San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

2012 Area Source Emissions Inventory Methodology
810 –CIVILIAN AIRCRAFT

I. Purpose

This document describes the Area Source Methodology used to estimate emissions of carbon monoxide (CO), nitrogen oxides (NO_x), fine particulate matter less than 10 microns (PM_{10}), volatile organic compounds (VOC) and sulfur oxides (SO_x) from the operation of civilian aircraft within the San Joaquin Valley Air Pollution Control District. This methodology includes emissions from the operation of aircraft for commercial, air taxi, agricultural crop dusting, and general aviation purposes. This methodology does not include military aircraft, as they are covered in a different methodology.

An area source category is a collection of similar emission units within a geographic area (i.e., a County). An area source category collectively represents individual sources that are small and numerous, and that may not have been inventoried as specific point, mobile, or biogenic sources. The California Air Resources Board (CARB) has grouped these individual sources with other like sources into area source categories. These source categories are grouped in such a way that they can be estimated collectively using one methodology.

II. Applicability

The emission calculations from this Area Source Methodology apply to emissions sources that are identified by the Category of Emission Source (CES) codes and Reconciliation Emission Inventory Codes (REIC) presented in Table 1. Table 1 also identifies the Federal Aviation Administration (FAA) aircraft activity types associated with each emissions category.

Table 1. Emission inventory codes.

CES	REIC	Description	Activity Type
47555	810-810-1400-0000	Jet Aircraft - Commercial	Commercial, Air Taxi
47589	810-812-1400-0000	Jet Aircraft - Civil	General Aviation
57315	810-802-1140-0000	Piston Aircraft - Commercial	Commercial, Air Taxi
57331	810-804-1140-0000	Piston Aircraft - Civil	General Aviation
47563	810-804-1140-0000	Agricultural Aircraft (Crop Dusting)	General Aviation

III. Point Source Reconciliation

Emissions from the area source inventory and the point source inventory are reconciled against each other to prevent double counting. This is done using relationships created by the California Air Resources Board (CARB) between the area source REIC and the point sources Standard Industry Classification (SIC) code and emissions process Source Category Code (SCC) combinations. The area sources in this methodology are not represented within our point source inventory, so reconciliation is not necessary.

IV. Methodology Description

Civilian aircraft can be operated for commercial, air taxi, agricultural crop dusting, or general aviation purposes. Commercial operations involve transport of passengers, freight, or both. Air taxis operate similar to commercial operations, but the aircraft involved are usually smaller and operate on a more limited basis. Crop dusting is the aerial application of chemicals (pesticides, fertilizers, etc.) to agricultural land. General aviation refers to most all other civilian aircraft operations not classified under the commercial, air taxi, and crop dusting categories. Some examples of general aviation include recreational flying and personal transportation. Emissions from civilian aircraft are differentiated based on the type of engine employed (piston or jet/turbine engines). This is due to piston engines using aviation gasoline (avgas) and turbine engines using jet fuel.

Preparing an emissions inventory for aircraft focuses on the emission characteristics of this source relative to the vertical column of air that ultimately affects ground level pollutant concentrations. This portion of the atmosphere, which begins at the earth's surface and is simulated in air quality models, is often referred to as the mixing zone. For the purposes of this methodology the mixing zone extends from the surface to a mixing height of 3,000 feet. The aircraft operations of interest within this layer are defined as the landing and takeoff (LTO) cycle. The cycle begins when the aircraft approaches the airport on its descent from cruising altitude, lands, and taxis to the gate. It continues as the aircraft starts back up, taxis back out to the runway for subsequent takeoff and climbout as it heads back up to cruising altitude. Thus, the six specific operating modes in an LTO are:

- Approach
- Taxi/idle-in
- Startup
- Taxi/idle-out
- Takeoff
- Climbout

The LTO cycle can provide a basis for calculating aircraft emissions. During each mode of operation, the aircraft engine(s) operates at a fairly standard power setting for a given aircraft category. Emissions for one complete cycle for a given aircraft can be calculated by knowing emission factors for specific aircraft engines at those power settings. Then, if the activity of all aircraft in the modeling zone can be determined for the inventory period, the total emissions can be calculated.

This methodology uses the following approaches to determine emissions from aircraft activity:

Commercial, Air Taxi, and General Aviation

LTO data was gathered for commercial, air taxi, and general aviation activities. For commercial air carriers for which detailed aircraft-specific activity data were available, the Federal Aviation Administration's (FAA) Emissions and Dispersion Modeling System (EDMS) was used to estimate emissions. For all other aircraft within these categories, emissions were calculated using LTO data and emission factors.

