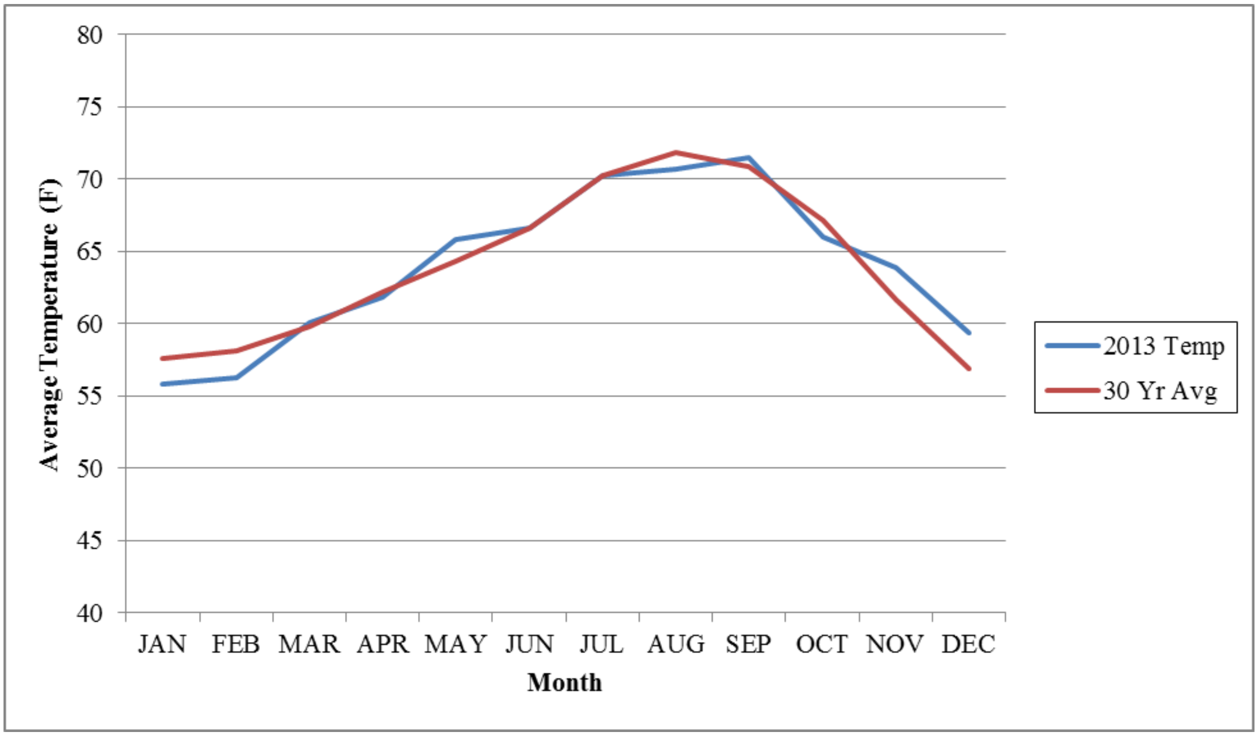
The significant warming in 2014 and 2015 is likely attributable to an extremely strong El Niño episode in the eastern Pacific Ocean in the same timeframe. Climate scientists have indicated this strong weather episode impacted global temperatures (on top of climate change warming). The cyclical nature of El Niño episodes means that extra heat added to the atmosphere will decrease as the episode fades. In August 2016, climate patterns suggested that a La Niña episode may be developing,[66] which could cause Pacific Ocean surface temperatures and atmospheric temperatures to decrease. Further, if a La Niña episode fails to develop,[67] but oceanic temperatures return to normal conditions, the region can still anticipate atmospheric cooling in comparison to higher than normal levels in 2014 and 2015. This suggests that recent high average temperatures in San Diego County may be short-lived, and lower temperatures can be anticipated in the near future (including the 2017 attainment year).

To further examine this concept, the District analyzed average monthly temperatures at SAN in 2013, 2014, and 2015, against the previous rolling 30-year average temperature. Figure 3-10 confirms that temperatures in 2013 were extremely close to the previous rolling 30-year period.

[66] "El Niño / Southern Oscillation (ENSO) Diagnostic Discussion." 11 August 2016. Climate Prediction Center/ National Centers for Environmental Prediction/ National Weather Service. http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_disc_aug2016/ensodisc.pdf

[67] "El Niño / Southern Oscillation (ENSO) Diagnostic Discussion." 8 September 2016. Climate Prediction Center/ National Centers for Environmental Prediction/ National Weather Service. http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_disc_sep2016/ensodisc.pdf

FIGURE 3-10
San Diego (SAN) Average Monthly Temperature, 1983 to 2012 vs. 2013



However, Figures 3-11 and 3-12 show increasingly higher monthly average temperatures in 2014 and 2015, respectively, compared to the 30-year rolling average. These elevated temperatures likely contributed to greater ozone formation, resulting in prolonged ozone seasons in 2014 and 2015 (as discussed in Section 3.4.4.8), and more ozone exceedance days (as discussed in Section 3.4.4.4).

FIGURE 3-11
San Diego (SAN) Average Monthly Temperature, 1984 to 2013 vs. 2014

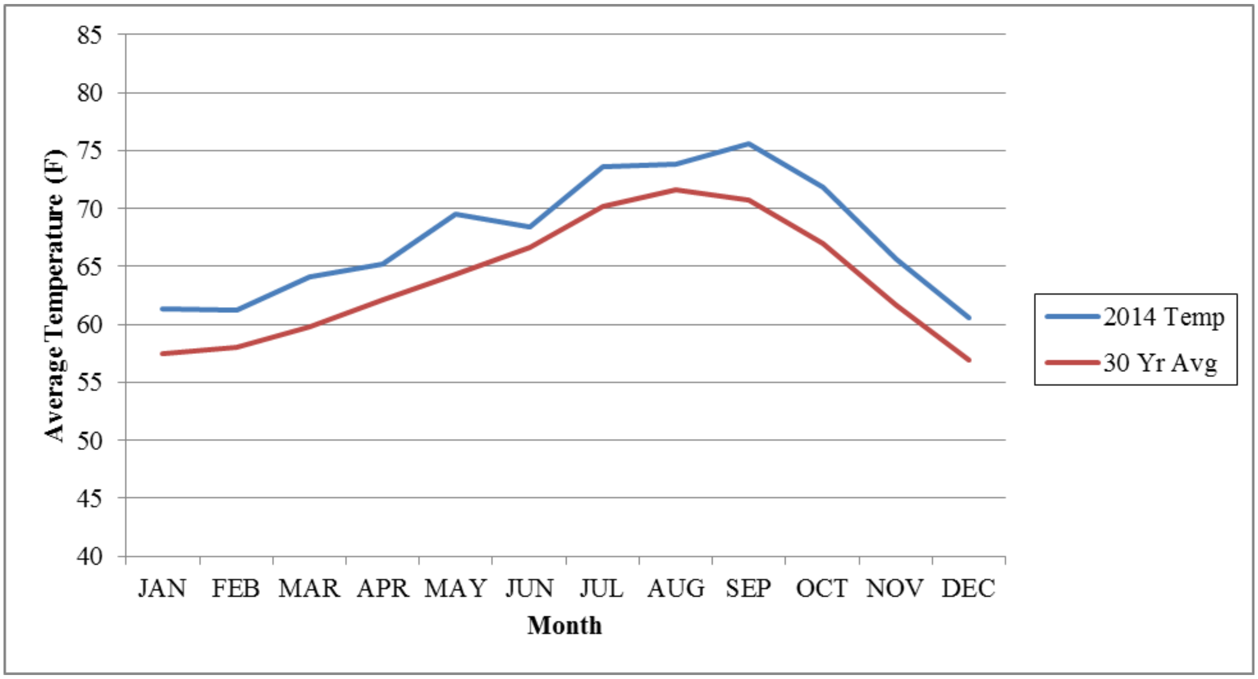
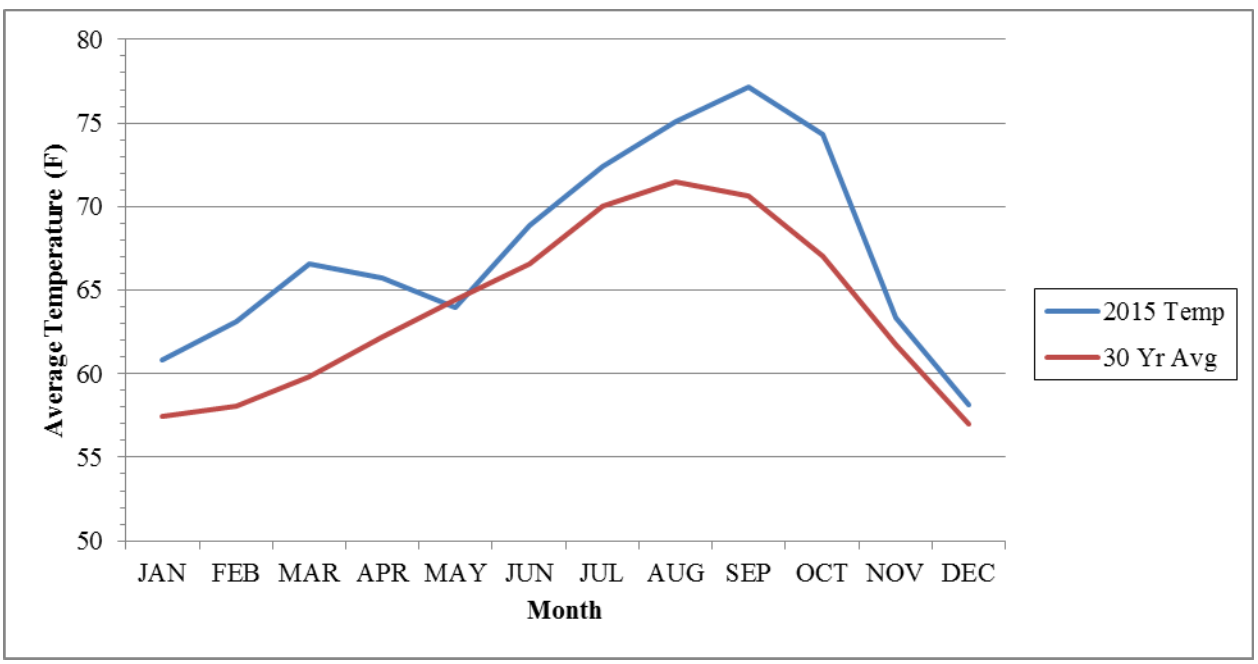


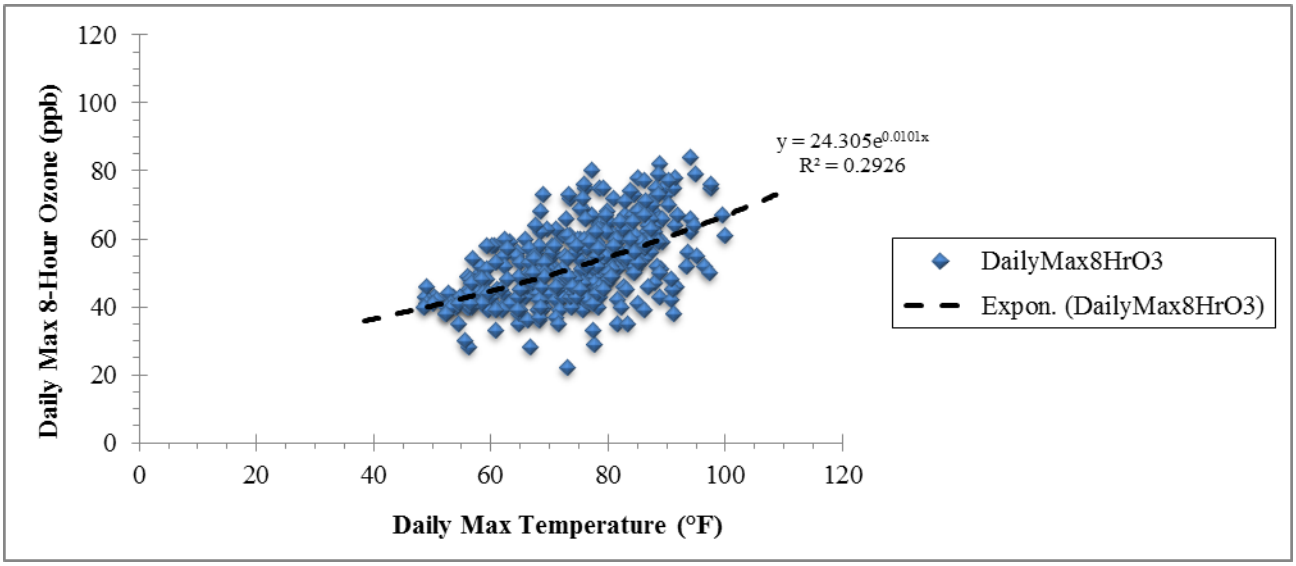
FIGURE 3-12
San Diego (SAN) Average Monthly Temperature, 1985-2014 vs. 2015



3.4.4.7 Graphical Representation of Recent Meteorological Conditions and Ozone Concentrations

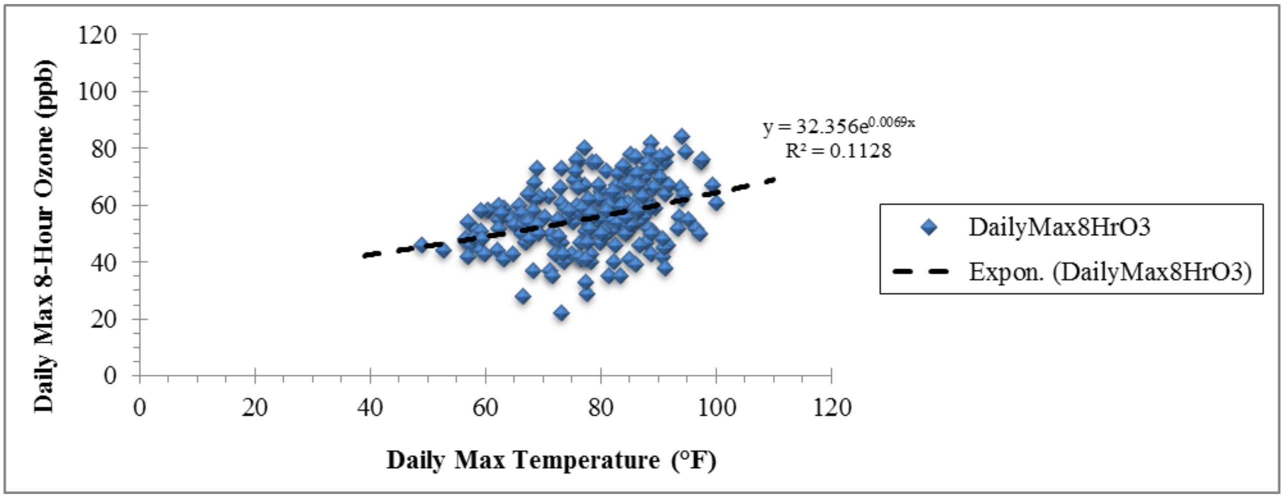
High atmospheric temperatures increase biogenic and evaporative emissions, thus increasing the chemical reaction efficiency of tropospheric ozone formation. Figures 3-13, 3-14, and 3-15 further illustrate this concept. Figure 3-13 depicts a scatter plot of daily maximum eight-hour ozone and daily maximum temperatures at the District's Alpine monitoring site. Although not linear, ozone concentrations do show a correlation with temperature.

FIGURE 3-13
Daily Maximum Eight-Hour Ozone vs. Temperature, Alpine (2015)



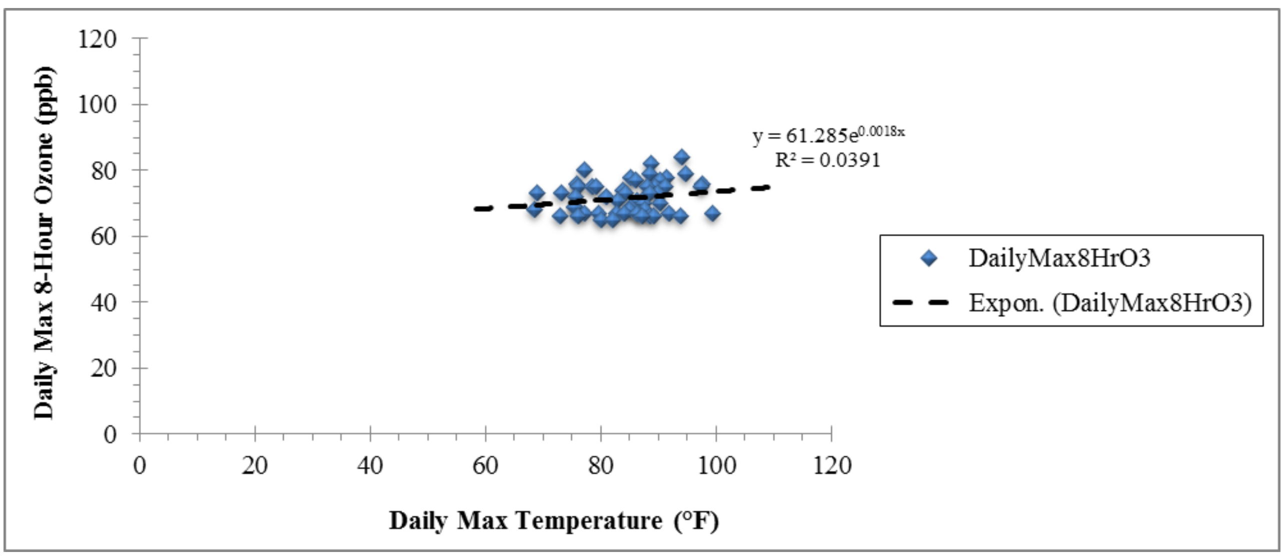
To reduce extraneous noise in the scatter plot, Figure 3-14 limits data to a typical "conservatively estimated" ozone season, from April to October. A correlation of higher temperatures to higher daily maximum ozone concentrations becomes more visible.

FIGURE 3-14
Daily Maximum Eight-Hour Ozone vs. Temperature, Alpine (2015 - April through October)



By further limiting the data to only days with eight-hour ozone concentrations of 65 ppb and higher (Figure 3-15), it is demonstrated that many of the highest eight-hour ozone values were measured on the hottest days in 2015. Although eight-hour ozone concentrations are not linearly correlated with temperature, there is a clear relationship of hotter days resulting in higher than normal ozone concentrations.

FIGURE 3-15
Daily Maximum Eight-Hour Ozone (65 ppb and above)
vs. Temperature, Alpine (2015 - April through October)

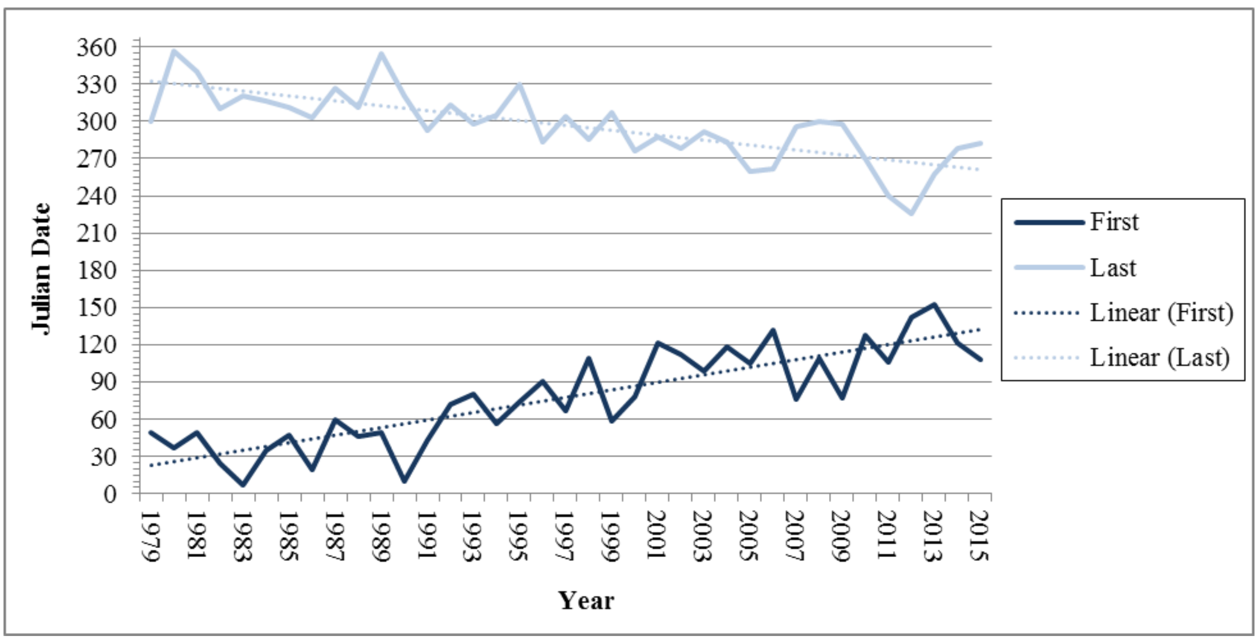


3.4.4.8 Shortened Ozone Season

In addition to abnormal meteorological conditions, San Diego County's ozone season has historically been shortening. The EPA officially identifies San Diego County (and all of California) as having a 12-month ozone season, meaning that ozone levels at any time of year have been capable of exceeding the 2008 eight-hour ozone NAAQS. However, since 1979, the length of the ozone season (i.e. number of days) has been shortening, beginning later and ending earlier. Figure 3-16 shows this trend through numbered calendar days of the first and last eight-hour ozone exceedances from 1979 to 2015. Over a shorter time period, (1999 to 2015), there were no observed eight-hour exceedances of the 2008 eight-hour ozone NAAQS at the Alpine monitoring site before March or after October.

Despite the small increase in exceedances in 2014 and 2015, the historical trend of a shortening ozone season supports the conclusion that the Emissions Control Measures outlined in this Attainment Plan are working, and that ozone concentrations and exceedance days can be expected to decrease in the near future.

FIGURE 3-16
Eight-Hour Ozone Season at Alpine Monitoring Site, 1979 to 2015



3.4.5 <u>Summary</u>

In summary, photochemical modeling performed as part of this Attainment Plan demonstrates that attainment of the 2008 eight-hour ozone NAAQS is likely by 2017. This conclusion is consistent with the additional analyses presented in the Weight of Evidence Demonstration, using observed ozone levels, meteorology, and precursor emissions as a basis for further support. This complementary analysis supplements the SIP-required Modeled Attainment Test, providing additional support for the Attainment Demonstration based on the following factors:

- Trends for multiple indicators of ozone air quality have shown progress at San Diego County's lone violating monitoring site (Alpine), with a decrease in design value of over 10% from 2010 to 2015.
- Exceedance days have decreased by over 70% in the past decade, while the overall severity of daily ozone concentrations has significantly declined throughout the county.
- The ARB emission inventory confirms that a countywide ozone-precursor reduction of approximately 42% (approximately 191 tons per day) occurred between 2000 and 2012. Similarly, the emission inventory data confirms that ozone-precursors are projected to continue decreasing by approximately 17% (38 tons per day) between 2016 and 2025.
- Based on available ambient precursor trends and emission inventory data, it is expected that Southern California (including San Diego County) will be increasingly responsive to further NOx controls. Current control programs are expected to reduce NOx emissions by 21% (approximately 26 tons per day) between 2012 and 2017.
- In 2014 and 2015, San Diego County endured an extreme El Niño weather pattern that resulted in unusually high regional temperatures, causing enhanced formation of ozone and more exceedance days. Other factors, such as overall pollutant levels and changes in diurnal patterns, were eliminated as potential causes for the recent increases.
- The long-term trend of a shortening ozone season suggests that the number of exceedance days is expected to decrease in the future, confirming that the Emission Control Measures outlined within this Attainment Plan are sufficient for the foreseeable future.

High temperatures experienced in San Diego County in 2014 and 2015 were a significant contributor to recent increases in ozone formation and exceedance days. However, cooler temperatures in the region are predicted in the near future, as the current El Niño condition fades and is followed by normal temperatures, or a cooling La Niña condition. Consequently, ozone concentrations and exceedance days are predicted to decrease, as well as overall emissions with the advent of new reduction strategies and control technologies. Taken together, all available statistical, graphical, and meteorological data indicate that all monitoring sites in San Diego County can be expected to attain the 2008 eight-hour ozone NAAQS by 2017 with current ARB and District control programs.

3.5 CONTINGENCY MEASURES

Contingency Measure requirements are not included in the Code of Federal Regulations, but are discussed in Section III.H of the 2008 eight-hour ozone implementation rule. Nonattainment areas are required to adopt contingency measures to be implemented in the event of failure to meet a RFP milestone, or to attain the 2008 eight-hour ozone NAAQS. It should be noted that the CAA requires states to identify contingency measures that will go into effect without further action on the part of the state or the EPA.

Since existing mobile source control measures are projected to continue providing significant emission reductions for many years beyond the 2017 attainment year as newer vehicles enter the fleet, this Attainment Plan relies on the continuing emission reductions from those existing mobile source control measures to fulfill the Contingency Measures requirement. These measures will continue to be implemented regardless of the air basin's attainment status in 2018.

As indicated in Table 3-8, existing mobile source control regulations will continue reducing San

Diego County total VOC emissions between 2017 and 2021 by an estimated 1.5 percent per year, and NOx emissions by about 4.6 percent per year. Such continuing emission reductions are ample to ensure reasonable further progress will continue to be achieved in the event the area fails to attain the 2008 eight-hour ozone NAAQS by the required deadline.

TABLE 3-8
Projected VOC and NOx Emissions, 2017-2021 (tons per day)

	VOC					NOx				
	2017	**2018**	**2019**	**2020**	**2021**	**2017**	**2018**	**2019**	**2020**	**2021**
Stationary Sources	29.2	29.2	29.1	29.2	29.3	4.0	4.0	4.0	3.9	3.9
Areawide Sources	36.7	37.0	37.3	37.6	37.9	1.7	1.8	1.8	1.8	1.8
On-road Mobile Sources	22.4	20.7	19.3	18.1	17.1	41.2	37.7	34.9	31.7	28.5
Off-road Mobile Sources	32.5	31.5	30.7	29.9	29.3	51.8	50.4	49.3	48.2	47.6
Total	**120.8**	**118.4**	**116.4**	**114.8**	**113.6**	**98.7**	**93.9**	**90.0**	**85.6**	**81.8**
Reduction		**2.4**	**2.0**	**1.6**	**1.2**		**4.8**	**3.9**	**4.4**	**3.8**
Percent Reduction		**2.0%**	**1.7%**	**1.4%**	**1.0%**		**4.9%**	**4.2%**	**4.9%**	**4.4%**

Source: ARB CEPAM emissions inventory, Version 1.04.

4.0 CONCLUSION

Pursuant to CAA requirements and EPA guidance, the District has conducted numerous and diverse analyses—including the Modeled Attainment Test and several analyses of air quality, emissions, and meteorological data—to judge whether timely attainment of the 2008 eight-hour ozone NAAQS as a Moderate nonattainment area in San Diego County is likely. The results of the modeling and Weight of Evidence analyses, on balance, provide persuasive support to a conclusion that the Emission Control Measures defined in this Plan are sufficient to continue reducing ozone concentrations throughout San Diego County to the level of the 2008 eight-hour ozone NAAQS by the conclusion of the 2017 ozone season.

ATTACHMENT A
EMISSION INVENTORIES FOR 2012 AND 2017

Table A-1
Emission Inventory of Ozone Precursors in San Diego County for 2012 and 2017 (tons per day)

SOURCE CATEGORY	VOC 2012	VOC 2017	NOx 2012	NOx 2017
ELECTRIC UTILITIES	0.0659	0.0522	0.5229	0.4138
COGENERATION	0.0431	0.0431	0.2186	0.2186
MANUFACTURING AND INDUSTRIAL	0.0824	0.0711	0.9111	0.8569
FOOD AND AGRICULTURAL PROCESSING	0.0243	0.0133	0.3172	0.157
SERVICE AND COMMERCIAL	0.2318	0.2345	1.0666	1.0959
OTHER (FUEL COMBUSTION)	0.0848	0.0744	0.8561	0.7223
SEWAGE TREATMENT	0.0249	0.0255	0.0702	0.0688
LANDFILLS	2.0673	2.153	0.2245	0.2327
INCINERATORS	0.0001	0.0001	0.0033	0.0035
SOIL REMEDIATION	0	0	0	0
OTHER (WASTE DISPOSAL)	0.248	0.2597	0	0
LAUNDERING	0.0973	0.1019	0	0
DEGREASING	1.494	1.5307	0	0
COATINGS AND RELATED PROCESS SOLVENTS	6.8601	7.2515	0	0
PRINTING	4.3291	4.5334	0	0
ADHESIVES AND SEALANTS	2.4423	2.6133	0	0
OTHER (CLEANING AND SURFACE COATINGS)	0.1141	0.1211	0	0
PETROLEUM MARKETING	8.5397	6.2675	0.0077	0.0076
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0003	0.0003	0	0
CHEMICAL	2.0918	2.5728	0	0
FOOD AND AGRICULTURE	0.0518	0.0578	0	0
MINERAL PROCESSES	0.1916	0.2258	0.1597	0.1881
METAL PROCESSES	0.0078	0.0082	0.0056	0.006
GLASS AND RELATED PRODUCTS	0	0	0	0
ELECTRONICS	0	0	0	0
OTHER (INDUSTRIAL PROCESSES)	0.6273	1.0195	0.0297	0.0482
STATIONARY SUBTOTAL	**29.7198**	**29.2307**	**4.3932**	**4.0194**
CONSUMER PRODUCTS	17.8551	17.4811	0	0
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	11.6644	12.0917	0	0
PESTICIDES/FERTILIZERS	0.6722	0.6053	0	0
ASPHALT PAVING / ROOFING	1.8278	2.2633	0	0
RESIDENTIAL FUEL COMBUSTION	0.5092	0.5243	1.6754	1.6663
FARMING OPERATIONS	1.2683	1.2683	0	0
CONSTRUCTION AND DEMOLITION	0	0	0	0
PAVED ROAD DUST	0	0	0	0
UNPAVED ROAD DUST	0	0	0	0
FUGITIVE WINDBLOWN DUST	0	0	0	0
FIRES	0.0478	0.0496	0.0166	0.0172
MANAGED BURNING AND DISPOSAL	0.2398	0.2357	0.0587	0.0568
COOKING	2.1104	2.2101	0	0
OTHER (MISCELLANEOUS PROCESSES)	0	0	0	0
AREAWIDE SUBTOTAL	**36.195**	**36.7294**	**1.7507**	**1.7403**
LIGHT DUTY PASSENGER (LDA)	13.4101	8.1149	9.2372	6.0312
LIGHT DUTY TRUCKS - 1 (LDT1)	3.9641	2.2734	2.2048	1.1031
LIGHT DUTY TRUCKS - 2 (LDT2)	5.2567	3.4507	5.4295	2.8487
MEDIUM DUTY TRUCKS (MDV)	3.9665	3.1215	4.973	2.9666
LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDV1)	1.4769	1.0111	1.9154	1.2258

Table A-1 (continued)
Emission Inventory of Ozone Precursors in San Diego County (tons per day)

SOURCE CATEGORY	VOC 2012	VOC 2017	NOx 2012	NOx 2017
LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDV2)	0.1628	0.1096	0.2361	0.1672
MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)	0.3843	0.1546	0.5482	0.3026
HEAVY HEAVY DUTY GAS TRUCKS (HHDV)	0.0581	0.0231	0.1191	0.0787
LIGHT HEAVY DUTY DIESEL TRUCKS - 1 (LHDV1)	0.2359	0.2002	5.5782	3.6632
LIGHT HEAVY DUTY DIESEL TRUCKS - 2 (LHDV2)	0.065	0.0598	1.4393	0.8749
MEDIUM HEAVY DUTY DIESEL TRUCKS (MHDV)	0.7119	0.3324	8.6859	5.2719
HEAVY HEAVY DUTY DIESEL TRUCKS (HHDV)	1.509	0.3999	21.8555	12.2446
MOTORCYCLES (MCY)	3.168	2.8077	0.7579	0.6752
HEAVY DUTY DIESEL URBAN BUSES (UB)	0.2648	0.1641	3.8569	2.3215
HEAVY DUTY GAS URBAN BUSES (UB)	0.038	0.0226	0.0654	0.0529
SCHOOL BUSES - GAS (SBG)	0.0521	0.0106	0.0465	0.0214
SCHOOL BUSES - DIESEL (SBD)	0.0386	0.0104	0.5451	0.5
OTHER BUSES - GAS (OBG)	0.0524	0.0368	0.1486	0.0939
OTHER BUSES - MOTOR COACH - DIESEL (OBC)	0.0255	0.0082	0.3579	0.2409
ALL OTHER BUSES - DIESEL (OBD)	0.0357	0.0073	0.4304	0.2276
MOTOR HOMES (MH)	0.1046	0.0519	0.4425	0.2785
ONROAD SUBTOTAL	**34.981**	**22.3708**	**68.8734**	**41.1904**
AIRCRAFT	3.5897	3.6515	5.7568	8.5589
TRAINS	0.1363	0.1345	2.232	2.4508
OCEAN GOING VESSELS	0.6842	0.7626	13.2478	15.3709
COMMERCIAL HARBOR CRAFT	0.5949	0.5026	8.1762	5.1084
RECREATIONAL BOATS	15.7734	12.239	2.9597	2.5915
OFF-ROAD RECREATIONAL VEHICLES	0.9895	0.9607	0.0172	0.0208
OFF-ROAD EQUIPMENT	13.1627	12.0311	15.267	15.6073
FARM EQUIPMENT	0.5982	0.46	2.5451	2.1265
FUEL STORAGE AND HANDLING	2.246	1.7612	0	0
OFFROAD SUBTOTAL	**37.7749**	**32.5032**	**50.2018**	**51.8351**
PRE-BASELINE EMISSION REDUCTION CREDITS SUBTOTAL		0.75		0.61
TOTAL	**138.6707**	**121.5841**	**125.2191**	**99.3952**

Source: ARB CEPAM emissions inventory, Version 1.04.

Table A-2
Emission Inventory of Ozone Precursors in San Diego County and South Coast Air Basin, Combined for 2012 and 2017
(tons per day)

SOURCE CATEGORY	VOC 2012	VOC 2017	NOx 2012	NOx 2017
ELECTRIC UTILITIES	1.1638	0.9226	3.3235	6.6708
COGENERATION	0.1501	0.1467	0.7717	0.6952
OIL AND GAS PRODUCTION (COMBUSTION)	0.1121	0.1157	1.6307	1.8685
PETROLEUM REFINING (COMBUSTION)	1.0165	1.0165	8.3712	9.3072
MANUFACTURING AND INDUSTRIAL	4.0971	4.486	16.1068	16.017
FOOD AND AGRICULTURAL PROCESSING	0.058	0.0496	0.5916	0.4162
SERVICE AND COMMERCIAL	5.1873	4.9155	14.4725	12.2485
OTHER (FUEL COMBUSTION)	0.3939	0.351	5.1218	4.3857
SEWAGE TREATMENT	0.3716	0.4166	0.077	0.0765
LANDFILLS	10.3401	10.7411	0.8884	0.9546
INCINERATORS	0.0738	0.0835	1.7565	1.9694
SOIL REMEDIATION	0.0015	0.0016	0	0
OTHER (WASTE DISPOSAL)	6.2853	7.2016	0	0
LAUNDERING	0.2562	0.2747	0	0
DEGREASING	11.9893	13.9724	0	0
COATINGS AND RELATED PROCESS SOLVENTS	27.0348	30.4872	0.022	0.0162
PRINTING	5.9902	6.4101	0	0
ADHESIVES AND SEALANTS	6.0449	6.9173	0	0
OTHER (CLEANING AND SURFACE COATINGS)	0.8333	0.9653	0.0791	0.0273
OIL AND GAS PRODUCTION	2.3168	2.3974	0.017	0.0388
PETROLEUM REFINING	4.5588	4.5421	1.3119	1.4356
PETROLEUM MARKETING	31.4229	21.1382	0.0134	0.0135
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0869	0.0988	0.001	0.0011
CHEMICAL	7.5608	8.9141	0.0059	0.007
FOOD AND AGRICULTURE	1.2633	1.3772	0	0.0001
MINERAL PROCESSES	0.9566	1.078	0.4818	0.6408
METAL PROCESSES	0.1517	0.1703	0.0564	0.0621
WOOD AND PAPER	0.2441	0.2675	0	0
GLASS AND RELATED PRODUCTS	0.0009	0.001	0	0
ELECTRONICS	0.0164	0.0222	0.0003	0.0004
OTHER (INDUSTRIAL PROCESSES)	3.778	4.3434	0.0531	0.0773
STATIONARY SUBTOTAL	**133.757**	**133.8252**	**55.1536**	**56.9298**
CONSUMER PRODUCTS	106.8149	107.265	0	0
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	25.3744	23.8723	0	0
PESTICIDES/FERTILIZERS	2.4933	2.3064	0	0
ASPHALT PAVING / ROOFING	2.7426	3.4735	0	0
RESIDENTIAL FUEL COMBUSTION	2.9193	2.758	16.4353	12.1799
FARMING OPERATIONS	4.3701	3.7583	0	0
CONSTRUCTION AND DEMOLITION	0	0	0	0
PAVED ROAD DUST	0	0	0	0
UNPAVED ROAD DUST	0	0	0	0
FUGITIVE WINDBLOWN DUST	0	0	0	0
FIRES	0.2825	0.2843	0.0936	0.0942
MANAGED BURNING AND DISPOSAL	0.4091	0.6852	0.13	0.2531
COOKING	3.8778	4.1344	0	0
OTHER (MISCELLANEOUS PROCESSES)	0	0	0	0
AREAWIDE SUBTOTAL	**149.284**	**148.5374**	**16.6589**	**12.5272**

Table A-2 (continued)
Emission Inventory of Ozone Precursors in San Diego County and South Coast Air Basin, Combined for 2012 and 2017 (tons per day)

SOURCE CATEGORY	VOC 2012	VOC 2017	NOx 2012	NOx 2017
LIGHT DUTY PASSENGER (LDA)	84.0923	47.9567	52.9367	30.3166
LIGHT DUTY TRUCKS - 1 (LDT1)	23.0015	13.1452	13.0469	6.6003
LIGHT DUTY TRUCKS - 2 (LDT2)	32.279	21.1218	32.8386	17.536
MEDIUM DUTY TRUCKS (MDV)	26.4659	21.1638	33.293	20.503
LIGHT HEAVY DUTY GAS TRUCKS - 1 (LHDV1)	7.0551	5.2575	9.2979	6.4418
LIGHT HEAVY DUTY GAS TRUCKS - 2 (LHDV2)	0.9581	0.6876	1.3935	1.0125
MEDIUM HEAVY DUTY GAS TRUCKS (MHDV)	2.0011	0.9232	3.0488	1.843
HEAVY HEAVY DUTY GAS TRUCKS (HHDV)	0.3956	0.1206	0.6622	0.4373
LIGHT HEAVY DUTY DIESEL TRUCKS - 1 (LHDV1)	0.6609	0.572	21.9367	15.3078
LIGHT HEAVY DUTY DIESEL TRUCKS - 2 (LHDV2)	0.2129	0.1846	6.9998	4.4612
MEDIUM HEAVY DUTY DIESEL TRUCKS (MHDV)	2.8023	1.4354	45.1474	28.9518
HEAVY HEAVY DUTY DIESEL TRUCKS (HHDV)	7.9382	2.3631	130.7385	81.2957
MOTORCYCLES (MCY)	13.2738	12.9971	2.8732	2.968
HEAVY DUTY DIESEL URBAN BUSES (UB)	1.4939	0.9503	22.815	13.8606
HEAVY DUTY GAS URBAN BUSES (UB)	0.5037	0.3608	0.7837	0.5993
SCHOOL BUSES - GAS (SBG)	0.1652	0.0564	0.159	0.0905
SCHOOL BUSES - DIESEL (SBD)	0.1987	0.0556	2.7608	2.6324
OTHER BUSES - GAS (OBG)	0.2563	0.1951	0.6893	0.4768
OTHER BUSES - MOTOR COACH - DIESEL (OBC)	0.1152	0.0418	1.8819	1.3187
ALL OTHER BUSES - DIESEL (OBD)	0.1331	0.0366	2.0096	1.3025
MOTOR HOMES (MH)	0.3592	0.1873	1.5459	1.0353
ONROAD SUBTOTAL	**204.362**	**129.8125**	**386.8584**	**238.9911**
AIRCRAFT	6.6479	7.3643	19.3094	23.1663
TRAINS	1.7259	1.6439	27.4811	31.5763
OCEAN GOING VESSELS	2.4345	2.8651	43.3892	44.7496
COMMERCIAL HARBOR CRAFT	1.7765	1.6065	24.4509	17.241
RECREATIONAL BOATS	59.214	45.9426	11.082	9.7037
OFF-ROAD RECREATIONAL VEHICLES	5.3875	5.3041	0.0699	0.0869
OFF-ROAD EQUIPMENT	74.8926	63.8109	91.125	79.1006
FARM EQUIPMENT	1.5848	1.1923	6.1556	5.1207
FUEL STORAGE AND HANDLING	13.9977	10.8208	0	0
OFFROAD SUBTOTAL	**167.6614**	**140.5505**	**223.0631**	**210.7451**
PRE-BASELINE EMISSION REDUCTION CREDITS SUBTOTAL		0.75		0.61
TOTAL	**655.0644**	**553.4756**	**681.734**	**519.8032**

Source: ARB CEPAM emissions inventory, Version 1.04.

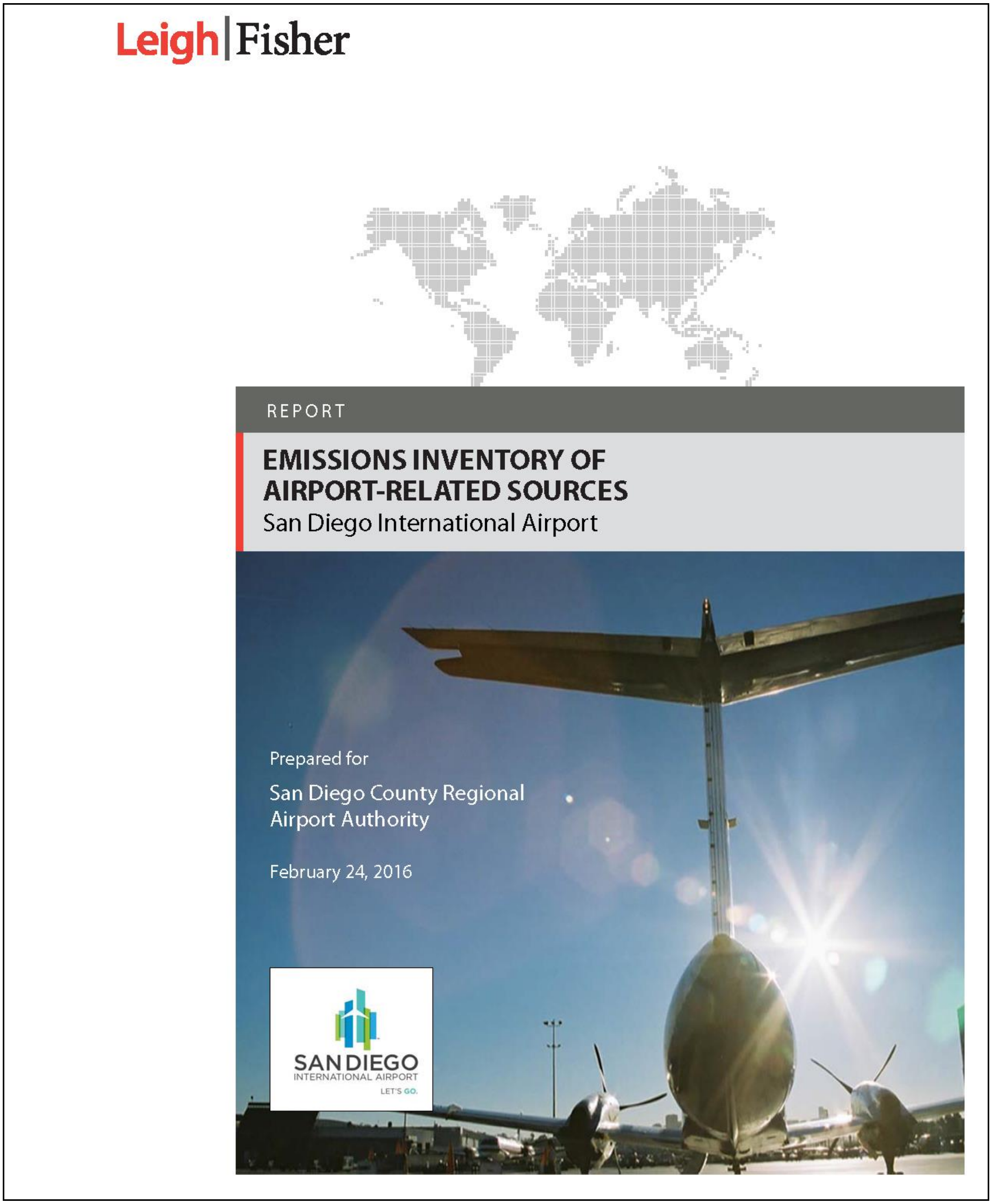
ATTACHMENT B
PLANNED MILITARY PROJECTS SUBJECT TO GENERAL CONFORMITY

TABLE B-1
Projected Emissions and Preliminary Schedule for USMC and DoN Projects through 2035

Year	Annual Emissions Change, tons per day	
	NO_X	VOC
2011	0.00	0.01
2012	0.25	0.04
2013	0.19	0.06
2014	0.19	0.00
2015	0.77	0.24
2016	0.35	0.04
2017	0.32	0.04
2018	0.32	0.04
2019	0.32	0.04
2020	0.39	0.04
2021	0.12	0.01
2022	0.30	0.01
2023	0.30	0.01
2024	0.30	0.01
2025	0.59	0.50
2026	0.12	0.001
2027	0.12	0.001
2028	0.12	0.001
2029	0.12	0.001
2030	0.12	0.001
2031	0.12	0.001
2032	0.12	0.001
2033	0.12	0.001
2034	0.12	0.001
2035	0.12	0.001
Total	**5.91**	**1.08**

Source: Letter to the District from the Department of the Navy and U.S. Marine Corps. February 29, 2016.

ATTACHMENT C
PLANNED SAN DIEGO INTERNATIONAL AIRPORT PROJECTS SUBJECT TO GENERAL CONFORMITY



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REPORT

EMISSIONS INVENTORY OF AIRPORT-RELATED SOURCES

San Diego International Airport

Prepared for

San Diego County Regional Airport Authority

February 24, 2016

SAN DIEGO INTERNATIONAL AIRPORT
LET'S GO.

LeighFisher

REPORT

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PREFACE

This study, conducted by the San Diego County Regional Airport Authority (the Authority), inventories the air pollutant emissions associated with operations and construction related to the San Diego International Airport (the Airport). It was undertaken in response to the California Air Resources Board (CARB) expectation that the San Diego Air Basin's ozone status will be reclassified to "moderate non-attainment." When this happens, San Diego County's Air Pollution Control District (APCD) will be required to prepare basin-wide emissions inventories for each ozone precursor, in support of revisions to the local ozone State Implementation Plan (SIP). The results from this study can be incorporated by APCD into the revisions being made to the local ozone SIP. They will represent the Airport's anticipated air pollution emissions through 2040. The methodology described in this document assumes that any future emission reduction initiatives, not explicitly accounted for in the modeling assumptions, would be considered voluntary actions. These voluntary actions could include, but are not limited to, installing remote ground power equipment, utilizing geothermal energy, purchasing electric or other alternative fuel vehicles and equipment, or reducing aircraft emissions.

EMISSION SOURCES:
All major sources of pollutant emissions at the Airport were reviewed in this study. The emission sources included:

- **Aircraft:** Takeoffs, landings, taxiing, power, and conditioned air needs
- **Ground Support Equipment:** Equipment supporting aircraft operations
- **Roadways:** Vehicular activity in, around, and enroute to / from the airport
- **Parking:** Vehicular activity in the Airport's parking structures
- **Construction:** Routine and growth construction projects to maintain and enhance Airport operations
- **Stationary Sources:** Boilers, emergency generators, fuel storage, and paint activities owned by the Authority

Emissions from training fires are not included in this study.

STUDY TIMEFRAME:
Emissions were estimated for five separate milestone years:

- Baseline Year—2012
- Forecast Year—2017
- Anticipated Attainment Year—2020
- Anticipated Maintenance Year—2030
- Anticipated Maintenance Year—2040

STUDY POLLUTANTS:
The focus of this study was specifically ozone and its precursors. However, whenever possible, emissions were estimated for the following EPA criteria air pollutants and precursors:

- Ozone
- Nitrogen oxides (precursor to ozone)
- Volatile organic compounds (precursor to ozone)
- Carbon monoxide
- Sulfur oxides
- Particulate pollution (often referred to as particulate matter) with aerodynamic diameters less than 10 (PM_{10}) microns and 2.5 microns ($PM_{2.5}$)

This study was prepared by LeighFisher, Inc. Questions related to this study should be directed to Darcy Zarubiak at 650-579-7722.

Emissions Inventory
San Diego International Airport
SAN680

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CONTENTS

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CONTENTS *(continued)*

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CONTENTS *(continued)*

1 INTRODUCTION

1.1 SAN DIEGO INTERNATIONAL AIRPORT

San Diego International Airport (the Airport) is owned and operated by the San Diego County Regional Airport Authority (the Authority). The Airport is located three miles west of the downtown business district, and is located on a 661-acre land-constrained site. As shown in Figure 1-1, it is bordered to the east by downtown San Diego; to the south by North Harbor Drive and the harbor itself; to the west by a marine channel and residential areas; and to the north by Interstate 5, the U.S. Marine Corps Recruit Depot, in addition to residential and other developments. Vehicle access is provided via Harbor Drive, for the 1.5-mile route, west of Interstate 5.

The Airport provides non-stop service to over 49 domestic and nine international destinations, with passenger service provided by 14 domestic carriers and five international carriers, including seven low-cost carriers. In addition, the Airport accommodates the majority of regional cargo demand via passenger airlines (belly cargo) and dedicated all-cargo air carriers.

The Airport is classified in the National Plan of Integrated Airport System (NPIAS) as a large-hub commercial service airport. Hub classifications are based on the number of passengers enplaned at the Airport, and a "large hub" classification means that the Airport accommodates at least 1.0 percent of total enplaned passengers in the United States, ranking it as one of the nation's busiest airports. The Airport is the busiest single-runway airport in the United States and has more than 190,000 annual aircraft operations.

The Authority is a leader in the San Diego community's efforts to be sustainable and strives to improve air quality in the region while maintaining the positive economic impacts and quality transportation services provided at the Airport. As such, the Authority is interested in ensuring that current and future criteria pollutant emissions emitted by Airport-related sources are properly represented in the emissions inventory of the California State Implementation Plan (SIP).

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Figure 1-1
SAN DIEGO INTERNATIONAL AIRPORT

Source: LeighFisher, February 2016.

1.2 THE CLEAN AIR ACT AND CRITERIA POLLUTANTS

Under the Federal Clean Air Act, the United States Environmental Protection Agency (EPA) has established health and environmentally protective standards for ozone in the air we breathe. EPA and others have instituted a variety of multi-faceted programs to meet these standards. The Clean Air Act requires EPA to set National Ambient Air Quality Standards (NAAQS) for six common air pollutants that can harm human health, the environment, and cause property damage. These commonly found air pollutants (also known as "criteria pollutants") are found all over the United States. They are ozone, nitrogen oxides (NO_X) and volatile organic compounds (VOCs), both of which are precursors to ozone, carbon monoxide (CO), sulfur oxides (SO_X), and particle pollution (often referred to as particulate matter) with aerodynamic diameters of 10 microns (PM_{10}) and 2.5 microns ($PM_{2.5}$), and lead. EPA calls these pollutants "criteria" air pollutants because it regulates them by developing human health-based and/or environmentally-based criteria (science-based guidelines) for setting permissible levels. Of these six pollutants, ground-level ozone and particulates are the most widespread health threats.

APCD
AIR POLLUTION CONTROL DISTRICT
COUNTY OF SAN DIEGO

The set of limits based on human health are called primary standards. Another set of limits intended to prevent environmental and property damage are called secondary standards. If the air quality in a geographic area meets or exceeds the national standard, it is called an attainment area; areas that don't meet the national standard are called nonattainment areas. In order to improve air quality, states must draft a SIP to improve the air quality in nonattainment areas. SIPs outline the measures that the state will take in order to improve air quality and contain "budgets" of emissions from various sources of air pollution. Once a nonattainment area meets the standards, EPA will re-designate the area to attainment, but it will require the area to demonstrate "maintenance" of the NAAQS standards for a subsequent 20-year period.