Agricultural Crop Dusting

Commercial, air taxi, and general aviation aircraft are expected to operate in their cruising modes (the mode between when an aircraft completes its climbout after takeoff until it begins its approach to land at its destination) above the 3,000 foot mixing height within which we calculate emissions. Crop dusters are believed to operate in their cruising modes exclusively within the 3,000 foot high mixing zone. These emissions, from the cruising modes of crop dusting aircraft need to be accounted for. Because of this, a different approach was required to estimate emissions from crop dusting aircraft. This methodology estimates crop dusting aircraft emissions by applying emission factors to the number of treated (crop-dusted) acres.

V. Activity Data

Activity data for this methodology was obtained from several sources which are described below:

A. Commercial, Air Taxi, and General Aviation

Commercial aircraft activity in the district was queried from the *Air Carrier Statistics* database, also known as the *T-100* data bank. This database contains domestic and international airline market and segment data. Certificated U.S. air carriers report monthly air carrier traffic information using Form T-100. Foreign carriers having at least one point of service in the United States or one of its territories report monthly air carrier traffic information using Form T-100(f). This data is collected by the Office of Airline Information, Bureau of Transportation Statistics, Research and Innovative Technology Administration. Information includes carrier, flight origin, flight destination, aircraft type and service class for transported passengers, freight and mail, available capacity, scheduled departures, departures performed, aircraft hours, and load factor when both origin and destination airports are located within the boundaries of the United States and its territories. The level of information obtained from this data source was sufficient to model aircraft emissions using the FAA's EDMS Model (BTS, 2013). Commercial LTO's for District airports represented in the *Air Carrier Statistics* database are summarized in Appendix A.

However, this databank only includes activities of large certified carriers, generally defined as having annual operating revenues of $20 million or more. For smaller commercial air carriers, like most air taxis, LTO data was obtained from the FAA's Terminal Area Forecasts (TAF) and Form 5010 databanks (FAA, 2013a; FAA, 2013b). These sources provide LTO estimates for general aviation airports (see Appendix A for a summary of this data). Because the aircraft make and models were not available, the District used assumptions regarding the percent of these LTOs that were associated with piston-driven versus turbine-driven aircraft. EPA assumes that at airports, 72.5% of all General Aviation and 23.1% of all Air Taxi activity is powered by piston-powered aircraft, with the remainder powered by turbine aircraft. At heliports, EPA assumed that 36.1% of all General Aviation and 2% of all Air Taxi activity was powered by piston-powered aircraft, with the remainder powered by turbine engines. These fractions were developed based on FAA's General Aviation and Part 135 Activity Surveys – CY 2008 (FAA, 2008) and are displayed in the table below.

Table 2. EPA Aircraft Activity Fractions for General Aviation and Air Taxi Operations.

Engine Type	Facility Type	Fraction Aircraft
General Aviation - Turbine	Airport	0.275
General Aviation - Piston	Airport	0.725
Air Taxi - Turbine	Airport	0.769
Air Taxi - Piston	Airport	0.231
General Aviation - Turbine	Heliport	0.639
General Aviation - Piston	Heliport	0.361
Air Taxi - Turbine	Heliport	0.980
Air Taxi - Piston	Heliport	0.020

B. Agricultural Crop Dusting

The acres of agricultural land treated by aerial application of chemicals was used as activity data for crop dusting. This activity data was obtained from the California Department of Pesticide Regulation (DPR, 2013). Since the most recent year available was 2011, it served as a surrogate for 2012. DPR has a pesticide use database containing information that includes chemical application date, time, location, acreage treated, and method of application. Please note that each chemical active ingredient is entered on a new line in the database, so care must be taken so as to not overestimate acreage. County level acreage of agricultural land chemically treated by crop dusters in presented in the table below.

Table 3. Acreage of agricultural land treated by crop dusters in 2011.

County	Acres Treated
Fresno	1,191,885
Kern	669,030
Kings	1,322,058
Madera	182,469
Merced	453,692
San Joaquin	268,798
Stanislaus	118,723
Tulare	356,067

VI. Emission Factors

A. Commercial Aircraft and Air Taxis

For commercial and air taxi aircraft activity obtained from the *Air Carriers Statistics Database*, sufficient information (aircraft/engine type) was available to estimate emissions using the FAA's EDMS software. EDMS allows users to specify the aircraft fleet make-up at a given airport and assign an engine type to each aircraft (default engine types are provided in most cases). Annual numbers of LTO cycles associated with each aircraft/engine combination are also input by the user. EDMS calculates emissions from the ground up to a user-defined mixing height, which has a default value of 3,000 feet.

B. General Aviation and Air Taxis

In general, neither the FAA nor airport traffic control towers track operations by aircraft model for General Aviation and some Air Taxi aircraft. Because of this, detailed emission factors by engine type cannot be used to estimate emissions from these aircraft. Instead, the fleet-average emission factors listed in the table below were applied. These emission factors are used by EPA in the development of the National Emissions Inventory and are described in the documentation for aircraft activity (Eastern Research Group, 2011). They may be used as conservative emission factors for all aircraft with known LTO data but without a known make, model, and/or engine type.

Table 4. Fleet-average aircraft emission factors.

Aircraft Type	Emission Factor (tons/LTO)					
	NOx	CO	SOx	VOC	PM_{10}	$PM_{2.5}$
Commercial Aircraft	9.29E-03	1.12E-02	8.91E-04	2.93E-03	5.39E-04	5.26E-04
Air Taxi - Jet	3.88E-04	1.81E-03	8.12E-05	5.03E-04	3.02E-04	3.92E-05
Air Taxi - Piston	7.90E-05	1.41E-02	7.50E-06	8.48E-05	3.02E-04	3.92E-05
General Aviation - Jet	1.62E-04	4.79E-03	3.68E-05	2.73E-04	1.18E-04	1.54E-05
General Aviation - Piston	3.25E-05	6.01E-03	5.00E-06	7.52E-05	1.18E-04	1.54E-05
Military	7.90E-05	1.41E-02	7.50E-06	6.82E-04	3.02E-04	3.92E-05

C. Agricultural Crop Dusting

As part of a study performed for the San Joaquin Valley Air Pollution Control District, Sonoma Technology Inc (STI) derived emission factors that could be used for determining emissions from crop dusting aircraft activity based on treated (crop-dusted) acreage (STI, 2004). STI, with the aid of a local crop dusting company, determined that an Air Tractor aircraft with a Pratt & Whitney PT6A-45 turboprop engine could be used as a surrogate for all crop dusting aircraft in the District. The emission factors that were derived from this study are presented in the table below:

Table 5. Crop Dusting Emission Factors.

NOx Tons/Acre	CO Tons/Acre	SOx Tons/Acre	VOC Tons/Acre	PM_{10} Tons/Acre
1.56E-05	6.75E-06	1.08E-06	4.17E-07	1.05E-07

VII. Emissions Calculations

Commercial and civil aviation emissions are estimated using one of three methods: (1) FAA's EDMS model with aircraft specific LTO activity data, (2) EPA emission factors with FAA Form 5010 LTO activity data, or (3) District developed emission factors with acres of cropland chemically treated by air as activity data. Operation of the EDMS model will not be described here as it is beyond the scope of this methodology document. Following are sample calculations for the other two methods:

A. Sample Calculation for General Aviation Piston Aircraft NOx Emissions

Given:

1. There were 6,250 LTOs performed at Sierra Sky Park in 2012
2. Piston aircraft performed 72.5% of general aviation LTOs at airports.
3. The fleet average emission factor for general aviation piston aircraft is 0.0000325 tons NOx per LTO cycle.

Equation:

$$Emissions_{tpy} = LTOs\ x\ FET\ x\ EF$$

Where,

$Emissions_{tpy}$ = *emissions in tons per year*

LTOs = number of landing/takeoff cycles performed

FET = fraction aircraft for a given engine type (jet/turbine or piston).

EF = emission factor in tons pollutant per LTO

<u>Calculate Emissions:</u>

$$Emissions_{tpy} = 6{,}250\ LTOs\ x\ 72.5\%\ piston\ x\ \frac{0.0000325\ tons\ NOx}{LTO}$$

$$Emissions_{tpy} = 0.15\ tons\ NOx$$

B. <u>Sample Calculations for Agricultural Aviation Aircraft NOx Emissions</u>

<u>Given</u>:

1. There were 1,191,885 acres of agricultural land treated by aerial application of chemicals in Fresno County in 2012.
2. The fleet average emission factor for general aviation piston aircraft is 0.0000156 tons NOx per LTO cycle.

<u>Equation:</u>

$$Emissions_{tpy} = Acreage\ x\ EF$$

Where,

$Emissions_{tpy}$ = *emissions in tons per year*

Acreage = acres agricultural land chemically treated by aircraft

EF = emission factor in tons pollutant per acre land treated

<u>Calculate Emissions:</u>

$$Emissions_{tpy} = 1{,}191{,}885\ acres\ x\ \frac{0.0000156\ tons\ NOx}{acre}$$

$$Emissions_{tpy} = 18.59\ tons\ NOx$$

VIII. Temporal Variation

Bureau of Transportation Statistics (BTS) data for commercial flights in the District is available by month (BTS, 2013). The monthly frequency of departures from District airports is used as a temporal surrogate for all commercial and civil aviation except crop dusting. For crop dusting, acreage treated per month is available from DPR (2013).