On March 12, 2009, the California Air Resources Board (CARB) proposed nonattainment boundaries pursuant to the 2008 8-hour ozone standard. These boundaries identified San Diego County (the County) as a marginal nonattainment area. The designation of 'marginal nonattainment' meant that the San Diego Air Pollution Control Board (APCD) was not required to develop a new SIP, instead the APCD was only required to adhere to the requirements of the December 5, 2012 maintenance plan for the 1997 8-hour standard covering the County. Based on the most recent air pollution measurements, the County is unlikely to attain the 2008 8-hour ozone standard and will be bumped up to moderate ozone nonattainment for the 2008 ozone standard. If this happens, APCD will be required to prepare revisions to the local ozone SIP to satisfy the Clean Air Act, §172(c)(3) and §182(a)(1), which includes emissions inventory reporting requirements for the San Diego nonattainment area under the 2008 8-hour ozone standard.

The County is also in maintenance for the NAAQS for CO. However, it is the local ozone SIP that is currently under revision.

1.3 IMPORTANCE OF OZONE EMISSIONS

What is ozone?

Ozone occurs both in the Earth's upper atmosphere (stratosphere) and at ground level (troposphere). Ozone is a gas composed of three atoms of oxygen and is a highly reactive molecule. Stratospheric ozone is created when ultraviolet (UV) radiation from sunlight strikes the air in the stratosphere, splitting oxygen molecules (O_2) into atomic oxygen (O). The atomic oxygen quickly combines with oxygen molecules to form ozone (O_3). Tropospheric ozone is formed near ground level when NO_X and VOC, emitted by fossil fuel combustion sources, undergo a series of complex interactions with UV radiation.

The formation of ground level ozone is conceptually illustrated in Figure 1-2.

Health Effects of Ozone

Near ground level, ozone is formed when pollutants emitted by cars, power plants, industrial boilers, refineries, chemical plants, and other sources chemically react in the presence of sunlight. Ozone at ground level is a harmful air pollutant.

Even relatively low levels of tropospheric ozone can cause adverse health effects. People with lung disease, children, older adults, and people who are active outdoors may be particularly sensitive to tropospheric ozone. Breathing ozone can trigger a variety of health problems including chest pain, coughing, throat irritation, and congestion. It can worsen bronchitis, emphysema, and asthma. Ground level ozone also can reduce lung function and inflame the linings of the lungs. Repeated exposure can permanently scar lung tissue.

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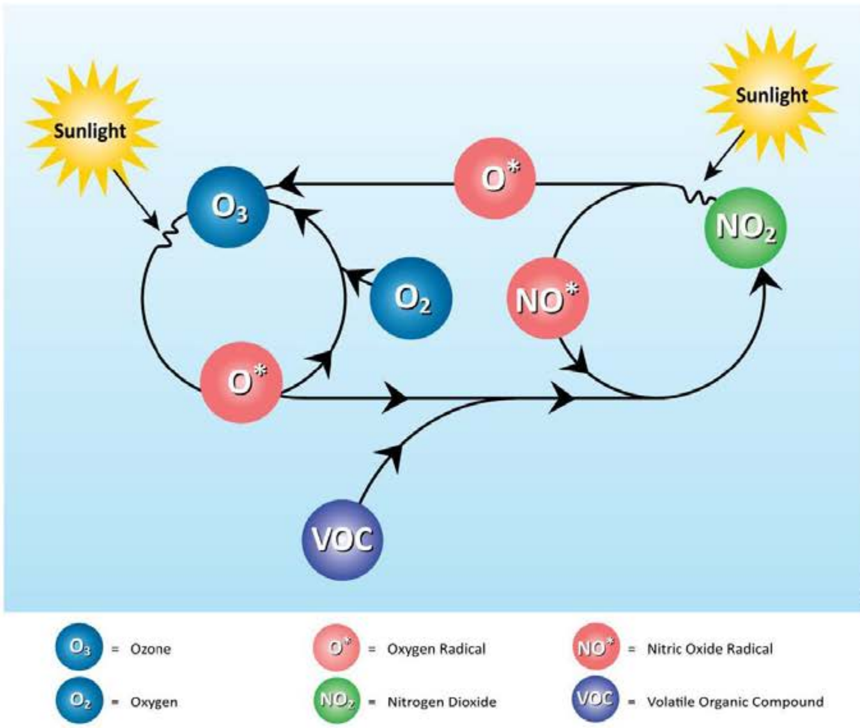
Figure 1-2
FORMATION OF GROUND LEVEL OZONE



Source: LeighFisher, May 2014.

The primary objective of this project is to ensure that an accurate and robust inventory of all on-Airport emission sources is included in the SIP so if the Federal Aviation Administration (FAA) makes a future environmental determination regarding a development project at the Airport, conformity can be demonstrated via the requirements of 40 CFR 93.158 (a) (1).

The purpose of this report is to present a comprehensive inventory of all Airport-related emission sources. The emissions inventory has been prepared with a goal to be included in the SIP and used to support the development of appropriate emission budgets for the County's emissions inventories.

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1.4 APPROACH

In developing the emissions inventory, the overarching goal was to ensure accuracy by using actual operational data, rather than air quality model defaults and assumptions, whenever appropriate. The overall approach to meeting this goal was based on the following:

- Interviewing Authority staff and relevant stakeholders
- Consulting Authority reports and operational records
- Utilizing commercial databases
- Utilizing FAA data
- Using forecasting studies already prepared for the Authority

The emission sources included in this inventory are:

Aircraft Engines: aircraft typically represent the largest category of on-airport sources of emissions, which occur during landing, departure, taxiing, and idling on taxiways and ramp areas.

Auxiliary Power Units (APUs): emissions generated by aircraft APUs occur most often when an aircraft is parked (1) at the gate, (2) at a cargo ramp, (3) at a remote hardstand, and (4) at a maintenance ramp or hangar.

Ground Support Equipment (GSE): encompasses all equipment that is needed to service aircraft on the ground during a normal turn around and primarily includes belt loaders and baggage tractors.

Other GSE includes catering trucks, pushback tractors, lavatory trucks, potable water trucks, airline support staff vehicles, and ground power units operated by fixed base operators (FBOs).

Roadways and Parking Facilities: roadway emissions include emissions throughout the air basin from Authority-owned, commercial, and private vehicles on trips to and from the Airport. Parking facility emissions refer to emissions from vehicles in Authority-owned parking facilities.

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Construction Activities: emissions resulting from routine and growth-related construction activities and regular maintenance are generally associated with the following types of construction projects:

- Demolition and construction of buildings
- Roadway pavement
- Garage structures
- Hangars
- Utility plants and distribution systems
- Roadway and transit structures
- Runway/taxiway repair

Stationary Sources: includes emissions associated with Authority-owned natural gas boilers and emergency diesel generators, Jet A fuel tank storage, and paint used for airfield marking.

Sections 3 to 8 describe the assumptions and methodology in computing emissions for each source group.

1.5 AIR QUALITY MODELING

As required by 40 CFR 93.159(d), the County is statutorily required to provide emissions inventories for each precursor and nonattainment pollutant at the Airport. As agreed to by APCD staff on February 25, 2015, emissions were calculated for the following SIP milestone years:

- Baseline Year—2012
- Forecast Year—2017
- Anticipated Attainment Year—2020
- Anticipated Maintenance Year—2030
- Anticipated Maintenance Year—2040

Actual ozone and ozone precursor inventories were prepared for the 2012 Baseline Year, while forecast emission inventories were prepared for ozone and each ozone precursor for the 2017 Forecast Year, the Anticipated Attainment year, and the two Anticipated Maintenance years.

Although the Airport is not located in an area designated as nonattainment or maintenance for any other criteria air pollutant than ozone and CO, emission estimates for other criteria air pollutants were provided as available.

Accordingly, emissions inventories were prepared for the following EPA criteria air pollutants and precursors, whenever possible:

- Ozone
- NO_X (precursor to ozone)
- VOC (precursor to ozone)
- CO
- SO_X
- PM_{10}
- $PM_{2.5}$

Some sources used to estimate emissions did not report PM_{10} and/or $PM_{2.5}$, but instead reported Particulate Matter (PM) or Total Suspended Particulate (TSP). PM and TSP are assumed to be equivalent, and define as particulate matter with an aerodynamic diameter less than 30 microns.

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A variety of tools were used to calculate Airport-related emissions, primarily FAA's Emissions and Dispersion Modeling System (EDMS). However whenever possible, to ensure accurate results, actual operational data was used rather than relying default model values.

* * * * *

This report provides a brief overview of the concepts, methodology, data inputs, and summarizes emission results for various scenarios modeled to support the development of the ozone inventory for the Airport. The report has been structured so that the emissions calculation methodologies and assumptions are summarized for every major source group of Airport-related emissions. Additional data is provided in the individual appendices for each emission source group.

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2 METHODOLOGY

2.1 MODELING TOOLS

This emissions inventory was developed for Airport-related sources using FAA's EDMS program, minimally using FAA's Aviation Environmental Design Tool (AEDT) program, and using additional models and databases to attain more accurate emission information when needed. Aircraft operation emissions, APU emissions, and stationary source emissions (Chapters 3, 4, and 8, respectively) were modeled exclusively with FAA tools EDMS and AEDT. GSE emissions (Chapter 4) were modeled using a combination of EDMS and the CARB 2011 Inventory Model for Off-Road Emissions (OFFROAD). Parking and roadways, and construction-related emissions, were the only Airport-related sources modeled with no reliance on EDMS. Parking and roadways were modeled using data from CARB's EMFAC 2014 database (EMFAC), and construction-related emissions were modeled using data from the OFFROAD model and the Airport Construction Emissions Inventory Tool (ACEIT), an FAA-designed tool specific for construction activities at airports.

2.1.1 Emissions and Dispersion Modeling System (EDMS)

EDMS was designed to assess the air quality impacts of airport emission sources, particularly aviation sources. Historically, its use has been required by the FAA when assessing aviation emission sources at airports* and has been recognized by the EPA** as a preferred tool for modeling aircraft emissions. As of May 29th, 2015, FAA now requires the use of AEDT when assessing aviation emission sources at airports. However, the use of EDMS for this project started in March 2015, prior to the release of AEDT, and is consistent with FAA's policy on using AEDT only for new modeling efforts. AEDT was minimally used for the Forecast Years to estimate emissions from aircraft that are not included in EDMS–specifically the Airbus A320-NEO and the Boeing 737-MAX.

The FAA developed EDMS in the mid-1980s in cooperation with the United States Air Force. The model has become increasingly sophisticated over time and provides users with the ability to conduct emission inventories and dispersion analysis for all of the major emission sources in an airport environment. EDMS develops time- and location-varying emissions from mobile sources, such as, aircraft engines, APUs, GSE, ground access vehicles, training fires, and stationary sources, such as generators, commercial kitchens, cooling towers, boilers, and bulk liquid storage tanks. EDMS incorporates specific details on types of aircraft and typical aircraft schedules for taxi, takeoff and landing to develop a more precise representation of airport emissions.

Figure 2-1 graphically illustrates the components of FAA's EDMS.

2.1.2 Other Tools

- **OFFROAD:** CARB's OFFROAD model's emission factors were used to model GSE and construction emissions, respectively. The model contains detailed data about California's off-road vehicle fleet, by air basin, for four categories: Airport Ground Support, Construction and Mining, Industrial, and Oil Drilling. Each category has data related to the unique equipment specific to that category. Key data, such as assumed age, horsepower, load factor, annual emissions, and air basin made it possible to calculate emission factors more accurately for the GSE and construction equipment at the Airport rather than using the EDMS defaults.

*Federal Register, Volume 63, No. 70, April 13, 1998.
***Guidelines on Air Quality Models (Revised) with Supplements A and B*, EPA-450/2-78-027R, U.S. Environmental Protection Agency, July 1, 1997. Codified in 40 CFR Part 51, Appendix W.

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- **ACEIT:** ACEIT is a tool that was developed as part of an Airport Cooperative Research Program (ACRP) project on estimation of airport construction emissions (ACRP Report 102, Guidance for Estimating Airport Construction Emissions, 2014). It contains a listing of construction equipment with key default operating parameters - horsepower, load factor, and operating time (annual hours) – that are specific to airport projects.
- **EMFAC:** EMFAC 2014 is the most recently available estimate of on-road vehicle emissions in California with county-level emissions for 42 classes of vehicles. EMFAC uses emission coefficients for criteria air pollutants and has assumptions regarding the mix of vehicle types, age, fuels, and driving speeds that are specific to San Diego County. It also includes assumptions for combustion, resting loss/evaporation, and particulates from brake and tire degradation.

2.2 COMPUTATION METHODS

2.2.1 EDMS

Aircraft-related emissions and stationary source emissions were inventoried using EDMS. EDMS has an internal database of emission factors for airport pollutant sources for all criteria air pollutants. These emission factors are typically in units of mass per unit of time or distance (e.g., grams/second, or grams/mile). The EDMS database of emission factors reflects differences in emissions based on fuel type, fuel burn, engine power load, manufacture year, and manufacturer, among many other characteristics.

These emission factors are used by EDMS to calculate a total estimated emission inventory for a specified time period by multiplying the emission factor for the particular source, by the time, distance, or number of events input by the user. The result is the estimated total emissions for each source group and ultimately total estimated emissions for the study period.

Airport-specific information such as latitude and longitude coordinates of the official Airport Reference Point (ARP) and elevation of the ARP above sea level are provided within EDMS. All other Airport-specific information must be estimated and input into the program.

2.2.2 Other Methods

Emissions not directly related to aircraft were modeled by obtaining detailed information about the emission factors and operating parameters specific to each piece of equipment. The key operating parameters required to estimate emissions were:

- **Age:** as the equipment gets older the engine can degrade and emit more pollutants, and tightening emission standards over the years has greatly reduced emissions, and continues to do so.
- **Horsepower:** the power rating of the engine. Generally speaking, as the horsepower increases, so do the emissions.
- **Load Factor**: refers to the time-weighted average of engine utilization relative to full power.
- **Operating Time:** refers to the annual utilization time of the equipment. Depending on the type of equipment, it can be in annual hours or annual miles travelled.

When a piece of equipment's operating parameters and emissions factor were known, emissions were estimated by the following formula:

Annual Emissions *= Population x* HP_{avg} *x Load Factor x Annual Hours x Emissions Factor (g/HP-Hr)*

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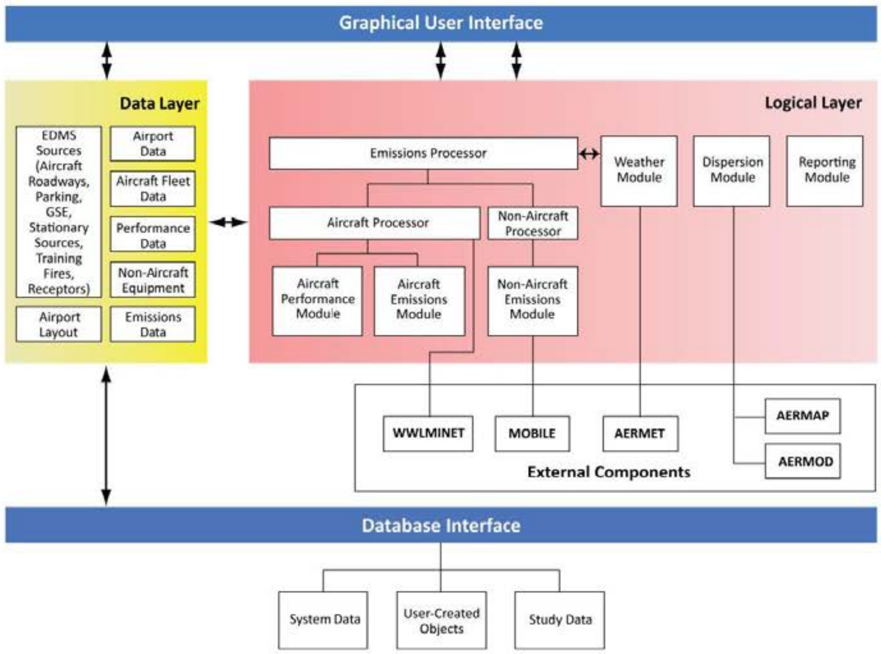
Figure 2-1
EMISSIONS AND DISPERSION MODELING SYSTEM



Source: Federal Aviation Administration.

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3 AIRCRAFT OPERATIONS

3.1 INTRODUCTION

Aircraft emissions typically represent the largest portion of emissions from any category of on-airport sources for most criteria air pollutants. To estimate emissions from aircraft sources, a series of operational data must be collected for model inputs.

Typically, these inputs include 1) aircraft operations (individual takeoff and landing), 2) unique aircraft frame type and engine model combinations (fleet mix), 3) operating time in the air, and 4) taxiing time.

The data for this analysis was gathered from a variety of sources, including:

- **FAA OPSNET Data (OPSNET):** the official source of National Air System (NAS) air traffic operations and delay data. OPSNET indicates how many operations occur annually by aircraft category. The OPSNET aircraft categories are:

  a) Air Carrier: an aircraft with seating capacity of more than 60 seats or a maximum payload capacity of more than 18,000 pounds carrying passengers or cargo for hire or compensation.

  b) Air Taxi: aircraft designed to have a maximum seating capacity of 60 seats or less or a maximum payload capacity of 18,000 pounds or less carrying passengers or cargo for hire or compensation.

  c) General Aviation: takeoffs and landings of all civil aircraft, except those classified as air carriers or air taxis.

  d) Military: all classes of military takeoffs and landings at FAA and FAA-contracted facilities.

- **San Diego Airport's Noise Monitoring System (NMS):** a system that records flight data for aircraft operations at the Airport. Data fields captured include an aircraft's tail number, airline, aircraft type, operation time, and operation origin/destination. Some operations have missing data fields.

- **JP Airline-Fleets International (JP-Fleets):** a catalogue listing aircraft frame type and engine model configurations for airlines, air taxi services, large non-commercial government, and corporate operators.

- **FAA Aircraft Registration Database (FAREDA):** a system that maintains registrations of United States civil aircraft, and includes aircraft frame type and engine model.

- **FAA Aviation System Performance Metrics (ASPM):** an FAA system that provides average taxi times for aircraft at federalized airports in the United States.

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3.1.1 Aircraft Operations

The standard EDMS input is the number of total annual operations for each unique aircraft-engine combination. Annual operations for historical years are recorded in OPSNET, and forecast year operations are based on professional judgment and consultant forecasts. Aircraft operations in this report are segmented into Passenger, Cargo, General Aviation, and Military. Final emission estimates are also summarized by aircraft engine type (jet or piston), as requested by APCD. Emissions will be incorporated into the SIP by engine type.

3.1.2 Fleet Mix (Aircraft Frame Type & Engine Model)

The fleet mix represents the specific aircraft frame type and engine combinations that operate at the Airport in a given year.

Matching operations to the correct aircraft and engine model is essential to accurately estimate emissions from aircraft operations. EDMS estimates emissions based on a specific aircraft type matched with a specific engine model. EDMS provides a suggested default engine model for most aircraft types. However, for the most accurate estimate it is important to identify the actual engines that an airline has chosen to use for an aircraft. This is made possible given that the NMS data includes aircraft tail numbers that can be referenced in JP-Fleets and FAREDA to determine each operation's aircraft frame type and engine model.

3.1.3 Airborne Mode and Ground Mode Operating Times

As discussed in Section 2, EDMS models aircraft landing-takeoff cycles in six modes of operation. Airborne modes include approach, takeoff, and climb out, and ground modes include taxi-in, startup, and taxi-out. The modes "taxi-out" and "taxi-in" have identical emission factors, as well as any time spent idling, which uses the same emission factors and is often referred to as the "taxi/idle" mode.

EDMS uses two different methods of calculating emissions from the airborne modes of operation (climb out, approach, and takeoff):

1. Static operating times developed by the International Civil Aviation Organization and EPA.
2. Dynamic operating times using the methodology presented in the Society of Automotive Engineers Aerospace Information Report 1845.

Since the FAA mandates the use of the dynamic performance model for airport analyses, the internal dynamic performance module in EDMS was used to compute times-in-mode. This module is also more precise and takes into account aircraft frame type, engine, weight, approach angle, elevation, and weather. However, the module does not take into account any delay due to queuing or congestion in the airspace.

3.1.4 Taxi Times

Aircraft taxiing times can be broken down into two components—unimpeded and delay. Unimpeded taxi time represents the time that it would take an aircraft to (1) taxi from the arrival runway to the gate, and (2) depart from the terminal to the departure runway without being delayed by other aircraft. Annual average taxi-in and taxi-out times were obtained from FAA's ASPM database for 2012. The annual average taxi times include the unimpeded taxi time and any associated delay, and are applicable to both runway ends.

3.2 EMISSIONS METHODOLOGY FOR THE BASELINE YEAR

The methodology for estimating emissions in the baseline year (2012) is described below.

3.2.1 Aircraft Operations for the Baseline Year

OPSNET indicated there were 187,314 aircraft operations at the Airport in 2012, which were recorded as: Air Carrier, Air Taxi, General Aviation, and Military. However, to align with the Airport Development Plan's growth forecast, and to assign accurate APU times to aircraft (discussed in detail in chapter 4), the OPSNET operations had to be segmented into the following four report categories: Passenger, Cargo, General Aviation, and Military. The methodology to distribute OPSNET operations into report categories is as follows:

1. **Determine total operations for the baseline year:** the total number of annual operations for air carrier, air taxi, general aviation, and military were acquired from OPSNET, and are listed in Table 3-1.
    a. Air carrier and air taxi operations are a combination of passenger and cargo aircraft.
    b. General Aviation and Military operations do not overlap with another category.

Table 3-1
BASELINE ANNUAL OPERATIONS

Year	Air Carrier	Air Taxi	General aviation	Military	**Total**
2012	151,790	24,940	9,918	666	**187,314**

Source: OPSNET.

2. **Distribute OPSNET operations into the four report categories:** The NMS data was used to accomplish this by segmenting NMS operations into two separate category types:
    a. **Air carrier or air taxi**, based on the NMS operation's aircraft frame type.
    b. **Commercial, cargo, or General Aviation**, based on the NMS operation's airline. General aviation included all operations that were not identified as a commercial or cargo operation.

Table A-1 and A-2 in Appendix A list the passenger and cargo airlines, and air carrier and air taxi airframe types, respectively.

With the commercial-to-cargo ratios, the OPSNET air carrier and air taxi operations could be distributed into passenger and cargo operations. General Aviation and Military operations remained as listed in OPSNET. Table 3-2 presents this process and the aircraft operations by report category used for the baseline year.

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Table 3-2
ANNUAL OPERATIONS BY REPORT CATEGORY

OPSNET	Air Carrier		Air Taxi		General aviation	Military	Total
	151,790		24,940		9,918	666	187,314
NMS Breakdown	***Passenger*** *98%*	***Cargo*** *2%*	***Passenger*** *94%*	***Cargo*** *6%*			
OPSNET x NMS %	*148,754*	*3,036*	*23,444*	*1,496*			
Report Operations	**Passenger** **172,198**		**Cargo** **4,532**		**General aviation** **9,918**	**Military** **666**	**Total** **187,314**

Source: OPSNET, NMS, LeighFisher, February 2016.

3.2.2 Aircraft Fleet Mix for the Baseline Year

The fleet mix, i.e., aircraft frame types and engine combinations, for the baseline year was derived from the NMS data and two aircraft data sources: (1) JP Fleets and (2) FAREDA. JP Fleets was used as the primary source due to its greater amount of detail. The tail numbers from the NMS data were matched to JP Fleets or FAREDA to determine the specific aircraft frame type and engine model. Overall, there were a total of 39 aircraft frame types, and a total of 71 aircraft frame types and engine combinations.

A total of 11% of operations from the NMS data were excluded from the fleet mix analysis—six percent of operations listed in the NMS data had no tail number, and five percent of NMS operations were excluded for one of the following reasons:

1. No match was found in the aircraft databases (JP-Fleets or FAREDA).
2. No logical match could be made to an aircraft in EDMS.
3. General aviation aircraft with fewer than 10 annual operations were excluded because they represented a small fraction of operations, and due to inconsistencies in the databases naming conventions, were frequently already represented in the flight mix under a different nomenclature.

Fleet mix for the four primary report categories was determined using the following sources:

1. Passenger: NMS and JP-Fleets
2. Cargo: NMS and JP-Fleets
3. General Aviation: NMS, JP-Fleets, and FAREDA
4. Military: Professional Judgment. Military aircraft accounted for only 666 operations in OPSNET (0.36%). Given the small number of military operations and a lack of available data on military aircraft types used at the Airport, all military operations were assumed to take place in C130s with the EDMS default engine.

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Professional judgment was used to determine which aircraft are powered by jet engine and which aircraft are powered by piston engine. Based on input from APCD, turboprop aircraft were categorized as being powered by a piston engine, even if not powered by Aviation Gasoline (Avgas). Information describing the engine type for each aircraft is presented in Tables A-3 through A-5 in the appendix, and below is a list of aircraft included in the category of piston-powered.

Aircraft Classified as Powered by a Piston Engine

- Bombardier de Havilland Dash 8 Q400
- Cessna 172 Skyhawk *(a)*
- Cessna 208 Caravan
- Embraer EMB120 Brasilia
- Piaggio P.180 Avanti
- Pilatus PC-12
- Piper PA46-TP Meridian
- Raytheon Super King Air 200
- Raytheon Super King Air 300

(a) The Cessna 172 Skyhawk is the only aircraft in this list that is fueled with Aviation Gasoline (Avgas).

Given the large number of NMS data operations that could be matched to an aircraft database and a defensible EDMS aircraft/engine configuration (approximately 89%), it was determined that this methodology provided an accurate fleet mix. The resulting fleet mix, with all aircraft and engine combinations, and their proportion of annual operations, is presented by category in Appendix A, Tables A-3 through A-5.

Once a defensible fleet mix with aircraft, engine model, and proportional representation was established, the report category annual operations (Table 3-2) were proportionally distributed to each unique aircraft-engine combination, and are listed in Appendix A, Tables A-6 through A-8.

3.2.3 Airborne Operating Times for the Baseline Year

As stated in this chapter's introduction, the internal dynamic performance module in EDMS was used to compute times-in-mode for airborne operating times.

3.2.4 Taxi Times for the Baseline Year

As stated in this chapter's introduction, annual average taxi-in and taxi-out times were obtained from FAA's ASPM database for 2012. As the Airport's terminal complexes are centrally located with respect to the runway, it was assumed that the average taxi-in and taxi-out times were the same for all aircraft types and airport gates. According to ASPM, the average taxi-in and taxi-out times were 3.78 minutes and 13.37 minutes, respectively.

3.3 EMISSIONS METHODOLOGY FOR FORECAST YEARS

Emissions for the forecast years (2017, 2020, 2030, 2040) were estimated as described below.

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3.3.1 Aircraft Operations for Forecast Years

Forecasts from the San Diego International Airport Development Plan were used to estimate the number of aircraft operations in forecast years by report category, and are presented in Table 3-3.

Table 3-3
ANNUAL OPERATIONS BY AIRCRAFT CATEGORY FOR FORECAST YEARS

Year	Passenger	Cargo	General aviation	Military	Total
2017	178,406	7,098	11,162	700	197,366
2020	185,270	7,441	11,492	700	204,903
2030	208,281	8,648	12,581	700	230,210
2040	228,298	9,283	13,536	700	251,817

Source: San Diego International Airport Development Plan.

3.3.2 Fleet Mix for the Forecast Years

3.3.2.1 Passenger Fleet Mix for Forecast Years

Detailed information for the passenger category was available in the Airport Development Plan, and included the percentage of annual operations attributed to each aircraft type. The aircraft/engine composition for the forecast years was the same proportion as used in the baseline year.

Over the study timeframe (2012 through 2040), certain passenger aircraft are removed from the fleet mix as they age and are replaced with newer aircraft. Table 3-4 lists the passenger aircraft expected to be retired during the study timeframe. The A320NEO, the A350, the B737MAX, and an increase in the number of B787s are expected to replace the aircraft being retired. As EDMS does not include data for the A320NEO or the B737MAX, the operations associated with those aircraft were modeled with AEDT.

The annual operations by unique aircraft-engine combination are listed in Appendix A, Table A-2.

Table 3-4
PASSENGER AIRCRAFT TO BE RETIRED DURING STUDY TIMEFRAME

A320	CRJ-100/200
B717	MD-80/90
B737-300/400/500	Q400
B757-200/300	

Source: LeighFisher, February 2016.

3.3.2.1 Cargo, General Aviation, and Cargo Fleet Mix for Forecast Years

The baseline fleet mix for Cargo, General Aviation, and Military was used for the forecast years.

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3.2.3 Airborne Operating Times for Forecast Years

Similar to the baseline year's airborne times, the internal dynamic performance module in EDMS was used to compute times-in-mode for airborne operating times. No changes were made to airborne times throughout the study timeframe.

3.3.4 Taxi Times for Forecast Years

Given that the physical layout of the runway and taxiways at the Airport are not expected to change in the study timeframe, it was assumed that taxi-in and taxi-out times, including delay time, remain unchanged at 3.78 minutes and 13.37 minutes, respectively.

3.4 ESTIMATED EMISSIONS

Table 3-5 and Figure 3-1 presents the total aircraft emissions for the baseline and forecast years. Tables 3-6 and 3-7 present the emissions by jet engine and piston engine, respectively, and will be the emission values incorporated into the SIP. Tables 3-8 through 3-12 present the emissions by aircraft market category and mode (airborne or ground) for each study year.

Table 3-5
TOTAL EMISSIONS FROM AIRCRAFT OPERATIONS
(Tons)

Year	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012	787.4	123.3	652.6	77.8	11.6	11.6
2017	900.5	136.0	693.1	85.8	12.6	12.6
2020	975.7	142.4	725.7	91.8	14.1	14.1
2030	1,203.7	162.5	849.9	110.3	19.7	19.7
2040	1,405.5	177.6	973.5	127.2	24.6	24.6

Source: LeighFisher, February 2016.

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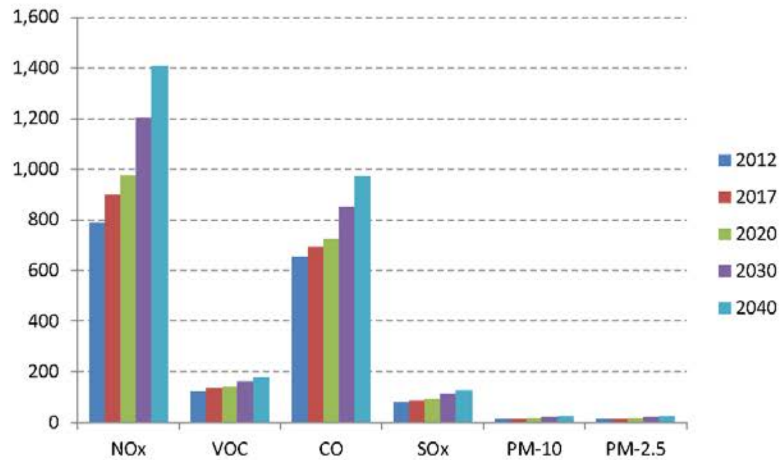
Figure 3-1
TOTAL AIRCRAFT EMISSIONS



Source: LeighFisher, February 2016.

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Table 3-6
JET AIRCRAFT ENGINE EMISSIONS – FOR INCLUSION INTO CALIFORNIA SIP
(Tons)

Year	Mode	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012	Airborne	673.7	10.5	73.3	45.6	7.0	7.0
	Ground	109.9	109.9	554.0	31.2	4.5	4.5
	Total	**783.5**	**120.3**	**627.4**	**76.9**	**11.4**	**11.4**
2017	Airborne	776.4	11.1	75.8	51.2	7.8	7.8
	Ground	121.5	121.6	598.5	34.0	4.7	4.7
	Total	**897.9**	**132.7**	**674.4**	**85.1**	**12.5**	**12.5**
2020	Airborne	846.5	11.7	82.2	55.8	9.1	9.1
	Ground	127.3	127.4	628.3	35.5	4.8	4.8
	Total	**973.8**	**139.2**	**710.6**	**91.3**	**14.0**	**14.0**
2030	Airborne	1,060.4	14.1	108.4	70.4	14.6	14.6
	Ground	142.4	144.9	731.2	39.6	5.1	5.1
	Total	**1,202.8**	**158.9**	**839.6**	**110.0**	**19.6**	**19.6**
2040	Airborne	1,250.3	16.0	133.2	83.8	19.3	19.3
	Ground	154.9	159.1	832.4	43.2	5.3	5.3
	Total	**1,405.2**	**175.2**	**965.5**	**127.0**	**24.6**	**24.6**

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

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Table 3-7
PISTON AIRCRAFT ENGINE EMISSIONS – FOR INCLUSION INTO CALIFORNIA SIP
(Tons)

Year	Mode	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012	Airborne	2.2	0.6	5.2	0.4	0.1	0.1
	Ground	1.6	2.3	20.0	0.6	0.1	0.1
	Total	**3.8**	**2.9**	**25.3**	**1.0**	**0.1**	**0.1**
2017	Airborne	1.5	0.7	4.0	0.3	>0.0	0.0
	Ground	1.1	2.6	14.7	0.4	0.1	0.1
	Total	**2.6**	**3.3**	**18.7**	**0.7**	**0.1**	**0.1**
2020	Airborne	1.1	0.7	3.4	0.2	>0.0	>0.0
	Ground	0.8	2.5	11.7	0.3	0.1	0.1
	Total	**1.9**	**3.2**	**15.1**	**0.5**	**0.1**	**>0.**
2030	Airborne	0.6	0.8	2.6	0.1	>0.0	>0.0
	Ground	0.3	2.8	7.7	0.2	0.1	0.1
	Total	**0.9**	**3.6**	**10.2**	**0.3**	**0.1**	**0.1**
2040	Airborne	0.3	0.6	2.2	0.1	>0.0	>0.0
	Ground	0.1	1.8	5.7	0.1	>0.0	>0.0
	Total	**0.3**	**2.4**	**8.0**	**0.1**	**>0.0**	**>0.0**

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

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Table 3-8
2012 AIRCRAFT EMISSIONS
(Tons)

Market Category	Mode	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
Passenger	Airborne	618.5	7.1	66.6	42.6	6.4	6.4
	Ground	105.4	80.1	501.4	29.7	3.8	3.8
	Total	723.9	87.2	568.0	72.3	10.3	10.3
Cargo	Airborne	51.2	0.9	4.2	2.7	0.4	0.4
	Ground	4.4	13.9	41.7	1.4	0.4	0.3
	Total	55.7	14.8	45.9	4.1	0.8	0.8
General Aviation	Airborne	5.5	2.9	7.4	0.6	0.2	0.2
	Ground	1.5	16.9	29.1	0.6	0.3	0.3
	Total	7.0	19.8	36.5	1.3	0.5	0.5
Military	Airborne	0.6	0.2	0.4	0.1	>0.0	>0.0
	Ground	0.2	1.2	1.9	0.1	>0.0	>0.0
	Total	0.9	1.4	2.3	0.2	.0.0	.0.0
	Total Airborne	675.8	11.1	78.6	46.0	7.0	7.0
	Total Ground	111.5	112.2	574.1	31.8	4.6	4.6
	Total 2012 Emissions	787.4	123.3	652.6	77.8	11.6	11.6

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

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Table 3-9
2017 AIRCRAFT EMISSIONS
(Tons)

Market Category	Mode	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
Passenger	Airborne	711.6	7.3	66.3	47.5	7.1	7.1
	Ground	115.5	87.9	529.8	32.0	4.0	4.0
	Total	827.1	95.2	596.1	79.5	11.1	11.1
Cargo	Airborne	59.4	1.1	4.9	3.1	0.5	0.5
	Ground	5.2	16.2	48.7	1.6	0.4	0.4
	Total	64.6	17.3	53.6	4.7	0.9	0.9
General Aviation	Airborne	6.2	3.3	8.3	0.7	0.2	0.2
	Ground	1.7	18.9	32.7	0.7	0.4	0.4
	Total	7.9	22.1	40.9	1.4	0.6	0.6
Military	Airborne	0.7	0.2	0.4	0.1	>0.0	>0.0
	Ground	0.2	1.2	2.0	0.1	>0.0	>0.0
	Total	0.9	1.5	2.4	0.2	>0.0	>0.0
	Total Airborne	777.9	11.8	79.9	51.4	7.8	7.8
	Total Ground	122.6	124.2	613.2	34.4	4.8	4.8
	Total 2017 Emissions	900.5	136.0	693.1	85.8	12.6	12.6

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

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Table 3-10
2020 AIRCRAFT EMISSIONS
(Tons)

Market Category	Mode	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
Passenger	Airborne	778.5	7.7	71.6	51.9	8.4	8.4
	Ground	120.8	92.4	553.5	33.3	4.1	4.1
	Total	899.2	100.1	625.1	85.2	12.5	12.5
Cargo	Airborne	62.1	1.1	5.1	3.2	0.5	0.5
	Ground	5.4	16.9	50.9	1.7	0.4	0.4
	Total	67.5	18.0	56.0	4.9	1.0	1.0
General Aviation	Airborne	6.4	3.4	8.5	0.7	0.2	0.2
	Ground	1.7	19.4	33.6	0.7	0.4	0.4
	Total	8.1	22.8	42.2	1.5	0.6	0.6
Military	Airborne	0.7	0.2	0.4	0.1	>0.0	>0.0
	Ground	0.2	1.2	2.0	0.1	>0.0	>0.0
	Total	0.9	1.5	2.4	0.2	>0.0	>0.0
	Total Airborne	847.6	12.4	85.6	56.0	9.1	9.1
	Total Ground	128.1	130.0	640.0	35.8	4.9	4.9
	Total 2020 Emissions	975.7	142.4	725.7	91.8	14.1	14.1

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

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Table 3-11
2030 AIRCRAFT EMISSIONS
(Tons)

Market Category	Mode	NO_X	VOC	CO	SO_X	PM_{10}	$PM_{2.5}$
Passenger	Airborne	981.2	9.6	95.2	65.9	13.7	13.7
	Ground	134.3	105.5	640.9	36.9	4.2	4.2
	Total	1,115.6	115.1	736.2	102.8	17.9	17.9
Cargo	Airborne	72.1	1.3	6.0	3.8	0.6	0.6
	Ground	6.3	19.7	59.2	2.0	0.5	0.5
	Total	78.4	21.0	65.1	5.7	1.1	1.1
General Aviation	Airborne	7.0	3.7	9.3	0.8	0.2	0.2
	Ground	1.9	21.3	36.8	0.8	0.4	0.4
	Total	8.9	25.0	46.2	1.6	0.6	0.6
Military	Airborne	0.7	0.2	0.4	0.1	>0.0	>0.0
	Ground	0.2	1.2	2.0	0.1	>0.0	>0.0
	Total	0.9	1.5	2.4	0.2	>0.0	>0.0
	Total Airborne	1,061.0	14.8	110.9	70.5	14.6	14.6
	Total Ground	142.7	147.7	738.9	39.7	5.1	5.1
	Total 2030 Emissions	**1,203.7**	**162.5**	**849.9**	**110.3**	**19.7**	**19.7**

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

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Table 3-12
2040 AIRCRAFT EMISSIONS
(Tons)

Market Category	Mode	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
Passenger	Airborne	1,162.7	11.0	118.4	78.7	18.4	18.4
	Ground	145.8	115.2	731.3	40.2	4.3	4.3
	Total	1,308.5	126.1	849.7	118.9	22.7	22.7
Cargo	Airborne	79.7	1.4	6.6	4.2	0.7	0.7
	Ground	6.9	21.7	65.2	2.2	0.6	0.6
	Total	86.5	23.1	71.8	6.3	1.2	1.2
General Aviation	Airborne	7.5	4.0	10.0	0.9	0.2	0.2
	Ground	2.0	22.9	39.6	0.9	0.4	0.4
	Total	9.5	26.8	49.6	1.7	0.7	0.7
Military	Airborne	0.7	0.2	0.4	0.1	>0.0	>0.0
	Ground	0.2	1.2	2.0	0.1	>0.0	>0.0
	Total	0.9	1.5	2.4	0.2	>0.0	>0.0
	Total Airborne	1,250.5	16.6	135.4	83.9	19.3	19.3
	Total Ground	155.0	161.0	838.1	43.3	5.3	5.3
	Total 2040 Emissions	**1,405.5**	**177.6**	**973.5**	**127.2**	**24.6**	**24.6**

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

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4 AUXILIARY POWER UNITS

4.1 INTRODUCTION

Auxiliary Power Units (APUs) are on-board generators that provide electrical power to an aircraft while its engines are shut down. These generators supply the aircraft with power for comfort heating and cooling, lights, and electronics as well as pressurized air for restarting the jet engines.

If the aircraft is parked at a gate that can provide preconditioned air (PCA) and ground power—an "electrified" gate—then the aircraft's APU can be turned off while loading and unloading passengers. The APU, in effect, serves as a small jet engine and the calculations for the emissions generated by it are similar to those of an aircraft engine operating in one power setting only.

Typical PCA and ground power units are shown in the graphic below.

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4.2 AIRCRAFT/APU COMBINATION

Within EDMS there is an extensive list of aircraft/APU combinations. When detailed information could not be obtained from the airlines, the default APU type was used, as defined by EDMS for each aircraft type. Based on NMS data, EDMS data, and manufacturer research, there were certain aircraft that were equipped with an APU but did not have a default APU in EDMS. When an aircraft type was known to have an APU but the specific APU type was unknown and EDMS did not have a default APU for the aircraft type, either the APU with the lowest horsepower rating in EDMS was used, the GTCP 36-100 APU, or professional judgment was used to assign a more appropriate APU. Aircraft that had an APU assigned to it based on professional judgment included:

Aircraft	Assumption
Airbus A320-NEO	Same APU as Airbus A320-200
Airbus A350 *(a)*	Same APU as Boeing 777
Boeing 737-MAX *(a)*	Same APU as Boeing 737-900
Boeing 787-800	Same APU as Boeing 777
Boeing 787-900	Same APU as Boeing 777

(a) As mentioned in Chapter 3, the Airbus A320-NEO and Boeing 737-MAX were not listed in EDMS, and the aircraft operations associated with them were modeled in AEDT. However, because AEDT had no default APU for these aircraft and they were assumed to have the same APU as the A320-200 and B737-900, their APU emissions were modeled in EDMS.

4.3 APU TIMES COMPUTATION METHODOLOGY

4.3.1 Passenger Aircraft

For passenger aircraft operations, the time that an APU unit operates depends on the time that an aircraft spends on the ground with the main engines shut down (also known as gate occupancy time) and whether there is PCA/ground power at the gate.

If a passenger gate is equipped with PCA and ground power, then the APU operates for a minimum period during the start-up, shutdown processes, and push back of the aircraft. FAA guidance recommends a default operating time of seven minutes of APU use per landing-and-takeoff (LTO) cycle for all aircraft parked at gates that provide PCA and electricity (3.5 minutes for attaching PCA hoses and electrical power cables and 3.5 minutes for disconnecting the equipment and pushing back the aircraft.)

For passenger gates that are not electrified, there would be higher APU operating times. It is assumed that the APU operating time is equivalent to the total gate occupancy time. However for flights that remained overnight at non-electrified gates, 90 minutes of APU time was assumed for cleaning and light maintenance activities after the flight, and 30 minutes of APU time was assumed for start-up procedures, loading of provisions, and passenger boarding prior to the next day's flight. This approach was also applied to all aircraft that had extended gate occupancy times (greater than 120 minutes). Therefore the longest duration an APU unit would be operating at a gate was 120 minutes. LeighFisher's proprietary gate modeling software was used to determine gate occupancy times and is described in detail in section 4.5.

4.3.2 Cargo Aircraft

All cargo aircraft operating at the Airport are assumed to have an APU except the Cessna 208 Caravan, which is in the air taxi category and transports mail to and from the Airport. Cargo aircraft do not occupy gates, but park at remote positions where they frequently use their APU during loading and unloading operations. Based on interviews with ground personnel at the Airport, an APU time of 40 minutes per cargo LTO was assigned to aircraft.

Remote parking positions for cargo aircraft can be equipped with PCA and ground power. If remote parking positions are electrified, an APU time of seven minutes is assumed per FAA guidance, similar to electrified passenger gates.

4.3.3 General Aviation Aircraft

General aviation aircraft typically do not occupy passenger gates, but the aircraft may still be equipped with APUs.

When it could not be determined exactly which APU was assigned to a specific aircraft, the GTCP 36-100 APU, the APU with the lowest horsepower rating in EDMS, was assigned. Because the APU operating times could not be determined with accuracy, the EDMS default operating time of 26 minutes was assigned to each general aviation aircraft type.

4.4 AVAILABILITY OF PCA AND GROUND POWER

Passenger gate power was available at varying amounts from 2012 - 2040. Cargo aircraft and general aviation aircraft were assumed to have no access to ground power and/or PCA in this study.

4.4.1 Passenger Gate Power

There were 51 operational passenger gates at the Airport in 2012. Thirteen of the gates were equipped with PCA and ground power in 2012 using a VALE Program grant, while all other gates were not included in the VALE Program project and were modeled to reflect that they were not electrified. PCA units supply heated/cooled air to parked aircraft so that passengers are comfortable as they enplane and deplane, and staff can clean and maintain the aircraft. Ground power provides power to aircraft for internal lighting and to ensure continuous power for navigational instruments. When used simultaneously, PCA and converter units enable parked aircraft to forego the use of APUs, resulting in a reduction of both emissions and the associated fuel consumption.

Based on conversations with Authority staff, it was assumed that aircraft had a 50% utilization rate of the PCA and ground power at the passenger gates. .

It was assumed that all of the 51 passenger gates would be electrified by 2017. Therefore from 2017 onwards, all aircraft that park at a passenger gate would have access to PCA and ground power, but would only utilize the electrification equipment 50% of the time.

4.5 PASSENGER GATE OCCUPANCY AND APU TIMES

The gate occupancy times for 2012 were derived from the 2012 OAG flight schedule for passenger aircraft. LeighFisher's proprietary flight matching software was used to match flights to determine the turnaround time for each aircraft. The flight matching software analyzes the following data:

- Flight number
- Local arrival time
- Local departure time
- Airline
- Aircraft type

If the software is unable to match flight numbers, it pairs flights that are the most realistic combinations, based on other identification criteria. Unmatched arrivals and departures were classified as: first flight of the day, last flight of the day or given the same characteristics as similar operations. As stated previously, APU times were a total of 120 minutes for aircraft that remained overnight: 90 minutes to reflect end of day cleaning and routine maintenance activities, and 30 minutes to account for preparing the aircraft for operation. APU times for flights that had extensive gate times during the day were also assumed to be no longer than 120 minutes. Aircraft that were not in operation in 2012 were assigned an APU time equal to the most similar aircraft operating at the Airport in 2012, as follows:

Aircraft	APU Time Based On
Airbus A320-NEO	Airbus A320-200
Airbus A350	Boeing 787-800
Boeing 717	Boeing MD-90
Boeing 737-MAX	Boeing 737-900
Boeing 787-900	Boeing 787-800

Gate occupancy and APU times were aggregated by aircraft type, and are presented in Appendix B, Table B-1.

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4.6 APU EMISSIONS

Table 4-1 shows the estimated emissions associated with aircraft APU activity at the Airport.

Table 4-1
EMISSIONS ASSOCIATED WITH APU ACTIVITY *(Tons)*

Year	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012	57.9	3.9	49.0	7.8	6.7	6.7
2017	45.7	3.0	34.2	6.4	5.2	5.2
2020	49.4	4.6	35.0	8.2	6.9	6.9
2030	58.9	11.8	42.2	15.7	14.2	14.2
2040	68.8	18.3	49.7	22.5	20.7	20.7

Source: LeighFisher, February 2016.

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5 GROUND SUPPORT EQUIPMENT

5.1 INTRODUCTION

Ground support Equipment (GSE) encompasses all motorized equipment that is required to service aircraft on the ground during a normal turnaround. This can include handling baggage and pushing back aircraft. It may also include specialized services (e.g., catering trucks, forklifts, etc.). All of the equipment emissions associated with providing these ground support operations are accounted for in this source group. In addition, the utilization of diesel-powered GPUs for aircraft maintenance activities is also accounted for in this inventory.

Baggage Tractor: passenger baggage and some cargo must be transferred to/from gates and from gate to gate. The baggage tractor is the most recognizable type of GSE at an airport. These vehicles are used to transport luggage, mail, and cargo between an aircraft and an airport terminal and/or processing/sorting facilities.

Belt Loader: the belt loader is used to load and unload baggage and cargo into/from an aircraft.

Catering Truck: provision or catering trucks are used to deliver food, drinks, and other supplies to aircraft while on the ground. These trucks tend to be powered by large diesel engines and have lifts in the back to move the storage compartment to the height of the aircraft. Catering trucks are usually owned by airlines and/or flight kitchens.

Pushback Tractor: although an aircraft's engines are capable of moving an aircraft in reverse, this is not typically done for aircraft with jet engines due to the resulting "jet blast" that would occur on the ramp. For this reason, and others, pushback tractors are used to maneuver aircraft away from/out of gates.

Deicing Trucks: deicing trucks are used to spray hot liquid on to aircraft in inclement weather to remove ice buildup and prevent future accumulation of ice. These trucks typically have (1) an engine on the front that is used to move the truck and run pumps and lifts, and (2) a rear engine that heats the deicing liquid. Deicing trucks typically carry a 2,000-gallon tank of deicing liquid, and a 100- to 110-gallon diesel fuel tank to run for an eight- to 10-hour shift.

Lavatory Truck: lavatory trucks and motorized carts are used by airlines to remove restroom waste from aircraft.

Maintenance Lifts: maintenance lifts are used by airlines to raise equipment or people to elevated work areas.

Potable Water Truck: water trucks are used to deliver potable water to aircraft while on the ground. These trucks tend to be powered by diesel engines and look similar to large pickup trucks.

Airline Support Vehicle: vans and small carts are used by airlines to transport employees in and around the secure side of the airfield. These vans include six-passenger minivans, 15-passenger vans, and maintenance vans with no seating. These support vehicles, which are essentially on-road vehicles, are not modeled in this chapter and are accounted for in Chapter 6, Parking and Roadways.

5.2 METHODOLOGY

Modeling GSE emissions requires knowing a piece of equipment's emission factor and its operating parameters. Once these variables are known, annual emissions were estimated for each equipment type by the following formula:

Emissions *=* HP_{avg} *x Load Factor x Annual Hours x Emissions Factor (g/hp hr)*

The variables in the equation were sourced from:

- **The Authority:** the Authority provided the types and quantity of GSE that were on-site in 2013 and 2014, which was required to calculate how many hours a GSE type was used.
- **EDMS:** the system contains a listing of GSE with default values for each piece of equipment, which includes horsepower, load factor, and operating time (annual hours).
- **CARB 2011 Inventory Model for In-Use Off-Road Equipment (OFFROAD):** this model contains detailed data about California's off-road vehicle fleet by air basin for the airport ground support sector, including age, horsepower, load factor, and annual emissions. This data was used to calculate emission factors in grams per horsepower hour (g/hp hr) for GSE specific to the San Diego Air Basin.

5.2.1 Equipment Population

The Authority provided an inventory of GSE operating on-site in 2013 and 2014, displayed in Table 5-1. In addition to the GSE listed in Table 5-1, there were 94 pieces of electric GSE (eGSE) operating at the Airport in 2013, and 123 pieces in 2014. The Baseline year's (2012) GSE was assumed to be the average of the 2013 and 2014 GSE inventory provided by the Authority. This Baseline GSE count was required to calculate the total hours each piece of GSE was used in a year, which is described in section 5.2.2.

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Table 5-1
AIRPORT GSE INVENTORY

Non eGSE Equipment Type	2013	2014	2013 – 2014 Average
AC Unit	0	5	2.5
Air Start	12	10	11.0
APU	22	6	14.0
Baggage Tug	74	66	70.0
Belt Loader	41	39	40.0
Cabin Service	5	2	3.5
Cargo Belt Loader	17	7	12.0
Cart	0	1	0.5
Catering Truck	16	20	18.0
Container Loader	8	4	6.0
Deicer	1	2	1.5
Forklift	13	12	12.5
Fuel Truck	26	18	22.0
Generator	20	35	27.5
GPU	21	29	25.0
Lavatory Truck	15	12	13.5
Lift	34	25	29.5
Passenger Stand	6	10	8.0
Push Back Tug –N *(a)*	42	38	39.8
Push Back Tug –W *(a)*	1	1	1.2
Sweepers	3	4	3.5
Water Service	1	0	0.5
Non-eGSE Total	378	346	362.0
eGSE	94	123	
Total GSE	472	469	

Note: Numbers may not add due to rounding.