C. Daily

a. Commercial and civil aviation: CARB Code 35. Max activity 7 a.m. to 1 a.m., remainder is low.

b. Agricultural aviation: CARB Code 37. Activity during daylight hours; less chance in early morning and late evening.

D. Weekly

CARB Code 7. 7 days per week - uniform activity every day of the week

E. Monthly

Commercial and civil aircraft activity was determined by querying the FAA's T100 report of commercial aircraft activity for monthly departures from District airports. Agricultural aircraft activity was determined by querying the California Department of Pesticide Regulation's Pesticide Use Report database for acres of farmland in the District treated by aerial application of chemicals.

Table 6. Monthly aircraft activity in the San Joaquin Valley, 2012.

Month	Commercial and Civil Aviation		Agricultural Aviation	
	Departures	Percent	Acres Treated	Percent
January	1,836	7.90%	239,466	5.25%
February	1,733	7.46%	384,921	8.44%
March	1,973	8.49%	533,291	11.69%
April	1,904	8.20%	220,051	4.82%
May	1,974	8.50%	193,862	4.25%
June	2,009	8.65%	551,181	12.08%
July	2,145	9.23%	775,705	17.00%
August	2,145	9.23%	842,944	18.47%
September	1,943	8.36%	343,079	7.52%
October	1,894	8.15%	375,830	8.24%
November	1,819	7.83%	39,146	0.86%
December	1,853	7.98%	63,246	1.39%
Grand Total	23,228	100.00%	4,562,722	100.00%

IX. Spatial Variation

Latitude and longitude coordinates for each airport included in this emissions estimate are provided in Appendix A. Emissions can be assigned to grid cells containing an airport having commercial and/or civil aviation activity as appropriate for the source category. For agricultural aviation, emissions can be assigned to grid cells corresponding to agricultural lands. Vertically, aircraft emissions can be dispersed uniformly between the ground and a mixing height of 3,000 feet.

X. Growth Factor

Growth factors are developed by either the District's Strategies and Incentives Department or CARB for each EIC. These factors are used to estimate emissions in future years. The growth factors associated with these emissions categories may be obtained from the Air Quality Analysis Section of the District's Strategies and Incentives Department.

XI. Control Level

Aircraft are not subject to District rules. Control levels associated with these emissions categories may be obtained from the Air Quality Analysis Section of the District's Strategies and Incentives Department.

XII. CARB Chemical Speciation

CARB has developed organic gas profiles in order to calculate reactive organic gasses (ROG), volatile organic compounds (VOC) or total organic gas (TOG) given any one of the three values. For each speciation profile, the fraction of TOG that is ROG and VOC is given. The organic gas profile codes can also be used to lookup associated toxics. CARB's speciation profiles for commercial and civil aircraft emissions are presented in the table below. Organic gas profile #586 is applied to REICs 810-810-1400-0000 (Jet Aircraft - Commercial) and 810-812-1400-0000 (Jet Aircraft – Civil). Organic gas profile #413 is applied to REICs 810-802-1140-0000 (Piston Aircraft - Commercial), 810-804-1140-0000 (Piston Aircraft – Civil), and 810-806-1140-0000 (Agricultural Aircraft).

Table 7. CARB organic gas speciation profiles for commercial and civil jet and piston aircraft emissions.

Profile Description	CARB Organic Gas Profile#	Fractions	
		ROG	VOC
Composite Jet Exhaust JP5 (EPA 1097-1099)	586	0.892	0.892
Gasoline Non-Cat FTP Composite ARB IUS Summer 1994	413	0.885	0.885

CARB has developed particulate matter speciation profiles in order to calculate particulate matter (PM), particulate matter with a diameter less than or equal to 10 microns (PM_{10}) or particulate matter with a diameter less than or equal to 2.5 microns ($PM_{2.5}$) given any one of the three values. For each speciation profile, the fraction of PM that is PM_{10} and $PM_{2.5}$ is given. The particulate matter profile codes can also be used to lookup associated toxics. CARB's speciation profiles for commercial and civil aircraft emissions are presented in the table below. Particulate matter profile #141 is applied to REICs 810-810-1400-0000 (Jet Aircraft - Commercial) and 810-812-1400-0000 (Jet Aircraft – Civil). Particulate matter profile #399 is applied to REICs 810-802-1140-0000 (Piston Aircraft - Commercial), 810-804-1140-0000 (Piston Aircraft – Civil), and , and 810-806-1140-0000 (Agricultural Aircraft).

Table 8. CARB particulate matter speciation profiles for commercial and civil jet and piston aircraft emissions.