(a) The Airport's "Push Back Tug" count was distributed into two different tug types: narrow body and wide body. 97% were assigned to a narrow body pushback tug, and 3% were assigned to a wide body pushback tug. The ratio at which they were distributed is equal to the ratio of narrow body aircraft operations to wide body aircraft operations at the Airport in 2012.

Source: San Diego International Airport, LeighFisher, February 2016

5.2.2 Emission Equation Variables

5.2.2.1 Equipment Operating Parameters

The equipment operating parameters were sourced from EDMS. Each piece of GSE in EDMS has a default horsepower, load factor, and operating time, described below:

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Operating Time: refers to the annual utilization time of the equipment. Depending on the type of equipment, it can be in annual hours or annual miles travelled.

Horsepower: refers to the power rating of the engine. Generally speaking, as the horsepower increases, so do the emissions.

Load Factor: refers to the time-weighted average of engine utilization relative to full power.

Before identifying the parameters, the equipment types listed in the Airport GSE inventory were mapped using professional judgment to the GSE types in EDMS, since they did not align perfectly. The Airport and EDMS equipment linkages are displayed in Table 5-2.

Table 5-2
AIRPORT GSE MAPPED TO EDMS GSE

Airport Equipment Type	EDMS GSE Equipment Type
AC Unit	Air Conditioner
Air Start	Air Start
APU	Ground Power Unit
Baggage Tug	Baggage Tractor
Belt Loader	Belt Loader
Cabin Service	Cabin Service Truck
Cargo Belt Loader	Cargo Loader
Cart	Cart
Catering Truck	Catering Truck
Container Loader	Cargo Loader
Deicer	Deicer
Forklift	Fork Lift
Fuel Truck	Fuel Truck
Generator	Generator
GPU	Ground Power Unit
Lavatory Truck	Lavatory Truck
Lift	Lift
Passenger Stand	Passenger Stand
Push Back Tug –N	Aircraft Tractor Narrow Body *(a)*
Push Back Tug –W	Aircraft Tractor Wide Body *(b)*
Sweepers	Sweeper
Water Service	Water Service

(a) The Aircraft Tractor selected for narrow body aircraft was rated at 190 HP.
(b) The Aircraft Tractor selected for wide body aircraft was rated at 617 HP.

Source: San Diego International Airport.
Source: LeighFisher, February 2016.

Once the Airport's GSE was accounted for in EDMS, each piece of equipment was assigned the default EDMS parameters for annual operating time (hours), horsepower, and load factor, as listed in Table 5-3. The

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annual operating time was applied to the GSE count listed in Table 5-1 to get the total annual operating hours for each piece of GSE at the Airport in the Baseline Year (2012), listed in Table 5-3. The annual operating time was the only parameter to change over the study timeframe; annual use grew at the same rate as the Airport's operations were forecasted to grow based on the Airport Development Plan. The forecasted growth and forecasted annual hours of use for each piece of GSE are listed in Tables 5-4 and 5-5, respectively. Load factor and horsepower were assumed to remain constant throughout the study.

Table 5-3
EDMS PARAMETERS FOR AIRPORT GSE

EDMS GSE Equipment Type	Horsepower	Load Factor	Operating Time (hours / year)
Air Conditioner	300	0.75	808
Air Start	425	0.90	333
Aircraft Tractor - Narrow Body	190	0.80	628
Aircraft Tractor - Wide Body	617	0.80	641
Baggage Tractor	71	0.55	1,500
Belt Loader	71	0.50	1,300
Cabin Service Truck	71	0.53	1,600
Cargo Loader	80	0.50	1,100
Cart	25	0.50	100
Catering Truck	71	0.53	1,600
Deicer	263	0.95	500
Fork Lift	55	0.30	976
Fuel Truck	300	0.25	564
Generator	158	0.50	1,630
Ground Power Unit	194	0.75	1,700
Lavatory Truck	56	0.25	1,492
Lift	115	0.50	341
Passenger Stand	65	0.57	188
Sweeper	53	0.51	12
Water Service	235	0.20	924

Source: EDMS, LeighFisher, February 2016.

Table 5-4
AIRPORT FLIGHT OPERATIONS GROWTH RATE

	2012 -2017	2017 -2020	2020 – 2030	2030 – 2040
Growth Rate	6.0%	3.8%	12.4%	9.4%

Source LeighFisher, February 2016.
Source: Airport Development Plan.

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Table 5-5
Non eGSE ANNUAL HOURS OF USE

EDMS GSE Equipment Type	2012	2017	2020	2030	2040
Air Conditioner	2,020	2,141	2,223	2,497	2,732
Air Start	3,663	3,882	4,031	4,529	4,954
Aircraft Tractor - Narrow Body	24,976	26,472	27,483	30,877	33,775
Aircraft Tractor - Wide Body	788	836	868	975	1,066
Baggage Tractor	105,000	111,290	115,540	129,809	141,993
Belt Loader	52,000	55,115	57,220	64,287	70,320
Cabin Service Truck	5,600	5,935	6,162	6,923	7,573
Cargo Loader	19,800	20,986	21,787	24,478	26,776
Cart	50	53	55	62	68
Catering Truck	28,800	30,525	31,691	35,605	38,947
Deicer	750	795	825	927	1,014
Fork Lift	12,200	12,931	13,425	15,083	16,498
Fuel Truck	12,408	13,151	13,654	15,340	16,780
Generator	44,825	47,510	49,324	55,416	60,618
Ground Power Unit	66,300	70,271	72,955	81,965	89,659
Lavatory Truck	20,142	21,349	22,164	24,901	27,238
Lift	10,060	10,662	11,069	12,436	13,604
Passenger Stand	1,504	1,594	1,655	1,859	2,034
Sweeper	42	45	46	52	57
Water Service	462	490	508	571	625
Total	411,389	436,032	452,683	508,593	556,328

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

5.2.2.1 Equipment Emission Factors

GSE emission factors were calculated from the OFFROAD model. The model contains data submitted by off-road equipment users, and has a specific category for "Airport Ground Support." Key pieces of data in this model that improved the emission factors used in this study are age and location of the equipment. Age is important because as the equipment gets older the engine can degrade and emit more pollutants, and tightening emission standards over the years has greatly reduced emissions, and continues to do so. The location data allows for equipment to be filtered by air basin, providing a more accurate age distribution for the equipment operating at the Airport.

To get the emission factors, the model was configured to calculate the annual amount of NO_x, particulate matter, and hydrocarbons by each Aircraft Ground Support vehicle from the San Diego Air Basin in 2012, 2017, 2020, and 2029. 2029 was the furthest into the future the OFFROAD model forecasted emissions. The two maintenance study years used the 2029 OFFROAD forecasted emission factors. The OFFROAD model does not specify what level of PM is measured in the model. Therefore for purposes of this report, PM as reported by OFFROAD is assumed to be TSP.

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The OFFROAD output, displayed in Appendix C Table C-1 lists the total emissions and the operating parameters for each year by equipment type. This level of granular information made it possible to calculate emission factors for GSE that is more likely to be operating at the Airport than the EDMS default emission factors. The following equation was used to calculate the emission factors specific to Airport Ground Support equipment in the San Diego Air Basin in tons per horsepower hour:

$$Emission\ Factor = Pollutant \div Total\ Annual\ Activity \div Load\ Factor \div HP_{avg}$$

The emission factors are presented in grams per horsepower hour, a more standard format than tons per horsepower hour, on the right hand side of Table C-1 in Appendix C. The hydrocarbon emission factor was converted to a VOC emission factor using EPA's suggested conversion factor, 1.053.

The final step to estimate the GSE emissions at the Airport was combining the operational parameters from EDMS with the emission factors from the OFFROAD model for each equipment type. To do so, the EDMS equipment types and OFFROAD equipment types were aligned using professional judgement. Table 5-6 displays the mapping convention used to link the two systems' equipment types. Once the two systems' equipment types were aligned, each equipment type had operational parameters and emission factors that were required to estimate GSE emissions at the Airport. Tables C-3 through C-7 list the operating parameters, emission factors, and total emissions for each piece of equipment throughout the study period.

Table 5-6
CARB EMISSION FACTORS MAPPED TO EDMS GSE TYPE

EDMS GSE Type	OFFROAD GSE Type
Air Conditioner	Bobtail
Air Start	A/C Tug Wide Body
Aircraft Tractor	A/C Tug Narrow Body
Baggage Tractor	Baggage Tug
Belt Loader	Belt Loader
Cabin Service Truck	Passenger Stand
Cargo Loader	Cargo Loader
Cart	Baggage Tug
Catering Truck	Passenger Stand
Deicer	Bobtail
Fork Lift	Forklift (GSE)
Fuel Truck	Passenger Stand
Generator	Bobtail
Ground Power Unit	Bobtail
Lavatory Truck	Passenger Stand
Lift	Lift (GSE)
Passenger Stand	Passenger Stand
Sweeper	Bobtail
Water Service	Passenger Stand

Source: LeighFisher, February 2016.

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5.3 ESTIMATED EMISSIONS

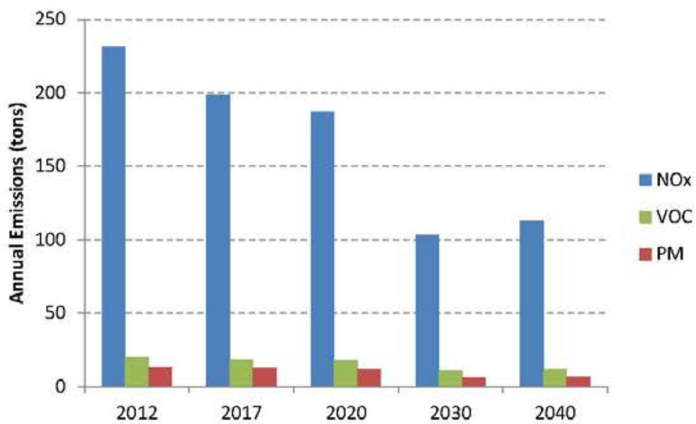
Table 5-7 and Figure 5-1 show the estimated emissions associated with GSE activity at the Airport for all study years. Detailed data for emissions is listed in Appendix C, Tables C-3 through C-7.

Table 5-7
ANNUAL AIRPORT GSE EMISSIONS

Year	NO_x	VOC	TSP
2012	231.5	20.2	13.1
2017	198.7	18.4	12.5
2020	187.4	17.7	11.9
2030	103.3	10.9	6.0
2040	113.0	11.9	6.5

Source: LeighFisher, February 2016.

Figure 5-1
ANNUAL GSE EMISSIONS
San Diego International Airport



Source: LeighFisher, February 2016.

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6 ROADWAYS AND PARKING

6.1 INTRODUCTION

Airport-related, on-road emissions from passenger and commercial vehicles can be categorized as those that take place "on-airport" and those that take place "off-airport". On-airport roadway emissions take place on airport roadways, feeder ramps, curbsides, cargo access roads, and parking facilities that exist on airport property. Airport-related off-airport roadway emissions take place on federal, state, and local roadways that provide origin and destination traffic access to/from some point in the region to/from the Airport. Airport-related, off-airport emissions are produced by passengers and cargo traveling throughout the county with the intent to depart from, or arrive at, the Airport. These emissions represent only a portion of the emissions produced on County roadways. Parking facility emissions refer to emissions from vehicles in Authority-owned parking facilities.

6.2 APPROACH & METHODOLOGY

Emissions from roadways and parking facilities were estimated in accordance with CARB's EMFAC 2014 emissions inventory model. At the time of study, EMFAC 2014 is the most-recently-available estimate of on-road vehicle emissions in California with county-level emissions for 42 classes of vehicles. EMFAC uses emission coefficients for criteria air pollutants and has assumptions regarding the mix of vehicle types, age, fuels, and driving speeds that are specific to the County. It also includes assumptions for combustion, resting loss/evaporation, and particulates from brake and tire degradation. The key steps were:

1. Identify sources of roadway and parking emissions for vehicles using the Airport
2. Estimate vehicle miles traveled (VMT) for each source occurring on on-Airport and off-Airport roadways, and in parking facilities
3. Multiply VMT for each source by pollutant emission factors, measured in tons of pollutant/VMT and derived from EMFAC 2014

By using VMT as the basis for determining Airport-related vehicle emissions, the methodology results in emission estimates using the same mix of vehicle types, ages, fuels, and driving speeds as the County-wide fleet provided in EMFAC 2014.

EMFAC provides an emissions factor for Reactive Organic Gases (ROG), and not for VOCs. Literature suggests that VOCs are often used in place of one another in California emissions modeling, and therefore ROG emissions in this chapter are reported as VOCs[1].

6.3 VEHICLE CATEGORIES

For this inventory, 11 source categories of roadway and parking emissions are considered. The sources were identified based on available data, industry standards, observation, and professional judgement and are defined by type(s) of vehicles, location of emissions, and methods used to estimate emissions. Table 6-1 lists each of the vehicle source categories, with a description, the applicability of the class to either roadways or parking, and the corresponding EMFAC vehicle types.

1 AQMD: Rule 2202 – On-Road Motor Vehicle Mitigation Options Emission Factor Methodology. Page 2.

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Table 6-1
VEHICLE CLASSES USED AT THE AIRPORT

Vehicle Class	Descriptions	Location	EMFAC Vehicle Type
Private Vehicles - Passengers	Privately-owned cars, SUVs, and light trucks that transport passengers to/from the Airport and their points of origin and destination	On-Airport and off-Airport roadways, parking facilities	LDA, LDT1, LDT2, LHD1, MCY
Rental Cars	Rented vehicles that transport passengers to/from the Airport and their points of origin and destination	On-Airport and off-Airport roadways, parking facilities	LDA, LDT1, LDT2, LHD1, MCY
Taxis / Limousines	Livery vehicles that transport passengers to/from the Airport and their points of origin and destination	On-Airport and off-Airport roadways	LDA, LDT1, LDT2, LHD1, MCY
Shared Ride Vans / Charters	Commercially-owned vans and buses that transport passengers to/from the Airport and their points of origin and destination	On-Airport and off-Airport roadways	LDA, LDT1, LDT2, LHD1, MCY
Private Vehicles - Employees	Privately-owned cars, SUVs, and light trucks that transport employees to/from the Airport and their points of origin and destination	On-Airport and off-Airport roadways, parking facilities	LDA, LDT1, LDT2, LHD1, MCY
Public Transit	Public buses owned by San Diego County MTS used by passengers and employees to travel to/from the Airport	On-Airport and off-Airport roadways	UBUS
Authority-Owned Shuttles	Authority-owned buses and modified trucks that provide shuttle service to employees and passengers at the Airport	On-Airport and off-Airport roadways	LDH2, MDV, SBUS, Motor Coach, OBUS, All Other Buses
Off-Airport Shuttles	Private commercial buses and modified trucks that provide shuttle services to Airport passengers	On-Airport and off-Airport roadways	LDH2, MDV, SBUS, Motor Coach, OBUS, All Other Buses
Cargo Vans	Commercial vans used to move cargo between the Airport and regional warehouses	On-Airport and off-Airport roadways	LDH2, MDV, SBUS, Motor Coach, OBUS, All Other Buses
Cargo Trucks	Commercial trucks used to move cargo between the Airport and regional warehouses	On-Airport and off-Airport roadways	T6 Instate Heavy, T6 OOS Heavy, T7 NNOOS, T7 NOOS, T7 Other Port, T7 POLA, T7 Tractor
Maintenance Vehicles and Other	Authority-owned light and medium-duty trucks that perform maintenance at the Airport	On-Airport roadways	LDH2, MDV, SBUS, Motor Coach, OBUS, All Other Buses

Source: LeighFisher, February 2016.

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6.4 ROADWAY EMISSIONS – BASELINE YEAR

Total VMT was estimated for each vehicle class as the product of the total number of annual trips and the average trip length.

$$Total\ VMT_{class} = Total\ Trips_{class} \times Average\ Trip\ Length_{class}$$

6.4.1 Vehicle Trips

Total vehicle trips are presented in Table 6-2. These estimates were developed for each vehicle class using sources of data available for that class, including forecasts developed under the 2012 Airport Development Plan, the 2012 Airport Passenger Survey, and professional judgement. The methodology and derivation of estimates are presented in subsequent sections.

Table 6-2
TOTAL VEHICLE TRIPS

Total Trips	2012
Private Vehicles - Passengers	4,853,259
Rental Cars	963,332
Taxis / Limousines	1,479,636
Shared Ride Vans / Charters	171,491
Private Vehicles - Employees	1,756,155
Cargo Trucks	20,402
Cargo Vans	18,158
Public Transit	20,759
Authority-Owned Shuttles	295,000
Off-Airport Shuttles	1,041,000
Maintenance & Other Vehicles	594,000
Total	11,213,193

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

6.4.1.1 Trips for Private Vehicles, Rental Cars, and On-Demand Passenger Transportation

Vehicle trips for private passenger vehicles, rental cars, and on-demand passenger ground transportation services, including taxis, limousines, shared ride vans, and charter buses, are presented together because each uses the same methodology to estimate vehicle trips. For these vehicle classes, total trips are the product of total originating enplanements from the 2012 Airport Development Plan passenger forecast, the ground transportation mode split provided by the 2012 Airport Passenger Survey, and the estimated vehicle trips per passenger by vehicle class.

$$Total\ Trips_{class} = Originating\ Enplanements \times Survey\ Mode\ Share_{class} \times Vehicle\ Trips\ per\ Enplanement_{class}$$

Total originating enplanements were obtained from the passenger forecast in the 2012 Airport Development Plan. Originating enplanements are passengers with an initial flight leg starting at the Airport,

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implying that they require local ground transportation services. Table 6-3 summarizes the originating enplanements for the inventory years.

Table 6-3
PASSENGER ENPLANEMENTS

	Year				
	2012	2017	2020	2030	2040
Total Enplanements	8,746,134	9,566,731	10,153,866	12,295,686	14,518,374
Domestic Enplanements	8,496,524	9,232,230	9,785,078	11,694,970	13,539,871
Originating	8,268,906	8,984,903	9,522,941	11,381,667	13,177,145
Connecting	227,617	247,327	262,137	313,302	362,726
International Enplanements	249,610	334,501	368,788	600,716	978,503
Originating	242,923	325,540	358,908	584,623	952,290
Connecting	6,687	8,961	9,880	16,093	26,214
Total Originating	8,511,829	9,310,443	9,881,849	11,966,291	14,129,434
Percent of Baseline	100%	109%	116%	141%	166%

Note: Numbers may not add due to rounding.

Source: 2012 Airport Development Plan.

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Table 6-4 summarizes the ground transportation mode choices and traveling party size provided by respondents to the 2012 Airport Passenger Survey. Choices are grouped into four vehicle classes: (1) personal vehicles, (2) rental cars, (3) taxis and limousines, and (4) shared ride vans and charters. Together, these classes account for 96% of all responses and 95% of originating enplanements. The balance of responses are those that reported the use of vehicles such as public transit and circulating shuttles that are considered later.

Table 6-4
2012 PASSENGER SURVEY – 2012 PASSENGER TRAVEL MODE SPLITS

	Responses		Enplanements		Party
Mode	Count	%	Total	%	Size
Private Vehicle					
Private Vehicle (Parking)	922	12%	1,481	11%	1.61
Private Vehicle (Drop-Off)	3,252	43	4,755	37	1.46
Sub-Total	4,174	55%	6,236	48%	1.49
Rental Car	1,474	19%	3,068	24%	2.08
Taxi / Limousine	1,132	15%	1,727	13%	1.53
Shared Ride Van / Charter					
Shared Ride Van	416	5%	901	7%	2.17
Charter	48	1	433	3	9.02
Sub-Total	464	6%	1,334	10%	2.88
Other-Excluded	336	4%	659	5%	
Total	7,580	100%	13,024	100%	

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

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Table 6-5 summarizes the number of vehicle trips and trips per originating enplanement by vehicle class. Trips per enplanement were estimated based on party size from the 2012 Airport Passenger Survey, observation, and professional judgement.

Table 6-5
2012 VEHICLE TRIPS

Mode	2012 Enplanements	Trips per Enplanement	Total Trips
Private Vehicle			
Private Vehicle (Parking)	967,907	0.62	602,573
Private Vehicle (Drop-Off)	3,107,628	1.37	4,250,686
Sub-Total	**4,075,535**	**1.19**	**4,853,259**
Rental Car	**2,005,090**	**0.48**	**963,332**
Taxi / Limousine	**1,128,680**	**1.31**	**1,479,636**
Shared Ride Van / Charter			
Shared Ride Van	588,848	0.18	108,751
Charter	282,987	0.22	62,741
Sub-Total	**871,835**	**0.20**	**171,491**
Total	**8,081,140**	**0.92**	**7,467,718**

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

6.4.1.2 Trips for Cargo Vehicles

Airport cargo operators use trucks and vans to transport cargo to/from the Airport and regional distribution centers. Based upon information gathered during Airport tenant interviews, there are 739 vehicles trips per day (391 trucks and 348 vans) and 38,560 trips per year (20,402 trucks and 18,158 vans), summarized in Table 6-6.

Table 6-6
2012 VEHICLE TRIPS—CARGO OPERATIONS

Cargo Vehicles	Trips per Week	Trips per Year
Trucks	391	20,402
Vans	348	18,158
Total	739	38,560

Source: LeighFisher, February 2016.

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6.4.1.3 Other Vehicle Trips

Other vehicles that travel to, from, and around the Airport include private employee vehicles, public transit, Authority-owned circulator and parking shuttles, maintenance vehicles and off-Airport shuttles, such as those for hotels and off-Airport parking companies. Total trips for these vehicle classes, presented in Table 6-7, are derived from published schedules, a forecast developed for the 2012 Airport Development Plan, and professional judgement.

Table 6-7
BASELINE YEAR VEHICLE TRIPS FOR OTHER VEHICLES

Mode	Total Trips
Private Vehicles – Employees	1,756,155
Public Transit	
MTS Public Bus 992	19,990
MTS Public Bus 923	769
Sub-Total	20,759
Authority-Owned Shuttles	
SAN Parking Shuttle	149,000
Employee Shuttle	73,000
Inter-Terminal Bus	73,000
Sub-Total	295,000
Off-Airport Shuttles	
Courtesy Vehicle (Hotel/Motel)	123,000
Rental Car Shuttles	677,000
Off-Airport Parking Shuttle	241,000
Sub-Total	1,041,000
Maintenance & Other Vehicles	594,000
Total	3,706,914

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

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6.4.2 Trip Length

The average trip length is defined as the total distance that a vehicle is driven per trip. In order to enable comparison to the SIP's regional emission budget for on-road emissions, trip length was separated into the distance driven on Airport property and the distance driven off-Airport. Average trip lengths are presented in Table 6-8.

Table 6-8
TRIP LENGTH

	Trip Length (mi)		
Vehicle Class	On-Airport	Off-Airport	Total
Private Vehicles – Passengers	1.1	39.0	40.2
Rental Cars	–	23.9	23.9
Taxis / Limousines	0.9	16.1	17.1
Shared Ride Vans / Charters	1.0	25.8	26.8
Private Vehicles – Employees	–	36.3	36.3
Public Transit	2.1	2.1	4.2
Authority-Owned Shuttles	2.0	1.4	3.5
Off-Airport Shuttles	1.4	2.8	4.2
Cargo Trucks	1.2	52.1	53.3
Cargo Vans	1.2	43.0	44.2
Maintenance & Other Vehicles	1.3	–	1.3

Source: LeighFisher, February 2016.

6.4.2.1 On-Airport Distance

On-Airport vehicle travel is considered for two areas of the Airport, (1) roadways near the passenger terminals and (2) the roadway adjacent to the North Ramp cargo area.

- **On-Airport roadways near the passenger terminals** consist of the roadways immediately adjacent to Terminal 1, Terminal 2, and the Commuter Terminal and the interlaced network that connects these roadways to North Harbor Drive as depicted in orange on Figure 6-1 and 6-2.

- **Roadways adjacent to the Airport** include North Harbor Drive and most other roadways adjacent to the Airport and airfield, but not on Airport property.

Emissions from roads in on-Airport parking facilities are included in the estimate of parking facility emissions in Section 6-6.

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Figure 6-1
ON-AIRPORT TERMINAL ROADWAYS

Source: LeighFisher, February 2016.

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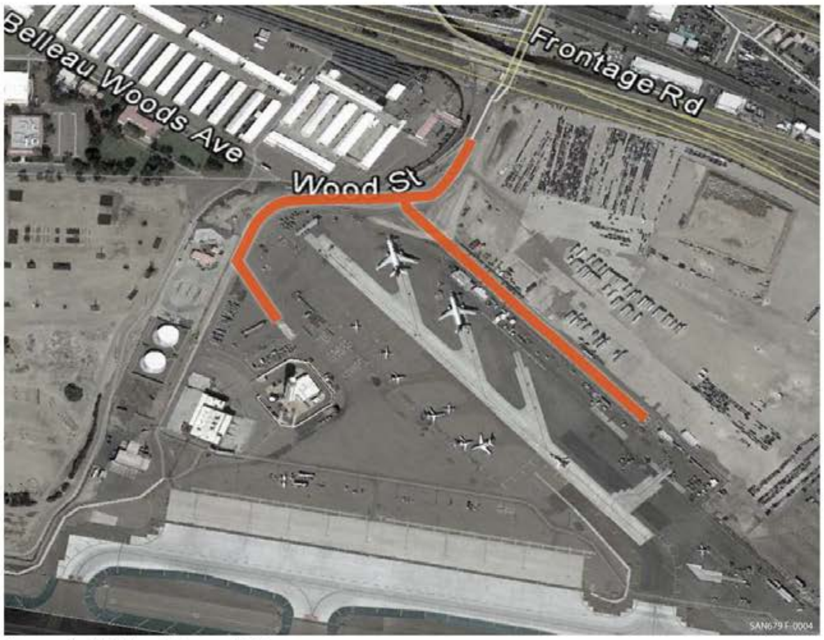
The on-Airport roadway adjacent to the cargo ramp consists of a short distance between the turnoff near the intersection of Wood and West Washington streets and the cargo staging areas along the north ramp.

Figure 6-2
CARGO AREA ON-AIRPORT ROADWAYS



Source: LeighFisher, February 2016.

The on-Airport trip distances shown in Table 6-8 were estimated using a combination of remote sensing, physical observation, and professional judgement for trips on the passenger terminal and cargo area roadways. Factors considered include the number of passenger vehicles that drop off passengers as compared to using a parking facility, observed routes to the three passenger terminals, a weighting of trips to terminals, and anticipated recirculation rates. Rental cars are assumed to have no on-Airport trip distance as all rental car facilities are currently located off-Airport.

6.4.2.2 Off-Airport Distance

For off-Airport travel legs, the trip distance is measured as the round trip route from the point of origin to a destination point at the edge of the Airport property. The points of origin are derived from various sources, depending on the vehicle service class. Route choice is that identified by Google Maps™ for travel on a weekday mid-afternoon. For passenger travel originating outside of San Diego County, the point of origin is set to the County boundary along the given route, so that only the VMT that occur in the County are included. The destination point at the edge of the Airport property is assumed to be the intersection of North Harbor Drive and Harbor Island Drive for vehicles using the passenger terminals and the intersection of West Washington Street and Wood Street for cargo vehicles.

Table 6-9 presents the average trip lengths assumed for private vehicles, rental cars, and on-demand passenger transportation. For these classes, the point of origin was derived from the 2012 Airport Passenger Survey.

Table 6-9
OFF-AIRPORT TRIP LENGTH FOR PASSENGER VEHICLES

Mode	Average Distance (mi)
Private Vehicle	
Private Vehicle (Parking)	52.54
Private Vehicle (Drop-Off)	37.06
Weighted Average	40.85
Rental Car	23.90
Taxi / Limousine	16.06
Shared Ride Van / Charter	
Shared Ride Van	25.58
Charter	25.88
Weighted Average	25.60
Other-Excluded	14.37
Weighted Average	31.72

Source: LeighFisher, February 2016.

For cargo vehicles, points of origin are regional cargo processing centers. Based upon interviews with cargo operators, the average off-Airport trip length was estimated to be 52.1 miles for cargo trucks and 43.0 miles for cargo vans. These estimates were based on distances from regional cargo centers in San Diego, Riverside, and Imperial counties to the intersection of West Washington Street and Wood Street, weighted by the expected number of vehicle trips to each center. As with passenger vehicles, only the portion of travel that occurs inside the County is considered.

For the remaining vehicle classes, the points of origin for vehicle trips were set according to anticipated route destinations and the off-Airport trip length as follows:

- For private employee vehicles, the points of origin were determined using the centroid of the employee home ZIP code. As with passenger and cargo vehicles, only the portion of travel within the air basin is considered.
- For public transit route with the Airport as a terminus, the off-Airport distance was measured using Google Maps™ as the distance from the intersection of North Harbor Drive and Harbor Island Drive to the nearest major stops, which were either North Harbor Drive and Rosecrans Street (3.4 mi.) or Hawthorne Street and the Pacific Highway (2.0 mi.), weighted by the share of trips listed in the 2014 Metropolitan Transit System schedule.
- For Authority-owned shuttles, the off-Airport distance is the distance traveled on the off-Airport road for an expected route.

- For off-Airport shuttles, off-Airport trip length assumes that vehicles travel to downtown or the private parking lots to the east and southwest of the Airport.
- Maintenance vehicles were assigned no off-Airport trip length

6.4.3 Air Pollutant Emissions

Air pollutant emissions are calculated as the product of the VMT for each vehicle class and an emissions coefficient, expressed in tons of pollutant per distance traveled, derived from the EMFAC 2014 inventory for the corresponding vehicle categories, or:

$$Emissions_{pollutant,\ class} = VMT_{class} \times EMFAC\ Emissions_{pollutant,\ class} \div EMFAC\ VMT_{class}$$

EMFAC 2014 reports both VMT and emissions as daily average values, not annual totals. As these two factors are divided against each other in the calculation, the difference is inconsequential.

Appendix D, Tables D1-D5 present the emissions coefficients for each vehicle class. The coefficients were derived from EMFAC 2014 by dividing the total 2012 emissions in EMFAC 2014 for the pollutants included in this study by the corresponding VMT.

Vehicle roadways emissions for Airport-related vehicle trips are presented in detail in Appendix D, Table D-6 through D-10.

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6.5 ROADWAYS EMISSIONS FOR FORECAST YEARS

Emissions estimates for inventory forecast years employ the same methodology as the baseline year.

6.5.1 Vehicle Trips

As with the baseline year, VMT are estimated as the product of vehicle trips and the estimated trip distance. Vehicle trips are shown in Table 6-10 and are estimated to grow in proportion to the originating enplanements forecast as part of the 2012 Airport Development Plan.

Table 6-10
VEHICLE TRIPS

	Year				
Vehicle Class	2012	2017	2020	2030	2040
Private Vehicles - Passengers	4,853,259	5,308,611	5,634,414	6,822,917	8,056,295
Rental Cars	963,332	1,053,716	1,118,385	1,354,293	1,599,108
Taxis / Limousines	1,479,636	1,618,462	1,717,791	2,080,135	2,456,161
Shared Ride Vans / Charters	171,491	187,581	199,094	241,090	284,672
Private Vehicles - Employees	1,756,155	1,920,925	2,038,817	2,468,877	2,915,176
Public Transit	20,759	20,759	20,759	20,759	20,759
Authority-Owned Shuttles	295,000	322,678	342,482	414,724	489,693
Off-Airport Shuttles	1,041,000	1,138,671	1,208,554	1,463,482	1,728,035
Cargo Trucks	20,402	22,316	23,686	28,682	33,867
Cargo Vans	18,158	19,862	21,081	25,527	30,142
Maintenance & Other Vehicles	594,000	649,731	689,607	835,070	986,026
Total	11,213,193	12,263,312	13,014,669	15,755,557	18,599,933

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

6.5.2 Trip Length

On- and off-Airport trip lengths for the forecast years for most vehicle classes are assumed to be the same as for the baseline year. The exception is for vehicles that are expected to use the new, on-Airport, consolidated rental car center (RCC), which is anticipated to be completed in 2016. When complete, the RCC will be used by various rental car companies that are currently located off-Airport, resulting in new routes for some Airport shuttles and additional, on-Airport travel or rental vehicles.

Figure 6-3 shows the planned location of the RCC, as well as the on-Airport roadways that will be used by vehicles accessing the RCC.

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Figure 6-3
PLANNED RCC FACILITY LOCATION

Source: LeighFisher, February 2016.

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Table 6-11 shows the estimated trip lengths for rental cars and off-Airport shuttles, which are estimated to experience route changes due to the RCC. For all other vehicle classes, the on- and off-Airport trip lengths in the forecast years are assumed to be identical to the baseline year.

Table 6-11
TRIP LENGTHS
(miles)

	Year				
	2012	2017	2020	2030	2040
Rental Cars					
On-Airport	0.0	0.3	0.3	0.3	0.3
Off-Airport	23.9	23.9	23.9	23.9	23.9
Total	23.9	24.2	24.2	24.2	24.2
Off-Airport Shuttles					
On-Airport	1.4	3.7	3.7	3.7	3.7
Off-Airport	2.8	2.1	2.1	2.1	2.1
Total	4.2	5.8	5.8	5.8	5.8

Source: LeighFisher, February 2016.

6.5.3 Emissions Coefficients

Emissions coefficients for the forecast years are estimated using EMFAC in an identical manner to the baseline year. As EMFAC adjusts the inventory for changes in the vehicle fleet over time, the coefficients are different for each year. Tables D-1 through D-5 in Appendix D provide the coefficients for the inventory years.

6.5.4 Air Pollutant Emissions

Tables D-6 through D-10 in Appendix D provide detailed emissions data for roadways for the study timeframe by vehicle class. Table 6-12 presents a summarized emissions total for roadways.

Table 6-12
ROADWAY EMISSIONS SUMMARY

	Emissions (Tons)					
Year	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012	152.2	132.1	1,048.9	1.5	18.3	8.3
2017	95.1	87.1	662.0	1.5	19.1	8.2
2020	74.9	72.5	529.8	1.4	20.1	8.6
2030	41.2	57.5	392.8	1.2	23.7	9.9
2040	35.6	51.3	375.6	1.2	27.5	11.3

Source: LeighFisher, February 2016

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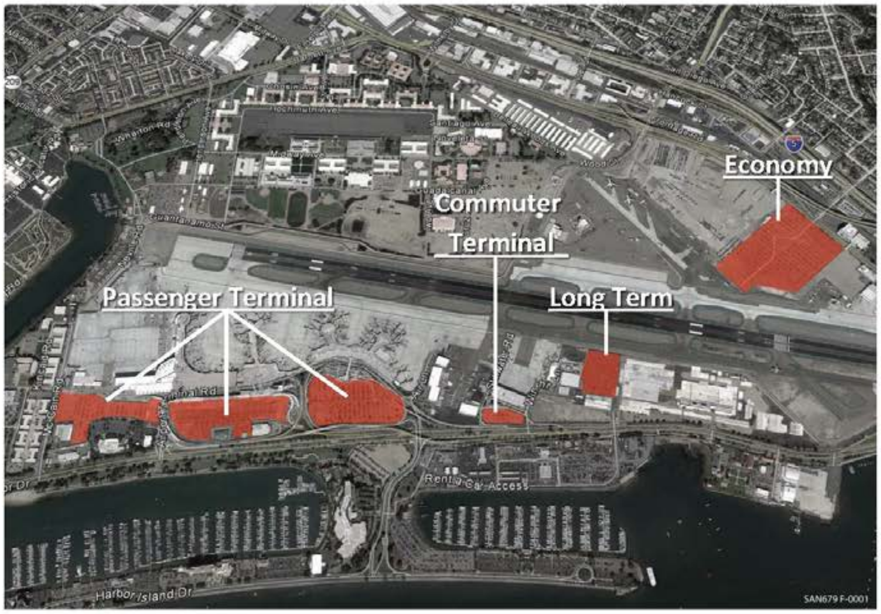
6.6 PARKING FACILITY EMISSIONS – BASELINE YEAR

This inventory includes emissions from vehicles in Authority-owned parking facilities, including parking lots at the passenger terminals, long-term parking lots, and the economy lot. Figure 6-4 shows the location of Airport parking facilities for the baseline year.

Figure 6-4
EXISTING AUTHORITY-OWNED PARKING FACILITIES



Source: LeighFisher, February 2016.

The methodology used to estimate emissions in Airport parking facilities is similar to that for roadways: emissions are calculated as the product of VMT within the parking facilities and emissions coefficients derived from EMFAC 2014. The emissions coefficients for the vehicle classes are identical to those used to determine roadway emissions, as the coefficients are expressed in units of tons per VMT.

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6.6.1 VMT in Parking Facilities

VMT is calculated as the product of the number of vehicles that use the Airport parking lots and the average VMT per use. Of the eleven vehicle classes, only two are considered to use the parking facilities: privately owned vehicles used by either passengers or Airport workers. Emissions from Authority-owned shuttles that serve the parking facilities were included in the on-Airport emissions in section 6.4.

For passenger traffic, the count of vehicles using the parking facilities is based upon estimates developed for the 2012 Airport Development Plan. These estimates are different than those derived from 2012 Airport Passenger Survey for use in roadways and may reflect vehicles that dropped off passengers before subsequently parking. For employee traffic, the count of vehicles using Airport parking lots is estimated based on the number of issued employee parking badges and professional judgement.

The average VMT per use of the parking facilities was estimated using a combination of remote sensing, physical observation, and professional judgement. The VMT for passenger and employee vehicles differ slightly as the parking facility usage distribution is expected to differ between the two types of traffic.

Table 6-13 provides the estimated usage, VMT per use, and total VMT for the parking facilities in the baseline year (2012).

Table 6-13
PARKING FACILITY VMT

	Private Vehicles (Passengers)	Private Vehicles (Employees)	Total
Total Usage	1,932,185	1,756,155	3,688,340
VMT / Use	0.95	0.87	0.91
Total VMT	1,833,751	1,532,601	3,366,352

Source: LeighFisher, February 2016:

6.6.2 Emissions from Parking Facilities

Table 6-14 in the next section provides the baseline emissions from parking facilities in tons of pollutant.

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6.7 PARKING FACILITY EMISSIONS – FORECAST YEARS

6.7.1 Parking Facility Emissions – Methodology

Emissions for the forecast years are estimated using a methodology similar to the baseline year. Figure 6-5 illustrates the location of parking facilities assumed for forecast years. Appendix D, Table D-11 and Table D-12 list estimated usage, VMT per use, and total VMT for the parking facilities in all study years.

Figure 6-5
AUTHORITY-OWNED PARKING FACILITIES INCLUDED IN FORECAST YEARS

Source: LeighFisher, February 2016.

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6.7.2 Parking Facility Emissions

The emissions for the study timeframe years are listed in Table 6-14.

Table 6-14
PARKING FACILITY EMISSIONS
Tons

Year	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012	1.4	1.4	11.0	>0.0	0.2	0.1
2017	0.9	0.9	6.9	>0.0	0.2	0.1
2020	0.7	0.8	5.5	>0.0	0.2	0.1
2030	0.4	0.6	4.1	>0.0	0.3	0.1
2040	0.3	0.5	3.9	>0.0	0.3	0.1

Source: LeighFisher, February 2016.

6.8 ROADWAY AND PARKING FACILITY EMISSIONS

Table 6-15 presents the total emissions from roadways and parking facilities. Detailed emissions for each year are listed in Appendix D, Table D-13.

Table 6-15
ROADWAYS AND PARKING FACILITY EMISSIONS
Tons

Year	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012	153.6	133.4	1,059.9	1.5	18.4	8.4
2017	96.0	88.0	668.8	1.5	19.3	8.3
2020	74.7	73.2	535.3	1.4	20.3	8.7
2030	41.6	58.1	396.9	1.2	24.0	10.0
2040	36.0	51.9	379.6	1.2	27.8	11.4

Source: LeighFisher, February 2016.

7. CONSTRUCTION ACTIVITIES

7.1 INTRODUCTION

Airport construction projects can be classified as either growth projects, where a major construction or expansion project is undertaken at the Airport (e.g. lengthening a runway or building a new terminal), or as routine, where day-to-day maintenance projects are undertaken (e.g. repaving taxiways and building or demolishing small structures). This emissions inventory includes both future growth projects, recommended in the Airport Development Plan, and routine construction activities that are performed on a day-to-day basis at the Airport.

7.2 METHODOLOGY

Modeling construction emissions required knowing a piece of equipment's operating parameters and emission factors. Once these variables were known, annual emissions were estimated for each equipment type by the following formula:

Emissions = Equipment Population x HP_{avg} x Load Factor x Annual Hours x Emissions Factor (g/HP-Hr)

The variables in the construction emissions equation were sourced from:

- **ACEIT:** ACEIT is a tool that was developed as part of an ACRP project on estimation of airport construction emissions (ACRP Report 102, Guidance for Estimating Airport Construction Emissions, 2014). It contains a listing of construction equipment with key default operating parameters - horsepower, load factor, and operating time (annual hours) – that are specific to airport projects.
- **CARB 2011 Inventory Model for In-Use Off-Road Equipment (OFFROAD):** this model contains detailed data about California's off-road vehicle fleet by air basin for the Construction and Mining sector, including age, horsepower, load factor, and annual emissions. This was used to calculate emission factors for the construction equipment specific to the San Diego Air Basin.

7.2.1 Operating Parameters

7.2.1.1 Baseline Routine Construction Projects

Because routine construction projects can vary from year to year, the most accurate way to capture the full spectrum of projects is to examine an extended time period, with the average of that time period representing a typical year's worth of routine construction projects. Environmental documents filed with the FAA (Categorical Exclusion, Environmental Assessment, etc.) by the Authority provided information on 13 projects listed in Table 7-1 for which environmental documentation was filed over the five-year time period 2010 to 2014.

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Table 7-1
RECENT CONSTRUCTION PROJECTS CONSIDERED ROUTINE

1. Construction of new Airport Park Pacific Highway Lot
2. Reconfiguration and Expansion of the Airport Park Pacific Highway Lot
3. Demolition of Small Storage Building
4. Terminal 2 East Improvements
5. Construction of a Receiving and Distribution Warehouse
6. Reconfiguration and Expansion of the Airport Park Harbor Drive Lot
7. Construction of an Airport Electrical Distribution System
8. Demolition of a Closed Pedestrian Bridge over Pacific Highway
9. Demolition of Existing General Aviation Facility and Construction of New Facility
10. Construction of an Overflow Rental Car Parking and Overflow Valet
11. Relocation of Existing 42-inch Storm Drain
12. Relocation of Runway 9 Displaced Threshold
13. Demolition of World Trade Center Building

Source: San Diego County Regional Airport Authority, 2010 – 2014 environmental filings with Federal Aviation Administration.

The environmental filings provided information on the size and scope of the routine construction at the Airport. This information was then used as input to ACEIT. For each project, ACEIT computed the total operational hours of activity per type of construction equipment. An operational hour is defined as an hour that the piece of construction equipment's engine was running during the project, and therefore responsible for criteria pollutant emissions.

The total hours of activity per type of construction equipment across all routine Airport projects were then summed to aggregate total hours of activity per type of construction equipment, over the five-year period. This provided a five-year total of activity per type of construction equipment. The aggregate total hours of activity per construction equipment were divided by five to determine a five-year average. The five-year total and average operating hours by ACEIT type of construction equipment are provided in Appendix E Table E-1.

Future routine construction emissions were estimated for a forecast year (2017), an anticipated attainment year (2020), and two maintenance years (2030 and 2040). For each milestone year, emissions were calculated assuming that routine construction projects for that year would result in operating hours equal to the five-year average operating hours determined for the baseline year.

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7.2.1.2 Growth Construction Activity Modeling Inputs

The Authority is currently working on an Airport Development Plan. The Airport Development Plan is identifying improvements that will enable the Airport to meet demand through 2035. At the time of this report, the Airport Development Plan Project Team has developed five alternatives that address the need for a replacement to Terminal 1, the need for additional ground transportation facilities and the associated enabling projects. It is expected that the Authority will select a preferred alternative in late 2015. After selection of a preferred concept, a detailed environmental analysis will be conducted. It is expected that the entire planning process will conclude in 2017.

Alternative 4 was selected as a basis for the emissions modeling. The recommended growth construction projects associated with this alternative are listed in Table 7-2. The results of the emissions modeling analysis would not significantly differ if another alternative had been selected as the recommended projects are the same for all five alternatives. There are differences in the size of certain improvements, such as the size of the proposed replacement for Terminal 1, but these differences are small and would not materially impact the emission estimates.

Table 7-2 also provides construction dates for the recommended projects. These dates, used as inputs to ACEIT, were determined based on:

- Facilities required to accommodate future activity levels, as determined in the Airport Development Plan forecasts and facility requirements analyses.
- Phasing constraints and enabling projects.
- Authority priorities–one of the main Authority priorities is the expedited replacement of Terminal 1, which is at the end of its useful life and does not meet the needs of the airlines and the traveling public.

In addition to the Airport Development Plan projects, the emissions related to the runway reconstruction project and the construction of a Terminal 2 parking plaza were calculated. The runway will likely need to be fully reconstructed in the next 15-20 years. During reconstruction, the aircraft would need to operate from a temporary runway. For Taxiway B to serve as this temporary runway, it would need to be strengthened and widened.

The hours associated with construction growth projects are listed in Appendix E Table E-1.

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Table 7-2
AIRPORT DEVELOPMENT PLAN RECOMMENDED PROJECTS

Project ID	Project Description	Construction Timeframe
1-8	Construct: Hydrant Fueling System at T2E and T2W	2020
1-10	Construct: Harbor Drive Bypass Road	2024-2027
1-13	Construct: RON Parking Apron (Phase 1)	2024-2025
1-14	Construct: Apron Edge Taxilane (Phase 1 - Eastern End along RON Positions)	2024-2025
1-17	Construct: T1 Parking Plaza	2023-2024
1-21	Construct: T1 Replacement (Eastern Section)	2026-2028
1-24	Demolish: T1	2029
2-3	Construct: T1 Replacement (Central Section)	2029-2031
2-6	Demolish: Commuter Terminal	2031-2032
2-7	Construct: RON Parking Apron (Ultimate Configuration)	2031-2032
2-8	Construct: T1 Replacement Apron (Eastern End of Terminal)	2032-2033
3-1	Construct: T2 West Concourse	2033-2035
3-2	Construct: Belly Cargo Facilities	2035-2036
3-4	Demolish: T2 East	2035
3-5	Construct: T1 Replacement (Western Expansion to Final Configuration)	2036-2037

Note: Some Airport Development Plan projects are considered routine projects and are therefore not included in this list.

Source: LeighFisher, Airport Development Plan, February, 2016.

7.2.2 Emission Factors

Construction equipment emission factors were calculated from the OFFROAD model. The model contains data submitted by off-road equipment users, and has a specific category for "Construction and Mining" equipment. Key pieces of data in this model that improve the emission factor estimate are the age and location of the equipment. Age is important because as the equipment gets older the engine can degrade and emit more pollutants, and tightening emission standards over the years has greatly reduced emissions, and continues to do so. The location data allows for equipment to be filtered by air basin, providing a more accurate age distribution for the equipment operating at the Airport.

To get the emission factors, the model was configured to calculate the annual amount of NO_x, hydrocarbons and PM by each Construction and Mining[2] vehicle type from the San Diego Air Basin in 2012, 2017, 2020, and 2029[3]. The OFFROAD model does not specify what level of PM is measured in the model. Therefore for purposes of this report, PM as reported by OFFROAD is assumed to be TSP.

2 One vehicle type, forklifts, was sourced from the "Industrials" module of the model.
3 The model estimates emissions up until 2029. Therefore, the emission factors for the two maintenance years, 2030 and 2040, used the emission factors from 2029.

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The model results, listed in Appendix E Table E-2, indicate the total emissions and the operating parameters for each year by equipment type. This level of granular information made it possible to calculate emission factors for construction equipment that is more likely to be operating at the Airport than the ACEIT default emission factors. The following equation was used to calculate the emission factors specific to construction equipment in the San Diego Air Basin in tons per horsepower hour:

$$\textit{Emission Factor (T/Hp Hr)} = \textit{Pollutant} \div \textit{Annual Activity} \div \textit{Population} \div \textit{Load Factor} \div HP_{avg}$$

Table E-3 in Appendix E lists the calculated emission factors for each type of OFFROAD equipment over the study timeframe. The factors are presented in grams per horsepower hour, a more standard format than tons per horsepower hour. The hydrocarbon emission factors were converted to volatile organic compounds emission factors using EPA's suggestion conversion factor of 1.053.

The final step to estimate the Airport's construction emissions was combining the operational and usage parameters from ACEIT (horsepower, load factor, and operational hours) with the emission factors from the OFFROAD model. To do so, the ACEIT equipment types and OFFROAD equipment types were aligned using professional judgement. Table E-1 displays the mapping convention used to link the two systems' equipment types. Once the two systems' equipment was aligned, each equipment type had operational parameters and emission factors required to estimate construction emissions at the Airport.

7.3 ESTIMATED EMISSIONS

Table 7-3 and Figure 7-1 show the estimated emissions associated with construction activity at the Airport for the study timeframe.

Table 7-3
ANNUAL CONSTRUCTION EMISSIONS
(Tons)

	Routine Projects			Growth Projects			All Construction Projects		
Pollutant	NO_x	VOC	TSP	NO_x	VOC	TSP	NO_x	VOC	TSP
2012	35.6	2.5	1.48	0.0	0.0	0.00	35.6	2.5	1.48
2017	28.9	2.2	1.19	22.3	1.7	0.94	51.3	3.9	2.14
2020	21.3	1.7	0.84	562.0	44.8	21.9	583.3	46.5	22.8
2030	9.1	1.0	0.29	235.0	25.7	7.2	244.1	26.7	7.5
2040	9.1	1.0	0.29	235.0	25.7	7.2	244.1	26.7	7.5

Source: LeighFisher, February 2016.

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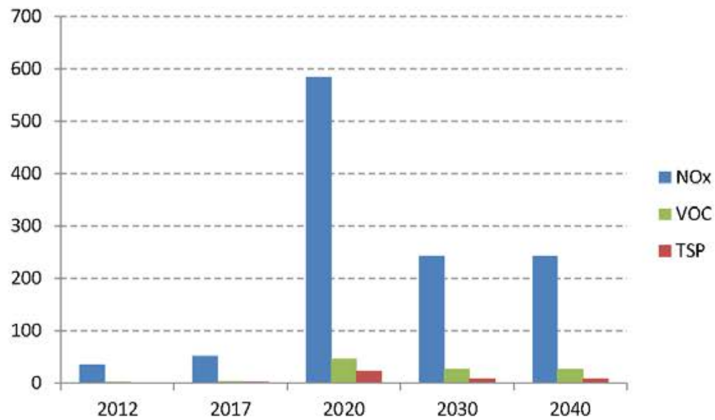
Figure 7-1
ANNUAL CONSTRUCTION EMISSIONS (Tons)



Source: LeighFisher, February 2016.

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8 KEY STATIONARY SOURCES

8.1 INTRODUCTION

This inventory considered only key stationary sources, which include emissions from Authority-owned, or aviation-specific stationary sources on Airport property. Stationary source emissions included in this analysis includes:

- Authority-owned natural gas boilers
- Authority-owned emergency diesel generators,
- Jet A fuel tank storage
- Paint used for airfield marking.

There were additional stationary sources located at the Airport, such as painting booths and training fires, but they were not included in this study due to the lack of readily available data. Additionally, data related to the storage of aviation gasoline and motor gasoline was not collected. It should be noted that, with the exception of Jet A fuel storage tanks, which are owned by Allied Aviation, the key stationary sources are owned and operated by the Authority. This inventory did not collect stationary source data pertaining to Airport tenants. All stationary source emissions on Airport property are also included in the County stationary source budget.

8.2 EMISSIONS ESTIMATION METHODOLOGY

EDMS databases contain emission factors for a large number of combustion and non-combustion stationary source categories typically found at airports. Each of these categories is further divided into sub-categories based on type of fuel consumed, equipment type, or the pollutant emitted. For example, fuel storage tanks have different emission factors for each fuel type (e.g., Jet A) and method of storage (e.g., fixed-roof tank).

Annual emission inventories of key on-Airport stationary sources were estimated based on data obtained from the Authority and modeled in EDMS. Annual emissions were computed based on the product of the actual annual fuel consumption or fuel throughput for a given calendar year. The specific methodologies for computing stationary source emissions vary by source type and are described below.