Profile Description	CARB PM Profile#	Fractions	
		PM_{10}	$PM_{2.5}$
Aircraft Jet Fuel	141	0.976	0.967
Gasoline Vehicles No Catalyst	399	0.90	0.68

XIII. Assessment Of Methodology

The strongest component of this methodology is the procedure for estimating emissions from commercial aircraft. The FAA T100 data provides activity data by aircraft type. This enables the use of the EDMS model, which applies engine-specific emission factors to the aircraft fleet at a given airport. On the other hand, estimates of emissions from general aviation aircraft and air taxis (which account for virtually all of the operations at the smaller airports in the District) relied on fleet-average emission factors.

Estimates of emissions from crop dusters were generated using approximations of a "typical" crop dusting operation. These estimates could be improved by the acquisition of more detailed information on crop duster aircraft/engine types, fuel usage, and practices for treating specific crops grown in the District. It is likely that such data could only be gathered through a survey of individual crop dusting operations.

Activity data could not be developed for a number of the smaller, private airfields and heliports in the District. Activity at these sites is assumed low, but the estimate would be improved by their inclusion.

Finally, commercial and civil aviation emissions could be reported as point sources to improve spatial resolution. Currently, the county level area source estimates are disaggregated using spatial surrogates.

XIV. Emissions

Following is the 2012 area source emissions inventory for commercial and civil aviation estimated by this methodology. Emissions are reported for each county in the District.

Table 9. Area source emissions for commercial and civil aviation (2012).

County	Emissions (tons/year)					
	NOx	CO	SOx	VOC[1]	PM_{10}	$PM_{2.5}$[2]
Commercial Jet Aircraft (810-810-1400-0000)						
Fresno	48.58	84.28	7.60	8.71	1.89	N/A
Kern	11.63	25.87	1.99	2.07	0.80	N/A
Kings	0.03	0.14	0.01	0.04	0.02	N/A
Madera	0.10	0.49	0.02	0.14	0.08	N/A
Merced	0.65	9.39	0.18	3.21	0.10	N/A
San Joaquin	4.68	6.05	0.73	0.41	0.30	N/A
Stanislaus	2.34	8.81	0.46	1.43	0.87	N/A
Tulare	1.20	13.17	0.31	4.41	0.63	N/A
TOTAL	69.21	148.20	11.30	20.42	4.69	N/A
Civil Jet Aircraft (810-812-1400-0000)						
Fresno	4.73	139.71	1.07	7.96	3.45	N/A
Kern	6.34	187.36	1.44	10.68	4.63	N/A
Kings	0.78	23.12	0.18	1.32	0.57	N/A
Madera	1.27	37.44	0.29	2.13	0.93	N/A
Merced	2.65	78.39	0.60	4.47	1.94	N/A
San Joaquin	3.67	108.47	0.83	6.18	2.68	N/A
Stanislaus	0.96	28.49	0.22	1.62	0.70	N/A
Tulare	2.30	68.13	0.52	3.88	1.68	N/A
TOTAL	22.70	671.11	5.15	38.24	16.58	N/A
Commercial Piston Aircraft (810-802-1140-0000)						
Fresno	0.08	14.00	0.01	0.08	0.30	N/A
Kern	0.05	8.48	0.00	0.05	0.18	N/A
Kings	0.00	0.32	0.00	0.00	0.01	N/A
Madera	0.01	1.14	0.00	0.01	0.02	N/A
Merced	0.00	0.17	0.00	0.00	0.00	N/A
San Joaquin	0.02	3.38	0.00	0.02	0.07	N/A
Stanislaus	0.07	11.93	0.01	0.07	0.26	N/A
Tulare	0.04	7.47	0.00	0.05	0.16	N/A
TOTAL	0.27	46.89	0.02	0.28	1.00	N/A
Civil Piston Aircraft (810-804-1140-0000)						
Fresno	2.50	461.91	0.38	5.79	9.10	N/A
Kern	3.35	619.39	0.52	7.76	12.21	N/A
Kings	0.41	76.43	0.06	0.96	1.51	N/A
Madera	0.67	123.79	0.10	1.55	2.44	N/A
Merced	1.40	259.08	0.22	3.25	5.11	N/A
San Joaquin	1.94	358.55	0.30	4.49	7.07	N/A
Stanislaus	0.51	94.19	0.08	1.18	1.86	N/A
Tulare	1.22	225.22	0.19	2.82	4.44	N/A
TOTAL	12.00	2,218.56	1.85	27.80	43.74	N/A

Table 9 continued.

County	Emissions (tons/year)					
	NOx	CO	SOx	VOC[1]	PM_{10}	$PM_{2.5}$[2]
Agricultural Aircraft (810-806-1140-0000)						
Fresno	18.59	8.05	1.29	0.50	0.13	N/A
Kern	10.44	4.52	0.72	0.28	0.07	N/A
Kings	20.62	8.92	1.43	0.55	0.14	N/A
Madera	2.85	1.23	0.20	0.08	0.02	N/A
Merced	7.08	3.06	0.49	0.19	0.05	N/A
San Joaquin	4.19	1.81	0.29	0.11	0.03	N/A
Stanislaus	1.85	0.80	0.13	0.05	0.01	N/A
Tulare	5.55	2.40	0.38	0.15	0.04	N/A
TOTAL	71.17	30.79	4.93	1.91	0.49	N/A

[1]The District only reports ROG to CARB. As noted in Section XII, ROG is the same as VOC.

[2]At this time, the District does not calculate PM2.5 emissions. PM2.5 emissions can be estimated using the speciation profiles found in Section XII.

Following is the net change in emissions between this update (2012 inventory year) and the previous inventory in CEIDARS (2011 inventory year) for commercial and civil aviation. The change in emissions are reported for each county in the District.

Table 10. Net emissions change for commercial and civil aviation (2012 – 2011).

County	Emissions (tons/year)					
	NOx	CO	SOx	VOC[1]	PM_{10}	$PM_{2.5}$[2]
Commercial Jet Aircraft (810-810-1400-0000)						
Fresno	38.25	-582.33	-46.25	-30.18	-1.27	N/A
Kern	5.72	-2,660.60	-29.05	-34.38	-6.91	N/A
Kings	-17.51	0.14	-0.39	0.04	0.02	N/A
Madera	0.10	0.49	0.02	0.14	0.08	N/A
Merced	-1.24	-17.68	-9.34	2.97	-1.52	N/A
San Joaquin	2.27	-69.99	-2.83	-2.18	-0.78	N/A
Stanislaus	2.34	8.81	0.46	1.43	0.87	N/A
Tulare	-21.40	-27.73	-7.49	2.01	-1.23	N/A
TOTAL	8.53	-3,348.89	- 94.87	- 60.15	- 10.74	N/A
Civil Jet Aircraft (810-812-1400-0000)						
Fresno	-26.69	-650.79	-11.27	-98.28	3.45	N/A
Kern	-48.73	-120.20	-0.73	-48.95	4.63	N/A
Kings	-0.32	-435.98	-0.22	-9.78	-0.01	N/A
Madera	0.77	22.04	0.09	0.05	0.93	N/A
Merced	-17.56	-491.12	0.25	-120.18	1.36	N/A
San Joaquin	-3.86	-1,582.09	-2.62	-46.30	-1.66	N/A
Stanislaus	-30.33	-281.96	-6.95	-68.51	-1.14	N/A
Tulare	-13.00	-710.67	-2.38	-11.28	-1.63	N/A
TOTAL	- 139.72	-4,250.77	- 23.83	- 403.23	5.93	N/A
Commercial Piston Aircraft (810-802-1140-0000)						
Fresno	-2.59	-737.19	0.01	-26.56	0.30	N/A
Kern	0.05	-66.13	0.00	-1.35	0.18	N/A
Kings	0.00	0.32	0.00	0.00	0.01	N/A
Madera	0.01	1.14	0.00	0.01	0.02	N/A
Merced	0.00	0.17	0.00	0.00	0.00	N/A
San Joaquin	-3.14	-150.18	-0.58	-11.88	-0.88	N/A
Stanislaus	0.07	11.93	0.01	0.07	0.26	N/A
Tulare	0.04	7.47	0.00	0.05	0.16	N/A
TOTAL	- 5.56	- 932.47	- 0.56	- 39.66	0.05	N/A
Civil Piston Aircraft (810-804-1140-0000)						
Fresno	-10.99	-4,894.12	0.38	-131.75	9.10	N/A
Kern	-7.69	-5,551.70	0.52	-118.89	12.21	N/A
Kings	0.41	76.43	0.06	0.96	1.51	N/A
Madera	-0.73	-468.11	0.10	-16.05	-0.35	N/A
Merced	1.40	259.08	0.22	3.25	5.11	N/A
San Joaquin	1.94	358.55	0.30	4.49	7.07	N/A
Stanislaus	-0.35	-831.07	-0.67	-23.16	0.70	N/A
Tulare	1.22	225.22	0.19	2.82	4.44	N/A
TOTAL	- 14.79	-10,825.72	1.10	- 278.33	39.79	N/A