8.2.1 Boilers

Boilers are powered by natural gas and are used to provide heat during winter months. Emissions from natural gas boilers were calculated using a methodology based on fuel consumption and pollutant emission factors. Pollutant-specific emissions were estimated by multiplying the annual fuel consumption by the emission factor associated with each pollutant. Boiler type, fuel type (natural gas), and annual fuel consumption data for 2010 and 2011 were based on the factors used by Authority staff for annual reporting. Annual natural gas consumption in 2012 was estimated by taking an average of gas consumption in 2010 and 2011. It is assumed that natural gas consumption will remain constant in future years as there are no plans to significantly expand the Airport's heating needs.

8.2.2 Emergency Generators

Emergency generators are powered by diesel fuel and are used as a back-up energy source when electricity is unavailable. Emissions from emergency generators were estimated by EDMS, which calculates emissions based on the capacity rating of generator engines and hours of operation. Logs containing annual generator usage (in hours) and capacity ratings (in horsepower), were provided by Authority staff. Annual generator

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usage in terms of number of generators and annual operating hours is assumed to remain the same in the future as (1) there are no plans to significantly expand the Airport's emergency generating capacity, and (2) it is not expected that regulations governing the annual testing of generators will change in the future.

8.2.3 Fuel Storage Tanks

Jet A fuel for aircrafts is stored in two fuel storage tanks, owned and operated by Allied Aviation. Emissions associated with fuel storage tanks were based on historical data provided by Authority staff for (1) Jet A fuel dispensed in 2012, and (2) the diameter and height of the storage tanks. It is assumed that EDMS estimates take into account emissions associated with both the dispensing and refilling of the storage tank units. Annual fuel storage throughput volumes for future years were estimated based on the number of aircraft operations expected to occur in each of those years—a 6% increase in operations between 2012 and 2017, a 3.8% increase between 2017 and 2020, a 12.4% increase between 2020 and 2030, and a 9.4% increase between 2030 and 2040.

8.2.4 Paint

Airfield marking paint is weather-resistant paint used for the marking of runways, taxiways and apron areas at the Airport. Emissions from airfield marking paint are based on the volume of paint used annually. No significant increases in aircraft pavement are expected to occur in future years at the Airport, therefore future annual paint usage is assumed to remain unchanged. Emissions may be expressed as the weight of VOCs per volume of material, less water and exempt compounds (AQMD Rule 102). The emissions factors for each type of paint are described in the AQMD VOC Rule 1113, Architectural Coatings.

8.3 STATIONARY SOURCES EMISSION PARAMETERS

Table 8-1 shows the baseline (2012) and future stationary sources usage at the Airport.

Table 8-1
ANNUAL THROUGHPUT PARAMETERS FOR KEY STATIONARY SOURCES

Stationary Source	Unit	2012	2017	2020	2030	2040
Boilers *(a)*	10^3 m^3	841.8	841.8	841.8	841.8	841.8
Emergency Generators *(b)*	Run Hours	178	178	178	178	178
Fuel Storage Tanks *(c)*	Gallons	280,000,000	290,640,000	326,679,360	326,679,360	357,387,220
Paint *(d)*	Gallons	10,490	10,490	10,490	10,490	10,490

(a) Natural gas consumption, in thousand cubic meters per year.
(b) Diesel consumption, in hours of usage per year. HP_{AVG} = 407
(c) Jet A fuel consumption, in gallons per year.
(d) Paint consumption, in gallons per year.

Source: Based on information provided by the Authority.

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8.3.1 Boilers

The three boilers at the Airport were modeled in EDMS as "natural gas controlled wall-fired" boilers with an hourly heat energy production of less than 100 million British Thermal Units (MMBTUs), controlled with Low-NO_x Burners and Flue-Gas Recirculation. The volume of natural gas consumed in 2010 and 2011, measured in thousand cubic feet, was obtained from Authority staff and is shown in Tables 8-2 and 8-3. Pursuant to EPA New Source Review requirements, natural gas consumption in 2012 was assumed to be equal to an annual average of the natural gas consumption that occurred in 2010 and 2011. Emission factors for "natural gas controlled wall-fired" boilers were provided by EDMS.

Table 8-2
2010 MONTHLY BOILER READINGS

Reading Date	Boiler 1	Boiler 2	Boiler 3
12/2/2009	24,596	11,610	7,251
1/4/2010	26,894	12,310	7,251
2/1/2010	27,291	13,542	7,251
3/1/2010	28,507	15,121	7,444
4/1/2010	28,675	15,990	9,505
5/3/2010	29,440	16,269	11,072
6/3/2010	30,362	16,726	12,586
7/1/2010	32,432	17,319	12,627
8/1/2010	33,353	17,530	12,637
9/1/2010	33,354	17,710	12,655
10/1/2010	33,354	20,491	13,097
11/1/2010	33,354	21,268	14,641
12/1/2010	34,638	22,277	15,266
Natural Gas Usage (10^3 cf)	10,042	10,667	8,015

Source: Based on information provided by the Authority.

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Table 8-3
2011 MONTHLY BOILER READINGS

Reading Date	Boiler 1	Boiler 2	Boiler 3
12/1/2010	34,638	22,277	15,266
1/18/2011	37,439	24,316	15,266
2/1/2011	38,503	24,873	15,574
3/1/2011	38,561	26,886	16,632
4/4/2011	38,573	29,342	16,928
5/2/2011	38,816	29,744	18,702
6/1/2011	38,940	31,615	19,167
7/1/2011	39,116	32,856	20,088
11/1/2011	39,920	34,246	25,068
12/1/2011	40,223	35,484	27,205
Natural Gas Usage (10^3 cf)	5,585	13,207	11,939

Source: Based on information provided by the Authority.

8.3.2. Emergency Generators

There are 15 diesel-powered emergency generators at the Airport and emissions were determined by the annual hours of usage and horsepower rating of the engines. Engine capacity ratings and usage data from 2014 were obtained from Authority staff and are shown in Table 8-4. Emission factors for each engine type were provided by EDMS.

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Table 8-4
EMERGENCY GENERATOR LOGS

Permit	Location	Allowable Maintenance and Testing Hours	Tank Fuel Gallon Capacity	HP	Actual Run Hours
770	Airside Portable generator "Emergency Use Only" for unplanned emergency use.	50	26.4	55.3	4.3
771	Airside Portable generator "Emergency Use Only" for unplanned emergency use.	50	26.4	55.3	4.2
1418	Green Build Gate 47	50	250 + 1000 secondary fuel storage room	1881	8
951081	Landside East of CT outside	20	190	211	8.1
961289	Airside T1E Gate 18 rooftop enter through baggage area	20	250	519	20
961809	Airside (runway) inside generator yard	30	425	755	5
961834	Airside T2E near Gate 22	20	240	900	15.9
972648	Landside Central Plant	30	120	650	17.6
972682	Airside T2W underneath Gate 36 in Generator Rm	30	240	760	8.3
973586	Airside CT by America West	20	140	277	6.4
978266	Airside behind ARFF Station	50	135	110	24.4
978267	Airside VSR-01 behind jet blast fence	30	78	64	22
978268	Landside near P-18	30	78	64	15.1
978269	Airside by P-25 near ASIG	30	78	64	13.9
986999	Landside West Wing	50	308	250	4.4

Source: Based on information provided by the Authority.

8.3.3 Fuel Storage Tanks

There are two internal floating roof fuel storage tanks which store Jet A fuel ("Jet Kerosene" in EDMS) at the Airport. Annual fuel consumption in 2012 and fuel tank specifications were obtained from Authority staff and are shown in Table 8-5. Default emission factors in EDMS were used to estimate emissions. Emission factors for storage tanks were provided by EDMS.

Table 8-5
STORAGE FUEL TANK SPECIFICATIONS AND FUEL DISBURSEMENT

Tank Type	Roof Type	Capacity (Gallons/Year)	Tank Height (ft)	Tank Diameter (ft)	Volume Dispensed at Airport (Gallons/Year per tank)
Jet Fuel	Fixed roof with a floating roof inside	1,000,000	28.25	80	140,000,000

Source: Based on information provided by the Authority.

8.3.4 Paint

The annual volumes of airfield marking paint ("Solvent Base," in EDMS) used in 2010, 2011 and 2012 were provided by Authority staff and were reported as the same volume each year—10,490 gallons per year. Future annual paint throughputs are assumed to remain the same. Paint emission factor limit requirements of 100 grams per liter for VOCs were provided by AQMD VOC Rule 1113, but do not account for any additional VOC controls.

8.4 REPORTED EMISSIONS

Each stationary source's respective emission parameters were entered into EDMS to estimate annual emissions in 2012, 2017, 2020, 2030 and 2040. Annual emissions are reported in Tables 8-6. It is important to note that, while emissions from boilers, generators, and paint are expected to remain unchanged in the future, emissions from fuel tank storage increase from 2012 to 2040 because of expected increases in aircraft operations as described in Section 8.2.3.

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Table 8-6
STATIONARY SOURCE EMISSIONS
(Tons)

	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012						
Boilers	0.5	0.1	1.2	>0.0	0.1	0.1
Emergency Generators	1.1	0.2	0.2	0.1	0.1	0.01
Fuel Storage Tanks	—	0.4	—	—	—	—
Paint	—	4.4	—	—	—	—
Total	1.5	5.1	1.4	0.1	0.2	0.2
2017						
Boilers	0.5	0.1	1.2	> 0.0	0.1	0.1
Emergency Generators	1.1	0.2	0.2	0.1	0.1	0.1
Fuel Storage Tanks	—	0.4	—	—	—	—
Paint	—	4.4	—	—	—	—
Total	1.5	5.1	1.4	0.1	0.2	0.2
2020						
Boilers	0.5	0.1	1.2	> 0.0	0.1	0.1
Emergency Generators	1.1	0.2	0.2	0.1	0.1	0.1
Fuel Storage Tanks	—	0.4	—	—	—	—
Paint	—	4.4	—	—	—	—
Total	1.5	5.1	1.4	0.1	0.2	0.2
2030						
Boilers	0.5	0.1	1.2	> 0.0	0.1	0.1
Emergency Generators	1.1	0.2	0.2	0.1	0.1	0.1
Fuel Storage Tanks	—	0.4	—	—	—	—
Paint	—	4.4	—	—	—	—
Total	1.5	5.1	1.4	0.1	0.2	0.2
2040						
Boilers	0.5	0.1	1.2	> 0.0	0.1	0.1
Emergency Generators	1.1	0.2	0.2	0.1	0.1	0.1
Fuel Storage Tanks	—	0.4	—	—	—	—
Paint	—	4.4	—	—	—	—
Total	1.5	5.2	1.4	0.1	0.2	0.2

Numbers may not add due to rounding.

Note: Fuel storage tanks and paint are associated with evaporative emissions, not combustion. Therefore, fuel storage tanks and paint only have emissions associated with VOCs and no emissions associated with NO_x CO, SO_x, PM_{10}, or $PM_{2.5}$.

Source: LeighFisher, February 2016.

Emissions Inventory
San Diego International Airport
SAN680

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9 SUMMARY OF EMISSIONS FOR INCLUSION IN THE CALIFORNIA SIP

This section provides a summary of the following Airport-related emission estimates for the 2012 Baseline Year, the 2017 Forecast Year, the 2020 anticipated attainment year, and two maintenance years, 2030 and 2040:

- **Aircraft engines**—emissions associated with aircraft engines during all phases of movement at or near San Diego International Airport (the Airport)
- **APUs**—emissions associated with the use of aircraft auxiliary power units while parked at passenger gates, cargo stands, or general aviation locations
- **GSE**—emissions associated with motorized equipment used to support aircraft operations at the passenger gate or for maintenance activities
- **Roadways and Parking facilities**—emissions associated with vehicles traveling to, from, and around the Airport, and vehicles utilizing the Airport's parking facilities
- **Construction projects**—emissions associated with routine and growth construction projects
- **Stationary sources**—emissions associated with Authority-owned natural gas boilers and emergency diesel generators, Jet A fuel tank storage, and paint used for airfield marking

9.1 TOTAL EMISSIONS INVENTORY

9.1.1 Total Aircraft Engine Emissions

The estimates for total aircraft engine emissions in 2012, 2017, 2020, 2030 and 2040 are summarized in Table 9-1.

Table 9-1
TOTAL AIRCRAFT ENGINE EMISSIONS
(Tons)

Year	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012	787.4	123.3	652.6	77.8	11.6	11.6
2017	900.5	136.0	693.1	85.8	12.6	12.6
2020	975.7	142.4	725.7	91.8	14.1	14.1
2030	1,203.7	162.5	849.9	110.3	19.7	19.7
2040	1,405.5	177.6	973.5	127.2	24.6	24.6

Source: LeighFisher, February 2016.

As discussed in Section 3, aircraft engine emissions will be incorporated into the SIP based on their engine type: jet or piston. Tables 9-2 and 9-3 summarize emissions for jet engine aircraft and piston engine aircraft respectively

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Table 9-2
TOTAL JET AIRCRAFT ENGINE EMISSIONS
(Tons)

Year	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012	783.5	120.3	627.4	76.9	11.4	11.4
2017	897.9	132.7	674.4	85.1	12.5	12.5
2020	973.8	139.2	710.6	91.3	14.0	14.0
2030	1,202.8	158.9	839.6	110.0	19.6	19.6
2040	1,405.2	175.2	965.5	127.0	24.6	24.6

Source: LeighFisher, February 2016.

Table 9-3
TOTAL PISTON AIRCRAFT ENGINE EMISSIONS
(Tons)

Year	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012	3.8	2.9	25.3	1.0	0.1	0.1
2017	2.6	3.3	18.7	0.7	0.1	0.1
2020	1.9	3.2	15.1	0.5	0.1	0.1
2030	0.9	3.6	10.2	0.3	0.1	0.1
2040	0.3	2.4	8.0	0.1	0.1	0.1

Source: LeighFisher, February 2016.

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9.1.2 Total Aircraft APU Emissions

The estimates for total aircraft APU emissions in 2012, 2017, 2020, 2030 and 2040 are summarized in Table 9-4.

Table 9-4
TOTAL AIRCRAFT APU EMISSIONS
(Tons)

Year	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012	57.9	3.9	49.0	7.8	6.7	6.7
2017	45.7	3.0	34.2	6.4	5.2	5.2
2020	49.4	4.6	35.0	8.2	6.9	6.9
2030	58.9	11.8	42.2	15.7	14.2	14.2
2040	68.8	18.3	49.7	22.5	20.7	20.7

Source: LeighFisher, February 2016.

9.1.3 Total GSE Emissions

The estimates for total GSE emissions in 2012, 2017, 2020, 2030 and 2040 are summarized in Table 9-5.

Table 9-5
TOTAL GSE EMISSIONS
(Tons)

Year	NO_x	VOC	TSP
2012	231.5	20.2	13.1
2017	198.7	18.4	12.5
2020	187.4	17.7	11.9
2030	103.3	10.9	6.0
2040	113.0	11.9	6.5

Source: LeighFisher, February 2016.

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9.1.4 Total Roadways and Parking Garage Emissions

The estimates for total roadway and parking garage emissions in 2012, 2017, 2020, 2030, and 2040 are summarized in Table 9-6.

Table 9-6
TOTAL ROADWAY AND PARKING GARAGE EMISSIONS
(Tons)

Year	NO_X	VOC	CO	SO_X	PM_{10}	$PM_{2.5}$
2012	153.6	133.4	1,059.9	1.5	18.4	8.4
2017	96.0	88.0	668.8	1.5	19.3	8.3
2020	74.7	73.2	535.3	1.4	20.3	8.7
2030	41.6	58.1	396.9	1.2	24.0	10.0
2040	36.0	51.9	379.6	1.2	27.8	11.4

Source: LeighFisher, February 2016.

9.1.5 Total Construction Emissions

The estimates for total growth and routine construction emissions in 2012, 2017, 2020, 2030 and 2040 are summarized in Table 9-7.

Table 9-7
TOTAL CONSTRUCTION EMISSIONS
(Tons)

Year	NO_X	VOC	TSP
2012	35.6	2.5	1.5
2017	51.3	3.9	2.1
2020	583.3	46.5	22.8
2030	244.1	26.7	7.5
2040	244.1	26.7	7.5

Source: LeighFisher, February 2016.

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9.1.6 Total Stationary Source Emissions

The total estimated emissions from stationary sources at San Diego International Airport in 2012, 2017, 2020, 2030 and 2040 are summarized in Table 9-8.

Table 9-8
TOTAL STATIONARY SOURCE EMISSIONS
(Tons)

Year	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012	1.5	5.1	1.4	0.1	0.2	0.2
2017	1.5	5.1	1.4	0.1	0.2	0.2
2020	1.5	5.1	1.4	0.1	0.2	0.2
2030	1.5	5.1	1.4	0.1	0.2	0.2
2040	1.5	5.2	1.4	0.1	0.2	0.2

Source: LeighFisher, February 2016.

9.1.7 Summary of Emissions

The total estimated emissions at San Diego International Airport in 2012, 2017, 2020, 2030 and 2040 are summarized in Table 9-9.

Table 9-9
TOTAL AIRPORT EMISSIONS
(Tons)

Year	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$	TSP
2012	1,267.5	288.4	1,762.9	87.2	36.9	26.9	14.6
2017	1,293.7	254.4	1,397.5	93.8	37.3	26.3	14.6
2020	1,872.0	289.5	1,297.4	101.5	41.5	29.9	34.7
2030	1,653.1	275.1	1,290.4	127.3	58.1	44.1	13.5
2040	1,868.9	291.6	1,404.2	151.0	73.3	56.9	14.0

Note: Due to the specifics of each model used, PM_{10} and $PM_{2.5}$ are reported for Aircraft Operations, APUs, Roadways and Parking, and Stationary Sources. TSP is reported for GSE and Construction emissions.

Source: LeighFisher, February 2016.

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APPENDIX A

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Table A-1
PASSENGER AND CARGO AIRLINES IN THE NMS DATA

Commercial Airlines		Cargo Airlines
Air Canada	Mesa Airlines	ABX Air
Alaska Airlines	Republic Airlines	Atlas Air
Allegiant Air	SkyWest Airlines	Corporate Air
American Airlines	Southwest Airlines	FedEx
American Eagle Airlines	Spirit Airlines	UPS Airlines
British Airways	Sun Country Airlines	
Delta Air Lines	United Airlines	
Frontier Airlines	US Airways	
Hawaiian Airlines	Virgin America	
Horizon Air	Volaris	
JetBlue Airways	WestJet	

Source: LeighFisher, February 2016.

Table A-2
AIR CARRIER AND AIR TAXI AIRCRAFT FRAME TYPES

Air Carrier Aircraft			Air Taxi Aircraft
Airbus A300F4-600	Boeing 737-900	Boeing DC-10-30	Bombardier Challenger 300
Airbus A318-100	Boeing 737-900-ER	Boeing MD-10-1 Freighter	Bombardier Challenger 601
Airbus A319-100	Boeing 747-400 Freighter	Boeing MD-10-30	Bombardier CRJ-100
Airbus A320-200	Boeing 757-200 Freighter	Boeing MD-11 Freighter	Bombardier CRJ-200-ER
Airbus A321-200	Boeing 757-200	Boeing MD-82	Bombardier CRJ-200-LR
Airbus A330-200	Boeing 757-300	Boeing MD-83	Bombardier Global Express
Boeing 737-300	Boeing 767-200 ER	Boeing MD-90	Cessna 208 Caravan
Boeing 737-400	Boeing 767-200 Freighter	Bombardier CRJ-700-ER	Embraer EMB120 Brasilia
Boeing 737-500	Boeing 767-300	Bombardier CRJ-900-ER	Embraer ERJ135-LR
Boeing 737-600	Boeing 767-300 ER	Bombardier Dash 8 Q400	Bombardier Challenger 300
Boeing 737-700	Boeing 767-300	Embraer ERJ190-AR	Bombardier Challenger 601
Boeing 737-800	Boeing 777-200-ER	Embraer ERJ190-LR	
Boeing 737-800 Winglets	Boeing 787-800		

Source: LeighFisher, February 2016.

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Table A-3
PASSENGER AIRCRAFT: BASELINE YEAR FLEET MIX

Aircraft Frame Type	Engine Model	Engine Type	Percent of Baseline Operations
Airbus A318-100 Series	CFM CFM56-5B8/P	Jet	0.1%
Airbus A319-100 Series	CFM CFM56-5A5	Jet	1.1%
Airbus A319-100 Series	CFM CFM56-5B5/P	Jet	1.1%
Airbus A319-100 Series	CFM CFM56-5B6/P	Jet	0.4%
Airbus A319-100 Series	CFM CFM56-5B7/P	Jet	0.1%
Airbus A319-100 Series	IAE V2522-A5	Jet	1.0%
Airbus A319-100 Series	IAE V2524-A5	Jet	1.4%
Airbus A319-100 Series	IAE V2527M-A5	Jet	0.1%
Airbus A320-200 Series	CFM CFM56-5A1	Jet	0.3%
Airbus A320-200 Series	CFM CFM56-5A3	Jet	1.2%
Airbus A320-200 Series	CFM CFM56-5B4	Jet	2.0%
Airbus A320-200 Series	IAE V2500-A1	Jet	0.2%
Airbus A320-200 Series	IAE V2527-A5	Jet	6.1%
Airbus A320-200 Series	IAE V2527E-A5	Jet	>0.0%
Airbus A320-Neo	CFM56-5B4/3	Jet	n/a
Airbus A321-200 Series	CFM CFM56-5B3/P	Jet	0.1%
Airbus A321-200 Series	IAE V2533-A5	Jet	2.5%
Airbus A330-200 Series	Trent 772	Jet	0.2%
Airbus A350 Series	Trent XWB	Jet	n/a
Boeing 717 Series	BR700-715A1-30 IFI	Jet	n/a
Boeing 737-300 Series	CFM CFM56-3B1	Jet	8.8%
Boeing 737-300 Series	CFM CFM56-3B2	Jet	0.6%
Boeing 737-400 Series	CFM CFM56-3C1	Jet	1.5%
Boeing 737-500 Series	CFM CFM56-3B1	Jet	0.8%
Boeing 737-500 Series	CFM CFM56-3C1	Jet	>0.0%
Boeing 737-600 Series	CFM CFM56-7B20	Jet	>0.0%
Boeing 737-700 Series	CFM CFM56-7B20	Jet	0.3%
Boeing 737-700 Series	CFM CFM56-7B22	Jet	27.1%
Boeing 737-700 Series	CFM CFM56-7B24	Jet	0.8%
Boeing 737-800 Series	CFM56-7B26 (8CM051)	Jet	>0.0%
Boeing 737-800 with winglets	CFM CFM56-7B24	Jet	2.2%
Boeing 737-800 with winglets	CFM CFM56-7B27	Jet	1.3%
Boeing 737-800 with winglets	CFM56-7B26 (8CM051)	Jet	7.9%
Boeing 737-900 Series	CFM CFM56-7B24	Jet	0.1%
Boeing 737-900 Series	CFM56-7B26 (8CM051)	Jet	0.3%
Boeing 737-900-ER	CFM CFM56-7B24	Jet	0.2%
Boeing 737-900-ER	CFM56-7B26 (8CM051)	Jet	1.2%
Boeing 737-Max	CFM56-7B24	Jet	n/a

(continued on next page)

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Table A-3 *(continued)*
PASSENGER AIRCRAFT: BASELINE YEAR FLEET MIX

Aircraft Frame Type	Engine Model	Engine Type	Percent of Baseline Operations
Boeing 757-200 Series	PW PW2037	Jet	5.1%
Boeing 757-200 Series	PW PW2040	Jet	>0.0%
Boeing 757-200 Series	RB211-535E4B Phase 5	Jet	0.5%
Boeing 757-300 Series	PW PW2043	Jet	>0.0%
Boeing 757-300 Series	RB211-535E4B Phase 5	Jet	>0.0%
Boeing 767-200 ER	GE CF6-80A2	Jet	>0.0%
Boeing 767-300 ER	GE CF6-80C2B6	Jet	0.4%
Boeing 767-300 ER	PW PW4x52	Jet	>0.0%
Boeing 767-300 ER	PW PW4062	Jet	0.1%
Boeing 767-300 ER	PW4060 Reduced Smoke	Jet	0.2%
Boeing 767-300 Series	GE CF6-80A2	Jet	0.3%
Boeing 767-300 Series	PW4060 Reduced Smoke	Jet	>0.0%
Boeing 777-200-ER	RR Trent 895	Jet	0.4%
Boeing 787-800	GE GEnx-1B64/P1	Jet	>0.0%
Boeing 787-900	GE GEnx-1B64/P1	Jet	n/a
Boeing MD-82	PW JT8D-217	Jet	0.8%
Boeing MD-82	PW JT8D-219	Jet	0.8%
Boeing MD-83	PW JT8D-217	Jet	>0.0%
Boeing MD-83	PW JT8D-219	Jet	1.3%
Boeing MD-90	IAE V2525-D5	Jet	0.2%
Boeing MD-90	IAE V2528-D5	Jet	0.3%
Bombardier CRJ-100	GE CF34-3A1	Jet	0.3%
Bombardier CRJ-200-ER	GE CF34-3B	Jet	0.7%
Bombardier CRJ-200-LR	GE CF34-3B	Jet	2.0%
Bombardier CRJ-700-ER	GE CF34-8C1	Jet	1.0%
Bombardier CRJ-700-ER	GE CF34-8C5A3	Jet	2.1%
Bombardier CRJ-900-ER	CF34-8C5 LEC (8GE110)	Jet	0.2%
Bombardier de Havilland Dash 8 Q400	PWC PW150A	Piston	1.0%
Embraer EMB120 Brasilia	PWC PW118	Piston	6.6%
Embraer ERJ135-LR	RR AE3007-A1/3 Type 1	Jet	4.2%
Embraer ERJ190-AR	CF34-10E5 2253M21	Jet	0.4%
Embraer ERJ190-AR	CF34-10E6 2253M21-PFN	Jet	>0.0%
Embraer ERJ190-LR	CF34-10E5 2253M21	Jet	>0.0%

Source: LeighFisher, February 2016.

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Table A-4
CARGO AIRCRAFT: BASELINE YEAR FLEET MIX

Aircraft Frame Type	Engine Model	Engine Type	Percent of Baseline Operations
Airbus A300F4-600 Series	GE CF6-80C2A5	Jet	12.6%
Airbus A300F4-600 Series	PW PW4158	Jet	5.0%
Boeing 747-400 Freighter	CF6-80C2B1F (1GE024)	Jet	>0.0%
Boeing 757-200 Freighter	PW2040	Jet	0.1%
Boeing 757-200 Freighter	RR RB211-535E4	Jet	0.1%
Boeing 767-200 Freighter	GE CF6-80A2	Jet	4.9%
Boeing 767-200 Freighter	0012 2 PW JT9D-7R4D	Jet	0.5%
Boeing 767-300	GE CF6-80C2B6	Jet	15.0%
Bombardier Challenger 300	HTF7000	Jet	0.1%
Bombardier Challenger 601	GE CF34-3A	Jet	0.1%
Bombardier Global Express	RR BR710A2-20	Jet	0.1%
Cessna 208 Caravan	PWC PT6A-114	Piston	10.0%
Cessna 208 Caravan	PWC PT6A-114A	Piston	17.2%
Boeing DC-10-30 Series	GE CF6-50C2	Jet	0.7%
Boeing MD-10-1 Freighter	GE CF6-6D	Jet	19.4%
Boeing MD-10-30	GE CF6-50C2	Jet	13.9%
Boeing MD-11 Freighter	GE CF6-80C2D1F	Jet	0.2%
Boeing MD-11 Freighter	PW PW4462	Jet	>0.0%

Source: LeighFisher, February 2016.

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Table A-5
GENERAL AVIATION AIRCRAFT: BASELINE YEAR FLEET MIX

Aircraft Frame Type	Engine Model	Engine Type	Percent of Baseline Operations
Boeing 757-200 Series	rB211-535E4 Phase 5	Jet	0.2%
Bombardier Challenger 300	HTF7000	Jet	2.8%
Bombardier Challenger 600	CF34-3B	Jet	2.6%
Bombardier Challenger 601	CF34-3A	Jet	0.3%
Bombardier Challenger 604	CF34-3B	Jet	0.5%
Bombardier Learjet 31	TFE731-2-2b	Jet	0.3%
Bombardier Learjet 35A	TFE731-2/2A	Jet	0.2%
Bombardier Learjet 40	TFE731-2-2B	Jet	0.7%
Bombardier Learjet 45	GA TFE731-2-2B	Jet	0.5%
Bombardier Learjet 45-XR	TFE731-2-2B	Jet	2.1%
Bombardier Learjet 60	PW306A	Jet	2.1%
Cessna 172 Skyhawk	IO-360-B	Piston	0.4%
Cessna 525 CitationJet	JT 15D-1	Jet	3.3%
Cessna 550 Citation II	JT15D-4	Jet	0.6%
Cessna 550 Citation II	PW530	Jet	0.4%
Cessna 560 Citation Excel	JT15D-5	Jet	12.4%
Cessna 560 Citation XLS	JT15D-5	Jet	6.4%
Cessna 650 Citation III	TFE731-3	Jet	1.2%
Cessna 680 Citation Sovereign	PW306B	Jet	4.9%
Cessna 750 Citation X	AE3007C Type 2	Jet	4.7%
Dassault Falcon 2000	PW308C	Jet	1.3%
Dassault Falcon 2000-EX	PW308C	Jet	2.9%
Dassault Falcon 50	TFE731-3	Jet	1.4%
Dassault Falcon 900	TFE731-3	Jet	0.7%
Dassault Falcon 900-EX	TFE731-3	Jet	1.6%
Eclipse 500	PW610F	Jet	1.2%
Embraer ERJ135 Legacy Business	AE3007A1E	Jet	0.8%
Falcon 7X	PW307A TALON II (11PW100)	Jet	0.6%
Gulfstream G150	TFE731-3	Jet	1.7%
Gulfstream G200	PW306A	Jet	5.7%
Gulfstream G280	HTF7250G	Jet	0.8%
Gulfstream G450	TAY 611-8C	Jet	1.5%
Gulfstream G550	BR710C4-11	Jet	0.4%
Gulfstream IV-SP	TAY 611-8C	Jet	6.4%
Gulfstream V-SP	BR710C4-11	Jet	4.3%
Piaggio P.180 Avanti	PT6A-66	Piston	5.4%
Pilatus PC-12	PT6A-67B	Piston	1.6%
Piper PA46-TP Meridian	PT6A-42	Piston	0.7%
Raytheon Beechjet 400	JT15D-5	Jet	4.8%
Raytheon Hawker 800	TFE731-3	Jet	3.0%
Raytheon Hawker 900XP	TFE731-2/2A	Jet	3.0%
Raytheon Super King Air 200	PT6A-42	Piston	1.6%
Raytheon Super King Air 300	PT6A-60A	Piston	2.0%

Source: LeighFisher, February 2016.

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Table A-6
PASSENGER AIRCRAFT ANNUAL OPERATIONS

		LTOs				
Aircraft Frame Type	Engine Type	2012	2017	2020	2030	2040
Airbus A318-100 Series	CFM CFM56-5B8/P	44	0	0	0	0
Airbus A319-100 Series	CFM CFM56-5A5	929	667	652	666	325
Airbus A319-100 Series	CFM CFM56-5B5/P	367	264	258	263	128
Airbus A319-100 Series	CFM CFM56-5B6/P	840	603	590	602	294
Airbus A319-100 Series	CFM CFM56-5B7/P	1,234	886	866	885	431
Airbus A319-100 Series	IAE V2522-A5	926	665	650	664	324
Airbus A319-100 Series	IAE V2524-A5	64	46	45	46	23
Airbus A319-100 Series	IAE V2527M-A5	115	83	81	83	40
Airbus A320-200 Series	CFM CFM56-5A1	1,684	1,437	1,234	375	0
Airbus A320-200 Series	CFM CFM56-5A3	228	195	167	51	0
Airbus A320-200 Series	CFM CFM56-5B4	1,015	866	744	226	0
Airbus A320-200 Series	IAE V2500-A1	184	157	135	41	0
Airbus A320-200 Series	IAE V2527-A5	5,241	4,471	3,839	1,166	0
Airbus A320-200 Series	IAE V2527E-A5	2	2	2	1	0
Airbus A320-Neo	CFM56-5B4/3	0	446	1,869	7,347	11,840
Airbus A321-200 Series	CFM CFM56-5B3/P	121	118	125	146	142
Airbus A321-200 Series	IAE V2533-A5	2,183	2,133	2,249	2,622	2,556
Airbus A330-200 Series	Trent 772	168	366	380	427	468
Airbus A350 Series	Trent XWB	0	0	0	0	152
Boeing 717 Series	BR700-715A1-30 IFI	0	902	951	587	0
Boeing 737-300 Series	CFM CFM56-3B1	7,523	4,566	2,552	0	0
Boeing 737-300 Series	CFM CFM56-3B2	485	295	165	0	0
Boeing 737-400 Series	CFM CFM56-3C1	1,282	778	435	0	0
Boeing 737-500 Series	CFM CFM56-3B1	729	0	0	0	0
Boeing 737-500 Series	CFM CFM56-3C1	34	0	0	0	0
Boeing 737-600 Series	CFM CFM56-7B20	1	0	0	0	0
Boeing 737-700 Series	CFM CFM56-7B20	275	337	371	398	373
Boeing 737-700 Series	CFM CFM56-7B22	23,270	28,492	31,389	33,645	31,586
Boeing 737-700 Series	CFM CFM56-7B24	686	840	926	992	931
Boeing 737-800 Series	CFM56-7B26 (8CM051)	5	8	8	10	11
Boeing 737-800 with winglets	CFM CFM56-7B24	1,854	2,791	2,938	3,480	3,981
Boeing 737-800 with winglets	CFM CFM56-7B27	1,119	1,684	1,773	2,101	2,403
Boeing 737-800 with winglets	CFM56-7B26 (8CM051)	6,744	10,150	10,685	12,659	14,481
Boeing 737-900 Series	CFM CFM56-7B24	56	202	230	455	583
Boeing 737-900 Series	CFM56-7B26 (8CM051)	268	965	1,100	2,178	2,790
Boeing 737-900-ER	CFM CFM56-7B24	188	677	771	1,528	1,957
Boeing 737-900-ER	CFM56-7B26 (8CM051)	1,029	3,705	4,221	8,362	10,712
Boeing 737-Max	CFM56-7B24	0	0	1,491	9,441	16,995

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Table A-6 *(continued)*
PASSENGER AIRCRAFT ANNUAL OPERATIONS

Aircraft Frame Type	Engine Type	LTOs 2012	2017	2020	2030	2040
Boeing 757-200 Series	PW PW2037	4,363	4,622	4,876	1,366	0
Boeing 757-200 Series	PW PW2040	10	11	11	3	0
Boeing 757-200 Series	RB211-535E4B Phase 5	396	420	443	124	0
Boeing 757-300 Series	RB211-535E4B Phase 5	10	11	11	3	0
Boeing 757-300 Series	PW PW2043	8	9	9	3	0
Boeing 767-200 ER	GE CF6-80A2	4	5	5	6	7
Boeing 767-300 ER	PW PW4062	65	81	84	95	104
Boeing 767-300 ER	GE CF6-80C2B6	318	396	411	462	507
Boeing 767-300 ER	PW4060 Reduced Smoke	158	197	205	230	252
Boeing 767-300 ER	PW PW4x52	1	1	2	2	2
Boeing 767-300 Series	GE CF6-80A2	298	371	386	433	475
Boeing 767-300 Series	PW4060 Reduced Smoke	37	46	48	54	59
Boeing 777-200-ER	RR Trent 895	383	366	290	436	481
Boeing 787-800 Series	GE GEnx-1B64/P1	20	357	832	1,137	2,120
Boeing 787-900 Series	GE GEnx-1B64/P1	0	0	0	521	912
Boeing MD-82	PW JT8D-219	676	104	0	0	0
Boeing MD-82	PW JT8D-217	694	107	0	0	0
Boeing MD-83	PW JT8D-219	1,093	168	0	0	0
Boeing MD-83	PW JT8D-217	12	2	0	0	0
Boeing MD-90	IAE V2525-D5	209	313	330	298	0
Boeing MD-90	IAE V2528-D5	292	437	461	416	0
Bombardier CRJ-100	GE CF34-3A1	253	240	41	0	0
Bombardier CRJ-200-ER	GE CF34-3B	618	587	101	0	0
Bombardier CRJ-200-LR	GE CF34-3B	1,678	3,730	4,441	4,993	4,573
Bombardier CRJ-700-ER	GE CF34-8C1	886	162	193	217	199
Bombardier CRJ-700-ER	GE CF34-8C5A3	1,822	333	397	446	409
Bombardier CRJ-900-ER	CF34-8C5 LEC (8GE110)	206	38	45	51	46
Bombardier Dash 8 Q400	PWC PW150A	842	938	832	965	0
Embraer EMB120 Brasilia	PWC PW118	5,626	3,048	1,917	0	0
Embraer ERJ135-LR	RR AE3007-A1/3 Type 1	3,595	1,955	2,006	18	19
Embraer ERJ190-AR	CF34-10E5 2253M21	316	330	343	386	423
Embraer ERJ190-AR	CF34-10E6 2253M21-PFN	22	23	24	27	30
Embraer ERJ190-LR	CF34-10E5 2253M21	12	13	13	15	16

Source: LeighFisher, February 2016.

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Table A-7
CARGO AIRCRAFT ANNUAL OPERATIONS

Aircraft Frame Type	Engine Type	LTOs 2012	2017	2020	2030	2040
Airbus A300F4-600 Series	GE CF6-80C2A5	44	0	0	0	0
Airbus A300F4-600 Series	PW PW4158	929	667	652	666	325
Boeing 747-400 Freighter	CF6-80C2B1F (1GE024)	367	264	258	263	128
Boeing 757-200 Freighter	PW PW2040	840	603	590	602	294
Boeing 757-200 Freighter	RR RB211-535E4	1,234	886	866	885	431
Boeing 767-200 Freighter	GE CF6-80A2	926	665	650	664	324
Boeing 767-200 Freighter	0012 2 PW JT9D-7R4D	64	46	45	46	23
Boeing 767-300	GE CF6-80C2B6	115	83	81	83	40
Bombardier Challenger 300	HTF7000	1,684	1,437	1,234	375	0
Bombardier Challenger 601	GE CF34-3A	228	195	167	51	0
Bombardier Global Express	RR BR710A2-20	1,015	866	744	226	0
Cessna 208 Caravan	PWC PT6A-114	184	157	135	41	0
Cessna 208 Caravan	PWC PT6A-114A	5,241	4,471	3,839	1,166	0
Boeing DC-10-30 Series	GE CF6-50C2	2	2	2	1	0
Boeing MD-10-1 Freighter	GE CF6-6D	0	446	1,869	7,347	11,840
Boeing MD-10-30	GE CF6-50C2	121	118	125	146	142
Boeing MD-11 Freighter	GE CF6-80C2D1F	2,183	2,133	2,249	2,622	2,556
Boeing MD-11 Freighter	PW PW4460	168	366	380	427	468

Source: LeighFisher, February 2016.

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Table A-8
GENERAL AVIATION AIRCRAFT ANNUAL OPERATIONS (LTOs)

Aircraft	Engine	2012	2017	2020	2030	2040
Boeing 757-200 Series	rB211-535E4 Phase 5	12	14	14	16	17
Bombardier Challenger 300	HTF7000	138	156	161	176	189
Bombardier Challenger 600	CF34-3B	128	145	149	163	176
Bombardier Challenger 601	CF34-3A	17	19	20	22	24
Bombardier Challenger 604	CF34-3B	26	30	31	33	36
Bombardier Learjet 31	TFE731-2-2b	13	15	15	17	18
Bombardier Learjet 35A	TFE731-2/2A	12	14	14	16	17
Bombardier Learjet 40	TFE731-2-2B	35	40	41	45	48
Bombardier Learjet 45	GA TFE731-2-2B	25	29	29	32	35
Bombardier Learjet 45-XR	TFE731-2-2B	106	120	124	135	146
Bombardier Learjet 60	PW306A	104	118	121	133	143
Cessna 172 Skyhawk	IO-360-B	22	25	26	28	30
Cessna 525 CitationJet	JT 15D-1	165	187	192	210	226
Cessna 550 Citation II	JT15D-4	29	33	34	37	40
Cessna 550 Citation II	PW530	19	22	22	24	26
Cessna 560 Citation Excel	JT15D-5	611	690	711	780	837
Cessna 560 Citation XLS	JT15D-5	314	355	366	400	431
Cessna 650 Citation III	TFE731-3	57	65	67	73	78
Cessna 680 Citation Sovereign	PW306B	241	273	281	307	331
Cessna 750 Citation X	AE3007C Type 2	230	260	268	293	315
Dassault Falcon 2000	PW308C	66	75	77	84	91
Dassault Falcon 2000-EX	PW308C	142	161	165	181	195
Dassault Falcon 50	TFE731-3	70	79	82	89	96
Dassault Falcon 900	TFE731-3	33	38	39	42	45
Dassault Falcon 900-EX	TFE731-3	79	90	92	101	109
Eclipse 500	PW610F	59	67	69	75	81
Embraer ERJ135 Legacy Business	AE3007A1E	39	44	46	50	54
Falcon 7X	PW307A TALON II (11PW100)	28	32	33	36	39
Gulfstream G150	TFE731-3	83	94	97	106	114
Gulfstream G200	PW306A	283	320	330	361	388
Gulfstream G280	HTF7250G	41	47	48	52	56
Gulfstream G450	TAY 611-8C	72	82	84	92	99
Gulfstream G550	BR710C4-11	20	23	24	26	28
Gulfstream IV-SP	TAY 611-8C	317	359	369	404	435
Gulfstream V-SP	BR710C4-11	214	242	249	273	294
Piaggio P.180 Avanti	PT6A-66	269	304	313	343	369
Pilatus PC-12	PT6A-67B	77	87	90	98	106
Piper PA46-TP Meridian	PT6A-42	36	41	42	46	50
Raytheon Beechjet 400	JT15D-5	236	267	275	301	324
Raytheon Hawker 800	TFE731-3	149	169	174	190	204
Raytheon Hawker 900XP	TFE731-2/2A	146	165	170	186	200
Raytheon Super King Air 200	PT6A-42	77	87	90	98	106
Raytheon Super King Air 300	PT6A	98	111	114	125	135

Source: LeighFisher, February 2016.

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APPENDIX B

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Table B-1
PASSENGER AIRCRAFT APU AND LTO APU DURATION

AIRCRAFT FRAME TYPE	APU TYPE	LTO APU TIME (minutes)				
		2012	2017	2020	2030	2040
Airbus A318-100 Series	APU GTCP 36-300 (80HP)	26	18	18	18	18
Airbus A319-100 Series	APU GTCP 36-300 (80HP)	39	26	26	26	26
Airbus A320-200 Series	APU GTCP 36-300 (80HP)	55	37	37	37	37
Airbus A320-NEO	APU GTCP 36-300 (80HP)	55	37	37	37	37
Airbus A321-200 Series	APU GTCP 36-300 (80HP)	73	49	49	49	49
Airbus A330-200 Series	APU GTCP 331-350	89	60	60	60	60
Airbus A350 Series	APU GTCP331-500 (143 HP)	78	53	53	53	53
Boeing 717 Series	APU GTCP 85 (200 HP)	53	36	36	36	36
Boeing 737-300 Series	APU GTCP85-129 (200 HP)	29	20	20	20	20
Boeing 737-400 Series	APU GTCP85-129 (200 HP)	56	38	38	38	38
Boeing 737-500 Series	APU GTCP85-129 (200 HP)	34	23	23	23	23
Boeing 737-600 Series	APU 131-9	45	30	30	30	30
Boeing 737-700 Series	APU 131-9	33	22	22	22	22
Boeing 737-800 Series	APU 131-9	61	41	41	41	41
Boeing 737-800 with winglets	APU 131-9	70	47	47	47	47
Boeing 737-900 Series	APU 131-9	55	37	37	37	37
Boeing 737-900-ER	APU 131-9	55	37	37	37	37
Boeing 737-MAX	APU 131-9	55	37	37	37	37
Boeing 757-200 Series	APU GTCP331-200ER (143 HP)	61	41	41	41	41
Boeing 757-300 Series	APU GTCP331-200ER (143 HP)	61	41	41	41	41
Boeing 767-200 ER	APU GTCP331-200ER (143 HP)	89	60	60	60	60
Boeing 767-300 ER	APU GTCP331-200ER (143 HP)	89	60	60	60	60
Boeing 767-300 Series	APU GTCP331-200ER (143 HP)	89	60	60	60	60
Boeing 777-200-ER	APU GTCP331-500 (143 HP)	82	55	55	55	55
Boeing 787-800 Series	APU GTCP331-500 (143 HP)	78	53	53	53	53
Boeing 787-900 Series	APU GTCP331-500 (143 HP)	78	53	53	53	53
Boeing MD-82	APU GTCP85-98 (200 HP)	61	41	41	41	41
Boeing MD-83	APU GTCP85-98 (200 HP)	61	41	41	41	41
Boeing MD-90	APU 131-9	53	36	36	36	36
Bombardier CRJ-100	APU GTCP 36-150[RR]	26	18	18	18	18
Bombardier CRJ-200-ER	APU GTCP 36-150[RR]	26	18	18	18	18
Bombardier CRJ-200-LR	APU GTCP 36-150[RR]	26	18	18	18	18
Bombardier CRJ-700-ER	APU GTCP 36-150[RR]	58	39	39	39	39
Bombardier CRJ-900-ER	APU GTCP 36-150[RR]	26	18	18	18	18
Bombardier de Havilland Dash 8	APU GTCP 36-150[RR]	24	16	16	16	16
Embraer EMB120 Brasilia	APU GTCP 36-150[]	15	10	10	10	10
Embraer ERJ135-LR	APU GTCP 36-150[]	32	21	21	21	21
Embraer ERJ190-AR	APU GTCP 36-150[]	35	24	24	24	24
Embraer ERJ190-LR	APU GTCP 36-150[]	35	24	24	24	24

Source: LeighFisher, February 2016.

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Table B-2
CARGO AIRCRAFT APU AND LTO APU DURATION

AIRCRAFT FRAME TYPE	APU TYPE	LTO APU TIME (minutes) 2012	2017	2020	2030	2040
Bombardier Challenger 601	APU GTCP 36-100	40	40	40	40	40
Bombardier Challenger 300	APU GTCP 36-150[]	40	40	40	40	40
Bombardier Global Express	APU GTCP 85 (200 HP)	40	40	40	40	40
Airbus A300F4-600 Series	APU GTCP331-200ER (143 HP)	40	40	40	40	40
Boeing 757-200 Freighter	APU GTCP331-200ER (143 HP)	40	40	40	40	40
Boeing 767-200 Freighter	APU GTCP331-200ER (143 HP)	40	40	40	40	40
Boeing 767-300	APU GTCP331-200ER (143 HP)	40	40	40	40	40
Boeing 747-400 Freighter	APU PW901A	40	40	40	40	40
Boeing DC-10-30 Series	APU TSCP700-4B (142 HP)	40	40	40	40	40
Boeing MD-10-1 Freighter	APU TSCP700-4B (142 HP)	40	40	40	40	40
Boeing MD-11 Freighter	APU TSCP700-4B (142 HP)	40	40	40	40	40
Cessna 208 Caravan	No APU					

Source: LeighFisher, February 2016.

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Table B-3
GENERAL AVIATION AIRCRAFT APU AND LTO APU DURATION

AIRCRAFT FRAME TYPE	APU TYPE	LTO APU TIME (minutes) 2012	2017	2020	2030	2040
Boeing 757-200 Series	APU GTCP331-200ER (143 HP)	26	26	26	26	26
Bombardier Challenger 300	APU GTCP 36-150[]	26	26	26	26	26
Bombardier Challenger 600	APU GTCP 36-100	26	26	26	26	26
Bombardier Challenger 601	APU GTCP 36-100	26	26	26	26	26
Bombardier Challenger 604	APU GTCP 36-100	26	26	26	26	26
Bombardier Learjet 40	APU GTCP 36-100	26	26	26	26	26
Bombardier Learjet 45	APU GTCP 36-100	26	26	26	26	26
Bombardier Learjet 45-XR	APU GTCP 36-100	26	26	26	26	26
Bombardier Learjet 60	APU GTCP 36-100	26	26	26	26	26
Cessna 525 CitationJet	APU GTCP 36-100	26	26	26	26	26
Cessna 550 Citation II	APU GTCP 36-100	26	26	26	26	26
Cessna 560 Citation Excel	APU GTCP 36-100	26	26	26	26	26
Cessna 560 Citation XLS	APU GTCP 36-100	26	26	26	26	26
Cessna 650 Citation III	APU GTCP 36-100	26	26	26	26	26
Cessna 680 Citation Sovereign	APU GTCP 36-100	26	26	26	26	26
Cessna 750 Citation X	APU GTCP 36-100	26	26	26	26	26
Dassault Falcon 2000	APU GTCP 36-150[]	26	26	26	26	26
Dassault Falcon 2000-EX	APU GTCP 36-150[]	26	26	26	26	26
Dassault Falcon 50	APU GTCP 36-100	26	26	26	26	26
Dassault Falcon 900	APU GTCP 36-150[]	26	26	26	26	26
Dassault Falcon 900-EX	APU GTCP 36-150[]	26	26	26	26	26
Embraer ERJ135 Legacy Business	APU GTCP 36-150[]	26	26	26	26	26
Falcon 7X	APU GTCP 36-150[]	26	26	26	26	26
Gulfstream G150	APU GTCP 36-150[]	26	26	26	26	26
Gulfstream G200	APU GTCP 36-150[]	26	26	26	26	26
Gulfstream G280	APU GTCP 36-150[]	26	26	26	26	26
Gulfstream G450	APU GTCP 36-100	26	26	26	26	26
Gulfstream G550	APU GTCP 36 (80HP)	26	26	26	26	26
Gulfstream IV-SP	APU GTCP 36-100	26	26	26	26	26
Gulfstream V-SP	APU GTCP 36-100	26	26	26	26	26
Raytheon Hawker 800	APU GTCP 36-150[]	26	26	26	26	26
Raytheon Hawker 900XP	APU GTCP 36-150[]	26	26	26	26	26
Raytheon Super King Air 300	APU GTCP 36-150[]	26	26	26	26	26
Bombardier Learjet 31	No APU					
Bombardier Learjet 35A	No APU					
Cessna 172 Skyhawk	No APU					
Eclipse 500	No APU					
Piaggio P.180 Avanti	No APU					
Pilatus PC-12	No APU					
Piper PA46-TP Meridian	No APU					
Raytheon Beechjet 400	No APU					
Raytheon Super King Air 200	No APU					

Source: LeighFisher, February 2016.