Table 10 continued

County	Emissions (tons/year)					
	NOx	CO	SOx	VOC[1]	PM_{10}	$PM_{2.5}$[2]
Agricultural Aircraft (810-806-1140-0000)						
Fresno	17.82	-196.88	0.43	-2.86	-0.01	N/A
Kern	10.05	-99.00	0.34	-1.37	0.00	N/A
Kings	20.16	-91.88	0.96	-1.09	0.07	N/A
Madera	2.77	-17.21	0.12	-0.27	0.02	N/A
Merced	6.92	-35.37	0.34	-0.36	0.05	N/A
San Joaquin	4.04	-26.62	0.14	-0.37	0.03	N/A
Stanislaus	1.77	-17.95	0.05	-0.22	0.01	N/A
Tulare	5.40	-34.24	0.23	-0.40	0.04	N/A
TOTAL	68.93	- 519.15	2.61	- 6.94	0.21	N/A

[1]The District only reports ROG to CARB. As noted in Section XII, ROG is the same as VOC.
[2]At this time, the District does not calculate $PM_{2.5}$ emissions. $PM_{2.5}$ emissions can be estimated using the speciation profiles found in Section XII.

XV. Revision History

2013. This is a new methodology based on one prepared for the District by Sonoma Technology Inc. (STI, 2003).

XVI. Update Schedule

Emissions estimates for these source categories will be updated as needed by the District for planning purposes.

XVII. References

1. Bureau of Transportation Statistics. 2013. The air carrier statistics database. Compiled by the Office of Airline Information, Bureau of Transportation Statistics, Research and Innovative Technology Administration. Accessed online on 9/25/2013 at http://www.transtats.bts.gov/Fields.asp?Table_ID=293

2. Eastern Research Group. 2011. Documentation for aircraft component of the national emissions inventory methodology. Report prepared for the U.S. Environmental Protection Agency under Contract No. EP-D-07-097. 63 pages.

3. Federal Aviation Administration. 2013a. Airport master record Form 5010 database. Accessed online on 9/25/2013 at http://www.faa.gov/airports/airport_safety/airportdata_5010/

4. Federal Aviation Administration. 2013b. Terminal area forecast. Accessed online on 9/25/2013 at http://aspm.faa.gov/main/taf.asp

5. Federal Aviation Administration. 2008. Table 2.4: General aviation and air taxi total number of landings by region, aircraft primarily flown by aircraft type. In: General aviation and part 135 activity surveys – CY 2007.

6. Sonoma Technology, Inc. 2004. Emission inventory methodology – Civilian aircraft. Report to the San Joaquin Valley Air Pollution Control District, 18 pages.

XVIII. Appendix

Appendix A. Airports in the District

Appendix A. Airports in the District

Table 11. Airports located within the San Joaquin Valley Air Pollution Control District for which landing and takeoff (LTO) data could be obtained for 2012.

Airport Name	City	Location ID	Latitude	Longitude	FAA Form 5010 Airport LTOs[1]			FAA T-100 LTOs
					Commercial	Air Taxi	General Av.	
Fresno County								
Dos Palos	Dos Palos	28CA	36-57-44.8100N	120-37-48.6580W	0	0	6,600	0
Firebaugh	Firebaugh	F34	36-51-35.9590N	120-27-52.0830W	0	0	5,000	0
Fresno Chandler Executive	Fresno	FCH	36-43-55.6000N	119-49-13.2000W	0	0	12,500	0
Fresno Yosemite Intl	Fresno	FAT	36-46-35.6000N	119-43-07.8000W	5,154	12,923	45,012	13,770
Harris Ranch	Coalinga	3O8	36-14-53.2000N	120-14-18.5000W	0	0	5,000	0
New Coalinga Muni	Coalinga	C80	36-09-43.6000N	120-17-41.4000W	0	0	1,200	0
Reedley Muni	Reedley	O32	36-40-15.6000N	119-27-03.7000W	0	0	16,500	0
Selma	Selma	0Q4	36-34-51.6018N	119-39-25.1208W	0	0	6,000	0
Sierra Sky Park	Fresno	E79	36-50-24.6000N	119-52-09.8000W	0	0	6,250	0
William Robert Johnston Muni	Mendota	M90	36-45-31.0000N	120-22-17.0000W	0	0	2,000	0
Kern County								
Bakersfield Muni	Bakersfield	L45	35-19-29.5000N	118-59-45.7000W	0	0	12,500	0
Delano Muni	Delano	DLO	35-44-44.0000N	119-14-11.4000W	0	0	9,500	0
Elk Hills-Buttonwillow	Buttonwillow	L62	35-21-12.4000N	119-28-47.0000W	0	0	600	0
Kern Valley	Kernville	L05	35-43-41.6000N	118-25-11.0000W	0	0	5,126	0
Lost Hills-Kern County	Lost Hills	L84	35-37-29.2000N	119-41-10.1000W	0	0	500	0
Meadows Field	Bakersfield	BFL	35-26-01.9000N	119-03-27.6000W	1,444	4,962	51,843	4,551
Mountain Valley	Tehachapi	L94	35-06-03.8800N	118-25-23.3010W	0	0	24,400	0
Poso-Kern County	Famoso	L73	35-35-47.0000N	119-07-41.8000W	0	0	500	0
Shafter-Minter Field	Shafter	MIT	35-30-26.9114N	119-11-31.6836W	0	0	22,500	0
Taft-Kern County	Taft	L17	35-08-30.0000N	119-26-16.1000W	0	250	4,750	0
Tehachapi Muni	Tehachapi	TSP	35-08-05.9800N	118-26-21.4800W	0	0	5,500	0
Wasco-Kern County	Wasco	L19	35-37-11.5000N	119-21-13.4000W	0	500	4,500	0
Kings County								
Corcoran	Corcoran	CRO	36-06-09.5000N	119-35-40.8000W	0	0	2,800	0
Hanford Muni	Hanford	HJO	36-19-00.2000N	119-37-39.6000W	0	100	14,250	0
Westlake Farms	Stratford	92CA	36-07-14.8270N	119-53-18.4780W	0	0	500	0
Madera County								
Chowchilla	Chowchilla	2O6	37-06-47.8000N	120-14-49.2000W	0	0	3350	0
Madera Muni	Madera	MAE	36-59-19.0000N	120-06-44.8000W	0	350	25,075	0

Table 11 Continued.

Airport Name	City	Location ID	Latitude	Longitude	FAA Form 5010 Airport LTOs[1]			FAA T-100 LTOs
					Commercial	Air Taxi	General Av.	
Merced County								
Castle	Atwater	MER	37-22-49.7000N	120-34-05.5000W	8	244	35,531	200
Gustine	Gustine	3O1	37-15-38.0000N	120-57-51.3000W	0	0	4,000	0
Los Banos Muni	Los Banos	LSN	37-03-50.0000N	120-52-11.5000W	0	0	8,000	0
Merced Rgnl//Macready Field	Merced	MCE	37-17-05.1000N	120-30-50.1000W	650	125	6,750	1,252
Turlock Muni	Turlock	O15	37-29-02.3000N	120-41-50.0000W	0	0	5,200	0
San Joaquin County								
Kingdon Airpark	Lodi	O20	38-05-29.7110N	121-21-33.8150W	0	0	7,650	0
Lodi	Lodi	1O3	38-12-08.9107N	121-16-09.0992W	0	230	14,490	0
Lodi Airpark	Lodi	L53	38-05-02.7130N	121-18-58.8130W	0	0	6,100	0
New Jerusalem	Tracy	1Q4	37-40-40.0000N	121-18-04.3000W	0	0	2,000	0
Stockton Metropolitan	Stockton	SCK	37-53-39.0000N	121-14-17.9000W	428	700	22,236	468
Tracy Muni	Tracy	TCY	37-41-20.4000N	121-26-29.8000W	0	150	29,851	0
Stanislaus County								
Modesto City/Harry Sham Fld	Modesto	MOD	37-37-33.0000N	120-57-15.9000W	14	4,658	16,376	1,183
Oakdale	Oakdale	O27	37-45-22.8000N	120-48-00.7000W	0	180	4,500	0
Turlock Airpark	Turlock	9CL0	37-28-14.7660N	120-50-38.7380W	0	0	750	0
Tulare County								
Eckert Field	Strathmore	1Q1	36-09-44.6000N	119-03-02.3000W	0	0	1,926	0
Exeter	Exeter	O63	36-14-32.9000N	119-08-58.9000W	0	0	200	0
Mefford Field	Tulare	TLR	36-09-23.7000N	119-19-35.6000W	0	0	13,090	0
Porterville Muni	Porterville	PTV	36-01-46.5000N	119-03-45.8000W	0	500	21,250	0
Sequoia Field	Visalia	D86	36-26-52.5000N	119-19-07.4000W	0	0	6,000	0
Visalia Muni	Visalia	VIS	36-19-07.1000N	119-23-34.3000W	1,100	2,500	3,250	1,802
Woodlake	Woodlake	O42	36-23-55.6000N	119-06-24.5000W	0	0	6,000	2

[1]FAA Form 5010 reports airport operations, which equals the sum of the number of landings and takeoffs. This value is divided by two to get the number of LTOs. Form 5010 also reports general aviation operations as itinerant and local. These numbers are combined in this table.