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Table B-4
EMISSIONS ASSOCIATED WITH AIRCRAFT APU ACTIVITY BY REPORT CATEGORY *(Tons)*

Passenger	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012	55.2	3.7	44.8	7.5	6.4	6.4
2017	42.6	2.8	29.4	6.0	4.9	4.9
2020	46.2	4.4	30.1	7.8	6.5	6.5
2030	55.2	11.5	36.8	15.2	13.8	13.8
2040	64.8	18.0	43.8	22.0	20.3	20.3

Cargo	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012	1.94	0.10	0.87	0.22	0.15	0.15
2017	2.25	0.12	1.02	0.26	0.18	0.18
2020	2.35	0.12	1.06	0.27	0.18	0.18
2030	2.73	0.14	1.24	0.31	0.21	0.21
2040	3.01	0.16	1.36	0.35	0.24	0.24

General Aviation	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012	0.683	0.088	3.028	0.133	0.123	0.123
2017	0.765	0.1	3.419	0.149	0.138	0.138
2020	0.787	0.102	3.52	0.154	0.143	0.143
2030	0.862	0.112	3.854	0.168	0.156	0.156
2040	0.927	0.121	4.145	0.181	0.168	0.168

Military	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012	0.056	0.007	0.328	0.011	0.01	0.01
2017	0.059	0.007	0.344	0.011	0.01	0.01
2020	0.059	0.007	0.344	0.011	0.01	0.01
2030	0.059	0.007	0.344	0.011	0.01	0.01
2040	0.059	0.007	0.344	0.011	0.01	0.01

Total	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012	57.9	3.9	49.0	7.8	6.7	6.7
2017	45.7	3.0	34.2	6.4	5.2	5.2
2020	49.4	4.6	35.0	8.2	6.9	6.9
2030	58.9	11.8	42.2	15.7	14.2	14.2
2040	68.8	18.3	49.7	22.5	20.7	20.7

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

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APPENDIX C

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Table C-1 *(Page 1 of 2)*

OFFROAD RESULTS FOR AIRPORT GROUND SUPPORT EQUIPMENT IN THE SAN DIEGO AIR BASIN

		OFFROAD	Annual Output (Tons)					Avg	Load	Calculated Emission Factor (G/HP Hr)			
Year	Basin	Equipment Type	NOx	PM	HC	Hours	Count	HP	Factor	NOx EF	PM EF	HC EF	VOC EF
2012	SD	A/C Tug Narrow Body	4.05	0.23	0.32	7,345	24.3	132	0.54	7.06	0.40	0.55	0.58
2012	SD	A/C Tug Wide Body	3.23	0.11	0.17	4,179	11.5	248	0.54	5.26	0.18	0.28	0.29
2012	SD	Baggage Tug	4.07	0.32	0.44	11,660	17.3	74	0.37	11.54	0.91	1.25	1.32
2012	SD	Belt Loader	1.85	0.15	0.21	7,035	14.9	75	0.34	9.57	0.78	1.09	1.14
2012	SD	Bobtail	0.46	0.02	0.03	1,244	3.1	144	0.37	6.32	0.25	0.42	0.44
2012	SD	Cargo Loader	3.37	0.21	0.26	14,225	32.8	117	0.34	5.50	0.35	0.42	0.45
2012	SD	Cargo Tractor	4.29	0.32	0.42	13,364	21.8	94	0.36	8.60	0.65	0.84	0.88
2012	SD	Forklift (GSE)	1.54	0.10	0.14	8,279	23.8	107	0.20	7.84	0.50	0.69	0.72
2012	SD	Lift (GSE)	1.02	0.07	0.09	5,427	14.2	95	0.34	5.39	0.38	0.47	0.50
2012	SD	Other GSE	8.14	0.45	0.68	33,855	77.1	108	0.34	6.04	0.33	0.50	0.53
2012	SD	Passenger Stand	0.03	0.00	0.00	212	4.8	70	0.40	4.87	0.31	0.44	0.46
2017	SD	A/C Tug Narrow Body	3.48	0.20	0.27	8,672	27.1	132	0.54	5.13	0.29	0.39	0.42
2017	SD	A/C Tug Wide Body	2.97	0.11	0.17	4,935	12.8	248	0.54	4.10	0.15	0.23	0.25
2017	SD	Baggage Tug	4.85	0.39	0.54	13,767	19.3	74	0.37	11.67	0.94	1.29	1.36
2017	SD	Belt Loader	1.85	0.17	0.22	8,307	16.6	75	0.34	8.08	0.72	0.96	1.01
2017	SD	Bobtail	0.41	0.02	0.03	1,469	3.4	144	0.37	4.71	0.24	0.35	0.37
2017	SD	Cargo Loader	2.58	0.14	0.19	16,795	36.6	117	0.34	3.56	0.20	0.26	0.27
2017	SD	Cargo Tractor	4.17	0.32	0.41	15,779	24.3	94	0.36	7.07	0.55	0.70	0.74
2017	SD	Forklift (GSE)	1.48	0.10	0.13	9,775	26.5	107	0.20	6.35	0.42	0.58	0.61
2017	SD	Lift (GSE)	0.95	0.07	0.08	6,407	15.8	95	0.34	4.24	0.29	0.37	0.39
2017	SD	Other GSE	6.74	0.39	0.61	39,972	86.0	108	0.34	4.24	0.24	0.38	0.40
2017	SD	Passenger Stand	0.03	0.00	0.00	250	5.4	70	0.40	3.48	0.17	0.22	0.23
2020	SD	A/C Tug Narrow Body	3.12	0.18	0.24	9,048	27.9	132	0.54	4.42	0.26	0.34	0.36
2020	SD	A/C Tug Wide Body	2.44	0.09	0.15	5,148	13.2	248	0.54	3.23	0.12	0.20	0.21

Notes: Hydrocarbon emission factor converted to VOC by EPA's suggested factor of 1.053.
Emission factors have been converted from tons/hp hr to g/hp hr by converting to pounds (*2000) and then into grams (*454)

Source: LeighFisher, February 2016, OFFROAD Model.

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Table C-1 *(page 2 of 2)*

OFFROAD RESULTS FOR AIRPORT GROUND SUPPORT EQUIPMENT IN THE SAN DIEGO AIR BASIN

Year	Basin	OFFROAD Equipment Type	Annual Output (Tons) NOx	PM	HC	Hours	Count	Avg HP	Load Factor	Calculated Emission Factor (G/HP Hr) NOx EF	PM EF	HC EF	VOC EF
2020	SD	Baggage Tug	4.89	0.39	0.54	14,363	19.8	74	0.37	11.25	0.90	1.25	1.32
2020	SD	Belt Loader	1.59	0.15	0.19	8,666	17.1	75	0.34	6.65	0.61	0.78	0.82
2020	SD	Bobtail	0.39	0.02	0.03	1,532	3.5	144	0.37	4.35	0.23	0.34	0.35
2020	SD	Cargo Loader	1.75	0.08	0.13	17,522	37.6	117	0.34	2.32	0.11	0.17	0.18
2020	SD	Cargo Tractor	3.37	0.25	0.34	16,462	24.9	94	0.36	5.49	0.41	0.55	0.58
2020	SD	Forklift (GSE)	1.37	0.09	0.13	10,199	27.3	107	0.20	5.64	0.38	0.52	0.54
2020	SD	Lift (GSE)	0.76	0.05	0.06	6,685	16.3	95	0.34	3.25	0.19	0.27	0.28
2020	SD	Other GSE	5.38	0.28	0.48	41,703	88.4	108	0.34	3.24	0.17	0.29	0.31
2020	SD	Passenger Stand	0.03	0.00	0.00	261	5.5	70	0.40	3.31	0.15	0.22	0.23
2029	SD	A/C Tug Narrow Body	1.82	0.10	0.17	10,174	30.0	132	0.54	2.28	0.12	0.21	0.22
2029	SD	A/C Tug Wide Body	1.83	0.08	0.15	5,789	14.2	248	0.54	2.16	0.09	0.17	0.18
2029	SD	Baggage Tug	3.08	0.21	0.34	16,152	21.4	74	0.37	6.30	0.43	0.70	0.74
2029	SD	Belt Loader	1.25	0.10	0.13	9,745	18.4	75	0.34	4.67	0.38	0.49	0.52
2029	SD	Bobtail	0.15	0.01	0.01	1,723	3.8	144	0.37	1.46	0.06	0.14	0.15
2029	SD	Cargo Loader	1.01	0.03	0.09	19,704	40.6	117	0.34	1.19	0.04	0.11	0.11
2029	SD	Cargo Tractor	1.87	0.07	0.17	18,512	26.9	94	0.36	2.71	0.11	0.25	0.26
2029	SD	Forklift (GSE)	1.04	0.07	0.10	11,469	29.4	107	0.20	3.81	0.26	0.38	0.40
2029	SD	Lift (GSE)	0.50	0.03	0.05	7,517	17.6	95	0.34	1.91	0.10	0.18	0.19
2029	SD	Other GSE	2.72	0.09	0.27	46,896	95.3	108	0.34	1.46	0.05	0.15	0.16

Notes: Hydrocarbon emission factor converted to VOC by EPA's suggested factor of 1.053.
Emission factors have been converted from tons/hp hr to g/hp hr by converting to pounds (*2000) and then into grams (*454)

Source: LeighFisher, February 2016, OFFROAD Model.

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Table C-2

EMISSION FACTORS BY EDMS EQUIPMENT TYPE

Equipment Type	NO_x Emission Factors *(a)*					VOC Emission Factors					PM Emission Factors				
	2012	2017	2020	2030	2040	2012	2017	2020	2030	2040	2012	2017	2020	2030	2040
Air Conditioner	6.32	4.71	4.35	1.46	1.46	0.44	0.37	0.35	0.15	0.15	0.25	0.24	0.23	0.06	0.06
Air Start	5.26	4.10	3.23	2.16	2.16	0.29	0.25	0.21	0.18	0.18	0.18	0.15	0.12	0.09	0.09
Aircraft Tractor – Narrow Body	7.06	5.13	4.42	2.28	2.28	0.58	0.42	0.36	0.22	0.22	0.40	0.29	0.26	0.12	0.12
Aircraft Tractor – Wide Body	5.26	4.10	3.23	2.16	2.16	0.29	0.25	0.21	0.18	0.18	0.18	0.15	0.12	0.09	0.09
Baggage Tractor	11.54	11.67	11.25	6.30	6.30	1.32	1.36	1.32	0.74	0.74	0.91	0.94	0.90	0.43	0.43
Belt Loader	9.57	8.08	6.65	4.67	4.67	1.14	1.01	0.82	0.52	0.52	0.78	0.72	0.61	0.38	0.38
Cabin Service Truck	4.87	3.48	3.31	2.30	2.30	0.46	0.23	0.23	0.18	0.18	0.31	0.17	0.15	0.10	0.10
Cargo Loader	5.50	3.56	2.32	1.19	1.19	0.45	0.27	0.18	0.11	0.11	0.35	0.20	0.11	0.04	0.04
Cart	11.54	11.67	11.25	6.30	6.30	1.32	1.36	1.32	0.74	0.74	0.91	0.94	0.90	0.43	0.43
Catering Truck	4.87	3.48	3.31	2.30	2.30	0.46	0.23	0.23	0.18	0.18	0.31	0.17	0.15	0.10	0.10
Deicer	6.32	4.71	4.35	1.46	1.46	0.44	0.37	0.35	0.15	0.15	0.25	0.24	0.23	0.06	0.06
Fork Lift	7.84	6.35	5.64	3.81	3.81	0.72	0.61	0.54	0.40	0.40	0.50	0.42	0.38	0.26	0.26
Fuel Truck	4.87	3.48	3.31	2.30	2.30	0.46	0.23	0.23	0.18	0.18	0.31	0.17	0.15	0.10	0.10
Generator	6.32	4.71	4.35	1.46	1.46	0.44	0.37	0.35	0.15	0.15	0.25	0.24	0.23	0.06	0.06
Ground Power Unit	6.32	4.71	4.35	1.46	1.46	0.44	0.37	0.35	0.15	0.15	0.25	0.24	0.23	0.06	0.06
Lavatory Truck	4.87	3.48	3.31	2.30	2.30	0.46	0.23	0.23	0.18	0.18	0.31	0.17	0.15	0.10	0.10
Lift	5.39	4.24	3.25	1.91	1.91	0.50	0.39	0.28	0.19	0.19	0.38	0.29	0.19	0.10	0.10
Passenger Stand	4.87	3.48	3.31	2.30	2.30	0.46	0.23	0.23	0.18	0.18	0.31	0.17	0.15	0.10	0.10
Sweeper	6.32	4.71	4.35	1.46	1.46	0.44	0.37	0.35	0.15	0.15	0.25	0.24	0.23	0.06	0.06
Water Service	4.87	3.48	3.31	2.30	2.30	0.46	0.23	0.23	0.18	0.18	0.31	0.17	0.15	0.10	0.10

Source: LeighFisher, February 2016 *OFFROAD*.

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Table C-3
2012 ANNUAL EMISSIONS ESTIMATION – BY EDMS EQUIPMENT TYPE

EDMS GSE Equipment Type	Total Annual Hours	Horse-power	Load Factor	Emission Factors *(a)* NO_x	Emission Factors *(a)* VOC	Emission Factors *(a)* PM	Annual Emissions *(Tons)* NO_x	Annual Emissions *(Tons)* VOC	Annual Emissions *(Tons)* TSP
Air Conditioner	2,020	300	0.75	6.3	0.44	0.25	3.2	0.22	0.13
Air Start	3,663	425	0.90	5.3	0.29	0.18	8.1	0.45	0.28
Aircraft Tractor – Narrow Body	24,975.6	190	0.80	7.1	0.58	0.40	29.5	2.42	1.65
Aircraft Tractor – Wide Body	788.4	617	0.80	5.3	0.29	0.18	2.3	0.13	0.08
Baggage Tractor	105,000	71	0.55	11.5	1.32	0.91	52.1	5.96	4.11
Belt Loader	52,000	71	0.50	9.6	1.14	0.78	19.5	2.33	1.58
Cabin Service Truck	5,600	71	0.53	4.9	0.46	0.31	1.1	0.11	0.07
Cargo Loader	19,800	80	0.50	5.5	0.45	0.35	4.8	0.39	0.30
Cart	50	25	0.50	11.5	1.32	0.91	0.0	0.00	0.00
Catering Truck	28,800	71	0.53	4.9	0.46	0.31	5.8	0.55	0.37
Deicer	750	263	0.95	6.3	0.44	0.25	1.3	0.09	0.05
Fork Lift	12,200	55	0.30	7.8	0.72	0.50	1.7	0.16	0.11
Fuel Truck	12,408	300	0.25	4.9	0.46	0.31	5.0	0.47	0.31
Generator	44,825	158	0.50	6.3	0.44	0.25	24.6	1.71	0.99
Ground Power Unit	66,300	194	0.75	6.3	0.44	0.25	67.1	4.67	2.69
Lavatory Truck	20,142	56	0.25	4.9	0.46	0.31	1.5	0.14	0.10
Lift	10,060	115	0.50	5.4	0.50	0.38	3.4	0.32	0.24
Passenger Stand	1,504	65	0.57	4.9	0.46	0.31	0.3	0.03	0.02
Sweeper	42	53	0.51	6.3	0.44	0.25	0.0	0.00	0.00
Water Service	462	235	0.20	4.9	0.46	0.31	0.1	0.01	0.01
Total	411,389						231.5	20.17	13.10

Note: Numbers may not add due to rounding.

(a) Emission Factors in grams per horsepower hour.

Source: LeighFisher, February 2016.

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Table C-4
2017 ANNUAL EMISSIONS ESTIMATION – BY EDMS EQUIPMENT TYPE

EDMS GSE Equipment Type	Total Annual Hours	Horse-power	Load Factor	Emission Factors *(a)* NO_x	Emission Factors *(a)* VOC	Emission Factors *(a)* PM	Annual Emissions *(Tons)* NO_x	Annual Emissions *(Tons)* VOC	Annual Emissions *(Tons)* TSP
Air Conditioner	2,141.0	300	0.75	6.3	0.44	0.25	2.5	0.20	0.13
Air Start	3,882.4	425	0.90	5.3	0.29	0.18	6.7	0.40	0.25
Aircraft Tractor - Narrow Body	26,471.6	190	0.80	7.1	0.58	0.40	22.7	1.84	1.30
Aircraft Tractor - Wide Body	835.7	617	0.80	5.3	0.29	0.18	1.9	0.11	0.07
Baggage Tractor	111,289.6	71	0.55	11.5	1.32	0.91	55.8	6.53	4.50
Belt Loader	55,114.8	71	0.50	9.6	1.14	0.78	17.4	2.17	1.55
Cabin Service Truck	5,935.4	71	0.53	4.9	0.46	0.31	0.9	0.06	0.04
Cargo Loader	20,986.0	80	0.50	5.5	0.45	0.35	3.3	0.25	0.18
Cart	53.0	25	0.50	11.5	1.32	0.91	0.0	0.00	0.00
Catering Truck	30,525.1	71	0.53	4.9	0.46	0.31	4.4	0.30	0.21
Deicer	794.9	263	0.95	6.3	0.44	0.25	1.0	0.08	0.05
Fork Lift	12,930.8	55	0.30	7.8	0.72	0.50	1.5	0.14	0.10
Fuel Truck	13,151.2	300	0.25	4.9	0.46	0.31	3.8	0.26	0.18
Generator	47,510.0	158	0.50	6.3	0.44	0.25	19.5	1.53	0.98
Ground Power Unit	70,271.4	194	0.75	6.3	0.44	0.25	53.0	4.18	2.68
Lavatory Truck	21,348.5	56	0.25	4.9	0.46	0.31	1.1	0.08	0.05
Lift	10,662.1	115	0.50	5.4	0.50	0.38	2.9	0.26	0.20
Passenger Stand	1,594.1	65	0.57	4.9	0.46	0.31	0.2	0.02	0.01
Sweeper	44.5	53	0.51	6.3	0.44	0.25	0.0	0.00	0.00
Water Service	489.7	235	0.20	4.9	0.46	0.31	0.1	0.01	0.00
Total	436,032						198.7	18.4	12.5

Note: Numbers may not add due to rounding.

(a) Emission Factors in grams per horsepower hour.

Source: LeighFisher, February 2016.

Emissions Inventory
San Diego International Airport
SAN680

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Leigh|Fisher

Table C-5
2020 ANNUAL EMISSIONS ESTIMATION – BY EDMS EQUIPMENT TYPE

EDMS GSE Equipment Type	Total Annual Hours	Horse-power	Load Factor	Emission Factors *(a)*			Annual Emissions *(Tons)*		
				NO_x	VOC	PM	NO_x	VOC	TSP
Air Conditioner	2,222.8	300	0.75	6.3	0.44	0.25	2.4	0.20	0.13
Air Start	4,030.7	425	0.90	5.3	0.29	0.18	5.5	0.36	0.21
Aircraft Tractor - Narrow Body	27,482.5	190	0.80	7.1	0.58	0.40	20.3	1.67	1.17
Aircraft Tractor - Wide Body	867.6	617	0.80	5.3	0.29	0.18	1.5	0.10	0.06
Baggage Tractor	115,539.5	71	0.55	11.5	1.32	0.91	55.9	6.53	4.46
Belt Loader	57,219.6	71	0.50	9.6	1.14	0.78	14.9	1.84	1.37
Cabin Service Truck	6,162.1	71	0.53	4.9	0.46	0.31	0.8	0.06	0.04
Cargo Loader	21,787.4	80	0.50	5.5	0.45	0.35	2.2	0.17	0.11
Cart	55.0	25	0.50	11.5	1.32	0.91	0.0	0.00	0.00
Catering Truck	31,690.8	71	0.53	4.9	0.46	0.31	4.3	0.30	0.19
Deicer	825.3	263	0.95	6.3	0.44	0.25	1.0	0.08	0.05
Fork Lift	13,424.6	55	0.30	7.8	0.72	0.50	1.4	0.13	0.09
Fuel Truck	13,653.5	300	0.25	4.9	0.46	0.31	3.7	0.26	0.17
Generator	49,324.4	158	0.50	6.3	0.44	0.25	18.7	1.52	0.98
Ground Power Unit	72,954.9	194	0.75	6.3	0.44	0.25	50.9	4.15	2.67
Lavatory Truck	22,163.8	56	0.25	4.9	0.46	0.31	1.1	0.08	0.05
Lift	11,069.2	115	0.50	5.4	0.50	0.38	2.3	0.20	0.14
Passenger Stand	1,655.0	65	0.57	4.9	0.46	0.31	0.2	0.02	0.01
Sweeper	46.2	53	0.51	6.3	0.44	0.25	0.0	0.00	0.00
Water Service	508.4	235	0.20	4.9	0.46	0.31	0.1	0.01	0.00
Total	452,683						187.4	17.7	11.9

Note: Numbers may not add due to rounding.

(a) Emission Factors in grams per horsepower hour.

Source: LeighFisher, February 2016.

Emissions Inventory
San Diego International Airport
SAN680

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Leigh|Fisher

Table C-6
2030 ANNUAL EMISSIONS ESTIMATION – BY EDMS EQUIPMENT TYPE

EDMS GSE Equipment Type	Total Annual Hours	Horse-power	Load Factor	Emission Factors *(a)* NO_x	Emission Factors *(a)* VOC	Emission Factors *(a)* PM	Annual Emissions *(Tons)* NO_x	Annual Emissions *(Tons)* VOC	Annual Emissions *(Tons)* TSP
Air Conditioner	2,497.3	300	0.75	6.3	0.44	0.25	0.9	0.1	0.04
Air Start	4,528.5	425	0.90	5.3	0.29	0.18	4.1	0.4	0.17
Aircraft Tractor - Narrow Body	30,876.8	190	0.80	7.1	0.58	0.40	11.8	1.1	0.64
Aircraft Tractor - Wide Body	974.7	617	0.80	5.3	0.29	0.18	1.1	0.1	0.05
Baggage Tractor	129,809.4	71	0.55	11.5	1.32	0.91	35.2	4.1	2.42
Belt Loader	64,286.6	71	0.50	9.6	1.14	0.78	11.7	1.3	0.96
Cabin Service Truck	6,923.2	71	0.53	4.9	0.46	0.31	0.7	0.1	0.03
Cargo Loader	24,478.4	80	0.50	5.5	0.45	0.35	1.3	0.1	0.04
Cart	61.8	25	0.50	11.5	1.32	0.91	0.0	0.0	0.00
Catering Truck	35,604.9	71	0.53	4.9	0.46	0.31	3.4	0.3	0.15
Deicer	927.2	263	0.95	6.3	0.44	0.25	0.4	0.0	0.02
Fork Lift	15,082.6	55	0.30	7.8	0.72	0.50	1.0	0.1	0.07
Fuel Truck	15,339.8	300	0.25	4.9	0.46	0.31	2.9	0.2	0.13
Generator	55,416.3	158	0.50	6.3	0.44	0.25	7.0	0.7	0.30
Ground Power Unit	81,965.4	194	0.75	6.3	0.44	0.25	19.1	2.0	0.81
Lavatory Truck	24,901.2	56	0.25	4.9	0.46	0.31	0.9	0.1	0.04
Lift	12,436.4	115	0.50	5.4	0.50	0.38	1.5	0.2	0.08
Passenger Stand	1,859.4	65	0.57	4.9	0.46	0.31	0.2	0.0	0.01
Sweeper	51.9	53	0.51	6.3	0.44	0.25	0.0	0.0	0.00
Water Service	571.2	235	0.20	4.9	0.46	0.31	0.1	0.0	0.00
Total	508,593						103.3	10.9	6.0

Note: Numbers may not add due to rounding.

(a) Emission Factors in grams per horsepower hour

Source: LeighFisher, February 2016.

Leigh|Fisher

Table C-7
2040 ANNUAL EMISSIONS ESTIMATION – BY EDMS EQUIPMENT TYPE

EDMS GSE Equipment Type	Total Annual Hours	Horse-power	Load Factor	Emission Factors *(a)*			Annual Emissions *(Tons)*		
				NO_x	VOC	PM	NO_x	VOC	TSP
Air Conditioner	2,731.7	300	0.75	6.3	0.44	0.25	1.0	0.1	0.04
Air Start	4,953.5	425	0.90	5.3	0.29	0.18	4.5	0.4	0.19
Aircraft Tractor - Narrow Body	33,774.8	190	0.80	7.1	0.58	0.40	12.9	1.3	0.70
Aircraft Tractor - Wide Body	1,066.2	617	0.80	5.3	0.29	0.18	1.3	0.1	0.05
Baggage Tractor	141,993.1	71	0.55	11.5	1.32	0.91	38.5	4.5	2.65
Belt Loader	70,320.4	71	0.50	9.6	1.14	0.78	12.8	1.4	1.05
Cabin Service Truck	7,573.0	71	0.53	4.9	0.46	0.31	0.7	0.1	0.03
Cargo Loader	26,775.8	80	0.50	5.5	0.45	0.35	1.4	0.1	0.04
Cart	67.6	25	0.50	11.5	1.32	0.91	0.0	0.0	0.00
Catering Truck	38,946.7	71	0.53	4.9	0.46	0.31	3.7	0.3	0.17
Deicer	1,014.2	263	0.95	6.3	0.44	0.25	0.4	0.0	0.02
Fork Lift	16,498.2	55	0.30	7.8	0.72	0.50	1.1	0.1	0.08
Fuel Truck	16,779.5	300	0.25	4.9	0.46	0.31	3.2	0.3	0.14
Generator	60,617.5	158	0.50	6.3	0.44	0.25	7.7	0.8	0.32
Ground Power Unit	89,658.5	194	0.75	6.3	0.44	0.25	20.9	2.1	0.88
Lavatory Truck	27,238.3	56	0.25	4.9	0.46	0.31	1.0	0.1	0.04
Lift	13,603.6	115	0.50	5.4	0.50	0.38	1.6	0.2	0.09
Passenger Stand	2,033.9	65	0.57	4.9	0.46	0.31	0.2	0.0	0.01
Sweeper	56.8	53	0.51	6.3	0.44	0.25	0.0	0.0	0.00
Water Service	624.8	235	0.20	4.9	0.46	0.31	0.1	0.0	0.00
Total	556,328						113.0	11.9	6.52

Note: Numbers may not add due to rounding.

(a) Emission Factors in grams per horsepower hour.

Source: LeighFisher, February 2016.

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APPENDIX D
ROADWAYS AND PARKING

Emissions Inventory
San Diego International Airport
SAN680

Leigh|Fisher

Table D-1
2012 EMISSIONS COEFFICIENTS BY VEHICLE CLASS

Vehicle Class	Emissions Coefficient (Tons / Million Miles)					
	NO_X	VOC	CO	SO_X	PM_{10}	$PM_{2.5}$
Private Vehicles - Passengers	0.422	0.412	3.268	0.005	0.055	0.024
Rental Cars	0.422	0.412	3.268	0.005	0.055	0.024
Taxis / Limousines	0.422	0.412	3.268	0.005	0.055	0.024
Shared Ride Vans / Charters	0.422	0.412	3.268	0.005	0.055	0.024
Private Vehicles - Employees	0.422	0.412	3.268	0.005	0.055	0.024
Public Transit	18.921	1.414	14.710	0.016	1.080	0.622
Authority-Owned Shuttles	0.756	0.371	3.781	0.007	0.065	0.030
Off-Airport Shuttles	0.756	0.371	3.781	0.007	0.065	0.030
Cargo Trucks	12.702	0.901	2.864	0.018	0.516	0.426
Cargo Vans	0.756	0.371	3.781	0.007	0.065	0.030
Maintenance & Other Vehicles	0.756	0.371	3.781	0.007	0.065	0.030

Source: LeighFisher, February 2016.

Table D-2
2017 EMISSIONS COEFFICIENTS

Vehicle Class	Emissions Coefficient (Tons / Million Miles)					
	NO_X	VOC	CO	SO_X	PM_{10}	$PM_{2.5}$
Private Vehicles - Passengers	0.242	0.246	1.862	0.004	0.053	0.023
Rental Cars	0.242	0.246	1.862	0.004	0.053	0.023
Taxis / Limousines	0.242	0.246	1.862	0.004	0.053	0.023
Shared Ride Vans / Charters	0.242	0.246	1.862	0.004	0.053	0.023
Private Vehicles - Employees	0.242	0.246	1.862	0.004	0.053	0.023
Public Transit	13.111	0.995	11.331	0.014	0.914	0.498
Authority-Owned Shuttles	0.512	0.307	2.666	0.007	0.062	0.027
Off-Airport Shuttles	0.512	0.307	2.666	0.007	0.062	0.027
Cargo Trucks	5.524	0.176	0.678	0.017	0.148	0.074
Cargo Vans	0.512	0.307	2.666	0.007	0.062	0.027
Maintenance & Other Vehicles	0.512	0.307	2.666	0.007	0.062	0.027

Source: LeighFisher, February 2016.

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Table D-3
2020 EMISSIONS COEFFICIENTS

Vehicle Class	Emissions Coefficient (Tons / Million Miles)					
	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
Private Vehicles - Passengers	0.175	0.192	1.402	0.004	0.053	0.023
Rental Cars	0.175	0.192	1.402	0.004	0.053	0.023
Taxis / Limousines	0.175	0.192	1.402	0.004	0.053	0.023
Shared Ride Vans / Charters	0.175	0.192	1.402	0.004	0.053	0.023
Private Vehicles - Employees	0.175	0.192	1.402	0.004	0.053	0.023
Public Transit	9.917	0.763	9.637	0.012	0.820	0.429
Authority-Owned Shuttles	0.386	0.264	2.071	0.006	0.063	0.027
Off-Airport Shuttles	0.386	0.264	2.071	0.006	0.063	0.027
Cargo Trucks	4.563	0.144	0.617	0.017	0.135	0.061
Cargo Vans	0.386	0.264	2.071	0.006	0.063	0.027
Maintenance & Other Vehicles	0.386	0.264	2.071	0.006	0.063	0.027

Source: LeighFisher, February 2016.

Table D-4
2030 EMISSIONS COEFFICIENTS

Vehicle Class	Emissions Coefficient (Tons / Million Miles)					
	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
Private Vehicles - Passengers	0.082	0.126	0.867	0.002	0.052	0.022
Rental Cars	0.082	0.126	0.867	0.002	0.052	0.022
Taxis / Limousines	0.082	0.126	0.867	0.002	0.052	0.022
Shared Ride Vans / Charters	0.082	0.126	0.867	0.002	0.052	0.022
Private Vehicles - Employees	0.082	0.126	0.867	0.002	0.052	0.022
Public Transit	3.234	0.280	6.212	0.010	0.631	0.292
Authority-Owned Shuttles	0.145	0.164	0.943	0.004	0.063	0.027
Off-Airport Shuttles	0.145	0.164	0.943	0.004	0.063	0.027
Cargo Trucks	2.101	0.085	0.481	0.015	0.123	0.050
Cargo Vans	0.145	0.164	0.943	0.004	0.063	0.027
Maintenance & Other Vehicles	0.145	0.164	0.943	0.004	0.063	0.027

Source: LeighFisher, February 2016.

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Table D-5
2040 EMISSIONS COEFFICIENTS

Vehicle Class	Emissions Coefficient (Tons / Million Miles)					
	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
Private Vehicles - Passengers	0.059	0.096	0.705	0.002	0.051	0.021
Rental Cars	0.059	0.096	0.705	0.002	0.051	0.021
Taxis / Limousines	0.059	0.096	0.705	0.002	0.051	0.021
Shared Ride Vans / Charters	0.059	0.096	0.705	0.002	0.051	0.021
Private Vehicles - Employees	0.059	0.096	0.705	0.002	0.051	0.021
Public Transit	1.150	0.126	5.091	0.009	0.565	0.244
Authority-Owned Shuttles	0.088	0.112	0.669	0.003	0.062	0.026
Off-Airport Shuttles	0.088	0.112	0.669	0.003	0.062	0.026
Cargo Trucks	1.945	0.082	0.467	0.015	0.123	0.049
Cargo Vans	0.088	0.112	0.669	0.003	0.062	0.026
Maintenance & Other Vehicles	0.088	0.112	0.669	0.003	0.062	0.026

Source: LeighFisher, February 2016.

Table D-6
2012 ROADWAY EMISSIONS

AIRPORT-RELATED EMISSIONS	Annual Emissions (Tons)					
	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
Private Vehicles - Passengers	82.21	80.29	636.87	0.89	10.73	4.72
Rental Cars	9.71	9.48	75.23	0.11	1.27	0.56
Taxis / Limousines	10.66	10.41	82.58	0.12	1.39	0.61
Shared Ride Vans / Charters	1.94	1.89	15.01	0.02	0.25	0.11
Private Vehicles - Employees	26.89	26.26	208.31	0.29	3.51	1.55
Public Transit	1.65	0.12	1.28	0.00	0.09	0.05
Authority-Owned Shuttles	0.77	0.38	3.86	0.01	0.07	0.03
Off-Airport Shuttles	3.34	1.64	16.72	0.03	0.29	0.13
Cargo Trucks	13.81	0.98	3.11	0.02	0.56	0.46
Cargo Vans	0.61	0.30	3.04	0.01	0.05	0.02
Maintenance & Other Vehicles	0.58	0.29	2.92	0.01	0.05	0.02
Total	152.18	132.05	1,048.92	1.50	18.26	8.28

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

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Table D-7
2017 ROADWAY EMISSIONS

Vehicle Class	Emissions (Tons) NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
Private Vehicles - Passengers	51.59	52.44	396.96	0.86	11.38	4.88
Rental Cars	6.17	6.27	47.48	0.10	1.36	0.58
Taxis / Limousines	6.69	6.80	51.47	0.11	1.48	0.63
Shared Ride Vans / Charters	1.22	1.24	9.36	0.02	0.27	0.12
Private Vehicles - Employees	16.88	17.15	129.84	0.28	3.72	1.60
Public Transit	1.14	0.09	0.99	0.00	0.08	0.04
Authority-Owned Shuttles	0.57	0.34	2.98	0.01	0.07	0.03
Off-Airport Shuttles	3.36	2.01	17.49	0.04	0.41	0.18
Cargo Trucks	6.57	0.21	0.81	0.02	0.18	0.09
Cargo Vans	0.45	0.27	2.34	0.01	0.05	0.02
Maintenance & Other Vehicles	0.43	0.26	2.25	0.01	0.05	0.02
Total	95.07	87.09	661.95	1.46	19.05	8.19

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

Table D-8
2020 ROADWAY EMISSIONS

Vehicle Class	Emissions (Tons) NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
Private Vehicles - Passengers	39.68	43.50	317.20	0.82	12.01	5.13
Rental Cars	4.75	5.20	37.94	0.10	1.44	0.61
Taxis / Limousines	5.14	5.64	41.13	0.11	1.56	0.67
Shared Ride Vans / Charters	0.94	1.03	7.48	0.02	0.28	0.12
Private Vehicles - Employees	12.98	14.23	103.75	0.27	3.93	1.68
Public Transit	0.86	0.07	0.84	0.00	0.07	0.04
Authority-Owned Shuttles	0.46	0.31	2.46	0.01	0.07	0.03
Off-Airport Shuttles	2.69	1.84	14.42	0.04	0.44	0.19
Cargo Trucks	5.76	0.18	0.78	0.02	0.17	0.08
Cargo Vans	0.36	0.25	1.93	0.01	0.06	0.03
Maintenance & Other Vehicles	0.35	0.24	1.86	0.01	0.06	0.02
Total	73.96	72.49	529.77	1.40	20.08	8.60

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

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Table D-9
2030 ROADWAY EMISSIONS

Vehicle Class	Emissions (Tons) NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
Private Vehicles - Passengers	22.49	34.60	237.56	0.68	14.20	5.93
Rental Cars	2.69	4.14	28.41	0.08	1.70	0.71
Taxis / Limousines	2.92	4.49	30.80	0.09	1.84	0.77
Shared Ride Vans / Charters	0.53	0.82	5.60	0.02	0.33	0.14
Private Vehicles - Employees	7.36	11.32	77.70	0.22	4.65	1.94
Public Transit	0.28	0.02	0.54	0.00	0.06	0.03
Authority-Owned Shuttles	0.21	0.24	1.35	0.01	0.09	0.04
Off-Airport Shuttles	1.22	1.39	7.95	0.04	0.53	0.22
Cargo Trucks	3.21	0.13	0.74	0.02	0.19	0.08
Cargo Vans	0.16	0.19	1.07	0.00	0.07	0.03
Maintenance & Other Vehicles	0.16	0.18	1.02	0.00	0.07	0.03
Total	41.22	57.50	392.76	1.16	23.72	9.91

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

Table D-10
2040 ROADWAY EMISSIONS

Vehicle Class	Emissions (Tons) NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
Private Vehicles - Passengers	19.23	30.98	228.01	0.69	16.46	6.73
Rental Cars	2.30	3.71	27.27	0.08	1.97	0.80
Taxis / Limousines	2.49	4.02	29.56	0.09	2.13	0.87
Shared Ride Vans / Charters	0.45	0.73	5.38	0.02	0.39	0.16
Private Vehicles - Employees	6.29	10.13	74.58	0.23	5.38	2.20
Public Transit	0.10	0.01	0.44	0.00	0.05	0.02
Authority-Owned Shuttles	0.15	0.19	1.13	0.01	0.11	0.04
Off-Airport Shuttles	0.88	1.12	6.66	0.03	0.62	0.26
Cargo Trucks	3.51	0.15	0.84	0.03	0.22	0.09
Cargo Vans	0.12	0.15	0.89	0.00	0.08	0.03
Maintenance & Other Vehicles	0.11	0.14	0.86	0.00	0.08	0.03
Total	**35.63**	**51.33**	**375.62**	**1.18**	**27.50**	**11.25**

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

Leigh|Fisher

Table D-11
PARKING FACILITY USAGE

	2012	2017	2020	2030	2040
Private Vehicles - Passengers	1,932,185	2,113,471	2,243,180	2,716,348	3,207,382
Private Vehicles - Employees	1,756,155	1,920,925	2,038,817	2,468,877	2,915,176
Total	**3,688,340**	**4,034,395**	**4,281,996**	**5,185,225**	**6,122,557**

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

Table D-12
PARKING FACILITY VMT

	2012	2017	2020	2030	2040
Private Vehicles - Passengers	1,833,751	2,005,801	2,128,902	2,577,965	3,043,984
Private Vehicles - Employees	1,532,601	1,676,395	1,779,280	2,154,595	2,544,081
Total	**3,366,352**	**3,682,197**	**3,908,183**	**4,732,561**	**5,588,065**

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

Leigh|Fisher

Table D-13
PARKING FACILITY EMISSIONS
Tons

	NO_x	VOC	CO	SO_x	PM_{10}	$PM_{2.5}$
2012						
Private Vehicles - Passengers	0.77	0.76	5.99	0.01	0.10	0.04
Private Vehicles - Employees	0.65	0.63	5.01	0.01	0.08	0.04
Total	**1.42**	**1.39**	**11.00**	**0.02**	**0.19**	**0.08**
2017						
Private Vehicles - Passengers	0.49	0.49	3.73	0.01	0.11	0.05
Private Vehicles - Employees	0.41	0.41	3.12	0.01	0.09	0.04
Total	**0.89**	**0.91**	**6.86**	**0.01**	**0.20**	**0.08**
2020						
Private Vehicles - Passengers	0.37	0.41	2.98	0.01	0.11	0.05
Private Vehicles - Employees	0.31	0.34	2.49	0.01	0.09	0.04
Total	**0.69**	**0.75**	**5.48**	**0.01**	**0.21**	**0.09**
2030						
Private Vehicles - Passengers	0.21	0.33	2.24	0.01	0.13	0.06
Private Vehicles - Employees	0.18	0.27	1.87	0.01	0.11	0.05
Total	**0.39**	**0.60**	**4.10**	**0.01**	**0.25**	**0.10**
2040						
Private Vehicles - Passengers	0.18	0.29	2.15	0.01	0.15	0.06
Private Vehicles - Employees	0.15	0.24	1.79	0.01	0.13	0.05
Total	**0.33**	**0.54**	**3.94**	**0.01**	**0.28**	**0.12**

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

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APPENDIX E

Leigh|Fisher

Table E-1
CONVERSION MAP FOR ACEIT AND OFFROAD CONSTRUCTION EQUIPMENT AND DEFAULT ANNUAL OPERATING PARAMETERS

		ACEIT Defaults			
ACEIT Construction Equipment	OFFROAD Equipment Type	Horse-power	Load Factor	Routine	Growth
40 Ton Crane	Cranes	300	0.43	110	1,032
40 Ton Rough Terrain	Cranes	300	0.43	0	1,158
40 Ton Rough Terrain Crane	Cranes	300	0.43	0	864
90 Ton Crane	Cranes	300	0.43	603	23,430
Air Compressor	Other Construction Equipment	100	0.43	132	1,239
Asphalt Paver	Pavers	175	0.59	100	1,692
Backhoe	Tractors/Loaders/Backhoes	100	0.21	1,005	24,236
Bob Cat	Tractors/Loaders/Backhoes	75	0.21	353	15,502
Caisson Drilling Rig	Bore/Drill Rigs	175	0.43	0	864
Chain Saw	Other Construction Equipment	11	0.70	212	2,395
Chipper/Stump Grinder	Other Construction Equipment	100	0.43	212	2,395
Concrete Boom Pump	Other Construction Equipment	11	0.43	0	2,592
Concrete Pump	Other Construction Equipment	11	0.43	32	1,397
Concrete Ready Mix Trucks	Off-Highway Trucks	600	0.59	248	8,754
Concrete Saws	Other Construction Equipment	40	0.59	14	1,239
Concrete Truck	Off-Highway Trucks	600	0.59	163	7,764
Crane	Cranes	300	0.43	118	0
Curb/Gutter Paver	Pavers	175	0.59	25	163
Distributing Tanker	Off-Highway Trucks	600	0.59	15	904
Dozer	Rubber Tired Dozers	175	0.59	1,606	17,857
Dump Truck	Off-Highway Trucks	600	0.59	1,329	28,076
Dump Truck (12 cy)	Off-Highway Trucks	600	0.59	2,659	28,253
Excavator	Excavators	175	0.59	515	6,881
Excavator with Bucket	Excavators	175	0.59	181	13,251
Excavator with Hoe Ram	Excavators	175	0.59	5	5,500
Flatbed Truck	Off-Highway Trucks	600	0.59	203	18,120
Fork Truck	Off-Highway Trucks	100	0.59	4,270	223,268
Forklift	Forklifts	100	0.59	0	1,728
Front Loader	Rubber Tired Loaders	100	0.21	0	2,005
Front Loader for Subgrade Materials	Rubber Tired Loaders	100	0.21	0	570
Generator	Other Construction Equipment	40	0.43	168	18,720
Generator Sets	Other Construction Equipment	40	0.43	176	7,751
Grader	Graders	300	0.59	82	963
Grout Mixer for Mortar	Other Construction Equipment	600	0.59	254	0
High Lift	Forklifts	100	0.59	1,226	62,192
High Lift Fork Truck	Off-Highway Trucks	100	0.59	424	0
Hydroseeder	Other Construction Equipment	600	0.59	75	867
Loader	Tractors/Loaders/Backhoes	175	0.59	193	3,616
Man Lift	Other Construction Equipment	75	0.21	3,271	192,360
Man Lift (Fascia Construction)	Other Construction Equipment	75	0.21	323	2,014
Masonry Saw	Other Construction Equipment	40	0.59	254	0
Material Deliveries	Off-Highway Trucks	600	0.59	54	3,778
Off-Road Truck	Off-Highway Trucks	600	0.59	75	867
Other General Equipment	Other Construction Equipment	175	0.43	919	30,776
Pickup Truck	Off-Highway Trucks	600	0.59	2,454	69,181

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Table E-1 *(continued)*

CONVERSION MAP FOR ACEIT AND OFFROAD CONSTRUCTION EQUIPMENT AND DEFAULT ANNUAL OPERATING PARAMETERS

		ACEIT Defaults			
ACEIT Construction Equipment	OFFROAD Equipment Type	Horse-power	Load Factor	Routine	Growth
Pressure Washer	Other Construction Equipment	25	0.43	12	0
Pumps	Other Construction Equipment	11	0.43	69	798
Roller	Rollers	100	0.59	944	10,990
Rubber Tired Loader	Rubber Tired Loaders	175	0.59	14	1,239
Scraper	Scrapers	600	0.59	386	3,739
Skid Steer Loader	Skid Steer Loaders	75	0.21	331	4,393
Slip Form Paver	Pavers	175	0.59	14	1,239
Surfacing Equipment (Grooving)	Surfacing Equipment	25	0.59	142	2,675
Survey Crew Trucks	Off-Highway Trucks	600	0.59	31	729
Sweepers/Scrubbers	Other Construction Equipment	175	0.43	12	0
Ten Wheelers- Material Delivery	Off-Highway Trucks	600	0.59	0	432
Tool Truck	Off-Highway Trucks	600	0.59	981	49,916
Tractor Trailer- Material Delivery	Off-Highway Trucks	600	0.59	957	55,438
Tractor Trailer- Steel Deliveries	Off-Highway Trucks	600	0.59	157	4,287
Tractor Trailer- Stone Delivery	Off-Highway Trucks	600	0.59	0	1,434
Tractor Trailer- Truck Delivery	Off-Highway Trucks	600	0.59	64	0
Tractor Trailer with Boom Hoist- Curbs Del & Place	Off-Highway Trucks	600	0.59	0	294
Tractor Trailers Temp Fac.	Off-Highway Trucks	600	0.59	13	295
Tractors/Loader/Backhoe	Tractors/Loaders/Backhoes	100	0.21	407	5,421
Trencher	Trenchers	75	0.59	0.000	864
Trencher for U/G Piping	Trenchers	75	0.59	0	1,434
Trowel Machine	Surfacing Equipment	600	0.59	24	749
Trowel Machines (4) machines	Surfacing Equipment	600	0.59	0	1,728
Truck for Topsoil & Seed Del&Spread	Off-Highway Trucks	600	0.59	0	294
Vibratory Compactor	Surfacing Equipment	6	0.43	51	325
Water Truck	Off-Highway Trucks	600	0.59	1,740	14,400

Notes: Construction growth project hours are applied in 2020, 2030, and 2040, with the construction of the parking plaza in Terminal 2 also being included in 2017.Source: LeighFisher, February 2016, ACEIT.

LeighFisher

Table E-2
OFFROAD RESULTS FOR CONSTRUCTION EQUIPMENT IN THE SAN DIEGO AIR BASIN

Year	Air Basin	OFFROAD Equipment Type	NOx	PM	HC	Hours	Count	Avg HP	Load Factor	NOx EF	PM EF	HC EF	VOC EF
2012	SD	Bore/Drill Rigs	15.5	0.61	0.82	32,876	104.9	206	0.50	4.15	0.16	0.22	0.23
2012	SD	Cranes	72.4	3.44	5.08	129,712	316.0	226	0.29	7.78	0.37	0.55	0.58
2012	SD	Crawler Tractors	148.4	7.06	10.05	234,325	582.1	208	0.43	6.44	0.31	0.44	0.46
2012	SD	Excavators	203.8	8.89	13.14	635,005	1,131.9	163	0.38	4.69	0.20	0.30	0.32
2012	SD	Graders	103.8	4.62	7.06	187,613	366.0	175	0.41	7.03	0.31	0.48	0.51
2012	SD	Off-Highway Tractors	50.9	2.86	4.56	148,750	257.5	123	0.44	5.82	0.33	0.52	0.55
2012	SD	Off-Highway Trucks	325.4	12.70	21.55	316,615	269.5	400	0.38	6.11	0.24	0.40	0.42
2012	SD	Other Construction Equipment	69.7	3.42	4.99	151,316	389.8	172	0.42	5.87	0.29	0.42	0.44
2012	SD	Pavers	16.1	0.89	1.23	47,570	138.4	126	0.42	5.87	0.32	0.45	0.47
2012	SD	Paving Equipment	9.7	0.53	0.72	31,749	78.4	131	0.36	5.97	0.32	0.45	0.47
2012	SD	Rollers	43.8	2.88	4.36	215,557	721.0	81	0.38	6.11	0.40	0.61	0.64
2012	SD	Rough Terrain Forklifts	41.2	2.52	2.82	178,379	727.0	100	0.40	5.19	0.32	0.36	0.38
2012	SD	Rubber Tired Dozers	39.8	2.03	3.07	43,026	64.3	255	0.40	8.31	0.42	0.64	0.67
2012	SD	Rubber Tired Loaders	395.2	18.20	27.70	803,517	942.3	200	0.36	6.18	0.28	0.43	0.45
2012	SD	Scrapers	280.2	11.64	17.75	215,504	529.2	362	0.48	6.77	0.28	0.43	0.45
2012	SD	Skid Steer Loaders	36.4	2.38	2.78	285,401	942.8	65	0.37	4.83	0.32	0.37	0.39
2012	SD	Surfacing Equipment	4.1	0.16	0.23	10,121	43.3	254	0.30	4.80	0.18	0.26	0.27
2012	SD	Tractors/Loaders/Backhoes	340.5	23.63	28.68	1,478,750	2,843.4	98	0.37	5.79	0.40	0.49	0.52
2012	SD	Trenchers	14.1	0.97	1.58	53,857	170.8	81	0.50	5.88	0.40	0.66	0.69
2012	SD	Sweepers/Scrubbers	16.6	1.37	2.15	71,263	116.8	64	0.46	7.24	0.60	0.94	0.99
2012	SD	Forklifts	86.1	6.58	8.53	590,621	896.8	89	0.20	7.36	0.56	0.73	0.77
2017	SD	Bore/Drill Rigs	11.6	0.43	0.70	33,049	98.1	206	0.50	3.08	0.12	0.19	0.20
2017	SD	Cranes	64.8	3.12	4.72	130,395	295.4	226	0.29	6.93	0.33	0.50	0.53
2017	SD	Crawler Tractors	139.3	6.85	9.99	235,559	544.1	208	0.43	6.01	0.30	0.43	0.45
2017	SD	Excavators	145.4	6.44	10.86	638,350	1,058.1	163	0.38	3.33	0.15	0.25	0.26

Notes: Notes: Only select fields and limited results from OFFROAD output displayed.
Hydrocarbon emission factor converted to VOC by EPA's suggested factor of 1.053.
Emission factors have been converted from T/HP Hr to G/HP Hr by converting to pounds (*2000) and then into grams (*454)

Source: LeighFisher, February 2016, OFFROAD Model.

Emissions Inventory
San Diego International Airport
SAN680

E-1

Leigh|Fisher

Table E-3

EMISSION FACTORS BY OFFROAD EQUIPMENT TYPE

	NOx Emission Factors *(a)*					HC Emission Factors					PM Emission Factors				
Equipment Type	2012	2017	2020	2030	2040	2012	2017	2020	2030	2040	2012	2017	2020	2030	2040
Bore/Drill Rigs	4.15	3.08	2.21	1.20	1.20	0.23	0.20	0.16	0.11	0.11	0.16	0.12	0.08	0.04	0.04
Cranes	7.78	6.93	5.92	2.74	2.74	0.58	0.53	0.46	0.25	0.25	0.37	0.33	0.29	0.13	0.13
Crawler Tractors	6.44	6.01	4.97	2.17	2.17	0.46	0.45	0.40	0.22	0.22	0.31	0.30	0.25	0.11	0.11
Excavators	4.69	3.33	2.18	0.85	0.85	0.32	0.26	0.19	0.12	0.12	0.20	0.15	0.09	0.03	0.03
Forklifts	7.36	6.13	4.52	2.02	2.02	0.77	0.64	0.46	0.22	0.22	0.56	0.47	0.32	0.09	0.09
Graders	7.03	6.75	5.96	2.40	2.40	0.51	0.52	0.46	0.25	0.25	0.31	0.31	0.27	0.11	0.11
Off-Highway Tractors	5.82	4.43	3.23	1.42	1.42	0.55	0.46	0.37	0.18	0.18	0.33	0.26	0.19	0.06	0.06
Off-Highway Trucks	6.11	4.89	3.51	1.42	1.42	0.42	0.36	0.27	0.16	0.16	0.24	0.19	0.13	0.04	0.04
Other Construction Equipment	5.87	4.85	3.83	1.79	1.79	0.44	0.39	0.33	0.19	0.19	0.29	0.24	0.19	0.08	0.08
Pavers	5.87	4.73	3.60	1.40	1.40	0.47	0.40	0.32	0.16	0.16	0.32	0.26	0.20	0.07	0.07
Paving Equipment	5.97	4.58	3.31	1.45	1.45	0.47	0.38	0.27	0.15	0.15	0.32	0.25	0.17	0.06	0.06
Rollers	6.11	4.92	3.67	1.95	1.95	0.64	0.54	0.40	0.21	0.21	0.40	0.32	0.23	0.08	0.08
Rough Terrain Forklifts	5.19	3.47	2.52	1.51	1.51	0.38	0.24	0.18	0.11	0.11	0.32	0.18	0.11	0.04	0.04
Rubber Tired Dozers	8.31	7.74	6.88	4.24	4.24	0.67	0.65	0.60	0.42	0.42	0.42	0.40	0.36	0.22	0.22
Rubber Tired Loaders	6.18	5.31	4.02	1.34	1.34	0.45	0.42	0.34	0.18	0.18	0.28	0.25	0.18	0.06	0.06
Scrapers	6.77	6.07	4.88	1.76	1.76	0.45	0.43	0.37	0.19	0.19	0.28	0.26	0.21	0.07	0.07
Skid Steer Loaders	4.83	3.42	2.64	1.82	1.82	0.39	0.26	0.19	0.13	0.13	0.32	0.18	0.11	0.04	0.04
Surfacing Equipment	4.80	3.83	2.75	1.14	1.14	0.27	0.23	0.18	0.11	0.11	0.18	0.15	0.11	0.04	0.04
Sweepers/Scrubbers	7.24	6.33	5.03	2.58	2.58	0.99	0.90	0.68	0.28	0.28	0.60	0.52	0.39	0.10	0.10
Tractors/Loaders/Backhoes	5.79	4.70	3.38	1.69	1.69	0.52	0.42	0.31	0.17	0.17	0.40	0.31	0.20	0.06	0.06
Trenchers	5.88	5.13	4.29	2.89	2.89	0.69	0.62	0.49	0.32	0.32	0.40	0.35	0.28	0.14	0.14

Source: LeighFisher, February 2016, OFFROAD.

Emissions Inventory
San Diego International Airport
SAN680

E-2

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Table E-4

2012 CONSTRUCTION EMISSIONS BY ACEIT EQUIPMENT TYPE *(Tons)*

ACEIT Construction Equipment	Routine Construction Projects			Growth Construction Projects			Total Construction Projects		
	NO_x	VOC	TSP	NO_x	VOC	TSP	NO_x	VOC	TSP
40 Ton Crane	0.12	0.01	0.01	n.a.	n.a.	n.a.	0.12	0.01	0.01
40 Ton Rough Terrain	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
40 Ton Rough Terrain Crane	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
90 Ton Crane	0.67	0.05	0.03	n.a.	n.a.	n.a.	0.67	0.05	0.03
Air Compressor	0.04	0.00	0.00	n.a.	n.a.	n.a.	0.04	0.00	0.00
Asphalt Paver	0.07	0.01	0.00	n.a.	n.a.	n.a.	0.07	0.01	0.00
Backhoe	0.13	0.01	0.01	n.a.	n.a.	n.a.	0.13	0.01	0.01
Bob Cat	0.04	0.00	0.00	n.a.	n.a.	n.a.	0.04	0.00	0.00
Caisson Drilling Rig	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Chain Saw	0.01	0.00	0.00	n.a.	n.a.	n.a.	0.01	0.00	0.00
Chipper/Stump Grinder	0.06	0.00	0.00	n.a.	n.a.	n.a.	0.06	0.00	0.00
Concrete Boom Pump	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Concrete Pump	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Concrete Ready Mix Trucks	0.59	0.04	0.02	n.a.	n.a.	n.a.	0.59	0.04	0.02
Concrete Saws	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Concrete Truck	0.39	0.03	0.02	n.a.	n.a.	n.a.	0.39	0.03	0.02
Crane	0.13	0.01	0.01	n.a.	n.a.	n.a.	0.13	0.01	0.01
Curb/Gutter Paver	0.02	0.00	0.00	n.a.	n.a.	n.a.	0.02	0.00	0.00
Distributing Tanker	0.04	0.00	0.00	n.a.	n.a.	n.a.	0.04	0.00	0.00
Dozer	1.52	0.12	0.08	n.a.	n.a.	n.a.	1.52	0.12	0.08
Dump Truck	3.16	0.22	0.12	n.a.	n.a.	n.a.	3.16	0.22	0.12
Dump Truck (12 cy)	6.33	0.44	0.25	n.a.	n.a.	n.a.	6.33	0.44	0.25
Excavator	0.27	0.02	0.01	n.a.	n.a.	n.a.	0.27	0.02	0.01
Excavator with Bucket	0.10	0.01	0.00	n.a.	n.a.	n.a.	0.10	0.01	0.00
Excavator with Hoe Ram	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Flatbed Truck	0.48	0.03	0.02	n.a.	n.a.	n.a.	0.48	0.03	0.02
Fork Truck	1.69	0.12	0.07	n.a.	n.a.	n.a.	1.69	0.12	0.07
Forklift	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Front Loader	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Front Loader for Subgrade Materials	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Generator	0.02	0.00	0.00	n.a.	n.a.	n.a.	0.02	0.00	0.00
Generator Sets	0.02	0.00	0.00	n.a.	n.a.	n.a.	0.02	0.00	0.00
Grader	0.11	0.01	0.01	n.a.	n.a.	n.a.	0.11	0.01	0.01
Grout Mixer for Mortar	0.58	0.04	0.03	n.a.	n.a.	n.a.	0.58	0.04	0.03
High Lift	0.59	0.06	0.04	n.a.	n.a.	n.a.	0.59	0.06	0.04
High Lift Fork Truck	0.17	0.01	0.01	n.a.	n.a.	n.a.	0.17	0.01	0.01
Hydroseeder	0.17	0.01	0.01	n.a.	n.a.	n.a.	0.17	0.01	0.01

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Table E-4 *(continued)*

2012 CONSTRUCTION EMISSIONS BY ACEIT EQUIPMENT TYPE *(Tons)*

ACEIT Construction Equipment	Routine Construction Projects			Growth Construction Projects			Total Construction Projects		
	NO_x	VOC	TSP	NO_x	VOC	TSP	NO_x	VOC	TSP
Loader	0.13	0.01	0.01	n.a.	n.a.	n.a.	0.13	0.01	0.01
Man Lift	0.33	0.03	0.02	n.a.	n.a.	n.a.	0.33	0.03	0.02
Man Lift (Fascia Construction)	0.03	0.00	0.00	n.a.	n.a.	n.a.	0.03	0.00	0.00
Masonry Saw	0.04	0.00	0.00	n.a.	n.a.	n.a.	0.04	0.00	0.00
Material Deliveries	0.13	0.01	0.01	n.a.	n.a.	n.a.	0.13	0.01	0.01
Off-Road Truck	0.18	0.01	0.01	n.a.	n.a.	n.a.	0.18	0.01	0.01
Other General Equipment	0.45	0.03	0.02	n.a.	n.a.	n.a.	0.45	0.03	0.02
Pickup Truck	5.84	0.41	0.23	n.a.	n.a.	n.a.	5.84	0.41	0.23
Pressure Washer	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Roller	0.38	0.04	0.02	n.a.	n.a.	n.a.	0.38	0.04	0.02
Rubber Tired Loader	0.01	0.00	0.00	n.a.	n.a.	n.a.	0.01	0.00	0.00
Scraper	1.02	0.07	0.04	n.a.	n.a.	n.a.	1.02	0.07	0.04
Skid Steer Loader	0.03	0.00	0.00	n.a.	n.a.	n.a.	0.03	0.00	0.00
Slip Form Paver	0.01	0.00	0.00	n.a.	n.a.	n.a.	0.01	0.00	0.00
Surfacing Equipment (Grooving)	0.01	0.00	0.00	n.a.	n.a.	n.a.	0.01	0.00	0.00
Survey Crew Trucks	0.07	0.01	0.00	n.a.	n.a.	n.a.	0.07	0.01	0.00
Sweepers/Scrubbers	0.01	0.00	0.00	n.a.	n.a.	n.a.	0.01	0.00	0.00
Ten Wheelers- Material Delivery	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Tool Truck	2.34	0.16	0.09	n.a.	n.a.	n.a.	2.34	0.16	0.09
Tractor Trailer- Material Delivery	2.28	0.16	0.09	n.a.	n.a.	n.a.	2.28	0.16	0.09
Tractor Trailer- Steel Deliveries	0.37	0.03	0.01	n.a.	n.a.	n.a.	0.37	0.03	0.01
Tractor Trailer- Stone Delivery	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Tractor Trailer- Truck Delivery	0.15	0.01	0.01	n.a.	n.a.	n.a.	0.15	0.01	0.01
Tractor Trailer with Boom Hoist- Curbs Del & Place	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Tractor Trailers Temp Fac.	0.03	0.00	0.00	n.a.	n.a.	n.a.	0.03	0.00	0.00
Tractors/Loader/Backhoe	0.05	0.00	0.00	n.a.	n.a.	n.a.	0.05	0.00	0.00
Trencher	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Trencher for U/G Piping	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Trowel Machine	0.04	0.00	0.00	n.a.	n.a.	n.a.	0.04	0.00	0.00
Trowel Machines (4) machines	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Truck for Topsoil & Seed Del&Spread	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Vibratory Compactor	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00
Water Truck	4.14	0.29	0.16	n.a.	n.a.	n.a.	4.14	0.29	0.16
TOTAL	35.59	2.53	1.48				35.59	2.53	1.48

Note: Numbers may not add due to rounding.
Source: LeighFisher, February 2016.

Emissions Inventory
San Diego International Airport
SAN680

E-4

Leigh|Fisher

Table E-5
2017 CONSTRUCTION EMISSIONS BY ACEIT EQUIPMENT TYPE *(Tons)*

	Routine Construction Projects			Growth Construction Projects			Total Construction Projects		
ACEIT Construction Equipment	NO_x	VOC	TSP	NO_x	VOC	TSP	NO_x	VOC	TSP
40 Ton Crane	0.11	0.01	0.01	0.00	0.00	0.00	0.11	0.01	0.01
40 Ton Rough Terrain	0.00	0.00	0.00	0.63	0.05	0.03	0.63	0.05	0.03
40 Ton Rough Terrain Crane	0.00	0.00	0.00	0.47	0.04	0.02	0.47	0.04	0.02
90 Ton Crane	0.59	0.05	0.03	1.89	0.14	0.09	2.48	0.19	0.12
Air Compressor	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
Asphalt Paver	0.05	0.00	0.00	0.17	0.01	0.01	0.22	0.02	0.01
Backhoe	0.11	0.01	0.01	0.17	0.02	0.01	0.28	0.03	0.02
Bob Cat	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
Caisson Drilling Rig	0.00	0.00	0.00	0.12	0.01	0.00	0.12	0.01	0.00
Chain Saw	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Chipper/Stump Grinder	0.05	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00
Concrete Boom Pump	0.00	0.00	0.00	0.04	0.00	0.00	0.04	0.00	0.00
Concrete Pump	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00
Concrete Ready Mix Trucks	0.47	0.03	0.02	5.03	0.37	0.19	5.50	0.41	0.21
Concrete Saws	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Concrete Truck	0.31	0.02	0.01	0.00	0.00	0.00	0.31	0.02	0.01
Crane	0.12	0.01	0.01	0.00	0.00	0.00	0.12	0.01	0.01
Curb/Gutter Paver	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Distributing Tanker	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
Dozer	1.41	0.12	0.07	0.00	0.00	0.00	1.41	0.12	0.07
Dump Truck	2.53	0.19	0.10	0.00	0.00	0.00	2.53	0.19	0.10
Dump Truck (12 cy)	5.07	0.37	0.19	0.00	0.00	0.00	5.07	0.37	0.19
Excavator	0.19	0.02	0.01	0.24	0.02	0.01	0.43	0.03	0.02
Excavator with Bucket	0.07	0.01	0.00	0.00	0.00	0.00	0.07	0.01	0.00
Excavator with Hoe Ram	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flatbed Truck	0.39	0.03	0.01	0.00	0.00	0.00	0.39	0.03	0.01
Fork Truck	1.36	0.10	0.05	0.71	0.05	0.03	2.07	0.15	0.08
Forklift	0.00	0.00	0.00	0.38	0.04	0.03	0.38	0.04	0.03
Front Loader	0.00	0.00	0.00	0.14	0.01	0.01	0.14	0.01	0.01
Front Loader for Subgrade Materials	0.00	0.00	0.00	0.04	0.00	0.00	0.04	0.00	0.00
Generator	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
Generator Sets	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
Grader	0.11	0.01	0.00	0.00	0.00	0.00	0.11	0.01	0.00
Grout Mixer for Mortar	0.48	0.04	0.02	0.00	0.00	0.00	0.48	0.04	0.02
High Lift	0.49	0.05	0.04	0.64	0.07	0.05	1.13	0.12	0.09
High Lift Fork Truck	0.13	0.01	0.01	0.00	0.00	0.00	0.13	0.01	0.01
Hydroseeder	0.14	0.01	0.01	0.00	0.00	0.00	0.14	0.01	0.01
Loader	0.10	0.01	0.01	0.00	0.00	0.00	0.10	0.01	0.01
Man Lift	0.28	0.02	0.01	0.00	0.00	0.00	0.28	0.02	0.01

LeighFisher

Table E-5 *(continued)*
2017 CONSTRUCTION EMISSIONS BY ACEIT EQUIPMENT TYPE *(Tons)*

ACEIT Construction Equipment	Routine Construction Projects			Growth Construction Projects			Total Construction Projects		
	NO_x	VOC	TSP	NO_x	VOC	TSP	NO_x	VOC	TSP
Man Lift (Fascia Construction)	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
Masonry Saw	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
Material Deliveries	0.10	0.01	0.00	0.00	0.00	0.00	0.10	0.01	0.00
Off-Road Truck	0.14	0.01	0.01	0.00	0.00	0.00	0.14	0.01	0.01
Other General Equipment	0.37	0.03	0.02	0.00	0.00	0.00	0.37	0.03	0.02
Pickup Truck	4.68	0.35	0.18	0.00	0.00	0.00	4.68	0.35	0.18
Pressure Washer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Roller	0.30	0.03	0.02	0.00	0.00	0.00	0.30	0.03	0.02
Rubber Tired Loader	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Scraper	0.91	0.06	0.04	0.00	0.00	0.00	0.91	0.06	0.04
Skid Steer Loader	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
Slip Form Paver	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Surfacing Equipment (Grooving)	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Survey Crew Trucks	0.06	0.00	0.00	0.07	0.01	0.00	0.13	0.01	0.00
Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ten Wheelers- Material Delivery	0.00	0.00	0.00	0.46	0.03	0.02	0.46	0.03	0.02
Tool Truck	1.87	0.14	0.07	2.00	0.15	0.08	3.87	0.29	0.15
Tractor Trailer- Material Delivery	1.83	0.13	0.07	3.35	0.25	0.13	5.18	0.38	0.20
Tractor Trailer- Steel Deliveries	0.30	0.02	0.01	1.83	0.14	0.07	2.13	0.16	0.08
Tractor Trailer- Stone Delivery	0.00	0.00	0.00	1.52	0.11	0.06	1.52	0.11	0.06
Tractor Trailer- Truck Delivery	0.12	0.01	0.00	0.00	0.00	0.00	0.12	0.01	0.00
Tractor Trailer with Boom Hoist- Curbs Del & Place	0.00	0.00	0.00	0.31	0.02	0.01	0.31	0.02	0.01
Tractor Trailers Temp Fac.	0.02	0.00	0.00	0.04	0.00	0.00	0.06	0.00	0.00
Tractors/Loader/Backhoe	0.04	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
Trencher	0.00	0.00	0.00	0.12	0.01	0.01	0.12	0.01	0.01
Trencher for U/G Piping	0.00	0.00	0.00	0.20	0.02	0.01	0.20	0.02	0.01
Trowel Machine	0.04	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
Trowel Machines (4) machines	0.00	0.00	0.00	1.43	0.09	0.05	1.43	0.09	0.05
Truck for Topsoil & Seed Del&Spread	0.00	0.00	0.00	0.31	0.02	0.01	0.31	0.02	0.01
Vibratory Compactor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water Truck	3.32	0.24	0.13	0.00	0.00	0.00	3.32	0.24	0.13
TOTAL	28.94	2.18	1.19	22.33	1.68	0.94	51.27	3.86	2.14

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

Leigh|Fisher

Table E-6

2020 CONSTRUCTION EMISSIONS BY ACEIT EQUIPMENT TYPE *(Tons)*

	Routine Construction Projects			Growth Construction Projects			Total Construction Projects		
ACEIT Construction Equipment	NO_x	VOC	TSP	NO_x	VOC	TSP	NO_x	VOC	TSP
40 Ton Crane	0.09	0.01	0.00	0.87	0.07	0.04	0.96	0.08	0.05
40 Ton Rough Terrain	0.00	0.00	0.00	0.97	0.08	0.05	0.97	0.08	0.05
40 Ton Rough Terrain Crane	0.00	0.00	0.00	0.73	0.06	0.03	0.73	0.06	0.03
90 Ton Crane	0.51	0.04	0.02	19.70	1.54	0.95	20.21	1.58	0.97
Air Compressor	0.02	0.00	0.00	0.22	0.02	0.01	0.25	0.02	0.01
Asphalt Paver	0.04	0.00	0.00	0.69	0.06	0.04	0.73	0.06	0.04
Backhoe	0.08	0.01	0.00	1.90	0.17	0.11	1.97	0.18	0.12
Bob Cat	0.02	0.00	0.00	0.91	0.08	0.05	0.93	0.08	0.06
Caisson Drilling Rig	0.00	0.00	0.00	0.16	0.01	0.01	0.16	0.01	0.01
Chain Saw	0.01	0.00	0.00	0.08	0.01	0.00	0.08	0.01	0.00
Chipper/Stump Grinder	0.04	0.00	0.00	0.43	0.04	0.02	0.47	0.04	0.02
Concrete Boom Pump	0.00	0.00	0.00	0.05	0.00	0.00	0.05	0.00	0.00
Concrete Pump	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00
Concrete Ready Mix Trucks	0.34	0.03	0.01	11.99	0.93	0.43	12.33	0.96	0.44
Concrete Saws	0.00	0.00	0.00	0.12	0.01	0.01	0.12	0.01	0.01
Concrete Truck	0.22	0.02	0.01	10.63	0.83	0.38	10.86	0.85	0.39
Crane	0.10	0.01	0.00	0.00	0.00	0.00	0.10	0.01	0.00
Curb/Gutter Paver	0.01	0.00	0.00	0.07	0.01	0.00	0.08	0.01	0.00
Distributing Tanker	0.02	0.00	0.00	1.24	0.10	0.04	1.26	0.10	0.04
Dozer	1.26	0.11	0.07	13.97	1.22	0.73	15.23	1.33	0.79
Dump Truck	1.82	0.14	0.06	38.45	3.00	1.37	40.27	3.14	1.44
Dump Truck (12 cy)	3.64	0.28	0.13	38.70	3.02	1.38	42.34	3.30	1.51
Excavator	0.13	0.01	0.01	1.71	0.15	0.07	1.84	0.16	0.08
Excavator with Bucket	0.04	0.00	0.00	3.29	0.29	0.14	3.33	0.29	0.14
Excavator with Hoe Ram	0.00	0.00	0.00	1.37	0.12	0.06	1.37	0.12	0.06
Flatbed Truck	0.28	0.02	0.01	24.82	1.93	0.89	25.10	1.96	0.90
Fork Truck	0.97	0.08	0.03	50.97	3.97	1.82	51.94	4.05	1.85
Forklift	0.00	0.00	0.00	0.51	0.05	0.04	0.51	0.05	0.04
Front Loader	0.00	0.00	0.00	0.19	0.02	0.01	0.19	0.02	0.01
Front Loader for Subgrade Materials	0.00	0.00	0.00	0.05	0.00	0.00	0.05	0.00	0.00
Generator	0.01	0.00	0.00	1.36	0.12	0.07	1.37	0.12	0.07
Generator Sets	0.01	0.00	0.00	0.56	0.05	0.03	0.57	0.05	0.03
Grader	0.10	0.01	0.00	1.12	0.09	0.05	1.21	0.09	0.05
Grout Mixer for Mortar	0.38	0.03	0.02	0.00	0.00	0.00	0.38	0.03	0.02
High Lift	0.36	0.04	0.03	18.27	1.87	1.30	18.63	1.91	1.33
High Lift Fork Truck	0.10	0.01	0.00	0.00	0.00	0.00	0.10	0.01	0.00
Hydroseeder	0.11	0.01	0.01	1.29	0.11	0.07	1.41	0.12	0.07
Loader	0.07	0.01	0.00	1.39	0.13	0.08	1.46	0.13	0.09
Man Lift	0.22	0.01	0.02	12.77	1.09	0.64	12.99	1.11	0.65

Leigh|Fisher

Table E-6 *(continued)*
2020 CONSTRUCTION EMISSIONS BY ACEIT EQUIPMENT TYPE *(Tons)*

ACEIT Construction Equipment	Routine Construction Projects			Growth Construction Projects			Total Construction Projects		
	NO_x	VOC	TSP	NO_x	VOC	TSP	NO_x	VOC	TSP
Man Lift (Fascia Construction)	0.02	0.00	0.00	0.13	0.01	0.01	0.16	0.01	0.01
Masonry Saw	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
Material Deliveries	0.07	0.01	0.00	5.17	0.40	0.18	5.25	0.41	0.19
Off-Road Truck	0.10	0.01	0.00	1.19	0.09	0.04	1.29	0.10	0.05
Other General Equipment	0.29	0.02	0.01	9.76	0.83	0.49	10.06	0.86	0.51
Pickup Truck	3.36	0.26	0.12	94.75	7.38	3.38	98.11	7.65	3.50
Pressure Washer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00
Roller	0.22	0.02	0.01	2.62	0.29	0.16	2.84	0.31	0.17
Rubber Tired Loader	0.01	0.00	0.00	0.57	0.05	0.03	0.57	0.05	0.03
Scraper	0.73	0.05	0.03	7.12	0.54	0.30	7.85	0.59	0.33
Skid Steer Loader	0.02	0.00	0.00	0.20	0.01	0.01	0.22	0.02	0.01
Slip Form Paver	0.01	0.00	0.00	0.51	0.04	0.03	0.51	0.05	0.03
Surfacing Equipment (Grooving)	0.01	0.00	0.00	0.12	0.01	0.00	0.13	0.01	0.00
Survey Crew Trucks	0.04	0.00	0.00	1.00	0.08	0.04	1.04	0.08	0.04
Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ten Wheelers- Material Delivery	0.00	0.00	0.00	0.59	0.05	0.02	0.59	0.05	0.02
Tool Truck	1.34	0.11	0.05	68.37	5.33	2.44	69.71	5.43	2.49
Tractor Trailer- Material Delivery	1.31	0.10	0.05	75.93	5.92	2.71	77.24	6.02	2.75
Tractor Trailer- Steel Deliveries	0.21	0.02	0.01	5.87	0.46	0.21	6.09	0.47	0.22
Tractor Trailer- Stone Delivery	0.00	0.00	0.00	1.96	0.15	0.07	1.96	0.15	0.07
Tractor Trailer- Truck Delivery	0.09	0.01	0.00	0.00	0.00	0.00	0.09	0.01	0.00
Tractor Trailer with Boom Hoist- Curbs Del & Place	0.00	0.00	0.00	0.40	0.03	0.01	0.40	0.03	0.01
Tractor Trailers Temp Fac.	0.02	0.00	0.00	0.40	0.03	0.01	0.42	0.03	0.02
Tractors/Loader/Backhoe	0.03	0.00	0.00	0.42	0.04	0.03	0.46	0.04	0.03
Trencher	0.00	0.00	0.00	0.18	0.02	0.01	0.18	0.02	0.01
Trencher for U/G Piping	0.00	0.00	0.00	0.30	0.03	0.02	0.30	0.03	0.02
Trowel Machine	0.03	0.00	0.00	0.80	0.05	0.03	0.83	0.05	0.03
Trowel Machines (4) machines	0.00	0.00	0.00	1.86	0.12	0.07	1.86	0.12	0.07
Truck for Topsoil & Seed Del&Spread	0.00	0.00	0.00	0.40	0.03	0.01	0.40	0.03	0.01
Vibratory Compactor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water Truck	2.38	0.19	0.09	19.72	1.54	0.70	22.11	1.72	0.79
TOTAL	21.34	1.70	0.84	561.96	44.76	21.95	583.30	46.47	22.79

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

Leigh|Fisher

Table E-7
2030 CONSTRUCTION EMISSIONS BY ACEIT EQUIPMENT TYPE *(Tons)*

ACEIT Construction Equipment	Routine Construction Projects			Growth Construction Projects			Total Construction Projects		
	NO_x	VOC	TSP	NO_x	VOC	TSP	NO_x	VOC	TSP
40 Ton Crane	0.04	0.00	0.00	0.40	0.04	0.02	0.45	0.04	0.02
40 Ton Rough Terrain	0.00	0.00	0.00	0.45	0.04	0.02	0.45	0.04	0.02
40 Ton Rough Terrain Crane	0.00	0.00	0.00	0.34	0.03	0.02	0.34	0.03	0.02
90 Ton Crane	0.24	0.02	0.01	9.13	0.84	0.44	9.37	0.86	0.45
Air Compressor	0.01	0.00	0.00	0.10	0.01	0.00	0.12	0.01	0.01
Asphalt Paver	0.02	0.00	0.00	0.27	0.03	0.01	0.29	0.03	0.01
Backhoe	0.04	0.00	0.00	0.95	0.09	0.03	0.99	0.10	0.03
Bob Cat	0.01	0.00	0.00	0.45	0.05	0.02	0.46	0.05	0.02
Caisson Drilling Rig	0.00	0.00	0.00	0.09	0.01	0.00	0.09	0.01	0.00
Chain Saw	0.00	0.00	0.00	0.04	0.00	0.00	0.04	0.00	0.00
Chipper/Stump Grinder	0.02	0.00	0.00	0.20	0.02	0.01	0.22	0.02	0.01
Concrete Boom Pump	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00
Concrete Pump	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00
Concrete Ready Mix Trucks	0.14	0.02	0.00	4.86	0.54	0.13	5.00	0.55	0.13
Concrete Saws	0.00	0.00	0.00	0.06	0.01	0.00	0.06	0.01	0.00
Concrete Truck	0.09	0.01	0.00	4.31	0.48	0.11	4.40	0.49	0.12
Crane	0.05	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00
Curb/Gutter Paver	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00
Distributing Tanker	0.01	0.00	0.00	0.50	0.06	0.01	0.51	0.06	0.01
Dozer	0.77	0.08	0.04	8.62	0.86	0.46	9.39	0.93	0.50
Dump Truck	0.74	0.08	0.02	15.59	1.73	0.41	16.33	1.81	0.43
Dump Truck (12 cy)	1.48	0.16	0.04	15.69	1.74	0.41	17.17	1.90	0.45
Excavator	0.05	0.01	0.00	0.67	0.09	0.02	0.72	0.10	0.02
Excavator with Bucket	0.02	0.00	0.00	1.28	0.17	0.04	1.30	0.18	0.04
Excavator with Hoe Ram	0.00	0.00	0.00	0.53	0.07	0.02	0.53	0.07	0.02
Flatbed Truck	0.11	0.01	0.00	10.06	1.12	0.26	10.18	1.13	0.27
Fork Truck	0.40	0.04	0.01	20.66	2.29	0.54	21.06	2.34	0.55
Forklift	0.00	0.00	0.00	0.23	0.02	0.01	0.23	0.02	0.01
Front Loader	0.00	0.00	0.00	0.06	0.01	0.00	0.06	0.01	0.00
Front Loader for Subgrade Materials	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00
Generator	0.01	0.00	0.00	0.63	0.07	0.03	0.64	0.07	0.03
Generator Sets	0.01	0.00	0.00	0.26	0.03	0.01	0.27	0.03	0.01
Grader	0.04	0.00	0.00	0.45	0.05	0.02	0.49	0.05	0.02
Grout Mixer for Mortar	0.18	0.02	0.01	0.00	0.00	0.00	0.18	0.02	0.01
High Lift	0.16	0.02	0.01	8.17	0.89	0.35	8.33	0.91	0.36
High Lift Fork Truck	0.04	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
Hydroseeder	0.05	0.01	0.00	0.60	0.06	0.03	0.66	0.07	0.03
Loader	0.04	0.00	0.00	0.69	0.07	0.02	0.73	0.07	0.03
Man Lift	0.10	0.01	0.00	5.96	0.63	0.28	6.06	0.64	0.28

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Table E-7 *(continued)*

2030 CONSTRUCTION EMISSIONS BY ACEIT EQUIPMENT TYPE *(Tons)*

ACEIT Construction Equipment	Routine Construction Projects			Growth Construction Projects			Total Construction Projects		
	NO_x	VOC	TSP	NO_x	VOC	TSP	NO_x	VOC	TSP
Man Lift (Fascia Construction)	0.01	0.00	0.00	0.06	0.01	0.00	0.07	0.01	0.00
Masonry Saw	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Material Deliveries	0.03	0.00	0.00	2.10	0.23	0.06	2.13	0.24	0.06
Off-Road Truck	0.04	0.00	0.00	0.48	0.05	0.01	0.52	0.06	0.01
Other General Equipment	0.14	0.01	0.01	4.56	0.48	0.21	4.69	0.50	0.22
Pickup Truck	1.36	0.15	0.04	38.42	4.26	1.01	39.78	4.41	1.04
Pressure Washer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00
Roller	0.12	0.01	0.00	1.39	0.15	0.06	1.51	0.16	0.06
Rubber Tired Loader	0.00	0.00	0.00	0.19	0.03	0.01	0.19	0.03	0.01
Scraper	0.26	0.03	0.01	2.56	0.28	0.11	2.83	0.30	0.12
Skid Steer Loader	0.01	0.00	0.00	0.14	0.01	0.00	0.15	0.01	0.00
Slip Form Paver	0.00	0.00	0.00	0.20	0.02	0.01	0.20	0.02	0.01
Surfacing Equipment (Grooving)	0.00	0.00	0.00	0.05	0.00	0.00	0.05	0.00	0.00
Survey Crew Trucks	0.02	0.00	0.00	0.40	0.04	0.01	0.42	0.05	0.01
Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ten Wheelers- Material Delivery	0.00	0.00	0.00	0.24	0.03	0.01	0.24	0.03	0.01
Tool Truck	0.54	0.06	0.01	27.72	3.07	0.73	28.26	3.13	0.74
Tractor Trailer- Material Delivery	0.53	0.06	0.01	30.79	3.41	0.81	31.32	3.47	0.82
Tractor Trailer- Steel Deliveries	0.09	0.01	0.00	2.38	0.26	0.06	2.47	0.27	0.06
Tractor Trailer- Stone Delivery	0.00	0.00	0.00	0.80	0.09	0.02	0.80	0.09	0.02
Tractor Trailer- Truck Delivery	0.04	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
Tractor Trailer with Boom Hoist- Curbs Del & Place	0.00	0.00	0.00	0.16	0.02	0.00	0.16	0.02	0.00
Tractor Trailers Temp Fac.	0.01	0.00	0.00	0.16	0.02	0.00	0.17	0.02	0.00
Tractors/Loader/Backhoe	0.02	0.00	0.00	0.21	0.02	0.01	0.23	0.02	0.01
Trencher	0.00	0.00	0.00	0.12	0.01	0.01	0.12	0.01	0.01
Trencher for U/G Piping	0.00	0.00	0.00	0.20	0.02	0.01	0.20	0.02	0.01
Trowel Machine	0.01	0.00	0.00	0.33	0.03	0.01	0.34	0.03	0.01
Trowel Machines (4) machines	0.00	0.00	0.00	0.77	0.07	0.03	0.77	0.07	0.03
Truck for Topsoil & Seed Del&Spread	0.00	0.00	0.00	0.16	0.02	0.00	0.16	0.02	0.00
Vibratory Compactor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water Truck	0.97	0.11	0.03	8.00	0.89	0.21	8.96	0.99	0.24
TOTAL	9.06	0.99	0.29	235.02	25.69	7.16	244.08	26.68	7.45

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

Leigh|Fisher

Table E-8
2040 CONSTRUCTION EMISSIONS BY ACEIT EQUIPMENT TYPE *(Tons)*

	Routine Construction Projects			Growth Construction Projects			Total Construction Projects		
ACEIT Construction Equipment	NO_x	VOC	TSP	NO_x	VOC	TSP	NO_x	VOC	TSP
40 Ton Crane	0.04	0.00	0.00	0.40	0.04	0.02	0.45	0.04	0.02
40 Ton Rough Terrain	0.00	0.00	0.00	0.45	0.04	0.02	0.45	0.04	0.02
40 Ton Rough Terrain Crane	0.00	0.00	0.00	0.34	0.03	0.02	0.34	0.03	0.02
90 Ton Crane	0.24	0.02	0.01	9.13	0.84	0.44	9.37	0.86	0.45
Air Compressor	0.01	0.00	0.00	0.10	0.01	0.00	0.12	0.01	0.01
Asphalt Paver	0.02	0.00	0.00	0.27	0.03	0.01	0.29	0.03	0.01
Backhoe	0.04	0.00	0.00	0.95	0.09	0.03	0.99	0.10	0.03
Bob Cat	0.01	0.00	0.00	0.45	0.05	0.02	0.46	0.05	0.02
Caisson Drilling Rig	0.00	0.00	0.00	0.09	0.01	0.00	0.09	0.01	0.00
Chain Saw	0.00	0.00	0.00	0.04	0.00	0.00	0.04	0.00	0.00
Chipper/Stump Grinder	0.02	0.00	0.00	0.20	0.02	0.01	0.22	0.02	0.01
Concrete Boom Pump	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00
Concrete Pump	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00
Concrete Ready Mix Trucks	0.14	0.02	0.00	4.86	0.54	0.13	5.00	0.55	0.13
Concrete Saws	0.00	0.00	0.00	0.06	0.01	0.00	0.06	0.01	0.00
Concrete Truck	0.09	0.01	0.00	4.31	0.48	0.11	4.40	0.49	0.12
Crane	0.05	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00
Curb/Gutter Paver	0.00	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00
Distributing Tanker	0.01	0.00	0.00	0.50	0.06	0.01	0.51	0.06	0.01
Dozer	0.77	0.08	0.04	8.62	0.86	0.46	9.39	0.93	0.50
Dump Truck	0.74	0.08	0.02	15.59	1.73	0.41	16.33	1.81	0.43
Dump Truck (12 cy)	1.48	0.16	0.04	15.69	1.74	0.41	17.17	1.90	0.45
Excavator	0.05	0.01	0.00	0.67	0.09	0.02	0.72	0.10	0.02
Excavator with Bucket	0.02	0.00	0.00	1.28	0.17	0.04	1.30	0.18	0.04
Excavator with Hoe Ram	0.00	0.00	0.00	0.53	0.07	0.02	0.53	0.07	0.02
Flatbed Truck	0.11	0.01	0.00	10.06	1.12	0.26	10.18	1.13	0.27
Fork Truck	0.40	0.04	0.01	20.66	2.29	0.54	21.06	2.34	0.55
Forklift	0.00	0.00	0.00	0.23	0.02	0.01	0.23	0.02	0.01
Front Loader	0.00	0.00	0.00	0.06	0.01	0.00	0.06	0.01	0.00
Front Loader for Subgrade Materials	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00
Generator	0.01	0.00	0.00	0.63	0.07	0.03	0.64	0.07	0.03
Generator Sets	0.01	0.00	0.00	0.26	0.03	0.01	0.27	0.03	0.01
Grader	0.04	0.00	0.00	0.45	0.05	0.02	0.49	0.05	0.02
Grout Mixer for Mortar	0.18	0.02	0.01	0.00	0.00	0.00	0.18	0.02	0.01
High Lift	0.16	0.02	0.01	8.17	0.89	0.35	8.33	0.91	0.36
High Lift Fork Truck	0.04	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
Hydroseeder	0.05	0.01	0.00	0.60	0.06	0.03	0.66	0.07	0.03
Loader	0.04	0.00	0.00	0.69	0.07	0.02	0.73	0.07	0.03
Man Lift	0.10	0.01	0.00	5.96	0.63	0.28	6.06	0.64	0.28

LeighFisher

Table E-8 *(continued)*
2040 CONSTRUCTION EMISSIONS BY ACEIT EQUIPMENT TYPE *(Tons)*

ACEIT Construction Equipment	Routine Construction Projects			Growth Construction Projects			Total Construction Projects		
	NO_x	VOC	TSP	NO_x	VOC	TSP	NO_x	VOC	TSP
Man Lift (Fascia Construction)	0.01	0.00	0.00	0.06	0.01	0.00	0.07	0.01	0.00
Masonry Saw	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Material Deliveries	0.03	0.00	0.00	2.10	0.23	0.06	2.13	0.24	0.06
Off-Road Truck	0.04	0.00	0.00	0.48	0.05	0.01	0.52	0.06	0.01
Other General Equipment	0.14	0.01	0.01	4.56	0.48	0.21	4.69	0.50	0.22
Pickup Truck	1.36	0.15	0.04	38.42	4.26	1.01	39.78	4.41	1.04
Pressure Washer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00
Roller	0.12	0.01	0.00	1.39	0.15	0.06	1.51	0.16	0.06
Rubber Tired Loader	0.00	0.00	0.00	0.19	0.03	0.01	0.19	0.03	0.01
Scraper	0.26	0.03	0.01	2.56	0.28	0.11	2.83	0.30	0.12
Skid Steer Loader	0.01	0.00	0.00	0.14	0.01	0.00	0.15	0.01	0.00
Slip Form Paver	0.00	0.00	0.00	0.20	0.02	0.01	0.20	0.02	0.01
Surfacing Equipment (Grooving)	0.00	0.00	0.00	0.05	0.00	0.00	0.05	0.00	0.00
Survey Crew Trucks	0.02	0.00	0.00	0.40	0.04	0.01	0.42	0.05	0.01
Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ten Wheelers- Material Delivery	0.00	0.00	0.00	0.24	0.03	0.01	0.24	0.03	0.01
Tool Truck	0.54	0.06	0.01	27.72	3.07	0.73	28.26	3.13	0.74
Tractor Trailer- Material Delivery	0.53	0.06	0.01	30.79	3.41	0.81	31.32	3.47	0.82
Tractor Trailer- Steel Deliveries	0.09	0.01	0.00	2.38	0.26	0.06	2.47	0.27	0.06
Tractor Trailer- Stone Delivery	0.00	0.00	0.00	0.80	0.09	0.02	0.80	0.09	0.02
Tractor Trailer- Truck Delivery	0.04	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
Tractor Trailer with Boom Hoist- Curbs Del & Place	0.00	0.00	0.00	0.16	0.02	0.00	0.16	0.02	0.00
Tractor Trailers Temp Fac.	0.01	0.00	0.00	0.16	0.02	0.00	0.17	0.02	0.00
Tractors/Loader/Backhoe	0.02	0.00	0.00	0.21	0.02	0.01	0.23	0.02	0.01
Trencher	0.00	0.00	0.00	0.12	0.01	0.01	0.12	0.01	0.01
Trencher for U/G Piping	0.00	0.00	0.00	0.20	0.02	0.01	0.20	0.02	0.01
Trowel Machine	0.01	0.00	0.00	0.33	0.03	0.01	0.34	0.03	0.01
Trowel Machines (4) machines	0.00	0.00	0.00	0.77	0.07	0.03	0.77	0.07	0.03
Truck for Topsoil & Seed Del&Spread	0.00	0.00	0.00	0.16	0.02	0.00	0.16	0.02	0.00
Vibratory Compactor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water Truck	0.97	0.11	0.03	8.00	0.89	0.21	8.96	0.99	0.24
TOTAL	9.06	0.99	0.29	235.02	25.69	7.16	244.08	26.68	7.45

Note: Numbers may not add due to rounding.

Source: LeighFisher, February 2016.

ATTACHMENT D
ARB Control Measures, 1985 to2015

Table D-1
ARB Control Measures, 1985 to 2015

ARB Board Action (Board)	Hearing Date
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 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
CA Cap on GHG Emissions and Market-Based Compliance Mechanisms (2 of 2) Amendments to the Cap and Trade Regulation to include a new Rice Cultivation Compliance Offset Protocol and an update to the United States Forest Compliance Offset Protocol that would include project eligibility in parts of Alaska.	6/25/15
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

Board Action	Hearing Date
CA Cap on GHG Emissions and Market-Based Compliance Mechanisms to Add the Rice Cultivation Projects and Updated U.S. Forest Projects Protocols (1 of 2) Updates to the Cap and Trade Regulation to include a new Rice Cultivation Compliance Offset Protocol and an update to the United States Forest Compliance Offset Protocol that would include project eligibility in parts of Alaska.	12/18/14
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
Amendments to Mandatory Reporting Regulation for Greenhouse Gases Further align reporting methods with EPA methods and factors, and modify reporting requirements to fully support implementation of California's Cap and Trade program.	9/19/14
Amendments to the California Cap on Greenhouse Gas Emissions and Market Based Compliance Mechanisms Technical revisions to Mandatory Reporting of Greenhouse Gas Emissions Regulation to further align reporting methods with EPA update methods and factors, and modify reporting requirements to fully support implementation of California's Cap and Trade program.	9/18/14
Amendments to the AB 32 Cost of Implementation Fee Regulation Amendments to the regulation to make it consistent with the revised mandatory reporting regulation, to add potential reporting requirements, and to incorporate requirements in the mandatory reporting regulation to streamline reporting.	9/18/14
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 California Environmental Quality Act. 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
Proposed Approval of Amendments to CA Cap on GHG Emissions and Market-Based Compliance Mechanisms Second hearing of two, continued from October 2013.	4/24/14
Truck and Bus Rule Update Amendments to the Regulation to Reduce Emissions of Diesel Particulate Matter, NOx, 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 EPA 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
Mandatory Report of Greenhouse Gas Emissions Approved a regulation that establishes detailed specifications for emissions calculations, reporting, and verification of GHG emission estimates from significant sources.	10/25/13

Board Action	Hearing Date
CA Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms Technical revisions to the Mandatory Reporting of Greenhouse Gas Emissions Regulation to further align reporting methods with EPA, update factors, and modify definitions to maintain consistency with the Cap and Trade program.	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
Consumer Products: Antiperspirants, Deodorants, Test Method 310, Aerosol Coatings, Proposed Repeal of Hairspray Credit) Amendments to require various consumer products to reformulate to reduce VOC or reactivity content to meet specified limits, and to clarify various regulatory provisions, improve enforcement, and add analytical procedures.	9/26/13
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
Consumer products (automotive windshield washing fluid) Adopted amendments to add portions of 14 California counties to the list of areas with freezing temperatures where 25% VOC content windshield washing fluid could be sold.	10/18/2012 EO 03/15/13
GHG mandatory reporting, Fee Regulation, and Cap and Trade 2012 Adopted amendments to eliminate emission verification for facilities emitting less than 25,000 MTCO2e and make minor changes in definitions and requirements.	9/20/12 11/2/12 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
Cap and Trade: Amendments to CA Cap on GHG Emissions and Market-Based Compliance Mechanisms, and Amendments Allowing Use of Compliance Instruments Issued by Linked Jurisdictions Amends Cap-and-Trade and compliance mechanisms to add security to the market system and to aid staff in implementation. Amendments include first auction rules, offset registry, market monitoring provisions, and information gathering necessary for the financial services operator.	6/28/12 7/31/12 EO
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

Board Action	Hearing Date
Tractor-Trailer GHG Regulation: Emergency Amendment Adopted emergency amendment to correct a drafting error and delay the registration date for participation in the phased compliance option	2/29/2012 2/29/12 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 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 AB 32 Cost of Implementation Fee Regulation Clarifies requirements and regulatory language, revises definitions.	10/20/11 8/21/12 EO
Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms Regulation, Including Compliance Offset Protocols Greenhouse Gas Emissions Cap-and-Trade Program, including compliance offset protocols and multiple pathways for compliance.	10/21/11 8/21/12 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

Board Action	Hearing Date
Tractor-Trailer GHG Regulation Amendment Enacts administrative changes to increase compliance flexibility and reduce costs	12/16/10
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
Amendments to the Regulation for Mandatory Reporting of Greenhouse Gas Emissions Changes requirements to align with federal greenhouse gas reporting requirements adopted by EPA.	12/16/10 10/28/11 EO
Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms Regulation Establishes framework and requirements for Greenhouse Gas Emissions Cap-and-Trade Program, including compliance offset protocols.	12/16/10 10/26/11 EO
Amendments to the Consumer Products Regulation Amendments set new or lower VOC limits for some categories, prohibit certain toxic air contaminants, high GWP compounds, and surfactants toxic to aquatic species. Also changes Method 310, used to determine aromatic content of certain products.	11/18/10 9/29/11 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
Amendments to New Passenger Motor Vehicle Greenhouse Gas Emission Standards Approved amendments deeming compliance with EPA's GHG standards as compliance with California's standards in 2012 through 2016 model years.	2/25/2010 03/29/10
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
Stationary Equipment High-GWP Refrigerant Regulation Approved a regulation to reduce emissions of high-GWP refrigerants from stationary non-residential equipment.	12/1/09 9/14/10 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

Board Action	Hearing Date
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
AB 32 Cost of Implementation Fee Regulation AB 32 authorizes ARB to adopt by regulation a schedule of fees to be paid by sources of greenhouse gas emissions regulated pursuant to AB 32. ARB staff will propose a fee regulation to support the administrative costs of AB 32 implementation.	9/24/2009 05/06/10 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
Consumer Products Amendments Approved amendments that set new VOC limits for multi-purpose solvent and paint thinner products and lower the existing VOC limit for double phase aerosol air fresheners.	9/24/09 8/6/10 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 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

Board Action	Hearing Date
In-Use Off-Road Diesel-Fueled Fleets Amendments Makes administrative changes to recognize delays in the supply of retrofit control devices.	1/22/09
Small Containers of Automotive Refrigerant Approved a regulation to reduce leakage from small containers, adopt a container deposit and return program, and require additional container labeling and consumer education requirements.	1/22/09 1/5/10 EO
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
Heavy-Duty Tractor-Trailer Greenhouse Gas (GHG) Reduction Approved a regulation to reduce greenhouse gas emissions by improving long haul tractor and trailer efficiency through use of aerodynamic fairings and low rolling resistance tires.	12/11/08 10/23/09 EO
Cleaner In-Use Heavy-Duty Diesel Trucks (Truck and Bus Regulation) Approved a regulation to reduce diesel particulate matter and NOx 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
Consumer Products Amendments Approved amendments that add VOC limits for seven additional categories and lower limits for twelve previously regulated categories.	6/26/08 5/5/09 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
Mandatory Report of Greenhouse Gas Emissions Approved a regulation that establishes detailed specifications for emissions calculations, reporting, and verification of GHG emission estimates from significant sources.	12/6/07 10/12/08 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

Board Action	Hearing Date
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
Consumer Products Regulation Amendments Approved amendments that set lower emission limits in 15 product categories.	11/17/06 9/25/07 EO

Board Action	Hearing Date
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

Board Action	Hearing Date
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 Superseded 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

Board Action	Hearing Date
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 harbor craft and intrastate locomotives Approved a regulation that required harbor craft and locomotives operating solely within California to use clean diesel fuel.	11/18/04 3/16/05 EO
Non-vehicular 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
Consumer Products Approved a regulation to reduce ROG emissions from 15 consumer products categories, prohibit the use of 3 toxic compounds in consumer products, ban the use of PDCB in certain products, allow for the use of Alternative Control Plans, and revise Test Method 310.	6/24/04 5/6/05 EO
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 EPA.	12/11/03 2/26/04 10/17/04

Board Action	Hearing Date
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

Board Action	Hearing Date
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
Automotive coatings Adopted Air Toxic Control Measure which prohibits the sale and use in California of automotive coatings that contain hexavalent chromium or cadmium.	9/20/01 9/2/02 EO
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

Board Action	Hearing Date
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
Antiperspirant and deodorant regulations Adopted amendments to relax a 0% VOC limit to 40% VOC limit for aerosol antiperspirants.	10/26/00
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
Aerosol Coatings Approved amendments to replace mass-based VOC limits with reactivity-based limits, add a table of Maximum Incremental Reactivity values, add limits for polyolefin adhesion promoters, prohibit use of certain toxic solvents, and make other minor changes.	6/22/00 5/1/01 EO
Consumer products aerosol adhesives Adopted amendments to delete a 25% VOC limit by 2002, add new VOC limits for six categories of adhesives, prohibit the use of toxic solvents, and add new labeling and reporting requirements.	5/25/00 3/14/01 EO
Automotive care products Approved an Air Toxic Control Measure to eliminate use of perchloroethylene, methylene chloride, and trichloroethylene in automotive products such as brake cleaners and degreasers.	4/27/00 2/28/01 EO
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

Board Action	Hearing Date
Consumer products – mid-term measures II Adopted a regulation which adds emission limits for 2 new categories and tightens emission limits for 15 categories of consumer products.	10/28/99
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 pleasure craft 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
Consumer products Adopted amendments to add new VOC test methods, to modify Method 310 to quantify low vapor pressure VOC (LVP-VOC) constituents, and to exempt LVP-VOC from VOC content limits	11/19/98
Consumer products Approved amendments to extend the 1999 VOC compliance deadline for several aerosol coatings, antiperspirants and deodorants, and other consumer products categories to 2002, to exempt methyl acetate from the VOC definition, and make other minor changes.	11/19/98
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

Board Action	Hearing Date
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, 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 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
Consumer products (hairspray credit program) Adopted standards for the granting of tradable emission reduction credits achieved by sales of hairspray products having VOC contents less than required limits.	11/13/97
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
Consumer products Adopted amendments to add VOC limits to 18 categories of consumer products used in residential and industrial cleaning, automobile maintenance, and commercial poisons.	7/24/97
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

Board Action	Hearing Date
Consumer products (hair spray) Adopted amendments to (1) delay a January 1, 1998, compliance deadline to June 1, 1999, (2) require progress plans from manufacturers, and (3) authorize the Executive Officer to require VOC mitigation when granting variances from the June 1, 1999 deadline.	3/27/97
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
Consumer products Adopted amendments to delay 25% VOC compliance date for aerosol adhesives, clarify portions of the regulation, exempt perchloroethylene from VOC definition, extend the sell-through time to three years, and add perchloroethylene reporting requirements.	11/21/96
Consumer products (test method) Adopted an amendment to add Method 310 for the testing of VOC content in consumer products.	11/21/96
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, 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

Board Action	Hearing Date
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

Board Action	Hearing Date
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
Consumer Products - Tier II Adopted Tier II of regulations to reduce emissions from consumer products.	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
Consumer Products Tier I Adopted Tier I of standards to reduce emissions from consumer products.	10/11/90
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

Board Action	Hearing Date
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
Consumer products Bay Area Air Quality Management District (BAAQMD)	6/14/90
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
Antiperspirants and deodorants Adopted first consumer products regulation, setting standards for antiperspirants and deodorants.	11/1/89
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
Architectural coatings Approved a suggested control measure to reduce ROG emissions from architectural coatings.	5/1/89
Chrome from cooling towers Adopted Airborne Toxic Control Measure to reduce hexavalent chromium emissions from cooling towers.	3/1/89
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
Chrome platers Adopted Airborne Toxic Control Measure to reduce emissions of hexavalent chromium emissions from chrome plating and chromic acid anodizing facilities.	2/1/88
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

Board Action	Hearing Date
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

ATTACHMENT E
ARB ANALYSES OF KEY MOBILE SOURCE REGULATONS AND PROGRAMS PROVIDING EMISSION REDUCTIONS

E.1 Overview

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

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

This multi-faceted approach has spurred the development of increasingly cleaner technologies and fuels and achieved significant emission reductions across all mobile source sectors that go far beyond national programs or programs in other states. These efforts extend back to the first mobile source regulations adopted in the 1960s, and pre-date the federal CAA Amendments of 1970, which established the basic national framework for controlling air pollution. In recognition of the pioneering nature of the ARB's efforts, the CAA provides California unique authority to regulate mobile sources more stringently than the federal government by providing a waiver of preemption for its new vehicle emission standards under CAA §209(b). This waiver provision preserves a pivotal role for California in the control of emissions from new motor vehicles, recognizing that California serves as a laboratory for setting motor vehicle emission standards. Since then, the ARB has consistently sought and obtained waivers and authorizations for its new motor vehicle regulations. The ARB'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. A list of regulatory actions the ARB has taken since 1985 is provided in Attachment D to highlight the scope of the ARB's actions to reduce mobile source emissions.

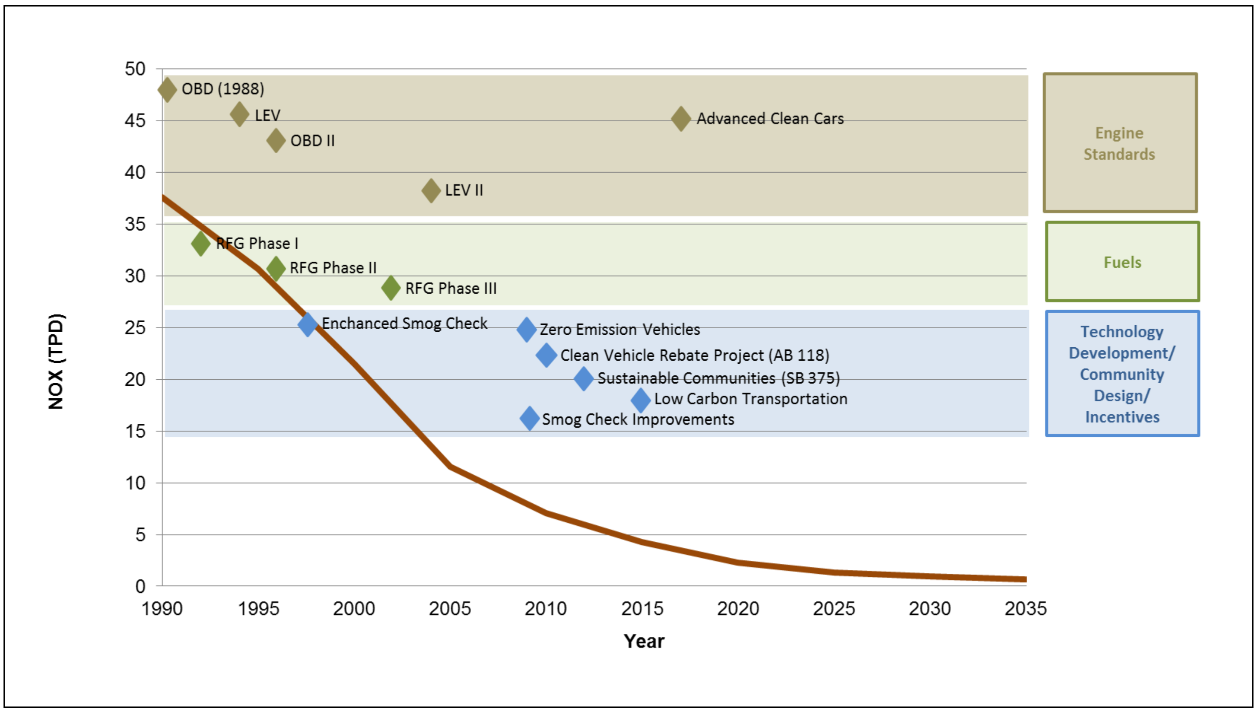
Recently, the ARB adopted numerous regulations aimed at reducing exposure to diesel particulate matter and oxides of nitrogen, from freight transport sources like heavy duty diesel trucks, transportation sources like passenger cars and buses, and off-road sources like large construction equipment. Phased implementation of these regulations will produce increasing emission reduction benefits from now until 2020 and beyond, as the regulated fleets are retrofitted, and as older and dirtier portions of the fleets are replaced with newer and cleaner models at an accelerated pace.

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

E.2 Light-Duty Vehicles

Figure F-1 illustrates the trend in NOx emissions from light-duty vehicles and key programs contributing to those reductions. As a result of these efforts, light-duty vehicle emissions in San Diego County have been reduced significantly since 1990 and will continue to go down through 2020 due to the benefits of the ARB's longstanding light-duty mobile source program. Key light-duty programs include Advanced Clean Cars (ACC), On-Board Diagnostics (OBD), Reformulated Gasoline (RFG), Incentive Programs, and the Enhanced Smog Check Program.

Figure E-1
Key Programs to Reduce Light-Duty NOx Emissions



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 ARB regulations, today's new cars pollute 99% less than their predecessors did thirty years ago. In 1970, the ARB 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 reformulated gasoline (RFG) that has removed the emissions equivalent of 3.5 million vehicles from California's roads. Since the ARB first adopted it in 1990, the Low Emission Vehicle Program (LEV and LEV II) and Zero-Emission Vehicle (ZEV) Program have resulted in the production and sales of hundreds of thousands of zero-emission vehicles (ZEVs) in California.

E.2.1 Advanced Clean Cars

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

The ARB's ACC Program, approved in January 2012, is a pioneering approach of a 'package' of regulations that although separate in construction, are related in terms of the synergy developed to address both ambient air quality needs and climate change. The ACC program combines the control of smog, soot causing pollutants and greenhouse gas emissions into a single coordinated package of requirements for model years 2015 through 2025. The program assures the development of environmentally superior cars that will continue to deliver the performance**,** utility, and safety vehicle owners have come to expect.

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

E.2.2 On Board Diagnostics

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, the ARB adopted OBD II, which required 1996 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles and engines to be equipped with second generation OBD systems. OBD systems are designed to identify when a vehicle's emission control systems or other emission-related computer-controlled components are malfunctioning, causing emissions to be elevated above the vehicle manufacturer's specifications. The ARB 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.

E.2.3 Reformulated Gasoline

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

E.2.4 Incentive Programs (Light-Duty Vehicles)

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

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

California's voluntary vehicle retirement program is administered by the Bureau of Automotive Repair (BAR) and provides $1,000 per vehicle and $1,500 for low-income consumers for unwanted vehicles that have either failed or passed their last Smog Check Test and that meet certain eligibility guidelines. This program is referred to as the Consumer Assistance Program.

The Enhanced Fleet Modernization Program (EFMP) was approved by the AB 118 legislation to augment California's existing vehicle retirement program. Approximately $30 million was available annually through 2015 to fund the EFMP, via a $1 increase in vehicle registration fees. The ARB developed the program in consultation with BAR. The program is jointly administered by both BAR for vehicle retirement, and local air districts for vehicle replacement.

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

E.2.5 California Enhanced Smog Check Program

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

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

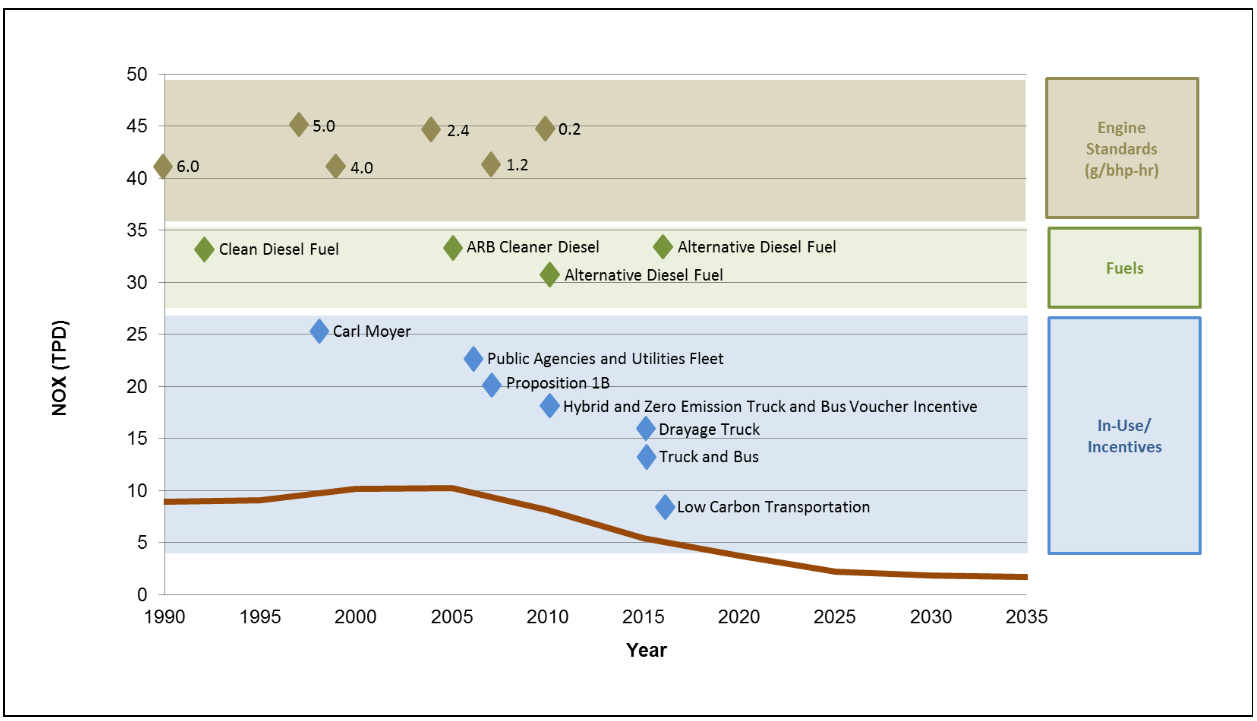
- Low pressure evaporative test;
- More stringent pass/fail cutpoints;
- Visible smoke test; and
- Inspection of light- and medium-duty diesel vehicles.

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

E.3 Heavy-Duty Trucks

Figure F-2 illustrates the trend in NOx emissions from heavy-duty vehicles and key programs contributing to those reductions. As a result of these efforts, heavy-duty vehicle emissions in San Diego County have also been reduced significantly since 1990 and will continue to go down through 2020 due to the benefits of the ARB's longstanding heavy-duty mobile source program. Key programs include Heavy-Duty Engine Standards, Clean Diesel Fuel, Truck and Bus Regulation and Incentive Programs.

Figure E-2
Key Programs to Reduce Heavy-Duty Emissions



E.3.1 Heavy-Duty Engine Standards

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 standard, which took effect in 2010. In addition to mandatory NOx standards, there have been several generations of optional lower NOx standards put in place over the past 15 years. Most recently in 2015, engine manufacturers can 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). The optional standards allow local air districts and the ARB to preferentially provide incentive funding to buyers of cleaner trucks, to encourage the development of cleaner engines.

E.3.2 Clean Diesel Fuel

Since 1993, the ARB has required that diesel fuel have a limit on the aromatic hydrocarbon content and sulfur content of the fuel. Diesel powered vehicles account for a disproportionate amount of the diesel particulate matter which is considered a toxic air contaminant. In 2006, the ARB required a low-sulfur diesel fuel to be used not only by on-road diesel vehicles but also for off-road engines. The diesel fuel regulation allows alternative diesel formulations as long as emission reductions are equivalent to the ARB formulation.

E.3.3 Cleaner In-Use Heavy-Duty Trucks (Truck and Bus Regulation)

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

Starting in 2012, the Truck and Bus Regulation phases in requirements applicable to an increasingly larger percentage of the truck and bus fleet over time. By 2023, nearly all older vehicles would need to be upgraded to have exhaust emissions meeting 2010 model year engine emissions levels. The regulation applies to nearly all diesel-fueled trucks and buses with a gross vehicle weight rating (GVWR) greater than 14,000 pounds 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. 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 would have to disclose the regulation's potential applicability to buyers of the vehicles. Approximately 170,000 businesses in nearly all industry sectors in California, and almost a million vehicles that operate on California roads each year are affected. Some common industry sectors that operate vehicles subject to the regulation include: for-hire transportation, construction, manufacturing, retail and wholesale trade, vehicle leasing and rental, bus lines, and agriculture.

ARB compliance assistance and outreach activities that are key support of the Truck and Bus Regulation include:

- The Truck Regulations Upload and Compliance Reporting System (TRUCRS), an online reporting tool developed and maintained by ARB staff;
- The Truck and Bus regulation's fleet calculator, a tool designed to assist fleet owners in evaluating various compliance strategies;

- Targeted training sessions all over the state; and
- Out-of-state training sessions conducted by a contractor.

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

E.3.4 Incentive Programs

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

Several state and local incentive funding pools have been used historically -- and remain available -- to fund the accelerated turnover of on-road heavy-duty vehicles. Since 1998, the Carl Moyer Program (Moyer Program) has provided funding for replacement, new purchase, repower and retrofit of trucks. Beginning in 2008, the Goods Movement Emission Reduction Program, funded by Proposition 1B, has funded cleaner trucks for the region's transportation corridors; the final increment of funds will implement projects through 2018.

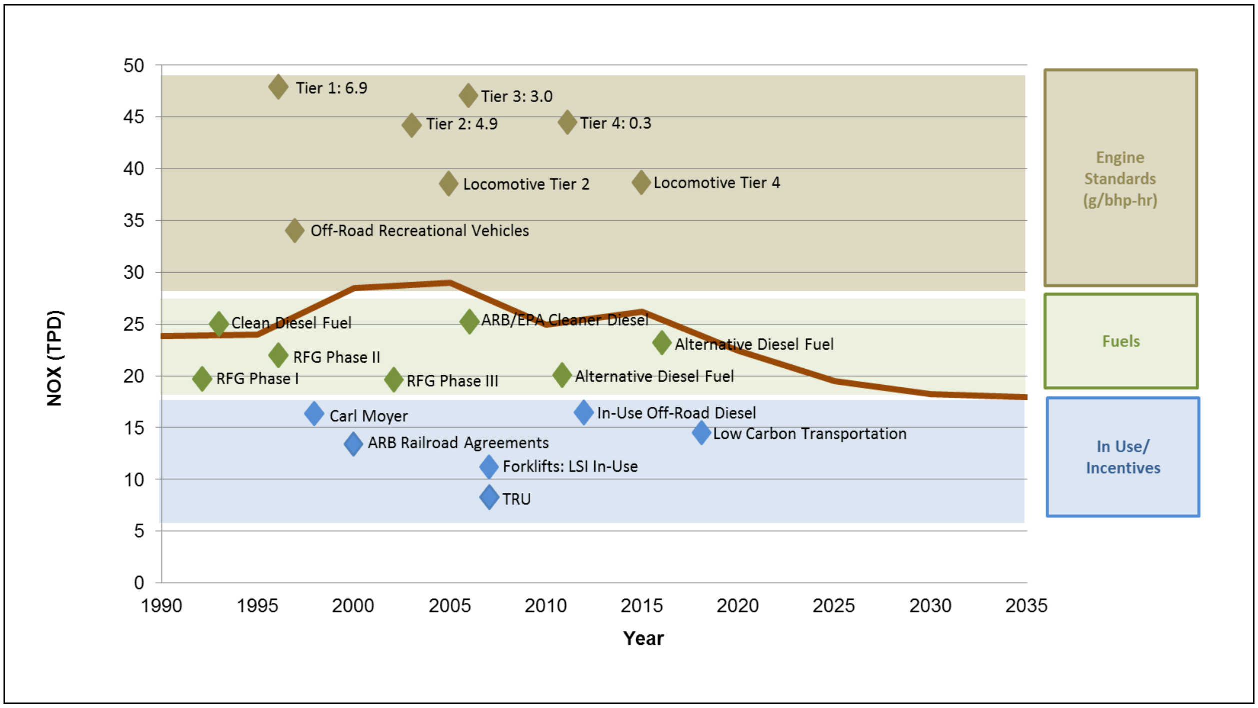
The AQIP has funded the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) since 2010, and continued San Diego County participation is expected. The ARB has also administered a Truck Loan Assistance Program since 2009.

E.4 <u>Off-Road Sources</u>

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

Figure F-3 illustrates the trend in NOx emissions from off-road equipment and key programs contributing to those reductions. As a result of these efforts, off-road emissions in San Diego County have been reduced significantly since 1990 and will continue to go down through 2020 due to the benefits of the ARB's and the EPA's longstanding programs. Key programs include Off-Road Engine Standards, Locomotive Engine Standards, Clean Diesel Fuel, Cleaner In-Use Off-Road Regulation and In-Use Large-Spark Ignition (LSI) Fleet Regulation.

Figure E-3
Key Programs to Reduce Off-Road Emissions



E.4.1 Off-Road Engine Standards

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

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

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

E.4.2 Locomotive Engine Standards

The CAA and EPA national locomotive regulations expressly preempt states and local governments from adopting or enforcing "any standard or other requirement relating to the control of emissions from new locomotives and new engines used in locomotives" (the EPA interpreted new engines in locomotives to mean remanufactured engines, as well). The EPA has approved two sets of national locomotive emission regulations (1998 and 2008). In 1998, the EPA approved the initial set of national locomotive emission regulations. These regulations 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%, from 13.2 to 5.5 g/bhp-hr.

In 2008, the 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% cleaner than Tier 0-2 PM emission standards. The 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 (2015 and later model years) locomotive NOx and PM emission standards. The EPA Tier 4 NOx and PM emission standards further reduced emissions by approximately 95% from uncontrolled levels.

E.4.3 Clean Diesel Fuel

Since 1993, the ARB has required that diesel fuel have a limit on the aromatic hydrocarbon content and sulfur content of the fuel. Diesel powered vehicles account for a disproportionate amount of the diesel particulate matter which is considered a toxic air contaminant. In 2006, the ARB required a low-sulfur diesel fuel to be used not only by on-road diesel vehicles but also for off-road engines. The diesel fuel regulation allows alternative diesel formulations as long as emission reductions are equivalent to the ARB formulation.

E.4.4 Cleaner In-Use Off-Road Equipment (Off-Road Regulation)

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

The Off-Road Regulation will significantly reduce emissions of diesel PM and NOx from the over 150,000 in-use off-road diesel vehicles that operate in California. The regulation affects dozens of vehicle types used in thousands of fleets by requiring owners to modernize their fleets by replacing older engines or vehicles with newer, cleaner models, retiring older vehicles or using them less often, or 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 the ARB and labeled, restricts the addition of older vehicles into fleets, and requires fleets to reduce their emissions by retiring, replacing, or repowering older engines, or installing verified exhaust retrofits. The requirements and compliance dates of the Off-Road Regulation vary by fleet size.

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

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

- The Diesel Off-road On-line Reporting System (DOORS), an online reporting tool developed and maintained by ARB staff.
- The Diesel Hotline (866-6DIESEL), which provides the regulated public with questions about the regulations and access to ARB staff. Staff is able to respond to questions in English, Spanish and Punjabi.
- The Off-road Listserv, providing equipment owners and dealerships with timely announcement of regulatory changes, regulatory assistance documents, and reminders for deadlines.

E.4.5 LSI In-Use Fleet Regulation

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

ATTACHMENT F
PRE-BASELINE BANKED EMISSION REDUCTION CREDITS

Table F-1
District Banking Registry Summary
Emission Reduction Credits Issued in 2012 and Earlier

Company Name	Certificate Number	NOx	VOC	Cumulative Totals	
		(TPY)	(TPY)	NOx	VOC
Applied Energy LLC	2010-000018-01	34.55		34.55	0.0
Cabrillo Enterprises, LLC	080527-01		1.25	34.55	1.25
Cabrillo Power II, LLC	978938-05	35.30		69.85	1.25
	981518-01	2.30		72.15	1.25
Callaway Golf Co.	2012-ERC-000019		6.09	72.15	7.34
	2012-ERC-000020		6.09	72.15	13.43
City of San Diego, Metropolitan Wastewater Dept.	950766-06		0.38	72.15	13.81
	970821-02		22.76	72.15	36.57
Dynergy	2011-000050-01	0.95		73.10	36.57
General Dynamics Properties, Inc.	970809-02	1.26		74.36	36.57
	970809-05		0.23	74.36	36.80
Grey K. Environmental Fund, LP	983809-01		25.10	74.36	61.90
	060328-01	1.90		76.26	61.90
	060328-02	2.20		78.46	61.90
	060328-03		2.90	78.46	64.80
	060328-04		0.54	78.46	65.34
	060328-05		0.10	78.46	65.44
	060328-06		0.30	78.46	65.74
	060803-04		36.70	78.46	102.44
	070731-01		20.70	78.46	123.14
Hanson Aggregates, Pacific SW Region	980772-01	0.93		79.39	123.14
	980772-03		0.26	79.39	123.40
Hughes-Aircraft Co., Electro-Opti Cal Systems	940261-01		1.06	79.39	124.46
	940261-02		0.22	79.39	124.68
Kyocera America	2012-ERC-000022	16.70		96.09	124.68
	2012-ERC-000023		7.60	96.09	132.28
Muht-Hei, Inc.	981002-01		0.18	96.09	132.46
	981002-02		0.18	96.09	132.64
	981002-03		0.18	96.09	132.82
	981002-04		0.18	96.09	133.00
	981002-05		0.57	96.09	133.57
	981002-06		0.19	96.09	133.76
	981002-07		2.23	96.09	135.99
	981002-08		1.28	96.09	137.27
	981002-09		0.18	96.09	137.45
	981002-10		2.07	96.09	139.52
	981002-11		1.28	96.09	140.80
	981002-12		0.57	96.09	141.37
National Steel & Shipbuilding	40995-02	0.18		96.27	141.37
	40995-03		0.60	96.27	141.97
	40996-02	0.04		96.31	141.97
	40997-02	0.32		96.63	141.97
	40997-03		0.02	96.63	141.99

Table F-1 (continued)
District Banking Registry Summary
Emission Reduction Credits Issued in 2012 and Earlier

Company Name	Certificate Number	NOx (TPY)	VOC (TPY)	Cumulative Totals NOx	Cumulative Totals VOC
Naval Air Station, North Island	991014-01	8.00		104.63	141.99
	991015-01	3.30		107.93	141.99
	991016-01	18.70		126.63	141.99
Naval Station, San Diego	950949-01	4.83		131.46	141.99
	940206-01	0.67		132.13	141.99
	940206-03		0.05	132.13	142.04
Navy Region Southwest	990223-01	12.02		144.15	142.04
Northrop-Grumman Ryan Aeronautical Center	975000-01		1.20	144.15	143.24
Olduvai Gorge LLC	070430-01	2.00		146.15	143.24
	070502-01	14.72		160.87	143.24
	070822-01	1.20		162.07	143.24
	070822-02		0.10	162.07	143.34
	070822-04		11.05	162.07	154.39
	071004-01		10.80	162.07	165.19
	071004-02	12.00		174.07	165.19
	080527-01		16.90	174.07	182.09
	080722-01		21.18	174.07	203.27
Otay Mesa Generating Co., LLC	000427-05	0.78		174.84	203.27
	000224-01	4.40		179.24	203.27
Performance Contracting Inc.	071217-01		1.00	179.24	204.27
SDG&E	983811-01	4.00		183.24	204.27
	060324-01		0.40	183.24	204.67
	060324-02	19.90		203.14	204.67
Sherwin Williams	987553-01		7.46	203.14	212.13
Shipyard Supplies, Inc.	060824-02		1.00	203.14	213.13
	070529-01		1.00	203.14	214.13
Solar Turbines	970123-04	10.00		213.14	214.13
	950562-01		0.60	213.14	214.73
Southern California Edison Company	950171-01	0.51		213.65	214.73
	950171-03		0.02	213.65	214.75
Surface Technologies	990325-01		1.48	213.65	216.23
United States Marine Corps	030507-01	3.00		216.65	216.23
US Foam	974375-03		0.10	216.65	216.33
SW Division, Naval Facilities Engineering Cmd.	954185-01		2.00	216.65	218.33
	960709-01		9.00	216.65	227.33
	970311-01		13.00	216.65	240.33
	980511-03		3.15	216.65	243.48
	980521-02		13.25	216.65	256.73
	980529-02		7.40	216.65	264.13
Unisys Corporation	901238-01		3.66	216.65	267.79
	921410-01		1.25	216.65	269.04
	940577-01		2.95	216.65	271.99

Table F-1 (continued)
District Banking Registry Summary
Emission Reduction Credits Issued in 2012 and Earlier

Company Name	Certificate Number	NOx	VOC	Cumulative Totals	
		(TPY)	(TPY)	NOx	VOC
USN Communications Station	940560-01	2.40		219.05	271.99
	940560-04		0.05	219.05	272.04
	940561-01	0.12		219.17	272.04
	940561-03		0.00	219.17	272.04
	940562-01	0.12		219.29	272.04
	940562-03		0.00	219.29	272.04
Veterans Administration Hospital	979555-01	1.90		221.19	272.04
TOTALS (tons/year)				**221.19**	**272.04**
TOTALS (tons/day)				**0.61**	**0.75**

ATTACHMENT G
ANALYSES OF POTENTIAL ADDITIONAL STATIONARY SOURCE CONTROL MEASURES

G.1 Petroleum Storage Tanks

This source category is regulated by District Rule 61.1 (Receiving and Storing Volatile Organic Compounds at Bulk Plants and Bulk Terminals), which is applicable to large storage tanks for gasoline and other high volatility motor vehicle fuels. Based on emission inventory information and updated equipment descriptions, estimated emissions from this source category are about 46 tons per year. Rule 61.1 has standards for fittings for internal floating roof tanks, external floating roof tanks, and fixed roof tanks and requires Best Available Control Technology (BACT) for new or replacement rim seals for external and internal floating roof tanks.

SCAQMD Rule 1178 (Further Reductions of VOC Emissions from Storage Tanks at Petroleum Facilities) has further control measures for this source category. This rule is applicable to above ground storage tanks at petroleum facilities emitting more than 20 of VOC tons per year. The rule specifies rim seal types and fittings for external and internal floating roof tanks and fixed roof tanks. The rule also required all external floating roof tanks subject to the rule be domed by July 1, 2008.

San Diego County has two petroleum storage facilities that emit more than 20 tons per year. Examination of the existing rim seals and fittings for the storage tanks at these facilities indicates that most of the existing seals and fittings at these facilities would meet the standards in SCAQMD Rule 1178. Based on emission factors in the SCAQMD Rule 1178 staff report, if the standards of SCAQMD Rule 1178 were incorporated in Rule 61.1 the estimated emission reduction potential would be about 21 tons per year. About 40% of the emission reduction potential (nine tons) would result from upgrading rim seals. However, since ongoing BACT adherence is required by Rule 61.1 for rim seal replacement, these emission reductions will be achieved over time by existing Rule 61.1. The remaining potential emission reduction benefit of the Rule 1178 standards would be approximately 12 tons per year, or 0.03 tons per day, from the more stringent requirements for fittings and the requirement for external floating roof tanks to be domed. Based on this initial evaluation, the District does not plan further evaluation for rule development for this source category because of the very limited VOC emission reduction potential.

G.2 Mobile Transport Tanks Loading

This source category is regulated by District Rule 61.2 (Transfer of Organic Compounds into Mobile Transport Tanks). Rule 61.2 controls vapors displaced by loading of mobile transport tanks with gasoline and other high volatility fuels from bulk terminals and vapor and liquid leaks during the loading process. The primary standard of Rule 61.2 requires a 90% emission reduction for all VOC vapors displaced during the transport tank loading process. Based on emission inventory information, total estimated VOC emissions in San Diego County due to vapor displacement are about 12 tons per year from three bulk terminal loading rack facilities. San Joaquin Valley Air Pollution Control District (SJVAPCD) Rule 4621 (Gasoline Transfer into Stationary Storage Containers, Delivery Vessels and Bulk Plants) requires a 95% emission reduction for displaced VOC vapors. Source testing data for the largest San Diego County facility shows that it consistently achieves greater than 97% control of VOC vapors released in the loading process. The estimated emission reduction potential for the two remaining facilities is about 2.8 tons per year, or 0.01 tons per day, if they were required to meet a 95% control level instead of the 90% control level in existing Rule 61.2. Based on this initial evaluation, the District does not plan further evaluation for this source category at this time because of the very limited VOC emission reduction potential.

G.3 Further Control of Architectural Coatings

District Rule 67.0, the District's previous Architectural Coatings Rule, was repealed effective January 1, 2016, in favor of new Rule 67.0.1, effective January 1, 2016. The rule incorporated more stringent VOC limits found in ARB's statewide Suggested Control Measures (SCM),[68] and SCAQMD Rule 1113 (last amended September 6, 2013). It should be noted that the ARB SCM was based upon the 2006 version of SCAQMD Rule 1113.

While generally similar to the SCM, Rule 1113 contains more stringent VOC limits in specific categories of coatings. These include nonflats, nonflat high gloss, aluminum roof, dry fog, faux finishing, fire resistive, floor, form release compounds, graphic arts (sign paints), metallic pigmented, rust preventative, stains, waterproofing membranes, and zinc-rich primers. During Rule 67.0.1 adoption, an incremental cost-effectiveness was determined to compare to the more stringent limits of Rule 1113. It was determined that the more stringent limits, going beyond what the SCM requires, could reduce approximately 2.4 tons per day from the source category if adopted in San Diego County. However, the additional limits were not found to be cost-effective to adopt in San Diego County (approximately $30,000 per ton of VOC reduced), and thus were not included in the final rule. Based on this evaluation, the District does not plan further evaluation for this source category until more stringent limits can be cost-effectively controlled within the District's thresholds.

G.4 Aerospace Manufacturing Operations

Emissions in this category have greatly declined in San Diego County since 1990 due to implementation of District Rule 67.9 (Aerospace Coating Operations), the decline in government funding for aerospace operations and, in particular, the closing of one large facility. All operations now primarily involve maintenance and rework. No aerospace manufacturing operations occur in the County. Based on emission inventory information, total VOC emissions from this source category are approximately 30 tons per year.

Coating limits in Rule 67.9 generally align with comparable rules at other air districts. SCAQMD Rule 1124 (Aerospace Assembly and Component Manufacturing Operations) has slightly lower VOC limits in some coating categories such as adhesive bonding primers, antichafe coatings, dry lubricative materials (nonfastener), form release coatings, fuel tank coatings, paint strippers, and sealants. Total estimated VOC emissions in San Diego County for materials in these coating categories, and for strippers that exceed the limits in SCAQMD Rule 1124, are less than four tons per year. Precise emission reductions have not been tabulated, but are expected to be less than two tons per year (0.005 tons per day).

Despite the limited amount of potential VOC emission reductions, the District may update the existing rule in the future. The existing rule was last revised in 1997, and may need to be revised to reflect current best practices and available products.

[68] A Suggested Control Measures (SCM) is a "model rule", developed by the ARB for source categories where statewide consistency in control requirements in particularly desirable, that local air districts can copy for their rules for the covered source category.

G.5 Graphic Arts Operations

This source category is regulated by District Rule 67.16 (Graphic Arts Operations). Based on emission inventory information at the time of amending the rule in 2011, total estimated VOC emissions from this source category were about 64 tons per year. The emissions result from printing processes or related coating processes.

SCAQMD Rule 1130 (Graphic Arts) has lower VOC limits than Rule 67.16 for fountain solutions. If the SCAQMD Rule 1130 VOC limits were incorporated in Rule 67.16, the estimated potential VOC emission reductions would be about seven tons per year, or 0.02 tons per day. Rule 1130 also has lower VOC limits than Rule 67.16 in several specialty ink or solvent cleaning categories (for example, flexographic ink on porous substrates and flexographic printing cleanup). While none of these materials have been identified as being used in San Diego County to date, if usage was occurring and the County adopted similar standards to Rule 1130, the estimated potential VOC emission reductions would be almost 11 tons per year, or 0.03 tons per day.

Based on this initial evaluation, the District does not plan further evaluation for the source category at this time because of the very limited VOC emission reduction potential.

G.6 Marine Coating Operations

District Rule 67.18 (Marine Coating Operations) regulates VOC emissions from coating of marine vessels, including ships and pleasure boats. Based on emission inventory information, total VOC emissions from this source category are approximately 237 tons per year, or 0.65 tons per day. VOC limits in Rule 67.18 are generally consistent with SCAQMD Rule 1106 (Marine Coating Operations). Specifically for pleasure craft, some coating limits in San Diego County are more stringent than Rule 1106, which include antenna coatings, antifoulants for aluminum substrates, high gloss coatings, pretreatment wash primers, and special markings.

In other pleasure craft coating categories, such as extreme high gloss topcoats, SCAQMD has a lower VOC content limit. However, as noted in the *"2008 Eight-Hour Ozone Reasonably Available Control Technology (RACT) Demonstration for San Diego County,"* industry and vessel owners in San Diego and Ventura Counties have indicated that, while compliant coatings at the lower 490 grams per liter (g/l) limit are available, they exhibited durability and gloss retention concerns when applied. Thus, the higher VOC content limit material was generally accepted for use in extreme high gloss topcoat applications. The industry-accepted extreme high gloss coatings available for pleasure craft currently do not meet the 490 g/l limit established by SCAQMD, but are still in compliance with Rule 67.18.

Further emission reductions by lowering the extreme high gloss coatings limits may be possible in the future, but would not be substantial. Additional emission reductions from updates to Rule 67.18 would more likely occur by lowering the VOC limit of materials used in the cleaning process. It is estimated that an additional four tons per year, or 0.01 tons per day, of additional VOC emission reductions could occur should the VOC limit of cleaning materials be lowered to 25 g/l. The District will be evaluating this source category during the next three years for further rule development.

G.7 Adhesive and Sealant Applications

This source category is regulated by District Rule 67.21 (Adhesive Material Application Operations). Potential emission reductions were estimated by comparing to SCAQMD Rule 1168 (Adhesive and Sealant Applications), which has more stringent VOC content limits than Rule 67.21 in several adhesive categories. Total VOC emissions in San Diego County from this category are estimated at approximately 827 tons per year, based on the emission inventory. Nearly all of the emissions and potential reductions (339 tons per year, or 0.9 tons per day) that would be affected by adoption of Rule 1168 requirements are from non-permitted sources.

Although the estimated emission reductions are relatively large, the estimate does not account for penetration of the current San Diego County market by low VOC adhesives sold in the South Coast region. Information from adhesive suppliers indicates that they typically provide all of Southern California with the same products. Consequently, it is likely that potential emission reductions have already occurred, and any further reductions from permitted sources would be minimal. Despite this conclusion, the District is including the potential emission reductions that could be possible, assuming products in the South Coast region were being used in San Diego County, for the purposes of this RACM analysis. Based on the limited potential of any additional reductions occurring in practice, the District does not plan further evaluation of the source category at this time.

G.8 Composting Operations (Non-Residential)

The District is currently evaluating proposed new Rule 67.25 (Composting Operations (Non-Residential)), which would apply to facilities that compost and/or stockpile organic material. Composting activities are expected to increase in the region in response to federal, state, and local mandates for waste diversion and waste reduction. Accordingly, the District is investigating the feasibility of a measure to control VOC emissions from non-residential composting operations.

Some other California air districts have adopted composting rules, including SCAQMD (Rule 1133 – General Administrative Requirements, Rule 1133.1 – Chipping and Grinding Activities, Rule 1133.2 – Emission Reductions from Co-composting Operations, and Rule 1133.3 – Emission Reductions from Green waste Composting Operations) and SJVAPCD (Rule 4565 – Biosolids, Animal Manure, and Poultry Litter Operations, and Rule 4566 – Organic Material Composting Operations). These rules establish best management practices (BMPs) for chipping and grinding of green waste to produce materials for composting (or non-composting) material, and to better manage stockpile operations to reduce VOC emissions. Accordingly, the District will evaluate these rules to determine which standards, if any, are feasible for implementation in San Diego County.

Importantly, other public agencies in California (including the California Department of Resources Recycling and Recovery and solid waste local enforcement agencies) are engaged in or are considering regulating composting activities to address other environmental objectives such as landfill diversion and water quality. This has resulted in a dynamic regulatory environment in the composting industry, which will require the District to closely coordinate with other agencies and the affected facilities to ensure that a possible District rule to control VOC emissions would be feasible, and not in conflict with other regulatory requirements.

SCAQMD estimated a reduction of 328.5 tons of VOC per year (0.9 tons per day) from 17 composting facilities within the SCAQMD region at time of adoption. Preliminary estimates for annual emission reductions in San Diego County, if similar controls are found to be feasible, are estimated to be at least 120 tons per year (0.3 tons per day), about a 40% reduction in VOC emissions. If adopted, full implementation of the proposed rule would not be anticipated until 2018 at the earliest, going beyond the period of this RACM analysis. Nonetheless, the District has included the proposed rule in the RACM analysis to conservatively demonstrate that even if the rule would have been implemented by 2016, the additional emission reductions would not have been enough to attain one year earlier.

G.9 Further Control of Industrial and Commercial Boilers, Process Heaters, and Steam Generators

Rule 69.2 (Industrial and Commercial Boilers, Process Heaters and Steam Generators) regulates NOx emissions from boilers with rated heat inputs of 5 million (MM) BTU/hour or more. Currently, Rule 69.2 exempts from NOx emission standards any unit with an annual heat input of less than 220,000 therms (for units with a heat input rating of less than or equal to 50 MMBTU/hour). These units are subject only to operational standards, such as unit maintenance, recordkeeping, and an annual boiler tune-up to minimize NOx emissions to the extent feasible. Facilities with annual heat inputs of 220,000 therms or more (or greater than 10% capacity factor for units with heat input ratings greater than 50 MMBTU/hour) must comply with NOx emission standards of 30 parts per million by volume (ppmv) for gas-fired units, and 40 ppmv for oil-fired units. Estimated NOx emissions from this source category are about 69 tons per year with over 99% of the emissions from gas-fired units.

The District has evaluated the feasibility, cost-effectiveness and emissions reduction potential of amending Rule 69.2 to be consistent with the more stringent emission limits included in SJVAPCD Rule 4306 (Boilers, Steam Generators, and Process Heaters – Phase 3, October 16, 2008), as well as lowering the exemption level to 90,000 therms per year for gas-fired boilers. The District evaluated the cost-effectiveness for the following three cases:

1. Lower Exemption Threshold/Retain Existing Emission Standards. Require that all boilers with annual heat input between 90,000 and 220,000 therms meet the 30-ppmv NOx standard of existing Rule 69.2, and retain the existing 30-ppmv NOx standard for higher usage boilers. This measure would apply to about 40 units with annual heat input between 90,000 and 220,000 therms, requiring installation of low-NOx burners and/or flue gas recirculation to meet the 30-ppmv NOx standard.

2. Lower Exemption Threshold/Tighten Emission Standards. Require that all boilers with annual heat input of 90,000 therms or more meet more stringent standards of 15 ppmv NOx for units rated at less than or equal to 20 MMBTU/hour heat input, and 9 ppmv NOx for units rated at greater than 20 MMBTU/hour heat input. These NOx standards are consistent with those for SJVAPCD Rule 4306, and the exemption thresholds meet SCAQMD Rule 1146 (Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters, November 1, 2013). This measure would require about 110 units with annual heat input of 90,000 therms or more to install emission controls such as ultra-low NOx burners and/or flue gas recirculation, to meet the more stringent limits.

3. Retain Existing Exemption Threshold/Tighten Emission Standards. Require that boilers with annual heat input of 220,000 therms or more meet the more stringent (15 ppmv / 9 ppmv) NOx standards. Units with annual heat input rates of less than 220,000 therms would remain exempt. This measure would require only the approximately 70 units with annual heat input of 220,000 therms or more to install emission controls such as ultra-low NOx

burners and/or flue gas recirculation to meet the more stringent limits.

For each case, cost-effectiveness values were estimated for each affected boiler. The potential emission reductions (averaged over 365 days of operation per year) and overall cost-effectiveness values for each of the three cases are summarized in Table E-1.

Table G-1
Cost-Effectiveness Range, Further Control of Industrial and Commercial Boilers, Process Heaters, and Steam Generators

Case	Potential NOx Emission Reductions (tons/day)	Cost-Effectiveness Range ($/ton reduced)
1	0.03	$11,000 to $45,000
2	0.10	$15,000 to $1,670,000
3	0.05	$15,000 to $1,670,000

For all three cases, the estimated overall cost-effectiveness exceeds the District's threshold for cost-effective feasible measures. Based on the poor cost effectiveness and small emission reduction potential, none of these further control measure combinations are feasible; therefore, none will be further considered at this time.

G.10 Small Boilers, Process Heaters, and Steam Generators

The District currently regulates residential water heaters through multiple rules which include Rule 69.5.1 (for residential water heaters up to 75,000 BTU/hour), and Rule 69.2.1 (for small boilers over 600,000 BTU/hour). However, large water heaters between 75,000 and 600,000 BTU/hour are not regulated. SCAQMD Rule 1146.2 (Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters) regulates units between 75,000 and 2 million BTU/hour, limiting NOx emissions to 14 ng/J.

At the public workshop to discuss tightening the District's residential water heater rule, water heater manufacturers and distributors requested that District staff consider adopting control requirements in San Diego County matching those in SCAQMD on water heaters larger than 75,000 BTU/hour, to prevent uncontrolled units from being purchased in San Diego County and installed in the South Coast air basin. The industry representatives complained about the undesirable burden caused by dealing with cases of uncontrolled units being imported into and illegally installed in the South Coast region. Industry confirmed that complying units in this size range are now available throughout the region.

The District preliminarily evaluated the local feasibility, cost-effectiveness, and emission reduction potential of amending Rule 69.2.1 to reflect the more stringent emission limit of 20 ppmv NOx included in SCAQMD Rule 1146.2 for all new boilers and large water heaters rated between 75,000 and 2 million BTU/hour. Preliminary cost-effectiveness was estimated between $3,800 and $17,500 per ton of NOx reduced, depending on the equipment type and size. The potential emission reductions (averaged over 365 days of operation per year) are estimated to be approximately 0.80 tons of NOx per day. The District has assigned this future control measure as a high-priority for consideration during the next three years.

G.11 Natural Gas-Fired Fan-Type Central Furnaces

The District adopted Rule 69.6 (Natural Gas-Fired Fan-Type Central Furnaces) on June 17, 1998, which established NOx emission limits of 40 ng/J for new residential furnaces. Subsequently, on September 5, 2014, SCAQMD amended their equivalent rule (Rule 1111 – Reductions of NOx Emissions from Natural-Gas-Fired, Fan-Type Central Furnaces) to further tighten the NOx emission limit for furnaces by 65% to 14 ng/J. Because the tightened emission limit is technology forcing, complying units are not currently available, and SCAQMD Rule 1111 phases the requirement in over four years.

Based on the emission inventory, the areawide source category cumulatively emits approximately 263 tons per year of NOx in San Diego County. The District analyzed potential emission reductions that would occur if the more stringent limits for furnaces were adopted in San Diego County. NOx reductions from adopting similar controls are estimated to be 170 tons per year, or 0.46 tons per day, upon full implementation, assuming an average ten-year lifespan for existing furnaces. The District will monitor the forthcoming availability of complying units, and when sufficient complying units are found to be cost-effectively available, the District will consider an amendment to Rule 69.6 to incorporate the 14 ng/J NOx emission limit.

G.12 Equipment Leaks

Consideration of this source category is prompted by Bay Area Air Quality Management District's (BAAQMD) Rule 8-18 (Equipment Leaks), which establishes vapor and liquid leak standards to reduce emissions of VOC from leaking equipment at refineries, bulk terminals, bulk plants, and chemical plants. The District currently has no comparable rule due to the limited associated emission reduction potential. BAAQMD Rule 8-18 exempts facilities with fewer than 100 valves or fewer than ten pumps and compressors (Rule 8-22, Valves and Flanges at Chemical Plants, applies in those cases). It also exempts equipment handling organic liquids having initial boiling points above 302º F. It does not apply to connections between the loading racks at bulk terminals and bulk plants and the vehicle (mobile transports) being loaded. It sets inspection frequency criteria (daily visual, quarterly instrument checks for most components), repair requirements, and leak standards – three drops per minute for liquid leaks, 100 ppmv as methane for most vapor leaks, and 500 ppmv as methane for pumps, compressors and pressure relief devices.

The Rule 8-18 definition of chemical plants includes any facility engaged in producing organic or inorganic chemicals or the manufacture of products by chemical processes and having "325" as the first three digits in the applicable NAICS code. This code applies to dozens of facilities in San Diego County, but few have 100 or more valves or ten or more pumps or compressors in VOC service. San Diego County has no petroleum refineries that would be subject to such a rule. Possibly, a rule such as Rule 8-18 could apply to the major gasoline bulk terminals, some of the bulk plants, and one kelp-processing facility. However, a valve, pump and compressor count would be needed to determine if such a rule would apply to these facilities.

Rule 8-18 establishes the same liquid leak standard (three drops per minute) as San Diego County rules applicable to gasoline bulk terminals and bulk plants (Rules 61.1, 61.2 and 61.7), kelp processing (Rule 67.10), coating and printing ink manufacturers (Rule 67.19), and pharmaceutical and cosmetics manufacturers (Rule 67.15). However, the District rules have a shorter allowable leak repair period than Rule 8-18 (zero to three days versus seven days). Rule 8-18 has a more stringent vapor leak standard for equipment at bulk terminals and bulk plants than District Rules 61.1 and 61.2 (100-500 ppmv @1.0 cm versus 1375 ppmv @1.3 cm as methane). However, District Rule 61.1 applies to the vapor transfer path including the connection to a mobile transport, while BAAQMD Rule 8-18 specifically exempts such connections. Inspectors in San Diego County generally do not find vapor leaks at the bulk terminals and bulk plants along the hard-piped components. Vapor leaks are more commonly found at the loading rack/mobile transport interface, and from the vapor fittings (e.g., drybreaks) on the mobile transports themselves.

The most recent inventory of these sources showed only about 12 tons per year (0.03 tons per day) of total VOC emissions from loading rack operations. Fugitive vapor and liquid leak emissions emanating from hard-piped components, pumps and compressors comprise only seven tons per year (0.01 tons per day). Furthermore, fugitive vapor emissions from operations subject to Rule 67.10 (kelp processing) have declined substantially since 2013 because of plant process changes and revised calculation methods. Lines used to transport VOC/air streams within the kelp processing facility are operated at only a few inches of water gauge pressure. It is anticipated that requiring additional requirements to control leaks from these facilities would not be very cost-effective because of the low emission reduction potential.

Based on this evaluation, and the limited emission reduction potential, the District does not plan further evaluation for this source category at this time.

G.13 Commercial Food Ovens

Consideration of this source category is prompted by SCAQMD 1153.1 (Emissions of Oxides of Nitrogen from Commercial Food Ovens). The District currently has no comparable rule. Rule 1153.1 primarily regulates manufacturers of ovens, roasters, and smokehouses (NAICS 333) and the manufacture of food and beverage products (NAICS 311 and 312). The rule requires units that maintain process temperatures below 500° F to emit no more than 40 ppm, and units above 500° F to emit no more than 60 ppm. The rule also limits CO emissions to no more than 800 ppmv to ensure that the NOx limit is not circumvented by extreme adjustment of burners during emission testing. Compliance is phased-in over the next nine years, with the oldest units being required to be replaced with compliant equipment as early as July 1, 2016. According to the SCAQMD staff report, an estimated 210 units in the South Coast region are anticipated to be regulated, eventually resulting in 21.9 tons per year, or 0.06 tons per day, of NOx emission reductions.

A per-capita estimate of commercial food ovens in the San Diego region totaled approximately 37 units. Using similar emission reduction factors as Rule 1153.1 (approximately 0.10 tons of NOx per year, per unit), if San Diego County were to adopt similar controls, the region could anticipate NOx reductions of approximately 3.8 tons per year, or 0.01 tons per day. Based on this initial evaluation, the District does not plan further evaluation for the source category at this time because of the very limited NOx emission reduction potential.

G.14 Food Products Manufacturing/Processing

Consideration of this source category is prompted by SCAQMD Rule 1131 (Food Product Manufacturing and Processing Operations). The District currently has no comparable rule. Rule 1131 requires use of solvents with less than 120 g/l VOC, or an 85% emission reduction for non-sterilization operations (emission reductions of about 75% are required for sterilization operations). The staff report for SCAQMD Rule 1131 indicates that the two solvents most often used for processing operations and sterilization processes in the food industry are hexane and IPA. The Socioeconomic Impact Assessment for SCAQMD Rule 1131 also indicates the Rule primarily affects the food manufacturing sector (SIC 20). A facility analysis was conducted of industries in this sector in San Diego County, and determined that no major facilities exist. However, one kelp-processing facility in the region does manufacture products used in food preparation, such as Xanthan and Gellan gums, that could potentially be subject to such a rule.

In 2014, this facility used 0.6 tons per year of hexane and nine tons per year of IPA, resulting in VOC emissions of 12.9 tons per year of VOC. The facility is already regulated by District Rule 67.10 (Kelp Processing and Bio-Polymer Manufacturing Operations). Under Rule 67.10, the kelp-processing facility has reduced their VOC emissions more than 90%. If a rule incorporating SCAQMD standards for VOC emissions for food processing facilities were adopted, estimated potential VOC emission reductions from the remaining unregulated IPA emissions would be about 10.9 tons per year, or 0.03 tons per day. Based on this initial evaluation, the District does not plan further evaluation for rule development for this source category at this time because of the very limited VOC emission reduction potential.

G.15 Medium Boilers, Process Heaters, and Steam Generators

Proposed Rule 69.2.2 (Medium Boilers, Process Heaters, and Steam Generators), currently under evaluation, would apply to medium-sized new and replacement units rated between 2-5 million BTU/hour. There are estimated to be 500 boilers of that size range in San Diego County, cumulatively emitting an estimated 200 tons per year of NOx. Proposed Rule 69.2.2 is intended to have the same NOx emission limits as existing District Rule 69.2.1

The District recently reviewed similar rules of other California air districts that regulate units in this size range. SCAQMD requires a permit to operate such equipment through Rule 1146.1 (Emissions of Oxides of Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters, November 1, 2013). The SCAQMD rule was recently strengthened in specific categories, such as units firing on landfill gas (25 ppm), digester gas (15 ppm), and natural gas (9 ppm or 0.011 pounds/106 BTU). On the other hand, SJVAPCD chooses to regulate the source category via registration through Rule 4307 (Boilers, Steam Generators, and Process Heaters – 2.0 MMBTU/hour to 5.0 MMBTU/hour, May 19, 2011). Registration is required to operate similar equipment at the same control levels for certain equipment categories. Both the SCAQMD and SJVAPCD rules were adopted with cost-effectiveness values well above the District's threshold for further reductions.

Instead, the District is currently investigating other approaches to regulate units within this size range. This includes a requirement that all medium-sized natural-gas-fired units (2 to 5 million BTU/hour) to be either certified as meeting a NOx emission limit of 30 ppm, or installed in accordance with a District permit. The approach could resemble BAAQMD Reg. 9, Rule 7.

Previous analyses determined that taking this approach in San Diego County was not feasible and cost-effective to implement. At the time of initial analysis, most boilers in this size range had not been certified by the manufacturers due to limited market availability of compliant models and higher costs for individual units. As a result, owners/operators in the Bay Area elected to purchase readily available non-certified models, and then apply to the BAAQMD for a permit to operate each unit. Without certified units being available in the region, operators were required to demonstrate compliance via source testing, along with adhering to other costly permit requirements.

Consequently, if the control measure were implemented in San Diego County at that time without certified units being available, operators would similarly be subject to costly requirements. This resulted in the District delaying adoption of the proposed rule.

Recent analyses have determined that certified units may be available for purchase in greater quantities, which may result in the proposed rule now being cost-effective to implement. Additional analysis, including revised cost-effectiveness and actual emission reductions, are necessary and will occur in the next few years to determine if adoption of the rule would be feasible in San Diego County. If and when proposed Rule 69.2.2 is eventually adopted and implemented, it is anticipated to reduce NOx emissions from medium-sized boilers by 89.5 tons per year (0.25 tons per day).

ATTACHMENT H
ARB ANALYSES OF POTENTIAL ADDITIONAL MOBILE SOURCE CONTROL MEASURES

H.1 Overview

To fulfill CAA control measure requirements for ozone nonattainment areas, an assessment of control measures in the SIP must be performed. For ozone nonattainment areas, the control measures must be shown to be Reasonable Available Control Measures (RACM). Since the ARB is responsible for measures to reduce emissions from mobile sources needed to attain the 2008 eight-hour ozone NAAQS, this document will discuss how California's mobile source measures meet RACM.

Given the severity of California's air quality challenges, the ARB has implemented the most stringent mobile source emissions control program in the nation. The comprehensive strategy put forth by the ARB to reduce emissions from mobile sources includes stringent emissions standards for new vehicles, in-use programs to reduce emissions from existing vehicle and equipment fleets, cleaner fuels that minimize emissions, and incentive programs to accelerate the penetration of the cleanest vehicles beyond that achieved by regulations alone. Taken together, California's mobile program meets RACM requirements in the context of ozone nonattainment.

H.2 RACM Requirements

CAA §172(c)(1) requires SIPs to provide for the implementation of RACM as expeditiously as practicable. The EPA has interpreted RACM to be those emission control measures that are technologically and economically feasible and when considered in aggregate, would advance the attainment date by at least one year.

The ARB developed its California SIP Strategy through a multi-step measure development process, including extensive public consultation, to develop and evaluate potential strategies for mobile source categories under the ARB's regulatory authority that could contribute to expeditious attainment of the 2008 eight-hour ozone NAAQS. First, the ARB developed a series of technology assessments for heavy-duty mobile source applications and the fuels necessary to power them,[69] along with ongoing review of advanced vehicle technologies for the light-duty sector in collaboration with the EPA and the National Highway Traffic Safety Administration. ARB staff then used a scenario planning tool to examine the magnitude of technology penetration necessary, as well as how quickly technologies need to be introduced to meet attainment of the 2008 eight-hour ozone NAAQS.

ARB staff released a discussion draft Mobile Source Strategy[70] for public comment in October 2015. This strategy specifically outlined a coordinated suite of proposed actions to not only meet federal air quality standards, but also achieve greenhouse gas emission reduction targets, reduce petroleum consumption, and decrease health risk from transportation emissions over the next 15 years. ARB

[69] Technology and Fuel assessments are available on the ARB website at http://www.arb.ca.gov/msprog/tech/tech.htm.
[70] "Mobile Source Strategy," ARB. http://www.arb.ca.gov/planning/sip/2016sip/2016mobsrc.htm

staff held a public workshop on October 16, 2015, and on October 22, 2015, the ARB held a public Board meeting to solicit comments on the draft Mobile Source Strategy.

ARB staff continued to work with stakeholders to refine the measure concepts for incorporation into related planning efforts, including SIPs for the 2008 eight-hour ozone NAAQS. On May 16, 2016, the ARB released an updated Mobile Source Strategy, and on May 17, 2016, the ARB released the proposed State SIP strategy for a 45-day public comment period.

The current mobile source program and proposed measures included in the State SIP Strategy provide attainment of the ozone standard as expeditiously as practicable and meet RFP requirements.

H.3 Waiver Approvals

While the CAA preempts most states from adopting emission standards and other emission-related requirements for new motor vehicles and engines, it allows California to seek a waiver or authorization from the federal preemption to enact emission standards and other emission-related requirements for new motor vehicles and engines and new and in-use off-road vehicles and engines. The requirements must be at least as protective as applicable federal standards, except for locomotives and engines used in farm and construction equipment which are less than 175 horsepower (hp).

Over the years, California has received waivers and authorizations for over 100 regulations. The most recent California standards and regulations that have received waivers and authorizations are Advanced Clean Cars (including ZEV and LEV III) for Light-Duty vehicles, On-Board Diagnostics, Heavy-Duty Idling, Malfunction and Diagnostics System, In-Use Off-Road Diesel Fleets, Large Spark Ignition Fleet, and Mobile Cargo Handling Equipment for Heavy-Duty Engines. Other Authorizations include Off-Highway Recreational Vehicles and the Portable Equipment Registration Program.

Finally, the ARB obtained an authorization from the EPA to enforce adopted emission standards for off-road engines used in yard trucks and two-engine sweepers. The ARB adopted the off-road emission standards as part of its “Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen and Other Criteria Pollutants from In-Use Heavy-Duty Diesel-Fueled Vehicles,” (i.e. Truck and Bus Regulation). The bulk of the regulation applies to in-use heavy-duty diesel on-road motor vehicles with a gross vehicle weight rating in excess of 14,000 pounds, which are not subject to preemption under CAA §209(a) and do not require a waiver under CAA §209(b).

H.4 Light and Medium-Duty Vehicles

Light and medium-duty vehicles are currently regulated under California’s Advanced Clean Cars program, including the Low-Emission Vehicle III (LEV III) and Zero-Emission Vehicle (ZEV) programs. Other California programs, such as the 2012 Governor Brown Executive Order to place 1.5 million zero-emission vehicles on the road by 2025, and California’s Reformulated Gasoline program (CaRFG), will produce substantial and cost-effective emission reductions from gasoline-powered vehicles.

ARB is also active in implementing programs for owners of older dirtier vehicles to retire them early. The “car scrap” programs, like the Enhanced Fleet Modernization Program, and Clean

Vehicle Rebate Project, provide monetary incentives to replace old vehicles with zero-emission vehicles. The Air Quality Improvement Program (AQIP), is another voluntary incentive program to fund clean vehicles.

Taken together, California's emission standards, fuel specifications, and incentive programs for on-road light and medium-duty vehicles represent all measures that are technologically and economically feasible within California.

H.5 Heavy-Duty Vehicles

California's heavy-duty vehicle emissions control program includes requirements for increasingly tighter new engine standards and address vehicle idling, certification procedures, on-board diagnostics, emissions control device verification, and in-use vehicles. This program is designed to achieve an on-road heavy-duty diesel fleet with 2010 engines emitting 98% less NOx and PM2.5 than trucks sold in 1986.

Most recently, in the ongoing efforts to go beyond federal standards and achieve further reductions, ARB adopted the Optional Reduced Emissions Standards for Heavy-Duty Engines regulation in 2014. This regulation establishes the new generation of optional NOx emission standards for heavy-duty engines.

The recent in-use control measures include the On-Road Heavy-Duty Diesel Vehicle (In-Use) Regulation, Drayage (Port or Rail Yard) Regulation, Public Agency and Utilities Regulation, Solid Waste Collection Vehicle Regulation, Heavy-Duty (Tractor-Trailer) Greenhouse Gas Regulation, Air Toxic Control Measure (ATCM) to Limit Diesel-Fueled Commercial Motor Vehicle Idling, Heavy-Duty Diesel Vehicle Inspection Program, Periodic Smoke Inspection Program, Fleet Rule for Transit Agencies, Lower-Emission School Bus Program, and Heavy-Duty Truck Idling Requirements. In addition, the ARB's significant investment in incentive programs provides an additional mechanism to achieve maximum emission reductions from this source sector.

Taken together, California's emission standards, fuel specifications, and incentive programs for heavy-duty vehicles represent all measures that are technologically and economically feasible within California.

H.6 Off-Road Vehicles and Engines

California regulations for off-road equipment include increasingly stringent standards for new off-road diesel engines, as well as in-use requirements and idling restrictions. The Off-Road Regulation is an extensive program designed to accelerate the penetration of the cleanest equipment into California's fleets, and impose idling limits on off-road diesel vehicles. The program goes beyond emission standards for new engines through comprehensive in-use requirements for legacy fleets.

Engines and equipment used in agricultural processes are unique to each process and are often re-designed and tailored to their particular use. Fleet turnover to cleaner engines is the focus for these engines.

Taken together, California's comprehensive suite of emission standards, fuel specifications, and incentive programs for off-road vehicles and engines represent all measures that are technologically and economically feasible within California.

H.7 Other Sources and Fuels

The emission limits established for other mobile source categories, coupled with EPA waivers and authorization of preemption establish that California's programs for motorcycles, recreational boats, off-road recreational vehicles, cargo handling equipment, and commercial harbor craft sources meet the requirements for RACM.

Cleaner burning fuels also play an important role in reducing emissions from motor vehicles and engines, as the ARB has adopted a number of more stringent standards for fuels sold in California. These include the Reformulated Gasoline program, low sulfur diesel requirements, and the Low Carbon Fuel Standard. These fuel standards, in combination with engine technology requirements, ensure that California's transportation system achieves the most effective emission reductions possible.

Taken together, California's emission standards, fuel specifications, and incentive programs for other mobile sources and fuels represent all measures that are technologically and economically feasible within California.

H.8 Summary

California's long history of comprehensive and innovative emissions control has resulted in the most stringent mobile source control program in the nation. The EPA has previously acknowledged the strength of the program in their approval of ARB regulations and through the waiver process. In its 2013 approval of San Diego County's Eight-Hour Ozone Maintenance Plan (1997 standard), which included California's current program and new measure commitments, the EPA found that there were no further reasonably available control measures that would advance attainment of the standard in San Diego County.

Since then, the ARB has continued to substantially enhance and accelerate reductions from mobile source control programs through the implementation of more stringent engine emissions standards, in-use requirements, incentive funding, and other policies and initiatives as described in the preceding sections.

The ARB finds that, with the current mobile source control program, there are no additional reasonable available control measures that would advance attainment of the 2008 eight-hour ozone NAAQS in San Diego County. There are no reasonable regulatory control measures excluded from use in this plan; therefore, there are no emission reductions associated with unused regulatory control measures. As a result, California's mobile source control programs fully meet the requirements for RACM.

ATTACHMENT I

CALCULATION OF CUMULATIVE POTENTIAL EMISSION REDUCTIONS FOR POSSIBLE REASONABLY AVAILABLE CONTROL MEASURES (RACM)

Table I-1
Calculation of Cumulative Potential Emission Reductions for Possible Reasonably Available Control Measures (RACM)

Control Measure	VOC Emission Reduction Potential (Tons/Day)	NOx Emission Reduction Potential (Tons/Day)
Receiving and Storing Volatile Organic Compounds at Bulk Plants and Bulk Terminals	0.03	
Transfer of Organic Compounds into Mobile Transport Tanks	0.01	
Architectural Coatings	2.4	
Aerospace Coating Operations	0.005	
Graphic Arts Operations	0.05	
Marine Coating Operations	0.01	
Adhesive Material Application Operations	0.9	
Composting Operations	0.3	
Industrial and Commercial Boilers, Process Heaters and Steam Generators		0.1
Small Boilers, Process Heaters, and Steam Generators		0.80
Natural Gas-Fired Fan-Type Central Furnaces		0.46
Equipment Leaks	0.01	
Commercial Food Ovens		0.01
Food Products Manufacturing/Processing	0.03	
Medium Boilers, Process Heaters, and Steam Generators		0.25
Stationary Sources Subtotal	**3.745**	**1.62**
Transportation Control Measures Subtotal	**0.448**	**0.822**
Mobile Sources Subtotal	**0.0**	**0.0**
Total	**4.193**	**2.442**

ATTACHMENT J
PHOTOCHEMICAL MODELING DRAFT PROTOCOL

CHAPTER 2

MODELING PROTOCOL

BACKGROUND

One of the basic requirements of a modeling attainment demonstration is the development of a comprehensive modeling protocol that defines the scope of the regional modeling analyses including the attainment demonstration methodology, meteorological and chemical transport platforms, gridded and speciated emission inventories, and geographical characteristics of the modeling domains. The protocol also defines the methodology to assess model performance and the selection of the simulation periods. The 2012 AQMP provided a comprehensive discussion of the modeling protocol used for the development of the PM2.5 and ozone attainment demonstrations. The 2012 AQMP Modeling Protocol, presented in the Chapter 2 of Appendix V, served as the prototype of the 2016 AQMP modeling protocol.

The 2016 AQMP demonstrates attainment of ozone and PM2.5 standards in 12 future landmark years. (See Table V-2-1) The future attainment years are identified based on nonattainment designation, pollutant standards, and geographical area. 2012 was chosen as the base year to maintain consistency with the base year employed in the SCAG's Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS).

TABLE V-2-1

Modeling Years for 2016 AQMP

Modeling Year	Plan	NAAQS	Areas
2012	Base Year	Modeling Base Year	
2017	2008 8-hour ozone	75 ppb	Imperial, San Diego
2018	1997 8-hour ozone	80 ppb	Coachella, W. Mojave Desert
2019	2006 24-hour PM2.5	35 µg/m3	South Coast
2020	2008 8-hour ozone	75 ppb	Ventura
2021	Annual PM2.5	12 µg/m3	South Coast
2022	1-hour ozone	120 ppb	South Coast
2023	1997 8-hour ozone	80 ppb	South Coast
	Annual PM2.5	12 µg/m3	South Coast
2025	Annual PM2.5	12 µg/m3	South Coast
2026	2008 ozone	75 ppb	Coachella, W. Mojave Desert
2031	2008 ozone	75 ppb	South Coast
2037	2015 ozone	70 ppb	South Coast

ATTAINMENT DEMONSTRATION

8-hour ozone

The methodology used to demonstrate attainment depends on the pollutant of interest. The 8-hour attainment demonstration was performed based on the U.S. EPA guidance document, "Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2s, and Regional Haze", issued on Dec 3rd, 2014. Compared to the previous guidance, US EPA (2007), the ozone attainment demonstration has been significantly updated. The new guidance requires that a maximum concentration be determined among 9 grids around a monitoring station and that the specific grid location be carried to a future year modeling scenario when calculating relative response factors (RRF). This 3 X 3 grid is recommended for all model grid resolutions, differing from the previous guidance, which recommended a 7 X 7 grid for a 4 km grid resolution simulation—the grid resolution used in this modeling. Another major difference is the number of days accounted for in the attainment demonstration. In the 2012 and earlier AQMPs, all days that met the selection criteria were used to calculate future year design values. The specific criteria used in the last AQMP required that the predicted daily max was within 20 % of the site-specific design value, the unpaired daily-max prediction error was less than 20%, and the prediction was higher than the federal standard, for inclusion. In the new guidance, the number of days accounted for in the RRF calculation is limited to the top 10 days of base year simulated concentrations. In the past, the uniquely high ozone concentrations in the Basin led to the inclusion of more than ten days in the RRF calculation. For example, the Crestline site, a design site in the 2012 AQMP, typically would have over 50 days or more included in the RRF calculation. On the other hand, a focus on the top ten days meeting the selection criteria in the new methodology produces future-year design values that are more responsive to emission reductions.

Annual PM2.5

The Final 2016 AQMP annual PM2.5 modeling employs the same approach to estimate the future year annual PM2.5 levels as was described in the 2012 and 2007 AQMP attainment demonstrations, except for the changes described in the 2014 U.S. EPA guidance document (U.S. EPA, 2014). The site- and species-specific RRF approach is consistent with the previous AQMPs. Four SASS sites and Mira Loma, the design site of the Basin, were used in the analysis. Quarterly averaged speciation fractions from the 2012 SASS measurements and quarterly-mean PM2.5 concentrations from corresponding FRM monitors (5 years and 20 quarters) were used to determine quarterly averaged concentrations of nitrate ion (NO3), ammonium ion (NH4), sulfate ion (SO4), elemental carbon (EC), organic carbon (OC), sea salt, and other primary PM2.5 material. The modeling platform developed for the ozone attainment demonstration was extended to the entire year to acquire quarterly average RRFs for each of the seven relevant species. Component-specific RRF values were applied to the base-year species concentrations to forecast future year component-specific concentrations. Particle bound water is then calculated using U.S. EPAs regression model approximation of the AIM model based on simulated concentrations of the ammonium, nitrate, and sulfate ions. (EPA, 2006). All species concentrations, along with a "blank" concentration, are summed for each quarter to produce quarterly averaged future total PM2.5 concentrations. A 5-year weighted average of the annual mean concentrations is then calculated to produce a future-year 5-year weighted design value.

24-hour PM2.5

FRM mass and species-specific mass were calculated using an approach similar to the one followed for the annual design value, except that the 8 highest days from each quarter were included in the calculation. This is based on the assumption that the 98^{th} percentile value can occur in any quarter and the 8^{th} highest is the 98^{th} percentile of 365 samples. Then, 32 sets of FRM mass and corresponding species fractions were retrieved per year, for the five-year period from 2010 to 2014. A set of species-specific RRFs were generated for each future year simulation from the top 10% of modelled PM2.5 days. RRFs were generated for the ammonium ion (NH4), nitrate ion (NO3), sulfate ion (SO4), organic carbon (OC), elemental carbon (EC), sea salt (Salt) and a combined grouping of other primary PM2.5 material (Other). A total of 7 species-specific RRFs were generated per quarter. Then future year concentrations of the seven component species were calculated by applying the model generated quarterly RRFs to the speciated 160 base year design values (8 days per quarter, 4 quarters per year and 5 year period). Particle bound water was determined using U.S. EPAs regression model approximation of the AIM model based on simulated concentrations of the ammonium, nitrate and sulfate ions (EPA, 2006). A blank mass of 0.5 µg/m3 was added to each base and future year simulation. The 32 days in each year (8 per quarter) were then re-ranked based on the sum of all predicted PM species to establish a new 98^{th} percentile concentration. A weighted average of the resulting future year 98^{th} percentile concentrations for each of the five years was used to calculate future design values for the attainment demonstration.

1-hour Ozone

For 1-hour ozone, no recent modeling guidance has been developed since the standard has been revoked.

The 1997 AQMP and 2003 AQMP 1-hour ozone attainment demonstrations relied on direct output from model simulations to project future year air quality and design values. This "deterministic" approach was based on the premise that future year projected baseline inventories were accurate and the impacts of implementing the control program were well simulated. In addition, the form of the 1-hour ozone standard was directed at the fourth highest concentration in a three year period for a given air monitoring station. In essence, the analysis looked at the 2nd highest concentration in a given year, typically occurring during the worst-case meteorological scenario.

The 2012 AQMP attainment demonstration relied primarily on the "deterministic approach", but included the RRF methodology as weight of evidence discussion. Similar to the 2012 AQMP, the current AQMP utilized both "deterministic" and RRF approaches, given the fact that there is no official guidance for 1-hour ozone and both approaches have their limitations and strengths. The deterministic method relies on accurate modeling and the proper selection of a meteorological episode while the RRF approach tends to place less reliance on individual day model performance since the factor is based on an average of several events having similar meteorological profiles. However, basing the RRF on multiple days may mask the meteorological profile characteristics of an extreme event such as an annual second maximum concentration.

However, even if the RRF approach similar to the 8-hour demonstration was employed, the number of days included in the RRF calculation was re-evaluated. This was intended to accommodate the definition of the 1-hour ozone design value in contrast to that of the 8-hour. The 8-hour ozone standards takes the 4th highest readings of a year averaged over a three-year period. However, the 1-hour standard allows one exceedance a year, resulting in a design value based on the 4th highest value in a three-year period. In other words, the 1-hour standard focuses on the 1st or the 2nd highest day of the year, while the 8-hour accounts for the 4th highest day. Therefore, the optimal number of days for inclusion in the RRF calculation was determined to be three days after carefully examining CMAQ performance to capture episode days in 2012.

NUMERICAL MODELS EMPLOYED FOR THE 2016 AQMP

Table V-2-2 provides a side-by-side comparison of the 2007, 2012 and the current 2016 AQMP modeling protocols. The modelling protocol was significantly updated from the 2007 to the 2012 AQMP; however, changes between the 2012 and 2016 AQMP were minimal. In general, changes have occurred in the following categories: emissions inventories, future-year simulations, the level of the non-attainment designation and the attainment demonstration methodology. As such, these changes are expected to occur with each subsequent modeling update.

TABLE V-2-2

Numerical Modeling Platforms and Domains for 2016 and previous AQMP's

	2007 AQMP	**2012 AQMP**	**2016 AQMP**
Modeling Base Year	2005 Ozone: episode based PM: Annual	2008 Ozone: June – Aug PM: Annual	2012 Ozone: May – Sep PM: Annual
Chemical Transport Model	CAMx	CMAQ as primary tool CAMx as weight of evidence	CMAQ
Meteorological Model	MM5 version 3 Non-Hydrostaic model Hybrid of MM5/CALMET as weight of evidence	WRF version 3.3 with Updated Land Use	WRF version 3.6 with Updated Land Use
Emission: On-Road Off-Road	EMFAC 2007 CARB OFFROAD Model	EMFAC 2011 EMFAC-LDV EMFAC-HD EMFAC-SG Category Specific Calculation	EMFAC 2014 Single package Category Specific Calculation
Modeling Domain	Separate domains for O3 and PM modeling O3: 550 km by 370 km in E-W and N-S PM: 325 km by 200 km	624 km by 408 km	624 km by 408 km
Grid Resolution	5km by 5km grid	4km by 4 km grid	4km by 4km grid
Vertical Layer	O3: 16 layers up to 5km above the ground level (agl) PM: 8 layers	18 layers with 14 layer below 2000 m agl and 50 hPa as top boundary	18 layers with 14 layer below 2000 m agl and 50 hPa as top boundary

An entire year from January to December was simulated for the PM attainment demonstration – both 24-hour and annual averages. Five consecutive months starting from May 1st until September 30th were modeled for the ozone analysis. While this approach is similar to the approach used in the 2012 AQMP, it differs from the 2007 AQMP and prior AQMPs, which focused on selected high ozone episodes.

As in the 2012 AQMP, CMAQ was selected as the primary chemical transport modeling platform in the 2016 AQMP. CMAQ is a community model readily available in the public domain, allowing for the incorporation of the most recent algorithms and parameterizations as compared to models maintained by the private sector. For example, CMAQ has been recently equipped with the newest chemical mechanism, SAPRC07, however, CAMx still uses the older version of SAPRC99. In addition, as demonstrated in the 2012 AQMP, CMAQ performed comparatively or better than CAMx when simulating photochemistry within the Basin. Note that CAMx was employed for a weight of evidence analysis in the 2012 AQMP and as the primary dispersion platform in the 2007 AQMP. Details of the CMAQ configuration are given in Table V-2.3.

TABLE V-2-3

Chemical Transport Modeling Platform for the 2016 and 2012 AQMP's

Options	2012 AQMP	2016 AQMP
Numerical Model	CMAQ version 4.7.1 as primary CAMx as Weight of Evidence	CMAQ version 5.0.2
Modeling Grid	156 by 102 grids with 4 km grid distance	Same
Gas Phase Chemical Mechanism	SAPRC99	SAPRC07 with version "c" toluene updates
Aerosol Mechanism	AERO5	AERO6
Chemical Solver	Euler Backward Iterative solver (EBI)	Same
Horizontal Advection	Piecewise Parabolic Method. (PPM)	Yamo
Vertical Advection	PPM	WRF
Horizontal Diffusion	Multiscale CMAQ scheme	Same
Vertical Diffusion	ACM2	Same
Photolysis	Lookup table	In-line Calculation
Initial Values	Clean Homogeneous Condition	Same
Boundary Values	Model for OZone and Related chemical Tracers (MOZART)	Same

The Weather Research and Forecast (WRF) model remains as the primary tool for meteorological modeling. For the 2016 AQMP, WRF was updated with the most recent version (version 3.6) available at this time and was evaluated with a set of input data, which include land-use classification and sea-surface temperature initialization fields (Table V-2-4).

TABLE V-2-4

Meteorological Modeling Platform for 2016 and 2012 AQMP's

Options	2012 AQMP	2016 AQMP
Numerical Model	WRF version 3.3	WRF Version 3.6.1
Nesting	Same	Same
Vertical Layers	30 layers with the lowest layer at 20 m above ground level	Same
Simulation Length	4 day with 24 hour spin-up	Same
Initial & Boundary Value	NAM Analysis field	NAM analysis field NARR analysis field
Landuse	Modified USGS landuse with 24 categories	Modified USGS landuse with 24 categories MODIS satellite retrieved landuse
Sea Surface Temperature	NAM surface analysis field	NAM surface anlaysis field Global Ocean Data Assimilation Experiment (GODAE) SST
Surface Layer Scheme	Slab Thermal Diffusion scheme	Slab Thermal Diffusion scheme NOAH scheme
Planetary Boundary Layer (PBL) scheme	YSU	Same
Date Assimilation	Analysis nudging at every 6 hours for the outermost domain only No temperature and moisture nudging for the PBL	Same

WRF simulations were conducted with three nested domains with grid resolutions of 36, 12 and 4 km (Figure V-2-1). The innermost domain spans 652 km by 460 km in the east–west and north–south directions, respectively, which includes the greater Los Angeles area, its surrounding mountains, and ocean waters off the coast of the Basin (Figure. V-2-2). A Lambert conformal map projection was used with reference latitudes of 30° and 60° N and the center of the modeling domain positioned at 37° N and 120° 30 ′ W.

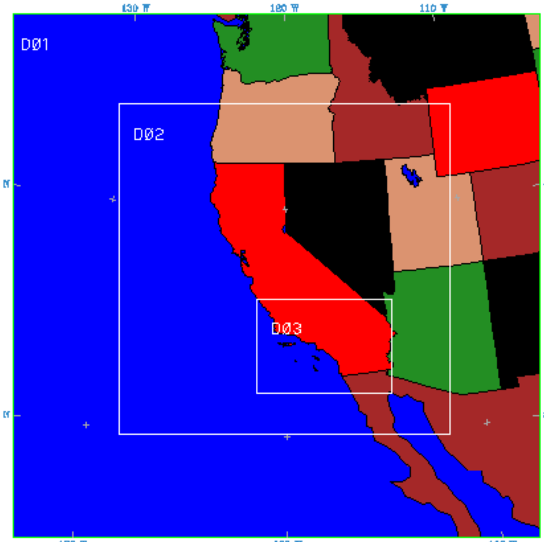


FIGURE V-2-1

Three nested domains used in WRF simulation

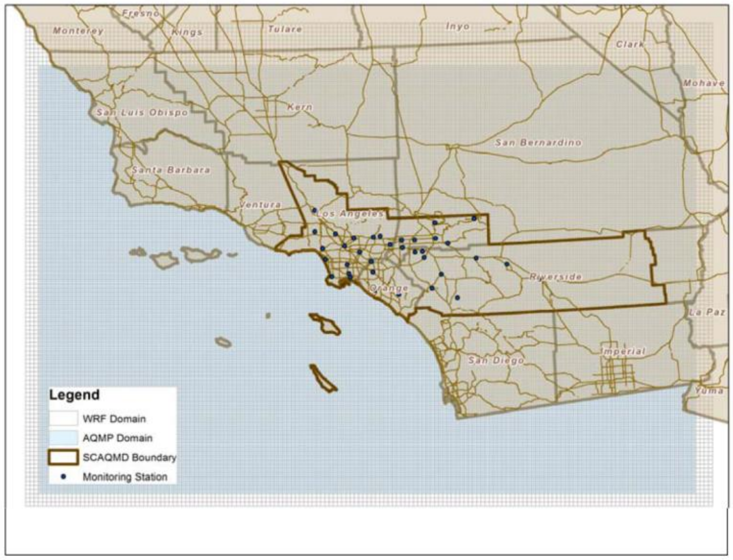


FIGURE V-2-2

The relative locations of the inner most WRF domain compared to the CMAQ domain. The boundary of South Coast AQMD boundary and air monitoring locations are overlaid by a thick solid line and black dots, respectively.

The model employed 30 vertical layers, with the lowest computational layer centered approximately at 20 m above ground level (agl) and a top layer centered at 50 hPa. Note that the WRF layers given in the Table V-2-5 are layer interfaces, meaning that actual computational volume is defined as the space between layer interfaces. The National Center for Environmental Prediction (NCEP) Eta model output (grid 212, 40 km grid spacing) together with vertical soundings and surface measurements, were used to compile initial and boundary values for the outermost domain as well as for the Four Dimensional Data Assimilation (FDDA) to WRF. The YSU planetary boundary layer scheme, WSM 3-class simple ice microphysics scheme, RRTM longwave radiation, Dudhia shortwave radiation were chosen as the default methods for the AQMP simulations after carefully considering various options available for WRF. Kain–Fritsch cumulus schemes were employed for the outer two domains, while no cumulus parameterization was used for the innermost domain. The thermal diffusion land-surface scheme was employed after evaluating the NOAH and Pleim-Xu schemes extensively.

TABLE V-2-5

Vertical Computational Layer Interfaces for 2016 AQMP modeling

Layer Index	Eta Level for WRF	Eta Level for CMAQ
31	0.0000	0.0000
30	0.0232	
29	0.0493	
28	0.0788	0.0788
27	0.1120	
26	0.1495	
25	0.1917	
24	0.2394	
23	0.2930	0.2930
22	0.3536	
21	0.4218	
20	0.4954	
19	0.5635	
18	0.6254	0.6254
17	0.6809	
16	0.7301	
15	0.7733	0.7733
14	0.8107	0.8107
13	0.8431	0.8431
12	0.8709	0.8709
11	0.8946	0.8946
10	0.9148	0.9148
9	0.9319	0.9319
8	0.9463	0.9463
7	0.9585	0.9585
6	0.9688	0.9688
5	0.9774	0.9774
4	0.9846	0.9846
3	0.9907	0.9907
2	0.9958	0.9958
1	1.0000	1.0000

EMISSIONS PROCESSING

On-Road mobile source emissions were calculated based on EMFAC 2014 and the 2016 Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS). Temporal and spatial allocation of on-road emissions were improved to accurately represent continuous measurements from in-road traffic sensors. Traditionally, on-road vehicle count is specified at five distinctive time zones of the day: morning peak (7-9AM), mid-day (10am-3pm), afternoon peak (4-7pm), evening peak (8-9pm) and night (10pm-6am). This profile was used to simulate a typical weekday traffic pattern in the Basin. The traffic count was then scaled to reflect changes in volume during each day of week based on an adjustment factor from CARB. However, this approach does not account for variations in traffic patterns due to seasonal changes, holidays, cultural activities or weather since it simulates a 'typical weekday' traffic flow. In an attempt to reflect such seasonal and cultural effects on on-road emissions, new temporal allocation profiles were constructed from traffic measurements available through the California Department of Transportation Performance Measurement System (PeMS). The PeMS network collects traffic data at over 9000 sensor locations within the Basin on a real-time basis at 5-minute time resolution, providing an actual real world traffic allocation that reflects social events, responses to weather conditions, and cultural behavior. This new PeMS-based methodology reallocates emissions temporally and spatially but does not affect the total amount of emissions from on-road mobile sources.

Off-Road emissions reflect updated speciation profiles and spatial surrogate factors for the following categories: construction equipment, recreational boats, composting, dairy cattle count, prescribed burning in future years, agricultural burning, architectural coatings, aircraft emissions, and military ordinance and vehicles on the San Clemente Naval Station. Gasoline dispensing facilities and oil and gas operations are subject to changes based on revised CARB and U.S. EPA emission calculation methodologies, respectively. Table V-2-6 summarizes changes in emission processing methodology between the 2012 and 2016 AQMP. The list of categories adjusted for day specific weather and activity is given in Table V-2-7.

TABLE V-2-6

Summary of Emission Processing for 2012 and 2016 AQMP

Options	2012 AQMP	2016 AQMP
On-Road Emissions	EMFAC 2011 ○ 3- modules Light Duty Vehicles (LDV), Heavy Duty vehicles (HD) and Scenario Generating module (SG). ○ Modified DTIM Temporal Allocation using CARB/Caltrans Adjustment Factors	EMFAC 2014 ○ Single package integrated all the three components of the previous version ○ Emissions mode to get total amount of emissions in Tons per Day ○ Emissions rate to estimate grams per emissions of specific vehicle category, activity, etc Temporal Allocation using Caltrans real-time traffic data
Vehicle Miles Traveled	2012 Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS)	2016 Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS)
Off-Road Emissions	Category Specific Calculation	Same
Mexico Emissions	Revised Mexican emissions profile	Same

TABLE V-2-7

List of Emissions Categories with Day-Specific Adjustments

Day-Specific Emission Categories
• Ocean-going vessels • Agricultural burning • Wildfires • Prescribed burns • Residential wood combustion (curtailment programs) • Facilities that have closed since 2012 • Facilities that have had large upsets • Paved road dust • Unpaved road dust • Windblown dust • Livestock dust • Biogenic and On-Road motor vehicle emissions are adjusted using day/hour-specific meteorological data.

COMPUTATIONAL RESOURCES

The main computation platform employs Linux-based parallel processing computers. New servers, compiled to enhance computational capability, were configured with Red-Hat version 6.4 O/S and 64 bit operating systems. The Fortran and C compilers were transitioned to Intel group compilers for the current AQMP, while Portland Group Compilers were used in the default configuration for the 2012 AQMP. The shift to the Intel compilers was initiated to provide a 10-20% improvement in computational speed. Details of the computing resources are summarized in Table V-2-8.

TABLE V-2-8

Details of Computational Resources used in the 2007, 2012 and 2016 AQMPs.

2007 AQMP	2012 AQMP	2016 AQMP
HP DL 380 G5, 32 bit 3.6GHz, 2x2 cores	HP DL380 G7, 64 bit 3.3 GHz, 2x6 cores	HP DL560 G8, 64 bit 4x8 cores
Canis 1-10, Total **112** processors	Iris1-6 Total **140** processors	Iris 7-10, Total **256** processors

REFERENCES

US EPA (2007) Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze, EPA -454/B-07-002

US EPA (2011) Memorandum on "Update to the 24 Hour PM2.5 NAAQS Modeled Attainment Test"

US EPA (2014) Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2s, and Regional Haze

ATTACHMENT K
METEOROLOGICAL AND PHOTOCHEMICAL MODELING – PERFORMANCE ANALYSIS FOR THE SAN DIEGO COUNTY 2016 EIGHT-HOUR OZONE STATE IMPLEMENTATION PLAN

Statistical Evaluation

The statistics used to evaluate 8-hour average CMAQ ozone performance include the following:

Statistic for O_3	Definition
Daily-Max Bias Error Unpaired	Average of the differences in observed and predicted daily maximum values. Negative values indicate under-prediction. $BiasError = \frac{1}{N}\sum(Obs - Pred)$
Daily-Max Bias Error Paired	Average of the differences in daily maximum observed value and the corresponding predicted concentration at the hour that the observational maximum was reached. Negative values indicate under-prediction. $BiasError = \frac{1}{N}\sum(Obs - Pred)$
Daily-Max Gross Error Unpaired	Average of the absolute differences in observed and predicted daily maximum values $GrossError = \frac{1}{N}\sum\lvert Obs - Pred\rvert$
Daily-Max Gross Error Paired	Average of the absolute differences in daily maximum observed value and the corresponding predicted concentration at the hour that the observational maximum was reached. $GrossError = \frac{1}{N}\sum\lvert Obs - Pred\rvert$
Normalized Daily-Max Bias Error Unpaired	Average of the quantity: difference in observed and predicted daily maximum values normalized by the observed daily maximum values. Negative values indicate under-prediction. $NormBiasError = \frac{1}{N}\sum\left(\frac{Obs-Pred}{Obs}\right)\cdot 100$
Normalized Daily-Max Bias Error Paired	Average of the quantity: difference in daily maximum observed value and the

	corresponding predicted concentration at the hour that the observational maximum was reached normalized by the observed daily maximum concentration. Negative values indicate under-prediction. $NormBiasError = \frac{1}{N}\sum\left(\frac{Obs-Pred}{Obs}\right)\cdot 100$
Normalized Daily-Max Gross Error Unpaired	Average of the quantity: absolute difference in observed and predicted daily maximum values normalized by the observed daily maximum concentration $NormGrossError = \frac{1}{N}\sum\left\|\frac{Obs-Pred}{Obs}\right\|\cdot 100$
Normalized Daily-Max Gross Error Paired	Average of the quantity: absolute difference in daily maximum observed value and the corresponding predicted concentration at the hour that the observational maximum was reached normalized by the observed daily maximum concentration $NormGrossError = \frac{1}{N}\sum\left\|\frac{Obs-Pred}{Obs}\right\|\cdot 100$
Peak Prediction Accuracy Unpaired	Difference in the maximum of the observed daily maximum and the maximum of the predicted daily maximum normalized by the maximum of the observed daily maximum $PPA = \frac{(maximum(Pred) - \mathrm{maximum}(Obs))}{\mathrm{maximum}(Pred)}$

Predicted concentrations are extracted from model output in the grid cell that each monitoring station resides.

We evaluated the base year average regional model performance for May through September 2012 for days when Basin maximum 8-hour ozone levels were at least 60 ppb. Ozone performance criteria are presented in Table 1. Only stations with more than 74.5% (EPA's data completeness requirement) of the hourly measurements during each month of the ozone season were included in the analysis.

Ozone measurements from monitors in Otay Mesa, San Diego (Kearny Villa Rd), San Diego (Beardsley St), Camp Pendleton, Alpine, Del Mar, El Cajon, and Chula Vista were compiled for the analysis.

TABLE 1

2012 Base Year 8-Hour Average Ozone Performance for Days When Regional 8-Hour Maximum ≥ 60 ppb

Region San_Diego

Month	Mean Pred. [ppb]	Mean Obs. [ppb]	Number of Daily Max > 60 ppb	Daily-Max Mean Pred. Unpaired [ppb]	Daily-Max Mean Pred. Paired [ppb]	Daily-Max Mean Obs. [ppb]	Daily-Max Bias Err. Unpaired [ppb]	Daily-Max Bias Err. Paired [ppb]	Daily-Max Gross Err. Unpaired [ppb]	Daily-Max Gross Err. Paired [ppb]	Norm Daily-Max Bias Err. Unpaired [%]	Norm Daily-Max Bias Err. Paired [%]	Norm Daily-Max Gross Err. Unpaired [%]	Norm Daily-Max Gross Err. Paired [%]	Peak Predict. Accuracy Unpaired [ppb]
May	49.6	41.4	136	63.9	60.6	52.6	11.3	8	11.7	9.9	17.2	11.5	17.9	15.9	17.6
Jun	41.8	36.9	102	56	53.7	48.2	7.6	5.8	8.2	7	13.6	10.2	14.8	13	14.5
Jul	36.1	36.2	136	48.7	46.1	46.2	2.6	0	7.8	7	2	-4.3	17.3	17.6	17.9
Aug	39	31.3	144	56.4	54.2	44.5	11.9	9.7	13.6	12.7	19.7	14.3	23.3	23.7	19.4
Sep	46	34.3	142	62.3	60	51.1	11.1	9.3	13.9	12.8	16.1	13.5	21.6	20.5	10.4

Density scatter plots displaying all 27,442 eight-hour ozone measurements from all monitors in the region is shown in Figure 1.

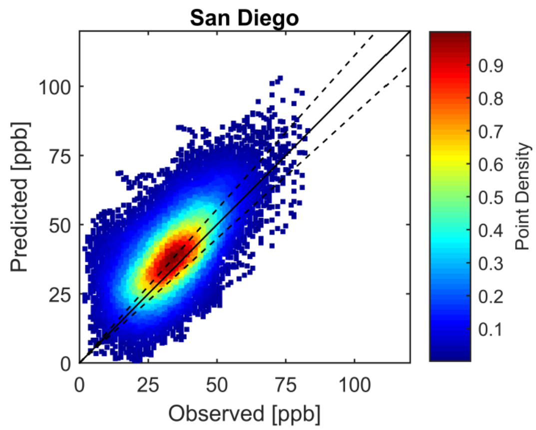


Figure 1: Density scatter plot of all 8-hour ozone values in the air district. Dashed lines indicate the bounds of 10% agreement

The model slightly over-predicts 8-hour measurements. Since the ozone standards are based on the daily maximum ozone values, model prediction of higher concentrations is more consequential. Figure 2 illustrate the model performance of daily maximum 8-hour ozone.

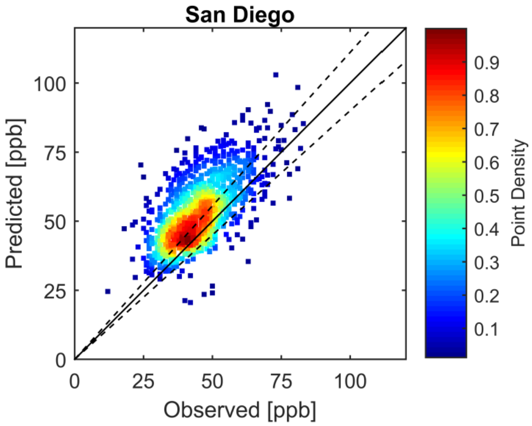


Figure 2: Density scatter plot of 8-hour daily maximum values in the air district. Dashed lines indicate the bounds of 10% agreement.

Daily maxima are over-predicted, but most of the data lie within 10% to 20% of the measured values.

The model performance of 8-hour ozone at each specific station in the air basin is illustrated in Figures 3-10.

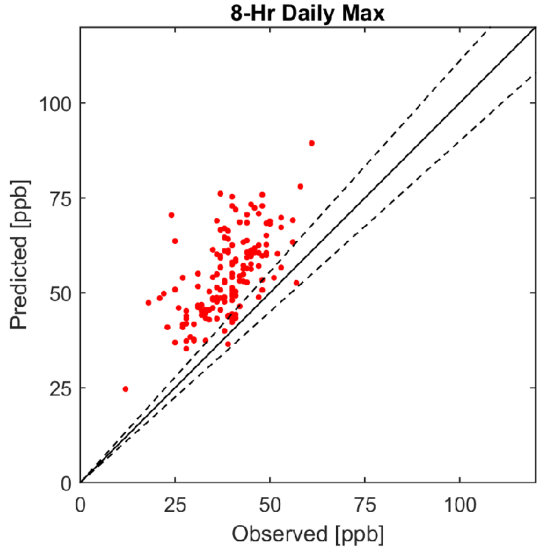


Figure 3: Eight-hour ozone daily maxima model performance at Otay Mesa (s2007).

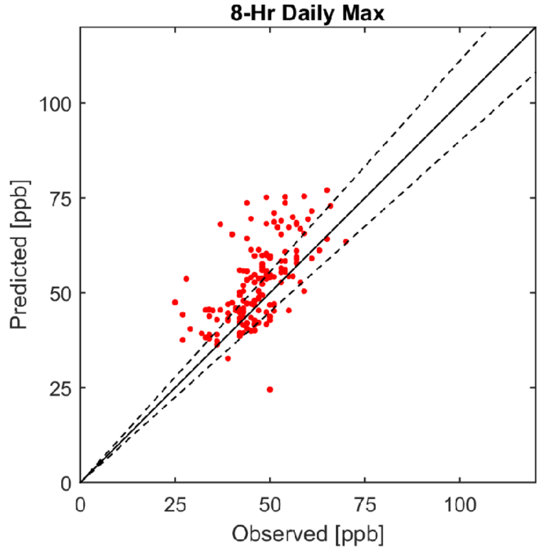


Figure 4: Eight-hour ozone daily maxima model performance at San Diego, Kearny Villa Rd (s1016).

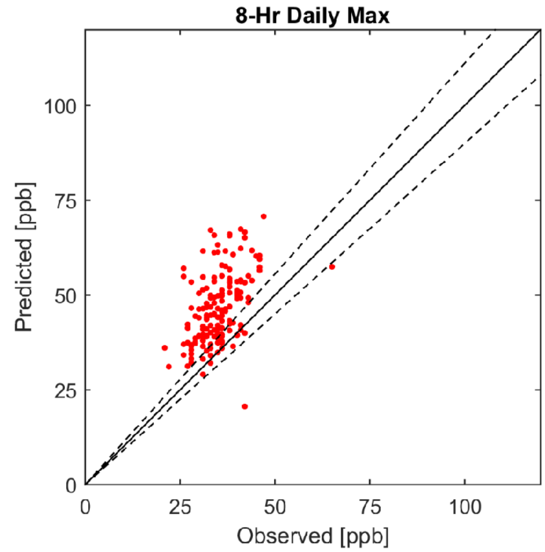


Figure 5: Eight-hour daily maxima model performance at San Diego, Beardsley St (s1010).

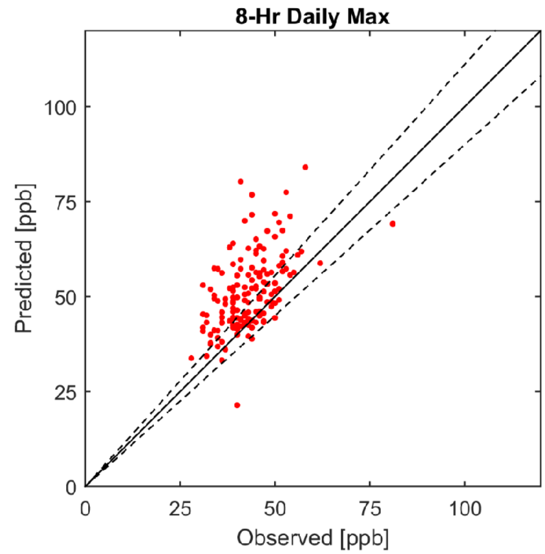


Figure 6: Eight-hour daily maxima model performance at Camp Pendleton (s1008).

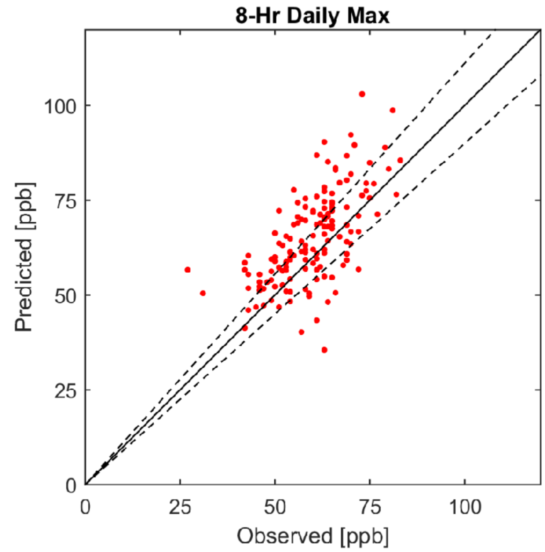


Figure 7: Eight-hour daily maxima model performance at Alpine (s1006).

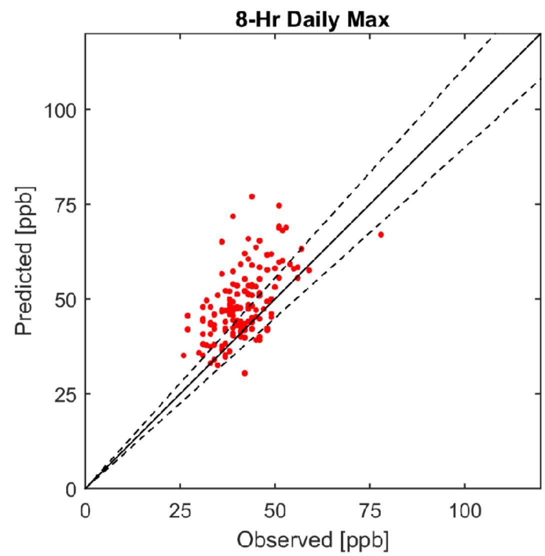


Figure 8: Eight-hour daily maxima model performance at Del Mar (s1001).

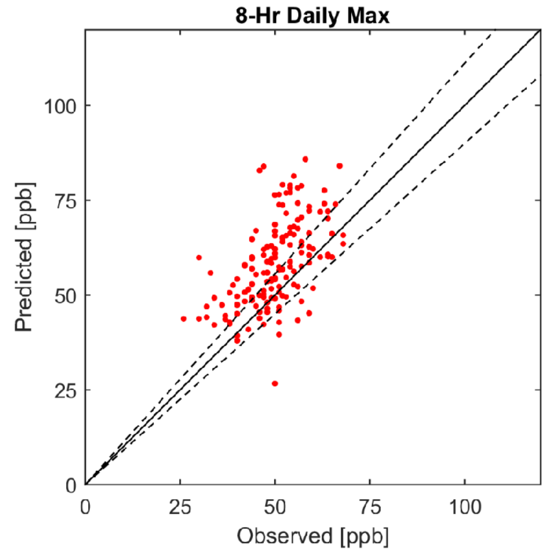


Figure 9: Eight-hour daily maxima model performance at Cajon (s3).

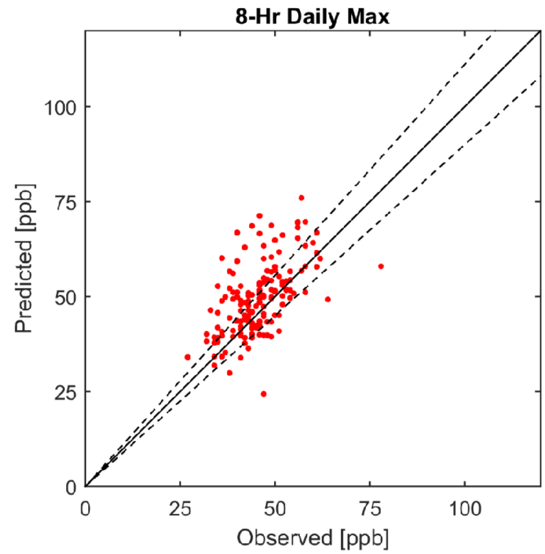


Figure 10: Eight-hour daily maxima model performance at Chula Vista (s1).

Base and Future Year Design Values

Table 2 details the base and future year design values for all stations with design values that meet the data completeness criteria. The base design value represents the 5-year weighted 8-hr ozone design value from 2012. Future design values were determined with comprehensive meteorological and chemical transport modelling and spatially resolved emissions projections.

TABLE 2

Base Year and Future Year Design Values

Station Name	Station Number	2012 Design Value	2017 Design Value
Chula Vista	1	61.0	59.5
Escondido-E Valley Parkway	1002	70.3	67.7
Alpine-Victoria Drive	1006	80.0	75.9
Camp Pendleton	1008	64.0	63.1

ATTACHMENT L
UNMONITORED AREA ANALYSIS FOR THE SAN DIEGO COUNTY 2008 EIGHT-HOUR OZONE STATE IMPLEMENTATION PLAN

Unmonitored Area Analysis

An unmonitored area analysis was conducted to estimate 8-hour ozone design values in unmonitored locations. This analysis uses both the measurement design values and the modelled ozone profiles throughout the modeling domain. Details of this analysis are presented in Appendix 5, Chapter 5 of the 2016 AQMP. The same procedures and methodology were used for the South Coast Air Basin unmonitored area analysis.

The same interpolation scheme was used to calculate the spatial distribution of design values throughout the County. Figure 1 illustrates the interpolated measured design value field.

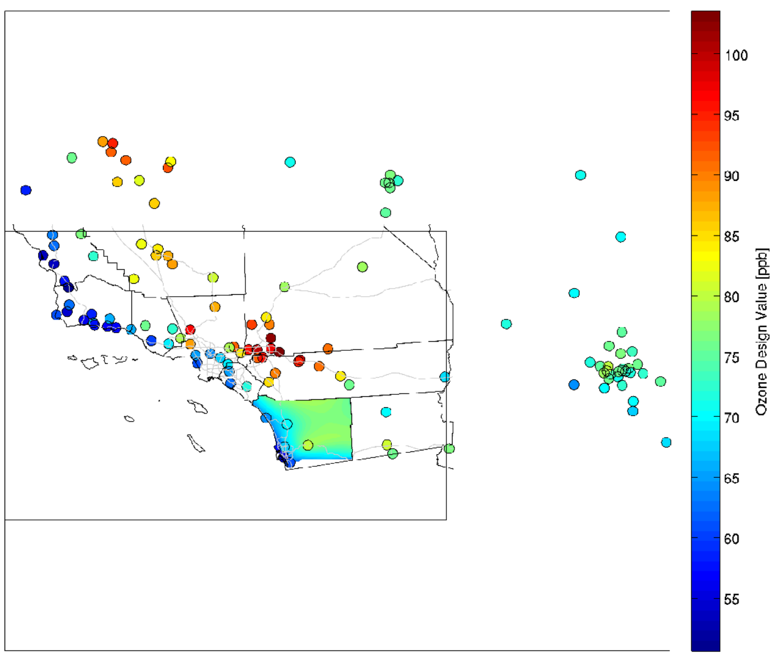


Figure 1: Interpolated 5-year weighted 2012 design values

Design values were interpolated and not extrapolated, leading to missing data along the southern border of the County. The relative response factors representing the ratio between the 2017 simulated ozone and the base-year (2012) simulated ozone are presented below in Figure 2.

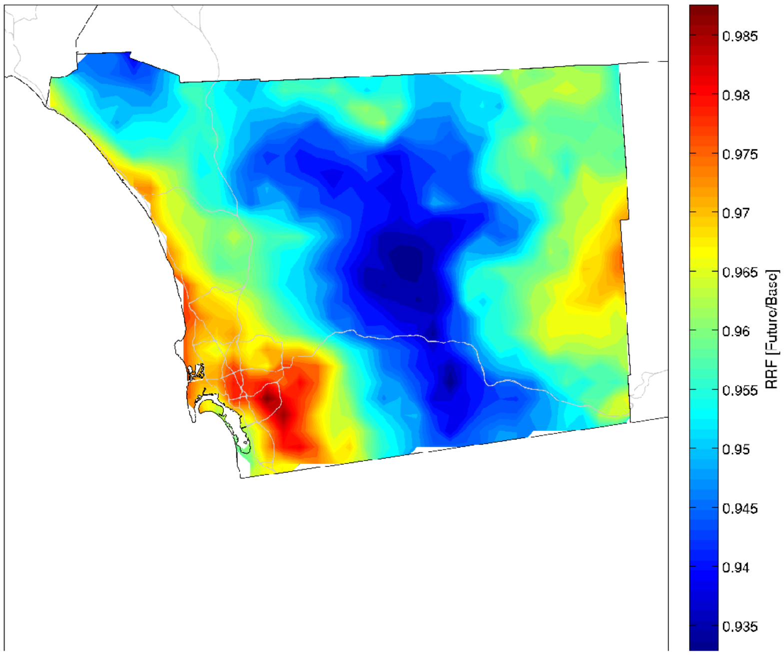


Figure 2: 2017 RRF Fields

The relative response factors suggest that ozone will decrease faster in the inland areas of San Diego County. Coastal San Diego county and the region boarding Imperial county will exhibit the slowest decrease in future ozone concentrations.

The calculated RRF field is then used to project the interpolated measurement field to simulate future year concentrations. Figure 3 shows the predicted future ozone concentrations for 2017 in San Diego County.

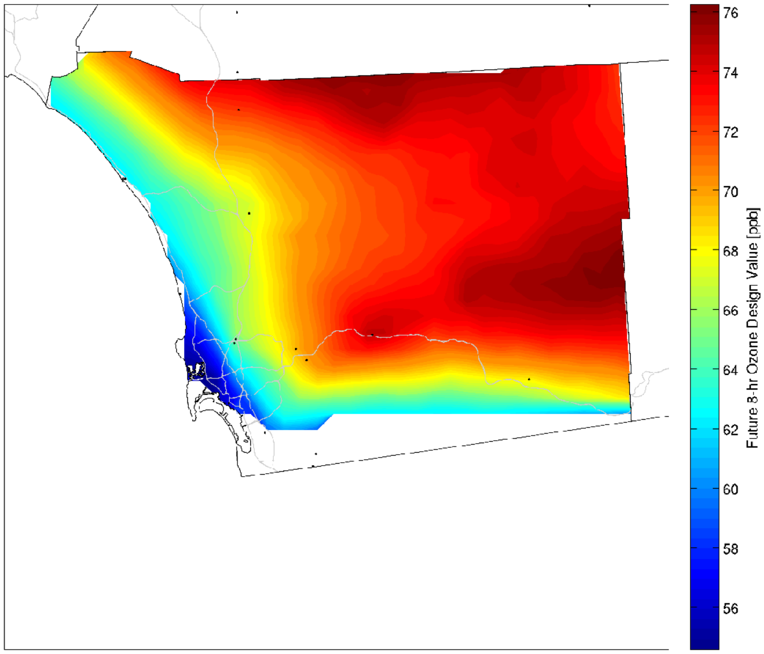


Figure 3: 2017 Predicted 8-hr Ozone Design Values. Monitoring stations are notated with black dots.

Northern and Eastern San Diego County is projected to exhibit the highest concentrations in the County. The maximum ozone design values is projected to be 76.5 ppb.